



Assembleia Luso-Espanhola de Geodesia e Geofísica
Asamblea Hispano-Portuguesa de Geodesia y Geofísica

24 a 27 **Universidade de Évora**
de junho 2024 Colégio do Espírito Santo

Resumos

Resumens



organização



UNIVERSIDADE
DE ÉVORA



Comisión Española de
Geodesia y Geofísica

+ info



Titulo:

Livro de Resumos da 11ª Assembleia Luso Espanhola de Geodesia e Geofísica
Libro de Resumens: 11ª Asamblea Hispano-Portuguesa de Geodesia y Geofísica

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Junho de 2024

University of Évora
R. Romão Ramalho, 59 7000-671
Évora Portugal

Apoios:

Estimado colega,

Tenemos el placer de darle la bienvenida a la 11ª Asamblea Hispano-Portuguesa de Geodesia y Geofísica, que este año tiene como escenario a la Universidad de Évora, la segunda más antigua de Portugal, fundada en 1559 en la ciudad de Évora, cuyo centro histórico ha sido declarado Patrimonio de la Humanidad por la UNESCO.

La Asamblea Hispano-Portuguesa está considerada, desde su primera edición en 1998 en Almería, como un espacio de participación y oportunidad para las comunidades científicas de España y Portugal que se dedican a la investigación en el campo de la ciencias que estudian la Tierra.

Este año se han registrado cerca de 110 trabajos enviados, que abarcan las diversas temáticas de la Asamblea y a cuyas presentaciones tendremos la oportunidad de asistir entre el 24 y el 27 de Junio, en el Colegio do Espírito Santo.

Le deseamos una agradable estancia en Évora.

El Comité Organizador
Junio de 2024

Caro colega,

É com grande prazer que lhe damos as boas-vindas à 11ª Assembleia Luso Espanhola de Geodesia e Geofísica, que este ano tem como palco a Universidade de Évora, a segunda mais antiga de Portugal, fundada em 1559 na histórica cidade de Évora, cujo centro histórico é classificado Património Mundial da Humanidade, pela UNESCO.

A Assembleia Luso Espanhola assume-se, desde a sua primeira edição em 1998 em Almeria, como um espaço de partilha e oportunidade para as comunidades científicas de Espanha e Portugal que se dedicam à investigação no campo das ciências que estudam a Terra.

Este ano registámos cerca de 110 trabalhos submetidos, que abrangem as várias temáticas da Assembleia a cujas apresentações teremos oportunidade de assistir entre 22 e 27 de Junho no Colégio Espírito Santo.

Desejamos-lhe uma agradável estadia em Évora.

A Comissão Organizadora
Junho de 2024

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Programa



Horário	Segunda-feira - Lunes - 24 de Jun.		Terça-feira - Martes - 25 de Jun.		Quarta-feira - Miércoles - 26 de Jun.		Quinta-feira - Jueves - 27 de Jun.			
09:00-09:20	Registo Registro		Mesa Redonda Dados em Ciências da Atmosfera e Clima José Manuel Vaquero Ricardo Deus Juan Luis Guerrero Rascado Maria João Costa Auditório CES		S01 - CES-119	S08 - CES-115	S01 - CES-119	S03 CES-115		
09:20-09:40										
09:40-10:00										
10:00-10:20										
10:20-10:40	Abertura da Assembleia Inauguración de la Asamblea Auditório CES		Coffee break - CES-129		Coffee break - CES-129					
10:40-11:00										
11:00-11:20	Coffee break - Auditório CES		S02 - CES-119 S05 - CES-115		Coffee break - CES-129		Encerramento da Assembleia Clausura de la Asamblea Auditório CES			
11:20-11:40	Kinematic of the Maghrebian Thrust Belt and the Eu-Nu convergence along the Plate Boundary in North Africa Mustapha Meghraoui Elisa Buforn Mourad Bezzeghoud Auditório CES				S07 & S09 - CES-119 S03 - CES-115					
11:40-12:00										
12:00-12:20										
12:20-12:40										
12:40-13:00										
13:00-13:30	Almoço (Livre) Almuerzo (Libre)		Almoço (Livre) Almuerzo (Libre)		Almoço (Livre) Almuerzo (Libre)					
13:30-14:00										
14:00-14:30										
14:30-15:00										
15:00-15:20	S02 - CES-119	S05 - CES-115	S02 - CES-119	S05 - CES-115	S04 - CES-119					
15:20-15:40										
15:40-16:00										
16:00-16:20										
16:20-16:40										
16:40-17:00										
17:00-17:30	Poster e ice break - CES-129		Poster e ice break - CES-129							
17:30-18:00										
18:00-18:30	Visita - Torre do Sertório		Visita - Percurso das Muralhas: Harmonia e Biodiversidade							
18:30-19:00										
19:00-19:30										
19:30-20:00										
20:00					Jantar/Cena (20:00) CES-129					

Sessões / Sesiones

- S01. Geodesia / Geodesia
- S02. Sismologia e Física do Interior da Terra / Sismología y Física del Interior de la Tierra
- S03. Geomagnetismo e Aeronomia / Geomagnetismo y Aeronomía
- S04. Vulcanologia / Vulcanología
- S05. Meteorologia e Ciências Atmosféricas / Meteorología y Ciencias Atmosféricas
- S06. Oceanografia Física / Oceanografía Física
- S07. Hidrologia / Hidrología
- S08. Geofísica Aplicada / Geofísica Aplicada
- S09. Ciências Criosféricas / Ciencias de la Criosfera

Segunda-feira – Lunes – 24 de junho		
09:00-10:00	Registo Registro	Auditório CES
10:00-11:00	Abertura da Assembleia Inauguración de la Asamblea José Benito Bravo Monge Dirección General del Instituto Geográfico Nacional, Espanha Helena Ribeiro Direção-Geral do Território, Portugal Rui Salgado Diretor do Instituto de Investigação e de Formação Avançada, Universidade de Évora Mourad Bezzeghoud Coordenador do Instituto de Ciências da Terra, Universidade de Évora	Auditório CES
11:00-11:20	Coffee-break	Auditório CES
11:20-13:00	Mesa-redonda Kinematic of the Maghrebian Thrust Belt and the Eu-Nu convergence along the Plate Boundary in North Africa Mustapha Meghraoui ITES, University of Strasbourg, France Elisa Buforn Universidad Complutense de Madrid, Espanha Mourad Bezzeghoud Universidade de Évora, Portugal	Auditório CES
13:00-15:00	Pausa para almoço (Livre) Pausa almuerzo (Libre)	
15:00-17:00	Sessões/Sesiones S02 e S05	
	S02. Sismologia e Física do Interior da Terra S02. Sismología y Física del Interior de la Tierra Moderadores: Elisa Buforn & Maria Rosa Duque	Sala CES-119
15:00	Análisis de la energía radiada por terremotos intermedios y profundos en la placa de Nazca. PRO, Carmen; ESCUDERO, Lucía; TAVERA, Hernando; BUFORN, Elisa; UDÍAS, Agustín; MATTESINI, Maurizio	
15:20	Historical Tsunamis in Spain: A Detailed Look through the Updated Catalogue. ROS BERNABEU, Elena; CANTAVELLA NADAL, Juan Vicente; GONZÁLEZ GONZÁLEZ, Carlos	
15:40	Sismólogas europeas, una larga tradición. BUFORN, Elisa	
16:00	El patrimonio sismológico en el Observatorio Fabra (Barcelona) MERINO, M.T.; BATLLÓ, Josep.	
16:20	Breve Estudio de las Señales de Largos Periodos del Terremoto de Lorca de 11 de Mayo de 2011. BRAVO, JOSÉ BENITO; SOSA, Maria Graciela	
16:40	Estudando o Maciço de Monchique. DUQUE, Maria Rosa	

	S05. Meteorologia e Ciências Atmosféricas S05. Meteorología y Ciencias Atmosféricas Moderadores: José Manuel Vaquero & Vanda Salgueiro	Sala CES-115
15:00	Effect of a volcanic plume event in the local shortwave radiative forcing (Évora, Portugal). SALGUEIRO, Vanda; COSTA, Maria João; GUERRERO-RASCADO, Juan Luis; BORTOLI, Daniele	
15:20	A assinatura climática na incidência dos incêndios rurais em Portugal. PEREIRA, Mário; PARENTE, Joana; Gonçalves, Norberto; AMRAOUI, Malik	
15:40	Latest advances in the study of the non-recent climate of Extremadura and the SW of Iberia: a review. VAQUERO, José Manuel	
16:00	Avaliação do regime de seca na África Austral, com base em índices de seca e vegetação. CHIVANGULULA, Fernando Maliti; AMRAOUI, Malik; PEREIRA, Mário Gonzalez	
16:20	Modelação da piro-convecção durante mega incêndios em Portugal COUTO, Flavio T.; CAMPOS, Cátia; FILIPPI, Jean-Baptiste; BAGGIO, Roberta; PURIFICAÇÃO, Carolina; SANTOS, Filipe L. M.; SALGADO, Rui	
17:00-18:00	Sessão de pôsteres e ice break Sesión de pósters Moderadores: Miguel Potes & José Luis Guerrero-Rascado	Sala CES-129
	S02. Sismologia e Física do Interior da Terra S02. Sismología y Física del Interior de la Tierra	
	Nueva información documental sobre los terremotos de 1855 y 1902 en la Región de Murcia y su asociación probable con la falla de Carrascoy GARCÍA-MAYORDOMO, Julián; MURPHY, Patrick; YAZDI, Pouye; MARTÍN-BANDA, Raquel; RUBIO SÁNCHEZ-AGUILILLA, Félix Manuel.	
	Estudio de posibles emplazamientos para el despliegue de estaciones sísmicas mediante el análisis de la densidad espectral de potencia BENABDELOUED, Boualem Youcef Nassim; JORNET-MONTEVERDE, Julio Antonio; GALIANA-MERINO, Juan Jose; DELGADO-MARCHAL, José; MOLINA-PALACIOS, Sergio; SOLER-LLORENS, Juan Luis	
	Preenchendo o mapa do fluxo de calor em Portugal continental DUQUE, Maria Rosa	
	Análisis de la aportación de las técnicas geoespaciales y la inteligencia artificial en el estudio de la exposición sísmica en ciudades prioritarias de Centroamérica y Caribe RODRÍGUEZ-SAIZ, Javier; UREÑA-PLIEGO, Miguel; GONZALEZ-RODRIGO, Beatriz; REJAS-AYUGA, Juan Gregorio; GARCÍA-LANCHARES, Carlos; MARCHAMALO-SACRISTAN, Miguel.	
	S05. Meteorologia e Ciências Atmosféricas S05. Meteorología y Ciencias Atmosféricas	
	Eventos extremos compostos quentes e secos no Mediterrâneo LOURENÇO, André Correia; RUSSO, Ana; BENTO, Virgílio A.; GEIRINHAS, João Lucas	
	Adaptation, characterization and calibration of a low-cost multi-channel sensor to measure solar radiation BOGEAT, José A.; GONZÁLEZ, Carmen; VILAPLANA, José M.; MEDINA, Jonathan; PIEDEHIERRO, Ana A.	
	Preliminary atmospheric boundary layer height determination at two rural locations in Southern Spain Jesús ABRIL-GAGO, Juana ANDÚJAR-MAQUEDA, Sergio ARANDA-BARRANCO, Alberto CAZORLA, Lucas ALADOS-ARBOLEDAS, Juan Luis GUERRERO-RASCADO	
	Influência do acoplamento temperatura-humidade na ocorrência de eventos compostos de seca e calor extremo na América do Sul: análise histórica e perspectivas futuras	

	GEIRINHAS, João L.; RUSSO, Ana; LIBONATI, Renata; MIRALLES, Diego G.; LIMA, Daniela C.A.; RIBEIRO, Andreia F.S.; TRIGO, Ricardo M.
	Integrated monitoring of the complex greenhouse gases and aerosol particle exchanges between atmosphere, ecosystem and vadose zone in drylands: the INTEGRATYON3 project GUERRERO-RASCADO, Juan Luis; SERRANO-ORTIZ, Penélope; DOMINGO, Francisco; KOWALSKI, Andrew S.; SÁNCHEZ-CAÑETE, Enrique P.; CARIÑANOS, Paloma; OYONARTE, Cecilio; VILLAGARCIA SAIZ, Luis; SOLÉ BENET, Albert; LÁZARO, Roberto; DEL BARRIO ESCRIBANO, Gabriel; COSTA, Maria João; ANTUNES, Célia; ARANDA-BARRANCO, Sergio; AGUIRRE-GARCÍA, Sergio David; ABRIL-GAGO, Jesús; ANDÚJAR MAQUEDA, Juana; AGEA PLAZA, Daniel; MOLINERO, Alberto; MARTÍN-GARCÍA, Juan Manuel; ECHEVERRIA-MARTÍN, Enrique; CABRERA CARRILLO, Germán; ORTIZ-AMEZCUA, Pablo; LYAMANI, Hassan; RUBIO, Consuelo; ALCALÁ, Francisco; GUERRERO BERENGUEL, Montserrat; PÉREZ-PRIEGO, Óscar; GARCÍA GARCÍA, Mónica; LÓPEZ, Clement.
	A avaliação e o mapeamento da Irradiância Solar em Timor-Leste com dados ERA5, MERRA2 e SOLCAST SARMENTO, Nelson; POTES, Miguel; CANHOTO, Paulo.
	Air pollutants modelling and forecast using in situ and CAMS data in Portugal BRITO, André; RUSSO, Ana; DURÃO, Rita
	Space-time characterization of fire-related air pollutants over Portugal SIMÕES, Madalena; GOUVEIA, Célia; DURÃO, Rita
	S03. Geomagnetismo e Aeronomia S03. Geomagnetismo y Aeronomía
	Caracterización de las variaciones geomagnéticas e ionosféricas en la Isla Livingston (Antártida) TORTA, J. Miquel; MARSAL, Santiago; SOLÉ, J. Germán; IBAÑEZ, Miguel; CID, Òscar; SEGARRA, Antoni; CURTO, Juan José
	Estudio sobre efectos en la ionosfera de la erupción del volcán Tonga del 15 de enero de 2022 RODRIGUEZ-DÍAZ, Sara; CAMPUZANO, Saioa A.; MIGOYA-ORUÉ, Yenca; RADICELLA, Sandro M; RODRIGUEZ-CADEROT, Gracia; HERRAIZ-SARACHAGA, Miguel.
18:00	Visita guiada – Torre do Sertório Moderadores: Vanda Salgueiro & Miguel Potes Ponto de encontro: Claustro principal junto à sala CES-115 Punto de encuentro: Claustro principal al lado de la sala CES-115

Terça-feira – Martes – 25 de junho		
09:00-10:40	Mesa-redonda Dados em Ciências da Atmosfera e Clima José Manuel Vaquero Universidad de Extremadura, Espanha Ricardo Deus IPMA, Portugal Juan Luis Guerrero Rascado Universidad de Granada, Espanha Maria João Costa Universidade de Évora, Portugal	Auditório CES
10:40	Coffee-break	Sala CES-129
11:00-13:00	Sessões/Sesiones S02 e S05	
	S02. Sismologia e Física do Interior da Terra S02. Sismología y Física del Interior de la Tierra Moderadores: Josep Batlló & José Borges	Sala CES-119
11:00	Estimación de la fuente sísmica del terremoto de Arenas del Rey de 1884 a partir de la distribución de intensidades BUFORN, Elisa; FERNANDEZ-FRAILE, Javier; CESCA, Simone; SANZ DE GALDEANO, Carlos; MARTÍNEZ-SOLARES, José Manuel; UDÍAS, Agustín; MATTESINI, Maurizio; MÁRQUEZ, David	
11:20	Sistema de Alerta Sísmica Temprana en la Región Ibero-Mogrebí: Actualidad y Perspectivas Futuras ESCUADERO, Lucía; ZOLLO, Aldo; MATTESINI, Maurizio; BUFORN, Elisa.	
11:40	Caracterização dos níveis de ruído sísmico registados a partir de uma rede temporária de banda larga implantada a norte de Évora WACHILALA, Piedade; BORGES, José; CALDEIRA, Bento; BEZZEGHOUD, Mourad	
12:00	Site Effects Mapping, Soil Characterization and Resonance Effects: Implications for Infrastructure Development in Algiers and the Mitidja Basin, Algeria Souhila Chabane, Mourad Bezzeghoud, Djamel Machane, Saci Kermani, Mouhaydine Tlemçani	
12:20	Estudo térmico acerca da região Vendas Novas-Arraiolos-Ciborro DUQUE, Maria Rosa	
12:40	Una historia tentativa y patrimonio preservado de una estación sísmica casi olvidada en Girona (NE Península Ibérica) BATLLÓ, Josep; MERINO, Maria Teresa.	
	S05. Meteorologia e Ciências Atmosféricas S05. Meteorología y Ciencias Atmosféricas Moderadores: Flávio Couto & Alejandro Aparicio	Sala CES-115
11:00	Deployment of UV and VIS-NIR Avantes AvaSpec-2048 for spectral measurements of direct and global solar radiation in Badajoz (Spain) FLORES, Alba; SERRANO, Antonio; SÁNCHEZ-HERNÁNDEZ, Guadalupe; VILAPLANA, José Manuel; CANCELLO, María Luisa.	
11:20	Comparison of UV Avantes AvaSpec-2048 with Brewer #150 along various campaigns FLORES, Alba; SERRANO, Antonio; VILAPLANA, José Manuel.	
11:40	Advances in the study of sunshine duration series in Portugal APARICIO, A. J. P.; TOVAR-HERNÁNDEZ, C. V.; CARRASCO, V. M. S.; COSTA, M. J.; ANTÓN, M.	
12:00	Quantifying the uncertainty in UV spectral measurements using the Monte Carlo methodology GONZÁLEZ, Carmen; VILAPLANA, José Manuel; SERRANO, Antonio.	

12:20	Aplicação da modelação atmosférica no estudo de incêndios florestais no Sul de Portugal PURIFICAÇÃO, Carolina; CAMPOS, Cátia; HENKES, Alice; KARTSIOS, Stergios; COUTO, Flavio T.
12:40	Associações entre Poluentes Atmosféricos, Fatores Meteorológicos e Mortalidade Cardiorrespiratória nas Áreas Metropolitanas Portuguesas DE SOUZA FERNANDES DUARTE, Ediclê; LUCIO, Paulo Sérgio; HENRIQUES-RODRIGUES, Lígia; COSTA, Maria João.
13:00-15:00	Pausa para almoço (Livre) Pausa almuerzo (Libre)
15:00-17:00	Sessões/Sesiones S02 e S05
	S02. Sismologia e Física do Interior da Terra Sala CES-119 S02. Sismología y Física del Interior de la Tierra Moderadores: Verónica Antunes & Bento Caldeira
15:00	Seismic Monitoring of Deep Geothermal projects in Switzerland: Network performance analysis and ground-truth test ANTUNES, Verónica; TOLEDO, Tania; SIMON, Verena; KRAFT, Toni.
15:20	Registros sísmicos del meteorito Traspensa TAPIA, Mar; ANDRADE, Manuel.
15:40	Detección automática y caracterización de desprendimientos usando datos sísmicos continuos de una única estación. Validación conjunta con LiDAR y fotogrametría TAPIA, Mar; GUINAU, Marta; TELLETXE, Bixen; MARTIN, Jana; MENESES, Francesc; ROYAN, Manuel; BLANCH, Xabier; ABELLAN, Antonio; GARCIA-SELLÉS, David; KHAZARADZE, Giorgi; SURIÑACH, Emma; VILAPLANA, Joan Manuel.
16:00	Modelo de rotura do sismo de Marrocos de 8 de Setembro de 2023 (Mw6.8) CALDEIRA, Bento; BUFORN, Elisa; OLIVEIRA, Rui; BORGES, José; HAMAK, Ines; BEZZEGHOUD, Mourad; PRO Carmen
16:20	Enxame Sísmico na Ilha de São Jorge, Açores no contexto de uma Intrusão magmática ocorrida em março de 2022 BORGES, José; CALDEIRA, Bento; OLIVEIRA, Rui; BEZZEGHOUD, Mourad; CARRILHO, Fernando; HAMAK, Ines; MOULIIN, Maëlys; CARTAXO, J. P.
	S05. Meteorologia e Ciências Atmosféricas Sala CES-115 S05. Meteorología y Ciencias Atmosféricas Moderadores: Juan Luis Guerrero-Rascado & Miguel Potes
15:00	Diseño de la red básica de observación regional en Europa (RBON) para la implementación robusta de sistemas de alerta temprana en todos los países de la AR VI (OMM). BELDA ESPLUGUES, Fernando.
15:20	Plan de Implementación del sistema WIGOS (WMO Integrated Global Observing System) en España BELDA ESPLUGUES, Fernando.
15:40	Análise do combustível da vegetação usando uma abordagem de detecção remota e modelação SANTOS, Filipe L.M.; COUTO, Flavio T.; DIAS, Susana S.; MONTEIRO, Maria J.; RIBEIRO, Nuno A.; SALGADO, Rui.
16:00	Avaliação das previsões de descargas elétricas do ECMWF no contexto dos incêndios florestais CAMPOS, Cátia; COUTO, Flavio T.; SANTOS, Filipe L. M.; RIO, João; FERREIRA, Teresa; PURIFICAÇÃO, Carolina; SALGADO, Rui.
17:00-18:00	Sessão de pôsteres e ice break Sala CES-129 Sesión de pósters y ice break Moderadores: Maria Conceição Neves & Rui Oliveira
	S01. Geodesia
	Acercando los productos geodésicos al público: base de datos y visualizador de productos geodésicos del Instituto Geográfico Nacional de España

	ROSILLO, Andrea; AZCUE, Esther; LARA, Sonia; SÁNCHEZ-SOBRINO, Jose Antonio
	Monitoring of hydraulic infrastructures using satellite radar interferometry: SIAGUA project RUIZ-ARMENTEROS, Antonio Miguel; MARCHAMALO-SACRISTÁN, Miguel; LAMAS-FERNÁNDEZ, Francisco; HERNÁNDEZ-CABEZUDO, Álvaro; FERNÁNDEZ-LANDA, Alfredo; DELGADO-BLASCO, José Manuel; BAKON, Matus; LAZECKY, Milan; PERISSIN, Daniele; PAPCO, Juraj; CORRAL, Gonzalo; MESA-MINGORANCE, José Luis; GARCÍA-BALBOA, José Luis; DA PENHA PACHECO, Admilson; JURADO-RODRIGUEZ, Juan Manuel; SOUSA, Joaquim J.
	S03. Geomagnetismo e Aeronomia S03. Geomagnetismo y Aeronomía
	Recuperación y procesamiento de datos de levantamientos aeromagnéticos de la Península Ibérica, zonas marítimas próximas e Islas Canarias NÚÑEZ, Alberto; PINTOR, Pablo; TORDESILLAS, José Manuel.
	Adquisición de datos geoelectrónicos en el Observatorio Geofísico de San Pablo de los Montes (Toledo) NÚÑEZ, Alberto; VALLE, José Luis; AGUADO, José; MOLINERO, Iván.
	S04. Vulcanología S04. Vulcanología
	Exploración del sistema magmático en los volcanes submarinos Edificio C, Three Sisters, Orca y Gebra Seamount (Estrecho de Bransfield, Antártida) POLO-SÁNCHEZ, Antonio; ÁLVAREZ-VALERO, Antonio; GARCÍA-ARIAS, Marcos; GEYER, Adelina; CARACASI, Antonio; BERTEA, Esteban S.; PETRELLI, Maurizio.
	Trazando las escalas de tiempo de pequeñas erupciones explosivas para entender los ciclos de caldera en Santorini (Grecia) POLO-SÁNCHEZ, Antonio; FLAHERTY, Taya; HERVÉ, Garance; DRUITT, Tim; FABBRO, Gareth N.; NOMIKOU, Paraskevi; BALCONE-BOISSARD, Hélène.
	Exploración y unificación de la nomenclatura del vulcanismo submarino en el Estrecho de Bransfield (Antártida). POLO-SÁNCHEZ, Antonio; GEYER, Adelina; ÁLVAREZ-VALERO, Antonio; SCHAMUELLS, Nia; CARACASI, Antonio.
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	Estudo geoelétrico de círculos de pedra junto à Estação Antártica Coreana King Sejong, Ilha Rei Jorge, Antártida Marítima TERESO, Vítor; CORREIA, António; PINA, Pedro.
	Estudo geoelétrico no sítio POND junto à Estação Antártica Coreana King Sejong, Ilha Rei Jorge, Antártida Marítima TERESO, Vítor; CORREIA, António.
18:00	Visita guiada – Percurso das Muralhas: Harmonia e Biodiversidade Moderadores: Carlos Pinto Gomes & Mauro Raposo Ponto de encontro: Claustro principal junto à sala 115 Trazer calçado confortável, água e chapéu. Punto de encuentro: Claustro principal junto a la sala 115 Llevar calzado cómodo, agua y sombrero.

Quarta-feira – Miércoles – 26 de junho	
09:00-11:00	Sessões/Sesiones S01 e S08
	S01. Geodesia Sala CES-119 Moderadores: Helena Ribeiro & José Sobrino
09:00	Enabling the integrated use of data, data products, and facilities from the solid Earth science: The EPOS-ES Node SÁNCHEZ-SOBRINO, J.A.; ANIEL-QUIROGA, I.; AZOR, A.; CANTAVELLA, J.V.; CURTO, J.J.; DOMÍNGUEZ-CERDEÑA, I.; FERNÁNDEZ-TORRES, J.; FERNÁNDEZ-TURIEL, J.L.; HERNÁNDEZ MACHADO, J.R.; MACÍAS, J.; NÚÑEZ, D.; DORADO-GARCÍA, O.; GEYER, A.; CARBONEL, R.
09:20	High-resolution coastal morphology: evolution of a sand-spit monitoring program BIO, Ana; MAGALHÃES, Améric; PINHAL, André; IGLESIAS, Isabel; BASTOS, Luísa; GONÇALVES, José Alberto
09:40	RAEGE Analysis Group: A comprehensive evaluation of RAEGE's future geodetic capabilities AZCUE, Esther; KARBON, María; BELDA, Santiago; MOREIRA, Mariana
10:00	Renovação da Rede Nacional de Estações Permanentes GNSS – ReNEP RIBEIRO, Helena; BERNARDES, Ana; MEDEIRO, Ana; PATRÍCIO, Paulo
10:20	The United Nations Global Geodetic Centre of Excellence: objectives, activities and synergies with the Global Geodetic Observing System RODRÍGUEZ, José; BROWN, Nicholas; DOSTAL, Jan; JØRGENSEN, Anne; KOWAL, Sarah; ANGERMANN, Detlef; LIDBERG, Martin; RIDDELL, Anna; SÁNCHEZ, Laura; SEHNAL, Martin
10:40	Satellite-Derived Estimation of Global Geostrophic Currents with High Spatial Resolution VARGAS-ALEMAÑY, Juan Adrián; Vigo Aguiar, Isabel; García García, David
	S08. Geofísica Aplicada Sala CES-115 Moderadores: Rui Oliveira & Carmen Pro
09:00	La red GNSS del Real Instituto y Observatorio de la Armada: Estado actual y resultados. RODRIGUEZ COLLANTES, David; BLANCO HERNANDEZ, Abel.
09:20	Resultados Preliminares da Aplicação da Muografia na Mina do Lousal TEIXEIRA, Pedro; AFONSO, Luís; ALEXANDRE, Isabel; ANDRIGA, Sofia; ASSIS, Pedro; BEZZEGHOUD, Mourad; BLANCO, Alberto; BORGES, José; CALDEIRA, Bento; CAZON, Lorenzo; DUARTE, Magda; HAMAK, Ines; LOPES, Luís; MATOS, João; OLIVEIRA, Rui; PIMENTA, Mário; SARMENTO, Raul; SILVA, Jorge; TOMÉ, Bernardo.
09:40	Estudio mediante tomografía eléctrica y LiDAR de la dinámica geoarqueológica en el castro de Villasviejas del Tamuja (Botija, Cáceres) DE TENA, M ^a Teresa; PRO, Carmen; MAYORAL, Victorino; QUIRÓS, Elia.
10:00	Three-dimensional seismic tomography in Lousal Mine HAMAK, Ines; TEIXEIRA, Pedro; AFONSO, Luís; ALEXANDRE, Isabel; ANDRIGA, Sofia; ASSIS, Pedro; BEZZEGHOUD, Mourad; BLANCO, Alberto; BORGES, José; CALDEIRA, Bento; CAZON, Lorenzo; COSTA, João; DUARTE, Magda; FERREIRA, Francisco; FIGUEIRA, Josué; KOULAKOV, Ivan; LOPES, Luís; MATOS, João; OLIVEIRA, Rui; PAIS, Vanessa; PIMENTA, Mário; SARMENTO, Raul; TOMÉ, Bernardo.
10:20	Instrumento de gestão de áreas contaminadas por metais combinando dados de Química Ambiental, Geofísica, Detecção Remota, Inteligência Artificial e Gestão OLIVEIRA, Rui J.; CALDEIRA, Bento; PALMA, Patrícia; COSTA, Maria J.; FIALHO, Ana.
11:00-11:20	Coffee-break Sala CES-129
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	S07. Hidrologia/Hidrología Sala CES-119 S09. Ciências Criosféricas/Ciencias de la Criosfera Moderadores: Miguel Potes
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11:40	Ground surface temperature-derived Growing Degree Days in Livingston and Deceptions Islands, Antarctica DE PABLO, Miguel Ángel
12:00	Testing ultrasonic sensors and miniature logger to monitor snow cover thickness in Antarctica. DE PABLO, Miguel Ángel; ROSADO, Belén.
12:20	Retrieving snowpack properties from temperature signals at different heights in Antarctica DURÁN, Luis; MARTÍNEZ-FORONDA Alejandro; GARCÍA-MAROTO Diego; DE PABLO Miguel Ángel.
	S03. Geomagnetismo e Aeronomia Sala CES-115 S03. Geomagnetismo y Aeronomía Moderadores: Anna Morozova & José Manuel Tordesillas
11:20	Mapa de Declinaciones Magnéticas de la Península Ibérica y las Islas Baleares de la época 2020.0 NÚÑEZ, Alberto; TORDESILLAS, José Manuel.
11:40	Spatial total electron content gradients for Iberian Peninsula and Portuguese and Spanish archipelagos during geomagnetically storm of 2023 MOROZOVA, Anna; BARATA, Teresa.
12:00	Información de la declinación geomagnética extraída de los trabajos topográficos de deslindes de municipios realizados por el IGN en el año 1871 TORDESILLAS, Jose Manuel; PAVÓN-CARRASCO, F. Javier; ANQUELA, Ana Belén; CAMACHO, Elena; LÓPEZ-MUGA, Marina; NÚÑEZ, Alberto.
12:20	Predicción del Ciclo Solar 26 mediante Parámetros Precursores Solares/Geomagnéticos, Análisis Espectral y Técnicas de Machine Learning RODRÍGUEZ, José Víctor; SÁNCHEZ-CARRASCO, Víctor-Manuel; RODRÍGUEZ-RODRÍGUEZ, Ignacio; PÉREZ-APARICIO, Alejandro-Jesús; VAQUERO, José-Manuel.
12:40-15:00	Pausa para almoço (Livre) Pausa almuerzo (Libre)
15:00-17:00	S04. Vulcanologia Sala CES-119 S04. Vulcanología Moderadores: Laura Cañada & José Borges
15:00	Computing numerical lava flow scenarios around the onset of a monogenetic eruption: the case of La Palma Island 2021 eruption FELPETO, Alicia; IGN Volcano Monitoring Team.
15:20	Data and service management of the European volcanological community by the Volcano Observations Thematic Core Service (EPOS-ERIC) SPAMPINATO, Letizia; DOMÍNGUEZ-CERDEÑA, Itahiza; INDOVINA, Enrico; GEYER, Adelina; JÚLÍUSDÓTTIR, Ríkey; REITANO, Danilo; PUGLISI, Giuseppe; NAVE, Rosella; SANTANGELO, Ileana; VOGFJÖRD, Kristín; LABAZUY, Philippe; CACCIOLA, Lucia; GUEHENNEUX, Yannick; KOMOROWSKI, Jean-Christophe; SAUREL, Jean-Marie.
15:40	Avances en el análisis de series temporales GNSS para la vigilancia volcánica en las Islas Canarias GARCÍA-CAÑADA, Laura.
16:00	Integración de un análisis sísmico automatizado y resultados GNSS para vigilancia volcánica: aplicación a la reactivación volcano-tectónica de São Jorge en 2022 SUAREZ, Eduardo D.; GARCÍA-CAÑADA, Laura; MELETIDIS, Stavros; DOMÍNGUEZ-CERDEÑA, Itahiza; DEL FRESNO, Carmen; PERDIGUER-LOPEZ, Raquel; POZATEK, Martyna J.
16:20	Evaluación de riesgos poseruptivos: el caso de la erupción de 2021 en la isla de La Palma (Canarias, España)Assessing post-eruptive hazards: the case of 2021 eruption in La Palma Island

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	S01. Geodesia Moderadores: Bento Caldeira & José Sobrino	Sala CES-119
09:00	Nueva realización del marco de referencia REGCAN95 para Canarias SÁNCHEZ-SOBRINO, Jose Antonio; VALDÉS PÉREZ DE VARGAS, Marcelino; GONZÁLEZ HIDALGO, Miguel; RODRÍGUEZ SUÁREZ, Juan Pedro	
09:20	Spanish contribution to the update of the Earth's rotation theory and precession-nutation models José M. FERRÁNDIZ, Alberto ESCAPA, Maria KARBON, Santiago BELDA, Juan GETINO, Tomás BAENAS	
09:40	Feature Selection and Deep Learning for Simultaneous Forecasting of Celestial Pole Offset (CPO) and Polar Motion (PM) GUESSOUM, Sonia; BELDA, Santiago; KARBON, Maria; FERRANDIZ, Jose Manuel; SCHUH, Harald; HEINKELMANN, Robert; SADEGH, Modiri	
10:00	The role of VLBI in modern geodesy Maria KARBON; S. BELDA; E. AZCUE; M. MOREIRA; A. ESCAPA; J.M. FERRÁNDIZ	
10:20	Advancing towards the creation of a new Geodetic Prediction Center S. BELDA, Maria KARBON, S. GUESSOUM, E. AZCUE, L.D. DEL NIDO HERRANZ, M. MOREIRA, J.C. RODRÍGUEZ, A. ESCAPA and J.M. FERRÁNDIZ	
	S03. Geomagnetismo e Aeronomia S03. Geomagnetismo y Aeronomía Moderadores: Fernando Pinheiro & José Manuel Tordesillas	Sala CES-115
09:00	Validación de la modelización de corrientes inducidas geomagnéticamente en la red eléctrica española mediante mediciones magnetométricas diferenciales TORTA, J. Miquel; MARSAL, Santiago; CURTO, Juan José; IBAÑEZ, Miguel; CID, Òscar; MARCUELLO, Alex; MARTÍ, Anna.	
09:20	Análise de séries temporais para estudo de viabilidade da instalação de um observatório magnético no Centro Meteorológico de Viseu (colaboração OGAUC/IPMA) RIBEIRO, Paulo; PAIS, Alexandra; NERES, Marta; VINICIUS, Marcos; PINHEIRO; FERNANDO, J.G.	
09:40	How differences in Earth's subsurface affect Geomagnetic Induced Currents estimations ALVES RIBEIRO, Joana; PINHEIRO, Fernando J. G.; SANTOS, Rute; PAIS, Maria Alexandra.	
10:00	Spanish candidate for the Definitive Geomagnetic Reference Field (DGRF) for 2020 SERRANO, Mario; PAVÓN-CARRASCO, F. Javier; CAMPUZANO, Saioa A.; MARSAL, Santiago; TORTA, J. Miquel; TORDESILLAS, J. Manuel; FIZ, Julian.	
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Oceanografía Física

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Resumos

Mesas redondas

Kinematic of the Maghrebian Thrust Belt and the Eu-Nu convergence along the Plate Boundary in North Africa

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SUMMARY

The Maghrebian Atlas Mountains in North Africa results from the Nubia – Eurasia (Nu-Eu) plate convergence in the western Mediterranean. In this study, we examine the correlation between the thrust belt and adjacent Sahara Platform domains in the light of new GPS data. The diffuse Nu-Eu plate boundary originally limited to the North Africa strip parallel to the Mediterranean coastline, extends further south to include the Maghrebides tectonic blocks (Rif and Tell Atlas, Middle Atlas, High Plateau, and High and Sahara Atlas) until the southern Sahara Atlas suture zone. The seismotectonic framework and GPS results indicate a transpressive tectonic system results made of large East-West trending right-lateral shear zones, and NE-SW thrust faulting. The strain accommodation shows westward anticlockwise rotations with an average $3^\circ/\text{Myr}$ from NNW-SSW to WNW-ESE consistent with paleomagnetic results along the Tell Atlas. The crustal deformation is documented along the tectonic blocks of the Atlas Mountains and Sahara Platform pointing out the displacement field with strain partitioning largely controlled by the Nu-Eu plate motions.

Geoscience data: insights from the past, lessons for the future

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SUMMARY

We are currently experiencing a thrilling revolution in Geosciences due to unprecedented advancements in data acquisition and processing. This is particularly striking given the relatively modest theoretical advances of our time. In this talk, we will discuss several historical examples to highlight relevant ideas that can help us navigate this new revolution in various Geoscience fields. Specifically, we will examine (i) the geomagnetic data collected by Don João de Castro in the first half of the 16th century, (ii) the meteorological data from Jovellanos (1806), (iii) the first space weather forecast in history (Spain, 1818), and (iv) some cases of massive recovery of meteorological data in Iberia..

S.01 Geodesia / Geodesia

Enabling the integrated use of data, data products, and facilities from the solid Earth science: The EPOS-ES Node

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SUMMARY

On October 28th 2018 the European Plate Observing System, EPOS (www.epos-eu.org) consolidated the legal status of European Research Infrastructure Consortium (ERIC). EPOS is a multidisciplinary, distributed research e-infrastructure that facilitates the integrated use of data, data products, software and services from the solid Earth science field in Europe. EPOS is an asset for the development of the EU's open science policies in the field by ensuring the dissemination of data and knowledge under the FAIR principles as soon as it is available using digital and collaborative technology enabling the knowledge-sharing and cooperation between different scientific disciplines, infrastructures and international organizations with the aim of improving the quality, efficiency and responsiveness of research. EPOS is the unique and exclusive infrastructure devoted to multidisciplinary and global research in Earth Sciences. The EU consortia consist of 19 member countries (including Portugal and Spain), 1 observer and, 6 more which are included in the integration plan. EPOS is a distributed infrastructure with headquarters base at the Instituto Nazionale di Geofisica e Vulcanologia (INGV) in Rome. The Central Hub (ICS-C) is hosted in the United Kingdom (BGS) and France (BRGM) with technical operational support from Denmark (GEUS). Furthermore, each member country has developed its own node. Thus, since May 2023, the Spanish node: EPOS-Spain (www.epos-es.org) seeks, among other actions to: (i) implement and consolidate Spanish contribution to the 10 thematic services (TCS); (ii) strengthen relationships with other international organizations and programs; (iii) act as information point regarding research initiatives carried out at the European level; (iv) promote the use of the data-lake and EPOS-portal with research and training programs; and (v) enhance the digital services based at national center contributing to EPOS. Additionally, EPOS-Spain aims to strengthen the relevance and of Spanish Earth Science Research community. (Support: EPOS-SpN RED2022-134516-E project funded by the MCIN/AEI/10.13039/501100011033).

High-resolution coastal morphology: evolution of a sand-spit monitoring program

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SUMMARY

The evolution in positioning and navigation through satellite systems, and in special the developments of Real-Time Kinematic (RTK) survey methodologies, have revolutionized the way coastal areas are monitored. In Portugal, these methods started being used in the late 90's, with the installation of permanent stations for the post-processing of positioning data. In 2001, a sand-spit monitoring program was put in place to assess the morphodynamics of the estuarine sand spit, at the outlet of the Douro river, in northern Portugal. Monitoring started with four surveys per year, before the extension and construction of breakwaters, changing to bi-annual surveys when the spit settled into a new and less dynamic shape. Through the more than two decades of monitoring, the survey technologies and methods developed from RTK surveys on foot, to the use of terrestrial mobile mapping vehicles and of unoccupied aerial vehicles (UAV). The resulting digital elevation models (DEM) from the terrestrial RTK methods and from the UAV surveys, based on RGB imagery and photogrammetry, are presented and compared. Near-simultaneous terrestrial and UAV surveys allowed direct comparison between the terrestrial mobile mapping and the photogrammetric UAV mapping, with the main differences being: the study-area coverage, which can be considered complete for the aerial survey, yet limited to tracks and requiring interpolation between tracks for the terrestrial survey; the capacity of the terrestrial methods to survey the ground level without interference of vegetation or trees, which affect the UAV-survey DEM; and the direct contact with the ground of the terrestrial system, which is informative but also invasive. Survey systems applicability, resolution, accuracy and efficiency are discussed.

Grupo de análisis RAEGE: Análisis exhaustivo del potencial geodésico de la red RAEGE.

RAEGE Analysis Group: A comprehensive evaluation of RAEGE's future geodetic capabilities

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RESUMEN

RAEGE (Red Atlántica de Estaciones Geodinámicas y Espaciales / Rede Atlântica de Estações Geodinâmicas e Espaciais) es un proyecto estratégico centrado en el establecimiento de cuatro estaciones multitécnicas para fortalecer la infraestructura geodésica en España y Portugal, y contribuir al Sistema Global de Observación Geodésica (GGOS, Global Geodetic Observing System). Este proyecto no solo tiene como objetivo desarrollar la instrumentación geodésica en los observatorios, sino que también fomenta el avance en el análisis VLBI y la combinación de técnicas geodésicas a través de la formación de un grupo de análisis RAEGE especializado.

Entre las actividades del grupo de análisis RAEGE, se está realizando una evaluación exhaustiva de las futuras capacidades geodésicas de RAEGE a través de simulaciones de observaciones. Actualmente solo dos de las cuatro estaciones, Yebes y Santa María, están operativas. Se han realizado simulaciones para explorar todo el potencial de la red una vez que las estaciones de Gran Canaria y Flores estén operativas. En esta contribución se presenta una introducción al proyecto y a las actividades del grupo de análisis RAEGE, así como los primeros resultados de las simulaciones VLBI.

SUMMARY

RAEGE (Red Atlántica de Estaciones Geodinámicas y Espaciales / Rede Atlântica de Estações Geodinâmicas e Espaciais) is a strategic project focused on establishing four multi-technique stations to strengthen the geodetic infrastructure within Spain and Portugal, and to contribute to the Global Geodetic Observing System. This project not only aims to amplify the scope of geodetic observations within the observatories but also fosters to strengthen the VLBI analysis and multi-technique combination through the formation of a dedicated RAEGE analysis group.

A comprehensive evaluation of RAEGE's future geodetic capabilities is underway through simulations of observations. Currently only two of the four stations, Yebes and Santa María are operational. Several simulations have been conducted to explore the full network's potential, once Gran Canaria and Flores stations are operative. An introduction to the project, the RAEGE analysis group activities and first results of VLBI simulations are presented.

Renovação da Rede Nacional de Estações Permanentes GNSS - ReNEP

Innovation of the Portuguese CORS Network - ReNEP

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RESUMO

A Direção-Geral do Território (DGT) é a entidade responsável pelo estabelecimento e manutenção da Infraestrutura Geodésica Nacional. A Rede Nacional de Estações Permanentes GNSS (Global Navigation Satellite System) – ReNEP, é constituída por 47 Estações Permanentes (EP), que garantem uma cobertura eficaz do território Português para trabalhos de posicionamento em tempo-real e para a definição do Referencial Geodésico Nacional.

Os dados de 6 destas EP contribuem para a definição dos sistemas de referência regionais, pertencendo à rede EPN (EUREF Permanent Network), e 3 destas pertencem também à rede IGS (International GNSS Service), contribuindo para a definição do referencial global. Os dados destas estações contribuem também para a rede EPOS (European Plate Observing System) e para a densificação da EPN.

No esforço contínuo de modernização e prestação de um serviço de qualidade, a DGT adquiriu 28 novos equipamentos GNSS (recetores e antenas) que permitem a receção dos sinais das constelações GPS, GLONASS, GALILEO e BEIDOU, e procedeu também à atualização do programa de gestão da rede, que permite o processamento e difusão de correções diferenciais destas 4 constelações, aumentando deste modo a precisão do posicionamento em tempo-real (RTK) e em pós-processamento.

A instalação das novas estações implicou, também, a manutenção dos suportes das antenas e a mudança do respetivo cabo de antena. Em algumas das estações a fixação destas estruturas não garantia a estabilidade necessária e espetável, havendo a necessidade de proceder à sua substituição e/ou realocização.

Prevê-se que até ao final de 2024 todas as estações da ReNEP, da responsabilidade da DGT, irão rececionar e disponibilizar as correções diferenciais das constelações GPS, GLONASS e GALILEO, com 32 destas EP a disponibilizarem ainda o sinal da constelação BEIDOU. Neste trabalho pretendemos apresentar os trabalhos realizados para melhorar a qualidade dos dados da ReNEP.

SUMMARY

The Directorate-General for the Territory (DGT) is the entity responsible for establishing and maintaining the National Geodetic Infrastructure. The GNSS CORS Network of DGT – ReNEP, already complete, consists of 42 stations on Portugal mainland, 2 in the Autonomous Region of Azores and 1 in the Autonomous Region of Madeira, being enough for an effective coverage of the national territory.

It is important to highlight that some of these stations belong to international networks of major relevance for the definition of regional and global reference systems, i.e., 6 are part of the EPN (EUREF Permanent Network), 3 of which also belong to the IGS network (International GNSS Service). The data from ReNEP stations contribute for the EPN Densification network and for the European Plate Observing System (EPOS) network.

In the continuous improvement of the service provided to the community, DGT acquired 28 multi-constellation GNSS stations (receiver and antenna) which allow the reception of signals from GPS, GLONASS, GALILEO and BEIDOU

constellations. The network management program was also updated, which allows the processing and dissemination of differential corrections from these 4 constellations, thus increasing the accuracy of positioning in real-time kinematic (RTK) and post-processing.

The installation of the new stations also involved the maintenance of the antenna supports and the change of the respective antenna cable. In some stations, the fixing of these structures did not guarantee the necessary and expected stability, so there was a need to replace and/or relocate them.

Thus, by the end of 2024, all DGT stations will receive and make available differential corrections from GPS, GLONASS and GALILEO constellations, with 32 of these stations also providing signal from BEIDOU. In this paper, we intend to present the work carried out to improve the quality of ReNEP data.

The United Nations Global Geodetic Centre of Excellence: objectives, activities and synergies with the Global Geodetic Observing System

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SUMMARY

The United Nations Global Geodetic Centre of Excellence (UN-GGCE) was officially opened in Bonn, Germany, in March 2023. Its primary objective is to work with Member States and partners to strengthen political support for the global geodesy supply chain. This consists in a large assortment of ground and space-based networks and sensors, data and analysis centres, and all the human resources required to operate this global infrastructure. The products and services thus provided by the geodetic community, which underpin many critical sectors of our economies, depend on the funding provided by national institutions, and are coordinated through the scientific structures of the International Association of Geodesy (IAG). Among other activities, in its first year the UN-GGCE has conducted extensive consultations with the geodetic community and stakeholders, identifying issues of concern that the Centre will focus on. The Global Geodetic Observing System (GGOS), established as the response of the international geodetic community to the need to continuously monitor changes in the Earth system, provides the interface between the scientific expertise of the IAG and society to demonstrate the fundamental value of geodesy and to facilitate access to geodetic products. GGOS is therefore perfectly placed to provide the UN-GGCE with expert technical advice from the scientific community. On the other hand, the leadership of the UN-GGCE in promoting strategic policies to maintain and improve the global geodetic supply chain opens many opportunities for GGOS to count on a better geodetic infrastructure, more knowledge capabilities, and a more efficient use of resources. In this context, we will present an introduction to the work of UN-GGCE and GGOS, together with examples of this synergistic collaboration.

Satellite-Derived Estimation of Global Geostrophic Currents with High Spatial Resolution

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SUMMARY

The ocean is a dynamic system influenced by a multitude of physical forces, including gravity, friction, pressure gradients, and the Coriolis force. Among these, geostrophic currents (GC) emerge as a crucial component of ocean circulation, playing a fundamental role in shaping Earth's climate system.

Estimating surface geostrophic currents geodetically is feasible through satellite data. Leveraging Sea Surface Height (SSH) data from satellite altimetry and an independent geoid derived from satellite gravity data, particularly from the GOCE satellite, enables the determination of Absolute Dynamic Topography (ADT). Utilizing the ADT, the velocity field of Surface Geostrophic Currents (SGC) is derived through partial derivatives along latitude and longitude. These currents are subsequently propagated downwards, using temperature and salinity profiles.

This study presents estimates of the GC for the whole global ocean circulation with a spatial resolution of $0.25^\circ \times 0.25^\circ$ uniformly across all depths. Our analysis encompasses the intricate interplay of ocean currents worldwide, capturing prominent features such as the Gulf Stream, the Antarctic Circumpolar Current, and the Kuroshio Current.

Validation of our findings is conducted through comparison with various in-situ measurements across different currents and choke regions, including the Drake Passage and the Strait of Gibraltar.

In summary, our research offers valuable insights into the estimation of global geostrophic currents using satellite-derived data, shedding light on the dynamic processes governing ocean circulation.

Nueva realización del marco de referencia REGCAN95 para Canarias

A new realization of REGCAN95 reference frame for Canary Islands

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RESUMEN

Desde la materialización del Sistema de Referencia Geodésico oficial REGCAN95 en el archipiélago canario han transcurrido 30 años, en los que las técnicas geodésicas a nivel de usuario han evolucionado desde la geodesia pasiva hasta la utilización masiva de los servicios de las redes de estaciones de referencia GNSS. La dotación de coordenadas a éstas se ha ido haciendo paulatinamente a medida que se iban instalando mediante observaciones directas a vértices REGENTE en las islas o bien mediante transformaciones Helmert sucesivas, que han ido provocando inconsistencias entre las coordenadas, más aún entre las dos redes existentes en las islas, la del IGN y la de GRAFCAN. Al mismo tiempo, las crisis volcánicas de El Hierro y La Palma han provocado cambios sustanciales en la corteza terrestre que ha afectado a la infraestructura geodésica de ambas islas.

Si bien en todo el territorio español el Grupo de Trabajo de la Comisión Especializada del Sistema Geodésico ha venido produciendo realizaciones periódicas de ETRS89 absolutamente consistentes con el marco de IGS/EUREF, su labor ha estado dentro del ámbito de ETRS89, dejando Canarias al margen. Por todo ello, IGN y GRAFCAN se han coordinado para calcular una nueva solución para todas las estaciones de referencia GNSS de Canarias, basándose en el marco original materializado por REGENTE. La consecuencia de ello ha sido que el pasado mes de febrero se ha publicado para las redes de IGN y GRAFCAN una solución conjunta de coordenadas en REGCAN95, mucho más consistente y precisa que la existente anteriormente y los servicios de posicionamiento de ambas redes cambiaron al mismo tiempo el marco de referencia de coordenadas. Además, en verano de 2023 se llevó a cabo una campaña en las islas de El Hierro y La Palma para dotar de coordenadas en este nuevo marco a los vértices REGENTE de ambas islas. En la presente ponencia se analizan las diferentes estrategias y metodologías utilizadas, así como los resultados de estas actuaciones.

SUMMARY

Since the epoch in which the materialization of the official Geodetic Reference System REGCAN95 in the Canary Islands was implemented, have passed 30 years, in which geodetic techniques at the user level have evolved from passive geodesy to the massive use of GNSS reference station networks services. The provision of coordinates to these stations has been done gradually as they were installed through direct observations at REGENTE vertices on the islands or through successive Helmert transformations, which have caused inconsistencies between the coordinates, even more so between the two existing networks in the islands, that of the IGN and that of GRAFCAN. At the same time, the volcanic crises of El Hierro and La Palma have caused substantial changes in the Earth's crust that have affected the geodetic infrastructure of both islands.

The Working Group of the Specialized Commission of the Geodetic System has been producing periodic productions of ETRS89 absolutely consistent with the IGS/EUREF framework, but only in the territory within the scope of ETRS89, leaving the Canary Islands aside. For all these reasons, IGN and GRAFCAN have coordinated to calculate a new solution for all GNSS reference stations in the Canary Islands, based on the original framework materialized by REGENTE. The consequence of this has been that last February a joint coordinate solution in REGCAN95 was published for the IGN and GRAFCAN networks, much more consistent and precise than the previously existing one, and the positioning services of both networks

changed at the same time the coordinates reference frame. Furthermore, in the summer of 2023, a campaign was carried out on the islands of El Hierro and La Palma to provide coordinates in this new reference frame to the REGENTE vertices of both islands. This paper exposes the different strategies and methodologies used, as well as the results of these actions.

Spanish contribution to the update of the Earth's rotation theory and precession-nutation models

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SUMMARY

In the last decade, the International Astronomical Union (IAU) and the International Association of Geodesy (IAG) organized successive joint working groups (JWG) for revising the current theories and models of the Earth's rotation, whose activity resulted in IAU and IAG resolutions encouraging improving the accuracy and consistency of such theories and models. Improving the consistency requires that all equations refer to the same reference frames and use the same geophysical models both in theoretical developments and in observational data analyses; however, current PN theories use models more than 20 years old different from current standards.

As for accuracy, it was showed that the unexplained variance of the PN variables, measured in terms of WRMS of the observed celestial pole offsets (CPO), can be significantly reduced by fitting simple empirical corrections to observations. Using such corrections also allows the derivation of alternative CPO series with lower WRMS when analyzing VLBI data. To give an idea of the magnitude of the reductions, for well-known benchmark series such as usn2023b, gsf2023a, and ivs19q4X, the percentage WRMS reductions of (dX, dY) after correcting for precession are (21%, 6%), (23%, 8%), and (11%, 8%), respectively, while correcting also for nutation the respective total decreases are (31%, 27%), (31%, 17%), and (32%, 19%).

However, the use of empirical nutation models is only a temporary solution and many periods whose corrections should be non-negligible are too close to each other to be numerically separable; it is thus necessary to derive complete theories with analytical formulas that provide amplitudes as a function of general Earth parameters. The latter is one of the most important tasks of the JWG on Consistent Improvement of the Earth's Rotation Theory (CIERT) that is currently starting with a remarkable Spanish participation, which includes overseeing its organization and leadership tasks by the first coauthors.

Feature Selection and Deep Learning for Simultaneous Forecasting of Celestial Pole Offset (CPO) and Polar Motion (PM)

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SUMMARY

Accurate prediction of Earth orientation parameters (EOPs) is critical for astrogeodynamics, high-precision space navigation, and positioning, and deep space exploration. However, the current models' prediction accuracy for EOPs is significantly lower than that of geodetic technical solutions, which can adversely affect certain high-precision real-time users. In this study, we introduce a simultaneous prediction approach for Polar Motion (PM) and Celestial Pole Offsets (CPO) employing deep neural networks, aiming to deliver precise predictions for both parameters. The methodology comprises three components, with the first being feature interaction and selection. The process of feature selection within the context of deep learning differs from traditional methods for machine learning, and may not be directly applicable to theme since they are designed to automatically learn relevant features. Consequently, we propose in this step a solution based on feature engineering to select the best set of variables that can keep the model as simple as possible but with enough precision and accuracy using recursive feature elimination and the SHAP value algorithm, aiming to investigate the influence of FCN (Free Core Nutation) with its amplitude and phase on the CPO forecasting. This investigation is crucial since FCN is the main source of variance of the CPO series. Considering the role represented by the effective Angular Momentum functions (EAM), and their direct influence on the Earth's rotation, it is logical to assess numerically the impact of EAM on the Polar motion and FCN excitations. SHAP value aids in comprehending how each feature contributes to final predictions, highlighting the significance of each feature relative to others, and revealing the model's dependency on feature interactions. During the second phase, we formulate two deep-learning methods for each parameter. The first Neural Network incorporates all features, while the second focuses on the subset of features identified in the initial step. This stage primarily involves exploring feature and hyperparameter tuning to enhance model performance. The SHAP value algorithm is also used in this stage for interpretation. In the final phase, we construct a multi-task deep learning model designed to simultaneously predict (CPO) and (PM). This model is built using the optimal set of features and hyperparameters identified in the preceding steps. To validate the methodology, we employ the most recent version of the time series from the International Earth Rotation and Reference Systems Service (IERS), namely IERS 20 C04 and EAM provided by the German Research Center for Geosciences (GFZ). We focus on a forecasting horizon of 30 days, the practical forecasting horizon needed in space-geodetic applications. In the end, We conclude that the developed model is proficient in simultaneously predicting (CPO) and (PM). The incorporation of (EAM), sheds light on its role in CPO excitations and Polar Motion predictions.

The role of VLBI in modern geodesy

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SUMMARY

Very Long Baseline Interferometry (VLBI) is a highly accurate method, used since the 1970s in astronomy as well as in geodesy. It contributes significantly to the global international terrestrial reference frame (ITRF) and is the only space geodetic technique able to realize the international celestial reference frame (ICRF) as well as to observe the full set of Earth orientation parameters (EOP: polar motion, universal time, precession / nutation).

The IVS (International VLBI Service for Geodesy and Astrometry) analysis center in Alicante UAVAC (University of Alicante VLBI Analysis Center) was established as an associate AC in 2018 at the department of Applied Mathematics at the University of Alicante, within the research group of Space Geodesy and Space Dynamics. In the first quarter of 2023 we became an operational AC, and contribute to operational products like the IVS combined EOP products, as well as the recent ITRF2020 re-processing.

In this report we will highlight current research topics within the VLBI community in general and within our group specifically.

Advancing towards the creation of a new Geodetic Prediction Center

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SUMMARY

Numerous characteristics of the Earth system, such as its form, gravitational field, and orientation in space, can be measured by using geodetic observations. The significance of these characteristics for research and society is demonstrated by the geodetic contributions to the study of geodynamic events, monitoring of climate change, and space and terrestrial navigation. The Global Geodetic Observing System (GGOS) recently spearheaded an initiative to define a collection of Essential Geodetic Variables (EGVs). These variables serve as fundamental metrics that characterize various geodetic aspects of the Earth. Accuracy, spatiotemporal precision, and latency are among the requirements that have been placed on EGVs. The latency of geodetic products has become crucial for many real-time applications. Several scientific disciplines require forecasts of specific EGVs at different time horizons in order to meet user requirements.

The Space Geodesy Group at University of Alicante and the Geodesy Group at Geographic National Institute in Spain (IGN) have broad knowledge and experience in Geodesy, but in particular on Earth rotation theory, models and predicting Earth Orientation Parameters (EOPs) by using traditional and novel algorithms thanks for the active involvement in the Second Earth Orientation Parameters Prediction Comparison Campaign (2nd EOP PCC) lasted from September 1, 2021 to December 31, 2022. These latest efforts will help us to establish the first Spanish-Portuguese Geodetic Prediction Center focus primarily on EOP forecasts, but with the idea to extend in near future to other important geodetic product and EGVs, such as Earth angular momentum functions, station coordinates, tropospheric zenith wet delays, ionospheric total electron content, and satellite orbits.

Acercando los productos geodésicos al público: base de datos y visualizador de productos geodésicos del Instituto Geográfico Nacional de España

Bringing geodetic products closer to the public: database and viewer of geodetic products of the National Geographic Institute of Spain

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RESUMEN

La geodesia es la ciencia que estudia de la forma y dimensiones de la Tierra y utiliza distintas técnicas para este fin. En el Instituto Geográfico Nacional de España se han implementado a lo largo de los años gran parte de ellas: GNSS, VLBI, gravimetría, mareógrafos y nivelación, de las que se tienen series de datos desde hace décadas. Además, en los últimos años se han construido nuevos emplazamientos en los que se podrán combinar y trabajar de forma simultánea dichas técnicas (Estaciones Fundamentales) e incluso algunas nuevas como SLR.

Para dar a conocer el trabajo llevado a cabo durante estos años y que el público pueda utilizarlos y consultarlos se está creando una base de datos donde se almacenan los datos y, posteriormente, se utilizará para poder crear un visualizador y distintas herramientas web que permitirán al usuario consultar y acceder a los distintos productos geodésicos de forma fácil e intuitiva.

En esta contribución presentaremos el proceso de creación de la base de datos así como los distintos productos que se servirán al público.

SUMMARY

Geodesy involves different techniques for measuring and studying the shape and dimensions of the Earth. In the National Geographic Institute of Spain, many of them have been implemented over the years: GNSS, VLBI, gravimetry, tide gauges and leveling, for which we have had data series for decades. In addition, in recent years, new sites have been built where these techniques can be combined and operated simultaneously (Core Sites) and even some new ones such as SLR.

In order to make available the work carried out during these years and so that the public can use and consult them, a database is being created where the data is stored and, later, it will be used to create a viewer and different web tools that will allow the user to consult and access the different geodetic products in an easy and intuitive way.

In this contribution we will present the process of creating the database as well as the different products that will be served to the public.

Monitoring of hydraulic infrastructures using satellite radar interferometry: SIAGUA project

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SUMMARY

Effective monitoring of water infrastructure and surrounding areas is essential to ensure their safety and optimal functioning. With the increasing importance of water supply systems and the construction of linear structures such as dams, the need to adapt these structures to changing conditions is becoming more pressing. Proper risk management of

dams is essential as their failure can have serious economic and social consequences. In this context, satellite radar interferometry (InSAR), in particular through the European Ground Motion Service (EGMS), provides a valuable solution for monitoring surface deformations with high accuracy and without the need for fieldwork. EGMS uses Sentinel-1 satellite data to provide accurate deformation measurements, allowing the identification of problems such as subsidence and landslides that can affect the stability of infrastructure. The SIAGUA project in Spain is an example of how EGMS can be used to monitor dams and surrounding areas, providing valuable information for dam management in the region. This technology not only improves monitoring efficiency, but also helps prevent economic losses and public safety risks by identifying potential problems before they become critical threats. In summary, InSAR, especially through EGMS and projects such as SIAGUA, is a powerful and non-invasive tool for monitoring the stability of water infrastructure and adjacent areas. This contributes to effective risk management and public safety. This paper presents the SIAGUA project, which is dedicated to the monitoring of hydraulic infrastructures using multitemporal InSAR. It uses tools such as EGMS and specific processing with satellite images of different resolutions.

S.02 - Sismologia e Física do Interior da Terra / Sismología y Física del Interior de la Tierra

Análisis de la energía radiada por terremotos intermedios y profundos en la placa de Nazca

Analyses of the radiated energy from intermediate and deep-depth earthquakes in Nazca plate

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RESUMEN

En este trabajo se presenta un análisis y comparación de la energía sísmica radiada para el caso de terremotos intermedios ($100 < h < 300$ km) y profundos ($h > 500$ km), localizados en la frontera entre Perú-Brasil y Bolivia y en el norte de Chile. La energía sísmica radiada ha sido calculada a partir del espectro de velocidad mediante el método de estación única y también a partir de la función temporal de la fuente. En el primer caso, a partir de los registros de la onda P a distancias telesísmicas ($30^\circ < \Delta < 90^\circ$), tras llevar a cabo la deconvolución de la respuesta instrumental, el espectro se corrige por la atenuación por la expansión geométrica del frente de ondas, por la atenuación anelástica, por el efecto de la superficie libre y por el patrón de radiación. Previamente, mediante la inversión de la distribución del slip sobre el plano de falla, a partir de ondas internas a distancias telesísmicas, se han determinado la profundidad, orientación del plano de falla, la función temporal de la fuente y las dimensiones de la fractura. A partir de la energía radiada, se ha obtenido la energía escalada y el esfuerzo aparente. Los resultados obtenidos muestran que el valor medio de la energía escalada es ligeramente superior para los terremotos profundos, mostrando una menor dispersión que para los intermedios. También se observa un aumento del esfuerzo aparente con la profundidad.

SUMMARY

This work presents an analysis and comparison of the radiated seismic energy for the case of intermediate ($100 < h < 300$ km) and deep depth ($h > 500$ km) earthquakes, located on the border between Peru-Brazil and Bolivia and in the north of Chile. The radiated seismic energy has been calculated from the velocity spectrum using the single-station method and from the source time function. In the first case, from the records of the P wave at teleseismic distances ($30^\circ < \Delta < 90^\circ$), after carrying out the deconvolution of the instrumental response, the spectrum is corrected for the geometric spreading attenuation, the anelastic attenuation, the effect of the free surface and by the radiation pattern. Previously, the depth, fault plane orientation, source time function and fracture dimensions have been determined through slip distribution inversion from teleseismic body waves. From the radiated energy, the scaled energy and the apparent stress have been obtained. The obtained results show that the average value of the scaled energy is slightly higher for deep depth earthquakes, with less dispersion than for intermediate ones. Besides, the apparent stress also increases with depth.

Historical Tsunamis in Spain: A Detailed Look through the Updated Catalogue

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SUMMARY

With nearly 8,000 kilometres of coastline, Spain is exposed to the risk of tsunamis; despite not being very frequent, the impact cannot be underestimated, as it can be significant. In this context, a recent review of the Tsunami Catalogue on the Spanish coasts is presented, providing a comprehensive compilation of 14 historical tsunami events, whose reliability is based on previously defined objective criteria. This compilation is based on the review of regional and international catalogues, historical documents, scientific studies, and tide gauge records.

The catalogue, accessible through the Seismic Information section on the website of the National Geographic Institute of Spain, provides detailed information on the main parameters of each tsunami and its generating cause, as well as descriptions of the observed effects in the affected localities.

Additionally, a viewer has been developed that allows users to dynamically explore the catalogue through an interactive map, which displays the location of tsunami sources and observation points. Available data includes the tsunami occurrence date, details on its cause, descriptive information of the event (including its reliability, intensity, maximum wave height, and number of observations), as well as a detailed list of affected populations and observed effects in each of them.

The new Tsunami Catalogue and its viewer constitute valuable tools to better understand the historical tsunami events that, with reasonable certainty, have impacted the Spanish coasts.

Sismólogas europeas, una larga tradición

European women in seismology, a long tradition

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RESUMEN

Inge Lehman es sin duda, la sismóloga europea más conocida, aunque no fu la primera ni un caso aislado. En Europa hay una larga tradición de sismólogas, si bien son minoría. Durante el siglo XIX, su presencia fue ocasional y en muchos casos sus conocimientos fueron resultado de su matrimonio con un científico. En Europa, hay una larga tradición de sismólogas desde los comienzos de la sismología instrumental a principios del siglo XX, aunque su presencia ha sido minoritaria. A comienzos del siglo XX encontramos en Reino Unido, Dinamarca, la antigua URSS y Francia a las primeras sismólogas. Tras la 2ª Guerra Mundial, hay una notable participación de sismólogas en organismos y reuniones internacionales tales como la ESC o IASPEI, en cuyas actas se puede encontrar sus contribuciones y trabajos. Esta comunicación se concentra en las contribuciones de las primeras sismólogas europeas (periodo 1920-1970). A partir de los años 70, la presencia y contribuciones en la sismología de la mujer ha aumentado considerablemente.

SUMMARY

Inge Lehmann is the best-known European woman seismologist, but she is not an isolated case. The presence of women seismologists in Europe has a long tradition, although they have been a minority in the field. The presence of women in geosciences was unusual in the nineteenth century, and in some cases, their scientific knowledge was due to their marriage to a scientist. The earliest women researchers appearing at the beginning of the 20th century in the different European countries, such as United Kingdom, Denmark, the former USSR, and France. After World War II, women seismologists in Europe had an important presence. Their names are present in the lists of participants in seismological international meetings (IASPEI or ESC), where information about these women and their roles in these institutions can be found. This communication concentrates on the presence of women seismologists in Europe in the 1920–1970 period. After the 1970s, the number of women in seismology has increased considerably.

El patrimonio sismológico en el Observatorio Fabra (Barcelona)

Seismic heritage in Fabra Observatory (Barcelona)

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RESUMEN

El Observatorio Fabra, activo en Barcelona desde 1904, fue creado por la Real Academia de Ciencias y Artes de Barcelona (RACAB), una asociación científica originada en 1764. El observatorio se ha dedicado desde sus orígenes a estudios y observaciones en astronomía, meteorología y sismología.

Las observaciones sismológicas comenzaron en 1906 y se han mantenido activas desde entonces. Incluyen registros instrumentales y datos macrosísmicos recogidos de múltiples fuentes, principalmente del Levante Español. Su archivo histórico incluye sismogramas y documentación complementaria como: manuscritos y boletines impresos; registros y libros de bitácora; artículos científicos y de divulgación en periódicos y revistas; cartas y correspondencia científica; publicaciones impresas de muchas otras instituciones; etc. Casi todos los instrumentos de esa época se han conservado en su pequeño museo o aún se utilizan para diferentes propósitos.

El Observatorio Fabra continúa en activo con el objetivo principal de aportar contribuciones interesantes para la comunidad científica. Gracias al inestimable consejo, ayuda y apoyo de otras instituciones (especialmente ICGC) y particulares también hemos podido realizar diversos proyectos sobre nuestro patrimonio sísmico: inventarios parciales, restauraciones, estudios y escaneos. Además, el observatorio tiene la divulgación como otro objetivo principal: tiene un pequeño museo de instrumentos, mantiene regularmente cursos, conferencias, visitas escolares y muchas otras actividades ocasionales. Estamos orgullosos de mantener tanto como nos es posible nuestra larga tradición de compartir y colaborar, tanto desde el punto de vista científico como de divulgación, con otros investigadores, instituciones, individuales y grupos.

En esta presentación detallamos el estado actual de nuestro patrimonio sísmico junto con algunos de los proyectos para recuperar, conservar y promoverlo. Presentamos esta contribución como un ejemplo de proyectos y actividades posibles que un observatorio pequeño e independiente puede realizar sobre su patrimonio sísmico, incluso con importantes limitaciones de recursos y personal.

SUMMARY

Fabra Observatory has been operating in Barcelona since 1904. It was created by the Royal Academy of Science and Arts of Barcelona (RACAB), a scientific association established in 1764. The Observatory has always been devoted to astronomical, meteorological and seismological observations and studies.

Seismic observations started in 1906 and have been maintained active since then. They include instrumental records and macroseismic data collected from a number of sources, mainly from Eastern Spain. Its historical archive includes seismograms and complementary documentation such as manuscript and printed bulletins, registers and station notebooks, scientific and divulgation articles in journals and periodicals, letters and scientific correspondence, printed publications from many other institutions, etc. Almost all instruments from that time, are preserved in its small museum or still being used for different purposes.

Fabra Observatory is still an active institution with the main goal of working on interesting contributions to the scientific community. Thanks to the inestimable advice, help and support from other institutions (especially ICGC) and particulars we have also been able to perform diverse projects on our seismic heritage: partial inventories, restorations, studies and scanning. Besides, the observatory has divulgation as another main goal: it has a small museum of instruments, holds regular courses, conferences, scholar visits, and many other occasional activities. We are proud of maintaining our long tradition of being willing to share and collaborate in both scientific and divulgation ways with other investigators, institutions, individuals and groups as much as possible.

In this presentation we review the present status of our seismic heritage, along with some of the projects to recover, preserve and promote it. This contribution is an example of doable activities and projects that a small independent observatory can undergo related to seismic heritage, even with severe limitations of resources and personnel.

Breve Estudio de las Señales de Largos Periodos del Terremoto de Lorca de 11 de Mayo de 2011

Brief Study of the Signals of Long Periods of the Lorca Earthquake of May 11, 2011

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RESUMEN

En este trabajo hemos intentado estudiar con cierto detalle las ondas de largo periodo del importante terremoto acaecido en la ciudad de Lorca (Murcia) el 11 de mayo de 2011. En este trabajo no se pretende sacar conclusiones generales que pudieran ser aplicables a otros terremotos, a falta de un estudio más extenso. Se han filtrado las señales del evento entre las frecuencias 0,03 Hz y 0,06 Hz, mediante la transformada de Hilbert hemos calculado la envolvente y estudiar así el comportamiento de la energía en ese rango de frecuencias. Primero para las estaciones mas cercanas, hasta aproximadamente 100 km de distancia del epicentro; segundo se han considerado estaciones a diferentes distancias para ver como estas ondas de muy baja frecuencia se desarrollan y por último, cómo cambian azimutalmente manteniendo la distancia aproximadamente constante. La motivación de este trabajo es la importancia que tiene la comprensión de las señales en esta parte del espectro para terremotos regionales, ya que estas señales son las se aprovechan para el cálculo del tensor momento sísmico y magnitud momento (M_w) mediante ajuste con sismogramas sintéticos en la Red Sísmica Nacional española.

SUMMARY

In this article we have tried to study in some detail the long-period waves of the great earthquake that happened in the city of Lorca (Murcia) on May 11, 2011. This work does not intent to get general conclusions that could be applicable to other earthquakes, since more studies would be necessary. The frequency of the event signals have been filtered between 0.03 Hz and 0.06 Hz, using the Hilbert transform we have calculated the envelope and studied the energy behavior in that frequency range. First at all for the closest stations, up to approximately 100 km away from the epicenter; Second, for stations at different distances in order to see how these very low frequency waves develop versus distance and, finally, how these waves change azimuthally while keep the distance approximately constant. The goal of this article is to understand better the behaviour of the signals in this part of the spectrum for regional earthquakes. These signals are used to calculate of the seismic moment tensor and moment magnitude (M_w), adjustmenting them with synthetic seismograms in the Spanish National Seismic Network.

Estudando o Maciço de Monchique

Studying the Monchique Massif

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RESUMO

A região em estudo neste trabalho está localizada entre as latitudes 37,2 e 37,4° N e longitudes 8,4 e 8,7 ° W. O Maciço de Monchique localizado no lado Oeste do Algarve é constituído por dois conjuntos de elevações aproximadamente paralelos, com direção NE-SW. O pico mais elevado (Foia) com uma altitude de 902 metros está localizado no lado W do maciço, tendo o ponto mais elevado da formação do lado Este (Picota) uma altitude de 773m. O maciço é formado por duas unidades de sienito nefelítico (a unidade central e a unidade de bordo) ocupando 90% de toda a área coberta pelo maciço (80 km²), e ainda, rochas ultrabásicas, básicas e intermédias e diversos tipos de brechas. A idade do Maciço é 72 Ma (Cretácico Superior).Salientam-se na região os valores elevados de radioatividade associados ao maciço, podendo observar-se na Carta Radiométrica de Portugal heterogeneidade na distribuição dos valores apresentados, identificando-se regiões com valores muito elevados.

Na construção dos modelos térmicos que apresentamos foi utilizada a estrutura da crosta fornecida por tomografia sísmica a profundidades de 1, 4, 8, 12, 16 e 20 km de profundidade, bem como os valores de V_P/V_S às mesmas profundidades. No lado Este do maciço foram utilizados os dados de um perfil vertical com orientação N-S, à latitude 8,5 °W. Para fluxo de calor na base da crosta utilizou-se o valor 35 mW m⁻², sendo considerada a temperatura média da superfície 17° C. Para espessura da crosta foi utilizado o valor 32 km. Os modelos feitos diferem no conteúdo de fontes de calor na crosta bem como nos valores da condutividade térmica utilizados e nos contrastes de temperatura obtidos para um mesmo valor de profundidade.

SUMMARY

The region under study in this work is located between latitudes 37.2 and 37.4° N and longitudes 8.4 and 8.7° W. The Monchique Massif located on the west side of the Algarve consists of two sets of elevations approximately parallel, with a NE-SW direction. The highest peak (Foia) with an altitude of 902 meters is located on the Western side of the massif. In the Eastern side, the highest point of the formation (Picota) has an altitude of 773 m. The massif is formed by two nefelitic syenite units (the central unit and the border unit) occupying 90% of the entire area covered by the massif (80 km²), and also, ultrabasic, basic and intermediate rocks and various types of breccias.

The age of the Massif is 72 Ma (Late Cretaceous). High values of radioactivity associated with the massif are highlighted in the region, and heterogeneity in the distribution of the values presented can be observed in the Radiometric Map of Portugal, identifying regions with very high values.

The crustal structure used in the construction of the present thermal models is provided by seismic tomography at depths of 1, 4, 8, 12, 16 and 20 km, as well as the values of V_P/V_S at the same depths. On the eastern side of the massif, data from a vertical profile with N-S orientation at latitude 8.5 °W were used. For the heat flow at the base of the crust, the value of 35 mW m⁻² was used, and the average surface temperature used was 17° C. The value of 32 km was used for crustal thickness. The models made differ in the content of heat sources in the crust as well as in the thermal conductivity values used and in the temperature contrasts obtained for the same depth value.

Estimación de la fuente sísmica del terremoto de Arenas del Rey de 1884 a partir de la distribución de intensidades

Determination of seismic source for the 1884 Arenas del Rey earthquake from intensity distribution

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RESUMEN

Se presenta un modelo de fuente sísmica para el terremoto de Arenas del Rey de 1884 basado en la distribución espacial de intensidades. A partir de nueva información contemporánea de daños causados por el terremoto se ha aumentado el número de IDPs de 157 hasta 213. Utilizando una relación empírica entre valores de intensidad y PGA se han generado valores empíricos de aceleración para los IDPs que se utilizará para verificar el modelo de fuente propuesto. Se han generado 181,440 modelos de fuente sísmica con una distribución uniforme de slip, en el que la orientación de la falla (strike, dip y slip) varía con intervalos de 15°, profundidades de 8, 14 y 20 km, valores de $M_w=6.5-7.0$, una anchura de falla 20 km (sin que la fractura alcance la superficie), y longitudes de falla entre 20 y 70 km. Se ha probado 5 modelos diferentes de ruptura, 1 bilateral y 4 unilaterales (vertical hacia arriba, hacia abajo, a lo largo del strike y en dirección opuesta) para los que se ha generado una distribución de PGA que corresponde a los IDPs. El mejor modelo, mínimo misfit entre PGA "observadas" y teóricas, corresponde a una falla de azimut 285°-330°, buzamiento 60°-75°, rake -75° a -90°, $h=8$ km, las dimensiones oscilan entre 11-14 km de anchura y 28-40 km de longitud, con un slip que varía entre 0.5 y 1.9 m

SUMMARY

We present for the 1884 Arenas del Rey earthquake a seismic source model based on the spatial distribution of intensities. Using new contemporary information the number of IDPs have increased from 157 to 213. PGA values have been obtained using an empirical relation between intensity and PGA, these values will be used to verify the proposed seismic source model. Source. The source model is based on uniform slip distribution, where the interval of strike, dip and rake varies 15°, checked depth are 8, 14 and 20 km, $M_w=6.5-7.0$, dimensions of fault are 20 km x 70 km. The results are a total of 181,440 models corresponding to one bilateral rupture and four unilateral (up-dip, down-dip, along strike, and against strike). For these values we have generated PGA for the IDPs sites. The best model (minimum misfit) corresponds to a fault with strike 285-330°, dip 60°-75°, rake -75° to -90°, $h=8$ km, width 11-14 km, length 28-40 km, and slip 0.5 to 1.9 m.

Sistema de Alerta Sísmica Temprana en la Región Ibero-Mogrebí: Actualidad y perspectivas futuras

Earthquake Early Warning System in the Ibero-Maghrebian Region: Current status and future perspectives

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RESUMEN

Los Sistemas de Alerta Sísmica Temprana (SAST), son una de las herramientas más eficaces para prevenir y mitigar los daños que puedan causar los terremotos. Desde octubre de 2015, el Departamento de Física de la Tierra y Astrofísica de la Universidad Complutense de Madrid ha implementado un SAST operativo en toda la región Ibero-Mogrebí (RIM). Este sistema se basa en el software PRESTo (*Probabilistic and Evolutionary Early Warning SysTem*) y utiliza un enfoque regional para calcular en tiempo real, la localización hipocentral y la magnitud de los terremotos detectados. El análisis del comportamiento del SAST desde su instalación ha sido objeto de diversos estudios, incluyendo la serie sísmica de Alborán de 2021-2022. Los resultados muestran que para el 70-80% de los terremotos las diferencias entre la hora origen y el epicentro de PRESTo y los cálculos del Instituto Geográfico Nacional (IGN) son inferiores a 2s y 20 km respectivamente. Las diferencias en M_w son inferiores a 0.3 para el 60-65% de los terremotos detectados. Para mejorar los resultados se ha aumentado la cobertura azimutal con la incorporación de 11 estaciones en PRESTo: 3 de la red *Western Mediterranean* (<https://doi.org/10.14470/JZ581150>) y 8 del IGN (<https://doi.org/10.7914/SN/ES>). Actualmente, en el mismo departamento, se está implementando un nuevo SAST (QuakeUp) basado en la predicción temporal progresiva del movimiento del suelo ("shaking"). A diferencia del SAST actual, basado en la determinación temprana del hipocentro y magnitud, el nuevo método determina las zonas de daño potencial (PDZ, *Potencial Damage Zone*) en términos de los valores de *Peak Ground Velocity* (PGV).

SUMMARY

Earthquakes Early Warning Systems (EEWS) are one of the most effective tools to prevent and mitigate the damage that earthquakes can cause. Since October 2015, the Department of *Física de la Tierra y Astrofísica* of the Universidad Complutense de Madrid has implemented an operational EEWS throughout the Ibero-Maghrebian Region (IMR). This system is based on the PRESTo (*Probabilistic and Evolutionary Early Warning SysTem*) software and uses a regional approach to calculate, in real time, the hypocentral location and magnitude of detected earthquakes. The performance of the EEWS since its installation has been the subject of various studies, including one from the 2021-2022 Alboran seismic series. The results show that for 70-80% of the earthquakes the differences between the origin time and the epicenter of PRESTo and those calculated by the *Instituto Geográfico Nacional* (IGN) are less than 2s and 20 km, respectively. The differences in M_w are less than 0.3 for 60-65% of the detected earthquakes. To improve the results, the azimuthal coverage has been increased with the incorporation of 11 stations in PRESTo: 3 of them from the *Western Mediterranean* network (<https://doi.org/10.14470/JZ581150>) and 8 from the IGN (<https://doi.org/10.7914/SN/ES>). Currently, a new EEWS (QuakeUp) based on progressive temporal prediction of ground motion ("shaking") is being implemented within the same department. Unlike the current EEWS, based on early determination of hypocenter and magnitude, the new method determines Potential Damage Zones (PDZ) in terms of Peak Ground Velocity (PGV) values.

Caracterização dos níveis de ruído sísmico registados a partir de uma rede temporária de banda larga implantada a norte de Évora

Characterization of seismic noise levels recorded from a temporary broadband network deployed north of Évora

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RESUMO

Compreender a origem do ruído sísmico de fundo em determinado espaço geográfico e saber quantificá-lo pode fornecer informações para melhorar o desempenho de uma rede sísmica e, consequentemente, aumentar a sua capacidade de deteção de eventos sísmicos. Neste estudo, usamos os dados registados pelas estações de Évora da rede temporária DOCTAR, constituída por 12 estações digitais de banda larga (CMG-3ESP 60s), instaladas no período de 2011 – 2012, a norte de Évora, em torno da Aldeia da Serra, onde ocorre uma atividade sísmica persistente de baixa a moderada magnitude. Para análise do ruído sísmico, desenvolvemos em MATLAB uma Hiper Matriz, onde é possível proceder toda a análise espectral para cada estação/componente, em qualquer faixa de frequência, e qualquer hora do dia e período do ano. Os espectros de ruído foram calculados sistematicamente em todas as faixas de banda larga e comparadas com os limites globais de ruído baseado no modelo de Peterson (1993). Os resultados mostram níveis de ruído moderados para a maioria das estações, em que, os espectros das componentes verticais estão dentro dos limites globais definidos, enquanto que nas baixas frequências (0,02 – 0,04 Hz) as componentes horizontais na maioria das estações ultrapassam ligeiramente o limite alto de ruído, em cerca de ~8%, devido a influência das variações da pressão atmosférica que causa inclinação do instrumento sísmico. A comparação do PSD durante a luz do dia e noite na banda de curto período, indica que o ruído diurno é mais elevado do que o noturno, o que pressupõe alguma influência das atividades antrópicas e tráfego. Em linhas gerais, este estudo é útil para implantações de estações sísmicas, deteção de terremotos, risco sísmico, bem como fornecer percepções sobre a interação entre os vários subsistemas da Terra.

SUMMARY

Understanding the origin of background seismic noise in a given geographic space and knowing how to quantify it can provide information to improve the performance of a seismic network and, consequently, increase its capacity to detect seismic events. In this study, we used data recorded by the Evora stations of the DOCTAR temporary network, consisting of 12 digital broadband stations (CMG-3ESP 60s), installed in the period 2011 – 2012, north of Évora, around Aldeia da Serra, where persistent seismic activity of low to moderate magnitude occurs. To analyze seismic noise, we developed a Hyper Matrix in MATLAB, where it is possible to carry out all spectral analysis for each station/component, in any frequency range, and at any time of day and period of the year. Noise spectra were systematically calculated across all broadband ranges and compared with global noise limits (Peterson, 1993). The results show moderate noise levels for most stations, in which the vertical component spectra are within the defined global limits, while at low frequencies (0.02 - 0.04 Hz) the horizontal components in most stations slightly exceed the high noise limit, by around ~8%, due to the influence of variations in atmospheric pressure that cause tilting of the seismic instrument. The comparison of the PSD during daylight and night in the short period band indicates that daytime noise is higher than at night, which presupposes some influence

from human activities and traffic. Overall, this study is useful for seismic station deployments, earthquake detection, seismic risk, as well as providing insights into the interaction between the Earth's various subsystems.

Site Effects Mapping, Soil Characterization and Resonance Effects: Implications for Infrastructure Development in Algiers and the Mitidja Basin, Algeria

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SUMMARY

The northern central part of Algeria is characterized by high seismic activity and geological conditions that pose significant challenges for construction and infrastructure development. The study area presented by Algiers and Mitidja basin is an excellent example. This study investigates the site and resonance effects, as well as the soil quality and the faults that border it (Sahel, Thenia, and south-Mitidja).

The geological setting of the area is complex, with a mixture of sedimentary, metamorphic, and volcanic formations. These diverse geological units, combined with the tectonic activity, contribute to susceptibility to seismic events.

Seismic hazard assessments indicate that the study area have a high seismic activity, with the potential for significant ground motion. Site effects, including local geology, soil characteristics, and topographic features, amplify seismic waves and exacerbate resonance effects.

The low quality of soil in the region and the excessive and uncontrolled pumping of the Mitidja water table (the cause of significant subsidence in the basin), poses additional challenges for construction projects and infrastructure resilience. The predominance of poorly consolidated sediments, alluvial deposits, and reclaimed land increases the risk of soil liquefaction, settlement, and slope instability during seismic events.

To address these challenges, comprehensive geological and geotechnical investigations have been conducted to provide insights into the stratigraphy, structural features and evaluating soil parameters to inform engineering design and construction practices. Horizontal to vertical spectral ratios (HVSr) have been employed to characterize site-specific soil properties and assess seismic wave amplification effects.

Strategies such as site effect study, ground improvement techniques, and land use planning can minimize the impact of seismic hazards and ensure the resilience of infrastructure.

Overall, this study highlights the importance of considering site, resonance effects, geological factors, and soil quality in seismic hazard assessments and urban planning to enhance the resilience of vulnerable regions to earthquake risks.

Estudo térmico acerca da região Vendas Novas-Arraiolos-Ciborro

Thermal study about the Vendas Novas-Arraiolos-Ciborro region

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RESUMO

A região aqui denominada Vendas Novas-Arraiolos-Ciborro, está localizada entre as latitudes 38,5 e 39,0° N e as longitudes 7,6 e 8,5 °W. Apesar de a estrutura da região ter sido obtida por tomografia sísmica e de existir, na latitude 38,75° N, um perfil vertical com direção Este-Oeste, e distribuições horizontais de velocidades a diferentes profundidades, não foi possível ainda explicar a existência dos sismos que têm sido registados na região bem como a sua localização em profundidade e epicentros em locais bem definidos à superfície. Para além dos dados referidos existe ainda valores do quociente V_P/V_S . Nos bordos laterais da área em estudo foram utilizados dois perfis verticais com orientação N-S, localizados a longitudes de 8,5 e 7,6°W.

A análise dos perfis sísmicos referidos permitiu identificar claramente na região valores de V_P/V_S no intervalo de 1,7 a 1,8, apresentando, por vezes, variações bruscas que nos permitiram antever alterações em propriedades mecânicas (coeficientes de Poisson) de materiais muito próximos e/ou variações de temperatura acentuadas.

O trabalho consistiu na elaboração de modelos térmicos da crosta que permitam obter valores de fluxo de calor de origem geotérmica na direção vertical, por condução, e distribuição de temperaturas em profundidade. O valor utilizado para fluxo de calor na base da crosta foi 35 mW m⁻² em toda a região. Para espessura da crosta foram utilizados valores entre 29 e 31 km, de acordo com informação existente sobre a região. As anomalias obtidas devem-se a heterogeneidades da crosta traduzidas por diferentes valores de condutividade térmica e / ou distribuição e intensidade de fontes de calor.

SUMMARY

The region called Vendas Novas-Arraiolos-Ciborro, is located between latitudes 38.5 and 39.0 °N and longitudes 7.6 and 8.5 °W. Although the structure of the region was obtained by seismic tomography and that there is, at latitude 38.75° N, a vertical profile with an east-west direction, and horizontal distributions of velocities at different depths, it has not yet been possible to explain the existence of the earthquakes that have been recorded in the region, as well as their location at depth and epicenters in well-defined places on the surface. In addition to the above-mentioned data, there are also values of the V_P/V_S quotient. On the lateral edges of the study area, two vertical profiles with N-S orientation were used, located at longitudes of 8.5 and 7.6 °W.

The analysis of the seismic profiles allowed us to clearly identify V_P/V_S values in the range of 1.7 to 1.8, presenting sometimes sudden variations that allowed us to foresee changes in mechanical properties (Poisson coefficients) of close materials and/or marked temperature variations.

The work consisted in the elaboration of thermal models of the crust to obtain values of heat flow of geothermal origin, by conduction in the vertical direction, and temperature distribution at depth. The value used for heat flow at the base of the crust was 35 mW m⁻² throughout the region. Values between 29 and 31 km were used for crustal thickness, according to previous information about the region. The anomalies obtained are due to heterogeneities of the crust translated by different values of thermal conductivity and/or distribution and intensity of heat sources.

Una historia tentativa y patrimonio preservado de una estación sísmica casi olvidada en Girona (NE Península Ibérica)

A tentative history and preserved patrimony of an almost forgotten seismic station at Girona (NE Iberian Peninsula)

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RESUMEN

La sismología no se desarrolló como una ciencia observacional cuantitativa hasta principios del siglo XX. Su desarrollo dio lugar al establecimiento de unos pocos cientos de observatorios sismológicos en Europa. Diez de ellos en la Península Ibérica (ALI, ALM, COI, CRT, EBR, FBR, LIS, MAL, SFS y TOL) son bien conocidos y sobrevivieron hasta nuestros días. El registro instrumental de los terremotos en la Península se basó en ellos hasta la celebración del Año Geofísico Internacional (1957), cuando se desarrollaron nuevas iniciativas.

Pero también hubo otras iniciativas menos exitosas. Dedicamos esta presentación a nuestros estudios sobre una de ellas: la Estación Sismológica de Girona (NE Península Ibérica). Fue creada en 1909 y estuvo activa, al menos, hasta 1919. Estaba instalada y pertenecía al Instituto General y Técnico de Girona y funcionaba bajo la supervisión de los Catedráticos de Ciencias Naturales del centro. Contó con el asesoramiento permanente de los directores de la estación sísmica del Observatorio Fabra (FBR) de Barcelona.

No es fácil reconstruir su historia operativa ya que los documentos y registros conservados son escasos. Sabemos que en esta estación se instalaron sucesivamente dos instrumentos diferentes: un sismoscopio Vicentini y un péndulo de Mainka. Estos instrumentos no han sobrevivido y, en la actualidad, sólo se conserva una reproducción de un registro obtenido con el sismoscopio Vicentini. Sin embargo, hemos encontrado casi doscientos registros de la estación sísmica de Girona (incluidos 147 sismogramas originales del péndulo de Mainka) entre los documentos y registros conservados en el archivo del Observatorio Fabra (FBR).

El estudio de los registros conservados, la escasa correspondencia disponible, anotaciones manuscritas encontradas en otros archivos y algunas notas publicadas sobre la estación, nos permiten formarnos una idea general sobre cómo funcionaba esta pequeña estación local y el valor científico de los registros conservados. Presentamos aquí estos resultados.

SUMMARY

Seismology developed as a quantitative observational science at the turn of the XX Century. Development of seismographs resulted in the establishment of a few hundreds of seismological observatories in Europe. Ten of them in the Iberian Peninsula (ALI, ALM, COI, CRT, EBR, FBR, LIS, MAL, SFS and TOL) are well known and survived up to present days. Instrumental record of earthquakes in the Peninsula relayed on them up to the celebration of the International Geophysical Year (1957) when new initiatives were developed.

But there were also other initiatives less successful. We devote this presentation to our studies on one of them: the Girona Seismological Station (NE Iberian Peninsula). It was created in 1909 and it was active up to, at least, 1919. It was installed at

and belonged to the Girona Instituto General y Técnico and was operated under the supervision of the Natural Sciences Professors. It received permanent advice from the Fabra Observatory (FBR) seismic station directors in Barcelona.

It is not easy to reconstruct its operational history as preserved documents and records are scarce. We know that two different instruments, a Vicentini Seismoscope and a Mainka pendulum, were installed successively at this station. These instruments did not survive and, at present, just a reproduction of one record obtained with the Vicentini seismoscope is preserved. However, we have found almost two hundred records from the Girona seismic station (including 147 Mainka pendulum original seismograms) among the documents and records preserved at Fabra Observatory (FBR) archive.

Study of the preserved records, some scarce correspondence, manuscript annotations found in other archives, and some published notes about the station, led us to get a general idea about how this small local station was operated and the scientific value of its preserved records. We are presenting these results here.

Seismic Monitoring of Deep Geothermal projects in Switzerland: Network performance analysis and ground-truth test

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SUMMARY

Switzerland is increasingly investing in geothermal as a sustainable source energy, to meet its energy and climate goals. However, the potential for induced seismicity is one of the main concerns to the safety and viability of such projects. In response, the Swiss Federal Office of Energy (SFOE) launched the GEOBEST2020+ project, in the scope of its SwissEnergy programme.

As part of the GEOBEST2020+ project, the Swiss Seismological Service (SED) provides operator-independent seismological consulting and baseline seismic monitoring services to the cantonal authorities issuing the exploration permits. To actively monitor microseismic activity in real time, we deploy dedicated seismic networks around the geothermal sites. These networks must be sensitive enough to track the development of microseismic activity, allowing operators to implement traffic-light systems and take action before major events occur. Prior to the installation, we carry a meticulous site survey, taking into account the real background noise level conditions. We evaluate the detection sensitivity of the networks using the Bayesian Magnitude of Completeness (BMC) and we estimate the theoretical location uncertainties, using a synthetic catalogue of events and the current noise levels at the stations.

In this study, we present a comparative analysis between the theoretical network performance results obtained with our tools and measured data from the continuous monitoring of the geothermal project at Lavey-les-Bains (Valais, Switzerland). Using a combination of machine learning and migration (MALMI), coherence (Pyrocko/Lassie) and template matching (QuakeMatch) methods, we produce a high-quality, manually revised catalogue of natural events recorded in the vicinity of the project. We use this enhanced catalogue to evaluate our performance analysis tools.

Our comparative analysis, shows the accuracy of the methods employed to assess the performance of our seismic networks, ensuring they meet the minimum monitoring requirements proposed in the Guidelines for Managing Induced Seismicity in Deep Geothermal Projects in Switzerland.

Registros sísmicos del meteorito Traspenna

Seismic records of the Traspenna meteorite

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RESUMEN

La entrada de bólidos en la atmósfera crea ondas infrasónicas mediante varios mecanismos: entrada hipersónica y fragmentación. Esos frente de ondas infrasónicos viajan a través de la atmósfera siendo refractados y guiados hasta largas distancias, dependiendo del gradiente de temperatura, humedad y de la estructura del viento. Este frente de onda sónico se atenúa en su propagación por el aire y posterior interacción con el suelo, convirtiéndose en ondas sísmicas y posibilitando su detección por estaciones sísmicas cercanas.

El meteorito Traspenna cayó el 18 de enero de 2021 a unos 20 km al sureste de la ciudad de Lugo (Galiza, España), poco después de observarse una enorme y brillante bola de fuego que cruzaba el cielo. Se utilizaron mediciones astrométricas obtenidas de las cámaras dedicadas a la detección de bólidos de la Universidade de Santiago de Compostela (USC), así como de numerosos vídeos casuales, para determinar su trayectoria atmosférica. Dos meses después de que ocurriera, se halló un meteorito de 527 g.

Podemos encontrar hasta 9 estaciones sísmicas en el entorno de la trayectoria del bólido de Traspenna pertenecientes a la Red Sísmica Digital Española (Instituto Geográfico Nacional, España). Sólo en tres de estas estaciones fue posible detectar un evento compatible con el bólido tras procesar y filtrar los datos adecuadamente. Al observar las historias temporales sísmicas, podemos identificar ondas superficiales provenientes de la entrada hipersónica del meteoritoide y ondas longitudinales con amplitudes predominantes debido a fragmentaciones y contenido frecuencial principalmente alrededor de 15 Hz. Los tiempos de llegada son compatibles con un valor de velocidad de $278 \pm 93 \text{ m s}^{-1}$ que es compatible con la velocidad de una onda sonora. Las amplitudes de la parte de fragmentación nos ofrecen valores energéticos entre $(0,8-1,3) \cdot 10^{10}$ y $(2-3) \cdot 10^7 \text{ J}$ dependiendo de la estación sísmica considerada.

SUMMARY

The entrance of bolides/fireballs in the atmosphere creates infrasound waves by various mechanism: hypersonic entry and meteoroid fragmentation. Those infrasound frontwaves travel through atmosphere being refracted and guided over long distances highly dependent on the temperature and humidity gradient and the wind structure of the atmosphere itself. The sonic wavefront also suffers the consequent decay of energy with distance in its propagation through the air and subsequent interaction with the ground, becoming seismic waves and making possible its detection by seismic stations in the vicinity.

The Traspenna meteorite fell on 18 January 2021 about 20 km southeast of the city of Lugo (Galiza, Spain), shortly after a huge and bright fireball crossed the sky. Astrometric measurements obtained from the fireball cameras of the Universidade de Santiago de Compostela (USC) as well as from many casual videos were used to determine the atmospheric trajectory of this fireball which penetrated the atmosphere and generated sound waves that were detected at three seismic stations. Two months after the fireball occurred, a 527 g meteorite was found.

We can find up to 9 seismic station in the surroundings of the Traspenna bolide trajectory belonging to the Spanish Digital

Seismic Network (Instituto Geográfico Nacional, Spain). Only in three of these stations was it possible to detect an event compatible with the bolide after processing and filtering the data appropriately. Observing the seismic time histories, we can identify surface waves from the hypersonic entry of the meteoroid and longitudinal waves with predominant amplitudes due to fragmentations and significant frequency content around 15Hz. Arrival times are compatible with a velocity value of $278 \pm 93 \text{ m s}^{-1}$ which is compatible with a sound wave velocity. Amplitudes from fragmentation part offer us energy values between $(0.8-1.3) \cdot 10^{10}$ and $(2-3) \cdot 10^7 \text{ J}$ depending on the seismic station considered.

Detección automática y caracterización de desprendimientos usando datos sísmicos continuos de una única estación. Validación conjunta con LiDAR y fotogrametría

Automatic detection and characterization of rockfalls using continuous seismic data from a single station. Joint validation with LiDAR and photogrammetry

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RESUMEN

Puigcercós (Cuenca de Tremp, NE España) es una localidad en la que se encuentra un escarpe de coronación de un antiguo deslizamiento en el que la ocurrencia de desprendimientos de rocas tiene una alta frecuencia y donde el grupo RISK NAT-UB ha desarrollado un sitio experimental para el desarrollo de técnicas y métodos para la monitorización de este riesgo geológico.

El estudio de la repetitividad es esencial para la estimación de peligrosidad y riesgo, pero a menudo los catálogos de desprendimientos son incompletos y no contienen series históricas representativas. A través de años de monitorización regular con LiDAR y fotogrametría aplicados en Puigcercós, RISK NAT-UB ha podido realizar estudios temporales sobre el mecanismo de caída de rocas e indicadores precursoros. Incorporando monitorización sísmica continua con una única estación mejoramos esta resolución temporal y precisamos fenómenos más complejos (pequeños desprendimientos precursoros y caídas ocurridas en diferentes eventos que se consideraron como un único evento). También hemos podido caracterizar caídas de rocas de volúmenes muy pequeños ($V = 0,0005 - 0,02 \text{ m}^3$), cosa útil para el estudio de caídas precursoras y descripción de la dinámica de los desprendimientos. En general no abundan estudios en los que sólo se analicen datos de una única estación sísmica y estudien fenómenos de pequeña magnitud.

Por otro lado, las señales sísmicas que generan estos fenómenos son difíciles de clasificar automáticamente. En el registro continuo encontramos infinidad de eventos que conviene discernir, descartando señales causadas por fenómenos naturales (terremotos) o artificiales (paso de aviones) de las caídas de rocas o deslizamientos. En una primera fase, la sísmica se estudiará con diversos parámetros y técnicas junto con el soporte de Lidar y fotogrametría. Finalmente, esto nos permitirá aplicar una monitorización sísmica automática no vigilada y que permita un sistema de alerta temprana.

SUMMARY

Puigcercós (Tremp, NE Spain) has a head escarpment of an ancient landslide with a high-frequency rockfall activity and is one of the RISK NAT-UB group's study sites where has developed an experimental site for the development of techniques

and methods for monitoring this geological risk.

The study of the repeatability is essential for estimating their hazard and risk, but rockfall catalogues are often incomplete and do not contain representative historical series. Through years of regular LiDAR and photogrammetric monitoring applied to Puigcercós, the RISKNAT-UB group has been able to conduct temporal studies on the rockfall mechanism and precursor activity. By incorporating continuous seismic monitoring with a single station we improved this temporal resolution and we can describe more complex phenomena (small rockfalls precursors of a larger one and rockfalls occurred in multiple events that were considered as a single event). We have also been able to characterize rockfalls of very small volumes ($V= 0,0005 - 0,02 \text{ m}^3$), which is useful for the study of precursory rockfalls and the description of their dynamics. In general, there are not many studies in which only data from a single seismic station are analyzed and low-magnitude phenomena are studied.

On the other hand, seismic signatures caused by rockfalls are difficult to classify automatically. In the continuous record, we find countless events that should be discerned from different phenomena (natural as earthquakes or artificial as aircraft passage). In a first phase, rockfalls seismic events will be studied with various parameters and techniques together with the support of Lidar and photogrammetry. Finally, this will allow us to apply unattended automatic seismic monitoring and will allow an early warning system.

Modelo de rotura do sismo de Marrocos de 8 de Setembro de 2023 (Mw6.8)

Rupture model of the Morocco earthquake of September 8, 2023 (Mw6.8)

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RESUMO

O sismo (Mw6.8) que ocorreu no dia 8 de setembro de 2023, com epicentro próximo da aldeia de Talat N'Yaaqoub no Alto Atlas (Marrocos), abalou violentamente uma vasta área, incluindo pequenas aldeias de montanha em torno do epicentro até à cidade de Marraquexe, 70 km a nordeste do foco, afetando profundamente as infraestruturas de suporte de 2,8 milhões de pessoas e causando a perda de aproximadamente 3.000 vidas humanas.

Nesta comunicação serão apresentados os resultados de um estudo da fonte deste sismo, baseado na interpretação conjunta de dados sísmicos e geodésicos, registados respetivamente a distâncias telessísmicas e regionais. Os parâmetros que descrevem a rotura foram calculados em dois ciclos de processamento de maneira a reproduzirem com o maior rigor possível tanto os movimentos sísmicos observados como as deformações geodésicas registadas. A orientação do plano de falha e a profundidade focal são primeiramente estimadas por inversão de ondas volúmicas (P e SH) usando um modelo cinemático de fonte pontual. Seguidamente é feita uma nova inversão, segundo um modelo cinemático de fonte extensa, para calcular a distribuição de deslizamentos sobre o plano de falha e reposicionado o próprio plano por ajuste direto da deformação cossísmica modelada à correspondente deformação observada (InSAR). O modelo final da fonte é obtido num segundo ciclo de processamento onde as duas inversões (fonte pontual e fonte extensa) são repetidas, considerando a nova localização do plano de rotura.

SUMMARY

The earthquake (Mw6.8) that occurred on September 8, 2023, with its epicenter located near the village of Talat N'Yaaqoub in the High Atlas (Morocco), violently shook a vast area, including small villages in the surroundings of the epicenter until Marrakech city, 70 km northeast of the focus. This earthquake deeply affected the supporting infrastructure of 2.8 million

people and caused the loss of approximately 3,000 human lives.

This talk will present the results of the earthquake source study, based on the joint interpretation of seismic and geodetic data, recorded respectively at teleseismic and regional distances. The method employed to analyze the source involves two inverse modeling / direct search cycles to describe the rupture that accurately reproduces the observed surface seismic motions and deformations. The fault plane orientation and focal depth are preliminary estimated by the inversion of body waves using a kinematic point source model. Subsequently, a new inversion is conducted using a kinematic extended source model to compute the slip distribution over the fault plane, and its repositioning using a direct adjustment of the modeled co-seismic deformation to the corresponding observed one (InSAR). The final source model is obtained in a second processing cycle where the two inversions (point source and extended source) are repeated considering the rupture plane location fixed in the first cycle.

Enxame Sísmico na ilha de São Jorge, Açores no contexto de uma Intrusão magmática ocorrida em março de 2022.

Seismic Swarm on São Jorge Island, Azores in the context of a magmatic Intrusion in March 2022.

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RESUMO

No dia 19 de Março de 2022, pelas 17h11, desencadeou-se na Ilha de S. Jorge (Açores, Portugal), uma crise sísmica do tipo “enxame” com uma FREQUÊNCIA que atingiu uma frequência máxima de eventos 700 eventos/hora e cuja magnitude máxima atingiu 4,0 (Ml). Os epicentros distribuíram-se numa direção próxima do alinhamento da Ilha, ocupando faixa entre as Velas e o Pico da Esperança e ocorreram profundidades variáveis principalmente entre os 7 e os 13 km.

Esta sequência sísmica é atribuída a uma intrusão magmática superficial, e essa relação é confirmada por imagens InSAR (Radar de Abertura Sintética Interferométrico), que revelaram padrões significativos de deslocamento do solo consistentes com movimento de magma sob a base da litosfera localizada sob a Ilha.

Apresentaremos os resultados da sismicidade e a fonte desta sequência, efetuada com base em dados recolhidas pelas estações permanentes do IIPMA e por uma rede sísmica temporária instalada nas ilhas de S. Jorge Pico e Faial destinadas à monitorização desta crise sísmica.

SUMMARY

On March 19, 2022, at 5:11 PM, a seismic swarm crisis occurred on São Jorge Island (Azores, Portugal), with a maximum frequency of 700 events per hour and a maximum magnitude of 4.0 (M). The epicenters were distributed in a direction close to the alignment of the island, spanning from Velas to Pico da Esperança, at depths ranging from 7 to 13 km.

This seismic sequence can be attributed to a shallow magmatic intrusion and its relationship is substantiated by InSAR (Interferometric Synthetic Aperture Radar) images, which revealed significant ground displacement patterns consistent with the movement of magma beneath the Earth's surface

We will present the results of the seismicity and source of this sequence, based on data collected by permanent IPMA stations and a temporary seismic network installed for the monitorization of this seismic crisis.

Nueva información documental sobre los terremotos de 1855 y 1902 en la Región de Murcia y su asociación probable con la falla de Carrascoy

New documentary information on the 1855 and 1902 earthquakes in Región de Murcia and its likely association with the Carrascoy Fault

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RESUMEN

La falla de Carrascoy ocupa una posición geodinámica clave en el contexto de las Cordilleras Béticas orientales (SE de España) al articular el relevo entre las fallas de Alhama de Murcia y Bajo Segura. Estudios recientes sugieren que terremotos generados en estas fallas producen un aumento de los esfuerzos de coulomb sobre la falla de Carrascoy (Yazdi y García-Mayordomo, in press) y, por tanto, la ocurrencia de terremotos disparados a lo largo de la misma. El catálogo sísmico español (IGN, 2023; Cabañas et al., 2015) localiza numerosos eventos de tamaño grande ($M_w > 6.0$) en poblaciones inmediatas a las fallas de Alhama de Murcia y Bajo Segura, indicando a priori una relación evidente con la actividad de éstas. Contrariamente, a lo largo de la falla de Carrascoy el catálogo del IGN no localiza apenas eventos significativos en todo el periodo pre-instrumental (1050 al 1920), excepto la serie sísmica de 1743-1756 (IEMS=VII; $M_w 5.4 \pm 0.8$) con epicentro macrosísmico en la ciudad de Murcia, apenas 5 km al norte de la falla de Carrascoy. Esta situación puede explicarse por un relativo silencio sísmico de la falla de Carrascoy, o porque la localización macrosísmica de algunos terremotos pueda estar sesgada por la ubicación predominante de las poblaciones en la margen norte del valle del Guadalentín, controlada por la falla de Alhama de Murcia. En relación con este aspecto, en este trabajo presentamos el caso de dos terremotos que por su situación podrían relacionarse con la falla de Alhama de Murcia, pero que a la luz de nuevas fuentes documentales se pueden asociar fehacientemente con la falla de Carrascoy. En particular nos referimos a los terremotos de noviembre de 1855 (IEMS=VI-VII; $M_w 5.1 \pm 0.8$) con epicentro macrosísmico entre Alhama de Murcia y Librilla, y el terremoto de mayo de 1902 (IEMS=VI; $M_w 4.9 \pm 0.5$) al norte de Javalí Viejo (oeste de Murcia metropolitana).

SUMMARY

The Carrascoy Fault holds a key geodynamic role in the Eastern Betic Cordillera context (SE Spain) in articulating the relay between the Alhama de Murcia and Bajo Segura faults. Recent studies suggest that earthquakes generated in these faults transfer positive Coulomb stresses onto the Carrascoy Fault (Yazdi and García-Mayordomo, in press) and so the triggering of earthquakes along it. The Spanish seismic catalogue (IGN, 2023; Cabañas et al., 2015) locates numerous major events ($M_w > 6.0$) in towns located in the vicinity of the Alhama de Murcia and Bajo Segura faults, thus, suggesting a priori relationship with them. Conversely, the IGN catalogue barely locates events along the Carrascoy Fault in the whole pre-instrumental period (1050 to 1920), except for the 1743-1756 seismic sequence with macroseismic epicenter in Murcia city (IEMS=VII; $M_w 5.4 \pm 0.8$), just 5 km north of the Carrascoy Fault. This may be interpreted as due to either a relative seismic silence of the Carrascoy Fault or a location bias due to higher population density along the northern margin of the Guadalentín Valley, controlled by the Alhama de Murcia Fault. In this work we present the case of two earthquakes initially thought to be related to the Alhama de Murcia Fault, but in the light of the new documentary evidence we can confidently relate to the Carrascoy Fault. In particular, we are referring to the November 1855 event (IEMS=VI-VII; $M_w 5.1 \pm 0.8$) with epicenter formerly located between Alhama de Murcia and Librilla towns, and the May 1902 event (IEMS=VI; $M_w 4.9 \pm 0.5$)

formerly located at Javalí Viejo (north of metropolitan Murcia).

Estudio de posibles emplazamientos para el despliegue de estaciones sísmicas mediante el análisis de la densidad espectral de potencia

Study of possible locations for the deployment of seismic stations using the power spectral density analysis

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RESUMEN

El nivel de ruido sísmico de fondo en un determinado emplazamiento ejerce una influencia significativa sobre el umbral de detectabilidad de un sismógrafo. La instalación de equipos de registro avanzados tecnológicamente, que suelen implicar un elevado coste, en ubicaciones con un alto nivel de ruido sísmico, conlleva el registro de señales de baja calidad. Esto puede dar lugar a errores significativos en la localización de eventos sísmicos registrados por estas estaciones. Por consiguiente, la selección adecuada de los emplazamientos para las estaciones sísmicas que componen una red es de suma importancia.

En este estudio, se analiza la densidad espectral de potencia de los registros obtenidos en varios emplazamientos. La recopilación de datos durante periodos continuos de entre 5 y 15 días permite evaluar el nivel de ruido sísmico en cada uno de ellos. La comparación de las curvas resultantes con los modelos de ruido sísmico establecidos por Peterson permite identificar qué emplazamientos son apropiados para la instalación de una estación sísmica, y cuáles deberían descartarse debido a su alto nivel de ruido.

SUMMARY

The background seismic noise level at a given site exerts a significant influence on the detectability threshold of a seismograph. The deployment of technologically advanced recording equipment, which typically entails considerable costs, in locations with a high level of seismic noise often results in the recording of low-quality signals. This can lead to significant errors in the localization of seismic events recorded by these stations. Therefore, the appropriate selection of sites for the seismic stations composing a network is of paramount importance.

In this study, the Power Spectral Density analysis is applied on the recordings obtained at various sites. Data collection during continuous periods ranging from 5 to 15 days allows the assessment of the seismic noise level at each location. The comparison of the resulting curves with the seismic noise models established by Peterson enables the identification of which sites are more suitable for the installation of the seismic stations, and which ones should be discarded due to their high noise level.

Preenchendo o mapa do fluxo de calor em Portugal continental

Filling the map of heat flow in mainland Portugal

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RESUMO

Tendo em vista o estudo térmico de duas regiões onde se têm vindo a registar sismos, foram obtidos, utilizando modelos numéricos, valores de fluxo de calor por condução, na direção vertical. Atendendo a que, nas regiões referidas, não existiam dados de fluxo de calor, os resultados obtidos constituem um aumento significativo do conhecimento deste parâmetro em Portugal Continental.

Por questões práticas vamos denominar as regiões por A e B. A região A, a que poderíamos chamar "Vendas Novas – Arraiolos" localiza-se na Zona de Ossa Morena incluindo no bordo Oeste formações miocénicas que poderemos associar à bacia do Tejo e seus afluentes. A região B, localizada na zona Ocidental do Algarve, inclui o Maciço de Monchique e formações que o rodeiam.

Os valores de fluxo obtidos estão diretamente relacionados com o conteúdo em fontes de origem radioativa, não tendo sido consideradas possíveis fontes térmicas associadas a reações químicas. Na região A os valores menos elevados foram obtidos no lado Oeste, não atingindo valores superiores a 85 mWm^{-2} na fronteira Este. O valor médio do fluxo de calor obtido nesta região é cerca de 80 mW m^{-2} . Na região B, o Maciço de Monchique é caracterizada por conteúdos radioativos elevados face aos observados nas regiões que o rodeiam, tendo sido obtidos valores de fluxo de calor em 4 regiões diferentes do Maciço, que contrastam com os valores obtidos para formações vizinhas.

SUMMARY

Trying to make the thermal study of two regions where earthquakes have been registered, values of heat flow by conduction in the vertical direction were obtained using numerical models. Considering that, in the aforementioned regions, there were no data on heat flow, the results obtained constitute a significant increase in the knowledge of this parameter in mainland Portugal.

For practical reasons, we will call the regions A and B. Region A, which we could call "Vendas Novas – Arraiolos", is located in the Ossa Morena Zone, including on the western border Miocene formations that we can associate with the Tagus basin and its tributaries. Region B, located in the western part of the Algarve, includes the Monchique Massif and the formations surrounding it.

The heat flow values obtained are directly related to the content in sources of radioactive origin, and no possible thermal sources associated with chemical reactions were considered. In region A, the lowest values were obtained on the western side, non reaching values higher than 85 mWm^{-2} on the eastern border. The average value of the heat flow obtained in this region is about 80 mW m^{-2} . In region B, the Monchique Massif is characterized by high radioactive contents compared to those observed in the regions surrounding it. Heat flow values were obtained in 4 different regions of the Massif, which contrast with the values obtained for neighboring formations.

Análisis de la aportación de las técnicas geoespaciales y la inteligencia artificial en el estudio de la exposición sísmica en ciudades prioritarias de Centroamérica y Caribe

Analysis of the contribution of geospatial techniques and artificial intelligence in the study of seismic exposure in priority cities in Central America and the Caribbean

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RESUMEN

En algunas regiones del planeta, como en Centroamérica, la amenaza sísmica condiciona el desarrollo y viabilidad de los núcleos de población. El análisis del riesgo sísmico requiere del conocimiento previo de la exposición sísmica de las poblaciones. El Global Earthquake Model (GEM) ha propuesto un método global para la evaluación de la exposición sísmica que caracteriza las edificaciones mediante trece atributos.

Se presenta la aplicación de técnicas geoespaciales y la inteligencia artificial en la evaluación de la exposición sísmica en tres capitales de la región Centroamérica-Caribe: San José, Guatemala y Santo Domingo. Se han obtenido varios atributos del GEM: superficie y forma en planta, material de la cubierta, año de construcción, posición relativa del edificio dentro de la manzana, porcentaje de superficie de la manzana ocupada por los edificios y altura de las edificaciones. Además, se han aplicado algoritmos de machine-learning en bases de datos de imágenes para la obtención de la huella y la altura de los edificios.

Tras esta primera fase, se clasifican todas las edificaciones en clases estructurales y, mediante un algoritmo Random Forest, se evalúa la capacidad de predecir la clase de las edificaciones a partir de los atributos geoespaciales. Se han probado varias configuraciones, obteniendo en la mejor de ellas un error de clasificación del 13,55%.

Las técnicas geoespaciales y la inteligencia artificial permiten la obtención rápida y masiva de un cierto número de atributos fundamentales para la exposición sísmica. No obstante, por ahora, no es posible caracterizar completamente las estructuras según la metodología GEM. Por ello, se recomienda aplicar esta metodología en casos de emergencia y en estudios preliminares, para estratificar los edificios y planear eficientemente los trabajos de campo subsiguientes.

Esta investigación se ha realizado con el apoyo del Programa de Doctorados Industriales de la Comunidad de Madrid (IND2020/TIC-17528; IND2023/TIC-28743)

SUMMARY

In some regions of the planet, such as Central America, the seismic threat conditions the development and viability of population centers. The analysis of seismic risk requires prior knowledge of the seismic exposure of the populations. The Global Earthquake Model (GEM) has proposed a global method for evaluating seismic exposure that characterizes buildings through thirteen attributes.

The application of geospatial techniques and artificial intelligence in the evaluation of seismic exposure in three capitals of the Central American-Caribbean region is presented: San José, Guatemala and Santo Domingo. Several attributes have been obtained from the GEM: surface area and plan shape, roof material, year of construction, relative position of the building within the block, percentage of the block surface occupied by buildings and building height. In addition, machine-learning algorithms have been applied to image databases to obtain the footprint and height of the buildings.

After this first phase, all buildings are classified into structural classes and, using a Random Forest algorithm, the ability to predict the class of the buildings from the geospatial attributes is evaluated. Several configurations have been tested, obtaining in the best of them a classification error of 13.55%.

Geospatial techniques and artificial intelligence allow the rapid and massive obtention of a certain number of fundamental attributes for seismic exposure. However, for now, it is not possible to fully characterize the structures according to the GEM methodology. Therefore, it is recommended to apply this methodology in emergency cases and in preliminary studies, in order to stratify buildings and efficiently plan subsequent field work.

This research has been carried out with the support of the Industrial Doctorate Program of the Community of Madrid (IND2020/TIC-17528; IND2023/TIC-28743)

S.03 - Geomagnetismo e Aeronomia / Geomagnetismo y Aeronomía

Mapa de Declinaciones Magnéticas de la Península Ibérica y las Islas Baleares de la época 2020.0

Magnetic Declination Map of the Iberian Peninsula and the Balearic Islands for the epoch 2020.0

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RESUMEN

A finales de 2023, el Instituto Geográfico Nacional (IGN) publicó el Mapa de Declinaciones Magnéticas de la Península Ibérica y las Islas Baleares de la época 2020.0, siguiendo el intervalo recomendado por la Asociación Internacional de Geomagnetismo y Aeronomía (IAGA) para la publicación de la cartografía de cada componente del campo geomagnético. El mapa muestra, a escala 1:2000000, las isólinas de declinación, o isógonas, y las isólinas de variación secular, o isóporas, referidas a la fecha común de 1 de enero de 2020 sobre la completitud del territorio de la Península y Baleares. De esta forma, se ha recuperado la unidad de representación mencionada, que había sido empleada regularmente en la cartografía geomagnética del IGN de las épocas 1924.0 a 1970.0, y por tanto se ha conseguido la deseable continuidad en la representación del campo geomagnético en la Península Ibérica.

Como novedad adicional, el Mapa de Declinaciones Magnéticas de 2020.0 se ha preparado a partir de la modelización regional del campo interno principal en el periodo 2014.5-2020.5, realizada por medio de técnicas de análisis armónico en casquetes esféricos (SCHA) y en claro contraste con la modelización isopórica polinomial empleada en épocas anteriores. En este sentido, el nuevo modelo ha permitido obtener la declinación magnética en 2020.0 en 751 estaciones de mapa distribuidas en España peninsular y Baleares, en las que el IGN había observado el campo interno completo, o campo total, entre los años 1988 y 1993. Igualmente, se ha modelizado la declinación en 2020.0 en 348 estaciones de mapa localizadas en Portugal continental, a partir de los valores de declinación utilizados en la producción del Mapa Geomagnético de la Península Ibérica de la época 1960.0.

SUMMARY

At the end of 2023, the Instituto Geográfico Nacional (IGN) from Spain published the Magnetic Declination Map of the Iberian Peninsula and the Balearic Islands for the epoch 2020.0, following the recommendations of the International Association of Geomagnetism and Aeronomy (IAGA) regarding the publication interval of the cartography of each geomagnetic component. This map shows, at a scale of 1:2000000, the declination isolines, or isogones, and the isolines of secular variation, or isopores, both referring to the common date of 1st January 2020 and covering the complete territory of the Iberian Peninsula and the Balearic Islands. In this regard, we have recovered the aforementioned representation unit, which had been used regularly in the geomagnetic cartography of IGN for the epochs between 1924.0 and 1970.0, and we have consequently achieved the desirable continuity in the representation of the geomagnetic field in the Iberian Peninsula.

As an additional novelty, the 2020.0 Magnetic Declination Map has been prepared by means of the regional modelling of the main geomagnetic internal field in the period 2014.5-2020.5. This geomagnetic model has been generated using

Spherical Cap Harmonic Analysis (SCHA) techniques, in clear contrast with the polynomial isoporic modelling applied in precedent epochs. In this context, the new model has allowed us to compute the magnetic declination at 2020.0 at 751 map stations deployed across mainland Spain and the Balearic Islands, where the IGN had observed the complete internal field, or total field, between the years 1988 and 1993. Furthermore, the 2020.0 declination has been modelled at 348 map stations located in continental Portugal, by means of the declination values used in the production process of the Geomagnetic Map of the Iberian Peninsula for the epoch 1960.0.

Spatial total electron content gradients for Iberian Peninsula and Portuguese and Spanish archipelagos during geomagnetically storm of 2023

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SUMMARY

Safety of civil aviation depends on the quality of GNSS services providing precise positioning during an aircraft landing. In turn, the quality of GNSS signal can be drastically affected by ionospheric disturbances including sharp spatial gradients of electron density.

Here we present an analysis of spatial gradients of the total electron content (TEC) for the Iberian Peninsula and Portuguese and Spanish archipelagos (Azores, Madeira, Canary Islands) during three strong geomagnetic storms of 2023. The analysis was performed using TEC gradients calculated both using the global ionospheric maps (GIMs) and data from ground GNSS receivers.

Información de la declinación geomagnética extraída de los trabajos topográficos de deslindes de municipios realizados por el IGN en el año 1871

Geomagnetic declination information extracted from the topographic works of municipal boundaries carried out by IGN in 1871.

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RESUMEN

En el año 1871, el recién creado Instituto Geográfico Nacional (IGN) comenzó a realizar los trabajos encaminados a la elaboración del Mapa Topográfico Nacional de España, una gran empresa que tardaría casi 100 años en finalizarse.

Dichos trabajos comenzaron con la medida de bases geodésicas por todo el territorio nacional. Posteriormente se llevaron a cabo los trabajos topográficos necesarios para delimitar los municipios y poder representar planimétricamente todos los elementos de cada término municipal. Parte de estos trabajos fueron realizados con brújulas topográficas, que permitían trabajar con bastante velocidad y suficiente precisión para las necesidades del Mapa.

El IGN conserva en sus archivos toda la documentación de los trabajos llevados a cabo para realizar este gran proyecto. De esta documentación se pretende extraer información de la declinación magnética medida en aquella época y valorarla como una posible fuente de información geomagnética histórica para su uso en posteriores trabajos.

SUMMARY

In 1871, the newly created Instituto Geográfico Nacional of Spain (IGN) began to carry out the works for the preparation of the National Topographic Map of Spain, a great project that would take almost 100 years to be completed.

These works began with the measurement of geodetic bases all over the national territory. Subsequently, the topographic surveys needed to delimit boundaries of municipalities and to represent all the planimetric elements, were performed. Part of these works were carried out with topographic compasses, which permitted working at good speed with enough accuracy for the map requirements.

The IGN preserves in its archives all the documentation generated in the works carried out to accomplish this great project. From this documentation, information of the magnetic declination measured in that time is intended to be extracted, and to be assessed as a possible source of historic geomagnetic information for its use in further works.

Predicción del Ciclo Solar 26 mediante Parámetros Precursores Solares/Geomagnéticos, Análisis Espectral y Técnicas de Machine Learning

Prediction of Solar Cycle 26 using Solar/Geomagnetic Precursor Parameters, Spectral Analysis, and Machine Learning Techniques

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RESUMEN

Se presenta un nuevo método para la predicción del Ciclo Solar —en términos del índice del número de manchas solares (S_N , versión 2 de SILSO: <https://www.sidc.be/SILSO/datafiles>)— basado en algoritmos de Machine Learning multivariante, parámetros precursoros solares/geomagnéticos y análisis espectral de todas las series temporales consideradas mediante la transformada rápida de Fourier. Esta última permite identificar periodicidades con las que desplazar las series, produciendo así nuevos predictores para el modelo de predicción. Así, se espera que la combinación de estas tres técnicas permita obtener estimaciones más precisas y fiables de la actividad solar. Para la predicción multivariante del S_N , con el fin de garantizar que sólo seleccionamos aquellos precursoros que estén altamente correlacionados con el S_N (es decir, que sean susceptibles de predecir dicho parámetro de una manera más precisa), utilizamos un clasificador de regresión lineal para realizar un ranking de relevancia (correlación) de las series precursoras con respecto al S_N . Finalmente, se presentan predicciones para el S_N hasta enero de 2038, abarcando el actual Ciclo Solar 25 y el próximo Ciclo Solar 26 (usando el S_N suavizado de 13 meses). Los máximos estimados para dichos ciclos son 134.2 ± 9.8 (en junio de 2024) y 115.4 ± 9.8 (en mayo de 2034), respectivamente. Esto sugiere que el máximo del Ciclo 25 estará por debajo de la media, mientras que el del 26 presentará un pico inferior al de los precedentes. De acuerdo con estos resultados, los Ciclos Solares 24, 25 y 26 podrían pertenecer a un mínimo del ciclo centenario de Gleissberg, tal y como ocurrió con los Ciclos 12, 13 y 14 a finales del siglo XIX y principios del XX.

SUMMARY

We present a new approach for solar cycle prediction regarding the sunspot number (S_N , version 2 from SILSO: <https://www.sidc.be/SILSO/datafiles>). Our method incorporates multivariate machine learning algorithms, a set of solar/geomagnetic precursor parameters, and spectral analysis of all considered time series using the fast Fourier transform; the latter enables the identification of periodicities with which the series can be lagged, thereby producing new attributes as predictors for the prediction model. The combination of the mentioned three techniques is expected to provide more accurate and reliable predictions of solar activity. For the multivariate forecast of S_N , to ensure that we only select those precursor series that highly correlate with S_N (i.e., are likely to predict it more precisely), we use a linear regression classifier to perform a relevance ranking (correlation) of the precursor series regarding S_N . Using this method, we offer predictions for S_N until January 2038, encompassing Solar Cycles 25 (the current one) and 26 (based on the 13-month smoothed S_N); the predicted maximum values for the cycles are 134.2 ± 9.8 (in June 2024) and 115.4 ± 9.8 (in May 2034), respectively. This suggests that the maximum of Cycle 25 will be below average, while that of Cycle 26 will have a lower peak than the preceding cycles. In view of these results, Solar Cycles 24, 25, and 26 could belong to a minimum of the centennial Gleissberg cycle, as was the case with Solar Cycles 12, 13, and 14 at the turn of the 20th century.

Validación de la modelización de corrientes inducidas geomagnéticamente en la red eléctrica española mediante mediciones magnetométricas diferenciales

Validating geomagnetically induced currents modeling in the Spanish power grid using differential magnetometer measurements

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RESUMEN

Este estudio aborda el fenómeno de las corrientes inducidas geomagnéticamente (GICs) y su impacto en las redes de transporte eléctrico, centrándose en España. Las GICs son causadas por la actividad solar que afecta a la magnetosfera y a la ionosfera de la Tierra, dando lugar a campos eléctricos que inducen corrientes en las líneas y transformadores de esas redes, pudiendo, en casos extremos, producir la interrupción del servicio. Describiremos el desarrollo y despliegue de una red de estaciones de medida del campo geomagnético usando el Método de Magnetometría Diferencial (DMM) para medir las GICs indirectamente a lo largo de las líneas de alta tensión. Explicaremos la configuración de las estaciones DMM y los retos que plantea su mantenimiento en ubicaciones remotas. También discutiremos la validación de nuestros modelos para estimar las GICs utilizando datos de estas estaciones. Destacaremos que para realizar predicciones precisas de las GICs hay que modelar con precisión la resistividad del subsuelo terrestre y tener medidas fiables de las variaciones del campo geomagnético y presentaremos resultados que muestran distintos niveles de concordancia entre la GIC medida y modelada durante tormentas geomagnéticas. Por último, describiremos el diseño de funciones de transferencia adecuadas para que, aprovechando los datos ya registrados en las estaciones DMM y los registros continuos en los observatorios geomagnéticos, podamos dejar de registrar en estos lugares remotos y seguir disponiendo de estimaciones razonables de las GICs.

SUMMARY

This study addresses the phenomenon of geomagnetically induced currents (GICs) and their impact on power grids, focusing on Spain. GICs are caused by solar activity affecting Earth's magnetosphere and ionosphere, leading to electric fields that induce currents in power grid infrastructure. We will describe the development of a network of Differential Magnetometry Method (DMM) stations to measure GICs indirectly along power transmission lines. We will explain the setup of the stations and the challenges of maintaining them in remote locations. We will also discuss the validation of our GIC models using data from these stations, comparing them with model estimates. We will stress that accurate GIC predictions require accurate modelling of the earth's subsurface resistivity and reliable measurements of geomagnetic field variations and will present case studies showing different levels of agreement between measured and modeled GICs during geomagnetic storm events. Finally, we will describe the design of appropriate transfer functions so that, taking advantage of the data already recorded at the DMM stations and the continuous records at the geomagnetic observatories, we could stop recording at these remote sites and still have reasonable estimates of GICs.

Análise de séries temporais para estudo de viabilidade da instalação de um observatório magnético no Centro Meteorológico de Viseu (colaboração OGAUC/IPMA)

Time series analysis for the feasibility study of installing a magnetic observatory at the Viseu Meteorological Centre (OGAUC/IPMA collaboration)

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RESUMO

À medida que o conhecimento e o interesse da Meteorologia Espacial progridem, os requisitos operacionais dos observatórios magnéticos tornam-se mais exigentes. Assegurar o registo de qualidade dos sinais de alta frequência (≥ 1 Hz), usualmente os mais perturbados pelo ruído eletromagnético urbano e industrial, torna-se essencial para estudar e mitigar o impacto dos fenómenos mais energéticos, como as tempestades geomagnéticas.

Fundado em 1864, o observatório magnético de Coimbra (COI), hoje operado pelo Observatório Geofísico e Astronómico da Universidade de Coimbra (OGAUC), enfrenta dificuldades relacionadas com a qualidade do sinal natural de alta frequência devido à sua localização periurbana. De forma a garantir a continuidade das observações geomagnéticas de qualidade na zona centro de Portugal, o OGAUC e o Instituto do Mar e da Atmosfera de Portugal (IPMA) planeiam a instalação de um novo observatório no Centro Meteorológico de Viseu (VIS), localizado a 70 Km a nordeste de Coimbra. Para estudar a viabilidade do local selecionado foi instalado (11/2022 – 10/2023) um variómetro (Geomag-02M) com uma taxa de aquisição 1 Hz das componentes ortogonais (XYZ) do campo geomagnético. Estas séries foram analisadas em comparação com as séries homólogas dos observatórios COI e SPT (San Pablo-Toledo, Espanha).

A análise prévia dos primeiros sete meses de dados mostrou que as curvas magnéticas das três estações apresentam um comportamento globalmente semelhante. Não obstante, foi possível confirmar a presença de perturbações artificiais da ordem de 1 nT nas séries de 1 Hz e 1 minuto de COI. Estes resultados preliminares mostram que, ao contrário de COI, as séries de VIS (e SPT) não exibem ruído no sinal geomagnético, o que sugere que as condições ambientais são favoráveis à aquisição de um sinal limpo de perturbações antropogénicas em toda a gama de frequências analisada.

SUMMARY

As knowledge and interest in Space Weather increase, the operational requirements of magnetic observatories become more demanding. Ensuring quality recording of high-frequency signals (≥ 1 Hz), often the most affected by urban and industrial electromagnetic noise, becomes essential to study and mitigate the impact of more energetic phenomena such as geomagnetic storms.

Founded in 1864, the Coimbra Magnetic Observatory (COI), now operated by the Geophysical and Astronomical Observatory of the University of Coimbra (OGAUC), faces difficulties related to the quality of the natural high-frequency signal due to its peri-urban location. In order to guarantee the continuity of quality geomagnetic observations in central Portugal, OGAUC and the Portuguese Institute of the Sea and Atmosphere (IPMA) are planning to install a new observatory at the Viseu Meteorological Centre (VIS), located 70 km north-east of Coimbra. To study the feasibility of the selected site, a variometer with a 1 Hz acquisition rate of the orthogonal components (XYZ) of the geomagnetic field was installed (11/2022 – 10/2023). These series were analyzed in comparison with the homologous series from the COI and SPT (San Pablo-Toledo, Spain) observatories.

Preliminary analysis of the first seven months of data showed that the magnetic curves of the three stations show a broadly similar behavior. Nevertheless, it was possible to confirm the presence of artificial disturbances of the order of 1 nT in the 1 Hz and 1 minute series from Coimbra. These preliminary results show that, unlike COI, the VIS (and SPT) data series do not exhibit noise in the geomagnetic signal, which suggests that the environmental conditions are favorable for acquiring a signal free of anthropogenic disturbances throughout the frequency range analyzed.

How differences in Earth's subsurface affect Geomagnetic Induced Currents estimations

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SUMMARY

Geomagnetically Induced Currents (GICs) result from rapid fluctuations in the Earth's geomagnetic field, driven by intense solar wind activity. These induced currents flow within the Earth's surface and traverse conductive human-made infrastructure, such as power systems grounded to Earth. In today's interconnected world, the calculation of GICs has assumed paramount significance, owing to the potentially catastrophic repercussions they can inflict, including large-scale blackouts.

Accurate GIC simulations require a comprehensive understanding of various factors, including geomagnetic field variations, Earth's conductivity, and parameters related to the power grid. To improve our ability to estimate GIC magnitudes, we investigate the impact of different conductivity models with varying spatial resolutions on our simulations. We introduce a novel metric, the correlation-regression ratio (CRR), to assess and quantify how these models influence GIC predictions.

Our research is centred on the complex geological environment of Southern Portugal. We employ two conductivity models with different MT sounding grids (50x50 km and 30x30 km) to investigate the impact on GIC simulations. We aim to enhance our comprehension of GIC behaviour and boost the precision of predictive models, increasing the resilience of vital infrastructure to geomagnetic disturbances.

Spanish candidate for the Definitive Geomagnetic Reference Field (DGRF) for 2020

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SUMMARY

As we approach 2025, the next generation of the International Geomagnetic Reference Field (IGRF) is being prepared by an international, multi-institutional collaboration in which different teams submit their candidates to describe the large-scale and time-varying part of the Earth's main magnetic field. This will be the fourteenth generation of the IGRF: the IGRF-14. For the previous generation, launched in 2020, a Spanish team from different national institutions participated for the first time by contributing the Spanish candidate for IGRF-13. For the next generation, this team will contribute with the submission of three models: one for the description of the main field in 2025, another for an estimate of the secular variation for the period 2025-2030, and a revision of the main field in 2020 defined by the previous generation IGRF-13. This model revision is known as Definitive-IGRF (DGRF). In this work, we present the preparation of our 2020 DGRF candidate, based on data from the trio of satellites of the Swarm mission (European Space Agency) and the global network of ground-based geomagnetic observatories. A retrospective analysis is presented comparing our previous 2020 IGRF candidate, IGRF-13, and our new DGRF candidate.

Propuesta de estudio de la influencia de los eclipses de Sol en el campo magnético terrestre mediante una red de detectores de rayos cósmicos en superficie

Proposal to study the influence of solar eclipses on the Earth's magnetic field using a network of ground-based cosmic ray detectors

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RESUMEN

En los años 2026 y 2027 se van a producir dos eclipses totales de Sol sobre la Península Ibérica y en el año 2028 un eclipse anular. Dada la poca frecuencia de dicho tipo de eclipses, se trata de una ocasión única para profundizar en el conocimiento de como afectan dichos fenómenos a la geosfera y estudiar la posible aparición de efectos geomagnéticos transitorios.

Entre otros efectos, la perturbación del campo magnético terrestre debería de influir sobre la llegada de rayos cósmicos a la superficie terrestre y, en concreto, sobre la asimetría Este-Oeste. Este efecto debería de poder ser medido con detectores de rayos cósmicos con suficientes resolución angular y capacidad de tasa de conteo. Hasta donde sabemos un estudio así no se ha hecho con anterioridad por lo que es difícil estimar las prestaciones necesarias para obtener un resultado significativo. Se trataría de un estudio de indudable interés que podría abrir un nuevo método para el estudio de las variaciones del campo magnético terrestre.

Una opción para realizar este estudio sin un gran esfuerzo económico podría ser a través de un proyecto colaborativo entre universidades y laboratorios de investigación españoles y portugueses. Muchos de estos centros disponen de telescopios de muones, bien para tareas de investigación o de docencia, que se podrían usar para la ocasión. Dichos equipos se podrían complementar con nuevos detectores como los que constituyen la red Trasgo en la que participan la U. de Santiago de Compostela y el LIP de Coimbra. Con un número suficiente de equipos cubriendo todo el área de ambos países de Este a Oeste y de Norte a Sur se podrían hacer un análisis diferencial de la evolución del fenómeno. Con posterioridad al estudio de los eclipses todos los equipos usados podrían quedar como una infraestructura permanente para el estudio del campo magnético terrestre y la predicción de tormentas magnéticas.

SUMMARY

In the years 2026 and 2027 there will be two total solar eclipses over the Iberian Peninsula and in 2028 an annular eclipse. Given the rarity of this type of eclipse, it is a unique opportunity to deepen our knowledge of how these phenomena affect the geosphere and study the possible appearance of transient geomagnetic effects.

Among other effects, the disturbance of the Earth's magnetic field should affect the arrival of cosmic rays to the Earth's surface and, specifically, the East-West asymmetry of the arrival of secondary cosmic rays to the ground. This effect should be able to be measured with cosmic ray detectors with appropriate angular resolution and counting capability. As far as we know, such a study has not been done before, so it is difficult to estimate the performance necessary to obtain a significant result. It would be a study of undoubted interest that could open up a new method for the study of variations in the Earth's magnetic field.

An option to carry out this study without a great financial effort could be through a collaborative project between Spanish and Portuguese universities and research laboratories. Many of these centers have muon telescopes, either for research or teaching, which could be used for this purpose. Such equipment could be complemented with new detectors such as those of the Trasgo network in which the University of Santiago de Compostela and the LIP of Coimbra participate. With a sufficient number of teams covering the entire area of both countries from East to West and from North to South, a differential analysis of the evolution of the phenomenon could be carried out. After the study of eclipses, all the equipment used could remain as a permanent infrastructure for the study of variations in the Earth's magnetic field and the prediction of magnetic storms.

Recuperación y procesado de datos de levantamientos aeromagnéticos de la Península Ibérica, zonas marítimas próximas e Islas Canarias

Recovery and processing of aeromagnetic survey data of the Iberian Peninsula, its surrounding maritime areas and the Canary Islands

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RESUMEN

El Área de Geomagnetismo del Instituto Geográfico Nacional (IGN) ha llevado a cabo recientemente un proceso de recuperación y recopilación de los datos digitales correspondientes a la mayor parte de los levantamientos aeromagnéticos realizados por distintas instituciones en la Península Ibérica y en las zonas marítimas próximas, entre los años 1974 y 2005. Con estos datos se ha generado una cartografía continua de anomalías de la componente magnética Campo Total (F) en la Península Ibérica y parte de su entorno más próximo a escala 1:2250000. Para su elaboración se ha generado una malla de puntos con valores de anomalía a una altura de 3000 metros sobre el nivel del mar, a la que se ha aplicado un proceso cartográfico de interpolación y suavizado usando el software ArcGIS. De esta manera se ha generado un mapa detallado de anomalías magnéticas que incluye, además de la Península Ibérica, el Mar de Alborán, el Golfo de Cádiz y la Plataforma Continental al oeste de la Península.

Por otro lado, se han reutilizado los datos de anomalía de F del levantamiento aeromagnético de las Islas Canarias con los que el IGN realizó el Mapa de Anomalías Magnéticas de Canarias del año 1993, con la finalidad de actualizar y mejorar la visualización de la información temática de esa cartografía con técnicas modernas de SIG. En consecuencia, se ha elaborado un mapa general de las Islas Canarias a escala 1:2250000 y uno específico de cada isla a escala 1:200000 que muestran las anomalías de F a 3200 metros sobre el nivel del mar y permiten observar con alta precisión los fuertes gradientes de anomalía magnética presentes en estas regiones.

SUMMARY

The Geomagnetism Area of the Instituto Geográfico Nacional (IGN) from Spain has recently completed a program of recovery and compilation of digital data from the majority of the aeromagnetic surveys conducted by several institutions in the Iberian Peninsula and its surrounding maritime areas between 1974 and 2005. Using this data, a continuous cartography of magnetic Total Field (F) anomalies of this region has been produced at a scale of 1:2250000. With this purpose, a grid of points with anomaly values at a fixed height of 3000 meters above sea level was generated. Then, this grid was introduced as input into an interpolation and smoothing process in ArcGIS software. In this particular way, a very detailed map of magnetic anomalies including, apart from the Iberian Peninsula, the Alboran Sea, the Gulf of Cádiz and the western Iberian Continental Platform was accomplished.

Furthermore, data of F anomaly from the Canary Islands aeromagnetic survey, which had been used by the IGN for its 1993 Mapa de Anomalías Magnéticas de Canarias (Map of Magnetic Anomalies of the Canary Islands), have been now reused with the goal of updating and improving the visualization of its thematic information by means of modern techniques of

GIS. Consequently, a new general map of the Canary Islands at a scale of 1:2250000 has been prepared, along with a specific map for each island at the scale of 1:200000. These maps show F anomalies at 3200 meters above sea level and allow the observation of the strong anomaly gradients in these regions with high accuracy.

Adquisición de datos geoelectricos en el Observatorio Geofísico de San Pablo de los Montes (Toledo)

Geoelectric data acquisition at the San Pablo de los Montes Geophysical Observatory (Toledo)

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RESUMEN

Desde el año 2018, el Instituto Geográfico Nacional realiza observaciones del campo eléctrico en una estación geoelectrica dispuesta en el Observatorio Geofísico de San Pablo de los Montes (Toledo). El objetivo de estas observaciones geoelectricas es analizar su variación temporal y, en combinación con las observaciones geomagnéticas de alta calidad del Observatorio, tratar de caracterizar las tormentas geomagnéticas debidas a la actividad solar. En una etapa inicial de cinco años, el dispositivo consistía en cuatro electrodos impolarizables de Cu-CuSO₄ enterrados con bentonita, dispuestos en los extremos de tres brazos con un electrodo central común. En 2023, se ha renovado el dispositivo, pasando a una configuración de dos parejas de electrodos dispuestas en dos brazos con direcciones N-S y E-O, cada uno con una longitud aproximada de 65 m. Las medidas de diferencia de potencial eléctrico entre electrodos (potencial espontáneo o self-potential) son recogidas con digitalizador ADAM-4017 y almacenadas en plataforma de adquisición de datos MAGREC, permitiendo obtener el dato de potencial con precisión de segundo, además de la medida de la temperatura interna de la estancia que acoge ambos instrumentos, y del voltaje constante de la batería de alimentación de digitalizador y plataforma. En el corto periodo de tiempo transcurrido desde su puesta en funcionamiento, el dispositivo renovado ya ha detectado tormentas significativas, destacando el evento del 24/09/2023, registrado con índice K igual a 5 en el Observatorio.

SUMMARY

Since 2018, the Instituto Geográfico Nacional (Spain) conducts observations of the electrical field at a geoelectrical station deployed at the Geophysical Observatory of San Pablo de los Montes (Toledo). The aim of this geoelectrical observations is to analyze its temporal variation and, jointly with the high-quality geomagnetic observations recorded at the Observatory, to try to characterize the geomagnetic storms caused by solar activity. At an initial stage of five years, the station consisted of four non-polarizable electrodes of Cu-CuSO₄ buried with bentonite, which lied at the endpoints of three arms which shared a central electrode. In 2023, we have renovated the device, so that its new configuration presents two pairs of electrodes deployed along two arms oriented in N-S and E-W directions, each arm measuring approximately 65 m long. Measurements of the electrical potential (self-potential) in each direction are collected with a digitizer ADAM-4017 and stored in a platform of data acquisition MAGREC, allowing us to obtain the potential data with one-second accuracy, as well as the measurement of the internal temperature of the room where the two instruments are placed and the constant voltage of the battery of both the digitizer and the platform. In the short period of time passed since the renovated station started

to operate, it has already detected significant storms, among which the event occurred on the 24th September 2023 can be pointed out, recorded with K-index equal to 5 at the Observatory.

Caracterización de las variaciones geomagnéticas e ionosféricas en la Isla Livingston (Antártida)

Characterization of geomagnetic and ionospheric variations at Livingston Island (Antarctica)

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RESUMEN

Hace tres décadas, el Observatorio del Ebro empezó a participar en proyectos de I+D en la Antártida, actividad que se inició en la campaña 1994-1995 con el análisis de datos de la intensidad del campo geomagnético cerca de la Base Antártica Española Juan Carlos I. Ese primer esfuerzo marcó el inicio del Observatorio Geomagnético de la Isla Livingston, que comenzó su operación en diciembre de 1996. A lo largo de los años, se ha actualizado gradualmente la instrumentación para cumplir con los estándares de observación, manteniendo su funcionamiento ininterrumpido mientras se ha garantizado el suministro eléctrico, con personal científico y técnico presente solo durante los veranos australes y operando de forma automática el resto del año. Los registros del observatorio han revelado variaciones en el campo magnético en diversas escalas temporales, desde segundos hasta décadas, proporcionando información crucial para comprender procesos terrestres y solares. Durante la campaña 2004-2005 se agregó una sonda ionosférica para complementar esos estudios en el ámbito de la actividad ionosférica que afecta la propagación de ondas de radio, aunque su operación se limita a los periodos en los que la Base dispone de la energía proporcionada por generadores diésel. Este estudio analizará la extensión y el comportamiento de los registros del campo magnético y de la ionosfera en la Isla Livingston, abordando tanto su climatología a largo plazo como su meteorología, que incluye eventos transitorios y condiciones perturbadas.

SUMMARY

Three decades ago, the Ebro Observatory started to participate in R&D projects in Antarctica. This activity began in the 1994-1995 campaign with the collection of data on the geomagnetic field strength near the Spanish Antarctic Base Juan Carlos I. This initial effort marked the start of the Livingston Island Geomagnetic Observatory, which began operation in December 1996. Over the years, the instrumentation has been gradually upgraded to meet observing standards, maintaining uninterrupted operation as long as the power supply has been guaranteed, with scientific and technical staff present only during the southern summers and automatically operating the rest of the year. The observatory's records have revealed variations in the magnetic field on various time scales, from seconds to decades, providing crucial information for understanding terrestrial and solar processes, as well as for understanding the ionospheric activity that affects radio wave propagation. During the 2004-2005 campaign, an ionospheric sounder was added, although its operation is limited to periods when the Base has power provided by diesel generators. This study will analyze the extent and behavior of the magnetic field and ionospheric records at Livingston Island, addressing both its long-term climatology and its meteorology, including transient events and disturbed conditions.

Estudio sobre efectos en la ionosfera de la erupción del volcán Tonga del 15 de enero de 2022

Study of the effects on the ionosphere of the Tonga volcano eruption on January 15, 2022

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RESUMEN

La influencia sobre la ionosfera de fenómenos atmosféricos o corticales muy energéticos, como huracanes, terremotos, tsunamis o erupciones volcánicas, es un problema de gran interés geofísico demostrado en múltiples estudios. Su aportación a la dinámica ionosférica “desde abajo” (bottom up) completa la influencia “desde arriba” (up down) que forma parte de la Aeronomía desde los inicios de esta ciencia, y enriquece la utilidad práctica del estudio de la ionosfera.

Esta comunicación presenta un análisis de algunos de los efectos en la ionosfera de la erupción del volcán Tonga (20.54°S, 175.38°W) que tuvo lugar el 15 de enero de 2022. La extraordinaria magnitud de este evento generó un tsunami que afectó a diversas zonas del océano pacífico, y originó numerosos fenómenos atmosféricos en amplias regiones del planeta. Nuestro estudio se centra en la influencia de la erupción y el tsunami en la ionosfera de la amplia zona entre el volcán y la costa suramericana. Para ello analiza datos del Contenido Total de Electrones (TEC) en la ionosfera obtenidos a partir de la constelación Swarm, 11 estaciones GNSS y registros ionosféricos procedentes de digisondas próximas al área de la erupción. Los resultados ponen de manifiesto la influencia de la erupción y del tsunami manifestada en variaciones de TEC en la zona de estudio.

SUMMARY

The influence on the ionosphere of very energetic atmospheric and crustal phenomena, such as hurricanes, earthquakes, tsunamis and volcanic eruptions, is an important topic with a relevant geophysical interest, as demonstrated by many studies. This bottom-up contribution to ionospheric dynamics reinforces the top-down effects analyzed since the first steps of Aeronomy and increases their practical interest. This communication presents several effects on the ionosphere caused by the giant volcanic explosion that took place on the island of Tonga (20.54°S, 175.38°W) on 15 January 2022. This extraordinary event triggered a tsunami and generated many atmospheric phenomena around the world. Our work deals with the effects of both the eruption and the tsunami on the ionosphere in the wide area of Tonga Island and the South American Pacific coast. To this end, the total electron content of the ionosphere is analyzed using data from the Swarm constellation, GNSS stations and ionosondes placed close to the eruption zone. The results show the influence of both phenomena on the study area.

S.04 – Vulcanologia / Vulcanología

Computing numerical lava flow scenarios around the onset of a monogenetic eruption: the case of La Palma Island 2021 eruption

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SUMMARY

14 historical eruptions have taken place in the Canary Islands in historical times since 1585, and 7 of them occurred in La Palma Island, making it the island with the highest eruption frequency in historical times in the archipelago. Due to the low eruption rate of the Canaries -roughly 3 eruptions per century- only the last two eruptions have been monitored from the beginning of the unrest: Tagoro eruption in 2011-12 in El Hierro Island, and the 2021 eruption in La Palma Island. All historical eruptions have been monogenetic, which implies that in most cases forecasting the location of the eruption can be difficult due to spatial migration of seismicity, deformation and even gas emissions. These spatial migrations are not limited to the pre-eruptive period as also in the early stages of the eruption there are often several changes in the location of vents or eruptive fissures. For these reasons, a few days before the onset of 2021 eruption, we began to assess the area likely to be invaded by lava and computing the spatial probability assuming that the possible vent would be close to the greatest vertical deformation, which also corresponded to the greatest cluster of epicentres. Once the eruption started and the coordinates of the main fissure were known, a new numerical simulation was calculated and recalculated as the eruption was evolving. Constant updating of numerical simulations of lava flows is a primary requirement for assessing the hazard posed by lava flows in the area and identifying the most likely paths that lava can follow.

Data and service management of the European volcanological community by the Volcano Observations Thematic Core Service (EPOS-ERIC)

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SUMMARY

The Volcano Observations Thematic Core Service (VOLC-TCS) is one of 10 core services forming the European Plate Observing System European Research Infrastructure Consortium (EPOS-ERIC). The main objective of the VOLC-TCS is the implementation of a technical, financial and legal framework compliant with EPOS-ERIC for (i) strengthening the European volcanology community made by Volcano Observatories (VOs) and Volcanological Research Institutions (VRIs), and (ii) providing virtual access to their data, data products and services of the EU and pan-EU volcanoes. One of the main challenges in the management of volcanological data has consisted in their great heterogeneity, regarding technical characteristics, and also legal aspects (e.g., different data policies among the data providers, different purposes for the use of data from science to monitoring, early-warning, information, etc.). Another challenge has derived from the consistency of the VOLC-TCS with the service provision of EPOS, whose characteristic is to merge different Earth Science communities (seismology, GNSS, geomagnetic, geochemistry, geology, etc.). Some of the services used in volcanology are in common with other communities, thus the implementation work was also devoted to harmonising the provision of data and products standardised by other TCSs with the provision of volcanological services. Another important task has been the implementation of the community Gateway for accessing services not fully compliant with EPOS to be visible in EPOS and creating the conditions to likely interface the VOLC-TCS with data infrastructures operating at global level (e.g., WOVOdat). Based on the experience gained and on the results achieved, here we report the state of the art of the VOLC-TCS implementation from 2018 and propose future actions addressing some of the main technical challenges as well as ensuring the mid-long term sustainability of the services. These activities are part of the EPOS-ES node and of the EPOS-SpN RED2022-134516-E project is funded by MCIN/AEI/10.13039/501100011033

Avances en el análisis de series temporales GNSS para la vigilancia volcánica en las Islas Canarias

Advances in GNSS time series analysis for volcano monitoring in the Canary Islands

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RESUMEN

La deformación de la superficie es uno de los parámetros más importantes en vigilancia volcánica. Los movimientos del terreno debidos a procesos volcánicos pueden producirse a diferentes escalas de espacio y tiempo, y la medición de estas deformaciones puede llevarse a cabo utilizando diferentes técnicas. En los últimos años, las técnicas por satélite han sido las más utilizadas para la monitorización de las deformaciones superficiales del terreno. En particular, la disponibilidad de una red de estaciones GNSS permanentes es uno de los requerimientos más útiles y sensibles en los procesos pre-eruptivos. En Canarias existen más de 50 estaciones GNSS permanentes y el Instituto Geográfico Nacional (IGN), como institución responsable de la vigilancia volcánica en España, procesa los datos automáticamente para obtener series temporales de coordenadas diarias en tiempo casi real. Esta aplicación geodésica requiere la mayor precisión posible, pero al mismo tiempo la mayor rapidez. Para ello se han utilizado series temporales GNSS procesadas por el IGN y el Nevada Geodetic Laboratory (UNR) para estudiar diferentes métodos de procesamiento, técnicas de Doble Diferencia (DD) vs Posicionamiento Puntual Preciso (PPP), utilizando varios marcos de referencia y correcciones del movimiento de placas. Posteriormente se han analizado las series temporales GNSS, para obtener un filtro espacial tipo CMB y variaciones estacionales, con el fin de desarrollar la metodología más eficaz para la vigilancia volcánica en las Islas Canarias. Mediante la combinación de técnicas avanzadas de procesamiento de datos y un análisis exhaustivo de las series temporales, nuestro estudio pretende mejorar la comprensión y pronóstico de la actividad volcánica en la región.

SUMMARY

Surface deformation is one of the most important parameters in volcano monitoring. Ground movements due to volcanic processes can occur at different spatial and temporal scales and the measurement of these deformations can be carried out using different methods. In recent years, satellite techniques have been the most widely used techniques for monitoring ground surface deformation. In particular, the availability of a network of GNSS stations is one of the most sensitive and condition requirements in pre-eruptive processes. There are more than 50 continuous GNSS stations in the Canary Islands and the Spanish Instituto Geográfico Nacional (IGN), as the institution responsible for volcanic monitoring in Spain, processes the data automatically to obtain time series of daily coordinates in near real time. This geodetic application requires the highest possible accuracy, but at the same time as quickly as possible. For this purpose, GNSS time series processed by the IGN and the Nevada Geodetic Laboratory (UNR) have been used to study different processing methods, Double Difference (DD) vs. Precise Point Positioning (PPP) techniques, using several reference frames and plate movement corrections. Subsequently the GNSS time series have been analyzed, to obtain a Common Mode Bias (CMB) filter and seasonal variations, in order to develop the most effective methodology for volcanic monitoring in the Canary Islands. By combining advanced processing techniques with comprehensive time series analysis, our study aims to improve the understanding and forecast of volcanic activity in the region.

Integración de un análisis sísmico automatizado y resultados GNSS para vigilancia volcánica: aplicación a la reactivación volcano-tectónica de São Jorge en 2022

Integration of automated seismic analysis and GNSS results in volcano monitoring: application to volcano-tectonic unrest on São Jorge in 2022

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RESUMEN

La interpretación conjunta de datos sísmicos y GNSS es una de las herramientas más valiosas en vigilancia volcánica durante periodos de reactivación, ya que proporciona información, con la frecuencia temporal necesaria, sobre el proceso volcánico a través de los resultados sísmicos y de deformación del terreno. Llegar a obtener resultados precisos, en el menor tiempo posible, es de vital importancia para la monitorización. Para lograr este objetivo, empleamos un análisis sísmico automatizado, utilizando un método de Deep Learning en la evaluación de la actividad sísmica, junto con el procesamiento PPP de datos GNSS, para investigar la actividad volcano-tectónica de la isla de São Jorge en 2022. Después de más de 50 años de inactividad, el 19 de marzo de 2022 comenzó un intenso repunte de sismicidad en la isla de São Jorge. La interpretación combinada de la deformación del suelo y la sismicidad, considerando la evolución volcánica de la isla de San Jorge, sugiere que el magma puede haberse acumulado asísmicamente bajo la isla durante años. A partir del 16 de marzo de 2022, la deformación vertical de la superficie durante dos días, junto con la actividad sísmica, indican una rápida intrusión de diques en la corteza, que se detuvo abruptamente a pocos kilómetros bajo la superficie. Posteriormente, se produjo una típica deflación causada por el enfriamiento del dique, mientras que la sismicidad reubicada sugiere una intensa sobrepresión cerca de la discontinuidad del Moho. Por último, desde la segunda semana de abril hasta finales de año, se observó una relajación del sistema. Este trabajo no sólo ayuda a comprender la crisis volcano-sísmica de São Jorge, sino que es de gran importancia para comprobar la validez de la metodología en vigilancia volcánica.

SUMMARY

The combined interpretation of seismic data and GNSS is one of the most powerful tools for volcano monitoring during periods of unrest. It provides crucial information on volcanic process through seismic and ground deformation results with the necessary temporal frequency. Obtaining accurate results as soon as possible is vitally important in volcanic monitoring. To achieve this objective, we employed automated seismic analysis, using a Deep Learning approach for seismic activity assessment, along with PPP processing for GNSS data, to investigate the 2022 São Jorge volcano-tectonic unrest. After more than 50 years of quiescence, a burst of seismicity started on 19 March 2022 at São Jorge Island. The combined interpretation of ground deformation and seismicity, considering the volcanic evolution of the island, suggests that magma may have

accumulated aseismically beneath São Jorge Island for years. Starting on 16 March 2022 two days of vertical surface deformation along with the seismic activity, marked a rapid dyke intrusion in the crust which abruptly stopped a few kilometres under the surface. This was followed by a typical of dyke cooling deflation, while relocated seismicity suggests an intense overpressure near the Moho discontinuity. Finally, from the second week of April until the end of the year, a relaxation of the system was observed. This work not only aids in understanding the volcano-seismic crisis at São Jorge but is of great importance in testing the validity of the methodology for volcanic monitoring.

Evaluación de riesgos poseruptivos: el caso de la erupción de 2021 en la isla de La Palma (Canarias, España)

Assessing post-eruptive hazards: the case of 2021 eruption in La Palma Island

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RESUMEN

La isla de La Palma (Islas Canarias) es una región volcánica activa que ha sufrido 7 erupciones datadas en los últimos 500 años, la mayor tasa eruptiva histórica del archipiélago. La última erupción tuvo lugar en 2021. Esta erupción comenzó el 19 de septiembre y acabó el 12 de diciembre. A finales de noviembre de 2021, dentro de una zona evacuada poco después de iniciarse la erupción, se detectó una importante emisión anómala de CO₂ en las localidades de Puerto Naos y La Bombilla. Se constató que el origen de estas emanaciones era volcánico por la medida de concentración de isótopos de helio en la zona. Al finalizar la erupción los gestores de la emergencia decidieron mantener estas dos zonas dentro del perímetro de exclusión mientras se estudiaba el fenómeno. Desde entonces, se comenzó a realizar campañas y preparar instrumentación para registrar las concentraciones de CO₂ en tiempo real en los dos núcleos de población mencionados. En agosto de 2022 se encuentra completamente operativa una malla de 21 estaciones que proporcionan una estimación de la concentración de CO₂ en el exterior de Puerto Naos. En septiembre de 2023 el proyecto conjunto IGN-INVOLCAN denominado ALERTA CO₂ comienza a desplegar una red de unos 1200 sensores en el interior de viviendas para ir facilitando datos de concentración de CO₂ en ambos núcleos. Actualmente, tras más de dos años y medio de emisiones, la concentración de CO₂ registrado tanto en interiores como en exteriores sigue siendo muy alta, con una gran estabilidad en los promedios.

SUMMARY

The island of La Palma (Canary Islands) is an active volcanic region that has suffered 7 eruptions dating back to the last 500 years, the highest historical eruptive rate in the archipelago. The last eruption took place in 2021. This eruption began on September 19 and ended on December 12. At the end of November 2021, within an area evacuated shortly after the eruption began, a significant anomalous CO₂ emission was detected in the localities of Puerto Naos and La Bombilla. The origin of these emissions was found to be volcanic by measurements of helium isotope concentrations. At the end of the eruption, the emergency managers decided to keep these two areas within the exclusion perimeter while the phenomenon was studied. Since then, campaigns began to be carried out and instrumentation was prepared to record CO₂ concentrations in real time in the two aforementioned population centers. In August 2022, a mesh of 21 stations was fully operational to provide an estimate of the CO₂ concentration outside Puerto Naos. In September 2023, the IGN-INVOLCAN joint project called ALERTA CO₂ began to deploy a network of about 1,200 sensors inside homes to provide CO₂ concentration data in both localities. To date, after more than two and a half years of emissions, the CO₂ concentration recorded both indoors and outdoors is still very high, with a great stability in averaged values.

Exploración del sistema magmático en los volcanes submarinos Edificio C, Three Sisters, Orca y Gebra Seamount (Estrecho de Bransfield, Antártida)

Exploring the magmatic systems of the submarine volcanic edifices Edifice C, Three Sisters, Orca and Gebra Seamount (Bransfield Strait, Antarctica)

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RESUMEN

El Estrecho de Bransfield, en el oeste de la Antártida, es una cuenca en transición de retro-arco a expansión con numerosos edificios volcánicos ubicados en su eje principal. Su evolución está vinculada a la subducción entre las placas Phoenix y Antártica, manteniendo aún la cuña mantélica bajo el Estrecho de Bransfield rasgos geoquímicos asociados a la subducción; siendo por tanto un lugar excepcional para estudiar esta transición. Sin embargo, apenas hay conocimiento sobre los sistemas magmáticos de los volcanes situados en el centro de la cuenca. El presente trabajo muestra las características petrográficas y geoquímicas (elementos mayores y traza en vidrio y fases minerales); geotermobarometría; y modelización termodinámica de los sistemas magmáticos de los volcanes submarinos Edificio C, Three Sisters, Orca y Gebra Seamount en muestras de lava procedentes del Repositorio Polar de Rocas (Polar Rock Repository, <https://prr.osu.edu/>).

Los resultados muestran que los rasgos geoquímicos ligados a la subducción fueron más significativos en Three Sisters y Orca. En todos los volcanes, el sistema magmático evolucionó por cristalización de clinopiroxeno y plagioclasa excepto en Gebra Seamount, el menos afectado por subducción, donde predominan olivino y plagioclasa. Los reservorios magmáticos principales se encuentran entre 12 y 20 kilómetros de profundidad, concordando con las estimaciones de estudios geofísicos previos. Además, en Orca, hay evidencias de otro reservorio magmático a 2-3 kilómetros de profundidad. Por otro lado, los tiempos de residencia (2-25 años) y de ascenso (12 horas a 53 días) de los magmas son muy similares entre Edificio C, Three Sisters y Orca.

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SUMMARY

Bransfield Strait, located in West Antarctica, is a back-arc evolving to rift basin hosting numerous volcanic edifices within its main axis. Its evolution is linked to the subduction between the Phoenix and the Antarctic plates. The mantle wedge beneath Bransfield Strait still preserves geochemical features linked to the subduction and thus is an exceptional place to understand back-arc to rift evolution. However, the knowledge about the magmatic systems of the volcanic edifices located in the center of the basin is still on its infancy. The present work highlights the petrographical and geochemical characteristics (major and trace element in glass and mineral phases); geothermobarometry and thermodynamical modelling of the magmatic systems of the submarine volcanic edifices Edifice C, Three Sisters, Orca and Gebra Seamount.

Results reveal that subduction-related geochemical features were more significative at Three Sisters and Orca. The magmatic evolution in all volcanic edifices was controlled by clinopyroxene and plagioclase crystallization except beneath Gebra Seamount, the least affected by subduction, where olivine and plagioclase were the main mineral phases. The magmatic main reservoirs are located between 12 and 20 kilometers depth, in agreement with previous geophysical studies estimations. Moreover, there is evidence of another shallow reservoir, located at 2-3 km depth, beneath Orca. In addition, magma residence (2-25 years) and ascent (12 hours to 53 days) timescales are very similar between Edifice C, Three Sisters and Orca.

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Trazando las escalas de tiempo de pequeñas erupciones explosivas para entender los ciclos de caldera en Santorini (Grecia)

Tracking the timescales of small explosive eruptions are the key to understand the caldera cycles at Santorini (Greece)

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RESUMEN

Los procesos pre-eruptivos y sus escalas de tiempo son parámetros críticos en la gestión del riesgo de volcanes explosivos. La caldera de Santorini (Grecia) es un buen ejemplo de aplicación.

Para ello, se calcularon las escalas de tiempo por difusión en piroxenos y plagioclasas de los materiales de una pequeña erupción explosiva del volcán de Kameni, comparándola con las erupciones de caldera en Santorini. La dacita de Kameni es muy parecida a los productos emitidos en tales erupciones (baja cristalinidad, plagioclasa con núcleos antecrísticos y envolturas autocrísticas, piroxenos con zonado en sector y morfologías dendríticas). Los tiempos obtenidos de los perfiles Mg-Fe en piroxenos muestran un rango entre <1-23 años; mientras que los de Mg en plagioclasa son menores a 10 años. El modelo eruptivo de Kameni es parecido al de las grandes erupciones, donde el fundido producido en un mush gabroico-diorítico en la corteza media-inferior asciende a un reservorio supracortical. Los cristales crecieron debido a descompresión, enfriamiento y mezcla de magmas durante su ascenso y emplazamiento.

Posteriormente, para comprobar vínculos entre los tiempos y el volumen eruptivo o la posición dentro del ciclo de caldera, se incorporaron tiempos de difusión Mg-Fe en piroxeno de otras tres erupciones, estudiándose en total siete erupciones de distintos tipos y ciclos. Los tiempos más cortos (<0.01-10 años) tienen lugar en erupciones tempranas dentro del ciclo mientras que los más largos (1-5000 años) ocurren en erupciones tardías. Esto se debe a la maduración térmica y al flujo de H₂O en el reservorio cortical a lo largo del ciclo de caldera, lo cual permite una mayor acumulación progresiva de magma resultando en un aumento de los tiempos de residencia.

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SUMMARY

Pre-eruptive processes and their timescales are critical information for risk management at explosive volcanoes. Santorini

caldera (Greece) provides an excellent context to approach this subject.

To complete so, a diffusion timescale characterization of pyroxenes and plagioclase of a small explosive eruption at Kameni volcano was performed followed by a comparison with the larger caldera-forming eruptions at Santorini. The Kameni dacite is very similar to the larger eruptions erupted products (crystal-poor, plagioclase with antecrystic cores and autocrystic rims, pyroxenes with sector zoning and skeletal morphologies). Diffusion timescales from Mg-Fe profiles in pyroxene phenocrysts are <1–23 years, while Mg diffusion modelling in plagioclase gives <10 years. The Kameni eruption model is similar to those proposed for larger eruptions, where silicic melt produced in gabbroic-dioritic lower to middle crustal mush bodies is transferred to an upper crustal reservoir. Crystals grew in the silicic melts due to decompression, cooling, and magma mixing during ascent and injection.

Secondly, to test if diffusion timescales relate to the eruptive volume or to the position in a caldera cycle, the pyroxene Mg-Fe diffusion timescales of three additional eruptions were considered completing the database to seven eruptions of different sizes and caldera cycles. Timescales showed a correlation with the caldera cycle, where shorter timescales (<0.01–10 years) are observed in early cycle eruptions while longer ones (1–5000 years) are observed in late cycle ones. This is explained by thermal maturation and H₂O flushing of the crustal caldera magma reservoir along the caldera cycle which allows larger magma accumulation in the reservoir resulting in increasing crystal residence times.

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Exploración y unificación de la nomenclatura del vulcanismo submarino en el Estrecho de Bransfield (Antártida).

Exploration of the submarine volcanic edifices at Bransfield Strait (Antarctica): Naming unification

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RESUMEN

En la Antártida se encuentran numerosos volcanes activos. Su situación remota y sus condiciones extremas hacen de su investigación todo un reto. El Estrecho de Bransfield, localizado en el oeste de la Antártida, es una de las zonas antárticas más accesibles para estudiar el vulcanismo submarino antártico. En el, se han identificado seis edificios volcánicos submarinos principales (Edificios A, B, C, Three Sisters, Orca, Hook Ridge); así como veinte pequeños montes submarinos, de los cuales solo dos de ellos han sido identificados (Eastern y Western Seamount); además de tres prominentes sistemas volcánicos subaéreos (islas Decepción, Penguin y Bridgeman).

La relativa accesibilidad al Estrecho de Bransfield ha permitido la realización de numerosos estudios vulcanológicos y geofísicos a lo largo de las últimas décadas. No obstante, estos estudios han asignado distintos nombres a un mismo edificio volcánico, generando cierta confusión entre la comunidad científica. Solo uno de ellos, Orca, ha sido debidamente registrado oficialmente en el inventario oficial que recoge todos los nombres identificativos de localizaciones en la Antártida: el SCAR Composite Gazetteer of Antarctica (<https://data.aad.gov.au/aadc/gaz/scar/>).

Por esta razón, el presente trabajo recoge y organiza los distintos nombres atribuidos a los edificios volcánicos submarinos del estrecho de Bransfield estableciéndolos como referencia de nomenclatura para futuras investigaciones. Dentro de estas, se recomienda utilizar el nombre más empleado en los estudios previos. En aquellos casos donde sea necesario asignar un nuevo nombre, se aconseja presentar una solicitud en el SCAR Composite Gazetteer of Antarctica y, posteriormente, utilizarlo de manera consistente para evitar posibles confusiones.

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SUMMARY

Antarctica hosts abundant active volcanoes. The remoteness and the extreme weather conditions makes their research a difficult challenge. Bransfield Strait, located in west Antarctica, stands out as one of the easiest places to access to study Antarctic volcanism. Within this region, six principal submarine volcanic edifices (Edifices A, B, C, Three Sisters, Orca, Hook Ridge) are found, along with approximately twenty smaller seamounts, of which only two have received names (Eastern and Western Seamount). Additionally, three notable subaerial volcanic systems (Deception, Penguin, and Bridgeman islands) are present.

Because of the easy accessibility, Bransfield Strait has been studied through multiple volcanological and geophysical studies

along the last decades. Nevertheless, these studies have attributed distinct names to the same submarine volcanic edifices, leading to confusion within the scientific community. Only one of these names, Orca, has been officially registered in the official catalogue that collects all the official names associated to Antarctic locations: the SCAR Composite Gazetteer of Antarctica (<https://data.aad.gov.au/aadc/gaz/scar/>). In this study we compile the various assigned names for the different submarine volcanic edifices as a nomenclature reference for further studies. For these, it is recommended to employ the name that appears in most studies. In case of need of assigning a name, it is advisable to first submit the proposed name to the SCAR Composite Gazetteer of Antarctica, and thereafter consistently refer to the assigned name to mitigate confusion.

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Aplicación de técnicas geoespaciales al mapeo de los tubos lávicos formados durante la erupción volcánica de Cumbre Vieja (septiembre - diciembre 2021, La Palma, España)

Application of geospatial techniques to the mapping of lava tubes formed during the Cumbre Vieja volcanic eruption (September - December 2021, La Palma, Spain)

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RESUMEN

La erupción de 2021 es la más duradera en La Palma desde que comenzaron los registros históricos. Los vuelos dron realizados durante la erupción y los trabajos posteriores han permitido formular la hipótesis de que se puede haber formado en La Palma el mayor tubo volcánico de Canarias. Para confirmar esta hipótesis, la ciencia va a necesitar años de investigación, inicialmente ralentizados por las altas temperaturas y las emisiones de gases, que dificultan el acceso.

Con el fin de seleccionar las tecnologías más adecuadas para el registro de este vasto patrimonio geológico, un equipo multidisciplinar ha comenzado la exploración de los nuevos tubos lávicos y su mapeo, empleando técnicas geoespaciales basadas en la fotogrametría terrestre y los escaneos LiDAR, en una serie de trabajos de campo coordinados por técnicos del Equipo de Espeleología Volcánica de la Federación Canaria de Espeleología.

Este trabajo presenta los resultados de los primeros levantamientos topográficos de las nuevas cavidades (diciembre 2022-marzo 2024), buscando la mayor resolución y versatilidad. Para ello se han empleado técnicas de fotogrametría terrestre con equipos iPhone Pro, escáneres láser estacionados (FARO Focus S150) y escáneres portátiles con tecnología SLAM (Leica BLK2GO). Gracias al uso combinado de estas tecnologías, se ha podido realizar el mapeo en 3D inicial de los segmentos accesibles (temperaturas inferiores a 40°C) del nuevo sistema de tubos lávicos. Los resultados obtenidos son muy satisfactorios y han permitido probar distintas técnicas, lo que conduce a un diseño eficiente de los futuros trabajos de exploración y mapeo del nuevo sistema de tubos formado tras la erupción de 2021 en la isla de La Palma. Esta investigación se ha realizado con el apoyo del Programa de Doctorados Industriales de la Comunidad de Madrid (IND2020/TIC-17528; IND2023/TIC-28743).

SUMMARY

The 2021 eruption is the longest on La Palma since historical records began. The drone flights carried out during the eruption and subsequent work have allowed us to formulate the hypothesis that the largest volcanic tube system in the Canary Islands may have formed on La Palma. To confirm this hypothesis, science will need years of research, initially slowed down by high temperatures and gas emissions, which make access difficult.

In order to select the most appropriate technologies for the recording of this vast geological heritage, a multidisciplinary team has begun the exploration of the new lava tubes and their mapping, using geospatial techniques based on terrestrial photogrammetry and LiDAR scans, in a series of field work coordinated by technicians from the Volcanic Speleology Team of the Canary Islands Speleology Federation.

This work presents the results of the first topographic surveys of the new cavities (December 2022-March 2024), seeking the greatest resolution and versatility. To achieve this, terrestrial photogrammetry techniques have been used with iPhone Pro equipment, stationary laser scanners (FARO Focus S150) and portable scanners with SLAM technology (Leica BLK2GO). Thanks to the combined use of these technologies, it has been possible to carry out the initial 3D mapping of the accessible segments (temperatures below 40°C) of the new lava tube system. The results obtained are very satisfactory and have allowed different techniques to be tested, which leads to an efficient design of future exploration and mapping work of the new tube system formed after the eruption of 2021 on the island of La Palma.

This research has been carried out with the support of the Industrial Doctorate Program of the Community of Madrid (IND2020/TIC-17528; IND2023/TIC-28743)

S.05 - Meteorologia e Ciências Atmosféricas / Meteorología y Ciencias Atmosféricas

Effect of a volcanic plume event in the local shortwave radiative forcing (Évora, Portugal)

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SUMMARY

Volcanic eruptions are natural sources of aerosols by releasing gases and ash particles into the atmosphere. In the atmosphere, the volcanic materials may interact with solar and thermal radiation through scattering and absorption affecting the Earth's radiative balance. In September 2021, the Tajogaite volcano (Canary Islands) erupted and several plumes were transported in the direction of the Iberian Peninsula during its eruptive activity (September-December 2021). This work aims at assessing the shortwave (SW) radiative effects of the volcanic plume event detected over the south of Portugal from 11-13 October 2021. These plumes were already investigated in terms of aerosol optical and microphysical properties and reported in literature by Salgueiro et al. (2023) in "Characterization of Tajogaite volcanic plumes detected over the Iberian Peninsula from a set of satellite and ground-based remote sensing instrumentation". During this event, satellite observations revealed the presence of a plume of sulphur dioxide over the south of Portugal. In addition, ground-based lidar measurements, taken at Évora, revealed a layer of fine-mode particles located between 2.5 to 5.0 km above sea level, as reported in Salgueiro et al. (2023). The SW radiative effects produced by the plume of volcanic aerosols are assessed by means of the uvspec program in the LibRadtran software package, which allows the calculation of the radiative fluxes at different vertical levels using the measured aerosol properties, such as the particle extinction coefficient profiles, as inputs for the model. The first results show a negative signal of the SW radiative effects (difference between the SW net fluxes in an atmosphere with aerosols and a pristine atmosphere without aerosols) produced by the plume along the vertical profile that relates with the nature of the particles presented in the atmosphere.

A assinatura climática na incidência dos incêndios rurais em Portugal

The climate signature in the incidence of rural wildfires in Portugal

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RESUMO

Portugal é um dos países europeus mais afetados pelos incêndios rurais. Este desastre natural tem causa predominantemente humana, mas a incidência do fogo depende significativamente das condições atmosféricas e da variabilidade climática que caracterizam o clima de cada região. Existem inúmeros estudos sobre a influência do tempo meteorológico, especialmente dos eventos extremos, nos incêndios rurais, mas a influência do clima é raramente avaliada, mesmo no resto do mundo. Assim este estudo tem como objetivo responder à questão: Como se caracteriza a influência do clima na incidência dos incêndios em Portugal?

Neste estudo foi utilizada a *Portuguese Rural Fire Dataset* (PRFD), atualizada para o período 2001 – 2017. A PRFD inclui informação sobre os incêndios ocorridos em Portugal continental, como a data e hora de ignição e extinção, local de ocorrência e área ardida em matos, povoamentos e áreas agrícolas. Foram ainda utilizados dados ERA5 de elementos climáticos (e.g., pressão média ao nível do mar, temperatura do ar a 2 m, velocidade do vento a 10 m, altura de geopotencial, temperatura e humidade relativa do ar a 850 hPa e 500 hPa). A abordagem metodológica incluiu técnicas de análise estatística climatológica (e.g., análise de compósitos, análise de distribuição espaço temporal) e algoritmos de machine learning.

Os resultados obtidos demonstram clara e inequivocamente a influência do clima na distribuição espacial e temporal da incidência do fogo. Em resumo, os resultados revelam (i) a influência do tipo de clima na distribuição espacial, (ii) o efeito da sazonalidade dos elementos climáticos no ciclo anual da incidência do fogo e, (iii) a relação entre a variabilidade inter-anual dos elementos climáticos e a incidência de fogo nas duas épocas de fogo observadas em Portugal. Estes resultados apoiam a gestão e decisão política dos incêndios, floresta e paisagem, especial no contexto das alterações climáticas.

SUMMARY

Portugal is one of the European countries most affected by rural wildfires. Humans mainly cause this natural disaster, but the incidence of fire depends significantly on the atmospheric conditions and climate variability that characterize the climate of each region. There are numerous studies on the influence of weather, especially extreme events, on rural wildfires, but the role of climate is rarely evaluated, even in the rest of the world. Therefore, this study aims to answer the following research question: How is the influence of climate on the incidence of wildfires in Portugal characterized?

This study used the Portuguese Rural Fire Dataset (PRFD), updated for the 2001 – 2017 period. The PRFD includes information about wildfires in mainland Portugal, including the date and time of ignition and extinction, place of occurrence, and burned areas in forests, settlements, and agricultural regions. ERA5 data on climatic elements were also used (e.g., mean pressure at sea level, air temperature at 2 m, wind speed at 10 m, geopotential height, temperature, and relative humidity at 850 hPa and 500 hPa. The methodological approach included climatological statistical analysis techniques (e.g., composite analysis, spatiotemporal distribution analysis) and machine learning algorithms.

The results obtained clearly and unequivocally demonstrate the influence of climate on the spatial and temporal distribution of wildfire incidence. In summary, the results reveal the (i) influence of the type of climate on the spatial distribution, (ii) effect of seasonality observed in the climatic elements on the annual cycle of wildfire incidence, and (iii) relationship between inter-annual variability of climatic elements and the incidence of wildfire in the two wildfire seasons observed in Portugal. These results support the management and political decision-making of wildfires, forests, and landscapes, especially in the context of climate change.

Latest advances in the study of the non-recent climate of Extremadura and the SW of Iberia: a review

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SUMMARY

During the last decade, numerous advances have been made to better understand the non-recent climate of the southwestern region of the Iberian Peninsula in general and the Spanish region of Extremadura in particular. In this communication, a review of these advances will be carried out.

First, a remarkable set of studies have been conducted on catastrophic flooding in the Guadiana River basin over the past five centuries. In particular, the catastrophic flood in December 1876 in Badajoz, and in other parts of the Guadiana River basin, has been studied in detail.

On the other hand, another notable research effort has been carried out in the context of "data recovery" tasks. In particular, more than 0.8 million meteorological readings have been recovered in Extremadura, as well as other early meteorological data of great interest from Almada (Portugal) and San Fernando (Spain).

In addition, documentary sources (non-instrumental) have also been used to study the historical climate of Extremadura. Some results related to the correspondence of the Duke of Feria and the preserved documents on the celebration of prayers for rain will be shown in detail.

Avaliação do regime de seca na África Austral, com base em índices de seca e vegetação

Assessment of the drought regime in Southern Africa, based on drought and vegetation indices

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RESUMO

A seca é um evento extremo que afeta sistemas naturais e humanos, a saúde humana e animal, e as atividades socioeconómicas. As consequências da seca dependem do seu tipo e classe bem como da preparação e resistência das comunidades a esta perturbação climática. Em África, no período de 1970 - 2019, as secas representaram cerca de 16% do número total de desastres, mas correspondem a 95% do número de mortes e 26% dos prejuízos económicos. Assim, este estudo tem como objetivo avaliar o regime de seca na África Austral (AA), num período de tempo suficientemente longo, com base em índices de seca e vegetação. Foram calculados os índices meteorológicos SPI e SPEI para diferentes escalas temporais, com base nos campos de precipitação e evapotranspiração potencia mensais, no período 1971 – 2020, utilizando dados ERA5. Foram também utilizados os índices de deteção remota NDVI, VCI e EVI, obtidos através de dados do satélite TERRA/MODIS, para complementar a caracterização de alguns eventos específicos de seca registados neste período. O cálculo e análise dos índices, dos vários descritores de seca (número, duração, severidade, intensidade e área afetada pela seca) e das suas distribuições espaciais e temporais, foram realizados em MATLAB e R. Estes resultados permitem caracterizar a variabilidade espacial, intra-anual e inter-anual revelando (i) uma elevada variabilidade espacial no número, duração, severidade e intensidade da seca, que tende a diminuir com a escala temporal, (ii) que a intensidade e número da seca é maior na região central da AA, (iii) que existe uma variabilidade intra-anual e inter-anual que aumenta significativamente com a escala temporal e, (iv) os índices de deteção remota confirmam a secura da vegetação nos períodos climatologicamente secos. Estes resultados são especialmente importantes para os decisores políticos e gestores dos recursos hídricos na AA.

SUMMARY

Drought is an extreme event that affects natural and human systems, human and animal health, and socioeconomic activities. The consequences of drought depend on its type and class as well as the preparedness and resistance of communities to this climate disturbance. Droughts in Africa represented 16% of the total number of disasters but corresponded to 95% of human deaths and 26% of economic losses, in the 1970 – 2019 period. Therefore, this study aims to evaluate the drought regime in Southern Africa (SA), over a sufficiently long period, based on drought and vegetation indices. The SPI and SPEI meteorological indices were calculated for different temporal scales, based on monthly precipitation and potential evapotranspiration fields, in the 1971 – 2020 period, using ERA5 data. The remote detection indices NDVI, VCI and EVI, obtained through data from the TERRA/MODIS satellite, were also used to complement characterising some specific

drought events recorded in this period. The calculation and analysis of the indices, the various drought descriptors (number, duration, severity, intensity and area affected by the drought) and their spatial and temporal distributions, were carried out in MATLAB and R. These results allow us to characterize the spatial, intra-annual and inter-annual revealing (i) a high spatial variability in the number, duration, severity and intensity of drought, which tends to decrease with the temporal scale, (ii) that the intensity and number of drought are greater in the central region of SA, (iii) that there is intra-annual and inter-annual variability that increases significantly with the temporal scale and, (iv) remote sensing indices confirm the dryness of the vegetation in climatologically dry periods. These findings are essential for policymakers and water resource managers in SA.

Modelação da piro-convecção durante mega incêndios em Portugal

Modelling pyro-convection during megafires in Portugal

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RESUMO

Em 2017, Portugal foi afetado por vários incêndios florestais que apresentaram um comportamento extremo. Para investigar a atividade piro-convectiva em dois mega incêndios ocorridos em 2017, foram realizadas três simulações numéricas com o modelo atmosférico Meso-NH acoplado ao modelo de propagação de fogo ForeFire. Os experimentos foram configurados para três domínios aninhados de resolução horizontal de 2000 m, 400 m, e 80 m, todos com 50 níveis verticais seguindo o terreno. A emissão de energia e de vapor de água para a atmosfera foi realizada pelo ForeFire, que permite o cálculo da evolução temporal da frente de fogo, considerando a inclinação do terreno, propriedades atmosféricas e características dos combustíveis. Foram realizadas duas simulações em que a evolução da frente de fogo foi imposta a partir de um mapa obtido de relatórios oficiais. A terceira simulação foi realizada com a versão totalmente acoplada do código, que permite investigar o impacto dos movimentos atmosféricos induzidos pelo fogo na própria propagação do fogo. As simulações mostraram que o acoplamento do modelo atmosférico com o modelo de propagação de fogo permite explorar os impactos do fogo na atmosfera, nomeadamente a formação de nuvens no interior da coluna de fumo. No mega incêndio de Quiaios, a experiência numérica indicou a formação de uma nuvem piroCu, enquanto em Pedrógão Grande foi possível verificar que a coluna piro-convectiva produziu uma nuvem piroCb. O estudo destaca a eficácia das simulações acopladas fogo-atmosfera na representação de fenómenos meteorológicos induzidos pelo fogo. Este estudo foi financiado pela FCT-Fundação para a Ciência e a Tecnologia, I.P. no âmbito do projeto PyroC.pt (Ref. PCIF/MPG/0175/2019).

SUMMARY

In 2017, Portugal was affected by several wildfires that exhibited extreme behaviour. To investigate the pyro-convective activity in two megafires that occurred in 2017, three numerical simulations were carried out with the Meso-NH atmospheric model coupled to the ForeFire fire propagation model. The experiments were configured for three nested domains of horizontal resolution of 2000 m, 400 m, and 80 m. The vertical grid is composed of 50 height-based terrain-following levels. Heat and water vapour fluxes were emitted into the atmosphere and carried out by ForeFire, which allows the calculation of the fire front temporal evolution, considering the terrain slope, atmospheric properties, and fuel characteristics. Two simulations were performed in a one-way coupling, i.e., the fire front evolution is directly imposed from a pre-defined map obtained from official reports. A third simulation was performed using the fully coupled version of the code, which allows to investigate the impact of fire-induced atmospheric motions on the fire's own propagation. The simulations showed that

coupling the atmospheric model with the fire propagation model allows to explore the impacts of fire on the atmosphere, namely the formation of clouds inside the smoke plume. In the Quiaios megafire, the simulation indicated the formation of a pyroCu cloud, while in Pedrógão Grande it was possible to verify that the pyro-convective column produced a pyroCb cloud. The study highlights the effectiveness of fire-atmosphere coupled simulations in representing fire-induced meteorological phenomena. This study was funded by FCT-Foundation for Science and Technology, I.P. under the PyroC.pt project (Ref. PCIF/MPG/0175/2019).

Deployment of UV and VIS-NIR Avantes AvaSpec-2048 for spectral measurements of direct and global solar radiation in Badajoz (Spain)

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SUMMARY

The monitoring of atmospheric aerosol and gasses requires spectral measurements of solar radiation. This need for spectral measurements has led many research groups to equip their radiometric stations with different types of spectroradiometers. The size and affordability of CCD-array spectrometers have made them a suitable solution for this purpose, and some brands have manufactured different types of these instruments. However, the majority are not designed for autonomous functioning in a radiometric station. Therefore, it is necessary to adapt them to their specific aims. The radiometric station located in Badajoz and operated by the research group ATMOS of the Universidad de Extremadura (Spain) has been equipped with four Avantes AvaSpec-2048 CCD-array spectrometers, two measuring UV and two measuring VIS-NIR, with the objective of recording direct and global solar radiation spectra. To this aim, Benthan and Avantes optics are used, and two bifurcated optical fibers guide the sunlight from the input optics to the four CCD-arrays, which are located inside. Each optic entrance is connected simultaneously to an UV and a VIS Avantes. Moreover, to measure the direct and the global radiation, a Kipp & Zonen sun tracker is used, with a home-made designed and built collimator attached. The instruments are placed inside a refrigerator, for cooling and temperature stabilization purposes. The measuring control is performed by programming with C++ code routines, which is complemented by additional programs codified in Python, thus allowing continuous measurement on a 1-minute basis, the use of different integration times, periodic backups and a warning system in case of malfunction.

Comparison of UV Avantes AvaSpec-2048 with Brewer #150 along various campaigns

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SUMMARY

The Brewer spectrophotometer has been the World Meteorological Organisation (WMO) Global Atmosphere Watch (GAW) standard for Stratospheric Ozone Measurement since 1988. This scanning spectrometer also measures ultraviolet (UV) spectral irradiance. Since it is very expensive and labor-intensive, the use of CCD-array based spectrometers has increased in the last decades. These instruments, which are more affordable and easier to operate, can offer high-quality spectral measurements provided some issues are addressed. To guarantee this quality, a previous characterization and calibration must be performed. The radiometric station deployed in Badajoz by the research group ATMOS of the Universidad de Extremadura (Spain) has been equipped with two UV Avantes AvaSpec-2048 CCD arrays spectroradiometers. In order to assess their performance, a preliminary comparison between each UV Avantes and the double monochromator Brewer #150 has been conducted at the El Arenosillo Atmospheric Sounding Station, located in Mazagón, Huelva (Spain). These measurements have been taken within the framework of three comparison campaigns performed in October 2021, May 2022 and September 2023. The Avantes spectrometers were calibrated against a PMOD-WRC-calibrated 1000W lamp. The Avantes/Brewer ratio was calculated for specific zenith angles between 20° and 80°, and for 5 nm-wide wavelength bands centered at 310, 320, 340 and 350 nm. Results showed excellent performance for zenith angles below 65° and wavelengths between 330 nm and 360 nm, with an approximately constant ratio around 1. However, the ratio notably increases for zenith angle over 65° and wavelengths shorter than 330 nm, indicating an overestimation in Avantes measurements in certain cases. For future comparisons, longer periods of time will be used to identify the causes of the deviations.

Advances in the study of sunshine duration series in Portugal

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SUMMARY

Solar radiation is a fundamental variable in the Earth's energy balance affecting numerous natural processes on our planet. Besides, its variation reaching the Earth's surface plays a relevant role in the context of climate change since it is related to changes in cloudiness and atmospheric aerosol load. Widespread measurements of surface solar radiation (SSR) started in the late 1950s. Unfortunately, measurements prior to that date are scarce. In this context, the use of proxies is of great importance. In the present work, series of Sunshine Duration (SD), which is one of the most widely used proxies for SSR, are analyzed for several locations in Portugal. Besides, series of Cloud Cover (CC) observed at the same locations are analyzed together with SD series since clouds are the main cause of interannual and decadal variability in SSR. Series of cloudless SD, which acts as an indicator of aerosol load, were also obtained selecting days without clouds. Finally, long-term trends in these variables are studied in search of dimming and brightening periods, as observed in other regions of the world, and the possible causes of them.

Quantifying the uncertainty in UV spectral measurements using the Monte Carlo methodology

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SUMMARY

Evaluating the uncertainty of solar ultraviolet (UV) radiation measurements is needed to ensure their quality and comparability to other measurements. The analytical determination of this uncertainty requires the calculation of its partial derivatives with respect to the various sources of uncertainty involved in the measurement process. For spectroradiometers measuring spectral UV irradiance, this task is highly complicated. In this case, the irradiance obtention procedure is very complex, involving a set of equations and additional processing software, which greatly complicates the partial derivation. Under these circumstances, a numerical approach such as the Monte Carlo method is a reliable alternative, as it requires no such calculation and considers the non-linearity and correlations between the variables of the measurement model.

In this work, the uncertainty of the global UV irradiance measured by Brewer MKIII #150 spectrophotometer is quantified using the Monte Carlo methodology. The spectral UV measurements used were recorded at El Arenosillo Atmospheric Sounding Station (37.1° N, 6.7 °W, 41 m a.s.l., Huelva, Spain) under cloudless sky conditions, during the XVI international comparison campaign of the Regional Brewer Calibration Center – Europe (RBCC-E).

The main results show that the average expanded uncertainty ($k = 2$) of the UV spectral irradiance measured by Brewer #150 depends significantly on wavelength and solar zenith angle (SZA), ranging from 10% at 300 nm to 7% at 363 nm at SZAs smaller than 60°. An increment in the uncertainty was observed at wavelengths below 300 nm, due to thermal and electronic noise as well as wavelength misalignment. These results indicate that while Brewer spectrophotometers are suitable instruments for model validation and climatological studies, they may be limited to accurately detect long-term UV spectral trends.

Aplicação da modelação atmosférica no estudo de incêndios florestais no Sul de Portugal

Application of atmospheric modelling to study wildfires in Southern Portugal

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RESUMO

No contexto da meteorologia dos incêndios florestais, o estudo explora as condições atmosféricas associadas com o desenvolvimento de incêndios significativos que ocorreram no Sul de Portugal. Duas simulações numéricas foram utilizadas para investigar dois grandes incêndios ocorridos a 18 de julho de 2012 e 19 de junho de 2020 e realizadas com o modelo atmosférico Meso-NH. As simulações foram configuradas com dois domínios aninhados, um domínio com 150 × 150 pontos de grelha numa resolução horizontal de 2.5 km e um domínio interno com 300 × 300 pontos de grelha numa resolução de 500 m. A grelha vertical foi configurada com 50 níveis acompanhando o terreno. As condições iniciais e de fronteira foram fornecidas pelas análises do Centro Europeu de Previsão do Tempo a Médio Prazo (ECMWF) e atualizadas a cada 6 horas. As simulações mostram o impacto significativo da topografia regional na criação de condições meteorológicas favoráveis ao fogo. Por exemplo, as experiências indicaram altas temperaturas (> 30°C), baixa humidade relativa do ar próximo à superfície (< 30%) e fortes rajadas de vento que favoreceram a propagação do fogo. O estudo destaca as vantagens da utilização da modelação atmosférica para compreender melhor o ambiente atmosférico dos incêndios florestais, sendo possível identificar o risco de incêndio em regiões com terreno complexo, o que aumenta a suscetibilidade e vulnerabilidade ao fogo em algumas regiões. Este estudo foi financiado por fundos nacionais através da FCT-Fundação para a Ciência e a Tecnologia, I.P. no âmbito do projeto PyroC.pt (Ref. PCIF/MPG/0175/2019).

SUMMARY

In the context of fire meteorology, the study explores the atmospheric conditions associated with the development of significant fires in Southern Portugal. Two numerical simulations were used to investigate in detail the atmospheric environments of two large fires that occurred on 18th July 2012 and 19th June 2020 and performed using the Meso-NH atmospheric model. The simulations were configured with two nested domains, a domain with 150 × 150 grid points at 2.5 km horizontal resolution and the inner domain with 300 × 300 grid points at 500 m resolution. The vertical grid was configured with 50 levels following the terrain. Initial and boundary conditions were provided by European Centre for Medium-Range Weather Forecasts (ECMWF) analysis and updated every 6 h. The simulations show the significant impact of regional topography in creating favourable fire weather conditions. For instance, the numerical experiments indicated high air temperatures (> 30°C), low relative humidity (< 30%) near the surface, and strong wind gusts that favour fire

spread. The study highlights the advantages of using atmospheric modelling to better understand wildfires events, and by the identification of fire risk in regions with complex terrain, which increases the fire susceptibility and vulnerability of some regions in Southern Portugal. This study was funded by national funds through FCT-Foundation for Science and Technology, I.P. under the PyroC.pt project (Ref. PCIF/MPG/0175/2019).

Associações entre Poluentes Atmosféricos, Fatores Meteorológicos e Mortalidade Cardiorrespiratória nas Áreas Metropolitanas Portuguesas

Associations between Atmospheric Pollutants, Meteorological Factors and Cardiorespiratory Mortality in Portuguese Metropolitan Areas

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RESUMO

Este estudo utiliza uma metodologia alternativa com recurso a tabelas de contingência e técnicas estatísticas avançadas, incluindo testes de qui-quadrado e análise de correspondência, para explorar as complexas relações entre poluentes atmosféricos - partículas com diâmetro aerodinâmico igual ou inferior a 10 ou 2,5 (μm) (PM₁₀, PM_{2.5}), monóxido de carbono (CO), dióxido de azoto (NO₂), ozono (O₃) - , variáveis meteorológicas (temperatura, humidade, velocidade do vento, direção) e mortalidade cardio-respiratória (CARDIO) nas áreas metropolitanas de Lisboa (LMA) e Porto (PMA) de 2011 a 2020. As análises mensais revelam padrões regionais e variações sazonais. Os ventos dominantes têm um impacto significativo na dispersão de poluentes, com influências sazonais e ambientais distintas observadas entre as duas principais áreas urbanas. A LMA regista consistentemente CARDIO, temperaturas e humidade mais elevadas em comparação com a PMA. Temperaturas mais baixas ($\text{TEMP} \leq 13^\circ\text{C}$) e concentrações mais elevadas de NO₂ ($\text{NO}_2 \geq 24 \mu\text{g}/\text{m}^3$) estão consistentemente associadas a um aumento do CARDIO em ambas as regiões. Além disso, níveis elevados de PM_{2.5} ($\geq 12 \mu\text{g}/\text{m}^3$) e CO ($\geq 0.31 \text{ mg m}^{-3}$) correlacionaram-se significativamente com o aumento do CARDIO na LMA. Esses resultados destacam a importância de considerar os padrões de exposição de médio prazo para poluentes atmosféricos e variáveis meteorológicas na compreensão da variação sazonal em grandes áreas urbanas, fornecendo insights críticos para o desenvolvimento de políticas e planeamento urbano de acordo com a Agenda 2030 da ONU para um ambiente saudável.

SUMMARY

This study presents an alternative methodology using contingency tables and advanced statistical techniques, including chi-squared tests and correspondence analysis, to explore the complex relationships between air pollutants - particulate matter with an aerodynamic diameter of 10 or 2.5 (μm) or less (PM₁₀, PM_{2.5}), carbon monoxide (CO), nitrogen dioxide (NO₂),

ozone (O₃) - , meteorological variables (temperature, humidity, wind speed, direction) and cardio-respiratory mortality (CARDIO) in the Lisbon (LMA) and Porto (PMA) metropolitan areas from 2011 to 2020. Monthly analyses reveal regional patterns and seasonal variations. Prevailing winds have a significant impact on pollutant dispersion, with distinct seasonal and environmental influences observed between the two major urban areas. The LMA consistently records higher CARDIO, temperatures and humidity compared to the PMA. Lower temperatures ($TEMP \leq 13^{\circ}C$) and higher NO₂ concentrations ($NO_2 \geq 24 \mu g/m^3$) are consistently associated with increased CARDIO in both regions. In addition, elevated PM_{2.5} ($\geq 12 \mu g/m^3$) and CO ($\geq 0.31 \text{ mg m}^{-3}$) levels significantly correlated with increased CARDIO in the LMA. These findings highlight the importance of considering mid-term exposure standards for air pollutants and meteorological variables in understanding seasonal variation in large urban areas, providing critical insights for policy development and urban planning in line with the UN 2030 Agenda for a Healthy Environment.

Diseño de la red básica de observación regional en Europa (RBON) para la implementación robusta de sistemas de alerta temprana en todos los países de la AR VI (OMM).

Design of the regional basic observation network in Europe (RBON) for the robust implementation of early warning systems in all RA VI countries (WMO)

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RESUMEN

El 23 de marzo de 2022, el Secretario General de las Naciones Unidas (ONU), esbozó un objetivo: "Garantizar que todas las personas en la Tierra estén protegidas por sistemas de alerta temprana en un plazo de cinco años". Para afrontar este desafío, se encomendó a la Organización Meteorológica Mundial (OMM) y a la Oficina de las Naciones Unidas para la Reducción del Riesgo de Desastres (UNDRR) la tarea de codirigir esta iniciativa de Alertas Tempranas para Todos (EW4All) con el apoyo de la Unión Internacional de Telecomunicaciones (UIT), la Federación Internacional de Sociedades de la Cruz Roja y de la Media Luna Roja (FICR) y otros socios (WMO, 2022). En el presente trabajo se hace una descripción del diseño de una red de observación básica regional (RBON) que de apoyo al desarrollo del Servicio de Alerta a todos los países de la Asociación Regional VI de la OMM. Este documento presenta las actividades prioritarias identificadas por los países de la AR VI y planes de acción para el desarrollo de la red; el análisis de deficiencias y mejoras del acceso y uso de productos y aplicaciones satelitales; la mejora de los productos de modelización y predicción inmediata a través de los centros regionales de la OMM en la AR y finalmente reforzar la monitorización de los peligros emergentes relacionados con la criosfera. La Asociación Regional de la OMM para Europa (AR VI) la constituyen 50 Estados Miembros, abarcando Europa, el Cáucaso Meridional y Oriente Medio. La diversidad geográfica de la región introduce una amplia gama de desafíos climáticos y meteorológicos que tienen impactos consecuentes en la sociedad y el medio ambiente. El diseño propuesto responde a las prioridades que la propia AR VI ha considerado, a saber, olas de calor y frío, sequías, tormentas extratropicales, e inundaciones.

SUMMARY

On March 23, 2022, the Secretary-General of the United Nations (UN) outlined a goal: "Ensure that every person on Earth is protected by early warning systems within five years." To address this challenge, the World Meteorological Organization (WMO) and the United Nations Office for Disaster Risk Reduction (UNDRR) were tasked with co-leading this Early Warning for All (EW4All) initiative with the support of the International Telecommunication Union (ITU), the International Federation of Red Cross and Red Crescent Societies (IFRC) and other partners (WMO, 2022). In the present work, a description is made of the design of a regional basic observation network (RBON) that supports the development of the Warning Service for all the countries of the WMO Regional Association VI. This document highlights the priority activities identified by the RA VI countries and action plans for the development of the network; analysis of gaps and improvements in access and use of satellite products and applications; improving modeling and nowcasting products through WMO regional centers and finally strengthening monitoring of emerging hazards related to the cryosphere. The WMO Regional Association for Europe (RA VI) is made up of 50 Member States, covering Europe, the South Caucasus and the Middle East. The geographical diversity of the region introduces a wide range of climatic and meteorological challenges that have consequential impacts on society and the environment. The proposed design responds to the priorities that RA VI itself has considered, namely, heat and cold waves, droughts, extratropical storms, and floods.

Plan de Implementación del sistema WIGOS (WMO Integrated Global Observing System) en España

Spanish WIGOS (WMO Integrated Global Observing System) Implementation Plan

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RESUMEN

El principal objetivo del trabajo es presentar el plan implementación del sistema WIGOS (WMO, 2019) en España. Todo el seguimiento y la predicción del tiempo y el clima parten de observaciones que proporcionan la única fuente de conocimiento sobre la atmósfera y el sistema climático. El tiempo y el clima son inherentemente globales, y para comprender y predecirlos en cualquier lugar, las observaciones incluso desde las áreas más lejanas del mundo son necesarias. Sin embargo, simplemente hacer las observaciones no es suficiente, para hacer un uso eficaz de ellas en la vigilancia y la predicción, los datos deben estar disponibles en los sistemas de modelos globales utilizados para el seguimiento y la predicción. Los servicios meteorológicos y climáticos son generados a partir de la cadena de valor meteorológica, estos incluyen observaciones, intercambio de datos y modelos globales/regionales/locales de predicción numérica. El papel de las observaciones es fundamental, una cantidad y calidad insuficiente llevaría a una gran incertidumbre tanto a nivel local como global. Los usuarios toman medidas en respuesta a la predicción del tiempo y el clima, lo que se traduce en salvar vidas y proteger bienes, además incrementa la actividad económica cuando todos los eslabones de la cadena funcionan de manera efectiva. Los datos considerados bajo este plan de implementación corresponden a datos de observación de todas las variables medioambientales y productos generados, provenientes de cualquier procedor público y privado, disponibles que repondan a los requisitos de los usuarios, cumplan los requerimientos técnicos y de difusión exigidas por las autoridades nacionales e internacionales, y permitan la generación de los servicios encomendados a la institución. El plan responde a una estrategia del dato nacional robusta y define el papel que tienen las dieferentes componentes del plan, gobernanza del dato, gestión del dato y gestión de la calidad del dato.

SUMMARY

The objective of this work is to show the implementation plan of the WIGOS system (WMO,2019) in Spain. All weather and climate monitoring and prediction is based on observations that provide the only source of knowledge about the atmosphere and climate system. Weather and climate are inherently global, and to understand and predict them anywhere, observations from even the most distant areas of the world are necessary. However, simply making observations is not enough, to make effective use of them in monitoring and prediction, the data must be available in the global model systems used for monitoring and prediction. Weather and climate services are generated from the meteorological value chain, these include observations, data exchange and global/regional/local numerical prediction models. The role of observations is fundamental; insufficient quantity and quality would lead to great uncertainty both locally and globally. Users take action in response to weather and climate prediction, which saves lives and protects property, and increases economic activity when all links in the chain function effectively. The data considered corresponds to observation data of all available environmental variables and delivered products, coming from public and private providers, that respond to user requirements, comply with the technical and dissemination requirements demanded by national and international authorities and allow the generation of products and services entrusted to the institution. . The plan address the National Data Strategy Plan and defines the role of different components inside the Plan, data governance, data management and quality data management.

Análise do combustível da vegetação usando uma abordagem de detecção remota e modelação

Vegetation fuel load analysis using a remote sensing and modeling approach

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RESUMO

As alterações climáticas exercem um grande impacto no aumento da ocorrência de incêndios florestais, em particular na Península Ibérica. Espera-se um aumento no número e na extensão dos fenómenos meteorológicos extremos, aumentando o risco de incêndios florestais. A disponibilidade de combustível, as condições climáticas e os fatores de ignição estão intrinsecamente ligados aos incêndios florestais. Neste contexto, a identificação de áreas com maior risco de incêndios florestais é crucial para os atores envolvidos na gestão do fogo, desde a prevenção ao combate. Este estudo apresenta uma nova abordagem para melhorar a representação da carga de combustível vegetal, utilizando dados de detecção remota e modelos físicos de superfície, para estimar a evolução do teor de humidade da vegetação viva (LFMC). Neste estudo utilizou-se uma abordagem baseada em aprendizagem automática (*machine learning*) para estimar o LFMC (LFMC-RS) em Portugal através de imagens de detecção remota do satélite Sentinel-2. Esta informação é, de seguida, combinada com resultados do modelo de superfície SURFEX, forçado a partir de variáveis meteorológicas de grande resolução obtidas a partir de simulações com o modelo atmosférico Meso-NH. Esta abordagem procura fornecer uma representação detalhada da carga de combustível da vegetação. O estudo utiliza as variáveis de saída do modelo como preditores para estimar o LFMC, desenvolvendo um modelo de aprendizagem automática (LFMC-SFX). Dados *in-situ* de LFMC obtidos através de trabalho de campo e os fornecidos pelo modelo LFMC-RS foram utilizados para validar o modelo LFMC-SFX. Espera-se que os resultados da investigação possam ser úteis na gestão eficaz dos incêndios florestais, contribuindo para o conhecimento do estado da vegetação.

SUMMARY

Climate change is a pivotal factor in the increased wildfire occurrence, particularly in the Iberian Peninsula. The number and extent of extreme weather events are projected to rise, heightening the wildfire risk likelihood. Fuel availability, weather conditions, and ignition factors are intricately linked to wildfires. In this context, identifying areas at higher wildfire risk is

crucial for stakeholders involved in integrated fire management, from prevention to combat. This study presents a novel approach to improving the representation of vegetation fuel load Using remote sensing and surface physical models to estimate the evolution of vegetation live fuel moisture content (LFMC). This study employed an approach based on machine learning techniques to estimate vegetation LFMC (LFMC-RS) in Portugal through remote sensing imagery by the Sentinel-2 satellite. This information is then combined with the SURFEX surface model results, forced from high-resolution meteorological variables obtained from simulations by the Meso-NH atmospheric model. This comprehensive approach endeavours to provide a detailed representation of vegetation fuel load. This study utilizes model output variables as predictors to estimate vegetation fuel moisture content, developing a model using a machine-learning approach called LFMC-SFX. In-situ fuel moisture content data obtained through fieldwork and provided by the LFMC-RS model were used to validate the LFMC-SFX model. The research results can be helpful in the effective management of forest fires, contributing to knowledge of the vegetation state.

Avaliação das previsões de descargas elétricas do ECMWF no contexto dos incêndios florestais

Evaluation of ECMWF lightning forecasts in the context of forest fires

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RESUMO

Os incêndios originados a partir de uma descarga elétrica atmosférica (DEA) representam apenas 1-2% dos incêndios em Portugal. No entanto, prever corretamente as descargas elétricas pode ajudar na mitigação de grandes incêndios florestais. Este estudo avalia a capacidade do ECMWF em prever DEA para Portugal continental durante 4 épocas de incêndios entre 2019 e 2022. Foram usados os dados de previsão da densidade média total de raios em 3 horas do ECMWF e os dados de observação da rede de deteção de DEA do IPMA agregados para os mesmos horários. Os dados foram ainda agregados em grelhas de resolução horizontal de 1° e 0.5°. Para realizar a análise estatística foram contruídas duas tabelas de contingência e calculados alguns índices estatísticos. Os resultados mostraram que o modelo tende a sobrestimar a ocorrência de raios, com o BIAS maior que 1. A taxa de sucesso para a previsão de raios foi de 57.7% (1°) e 49% (0.5°). A análise temporal indicou um desfasamento temporal entre ambos os dados, com o modelo a começar e a terminar a previsão mais cedo que o observado. Foram encontrados 2 padrões meteorológicos que deram origem às descargas elétricas em Portugal: o desenvolvimento da baixa térmica sobreposta com uma depressão de altitude e a passagem de sistemas de larga escala. As descobertas demonstram que é possível usar as previsões de raios do ECMWF como uma ferramenta adicional de apoio ao combate aos incêndios. O estudo foi financiado pela União Europeia através do CILIFO (0753-CILIFO-5-E) e através de fundos nacionais através da FCT com o projeto PyroC.pt (PCIF/MPG/0175/2019).

SUMMARY

Wildfires originating from lightning represent only 1-2% of the fires in Portugal. However, correctly predicting lightning can help to mitigate large forest fires. This study evaluates the ECMWF's ability to predict lightning for mainland Portugal during 4 fire seasons between 2019 and 2022. The dataset used is composed by the total average lightning density in 3 hours from the ECMWF and the observation data from the detection network from IPMA and aggregated for the same times. The data was also aggregated into horizontal resolution grids of 1° and 0.5°. To carry out the statistical analysis, two contingency tables were constructed, and some statistical indices were calculated. The results showed that the model tends to overestimate the occurrence of lightning, with the BIAS greater than 1. The success rate for lightning prediction was 57.7% (1°) and 49% (0.5°). The temporal analysis indicated a time lag between both data, with the model starting and ending the prediction earlier than observed. Two meteorological patterns were found producing lightning in Portugal: the development of a thermal low overlapping with an Upper Level Low and the passage of large-scale systems. The findings demonstrate that it is possible to use the ECMWF lightning forecast as an additional combat support tool. The study was funded by the European Union through CILIFO project (0753-CILIFO-5-E) and through national funds through FCT with the PyroC.pt project (PCIF/MPG/0175/2019).

Eventos extremos quentes e secos no Mediterrâneo

Compound dry and hot extreme events in the Mediterranean region

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RESUMO

Nas últimas décadas, a frequência, duração e magnitude das ondas de calor na Europa aumentaram consideravelmente, com significativos impactos naturais e socioeconómicos. Prevê-se que estes eventos apresentem uma tendência crescente sob cenários de alterações climáticas, provocando uma redução da produção agrícola e do abastecimento dos reservatórios de água. A região mediterrânica é um hotspot de alterações climáticas e, portanto, uma região suscetível ao desenvolvimento de eventos quentes e secos.

Este trabalho tem como objetivo estudar ondas de calor e secas individuais e compostas, com base na dinâmica entre a humidade no solo e na atmosfera, através de dados ERA5 para o Sul da Europa numa resolução espacial de 0,25° x 0,25°.

Os resultados mostram tendências positivas para a duração e intensidade das ondas de calor e das secas e, inversamente, tendências negativas para a humidade do solo. A maior parte da área de estudo apresenta tendências negativas estatisticamente significativas quando agregadas espacialmente. Por outro lado, as médias de temperatura migram para valores mais elevados e as de precipitação registam um pequeno decréscimo. Além disso, a relação entre os padrões climáticos de grande escala e os eventos compostos é aqui estudada.

Espera-se que os eventos compostos tenham uma tendência positiva na frequência, duração e intensidade, como consequência de sistemas sinóticos ou devido a características secas anteriores. Os nossos resultados evidenciam uma forte interação entre diferentes mecanismos na ocorrência destes eventos no Mediterrâneo, colocando em evidência a necessidade de uma melhor representação desta interação nos modelos climáticos.

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SUMMARY

In recent decades, the frequency, duration and magnitude of heatwaves in Europe have increased considerably, with significant natural and socio-economic impacts. These events are expected to increase under climate change scenarios, leading to a reduction in agricultural production and in the supply of water reservoirs. The Mediterranean region is a climate change hotspot and is therefore vulnerable to the development of hot and dry events.

This work aims to study individual and composite heatwaves and droughts, based on the dynamics between soil and atmospheric moisture, using ERA5 data for southern Europe at a spatial resolution of 0.25° x 0.25°.

The results show positive trends for the duration and intensity of heatwaves and droughts and, conversely, negative trends for soil moisture. Most of the study area shows statistically significant negative trends when aggregated spatially. On the other hand, temperature averages migrate towards higher values and precipitation averages decrease slightly. In addition,

the relationship between large-scale climate patterns and compound events is studied here.

Compound events are expected to have a positive trend in frequency, duration and intensity, as a consequence of synoptic systems or due to previous dry characteristics. Our results show a strong interaction between different mechanisms in the occurrence of these events in the Mediterranean, highlighting the need for a better representation of this interaction in climate models.

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Adaptation, characterization and calibration of a low-cost multi-channel sensor to measure solar radiation

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SUMMARY

The new trend in solar radiation measurement networks requires greater spatial resolution by increasing the number of sampling points. This makes the use of new low-cost sensors necessary. We can find in the market a wide variety of sensors, mostly of them developed for other indoor applications, but they can be adapted to measure solar radiation easily. In this case, an AS7341 multichannel sensor manufactured by AMS OSRAM has been used. It has 8 narrowband channels in the visible range, plus a near-infrared channel and a broadband channel sensitive in the range from ultraviolet to near-infrared. This sensor offers many possibilities for measuring solar radiation, having potential for calculating different action spectra and parameters related to aerosols.

In order to use this sensor for solar radiation applications, an adaptation has been made. A diffuser has been added and the system has been installed inside a radiometer body to facilitate testing and adaptation to existing systems. Device control and data access is implemented through a serial I²C interface. Software has also been designed in Python to facilitate control and data acquisition using a Raspberry Pi.

The system has been characterized in the INTA radiometric calibration laboratory in "El Arenosillo". Its angular response and the spectral response of all channels has been obtained. The sensor has been exposed to a calibrated lamp, specifically a DXW 1000W halogen lamp placed at 50 cm. Once calibrated, the instrument has been installed in the Atmospheric Sounding Station roof.

Preliminary results are presented and compared with the well-calibrated instrumentation of the Observatory

Preliminary atmospheric boundary layer height determination at two rural locations in Southern Spain

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SUMMARY

A proper characterization of the Atmospheric Boundary Layer (ABL) and its composition and dynamics is essential to accurately characterize aerosol dispersion, weather forecast and environmental impact on health. The ABL can be divided into different sub layers and its ideal daily pattern is known. The Mixing Layer (ML) forms when convection starts, developing towards higher altitudes. When convective mechanisms cease, the ML gains stability, and remains as a Residual Layer (RL). However, this pattern varies throughout the year and is highly affected by the atmospheric conditions.

A key characteristic of the ABL is its height (ABLH), representing the altitude at which the ABL transitions into the free troposphere. However, determining the ABLH, and the analogous ML height (MLH), is not trivial. In this study, a standardized algorithm was used to determine the ABLH and MLH from ceilometer data, known as STRATfinder, at two rural stations, namely Guadiana-UGR (37.91°N, 3.23°W, 370 m asl) and Aguamarga (36.94°N, 2.03°W, 205 m asl), managed by the ACTRIS/AGORA facility. The same ceilometer was installed in the stations, from November 2020 to July 2023 and since April 2024 in Guadiana-UGR, and from July 2023 to January 2024 in Aguamarga, most of these periods along an AERONET Sun-photometer. The ceilometer is included in the Iberian Ceilometer Network (ICENET) and consequently, the processing of their data is standardized.

Products from STRATfinder were ultimately improved with auxiliary information from the Sun-photometer, and characterization of Saharan dust events and low cloud and rain presence was carried out in order to filter out erroneous ABLH and MLH estimations.

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Influência do acoplamento temperatura–humidade na ocorrência de eventos compostos de seca e calor extremo na América do Sul: análise histórica e perspectivas futuras

The influence of temperature-moisture coupling on the occurrence of compound dry and hot events over South America: historical and future perspective

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RESUMO

O aquecimento global observado nos últimos 50 anos tem provocado uma intensificação do ciclo hidrológico, promovendo um aumento de episódios extremos de precipitação e seca. Esta é uma tendência que se espera vir a agravar num contexto futuro de alterações climáticas, gerando mudanças nas distribuições de temperatura e precipitação. Estima-se que estas mudanças possam conduzir a distúrbios nos processos físicos de acoplamento entre a temperatura e a humidade (ATH) e, em última análise, à ocorrência de mais eventos compostos de seca e calor (CSC) com impactos ambientais e socioeconómicos severos.

O ATH pode ser conceptualizado e dividido em dois ramos: (1) o ramo atmosférico, quantificado pela correlação entre a temperatura e a precipitação e (2) o ramo superfície–atmosfera, quantificado por uma métrica de acoplamento entre a humidade do solo e a temperatura. Para calcular os níveis de ATH, foram usados dados provenientes do modelo de reanálise da ERA5 e de um *ensemble* pesado construído com base nas saídas de modelos do projecto CORDEX assumindo dois cenários de alterações climáticas (RCP2.6 e 8.5).

Os resultados permitem observar que no clima presente, os níveis de ATH são bastante variáveis de região para região na América do Sul. Modelos regressivos multivariados demonstram também que, enquanto nalgumas regiões, as alterações nas condições CSC se encontram dependentes de um ou de outro ramo em específico do ATH, noutras áreas, parece haver uma relação simultânea com os dois ramos. Finalmente, foi ainda possível determinar de que forma as alterações climáticas irão produzir um efeito diferenciado nestes dois ramos do ATH, tendo sido observado que futuros aumentos nas condições CSC serão, em certa medida, explicados por um efeito conjunto suportado, por um lado, pela intensificação do regime ATH e, por outro, por uma maior interligação entre o ATH e a ocorrência de condições de CSC.

SUMMARY

The global warming observed in the past 50 years has intensified the Earth's water cycle, triggering more frequent and severe rainfall and drought episodes, a trend that is expected to be aggravated in many regions. Consequently, changes in the distribution of temperature and precipitation levels are foreseen. Such changes will likely cause disturbances to the physical coupling between temperature and moisture and, ultimately, to the occurrence of compound dry and hot (CDH) extremes, leading to severe environmental and socio-economic impacts.

These coupling interactions can be conceptualized and categorized in two branches: (1) the atmospheric

component, quantified by the correlation between temperature and precipitation and (2) the land–atmosphere component, quantified by a soil moisture-temperature coupling metric. Data from ERA5 reanalysis and from a weighted CORDEX-CORE ensemble assuming two climate change scenarios (RCP2.6 and 8.5), was used to assess coupling under an historical and future perspective.

Results allowed to observe for the present climate, that the strength of the temperature–moisture coupling is region dependent. Multivariate regression models also demonstrate that, while in some regions, changes in CDH conditions are mostly related to a particular branch of the temperature-precipitation coupling, in others, there is a strong and simultaneous relation with the two branches. Finally, it was possible to observe how climate change is expected to produce a differentiated impact on these two coupling branches throughout South America, allowing to conclude that future changes in the CDH conditions are estimated to be explained, to a certain point, by a jointly effect produced, in one hand, by an intensification of the temperature-moisture regime and, in the other, by a larger inter-link between this coupling and the definition of CDH conditions.

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Integrated monitoring of the complex greenhouse gases and aerosol particle exchanges between atmosphere, ecosystem and vadose zone in drylands: the INTEGRATYON³ project

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SUMMARY

Recent decades have seen increasing concern about climate change and air quality, and how natural and anthropogenic processes affect them. However, certain atmospheric components and mechanisms remain inadequately understood or measured, resulting in high uncertainties, as highlighted by the Fifth IPCC and related studies. To address these challenges and support climate change mitigation strategies, international initiatives are focusing on monitoring various components of the climate system. These efforts aim to generate standardized, high-precision, and long-term observations at different spatial levels, with ACTRIS concentrating on aerosols, clouds and trace gases, ICOS on the carbon balance, and LifeWatch-ERIC on biodiversity. While members of INTEGRATYON³ actively contribute to these initiatives, a lack of clear collaboration

exists among the three e-infrastructures.

Collaboration is particularly crucial in understanding surface/atmosphere exchanges. INTEGRATYON³ proposes to enhance knowledge of greenhouse gases and aerosol particle exchanges in drylands, considering atmosphere, ecosystem, and vadose zone spatial levels. The project's objectives include understanding drivers controlling CO₂ emissions in the vadose zone and quantifying particle emissions and atmospheric dispersion drivers in the atmospheric boundary layer (ABL) over drylands.

Thus, INTEGRATYON³ combines measurements for advanced studies on CO₂ and natural and anthropogenic aerosol particle emissions, focusing on land surface fluxes, ABL dynamics, and soil features. INTEGRATYON³ distinguishes itself through its multidisciplinary approach, utilizing a novel experimental design that integrates instrumentation from the three e-infrastructures. This approach improves the evaluation and understanding of surface/atmosphere exchanges and turbulent processes.

This work is supported by the project PID2020-117825GB-C21 and PID2020-117825GB-C22 funded by MCIN/AEI/10.13039/501100011033. This work is also partially supported by the projects LIFEWATCH-2019-09-CSIC-13, LIFEWATCH-2019-04-AMA-01 and CIROCCO Project 101086497 funded by UE, and P20_00016 C-EXP-366-UGR23 funded by the Government of Andalusia and the European Union through the European Regional Development Fund. Authors also acknowledge the exchange of expertise through the Cost Actions PROBE (CA18235) and HARMONIA (CA21119).

A avaliação e o Mapeamento da Irradiação solar em Timor-Leste com os dados ERA5, MERRA2 e SOLCAST

Assessment and mapping of the solar irradiation in Timor-Leste using ERA5, MERRA2 and SOLCAST data

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RESUMO

Este trabalho faz parte da dissertação de Mestrado em Engenharia da Energia Solar e tem como objetivo avaliar e mapear o recurso solar em Timor-Leste. Para esse fim, foram usados dados de reanálise de ERA5 e MERRA2, envolvendo uma malha com a área compreendida entre 123.75° e 127.5° de longitude, e entre -9.5° e -8.0° de latitude durante de um período de 23 anos (2000-2022), bem como os dados de Solcast adquiridos em 39 pontos distribuídos pelos municípios de Timor-Leste ao longo de 16 anos (2007-2022). Os dados de reanálise foram submetidos a um ajuste da grelha original para uma resolução 0,5° x 0,5° e posteriormente para 0,01° x 0,01° através de interpolação triangular bicúbica e linear para proceder a avaliação e mapeamento. Além disto, investigou-se também a influência da altitude, cobertura de nuvens e precipitação na irradiância solar. Os resultados do estudo mostram que as relações entre os dados de ERA5 e MERRA2 para a variável de GHI (Global Horizontal Irradiance) têm um coeficiente de determinação de $R^2=0,386$, enquanto para o GHI em condição de céu limpo é de $R^2=0,992$. As relações dos dados Solcast, também para o GHI, têm coeficientes de determinações $R^2=0,717$ e $0,299$, com o ERA5 e MERRA2, respectivamente. Para a condição de céu limpo têm $R^2=0,930$ e $0,944$ para o ERA5 e MERRA2, respectivamente. Os mapas mensais entre ERA5 e MERRA2 mostram uma similaridade entre os meses de Julho e Agosto sendo os restantes meses muito diferentes.

SUMMARY

This work is part of the Master's thesis in Solar Energy Engineering and aims to assess and map the solar resource in East Timor. To this end, reanalysis data from ERA5 and MERRA2 were used, involving a grid with an area between 123.75° and 127.5° of longitude, and between -9.5° and -8.0° of latitude over a period of 23 years (2000-2022), as well as Solcast data acquired at 39 points distributed throughout the municipalities of Timor-Leste over 16 years (2007-2022). The reanalysis data was subjected to an adjustment of the original grid to a resolution of 0.5° x 0.5° and then to 0.01° x 0.01° by means of triangular bicubic and linear interpolation in order to carry out the evaluation and mapping. In addition, the influence of altitude, cloud cover and precipitation on the solar irradiance was also investigated. The results of the study show that the relationship between the ERA5 and MERRA2 data for the GHI (Global Horizontal Irradiance) variable has a coefficient of determination of $R^2=0.386$, while for the GHI in clear sky conditions it is $R^2=0.992$. The relationships of the Solcast data, also for the GHI, have coefficients of determination $R^2=0.717$ and 0.299 , with the ERA5 and MERRA2, respectively. For clear skies, $R^2=0.930$ and 0.944 for ERA5 and MERRA2, respectively. The monthly maps between ERA5 and MERRA2 show a similarity between the months of July and August, with the remaining months being very different.

Air pollutants modelling and forecast using in situ and CAMS data in Portugal

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SUMMARY

The Copernicus Atmosphere Monitoring Service (CAMS) rely on the key idea of adding value to observations and providing consistent information of the atmosphere composition and its related processes, anywhere in the world. The rationale of this work is to explore the open access data disseminated by CAMS, taking advantage of the added value of having air quality (AQ) information in a consistent manner across the Portuguese territory. The main goal is to benefit from the accuracy of CAMS products, and use them to build a forecast model to identify AQ environmental emergencies, particularly the exceedance of concentrations thresholds of Particulate Matter (PM) during dust intrusions outbreaks and wildfires events. An AQ forecasting tool will be developed by combining two independent and complementary databases, namely from CAMS and AQ monitoring stations, to provide AQ forecasts in areas that are not covered by the national air quality monitoring network (APA). To achieve the proposed goal, methodological approach will rely on Machine Learning (ML) methods, namely Non-Linear Artificial Neural Network (ANN) and Deep Learning Long-Short-Term Memory (DL-LSTM), to find the most efficient model architecture to predict pollutants' concentration one day ahead. Being able to forecast pollutants' concentrations in regions that are not covered by the APA network is essential for authorities to adopt suitable measures to mitigate pollutants' exceedances and their harmful effects, without being limited to areas closer to monitoring stations. MLP models reveal coefficient of determination (R) values ranging from 0.85 to 0.98 for their 2022 forecasts. Preliminary results reveal the potential to develop an air quality tool over regions less covered by the national air quality monitoring network.

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Space-time characterization of fire-related air pollutants over Portugal

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SUMMARY

Air pollution has a significant impact on human life and Earth's ecosystems. As a consequence of the severe impacts on human health, environment, vegetation, materials, and the economy, air pollution has emerged as a key issue for microclimate regulation and air quality. Therefore, the study of air pollutants and their association with meteorological constraining factors is of utmost importance, particularly under a climate change perspective. This work intends to use the open data disseminated by the Copernicus Atmosphere Monitoring Service (CAMS), taking advantage of the added value of having air quality (AQ) information in a consistent manner across the whole Portuguese territory. Since CAMS rely on the key idea of adding value to observations and providing consistent information of the atmosphere composition and its related processes, anywhere in the world. The rationale is to have information in Portuguese regions of interest, prone to air pollution events that are not sufficiently covered by the national air quality monitoring network, over the study period 2012-2023. Firstly, space-time patterns of air pollutants monitored by CAMS were assessed and secondly, air pollutants patterns are analyzed in terms of their intra-annual and inter-annual variability, their relations and the characteristics of the major extreme events over Portugal. Preliminary analysis reveals a good space-time agreement between CAMS data and extreme fire events, being this agreement clearer for maximum concentrations measured by CAMS pollutants such as CO, PM10, PM2.5, as well as the exceedances of pollutant thresholds during fire activity periods, over affected regions.

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S.06 - Oceanografia Física / Oceanografía Física

Deep-Sea-mining rock-fragments transport driven by topographically induced circulation

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SUMMARY

In recent years there has been an increase in interest in deep sea mining to meet the industry demand for mineral resources. However, deep-sea resources, such as polymetallic crusts on seamounts, polymetallic nodules (PMN) on abyssal plains and polymetallic sulphides (PMS) on mid-ocean ridges, are generally found close to vulnerable ecosystems. Aware of the potential hazards associated with deep-sea mining, the International Seabed Authority has been working on the consolidation of Regional Environmental Management Plans (REMP) aiming at a preventive regulation of activities in the deep ocean. A first REMF was adopted for the Clarion-Clipperton Zone (CCZ), a PMN rich abyssal region. However, this plan cannot be used as an initial standard for other mining regions, because mining techniques and bottom topography of an abyssal plain differ significantly from, for instance, those of seamounts and ridges systems. Indeed, the deep-sea bottom topography of seamounts and ridge-system regions can either constrain the circulation or enhance the free passage of water currents through valleys, and the eddies related to the abrupt topographic changes can broaden the impacted areas. In addition, the local bottom circulation can become an order of magnitude more energetic due to the passage of remotely generated mesoscale eddies. In order to investigate the dynamics and impacts of deep-sea mining in a PMS rich area of the Northern Mid-Atlantic Region, a high-resolution eddy-resolving ocean circulation model with embedded nesting capability was coupled to a Lagrangian model, comprising three different hydrothermal fields. Results have shown that the local topography plays a major role in the dispersion, residence-time and settling of the rock-fragments. In the presence of local submesoscale processes, the residence-time does not follow the neutral height-settling velocity (H/v_s) relationship, being the residence-time greater in flatter areas than in rugged-topography regions, even when the latter are deeper.

S.07- Hidrologia / Hidrología

Aplicación de la teledetección en proyectos de restauración y conservación de riberas.

Application of remote sensing in riverbank restoration and conservation projects.

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SUMMARY

La teledetección emplea sensores remotos para la adquisición de datos sobre la superficie terrestre, sin requerir un contacto físico directo. A través de Google Earth Engine, se puede acceder a imágenes satelitales y a datos geoespaciales con el propósito de analizar y monitorear los cambios que ocurren en la superficie terrestre a lo largo del tiempo.

En el ámbito del proyecto LIFE Alnus Tajo se ha utilizado esta herramienta para obtener el índice NDVI (Índice de Vegetación de Diferencia Normalizada) de 500 parcelas de bosque de ribera. El objetivo principal era determinar si las parcelas objetivo, identificadas como aquellas que albergan alisedas de referencia, presentan un patrón distintivo en su índice NDVI. Sin embargo, los resultados obtenidos no han sido satisfactorios, ya que las parcelas objetivo exhiben valores de NDVI similares a las demás parcelas, e incluso en algunos casos muestran un índice NDVI inferior en comparación con aquellas áreas que albergan zonas agrícolas.

En esta aplicación se concluye que el índice NDVI resulta ser una herramienta adecuada para el estudio del estado y la salud de zonas agrícolas o extensiones forestales de gran amplitud y que no es de utilidad para parcelas de pequeño tamaño donde se comparan diferentes especies arbóreas.

PALABRAS CLAVE

Teledetección, NDVI, bosque de ribera, conservación y restauración de riberas,

Indicadores de desempenho em resposta a seca hidrológica nos aquíferos do Algarve

Performance indicators in response to hydrological drought in the Algarve's aquifers

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RESUMO

Os aquíferos em regiões costeiras semiáridas como o Algarve são severamente afetados por secas. A extração excessiva agrava a situação levando à degradação da qualidade da água e ao risco de intrusão salina. Monitorar minuciosamente os poços usando vários indicadores é crucial para prever e mitigar as consequências da seca. Este estudo propõe uma metodologia que envolve o cálculo de indicadores de desempenho com base no Standardized Groundwater Index (SGI) e no Standardized Precipitation Evapotranspiration Index (SPEI). São utilizados dados de reanálise atmosférica e observações in situ do nível da água subterrânea para determinar a memória dos aquíferos e encontrar tempos de acumulação ótimos do SPEI consistentes em cada local. O inverso da memória calculada a partir da autocorrelação do SGI produz a melhor estimativa da capacidade de recuperação de cada poço em condições de seca, fornecendo uma indicação confiável de resiliência e sustentabilidade. O SPEI calculado para um tempo de acumulação de 12 meses (SPEI-12) é o que melhor captura a variabilidade regional média do nível da água subterrânea. No entanto, as memórias do aquífero e os tempos ótimos de acumulação do SPEI variam muito espacialmente, variando entre SPEI-5 e SPEI-48. Poços com memórias mais curtas (< 6 meses) demonstram maior sustentabilidade, enquanto aqueles com memórias mais longas (> 16 meses), no interior ou ao longo da costa, exibem menor resiliência e sustentabilidade. Neste trabalho são identificados os poços que têm menor resiliência e que requerem monitorização intensificada para adaptar estratégias de gestão da água.

SUMMARY

Aquifers in semi-arid coastal regions such as the Algarve are severely affected by droughts. Excessive groundwater abstraction exacerbates the situation, leading to the degradation of water quality and the risk of saline intrusion. Thoroughly monitoring using various indicators is crucial to predicting and mitigating the consequences of drought. This study proposes a methodology that involves calculating performance indicators based on the Standardized Groundwater Index (SGI) and the Standardized Precipitation Evapotranspiration Index (SPEI). Atmospheric reanalysis data and in situ groundwater level observations are used to determine the aquifers' memory and to find optimal accumulation times for the SPEI at each well. The inverse of the memory calculated from the SGI's autocorrelation provides the best estimate of each well's recovery capacity under drought conditions, offering a reliable indication of resilience and sustainability. The SPEI calculated for an accumulation time of 12 months (SPEI-12) best captures the average regional variability of groundwater levels. However, aquifer memories and optimal SPEI accumulation times vary greatly spatially, ranging from SPEI-5 to SPEI-48. Wells with shorter memories (< 6 months) demonstrate greater sustainability, while those with longer memories (> 16 months), inland or along the coast, exhibit lower resilience and sustainability. This work identifies the wells with the least resilience that require intensified monitoring to adapt water management strategies.

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Completude das linhas de água do OpenStreetMap numa região da Serra da Estrela

Completeness of OpenStreetMap waterlines in a region of Serra da Estrela

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RESUMO

A representação cartográfica das linhas de água é útil para o estudo dos processos hidrológicos que ocorrem no território. O presente estudo faz uma abordagem relativa à variação da completude das linhas de água extraídas do OpenStreetMap (OSM) numa região montanhosa de Portugal (Gouveia-Guarda) em dois períodos temporais distintos relativos aos anos de 2014 e 2023. A literatura refere que a completude dos dados OSM no mundo é variável de região para região, sendo diversos os estudos já publicados que mostram que a completude de alguns temas do OSM é influenciada e correlacionada pela presença humana (e.g., os temas: estradas, edificações, equipamentos urbanos, entre outros), o mesmo não sucedendo com as linhas de água. Uma análise mais detalhada teve por objetivo perceber a eventual influência de alguns indicadores na variação da completude das linhas de água do OSM nesse período temporal, tais como: declive, altitude e a proximidade ou atravessamento de aglomerados populacionais. Como dados de referência, utilizou-se a hidrografia da folha nº 201 da série cartográfica M888 do Centro de Informação Geoespacial do Exército de Portugal à escala 1/25 000. As análises visuais foram apoiadas em imagens de satélite da área de estudo. Para o efeito foram também gerados o MDE SRTM e o mapa de declives. Os resultados obtidos mostram que a completude das linhas de água na área de estudo aumentou, no entanto, considera-se esse aumento pouco significativo, face ao período temporal estudado e à atual possibilidade de criação dessa “feature” remotamente através da digitalização efetuada sobre dispositivos que possuam fácil acesso a imagens de satélite.

Palavras Chave: linhas de água, completude, OpenStreetMap

ABSTRACT

The cartographic representation of watercourses is useful for studying the hydrological processes that occur in the territory. The present study takes an approach to the variation in the completeness of water lines extracted from OpenStreetMap (OSM) in a mountainous region of Portugal (Gouveia-Guarda) in two distinct time periods relating to the years 2014 and 2023. The literature states that the completeness of OSM data in the world varies from region to region, with several studies already published that show that the completeness of some OSM themes is influenced and correlated by human presence (e.g., themes such as: roads, buildings, urban equipment, among others) and the same does not happen with watercourses. A more detailed analysis aimed to understand the possible influence of some indicators (slope, altitude and the proximity or crossing of population clusters) on the variation in the completeness of the OSM watercourses in this period of time. As reference data was used, the hydrography of sheet number 201 of the M888 cartographic serie of the Geospatial Information Center of the Portuguese Army at scale 1/25,000. Visual analyzes were supported by satellite images of the study area. For this purpose, the Digital Elevation Model SRTM and the slope map were also generated. The results obtained show that the completeness of the watercourses in the study area has increased, however, this increase is considered to be insignificant, given the time period studied and the current possibility of creating this “feature” remotely through digitalization carried out on devices. that have easy access to satellite images.

Keywords: watercourses, completeness, OpenStreetMap

S.08 - Geofísica Aplicada / Geofísica Aplicada

La red GNSS del Real Instituto y Observatorio de la Armada: Estado actual y resultados.

GNSS Network of the Royal Institute and Observatory of the Navy: Current status and results.

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RESUMEN

Actualmente, la frontera tectónica de la región Ibero-Magrebí formada por la confluencia de placas Euroasiática (EURÁ) y Africana (Nubia), muestra una clara tendencia NO-SE. Esta zona de gran interés geodinámico, más conocida como Arco de Gibraltar, correspondiente a la región comprendida entre las cordilleras Béticas y el Rif, presenta varias zonas de fractura o fallas activas de interés como la Bahía de Alhucemas. El Real Instituto y Observatorio de la Armada Española (ROA) cuenta actualmente con estaciones geodésicas en diferentes puntos del norte de África, algunas de ellas en lugares muy interesantes como los peñones de Alhucemas (ALHU) y Vélez de la Gomera (PVLZ) o las islas Chafarinas (CHAF); pero también tiene otras en zonas más estables dentro de la placa de Nubia como Tiouine (TIOU). Contar con estaciones permanentes en estos emplazamientos que puedan ofrecer resultados de series temporales continuas es un privilegio que permite entender mejor el difícil comportamiento de esta zona. En este trabajo se pretende mostrar el estado actual de estas estaciones (equipamiento, emplazamiento, comunicaciones, problemática...) y los resultados obtenidos de las mismas tras el procesamiento de las series anuales (desplazamiento en milímetros por año); además, mostrar la dificultad real que supone el mantener y explotar este tipo de recursos.

SUMMARY

Currently, the tectonic boundary of the Ibero-Maghrebian region formed by the convergence of the Eurasian (EURÁ) and African (Nubian) plates exhibits a clear NW-SE trend. This area of significant geodynamic interest, commonly known as the Gibraltar Arc, spanning from the Betic Cordillera to the Rif, features several fracture zones or active faults of interest such as the Alhucemas Bay. The Royal Institute and Observatory of the Spanish Navy (ROA) currently operates permanent geodetic stations at various points in North Africa, some situated in highly intriguing locations like the Alhucemas Rocks (ALHU) and Vélez de la Gomera (PVLZ), or the Chafarinas Islands (CHAF); it also maintains others in more stable zones within the Nubian Plate, like Tiouine (TIOU) in the High Atlas. Having permanent stations in these locations capable of providing continuous time series results is a privilege that enhances the understanding of the complex behavior of this region. This work aims to present the current status of these stations (equipment, location, communications, issues...) and the results obtained from them after processing the annual series (displacement in millimeters per year); furthermore, it seeks to highlight the real challenges involved in maintaining and exploiting such resources.

Three-dimensional active seismic tomography in Lousal Mine

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SUMMARY

Muon tomography was applied to the Lousal Mine (located southwest of the Alentejo) to evaluate its efficiency in subsurface analysis. After its exploitation ended in 1988, the mine was rehabilitated to become a museum open to visitors. LouMu project gathers the Laboratory of Instrumentation and Experimental Particle Physics, the Institute of Earth Science, the Lousal Ciência Viva Center and the National Laboratory of Energy and Geology that collaborated to conduct the project in optimal conditions. This work consists of testing for the first time in Portugal the muography technique to explore the subsurface and confirm the results with other classical geophysical methodologies such as seismic tomography. The survey targets mainly the Corona fault that passes through the Waldemar Gallery located at a depth of 18m. After carrying out two profiles of 2D seismic imaging, the ray coverage couldn't resolve the whole studied media in velocities. This led to a resolution not even reaching the gallery, imaging the subsurface only until a depth of 10m. A specific configuration of geophones and shots was elaborated to overcome this limitation, generating a robust seismic ray coverage and providing a three-dimensional model. The geophones were installed in the Gallery and shots were performed at the surface increasing the ray density that covered a larger area. The first results obtained after running the travel time inversion, have shown the clear presence of the major Corona fault correlating perfectly with the limit that separates negative and positive velocity anomalies related respectively to the phyllites-quartzite group and the volcano-sedimentary complex composed of grey shales.

Finally, this project aims to compare the results to the muography images to evaluate the methodology's accuracy for its application to other geophysical surveys.

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Estudio mediante tomografía eléctrica y LiDAR de la dinámica geoarqueológica en el castro de Villasviejas del Tamuja (Botija, Cáceres)

Study using electrical tomography and LiDAR of the geoarchaeological dynamics in the Villasviejas del Tamuja fort (Botija, Cáceres)

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RESUMEN

Se presenta el estudio llevado a cabo mediante tomografía eléctrica, junto con el análisis de nubes de puntos LiDAR, en el castro protohistórico de Villasviejas del Tamuja (Botija, Cáceres, España) con el fin de valorar los procesos dinámicos y de conservación en la vertiente oriental de este recinto. En esta vertiente se observa parte del tramo de la muralla, construida con bloques de granito, siendo abundante los bloques deslizados a lo largo de ella. El estudio de tomografía eléctrica ha revelado diferentes anomalías relacionadas con la muralla y con otras construcciones que han influido en la evolución de la ladera. Además, este estudio ha permitido precisar el límite de los niveles de depósitos que cubren la vertiente y el sustrato de pizarras sobre el que se edificó la muralla. En cuanto a la dinámica geoarqueológica, se ha determinado que esta vertiente ha estado afectada por procesos antrópicos y naturales, detectándose estructuras enterradas que indican sucesivas etapas de inestabilidad gravitacional. Por otro lado, la caracterización microtopográfica del terreno mediante LiDAR, tras procesar el Modelo Digital de Elevaciones de la vertiente, ha servido como complemento a la exploración de campo, aportando detalle de las áreas donde se han realizado los perfiles de tomografía.

SUMMARY

The study carried out using electrical tomography is presented, together with the analysis of LiDAR point clouds in the protohistoric fort of Villasviejas del Tamuja (Botija, Cáceres, Spain) in order to assess the dynamic and conservation processes on the eastern slope of this enclosure. On this slope one can see part of the section of the wall, built with granite blocks, and there are abundant blocks slid along it. The electrical tomography study has revealed different anomalies related to the wall and other constructions that have influenced the evolution of the slope. Furthermore, this study has made it possible to specify the limit of deposits that cover the slope and the slate substrate on which the wall was built. Regarding geoarchaeological dynamics, it has been determined that this slope has been affected by anthropic and natural processes, detecting buried structures that indicate successive stages of gravitational instability. Besides the microtopographic characterization of the terrain using LiDAR, after processing the Digital Elevation Model of the slope, it has served as a complement to the field exploration, providing details of the areas where the tomography profiles have been made.

Resultados Preliminares da Aplicação da Muografia na Mina do Lousal *Preliminary Results of the Muography Application in the Lousal Mine*

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RESUMO

A galeria subterrânea da Mina do Lousal (Portugal) constitui o local onde se realizou a primeira fase de avaliação do desempenho dos instrumentos e dos métodos muográficos criados pela equipa do Projeto LouMu. O projecto foi criado para desenvolver a muografia como técnica de sondagem aplicada à Geofísica e tem sido uma colaboração entre o Laboratório de Instrumentação e Física Experimental de Partículas, o Instituto de Ciências da Terra – Universidade de Évora e o Centro Ciência Viva do Lousal, também com o apoio do Laboratório Nacional de Energia e Geologia.

O telescópio de muões equipado com 4 detetores RPC instalado num paiol da galeria, 18 m abaixo da superfície, observou o terreno acima da sua posição e muografou a falha geológica que atravessa a zona. A Falha de Corona é uma falha regional subvertical que cria um contraste de densidades na geologia da área em estudo e que conseguiu ser vista com a muografia através dos mapas de contagem de muões que atravessam o terreno, também chamados de muografias.

Como meio de referência e comparação para usar na interpretação dos dados muográficos, um estudo geofísico da área foi também efetuado usando as técnicas de tomografia sísmica de refração 2D e 3D e GPR. A implementação destas técnicas contribuiu para uma melhor compreensão da estrutura subterrânea, da posição da Falha Corona e da extensão do sistema de falhas dentro da área estudada.

O estudo da complementaridade entre a muografia e as técnicas geofísicas padrão é também um aspeto importante no objetivo do projeto. Este caso de estudo na Mina do Lousal constitui a fase teste da muografia desenvolvida pelo LouMu que pretende criar as condições para a utilização da técnica como um método inovador para realizar levantamentos geofísicos em Portugal.

SUMMARY

The underground gallery at Lousal Mine (Portugal) is where the first phase of evaluating the performance of the muographic instruments and methods created by the LouMu Project team took place. The project was created to develop the muography as a survey technique applied to Geophysics and has been a collaboration between the Laboratory of Instrumentation and Experimental Particle Physics, the Institute of Earth Sciences – University of Évora and the Lousal Ciência Viva Center, also with the support of the National Laboratory of Energy and Geology.

The muon telescope equipped with 4 RPC detectors installed in a warehouse in the gallery, 18 m below the surface, surveyed the terrain above its position and muographed the geological fault that crosses the area. The Corona Fault is a subvertical regional fault that creates a contrast of densities in the geology of the area under study that can be seen with muography through muon count maps of the muons that cross the terrain, also called muographs.

As a form of reference and comparison to use in the interpretation of muographic data, a geophysical study of the terrain was also carried out using 2D and 3D seismic refraction tomography and GPR methods. The implementation of these techniques contributed to a better understanding of the underground structure, the position of the Corona Fault and the extension of the fault system within the studied area.

The study of complementarity between muography and standard geophysical techniques is also an important aspect of the project's objective. This case study at the Lousal Mine constitutes the test phase of the muography developed by LouMu, which aims to create the conditions for using the technique as an innovative method to carry out geophysical surveys in Portugal.

Instrumento de gestão de áreas contaminadas por metais combinando dados de Química Ambiental, Geofísica, Deteção Remota, Inteligência Artificial e Gestão

Instrument for managing areas contaminated by metals combining data from Environmental Chemistry, Geophysics, Remote Sensing, Artificial Intelligence and Management

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RESUMO

O Projeto INCOME propõe a criação de um modelo de gestão ambiental para áreas mineiras contaminadas por metais tóxicos. Este modelo integra os resultados da aplicação de um conjunto de métodos analíticos e instrumentos de monitorização de áreas contaminadas, como análises biofísicas, química do solo e da água (parâmetros de qualidade e quantificação de metais potencialmente tóxicos em amostras de solo e água), geofísica (magnética, métodos eletromagnéticos, elétricos e sísmicos) e deteção remota hiperespectral satélite. Estes dados serão utilizados como inputs a serem utilizados como inputs em algoritmos de inteligência artificial, o que permitirá a produção de modelos de contaminação utilizando menos dados do que as metodologias-padrão. Propõe-se a criação de um modelo de gestão sustentável, baseado na combinação de ferramentas a desenvolver, que permitirá a otimização e poupança de recursos nas fases de amostragem e análise, fornecendo informação importante em tempo real para a tomada de decisão com vista ao acompanhamento e gestão da poluição. O instrumento tem ampla aplicabilidade na deteção de contaminação por metais, permitindo a transferência de tecnologia para diferentes áreas geográficas e para outros cenários de contaminação por metais, como aterros sanitários e explorações agrícolas. O retorno ambiental, social e económico para a região resulta da incorporação de novas estratégias às rotinas atuais; redução e otimização de procedimentos e tempos de execução; economia de recursos; recuperação do local contaminado; equilíbrio dos ecossistemas; retorno para empresas; redução da pegada ambiental; promover a sustentabilidade social, ambiental e económica da região.

Este trabalho é apoiado pelo Programa Promove da Fundação “la Caixa”, em parceria com o BPI e a Fundação para a Ciência e a Tecnologia (FCT), no âmbito do projeto INCOME – Inputs para uma região mais sustentável: Instrumentos para a gestão de zonas contaminadas por metais, PD23-00013.

SUMMARY

The INCOME Project proposes the creation of an environmental management model for mining areas contaminated by toxic metals. This model integrates the results of the application of a set of analytical methods and instruments for monitoring contaminated areas, such as biophysical analyses, soil, and water chemistry (quality parameters and quantification of potentially toxic metals in soil and water samples), geophysics (magnetic, electromagnetic, electrical, and seismic methods), and satellite hyperspectral remote sensing. This data will be used as inputs by artificial intelligence, which will allow the production of contamination models using less data than standard methodologies. It is proposed to create a sustainable management model, based on the combination of tools to be developed, which will allow the optimization and saving of resources in the sampling and analysis phases, providing important information in real time for decision making with a view to monitoring and pollution management. The instrument has broad applicability in detecting metal contamination, allowing technology transfer to different geographic areas and to other metal contamination scenarios, such as landfills and agricultural farms. The environmental, social, and economic return for the region results from the incorporation of new strategies into current routines; reduction and optimization of procedures and execution times; resource saving; recovery of the contaminated site; balance of ecosystems; return for companies; reduction of the environmental footprint; promote the social, environmental, and economic sustainability of the region.

This work is supported by the Promove Program of the "la Caixa" Foundation, in partnership with BPI and the Foundation for Science and Technology (FCT), in the scope of the project INCOME – Inputs para uma região mais sustentável: Instrumentos para a gestão de zonas contaminadas por metais (Inputs for a more sustainable region: Instruments for managing metal-contaminated areas), PD23-00013.

Exploración gravimétrica de pegmatitas enriquecidas en Li en la región de Giraúl (SW de Angola)

Gravimetric exploration of Li-enriched pegmatites: a case study in the Giraul region (SW Angola)

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RESUMEN

Dentro de los métodos de exploración geofísica, el uso de la gravimetría se considera fundamental para realizar una primera aproximación a la investigación geológico-minera, por tratarse de un método no invasivo y con una relación coste/beneficio muy baja. El método es especialmente prometedor en investigaciones mineras donde el contraste de densidad entre el yacimiento y la roca encajante es elevado. En la región de Namibe (SW de Angola) se encuentra el Enjambre Pegmatítico de Giraúl, con algunas pegmatitas enriquecidas en Li, Be, B, Cs, Rb, Sn y/o Ta, actualmente en explotación por Tyranna Resources Ltd y Angolitio Exploração Mineira (SU) Lda. Este enjambre pegmatítico intruye en una extensa secuencia metasedimentaria y en cuerpos plutónicos básicos paleoproterozoicos. El interés por ampliar las zonas de explotación nos ha llevado a la realización de una campaña gravimétrica de detalle cubriendo una superficie de 307.800 m² (570 x 540 m) dividida en dos áreas en función del potencial de la mineralización: área interna, actualmente en explotación (separación de estaciones 25 m) y área externa, potencialmente explotable (separación de estaciones de 50 m). Se midieron 236 estaciones según perfiles N-S y E-W usando el gravímetro de reciente adquisición CG-6 AUTOGRAV™ y el GPS PENTAX G-7. Para el cálculo de la densidad de reducción utilizamos la correlación entre anomalía gravimétrica y topografía según Nettleton (1939) y Yamamoto (1999), para densidades de reducción entre 2,4 g/cm³ y 3,3 g/cm³, en concordancia con la variedad litológica de la región de estudio. La densidad de reducción que mejor correlaciona la anomalía gravimétrica y la topografía es 3,1 g/cm³, con la que se obtiene un mapa de anomalías de Bouguer cuyos mínimos gravimétricos relativos se relacionan con estructuras pegmatíticas, y cuyo elevado contraste de densidad indica que son susceptibles de explotación de litio.

SUMMARY

Exploration geophysics based on gravity is one of the most efficient non-invasive and cost-effective methods as a first approach to any mining investigation. The method is remarkably promising in mining prospecting in terms of the location and depth of the geological bodies where there is enough contrast in density between the involved lithologies. In the Namibe region (SW Angola), the Giraúl Pegmatitic Field contains some pegmatite bodies enriched in Li, Be, B, Cs, Rb, Sn and Ta, currently being exploited by Tyranna Resources Ltd and Angolitio Exploração Mineira (SU) Lda. This pegmatitic dike swarm intrudes into a broad Palaeoproterozoic metasedimentary sequence and basic plutonic bodies. The interest in expanding the area of exploitation led us to perform a gravity survey covering an area of 307,800 m² (570 x 540 m), divided into two sections based on mineralisation potential: the inner area (25 m station spacing) and the outer area (50 m station spacing). 236 gravimetric stations were measured along N-S and E-W profiles using the newly acquired CG-6 AUTOGRAV™ gravimeter and the PENTAX G-7 GPS. To calculate the reduction density we use the correlation between Bouguer anomalies and topography of Nettleton (1939) and Yamamoto (1999) to densities between 2.4 g/cm³ and 3.3 g/cm³ in agreement with the lithological variety of the region. The best fitting between Bouguer anomaly and topography is obtained with density 3.1 g/cm³ that provides a map with a few relative gravity minima related to pegmatitic structures, whose high density contrast suggests promising for exploration of Li-bearing pegmatites.

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Modelización de anomalías gravimétricas para caracterizar en profundidad la distribución de evaporitas; ejemplo del Saliente Surpirenaico Central

Modelling of gravity anomalies to constrain the distribution at depth of evaporites; Central South Pyrenean Salient example

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RESUMEN

El Saliente Surpirenaico Central de los Pirineos se caracteriza por la presencia de varias láminas de cabalgamientos que despegan en las evaporitas del Triásico, las cuales actúan como nivel de despegue regional. A pesar de su presencia bien establecida en el Saliente Surpirenaico Central, su distribución y las implicaciones geométricas y cinemáticas asociadas, continúan siendo motivo de debate. Este trabajo presenta la integración de datos geológicos y gravimétricos para caracterizar en profundidad la distribución tanto cualitativa como cuantitativa de las evaporitas Triásicas en el Saliente Surpirenaico Central.

Se realizaron un mapa de anomalías gravimétricas de Bouguer y un mapa de anomalías gravimétricas residuales a partir de una exhaustiva actualización y homogeneización de datos provenientes de diversas fuentes, así como de nuevas mediciones (más de 3000) realizadas durante los últimos años en la zona de estudio. La geometría en profundidad de las evaporitas Triásicas se ha constreñido a partir de la modelización gravimétrica de 4 cortes geológicos representativos de la zona de estudio y la medida de densidad de más de 2000 muestras.

Los resultados obtenidos revelan una distribución irregular de las evaporitas Triásicas, con acumulaciones principalmente en la zona noroeste, debajo de un depocentro de materiales del Cretácico Superior y en el núcleo de pliegues de despegue en la parte media del saliente. En la lámina más frontal de los Pirineos en esta área, conocida como la lámina de Gavarnie-Sierras, se observa la presencia de varios cuerpos salinos asociados a una zona de sal hinchada.

SUMMARY

The Central South Pyrenean Salient is characterized by the presence of several thrust sheets detached in the Triassic evaporites, which act as the regional detachment level. Despite their well-established presence in the Central South Pyrenean Salient, their distribution and associated geometric and kinematic implications continue to be a matter of debate. This work

presents the integration of geological and gravimetric data to constrain at depth the qualitative and quantitative distribution of Triassic evaporites in the Central South Pyrenean Salient.

Maps of the Bouguer and residual gravimetric anomalies were created based on an exhaustive update and homogenization of data from various sources, as well as new measurements (more than 3000) carried out in recent years in the study area. The geometry at depth of the Triassic evaporites has been constrained from gravity modelling of 4 representative cross-sections of the study area and the density measurement of more than 2000 samples.

The results obtained reveal an irregular distribution of Triassic evaporites, with accumulations mainly in the northwest area, beneath a depocenter of Upper Cretaceous materials and in the core of detachment folds in the middle part of the salient. In the forefront sheet of the Pyrenees in this area, known as the Gavarnie-Sierras thrust sheet, the presence of several saline bodies associated with a swollen salt zone is observed.

Insights into the Porto-Tomar Shear Zone (Mainland Portugal): Preliminary Analysis Using Magnetotelluric Data and Geomagnetically Induced Current Measurements

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SUMMARY

The pre-Mesozoic basement of the Iberian Peninsula (Variscan Massif) is constituted by several tectono-stratigraphic units that are separated by major tectonic accidents, such as deeply rooted fault zones known as first order shear zones. This study will focus on the Porto-Tomar Shear Zone (PTSZ), a highly important tectonic structure that has been active since the Neo-Proterozoic until the present day with notorious geodynamic implications. It separates the Variscan Massif from the western Mesozoic basin. Previous studies have explored the PTSZ geomorphic signatures, kinematics, and tectonostratigraphy, however, an investigation of its subsurface geometry is still lacking.

The magnetotelluric (MT) method is a type of passive electromagnetic survey that measures the natural magnetic (H) and electric (E) fields at the Earth's surface simultaneously. These two fields are related to each other by the impedance tensor (Z), which holds information about the electrical distribution of the Earth's subsurface. Portugal's mainland has the first 3D conductivity model derived from 31 MT soundings on a 50x50 km grid.

This study seeks to gain a deeper understanding of the PTSZ by testing geological concepts related to the shear zone's depth characteristics through forward inversions. Furthermore, this region is particularly significant for Geomagnetically Induced Currents (GIC) as estimations are notably higher along this shear zone. This highlights the importance of improving the understanding of electromagnetic properties in this area. To validate the model, the different geological concepts will be cross-referenced with GIC measurements at the Paraimo substation.

Estudio geofísico del deslizamiento de Albuñuelas (sureste de España) mediante el uso de medidas de ruido ambiente

Geophysical study of the Albuñuelas landslide (S Spain) using ambient noise measurements

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RESUMEN

Los deslizamientos de tierra son efectos comunes del suelo que pueden inducirse como efecto de un terremoto. En el caso de grandes deslizamientos, sus efectos pueden ser bastante peligrosos para las poblaciones cercanas. Este el caso del núcleo urbano de Albuñuelas (Granada, S España), que se ha desarrollado sobre un gran deslizamiento que tiene una tasa de movimiento muy lenta. Esta actividad se manifiesta claramente en múltiples viviendas, las cuales han sufrido visibles rotaciones de su estructura. A pesar de ello, hasta el momento se desconoce la estructura interna del deslizamiento y cómo ha evolucionado hasta su estado actual. En el caso de deslizamiento de grandes dimensiones, como es éste, el uso de sondeos puede resultar prohibitivo, desde el punto de vista económico. En este trabajo se ha optado por técnicas basadas en el análisis de ruido sísmico (medidas de H/V y medidas en array) para de este modo definir por primera vez la estructura y características del deslizamiento bajo estudio. La inversión tanto de las curvas de H/V como de las curvas de dispersión (obtenidas de las medidas en array mediante el método de frecuencia - número de onda) ha permitido estimar la estratigrafía del suelo en cada punto. Adicionalmente, se ha contado con la información de un sondeo realizado en dicha área y con las observaciones de campo de la geología local, para reducir las incertidumbres en los resultados. A partir de estos datos se ha construido un modelo geológico-geofísico del deslizamiento, demostrando que el espesor del deslizamiento es superior a 50 m en sus partes centrales y superior a 60 m en las partes superiores. Este modelo muestra que la evolución del deslizamiento fue compleja, con varios cuerpos moviéndose en secuencia (retrogresión) y siendo parcialmente erosionados en su parte baja para explicar la morfología actual del deslizamiento.

SUMMARY

Landslides are common soil effects that can be induced as an effect of an earthquake. In the case of large landslides, their effects can be quite dangerous for nearby populations. This is the case of the urban area of Albuñuelas (Granada, S Spain), developed on a large landslide characterized by very low rate of movement. These effects are clearly observed in multiple houses, which have suffered visible rotations of their structure. Despite this, the internal structure of this landslide, and how it has evolved to its current state is unknown. In the case of large landslide, such as this one, the use of boreholes may be prohibitive from an economic point of view. In this work, other techniques based on seismic noise analysis (H/V measurements and array measurements) have been chosen to define for the first time the structure and characteristics of the landslide under study. The inversion of both the H/V curves and the dispersion curves (obtained from array measurements using the frequency - wavenumber method) has allowed us to estimate the soil stratigraphy at each measurement site. Additionally, information from a borehole carried out in this area and field observations of the local geology have been used to reduce uncertainties in the results. From these data, a geological-geophysical model of the landslide has been built, demonstrating that the thickness of the landslide is greater than 50 m in its central parts and greater than 60 m in the upper parts. This model shows that the evolution of the landslide was complex, with several bodies moving in sequence (retrogression) and being partially eroded at the toe to explain the current morphology of the landslide.

S.09 - Ciências Criosféricas / Ciencias de la Criosfera

Retrieving snowpack properties from temperature signals at different heights in Antarctica

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SUMMARY

Numerous approaches exist for gauging snow depth, most of them relying on measuring distances from specific elevations to the ground. Ultrasound or laser technology is often employed to gauge these distances. Always, these methods albeit at a significant cost and infrastructure requirement, including support for sensors and solar panel installations for winter power. Such systems can encounter operational, structural, or energy-related issues that may lead to a complete loss of data. Conversely, manual techniques involving probes offer a simpler and more robust alternative but they depend on human intervention.

Some international monitoring networks such as GTN-P, a method leveraging temperature data collected at various heights, known as snowpoles, has become popular since long time ago. These systems combine the simplicity of manual techniques with the higher temporal resolution of automated methods since no human intervention is necessary, only during installation and data retrieval. Moreover, they have some extra advantages such as affordability and minimal environmental impact, facilitating denser measurement points, particularly in challenging terrains like mountains or remote areas like the poles. This study uses temperature data from a set of snowpoles in Antarctica not only for determining snowpack height but also for estimating its water equivalent, a novel aspect in the field. Additionally, spatial interpolation of the results are extended to a small domain and snow water equivalent estimates are calculated and compared with observations.

Ground surface temperature-derived Growing Degree Days in Livingston and Deceptions Islands, Antarctica.

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SUMMARY

The PERMATHERMAL network comprises a series of frozen soil thermal monitoring stations established since 2000 on Livingston and Deception Islands, Antarctica, integrated into the Global Terrestrial Network for Permafrost (GTN-P). Each station is equipped with sensors to monitor air, surface, and ground temperatures in shallow (<15 m) and deep boreholes, alongside other environmental parameters. These data contribute to characterizing seasonal and permanent frozen soils in Antarctica and assessing their evolution within the context of climate change. Antarctica, known for its extreme climate and sparse vegetation, epitomizes the profound impacts of global warming. The Antarctic Peninsula, where our monitoring sites are situated, is among the fastest-warming regions globally, serving as a sentinel for understanding climate change effects on polar environments.

Despite the cryospheric focus of the PERMATHERMAL instruments, here we present an interdisciplinary analysis of how these data can elucidate environmental conditions for plant growth. Air and ground temperature data are crucial, as shifts in temperature patterns may either accelerate vegetation growth in certain regions or induce stress and decline in others. Temperature regime changes and alterations in weather event frequency and intensity affect vegetation distribution and phenology, leading to complex responses within plant communities.

Our study primarily aims to assess Growing Degree Days (GDD) values derived from ground surface temperatures recorded by the PERMATHERMAL network between 2007 and 2022. We aim to delineate the challenging conditions for vegetation growth in these Antarctic fringe locations and monitor changes over the study period. Our focus is not to pinpoint causative factors for site-to-site differences but rather to comprehend the resultant conditions for vegetation thriving in the demanding environment of Maritime Antarctica.

Testing ultrasonic sensors and miniature logger to monitor snow cover thickness in Antarctica.

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SUMMARY

The use of snow poles is common in stations dedicated to monitoring the thermal regime of frozen soils within the Global Terrestrial Network for Permafrost (GTN-P). Snow cover conditions the soil thermal regime by providing insulation from the atmosphere, depending on factors such as thickness, density, and duration.

Snow poles consist of an array of temperature sensors at different elevation above the ground attached to a wooden mast (low thermal transmissivity). Despite their convenience due to relatively low economic and maintenance costs and time requirements, data could not be hourly, and their processing is slow and relatively subjective. Additionally, their vertical resolution is limited by sensor number and spacing on the mast, which worsens if sensors fail, leading to poorer results or the inability to measure snow thickness. In contrast, ultrasound-based systems are higher accuracy devices that could measure directly snow depth hourly (or better), but they are traditionally less used because they are expensive and require higher maintenance costs and tasks due to electronic components.

In PERMATHERMAL network stations, active in Antarctica since 2000 and part of GTN-P, snow poles were traditionally used. However, between 2023 and 2024, they were replaced by ultrasonic sensors connected to miniature loggers of new technology, enabling to calculate hourly (or better) snow thickness with millimeter resolution. This improvement over snow poles is achieved while using miniature temperature loggers, eliminating logistical and economic challenges of more complex systems based on the use ultrasonic sensors.

This study presents the experience gained after one year of operating the new devices in harsh Antarctic conditions, comparing the pros and cons of each system and lessons learned. Results of snow thickness derived from snow poles and ultrasonic sensors coupled with mini dataloggers are compared, highlighting the enhanced performance of the latter.

Estudo geoelectrico de círculos de pedra junto à Estação Antárctica Coreana King Sejong, Ilha Rei Jorge, Antárctica Marítima

Geoelectric study of stone circles near the King Sejong Korean Antarctic Station, King George Island, Maritime Antarctica

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RESUMO

Como resultado de variações sazonais de temperatura, nas regiões polares e de alta montanha formam-se, à superfície no solo, círculos de fragmentos de pedra. Geralmente, estes círculos formam-se em áreas onde existe permafrost e têm diâmetros de 1 a 4 metros. A sua formação parece estar ligada a fenómenos de dinâmica do permafrost e da camada activa e o seu estudo tem grande importância na compreensão da evolução do clima ártico e antárctico. Com o objectivo de delinear a estrutura vertical de um campo de círculos de pedra numa área perto da Estação Antárctica Coreana King Sejong, na Península de Barton da Ilha King George da Antárctica Marítima, vários perfis de tomografia de resistividade eléctrica foram realizados. Os perfis utilizaram 40 eléctrodos metálicos em linha distanciados de 1 metro; com esta configuração foi possível obter perfis de tomografia de resistividade eléctrica com cerca de 39 metros de comprimento e atingir profundidades de investigação de cerca de 7 metros. Com vista a tentar criar um modelo tridimensional da área onde os círculos de pedra se encontram, vários perfis paralelos distanciados de 2 metros foram implantados; cinco perfis de resistividade eléctrica foram obtidos. Uma análise preliminar dos dados recolhidos parece indicar que há, de facto, uma relação entre a distribuição espacial dos círculos de pedra atravessados pelos vários perfis tomográficos e a topografia do permafrost local.

SUMMARY

As a result of seasonal temperature variations, in polar and high mountain regions, circles of stone fragments form on the surface of the ground. Generally, these circles form in areas where there is permafrost and have diameters of 1 to 4 meters. Its formation appears to be linked to phenomena of permafrost and active layer dynamics and its study is of great importance in understanding the evolution of the Arctic and Antarctic climate. With the aim of delineating the vertical structure of a field of stone circles in an area near the King Sejong Korean Antarctic Station on the Barton Peninsula of King George Island of Maritime Antarctica, several electrical resistivity tomography profiles were performed. The profiles used 40 metallic electrodes in line spaced 1 meter apart; With this configuration it was possible to obtain electrical resistivity tomography profiles of around 39 meters in length and reach investigation depths of around 7 meters. In order to try to create a three-dimensional model of the area where the stone circles exist, several parallel profiles spaced 2 meters apart were implanted; five electrical resistivity profiles were obtained. A preliminary analysis of the data collected seems to indicate that there is, in fact, a relationship between the spatial distribution of the stone circles crossed by the various tomographic profiles and the topography of the local permafrost.

Estudo geoelectrico no sítio POND junto à Estação Antárctica Coreana King Sejong, Ilha Rei Jorge, Antárctica Marítima

Goelectric study in the POND site near the King Sejong Korean Antarctic Station, King George Island, Maritime Antarctica

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RESUMO

No âmbito do projeto HYDROTOMO foi realizado, em 2017, uma campanha de prospeção geoelectrica por tomografias de resistividade eléctrica numa área denominada POND na Península Barton da Ilha Rei Jorge, junto à Estação Antárctica Coreana King Sejong. O objetivo principal do estudo era detetar e estudar a distribuição espacial do permafrost e da camada ativa e iniciar um estudo de monitorização do permafrost durante vários anos; como objetivo secundário havia interesse em correlacionar a distribuição do permafrost e da quantidade de água na camada ativa com a distribuição de musgos e líquens no sítio POND. O sítio POND é uma área de 15 metros por 15 metros, plana, mas com uma inclinação de cerca de 20 graus; nela podem-se encontrar várias manchas de musgos e líquens e manchas sem qualquer tipo de vegetação. Por vários motivos não foi possível voltar ao sítio POND até 2024. Contudo, em janeiro desse ano, no âmbito do projeto HYDROPERMA 3, o sítio POND foi reocupado, e repetiu-se não só a tomografia de resistividade eléctrica no local onde ela tinha sido realizada em 2017, como se cobriu toda a área do sítio POND com tomografias de resistividade eléctrica, com 40 eléctrodos em linha, distanciadas de 50 cm, permitindo obter perfis de resistividade eléctrica real do solo com cerca de 19 m de comprimento e 3 metros de profundidade. Foram realizados 17 perfis de tomografia de resistividade eléctrica paralelos distanciados de 1 metro; estes estão a ser analisados com vista a criar um modelo geoelectrico a três dimensões do sítio POND. Quanto à comparação entre o perfil tomográfico realizado em 2017 com o perfil realizado em 2024 pode dizer-se que houve uma diminuição acentuada da espessura do permafrost no sítio POND que, em algumas zonas, atinge valores da ordem de 1 metro.

SUMMARY

In 2017, a geoelectrical prospecting campaign using electrical resistivity tomography (ERT) was carried out in an area called POND site on the Barton Peninsula of King Jorge Island, next to the Korean Antarctic Station. The main objective of the study was to study the spatial distribution of permafrost and the active layer and to initiate a multi-year permafrost monitoring study; a second objective was to correlate the distribution of permafrost and the amount of water in the active layer with the distribution of mosses and lichens at the POND site. The POND site is an area measuring 15 meters by 15 meters, flat, but with a slope of around 20 degrees; in it you can find several patches of mosses and lichens and patches without any type of vegetation. For various reasons it was not possible to return to the POND site until 2024. However, in January of that year, within the scope of the HYDROPERMA 3 project, the POND site was reoccupied, and not only the ERT was repeated at the location where it had been carried out in 2017, as the entire area of the POND site was covered with ERT profiles, with 40 electrodes in line, 50 cm apart, allowing to obtain real electrical resistivity profiles of the soil with around 19 m in length and 3 meters in depth. 17 parallel ERT profiles were carried out at a distance of 1 meter; these are being analyzed to create a three-dimensional geoelectric model of the site. Regarding the comparison between the tomographic profile carried out in 2017 with the profile carried out in 2024, it can be said that there was a marked decrease in the thickness of the permafrost at the POND site, which, in some areas, reaches values of the order of 1 meter.

