International Conference
"Marine Geology: Marginal Seas - Past and Future"

November 27 - December 1, 2023

Abstracts

Guangzhou Marine Geological Survey,
China Geological Survey,
Guangzhou, P.R. China

2023-11-27

Co-organized by

DDE Marginal Seas Task Group

Baltic Earth

University of Szczecin, Poland

Helmholtz-Zentrum Hereon, Germany

China University of Geosciences, Wuhan, China

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Outline

Conference Session's Information

1. River impacted continental shelves - sediments and environment

River-influenced continental shelf sediments, with their architecture and material composition, uniquely reflect as proxies the history of global climate dynamics and continental margin tectonics. This refers to both the material and energy transport as well as the hierarchically structured periodicity of the controlling processes. With the beginning of the industrial age, natural processes are superimposed by anthropogenic influences, which are to be interpreted separately. With the help of geostatistical and functional models, the structure and genesis of the sediment sequences can be represented in an exemplary manner. The reconstruction of the paleoenvironment based on proxies of the sedimentary record is carried out as a solution to a reverse task. Forward modeling, which takes into account climate change in particular, enables the generation of future scenarios needed to develop management strategies for the coastal and marine environment.

Conveners: Peter Clift (University College London, UK), Gary Greene (Moss Landing Marine Laboratories, California, USA), Jan Harff (University of Szczecin, Poland), Joanna Waniek (Leibniz Institute for Baltic Sea Research, Warnemünde, Germany)

Note: We will have an extension session after the Session One to discuss "International drilling campaign front of Pearl River Estuary and Peal River Delta joint research".

2. Coastal processes

Coasts around the world are constantly changing as a result of land-sea-atmosphere interaction. The consequence of the ongoing climate change is the observed intensification of extreme phenomena such as storm surges, floods, tsunamis, and heavy rain falls. This superimposed by eustatic sea level rise, changes in the wind and wave direction and a general deficiency of sediments in the coastal zone result in increased coastal erosion and pose a real threat to the safety of the coast in terms of the natural environment and the existing infrastructure crucial for coastal municipalities and society. To mitigate current coastal hazards and prevent future impacts, it is essential to have a comprehensive understanding of the physical, geological, biological, and chemical processes that control the source-to-sink transport of sediments on the Earth's surface, including their anthropogenically driven modifications. The aim of this session is to bring together interdisciplinary, international expertise to provide an overview of the current research status of coastal morphodynamics research and future perspectives. We welcome submissions that are of an

analytical or laboratory nature, in the field or involve numerical modeling on a local, regional or global scale, from single events to the scale of decades and millennia.

Conveners: Joanna Dudzińska-Nowak (University of Szczecin, Poland; Section of Marine Geology, Polish Scientific Committee on Oceanic Research, Polish Academy of Sciences), Tarmo Soomere (Estonian Academy of Sciences; Tallinn University of Technology, Estonia), Xinong Xie (China University of Geosciences in Wuhan, China), Abdullah Sulaiman (Department of Mineral and Geoscience Malaysia, Kuala Lumpur, Malaysia)

3. Ecosystem dynamics

Out of the complicated system of Marginal Seas ecology, we decided to include just one, of many, topics as a session subject. Thus, we focus on the important group of primary producers - diatoms. The main topic: "Recent and fossil diatom flora from the Marginal Seas - with particular reference to habitat characteristics and biogeography", to be considered in terms of its geological past and its recent development. Diatom evolution extends back to the Mesozoic era, and through time they became an important group of primary producers in oceanic (plankton) and coastal marine environments (benthic) with a species number estimated to exceed 100,000. With their role in biogenic elements cycles, diatoms greatly influence the global climate, atmospheric carbon dioxide concentration, and marine ecosystem functions. Through the micropaleontological application in environmental and age dating studies, diatoms have been widely used in coastal and marine systems to reconstruct paleoenvironment and changes in paleoceanographic proxies in multi-dimensions. With technological progress diatoms have become also a target for the marine blue biotechnology as a source of valuable metabolites. However, we are open to considering contributions from other fields in ecosystem dynamics.

Conveners: Yenny Risjani (Brawijaya University, Indonesia), Jinpeng Zhang (Guangzhou Marine Geological Survey, CGS, China), Yahui Gao (Xiamen University, China)

4. Methodological approaches and Geodata management, including Machine Learning and Artificial Intelligence

The comparative studies of marginal seas (from mapping to process modeling), including both historical reconstruction and future projection, requires fast and convenient access to databases containing necessary geological, oceanographic, bathymetric, ecological, and climate data, including Remote Sensing data. For a reflection of geo-processes by models from the global to the regional level, a harmonization of geodata and their international accessibility are required. A basic task is the visualization of maps of both empirical data and model results using geographic information systems (GIS) tools and mapping techniques. Over the past decade GIS has been

significantly and positively influenced by Artificial Intelligence (AI) and Machine Learning (ML) techniques, becoming crucial in geoscience research.

The main focus of this topic is on: 1) formatting, harmonizing, processing, and mapping marginal sea data including AI and ML various application scenarios (such as data cleansing, image interpretation, semantic classification and segmentation, digital mapping), and 2) the presentation of methodological approaches to manage geodata and to make the spatial database FAIR (Findable, Accessible, Interoperable, and Reusable) through the implementation of dedicated Marine Spatial Data Infrastructure at different scales.

Conveners: Federica Foglini (The Institute of Marine Sciences of the National Research Council, Bologna, Italy), Jennifer McKinley (Queen's University Belfast, UK), Minghua Zhang (R&D Center of CGS, Beijing, China), Yuanzhi Zhang (The Chinese University of Hong Kong, China)

Plenary Keynote Speech

The influence of the Fraser River Delta on an active margin Urban Sea system – Central Salish Sea – USA and Canada

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Abstract:

The Salish Sea is a marginal inland sea, a deep glacial (fjord) estuarine system whose water circulation is beneficial in sustaining ecology through the delivery of nutrient-rich ocean waters and freshwater inputs from the many upland rivers and streams. The System lies within the forearc basin of the active Cascadia Subduction zone. The combined land and sea area that this Urban Sea System encompasses is ~560,000 km^2. The single largest river input is the Canadian Fraser River that supplies nearly 50% of the fresh water entering the System from a drainage basin of over ~240,000 km^2.

Sediment and organic matter are also introduced by the Fraser, such that sand and silt build progressive delta fronts, while finer material (mud) is swept into the Georgia Basina and the San Juan Archipelago. Parts of the delta front is unstable and prone to mass wasting, stimulated by earthquakes, fluid seeps, or sediment overload, potentially generating tsunamis. The back waters of the bays, sounds, and inlets are depot centers for organic detritus that are buried, reduce oxygen, and produce methane and sulfide-rich gases that vent into the water column. These processes are just a small part of how an Urban Sea System is evaluated.

We classify an Urban Sea System based on size (geographic extent), population, age (Human activity, industrialization), impacts (natural & anthropogenic), self-sufficiency, economic vitality, ecological status, cultural diversity, and significance (contribution to global stability and economy). Here we focus on IMPACTS on the Salish Urban Sea System. Natural impacts consist of earthquakes, tsunamis, mass wasting, floods, sediment erosion and accumulation due to active plate margin processes (subduction, faulting). Anthropogenic impacts on the Salish include air pollution (from transportation, power generation), and forest fires, and water pollution from sewer and septic tank systems,

shipping (oil/container ship spills), and global warming (acidification, sea level rise). All of these reflect a moderate to high impact on the Salish System.

Revisiting spatio-temporal evolution of Ganges-Brahmaputra-Meghna Mega Delta System

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(Snigdha Ghatak, Keynote speaker)

Abstract:

Networked by a complex tidal waterways, mudflats and series of small islands, the Sunderbans Delta - an end product of Ganges-Brahmaputra-Meghna (GBM) River systems harbors world's largest mangrove ecosystem. Located at the northern apex of Bay of Bengal, the GBM river delta is represented by a low-lying flood plain covering ~ 100,000 sq. km in India and Bangladesh and grades into a more extensive sub-aqueous delta and deep-sea fan complex. Known to be recognized as UNESCO world Heritage site, 62% of the total area falls within Bangladesh and 38% in India. The delta outbuilding of GBM has been reported to have been initiated between Cretaceous to Neogene period. The deltaic arcs or lobes are reported to have developed about 50,000 YBP with south and eastward progradation. However, the present location of the mega delta was attained not more than 10,000 years back (Pleistocene to Recent). The much-celebrated South Asian Monsoon coupled with Himalayan source area sediment flux contributes to one of the world's largest tropical riverine sediment loads (1.8–2.4 billion tons annually) passing through the GBM dispersal system. The geological formation covering the island system belongs to the so called 'Bengal Alluvium'. The Bengal basin as the depositional loci for this sediment load is often subjected to faulting, earthquakes, and other tectonic activity that has a direct bearing on delta evolution, river course avulsions, sediment dispersal vis-à-vis compaction or isostatically induced subsidence and facies preservation. The discontinuation of the eastward thickening of sedimentary formations from Pleistocene to Recent period occurred probably due to the reduction in the rate of subsidence of the Bengal Basin floor along the N-S axis, leading to rapid filling up of the basin. The sediments brought in by the Ganga - Brahmaputra system during the post Pleistocene period eventually bypassed the deltaic plain contributing to the rapid growth of Bengal deep sea fan. Early Holocene marked

vigorous aggradation of the delta plain under rapid sea-level rise and high river discharge and supported the construction of sand-dominated stratigraphy. Geochemical studies indicate, vertically (i.e., temporally) uniform, but geographically distinct fluvial systems of Ganges, Brahamaputra and Meghna which apparently remained constrained within their low stand valleys. Mid-Holocene represents a period of recurring avulsions and unconstrained channel migration comparable with the modern Ganges and Brahmaputra fluvial systems. Bengal delta acquired a typical tide dominated lobate form (with a typical seaward flaring funnel shaped pattern) with a tidal range between 3.7 to 5 m during the recent times. Since, past few centuries, this composite macrotidal deltaic tract (~ 260 kms from Hooghly River in the west to Meghna River in the east) generally showed a continuous trend of shoreline retreat, although rate of retreat varies from one sector to other. Moreover, rapid siltation in the delta plains, and the progradation of subaqueous sediment plumes in the shelf region are also observed. This densely populated deltaic plain (with over 100 million inhabitants) is proven to be vulnerable in view of climate change and being exposed to multi- hazardous events viz., sea level rise, tropical cyclones, coastal floods, erosion, landward prograding salinity front etc. Geological-geomorphological parameters, coastal and shelf processes /dynamics, hydro-meteorological parameters coupled with anthropogenic (land reclamation, deforestation, irrigation etc.) factors are guiding the future course of evolution of GBM delta. Assessing the long-term (up to 100 years) as well as the short-term (5-10 years) prediction of morphological behaviour of this coastal zone and sediment transport in response to changing environmental conditions is thus a prerequisite to help adopt sustainable development practices. A study indicates, sea level rise over long time scale alone, can account at the best for 50-60% of the shoreline retreat. This suggests that sea level rise, over a longer time frame plays a permissive role for shore line retreat for this coastal tract in presence of the other coastal processes like wave, tide etc. Tidal flow is one of the pivotal processes that controls the transportation and sorting of sediments driving the shoreline/landform changes within the coastal inlets, at least over decadal to sub-decadal scale. Further, coastal area morphological/morphodynamic models have been explored to understand shoreline evolution, land use-landcover changes etc. in various parts of West Bengal and Bangladesh deltaic coast both over short- and long-term period correlating continuous along shore variation of sea level rise scenarios (for Ghoramara, Sagar and Bhangaduani Islands). The projected configuration of the islands for different time intervals and for a set of Sea Level Rise (SLR) scenarios shows that generally, with increase in sea level rise rate, rate of erosion increases. Model derived SLR scenario varies between

2.8mm/yr. in the west (Sagar Island) to 3.1mm/yr. SLR in the uninhabited, forested eastern part of the deltaic coast. The general agreement of the projected model output with the observed shoreline configuration establishes the predictive potentiality of the empirical model. The present knowledge base with further research is expected to open up new vistas aiding formulation of Coastal Zone Management Plan in this vulnerable niche.

Session One: River impacted continental shelves - sediments and environment

Large River Deltas and their continental shelves in Southeast Asia as recorders and controllers of regional and global climate

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Abstract:

The large rivers of southern China and Indochina, deliver large quantities of sediment to the marginal seas of Asia. The composition of the sediments reflects the composition of the bedrocks, and which they were eroded, as well as the environmental conditions that prevailed in the drainage basin during transport to the ocean. Significant chemical weathering may be experienced by the sediment when the climate is humid and warm, as well as if the transport to the ocean is of long duration, allowing significant alteration of unstable minerals. Because the speed of transport is also controlled by the discharge of the river, and in turn by the strength and seasonality of summer monsoon rains, the sediment records in the deltas, shelves and slopes of Southeast Asia can be important recorders of environmental change onshore. Records of past change provide us with clues as to how the landscape may be affected by future climate change. As well as recording environmental change, the sediments on the continental shelf made themselves play a role in controlling global climate through their interaction with the carbon cycle. During glacial times, as sea level falls, the continental shelf is exposed and large volumes of sediment are exposed to more intense chemical weathering. The breakdown of silicate minerals is important in removing carbon dioxide from the atmosphere. CO_2 is a key greenhouse gas which means that the continental shelves of Southeast Asia may be amplifying the climate variability. Furthermore, as the shelf is exposed, tropical rainforest may grow and sequester further carbon. Conversely, as sea level rises, the forests are destroyed, the sediment is removed from weathering processes, and coastal wetlands are established that themselves are major sources of methane. These processes also reinforce one another in enhancing global variations and climate driven by orbital processes. Detailed scientific exploration both by

geophysics, and through coring of the continental shelves of Southeast Asia is critical to test these models, and if we are to understand their role in modulating, the Earth's climatic evolution over orbital timescales and potentially longer.

Keywords: Sediment; Monsoon; Weathering; Carbon.

The source of metals pollution using lead isotopic in Brunei Bay, Malaysia

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Abstract:

Metal pollution in sediments poses significant environmental and health concerns, necessitating the use of advanced techniques like lead isotopic analysis to trace contamination sources and assess its impact. This study investigates lead pollution in sediment cores from Brunei Bay, exploring variations in total lead concentrations and their correlations with organic matter content and particle size. Additionally, lead isotopic ratios ($^{206}Pb/^{207}Pb$, $^{208}Pb/^{206}Pb$, $^{206}Pb/^{207}Pb$, and $^{208}Pb/^{207}Pb$) are compared with other research studies to identify lead pollution sources and pathways. The analysis of total lead concentrations in sediment cores from Brunei Bay reveals notable variations among different locations. Core B13 exhibits the highest average concentration, indicating higher lead accumulation, potentially due to anthropogenic activities. Core LB follows closely, suggesting significant lead presence, possibly influenced by local factors. Core B5 records a lower average concentration, and core B9 exhibits the lowest concentration, likely due to factors like proximity to pollution sources and sediment characteristics. Despite the expectation that particle size affects lead distribution, the analysis shows no significant correlation between total lead content and particle size. This result may be due to variations in sediment sources and sedimentation processes. The correlation between lead isotopes and TOC content in sediment cores highlights the complexity of lead behavior in sediments. The presence of different lead sources and the influence of sediment transport and diagenesis processes can weaken the correlation between lead and TOC.

Keyword: Metal pollution; Lead pollution; Core sample.

Three-dimensional seismic evidence for depositional undulations nucleated around pre-existing relief, South China Sea

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Abstract:

Sediment undulations are widely distributed along continental shelf and slope worldwide. The driving mechanisms of undulations are crucial for assessing the long-term stability of continental slope, which, however, remain poorly understood. We used high-resolution 3D seismic data to investigate the internal architecture and origin of a field of seafloor and subsurface undulations along the slope of South China Sea (SCS). The undulations have narrow troughs and broad ridges. The reflection geometries in the troughs between undulations tend to be continuous and not offset by faults. These troughs terminate at different subsurface depths, commonly ranging from 50 to 400 ms in two-way travel time (TWTT) below the seafloor, often at locations related to subsurface geological structures, such as buried faults and steps within mass transport deposits (MTDs). These subsurface terminations therefore suggest that the undulations are probably depositional features not linked to creep-related basal detachment. The troughs between undulations display an absence of growth features, while the undulations increase in amplitude from base to top (characteristics that are also incompatible with gravitational deformation). Erosional and depositional features are commonly found in the undulations; thus, we interpret the narrow troughs between undulations to represent the areas where sediment-laden bottom currents undergo passage from supercritical to subcritical conditions. These troughs nucleated

mostly from fault scarps and seafloor steps induced by past slope failures. Previous alternative interpretations report that these features originate from subsurface creep; alternatively, the present interpretation as sediment transport structures has significant implications for seafloor management and engineering projects.

Influence of neo-tectonic movement on south coast of Hainan Island of China

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Abstract:

Topography, climate, ocean currents, waves, tides, and other factors contribute to the changes of the coastal zone. However, tectonic subsidence exerts a significant impact on the long-term changes of the coastal sedimentary environment, which is not easily observable in a short period of time. In this study, five drill cores were selected from the southern coast of Hainan Island. With the assistance of Pb-Cs dating technology and through grain size and elemental geochemical analysis, it was found that the three coastal areas in southern Hainan Island exhibited different sedimentary environment evolution trends over the past century.

The sediments in East Lingshui bay are mainly fine-grained silt-bearing sediments. Over the past century, the sediment particles have gradually become finer. The sediments in Sanya Bay are also dominated by silt-bearing sediments, showing three stages of changes. Prior to 1880-1990, the sedimentary environment was relatively stable. From 1990 to 2006, the coarse-grained sandy sediments increased significantly, and since 2006, the sediment particles have become finer. In the southeast coast of Hainan Island, the sediment particles are mainly silt-bearing sediments, and the sediment particles are becoming coarser over the past century.

It is believed that tectonic subsidence, coupled with sea level rise, is the main controlling factor affecting the sedimentary environment changes in the studied area over the past century. Additionally, climate change is another important factor that affects the evolution of sedimentary environment.

Keywords: Neotectonic Movement; Coast of Hainan Island;
          Sedimentary Environment.

Annual assessment of seawater quality of Qinzhou Bay in 2020

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Abstract:

Based on monitoring Data of Qinzhou Bay seawater quality collected in October,2020, we used single factor, index of organic pollution and eutrophication level methods to analyze and evaluate the coastal seawater quality. The pollution assessment of 7 heavy metals in surface seawater were analyzed using the comprehensive pollution index method. The results showed that the pH value and the concentrations of DO, COD, and DIN exceeded the standards at different degrees. The acidity(pH) and the pollution degrees of DO, COD and DIN were aggravated in mariculture zone.The heavy metal pollution index ranged from 0.1124 to 0.6282 and integrated pollution assessment of heavy metals was clean in term of level.

Keywords: Qinzhou Bay; Water quality; Heavy metal; Pollution evaluation.

Heavy metals pollution history and trend on semi-enclosed embayment — take Shenzhen Bay for example

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Abstract:

Shenzhen bay, a typical semi-enclosed embayment, which was effect of human intervention for environmental problems. Shenzhen bay consists of Shekou port, highly urbanized coast and mangrove reserve. Tide from Lingdingyang estuary is the dominate hydrological characteristic of Shenzhen Bay, and run-off from Shenzhen River and Dasha river have significantly influenced on part of it. From 2016 to 2019, Waste water treatment project was implemented and in 2020, water quality in Shenzhen Bay has been significantly improved. Maintaining status of water quality and finding potential pollution sources are necessaries for local economy. Heavy metals, Pb isotopes and grading analysis in sediment and water from Shenzhen Bay. Heave metal pollution in sediment from 1990 to 2010 decreases, however, it increases from 2010 to 2020. According sediment transport trend analysis, surficial sedimentary pollution was accumulated in highly urbanized coast and mangrove reserve. In contrast, Heavy metal concentrations and EFs in surficial sediment are most enriched in mangrove reserve. Based on the observation of this study, Sediment pollution in mangrove reserve should be regarded as a serious threat to water quality. For semi-enclosed embayment, tidal and run-off flow have effect on pollution accumulation by sediment transport.

Keywords: Semi-enclosed embayment; Sediment pollution; Heavy metals; Pb isotopes.

Exploring origin and extent of freshened groundwater on the continental shelf of the northern South China Sea

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Abstract:

Continental shelves are submerged extensions of continents that contain significant aquifers beneath the seafloor. The ~100 ka Milankovitch cycles during the Quaternary generated a significant sea level fluctuation on a geological timescale. Shelf areas that were exposed during the sea-level low-stands were covered by the freshwater lake and river systems, and were subject to the infiltration of atmospheric precipitation. Therefore, we hypothesize that the offshore freshened groundwater (OFG) may be widely distributed in the shallow continental shelves so far. To address the key scientific issues raised in such offshore freshened groundwater in the current submerged continental shelves, we conducted an integrated study of the offshore hydrogeology, paleoceanography, and interstitial water geochemistry on the northern continental shelf of the South China Sea. A valuable dataset of offshore boreholes with high-resolution interstitial water geochemistry profiles have been obtained in the northern margin of the South China Sea. These boreholes have led to an identification of a large subseafloor OFG with a volume of ~575.6 ± 44.9 km^3, with the freshened (salinity ≤5 PSU) groundwater extending as far as 180 km offshore with a water depth of 92.5 m. The distribution of the OFG is closely related to the morphology of the subaqueous paleo-delta of the Pearl River, where the buried paleochannel system is widely distributed. The depleted values of δ^2H and $\delta^{18}O$ (i.e., -5.2‰ and -28.5‰ respectively) together with the chlorinity of the OFG clearly reveal its meteoric origins. Hotspots of OFG

in the continental shelves, likely a global phenomenon, have a great potential for water resources for highly urbanized coastal areas suffering from water shortage.

Heavy minerals occurrence as the potential source for Rare Earth Element (REE) - A case study from lower coastal plain fluvial systems (Sungai Terengganu and Sungai Dungun)

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Abstract:

In this study, we investigated the REE potential of heavy mineral occurrences in two lower coastal plain rivers in Malaysia, Sungai Terengganu and Sungai Dungun. We collected and analyzed sediment samples from both rivers and found that they contain significant concentrations of REE-bearing heavy minerals, such as Monazite, Xenotime, and Zircon. To extract REEs from river sediments, the sediments are first dredged from the riverbed. The sediments are then processed to separate the REE-bearing minerals from the other minerals in the sediment. This can be done using a variety of methods, such as gravity separation, magnetic separation, and flotation. Once the REE-bearing minerals have been separated from the other minerals, they can be processed to extract the REEs. Form the initial results gather from Sungai Terengganu and Sungai Dungun, the occurrence of Zircon, Monazite and Xenotime from the heavy minerals analysis is relatively low to trace amount cumulatively of the total volumes of samples send for the analysis. Except for the unavailability of Xenotime at Sungai Dungun, overall occurrence of the heavy minerals shows a promising potential for rare earth elements for both rivers. However, it is important to note that more details and close space sampling need to be done to gather more data and properly map the economic potential of the river sediments.

Vegetation succession, climate change and cold events during 9.2–8.0 cal kyr BP in eastern China: High-resolution pollen evidence from the Yangtze delta plain area

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Abstract:

High resolution pollen records in the northern edge of subtropical China are crucial to understand the pattern of postglacial vegetation change and climate transition. Here we present vegetation succession and climate change during 9.2–8.0 cal kyr BP based on sub-decennial scale pollen data. Pollen spectra show that *Quercus* (evergreen) & Cyclobalanopsis were relatively stable during the whole period, while Quercus (deciduous) were gradually decreased. Pollen-based climate change shows gradual warming during this period, and noticeably, the rapid warming during 8610–8545 cal yr BP can be detected according to the sharp decrease of *Quercus* (deciduous). Our results show two cold and dry events at 8.5 ka and 8.2 ka. The 8.5 ka event is rarely reported in the East Asian Monsoon area, while the 8.2 ka event is frequently mentioned. In this study, the 8.2 ka event has two

peaks, similar to the previous reports from the Yangtze delta area and Dongge Dong Cave. In the Yangtze delta area, the vegetation and climate change show a strong relationship with the high latitude area, indicating that they are not only related to solar activity, but also impacted by the high latitude climate events. However, the impacts of these events on the Asian monsoon area still need further studies to verify.

Mn (II) carbonate authigenesis marks the benthic SMTZ and is fueled by Mn-driven anaerobic oxidation of methane: A Black Sea perspective

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Abstract:

In the Black Sea, sediment cores covering the last brackish-limnic transition were recovered and investigated for anaerobic biogeochemical processes controlling sulfur, carbon, and metal cycling. The development of a sulfate-methane transition zone (SMTZ) is nowadays found below the brackish zone in the limnic part of the sediments that limits the upward migration of biogenic methane into surface sediments and the water column. The position of the SMTZ may have changed in the past due to dynamic fluxes of dissolved species in the pore water. Besides dissolved sulfate, metal-bearing minerals have been shown to serve as potential reactants, also converting CH_4 into dissolved inorganic carbon (DIC). The pore water and sediment stable isotope (C, S, O) and geochemical composition were investigated, as well as in-situ microbial rates of sulfate reduction and total anaerobic oxidation of CH_4 (AOM) obtained from sediment incubations for the identification of a potential contribution of manganese-bearing minerals to AOM in the limnic part of the sediments (Mn-AOM). In the limnic Black Sea sediments Mn-AOM is causes an upward flux of dissolved Mn whereas intense SO_4-AOM located in shallower sediments leads to an increase in pH and a maximum in DIC concentrations in the SMTZ. The resulting change

in saturation states leads to the precipitation of mixed MnCa-carbonate solid-solutions ('rhodochrozitization front') and the development of a zone enriched in excess sedimentary Mn (II). We further argue that these authigenic fronts may survive changes in pore water composition and are stable in the anoxic sedimentary record, marking the position of paleo-SMTZs. The persisting formation of this geochemical marker is in contrast to the temporal development of a sulfidization front of metastable mackinawite, that is fromed by the reaction of downard migrating sulfide with upward diffusing Fe(II), originating from SO_4-AOM and Fe-AOM, respectively.

Evolution of barrier coast under condition of sand starvation and sea-level changes; an example from the Polish coast of the Baltic Sea

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Abstract:

The formation and evolution of intracontinental, tideless sea barrier coasts is still poorly known in comparison to open-ocean and tidal sea barrier systems. The main goal of the study is a better insight into the evolution of the barriers in the condition of sand starvation and relations to sea level changes. The study area includes a 90-km section of the middle part of the Polish southern Baltic coast. Historical data (132 borehole and outcrops profiles, results of biostratigraphic analysis) was supplemented by new drillings (18 core drillings) and analyses (radiocarbon and OSL datings). Analysis of collecetd data suggest that in the study area barriers during its middle and late Holocene history were retrogradational despite of varied geological and morphological features of its subsoil. The average rate of barrier's retreat has shown considerable variation in a close relation to the rates of sea-level rise. During the period 8500-7500 yr b2k when the sea level rose by 6-5 mm/yr, the coast retreated ca. 4.6-3.5 m/yr. Between 7500-6000 yr b2k, the sea-level rise slowed down to ca. 1.7 mm/yr and the rate of coastline retreat fell to ca. 1.0 m/yr. During the last 6000 years, coastal retreat slowed down to ca. 0.3 m/yr as the average sea level rise was ca. 0.5 mm/yr. The permanent retrogradational history of the barrier coast is explained by the existence of a divergence zone of longshore currents and a related source zone for the alongshore sandy streams. As a result, erosional trends dominates here, which contributes to the presence of retrogradational barriers.

Keywords: Sea-level changes; Holocene; Sediment transport; Barrier coast.

Biogeochemical characterization of benthic processes in a range of coastal sediments affected by submarine groundwater discharge in the southern Baltic Sea

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(Oral Presenter, Cátia Milene Ehlert von Ahn)

Abstract:

Elemental fluxes in the coastal waters strongly depend on the benthic processes near the sediment-water interface. In addition, submarine groundwater discharge (SGD) can impact benthic processes and act as a source of water and dissolved substances for coastal waters. The present study investigates the biogeochemical processes at surficial sediments with different lithology in Puck Bay (PB), southern Baltic Sea, impacted by SGD. Porewater gradients of salinity and conservative elements were used to identify SGD. SGD drove advection in sandy sediments, whereas a diffusion dominated transport in the muddy sediments. On these SGD sites, porewaters showed a decrease in dissolved sulfate at depth due to the upward impact of fresh groundwater depleted in sulfate. Dissolved inorganic

carbon (DIC) and the $\delta^{13}C_{DIC}$ revealed a wide range of values, suggesting active carbon cycling where organic matter mineralization and groundwater input form sources of DIC. The sandy sediments showed a strong impact by SGD, modifying most of the porewater chemical gradients. However, the impact of SGD was less pronounced at muddy sediments due to the strong diagenetic overprint. To conclude, areas impacted by SGD demonstrate a strong coupling between groundwater input and biogeochemical processes in the surfacial sediments.

Keywords: Puck Bay; Stable Isotopes; Porewater.

Geomorphologic characteristics and genetic analysis of the submarine pockmarks in the west of the North Yellow Sea
(East of Miaodao Islands)

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Abstract:

The western part of the North Yellow Sea is an important channel area for material exchange between the Yellow Sea and the Bohai Sea. Multiple-beam surveys, single-channel seismic surveys, and geological sampling works have been carried out in this area. Large-scale pockmarks were first discovered in this region, with their basic shape being elliptical. The major axis of these pockmarks is approximately 130 meters, the minor axis is 80 meters, and the depth is 1.5 meters. Pockmarks in this area develop into a relatively regular distribution pattern, including discrete pockmarks, compound pockmarks, and pockmark chains. The formation of pockmarks in this area is closely related to the shallow gas migration caused by early sea-land interaction. Ancient channels have a significant impact on gas generation. Shallow fault structures are the main controlling factors for the basic shape of pockmarks in this area. After the shallow fluid overflows the bottom layer, the shape of the pockmark's changes under the influence of the underlying flow. This study is of great significance for the regional geological hazard assessment of the marine area and serves as an important reference for marine engineering construction.

Keywords: North Yellow Sea; Pockmarks; Geological hazard.

Graphical Abstract
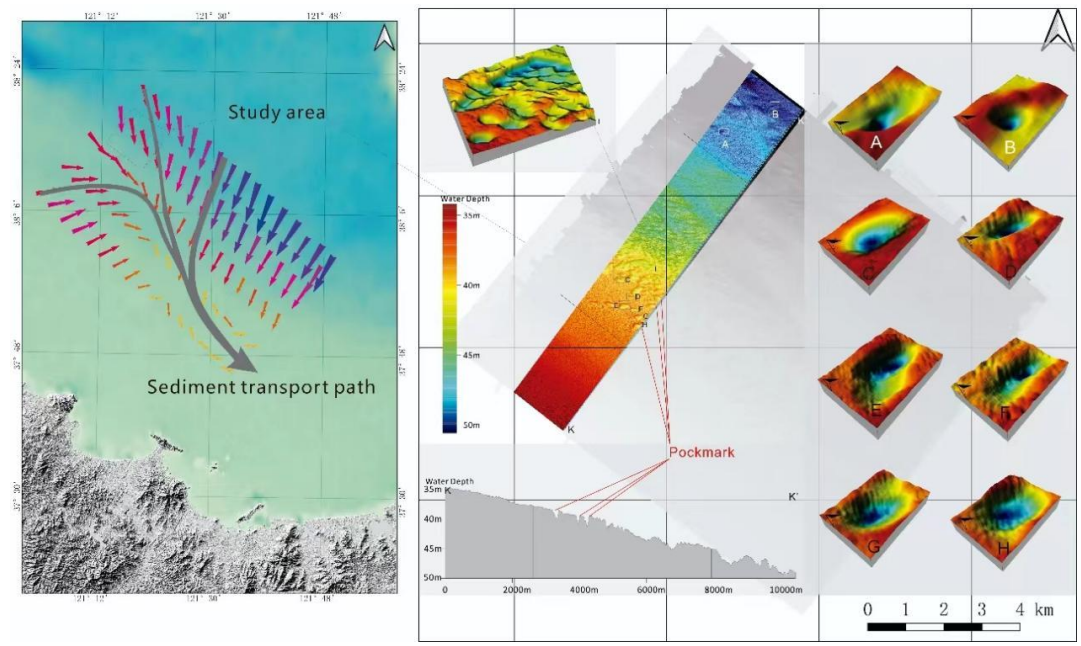
Identification of three Stages of paleochannels and main source analysis beginning in the Middle Pleistocene in the Western Bohai Sea in North China

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Abstract:

The global sea level has fluctuated substantially, with continental shelves experiencing transgressions and regressions throughout the Quaternary period; therefore, a series of transgression and regression sedimentary strata have developed. Paleochannels are important features that develop during regression periods. Paleochannels clearly record the development of the sedimentary strata and contain rich information on environmental evolution. Examples of paleochannels are found on the western shelf of the USA, in the northern continental shelf of South Africa, in western India, on the continental shelf of northwestern Europe, and in the East Asian Seas.

Exposed shelves experienced a cold and arid climate, resulting in the development of a concentrated distribution of paleochannels. The interpretation of the sedimentary environment and the source of these paleochannels remains disputed. Adequate provenance is needed for the development of paleochannels: which river system is the source of the paleochannels in this area? Is it the Yellow River, the Luan River, the Hai River, or the Liao River? Sedimentary environmental analysis and the evolutionary pattern of the paleochannels are also the subject of significant debate.

In recent years, the Yantai Center of Coastal Zone Geological Survey (YCCZGS) has acquired a significant amount of high-resolution single-channel seismic data in this region, revealing the strata can reach a depth of more than 300 m. In addition, YCCZGS has drilled the 302-m-long core DZQ01 in this area and conducted stratigraphic sequence division and sedimentary environment research correlating with two earlier cores, namely TJC-1 and H6,

drilled by the Qingdao Institute of Marine Geology.

The objectives of this study are (1) to combine accelerator mass spectrometry (AMS) ^{14}C dating and optically stimulated luminescence (OSL) age dating, correlating the findings with two adjacent cores (TJC-1 and H6) and divide sequence stratigraphy into six depositional units (DUs) in this study; (2) based on the well–seismic tie and the characteristic of seismic reflections, to interpret high-resolution single-channel seismic profiles into six stratigraphic units (SUs) and identify three stages of paleochannels since the Middle Pleistocene; (3) to characterize the features of grain size, clay minerals, and the assemblage of micropaleontology of the three stages of paleochannels by analyzing the main source and modeling the sedimentary evolution of these paleochannels. The results can provide a solid foundation for solving the problems listed above.

The results indicate that (1) three stages of paleochannels, namely Seismic Unit 6 (SU_6), SU_4, and SU_2 are identified from bottom to top during Marine Isotope Stage 8 (MIS 8), MIS 6, and MIS 4, respectively; (2) from 300 to 243 cal. ka B.P., the SU_6 paleochannel has four pathways, with the Yellow River serving as a primary source; from 191 to130 cal. ka B.P., the SU_4 paleochannel has three pathways, and the main sources are the Yellow River, the Liao River, and the Luan River; from 74 to 14 cal. ka B.P., the SU_2 paleochannels have two large tributaries, with the principal sources being the Yellow River and the Luan River. We, therefore, it can be inferred that the uplift of the Tibetan Plateau and glacial–interglacial climatic change constitutes the formation mechanism for the paleochannels.

Characterization of grain size and clay mineral distribution and provenance implication of surface sediments in Tangshan Harbor, Bohai Bay

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Abstract:

161 surface sediments from the Tangshan Harbor, Bohai Bay were analyzed for grain size and clay composition and distribution to explore the sources of sediment and their controlling factors. The results show that the average grain size (Mz)Φ of surface sediments in Tangshan Harbor ranges from 1.4 to 7.7, and mainly consists of silty sand, sandy silt, and a small amount of sand and clay. According to the characteristics of grain size parameters and end-element model analysis, the sediments can be divided into three zones and four end-elements from EM1 to EM4: the northeastern part of the area is dominated by EM3 end-element sand and chalky sand, with poor sorting, positive skew, and strong dynamics of depositional environments; the central Caofeidian Deep Trough area is dominated by EM4 end-element sandy chalk and chalky sand, with poor sorting, positive skew, and strong dynamics of depositional environments; and the southern part and the Tangshan Harbor area is dominated by EM1 and EM2 end-element chalk, with moderate to poor sorting and weak depositional dynamics. The clay minerals are relatively high in illite (72%), smectite (12%) followed by chlorite (8%) and kaolinite (8%). The provenance analysis shows that the source of surface sediments in Tangshan Harbor is mainly the detrital material mixed Yellow River and Haihe River, while the northeastern part of the study area and the Caofeidian Deep Trough may have some coarse-grained material from the ancient Luanhe Delta. The Bohai Sea circulation and tidal currents control the transport of fine-grained sediments mainly to the south and near Tangshan harbor, while coarse-grained materials are transported and deposited to the northeastern and central Caofeidian area.

Gravity-driven sediment transport processes on muddy coasts

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Abstract:

Wave and/or current supported gravity-driven sediment flows (GDSFs) cause substantial sediment movement across the continental shelf, contributing to morphological evolution in many regions worldwide. However, they appear to occur episodically and ephemerally and, therefore, it remains a challenge to document them in detail with in situ measurements. Here we present solid evidence of frequent generation of such flows over the shallow sea floor of a muddy open coast, Jiangsu Coast, China. They were triggered by wave resuspension and/or sediment settling from the overlying water column, maintained by wave- and/or current-induced bed stress, and terminated due to upward spreading of bottom sediment within the high concentration layer. Randomly selected GDSF events were analyzed to realize parameterization with a buoyancy-friction model; the resultant bed drag coefficient for two of the cases is higher than the value of 0.003, which is attributed to the additional drag at the interface between the overlying flow and the moving GDSFs. For GDSF events which developed at the low slack water, time lags of events at the break and toe sites of a cross-shore submarine slope were consistent with what could be expected in terms of gravity-driven velocities and distances, showing gravity-driven downslope movement of sediments across the gently sloping coast. Although short-lived, the observed GDSF events in the three different seasons indicate that they occur more frequently than previously thought. GDSF events result in considerable cross-shore sediment transport and sedimentation effects, highlighting the importance of GDSFs for the transport processes of sediments in muddy coastal areas.

Keywords: Wave and/or current supported gravity-driven sediment flows; Muddy coast; In situ observation.

Session Two: Coastal processes

Multi-decadal barrier behaviour: some geological constraints

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Abstract:

Coastal barriers are diverse in size, morphology, geological and oceanographic setting. They occupy a large proportion of the world's coast. Because they are dynamic landforms that are often under development pressure, understanding their behaviour at multi-decadal timescales is an important scientific and societal goal. The study of historical barrier behaviour is hampered by an incomplete evidence base of morphological change as well as dynamic and internal forcing factors (drivers). The biggest constraint, however, is a lack of information on the specific geological context.

The record of morphological change is improving with advances in technology and chronological control and the record of dynamics is improving with new hindcast datasets but straightforward linking of dynamic forcing and response is seldom able to account for observed behaviour. Instead, geological factors exert a significant or even dominant control on barrier behaviour at multi-decadal timescales. In all but a few locations, the absence of geological data impairs efforts to quantitatively predict the future behaviour of barrier systems. Geological influences are usually disregarded when conceptualizing and modelling barrier evolution but they must be considered in efforts to predict future behaviour at multi-decadal (management) timescales.

Isotope hydrobiogeochemistry of and material transport from modern hard-water creeks discharging to the southern Baltic Sea: In crusts we trust

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Abstract:

Coastal regions play a crucial role in the global carbon cycle, as a transition between terrestrial and marine ecosystems. Hard water creeks are attracting attention as a potential source of atmospheric CO_2 and as a contributor to the buffering capacity of coastal waters. Carbon dioxide super- and calcium carbonate-saturated groundwaters percolate through limestones or soils finally discharging from springs, and, once in contact with the atmosphere, CO_2 begins to degas, inducing alkalization and, after a critical threshold value is reached, calcium carbonate starts to precipitate. In this way, CO_2 is both, released to air and fixed in the solid phase, providing proxy potential for past ecosystem developments. In the present study, different hard-water creeks on the Jasmund peninsula, Rügen Island, Southern Baltic Sea, are investigated. The hydrogeochemistry composition of the streams was investigated along the flow path before entering the Baltic Sea and within the mixing zone. To gain insight into the spatial and temporal dynamics, in-situ geochemical investigations were carried out for isotope and trace element analyses. It was found that different stages of terrestrial processes with relevance for the carbon system can be separated, with modulations of the dissolved and solid-phase carbon system, before entering the direct marine-fresh water mixing zone. In the first step, water emerges from

the underground and is controlled by CO_2 degassing. After reaching critical supersaturation, calcium carbonate precipitation begins in the second phase, eventually reaching a steady state between CO_2 outgassing and carbonate precipitation. This leads to an enrichment of the heavy carbon isotope in the remaining dissolved inorganic carbon. The impact of various carbon removal processes depends on factors such as stream length, topography, vegetation, and initial groundwater development. Finally, complex processes occur in the mixing zone with brackish seawater from the Baltic Sea. Water isotopes identify water sources and potential evapotranspiration, the carbon isotope signatures indicate processes affecting the dissolved carbon system. Trace element partitioning allow by comparison with experimental calibrations for an estimate of carbonate formation rates. In-situ quantification of precipitation rates, using different substrates as precipitation grounds are on the way to help understanding better the C removal processes.

Study on changes of coastline morphology and submarine geomorphology in Caofeidian Area, Bohai Sea

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Abstract：

Land reclamation projects typically alter the natural coastline morphology and submarine topography, affecting the conditions of coastal erosion and deposition, thereby influencing the topography of the seabed. Using the Caofeidian land reclamation project in the Bohai Sea as a case study, this research employs multi-phase nearshore remote sensing data, submarine topography measurements and sub-bottom profiles since 2001. It combines tidal currents, the types of seabed sediments and suspended particle concentration data to discover that there has been a gradual decrease in the rate of coastline change. The land reclamation efforts in Caofeidian have successfully preserved the geomorphic features of the Caofeidian Cape. The strong tidal flow within the deep trough generates shear stress greater than the critical erosional shear stress of the surface sediment, resulting in the removal of surface sediment and the continual erosion in the deep trough. Consequently, new underwater landslides and eroded basins have emerged in the marine area of the deep trough. While this helps to maintain the depth of the deep trough, attention should be given to whether the underwater landslides are advancing towards the front edge of the Caofeidian headland. In order to address this issue, timely measures should be implemented, such as reinforcing submarine slope engineering in Caofeidian and enhancing monitoring and early warning systems for marine geological hazards in the deep trough marine area. The research findings will provide valuable technical support for the management of natural resources and the protection and restoration of coastal areas.

Keywords: Geomorphology; Erosion; Remote sensing; Marine deep trough; Caofeidian.

Asymmetric evolution of river mouth bifurcation under angled river-tide interaction, a case study at river mouths of Lingding Bay, Pearl River Estuary

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Abstract:

A thorough understanding of the evolutionary trends of river bifurcation channels is crucial for effective estuarine management in China's Greater Bay Area due to significant morphological changes observed in river mouth channels. At this tide-influenced river mouth, where suspended sediment transport is dominant, how river mouth bifurcated channels that have different angles to the major axis of the incoming tidal flow in the receiving basin evolve on decadal scales remains unclear. Based on a comparative analysis of historical bathymetric data and numerical experiments using a validated morphodynamic model, we developed a conceptual model to illustrate the two end members of the morphological evolution of river mouth channels: a low-angle (<45°) main channel and a high-angle (>45°) secondary channel relative to the major axis of tidal flow in the receiving basin. If the mouth outflow also has a low angle with the main channel, the incoming tidal discharge fluxes have first-order control over changes in the evolutionary trend of the bifurcated channels by changing the partition of residual sediment discharges between the two bifurcated channels. For example, a high incoming tidal discharge that varies around the mean flow increases the partitioning of residual sediment discharges from the upstream channel to the low-angle channel, facilitating tide-induced erosion in the low-angle channel. By contrast, a low incoming tidal discharge decreases the partitioning of residual sediment discharges from the upstream channel to the low-angle channel, which facilitates fluvial-induced erosion in the high-angle channel. Thus, high tidal discharges usually coincide with the river mouth adopting a single channel, and low tidal discharges facilitate the formation of fluvial-induced bifurcation. The historical evolution of the river mouth and modern velocity measurements corroborated results derived from model experiments. The

conceptual model applies to river mouths where suspended sediment transport is dominant and influenced by angled incoming tides.

Decadal scale morphodynamics of the southern Baltic Sea Coast, Western Pomerania, Poland

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Oral Presenter, E-mail: rachmierz@gmail.com (Rachel Jankowski)

Abstract:

Morphodynamic coastal processes of the southern Baltic Sea are determined by a complex interplay of the geological setting, eustatic sea-level change, glacio-isostatic adjustment, wave driven sediment dynamics, storm surges and aeolian processes, which occur in various temporal and spatial scales from millennia to hours and in spatial scale from kilometers to centimeters. The results of the interference are visible as a morphology pattern of beach and dune / cliff as well as a nearshore area. Airborne historical photographs collected in 1938, 1951, 1973, 1996 and recent orthophotomaps taken in 2012 and 2021 were used to determine the magnitude and spatio-temporal distribution of decadal coastal changes of an almost 80 km-long coastal section of the Pomeranian Bay (southern Baltic Sea). The aim of this study was to determine the size of the long-term coastal changes as well as their spatial and temporal variations along the southern Baltic Sea coast in relation to geological and geomorphological settings as well as water level fluctuations. Conducted analyses show the considerable temporal and spatial variability as well as high dynamics of the coastal changes taking place in neighboring, geomorphologically, and geologically uniform coastal segments which are similar also in terms of evolutionary trends. The strong relation between the coastal zone changes and water level fluctuations as well as the number and structure of storm surges was also noticed. Obtained results are very important to develop more reliable future projections necessary for coastal protection and safety. They clearly point out the high importance of the appropriate selection of representative sites used to forecast the magnitude of coastal changes and also the selection of the time span for the analyses. An accidental location and too short period of observations, may substantially bias the forecast and pose a potential threat to the infrastructure planned to be constructed at such sites.

Multi-technical approach for coastal changes reconstruction in urbanized context

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(Oral presenter, Giovanni Fasciglione)

Abstract:

Nowadays global repositories and open-access datasets, are revolutionizing coastal geomorphological researches allowing advanced spatial analyses for mapping and risk prediction studies related to both anthropic and natural forcing. Their use typically needs to be combined with field measurements, geographic information system (GIS) analyses and related tools. In the sea environments the construction of barriers strongly modifies coastal morpho-dynamics, therefore effective management of these areas requires a full understanding of their impact on both coastal assets and sediment circulation.

In this research, we integrated the analysis of global open access datasets (meteo-marine data, aerial and satellite photos between 1994 and 2021) and high-resolution ones (morpho-acoustic and GPS data) collected by innovative technologies for marine surveys in order to assess the main coastal changes due to the restoration of two breakwaters protecting a significant urban beach of Naples' coast (southern Italy).

Firstly, the integrated GIS-analysis of historical maps and data coming from a GPS onsite survey resultedin the evaluation of net shoreline movements occurred in the last 30 years. Secondly, the calculation of seabed DTMs before and after the breakwater restoration allowed the quantification of sediment loss and accumulation volumes. In the last decade, the progradation rate has more than tripled towards the east, reaching 3,5m/y. Wave diffraction calculations showed that sand accumulated in the bathymetric sector between -4 and -5 m during the winter and is redistributed up to the shoreline during the summer; accordingly, DTMs underlined that sediment mainly accumulates close to the eastern shoreline, causing advancement of the emerged beach of 35 – 39m in 10 years. Lastly, thanks to Copernicus data elaboration,a ground uplift trend of 0.24 mm/y was observed since 2006; while, according to IPCC reports, a relative sea-level rise (RSLR) rate of 4.2

mm/y was measured, amounting to 7-8 cm of rising over the last 15 years for the Mediterranean area.

In this study, we evaluated the positive effect of the breakwater restoration that induced a widening of the usable beach; moreover, we demonstrated the effectiveness of a multi-technical approach involving environmental data from global repositories and those from onsite surveys by innovative technologies.

In conclusion the integration of open-source software, field surveys and analytical calculations provided fundamental information for planning prevention and adaptation strategies paying particular attention to low-lying coastal sectors in urbanized contexts prone to flooding due to the ongoing climate changes.

Keywords: Coastal changes; Urban beach; Multi-technical approach;

Innovative technologies.

Unmanned surface vessel for coastal seabed and sub-seabed mapping

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(Oral presenter, Mirza Iryawan Bin Hamza)

Abstract:

Unmanned Surface Vessel (USV) represents a part of the robotic evolution through engineering, providing user controls either via remote or autonomous. The major push factor in the utilisation of this technology in the marine environment are mainly cost effectiveness and personnel safety (HSE). This is more relevant in the management of a state's asset especially within the 3 nautical miles from shoreline which caters to range of diverse user ecosystem ranging from, but not limited to coastal protection, fisheries, subsea utilities (cables and pipelines), ports and coastal townships. The capital invested into these assets may turn into liabilities without proper planning and maintenance. Hence, this highlights the importance of bathymetric seabed and sub-seabed data. Moreover, yearly coastal erosion and flood problems measures can be better addressed with proper mitigations with the availability of consistent coastal bathymetric and seismic data. The barriers to the acquisition of this data can be eliminated by the increased use of USVs to carry payloads such as multibeam and sub-bottom profilers to carry out mapping operations with minimal manning. Moreover, data which are acquired over network protocols which forms the basis of USV data transmission can be tunnelled directly into servers. Hence, this provides a method of data centralization, avoiding duplication of survey works leading to better management of data resources.

Keywords: USV; Coastal Mapping; Seabed; Bathymetry

Last 15 years erosion patterns along the root section of the Hel Peninsula, Poland in the light of LiDAR measurements

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Abstract:

Morphometric studies of the coastal zone have long been a significant challenge for scientists due to the necessity of conducting measurements in two adjacent but vastly different environments – land and sea. However, numerical models of land surface terrain have been successfully created in recent years with high resolution using the Light Detection and Ranging (LiDAR) method. In the past decade, tests of this technology in Poland have begun to acquire bathymetry data for shallow coastal areas. For the past fifteen years, data obtained through a LiDAR have been publicly available through the SIPAM platform, maintained by maritime authorities.

The Hel Peninsula is a sandy spit formed over the last several thousand years by the action of the longshore current transporting sediment in the eastern part of the Polish coast mainly from west to east due to prevailing westerly winds. However, the supply of carried sediment is not equal along the entire length of the spit. The root section of the peninsula is impacted by continuous erosion. In order to counteract this process plenty of coast protection activities are being taken, among them the building of a coastal groynes system.

The research aims to determine the shift in the shoreline and dune foot position as well as beach volume changes along the root section of the Hel Peninsula's coast based on data obtained through LiDAR technology. The possible impact of coastal protection techniques applied in this segment on the shoreline change is also analyzed.

As part of the methodology, the method for calculating changes in coastal morphometry based on profiles extracted from a numerical terrain model is briefly explained. The results show the average annual variability of the shoreline position, dune foot, and beach volume. As an example of a location severely affected by erosion, the vicinity of the Kuźnica settlement is presented. In summary, attention is drawn to the effectiveness of the discussed method and its potential for long-term monitoring and analyzing changes in various morphometric parameters over time, such as shoreline change

or sediment erosion in the nearshore zone.

Changes in sedimentary environment of the bayhead delta front depositions of the Lingding Bay, Pearl River Estuary

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Abstract:

The evolution of bayhead delta front depositions has long been a significant concern for studying estuarine infilling processes. Human activities have been recognized as an important factor in the development and evolution of underwater deltas. By utilizing nautical chart data from 1900, 1935, 1955, 1975, 2010, and 2020, alongside records of human activities, changes in the coastline and land area of the Lingdingyang coastal area over the past century were calculated. Furthermore, shallow stratigraphy within the bayhead delta front was determined based on shallow seismic profile data. Combining this information with underwater topography and geomorphology allowed for analysis of changes in sedimentary facies within the bayhead delta front using existing borehole and shallow drilling data. This approach enabled construction of sedimentary stratigraphic structure on decadal to centennial time scales. Subsequently, a comparative validation was performed against erosion and deposition results obtained from nautical chart calculations. This preliminary analysis provided insights into the sedimentary and geomorphological evolution of the bayhead delta in a tide-dominated embayment under the influence of human activities.

Keywords: Bayhead delta; River mouth; Sedimentary processes; Human influences.

Application of ambient noise tomography to coastal granite islands- A case study of Wuzhizhou Island in Hainan, China

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Abstract:

Islands are valuable land resources in the ocean, and understanding their detailed underground velocity structures is highly important for the planning and utilization of island space, engineering construction and geological disaster prevention. Ambient noise tomography and horizontal–vertical spectral ratio (HVSR) methods do not require specific natural or artificial sources and can prevent environmental disruption. They are potential optimization schemes for the investigation of detailed structures under islands. However, the application of these technologies to small granite islands along coasts is relatively deficient, and the applicability needs to be further verified. In this study, noise power spectral density analysis, ambient noise tomography and HVSR analysis were carried out by using background noise data recorded by a dense array on Wuzhizhou Island, Hainan. The environmental noise below 8 Hz on Wuzhizhou Island is mainly caused by natural activities, and high-quality noise cross-correlation functions of 3-8 Hz can be extracted. The results of ambient noise tomography and HVSR analysis show that the underground S-wave velocity structure and sedimentary characteristics of Wuzhizhou Island are coupled with its topography. The high-terrain area of the island shows low-speed characteristics, where a sedimentary layer did not develop. The low-terrain area of the island shows high-speed characteristics, where a thin Quaternary sedimentary layer developed. These results imply that the island topography is controlled by deep magmatic activity and coastal deposition on the island, which in turn affects the distribution of the island sedimentary layer. This study successfully verifies the feasibility of ambient noise detection in small granite islands along the coast. It not only increases the understanding of underground

structure detection based on background noise on the island but also provides key basic information for studying the geological evolutionary history, island spatial planning and geological disaster prevention of Wuzhizhou Island.

Scale characteristics of InSAR surface deformation and its analysis of natural and human-induced drivers along the coast of Fujian, China

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Abstract:

Coastal evolution and disaster prevention and mitigation requires understanding the surface deformations caused separately by human activities and natural processes. Large-scale, high-resolution surface deformations can be extracted by InSAR (Interferometric Synthetic Aperture Radar), but its results are the combined effects of both factors. At present, it is still difficult to effectively distinguish them, especially because small natural deformations are easily obscured by large man-made deformations. Therefore, this study attempts to analyze natural and anthropogenic deformation from the perspective of spatiotemporal characteristics of surface deformations. Firstly, we used the Multi-temporal InSAR method to extract surface deformation with a spatial resolution of 30 meters from 2015 to 2022. Then, a multi-scale spatial statistical method was employed to analyze the surface deformations caused by human activities and natural factors, and their respective scale characteristics are identified. Finally, the different types of deformation are discussed in terms of their corresponding spatiotemporal dimensions. The results show that tectonic movements,

sea level change, and sediment transport systems in river-sea systems are natural elements driving slow surface deformations. These deformations are relatively small but persistent, extending beyond the timeframe of InSAR data and covering the entire region. In contrast, the impact of human activities such as groundwater extraction, coastal reclamation, and urbanization is typically localized and can significantly accelerate deformation rates within 1-2 years, potentially causing significant jumps in the surface deformation process.

Coastal geological and geohazard mapping in Malaysia

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Abstract:

Most of the coastal developments in Malaysia are close to the coastline and this number will likely increase dramatically in the next decade. Therefore, continual efforts are made by the government to study the coastal zone resources and its ecological habitats in a sustainable manner as an integral part of the coastal development. Coastal resources play an important role in economics of a maritime nation. Beaches are one of the most important natural resources and its contributing significant revenue through tourism. The first National Coastal Erosion Study in 1985 has identified most of the erosion problems were due to the development took place too close to the active zone of the shore.   In year 2015, the second National Coastal Erosion Study showed 15% of Malaysia's shorelines were eroded. Department of Mineral and Geoscience Malaysia has undertaken the marine geological coastal mapping project in Langkawi Island (pioneer project) and Penang Island under the Eighth (2000-2005) and Ninth Malaysia Plan (2006-2010) respectively. Recently, in year 2018 to 2019 the coastal geology and geohazard mapping was introduced in Tioman Island. The study intends to address the 'health' of the beaches and its possible impact from nearby coastal development as well as the baseline data for coastal planning and future development. The primary objective

of this study is to integrate various datasets, such as geological and geophysical data, in order to evaluate the usefulness of the data towards understanding the coastal stability of the island, and in particular the beaches, with regards to the coastal development that are being carried out. A number of geological indicators were developed to address coastal environmental issues with regard to development in coastal zone.

Distribution and ecological risk assessment of pollutant in the coastal zone of Yantai, China

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Abstract:

Yantai is a city located in the south coast of the north Yellow Sea, with active mineral exploitation activities, and frequent outbreaks of red tide in coastal waters. However, in this area, the effective assessment of eutrophication and heavy metal pollution degree in the coastal waters is still lacking. Recently, we have analyzed sea water and sediment along the coastal area of Yantai City. Results showed that nutrient element indicators of coastal seawater in Yantai city were generally inferior to the class IV seawater standard. Jiahe River and Qinshui River transported a large amount of NO_3^- and PO_4^{3-} into the sea, which was an important cause of increasing offshore eutrophication. Eutrophication assessment results showed the coastal area of Yantai city was generally in a state of severe eutrophication. Cu was the most abundant heavy metal in seawater and also the only heavy metal that exceeded the standard of Class IV in seawater, but it had not been significantly accumulated in sediments. In surface sediments, the heavy metal pollution was dominated by Pb in Laishan District and Muping District, and its main source was aerosol deposition; and in the Economic and Technological Development Zone and Zhifu District, the heavy metal pollution was dominated by As, its main source came from mariculture. Besides, Zn, Cr, Cu, Hg and Cd were in a slightly polluted state with low enrichment factors, mainly from natural sources. In general, the coastal zone of Yantai city was in the state of light heavy metal

pollution and low potential ecological risk. The focus of environmental control should be on eutrophication prevention.

Isotope biogeochemical investigations on the spatial and temporal dynamics of a coastal peatland in the southern Baltic Sea

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Abstract:

The coastal zone serves as the buffer, modulating processes and the transport of elements in and between the terrestrial and the marine environment. Furthermore, with organic-rich peatlands proximal to the coast, the complexity of the processes arise and the interactions between organic and inorganic species are becoming evident. Vertical and temporal pore water samples were collected at two permanent pore water lances along the coast of the southern Baltic Sea near the peatland Hütelmoor. The present study aims to identify the basic processes and the possible influence of the on-going anthropogenic changes due to the disturbance of the coastal protection systems. Physico-chemical parameters in pore waters were measured and also for water, carbon and sulfur stable isotope information, for dissolved organic and dissolved inorganic carbon (DOC and DIC), for major ions and nutrient concentrations. Results indicate a mixture of different brackish (Baltic Sea) and freshwater (local precipitation, groundwater, Warnow River) sources. DOC comes mainly from peatland plants with DIC from marine carbonates, Baltic Sea-derived DIC and carbonate dissolution. The submarine groundwater discharges at maximum between 150 to 250 cmbsf. Sulfur comes mainly from the Baltic Sea (as sulfate) and is influenced by microbial sulfate reduction. High concentrations of diagenetic products may be both in-situ-produced and/or peatland-produced. This study indicates the influence of lithology and coastal

morphology on the hydrogeodynamics of the coast and may also serve as a prototype to understand the long-term influence of coastal reconfiguration.

Coastal vulnerability assessment in a Mediterranean changing environment: A case study from the Maltese Islands

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Abstract:

The Maltese Islands, located in the centre of the Mediterranean Sea, are prone to the impacts of several coastal hazards, including both climate- and marine-related processes, due to their local geomorphological characteristics and natural and anthropogenic settings. These processes increase the propensity of the Maltese Islands to be affected by various coastal risks in the form of erosion, flooding, rock falls, storm surges and, on a longer-term, permanent inundation as a consequence of the ongoing global warming. Based on various primary and secondary data sources, the north-west coast of Malta is identified as one of the most hazard prone areas in the entire archipelago. This coastal stretch attracts a large number of visitors each year, raising serious concerns about coastal vulnerability, thus, challenging sustainable management of coastal touristic assets. Considering this, a study has been made to assess coastal vulnerability with respect to a series of hazardous processes, using an index-based approach supported by extensive field surveys. In the first step of this study, the level of coastal vulnerability was assessed based on the evaluation of the exposed elements

in the investigated area by applying a set of indicators associated with local land use, anthropogenic and natural assets. Furthermore, rock-fall runout was calculated and integrated in the coastal vulnerability assessment in order to tailor the approach to the local setting of the investigated area. The second step envisions zonation of storm surges and sea level rise-induced inundation in the investigated territory, in order to estimate the overall vulnerability. The results show that the bay areas of the north-west coast of Malta, characterized by significant touristic activities, can be considered the most critical spots where the expected impacts of coastal hazards will be higher and prevention of future impacts would be difficult, if no sustainable management strategy and adaptation actions are taken in the near future.

Reconstructing recent coastal changes in sites of community importance by integrating geomorphological and remote sensing surveys: the case of Cala Cefalo (Southern Italy)

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Abstract:

Coastal environments undergo continuous changes due to the complex interactions of geological, oceanographic, climatic, and anthropic processes. In the last centuries, human activities have deeply altered the natural balance of coastal areas, making coastal evolution studies crucial for planning strategies related to prevention, preservation, and restoration, particularly in areas with a relevant role in biodiversity conservation.

The aim of this research is the evaluation of recent morphological and environmental changes that occurred since the second half of the 20th century along the sandy stretch belonging to the Site of Community Importance (SCI) "Spiaggia del Mingardo e Scoglio di Cala del Cefalo" in the Campania region (Southern Italy), near the mouth of the Mingardo River. Through an integrated GIS analysis of topographic maps, aerial and satellite photos, and high-resolution data (a photogrammetric survey carried out with an aerial drone in April 2023), a retreating trend of both the shoreline and the dune system was observed. In particular, a decrease in the retreating trend of the shoreline has been detected since 2004, while the mean erosion rate is equal to -0.354 m/y for the period between 2011 and 2016, approximately 12 cm more than the previous timespan. On the other hand, the retreat of the dune system over the whole period amounted to 40 m, 35 m, and 27 m in the northern, middle, and southern areas

respectively, while the highest retreat has been detected for the period between 2012-2016. This coincides with the results obtained for the shoreline between 2011 and 2016. Since one of the strongest storm surges occurred in 2014, this result demonstrates the great influence of storm surges on the state of conservation of the coast, as testified by detected wash-over fans and strong degradation of the vegetation cover. Therefore, the resulting forcing factors acting in the area are the winter wave regime, which can cause flooding and consequent dragging of sediment offshore, and the draining of the Mingardo River. Another relevant aspect is the intense anthropization of the area, especially during the summer season.

To conclude, this work provides evidence of the high impact of storm surges on beach and dune environments, showing the importance of an integrated approach for the analysis of coastal dynamics in a fast-evolving world, where human presence could strongly interfere with natural processes. The potential erosion risk is crucial information for sustainable management of the coast, also taking into account the expected increase in storm surge frequency and magnitude strictly related to climate change.

Keywords: Coastal change; GIS analysis; Multi-technique approach;

Dune system evolution.

Study on erosion and deposition and hydrodynamic environment changes in Bohai Bay under the combined action of estuary sluices and reclamation

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Abstract:

With the rapid development of coastal areas, coastal zones have become economic and population hotspots. In order to resist the impact of tides and solve the contradiction between development and land demand, we have established a large number of estuarine sluices and carried out large-scale reclamation. However, with the construction of estuarine sluices and reclamation, the hydrodynamic conditions in the estuarine and nearshore areas have changed, disrupting the natural balance of sediment erosion and deposition, resulting in increasingly serious sediment deposition in the downstream section of the sluice and the surrounding areas of the reclamation. This article studies the changes in the hydrodynamic environment and seabed erosion and sedimentation in the Bohai Bay under the combined action of the estuarine sluices and reclamation based on the FVCOM model, evaluated the contribution rates of two types of engineering projects to the change and predicted the long-term impact of current engineering construction on offshore area. The results show that the offshore hydrodynamic environment and the sea floor erosion and deposition around the reclamation area of Bohai Bay have changed significantly before and after the construction. Based on the current situation, this paper will further predict the future siltation situation of Bohai Bay coastal area, and provide support for the subsequent scientific development and utilization of Marine resources in Bohai Bay region.

Periodicity of suspended sediment concentration from diverse data perspectives

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Abstract:

Suspended sediment concentration (SSC) is a key parameter of physical and biogeochemical processes in nearshore waters, which is controlled by periodic forcing factors and exhibits periodic variations at multiple time scales. Identifying the key periods and extracting the corresponding amplitudes and phases can greatly help to characterize the representative features of SSC and further assist in physical interpretation. However, in actual observations, the SSC time series inevitably contains random or systematic data gaps, such as data gaps during high cloud cover periods in remote sensing time series and extensive data gaps during low tide periods in tidal flat measurements.

In this study, we obtained buoy hydrological data from the Xiaomiaohong tidal channel in Jiangsu, China, tripod observation data from the tidal flat along the channel edge, and SSC time series derived from hourly GOCI satellite images from 2011 to 2019 in the study area. We then used Lomb-Scargle periodogram and phase folding diagrams to extract the periodic information of the above data sets, and interpreted the differences in the multi-period SSC variations extracted from different data types in the same area. We further filtered the SSC data retrieved from the buoy echo intensity based on water level data, and designed random experiments as a control to simulate the data characteristics of systematic data gaps during low tide periods and investigate the impact of such gaps on periodicity extraction.

Remote sensing data successfully identified the periods of semidiurnal, diurnal, spring-neap, and seasonal variations, while high-resolution buoy data additionally identified the M4 period. The phases of the SSC variations in the spring-neap tide extracted from remote sensing and buoy data were basically consistent, while the peak SSC appeared during peak flood and peak ebb, respectively. Sediment at the bottom of the tidal channel is suspended and diffused to the water column surface after being stirred up by waves during high tide, while the remote sensing retrieval area includes the tidal flats on both sides of the channel, where the sediment is transported into the water column during peak floods. The short duration of the semidiurnal tides enables this phase difference to be reflected. We also found that data missing during low tide period can cause the splitting of M2 period into other harmonic periods, such as the μ2 harmonic period of 12.87 hours, which is consistent with the results of tripod SSC data period identification.

This study uncovers variances in the efficacy of distinct datasets when extracting periodic features, thus aiding individuals in comprehending the range of application scenarios and constraints associated with such extractions.

Keywords: Suspended sediment concentration; Multiple periodicity;
Unevenly spaced observations; Lomb-Scargle periodogram;
Phase folded diagrams.

Enhancing estuarine evolution projection under human influences: A synergy of Bayesian network and process-based modelling

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Abstract:

Over the past century, intensive human activities have disrupted the natural dynamic equilibrium of sediment transport and deposition in the Pearl River Estuary (Lingding Bay). Under the combined influence of human activities and climate change forcing, the evolution of the estuary exhibits complexity and uncertainty. This paper aims to use a data-driven model called Bayesian Network to train and verify the estuary filling evolution over the past century, as well as predict future changes based on different scenarios such as sea level rise and riverine sediment supply. The data-driven modeling approach will be compared with an existing process-based morphodynamic model and historical measurements. Both models' results indicate that sediment discharge is the most significant factor influencing volume changes in Lingding Bay, while sea-level rise has minimal impact in the past. Results from the Bayesian Network show that sediment discharge effect accounts for 31%, reclamation effect for 26%, navigation maintenance effect for 17%, sand excavation effect for 15%, and sea-level rise effect for 9%. The future evolution still needs to be studied over various scenarios.

Keywords: Human activities; Modelling; Bayes network; Morphodynamics.

Session Three: Ecosystem dynamics

Indonesian Archipelago reveals sustainable and high biodiversity and species richness of marine diatoms. What's next? (In memories with A. Witkowski)

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Abstract:

Biodiversity and biogeography of marine benthic diatoms from coral reefs of tropical islands of Indonesia, including West Borneo, East Java, South Celebes, Komodo, Rinca and Flores are exceptionally high. The islands sampled offer a broad range of coral reef microhabitats and host diatom assemblages from seaweeds, sea grass, dead corals, scrapes from other biological surfaces, sand, rocks and other solid surfaces.

The previous work collaborated with several institutions is a part of the GHaNA project (In memories with our great friend, Andrzej Witkowski). These works were based on the light (LM) and scanning electron microscopy (SEM) identification of diatoms only. Our taxonomic analysis revealed the presence of 911 diatom taxa representing 176 genera. Many taxa were identified only to genus level, and may turn out to be new to science. Among hundreds of genera, some of them were new species, i.e: *Haslea nusantara, Catenula javanica, Luticola cribriareolata and Upsilocapconeis depalistriata* comb. nov. We describe some of these new species sampled from Indonesian Archipelago. These genera need to be developed and studied for their economic value in the fields of pharmacology, biotechnology, energy, aquaculture and agriculture or other uses. We suggest some recommendations for their sustainability.

Key words: Marine diatom; Biodiversity; Species richness.

Microfossil records of modern Typhoons along the coast of China

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Abstract:

Tropical storms are one of the main marine natural disasters in the world, and the coastal areas of China in the western Pacific are one of the areas that are the most severely affected by tropical storms. The study of the variation of tropical storms in geological history is an important part of revealing global climate change and coastal environmental evolution. Microfossils are one of the important indicators of paleostormology, which can be used to identify storm events in sedimentary layers. Research has been conducted on the formation and preservation of microfossils in modern storm deposits along the coast of China, providing a scientific basis for the application of this indicator in paleostormology. This paper introduces the research work and latest progress of microfossils, especially diatoms under the action of modern typhoons in different sedimentary environments of lagoons, tidal flats and inland shelves along the coast of China from the East China Sea to the coast of Guangdong.

Keywords：Microfossil record; Modern Typhoons; China coast.

Acute heat stress induces autophagy of zooxanthellae and host cells in the outer mantle of the giant clam Tridacna noae with a stable fecal microbiota

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Abstract:

Giant clams (Tridacninae), one of the most prominent species on coral reefs and model organisms of extracellular symbiosis, are severely threatened worldwide by rapid environmental changes associated with elevated temperatures. Despite conservation and restoration efforts, the physiological responses and regulatory mechanisms

involved are still poorly understood. Here, we used *in situ* seawater and mimicked the extremely high environmental temperature to culture the giant clam *T. noae* and reported autophagy mechanisms to remove cytosolic proteins and organelles, lytic lipid droplets and/or damaged zooxanthellae (Zx) cells. In the outer mantle biophotonic system, host iridocytes were unaffected whereas Zx cells and the Zx tubule, composed of host epithelial siphonal mantle cells, were damaged and induced macroautophagy and microautophagy. Microautophagy was the major mechanism in the Zx tubule. Acute exposure to extreme heat stress negatively affected the metabolism and proliferation of heat-sensitive Zx cells, causing them to die more rapidly and/or not multiply fast enough to compensate for the loss of Zx, resulting in a decrease in viability and density and a change in the Zx community in the feces while maintaining Zx cell size. In the outer mantle, mean abundance increased in the heat-resistant *Cladocopium*, but decreased in the heat-sensitive *Durusdinium* and *Symbiodinium*. Metagenomic profiling of 16S and 18S ribosomal DNA revealed the stable gut microbial composition and metabolism of giant clams on basis of unchanged fecal microbiota of bacteria, archaea, fungi, and eukaryotes from the random filter feeding under acute heat stress. All results reveal the early cellular mechanisms of autophagy in both symbiotic Zx and host cells, and elucidate the stability and adaptability of the gut microbiota in the giant clam-zooxanthellae holobiont in response to extreme heat stress before bleaching.

Keywords: Heat stress; *Tridacna noae*; Regulatory mechanism; Autophagy; Fecal microbiota.

Mediterranean-like "fall dump" events in the Baltic Sea

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Abstract:

In the Mediterranean Sea, organic carbon-rich sapropels have been deposited periodically over the last fifteen million years. Some sapropels are characterized by high contents of the mat-forming, planktonic diatom *Pseudosolenia calcar-avis* and the planktonic diatom *Thalassionema nitzschioides* as a result of their mass sinking in autumn (the so-called "fall dump"). The present study shows that fall dump events also occurred in the brackish Baltic Sea around 6300 – 5800 calibrated years before present (cal yr BP; present = AD 1950). In sediments from the northern Baltic Sea these events are evidenced by high contents of a lipid specific for *P. calcar-avis* (a $C_{25:2}$ highly branched isoprenoid alkene) and corroborated by fossil remains of both *P. calcar-avis* and *T. nitzschioides*. A biomarker index based on long-chain alkyl diol lipids indicates that mat-forming *Proboscia* diatoms were also present. High contents of calanoid resting eggs further suggest that the copepod population was stressed being unable to feed on such large diatoms. The fall dump events occurred during a complete stratification of the water column and euxinic conditions, as reflected by the redox-sensitive trace metal uranium, allowing upward diffusion of nutrients and the growth of rhizosolenid mat-forming diatoms in a deep chlorophyll maximum. Synchronous remains of *P. calcar-avis* in the central Baltic Sea further suggest that these events occurred on a basin-wide scale.

Unraveling the complex interplay between diatoms and bacteria under fluctuating nutrient conditions

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Abstract:

Diatoms account for approximately 45% of primary productivity in marine environments, serving as crucial components in both the food web and global biogeochemical cycles. The intricate symbiosis between bacteria and diatoms significantly influences the stability of marine ecosystems. However, the specific impacts of bacteria on diatom growth under variable nutrient conditions remain largely unexplored. In this study, we isolated bacteria associated with *Phaeodactylum tricornutum* and conducted individual assessments to identify strains that stimulate diatom growth. We discovered that two bacterial strains, *Alteromonas macleodii* SN1 and *Labrenzia aggregate* N23, significantly enhance the growth of *P. tricornutum* under nitrogen-replete conditions. Subsequent experiments involving the growth of *P. tricornutum* with strains SN1 and N23 under both nitrogen-sufficient and nitrogen-deficient conditions were conducted, where diatom and bacterial cell densities were quantified, and transcriptome data were harvested. Our physiological and transcriptomic analysis indicates that the presence of either bacterial treatment promotes diatom growth by upregulating genes involved in the uptake and assimilation

of nutrients (nitrate, silica, and phosphorus), reducing viral DNA integration, and consequently enhancing cell division under nitrogen-sufficient conditions. Conversely, under nitrogen deprivation, bacterial treatment enabled *P. tricornutum* to better withstand nitrogen stress by downregulating photosynthesis and enhancing intracellular nitrogen recycling. Overall, our findings elucidate the pivotal role of bacteria in triggering and sustaining diatom blooms, providing insights into microbial interactions that shape marine primary productivity.

Keywords: *Phaeodactylum tricornutum*; Heterotrophic bacteria; Interaction; Fluctuating nitrogen.

Biological facies variations since the late MIS 3 in northwestern South China Sea and their paleoenvironmental implications

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Abstract:

The sediments from marginal seas are specifically sensitive to paleoenvironmental variability driven by relative sea-level changes, sediment supply, and current circulations under the conjunction between terrigenous and oceanic influences. These effects also profoundly shape marine ecosystem and productivity changes in the northern South China Sea (SCS), which is one of the most diverse and productive regions in the world. In this study, a combined analysis of diatom assemblages, planktonic foraminiferal variations and coccolithophores from a core off the northeastern Xisha Islands was conducted to elucidate the possible linkage between the biological characteristics and paleoenvironmental changes in the north SCS. Planktonic foraminifera assemblages, diatom assemblages and PP records show that the studied core has undergone a significant transition from a high productivity environment to a relatively low productivity condition since the Holocene, coinciding with the decline of East Asian Winter Monsoon during the middle-late Holocene. Since the late MIS 3, the relatively decease of warm water species and increase of cold-water species during ~35-18 cal. kyr BP may have been affected by the weakening of East Asian Summer

Monsoon. Meanwhile, the abundance of biological species was possibly influenced by a strong dilution effect of terrigenous materials in relation to sea-level changes and terrestrial weathering variations. Therefore, this study contributes new evidence to the multiple interactions between land-sea processes modulated by the East Asian Monsoon in the northern SCS. In addition, more work from other parts of the SCS and other marginal seas should be in urgent need for better understanding this issue.

Keywords: Biological facies; Paleoenvironment; Asian Monsoon; Northern SCS.

The distributed characteristics and transport processes of harmful algal species attached to microplastics in the typical bays, East China Sea

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Abstract:

The microalgal communities, including harmful algal species, attached to the surface of microplastics are called as "Epimicroplastic microalgae". Algal species on the traveling microplastics could spread away with the movement of sea currents, entering the neighboring waters as alien species and potentially affecting the marine ecological environment. Based on the investigations of three typical bays (Luoyuan Bay, Dongshan Bay and Quanzhou Bay) in East China Sea in 2021-2022, the distributed characteristics of harmful algal species attached to microplastics were learned. To discuss the potential risk of those harmful algal species, Lagrangian model was used to analyzed their transport processes and pathway. This study provides a new perspective for the research of the traceability and formation process of harmful algal bloom event.

Keyword: Microplastics; Harmful algal species; Distribution; Transport.

Sub-fossil diatom in marine sediments from the Taiwan Strait and their environmental significance

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Abstract:

In the western Pacific Ocean, the Taiwan Strait (TWS) is a special coastal and shallow sea ecosystem connecting the East China Sea (ECS) and the South China Sea (SCS). This study aims to investigate the major environmental factors affecting the sub-fossil diatom distributions in the TWS. Based on *in-situ* and laboratory-measured environmental data, we used statistical analyses, including Pearson correlation analysis and canonical redundancy analysis (RDA), to explore the relationships between sub-fossil diatom distribution and environmental factors. A total of 72 diatom taxa belonging to 29 genera were identified from 32 marine surface sediment samples. The diatom absolute abundance (DAA) ranged from 5 to 9980 valves/g with an average of 2160 valves/g. In the sub-fossil diatom flora, the eurythermal and marine-brackish water (coastal and neritic) species were the primary component. There was believed that the main environmental factors affecting the distribution of sub-fossil diatom in the TWS were seawater salinity and sediment properties (i.e., sediment particle size and type) using statistical tools. Our study contributes to a more comprehensive understanding of the modern water environment (e.g., water currents, freshwater input, and seawater salinity) in the TWS, and makes sense to provide a foundation for future paleoenvironmental and paleoceanographic reconstructions of the region.

Marine facies deposition history in inner bay of Pearl River Estuary, South China recorded from diatom and grainsize in Holocene

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Abstract:

Under the enhanced natural and human being forces, to understand the evolution of river mouth systems is one of critical tasks in coastal and marine sciences. We present sedimentary record with diatom, grainsize analysis and radiocarbon age dating, recovered from a drilling core in an inner bay of the Pearl River Estuary, South China, in order to describe marine facies depositional history and to examine relative palaeo-climatic, palaeo-envrionmental changes during the Holocene. The occurrence of marine diatoms at ca. 9,000 cal. yr. BP provided marine facies starting point at this core profile

in the shoal area, west of the Pearl River Estuary. Three fossil diatom units were distinguished following the early to late Holocene epoch division. The changed diatom bio-facies before and after ca. 8,200 cal. yr. BP, especially in coastal and neritic species relative abundances contrast, offered a response of diatom flora to "8.2 kyr." event. In middle Holocene, enhanced diatom absolute abundances, occurred of tropical open-sea water species and increased neritic species number and their relative abundances, with more sand fractions, those provided evidences of diatom bio-facies response to higher sea-level and strong hydrodynamic clearly. Following the regression, fossil diatom flora has experienced a long-term decline after ca. 5,500 cal. yr. BP, until to ca. 1,400 cal. yr. BP. In the past ca. 1,400 years, there has been a clear increase in the absolute abundances and biodiversity of diatoms, along with a greater presence of coarse granularity fractions. This is a strong signal that human being activities have influenced local environmental change, overlapping with natural forces.

An interesting phenomenon of higher sedimentation rate was observed in three periods as a millennial-scale pulse, at ca. 9,000 - 8,000 cal. yr. BP, ca. 6,500 - 5,500 cal. yr. BP, and ca. 1,000 - 0 cal. yr. BP, respectively. Meanwhile, two periods of lower sedimentation rate longer time inserted into those pulses. Through regional correlation, this study presents a relative whole infilled record of deposition after ca. 9,000 cal. yr. BP as marine facies in Holocene, making a valuable progress to understand the west shoal evolution history in Pearl River Estuary, and making sense to understand natural and human being impact on diatom flora and coastal geo-environment in low latitude river mouth system in Asian Monsoon realm.

Keywords: Diatom; Holocene; Coastal zone; 8.2 kyr. event; Human being force; Pearl River Estuary.

Session 4: Methodological approaches and Geodata management,

including Machine Learning and Artificial Intelligence

AI State of the art, gaps and opportunities in marine science

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Abstract:

The recent advances in Artificial Intelligence (AI) have a relevant impact on the scientific discoveries, not only by improving the results of the research activities through new advanced data analysis tools, rather supporting scientists generating new hypotheses and designing experiments, allowing the acquisition of large datasets and providing their interpretation as well as providing insights that might not have been possible using traditional scientific methods alone. As AI needs a vast amount of data to be developed, data-rich environments provide for more opportunities to advance their domain of knowledge and allow AI based approaches to perform autonomous intelligent actions. This is true especially for the Machine Learning approaches (ML) where algorithms are designed to learn patterns in the available data and then apply this knowledge to new data. Marine observing systems are a remarkable case of data-rich environments where AI-based approaches for data acquisition and analysis are gaining a growing consensus in the marine science and technology community. Such increasing interest deals mainly with the expansions of the scope and scale of ocean observations, as well as with the increment of smart sensors, leading to a continuous flood of data. While a large amount of publications present the current status of AI methodologies used by the marine science community, many other AI topics are not yet in use in the marine domain and need to be considered to advance the current observing systems and data analysis procedures. This presentation try to fill the gap between the marine science and the computer science community by focusing both on general AI concepts and new advanced methodologies.

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Automatic classification of coastline and prediction of change - an exemplary study for the North Sea and Baltic Sea

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Abstract:

Automatic coastline classification based on machine learning is proven to be robust for sandy beaches on regional and global scales. However sandy beaches only make around one third of the world's ice-free shoreline. The rest consists of mudflats, cliffs, different types of vegetation and human constructions. Classification of these feature is more challenging. For instance, mild foreshore slopes resulting in large horizontal tidal excursions and high water content impede shoreline identification and classification in mudflats. Seasonal growth cycles pose difficulties in classification of vegetation.

Developing a classifier which is able to identify all different types of coastlines requires a large amount of training data. Labeling all this data is a time consuming task which cannot be handled by a small team. Therefore, we present an active learning framework which strongly reduces the amount of data which has to be labeled, combined with an unsupervised labeling method to accelerate the labeling process.

Keywords: Image segmentation; Remote sensing; Machine learning; Active learning; Sentinel-2.

Marginal Seas – diversity and generalization

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Abstract:

As highly sensitive areas of the ocean, marginal seas are particularly exposed to pressures driven by changing climate but also anthropogenic impacts caused by the increased economic use of seas, their coasts and associated drainage areas. To protect the fragile ecosystems and habitats of marginal seas, new holistic approaches for management strategies must be considered. These strategies require the description of evolutionary trends in the interaction of humans with the marine and coastal environment on integrated time scales from historical and prehistoric developments to modern (industrialized) times and future projections. Data provided by new interdisciplinary collaboration chains must be integrated. These chains include the integration of real-time and longer series of monitoring data as well as "paleo-data" derived from transfer functions, allowing the interpretation of geological proxies. As a result of high sedimentation rates, sediments in marginal seas provide high-resolution archives of regional environmental and climatic history that can be deciphered by

reading these archives as proxy-data. Future projections of environmental change require numerical models that describe the impact of changing climate and anthropogenic drivers on the natural environment. Sustainable management strategies require generalization of the diversity of these interdisciplinary data sets. In the particular case of marginal seas, a classification (taxonomy) scheme is recommended that can generalize marginal seas' data diversity based on process-controlling parameters including climate, geo-, eco- and socio-economic systems. The concept is exemplified by comparisons of the glacio-isostatically controlled NW-European Baltic Sea with the isostatically relatively stable South African shelf (Agulhas Bank), monsoon controlled southern Asian marginal seas and the socio-economically impacted NW-American Salish Sea ("Urban Sea"). Using the example of the Baltic Sea, a generally applicable correlation methodology is proposed that illustrates the regional interrelationships between various driving natural and anthropogenic factors and the marine environment as a basis for sustainable management.

Keywords: Sustainable management; Environment; Classification; Taxonomy; Modeling; Data-integration.

The FAIR "Research Object" paradigm for supporting the research lifecycle management within Earth Science communities – the example of the Sea monitoring community within the H2020 REALIANCE project

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Abstract:

Facilitating wider access and reuse of research data in environmental sciences has rapidly gained traction because of the need for research integrity, reproducibility, and accountability as well as new opportunities for large-scale data analysis and reanalysis. In November 2018, the European Commission launched the European Open Science Cloud (EOSC) infrastructure to push European research towards a culture of Open Science where research data are detectable, accessible, interoperable, and reusable (FAIR).

In this context, the H2020 project RELIANCE aims at providing Earth Scientists and Copernicus user communities with innovative and interoperable services for an open-by-default, efficient, and cross-disciplinary research management environment supporting FAIR data and Open Science principles. The service portfolio covers the entire research lifecycle management, from data discovery and access to processing, sharing, collaboration, results validation and reuse, metadata enrichment for search and recommendation, versioning, and evolution management. At the core of this offering are Research Objects, the placeholders of scientific methods, materials, and breakthroughs as well as intermediate results produced on a day-to-day basis, rich with descriptive metadata. Research Objects are the innovative and interoperable service, open-by-default, and cross- disciplinary research management environment. Research Objects are virtual aggregations of resources that bring together data, methods, results

and people to document scientific investigations, according to Open Science principles. To guide researchers, different types of Research Objects can be created: Basic, that can contain anything; Bibliography-centric, including manuals, and/or other material that support research; Data-centric, focused on datasets which can be indexed, discovered, and manipulated; Executable, including code, data and computational environment. This type of Research Objects can be executed and is often used for scripts and/or Jupyter Notebooks. Research Objects can be public/open/private and can be snapshotted or archived with permanent identifier (DOI).

The Sea Monitoring VRC involves marine scientists, in particular ecologists, biologists, geologists, geophysicists, geochemists, oceanographers, paleo-oceanographers and Earth observation experts studying the marine habitats, the present and past dynamics of the ocean and the interface between ocean and atmosphere, with a particular focus on the Mediterranean and the polar regions, focusing on the following themes. This presentation shows how the Sea monitoring community demonstrated the great value of the Research Object paradigm trough multidisciplinary scenarios including mapping of seascape and habitats in the Mediterranean Sea.

Exploring avian biodiversity patterns: insights from extensive geodata analysis and structural equation modeling

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Abstract:

In avian ecology, research efforts often focus on specific factors influencing birddiversity within limited geographical regions, leaving gaps in our understanding of overall national avian diversity, notably in countries as biodiverse as China. Addressing this, our study conducted an expansive analysis covering all 30 provinces in China. Leveraging extensive data from eBird and China Bird Report spanning 2015-2021, we explored the intricate relationship between avian diversity and environmental variables, including temperature, snow cover, hydrology, vegetation, and human activities. Our findings revealed a discernible latitudinal gradient in China, with higher species richness in the Central and Southern regions and lower diversity n the Northeast. Through advanced structural equation modeling, we identified hydrology as a significant influencer of waterbird diversity, displaying positive correlations with temperature and human population. Conversely, snow cover and vegetation negatively impacted waterbird diversity. Forest birds exhibited lower sensitivity to environmental factors, with vegetation emerging as their primary diversity driver, complemented by partial effects from temperature and hydrological conditions. Notably, snow cover and human activities did not significantly affect orest bird diversity. This study advances our understanding of the complex interplay between environmental factors and avian diversity on a national scale. These insights are invaluable for the development of nuanced bird conservation strategies, vital in

the face of ongoing biodiversity challenges.

Keywords: Avian diversity; Spatial distribution; Structural Equation Model (SEM).

New findings on the spatiotemporal distribution of submesoscale eddies based on latest InIRA data

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Abstract:

Submesoscale eddies (SMEs) are one of the strongest drivers of ocean vertical motion. A variety of satellite data cannot be used to measure smaller SMEs due to insufficient resolution. With updated satellite altimetry, SMEs can be observed using satellite sea level data. In this study, 264 swaths of 10 orbits of interferometric imaging radar altimeter (InIRA) data are used to identify 7348 SMEs in the South China Sea (SCS) from September 22, 2016, to April 30, 2018, using a newly developed SME identification method. There were 3806 submesoscale cyclonic eddies (SMCEs) and 3542 submesoscale anticyclonic eddies (SMAEs) among these eddies, implying quite close occurrence probabilities for the two polarities of SMEs. The mean radius of the SMCEs is 1.92 km, larger than the 1.68 km of the SMAEs. Among SMEs with a radius of less than 2 km, SMAEs are more abundant than SMCEs. The number of SMEs varies seasonally. The mean number of SMEs per swath is 27.83, with the lowest amount in autumn and the highest in summer. The latitudinal and longitudinal distributions of

SMEs are not obvious, but more SMEs are generated at the edges of mesoscale eddies and sea surface temperature fronts. Combining various satellite data reveals that the number and mean radius of SMEs have weak correlations with the sea surface temperature (SST) gradient, mass concentration of chlorophyll a, and the speed and vorticity of the surface flow. This phenomenon can also be observed in the temperature data of surface drifting buoys. The temperature amplitude caused by SMEs can reach 0.55°C.

Marine oil spills detection and classification based on polarimetric synthetic aperture radar

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Abstract:

Marine oil spill is one of the main pollution sources of marine environment. The polarimetric SAR system can obtain the polarimetric scattering characteristics of surface objects, and provide support for the accurate classification of oil film and its look-alikes. In this talk, the key difficulties, and recent development of marine oil spills detection and classification based on synthetic aperture radar systems is first introduced by highlighting the benefits and drawbacks of existing approaches. Then a complex-valued neural network framework is introduced to extract and process the discriminative information carried by the complex polarimetric SAR data matrix. Moreover, its performance is further evaluated on several typical compact polarimetric SAR modes, which can obtain partial polarimetric information of ground objects while keeping the twice swath width of the quad-polarimetric system. The introduced research will provide technical support for the operational applications of wide-coverage SAR-based marine oil film detection.

Estimation of total suspended soilds and chlorophyll-a in estuaries by remote sensing: A case in Pearl River Estuary and its coast

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Abstract:

Total suspended soilds (TSS) and chlorophyll-a (Chl-a) are important water quality parameters. With the increase of remote sensing data, machine learning algorithms were tried to be used to estimate water quality parameters. In this study, we used extreme Gradient Boosting (XGBoost) algorithm to establish the relationship between Landsat remote sensing reflectance (Rrs) and TSS and Chl-a in the Pearl River Estuary during 2000 - 2021. The results showed that TSS and Chl-a mainly showed a trend of high in the northwest and low in the southeast, high in the spring and summer and low in the fall and winter, with higher values occurring near the Pearl River Estuary. In summer, a band of higher Chl-a was observed from southern Yaimen to southern Hong Kong. From 2000 to 2021, a decreasing trend of TSS and Chl-a is observed in the area around the Hong Kong-Zhuhai-Macao Bridge. Since the beginning of the construction of the bridge, influenced by the changes in water flow caused by the bridge piers and artificial islands, the change in the rate of change of TSS in the west area of the bridge is greater than 0, and the TSS in the upstream area of the west side changes from a decreasing trend to an increasing trend; the change in the rate of change of Chl-a in the downstream area of the west side of the bridge is greater than 0. The change in

the rate of change of Chl-a in the downstream area of the bridge is greater than 0. The machine learning algorithms have a promising future for application in the direction of inversion of water quality parameters.

Effect of atmospheric corrections on shallow sea bathymetric mapping using GaoFen-2 Imagery: A case study in Lingyang Reef, South China Sea

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Abstract:

Satellite-derived bathymetry (SDB) with high spatial resolution effectively maps detailed infor-mation about shallow sea depths. Proper selection of atmospheric correction (AC) methods is cru-cial to obtain precise bathymetric information from satellite data. In this work, three different AC methods (FLAASH, 6S, and DOS) were applied to GaoFen-2 imagery in Lingyang Reef, South China Sea. Three water depth retrieval models, such as single-band, multiband, and band ratio models, were established by 470 points of in-situ water depth data and used for evaluating the model performances. Additionally, the optimal model was applied to depth inversion. The results show that the multiband model based on four bands performs well in this study area with R^2=0.736. The choice of the AC method significantly affects SDB, although acceptable results can be derived without AC. Specifically, the DOS method has the highest inversion accuracy, with a mean relative error and root mean square error of 14.05% and 3.31 m, respectively. Furthermore, the inversion accuracy in various depth ranges may be primarily influenced by suspended sediment concentration and bottom-

type uniformity. This study provides a valuable reference for selecting AC approaches and inversion models in high-spatial-resolution SDB for shallow seas.

Deep convolutional neural network for Sentinel-1 SAR oil spill detection

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Abstract:

Synthetic aperture radar (SAR) can provide all-weather all-time data observation and it has high potential for oil spill detection. The challenge for SAR oil spill detection is distinguishing real oil spill from look-alike areas. The Sentinel-1 SAR satellites provide single and dual-polarimetric data and deep neural network methods offer a chance for identifying oil spill areas for a certain frequency with low cost and high precision. However, the characteristics of the sea surface and oil film on different images are not the same when imaging at different locations and in different conditions, which leads to the inconsistent accuracy of these images with the application of the current oil spill detection methods. In order to avoid the above limitation, we propose an oil spill detection method using image stretching based on superpixels and a convolutional neural network. Experiments were carried out on eight Sentinel-1 dual-pol data, and the optimal superpixel number and image stretching parameters are discussed. Mean intersection over union (MIoU) was used to evaluate classification accuracy. The proposed method could effectively improve the classification accuracy; when the expansion and inhibition coefficients of image stretching were set to 1.6 and 1.2 respectively, the experiments achieved a maximum MIoU of 85.4%, 7.3% higher than that without image stretching.

Remote sensing monitoring of Green Tide disaster from MODIS and GF-1 Data: A case study in the Yellow Sea

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Abstract:

Satellites with low-to-medium spatial resolution face challenges in monitoring the early and receding stages of green tides, while those with high spatial resolution tend to reduce the monitoring frequency of such phenomena. This study aimed to observe the emergence, evolution, and migratory patterns of green tides. We integrated GF-1 and MODIS imagery to collaboratively monitor the green tide disaster in the Yellow Sea during 2021. Initially, a linear regression model was employed to adjust the green tide coverage area as captured by MODIS imagery. We jointly observed the distribution range, drift path, and coverage area of the green tide and analyzed the drift path in coordination with offshore wind field and flow field data. Furthermore, we investigated the influence of SST, SSS, and rainfall on the 2021 green tide outbreak. The correlations calculated between SST, SSS, and precipitation with the changes in the area of the green tide were 0.43, 0.76, and 0.48, respectively. Our findings indicate that the large-scale green tide outbreak in 2021 may be associated with several factors. An increase in SST and SSS during the initial phase of the green tide established the essential conditions, while substantial rainfall during its developmental stage provided favorable conditions. Notably, the SSS exhibited a close association with the outbreak of the green tide.

Keywords: Green tide; GF-1; MODIS; The Yellow Sea.

Algal blooms distinguished from normal waters from enhanced chromatic parameters

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Abstract:

Algal blooms can have significant impacts on aquatic ecosystems and human well-being. This study used a global bio-optical database from 13 different types of water bodies to develop enhanced chromatic parameters for identifying algal blooms. The database allowed for the creation of improved chromatic parameters that incorporated three stimulus values and the Apparent Visual Wavelength (AVW), within a wavelength range of 360-830 nm. Findings show that normal water bodies are mainly located in the eyebrow-shaped region on the color chart. The chromatic parameters of algal bloom data points indicate concentrations with hue angles above 150 degrees, AVW values above 530 nm, and saturation levels in the range of 0-0.2. The relationships between hue angles, AVW, and dominate wavelength in normal water bodies follow a sigmoid function. Algal bloom data points have AVW values concentrated between 500-580 nm, hue angles between 120-230 degrees, and dominate wavelengths spanning 500-580 nm. Different species of algae occupy distinct positions on the color chart. Changes in fluorescence peak heights correspond to variations in algal concentration and chlorophyll content. Algal species without fluorescence peaks have chromatic parameters similar to normal water bodies. Floating algal species demonstrate distinct differences in chromatic parameters compared to normal water bodies. This study explores the relationships between chromatic parameters, red shifts, and factors such as algal cell count, chlorophyll concentration, and SCIF, providing insights for the remote sensing detection of extensive algal proliferation.

Demystifying the changes and characteristics of Persistent Heavy Rainfall in the Guangdong-Hong Kong-Macao Greater Bay Area, South China

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Abstract:

Persistent heavy rainfall (PHR) often leads to economic losses and even casualties in urban areas. Based on the daily precipitation dataset of 31 meteorological stations in the Guangdong-Hong Kong-Macao Greater Bay Area (GBA), South China, we analyzed the temporal and spatial variation characteristics of PHR. Twenty-nine stations are locating in the Pearl River Delta region, covering time span from 1961 to 2020. The results showed that a total of 130 PHR processes occurred in the GBA, with occurrence ranging from 0 (1963, 1988, 1986, 2004) to 5 times (1966, 1968, 1975, 1992, 2001, 2008). The total number of PHR days per year ranged from 0 to 24 days (2004). PHR mainly occurred from April to September, accounting for 95.4% of the total, with the highest number in June (43 times), while the PHR process did not occur in February, November and December. Further 10-day changes show that PHR mainly occurs in the first, middle and last 10 days of June, in the middle of May, in the last 10 days of July and in the middle of August, and that the number of PHRs in these periods is more than 8 times. The spatial variation of PHR shows that except for Fengjia, Deqing and Huadu stations, the number of occurrences at other stations ranges from 1 to 26 (Shangchuan Island station). There are two main high incidence areas in the GBA, located in the northeast (Conghua-Boluo-Longmen area) and southwestern (Enping-Zhuhai-Macao-HongKong).

In addition, there is a significant interdecadal variation in the PHR in the GBA, experiencing a downward trend from 1961 to 1990 and 2011 to 2020, and an upward trend from 1991 to 2010. The lowest number of PHR occurrences was from 1981 to 1990 (15 times) and the highest period was from 2001 to 2010 (28 times). For the multi-scale fluctuation of the number of PHR occurrences (days), there are mainly 8a, 20a and 30a cycles in the GBA, of which the 20a cycle may have a greater impact in the later flood season (July to September), while the 30a cycle has a greater impact in the early flood season (April to June).

Key words: Persistent heavy rainfall (PHR); Climate Changes;

Guangdong-Hong Kong-Macao Greater Bay (GBA).

Definition: Persistent heavy rainfall refers to a situation in which daily precipitation exceeds 50mm for three or more consecutive days, and daily precipitation is less than 50mm for two consecutive days starting from the fourth day or more. If multiple sites occur in the same PHR process, or if the time interval between different sites is less than a day, we classify this situation as the same PHR process.

DataExpo: A One-Stop Dataset Service for Open Science Research in Geosciences

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Abstract:

In the era of big data, rich geoscientific datasets on the internet lay a solid foundation for scientific research. However, the lack of unified semantic markups makes accurate data webpage retrieval a significant challenge. To address this problem, we developed a one-stop dataset service called DataExpo (https://dataexpo.deep-time.org/) in the context of the Deep-time Digital Earth Program (DDE). It introduces deep-learning-based methods for multi-source geoscientific metadata aggregation, data webpage classification, and structured information extraction.

DataExpo provides geoscientists with data discovery, search, and recommendation services for open scientific research. Considering the characteristics of Earth science data, DataExpo has also developed a spatiotemporal map retrieval service, which allows users to further refine search results based on geographic location and time scale. Taking the "Global Ocean Dissolved Oxygen Spatiotemporal Database" as an example, we have accumulated websites that not only include multidisciplinary databases such as GBIF and Zenodo, but also specialized geoscientific databases such as PANGAEA and NOAA, and even long-tail data that is difficult to find on the internet. We collect dissolved oxygen data from 1900 to 2023, and establish uniform quality standards for multi-source data to construct a global spatiotemporal ocean dissolved oxygen database.

In the future, we will continuously improve the services of DataExpo and facilitate data-driven scientific discovery for open science research.

Keywords: Data discovery, Data-driven, Webpage mining

Others

Influence of different experimental conditions on the determination of available phosphorus content in alkaline soils

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Abstract:

Phosphorus, as a critical nutrient for plant growth, necessitates precise quantification in agricultural practices. This study delves into the intricate interplay of diverse experimental conditions on the accurate determination of available phosphorus content in alkaline soils. Employing the advanced analytical technique of Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES), we systematically explored the methodology for evaluating available phosphorus in calcareous soils. The extraction process involved a 0.5 mol/L sodium bicarbonate solution, a key step in national soil standard sample analysis. Notably, the choice of leaching methods, notably the Bray P1 and Olsen techniques, wielded profound disparities in determining available phosphorus content. The experimental findings unearth a multifaceted array of influential factors. Parameters including soil pH levels, soil moisture content, spectral analysis lines, soil-to-solution ratio, acidification procedures, filtration duration, and filtrate settling duration, all wield discernible impacts on the experimental

outcomes. Furthermore, the research uncovered a linear relationship between phosphorus mass concentration and emission intensity within a concentration span of 50.00 mg/L. The detection limit, calculated at a level of 3 times the standard deviation (3S), was revealed to be 0.054 mg/kg. Precision, as expressed by Relative Standard Deviation (RSD%), spanned from 0.93% to 3.87%, and accuracy, gauged as $\Delta |\log C| < 0.1$, met stringent standards. Moreover, an intriguing observation was made in alkaline soils, where elevated pH levels yielded notably lower available phosphorus content determinations. Additionally, augmented soil moisture levels exhibited the potential to enhance the efficiency of available phosphorus extraction, yet excessively high moisture content risked introducing dilution effects into the extraction solution, thereby compromising result accuracy. In summation, this comprehensive investigation into the methodology for determining available phosphorus content in alkaline soils stands as a pivotal contribution to advancing agricultural and soil management practices. By unveiling the nuances of experimental conditions and providing insights into optimizing available phosphorus utilization, this research offers a valuable tool for bolstering crop yields and sustainable agriculture.

Keywords： Leaching agent; Available phosphorus; Calcareous soil;

Inductively coupled plasma emission spectroscopy.