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Reconstructing Holocene seasonal hydrographic variability in Scottish Shelf Seas using Glycymeris glycymeris shells

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The long-lived (>190 years) bivalve Glycymeris glycymeris is an annually resolved palaeoclimate archive for the eastern North Atlantic and adjacent shelf seas. G. glycymeris chronologies have already been published for the Inner Hebrides, Scotland, and the Irish Sea, as well as other areas. The aim of this study is to detect a signal of Atlantic hydrographic variability in Scottish Shelf Seas that is as far as possible uncontaminated by other influences. In May 2014, we collected dead valves and young live specimens of G. glycymeris from St Kilda, Outer Hebrides, Scotland. This area is of particular interest as it is close to the Scottish shelf margin, has negligible freshwater input and is thought to represent open-ocean North Atlantic signals well. We here present two floating chronologies, each spanning >200 years, built from dead-collected G. glycymeris shells from St Kilda. All the shells in these chronologies were assigned radiocarbon ages between 3700-3300 cal yr BP. The radiocarbon ages confirm our findings by grouping the shells into two distinct age bands consistent with our two floating chronologies. This archive provides the potential to compare hydrographic conditions between the present and earlier in the Holocene. We present sub-annual δ18O data of these floating chronologies as well as of modern specimens from St Kilda and instrumental data to compare changes in mean state and seasonality between the present and the fourth millennium BP.

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A better understanding of the recent past of the Faroe Current: Contributions from molluscan sclerochronological-derived paleorecords

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In this study we apply sclerochronological techniques to obtain closer insights into paleoceanographic and climatic conditions of the Faroe Current. The Faroe Current is one of the main inflow branches of warmer water masses into Northern Europe and is therefore of great importance for the climate development in this region. The shells of the bivalve species Arctica islandica provide annually resolved paleorecords because it forms annual growth increments, which can be analyzed similarly to tree rings. Here we present the first multi-centennial absolutely dated chronology (AD 1625-2013) from the Faroese Shelf. The standardized growth indices of the chronology correlate best with spring/summer SSTs for the last 100 years. δ18O-based temperature reconstructions from selected growth increments also correlate best with spring/summer SSTs suggesting that the main growing season of the growth increments occurs in this time period. Correlations of the RBAR, which is an indicator for the signal strength throughout the chronology with AMO-data suggest an inverse relationship between these variables indicating that periods of higher AMO-indexes result in weakened signal strengths. In conclusion, our results suggest that the growth increment variability in shells of A. islandica from the Faroese Shelf reflects to some extent changes in SSTs. In combination with δ18O measurements of the growth increments our chronology can provide a tool to obtain information about the year-to-year SST variability. Furthermore, the variability of the signal strength throughout the chronology may provide information about AMO variations on multi-decadal time scales.

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21st century rise in anthropogenic nitrogen on a South China Sea coral reef

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With the rapid rise in pollution-associated nitrogen inputs to the western Pacific, it has been suggested that even the open ocean has been impacted. In a coral core from Dongsha Island, an atoll 300 km from shore, we observe a decline in the 15N/14N of coral skeleton-bound organic matter, which is best explained by increased deposition of anthropogenic atmospheric N on the open ocean and its incorporation into plankton and the atoll corals. The decrease began just before 2000 CE, decades later than other work would have suggested, and the amplitude of decline suggest that anthropogenic atmospheric N input is now ~15% of the upward mixing of natural subsurface nitrate in this region, a third to a half of the percentage estimated by models and nutrient ratio analyses.

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Deep-surface ocean and atmosphere interactions during the last 2700 years in the central-western Mediterranean: A multi-archive approach

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Western Mediterranean Deep Water (WMDW) forms in the Gulf of Lion by the action of winter cold and dry winds. Here we analyse ocean-atmosphere linkages in this region for the last 2.7 kyr. Ocean conditions are evaluated in base to a group of sediment cores from the North Minorca drift and atmospheric conditions in base to speleothem records from a Mallorca Cave. The integration of several marine cores from the same region allows the construction of stacked records that better represent the regional oceanographic signal. Deep current intensity changes associated to the main core of the WMDW are evaluated by means of grain-size analysis (UP10-fraction). Sea surface temperatures are derived from Mg/Ca-Globigerina bulloides ratios (Cisneros et al., 2016; Climate of the Past). Humidity changes on land are interpreted from carbon isotope records from four speleothems, well dated by U-Th methods. The strongest WMDW currents occurred mostly during the Roman Period (RP) coincident with the warmest SST and apparent transition from wet to drier conditions on land. A second interval of enhanced WMDW currents occurred by the end of Medieval Climate Anomaly and also during the Little Ice Age (LIA). All atmospheric and marine records show high frequency variability for this period, which presents robust correlation patterns with the North Atlantic Oscillation. A review of other Mediterranean and European records of the RP and LIA, reveals distinctive regional patterns in humidity and temperature supporting different atmospheric forcings causing deep Mediterranean convection during these periods.

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Reconstructing Pliocene sea-ice cover in the Nordic and Labrador seas: preliminary results

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Arctic sea ice, a critical component in the global climate system, decreased dramatically over the last decades, and the causes of these recent changes are poorly understood. In this context, records of past climate and sea-ice conditions, going beyond instrumental records and representing times of different boundary conditions, may help to decipher the processes controlling Arctic sea-ice variability.
Here, we present preliminary data on the Pliocene sea-ice extent in the Nordic Seas and Labrador Sea using specific biomarkers (i.e. IP25, brassicasterol, dinosterol) from three (Integrated) Ocean Drilling Program sites around Greenland. These biomarkers provide semi-quantitative estimates of sea-ice cover and information on sea-ice-dependent primary production. Additionally, we used alkenones to reconstruct Pliocene sea surface temperatures (SST). At all three locations, the Pliocene SST values are significantly higher than those measured at these locations today.
Our sea-ice biomarker proxy data from IODP Site U1307 suggest sea-ice free conditions during Late Pliocene, but a more variable sea-ice cover between 3.3 and 3.0Ma and 2.6 and 2.4Ma. Biomarker records from ODP Site 907 also suggest dominantly sea-ice free conditions, but point towards the presence of sea ice from about 3.9 to 3.0Ma and around 2.4Ma. At ODP Site 987, on the other hand, we did not detect any IP25 in the Pliocene interval. In summary, a varying sea-ice cover probably occurred occasionally in the Nordic Seas during the globally warm Pliocene.

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Sea surface and global mean temperature change since the Pliocene

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How warm our future will become depends critically on the sensitivity of the climate system to the radiative forcing from CO2 change. The geological record provides a rich archive of different climate states with which we can determine Earth's climate sensitivity and examine whether climate sensitivity is a state dependent variable. However, in order to use the geological record in this way we need reliable and ideally continuous high-resolution records of global mean temperature change. This significant challenge is traditionally met through either extensive compilations during discrete, narrow, time intervals (e.g. PRISM 4) or by parameterisations of other more indirectly related variables (e.g. benthic □18O). Here we present a new approach using ~10 continuous records of sea surface temperature (SST) covering the last 3.5 million years - the most recent interval when global temperatures were significantly warmer than today. By using climate model output and records of historical temperature change we first assess how SST change at the study locations reflect the global mean SST change. We then explore the relationship between global mean SST change and global mean surface temperature change. Together this information allows a scaling, with thorough uncertainty assignment, of our simple "SST stack" to a continuous high resolution record of global mean surface temperature change since the Pliocene. The significance of this record in terms of climate sensitivity will be discussed as will the insights it may provide on the character of our warm future world.

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Centennial- to millennial-scale evolution of lower North Atlantic Deep Water ventilation during MIS 5e

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Constraining interglacial North Atlantic Deep Water (NADW) variability is important for assessing its potential for change under different background climate conditions. We use new epibenthic C. wuellerstorfi stable isotope records from IODP Site U1304 (53°03'N, 33°32'W; 3082m) to characterize deep northeast Atlantic bottom water chemistry (δ13C) and NADW variability across MIS 5e. We increased the temporal resolution from Hodell et al.'s (2009, EPSL 288) Site U1304 epibenthic record to ~50 year sample spacing; comparable to the high fidelity MD03-2664 record from the deep northwest Atlantic (Galaasen et al., 2014, Science 343). Together, these series provide a unique spatiotemporal depiction of MIS 5e deep Atlantic δ13C and the antecedents of (warm) interglacial NADW variability.
Variability and absolute values of deep northeast and -west Atlantic δ13C were closely coupled over the first ~8 kyr of the MIS 5e plateau. Both records track a long-term increasing Nordic Seas δ13C trend concurrently punctuated by centennial-scale excursions to low absolute values (0.0 to -0.5‰). This supports the inference that NADW influence was intermittently curtailed during early MIS 5e warmth, indicating that NADW shoaled to water depths shallower than at least ~3.1 km across the North Atlantic. Over the last ~4 kyr of MIS 5e, conversely, deep east-west δ13C gradually diverged resulting in a ~0.5‰ gradient by late MIS 5e and MIS 5d, suggesting different evolutions of ventilation and/or bottom water chemistry as the interglacial waned and the last glaciation began.

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Character of the enhanced South Asian Monsoon during the mid Holocene revealed by oxygen isotope analysis of individual foraminifera

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The South Asian Monsoon (SAM) is a seasonal climatic phenomenon with distinctive inter-annual and decadal modes that occur on human timescales. The monsoon provides vital water resources for billions of people but has proven difficult to predict. With only one century of instrumental data for the Indian Monsoon we must look to palaeoclimate proxy records to better understand past SAM variability and improve future predictions. As some planktonic foraminifera species calcify the major part of their shells within lunar periods, the analysis of many single shells has the potential to reveal the range of conditions prevailing on seasonal and inter-annual timescales. The SAM causes a strong seasonal salinity signal in the Andaman Sea where the studied sediment cores were obtained. We have measured oxygen isotope compositions of many individual N. dutertrei shells and have modeled individual foraminifera pseudo-δ18O data based on observational time series for this location. The distribution of individual shell oxygen isotopes from the core top agrees very well with the modeled distribution providing confidence in this technique to reconstruct past variability. The recent and last glacial maximum δ18O distributions are relatively similar although the mean values are offset as expected. In contrast, the distributions from two samples from the early to mid Holocene exhibit a significant skew towards negative values reflecting increased freshwater addition. Modeled time series that reproduce these skewed distributions reveal periods of enhanced river runoff and precipitation over the ocean during the early to mid Holocene.

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Atlantic Meridional Overturning Circulation during Heinrich stadials 1 and 2

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Abrupt climate oscillations punctuated the last deglaciation and the preceding ice age in the North Atlantic realm. Several of the colder stadials were associated with Heinrich events, layers of ice rafted debris deposited during episodes of massive iceberg discharge. In the context of modern ice sheet melting and increasing precipitation in the northern North Atlantic as a result of global warming, Heinrich stadials (HS) may provide a conceptual model scenario improving our understanding of the response of the Atlantic Meridional Overturning Circulation (AMOC) to climate changes. HS1 was associated with an increase in atmospheric CO2, hypothesized to result from a disruption of the AMOC. In contrast no substantial increase in pCO2 has been reported for HS2. There is debate on the relative AMOC instability amongst individual Heinrich stadials, and if in fact, whether the AMOC was indeed perturbed during every Heinrich stadial. Furthermore, it remains unclear whether Heinrich stadial were directly involved in the cessations of AMOC or whether in contrast Heinrich stadial are the result of AMOC instabilities. Here we reconstruct the strength of the AMOC during HS1 and HS2 based on sedimentary 231Pa/230Th. The 231Pa/230Th proxy is a measure of the large-scale strength of the AMOC based on the longer residence time of 231Pa compared to 230Th, both produced by the decay of Uranium in the water column. We present a new compilation of down-core profiles of 231Pa/230Th in order to constrain the relative AMOC strength during both Heinrich events.

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Revisiting the Last Interglacial period in the SW Pacific: new palynological evidence

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The Last Interglacial (~130-115 ka) has been the focus of international research interest over the last few decades as its study (either proxy-based or modelling) underlines temperatures globally warmer by 2 to 3º C and a sea level 4 to 6 m higher than present-day. Because these conditions may represent the likely increase in oceanic temperature (~0.6 to 2ºC) in the next 85 years as forecast by the latest IPCC scenarios, it is therefore crucial that LIG climatic variability and its regional expression are understood. Whereas the Atlantic Ocean has been well studied, the SW Pacific Ocean yields sparse records of past LIG conditions. Annual sea-surface temperatures have been estimated in this region for the LIG time-slices using foraminiferal assemblages, and there are a handful of core sites in the region where SST has been estimated using other proxies. To support and test this previous work, the aim is to produce maps of LIG time-slices of annual and seasonal sea-surface temperature (SST), salinity (SSS) and marine productivity, from 55º S to 25º S, over a 40º east-west gradient. To this end, dinoflagellate cyst assemblages from a number of cores, collected east and west of New-Zealand, are being studied and the Holocene and LIG records compared. Preliminary results will be presented, comparing dinocyst assemblages for Holocene and LIG as well as the quantitative reconstructions of sea-surface conditions based on a set of different palaeoceanographical proxies for LIG time-slices.

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The role of sea ice and buoyancy fluxes in shaping glacial and modern ocean circulation: an analysis of PMIP simulations

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Changes in ocean circulation and the resulting water mass distributions are likely to have played a key role in the recorded glacial-interglacial swings in atmospheric CO2 concentrations. However, we still lack a quantitative understanding of the physical mechanisms leading to the inferred modifications in water masses distribution, and the link between changes in ocean circulation and carbon storage. This lack of understanding of past climatic transitions inevitably shakes our confidence in future climate projections.
This study explores the mechanisms leading to changes in deep ocean circulation between the present and the Last Glacial Maximum (LGM), by analyzing a suite of numerical model simulations from the Paleoclimate Modelling Intercomparison Project (PMIP). Significant discrepancies exist in the representation of LGM ocean circulation between different models, as well as between models and proxy reconstructions. These inconsistencies cast some doubts on the reliability of these models, which are also used for future climate scenarios.
This analysis attempts to explain the different model results in terms of differences in both ocean boundary conditions and physical parameterizations. A particular focus is on changes in Antarctic sea ice between the present and the LGM. Variations in the sea ice extent and formation rates, possibly correlated to shifts in the wind stress across this region, could have driven changes in the surface buoyancy fluxes and therefore played a key role in the rearrangement of deep water masses. We analyze these processes in PMIP models to evaluate their effect on the glacial deep ocean circulation and stratification.

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Late Holocene benthic ecosystem variability and geochemical processes in the Gulf of Taranto (Italy)

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Marine ecosystems depend on organic matter fluxes and oxygen availability, two conditions that are strongly influenced by the regional climate and oceanography. In the Mediterranean region, natural forcing has been overprinted by anthropogenic activity for several millennia. The Gulf of Taranto is especially susceptible to changes in land use because it is a depocenter, collecting materials originating in the Adriatic Sea and the Po Valley. Global and regional climate dynamics remain critical forces for local conditions but their imprint in late-Holocene processes in comparison to anthropogenic influence in the Gulf of Taranto is not fully understood. This study examines the relative contributions of natural and anthropogenic forcing on ecosystem variability and geochemical processes by investigating sediment samples from the Gulf of Taranto and the western coastline of the Adriatic Sea. High sedimentation rates allow for sub- decadal climate reconstructions. Benthic foraminifer assemblages were used to analyze the trophic situation and oxygen concentration of the bottom water. The stable carbon isotope signature in benthic foraminifera shells reveal the quality and quantity of organic matter while Total Organic Carbon, Total Organic Nitrogen and the amino acid composition of bulk sediment samples give insights into organic matter preservation and decay. Sedimentation, biogeochemical processes and ecosystem dynamics reveal decadal-scale fluctuations, which are likely related to North Atlantic climate variability. In addition, eutrophication in modern times is closely linked to human activity in the Po valley and other Italian river catchments suggesting a pronounced influence of anthropogenic activity on local marine processes.

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Hazards of warm climates: Reconstructing past mid-latitude storm activity for the British Isles during the Holocene Thermal Maximum

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There is increasing evidence that the accelerated warming in the Arctic (Arctic Amplification) is associated with increased climate variability at mid-latitudes resulting in extreme winters, flooding, and summer heat waves in Europe. However, the impact of Arctic Amplification for north-western Europe remains unknown because of short instrumental datasets and a lack of paleoclimate records focussing on the impact of warmer global climates for this region. Targeting the warmer than present Holocene Thermal Maximum (HTM) we present a paleoclimate record collected west of the Aran Islands from the Irish continental shelf. At 110m water depth the site is bathed in warm North Atlantic Current water while at the surface the Irish Coastal Currant transports freshwater and sediments from the Shannon estuary. Reconstructions of bottom water temperatures (BWT) and salinities (Mg/Ca - δ18Oc – Hyalinea balthica) combined with past Shannon discharge events (sortable silt), allow us to test the relationship between ocean surface forcing and atmospheric variability (storms) during HTM winters. Our results show that BWT during the HTM are up to 2 ± 0.7°C warmer than present until ca. 4.0 ka. These high temperatures are followed by a long term Neoglacial trend reaching the coldest Holocene temperatures during the Little Ice Age. By combining paleoceanoraphic properties with past discharge events we assess the propensity of more extreme weather events for the British Isles under a warmer climate. Our findings thus have the potential to uncover storms as a potential future geohazard for this region.

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Using Eurasia's Neogene records of sea-sea interactions to better understand the sensitivity of the marine connections

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The Neogene system of seas and lakes of Eurasia, known as the Paratethys realm, is an incomparable natural laboratory to study environmental changes under different geodynamic and climatic conditions. Here, past changes of the marine connections, in conjunction with changes in hydrological budgets and water circulation patterns have repeatedly caused anoxia, hypersalinity, desiccations and catastrophic floods, seriously deteriorating or completely destroying marine biological ecosystems.
In studying Paratethys, we have used an integrated stratigraphic approach (paleomagnetic, biostratigraphic and cyclostratigraphic research) to develop an age model, focused on precisely timing the events that led to the major changes of the marine, brackish and lacustrine environments.
By precisely timing the Badenian-Sarmatian Extinction Event (BSEE), the largest extinction event in the history of the system of seas and lakes of Eurasia, we link this catastrophic event to a change in the nature of the water exchange in the gateways that connect the Eurasian seas. This natural experiment provides insights on the sensitivity of the marine connections and the effects on the dynamics of the bio-chemistry of interacting marine ecosystems.

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The new giant sediment corer capacities of the refitted R/V MARION DUFRESNE

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The R/V MARION DUFRESNE is equipped with a unique sediment coring facility, called CALYPSO, developed by IPEV that operates the vessel 217 days per year in all oceans.
This vessel is then a fantastic opportunity for the paleoceanographic community to carry out expeditions at sea. Over the last 20 years, many international IMAGES coring expeditions were organized in all the ocean basins around the world, with sometimes Universities at Sea. More than 1500 cores were retrieved, leading to numerous major publications in paleoceanography.
The vessel celebrated her 20th anniversary in 2015 and underwent a major refit. The coring capacity has been developed to further improve the length of the retrievable cores, with an objective of 75 m long cores in routine, and their quality, with un-disturbed sediment due to a specially designed coring cable with controlled minimum elasticity. Moreover, there have been improvements on safety, monitoring and time requested for each operation through the upgrading of coring winch (45 tons capacity), A-frames, booms and ship structure. A new suite of acoustic sensors has been integrated, amongst which a KONSBERG EM122 multibeam echo-sounder and a SBP 120-3 sub-bottom profiler, both mounted on a gondola.
These improvements proved to be very efficient during the ACCLIMATE cruise, sailing in the Southern Atlantic Ocean in march 2016, leading to retrieval of exceptional cores regarding their size and quality : recovery rates is 95% in average, for an average core size of 50 meters at any water depth.

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The extent and evolution of the glacial South Pacific carbon pool

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To understand the cycling of CO2 during glacials and deglacial transitions is one of the main priorities in paleoclimate research. The opposing patterns of atmospheric CO2 and Δ14C suggest that the bulk of CO2 was released from an old and 14C-depleted carbon reservoir. Nowadays, the ocean below ~2000 m, stores about 60-times more carbon than the atmosphere, hence it is considered to be a major driver of the atmospheric CO2 pattern.
We use a South Pacific transect of sediment cores, covering the AAIW, the UCDW and the LCDW, to reconstruct the spatio-temporal evolution of oceanic Δ14C over the last 30,000 years.
During the last glacial, we find significantly 14C-depleted waters between 2000 and 4300 m water depth, indicating a strong stratification and the storage of carbon in these waters. However, two sediment cores from 2500 m and 3600 m water depth reveal an extreme glacial atmosphere-to-deep-water Δ14C offset of up to -1000‰ and ventilation ages of ~8000 years. Such old water masses are expected to be anoxic, yet there is no evidence of anoxia in the glacial S-Pacific.
Recent studies showed an increase of MOR volcanism during glacials due to the low stand of global sea level. With a simple 1-box model, we calculated if the admixture of hydrothermal, 14C-dead CO2 has the potential to lower the deep Pacific Δ14C signal. We show, that the combined effects of ventilation changes and MOR-volcanism can account for the observed patterns.

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Deposition of black carbon and heavy metals in marine sediments along the Swedish west coast

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The Oresund strait has been exposed to air- and waterborne pollution from the vicinal industrial areas of Denmark and Sweden since the mid-19th century. The strait connects the Baltic Sea with the North Sea through the Kattegat the Skagerrak. The focus of this project is to reconstruct the historical deposition and spatial distribution of black carbon (BC), the recalcitrant carbonaceous residue of incomplete combustion from fossil fuel burning, in the coastal marine sediments in the regions of west and south Sweden region during the last ca. hundred years. In addition, heavy metals, sulfur content and stable isotopes are also analysed. The study is based on a well dated sediment core from Oresund and surface sediment samples from the Swedish west coast Total sedimentary BC content has been estimated using thermal and chemical oxidation of sediment samples followed by elemental analysis. Counting and characterization of spheroidal carbonaceous particles (SCPs) will be carried out using light microscope and scanning electron microscopy. Our preliminary results of black carbon deposition show increased BC deposition since 1914 with highest depositions in 1929, 1960 and 2011. Highest BC content in surface sediments are found in the Gullmarn Fjord and Oresund. The results will be of importance for understanding recent trends in pollution loads and marine sediments as carbon sink for BC in the marine coastal environment of Sweden.

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Connecting decadal, centennial, and millennia time scales of ocean warming and time varying climate sensitivity

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The history of climate models, the computational costs of running them, and the apparently well separated time scales of global change processes lead to different strands of model development. State-of-the-art climate models focus on simulating centennial scenarios, whereas intermediate complexity models focus on millennia scale questions, but come with low resolution and neglect important climatic variables like clouds. To make full use of paleo proxies to understand (future) climate change, the gap between understanding decadal and millennia scales should be bridged. We do so by comparing--for the first time--these two types of models run to equilibrium. Two major findings for paleoceanography are highlighted:
(A) Over centuries to millennia, the response time scales, regions of ocean heat storage, and global thermal expansion depend nonlinearly on the forcing level and surface warming. Thus, it is problematic to deduce long-term from short-term heat uptake or scale the heat uptake patterns between scenarios. These results also question simple methods to estimate long-term sea level rise from surface temperatures, and the use of deep sea proxies to represent surface temperature changes in past climate.
(B) Spatially varying surface warming pattern lead to non-constant atmospheric feedbacks. This means that ocean heat storage influences the atmosphere both through the amount of heat taken up and also through changing the atmospheric feedback strengths. These results suggest to which degree regional ocean processes can influence global climate sensitivity and set limits to the predictability of climate sensitivity from transient observations.

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Carbon cycling in tropical river systems controlled by continental hydrology

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Tropical humid ecosystems are hot spots of terrestrial carbon storage and large tropical river systems transport vast amounts of biosynthetically fixed organic matter into the ocean. The Congo River basin is the second largest watershed on Earth mainly vegetated by tropical rainforest with high plant cover. Due to rapid carbon turnover in tropical ecosystems predominantly modern organic carbon should be discharged by the Congo River. Based on investigation of a marine sedimentary archive off the river mouth we detect high ages for all terrestrial organic components under the present relatively dry conditions. Using Holocene records of compound-specific 14C ages, we detect a systematic and hydrologically-mediated variation of carbon transfer times in the watershed. By comparison to specific lipid markers for wetland-hosted bacteria, we identify carbon release from anoxic swamp deposits in the central Congo basin as primary source of aged organic matter. Similar wetland systems characterize all tropical river systems. Our data show that tropical watersheds do not work as simple carbon transfer conduits but as large hydrologically-mediated carbon buffers with the potential to induce large carbon cycle perturbations upon hydrologic changes. Release of organic matter from anoxic wetland deposits will lead to direct climatic feedbacks from oxidation of labile organic carbon prevented from remineralization in wetlands. As hydrologic changes in tropical continental areas are influenced by oceanic temperature changes interesting connections arise between changes in ocean circulation and carbon release from continental settings.

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Early Holocene seasonality of bottom water temperature in the northern North Sea reconstructed from the oxygen isotope composition of bivalve shells Arctica islandica

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The knowledge of seasonality in climate is limited by the history of observations. Observational data are available for the last 150 years, while existing information prior to 18th century come solely from proxy reconstructions. However, the vast majority of paleoenvironmental reconstructions on seasonal time scales depend on land-based proxies. Established marine proxy records for the ocean, especially at high latitudes, are both sparsely distributed and poorly resolved in time. The identification and development of proxies for studying key ocean processes at sub-annual resolution that can extend the marine instrumental record and facilitate climate predictions is a clear priority for marine climate science.

Here we present a record of early Holocene seasonal variability of bottom water temperature from the Viking Bank in the northern North Sea. It is a key paleooceanographical location in the midst of inflowing Atlantic water. The reconstruction is based on the oxygen isotope composition of growth increments in shells of Arctica islandica dated to 9335-9600 cal. yr BP. The results are compared with stable oxygen isotope profiles from modern shells. In this study we used live-collected and sub-fossil shells of A. islandica captured by dredging at depth around 100 m. To construct the oxygen isotope profiles we analyzed carbonate powder samples extracted from 10 subsequent years with a minimum resolution of 8 samples per year. Shell-derived oxygen isotope values together with ice-volume corrected oxygen isotope values for the seawater were used to calculate bottom-water temperatures on a seasonal timescale.

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Ventilation of South Atlantic water masses during the last glacial period

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We present new sub-millennially resolved time series for the last 40 kyr from cores MD08-3167 and MD96-2086, retrieved on the Namibian margin at 23°S and 1950 m and 26°S and 3606 m water depth respectively. Core MD08-3167 records were dated based on 23 14C dates covering the last 30 ky; the temporary chronology of core MD96-2086 is based on correlation of reflectance levels with those of core MD08-3167. Stable isotopes (δ18O and δ13C) were measured on the benthic foraminifer Cibicides wuellerstorfi.These records are compared with new and published deep-water records from cores from the North-East Brazil margin (MD09-3257, 4°S, 2340 m; MD09-3256Q, 3°S, 3537 m) and the South Atlantic (MD07-3076Q, 44°S, 3770 m; MD02-2588Q, 41°S, 2907 m).
The comparison of the deep water records shows that deep Subantarctic waters (>3700 m) were very poorly ventilated during the last glacial period, and remained isolated until the end of Heinrich Stadial 1 (~ 15 ky). The shallower records show higher ventilation during the last glacial period, with increasing ventilation at decreasing water depths. However, during Heinrich Stadials 1 to 4, the same water mass seems to have bathed all the sites located above ~ 3000 m in the South Atlantic, from 4°S to 41°S. This seems to indicate the presence of a 'chemical divide' between the deep Subantarctic Atlantic and waters further to the north and shallower.

P-623

Global Sea Surface Temperature and Ecosystem Change Across the Mid-Miocene Climatic Optimum

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The Mid-Miocene Climatic Optimum (MMCO) (ca. 17 to 14 Ma) is generally considered as the warmest episode of the Neogene and a potential analogue for future climate. To date, however, reasonable resolution high-quality sea surface temperature (SST) proxy records spanning its onset are scarce at best. Moreover, reliable absolute SST reconstructions are absent from the tropics and very scarce in temperate and polar regions. This leaves the question if the warmth of the MMCO was truly global. Finally, it remains uncertain how marine ecosystems responded to this hypothesized warming.
We use organic biomarker paleothermometry (TEX86) to reconstruct SST across the MMCO at four locations along a pole-to-pole transect in the Atlantic and Pacific Ocean. Additionally, we use marine palynology (mostly dinoflagellate cysts) to assess ecosystem change at these locations.
This study includes the first tropical biomarker-based SST records of the MMCO from Ocean Drilling Program Site 959 in the eastern Tropical Atlantic. Together with SST records from ODP Site 643 in the Norwegian Sea and the corresponding palynological records, our results for the first time show that Middle Miocene warming was global and marked by prominent changes in ecological and depositional setting at the studied sites.

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Antarctic contribution to deglacial meltwater pulses – a new perspective from Iceberg Alley with implications for future sea-level rise

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Knowledge on the response of the Antarctic Ice Sheet to deglacial changes is very limited because most shallow marine and terrestrial sequences cannot be dated adequately, reveal only the late stage of ice retreat, or resolve only local responses, leaving much room for speculation on large-scale processes. Far-field records from Iceberg Alley (Scotia Sea) revise our current understanding of ice-sheet dynamics because they can be precisely dated and contain a continuous and detailed deglacial record. Most importantly their record of iceberg-rafted debris provides a nearly continuous signal of ice-sheet dynamics, capturing an integrative signal of Antarctic ice mass loss (Weber et al. 2014, Nature). We detected eight phases of enhanced deglacial iceberg routing that commenced abruptly (within a decade!) and lasted from centuries to a millennium. These Antarctic Ice-sheet Discharges (AIDs) indicate that AID7 (ca. 17-15.7 ka) represents the turning point for Southern Hemisphere climate and that it is of key importance to reconstruct Antarctic deglacial history. Moreover, AID6 (~15-13.9 ka) constitutes the peak of deglaciation, synchronous to Meltwater Pulse 1A. Also, AID2 occurred ca. 11.3 ka, corresponding to Meltwater Pulse 1B. Our reconstruction is in marked contrast to previous scenarios and argues for a much more dynamic Antarctic Ice Sheet, which is important in light of current discussions on potential Antarctic Ice Sheet collapse and its impact on future sea-level rise.