Lecture presentations

Presenting author	Nele Meckler University of Bergen/GEO
Title	New tools for reconstructing old climate
Key words	
Abstract	With ongoing climate change moving us quickly outside the climate states we are used to and have observations for, the need to extend our "climate memory" to past climates is increasing. Geologic archives store a huge amount of valuable information about past climate states and variations. However, deciphering them is not straight-forward, as we mostly have to rely on indirect evidence. Over the past years we have been further developing some emerging tools that improve our ability to extract quantitative climate information from archives such as marine sediments or stalagmites. I will give an example of a method that allows us to reconstruct past temperature from small amounts of ancient water trapped in stalagmites from tropical caves. I will explain how the method works and how we can use this new information to better understand climate in tropical regions and its relationship to atmospheric CO2 and high–latitude climate. I will also show some of the groundwork necessary to obtain the samples and understand the environment they were formed in.

Presenting author	Evelien van Dijk University of Oslo/GEO
Title	Large volcanic eruptions as a natural hazard: The impact of the 536/540 CE double event on the atmospheric circulation, surface climate, vegetation and society in Southern Norway
Key words	volcanism, paleoclimate, atmospherc circulation, Scandinavia
Abstract	Large volcanic eruptions that reach the stratosphere cool the surface climate and impact the atmospheric circulation on large to global scale, feeding back on the local climate. The mid-6th century is an outstanding period in climate history featuring one of the coldest decades in the past 2000 years. It was triggered by the 536/540CE volcanic double event, creating the strongest decadal volcanic forcing in the last two millennia. During this century, societal effects were recorded around the world, like the Great Migration period and the outbreak of the Justinian Plague. However, less is known about causal relationships between global cooling and local societal change, and the impact of the large-scale atmospheric circulation on the climate, vegetation and society in Scandinavia after this volcanic double event. Here we aim to improve this understanding by combining global climate and local growing-degree-day (GGD) modeling with climate proxies and archaeological records from Southeastern Norway. We use the PMIP4 past2k and the 6th-7th century (520-680 CE) ensemble simulations of the MPI-ESM, to analyze the atmospheric circulation, surface climate and vegetation changes as a response to the 536/540 CE volcanic double event , over Scandinavia and specifically Southeastern Norway. We focus on the response of the major circulation patterns that influence the climate over Scandinavia. The results of the GDD model, driven with the MPI-ESM model input, are compared to archaeological records, such as number of graves and artifacts, to shed more light on the climate, vegetation and society impacts in Scandinavia and Southeastern Norway.

Presenting author	Marius Lambert University of Oslo/GEO
Title	Causes of plant mortality from extreme winter events: model insights into desiccation processes during frost droughts
Key words	Frost drought, Land surface model
Abstract	Frost droughts are suggested to occur when sudden warm events trigger leaf transpiration combined with deeply frozen soils preventing root water uptake. The recent incorporation of a detailed plant hydraulic module based on tissue (root, stem, leaf) level traits in terrestrial biosphere models, opens up the possibility to investigate how frost droughts experienced by plants impact land-atmosphere interactions. In this study, we use CLM5.0-FATES-Hydro (a cohort model of vegetation coexistence and competition) driven by high-resolution atmospheric forcing (ERA5-land), to evaluate how frost droughts impacted vegetation mortality in northern Norway during the unusual (cold and dry) winter 2017-2018. We establish a clear link between the insulation effect of snow, drought types (chronic winter and acute frost desiccation) and their intensity, demonstrate the ability of the model to simulate root water exudation as soil freezes, show that acute frost desiccation can be represented in cases where a sudden atmospheric temperature increase triggers excessive stomatal transpiration, and highlight the dependence of a drought's severity to the state of dryness of vegetation. Our results, for the first time connect hydraulic redistribution to plant damage from extreme winter events by linking root water efflux, tissue dehydration, and chronic winter desiccation. We are now expanding our research to the whole northern Norwegian area to see if this is still observed at larger scales, and to identify id some regions have been strongly hit by droughts over the period 2012-2020.

Presenting author	Elin Ristorp Aas University of Oslo/GEO
Title	Representing microbial activity in a soil decomposition model
Key words	soil, terrestrial, carbon cycle, CLM, Modelling
Abstract	Representation of litter decomposition in ESMs have traditionally been very simplified, something that has introduced large uncertainties in models. An emerging approach to tackle these challenges is to represent microbial soil processes explicitly in the models. During plant litter decomposition, bacteria and fungi both store carbon as biomass, and respire CO2 back into the atmosphere. In addition, symbiotic relationships between plants and fungi are important for the flow of carbon and nutrients between the aboveground and below-ground world. Changes in abiotic factors like temperature and moisture will likely affect the rate and efficiency of these soil processes, which again may affect the rate of carbon to and from the atmosphere. We have built a process based module that represent the carbon and nitrogen fluxes during soil decomposition, from aboveground litter to soil organic matter (SOM). The role of saprotrophs (decomposers) and mycorrhizal fungi (in symbioses with host plants) is explicitly represented with separate carbon and nitrogen pools with associated fluxes. Comparisons between site simulations and observational data from a Norwegian soil database (Strand et al. 2016) will be shown. The long-term objective is to develop an improved module that can be used to represent soil processes in ESMs, and thereby reduce the uncertainty connected to the exchange of carbon between land and atmosphere.

Presenting author	Maaike Weerdesteijn University of Oslo/CEED
Title	A new open source 3D glacial isostatic adjustment modeling code using ASPECT
Key words	glacial isostatic adjustment, numerical modeling, mantle viscosity, sea level change
Abstract	Models of Glacial Isostatic Adjustment (GIA) processes are useful because they help us understand landscape evolution in past and current glaciated regions. Such models are sensitive to ice and ocean loading as well as to Earth material properties, such as viscosity. Many current GIA models assume radially symmetric (layered) viscosity structures, but viscosity may vary laterally and these variations can have large effects on GIA modeling outputs. Here we present the potential of using ASPECT, an open-source finite element mantle-convection code that can handle lateral viscosity variations, for GIA modeling applications. ASPECT has the advantage of adaptive mesh refinement, making it computationally efficient, especially for problems such as GIA with large variations in strain rates. Furthermore, ASPECT is open-source, as will be the GIA extension, making it a valuable future tool for the GIA community. We benchmark the code for free surface traction on a layered viscoelastic 3D box model with a spherical analytical solution (TABOO) and with another finite-element-based GIA model (ABAQUS, based on different underlying physics) for a linearly growing and constant ice load. We show the capability of using lateral viscosity variations, and how it affects the free surface deformation. We also show that a laterally varying viscosity structure is a more accurate approach of reality compared to a summation of deformations from discretized ice loads using layered viscosity structures, as the ice load is also sensitive to the viscosity not directly underneath the load.

Presenting author	Kine Onsum Moseid Norwegian Meteorological Institute
Title	Using Ice cores to constrain aerosol treatment in Earth System Models
Key words	ice core aerosol cmip6 earth system models emissions
Abstract	Previous studies have found that the direct effect of aerosols may not be accurately represented in Earth System Models (ESMs) as compared to surface radiation measurements over the past 100 years. This bias may be sourced in how models treat aerosols or in the input of these models - the anthropogenic aerosol emission inventories. Ice core retrievals contain valuable information on the deposition of aerosols in times where observations are sparse. The depositon of an aerosol is a result of emission, burden, and the lifetime of that aerosol. Here we compare aerosol deposition in ESMs parttaking in CMIP6 to ice core deposition, and evaluate whether deposition trends correspond to trends in emission inventories of CMIP6, and perform an intermodel analysis on aerosol lifetimes.

Presenting author	Alexios Theofilopoulos University of Bergen/GEO
Title	Reconstructing surface mass balance from ice sheet stratigraphy
Key words	surface mass balance, ice sheet, isochrones, reconstruction, past, sensitivity matrix
Abstract	The aim of the project is to reconstruct past surface mass balance (SMB) rates by examining the thickness of the layers of accumulated snow in the interior of an ice sheet, also called isochrones. . Their final thickness is affected by two factors: the amount of SMB from which they were created and the dynamical thinning that they endured during their evolution in history. Yet, because these two factors act at at the same time in an entangled way, it becomes hard to isolate the effect of SMB and reconstruct it. In this study, we use an isochronal layer model which treats the discretization of the vertical axis not as a fixed in space grid, but rather as individual layers corresponding to different time instances. This explicit simulation of isochrones makes it possible to draw a linear relation between the changes in SMB and the final thickness of the isochronal layer, by substituting the dynamical effect with a linear system of equations. The parameters of this system are calculated from the model itself by forcing infinitesmal perturbations in SMB and creating a sensitivity matrix, which indicates how sensitive the simulation is to SMB. These results are later extrapolated in order to create the linear relation between SMB and layer thickness. Once the linearization process is completed, the focus is thrown into inverting the system of equations and finding the SMB for known values of the layers' thickness. The reconstruction seems promising, at least for the area surrounding the ice divide.

Presenting author	Laura Dietrich University of Bergen/GFI
Title	The Role of Sublimation on the Surface Mass Balance of the Greenland Ice Sheet
Key words	regional climate model, surface mass balance, Greenland Ice Sheet
Abstract	Precipitation along with sublimation and deposition are the main contributors to the surface mass balance (SMB) in the accumulation area of the Greenland Ice Sheet (GrIS). However, precipitation events are rare and intermittent. In between precipitation events the surface snow continuously undergoes sublimation and deposition. Recent studies imply that these surface exchange processes influence the isotopic composition of the surface snow which is later archived as a climate record in ice cores. In order to understand the possible implications on the recorded climate signal sublimation needs to be quantified on a local scale. Here we present simulated SMB components for eight ice core drilling sites on the GrIS using the regional climate model MAR (Modèle Atmosphérique Régional). We validated MAR against in-situ flux observations at the East Greenland Ice Core Project site and found a high sensitivity of sublimation to the downward long wave flux and to the parameterization of the surface roughness length. We propose a surface roughness length optimized for the interior of the GrIS which is supported by our observations. Our results show that on the GrIS accumulation area the mass turnover via sublimation and deposition can reach the same order of magnitude as precipitation. This highlights the importance of a better understanding of how the climate signal is imprinted in the surface snow isotopic composition.

Presenting author	Tobias Zolles University of Bergen/GEO
Title	Climate reconstruction for the last glacial based on an analog method
Key words	climate, Greenland, reconstruction, proxy
Abstract	Simulations of the Greenland ice-sheet require a proper climate forcing to accurately model the atmosphere-ice interaction. Due to the lack of computational power for long higher resolution climate simulations for the last glacial, we try to reconstruct the climate over the region based on ice and marine cores. This is done using an analog method searching for climate model simulations to best represent the proxy-based temperature reconstructions. This enables us to also provide other atmospheric variables than temperature.

Presenting author	Adriano Mazzini University of Oslo/CEED
Title	Geological methane emission at onshore and offshore sedimentary basins
Key words	
Abstract	Methane is a greenhouse gas 28 times more powerful than CO2 on a 100 year time horizon. It is released to the atmosphere by both natural and anthropogenic sources. About 30% of this methane is fossil released by industrial fugitive emissions or naturally emitted through the Earth's degassing via surface gas manifestations (seeps, mud volcanoes, diffuse microseepage) in petroleum-bearing sedimentary basins and geothermal areas. Here are presented some examples of the main methane natural degassing systems located at onshore and offshore sedimentary basins. These emissions may have/had a significant impact on future and past global climate. Today it is difficult to constrain these greenhouse emissions. Likewise is hard to quantify and model the contribute of methane budget in the water column, estimate the influence in ocean acidification and oxygen loss, and how this may influence ecology, movements of water masses and, in turn, have impact on local and global climate.

Presenting author	Kjetil Våge University of Bergen/GFI
Title	Water mass transformation in the western Nordic Seas
Key words	
Abstract	Dense water masses formed in the Nordic Seas flow across the Greenland-Scotland Ridge and provide a major contribution to the lower limb of the Atlantic Meridional Overturning Circulation - a critical component of the global climate system. The largest of these overflow plumes passes through Denmark Strait between Greenland and Iceland. I will discuss recent progress to identify the sources of the dense overflow waters and their pathways into Denmark Strait, the air-sea interaction that forms the dense water, and the impact on water mass transformation of a retreating ice edge along east Greenland.

Presenting author	Xabier Davila University of Bergen/GFI
Title	Global ocean transport of anthropogenic carbon
Key words	Ocean Transport Anthropogenic Carbon Inversion Model
Abstract	About a quarter of the anthropogenic CO2 emissions are absorbed by the ocean. The rate-limiting step for this uptake is the transport of the anthropogenic carbon (Cant) from the surface ocean where it is absorbed, to the deep where it is stored. While it is generally known that regions where deep water formation occurs are important for the vertical carbon transport, the exact magnitude of these fluxes in different regions is uncertain. Here we determine where, when and how much Cant has been injected into the deep ocean since the start of the industrialized era by combining a transport matrix derived from observations with a time-evolving Cant boundary condition derived from the Norwegian Earth System model and climatological distributions of surface ocean pCO2 and other properties. Our results show that most of the total Cant inventory is injected in the subtropics (45.0 %) and the southern ocean (30.3 %), while the subpolar North Atlantic has the highest areal injection. The subpolar North Atlantic is, however, the most efficient region effectively isolated from the atmosphere in the long-term, 81.6 % of the Cant injected here reaches depths greater than 1000 m. This study shows how the oceanic Cant uptake relies on vertical transports in a few oceanic regions and sheds light on the pathways that fill the ocean Cant reservoir.

Presenting author	Marie Stetzler University of Tromsø
Title	Hydro-acoustic analysis of free gas seepage: detection, flux estimate and variability offshore Svalbard
Key words	methane, cold seeps, Arctic, spatio-temporal variability, echo-sounder
Abstract	In the context of a warming Arctic Ocean, accurate estimations of regional methane emissions from the seafloor obtained by upscaling from local cold seeps are necessary. This upscaling process might however neglect potential flux variability. Fluxes are known to fluctuate at deep, gas hydrate-sourced seepage sites, but whether it was the case at a shallower seepage site venting from sediments had to be studied. To constrain this variability, hydro-acoustic data gained offshore western Svalbard during five surveys between May and October (from 2014 to 2017), was investigated for changes in methane seepage activity, using a ship mounted split-beam echosounder. Analysis of the data with the software FlareHunter revealed increase of areal fluxes of two orders of magnitude from summer to autumn, representing a difference in fluxes of 96%, and of 84% between spring and autumn. This is mainly due to an increase in seepage density, and a slight increase in seepage flow rates. Two zones of persistent venting were observed around 70 m and 120 m depth, and depth slightly increased towards autumn.

Presenting author	Danielle Grant NORCE
Title	Sedimentary Ancient DNA: An Exciting Tool for Paleoceanography
Key words	sedaDNA, Arctic, Sea-Ice, paleoceanography, molecular ecology, Last Interglacial
Abstract	The application of sedimentary ancient DNA (sedaDNA) has provided new glimpses into past ocean conditions and may offer new insights into past sea ice variability (De Schepper et al., 2019). Our group has developed a sedaDNA record covering the Last Interglacial (LIG, ~128–116ka) from an Eirik Drift core in the Labrador Sea. The LIG was characterized by a warmer climate, and if climate change remains unabated the LIG may resemble our future climate. Marine sedaDNA is collected from ocean sediment and represents all of the DNA molecules trapped in the sediment layer. For retracing sea ice throughout the paleorecord, the key concept underlying the utility of sedaDNA as a sea ice proxy is that different sea ice conditions support different ecological communities. The community of organisms supported by seasonal sea ice, open ocean, thick vs thin cover, etc. differ. When these organisms die, sink, and settle on the ocean floor over time their organic components degrade but fragments of their DNA remain (Angeles, et al., 2020). Qualitative data is generated through sedaDNA metabarcoding, which reconstructs the full community of past sea ice algae/diatoms/dinoflagellates. The quantitative approach targets indicator species-specific to different sea ice conditions through droplet digital PCR (ddPCR). The proxy data generated through sedaDNA works in concert with established paleoceanography proxies (e.g. microfossil assemblages, biomarker(s), foraminifera, etc.) to provide robust multi-proxy paleo-reconstructions. Our work strengthens the growing potential of Arctic marine sedaDNA as a paleoceanography tool for climate reconstructions in the Late Quaternary.

Presenting author	Kristine Flacké Haualand University of Bergen/GFI
Title	Cyclone development and its influence by weather structures far up in the atmosphere
Key words	midlatitude weather, cyclone intensification, wind shear, stratification, tropopause, baroclinic development
Abstract	About 10 km above us sits a tropopause featuring a maximum in the wind speed - also known as the jet - and separating weakly stratified air below from strongly stratified air above. The abrupt transitions in wind shear and stratification at this interface are important for the intensification of midlatitude cyclones at the surface, but it is unknown how important it is to accurately represent the complex structure around the tropopause for cyclone development. We examine how the sharpness and altitude of the tropopause as well as modifications in wind and temperature just above it influence cyclone development in the idealised Eady model. We are the first to quantify their impact on cyclone growth by comparing the effect of tropopause structures with the important and well-established contribution from cloud condensation. We find that the representation of tropopause structure is mostly sensitive to the structure above the tropopause. Nevertheless, cyclone development is always most sensitive to effects related to cloud condensation rather than tropopause structure.

Presenting author	Kai-Uwe Eiselt University of Tromsø
Title	Time Dependence of Climate Sensitivity
Key words	climate sensitivity, lapse rate feedback, climate model, radiative kernel
Abstract	Equilibrium climate sensitivity (ECS) is a widely used single-number metric to gauge global climate change. It is typically defined as the global mean surface temperature response to a forcing due to doubling of the CO2 concentration. This response is controlled by feedbacks in the climate system. It is common to estimate ECS by performing numerical climate model experiments where the CO2 concentration is instantaneously doubled. The relationship of global mean surface temperature and top-of-atmosphere radiative imbalance is extrapolated linearly to radiative equilibrium to derive ECS. For most available models, though, the relationship is not linear, meaning that the climate feedback, and thus the ECS estimate, is not constant over time. The cause for this time dependence is not yet clear. We employ the radiative kernel method to estimate climate feedbacks due to individual processes in the climate system for members of the Coupled Model Intercomparison Project (CMIP) Phases 5 and 6. We find that the change over time in total climate feedback results mainly from changes in cloud, lapse rate, and water vapour feedback. Since the latter two are strongly anti-correlated, we investigate their sum (LR+Q). The models with the largest cloud feedback change exhibit only small change in the LR+Q feedback. If these models are excluded, LR+Q feedback change explains the largest part of the total climate feedback change. Furthermore, we find that across these models the change over time of Arctic warming at least partly explains the variation in change over time of total climate feedback.

Presenting author	Mika Lanzky University of Oslo/GEO
Title	Seasonality of Scandinavian moisture sources, its spatial extent, and physical characteristics
Key words	Lagrangian, moisture sources, scandinavia, water cycle
Abstract	Snow is an important factor for hydropower production, leisure activities, and flooding in Norway. Moisture sources of precipitation in Norway is controlled by the weather patterns, which themselves are governed by the overall climate. To determine the moisture sources for Scandinavia over the previous 40 years, we utilize meteorological information from ERA-Interim coupled with Lagrangian particle trajectories from FLEXPART to characterize the precipitation in terms of source location as well as environmental meteorological state variables. We found that Scandinavian precipitation is comprised of a blend of nearby and remote moisture sources, transported by south-westerlies. Different ocean and land sectors' exhibit varying behaviour during the year like in the timing of their minimum and maximum relative moisture contribution to Scandinavia. Seasonal differences are also seen by the movement of the maximum source location from ocean to land, with terrestrial, recycled contributions showing a clear seasonal maximum in summer. In the analyzed region, we observe a gradient in different moisture properties related to the Scandinavian mountain chain. Compared to the European Alps, which Sodemann & Zubler (2009) founds acts as a topographic barrier, the effect seem less strong. Comparison of deuterium excess, a source humidity proxy, with stable water isotope observations from Finse serves as validation for the moisture source analysis method. By characterizing the broader Scandinavian precipitation sources, we set the background for further focused studies of the potential impacts of a changing climate on the catchment-scale seasonal snowpack which represents the prime resource for the hydropower industry.

Presenting author	Herman Fuglestvedt University of Oslo/GEO
Title	Modelling the atmospheric impacts of high-latitude explosive volcanic eruptions
Key words	earth system modelling volcanoes iceland ozone sulphur aerosols stratosphere cesm
Abstract	Large explosive volcanic eruptions inject sulphur into the stratosphere where it is converted to sulphur dioxide and sulphate aerosols. Due to atmospheric circulation patterns, the aerosols from high-latitude eruptions typically remain concentrated in the hemisphere in which they are injected, and undergo other processes than those emitted by the more commonly studied tropical eruptions. Iceland is a volcanic hotspot that has seen several moderate eruptions in the last decades, as well as possibly some of the largest eruptions in the Common Era. Besides this, several Icelandic magmas are rich in halogens, of which a fraction will likely reach the stratosphere in the event of an explosive eruption. On this basis, we model a set of Icelandic explosive eruptions in a pre-industrial atmosphere, varying magnitude, season, and injection height, and taking both sulphur and halogen loading into account. We use the fully coupled Earth system model CESM2 with the atmospheric component WACCM6, which extends to the lower thermosphere and has prognostic stratospheric aerosols and full chemistry. We focus on the atmospheric response to co-emitting sulphur and halogens, especially the impacts on sulphate aerosol lifetime and size distribution, and on stratospheric ozone. The modelled volcanic sulphate deposition is evaluated against the deposition in ice cores following comparable historical eruptions. To study inter-model differences, we also compare the CESM2-WACCM6 simulations to similar simulations with the coupled aerosol-general circulation model MAECHAM5-HAM.

Presenting author	Nikolai Figenschau University of Tromsø
Title	Seasonal Variability of Atmospheric Emissions from Shipping along the Northern Sea Route
Key words	Climate change; sea ice; arctic shipping; atmospheric emissions
Abstract	Climate change and the associated melting of sea ice have increased the potential for shipping activities in the Arctic. This study aims to analyze the spatial and seasonal variations of ship traffic, the seasonal changes in sea ice conditions and atmospheric emissions of CO2, CO, SO2, NOx, N2O, CH4, PM, BC, OC, NMVOC along the Northern Sea Route for the year 2013. We find that both ship traffic and the associated emissions have an inverse relationship to sea ice extent. The ship traffic showed strong seasonal and spatial variations, with an eastward and northward expansion during summer. The monthly emissions of CO2, CH4, N2O, CO, NOx, NMVOC, BC and OC follow similar variations to those of fuel consumption, and emissions of SO2 and PM showed a different variation trend compared to other pollutants. Ship and fuel type are important factors to the observed seasonal variations in emissions.

Presenting author	Kenny Matsuoka Norwegian Polar Institute
Title	Radioglaciology in Antarctica: impacts on subglacial hydrology, climate science, and future sea-level rise
Key words	
Abstract	Ice-penetrating radar is a viable tool to visualize ice stratigraphy and subglacial conditions. As the capacity of satellite observations and models has been rapidly improved particularly in the last decade, limited coverage of radar data in Antarctica is highlighted as a major knowledge gap. Here, I present three applications of radioglaciology to demonstrate its potential and need of more surveys to understand the linkages between Antarctica and the global climate system. The foremost outcome of radar surveys is ice thickness and bed topography. Some major voids of topography data were filled in the past decade, but bed topography along the margin of the ice sheet are severely sparse, though it is fundamental to monitor current Antarctic contribution to the sea level rise and predict the future of the ice sheet. We just started a new initiative RINGS to generate synergies between distinct disciplinaries and truly international collaboration to map bed topography all around Antarctica. Radar reflections from the bed of the ice sheet are also used to characterize bed conditions, such as thawed or frozen and in an extreme case subglacial lakes. Our recent work in the inland Antarctica showed that radar is capable to provide independent evidence of geothermal flux, a key unknown to constrain basal melting of the ice sheet. When this method is applied to a larger area, it can constrain subglacial hydrology and basal melt of the ice sheet, another major missing piece in estimating Antarctic contribution to the sea level rise. Finally, radar reveals isochronous stratigraphy within the ice sheet. Deep stratigraphy is affected by past ice flow and basal conditions, whereas shallow stratigraphy represents more recent changes at the surface. Surface mass balance remains also as a major unknown to estimate Antarctic contribution to the sea level rise, and our recent work found that surface mass balance is highly variable in space and largely controlled by local topography, which may affect the model-based estimates of mass inputs to Antarctica.

Poster presentations

Presenting author	Kjersti Konstali University of Bergen/GFI
Title	Mechanisms behind observed precipitation trends in Norway
Key words	precipitation, norway
Abstract	We use a dataset with observations of daily precipitation from 55 homogeneity tested stations in Norway over the period 1900-2019 available from MET-Norway. These observations show that precipitation in Norway has increased monotonically by 19% since 1900. Notably, over half of the overall increase was recorded within the decade of 1980-1990. To examine possible mechanisms behind the precipitation increase, we use a diagnostic model to separate the effects of changes in vertical velocity, temperature and relative humidity. We use vertical velocity, near-surface temperature and relative humidity from two reanalysis products, ECMWF's ERA-20C and NOAA's 20th Century Reanalysis. The model-based precipitation estimates capture the interannual variability as well as the long-term trend, but the absolute magnitude of precipitation is underestimated. Within our model, we find that the variability in vertical velocity chiefly determines the interannual variability and long-term trends. However, over the last decades (1979 to 2019), changes in temperature and relative humidity are the main contributors to the modelled trend in precipitation. Thus, different physical processes shape the trend at different times. We hypothesize that the strong precipitation increase in the 1980's is linked to an unusual high number of low pressure systems reaching Norway from the North-Atlantic. In recent decades however, direct effects of global warming (rising temperatures and hence increased water vapour content) are thought to be the main cause of the positive trend in precipitation over Norway.

Presenting author	Jan Markus Diezel University of Bergen/GFI
Title	Sensitivity of airborne wind energy systems' operation on meteorological conditions
Key words	airborne wind energy, Lidar, atmospheric boundary layer
Abstract	Airborne Wind Energy Systems (AWES) are a set of technologies that use flying tethered objects (kites) to produce power from the wind. The amount of time these kites can stay in the air depends on the meteorological conditions. These conditions include the wind speed, whereby the operation of the system is limited by a minimum (cut-in) wind speed and a maximum (cut-out) wind speed. The altitude of operation of AWES is variable. Therefore vertical profiles of the wind speed have to be taken into account. Also, extreme precipitation and the danger of lightning strikes limits the total flight hours. Weather data from a reanalysis model can be used to evaluate the influence of these meteorological conditions on the annual power production of AWES. The reanalysis model used in this study is the NORA3 model by the Norwegian Meteorological Institute. This is a non-hydrostatic regional hindcast for Scandinavia with a resolution of 3 km. The data has been made available for a period of 15 years (2004 - 2018) and is scheduled to be extended beyond that. A parameter study is being carried out using this model to determine how many flight hours and through that power production can be gained by extending the flying conditions to a wider range of wind speeds and by continuing operation during stronger precipitation events.

Presenting author	Franziska Hellmuth University of Oslo/GEO
Title	Assessment of snowfall rates and their connection to cloud microphysics in global climate models at high latitudes
Key words	Clouds and climate, Mixed phase clouds, Clouds and remote sensing
Abstract	Cloud feedbacks are the major contributor to high climate sensitivity in global climate models. Moreover, the cloud phase is expected to change with climate change, and this has significant implications for radiation, glacier, and ice sheet mass balances. Using a combination of satellite remote sensing and reanalysis data shall improve the understanding of how the cloud phase influences snowfall in the present climate. The use of the cloud and snowfall products of CloudSat and the European Centre for Medium-Range Weather Forecast Re-Analysis 5 produces a global surface snowfall rate climatology. This study will compare the outputs from the Coupled Model Intercomparison Project Phase 6 (CMIP 6) climate models to satellite observations and reanalysis. Comparing present-day simulations from climate models archived through CMIP 6 will relate the already identified cloud phase biases with snowfall in specific regions for 2006 through 2015. Statistical analysis is carried out to analyze the biases in the CMIP 6 models over the past century, which we expect is similar to the cloud biases in specific regions. Expanding our knowledge of how the cloud phase affects snow formation will provide a valuable contribution to further development of GCMs and therefore help to improve future climate predictions.

Presenting author	Thea Josefine Ellevold University of Oslo/GEO
Title	How to model strongly nonlinear internal waves and wave-induced particle transport?
Key words	Internal waves, modeling, Basilisk, wave induced particle transport
Abstract	Internal waves tend to have large amplitude; consequently, we need strongly nonlinear internal wave models. Using the software program Basilisk developed by Stephane Popinet, we can use this numerical solver to model internal wave calculations. By focusing on ideal wave scenarios to implement wave-breaking, Kelvin-Helmholtz instabilities, local - and global instabilities, we can direct our primary focus on wave-induced vertical and horizontal particle transport. The aim is to comprehend if there is a connection between the structure and functioning of marine ecosystem communities living in topographically complex settings and how strong these communities depend on the interplay between water flow and seafloor relief.

Presenting author	Anna-Marie Strehl University of Bergen/GFI
Title	Water mass transformation in the warming Greenland Sea between 1950 and 2019
Key words	Greenland Sea, water mass transformation
Abstract	The Greenland Sea is a major contributor to water mass transformation within the Nordic and Arctic Seas and makes an important contribution to the overflows across the Greenland Scotland Ridge and the lower limb of the AMOC. We examine hydrographic profiles from 1950 to 2020 to understand the long-term changes in the Greenland Sea Gyre. Since the late 1990s, significant changes in the hydrography and stratification in the Greenland Sea have been reported. This change stands out clearly also in the longer time frame, with a gradual warming down to 2000 m as the most obvious. Diminishing sea ice cover has left the gyre ice-free since 1999, resulting in substantially different surface boundary conditions. Bottom-reaching convection as it has been reported in historical literature is not found after the 1980s. In the mid-1990s a new class of intermediate water started forming. A layer of stable stratification separates the intermediate water from remnant deep water masses and prevents convection deeper than 2000m. The formation of this layer coincided with a reduction of the potential for thermobaric convection. A one-dimensional mixed-layer model will be used to investigate the various processes that have contributed to water mass transformation in the Greenland Sea over the 1950 to 2020 period, including open-ocean convection, brine rejection, thermobaric convection, and cabbeling.

Presenting author	Julius Lauber Norwegian Polar Institute
Title	Mechanisms Controlling the Inflow of Warm Water below Fimbul Ice Shelf, East Antarctica
Key words	ice shelf, Antarctica, physical oceanography, observations
Abstract	The Antarctic Ice Sheet represents a key component of the global climate system, providing huge amounts of freshwater that could possibly end up in the ocean in the future and thus contribute to global sea level rise. Inflows of warm water masses into the cavities (the oceans below the ice shelves) are known to drive a significant amount of basal melting of the Antarctic ice shelves. However, the mechanisms controlling the behavior of these warm inflows are not exactly known yet. An understanding of these controls is important to predict the melting for future climate scenarios. My core data consist of 9 years of observations of temperature and velocity from three moorings below Fimbul Ice Shelf, East Antarctica. There, an inflow of warm water usually happens only periodic and can be generally attributed to changes in alongshore winds. However, the behavior of this inflow changes throughout the years. From 2016 on, it happens much more continuous and is not caused by the wind any more, but mainly by other mechanisms that include sea surface height, alongshore currents and sea ice.

Presenting author	Karl Purcell University of Bergen/GEO
Title	X-ray fluorescence core scanning of marine core site MD-3592 off Africa's southern Cape - evidence of terrestrial climate variability over the last two glacial cycles
Key words	South-Arica, XRF-scanning, marine core, paleoclimate, glacial-interglacial timescales, age model
Abstract	This project aims to reconstruct the hydroclimatic conditions that were associated with human cognitive and technological development in South African's southern Cape coast between 100-50 ka years ago. Regional climatic shifts and their drivers during this time interval are still being debated. However, to date, very few continuous, high-resolution terrestrial records exist that reveal the climate history of this area during the time. To resolve this issue, we focus on one of two new marine sediment cores that were retrieved offshore the southern Cape coast of South Africa (MD20-3592). This core gives the opportunity to add to the spatial coverage of the hydroclimate reconstructions from neighboring marine cores. In addition, the climatic record spans from the present to as far back as ~250 ka, hence allowing it to be compared to other regional climate archives that cover only portions of this timespan and thus fill the temporal data gaps. The sediments near the study sites are mostly from local terrestrial sources and from eastern South Africa brought via the Agulhas Current. Major rivers near the coring sites are the closest sources of terrestrial inputs, and the sediments they carry can record periods of increased rainfall in their catchment. Here will be presented elemental compositions data from core MD20-3520 from X-ray fluorescence (XRF) scanning, its analysis, and the associated interpretations about rainfall changes. Moreover, the age models for the cores based on stable oxygen isotope stratigraphy and tuning to well dated near and far field climatic archives will be discussed.

Presenting author	Christine Kollsgård University of Tromsø
Title	Sedimentary processes and lithological records from the continental slope north of Kvitøya (northern Barents Sea)
Key words	marine geology, ice-sheet dynamics, paleo-reconstruction, ocean currents
Abstract	Gaining knowledge on the dynamics of paleo-ice sheets and their forcing factors is crucial to understand our presently changing global climate. We investigate the continental margin offshore of the northern Barents Sea, a great area for studying the dynamics of the northern part of the previously existing Barents Sea Ice Sheet and its interplay with the ocean currents during the last glacial-interglacial. The Kvitøya Trough-Mouth Fan is located on the continental slope north of Kvitøya and Nordaustlandet (Svalbard) beyond the shelf edge in front of the Kvitøya Trough. Erosional features on the fan observed from bathymetrical data reflect downslope activity such as debris flows and turbidity currents. The morphology of the continental slope to the west of the fan is smooth in the upper parts and rugged in the lower parts (below ~1000 m b.s.l) suggesting contouritic accumulations of sediments from along-slope-flowing ocean currents on the upper slope, and gravity flows on the lower slope. We present preliminary results of multi-proxy analyses from the upper sections of one giant piston core, three gravity cores and a multi-core including lithology and radiocarbon chronology. The results reveal an interplay between suspension settling, as well as down-slope and along-slope sedimentary processes, supporting the observations from the bathymetrical data. The chronologies of the sediment cores are established to constrain the timing of the various sedimentary processes with the purpose of reconstructing variations in ocean current regime and glacial dynamics in the past.

Presenting author	Paul Halas University of Bergen/GEO
Title	Greenland land-terminating glaciers velocity trends during the last two decades
Key words	Greenland velocity optical remote-sensing
Abstract	Here we present the ice motion over many land-terminating glaciers on the Greenland Ice Sheet for the last two decades. The velocities were obtained using optical Landsat 7 & 8 imagery and feature-tracking algorithm. We focused on this specific type of glacier here because they are ideal for studying processes at the interface between the bed and the ice since they are exempted from interactions with the sea, while still being relevant for all glaciers as they share the same basal friction laws. Our results show similar velocity trends for previously studied areas with a slowdown until 2012 followed by an acceleration (SW Greenland Ice Sheet previously studied by Tedstone and Joughin). This trend however does not seem to be observed on the whole ice sheet and is probably specific to this region's climate forcing. Moreover comparison between ice velocities from different parts of Greenland allows us to observe the impact of different climatic trends on ice dynamics.

Presenting author	Tuomas Heiskanen University of Tromsø
Title	Abrupt changes in Greenland surface mass balance due to changes in atmospheric latent heat transport
Key words	Greenland, SMB, Energy transport, Waves, Ice-sheet, Atmosphere
Abstract	Climate change in the Arctic is likely to lead to a significant melting of ice sheets and glaciers. This will be an important driving mechanism for future sea-level rise. During the last decades the Greenland ice sheet has lost mass at an unprecedented rate. This has lead to the Greenland ice sheet to be an important contributor to sea-level rise. Here we test the hypothesis that a change in the atmospheric circulation over Greenland contributes to the exceptionally negative surface mass balance observed over the last decades. From recently developed Fourier and wavelet based methods it has been found that the planetary component of the latent heat transport affects that Arctic surface temperatures stronger than the decomposed dry-static energy transport and the synoptic scale component of the latent heat transport. The south west ablation zone of the Greenland ice-sheet is one of the main contributors to mass loss of the ice-sheet. Comparing the ablation in this area with patterns of the divergence of latent heat transport shows that similar decadal-scale trends are found in the surface mass balance and divergence of latent heat transport data. During the last decades the divergence of latent heat has shifted from synoptic scale to planetary scale. The total amount of energy transported into this region has not changed dramatically. Hence this indicates the importance of the systems transporting the energy or conditions under which the transport by the different wave types take place.

Presenting author	Julien-Pooya Weihs University of Bergen/GFI
Title	Motivation, relevance and needs of mathematics in the geophysics curriculum
Key words	geophysics educational science mathematics integrated teaching
Abstract	This presentation will address the core ideas of my research proposal. From a first motivation for the research aim, I will propose an investigation of the geosciences students' perceptions of their mathematics course and suggest potential outcomes expected by the literature. I will then make the hypothesis that mathematics anxiety gets revealed during this diagnosis and further discuss its possible causes and implications on the affected communities of practice and their on-task cognitive performances. Lastly, I will offer an overview of how integrated teaching merging mathematics and geophysics could tackle such an educational issue and improve the overall students' learning.

Presenting author	Johannes Lutzmann University of Bergen/GFI
Title	Towards a Climatology of Frontal Life Cycles
Key words	atmospheric dynamics, fronts, climatology
Abstract	Atmospheric baroclinicity drives the intensification of extratropical cyclones and is in turn dissipated by them. In association with these cyclones, diabatic heating through condensation of water vapour, replenishes baroclinicity and thus sustains areas of elevated cyclone activity in the mid-latitudes, called storm tracks. Synoptic Fronts are sharp zones of both elevated baroclinicity as well as intense latent heating. In the case of strong trailing cold fronts, this diabatic baroclinicity production persists beyond the life cycle of the parent cyclones. This can lead to the formation of one or more secondary cyclones, potentially forming cyclone clusters that are often associated with severe-weather impacts. The role of fronts in maintaining storm tracks through raising the ambient baroclinicity is, however, not fully understood. In my PhD, I aim to characterize frontal lifecycles, with particular focus on the formation of intense trailing cold fronts. To achieve this, I will detect synoptic fronts in two recent atmospheric reanalyses (ERA5 and ERA20C), track their life cycles in time, and classify these life cycles with respect to the properties of the front (strength, length, shape, position, longevity, intensity of diabatic heating) as well as its environmental forcing (strength and relative position of the jet stream, life cycle of the parent cyclone, advection of moist air, surface fluxes). I will present preliminary results of a climatology of fronts based on a front detection algorithm as well as details of the formulation of this algorithm together with an outlook of the ensuing steps in my project.

Presenting author	Mauro Ghirardelli University of Bergen/GFI
Title	Development and Test of a Multi-rotor based system carrying a sonic anemometer
Key words	anemometer, turbulence, UAV, multi-rotor, coherence, ABL, CFD, wind-farm, entrainment
Abstract	The total energy yield of offshore wind farms is heavily affected by wind turbine wakes since they define the loading of downstream wind turbines and they play a big role in the entrainment process. In order to improve the models, we currently use to describe wakes behaviour, experimental data and measurements are needed. New techniques and technologies are also required to overcome the difficulties offshore environment poses. My PhD project focuses on the development and test of a multi-rotor UAV based system equipped with a sonic anemometer. This sensor will be mounted on a semi-fixed mechanical arm connected to the drone itself. The first step of the research will be the evaluation of rotor blades downwash and the velocity contour of turbulence around the UAV; this will be done through a CFD analysis that will also show the best suitable position for the sensor placement. Secondly, the accuracy and effectiveness of the system will be evaluated through a comparison with an anemometer mounted on a mast. The goal is to reach the same level of reliability and to consequently use the drone-system offshore as if it were a portable mast.

Presenting author	Eirik Rolland Enger University of Tromsø
Title	Estimating temperature response to volcanic eruptions
Key words	equilibrium climate sensitivity, filtered Poisson process, climate simulation
Abstract	In order to estimate the global temperature response and climate sensitivity to radiative forcing, volcanic activity is an important testbed. This work uses a non-parametric method for estimating the temperature response due to volcanic forcing from a simulation of the NorESM model. In addition, this response will be convolved with reconstructed volcanic forcing and compared to temperature recordings. The volcanic forcing and the temperature response data sets cover the last two millennia. Under the assumption that the temperature responds linearly to the forcing, the system is modelled using the filtered Poisson process (FPP) such that the Richardson-Lucy deconvolution algorithm can be applied. The FPP is a methodological model that describes a signal as superposed pulses. The sum of pulses can be written as a convolution as $T = G * F$, where T is the temperature, F is the forcing and G is some response function. Using the Richardson-Lucy deconvolution algorithm we can get back G given F and T , that is, we get back the response from knowing the volcanic forcing and the temperature recording. This approach is thus a non-parametric method of acquiring the response function, and because of the superposition of pulses it is also insensitive to pulse overlap. Further, the response function obtained may be used within the same framework to predict the temperature evolution when different forcing scenarios are run, for example a doubling of CO2 scenario. This is, of course, still assuming a linear dependence between the forcing and temperature response.

Presenting author	Thodoris Karpouzoglou Norwegian Polar Institute
Title	Transport and Hydrography of low salinity waters in the East Greenland Current, Fram Strait
Key words	Arctic, freshwater outflow, Fram strait.
Abstract	The Arctic is experiencing rapid changes related to ongoing anthropogenic climate change. Since the beginning of the century, the freshwater storage of the Arctic ocean is rapidly increasing. Motivated by the importance of freshwater forcing on the deep-water formation occurring in the Nordic Seas, emerges the need to quantify accurately the Arctic freshwater outflow through the Fram Strait, the main gateway between the central Arctic Ocean and the Nordic Seas. Here we discuss the validity of previously calculated transports by analysing newly acquired data, and provide preliminary results of the transport observed after 2015.

Presenting author	Vår Dundas University of Bergen/GFI
Title	An idealized model setup to study storm events as a driver of heat transport onto the Antarctic continental shelf
Key words	Antarctica "physical oceanography" "idealized model" "shelf break processes" "heat transport"
Abstract	While the ice shelves in the southern Weddell Sea do not currently experience rapid changes in melt rates and ice shelf thickness (Shepherd et al., 2018), both observations and model studies indicate that this might change in the future due to interactions at the Filchner Trough opening at the eastern edge of the Weddell Sea continental shelf (e.g. Schmidtkoet al., 2014; Couldrey et al., 2013; Hellmer et al., 2017). A year-long mooring time series indicate storm events on a weak background wind field as a driver of warm inflow into the Filchner Trough (Darelius et al., 2016), contrary to results from nearby moorings (Ryan et al., 2017). We want to investigate this further by adapting an existing idealized model (Daae et al., 2017) to include periods of short-lasting, but sudden and strong winds. Storms in succession may lead to the same situation as persistent strong winds, where a sharp ASF impedes heat transport into the trough. Questions to answer therefore include where the limit goes between storms that lead to increased on-shelf heat transport, and when the inflow is blocked, as well as the importance of the background hydrographic setting for the effect of such storm events. Another, possibly quantifiable, question is the relative importance of storm events versus surface layer stratification and the upper layer eddy overturning cell described by Daae et al. (2017). This poster presents the setup of the idealized model we will use to address these questions.

Presenting author	Gaurav Madan University of Oslo/GEO
Title	Evaluating Weakening Overturning Circulations using CMIP6 Models
Key words	AMOC, Weakening, CMIP6, Climate Change, Warming, Arctic Sea Ice
Abstract	Meridional Overturning Circulation (MOC) is a circulation where dense surface waters sink at the regions of deep convection like in the subpolar North Atlantic, spread at depth and return to the surface by diapycnal mixing in the interior which establishes the conditions necessary for upwelling of the dense waters. AMOC is an important tipping point of the Earth's Climate System and it has been observed to weaken over the past decade in the Rapid Climate Change (RAPID) array in the North Atlantic. In coupled climate simulations, the AMOC weakens typically by 10-30% by 2100, depending on the CO2 emissions scenario. In our study, we characterize AMOC reduction under abrupt quadruple CO2 scenario and quantify the relative importance of surface temperature, temperature gradients and salinity as a difference between abrupt-4xCO2 and the pre-industrial control run. We seek to identify the key physical processes at work in the maintenance and modulation of the AMOC in the CMIP6 simulations. Our initial analysis shows that change in density gradient due to salinity and wind stress curl are the primary driving factors of such weakening as we further investigate 22 different models.

Presenting author	Johanne Skrefsrud University of Bergen/GFI
Title	Poleward ocean heat transport and its horizontal and vertical partitioning
Key words	poleward heat transport, AMOC, gyre circulation, large scale circulation
Abstract	My PhD project involves investigation of the mechanisms behind ocean circulation and poleward heat transport in the North Atlantic, Nordic Seas and the Arctic Ocean, focusing on the division between the vertical and horizontal components of the circulation system and their contribution in transporting heat poleward. Changes in the Atlantic Meridional Overturning Circulation (AMOC) are often assumed to lead to equivalent changes in poleward ocean heat transport. Hence, in the absence of overturning, there can be no poleward ocean heat transport. The overall aim of my PhD project is to challenge this understanding, hypothesising that the ocean's poleward heat transport can be maintained by the horizontal component, independent of an overturning circulation. This suggestion becomes more and more relevant moving northward.

Presenting author	Lea Belosa University of Oslo/CEED
Title	Constraining the enigmatic source of Vesteris Seamount volcanism
Key words	seamounts, intraplate magmatism, geodynamic evolution
Abstract	Most seamounts related to intraplate volcanism form linear chains with an age progression. Less commonly, seamounts are scattered on the ocean floor, showing no apparent link to stationary mantle thermal anomalies. Several of these appear on the NE Atlantic crust, and Vesteris seamount (13 Ma -10 ka), situated in the Greenland Basin ca. 280 km N of Jan Mayen Island, is the most prominent one. Vesteris is considered an intraplate volcano, a single isolated feature far-removed from the active mid-ocean ridge, the Iceland plume and fracture zones. Isotope geochemistry indicates that the mantle source of this volcanism is relatively similar to that of Jan Mayen and differs from the Iceland plume. However, a clear picture of the Vesteris mantle source remains elusive. Here, we report on a new suite of samples dredged in 2012. Many centimetric clasts of vesicular lava were recovered. The lavas classify chemically as alkali-basalts, phonotephrites and benmoreitic trachyandesites, suggesting that different lava flows were sampled by dredging. We report for the first time the occurrence of hauyne-phyric trachyandesites from Vesteris. Many phenocrysts contain apatite, sulphide and melt inclusions. Zoning, resorbed textures, and inclusions in the phenocrysts reveal a complex history of magma mixing and disequilibrium, while broken phenocrysts suggest a fast ascent of these magmas upon eruption. Whole-rock Rare Earth Elements are used to model mantle melting dynamics. Further analyses will target Sr-Nd-Pb-Hf isotopes to constrain the Vesteris mantle source in the context of compositional heterogeneities and geodynamic evolution of the NE Atlantic.

Presenting author	Kristine Steinsland NORCE
Title	Last interglacial sea ice variability and paleoceanography of the Labrador Sea
Key words	sea ice, biomarkers, dinoflagellate cysts, paleoceanography
Abstract	Sea ice provides strong feedback in the climate system, and it plays an important role in modulating the strength of the Thermohaline Circulation through glacials, and even interglacials. The warmer than present Last Interglacial (LIG, ~116-128 ka) is thought to have a less stable climate than the current interglacial. Proxies from the deep- and surface subpolar North Atlantic Ocean show prominent instabilities pointing toward coupled ocean-climate variability. Here we reconstruct sea surface and sea ice changes of the subpolar gyre through the penultimate deglaciation and LIG in order to evaluate sea ice's role as a driver and amplifier of these ocean circulation and climate changes. We reconstruct the sea ice and sea surface conditions using biomarkers (IP25, sterols) and dinoflagellate cyst assemblages from the Eirik Drift. Low productivity combined with an absence of IP25 could indicate a potential full sea ice cover through MIS 6. The surface ocean experienced large variability through the first half of the LIG, including an early cooling with potential seasonal sea ice cover evident from the dinoflagellate cyst assemblage and IP25. The peak warm period of the LIG is seen in the second half, followed by a brief cooling period towards the end. Following the LIG, MIS 5d is characterized by an IP25 signal and high relative abundances of round brown dinocysts indicating cooling with seasonal sea ice cover. Initial comparisons with deep ventilation proxies (benthic foraminiferal δ13C data) indicate a potential close link between sea ice, surface hydrography and deep circulation.

Presenting author	Jakob Dörr University of Bergen/GFI
Title	Patterns and mechanisms of low-frequency variability of Arctic sea ice
Key words	variability, sea ice, climate, Arctic,
Abstract	The Arctic sea ice cover is strongly influenced by natural variability at longer (decadal to interdecadal) time scales, which affects long-term trends and for instance the timing of the first ice-free summer. The origins of this variability have not been fully understood. Using a novel technique called low-frequency component analysis (LFCA), we aim to identify dominant spatial patterns of decadal sea-ice variability and their underlying mechanisms, both in observations and in climate models. We apply LFCA to seasonal means of sea-ice concentration and find, as a first result, that LFCA is able to isolate the externally forced sea-ice decrease in the observations.

Presenting author	Anais Bretones University of Bergen/GEO
Title	Arctic deep-water formation and deep circulation enhancement under sea-ice retreat: a comparison between CMIP6 models
Key words	Arctic, winter sea ice retreat, open water convection, overturning
Abstract	While a rapid sea-ice retreat in the Arctic has become ubiquitous, the potential weakening of the Atlantic Meridional Overturning circulation (AMOC), in response to rising greenhouse gases, is still under debate. Although climate models predict a weakening of the AMOC, observations are so far inconclusive. It has been suggested that the strength and vertical extent of the AMOC responds to sea-ice retreat, as deep mixing occurs in open-ocean areas close to the sea-ice edge. Here, we investigate this hypothesis by looking at the Arctic tidional Overturning Circulation (ArMOC) and mixed-layer depth in several CMIP6 models forced with the SSP5- 8.5 scenario. For every models we find a decoupling of the ArMOC with the AMOC: while the AMOC weakens during the 21st century, the ArMOC is enhanced.