UP 5: Cryosphere and Arctic Oceans

Time: Wednesday 11:00–12:30 Location: ELP 6: HS 4

Invited Talk UP 5.1 Wed 11:00 ELP 6: HS 4

Melting from below: An abrupt transition in Antarctic sea ice-ocean system — •Alexander Haumann[1,2] and et al.[3] — [1]Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven, Germany — [2]Ludwig Maximilian University of Munich, Munich, Germany — [3]other institutions

After increasing for more than three decades, Antarctic sea ice extent rapidly declined in 2015/16 and exhibits multiple record minima since. This rapid decline has been unexpected and raises the question if global warming has now reached the high-latitude Southern Ocean. In my talk, I will provide evidence that Antarctic sea ice experienced an abrupt transition from a high to low extent state due to a complex interaction with the ocean. I will show that a combination of deep water warming, a signal that is expected from global climate change, and surface ocean destabilization abruptly shifted the ice-ocean system to a new state, with wide implications for the ecosystems and the Antarctic Ice Sheet, and possibly the global climate.

UP 5.2 Wed 11:30 ELP 6: HS 4

Analyzing ^{39}Ar depth profiles in the Arctic Ocean with the new ArTTA measuring technique — •Carl Kindermann[1], Yannis Arck[1], David Wachs[1], Julian Robertz[2], Markus Oberthaler[2], and Werner Aeschbach[1] — [1]Institute of Environmental Physics, Heidelberg University, Heidelberg, Germany — [2]Kirchhoff-Institute for Physics, Heidelberg University, Heidelberg, Germany

Timescales of ventilation of the Arctic Ocean are still only poorly known. The commonly used tracers for ocean ventilation studies like CFCs and SF_6 are limited to young water masses that occur either close to the surface or in highly ventilated deep waters. The radioisotope ^{39}Ar with its half-life of 268 years covers time scales of 50 to 1000 years, perfectly suited for the investigation of ventilation timescales of deep and intermediate water masses. The new measurement technique called Argon Trap Trace Analysis (ArTTA) is based on quantum-optical methods to catch and count single ^{39}Ar atoms. In contrast to the previously used low-level counting method, which required about 1000 liters of water, ArTTA only requires sample sizes of a few liters of ocean water. The benefit of ArTTA for ocean studies is evident by enabling a better resolution of the water column at great depths. This contribution presents results of ^{39}Ar depth profiles analyzed in the project Ventilation and Anthropogenic Carbon in the Arctic Ocean (VACAO), which is part of the Synoptic Arctic Survey carried out in summer 2021 (SAS21). Samples, taken in the Nansen, Amundsen and Makarov Basins, were measured with ArTTA.

UP 5.3 Wed 11:45 ELP 6: HS 4

Snowdepth on Antarctic Sea Ice Retrieved from Microwave Satellite Data — •Christian Melsheimer and Gunnar Spreen — Institute of Environmental Physics, University of Bremen, Bremen, Germany

Snow on sea ice has a large effect on heat and energy fluxes because it is a strong thermal insulator and is very bright; a thick snow layer even influences the freeboard of the underlying ice. Therefore, comprehensive and up-to-date satellite-based data about the variable snow layer on sea ice are very much sought after. Until now, more research has gone into snow on Arctic sea ice, and also the amount of direct snow measurement data from the Arctic is much larger than the amount of data from the Antarctic.

We have applied an existing snow depth retrieval for *Arctic* sea ice without modifications to *Antarctic* sea ice. This retrieval method uses the brightness temperatures at 10 and 17 GHz from the satellite radiometer AMSR2 (Advanced Microwave Scanning Radiometer, on the Japanese Satellite GCOM-W). We have compared snow depth data on Antarctic sea ice thus retrieved with airborne snow depth measurements from two flight campaigns (Operation Ice Bridge, OIB). This showed that the satellite retrieval produces meaningful results but strongly underestimates the snow depth. Therefore, we now train the retrieval method with Antarctic snow depth measurements, preferably from one of the already mentioned OIB flights and compare the results with independent snow depth measurements.

UP 5.4 Wed 12:00 ELP 6: HS 4

Bromine explosions and catalytic ozone depletion in the Arctic spring-time boundary layer — •Stefanie Falk[1,2], Luca Reissig[1], Andreas Richter[3], Hans-Werner Jacobi[4], and Björn-Martin Sinnhuber[1] — [1]Karlsruher Institut für Technologie — [2]Ludwig-Maximilians-Universität München — [3]Institut für Umweltphysik, Universität Bremen — [4]Institute of Environmental Geosciences (IGE), Université Grenoble Alpes / CNRS / Grenoble INP / INRAE / IRD

Ozone depletion in the polar boundary layer is observed frequently during springtime and is related to an enhancement of reactive bromine. Consequently, increased amounts of volume mixing ratio and vertical column densities of BrO have been observed by in situ observation, ground-based and airborne remote sensing, and satellites. Such activated reactive bromine serves as a source of tropospheric BrO at high latitudes, which otherwise is underestimated in global models. We have implemented a treatment of reactive bromine deposition, release, and recycling on sea ice and snow-covered terrestrial surfaces in the global chemistry-climate model ECHAM/MESSy Atmospheric Chemistry (EMAC).

Within the BromoPole project, we will compare EMAC model predictions with bromide concentrations determined in snow samples taken at Spitsbergen (Ny-Ålesund) and BrO observations from satellite (e.g. TROPOMI) and improve the modeled AirSnow mechanism in EMAC. Possible applications in ICON will be explored.

UP 5.5 Wed 12:15 ELP 6: HS 4

Applications of ^{39}Ar-ATTA in Alpine ice samples - surface ages and constraints on diffusion — •Joshua Marks[1], David Wachs[1,2], Pascal Bohleber[3,4], Andrea Fischer[3], Yannis Arck[1], Martin Stocker[3], Susanne Preunkert[1,5], Markus Oberthaler[2], and Werner Aeschbach[1] — [1]Institute of Environmental Physics, Heidelberg, Germany — [2]Kirchhoff-Institute for Physics, Heidelberg, Germany — [3]Institute for Interdisciplinary Mountain Research, Innsbruck, Austria — [4]Ca' Foscari University of Venice, Venice, Italy — [5]Institut des Géosciences de l'Environnement (IGE), Grenoble, France

In the study of alpine ice cores, dating with radiometric methods is an important tool. Common tracers used for dating like ^{3}H, ^{210}Pb and ^{14}C do not cover the important age range of several 100 years. ^{39}Ar with its half-life of 269 years is well suited for dating between 50 and 1000 years. However, due to its low abundance of 10-15 a very selective measurement method is needed. This is implemented by the quantum technology of Argon Trap Trace Analysis (ArTTA) which enables ice dating with samples of only few kg of ice.

This work focuses on the further development of the sampling methods and sample preparation for the ArTTA dating tool. Several alpine glaciers have been investigated with surface age profiles. Furthermore, the possible contamination of samples by diffusion of argon into the ice has been addressed and a first estimation of effective magnitude of diffusion was conducted