UP 3: Kryosphäre

Zeit: Dienstag 11:00–15:45 Raum: GW2 B3009

Hauptvortrag UP 3.1 Di 11:00 GW2 B3009

Future sea level: Antarctica's ways of losing ice — •Anders Levermann — Potsdam Institute for Climate Impact Research, Germany — Physics Institute, Potsdam University, Germany — Columbia University, USA

The state of discussion on future sea level rise is discussed for different magnitudes of future warming. As one important contributor to future sea level rise, the Antarctic ice loss is singled out. A scaling analysis of the ice dynamic equations is provided and the different outlet glaciers that bear the potential of an ice instability are discussed in light of this scaling analysis. This way the fastest and slowest potential instabilities of Antarctica are identified.

UP 3.2 Di 11:30 GW2 B3009

Sea ice in the Arctic and Antarctic: recent developments and understanding — •Gunnar Spreen[1], Malte Gerken[1], Christian Haas[2], Stefan Hendricks[2], Christian Melsheimer[1], Marcel Nicolaus[2], Renate Treffeisen[1], Justus Notholt[1], and Georg Heygster[1] — [1]University of Bremen — [2]Alfred Wegener Institute

Air temperatures in the Arctic are increasing twice as fast as the global mean. As a consequence, the sea ice extent in the Arctic is declining (4%/decade). In summer the decline is strongest. In conjunction also ice thickness, volume, and age decrease while ice drift speed and melt season length increase. 2016 was an extreme year: due to mild temperatures, the winter sea ice maximum in March was the lowest on record. The modal ice thickness was about 35% below average. Due to cooler Arctic summer temperatures, the 2016 sea ice minimum was only second lowest. In autumn above average air temperatures prevailed, causing a late Arctic sea ice freeze up. The average sea ice extent in November 2016 was the lowest November value observed. The average 2016 sea ice extent therefore likely will be the lowest on record. In the Antarctic, sea ice extent is increasing by 1.5%/decade due to more divergent ice dynamics in recent years. In early Antarctic summer 2016, however, the ice extent is much below climatology. While not connected, the low ice extent in Arctic and Antarctic result in a record low worldwide sea ice area. We will present the latest data and discuss causes of the unusual 2016 sea ice situation. Observations from multiple satellite sensors allow a comprehensive analysis by not only taking ice area but also ice thickness and drift into account.

UP 3.3 Di 11:45 GW2 B3009

changes in Arctic sea ice dynamics observed by satellites — •Alexandra Kazlova and Gunnar Spreen — IUP, University of Bremen, Otto-Hahn-Allee 1, D-28359 Bremen, Germany

From buoy and satellite observations it is known that Arctic sea ice speed and deformation has increased during recent decades by 10*15% per decade. Buoys, however, do not cover the complete Arctic Basin and the number and location of observations changes with time. Satellite observations were not yet fully analysed for long-term ice deformation changes, which is the topic of this study. How much the different elements in the sea ice force balance have contributed to the observed changes in sea ice dynamics is not fully understood. Here, different satellite remote sensing datasets of sea ice drift and deformation are analyzed for changes in space and time (e.g., trend patterns). Synthetic Aperture Radar (SAR) satellite observations deliver high resolution, all weather and season observations of the Arctic sea ice cover since the 1990s. Recently, with the launches of Sentinel-1a & b this dataset got much more extensive. Available SAR datasets of sea ice drift and deformation are analyzed for changes in space and time (e.g., trend patterns). Findings will contribute to better quantify the changes in Arctic sea ice dynamics and help evaluate sea-ice models.

UP 3.4 Di 12:00 GW2 B3009

Snow on Antarctic Sea Ice: Distribution and Trends — Torben Frost[1], Stefan Kern[2], and •Georg Heygster[1] — [1]University of Bremen, Institute of Environmental Physics — [2]University of Hamburg, Integrated Climate Data Center

Snow on sea ice is an important cryospheric parameter. It is needed to determine the energy flux between ocean, sea ice and atmosphere, the sea ice thickness from altimeter observations, the solar radiation at and underneath sea ice, and the high snow load on Antarctic sea ice frequently leads to flooding and formation of superimposed ice when the water on top of the ice freezes. Moreover, snow depth is needed operationally because the ship friction of snow is similarly high as that of sea ice.

Currently the only operationally used algorithm for snow depth retrieval from satellite observations is the one introduced by Markus and Cavalieri [1998]. It was originally developed for the passive microwave sensor SSM/I and uses for more recent AMSR-E/2 data a linear regression between the brightness temperatures of the two sensors. Within the framework of the Antarctic Option of the ESA Sea Ice Climate Change Initiative project, the algorithm has been re-derived for AMSR-E data from ship based snow depth estimates according to the ASPeCT (1981-2011) protocols. Based on the new snow depth algorithm we will present monthly snow depth means as well as snow depth trends and trend uncertainty maps for the AMSR-E and AMSR2 observation period 2002-2016. Monthly regions of positive, negative and uncertain trends will be identified.

UP 3.5 Di 12:15 GW2 B3009

Multiyear sea ice concentration estimates using ASCAT and AMSR2 data — •Yufang Ye[1], Gunnar Spreen[1], Georg Heygster[1], and Mohammed Shokr[2] — [1]University of Bremen, Bremen, Germany — [2]Environment and Climate Change Canada, Toronto, Canada

Arctic sea ice area is decreasing rapidly during recent decades. Especially strong is the decrease of old multiyear ice (MYI), which survived at least one summer. MYI concentration can be retrieved from passive or active microwave satellite observations. One of the algorithms that combine both types of observations is the Environmental Canada Ice Concentration Extractor (ECICE). In this study, data from the Advanced Scatterometer (ASCAT) and the Advanced Microwave Remote Sensing Radiometer 2 (AMSR2) are employed to retrieve MYI concentration. Combined active and passive microwave data can help to identify MYI, however, the retrieval shows flaw under specific weather conditions. Here, two corrections are applied to the MYI concentration retrievals. One correction utilizes air temperature to restore the underestimated MYI concentrations under warm conditions, the other mainly uses sea ice drift to correct the overestimated MYI concentrations. The results are compared with the Canadian Ice Service (CIS) charts and the sea ice age dataset available from the National Snow and Ice Data Center (NSIDC). The MYI concentration from ASCAT/AMSR2 agrees well with that in the CIS charts. Compared to the ice classified as two years or older in the sea ice age dataset, the MYI concentration from ASCAT/AMSR2 is approximately 50% or greater.

Mittagspause (90 min)

UP 3.6 Di 14:00 GW2 B3009

Sea ice concentrations at 1 km resolution from combined optical and passive microwave data — •Valentin Ludwig, Larysa Istomina, and Gunnar Spreen — University of Bremen

Although it covers only about 1.5% of the Earth's surface, Arctic sea ice is a key element of the climate system. The percentage of sea ice within a grid cell (sea ice concentration) is of special importance for various disciplines. For more than 40 years, passive microwave measurements from space have been used for monitoring sea ice in general and sea ice concentration in particular. Their capability to provide year-round daily measurements almost independently of the state of the atmosphere and their good spatial coverage make them a powerful tool for sea ice concentration retrieval. However, they suffer from a coarse spatial resolution of 5 km at maximum. Optical measurements provide higher spatial resolution and complementary errors: while depending on daylight in the visible spectrum and cloud-free conditions in the whole optical spectrum, they come with spatial resolutions of 250 m to 4 km for daily Arctic-wide coverage. We present sea ice concentrations from optical data at a resolution of 1 km and their evaluation against a higher-resolution dataset. The so-derived uncertainty estimates are used to merge optical and passive microwave sea ice concentrations. A multi-year time series is analysed to assess the algorithm's performance throughout the year.

UP 3.7 Di 14:15 GW2 B3009

Atmospheric Correction of Sea Ice Concentration Retrieval of

89 GHz AMSR-E Observations — •Junshen Lu, Georg Heygster, and Justus Notholt — University of Bremen, Institute of Environmental Physics, Otto-Hahn-Allee 1, 28359 Bremen, Deutschland

An improved sea ice concentration (SIC) retrieval algorithm named ASI2 using weather corrected polarisation difference (PD) in brightness temperatures (TBs) at 89 GHz measured by AMSR-E is developed. Effects of wind, total water vapour, cloud liquid water and surface temperature on the measured TBs are evaluated through a fast radiative transfer model, and corrected by simulating changes in TBs caused by the atmospheric influences using reanalysis data fields as atmospheric profiles. ASI2 is tested on (i) a validation dataset called Round Robin Data Package (RRDP) consisting of TBs measured by AMSR-E over pure surface types of open water and 100% SIC, and (ii) AMSR-E Level 2A re-sampled swath data from 2008. The correction on the RRDP dataset significantly reduces both standard deviation and bias in SIC over open water throughout the year, yet causes higher bias in summer over consolidated ice possibly due to melt ponds. A qualitative comparison with MODIS images shows that ASI2 using AMSR-E swath data resolves a more realistic ice gradient across the ice edge than the original ASI algorithm. In March 2008, the ASI2 SIC is about 10% to 35% higher than ASI along the ice edges.

UP 3.8 Di 14:30 GW2 B3009

Daily lead map of the European Arctic from Sentinel-1 SAR scenes — •Dmitrii Murashkin[1], Gunnar Spreen[1], and Marcus Huntemann[2,1] — [1]Institute of Environmental Physics, University of Bremen, Germany — [2]Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany

Leads are linear-like areas with open water within sea ice cover. They are of interest for environmental science, weather forecasting and ship navigation in polar regions. Here, an algorithm that provides an automatic binary classification of leads is proposed. Synthetic Aperture Radar (SAR) satellites provide all-weather and season observations and the necessary high resolution to identify leads. Previously often a single co-polarized band was used for ice-water classification which can result in misclassification of leads under windy conditions. The presented algorithm benefits from the use of Sentinel-1 SAR dual channel products which include measurements in co- and cross-polarized modes. Exploiting information from both, the algorithm is capable to identify leads which can not be identified using single co-polarized measurements. The algorithm is based on Haralick texture features and a supervised classification algorithm. Its stability and high parallelization makes Random Forest Classifier a perfect tool for SAR image feature recognition. It allows per-pixel processing of images with speckle noise. Leads are identified in single SAR scenes, which are then compiled to maps covering a larger region from a set of individual products. Maps of lead distributions for the European Arctic with a resolution of 200 meters are presented.

UP 3.9 Di 14:45 GW2 B3009

Microwave emission from growing sea ice at L-band: a modeling study — •Marcus Huntemann[1,2] and Georg Heygster[2] — [1]Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany — [2]University of Bremen, Bremen, Germany

Satellite based microwave observations of sea ice are taken continuously since the late 70s while even lower frequencies like L-band became available just recently with SMOS (2010), Aquarius (2012) and SMAP (2015). At L-band the penetration depth into sea ice is deeper compared to the higher frequencies and many studies found a relation with the actual ice thickness up to about 50 cm. We simulated many cases of the sea ice evolution using a thermodynamic ice growth and snow accumulation model driven by atmospheric reanalysis data. The resulting profiles of sea ice and snow parameters are used as input for a microwave emission model to model the emitted radiation. This large database of sea ice conditions and corresponding simulations of emitted radiation serves to analyze the sensitivity of the emitted radiation to variation in the geophysical parameters. We find correlations with physical parameters like ice thickness, temperature and salinity, as well as snow densification and thickness. Using specialized models, we additionally quantify the influence of coherence effects originating from thin snow cover and the roughness of the sea ice top and bottom interfaces. Most of these parameters are simplified or unconsidered in current emissivity models and retrievals of ice thickness from L-band satellite observations.

UP 3.10 Di 15:00 GW2 B3009

Cloud screening over sea ice and snow for MERIS/OLCI data — •Larysa Istomina, Henrik Marks, and Georg Heygster — Institute of Environmental Physics, University of Bremen, Bremen, Germany

An accurate cloud screening over snow/ice is important for many remote sensing applications such as satellite retrievals concerning atmospheric parameters or snow and sea ice properties. As optical properties of sea ice/snow and clouds are alike, an accurate cloud screening in the Arctic is a challenging task. Some satellite sensors are better equipped for this task, e.g. with a set of thermal infrared bands. However, they may be not suited for certain retrieval methods due to various other limitations. That is why it is important to develop quality cloud masks also for sensors which are not specifically designed for the task.

In this work, we present a cloud mask developed specifically for retrievals over bright snow and sea ice surfaces from MERIS/OLCI data. The presented dataset consists of pixelwise cloud probability for each available MERIS/OLCI swath. The newly developed cloud screening procedure utilizes data from MERIS/OLCI oxygen A band as well as synergy with SLTSR/AATSR in order to benefit from their infrared bands. The method is able to correctly classify over 90% of the sea ice observations from MERIS during the period May to September if compared to a high-quality cloud mask derived from AATSR.

Kaffeepause (30 min)