RV Polarstern frozen in the Central Arctic during MOSAiC (Photo: Esther Horvath, Alfred-Wegener-Institute).

Polar lights meet the laser beam of lidar (Photo: Stefan Hendriks, Alfred-Wegener-Institute).

Transregional Collaborative Research Center on Arctic Amplification

(AC)^3 Newsletter

July 2020
9th Issue

TOPICS IN THIS ISSUE

EDITORIAL

Dear readers,

Here we go!
The second phase of our project has begun and we are looking so much forward to the exciting work ahead of us. After the very successful evaluation last September we have the approval and funding by DFG to continue our work. And the first thing we do is to look for new PhD students and postdocs bringing fresh ideas and new aspects to (AC)^3. We enthusiastically greet all the newcomers to our project! Feel cheerfully welcomed.

Corona influenced and changed our lives, and we hope that all of you could master the challenges caused by the virus in both your personal and professional living. Such major challenges remind us of the importance of personal health as the most crucial precondition, also for our work in (AC)^3. Our project suffered from the Corona outbreak too, although we think we can handle and restrict the impact of the virus on our work. In particular, our airborne measurement program had to be modified. We were forced to cancel the MOSAiC accompanying airborne observations with the Polar 5 and Polar 6 aircraft from AWI, planned to take place in March/April 2020; we were simply not allowed to enter Spitzbergen. The second MOSAiC accompanying aircraft measurements scheduled for August/September 2020 are still insecure; currently we are awaiting the GO/NOGO decision from the Norwegian authorities. Also, the HALO-(AC)^3 campaign originally planned for 2021 had to be postponed by one year; it has been decided that it will take place in March/April 2022. On the positive side, AWI generously agreed not to simply cancel the March/April 2020 campaign with Polar 5 and Polar 6, but to provide the funding to realize these flight activities in 2022, in parallel with HALO-(AC)^3. Actually, this might turn into a scientific advantage, because HALO-(AC)^3 would strongly benefit from additional in-situ and remote sensing measurements from the polar aircraft. Furthermore, in case the summer 2020 MOSAiC accompanying airborne campaign will not be possible because of Corona, AWI has indicated that then we would be enabled to catch up these measurements in the Arctic summer of 2022. In this way we try to mitigate the Corona issues as best as we can.

So, let's keep the optimistic and enthusiastic spirit typical for our project and enjoy the forthcoming years of exciting Arctic research!

And most importantly, stay healthy!

With kind regards from Leipzig,
Manfred, Marlen, and Simone.

PROJECT REPORT

AND SUDDENLY, EVERYTHING IS DIFFERENT…

by Marlen Brückner

Usually we report in the newsletter on recent conferences, meetings, and workshops. But in this first half of 2020 everything became different…One after another cancellation or postponement of meetings were announced. Everyone had to rearrange and organize his private life and the "home office" became our new workplaces which we often had to share with our kids, which had to be kept busy.

Still, we are so excited and motivated in the beginning of our second funding period. We started advertising and hiring new $(AC)^3$ people, started to plan our $(AC)^3$ Kick-off meeting in Cologne in May and prepared upcoming campaigns. Especially for our young PhDs and Postdocs the kick-off meeting would be a welcome to our $(AC)^3$ family to start collaborating and networking. Now, we are trapped in virtual meetings. New PhDs had to start directly from home office. Everyone could never have guessed that.

The old work-life balance is now even more severely out of whack. Balance? It's like walking a tightrope to satisfy competing needs. Virtual work has no knockoff time: email, WhatsApp and the dreaded, supposedly upbeat, Zoom meetings suppose we are available all the time.

People like to see and talk in person to each other. In real life. If anything, this situation reminds us that there is something about human contact, even eye contact, that no tech can yet produce. Spontaneity and laughter is missing from stilted digital events. Whenever you ask folks about where they got their career breaks or great ideas, it is nearly always from personal encounters; a snatched conversation on the way to lunch or being asked to step in when someone else was too busy. But how are young people, who already can't afford city rents, to work in their cramped doorm rooms? When do they get the opportunity to fly, to improvise, to step up to the plate in informal ways? Face-to-face interaction matters. Serendipity is the mother of creation.

But as a team we figured out how to make the best out of that. We tested almost every existing online meeting platform and improved our meeting documentation. The ability to combine ideas and collaborate on finding solutions is something that makes human beings unique.

Nevertheless, we are looking very much forward to meet altogether face-to-face some day and report on this here in the next newsletter.

News from the field

WITH ARIELLE TOWARDS THE NORTH POLE

by Hannes Griesche, PhD student in A01 at TROPOS

The OCAENET-Atmosphere container from the Leibniz Institute for Tropospheric Research (TROPOS) is a constant attendant of the MOSAiC campaign. Though being equipped with state-of-the-art remote-sensing instruments that largely run autonomously, the presence of one member of the lidar group from TROPOS is necessary for instrument maintenance during the entire year. Ronny Engelmann, responsible scientist of the OCEANET project, was part of the first leg.

His main task on Polarstern from September to December 2019 was to set up all the instruments of OCEANET, keep the measurements running, and perform early data analysis as he has done several times before on this ship. Since the container is located on the bow of the ship, where sea-spray and saltwater from the open ocean could be an issue, most instruments could only be unpacked after Polarstern reached the ice edge. "It was a bit surprising how well the instruments behaved in these harsh conditions of the central Arctic", he said.

Fig. 1: Team ATMOS during MOSAiC leg 1 (Photo: Hannes Griesche)

News from the field

WITH ARIELLE TOWARDS THE NORTH POLE

(continued)

The lidar system from OCEANET, a multi-wavelength polarization Raman lidar PollyXT, also affectionately called Arielle, revealed almost continuously aerosol layers in different heights up to the stratosphere during the entire time. At least, when the laser beam was not blocked by blowing snow or the exhaust (which in turn serves as a nice photo scene, see Fig. 2) or the laser was not switched off due to helicopter flights. Two microwave radiometers measured the thermal radiation of the atmosphere at three different frequency bands: a HATPRO at 22-31 GHz to retrieve humidity profiles and at 51-58 GHz for temperature profiling and a LHUMPRO at 176-200, 243 GHz and 340 GHz specified for low humidity conditions. In addition, there is a Parsivel disdrometer, a 2-D video disdrometer, an all-sky camera, a weather station, and pyranometer and a pyrgeometer mounted on the container roof (…well the pyranometer and the pyrgeometer are actually on the crane at the bow of Polarstern, to be less influenced by the ship's superstructure). Furthermore, a Cimel sun and moon photometer performed some first measurements in the Arctic during Polar night on a moving vessel.

Fig. 2: The green beam of Arielle visible in the exhaust from Polarstern. (Photo: Hannes Griesche)

Fig. 3: Team ATMOS from MOSAiC leg 2 & 3. (Photo: Ivo Beck)

MEET THE $(AC)^3$ FELLOWS

Moin moin everyone,

my name is Janosch, I'm doing a PhD at the Alfred-Wegener-Institute in Bremerhaven, and recently I also became part of the $(AC)^3$ project A03. Originally, I'm from Lauenbrück in Northern Germany and I was fortunate to grow up bilingually because one part of my family is from Hungary.

Since I got fascinated by weather phenomena and their mechanisms quite early in my life, I decided to study meteorology, which I finally did at the University of Hamburg. Also my PhD project deals with a meteorological topic, namely with the investigation of atmospheric processes generated over elongated open-water channels (so-called leads) in sea ice. Regions dominated by leads are often characterized by large temperature differences causing a strong heat input into the atmosphere, which is followed by many complex effects on the near-surface airflow. In our working group, we focus on deriving suitable mathematical expressions (parametrizations) for describing the determining processes, which then can be used in computer models.

So far, we've already formulated and published a new parametrization for describing the heat transport over leads for idealized situations. As another main part of my PhD work, I'm doing an analysis of observed situations with the applied computer model. After finishing my PhD, I am going to continue my research in $(AC)^3$ to analyse data from the most recent and upcoming airborne campaigns also with the goal to further improve different parametrizations. Therefore, I am really looking forward to further working for $(AC)^3$ to help improving the understanding of high-latitude processes, which, in some way, are likely to influence also the weather and climate of „our" latitudes.

News from the field

WITH ARIELLE TOWARDS THE NORTH POLE

(continued)

Mid of December I have replaced Ronny. I took over for the darkest MOSAiC leg (polar night) as the only member from (AC)³. This leg was, besides the northernmost Christmas and New Year's Eve celebration, characterized by rather stable ice conditions at the floe around Polarstern. Hence, we were luckily able to almost solely focus on our scientific measurements. Since the OCEANET facility runs largely autonomously, I was, besides taken care of the instruments, able to help with tasks that needed more manual work or simply a bear guard. I have assisted frequently the Team Data with checking all the data cable connection from the different cities to Polarstern. Since the ice, conditions at the remote sites were not as stable as close to Polarstern, a pressure ridge damaged one of the Atmospheric Surface Flux Stations (ASFS) at the three L-sites. Together with Michael Gallagher, my cabin mate and one of the responsible scientists of the ASFS from CIRES, and Eric Brossier, a polar bear guard, I spent a day out in the complete darkness at roughly 10 km away from Polarstern at L-3 to rescue what was left to be rescued. Given the dynamics that must have happened at the site, we were surprised how much we actually were able to recover. Also, other trips on the ice have been organized, but rather to avoid ship's tantrum than for scientific reasons: regularly cross-country ski- and walking-trips over the floe were performed. Moreover, we did two camping trips in the middle of the Arctic winter (again good conditions to take pictures of the lidar beam, see Fig. 4). These trips were usually followed by a relaxing evening in the sauna, to heat up again.

Other than the stable ice conditions in the surrounding of Polarstern, this leg was accompanied by a quite fast ice drift. With the official end of leg 2 (regarding the internal data management system DSHIP) on 24 February 2020 we have been way more south-west than expected, about a month ahead. By the end of February, we were visited by the Russian icebreaker Kpt. Dranitsyn for resupply and to hand over our measurements to the participants of Leg 3. The long return trip towards Tromsø until early April remains another story to be told.

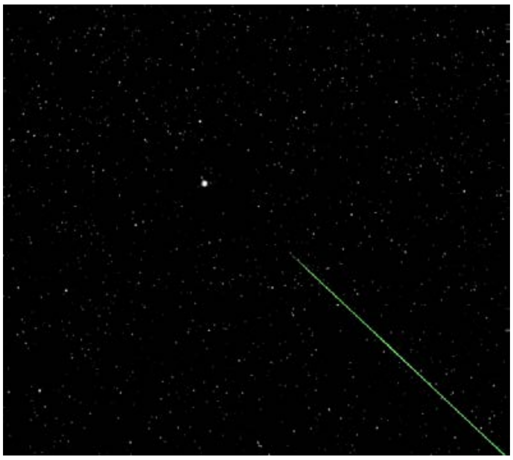
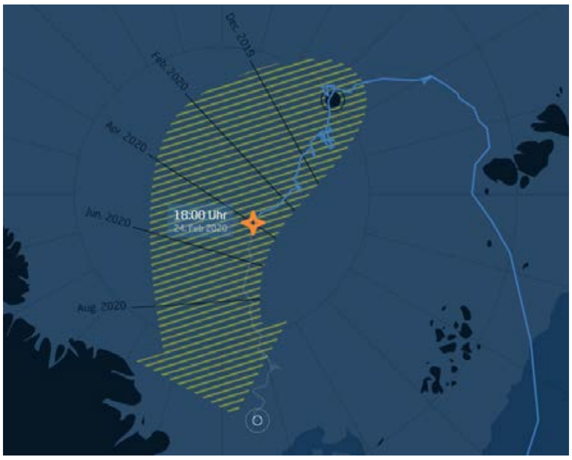


Fig. 4: Left: The location of the actual "Polar Star" straight above Arielle's beam is a nice indicator for our almost 90°N latitude (Photo: Hannes Griesche). Right: Predicted potential drift of Polarstern during MOSAiC (yellow arraow) and actuall drift (blue and grey line) with position on 24 February 2020 (orange marker).



MEET THE (AC)³ FELLOWS

I am Janna Rückert and I started my PhD in April in the group of Gunnar Spreen at Uni Bremen, in the midst of the Corona lockdown.

I received both my BSc & MSc degrees in physics from the TU Dresden. There I performed research at the Institute for Theoretical Physics in condensed matter theory. I am now eager to contribute to understanding our Earth better, combining my expertise in theoretical physics with curiosity and concern about a changing climate.

Within (AC)³ I am in the project B05 investigating the influence of water vapour in the atmosphere on Arctic amplification. I am currently looking at an optimal estimation method to retrieve geophyiscal parameters, including total water vapour, from satellite data. I am also preparing for analyzing data obtained during the MOSAiC campaing.

Besides, I am really looking forward to getting to know my colleagues not only via video conferences in the future :)

Cartoons meet (AC)³
by Simone Lindemann

News from the modelers

AMPLIFIED ARCTIC SURFACE WARMING AND SEA-ICE LOSS DUE TO PHYTOPLANKTON AND COLOURED DISSOLVED MATERIAL

by Vasilis Pefanis, PhD student C03 at AWI-Bremerhaven

The Arctic near-surface air temperature increased at least twice as much as the global average in the last decades. This warming is accompanied by the melting of sea ice, which decreases the surface albedo and increases the penetration of solar radiation in the ocean. The light entering the ocean is attenuated by its scattering and absorption by optical constituents such as water molecules, phytoplankton, as well as suspended and coloured dissolved material. The attenuation affects the vertical distribution of energy, and thus, the near-surface water temperature. Biologically-induced surface warming, by enhancing sea-ice melting, further increases light availability for phytoplankton, which in turn may amplify this effect. The warming in the Arctic also contributes to the thawing of permafrost, where large amounts of organic carbon are stored. Consequently, progressive permafrost thawing together with an increase in precipitation and freshwater discharge is expected to result in higher loads of dissolved organic matter (DOM). A fraction of DOM is colored (CDOM), and by absorbing ultraviolet and visible light efficiently, it accounts for a large part of the total non-water absorption in the Arctic.

In the context of project C03, we operated an ocean biogeochemical model coupled to a general circulation model with sea ice to simulate the variability of the ocean's major optically active constituents. We further set up the general circulation model to account for the biogeochemical processes, in terms of light attenuation. That way, we examined how the light attenuation by phytoplankton and CDOM contributes to surface warming and sea ice reduction in the Arctic Ocean.

(AC)³ NEWS

- HALO-(AC)³ campaign has been postponed to March/April 2022
- Stay informed: if you want to receive this newsletter regularly, you can subscribe online at http://ac3-tr.de
- Our Special Issue in ACP/AMT is still open for submission.Please check out https://www.atmos-chem-phys.net/special_issue971.html

MEET THE (AC)³ FELLOWS

Hi, my name is Sebastian Becker. I was born in Brandenburg and grew up in the Chemnitz region of Saxony. But now I'm almost a real „Leipziger" because I have been living here for six years, already doing my bachelor and master in meteorology at the University of Leipzig.

Since April 2020 I am a PhD student at the Leipzig Institute for Meteorology (LIM), part of project A03 and dealing with radiative budget in the Arctic atmospheric boundary layer and cloud radiative forcing (CRF, the impact of clouds on the energy budget of the surface). To retrieve this, we use airborne radiation measurements. I will participate in the MOSAiC-ACA-Summer campaign in August 2020 (hopefully it will not be cancelled due to corona :/) and the HALO-(AC)³ airborne campaign in 2022.

With these new data, I will study the spatial and seasonal variability of the CRF and the radiative energy. After a lot of reading I have just begun to calculate the CRF for old campaigns in order to learn how it's done.

AMPLIFIED ARCTIC SURFACE WARMING AND SEA-ICE LOSS DUE TO PHYTOPLANKTON AND COLOURED DISSOLVED MATERIAL (continued)

Including the simulated chlorophyll and CDOM in the light attenuation scheme leads to higher SST during summer, with maximum increases above 1°C in the Greenland Sea (Fig. 5a), when compared to a scenario with a fixed light attenuation depth of 23 m (control run). By reducing the available heat at depth, the sub-surface layer cools in almost the entire Arctic (Fig. 5b). At the same time, sea-ice is reduced mainly in the Eastern Arctic (Fig. 5c). Summertime surface warming induces more heat loss to the atmosphere (Fig. 5d) primarily through latent and sensible heat flux. By accounting for the combined effect of chlorophyll and CDOM, the sea ice season is shorter by up to one month (Fig. 6). Over the last 10 years of the simulations (2007-2016), the mean SST of the warmest climatological month (July) in the Arctic Ocean increases by 0.3°C.

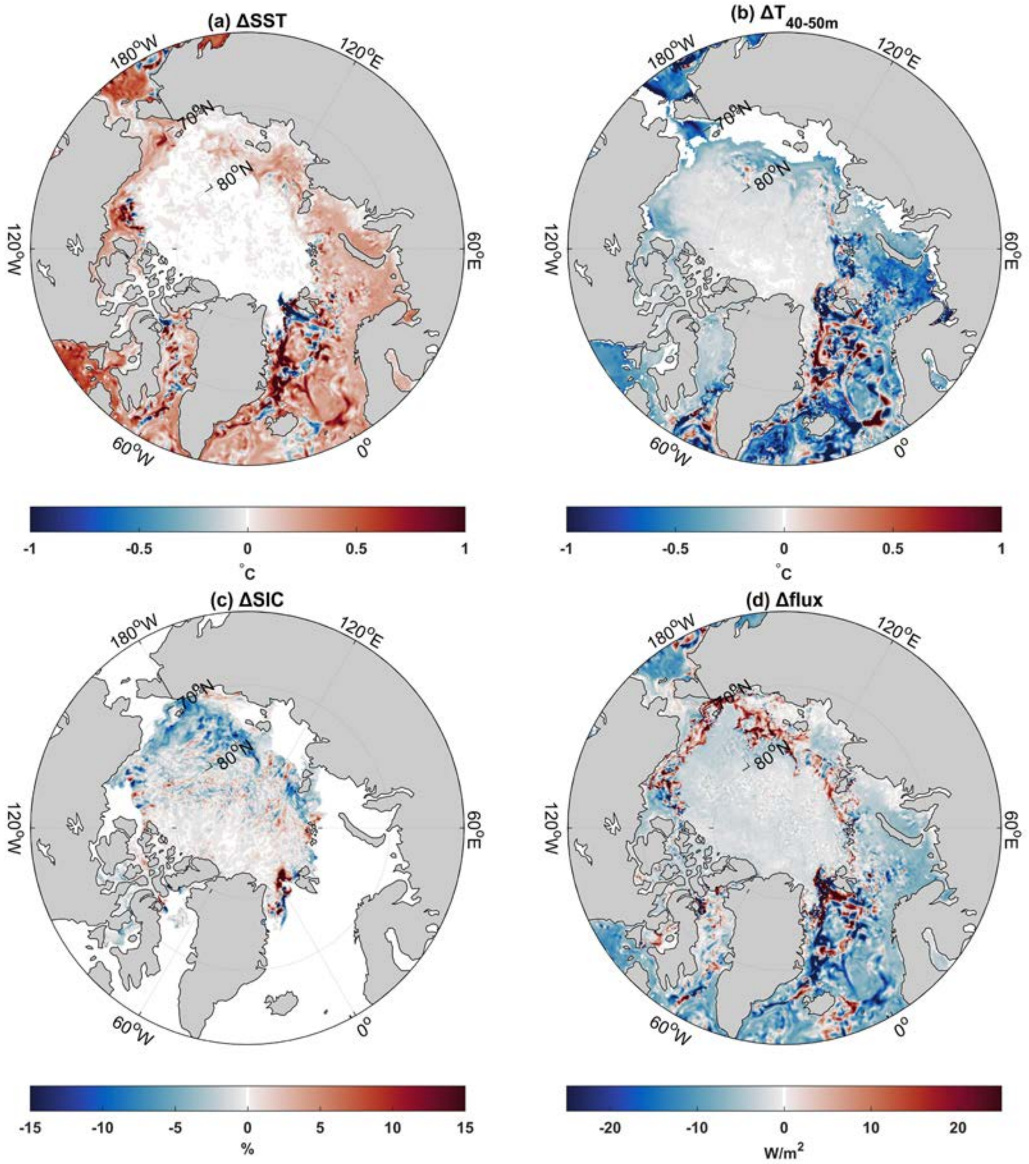
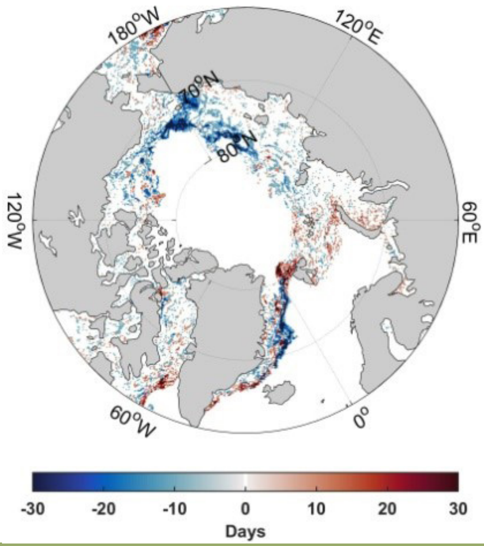


Fig. 5: Mean differences of: a) sea surface temperature (SST), b) 40-50 m temperature, c) sea ice concentration (SIC) and d) surface heat flux (positive changes indicate heat gain for the ocean), for August 2012, between the run with chlorophyll and CDOM and the control run.

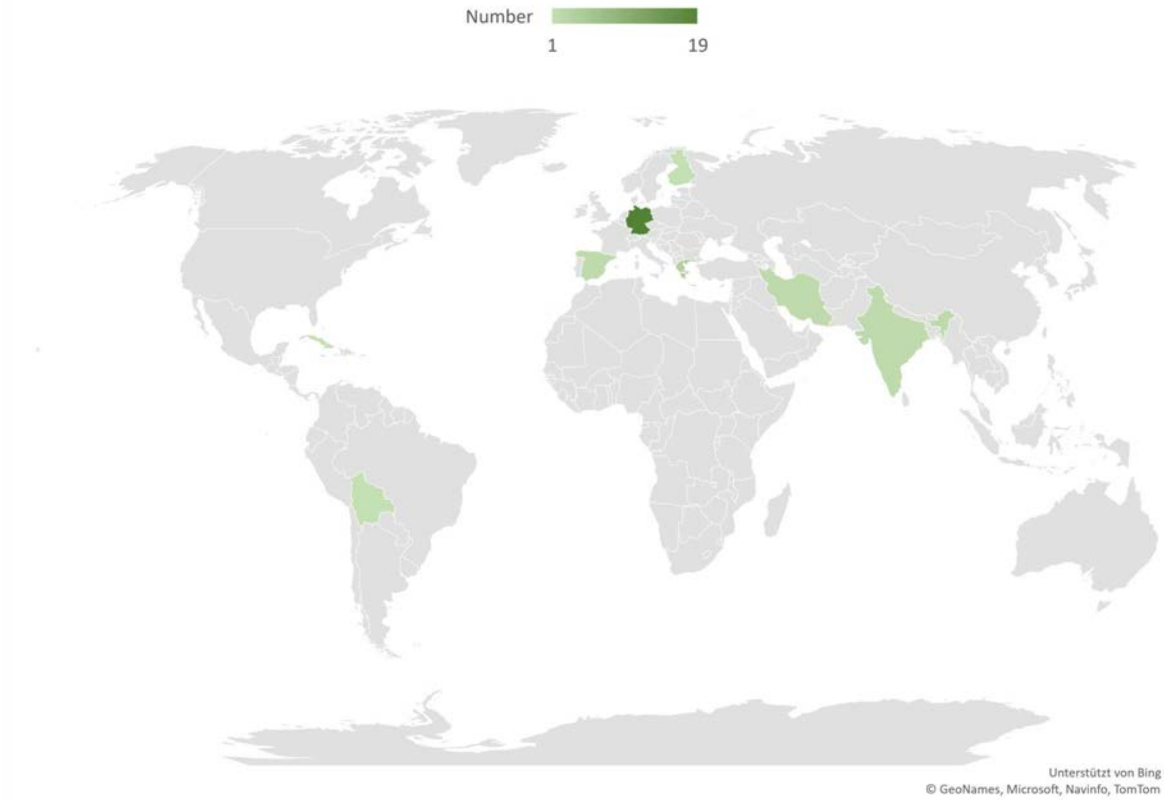


Almost half of the observed changes in summertime surface temperature are attributed to the effect of CDOM, suggesting that an increase of this material will amplify the observed Arctic surface warming through its direct thermal effect. A northward increase in the meridional component of advection (not shown here) further increases the upper ocean temperature in the Nordic Seas. This finding underlines the potential of indirect changes in advective processes in intensifying the direct thermal effect of CDOM. Our results suggest that the variability of phytoplankton and CDOM and their optical properties need to be treated appropriately in Earth system modelling studies involving sea-ice and temperature projections.

Fig. 6: Mean differences of the days in 2012 with more than 15% SIC, between the run with chlorophyll and CDOM and the control run.

(AC)³ PhD students

WHERE DO YOU COME FROM?



We asked our PhD students where they are coming from and we're impressed to see that they are distributed allover the globe. (AC)³'s universities and research institutions welcome international researchers and offer excellent opportunities for your doctoral studies. We are thrilled that you are considering joining our (AC)³ team to do your doctorate!

MEET THE (AC)³ FELLOWS

Hello to all, I am Theresa Kiszler, known as Tracy, and I joined (AC)³ in Mai at the University of Colonge as PhD student in the E03 project. I am now working on simulations of mixed phase clouds over Ny-Ålesund with the atmospheric model ICON.

I did my bachelor in Meteorology at the Free University Berlin. Because I like programming and high performance computing, I decided to get into that topic so I continued with my master in Computational Sciences.

Communicating reasearch results and the basic concepts of how weather works to young people is another subject that I enjoy. Being able to see the atmospheric system at work and to understand why things happen and putting everything into equations motivates and fascinates me.

(AC)³ NEWS

- Announcement: (AC)³ IRTG online lessons

6 July 2020: Arctic Climate System – Manfred Wendisch

3 August 2020: Clouds and Radiation – Kerstin Ebell

7 September 2020: Feedback Mechanisms – Johannes Quaas

18 October 2020 (?): Arctic Sea Ice – Gunnar Spreen

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DFG Deutsche Forschungsgemeinschaft

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(AC)^3 Publications

DIVERGENT CONSENSUSES ON ARCTIC AMPLIFICATION INFLUENCE ON MIDLATITUDE SEVERE WINTER WEATHER

Abstract

The Arctic has warmed more than twice as fast as the global average since the late twentieth century, a phenomenon known as Arctic amplification (AA). Recently, there have been considerable advances in understanding the physical contributions to AA, and progress has been made in understanding the mechanisms that link it to midlatitude weather variability. Observational studies overwhelmingly support that AA is contributing to winter continental cooling. Although some model experiments support the observational evidence, most modelling results show little connection between AA and severe midlatitude weather or suggest the export of excess heating from the Arctic to lower latitudes. Divergent conclusions between model and observational studies, and even intramodel studies, continue to obfuscate a clear understanding of how AA is influencing midlatitude weather.

J. Cohen, X. Zhang, J. Francis, T. Jung, R. Kwok, J. Overland, T. Ballinger, U.S. Bhatt, H. W. Chen, D. Coumou, S. Feldstein, **D. Handorf**, G. Henderson, M. Ionita, M. Kretschmer, F. Laliberte, S. Lee, H. W. Linderholm, W. Maslowski, Y. Peings, K. Pfeiffer, I. Rigor, T. Semmler, J. Stroeve, P.C. Taylor, S. Vavrus, T. Vihma, S. Wang, **M. Wendisch**, Y. Wu, J. Yoon, 2020: Divergent consensuses on Arctic amplification influence on midlatitude severe winter weather. *Nature Climate Change,* 10, 20–29, doi:10.1038/s41558-019-0662-y. https://www.nature.com/articles/s41558-019-0662-y

FLUXES TRANSPORT CLOUDS SURFACE ARCTIC AMPLIFICATION (AC)^3

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