HALO is taking off from Kiruna airport for measurements in the Arctic (Photo: Daniel Beckmann, DLR)

Polar 5 seen from below during take off from Longyearbyen airport (Photo: Hanno Müller, Uni Leipzig).

Transregional Collaborative Research Center on Arctic Amplification

(AC)³ Newsletter

July 2022
13th Issue

TOPICS IN THIS ISSUE

- Editorial
- Meeting report
- News from the field - Special: HALO-(AC)³ campaign
- News from the PhDs
- Publications

EDITORIAL

Dear readers of the (AC)³ newsletter,

the last half of this year has been very busy for us (as usual, no surprise). First, we had to take care of the final preparations for the HALO-(AC)³ campaign, which involved many (AC)³ students, PostDocs, PIs, and collaborators. This also included the operators of the participating aircraft (Polar 5 and Polar 6 from AWI and HALO from DLR) and the corresponding instruments, but also many (AC)³ modelers, teams for the analysis of satellite data, and last but not least numerous people who organized the campaign in terms of logistics and public relations. In the end, all these preparations paid off, and even Corona could not stop us. Moreover, the weather conditions during the campaign were extremely favorable. Thus, we were able to complete the HALO-(AC)³ campaign very successfully. This will give us years of work for exciting data analyses, in particular many PhD students who participated in HALO-(AC)³ will have a wealth of data available for their PhD thesis, this is so important! The HALO-(AC)³ campaign is one of the most important events within our Phase II of the (AC)³ project, which is currently underway. So it was super important that we were successful with the measurements. A big thank you goes out to the entire HALO-(AC)³ team!

The second major event in the first half of this year was the Spring General Assembly of (AC)³ in May. We were able to meet in person and everyone enjoyed the high level presentations, stimulating face-to-face discussions and personal contacts. All in all, this was a fruitful meeting where we have already started planning our strategy for Phase III of (AC)³.

Enjoy reading this latest issue of the (AC)³ newsletter!

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

MEETING REPORT

(AC)³ GENERAL ASSEMBLY IN BAD HONNEF

by Marlen Brückner

In May we had our Spring (AC)³ General Assembly in the beautiful Bad Honnef close to the Rhine. We were all very grateful and happy that this meeting could be held in person despite the pandemic. These joint project meetings are so important and effective for us. Besides highlight talks of project members from our five project clusters, the four crosscutting activities had again a big focus and a lot of room for discussion and developing ideas for joint papers. Also, first insights and overviews of the recent HALO-(AC)³ campaign were presented. A topical highlight was the keynote talk by Judah Cohan on midlatitude linkages. Another highlight was the evening talk by Sigrun Korsching from the University of Cologne on the topic of Unconscious Bias and what it has to do with oneself. Its content is strongly influenced by cultural traditions. However, we ourselves are not responsible for what our unconscious whispers to us, but we are responsible to minimize resulting unfairness and harm.

Fig. 1: Group photo of all participants in Bad Honnef (Photo: Marlen Brückner).

News from the field

WHAT DO RESEARCHES DO IN LONGYEARBYEN?

by Imke Schirmacher & Nina Maherndl (PhD students in B03 at Uni Cologne & B08 at Uni Leipzig)

From the 14th of March to the 14th of April, researchers from AWI, University Leipzig, University Cologne, TROPOS, MPI Mainz, DLR, LaMP and University Mainz spent four weeks in Longyearbyen. As an integral part of the HALO-(AC)³ aircraft campaign, a comprehensive data set using instruments on board the AWI research aircraft Polar 5 and Polar 6.

Fig. 2: HALO-(AC)³ group photo of the Longyearbyen crew (Photo: Esther Horvath, AWI).

WHAT DO RESEARCHES DO IN LONGYEARBYEN?

(continued)

Synoptically, we encountered all conditions we hoped for, including an atmospheric river, cold air outbreaks and polar lows. When we arrived in Longyearbyen, temperatures were atypically high and the sea ice declined north of Svalbard. That was the result of a warm air intrusion and an atmospheric river, which also brought precipitation in form of a snowstorm to Longyearbyen. While scientifically interesting, the storm prevented us from flying.

The atmospheric river was followed by an about 2.5 week period of north- and northeasterly winds bringing cold air masses. Temperatures dropped and due to the lee effect, caused by the mountains in the northern part of the Island, we had clear sky and excellent flight conditions west of Svalbard during almost the rest of the campaign.

With some delay, both polar aircraft arrived on the 19th of March 2022, allowing the first flights to take place on 20th of March. In total 13 flights could be conducted with each airplane, two of which were short media flights on Polar 5. Media interest for the campaign was strong, with film teams from ARD, ZDF, and Pellefilm accompanying us. The total flight duration were 73 h on Polar 5 and 84 h on Polar 6. We covered a total distance of 14089 km and 22838 km on board Polar 5 and 6 respectively and dropped 142 dropsondes from Polar 5.

Polar 5 had passive and active remote sensing instrumentation (albedometer, spectrometer, 180° fish-eye camera, lidar, radar, microwave radiometer, broadband radiometer, sun photometer) on board. In addition, the nose boom at the top of the aircraft measured turbulence. While also equipped with a broadband radiometer and nose boom, Polar 6 carried predominately further in situ instruments, such as cloud, aerosol and trace gas probes.

In Longyearbyen and during HALO-$(\mathcal{AC})^3$ in general, a focus was on collocated flights of the aircraft. Out of the 13 flights, we achieved close spatial and temporal collocation during 7 flights, giving us about 5 hours of data, where in situ and radar measurements of clouds can be compared. In addition, collocated flights of the Polar aircraft with HALO enable us to study interesting synoptic conditions, such as atmospheric rivers, cold air outbreaks and polar lows, on different scales.

Another interesting flight strategy was the so called "Fram Strait crossings", where one or both aircraft flew back and forth along the same track over the Fram Strait. They give us unique opportunities to study air mass and cloud developments in great detail.

Not all went rosy, however. We had some delays at the start of the campaign, certain instruments were causing trouble, Covid cases among the crew lead to suspended flights and both Polar 5 and 6 needed more maintaining than usual. But with a lot of hard and often overtime work from the engineers, pilots and scientists, we managed to get everything running in an impressively short times. That is the Arctic team spirit!

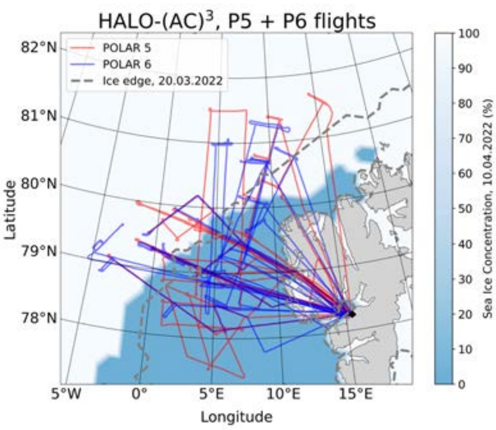


Fig. 4: Flight tracks of all measurement flights with Polar 5 (red) and Polar 6 (blue) during the HALO-$(\mathcal{AC})^3$ campaign in Longyearbyen. A total distance of 36.927 km flown by both aircraft were covered and 142 dropsondes were dropped from Polar 5 in the Arctic.

Fig. 3: Left: Polar 6 is leaving Longyearbyen airport for measurement flight over Fram Strait, while Polar 5 is waiting for their take off (Photo: Max Maahn, Uni Leipzig). Right: Arctic sea ice seen from the window of Polar 5 (Photo: Imke Schirmacher, Uni Cologne).

MEET THE (AC)^3 FELLOWS

Hello everyone,

I am Anisbel Leon Marcos, a Ph.D. candidate at TROPOS and part of the (AC)^3 project. I studied meteorology at the University of Havana. Since my bachelor's and master's studies, I have loved studying aerosols and cloud microphysics. I was looking for a Ph.D. position in the same field, and I started in November 2020, working on modeling marine organic aerosols and their influence on Arctic mixed-phase clouds. It is a fascinating topic fulfilling all my expectations.

Since then, I have been part of the (AC)^3 community, an excellent opportunity to exchange with experts in climate modeling, Arctic clouds and feedback processes, and ocean biogeochemistry, which profoundly motivates me to keep investigating and discussing my work.

I look forward to finalizing the modeling studies, which will come together soon with a thorough evaluation of aerosol and aerosol-cloud processes using recent observation campaigns.

News from the field

CHASING LARGE-SCALE EVENTS WITH HALO FROM KIRUNA

by Melanie Lauer & Fiona Paulus (PhD students in E04 & associated HALO project at Uni Cologne)

The Arctic near-surface air temperature increase, with over 3°C in the last 50 years, is much more pronounced than the changes in other regions of the Earth and impacts the regional climate system, e.g., sea ice loss. This phenomenon is called „Arctic amplification". The focus of the HALO-(AC)^3 campaign was a better understanding of the air mass transformation within Warm Air Intrusions (WAIs) and Cold Air Outbreaks (CAOs). Those cannot be characterized by local ground-based measurements only. Therefore, HALO-(AC)^3 made use of the long endurance of aircraft and characterize the air masses transformations by quasi-Lagrangian observations. In this type of measurement, the air mass is followed by aircraft to observe changes of clouds, humidity and temperature. The observations by HALO-(AC)^3 will test whether numerical atmospheric models are able to reproduce measurements that can help to investigate the influence of Arctic Amplification on mid-latitude weather. During a WAI, warm and moist air is transported into the Arctic. Whereas during a CAO cold and dry air is transported out of the Arctic. These events may not only amplify Arctic warming via feedback effects (positive feedback), but also influence our mid-latitude weather through meridional heat and moisture transports.

Since these are large-scale phenomena and the measurement stations are rare due to the given conditions, there is still a lack of understanding how the air masses transform. A possible way to study this transformation is to use a research aircraft. Therefore, the research aircraft HALO from the German Airspace Centre (DLR) was operated in Kiruna. HALO is able to fly at higher altitudes (up to 15 km) and reach longer distances (up to 10 000 km). Thus, it is able to monitor these systems.

HALO arrived on the 11th of March from Oberpfaffenhofen in Kiruna and spent the following 5 days in the air. From the 12th to 14th of March, a WAI intrusion originated in the North Atlantic moved across the Greenland Sea and Fram Strait (see also the report on the campaign weather). During this event, the near-surface air temperature was about 11°C warmer than expected (see figure 5). Also the precipitation was 0.08 m higher compared to the climatological mean. However, it is not only the amount of precipitation that needs to be highlighted. The type of precipitation is also important. Therefore, the amount of rainfall in the central Arctic was 0.08 m higher than in the previous years. For these days, rainfall was also observed over sea ice. Consequently, these high temperatures and precipitation in the form of rain have led to a decrease in sea ice in the Fram Strait and central Arctic.

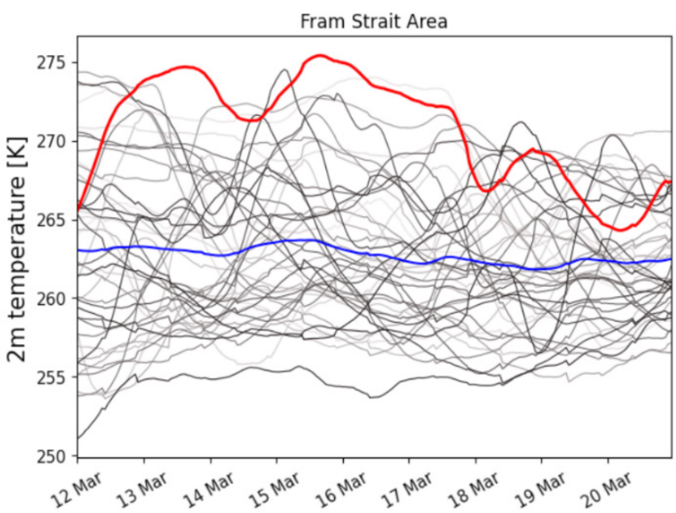


Fig. 5: The near-surface air temperature in the Fram Strait area during the the period from 12 to 20 March 2022 observed during the HALO-(AC)^3 campaign (red line). Grey lines illustrates temperatures over the last 30 years, while the blue line indicates the mean air temperature.

News from the field

CHASING LARGE-SCALE EVENTS WITH HALO FROM KIRUNA

(continued)

Subsequently, an Atmospheric River (AR) penetrated into the Arctic on the 15th of March, which is also visible in the Fig. 5. ARs are long narrow bands which transport a huge amount of water vapor. They are responsible for 80-90% of the poleward moisture transport. Also for this AR event, the near-surface air temperature was 11°C and the amount of precipitation was 0.09 m higher compared to the climatological mean in the Fram Strait. In addition to the WAI, the AR has increased the decline in sea ice.

A few days later, a CAO formed and we were able to sample the formation process on multiple subsequent days. A variety of different flight patterns with different observational goals were flown in order to capture different processes during air mass transformations. These measurements can now be used to further analyse these developments by combining them with atmospheric models.

Atmospheric models aim to provide a full description of the state of the atmosphere in a specified region and time and can thus be used to understand the transformation processes. Due to computational constraints, these atmospheric models have to be provided with assumptions and simplifications which have to be derived from observational data. The observational coverage in remote regions like the Arctic are quite coarse making it more difficult to obtain these assumptions and simplifications. The different flight patterns, atmospheric situations and instruments on board HALO and the polar aircraft, combined with modelling analysis will allow for a better understanding of the observed processes and the Arctic amplification in general.

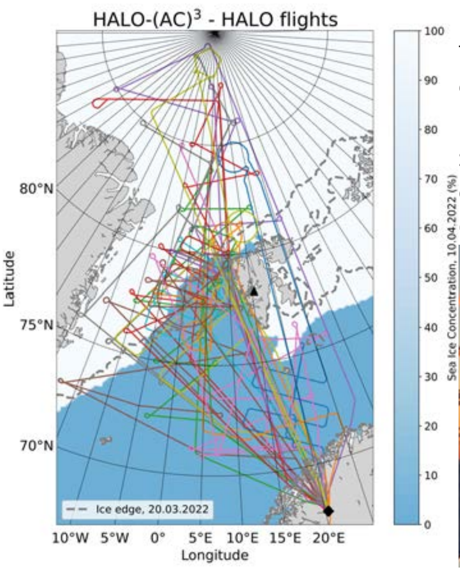


Fig. 6: Left: Flight tracks of all measurement flights with HALO during the HALO-(AC)³ campaign in Kiruna. A total distance of 113.112 km were covered and 347 dropsondes were dropped. Right: Orographic clouds during sun set observed from HALO (Photo: Maximilian Ringel).

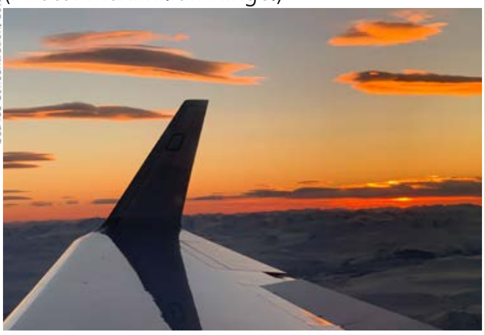


Fig. 7: The Uni Cologne team during the HALO-(AC)³ campaign (Photo: Adam Polczyk).

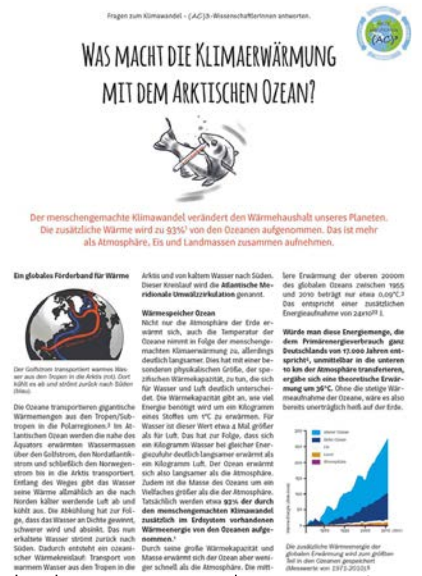
(AC)³ NEWS

(AC)³ hackathon 8 - 10 Feb 2022:

- Online workshop in Gathertown with 25 participants.
- Goal: prepare data products for HALO-(AC)³ campaign.
- Development of quicklook products to link and present different data.
- Very helpfull, especially for new PhD's and Postdocs.
- Hackathon helps participants to work much faster and more effectively with the data during and after the HALO-(AC)³ campaign and they already know the respective contact persons of the instruments.

Stay informed: If you want to receive this newsletter regularly, you can subscribe online at http://ac3-tr.de

- Evaluation of proposal for third funding period if (AC)³ in Cologne: **27 - 28 June 2023**


Fragen zum Klimawandel - (AC)³-Wissenschaftlerinnen antworten.

WAS MACHT DIE KLIMAERWÄRMUNG MIT DEM ARKTISCHEN OZEAN?

Der menschengemachte Klimawandel verändert den Wärmehaushalt unseres Planeten. Die zusätzliche Wärme wird zu 93%[1] von den Ozeanen aufgenommen. Das ist mehr als Atmosphäre, Eis und Landmassen zusammen aufnehmen.

Ein globales Förderband für Wärme

Wärmespeicher Ozean

Check out our Fact Sheet #2 on interesting aspects on Arctic Amplification on http://www.ac3-tr.de/outreach/fact-sheets/.

(AC)³ scientists explain key facts in an easy and comprehensive language to intersted adults illustrated by drawings from Kerstin Heymach.

MEET THE (AC)^3 FELLOWS

Moin, I'm Moritz Zeising and I'm currently working on the modelling of organic carbon in the Arctic. I try to understand how phytoplankton contributes to biogenic aerosol precursors on temporal and spatial scales. The AWI-developed coupled ocean-circulation and biogeochemical models FESOM2 and REcoM2 should be helpful tools to finally construct an ocean forcing, which can be used in atmospheric modeling in (AC)^3-D02. Before this computational extensive journey, I studied Geoecology in Bayreuth with a focus on geochemistry, and Marine Environmental Science in Oldenburg. Large phytoplankton mesocosm experiments during my Master thesis link quite well to the PhytoOptics group at AWI, where I'm now analyzing phytoplankton in bits and bytes only.

Aside of my computer screen, I enjoy the river Weser in Bremen, especially for rowing and sunsets on the dyke. Phytoplankton can be found there as well, but it doesn't bother you to jump into the water yourself.

News from the field

HALO-(AC)^3 CAMPAIGN WEATHER

by Andreas Walbröl, Sebastian Becker & Janosch Michaelis (PhD students in B05 at Uni Cologne, in A03 at Uni Leipzig & Postdoc in A03 at AWI Bremerhaven)

Weather conditions have a strong influence on measurement campaigns and decisevely affect their success. During HALO-(AC)^3, we were inconceivably lucky that we could not only sample Warm Air Intrusions (WAIs) and Cold Air Outbreaks (CAOs) as the main objectives of the campaign but also phenomena related to secondary goals such as a polar low or cirrus clouds over sea ice.

The first week of the campaign (7 – 13 March 2022), was dominated by low pressure systems over Greenland and Iceland and high pressure over Scandinavia. Initially southerly and southwesterly winds transported cool subpolar maritime air towards Fram Strait. With the arrival of HALO (11 March), intense southerly winds started to transport warm and moist airmasses to the North bringing exceptionally high reaching clouds and high amounts of humidity into the central Arctic. At the beginning of the second week, this situation developed into a narrow band of extreme moisture transport (Atmospheric River, Fig. 8, left) reaching from the British Isles to the central Arctic. This led to strong snow- and even rainfall over both Fram Strait and Svalbard. In the second half of the week, a few cyclones passed over Svalbard with partly very strong winds and additional precipitation.

On 20 and 21 March, a Shapiro-Keyser shaped cyclone crossed Svalbard causing another heavy snow storm in Longyearbyen (Fig. 8, centre). However, the cyclone then remained East of Svalbard and it also got access to cold air from the central Arctic on its western flank. Supported by increasing high pressure over Greenland, this resulted in a northerly flow and thus a CAO over Fram Strait. Once the cold and dry air started streaming over the relatively warm ocean in Fram Strait, cloud streets with partly strong convective precipitation were formed (Fig. 9, left). The CAO conditions prevailed until almost the end of the third week, especially in the eastern Fram Strait.

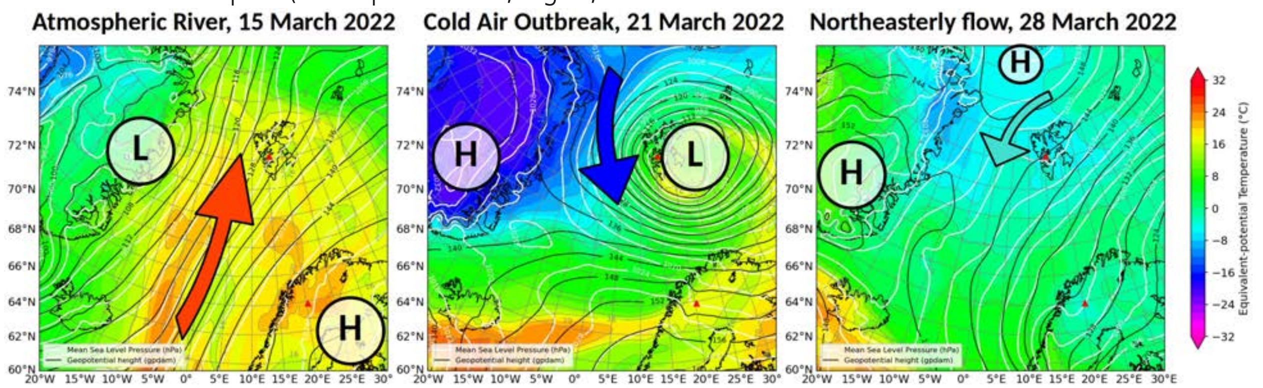


Fig. 8: Large-scale weather patterns and airmasses during HALO-(AC)^3 on 15 March (left), 21 March (centre), and 28 March 2022 (right) in terms of the equivalent potential temperature (coloured) and geopotential (black contours) at the 850hPa pressure level and of the mean sea level pressure (white contours). Data: ERA5 reanalysis (retrieved from https://cds.climate.copernicus.eu/cdsapp#!/dataset).

From 27 to 31 March, a new high pressure system formed over the Arctic Ocean. Although this caused only a slight shift in the flow over Fram Strait from north to northeast, warmer airmasses reached this area (Fig. 8, right). They originated from different subpolar regions and were cooled on their way South while being transported over the sea ice covered Arctic Ocean. The advection of the aged warm air still promoted the formation of cloud streets over Fram Strait but not as strong as in the week before. In addition, with an easterly flow over Svalbard, we occasionally observed cloud-free areas directly west of the island due to lee effects. Another reoccurring pattern in this period were converging winds over central Fram Strait and thus increased cloud formation (Fig. 9, centre). These conditions prevailed almost until 7 April, with only short interruptions of stronger CAO conditions and weaker lee effects on 1 and 2 April.

From 7 to 9 April, our focus was on a small (polar) low that had formed over the central Fram Strait (Fig. 9, right). Unusually, it moved towards the Northwest over the sea ice edge, where it then quickly vanished. On the final days of the campaign (10 – 12 April), high-level cirrus clouds were transported towards the central Arctic as a result of warm air advection due to a strong low over Northern Scandinavia. This allowed us to finally also study the influence of cirrus clouds over sea ice.

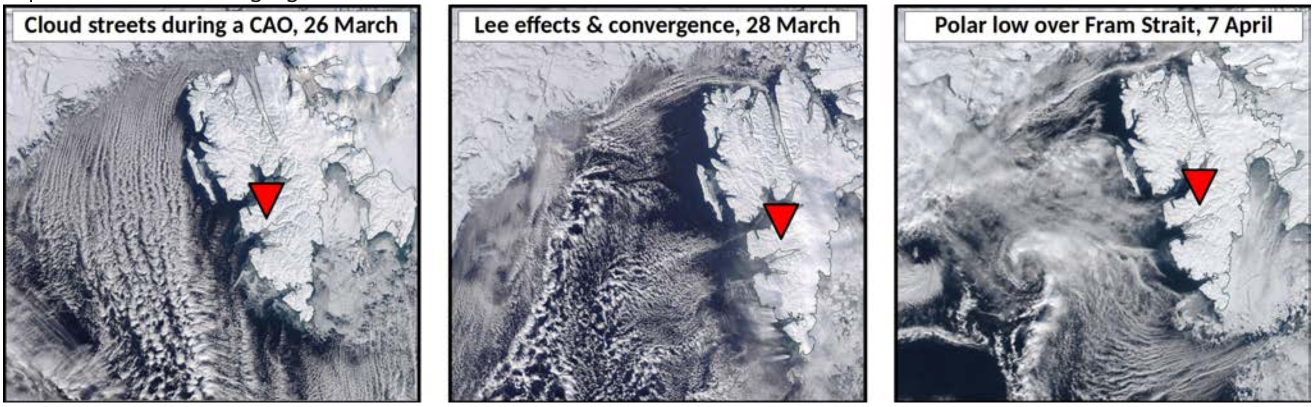


Fig. 9: Satellite images (source: NASA Worldview, https://worldview.earthdata.nasa.gov/) of cloud streets over Fram Strait on 26 March during the CAO period (21 – 26 March, left), of the cloud pattern on 28 March during the period with mainly northeasterly winds, reoccurring lee effects west of Svalbard, and converging winds over central Fram Strait (27 March – 6 April, centre), and of the polar low over Fram Strait on 7 April (right).

PhD News

PHD RETREAT IN BAD HONNEF

by Zerlina Hofmann, PhD representative & student in C04 at AWI Bremerhaven

Before the (AC)³ General Assembly in May 2022 all the PhD students met up a day early to connect and enjoy some time together. One of the topics that has been on our minds a lot during the ongoing pandemic is mental health and resilience, so we decided to invite Julia and Johanna from Wild Consulting. They gave us some theoretical background on resilience and stress management interlaced with some fun exercises outside, as the weather was fantastic. We got to find out, who our most senior PhD student in the current phase is (Enrico) and who feels the most stressed (mostly, but certainly not exclusively the women). We went on a walk and talk (because talking is easier in motion and without the need of constant eye contact) and learned how to take a literal step away from stressful situations.

On the morning before the GA started, we voted on our new local and overall PhD representatives and thanked the previous team and overall PhD representative Janna for doing a great job! The rest of the morning we spent in an open space format, where we discussed different topics of interest (workshop ideas, outreach, PhD contracts, experiences from the first phase from Rosa, and more) and were free to move between the different groups. We will meet again in November in Bremen for the next GA and have already started planning, what we want to do next!

ACKNOWLEDGEMENTS

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DFG Deutsche Forschungsgemeinschaft

CONTACT US

SPEAKER:
Prof. Dr. Manfred Wendisch
University of Leipzig
Leipzig Institute for Meteorology (LIM)
Stephanstr. 3
04103 Leipzig
Germany

E-MAIL:
m.wendisch@uni-leipzig.de

ac3-tr.de

(AC)³ NEWSLETTER EDITORS:
Manfred Wendisch (LIM)
Marlen Brückner (LIM)
Simone Lindemann (LIM)

admin@ac3-tr.de

(AC)³ Publications

OVERVIEW OF THE MOSAIC EXPEDITION - ATMOSPHERE

Abstract

With the Arctic rapidly changing, the needs to observe, understand, and model the changes are essential. To support these needs, an annual cycle of observations of atmospheric properties, processes, and interactions were made while drifting with the sea ice across the central Arctic during the Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC) expedition from October 2019 to September 2020. An international team designed and implemented the comprehensive program to document and characterize all aspects of the Arctic atmospheric system in unprecedented detail, using a variety of approaches, and across multiple scales. These measurements were coordinated with other observational teams to explore cross-cutting and coupled interactions with the Arctic Ocean, sea ice, and ecosystem through a variety of physical and biogeochemical processes. This overview outlines the breadth and complexity of the atmospheric research program, which was organized into 4 subgroups: atmospheric state, clouds and precipitation, gases and aerosols, and energy budgets. Atmospheric variability over the annual cycle revealed important influences from a persistent large-scale winter circulation pattern, leading to some storms with pressure and winds that were outside the interquartile range of past conditions suggested by long-term reanalysis. Similarly, the MOSAiC location was warmer and wetter in summer than the reanalysis climatology, in part due to its close proximity to the sea ice edge. The comprehensiveness of the observational program for characterizing and analyzing atmospheric phenomena is demonstrated via a winter case study examining air mass transitions and a summer case study examining vertical atmospheric evolution. Overall, the MOSAiC atmospheric program successfully met its objectives and was the most comprehensive atmospheric measurement program to date conducted over the Arctic sea ice. The obtained data will support a broad range of coupled-system scientific research and provide an important foundation for advancing multiscale modeling capabilities in the Arctic.

Shupe, M.D. et al. (including 20 (AC)³ co-authors), 2022: Overview of the MOSAiC expedition – Atmosphere. Elementa: Science of the Anthropocene, 10 (1): 00060, https://doi.org/10.1525/elementa.2021.00060.

Matt Shupe is one of the leading PIs of MOSAiC, he is a Mercator Fellow of (AC)³.

(AC)³ PROJECT PARTNERS

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