Wing-by-wing flight with Polar 5 over Svalbard (Photo: Thomas Krumpen, Alfred-Wegener-Institute).

Balloon town at the MOSAiC ice floe during Leg 4 (Photo: Michael Lonardi, Uni Leipzig).

Transregional Collaborative Research Center on Arctic Amplification

(AC)³ Newsletter

December 2020
10th Issue

EDITORIAL

Dear Reader,

... what a year 2020!
The first year of the second phase of our project is almost over, and it is amazing what we have achieved in spite of all the difficulties caused by the Corona virus. The MOSAiC campaign with numerous (AC)³ participants has successfully returned in October; now we have tons of incredible data to analyze. We managed to perform the second of the two planned aircraft campaigns accompanying MOSAiC in August and September. And, eventually we were able to conduct our project kick-off meeting, originally planned for May, in the form of a hybrid meeting. Most of the students could attend in person, mingle with each other, and communicate with some of the (AC)³ PIs. From what we have heard, the kick-off meeting has boosted the motivation of our students. What was also very well received by our students was the newly established, monthly online lecture series with introductory talks by senior (AC)³ scientists on major topics related to Arctic amplification. This turned out to be a success story and we are planning to continue with the lecture series during the coming year.

With this we would like to wish all of us a Merry Christmas and a Happy New Year, and some restful days in between the years.
Stay optimistic and healthy!

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

TOPICS IN THIS ISSUE

MEETING REPORT

(AC)³ KICK-OFF MEETING OF PHASE II

by Marlen Brückner

As the restrictions and limitations of personal meetings due to the ongoing Corona pandemic still force us to meet virtually, we had to change our plans for the (AC)³ kick-off meeting of phase II. So we had to rearrange our plans and decided to perform the kick-off as a hybrid meeting to take place in the beginning of October.

Although, we had to shorten and limit the number of scientific talks, as long lasting meetings in front of your computer in home office are exhausting, we came up with a good mixture of science and organization relevant in the second phase of our project. With a short ice breaker warm-up in the beginning we got to know new faces of PhD students, postdocs and PIs. In these crazy times it is often challenging to became familiar with your new colleagues. More than 100 participants from different countries and continents listened to new (AC)³ aspects and plans. Here, especially the "new component" of the Arctic ocean was introduced. All members of (AC)³ got inside in our well established structures and measures. New in phase II is our (AC)³ Integrated Research Training Group (IRTG) for PhD students and early career scientists, which will strengthen their development of scientific independence, and prepare them for future positions in academia, industry, in various fields, and in administration.

We also managed to nominate and elect online different bodies of (AC)³. We are deeply grateful for this enormous reliance by all members to keep our project on track.

Although, we were sad not to really see each other, we were able to convey the spirit of (AC)³ and reconcile the interests and fascination on the Arctic of all.

We would like to thank all involved for this successful kick-off meeting and looking very much forward to work with you.

Fig. 1: Resulting word cloud from one of the warm-up questions (platform: mentimeter.com).

News from the field

THE ONLY FLYING RESEARCH AIRCRAFT WHILE OTHERS WERE GROUNDED

by Andreas Herber, PI in B04 at AWI Bremerhaven

The MOSAiC airborne campaign ACA (**A**tmospheric Airborne observations in the **C**entral **A**rctic) aimed at providing data to put the local measurements conducted during the MOSAiC Polarstern drift across the Arctic Ocean into a regional context. MOSAiC-ACA focussed on atmospheric and sea ice measurements using the Polar 5 and Polar 6 aircraft of AWI.

Originally, two atmospheric airborne campaigns had been planned during the MOSAiC expedition – one in spring, and another one in summer. However, due to the Corona virus pandemic, the spring campaign had to be cancelled. Fortunately, the summer campaign could be realized in the period between 28 August and 16 September 2020. The two AWI aircraft Polar 5 and Polar 6 were based at Longyearbyen (Svalbard). With Polar 5 we focused on atmospheric observations, whereas Polar 6 observed sea ice distributions. Before the start of the campaign, we had to overcome huge difficulties in preparing the campaigns and travelling to Spitzbergen in these challenging times of the pandemic. In spite of these issues, the summer campaign became possible mainly because of the support by both the Government of Norway and the Governor of Svalbard. For our Canadian aircraft crew, the campaign began already ten days earlier than for the other participants because all crew members had to endure a ten-days quarantine in Oslo, before they could fly with the Polar 5 aircraft to Svalbard on 28 August. The scientific crew had to leave Germany two days earlier than planned to avoid new regulations prescribing ten days of quarantine also for Germans in Oslo because of an observed increase of the number of corona-infected people in Germany during end of August.

During the survey flights (in total 7 research flights with 41 flight hours), we intended originally to fly from Spitzbergen far into the inner Arctic, following roughly air mass trajectories passing the RV Polarstern. However, RV Polarstern eventually moved to a position far away from the aircraft's possible flight range. Nevertheless, the airborne measurements still have the potential to contribute to the main goals of MOSAiC, as it turned out that some flights could be linked to the Polarstern position via trajectory analysis. While atmospheric parameters are recorded locally on the ship, we used the research aircraft

THE ONLY FLYING RESEARCH AIRCRAFT WHILE OTHERS WERE GROUNDED

(continued)

to study the transformation of air masses over the marginal sea ice zone and open ocean, with a maximum endurance up to 6 hours per flight depending on the local conditions.

The AWI Polar 5 and Polar 6 research aircraft were the first 'foreign' planes that were allowed to operate on Svalbard since the Corona lockdown in March 2020. Both aircraft operated over the Marginal Sea Ice Zone and the Central Arctic, with each flight taking between four and six hours. Scientists and engineers from four German institutes (AWI, DLR, Universities of Leipzig and Cologne) participate in the campaign with additional contributions by a French partner (University Clermont Ferrand). Polar 5 was instrumented to conduct an extensive atmospheric research program.

We aimed to study the cloud impact on the energy budget of the surface and low atmosphere along trajectories and the related role of aerosol particles. For this purpose, Polar 5 was equipped with various meteorological measuring instruments, as well as a hyperspectral camera, a cloud radar, a photometer and several radiometers as well as a turbulence sensor, and also drop sondes were launched from the aircraft.

From previous investigations it is known that clouds contribute significantly to the rapid warming of the Arctic. For this reason, all factors relevant to cloud formation were investigated in detail. The measurements will be used to detect weaknesses in the currently used Arctic forecast models (weather, climate). Subsequently, the measured data will be compared with calculations to quantify differences between model and measurements and to identify possible key parameters and parameterizations that have so far prevented the models from providing a reliable description of Arctic clouds. The analysis of the data is ongoing.

Fig. 2: Polar 5 team in Longyearbyen (Photo: Esther Horvath, Alfred-Wegener-Insitute).

Fig. 3: On board of Polar 5 during a science flight (Photo: Stephan Schön, Sächsische Zeitung).

MEET THE (AC)³ FELLOWS

Hej hej, I am (Kevin) Cheuk Hang Sze, originally from Hong Kong. I am a new PhD student in cloud group at TROPOS since November, specifically working with the B04 project.

My background is physics. I got my BSc degree at City University of Hong Kong. Then I went over to KTH Royal Institute of Technology, Sweden for my MSc which I just got this summer. During my master's thesis at Lund University, I started working on atmospheric aerosol with a strong focus on ice nucleating particles and cold stage measurement. I get obsessed with the topic, and I want to know more about how it affects cloud formation and climate. This motivates me to start my new chapter in Germany! Under the project, we will continue from the first phase, conduct measurement of INP, along with CCN and BC. This hopefully can give a broader picture of our Arctic system.

Looking forward to exploring the Arctic with you guys :)

MEET THE (AC)³ FELLOWS

My name is Wiebke Körtke and I am part of the subproject C04 of (AC)³.

I did my Bachelor in Environmental Science in Oldenburg. Within the broad range of subjects, I discovered that the Ocean (and its processes) is quite interesting. I joined the oceanography classes and took part in small research cruises on even smaller vessels. For the Master's program, I chose to stay in the multidiscipline study and went to Bremen to study Environmental Physics. I completed this degree with my master thesis about Atlantic Water in the Arctic Ocean. And I am very happy to stay in the arctic polar region within the (AC)³ project.

Since April 2020, I am part of the oceanography group at the University of Bremen. In my PhD project, I will work on vertical (heat) fluxes in the Arctic Ocean. A cold water layer close to the surface is preventing melting of sea ice. Beneath the cold water, warmer water originating from the Atlantic Ocean is found. If vertical exchange processes can bring up heat from the warm layer closer to the surface, it might enhance sea ice melting. Due to the climate change, the Arctic Ocean is going towards an atlantified regime. For my analyses I will use tracer gas data from a cruise to the Fram Strait – a region strongly influenced by Atlantic Water – and compare it to data from the MOSAiC campaign. With these trace gas data, I will be able to calculate upwelling velocities and see which influence atlantification has on mixed layer processes.

I am very happy to work on such an interesting, important, and up-to date topic, which hopefully will help to increase the knowledge on the changing processes in the Arctic Ocean.

News from the modelers

CHANGES IN ATMOSPHERIC CIRCULATION REGIMES OVER THE NORTH-ATLANTIC-EURASIAN REGION AND POSSIBLE LINKS TO ARCTIC AMPLIFICATION

by Dörthe Handorf, PI D01 at AWI-Potsdam

Since the early work of Rossby (1939), many studies showed evidence that extra-tropical atmospheric variability is characterised by a few preferred recurrent and/or persisting large-scale flow patterns which occur at fixed geographical regions. Therefore, the concept of atmospheric circulation regimes has been developed to connect these observations with atmospheric dynamics. In the framework of this concept, low-frequency climate variability can arise due to irregular transitions between the distinct atmospheric regimes and is manifested, primarily, in terms of changes in the frequency of occurrence of the preferred circulation regimes.

The existence of multiple atmospheric circulation regimes has been proven in many studies based on reanalysis as well as climate model data. Almost all of them agreed on the existence of two to six circulation regimes for the Atlantic part as well as for the Pacific part of the Northern Hemisphere.

The frequency of occurrence of preferred atmospheric regimes is influenced by external forcing, e.g., from other components of the climate system (e.g., the forcing by SST or sea-ice anomalies) or anthropogenic forcing. It is suggested, that weak external forcing does not change the structure and number of atmospheric regimes, but instead changes the frequency of occurrence of the regimes. This determines, at least partly, the time mean response of the atmospheric flow to the external forcing. In D01 we are in particular interested in studying whether Arctic amplification and the related strong Arctic sea ice loss can act as an additional external forcing to the atmosphere. Consequently it would influence the frequency of occurrence of the preferred circulation regimes hypothetically leading to a more frequent occurrence of particular patterns.

To accomplish our objective, we have started with analysing the historic changes of NH atmospheric circulation regimes based on ERA5 over the period from 1979-2018. The regimes have been determined based on sea-level pressure fields over the North-Atlantic-Eurasian region (30°- 90°N, 90°W - 90°E) for extended winter (DJFM) and summer (JJAS) seasons by means of k-means clustering.

In order to detect changes in the relative frequency of occurrence of the regimes between the early ER5 period from 1979-1999 and the late period (2000-2018) we calculated histograms for each period.

The five preferred large-scale patterns determined for the extended winter season for ERA5 are shown in Fig. 4. These patterns resemble a positive NAO signal (NAO+); a pattern with a low pressure anomaly over the North Atlantic and Europe (ATL); Scandinavian/Ural blocking (SCA); a west-east dipole structure with blocking over the North Atlantic (DIP); and a negative NAO signal (NAO-).

News from the modelers

CHANGES IN ATMOSPHERIC CIRCULATION REGIMES OVER THE NORTH-ATLANTIC-EURASIAN REGION AND POSSIBLE LINKS TO ARCTIC AMPLIFICATION

(continued)

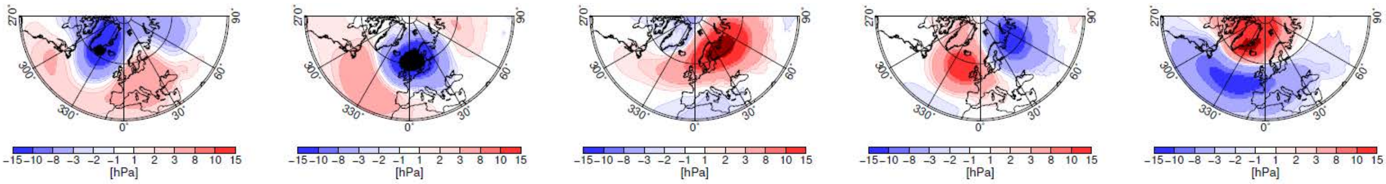

Fig. 4: Anomaly fields of sea level pressure of the 5 circulation regimes over the North Atlantic-Eurasian region in winter from ERA5. From left to right: NAO+, ATL-, SCA, DIP, NAO-.

We find that the SCA pattern occurs significantly more frequent in December and January for the early period. In February and March, the NAO- pattern appears significantly more frequent during the late period.

The five preferred large-scale patterns determined for the extended summer season for ERA5 are shown in Fig. 5. These patterns resemble a positive summer NAO signal (NAO+); the ATL pattern, Scandinavian blocking (SCA), a negative summer NAO signal (NAO-); and a west-east dipole structure (DIP). The most pronounced changes in the frequency of occurrence between the late and the early period are the significant increase in the occurrence of the NAO- pattern in June, July and August which is related to more Greenland blocking, whereas in September the NAO+ pattern occurs more frequently during the late period.

Atmospheric circulation changes between the late and early period in ERA-Interim cannot solely be associated with Arctic sea ice changes because of additional forcing factors. Specific sensitivity experiments with the global atmospheric model ICON are planned in D01 to attribute such changes to the influence of Arctic amplification, and in particular to the influence of Arctic sea ice changes. In these experiments, sea ice will be the only varied parameter between the different model runs. Complemented by previous sensitivity sea-ice simulations with other global atmospheric models, we expect a better assessment of the possible range of circulation changes under Arctic amplification. To gain better insight how these circulation changes dynamically interact with Arctic amplification, the related meridional transport of heat and moisture will be analysed in total, as well as dependent on synoptic and planetary scales.

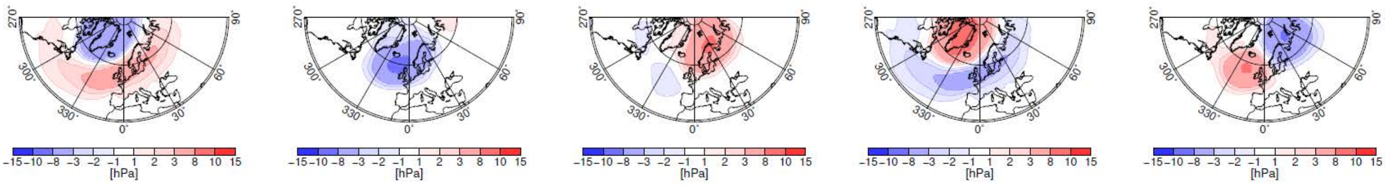

Fig. 5: Anomaly fields of sea level pressure of the 5 circulation regimes over the North Atlantic-Eurasian region in summer from ERA5.

MEET THE (AC)³ FELLOWS

Hi everyone,

I'm Benjamin and I started my PhD just in April this year. My long path to meteorology started with a BSc in Environmental Sciences at Uni Freiburg. I then decided to take a "small" 6-year detour and studied Physics (BSc+MSc) at TU Dresden.

However, my passion for weather and climate prevailed. I am happy to now work in the group of Manfred Wendisch at the University of Leipzig. As part of A03, we investigate radiative properties through in-situ airborne campaigns.

My contribution to (AC)³ is the analysis of air mass trajectories. This is performed both in retrospect as well as in prospect. Latter is used in our flight planning. We are especially interested in forecasting warm air intrusions and cold air outbreaks. Using quasi-Lagrangian flight patterns, we want to observe air mass transformations and cloud evolution during these phenomena in-situ.

Finally, I want to thank you all for the very nice Kick-Off meeting this October in Cologne; I look forward to see you again next year!

(AC)³ NEWS

We are pleased to announce that Sebastian Schmidt (Associate Professor, University of Boulder, USA) will work as the Leibniz Professor in the winter semseter 2021/22. This is the most prestiging honor the University of Leipzig offers. He will join the Leipzig Institute for Meteorology and participates in particular as PI of the Arctic Radiation Cloud-aerosol-Surface Interaction eXperiment (ARCSIX) in collaboration with the HALO-(AC)³ campaign in spring 2022. He will enrich (AC)³ collaborations and give lectures within the (AC)³ IRTG.

Beginning of reconstriction of building of Leipziger Institute for Meteorology: Thanks to (AC)³ and Uni Leipzig, we finally will get our new institute building.

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

MEETING REPORT

PHD MEETING

by Tracy Kiszler, PhD student E03 at Uni Cologne

From the 7th to 9th October we had the IRTG welcome meeting including the (AC)³ kick-off. The IRTG workshops and get-together were especially aimed at the PhD students and new Postdocs. The meeting was held in an hybrid offline and online version so that some took part in person and others joined in virtual sessions. I myself joined first in the online and then in the onsite group and had the possibility to experience both versions.

On the first day there were two separate workshops, online and onsite, aimed at getting to know each other and covering topics like communication. We got to see many new faces from many different locations. One person in the virtual session even joined from Cuba where it was very early in the morning! A team challenge was introduced where we were split into teams made up of online and onsite participants. The challenge was to use our creativity to prepare answers to the questions "How to improve support and supervision during your PhD/Postdoc?" which we presented on the last day of the meeting.

On the second day we all took part in the general (AC)³ kick-off meeting. In the late afternoon we got together in our clusters to present posters we had prepared, explaining what each of us are working on.

The last day started off with an introduction of the graduate schools that are cooperating with the IRTG. After that we took part in a workshop where we talked about motivation and did some fun interactive exercises. During the last parts we saw some funny presentations and sketches by the different teams presenting their answers to the challenge question.

We had three great days together, with vegan muffins, some scientific and not so scientific discussions, while exploring some Cologne parks and time to get to know our fellow (AC)³ PhD students.

Fig. 6: All participants from the on-site group at the Institute of Geophysics and Meteorology (IGM) in Cologne (Photo: Marlen Brückner).

News from the PhD students in the field - Balloon

BELUGA IN THE ARCTIC

by Michael Lonardi, PhD student A02 at Uni Leipzig

I'm at my workplace, running some routines from my laptop. For a second, I wonder through the colourful image on my desktop, then the breeze on my face brings me back to the white and blue of the life on an ice floe. The sun shines, as it normally does at 4 a.m. Wait, does it? Ah yes, it's the Arctic summer here at MOSAiC Leg 4, meaning day all-day long.

Today we got up really early to perform an irradiance measurement of the boundary layer. I yawn at Christian and he yawns back to me: it's clearly the signal that he is ready to release the BELUGA. As the name suggests, it is something that can fly. Our 90 m³ tethered balloon is capable of lifting 20 kg of meteorological probes up to 1500 m, enabling us to do profiles of the standard atmospherical thermodynamic variables, turbulence, aerosol and radiation. An incredible dataset, but to get it one has to "earn" it working on the ice, where we installed the balloon camp, named balloon town, some days ago. Our colleagues, some tens of meters away, are setting up their drone, visibly annoyed by the fog layer that is starting to swallow us.

Then Jay, our bear guard, warns everyone on our radio channel. Polar bear! At balloon town we smile at each other: Jay is very good at making jokes. He calls again! We freeze. With a quick look at 3 o'clock we locate the bear in the distance, then we observe the other team moving back towards our position to group up. In a few seconds we secure our equipment, while waiting for our friends. Then, keeping an eye on the bear and one on the snowy trail that leads back to Polarstern, we calmly move back. In few minutes we are back on board, while our fluffy visitor is still far away, wondering about the noisy metal box that we sit on.

The bear will stay some more hours, but we will have time to measure later on. It's the Arctic summer, it's day all-day long …

Oh wait, did you expect more science? Then wait for our paper. Data goes into publications, emotions stick to you.

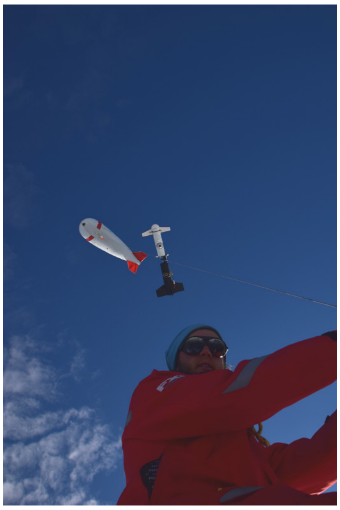

Fig. 7: Left: Radiation probe is ready to fly. Middle: Michael in front of Polarstern – The picture each Arctic scientist has to have. Right: Our two balloon guys in the Arctic – Christian Pilz (from TROPOS) & Michael (Photos: Michael Lonardi).

Cartoons meet (AC)³

by Simone Lindemann

(AC)³ NEWS

- Announcement: (AC)³ IRTG online lessons

7 December 2020:
The Arctic Ocean – Torsten Kanzow

11 January 2021:
Ocean Measurements – Monika Rhein

1 February 2021: Ocean Modelling – Marc Salzmann

1 March 2021: Ocean Color Remote Sensing – Astrid Bracher

ACKNOWLEDGEMENTS

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DFG Deutsche Forschungsgemeinschaft

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(AC)³ Publications

DOES THE INTRA-ARCTIC MODIFICATION OF LONG-RANGE TRANSPORTED AEROSOL AFFECT THE LOCAL RADIATIVE BUDGET? (A CASE STUDY)

Abstract

The impact of aerosol spatio-temporal variability on the Arctic radiative budget is not fully constrained. This case study focuses on the intra-Arctic modification of long-range transported aerosol and its direct aerosol radiative effect (ARE). Different types of air-borne and ground-based remote sensing observations (from Lidar and sun-photometer) revealed a high tropospheric aerosol transport episode over two parts of the European Arctic in April 2018. By incorporating the derived aerosol optical and microphysical properties into a radiative transfer model, we assessed the ARE over the two locations. Our study displayed that even in neighboring Arctic upper tropospheric levels, aged aerosol was transformed due to the interplay of removal processes (nucleation scavenging and dry deposition) and alteration of the aerosol source regions (northeast Asia and north Europe). Along the intra-Arctic transport, the coarse aerosol mode was depleted and the visible wavelength Lidar ratio (LR) increased significantly (from 15 to 64–82 sr). However, the aerosol modifications were not reflected on the ARE. More specifically, the short-wave (SW) atmospheric column ARE amounted to +4.4 - +4.9 W m^{-2} over the ice-covered Fram Strait and +4.5 W m^{-2} over the snow-covered Ny-Ålesund. Over both locations, top-of-atmosphere (TOA) warming was accompanied by surface cooling. These similarities can be attributed to the predominant accumulation mode, which drives the SW radiative budget, as well as to the similar layer altitude, solar geometry, and surface albedo conditions over both locations. However, in the context of retreating sea ice, the ARE may change even along individual transport episodes due to the ice albedo feedback.

Nakoudi, K.; **Ritter, C.**; Böckmann, C.; Kunkel, D.; Eppers, O.; Rozanov, V.; **Mei, L.**; **Pefanis, V.**; **Jäkel, E.**; **Herber, A.**; **Maturilli, M.**; **Neuber, R.**,2020. Does the Intra-Arctic Modification of Long-Range Transported Aerosol Affect the Local Radiative Budget? (A Case Study). Remote Sens., 12, 2112, https://www.mdpi.com/2072-4292/12/13/2112.

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