Polar 6 during the survey flight on 11 April 2024 (Photo: Stephan Borrman, MPI).

Parked balloon in the snow at Station North (Photo: Michael Schäfer, Uni Leipzig).

Transregional Collaborative Research Center on Arctic Amplification

(AC)³ Newsletter

EDITORIAL

Dear readers of the (AC)³ newsletter,

Welcome to the third phase of our (AC)³ project! Following the approval of our application to continue (AC)³, which we received in December 2023, we wasted no time. From March to April 2024, we conducted a tethered balloon measurement campaign at Station North in Greenland as part of project A02. These observations were intended to collect vertical turbulence and radiation data with high temporal resolution to observe the transitions between typical states in the Arctic atmosphere (e.g., from cloud-free to cloudy conditions). Despite the harsh winter with temperatures down to -35 °C, Holger Siebert and Michael Schäfer succeeded in obtaining a large data set, which will be confronted with corresponding simulations by two PhD students who will work in A02. A short report on this activity can be found in this newsletter.

Furthermore, some missing data on turbulence and aerosol properties were collected during a flight campaign with the new T-Bird sensor shuttle, which was attached to Polar 6 in April 2024. The aircraft was based in Longyearbyen, Svalbard. 11 flights were carried out, including a flight to Greenland and over the central Arctic. Beautiful data was also obtained during the campaign. You can read more about this campaign in this newsletter.

For the kick-off meeting of phase III, we had booked a convenient location in the scenic surroundings of the Harz Mountains. We deliberately waited until May to hold this meeting because we wanted to involve as many new doctoral students and postdocs as possible in the kick-off event. But not only for our new members, this event was a very motivating and refreshing introduction to the structure, interactions, and goals of phase III of (AC)³. In phase III, we ultimately want to contribute to the major challenges that we have identified as Strategic Questions in our proposal. During the meeting, we summarized how we want to achieve these general goals, but also discussed concrete science. Following the kick-off meeting, the early career researchers met for a get-to-know-you meeting. Again, you will find a detailed report in the newsletters.

It is always a great pleasure for us to publish this newsletter. Enjoy reading it and if you have any comments, just let us know.

With kind regards from Leipzig,
Manfred and Marlen.

July 2024
17th Issue

TOPICS IN THIS ISSUE

KICK OFF MEETING REPORT

SUCCESSFUL KICK-OFF MEETING FOR PHASE III IN THE BEAUTIFUL HARZ MOUNTAINS

by Marlen Brückner

On May 27-29, 2024, our kick-off meeting for phase III took place in Braunlage in the Harz Mountains. We wanted to choose a special location for this special kick-off meeting and the first gathering of the "new people" in phase III. We found what we were looking for in Braunlage. The town lies at the foot of the Wurmberg (971 m), the small brother of the Brocken, in an idyllic location surrounded by greenery. Although the journey by train and bus was quite adventurous for many, all 90 participants made it on time. We were particularly pleased and grateful that so many new PhDs and postdocs, some of whom had not even officially started, made it to this meeting. After all, (AC)³ is a large consortium and, compared to many other projects, quite complex in its organization and structure. Therefore, it is important to get an overview of the five different clusters with their 26 sub-projects.

Fig. 1: The (AC)³ meeting room is ready to host and entertain its new and old (AC)³ members (Photo: Marlen Brückner).

But first we all had to get to know each other better. We used various interactive games to find out what the team already has in common and how much we have already achieved in (AC)³ over the last 8 years. For example, we had to estimate how many measurement campaigns have already been carried out within (AC)³? Well, would you have known? We have successfully carried out 14 measurement campaigns despite difficulties such as the pandemic. And that was by no means all, because there will be a few more in phase III. In his (AC)³ overview presentation, Manfred Wendisch presented the basic idea and, above all, the challenges and open questions that we want to answer together over the next four years. In the final phase of this project, all the pieces of the puzzle will now be put together, gaps will be closed and answers will be found to the central key questions of the project. The four central projects and their work on organization and management, the structuring of doctoral training within our Integrated Research Training Group (IRTG), as well as data infrastructure management and the newly added data modelling project then presented themselves. Quite a lot of input for the first day, but it was also a good recap for many of the old-timers. At the ice breaker in the evening we tried to get to know each other even better. The (AC)³ person bingo was a total success! By asking questions, we had to find the people who matched a certain characteristic. In a wild and loud confusion, the first "Bingo!" could be heard ringing through the room very quickly.

In the morning of the second day, we heard overview presentations from our cluster spokespersons on which projects are working together on key topics and, above all, which faces belong to them. In the subsequent poster session, we were able to get to know the individual projects and their people better in individual discussions and also exchange initial scientific ideas.

The afternoon was all about team building. After the photo session, we set off on an exciting 3-hour hike to the Wurmberg. Fortunately, the weather was fine. To make the hike even more exciting, we were able to get together in teams and play a photo scavenger hunt. This resulted in many creative and funny photos that we will remember for a long time to come. The team with the best photos was awarded a prize.

Fig. 2: Some photos from the scavenger categories "Photo with…": …highest number of hiking boots, …hiker in a yoga pose on the summit, …a witch, …hiker on a park bench or shelter, …with a "worm", …tired hikers (Photos: Nina Maherndl, André Ehrlich, Sebastian Zeppenfeld, Maximilian Ringel, Florian Gebhardt).

On the last day, we used the time in various bar camps to talk about the crosscutting issues of equality and diversity, sustainability, public relations, and the modeling structure in $(AC)^3$. After all, such a large project comes with a certain amount of responsibility. We talked about how we want to collaborate with each other within the project and what standards we want to have not only on paper, but also how we want to live them and show them to the outside world. We want to make our work transparent and sustainable. Numerous good ideas came together, some of which will certainly be reported on in future newsletters.

After three days of meetings, all new and already estabished project members were able to return home feeling motivated and in the right frame of mind. This phase is once again characterized by wonderful people and scientists who want to understand the Arctic better together. We are all looking forward to our next reunion. Thank you Braunlage!

Fig. 3: Group picture of all participants (Photo: Tilo Arnold, TROPOS).

News from the observations

AIRBORNE CAMPAIGN BACSAM II

by Andreas Herber & Team (PI in A03 & B04 at AWI Bremerhaven)

In spring 2024, we conducted our second airborne campaign using the towed vehicle T-Bird. The first campaign took place in fall 2022, but this time we have collected data during the spring season. As part of the BACSAM II (Boundary Layer and Atmospheric Aerosol- and Cloud Study of Atmospheric Processes), we investigated the atmosphere boundary layer over the Fram Strait marginal sea ice zone northwest of Svalbard, as well as surrounding regions of the Spitsbergen Archipelago and northwest Greenland. The goal was to study aerosol-cloud-turbulence interactions in the Arctic atmosphere boundary layer (ABL) and lower troposphere. The airborne program was carried out together with the $(AC)^3$ partners TROPOS Leipzig, and LIM Leipzig as well as MPI for Chemistry Mainz.

Following its initial deployment in autumn 2022, the T-Bird airborne turbulence and aerosol probe was deployed for the second time in polar regions. The advantage of the combined aircraft-T-Bird-setup is the ability to perform simultaneous measurements at two altitude levels simultaneously (T-Bird, aircraft) with a maximum rope length of 325 feet. The T-Bird allows to measure meteorological variables, including turbulent fluxes at altitudes below 30 – 50 feet above ground, which are crucial for better understanding air-ice interactions over fractional sea ice and the processes of aerosol-cloud interaction and aerosol formation in the ABL. For the pilots it is very demanding to fly in this altitude range for example because of risks due to collision with ice ridges.

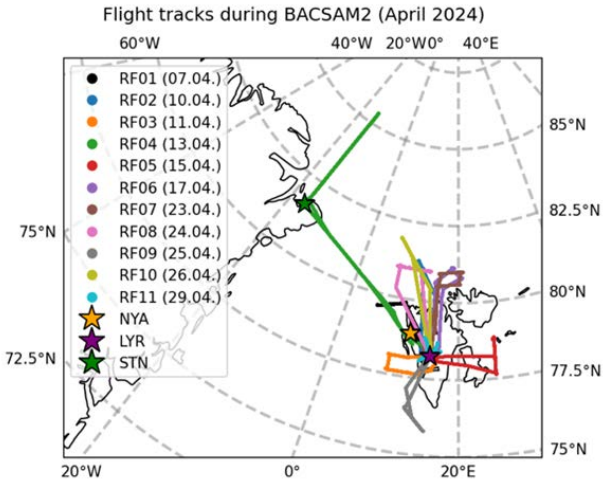

Fig. 4: Flight activity during BACSAM II (Bruno Wetzel).

AIRBORNE CAMPAIGN BACSAM II

(continued)

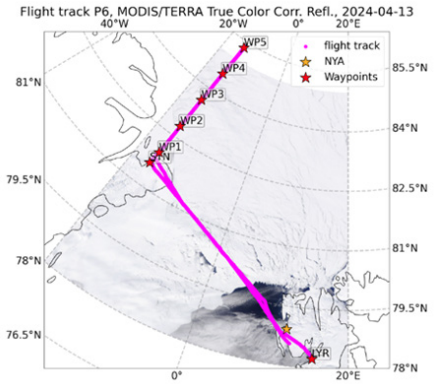

Fig. 5: Flight track Polar 6 during the Greenland survey flight on 13 April 2024 (Joshua Müller, LIM) and an impression on the meteorological conditions (Photo: Laura Köhler, AWI).

Polar 6 began its airborne operations from Longyearbyen after arriving on the afternoon of April 5. Between April 7 and April 29, 2024, we conducted a total of 11 survey flights, including a flight to Greenland on April 13, 2024, with two refueling stops at Station Nord. The weather conditions during the campaign allowed to operate in various areas, including over sea ice northwest and northeast of Svalbard. The measuring systems installed on board Polar 6 and in the T-Bird performed well, enabling to collect a significant amount of important data in the ABL at very low altitudes and at two levels in the free troposphere.

In Figure 4, you can see the summary of the flight activities carried out during BACSAM2, and picture (front page-left panel) Polar 6 during its takeoff from Longyearbyen on April 11, 2024. One of the highlights of the campaign was a flight up to 85.5°N on 13 April 2024. This northern flight with an extended low-level track utilizing the T-Bird, was made possible by refueling at Station Nord. Figure 5 shows the flight track and an example for the ice conditions encountered during the flight. A situation influenced by westerly winds was probed during the research flight on April 29. We characterized the development of below-cloud turbulent flow and aerosol from the Isfjorden entrance deep into the various fjords. During different flight sections, cloud base height increased from almost zero to a couple of hundred meters, and the surface changed from open water, to marginal ice, to closed ice, and partially snow-covered land, as seen in Figure 6.



Fig. 6: The different surfaces encountered inside of Norfjorden on 29 April 2024 (Photo: Frank Stratmann, TROPOS).

(AC)³ NEWS

Next (AC)³ Online lectures:

- 2 Sept 2024: "Clouds and radiation: What do we learn about the radiative impact of Arctic clouds from ground-based remote sensing?" Kerstin Ebell (University of Cologne)
- 12 - 13 November 2024 in Leipzig: Advanced Training Module (ATM) on "Arctic-mid-latitude linkages"
- 14 - 15 November 2024 in Leipzig: IRTG workshop

- **SAVE THE DATE:**
- 3rd (AC)³ Winter school in Hyytiälä, Finland planned for 24 - 30 March 2025
- (AC)³ General Assembly in Bremen, 3 - 6 February 2025

MEET THE (AC)³ FELLOWS

Hello everyone,
my name is David Simon and I am part of the (AC)³ project B04. I received my bachelor's and master's degrees in physics from Leipzig University with a focus on Soft Matter and Active Matter Physics. As I am very interested in interdisciplinary research in general, I took elective courses in meteorology during my last year of studies after attending a fascinating talk about the MOSAiC expedition. Seeing great results and impressions of such a large, multidisciplinary campaign highly motivated me to delve further into the field of atmospheric and Arctic science. Thus, I subsequently, worked as a student research assistant at TROPOS, focusing on the characterization of cloud condensation nuclei and ice nucleating particles through wind tunnel experiments and droplet freezing assay measurements. I am very glad to now be able to continue conducting exciting research on aerosol-cloud interactions in the Arctic as a PhD student within (AC)³. In particular, I really enjoyed participating in the recent BACSAM II aircraft campaign, which took place in April 2024 from Longyearbyen, Svalbard and meeting so many people during the kick-off meeting of phase III. I am very excited to analyze the various data sets we collected, collaborate with researchers from other projects, and be part of the (AC)³ community for the next three and a half years!

Hey everyone,
I am Linnea, and I started my PhD in February at the University of Cologne in the E03 project. I did my bachelor's in Applied Geosciences at RWTH Aachen and there, I started working with remote sensing measurements. In my master's, I changed fields of research to Climate Sciences, which I studied at University of Bern in Switzerland and where I first familiarized myself with the atmosphere and its phenomena and was intrigued by the multitude of processes interplaying in the atmosphere and generating our weather.
Now, I am working on G-band radar measurements of Arctic mixed-phase clouds and will be investigating their supercooled liquid water droplet properties. For that, I will be using airborne, ship- and groundbased observations from multi-frequency radars and I'm looking forward to everything that I will learn!

News from the observations

BALLOON MEASUREMENTS AT THE SECOND NORTHERNMOST MANNED STATION

by Michael Schäfer (PI in A03 at Uni Leipzig) & Holger Siebert (PI in A02 at TROPOS)

As part of A02, a measurement campaign took place this spring at the Villum Research Station at Station Nord (81° 36′ 9″ N, 16° 40′ 12″ W) on Greenland, which is the second northernmost permanently manned station in the world. From March 19 to April 18, we, that is Holger Siebert and Michael Schäfer, were there in the company of only three other scientists and a few station personnel.

Our aim was to characterize the lower boundary layer. In particular, its temporal development during the transition from day to night, or the transition from cloudy to non-cloudy conditions, when the type of cloud changes or also during the transition to precipitation conditions.

Fig. 7: Another part of the daily work is the ascent of radiosondes to obtain a profile of the current state of the atmosphere (Photo: Michael Schäfer).

MEET THE (AC)³ FELLOWS

Hello everyone,

My name is Sophie Vliegen, and I am originally from Darmstadt, Germany. I started my PhD at the University of Leipzig at the beginning of April 2024 in the E01 project, investigating the changing role of convection in the Arctic climate. Even though my academic path began with studying Econometrics in Amsterdam during my Bachelor's, I am happy that it eventually has brought me to the highly fascinating and relevant topic of Arctic amplification. Over the next few years, I will be working with CMIP6 data and observations to delve deeper into the changing atmospheric energy budget, with increasing convection and a therefore rising radiative-convective-advective equilibrium. Additionally, I will be looking into how the increasing occurrence of convection will influence feedback mechanisms like water vapor and the lapse rate feedback, and thus Arctic warming. I am very excited and eager to investigate my topic further and to discuss and work alongside you all!

News from the observations

BALLOON MEASUREMENTS AT THE SECOND NORTHERNMOST MANNED STATION

(continued)

Our working material for achieving these goals were daily radiosondes and the BELUGA system, which has proven its worth in boundary layer surveys in the Arctic. This is a tethered balloon to which various probes are attached and which can be slowly lifted to different heights using a winch anchored to the ground. We opted for a small 9 m^3 balloon, filled with Helium, which can be handled very easily by just one person. This meant that one of us could control the height of the balloon on the winch, while the other could simultaneously monitor its transmitted live data from a heated cabin.

The data collected included high-resolution three-dimensional wind fields, temperature and humidity measurements, and upward and downward broadband terrestrial irradiance. Most of the time we recorded these as profile measurements. In other words, we let the balloon ascend and descend continuously. Initially, we always did this at high altitudes in order to obtain an overview of the overall situation and then intensively over short sections of interest to increase the temporal resolution. We did this for several hours at a time during each measurement phase, as long as the batteries lasted. With the exception of a single day, we were able to carry out these measurements every day during the entire campaign despite the harsh environmental conditions. During the first two-thirds of the campaign we had an average temperature of -35°C, before it became significantly warmer in the last third with an average of -20°C and we slowly started to sweat in our polar clothing.

Fig. 8: Above: Flying red small 9 m^3 balloon with several probes attached. Bottom: Highly concentrated scientists at work (Photos: Michael Schäfer & Holger Siebert).

BALLOON MEASUREMENTS AT THE SECOND NORTHERNMOST MANNED STATION

(continued)

Our measurements were supported by internal station recordings of standard meteorological data, ceilometer, lidar and cloud radar observations. In addition, colleagues from Lausanne provided aerosol data from the lower boundary layer via a Helikite system. All of this is valuable additional information that will help us to characterize the development of the lower Arctic boundary layer under the above-mentioned transition conditions and to improve various models.

In terms of measurements, this campaign was a great success, as we were able to achieve all our goals. But we also really enjoyed our time there personally. It was an extremely harmonious collaboration with all the other participants in an absolutely fantastic environment, so we very much regretted the end of the campaign.

MEETING REPORT

PhD Kick off

by Linnea Bühler, PhD representative & student in E03 at Uni Cologne

After the $(AC)^3$ General Assembly in May, there was an additional PhD kick-off day for the over 30 PhDs that attended, most of which are new in $(AC)^3$ and have just started or will start in phase III.

The main goal of the PhD kick-off day was to get to know the other PhDs, familiarize ourselves with the $(AC)^3$ projects, and get to know the IRTG. For that, we played another more in-depth get-to-know-each-other game where we discussed what is important to us in general. Very quickly, we could see that there were many overlaps there that we could build on for conversations during the rest of the day. After that, we got introductory talks by Matthias about data management and by Christa about the IRTG, which were both very helpful for knowing where to ask for all kinds of problems. After that, we elected a new council with representatives of every participating institution.

The PhD dinner was super nice to connect to more people, and we played several rounds of "Flüsterpost" around the very squeezed tables (as you can see in the picture), which was great fun!

The next day, we each gave an elevator pitch about our PhD projects in regard to the three Strategic Questions that Gunnar, Susanne, and Manfred presented. Even though we had already talked about our research topics before, it was helpful to have it all in one place and to already have a look at where we can potentially connect.

Overall, it was a great opportunity to get to know the fellow PhDs and become more acquainted with the structures within $(AC)^3$ and the IRTG. It was really cool that so many people that hadn't started yet could join as well, and that some of them even came from other continents just for the General Assembly!

Many, many thanks to Christa for organizing the day, to everyone giving talks and to Nina for planning the dinner get-together!

Fig. 9: Group picture of PhD dinner (Photo: Nina Maherndl).

Fig. 10: The new $(AC)^3$ PhD council, from left to right: Fatima, David, Philipp, Lara, Awadesh, and Linnea (kneeling) (Photo: Christa Genz).

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DFG Deutsche Forschungsgemeinschaft

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(AC)³ Publications

OVERVIEW: QUASI-LAGRANGIAN OBSERVATIONS OF ARCTIC AIR MASS TRANSFORMATIONS - INTRODUCTION AND INITIAL RESULTS OF THE HALO–(AC)³ AIRCRAFT CAMPAIGN

Abstract

Global warming is amplified in the Arctic. However, numerical models struggle to represent key processes that determine Arctic weather and climate. To collect data that help to constrain the models, the HALO–(AC)³ aircraft campaign was conducted over the Norwegian and Greenland Seas, the Fram Strait, and the central Arctic Ocean in March and April 2022. The campaign focused on one specific challenge posed by the models: The reasonable representation of transformations of air masses during their meridional transport into and out of the Arctic via northward moist and warm air intrusions (WAIs) and southward marine cold air outbreaks (CAOs). Observations were made over areas of open ocean, the marginal sea ice zone, and the central Arctic sea ice. Two low-flying and one long-range, high-altitude research aircraft were flown in collocated formation whenever possible. To follow the air mass transformations, a quasi-Lagrangian flight strategy using trajectory calculations was realized enabling to sample the same, moving air parcels twice along their trajectories. Seven distinct WAI and 12 CAO cases were probed. From the quasi-Lagrangian measurements, we have quantified the diabatic heating/cooling and moistening/drying of the transported air masses. During CAOs, maximum values of 3 K h^{-1} warming and 0.3 g kg^{-1} h^{-1} moistening were obtained below 1 km altitude. From the observations of WAIs, diabatic cooling rates of up to 0.4 K h^{-1} and a moisture loss of up to 0.1 g kg^{-1} h^{-1} from the ground to about 5.5 km altitude were derived. Furthermore, the development of cloud macrophysical (cloud top height and horizontal cloud cover) and microphysical (liquid water path, precipitation, ice index) properties along the southward pathways of the air masses were documented during CAOs, and the moisture budget during a specific WAI event was estimated. In addition, we discuss the statistical frequency of occurrence of the different thermodynamic phases of Arctic low-level clouds, the interaction of Arctic cirrus with sea ice and water vapor, and the characteristics of microphysical and chemical properties of Arctic aerosol particles. Finally, we provide proof of concept to measure mesoscale divergence and subsidence in the Arctic using data from dropsondes released during the flights.

Manfred Wendisch et al., 2024: Overview: Quasi-Lagrangian observations of Arctic air mass transformations - Introduction and initial results of the HALO–(AC)³ aircraft campaign, **accepted for publication in Atmos. Chem. Phys.**

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