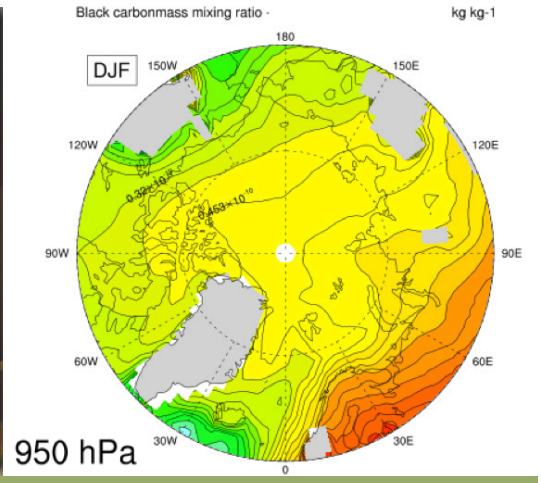
Figures: Polar lights over Ny-Ålesund (Sandro Dahlke, left); Modeled black carbon over the Arctic during winter 2010 (Jacob Schacht, right, see Page 5).



Transregional Collaborative Research Center on Arctic Amplification

(AC)³ Newsletter

EDITORIAL

Dear Reader,

This is the second of our regular, biannual Newsletters; time flies! We have already almost one year of (AC)³ behind us – unbelievable. Within the past half year we completed our staff and worked hard to prepare the upcoming field campaigns, namely the Polarstern (PASCAL) ship, and Polar 5 & 6 (ACLOUD) aircraft adventures, combined with balloon-borne measurements based at an ice camp, and ground-based observations at Ny Ålesund (Spitzbergen). In particular, the installations of new sensors (for example, the airborne radar/radiometer MiRAC: Microwave Radar/radiometer for Arctic Clouds, see the article in the current issue) on the aircraft consumed much of our time and efforts. Also the (AC)³ modelling community achieved first major results, as is reported in this issue in the contribution by Jacob Schacht (TROPOS). Students are busy to digest the seemingly never-ending continuos stream of Arctic literature, to program computer codes, to calibrate instrumentation in the laboratories, etc. Just recently, they mingled in Cologne for their "Getting Started" workshop; a Winter School on the "Observation and modeling of high-latitude and Arctic clouds" is currently being prepared, which will take place at Hyytiälä (Finland) from 19 to 25 March 2017. We also started to organize the first (AC)³ Science Conference to take place in Bremen in March next year. A special highlight achieved within the past half year was the first high impact paper with one of the (AC)³ members as a co-author (Overland et al., 2016). Also, we succeeded to publish a summary of the (AC)³ project motivation and description in the widely read EOS magazine published by the American Geophysical Union (Wendisch et al., 2016).

The spirit in the (AC)³ community remains to be excellent; everybody is excited and we all can't wait to collect and analyze the measurements from the PASCAL and ACLOUD campaigns in May – June 2017. That will be one of the first milestones of (AC)³ and we keep fingers crossed that the observations will run smoothly. Well, we know that complications might (and most certainly will) happen, but we do our best to be able to report on great measurements from PASCAL and ACLOUD in our next Newsletter to appear in July 2017! Stay tuned …

Manfred Wendisch, Speaker of (AC)³; Marlen Brückner, Scientific Coordinator.

December 2016
2nd Issue

TOPICS IN THIS ISSUE

(AC)³ NEWS

- **Call for Abstracts – 1st (AC)³ Science Conference on Arctic Amplification in Bremen, Germany, 26 to 28 March 2017. Further details and application at http://www.ac3-tr.de/news/1st-ac3-science-conference/**
- **Winter School on the Observation and Modeling of High-latitude and Arctic clouds Hyytiälä, Finland, 19 to 25 March 2017. Registration and application online at http://ac3-tr.de**
- **Stay informed: if you want to receive this newsletter regularly, you can subscribe online at http://ac3-tr.de**

(AC)³ GENERAL ASSEMBLY

On 1 to 2 December 2016, the second (AC)³ General Assembly (GA) was held at the "Wissenschaftsetage" in Potsdam with about 50 participants. Beside organizational issues representatives of all 19 scientific sub-projects of (AC)³ reported and discussed on their work during the first year. Additionally, Heiko Bozem from Johannes Gutenberg University Mainz presented his ideas for a collaboration with (AC)³. He was nominated to become an Associate Member of our Transregional Collaborative Centre.

This meeting provided a first overview of the scientific progress achieved so far in 2016. Our team is now complete and we have filled all vacancies. The Scientific Steering Team (SST) has started to steer (AC)³ and discussed the roadmap of the project during eight web conferences. The Scientific Advisory Board (SAB), consisting of international esteemed scientists highly experienced in Arctic research, has been estabished. We had no problems to appoint people for the SAB, every nominee was enthusiastic about the project and happily agreed to join the SAB.

During the first day of the meeting the five Cluster Speakers presented one or two major scientific highlights achieved so far. Later on that day, we have discussed further work and collaborations in joint or individual Cluster breakout groups. This turned out to be a rather successful approach. Especially, with regard to the quite busy upcoming year 2017 with major field campaigns, there were several issues to be identified and clarified. The combined research campaigns using the research vessel Polarstern, the two aircraft Polar 5 & 6, and the thethered balloon measurements on an ice floe needs to be well planned, organized and coordinated. It is a major challenge to reconcile the different observations and scientific objectives, especially in extreme Arctic conditions. Although, it is not as simple as it seems it is of utmost importance to use "the same language" between the observational and the modelling communities, which is why we are going to strengthen our cross-cutting activities with topical workshops.

Fig. 1: Some meeting impressions from the General Assembly in Potsdam.

In the evening we enjoyed a nice dinner at Genusswerkstatt Potsdam which was also used for in-depth discussions between sub-projects and collaborators.

On the second day we had time to summarize the achievements of the Cluster breakout groups and discuss them with the whole audience. Several issues like the planning of certain flight patterns to tackle specific research questions and the coordination between ship and aircraft activities were debated. We also established guidelines how to publish the different (AC)³ data sets which will be produced. The AWI data base PANGAEA will be used for data exchange and archiving.

After two days of interesting talks and discussions the entire (AC)³ team returned with new ideas and freshly motivated back to work to their home institutes.

MIRAC – MICROWAVE RADAR/RADIOMETER FOR ARCTIC CLOUDS

by Susanne Crewell and Mario Mech, University of Cologne (PI/Postdoc of B03)

Finally it is there! We are happy to present the MiRAC – our novel, MiRACulous new research instrument that will be flown on Polar 5, the "remote sensing" aircraft in the ACLOUD campaign in early summer 2017. The Microwave Radar/radiometer for Arctic Clouds has been finalized by the manufacturer (Radiometer Physics GmBH) and is now in ground based test mode at the manufacturers demonstration plattform. After a last-minute re-design of the mounting of the instrument into the aircraft - entailing several optimization adjustments - it seems like everything is finally sorted out now. All the intensive discussions on how to best mount and wire MiRAC within the aircraft seem to be overcome and we look very much forward for the first test flights in January 2017.

We are eager to perform our first measurements decoding the secrets of Arctic clouds. How can MiRAC help us with this? MiRAC provides the vertical structure of clouds using an active module - a 94 GHz frequency modulated continuous wave radar - and a passive module measuring the weak thermal emission of water vapor and clouds at several wavelengths. The different frequency channels extending up into the submillimeter region act like a radio with each frequency providing another part of the story about the amount and size of liquid an ice particles in the atmosphere. The passive module will be mounted in the rear part of the aircraft looking down through an opening in the aircraft floor. The active module will -due to its larger size- be mounted below the front part of the aircraft in a belly pod.

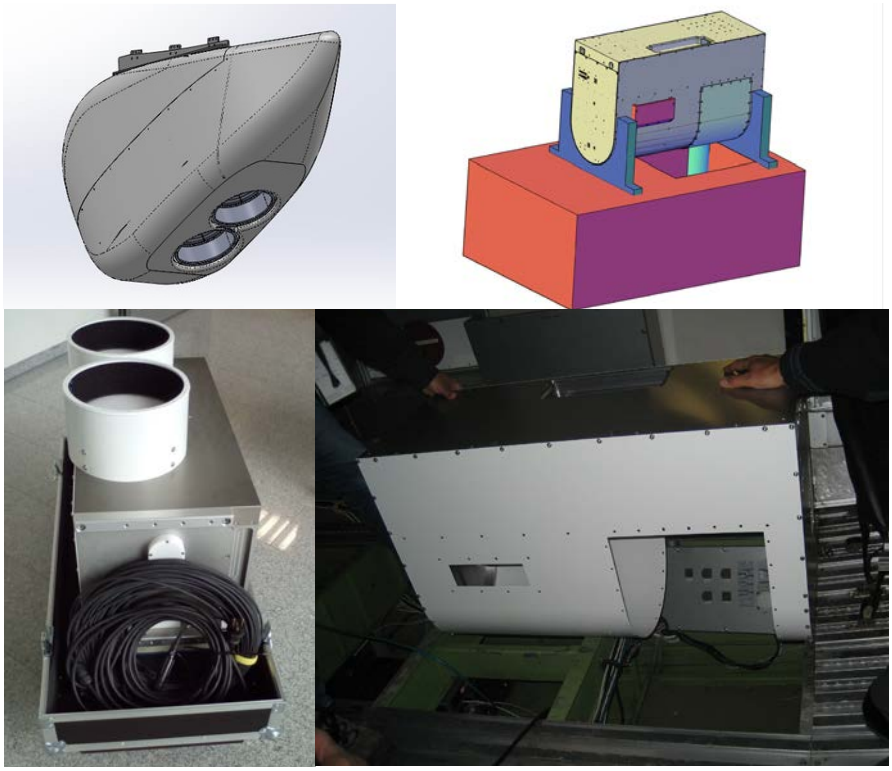


Fig. 2: From planning to reality: Top left: Bellypod which will carry the MiRAC radar shown in the center with two antennas (one transmitting– one receiving microwave radiation). Top right: Sketch of MiRAC's passive part whose frame is integrated in the Polar 5 aircraft shown on the bottom.

MEET THE (AC)³ FELLOWS

My name is Elena Ruiz and I come from a small village in Spain located in the heart of La Mancha (the region where Don Quixote used to fight windmills). I obtained my Diploma in Physics with a focus in Atmospheric Physics in Madrid in 2013 and I completed my education with traineeship programs at two Spanish research institutes. At the Instituto de Astrofísica de Canarias (IAC), I have applied several methods for the inspection of optical components. At the National Institute for Aerospace Technology (INTA) I learned to use sun photometry measurements in order to support the atmospheric correction of airborne remote sensing images.

Since the end of May 2016 I am working at the University of Leipzig within sub-project B03 of (AC)³. My PhD topic deals with the study of the horizontal distribution of thermodynamic particle phases in Arctic mixed phase clouds using airborne solar spectral imaging techniques. Currently, I am performing simulations with a radiative transfer code in order to learn and extend the existing methods for cloud phase discrimination. Later on I will apply these methods to the cloud airborne observations, which will be acquired during the ACLOUD campaign (Svalbard, June 2017) with the hyperspectral spectrometers Eagle and Hawk.

MIRAC – MICROWAVE RADAR/RADIOMETER FOR ARCTIC CLOUDS (continued)

This unique combination of active and passive microwave frequencies is taylored to investigate the microphysical properties of Arctic mixed phase clouds (consisting of ice particles and liquid water droplets at the same time). By exploiting these simultaneous active and passive measurements we will retrieve the spatial variation of ice and liquid water in Arctic mixed phase clouds.

We are optimistic that MiRAC will crucially contribute to a better understanding of Arctic mixed phase clouds.

$(AC)^3$ GUESTS

GUEST STAY OF DR. JUSSI LEINONEN (UCLA) AT UNIVERSITY OF COLOGNE

by Stefan Kneifel, University of Cologne (Project member)

Ideal single ice particles as we can buy them on Christmas Markets are quite rare in natural clouds. In the atmosphere, single crystals often build aggregates (snowflakes) or become rimed, i.e. liquid droplets freeze onto them which leads to much denser particles (graupel). While these ice processes are known to be of key importance for climate and weather forcast models, they are still poorly understood.

Dr. Jussi Leinonen from the Joint Institute for Regional Earth Science and Engineering, University of California (UCLA) developed a comprehensive numerical model for ice particle aggregation and riming and is also an expert in the field of how these particles interact with microwave radiation used by ground-based and satellite remote sensors. During his two-week visit of the University of Cologne (UoC), he introduced the $(AC)^3$ members in his aggregation and riming model and future topics of collaboration within $(AC)^3$ were discussed. This exchange will help to further improve the microwave forward models needed to generate synthetic observations based on model simulations performed in $(AC)^3$. Members of the UoC also visited with Dr. Leinonen the German Weather Service (DWD) and discussed with Dr. Axel Seifert how his aggregation and riming model could help to improve ice microphysical parametrizations which are currently under devlopment at DWD. In future such novel parametrizations will also be tested with the long-term and campaign data collected within $(AC)^3$.

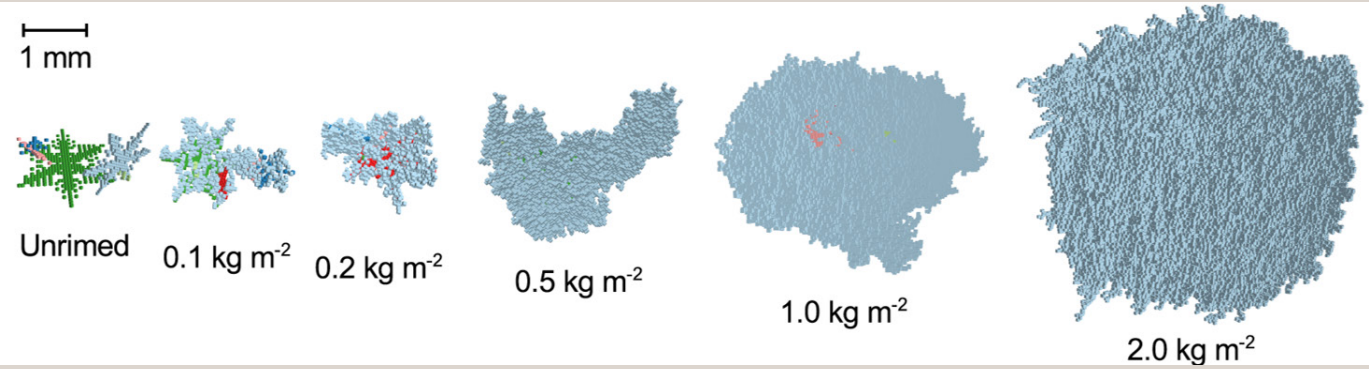


Fig. 3: Illustration of modeled snow particles with a numerical aggregation and riming model.

$(AC)^3$ NEWS

- **A new Aerosol Optical Thickness (AOT) retrieval algorithm for MERIS instrument has been successfully developed in IUP/University Bremen.**
  Further details can be found on
  http://dx.doi.org/10.1016/j.rse.2016.11.015
- **Wendisch, M., M. Brückner, J. P. Burrows, S. Crewell, K. Dethloff, K. Ebell, Ch. Lüpkes, A. Macke, J. Notholt, J. Quaas, A. Rinke, and I. Tegen, 2016: Understanding causes and effects of rapid warming in the Arctic. Accepted by Eos.**

CONFERENCE REPORT

by Erlend Moster Knudsen, University of Cologne (Posdoc in E04)

The 28th annual Canadian conference merging scientists, policy-makers and members of rural communities was organized October 12-15, 2016 in Guelph, Ontario. This year's theme was "Building Vibrant Rural Futures:- Mobilizing Knowledge and Informing Policy", organized by the Canadian Rural Revitalization Foundation (CRRF) and Rural Policy Learning Commons (RPLC).

I was invited to the conference as a keynote speaker due to my role in the climate outreach NGO Pole to Paris (poletoparis.com). In an ever more politicized world headed for self-destruction in environmental terms, it is difficult to balance the objectivity of science with the society's need for implementing science in its political and economical decisions. This calls for a climate scientists more adapted to the current trends, informing policy-makers, media and the general public about scientific facts in an understandable language, known format and common forum.

I gave a talk as a representative of the $(AC)^3$ project and of the University of Cologne. In this talk, I outlined the motivation for this project, its structure, objective and tools, as well as how our results are planned to be disseminated. This is of particular interest to the Canadian audience, being one of the largest Arctic nations and recently opening up renewed interest and allowance for Arctic climate research and interaction.

The rest of the conference was also great, with a wide range of topics presented (I focused on the climate-related ones). Especially beneficial was the conference set-up that allowed for extensive two-way interaction, networking and deep discussions. I came only knowing one person, but left with many new friends and outstanding potential for future collaborations.

Fig. 4: Members of First Nations performing traditional dances (light); Some of the conference participants at a local karaoke bar on the final night of the conference. Photo by Sarah Cook (right).

News from the Modeling Groups

THE ROLE OF AEROSOL IN ARCTIC AMPLIFICATION – FIRST RESULTS FROM AN AEROSOL-CLIMATE MODEL EVALUATION STUDY

by Jacob Schacht, TROPOS (PhD student in D02)

Aerosol particles from long-range transport and local sources modulate the Arctic energy balance directly by interactions with solar and thermal infrared radiation and indirectly by changing cloud properties and atmospheric dynamics. This includes a potentially important but yet not well explored contribution of aerosol particles to the positive feedback mechanisms driving the current rapid Arctic warming.

Global and regional Arctic climate simulations are used to investigate the sources and transport pathways of natural and anthropogenic aerosol particles to the Arctic region, as well as their impact on atmospheric radiation and clouds. This includes considering the important impact of ageing and mixing processes as well as the snow/ice-albedo forcing. A particular focus will be on black carbon (BC) from increasing ship and wildfire emissions.

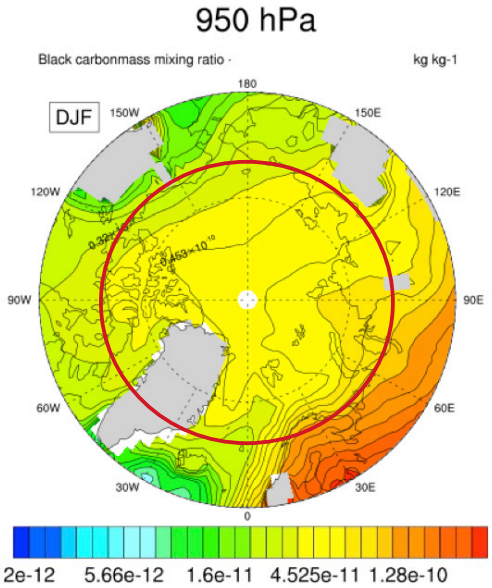


Fig. 5: Black carbon (BC) over the Arctic in the winter 2010, as computed with the aerosol-climate model ECHAM6-HAM2. Horizontal distribution of BC at the 950-hPa level. Red line roughly marks 70°N.

MEET THE (AC)³ FELLOWS

My Name is Sandro Dahlke, I was born in 1989 in Lutherstadt Wittenberg (Sachsen-Anhalt). From 2009 to autumn 2015, I studied Physical Oceanography and Climate Physics in Kiel, my Masters thesis dealt with atmospheric teleconnection patterns that are associated with sources of diabatic heating.

In May 2016, I have started my PhD work at AWI Potsdam. Within (AC)³ I am working in sub-project E02. The goal of my studies is to assess the representativeness of the Arctic site Ny-Ålesund (Svalbard) across other Arctic sites. Therefore, I plan to investigate synoptic situation, thermodynamic state of the air column above Ny-Ålesund, as well as connections to large-scale circulation. Recently, I am analyzing NILU FLEXTRA trajectories to identify key source regions of the tropospheric air at Zeppelin Mountain, Ny-Ålesund.

Furthermore, I am currently participating in the ARCROSE radiosonde campaign in Ny-Ålesund, which takes place during 2-19 December 2016. My responsibility is to carry out intensive balloon radiosoundings in 6-hourly intervals to gather high-resolution data of the wintertime atmospheric column.

THE ROLE OF AEROSOL IN ARCTIC AMPLIFICATION – FIRST RESULTS FROM AN AEROSOL-CLIMATE MODEL EVALUATION STUDY (continued)

The global long-term simulations are performed with the aerosol-climate model ECHAM6-HAM2 and latest emission datasets. Using the model as a research tool in an exceptional region such as the Arctic makes it inevitable to evaluate the model specifically in that region. For a first evaluation study the ECHAM6-HAM2 has been run in nudged mode at T63 (approximately 1.8°) horizontal resolution for the years 2010 and 2014/15, including former Arctic field campaigns.

As an example for anthropogenic aerosol particles in the Arctic, we present model results for BC, which is typically transported from urban and industrial sources in Europe and South-East Asia, but can also originate from widespread (mainly natural) boreal forest fires and local ship tracks. The modelled horizontal distribution of BC in winter at 950 hPa can be seen in Figure 5. A red circle indicates the location of the vertical cross-sections shown in Figure 6. Figure 6 shows vertical cross-sections along 70°N latitude. They suggest that the transport patterns that were found in previous aerosol transport studies can be reproduced. There is an increased transport in the lower troposphere from Europe (15 – 35°N) during the winter months (Figure 2, left panel). This is connected to a lower temperature gradient from North to South, as well as to higher European emissions in wintertime. During summer, an increased transport occurs at higher altitudes around 120°E (Figure 2, right panel), which is related to long-range transport from Central Asia. Comparisons to station measurements of monthly mean surface BC concentrations in the Arctic reveal that the model reproduces both the order of magnitude with values up to 110 ng m^{-3} and the general annual cycle. The modelled BC concentration, however, tends to peak in February, which is one month earlier than observations suggest. The results of ECHAM6-HAM2 have considerably improved compared to a previous model version in earlier model intercomparison studies, in which the modelled near-surface BC concentrations were dramatically underestimated.

After thorough evaluation, the model results will provide a state-of-the-art estimate of the aerosol budget and the effective radiative forcing by anthropogenic aerosol particles in the Arctic region.

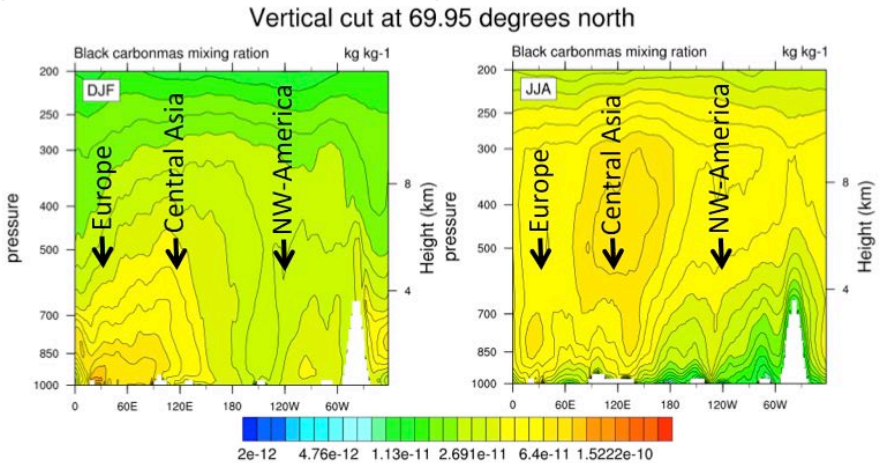


Fig. 6: Black carbon (BC) over the Arctic in 2010, as computed with the aerosol-climate model ECHAM6-HAM2. Vertical distribution of BC at 70°N (see red line in Fig. 1) as a longitudinal cross-section. For winter (December-January-February; left) and summer (June-July-August; right).

MEET THE (AC)³ FELLOWS

Hello, my name is Philip Rostosky. I have studied at the University of Hamburg and recieved a masters degree in meteorology in 2015. During my study I focused on theoretical meteorology and numerical modelling. In April 2016 I started my PhD, which is part of the (AC)³ project, at the Institute of Environmental Physics at the university of Bremen. Within (AC)³, I work in the sub-project D03 with the major objective to improve the understanding of feedback mechanisms between the atmosphere and sea ice-ocean in the Arctic. My PhD topic is about retrieving snow depth over Arctic sea ice from satellite radiometers. My first step was to analyze the reliability of the existing snow depth retrievals and to develop a new, improved retrieval, which is trained with airborne Arctic snow depth measurements. In a second step, I will use additional data (e.g. from scatterometers) and perform a model sensitivity study (with the microwave emission model MEMLS) to improve the understanding of how snow on sea ice influences the emitted radiation in the microwave region. In February 2017 I'll attend the 3rd Snow Science Winter School in Finland.

PhD Workshop in Cologne

GETTING STARTED

by Matthias Gottschalk, University of Leipzig (PhD student in A02)

Started in January. Kicked-off in June. The first year of (AC)³ bends to the end, time for the next PhD-workshop. This time the University of Cologne organized a workshop from the 14th to 16th December at a youth hostel in the north of Cologne. 22 participants learned about the topic "Getting Started". It was also the chance to get to know each other better, especially the newly employed PhD students.

The workshop started with a short presentation of each participant. Sounds easy, but try to explain your research to a 10-year old child. These presentations were a good reminder on our topics and probably everyone will remember the drawings, e.g. of Jacob Schacht and his Computer, numerous snowflakes with 8 arms or 20 different ways how to draw clouds.

Furthermore, we discussed our time management, the writing process, motivation problems, how to talk to your supervisor (especially when problems arises) and communication in general. None of the PhD students have serious problems with their supervisors and we can contact them anytime, which was unexpected by the workshop tutors (social science guys).

At last we discussed "networking", which we already practiced during breaks and the evening visit of the Christmas market. Within two days, we could only get a broad overview of all the topics. Hence, most of us will attend specialized courses for deeper insides.

We are all looking forward to enhance our networking skills and get started for the campaigns in 2017.

Fig. 7: Some impressions from the students workshop in Cologne. (Felix Lauermann)

ACKNOWLEDGEMENTS

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DFG Deutsche Forschungsgemeinschaft

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(AC)³ Publications

NONLINEAR RESPONSE OF MID-LATITUDE WEATHER TO THE CHANGING ARCTIC

Abstract

Are continuing changes in the Arctic influencing wind patterns and the occurrence of extreme weather events in northern mid-latitudes? The chaotic nature of atmospheric circulation precludes easy answers. The topic is a major science challenge, as continued Arctic temperature increases are an inevitable aspect of anthropogenic climate change. We propose a perspective that rejects simple cause-and-effect pathways and notes diagnostic challenges in interpreting atmospheric dynamics. We present a way forward based on understanding multiple processes that lead to uncertainties in Arctic and mid-latitude weather and climate linkages. We emphasize community coordination for both scientific progress and communication to a broader public.

Reprinted by permission from Macmillan Publishers Ltd: Nature Climate Change, advance online publication, 27 10 2016 (doi:10.1038/nclimate3121).

James E. Overland, **Klaus Dethloff**, Jennifer A. Francis, Richard J. Hall, Edward Hanna, Seong-Joong Kim, James A. Screen, Theodore G. Shepherd, and Timo Vihma, Nonlinear response of mid-latitude weather to the changing Arctic, *Nature Climate Change* 6, 992–999 (2016), doi:10.1038/nclimate3121.

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