

AGENDA WP 5 meeting

Park Inn by Radisson Copenhagen Airport
January 15-16 2014



Wednesday January 15

12.00-13.00: Lunch at the hotel

13.00: Welcome and outline, Merete Bilde

After the welcome we have budgeted time for short updates from each attending research person/group. Rather than trying to have 30 people present we would like each group to coordinate. Please give a short introduction of your research group (including new people etc.) and your CRAICC contributions. We hope to have a short summary of what you have been doing that relates to WP5 and what you plan in the future. Please include whom you are collaborating with and where you see potential for more collaboration. Try to stimulate scientific conversation – this is a small group and a good forum for discussing your results and ideas. If you will use slides please use ppt format and email them to erik.thomson@chem.gu.se and quynh@chem.au.dk by 18:00 January 14. No more than 5 to 10 slides!

13.10:	Aarhus
13.25:	Lund
13.40:	Göteborg
13.55:	Helsinki
14.10:	FMI
14.25:	Stockholm
14.35:	DTU/Risø

We also have some outside guests to the WP meeting and hope that similar short presentations by them can give us some perspective on what other important research groups are doing.

14:45: ETH

15:05: Tropos

15:30: Coffee break

16:00: Tying it all together and interface with modeling – Jon Egill Kristjansson

16:10: 10 minutes for discussion

16:20: Guest Lecture: Heinz Bingemer, Goethe-University Frankfurt, Germany

Establishment of a small network for off-line sampling ice nuclei with subsequent analysis in an isothermal static diffusion chamber.

17.00: Stretch of legs

17.10: Erik Thomson

Special discussion session on IN measurements and future strategy

Forming of smaller groups for Thursday discussions

19.00: Dinner

Thursday January 16

- 9.00:** Julien Savre, Stockholm University
Heterogeneous ice nucleation parameterization in Large-Eddy Simulations: A case study based on an arctic mixed-phase cloud observed during ISDAC
- 9.30: Work in smaller groups
- 10.30: Coffee break**
- 11:00: Presentations from group work, rounding up.
- 12.00-13.00: Lunch and end of meeting**

List of participants:

1. Jon Egill Kristjansson, University of Oslo
2. Michael Boy, University of Helsinki
3. Sven-Erik Gryning, Technical University of Denmark
4. Gerrit de Leeuw, FMI & Univ. Helsinki
5. Ksenia Atlaskina, University of Helsinki
6. Quynh Nguyen, Stockholm University
7. Eva Emanuelsson, Aarhus University
8. Merete Bilde, Aarhus University
9. Ella-Maria Kyrö, University of Helsinki
10. Aki Virkkula, Finnish Meteorological Institute
11. Cerina Wittbom, Lund University
12. Erik Thomson, University of Gothenburg
13. Erik Swietlicki, Lund University
14. Giulia Saponaro, Finnish Meteorological Institute
15. Jan Pettersson, University of Gothenburg
16. Julien Savre, Stockholm University
17. Larisa Sogacheva, Finnish Meteorological Institute
18. Maryam Dalirian, Stockholm University
19. Mikhail Paramonov, University of Helsinki
20. Mikko Sipilä, University of Helsinki
21. Moa Sporre, Lund University
22. Nonne Prisle, Helsinki University
23. Pekka Kolmonen, Finnish Meteorological Institute
24. Heinz Bingemer, Goethe-University Frankfurt, Germany
25. Frank Stratmann, TROPOS
26. Berko Sierau, ETH Zurich
27. Zamin Kanji, ETH - Zurich

Minutes (kept by Quynh Nguyen)

January 15, 2014

13:00 **Merete Bilde** gave a summary of WP5, aim, plan, progress and an update from Aarhus University

- Aarhus University has been involving in building the ice nucleus counter, measuring CCN activities, SEM/TEM imaging, sea spray tank available which could be good to combine with future ice nucleating measurements.
- There have been 2 new postdocs and 2 new Master students whose works involve CRAICC. Currently looking for 2 PhD and 1 postdoc.
- There have been some publications from Copenhagen/Aarhus University with CRAICC acknowledgement in relation to WP5. Further can be read at King et al. Environ. Sci. Technol., 2012, 46 (19); Rinnan et al. 2013 Frontiers in Terrestrial Microbiology; Kristensen 2013 on Cloud activation, accepted in Atmospheric Research; Nguyen et al. HULIS in the Arctic, submitted to JGR (2013), etc.

13.30 **Erik Swietlicki** gave an update from Lund University. Results available in the following papers:

- Sporre et al., Atm. Res., 2012. A study of the indirect aerosol effect on subarctic marine liquid low-level clouds using MODIS cloud data and ground-based aerosol measurements.
- Sporre et al., ACPD, 2013. A long term study on effects of aerosols on effective radius of clouds, cloud optical thickness at Vavahill and Hyytiälä (10 years data). <http://www.atmos-chem-phys-discuss.net/13/13853/2013/acpd-13-13853-2013.pdf>
- CCN activities of soot: fresh versus aged soot. A campaign in Copenhagen winter 2012. Results are in Wittbom et al., 2014 (to be submitted soon).

14:00 **Jan Pettersson, Erik Thomson** gave an update from University of Gothenburg

- Gothenburg has been very active in contributing to the development of PINCii together with ETH, TROPOS, Helsinki, Århus and Lund,
- FRIDGE instrument: there have been long term ice nuclei measurements in Nordic and Arctic conditions.
- IN measurements in individual ship plumes: FRIDGE measurements in the harbor of Gothenburg, autumn 2013. Results will be reported in future CRAICC meetings.
- Otherwise there have been lab studies and molecular level modelling of ice processes

Discussed results involved heterogeneous ice nucleation, deposition freezing, studying saturation ratio with respect to ice as a function of temperature (on bare and coated graphite surfaces (coated with monolayers of different compounds such as methanol, acetic acid, etc.)).

Kinetic modelling of deposition freezing using molecular level description of the nucleation process. Kimmel et al (JACS, 2009) and Kong et al. (JPCC 2012).

Recent study on water uptake (accommodation) by/onto bare and surfactant covered ice surfaces. E.g. having a monolayer of acetic acid on the surface will improve “accommodating” water considerably. Having

alcohol on the surface, however does not prevent water from accessing the surface → to be investigated further.

They are also trying to improve molecular beam experiments so that it can be done at higher temp and pressure.

14:20 **Mikko Sipila** gave a short update from Uni of Helsinki

Jonathan Dulipssy, from Helsinki, will be a new postdoc working on PINCii.

A postdoc working on theoretical ice nucleation study will start from beginning of April 2014.

Mikhail Paramonov has published results on time series of CCN measurements from Hyttiala, Joan Hong has another paper from campaign in 2010 (under review), Anne Maria Hansen from Århus has been visiting for 3 months and did some lab studies on CCN and organosulfates with Joan Hong.

14:30 **Giulia Saponaro** and **Larisa Sogacheva** from FMI summarized results on satellite remote sensing of aerosol and cloud properties

FMI has been developing algorithm for retrieving cloud and aerosol properties, then apply statistical analysis over long term series data using MODIS, AATSR and other satellites instruments. In addition FMI also works on retrieving ice cloud properties.

Giulia reported results on effects of aerosols on cloud properties using level 2 MODIS-Aqua platform. Trying to work out an Aerosol Cloud Interaction (ACI) value.

By combing aerosols/clouds retrieval, multiple outputs can be obtained, such as Cloud optical thickness, effective radius, liquid water path, cloud albedo and cloud top height. Currently, AOD over snow algorithm is still under development. For cloud retrieval over snow, with thick clouds the algorithm are working well, whereas thin clouds are still a problem.

In general, AOD and cloud properties can be retrieved using ADV algorithm (AATSR top-of-the-atmosphere reflectance), been using cloud screening to distinguish between aerosols and clouds.

14:45 **Berko Sierau** gave an introduction from ETH Zürich. Atmospheric Physics Group (Ulrike Lohmann). The group focuses on ice nucleation study, aerosol chemical composition and modelling.

IN measurements at JFJ (Jungfraujoch) and Tenerife at different time of the year, also during dust storm events using ice nucleation chamber.

Are also investigating different dust types, e.g. Martian dust (!), Saharan dust, Afghanistan dust, to see which types are more IN-active. Soil dust and desert dust seem to behave differently regarding IN-activity, soil dust is more soil-active than pure dust, which needs to be investigated further.

Investigating the chemical composition using ATOFMS. Been studying MS-fingerprints for the biological marker in different types of soil dust collected in different countries.

Berko also discussed their participation into the EU project BACCHUS (20 partners from 11 European countries).

Research related to CRAICC: Sierau et al., 2014. Single particle characterization of summer time high arctic aerosol, which showed biomass burning characteristic. <http://www.atmos-chem-phys-discuss.net/14/593/2014/acpd-14-593-2014.html>

15:50 **Frank Stratmann** from TROPOS, Leipzig gave a talk on ice nucleation at the TROPOS cloud group

Lab activities: LACIS (Leipzig Aerosol Cloud Interaction Simulator, study immersion freezing), INUIT project (immersion freezing, instrument development), SPIN (commercial available ice nuclei counter from DMT, currently available at MIT, U of Toronto, U of Manchester, TROPOS, studying deposition and immersion freezing), LACTT (studying interactions between microphysics and turbulence)

Field activities: ACTRIS (CCN and SPIN IN measurements in Leipzig), Polarstern/BACCHUS (CCN and SPIN IN in the Atlantic), Arctic amplification (CCN and IN in the Arctic). Except for CCN measurements, other field activities are still in an early stage.

SPIN work: homogeneous ice nucleation and heterogeneous ice nucleation on mineral dust and SNOMAX (bacteria) particles. Current problem with plate temperature stability, signal of SPIN optical size spectrometer (OSS) and also how to interpret OSS signals.

INUIT work: Develop an impactor as interface between an ice nucleus counter and instruments for physical and chemical characterization, such as size distribution, single particle MS etc. TROPOS also studies immersion freezing behavior of various substances such as minerals, SNOMAX and fungal spores with LACIS.

TROPOS found that biological components of IN are highly interesting.

16.30 **Heinz Bingemer** (Goethe University Frankfurt) talked about *Establishment of a small network for offline sampling of ice nuclei with subsequent analysis*.

IN measurements are flawed because of low IN concentration, different methods addressing different nucleation modes, different analyzing conditions, lack of standards.

Thus a FRIDGE offline ice nucleus measurement was set up, where sampling was done by electrostatic precipitation → then allow crystal growth in static vapour diffusion chamber, then counting is performed (photography). The FRIDGE method is comparable with other methods, though there are some unexplained discrepancies.

Daily IN measurements have been performed at Taunus Observatory at 825 m. a.s.l., 20 km north of Frankfurt. Results actually showed dust event, volcanic eruption, which were traceable as observed large peaks.

It was found that IN concentration is not related to local wind direction, wind speed, soil humidity, solar radiation, RH... However IN is correlated to local aerosol optical depth (AOD).

As part of BACCHUS, the group is planning daily IN number concentrations and vertical profiles at Svalbard, Central Europe, Caribbean and Amazon.

17:10 **Erik Thomson** gave an update on IN measurements and future strategy.

FRIDGE sampling effort: Ship plume sampling (6 weeks) for 50+ ships at Gothenburg.

PINCii development between Gothenburg, Aarhus, Tropos, ETH, Helsinki and Lund. Erik reported the progress of the development. More details on the development and status update of the instrument are available from the minutes of the pre-WP5 meeting on the ice nuclei counter PINCii.

As the expected lead time for the first two PINCii to be made will be end of 2014, taking into account characterization time, it would be unrealistic to ship the PINCii to Station Nord for the spring 2015 campaign.

January 16th, 2014

9:00 **Julien Savre** from Stockholm University gave a talk on *Heterogeneous ice nucleation parameterization in an LES model: A case study based on ISDAC*.

Julien Savre aims to develop ice nucleation parameterization that can be efficiently implemented in atmospheric models, where as much “physics” as possible are included. In heterogeneous nucleation processes, the fitted contact angles are a crucial parameter to tune the model. So far, deposition, immersion and contact freezing of dust and uncoated black carbon have been considered.

Model: Large Eddy Simulation (LES) working on the order of 1-10 km, to study very fine scaled processes.

Parameterization has been evaluated during a campaign in April 2008 at Barrow. The issue was how to account for the evolution (or aging) of aerosol population in the cloud. Most efficient INs nucleate ice and thus quickly removed, only the least efficient ones remained. As a solution, Julien almost kept the whole distribution, and removed a few bins. Truncated PDF method.

Major issues are uncertainties related both to the parameterization of the contact angles but also composition of atmospheric aerosols. The considered composition might not be relevant in the Arctic. It was either not clear what mechanisms can sustain the ice phase. There is also a lack of detailed field data to evaluate the model. Finally the model is limited to small spatial and temporal scale and thus it will be an issue to extend this to larger scales.

It would be beneficial for the model to have more lab data on ice nucleation, to find out what is currently missing as parameterization. The lab must know what kind of data is needed for parameterization. Understanding of cloud processes from LES can provide an input to larger GCM model. GCM can communicate back on new case studies as well as forcings/conditions for LES. In addition, observed field campaign data are needed to evaluate the model.

09:40 **Jon Egill Kristjansson** – What do modelers need.

Jon Egill gave a short summary on Earth System Models (ESMs) to capture the global interaction and feedbacks. The models require parameterizations of the relevant mechanisms. The models also need to be

validated. Due to computational constraints on large scale models (~100 km horizontal, 1 km vertical), the treatment of many processes such as radiation and chemistry must be greatly simplified.

The possible aerosol-related feedback loops in the Earth System.

Parameterization means expressing small-scale and complex process using model resolved variables (simplified relations). Parameterization is typically based on a combination of theory, lab or field measurements.

For an example of parameterizing heterogeneous ice nucleation in mixed-phase clouds (CAM-Oslo), see Hoose et al. (2010), JAS. For validating the model, see examples in Hoose et al. (2010), JAS; Cloud susceptibility Alterskjær et al (2012), ACP; Kirkevåg et al. (2013), GMD; Arctic CN by species Makkonen et al. (2013), ACP.

In general, in order to achieve integration between observations and models in the last 2 years of CRAICC. It is probably too late to develop new parameterization from scratch (that can contribute to CRAICC), need to identify the low hanging fruits (where progress can be achieved quickly), and gives priority to processes that closely address CRAICC objectives.

Discussions:

- It could be beneficial to validate the models with an additional postdoc hired.
- Any communications with WP8 should be by end of 2014.
- Frank Stratmann provided that there is a new paper in JGR in late 2013 about contact angle which could be applied in LES.
- Radek Krejci mentioned a work by Japanese scientist on mineral dust in the Arctic (airplane measurement data) – Vertical profile of number of different particles (except sulfate) found during ASTAR2004 (May-June 2004).
- The low hanging fruit could probably be from summarizing the data from the different campaigns in the Arctic, however this would still require some time and would be difficult for WP8 to report in time for CRAICC.

11:00 **Merete Bilde** led a discussion on WP5 aims (*in italics*) and how we can meet these aims

The aim is to gain detailed understanding of the relation between the cryosphere, aerosols and clouds, as well as their climate feedbacks in the Arctic, with a combination of field and lab studies and modeling. The objectives are to analyze:

- *the contributions of natural and anthropogenic aerosol types in the North (primary, secondary, BC and their combinations) to different cloud types*

Berko Sieurau initiated the discussion on How do we differentiate natural and anthropogenic aerosols? This is applicable in the Arctic context; however it cannot be resolved easily. This is also part of BACCHUS

There have been field campaigns and lab studies, we delivered Kappa values. Combination is needed.

- how cloud properties (radiative influence, microstructure and precipitation) depend on aerosol characteristics

We have performed a sufficient amount of work regarding this.

- how these properties change moving into and out of the Arctic, and how they have changed and will change over the coming decades

This is done by a combination of 1) field studies including existing long-term data sets as well as new Arctic field data. Key components are Cloud Condensation Nuclei counters, the Droplet Aerosol Analyzer, and radiation measurements, together with aerosol data from WP 3 and 4. In addition Ice Nuclei counters are developed and deployed as part of this project; 2) satellite retrievals of cloud properties and extent; 3) laboratory studies on ice nucleating properties of aerosols and cloud droplet formation ability of e.g. organics from the Arctic sea surface water; 4) detailed modeling of the quantum chemistry and microphysics of ice nucleation; 5) process-based modeling evaluated against field observations generate parameterizations to be supplied to ESMs in WP8.

Future plans regarding the Ice nuclei counter. Radek Krejci discussed Treffeisen et al. Humidity observations in the Arctic troposphere over Ny-Alesund. <http://www.atmos-chem-phys.net/7/2721/2007/acp-7-2721-2007.pdf> There might be 4 times more likely to have ice clouds in the winter, which has not been investigated. This could be studied further with regards to the ice nuclei counter.

There are measured CCN activities in Hyytiala and Vavihill.

The “coming decades” part in the aim must be from modelling.