BACCHUS

Impact of Biogenic versus Anthropogenic emissions on Clouds and Climate: towards a Holistic UnderStanding

Collaborative Project

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Summary of results

The EGU 2016 conference took place from 17-22 April 2016 in Vienna, Austria. The BACCHUS Project Management Office (PMO) together with the Steering Committee (SC) organized a special BACCHUS session "AS4.5: Impact of Biogenic versus Anthropogenic emissions on Clouds and Climate: towards a Holistic UnderStanding (BACCHUS)", which took place on Wednesday 20 April. The oral session consisted of six presentations of 15 minutes each in the morning from 8:30-10 am, and the poster session exhibited another 15 presentations in the afternoon from 5 pm to 7 pm on the same day.

Oral session

The session started with two solicited presentations, the first by Markku Kulmala from the project partner UHEL, and the second by Graham Feingold from NOAA, member of the BACCHUS Scientific Advisory Board.

Markku Kulmala gave an introduction and overview on the Continental Biosphere-Aerosol-Cloud-Climate feedback (COBACC), which constitutes one of the two main feedback loops investigated in BACCHUS. Kulmala demonstrated the first quantification of the COBACC feedback loop by continuous comprehensive observations at the Station for Measuring Forest Ecosystem-Atmosphere Relations (SMEAR II) in Hyytiälä, Finland, which showed that a 10 ppm increase in atmospheric CO_2 concentration leads to a significant increase in both carbon sink and aerosol source. He explained that these effects operate through changes in gross primary production, volatile organic compound (VOC) emissions and secondary aerosol formation associated with atmospheric oxidation of VOCs.

Graham Feingold presented work on "Quantifying Aerosol influences on the Cloud Radiative Effect". He demonstrated through idealized large eddy simulations and 14 years of surface-based remote sensing measurements at a continental US site that the existence of a detectable cloud microphysical response to aerosol perturbations is neither a necessary, nor a sufficient condition for detectability of a radiative response of shallow liquid cloud fields. He then presented a new framework that focuses on the cloud field properties that most influence shortwave radiation. In this framework, he showed that scene albedo is a robust function of cloud fraction for a variety of cloud systems. Feingold explained that they use the albedo-cloud fraction framework to quantify the cloud radiative effects of shallow liquid clouds. They also use it to demonstrate the primacy of cloud field properties such as cloud fraction and liquid water path for driving the cloud radiative effect, and that the co-variability between meteorological and aerosol drivers has a strong influence on the detectability of the cloud radiative effect, regardless of whether a microphysical response is detected.

Afterwards, Julia Schmale from the project partner PSI presented results from a large collaboration of 18 different institutions, among them 9 BACCHUS partners, on the "Global synthesis of long-term cloud condensation nuclei observations". Schmale presented results of long-term CCN and aerosol number concentrations, as well as size distribution data covering the period 2006 to 2014. 12 locations were investigated including ACTRIS stations in Europe, and further sites in North America, Brazil and Korea. Aerosol populations and their activation behavior show significant differences across the stations. While peak concentrations of CCN are observed in summer at the high altitude sites, in the Arctic the highest concentrations occur

during the Haze period in spring. The rural-marine and rural-continental sites exhibit similar CCN concentration characteristics with a relatively flat annual cycle. At some stations, e.g. in the boreal environment, the annual cycle is more pronounced for higher supersaturations.
Autocorrelation analysis was performed to investigate the persistence of variables over different timescales. Schmale et al. find three different regimes: (1) CCN concentrations persist for a week or longer showing also seasonal patterns. (2) CCN concentrations persist for less than one week and there is little seasonal pattern. And (3) CCN concentrations are highly variable and do not persist longer than 2 days but show seasonal cycles. Several but not all sites show diurnal cycles. These different behaviors are influenced by environmental factors such as rainy seasons in the Amazon or Korea (monsoon) but also by anthropogenic pollution episodes such as during the Arctic Haze period.

In the next contribution, Jurgita Ovadnevaite from the project partner NUIG reported on CCN in the marine environment, presenting results from two intensive measurement campaigns - The Eastern North Atlantic (Mace Head) and The Southern Ocean (PEGASO cruise) - with the main focus on the dependence of CCN spectra on aerosol chemical composition and, especially, origin and sources of marine organics. Activation of sea spray composed of sea salt externally mixed with nss-sulphate as well as sea spray highly enriched in organics was investigated stressing the importance of the latter to the formation of the cloud droplets. In addition, the suitability of existing theories to explain the marine aerosol activation to CCN was explored.

Johannes Bühl from the project partner TROPOS talked on “Measuring the efficiency of ice formation in mixed-phase clouds over Europe with Cloudnet”. They evaluated combined remote sensing data gathered at four different European Cloudnet sites to study the relation between ice and liquid water in mixed-phase cloud layers and to quantify the efficiency of ice production within these clouds. Bühl explained that they derived liquid and ice water content together with vertical motions of ice particles falling through cloud base. The ice mass flux was quantified by combining measurements of ice water content and particle fall velocity. The efficiency of heterogeneous ice formation and its impact on cloud lifetime was estimated for different cloud-top temperatures by relating the ice mass flux and the liquid water content at cloud top. Cloud radar measurements of polarization and fall velocity showed that ice crystals formed in cloud layers with a geometrical thickness of less than 350 m are mostly pristine when they fall out of the cloud. A difference of four orders of magnitude in ice formation efficiency in mixed-phase cloud layers was found over the cloud-top-temperature range from -40 to 0 °C.

The last presentation was given by Stelios Myriokefalitakis from the project partner UOC and was entitled “The contribution of bioaerosols to the organic carbon mass of the atmosphere”. He presented an investigation of the atmospheric cycle of Primary Biogenic Aerosol Particles (PBAPs) by means of parameterization in a global 3-D chemistry-transport model. Primary emissions, as well as chemical ageing during long-range transport in the atmosphere were taken into account due to long-range transport in the atmosphere. In the presented study, Myriokefalitakis et al. explicitly accounted for emissions of bacteria, fungi spores and pollen to the atmosphere, using different ecosystems to parameterize their respective flux rates as well as meteorological parameters to account for their seasonal variation. Changes in the solubility of bioaerosols via atmospheric oxidation during their atmospheric cycle were parameterized. Model results were compared to observations to constrain the PBAPs contribution to the aerosol organic mass. Uncertainties were discussed based on model simulations.

Poster session

Out of the 15 poster presentations, 13 were from the BACCHUS project illustrating the progress in the project. The below presentations were given:

- CCN frequency distributions and aerosol chemical composition from long-term observations at European ACTRIS supersites. Stefano Decesari, Matteo Rinaldi, Julia Yvonne Schmale, Martin Gysel, Roman Fröhlich, Laurent Poulain, Silvia Henning, Frank Stratmann, and Maria Cristina Facchini (CNR-ISAC).
- Cloud condensation nuclei closure study on long-term observation data. Julia Schmale, Silvia Henning, Frank Stratmann, Bas Henzing, Gerard Kos, Patrick Schlag, Ruprecht Holzinger, Pasi Aalto, Helmi Keskinen, Mikhail Paramonov, Laurent Poulain, Jurgita Ovadnevaite, Mira Krüger, Samara Carbone, Joel Brito, Roman Fröhlich, Erik Herrmann, Emanuel Hammer, Urs Baltensperger, Martin Gysel and the CCN Team (PSI).
- Study of the CCN formation as a function of aerosol components. George S. Fanourgakis, Stelios Myriokefalitakis, and Maria Kanakidou (UOC).
- 10 years of cloud droplet activation data from Pallas, Northern Finland – preliminary results. Niku Kivekäs, Eija Asmi, David Brus, Mika Komppula, and Heikki Lihavainen.
- European Marine Background Ice Nucleating Particle concentrations Measured at the Mace Head Station, Ireland. James Atkinson, Zamin A. Kanji, Jurgita Ovadnevaite, Darius Ceburnis, and Colin O'Dowd (ETHZ).
- Ice Nucleating Particles at Mace Head during the 2015 BACCHUS campaign through online measurements. Matteo Rinaldi, Franco Belosi, Alessia Nicosia, Gianni Santachiara, Stefano Decesari, and Maria Cristina Facchini (CNR-ISAC).
- multi-dimensional Cloud-aERosol Exploratory Study using RPAS (mCERES): Bottom-up and top-down closure of aerosol-cloud interactions. Greg Roberts, Radiance Calmer, Kevin Sanchez, Grégoire Cayez, Kerianne Nicoll, Eyal Hashimshoni, Daniel Rosenfeld, Albert Ansmann, Jean Sciare, Jurgita Ovadneite, Murat Bronz, Gautier Hattenberger, Jana Preissler, Johannes Buehl, Darius Ceburnis, and Colin O'Dowd (CNRS-GAME).
- Closure between ice-nucleating particle and ice crystal number concentrations in ice clouds embedded in Saharan dust: Lidar observation during the BACCHUS Cyprus 2015 campaign. Rodanthi-Elisavet Mamouri, Albert Ansmann, Johannes Bühl, Ronny Engelmann, Holger Baars, Argyro Nisantzi, Diofantos Hadjimitsis, James Atkinson, Zamin Kanji, Michalis Vrekoussis, Jean Sciare, and Nikos Mihalopoulos (CUT).
- IN and CCN Measurements on RV Polarstern and Cape Verde. André Welti, Paul Herenz, Silvia Henning, and Frank Stratmann (TROPOS).
- Long-Term INP Measurements within the BACCHUS project. Jann Schrod, Heinz Bingemer, and Joachim Curtius (UOF).
- Atmospheric aging of dust ice nucleating particles – a combined laboratory and field approach. Yvonne Boose, Sergio Rodríguez, M. Isabel García, Claudia Linke, Martin Schnaiter, Assaf Zipori, Ian Crawford, Ulrike Lohmann, Zamin A. Kanji, and Berko Sierau (ETHZ).
- Observations of alkylamines at a costal site in the East Mediterranean. Evaggelia Tzitzikalaki, Antti-Jussi Kieloaho, Heidi Hellén, Hannele Hakola, Nikolaos Kalivitis, Giorgos Kouvarakis, Veli-Matti Kerminen, Nikolaos Mihalopoulos, and Maria Kanakidou (UOC).

- Number size distribution measurements of biological aerosols under contrasting environments and seasons from southern tropical India. Aswathy Valsan, Biju Cv, Ravi Krishna, Alex Huffman, Ulrich Poschl, and Sachin Gunthe.
- How Will Aerosol-Cloud Interactions Change in an Ice-Free Arctic Summer? Anina Gilgen, Wan Ting Katty Huang, Luisa Ickes, and Ulrike Lohmann (ETHZ).
- Investigations of BVOC-SOA-cloud-climate feedbacks via interactive biogenic emissions using NorESM. Kari Alterskjær, Jon Egill Kristjansson, Alf Grini, Trond Iversen, Alf Kirkevåg, Dirk Olivié, Michael Schulz, and Øyvind Seland (UiO).

Summary
We look back on a very successful conference day with a large number of highly interesting and excellent oral and poster presentations. Both sessions were very well attended, and the poster session featured many lively and intense discussions of the BACCHUS results.

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No changes with respect to the Dow.