BACCHUS

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

Collaborative Project

SEVENTH FRAMEWORK PROGRAMME
ENV.2013.6.1-2

Atmospheric processes, eco-systems and climate change

Grant agreement no: 603445

Deliverable number:	**D5.6**
Deliverable name:	Summer school for PhD students and young researchers
WP number:	5
Delivery date:	Project month 33 (31/08/2016)
Actual date of submission:	29/08/2016
Dissemination level:	PU
Lead beneficiary:	UHEL
Responsible scientist/administrator:	Markku Kulmala (UHEL)
Estimated effort (PM):	1
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Estimated effort contributor(s) (PM):	1
Internal reviewer:	Ulrike Lohmann/Monika Burkert

Summary of results

Hyytiälä Winter School 2016: "Atmospheric processes and feedbacks, and biosphere-atmosphere interactions"

The work on the course continued on the topics initialized in the BACCHUS winter school 2015 (see Deliverable D5.3).

The winter school was organized by University of Helsinki at the Hyytiälä Forestry field station 7–18 March, 2016. It was aimed at PhD students in the fields of atmospheric and biospheric sciences. The participants of the winter school obtained 5 ECTS. The work during the winter school was based on analyzing measurement data from the Hyytiälä SMEAR II station and the CLOUD experiments in three groups, each consisting of 6–10 students led by assistants and teachers. The progress of the group works was presented in 3 presentations during the winter school, and a final report summarizing the main scientific results and conclusions was written by each group. For the abstracts of the final reports, please see Appendix 1. The winter school established a network for a number of young researchers to work in the field of BACCHUS.

The main topics of the winter school were covering several BACCHUS objectives:

1. Quantification of feedback loops related to the interactions between atmosphere and biosphere, and global scale assessments of the feedback loops. As an example, see the COBACC[1]/BACCHUS feedback loop on the right (related to BACCHUS WP1 and in connection with WP4). The following aspects were covered:
   - Gross primary production (GPP) during dry periods
   - The controllers of biogenic volatile organic compound (BVOC) emissions

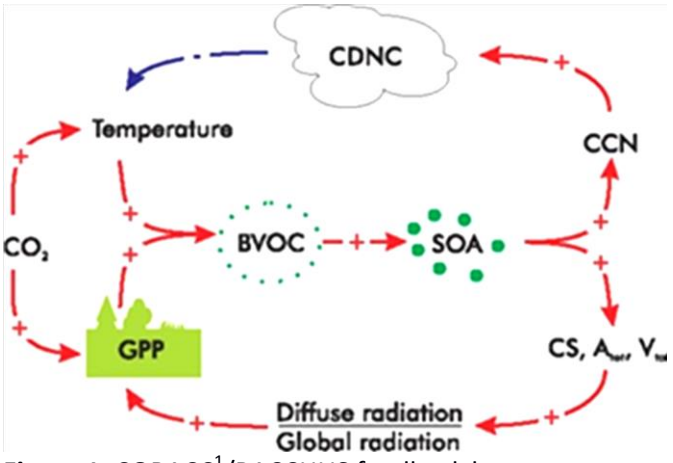

Figure 1. COBACC[1]/BACCHUS feedback loop

   - The BVOC – SOA (secondary organic aerosol) – CCN (cloud condensation nucleus) continuum
   - CCN – CDNC (cloud droplet number concentration) relationship
   - CDNC – BVOC concentration relationship
   - SOA effect on CS (condensation sink)
   - Relationship between sea ice extent in northern hemisphere, CO_2, GPP, BVOC, and nucleation events
   - Effect of air masses using back trajectories

2. Detailed study of the steps leading to new particle formation and further growth into cloud condensation nuclei (CCN) in the boreal forest environment, involving data from mass

[1] COntinental Biosphere-Aerosol-Cloud-Climate

spectrometers and aerosol size distribution measurements (BACCHUS WP2). To calculate continuous growth rates (GR), GRs defined for new particle formation events were compared to different kinds of variables, e.g. concentrations of oxidized organic compounds, ammonia, monoterpenes, ozone, and ions, as well as temperature, time of day, relative humidity, and condensation sink.

3. The role of negative ions and neutral clusters in formation of atmospheric aerosol were studied by determining the chemical composition of various volatile organic compound (VOC) oxidation products with mass spectrometric techniques on selected new particle formation (NPF) event and non-event days from Hyytiälä (BACCHUS WP2). As an example see the figure below.

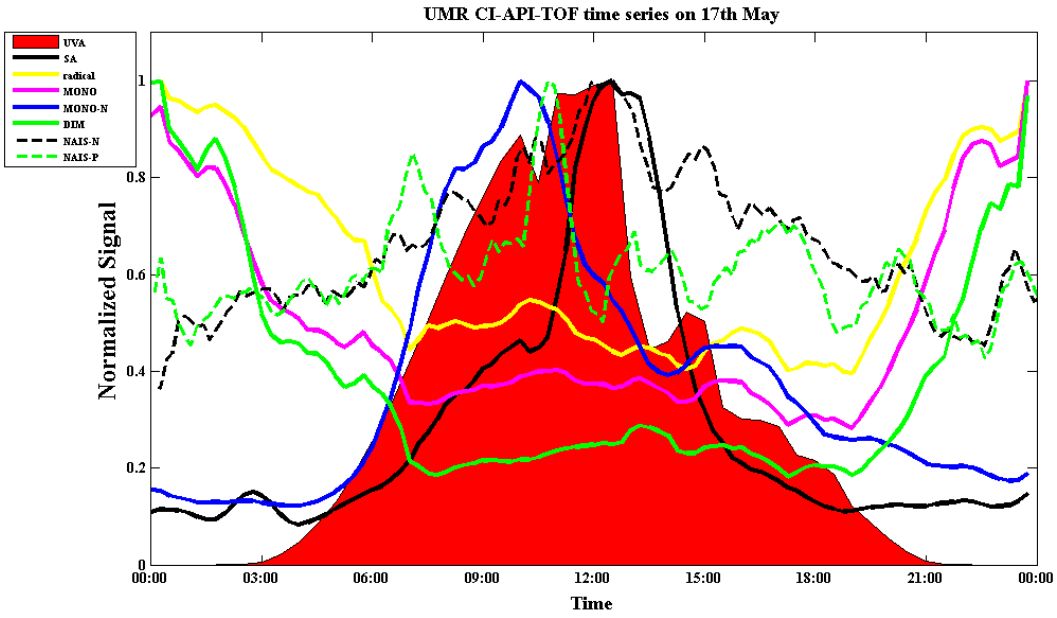

Figure 2. UMR CI-APi-TOF time series of HOM monomer (MONO), HOM dimer (DIM), organonitrate monomer (MONO-N), monomer radical (radical), sulfuric acid (SA), number concentration of neutral particles measured by NAIS (NAIS-N: NAIS negative channel; NAIS-P: NAIS positive channel) on a non-event day, May 17, 2013. The red shaded area represents the UVA radiation. All time traces are normalized by their maximum.

In addition to the group work, the winter school had also lectures supporting the work (e.g. utilizing the quantified feedback loops in ESMs and efficient use of data analysis and data mining methods) as well as on career development and philosophy of science. The winter school programme is attached (Appendix 2).

The leader of the winter school was Prof. Markku Kulmala from University of Helsinki. Lecturers and teachers were mainly from the University of Helsinki:
Prof. Jaana Bäck (University of Helsinki)
Prof. Pepe Hari (University of Helsinki)
Prof. Tuukka Petäjä (University of Helsinki)
Dr. Heikki Junninen (University of Helsinki)
Dr. Olaf Krüger (University of Helsinki)
Dr. Katrianne Lehtipalo (Paul Scherrer Institute)
Dr. Risto Makkonen (University of Helsinki)

The winter school had 20 students from 6 European universities and China (BACCHUS partner institutes indicated with *):

Hari Adhikari (University of Helsinki) *
Lauri Ahonen (University of Helsinki) *
Kirill Barskov (A.M.Obukhov Institute of Atmospheric Physics RAS)
Elisa Halmeenmäki (University of Helsinki) *
Xucheng He (University of Helsinki) *
Jinxiu Liu (University of Helsinki) *
Yuqin Liu (University of Helsinki) *
Krista Luoma (University of Helsinki) *
Teemu Paljakka (University of Helsinki) *
Kaisa Rissanen (University of Helsinki) *
Ida Alexandra Rosendahl (Aarhus University)
Sophia Theodorou (Stockholm University)
Zhou Ying (Lund University)
Robert Chellapermal (University of Helsinki) *
Ximeng Qi (University of Helsinki) *
Yicheng Shen (Nanjing University)
Zhang Yurui (University of Helsinki) *
Xu Zhengning (Nanjing University)
Wan Ting Katty Huang (ETH Zürich) *
Siddharth Iyer (University of Helsinki) *

Changes with respect to the DoW

Instead of a summer school in month 31 as planned in the DoW, the course was given as a winter school in month 26 already. This change allowed that the results from the course can be better utilized in the BACCHUS project.

Appendices

Appendix 1: Abstracts of the final reports from groups (pp. 5-7)
Appendix 2: Programme of the course (p. 8)

Appendix 1: Abstracts of the final reports from groups

An updated ecosystem - climate feedback loop

H. Adhikari[1], K. Barskov[2], E. Halmeenmäki[3], W. T. K. Huang[4], J. Liu[1], Y. Liu[5], T. Paljakka[6], K. Rissanen[6], S.E. Theodorou[7], Y. Zhou[8], Y. Zhang[1], J. Aalto, J. Hong[3], R. Makkonen[3], A. Manninen[3], S. Buenrostro Mazon[3], S. Schallhart[3]

[1] Department of Geosciences and Geography, Helsinki University,
[2] A.M. Obukhov Institute of Atmospheric Physics, Russian Academy of Science,
[3] Department of Physics, University of Helsinki,
[4] Institute for Atmospheric and Climate Science, ETH Zurich,
[5] Institute of remote sensing and digital earth, Chinese Academy of Science,
[6] Department of Forest Sciences, University of Helsinki,
[7] Department of Environmental Science and Analytical Chemistry (ACES), Stockholm University,
[8] Department of Physical Geography and Ecosystem Science, Lund University,

Abstract

The separate parts of COBACC (COntinental Biosphere-Aerosol-Cloud-Climate) feedback loop were evaluated and partly quantified using SMEAR II station data from 1996 to 2015. In addition, the effect of sea ice extent and back trajectories were taken into consideration. Certain relation inside the feedback loop are verified quantitatively and some additions to the loop are proposed.

New Particle Formation

Hyytiälä Winter School 2016
Course Report

Students:
[1]Lauri Ahonen,
[1]Robert Chellapermal,
[1]Krista Luoma,
[1,3]Ximeng Qi,
[3]Yicheng Shen,

Assistants:
[1]Lubna Dada,
[1]Robert Wagner,
[1]Xuemeng Chen,
[1, 2]Katrianne Lehtipalo

[1]Department of Physics, P.O. Box 64, 00014, University of Helsinki, Helsinki, Finland
[2]Paul Scherrer Institute, 5232 Villigen PSI, Switzerland
[3]Department of Atmospheric Science, 210046, Nanjing University, Nanjing, China
keywords: Nucleation, Growth/Formation rate, Ion, OxOrg proxy

Abstract

Comprehensive data analysis was performed to shed light on mechanisms driving or inhibiting new particle formation in the boreal forest at the SMEAR II station in Hyytiälä, Finland. We used several approaches to cover as many factors as possible. Growth rates of aerosol particles and ions were compared to different kind of variables and continuous growth rate for aerosol particles was defined by [OxOrg] proxy. The relation between ions measured by ion spectrometers and by mass spectrometers was investigated. We present first results of atmospheric measurements with the ion-trap-PSM setup. We investigated the start time of ions in comparison to particles during new particle formation episodes.

Comparison of atmospheric ions and neutral molecules during new particle formation event and non-event days

Mass Spectrometry Group Report
Winter School Hyytiälä 2016
University of Helsinki

Students:
Xucheng He, Division of Atmospheric Sciences, University of Helsinki
Siddharth Iyer, Laboratory of Physical Chemistry, University of Helsinki
Ida Rosendahl, Department of Chemistry, Aarhus University
Zhengning Xu, School of Atmospheric Sciences, Nanjing University

Assistants:
Federico Bianchi
Olga Garmash
Matti P. Rissanen
Chao Yan

Abstract

The role of ions and neutral molecules in the formation of aerosols over Hyytiälä was investigated by comparing the negative ion and neutral molecule concentrations in the ambient air during new particle formation (NPF) event and non-event days. The composition of neutral air molecules was retrieved from a nitrate-based Chemical Ionization Atmospheric Pressure interface Time-Of-Flight mass spectrometer (CI-APi-TOF). The composition of air ions was recorded by an APi-TOF, an instrument without the ionization inlet. This study focuses on the diurnal pattern of Volatile Organic Compound (VOC) oxidation products. The Highly Oxidized Multifunctional molecules (HOM) monomers, dimers and organonitrates (ON), both neutrals and negative ions, show similar diurnal patterns on the event and non-event days studied here. Ion ON and HOM sulfate show different diurnal changes in comparison to ion HOM dimer clusters and HOM nitrate; they peak during the day rather than in the night, due to photochemical reactions. This finding confirms the diurnal changes observed by CI-APi-TOF. A further investigation of differences in ON concentration during the event and non-event day could shed light into their role in the mechanism involved in the new particle formation.

Appendix 2: Programme of the course

BACCHUS WINTER 2016 SCHOOL

Atmospheric Processes and Feedbacks and Atmosphere-Biosphere Interactions

COURSE PROGRAMME

March 7 – 12:

	Mon 7th	Tue 8th	Wed 9th	Thu 10th	Fri 11th	Sat 12th
Morning		**Visit to SMEAR II**	**5-minute presentations of groups' plans** **Specifications to the Group Work topics** (M. Kulmala) **Group Work**	**Global scale assessments of feedback loops** (R. Makkonen) **Group Work**	**Group Work**	**Group Work**
Afternoon		**Introduction to the Course and the Requirements** (M. Kulmala) **MATLAB + SmartSMEAR** (H. Junninen) **Group Division & Start of Group Work**	**Group Work**	**Group Work**	**1st students' presentations** **Group Work**	**Group Work**
Evening	**Travel to Hyytiälä**		**Group Work** **Sauna**	**Group Work**	**Group Work**	**Group Work**

March 13 – 18:

	Sun 13th	Mon 14th	Tue 15th	Wed 16th	Thu 17th	Fri 18th
Morning	**Group Work**	**2nd students' presentations**	**Group Work**	**Group Work**	**3rd students' presentations**	**Travel to Helsinki**
Afternoon	**Excursion**	**Group Work**	**Group Work** **Career and Writing in Science** (M. Kulmala) **Philosophy of Science** (P. Hari) **Sauna**	**Group Work**	**Group Work**	
Evening		**Table Tennis Tournament**		**Group Work**	**Course Party**	