Biogenic Aerosols: Effects on Clouds and Climate (BAECC) 2014

Tuukka Petäjä
Dmitri Moisseev
Ewan O'Connor
et al.

Department of Physics, University of Helsinki, Finland

Finnish Meteorological Institute, Helsinki, Finland

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University of Helsinki Atmospheric Sciences

Biogenic Aerosols- Effects on Clouds and Climate (BAECC) a proposal for the ARM Mobile facility incl. (M)AOS

Lead Scientist *

Dr. Tuukka Petäjä	Division of Atmospheric Sciences, Department of Physics, University of Helsinki (UHEL)
For Contact:	**e-mail:** tuukka.petaja@helsinki.fi ; **mobile:** +358-50-41 55278

Co-Investigators

Dr. Dmitri Moisseev	Radar laboratory, Division of Atmospheric Sciences, Department of Physics, University of Helsinki (UHEL)
Dr. Ewan O'Connor	Finnish Meteorological Institute, Helsinki, Finland (FMI), and University of Reading, UK
Dr. Hanna Lappalainen	Division of Atmospheric Sciences, Department of Physics, University of Helsinki (UHEL), and Finnish Meteorological Institute (FMI)
MSc. Janne Levula	Station for Measuring Forest Ecosystem – Atmosphere Relations (SMEAR), and Division of Atmospheric Sciences, Department of Physics, University of Helsinki (UHEL)
Dr. Jaana Bäck	Department of Forestry, University of Helsinki, and Division of Atmospheric Sciences, Department of Physics, University of Helsinki (UHEL)
Dr. Michael Boy	Division of Atmospheric Sciences, Department of Physics, University of Helsinki (UHEL)
Dr. Mika Komppula	Finnish Meteorological Institute (FMI)
Dr. Anders Lindfors	Finnish Meteorological Institute (FMI)
Dr. Harri Kokkola	Finnish Meteorological Institute (FMI)
Dr. Hannele Korhonen	Finnish Meteorological Institute (FMI)
Dr. Heikki Lihavainen	**Finnish Meteorological Institute (FMI)**
Dr. Sami Romakkaniemi	University of Eastern Finland (UEF)
Prof. Veli-Matti Kerminen	Division of Atmospheric Sciences, Department of Physics, University of Helsinki (UHEL)
Prof. Kari Lehtinen	Finnish Meteorological Institute (FMI)
Prof. V. Chandrasekar	Division of Atmospheric Sciences, Department of Physics, University of Helsinki (UHEL), and Colorado State University (CSU)
Prof. Gerrit de Leeuw	Division of Atmospheric Sciences, Department of Physics, University of Helsinki (UHEL), and Finnish Meteorological Institute (FMI)
Prof. Ari Laaksonen	Finnish Meteorological Institute (FMI), and University of Eastern Finland (UEF)
Prof. Douglas R. Worsnop	University of Helsinki (UHEL-ATM), Finnish Meteorological Institute (FMI), and Aerodyne, USA
Prof. Markku Kulmala	Division of Atmospheric Sciences, Department of Physics, University of Helsinki (UHEL)

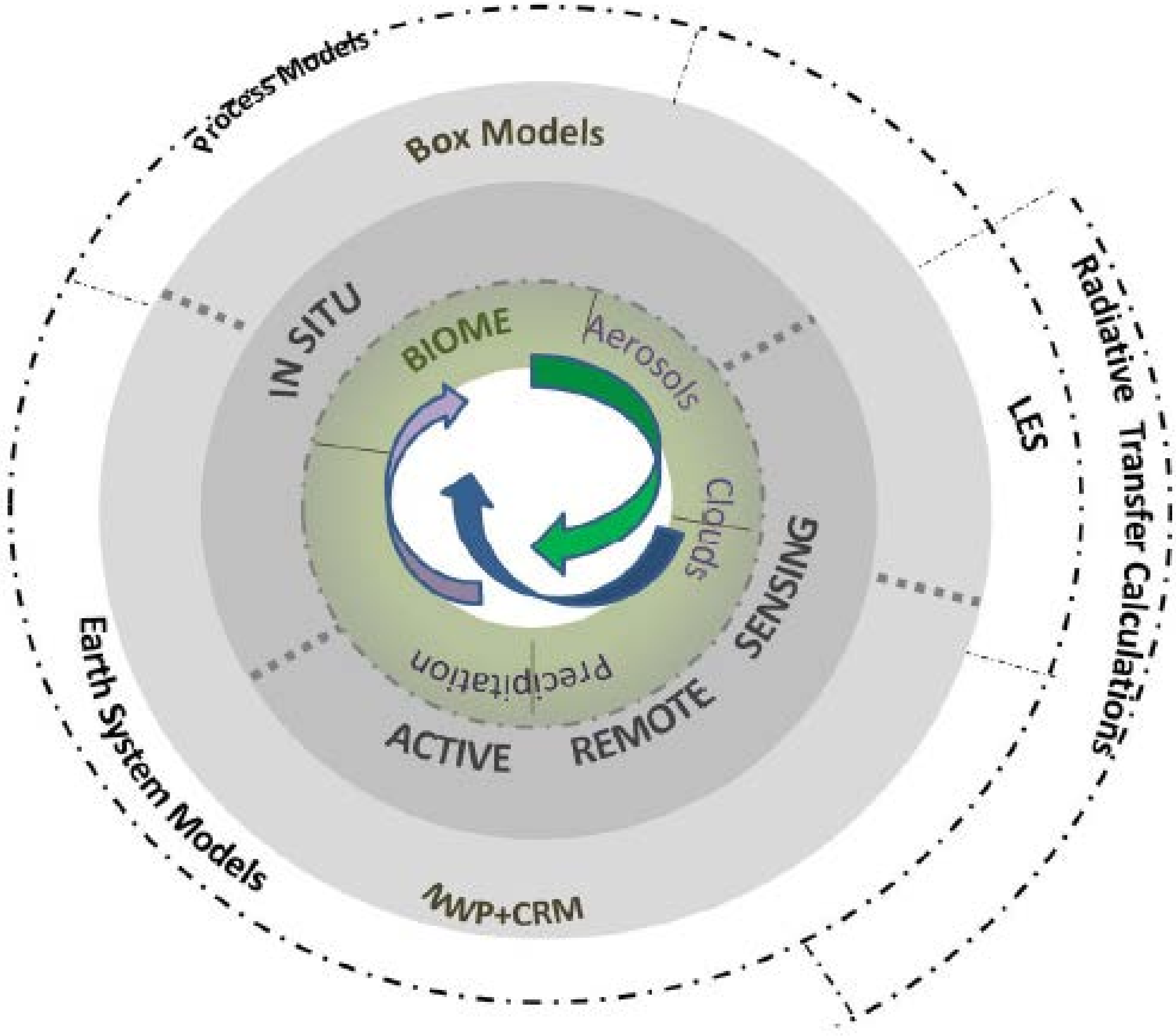
BAECC goals

Generally:

1) To understand the impact of biogenic aerosol formation on cloud properties and climate

Specifically:

1) To resolve the role of biogenic secondary aerosol formation in cloud processes in warm, mixed phase and ice clouds over boreal environment,
2) by utilizing AMF2 remote sensing capabilities with process-scale modeling to complete the link between our comphrehensive 19-year observational record of aerosol and biosphere-atmosphere interactions to cloud processes,
3) To expand our local observations over larger spatial scales up to Earth System behavior via hierarchy of models and satellite observations

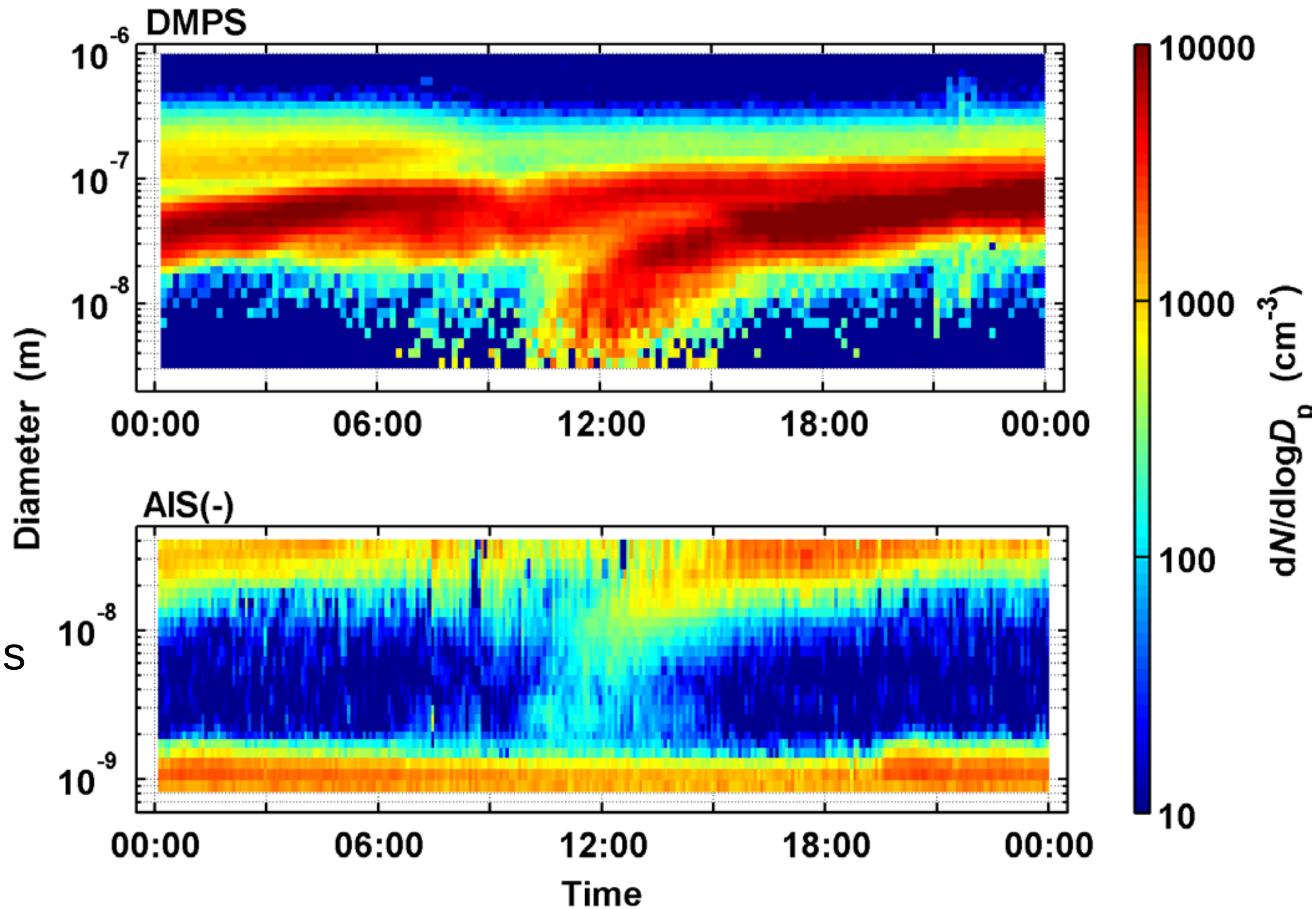

Process Models
Box Models
IN SITU
BIOME
Aerosols
Clouds
precipitation
SENSING
REMOTE
ACTIVE
NWP+CRM
Earth System Models
LES
Radiative Transfer Calculations

Atmospheric new particle formation and growth events

Composition & concentration of:

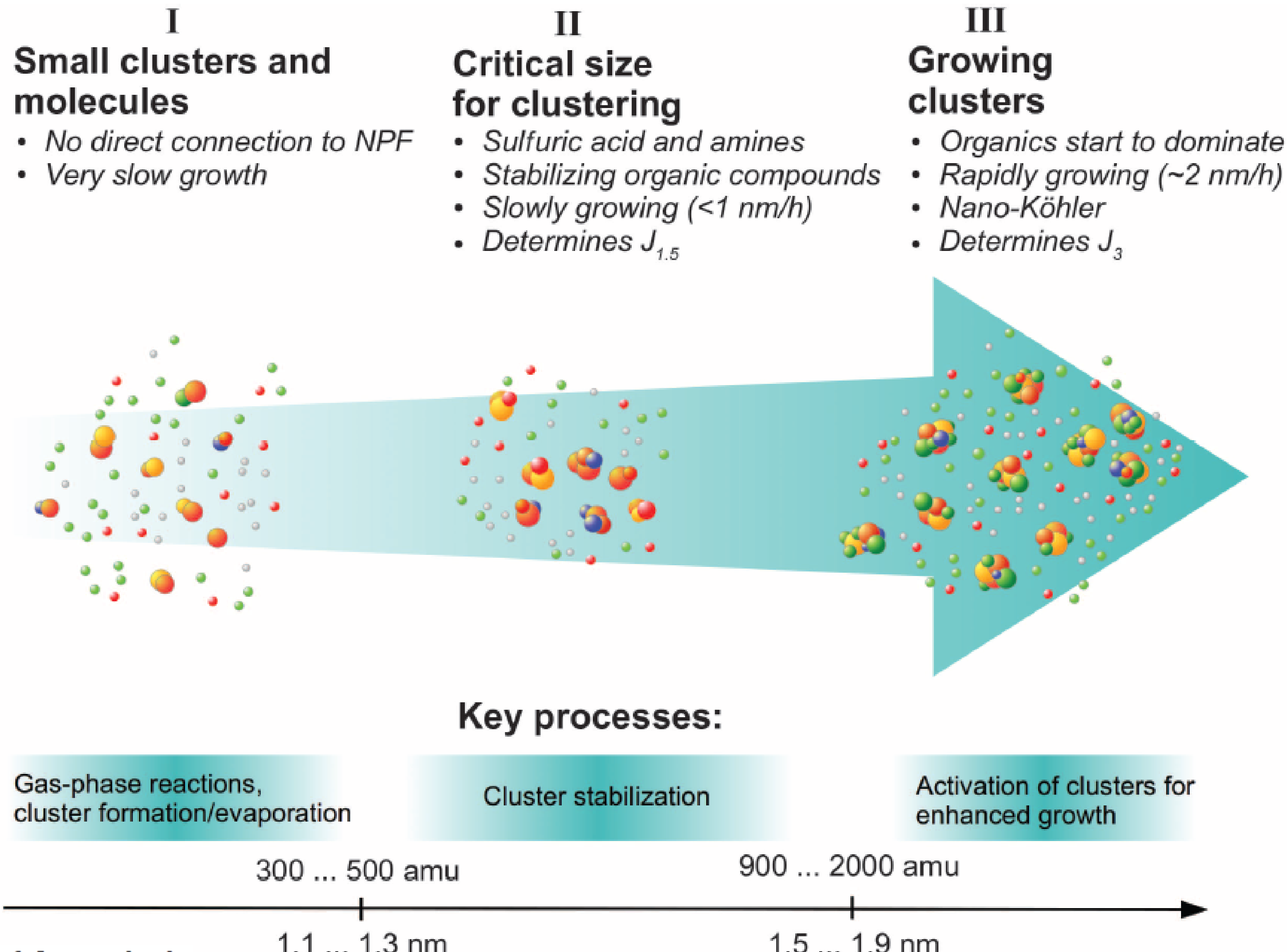
- precursor gases
- initial clusters
- gases responsible for the subsequent growth

From nano to global



Mäkelä et al. 1997, GRL
Kulmala et al. 2001, Tellus

Science AAAS



Direct Observations of Atmospheric Aerosol Nucleation

Markku Kulmala,[1*] Jenni Kontkanen,[1] Heikki Junninen,[1] Katrianne Lehtipalo,[1] Hanna E. Manninen,[1] Tuomo Nieminen,[1,14] Tuukka Petäjä,[1] Mikko Sipilä,[1] Siegfried Schobesberger,[1] Pekka Rantala,[1] Alessandro Franchin,[1] Tuija Jokinen,[1] Emma Järvinen,[1] Mikko Äijälä,[1] Juha Kangasluoma,[1] Jani Hakala,[1] Pasi P. Aalto,[1] Pauli Paasonen,[1] Jyri Mikkilä,[2] Joonas Vanhanen,[2] Juho Aalto,[3] Hannele Hakola,[4] Ulla Makkonen,[4] Taina Ruuskanen,[1] Roy L. Mauldin III,[1,5] Jonathan Duplissy,[1] Hanna Vehkamäki,[1] Jaana Bäck,[6] Aki Kortelainen,[7] Ilona Riipinen,[8] Theo Kurtén,[1,9] Murray V. Johnston,[10] James N. Smith,[7,11] Mikael Ehn,[1,12] Thomas F. Mentel,[12] Kari E. J. Lehtinen,[4,7] Ari Laaksonen,[4,7] Veli-Matti Kerminen,[1] Douglas R. Worsnop[1,4,7,13]

Direct Observations of Atmospheric Aerosol Nucleation

Markku Kulmala *et al.*
Science **339**, 943 (2013);
DOI: 10.1126/science.1227385

Cloud condensation nuclei production associated with atmospheric nucleation: a synthesis based on existing literature and new results

Atmospheric Chemistry and Physics

V.-M. Kerminen[1], M. Paramonov[1], T. Anttila[2], I. Riipinen[3], C. Fountoukis[4], H. Korhonen[5], E. Asmi[2], L. Laakso[2], H. Lihavainen[2], E. Swietlicki[6], B. Svenningsson[6], A. Asmi[1], S. N. Pandis[4], M. Kulmala[1], and T. Petäjä[1]

Atmos. Chem. Phys., 12, 12037–12059, 2012

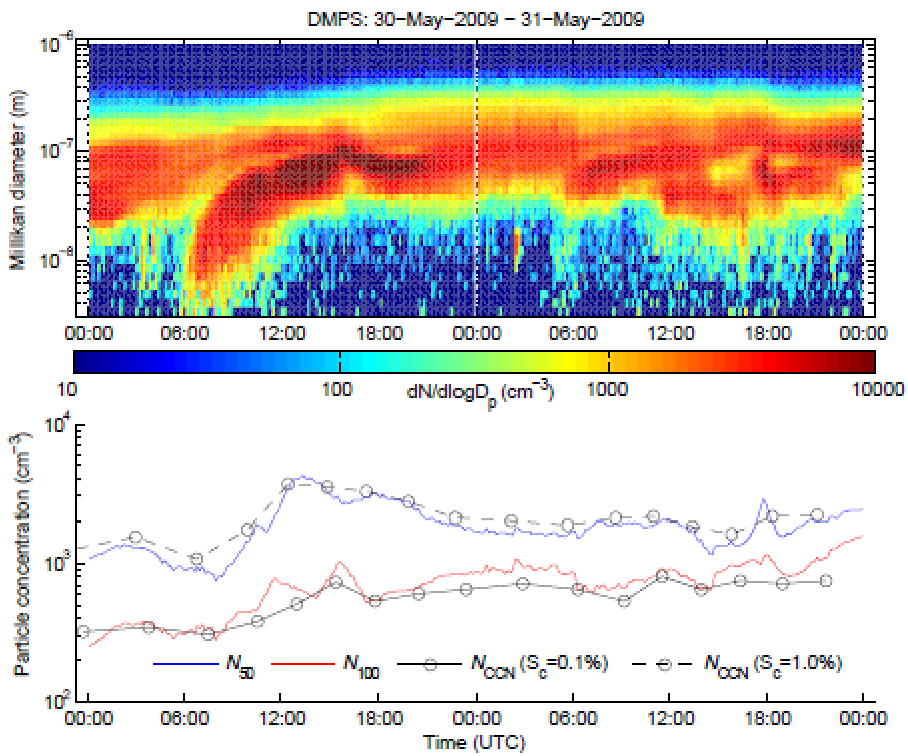


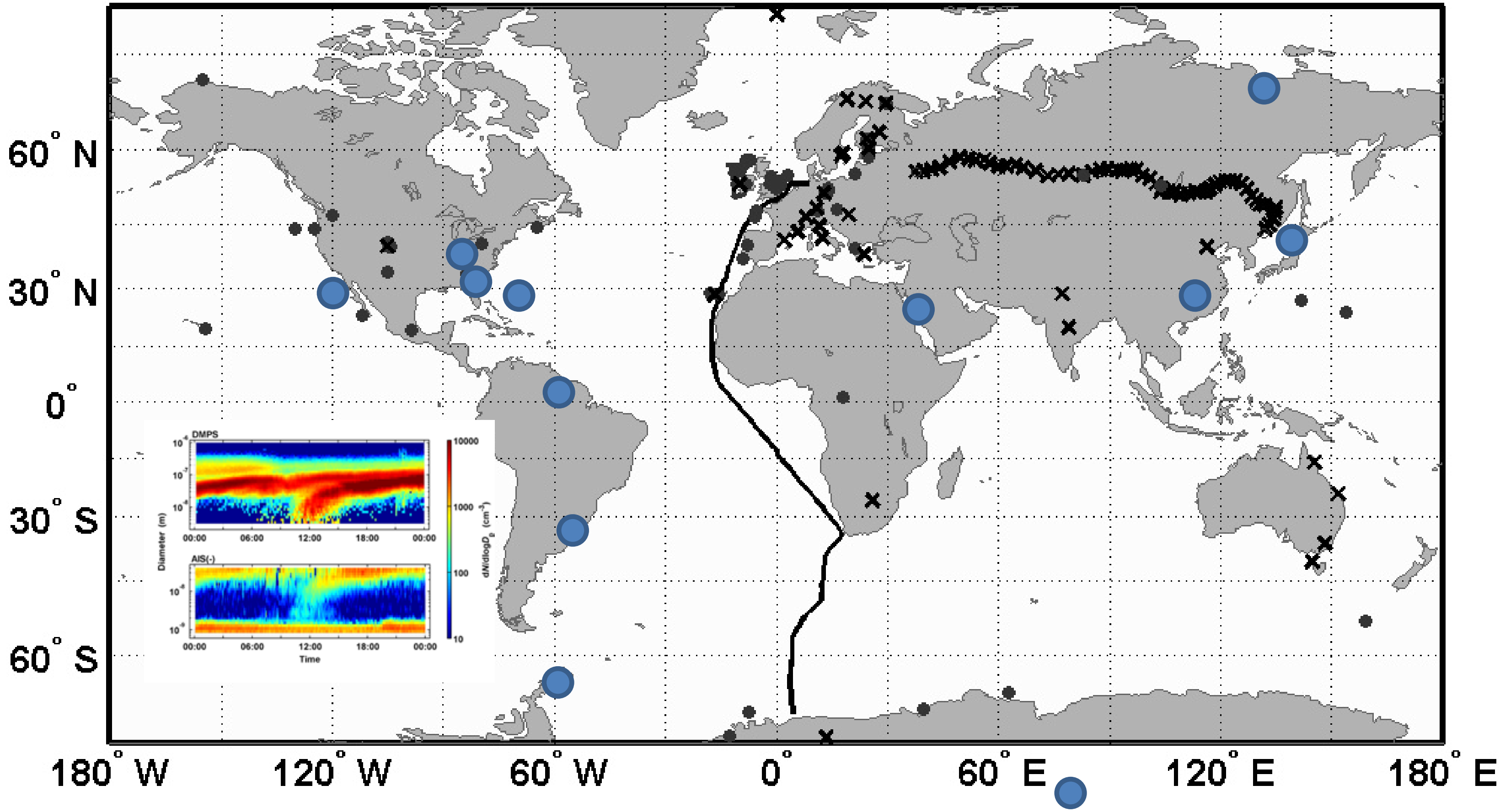
Fig. 3. An example of a nucleation event in Hyytiälä station on May 30, 2009. The top panel depicts the time series of particle number size distribution. The bottom panel shows the corresponding time series of two DMPS-derived CCN concentrations (N_{50} and N_{100}) and two CCN concentrations N_{CCN} measured by the CCNC at two supersaturation (S_c) levels of 0.1 % and 1.0 %.

Aerosol formation leads to a substantial increase in CCN concentrations (based on in-situ observations).

In boreal environment the increase can be 100% (Sihto et al. 2011, ACP).

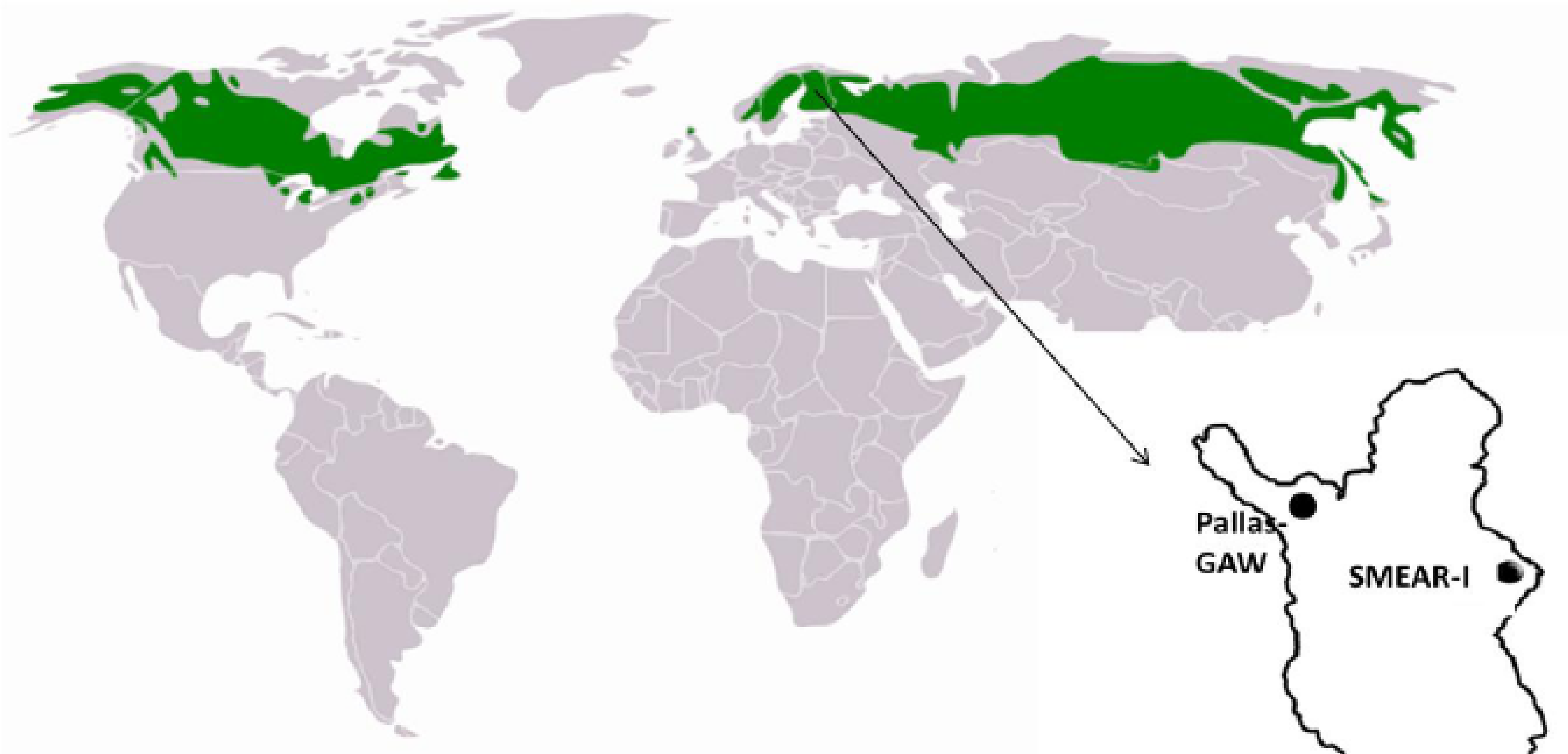
Global measurement activities

Particle formation and growth is a global phenomenon (Kulmala et al., JAS 2004)



- Contributes significantly to global particle and CCN numbers

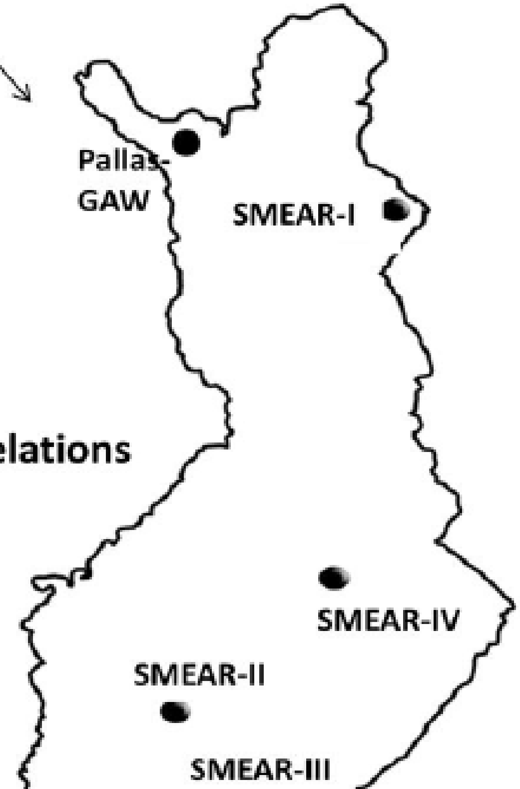
(Spracklen et al., 2006; 2008; Merikanto et al. 2009)



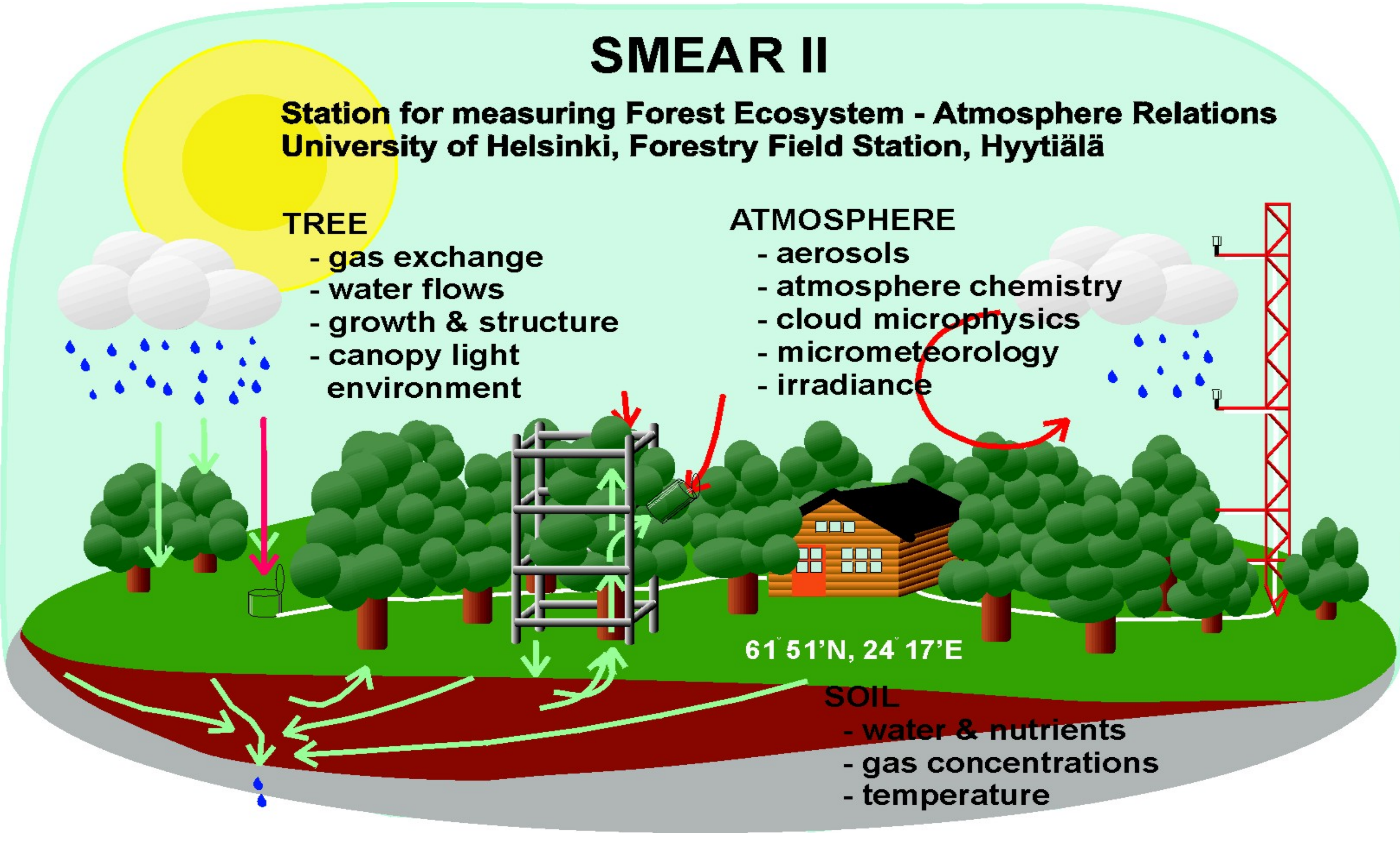
Stations for Measuring Forest Ecosystem–Atmosphere Relations

SMEAR-I Värriö 67°46' N, 29°35' E
SMEAR-II Hyytiälä 61°51 ' N, 24°17´E
SMEAR-III Helsinki 60° 12'N, 24° 57' E
SMEAR-IV Puijo 62°54 'N, 27 °39'E

Pallas-GAW station 67°58'N, 24°07'E



Continuous Measurements



SMEAR stations

I Värriö
II Hyytiälä
III Kumpula
IV Kuopio, Puijo

Welgegund, South Africa
Järvselja, Estonia
Nanjing, China

Pallas-Sodankylä
GAW, Finnish Met. Institute


Aerial image (2010) 1: 8 000
Mast
AOS
Doppler lidar
Hyytiälä
Radars
0
250 m
Copying not authorized
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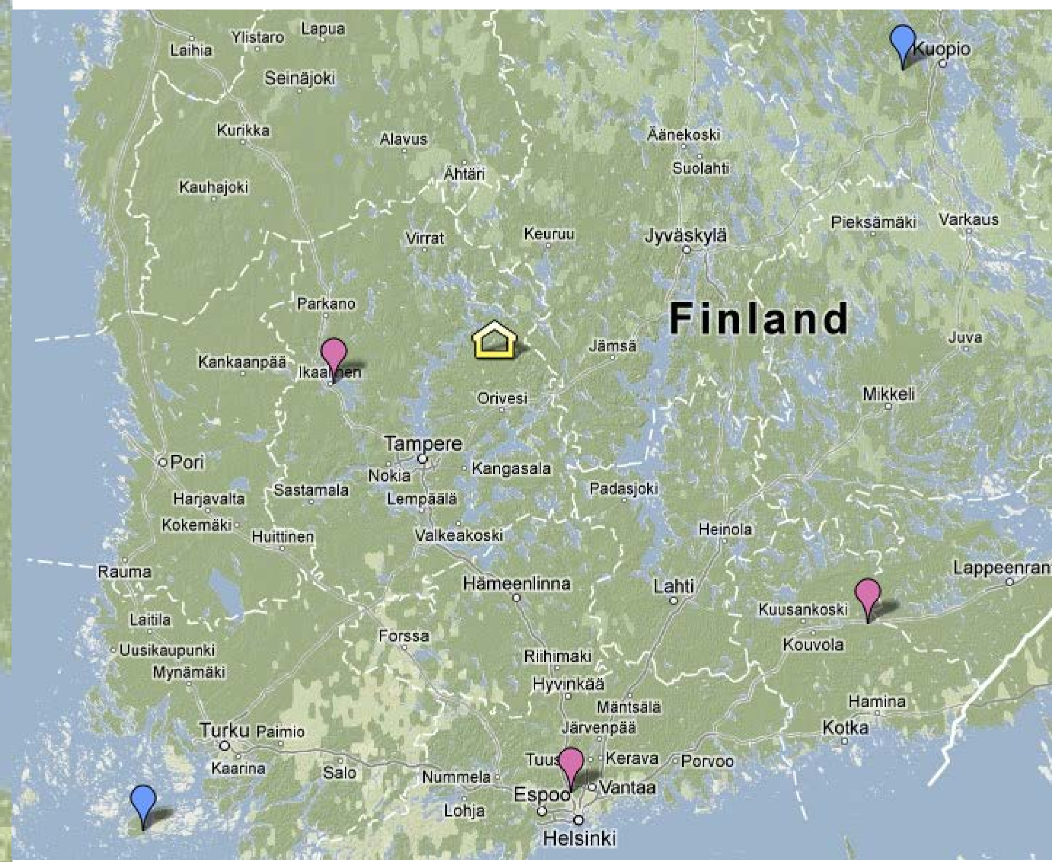
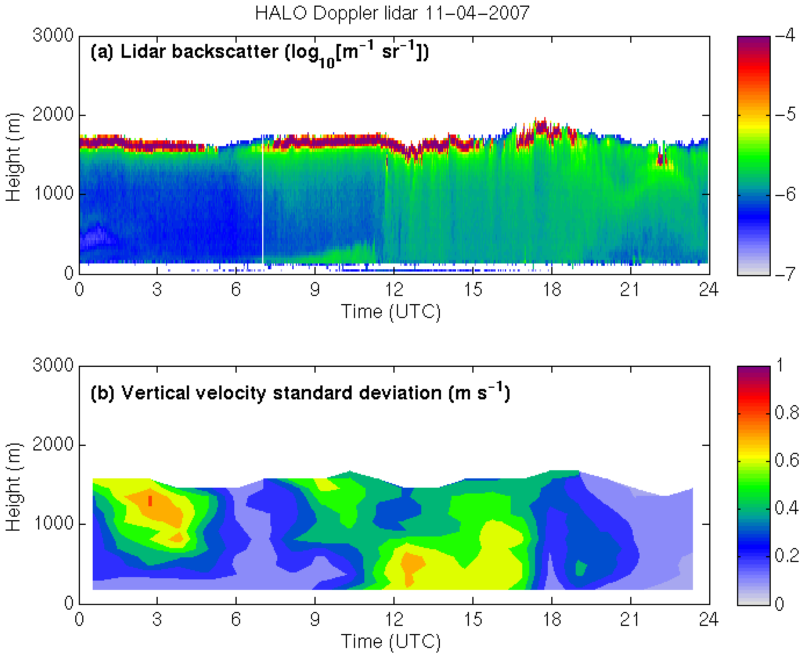
BAECC – Measurement Setup

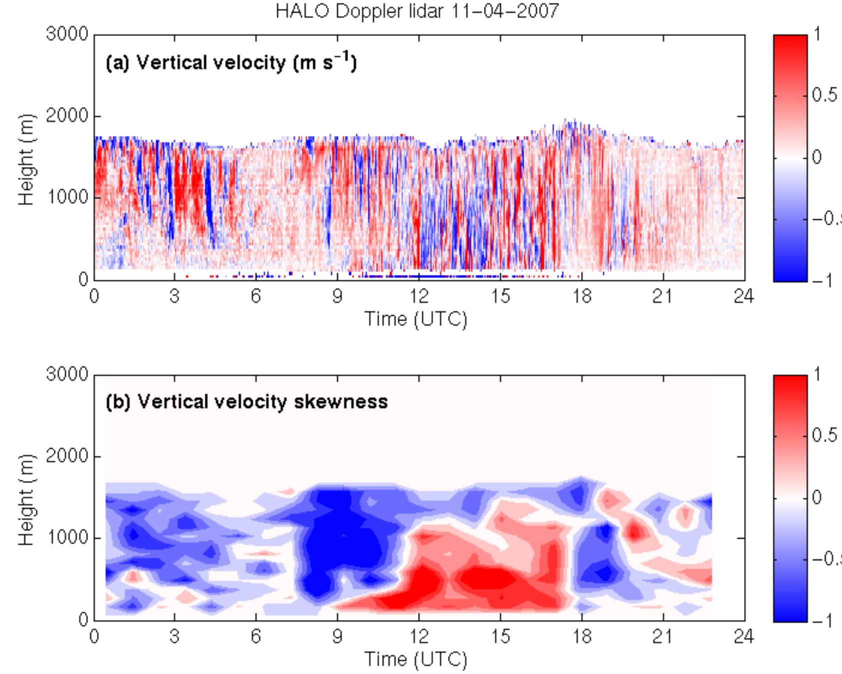
Finnish Weather Radar Network

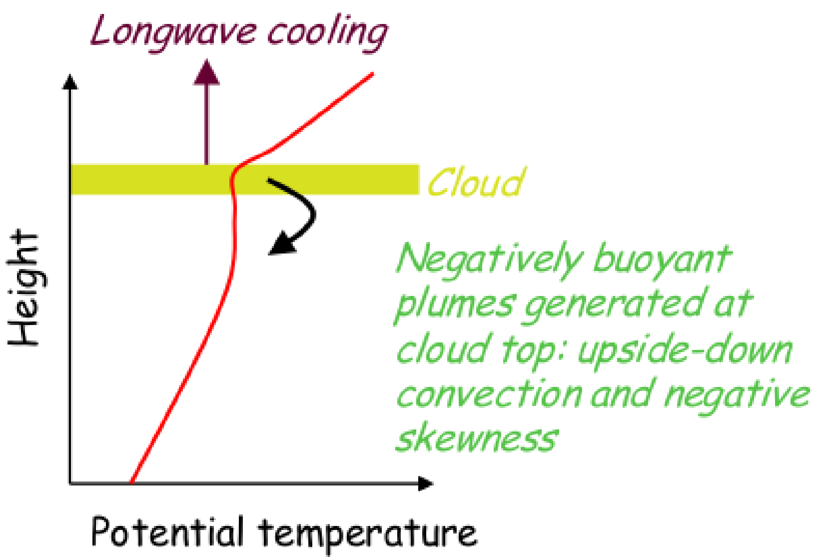
- 8 C-band weather radars
- 3 Dual-pol radars
- 5 Doppler radars

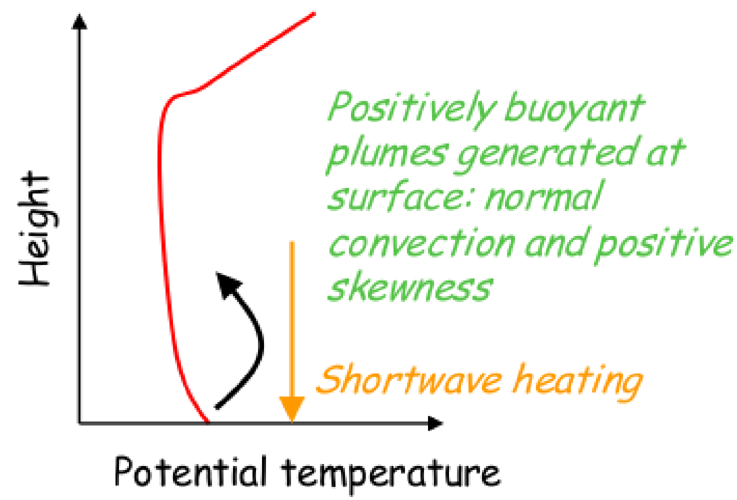
Closest radar is at about 65 km





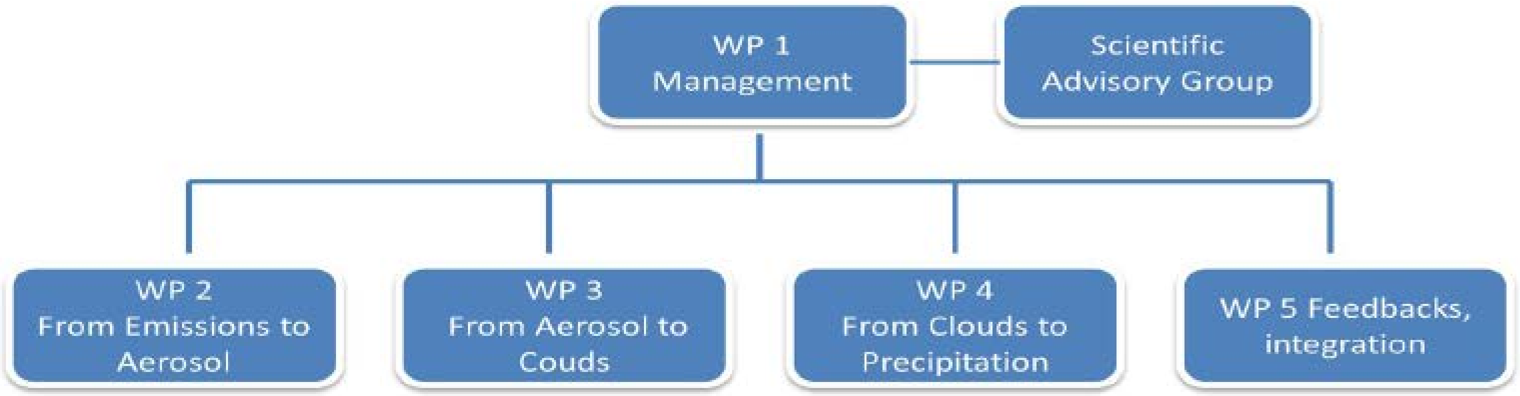






Courtesy of E. O’Connor

Practical organization



WP 1: Project coordination
WP leader Tuukka Petäjä

Task 1.1 Scientific coordination
Dr. Tuukka Petäjä, UHEL; Dr. Hanna Lappalainen, UHEL

Task 1.2 Technical Management
MSc. Janne Levula, SMEAR site operation manager

WP 2: From emissions to aerosol
WP Leader Jaana Bäck

WP 3: From Aerosol to Clouds
WP leader Dr. Ewan O'Connor FMI

WP 4: From Clouds to Precipitation
WP leader Dr. Dmitri Moisseev, UHEL

WP 5: Feedbacks and interactions, integration to existing activities
WP leader Prof. Veli-Matti Kerminen

WP/ Task	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
WP 1 Management																					
T 1.1 Scientific coordination																					
T 1.2 Technical coordination																					
WP 2 From emissions to aerosol																					
T 2.1 Precursor vapor emission rates																					
T 2.2 Aerosol in-situ measurements																					
WP 3 From Aerosol to clouds																					
T 3.1 Aerosol transport																					
T 3.2 Cloud properties																					
WP 4 From Clouds to Precipitation																					
T4.1 Surface precipitation mapping																					
T4.2 . Vertical structure of precipitation																					
WP 5 Feedbacks, interactions, integration																					
T 5.1 Radiative transfer model & satellite products																					
T 5.2 Development of new parametrizations																					
T 5.3 Quantification of new feedbacks & interactions																					
Airborne IOP's																					
Data delivery																					