Aerosol Mass Spectrometry at the Max Planck Institute for Chemistry, Mainz

Johannes Schneider, Frank Drewnick, Saskia Walter, Sören Zorn, Marco Brands, Paul Reitz, Julia Schmale, Sarah-Lena von der Weiden, Thomas Klimach, Friederike Freutel, Jovana Diesch, and Stephan Borrmann

Particle Chemistry Department
Max Planck Institute for Chemistry, Mainz

Institute for Atmospheric Physics,
Johannes Gutenberg University, Mainz

Germany

9th AMS Users' Meeting, Manchester, 05.-07.09.2008

Max-Planck-Institut für Chemie (Otto-Hahn-Institut)

Overview

JOHANNES GUTENBERG UNIVERSITÄT MAINZ

Department "Particle Chemistry", joint facility of MPI and University Mainz,
Head: Prof. Stephan Borrmann
Two mass spectrometry research groups:

Johannes Schneider

Saskia Walter

Marco Brands

Paul Reitz

Julia Schmale

Friederike Freutel

Frank Drewnick

Sören Zorn

Thomas Klimach

Sarah-Lena von der Weiden

Jovana Diesch

Instruments

C-ToF-AMS

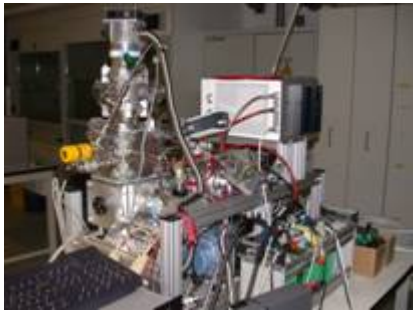
(upgraded from Quad in 2007)

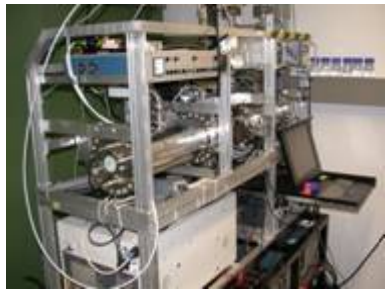
HR-ToF-AMS

(upgraded from C-ToF in 2005)

ALABAMA
Aircraft-based **L**aser **AB**lation
Aerosol **MA**ss spectrometer

IT-AMS
Ion **T**rap **A**erosol
Mass **S**pectrometer





SPLAT
Single **P**article **L**aser **A**blation
Time-of-flight mass spectrometer

Research Topics

J. Schneider

"Atmospheric Aerosol Chemistry"

- General aerosol chemistry
- Aerosol-cloud interactions
- Aircraft based measurements
- Particle sources (traffic / combustion)

F. Drewnick

" Single particle aerosol analysis"

- Instrument development and characterization
- Characterization of aerosol sources
- Design and set-up of a mobile measurent platform (Mo-La)
- Investigation of urban aerosol and its transformation processes

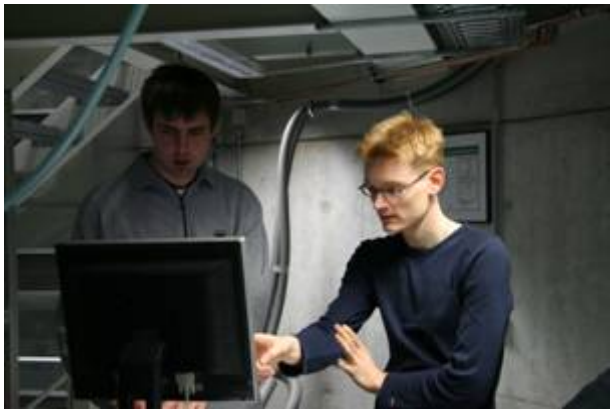
Recent Projects

CLACE-6 (Jungfraujoch, Switzerland, Feb/March 2007)
HR-ToF

OOMPH, Southern Atlantic, Jan-Mar 2007,
HR-ToF (Hoffmann)

ULTRAFINE
(Liege, April 2007)
HR-ToF

AMAZE (Amazonia, Brazil, Feb/March 2008), HR-ToF



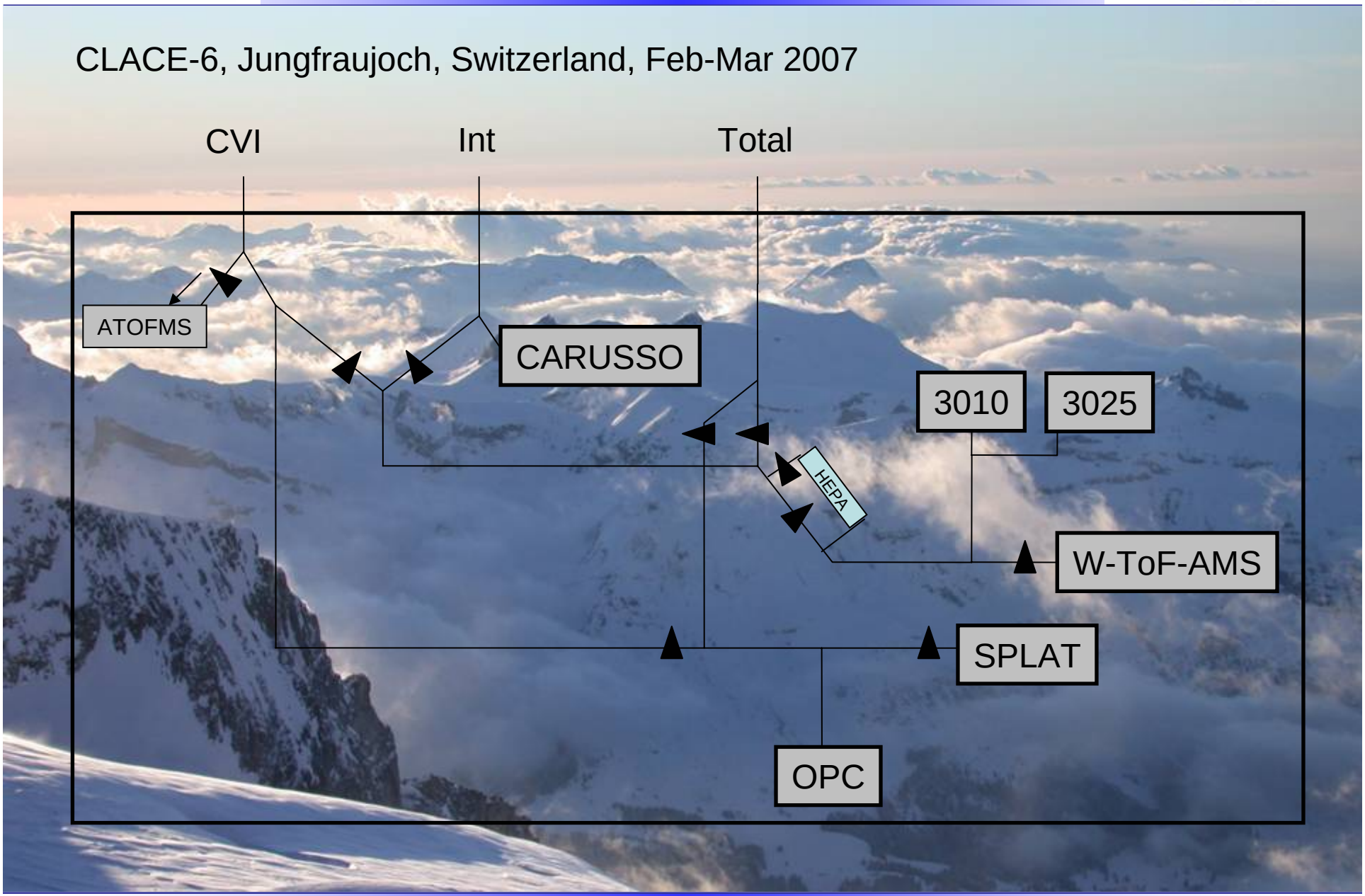
VI-ACI "FROST", Leipzig
April 2008, C-ToF

POLARCAT (Kangerlussuaq, Greenland, July 2008), C-ToF

Some recent results:

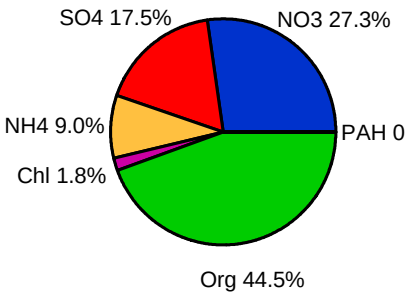
1. CLACE-6
2. OOMPH
3. Waste Incinerator
4. ULTRAFINE
5. AMAZE
6. POLARCAT

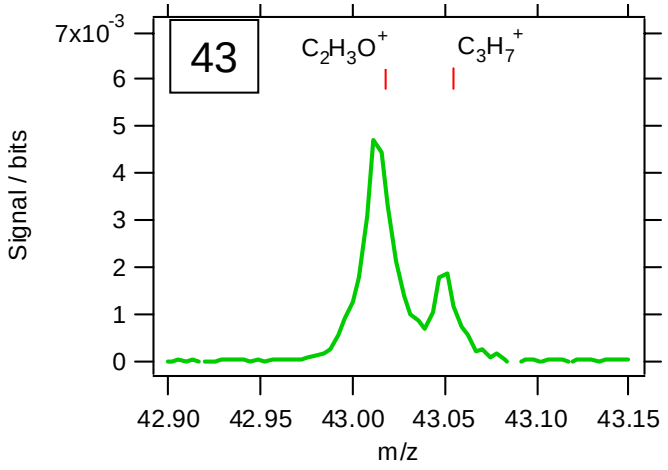
CLACE-6, Jungfraujoch, Switzerland, Feb-Mar 2007



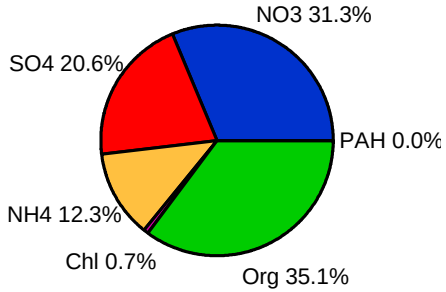
CLACE-6: Droplet residuals (CCN)

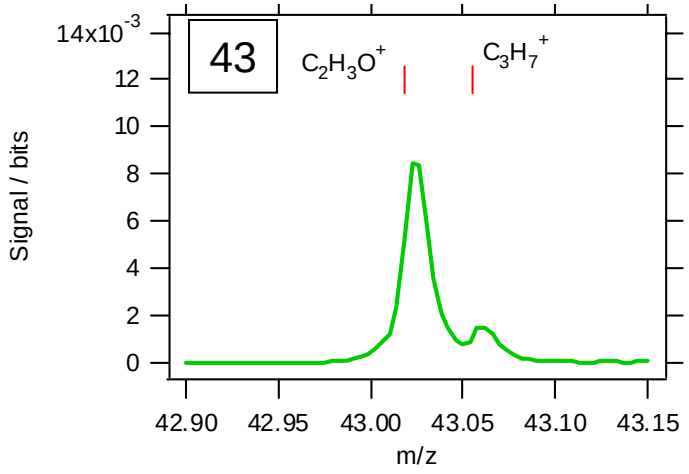
CCN during Cloud Event





Out-of-cloud aerosol after Cloud Event

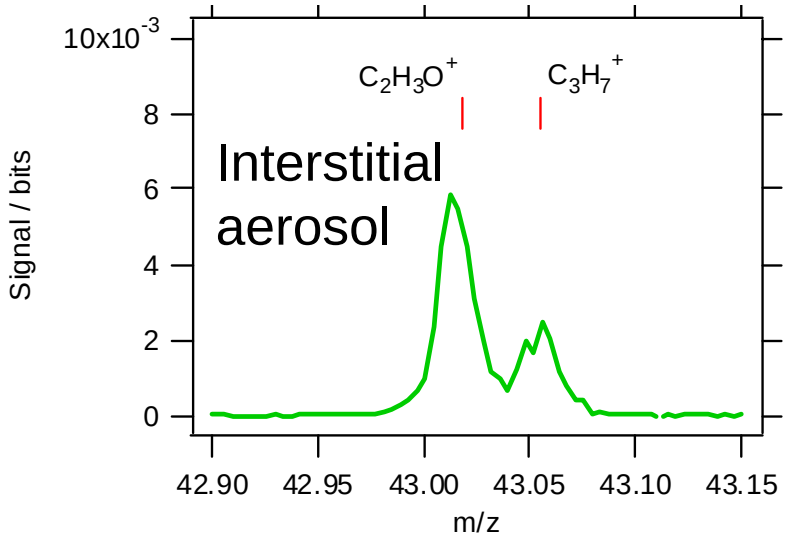


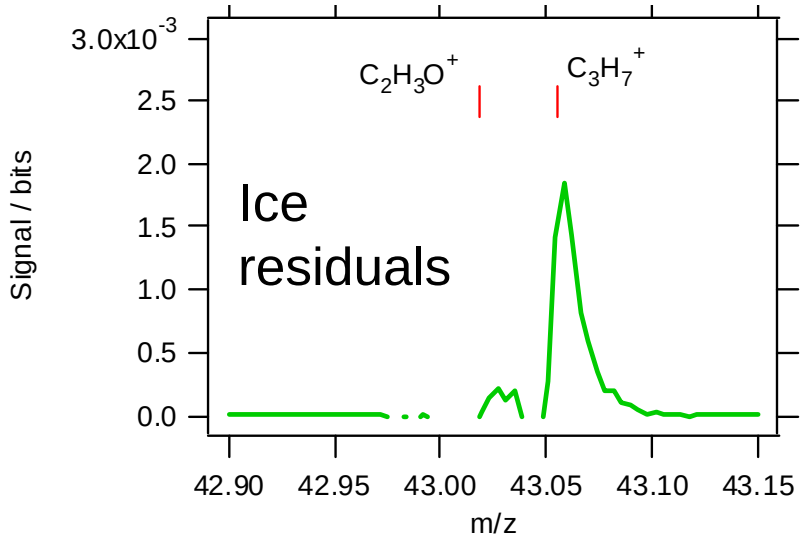


- High organic fraction in CCN
- CCN show similar composition as background aerosol
- Oxidized aerosol: water-soluble → good CCN

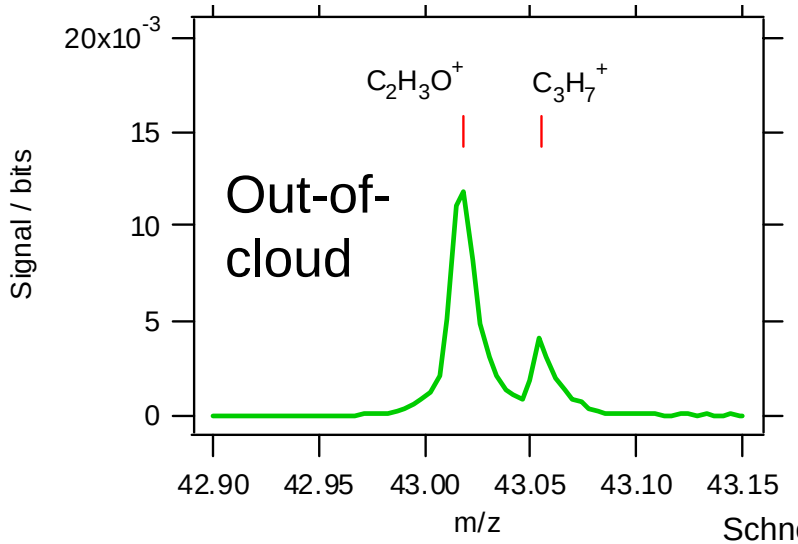
Schneider et al., EAC Salzburg, 2007

CLACE-6: Ice residuals

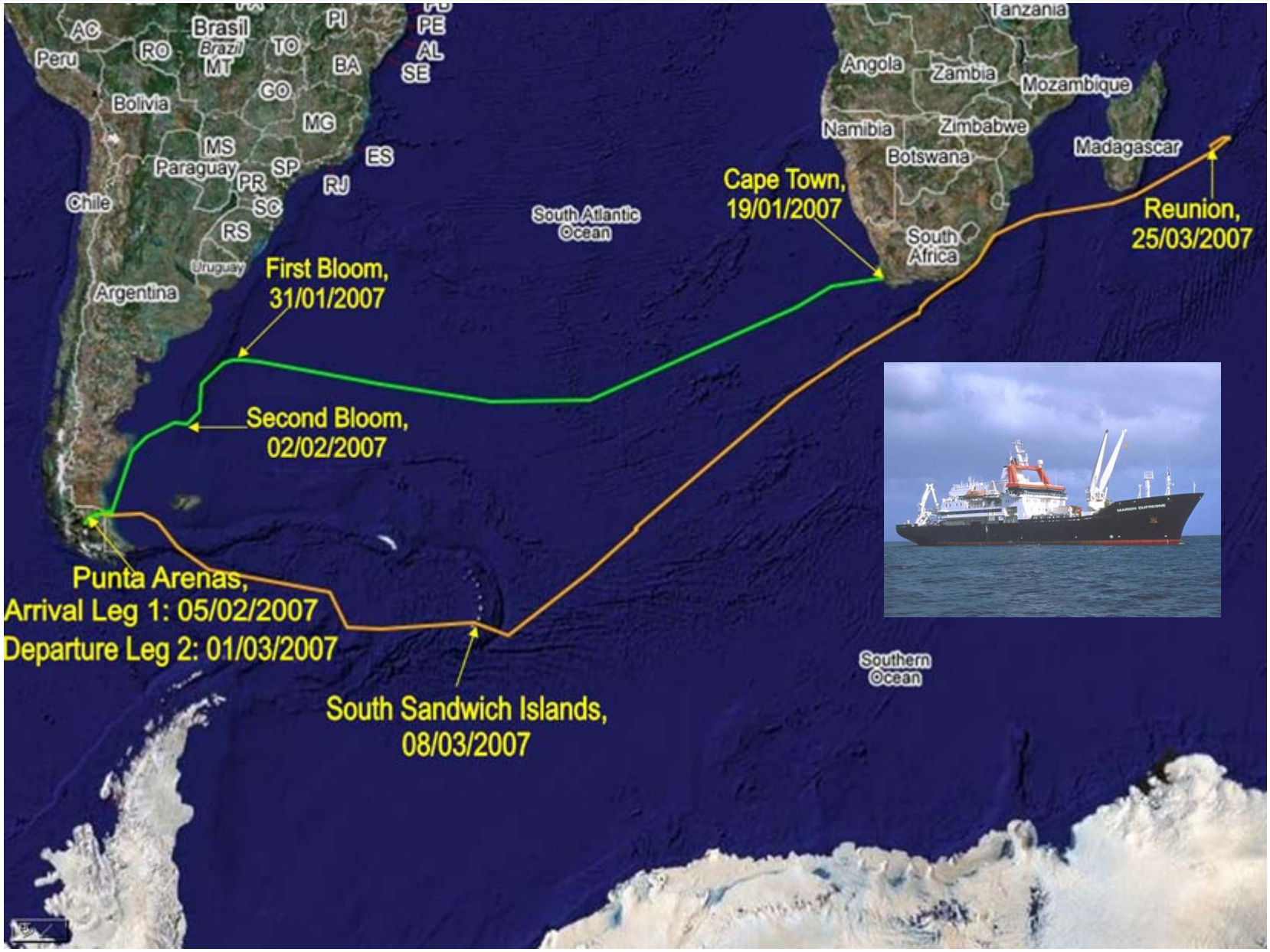




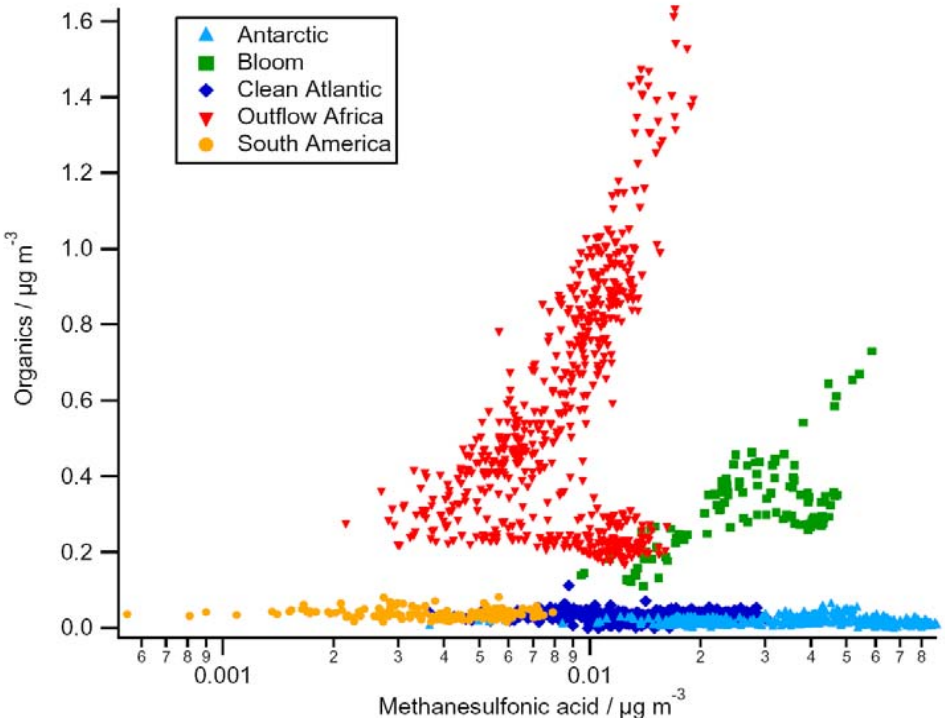
- No oxygenated components in ice residuals.
- Enrichment of HOA (hydrocarbon-like aerosol)
- Possible explanation: HOA is associated with black carbon (soot)

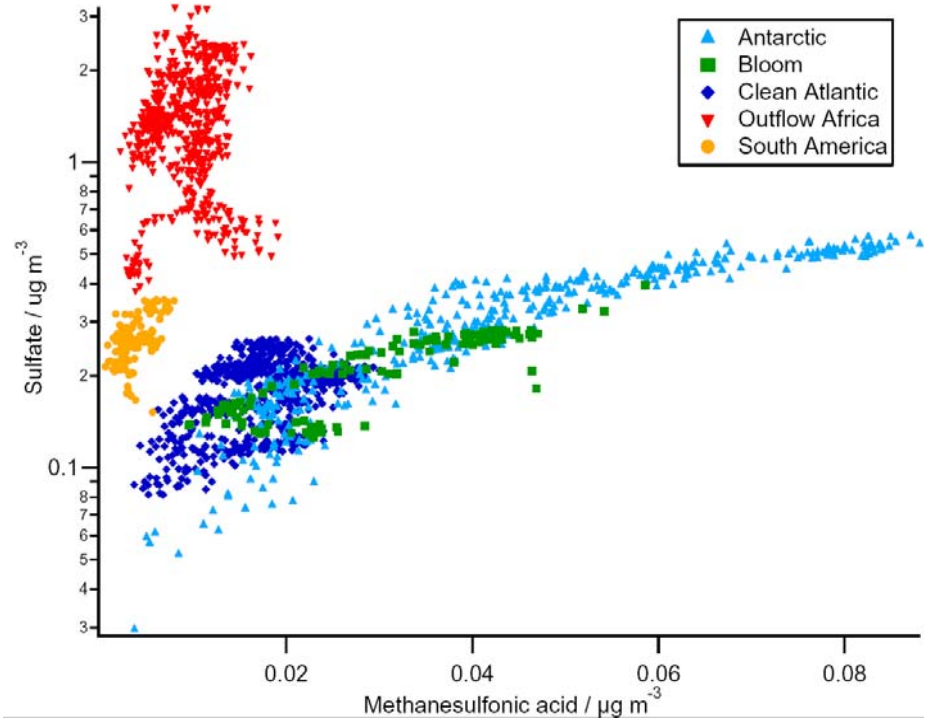


Schneider et al., EAC Salzburg, 2007


AC
Brasil
Brazil
PI
PE
AL
SE
RO
TO
MT
BA
Peru
Bolivia
GO
MG
MS
ES
Paraguay
SP
PR
RJ
Chile
SC
RS
Uruguay
Argentina
South Atlantic Ocean
Tanzania
Angola
Zambia
Mozambique
Namibia
Zimbabwe
Botswana
Madagascar
South Africa
Cape Town, 19/01/2007
Reunion, 25/03/2007
First Bloom, 31/01/2007
Second Bloom, 02/02/2007
Punta Arenas, Arrival Leg 1: 05/02/2007
Departure Leg 2: 01/03/2007
South Sandwich Islands, 08/03/2007
Southern Ocean

Correlations between SO_4, MSA and Organics



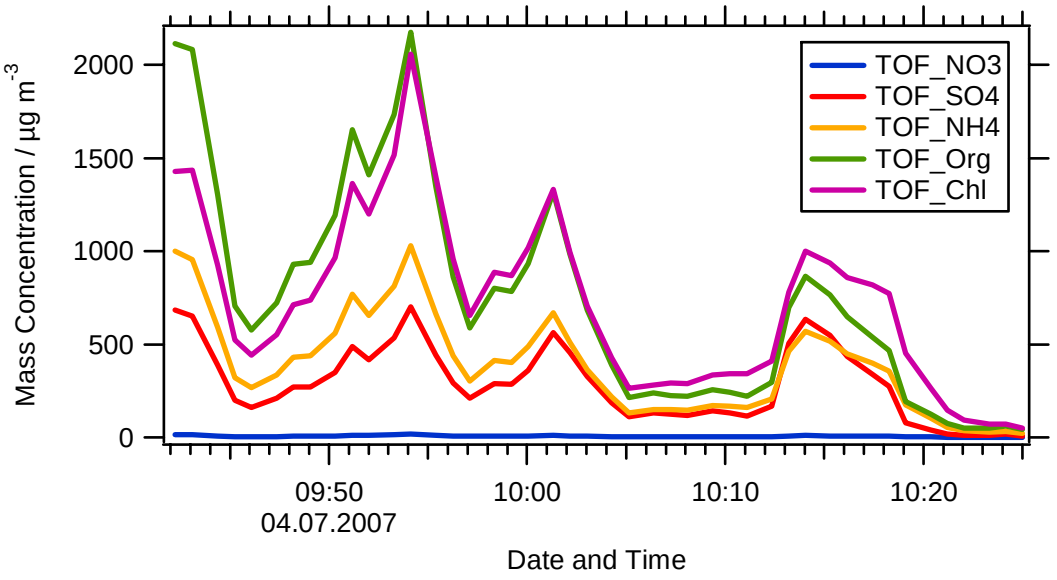


- Organics/MSA ratio:
  - South America, Antarctic and Clean Atlantic on one branch
  - Outflow Africa split into two different modes
- MSA/Sulfate ratio:
  - Antarctic, Clean Atlantic and Bloom show similar behavior
  - Outflow Africa and South America clearly separated

Zorn, S., et al., Characterization of the South Atlantic marine boundary layer aerosol using an Aerodyne Aerosol Mass Spectrometer; Atmospheric Chemistry and Physics 8, 4711-4728, 2008

Waste Incinerator

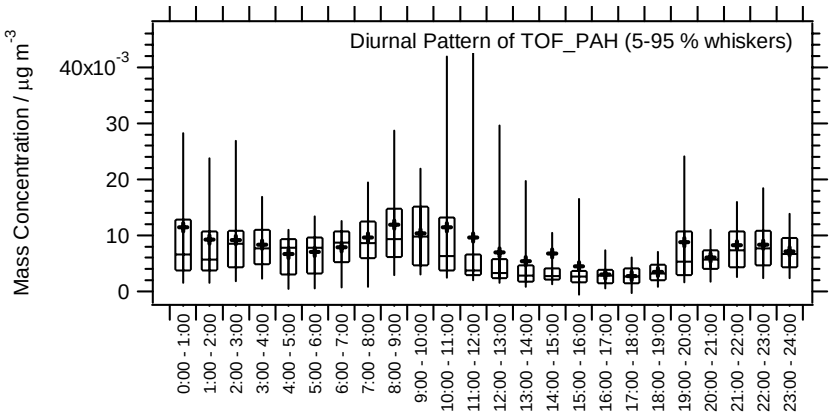
Setup at the exhaust line of a municipal waste incinerator in central France, July 2007
Measurements with HR-ToF-AMS and ELPI



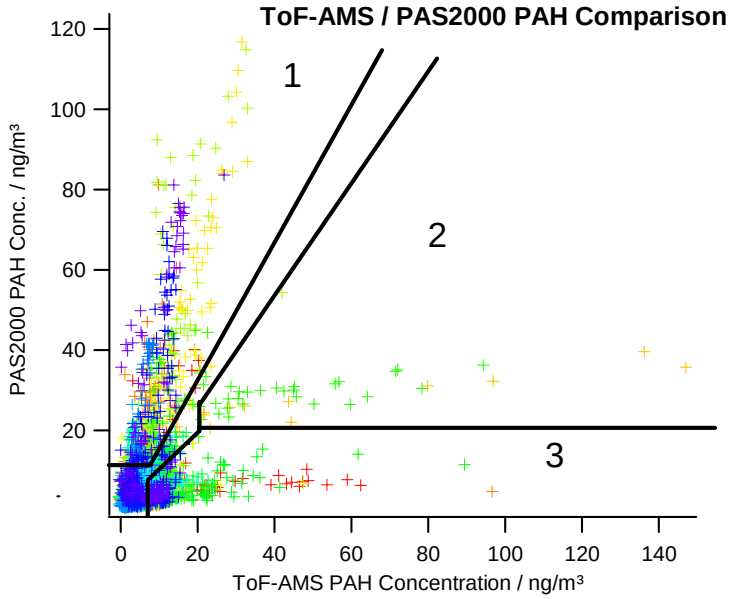
Time series of various species mass concentrations at waste incinerator exhaust line after cleaning units. Note: very high chloride concentrations.

F. Drewnick, unpublished

EU RFCS Project ULTRAFINE – Measurement Campaign in Liege near integrated steelworks



Diurnal pattern of AMS PAH signal



Comparison of ToF-AMS and PAS2000 PAH Monitor: Three branches observed: 1) Fresh traffic-related PAH; 2) PAH from steel plant; 3) Aged traffic-related PAH

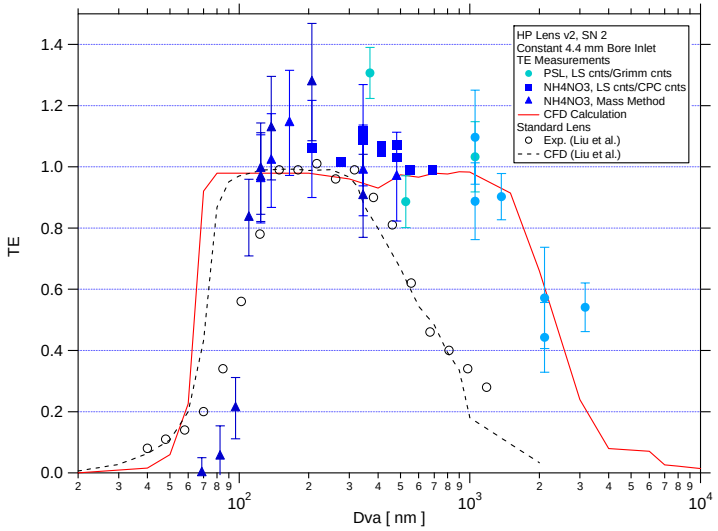
F. Drewnick, unpublished

Amazonian Aerosol Characterization Experiment, Feb/Mar 2008, near Manaus, Brazil

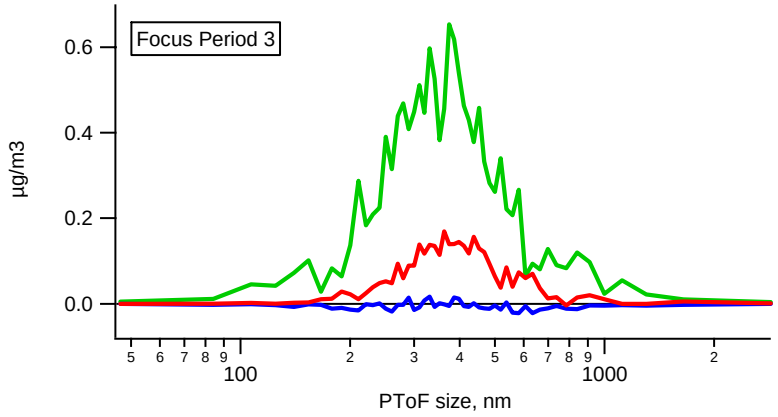
2 HR-ToF-AMSs:

Harvard (S. Martin, Q. Chen, D. Farmer)
- connected to turbulent inlet line

Mainz AMS
- equipped with high pressure lens
- connected to laminar PM7 inlet



Transmission for supermicron particles not as good as expected:

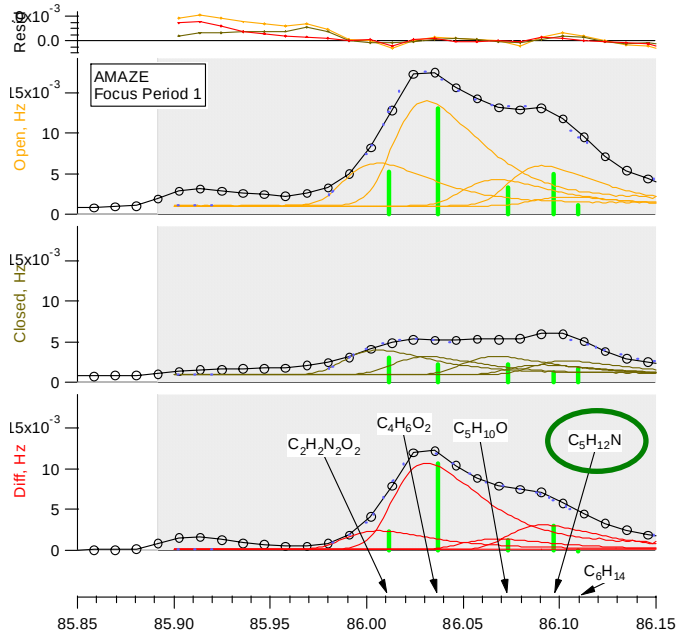


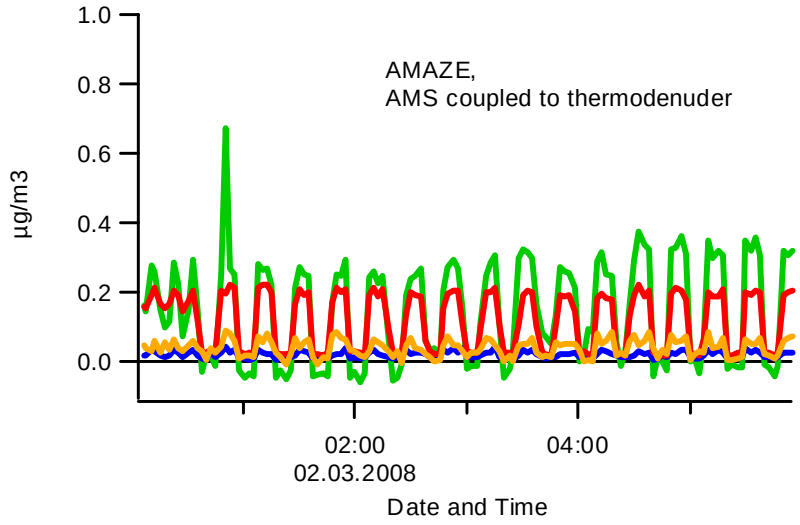
Two research foci:

- Search for evidence for primary organic particles.
  Expected markers:
  - Sugars,
  - Chlorophyll,
  - Proteins (amino acids)

- AMS coupled with Thermodenuder (S. Zorn)

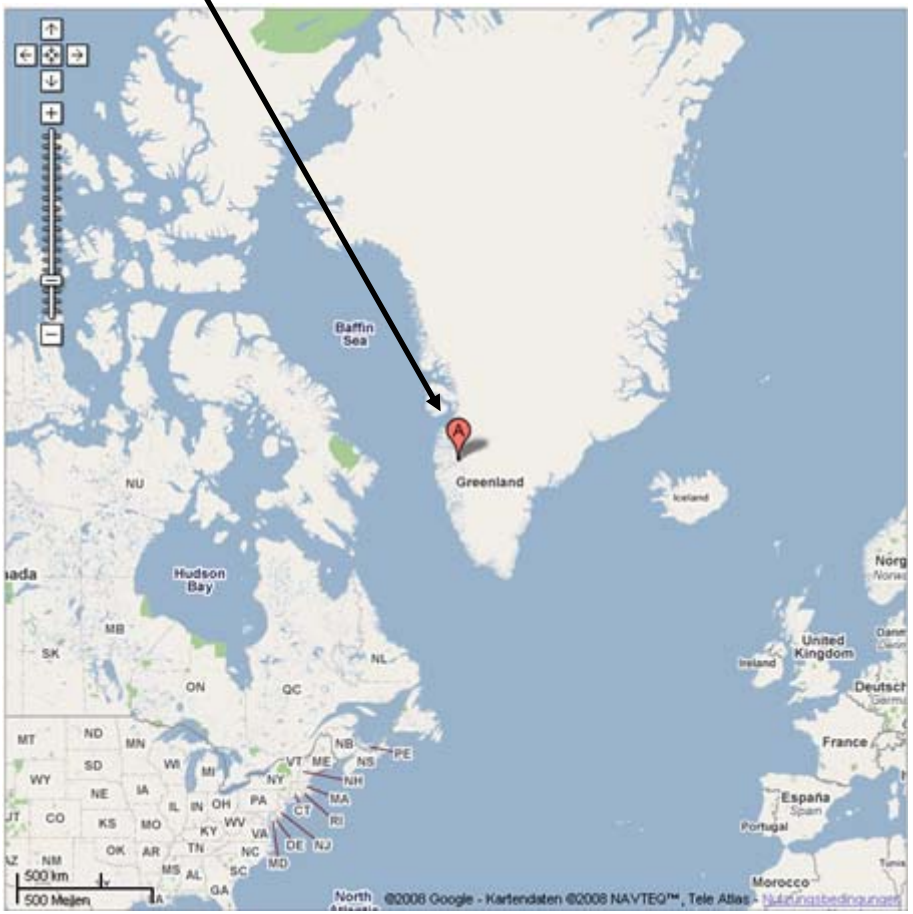
…ongoing work

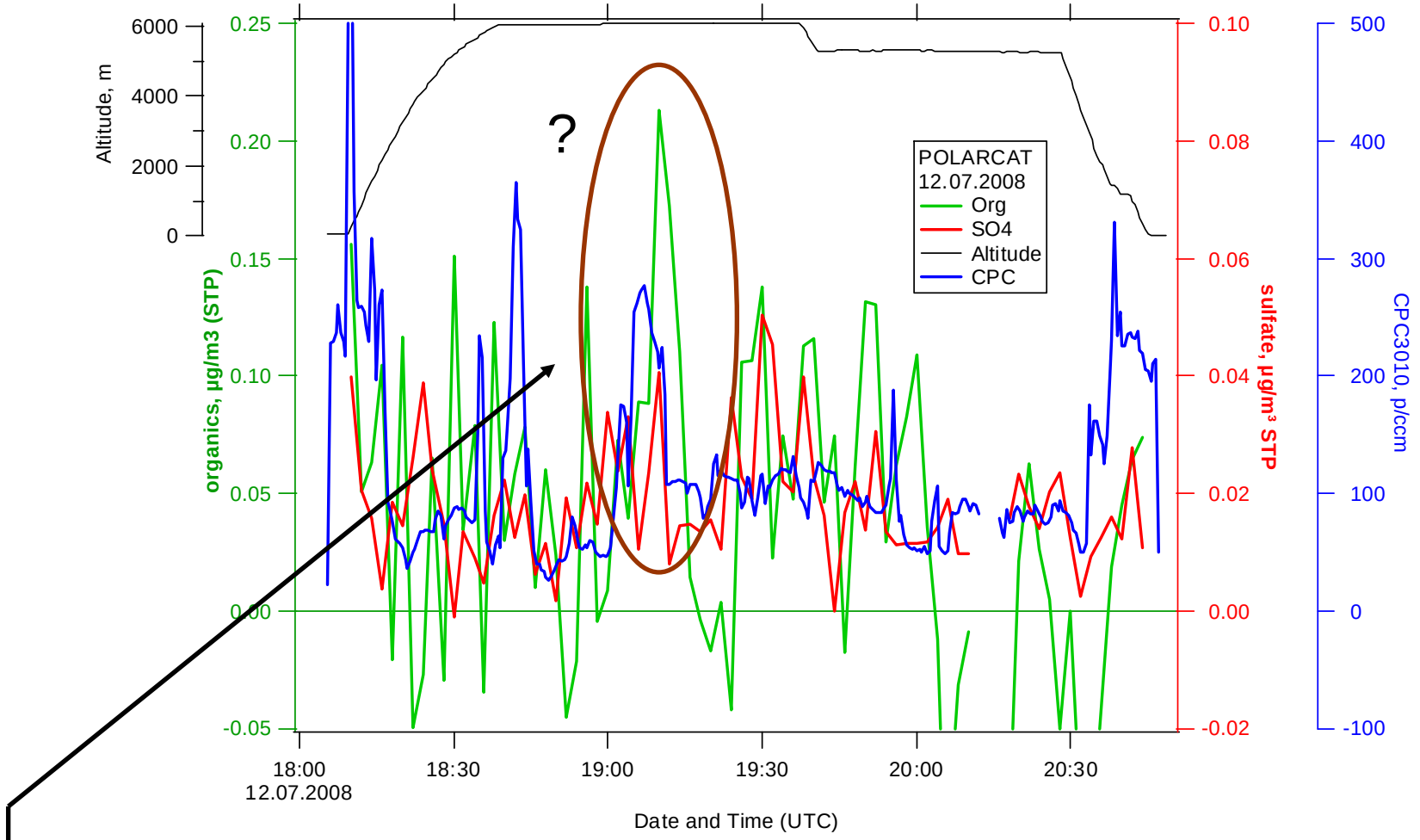




J. Schneider / S. Zorn, unpublished

POLARCAT-France
30.06. – 14.07.2008
Kangerlussuaq, Greenland



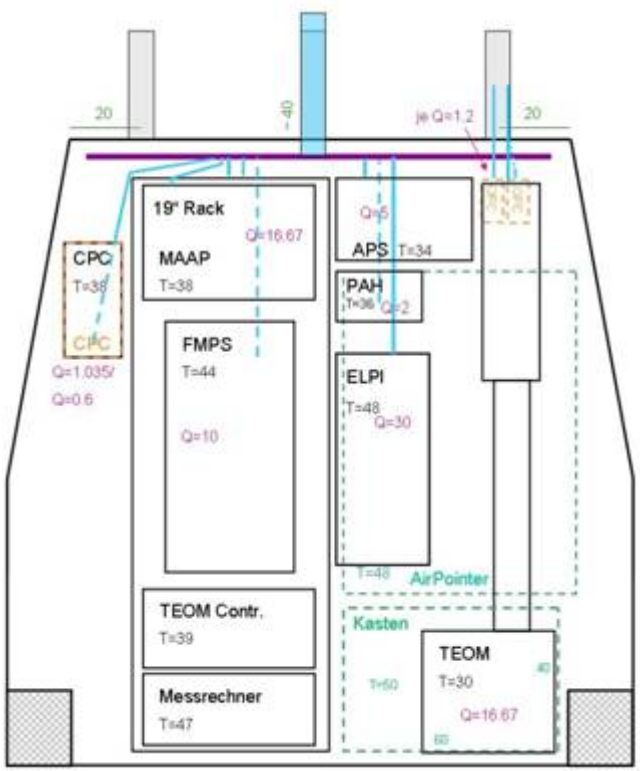


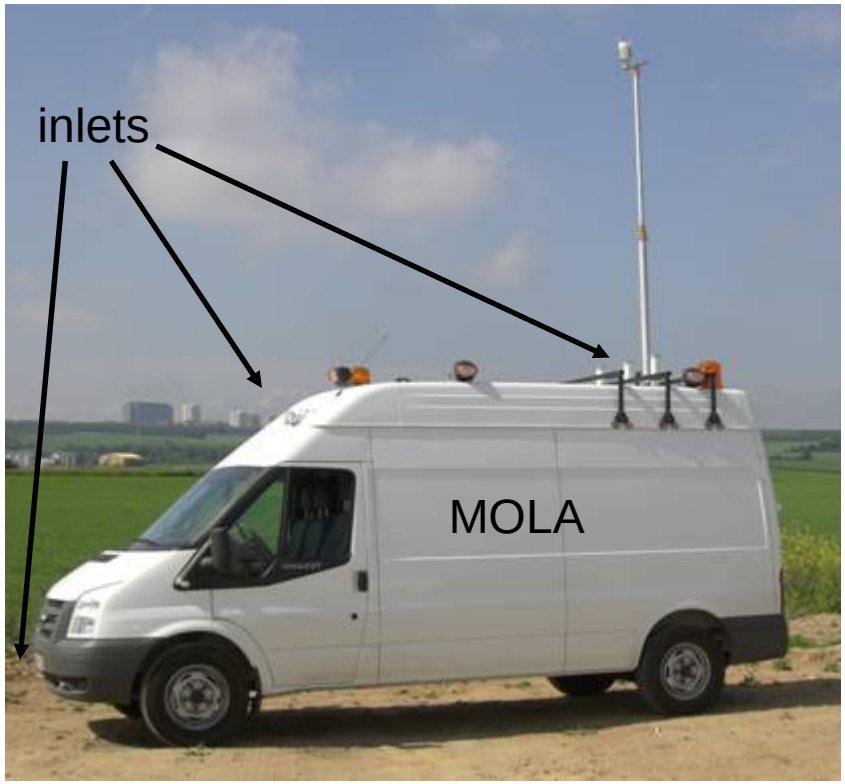
In general: very low aerosol concentrations above the Arctic
Objective of this flight: Siberian biomass burning plumes
(up to now not confirmed by CO data)

J. Schmale / J. Schneider, unpublished

Ongoing / future projects

Ongoing projects





Mobile Laboratory: Ford Transit, equipped with standard gas analytics plus state-of-the-art aerosol measurement devices:
CPC, FMPS, ELPI, TEOM, APS, MAAP, PAH, mass spectrometer(s)…

First field project: DOMINO, Spain, November-December 2008, HR-ToF-AMS (Drewnick et al.)

Near future projects (2008):

VI-ACI2
October 2008, AIDA, Karlsruhe (SPLAT)
Objectives:

- Hygroscopic growth, CCN, IN
- Effect of coating layers and crystallisation.

CONCERT
October 2008, Aircraft campaign, Falcon, DLR Germany, (C-ToF-AMS)
Objectives:

- Aircraft exhaust, contrail and cirrus cloud particles

DOMINO
Nov/Dec 2008, Spain (HR-ToF-AMS within MOLA)

Later (2009):
HALO: New German research aircraft, similar to HIAPER (Gulfstream),
→ C-ToF-AMS and ALABAMA to be integrated into HALO racks


Thank you for your attention!