The Cloud Condensation Nuclei (CCN) Rack on board of the HALO aircraft during ACRIDICON-CHUVA –

Current state of data analysis


as well as the whole ACRIDICON and ATTO teams

ACRIDICON-CHUVA Meeting, Ilha Bela, Feb/Mar 2016
Aerosol sampling for microspectroscopy
- e.g., STXM-NEXAFS, SEM-EDX, AFM, Raman, etc.
- particle microstructure and composition

Status:
- 2 beamtimes invested; more is planned
- So far: AC12 & AC18

Single Particle Soot Photometer (SP2)
- BC concentration and coating

Status:
- Data analysis in progress

Cloud Condensation Nuclei Counter (CCNC)
- Column A: HASI only, S scans (0.3-0.7 %)
- Column B: HASI/CVI, S = 0.5 %

Status:
- All flights systematically analyzed
CCN Vertical Profiles - Overview

S~0.5% @ HASI
CCN Vertical Profiles - Clean vs. Polluted

$S \approx 0.5\% @ HASI$
CCN @ ATTO site during ACRIDICON-CHUVA

\[ N_{CCN}(0.47\%) = 500 - 2000 \text{ cm}^{-3} \]

\[ \kappa(0.47\%) = 0.1 - 0.2 \]

\[ N_{CCN}(0.47\%)/CN_{10} = 0.6 - 0.9 \]

Mira Pöhler et al., ACP in prep.
CCN Vertical Profiles - Clean vs. Polluted

AC12 (polluted)

AC18 (clean)
CCN Vertical Profiles - Clean vs. Polluted

AC12 (polluted)

AC18 (clean)
CCN Vertical Profiles – Estimating S Levels

AC12 (polluted)

AC18 (clean)

Supersaturation [%]

Altitude [m asl]

CCN(0.5 %) / CN (both CVI)

CCN(0.5 %) / CN (both CVI)
Automated impaction sampling (42 substrates)

Cuf-off: ~200 nm, also diffusive deposition

Sampling of in cloud and out of cloud conditions linked with CCNC and SP2 operation
X-ray Microspectroscopy on Aerosols

Scanning Transmission X-ray Microscopy with Near-Edge X-ray Absorption Fine Structure analysis

ALS (LBNL), Berkeley, CA, USA

MAXYMUS-STXM @ BESSY II, Berlin
**STXM-NEXAFS – Concept**

**Scanning Transmission X-ray Microscopy with Near-Edge X-ray Absorption Fine Structure analysis**

**Fine structure**

- Optical Density
- Energy (eV)

**X-ray absorption spectrum**

- C=C
- R(C*=O)R/C=OH
- CH\_x
- R(C*=O)OH
- CO\_3
- R\(\text{C}^{3+} \text{O}_2\)
- R\(\text{C}^{3+} \text{O}_4\)
- K\(\text{L}_{2} \text{p}\text{\_}1/2\)
- K\(\text{L}_{3} \text{p}\text{\_}3/2\)
- C=O
- C=O

**Moffet et al. STXM - Applications in atmospheric aerosol research, 2010; Moffet et al., ACP 2010**
STXM @ AC12 – Dark Field Microscopy

AC12_16 @ HASI

AC12_15 @ CVI

~ 300 µm

~ 300 µm
(3) **Nucleation at high altitude**
- SEM-EDX, AFM
- 1 sample @ HASI

(1) **Characterization of biomass burning aerosol**
- STXM-NEXAFS
- 2 sample @ HASI

(2) **Contrasting CVI and HASI during cloud profiling**
- STXM-NEXAFS
- 2 sample @ HASI
- 4 sample @ CVI
1. Organic Aerosol
2. Soot (rather fresh)
3. $K_x(NH_4)\gamma SO_4$ (+ Mg ?)
STXM @ AC12: Biomass Burning Smoke

1. Organic Aerosol (~ 60 %)
2. Soot (rather fresh) (~ 30 %)
3. $K_x(NH_4)_ySO_4$ (+ Mg) (~ 10 %)
STXM @ AC12: Flight Map

(3) Nucleation at high altitude
- SEM-EDX, AFM
- 1 sample @ HASI

(1) Characterization of biomass burning aerosol
- STXM-NEXAFS
- 2 sample @ HASI

(2) Contrasting CVI and HASI during cloud profiling
- STXM-NEXAFS
- 2 sample @ HASI
- 4 sample @ CVI
STXM @ AC12: HASI vs. CVI
STXM @ AC12: HASI vs. CVI

Normalized Optical Density

Energy [eV]

R(C*=C)R'  R(CH_n)R'  K  OA2  a/b/d/e/h/g/f/c

n:  C1s -> *  (C*-C, C*-O, C*=C, C*=O)

AC12_11 & AC12_15 & AC12_19

AC12_11 & AC12_15

AC12_09

AC12_35 & AC12_16

ACRI12_15 & AC12_19

Energy [eV]

282 284 286 288 290 292 294

Normalized Optical Density
(3) Nucleation at high altitude
- SEM-EDX, AFM
- 1 sample @ HASI

(2) Contrasting CVI and HASI during cloud profiling
- STXM-NEXAFS
- 2 sample @ HASI
- 4 sample @ CVI

(1) Characterization of biomass burning aerosol
- STXM-NEXAFS
- 2 sample @ HASI
SEM @ AC12_10: Particles < 100 nm

SEM: together with Gunnar Glasser, MPIP, Mainz
SEM @ AC12_10: Particles < 100 nm

SEM: together with Gunnar Glasser, MPIP, Mainz
AFM @ AC12_10: Particles < 100 nm

AFM data from Johannes Ofner, TU Vienna
SEM-EDX @ AC12_10: Particles < 100 nm

SEM: together with Gunnar Glasser, MPIP, Mainz
Summary

**CCNC**

- Data systematically analyzed (*contact Mira*)
- Major trends are plausible (*e.g.*, pollution vs. clean, CCN profiles, ACRI/ATTO comparison)
- Certain questions remain to be discussed (*e.g.*, low kappa, cloud S levels, etc.)

**Aerosol Sampling & Microspectroscopy**

- So far: Analysis of 2 flights - work in progress
- X-ray microscopy provides further insights in combination with *e.g.* AMS, CCNC, SP2, etc.
- Analysis so far: Some plausible trends + several open questions
UHSAS & CCN Data shows good agreement.

UHSAS Data Weinzierl$^5$ et. al. DLR.