Integrating measurements at ATTO, GoAmazon and Embrapa sites to better understand anthropogenic effects on cloud life cycle

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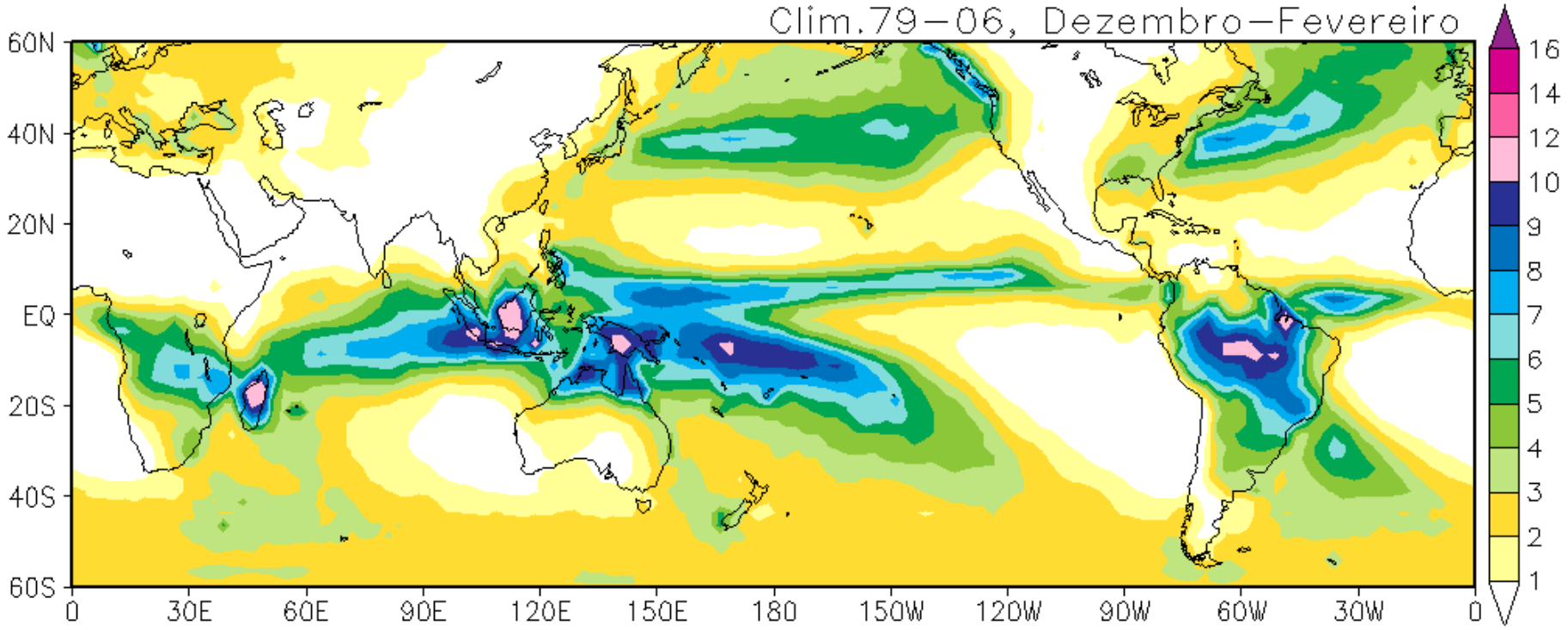
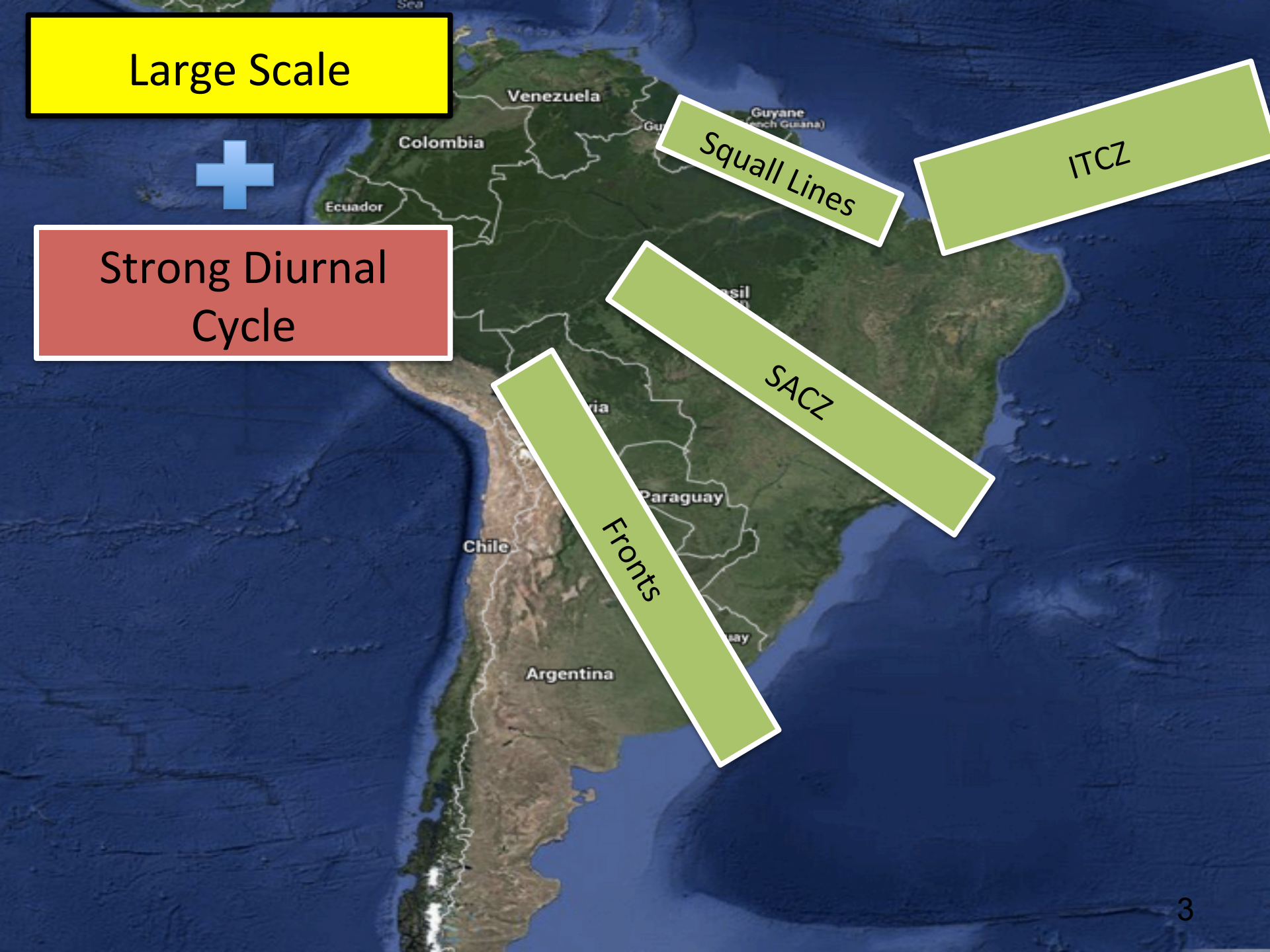
Global Precipitation

- The Amazon is one of the three large convective regions in the world

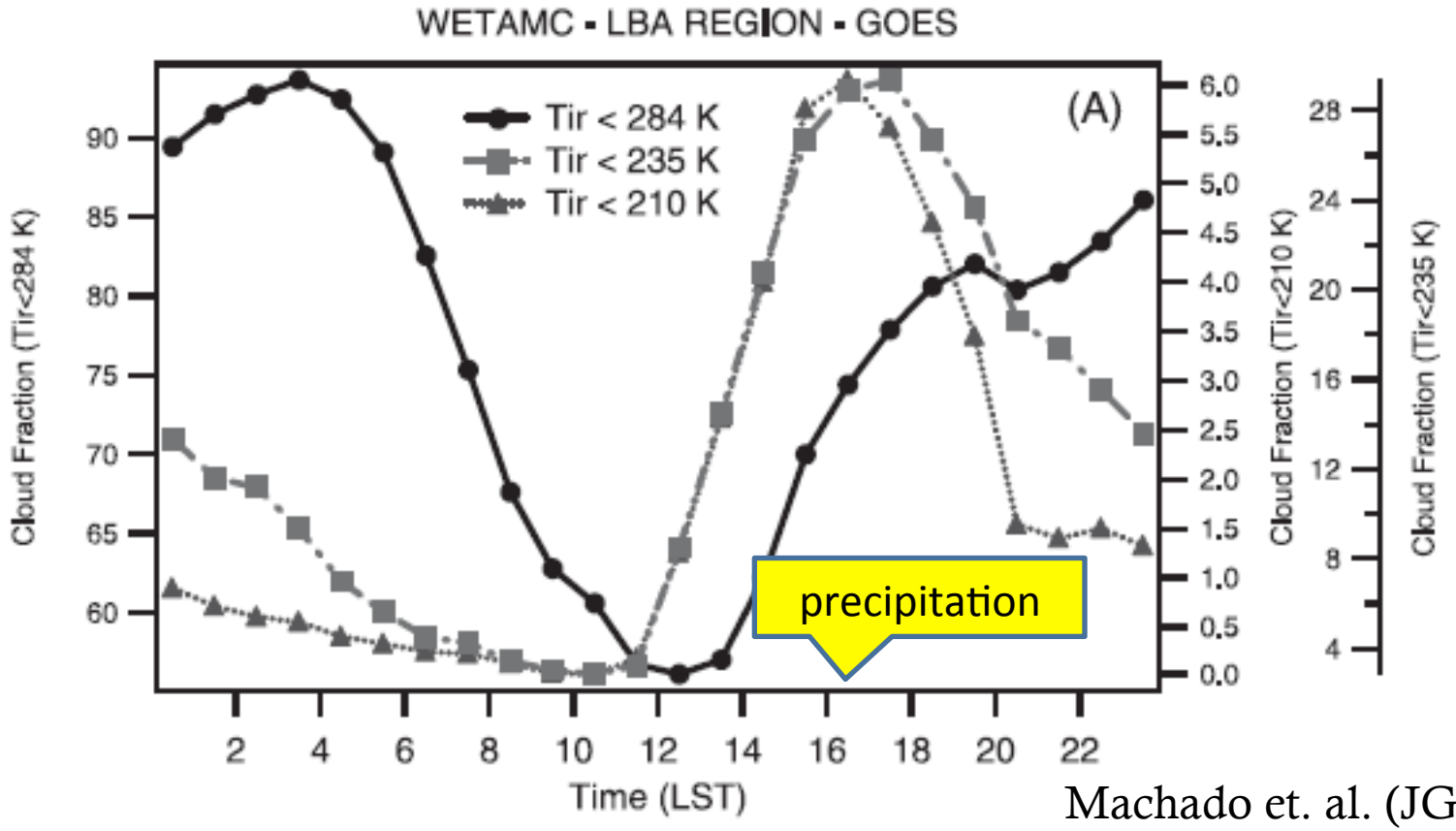



Large Scale
Strong Diurnal Cycle
Squall Lines
ITCZ
SACZ
Fronts
Venezuela
Colombia
Ecuador
Guyane
Paraguay
Chile
Argentina

Convection Diurnal Cycle

- Last studies in early 2000's:
  - WETAMC and TRMM/LBA

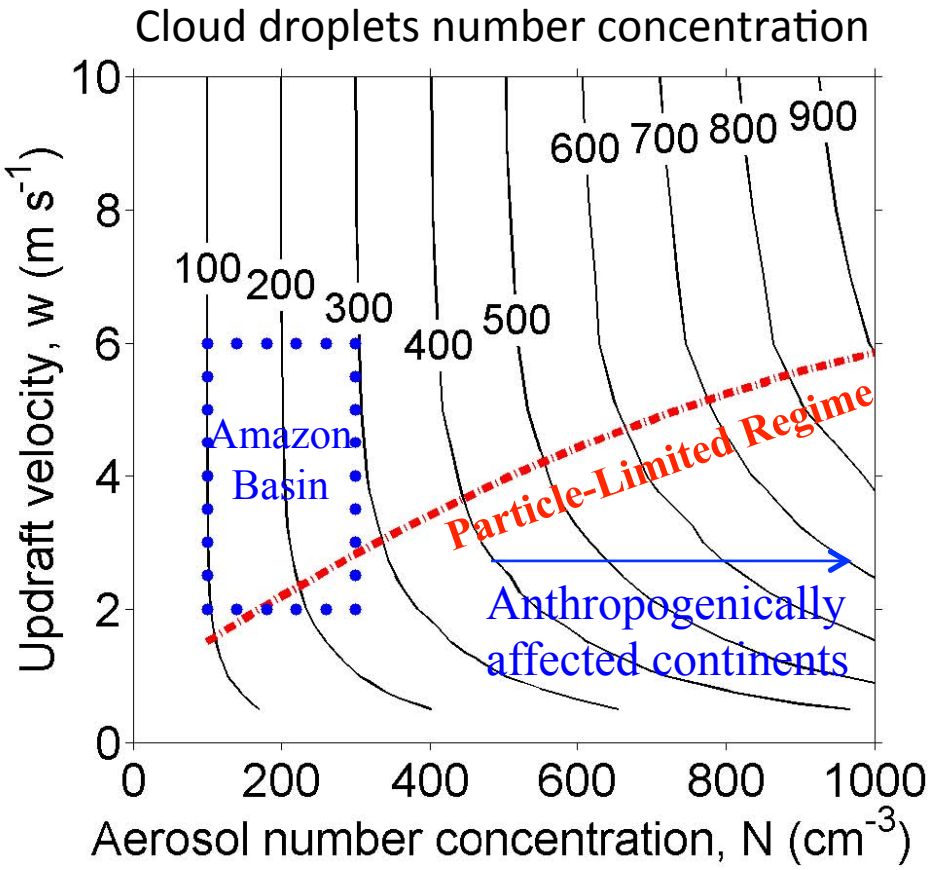
Rather short intensive campaigns – no climatology



Machado et. al. (JGR 2002)

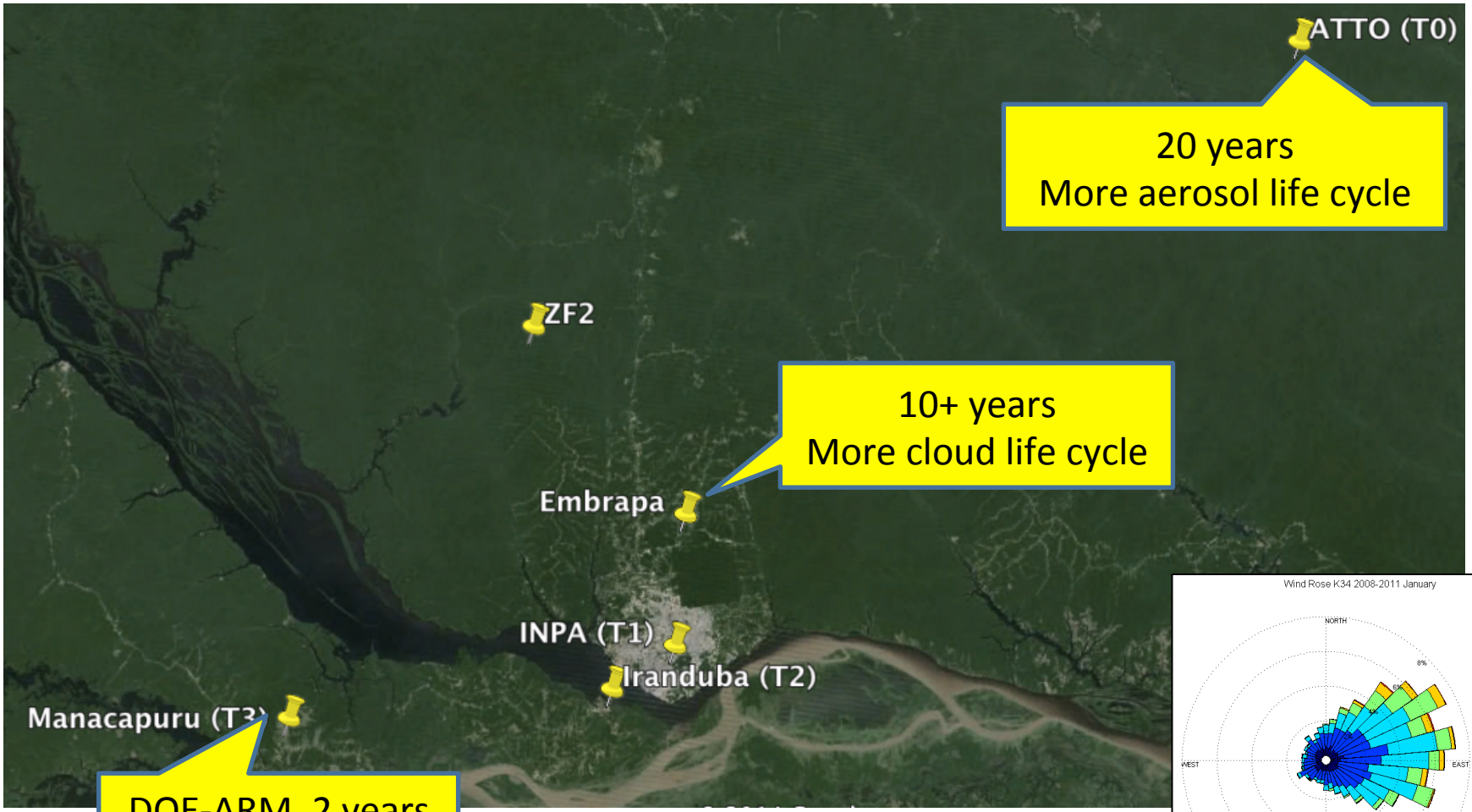
Possible Aerosol Effects

- The Amazon region is particularly susceptible to changes in CN because of the low background concentrations and high water vapor levels, indicating a regime of cloud properties that is highly sensitive to aerosol microphysics.



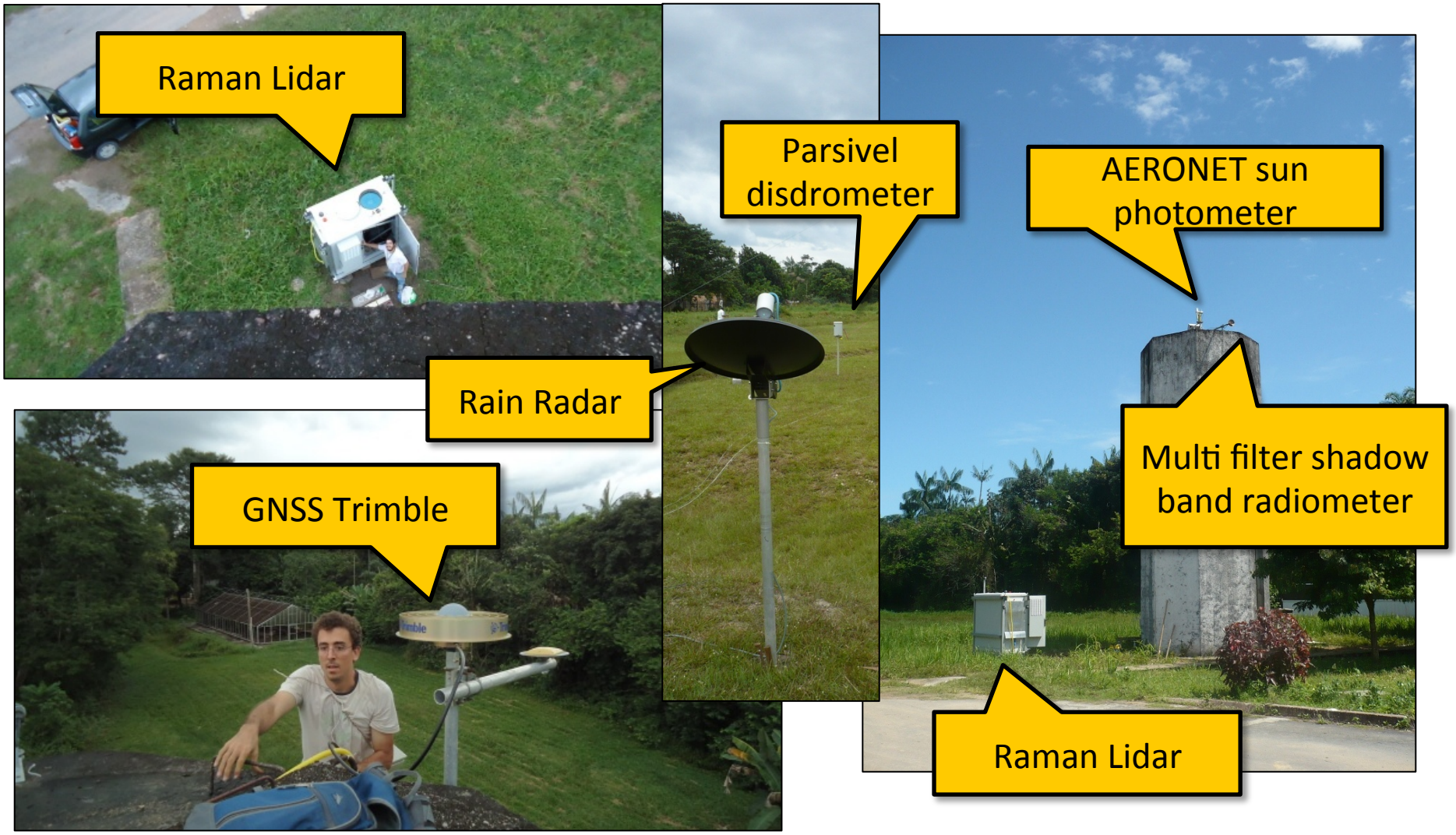
Poschl et al, Science 2010

Picture has changed!



Embrapa Site - Closeup

Embrapa Site - Instruments



Embrapa Site - Measurements

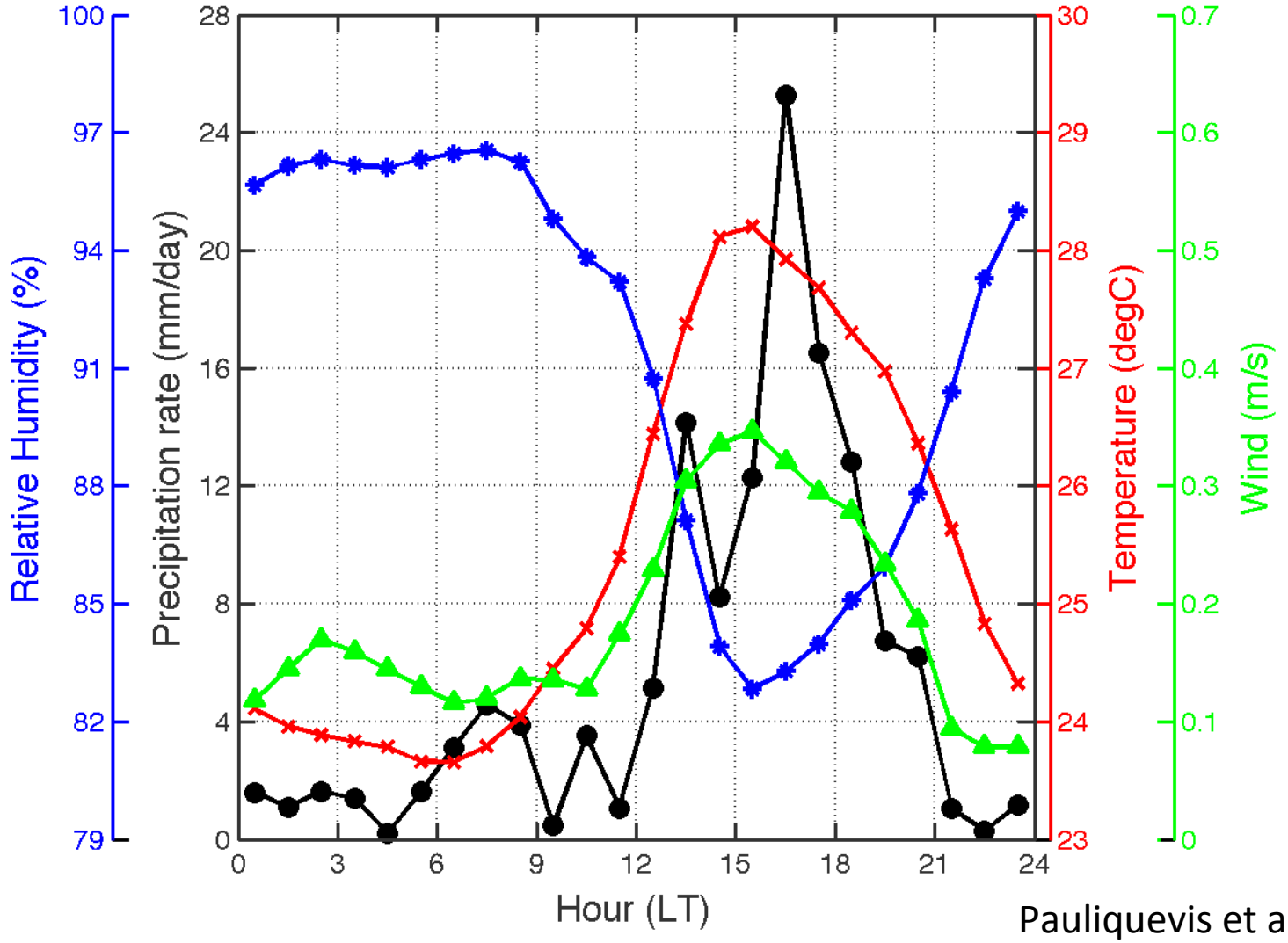
- Profiles of aerosol, water vapor and clouds from a UV Raman lidar;
- Profiles of cloud layers from a ceilometer;
- Profiles of temperature, water vapor and in-cloud liquid water from a infrared radiometer;
- Profile of rain drops size distribution from disdrometer and vertical pointing rain radar;

- Column aerosol and cloud optical depth from aeronet;
- Column water vapor from GNSS;
- Cloud cover and dir/dif radiation from a multi-filter radiometer;

- Aerosol scattering from a nephelometer;
- Surface fluxes and standard meteorological obs.

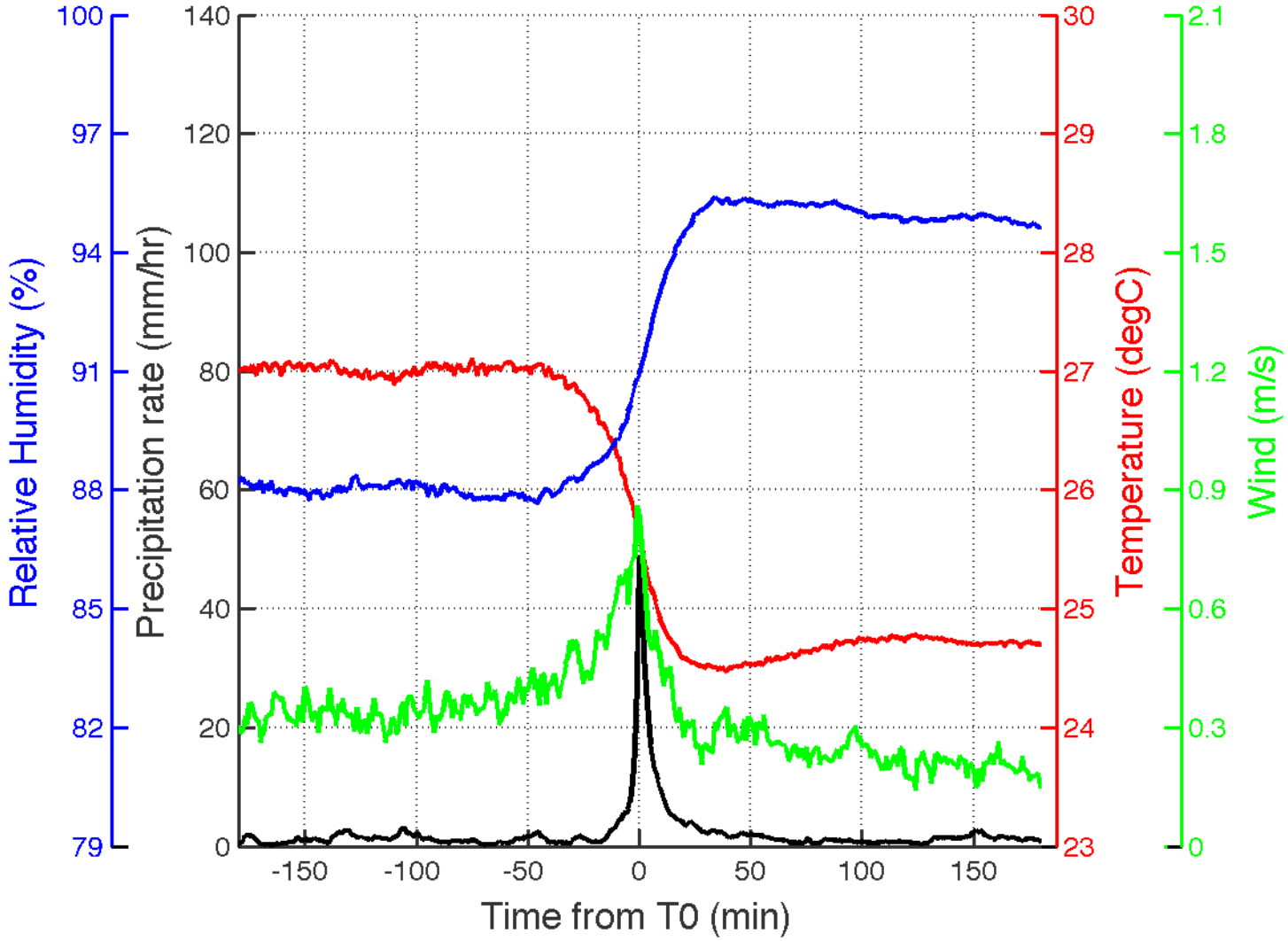
Why not doing all of this at ATTO? Some instruments are too heavy, or need too much maintenance, or too much internet bandwidth, etc…

Diurnal Cycle @ Embrapa

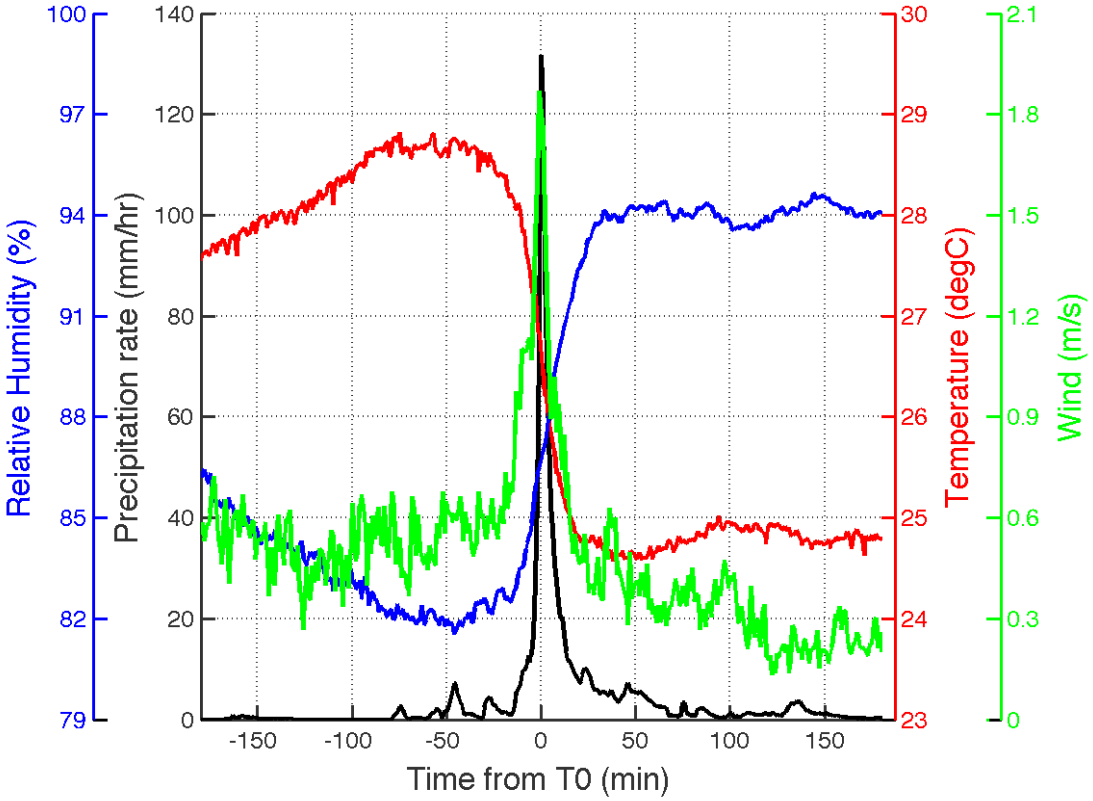


Pauliquevis et al., in prep

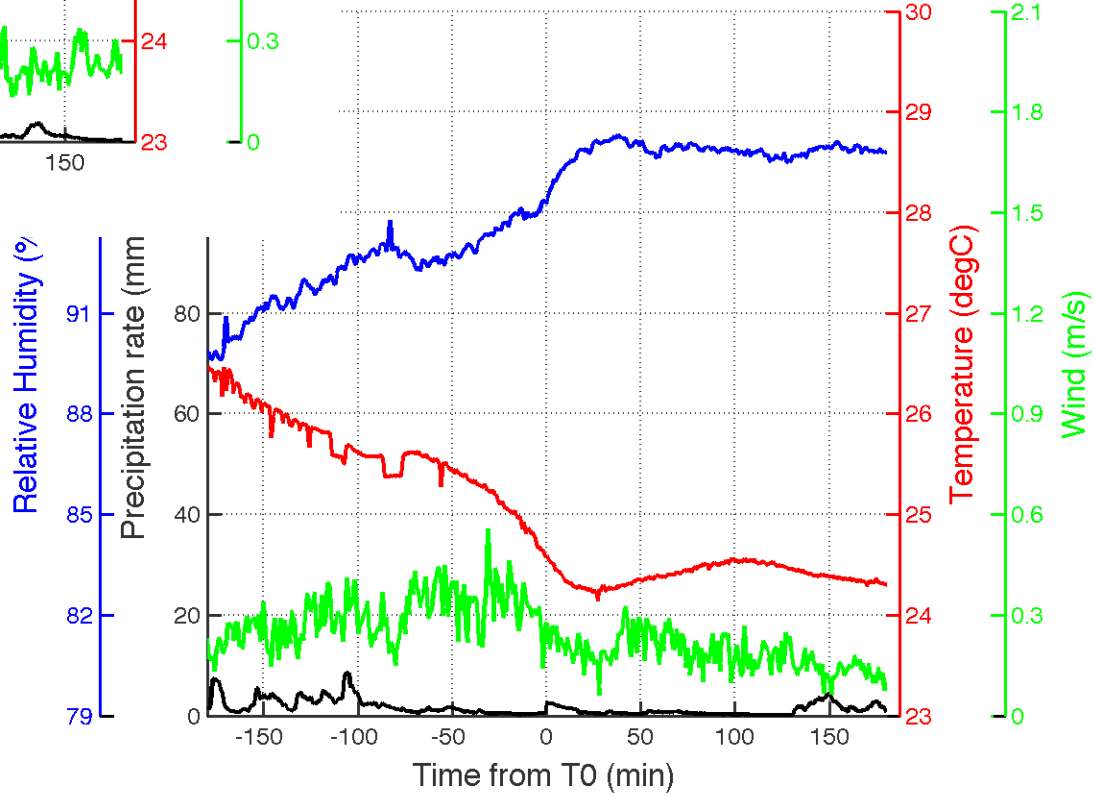
Precipitation Events Life-Cycle @ Embrapa, T0= time of max precip



Strong events q>75%

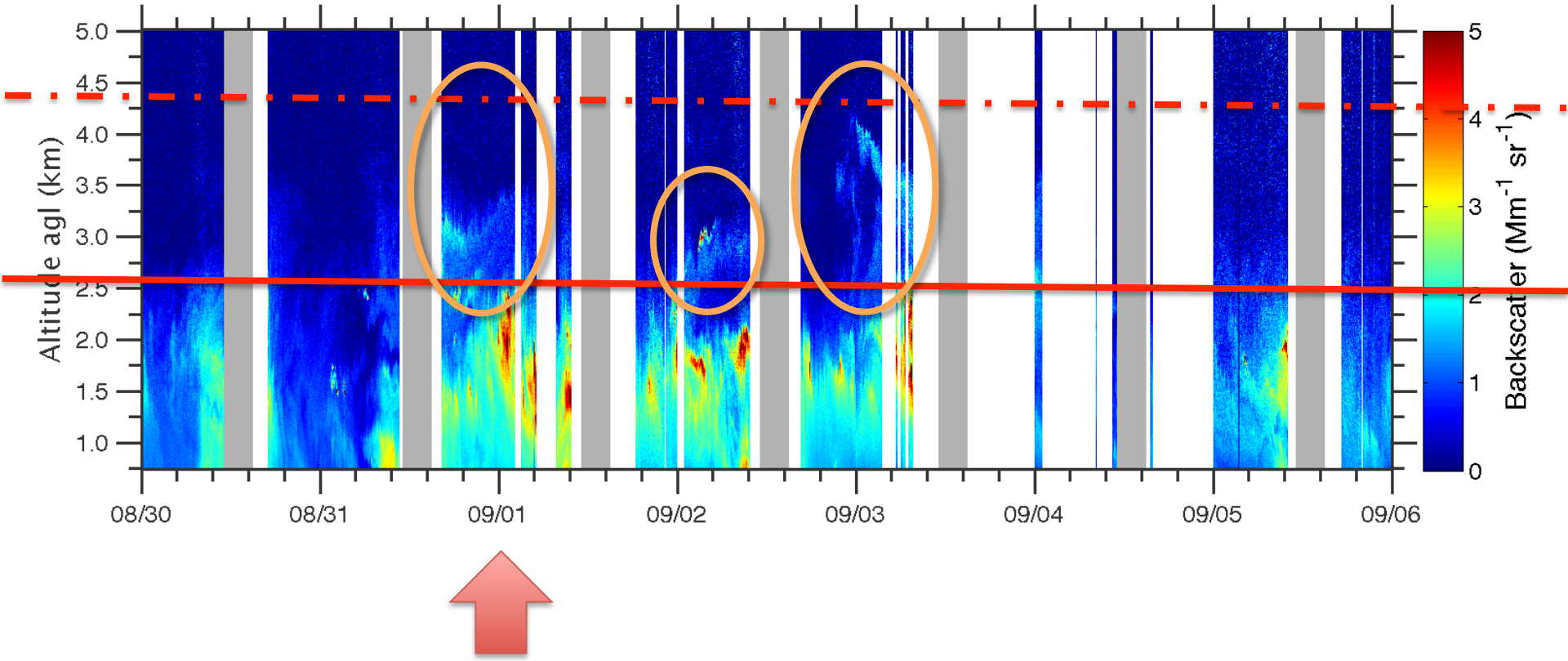


Weak events q<25%

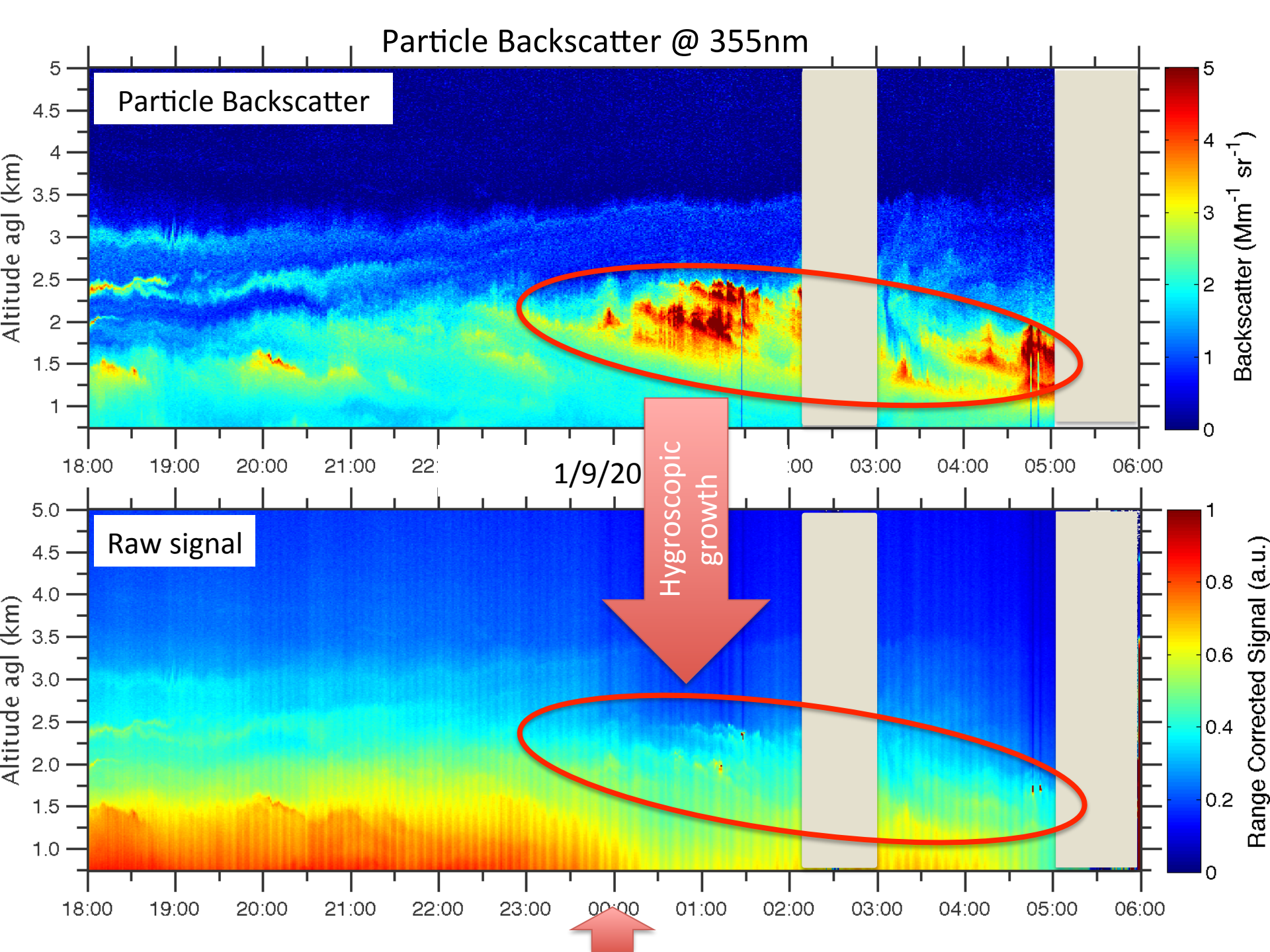


Example of Lidar Measurements

- Particle backscatter coefficient @ 355nm

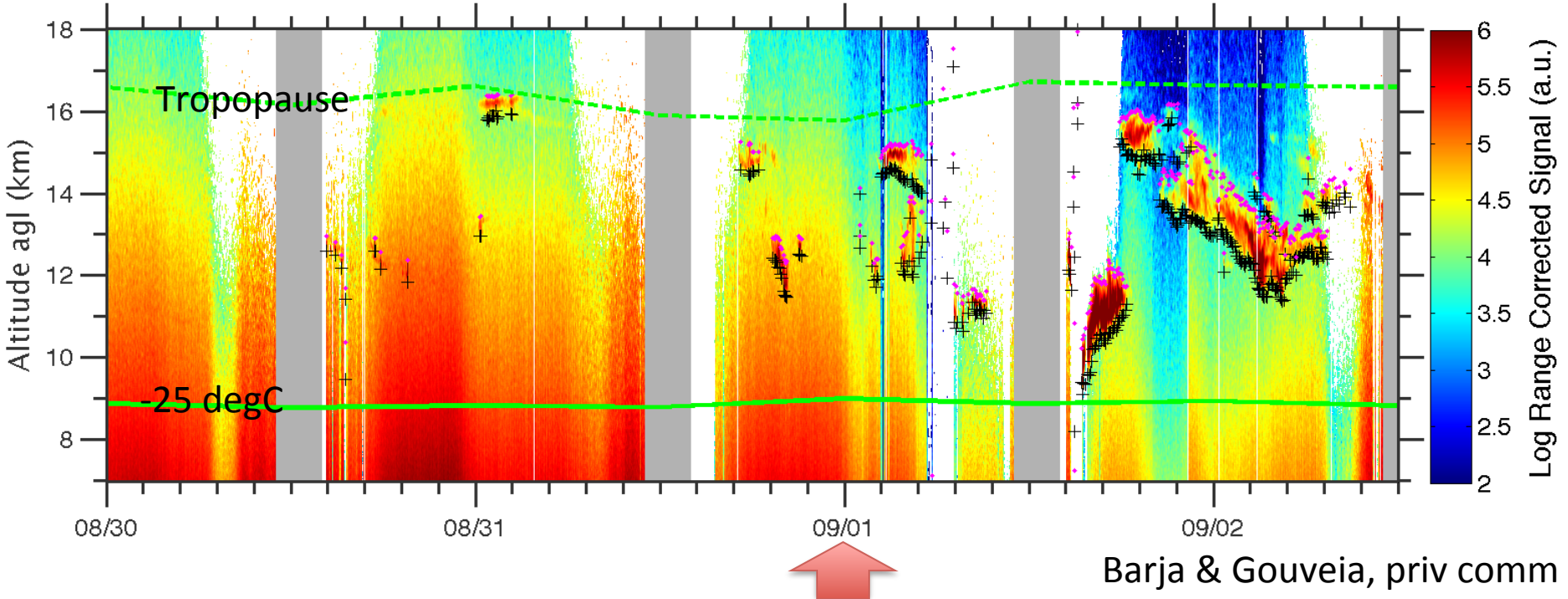


Barbosa et al., AMTD 2014


Particle Backscatter @ 355nm
Particle Backscatter
Altitude agl (km)
Backscatter (Mm-1 sr-1)
1/9/20
Hygroscopic growth
Raw signal
Altitude agl (km)
Range Corrected Signal (a.u.)
18:00
19:00
20:00
21:00
22:00
23:00
00:00
01:00
02:00
03:00
04:00
05:00
06:00

Cirrus Clouds

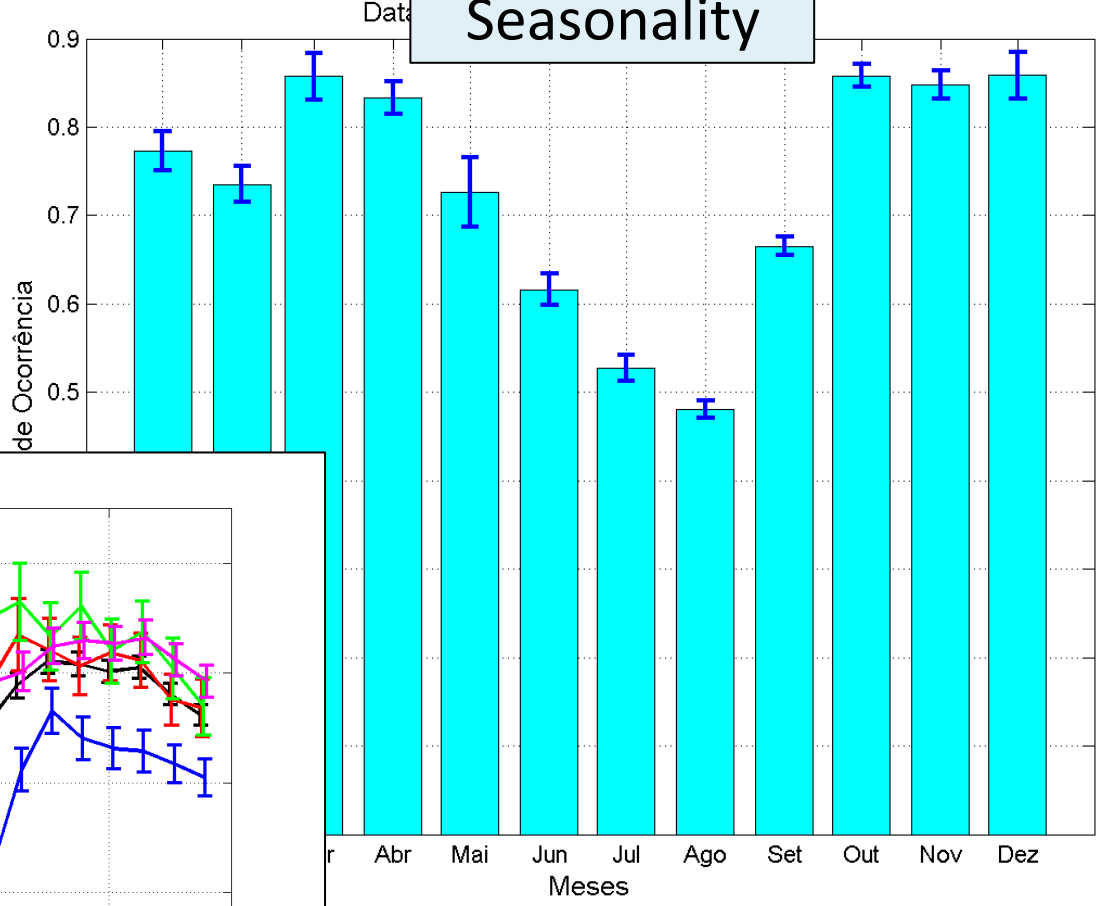
- Cirrus found from 8 to 19.6km
  - Base 12.5±2.4 km
  - Top 14.2±2.2 km



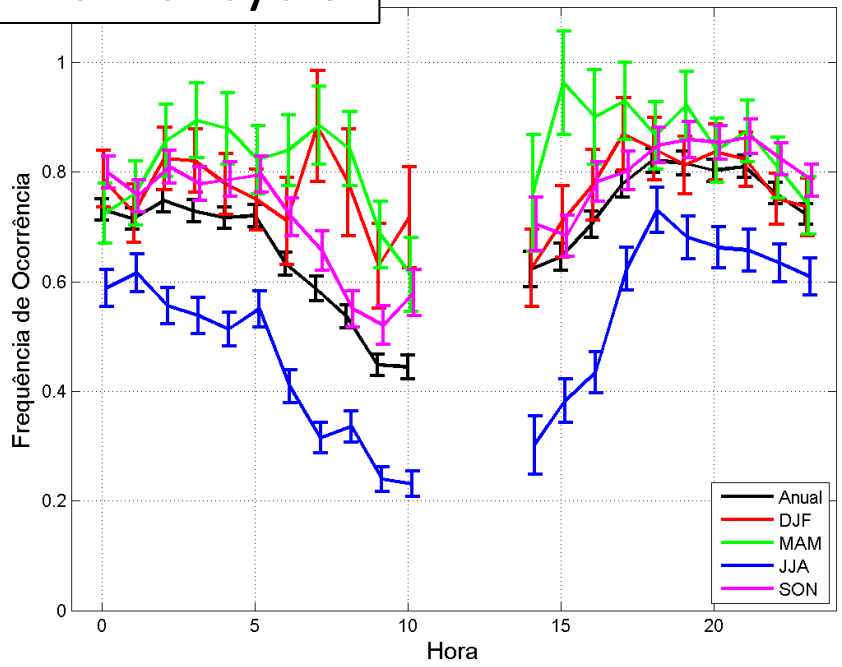
Barja & Gouveia, priv comm

- Cirrus cloud cover at Manaus
  - 83% MAM
  - 52% JJA

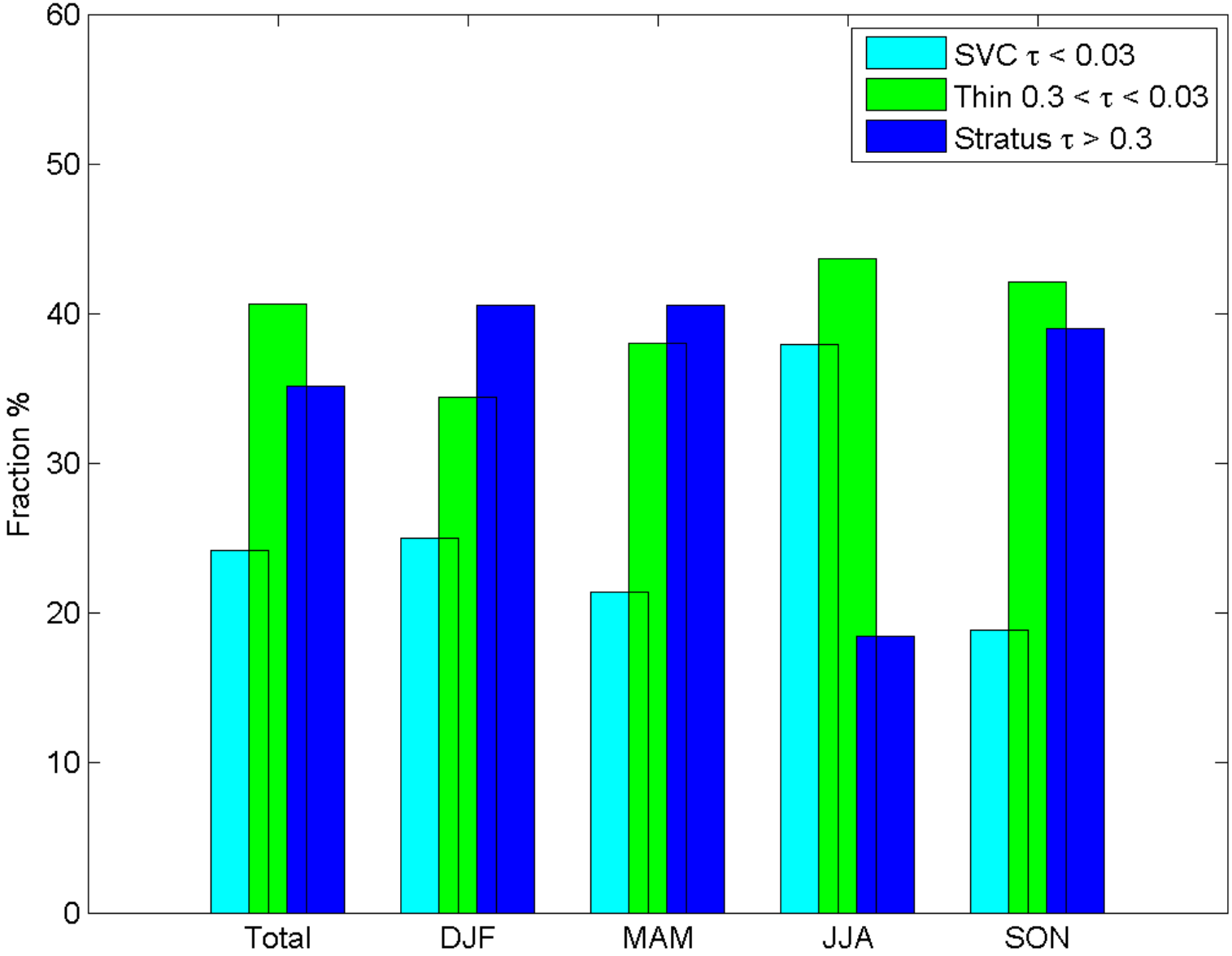
Seasonality



Diurnal cycle



D. Gouveia, Msc dissertation, USP



Frequency 78 % 83 % 52 % 77 %

This kind of base line characterization of cloud properties, is long needed, and may serve as a reference for investigating aerosol effects on cloud development.

Could ATTO help building this reference for the natural life cycle of clouds in the pristine Amazon?

Gather group of interested researchers?

Start with simpler instruments?

- Ceilometer
- Vertical pointing radar
- Disdrometer

How the variability in the number-diameter distribution $n(d)$ of the particle population for natural and polluted conditions as well as variability in the intrinsic effective hygroscopicity k of the particles affects cloud properties?

1) Monitor $n(d)$ of the aerosol particle population under variable natural and polluted conditions:

- T3 (DOE), T2 (Artaxo) and ATTO (Poelker)

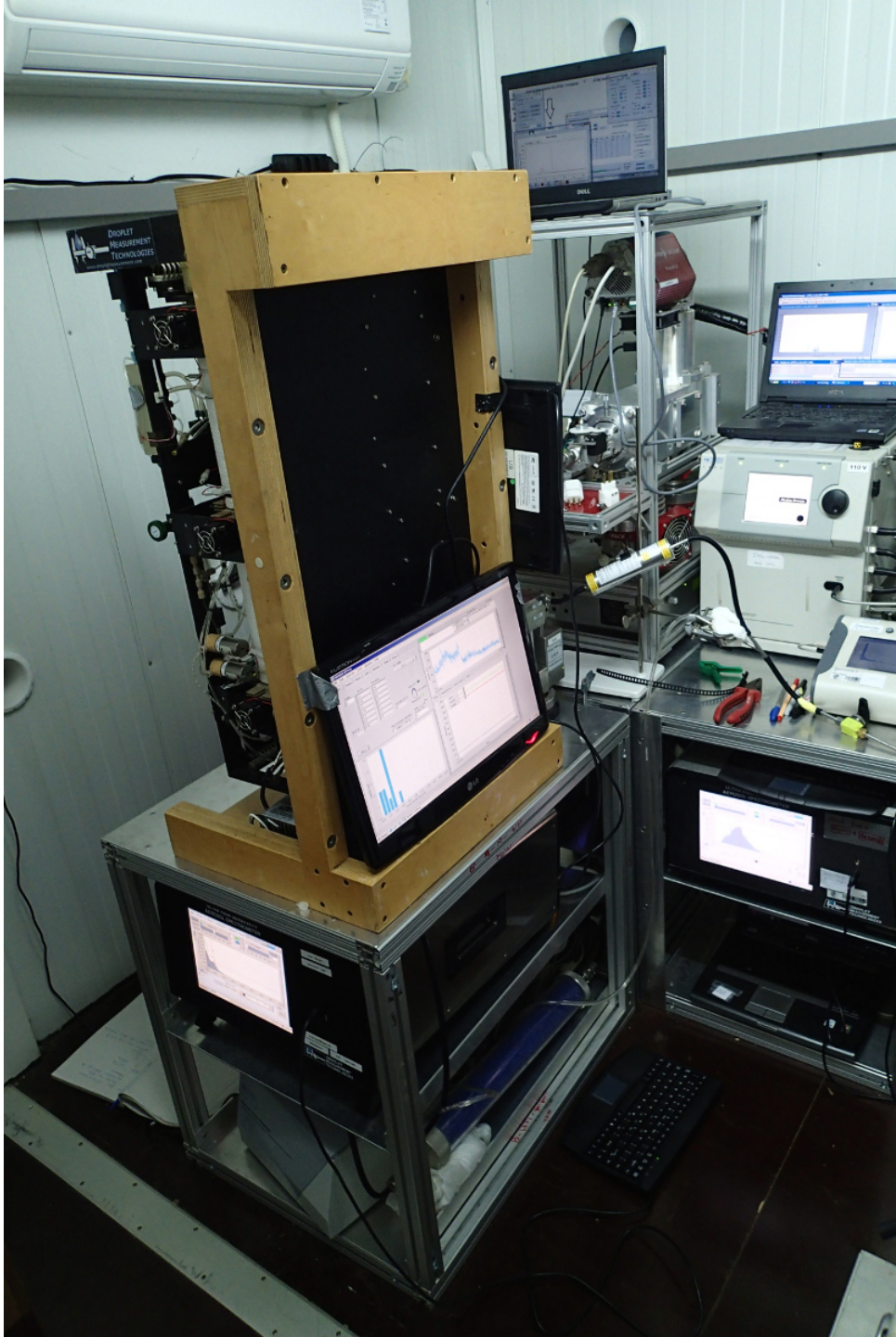
2) Measure k by coupling DMA+CCNC+CPC

- T3 (Wang), ATTO + ACRIDICON (Poeschl)

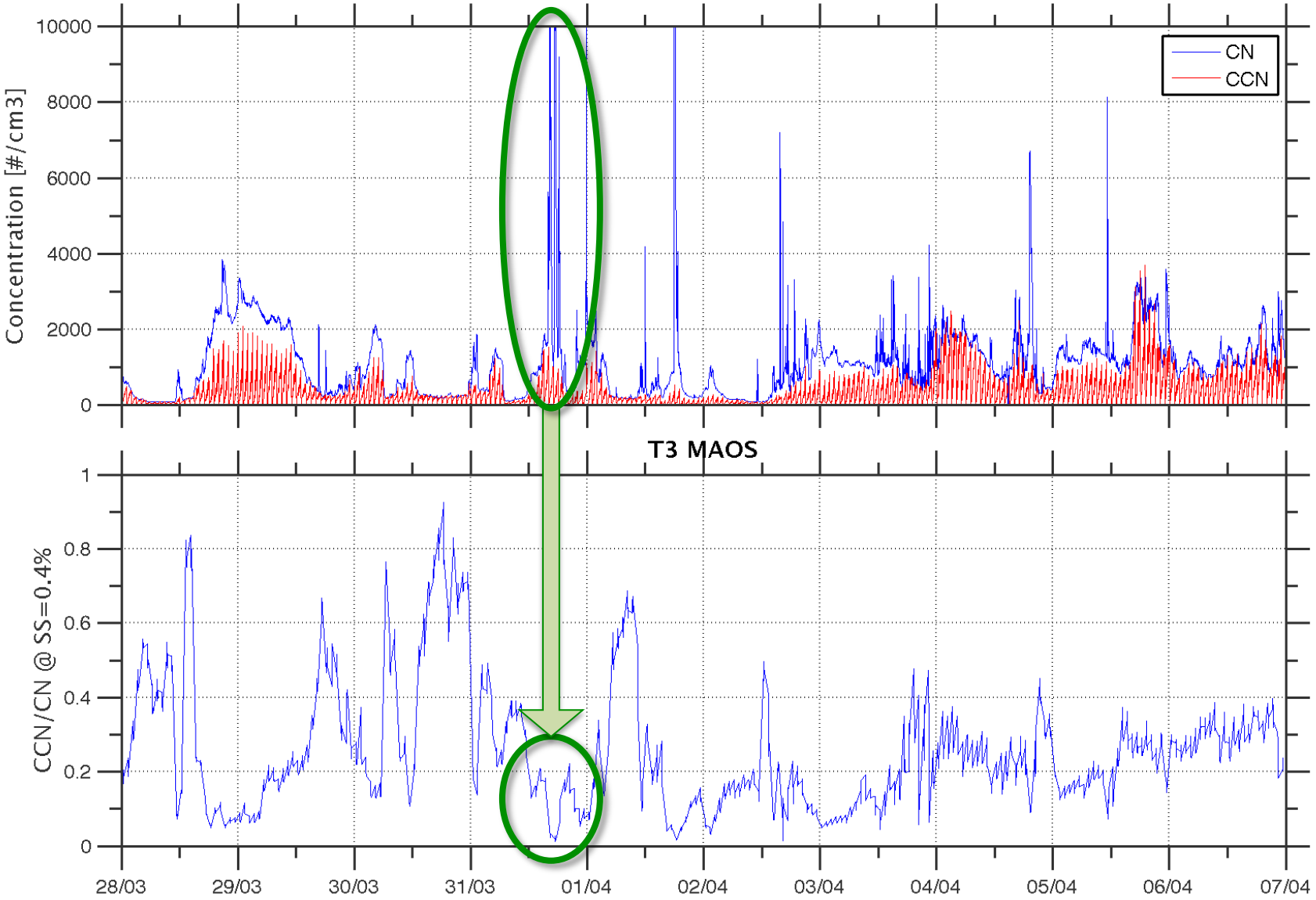
Shouldn't we do it under more heavy pollution at T2?

Mira's measurements

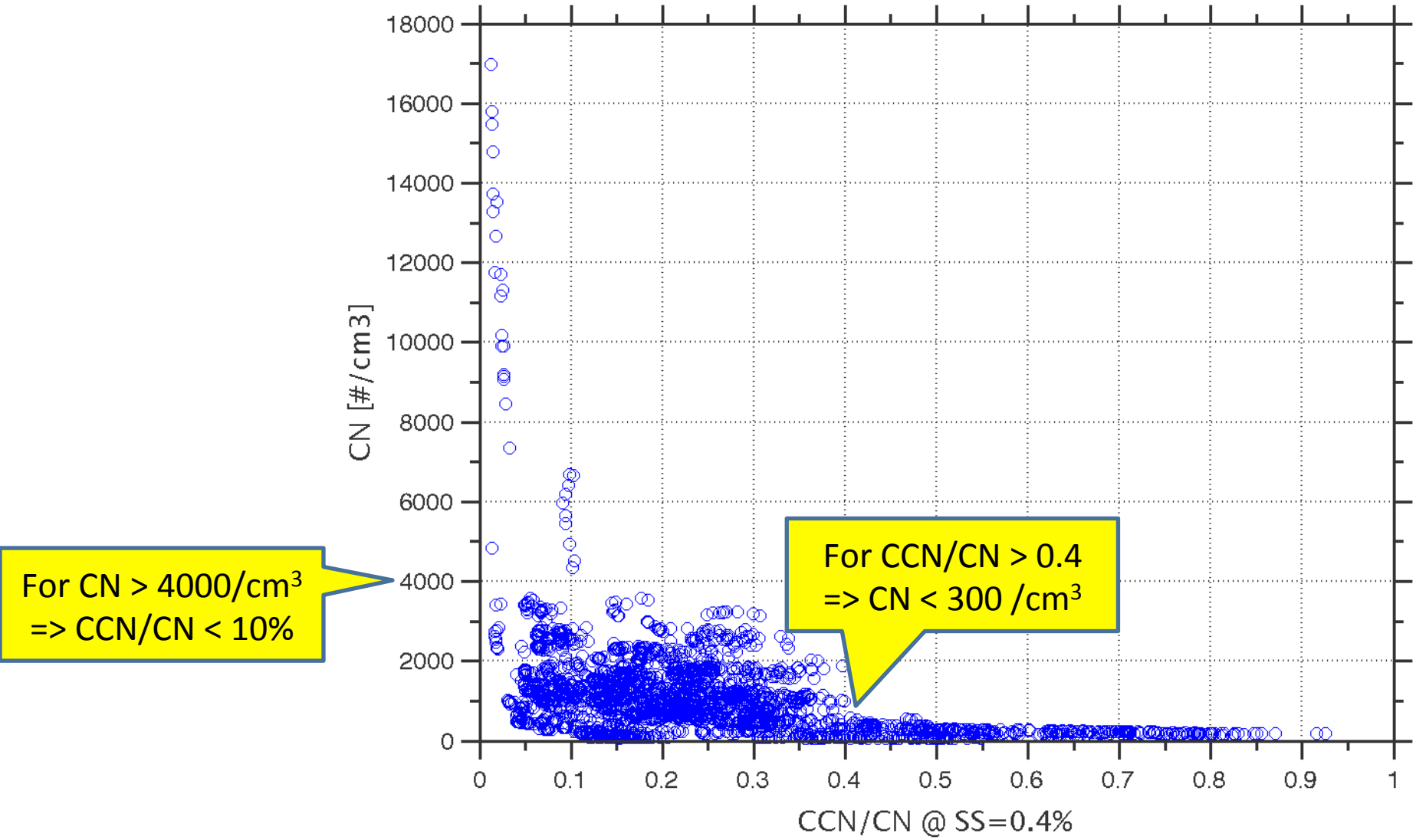
- 17-21 March
  - Initial setup
  - Calibration
  - Intercomparison w/ J. Wang at T3
- 22-26 March
  - Moved to ATTO
  - CCNC calibration
  - DMA/UHSAS calibration with PSL's
  - Started data acquis…



CCN/CN Measurements at ATTO



CCN/CN Measurements at ATTO



Modeling

- Based on the data sets of $n(d)$ and κ, microphysical modeling will be conducted
  - The cloud droplet number concentration (CDNC) will be calculated using the parcel model *COGr-Model* ("CONdensational Growth Model");
  - How changes in CDNC induce changes in the time and height of rain formation in warm convective clouds will be studied using a a bin-microphysics scheme in a 2D model embedded in a full 3D model.

Thanks