Modeling microphysics effects in cloud life cycle in the context of ACRIDICON-CHUVA

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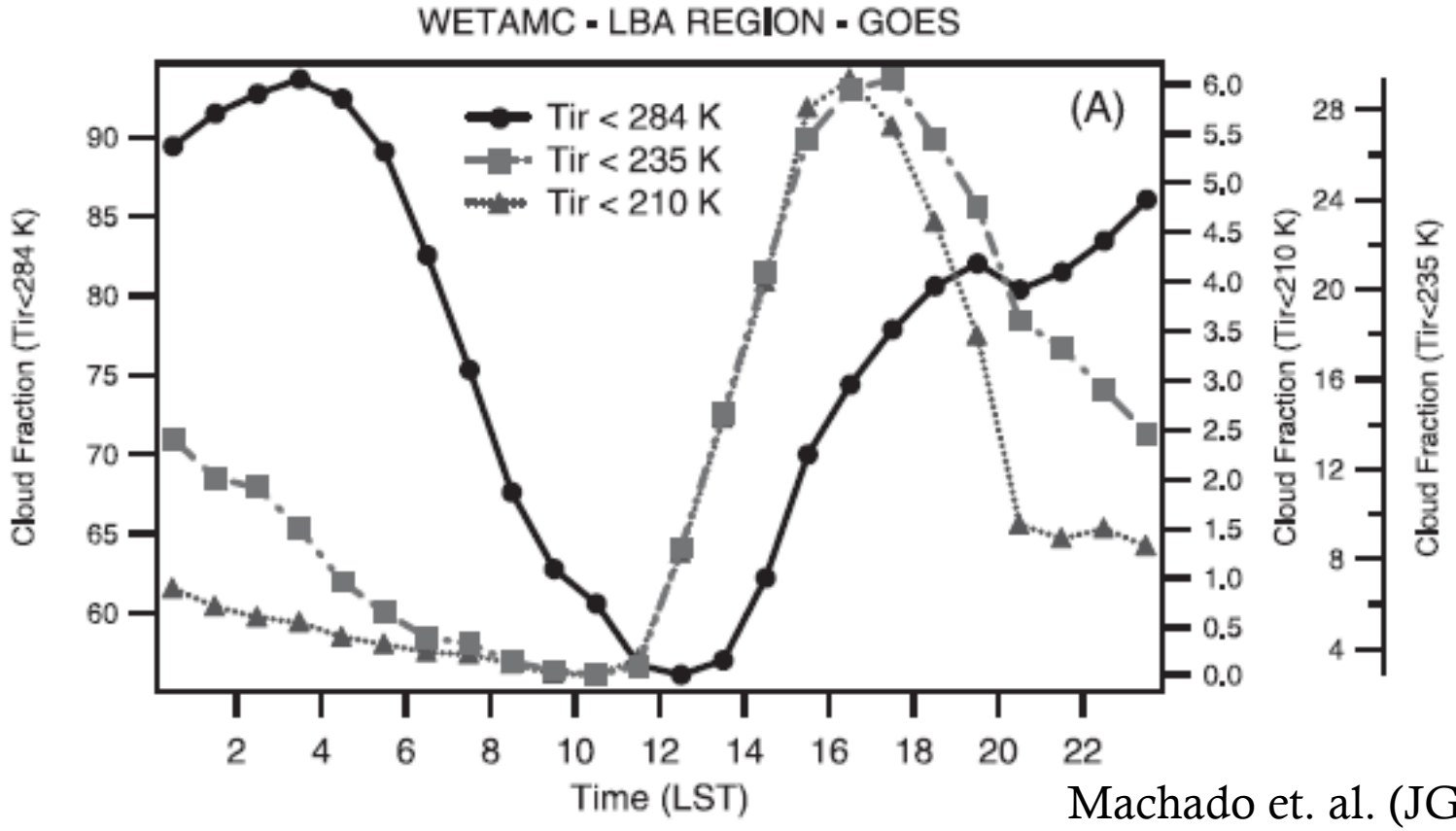
Convection Diurnal Cycle

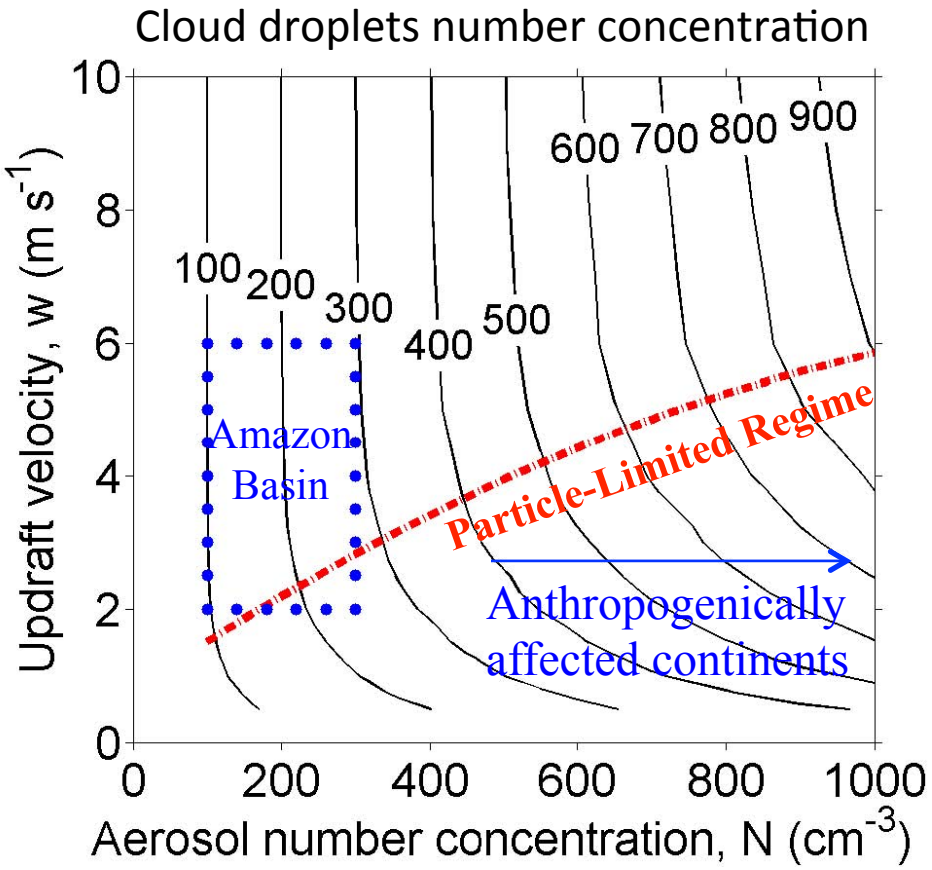
- Last studies in early 2000's:
  - WETAMC and TRMM/LBA



Machado et. al. (JGR 2002)

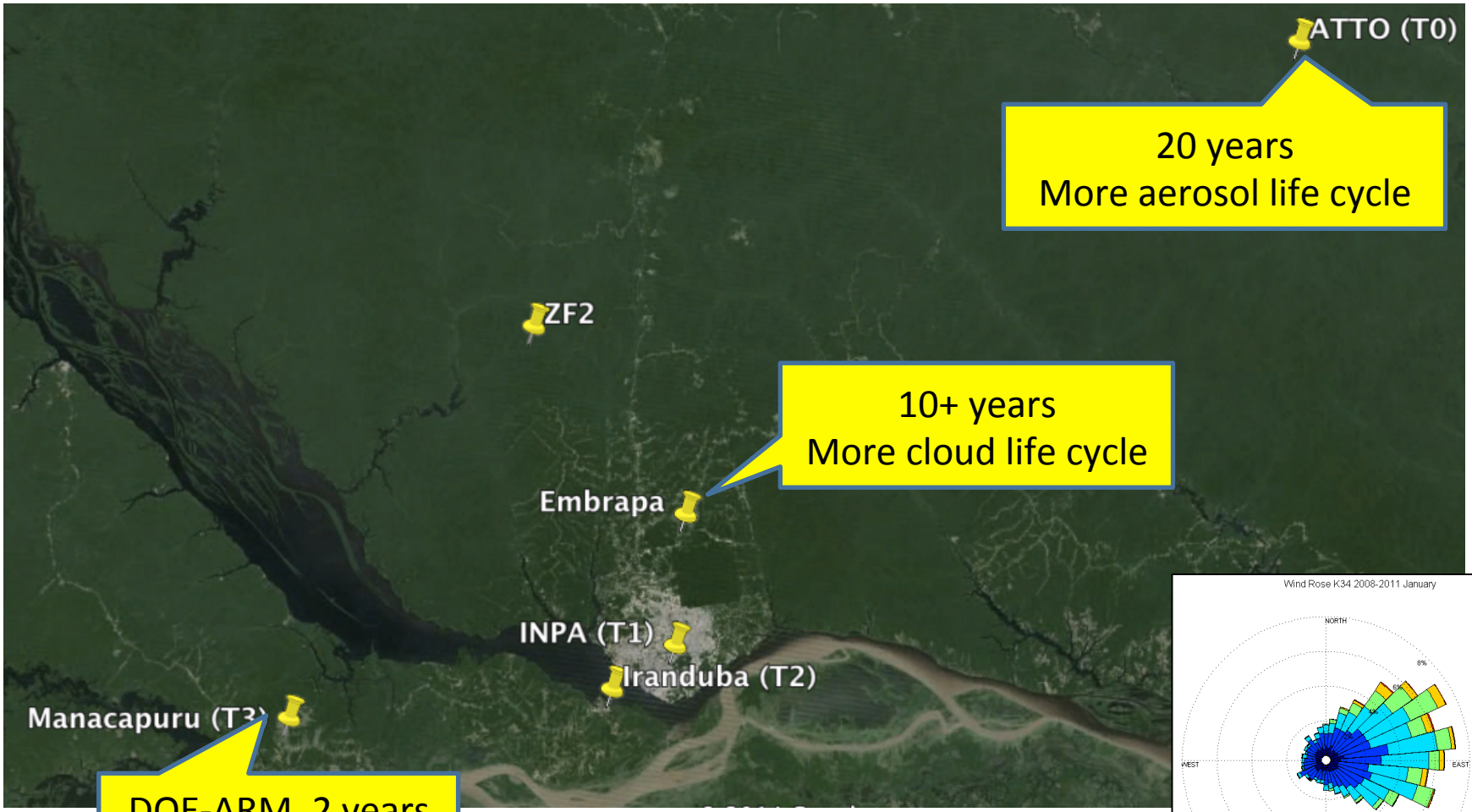
Possible Aerosol Effects

- 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.



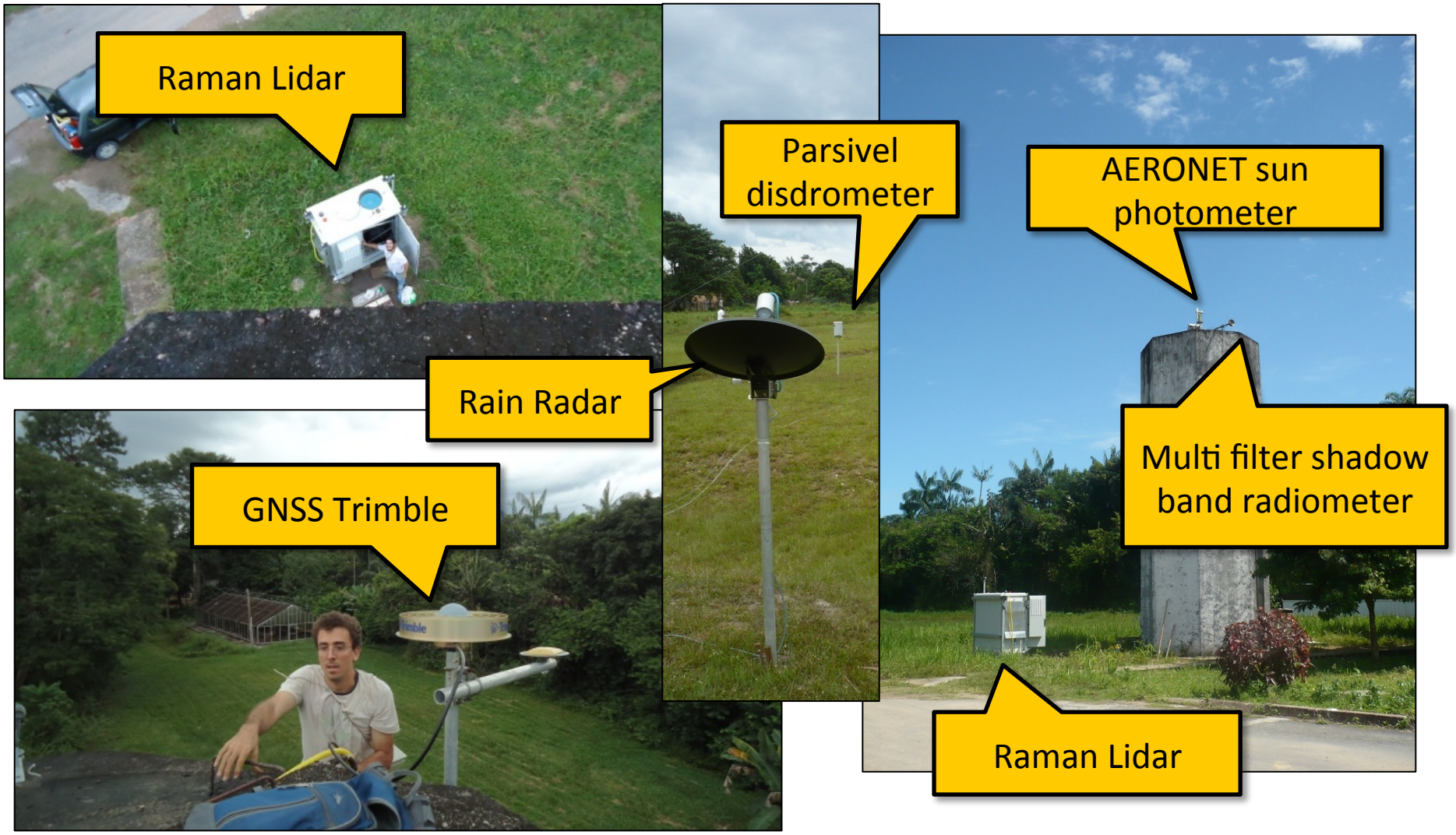
Poschl et al, Science 2010

Large coordinated effort



Embrapa Site - Closeup

Embrapa Site - Instruments



Embrapa Site - Measurements

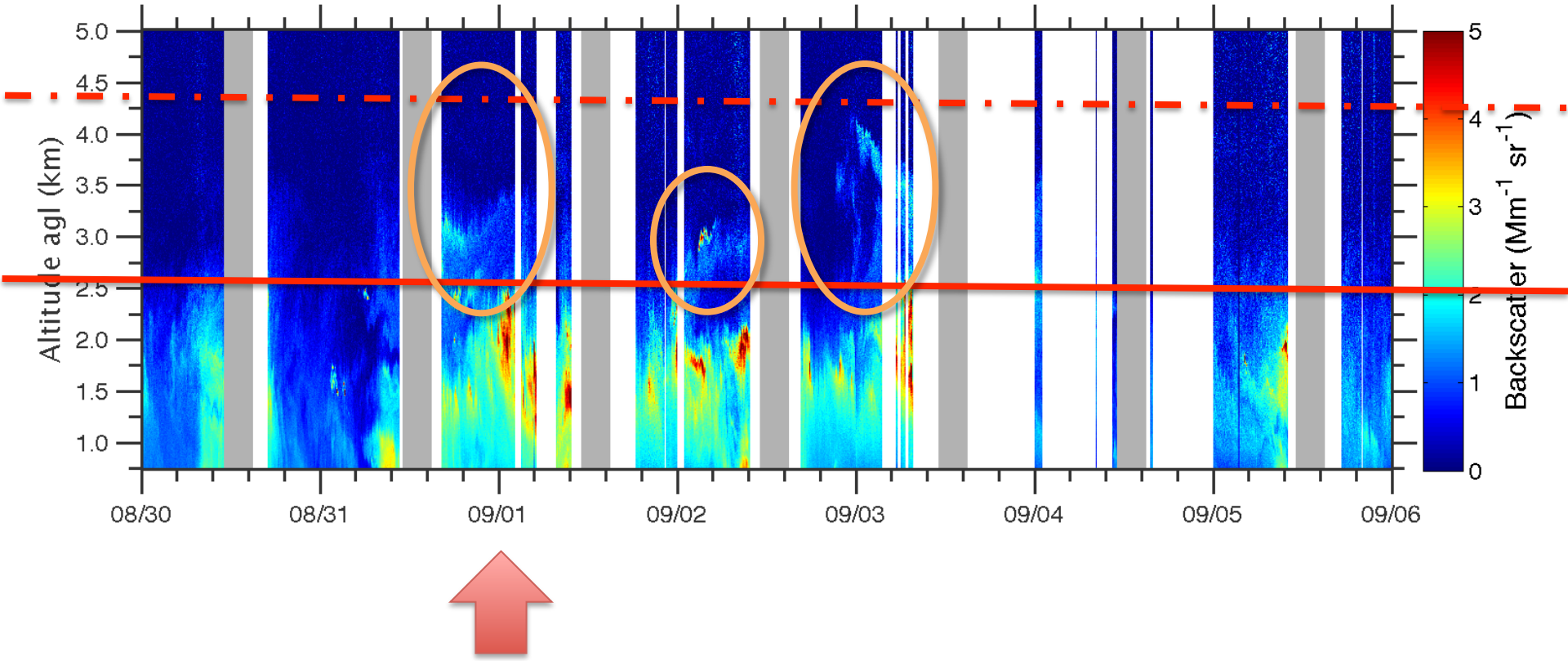
- Profiles of aerosol, water vapor and clouds from a UV Raman lidar;
- Profiles of cloud layers from a ceilometer;
- Profiles of temperature, water vapor and in-cloud liquid water from a infrared radiometer;
- Profile of rain drops size distribution from disdrometer and vertical pointing rain radar;

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

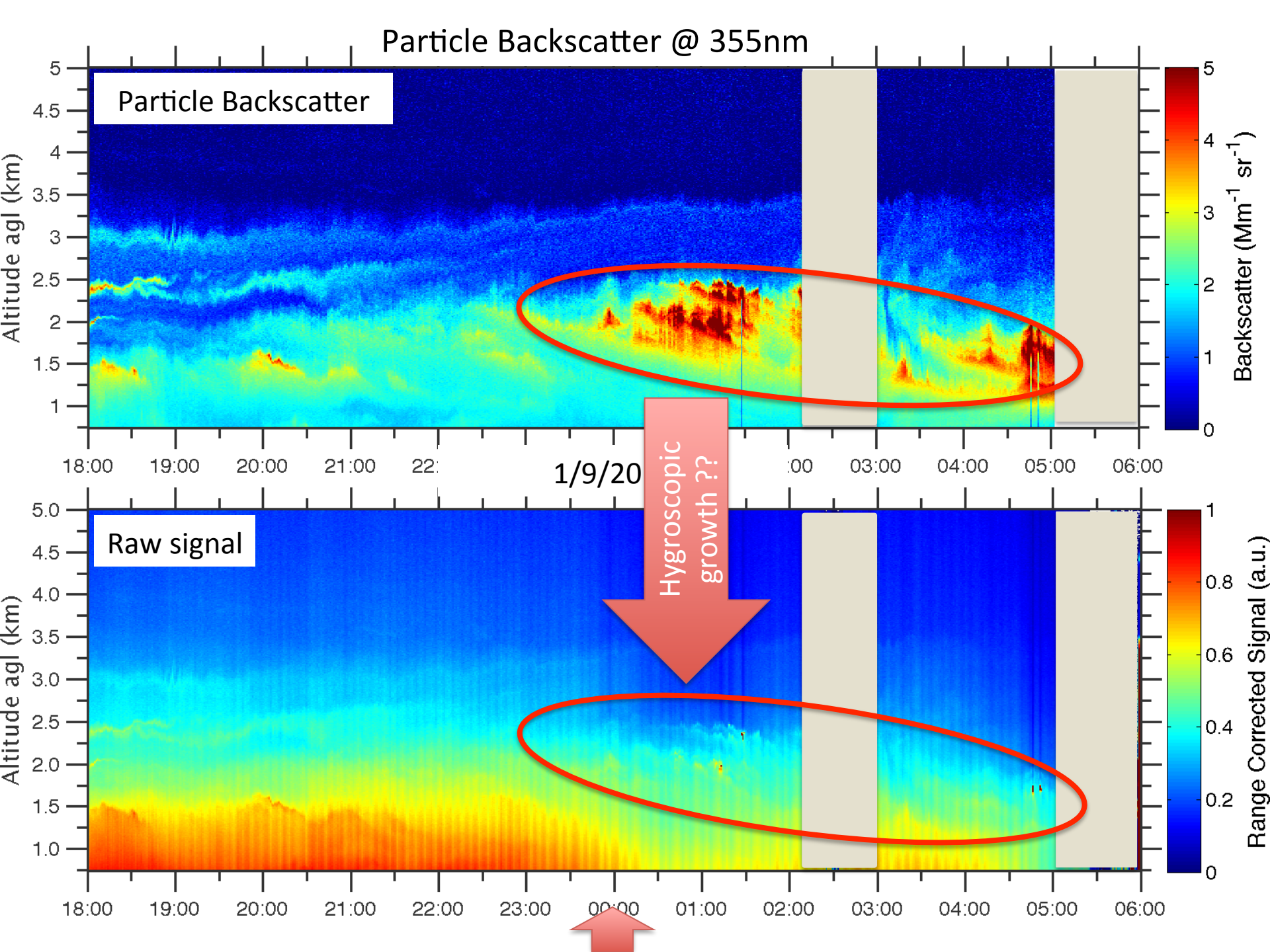
- Aerosol scattering from a nephelometer;
- Surface fluxes and standard meteorological obs.

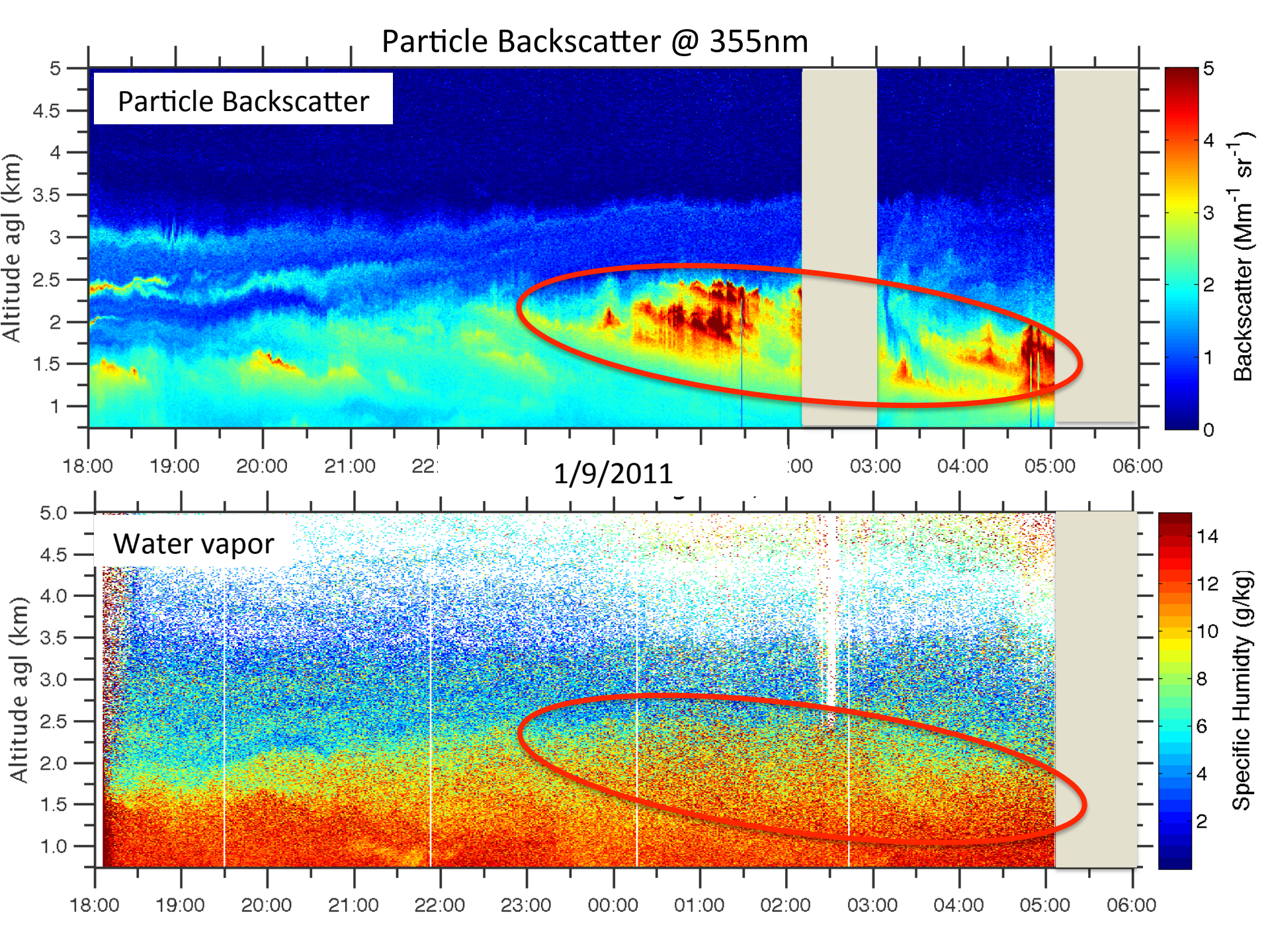
Example of Lidar Measurements

- Particle backscatter coefficient @ 355nm



Barbosa et al., AMT 2014

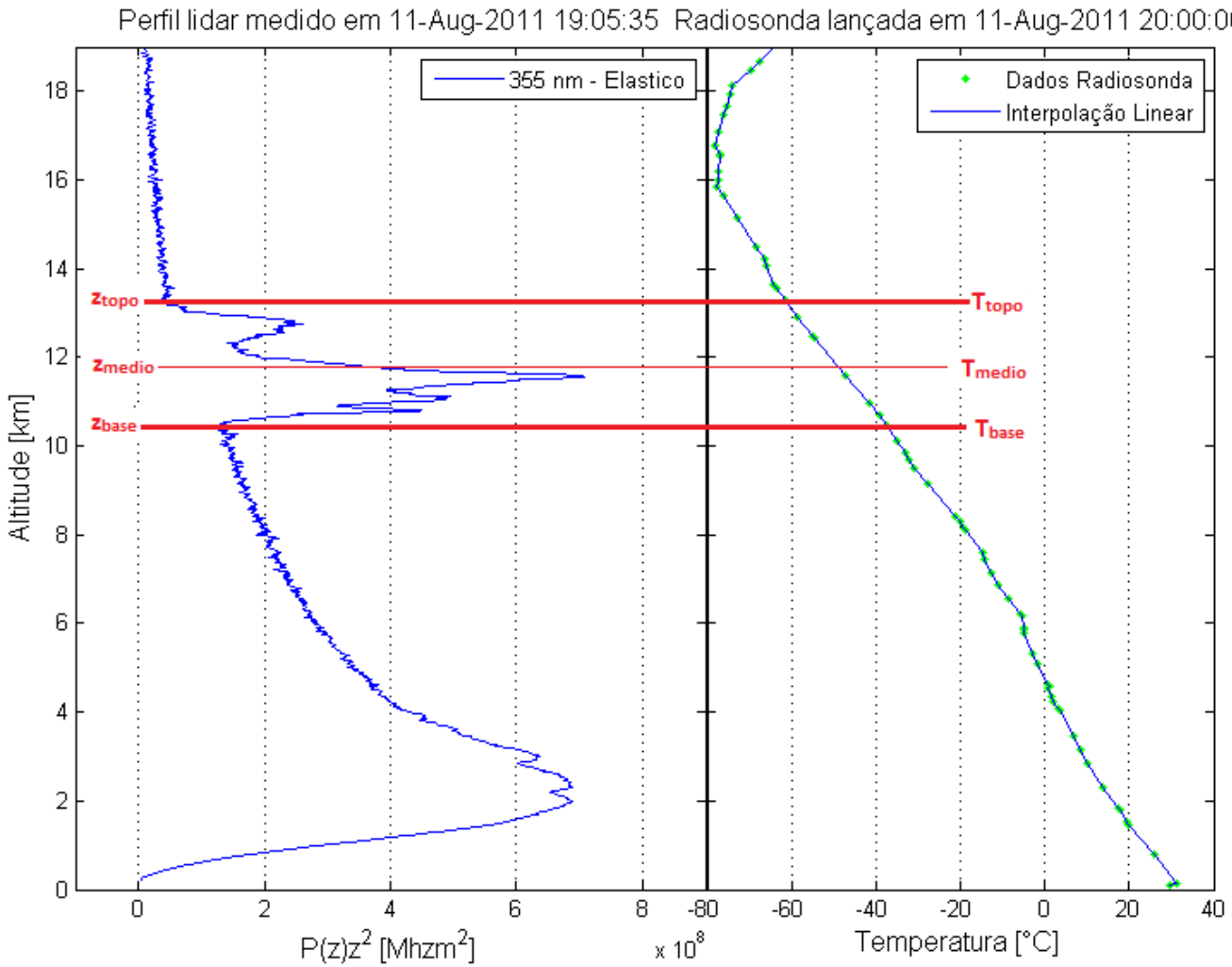

Particle Backscatter @ 355nm
Particle Backscatter
Altitude agl (km)
Backscatter (Mm-1 sr-1)
1/9/20
Hygroscopic growth ??
Raw signal
Altitude agl (km)
Range Corrected Signal (a.u.)
18:00
19:00
20:00
21:00
22:00
23:00
00:00
01:00
02:00
03:00
04:00
05:00
06:00


Particle Backscatter @ 355nm
Particle Backscatter
Altitude agl (km)
Backscatter (Mm-1 sr-1)
1/9/2011
Water vapor
Specific Humidty (g/kg)
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

Thinking of ACRIDICON…

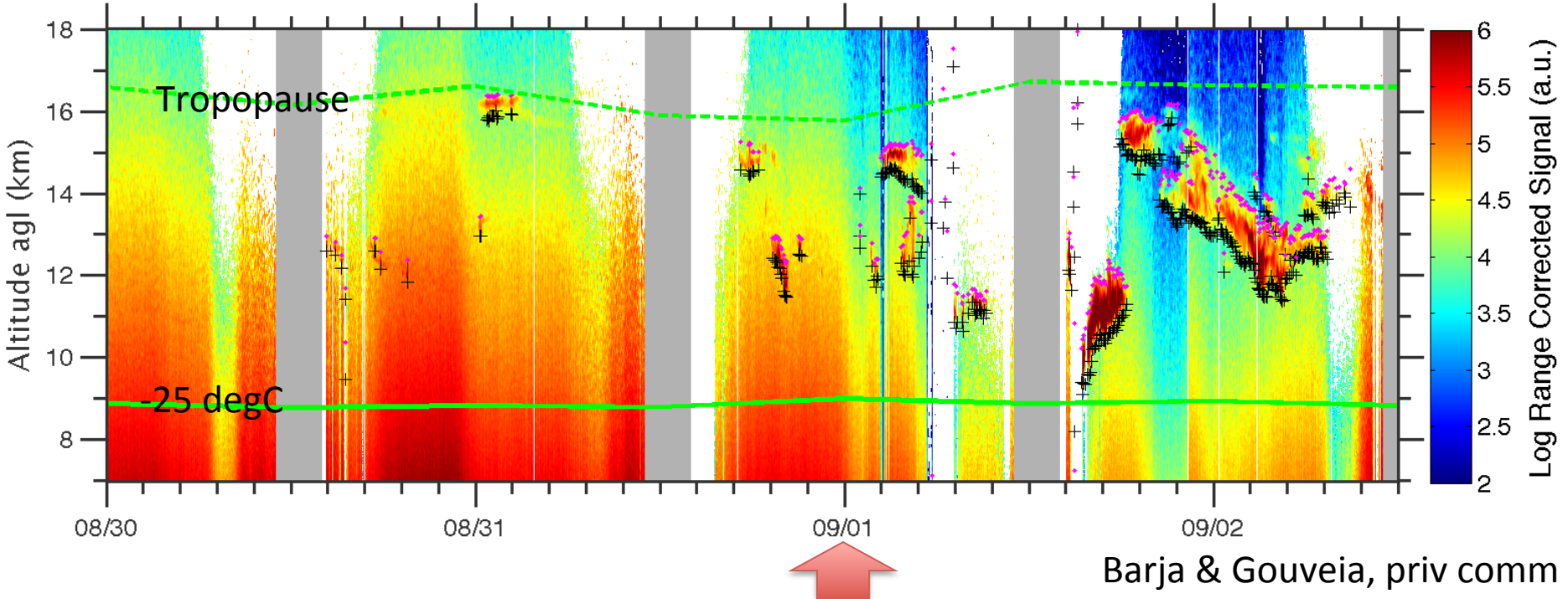
1. Twilight
   - Could we do measurements in the zone between clouds and aerosols?

Cirrus Clouds, from ground based Lidar



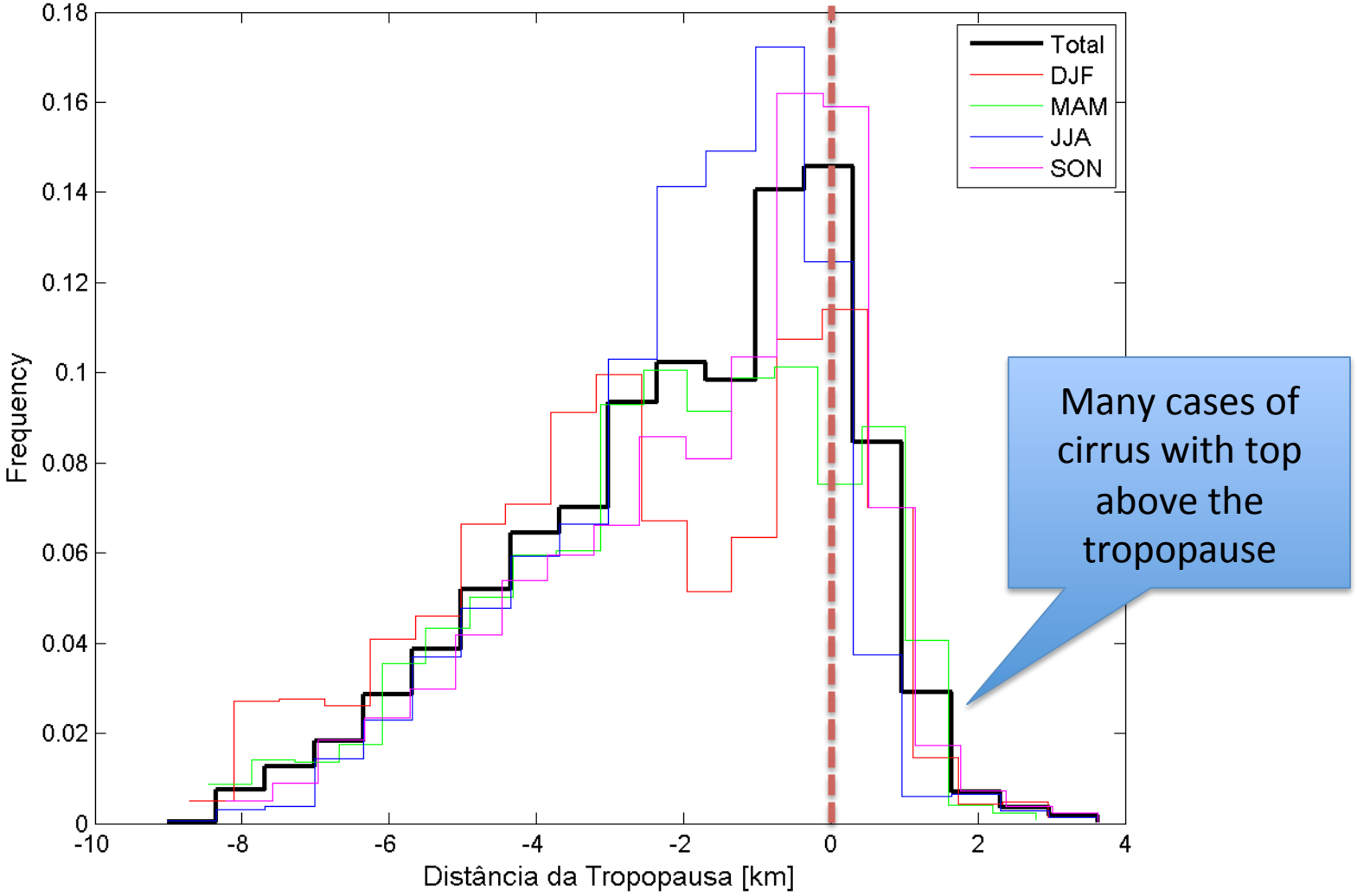
Cirrus Clouds

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



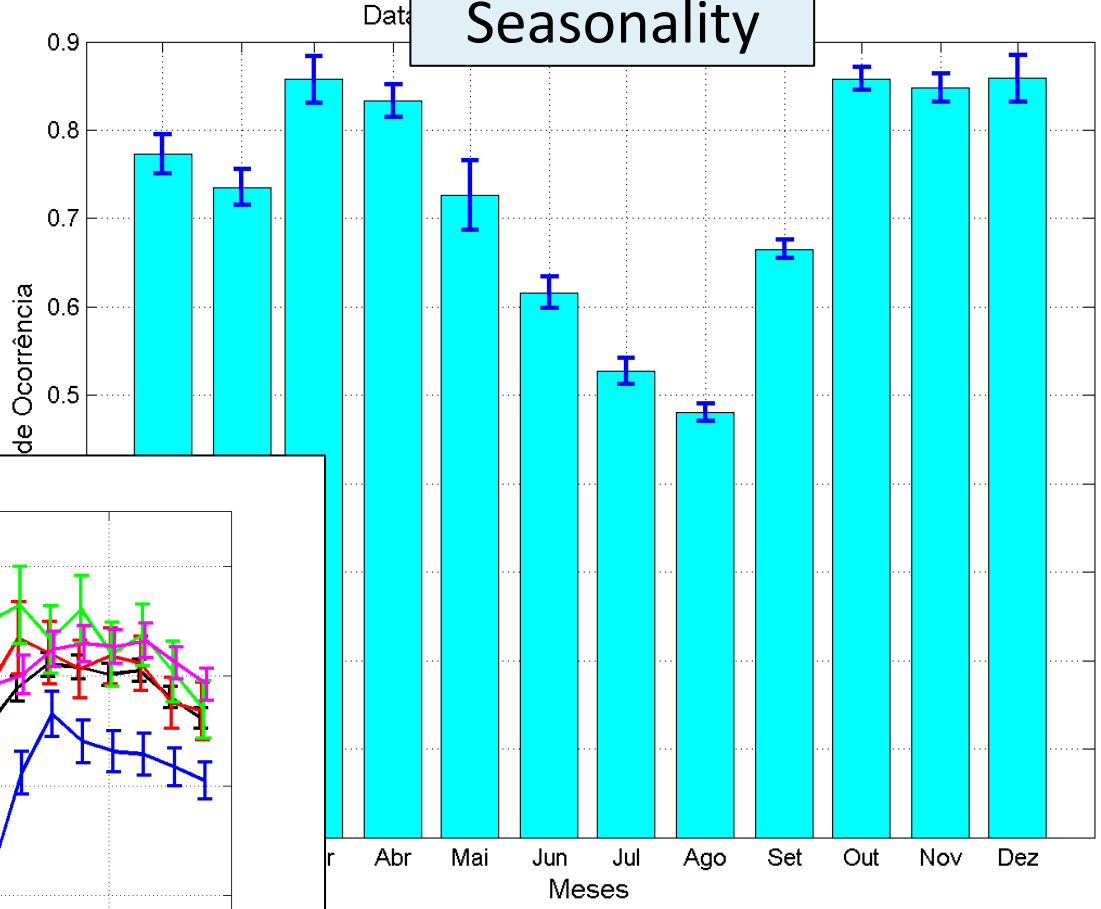
Barja & Gouveia, priv comm

And above the tropopause…

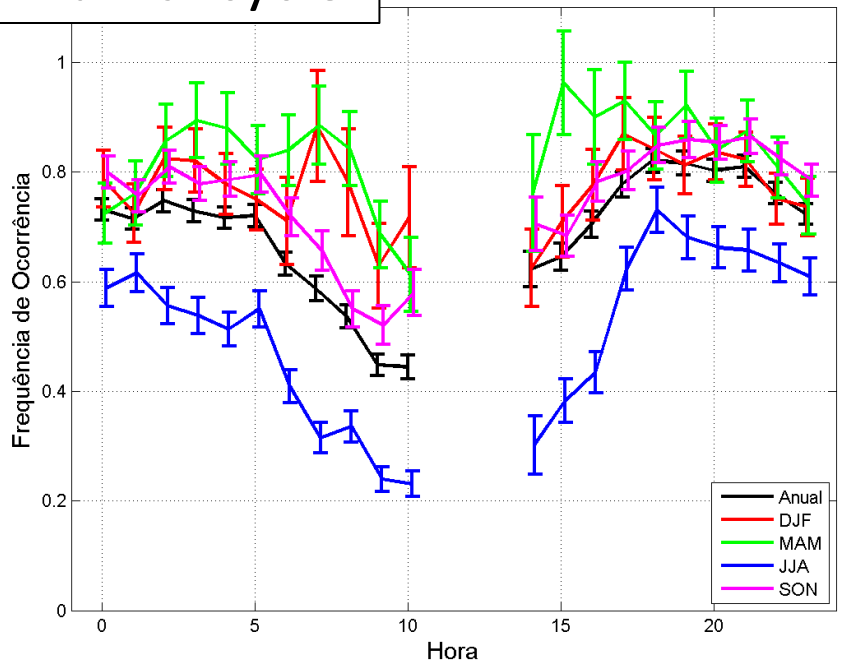


- Cirrus cloud cover at Manaus
  - 83% MAM
  - 52% JJA

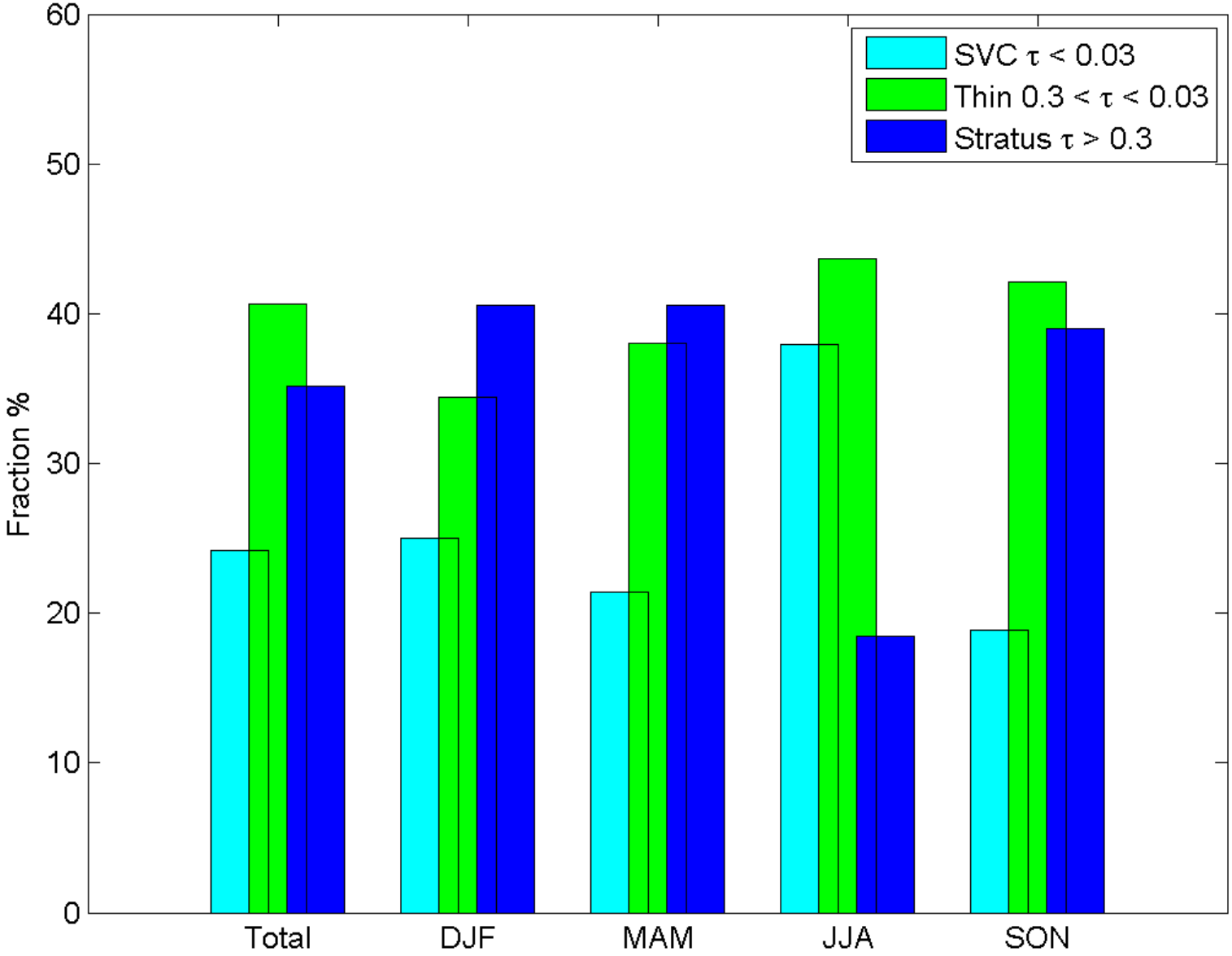
Seasonality



Diurnal cycle

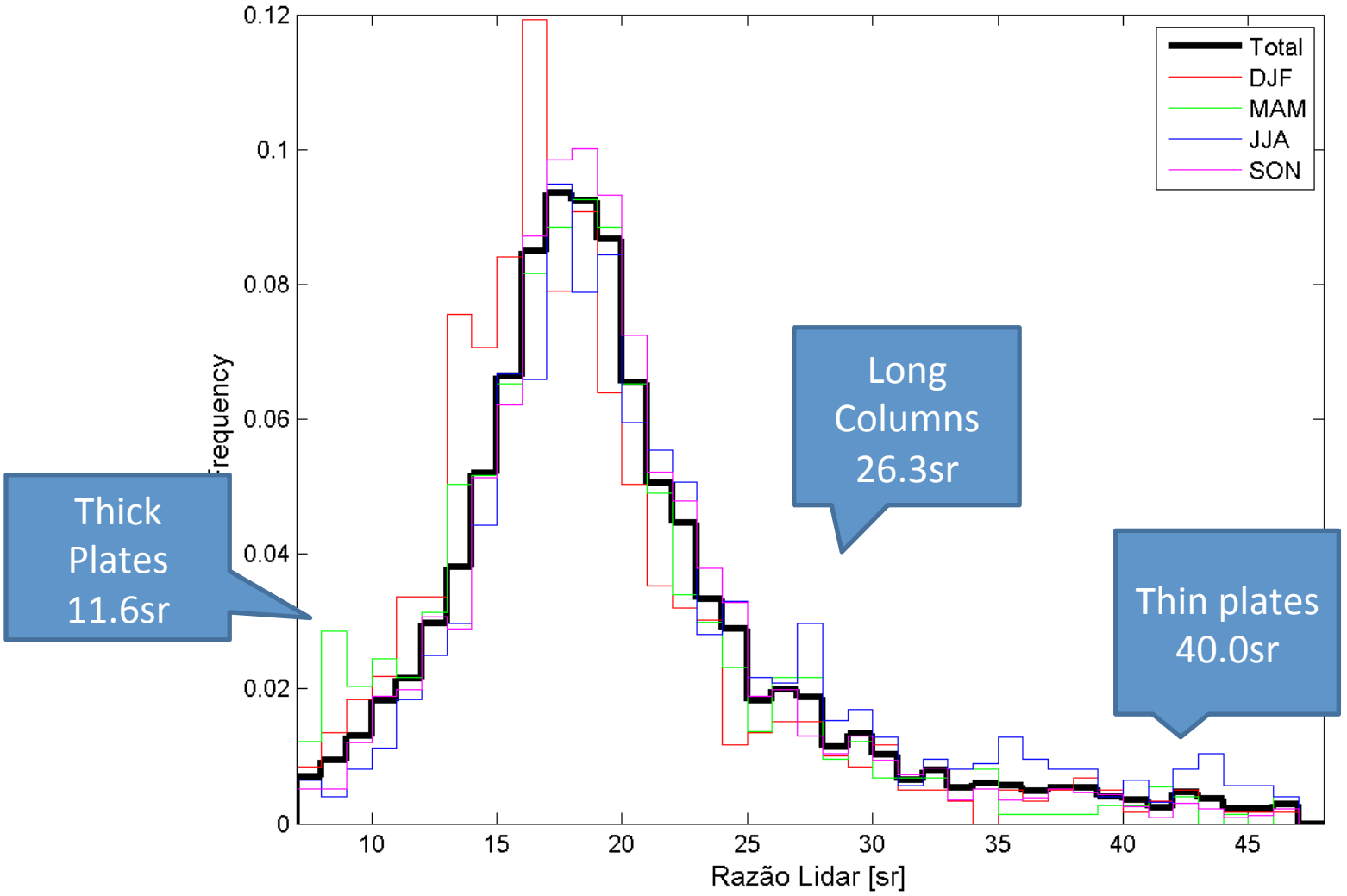


D. Gouveia, Poster

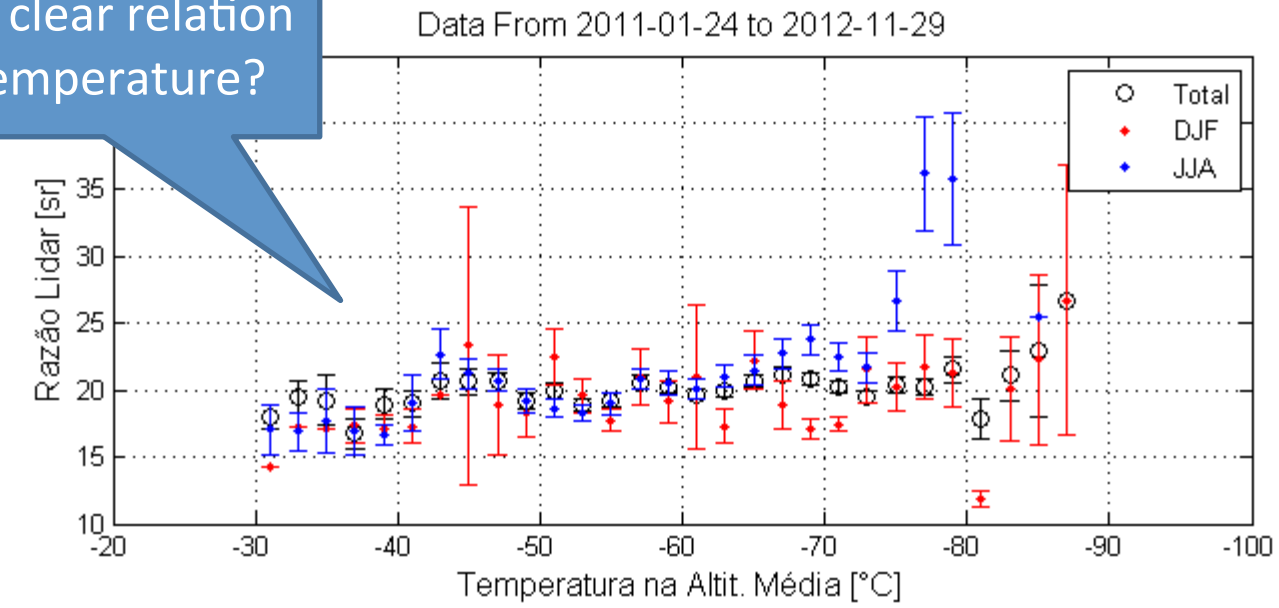


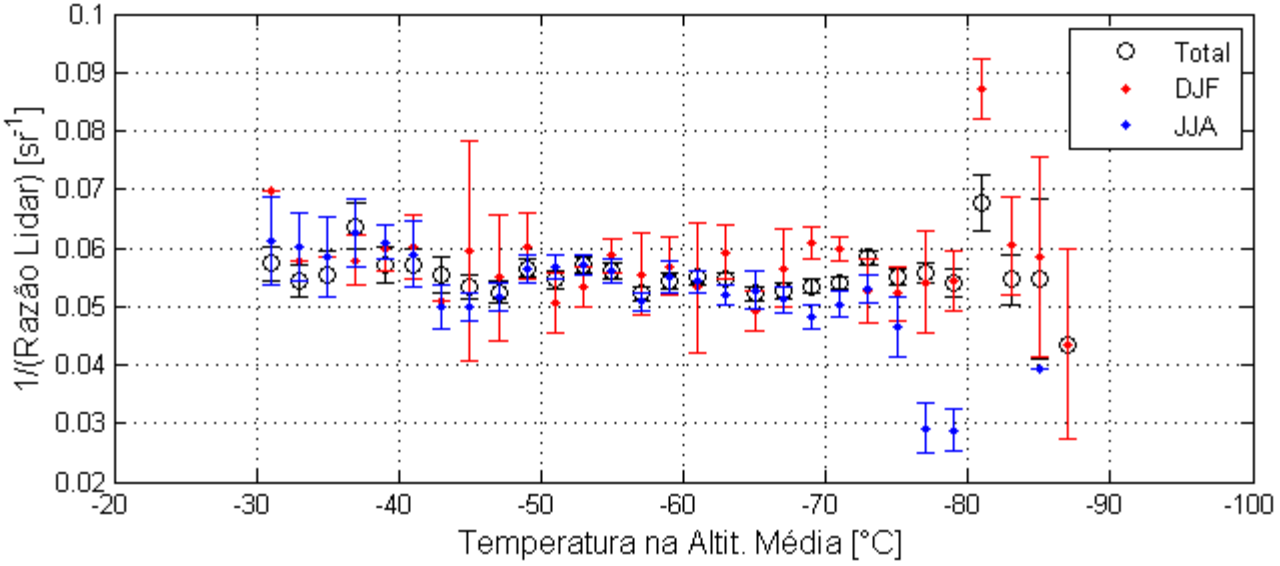
Frequency 78 % 83 % 52 % 77 %

Cirrus clouds – Lidar Ratio



Why no clear relation with temperature?





Thinking of ACRIDICON…

1. Twilight
   - Could we do measurements in the zone between clouds and aerosols?
2. Cirrus
   - What about measuring ice crystals in cirrus clouds (not only anvils?) ?
   - Will there be instrumentation for cloud radiative forcing?

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:

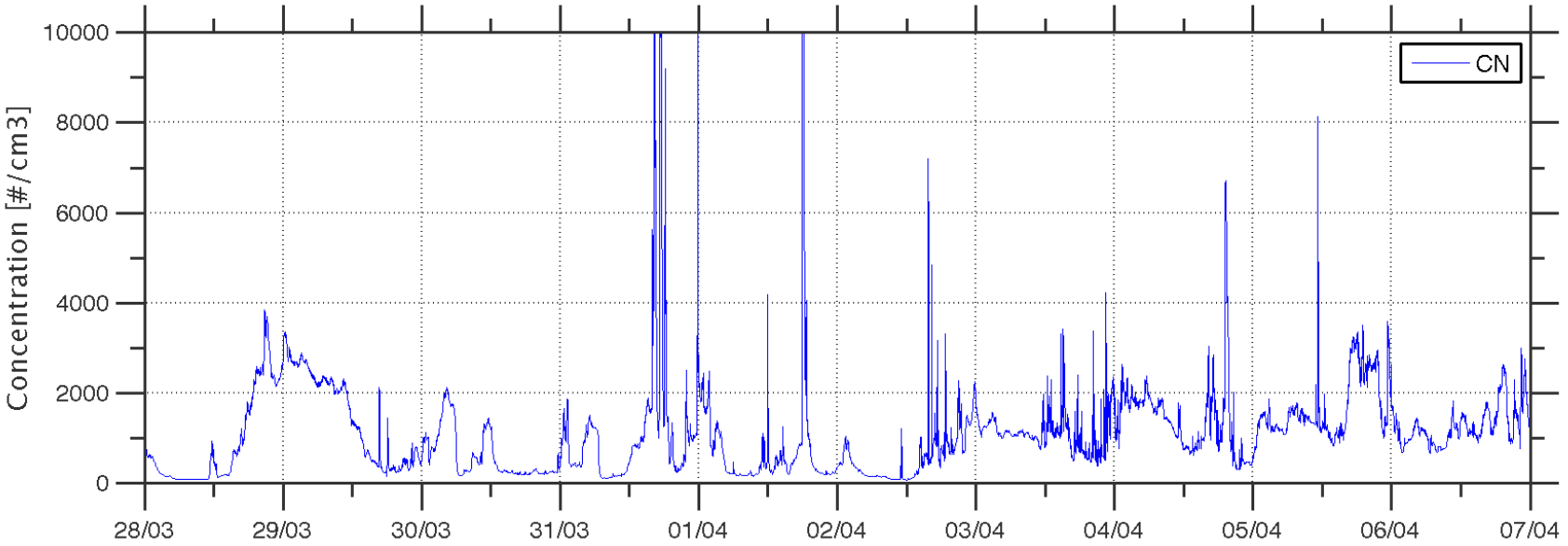
- T3 (DOE), T2 (Artaxo) and ATTO (Poelker)

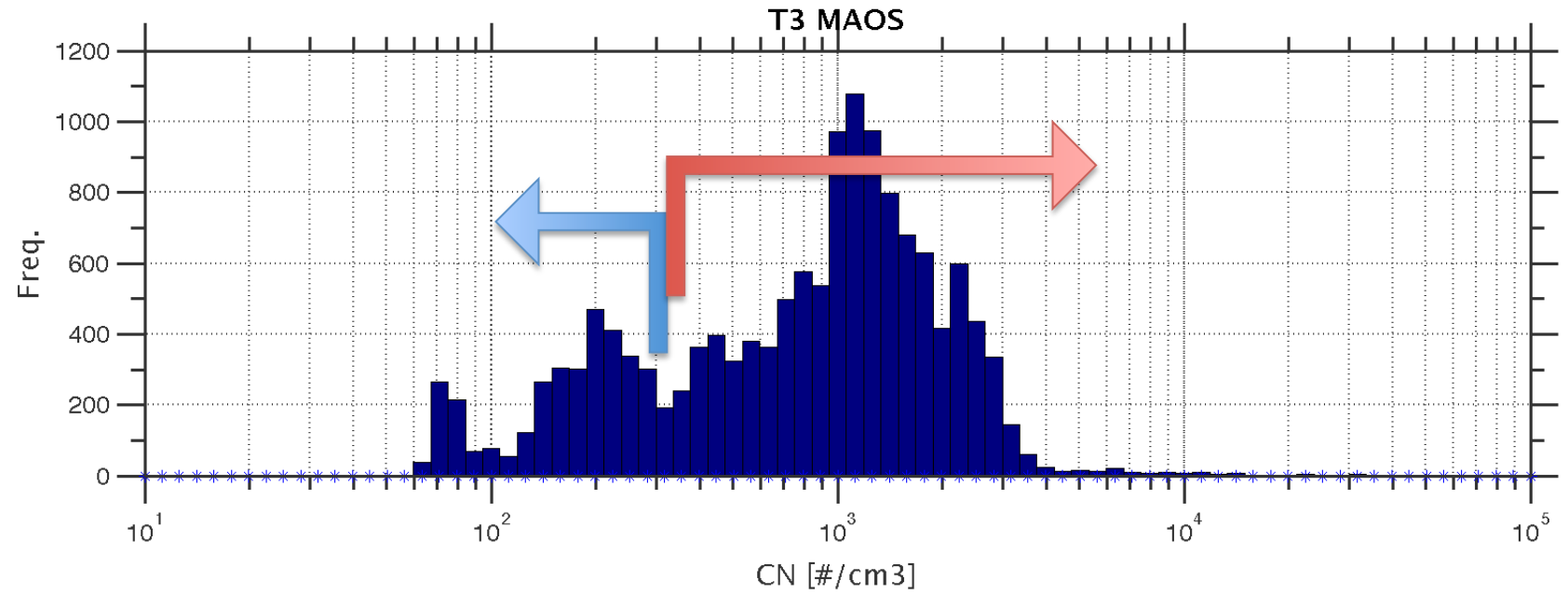
2) Measure k by coupling DMA+CCNC+CPC

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

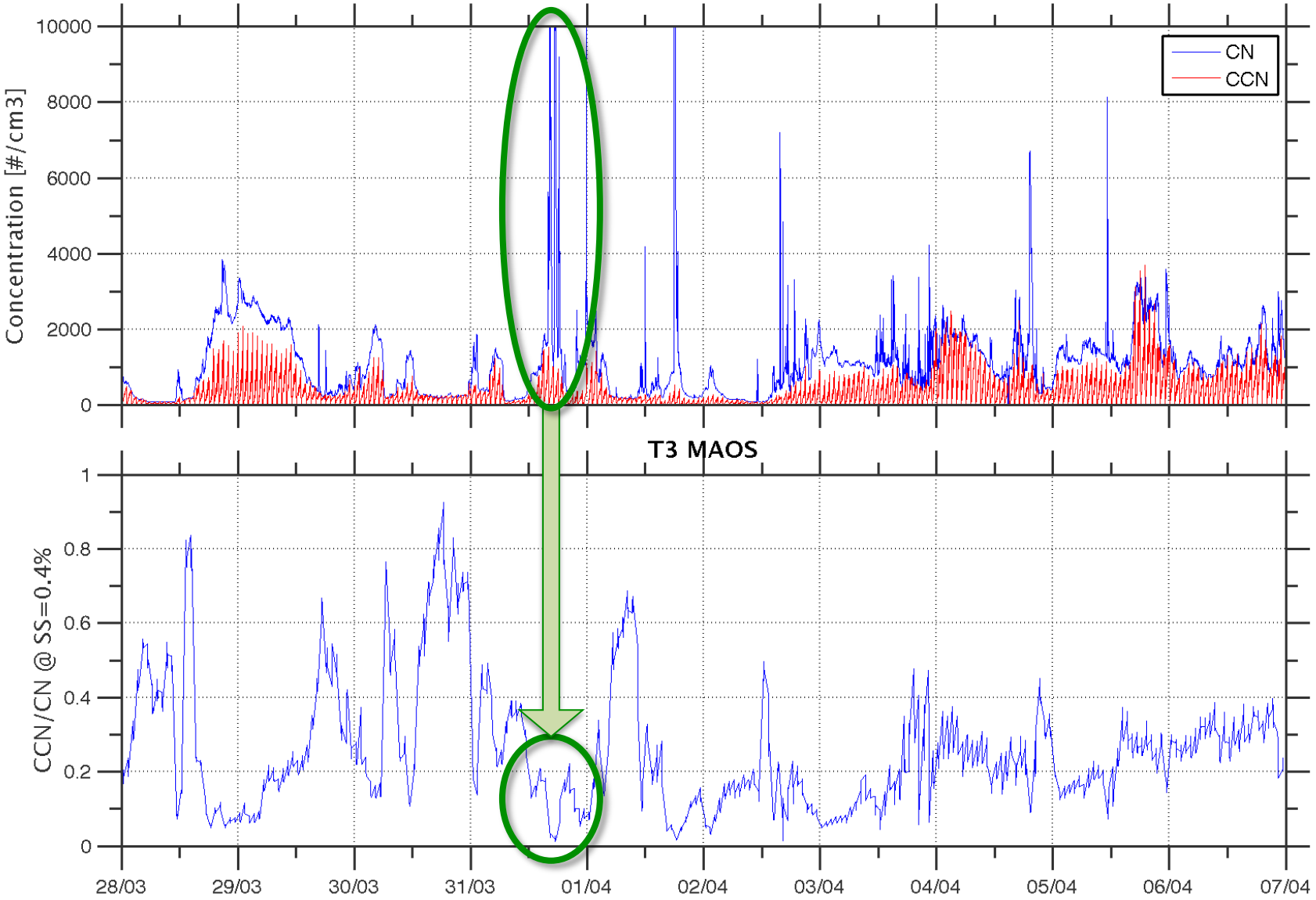
Putting together new instrumentation for T2 - more heavy pollution

CPC – T3 - MAOS

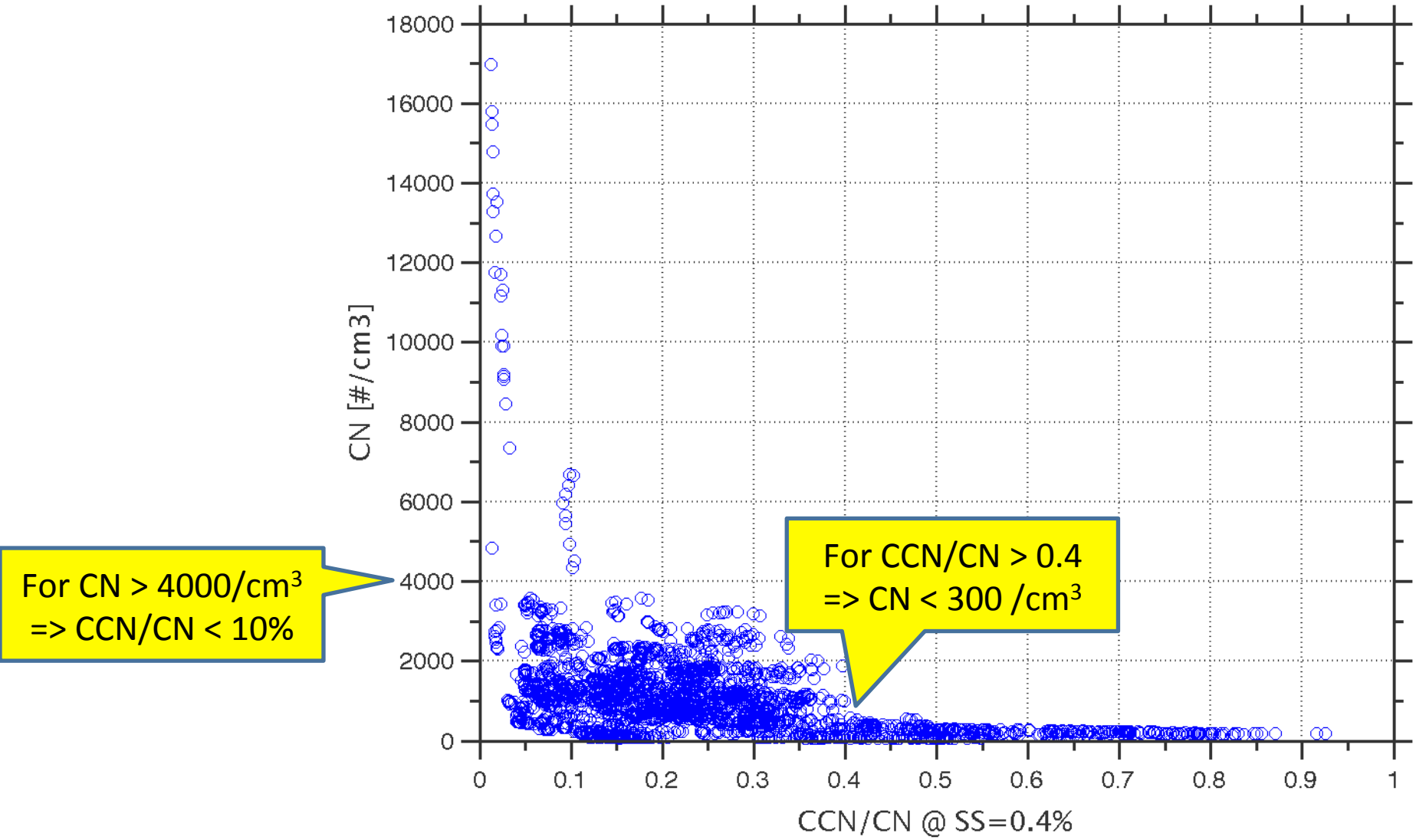

Concentration [#/cm3]
10000
8000
6000
4000
2000
0
CN
28/03
29/03
30/03
31/03
01/04
02/04
03/04
04/04
05/04
06/04
07/04


T3 MAOS
Freq.
1200
1000
800
600
400
200
0
10^1
10^2
10^3
10^4
10^5
CN [#/cm3]

CCN/CN Measurements at ATTO

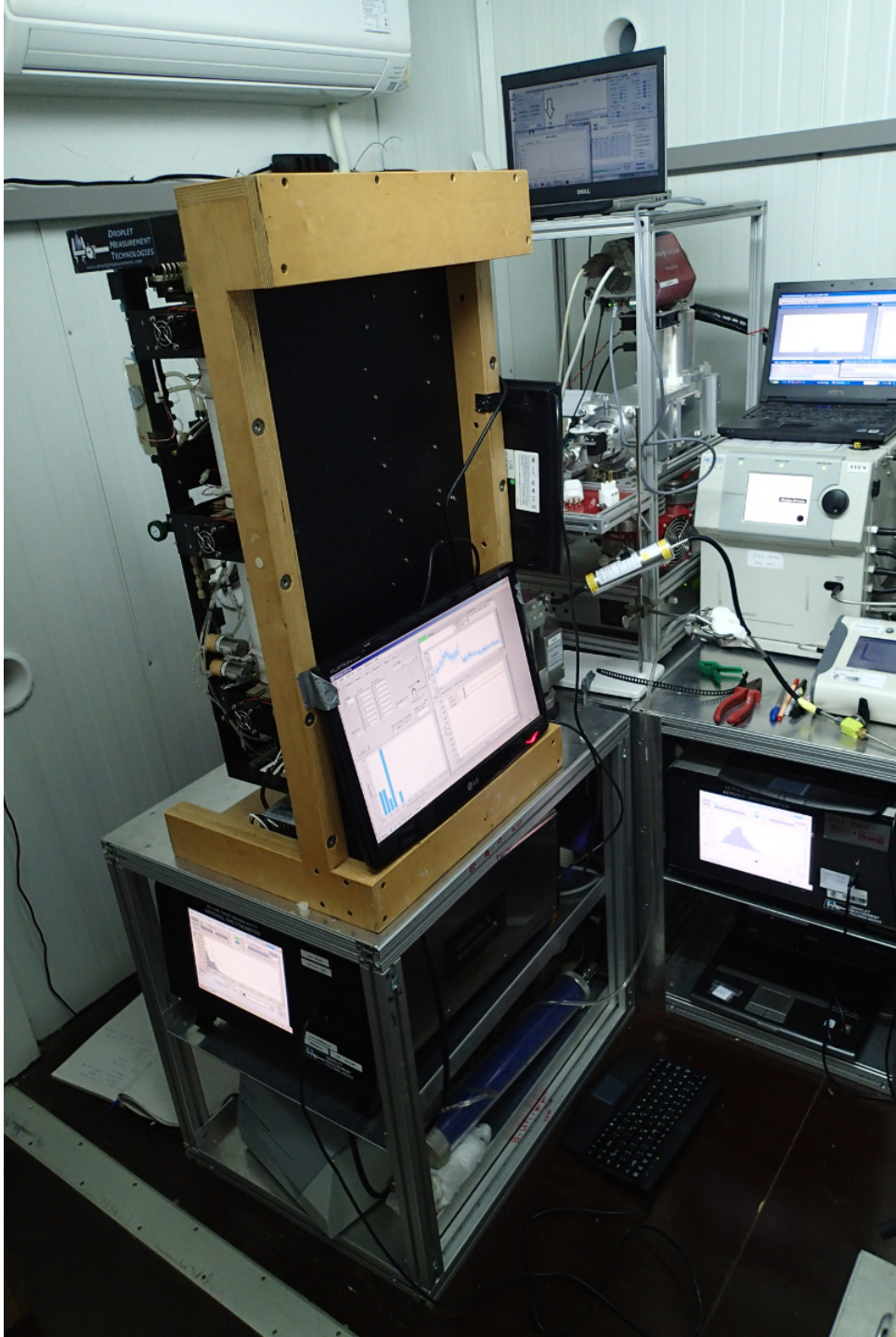


CCN/CN Measurements at ATTO

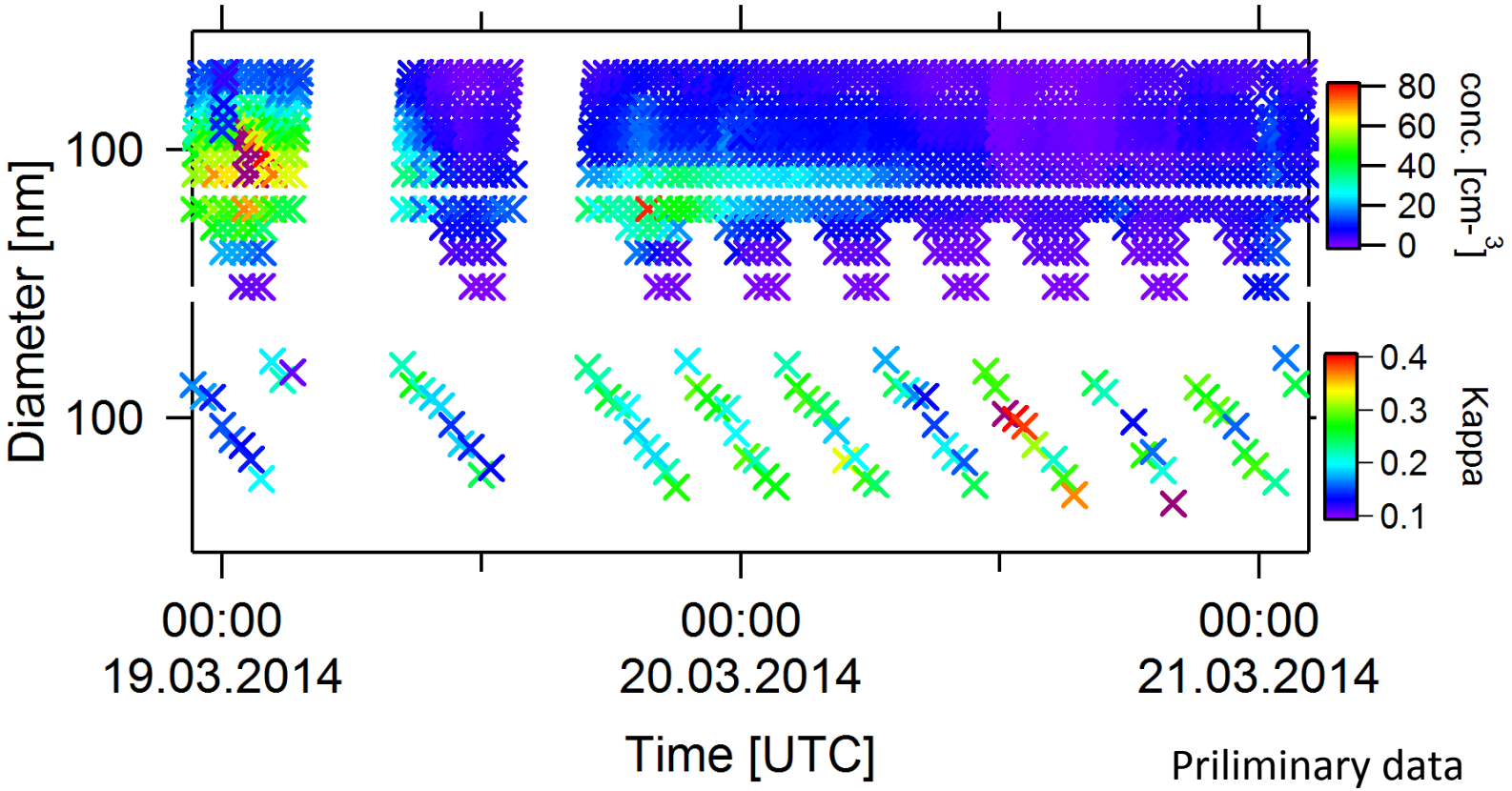


Measurement Setup

- 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 DAQ…



Results from T3

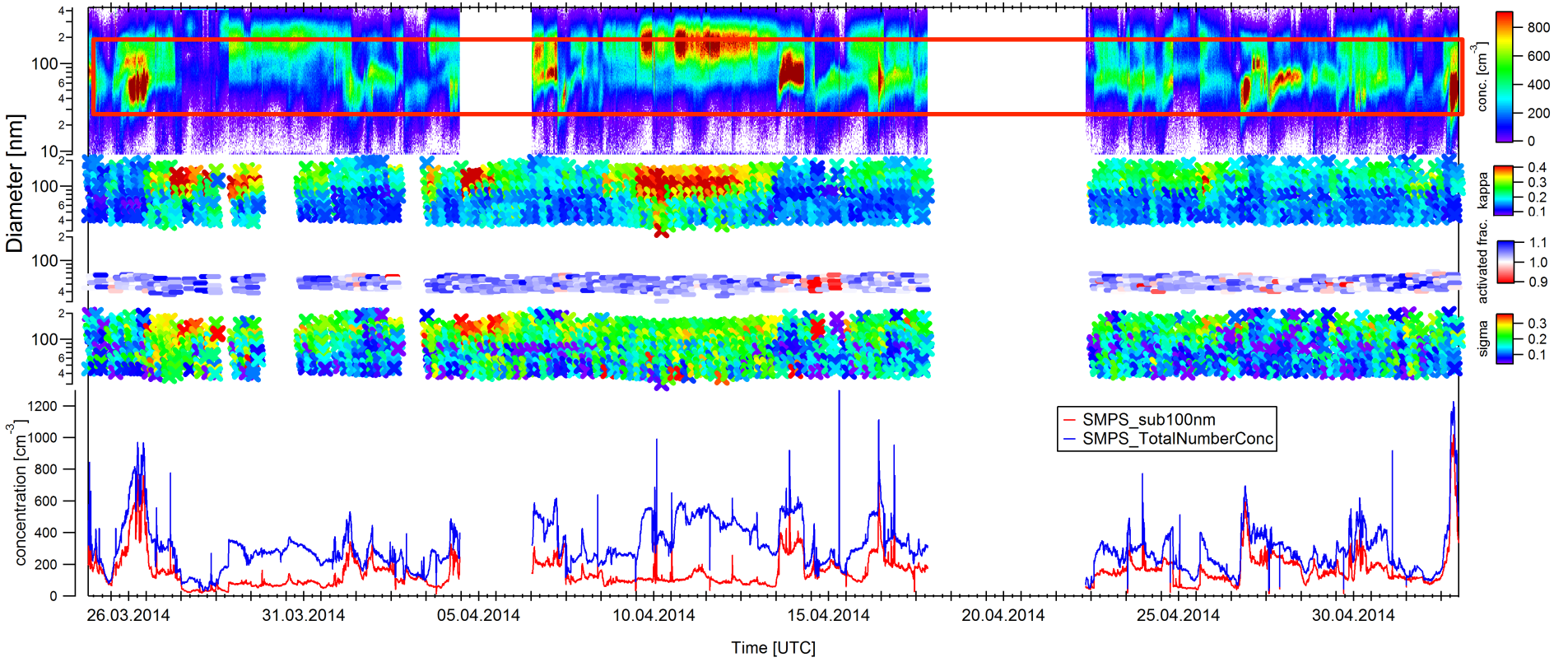


- Impact of tractor at first day??

- κ_{mean}(T3) = 0.23 ± 0.08

Krüger et. al

Results from ATTO



- κ Two modes visible in SMPS data and κ
- K_{mean}(ATTO) = 0.21 ± 0.08
- Activated fraction ~ 1
- Lager κ values are correlated with slightly higher σ values

Krüger et. al

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1. Twilight
   - Could we do measurements in the zone between clouds and aerosols?
2. Cirrus
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   - Will there be instrumentation for cloud radiative forcing?
3. Size resolved CCN
   - How well will ground and aircraft measurements match? Possible important implications for modeling?

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.

ANÁLISE

❑<u>CRESCIMENTO NÃO ENCERRA-SE NA ATIVAÇÃO</u>

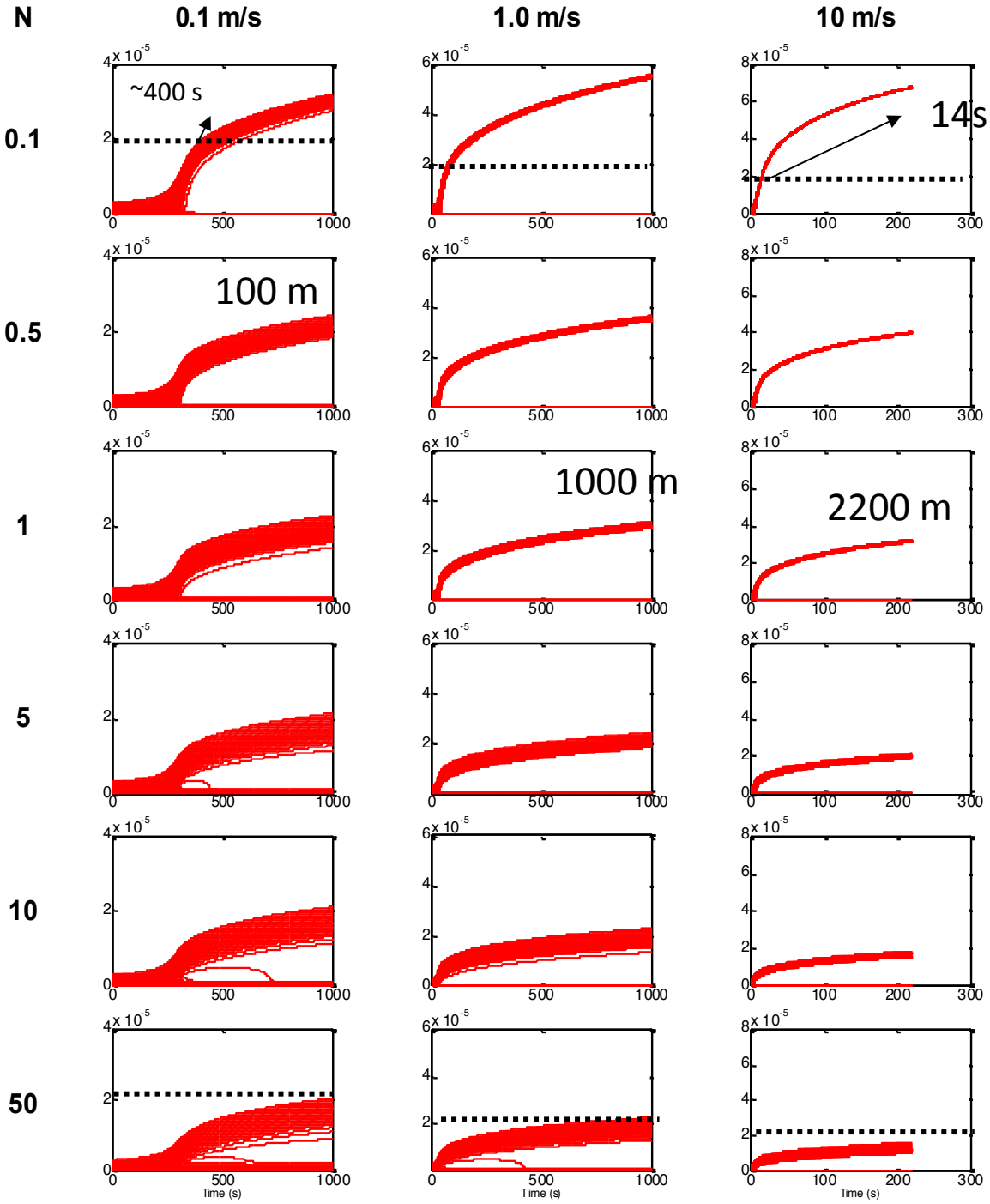
❑ Quanto maior N, menor é o diâmetro final

❑ Quanto menor é a velocidade, menor é o diâmetro final NO MESMO TEMPO

❑ Quanto menor a velocidade, maior é a largura da distribuição

❑ Para W = 10 m/s, ocorre um claro atraso para gotas chegarem a D_{crit}

❑ Para W = 0.1 m/s o atraso é muito mais suave



Thanks