

# Volcanic Ash Detection With Lidar: Minimizing False Positives and False Negatives

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Photo credit: Klaus Sievers, IFALPA

7th International Workshop on Volcanic Ash (IWVA/7)  
19-23 October 2015 Anchorage, Alaska

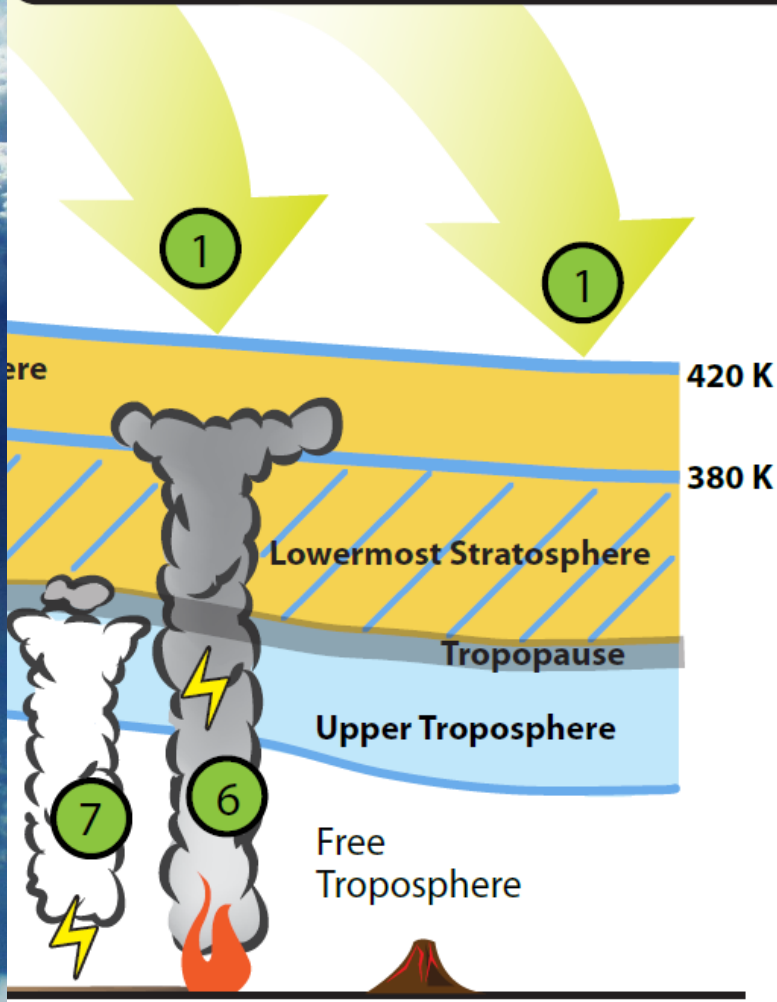
## Outline

- 1. Why does NRL care about volcanoes?**
- 2. Motivation: a false-positive ash detection**
- 3. Lidar depiction of co-resident particle types**
- 4. Ash false positive and negative signatures**

Up



- ### UTLS Pathways
- |                              |            |
|------------------------------|------------|
| 1. Brewer-Dobson circulation | 5. Volcano |
| 2. Quasi-isentropic exchange | 6. pyroCb  |
| 3. Monsoon                   | 7. xCb     |
| 4. Baroclinic cyclone        |            |



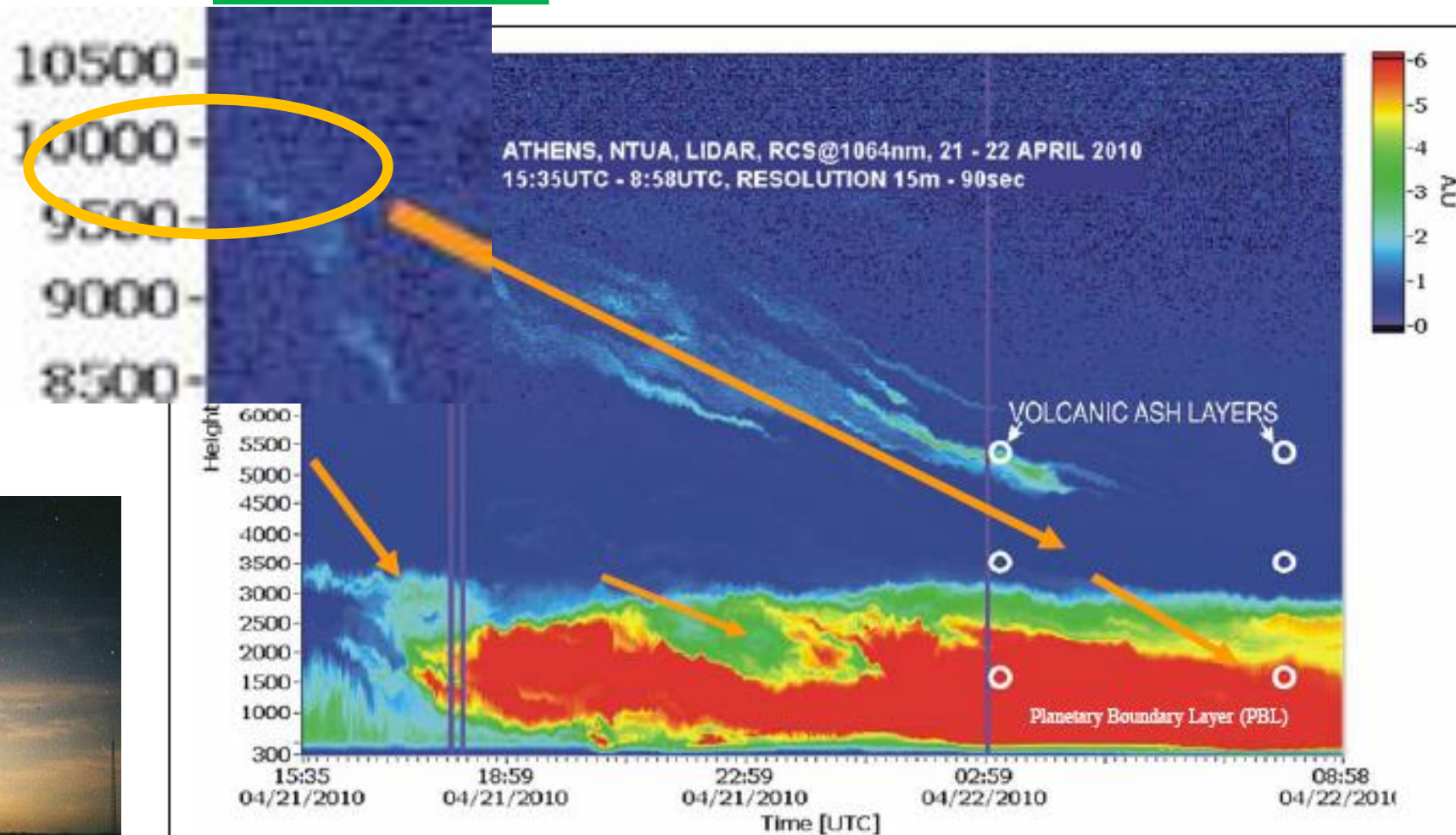
ics

Polar

# Interpretation: all the particles are ash

PRESS RELEASE (April 22, 2010; 11:45 UTC)

## Ash penetration over the Athens Basin (38°N, 23°E), Greece



Credit: National Technical University of Athens and EARLINET

19 April



Volcano

Backward Trajectory

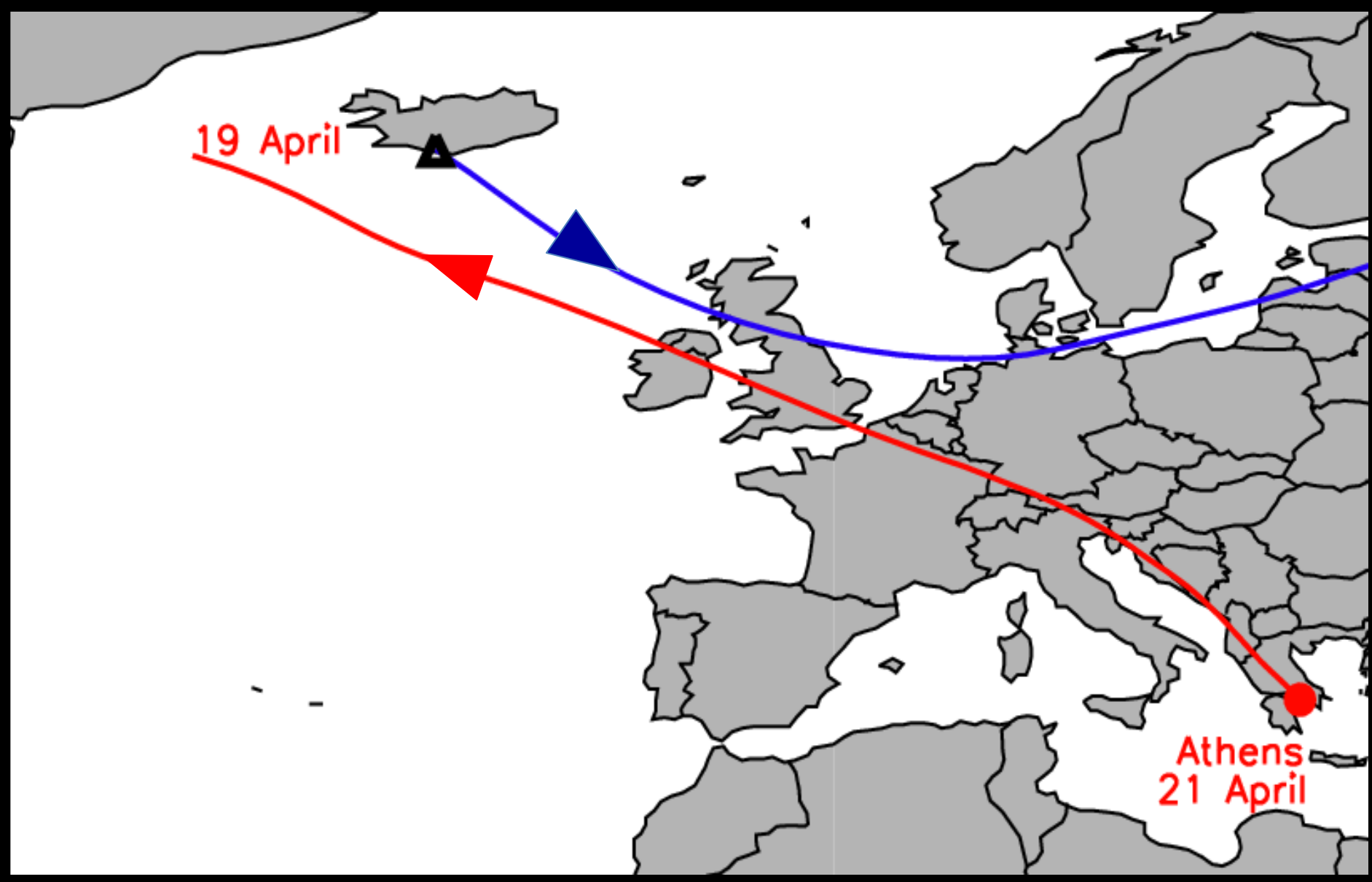
2-day calculation

Athens  
21 April

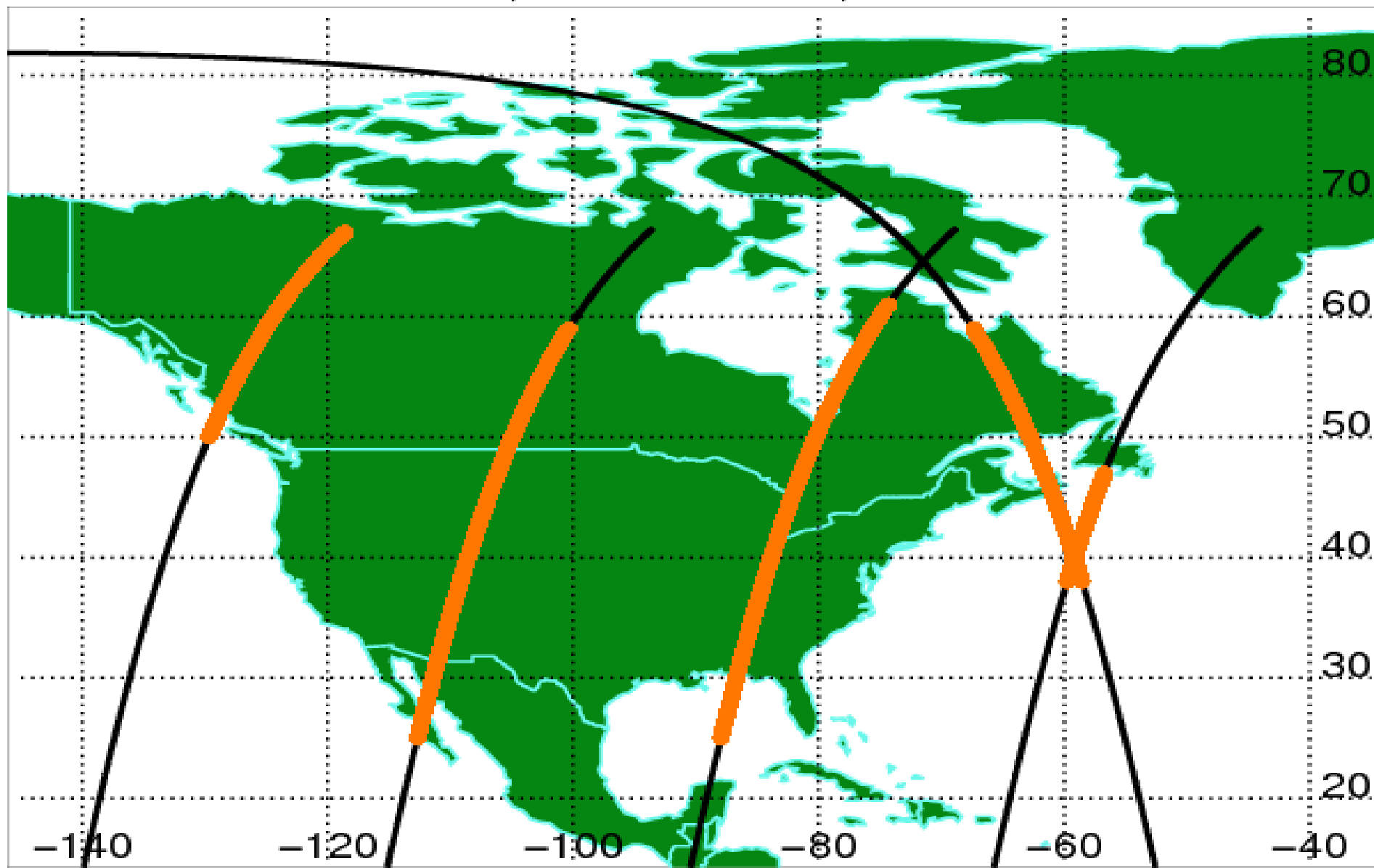


19 April

Athens  
21 April

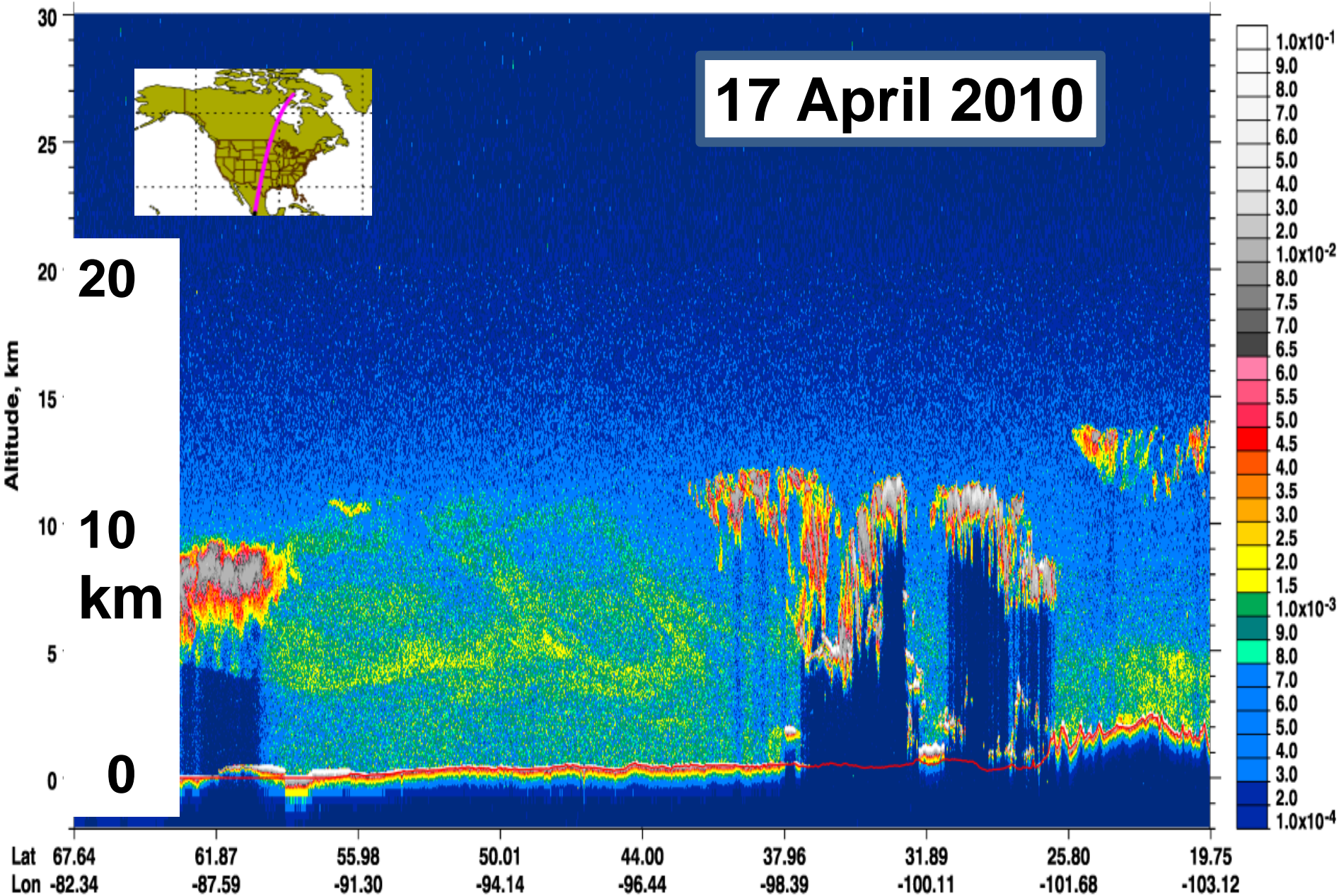


# 18 April 2010 CALIPSO passes

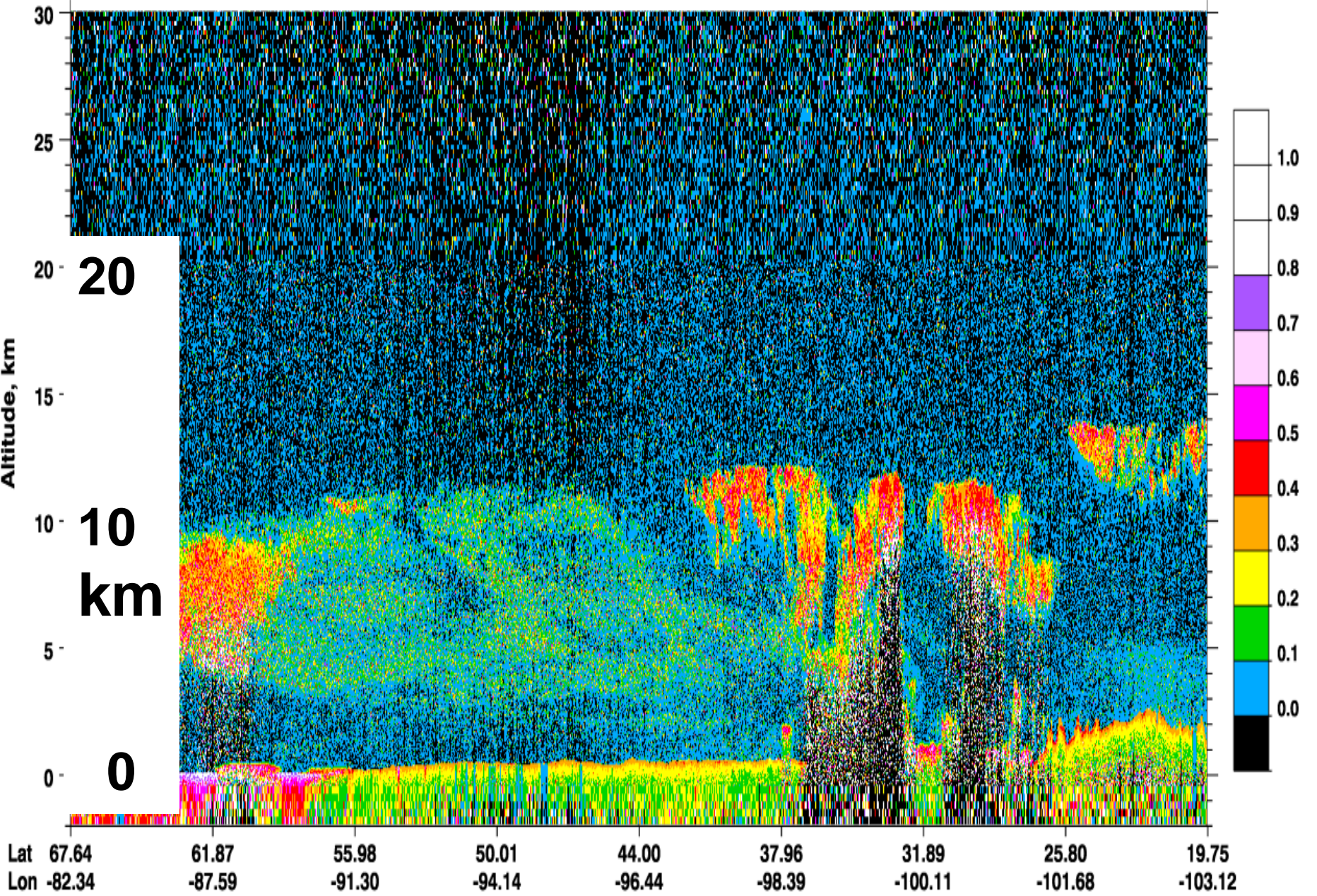


— Dust above 5 km (CALIPSO VFM)

**17 April 2010**

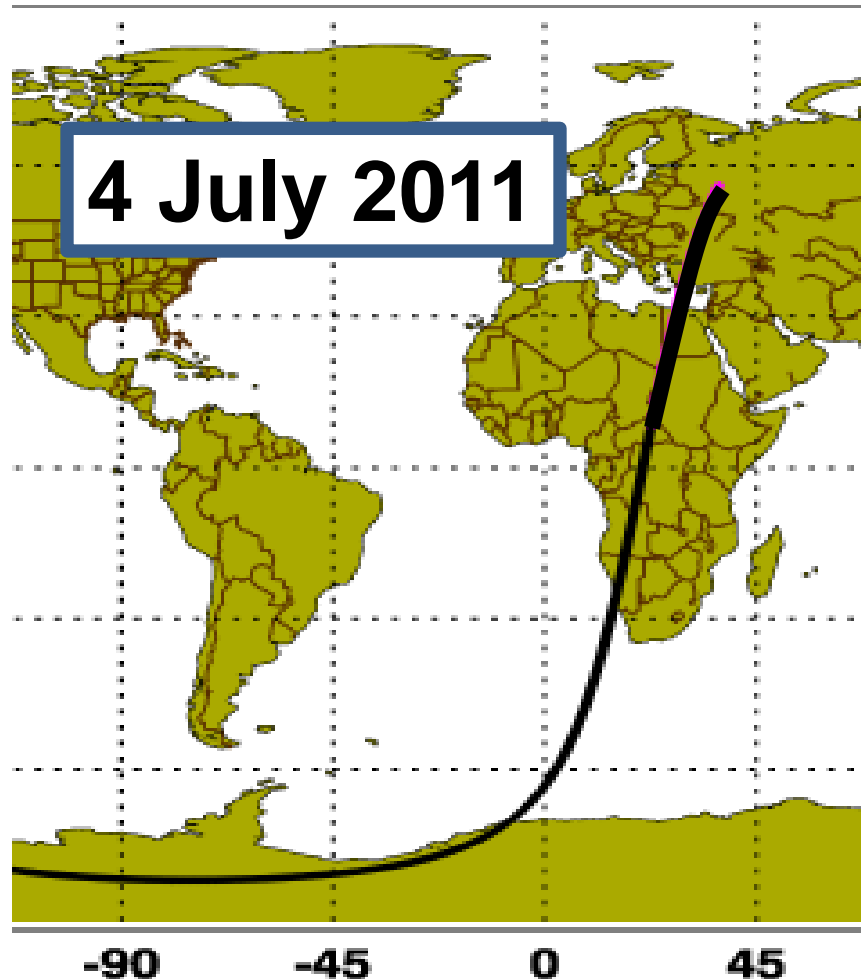


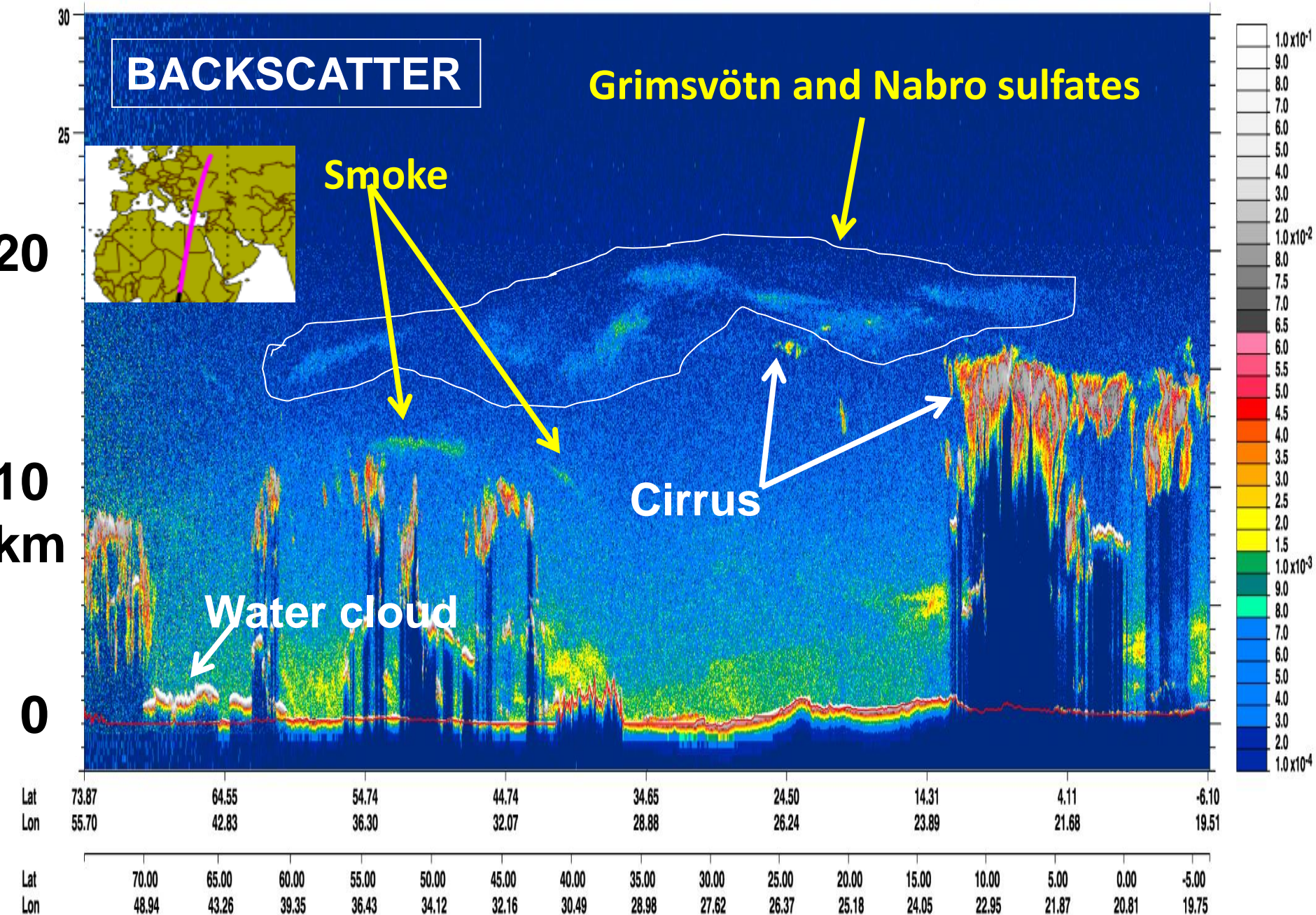


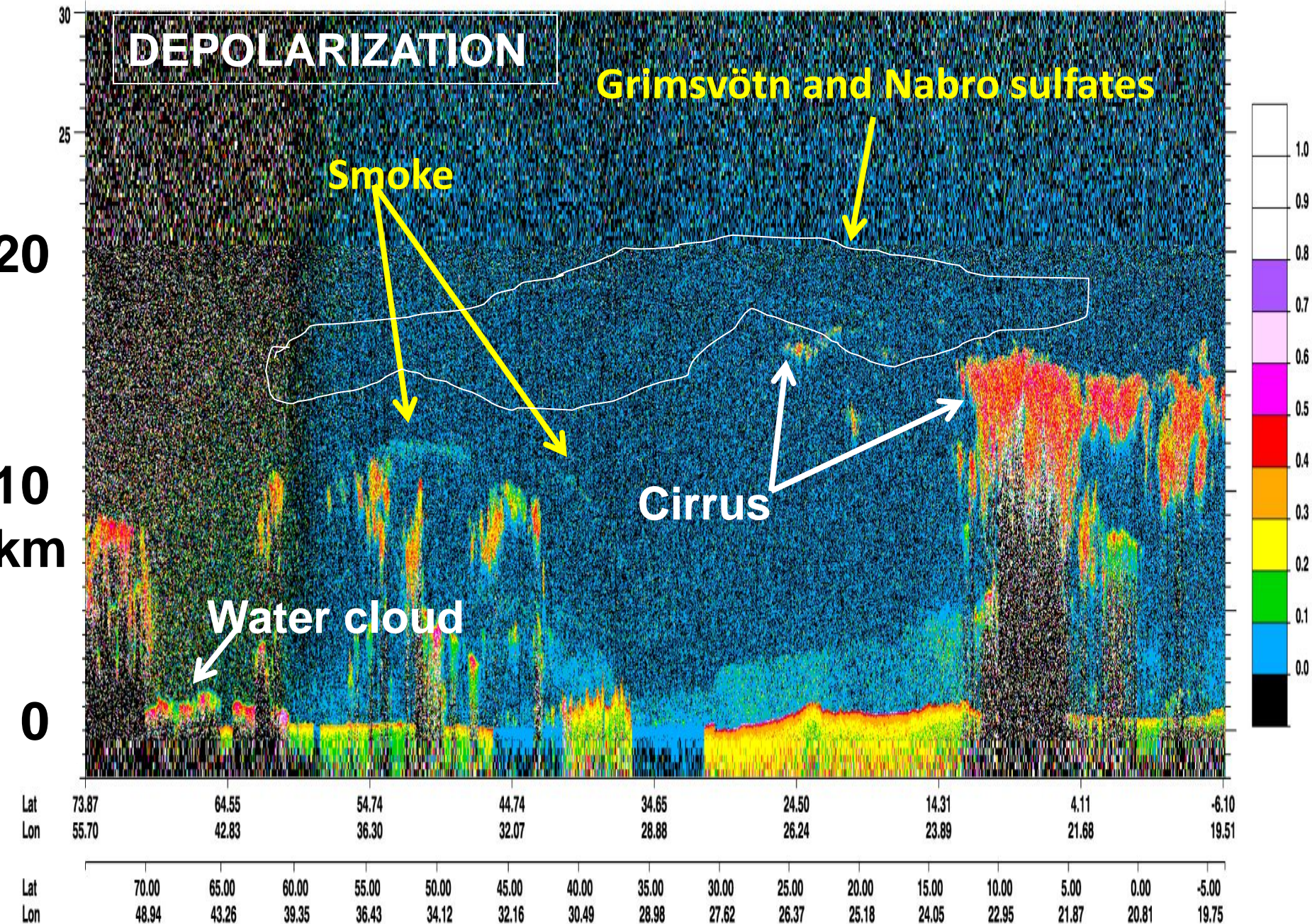


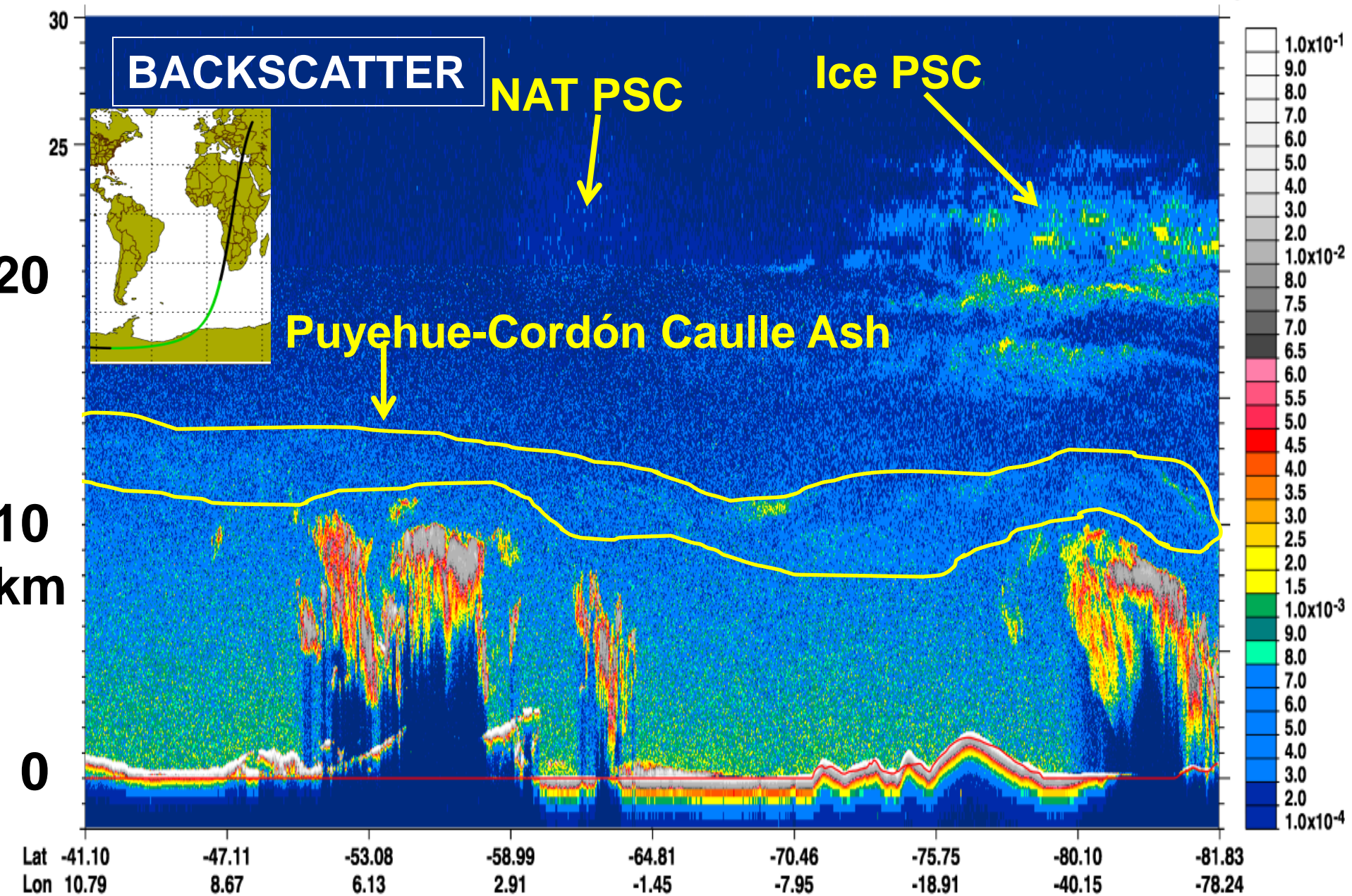
# The Big Picture: CALIPSO Lidar in Space

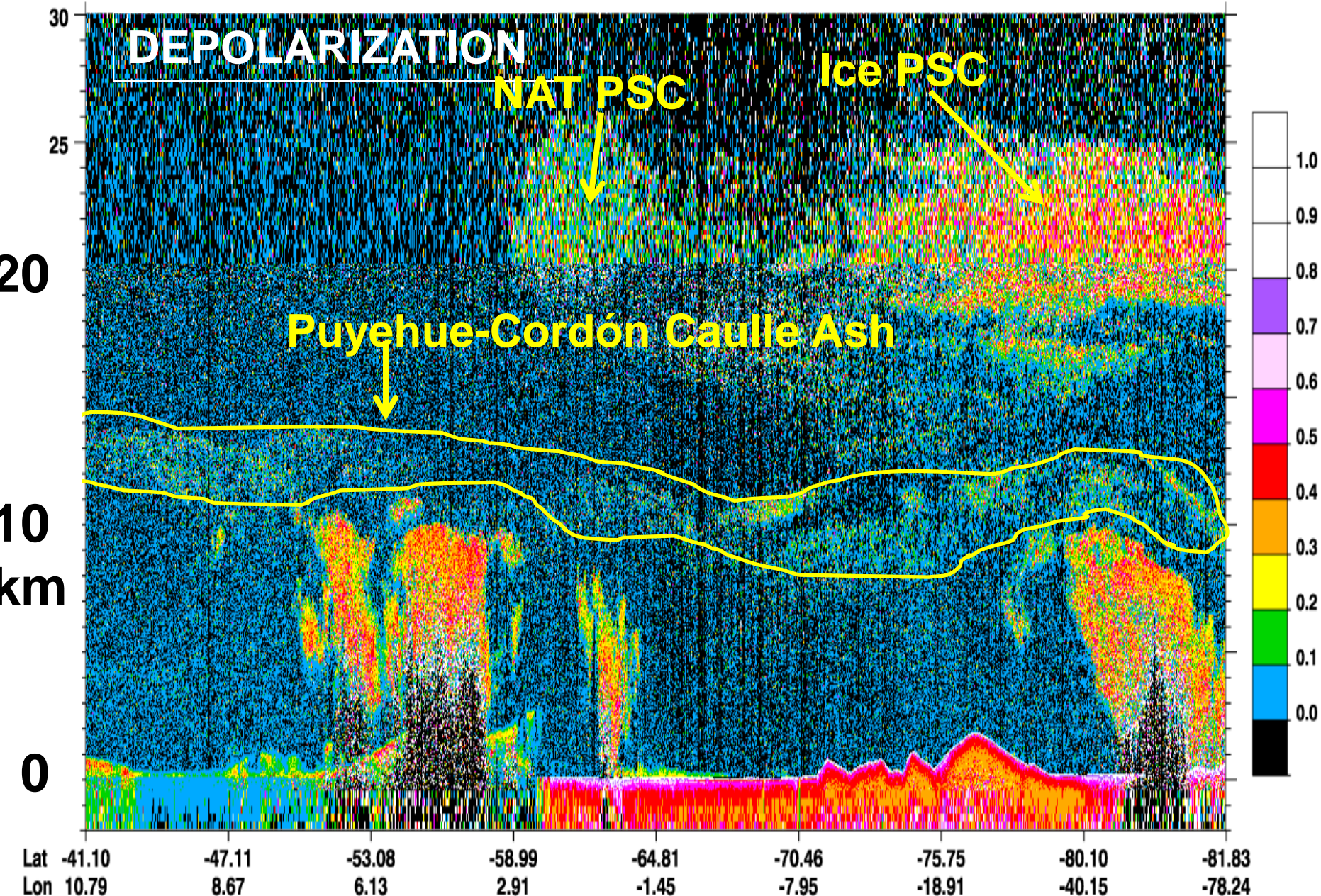
## 8 Particle Types at 1 Time in the UTLS



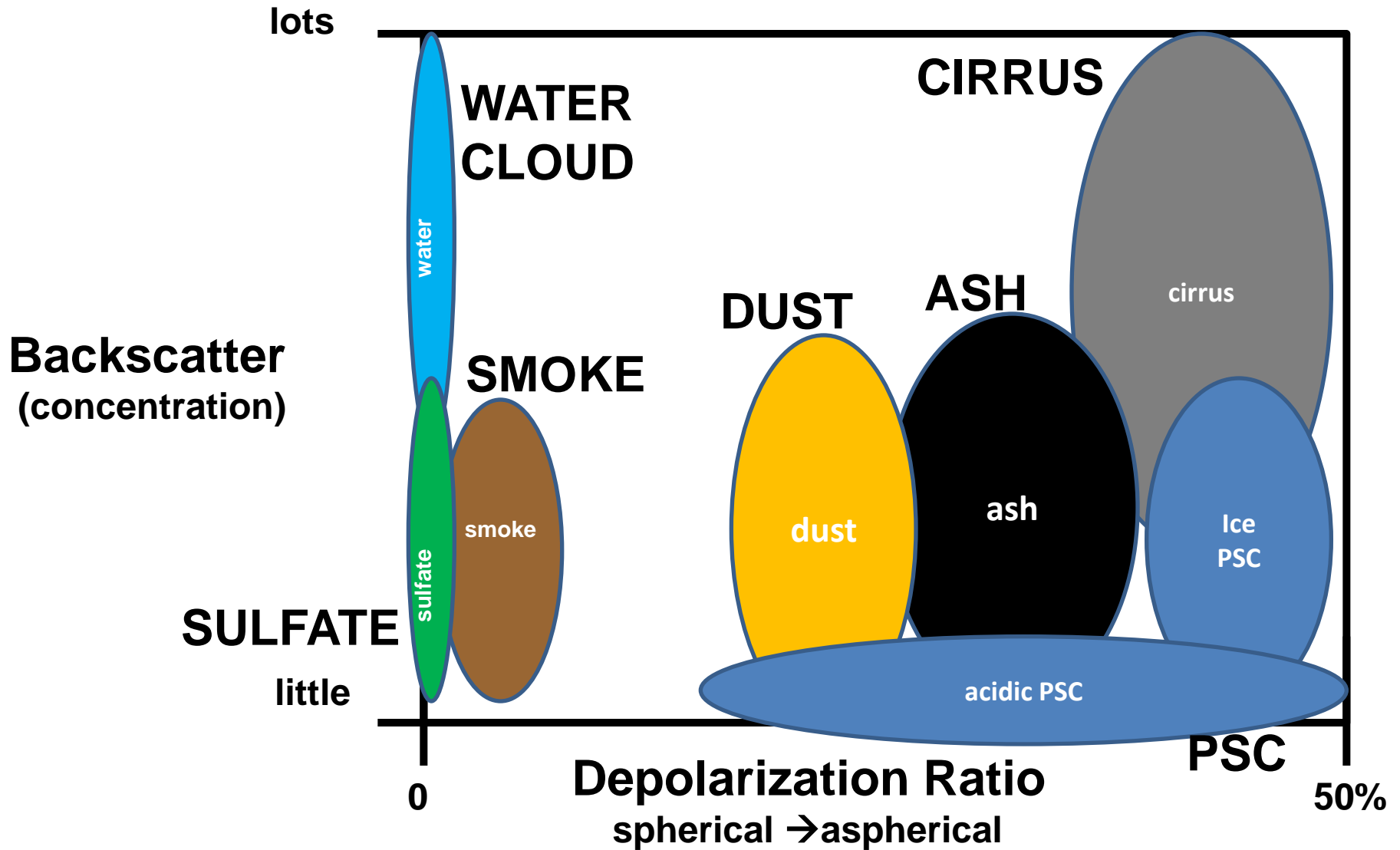








# Lidar Particle Phase Space: distinction, blurred lines



s: Lidar  
many

Geiß, Franziska Schnell

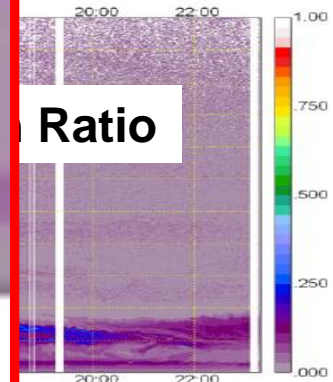
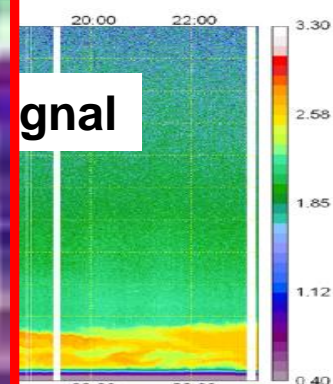
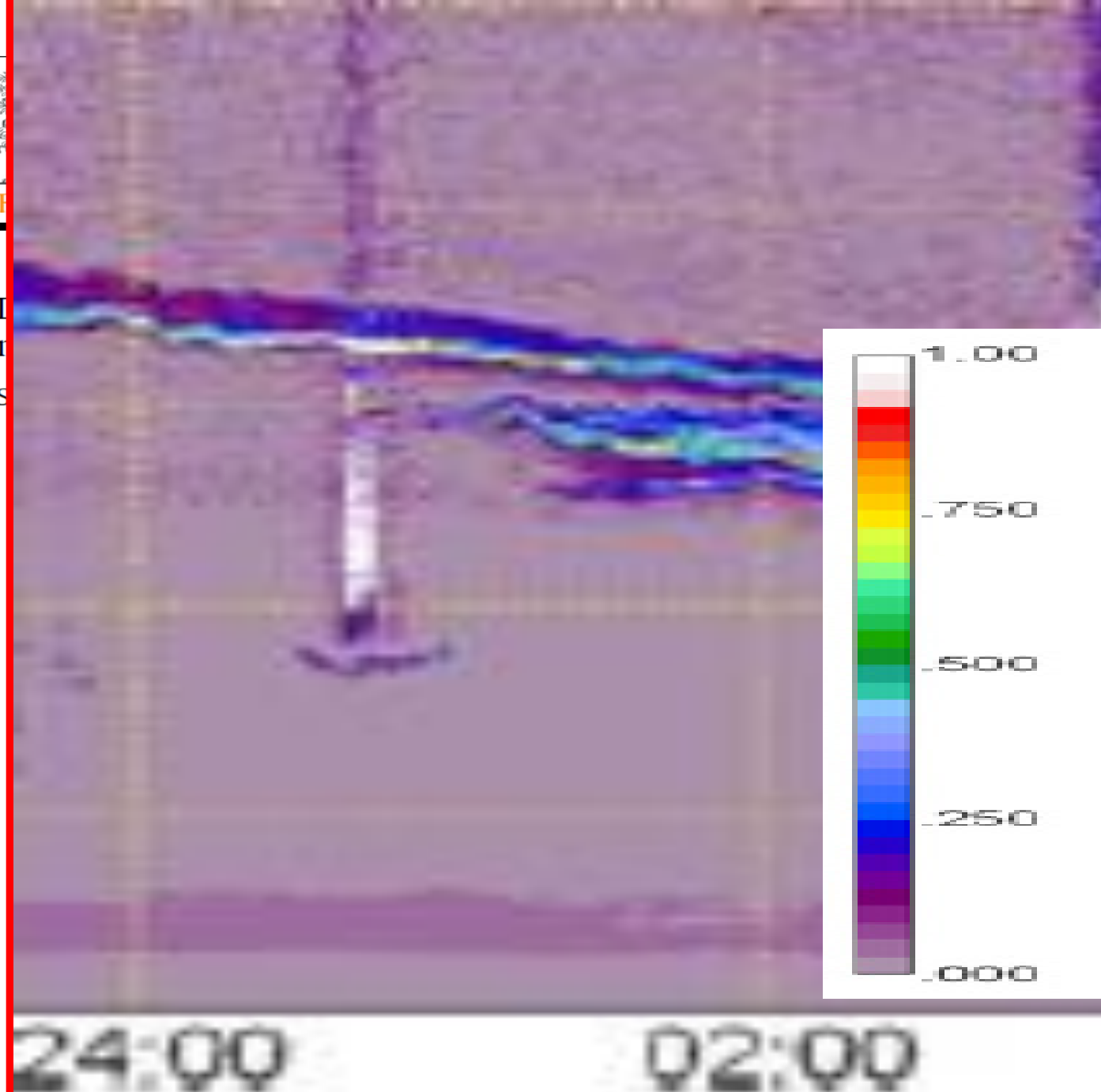
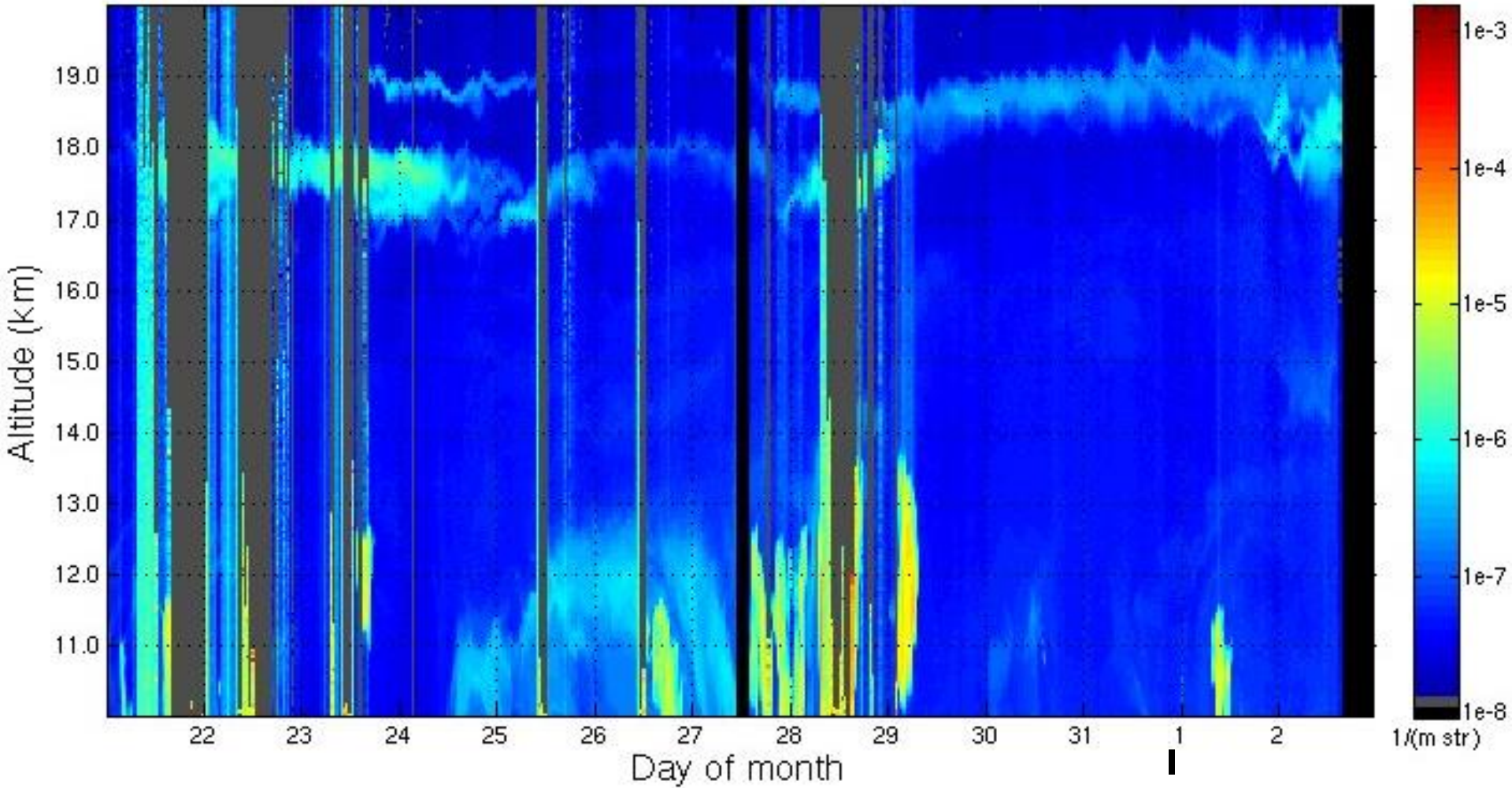


Fig. 1. Time–height cross section of the range-corrected signal (upper panel, log-scale, a.u.) and the volume linear depolarization ratio (lower panel) at 532 nm derived from MULIS lidar measurements at Maisach from 16 April 17 UTC to 17 April 24 UTC.



# Kasatochi plume over Madison Wisconsin 532 nm Backscatter

Continuous volcanic layers for 13 days!



Lidar PI: Ed Eloranta

August

September

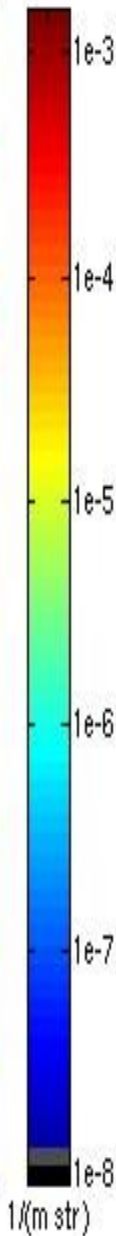
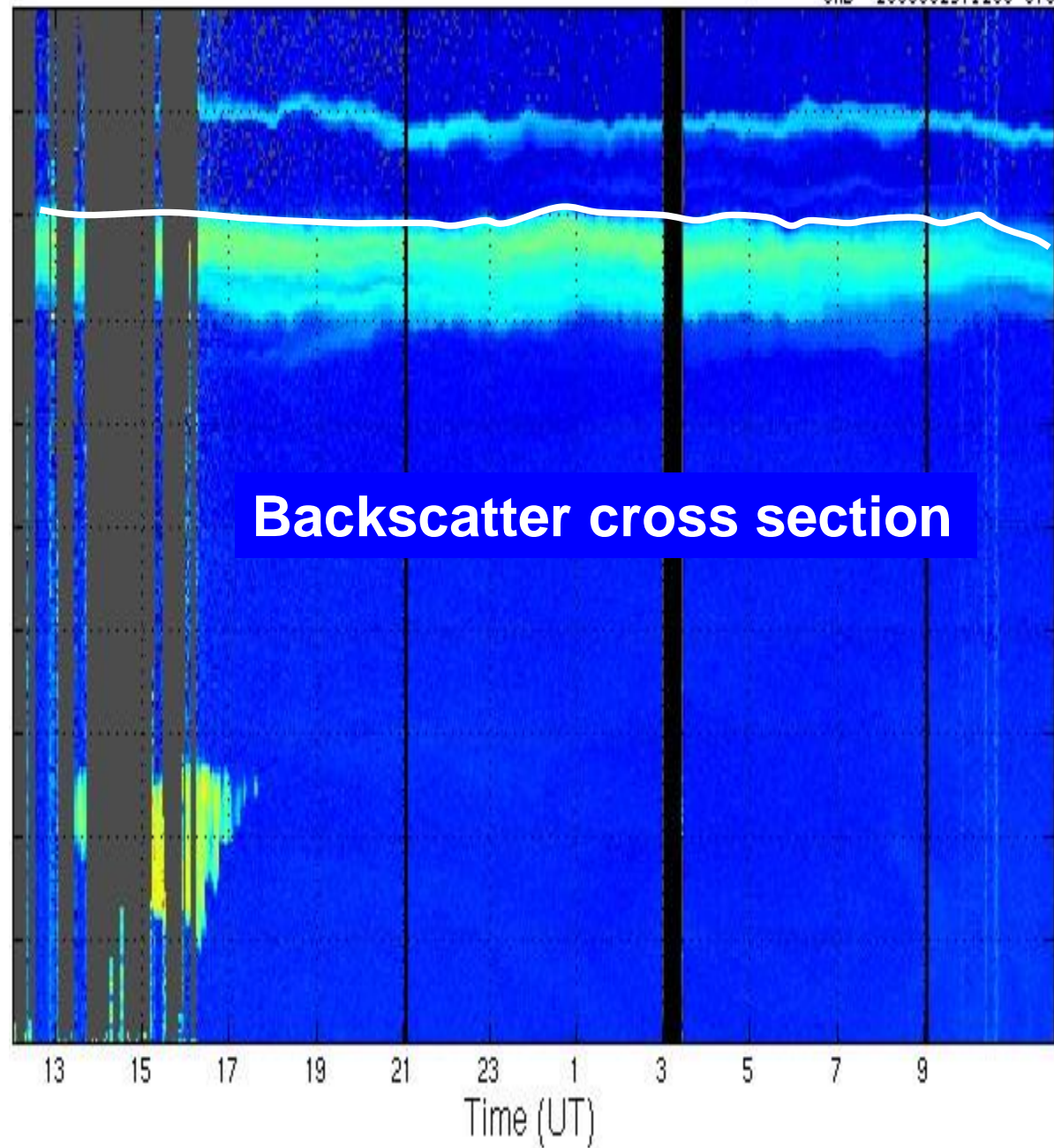
# Aerosol backscatter cross section 23-Aug-2008

GRB 20080823T1200 UTC

20

15  
km

10



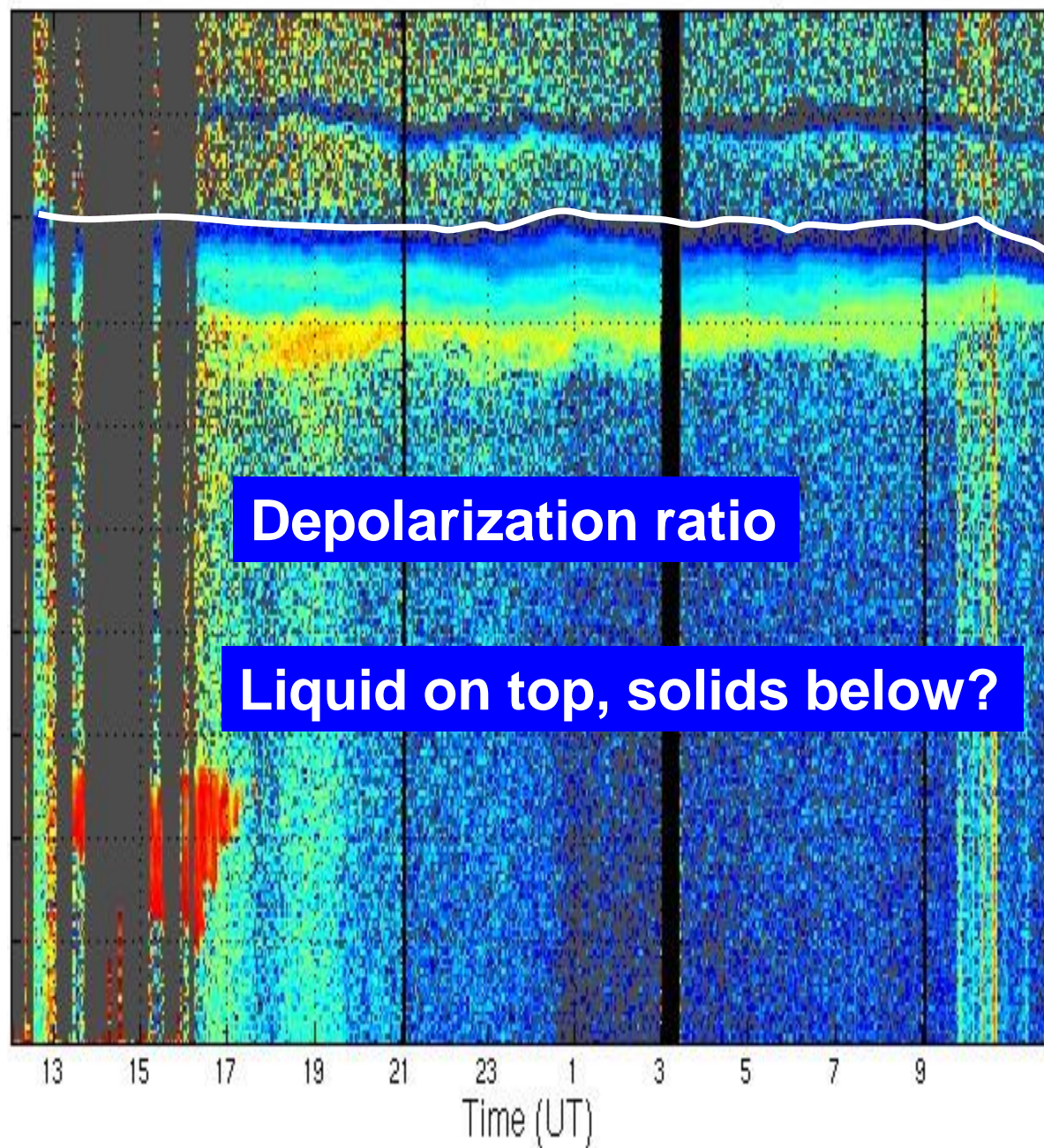
**Zoom to  
23 August**

Particulate circular depolarization ratio 23-Aug-2008

20

15  
km

10



**Zoom to  
23 August**

**Depolarization ratio**

**Liquid on top, solids below?**

Time (UT)

%

# **Volcanic ash (VA) signature in elastic, multi-wavelength, polarization lidar:**

- \* backscatter range from detection limit to cloud-like**
- \* depolarization ratio range, ~20-35%**

# **VA false positive potential:**

- \* mineral dust: similar backscatter and depolarization range**
- \* ice cloud: overlapping backscatter & depolarization**
- \* smoke: similar backscatter range as VA**
- \* volcanic sulfate plume**

# **VA false negative potential:**

- \* cirrus/ash blend**
- \* VA lost in particle mixtures**
- \* weak signal, inhomogeneous plume**

# Conclusions

- \* **Elastic lidar data: wunderbar! but under-constrained**
  - \* **overlap in backscatter and/or depolarization signal**
  - \* **assumptions and groupthink abound**
  
- \* **Critical issue: context awareness**
  - \* **real-time maps of extant plume types.**
  - \* **particle-type attribution must be an ongoing activity**