Interpretative synergy of starphotometry and lidar measurements at two High-Arctic stations during Polar Winter of 2010-11.

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Motivation

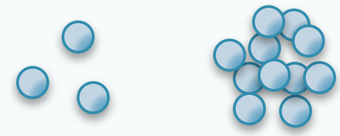
- Warming temperatures, increased ozone depletion and decreasing sea ice extent are among the recent changes in the Arctic.
- Aerosols have important (direct and indirect) effects on the Arctic climate.
- What are the dynamics of Arctic aerosols and how do they influence and change with changing climate? (an emphasis on the Polar Winter)

Unprecedented Arctic ozone loss in 2011

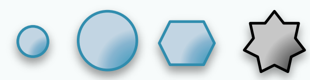
Gloria L. Manney[1,2], Michelle L. Santee[1], Markus Rex[3], Nathaniel J. Livesey[1], Michael C. Pitts[4], Pepijn Veefkind[5,6], Eric R. Nash[7], Ingo Wohltmann[3], Ralph Lehmann[3], Lucien Froidevaux[1], Lamont R. Poole[8], Mark R. Schoeberl[9], David P. Haffner[7], Jonathan Davies[10], Valery Dorokhov[11], Hartwig Gernandt[3], Bryan Johnson[12], Rigel Kivi[13], Esko Kyrö[13], Niels Larsen[14], Pieternel F. Levelt[5,6,15], Alexander Makshtas[16], C. Thomas McElroy[10], Hideaki Nakajima[17], Maria Concepción Parrondo[18], David W. Tarasick[10], Peter von der Gathen[3], Kaley A. Walker[19] & Nikita S. Zinoviev[16]

Aerosol characterization

- Aerosols properties:
  - Extensive: amount of aerosol



  - Intensive: single-particle attributes



- Optical measurements:
  - Photometry: Aerosol Optical Depth (AOD)
  - Lidar: Backscatter and extinction profiles

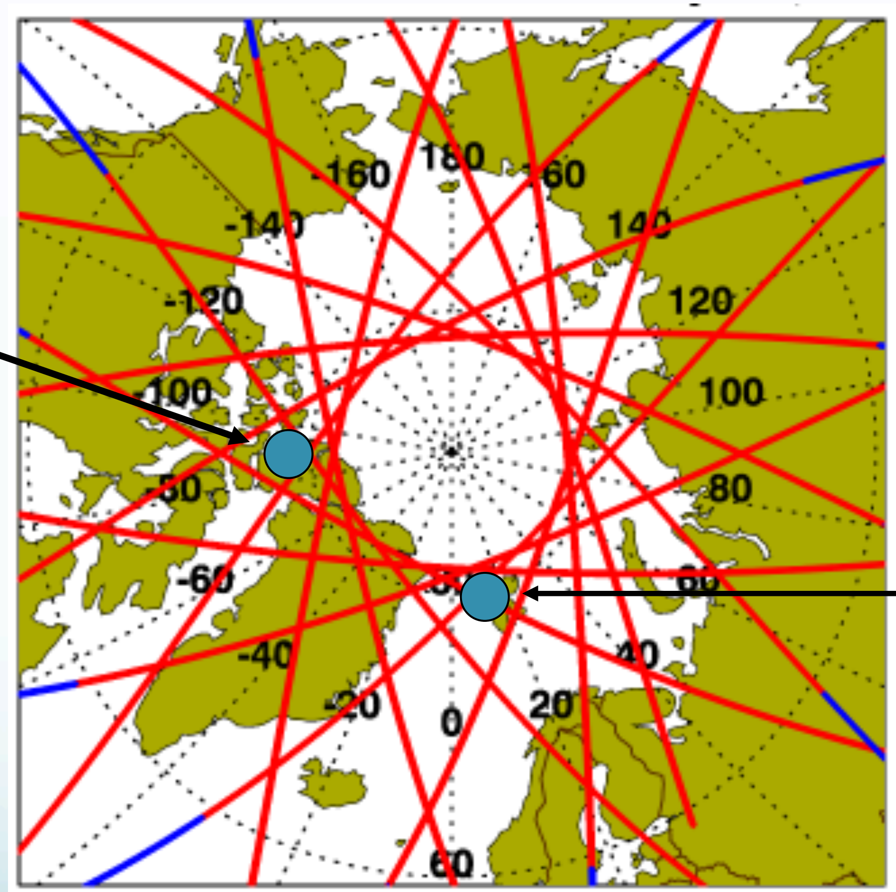
Photometry-lidar synegy

- Extinction-to-backscatter ratio ("lidar ratio") values needed in the Klett method of lidar analysis can be deduced from the ratio of AOD to integrated β_a
- Lidar vertical profiles of backscatter coefficient and depolarization ratio help in understanding retrievals from sunphotometry (for example the division into fine and coarse ODs) and vice versa
- **Higher degree of confidence and comprehension**

The two Arctic sites

Eureka (Nunavut, 79°59"N, 85°56"W)

Starphotometer, AHSRL, Raman lidars



Ny Alesund (Svalbard, 78°55"N, 11°55"E)

Starphotometer, Raman, MPL lidars

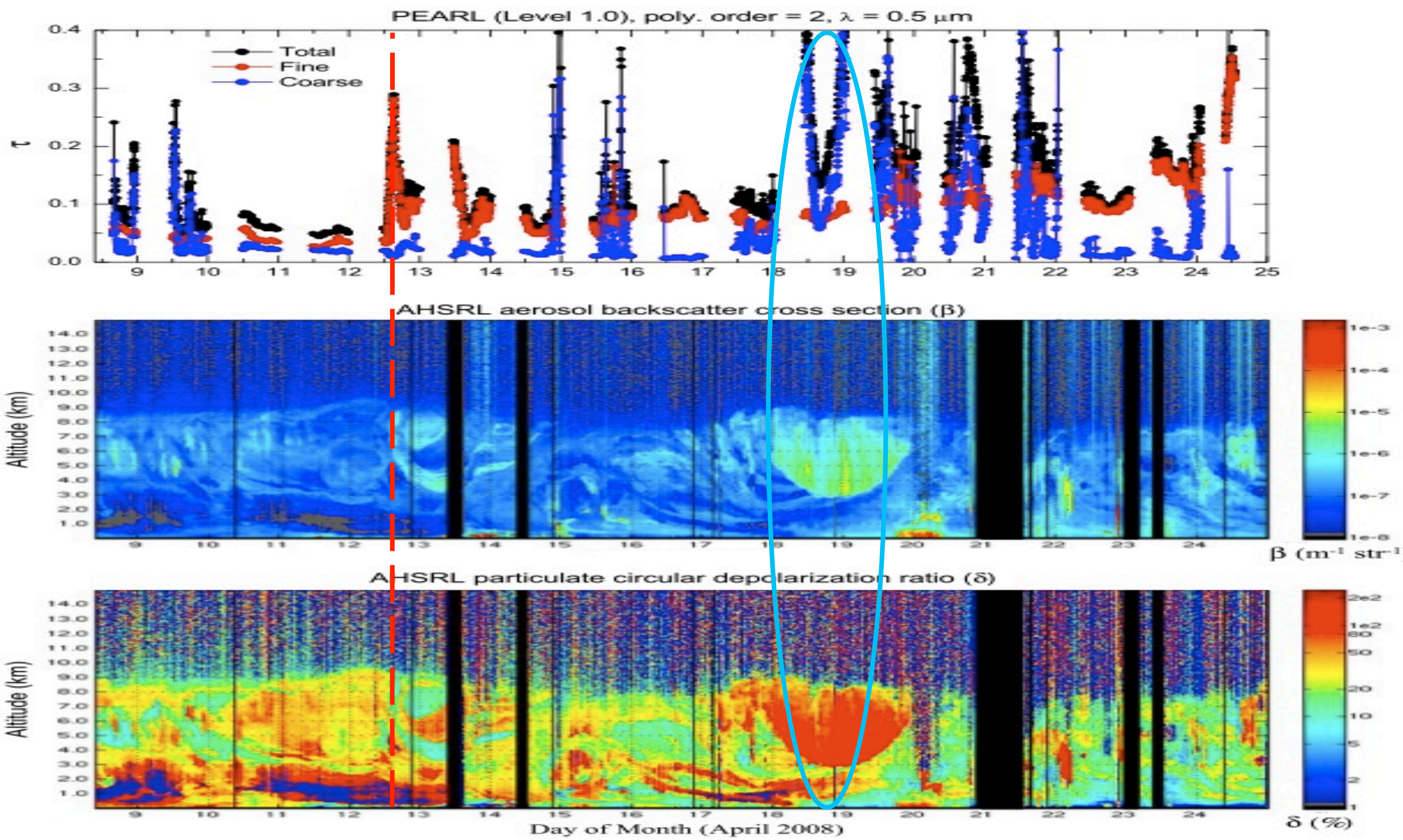
Frequent overpasses by CALIPSO!

Eureka

Ny Alesund

Source: André Gröschke

Sunphotometry-lidar synergy



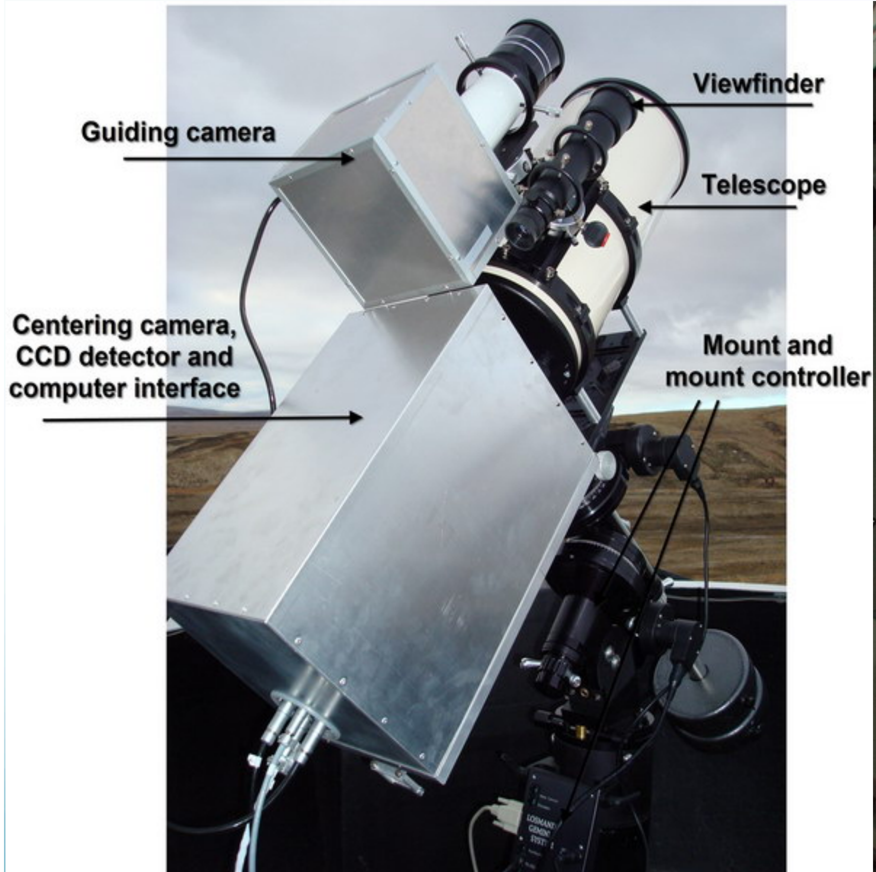
Eureka, April 2008

Saha et al, GRL, 2010

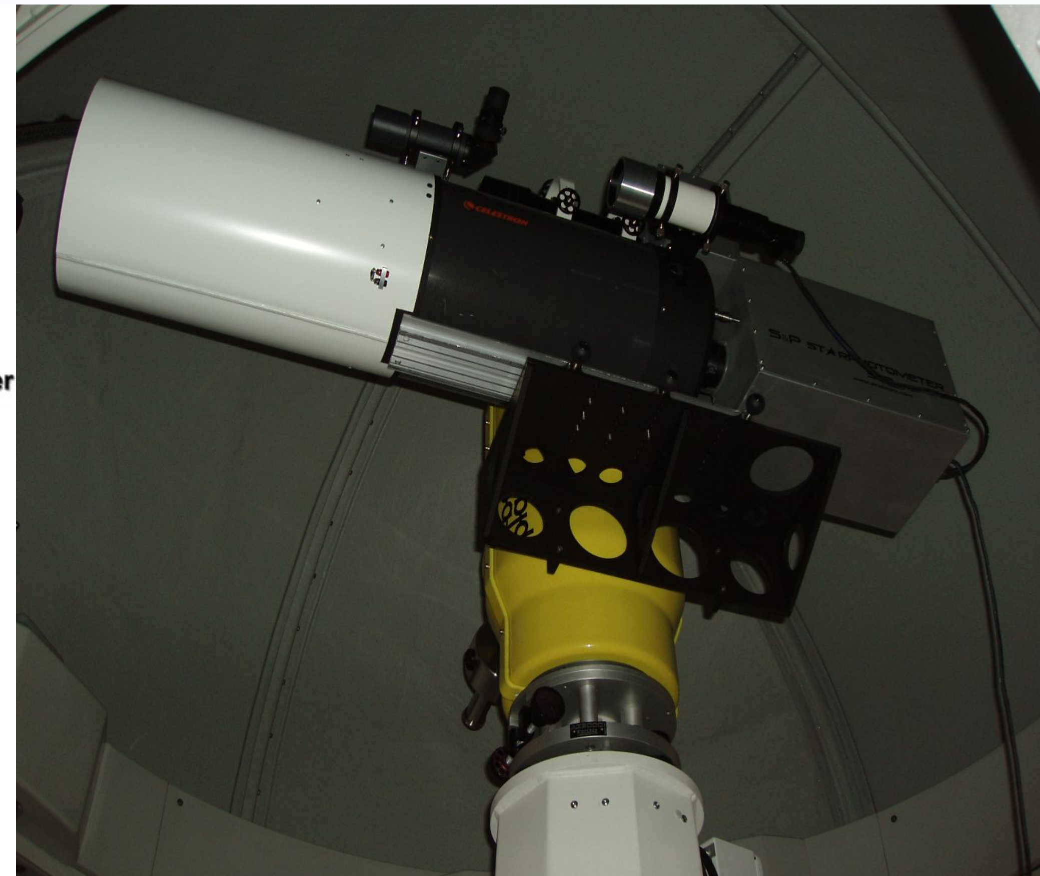
Starphotometer SPSTAR09

14 AOD bands: 420-1040nm

2007

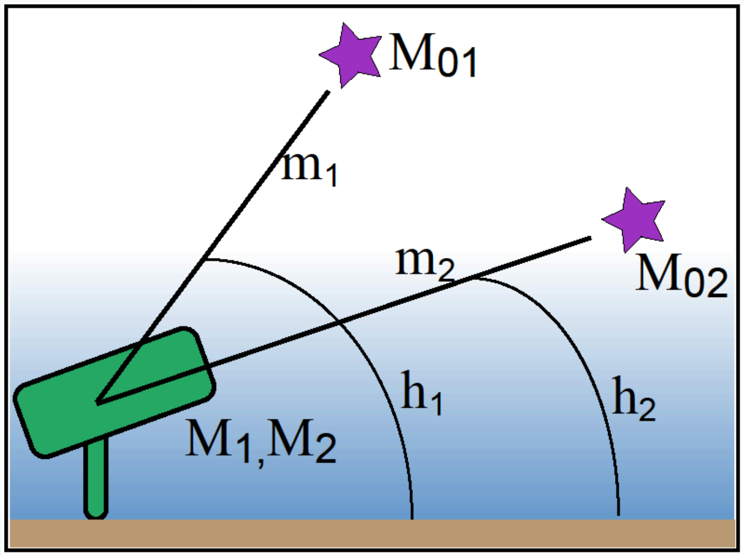


2010

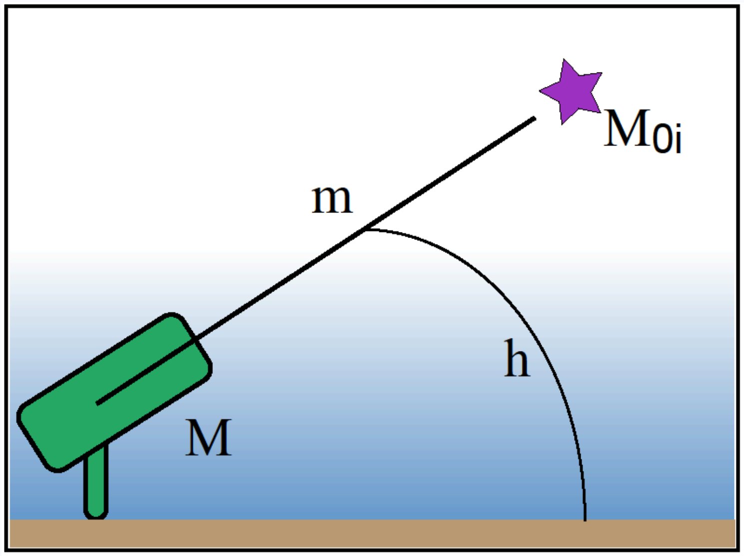


Starphotometry

Two stars **(TSM)**



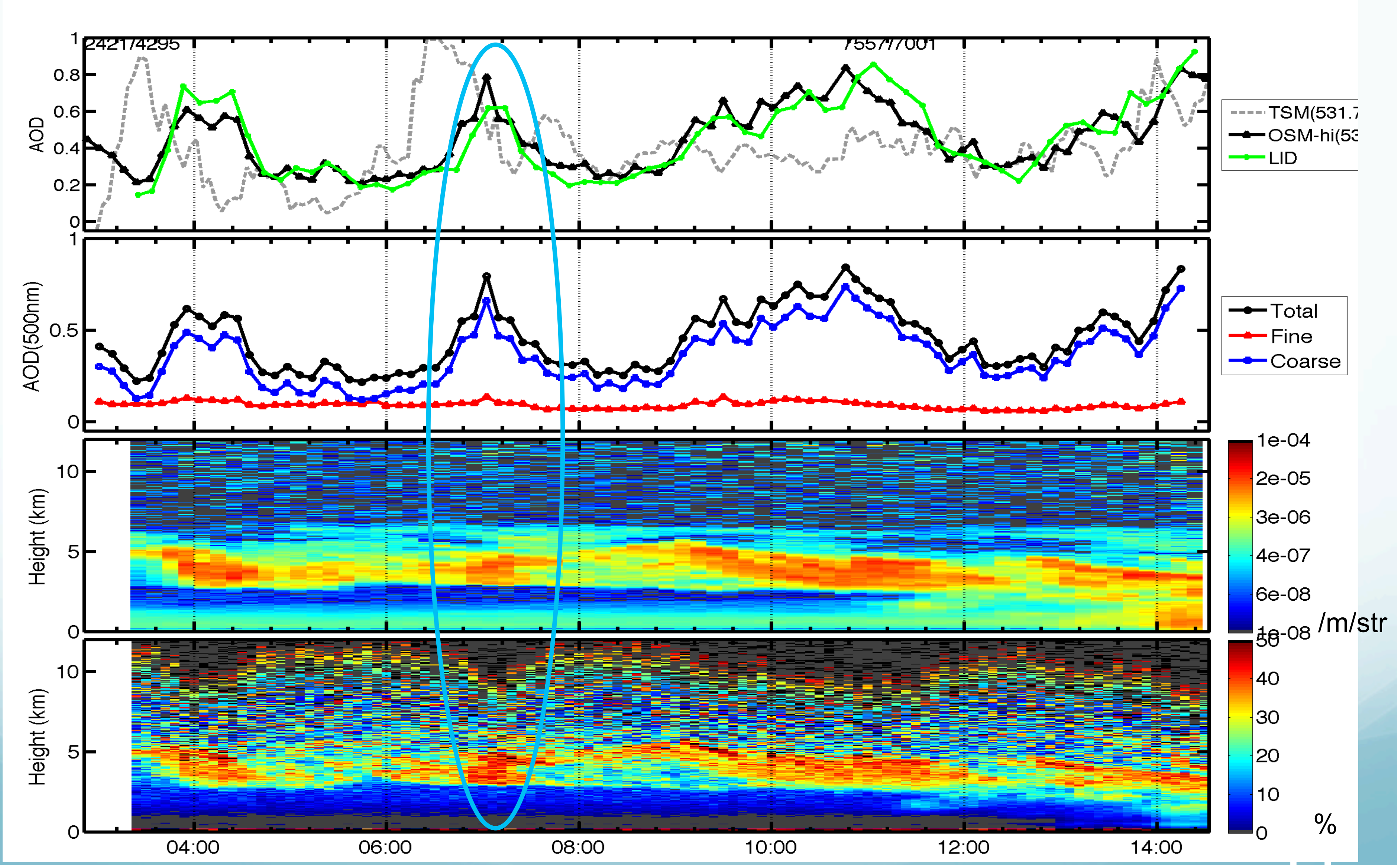
One star **(OSM)**



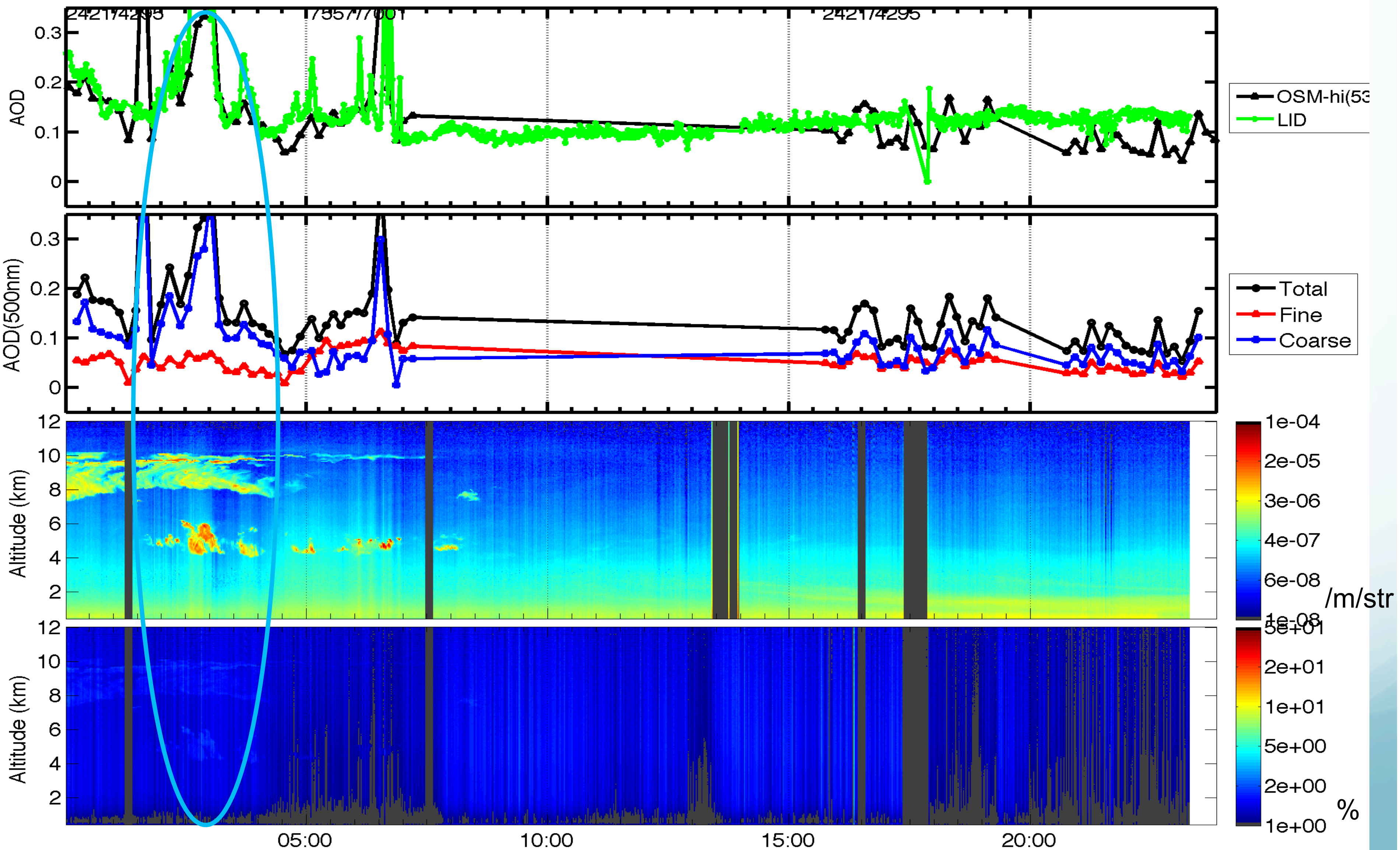
M, M_0 : measured, extraterrestrial magnitude; **m**: air mass; **h**: elevation

- **TSM**: assumption of homogeneous horizontal distribution of absorbing and scattering particulates
- **OSM:** calibration values

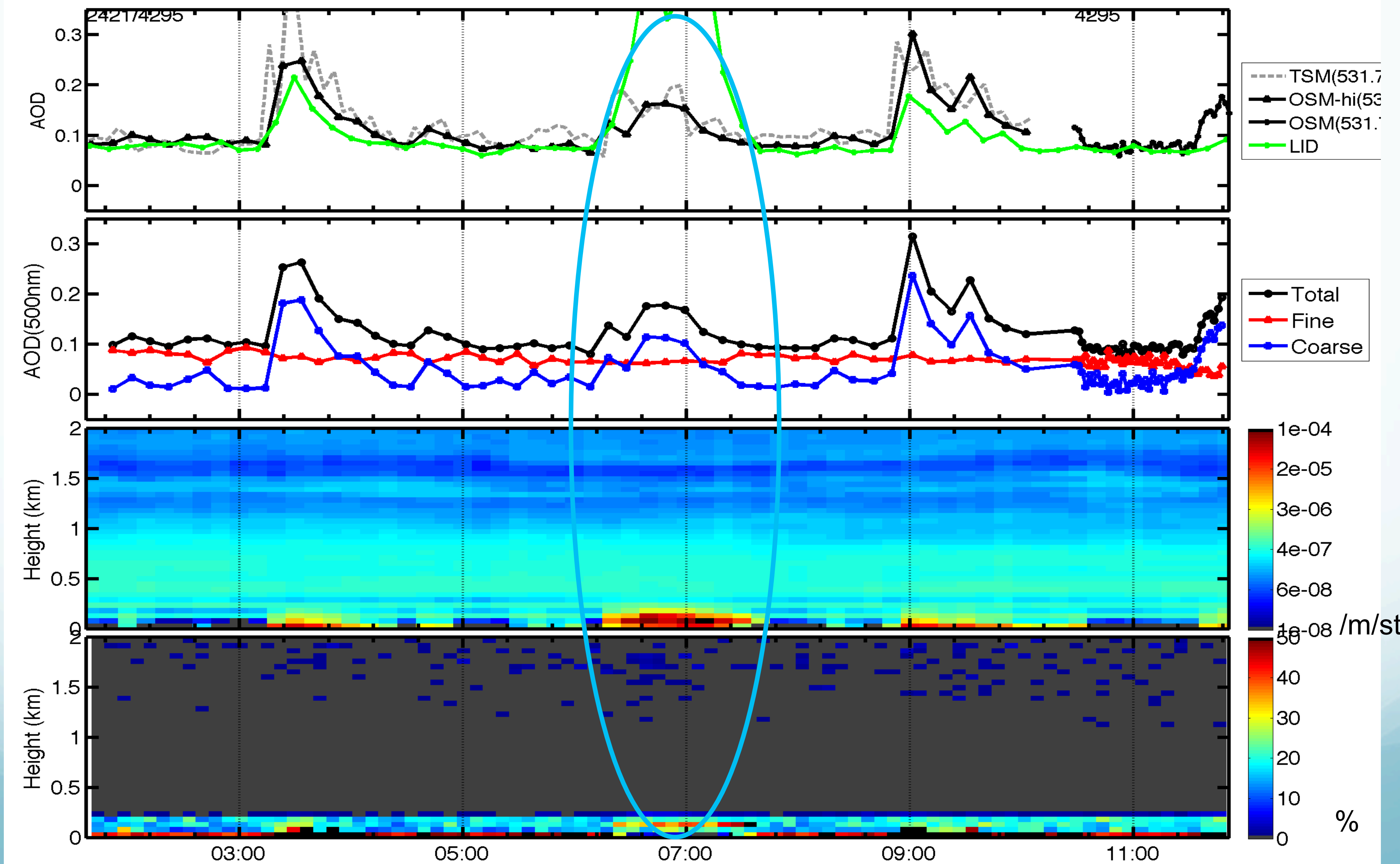
Eureka (Feb. 21, 2011)



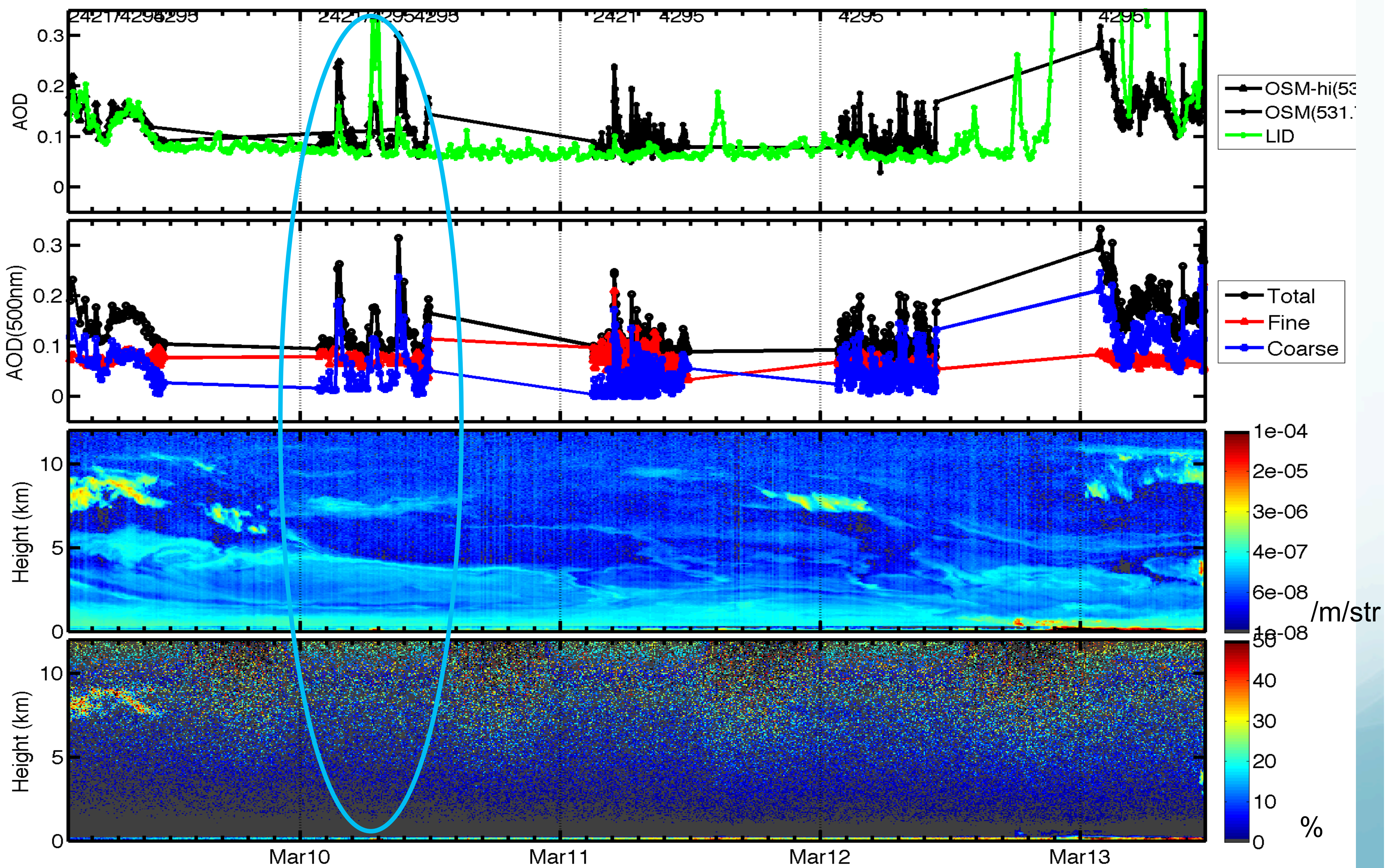
Ny Alesund (Feb. 8, 2011)



Eureka (Mar. 10, 2011)

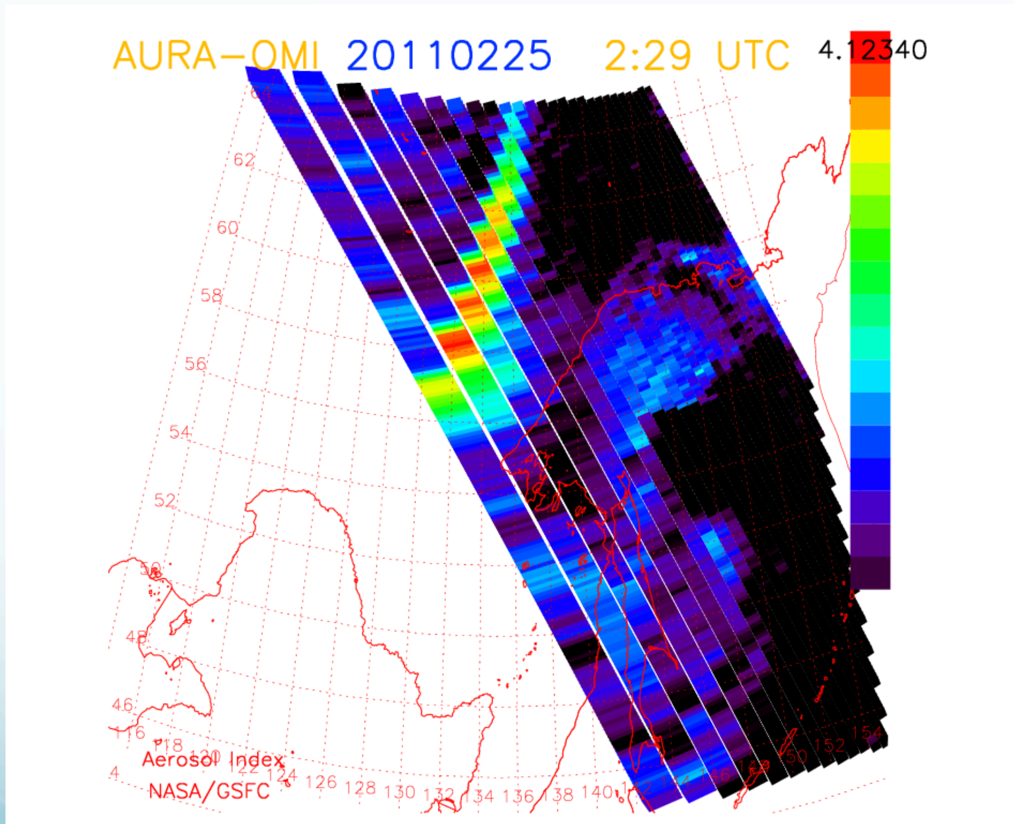


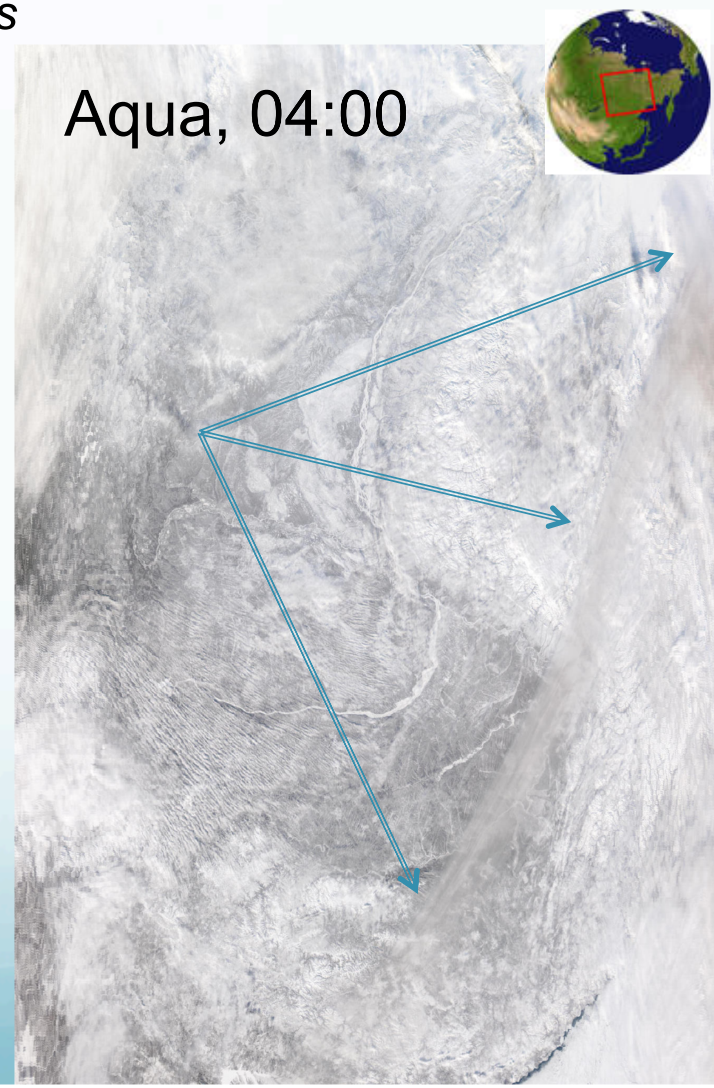
Eureka (March 2011)



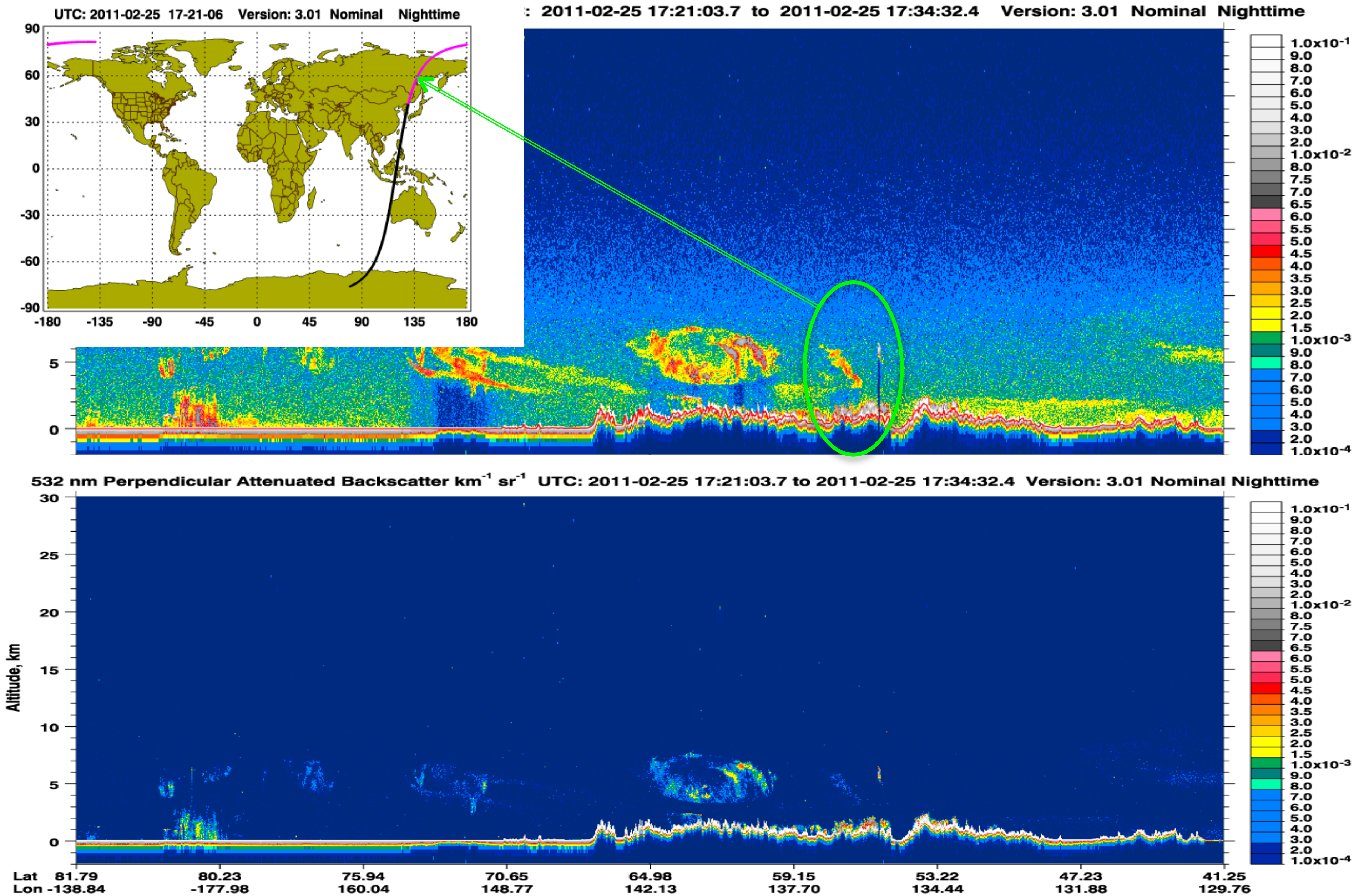
Potential source (OMI and MODIS)

pyroCB discussions





CALIPSO


UTC: 2011-02-25 17-21-06 Version: 3.01 Nominal Nighttime
: 2011-02-25 17:21:03.7 to 2011-02-25 17:34:32.4 Version: 3.01 Nominal Nighttime
532 nm Perpendicular Attenuated Backscatter km-1 sr-1 UTC: 2011-02-25 17:21:03.7 to 2011-02-25 17:34:32.4 Version: 3.01 Nominal Nighttime
Altitude, km
Lat 81.79 80.23 75.94 70.65 64.98 59.15 53.22 47.23 41.25
Lon -138.84 -177.98 160.04 148.77 142.13 137.70 134.44 131.88 129.76

Take home points:

- We have tens of days of simaltaneously acquired starphotometry AODs and lidar backscatter profiles at Eureka and Ny Alesund during 2010-11
- Excellent starphotometry-lidar correlation for several days, but...
- ...starphotometry data is not perfect
- Some potential aerosol and ice crystal events are under investigation.


Thank you!