

Climatology of Aerosol Optical Properties over the High Arctic

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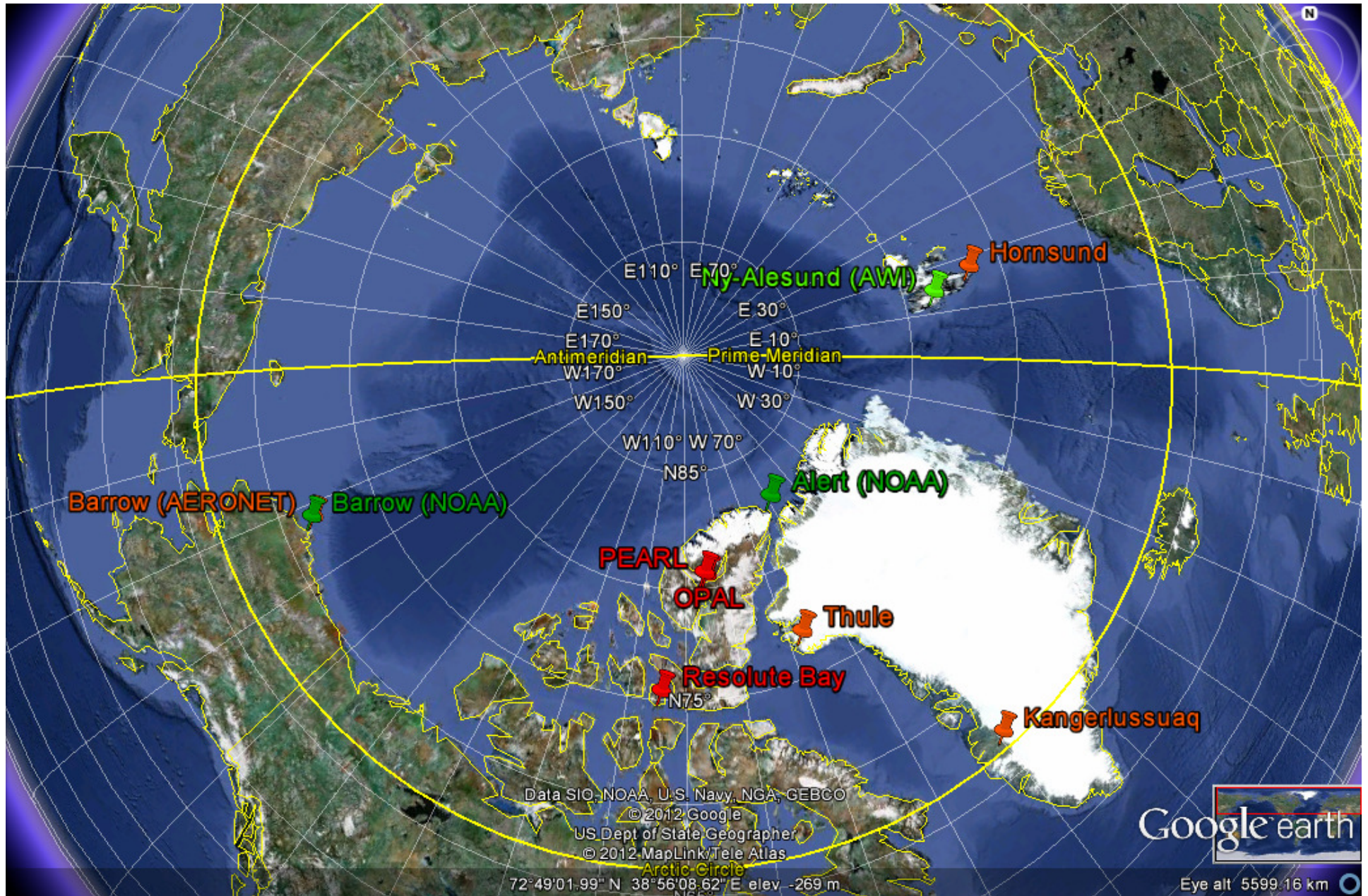
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⁴ University of Toronto, Toronto, Ontario, Canada

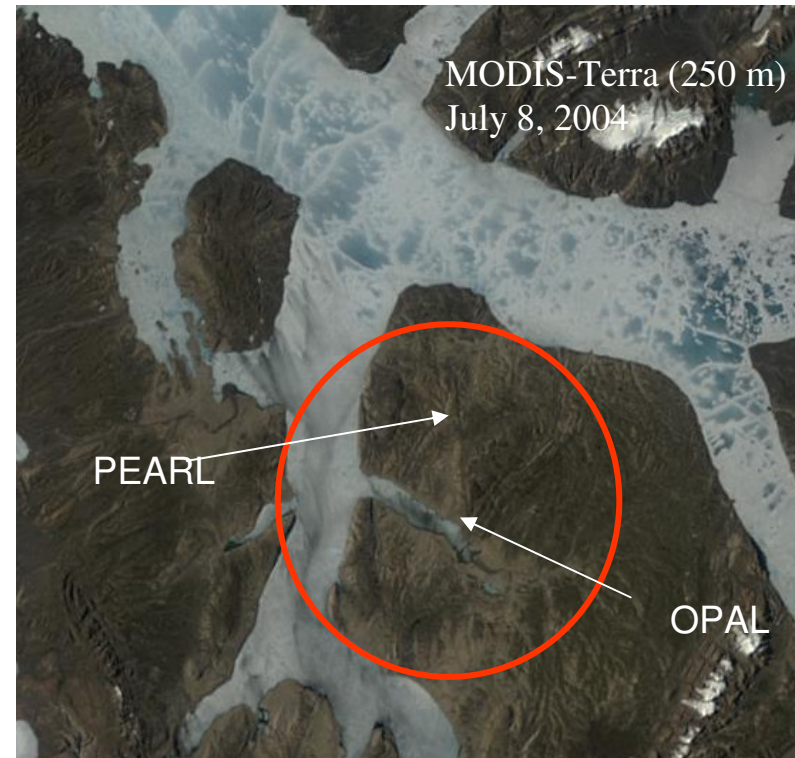
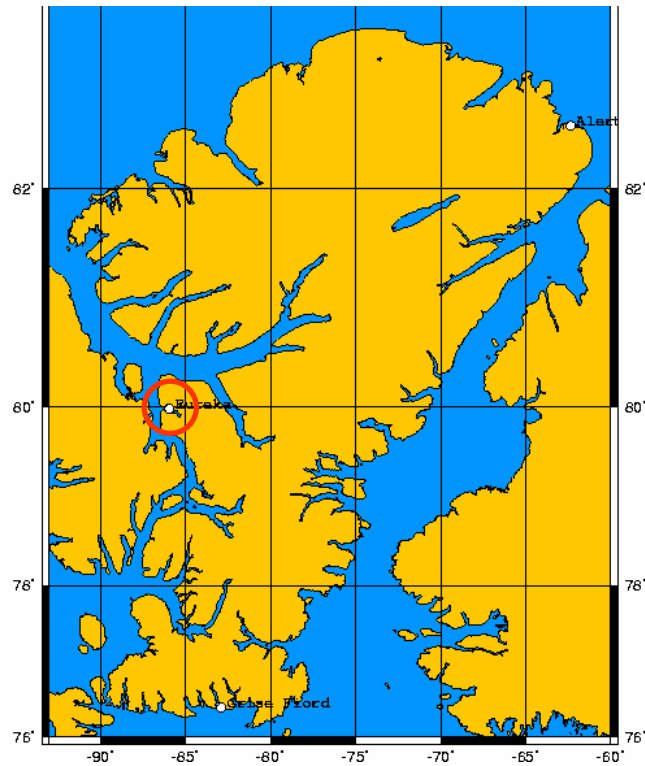
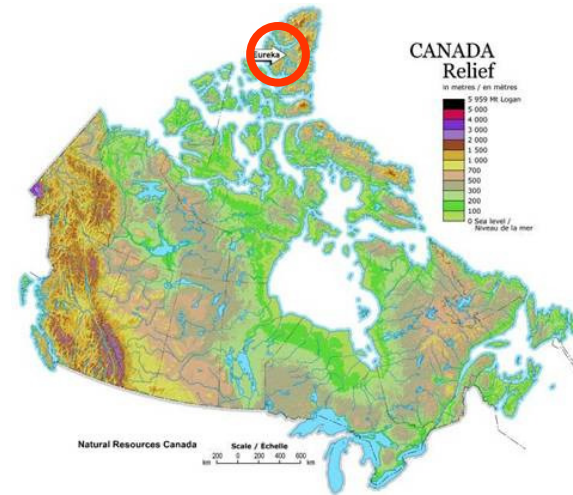
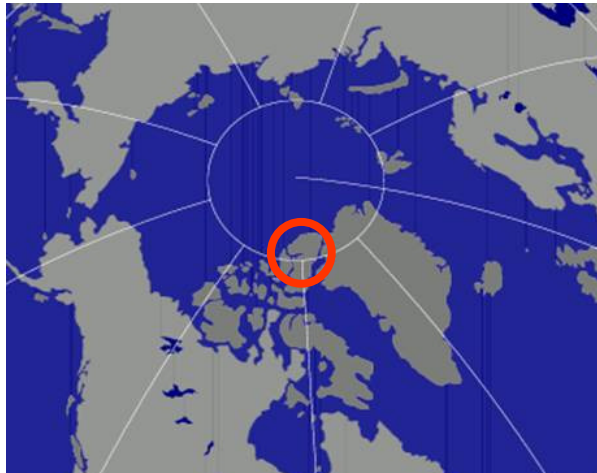
⁵ Alfred Wegener Institute for Polar & Marine Research, Germany

⁶ Environment Canada, Canada

High Arctic Sites



Closer look at Eureka





What is PEARL?

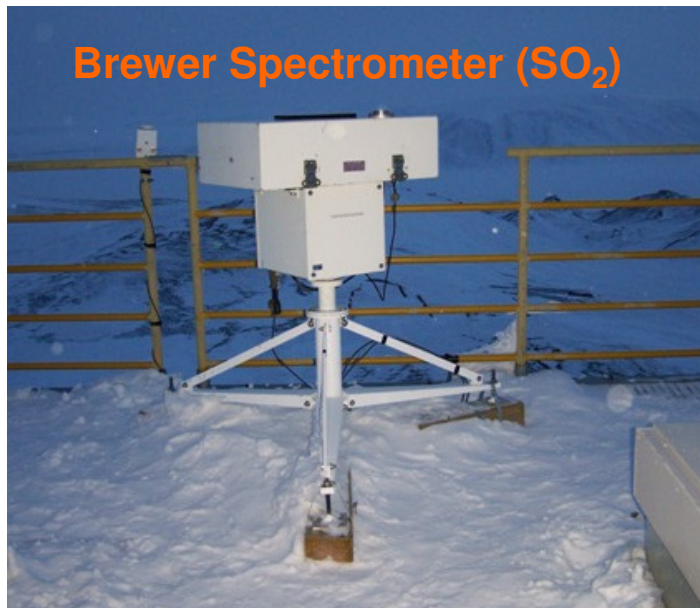


- PEARL - Polar Environmental Atmospheric Research Lab. It is operated by the Canadian Network for the Detection of Atmospheric Change (CANDAC).
- PEARL is located at Eureka, Nunavut (80N, 86W) on Ellesmere Island in Canada's high Arctic, 450 km north of Grise Fiord, the most northerly permanent settlement. PEARL is 1,100 km from the North Pole.
- ØPAL - Zero altitude Polar Atmosphere Laboratory. It is located about 15 km southeast of the PEARL ridge lab which is at an elevation of 610 m.

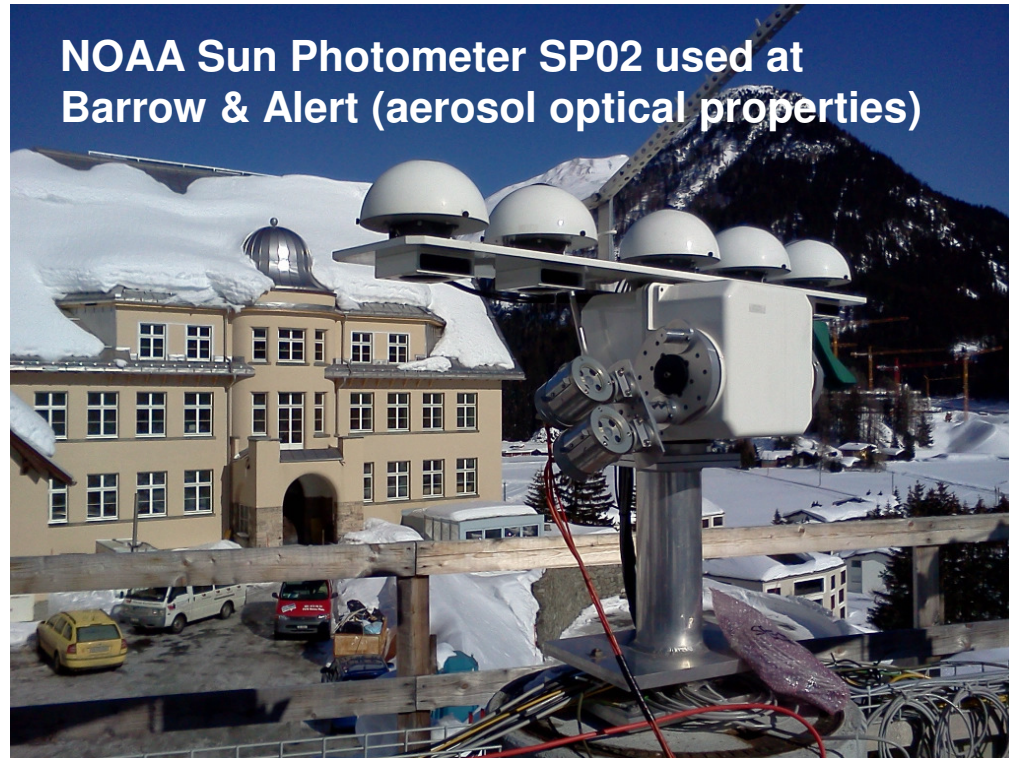
Instruments & Data used in this Study (Eureka)



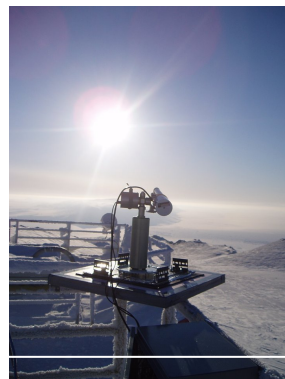
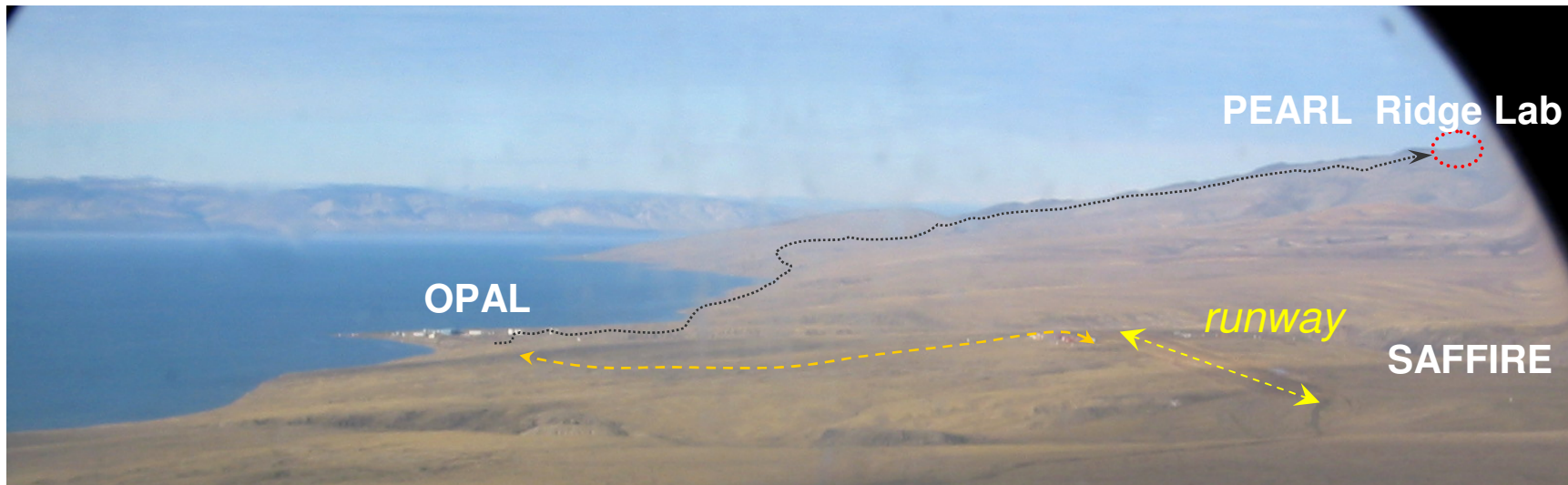
NOAA/SEARCH
Arctic High Spectral
Resolution Lidar
(AHSRL) for vertical
profiles of backscatter
coefficient (β) &
depolarization ratio (δ)



Instruments & Data used in this Study (Barrow & Alert)



Sunphotometers installation in Eureka





AERONET Data Display Interface **Version 2 Direct Sun Algorithm**

Level 1.0. Real Time Data.

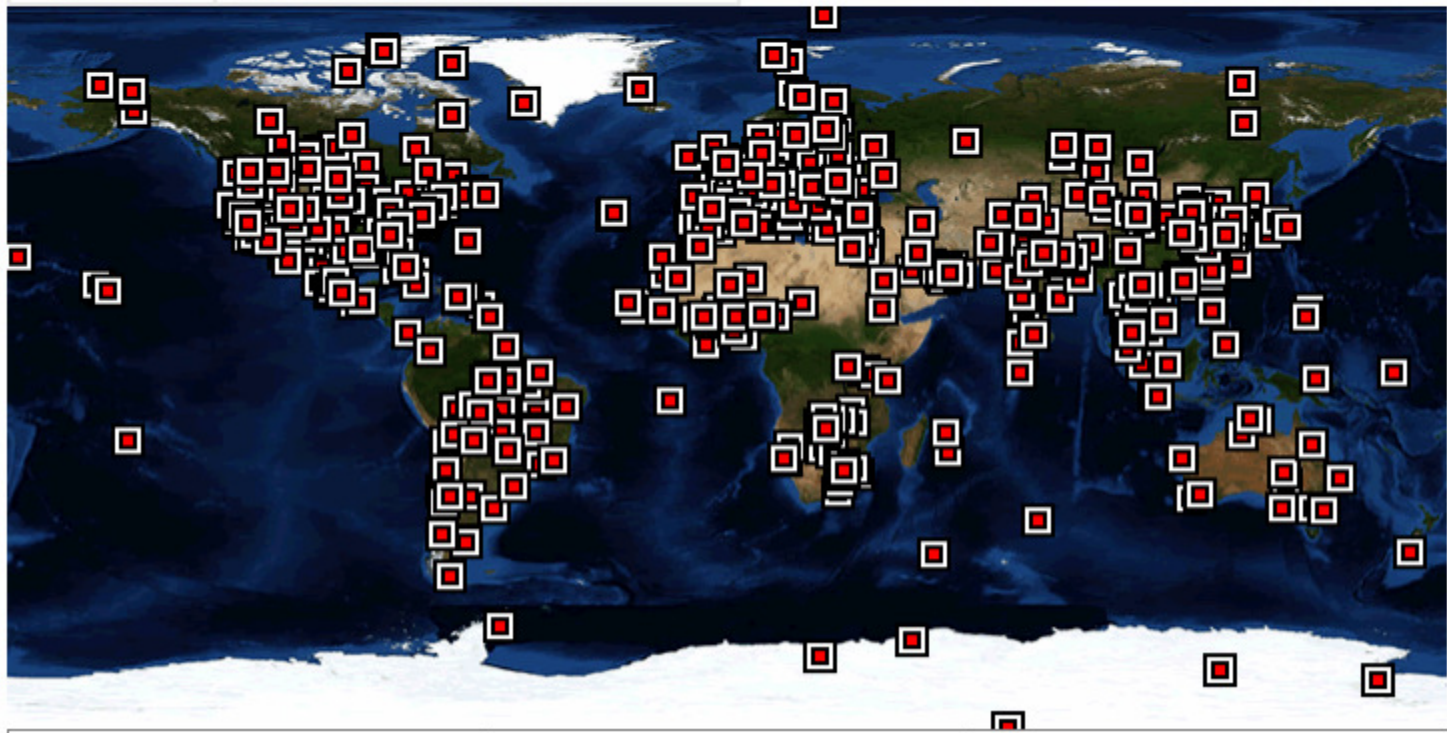
The following AERONET data are unscreened and may not have final calibration applied

[1993](#) [1994](#) [1995](#) [1996](#) [1997](#) [1998](#) [1999](#) [2000](#) [2001](#) [2002](#) [2003](#) [2004](#) [2005](#) [2006](#) [2007](#) [2008](#) [2009](#) [2010](#) [2011](#) [2012](#)

To zoom the map click on it.

[Back to World Map](#)

Total Data (Years):	<input checked="" type="radio"/> All	<input type="radio"/> >0.5	<input type="radio"/> >1	<input type="radio"/> >2	<input type="radio"/> >3	<input type="radio"/> >5	<input type="radio"/> >7
AOT Level	<input checked="" type="radio"/> Level 1.0	<input type="radio"/> Level 1.5	<input type="radio"/> Level 2.0				



AEROCAN (Canadian Sunphotometer Network)



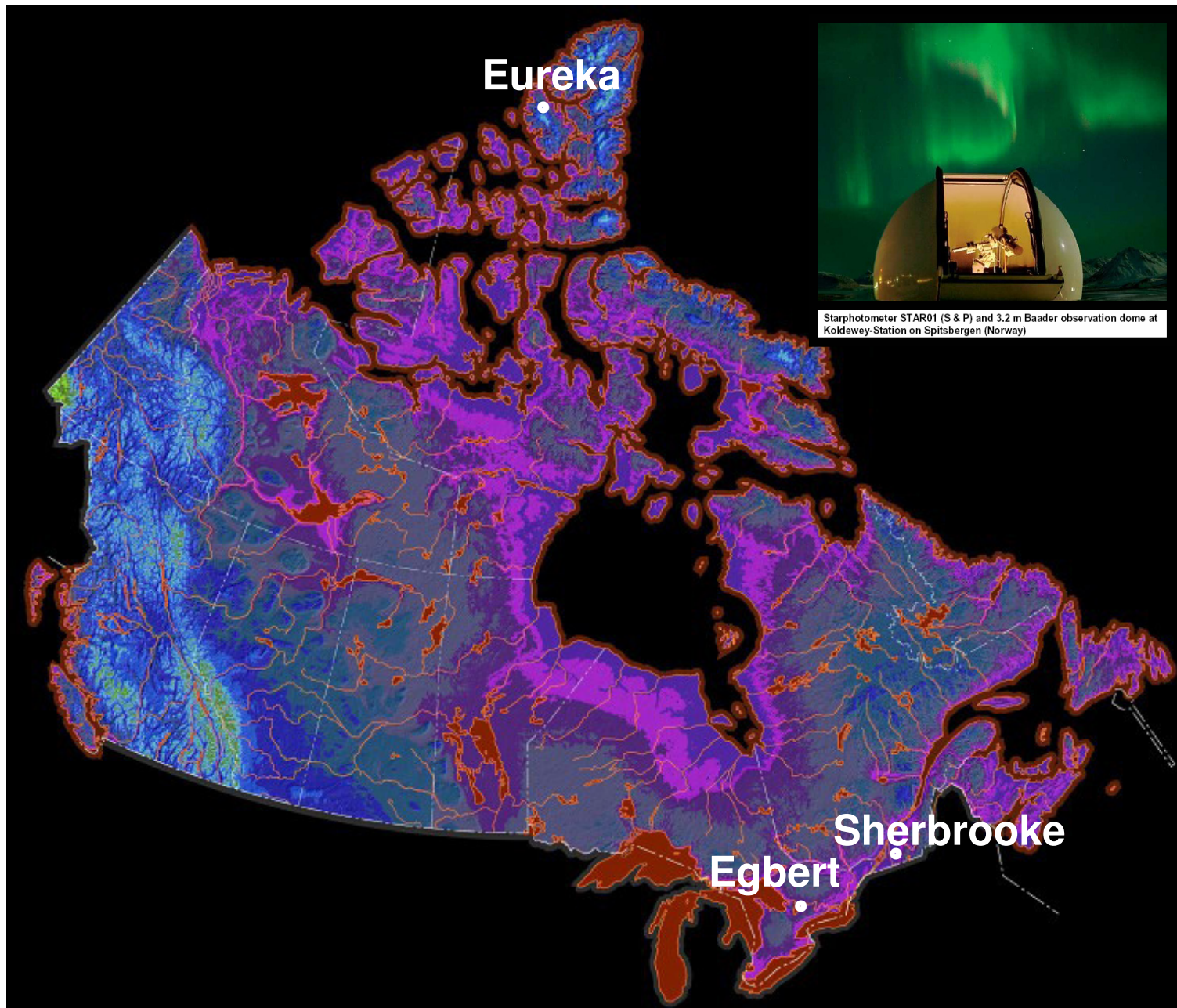
AERONET vs AEROCAN

AEROCAN is a full fledged sub-network of AERONET and benefits from all services that AERONET offers.

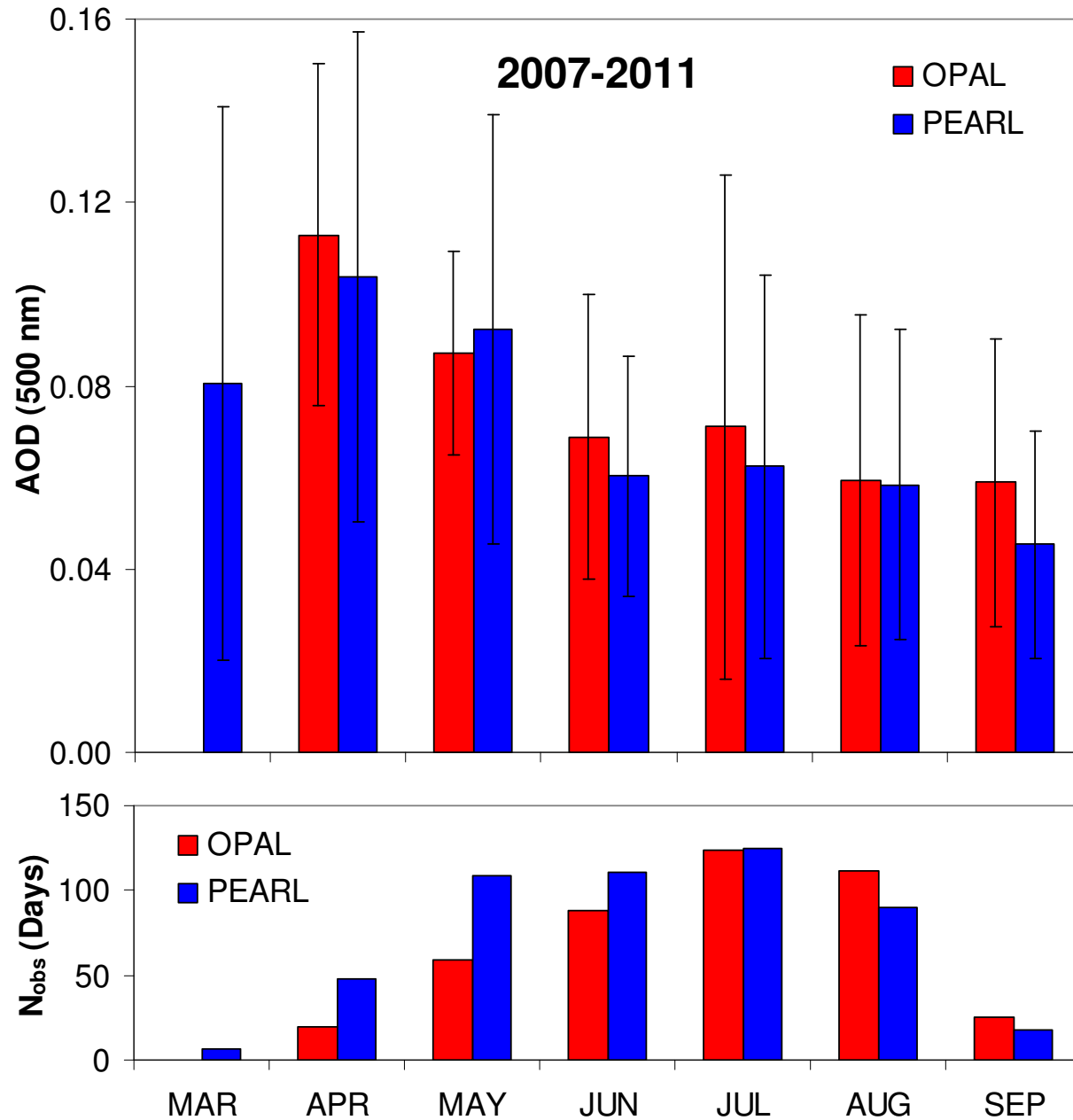
AEROCAN has a few unique features that go beyond AERONET protocols:

- All instruments use the high frequency, 3-minute mode (O'Neill mode).
- All data transmission is done using FTP.
- Complementary AOD processing chain in preparation for real time ingestion into an aerosol assimilation model (currently on hold).
- System wide display tools for real-time QA & troubleshooting.
- Separate prototype MySQL database for data QA (and science).
- Satellite calibration facility being developed (on hold with EC freezes).

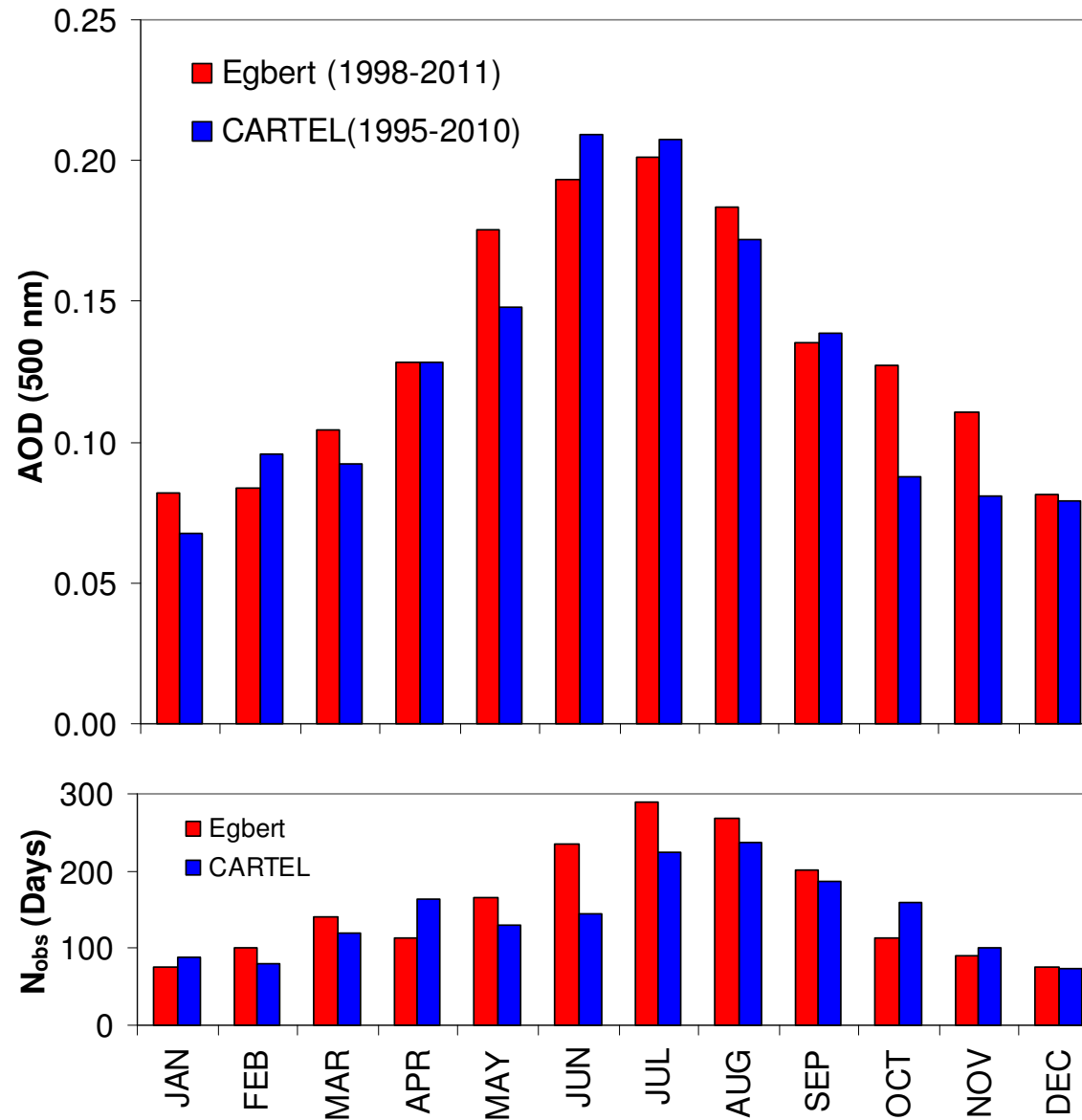
AEROCAN* (Canadian Starphotometer Sites)



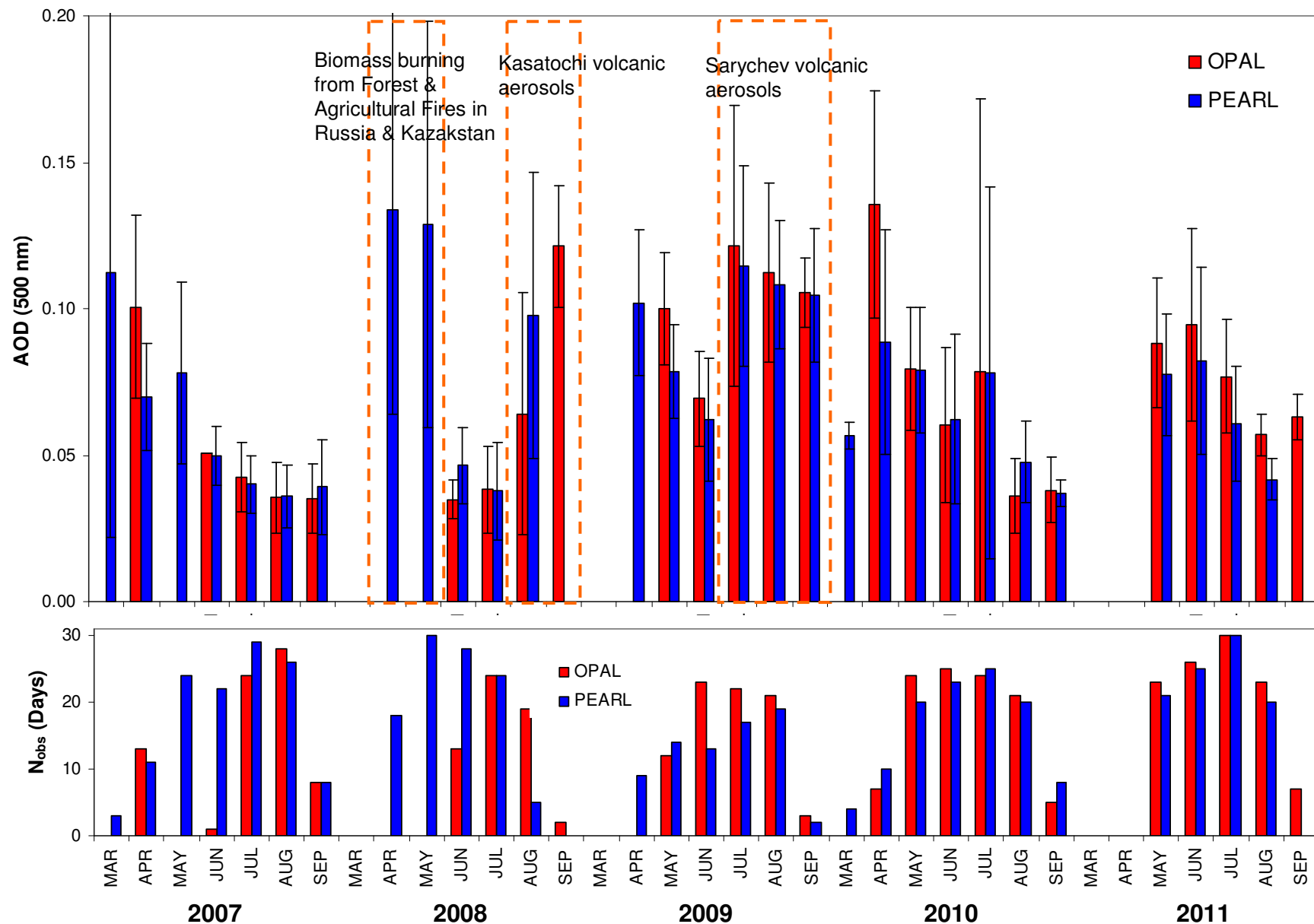
Eureka Aerosol Optical Depth Climatology



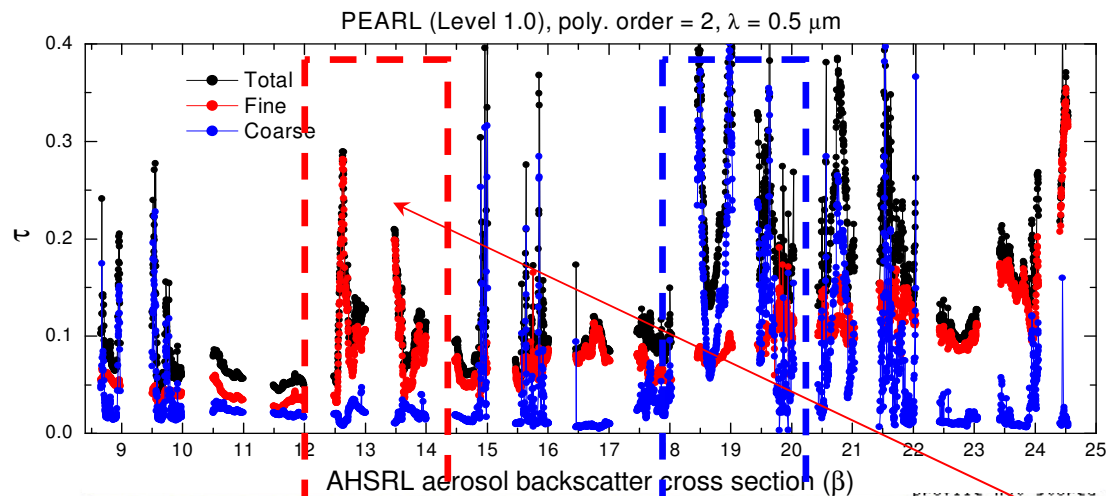
Mid-Latitude AOD Climatology



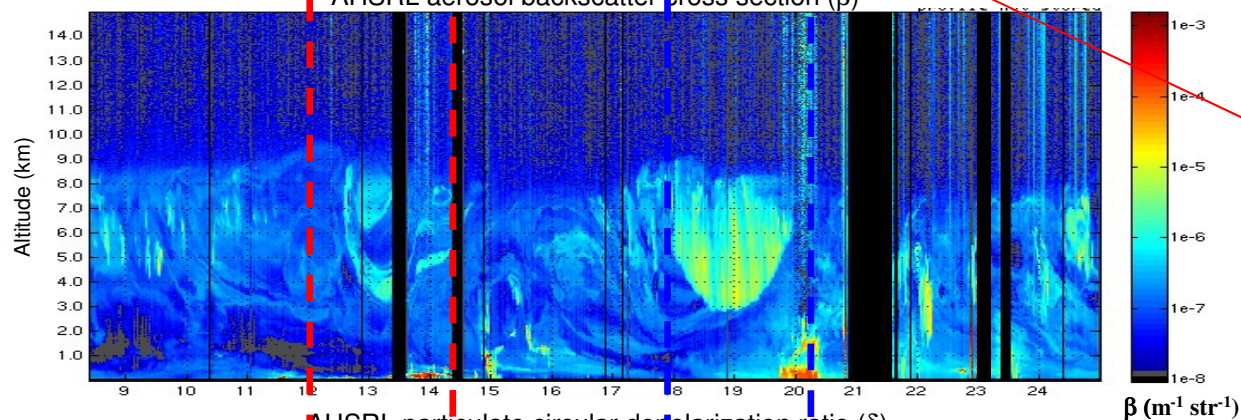
Seasonal and inter-annual variation of AOD over Eureka



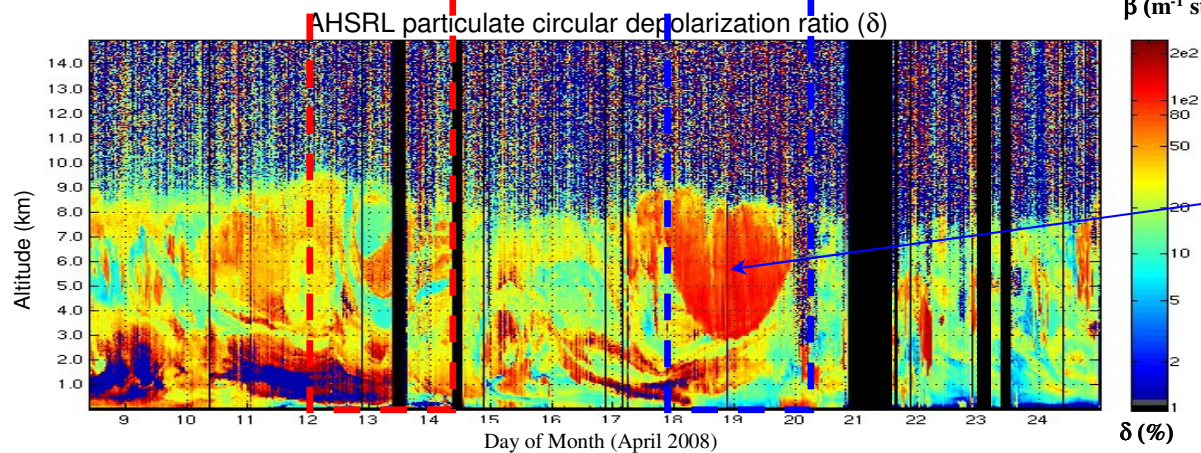
Biomass burning aerosols during Spring 2008 (ARCTAS)*



τ_f correlates well with β variations in the presence of small δ , while τ_c values correlate with β in the presence of large δ .



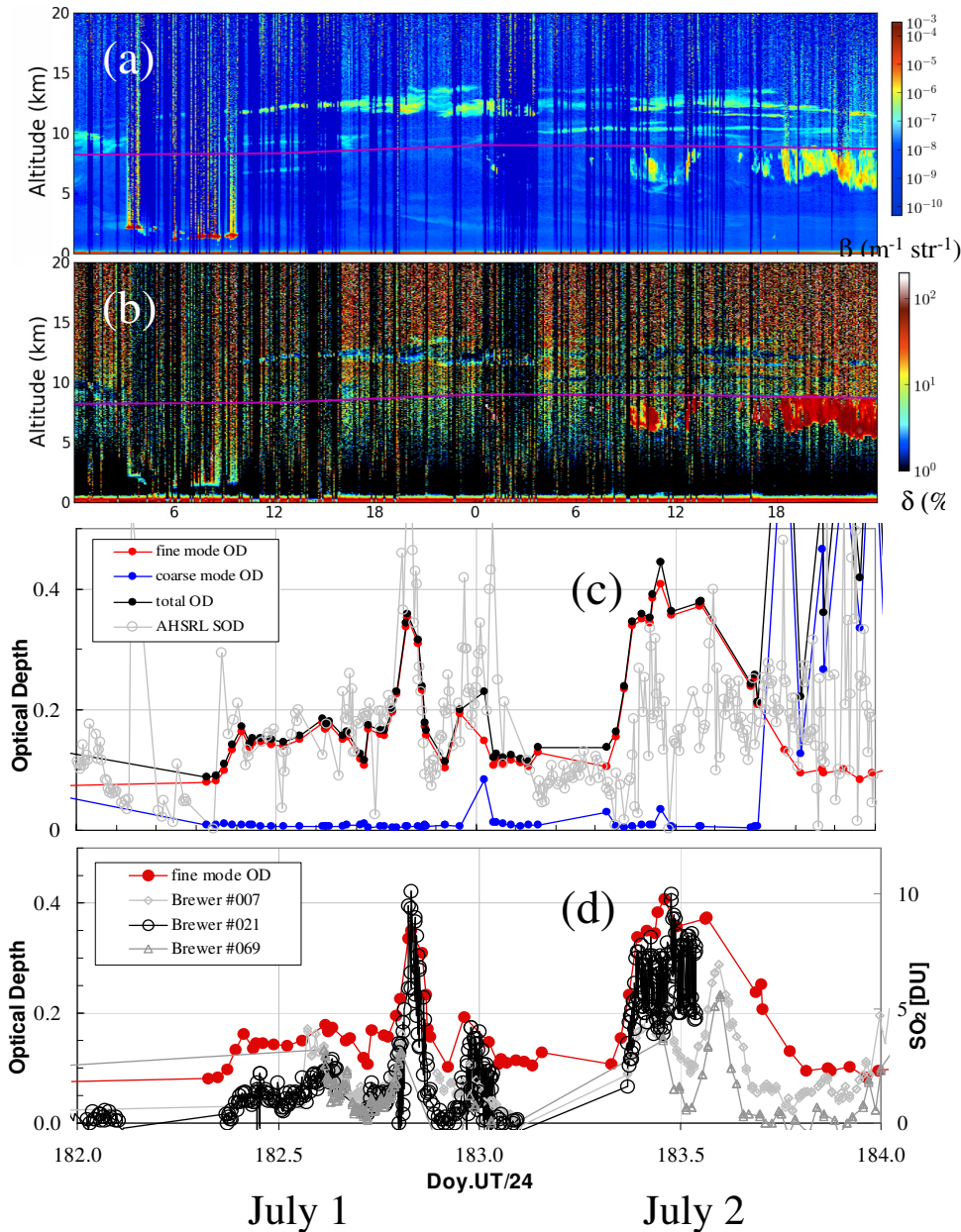
Fine mode aerosols were associated with biomass burning (agricultural and forest fires) from E/SW Russia & northern Kazakhstan.



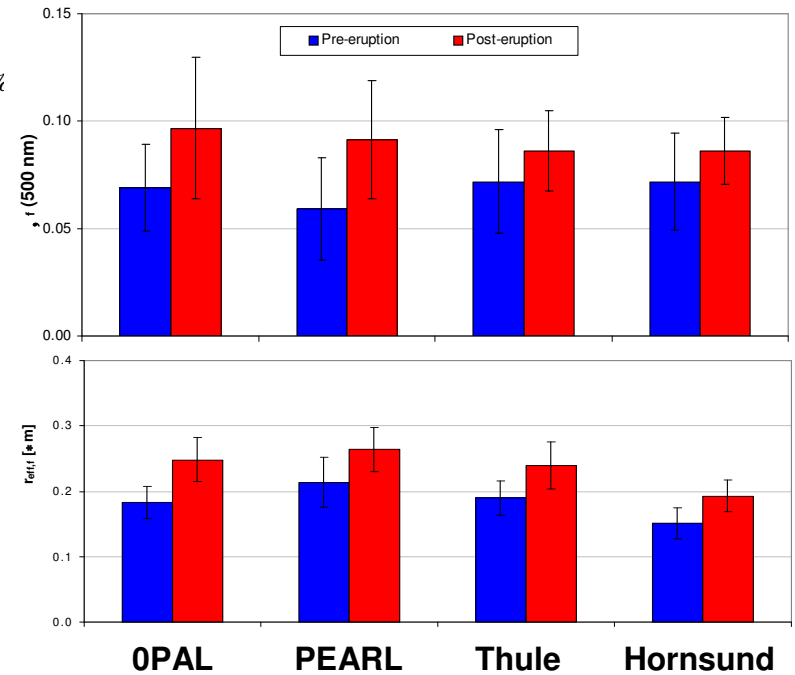
Coarse - mode events were likely due to ice particles whose nucleation may have been associated with the presence of smoke, or possibly dust.

*Saha et al., GRL, 2010

Sarychev volcanic aerosols over the Arctic during Summer 2009*

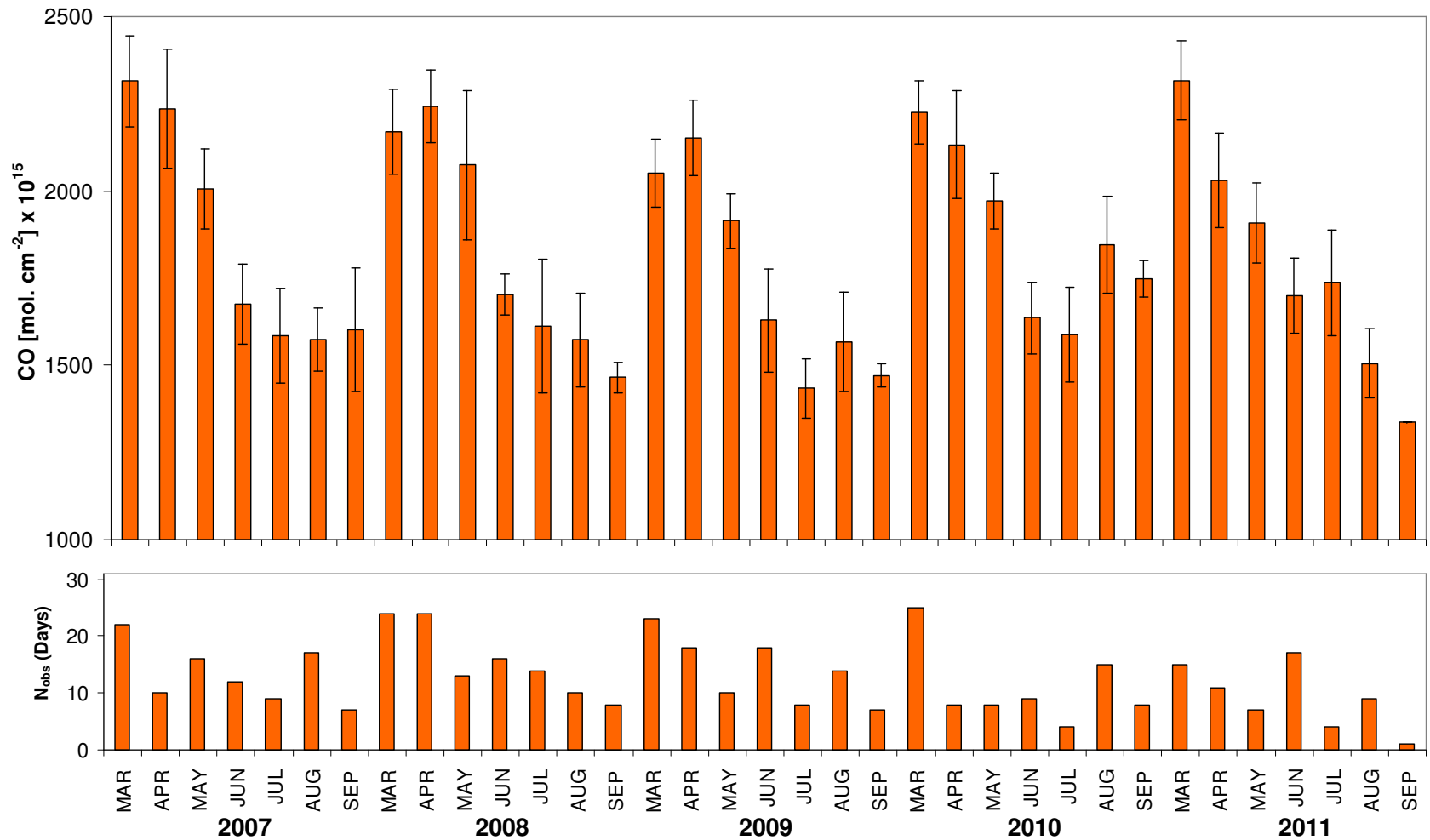


Pre- and post- SAT τ_f and $r_{\text{eff},f}$ for four AEROCAN / AERONET high-Arctic stations



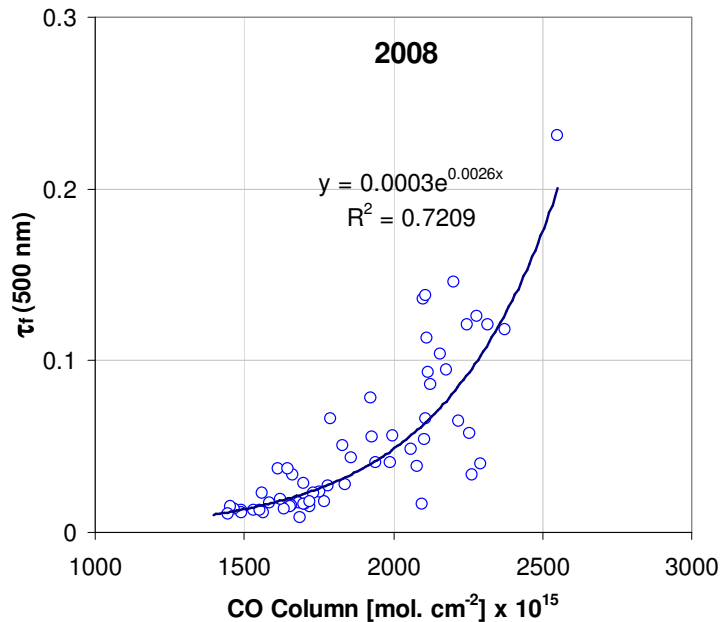
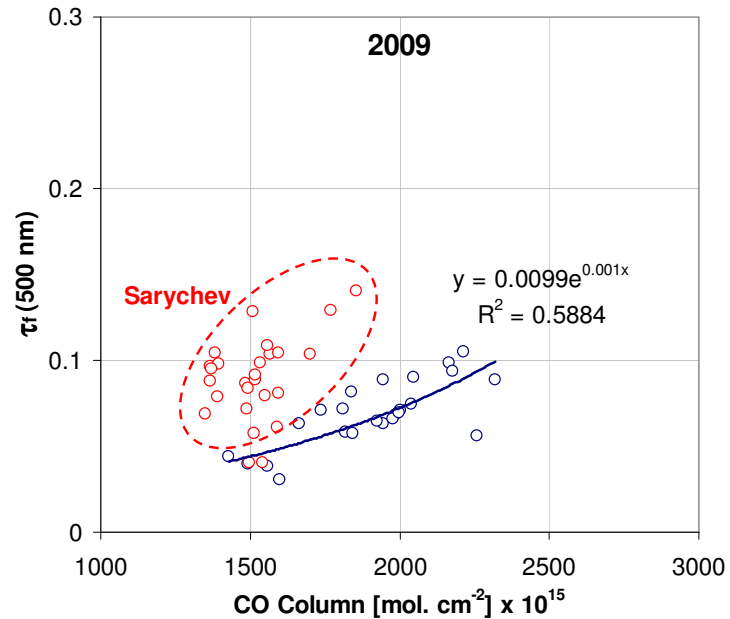
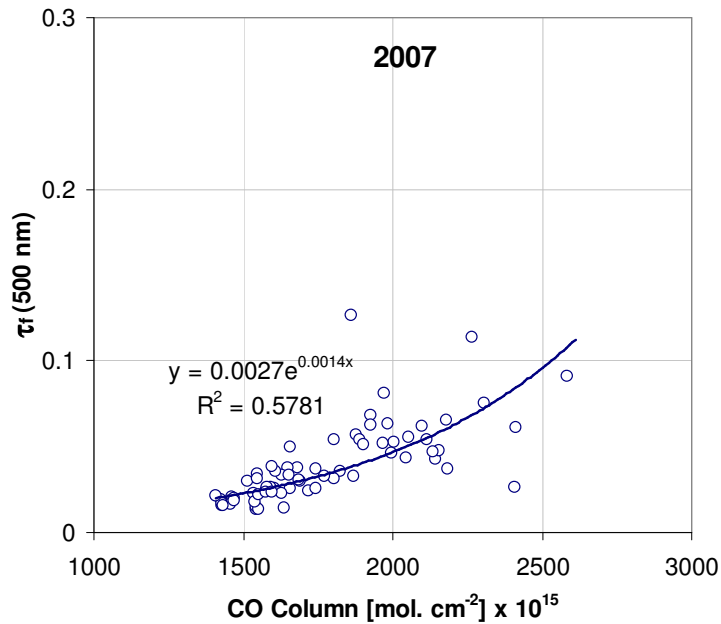
*O'Neill et al., JGR 2012

Variations of CO Total Column over Eureka



CO being a tracer of biomass, one would expect a degree of correlation with the fine mode aerosols that are also a primary product of biomass burning.

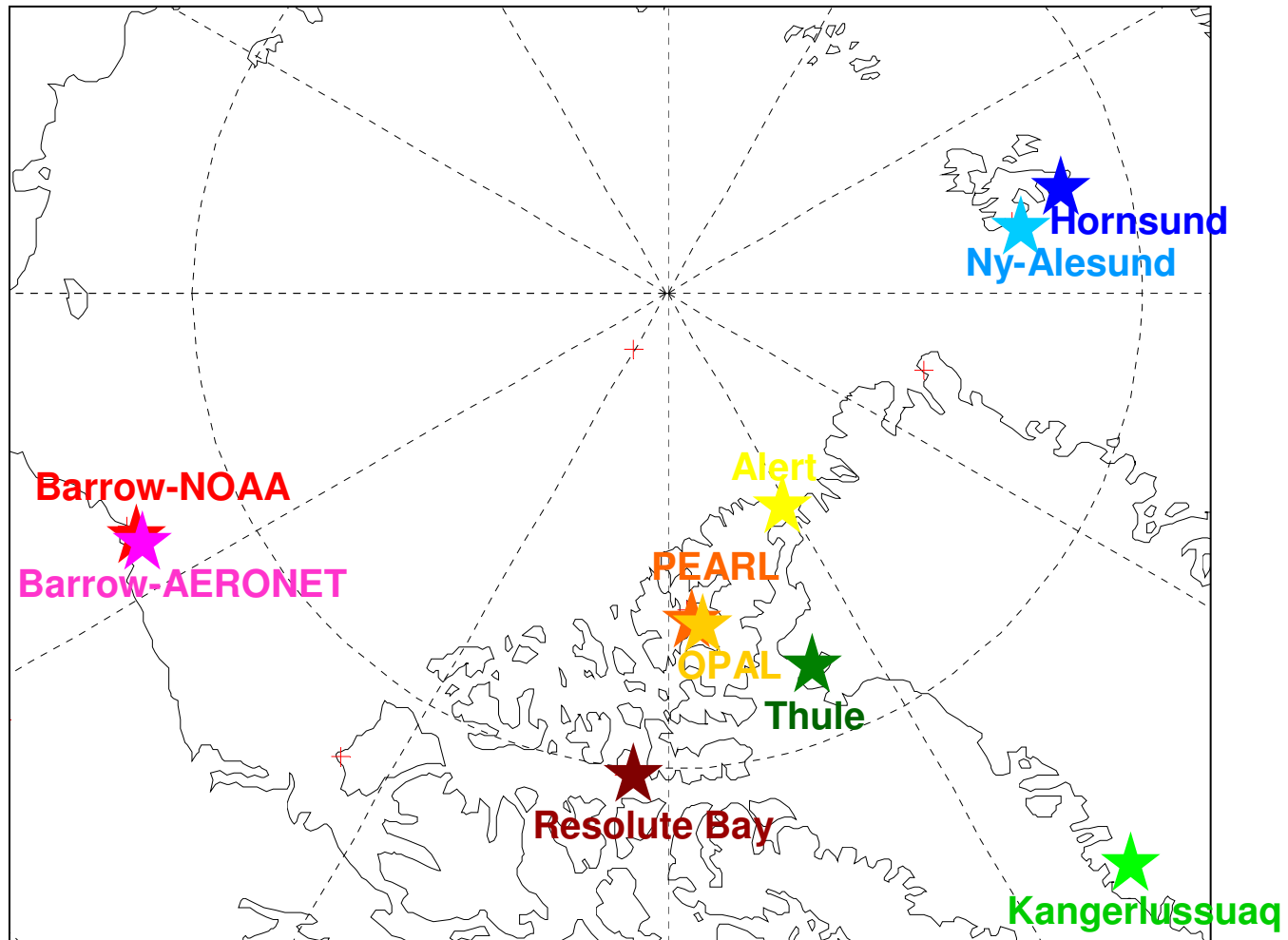
Fine Mode AOD vs CO



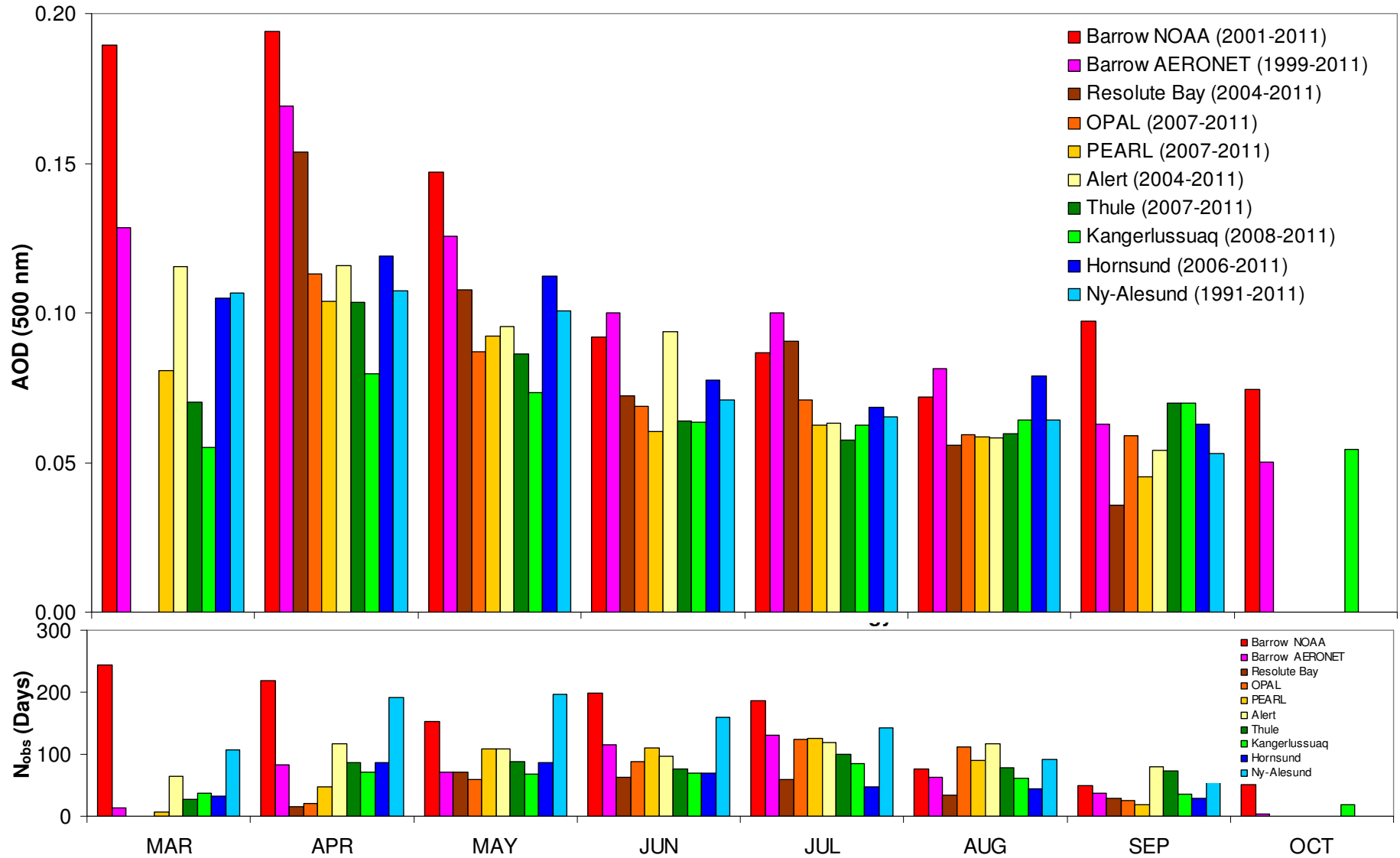
Shown in the figures are the variation of fine-mode AOD as a function of CO concentration for the three years of 2007, 2008 and 2009.

One can observe a moderate (2007), strong (2008) and insignificant (2009) correlation respectively for these three years. However if we separate out the Sarychev fine-mode AODs from the 2009 regression, we find a R² value that is comparable to the other two years.

Pan-Arctic sites for the AOD Climatology

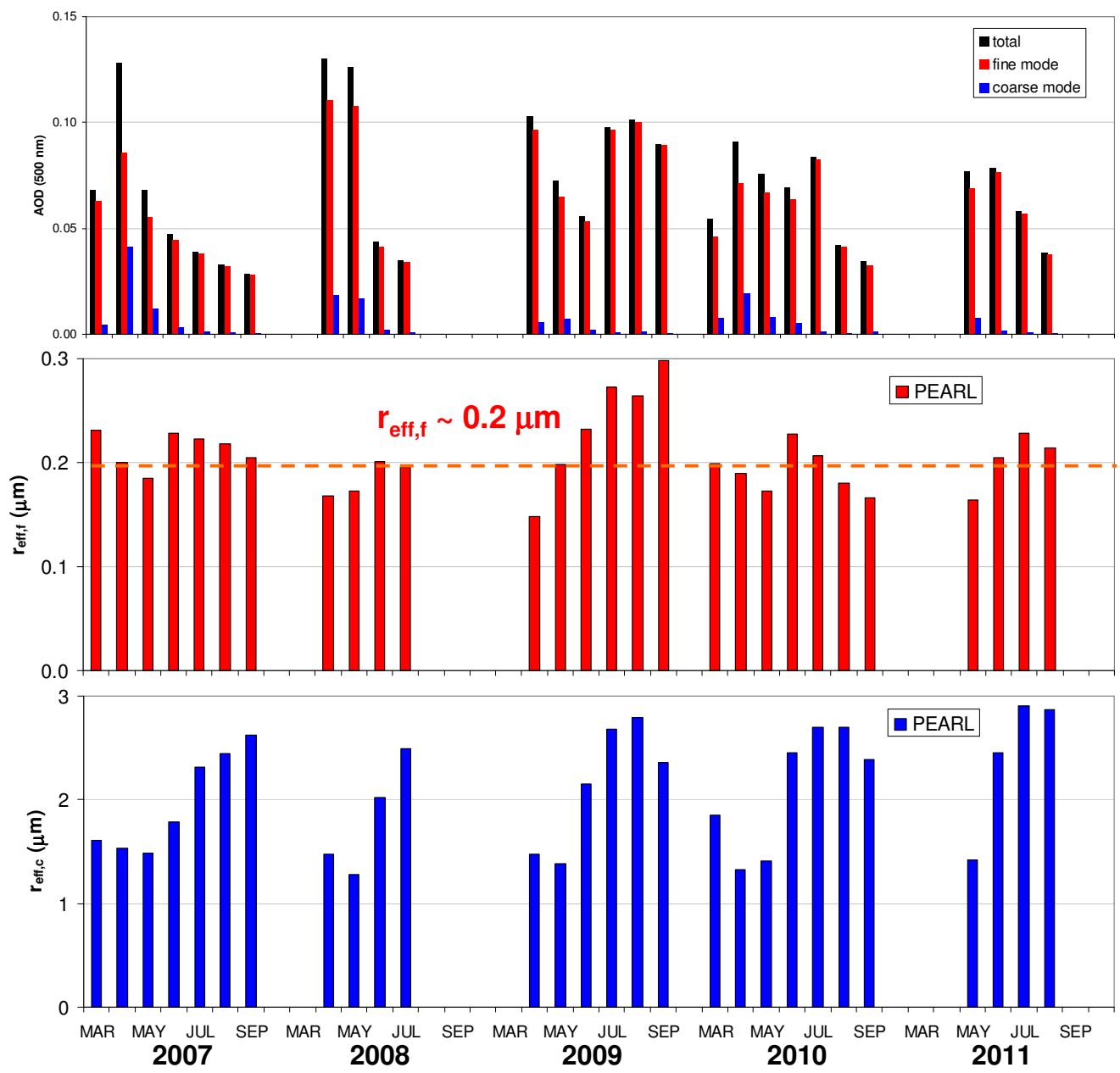


Pan-Arctic AOD Climatology



AOD monthly climatology for an enhanced number of high Arctic stations on a pan-Arctic scale. It simultaneously shows the spring to summer decrease noted for Eureka as well as a west to east AOD decrease.

Retrievals of fine & coarse mode AOD and effective radius



The fine-mode AOD shows the spring to summer decrease (confirms that the total AOD is fine-mode dominated).

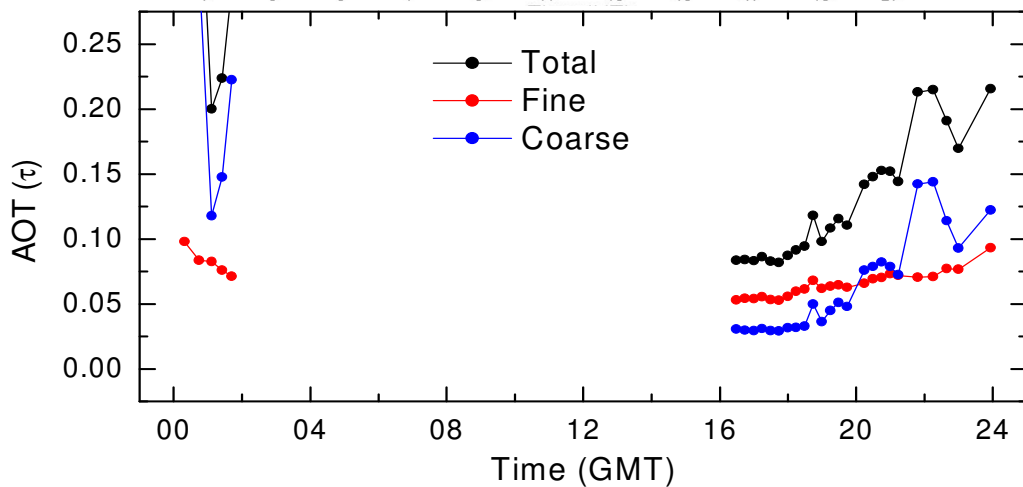
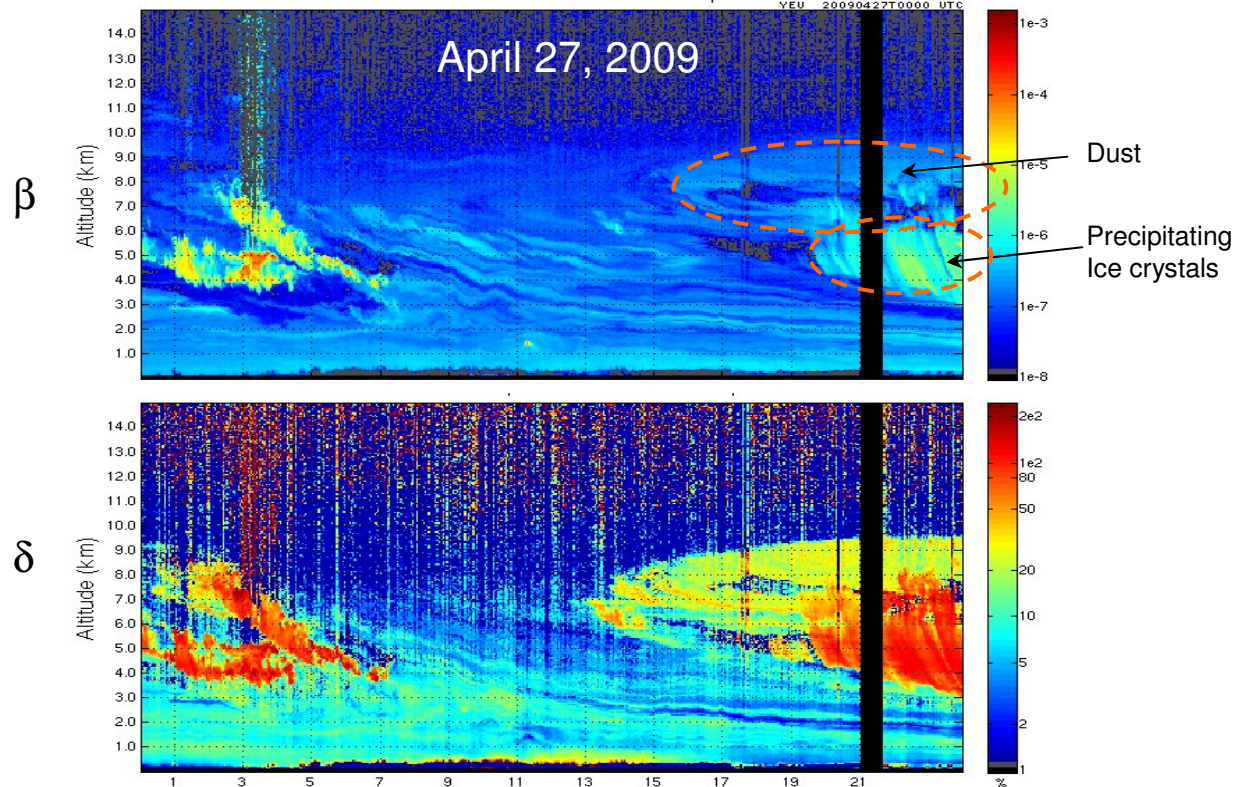
The coarse mode AOD shows apparent springtime activity that could possibly be Asian Dust.

The fine-mode effective radius shows a relatively consistent variation except in 2009 where we know there was a strong Sarychev influence (O'Neill et al., 2012).

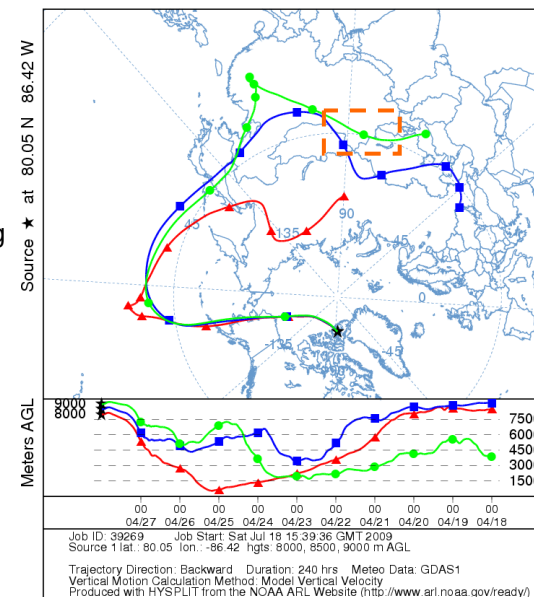
The coarse mode effective radius shows significant variations that could be real (possibly associated with marine aerosols) but which might, just as well, be associated with low-AOD retrieval artifacts.

Illustration of Coarse Mode Event (Asian Dust)

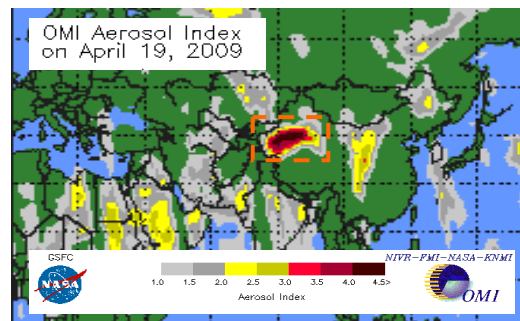
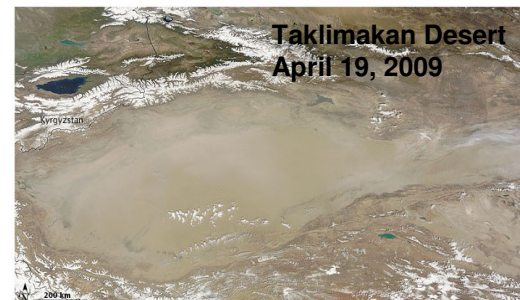
Aerosol backscatter cross section 27-Apr-2009



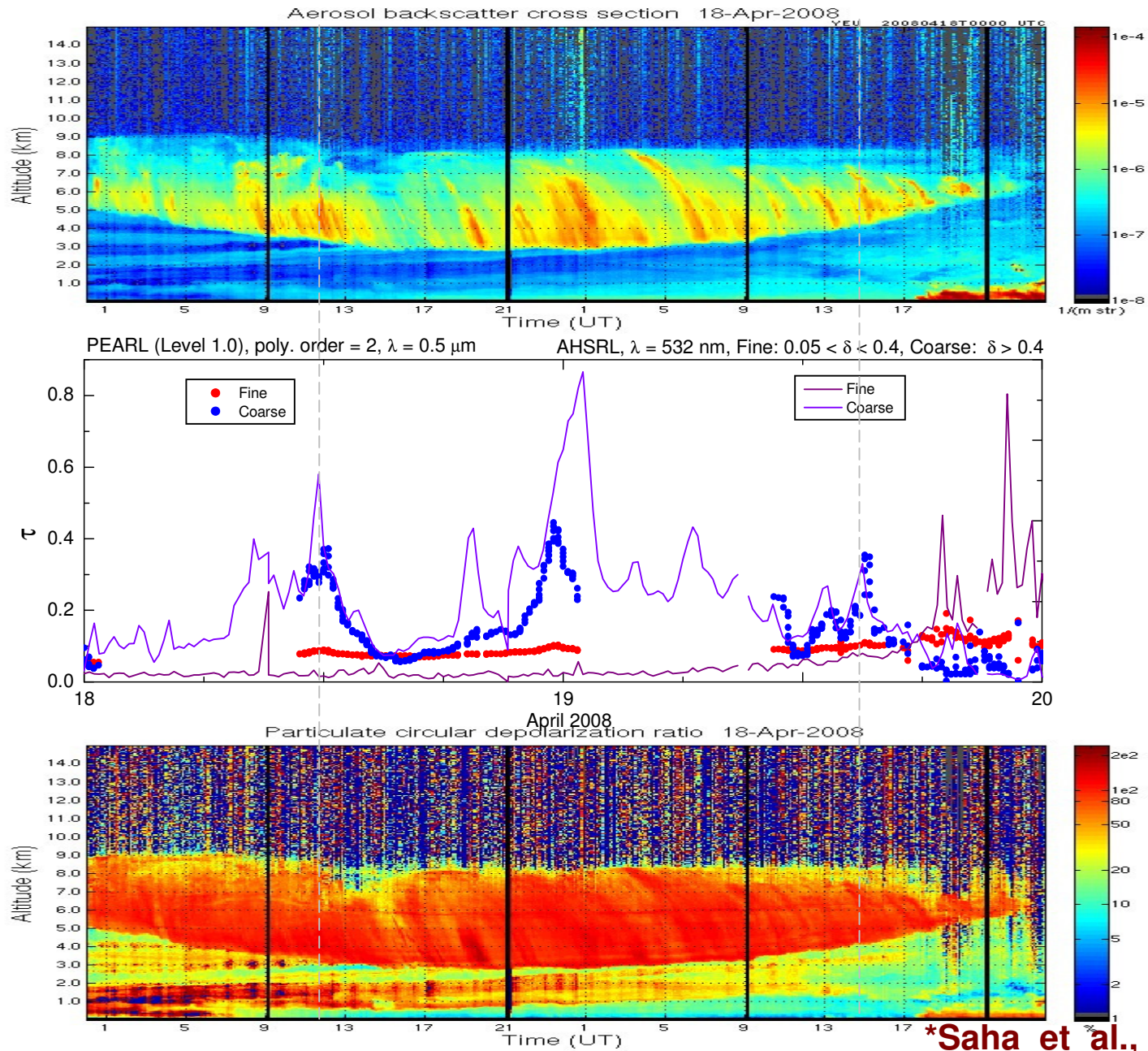
NOAA HYSPLIT MODEL
Backward trajectories ending at 0000 UTC 28 Apr 09
GDAS Meteorological Data



Dust Storm in the Taklimakan Desert

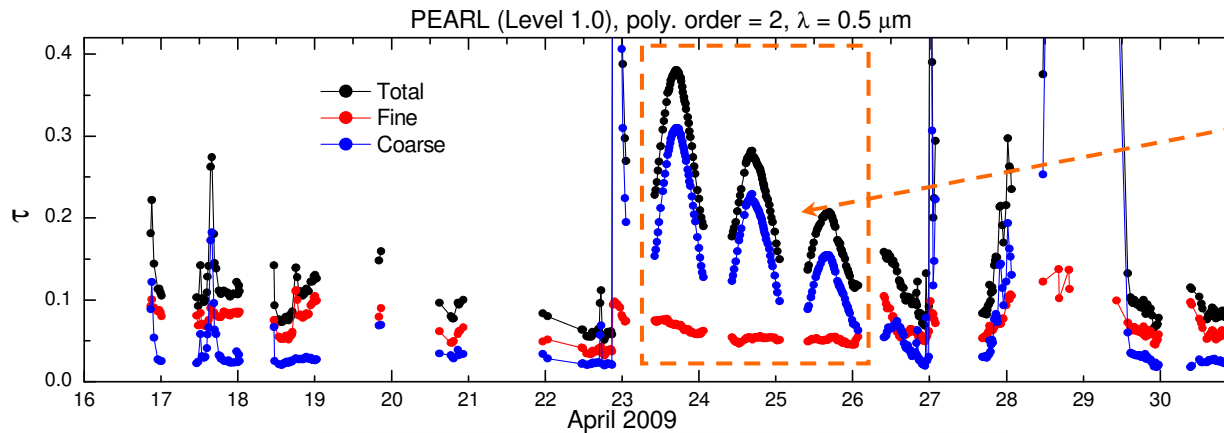


Coarse Mode Event (Nucleation of Smoke & Dust) during ARCTAS*

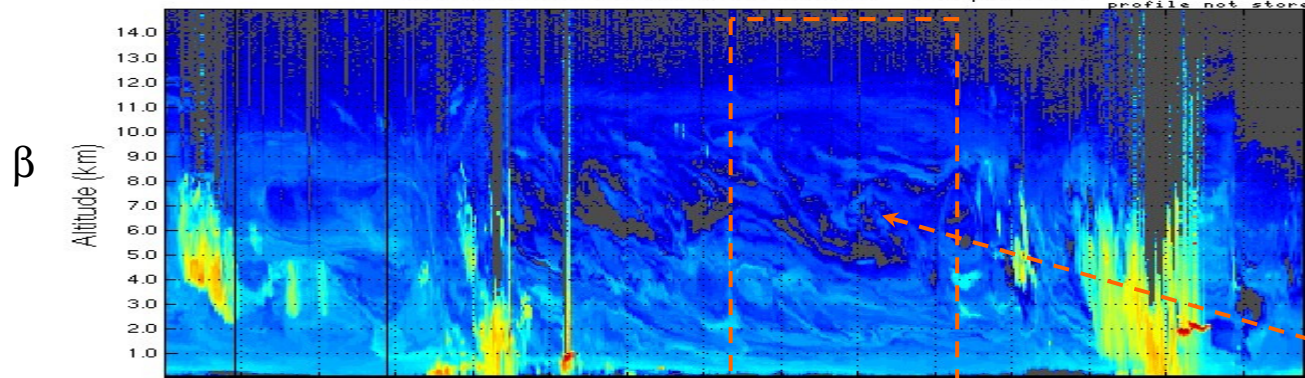


*Saha et al., GRL, 2010

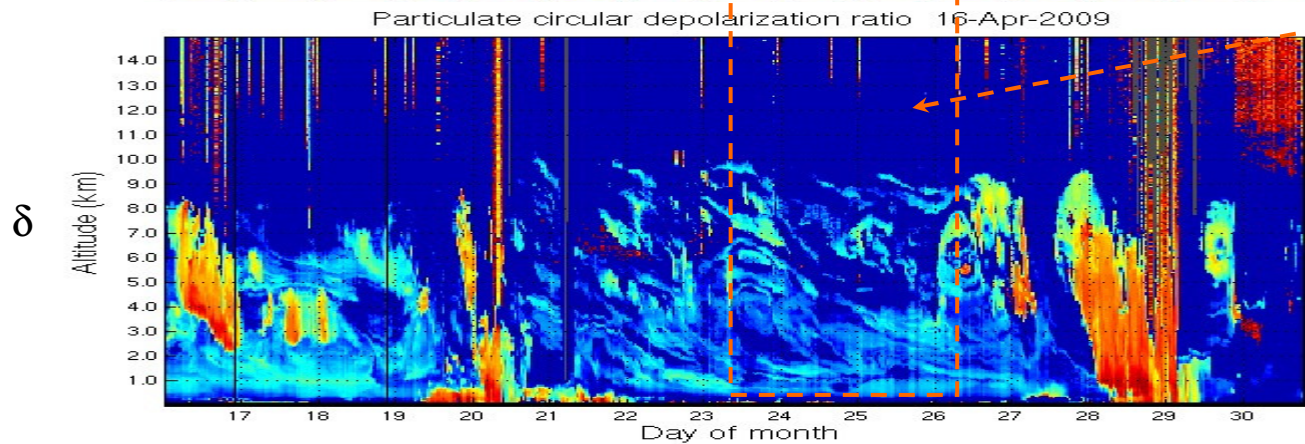
Coarse mode event at PEARL (Artifacts)



Suspicious coarse mode peaks possibly due to frost in the Cimel optics.



AHSRL does not show any coarse mode event

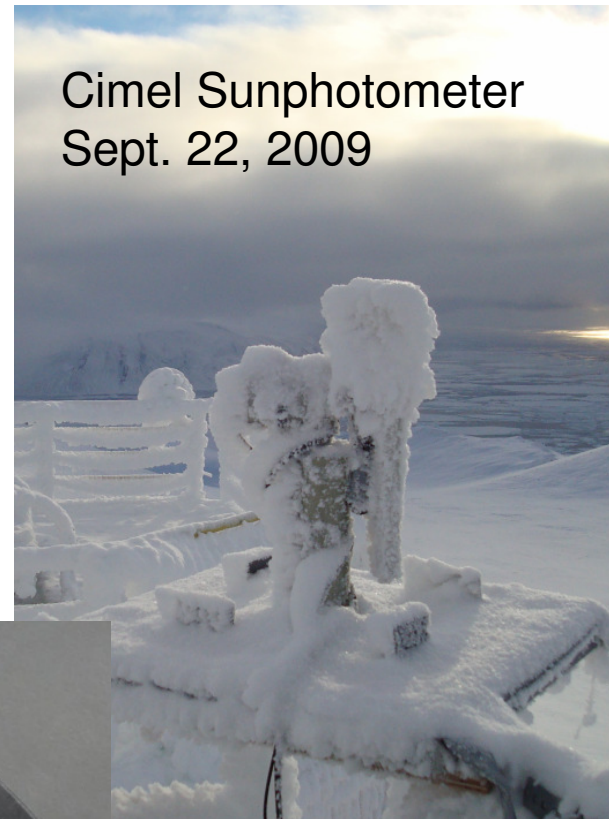


Frost Issues

Cimel Sunphotometer
Sept. 9, 2011



Cimel Sunphotometer
Sept. 22, 2009

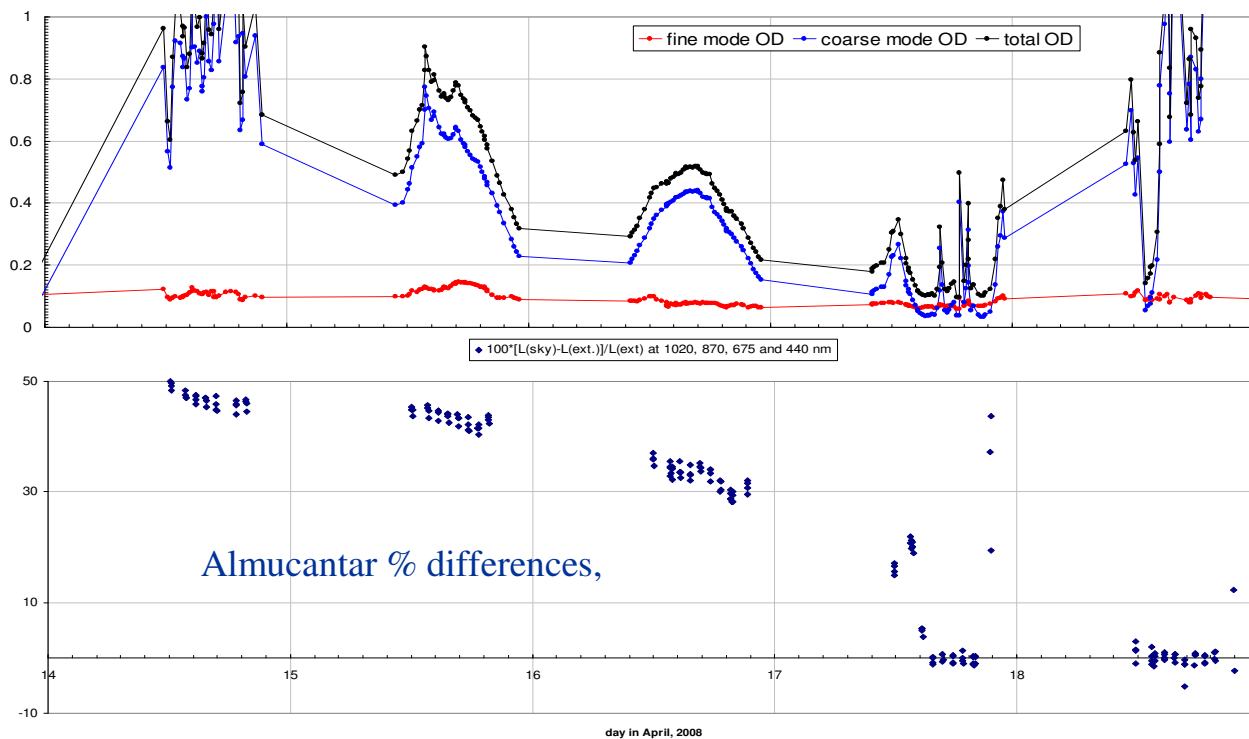


Star Photometer
Winter 2012

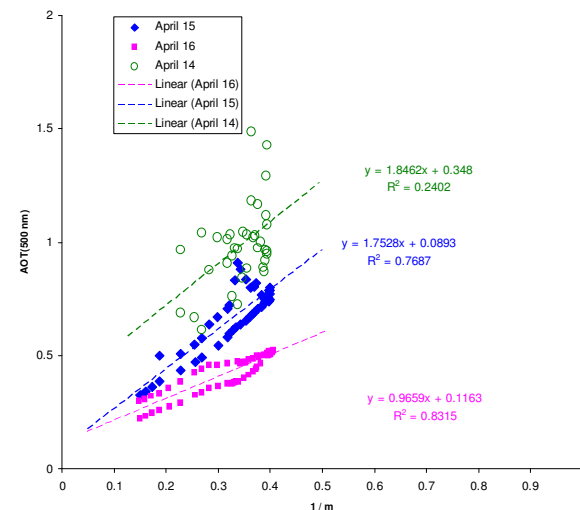


Coarse mode event at Thule (Artifacts)

April 2008

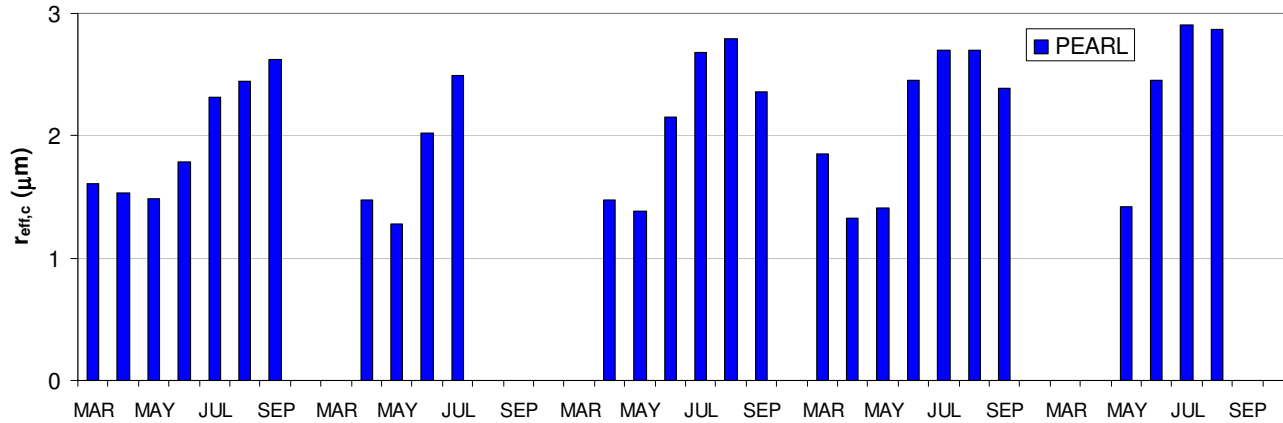


Almicantar radiance differences at 6° azimuth should agree within 5%.

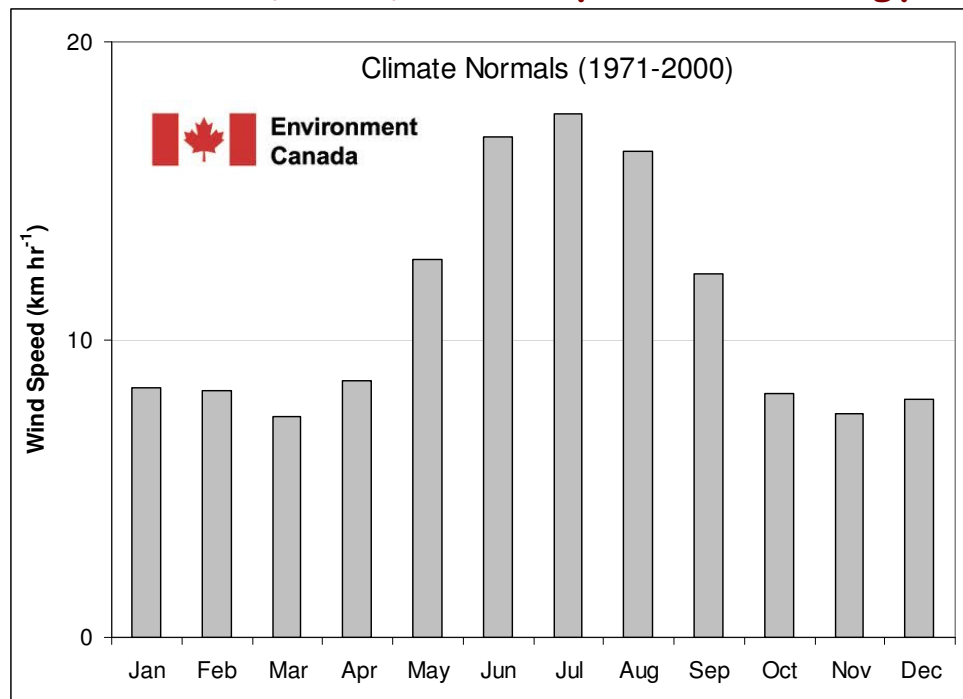


Computed AOT varies suspiciously as $1 / m$ (m - airmass)

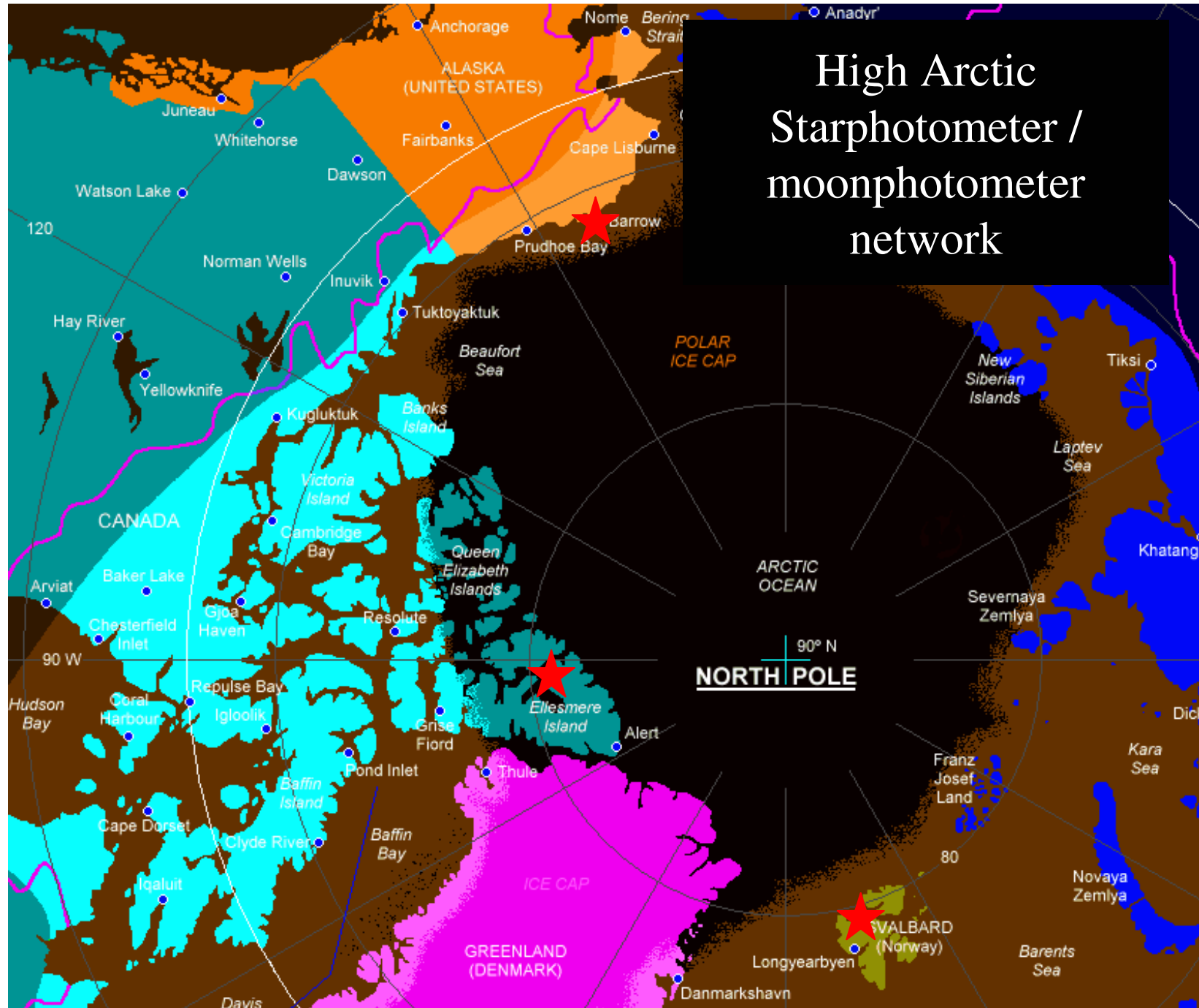
Coarse Mode Retrievals vs Wind speed (Eureka)



Eureka (OPAL) Wind Speed Climatology



High Arctic Starphotometer / moonphotometer network



Summary & Conclusions

A multi-year AOD and effective radius climatology for the high Arctic showed a number of consistent features:

- ❖ Spring to summer decrease of fine-mode AOD (probably attributable to biomass burning and/or anthropogenic pollution).
- ❖ Significant correlation of fine mode AOD with CO concentration (which indicates a predominance of biomass burning aerosols throughout the entire year).
- ❖ West to east decrease in AOD on a pan-Arctic scale.

Acknowledgements



Canada Foundation for Innovation
Fondation canadienne pour l'innovation



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and Atmospheric Sciences (CFCAS)
Fondation canadienne pour les sciences
du climat et de l'atmosphère (FCSCA)

Fonds de recherche
sur la nature
et les technologies

Québec 



CANDAC
Canadian Network for the Detection of Atmospheric Change 



High Arctic research station forced to close

PEARL played a key role in ozone measurements, international collaborations

CBC News Posted: Feb 28, 2012 2:29 PM ET | Last Updated: Feb 28, 2012 4:14 PM ET 477



Arctic lab shuts down 2:14

Canada's northernmost research laboratory is shutting down due to lack of funding.

The Polar Environment Atmospheric Research Laboratory (PEARL) in Eureka, Nunavut, which made key measurements last winter used to detect and analyze the largest ozone hole ever detected over the Arctic, will cease year-round

operations on April 30. At that time, its equipment will be removed and the building will remain available only for intermittent, short-term projects.

"When you run out of money, there's no alternative but to close the lab," Jim Drummond, a Dalhousie University researcher who is the principal investigator for PEARL, said Tuesday.

The station has been tracking ozone depletion, air quality and climate change in the High Arctic since 2005. But the Canadian Network for Detection of Atmospheric Change, an informal network of university researchers that runs the station, hasn't been able to secure the \$1.5 million annual funding required to continue running the station all year round.



The Polar Environment Atmospheric Research Laboratory is located at Eureka, Nunavut on Ellesmere Island, at a latitude of 80 degrees north. (CANDAC)



Thanks for your attention!