Comparison of Aerosol Absorption Optical Depth from In-situ and Remote-sensing Measurements

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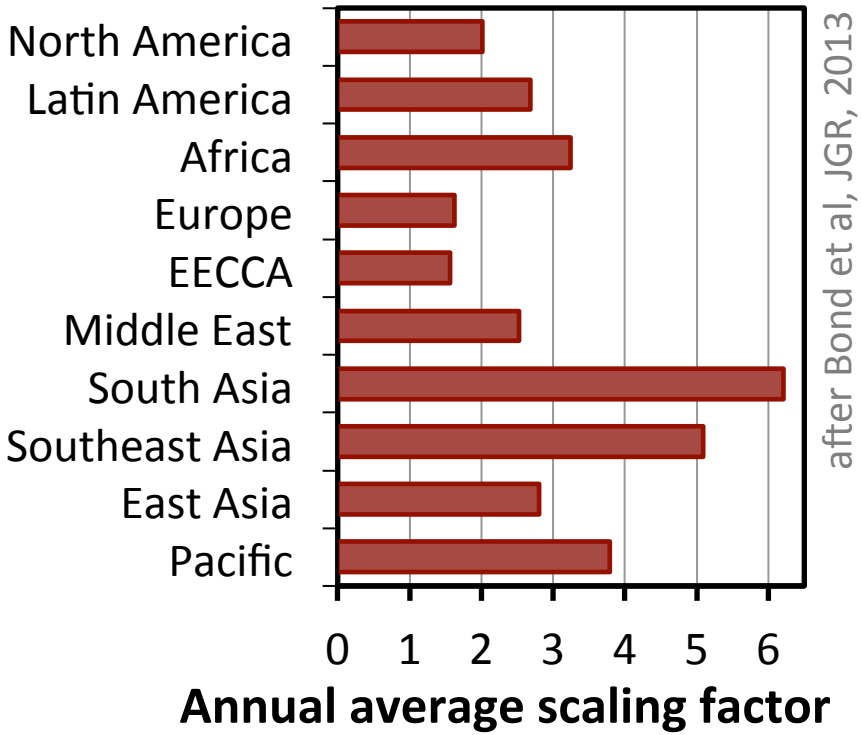
Are Model Estimates of AAOD too Low?

Bounding BC Assessment (Bond et al., JGR, 2013)

- BC assessed as #2 global-average warming species (+1.1 W m^{-2}, 90% bounds +0.17 to +2.1 W m^{-2})
- *"The AeroCom BC-AAOD values do not agree with the AERONET retrievals, so the BC-AAOD distribution from AeroCom is scaled to agree with the AERONET retrievals"*



- Global-average scaling factor was 2.5, varied by region

How do the AERONET AAOD retrievals compare with *in-situ* measurements?

Measurement Methods and Data

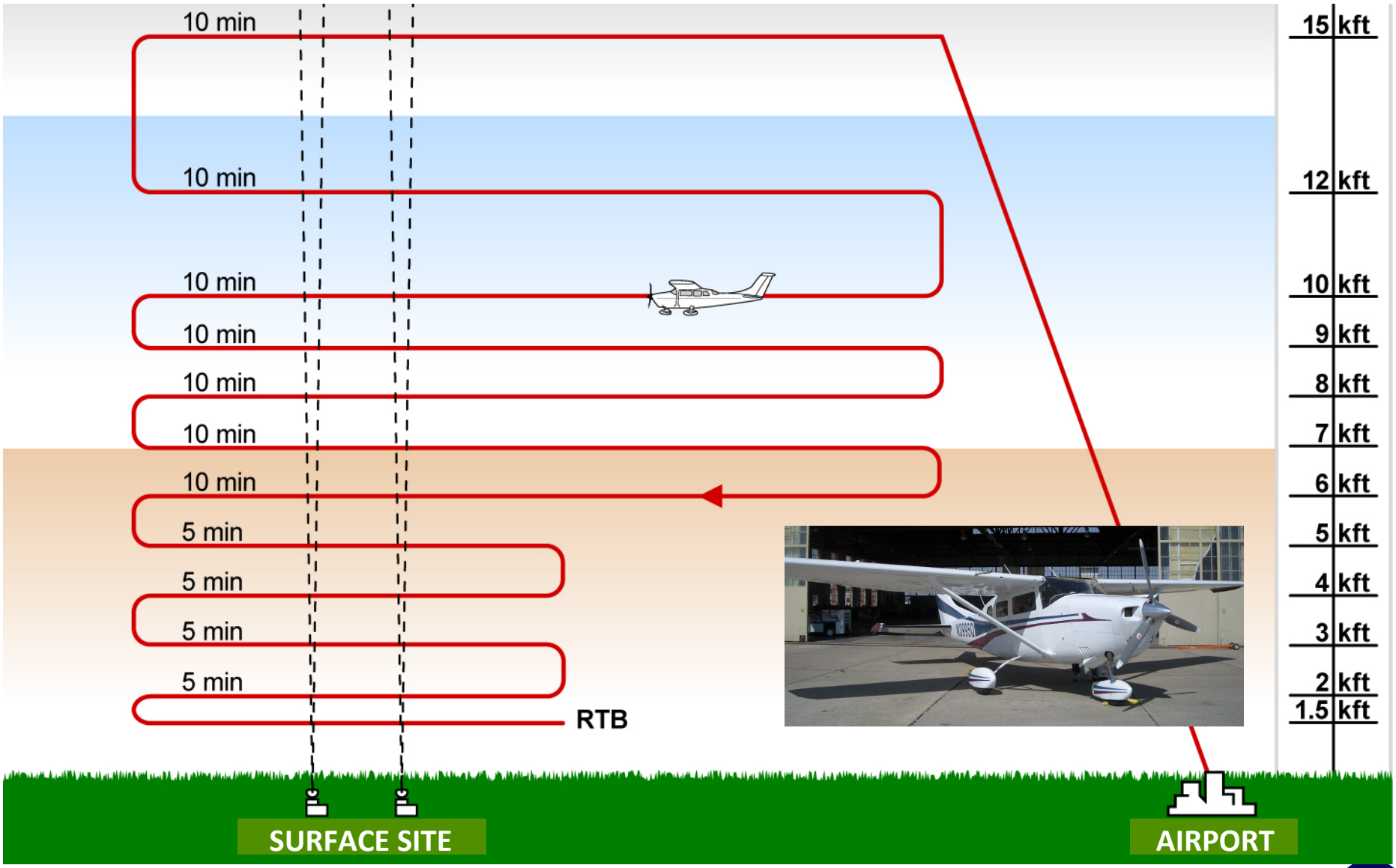
AERONET

- CIMEL sun/sky radiometer at Bondville (BND) and Southern Great Plains (SGP)
- Level 1.5 retrievals of single-scattering albedo were combined with Level 2.0 retrievals of AOD to derive AAOD (same procedure as used in Bond et al., 2013)
- Measurement wavelengths ca. 440 and 670 nm

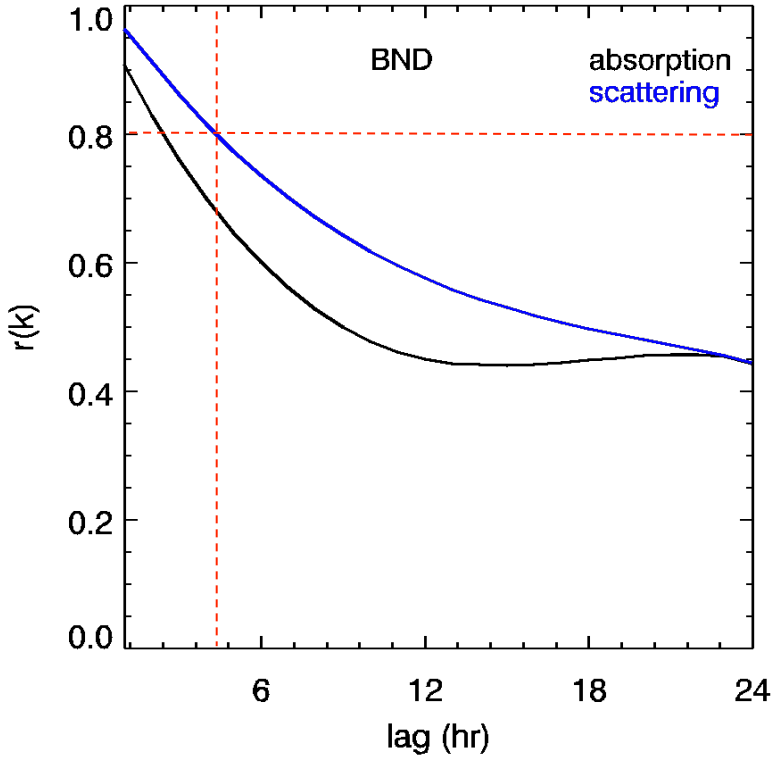
In-situ

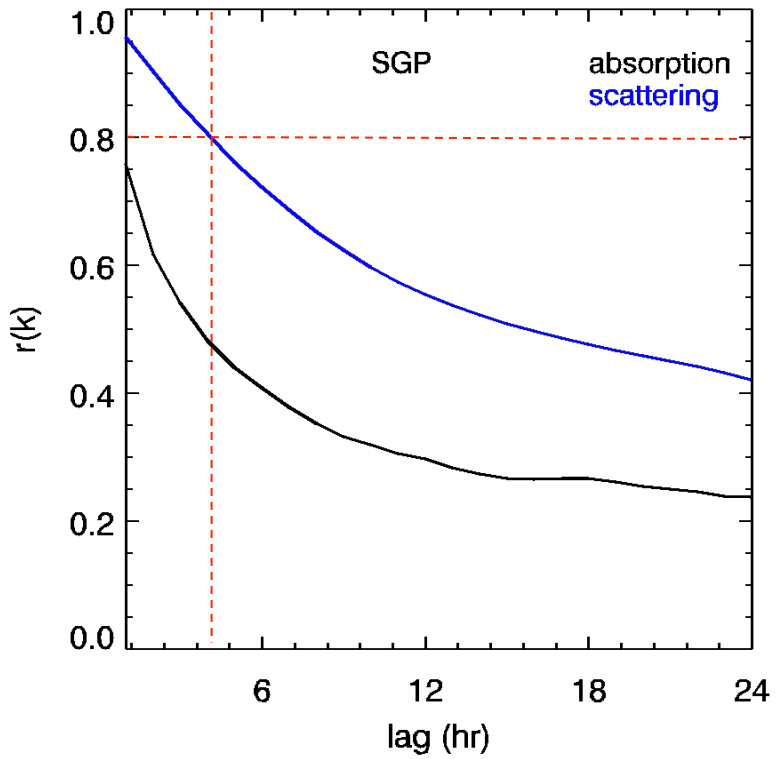
- Cessna 206 airplane sampled particles with D<7μm
- 401 flights at BND (2006-2009), 302 at SGP (2005-2007)
- Particle-Soot Absorption Photometer measured light absorption coefficient at low RH
- Integrating nephelometer measured light scattering, adjusted to ambient RH
- Measurement wavelengths 467 and 660 nm (PSAP) and 450 and 700 nm (Neph), adjusted to 440 and 670 nm

Flight Profile



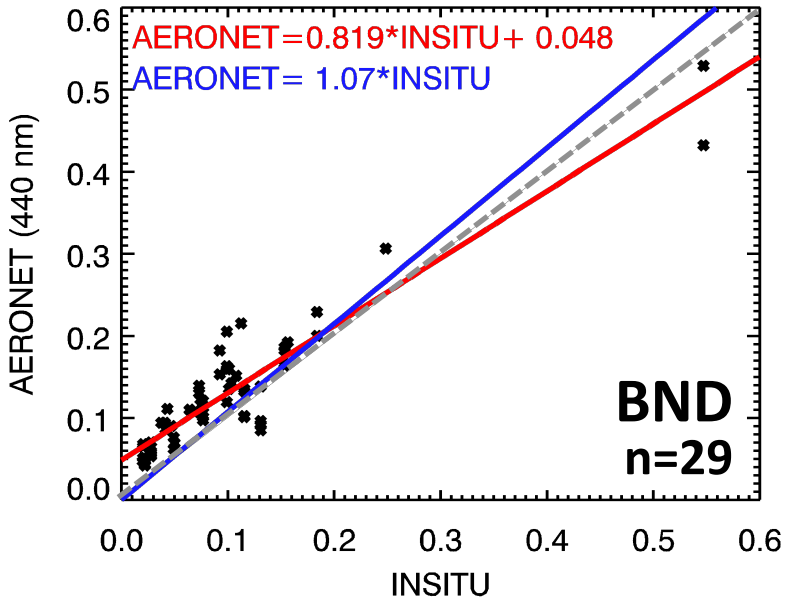
How close do measurement times need to be?

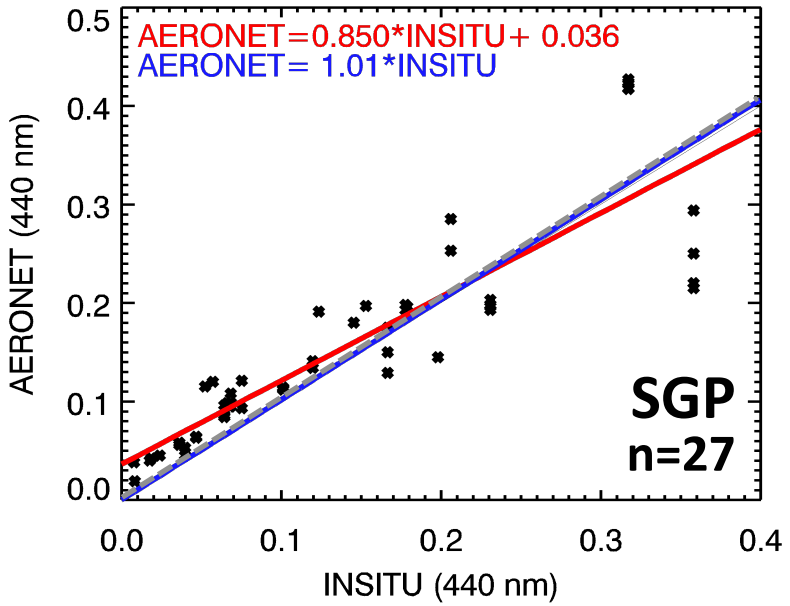




- Lag-autocorrelation analysis of surface measurements determines time window
- Scattering well correlated (r(k)>0.8) out to 4-5 hr lag
- Absorption less correlated than scattering.
- AERONET vs. in-situ comparison time window chosen as 3-hr based on this analysis

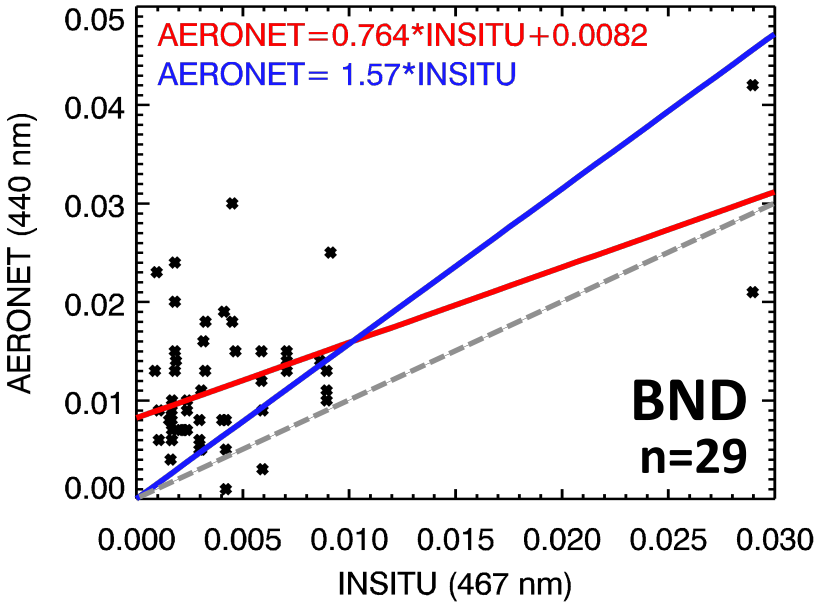
AOD Comparison

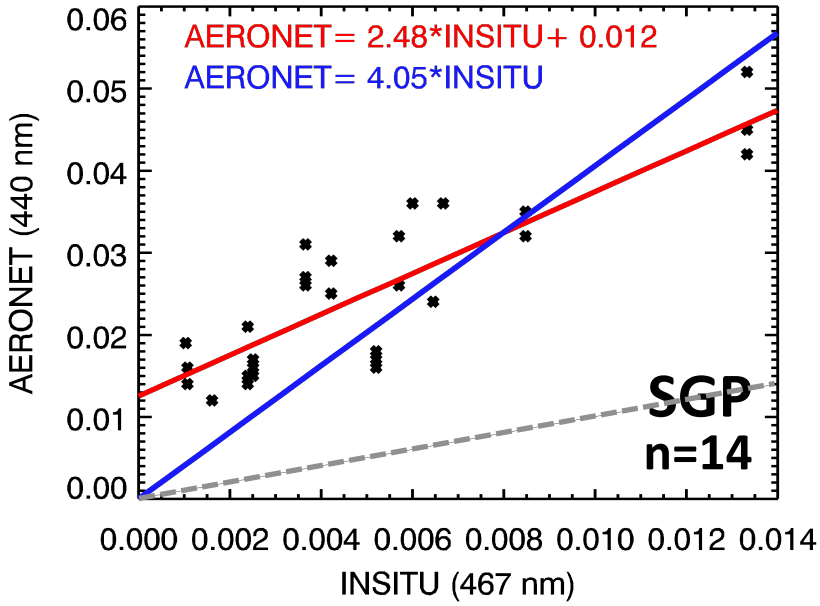




- **Similar results for red and blue wavelengths**
- **Good agreement (ca. 10%) between AERONET and in-situ measurements of aerosol extinction**

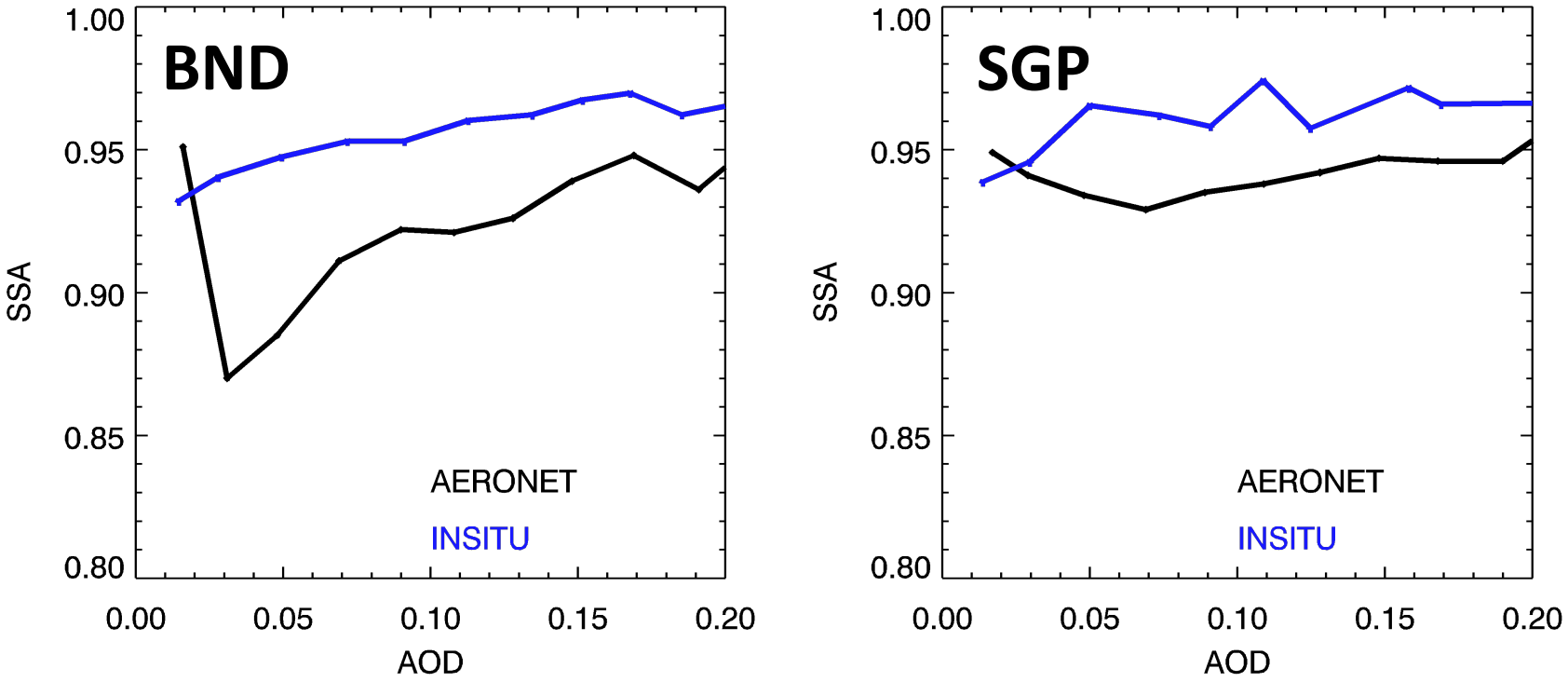
AAOD Comparison





- **Similar results for red and blue wavelengths**
- **AERONET results significantly greater than in-situ**
- **Poorer correlation than for AOD, especially at BND**

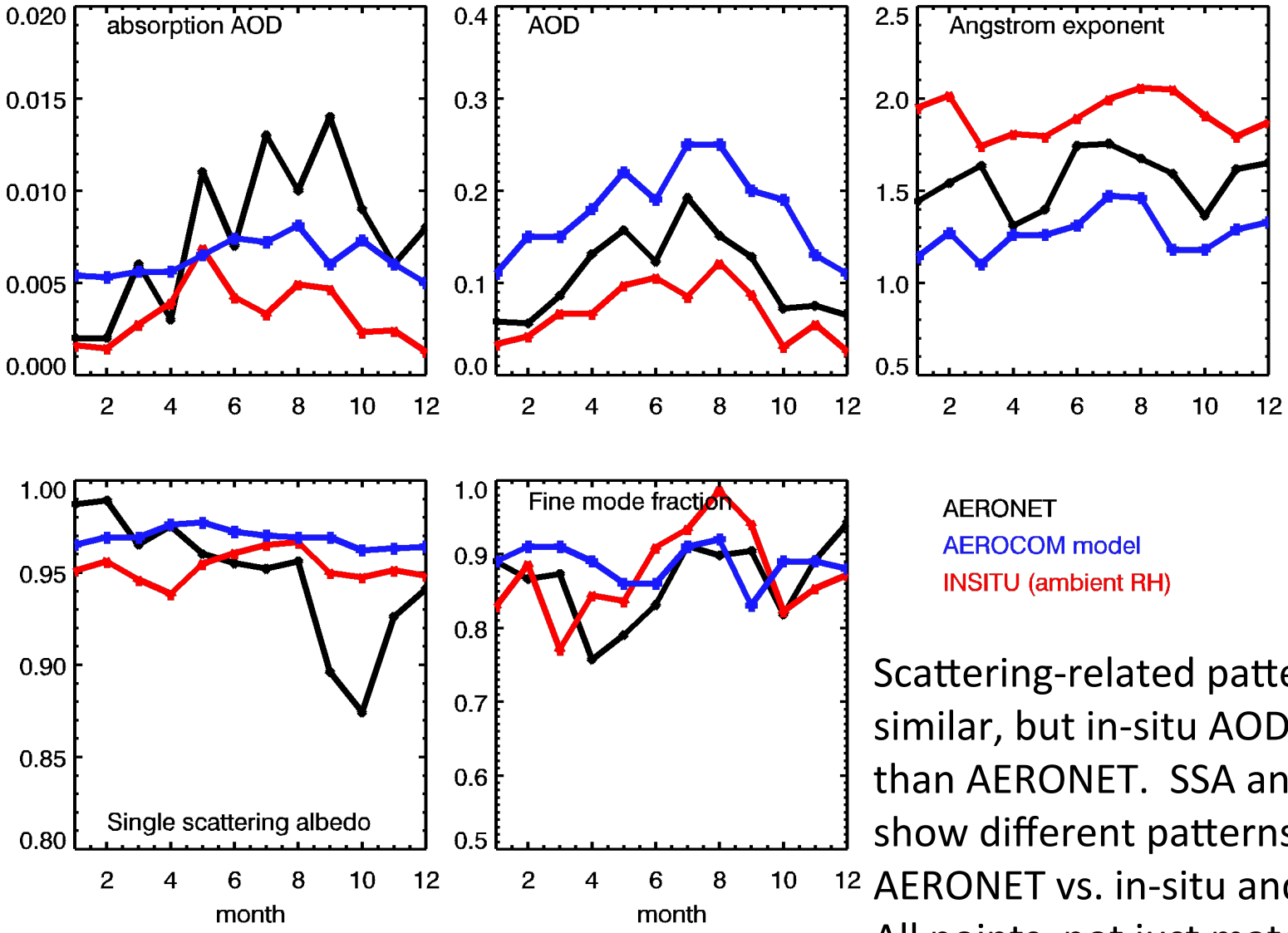
Dependence of SSA on AOD (670 nm)



Comparisons show similar patterns, except

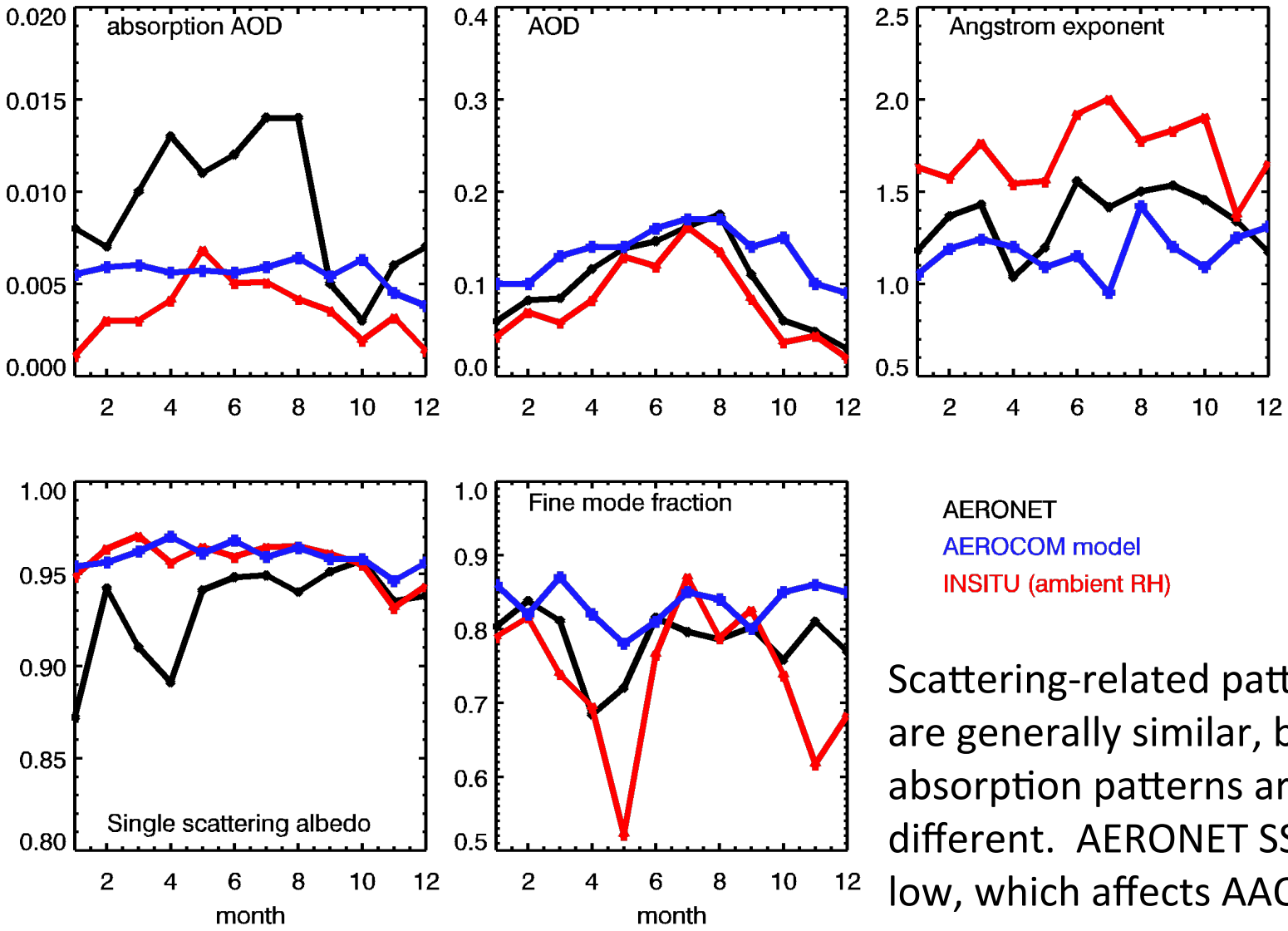
- **AERONET SSA values are lower**
- **AERONET SSA values at the lowest AOD values diverge**
  - Problem with retrievals in cleanest conditions?

Comparison with AeroCom (BND)



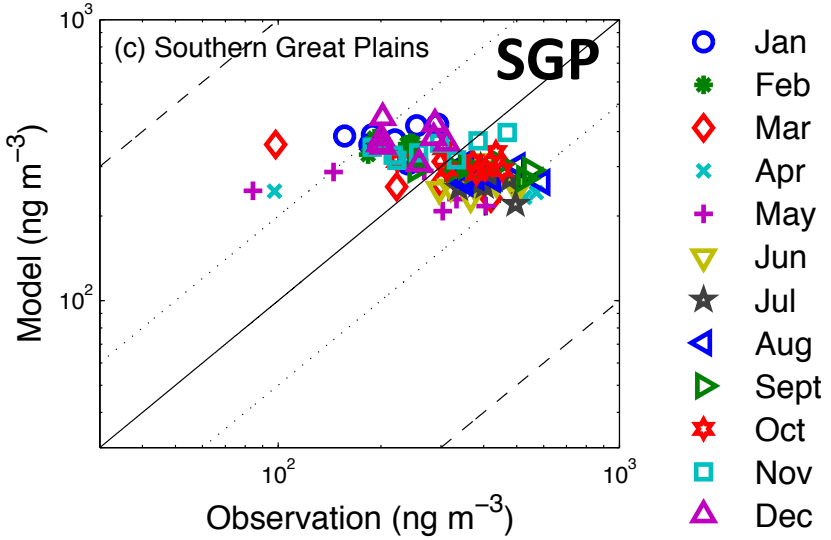
Scattering-related patterns are similar, but in-situ AOD is lower than AERONET. SSA and AAOD show different patterns for AERONET vs. in-situ and model. All points, not just match-ups.

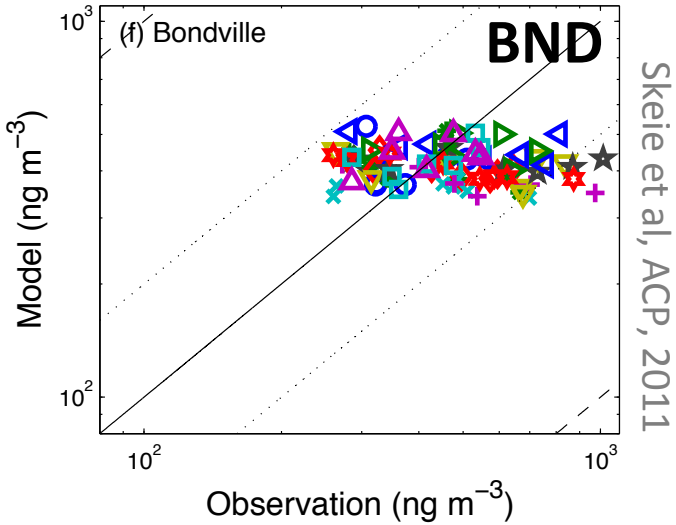
Comparison with AeroCom (SGP)



Scattering-related patterns are generally similar, but absorption patterns are different. AERONET SSA is low, which affects AAOD.

In-situ vs. modelled EBC at surface





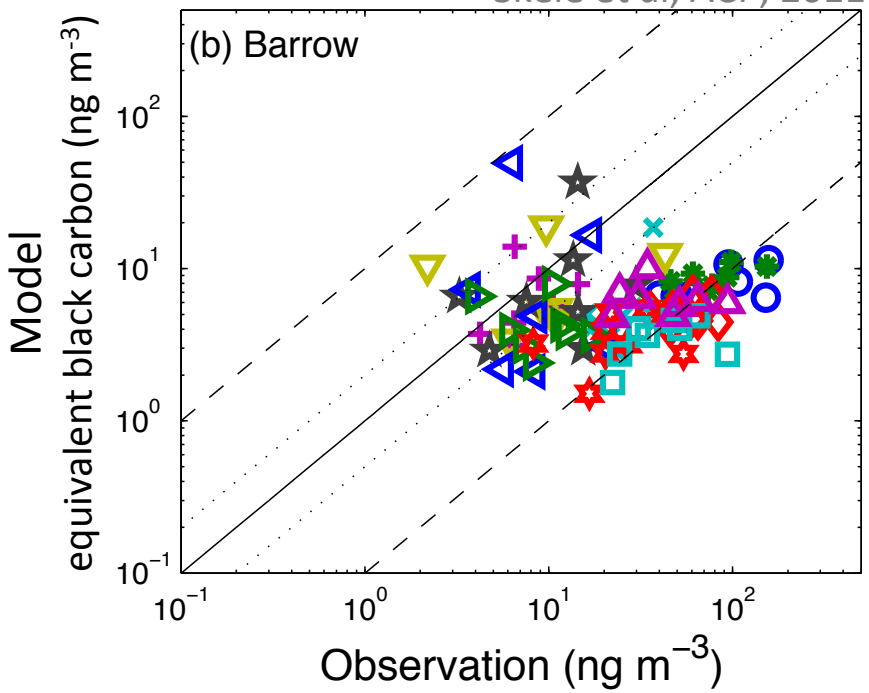
Skeie et al, ACP, 2011

- **Oslo CTM2 model (Skeie et al., 2011)**
- **Model does not show a pronounced low bias when compared to in-situ measurements**
- **Model shows much lower range of values**
- **Note the log-scales**

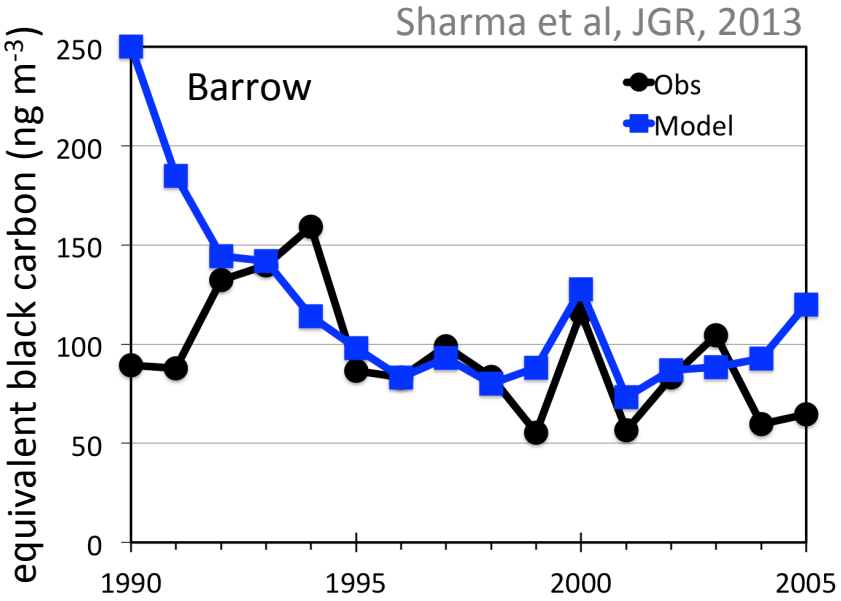
Need to repeat for other sites/models

NIES (Canada) model ⇒ reproduces long-term, wintertime-average trend at Barrow

Skeie et al, ACP, 2011

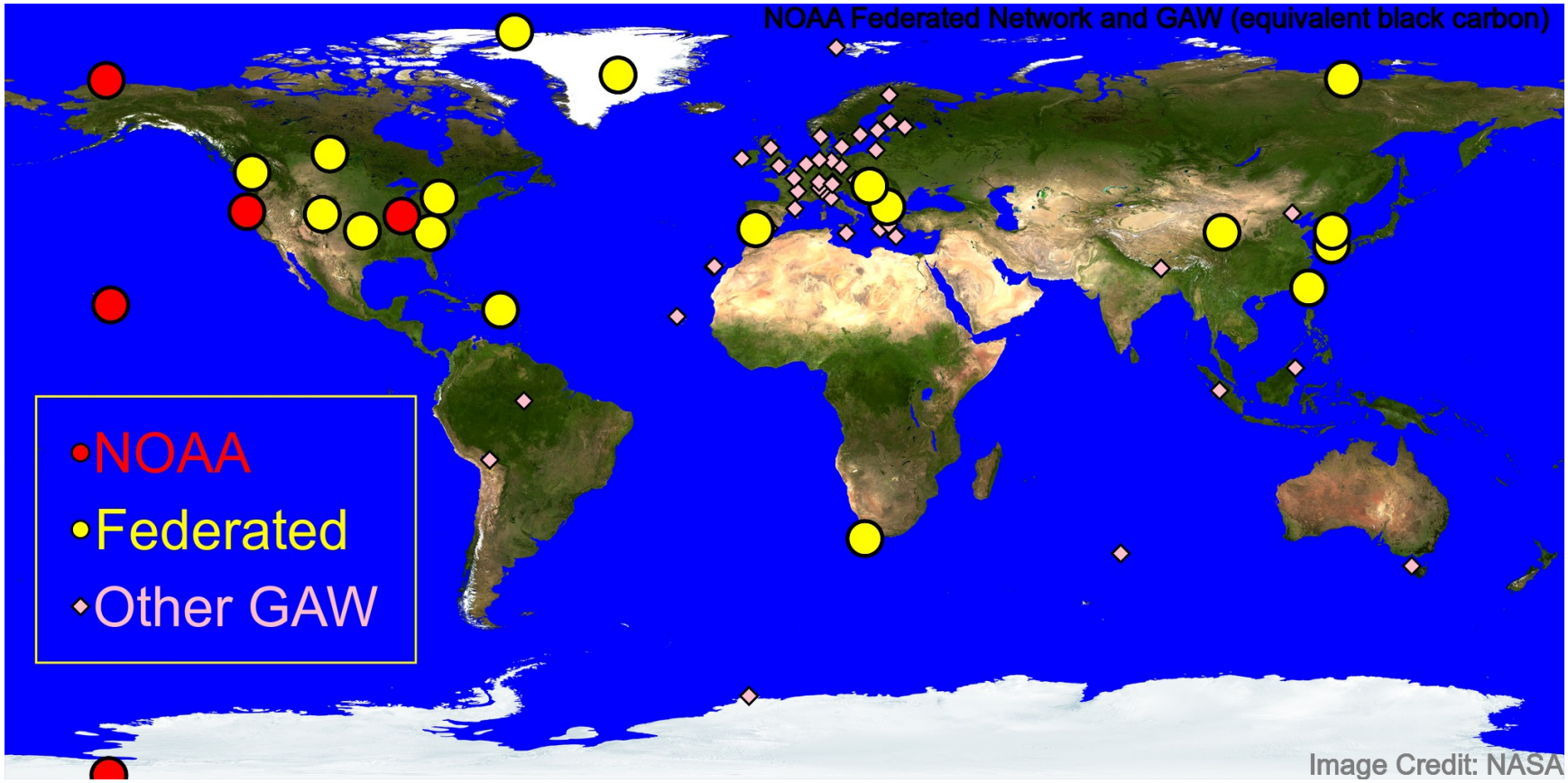


Sharma et al, JGR, 2013



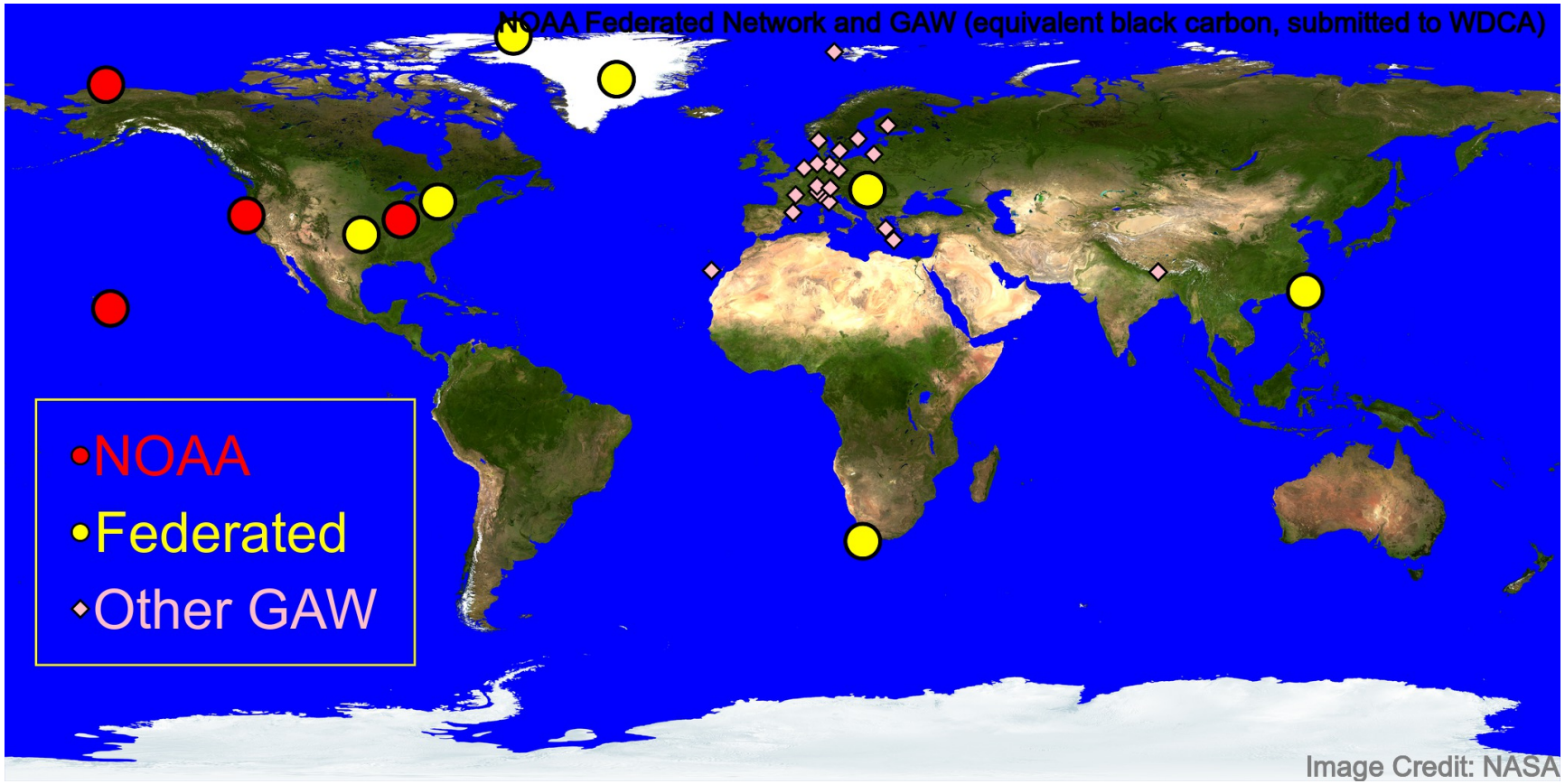
⇐ Oslo CTM2 model is biased low and has less variability than observations (monthly averages, 2001-2008)

Surface EBC Monitoring Sites



Sites shown are listed in GAWSIS as measuring "black carbon" or light absorption coefficient

Surface EBC Data Providers



Sites shown are listed in WDCA as submitting "black carbon" or light absorption coefficient data (pre-2012)

Conclusions

- **In-situ measurements do not provide support for up-scaling of modelled aerosol absorption optical depth to agree with AERONET measurements at two U.S. continental sites**
- **Surface measurements of equivalent black carbon provide an independent data set for evaluating whether the AEROCOM models systematically underestimate black carbon**

Acknowledgements

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