Comparison of Model Predictions of Aerosol Radiative Properties with Long-Term Measurements: Effect of Cloud Processing

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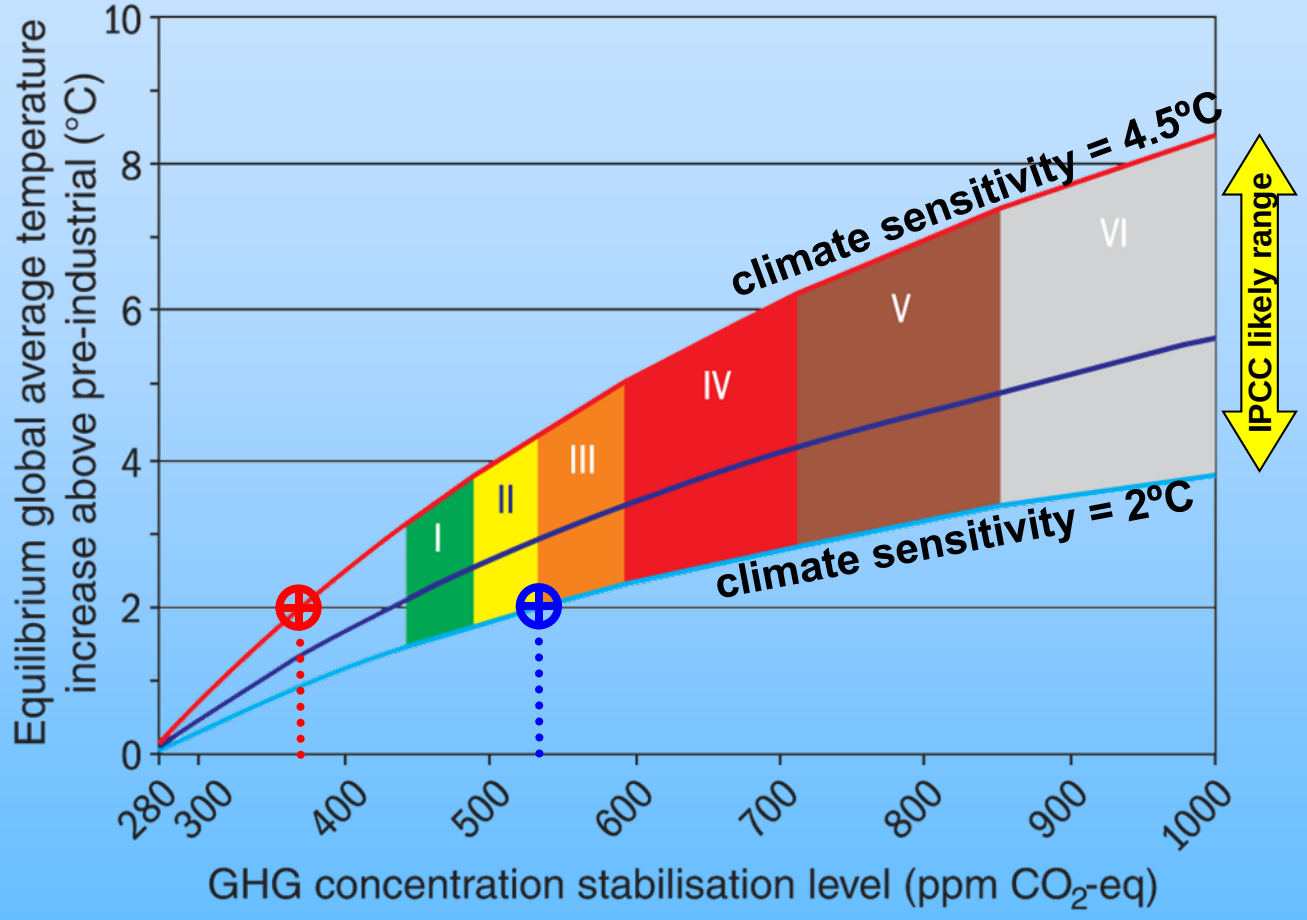
Aerosol forcing is large and uncertain

QuickTime™ and a
decompressor
are needed to see this picture.

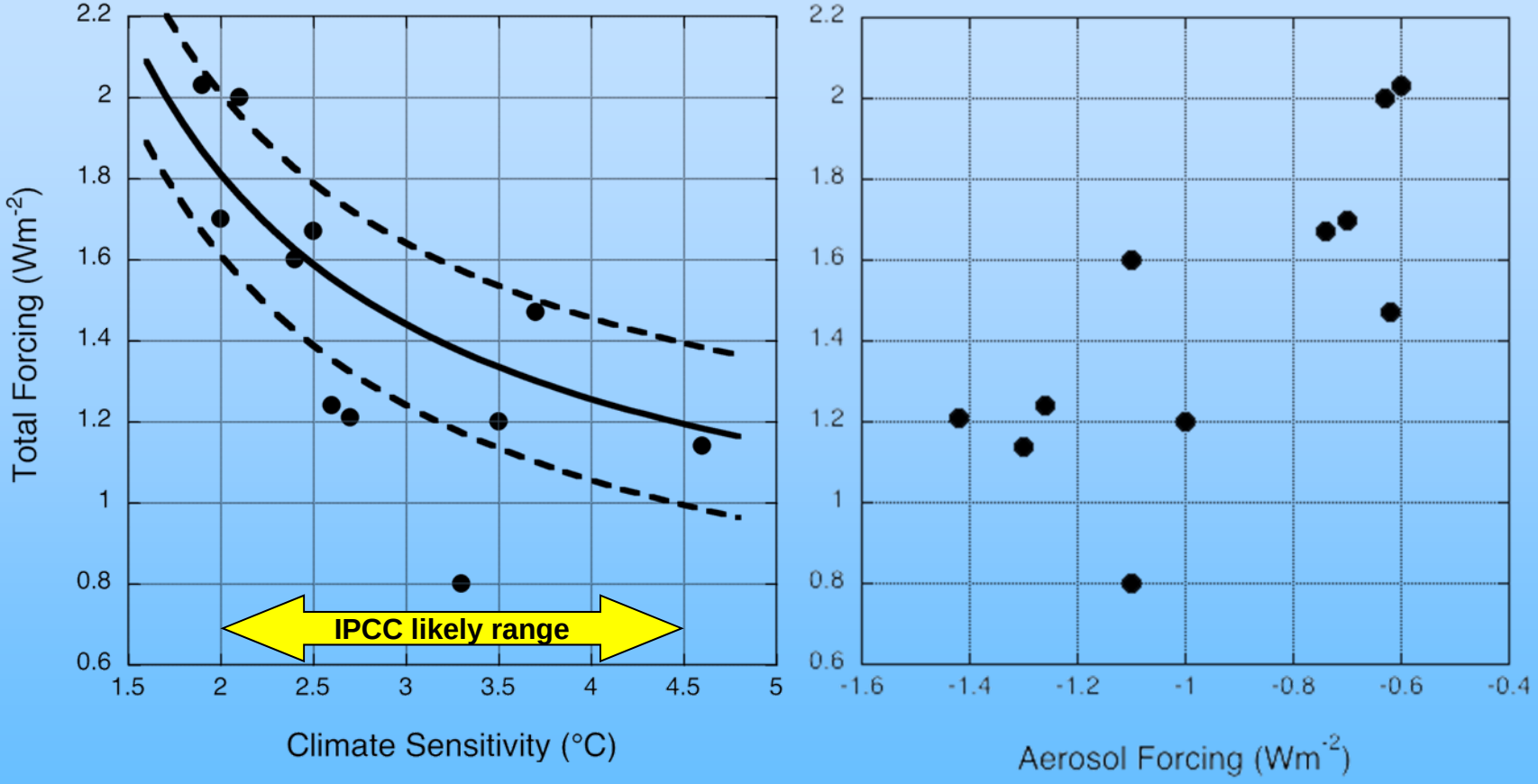
Source: IPCC (2007)

Climate sensitivity is a key uncertainty for mitigation scenarios



Limiting global warming to 2ºC requires GHG stabilization levels of 533 and 371 ppm at the lower and upper bounds of "likely" values of climate sensitivity. Source: IPCC (2007) Synthesis Report, Fig. SPM.11.

Reducing uncertainty of aerosol forcing will better constrain climate sensitivity

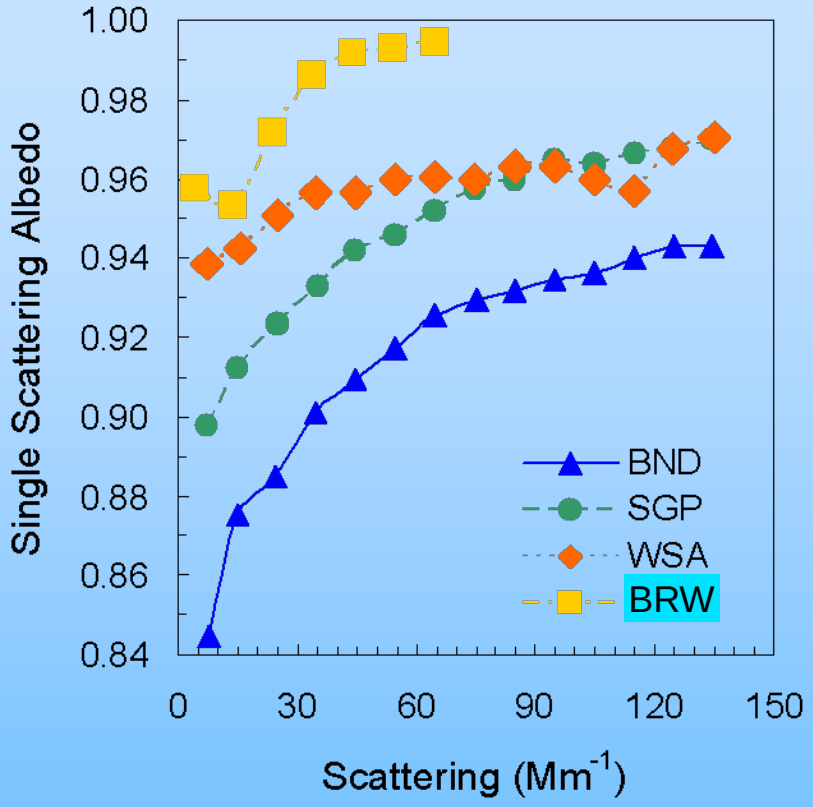


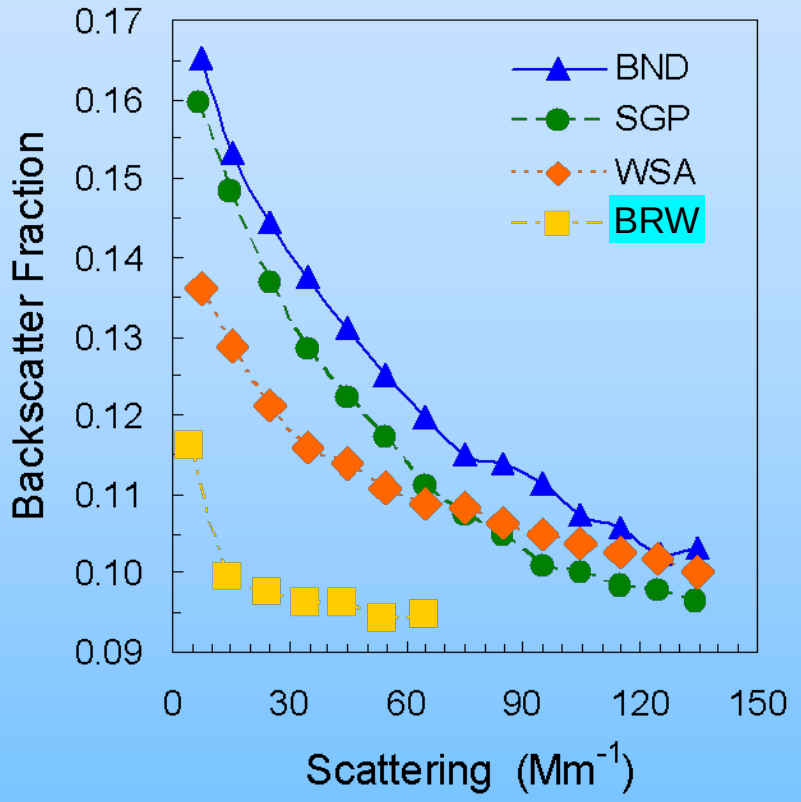
GCMs with lowest climate sensitivity have largest total forcing and least aerosol cooling. Source: Kiehl (GRL, 2007)

How Does Cloud Scavenging Affect Direct Aerosol Radiative Forcing?

- **Reduces aerosol amount**
- **Changes aerosol radiative properties**
  - single-scattering albedo (SSA) (light absorption vs. scattering)
  - angular scattering

Is Systematic Variability Related to Scavenging?

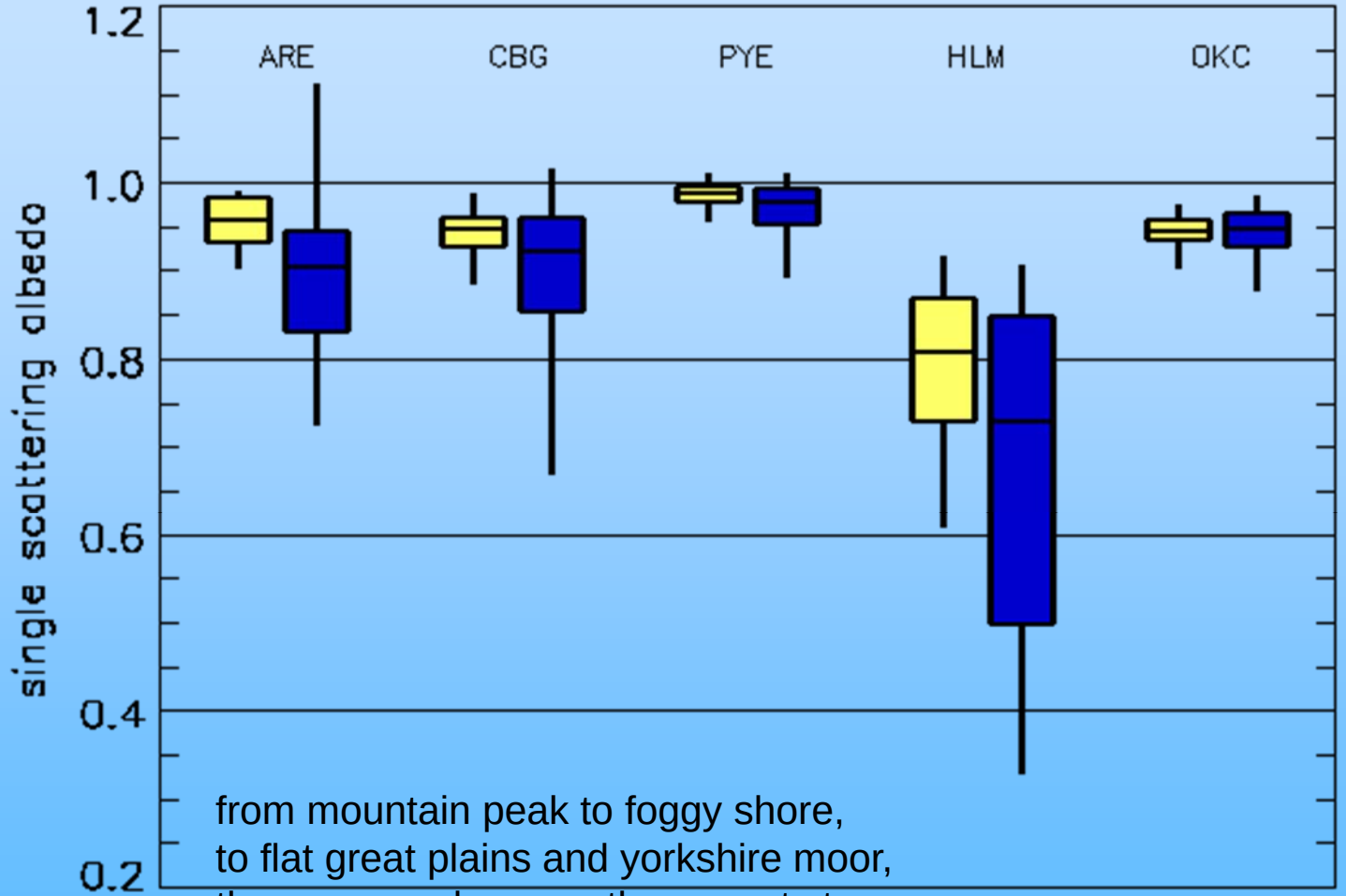


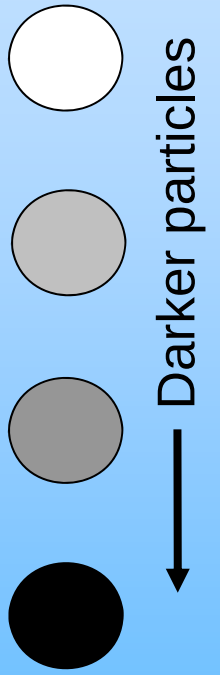


From Delene and Ogren, 2002

Long-term surface and aircraft data from a wide range of places show similar behavior: the lowest single-scattering albedos and highest backscatter fractions occur under the cleanest conditions for that site.

Effect of Scavenging on SSA





from mountain peak to foggy shore,
to flat great plains and yorkshire moor,
the scenery changes, the accents too,
but not the scavenging that clouds do.

E. Andrews

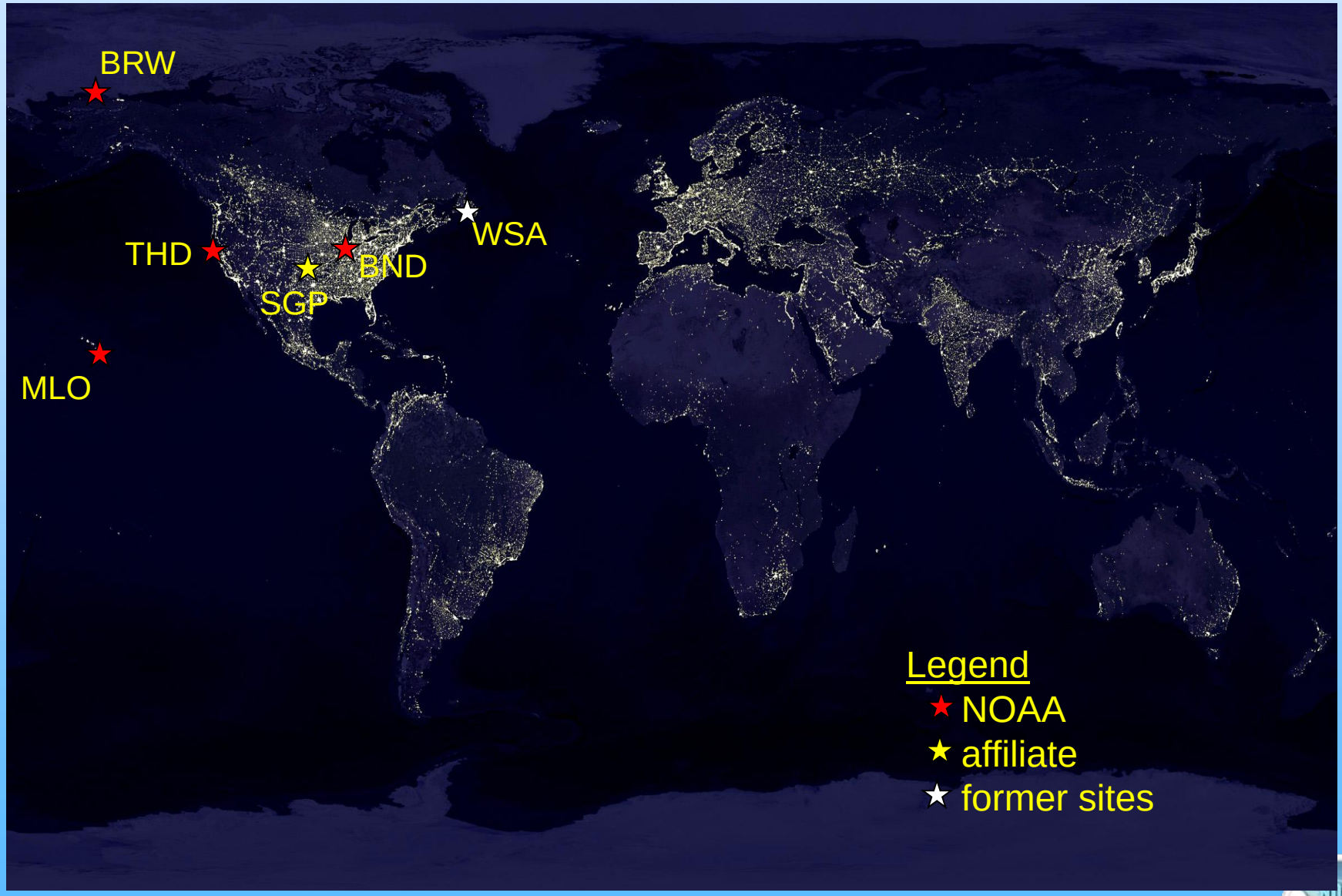
Clear

Interstitial

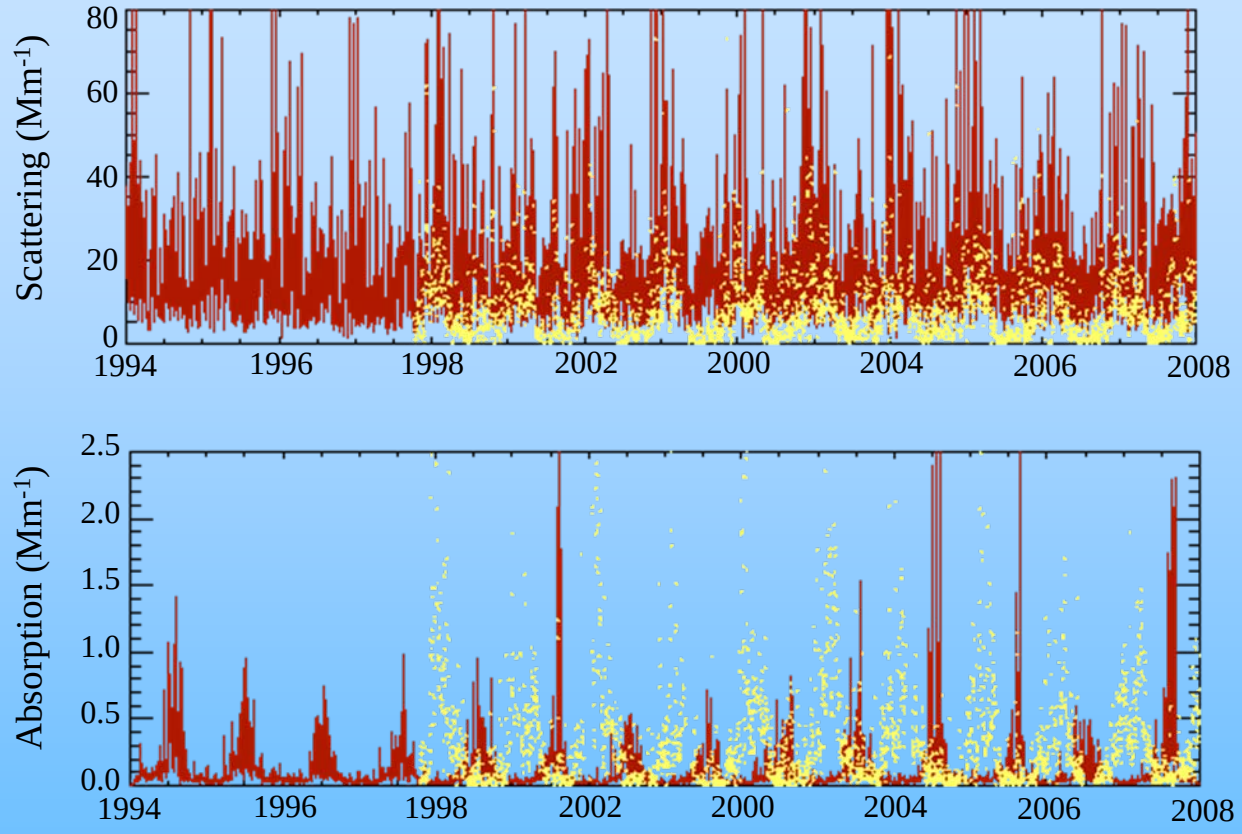
Model Overview

Model	NOAA/GFDL AM2	NASA/GSFC GOCART
Grid	2ºx2.5º grid, 24 vertical levels	2ºx2.5º grid, 30 vertical levels
Simulation	1994 - 2007	2000-2007
Meteorological fields	u, v, T, q nudged from NCEP re-analysis (6 hr relaxation time)	u, v, T, q from Goddard (GEOS DAS) assimilated fields
Aerosol species	sulfate, organic carbon, black carbon, dust, sea salt	same
Prescribed aerosol properties for each aerosol type	Size distribution, particle shape, refractive index. Hygroscopic growth, limited to 40% RH for comparison with data Optical properties from Mie theory	same

Long-term Aerosol Comparision Sites

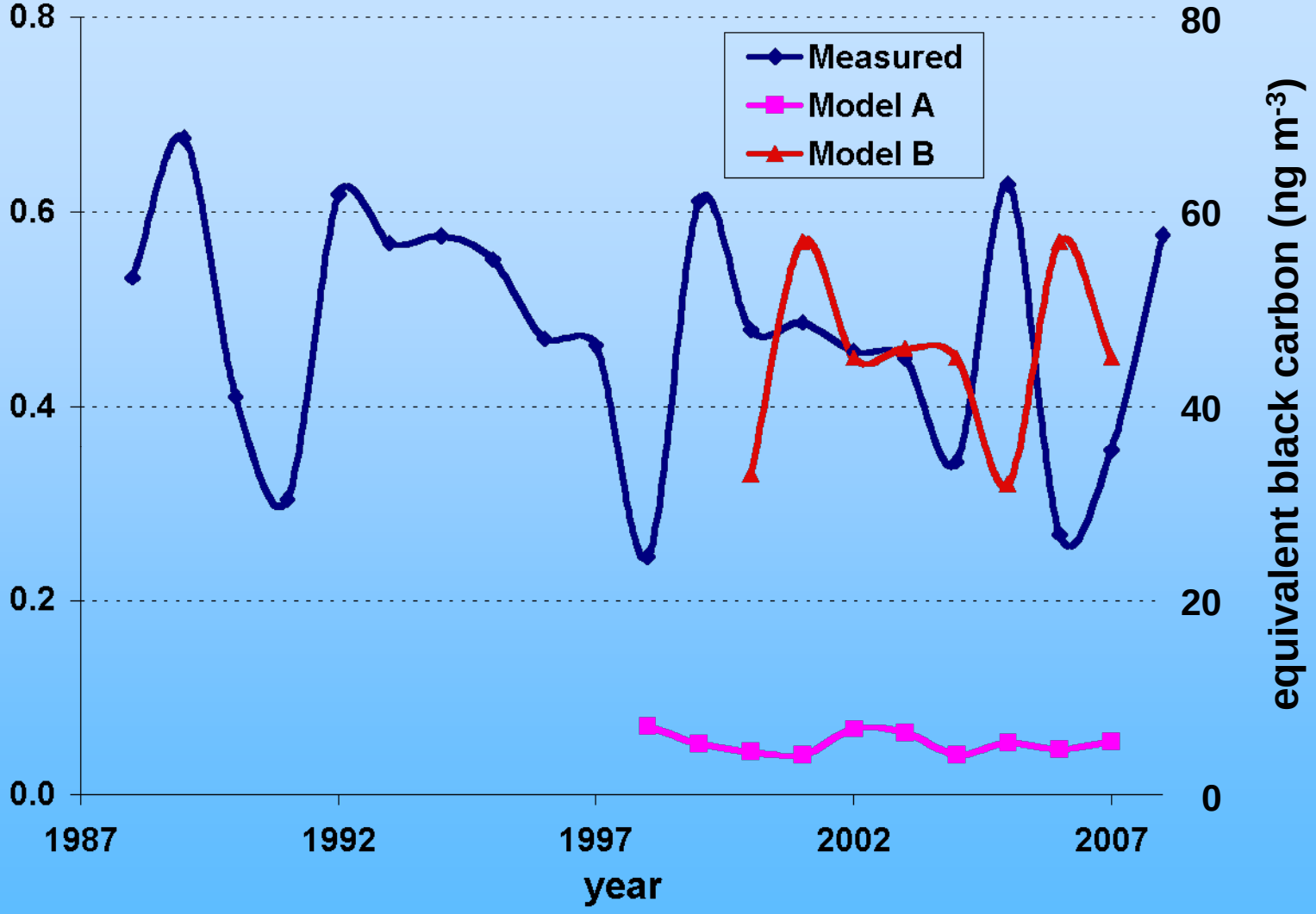


Time Series Comparison (Alaska)



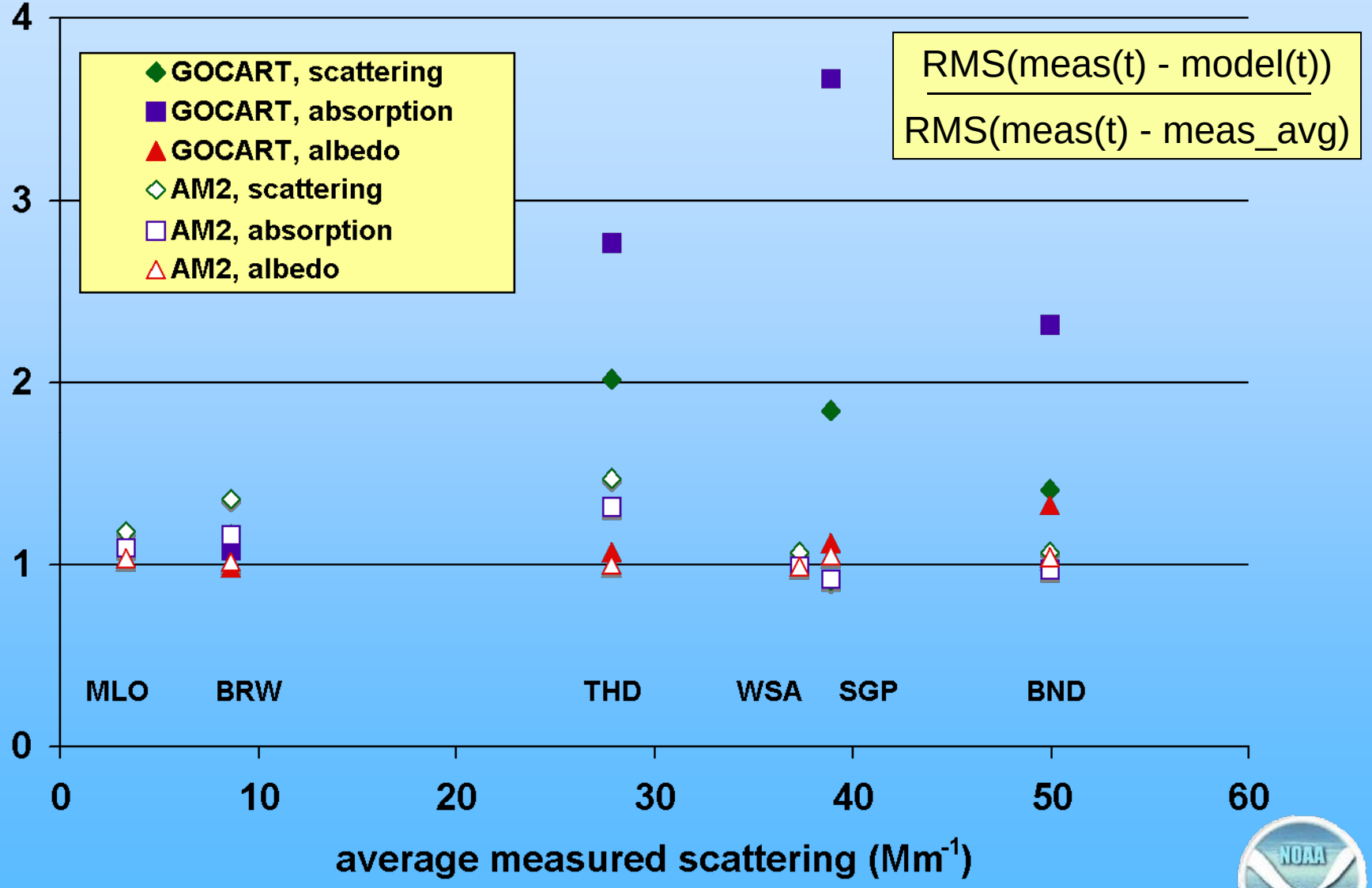
BRW time series – AM2 modelled and measured

Long-term Trend of Black Carbon in Arctic Haze at Barrow, Alaska

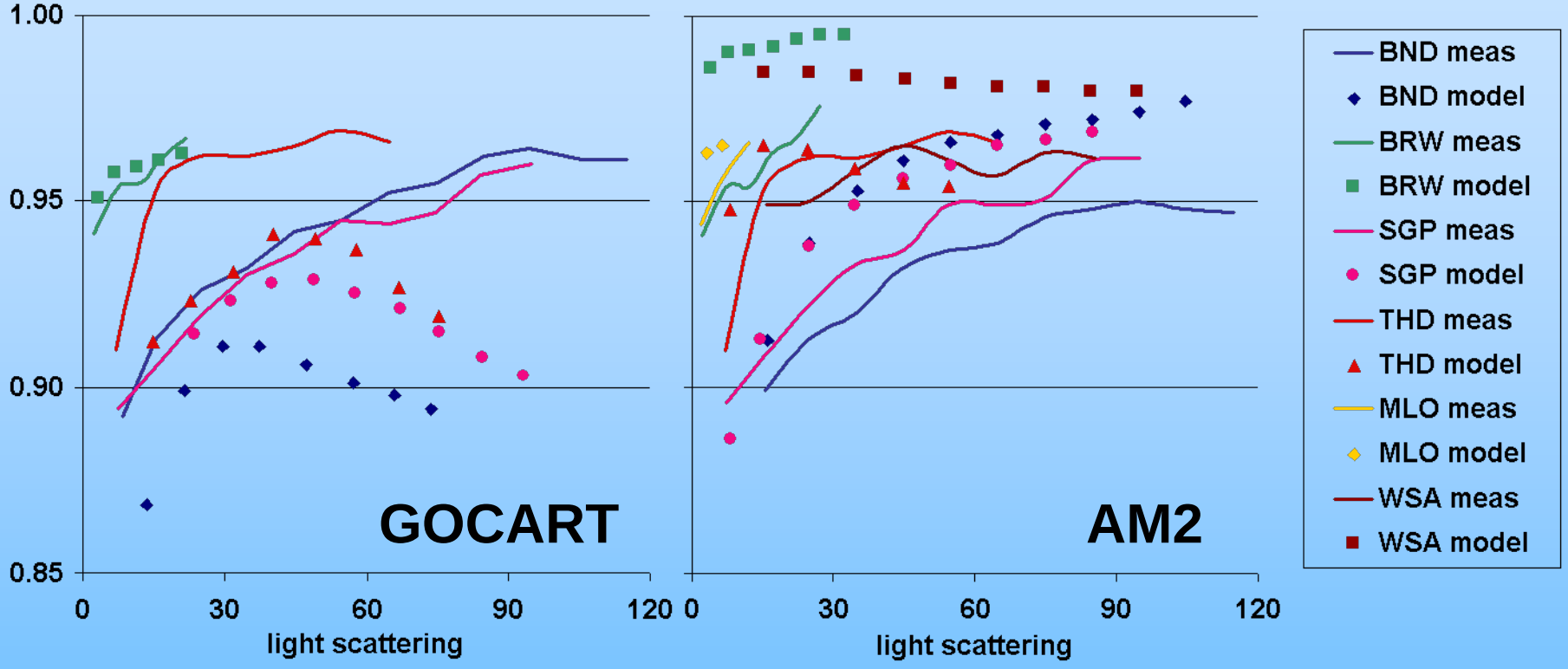


Parameter plotted is April-average aerosol light absorption coefficient at 550 nm

RMS Error for SSA is Comparable to Variability of Observed SSA



Modelled Systematic Variability of SSA

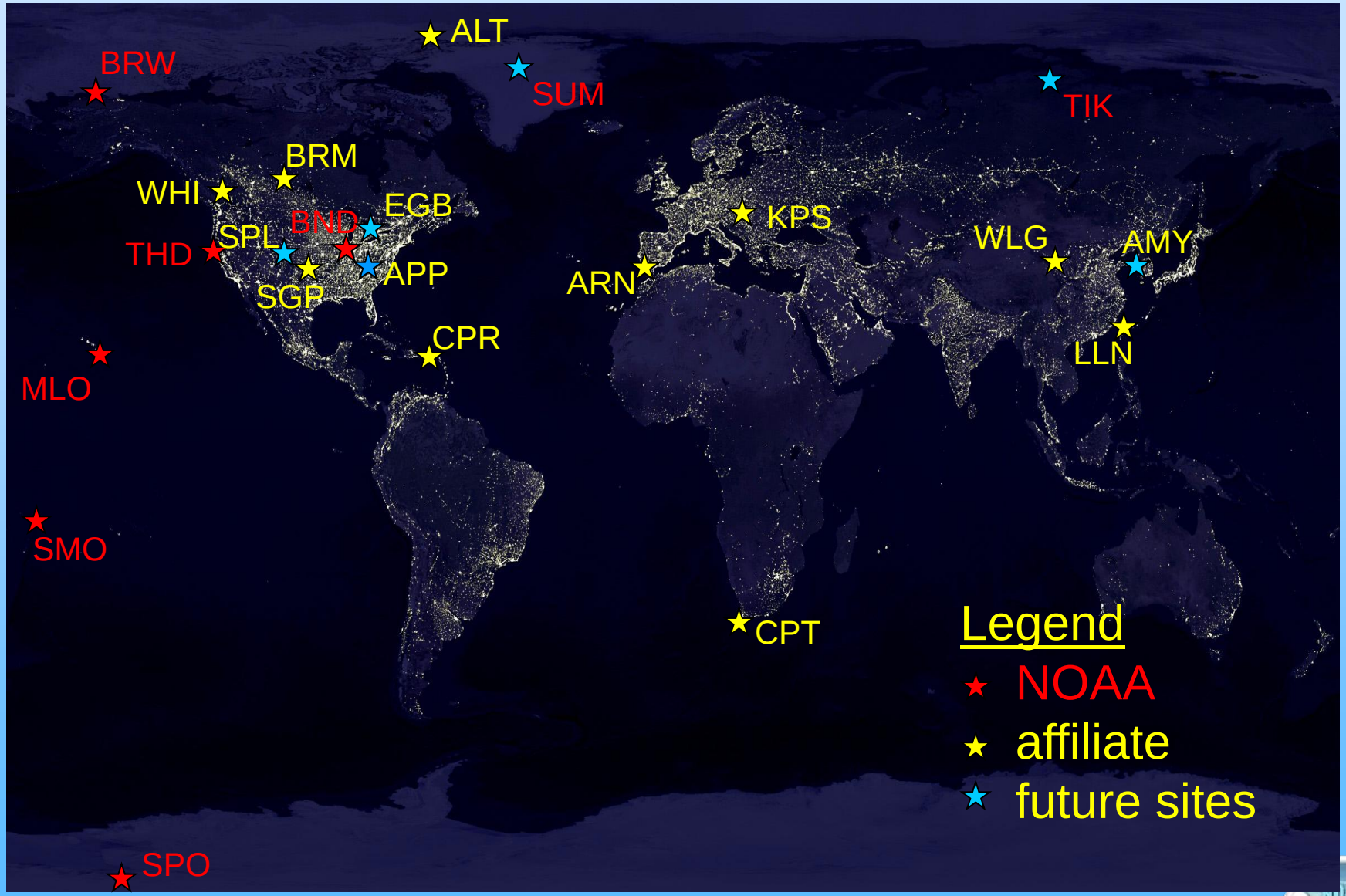


Modelled single-scattering albedo is generally higher than measured values. AM2 displays similar systematic dependence on light scattering at continental sites

Conclusions

- **Observations show that the darkest aerosols are found in the cleanest air, for a wide range of sites**
- **Models also suggest that the darkest aerosols are in the cleanest air, but…**
  - quantitative values are different
  - modelled relationships do not show the monotonic behavior that is observed
  - model error is comparable to or greater then the observed variability

NOAA-federated Long-term Aerosol Network



http://www.esrl.noaa.gov/gmd/aero/