Aerosol absorption working group

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AeroCom meeting October 26, 2007

Assessment of aerosol absorption in models?

We could do now, compare models with:

- **BC surface concentrations**

1) Sun and Bond BC/OC dataset?

3) SP2 BC aircraft measurements

4) AERONET AAOD

5) BC load from AERONET using Schuster et al. method

6) OMI AAOD estimates

More diagnostics needed:

7) Absorption from e.g. aetholometer measurements

8) AAOD at multiple wavelengths (550 and 1000 nm?)

Experimental:

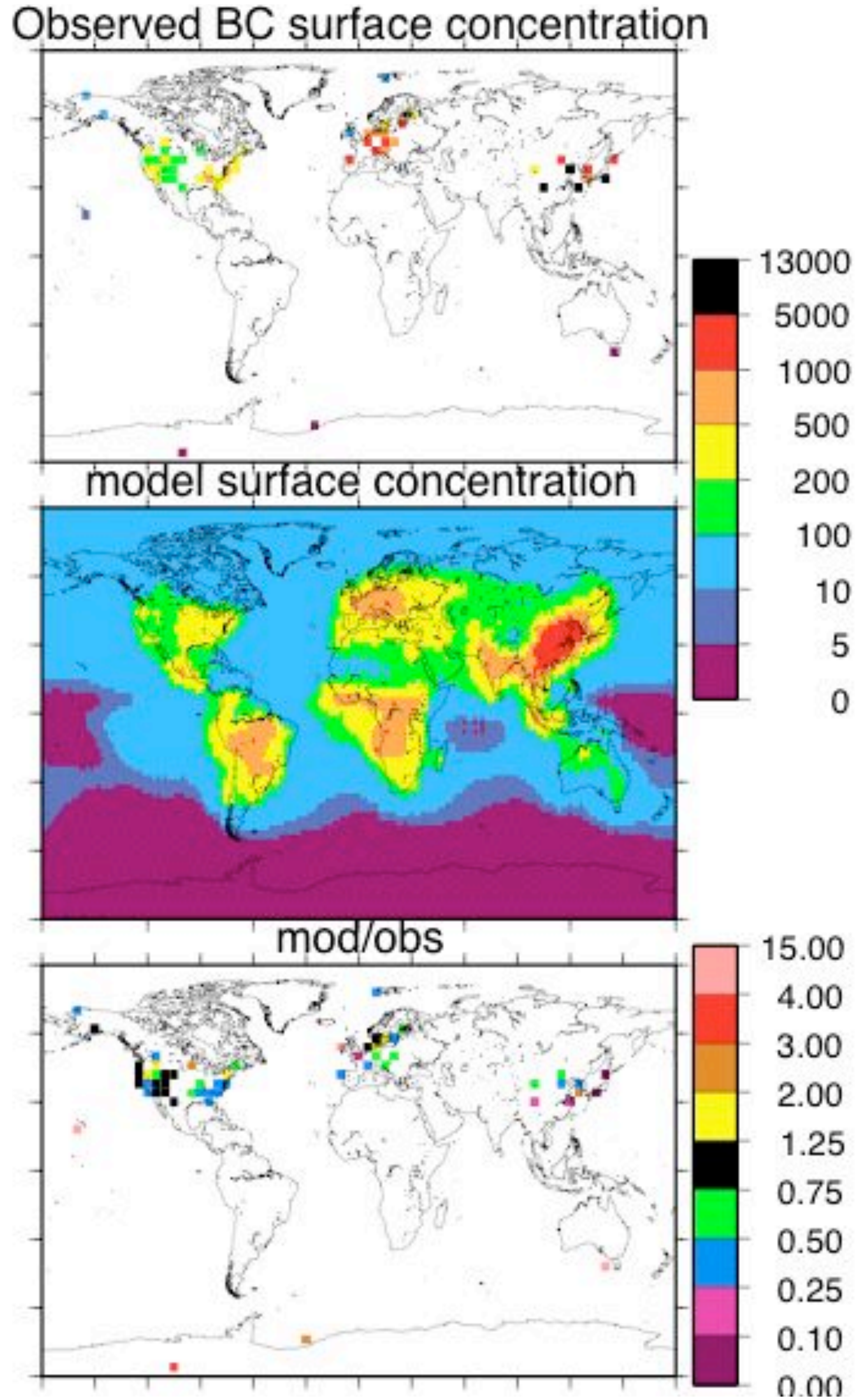
9) OMI Aerosol Index: higher altitudes

We need to know:

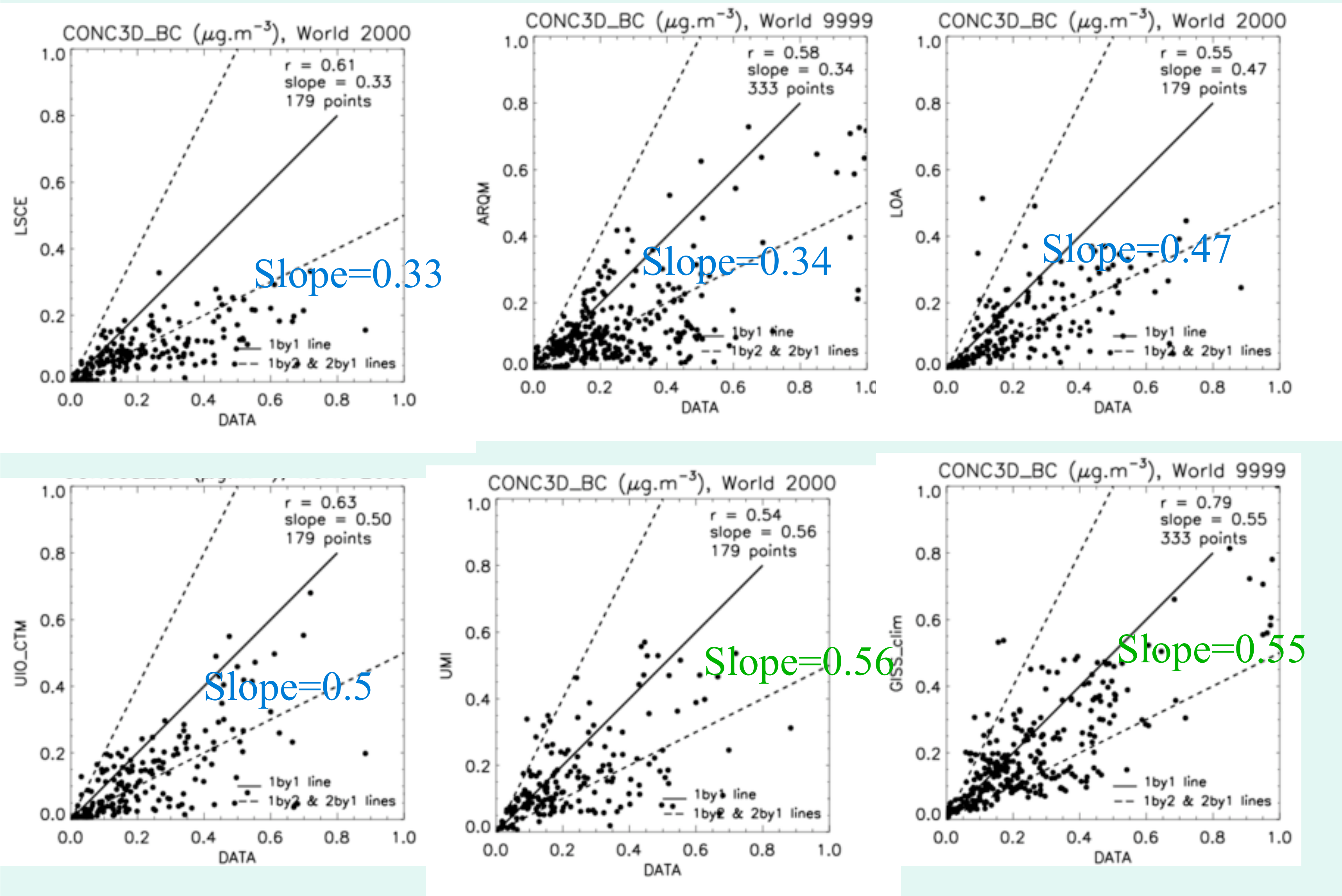
1) Treatment of mixing
2) Removal assumptions ice vs liquid phase clouds
3) mass absorption and scattering cross section
4) backscatter fraction of unmixed and mixed aerosol
5) treatment of absorption for mixed BC and other aerosols
6) BC size distribution and host size distributions for internal mixtures
7) BC refractive index and BC density
8) Hydrophobic-hydrophilic conversion times

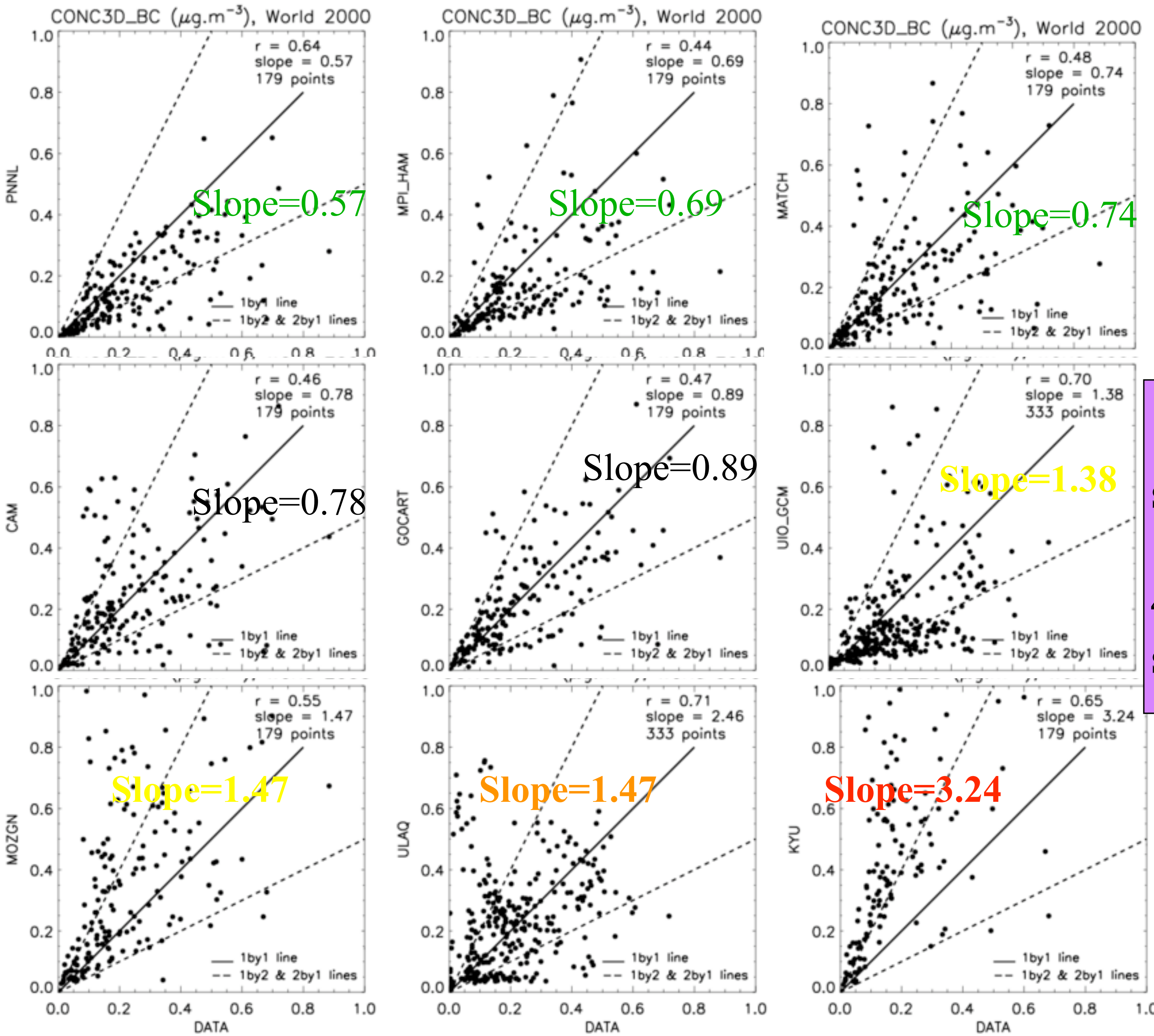
BC Surface Concentrations
(annual average)
and
GISS model

Region	Mod/Obs
NAM	0.78
EUR	0.72
ASIA	0.49
Global	1.0



AeroCom models vs BC surface concentrations in USA: IMPROVE network. From AeroCom website.

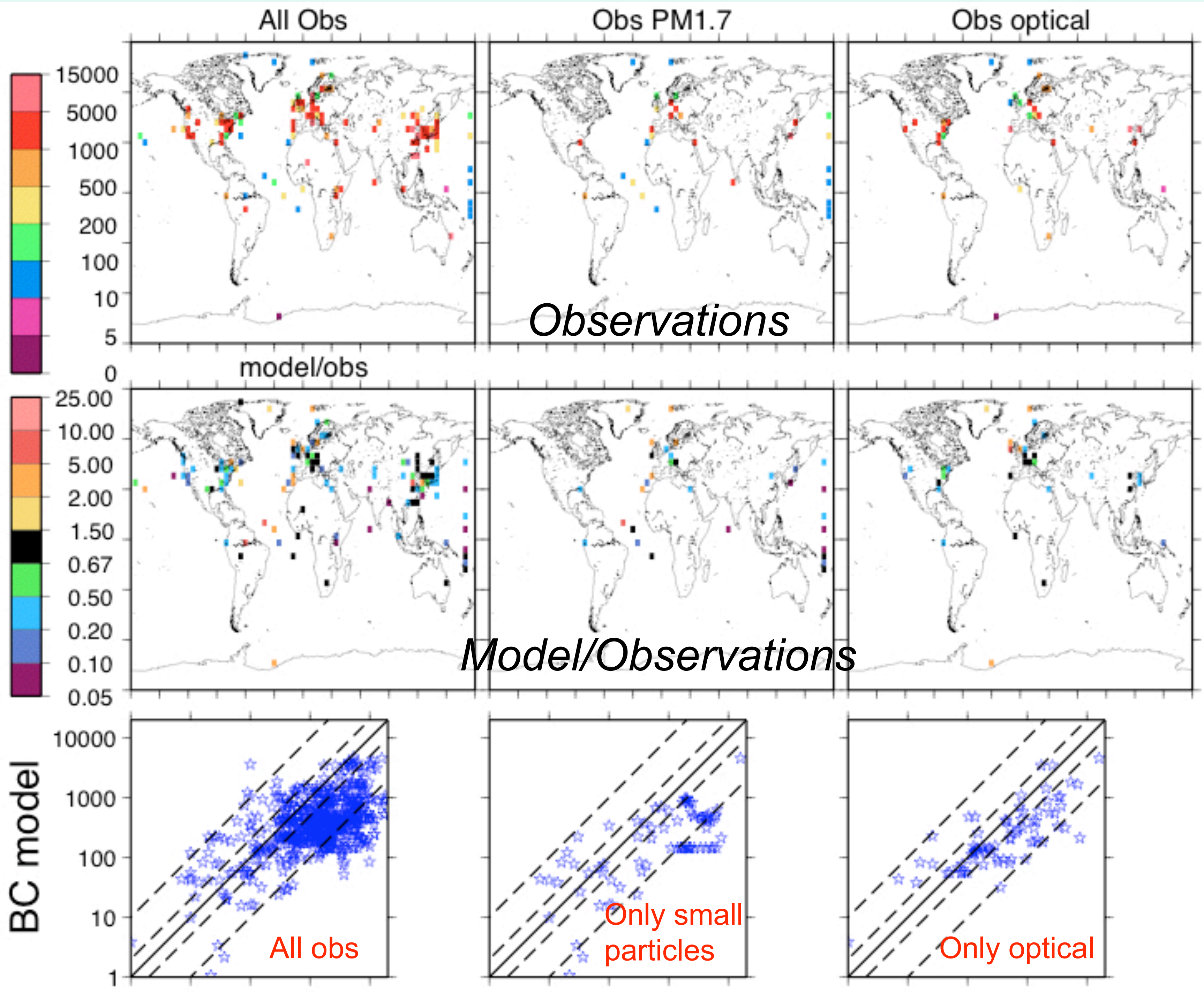




11 models: slope<1

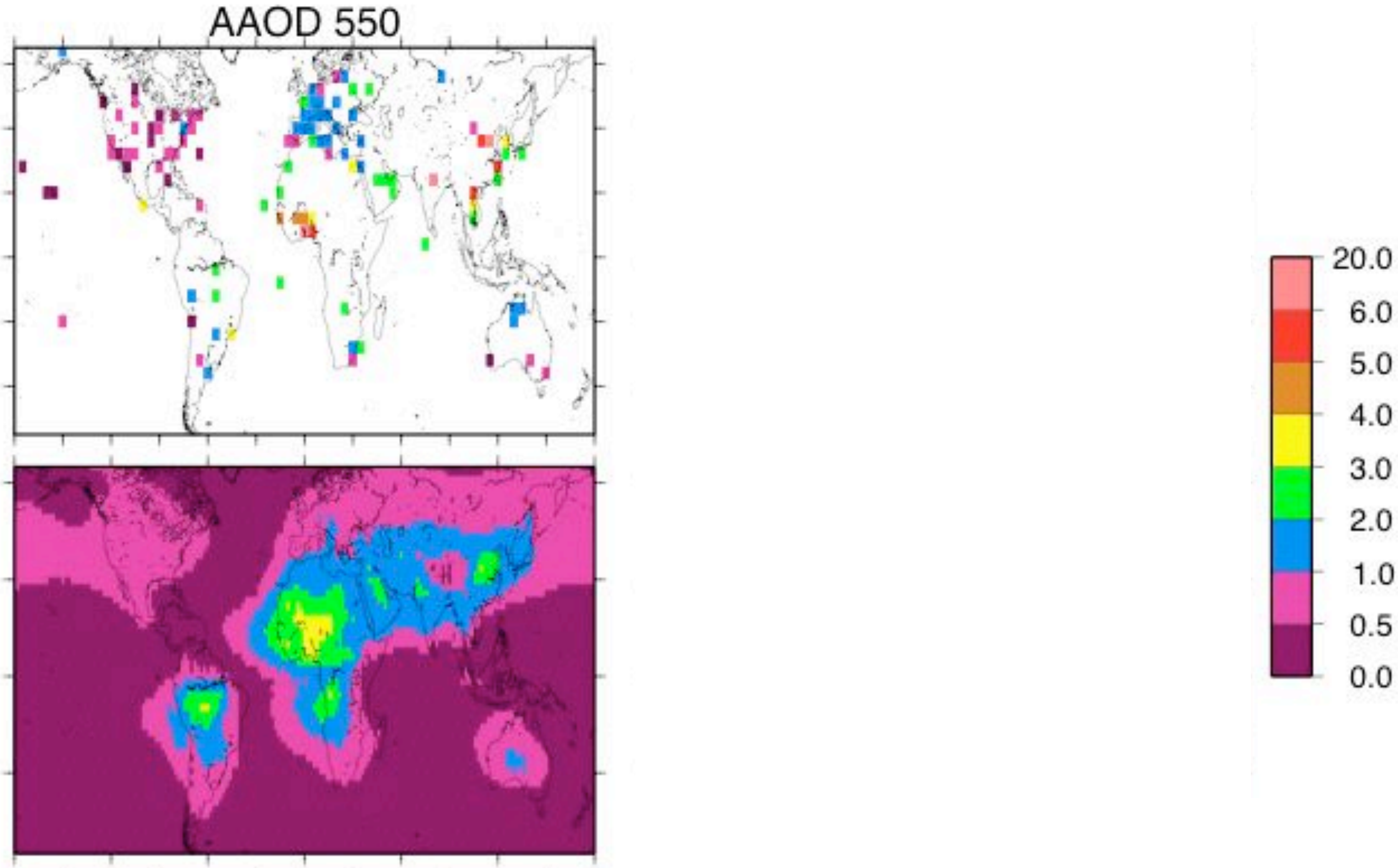
4 models: slope >1

Sun and Bond observation dataset



AERONET
v2
(1996-2006)

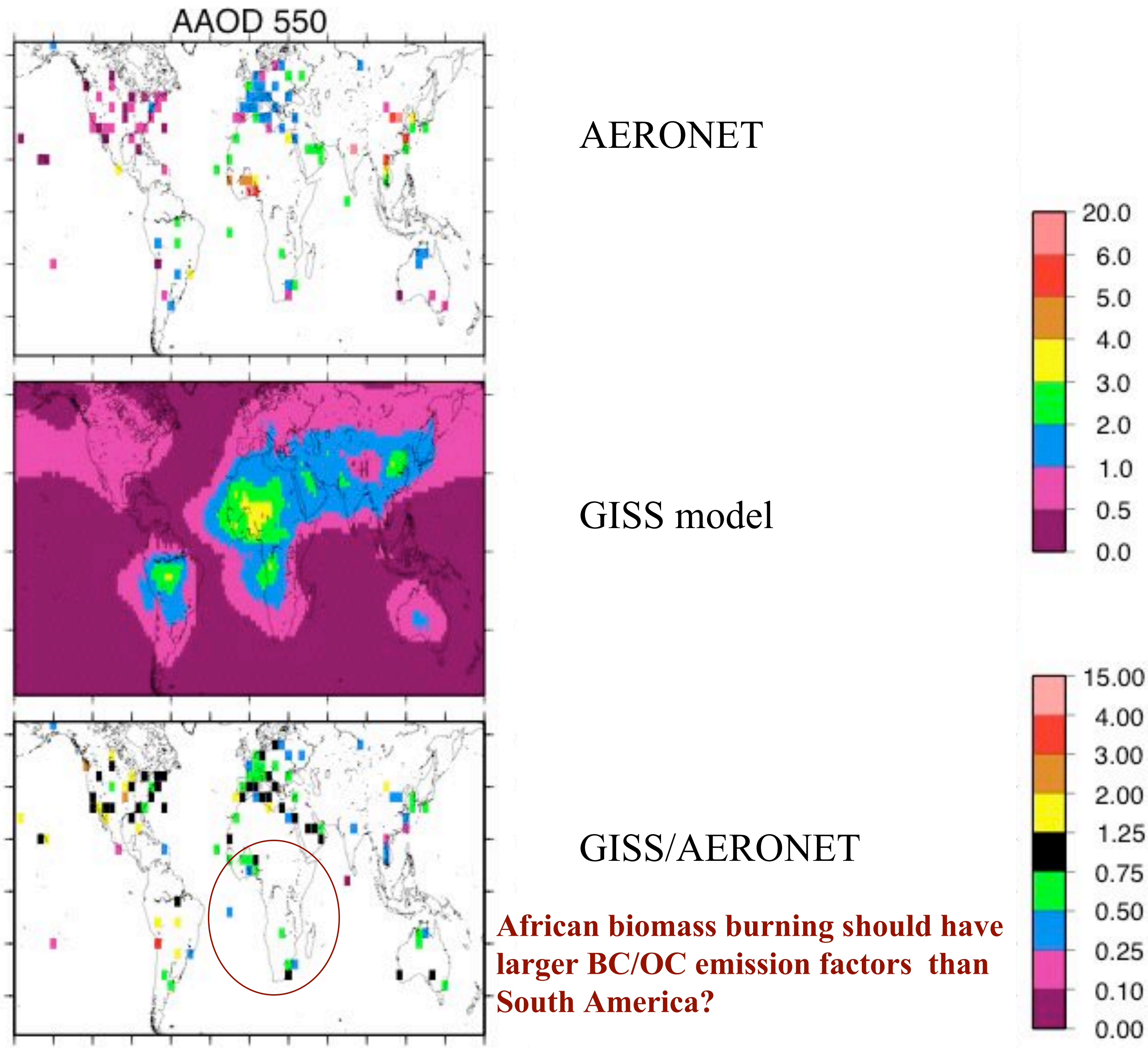
GISS model



Absorption Aerosol Optical Depth (AAOD) = Extinction OD - Scattering OD
= AOD (1 - SSA)

BC-dominated regions (avoiding dust)

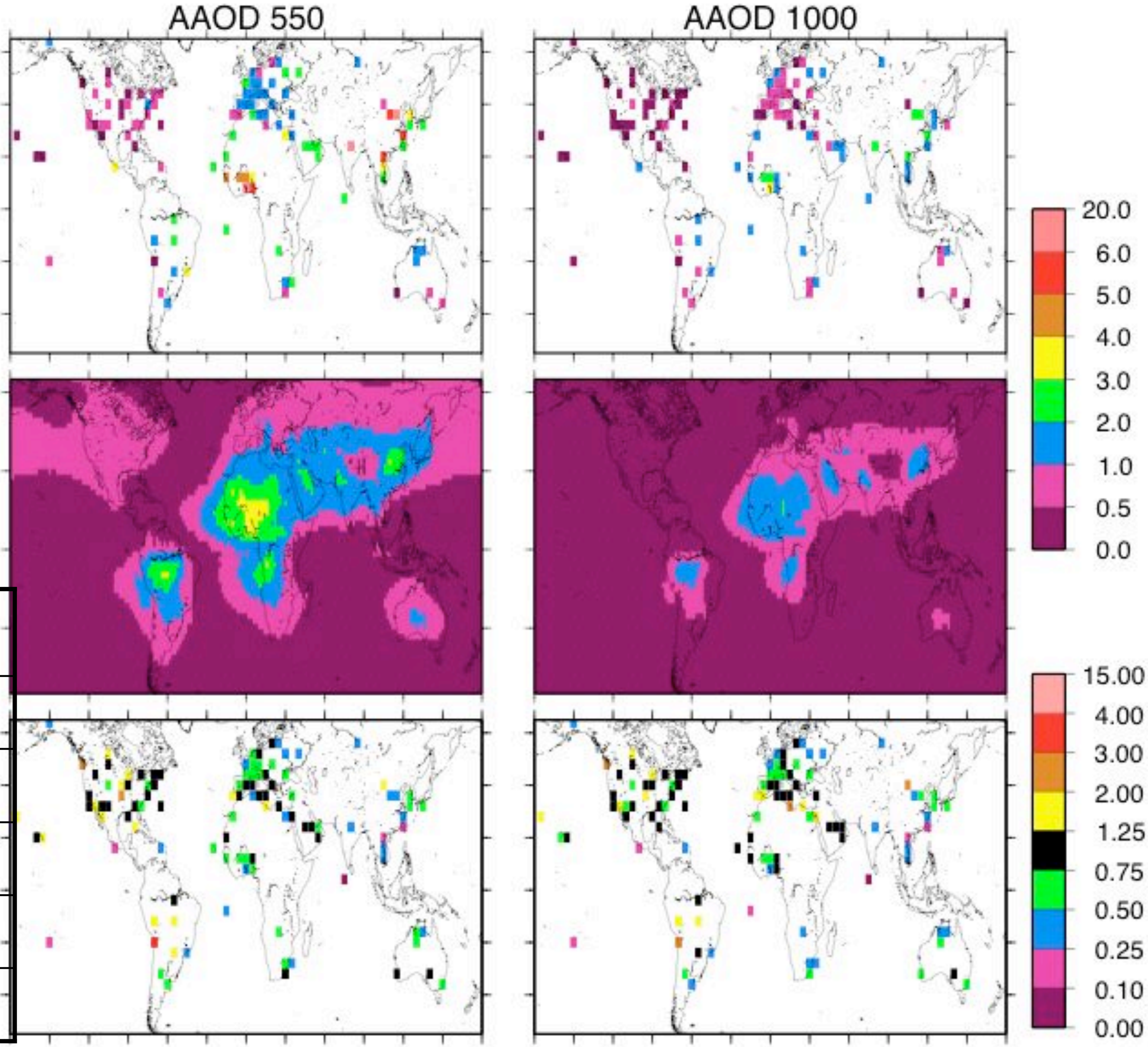
Mod/AER	550 nm
NAM	1.0
EUR	.70
ASIA	.43
SAM	1.0
AFR	.39

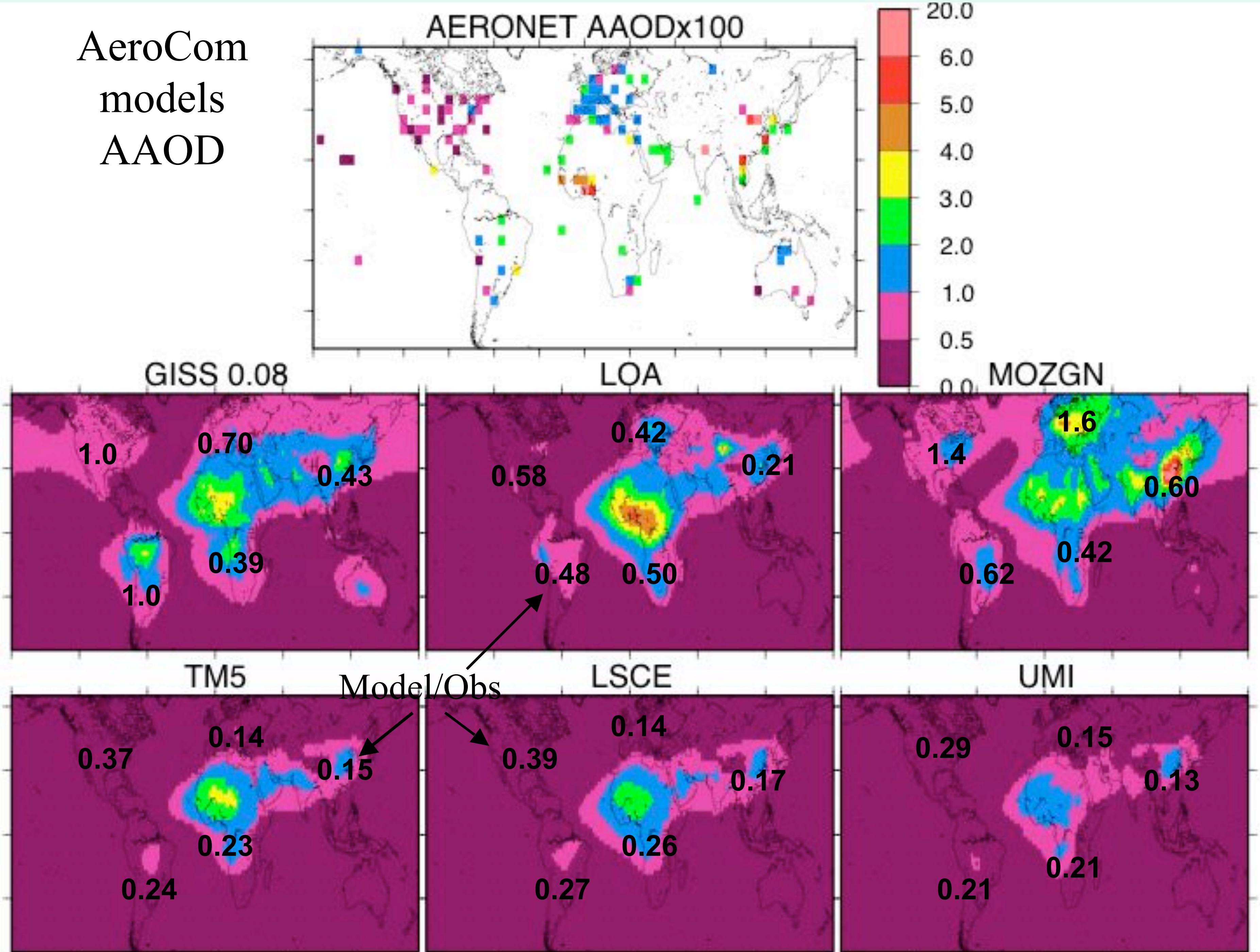


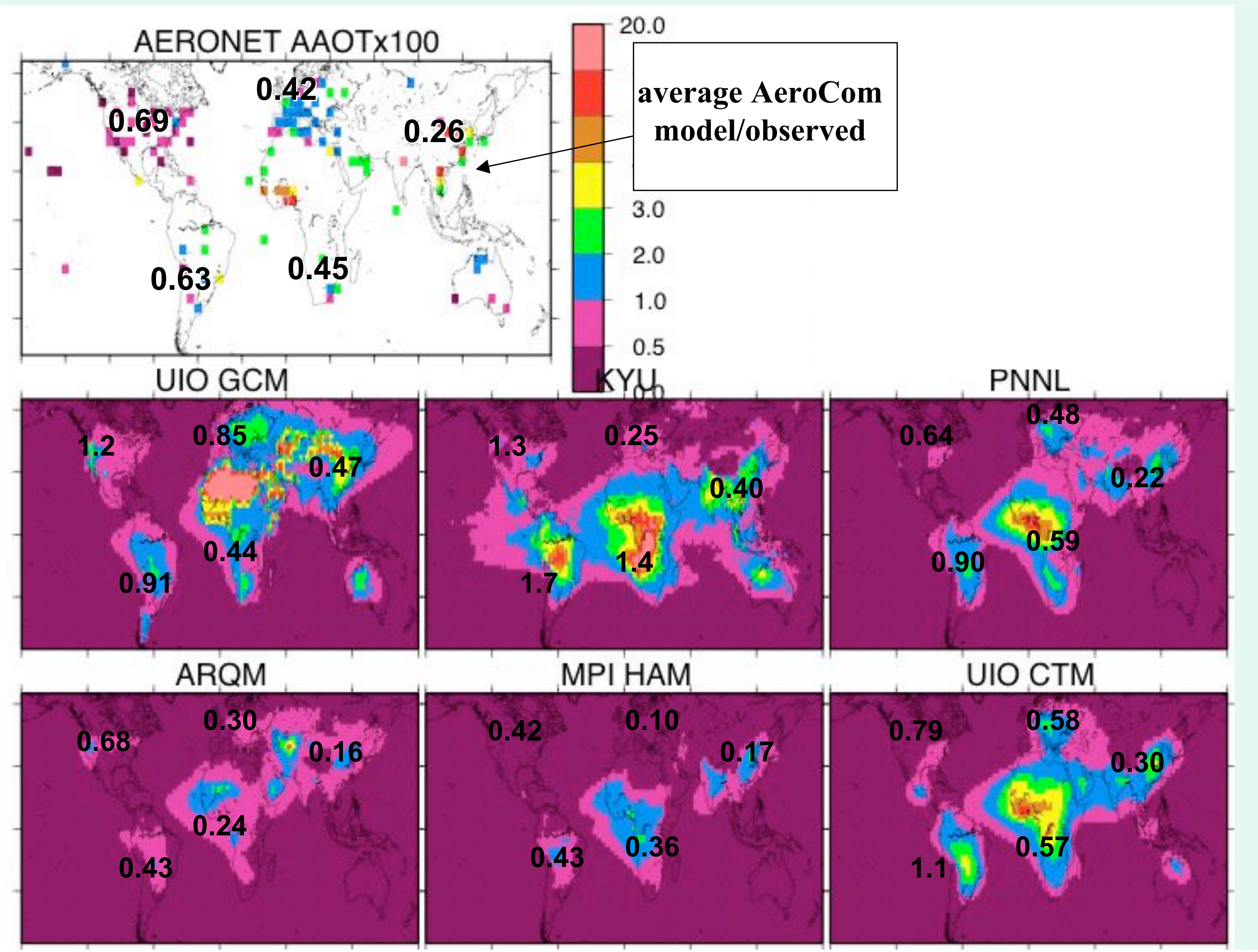
African biomass burning should have larger BC/OC emission factors than South America?

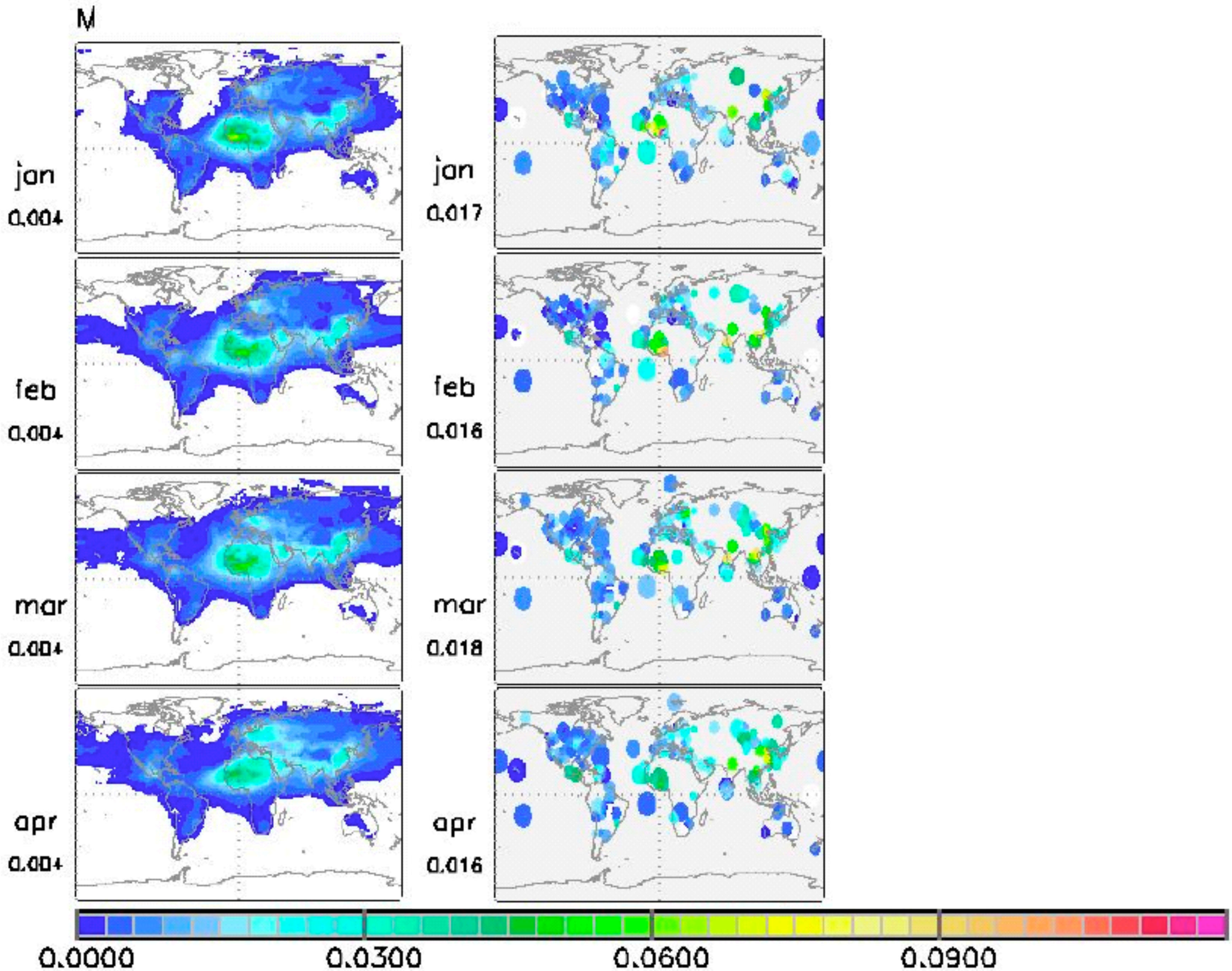
We can use wavelength dependence to test model chemistry

Mod/ AER	550 nm	1000 nm
NAM	1.0	.87
EUR	.70	.72
ASIA	.43	.46
SAM	1.0	.91
AFR	.39	.32




AeroCom
models
AAOD
AERONET AAODx100
20.0
6.0
5.0
4.0
3.0
2.0
1.0
0.5
0.0
GISS 0.08
1.0
0.70
0.43
0.39
1.0
LOA
0.42
0.58
0.21
0.48
0.50
MOZGN
1.6
1.4
0.60
0.42
0.62
TM5
0.14
0.37
0.15
0.23
0.24
Model/Obs
LSCE
0.14
0.39
0.17
0.26
0.27
UMI
0.15
0.29
0.13
0.21
0.21


AERONET AAOTx100
0.42
0.69
0.26
0.63
0.45
20.0
3.0
2.0
1.0
0.5
0.0
average AeroCom
model/observed
UIO GCM
1.2
0.85
0.47
0.44
0.91
KYU
1.3
0.25
0.40
1.4
1.7
PNNL
0.64
0.48
0.22
0.59
0.90
ARQM
0.68
0.30
0.16
0.24
0.43
MPI HAM
0.42
0.10
0.17
0.36
0.43
UIO CTM
0.79
0.58
0.30
0.57
1.1


M
jan
0.004
jan
0.017
feb
0.004
feb
0.016
mar
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apr
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0.016
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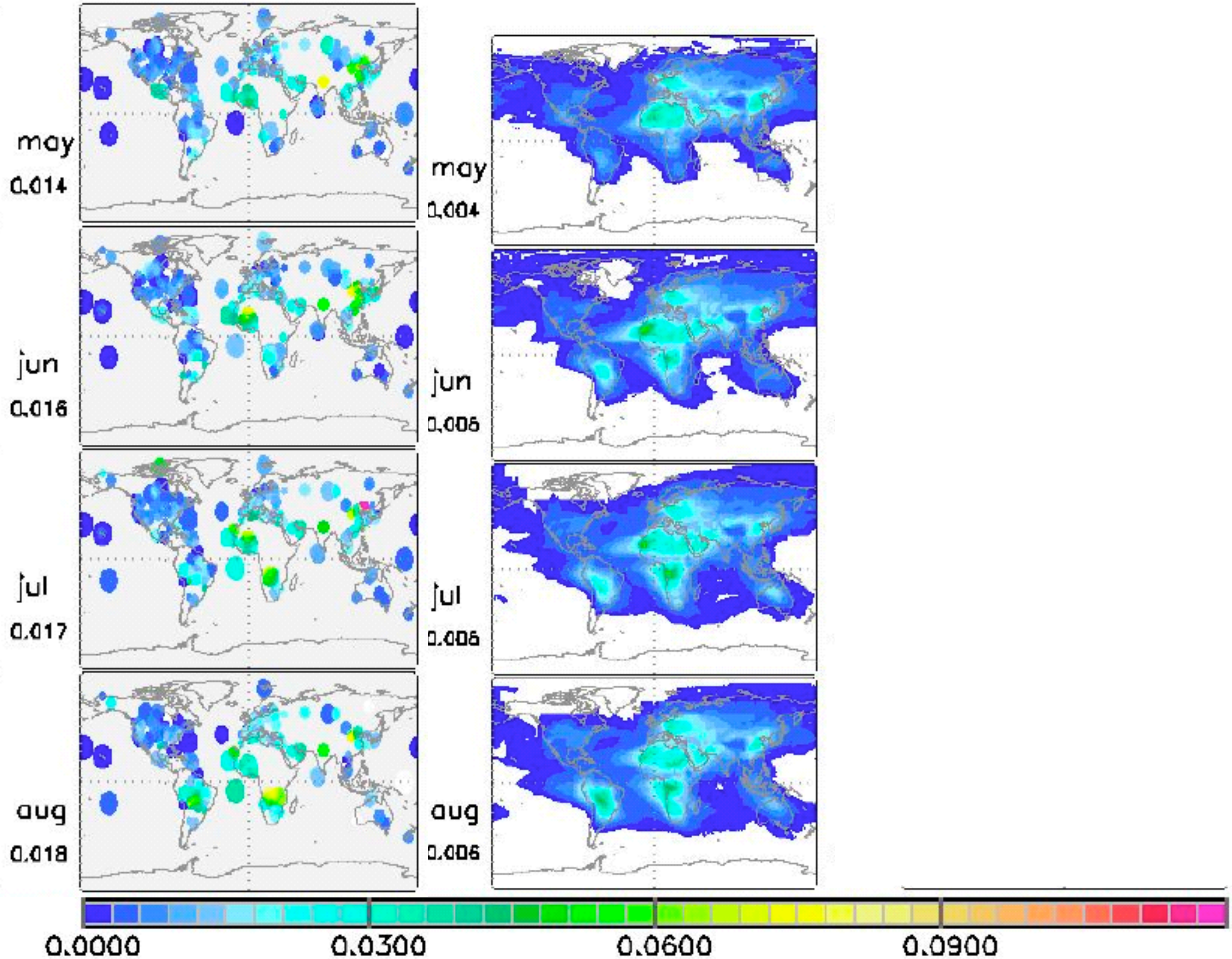
0.0300
0.0600
0.0900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aug
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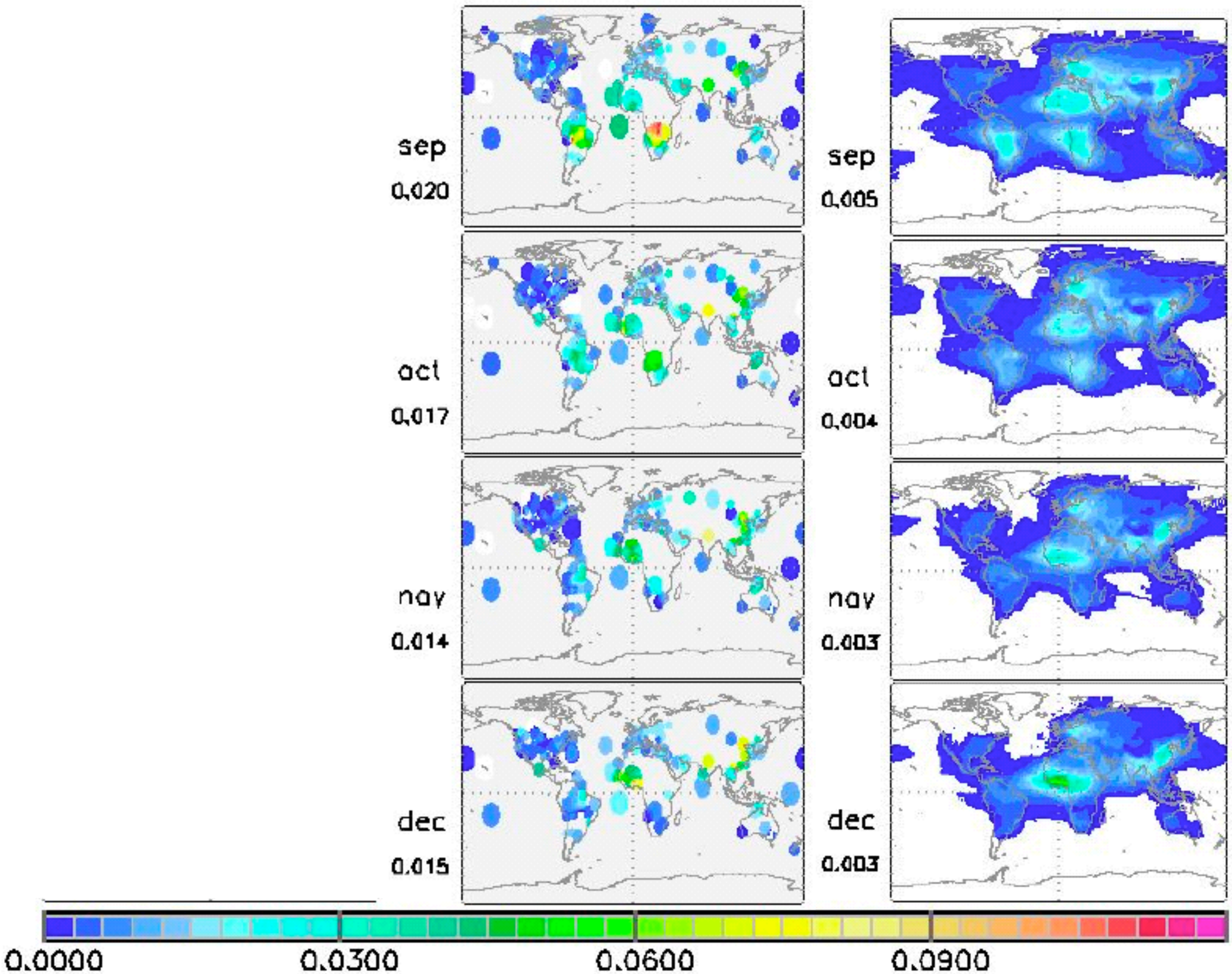
0.0000
0.0300
0.0600
0.0900


sep
0.020
oct
0.017
nov
0.014
dec
0.015
sep
0.005
oct
0.004
nov
0.003
dec
0.003
0.0000
0.0300
0.0600
0.0900

BC load using Schuster algorhythm

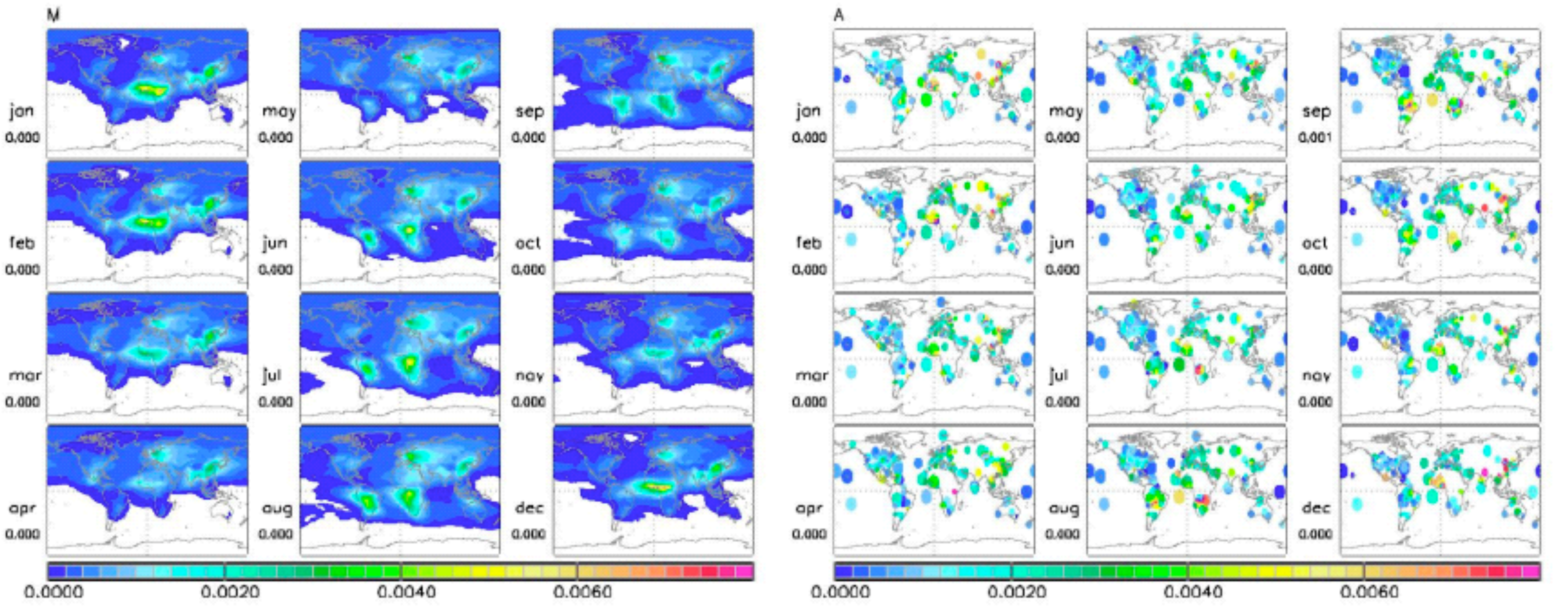
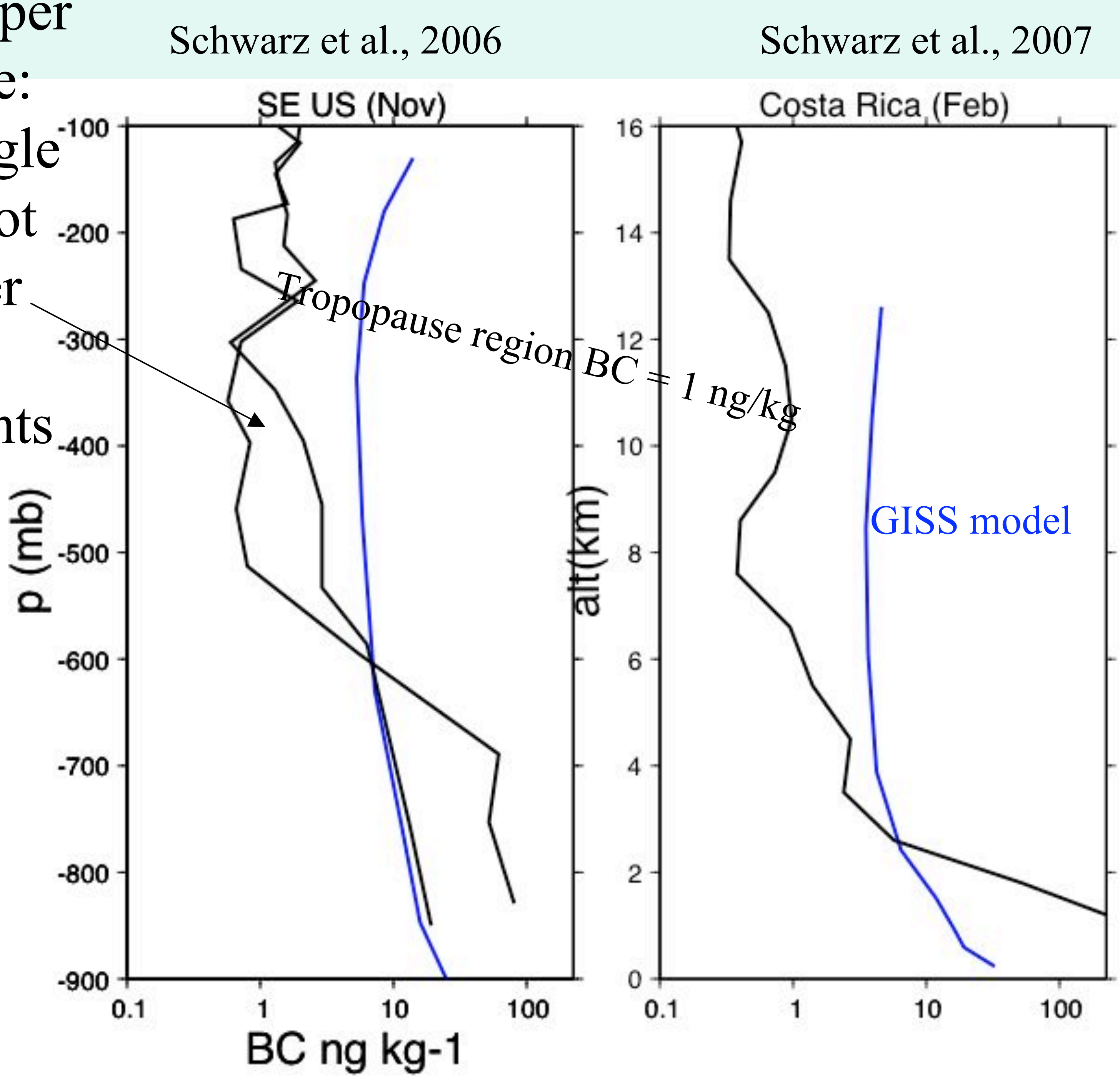


Fig. A3. Monthly soot mass (in g/m2) suggested by modeling (M) and by AERONET (A)

BC in the upper troposphere: Aircraft Single Particle Soot Photometer (SP2) measurements



GISS model actually has excessive BC in UT/LS region.

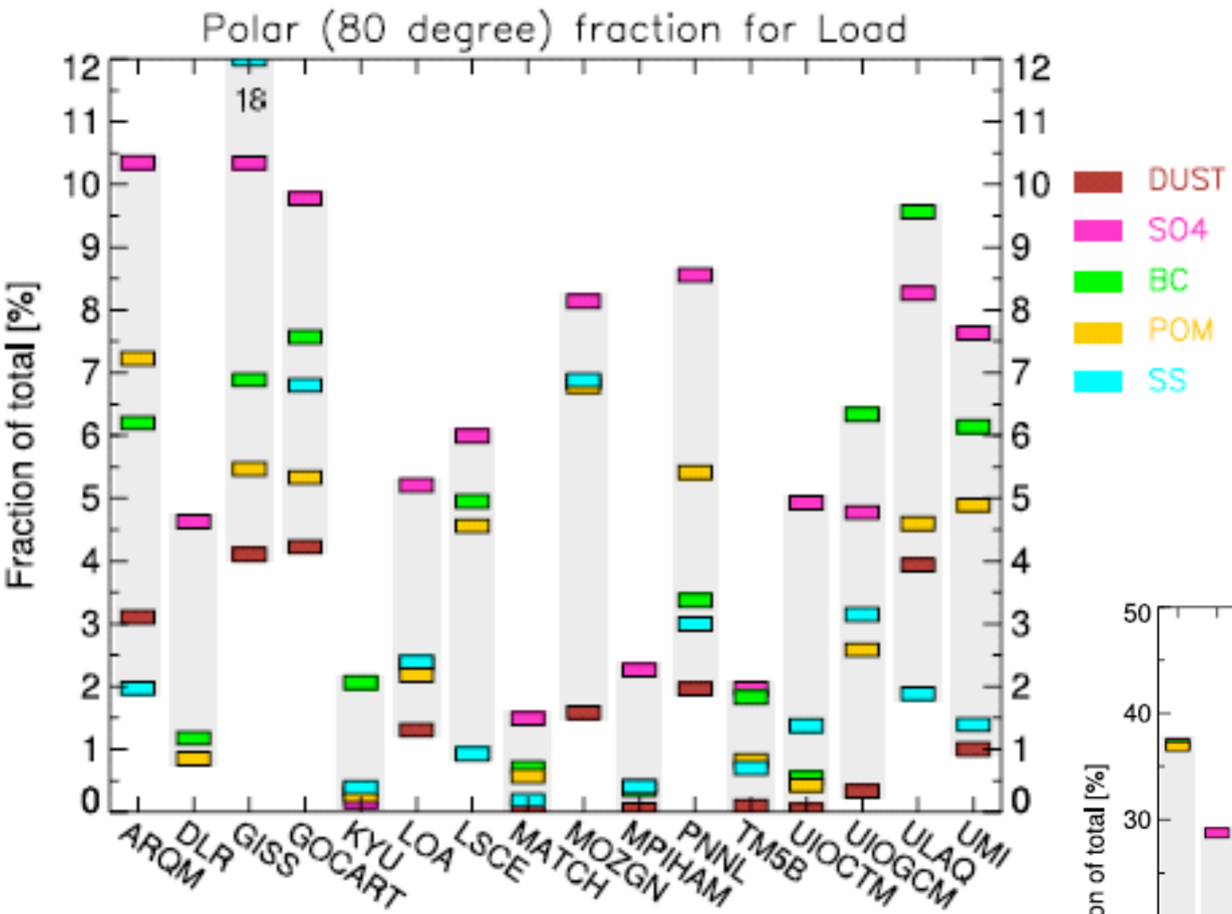
What about ratio of BC to other aerosols?

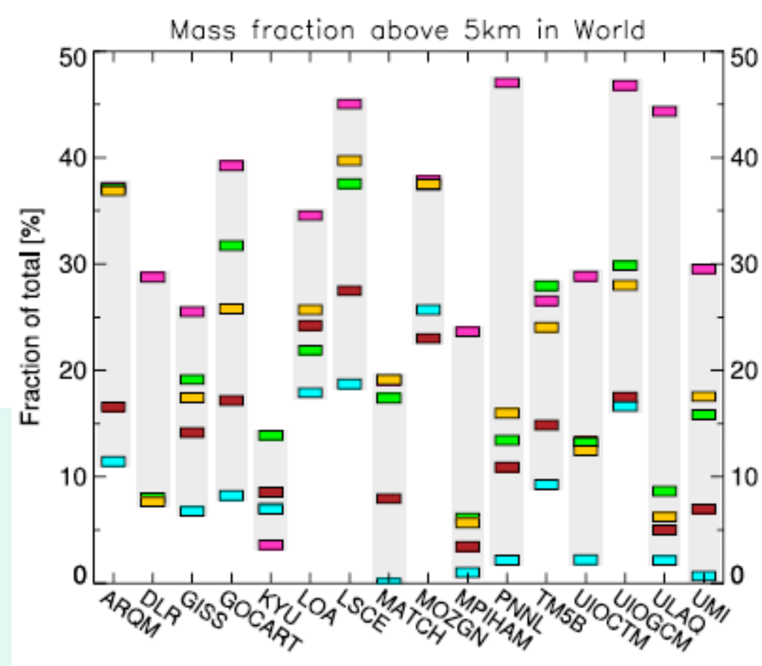
BC in the Arctic

Do models transport BC to the Arctic correctly?

Do models remove BC in the Arctic correctly: Deposition has implications for BC-snow albedo effects. Are model Arctic clouds liquid or ice phase? How much BC is removed by liquid/frozen precipitation?

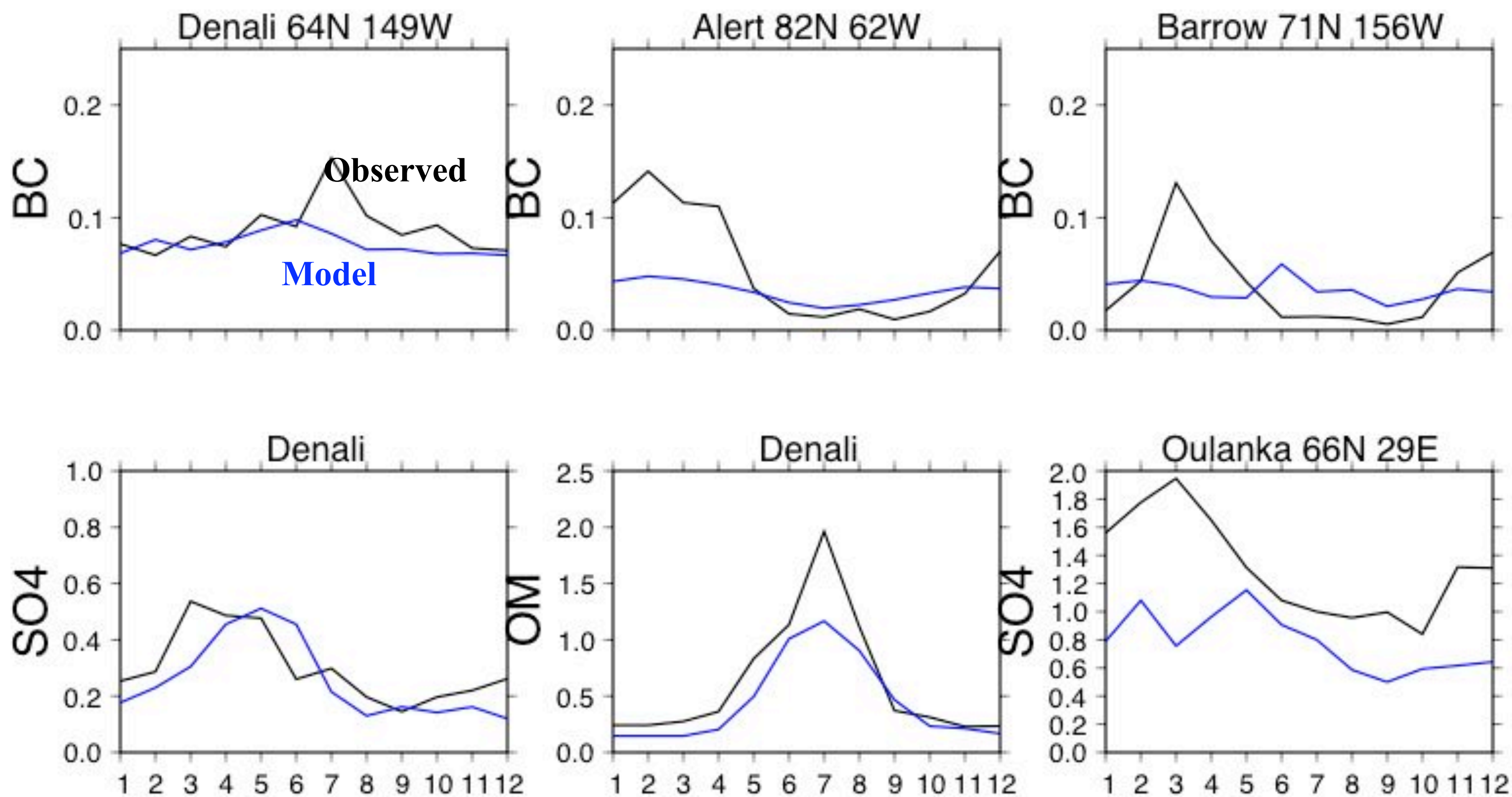
Where do (AeroCom) models distribute their loads?



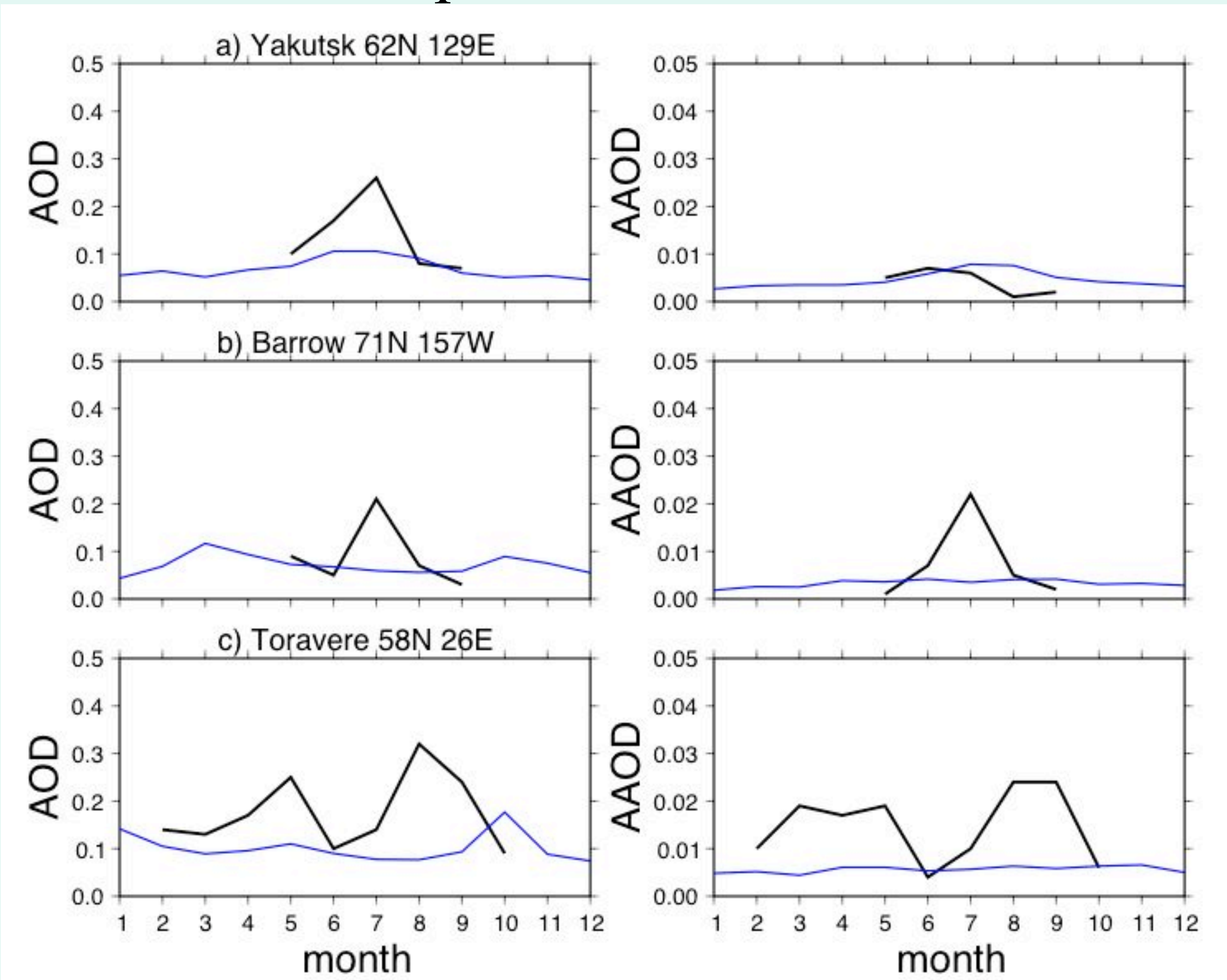


Textor *et al., ACP*, 2006

Model compared to Arctic aerosol surface concentrations



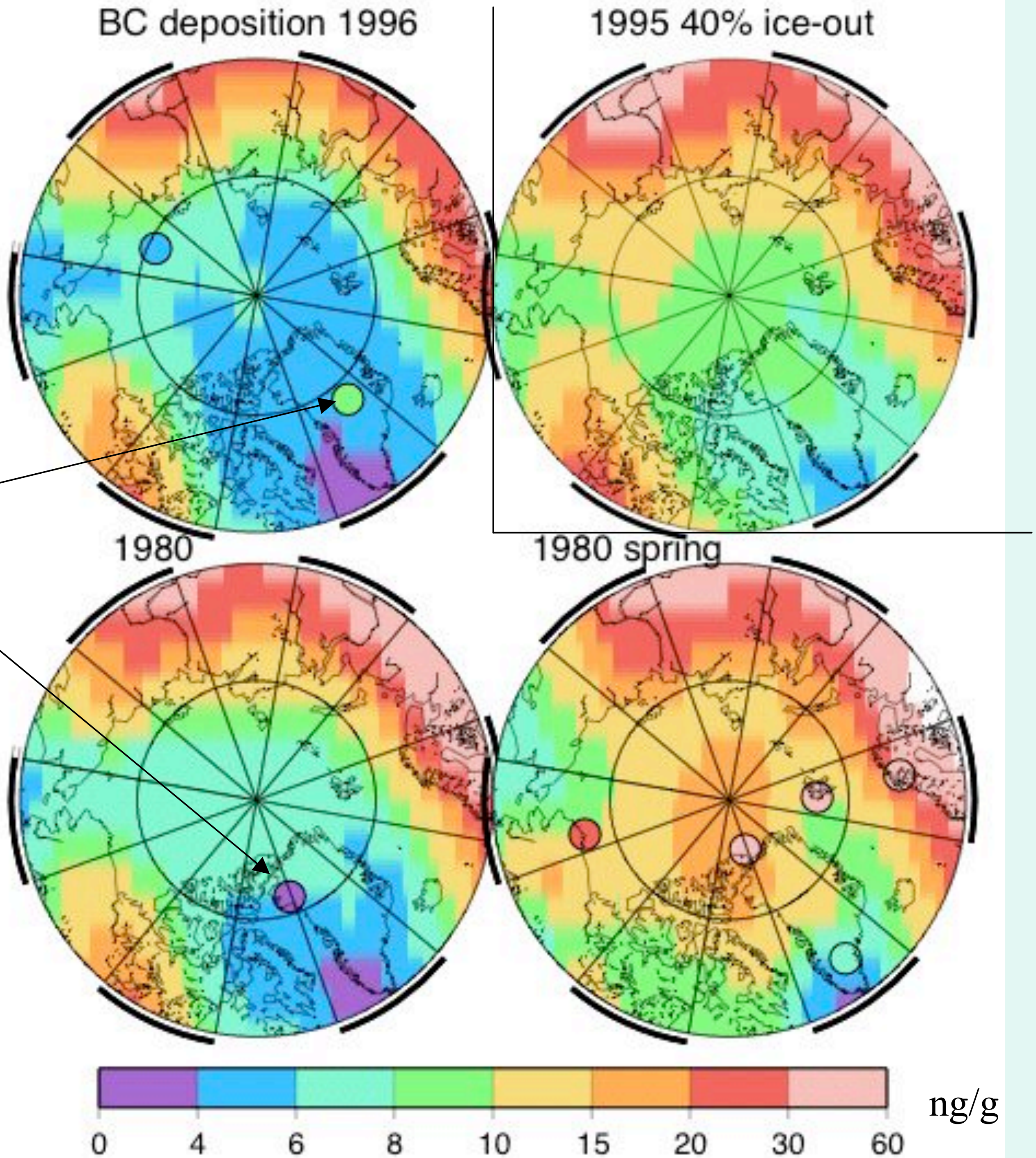
Model compared to Arctic AERONET



BC snow concentration

Observations compiled by Flanner et al. (2007)

GISS model with 5% ice phase cloud removal (compared to liquid), Arctic BC is generally smaller than observed

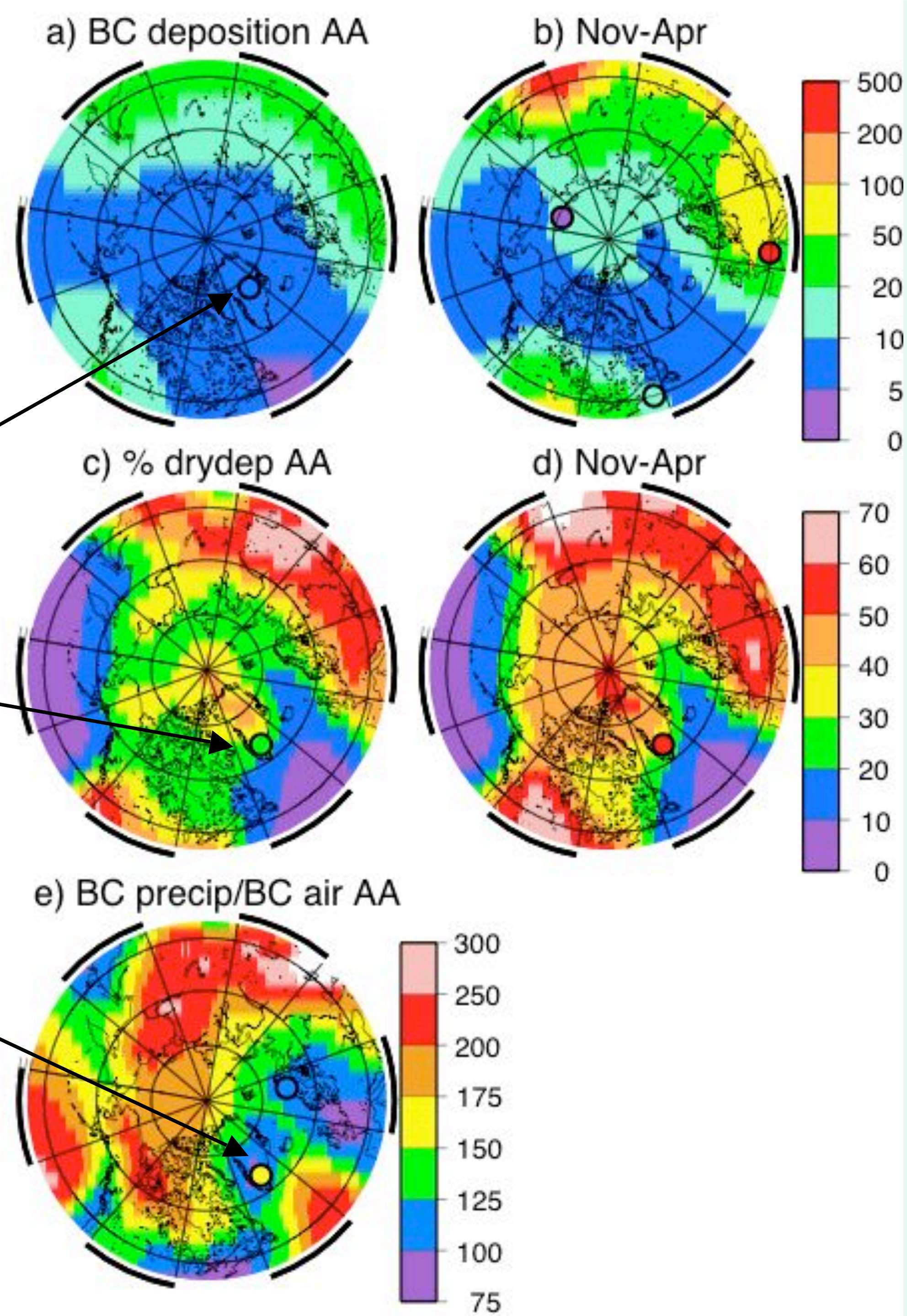


These are sensitive to removal assumptions. Here we assume 12% removal by ice phase (compared to liquid phase)

BC deposition compiled in Flanner et al. (2007)

Percent dry deposition from Davidson et al (1985)

Scavenging ratio from Davidson et al (1985) and Noone and Clarke (1988)

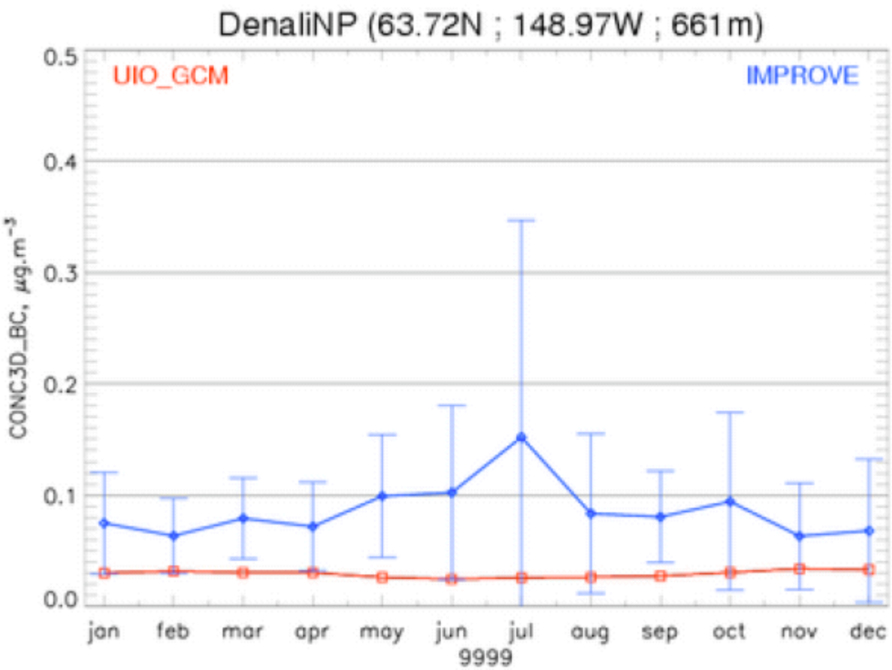


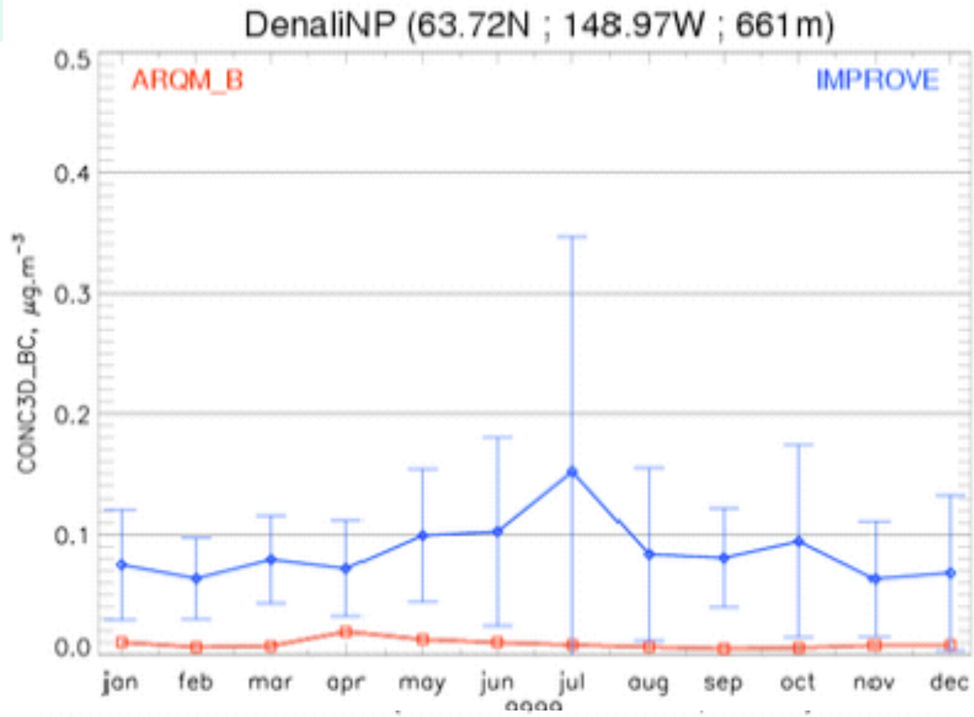
AeroCom BC models in Denali and Barrow Alaska

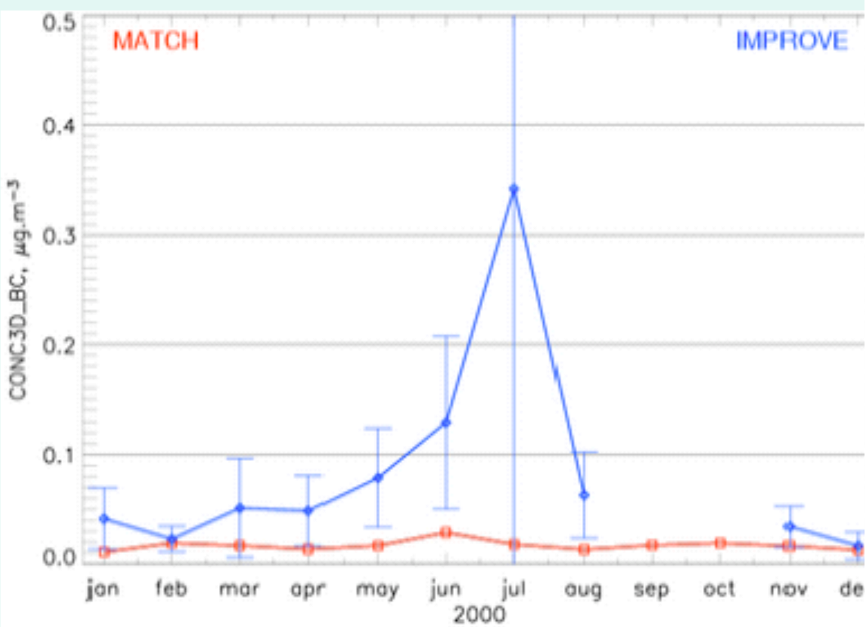
Denali

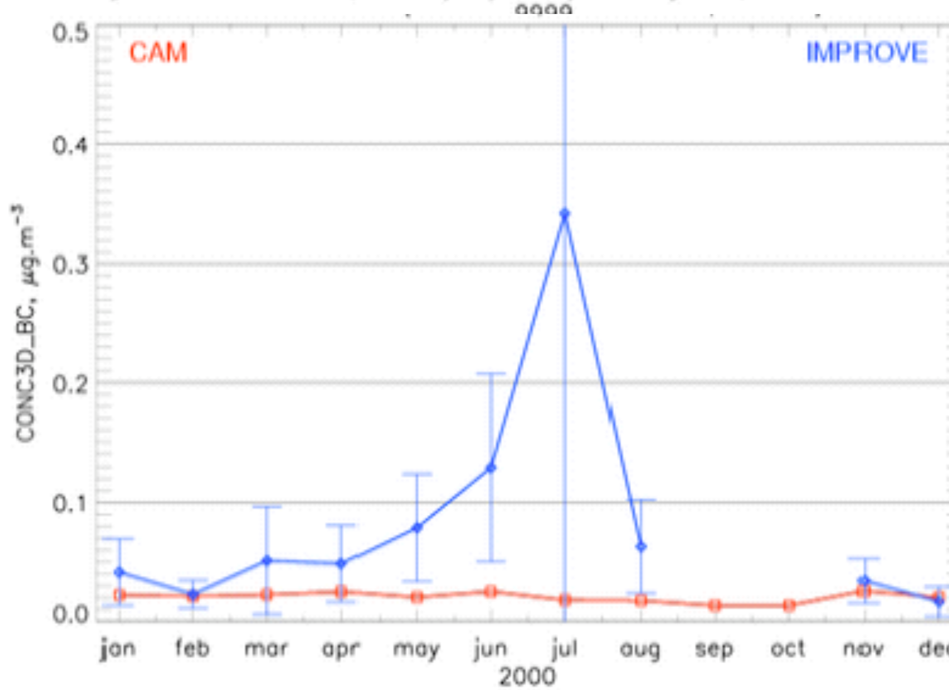
Barrow

BC Models in Denali, Alaska

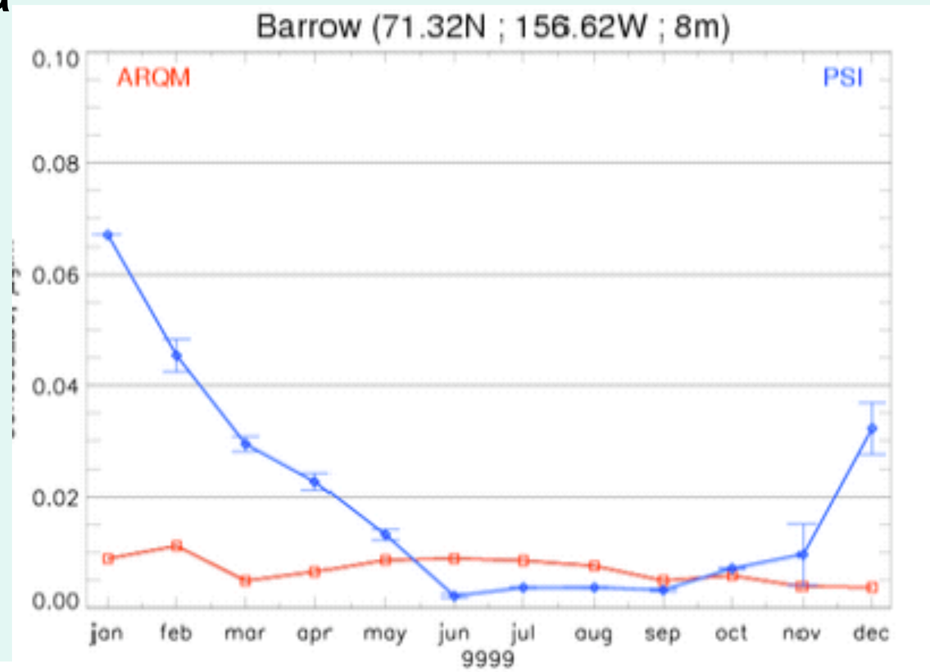


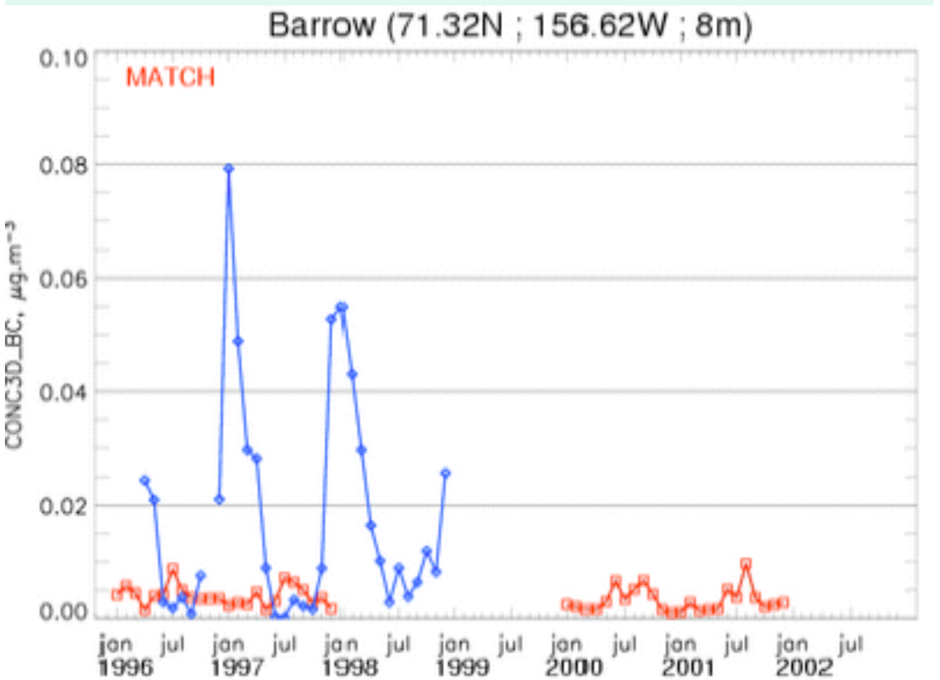


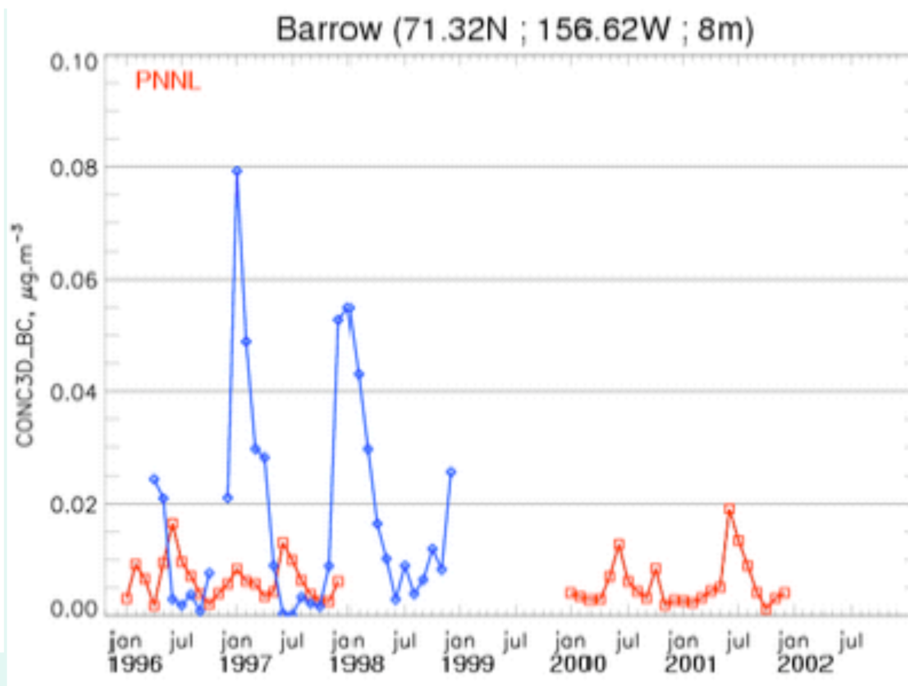




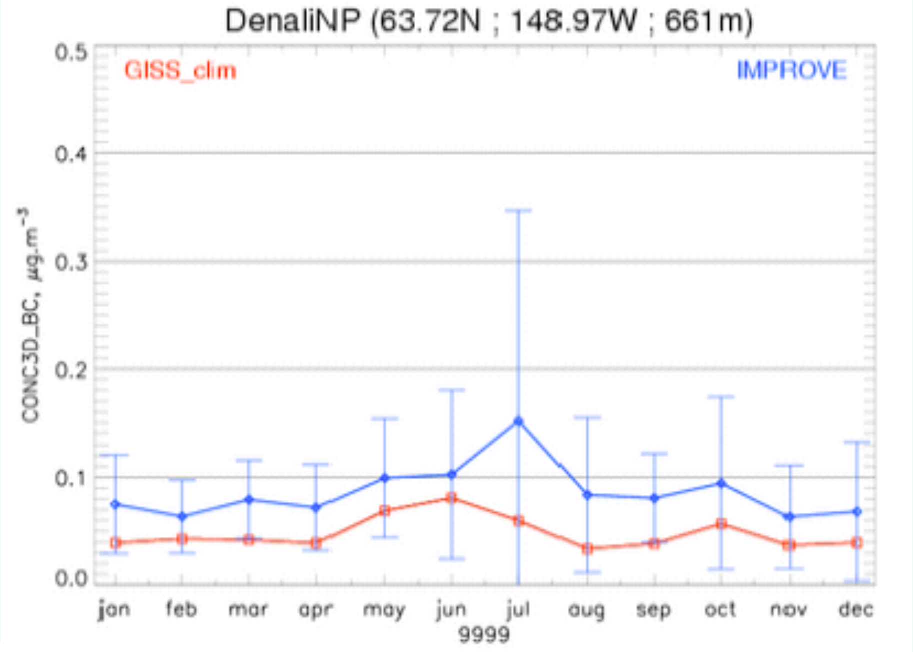
BC Models in Barrow, Alaska

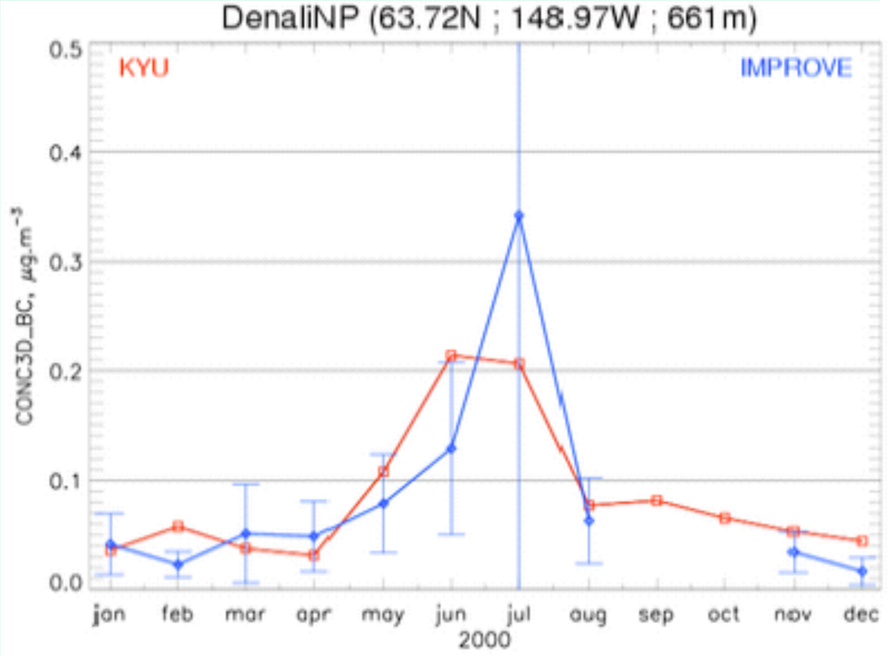


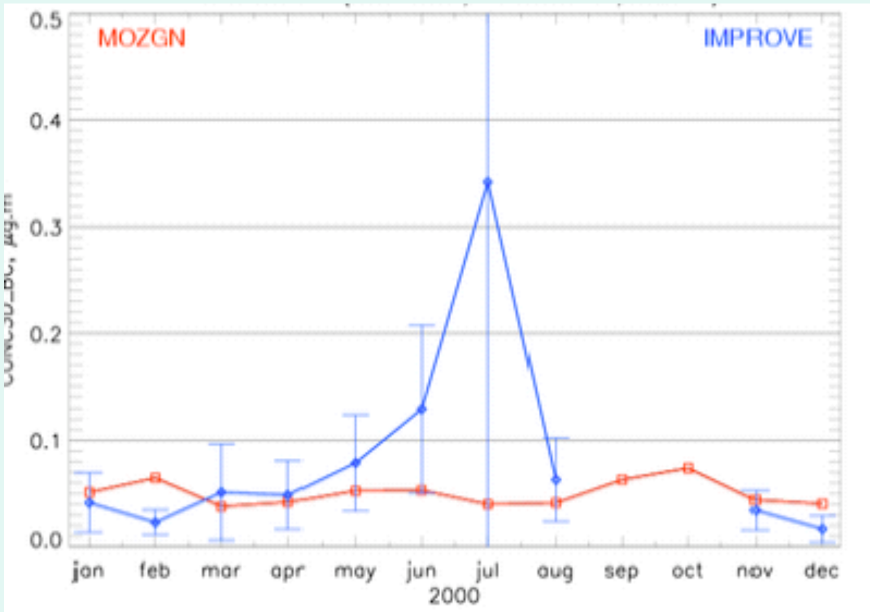




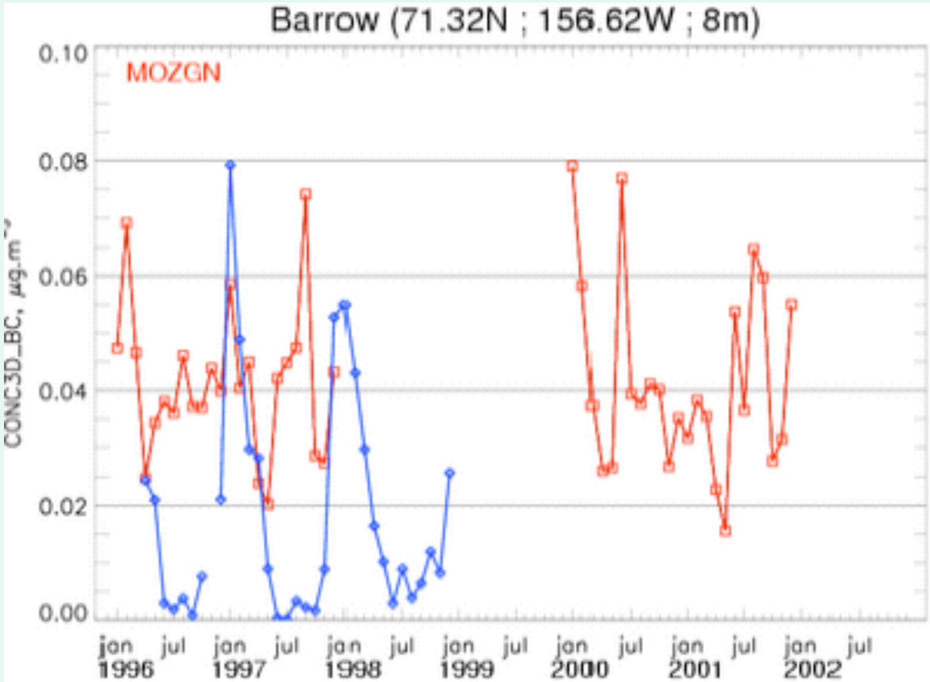
BC Models in Denali, Alaska

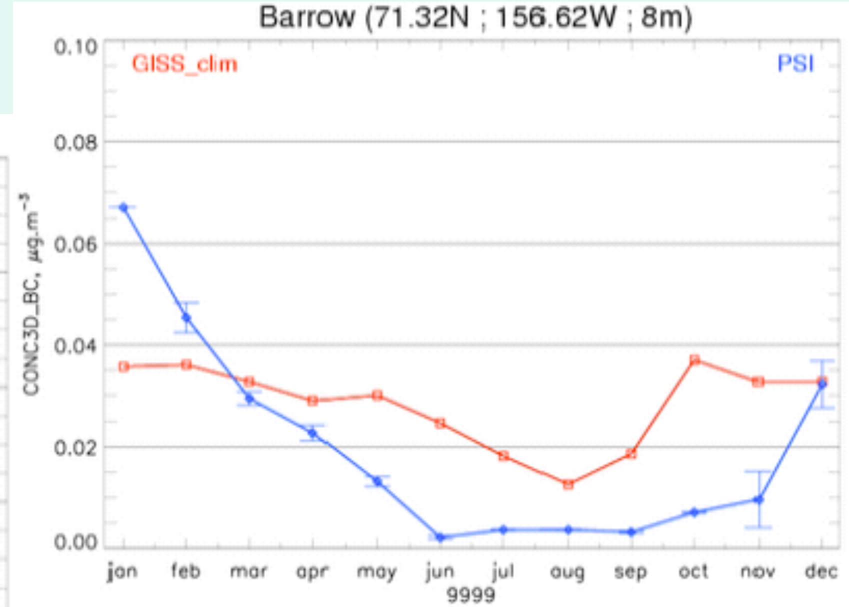


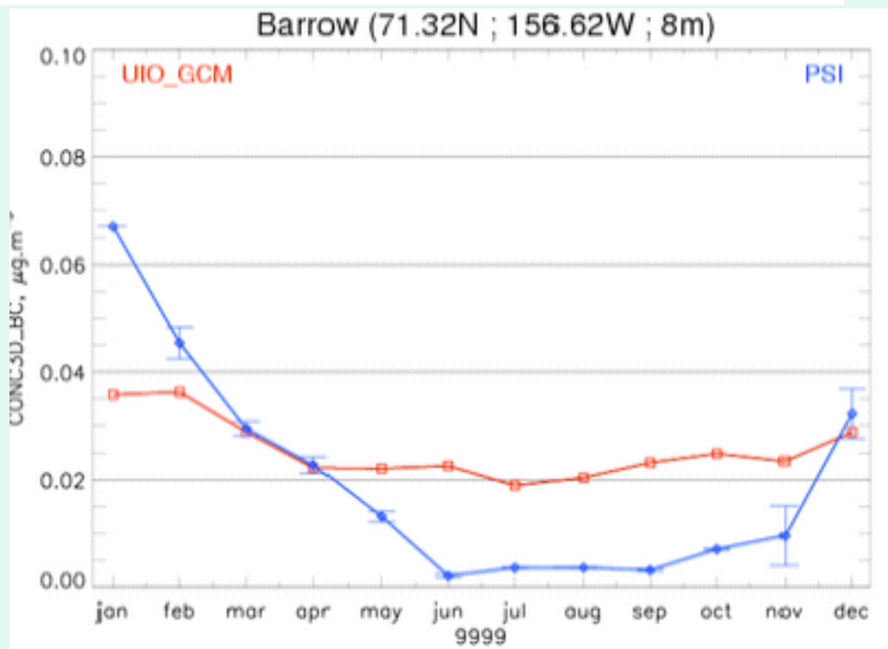


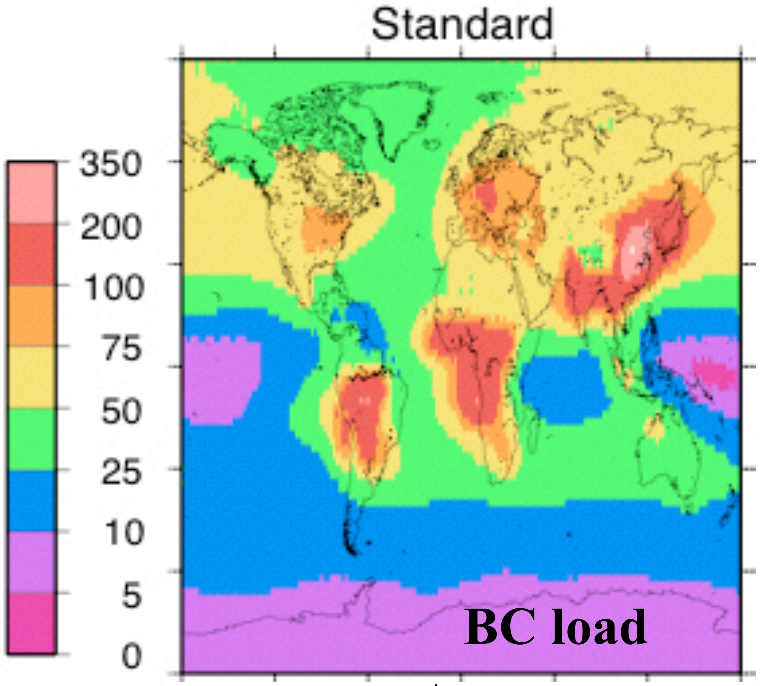


BC Models in Barrow, Alaska



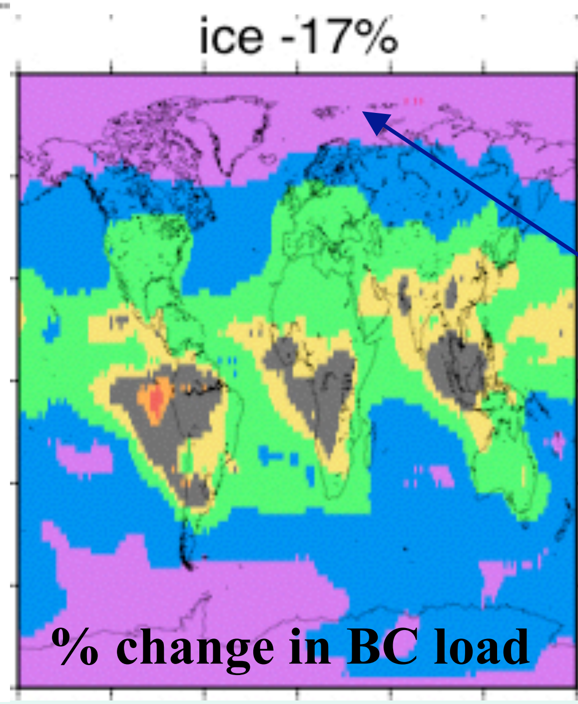


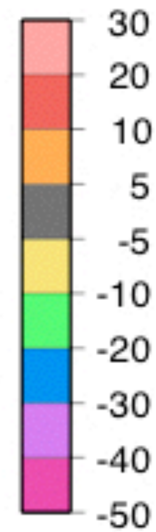




Standard BC load assuming 5% ice scavenging (relative to rain)

% BC load change for 40% ice scavenging

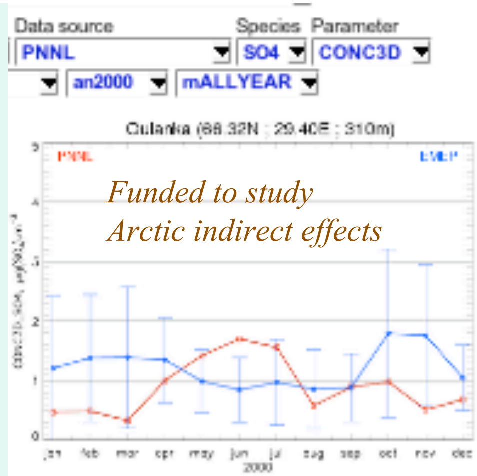


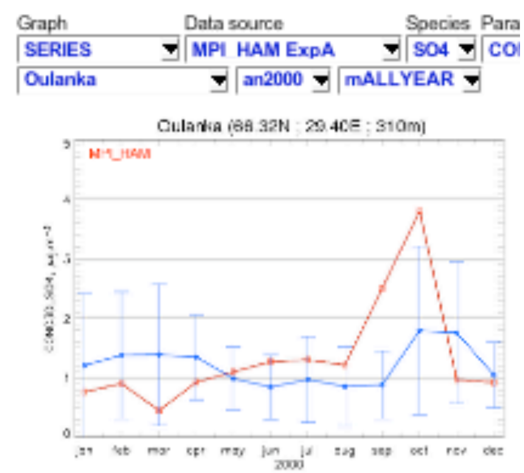


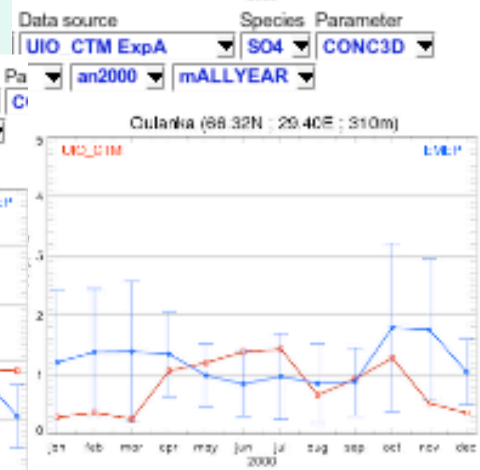
Enhancing ice removal has big effect at the poles.

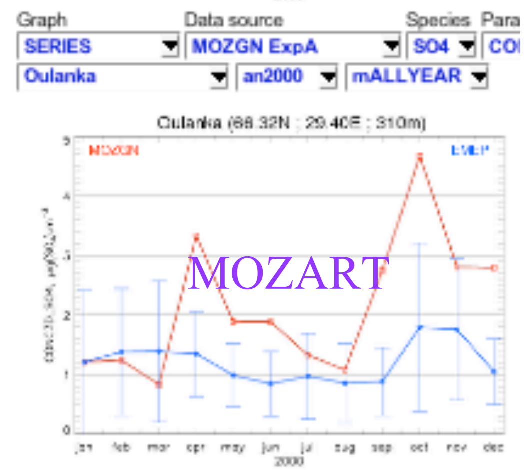
(Note: GISS model has large fraction of ice-clouds)

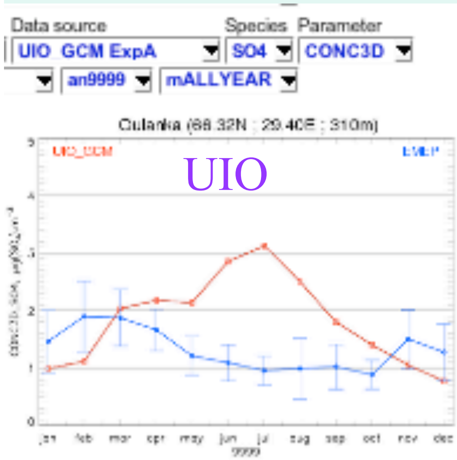
AEROCOM models in Oulanka, Norway sulfate

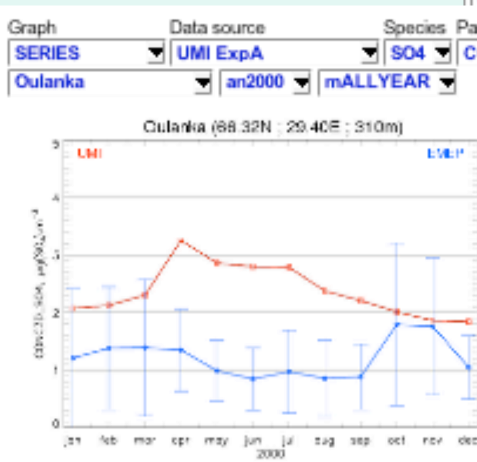


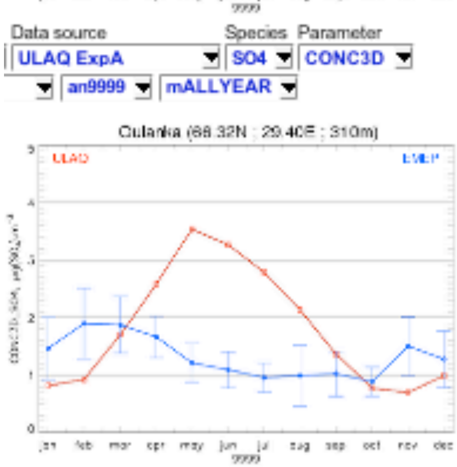


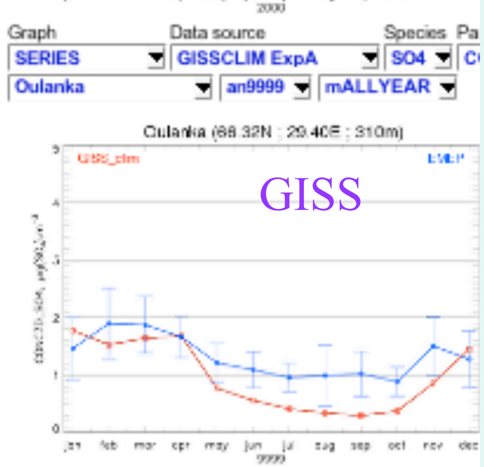












AEROCOM models in Denali, Alaska sulfate