IPCC Model Intercomparison: Lessons Learned

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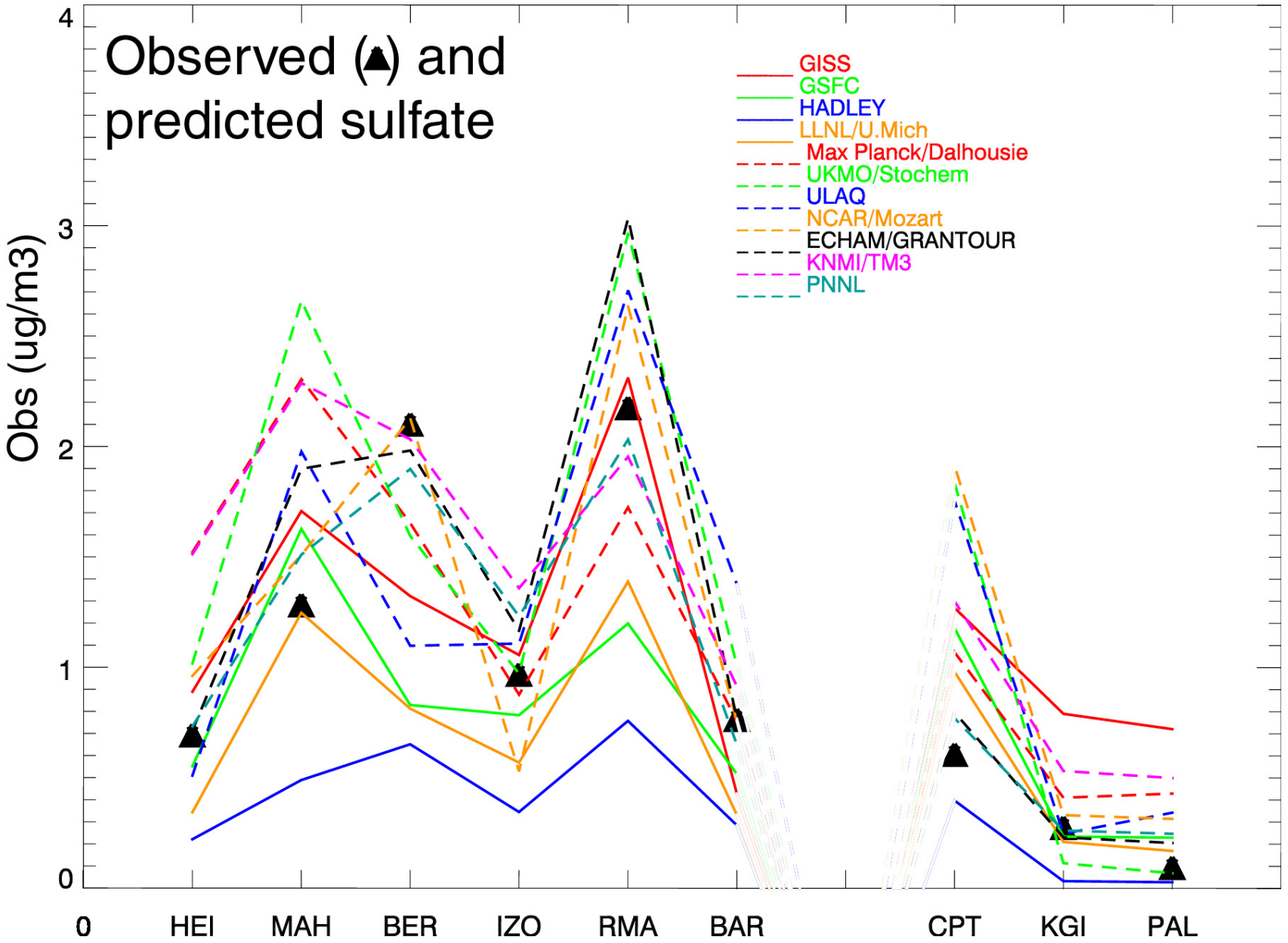
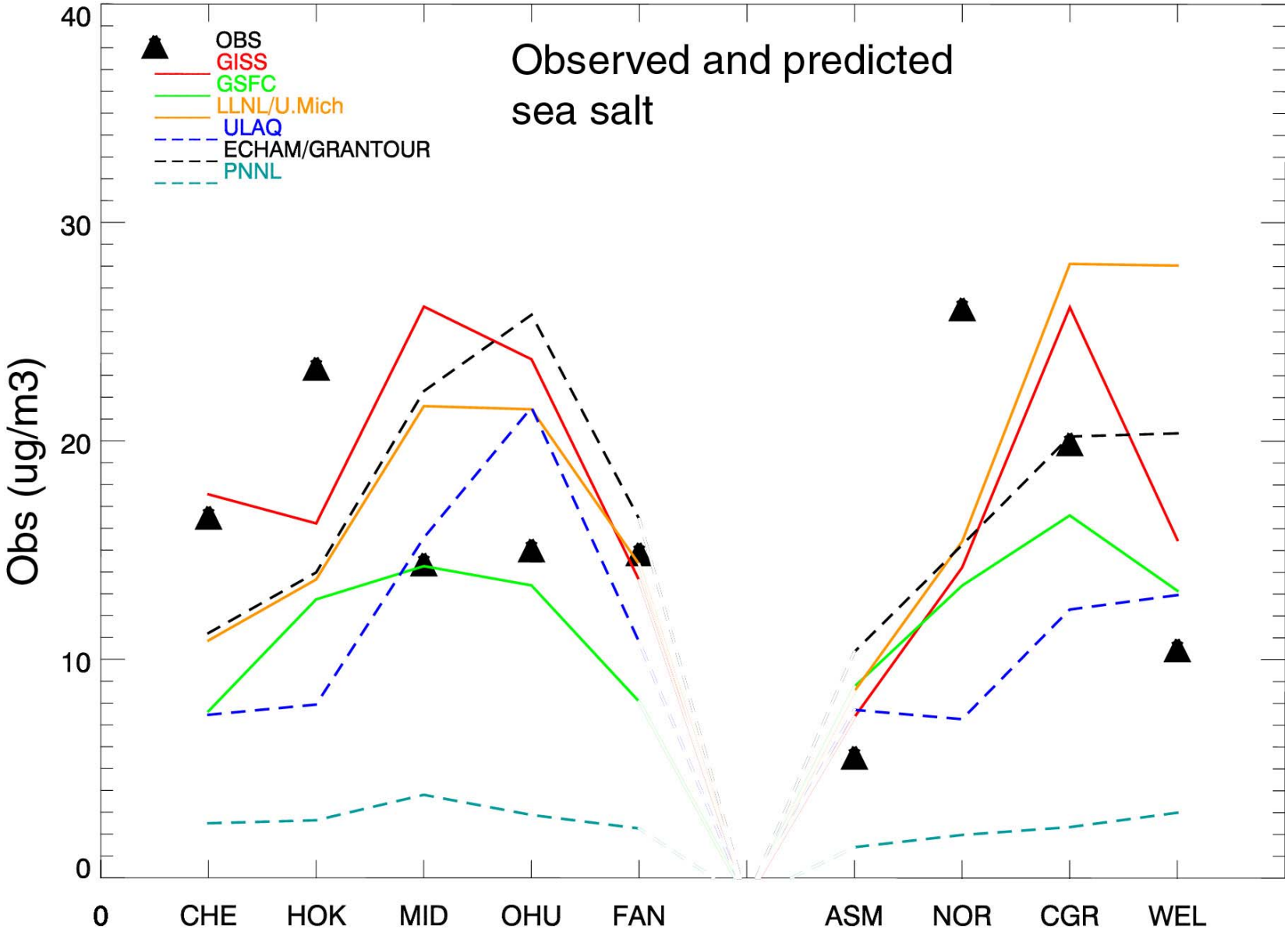
There are major uncertainties in emissions

In assessing models, the emissions should account for differences between the year of the emissions and year of observations

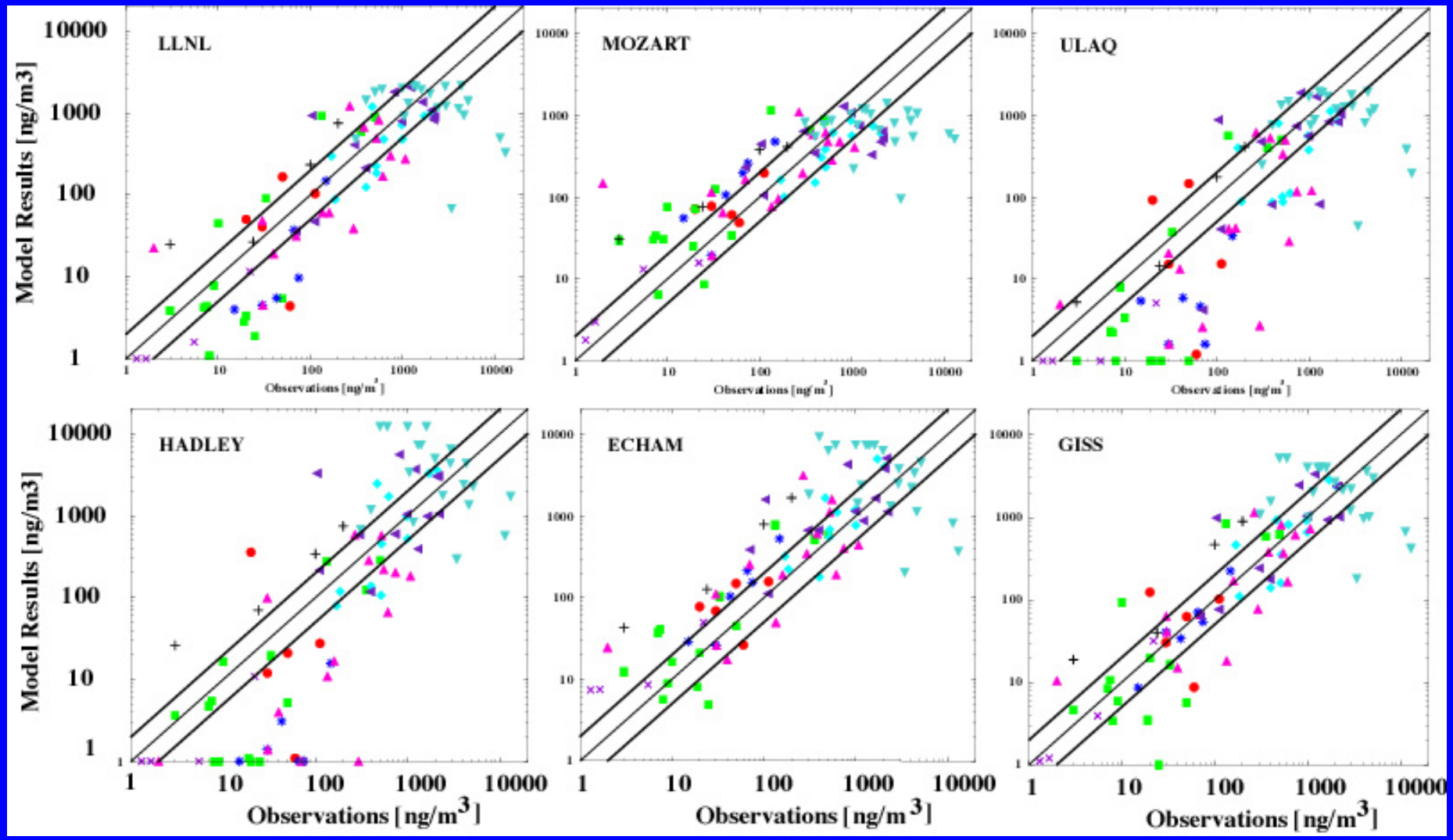
The quality of the simulation should be judged in light of uncertainties in emissions

	Anthropogenic		Natural	
Aerosol type	Source strength ($Tg\ yr^{-1}$)	Range	Source strength ($Tg\ yr^{-1}$)	Range
Sulfates (as HSO_4-)	104	(59-182)	67	(32-142)
Organic Carbon	20	(10-30)	14	(8-40)
Black Carbon	7	(4-11)		
Smoke	70	(50-90)	?	
Nitrates (as NO_3^{-})	14	(10-20)	4	(2-8)
Ammonium (as NH_4^{+})	19	(11-34)	12	(6-26)
Sea salt			88	(30-165)
Dust r<1 um	200	(100-300)	200	(100-300)


Observed (▲) and predicted sulfate
GISS
GSFC
HADLEY
LLNL/U.Mich
Max Planck/Dalhousie
UKMO/Stochem
ULAQ
NCAR/Mozart
ECHAM/GRANTOUR
KNMI/TM3
PNNL
Obs (ug/m3)
0
1
2
3
4
0
HEI
MAH
BER
IZO
RMA
BAR
CPT
KGI
PAL


Observed and predicted
sea salt
OBS
GISS
GSFC
LLNL/U.Mich
ULAQ
ECHAM/GRANTOUR
PNNL
Obs (ug/m3)
40
30
20
10
0
0
CHE
HOK
MID
OHU
FAN
ASM
NOR
CGR
WEL

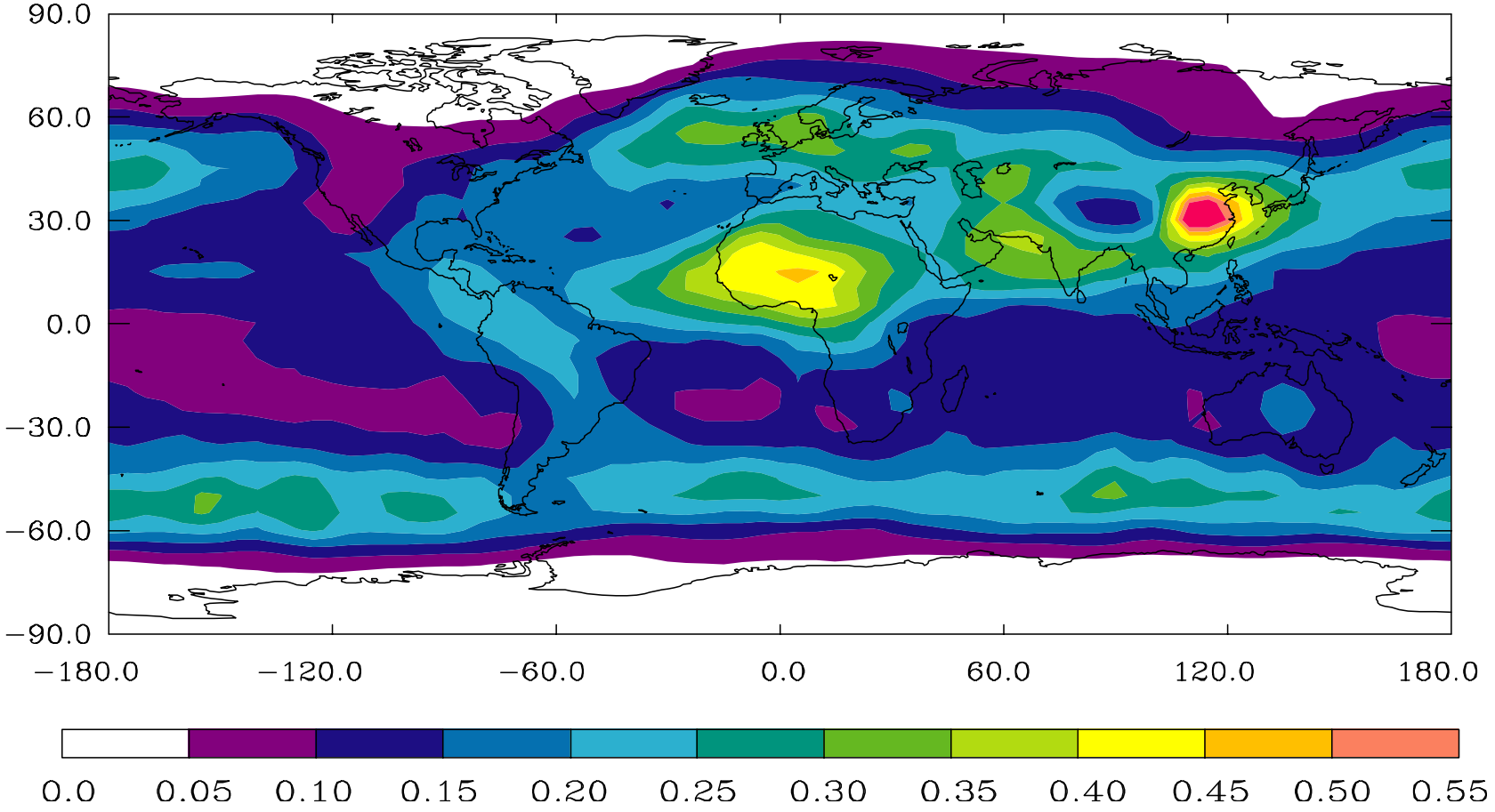
Observed and predicted black carbon



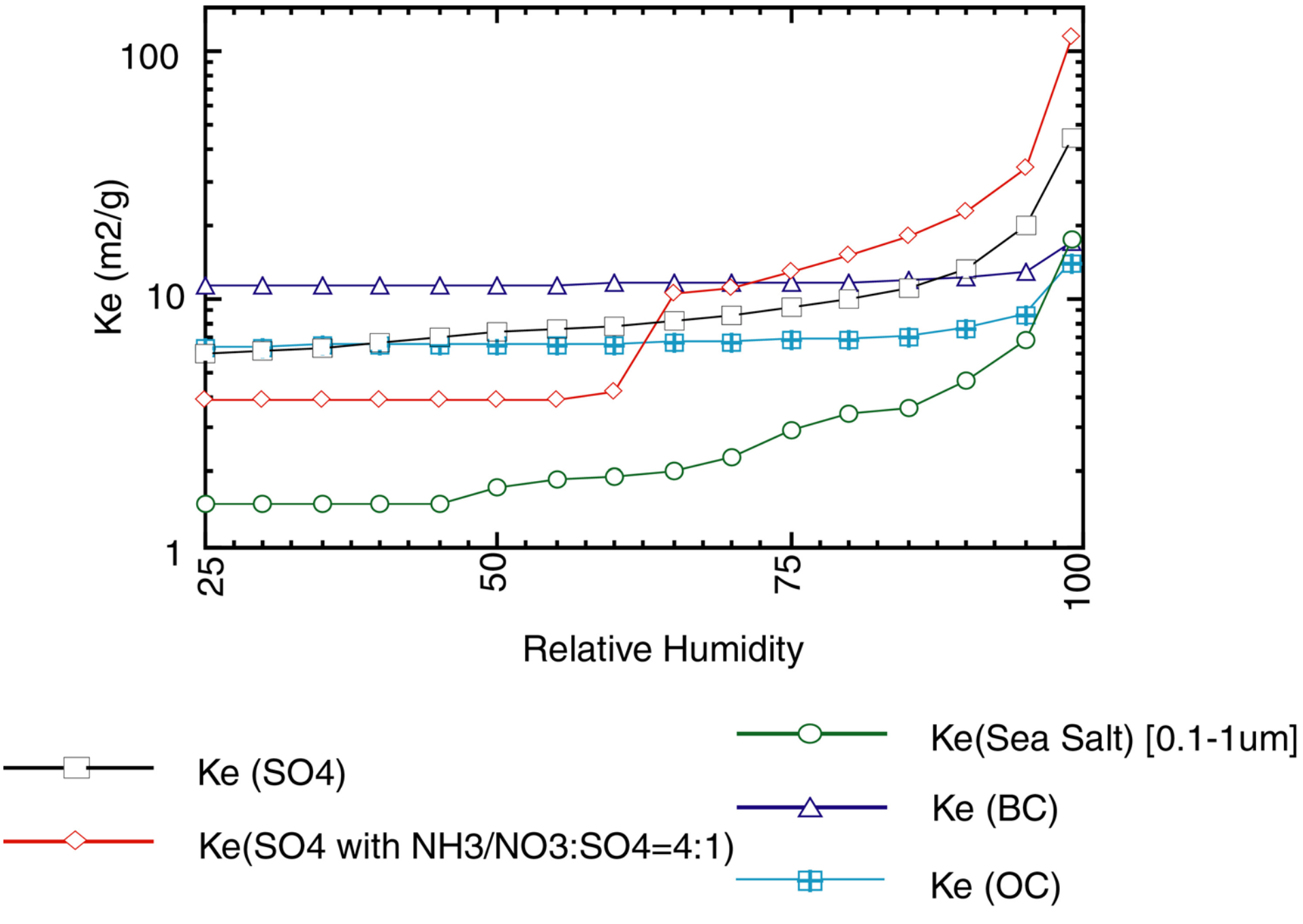
Average absolute error between models and observations of aerosol species at selected surface locations (%).

Model	Sulfate	Black Carbon	Organic Carbon	Dust	Sea Salt
GISS	31	127	121	121	40
GSFC	15	219	134	42	30
Hadley	16	220			
CCM/Grantour	15	111	85	80	68
ECHAM	35	276	285		
Stochem	34				
ULAQ	17	84	100	35	88
Mozart	31	211			
ECHAM/Grantour	31	230	135	70	33
TM3	46				
PNNL	21	133	220		16
Average of all	26	179	154	70	46

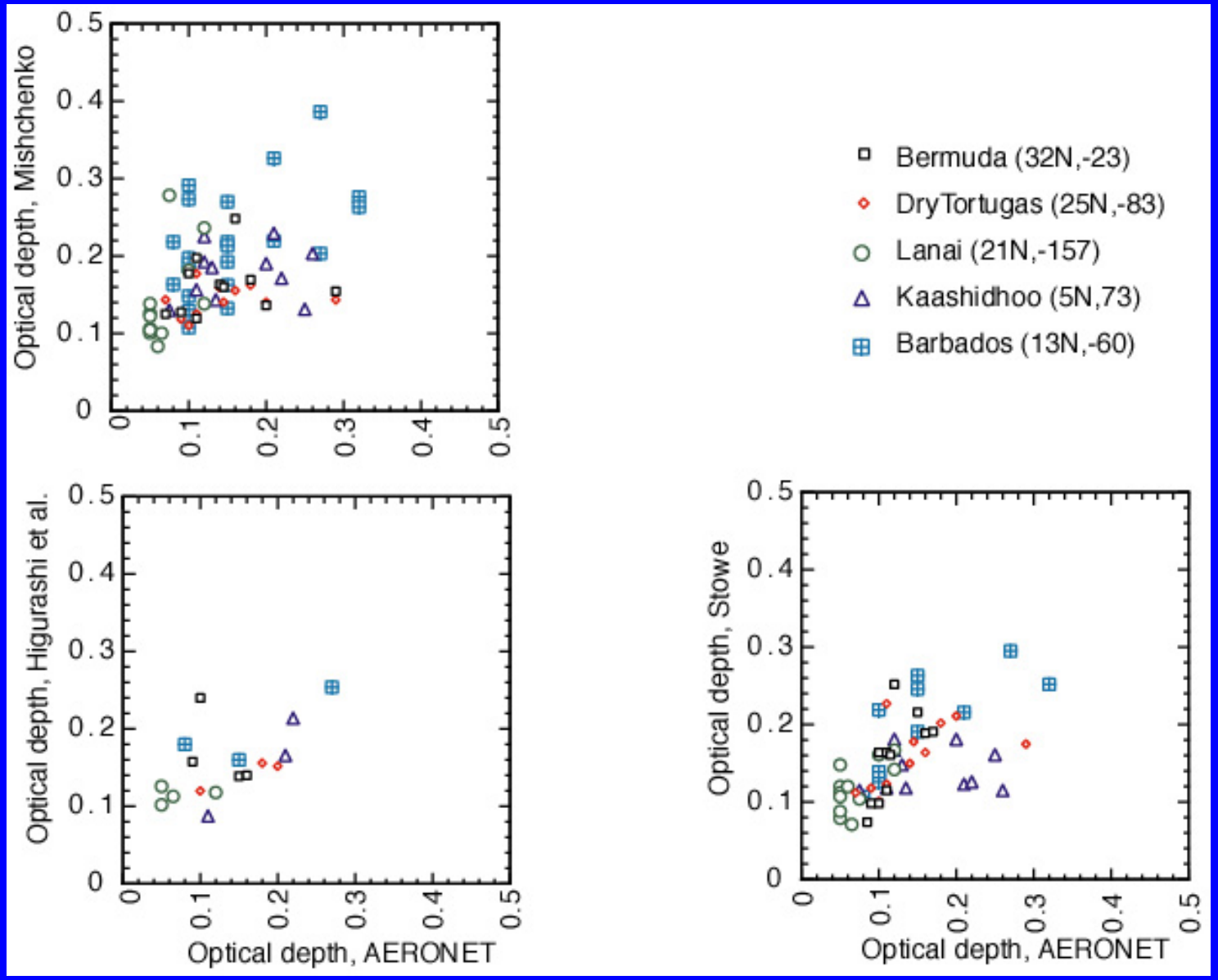
Total optical depth

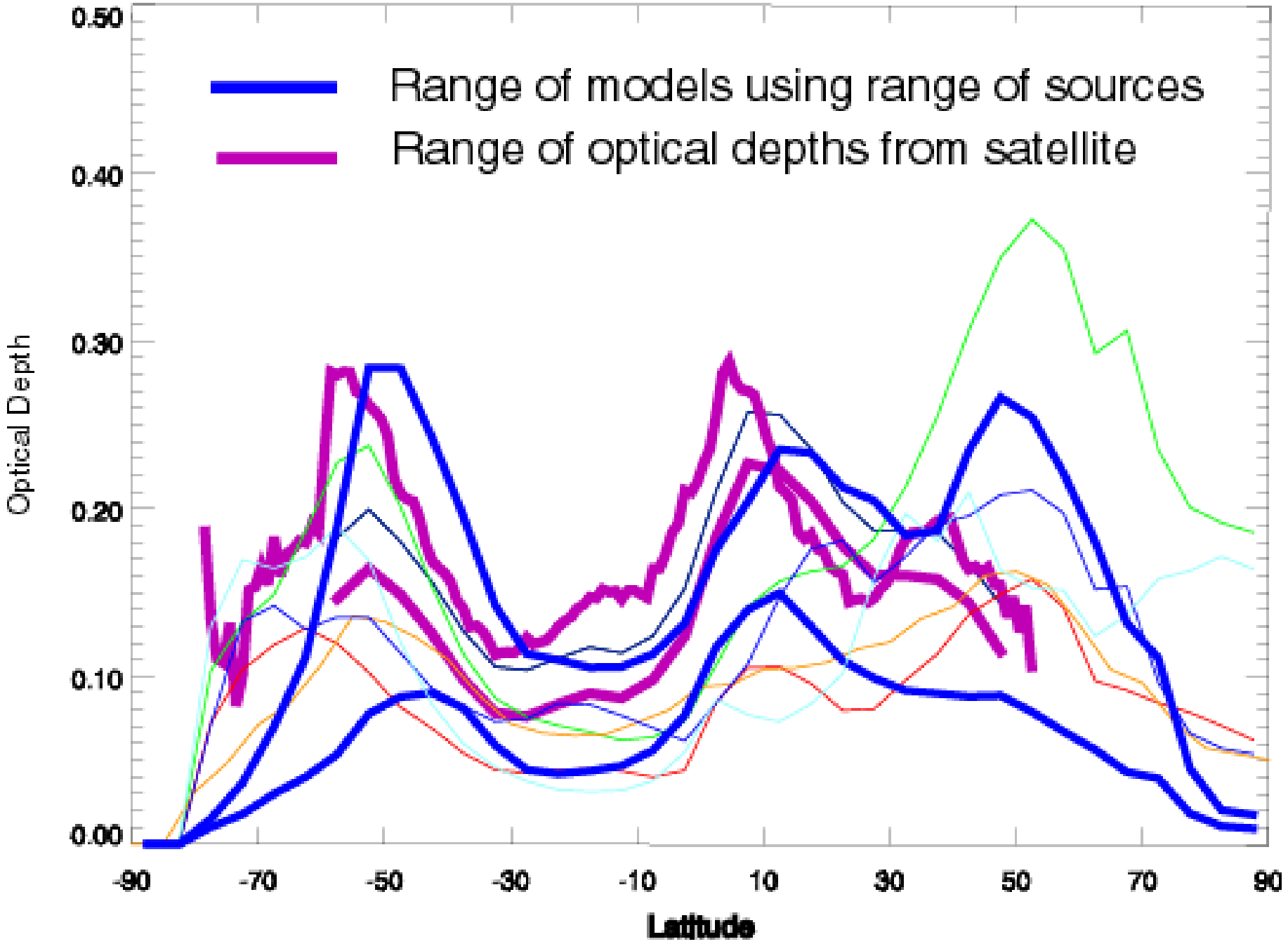


Total optical depth was used to examine the adequacy of the models


100
10
1
Ke (m2/g)
25
50
75
100
Relative Humidity
Ke (SO4)
Ke(SO4 with NH3/NO3:SO4=4:1)
Ke(Sea Salt) [0.1-1um]
Ke (BC)
Ke (OC)

Comparison of AERONET and AVHRR satellite optical depth




Range of models using range of sources
Range of optical depths from satellite
Optical Depth
0.50
0.40
0.30
0.20
0.10
0.00
-90
-70
-50
-30
-10
10
30
50
70
90
Latitude

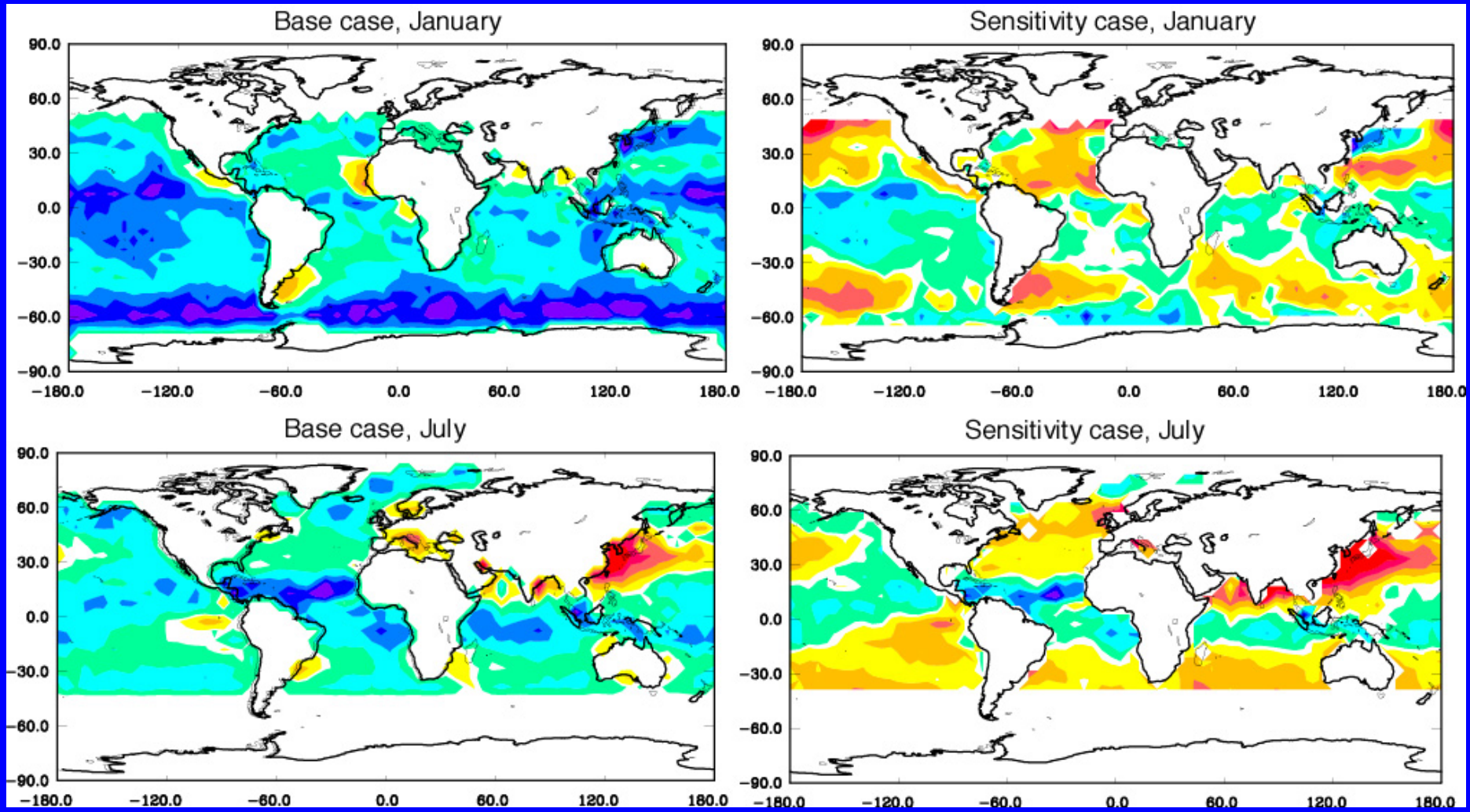
Difference between model-derived optical depth and that for each satellite-retrieved optical depth

4-Month Average	Nakajima	Michchenko	Stowe
CCM1/GRANTOUR	-0.04	-0.06	-0.01
ULAQ	-0.02	-0.04	0.00
MPI/Dalhousie	-0.06	-0.08	-0.03
GISS	-0.05	-0.07	-0.03
ECHAM/GRANTOUR	-0.06	-0.08	-0.03
GOCART	0.01	-0.01	0.04
Model Mean	-0.04	-0.06	-0.01

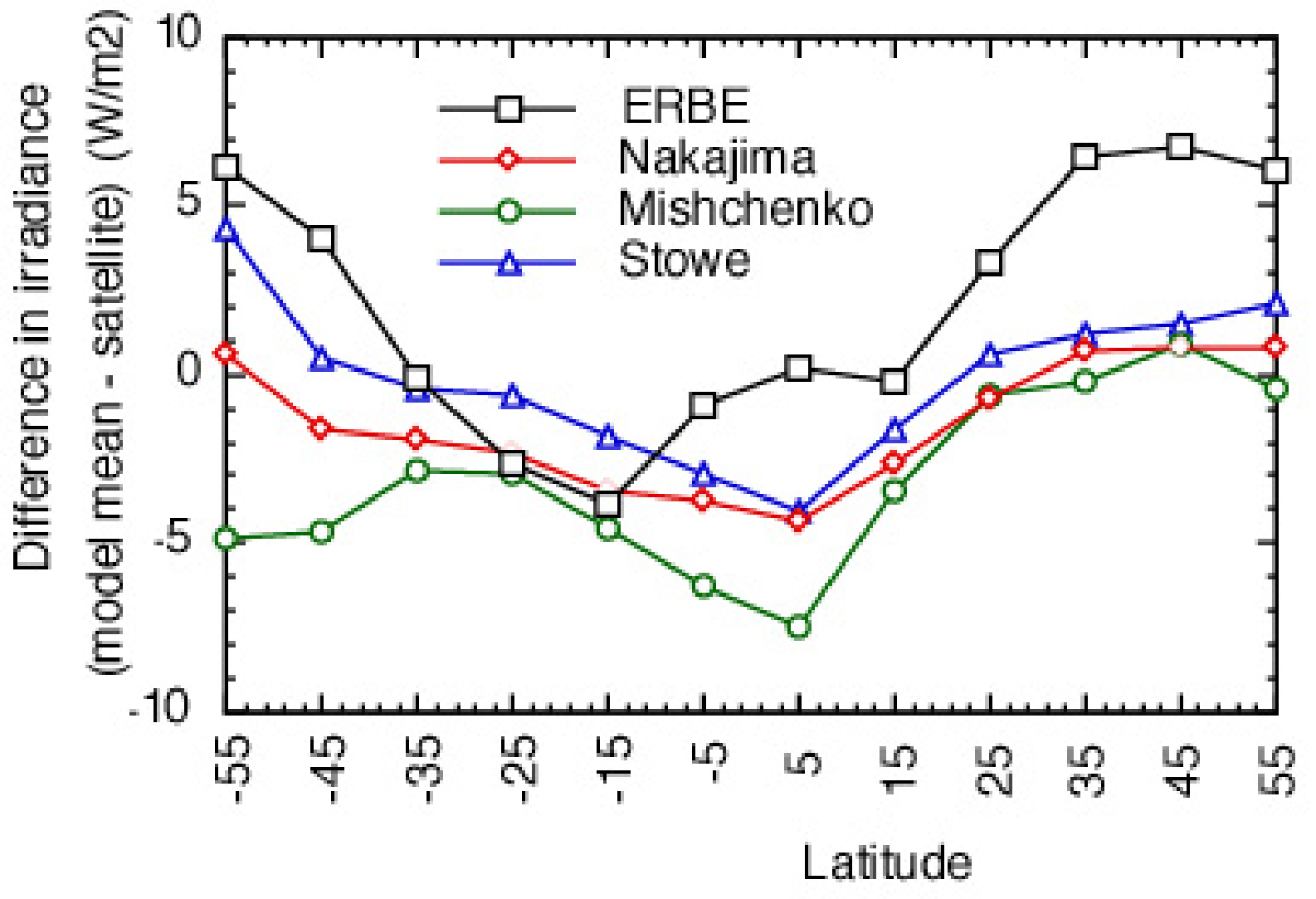
Difference between model-derived aerosol forcing and that for each satellite-retrieved forcing (W/m^2)

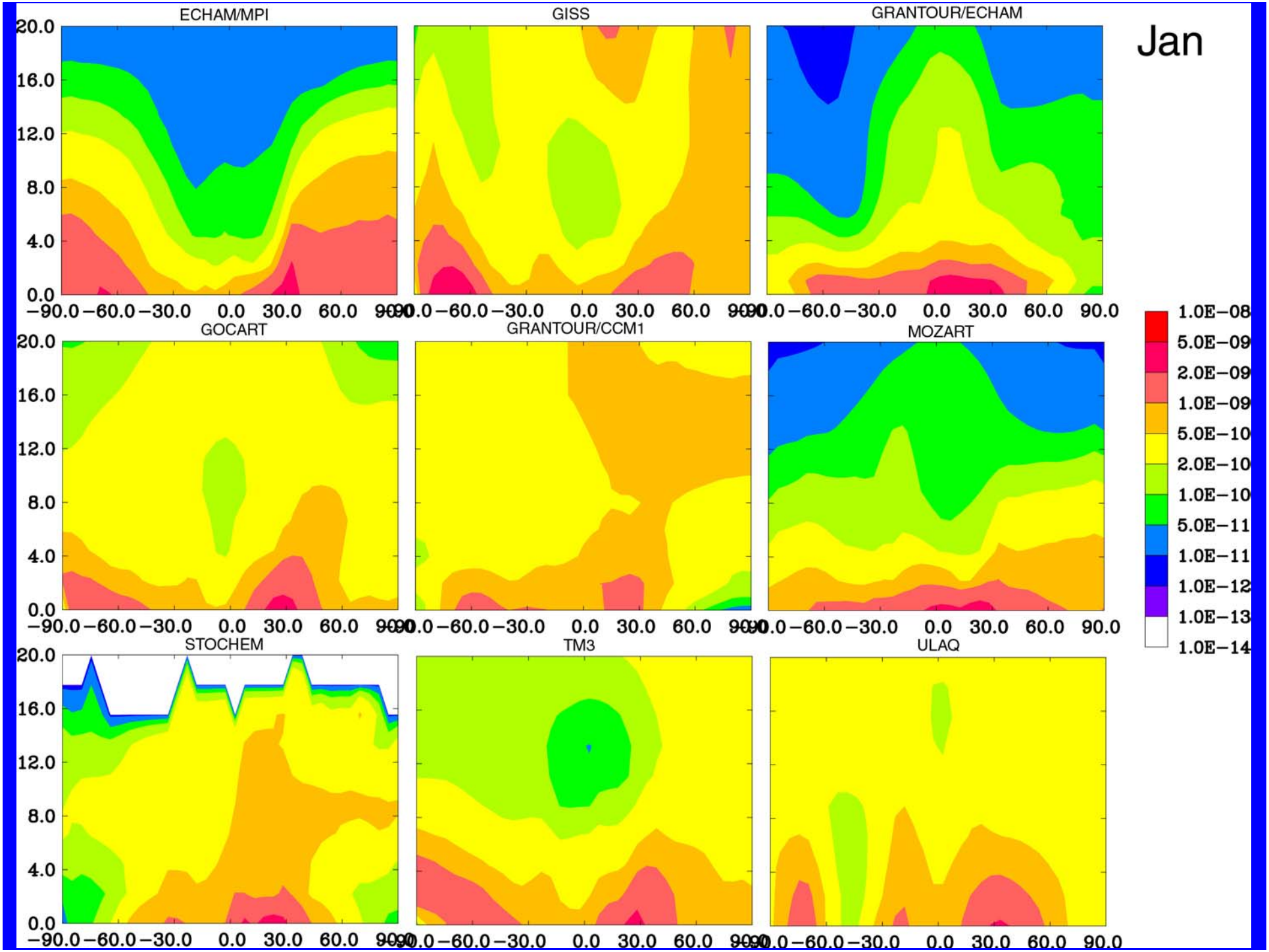
4-Month Average	Nakajima	Michchenko	Stowe
CCM1/GRANTOUR	-2.34	-3.76	-0.84
ULAQ	0.86	-2.00	0.47
MPI/Dalhousie	-2.84	-4.64	-1.40
GISS	-2.82	-4.32	-1.35
ECHAM/GRANTOUR	-3.20	-4.64	-2.04
GOCART	1.04	-0.75	2.19
Model Mean	-1.80	-3.32	-0.47

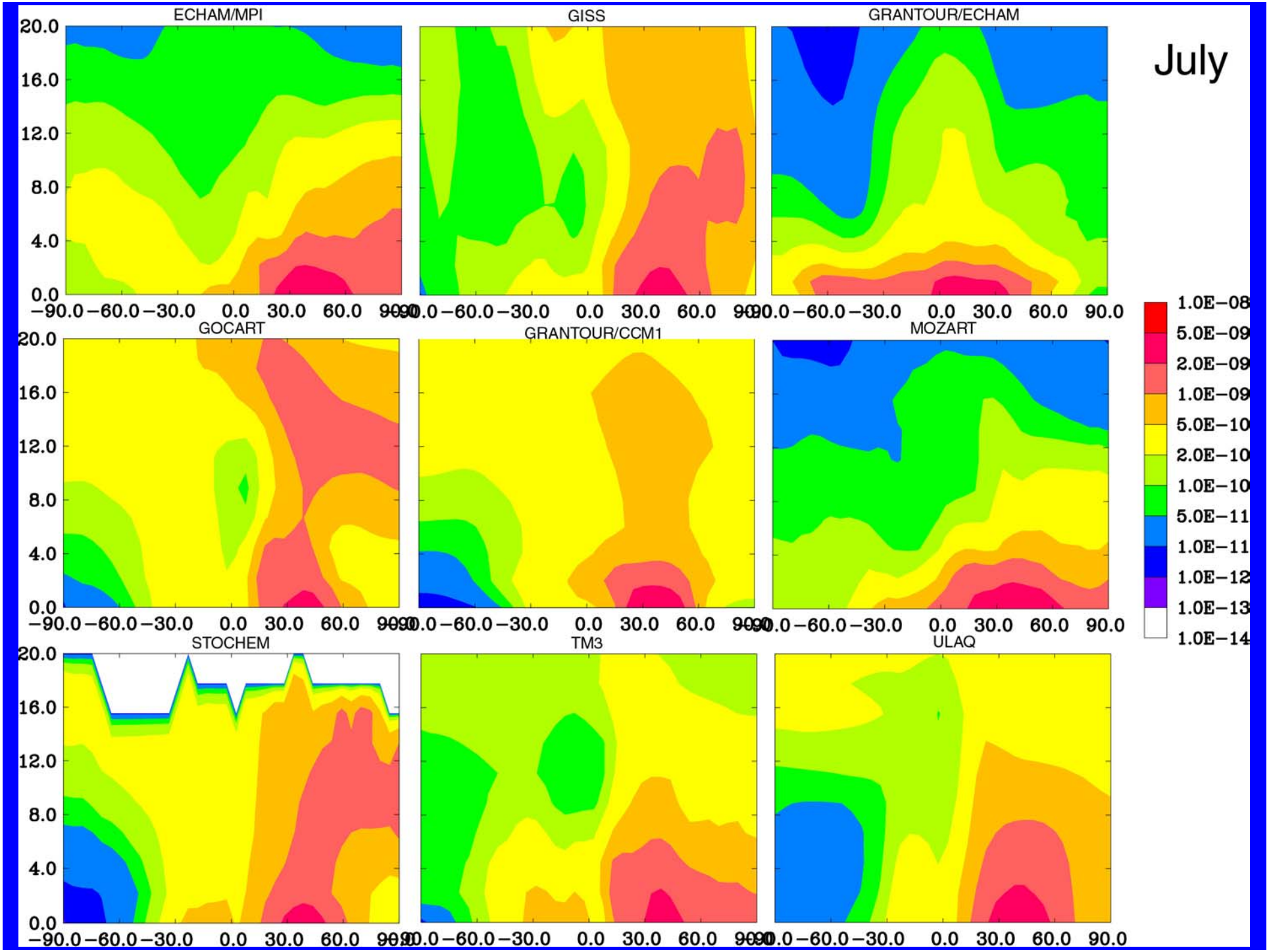
Difference between satellite optical depth and modeled optical depth



Comparison of satellite and modeled optical depth may indicate that forcing estimates from models are too low




ECHAM/MPI
GISS
GRANTOUR/ECHAM
Jan
GOCART
GRANTOUR/CCM1
MOZART
STOCHEM
TM3
ULAQ
20.0
16.0
12.0
8.0
4.0
0.0
−90.0 −60.0 −30.0 0.0 30.0 60.0 90.0
1.0E−08
5.0E−09
2.0E−09
1.0E−09
5.0E−10
2.0E−10
1.0E−10
5.0E−11
1.0E−11
1.0E−12
1.0E−13
1.0E−14


ECHAM/MPI
GISS
GRANTOUR/ECHAM
July
GOCART
GRANTOUR/CCM1
MOZART
STOCHEM
TM3
ULAQ
20.0
16.0
12.0
8.0
4.0
0.0
−90.0 −60.0 −30.0 0.0 30.0 60.0 90.0
1.0E−08
5.0E−09
2.0E−09
1.0E−09
5.0E−10
2.0E−10
1.0E−10
5.0E−11
1.0E−11
1.0E−12
1.0E−13
1.0E−14