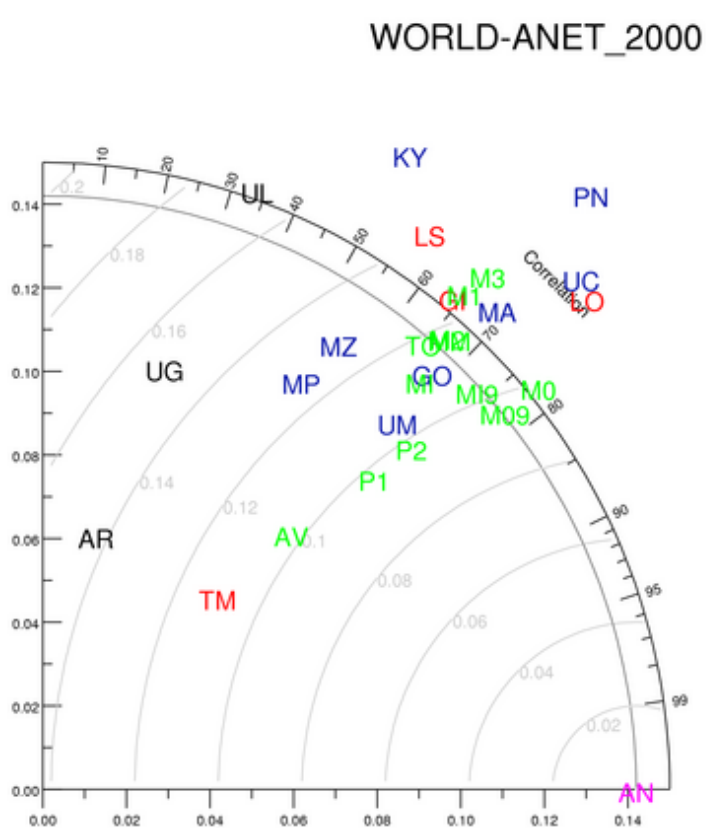
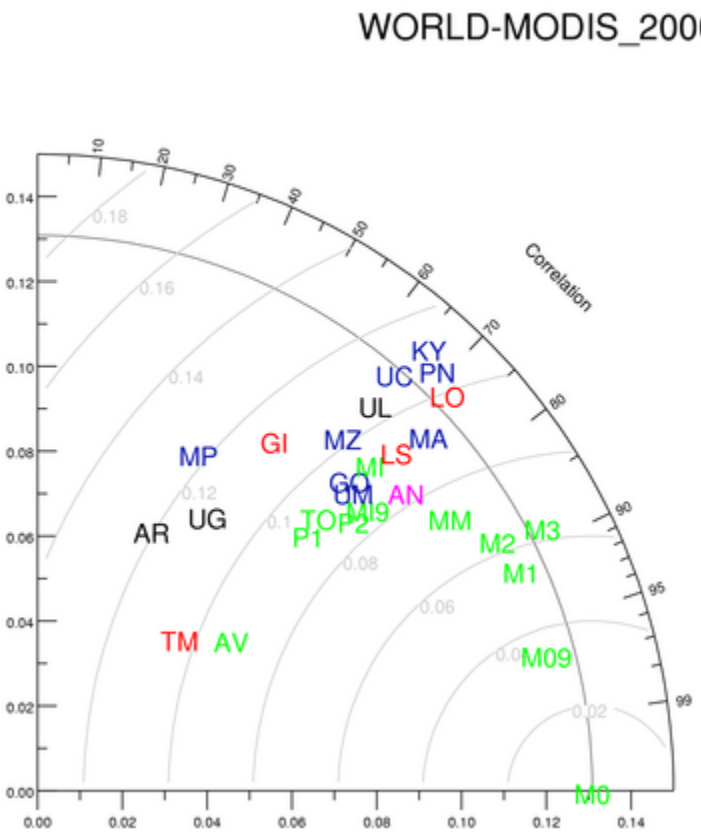
Discussion of the forcing estimates from AeroCom

M. Schulz, Y. Balkanski, O. Boucher, P. Stier, H. Feichter, G. Myhre, J. Penner, T. Takemura, S. Bauer, D. Koch, V. Montanaro, G. Pitari, J. Penner, X. Liu, O. Seland, T. Iversen, A. Kirkevag, C. Textor, S. Guibert

Different observations provide different model grades
Satellites (green) have also problems

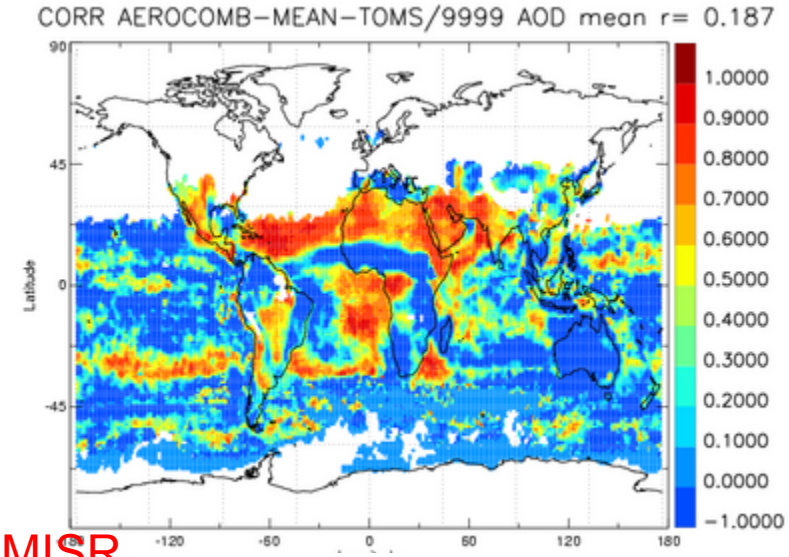




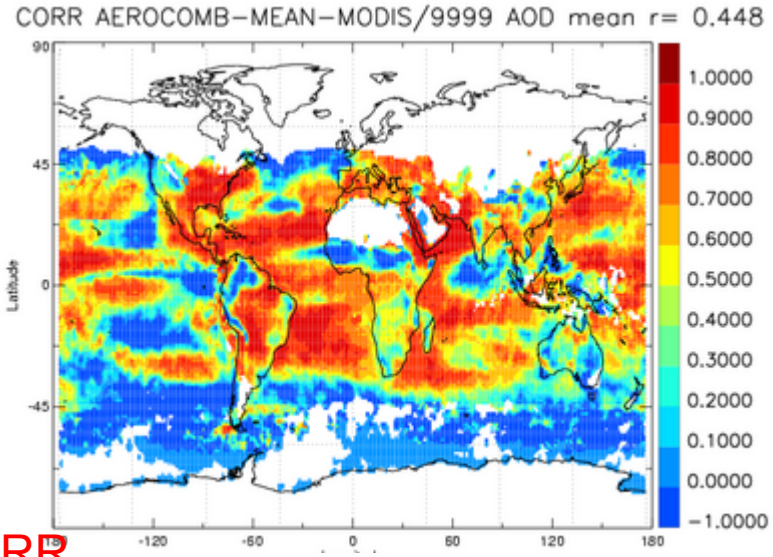
AN: ANET_2000
AR: ARQM_9999
AV: AVHRR_9999
GI: GISS_2000
GO: GOCART_2000
KY: KYU_2000
LO: LOA_2000
LS: LSCE_2000
MA: MATCH_2000
MI: MISR_2000
MI9: MISR_9999
M0: MODIS_2000
M1: MODIS_2001
M2: MODIS_2002
M3: MODIS_2003
M09: MODIS_9999
MM: MODMIS_2000
MZ: MOZGN_2000
MP: MPI_HAM_200
PN: PNNL_2000
P1: POLDER_1997
P2: POLDER_2003
TM: TM5_B_2000
TO: TOMS_9999
UC: UIO_CTM_200
UG: UIO_GCM_999
UL: ULAQ_9999
UM: UMI_2000

Monthly fields of AeroCom Mean Model correlated with 4 satellite products

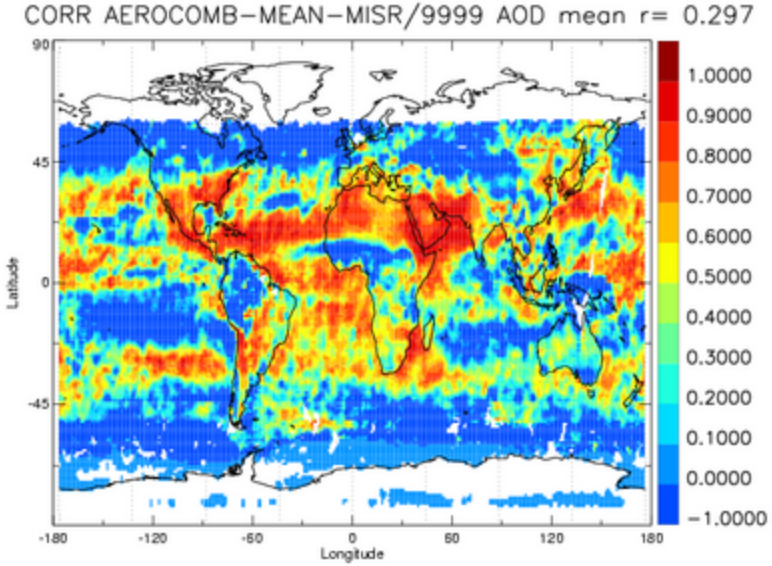
vs TOMS



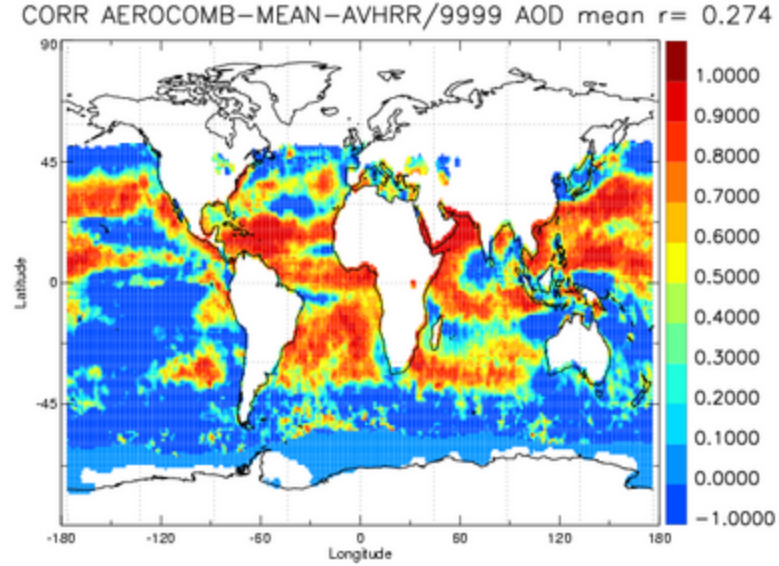
vs MODIS



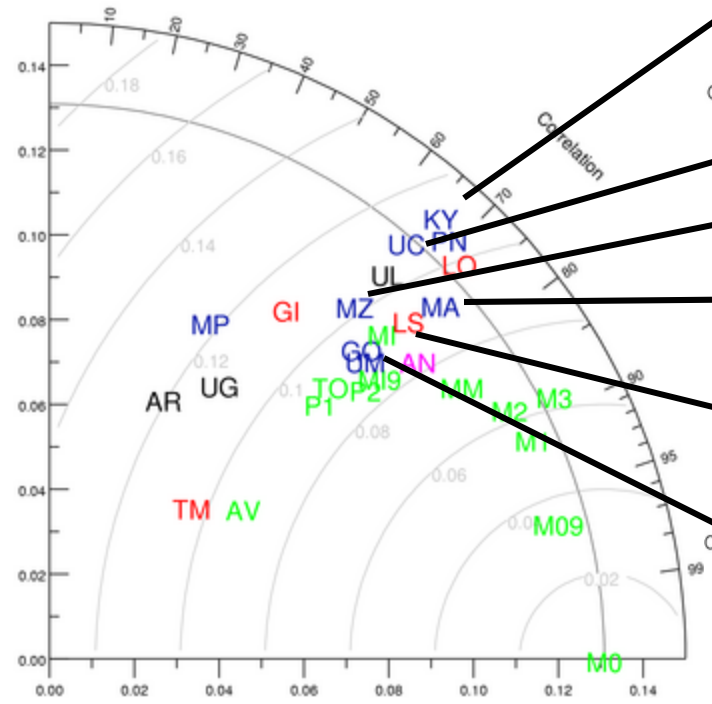
vs MISR

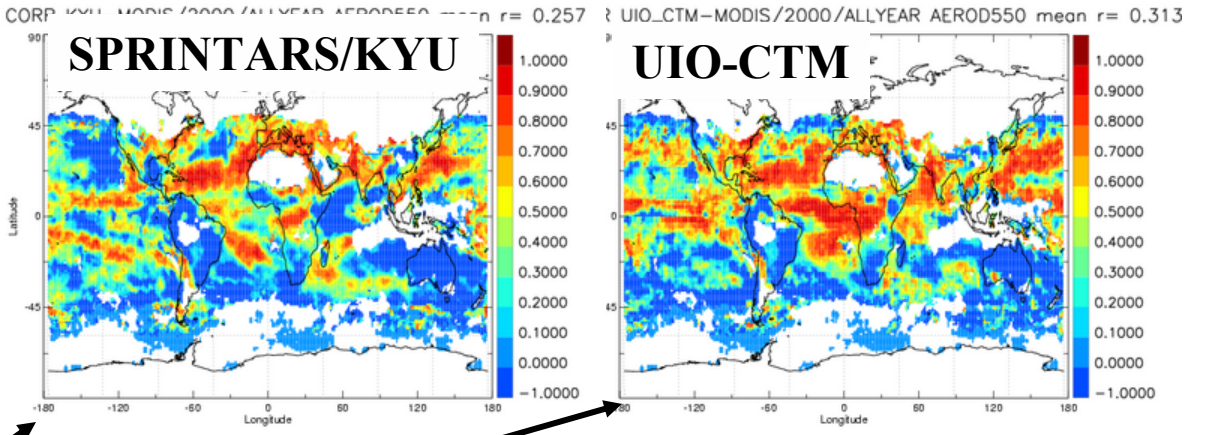


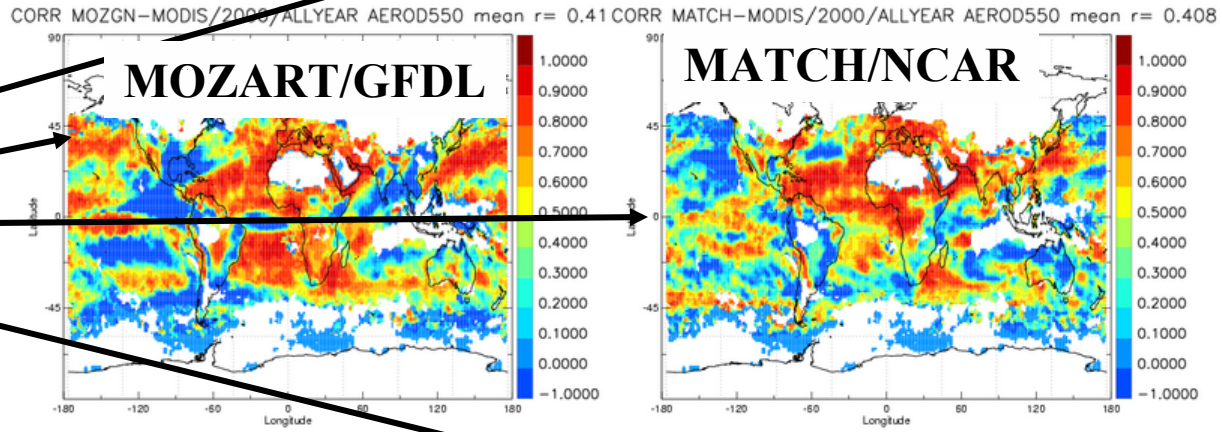
vs AVHRR

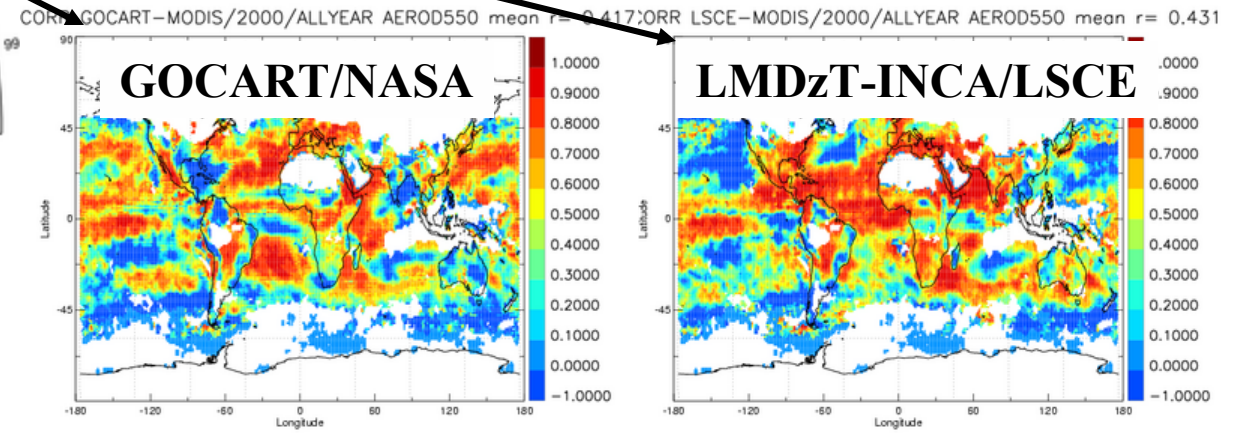


Where is correlation Models vs MODIS



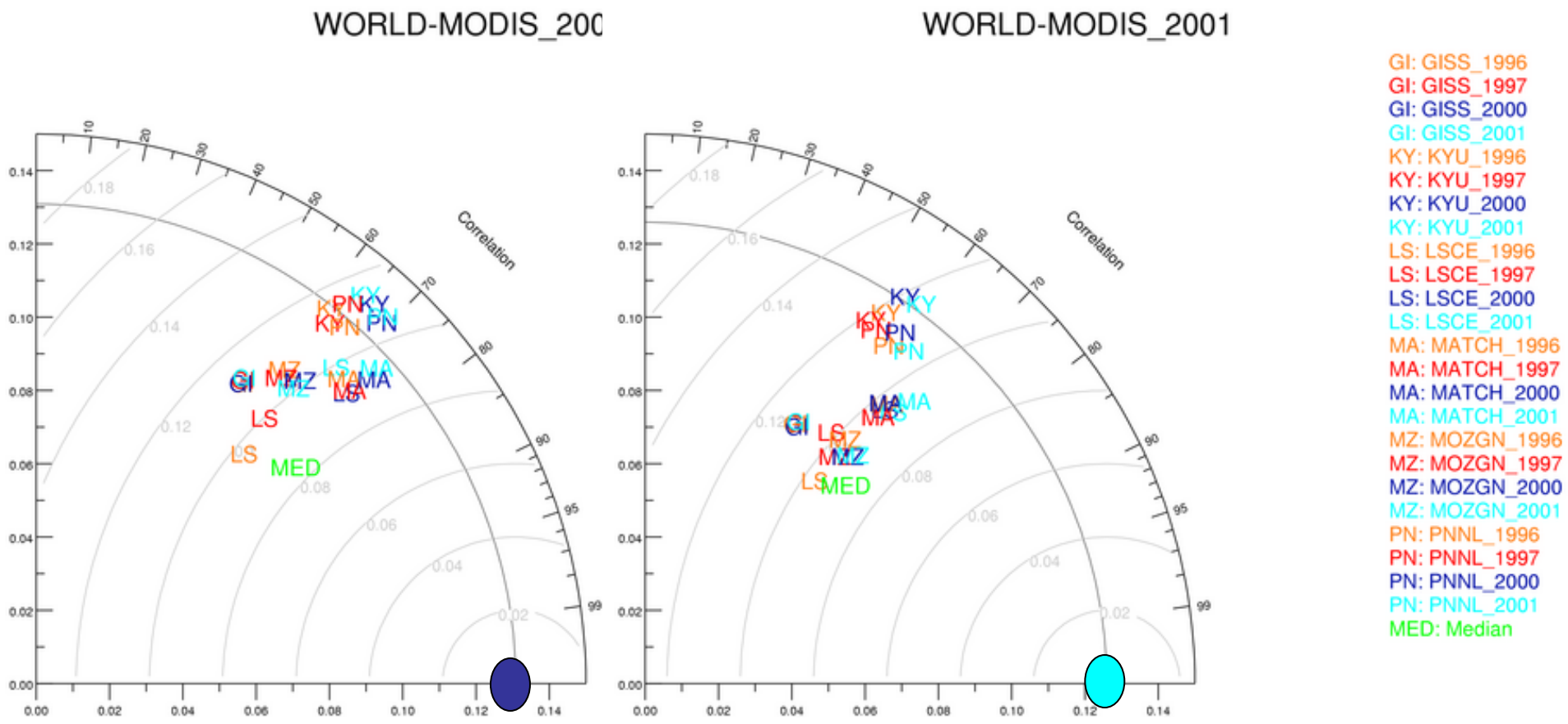






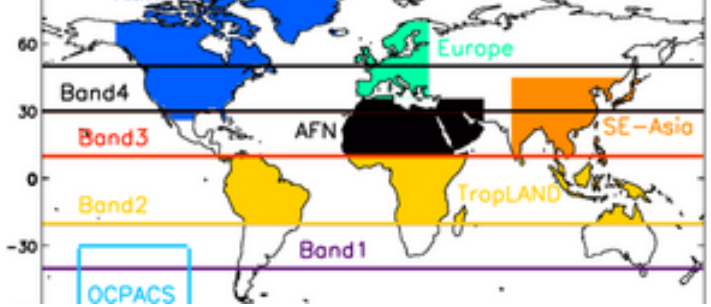
Reproduction of interannual variability
(models have inherent quality, but year shows up as well)

Reference MODIS 2000 **Reference MODIS 2001**

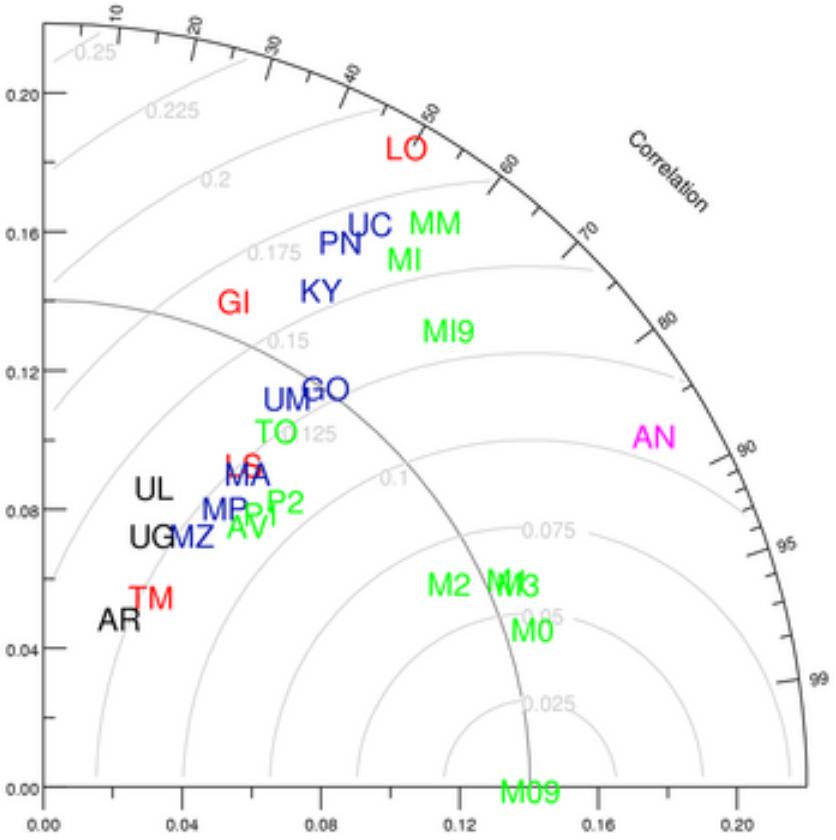


Model simulations of 1996 1997 2000 2001

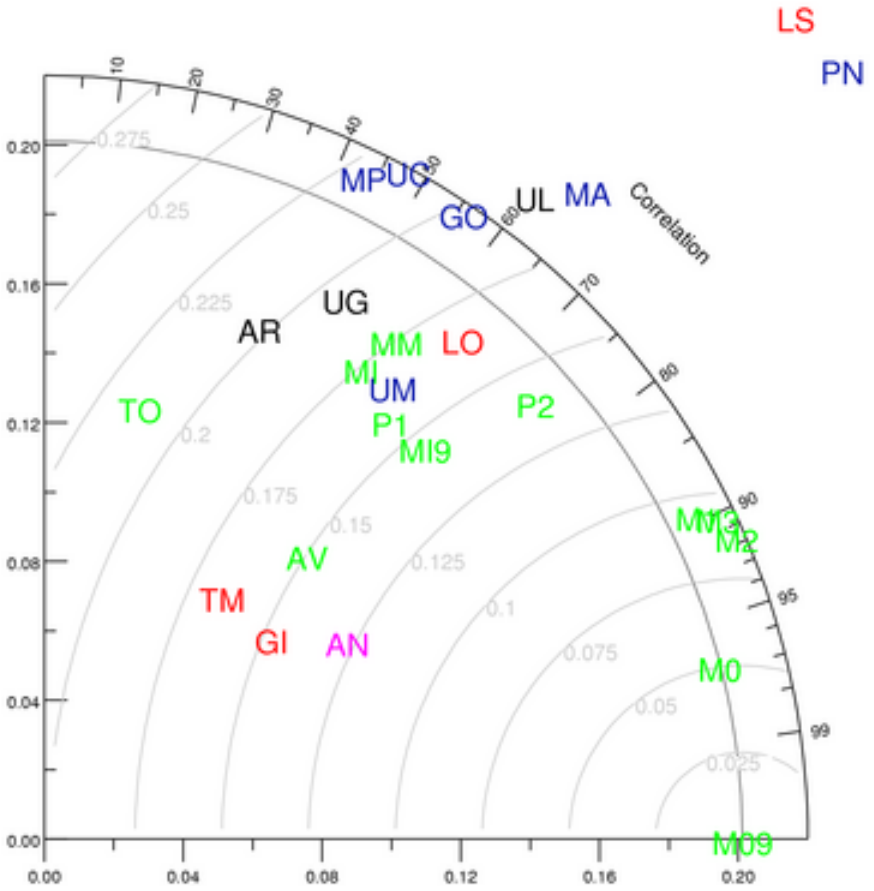
Regional model quality

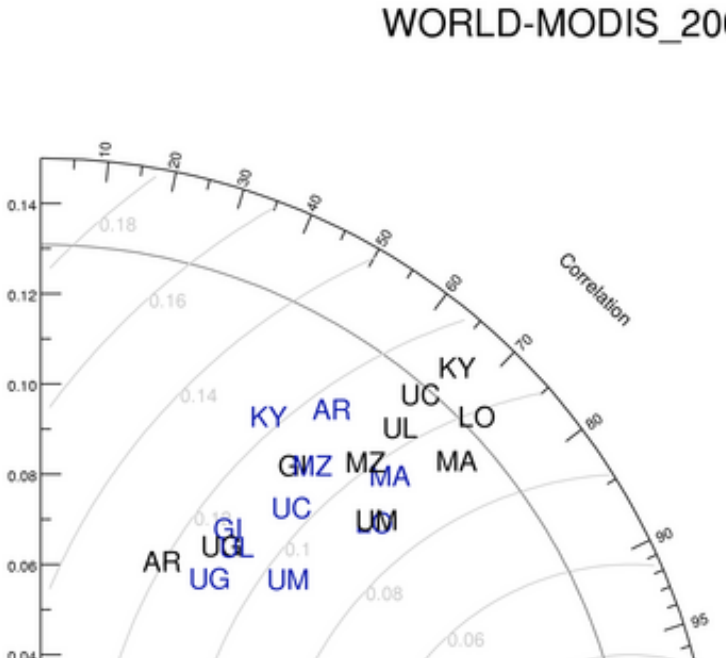


TropLAND-MODIS_9999



AsiaS-MODIS_9999

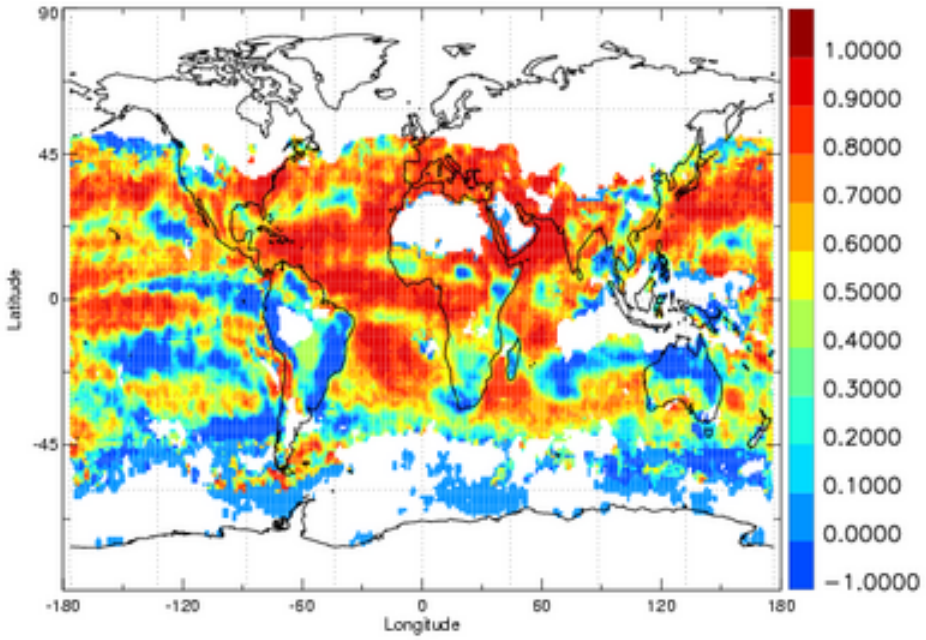




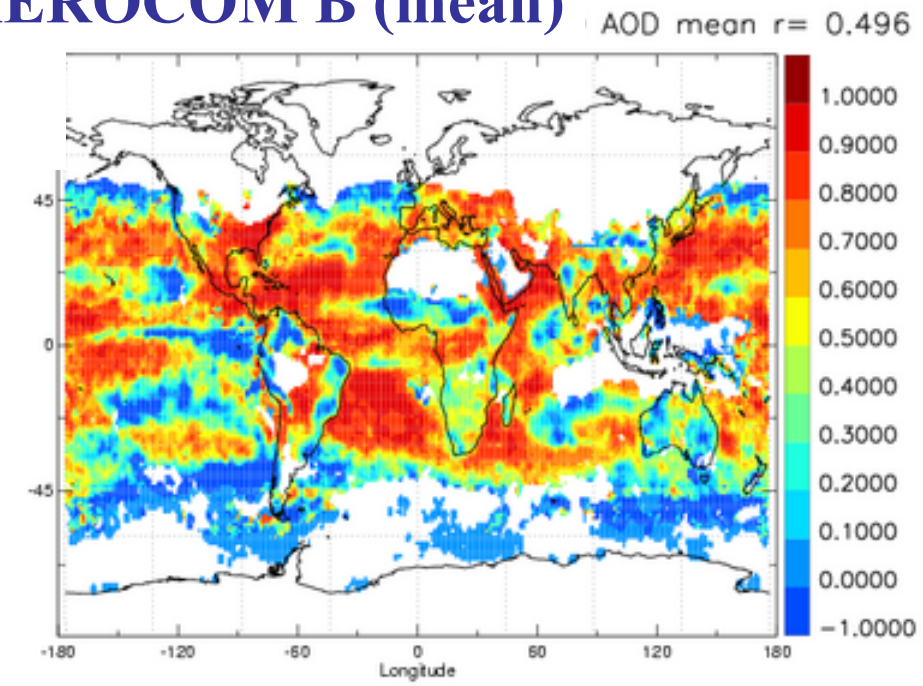
Between AEROCOM Exp. A and B:

The regions where model and obs agree have slightly changed.

AEROCOM A (mean)

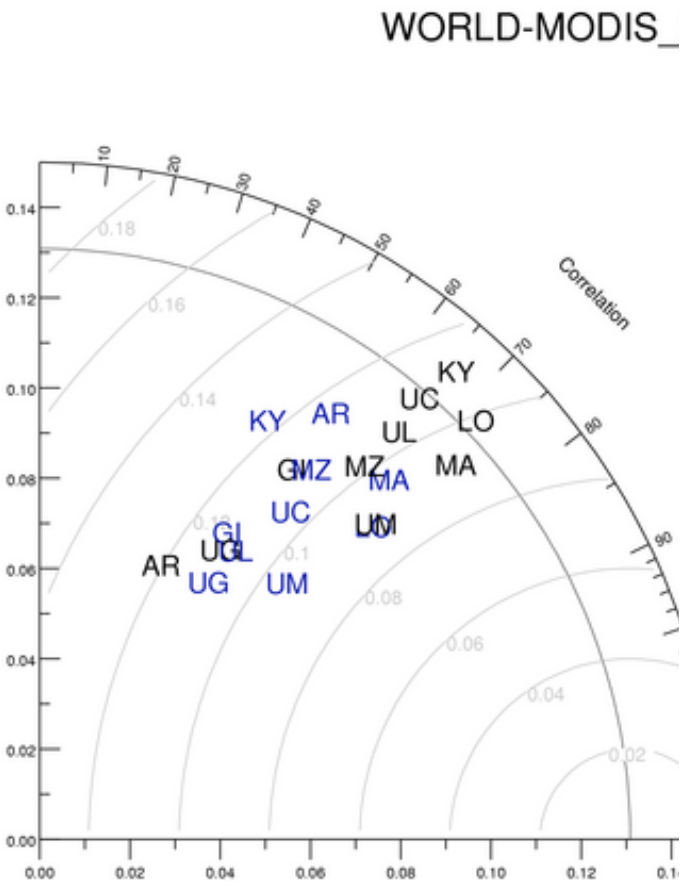


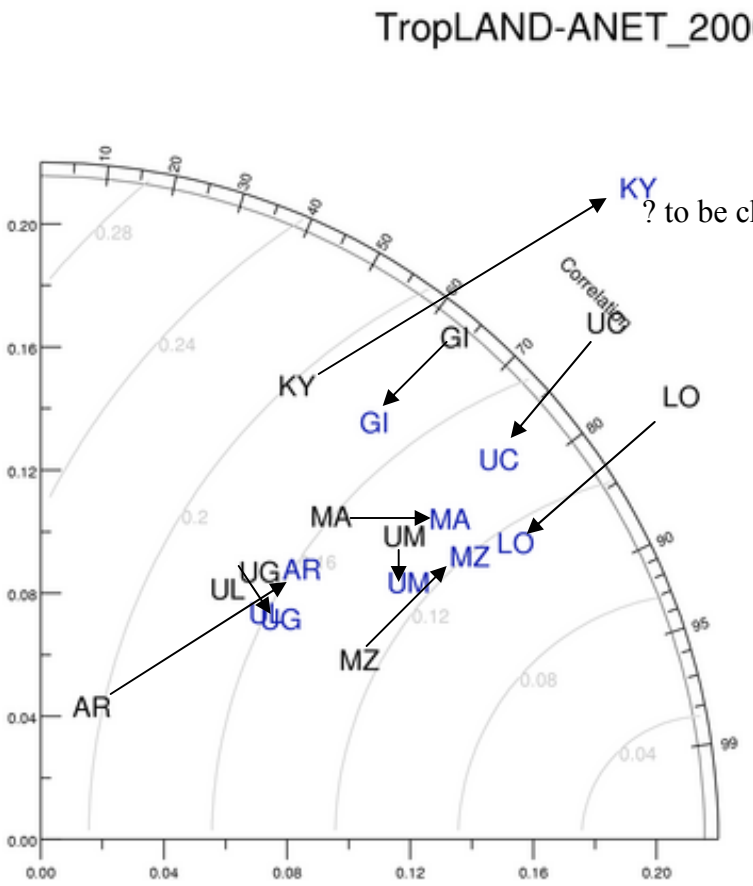
AEROCOM B (mean)



Comparing A an B / Exchanging the model emissions

sometimes worse | but better biomass-seasonality?





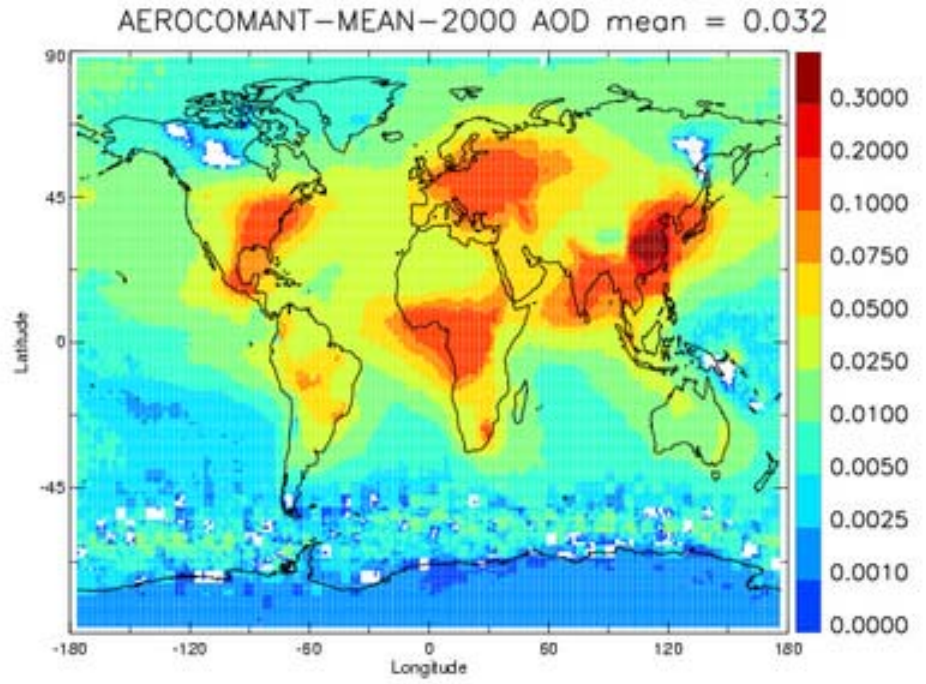
AR: ARQM_9999
AR: ARQM_B_9999
GI: GISS_2000
GI: GISS_B_2000
KY: KYU_2000
KY: KYU_B_2000
LO: LOA_2000
LO: LOA_B_2000
MA: MATCH_2000
MA: MATCH_B_200
MZ: MOZGN_2000
MZ: MOZGN_B_200
UC: UIO_CTM_200
UC: UIO_CTM_B_2
UG: UIO_GCM_999
UG: UIO_GCM_B_9
UL: ULAQ_9999
UL: ULAQ_B_9999
UM: UMI_2000
UM: UMI_B_2000

AEROCOM A

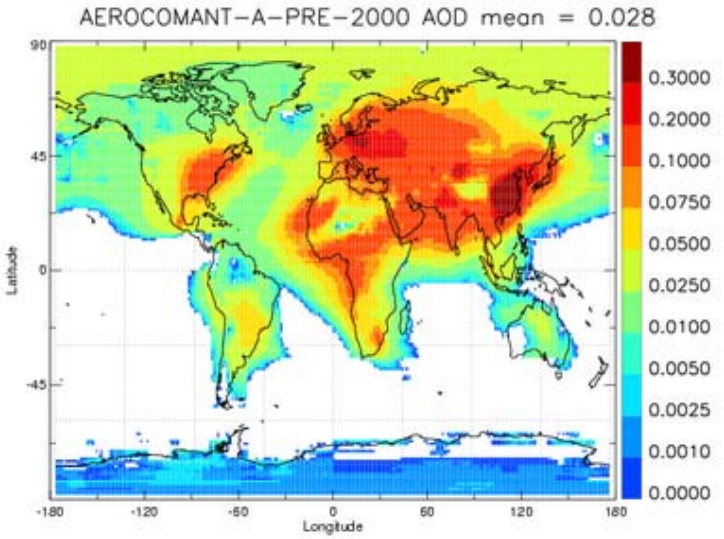
AEROCOM B (models with identical emissions)

Averaged model anthropogenic aerosol optical depth
AEROCOM (B) – (PRE) (2000-1750)

GISS - KYU - LOA - MATCH - MPI_HAM - UIO_GCM – ULAQ
(+ available in principal… LSCE, UIO_CTM, UMI)



AEROCOM
(A) – (PRE)
15 models – 7 models

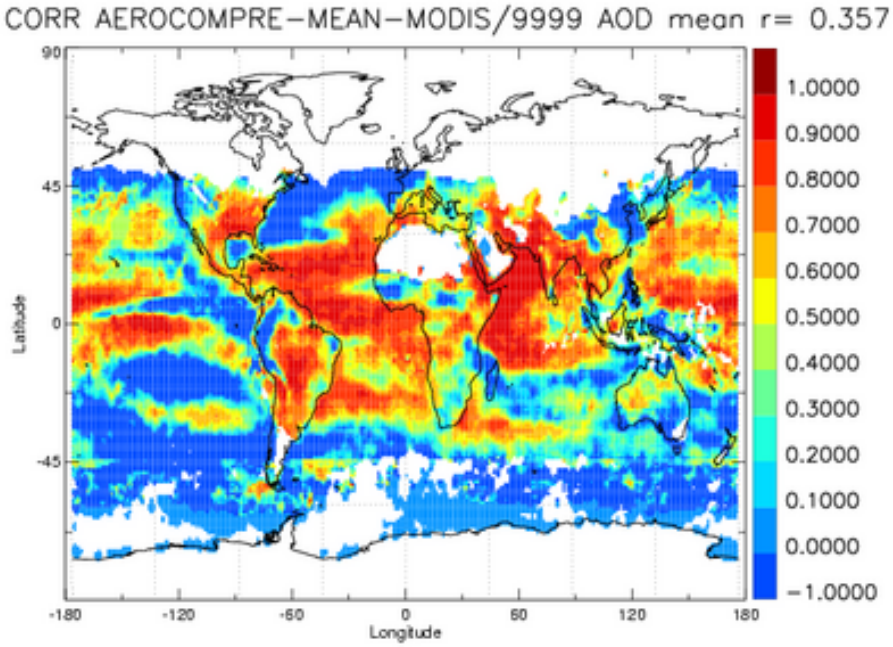


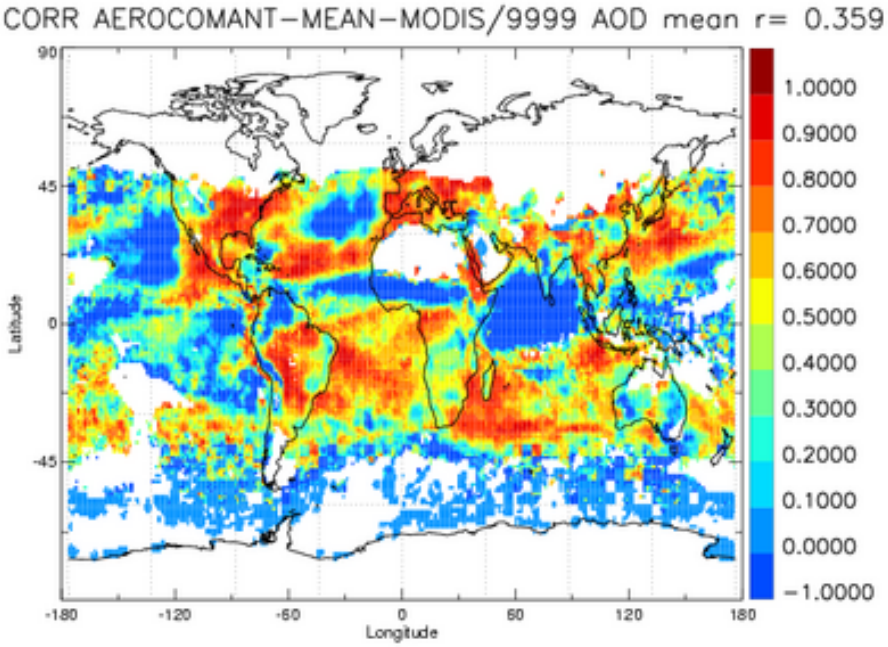
Anthropogenic AOD 25%

How much <regional> variation of MODIS AOD
is explained by modelled natural (75%) & anthropogenic (25%) AOD

<u>Map of correlation coefficients</u>

Natural AOD vs MODIS - Anthropogenic AOD vs MODIS





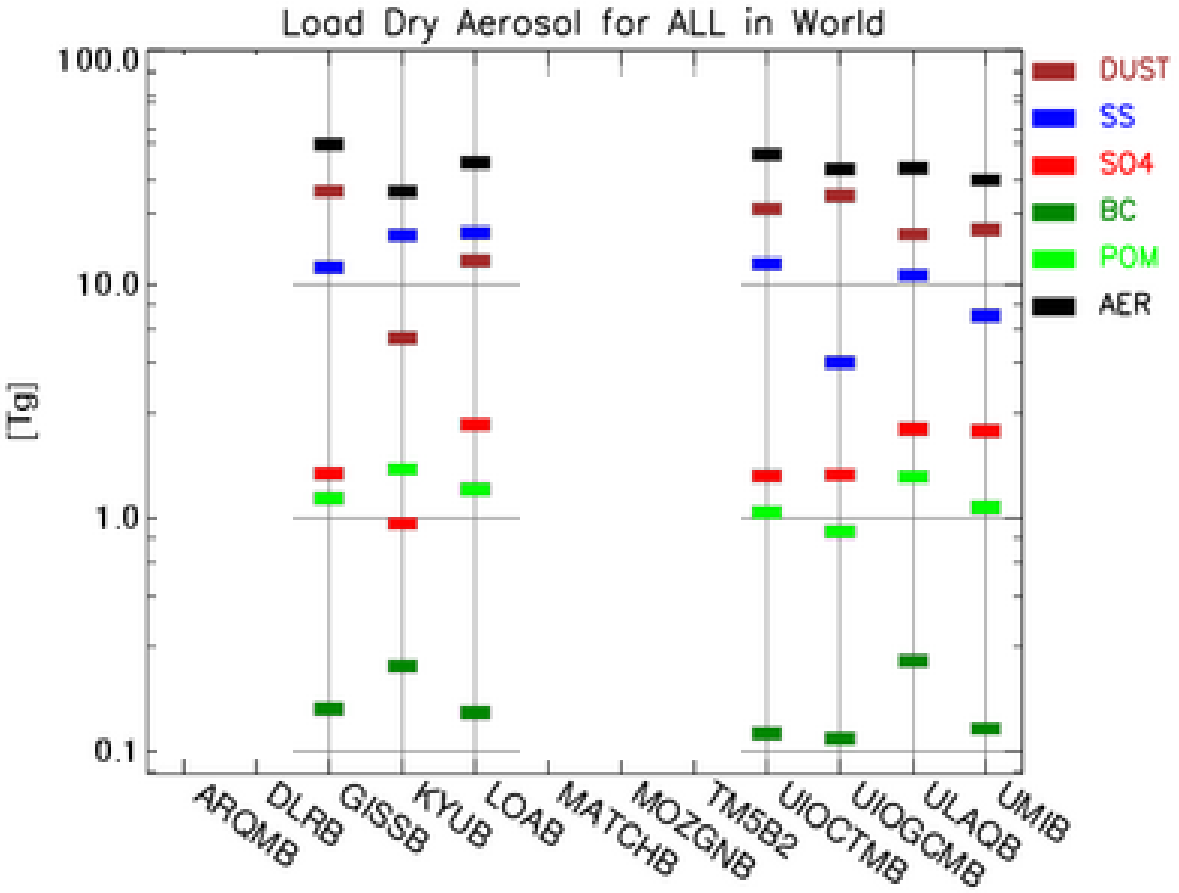
Monthly fields from AEROCOM B and PRE mean models

Anthropogenic aerosol	Top of the atmosphere aerosol forcing global			Cloud Fraction	MEC S04	Aerosol water	BC Load
	all [W/m2]	clear [W/m2]	cloudy [W/m2]	[%]	[m2/g]	[m2/g]	[mg/m2]
UMI	-0.41	-0.80	0.13	33%			0.24
UIO_CTM	-0.34	-0.85	-0.08	70%	32	226	0.23
LSCE (Exp A)	-0.29	-1.27	0.09	70%	23	115	0.43
LOA	-0.23	-0.60	-0.05	70%		155	0.29
MPI_HAM	-0.12	-0.50	0.02	72%	13	149	0.22
GISS	-0.01		-0.01	79%	17		0.30
UIO_GCM	-0.01		-0.01	57%	21	54	0.22
KYU	0.04		0.04	63%	37	49	0.45
ULAQ	0.23				27	72	0.48
Median w/o ULAQ	-0.18						
Median	-0.12						

MEC = Mass extinction coefficient

Global
SW TOA all sky
radiative forcing

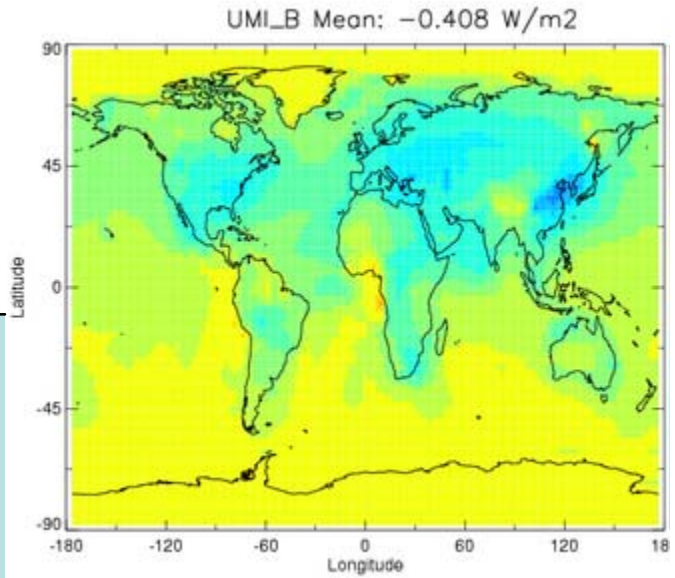
Anthropogenic aerosol	[W/m2]
UMI	-0.41
UIO_CTM	-0.34
LSCE	-0.29
LOA	-0.23
MPI_HAM	-0.12
GISS	-0.01
UIO_GCM	-0.01
KYU	0.04
ULAQ	0.23

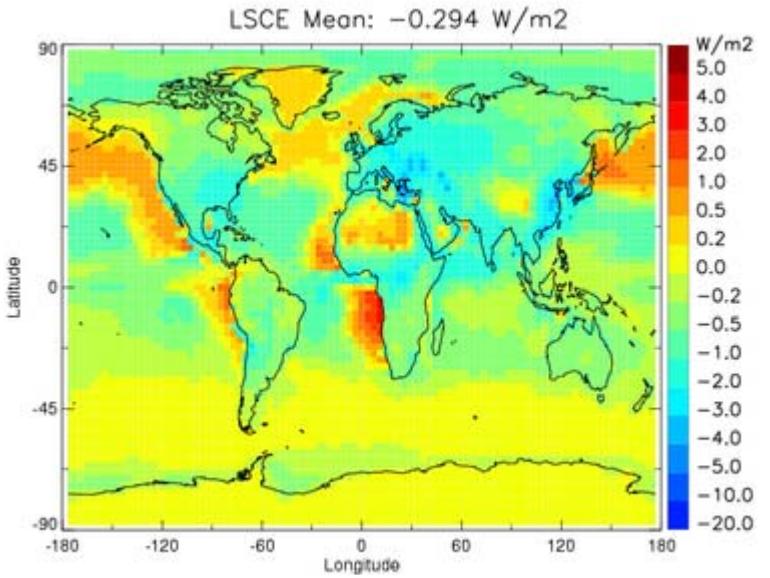


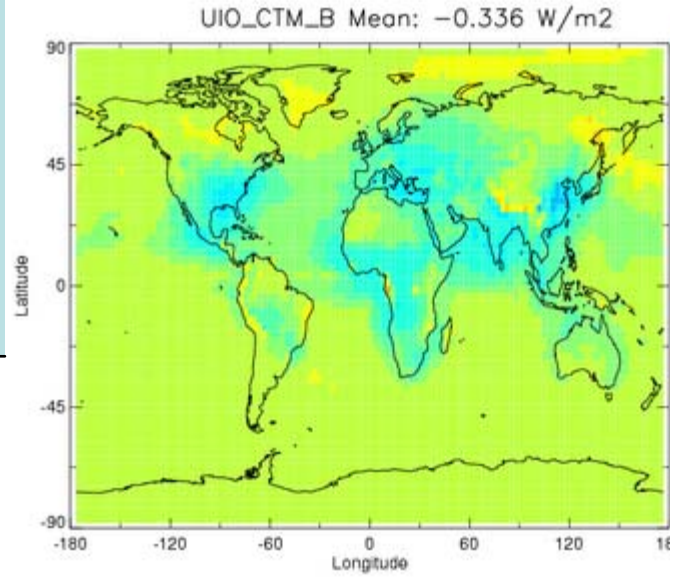
TOA global forcing

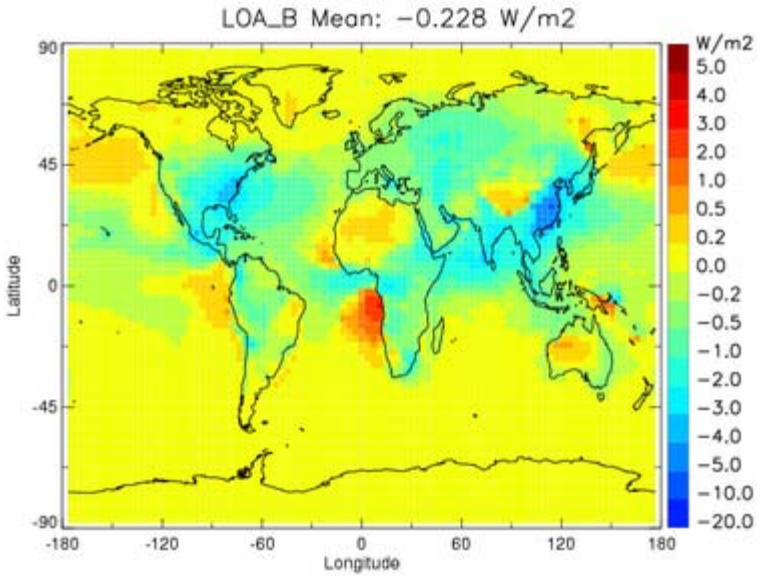
Anthropogenic aerosol

	[W/m2]
UMI	-0.41
UIO_CTM	-0.34
LSCE	-0.29
LOA	-0.23
MPI_HAM	-0.12
GISS	-0.01
UIO_GCM	-0.01
KYU	0.04
ULAQ	0.23









TOA global forcing

Anthropogenic aerosol

	[W/m2]
UMI	-0.41
UIO_CTM	-0.34
LSCE	-0.29
LOA	-0.23
MPI_HAM	-0.12
GISS	-0.01
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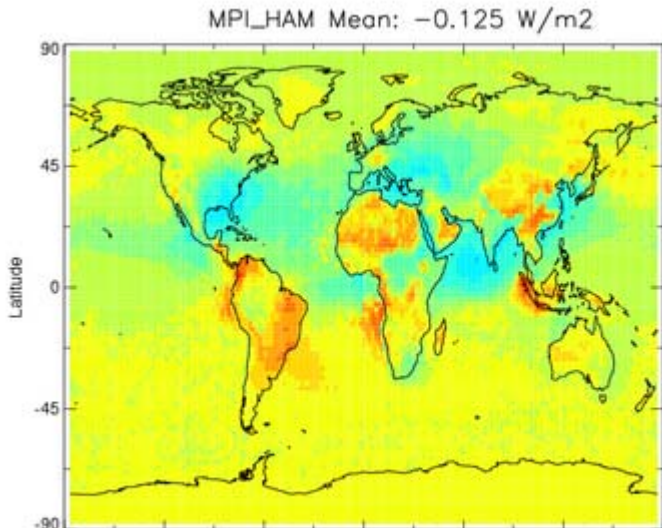
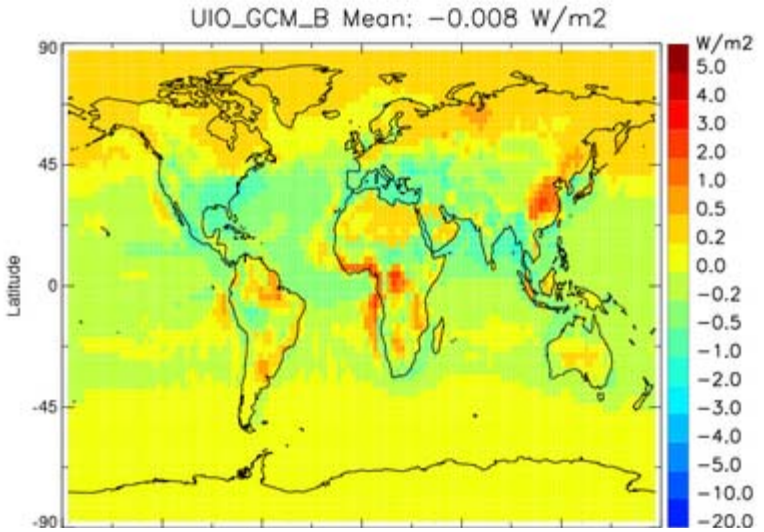
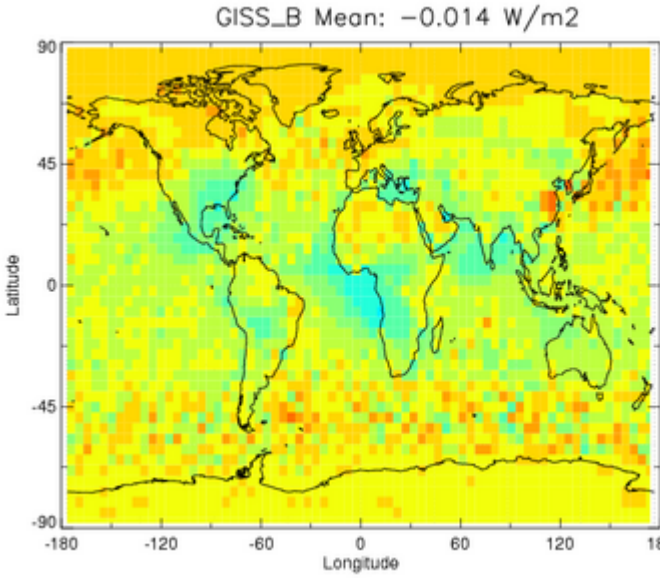
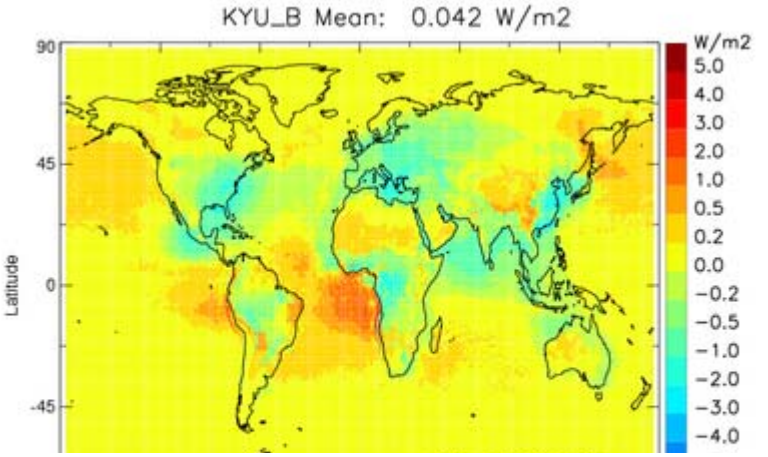
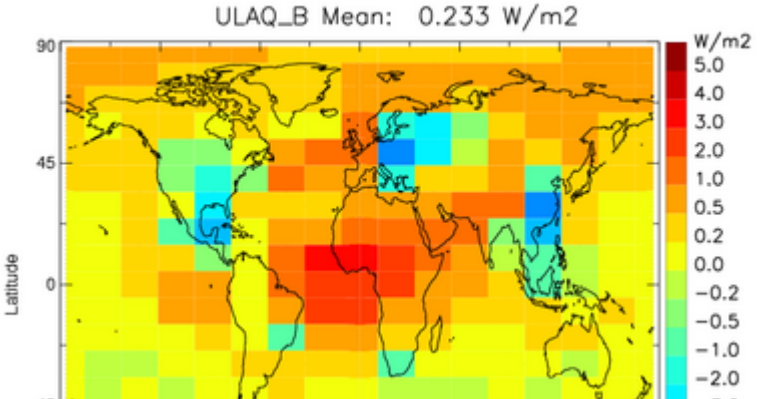
KYU	0.04
ULAQ	0.23









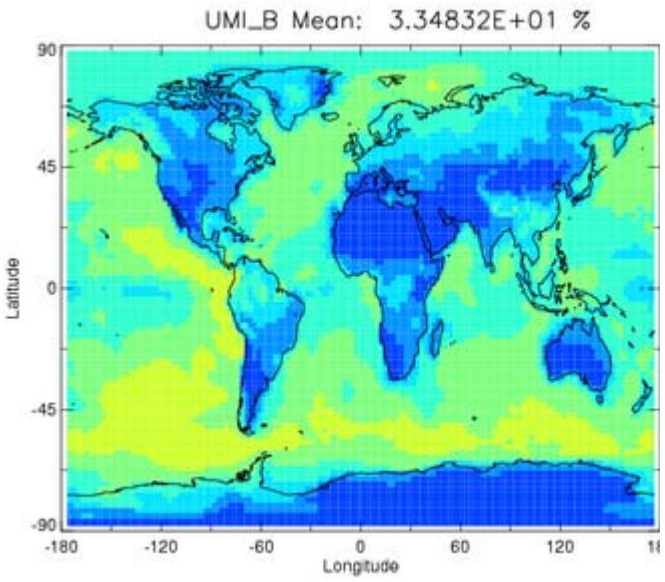


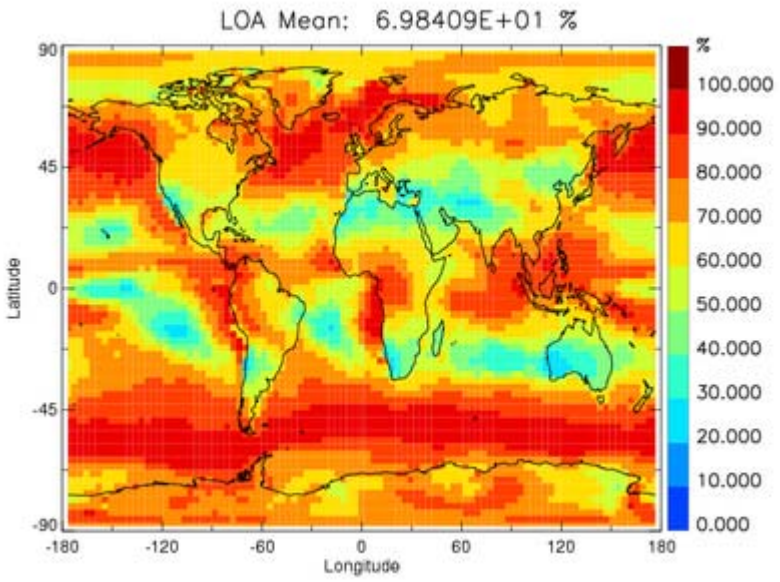
TOA global forcing

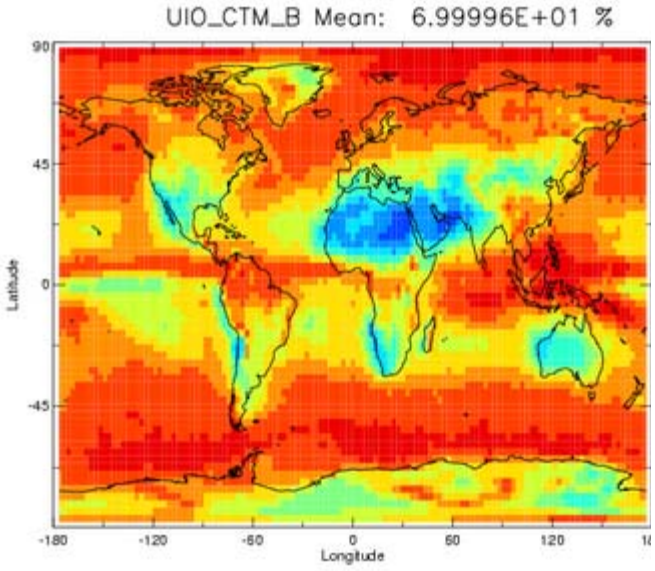
Anthropogenic aerosol

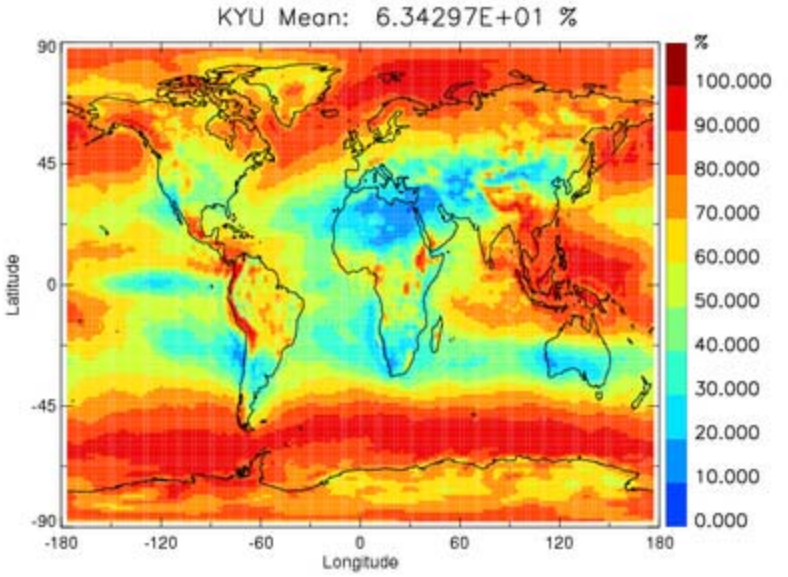
	[W/m2]
UMI	-0.41
UIO_CTM	-0.34
LSCE	-0.29
LOA	-0.23
MPI_HAM	-0.12
GISS	-0.01
UIO_GCM	-0.01
KYU	0.04
ULAQ	0.23

Cloud cover







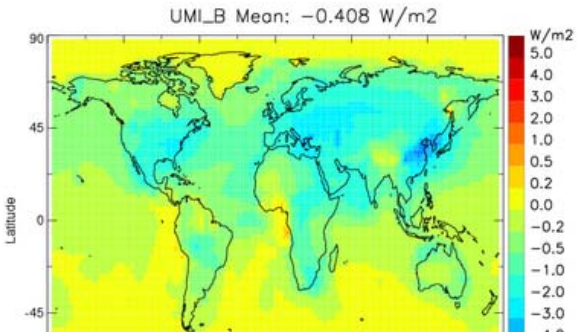


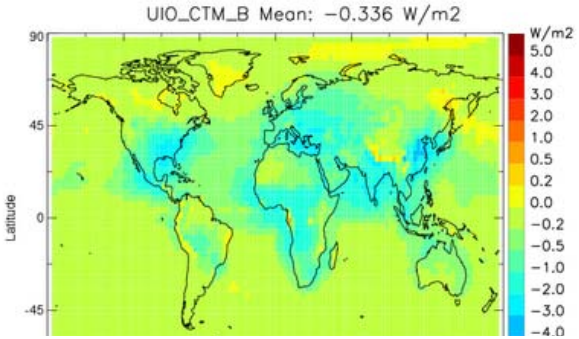
Global
SW TOA all sky
radiative forcing

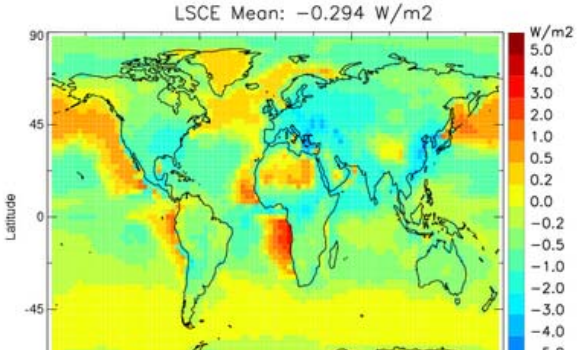
Anthropogenic
aerosol

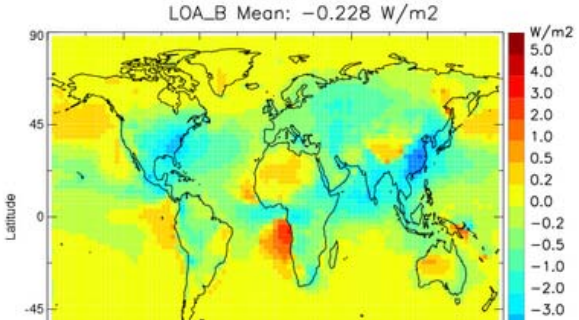
	[W/m2]
UMI	-0.41
UIO_CTM	-0.34
LSCE	-0.29
LOA	-0.23
MPI_HAM	-0.12
GISS	-0.01
UIO_GCM	-0.01
KYU	0.04
ULAQ	0.23

All sky forcing

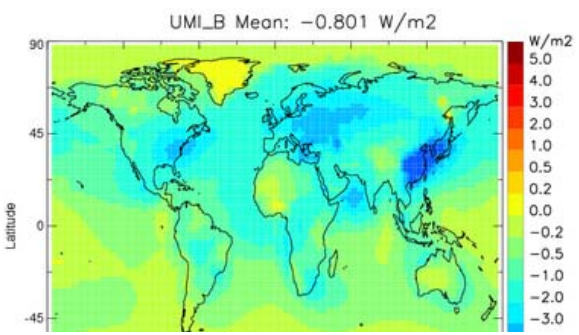


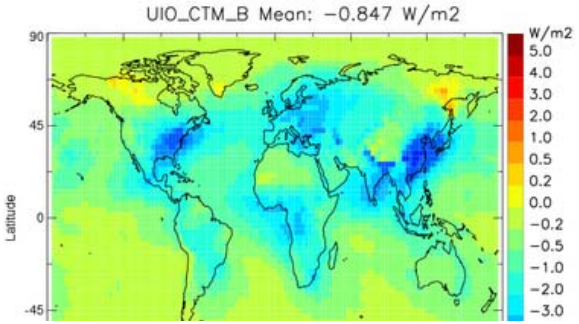


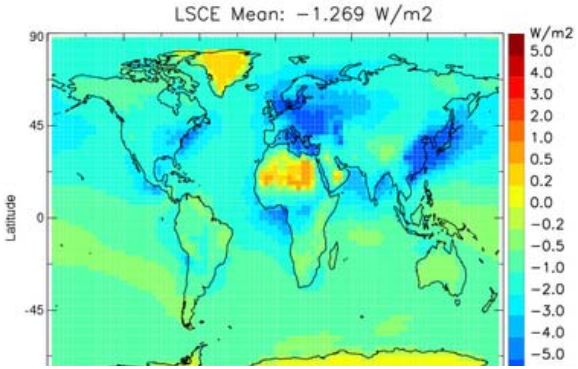


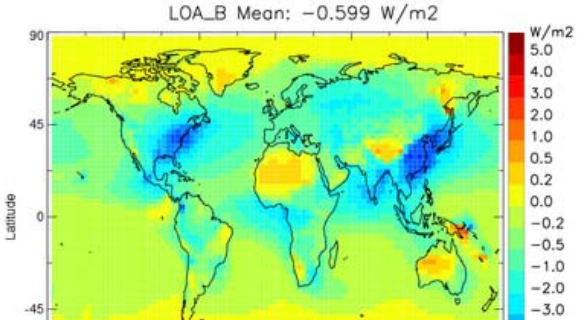


Clear sky forcing

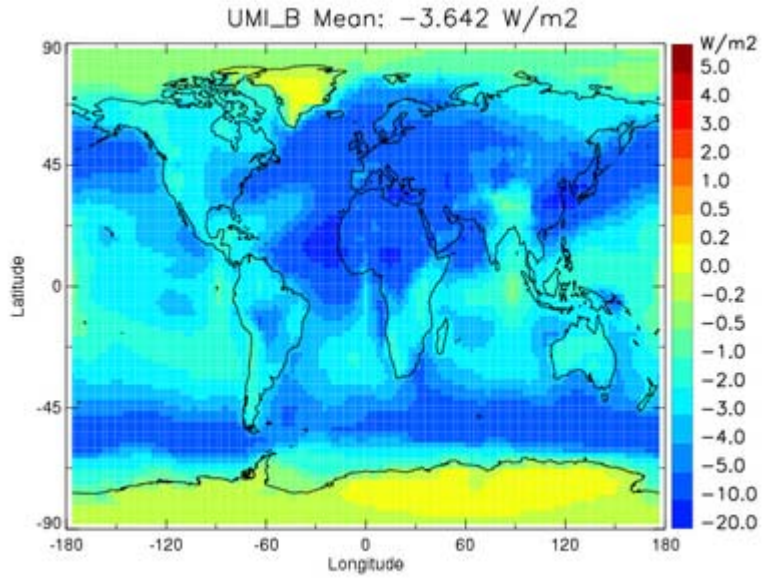


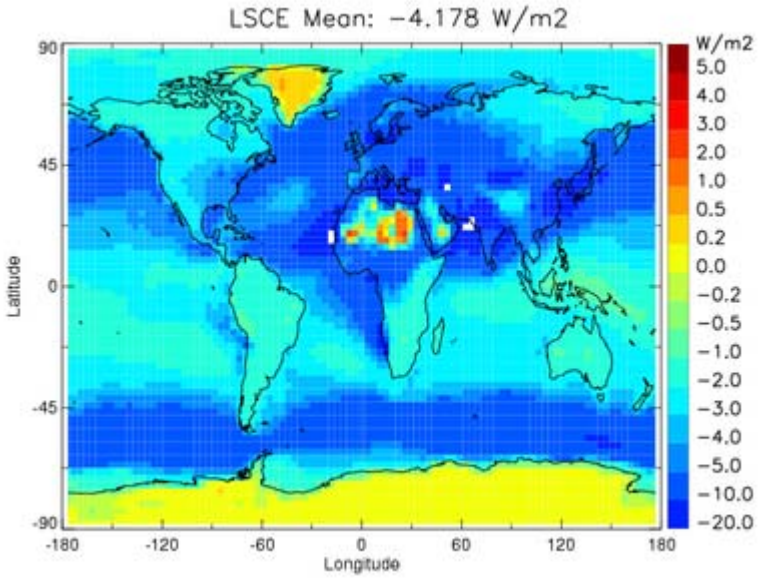


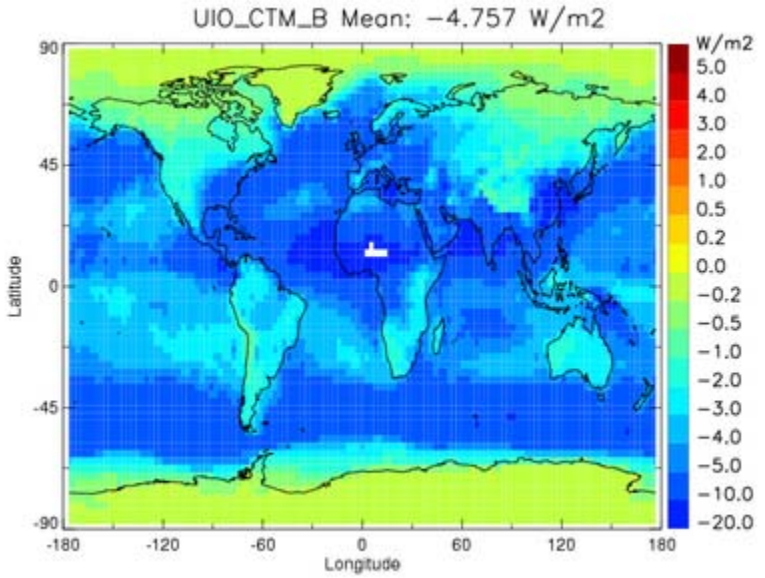


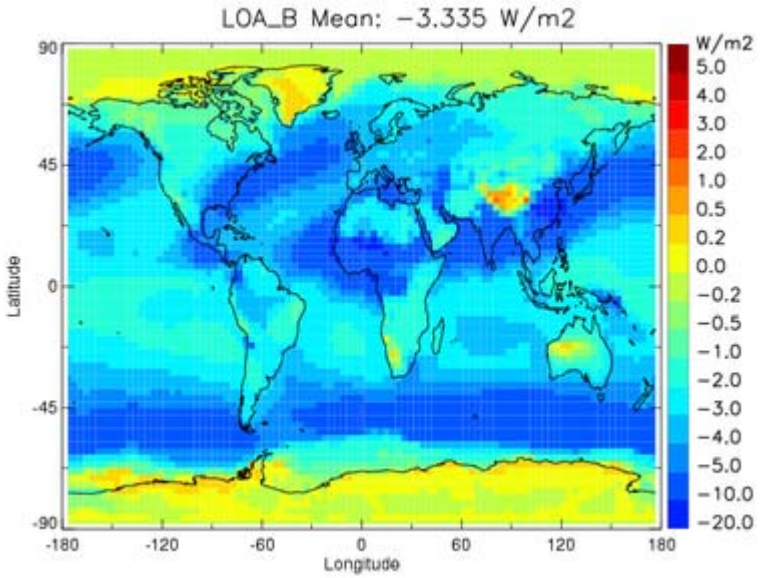


Comparable to observations:
TOA clear sky total aerosol radiative perturbation









Global
TOA all sky forcing

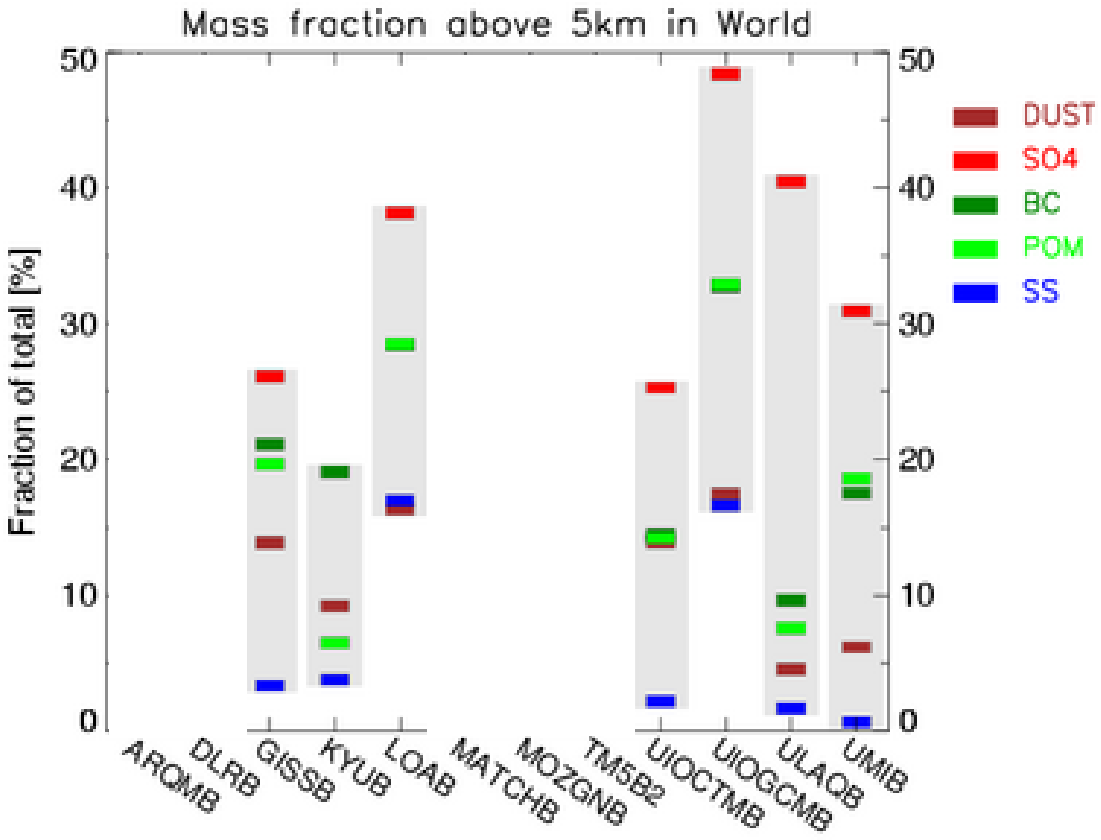
Anthropogenic aerosol B-PRE	[W/m2]
UMI	-0.41
UIO_CTM	-0.34
LSCE	-0.29
LOA	-0.23
MPI_HAM	-0.12
GISS	-0.01
UIO_GCM	-0.01
KYU	0.04
ULAQ	0.23
GOCART	
Satellites	

B-PRE	Total aerosol Year 2000					
Ocean global					Ocean 60S-60N	
TOAall [W/m2]	TOAall [W/m2]	TOAclear [W/m2]	SRFclear [W/m2]		TOAclear [W/m2]	SRFclear [W/m2]
-0.3	-1.7	-3.7	-4.6			
-0.3	-2.0	-5.1	-6.3			
-0.2	-1.2	-4.4	-5.7		-4.7	-5.8
-0.3	-1.8	-3.3	-5.5		-2.3	-4.1
-0.2						
0.0	-3.8				-3.5	-4.8
0.0	-1.8					
0.1	-0.6				-1.6	-2.7
0.2	-3.5					
					-4.1	-6.9
					-5.5	**-8.8**
					Yu et al, ACP, 2005	

Global SW TOA all sky radiative forcing Anthropogenic aerosol		BC Exp B Load	Dust+ BC Exp B Absorp.	BC B-PRE Absorp	BC B-PRE AbsCoeff	Anthropogenic troposphere heating SWTOA - SWSRF all	clear	cloudy
	[W/m2]	mg/m2	[*1000]	[*1000]	[m2/g]	[W/m2]	[W/m2]	[W/m2]
UMI	-0.41	0.24	1.7	0.8	3.4	0.84	0.8	0.25
UIO_CTM	-0.34	0.23	5.7			0.61	0.7	0.50
LSCE	-0.29	(0.43)	2.0			1.06	1.2	0.85
LOA	-0.23	0.29	3.2	1.8	6.2	1.03	1.0	0.69
MPI_HAM	-0.12	0.22				0.95	1.0	0.70
GISS	-0.01	0.30				0.79		
UIO_GCM	-0.01	0.22	5.3	2.0	8.9	0.84		
KYU	0.04	0.45				0.96		
ULAQ	0.23	0.48	6.1	2.9	6.1			

Global
SW TOA all sky
radiative forcing

Anthropogenic aerosol	[W/m2]	cloudy [W/m2]
UMI	-0.41	0.13
UIO_CTM	-0.34	-0.08
LSCE	-0.29	0.09
LOA	-0.23	-0.05
MPI_HAM	-0.12	0.02
GISS	-0.01	-0.01
UIO_GCM	-0.01	-0.01
KYU	0.04	0.04
ULAQ	0.23	



Global SW TOA all sky radiative forcing		TOA anthropogenic all sky		
Anthropogenic aerosol		Land	Ocean	Difference Land-Ocean
	[W/m2]	[W/m2]	[W/m2]	[W/m2]
UMI	-0.41	-0.80	-0.27	-0.53
UIO_CTM	-0.34	-0.53	-0.27	-0.26
LSCE	-0.29	-0.57	-0.20	-0.37
LOA	-0.23	-0.12	-0.27	0.15
MPI_HAM	-0.12	-0.06	-0.16	0.11
GISS	-0.01	-0.03	-0.01	-0.02
UIO_GCM	-0.01	0.06	-0.04	0.10
KYU	0.04	-0.05	0.07	-0.12
ULAQ	0.23	0.31	0.20	0.11

Conclusions

Small TOA forcing: 0.2 W/m2

Considerable impact of cloud position relative to aerosol,
absorption and hygroscopicity on estimate

Issues to be resolved:

- Missing data
- Definition of cloudfree area / cloud overlap assumption
- Absorption coefficient, BC distribution
- Regional differences (clouds, absorption, vertical profile)
- Regional investigation consideration regional circumstances
- Evaluation of AEROCOM B and PRE emission assumptions
- Comparisons to other recent forcing estimates
- Mean forcing maps for regional forcing estimate?
- Separate scattering and absorbing aerosol forcing?