Absorption Topics

(Black Carbon)

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Topics

1. BC-model-measurement ACPD paper update
2. “Bounding BC” project
3. BC-Indirect effect model exercise

Atmos. Chem. Phys. Discuss., 9, 15769–15825, 2009
www.atmos-chem-phys-discuss.net/9/15769/2009/

Atmospheric Chemistry and Physics Discussions

This discussion paper is/has been under review for the journal *Atmospheric Chemistry and Physics (ACP)*. Please refer to the corresponding final paper in *ACP* if available.

Evaluation of black carbon estimations in global aerosol models

D. Koch[1,2], M. Schulz[3], S. Kinne[4], T. C. Bond[6], Y. Balkanski[3], S. Bauer[1,2], T. Berntsen[13], O. Boucher[14], M. Chin[15], A. Clarke[10], N. De Luca[26], F. Dentener[16], T. Diehl[17], O. Dubovik[14], R. Easter[18], D. W. Fahey[9], J. Feichter[4], D. Fillmore[23], S. Freitag[10], S. Ghan[18], P. Ginoux[19], S. Gong[20], L. Horowitz[19], T. Iversen[13,28], A. Kirkevåg[28], Z. Klimont[7], Y. Kondo[11], M. Krol[12], X. Liu[25,18], C. McNaughton[10], R. Miller[2], V. Montanaro[25], N. Moteki[11], G. Myhre[13,21], J. E. Penner[24], Ja. Perlwitz[1,2], G. Pitari[25], S. Reddy[14], L. Sahu[11], H. Sakamoto[11], G. Schuster[5], J. P. Schwarz[9], Ø. Seland[28], J. R. Spackman[9], P. Stier[26], N. Takegawa[11], T. Takemura[27], C. Textor[3], J. A. van Aardenne[8], and Y. Zhao[22]

ACPD paper conclusions and next generation?

- Compared to surface concentration measurements, BC models were generally not underestimating. However will aerosol microphysics decrease BC lifetime and result in underestimation, especially in remote locations?
- Compared to column retrievals of absorption aerosol optical depths (AAOD), old models generally underestimate, especially in Asia, biomass burning regions, remote regions. Aerosol microphysics (BC-core-shell) will improve this.
- Compared to aircraft SP2 data over North America, models typically overestimate BC aloft at low-mid latitudes; they underestimate lower tropospheric BC in the Arctic. Aerosol microphysics may again decrease transport to the Arctic since BC lifetime will typically decrease.

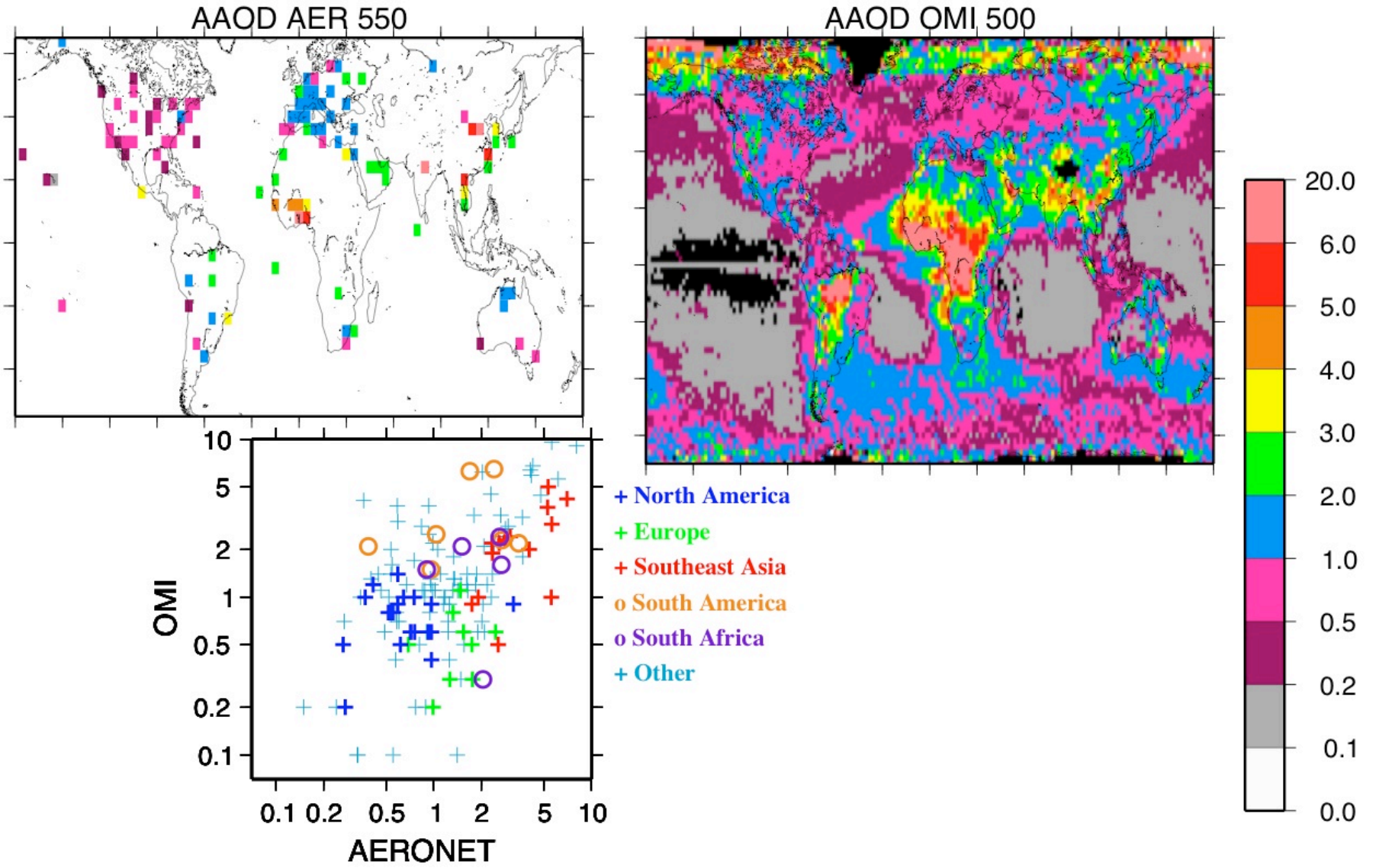
Summary tables, ratio of model to observed

Surface, AAOD measurements

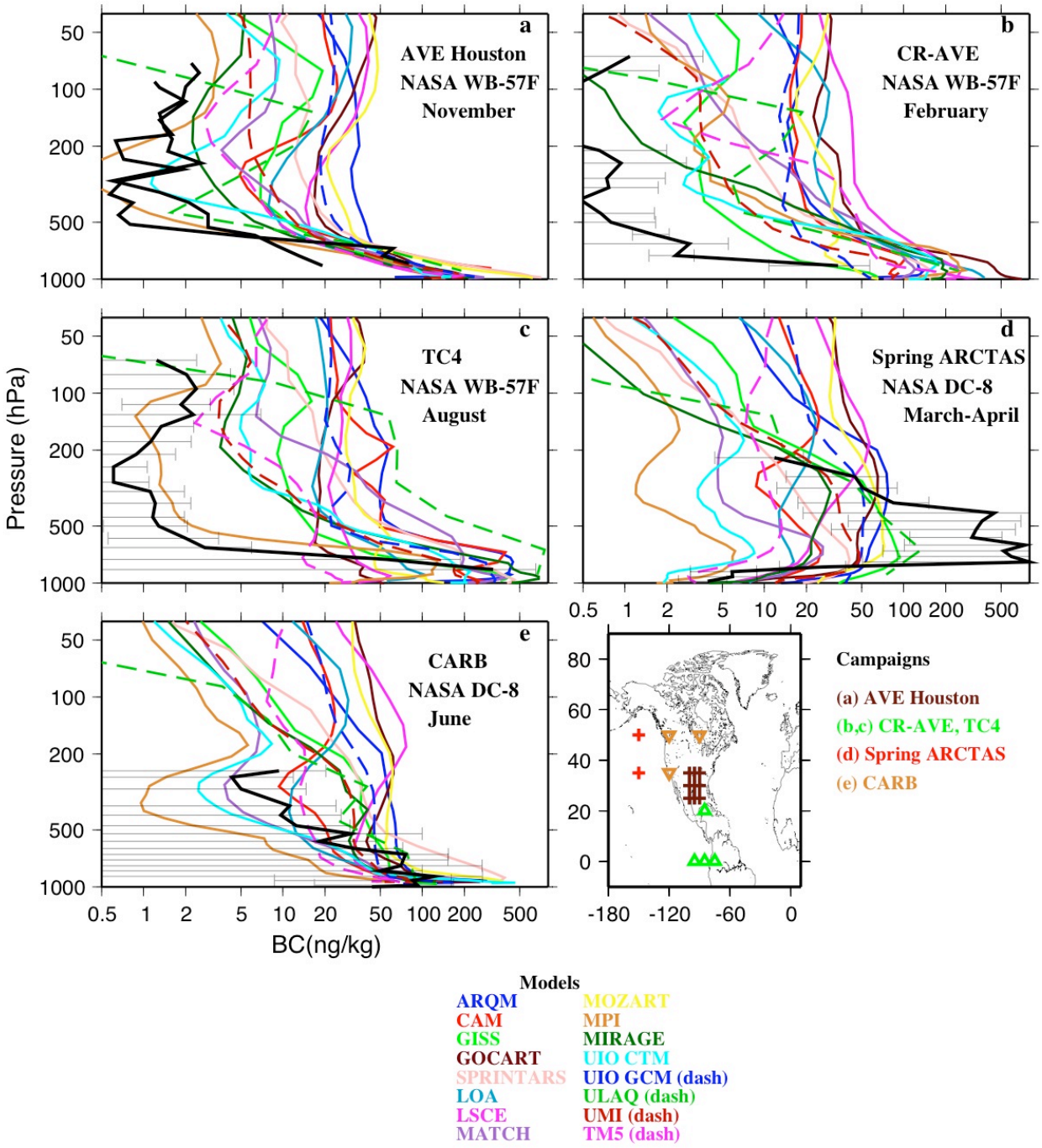
Average model biases	N Am	Eur	Asia	S Am	Afr	Rest
Surface concentration	1.6	2.8	0.54	NA	NA	1.5
BC burden	0.42	0.58	0.64	0.42	0.64	0.40
AERONET AAOD	0.82	0.75	0.60	0.67	0.51	0.52
OMI AAOD	0.50	1.5	0.64	0.35	0.45	0.24

aircraft

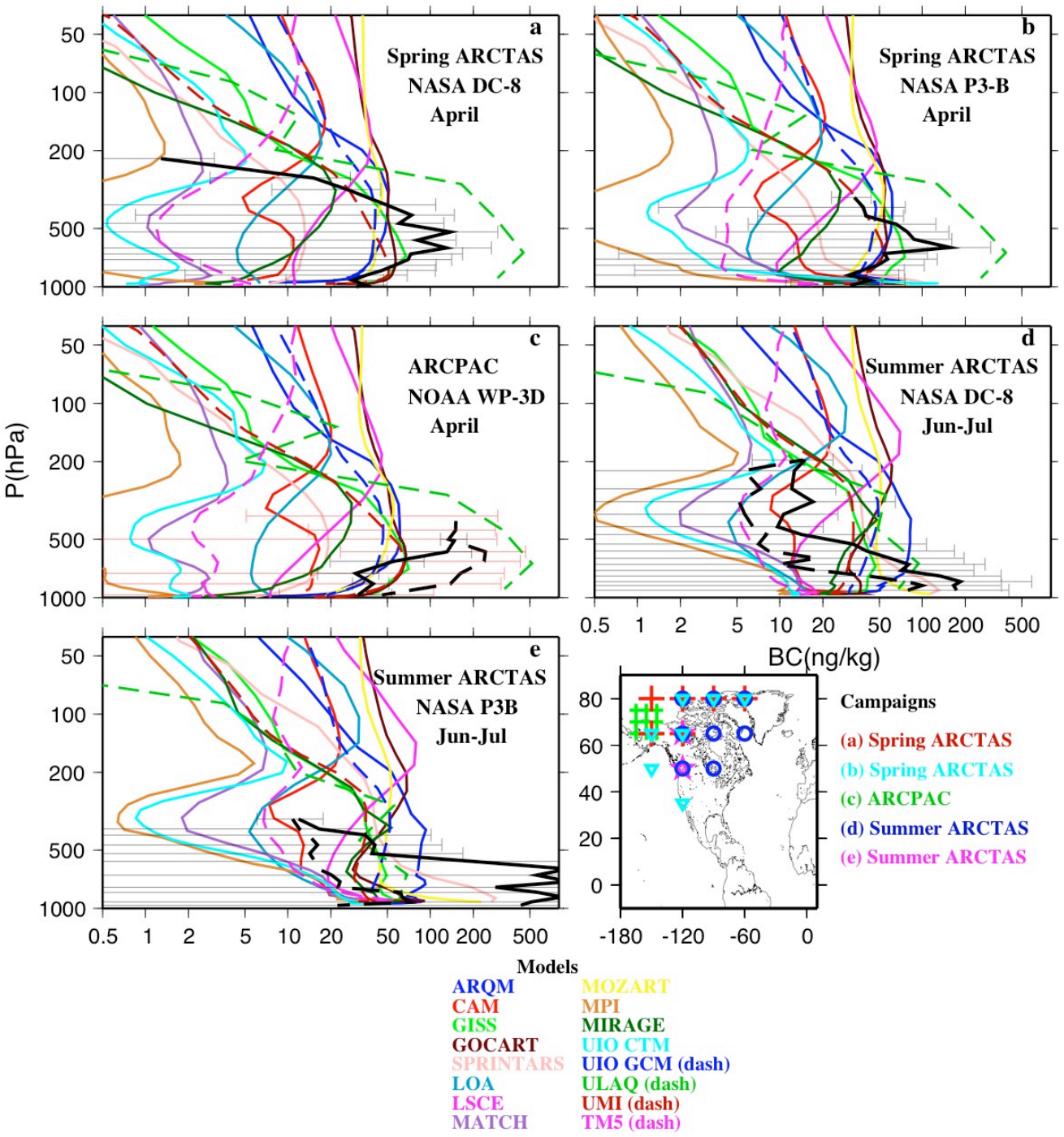
model/observed	south	north
GISS	3.8	0.61
ARQM	14.9	1.5
CAM	15.4	0.20
GOCART	12.6	0.86
SPRINTARS	9.2	0.91
LOA	12.3	0.16
LSCE	19.0	0.43
MATCH	12.6	0.13
MOZART	13.8	1.0
MPI	5.3	0.08
MIRAGE	4.5	0.54
TM5	7.0	0.15
UIOCTM	6.6	0.17
UIOGCM	11.0	0.90
ULAQ	14.4	0.71
UMI	3.6	0.63
Ave	10.4	0.56


AAOD AER 550
AAOD OMI 500
OMI
AERONET
10
5
2
1
0.5
0.2
0.1
0.1 0.2 0.5 1 2 5 10
+ North America
+ Europe
+ Southeast Asia
o South America
o South Africa
+ Other
20.0
6.0
5.0
4.0
3.0
2.0
1.0
0.5
0.2
0.1
0.0

Low-mid-latitude SP2 data and models



Arctic SP2 data and models



2. "Bounding the Role of Black Carbon in Climate" led by Tami Bond, with AC&C support

- Purpose: Produce a document that synthesizes the current state of science regarding BC as a climate forcing agent and present it in a form accessible to policy makers.

- Timeline: first draft by November 30, next author meeting January.

BBC sections and lead authors

- BC Emissions (Venkataraman)
- BC Direct radiative forcing (Schulz)
- BC snow (Warren) and cloud indirect (Lohmann) forcings (including both liquid and ice-cloud effects)
- Climate response (Boucher) and metrics (Berntsen). Climate response includes response to above forcings as well as cloud semi-direct effects
- Impacts (Bond, Ghan) and mitigation (DeAngelo) of BC-rich sources (i.e. considering whole sources, not BC in isolation)

3. BC effects on the indirect effect:

Add-on experiments to last set of AeroCom indirect effect experiments

- Since BC (primary particle) influences CCN, reduction in BC could either:

1) Reduce CCN since secondary species would condense upon a reduced number of primary particles, therefore reduce the indirect effect

and/or

2) Increase CCN since cleanup of BC particles could enhance nucleation from secondary species, therefore increase the indirect effect.

AeroCom BC-IE year 2000 Experiments

1) BC_FF fossil fuel BC emissions are zero.

2) BCOC_BF biofuel BC and OC are zero.

3) BCOC_D BC/OC with zero diesel emissions (provided)

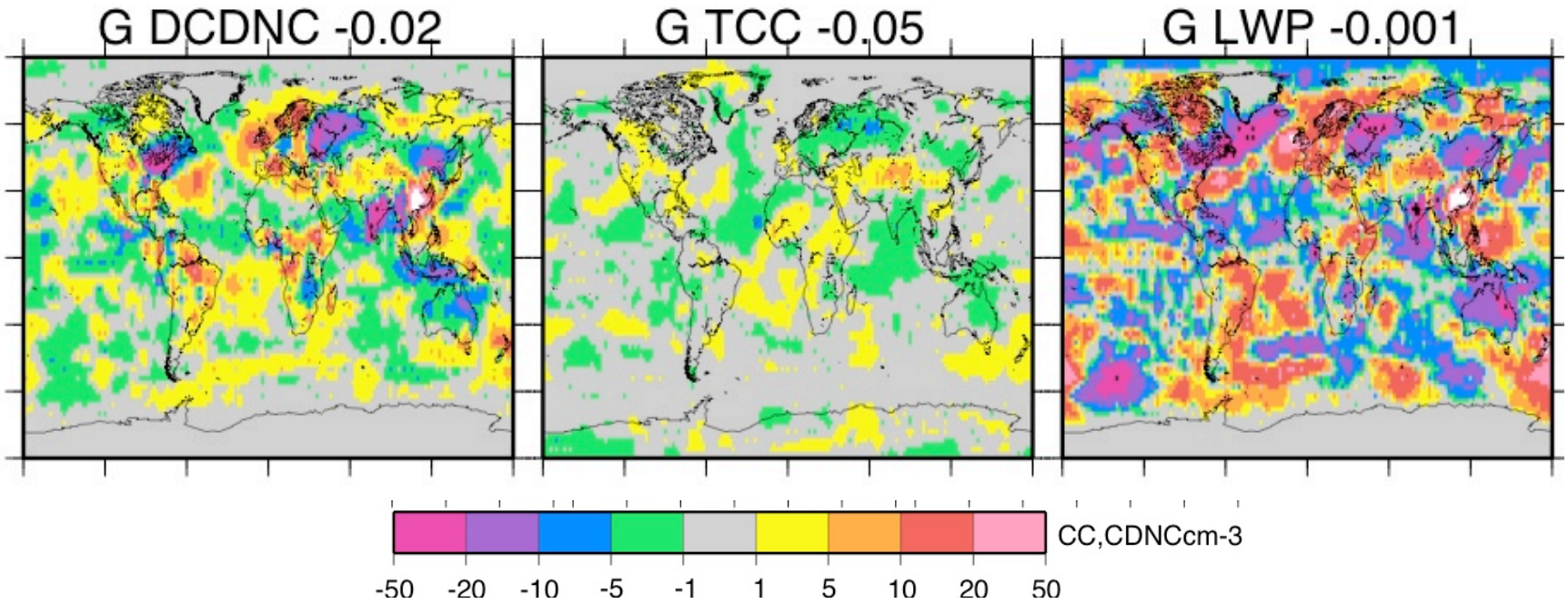
4) BCOC_WS using BC/OC with zero woodstove emissions (soon to be provided)

Participating models

1) LSCE
2) CAM-Oslo
3) ECHAM5-HAM
4) GISS 
5) CAM-PNNL
6) SPRINTARS 

VERY preliminary results for no FF BC
GISS model (Bauer et al.)

Cloud droplet number concentration change



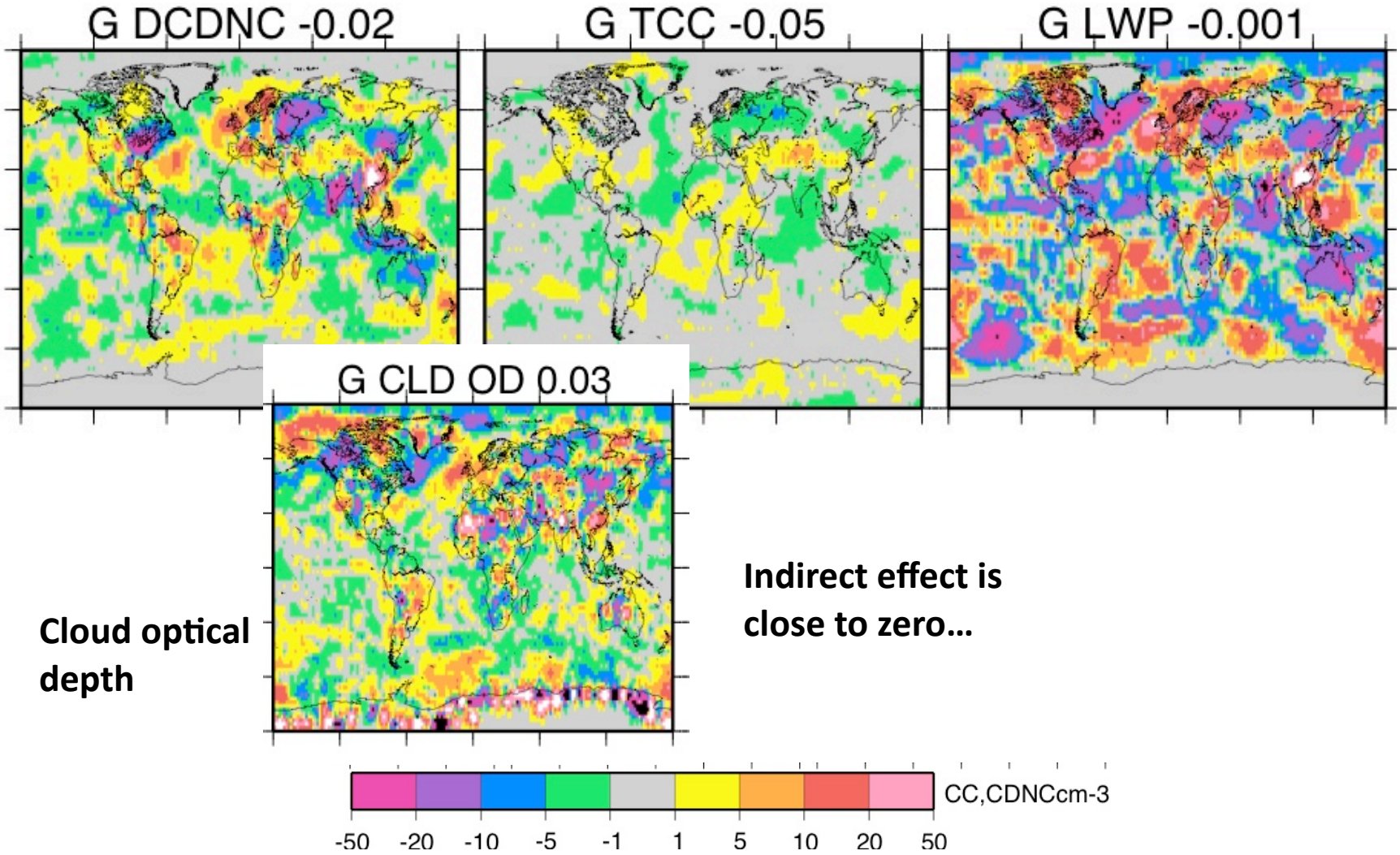
Removal of FF BC:

CDNC, cloud cover and LWP increase in some regions, decrease in others….

So far looks like positive forcing change (loss of cloud)

VERY preliminary results for no FF BC

GISS model



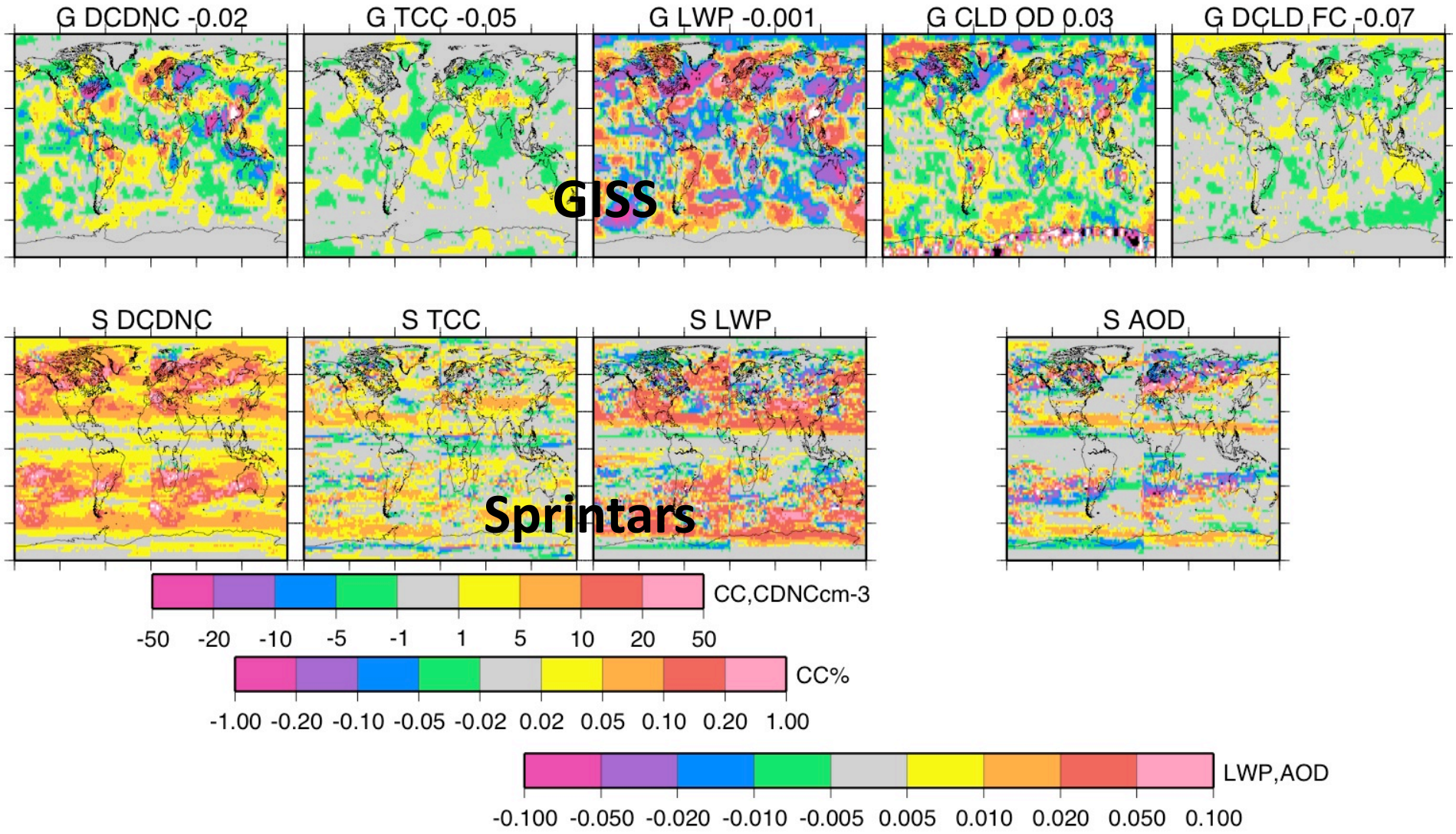
Cloud optical depth

Indirect effect is close to zero…

But regions where CDNC INCREASE have increased cloud optical depth, negative forcing.

So DE is about -0.08 and IE is small, so net effect is negative.

VERY preliminary results for no FF BC



Sprintars has +CDNC, clouds, LWP, probably also negative forcing