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AeroCom Phase III: Absorption intercomparison (ABS)

Maria Sand, Bjørn H. Samset, …

Deep thanks to the modellers who have taken the extra effort to provide additional absorption diagnostics

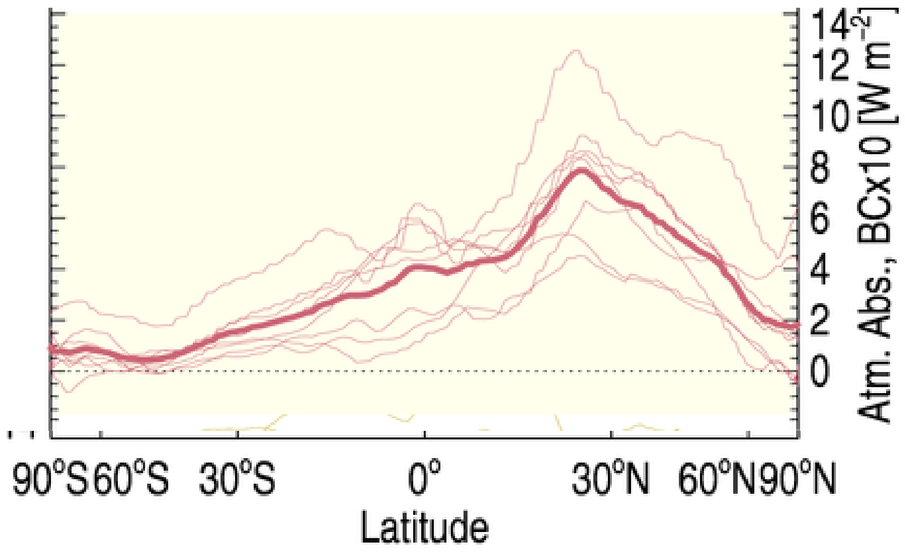
Outline

- **Motivation**
- Absorption time evolution and natural variability in the CESM1 Large Ensemble
- AeroCom ABS experiment: First look

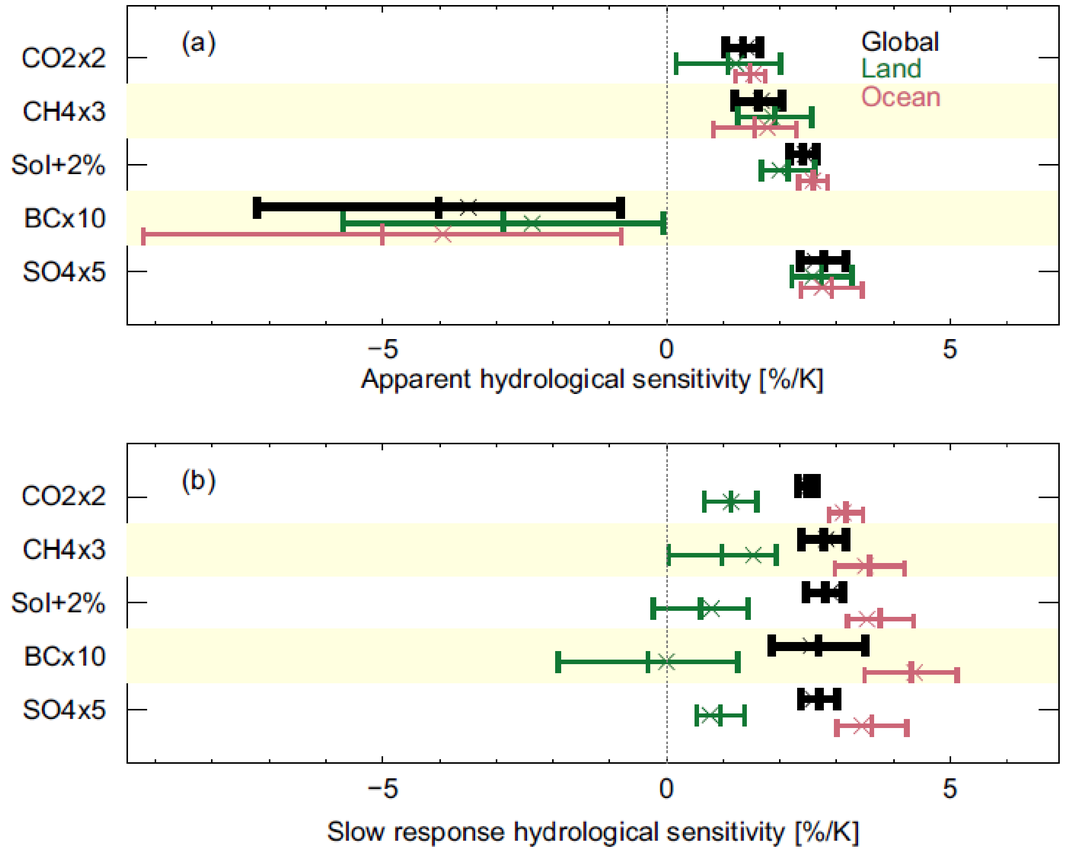
NB: «Absorption» here refers to shortwave only, and in most models comes from black carbon (BC), brown carbon (BrC, or absorbing OC), and dust.

Modelled absorption strongly affects modelled precipitation…

Myhre 2017, BAMS



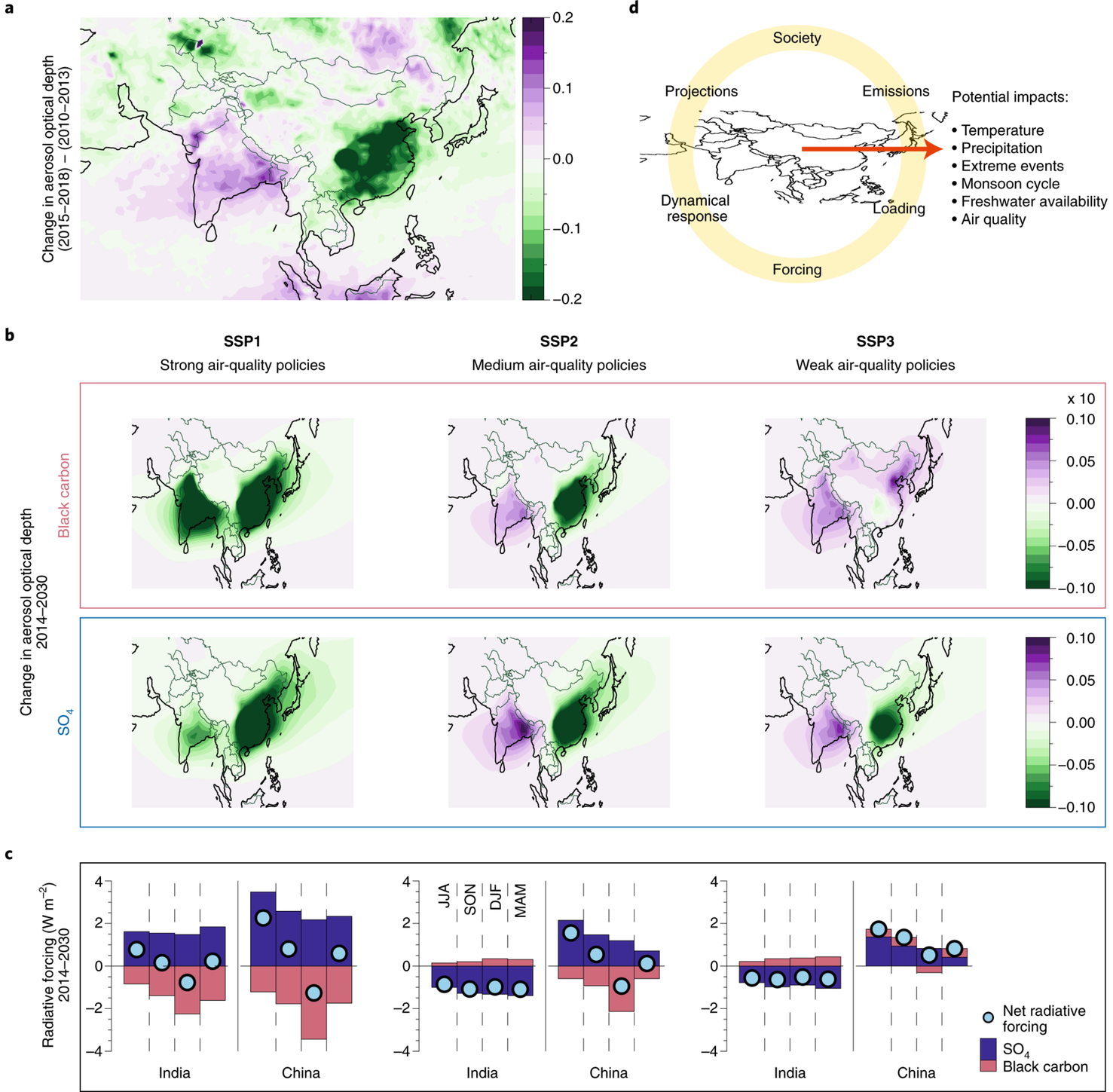
Samset 2018, npj Clim. Atm. Sci.



Emerging Asian aerosol patterns

Bjørn H. Samset, Marianne T. Lund, Massimo Bollasina, Gunnar Myhre & Laura Wilcox

Nature Geoscience, volume 12, pages 582–584 (2019)



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AGU PUBLICATIONS

JGR

Journal of Geophysical Research: Atmospheres

RESEARCH ARTICLE

10.1002/2015JD023501

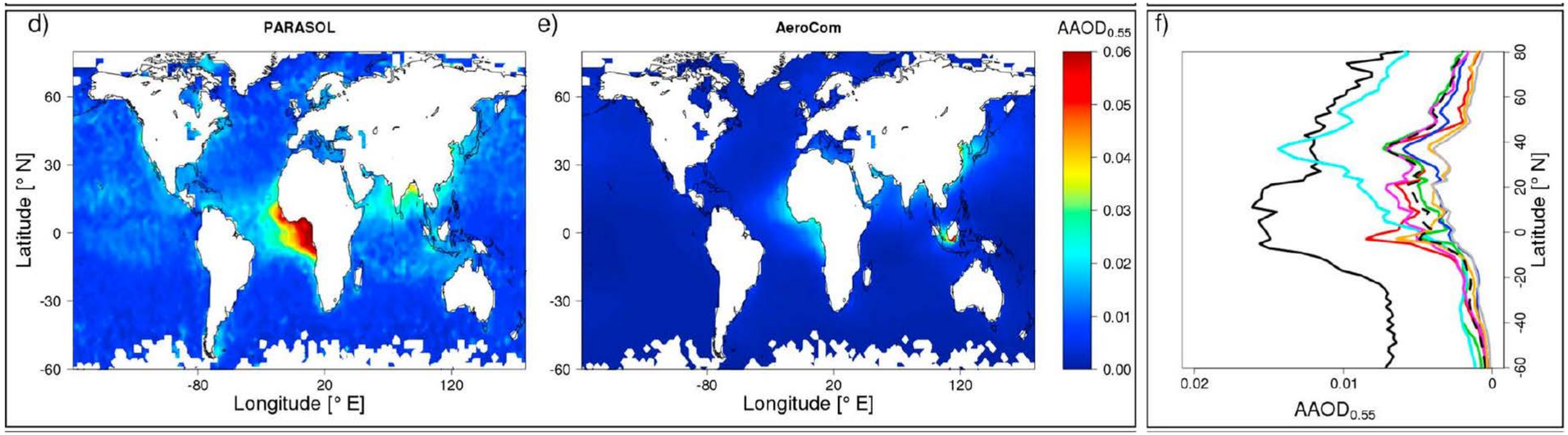
Aerosol single-scattering albedo over the global oceans: Comparing PARASOL retrievals with AERONET, OMI, and AeroCom models estimates

Carlo Lacagnina[1], Otto P. Hasekamp[1], Huisheng Bian[2], Gabriele Curci[3,4], Gunnar Myhre[5], Twan van Noije[6], Michael Schulz[7], Ragnhild B. Skeie[5], Toshihiko Takemura[8], and Kai Zhang[9,10]

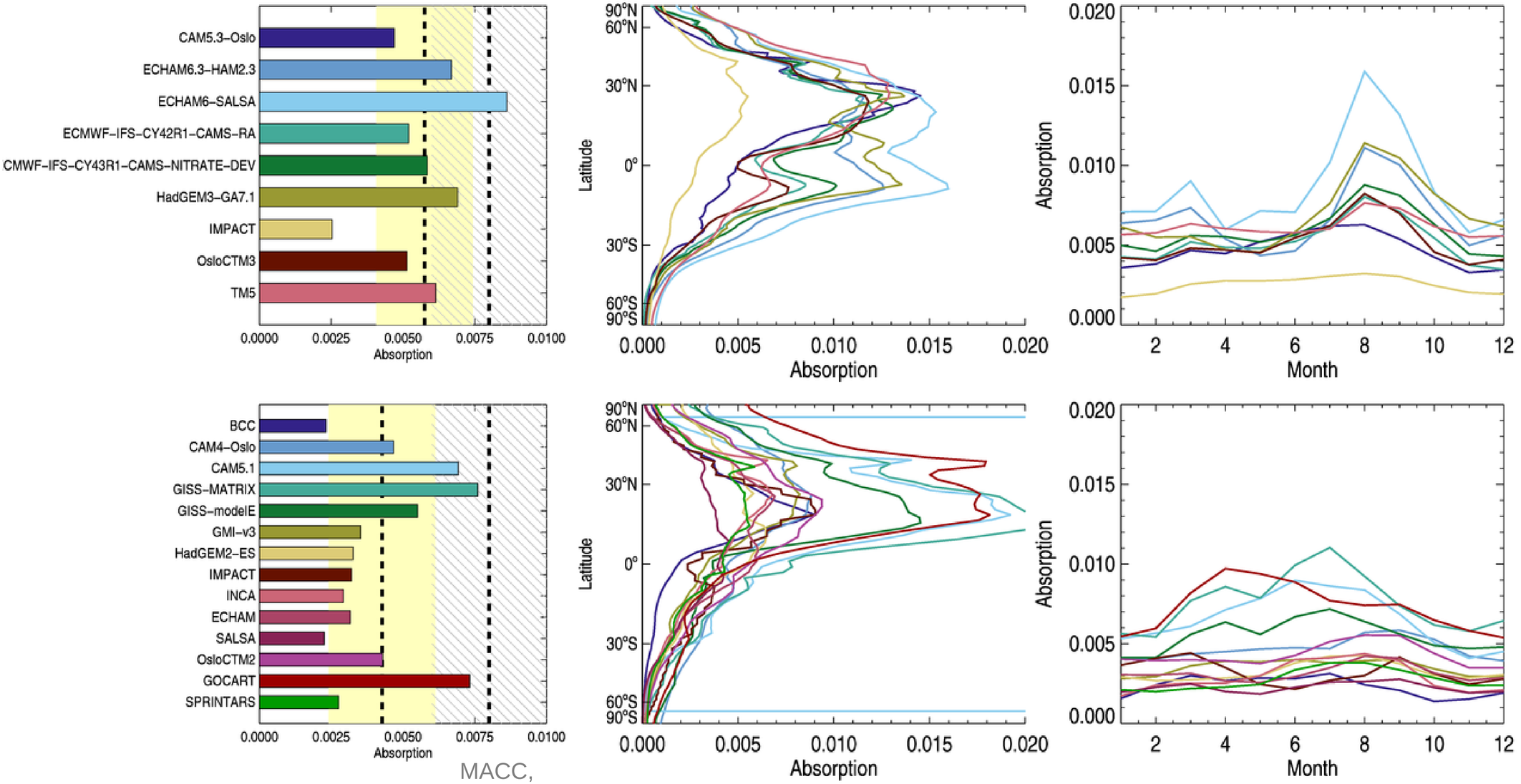
[1]SRON Neth
University o
University o
Environmen
[7]Norwegian
Fukuoka, Ja
Meteorolog

Key Points:
- First global ocean comparison of PARASOL SSA with observations and models
- PARASOL observes stronger aerosol absorption than models, larger in the tropics
- Direct aerosol radiative effect at TOA is overestimated by models

Correspondence to:
C. Lacagnina,
C.Lacagnina@sron.nl



underestimated in the models. This implies that aerosols exert larger direct and semidirect effects within the atmosphere to alter the atmospheric circulation, cloud processes and the water cycle than currently estimated by models. Given the consistency between PARASOL, AERONET, and OMI-Aura, it is most likely that these conclusions reflect model biases rather than observational uncertainties. Future analyses with radiative transfer calculations are needed to quantify and explore further the impact of these biases on the Earth's climate system.



Phase III
CTRL2016
Year 2010

Phase II

MACC,
Bellouin 2013

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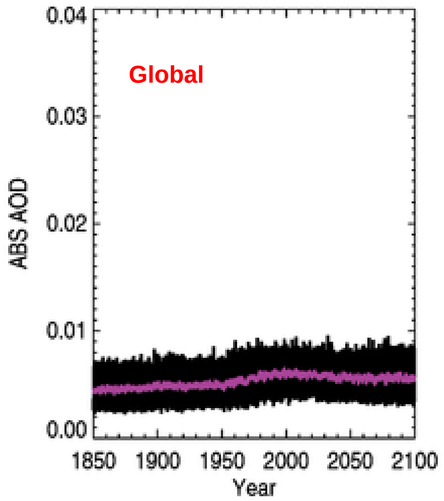
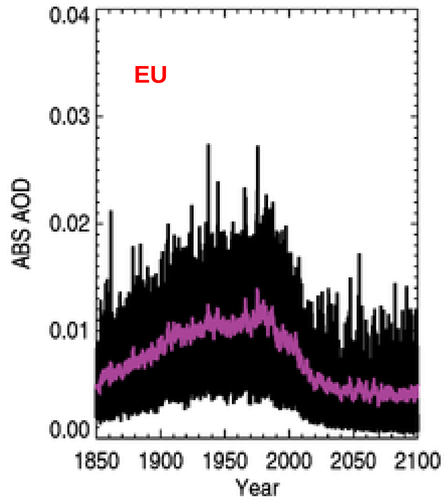
Outline

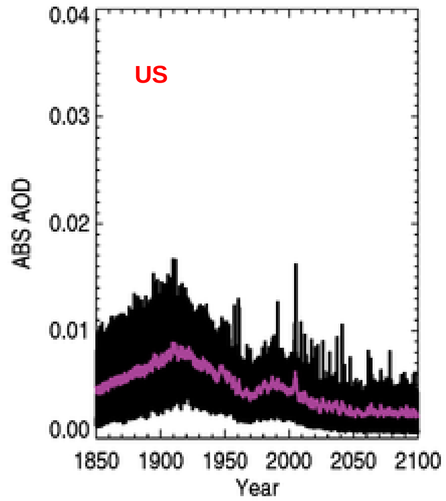
- Motivation
- **Absorption time evolution and natural variability in the CESM1 Large Ensemble**
- AeroCom ABS experiment: First look

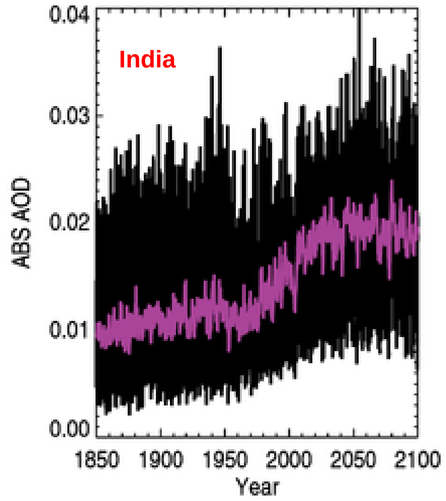
NB: «Absorption» here refers to shortwave only, and in most models comes from black carbon (BC), brown carbon (BrC, or absorbing OC), and dust.

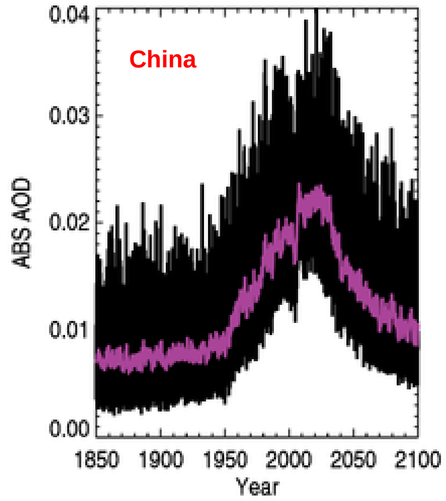
CESM Large Ensemble:
AAOD time series (single member, RCP8.5)



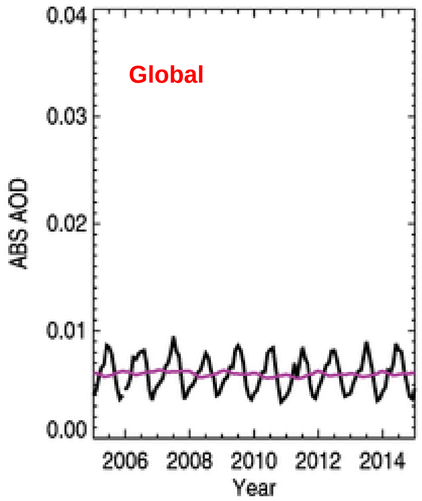


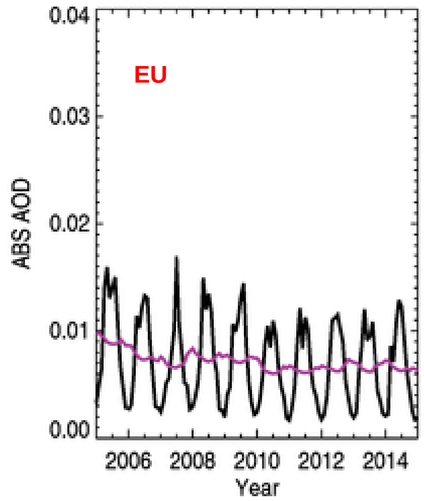


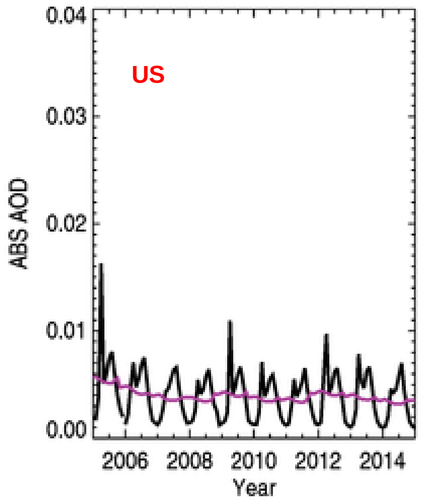


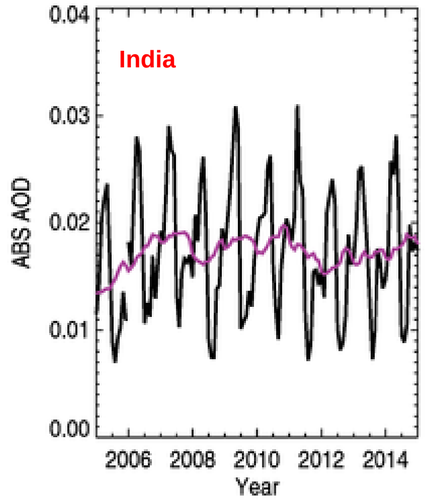


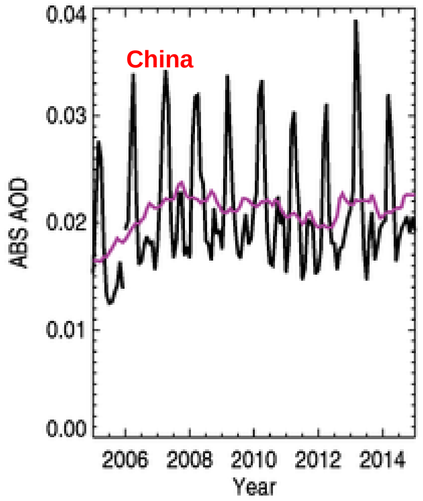
CESM Large Ensemble:
AAOD time series (single member, RCP8.5)



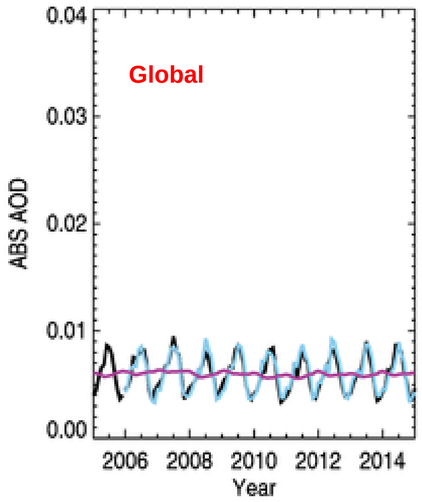


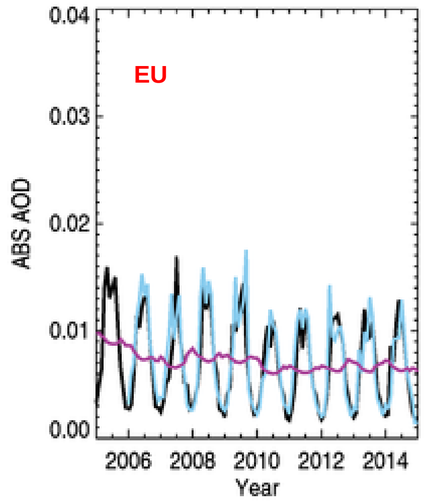


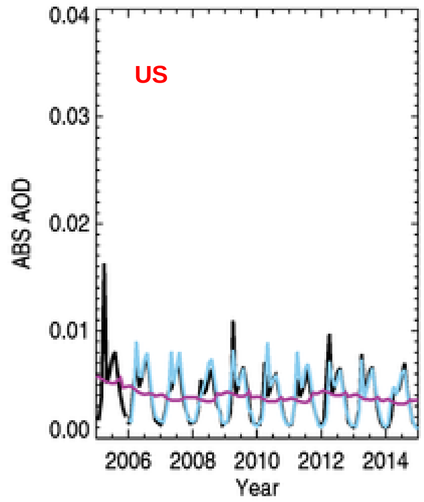


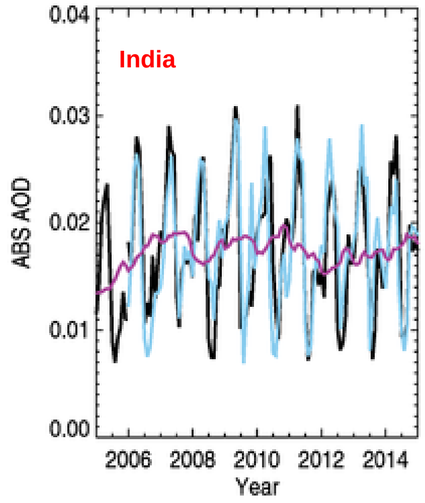


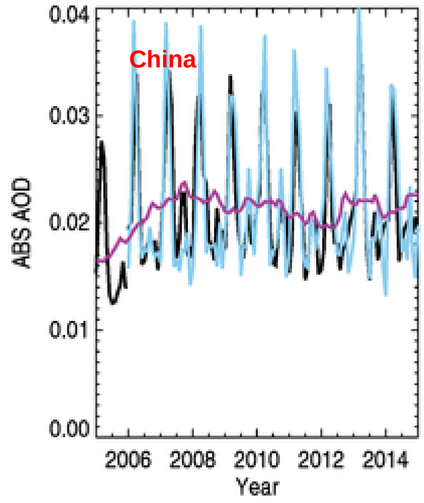
CESM Large Ensemble:
AAOD time series (two members, RCP8.5)



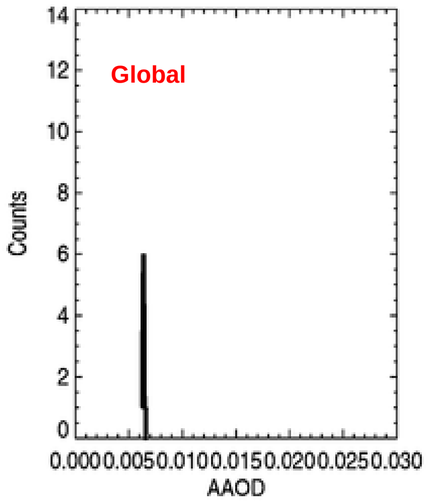


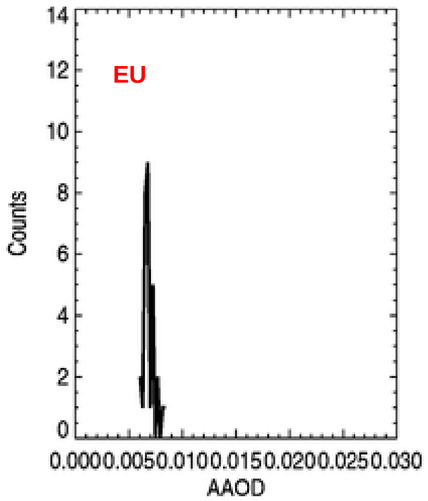


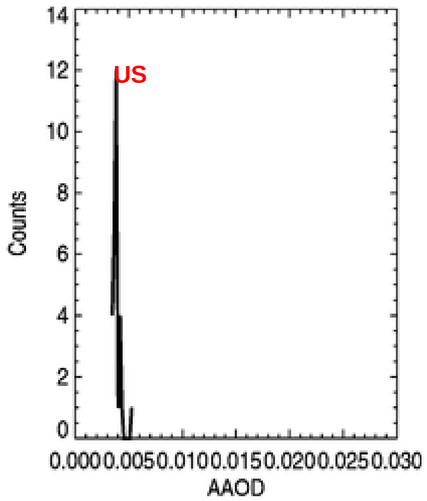


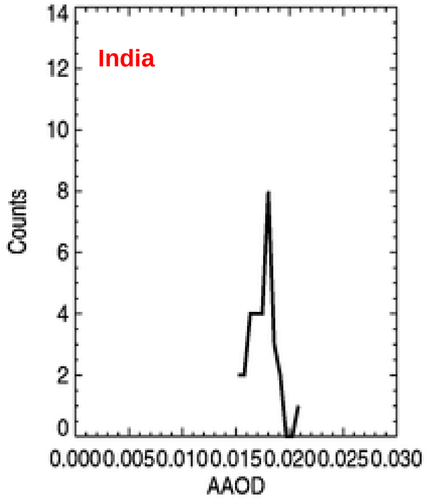


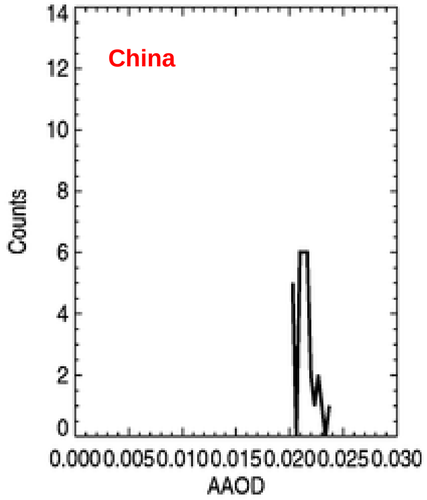
CESM Large Ensemble: AAOD, 2010 (30 members, RCP8.5)



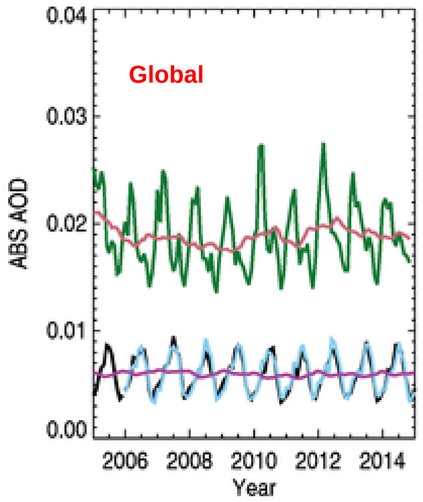


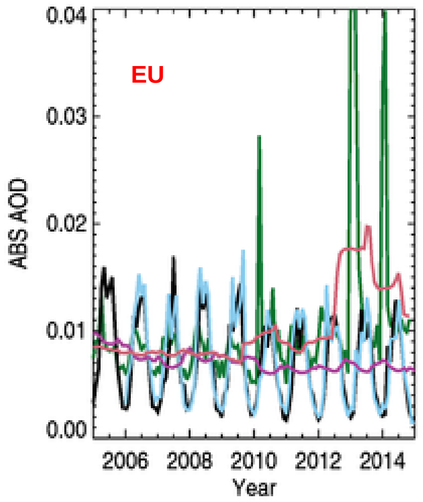


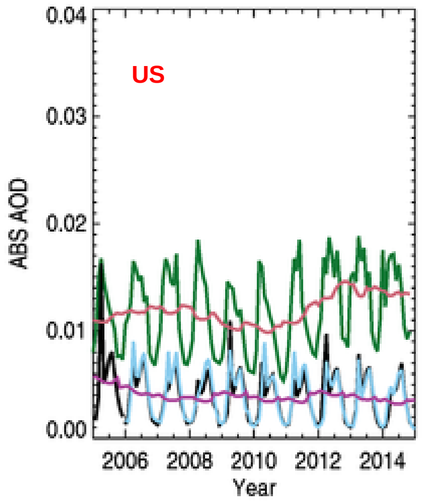




CESM Large Ensemble vs OMI: AAOD, 2010







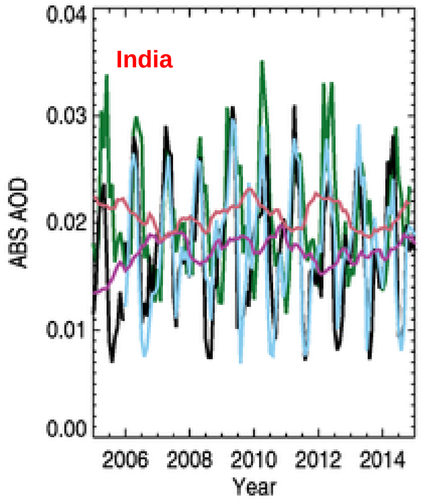
CESM1 LENS (Member 1)

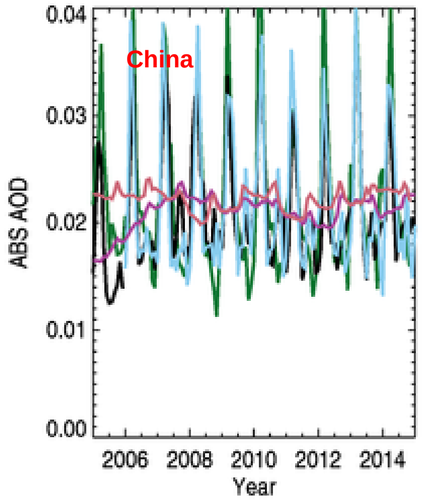
CESM1 LENS (Member 1), 12M running mean

CESM1 LENS (Member 3)

OMI

OMI, 12M running mean





Outline

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- **AeroCom ABS experiment: First look**

NB: «Absorption» here refers to shortwave only, and in most models comes from black carbon (BC), brown carbon (BrC, or absorbing OC), and dust.

ABS experiment data request

- Simulations: CTRL2019 (i.e. no additional runs)
- Additional diagnostics:

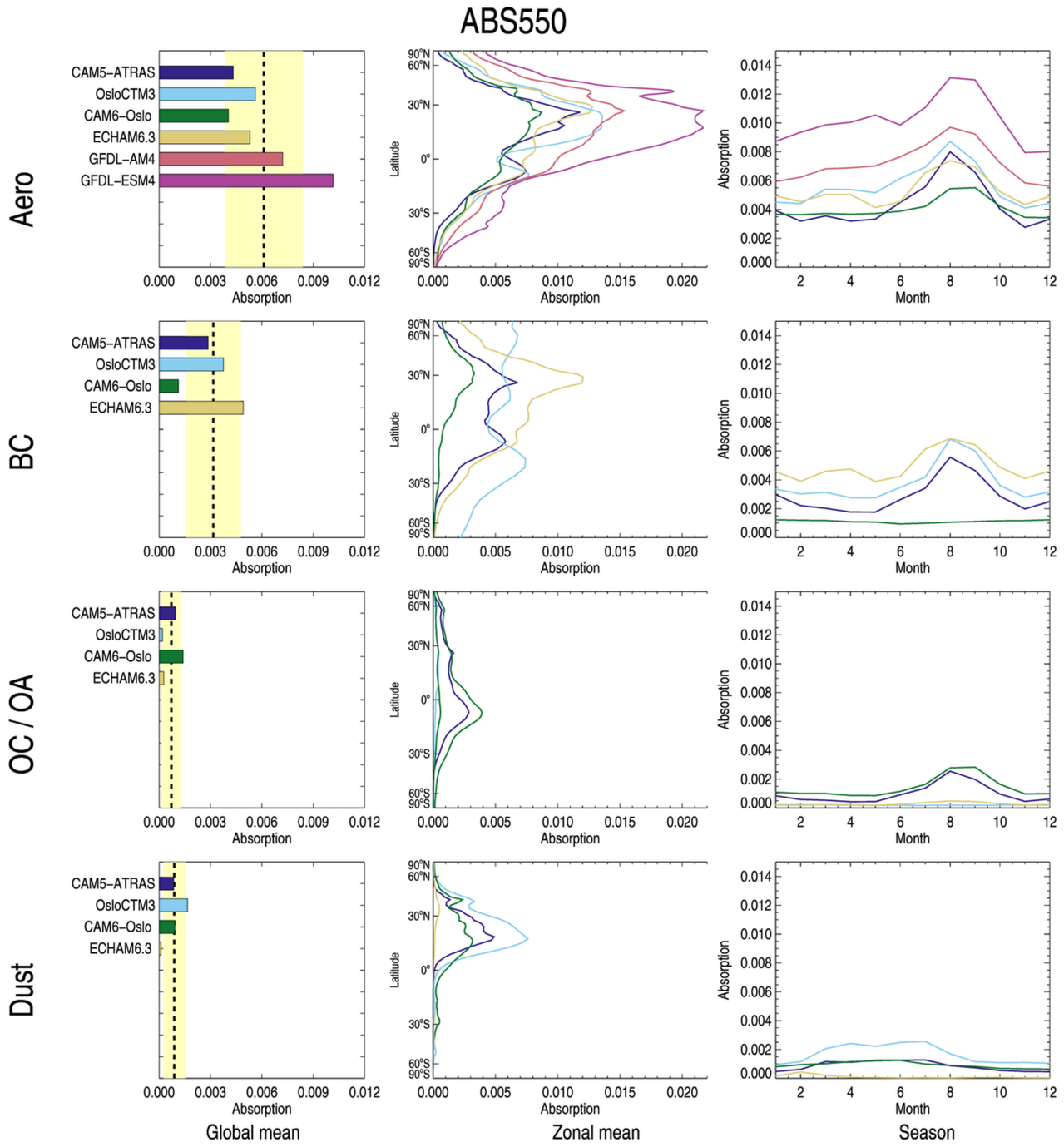
  Aerosol absorption optical depth (column)

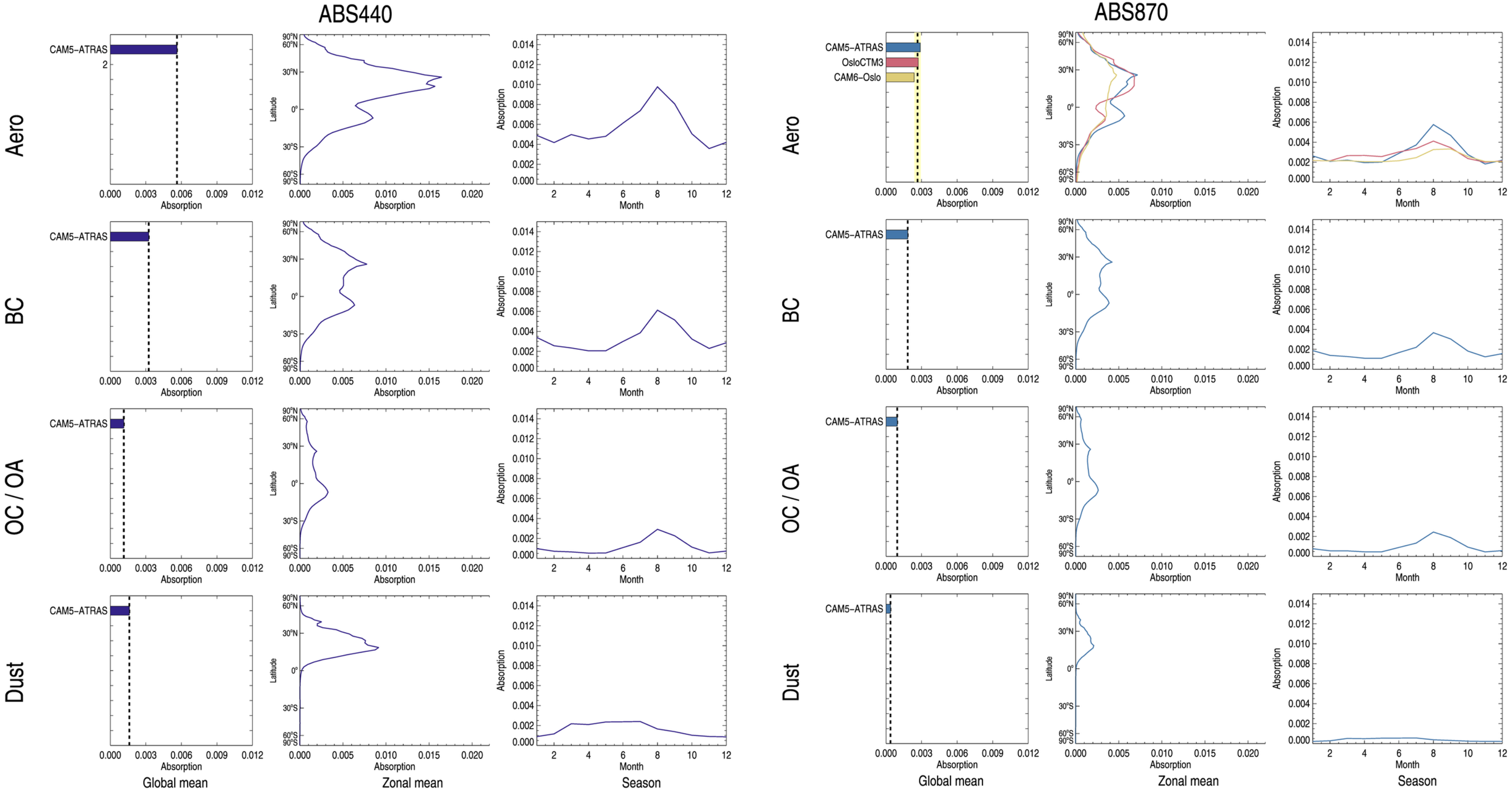
  …at 440nm, 550nm and 870nm

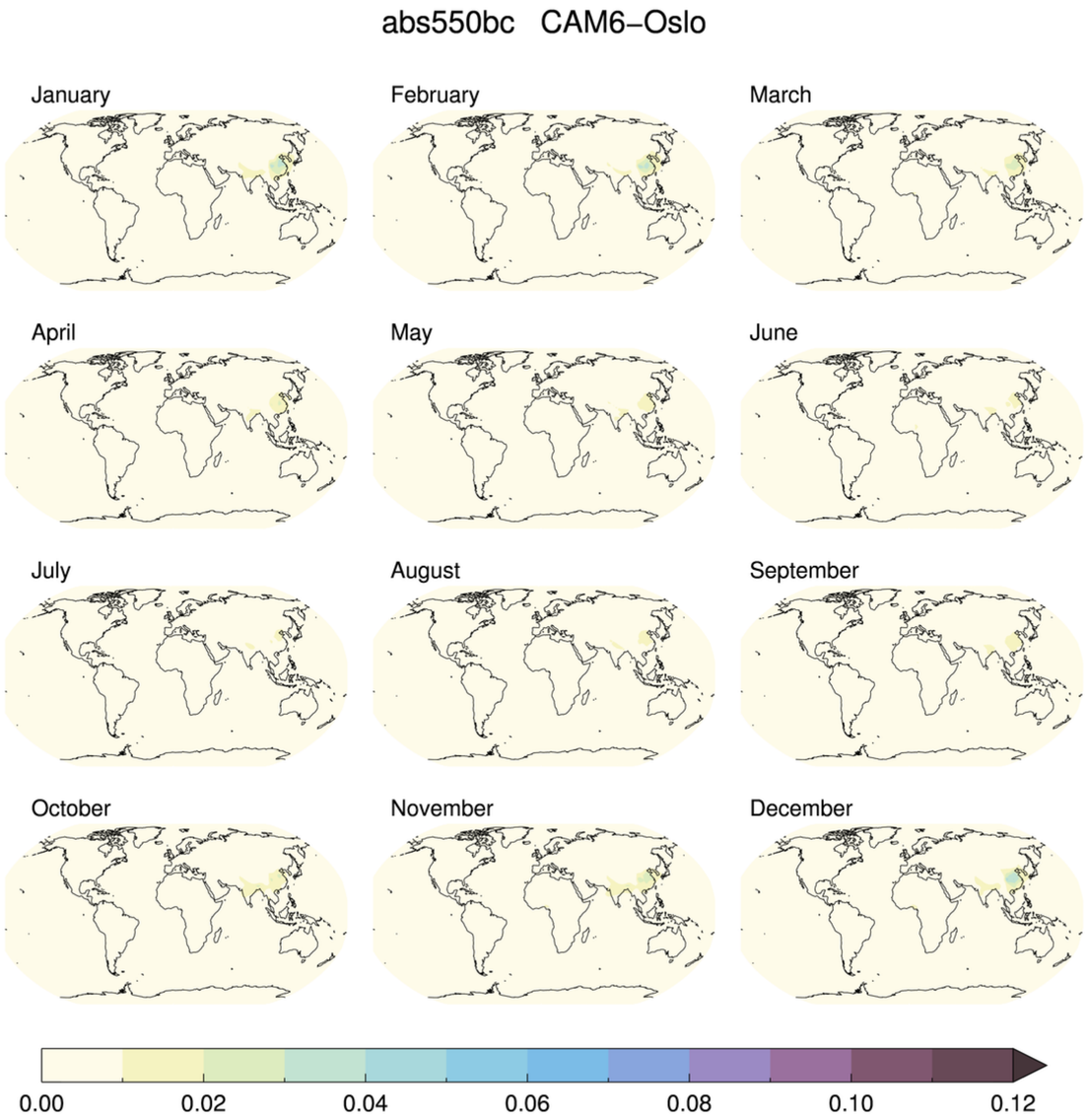
  …for total aerosol (abs550aer, abs440aer, abs870aer)

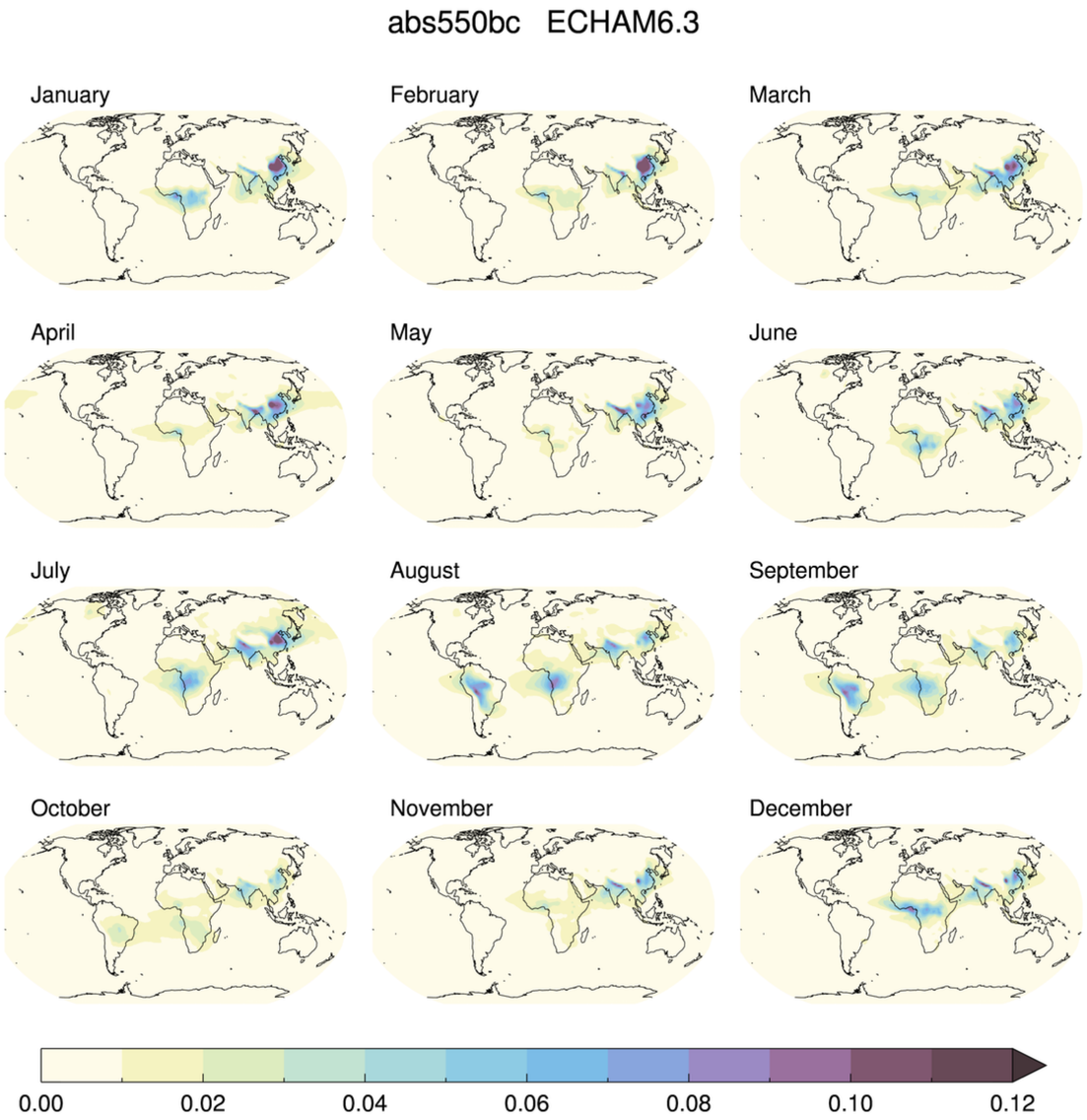
  …and for individual absorbing components

  (abs550bc, abs550oc, abs550dust, + other wvl)


ABS550
Aero
BC
OC / OA
Dust
CAM5-ATRAS
OsloCTM3
CAM6-Oslo
ECHAM6.3
GFDL-AM4
GFDL-ESM4
Absorption
Latitude
Month
Global mean
Zonal mean
Season


ABS440
ABS870
Aero
BC
OC / OA
Dust
CAM5-ATRAS
OsloCTM3
CAM6-Oslo
Absorption
Latitude
Month
Global mean
Zonal mean
Season


abs550bc CAM6–Oslo
January
February
March
April
May
June
July
August
September
October
November
December
0.00
0.02
0.04
0.06
0.08
0.10
0.12


abs550bc ECHAM6.3
January
February
March
April
May
June
July
August
September
October
November
December
0.00
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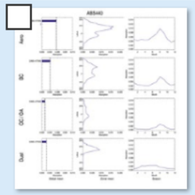
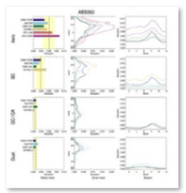
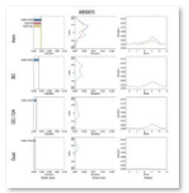
0.04
0.06
0.08
0.10
0.12



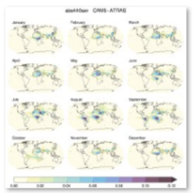
FIG_abs440_AC3_1



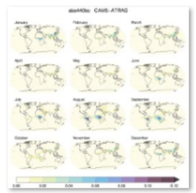
FIG_abs550_AC3_1



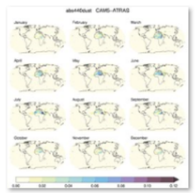
FIG_abs870_AC3_1



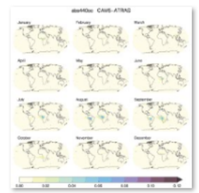
FIG_monthlymaps_abs440aer_CAM5-ATRAS_AC3



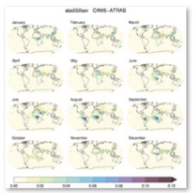
FIG_monthlymaps_abs440bc_CAM5-ATRAS_AC3



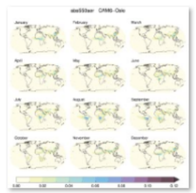
FIG_monthlymaps_abs440dust_CAM5-ATRAS_AC3



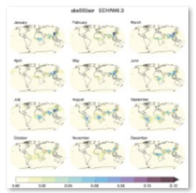
FIG_monthlymaps_abs440oc_CAM5-ATRAS_AC3



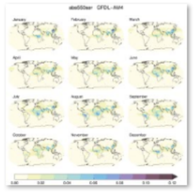
FIG_monthlymaps_abs550aer_CAM5-ATRAS_AC3



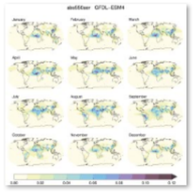
FIG_monthlymaps_abs550aer_CAM6-Oslo_AC3



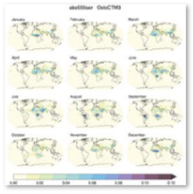
FIG_monthlymaps_abs550aer_ECHAM6.3_AC3



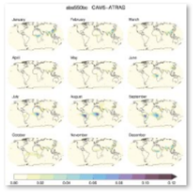
FIG_monthlymaps_abs550aer_GFDL-AM4_AC3



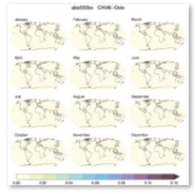
FIG_monthlymaps_abs550aer_GFDL-ESM4_AC3



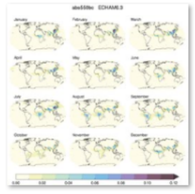
FIG_monthlymaps_abs550aer_OsloCTM3_AC3



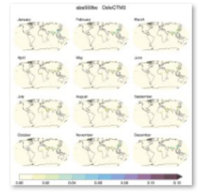
FIG_monthlymaps_abs550bc_CAM5-ATRAS_AC3



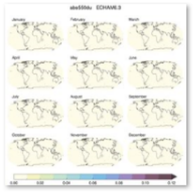
FIG_monthlymaps_abs550bc_CAM6-Oslo_AC3



FIG_monthlymaps_abs550bc_ECHAM6.3_AC3



FIG_monthlymaps_abs550bc_OsloCTM3_AC3



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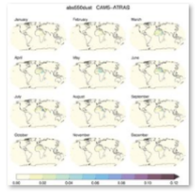
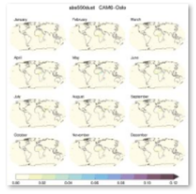


FIG_monthlymaps_abs550dust_CAM5-ATRAS_AC3



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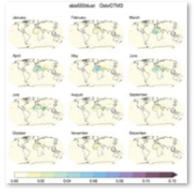

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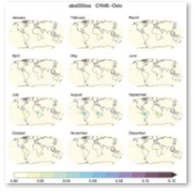

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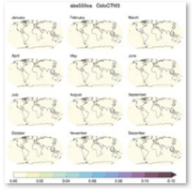

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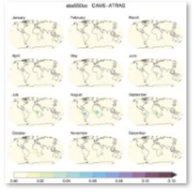

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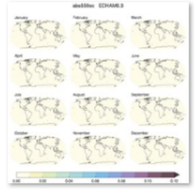

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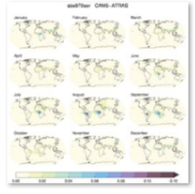
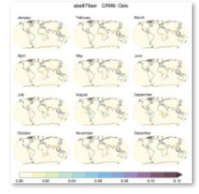
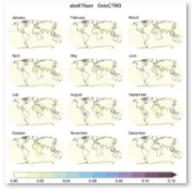


FIG_monthlymaps_abs870aer_CAM5-ATRAS_AC3



FIG_monthlymaps_abs870aer_CAM6-Oslo_AC3



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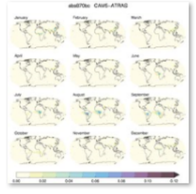
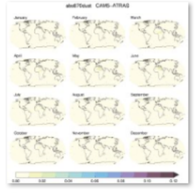


FIG_monthlymaps_abs870bc_CAM5-ATRAS_AC3



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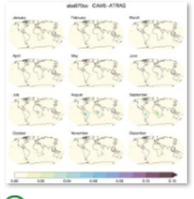

FIG_monthlymaps_abs870oc_CAM5-ATRAS_AC3

Conclusions

- Absorption matters if we want to model aerosol-climate interactions properly
- Ongoing and possible future strong trends in emissions make this a highly timely topic
- Large Ensembles provide new window on inter-annual variability in modelled absorption, giving information to constraints
- AeroCom models differ significantly in their AAOD calculations in the CTRL experiment. Possible reasons include:
  - Species treated
  - Optical properties
  - Radiative transfer
  - Transport / ageing / removal
- Thanks for the absorption data provided so far – and we'll happily accept more!
- Looking forward to absorbing discussions over the coming days.

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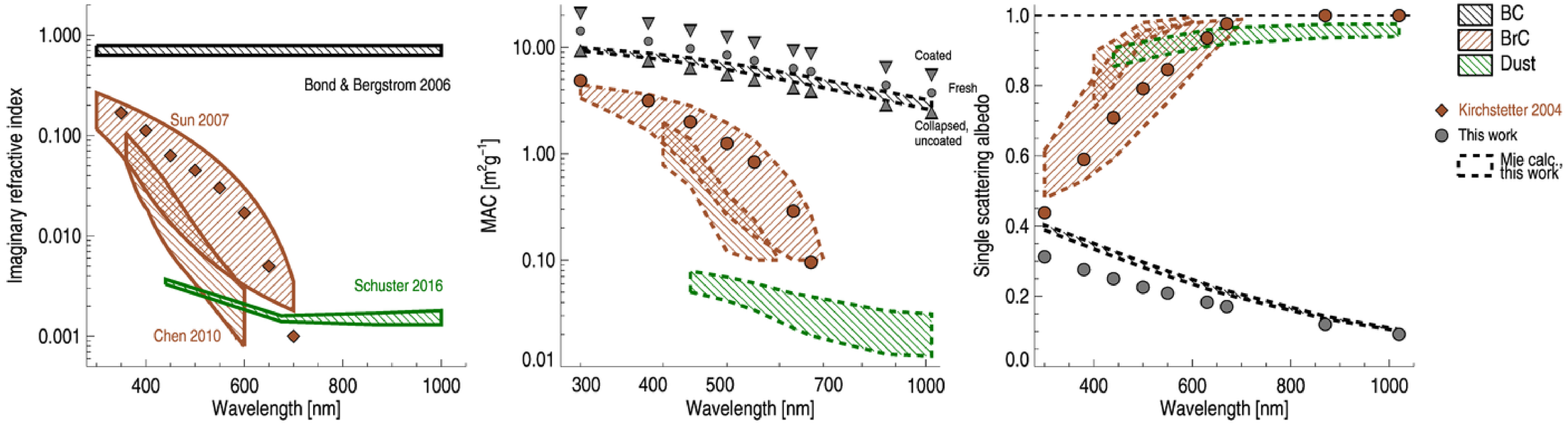
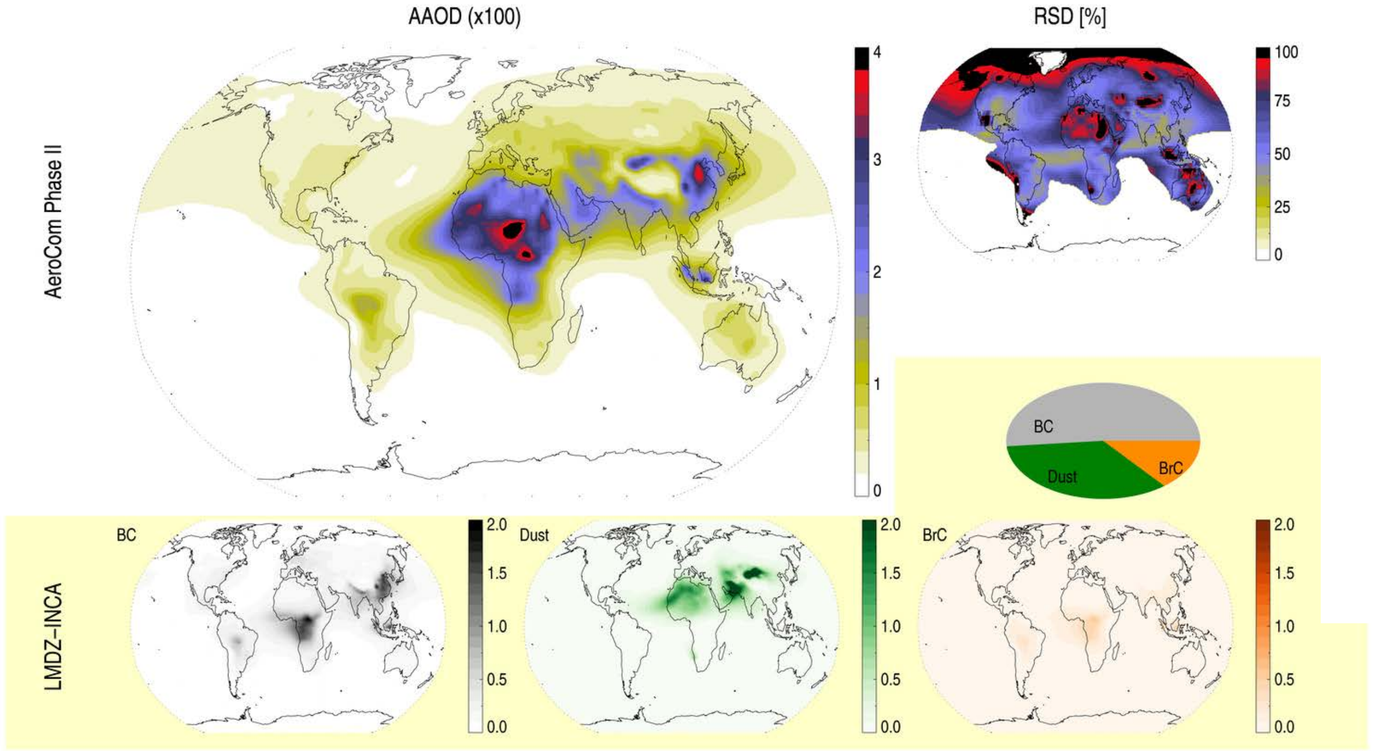
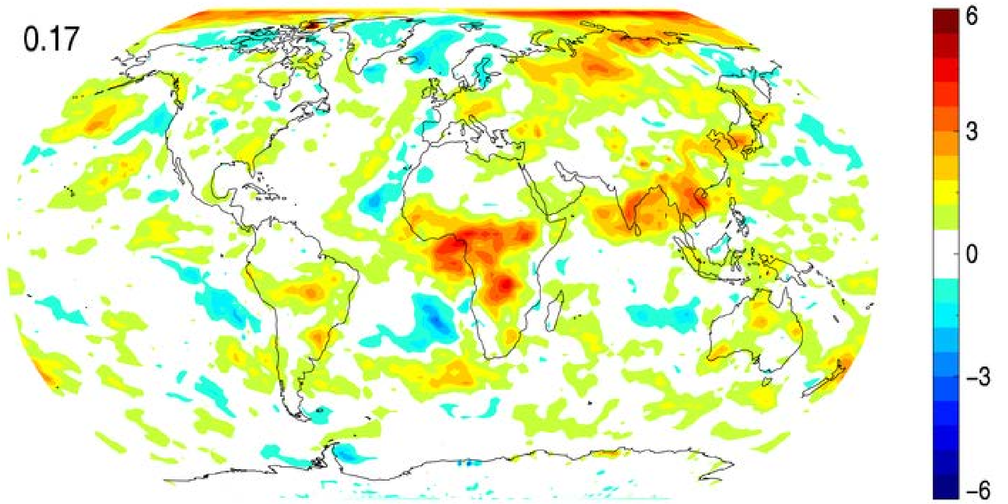
Consistent set of optical properties for absorbing aerosol species

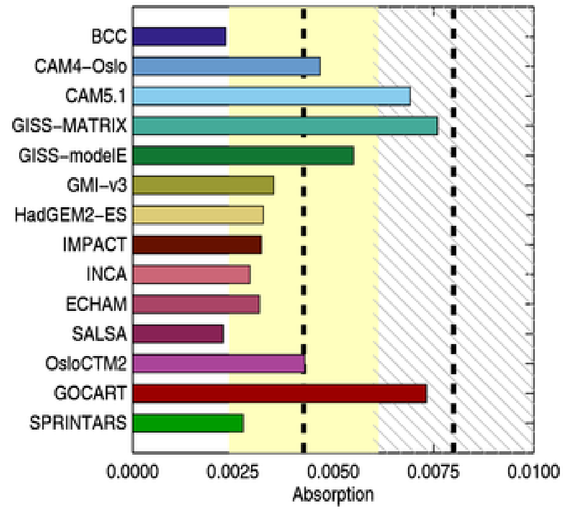


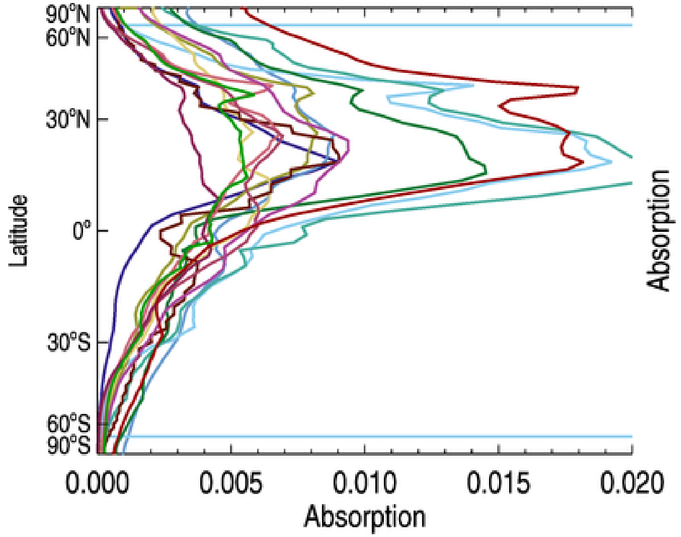


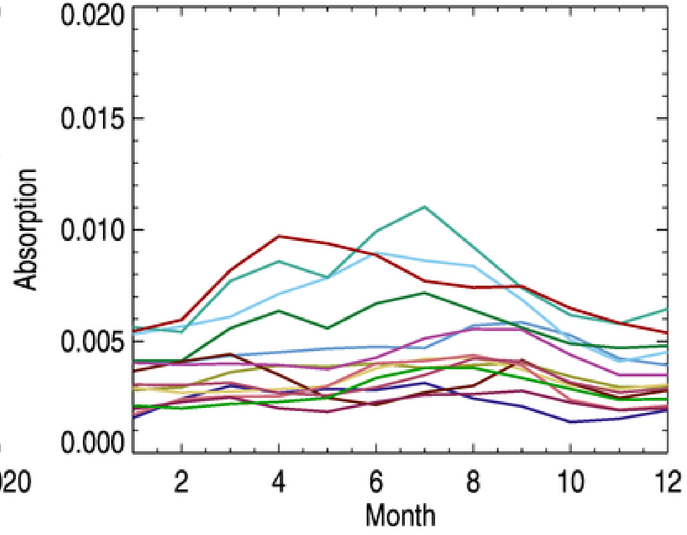
ERF (CAM4)



AAOD
Base: 0.003
Signal: 0.004







CESM Large Ensemble vs OMI: AAOD, 2010