Current aerosol results from ACCESS and the new GLOMAP-mode scheme

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OCEAN AND ATMOSPHERE FLAGSHIP
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CMIP5 sstClim experiments

- **sstClim** – an atm-only run driven by prescribed SST and sea ice (long term av PI control run)
- **sstClimAerosol** – sstClim but year 2000 aerosols
- 30 year run after spin up

sstClimAerosol – sstClim

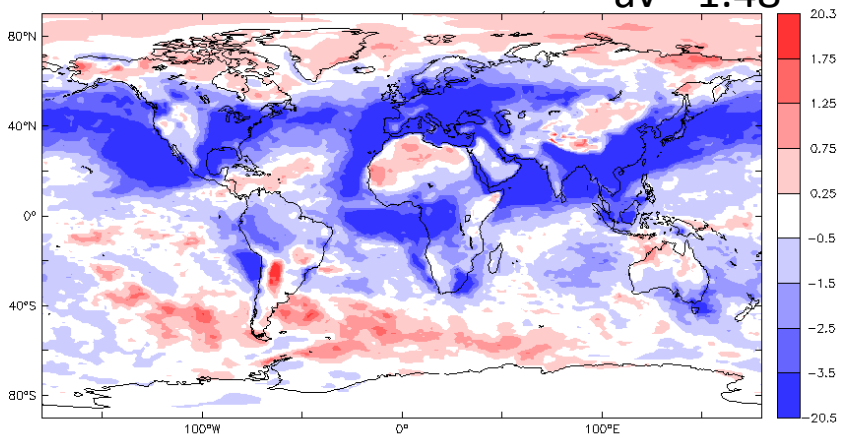
- estimate aerosol forcing for the year 2000 relative to 1850

ERF – Effective Radiative Forcing

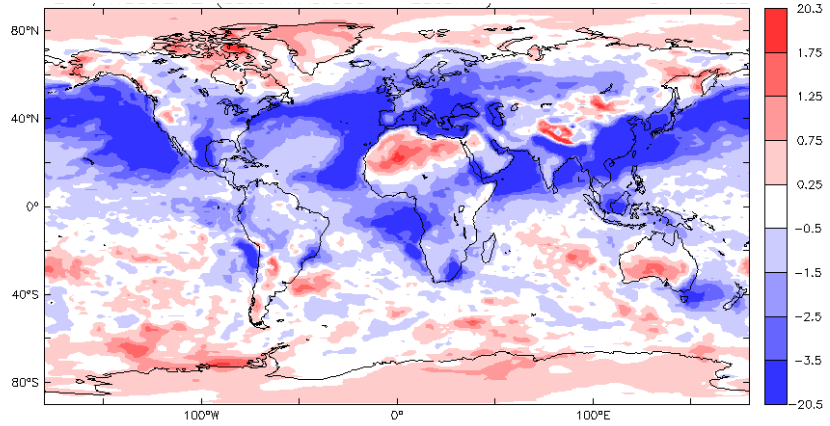
- change in the net radiation at the TOA from pre-industrial to present day - ocean conditions held fixed, all other processes allowed to respond to the aerosol changes
- direct aerosol-radiation interactions (scattering and absorption of radiation)
- aerosol-cloud interactions (aerosol indirect effects, such as changes in cloud albedo and lifetime)

ACCESS-1.0 – MOSES land surface, HadGEM2
ACCESS-1.3 – CABLE land surface, PC2 clouds, HadGEM3
ACCESS-1.4 – Updated 1.3, newer version of CABLE, improved dust uplift

av=-1.48



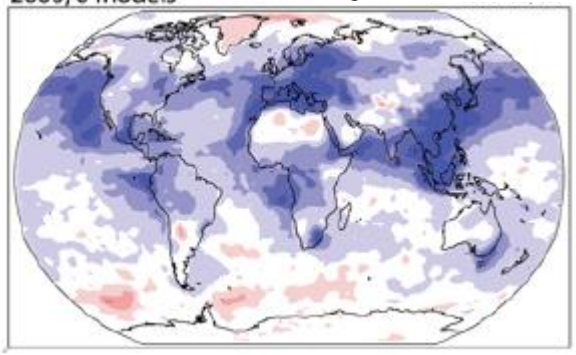
av=-1.23



ACCESS 1.4

HadGEM2

av=-1.17



ACCMIP

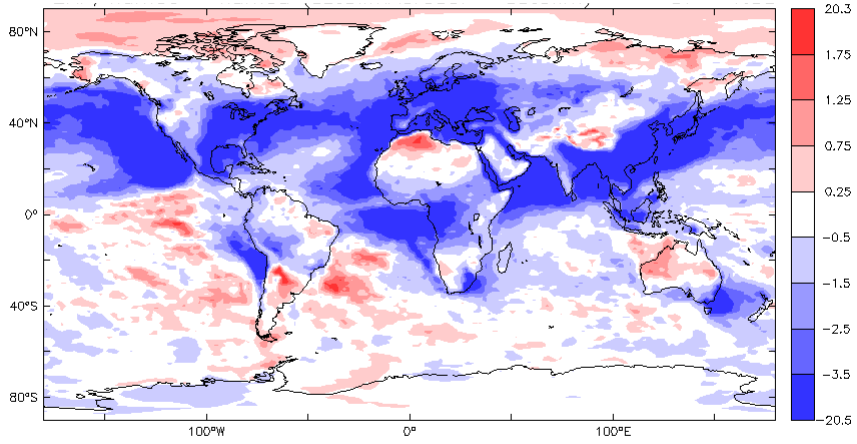
Shindell et al.

Atmos. Chem. Phys., 13, 2939–2974, 2013

Aerosol ERF

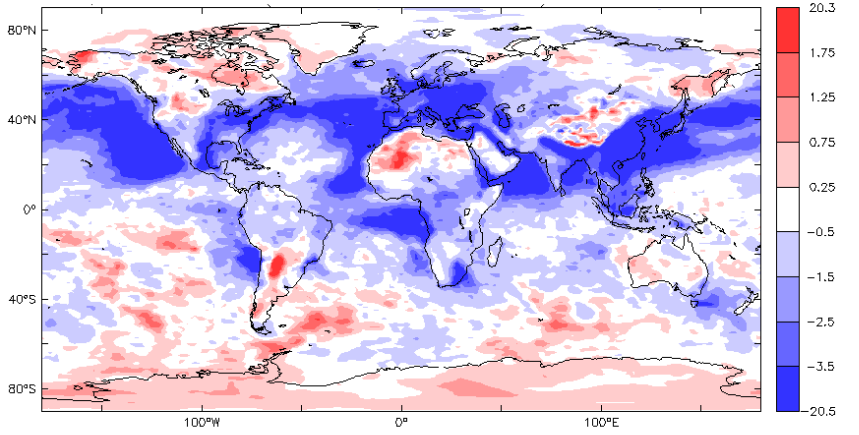
ACCESS 1.3

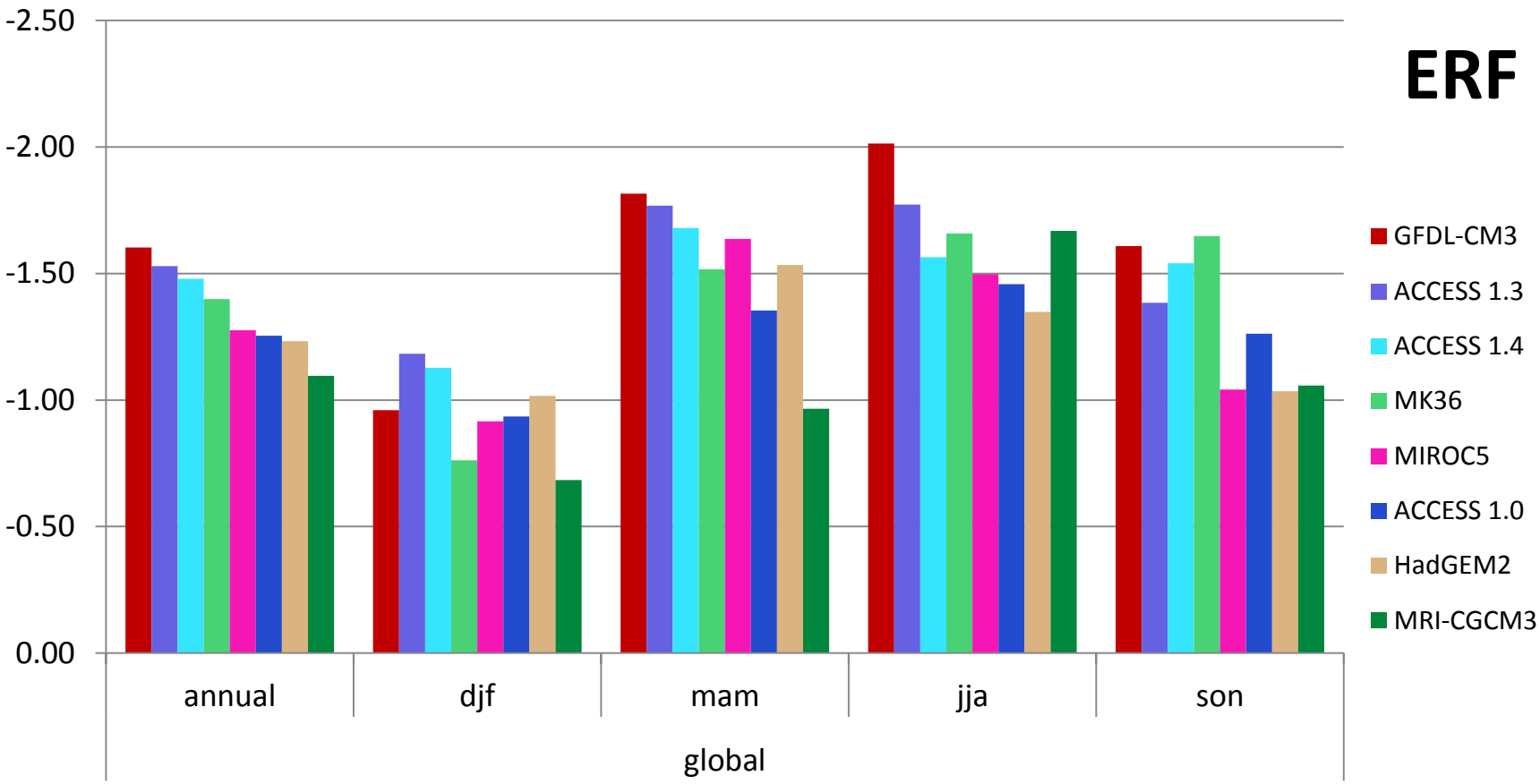
av=-1.53



ACCESS 1.0

av=-1.25




ERF
-2.50
-2.00
-1.50
-1.00
-0.50
0.00
annual
djf
mam
jja
son
global
GFDL-CM3
ACCESS 1.3
ACCESS 1.4
MK36
MIROC5
ACCESS 1.0
HadGEM2
MRI-CGCM3

UM-UKCA GLOMAP-mode and CHeST

- UM vn8.4
- Matt Woodhouse, Marcus Thatcher, Lauren Stevens (model and emissions database)

UKCA

- United Kingdom Chemistry and Aerosol framework for putting chemistry and aerosols into UM
- CHeST – chemistry for stratosphere and troposphere

GLOMAP

- Global Model of Aerosol Processes – simulates evolution of particle composition across the size spectrum over several different components
- GLOMAP-bin – typically 20 bins spanning the size spectrum (expensive)
- GLOMAP-mode – same process representations but modal version of GLOMAP

CLASSIC
(Coupled Large-scale Aerosol Simulator for Studies In Climate)

- sulphate, black carbon, organic carbon, sea-salt, biomass burning, dust, secondary organic aerosols
- aerosol mass per component is predicted
- bulk approach, number of particles derived from an assumed fixed size distribution for each aerosol component
- external mixtures (particles consist of only one component)

GLOMAP-mode

- sulphate, black carbon, organic carbon, sea-salt, dust (from CLASSIC)
- aerosol microphysics scheme predicts particle number and mass concentrations, enabling changes in the particle size distribution in time and space
- 5 modes (4 soluble, 1 insoluble)
- internally mixed (important for optical properties, etc)
- new particle formation (nucleation) and growth (by coagulation, condensation and cloud processing).

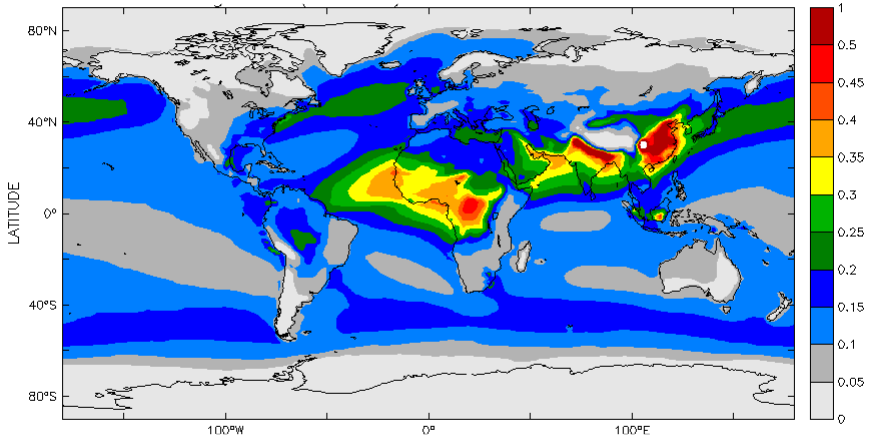
GLOMAP-mode aerosol configuration

Mode	Soluble	Size boundaries (nm) d = dry diameter	Composition
Nucleation	Yes	d < 10	SU, OC
Aitken	Yes	10 < d < 100	SU, BC, OC
Accumulation	Yes	100 < d < 1000	SU, BC, OC, SS
Coarse	Yes	1000 < d	SU, BC, OC, SS
Aitken	no	10 < d < 100	BC, OC

SU – sulphate, BC – black carbon, OC – organic carbon, SS – sea-salt

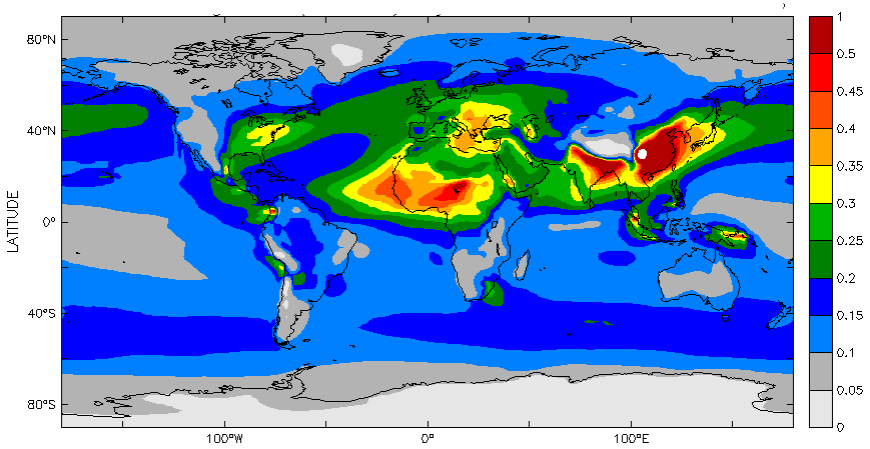
Aerosol Optical Depth 550nm

ACCESS 1.4



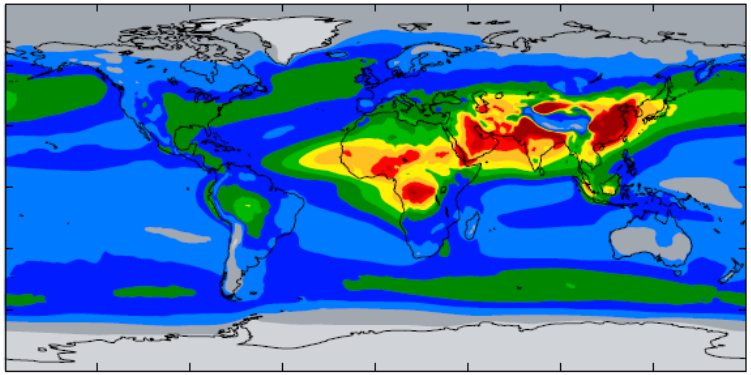
Mean = 0.132

GLOMAP-mode



Mean = 0.165

MACC AOD

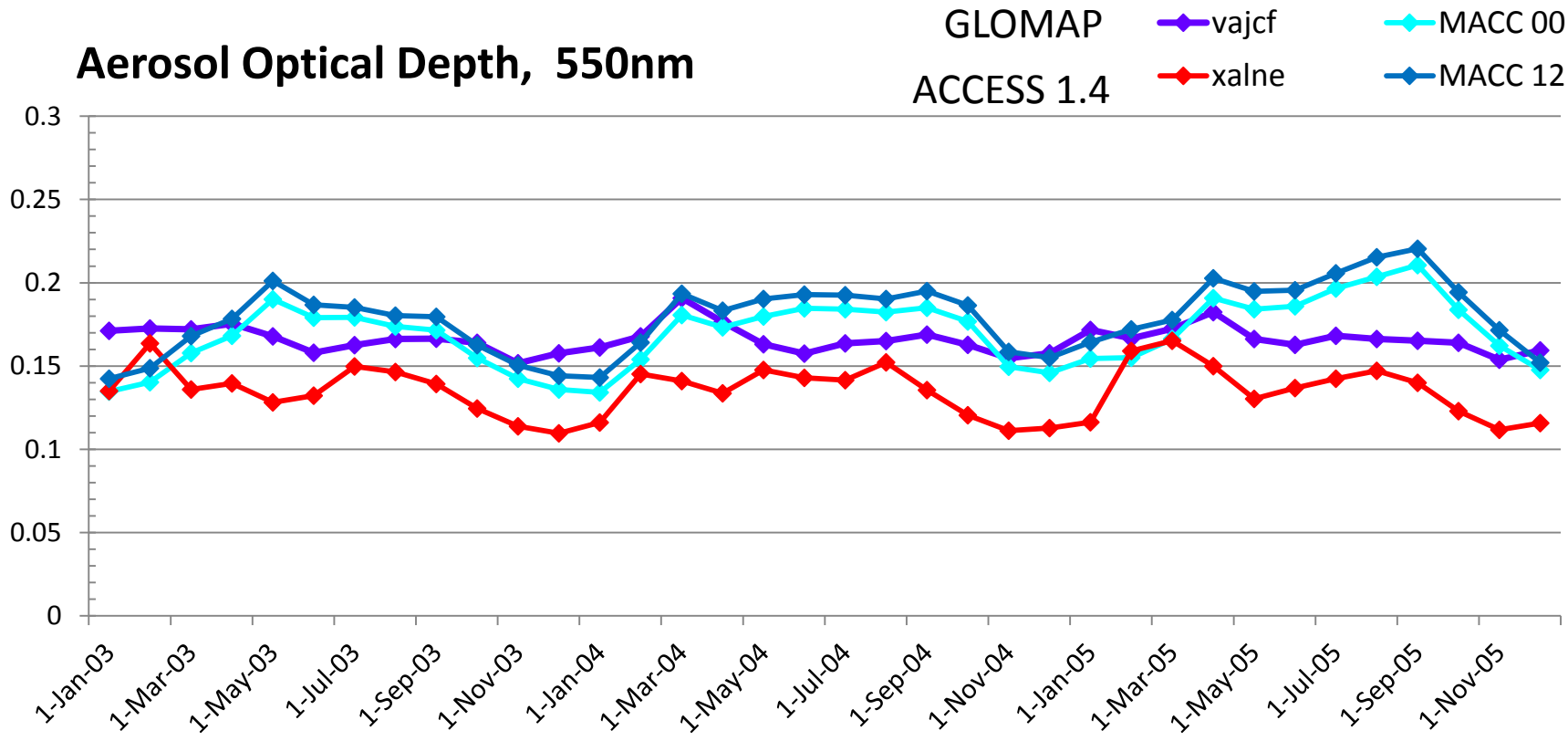


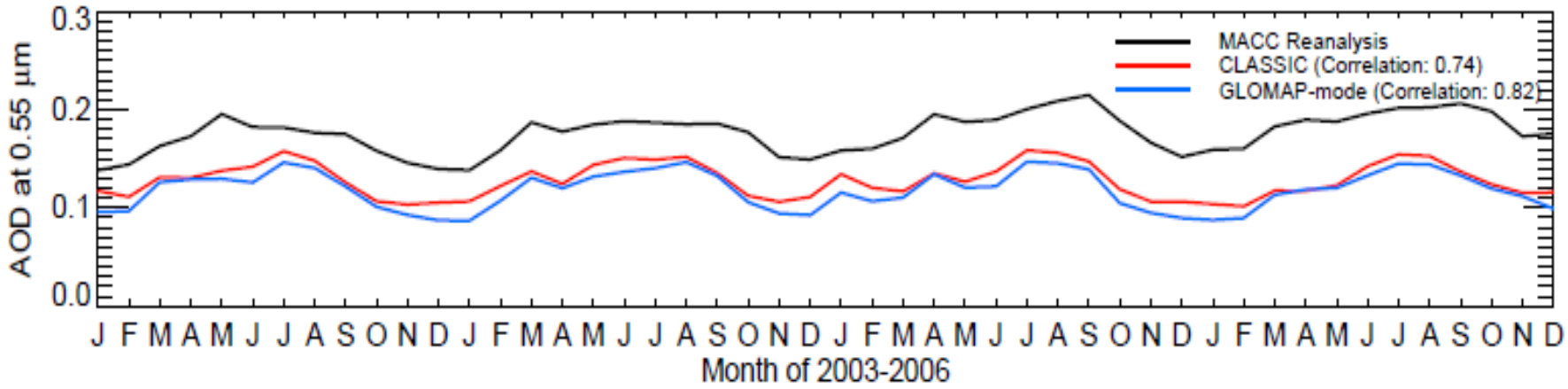
Mean: 0.176

Atmos. Chem. Phys., 13, 3027–3044, 2013

N. Bellouin et al.: Modal aerosol scheme and forcing

Aerosol Optical Depth, 550nm





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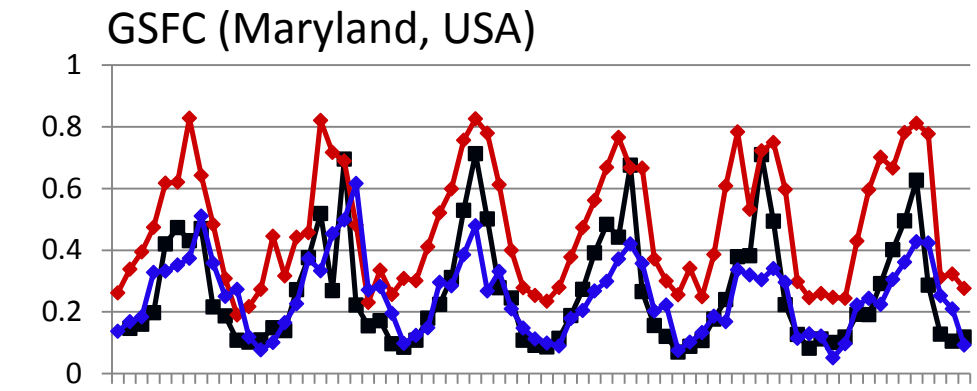
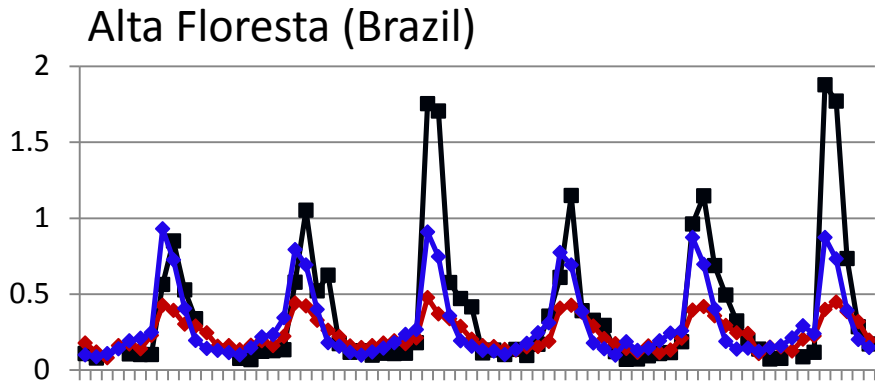
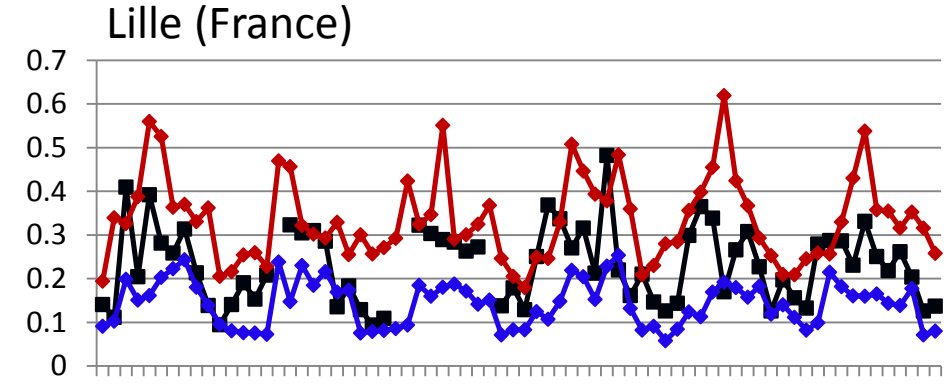
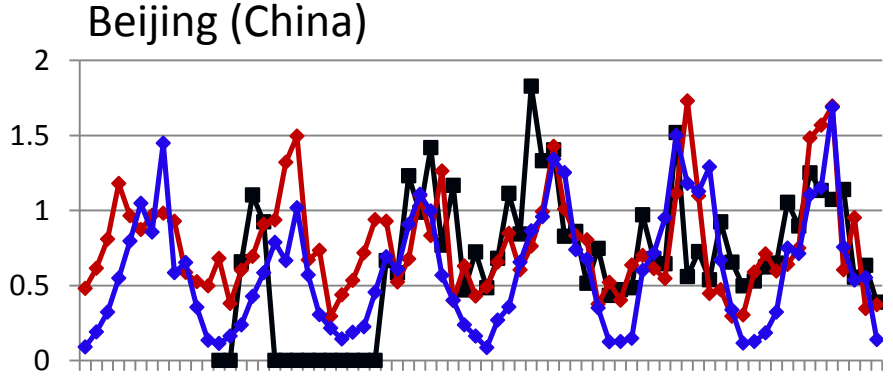
AOD 440nm

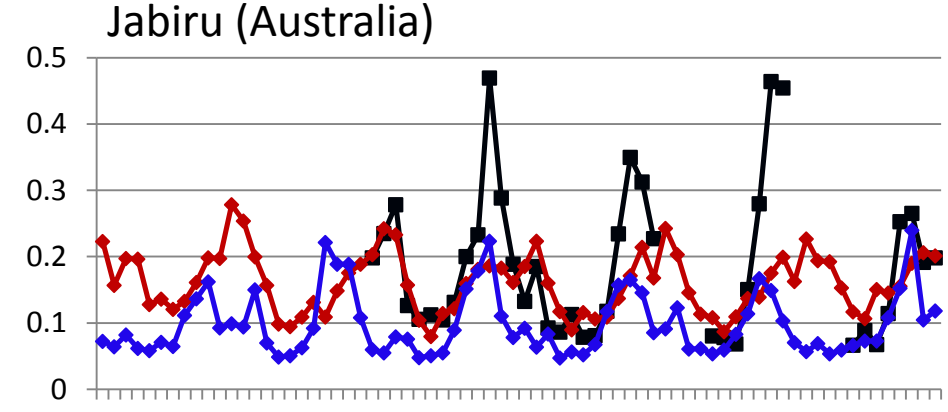
AERONET GLOMAP ACCESS 1.4

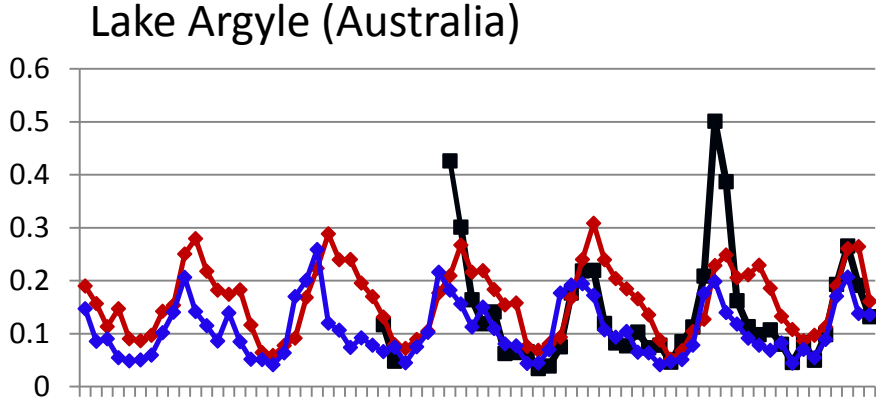


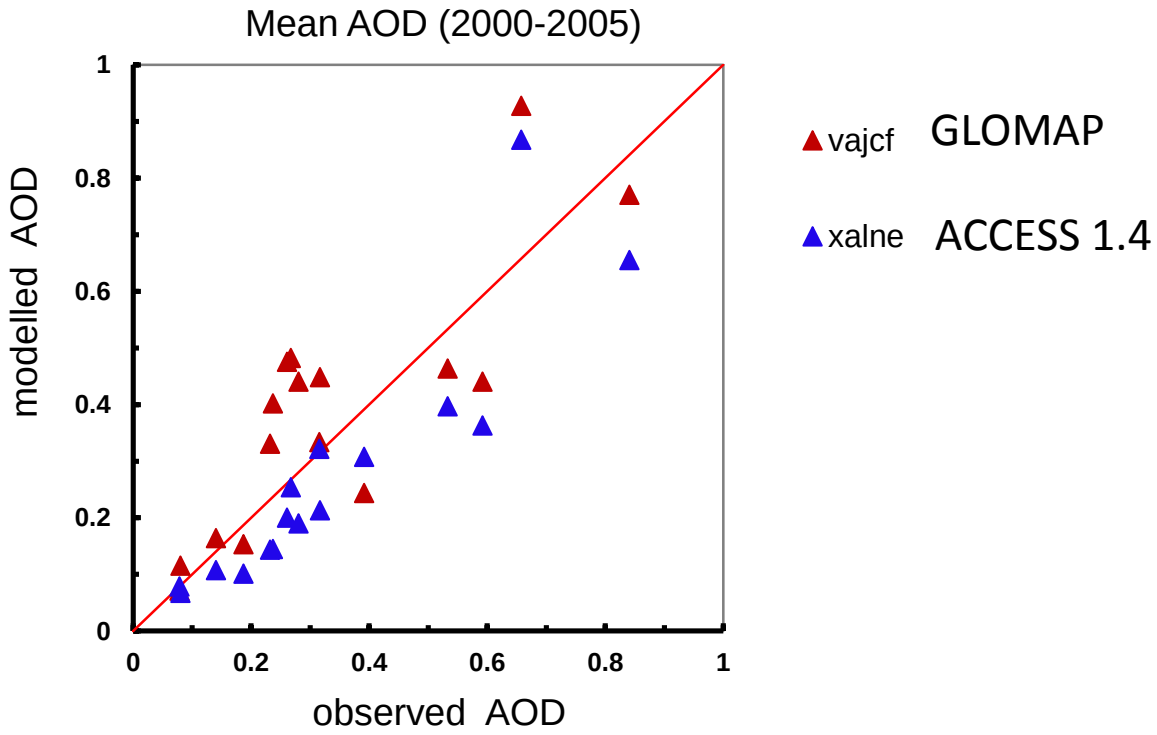






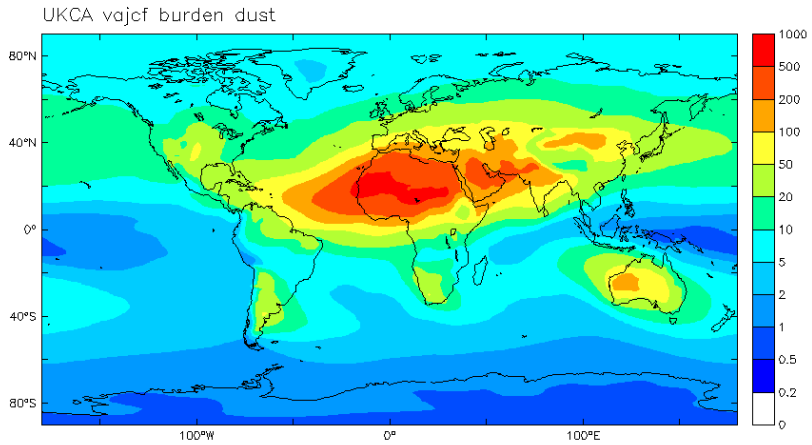




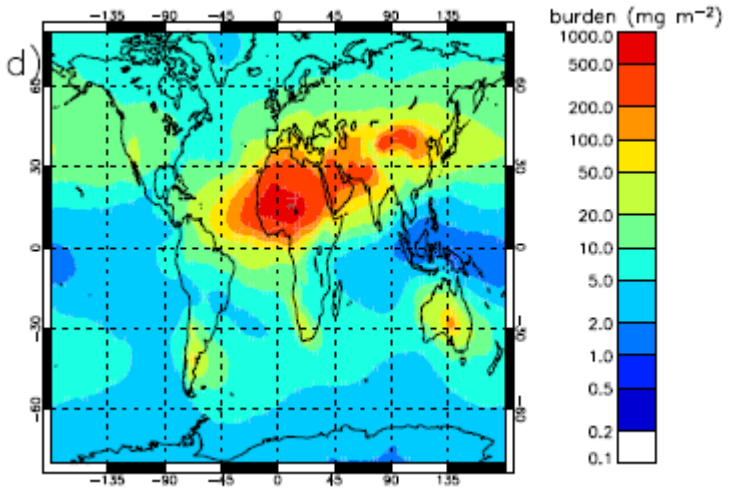

Mean AOD (2000-2005)
modelled AOD
observed AOD
0
0.2
0.4
0.6
0.8
1
vajcf
GLOMAP
xalne
ACCESS 1.4

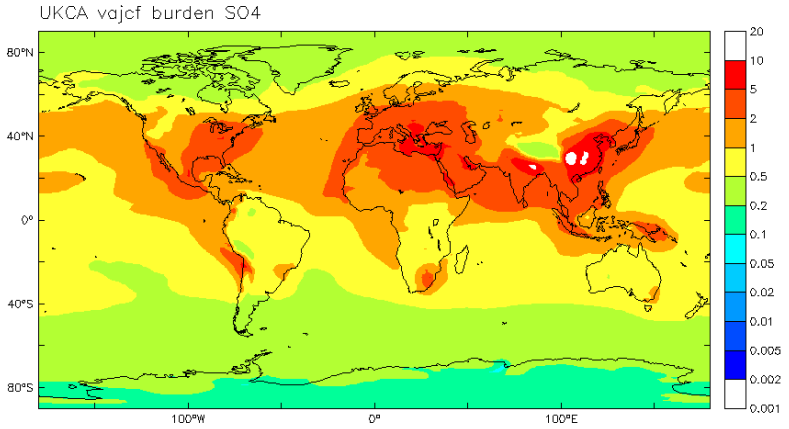
GLOMAP-mode

Annual mean aerosol burden

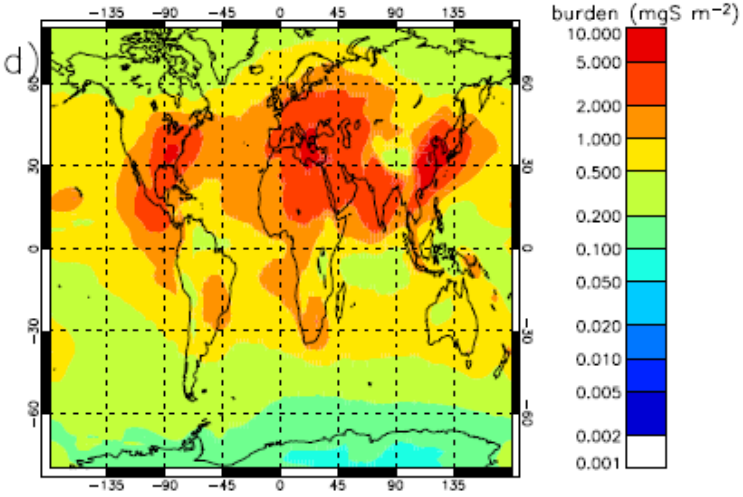


dust





sulphate



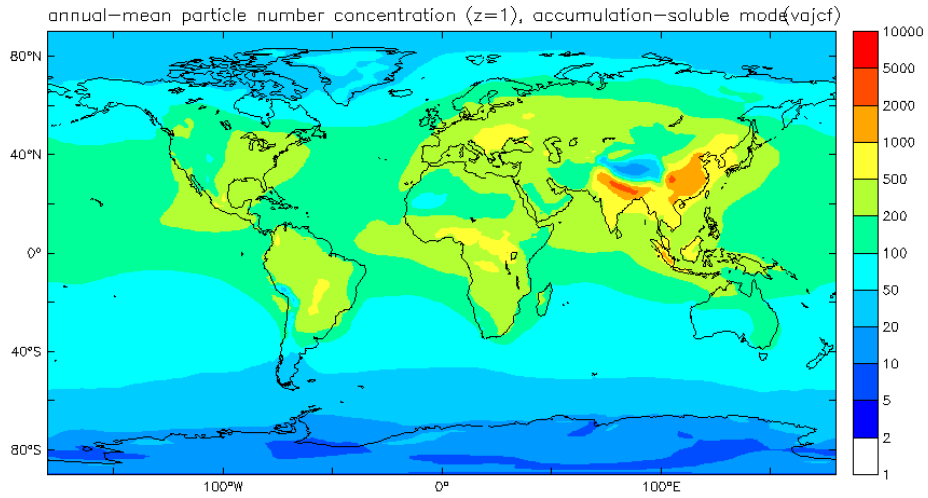
Geosci. Model Dev., 3, 519–551, 2010

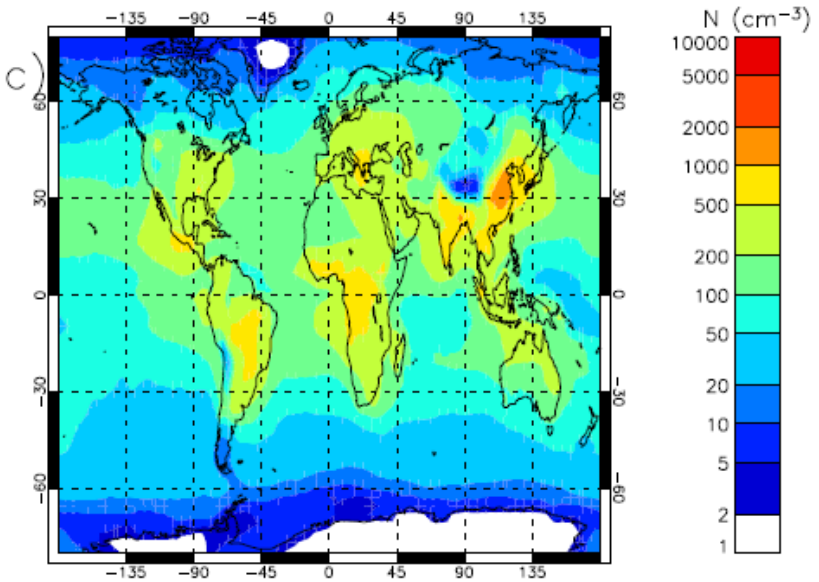
G. W. Mann et al.: GLOMAP-mode description and evaluation

Annual-mean particle number concentration

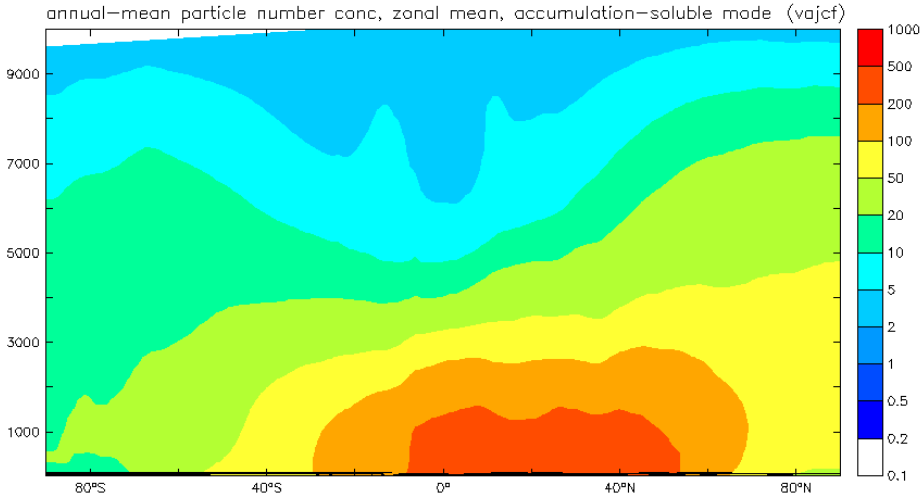
Accumulation-soluble mode

Z=1





Zonal mean



Geosci. Model Dev., 3, 519–551, 2010

G. W. Mann et al.: GLOMAP-mode description and evaluation

Thank you

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MACC – (Monitoring Atmosphere Composition and Climate) re-analysis.

The MACC re-analysis uses an aerosol model (Morcrette et al., 2009) embedded into the European Centre for Medium-Range Weather Forecasts (ECMWF) Integrated Forecast System (IFS) model.
IFS 4D variational assimilation system, assimilates Moderate Resolution Imaging Spectro-radiometer (MODIS) total AOD at 0.55 um – corrects the modelled total AODs for departure form obs.

ACCMIP – Atmospheric Chemistry and Climate Model Intercomparison Project

10 models included aerosols – 8 also in CMIP5
Intended primarily to examine the anthropogenic drivers of climate change in CMIP5

- reproduce total AOD relatively well, though many are biased low
- most models underestimate east Asian AOD
- Strongly underestimate absorbing AOD in many regions

AERONET – AErosol RObotic NETwork

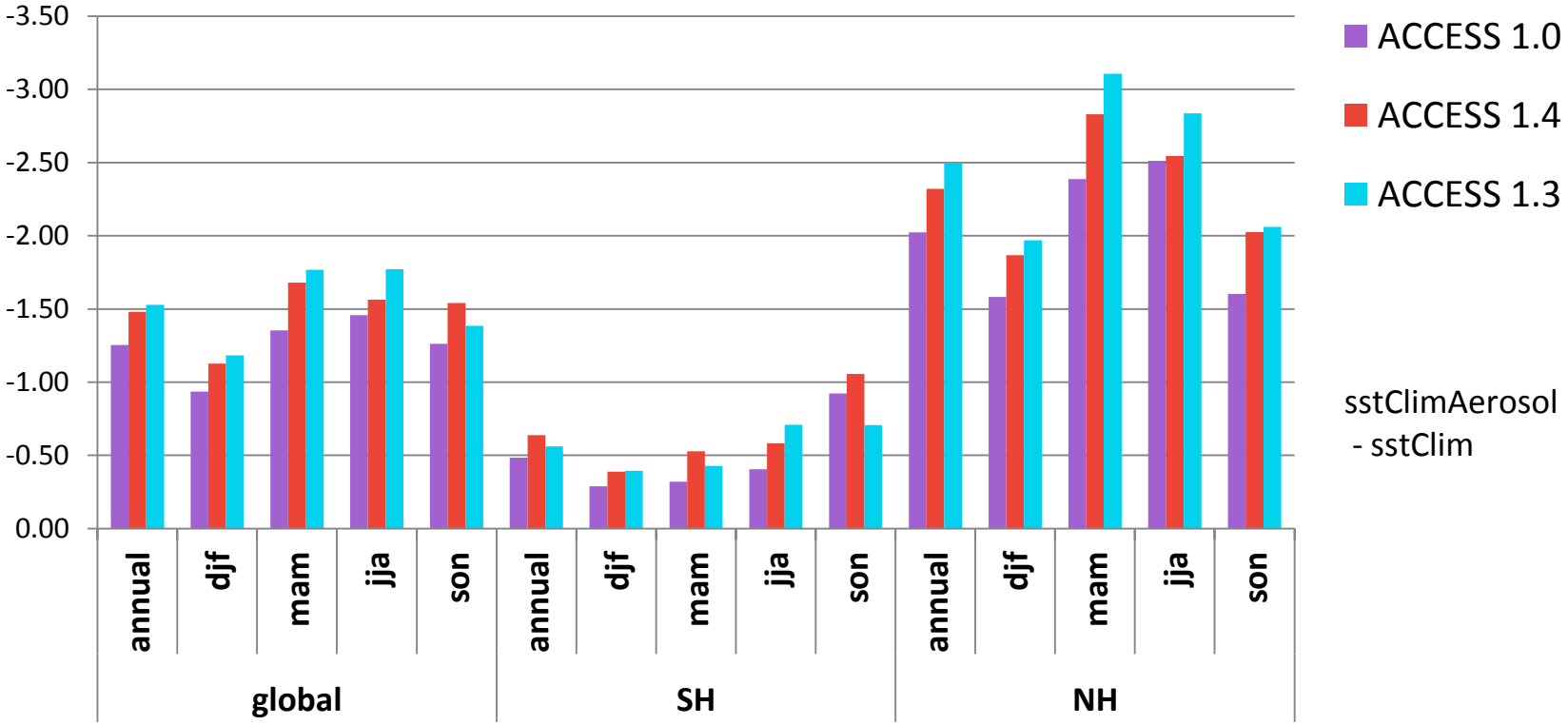
Models

GFDL-CM3 - Geophysical Fluid Dynamics Laboratory (NOAA)

MIROC5 - Model for Interdisciplinary Research on Climate (MIROC5)
Atmosphere and Ocean Research Institute (The University of Tokyo),
National Institute for Environmental Studies, and Japan Agency for Marine-Earth Science and Technology

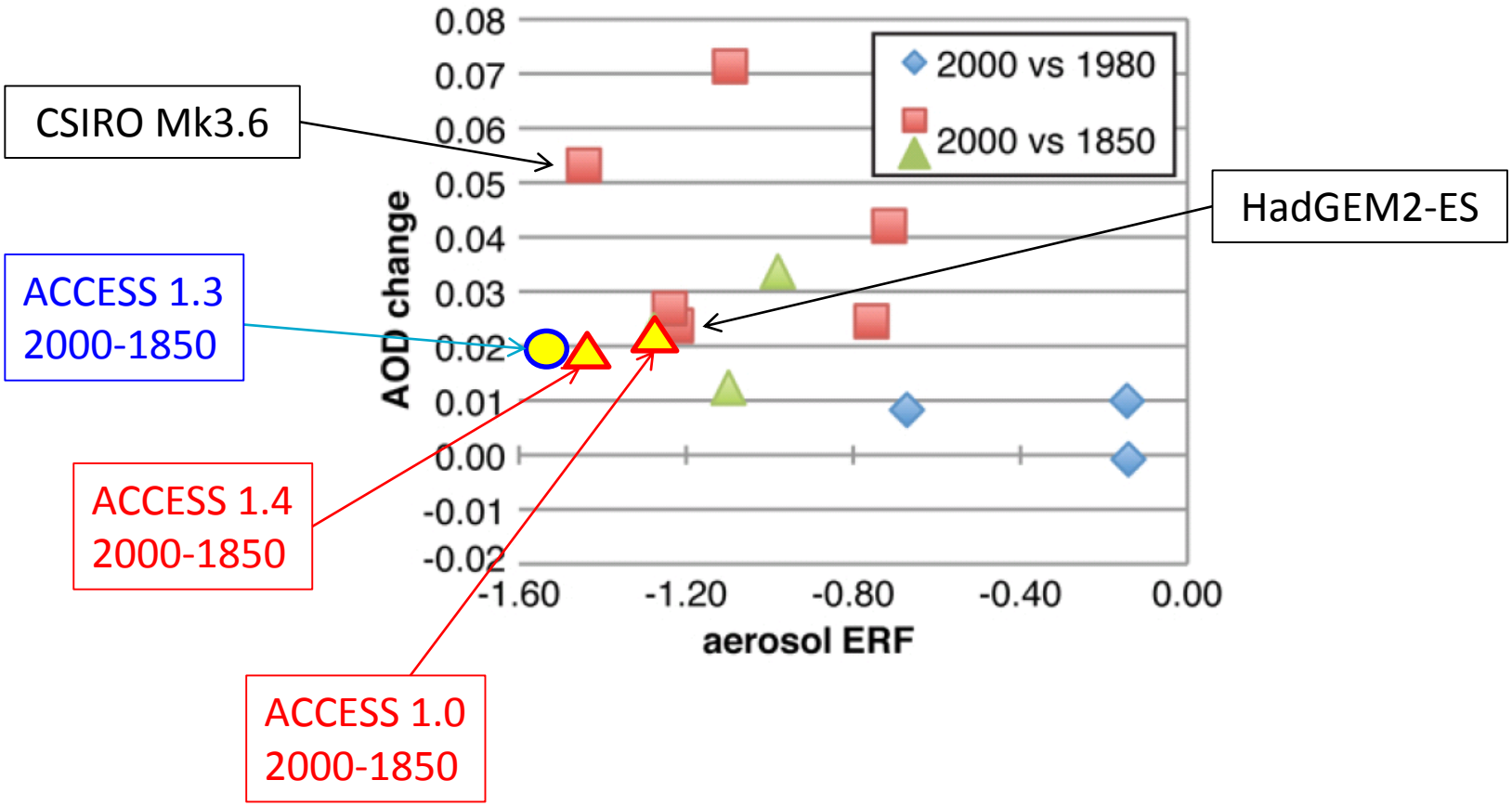
MRI-CGCM3 - Meteorological Research Institute, Japan

ERF Aerosol


-3.50
-3.00
-2.50
-2.00
-1.50
-1.00
-0.50
0.00
annual
djf
mam
jja
son
annual
djf
mam
jja
son
annual
djf
mam
jja
son
global
SH
NH
ACCESS 1.0
ACCESS 1.4
ACCESS 1.3
sstClimAerosol
- sstClim

Radiative forcing in the ACCMIP historical and future climate simulations

D. T. Shindell[1], J.-F. Lamarque[2], M. Schulz[3], M. Flanner[4], C. Jiao[4], M. Chin[5], P. J. Young[6,*], Y. H. Lee[1], L. Rotstayn[7], N. Mahowald[8], G. Milly[1], G. Faluvegi[1], Y. Balkanski[9], W. J. Collins[10,**], A. J. Conley[2], S. Dalsoren[11], R. Easter[12], S. Ghan[12], L. Horowitz[13], X. Liu[12], G. Myhre[11], T. Nagashima[14], V. Naik[15], S. T. Rumbold[10], R. Skeie[11], K. Sudo[16], S. Szopa[9], T. Takemura[17], A. Voulgarakis[1,18], J.-H. Yoon[12], and F. Lo[8]



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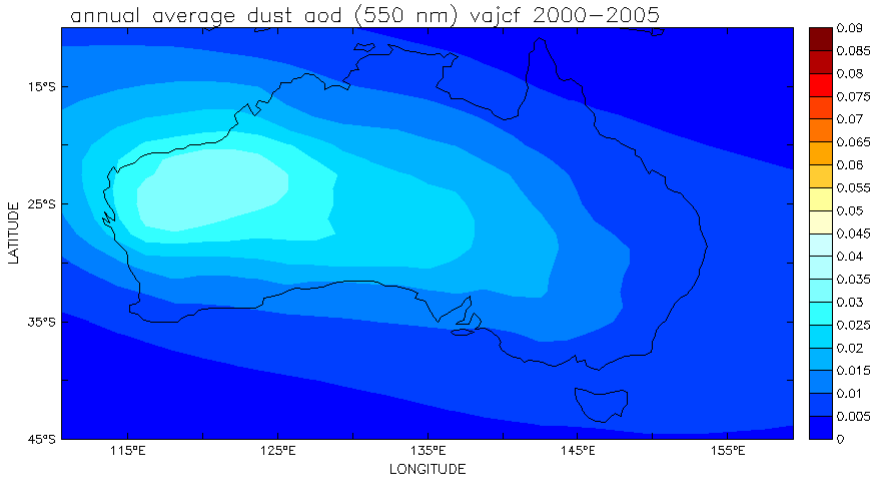
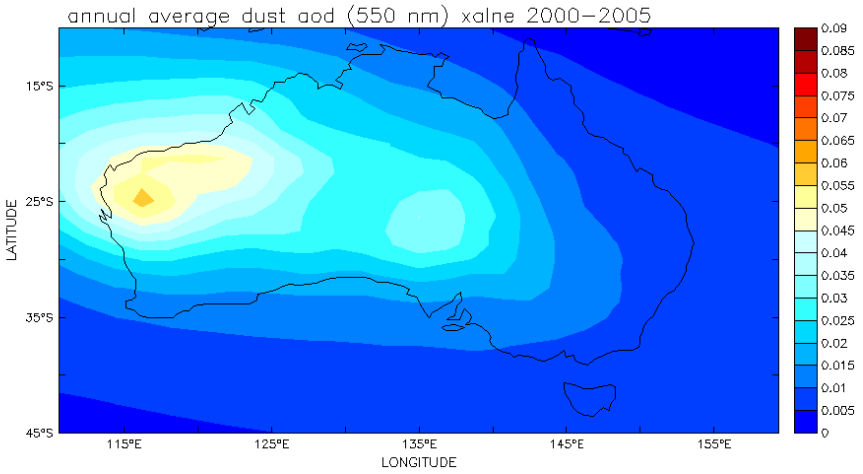
GLOMAP



ACCESS 1.4



Aerosol optical depth from dust, ACCESS-1.4 model, 1990-1999

(Peter Vohralik)