DEPARTMENT OF PHYSICS

Aerosol Radiative Forcing

The AeroCom Prescribed Experiment: Towards the Quantification of Host Model Errors

AeroCom Meeting, Oxford

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University of Oxford

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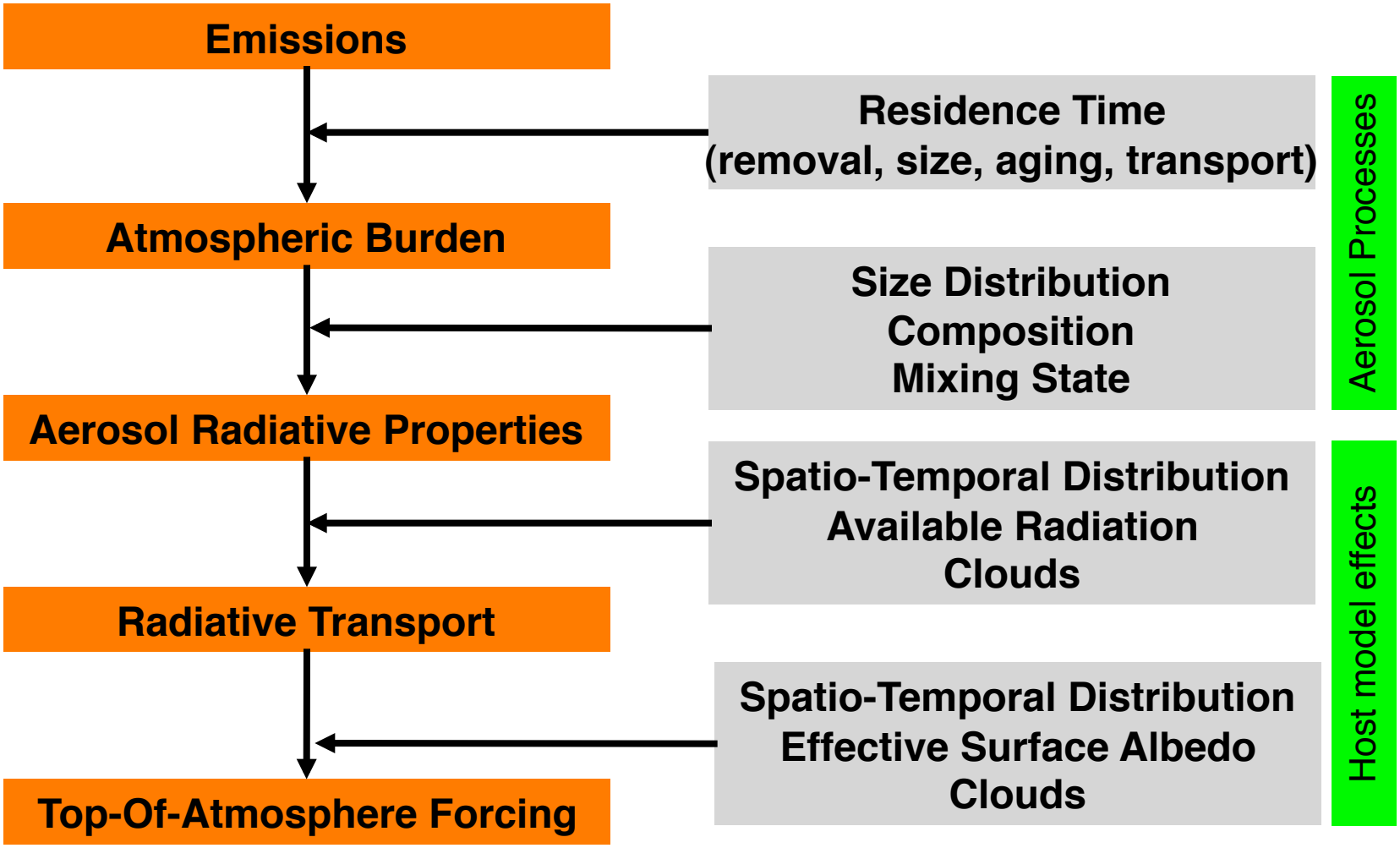
Assessment of aerosol direct radiative forcing

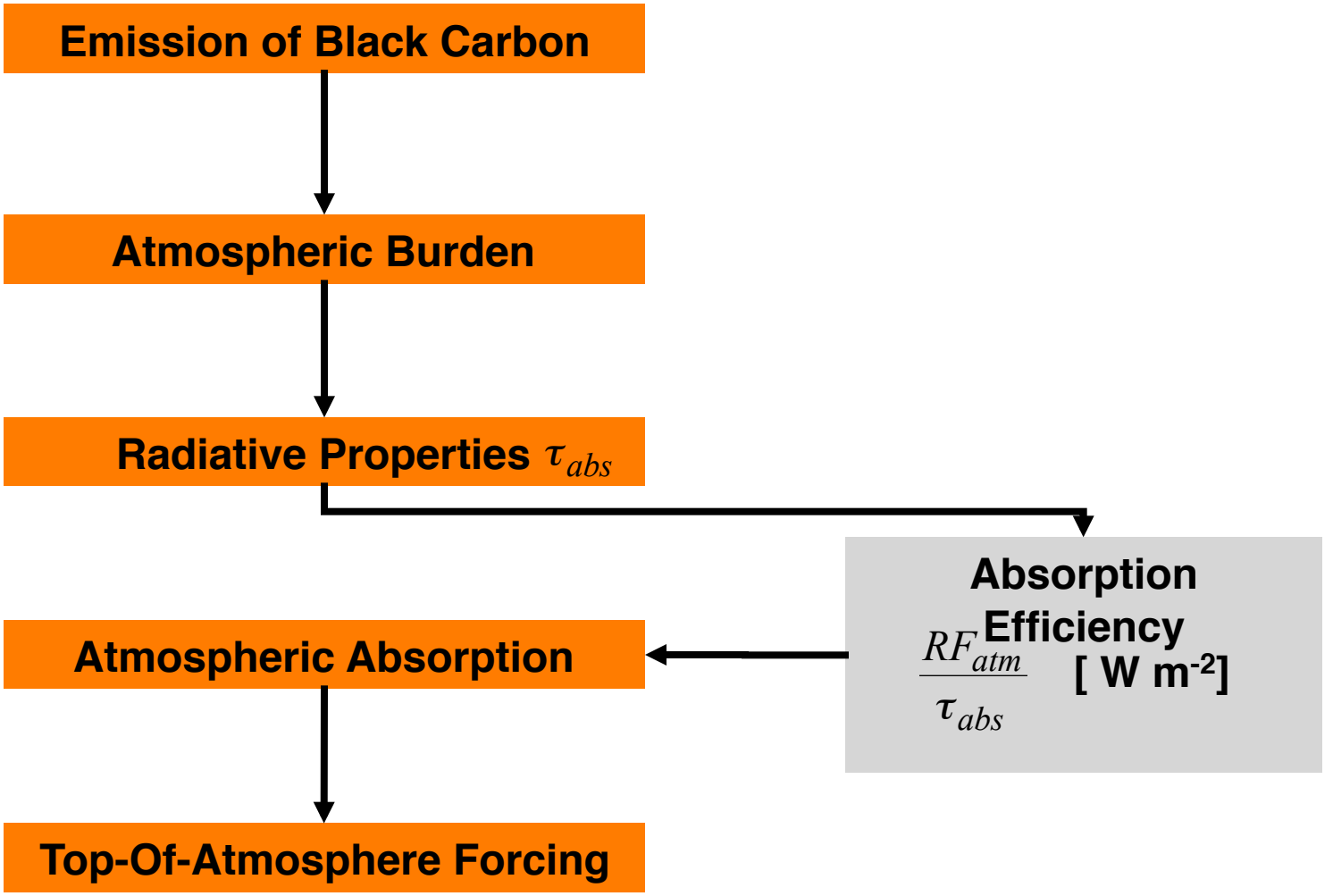
AeroCom: Intercomparison and assessment of the underlying process representations



Assessment of aerosol direct radiative forcing

Analysis of AeroCom forcing experiment:

Large diversity in absorption efficiency from aerosol radiative properties:



Aerosol Processes

Host model effects

AeroCom Radiative Forcing

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Analysis of AeroCom Forcing Experiment

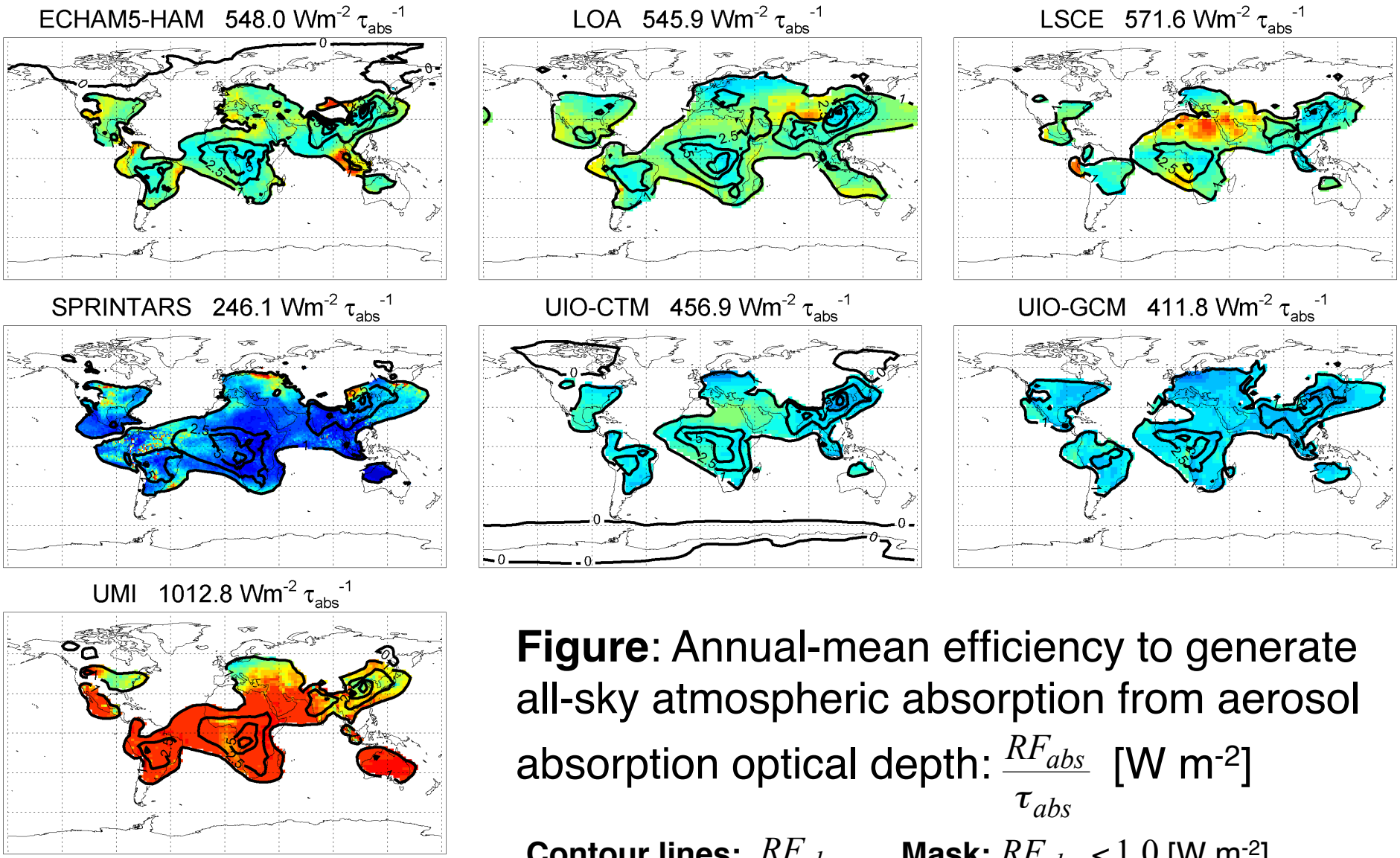
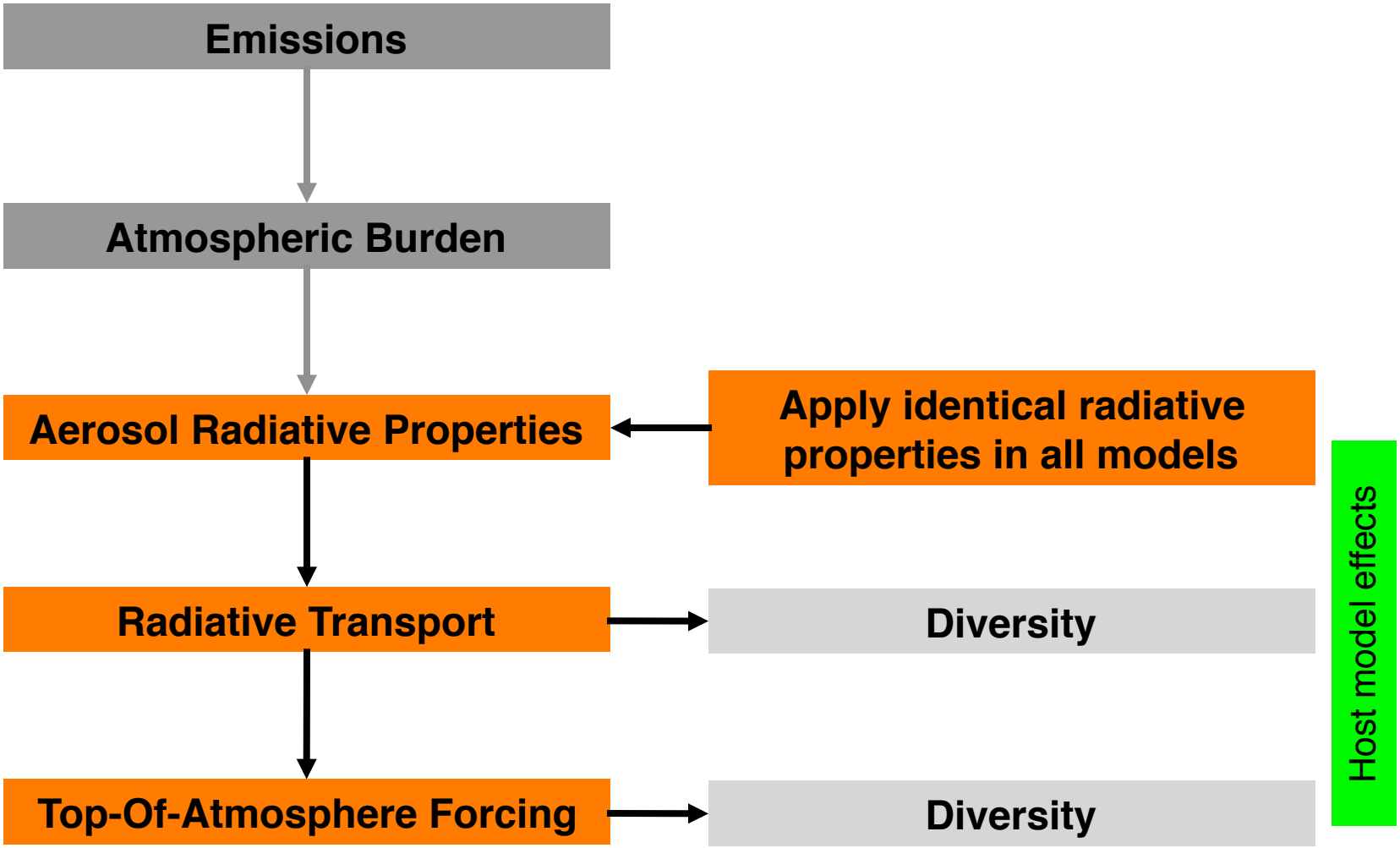


Figure: Annual-mean efficiency to generate all-sky atmospheric absorption from aerosol absorption optical depth: $\frac{RF_{abs}}{\tau_{abs}}$ [W m^{-2}]

Contour lines: RF_{abs} **Mask:** $RF_{abs} < 1.0$ [W m^{-2}]

The AeroCom Prescribed Experiment

Facilitate inter-comparability through fixing 3D aerosol radiative properties



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AeroCom Prescribed - Set-up

Prescribe **aerosol radiative properties** identically in all **"models"**:

- Extinction, Single Scattering Albedo, Asymmetry Factor:

  - 3D distributions

  - 24 SW wavelengths

  - "fool proof" offline mapping tools to model resolution and radiation bands

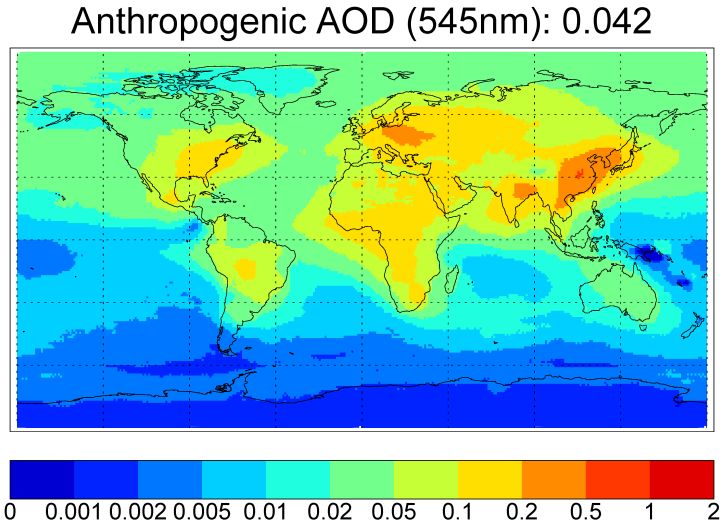

Figure: Annual-mean anthropogenic and total aerosol optical depth at 550 nm derived from AeroCom median model and AERONET.

AeroCom Prescribed - Set-up

Prescribe **aerosol radiative properties** identically in all **"models"**:

- Extinction, Single Scattering Albedo, Asymmetry Factor:

  - 3D distributions

  - 24 SW wavelengths

  - "fool proof" offline mapping tools to model resolution and radiation bands

To make this very clear:

- **You do not need to run your aerosol model for this experiment**
- **You may want to run parts of it anyway to keep your AeroCom diagnostics routines**

Input Data Set-up - Step 1 out of 3

AeroCom Prescribed

Emacs@cloud-2.local

```
#!/bin/tcsh -xv
#
#############################################################################
#
# AeroComPrescribed_Step_1_SpectralMapping.sh
#
# Purpose:
# ========
# Performs spectral mapping from 24 streamer short-wave bands to
# respective model bands.
#
# Usage:
# ======
# Example set-up for 6 SW bands of ECHAM5. Simply adjust the weighting
# below to the respective model bands. Please include the 545nm band as
# below for quality control. Warning: ensure proper usage of brackets as
# errors give incorrect results but no warning using the nco tools.
#
# Input:
# ======
# - AeroComPrescribed_RadiativeProperties_${TYPE}_SW.nc
#   for each TYPE ( Fine_PresentDay Fine_PreIndustrial Coarse)
#
# Output:
# =======
# - AeroComPrescribed_RadiativeProperties_${TYPE}_SW_mapped.nc
#   for each TYPE ( Fine_PresentDay Fine_PreIndustrial Coarse)
#
# Authors:
# ========
# Philip Stier, University of Oxford (philip.stier@atm.ox.ac.uk), 2009
#
# Required tools:
# ===============
# NetCDF Operators (nco-tools) available from http://nco.sourceforge.net
#
#############################################################################
#
foreach TYPE ( Fine_PresentDay_SW Fine_PreIndustrial_SW Coarse_SW )
#
set IFILE=AeroComPrescribed_RadiativeProperties_${TYPE}.nc
#
set OFILE=${IFILE:r}_mapped.nc
--:--  AeroComPrescribed_Step_1_SpectralMapping.sh   Top L1     (Shell-script[tcsh])----------
No indentation for this shell type.
```

Input data on 2D 1x1 degree with 24 spectral bands

Step 1:
Mapping to model specific spectral bands.

Required:

NetCDF operators (nco tools)

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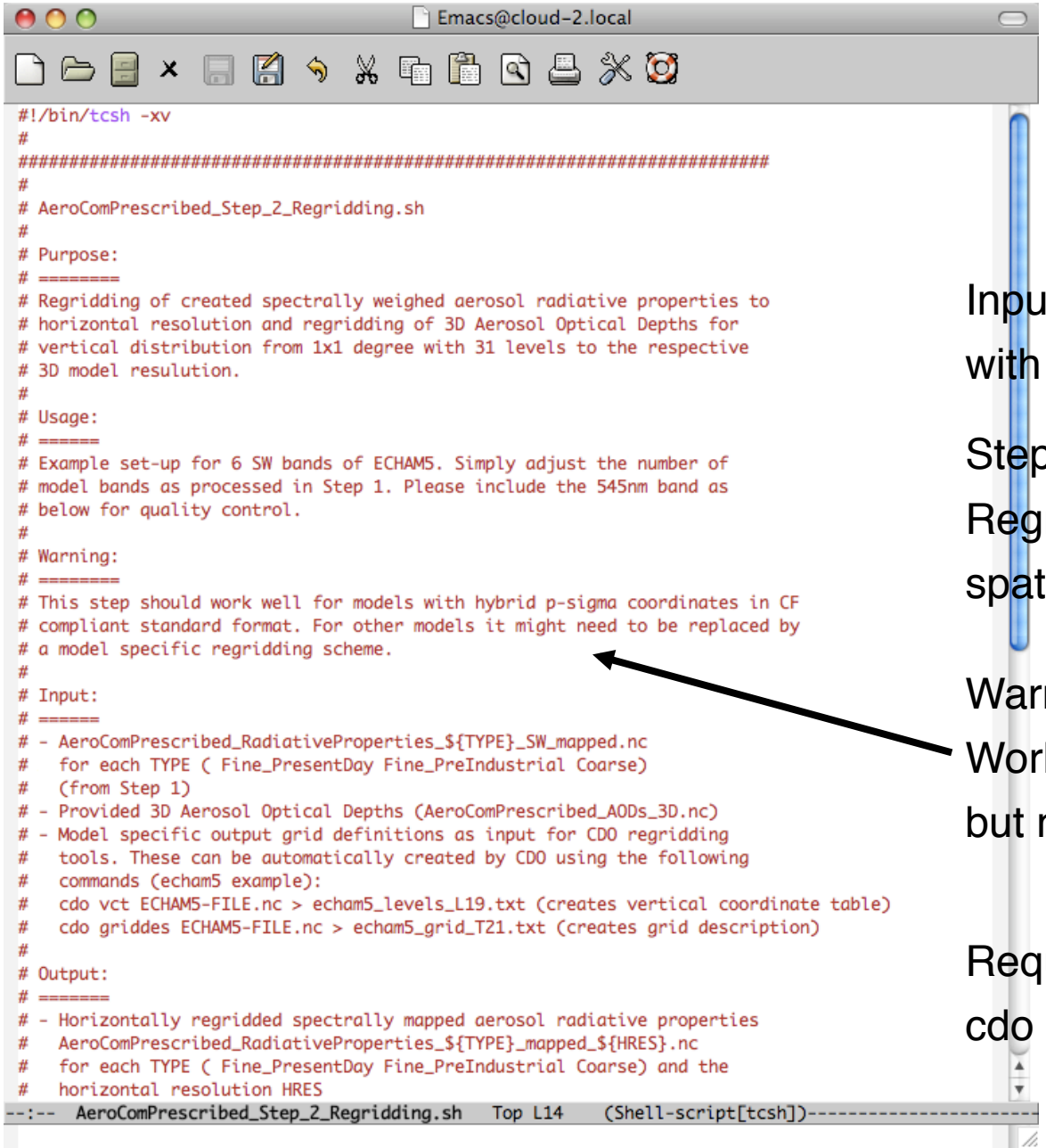
Input Data Set-up - Step 2 out of 3



Input data on 2D 1x1 degree with 24 spectral bands

Step 2:
Regridding to respective spatial model resolution.

Warning:
Works with hybrid p-sigma but not all grids

Required:
cdo climate data operators

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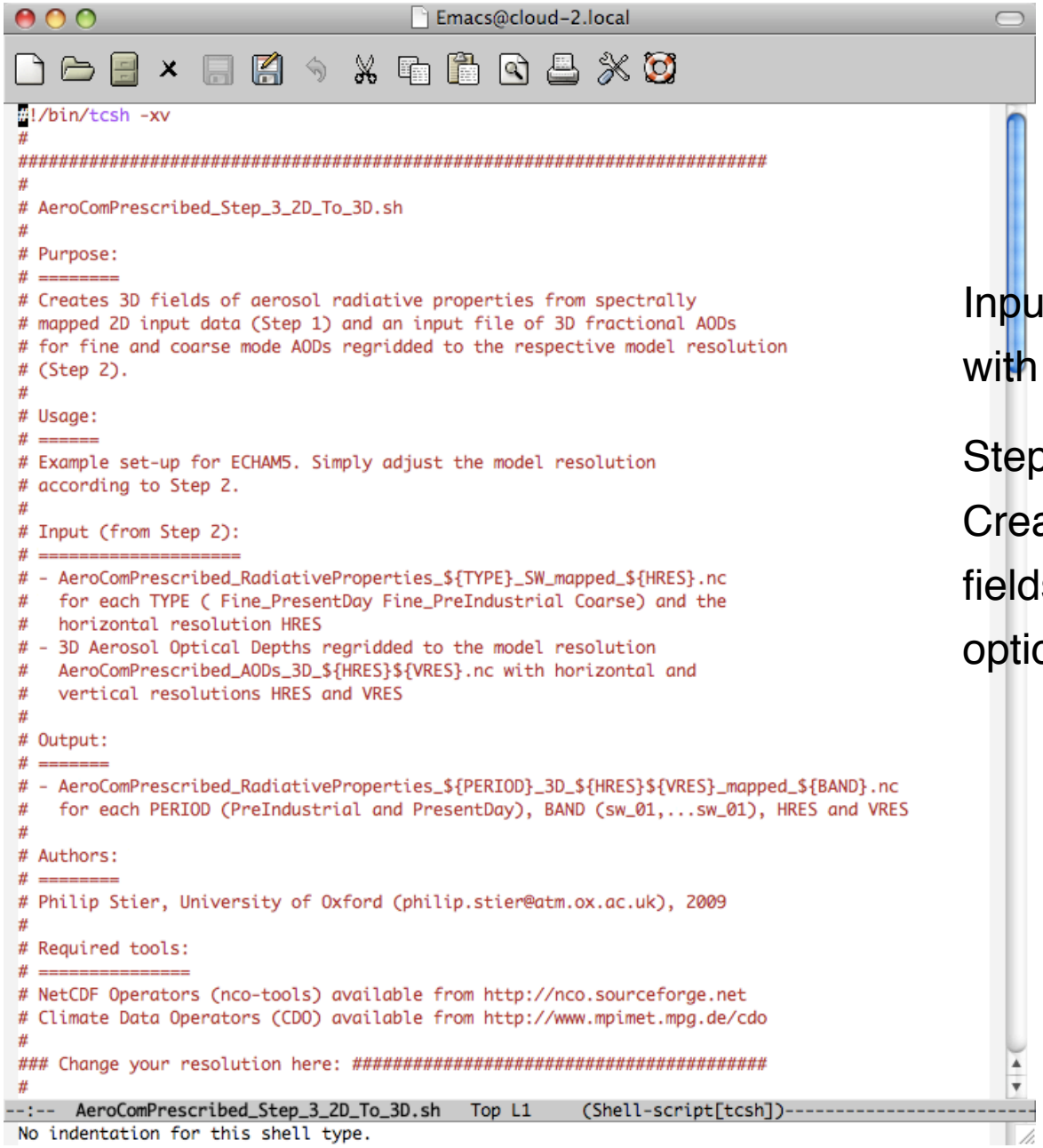
Input Data Set-up - Step 3 out of 3



Input data on 2D 1x1 degree with 24 spectral bands

Step 3:

Creation of 3D files from 2D fields using 3D fractional optical depth input file.

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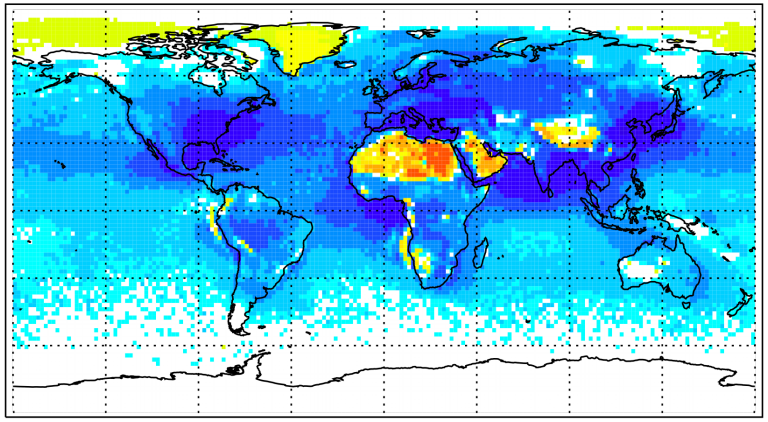
First results - Forcing

Present-Day – Pre-Industrial Aerosol Radiative Forcing:

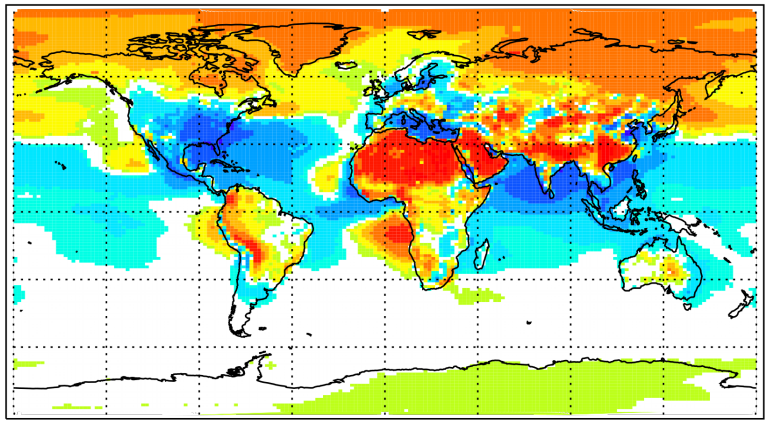
TOA All-Sky: -0.59 W m^{-2}



-20 -10 -5 -2 -1 -0.5 -0.2 -0.1 0 0.1 0.2 0.5 1 2 5 10 20

[W m^{-2}]

HadGEM2-ES Forcing: 0.15



-20.0 -10.0 -5.0 -2.0 -1.0 -0.5 -0.2 -0.1 0.0 0.1 0.2 0.5 1.0 2.0 5.0 10.0 20.0

[W m^{-2}]

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HadGEM-ES2

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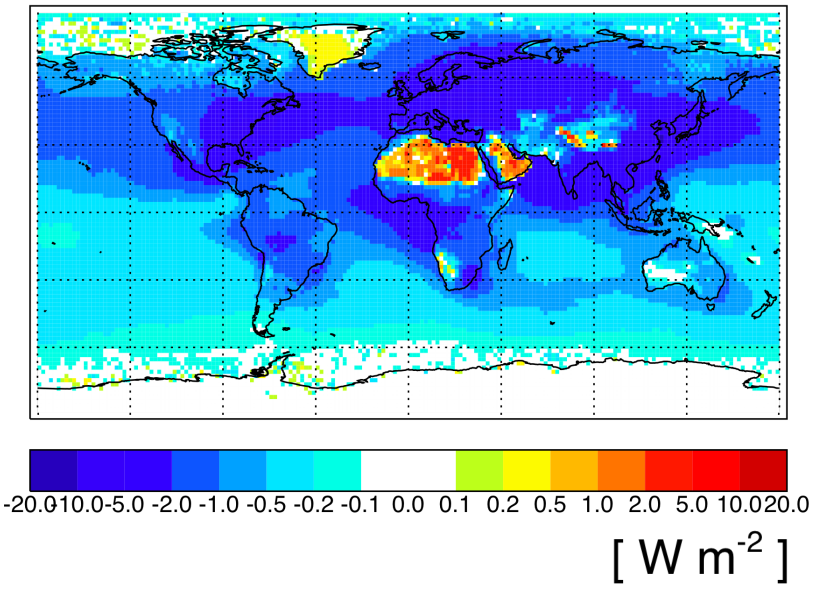
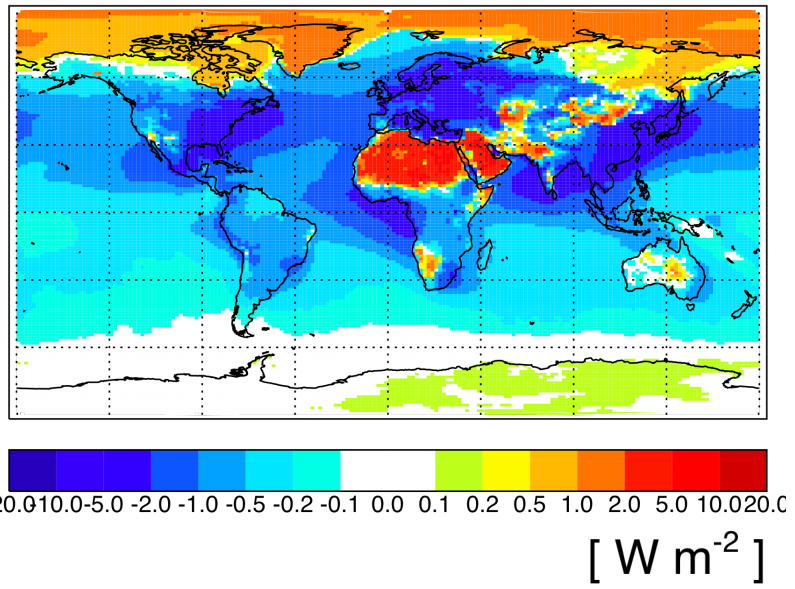
First results - Forcing

Present-Day – Pre-Industrial Aerosol Radiative Forcing Clear-Sky:

MPIHAM_V2 Forcing Clear-Sky: -1.12



HadGEM2-ES Forcing Clear-Sky: -0.53



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HadGEM-ES2

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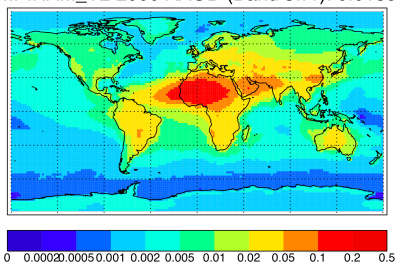
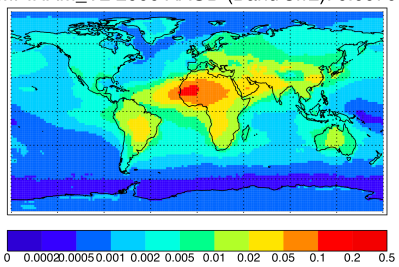
First results - Input Data

Present-Day Aerosol Absorption Optical Depth:

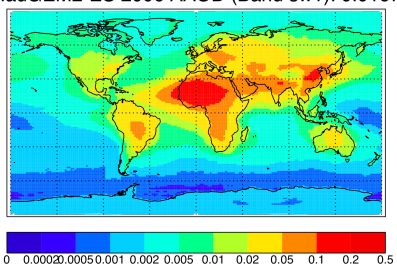
MPIHAM_V2 2000 AAOD (Band sw1): 0.0139



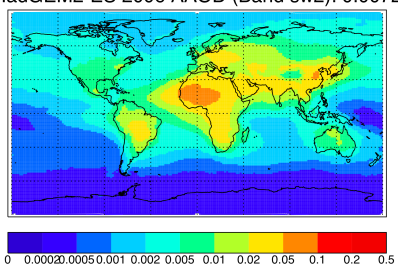
MPIHAM_V2 2000 AAOD (Band sw2): 0.0070



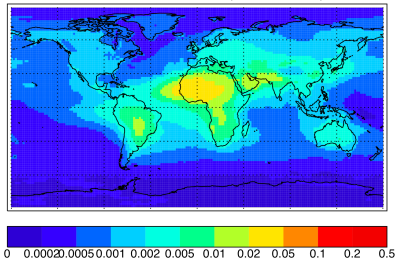
HadGEM2-ES 2006 AAOD (Band sw1): 0.0167



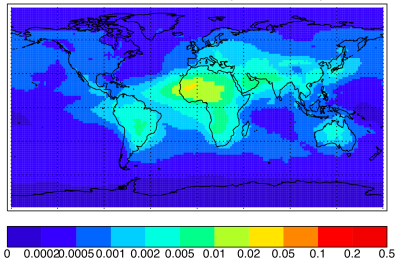
HadGEM2-ES 2006 AAOD (Band sw2): 0.0072



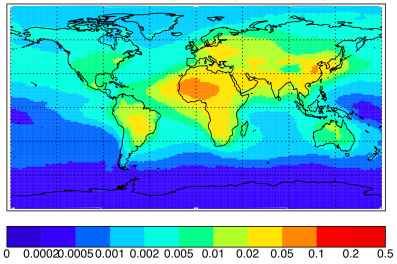
MPIHAM_V2 2000 AAOD (Band sw3): 0.0025



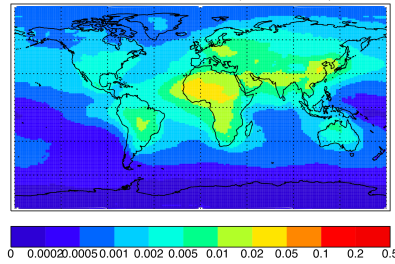
MPIHAM_V2 2000 AAOD (Band sw4): 0.0013



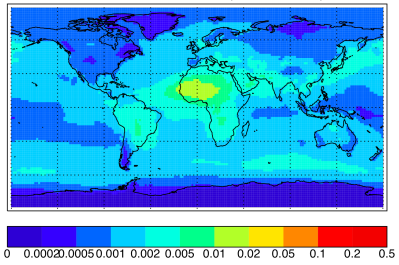
HadGEM2-ES 2006 AAOD (Band sw3): 0.0072



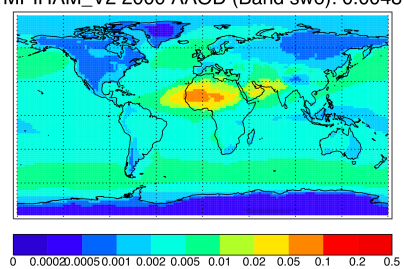
HadGEM2-ES 2006 AAOD (Band sw4): 0.0031



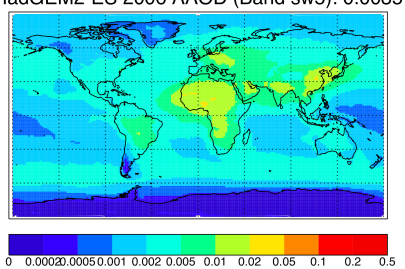
MPIHAM_V2 2000 AAOD (Band sw5): 0.0017



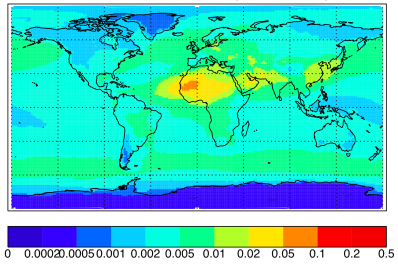
MPIHAM_V2 2000 AAOD (Band sw6): 0.0048



HadGEM2-ES 2006 AAOD (Band sw5): 0.0035



HadGEM2-ES 2006 AAOD (Band sw6): 0.0052



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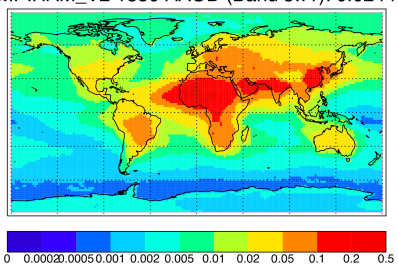
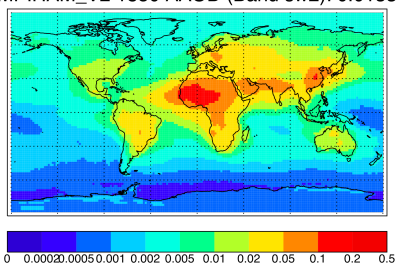
First results - Input Data

Pre-Industrial Aerosol Absorption Optical Depth:

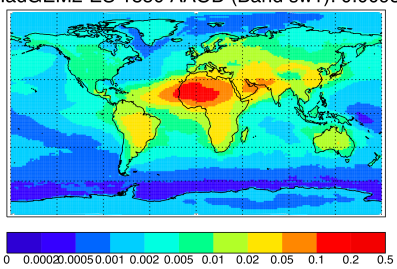
MPIHAM_V2 1850 AAOD (Band sw1): 0.0244



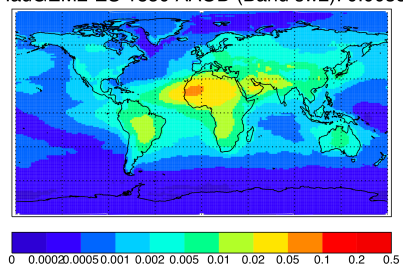
MPIHAM_V2 1850 AAOD (Band sw2): 0.0133



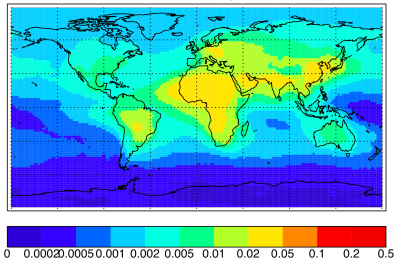
HadGEM2-ES 1850 AAOD (Band sw1): 0.0093



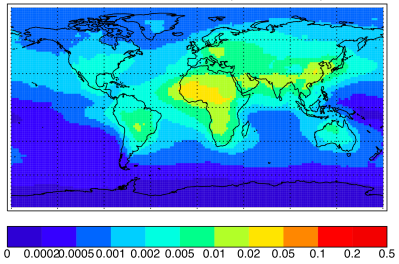
HadGEM2-ES 1850 AAOD (Band sw2): 0.0035



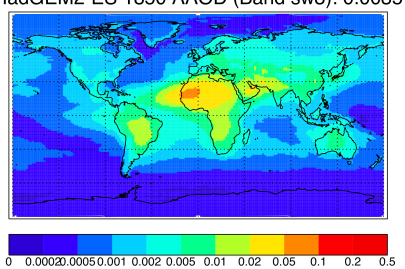
MPIHAM_V2 1850 AAOD (Band sw3): 0.0055



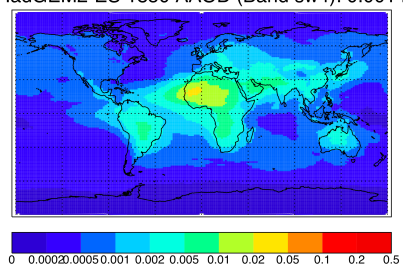
MPIHAM_V2 1850 AAOD (Band sw4): 0.0029



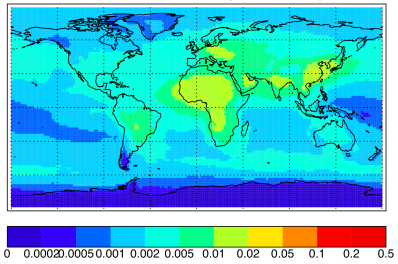
HadGEM2-ES 1850 AAOD (Band sw3): 0.0035



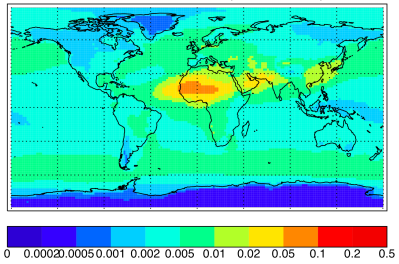
HadGEM2-ES 1850 AAOD (Band sw4): 0.0014



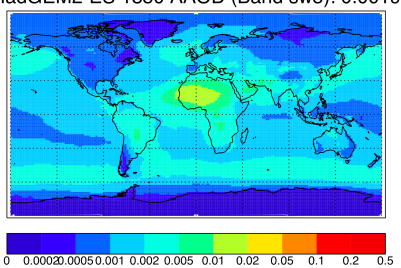
MPIHAM_V2 1850 AAOD (Band sw5): 0.0033



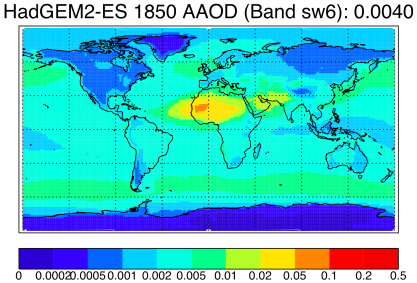
MPIHAM_V2 1850 AAOD (Band sw6): 0.0058



HadGEM2-ES 1850 AAOD (Band sw5): 0.0019



HadGEM2-ES 1850 AAOD (Band sw6): 0.0040



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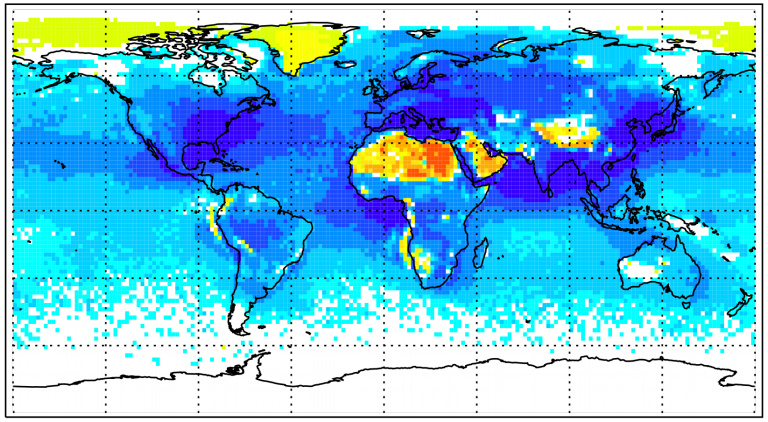
First results - Forcing

Present-Day – Pre-Industrial Aerosol Radiative Forcing:

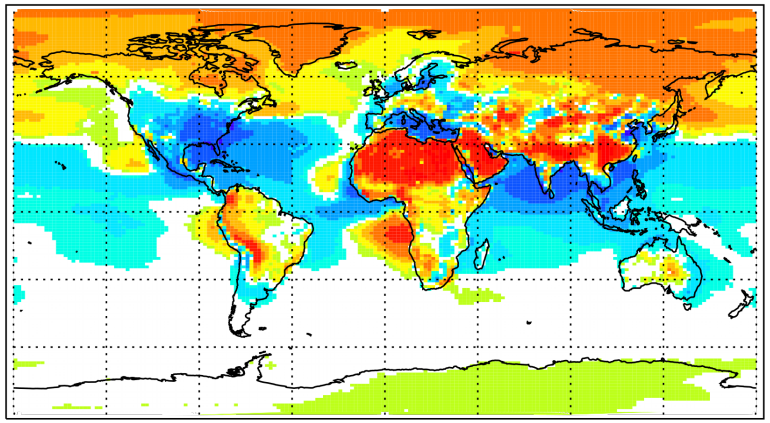
TOA All-Sky: -0.59 W m^{-2}



-20 -10 -5 -2 -1 -0.5 -0.2 -0.1 0 0.1 0.2 0.5 1 2 5 10 20

[W m^{-2}]

HadGEM2-ES Forcing: 0.15



-20.0 -10.0 -5.0 -2.0 -1.0 -0.5 -0.2 -0.1 0.0 0.1 0.2 0.5 1.0 2.0 5.0 10.0 20.0

[W m^{-2}]

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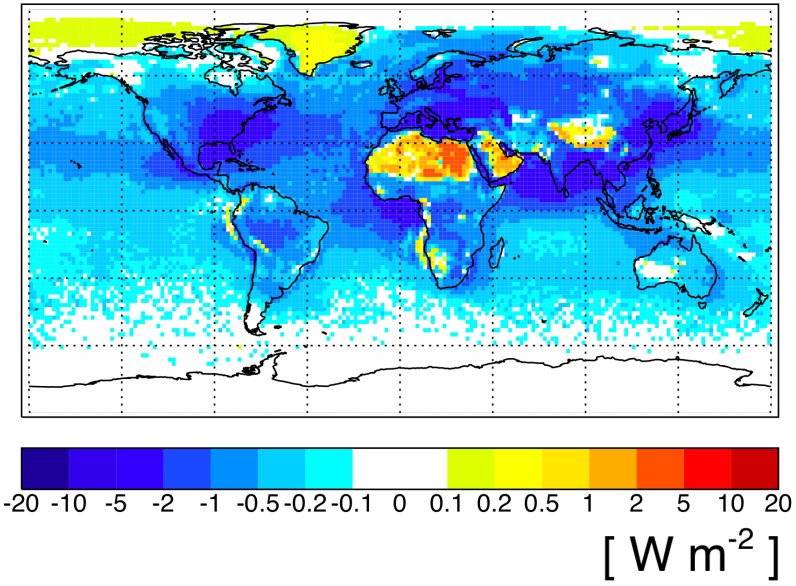
First results - “Forcing”?

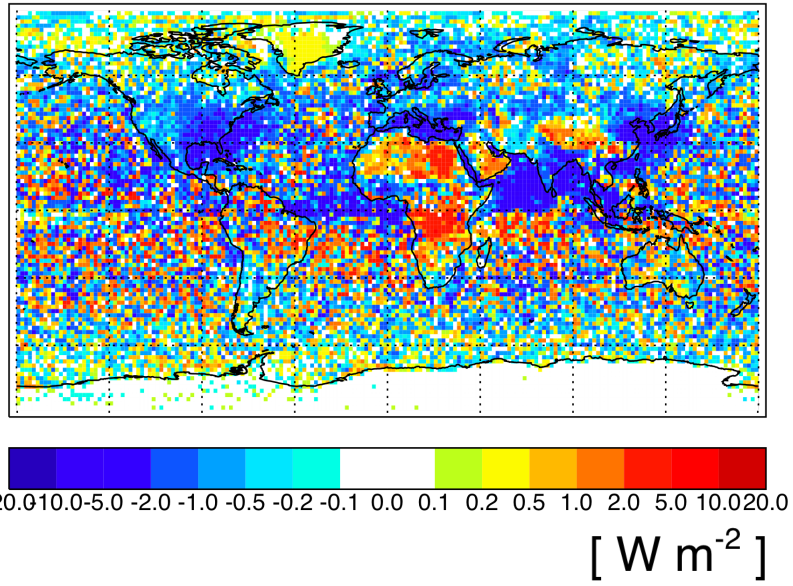
ECHAM instantaneous forcing versus radiative flux perturbation:

(Nudged, aerosols online and coupled to radiation)

Instantaneous: -0.59 W m^{-2}



Flux Perturbation: -0.40



We requested flux perturbations in the AeroCom protocol but not total aerosol instantaneous forcing (just by component).

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Participation

Interested? Speak to me.

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