DEPARTMENT OF PHYSICS

Aerosol Radiative Forcing

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

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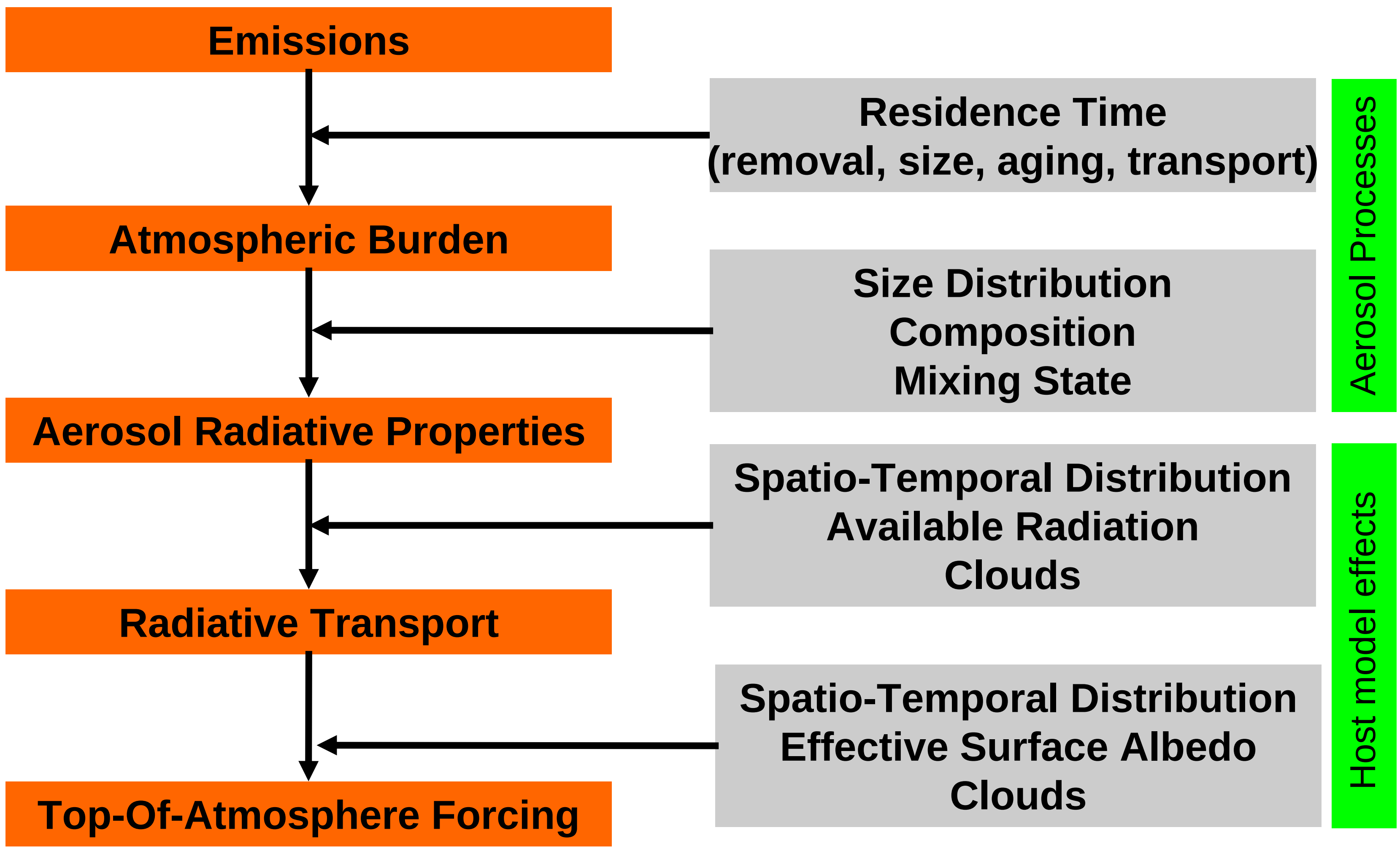
Assessment of aerosol direct radiative forcing

AeroCom: Intercomparison and assessment of the underlying process representations



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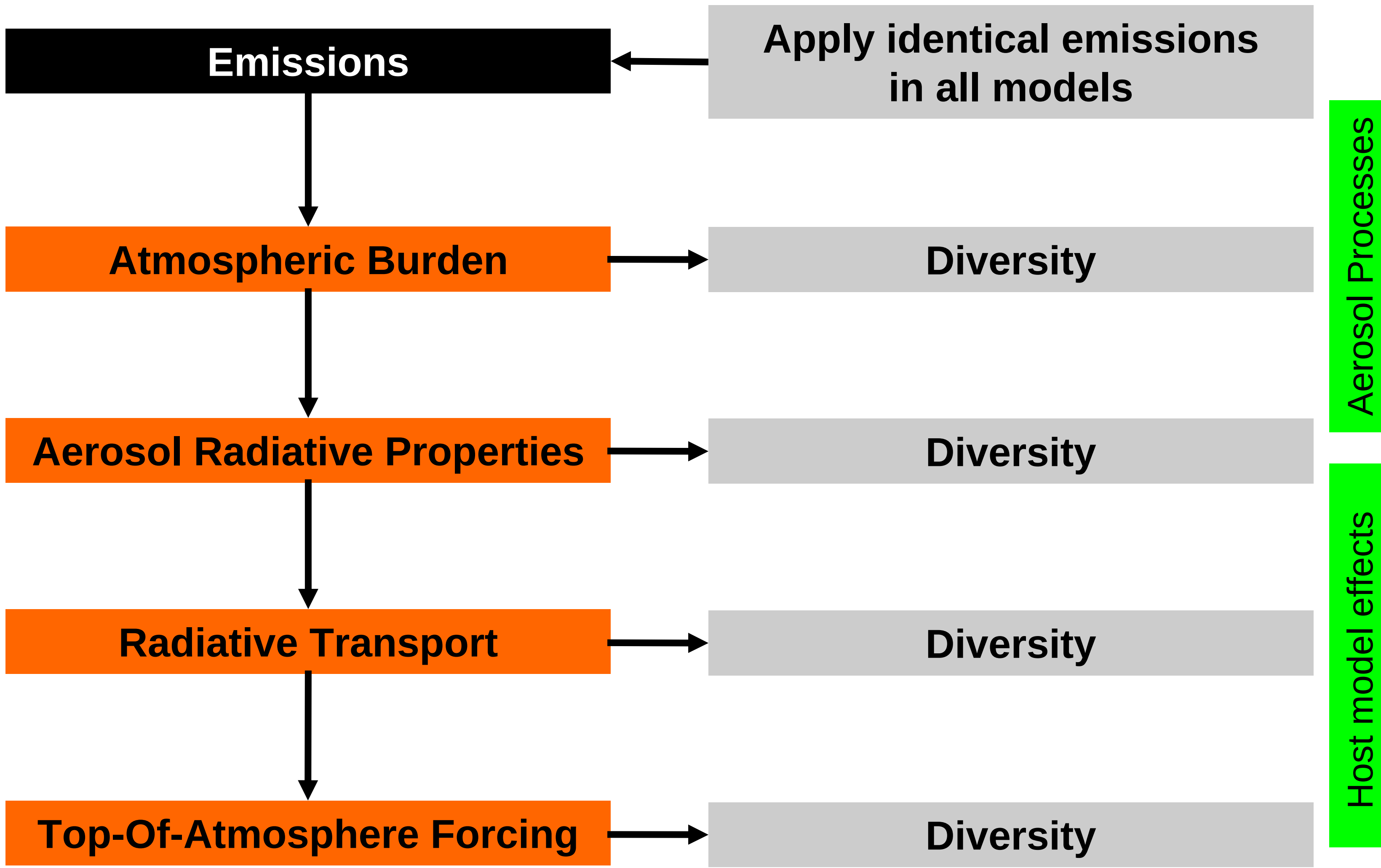
Assessment of aerosol direct radiative forcing

AeroCom Hindcast: Facilitate inter-comparability through fixing emissions



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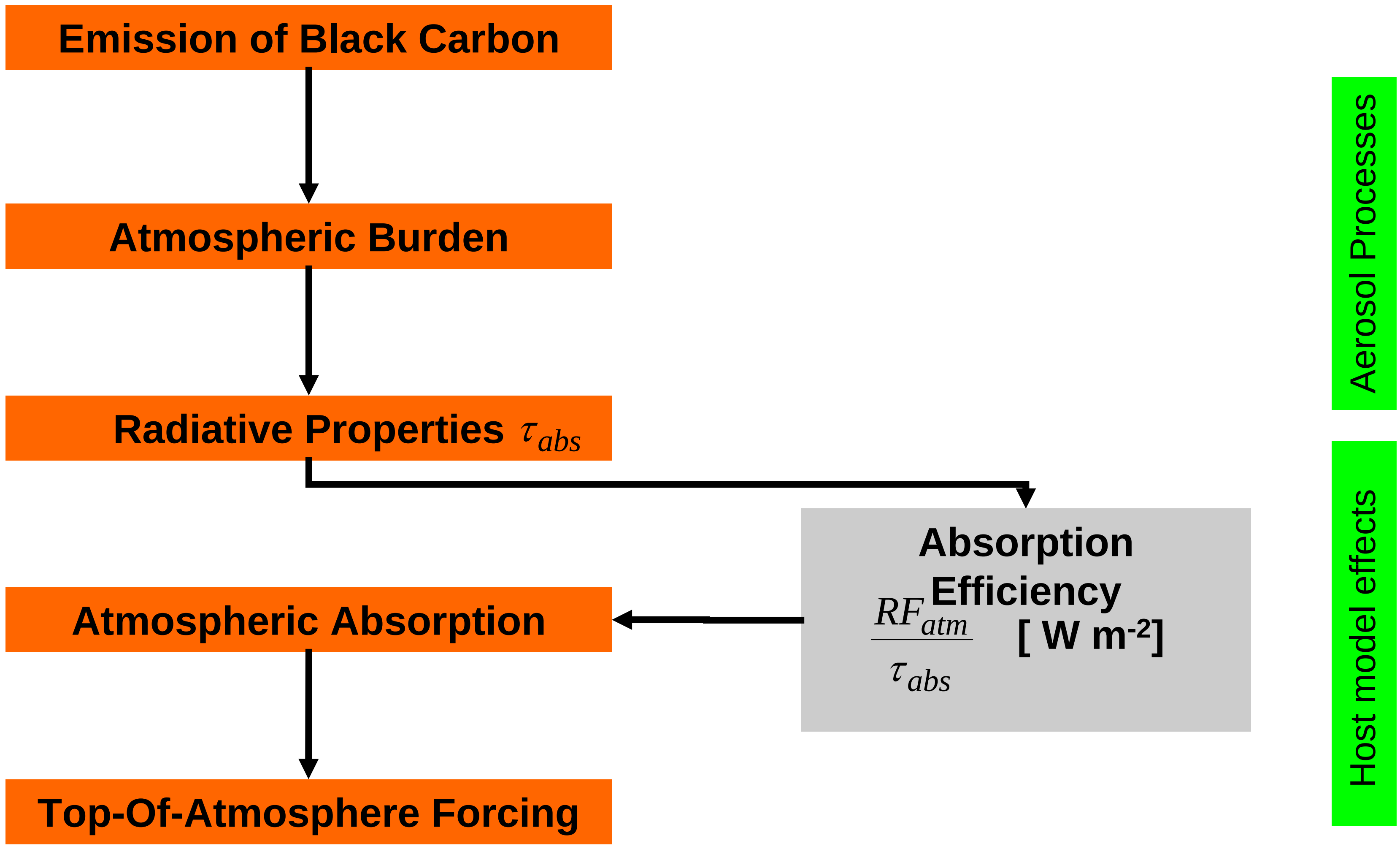
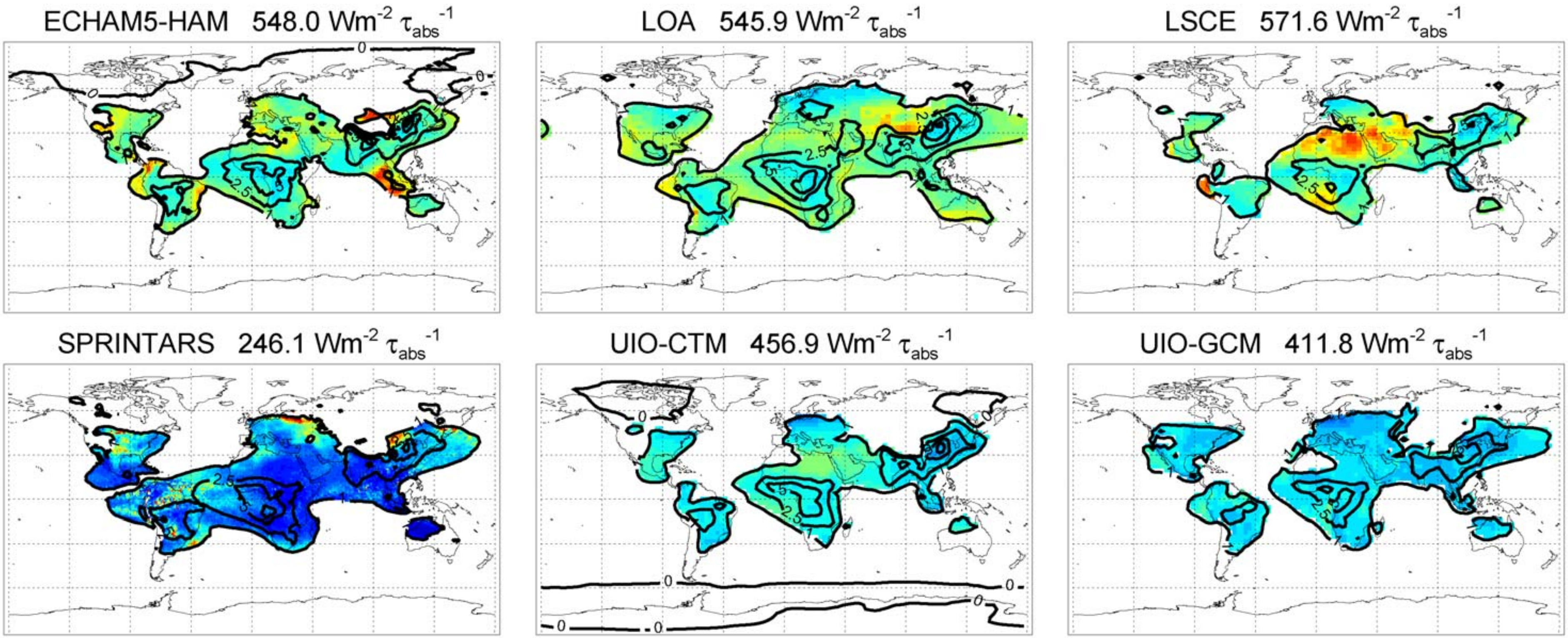
Assessment of aerosol direct radiative forcing

Analysis of AeroCom forcing experiment:

Large diversity in absorption efficiency from aerosol radiative properties:



Analysis of AeroCom Forcing Experiment



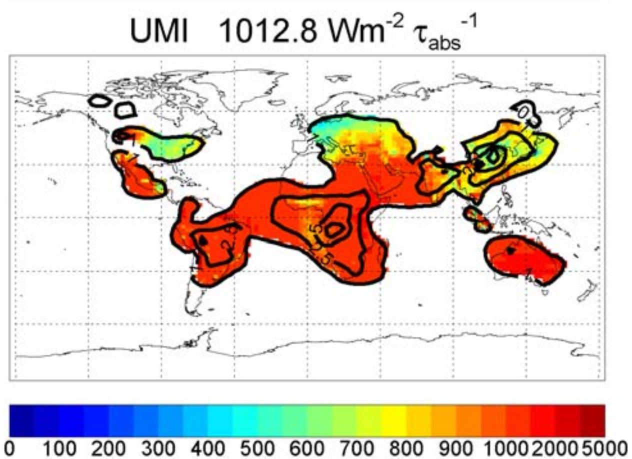


Figure: Annual-mean efficiency to generate all-sky atmospheric absorption from aerosol absorption optical depth: $\frac{RF_{abs}}{\tau_{abs}}$ [W m^{-2}]

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

Assessment of host model effects in AeroCom

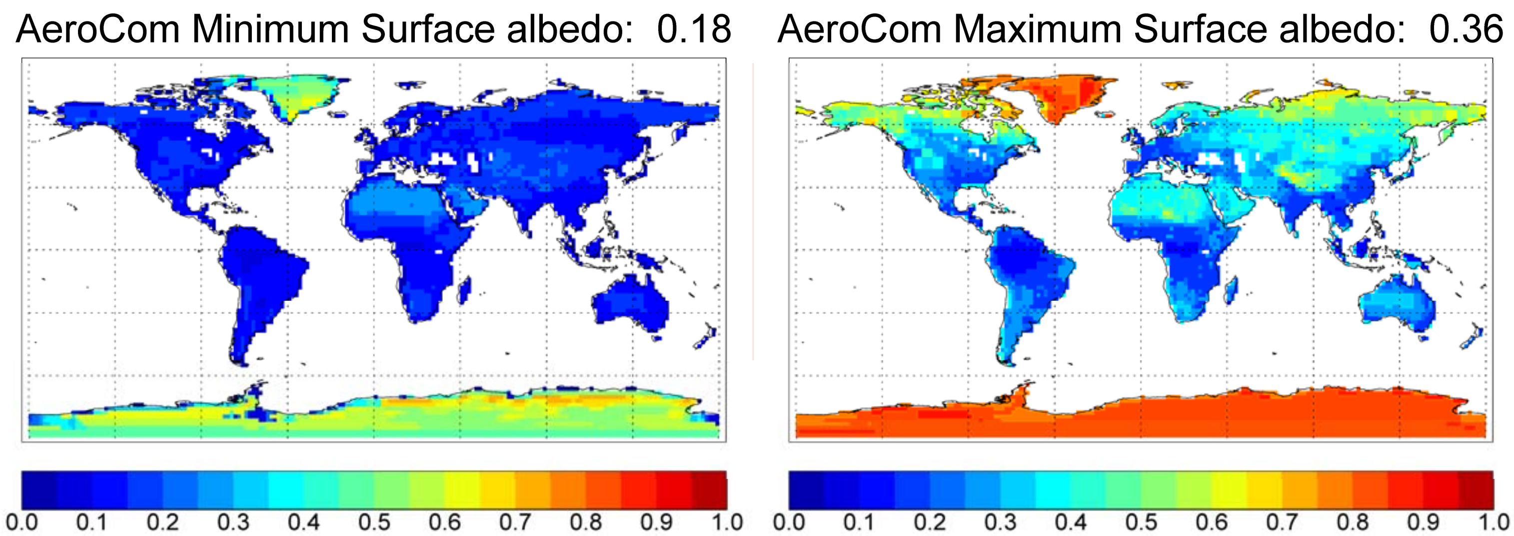


Figure: Annual-mean upper and lower bounds of broad-band shortwave land surface albedos derived from AeroCom submissions.

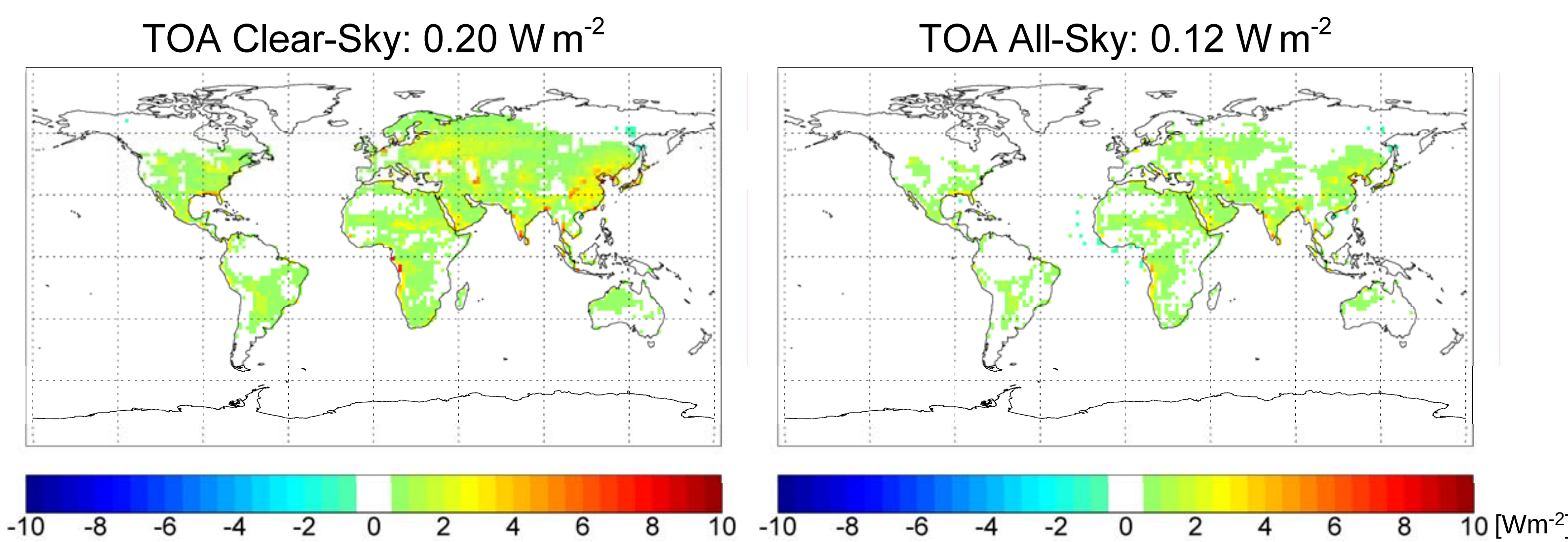
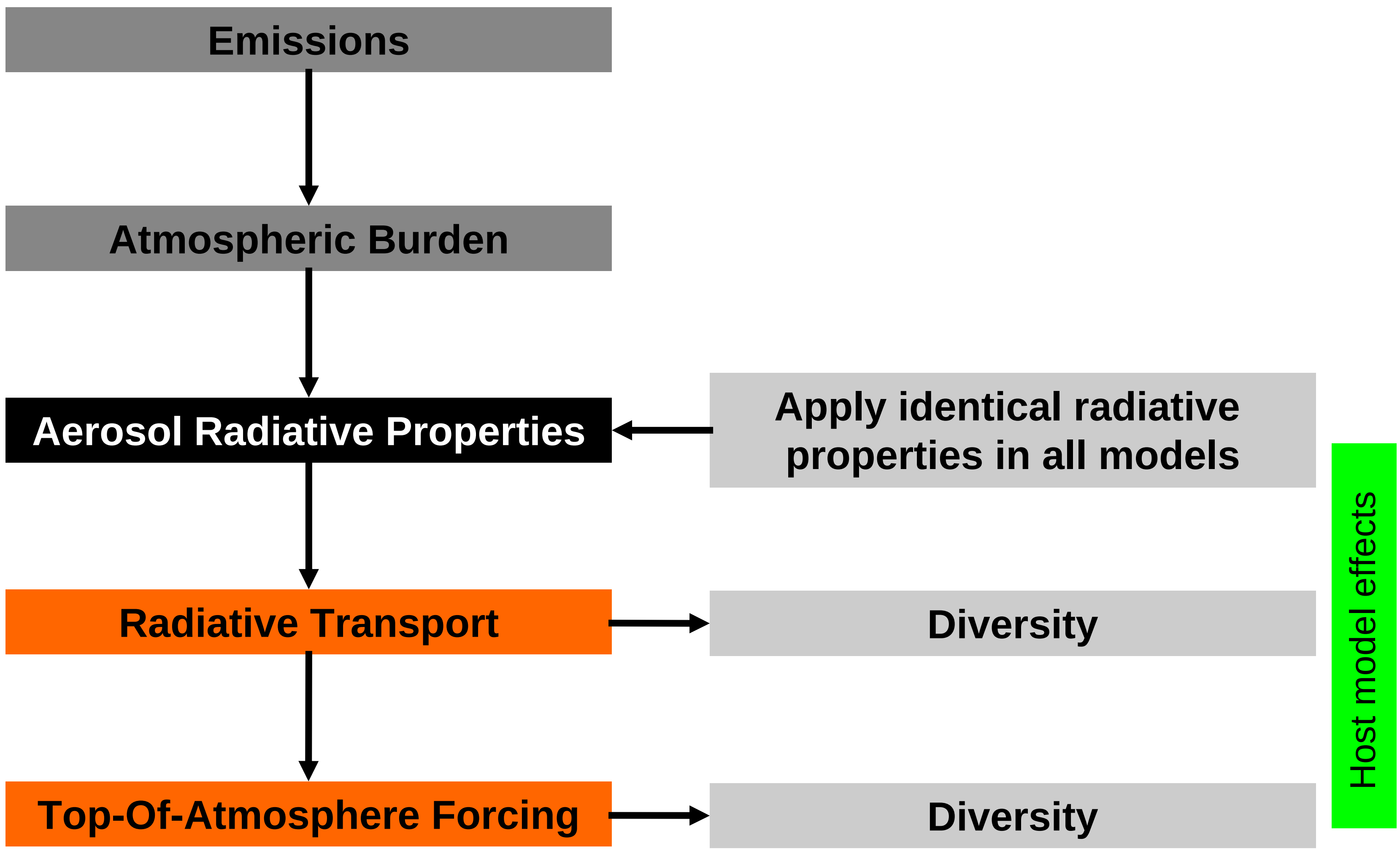


Figure: Annual-mean anthropogenic direct aerosol radiative forcing difference due to usage of upper minus lower bound of surface albedo (Stier et al., ACP, 2007).

The AeroCom Prescribed Experiment

Facilitate inter-comparability through fixing 3D aerosol radiative properties



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

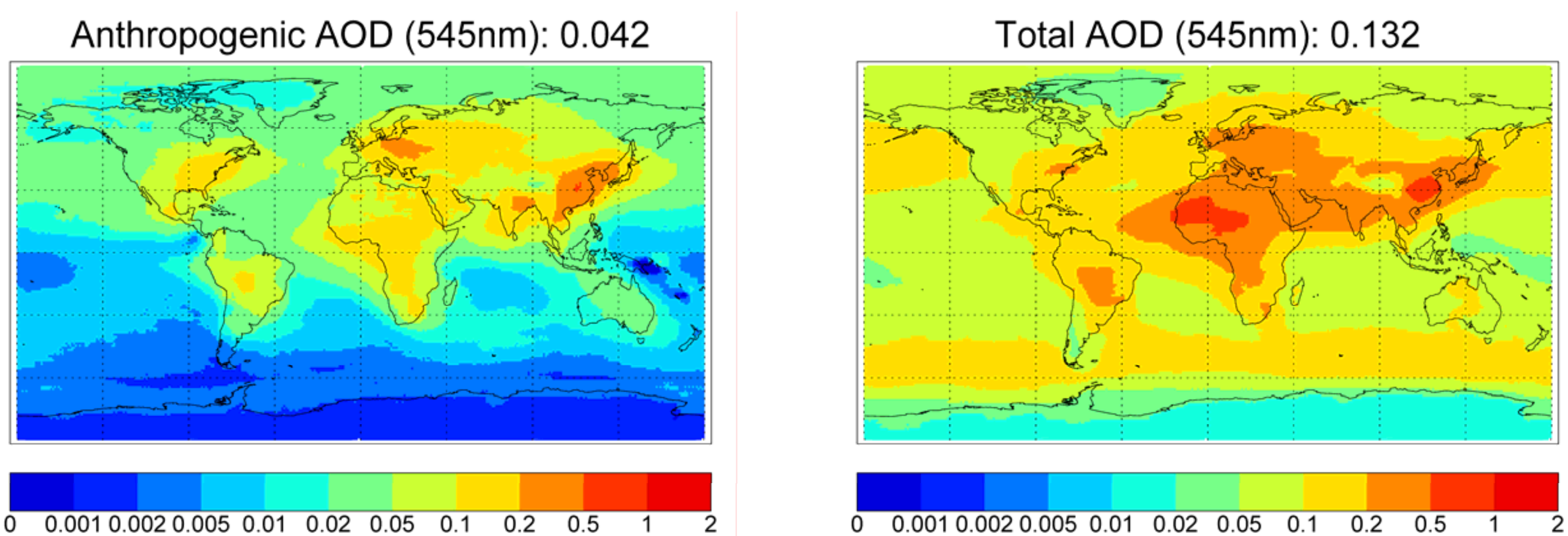


Figure: Annual-mean anthropogenic and total aerosol optical depth at 550 nm derived from AeroCom median model and AERONET.

AeroCom Prescribed - First results

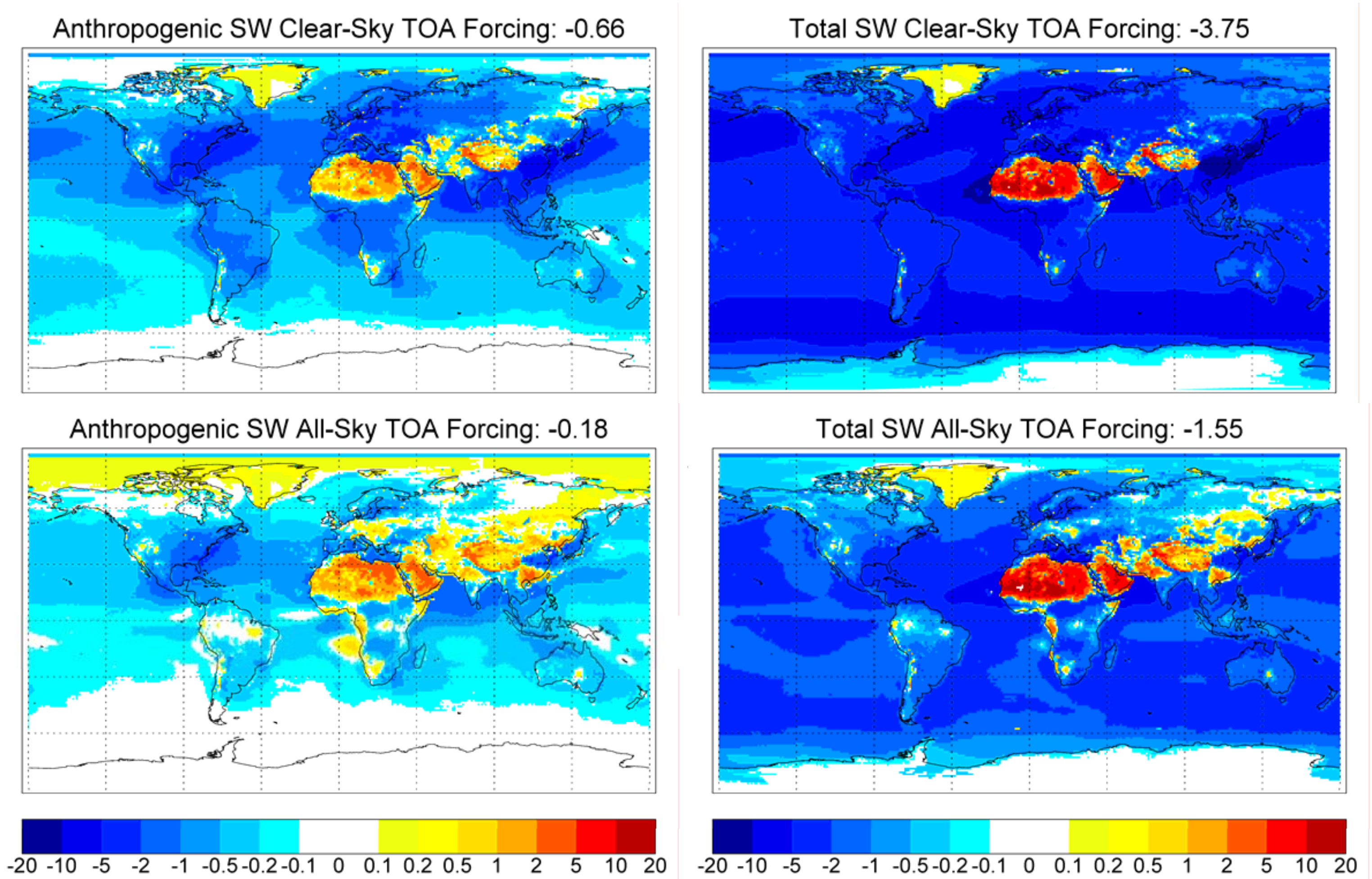


Figure: Annual-mean top-of-atmosphere anthropogenic and total aerosol direct aerosol radiative forcing [Wm^{-2}]. Offline model calculation by Stefan Kinne from the AeroCom Prescribed aerosol radiative properties.

Input Data Set-up - Step 1 out of 3

Emacs@aerosol.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.
#
# Input:
# ======
# - AeroComPrescribed_RadiativeProperties_${TYPE}_SW.nc
#   for each TYPE ( Fine_PresentDay Fine_PreIndustrial Coarse)
#
# Output:
# =======
# - AeroComPrescribed_RadiativeProperties_Fine_${TYPE}_SW_mapped.nc
#   for each TYPE ( Fine_PresentDay Fine_PreIndustrial Coarse)
#
# Authors:
# ========
# Philip Stier, University of Oxford (philip.stier@atm.ox.ac.uk), 2008
#
# Required tools:
# ===============
# NetCDF Operators (nco-tools) available from http://nco.sourceforge.net
#
##############################################################################
#
foreach TYPE ( Fine_PresentDay_SW Fine_PreIndustrial_SW Coarse_SW )
#
--:-- AerComPrescribed_Step_1_SpectralMapping.sh   Top L1     (Shell-script[tcs
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

Emacs@aerosol.local

```
#!/bin/tcsh -xv
#
################################################################################
#
# AeroComPrescribed_Step_2_2D_to_3D.sh
#
# Purpose:
# ========
# Creates 3D fields of aerosol radiative properties from spectrally
# mapped 2D input data (Step 1) and an input file of 3D fractional AODs
# for fine and coarse mode AODs.h
#
# Usage:
# ======
# Example set-up for 6 SW bands of ECHAM5. Simply adjust the number of
# model bands as processed in Step 1. Please include the 545nm band as
# below for quality control.
#
# Input (from Step 1):
# ====================
# - AeroComPrescribed_RadiativeProperties_Fine_${TYPE}_SW_mapped.nc
#   for each TYPE ( Fine_PresentDay Fine_PreIndustrial Coarse)
#
# Output:
# =======
# - AeroComPrescribed_RadiativeProperties_${PERIOD}_3D_mapped_${BAND}.nc
#   for each PERIOD (PreIndustrial and PresentDay) and BAND
#
# Authors:
# ========
# Philip Stier, University of Oxford (philip.stier@atm.ox.ac.uk), 2008
#
# Required tools:
# ===============
# NetCDF Operators (nco-tools) available from http://nco.sourceforge.net
#
################################################################################
#
foreach PERIOD ( PresentDay PreIndustrial )
--:--  AerComPrescribed_Step_2_2D_to_3D.sh   Top L1    (Shell-script[tcsh])----
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```

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

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

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Input Data Set-up - Step 3 out of 3

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```
#!/bin/tcsh -xv
#
###############################################################################
#
# AeroComPrescribed_Step_3_Regridding.sh
#
# Purpose:
# ========
# Regridding of created 3D fields of spectrally weighed aerosol radiative
# properties from 1x1 degree resolution with 31 levels to respective model
# specific resolution.
#
# Usage:
# ======
# Example set-up for 6 SW bands of ECHAM5. Simply adjust the number of
# model bands as processed in Step 1. Please include the 545nm band as
# below for quality control.
#
# Input:
# ======
# - AeroComPrescribed_RadiativeProperties_${PERIOD}_3D_mapped_${BAND}.nc
#   (from Step 2)
# - Model specific output grid definition file according to ncregrid
#   manual. Example file echam5_T63L31_grid.nc for ECHAM5 provided.
#
# Output:
# =======
# AeroComPrescribed_RadiativeProperties_${PERIOD}_3D_mapped_${BAND}_{RES}.nc
# for each PERIOD (PreIndustrial and PresentDay) and BAND and the
# respective model resolution RES
#
# Authors:
# ========
# Philip Stier, University of Oxford (philip.stier@atm.ox.ac.uk), 2008
#
# Required tools:
# ===============
# ncregrid regridding tool available from
--:--  AerComPrescribed_Step_3_Regridding.sh   Top L1   (Shell-script[tcsh])--
No indentation for this shell type.
```

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

Step 3:

Regridding to respective spatial model resolution.

Required:

ncregrid regridding tools

Diagnostics

Aerosols

- 3D aerosol radiative properties as implemented (545nm for quality control)
- Separate diagnostics for in-cloud and clear-sky radiative properties

Clouds

- 3D fractional cloud cover
- 3D cloud optical depth

Radiation

- AeroCom forcing protocol:

  Upwelling and downwelling clear-sky and all-sky radiative fluxes at TOA and surface
- Explicit cloudy-sky and clear-sky aerosol radiative properties as applied in the model

Host model parameters

- Surface albedo / “effective” surface albedo

More information and discussion

- http://wiki.esipfed.org/index.php/AeroCom_Prescribed

Issues

AeroCom Prescribed experiment:

- Set-up / Diagnostics
  SW only or SW + LW?
- Single column diagnostics at selected locations for benchmarking with reference radiation codes?
- Procedures
- Participation

Other suggestions:

- ?

Discussion

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