ILMATIETEEN LAITOS
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Identifying the model properties contributing to aerosol forcing uncertainty

AEROCOM Meeting 2020

10/05/2020 **Harri Kokkola**

Aerosol forcing

MODEL BASED UNCERTAINTY ≈ MULTI-MODEL “DIVERSITY”

- Which model properties contribute to this variability?
- Developed an offline Python tool where model output can be used interchangeably
- Instead of studying model sensitivity, we study “forcing sensitivity” to different parameters

- **Offline Python tool for**
  - **calculating aerosol radiative properties**
  - **calculating cloud droplet number concentration**

Offline tool for radiation and cloud activation

Aerosol properties

number concentration
conccn(lon, lat, lev, time, size class)

mass mixing ratio
mmr??(lon, lat, lev, time, size class, compound)
?? = SO4, OA, NH4, NO3, DU, SS, BC

Ambient conditions:

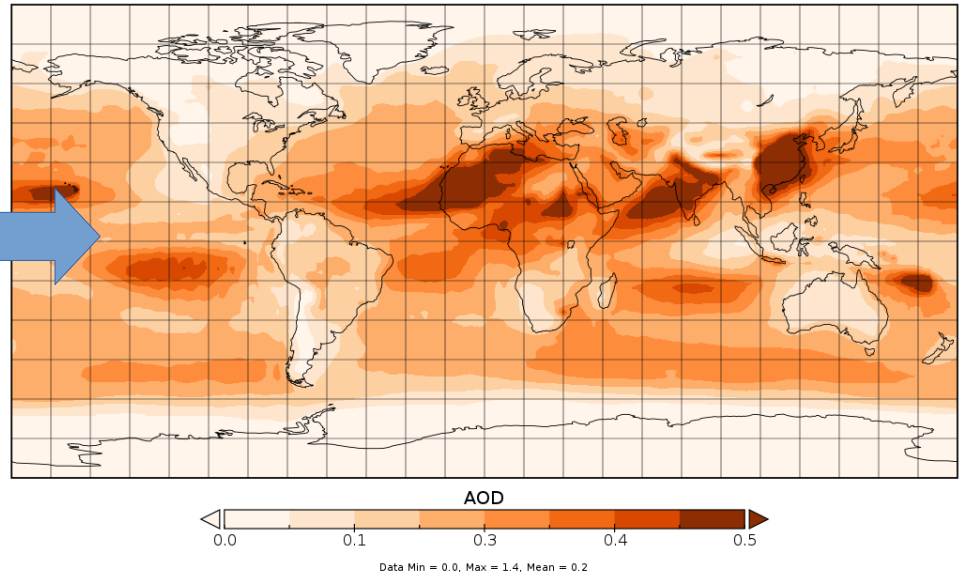
air temperature
ta(lon, lat, lev, time)

pressure
ta(lon, lat, lev, time)

Offline tool

Radiation calculation
extinction(lon,lat,lev,time)

AEROSOL OPTICAL DEPTH



Offline tool for radiation and cloud activation

Aerosol properties:

number concentration
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mass mixing ratio
mmr??(lon, lat, lev, time, size class, compound)
?? = SO4, OA, NH4, NO3, DU, SS, BC

Ambient conditions:

air temperature
ta(lon, lat, lev, time)

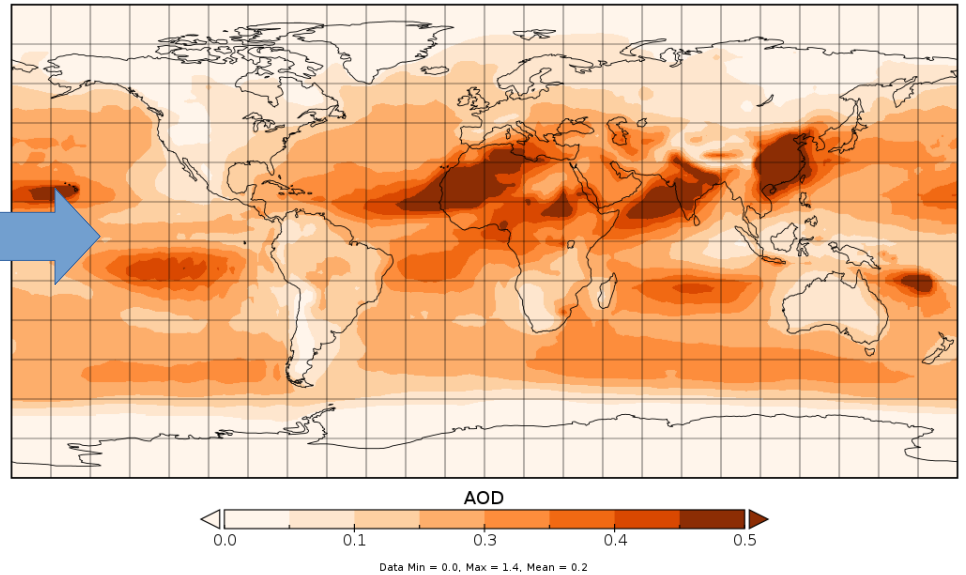
pressure
ta(lon, lat, lev, time)

RELATIVE HUMIDITY
rh(lon, lat, lev, time, **model**)

Offline tool

Radiation calculation
extinction(lon,lat,lev,time)

AEROSOL OPTICAL DEPTH



Offline tool for radiation and cloud activation

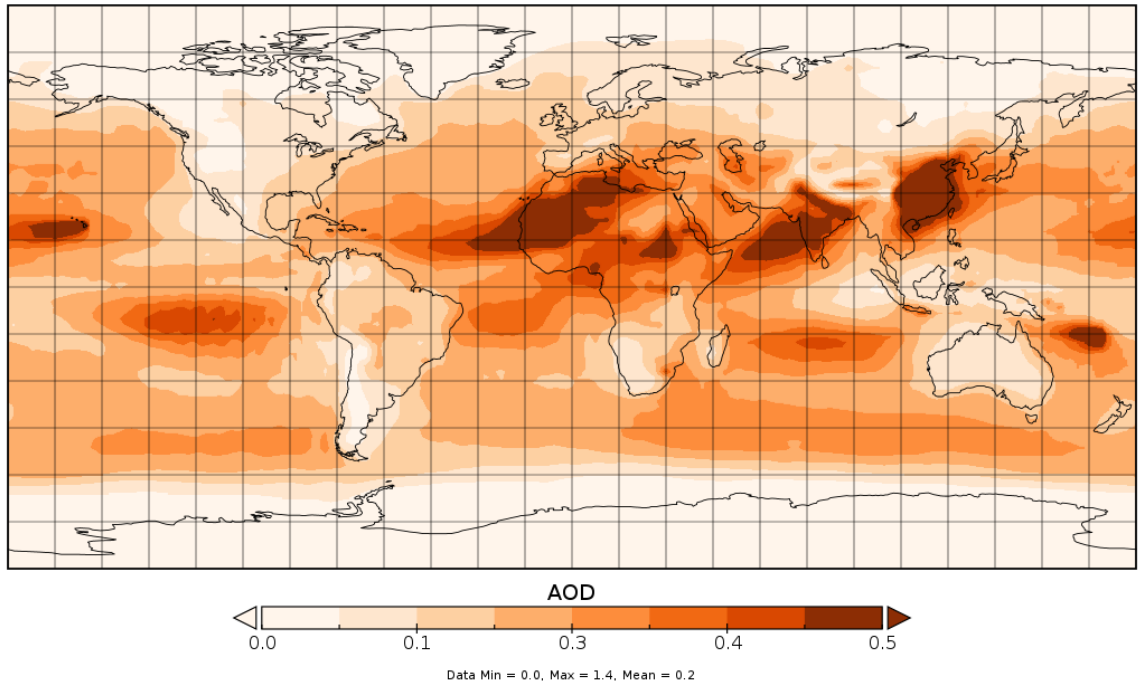
How much inter-model variability in AOD is due to inter-model variability in RH?

RELATIVE HUMIDITY

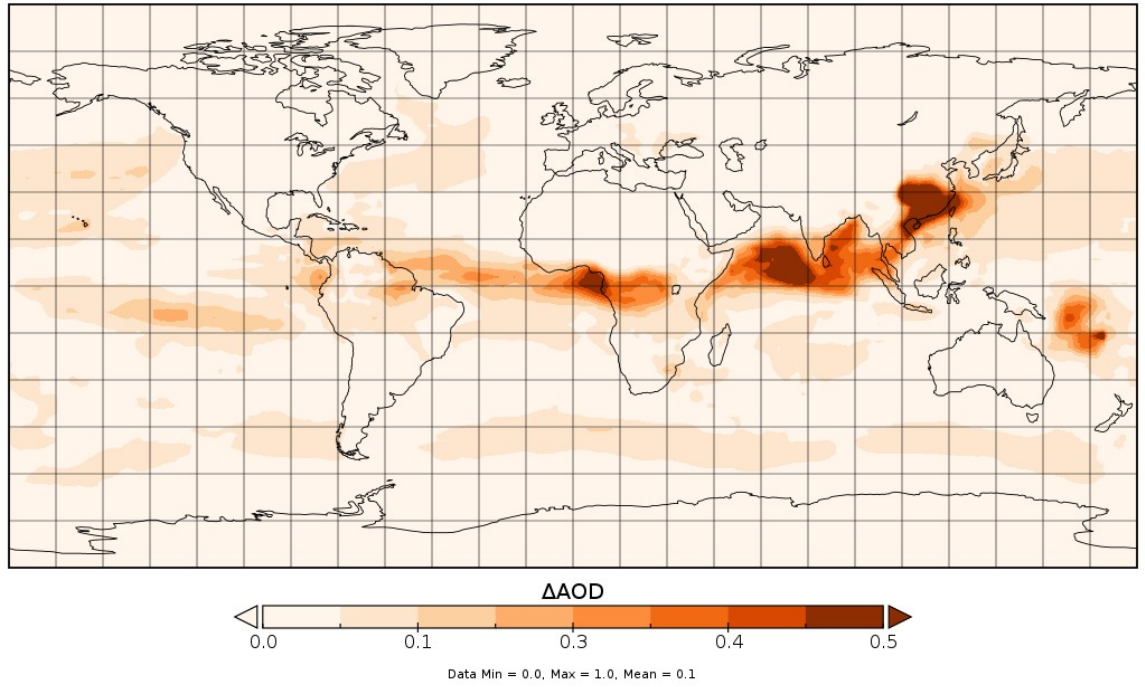
rh(lon, lat, lev, time, **model**)

model = [CAM5-ATRAS, GEOS-i33p2, GFDL-AM4, GISS-ModelE2p1p1-OMA, INCA, MIROC-SPRINTARS, ECHAM6.3-SALSA2.0, ECHAM6.3-HAM2.3]

AOD



Difference between the maximum and minimum AOD



Offline tool for radiation and cloud activation

Aerosol properties:

number concentration
conccn(lon, lat, lev, time, size class, **model**)

mass mixing ratio
mmr??(lon, lat, lev, time, size class, compound)
?? = SO4, OA, NH4, NO3, DU, SS, BC

Ambient conditions:

air temperature
ta(lon, lat, lev, time)

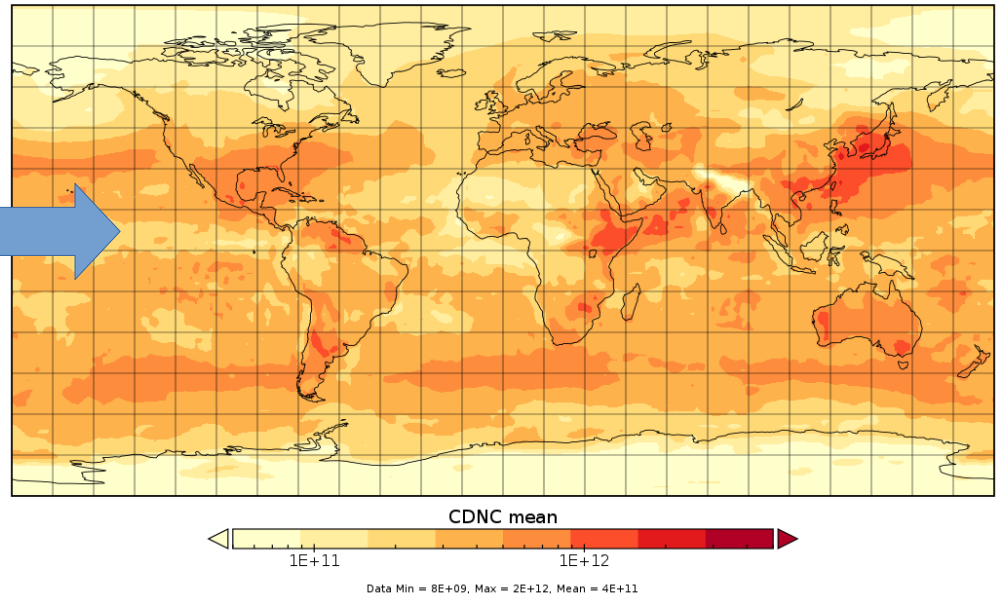
pressure
ta(lon, lat, lev, time)

relative humidity
rh(lon, lat, lev, time)

Offline tool

Cloud activation calc.
CDNC(lon,lat,lev,time)

CDNC BURDEN

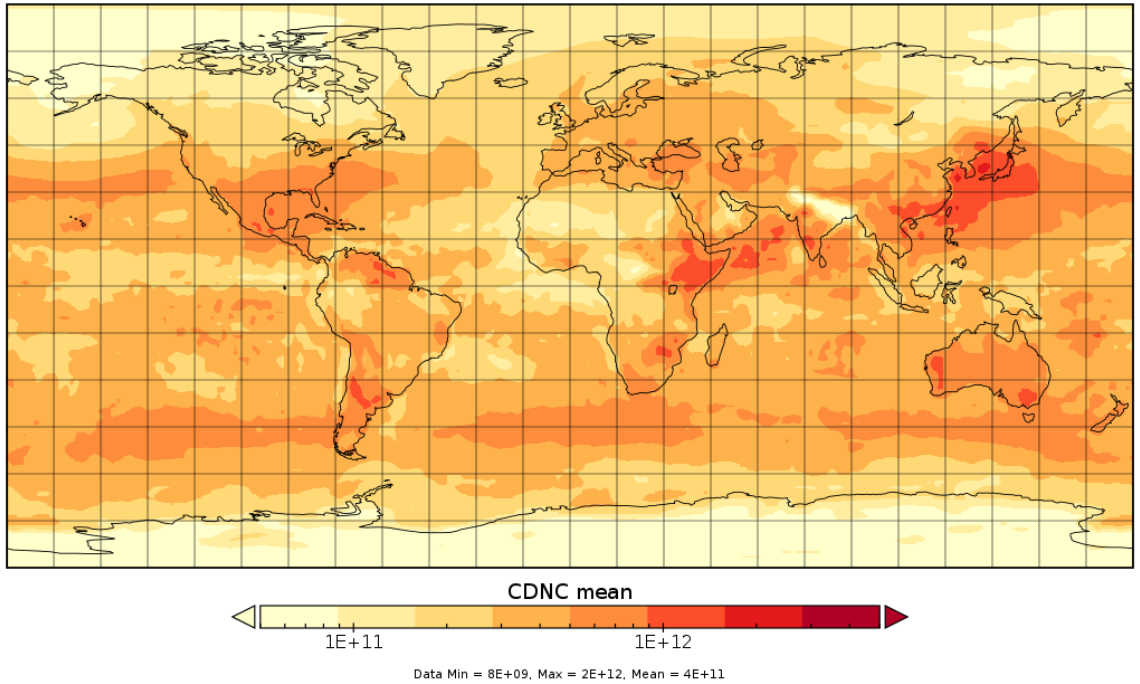


Offline tool for radiation and cloud activation

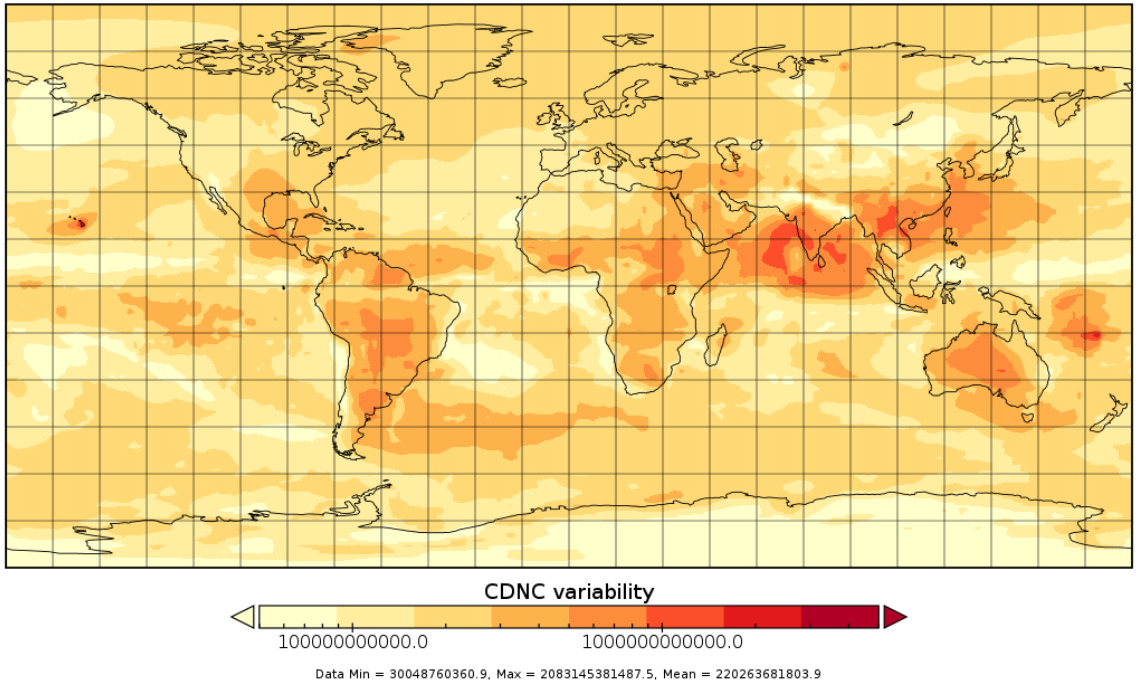
How much inter-model variability in CDNC is due to inter-model variability in number concentration?

CDNC burden
CDNCb(lon, lat, time, **model**)
model = [CAM5-ATRAS, GFDL-AM4, GISS-ModelE2p1p1-OMA, ECHAM6.3-SALSA2.0, ECHAM6.3-HAM2.3]

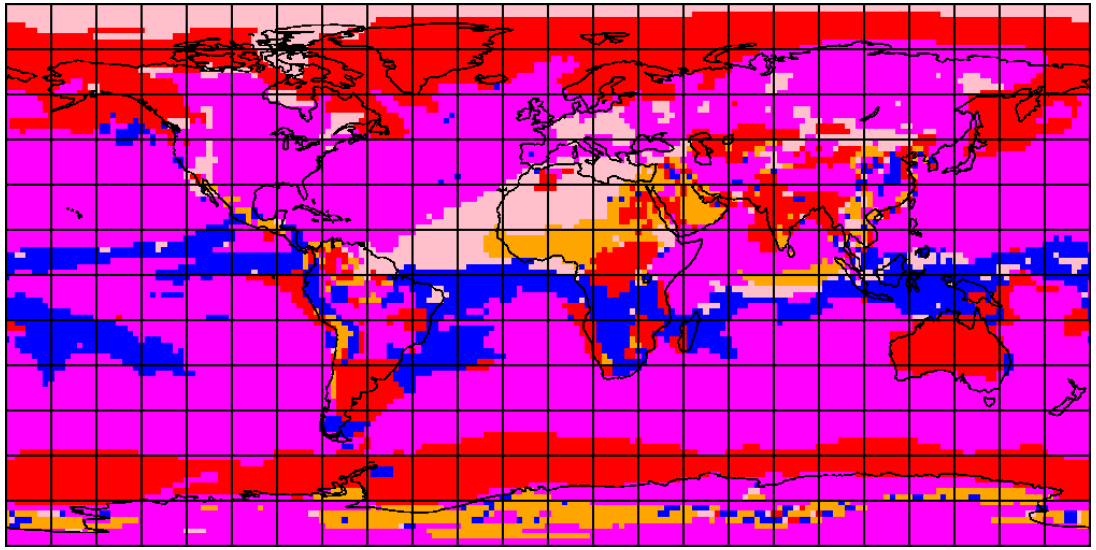
CDNC burden

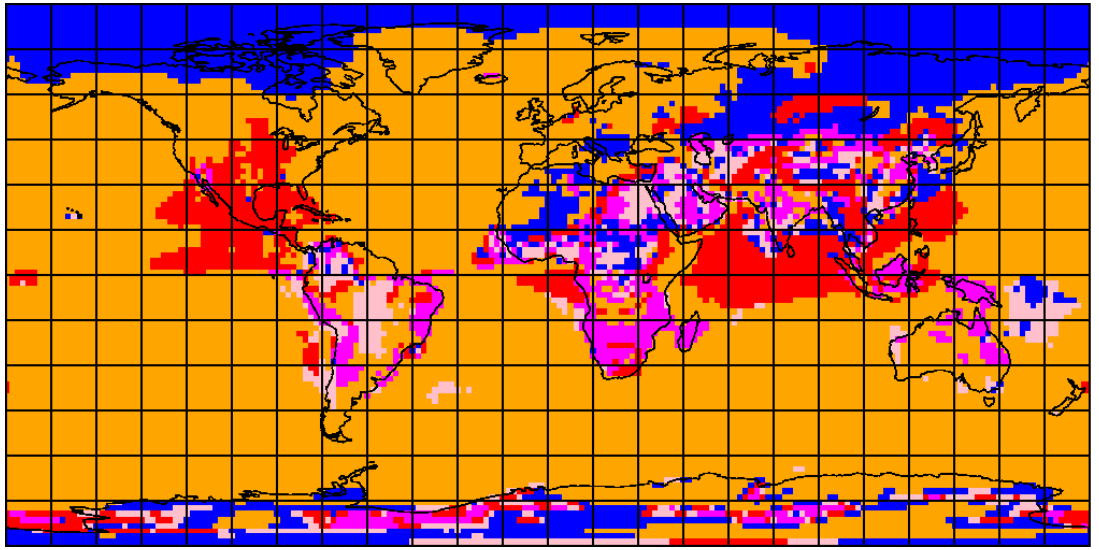


Difference between the maximum and minimum CDNCb



Models of lowest and highest values





SALSA
HAM
CAM5
AM4
GISS

Intercomparison

- Repeat the procedure for all relevant model properties
- Obtain a distribution of aerosol extinction and CDNC

- Data:
  - CRESCENDO (EU project, ESM-data)
  - Trajectory experiment GCMTraj
    - high time resolution
    - size resolved

item	*details*	*RFari*	*RFaci*
Simulated properties			
number size distribution	Global 3D values for each size class	x	x
composition size distribution	Global 3D values for each size class, each chemical compound	x	x
relative humidity	Global 3D values of the cloud-free part of the grid box	x	
updraft velocity	Global 3D values for the mean of positive updraft velocities		x
cloud fraction	Global 3D values of the cloud fraction within each grid box	x	x
Model parameters			
refractive index	Values for aerosol species used in each global climate model	x	
hygroscopicity	Values for aerosol species used in each global climate model	x	x
surface albedo	Global 2D values of surface albedo	x	x
Model parametrization			
Treatment of model hygroscopicity	Parameterizations used in each global climate model	x	
cloud activation parameterization (liquid)	Parameterizations used in each global climate model		x
Cloud activation parameterization (mixed)	Parameterizations used in each global climate model		x