# The MAC AEROSOL climatology

## Max-Planck Aerosol Climatology

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**ftp ftp-projects.zmaw.de/aerocom/climatology/MACv2_2015**

# why

- **why: get a general idea on aerosol column properties as function of month and regions**
- **how: take advantage of observational accuracy and of regional context / coverage by modeling**
  - **merged monthly maps = MAcv2 climatology**
- **ocean obs**

**MAN**

**land obs**

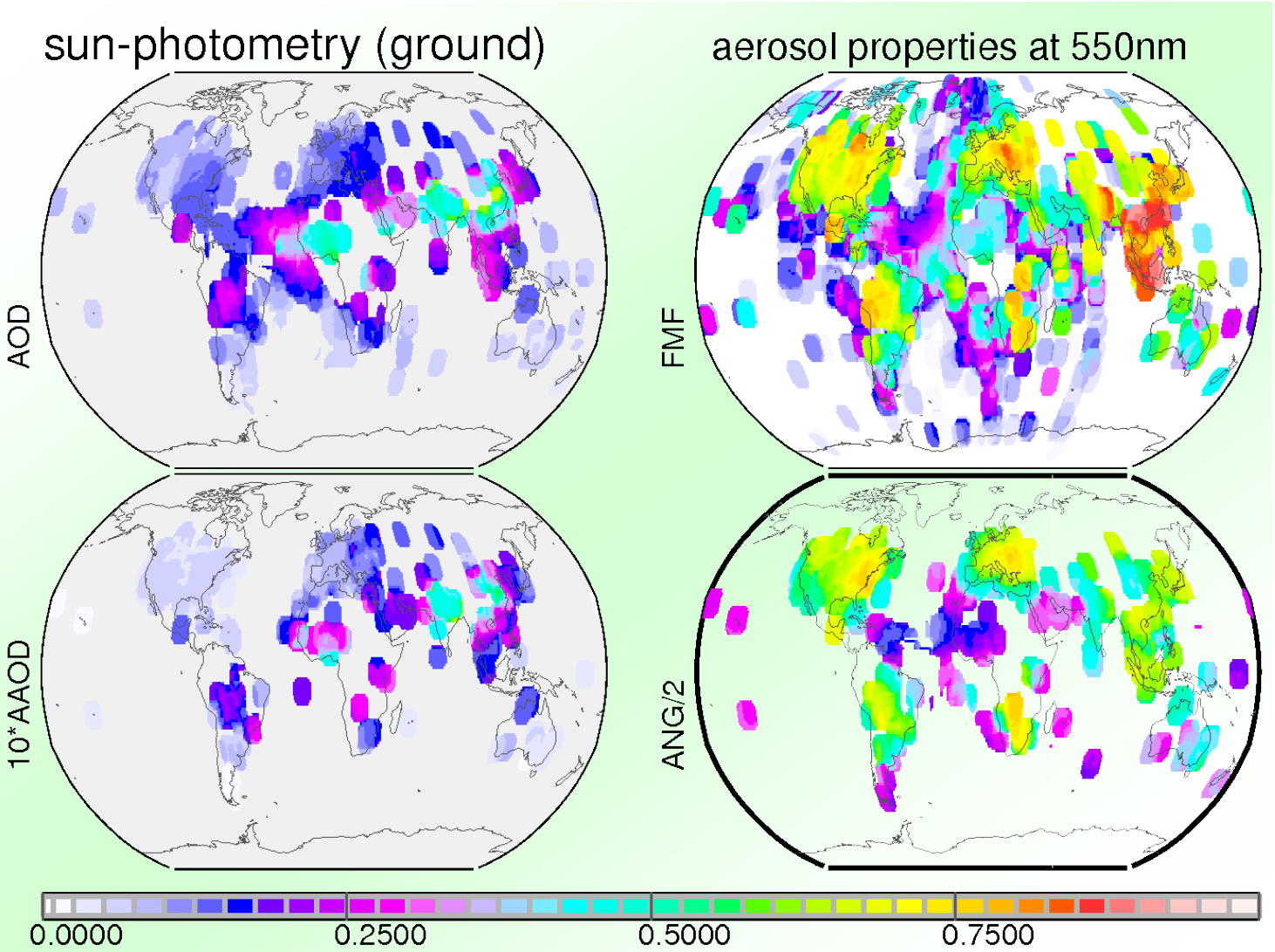
**AERONET**

# trusted observations !

*annual averages*

**AOD**

**AAOD**
**(10 times)**




**FMF**

**ANG**
**(div by 2)**

# merged properties

## at 550nm (unless otherwise indicated)


- AOD
- AAOD

- AOD, 440nm
- AOD, 870nm
- AODf (r<.5um)
- AODc (r>.5um)

**Angstrom parameter**
**Ang = - ln (AOD, 440/ AOD, 870) / ln (440/870)**

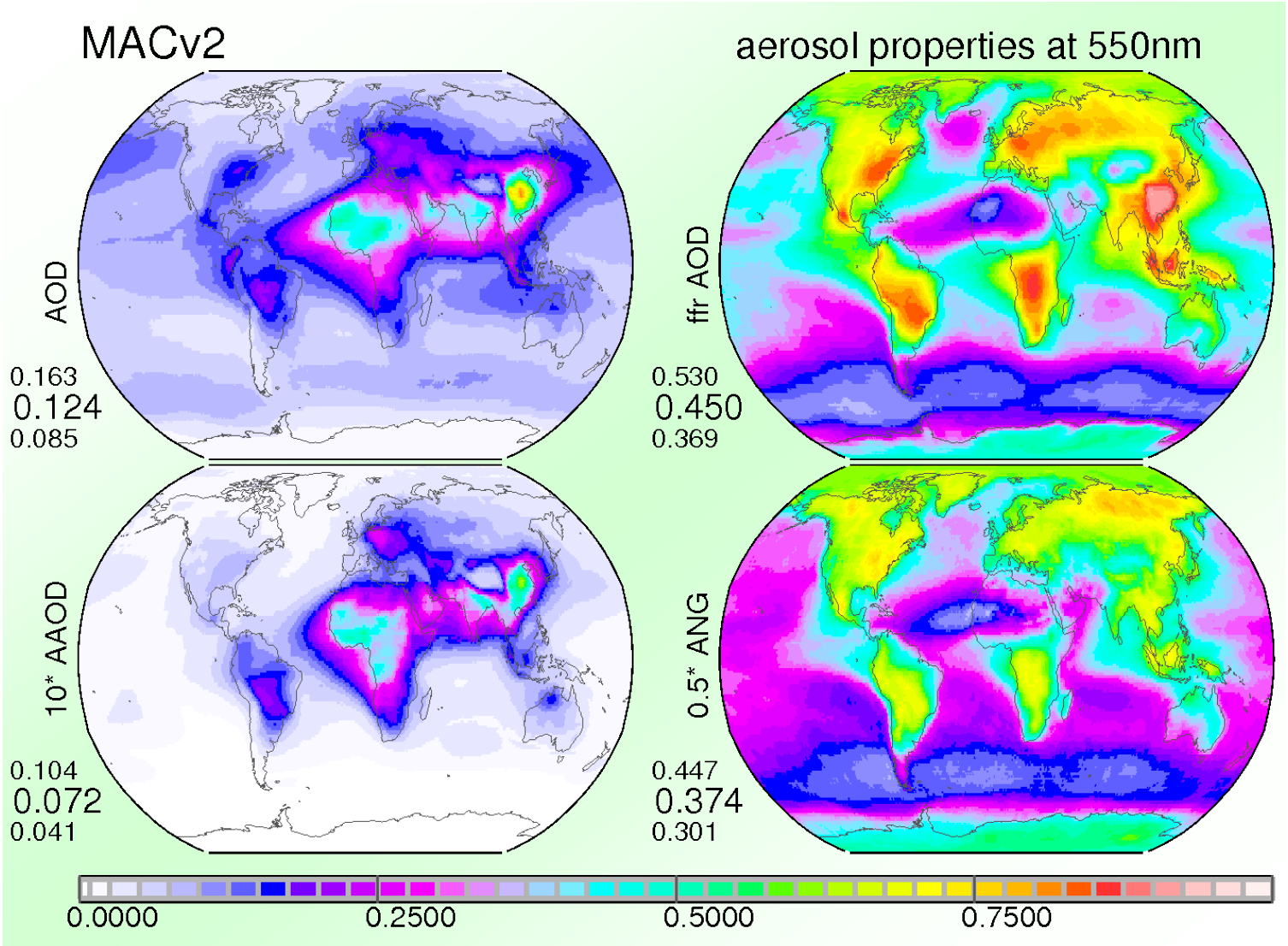
**fine-mode AOD fraction**
**FMF = AOD,f / (AOD,f + AOD,c)**

**Ang +FMF → fine reff → CCN**

- AADOf (mainly BC)
- AADOc (mainly DU)

**fine-mode AAOD fraction =**
**absFMF = AAOD,f / (AAOD,f + AAOD,c)**

# MACv2 merged on modeling *annual averages*




**AOD**

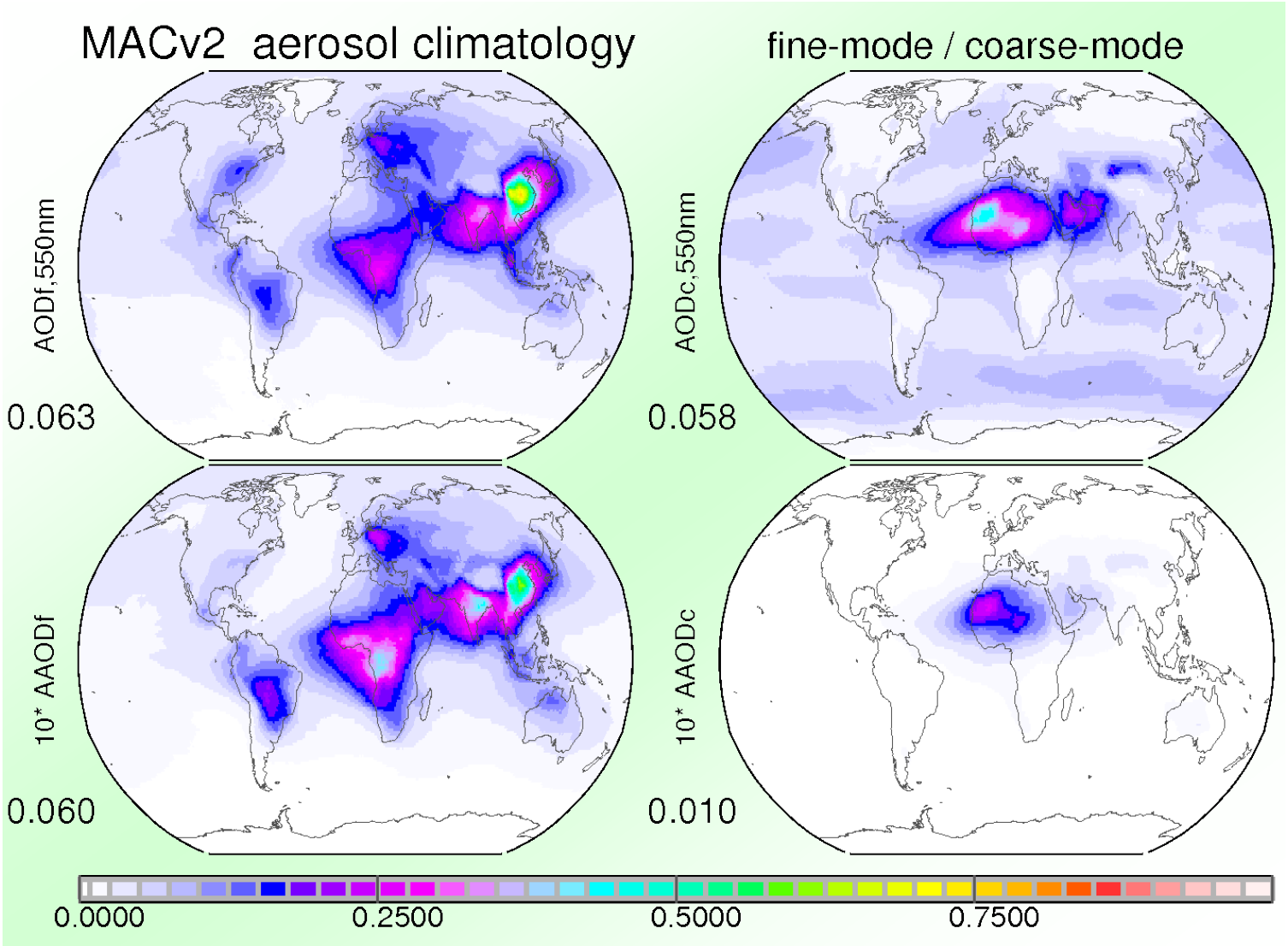
**FMF**

**AAOD**
**(10 times)**

**ANG**
**(div by 2)**

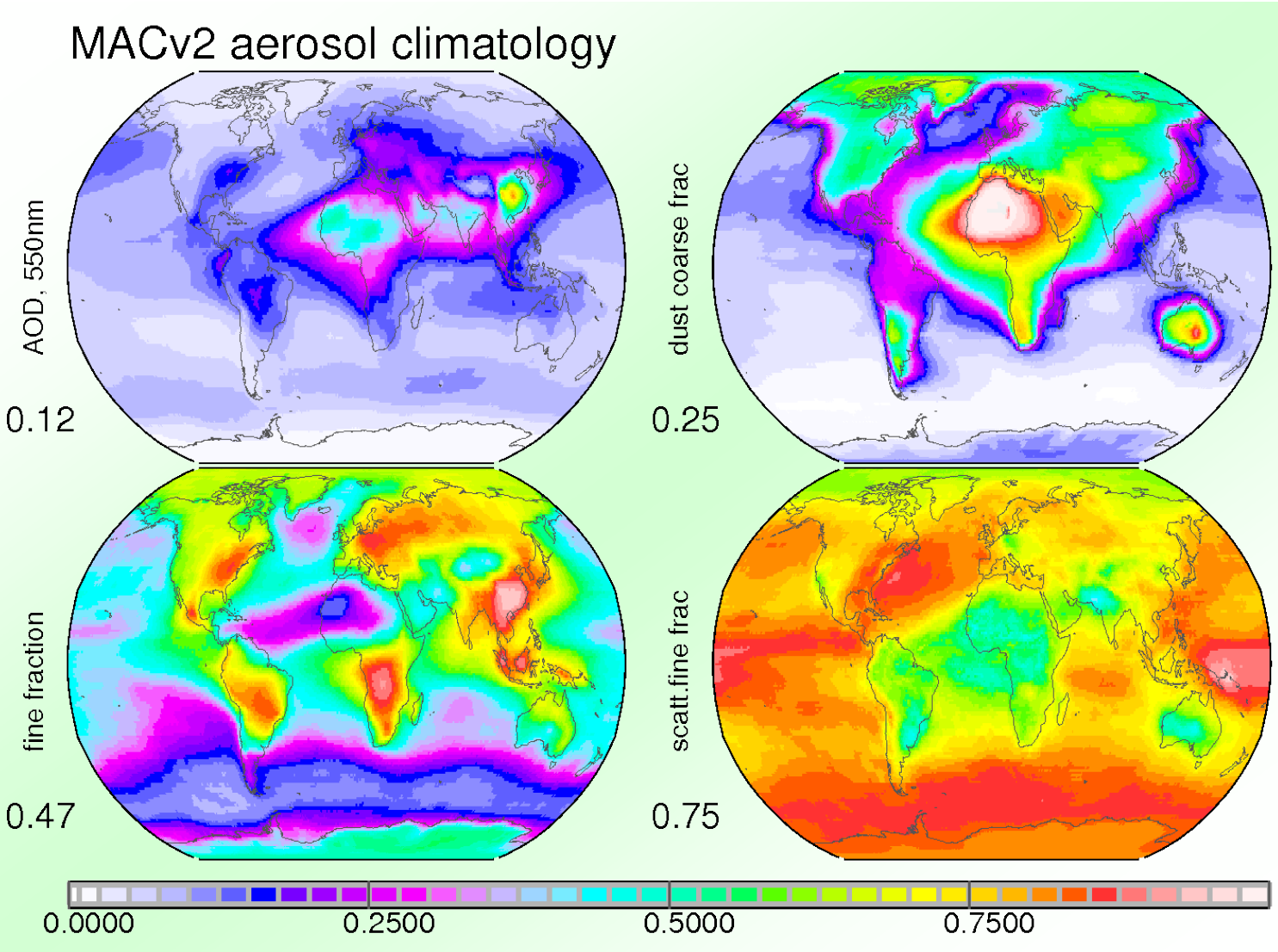
# fine (r<.5um) vs coarse (r>.5um)

## AOD , AAOD



# 1.guess for satellite models

**SSAf = sff *1.0 [Rf,imag=0] + (1-sff) * (0.76) [RF,imag=0.05]**



# expansion with modeling help

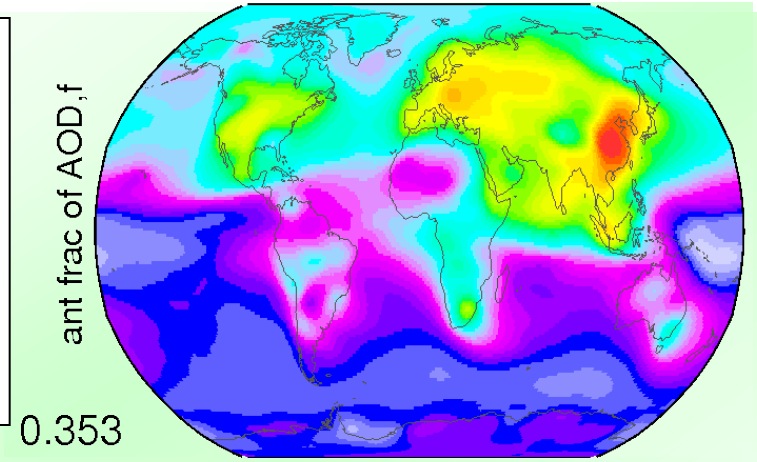
- to make it useful for climate applications
  - inter-annual variability
    - only anthropogenic is allowed to change
      - coarse mode and PI fine-mode unchanged
  - spectral variability (0.25 to 100μm wavelength)
      - derived aerosol typing with pre-scribed aerosol component properties
  - vertical variability (CALIPSO stats preferred)
      - separately for fine-mode and coarse $_{mode}$
  - microphysics (fine-mode size → CCN conc.)
      - reff-fine, T, supersat, kappa, dry→wet at 1km

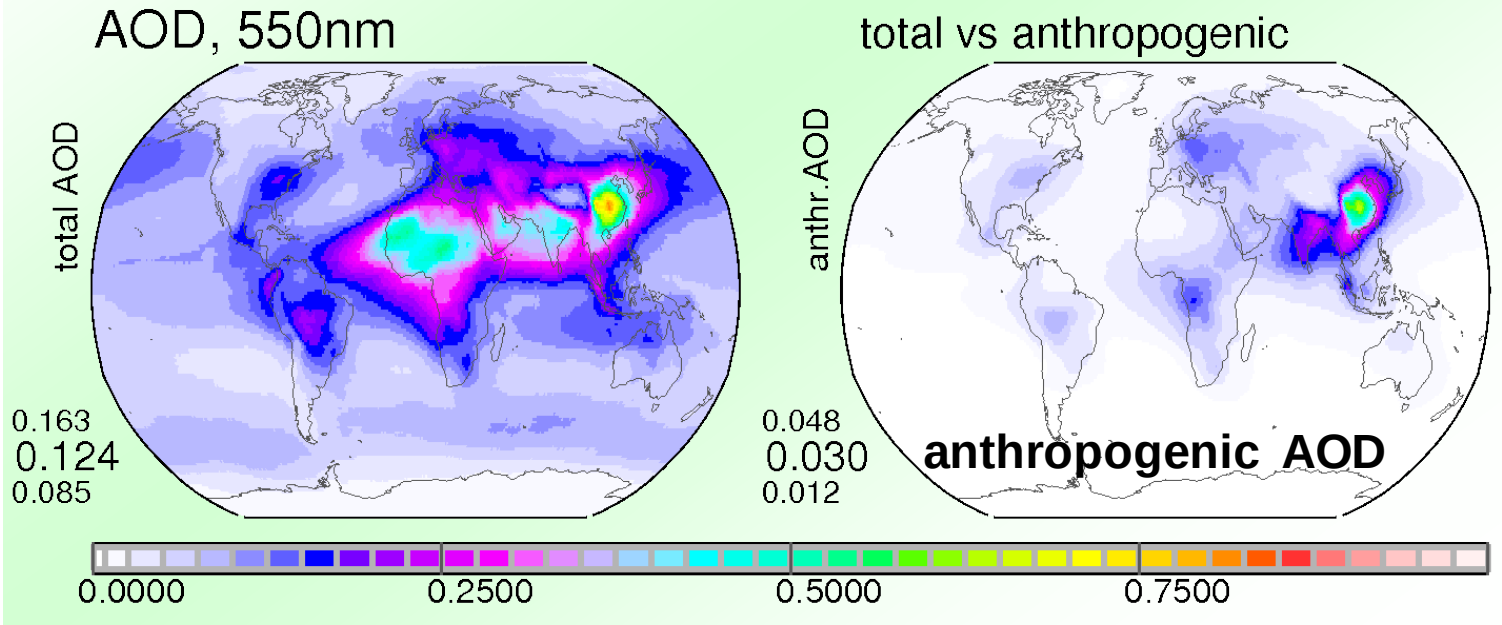
# anthropogenic – via PD & PI modeling

**only 25% of today's AOD is anthrogogenic**

**anthropogenic AOD fraction of today's fine-mode AOD →**

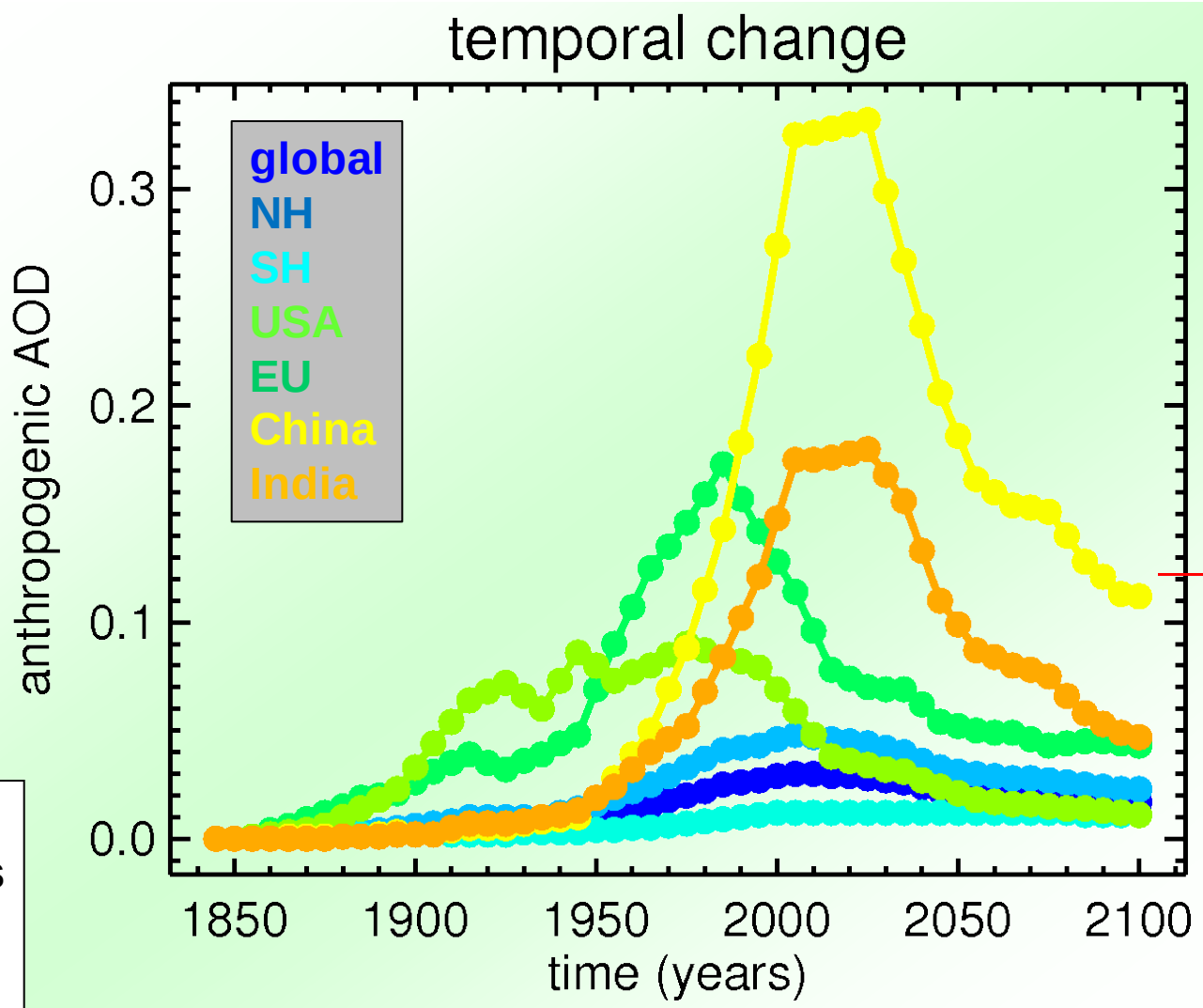
..based on gl.model simulations of the fine-mode AOD at pre-industrial times (year 1850) and for today's conditions



# temporal – via modeled emission scaling

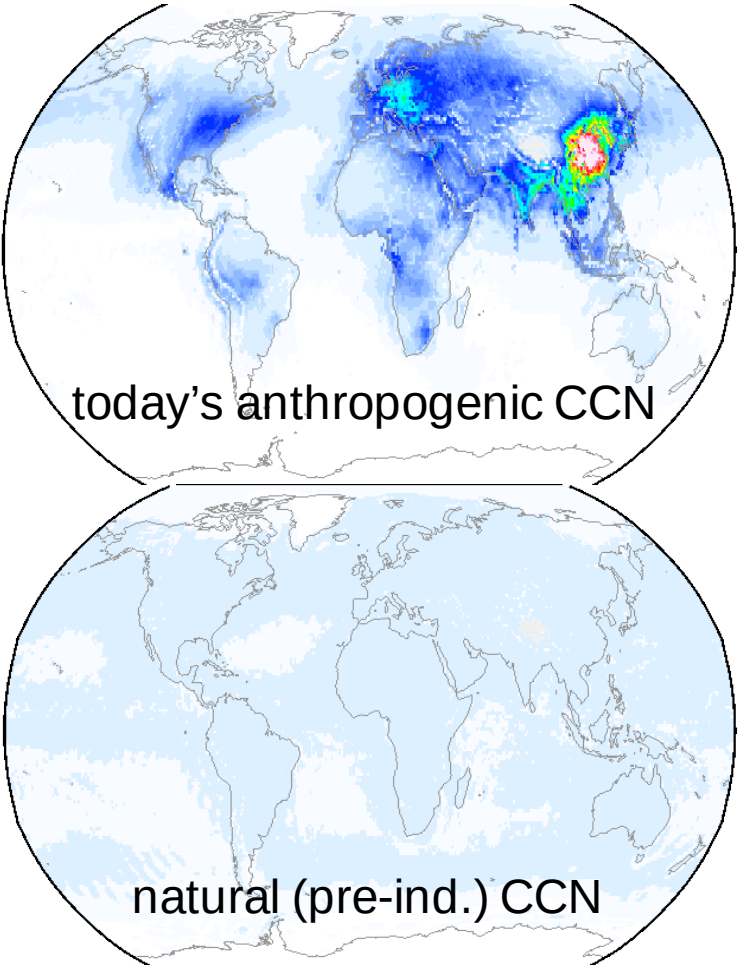
## … if we believe sulfate IPCC RCP futures (no nitrates)



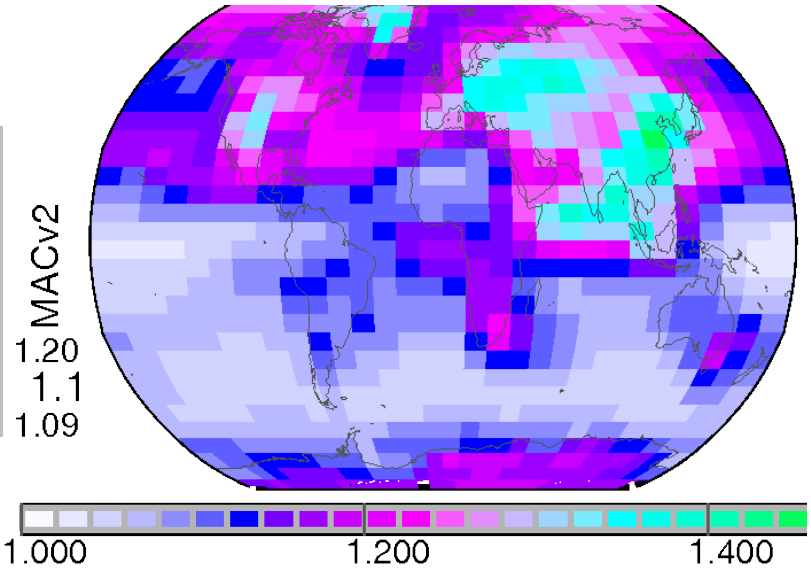

**scaled with simulations from global modeling**

# fine-mode properties

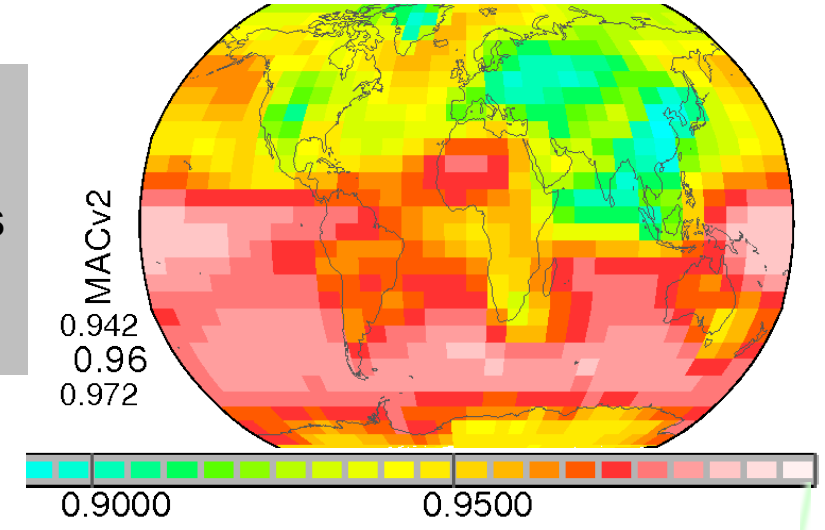
## AODf(z) + re (ANG, AODf) →




**today's low cloud CDNC increase factor →**




**today's low cloud drp radius decrease factor →**

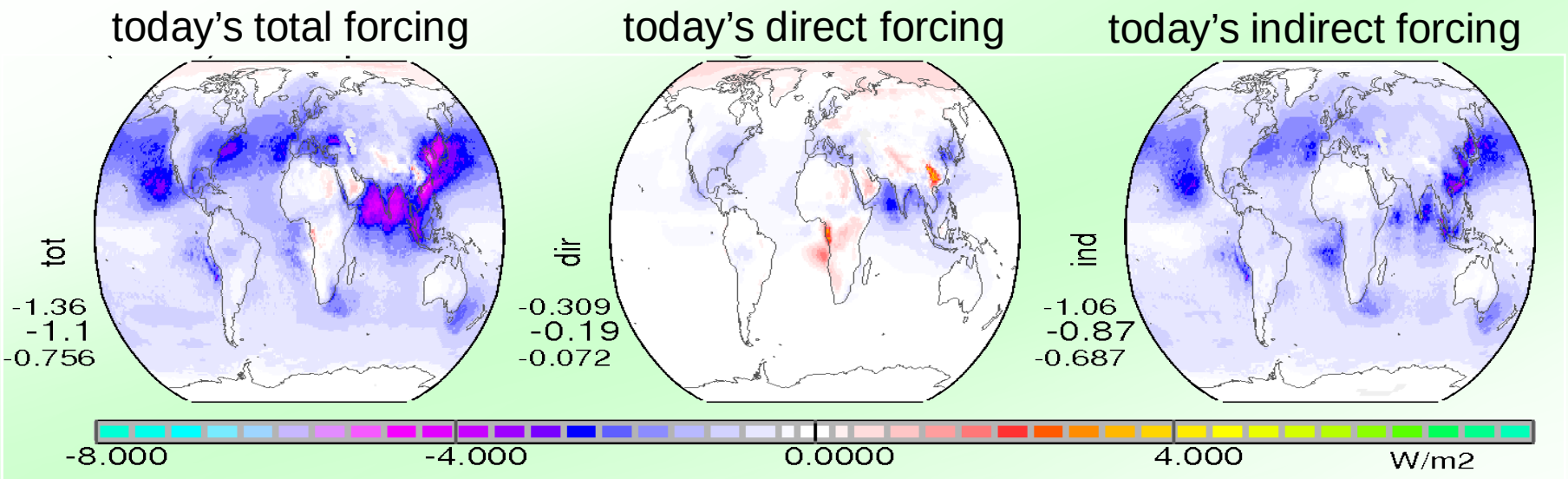


# selected applications

- forcing
  - comparing direct vs indirect
- aerosol effect
  - for atmosphere (heating → dynamics)
  - on the surface radiation budget (flux reduction)
- aerosol forcing over time
  - anthropogenic has reached a maximum

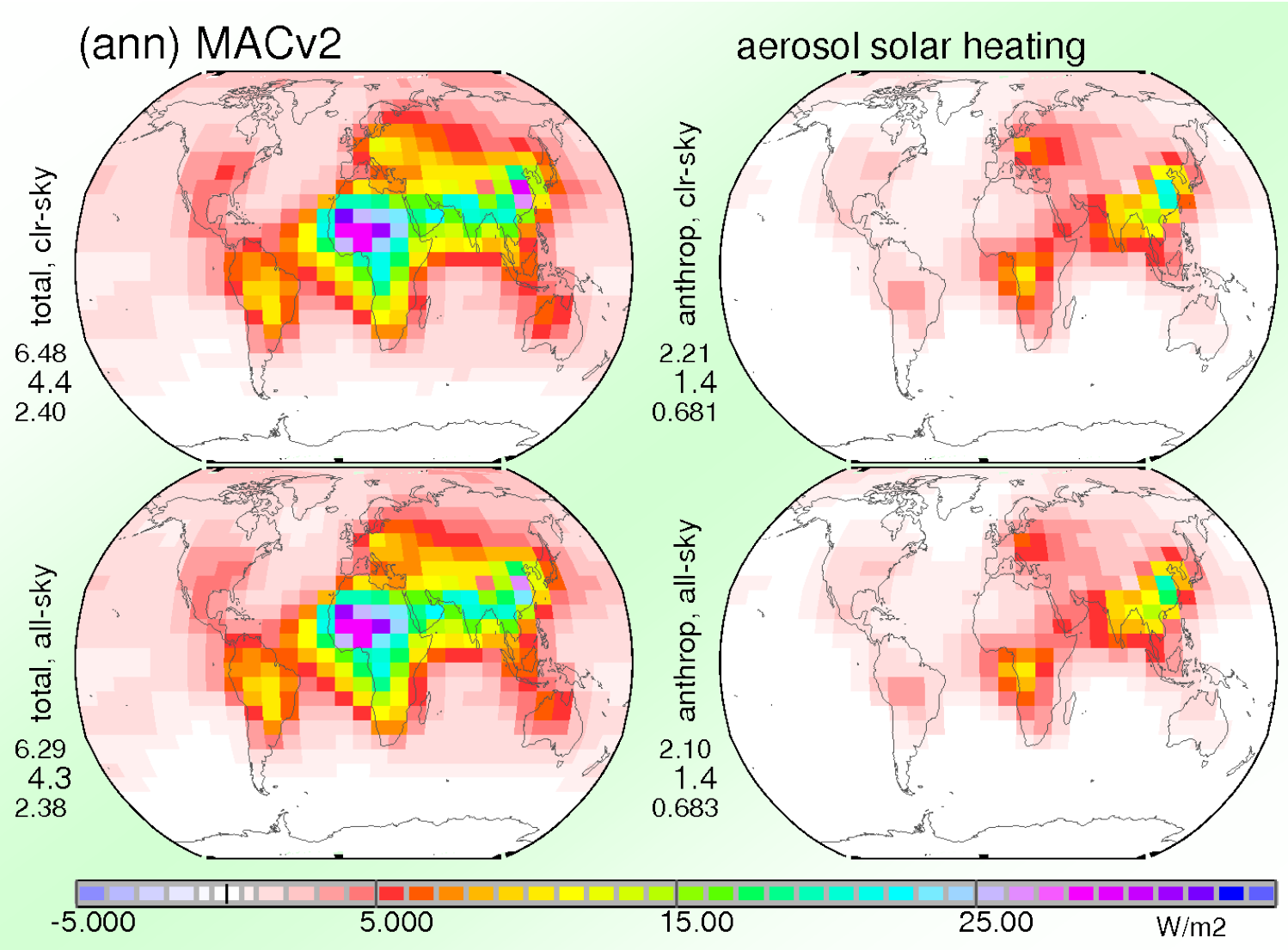
# comparing – direct vs indirect

- **at TOA:** **indirect forcing is dominant**

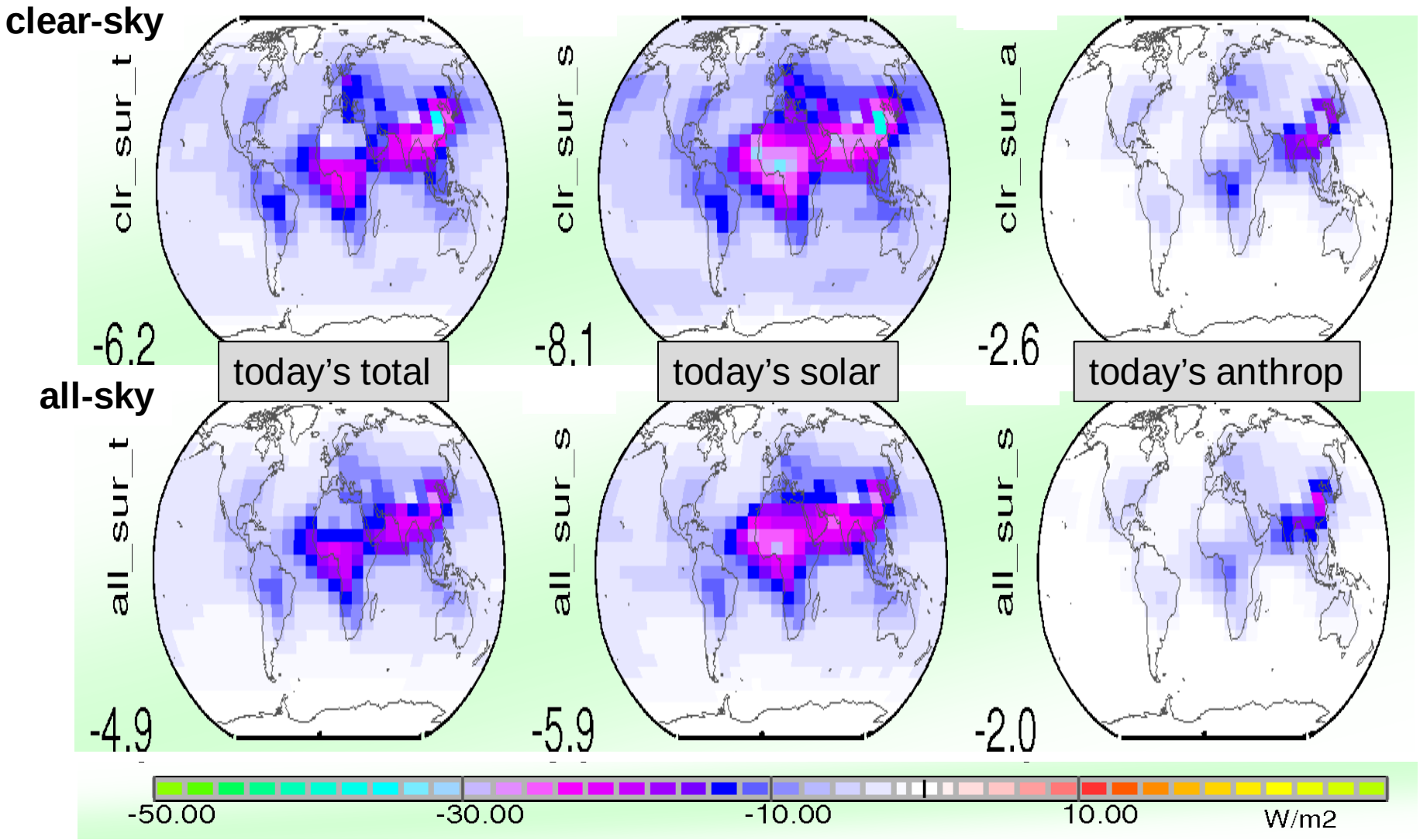



- **in atmosph:** **direct (heat) effect is stronger**
- **at surface:** **direct effect is much stronger**

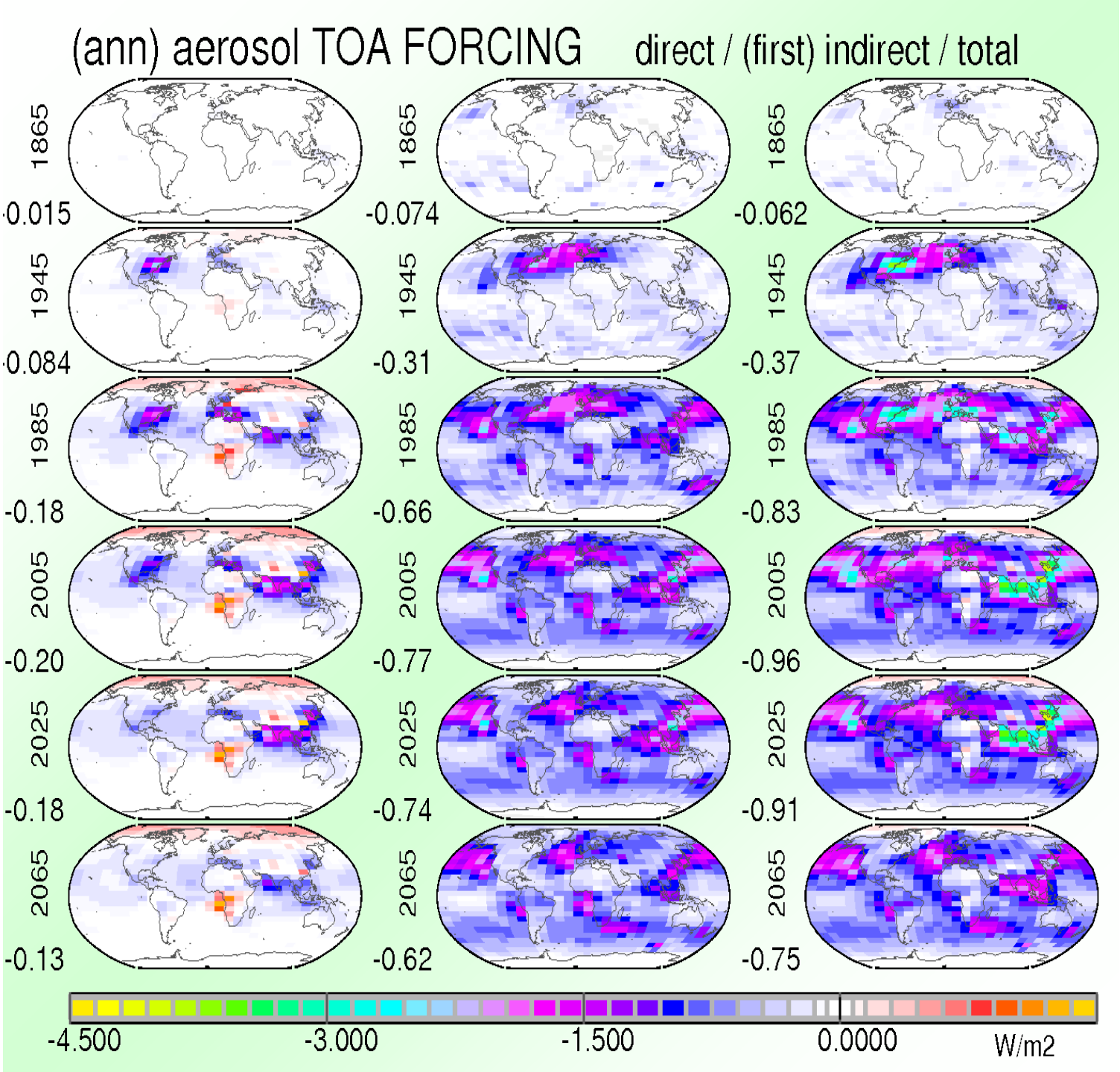
# direct effects in atmosphere



# direct effects on surface budgets



**force (time)**


(ann) aerosol TOA FORCING
direct / (first) indirect / total
1865
0.015
-0.074
-0.062
1945
0.084
-0.31
-0.37
1985
-0.18
-0.66
-0.83
2005
-0.20
-0.77
-0.96
2025
-0.18
-0.74
-0.91
2065
-0.13
-0.62
-0.75
-4.500
-3.000
-1.500
0.0000
W/m2

# summary

- **MAC climatology is freely available**
  - **ftp ftp-projects.zmaw.de/aerocom/climatology/MACv2_2015**
- **applications demonstrated usefulness**
  - **regional, seasonal, temporal varying impacts**
  - **indirect impact dominates at TOA**
  - **direct impact dom. at surface and atmosphere**
- **major uncertainties**
  - **PI reference (to define 'anthropogenic')**
  - **composition (absorption properties)**

# end

# complicate – spectral / comp variability

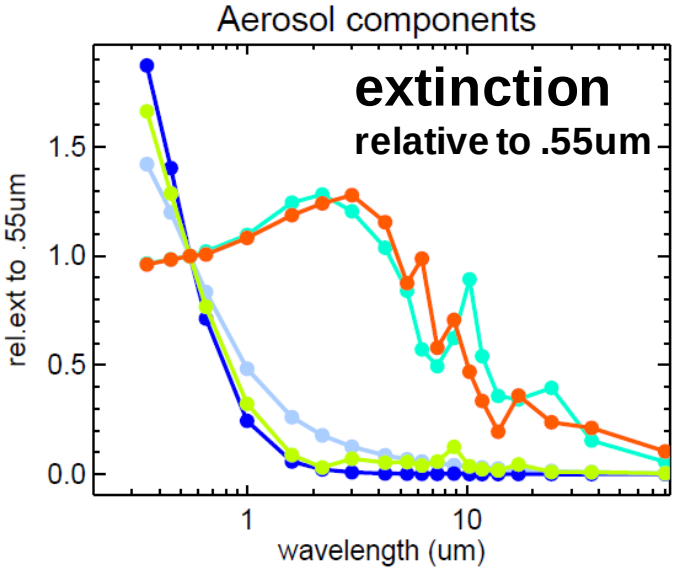
**BC**
black carb

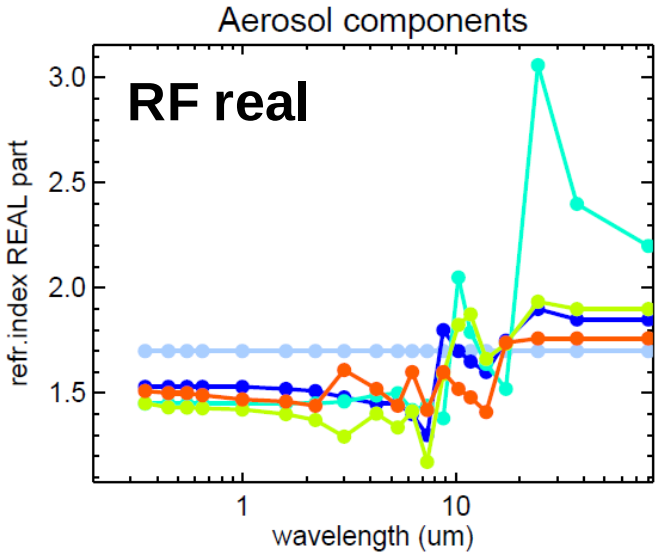
**OC**
org. carb

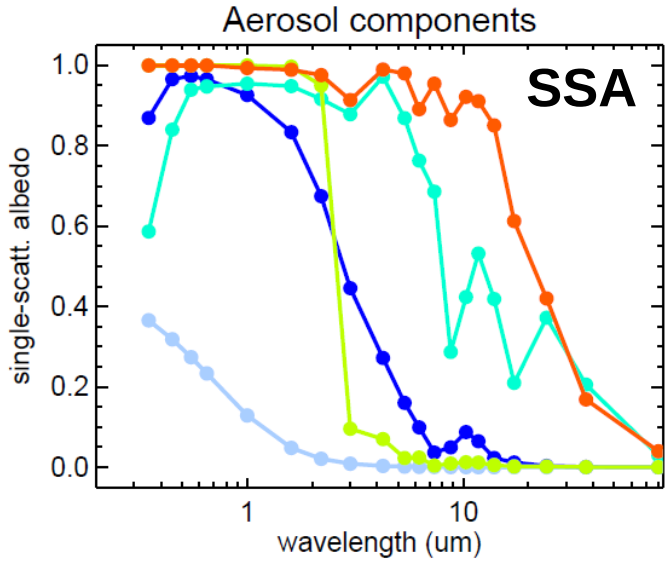
**SU**
sulfate

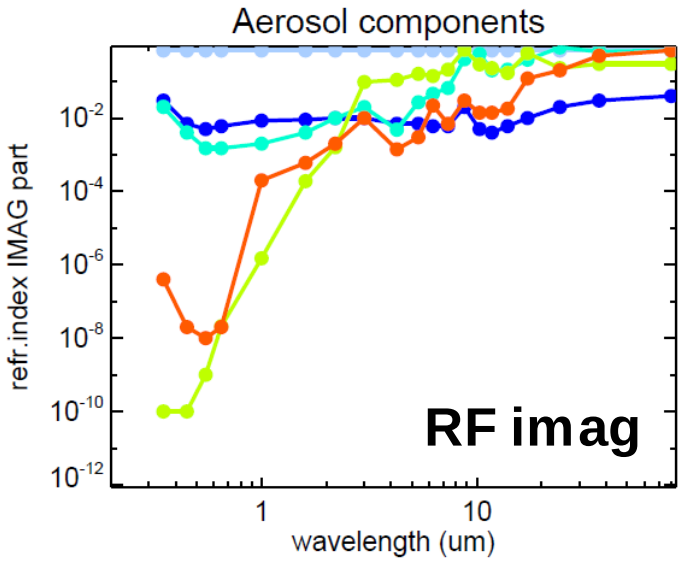
**DU**
dust

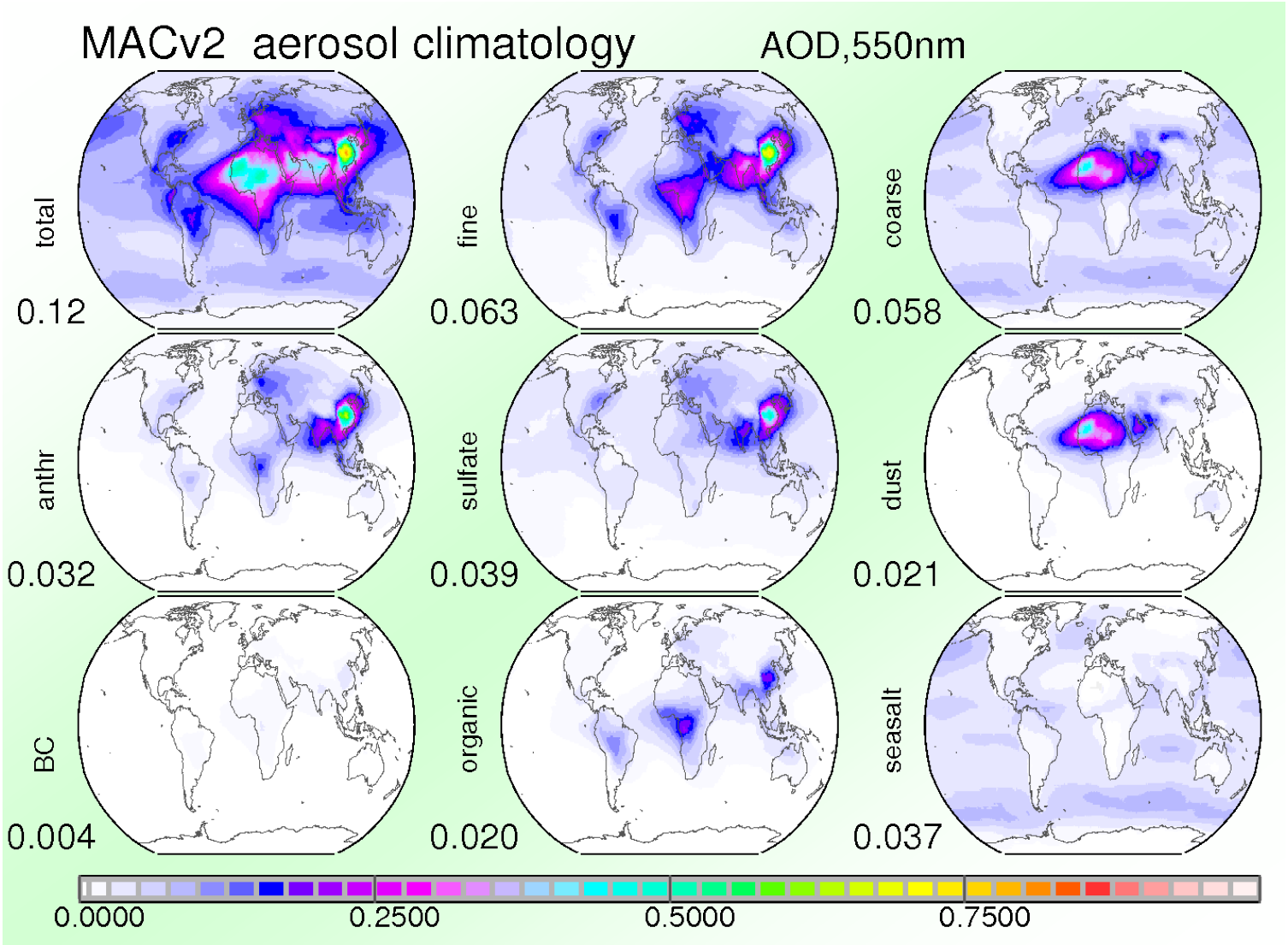
**SS**
seasalt




MACv2 aerosol climatology
AOD,550nm
total
0.12
fine
0.063
coarse
0.058
anthr
0.032
sulfate
0.039
dust
0.021
BC
0.004
organic
0.020
seasalt
0.037
0.0000
0.2500
0.5000
0.7500