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

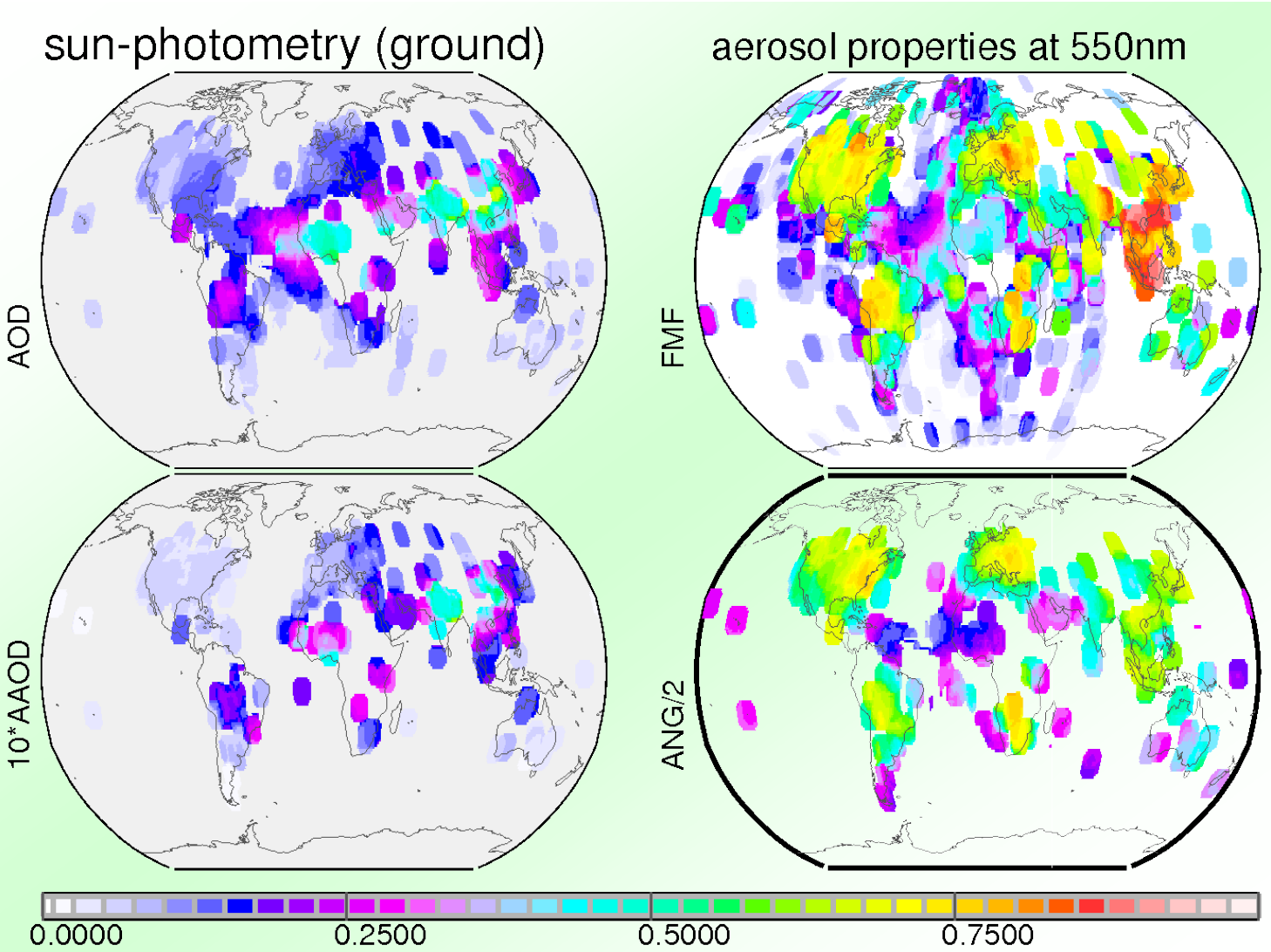
AERONET

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)

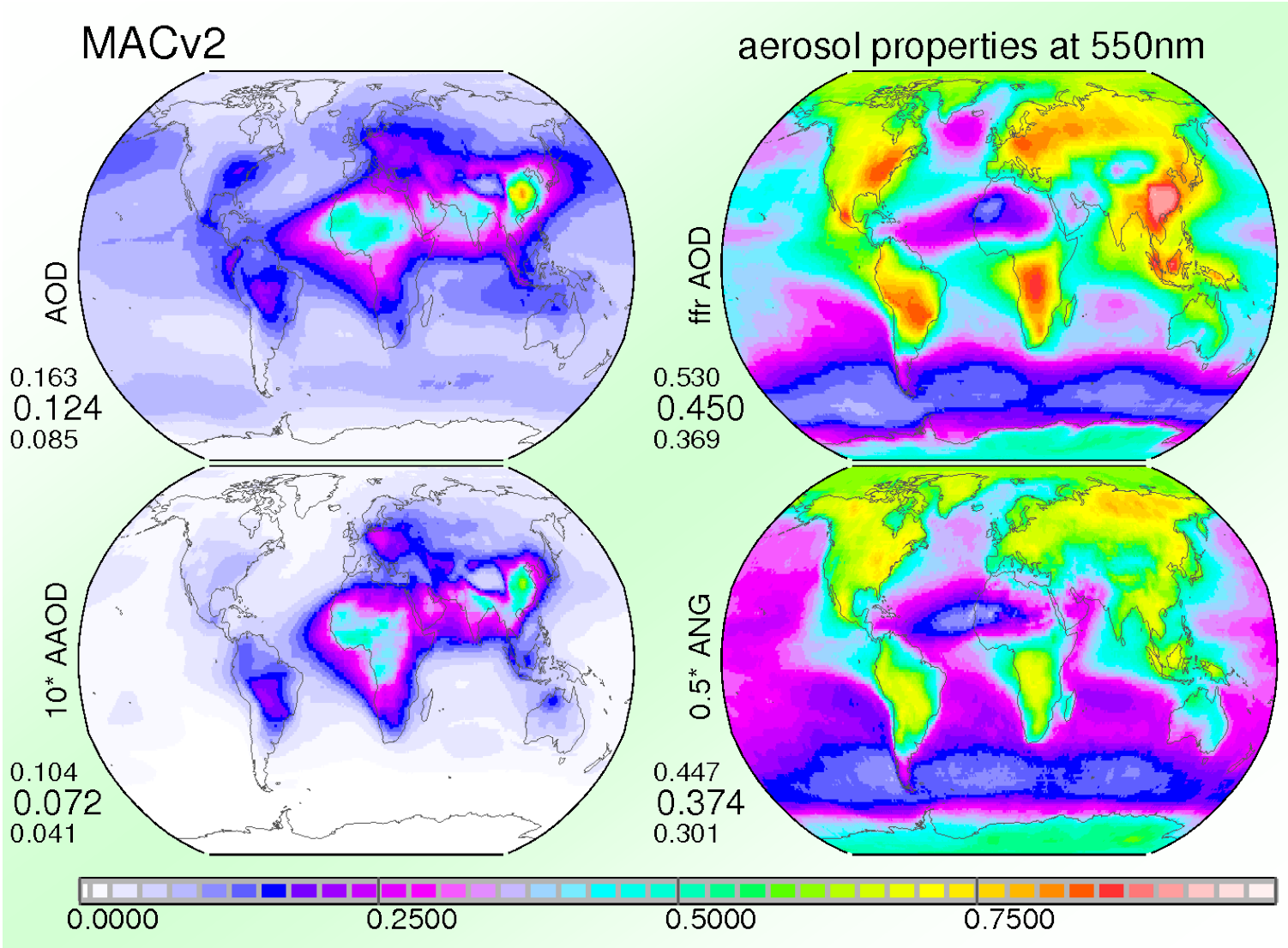
fine-mode AOD fraction
FMF = AOD,f / (AOD,f + AOD,c)

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

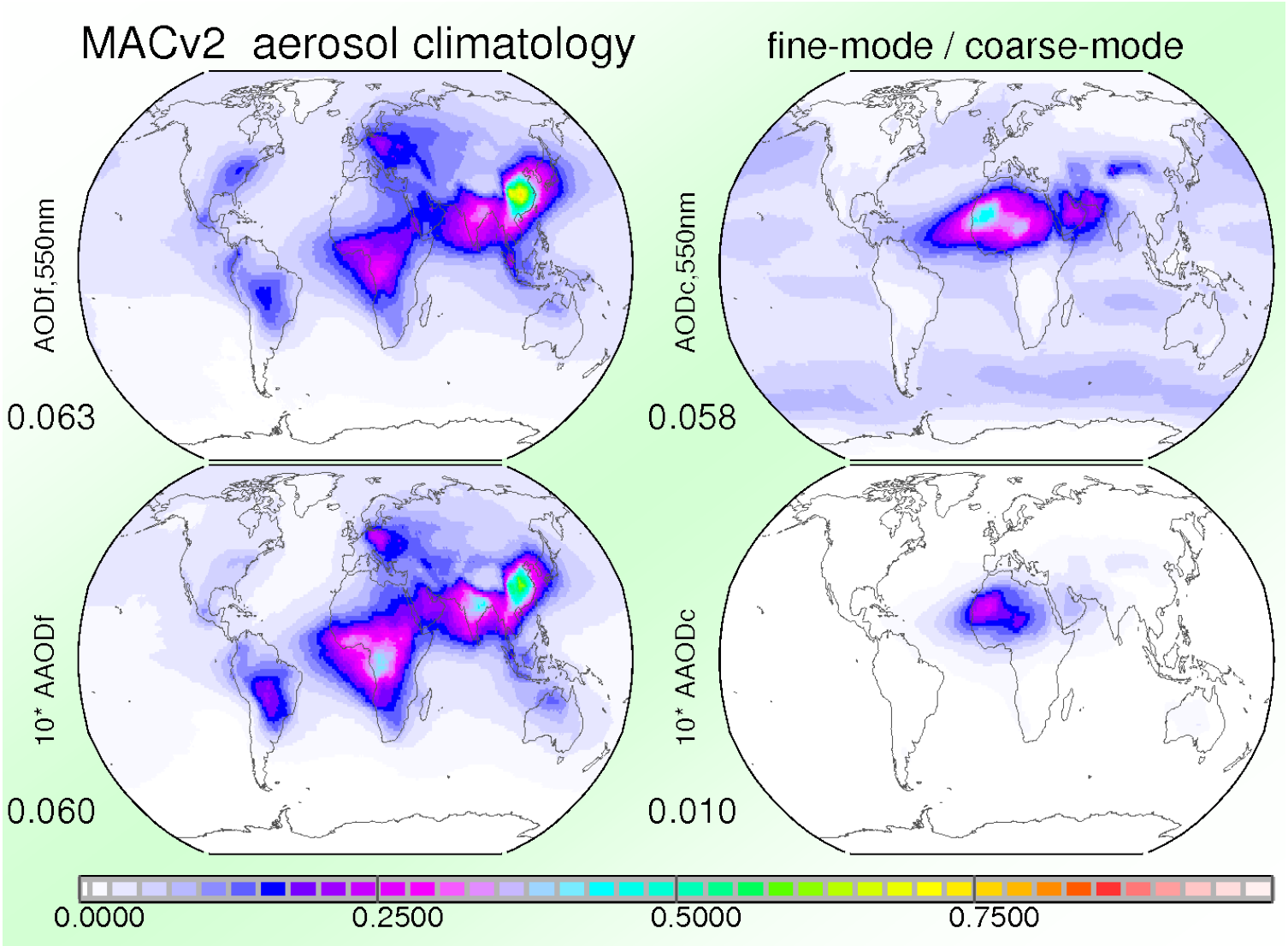
FMF

AAOD
(10 times)

ANG
(div by 2)

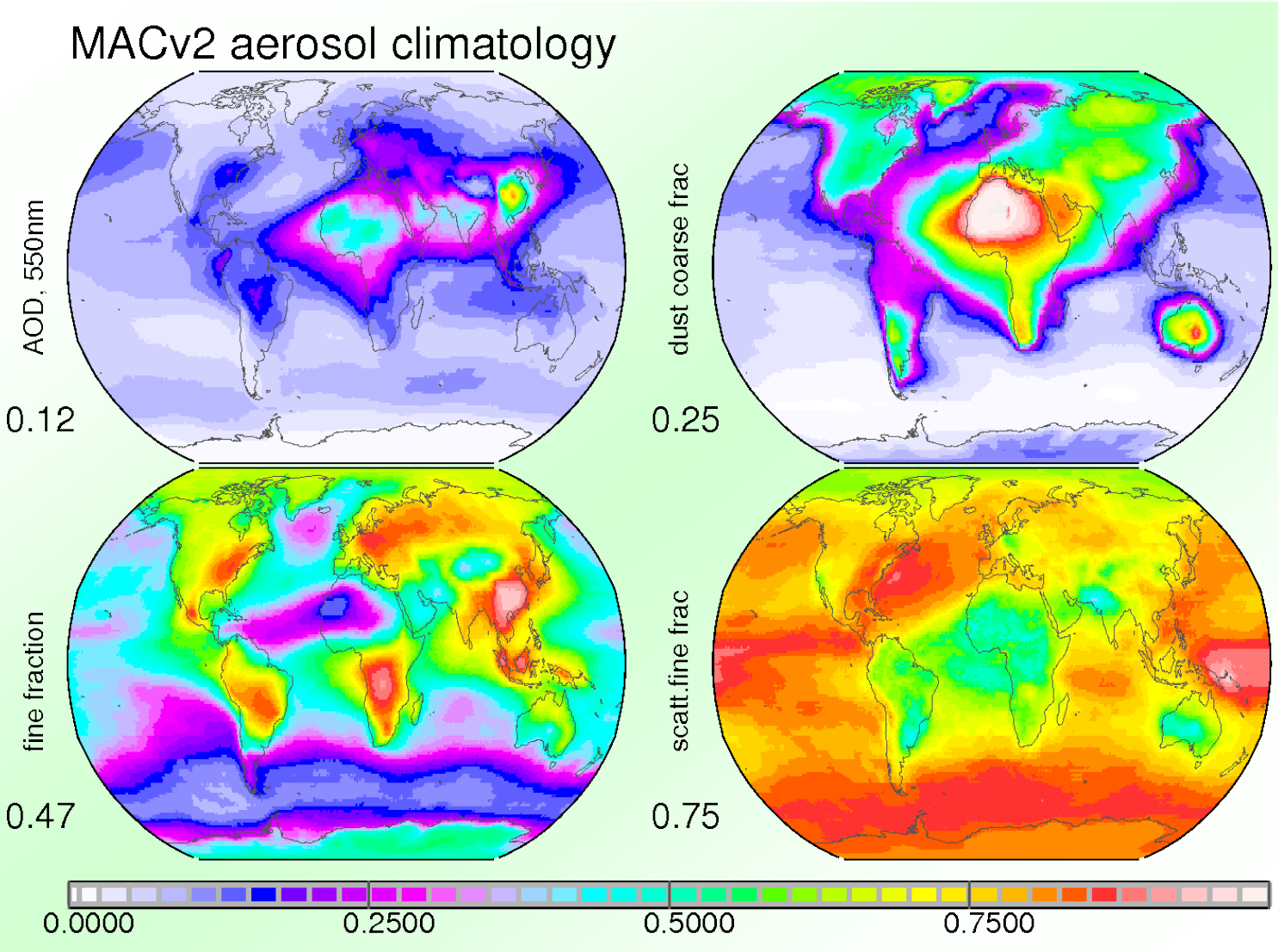
fine (r<.5um) vs coarse (r>.5um)

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

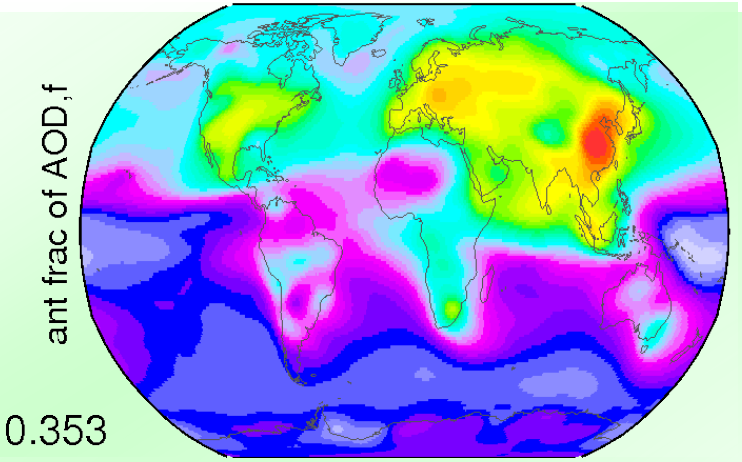
- to make it useful for climate applications
  - inter-annual variability
    - only anthropogenic is allowed to change
      - coarse mode and PI fine-mode unchanged
  - spectral variability (0.25 to 100μm wavelength)
      - derived aerosol typing with pre-scribed aerosol component properties
  - vertical 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

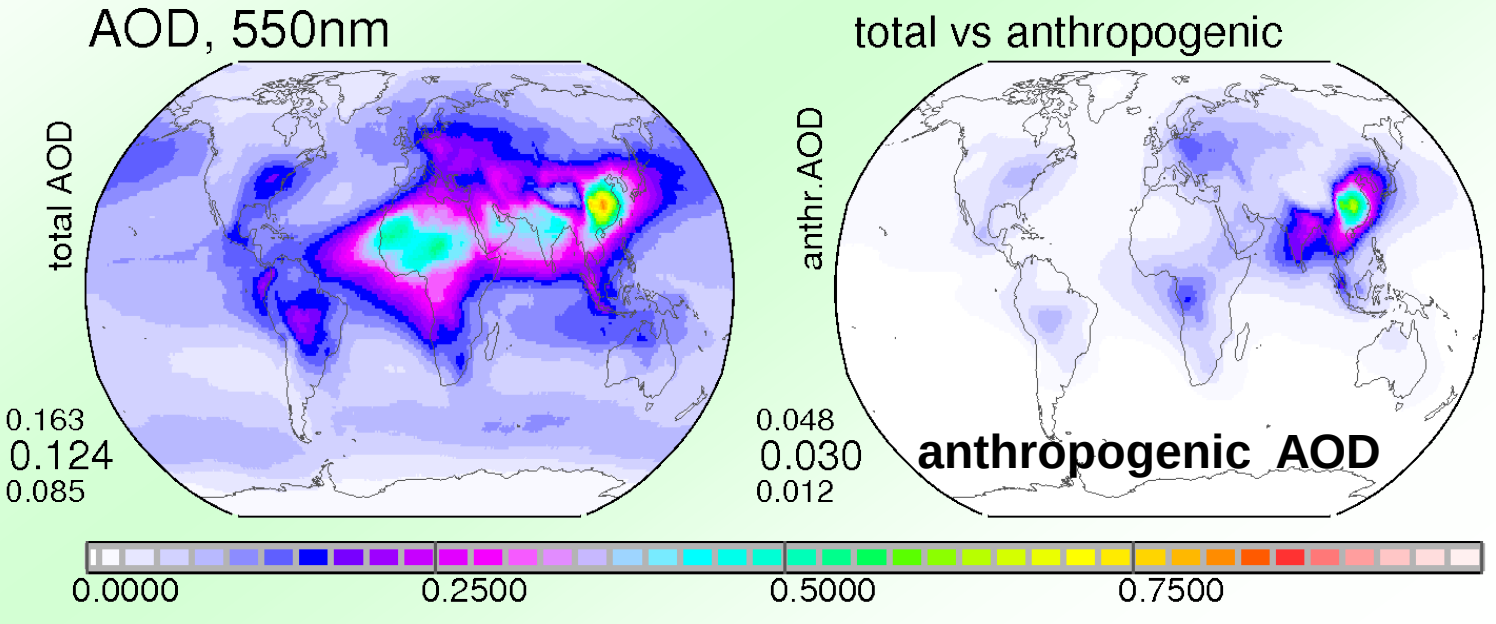
anthropogenic – via PD & PI modeling

only 25% of today's AOD is anthrogogenic

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

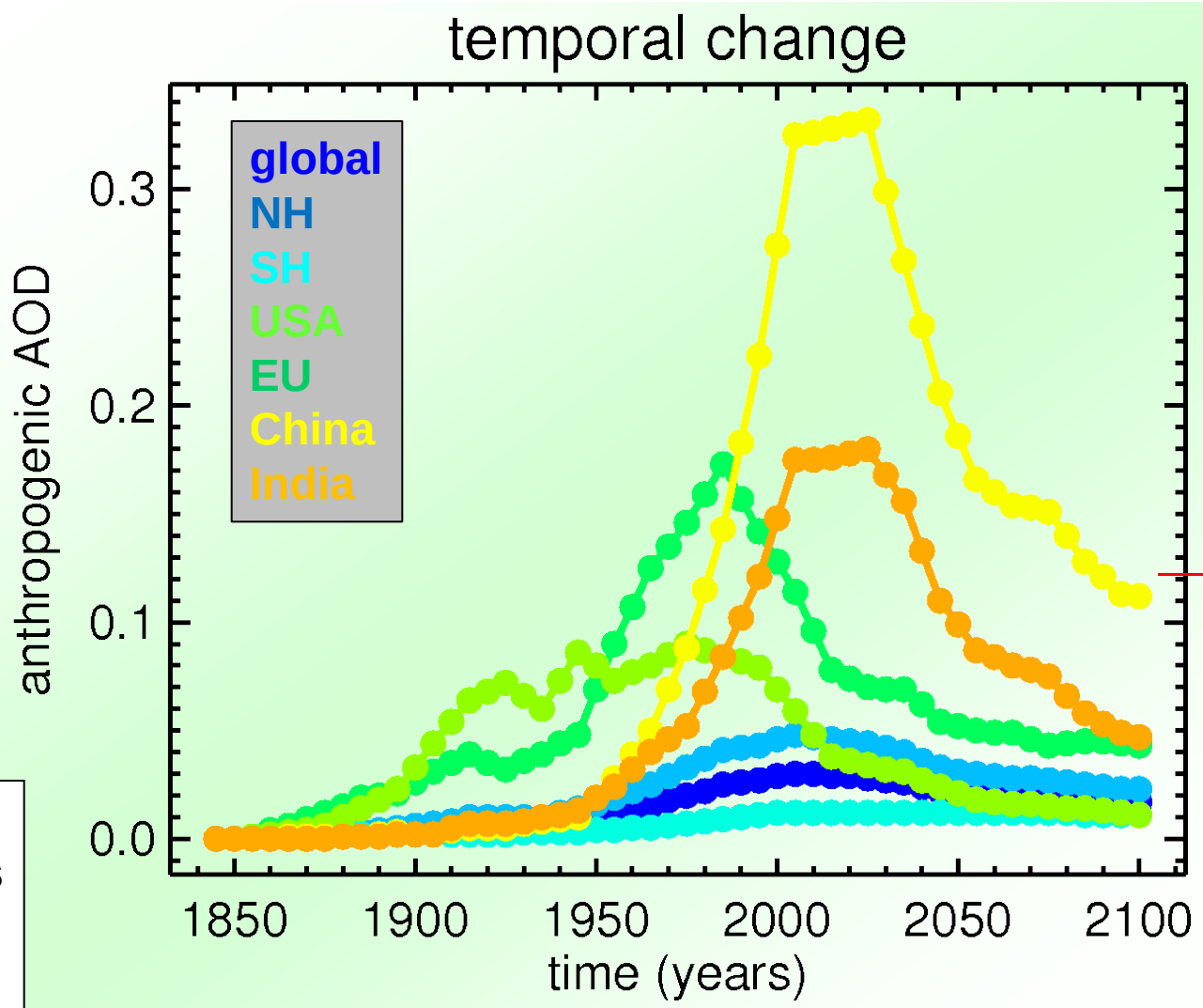
..based on gl.model simulations of the fine-mode AOD at pre-industrial times (year 1850) and for today's conditions





temporal – via modeled emission scaling

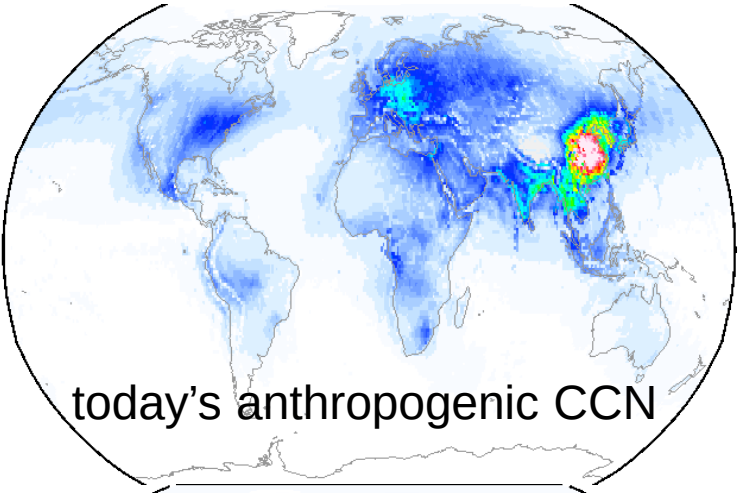
… if we believe sulfate IPCC RCP futures (no nitrates)

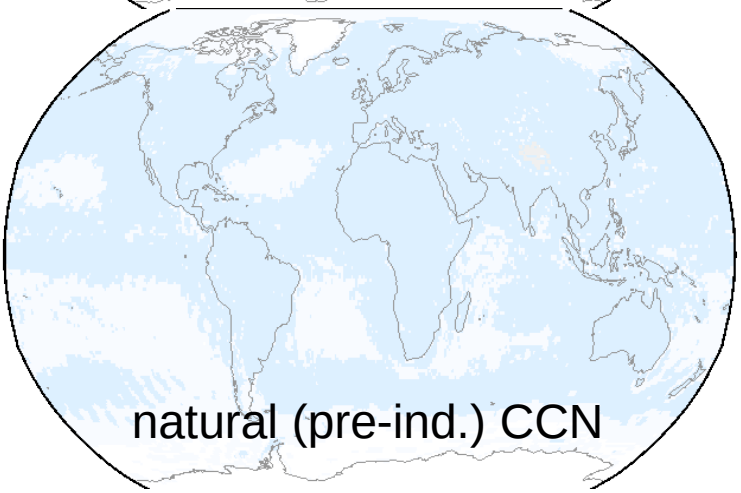


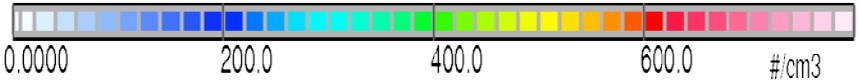
scaled with simulations from global modeling

fine-mode properties

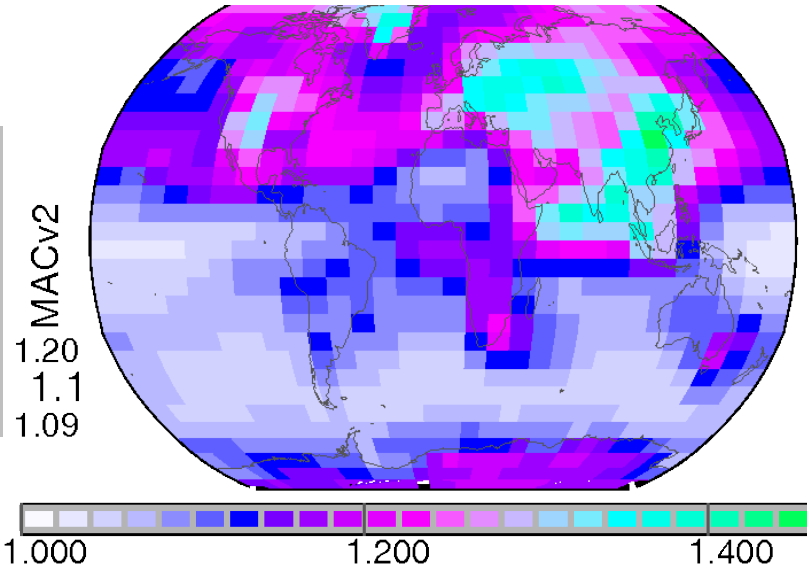
AODf(z) + re (ANG, AODf) →



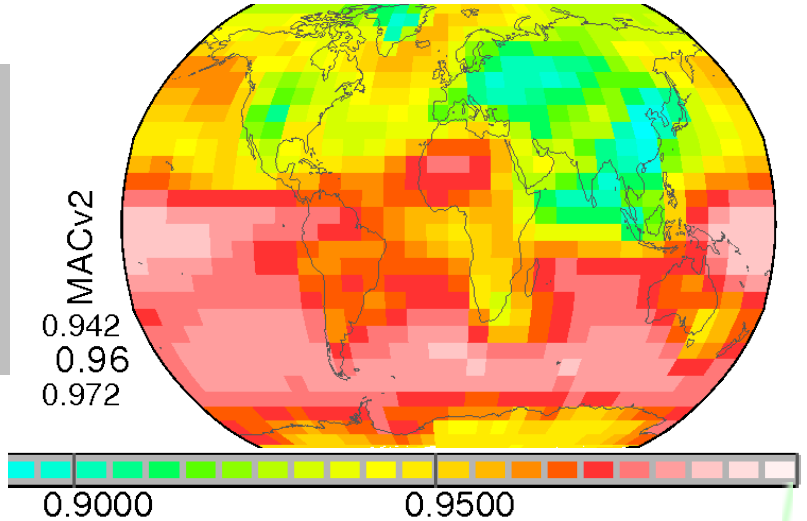




today's low cloud CDNC increase factor →



today's low cloud drp radius decrease factor →

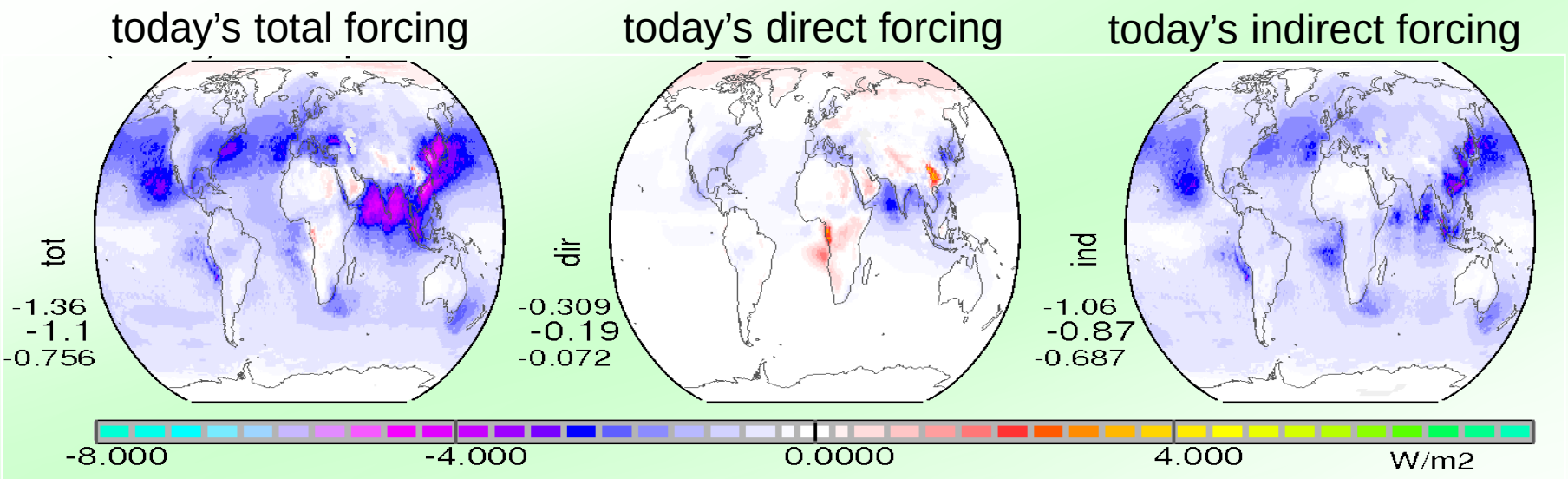


selected applications

- 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

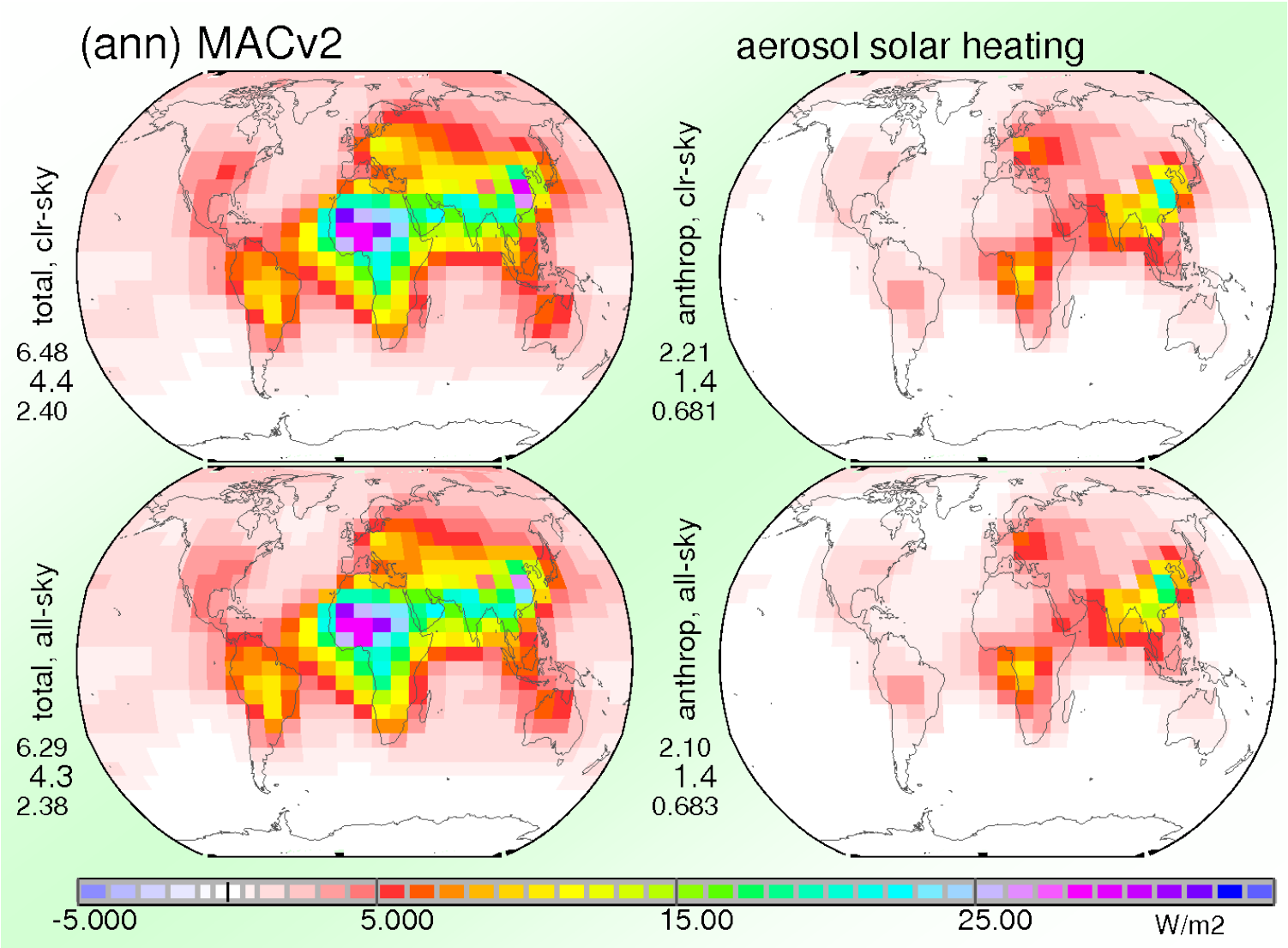
comparing – direct vs indirect

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

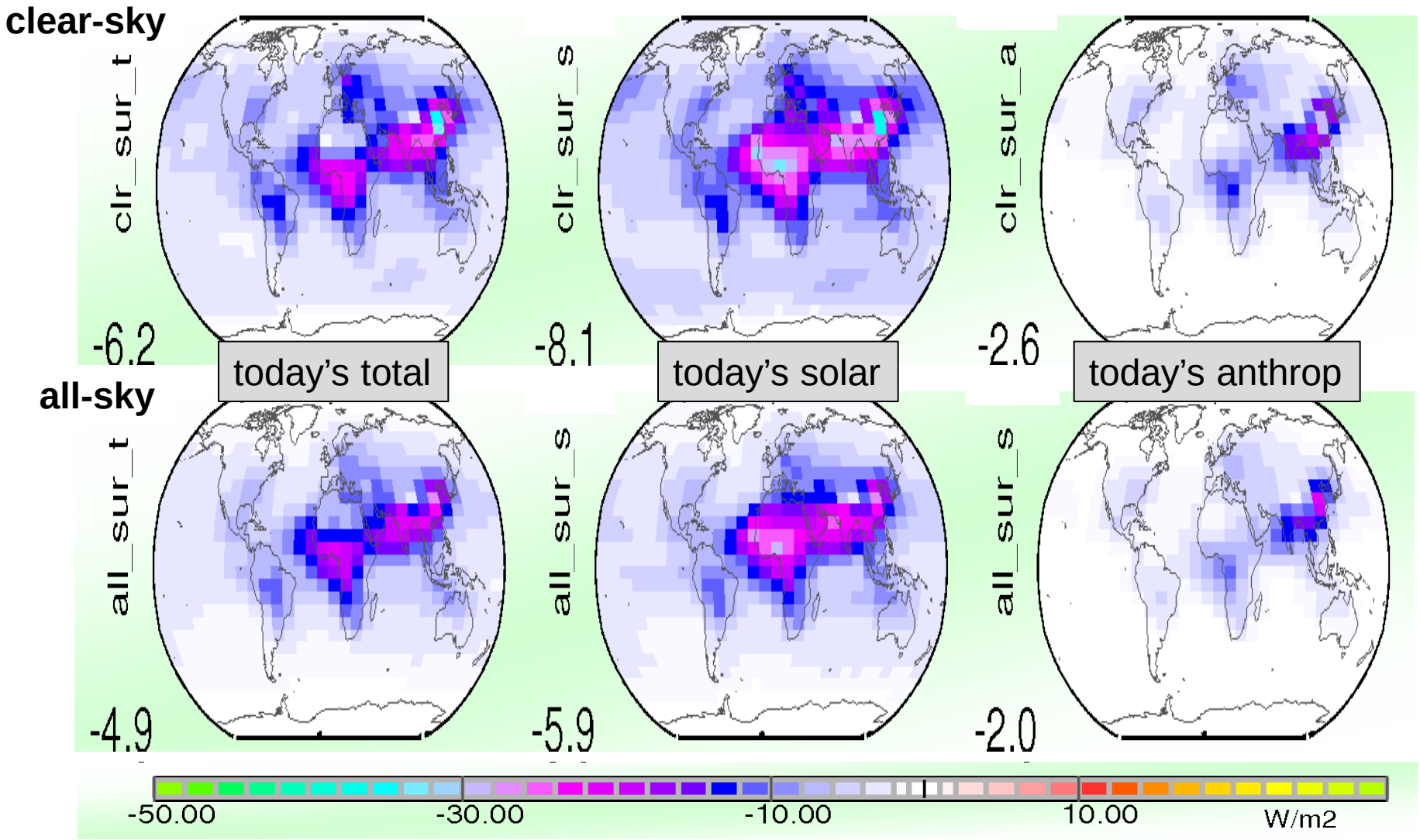


- **in atmosph: direct (heat) effect is stronger**
- **at surface: direct effect is much stronger**

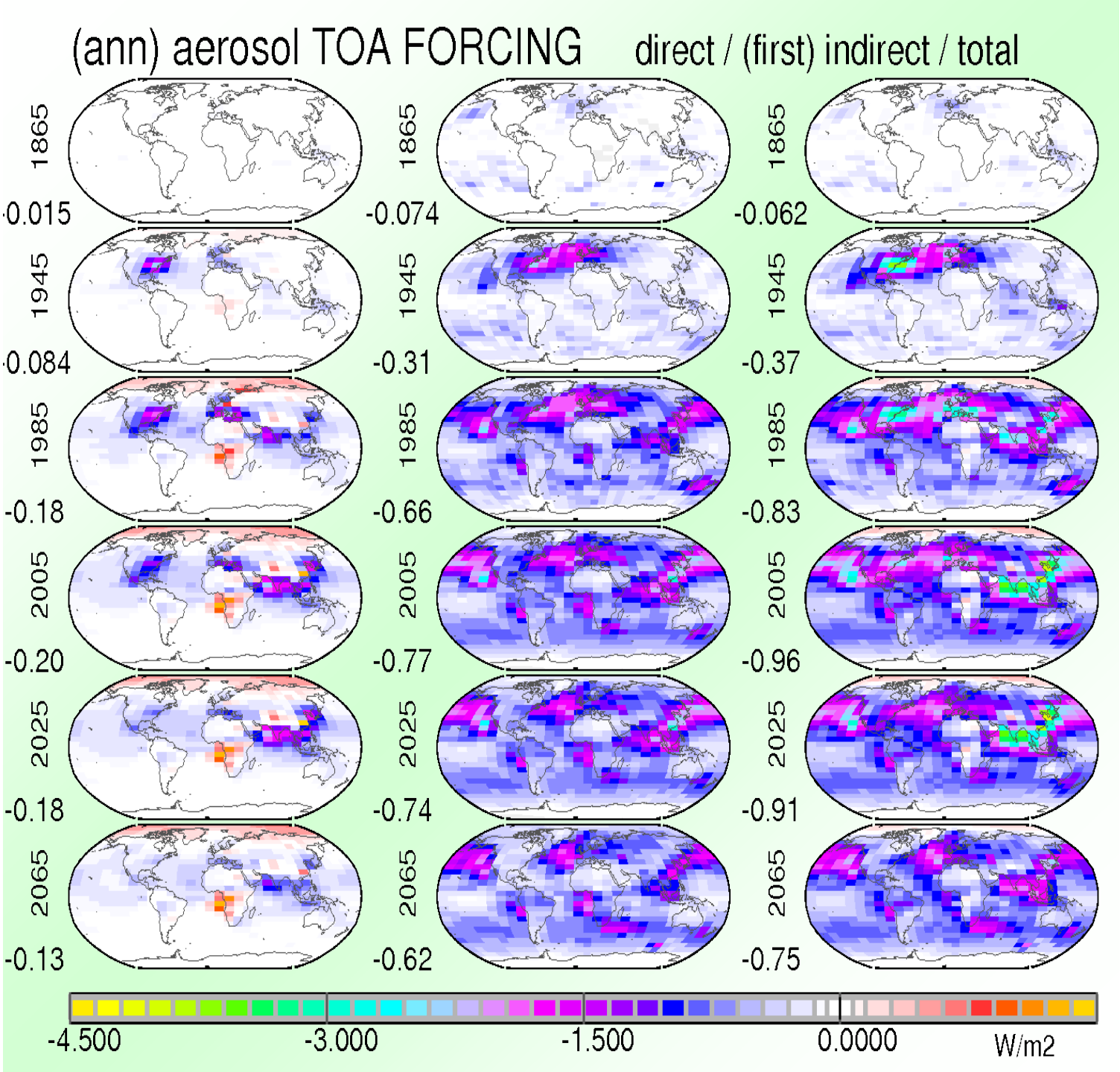
direct effects in atmosphere



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

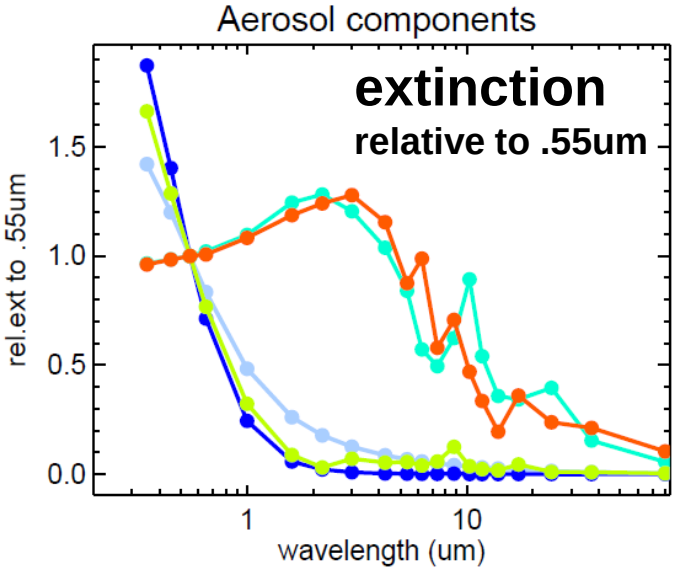
BC
black carb

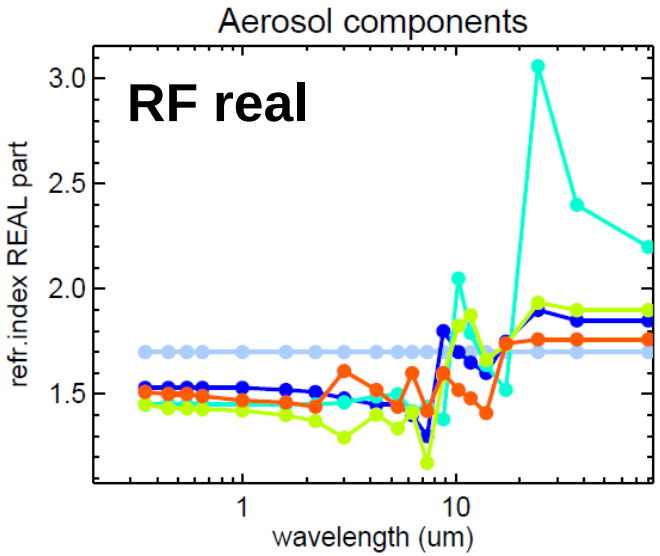
OC
org. carb

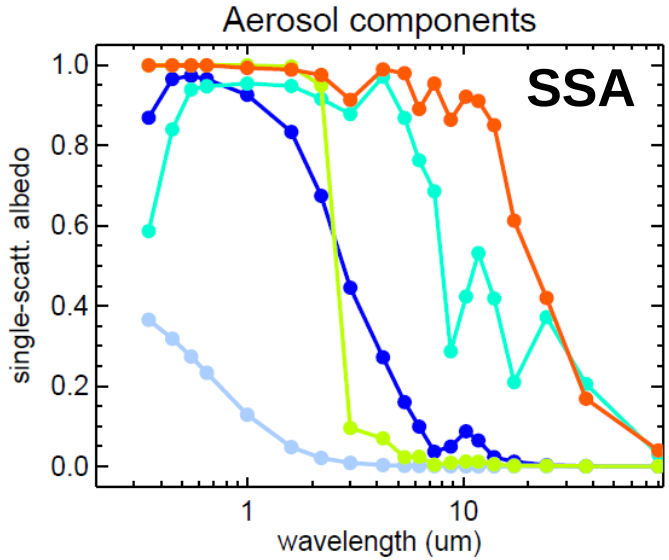
SU
sulfate

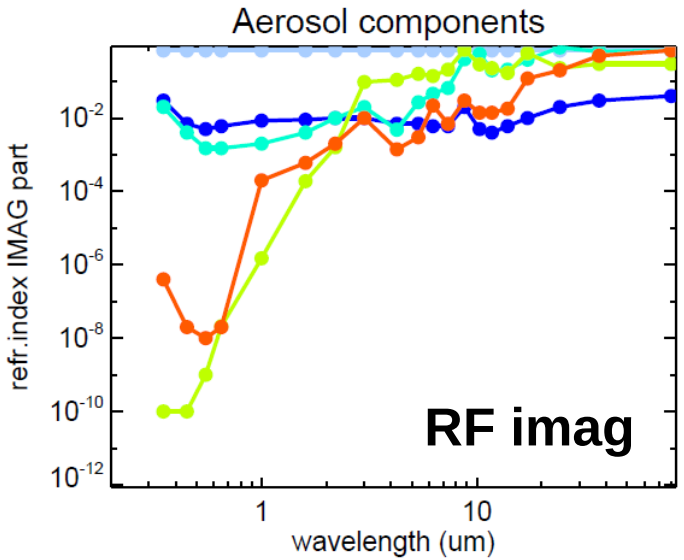
DU
dust

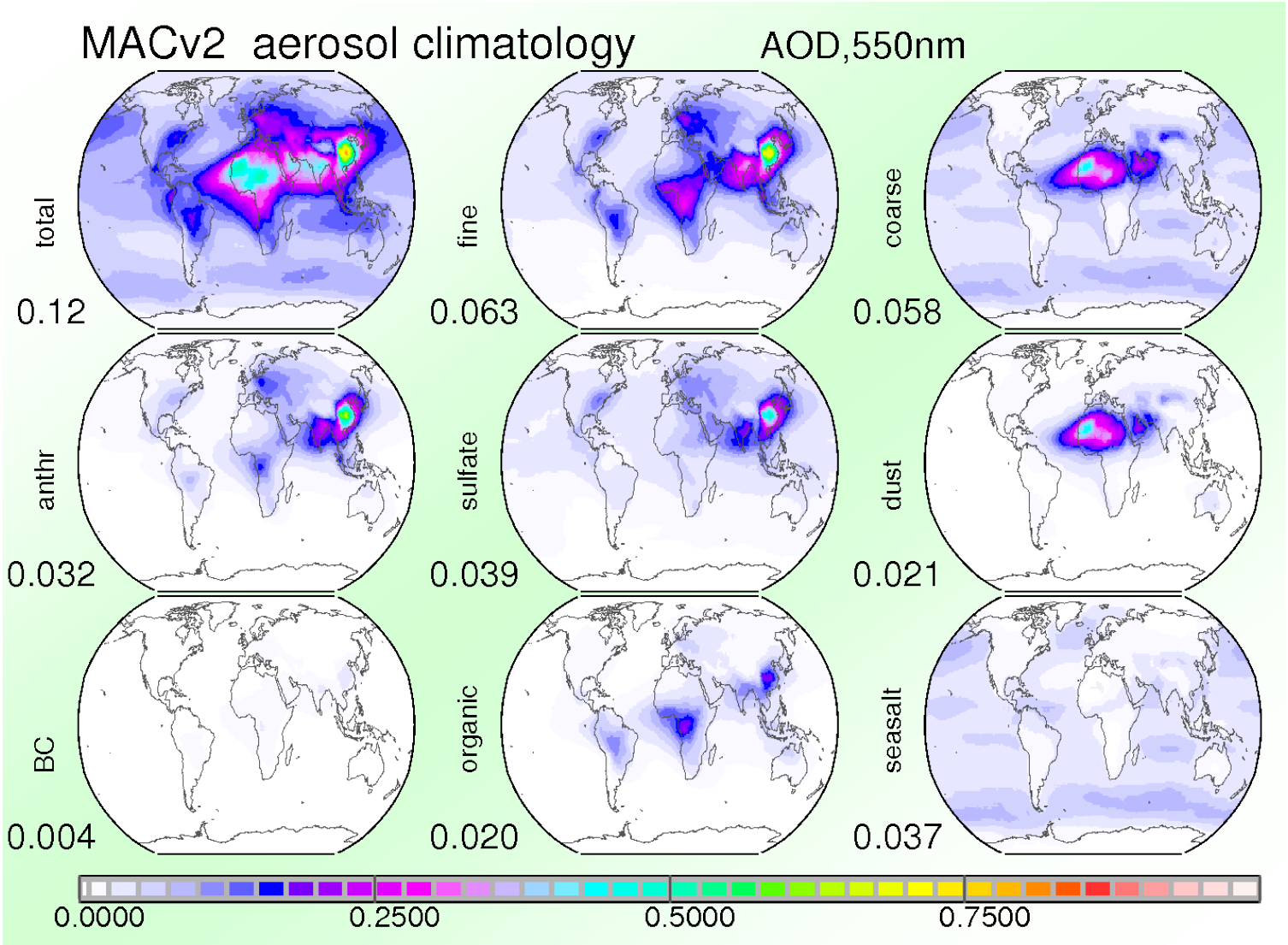
SS
seasalt










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