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

sun-photometry (ground)
aerosol properties at 550nm

AOD
AAOD (10 times)

10^AAOD

FMF
ANG (div by 2)
merged properties
at 550nm (unless otherwise indicated)

• AOD
• AAOD

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

• AOD, 870nm

• AODf (r<.5um)
fine-mode AOD fraction
FMF = AOD,f / (AOD,f + AOD,c)

• AODc (r>.5um)

• AAODf (mainly BC)

• AAODc (mainly DU)

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

Ang +FMF → fine reff  → CCN
MACv2 merged on modeling annual averages

AOD

AAOD (10 times)

aerosol properties at 550nm

FMF

ANG (div by 2)
fine (r<.5um)  vs  coarse (r>.5um)
AOD, AAOD

MACv2 aerosol climatology

fine-mode / coarse-mode

AODf,550nm
0.063

10° AAODf
0.060

AODc,550nm
0.058

10° AAODc
0.010

0.0000  0.2500  0.5000  0.7500

0.0000  0.2500  0.5000  0.7500
1. guess for satellite models

\[ SSAf = sff \times 1.0 \, [Rf,imag=0] + (1-sff) \times (0.76) \, [RF,imag=0.05] \]
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 \((0.25\, \text{to } 100\, \mu\text{m wavelength})\)
    – derived aerosol typing with pre-scribed aerosol component properties
  – vertical variability \((\text{CALIPSO stats preferred})\)
    – separately for fine-mode and coarse mode
  – microphysics \((\text{fine-mode size } \rightarrow \text{CCN conc.})\)
    – \(\text{reff-fine}, T, \text{supersat}, \text{kappa, dry} \rightarrow \text{wet at } 1\text{km}\)
only 25% of today’s AOD is anthropogenic

.. 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

2005 total AOD mean
fine-mode properties

AOD_f(z) + re (ANG, AOD_f) →

today’s anthropogenic CCN

today’s low cloud CDNC increase factor →

natural (pre-ind.) CCN

today’s low cloud drp radius decrease factor →
selected applications

• forcing
  – comparing direct vs indirect

• aerosol effect
  – for atmosphere (heating $\rightarrow$ 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

(ann) MACv2

aerosol solar heating

-5.000 5.000 15.000 25.000
-5.000 5.000 15.000 25.000

总, clr-sky

总, all-sky

-5.000 5.000 15.000 25.000
-5.000 5.000 15.000 25.000

总, clr-sky

总, all-sky

-5.000 5.000 15.000 25.000
-5.000 5.000 15.000 25.000

2.40 4.4 6.48
2.38 4.3 6.29
0.681 1.4 2.21
0.683 1.4 2.10

W/m2
direct effects on surface budgets

clear-sky

today’s total

all-sky

today’s solar

today’s anthrop
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

**extinction**
relative to .55um

**RF real**

**SSA**

**RF imag**
MACv2 aerosol climatology

AOD, 550 nm