Aerosols in LMDZ model

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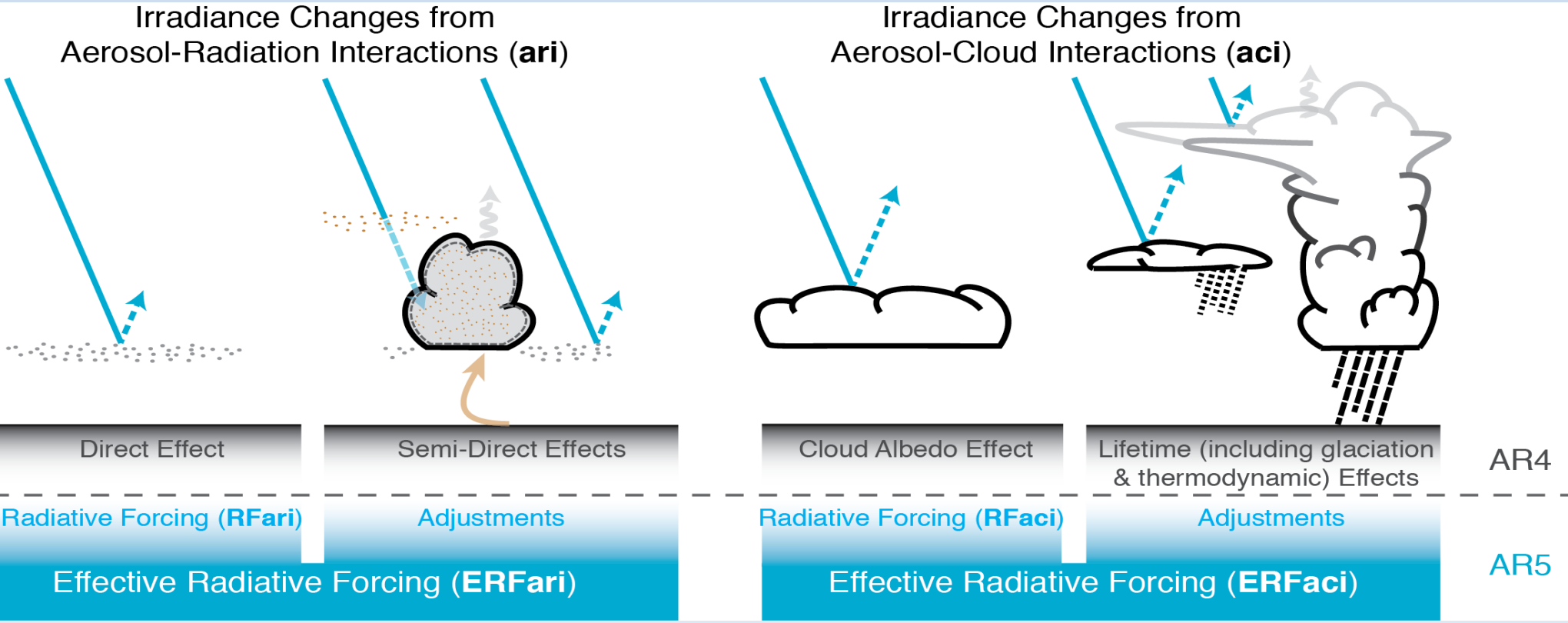
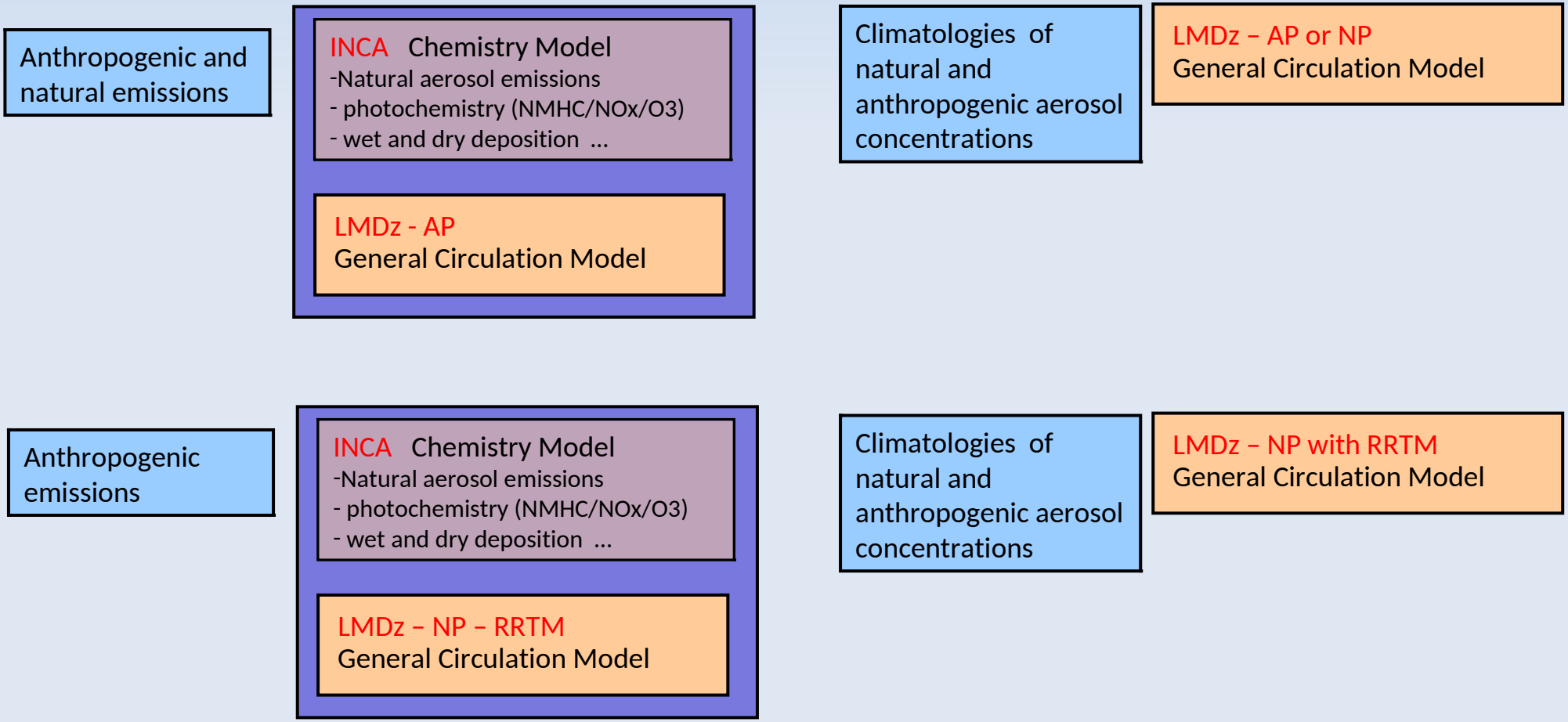
LMDZ training 15-17 December 2014

Categorization of aerosol effects



Boucher et al., AR5, Chapter 7, Clouds and Aerosols

Aerosols: online vs offline



Aerosols: running without INCA

- LMDZ without INCA:
  runtime parameter in config.def
  aerosol_couple = n

- LMDZ with INCA version with interactive aerosols, management of radiative transfer is different to LMDZ without INCA in AP but same in NP + RRTM

Nature of aerosols

Runtime parameter in config.def
flag_aerosol (integer):

- 0: no tropospheric aerosol
- 1: sulfate
- 2: black carbon
- 3: particulate organic matter
- 4: marine salts
- 5: dust
- 6: all tropospheric aerosols

Aerosols: input files

- If flag_aerosol > 0:
  gcm.e reads aerosol data from files
  aerosols.nat.nc
  [+ another file, depending on aer_type]

Aerosols: input files (continued)

- Runtime parameter aer_type (character variable) in config.def:
  - preind: pre-industrial aerosols → **aerosols.nat.nc** only
  - actuel: when you want to use a climatology of anthropogenic aerosols → **aerosols.nat.nc** + **aerosols1980.nc** (fixed name, meaningless)
  - annuel: **aerosols.nat.nc** + **aerosolsYYYY.nc** where YYYY is the current year

Aerosols: input files (continued)

- Input files should contain concentrations of aerosols of all the desired types (according to flag_aerosol)
- Input files should already be horizontally regridded to the LMDZ grid
- For LMDZ5 as used in AR5 runs, the input is for 19 layers and regridded online to the klev layers of the model but providing the input for klev layers is also acceptable

Aerosols: direct and indirect effects

- Runtime parameters ok_ade and ok_aie (logical) in config.def to activate direct and indirect effects of anthropogenic aerosols
- If ok_ade = n then direct effect of natural aerosols only (but no anthropogenic aerosols)
- If ok_aie = n then indirect effect of natural aerosols only (but no anthropogenic aerosols)

Aerosols: direct and indirect effects (continued)

- You can choose ok_ade and ok_aie independently
- flag_aerosol must be ≥ 1 if ok_ade or ok_aie is y
- If ok_ade or ok_aie is y then corresponding diagnostics are output (in particular instantaneous radiative forcing variables: topswad, solswad, topswai and solswai)

Aerosols for expert users

- Runtime parameter new_aod (logical):
  to use the most recent parameterization of aerosol optical depth.
  y is the default value.

  Note: new_aod = n can only be used with flag_aerosol = 1 (sulfate aerosols only).
  Obsolete.

Aerosols for expert users (continued)

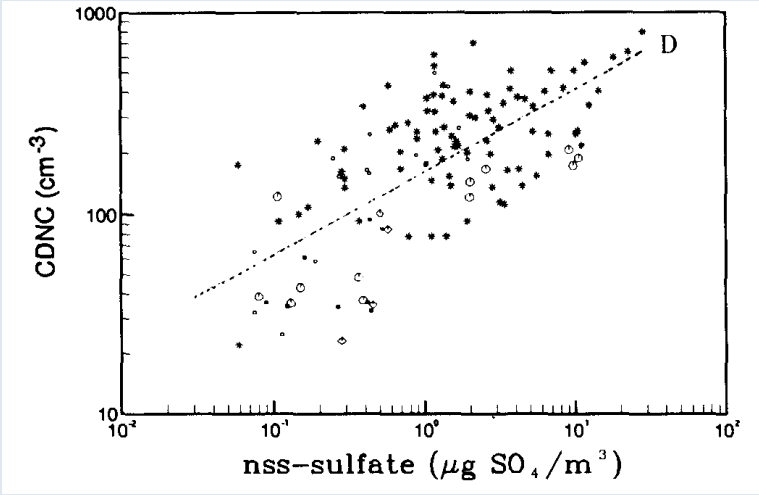
Runtime parameters in config.def in case ok_aie = y

$$CDNC = 10^{\,b0 + b1 \log(m\ SO4)}$$

bl95_b0 = 1.7
bl95_b1 = 0.2
(recommended values)

Link cloud droplet number concentration to aerosol mass concentration (Boucher and Lohmann, Tellus, 1995)

Now uses mass of all soluble species



Aerosols for expert users (continued)

- If you want to compute at each time step the direct or indirect effect that aerosols would have, but not let those effects impact the simulation (eg to get the same meteorology with different RF estimates)
  - Set the variable aerosolfeedback_active to .false. in routine sw_aeroAR4.F90
  - Recompile the program
  - Choose flag_aerosol > 0 and ok_ade = y or ok_aie = y at runtime

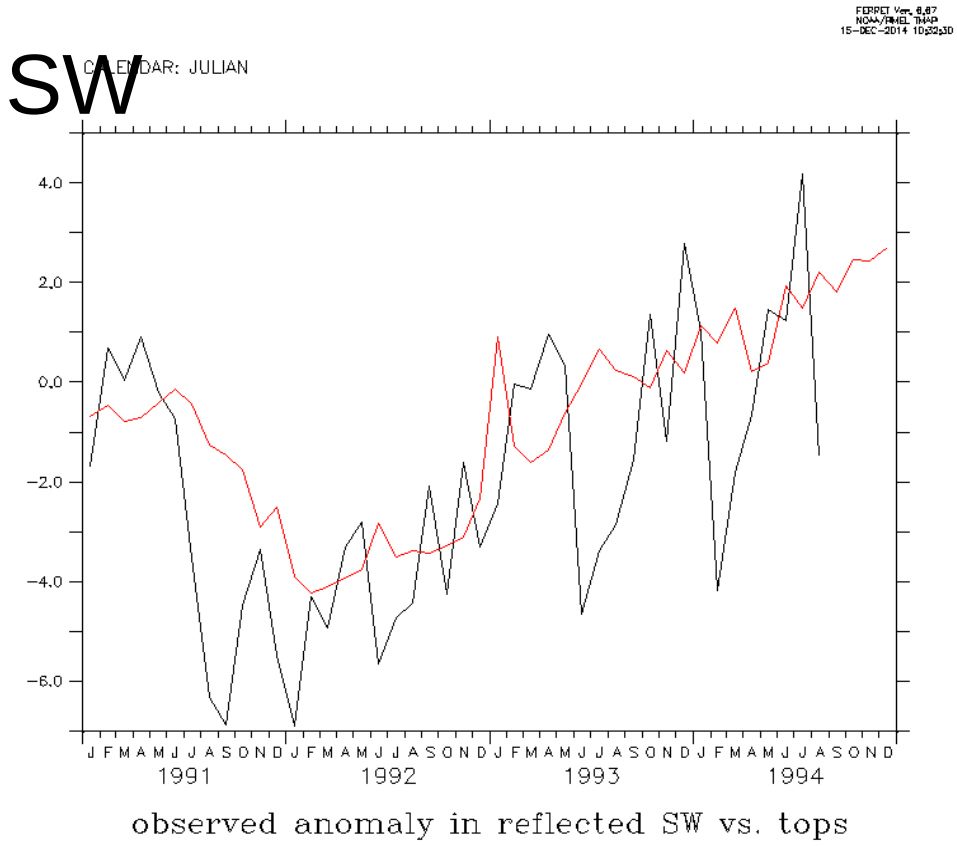
Stratospheric aerosols

- flag_aerosol_strat = y
- gcm.e reads 3D aerosol input data from files with monthly timestep
- Input data are available over period 1750 to 2010
- A routine exists to prepare input files to various model resolutions
- Direct effect in SW (old radiation + RRTM) and in the LW (RRTM only, dependent on aerosol size)

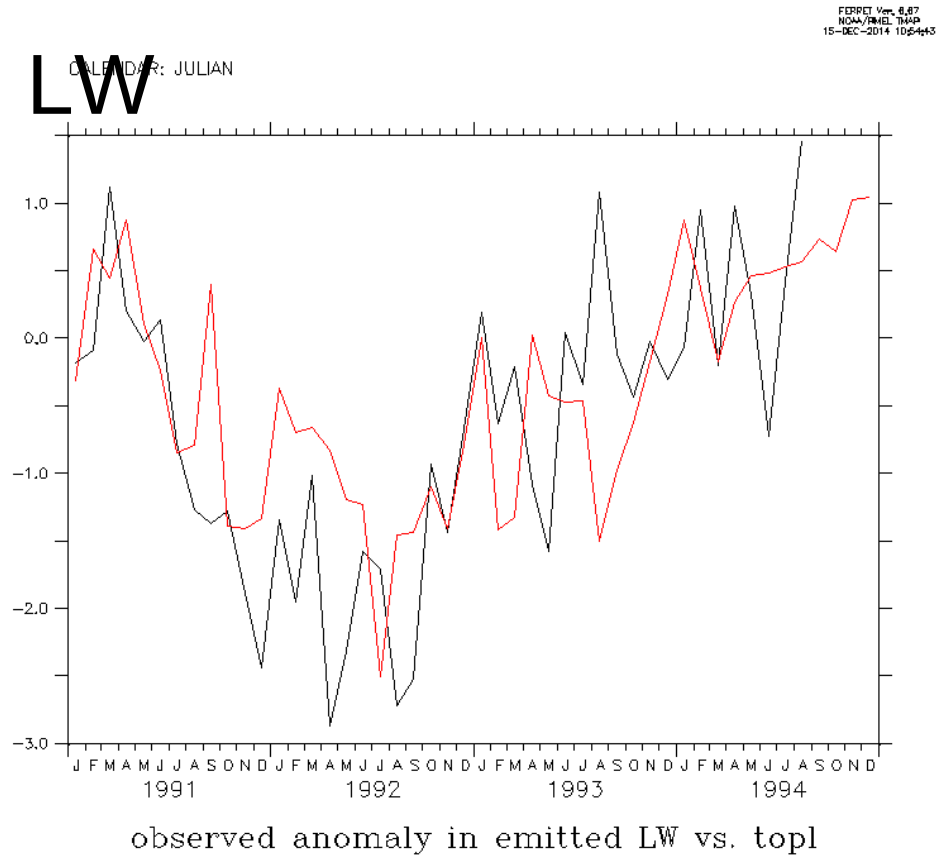
Stratospheric aerosols: Pinatubo

Observations Model

SW



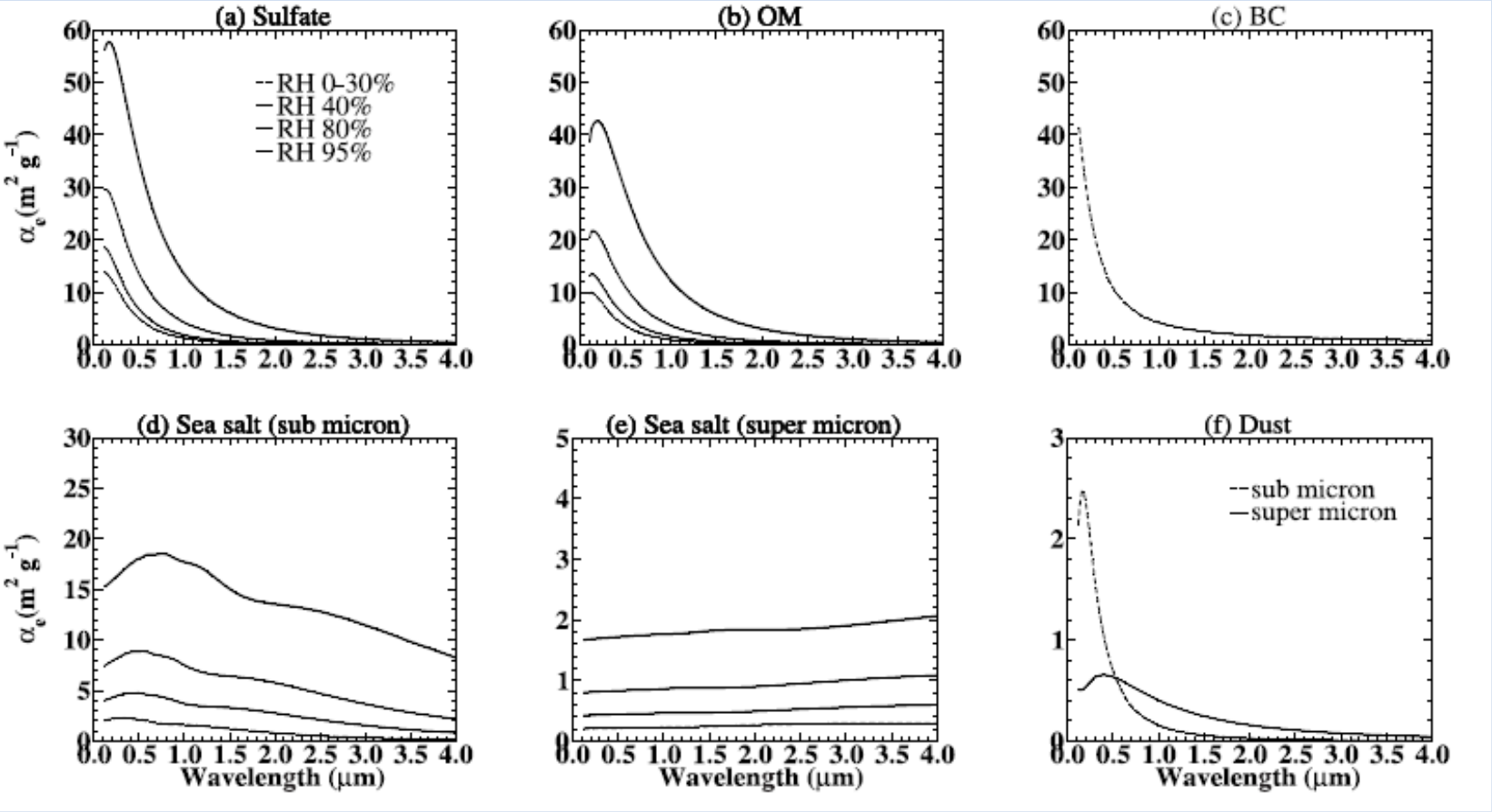
LW



RRTM

- Tropospheric and stratospheric aerosols are available in RRTM, but only for the 6 SW wavebands case (NSW=6)
- Revised optical properties, need to be checked
- Reunified routine for offline (LMDZ) and online (INCA) aerosols

Aerosol optical properties



Example only f(RH,λ)

INCA aerosol in LMDZ-NP

- Reunified aerosol optical properties routine for offline (LMDZ) and online (INCA) aerosols
- Takes into account mixing by BL, thermals and convection (with or without simultaneous scavenging)
- Requires interactive natural sources of aerosols