Indirect effect of aerosols

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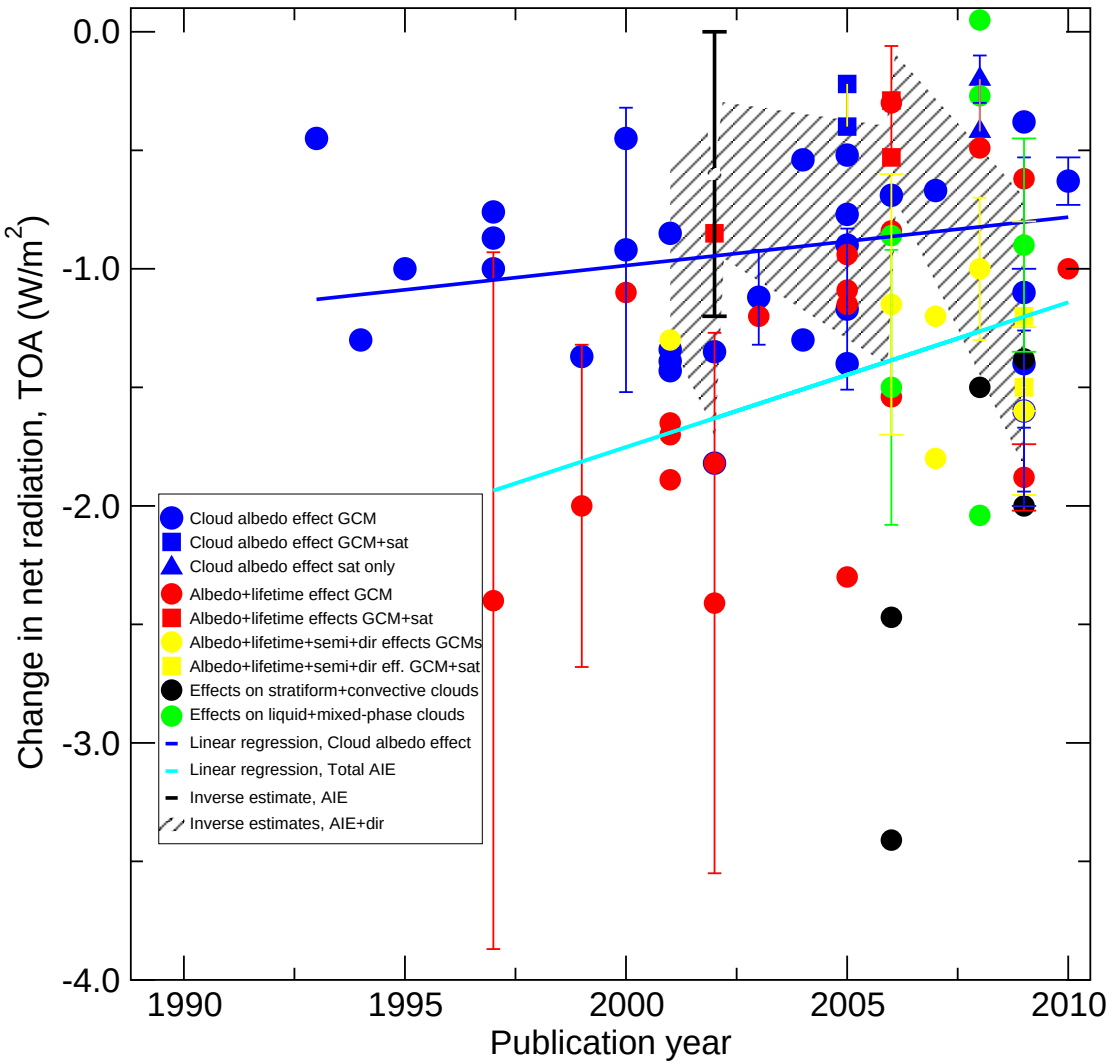
Acknowledgements:
S. Ferrachat and
T. Storelvmo

Published estimates of the aerosol indirect effect

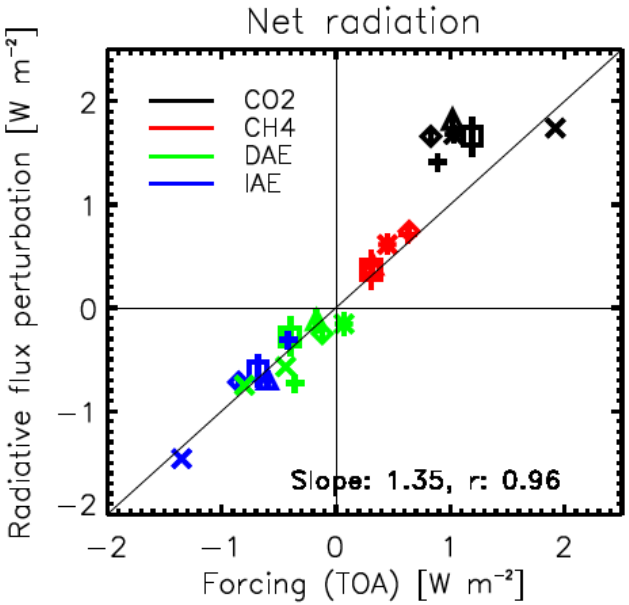
Anthropogenic changes in net radiation at the TOA

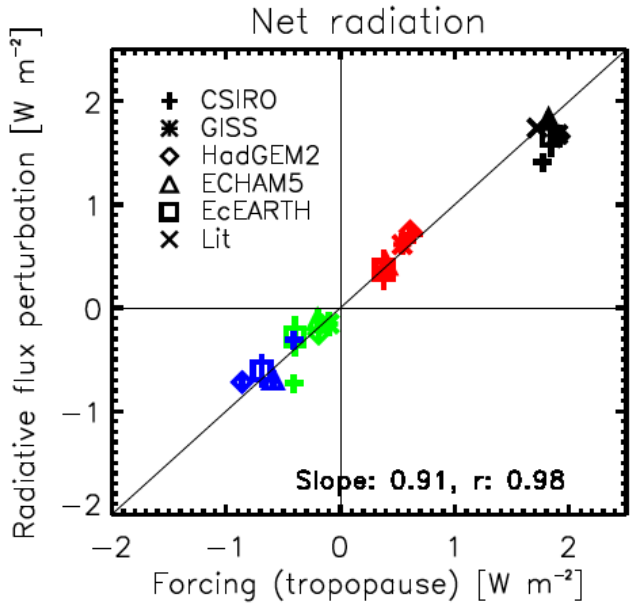


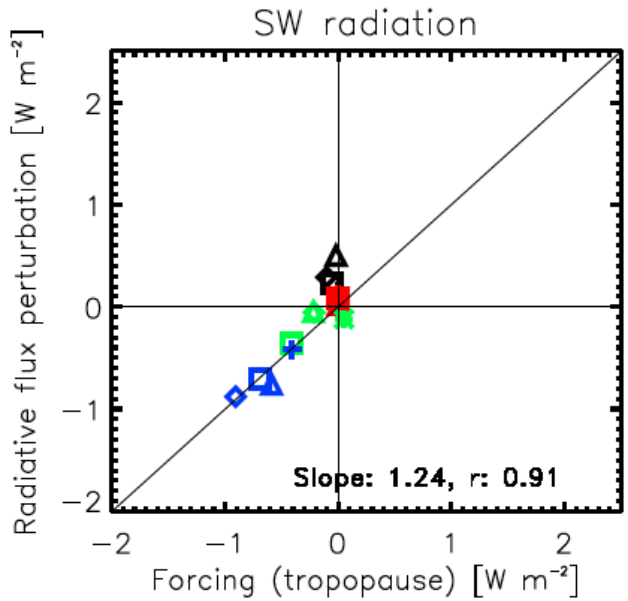
Cloud albedo effect: -0.9 W m^{-2}; (Updated from Lohmann et al., ACP, 2010)

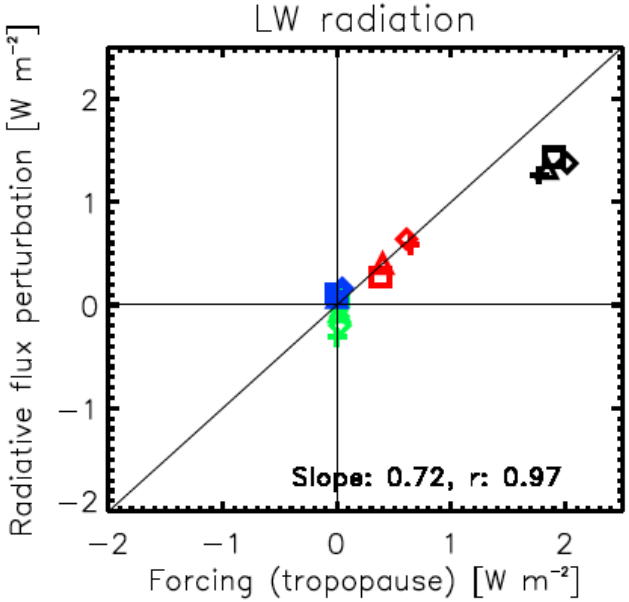
Indirect aerosol effect: Forcing or flux perturbation?

- Forcing: call the radiation code twice keeping the meteorology fixed:
  - once with pre-industrial GHG, aerosol or cloud droplet number concentration
  - once with present-day GHG, aerosol or cloud droplet number concentration
- Radiative flux perturbation (RFP): two multi-year simulations with different aerosol emissions:
  - once with pre-industrial aerosol emissions or GHG concentrations (year 1750)
  - once with present-day aerosol emissions or GHG concentrations (year 2000)
- RFP simulations include fast feedbacks because of the interaction of aerosols with clouds and radiation



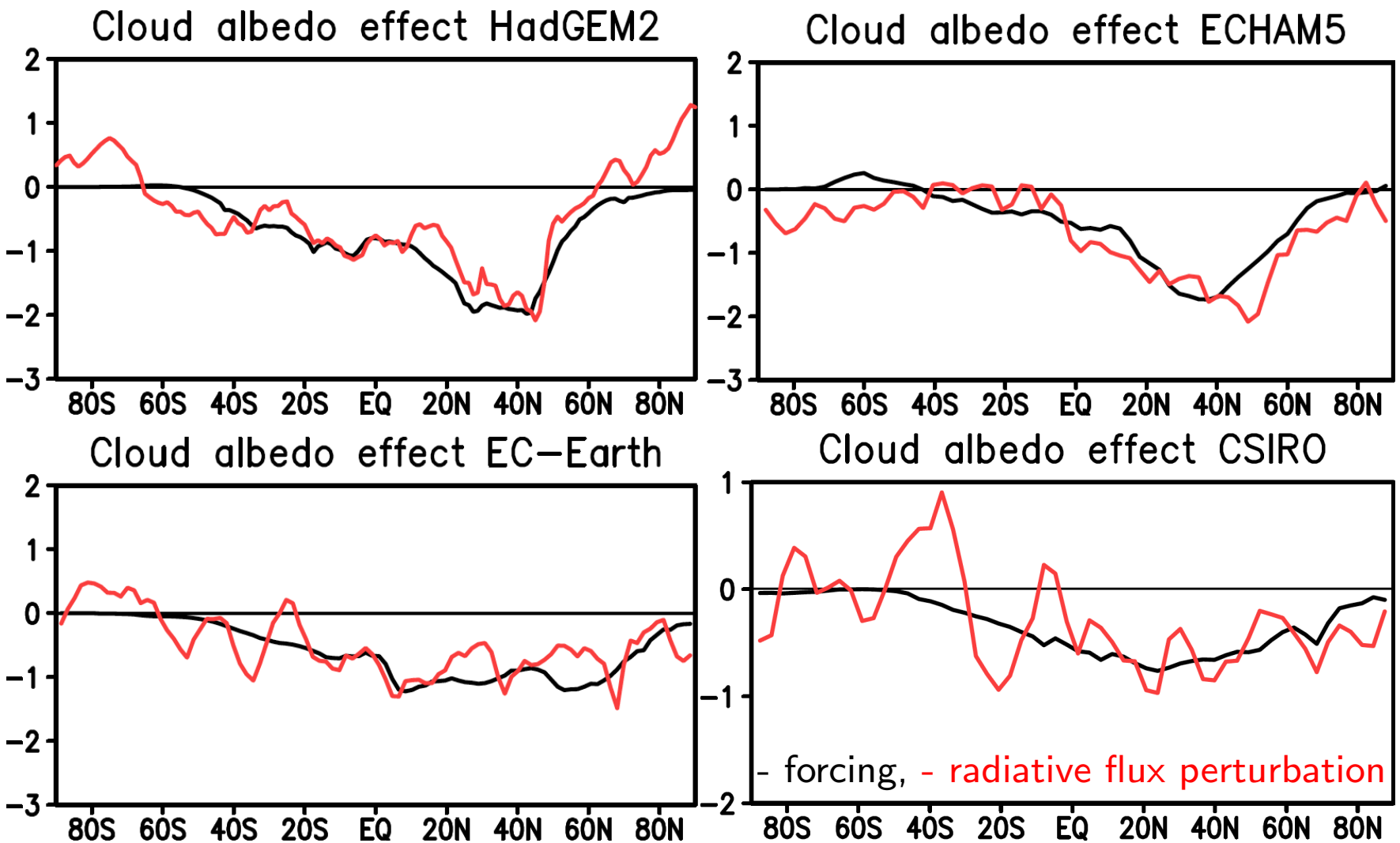






Lohmann et al., ACP, 2010

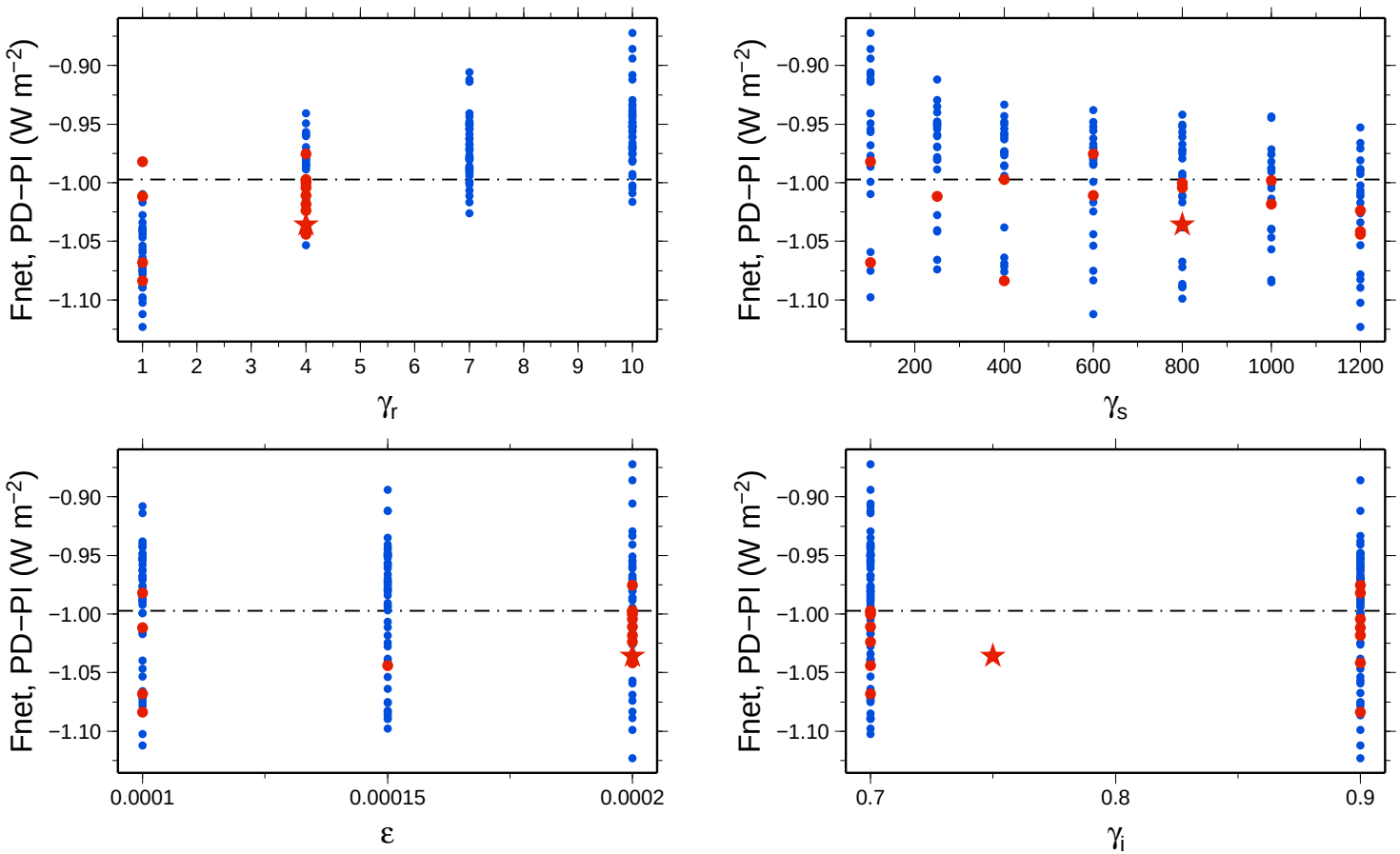
Indirect aerosol effect: Forcing or flux perturbation?



Goal and model description

- Motivation: Study the impact of tuning on the anthropogenic aerosol effect
- Parameters that were varied:
  - γ_r: controls rate of rain formation (1, 4, 7, 10): 4 values
  - γ_s: controls rate of snow formation (100-1200): 7 values
  - γ_i: inhomogeneity factor of ice clouds (0.7, 0.9): 2 values
  - ϵ: controls entrainment into deep convective clouds (10^{-4}, 1.5 x 10^{-4}, 2 x 10^{-4}): 3 values
- Total: 169 simulations with ECHAM5-HAM at T42L19
- Nudged simulations to ECMWF reanalysis for the year 2000 both for PD and pre-industrial (PI)

Impact on the anthropogenic aerosol effect

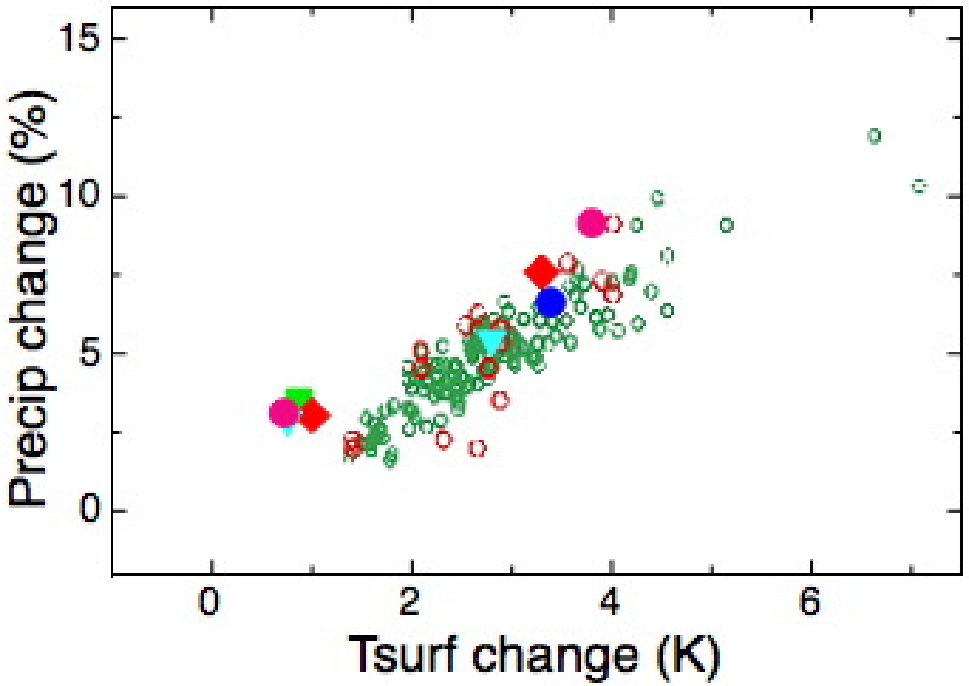


Lohmann and Ferrachat, ACPD, 2010

Planned work in EUCLIPSE

- Continue SCM evaluation at Cabauw test bed (with Roel Neggers)
- Investigate cloud feedback with 1-moment vs. 2-moment cloud schemes with and without aerosol-cloud interactions (started with Sandrine Bony, to be revisited)
- Run 2-moment schemes with present-day, pre-industrial and future aerosol concentrations/emissions
- Goal in EUCLIPSE: Evaluate whether narrowing the range in feedbacks of cloud processes narrows the spread in associated aerosol-cloud effects
- Task 4.2.2: Evaluate cloud-aerosol interactions, using different representations, across a subset of EUCLIPSE models (lead ETHZ, contributions MPG, KNMI).

Precip. change vs. temp. (prelim. results)



- ECHAM5-IPCC AR4 (2xCO2)
- ECHAM4 (PI)
- ECHAM5-HAM, version as in Lohmann et al, ERL 2008, (strat), PI and 2xCO2
- ECHAM5.5.00-rc2 (strat), PI and 2xCO2 (this work)
- ECHAM5.5.00-rc2 (conv), PI and 2xCO2 (this work)

Conclusions

- The total anthropogenic aerosol effect (AE) remains uncertain
- Estimates of the tropopause forcing vs. the radiative flux perturbation (RFP) method at the top-of-the-atmosphere yield comparable results for the considered forcing agents, CO_2, CH_4, the direct aerosol effect and the cloud albedo effect
- The zonal and annual mean pattern of the RFP estimates are just a noisy version of the forcing distributions
- The averaged AE amounts to -1 W m^{-2} $\pm$ 12.5% for all experiments and to -1.02 W m^{-2} $\pm$5.5% in the balanced experiments
- Preliminary results show a larger change in precip. vs. temp. for 2 $\times$ CO_2 when microphysics are included also in convective clouds than in the 1-moment and 2-moment scheme