Indirect effect intercomparison

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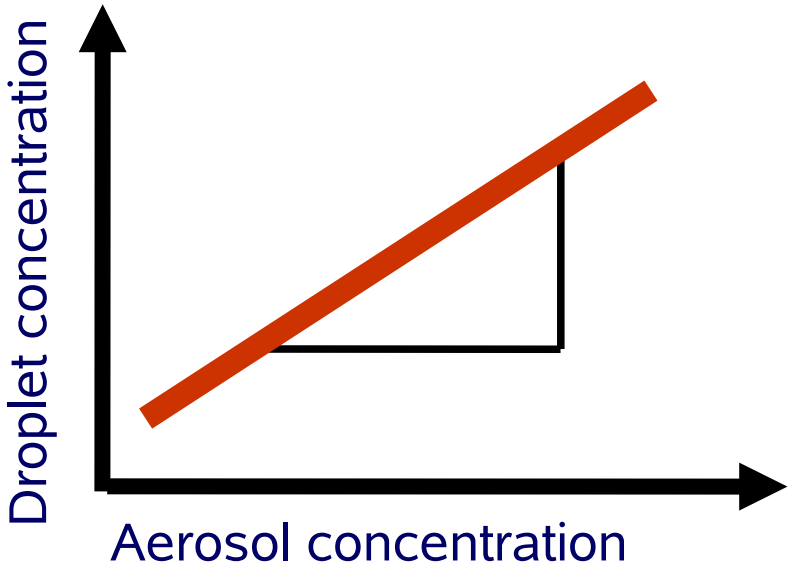
2) **First indirect effect**: Cloud droplet number concentration
3) **Second indirect effect**: Liquid water path and autoconversion
4) **Scaled forcing estimate**

Aerosol-cloud interactions



Slopes of the statistical relationship

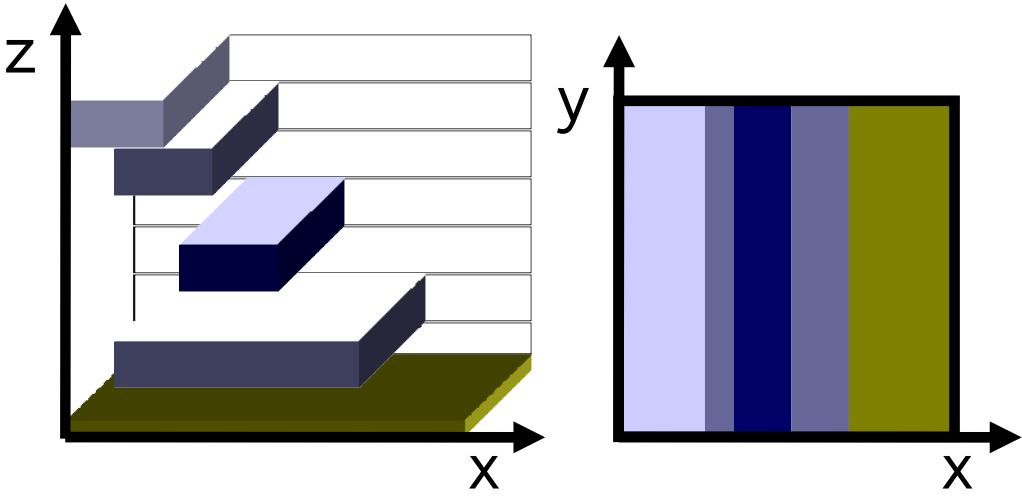
$$\text{Slope} = \frac{\Delta \ln \Phi}{\Delta \ln \tau_a}$$

with τ_a aerosol optical depth (AOD) and Φ being a cloud or radiation parameter shown.

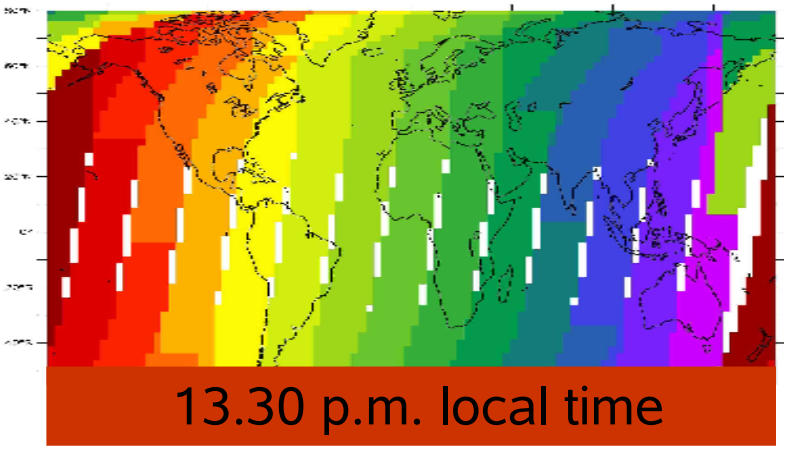
The slopes are computed as a linear regression ln Φ vs. ln τ_a for individual regions/seasons

Simple “MODIS Simulator”

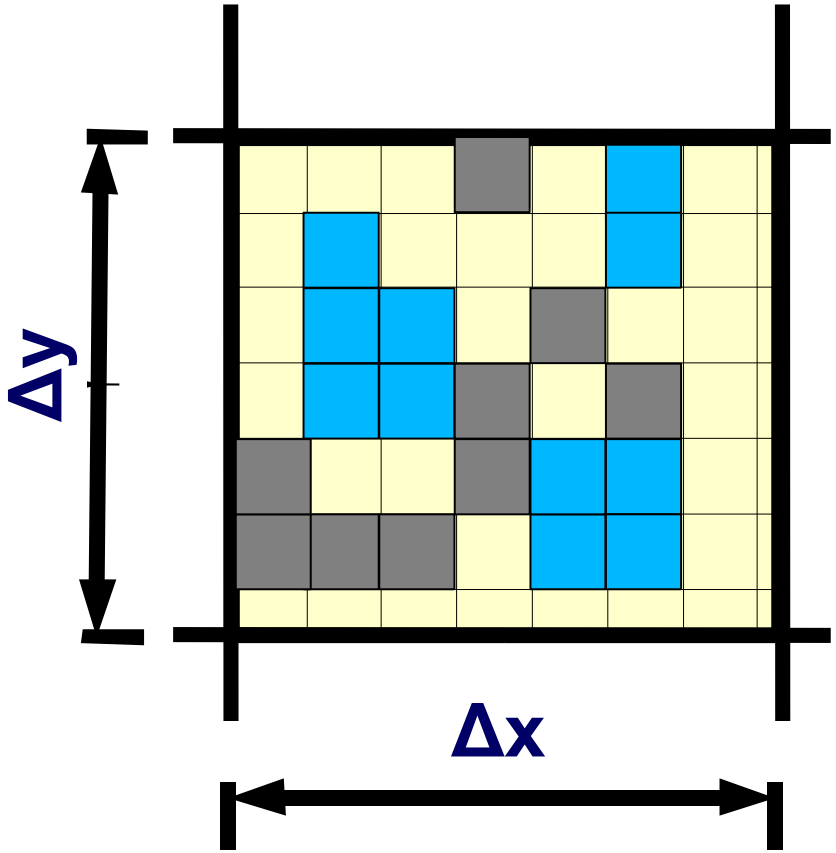
- 2D cloud top quantities from 3D cloud field using overlap assumption



- Sampling of daily fields at satellite overpass time
- Visible clouds only ($\tau_c > 0.3$)



Aerosol-cloud relationship in satellite data



Aerosol measurements

Cloud measurements

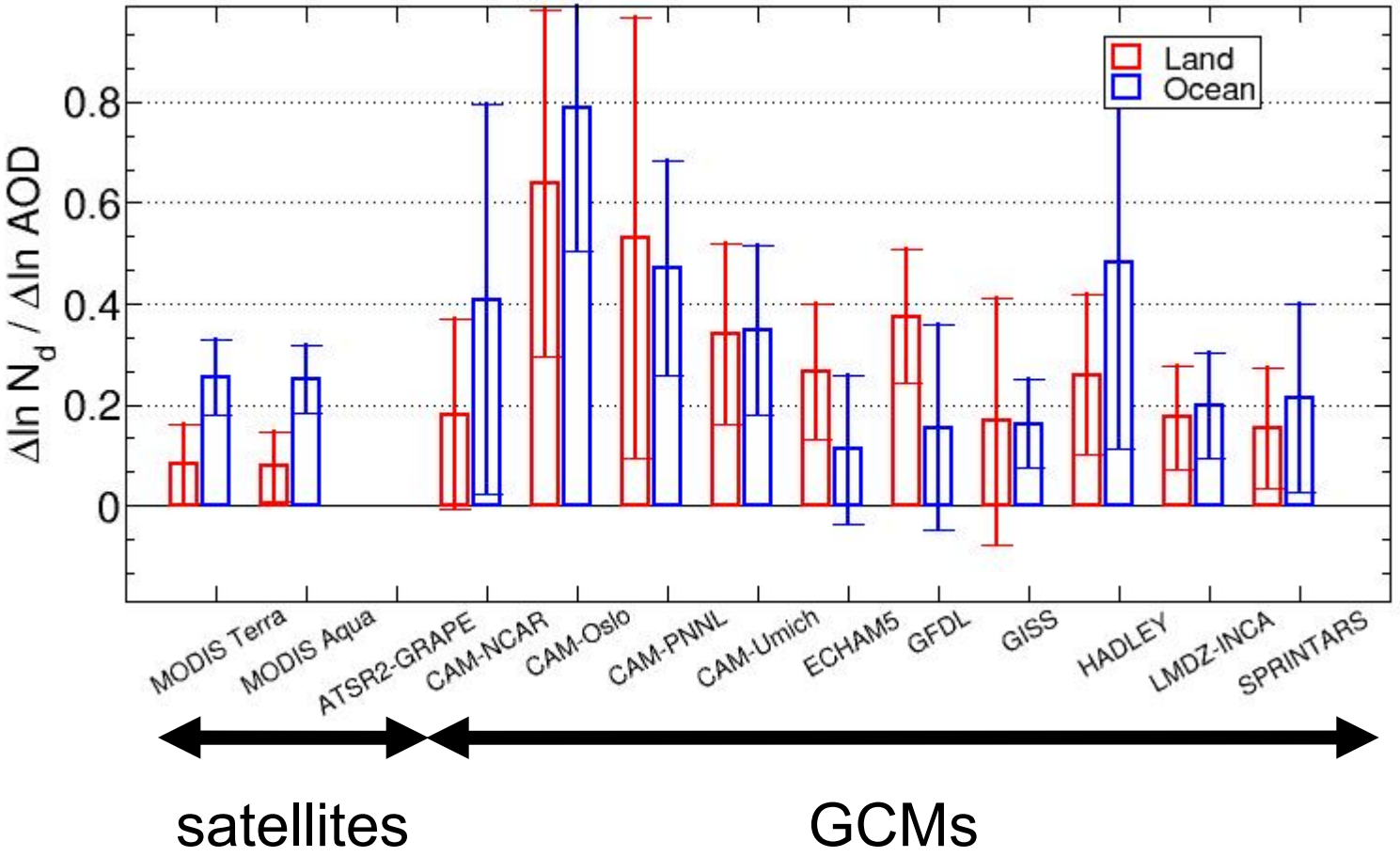
No retrieval

Method adopted:
relate aerosol and cloud quantities within a model gridbox (daily values)

Δx / Δy : model resolution
here: 2.5° x 2.5°

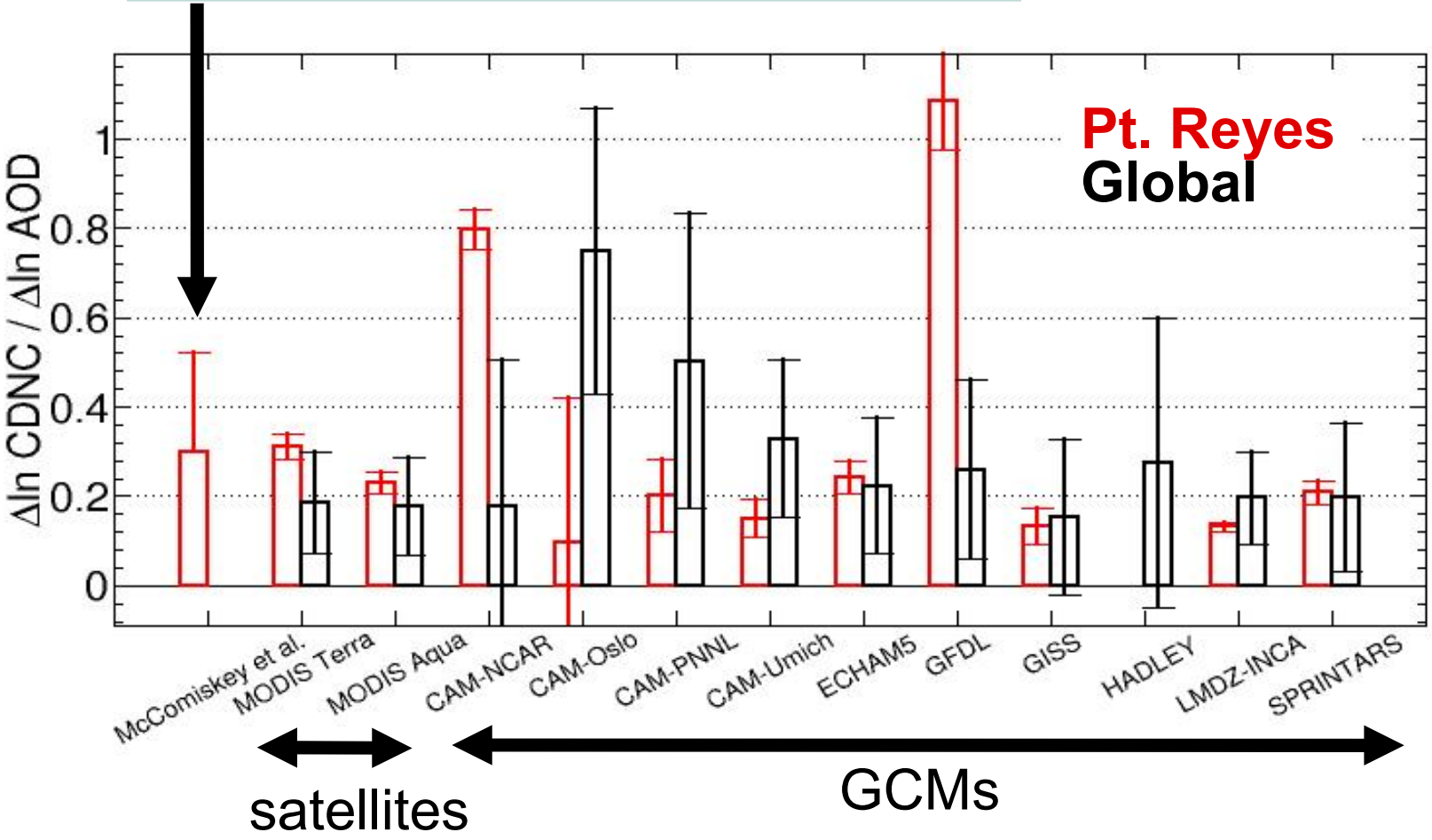
Aerosol-cloud-radiation interactions

Cloud droplet number concentration (N_d) vs. Aerosol optical depth (AOD)



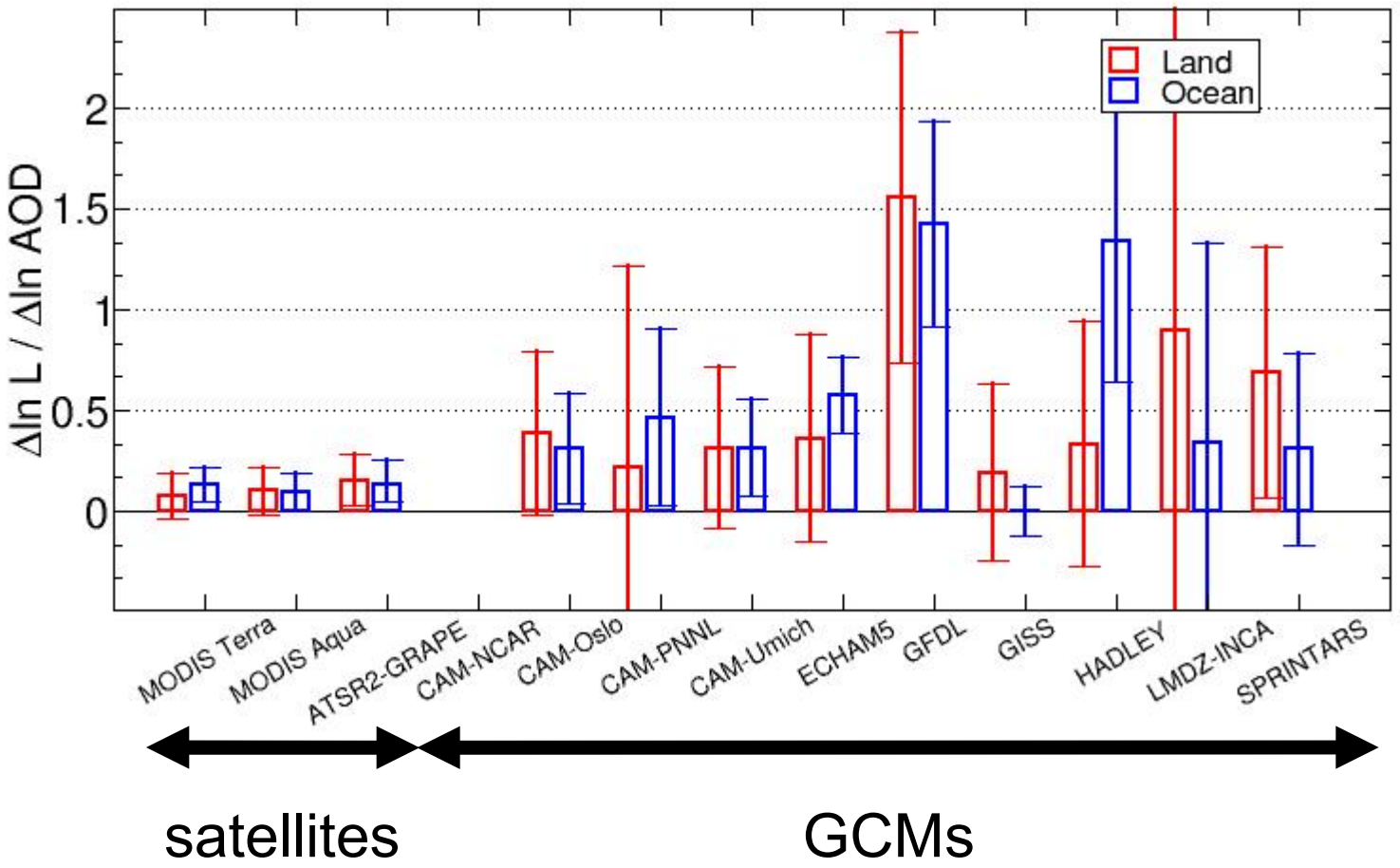
Aerosol-cloud-radiation interactions

- one season (JJA) of ground-based data
- coastal site in California (stratocumulus)



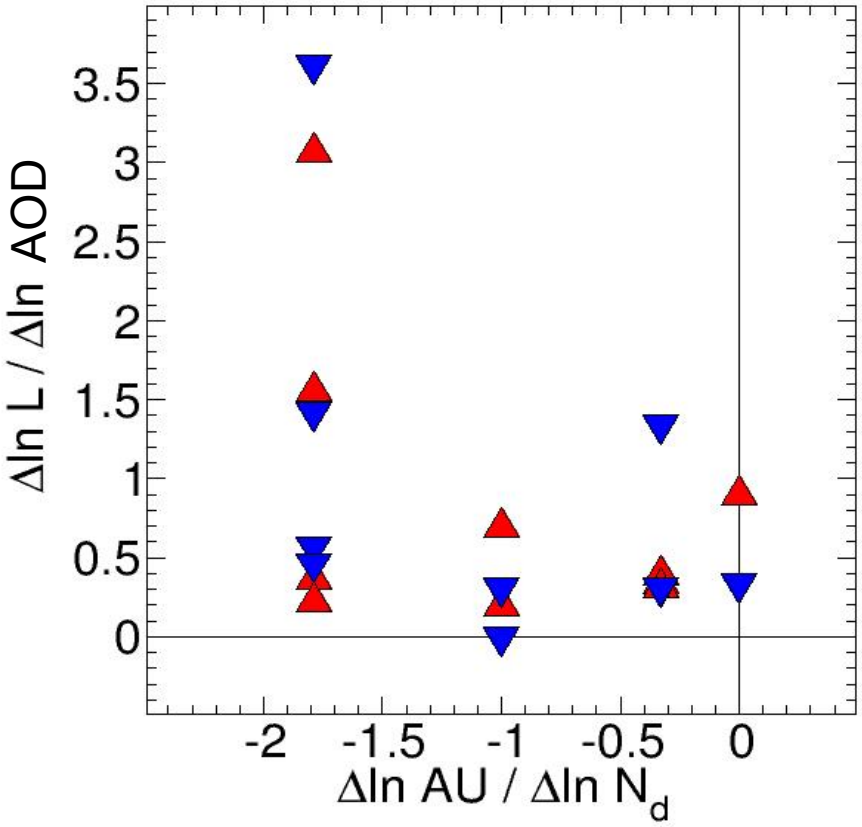
Aerosol-cloud-radiation interactions

Liquid water path (L) vs. AOD



Aerosol-cloud-radiation interactions

Second aerosol indirect effect implemented overly simplistic in GCMs



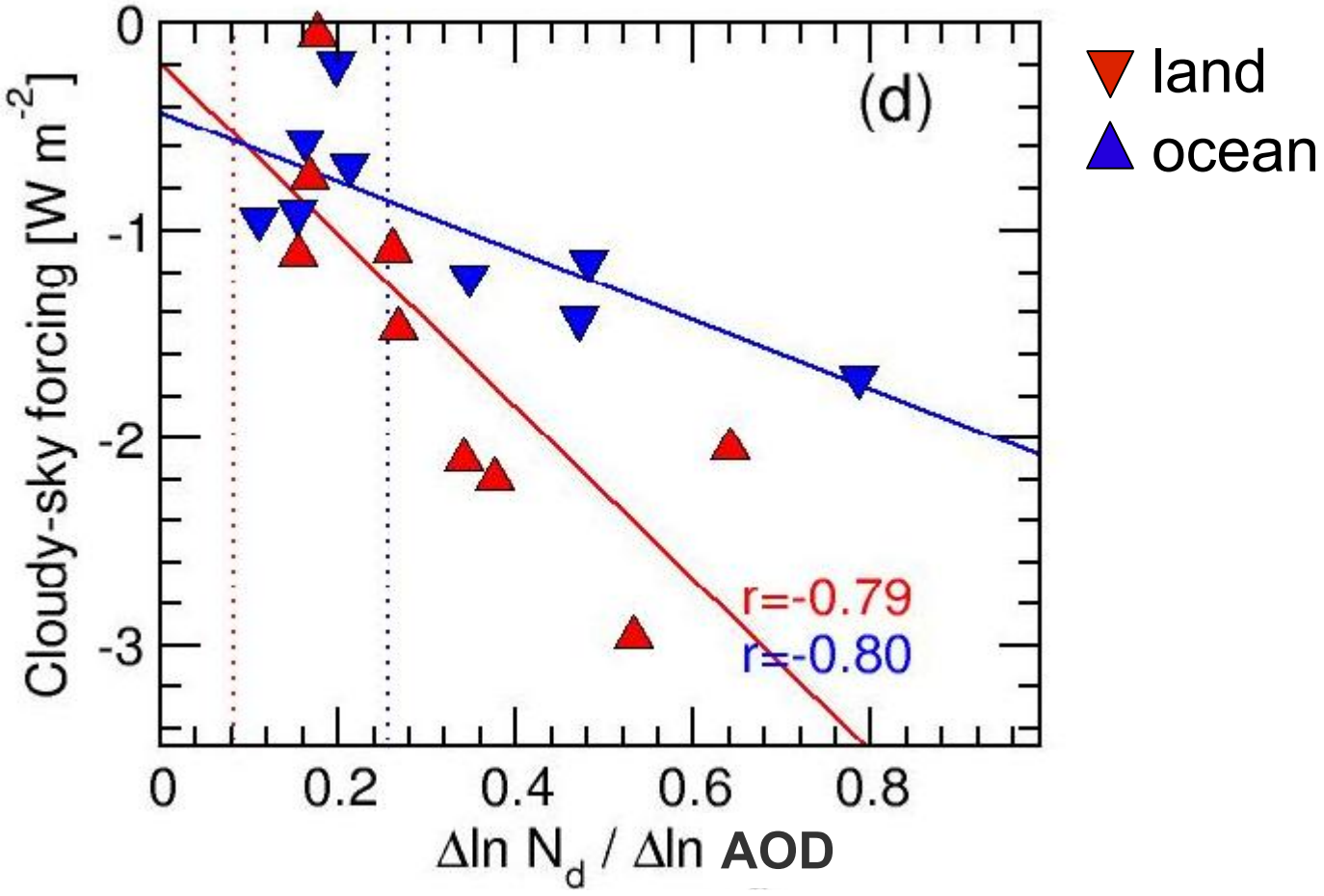
Precipitation by autoconversion (AU) depends on cloud droplet number concentration N_d

$$AU \sim N_d^{\,x}$$

$x \in \{-1.79, -1.0, -0.33, 0\}$

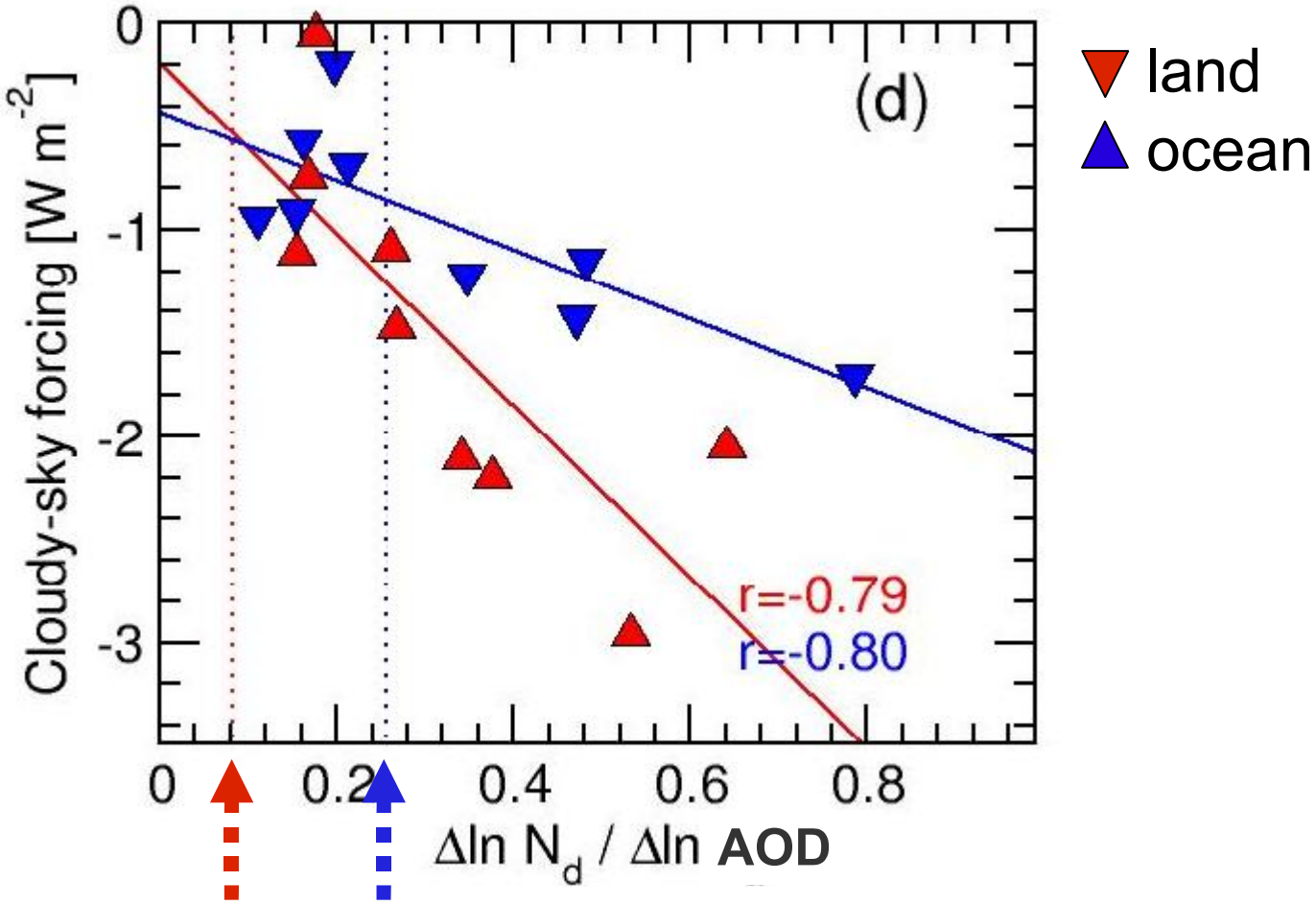
Aerosol-cloud-radiation interactions

Constraint on aerosol indirect forcing



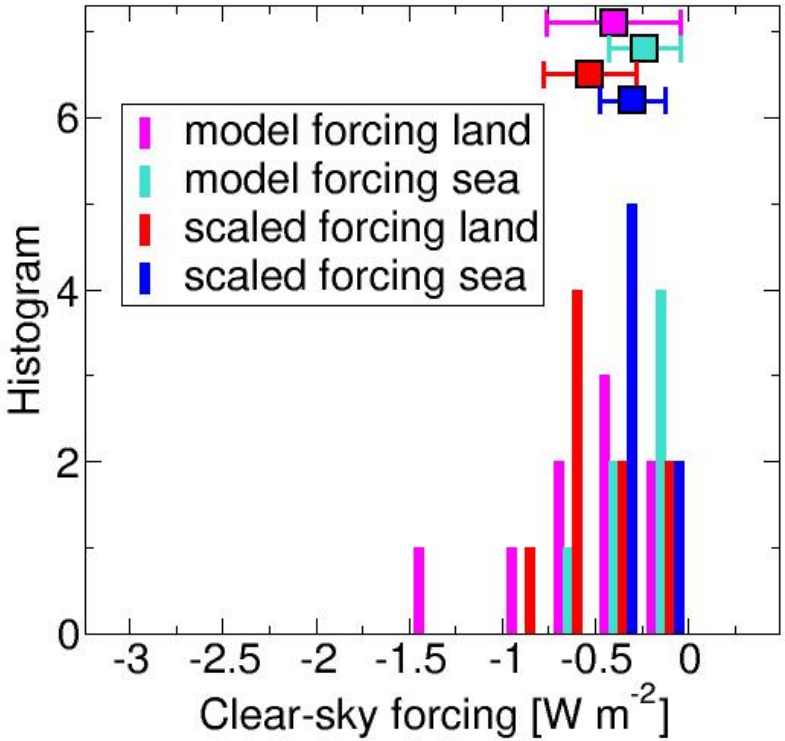
Aerosol-cloud-radiation interactions

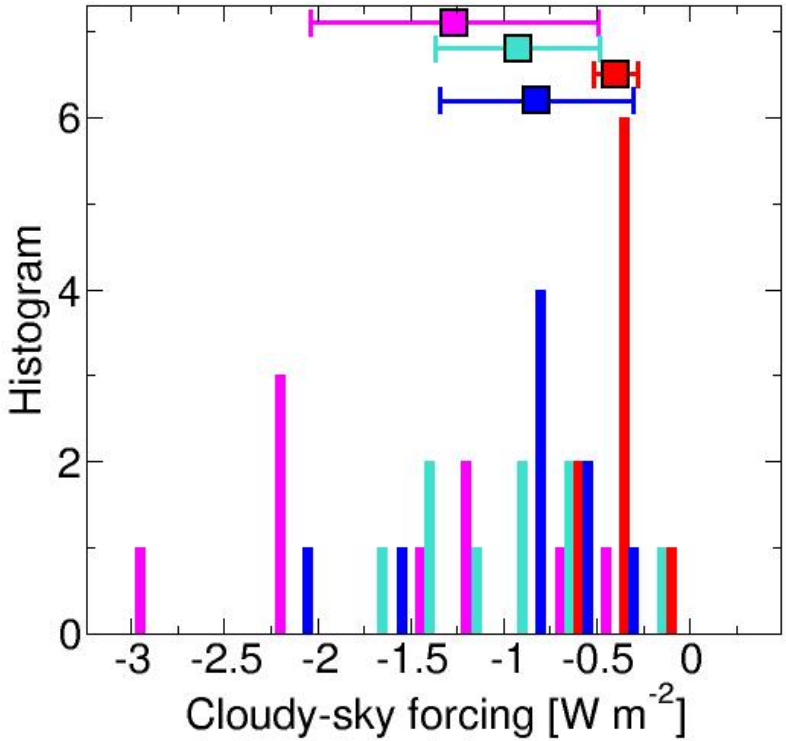
Constraint on aerosol indirect forcing



Satellite estimates over land and ocean

Constraint on aerosol forcing





estimate	modelled	scaled
clear	**-0.27±0.23**	**-0.38±0.19**
cloudy	**-1.13±0.51**	**-0.70±0.37**
total	**-1.53±0.60**	**-1.15±0.43**

Conclusions

1. Evaluation of **aerosol-cloud interactions**

a) **Droplet number concentration parameterization relatively well over ocean, overestimated over land**

b) **Second indirect effect in terms of autoconversion yields a too strong liquid water path – AOD relationship**

Conclusions

1. Evaluation of **aerosol-cloud interactions**

- **a)** **Droplet number concentration parameterization relatively well over ocean, overestimated over land**
- **b)** **Second indirect effect in terms of autoconversion yields a too strong liquid water path – AOD relationship**

2. Scaled **forcing estimate**

- **a)** **Clear sky (direct effect): -0.4±0.2 Wm^{-2}**
- **b)** **Cloudy sky (indirect effect): -0.7±0.4 Wm^{-2}**

Outlook

Available for all of us on AEROCOM server (*)

- all data (both satellite and models)
- scripts for regressions and plotting

Ideas:

- Evaluate cloud parameters
- Indirect effects by cloud regimes

* **Server**: idefix2.saclay.cea.fr
Directory: /home/aerocom1/IND2_ANALYSIS_QUAAS09
(see **Readme-file** there for more info)

AEROCOM project

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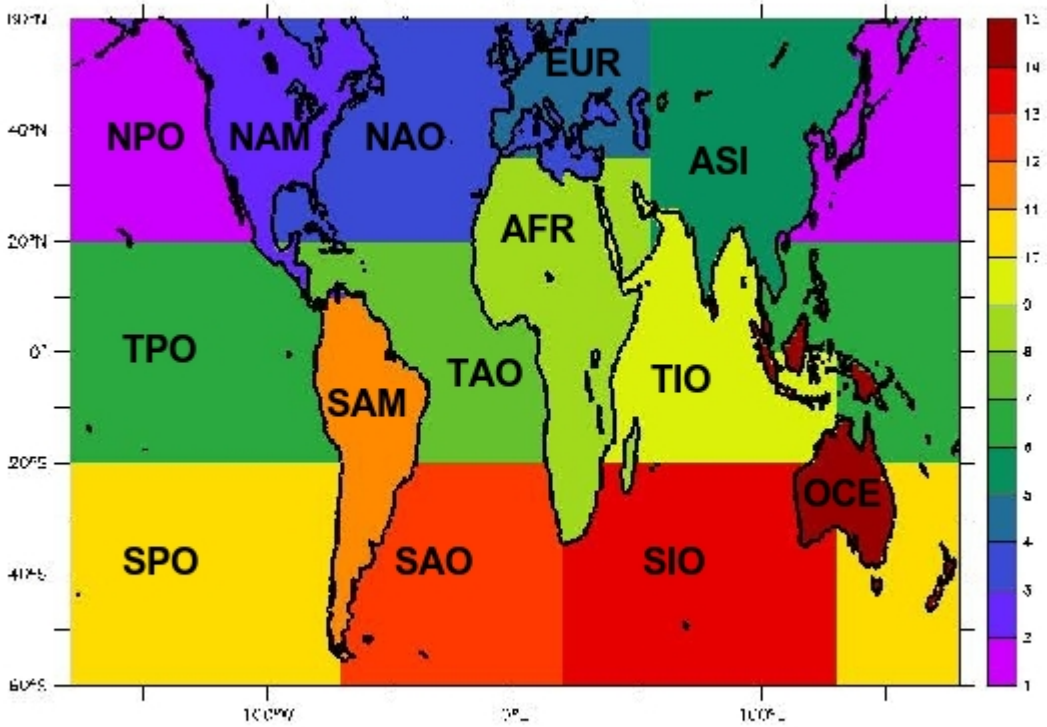

Analyse separately

- 14 different regions
- 4 seasons (MAM,JJA,SON,DJF)