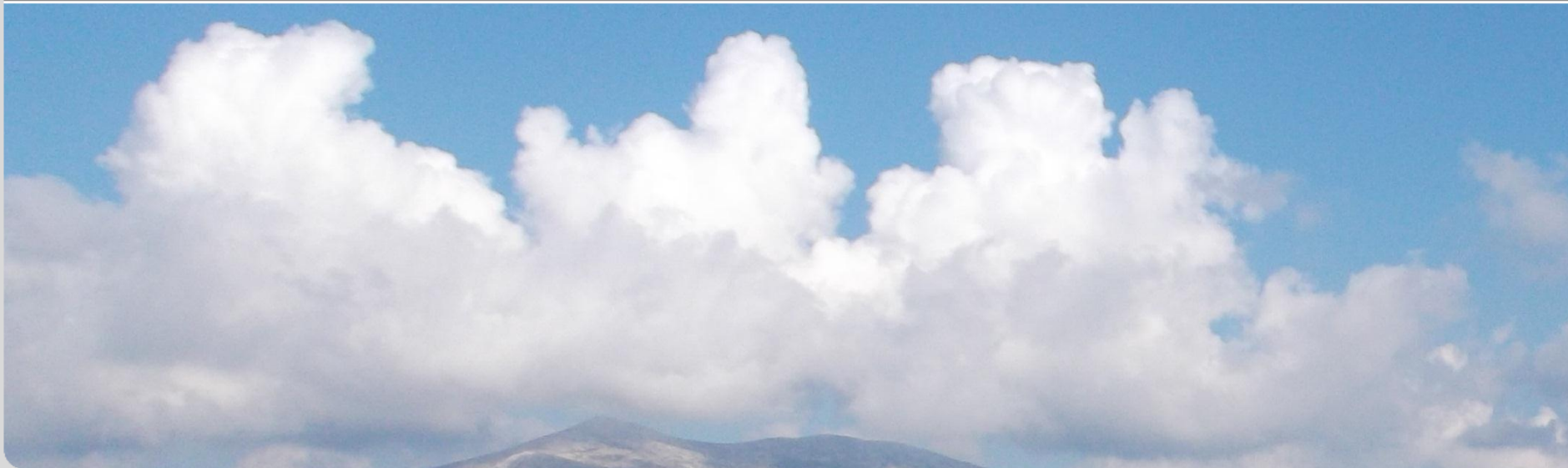


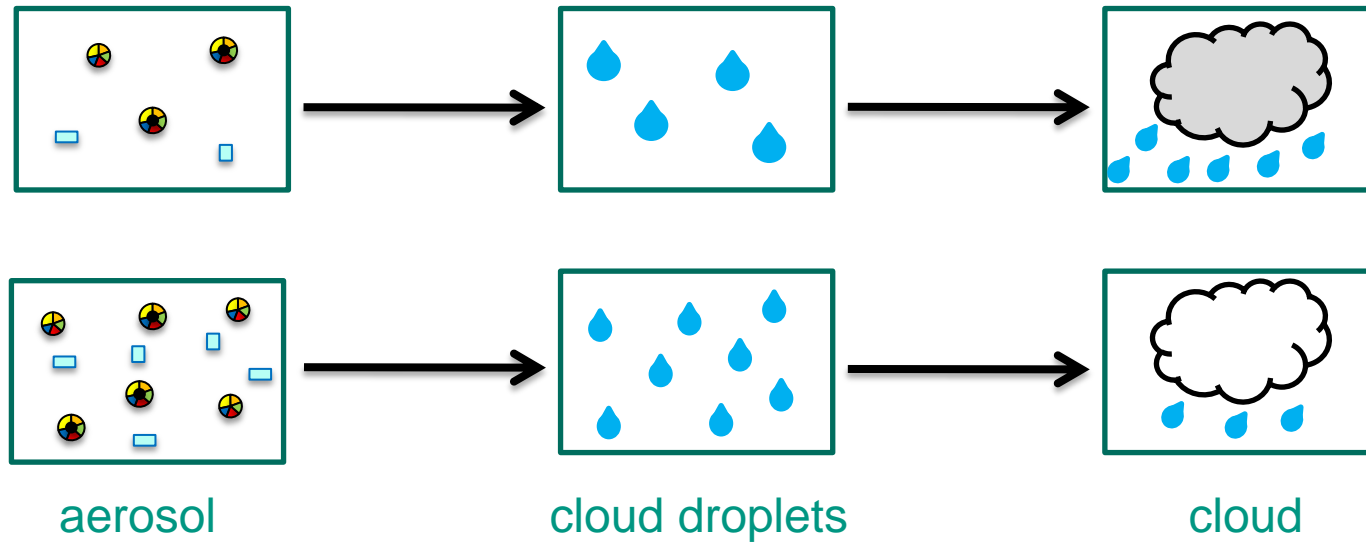
# Impact of natural and anthropogenic aerosol on postfrontal convective clouds

Daniel Rieger, Max Bangert, Heike Vogel and Bernhard Vogel

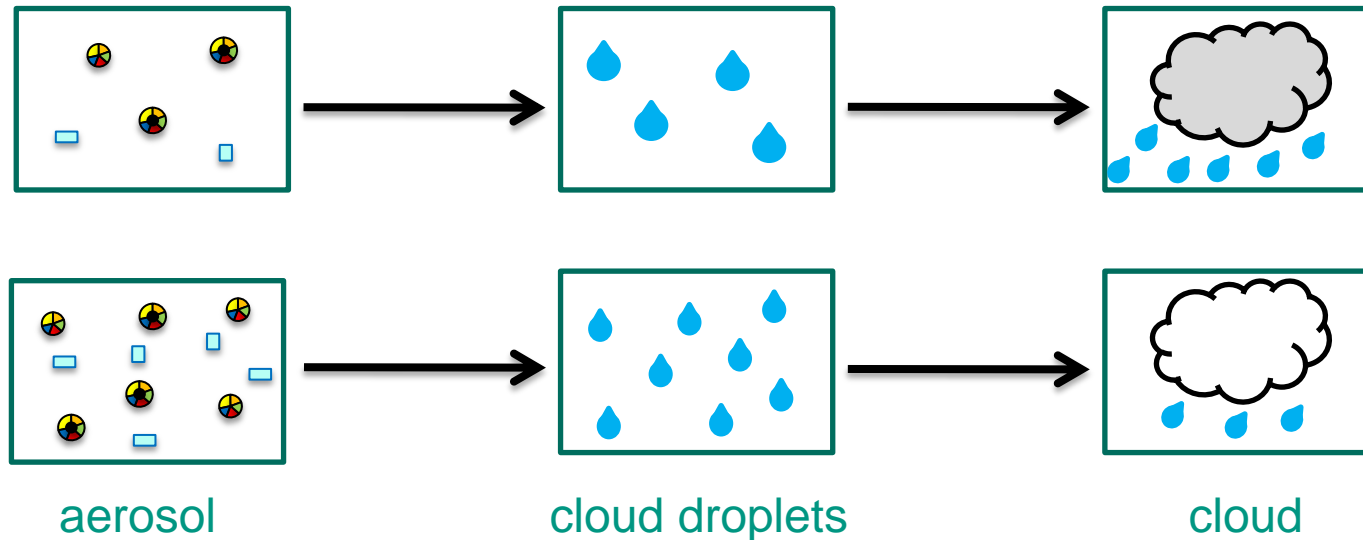
Institute for Meteorology and Climate Research



# Aerosol effects: Hypotheses



# Aerosol effects: Hypotheses

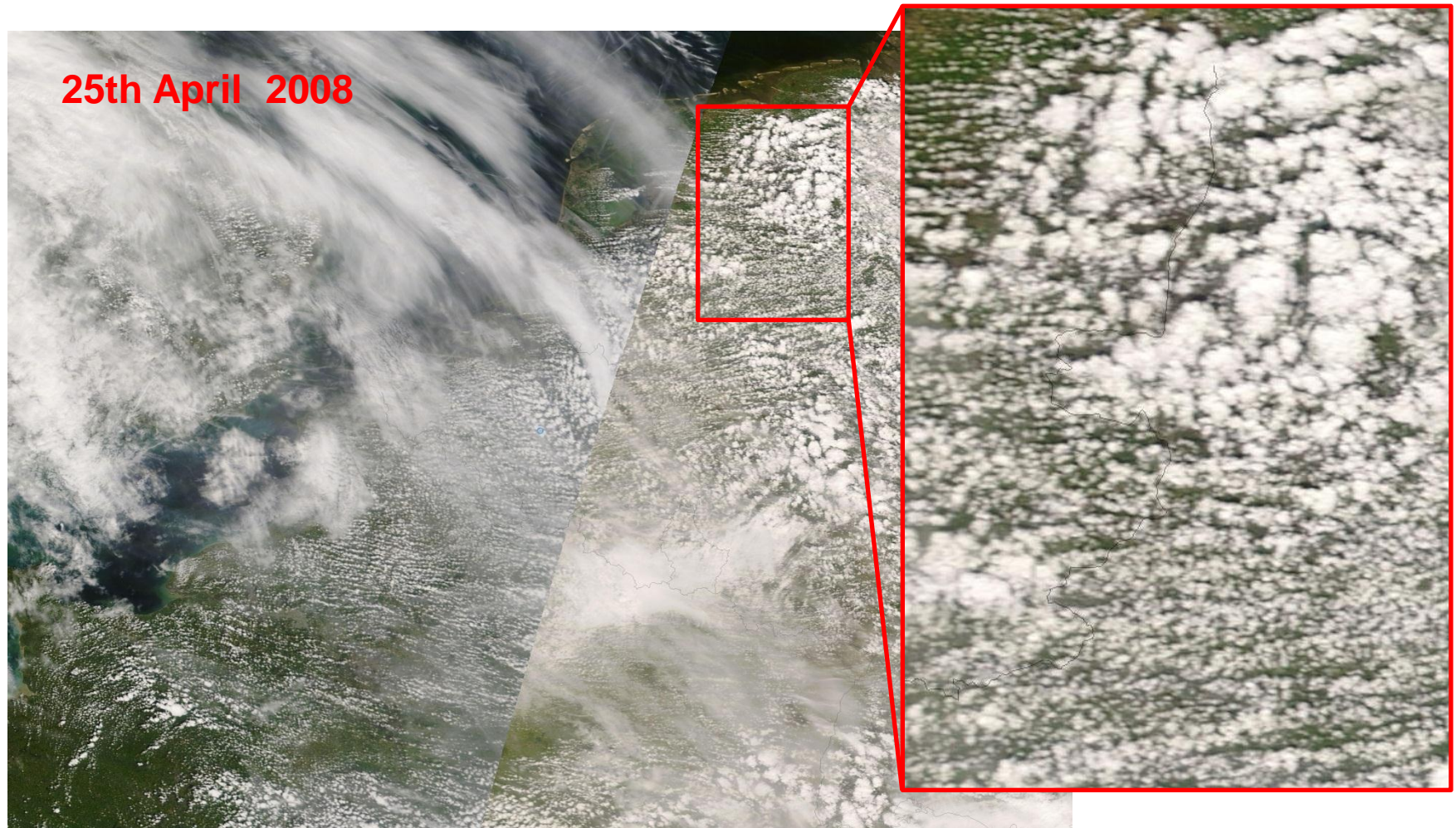


- The hypotheses count for warm-phase clouds, but most precipitating clouds in the mid-latitudes are mixed-phase

# Aerosol effects: State of the art

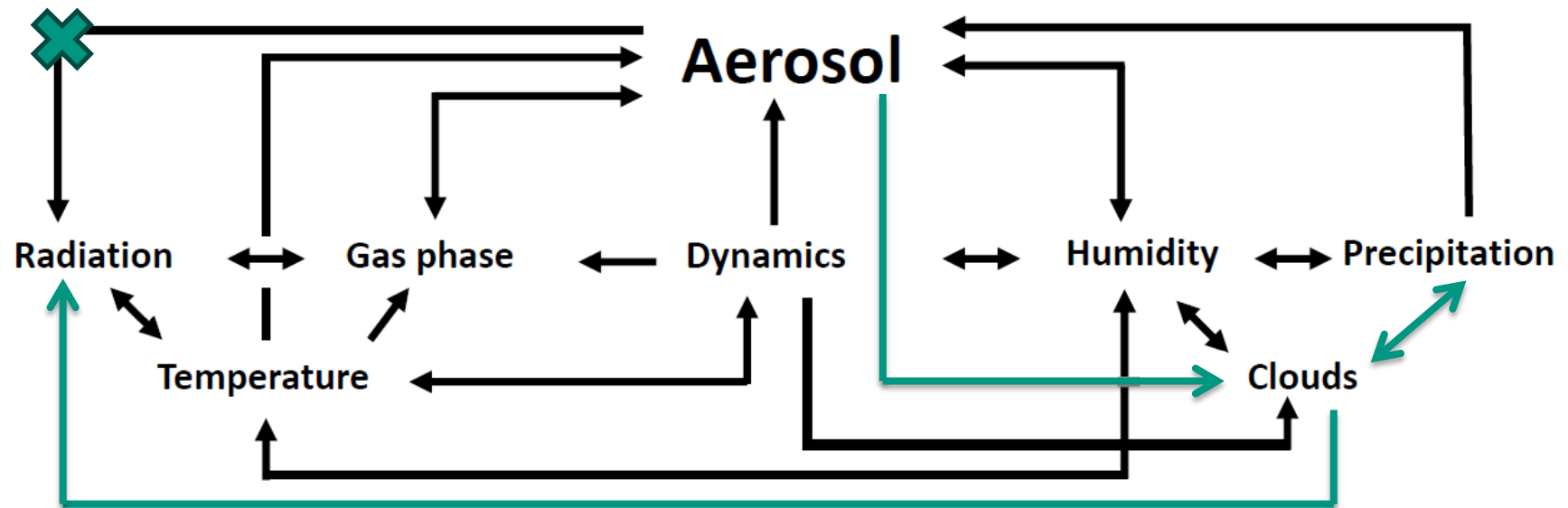
- “Averaged - over space and time - precipitation difference due to aerosol is found to be small”  
Seifert et al., 2012
- “Aerosol effects are buffered and compensated by other effects”  
Stevens et al., 2009
- “Model studies have to be applied to certain cloud types”  
Stevens et al., 2009
- “A full aerosol-chemistry-cloud model is necessary”  
Seifert et al., 2012

# Postfrontal convection – sensitive to aerosol?



Aeronet (TERRA): <http://earthdata.nasa.gov/data/nrt-data/rapid-response/>




# Model framework COSMO-ART



Bangert et al., 2012

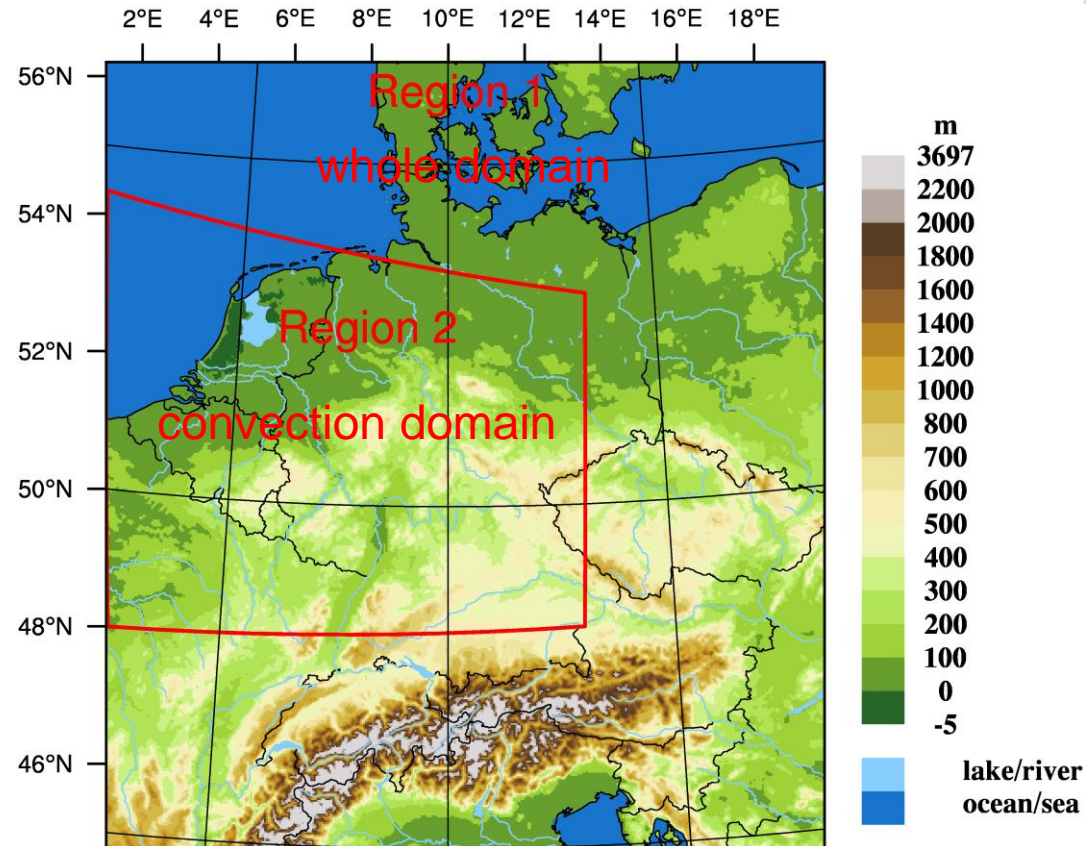
- Two-moment-cloud microphysics scheme  
Seifert and Beheng, 2006
- Activated particles are calculated from the Koehler-Theory  
Bangert et al., 2012

# Objective

- Quantifying the influence of aerosol on precipitation from postfrontal convective clouds
  - Model runs with predefined aerosol burdens: (Segal et al., 2009)
    - **Extreme maritime** (100 particles  $\text{cm}^{-3}$ ) 
    - **Continental** (1700 particles  $\text{cm}^{-3}$ ) 
  - Model run with simulated aerosol
    - **Interactive** 

# Sensitivity runs: Model setup

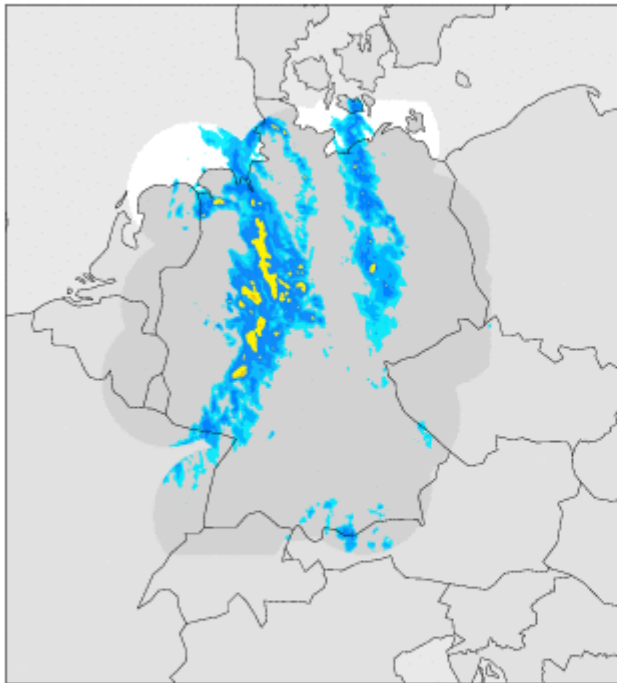
- 25th April 2008
- COSMO-DE domain
- 2.8 km horizontal resolution
- 50 vertical layers
- Boundary data: Operational COSMO-DE forecast by DWD
- Aerosol boundary and initial data by COSMO-ART EU (2-day spin-up)
- Emissions: TNO/MACC



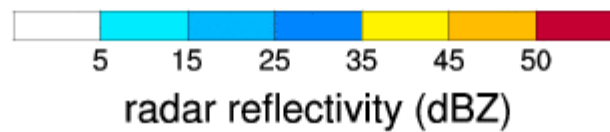
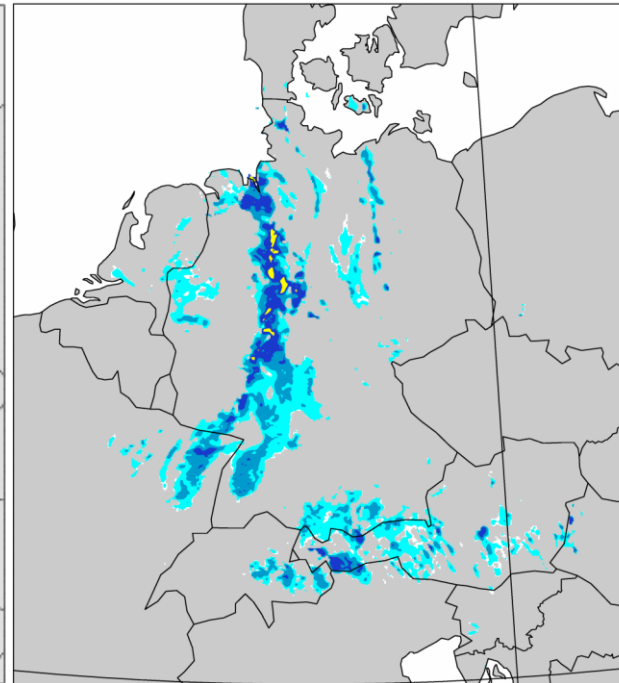


# Radar reflectivity 850 hPa

20080425, 00:00 measured

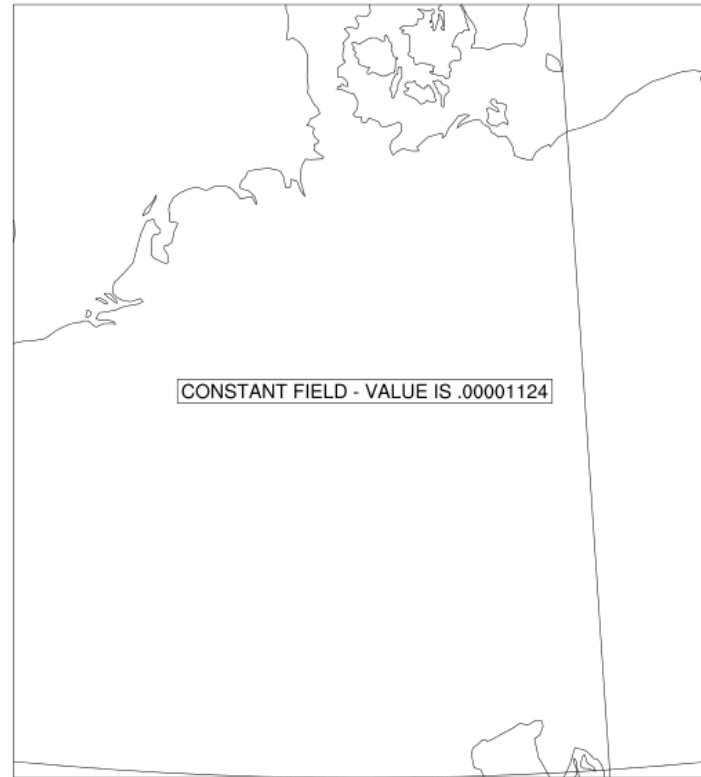


SIM 20080425 00 UTC

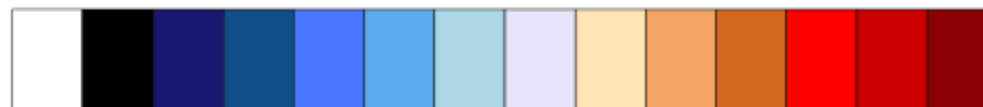


# Seasalt aerosol 850 hPa

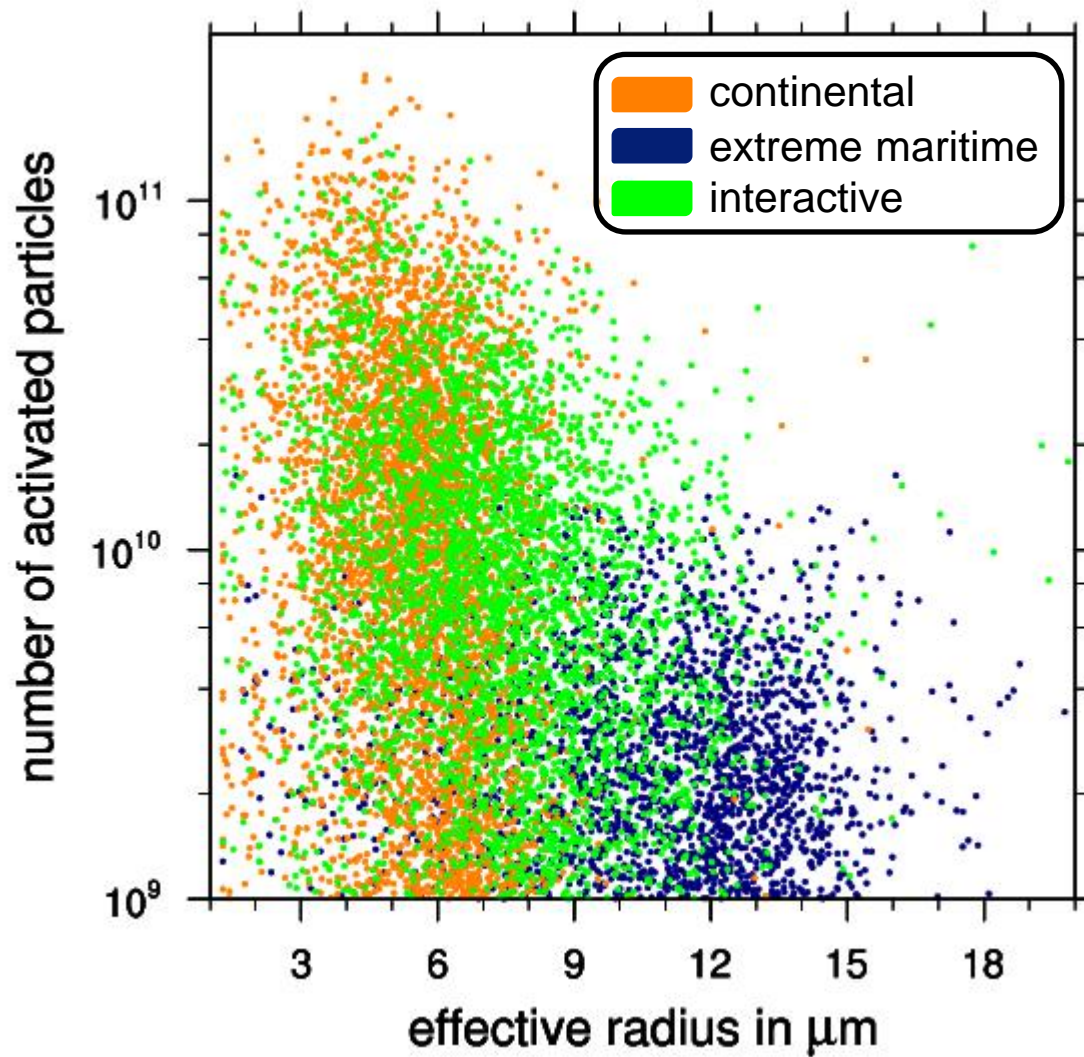
20080425 00 UTC



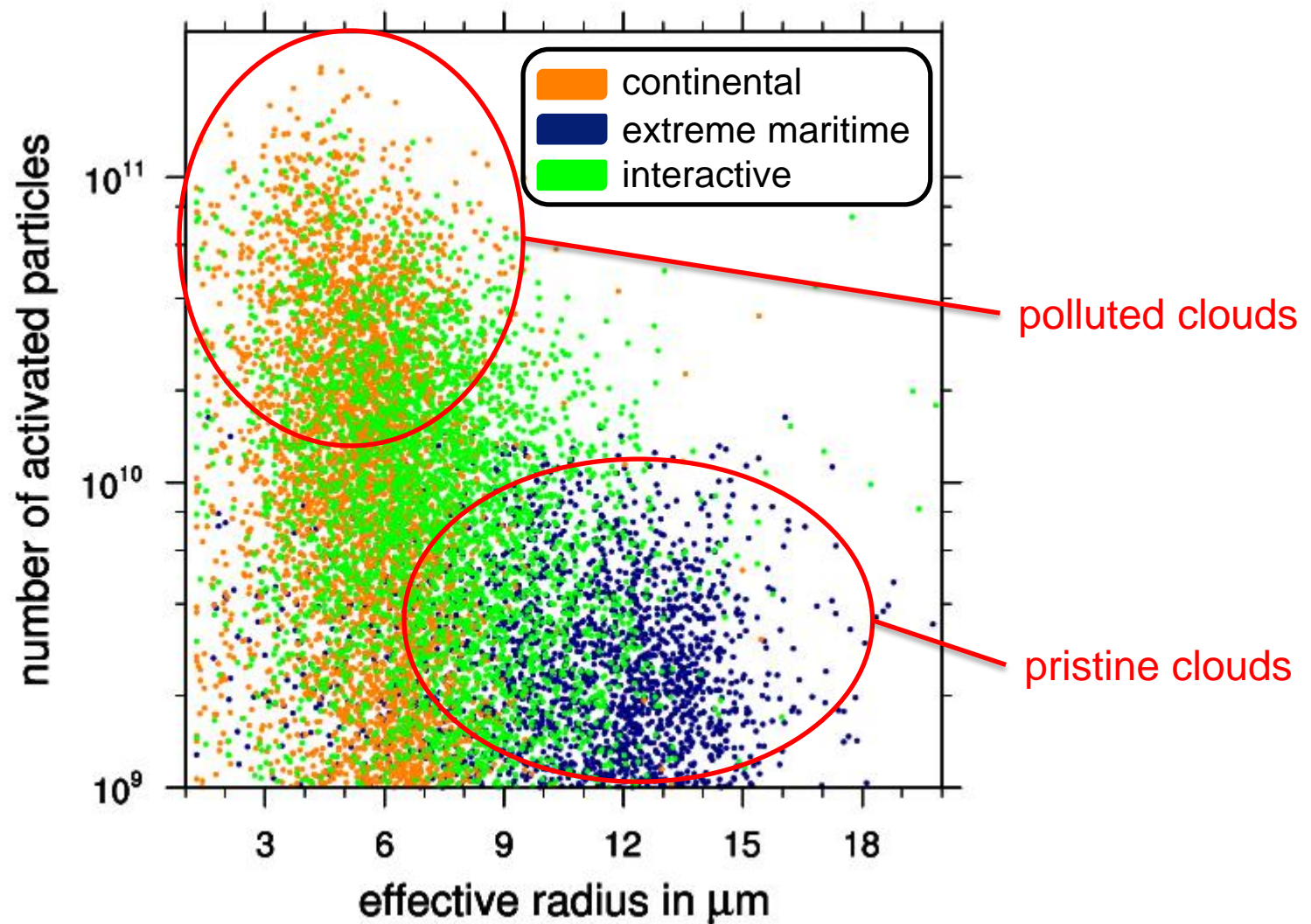
seasalt number concentration in  $\text{cm}^{-3}$



# Cloud properties

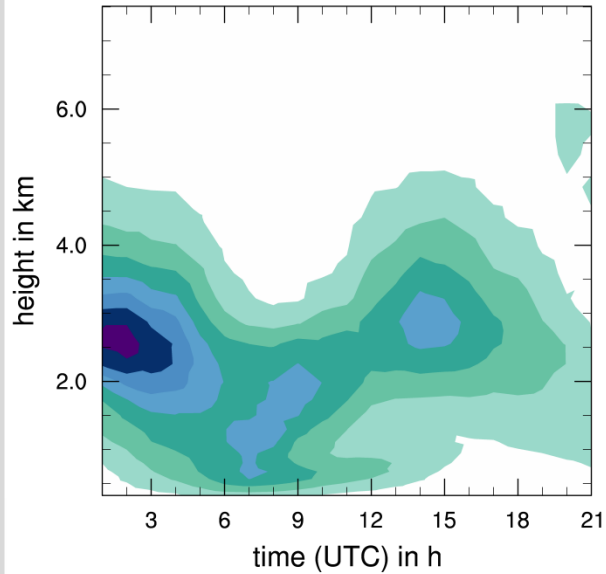


# Cloud properties

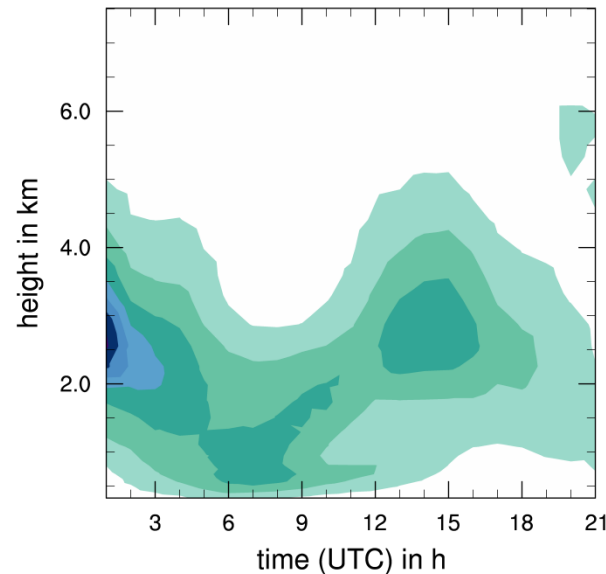


# Mean cloud liquid water content

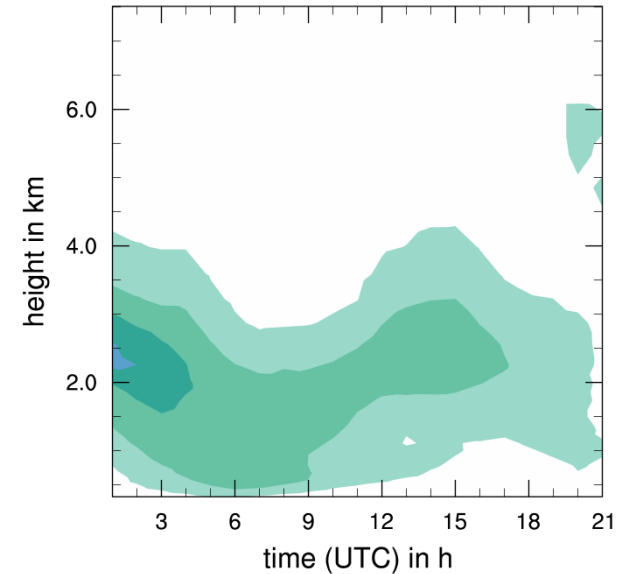
continental



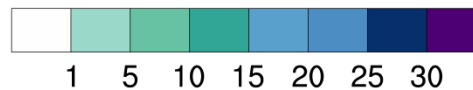
interactive



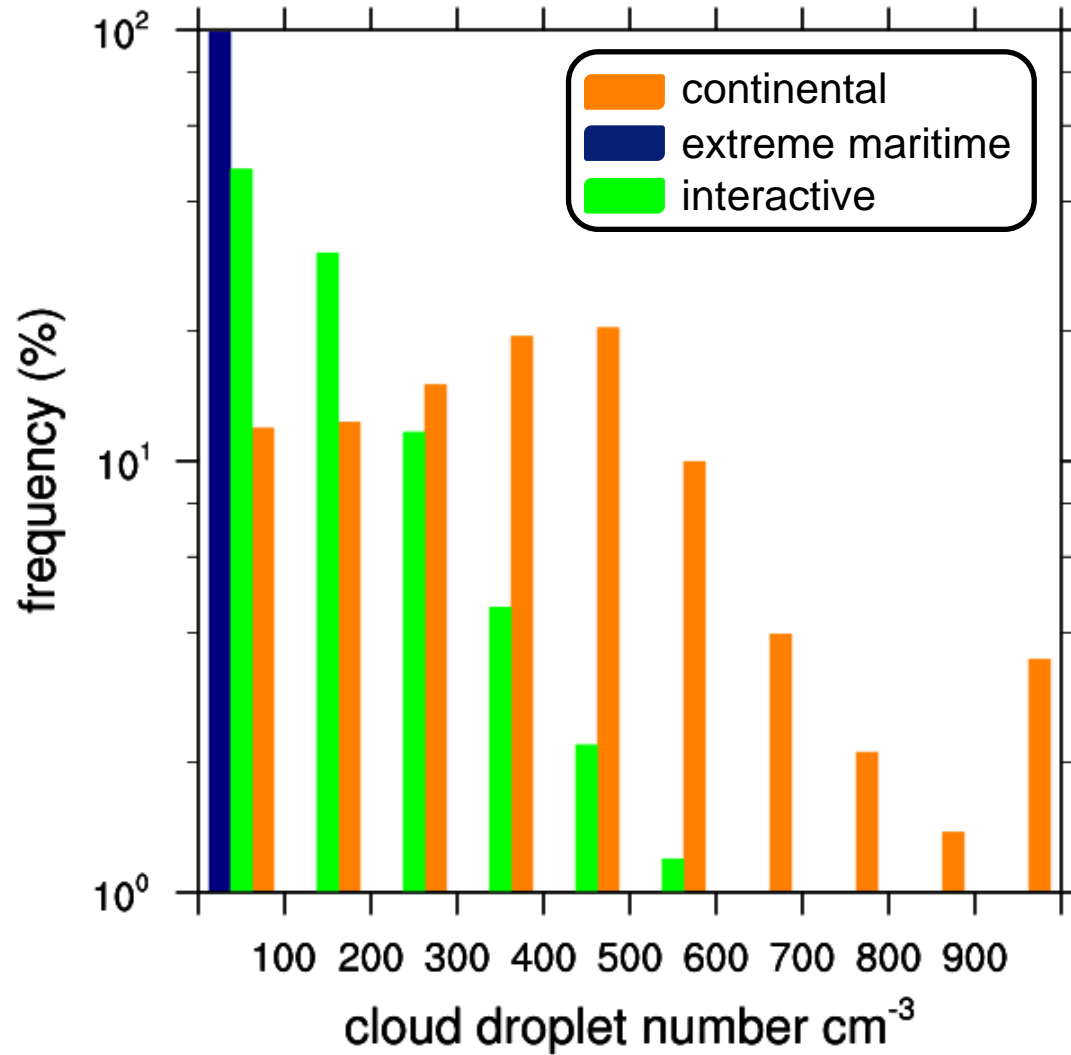
extreme maritime



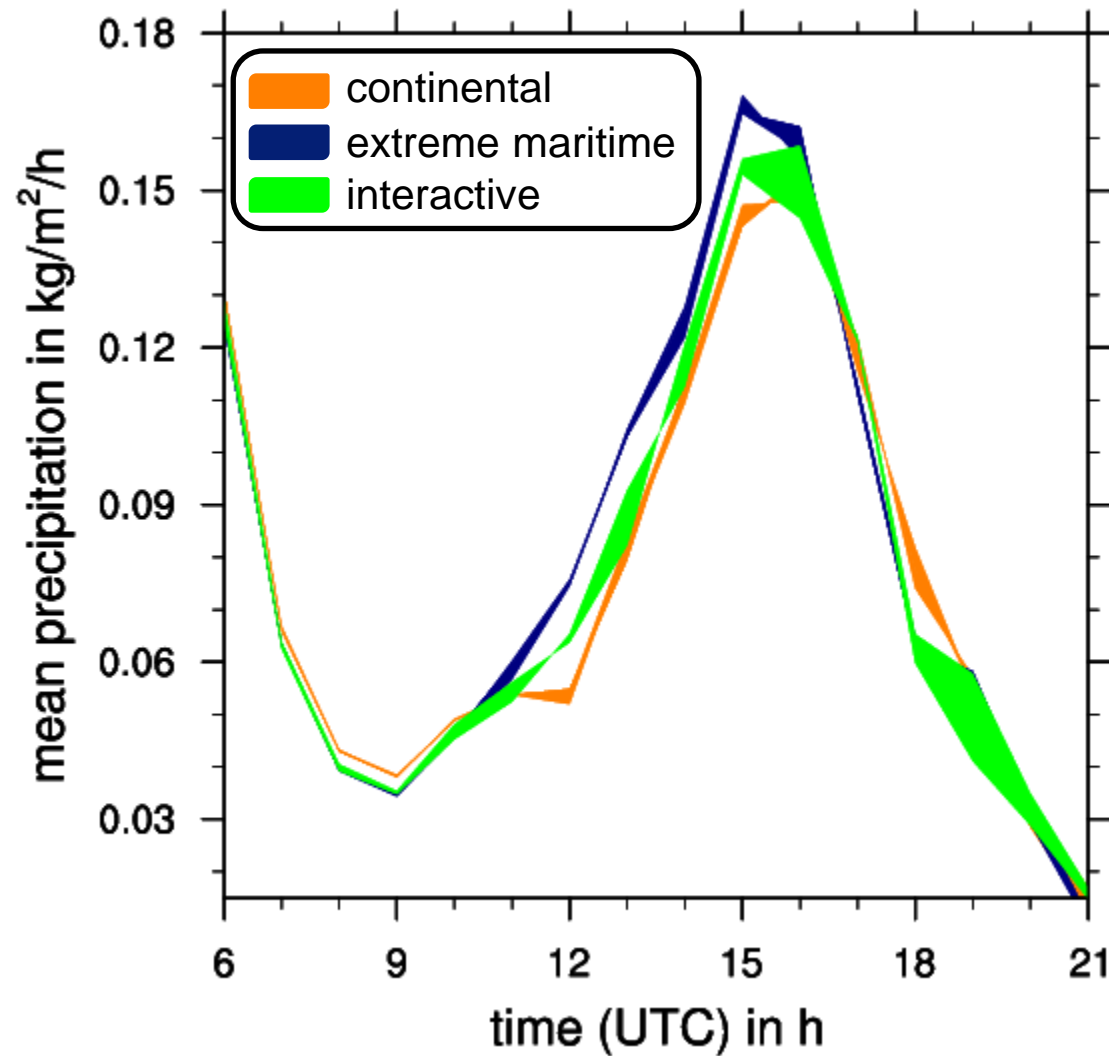
cloud liquid water content in mg/kg



# Impact of aerosol on cloud droplet number

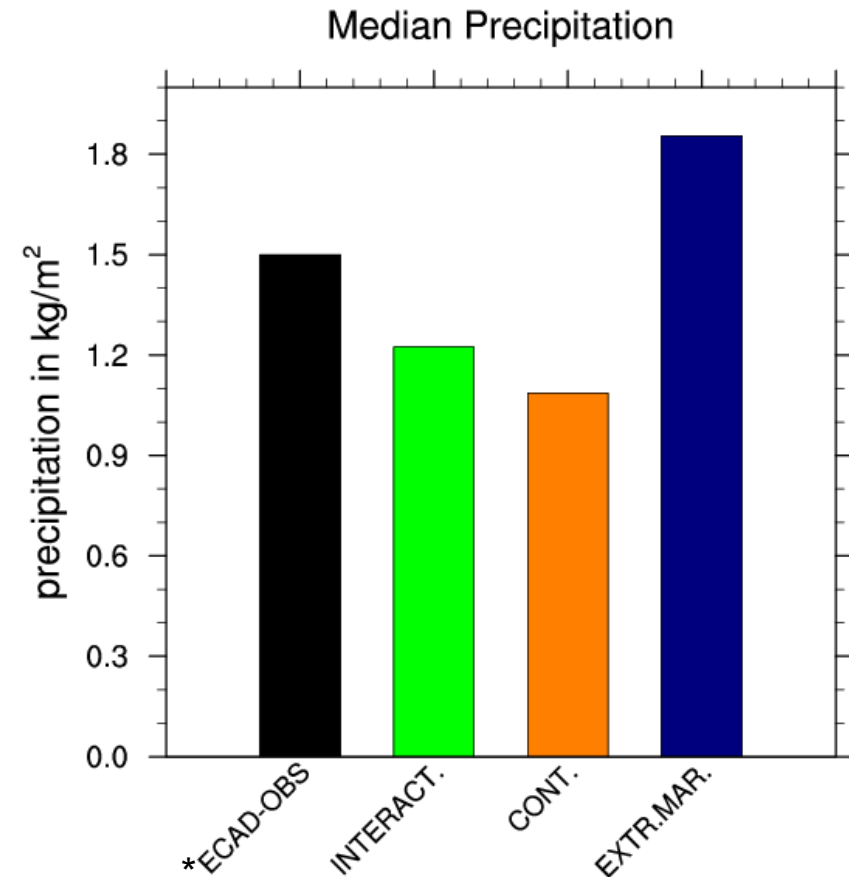
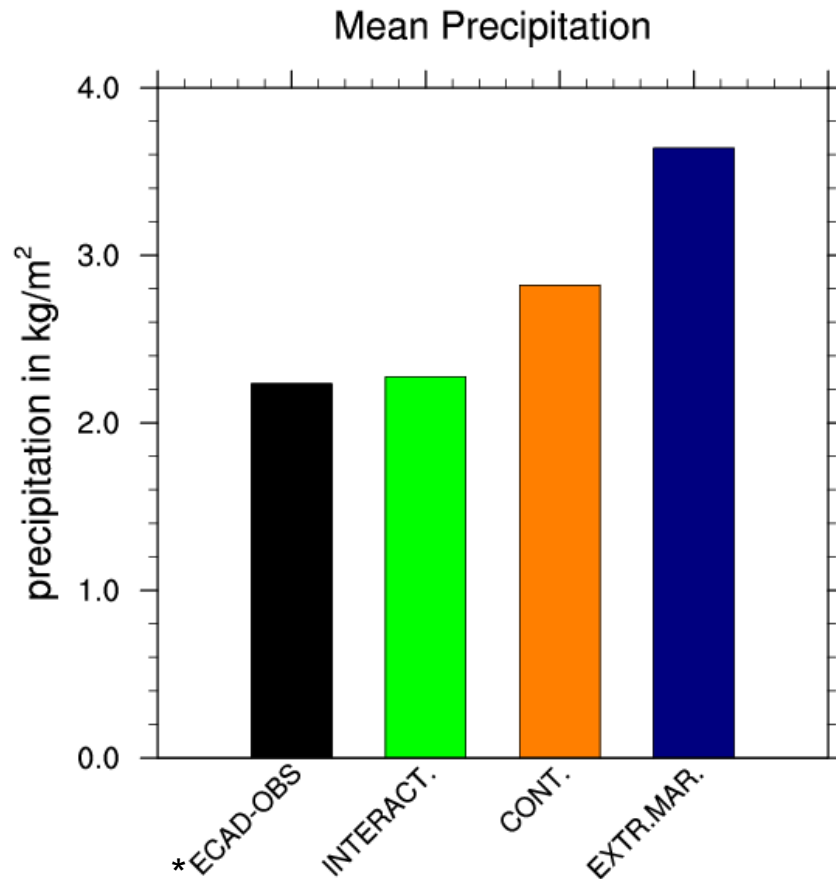


# Mean precipitation



# Precipitation

*model runs vs. measurements, at 58 EOBS stations in the convection domain*



\*Klok and Tank, 2009



# Take home messages

## *for postfrontal, convective clouds*

- Only the interactive scenario is capable of simulating the wide spread of conditions
- Systematic decrease of mean precipitation with an increase in aerosol
- Higher aerosol load leads to an increased vertical extension of clouds