Detectability of fast cloud adjustments in large-scale high-resolution simulations

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Motivations

- Cloud adjustments to anthropogenic aerosol perturbations remain an important source of uncertainties on global radiative forcing estimates. Joint modeling-observation efforts are needed.
- This study seeks to identify, quantify and better understand these effects through sensitivity analyses based on large-scale high-resolution simulations. Their detectability by spaceborne or ground-based observations is also assessed.

Model and experiment framework

- The high resolution simulations are performed by ICON in a Large Eddy Model configuration.
- The domain covers Germany.
- We focus on a 24-hr simulation (02 May 2013).
- Two moment microphysics scheme with 6 hydrometeor classes (Seifert-Beheng).
- Aerosols are not yet interactive!
- The framework consists in analyzing the response of clouds, precipitation and radiation to a CCN (Cloud Condensation Nuclei) perturbation.

Cloud adjustments in ICON LEM simulations

- Characteristics of ICON-LEM (Heinze et al., 2017):
  - 156-m of horizontal resolution, 150 vertical levels
  - The domain covers Germany.
  - We focus on a 24 hr simulation (02 May 2013)
  - Two moment microphysics scheme with 6 hydrometeor classes (Seifert-Beheng)
  - Aerosols are not yet interactive!

Detectability in observations

- Can the adjustments found in ICON-LEM be detected?
  - Use of data from supersites and satellite measurements.
  - Comparisons to initial 1xCCN and 2xCCN simulations. Is one more realistic than the other?

Representativeness for global adjustments

- Similar runs (1xCCN and 2xCCN) were made with ICON-NWP.
  - 14 days simulations from 02 May 2013 and no restart. Different initialization (IFS).
  - New and old radiation modules were tested.
  - 0.25°x0.25° over DOM03 domain.

- Analyses of daily mean adjustments to 2xCCN in T-AMIP with updated radiation.
- Impact on SW net TOA fluxes: -5 W.m^-2 with old radiation (adjustment effects) and -10 W.m^-2 with new module (Twomey + adjustments).
- Different from LEM (old radiation predicted -0.7 W.m^-2).
- This suggests about half Twomey and half adjustment contributions to the ERF.
- Roughly agrees with literature studies (e.g. Cherian et al. 2014: -4W.m^-2/decade between 1990 and 2005)