Evaluating cloud ice microphysics in COSMO-DE with satellite observations

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1. Motivation

DWD simulates MSG SEVIRI BTs from COSMO-DE output, in order to enable the assimilation of observed BTs in the future. COSMO-DE is known to distinctly underestimate the occurrence of low BTs at 10.8 µm (Böhm et al., 2011).

Questions
- Is this reproducible on a case study basis?
- Is a novel ice microphysical scheme able to perform better?
- If yes, which part of the new scheme is responsible for the improved performance?
- Does an increase in vertical level number have a similar effect?

2. COSMO-DE

General
- Non-hydrostatic cloud-resolving regional NWP model of DWD
- Resolution: 2.8 x 2.8 km, 50 hybridlevels (50 – 1000 m thick)

This study
- 3 main experiments: June 2010, driven by COSMO-EU analyses (only 0, 6, 12 UTC runs, but 24h):
  - 9009
    - currently operational
    - 5 hydrometeor classes: cloud water, rain, cloud ice, snow, graupel
    - 1 moment bulk scheme
  - 8819
    - as 9009 but without graupel
  - 8822 (AA/NC/15)
    - hydrometeor classes as 8819
    - 2 moment: 2-mode cloud ice scheme:
      - cloud ice: 2 moment (CI: QI, INI: prognostic variables)
      - 2 mode: heterogeneously and homogeneously formed cloud ice are treated separately
      - sedimentation of cloud ice
      - tracking variable for activated ice nuclei to avoid cloud ice overproduction
      - relaxation approach instead of simple saturation adjustment for depositional growth of cloud ice

- Sensitivity experiments – part I:
  - COS/85/150
    - as 8819 but with increasing level number (50, 84, 150)

3. Main runs vs MSG

- Multiyear feature is reproducible for 1 month and for single cases
- Ctrl runs COSMO-DE9009 and 8819 do not differ much
- The new COSMO-DE8822 performs distinctly better than 9009 and 8819.

4. Main runs vs level runs

- Both the new COSMO-DE8822 and the increased level number COSMO-DEK150 produce more distinct features in comparison to the ctrl run COSMO-DE8819.

- Both the new COSMO-DE8822 and COSMO-DEK150 reduce CIWP distinctly.

- Both in the new COSMO-DE8822 and in COSMO-DEK150 cloud ice is shifted to lower layers.

5. Summary & Outlook

Novel ice microphysical scheme in COSMO-DE8822 has similar effect on cloud ice water content and vertical distribution of cloud ice as an increase in level number. To-Do: Perform sensitivity experiments – part II: Which of the changes in the new scheme of COSMO-DE8822 is responsible for the improved performance? One specific different process treatment or rather the combination of all four?

References:
- Klein, R., 1980: Cloud and Radiation Physics, University Press
- Lauer, A., 2007: A higher-order cloud microphysics scheme for the COSMO model, Proc. 10th COSMO Workshop

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