

# WG3a activities for microphysics and radiation

**Ulrich Blahak** 

Carmen Köhler, Ulrich Schättler, Ulrich Görsdorf, Xavier Lapillone, Axel Seifert, Oliver Fuhrer, Günther Zängl, Felix Köhler



#### ➔ Microphysics:

- Unified subroutines in the COSMO and ICON (Carmen Köhler)
- → Model Changes (Carmen Köhler, Felix Köhler, Günther Zängl)
- → [ Rewrite of the 2-moment scheme for ICON (Axel Seifert) ]
- Cloud radiation coupling (Ulrich Blahak)
  - Some further development work
  - Sensitivity studies
- → Radiation:
  - Work towards GPU implementation (Xavier Lapillone)



Deutscher Wetterdienst





1. Cloud Ice Sedimentation

2. Sticking Efficiency

3. Supercooled Liquid Water

4. Reduced Rain Freezing Rate

**Deutscher Wetterdienst** Wetter und Klima aus einer Hand



1. Cloud Ice Sedimentation

2. Sticking Efficiency

3. Supercooled Liquid Water

4. Reduced Rain Freezing Rate





**Deutscher Wetterdienst** Wetter und Klima aus einer Hand



1. Cloud Ice Sedimentation

2. Sticking Efficiency

3. Supercooled Liquid Water

4. Reduced Rain Freezing Rate







**Deutscher Wetterdienst** Wetter und Klima aus einer Hand









1. Cloud Ice Sedimentation

2. Sticking Efficiency

3. Supercooled Liquid Water



Both changes by Felix Köhler have been presented last year

4. Reduced Rain Freezing Rate -



### Case study, comparison with obs

**Deutscher Wetterdienst** Wetter und Klima aus einer Hand





### Verification COSMO-DE experiment July 2013

**Deutscher Wetterdienst** Wetter und Klima aus einer Hand DWD

G

LM3M0: 01.07.2013 00 UTC — 31.07.2013 00 UTC (exp. run 9667\_national: Aenderungen von Wolkeneissedimentation, unterkuehltem Fluessigwa Im3mo: 01.07.2013 00 UTC — 31.07.2013 00 UTC (exp. run 9688\_national LON: 02.98 till 19.84 deg LAT: 44.77 till 56.14 deg: nearest gridpoin



### Verification COSMO-DE experiment January 2014

**Deutscher Wetterdienst** Wetter und Klima aus einer Hand DWD

6

LM3M0: 01.01.2014 00 UTC — 31.01.2014 00 UTC (exp. run 9681\_national: Aenderungen von unterkuehltem Fluessigwasser und das Zusammer Im3mo: 01.01.2014 00 UTC — 31.01.2014 00 UTC (exp. run 9689\_national LON: 02.98 till 19.84 deg LAT: 44.77 till 56.14 deg: nearest gridpoin



## Summary for microphysics



- Clear improvement of supercooled liquid (presented last year)
- Cirrus clouds lower (and fewer?)
- Not shown: some improvements of wind- and solar power forecasts for certain weather situations
- ➔ However, standard scores insensitive (at least no worsening)
- Ice sedimentation: would have expected more improvement in high cloud cover (reduction of overestimation), but perhaps the reduction of minimum sticking efficiency for ice particles counteracts. Also, observations of high cloud cover are uncertain!
- → Have achieved common code for COSMO and ICON in COSMO 5.1

#### → Plans (in accordance with the Science Plan):

- Further implementation of the full improved cloud ice scheme of Carmen Köhler as has presented last year, with a more clear reduction effect on cirrus clouds
- → Work on hail melting for the 2-moment scheme (MPI Hamburg, Vivek Sant)
- Snow melting scheme



#### Revised cloud radiation coupling – summary of the Deutscher Wetterdienst Wetter und Klima aus einer Hand



- Implemented Re based parameterizations of the optical properties of cloud droplets and cloud ice from literature
- Extrapolation of these parameterizations for the larger Re of snow, graupel and rain with the help of a large size approximation
- $\rightarrow N_{c0}$  of cloud droplets is new tuning parameter
- Subgrid variability factor k for grid scale clouds investigated. Previous value 0.5 too low. Treated as new tuning parameter.
- → Uncertain properties of SGS clouds are treated as tuning parameters
- → Some other minor new tuning parameters





- → Re-done the fits for the optical properties of cloud droplets
- → Large-size approximation for snow, graupel, rain (and hail)
- Concerning SGS clouds: introduced new tuning parameters for diagnosis of their water content (previously these were fixed tuning values in the code)
- Introduced synthetic vertical profiles of the assumed number densities for cloud drops, cloud ice and snow, controlled by new tuning parameters
- Sensitivity studies
- Developed a method to diagnose cloud droplet number density from Tegen aerosol climatology and vertical speed, but not yet extensively tested
- For 2-moment-scheme and COSMO-ART: code-parts which concern the 2moment scheme and which are needed by COSMO-ART have been implemented under preprocessor flag –DCOSMO\_ART (work done at KIT)



# Case study example: 1.6.2013

**Deutscher Wetterdienst** Wetter und Klima aus einer Hand DWD

6



# Case study example: 1.6.2013

**Deutscher Wetterdienst** Wetter und Klima aus einer Hand





COSMO General Meeting, Eretria, 8.9.2014



- Changes in cloud radiation coupling can lead to big changes of T\_2M and possibly other model variables. This gives us a pretty big handle on the model!
- Sensitivities: The implemented R<sub>e</sub>-parameterisations make the ice clouds optically thinner in the visible and infrared, therefore increased shortwave heating and longwave cooling in the presence of clouds. Including qs/qg and increasing factor k both counteract this, the clouds get optically thicker at all wavelengths, so Tmax during day is reduced.
- However, entire model currently tuned to the previous method of cloud radiation coupling (SGS cloud diagnostics, ...). Therefore, to uncover possible beneficial effects of the presented new method requires extensive re-tuning of the model!
- $\rightarrow$  We are in the middle of this process, but will perhaps take a long time!
- Changes in the cloud microphysics scheme now also have a more direct influence on the radiation!





- Replace large size approximation of optical properties (which has some flaws) by new fits based on new data of Quiang Fu.
- New parameterization for asymetry parameter g for ice particles by Fu (2007), based on a mean aspect ratio (AR) instead of R<sub>e</sub>
- → New aerosol-climatology-based diagnosis of cloud number density
- $\rightarrow$  Very important: a considerable reduction of the ~20 new tuning parameters!
- New PT to be presented on Thursday!

