Regional Cooperation for
Limited Area Modeling in Central Europe

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ALARO experience in Czech Republic – tuning with new shallow convection closure

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Introduction

- Shallow convection with the mass flux type of closure modifies moisture transport and therefore this has an impact on cloudiness;
- The effect is namely seen by the radiation;
- In ALARO we have still separated schemes for cloudiness used by the radiation and by the microphysics (adjustment). Some points are common, however:
  - Critical Relative Humidity (PHUC) basic profile, but NOT its modulation (dependency on dx, on cloud water phase …);
  - Relation between cloud water and cloud fraction (Xu-Randall) but the determination of the "resolved" cloud water is different between the adjustment and radiation.
- Parameterization of the "resolved" cloud water for radiation is a candidate for the retuning (later for a deeper revision => cloudiness unification).

Radiation cloudiness

tuning parameters

1. Parameter ***α*** (QXRAL)

   This is a tunable parameter relaying cloud water and cloud cover:

   $$N = \left(\frac{q_v}{q_w}\right)^r \frac{\alpha q_c}{\alpha q_c + (q_w - q_v)^\delta}$$ it can modify cloud cover where $\boldsymbol{q_c}$ exists

2. Geometry - ***vertical overlaps***

   Till now, only the maximum-random (LRNUMX=.T.) or fully random (LRNUMX=.F.) options existed inside the radiation scheme. Recently, the exponential overlap (LRNUEXP=.T.) has been developed. A bit of randomness is introduced, see talk of Jan;

3. Critical Relative Humidity ***Huc***

   Basic profile is tunable by HUCOE, HUTIL1, HUTIL2;

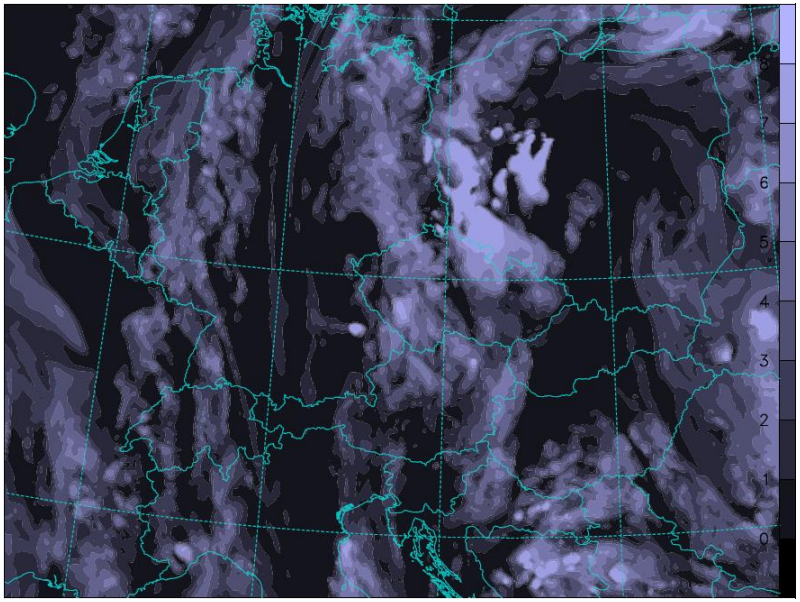
   In the adjustment the horizontal resolution dependency is introduced and also further modulation (HUCRED) and phase (ice/liquid) dependent modulation (SCLESPS, SCLESPR) are there;

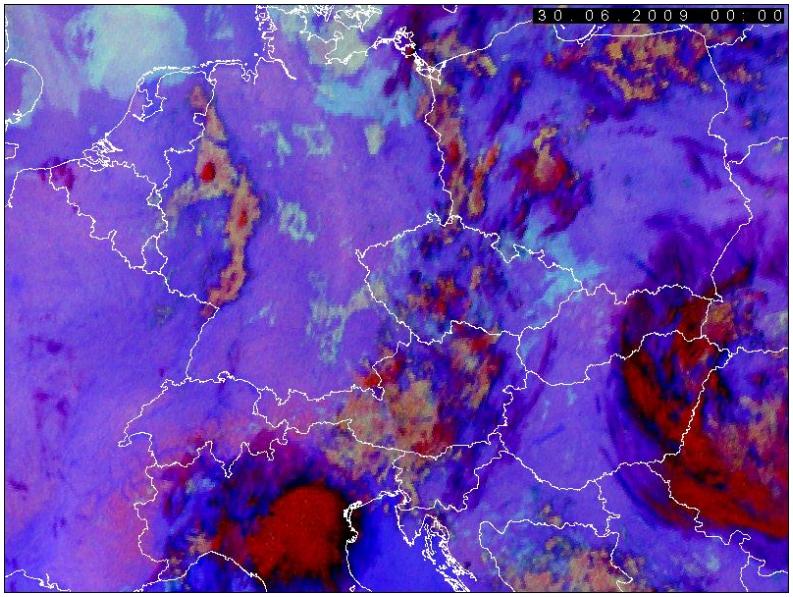
   Huc drives whether and how much cloud water we get in the grid box.

Radiation cloudiness

current defficiency

- In summer there is too much cloud cover, especially in higher levels (already QSMODC remedy introduced with ALARO1)





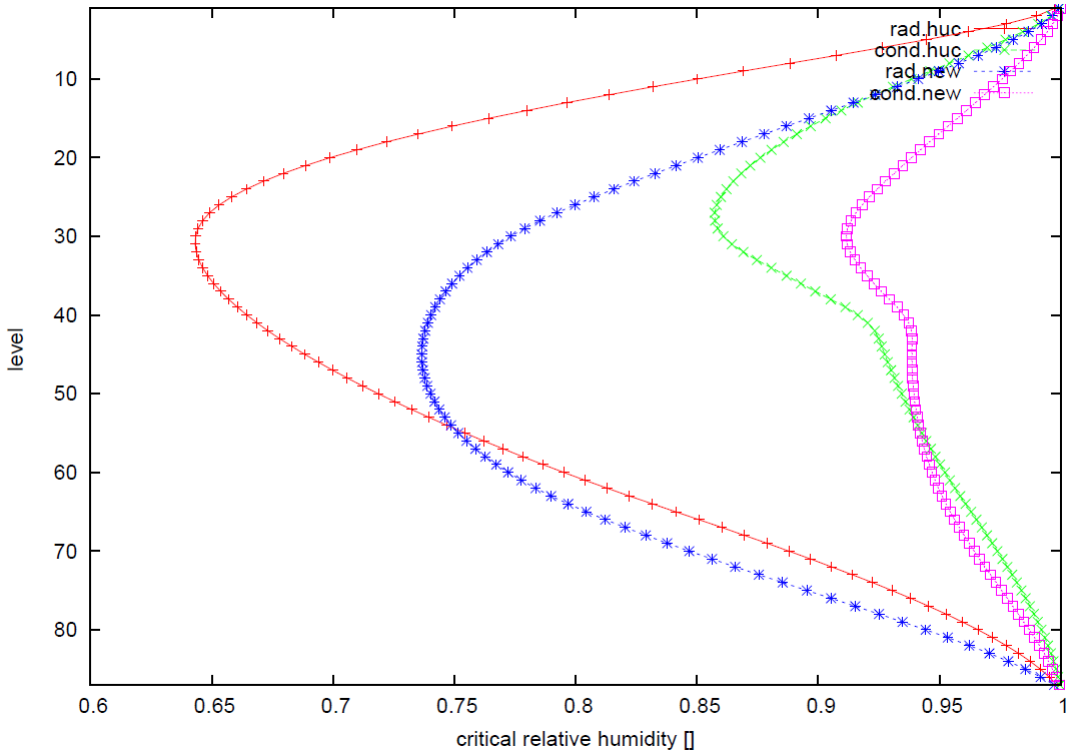
Left: high-level cloudiness +24h forecast valid at 0h UTC with ALARO1;
Right: satellite picture, where high-level cloudiness has red color;
Despite the QSMODC reduction there is still too much high-level clouds in the model
New shallow convection enhances cloudiness further – need to retune the cloud scheme

Radiation cloudiness
proposed tuning (1)

- The QXRAL parameter is the easiest one but not sufficient to address the problem of the vertical profile;
- The geometry may help to mitigate the seasonal bias of cloudiness – to increase resulting cloud cover in winter and keep the summer one close to the maximum-random limit thanks to the dependency on sun declination; however one cannot go out of reasonable values either;
- Change of the critical humidity profile offers the way out, however it has the direct impact both on radiation and on microphysics (via the adjustment).

Radiation cloudiness

changing HUC profile – suggestion of Luc



Red – current radiative RHUc, Green – current adjustment;

Blue – proposed radiative RHUc;, Violet – impact on the adjustment;

Strategy: retune the adjustment RHUc profile to get close to the current one.

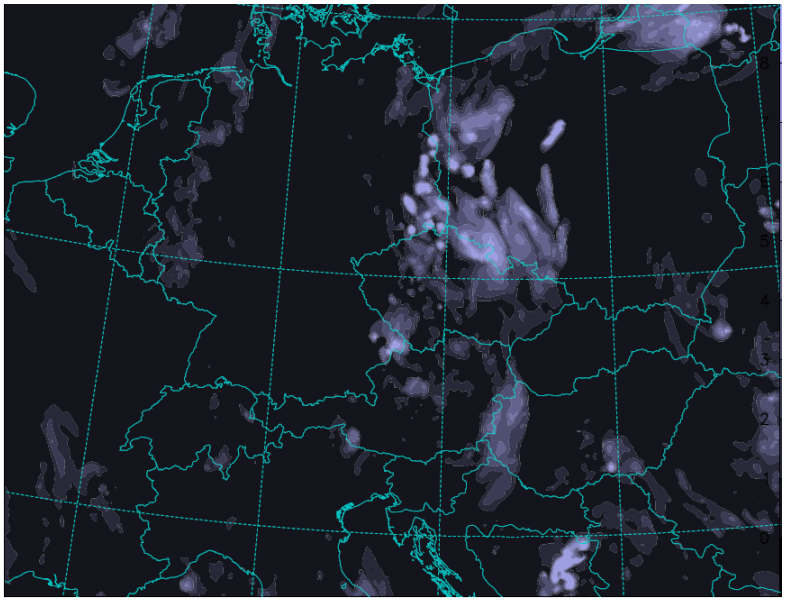
Radiation cloudiness
proposed tuning (2)

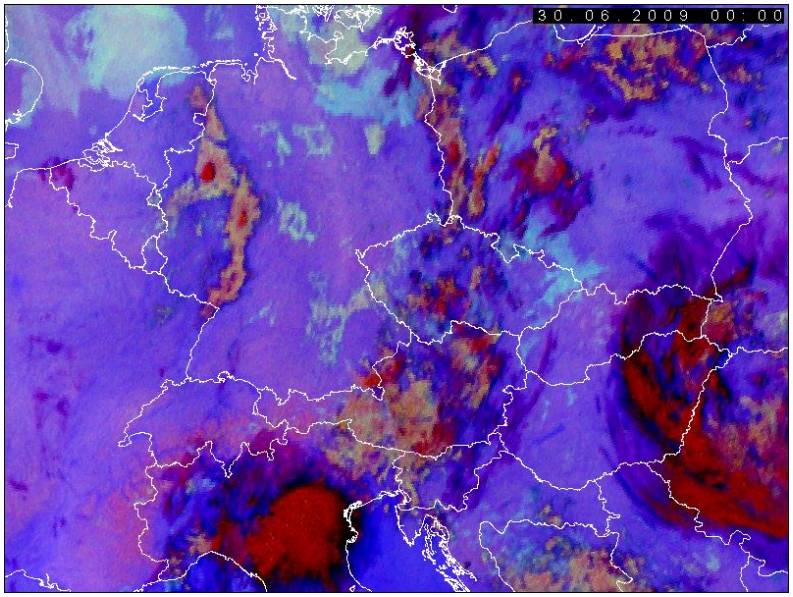
- There is a combination of the critical relative humidity profile modification compromise and of new vertical geometry option (exponential overlap). This is to be used with new shallow convection closure:
  - HUCOE=1., (basic RHUc profile);
  - HUTIL2=0.5, (basic RHUc profile);
  - HUCRED=1.2, (modulation in the adjustment);
  - SCLESPS=5100., (modulation for solid q_c in the adjustment);
  - LRNUEXP=.TRUE. (LRNUMX=.TRUE. as well),
- These tunings make part of the parallel suite currently running at CHMI.

Radiation cloudiness

new tuning

- High-level cloudiness is further reduced with the new tuning.

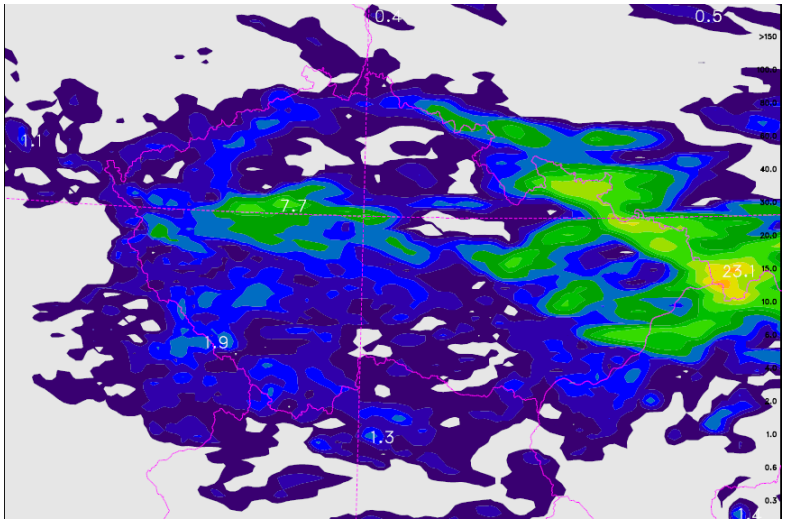


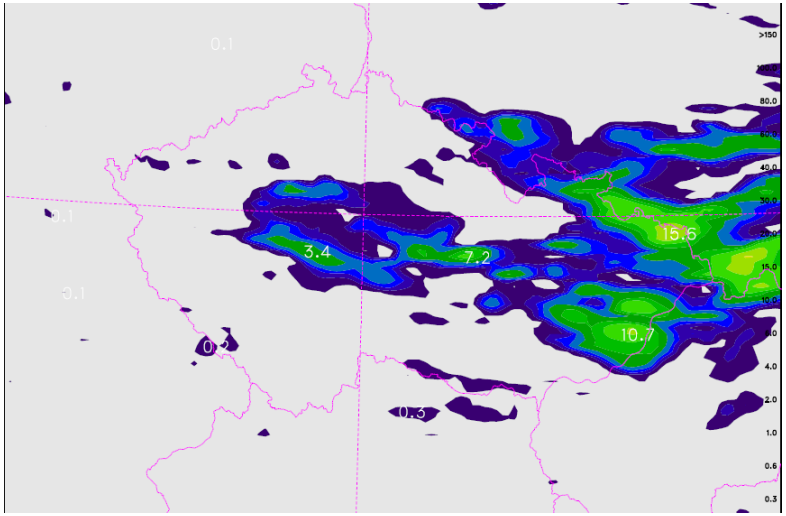


Left: high-level cloudiness +24h forecast valid at 0h UTC with the retuned ALARO1;
Right: satellite picture, where high-level cloudiness has red color;
There is a better agreement with the observations.

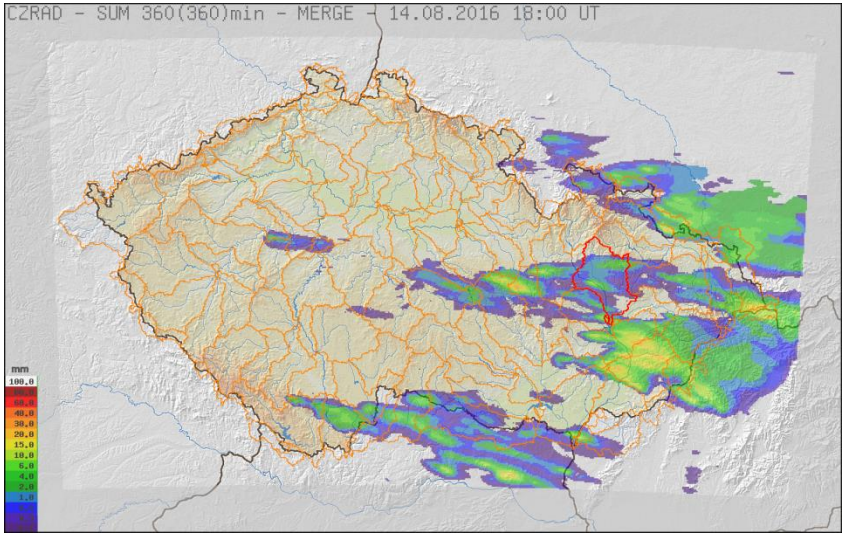
Results

current e-suite – precipitation (1)



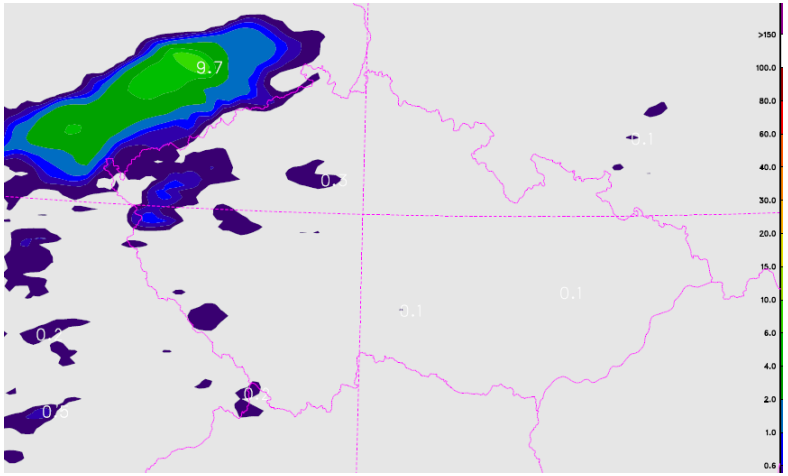


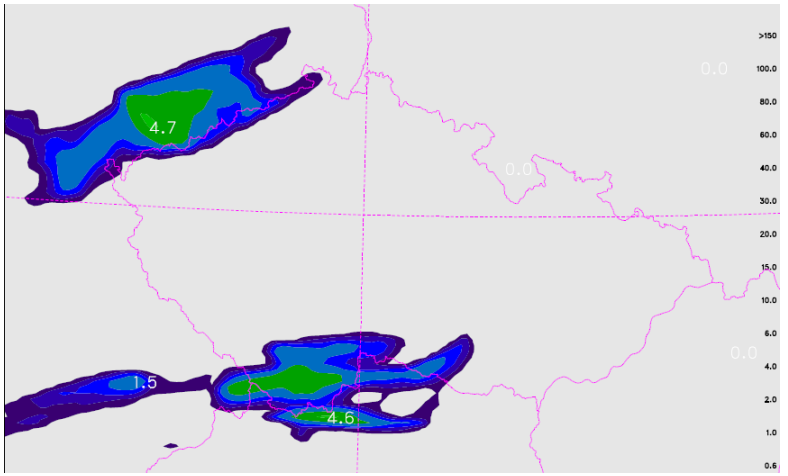
Left: precipitation sum between 12h and 18h fcst ranges for the operational run from 14/08/2016 , 0UTC;
Right top: idem but for the e-suite run;
Right bottom: observed radar and rain gauges precipitation.
New shallow convection reduces weak rain spread present in the reference.



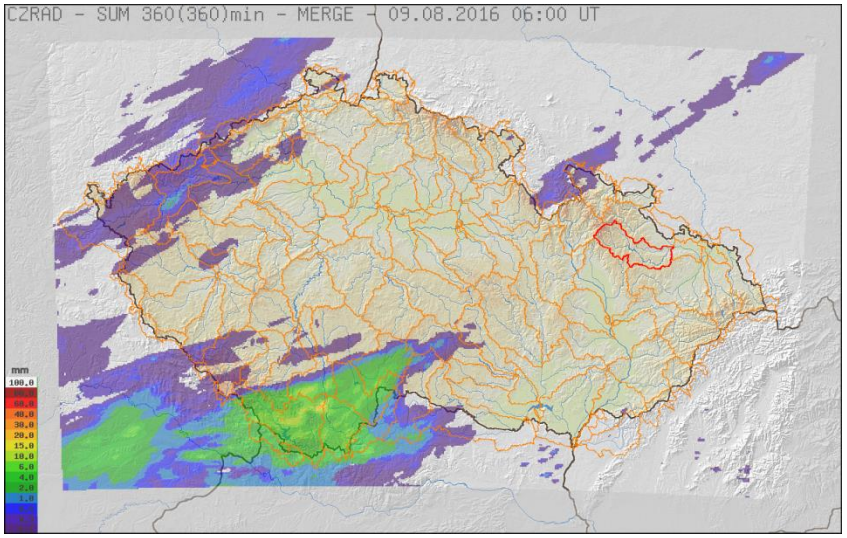
Results

current e-suite – precipitation (2)



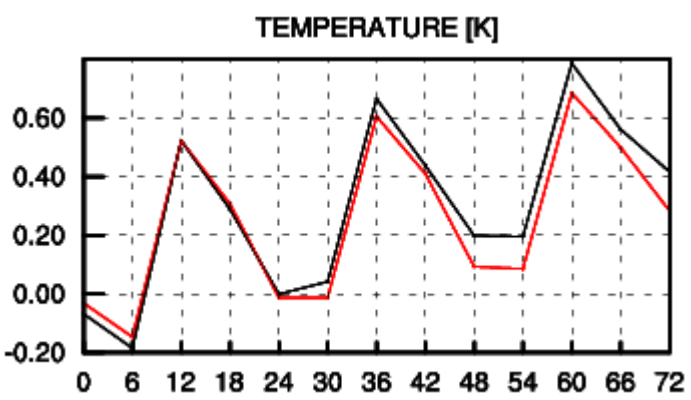


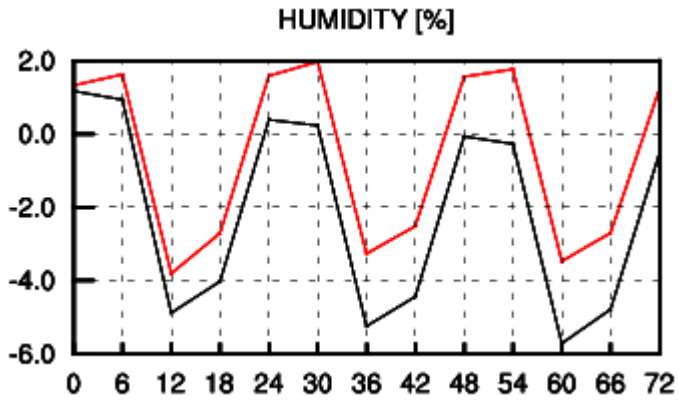
Left: precipitation sum between 36h and 42h fcst ranges for the operational run from 07/08/2016 , 12UTC;
Right top: idem but for the e-suite run;
Right bottom: observed radar and rain gauges precipitation.
New shallow convection helps the precipitating convection to start at the right place.

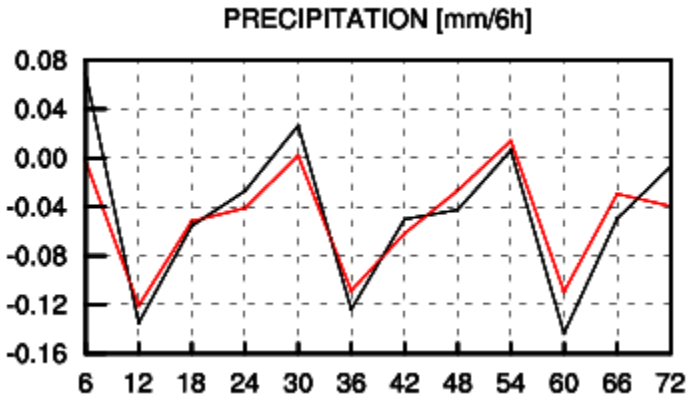


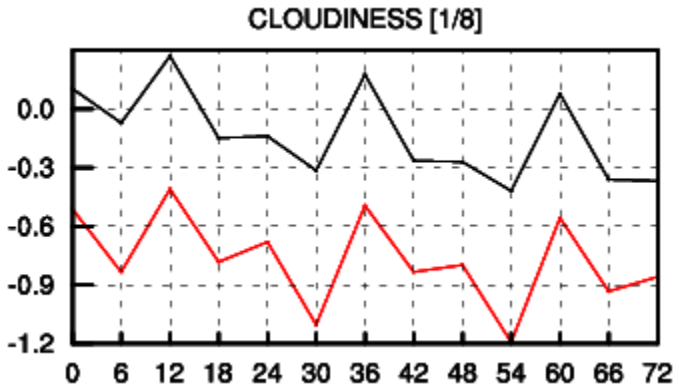
Results

current e-suite – scores: screen level bias







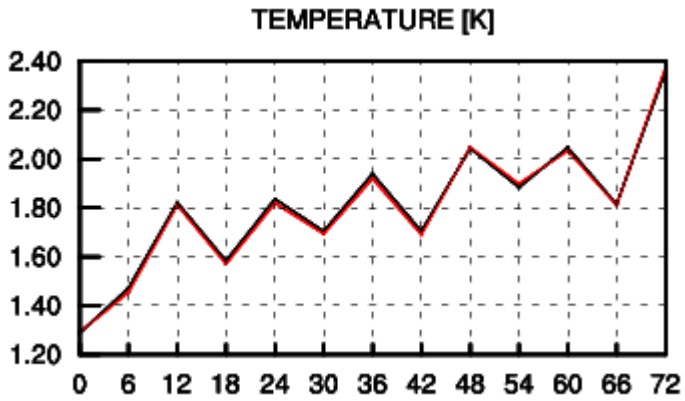


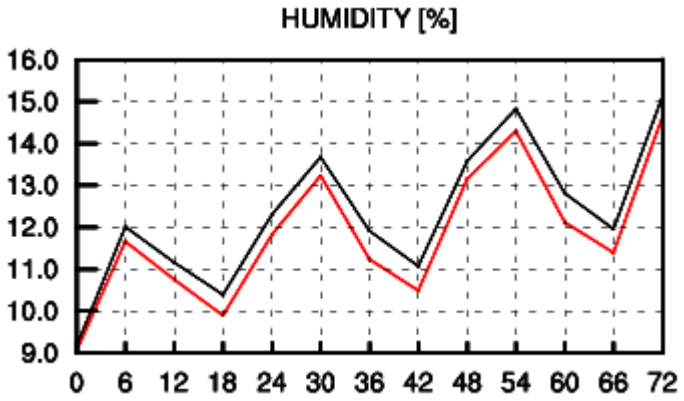
Summer 45 days long test.

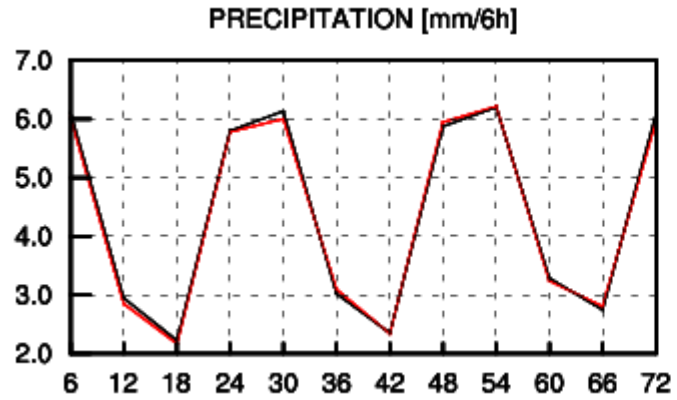
There is less "diagnosed" cloudiness since the LACPANMX overlap is abandoned in the e-suite. Precipitation, temperature and humidity bias is reduced.

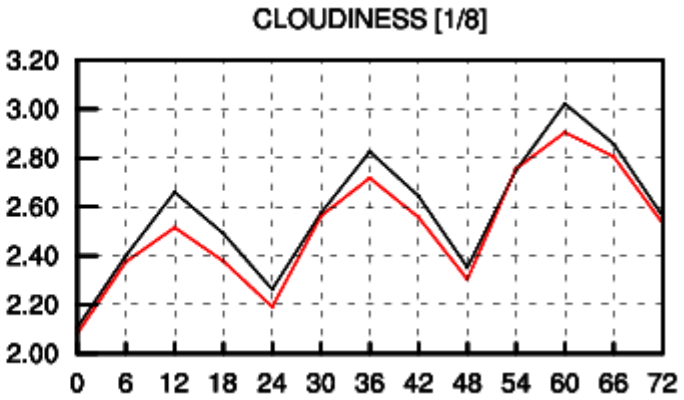
Results

current e-suite – scores: screen level STDEV









There is a robust improvement of humidity and cloudiness standard deviation.
Other scores are neutral.

Conclusions

- New shallow convection closure is more realistic, namely in moisture transport, and helps improving model results;
- Highest impact is in summer season, due to a higher amount of water in the atmosphere and the interaction with the precipitating convection;
- Radiation cloudiness had to be retuned and its formulation will be revised more deeply in the coming months.
- Some refinements could be still done in the shallow convection, where the C-parameter profile is the key part of the scheme.