Regional Cooperation for
Limited Area Modeling in Central Europe

LACE
nwp central europe

ALARO-1: First Operational Implementation

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DHMZ SHMU OMSZ ZAMG ROMANIA ANM

New Ingredients of the ALARO-1 vs ALARO-0

- New radiation scheme ACRANEB2
  - Precision - cost ratio comparable with other state-of-the-art schemes;
  - Main advantage: cloud radiation interaction affordable at every model time-step.
- New turbulence scheme TOUCANS:
  - First ever NWP implementation of the Total Turbulent Energy = sum of the TKE and moist Turbulent Potential Energy;
  - Accounting for Third Order Moments;
  - Turbulent diffusion of cloud condensates.
- New rain drop size distribution in microphysics
  - Better accounting of small drops, following Abel & Boutle 2012

New Ingredients of the ALARO-1 vs ALARO-0

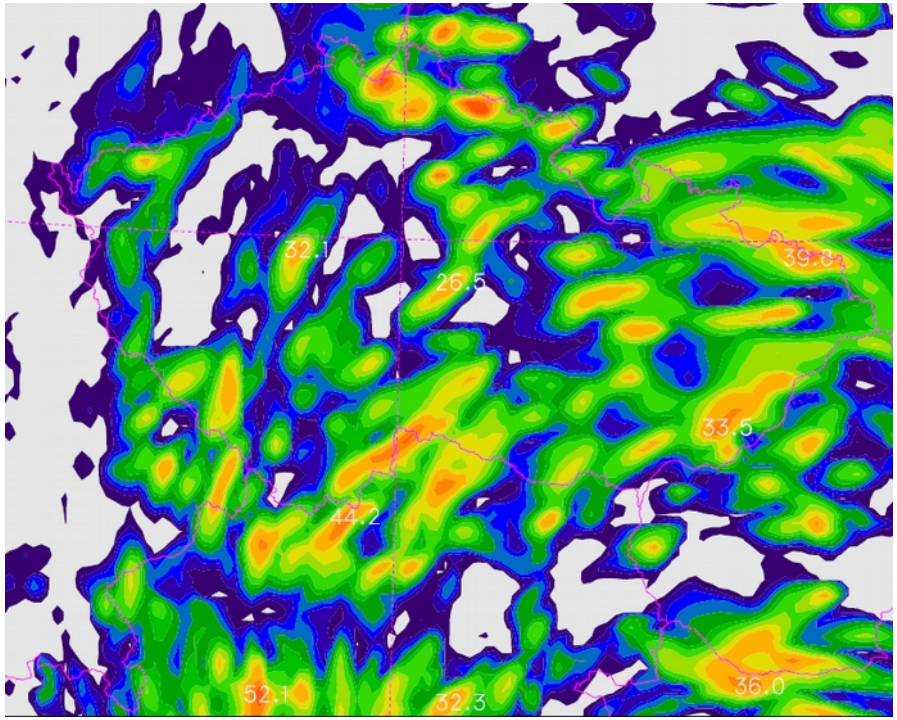
- Improved geometry of clouds and precipitation in microphysics
  - Inspired by Shonk at al. 2010 to get more realistic cloud scenes;
  - A parameter is introduced to get a bit away from the strict maximum-random overlap.
- Improved interpolation of temperature and moisture to screen level
  - Introduction of regime dependent weights.
- Complementary re-tunings
  - Cloudiness for radiation
  - Automatic moist deep convection closure modulation.

ACRANEB2 – current operational choices

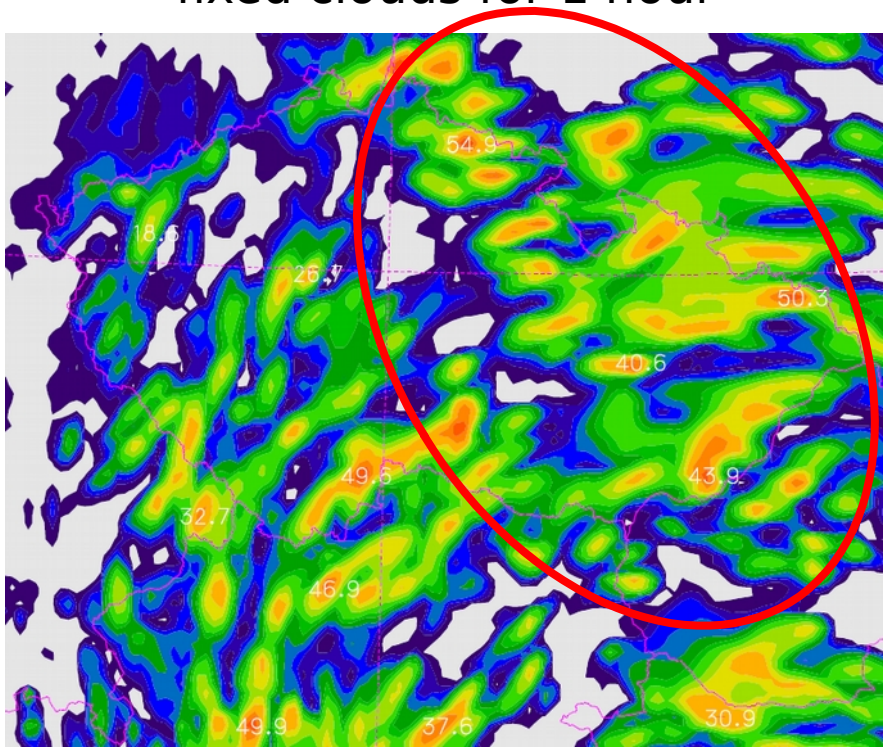
- For more details, please see the presentation by Neva;
- Transmission functions:
  - Better fit for both solar and thermal bands;
  - Single level intermittency for solar band, set to 1 hour;
  - Double level intermittency for thermal band, set to 1 hour for the transmissions and to 3 hours for the exact evaluation of the full Net Exchange Rate matrix.
- Cloudiness:
  - Interaction radiation-cloudiness at every time-step;
  - Parameterization of cloud-gas overlap;
  - New radiative cloud model – new fit of ice and water clouds, better parameterization of short-wave optical saturation.

ACRANEB2 – impact of cloudiness

reference



fixed clouds for 1 hour



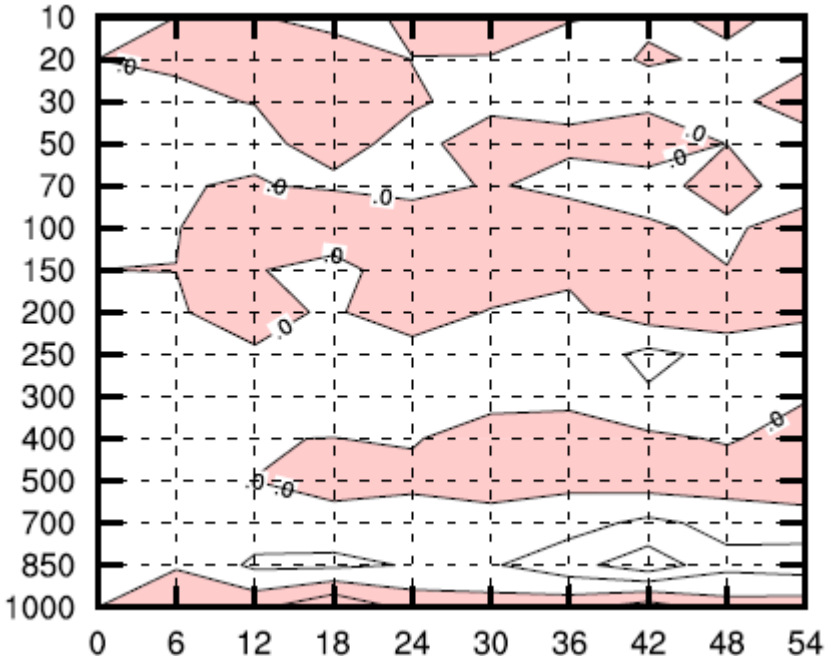
cast of 6h precipitation sum starting from 29 June 2009 00UTC, range +18h.
ermittent cloudiness" creates more granularity in the organization of the convect

TOUCANS – current operational choices

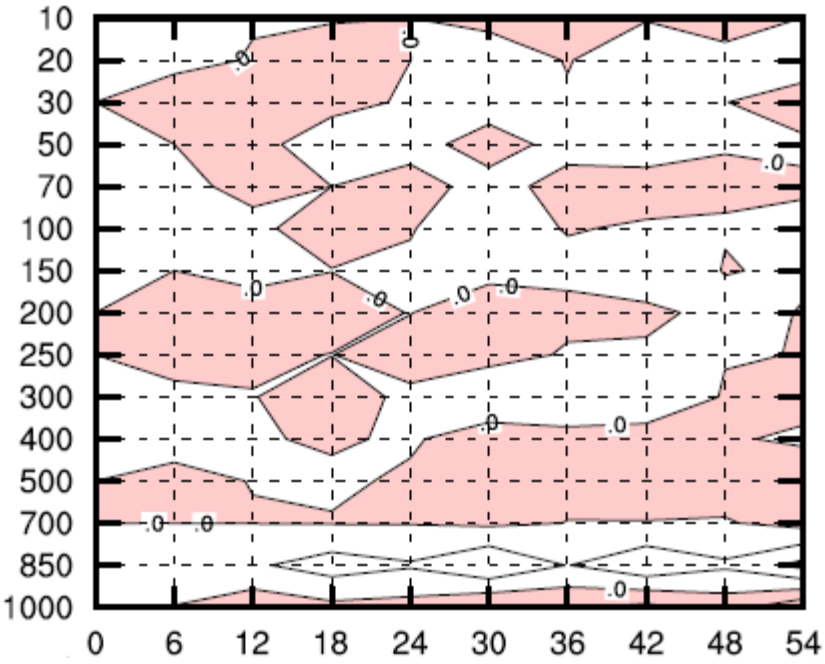
- For theoretical details, please see presentation by Ivan;
- Stability functions:
  - For the operational implementation, the choice is the so-called "tuned model II", yielding best results;
  - Other models, like QNSE and/or EFB were tested, results are also reasonable but do not beat the model II;
- Length scale:
  - It is still based on the p-TKE form (conservative choice);
- Shallow convection:
  - Still Ri* based (work on the new formulation going on);
- Third Order Moments:
  - Most impact under the unstable conditions;
- Prognostic TTE:
  - Most revolutionary ingredient; large impact on temperature and moisture turbulent transport.

TTE impact on Temperature stratification

summer



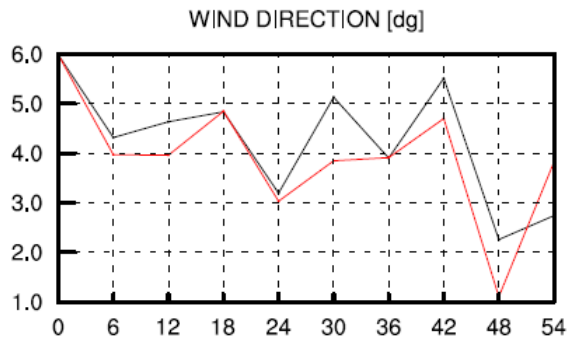
winter

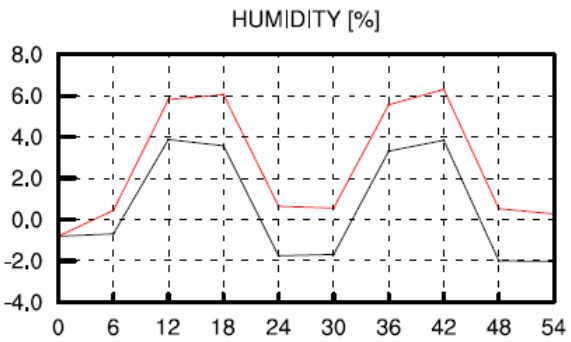


Difference of Temperature bias between the ALARO-1 reference and the experiment
running without the TTE option. In both seasons there is warmer PBL top and
colder surface in the experiment without TTE. There is almost no influence on wind,
neither at the surface. TTE yields better results

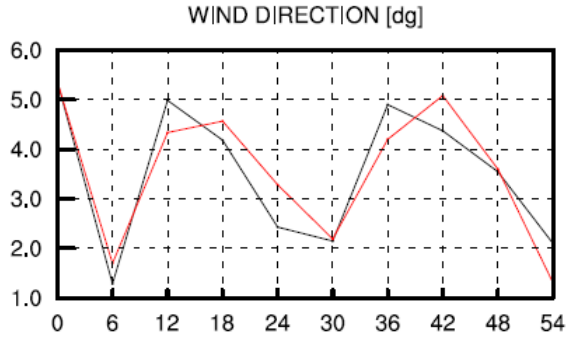
TTE impact on the surface

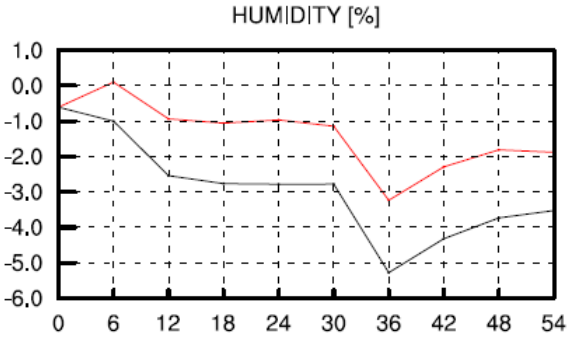
summer





winter



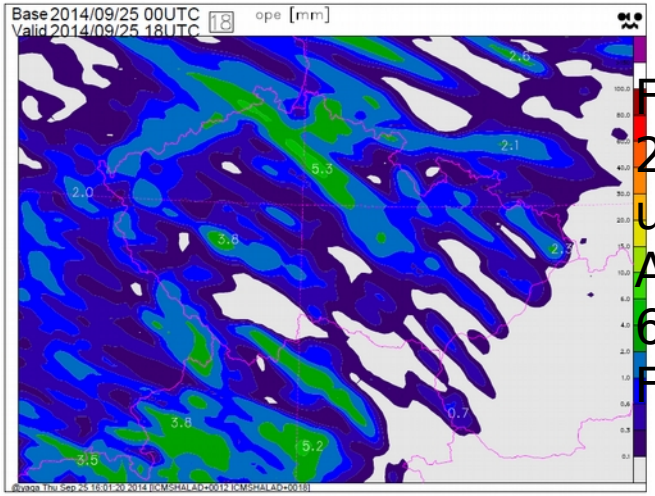


Wind direction and RH bias of the ALARO-1 reference (**black**) and the experiment
running without the TTE option. (**red**). Whilst in wind scores there is no signal, Relative
Humidity is higher in the experiment in both seasons, partly due to temperature bias (colder in the experiment).

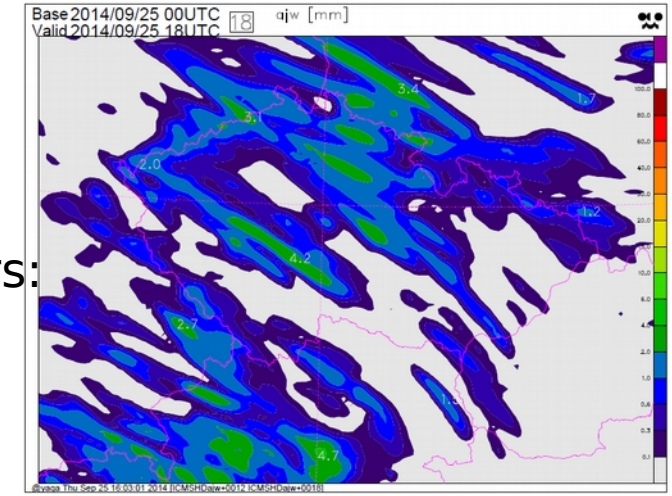
Rain drop size improved distribution

- According to more recent measurements, there is higher amount of small drops than given by the Marshall-Palmer formula, used in numerous bulk microphysics schemes, see Abel & Boutle 2012;
- Better transition of the drop size distribution between large and small drops leads to easier evaporation of small drops => less light rain and drizzle;
- In APLMPHYS, new parameterization was adapted from AB12 proposal by M. Van Ginderachter;
- It applies to the liquid phase only. It modifies the rain rate computations and sedimentation, collection, evaporation and melting.

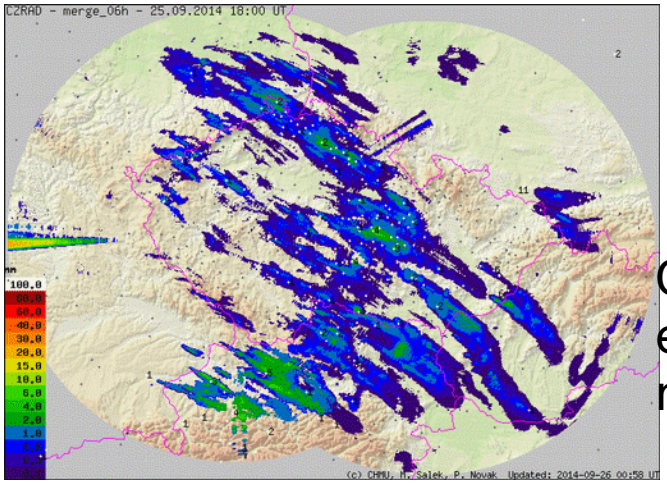
AB12 Impact - showers



Forecast starting at 25/09/2014 00UTC up to +18h.
Afternoon light showers: 6h precipitation sum From 12h to 18h UTC



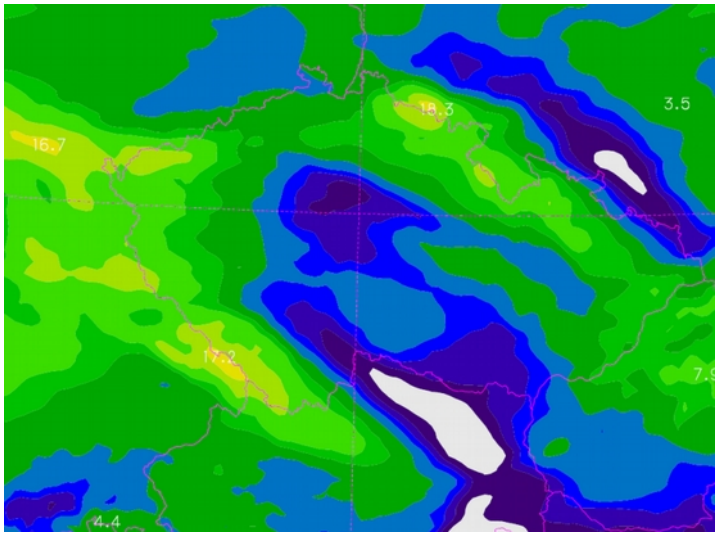
Operational forecast

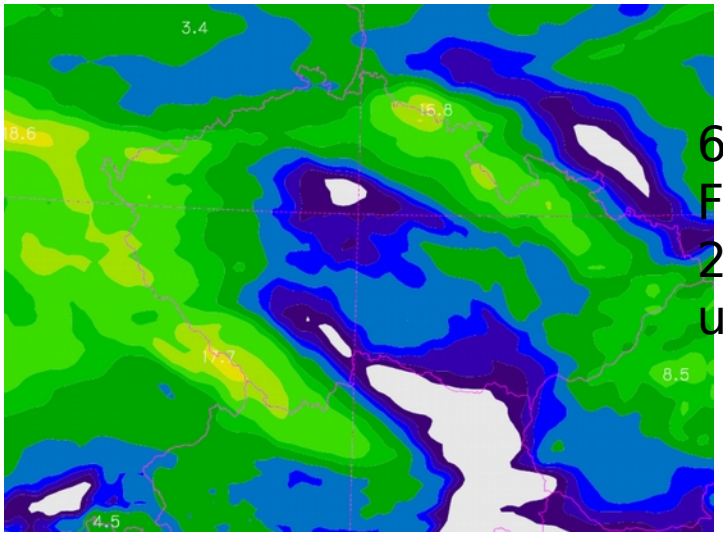


Parallel suite forecast: less areas of weak rain.

Observations – radar estimate combined with rain gauges.

AB12 impact – steady rain



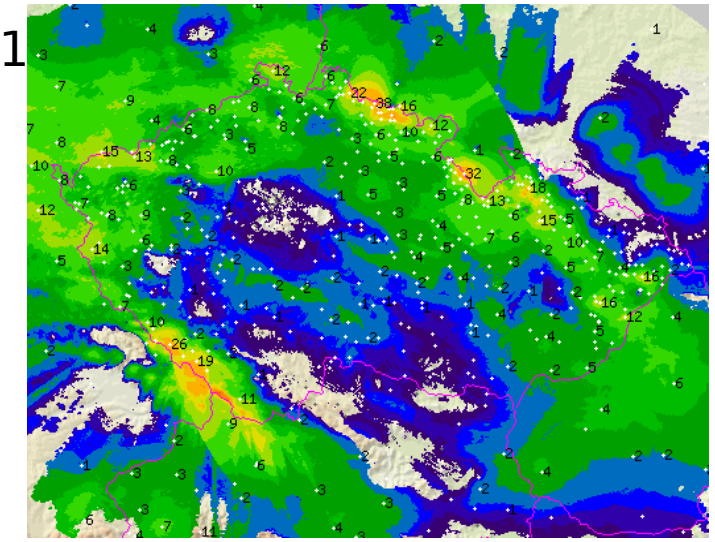


6h precipitation sum
Forecast from
29/03/2015 at 0h
up to 24h

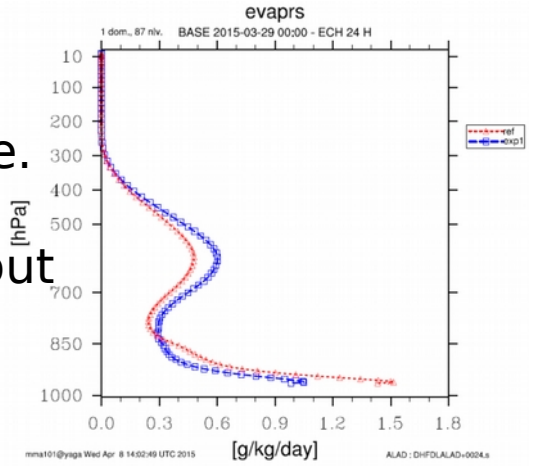
Without AB12 option

Reference ALARO-1

Radar and gages



24h DDH evaporation rate.
ALARO-1 reference
and the experiment without
AB12 option.



Vertical overlap in microphysics

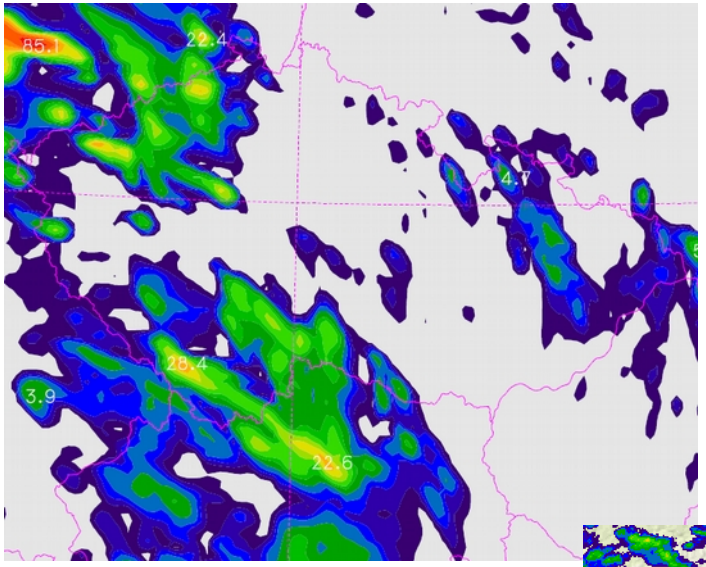
- In ALARO-0 we had for the vertical overlap of clouds and precipitation the widely used maximum-random overlap;
- Paper of Shonk et al., 2010, gives an overview on the vertical overlap parameterization: according to observations and studies focused on the topic (Hogan and Illingsworth, 2000), it is more realistic to avoid extremes of the “maximum” overlap for adjacent levels and “random” overlap for layers with clear sky in between, with the weight ε.

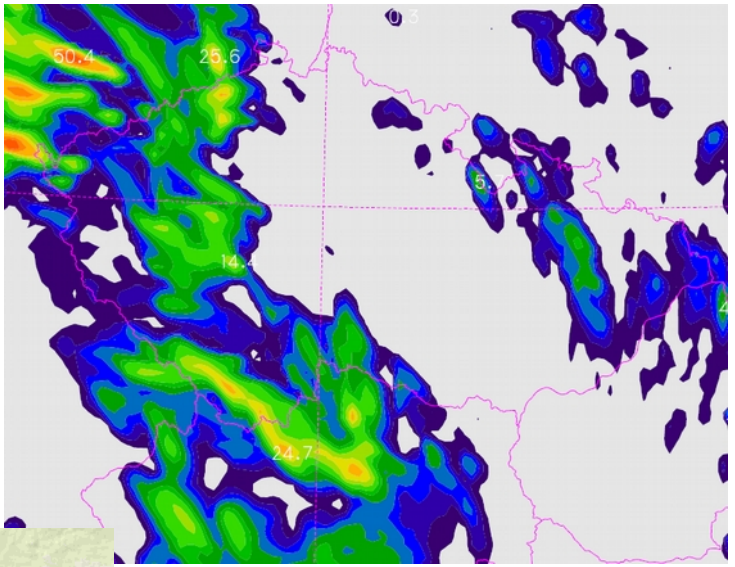
$$\varepsilon_l = e^{-\frac{\Delta p_l}{\Delta p_0}}$$

With big Δp_0 we obtain ε close to 1, hence the maximum-random overlap as befor

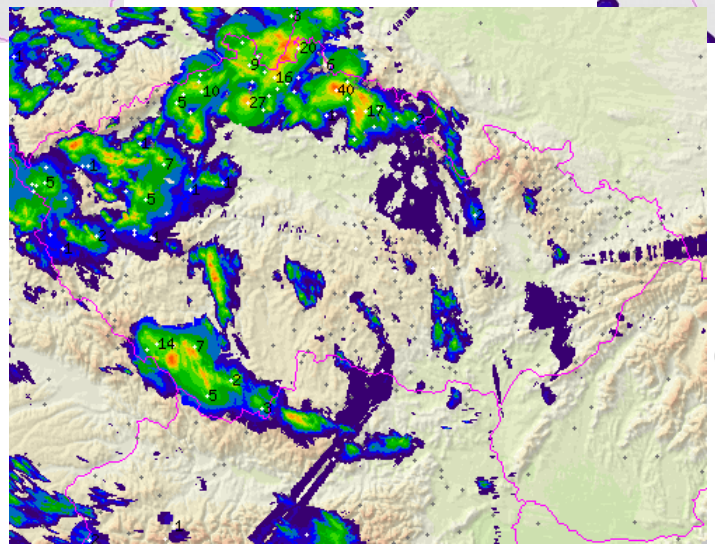
Major contribution by J. Van den Bergh

Vertical overlap in microphysics - impact





ALARO-1 reference



observations

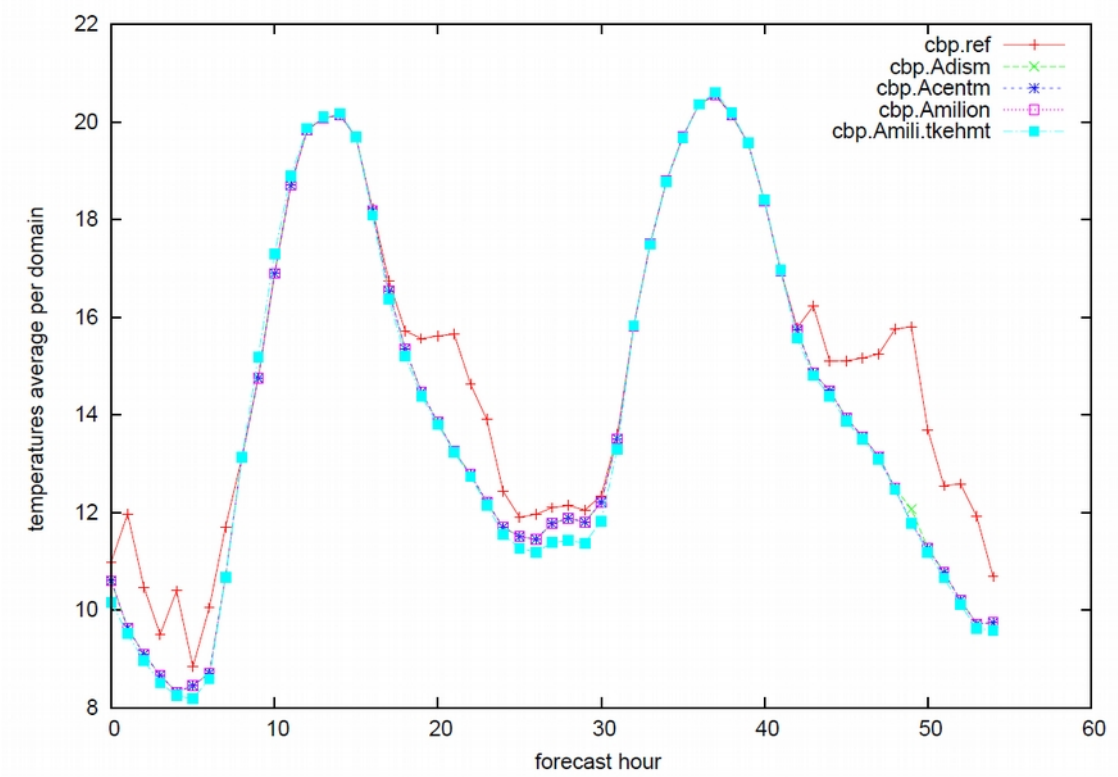
Vertical overlap without the new parameterization

Overlap influences the internal organization of moist deep convection.

Screen level interpolation of T and RH (1)

- To get values of temperature and moisture at 2m above the ground is essential for products and also for the surface assimilation.
- In ALARO there are two options:
  - Original algorithm Geleyn 1988;
  - Updated version (Kullman, Geleyn) with modified interpolation weights.
- None of these solutions is optimal – the original one yields too high horizontal contrasts and colder temperatures, the modified one yields too warm and oscillating solution in warm season nights.

Screen level interpolation of T and RH (2)



emonstration of the problem of the choice of the interpolation weights:
aily cycle of T2m under clear sky stable conditions in the night.

compromise solution is now adopted, in function of exchange coefficie

Complementary tunings

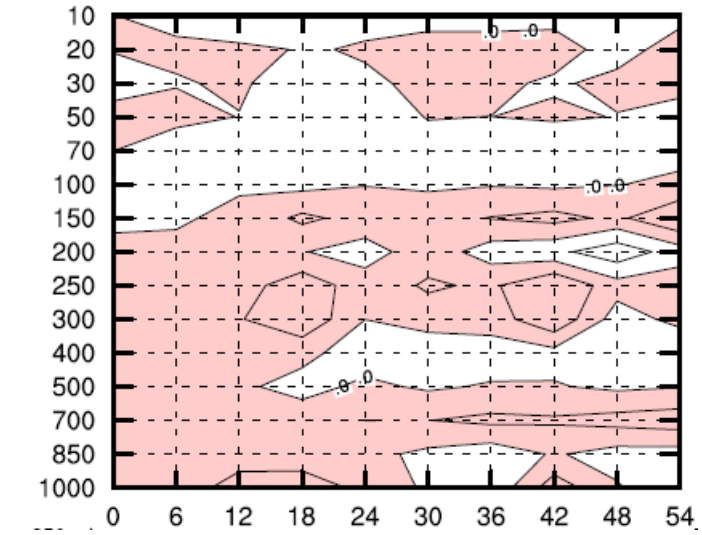
- Vertical modulation of cloudiness used in the radiation scheme (X-R stratiform scheme):
  - Low level clouds are thicker than high level ones;
  - This helps to improve winter season results and is neutral in summer season.
- Automatic modulation of moist deep convection closure to control the proportion of consumption/storage of moist static energy:

$$\mu = min\left(|RMULACVG|, max\left(1., \left(\frac{\Delta x}{1200.} \right)^2 \right) \right)$$

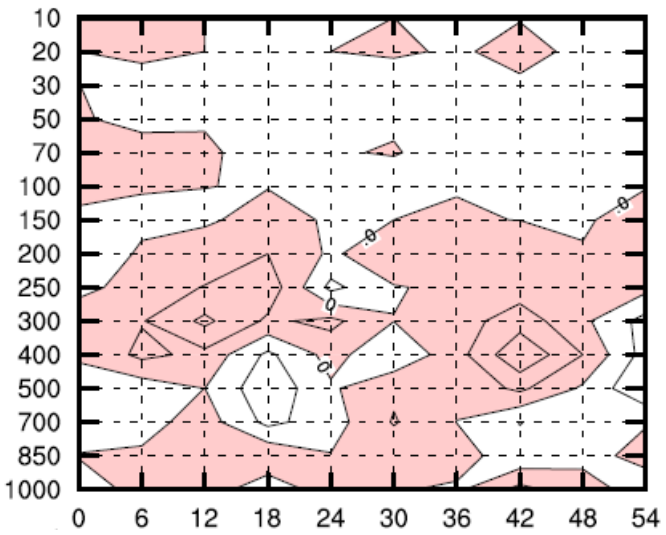
  - Coefficient μ vary according to the mesh size;
  - RMULACVG is a tuning parameter with recommended value -25.

Some scores of ALARO-1

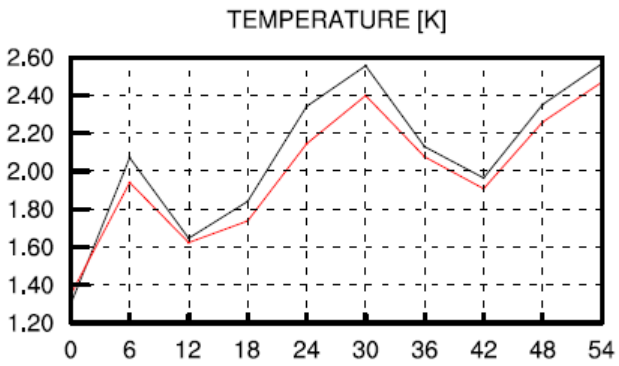
ummer T RMSE **red** = improvement



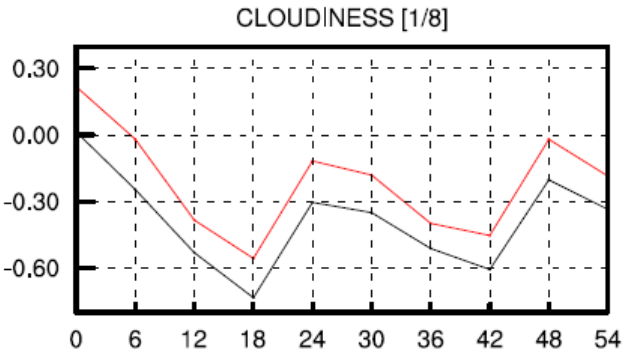
Summer RH STDEV



Winter T STDEV



Winter N bias



Conclusion and Outlook

- ALARO-1 first version has got operational realizations;
- ALARO-1 is **multi-scale**, able to run at various horizontal resolutions, across those of the gray zone of convection down to 1km.
- Ongoing and future work:
  - New shallow convection in TOUCANS;
  - Harmonization of the cloud scheme for microphysics and radiation;
  - Refinements of the moist deep convection;
  - Screen level interpolation.