Regional Cooperation for
Limited Area Modeling in Central Europe

LACE
nwp central europe

Microphysics in 3MT and Grey Zone Experiment

ALADIN/HIRLAM Workshop, 7-11 April 2014

Presentation plan

- Microphysics in ALARO and Tests in Real Forecast Regimes:
  - Use for joint “resolved” and “convective” input – geometry of clouds and rain;
  - Choices at the level of processes;
  - Choices at the level of the sedimentation;
- WGNE Grey Zone Experiment

Summer Mid-Latitude Convection Situation Benchmarks

- Period 21 June to 4 July 2009
  - Relatively weak but spatially large low over Central Europe;
  - Important convection developed every day, accompanied by numerous flash floods;
  - Weak large scale forcing towards the end of the period with a tropical-type diurnal cycle of convection.
- 1 June – 2 June 2013
  - Deep low moving westward, accompanied by floods;
  - Combination of large-scale structured precipitation and meso-scale convection.

geometry: dx=4,7km, 29/06/09 afternoon convection

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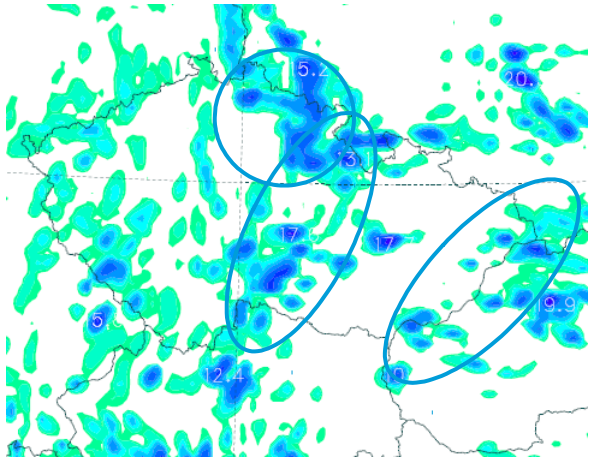
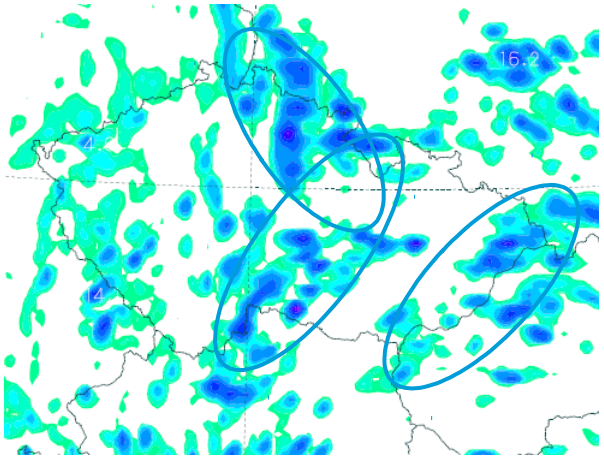
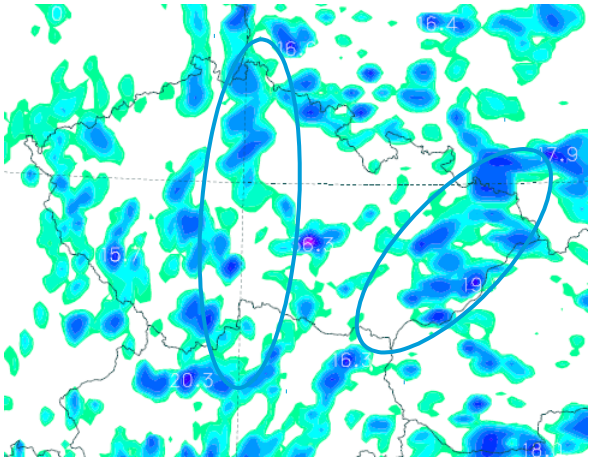


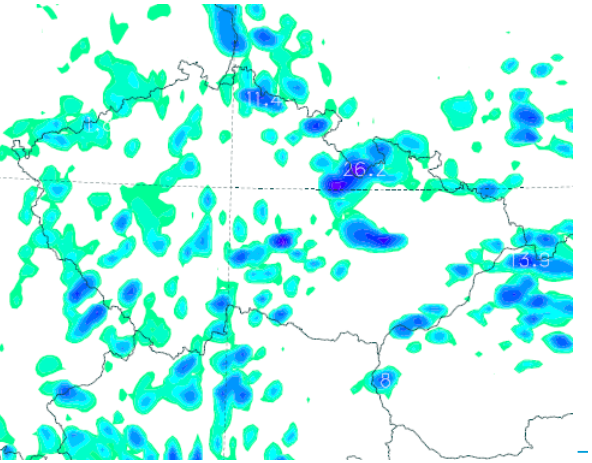




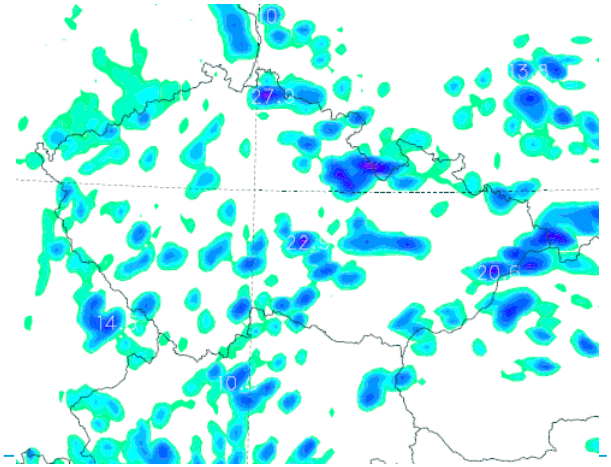
maximum-random

Red circles: agreement with radar on active areas

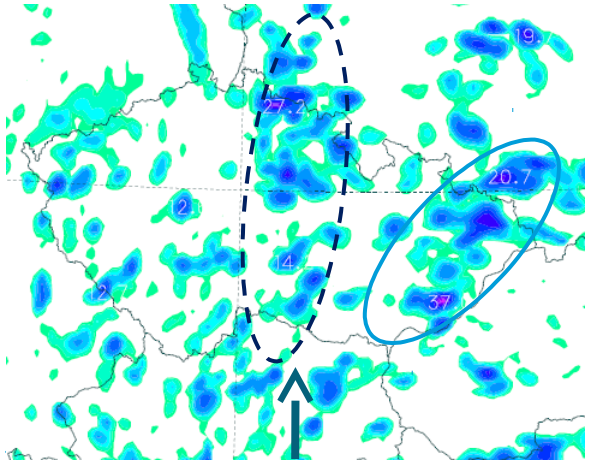
12h



13h

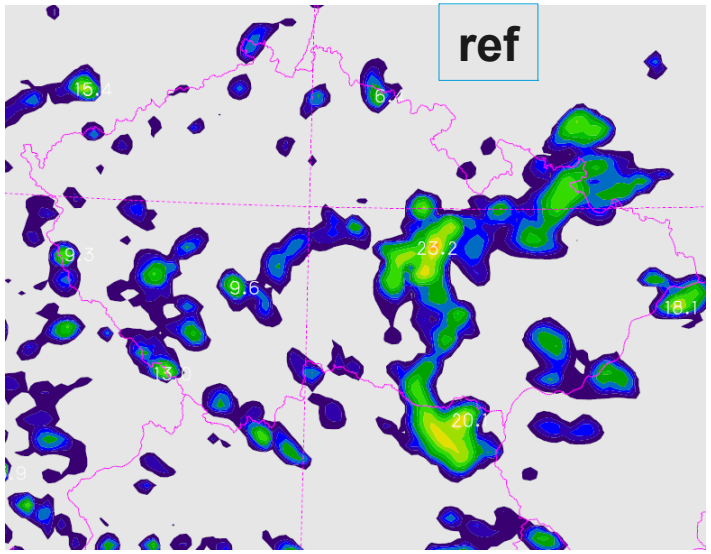


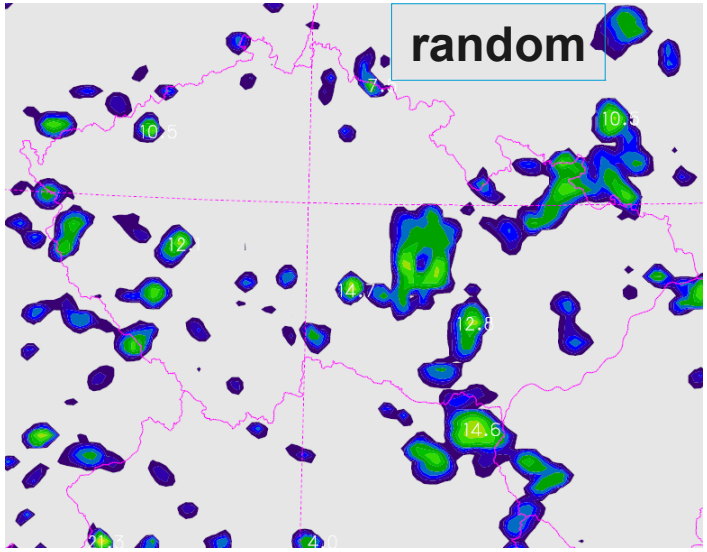
15h

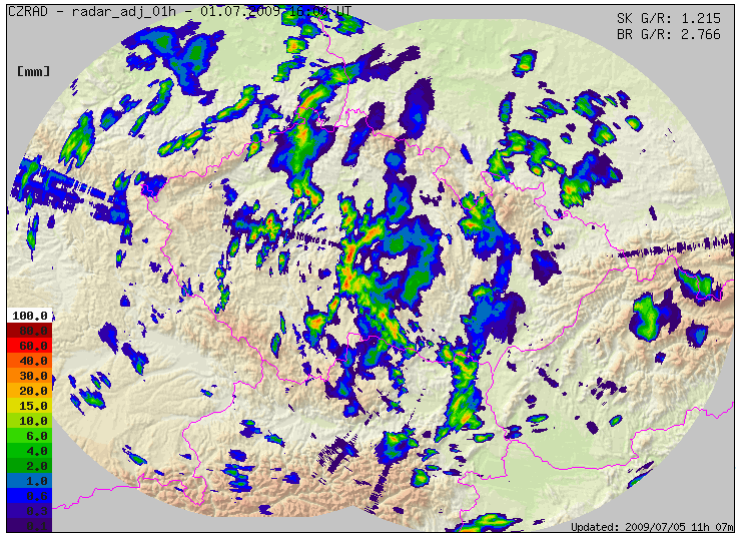


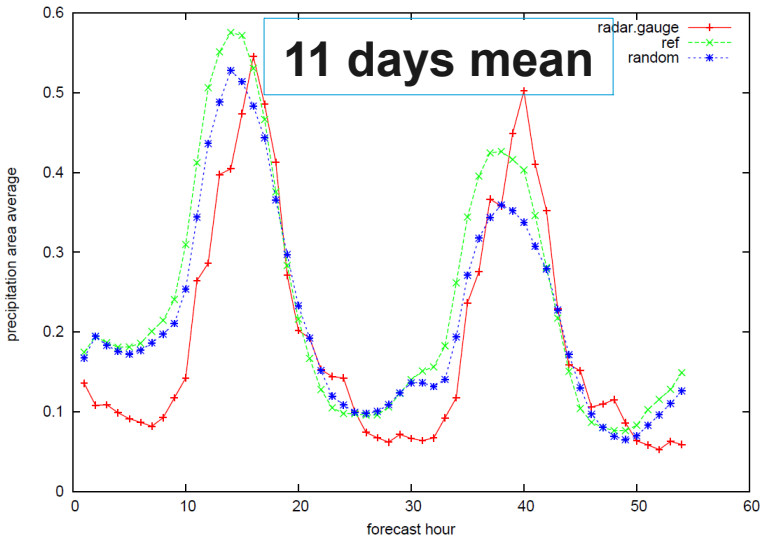
random Areas in agreement but less organized, slower propagation, 50km error in 3h

geometry: dx=4,7km, June-July 2009, structure and diurnal cycle



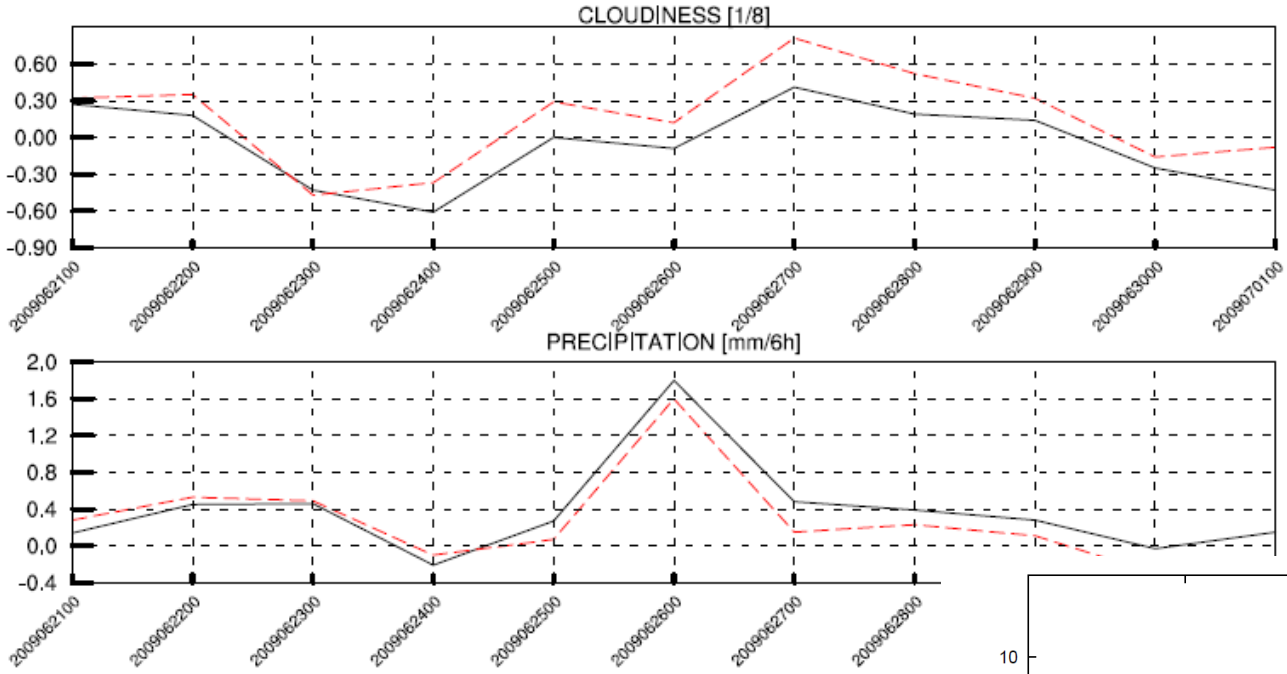






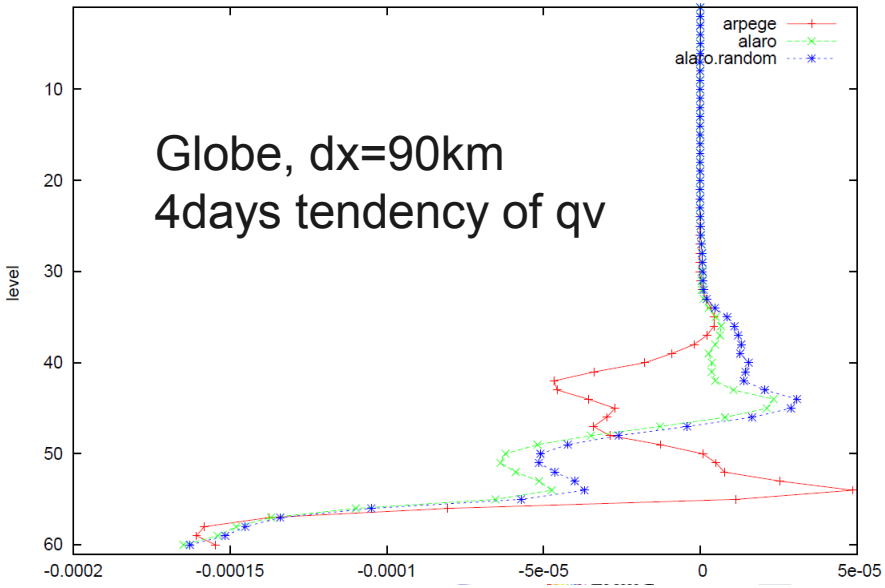
radar
ref
random

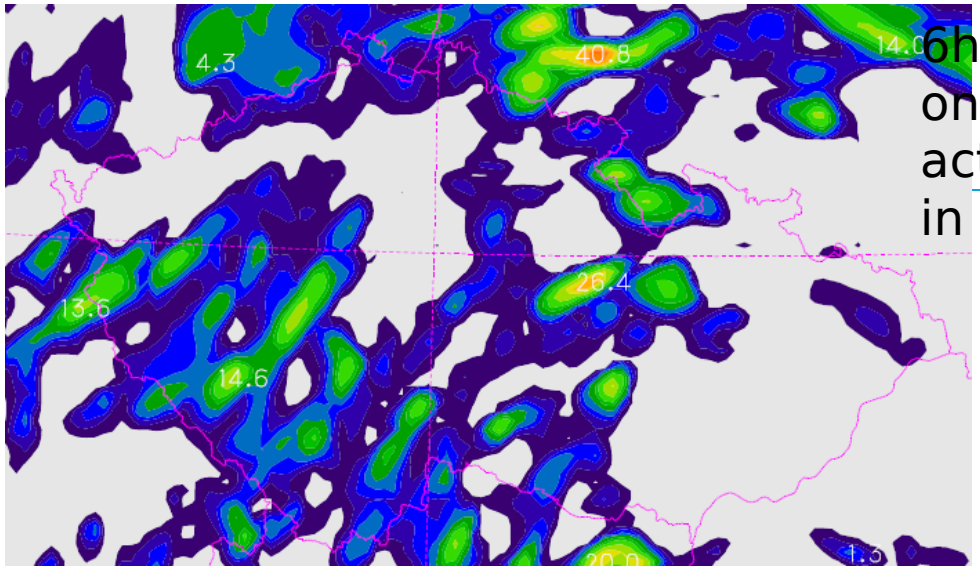
Geometry – bias impact and summing up



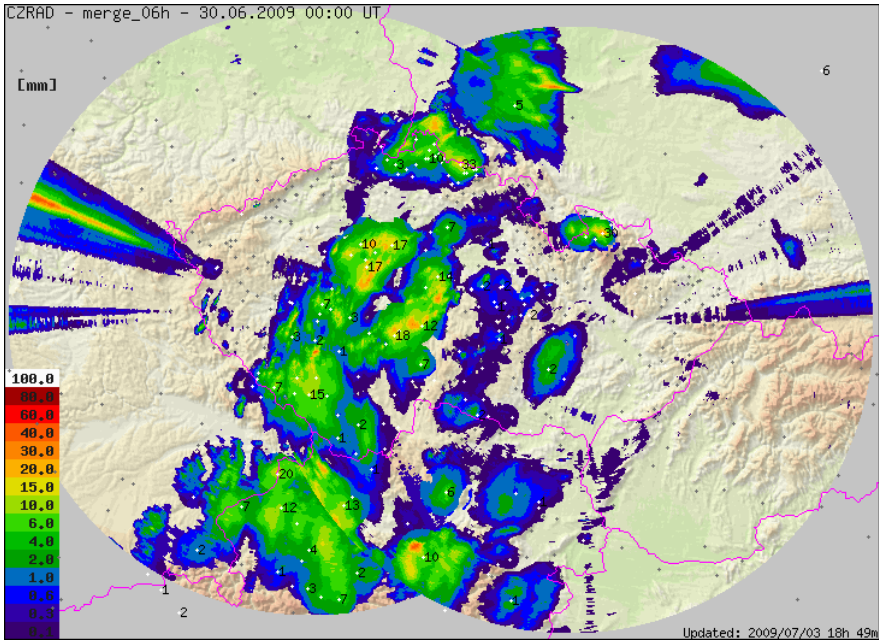
Central Europe, 2009
dx-= 4,7km
------ reference
- - - - random overlap

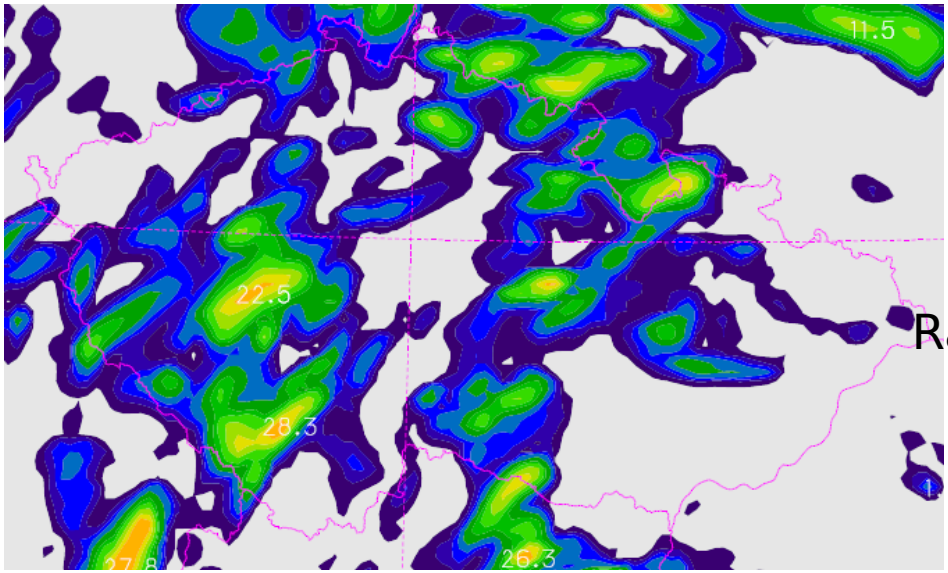
Random overlap in microphysics =>
- more evaporation of falling species
- more cloudiness
- less precipitation
- less good structuration via the cold pool effect of the 3MT scheme.





6h precipitation sum from 18 h to 24h on 29 June 2009. Evening convection activity is usually underestimated, like in the reference run





Radar & gauge precipitation observation

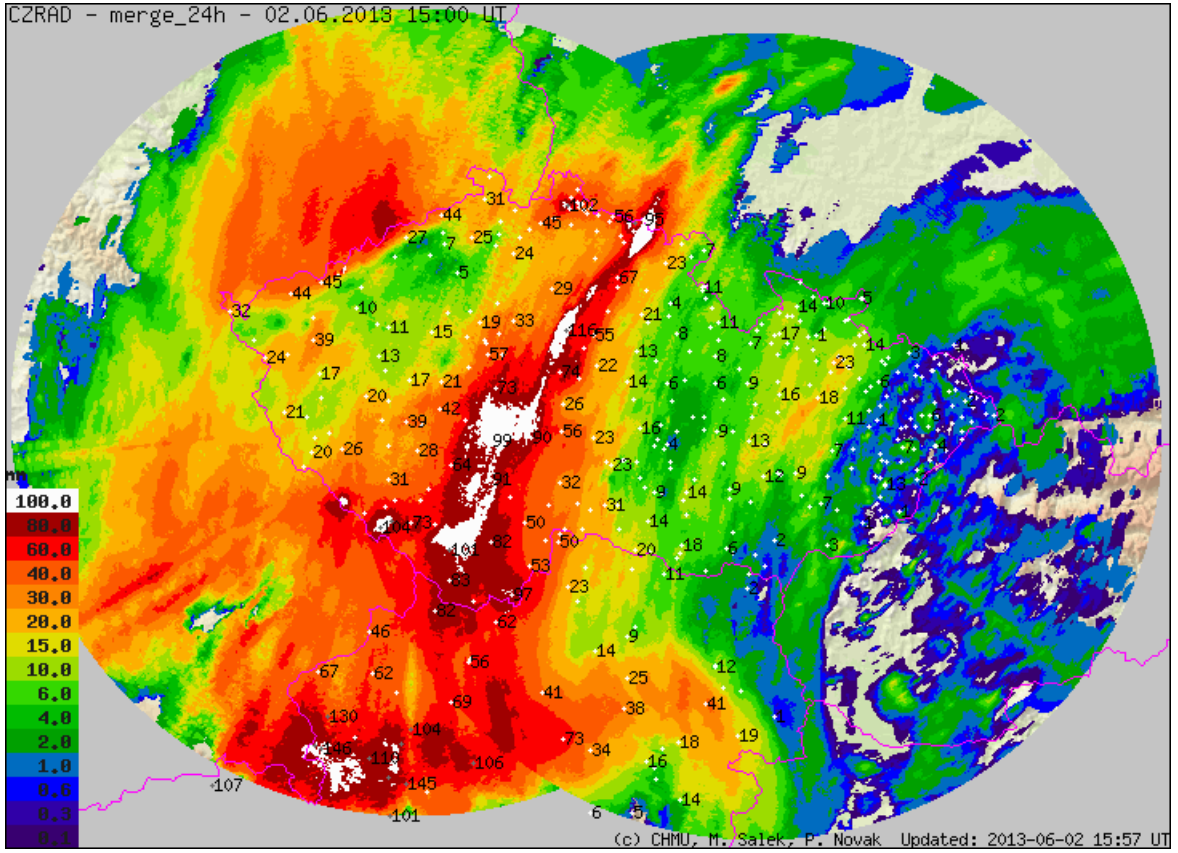
Experiment with ACRANEB2: improvement (stronger evening convection
thanks to a better radiation scheme)

Role of sedimentation and processes

- Sedimentation choices:
  - Statistical and variable fall speeds (ALARO);
  - Semi-Lagrangian and fixed fall speeds (ARPEGE);
- Processes choices:
  - ALARO setup
  - Sundquist type of autoconversion, WBF process added;
  - Kessler type of evaporation/melting/freezing;
  - ARPEGE setup
  - Kessler type of autoconversion;
  - Lopez (2002) derived evaporation/melting/freezing;
  - Cloud ice is not collected by rain;
  - Otherwise the same level of complexity, same basic constants, similar tuning.

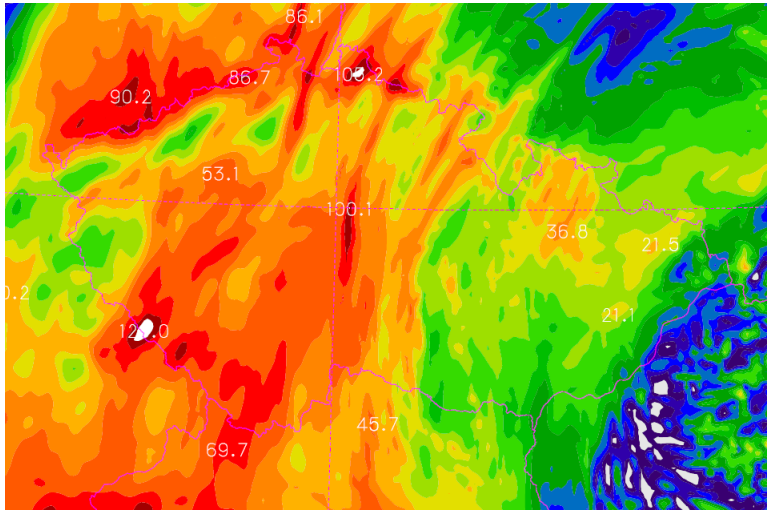
June 2013 flood case extreme precipitation

- 24h precipitation sum from June 1 , 15UTC to June 2, 15UTC.
- Merge of rain gauge measurements and radar estimation – more than 100mm/24h.
- Very difficult to forecast.
- High resolution (2,2km), NH, meso-scale initial conditions.

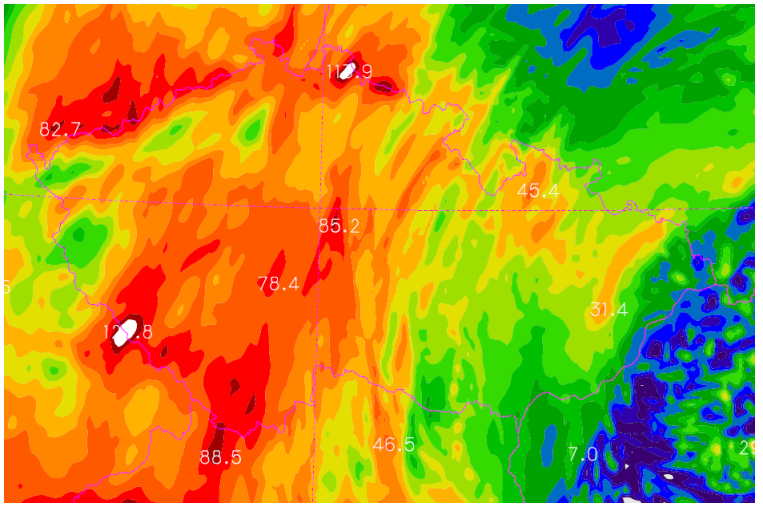


June 2013 flood case extreme precipitation

ALARO reference, 24h sum P27h-P3h

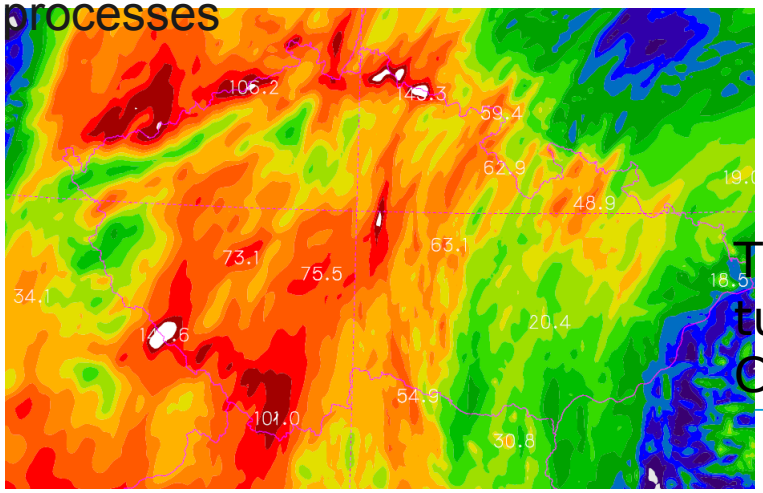


Change in the sedimentation



Very similar result, a bit more spread

Change in the sedimentation & processes



Less spread, more intense maxima – there is a compensation.

There is not so large impact (more matter of tunings). Further tests done for the WGNE Cold air outbreak case.

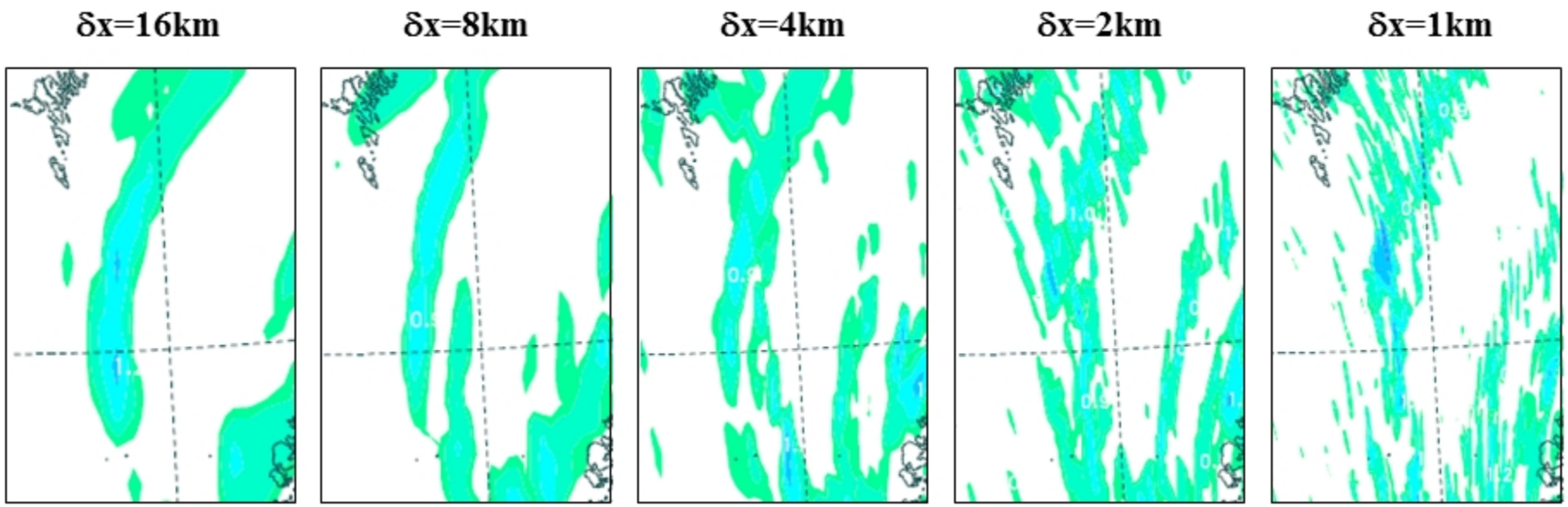
Partial conclusions

- There is some sensitivity to the choices in cloud and rain geometry, sedimentation and parameterization of processes, however ..
  - Complexity of the operational model's microphysics is not so pushed (still one moment scheme, etc.);

WGNE Grey Zone Experiment

- Cold Air Outbreak Case:
  - Run from 30 January 2010, 12 UTC, up to 36h;
  - Tests across horizontal resolutions 16km, 8km, 4km, 2km and 1km: a very good testbed for the multi-scale convection parameterisation like 3MT.
- Here we use the experiment framework to look at the convection parameterization interplay with the rest of the model physics.
  - Configuration named “3MT in ARPEGE” : the other parameterisations than 3MT are kept like in the global model ARPEGE;
  - Tests are made at 2km horizontal resolution (realistic and still reasonably cheap).

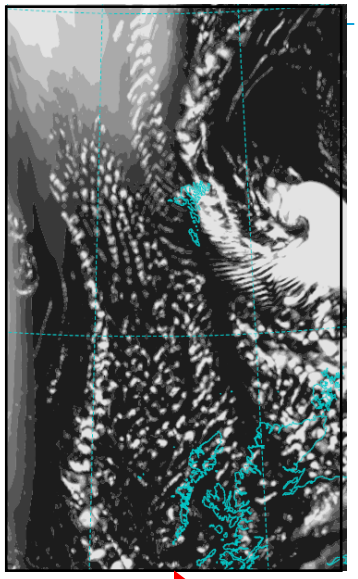
ALARO “seamless” forecast: precipitation

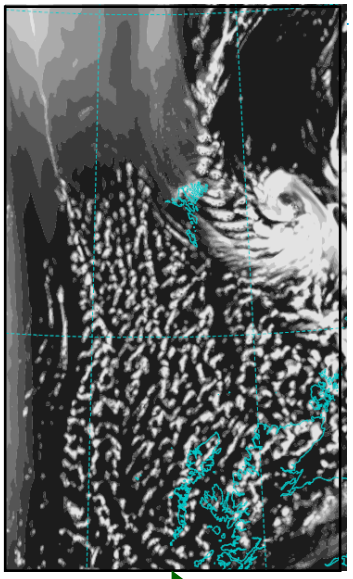


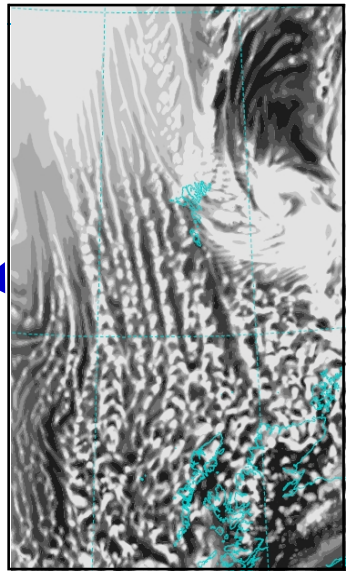
1h precipitation sum from +30h to 31h, forecast base 30 January 2010, 12h UT
area between Faeroe and Orkney islands.

Cold air outbreak; WGNE grey-zone test; parameterisation schemes' dichotomy

3MT-in-ARPEGE — **δx=2km - 24 h cloud-cover (from 30/01/10 12UTC)** — **ALARO-0 (A2Rad)**





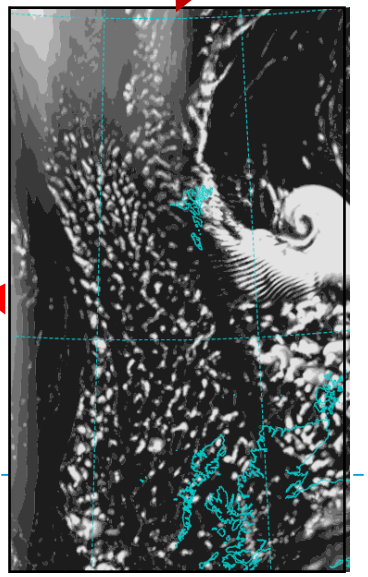


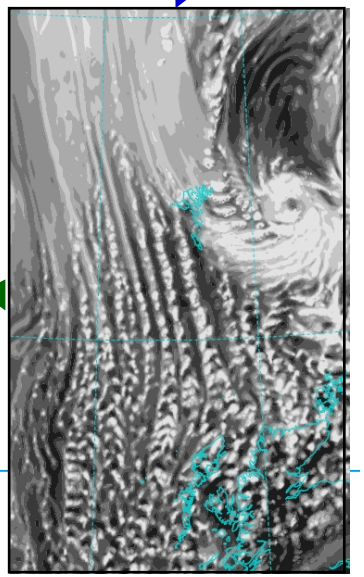
Δ = (moist) turbulence

Δ = therm. adj. & miscellaneous

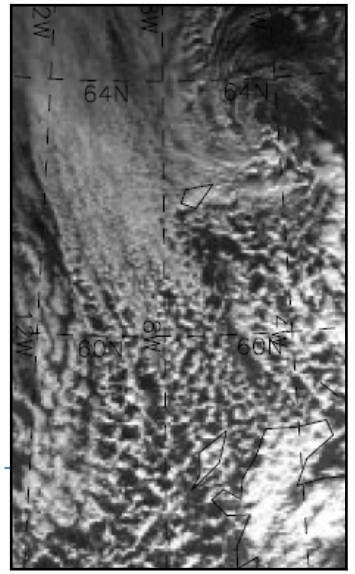
Δ = micro-physics

Δ = radiative cloud-cover



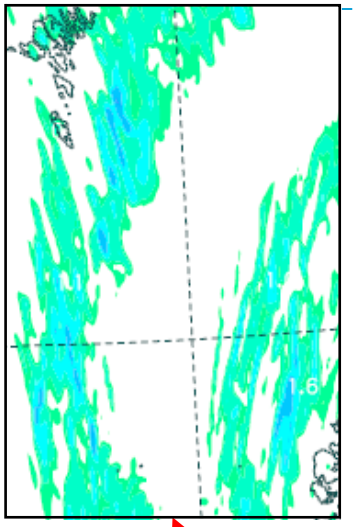


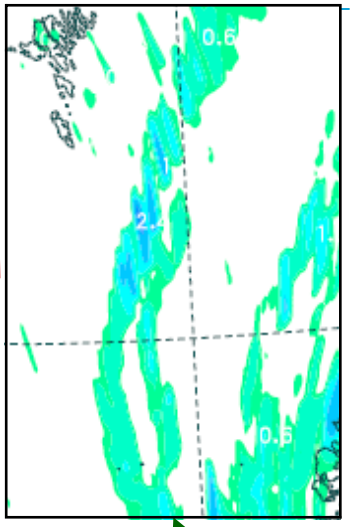
MODIS observation

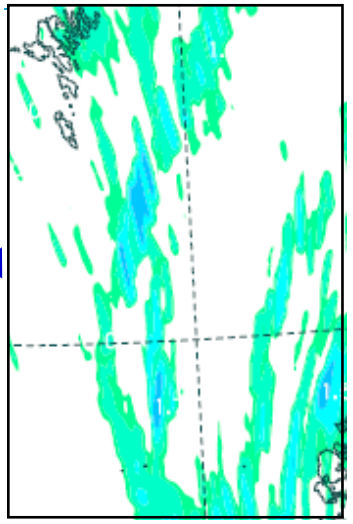


Cold air outbreak; WGNE grey-zone test; parameterisation schemes' dichotomy

3MT-in-ARPEGE — **δx=2km - 30-31 h precipitations (from 30/01/10 12UTC)** — **ALARO-0 (A2Rad)**







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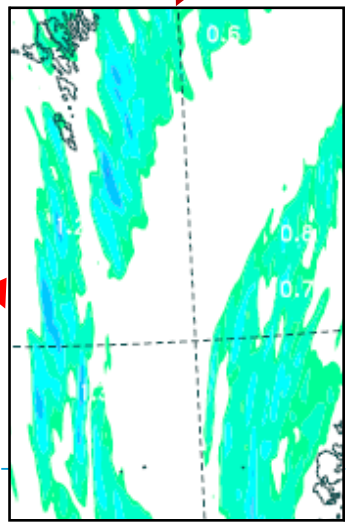

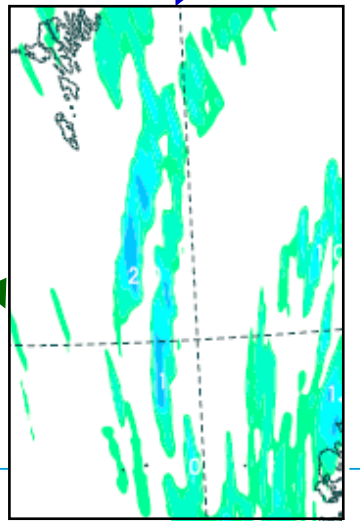

Cold air outbreak; WGNE grey-zone test; parameterisation schemes' dichotomy

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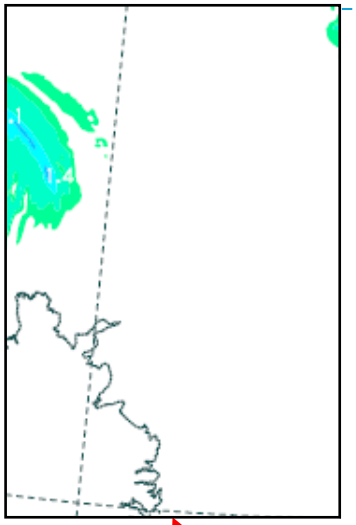

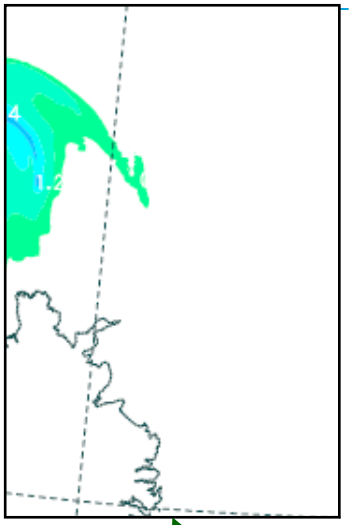

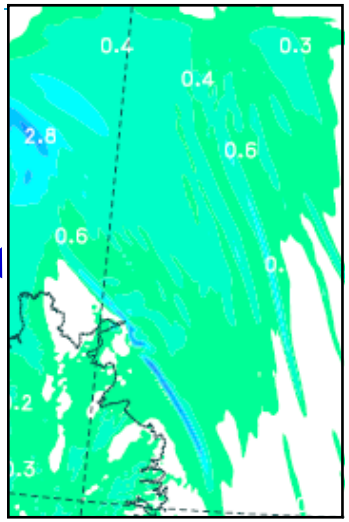

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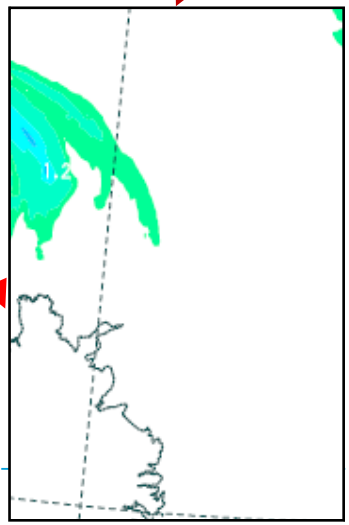

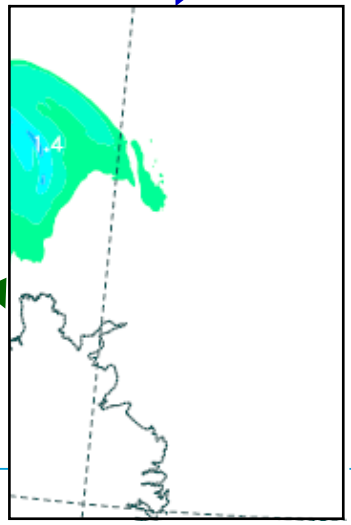

Δ = micro-physics

Δ = radiative cloud-cover

Conclusions

- Largest microphysical impact on the forecast:
  - phase changes of falling species (e.g. cold pool effect due to evaporation etc.);
  - Geometry of cloudiness and precipitation (e.g. intensity and propagation of convective cells).
- Microphysics has also important indirect impacts (e.g. via radiative cloudiness input).
- ALARO with 3MT provides a consistent forecast across the horizontal mesh box sizes down to 1 km. This was outlined at the COST ES0905 final workshop as a key result of the Action (Toulouse, March 2014).