Existing Validations

And associated problems

Plan of the lecture

- Validation tools and problems
- Validation of new bricks
  - pTKE in turbulence
  - Cloud-model in radiation
  - Condensation/evaporation
  - Elements in microphysics
  - Cascade in APLPAR
  - 3MT

Validation tools

- Classical approach:
  - academic test, when possible;
  - if OK one proceeds to 1D model and comparison to observation campaigns;
  - then 3D model with DDH (not yet available with new pseudo-fluxes);
  - structure of fields;
  - values of fluxes;
  - scores;
  - spatial structure of differences and errors;
  - tests of the algorithms: negative values, test of the sum of fluxes, test of stiffness, etc.

Validation problems

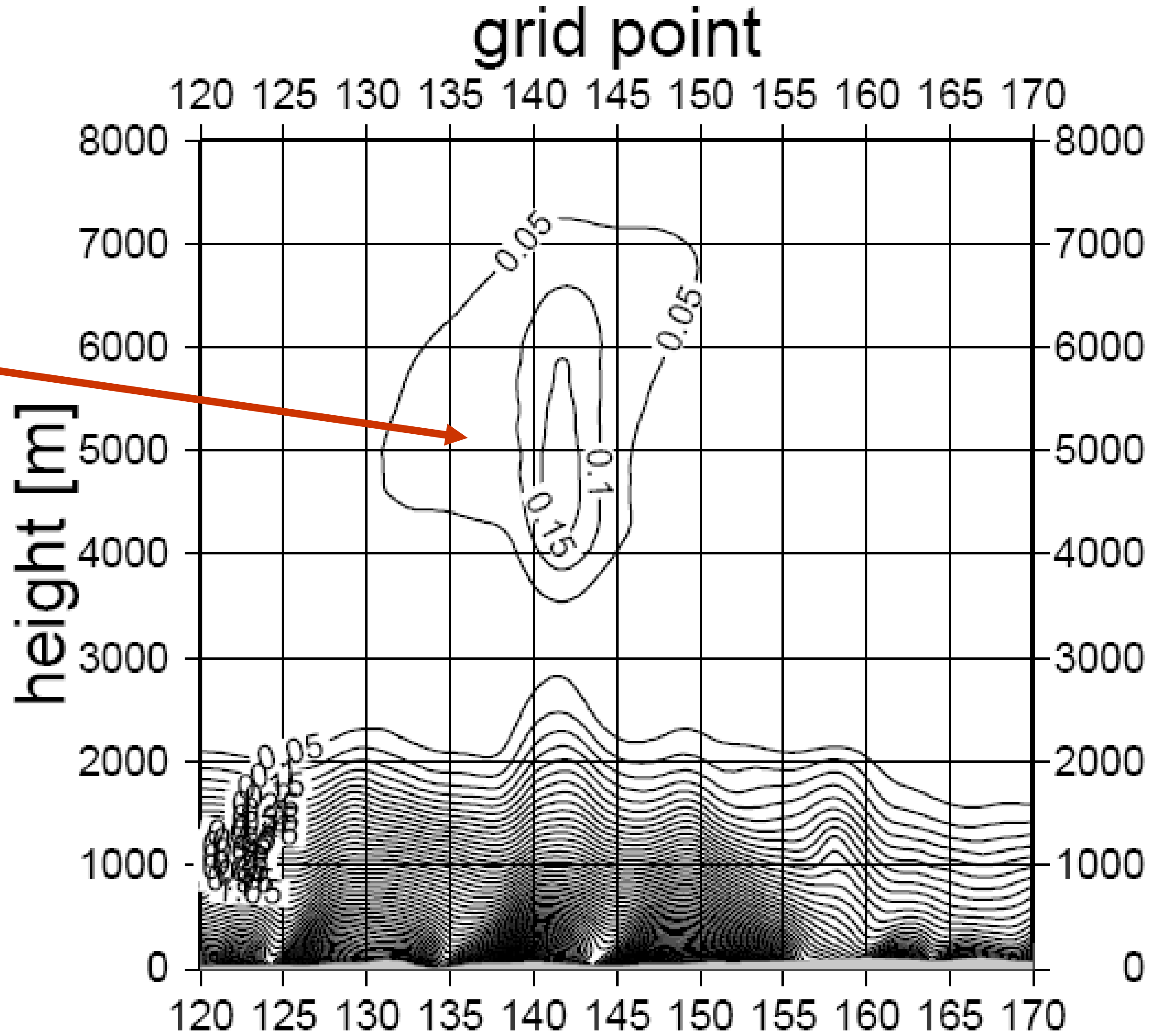
- The classical validation tools are not all always available, one has to invent something else to replace the missing tool(s).
- There are feedbacks in the 3D model: this makes the validation and tuning of physics much more tricky compared to dynamics!
- The philosophy of ALARO-0 is to build on the safe, operationally proven bricks, and to add the novelties carefully. Despite this we had some surprises, especially in the water cycle part.

Pseudo-prognostic TKE scheme

- 1D model: GABLS experiments, see Filip's lecture
- 3D model tests:
  - see how TKE values are realistic – comparison to AROME values (and maybe further retuning could be done)
  - see shape of the TKE field: vertical cross-sections
  - compute scores to verify that there is no deterioration, look at the top PBL values

Values and shape of TKE

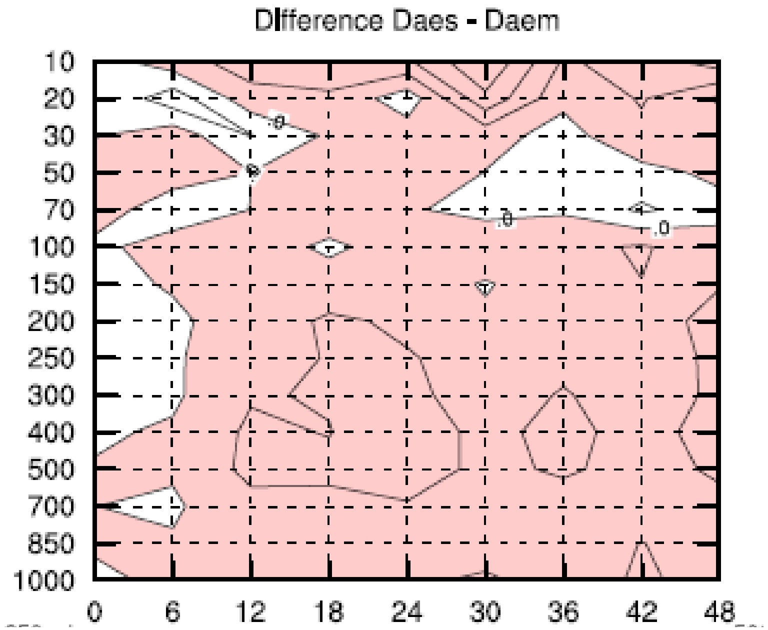
Tropopause
Folding
(local maximum)

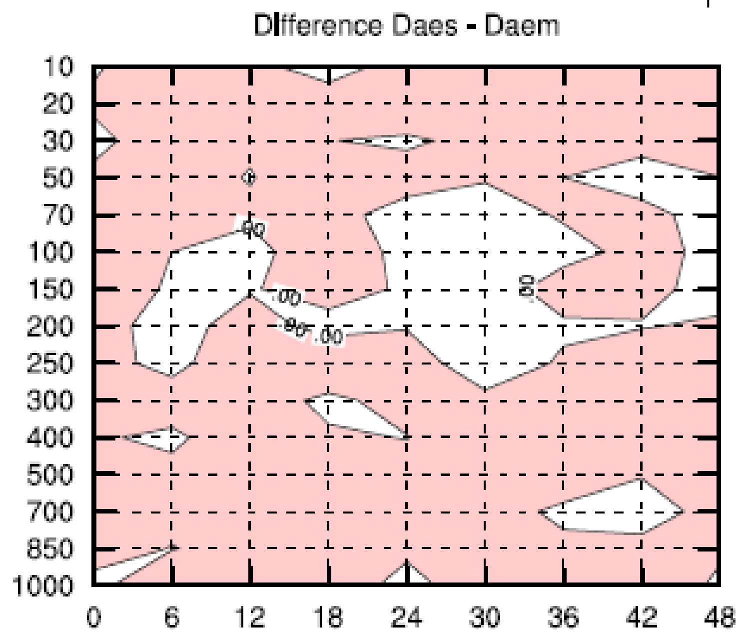


Strongest values:
boundary layer

Field is realistic

3D tests with scores

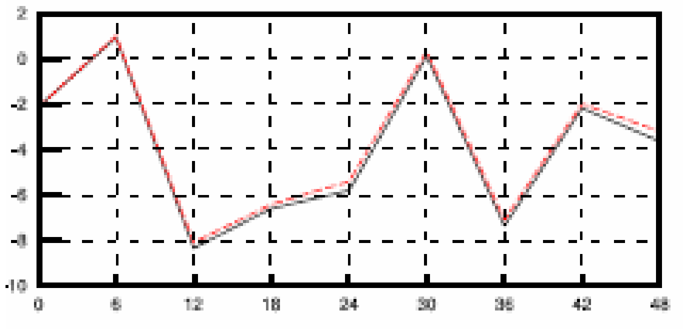




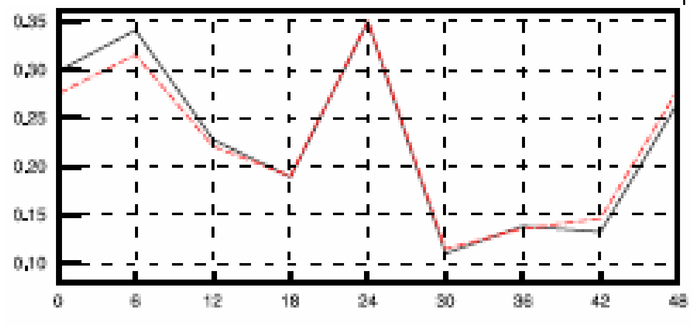
RMSE difference maps

pTKE – Oper, vs TEMPs (8 days): left geopotential (m); right: temperature (K). Negative values (color) -> e-suite is better.

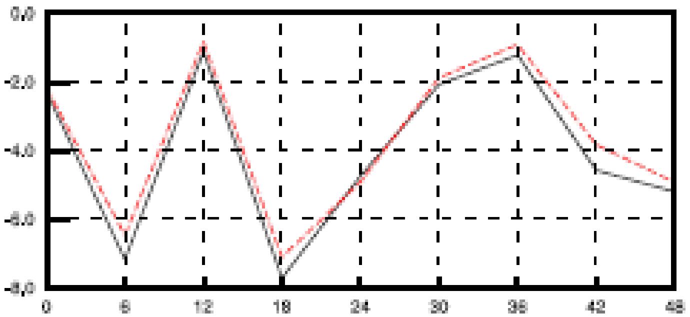
3D test with scores (2/2)



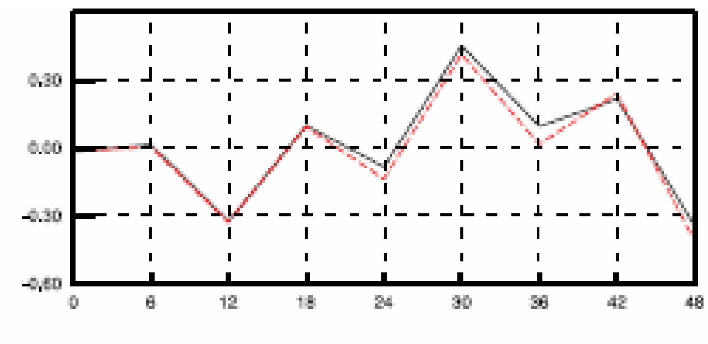
Z500



T850



RH850



W700

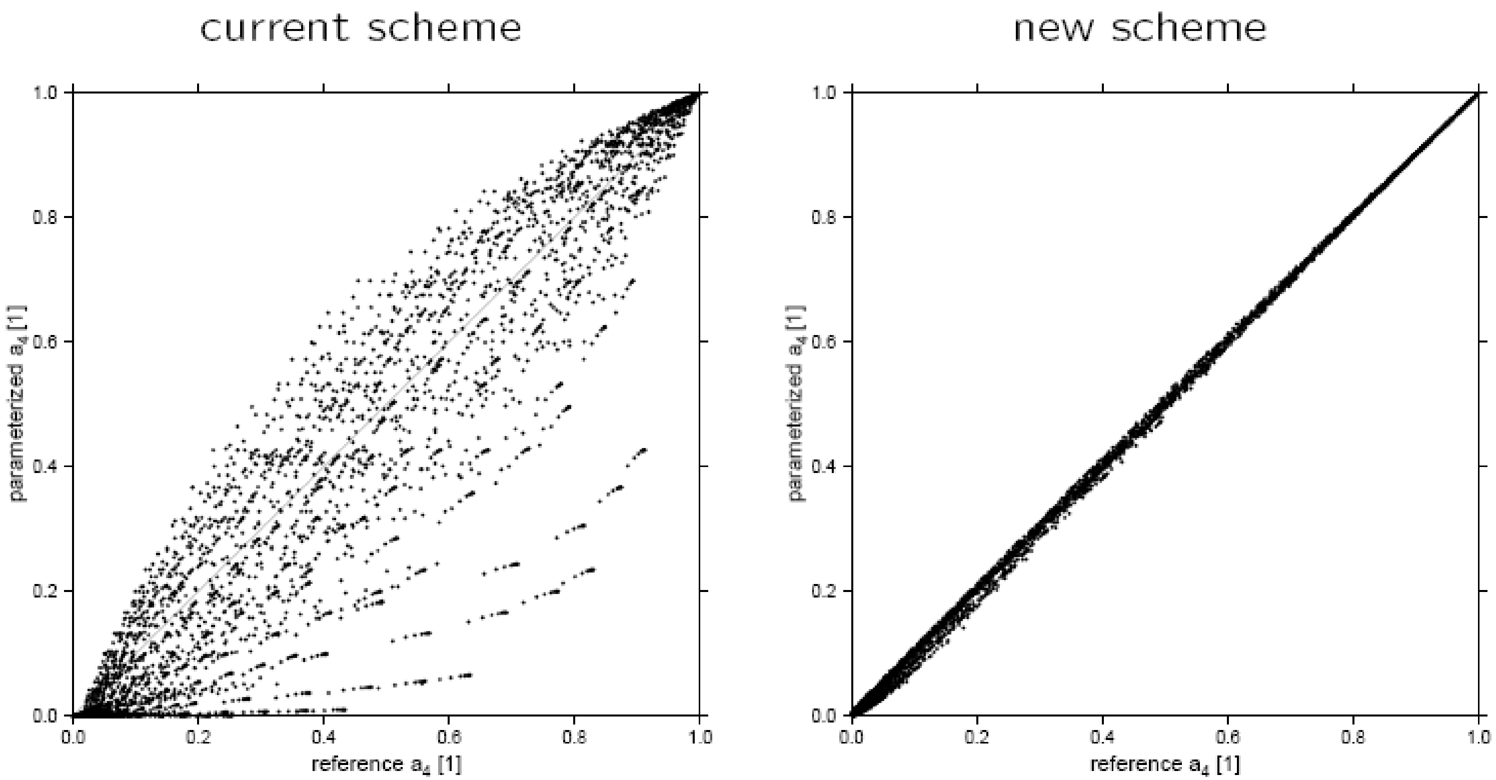
Bias: black solid: operational, red dashed: pTKE

Cloud model (LCLSATUR): optical properties

- Verification using the ideal homogeneous cloud
- Looking at the vertical profiles of solar band absorption
- Comparison with other radiation scheme while keeping the same cloudiness – checking cumulated fluxes
- Computation of scores

Ideal cloud experiment: comparison of old and new cloud model

Parameterized versus reference total transmittance T,
sample of homogeneous clouds
(solar band, $\mu_0 = 0.1, 0.3, 0.5, 0.7, 0.9$)



Tuning the cloud absorption saturation for solar band

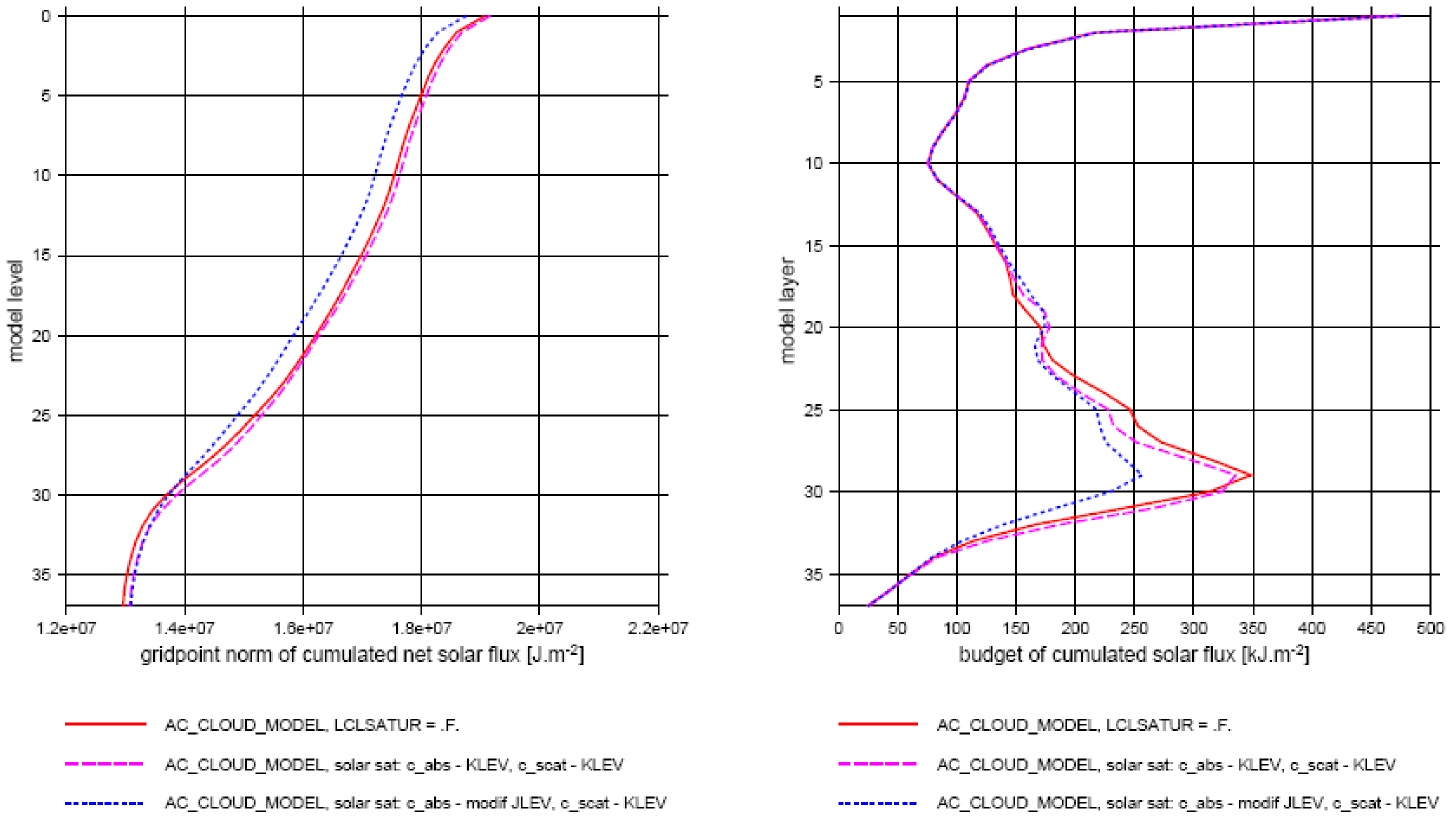


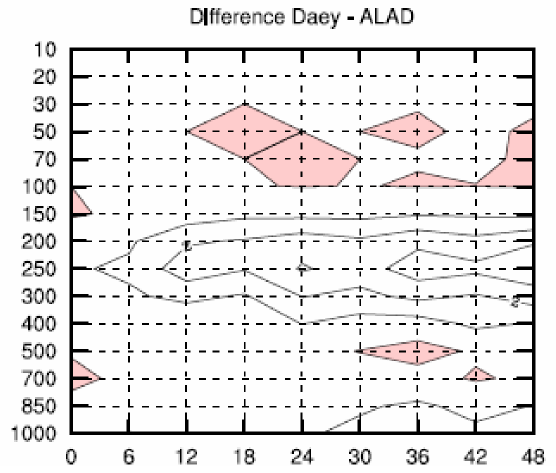
Fig. 2: 24-hour cumulated values: left – net solar flux, right – solar budget.

Condensation/evaporation

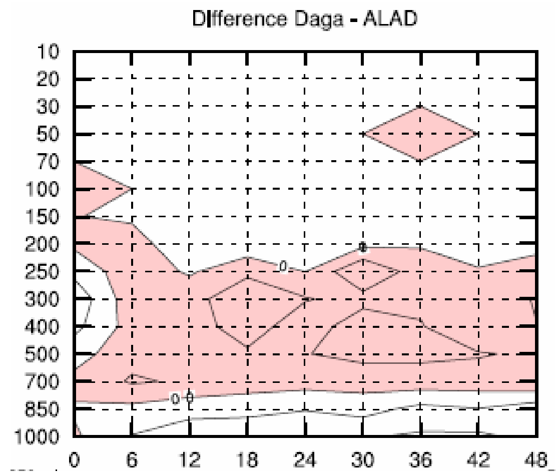
- Computation of resolved condensation fluxes is an important input for microphysics
- It determines the portion of moisture entering the precipitation process and the one remaining in the air
- It is based on finding a point of equilibrium, taking into account the critical humidity, which depends on the mesh-size; “washing-out” mechanism is a major tuning parameter.

Score of QV pending the washing-out

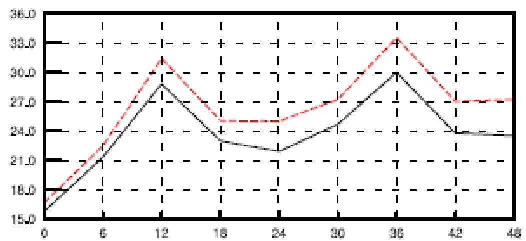
Bias of RH vs TEMP



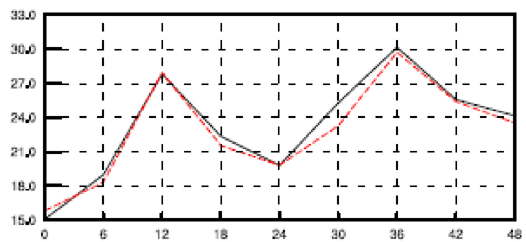
Saturation equilibrium as if N=1 in the whole grid-box



Wash out active



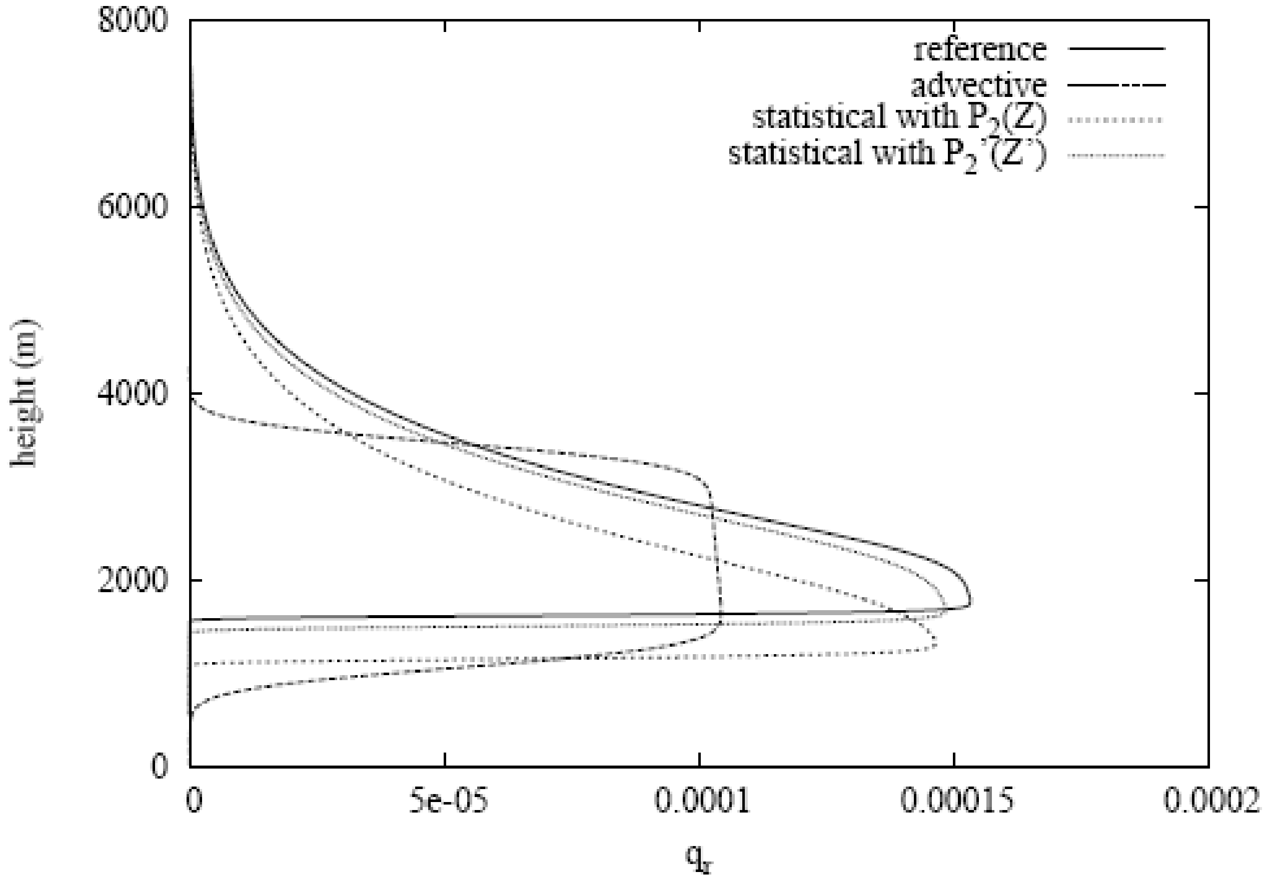
250 hPa



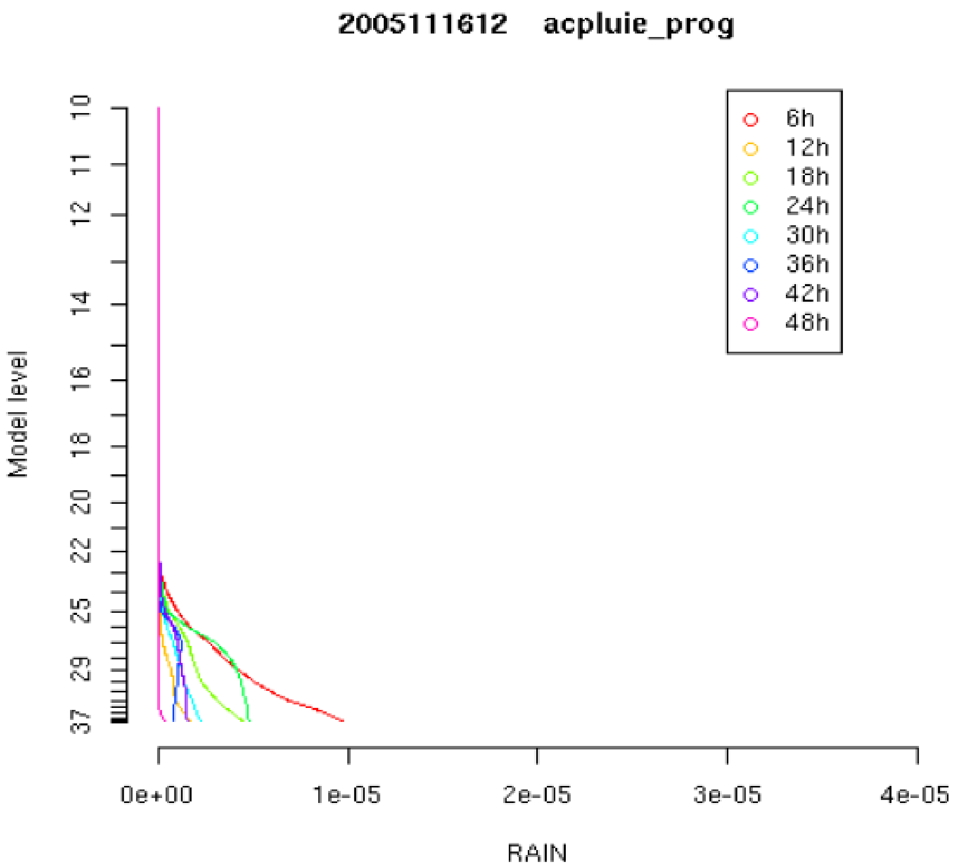
Microphysics

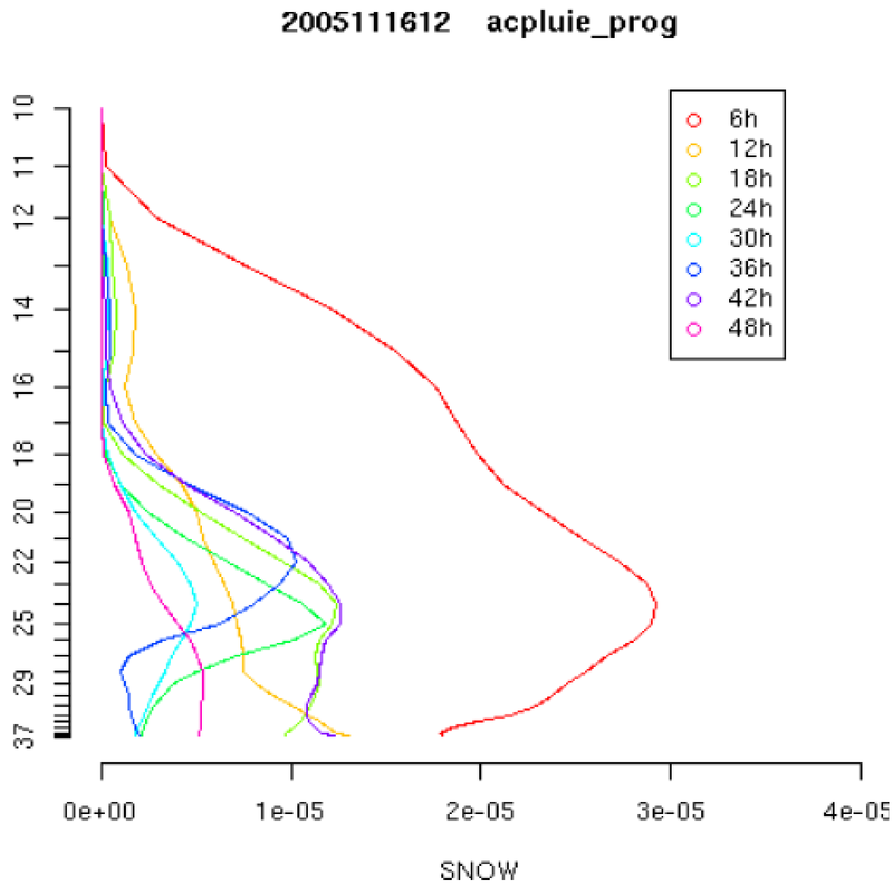
- Auto-conversion (including the Wegener-Bergeron-Findeisen process): which time characteristics?
- Evaporation/melting (it is made like in ACPLUIE)
- Falling speed of precipitation – sedimentation scheme
- Need to check: amounts of QV and water species

Statistical sedimentation: idealized test of "falling" cloud



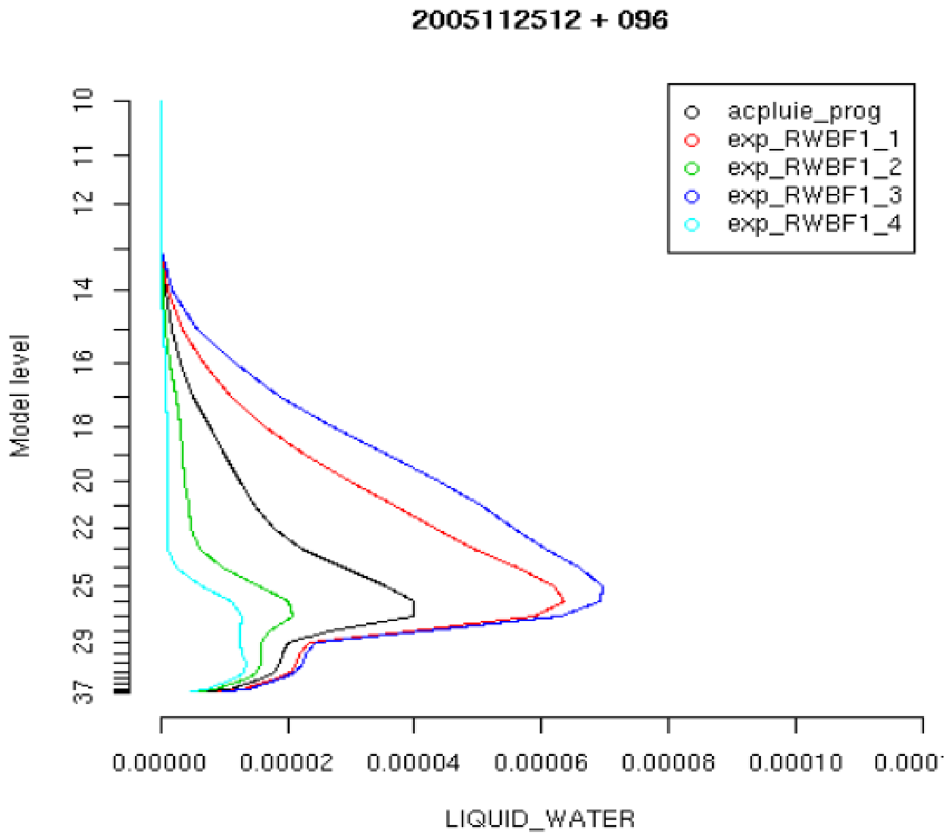
3D tests: vertical profiles of water species

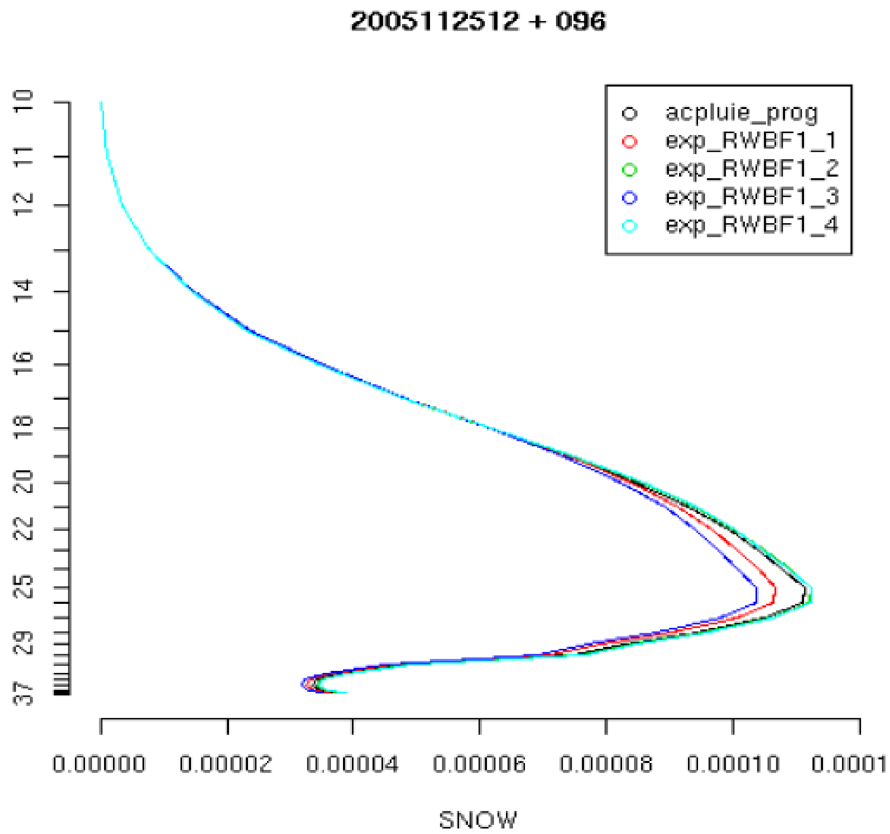




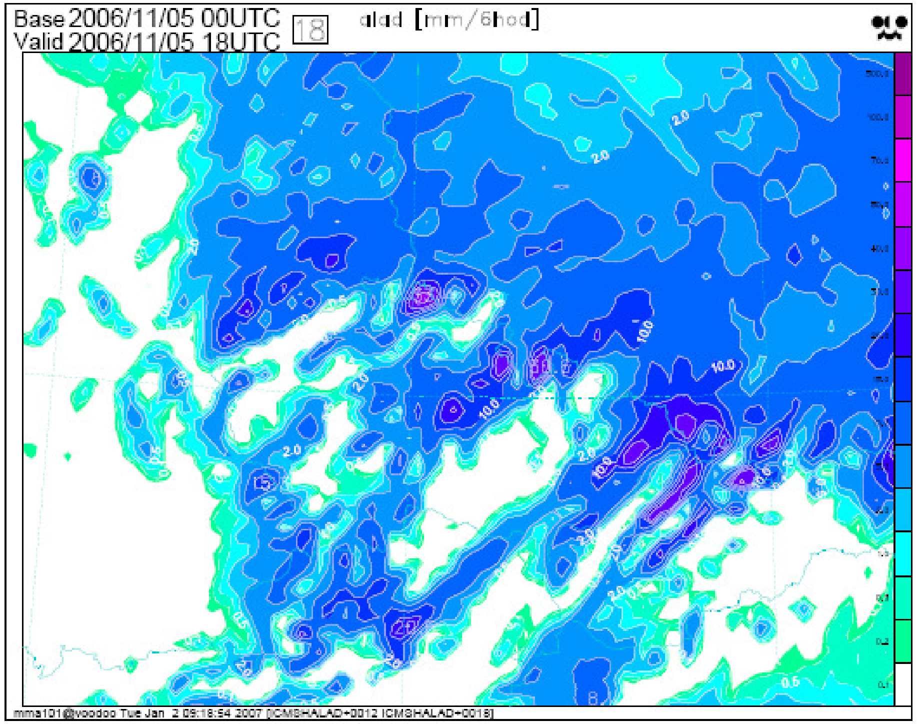
Test of WBF coefficients: values from 30 to 30000

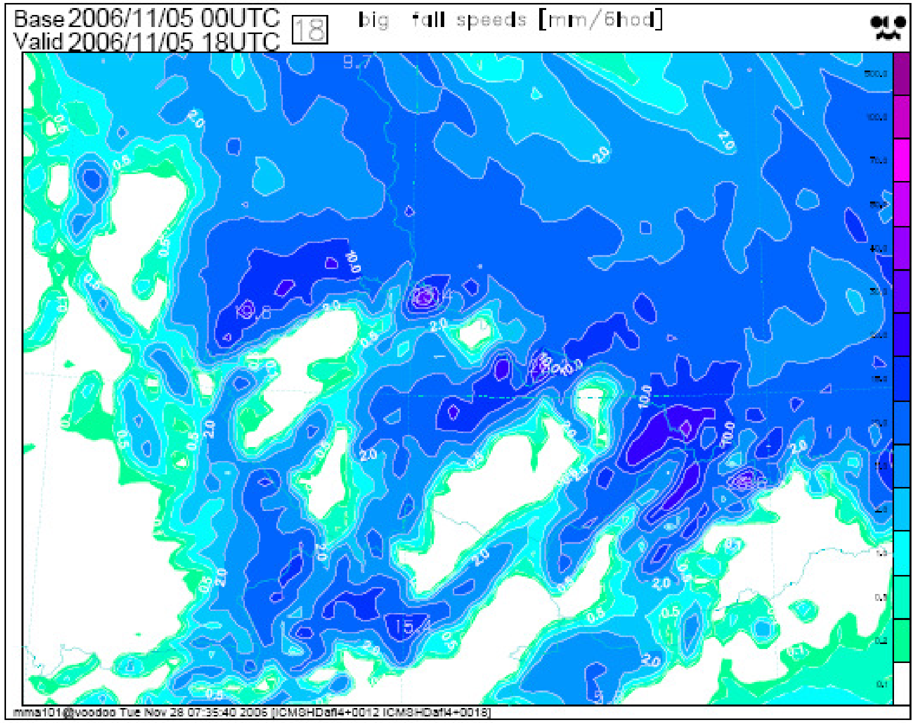
Rather no impact on QV, QI and QR (rather logical)



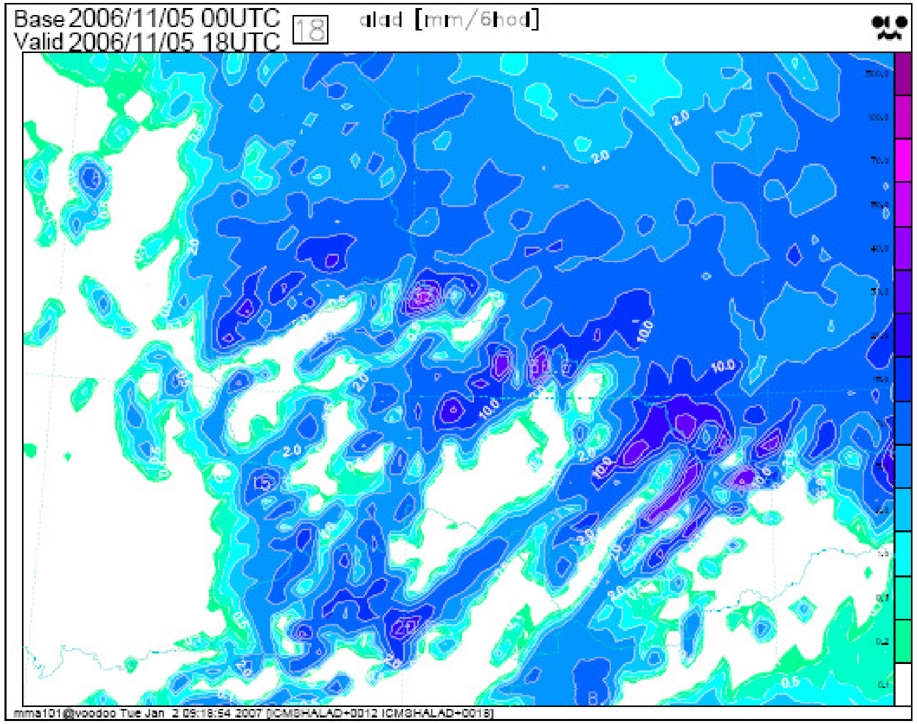


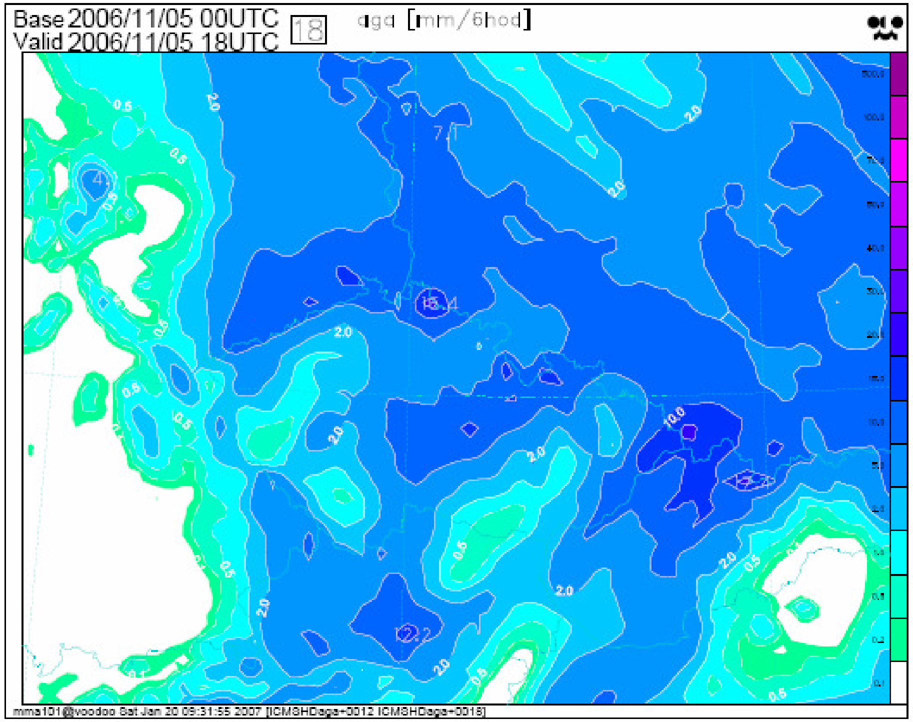
Checking precipitation maps



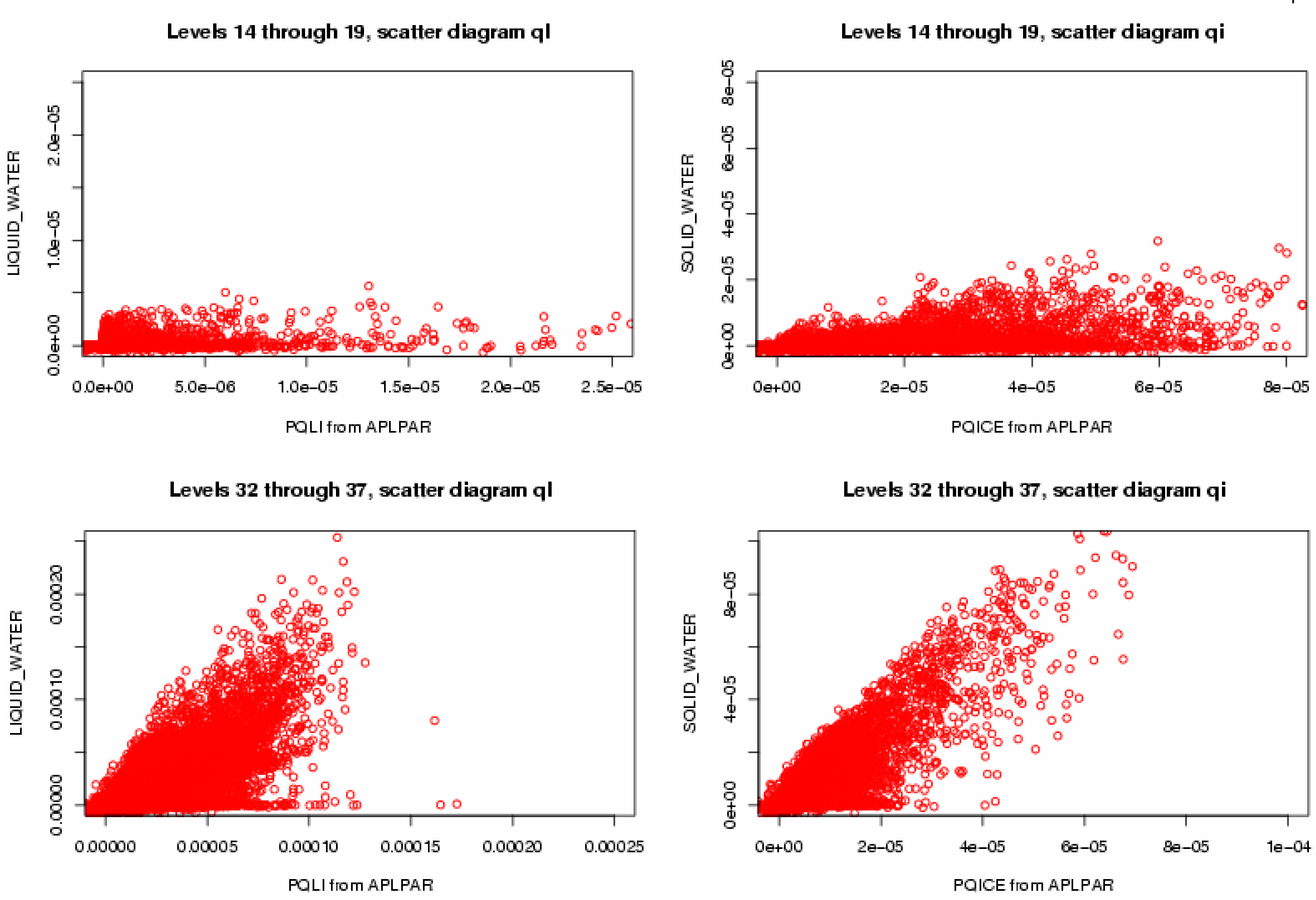


Checking precipitation maps





Checking prognostic QL/QI against ACNEBN diagnostic output



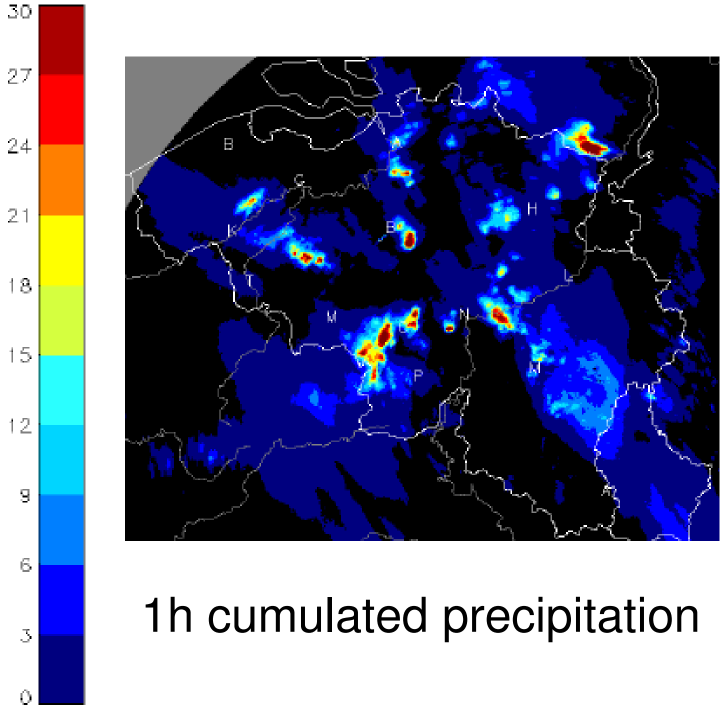
Validation of the APLPAR cascade: some tricks

- Big errors can be identified within one time-step:
  - An update after just one process: check-up the updated Z* values against the CPTEND_NEW result. One by one.
  - Check where from you get negative values: set ‘no advection’ to one/all of the species and do one time step. Check norms.
  - Set a negative initial value to one field and check what happens.
- Tricky errors with less obvious symptoms: more nasty (as usual)
  - Wrong assignment of the fluxes (example: set the condensation flux equal to precipitation flux when it should not be the case; that one was found when cleaning the code).

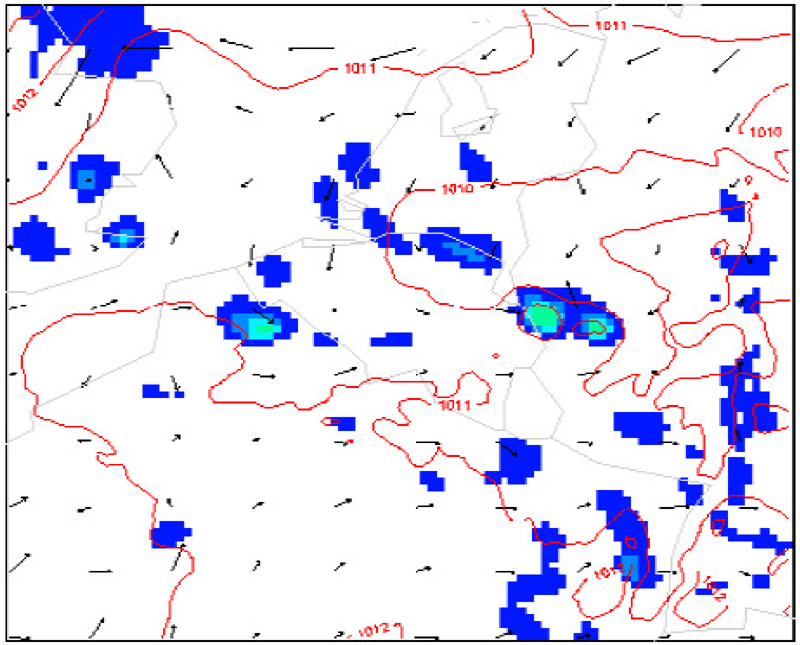
Validation of 3MT

- Quite a lot of technical work at the first stage
  - Important pieces of new code: routines and cascade;
  - Large number of switches and tuning constants;
- First validation (rather cascade oriented):
  - Implement alternative forcing from the existing operational routines: a crude check of not getting completely crazy results;
- Next step:
  - Verify that we get the same quality of results with cleaned library, merging other developments, compared to the research 3MT code.

Validation of new library (Bruxelles-Prague, November 2006)

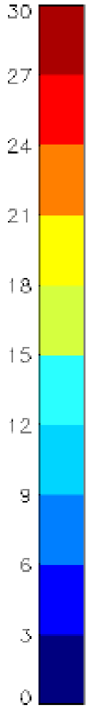


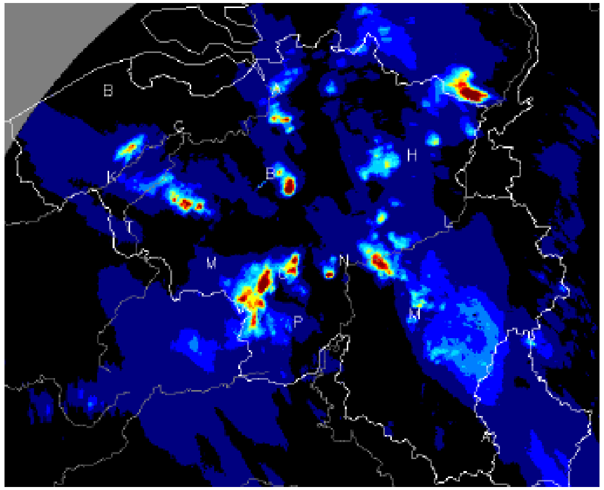
1h cumulated precipitation



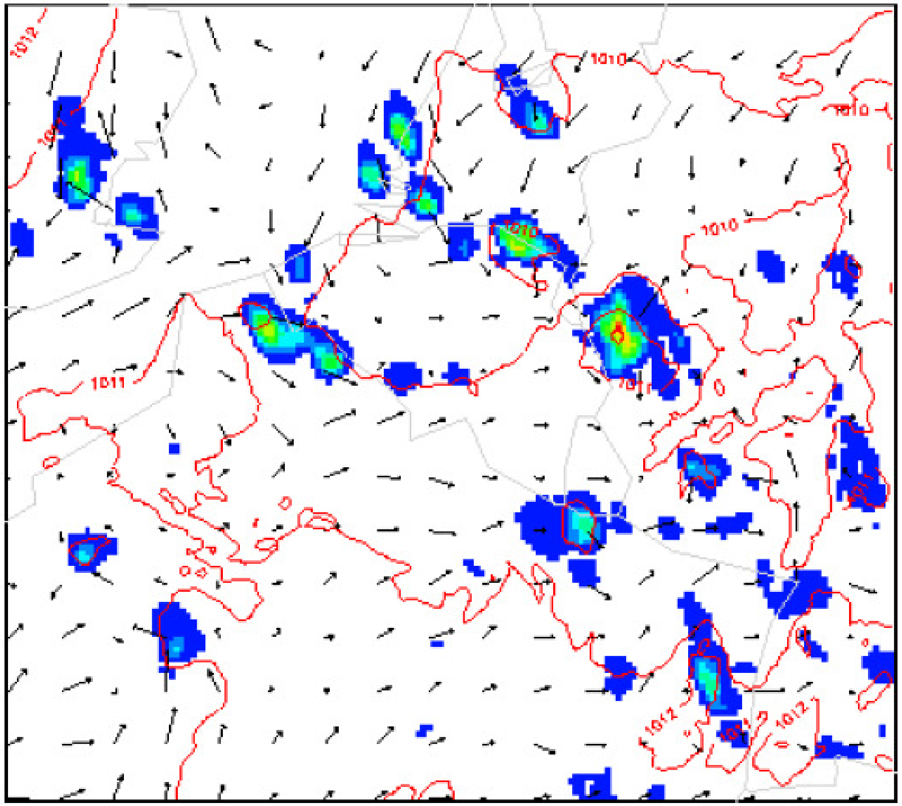
7 km

Validation of new library (Bruxelles-Prague, November 2006)



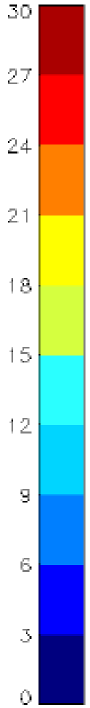


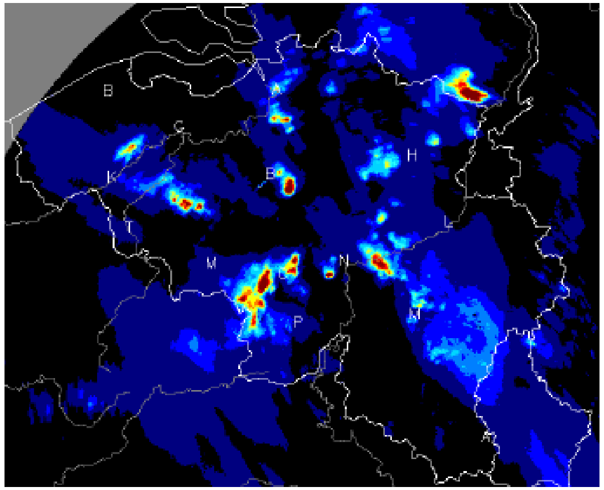
1h cumulated precipitation



4km

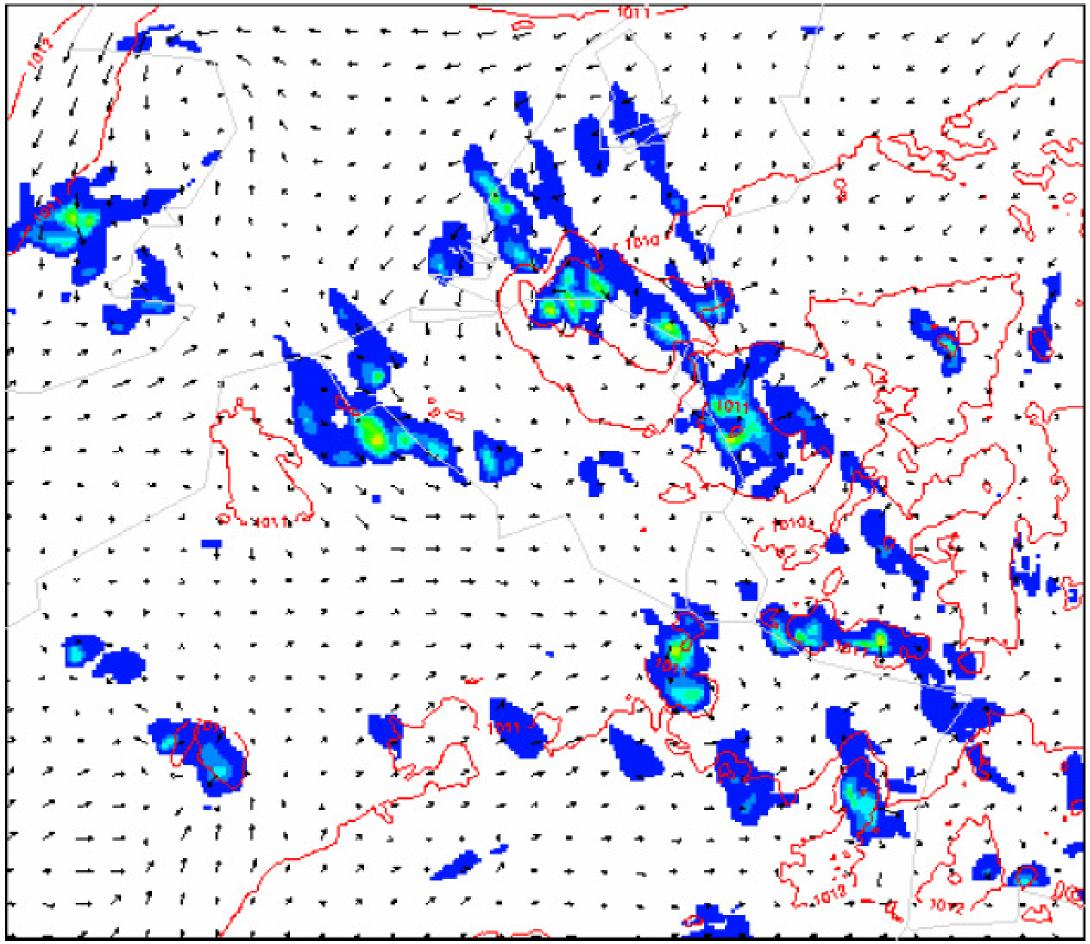
Validation of new library (Bruxelles-Prague, November 2006)



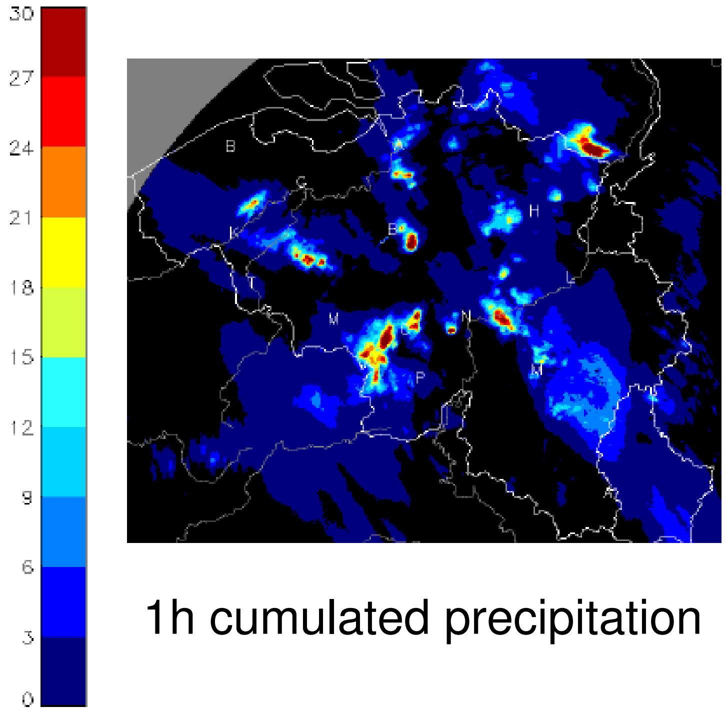


1h cumulated precipitation

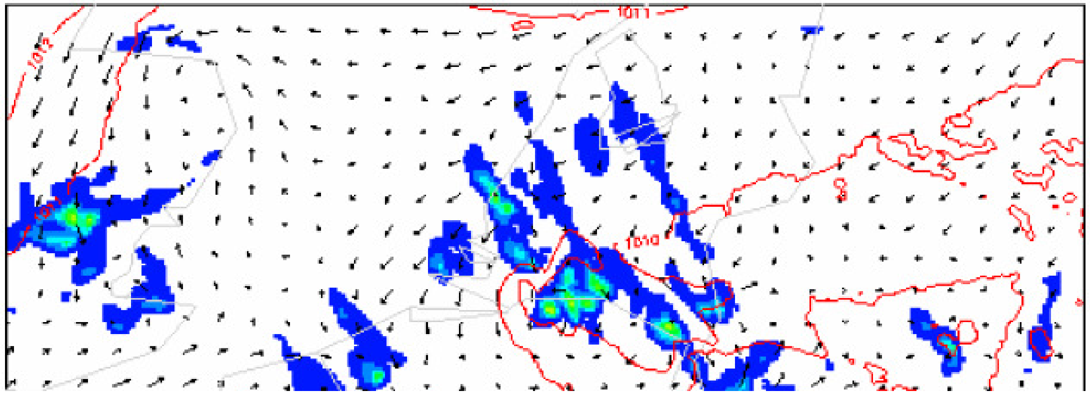
2.2 km



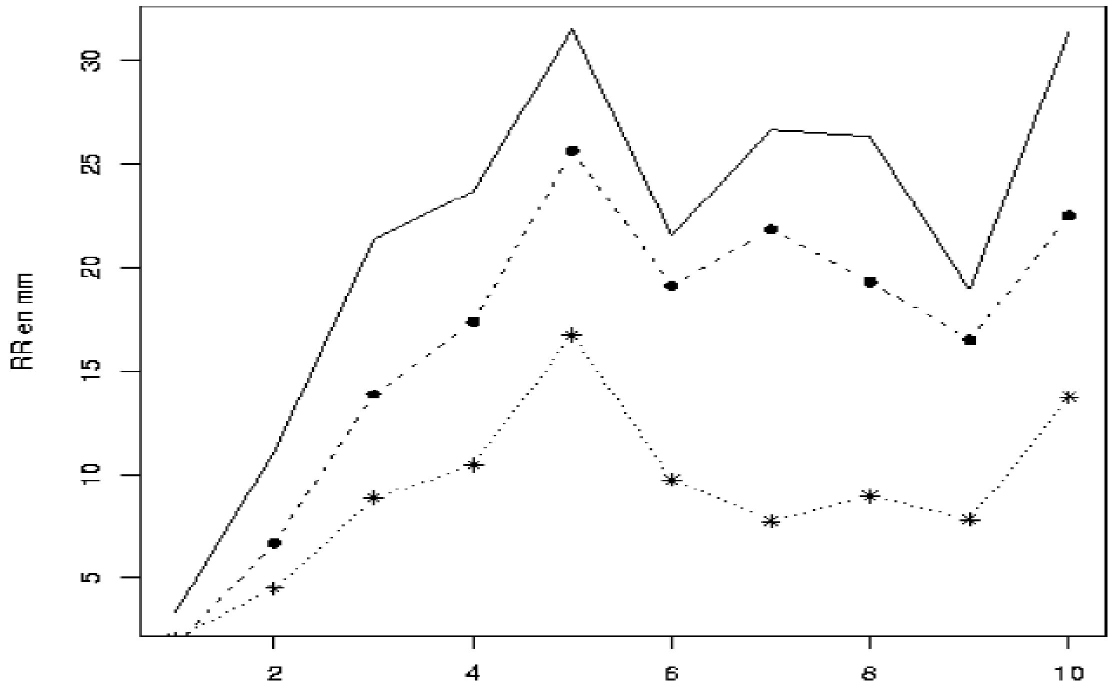
Validation of new library (Bruxelles-Prague, November 2006)



1h cumulated precipitation

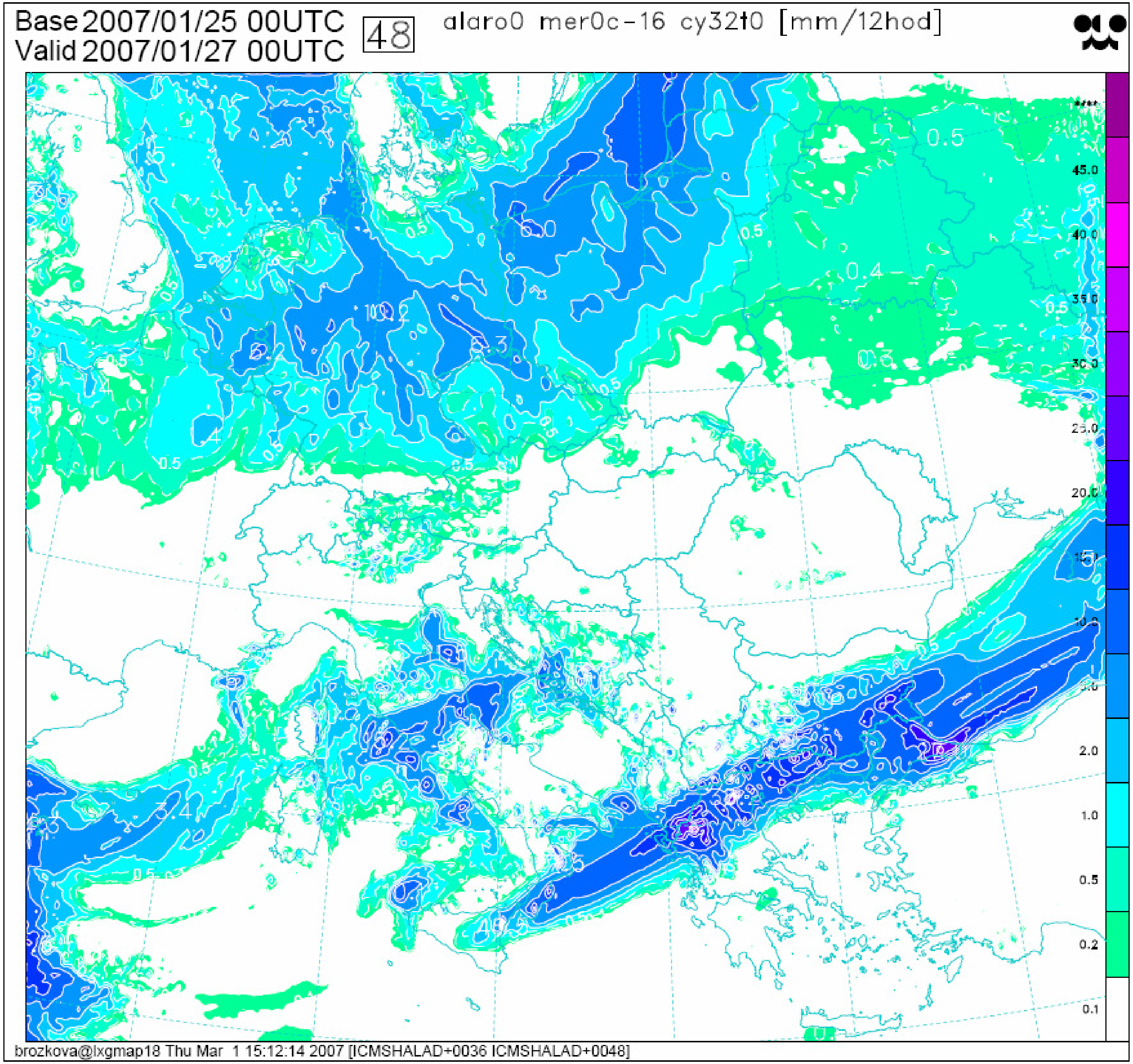


2.2 km



Example of other situation – need for tuning

Exar
need



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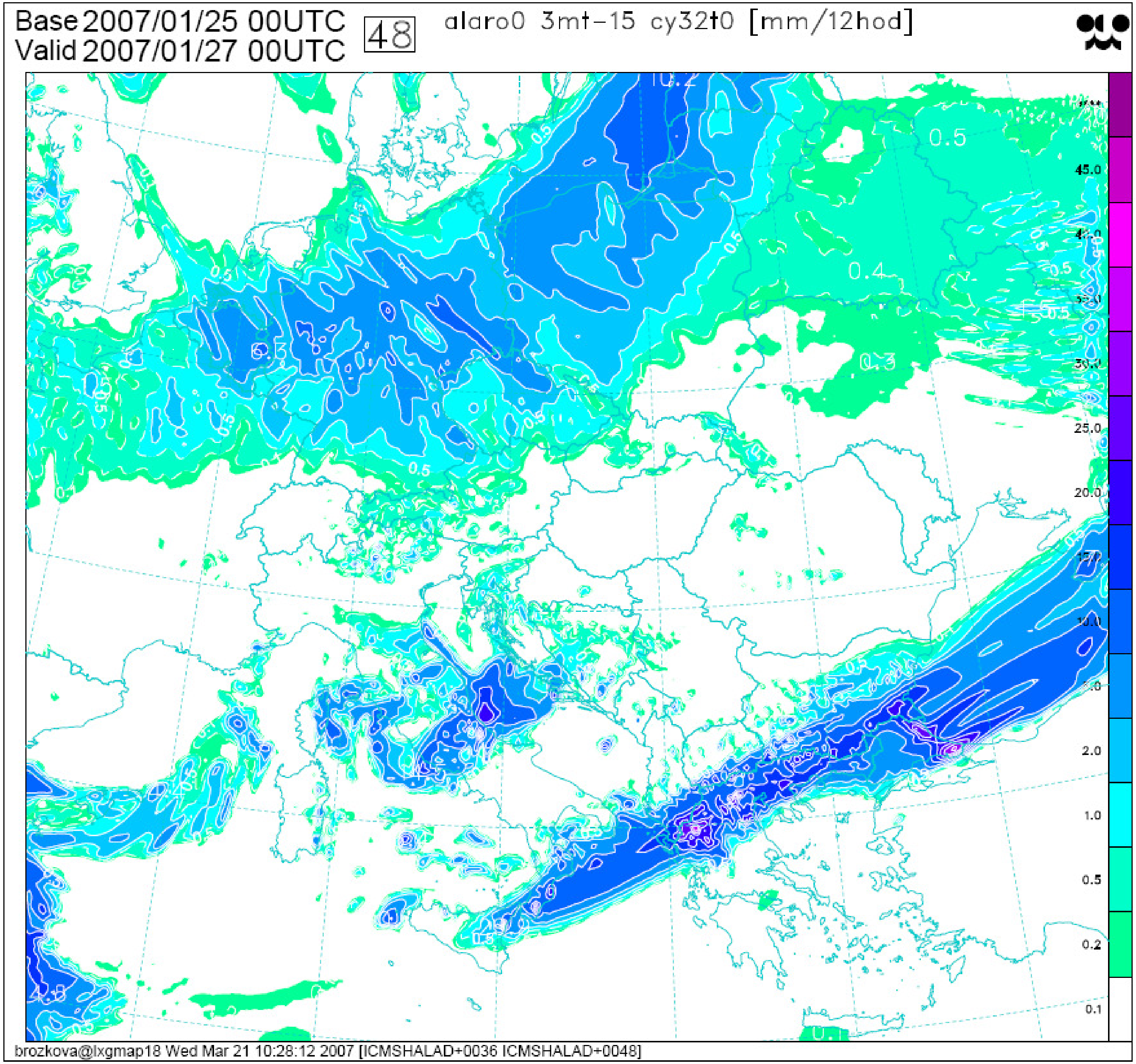
Exa… nee…



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Exa
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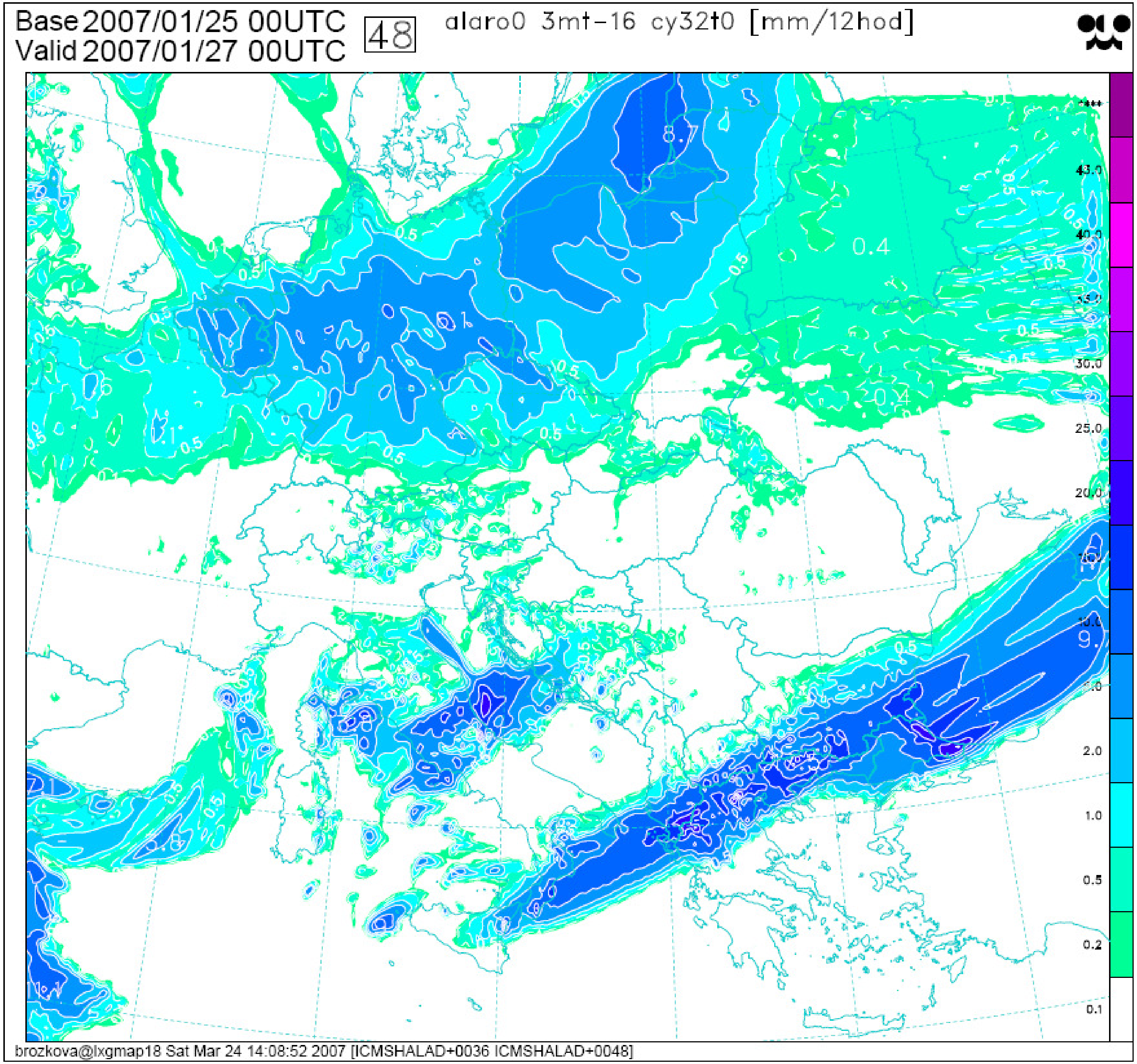

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Exar
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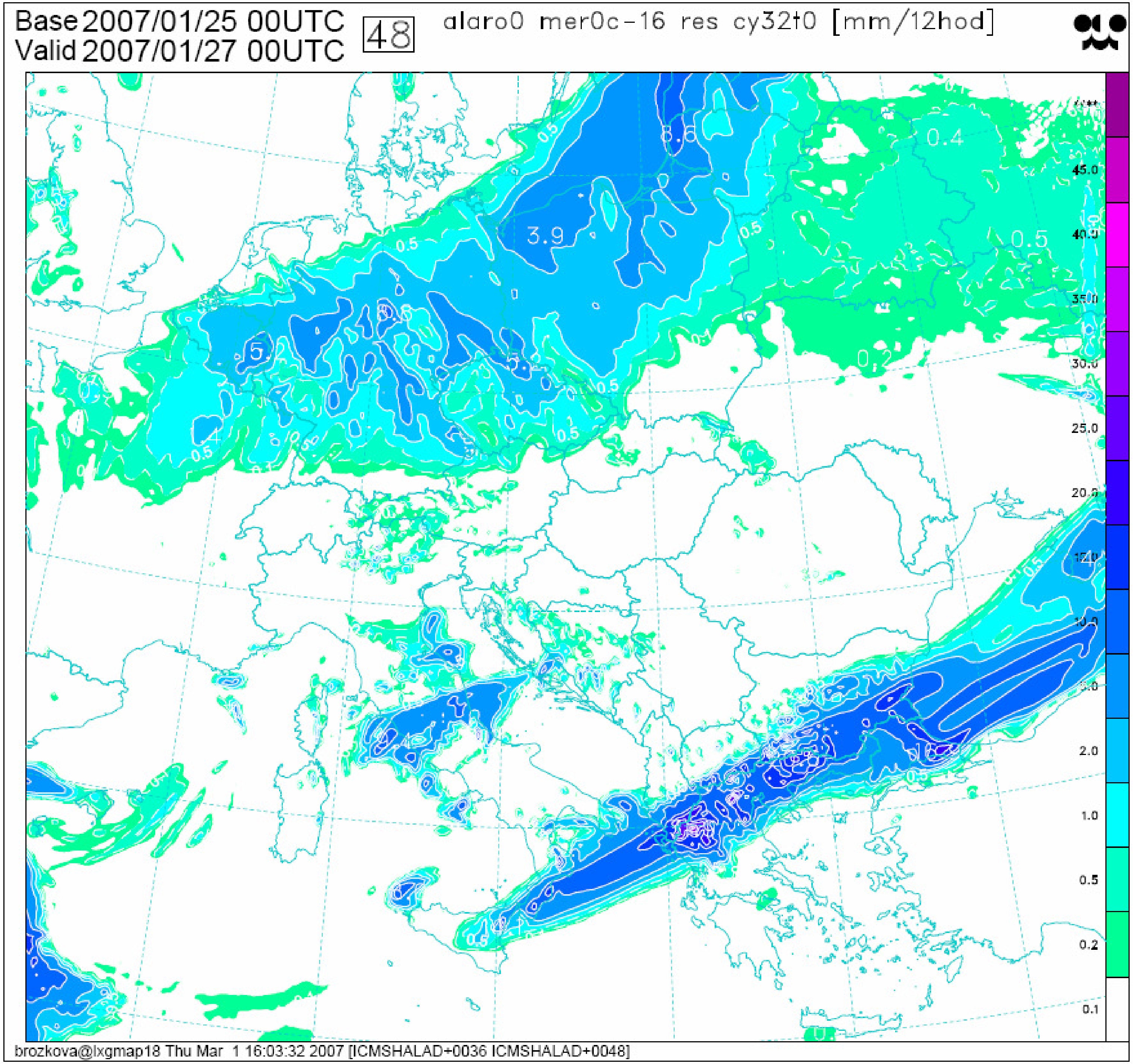
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Conclusions

- Validation is a difficult exercise
  - Bug chase
  - Numerics
  - Meteorological realism
  - Scores (should not get worse)
  - Tunings (try (reasonably) extreme limits first)
  - Compensating mechanisms and feedbacks (find the trigger)
- Need to use various tools to be successful