10. Klaus STADLBACHER : "Systematic qualitative evaluation of high-resolution non-hydrostatic model"

Generalities :

The last months of the ALATNET stay in Ljubljana were mainly dedicated to two different topics. On one hand it was tried to find a more optimal description of the orography at very high resolution, to obtain more realistic precipitation fields in mountainous areas. As basis served an additional spectral cost function, which has been developed in Toulouse (and evaluated first on ALADIN-France) and has been tested for its usefulness for smaller domains here. On the other hand the evaluation of the non-hydrostatic dynamics at very high resolution continued, and therefore the switch to cycle 25T1 of ALADIN had first priority.

The Orography :

The fact that precipitation fields in mountainous areas have a strong tendency of becoming stranger and stranger with increased resolution led to the idea to find a more proper description of the orography, which was mainly meant to be the main cause for the "chaotic" structure of the fields.

Based on the new spectral cost function developed in Toulouse for the optimization of orography, it was tried to test the usefulness for small domains and the impact on the forecasted fields. Different weights are put to different wavenumbers to damp out the smallest wavenumbers, hence smoother orography is obtained.

The tests were done on small domains in the Alps with 2.5 km resolution on MAP-cases. The sizes of the domains did not exceed 100x100 points.

Figure 1 shows an example of the orography that was obtained by using the often used "Jerczinsky" cost function, while in Figure 2 spectral smoothing was applied additionally. The spectral cost function has two independent tuning parameters, which means that the shown orography is just one possibility how the orography could be modified. In this case the differences to the original orography are rather big, to enable a clear illustration of the impact in this example.

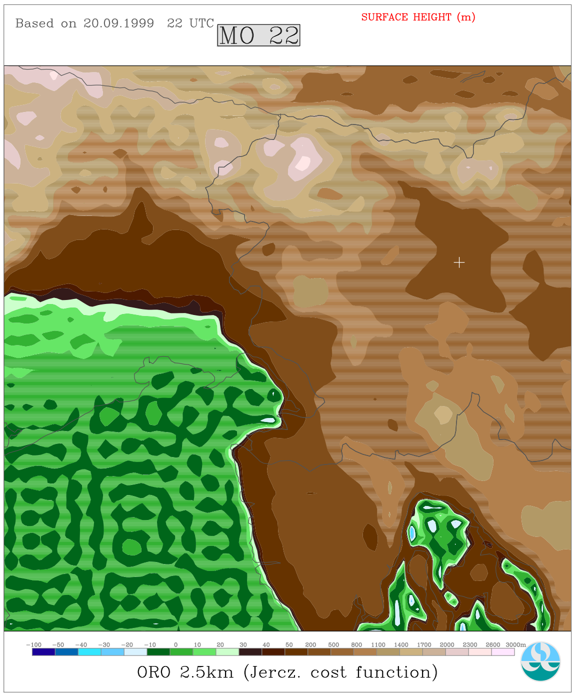
The corresponding precipitation forecasts can be seen in Figures 3 and 4. It is not hard to recognize the dramatic impact of the "new" orography on the resulting precipitation field. The loss of "accurate" information about the orography has the expected positive influence on the precipitation field (smoother field and reduced peak amounts). On the other hand one has to expect that other fields (like horizontal wind) become less accurate. The real loss on other meteorological information has to be checked in detail, but as a preliminary result it can be stated that the gain for precipitation might compensate the rather small losses for the other surface fields. This is valid, if a rather balanced way of applying the spectral cost function is done in order not to destroy relevant and realistic meteorological information.

The trial of using a spectral smoothing can be seen as a prolongation of the tests performed with keeping a "quadratic" spectral truncation for the orography, while calculating the other fields with a "linear" spectral resolution, which more or less follows the same idea. The spectral smoothing provides one more degree of freedom and allows some finer tuning, while in the former approach the truncation of the wavenumber for orography was restricted to a single value.

The tests were performed with cycle 12, but spectral smoothing will also be included in the more recent cycles. (see the mail from Dominique Giard)

<u>Caution</u>: The spectral cost function is very sensitive to the domain characteristics (mainly the shape and height of the mountains inside it) and the coefficients have to be tuned individually and carefully, because if this is not done it is even possible to get some undesirable effects.

1

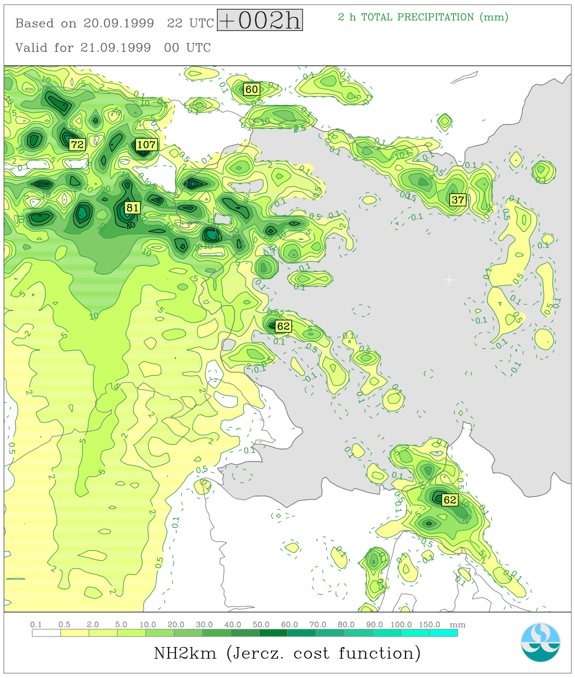


2

Figure 1 : Orography on 2.5 km resolution - applying the Jerczinsky cost function

Figure 2 : Orography on 2.5 km resolution - additional introduction of a spectral cost function

3



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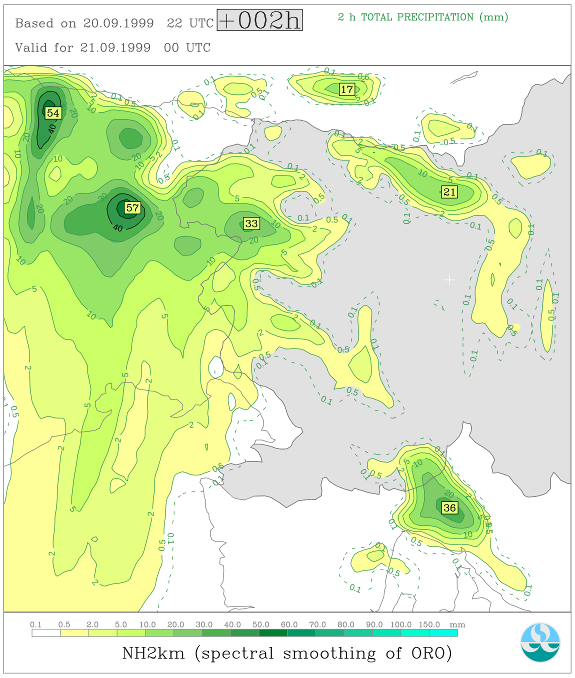

Figure 3: 2.5 km resolution; NH-dynamics (3TL-SL) ; 30 s time-step; cycle AL12; 2 hours precipitation forecast using the orography shown in Figure 1

Figure 4: 2.5 km resolution; NH-dynamics (3TL-SL) ; 30 s time-step; cycle AL12; 2 hours precipitation forecast using the orography shown in Figure 2

Running NH with AL25 :

Due to the progress in NH developments, that entered cycle 25T1, the decision was made to switch as soon as possible to this Cycle in Ljubljana. Thanks to Jure Jerman this was possible within a very short time and some experiments have been performed already. Please notice that the orography used in these experiments is the "standard" one, hence the fields itself aren’t looking too nice, but the focus here is put on the differences concerning the various options for dynamics.

Figures 5 and 6 show 8h-10h precipitation forecasts on a domain with 5 km resolution (the pictures are a zoom of the whole domain to make them comparable with the following ones at a resolution of 2.5 km). Figure 5 is the hydrostatic run while Figure 6 shows the NH counterpart. The forecasted fields are very similar and introducing non-hydrostatism doesn’t have a big influence on the forecasted precipitation field in this case .

In figures 7 and 8 the same forecasts at 2.5 km resolution can be seen. It is obvious that there is a remarkable difference if compared to the former figures. The non-hydrostatic dynamics leads to an extended precipitation field and additionally increases the peak values.

Figures 9 and 10 show differences in the forecast of the 850 hPa temperature field. In figure 9 the 2.5 km NH-model was run from different coupling files: first directly from the ALADIN-LACE forecast and second from the 5 km hydrostatic run, while in figure 10 the shown differences are purely due to the dynamics (the coupling is done from the 5 km hydrostatic run for both the hydrostatic and the non-hydrostatic 2.5 km runs).

It is noticeable that the difference in resolution of the coupling files causes bigger differences in the forecasted fields. It should be mentioned that the differences for the different dynamics became bigger compared to cycle 12. It follows that the recent developments in NH dynamics that entered cycle 25T1 have a significant impact on the forecasted fields. Unfortunately the influence of the resolution of the coupling files still dominates. Therefore the problem of a straightforward comparison of NH and H dynamics and of identifying advantages and disadvantages still remains.

Further it should be mentioned that the use of 5 km resolution NH coupling files for the 2.5 km NH run additionally leads to differences in the forecasts, although the magnitude is small compared to the previously depicted ones.

Up to now the results for finding the optimal nesting chain indicate that down to ~ 5 km the non-hydrostatism doesn’t seem to play that important role compared to higher resolutions, though other cases with different meteorological situations will be examined to generalise this result.

At higher resolution NH seems to become much more different from the hydrostatic model. This would mean that just the best choice of the resolution of the coupling files remains an open question.

The work in the near future will be dedicated to try to find conclusive results concerning the prove of the theoretical confirmed necessity of NH for practical forecasts and the corresponding resolution, where NH should be introduced. The other topic is the trial to somehow quantify the impact of the resolution of the coupling files in order to find the optimal nesting strategy.