The HIRALD setup

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1. Introduction

A new model setup based on non-hydrostatic ALADIN, the so-called HIRALD setup at ECMWF has been established. The idea is that this setup can be accessed in the future by both HIRLAM staff and people from Météo-France and the ALADIN community for various experimentation. The setup represents a concrete sign of a new collaboration between the HIRLAM community, Météo-France and the ALADIN community. More details about the planning of future collaborations are expected to become available during 2005.

The background for establishing the HIRALD setup is connected to the strong expectation that modelling at a very high resolution will be important for the HIRLAM community in the future. Non-hydrostatic model effects will then start to become significant. Since non-hydrostatic dynamics has not been developed so far by the HIRLAM members it has been considered necessary to look for an adequate limited-area model system for very high resolution non-hydrostatic experiments. It has been found most suitable to propose a collaboration with Météo-France and ALADIN countries around the ALADIN model.

The very first HIRALD setup at ECMWF was established by Ryad EL KHATIB and a small group of HIRLAM people during a working week at DMI in July 2004. The HIRLAM people who have started to work with ALADIN have been in a learning process since March 2004 where a one-week training course on IFS/ALADIN was arranged for HIRLAM people by Météo-France

The purpose of the present short report is to briefly review the status by early January 2005 of the HIRALD setup at ECMWF and to summarise some preliminary experiences.

2. Evolution of the HIRALD setup

It was realised that the first model area of the HIRALD setup was insufficient (10 km grid size) for meso-γ scale studies. As a consequence the setup was developed further to become a double nested system. Hence a "Scandinavian setup" was defined (shown in figure 1). An outer model (grid size 11 km) is covering the whole of Scandinavia, the North Sea and the British Isles. Two internal models (grid size 2.5 km) were defined with target areas of southern Scandinavia and Finland, respectively.

In order to run experiments a period of interest was defined. The first week of July 2003 has been chosen, with significant precipitation events over Scandinavia. With the help of Météo-France staff the associated climate generations were generated. Small modifications to the areas shown in figure 1 were needed to do this. Also the appropriate ARPEGE boundary files for the outer area were transferred to ECMWF to be used for the outer Scandinavian model area. The boundary conditions for the inner model areas were then generated from ALADIN runs with the outer Scandinavian model area. After these modifications experiments could start on the inner model areas using the available model code of cycle 29 (ARPEGE physics). A re-assimilation of observational data has not been done so far, which is likely to put a limit to the potential of the model experiments with this setup to reproduce observed critical parameters such as accumulated precipitation with high accuracy.

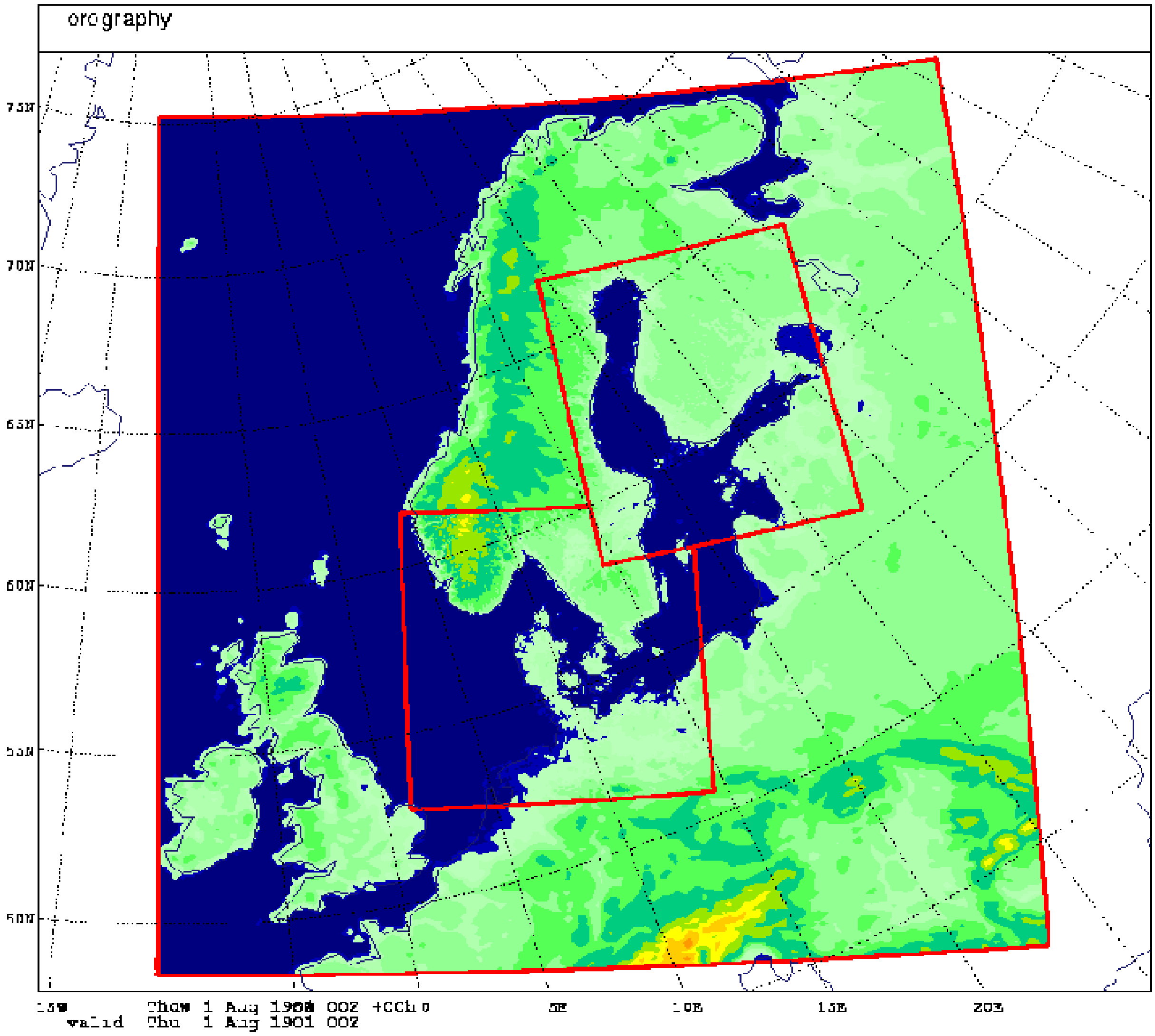

Fig. 1: ALADIN domains

3. First experiments

It is often difficult to start experiments with a new model system. Getting started with ALADIN has been no exception. Even though there is some good documentation of some parts it seems not always up to date, and more guidance for newcomers on how to make simple experiments would be advantageous. A specific challenge is to understand to use the many namelist options. This problem will be met as soon as "non-standard" experiments are to be carried out, e.g. in the context of testing new code. An example of this has been met when trying to test HIRLAM physics code with cloud condensate as a prognostic variable and a new "pseudo" (one time level) humidity variable. A HIRLAM cloud and condensation scheme has been coded and linked successfully without too many problems, but runs could not start immediately because of some basic problems linked to the fact that the new fields were introduced. This means that problems occurred even with the new physics schemes not activated, e.g. complaints from the system related to non-availability of new fields at the boundaries. Subsequently the model crashed immediately after DFI. The initial problems were not solved by the end of 2004, but will hopefully be clarified and solved during the first quarter of 2005.

Instead it has been possible to start running with the existing ARPEGE physics and investigate features connected to the setup. Preliminary experiments show that the permissible time-step for the NH forecast on the 2.5 km Danish domain is 60 s or smaller. For this reason, a good parallel performance on a multiprocessor system is essential in order to obtain a reasonable execution time for a complete forecast. To test the performance, forecasts are run with and without the NH option on an increasing number of processors from 4 to 128. The average elapsed computing time for a time-step is plotted against the number of processors in Fig. 2. In an ideally scalable situation the two graphs should be straight lines with slope -1. However the slopes of the graphs decrease when more processors are added indicating the significance of the communication overhead and the inherent sequential part of the code.

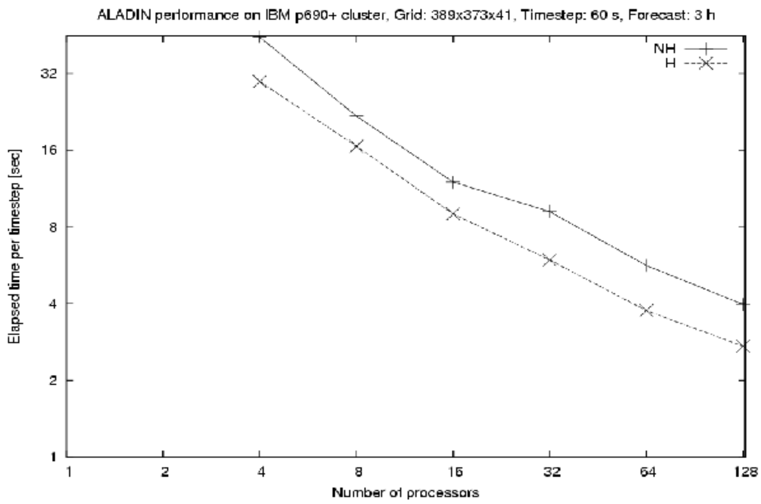

Fig. 2: Elapsed time per time-step versus Number of processors. Logarithmic axes

Also preliminary runs with the ALADIN-NH model have been made using ARPEGE physics (model domains of Fig.1). The test period is the one mentioned above, that is, the first week of July 2003 where some convective storms are observed over Denmark. One example of a test case is the 2nd of July 2003 18 UTC where we have an unstable atmosphere with weak winds. Convection is activated over parts of Denmark. The 12 hour forecasted accumulated precipitation using ALADIN NH-dynamics is shown in Fig. 3. and the corresponding 12 hour accumulated precipitation from observations are shown in Fig. 4. We see that the model captures the locations of the local precipitation maxima very well, but the quantitative values are not very good; in this case they are too low. In general it is found for this test period that convective type precipitation is underestimated in the model whereas large-scale (stratiform) precipitation is overestimated. Concerning other forecast parameters such as mean-sea-level pressure, 10 meter wind and 2 meter temperature, the model simulates the observations fairly well although we haven't looked into the details yet.

4. Future work

The model setup at ECMWF will be further developed and some documentation material on the system will become available. It is intended to implement various upgrades during 2005. These should make it possible to test different physical parameterizations, e.g. HIRLAM parameterizations. Also the climate generation system for ALADIN will be installed, and it is hoped to make it possible to run ALADIN with lateral boundary forcing from HIRLAM fields. After these developments it will be possible to set up runs on a daily basis which will allow for much more experience on the behaviour of high resolution runs using ALADIN NH-dynamics.

Acknowledgments: We would like to thank Météo-France staff and ALADIN people for their helpful support during 2004.

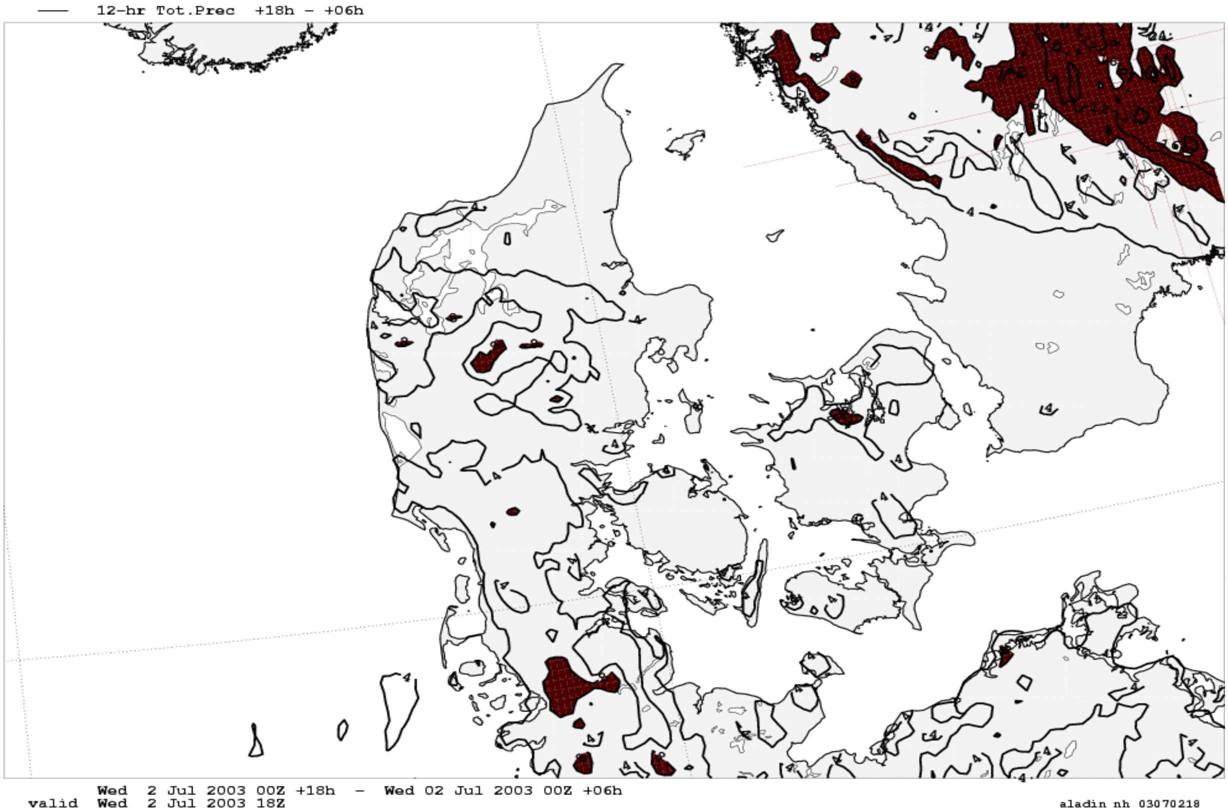

Fig.3: 12 hours accumulated precipitation forecasted with ALADIN-NH the 2nd of July 18 UTC. Black shaded areas has precipitation above 8mm.

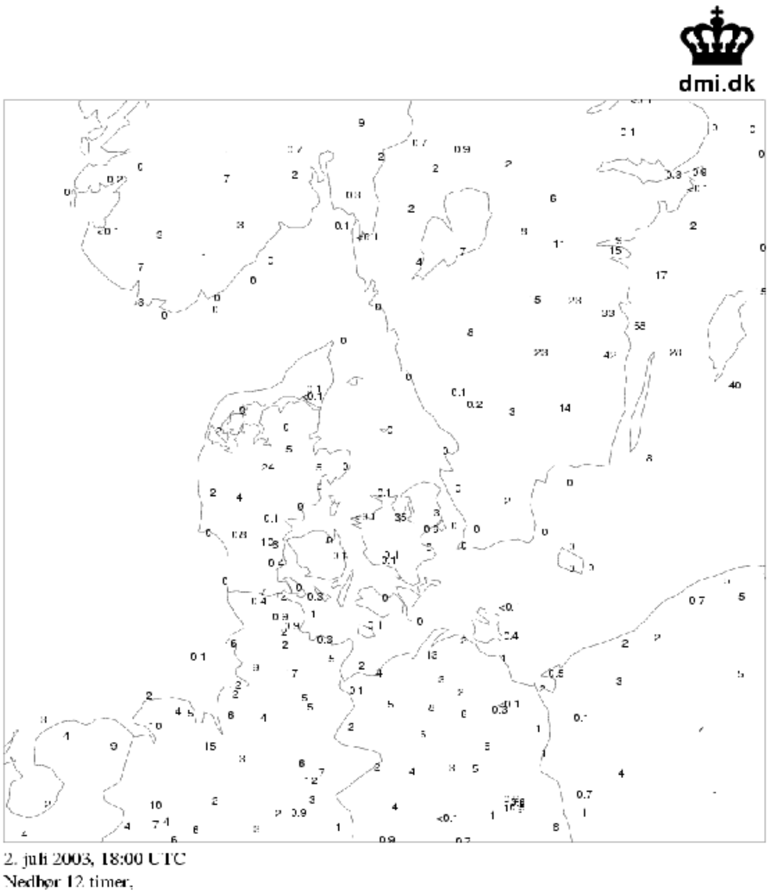

Fig. 4: Observations 2nd of July 18 UTC. 12 hour accumulated precipitation

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