Royal Netherlands
Meteorological Institute
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Influence of domain size and boundaries on the HARMONIE precipitation forecast

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The IMPACT project aims to study the impact of climate change on critical weather conditions at Schiphol Airport. This is done by testing the validity and quality of HARMONIE forecasts for a number of selected extreme weather cases that affected the operations at Schiphol. The outcome is compared to observations and the current operational Hirlam suite. The results seem to depend strongly on the domain size and the origin of the boundaries used. Especially the precipitation patterns predicted by HARMONIE compared to radar images are better captured using a domain of at least 400^2 2.5 km gridpoints and using Hirlam instead of ECMWF boundaries.

1. Introduction

The high resolution HARMONIE model will soon be evaluated to be part of the operational suite at KNMI. The ability of HARMONIE to accurately predict severe weather is one of the main criteria to assess the quality and usefullness of the model for general and aviation purposes. Within the IMPACT project, a number of cases with weather that was severe enough to affect the operations at Schiphol Airport was selected to study how the model performed compared to Hirlam and observations (such as radar and meteorological stations) available for these dates.

2. Setup

The HARMONIE model was run at ECMWF using mostly default settings, i.e. non-hydrostatic AROME physics and EDKF convection, but with varying domain size and using either Hirlam or ECMWF boundaries. The default domain size for the Netherlands is 300^2 2.5 km gridpoints, and for one case a smaller area was tried (200^2 gridpoints), see also Fig. 1. With 400^2 and 500^2 gridpoints significant improvements of the forecast were noticed. An operational version of Harmonie will likely use a domain of 1000^2 gridpoints.

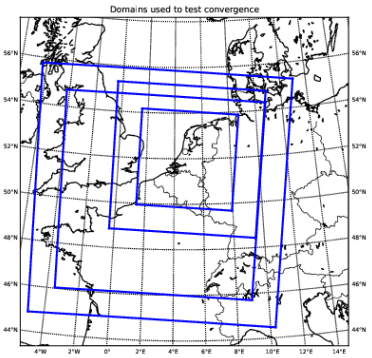

Figure 1: The different domains over the Netherlands, using 200^2, 300^2, 400^2 and 500^2 gridpoints.

3. Results: Domain size

In Fig. 2 the instantaneous precipitation of a 12 hour forecast using a domain 200^2 and 400^2 gridpoints is compared to radar images of the same time. The forecast on the smaller domain evidently lacks essential features, such as the rainband in the northeast.

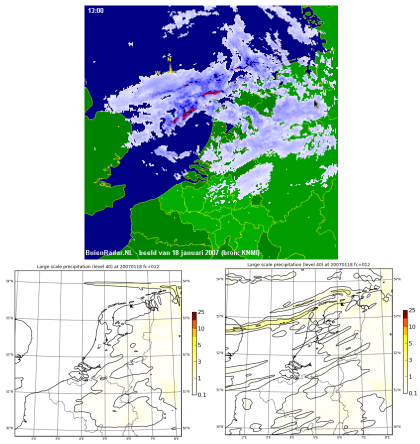

Figure 2: The radar image (top), and HARMONIE forecasts of precipitation intensity at 18 january 2007, 12.00 UTC using resp. 200^2 (bottom left) and 400^2 (bottom right).

4. Results: Boundaries

For several different cases it was observed that forecasts using ECMWF boundaries produced significantly less rain than forecasts using Hirlam RCR boundaries. The corresponding radar image seems to bear more resemblance to the version with Hirlam boundaries. Two examples are given in Figures 3 and 4. It remains to be verified that statistics on a larger temporal and spatial scale are also better. Substantially larger domains and cycled runs may not be influenced so severly by the choice of the boundary input.

The specific humidity of the Hirlam and ECMWF boundaries was compared on several model levels with comparable pressure. This seems to indicate that especially the lower Hirlam levels are more humid than its ECMWF counterpart.

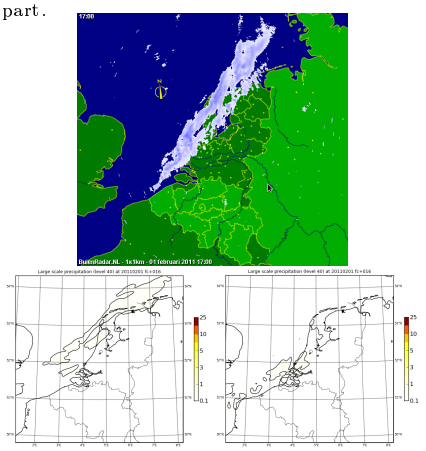

Figure 3: The radar image (top), and HARMONIE forecasts of precipitation intensity at 1 february 2011, 16.00 UTC using resp. Hirlam (bottom left) and ECMWF boundaries (bottom right).

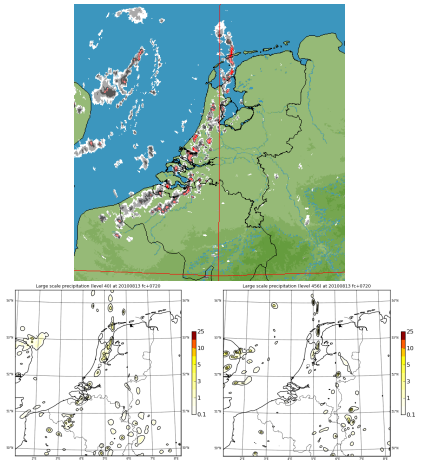

Figure 4: The radar image (top), and HARMONIE forecasts of precipitation intensity at 13 August 2010, 12.00 UTC using resp. Hirlam (bottom left) and ECMWF boundaries (bottom right).

5. Conclusions and recommendations

The HARMONIE model seems able to accurately predict severe weather phenomena that have affected Schiphol Airport operations. A number of case studies seem to reveal that the quality of HARMONIE forecasts benefits from using a domain of at least 1000 km x 1000 km, and from using Hirlam boundaries. The evaluation of the quality of HARMONIE forecasts should include a detailed examination and verification of the mesoscale phenomena that differentiates HARMONIE from existing models such as Hirlam.

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