Validation of high-resolution simulations with the MM5 system

Haraldur Ólafsson[1] and Ólafur Rögnvaldsson[1]

University of Iceland, Icelandic Meteorological Office and Institute for Meteorological Research, Reykjavík, Iceland

1. INTRODUCTION

In this paper three attempts to validate high-resolution simulations with the MM5 modeling system (Grell et al. 1995) will be briefly outlined. The first case is a simulation of accumulated one-month precipitation, the second case is a high-resolution simulation of wind on the slopes of a hill and the third case of a convergence zone created by thermally driven local winds. In the first case, the simulations are compared to conventional precipitation observations (rain gauges). In the second case, the simulated wind speed is compared to observations made in a 300x300 m nest and in the last case the low level wind field is compared to the winds that affected the flight of a helicopter. All the simulations have initial and boundary conditions from the ECMWF archives.

2. SIMULATIONS OF PRECIPITATION

Figures 1 – 3 show simulated and observed accumulated precipitation over Iceland during August 2001. The two simulations (Fig. 1 and Fig. 2) show the result with different horizontal resolutions (15 km and 5 km). There are 40 levels in the vertical and the physics schemes used are indicated in the figures.

The overall simulated precipitation pattern simulated with a 15 km horizontal resolution well with the observations, but observed local maxima in Southwest Iceland, at the westernmost part of the north coast and at the northeast coast are either weak or absent. These maxima appear in the 5-km simulation, and not unexpectedly, they are related to topography which is better resolved at the higher resolution.

3. SIMULATION OF WIND PAST A HILL

Figure 4 shows simulated and observed 10 m surface wind speed on 26 November 1999 past a about 300 m high hill in the vicinity of Reykjavík, Southwest-Iceland. The horizontal resolution of this simulation is 200 m. During this day, the synoptic conditions remained almost stationary and the wind was observed by a portable network of anemometers.

Generally the model underestimates the wind speed by about 2 m/s. Two interesting features can be detected where the observations deviate from the simulation. Firstly, the wind speed in the southernmost part of the domain is overestimated by the model. This is presumably due to boundary layer separation which is not reproduced properly in the model, possibly because of too smooth topography. A second feature is high observed winds in the easternmost part of the domain. These winds appeared to come from the mountain and they are presumably linked to a gravity wave which is not simulated. Greater vertical resolution and less surface friction may improve the representation of the waves and less surface friction may also give a more correct overall wind speed.

3. SIMULATION OF THERMALLY DRIVEN WIND IN MOUNTAINS

On 26 May 2001 a helicopter flew into an updraft and was damaged (Fig. 5). The updraft was weak, but totally unexpected. There was weak northerly flow over the area, but a MM5-simulation with the MRF PBL-scheme and a horizontal resolution of 1 km showed some thermally generated southerly flow (Fig. 6). Such flows are rare so early in the spring. At the convergence zone between these flows there is some updraft simulated and it coincides with the location of the helicopter incident. The simulation showed the convergence line to be non-stationary.

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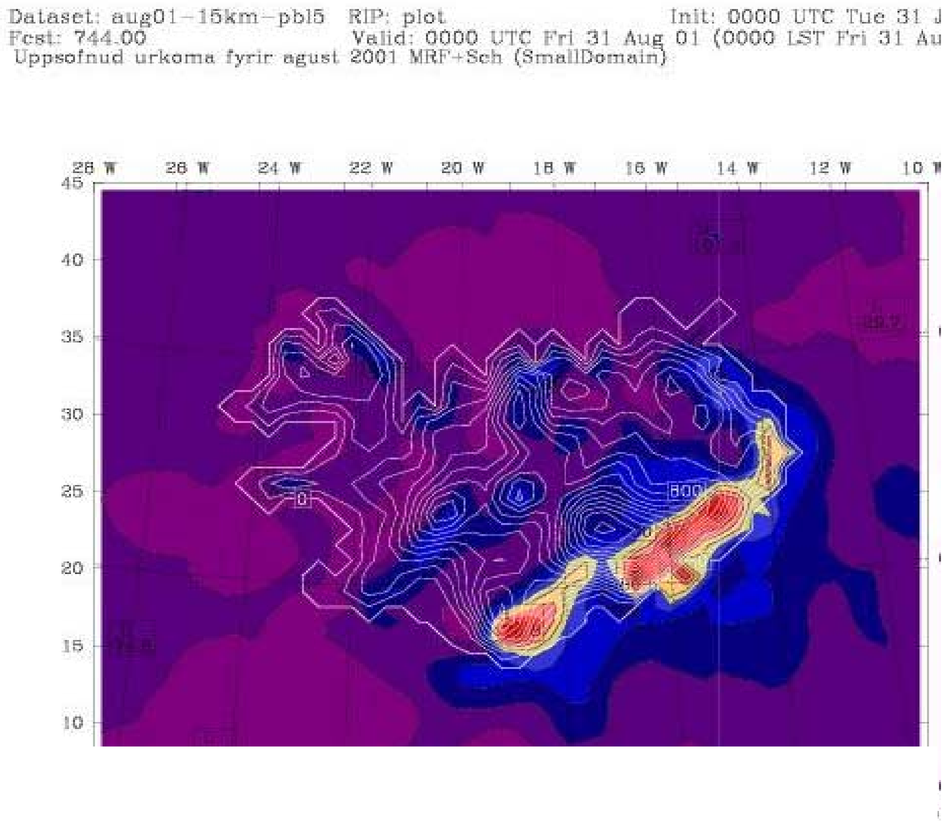
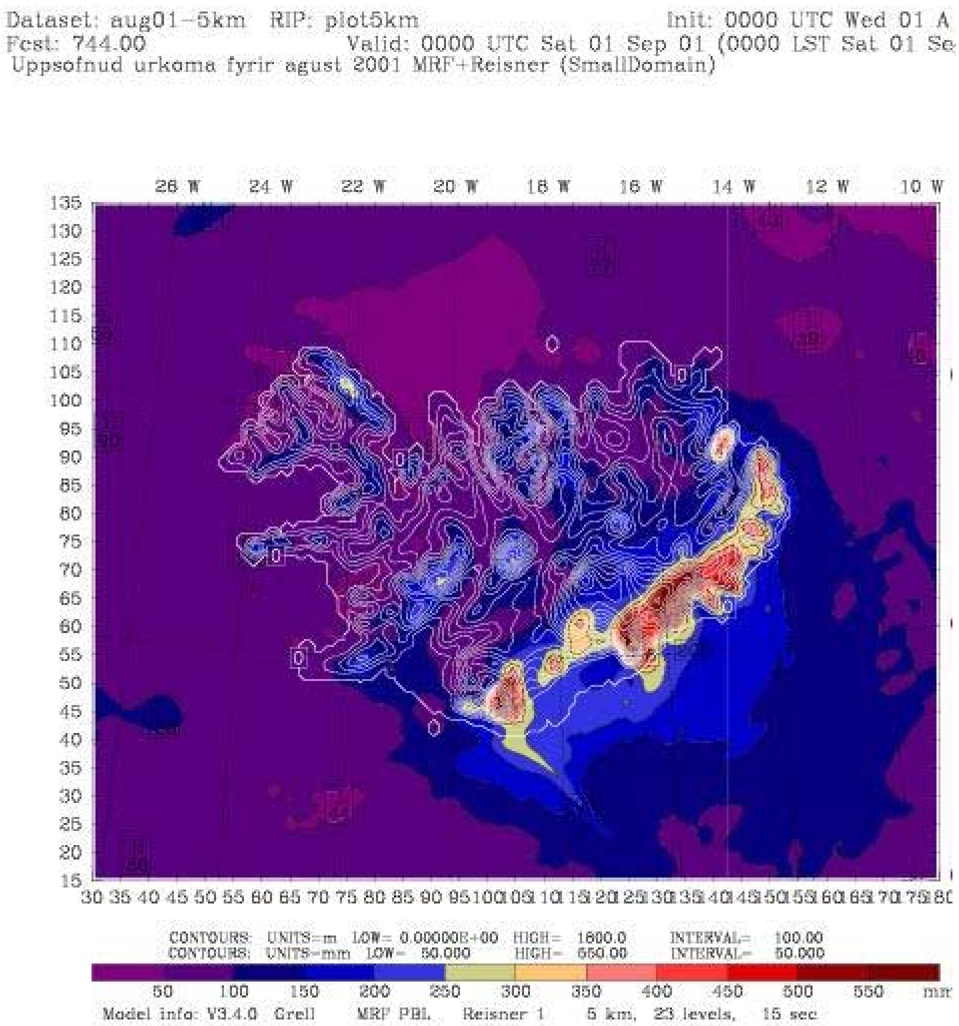
[1] E-mails: haraldur@vedur.is or olafurr@vedur.is, web: http://www.vedur.is/~haraldur or http://www.os.is/~or





Figures 1-2. Simulated accumulated precipitation over Iceland in August 2001 at 15 km horizontal resolution and at 5 km horizontal resolution.

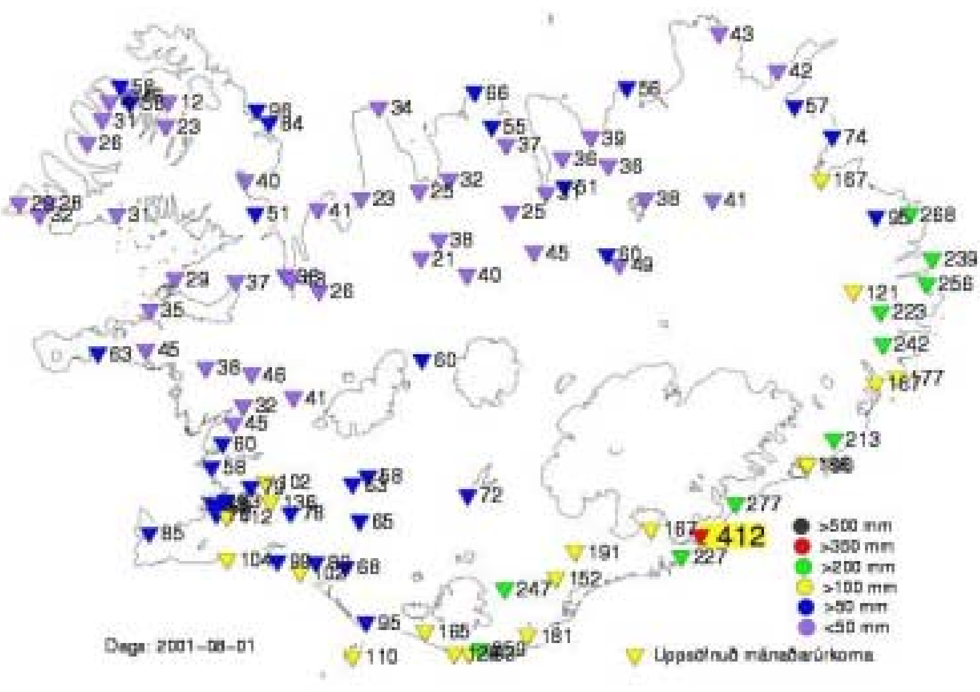


Figure 3. Observed accumulated precipitation in Iceland in August 2001.

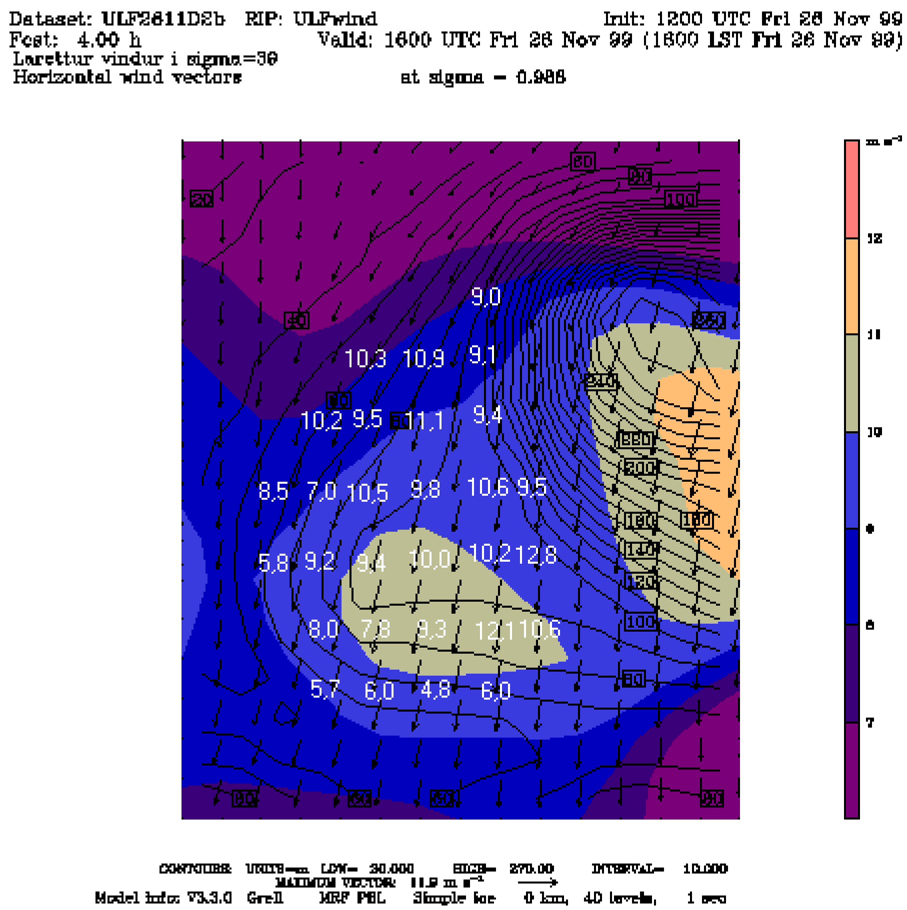


Figure 4. Observed (white numbers) and simulated 10-m wind (ms^{-1}) past Úlfarsfell SW-Iceland. Terrain contours interval is 10 m.

Figure 4. The helicopter that was damaged after flying into an unexpected updraft on 25 May 2001.

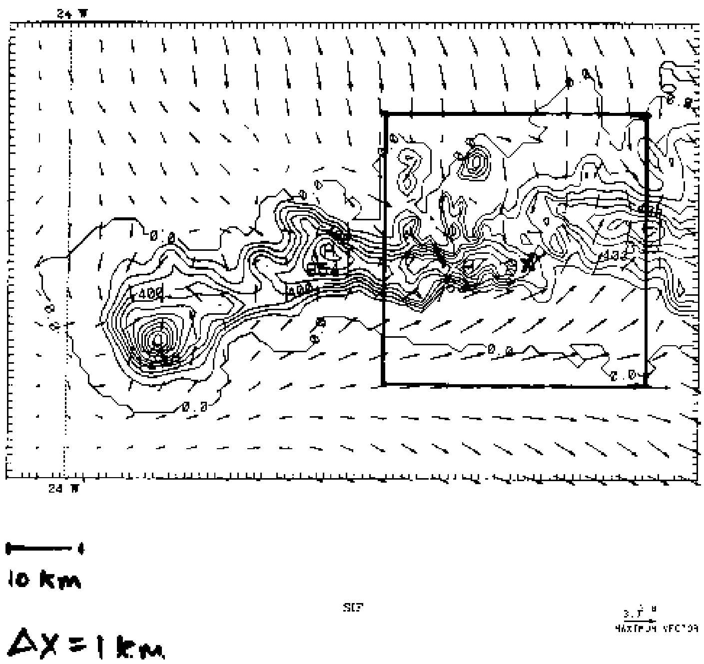


Figure 6. Simulation of the 10 m wind field (m/s) over the Snæfellsnes peninsula on 25 May 2001 at 1800 UTC. The cross indicates where the helicopter came into unexpected updraft.

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