THE FREYSNES WINDSTORM

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Abstract: A devastating windstorm in SE-Iceland is studied with the help of observations from automatic weather stations and high-resolution simulations. In this windstorm there is at the same time a strong downslope acceleration of the flow and acceleration at the edge of the mountain. The downslope windstorm is associated with strong wave breaking below a reverse wind shear in the lower troposphere. The method of Brasseur is applied for calculating the gusts. In the downslope flow, the mean wind is underestimated by the model, but a high observed gust factor is reproduced in the calculations. In the corner wind, the mean wind is reproduced, but the gust factor is somewhat underestimated by the calculations.

Keywords *- Downslope windstorm, wave breaking, corner wind*

1. INTRODUCTION

On the morning of 16 September 2004 a violent windstorm hit Freysnes, SE-Iceland. The windstorm was quite well forecasted in the region by the operational HRAS-system, which at that time ran the MM5 model (Grell et al. 1995) with a horizontal resolution of 9 km. Locally, the winds became however stronger than expected. At Freysnes (cf. Fig. 5), which is located immediately downstream of Mt. Öræfajökull (2119 m.a.s.l.) some structural damage occurred, including a hotel that lost its roof.

Here, the windstorm is investigated by numerical simulations and observations from two nearby automatic weather stations. We employ the numerical model MM5 and nest down to a horizontal resolution of 1 km. Boundary conditions are from the ECMWF. Gusts are estimated with the method of Brasseur (2001) and the predicted gusts are compared with observations.

2. THE WINDSTORM

Fig. 1 shows the surface wind field when the storm was at maximum in SE-Iceland. The surface flow is coming in from the east, but turning to northeast at the mountainous coast. At middle tropospheric levels, the wind was from the south or south-east. There was in other words strong veering of the wind in the lower troposphere. The Figure reveals very strong winds over the Vatnajökull glacier and also locally over the lowlands. There is a pronounced wind speed maximum immediately downstream of the highest mountain. This maximum does not extend far downstream. There is also a local maximum eminating from the edge of the same mountain, but extending far downstream.

Fig. 2 shows a cross section along the surface flow, over Mt. Öræfajökull, and through the area of maximum wind speed, which happens to be where Freysnes is located. The figure reveals very strong mountain wave breaking between ca. 800 and 550 hPa, a very stable layer at 750–800 hPa and very little wave activity above 500 hPa. There is strong turbulence associated with the wave breaking. At the surface, there is also a high concentration of turbulent kinetic energy.

3. MEAN WINDS AND GUSTS

A major characteristic of this windstorm is the gustiness (Figs. 3 and 4) which was observed both at Skaftafell and Öræfi. The maximum gusts are a little above 50 m/s in both places. The simulation underestimates the maximum wind speed at Skaftafell by some 13 m/s, but in Öræfi (edge), the model reproduces the mean winds. The maximum gusts are underestimated by approximately 5–10 m/s in both places.

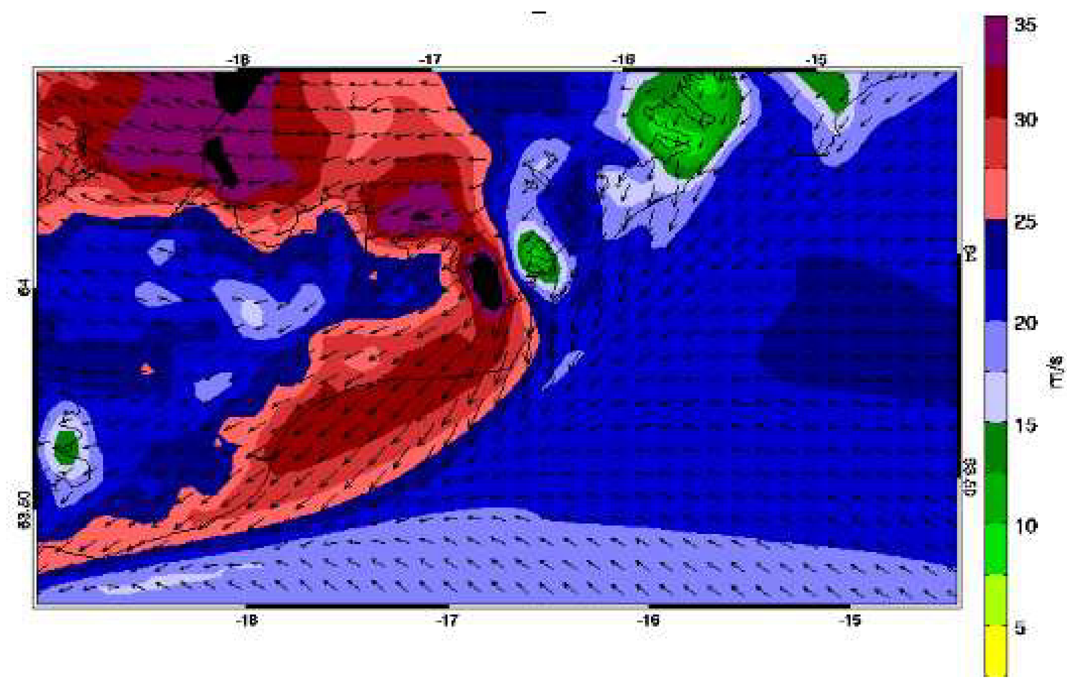

Figure 1. Simulated surface wind field [m/s] in SE-Iceland on 16 September 2004 at 06 UTC. The topography can be seen more clearly in Fig. 5.

The damage indicates that the gusts were stronger at Freysnes than those observed at Skaftafell, which is located approximately 4 km further downstream of the mountain. The simulated winds support this, and so do the gust calculations (Fig. 5).

4. DISCUSSION AND CONCLUSIONS

The present case features spectacular breaking of a mountain wave. The atmospheric conditions are particularly favourable for the creation of the wave; strong winds and a stable layer close to mountain top level. The conditions for breaking the wave at low levels are also favourable; a reverse wind shear and veering of the wind.

The simulation and the observations confirm that one can have a downslope windstorm and a strong corner wind at the same time. In fact, the previously mentioned stable layer contributes to both patterns. The outcome of the gust calculations are very encouraging for application of the method of Brasseur in both corner winds and downslope windstorms. The underestimation of the mean wind downwind of the mountain is however of some concern.

REFERENCES

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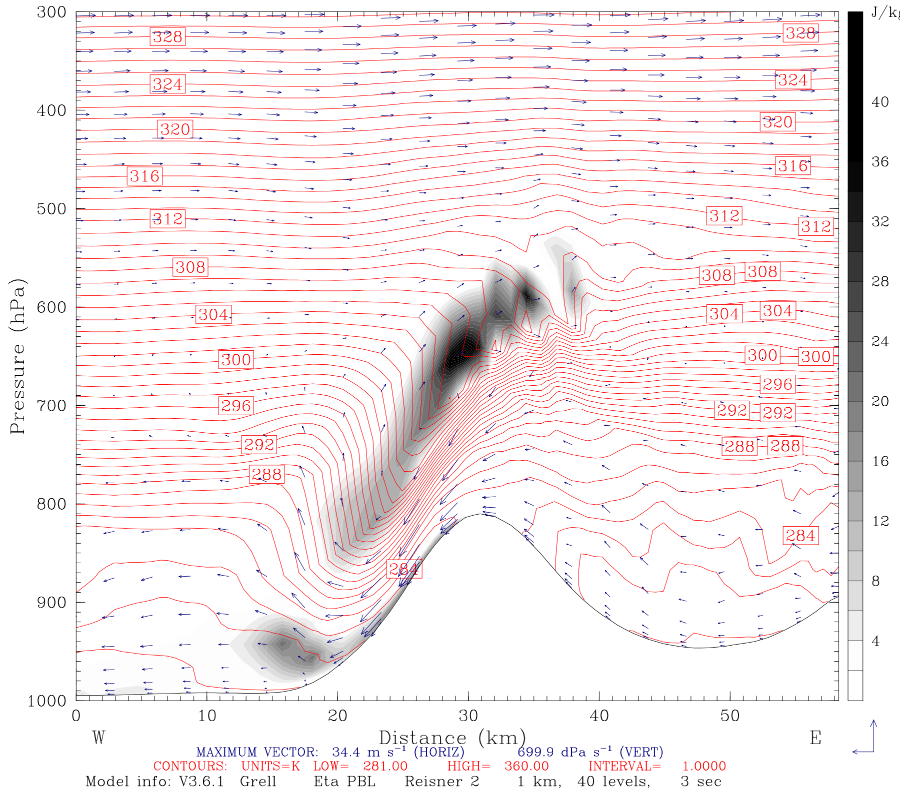

Figure 2. A cross section along the surface flow, across Mt. Öræfajökull. The figure shows potential temperature [K], wind vectors and turbulence kinetic energy [J/kg].

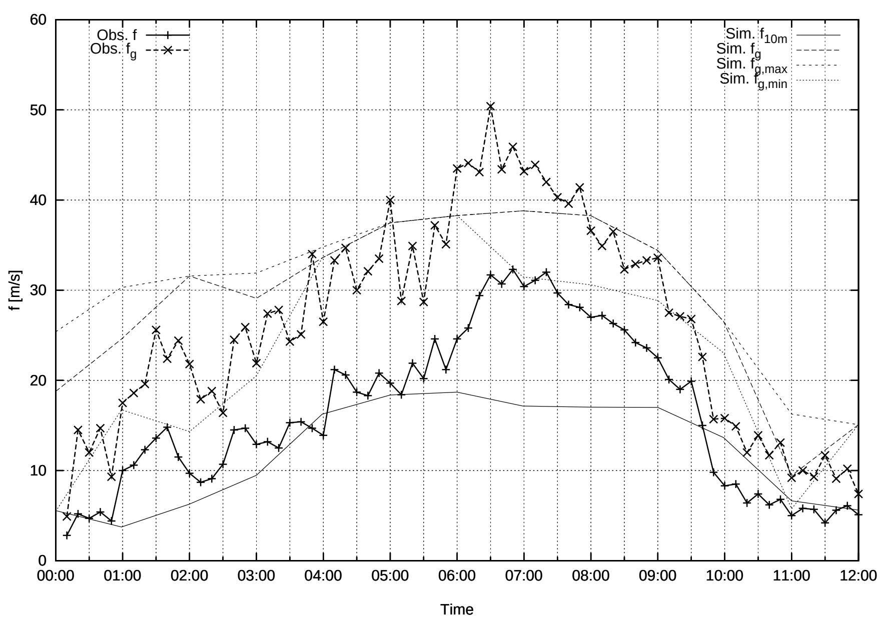

Figure 3. Observations and simulations of mean wind and wind gusts at Skaftafell weather station (approx. 4 km downstream of the foothills of Mt. Öræfajökull).

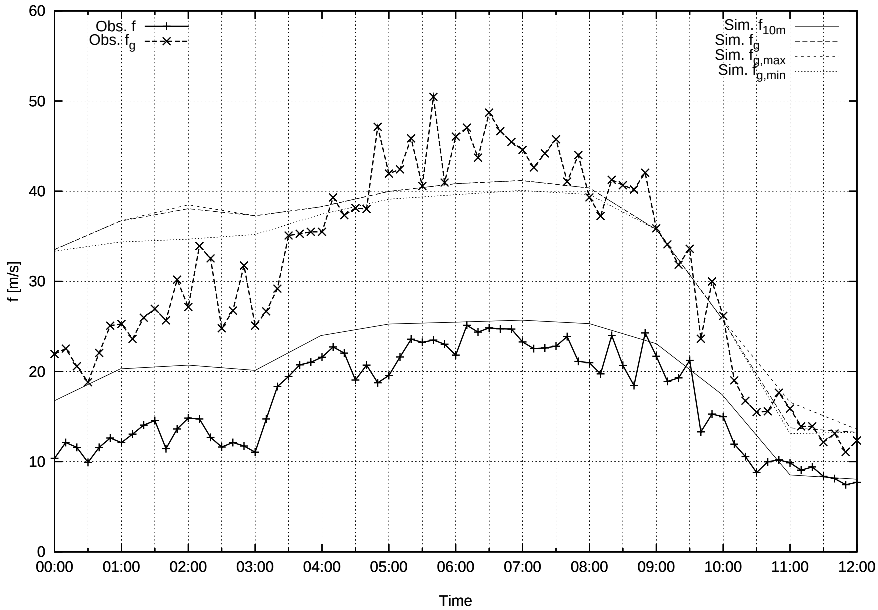

Figure 4. Observations and simulations of mean wind and wind gusts at Öræfi at the southern edge of Mt. Öræfajökull.

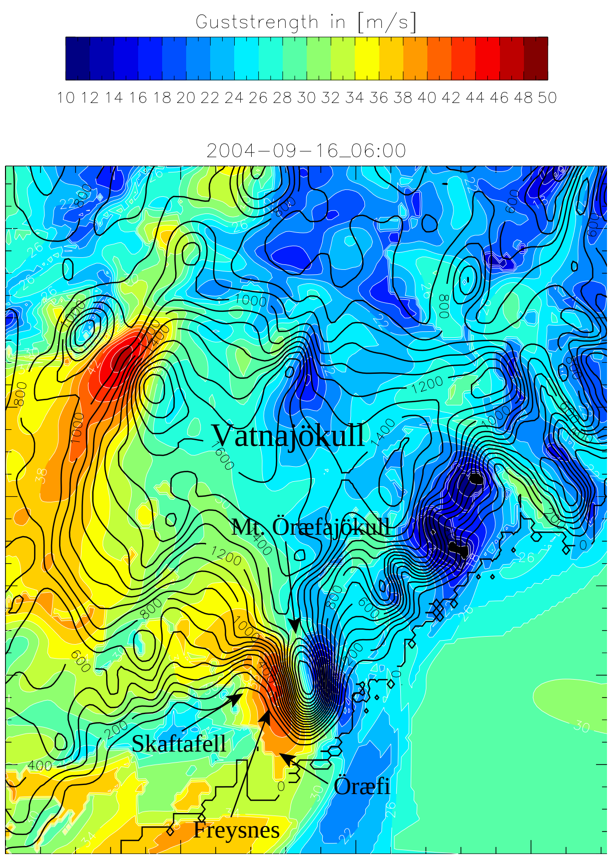

Figure 5. Simulated gust strength [m/s] and topography [m] SE-Iceland on 16 September 2004 at 06 UTC.