THE KVÍSKER 2002 PRECIPITATION RECORD

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Abstract: The precipitation record of Kvísker, SE-Iceland (293 mm/24 hrs) is investigated. Kvísker is located downstream of a 2119 m high mountain and observations indicate that strong wind upstream of the mountain is a key factor in generating the maximum precipitation intensity within the 24 hours period. A numerical simulation of the flow suggests that there are two distinct maxima in the precipitation intensity. One is situated close to the mountain top and is directly associated with the updraft and high concentration of liquid cloud water. The second maximum is located downstream and is associated with localized downdrafts and horizontal convergence of the spillover rain.

***Keywords** – Kvísker, extreme orographic precipitation, Iceland, spill-over*

1. INTRODUCTION

At 9 UTC on January 10th 2002, 293.3 mm of rain were observed to have fallen during the previous 24 hours at Kvísker, Southeast-Iceland. This was more precipitation than ever observed before at an Icelandic weather station and is still the 24 hrs precipitation record for Iceland. The extreme precipitation in Southeast-Iceland occurred during strong and persistent southwesterly winds. The Kvísker weather station (Fig.1) is located immediately to the east of Mt. Öræfajökull (2119 m.a.s.l.), i.e. downstream of the mountain. This makes the 2002 record fundamentally different from the previous record from 1979 where the wind was blowing from the southeast and Kvísker was upstream of the mountain. (Ólafsson and Jónsson, 2004) In this short paper, mesoscale features of the Kvísker 2002 event will be described with the help of observations and a numerical simulation and an attempt will be made to explain why the precipitation is so great downstream of the mountains.

Figure 1. Location of the Kvísker weather station.

2. OBSERVATIONS

Figure 2 shows the wind observations at Fagurhólsmýri weather station, which is located at the coast, south of Mt. Öræfajökull. The graph shows 10 min mean wind speed from 09/01/2002 9UTC – 10/01/2002 9 UTC. In the beginning of the period, the mean wind speed is close to 13 m/s. At 15 UTC the wind speed starts to increase until a maximum of almost 20 m/s is reached shortly before 19 UTC. For the rest of the period, the wind speed is close to 16 m/s. The precipitation record from Kvísker for the same period is shown in Figure 3. There is a clear correlation between the wind speed and the precipitation intensity; the greatest intensity of the precipitation is when the Fagurhólsmýri winds are at a maximum (16-19 UTC). Outside this period, the precipitation intensity is less and both winds and precipitation intensity remain stable until late in the night.

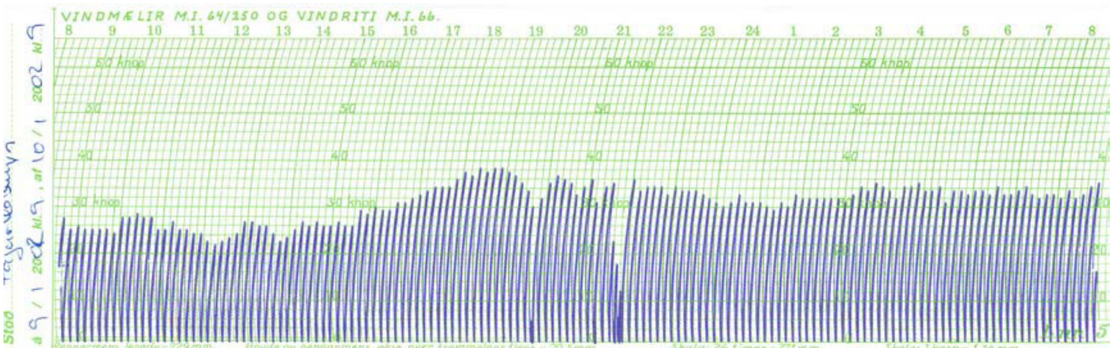

Figure 2. Mean 10 m wind observations at Fagurhólsmýri from /01/2002 9 UTC to 10/01/2002 9 UTC. The vertical scale is in knots and the horizontal scale is in hours.

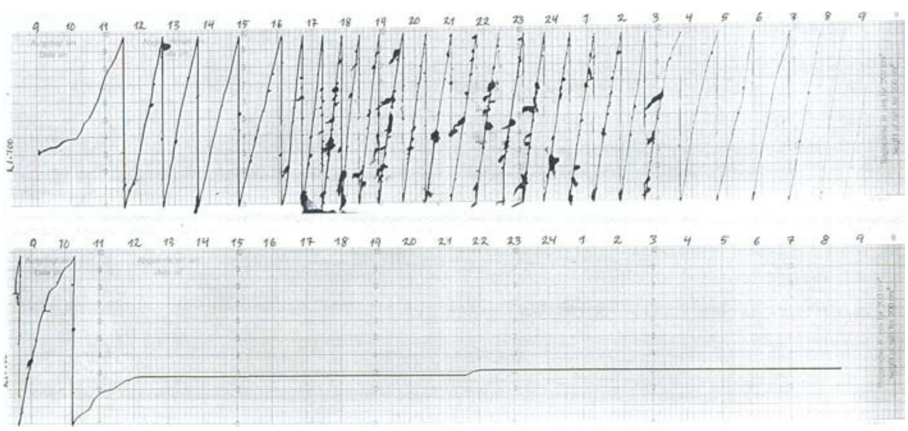

Figure 3. Observations from a tipping-raingauge at Kvísker from 09/01/2002 9 UTC to 10/01/2002 9 UTC. The vertical scale is in mm (max 10 mm) and the horizontal scale is in hours.

2. SIMULATED FLOW

The flow during this period has been simulated with the numerical model MM5 (Grell et al., 1995). The simulation has a horizontal resolution of 8 km and further information on the setup of the simulation, including the parameterization can be found in Rögnvaldsson et al., (2004). At this resolution, the height of Mt. Öræfajökull is only about 50% of its true value. Correct detailed quantitative results can therefore not be expected, but the simulation should be expected to reproduce qualitatively the features of the flow.

Figure 4 shows the surface wind field. The winds are from the southwest in the boundary layer. The wind speed over land, upstream of Mt. Öræfajökull is indeed less than over the ocean, but as expected the flow is not blocked and there are relatively small variations in wind direction. At mountain top level the wind is from the southwest and the wind speed in the free atmosphere at mountain top level is about 35 m/s (not shown). A cross section (Fig. 4) reveals updraft of more than 1 m/s over the upstream slopes. Over the downstream slopes there is downward motion of almost the same magnitude. The maximum updraft is at low levels, while the maximum downdraft is in a narrow region extending far up. The flow is almost neutral with respect to the wet adiabatic lapse rate from the surface up to about 800 hPa. Figure 6 shows the liquid cloud water and the rain water as simulated at 00 UTC on January 10th. There is high concentration of cloud water over the upstream slopes, and intense precipitation (rain water). Over the lee slope, there is little cloud water, but a secondary maximum in rain water. The lee-side maximum in rain water is a very short distance downstream of the maximum downdrafts.

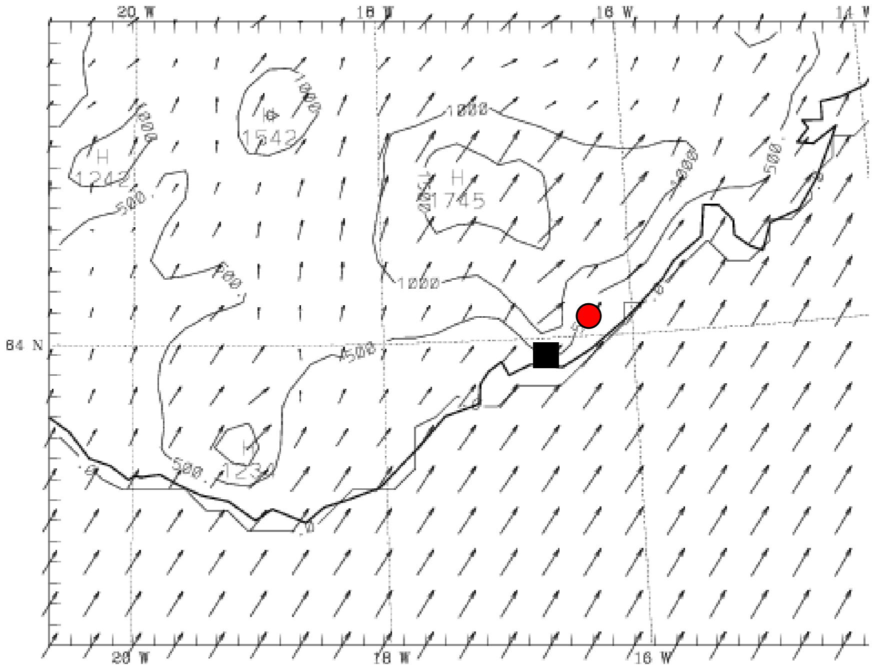

Figure 4. Simulated winds at 10 m above the ground on 10/01/2002 at 00UTC. The Kvísker weather station is indicated by a red dot. The Fagurhólsmýri weather station is indicated by a black box.

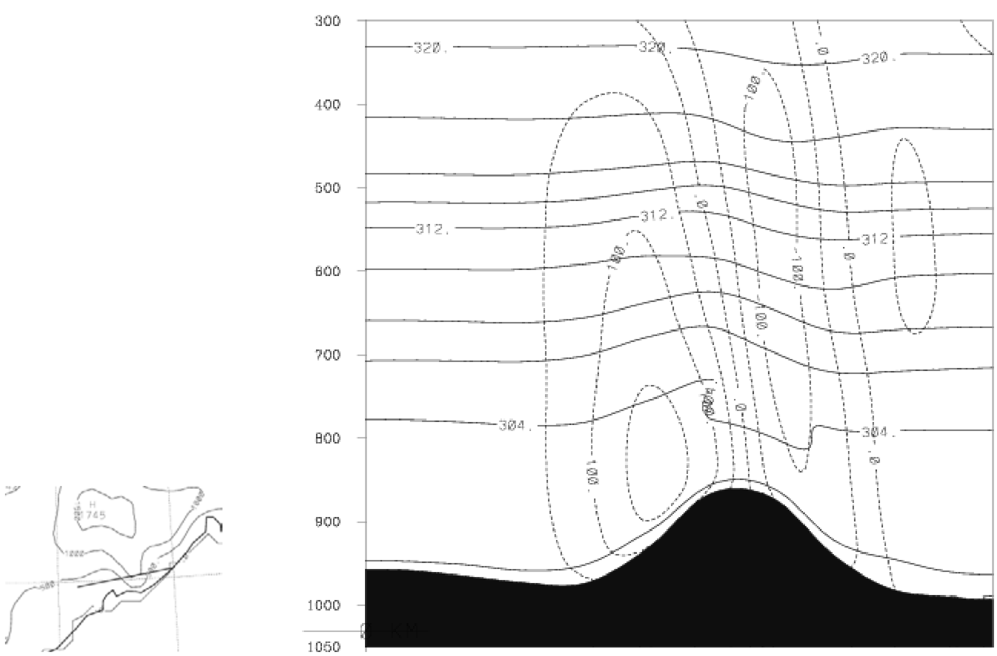

Figure 5. Simulated equivalent potential temperature (K) and vertical velocity (cm/s) on 10/01/02 at 00UTC. The position of the cross section is shown in the left panel.

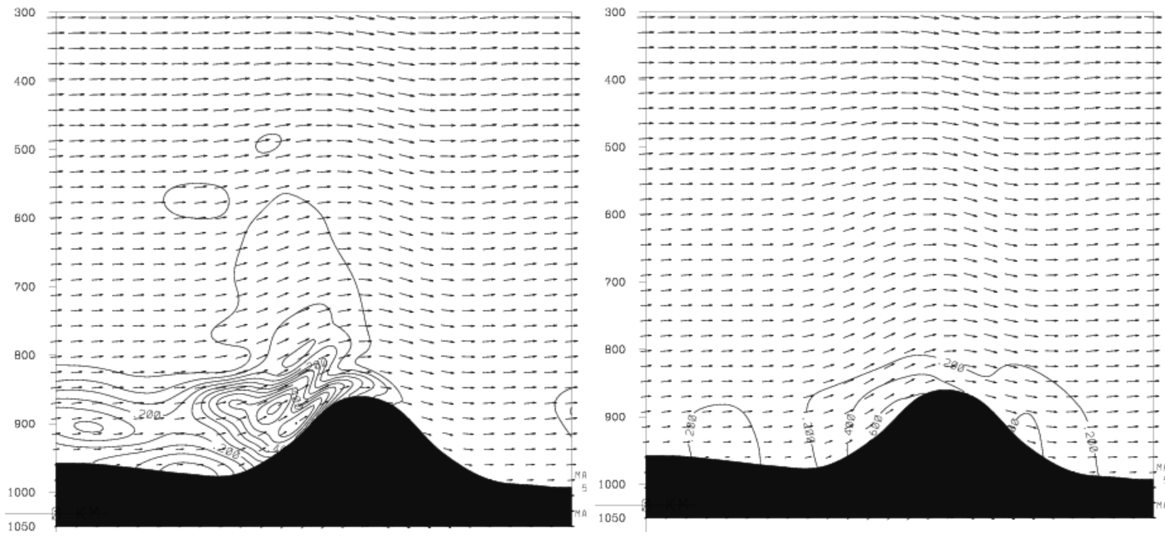

Figure 6. Simulated cloud water (left) and rain water (right) on 10/01/02 00UTC. The intervals are 0.05 g/kg for cloud water and 0.2 g/kg for rain water. The position of the cross section is the same as in Fig. 5.

3. DISCUSSION

The observations of the Kvísker precipitation record show a clear and positive correlation between the surface wind speed and the maximum precipitation intensity. The increase/decrease in precipitation intensity at Kvísker occurs almost simultaneously with an increase/decrease in wind speed at Fagurhólsmýri. This underlines the orographic nature of the precipitation, the faster the horizontal flow is, the stronger are the updrafts. This correlation could also be associated with changes in the flow pattern leading to stronger horizontal downdrafts and stronger horizontal convergence over the lee slope. The lee-side maximum in rainwater appears to be associated with the horizontal convergence and strong concentrated downdrafts. These elements of the flow pattern are probably responsible for the extreme precipitation that was recorded downstream of the mountain. The simulation indicates much more intense precipitation upstream than in the secondary maximum downstream. This does not necessarily need to be the case in reality and may be different if simulated at higher resolutions.

4. CONCLUSION

The paper reveals strong connection between precipitation intensity immediately downstream of a 2119 m high mountain in SE-Iceland and the wind speed at the edge of the mountain. A numerical simulation of the event suggests that advection of precipitation over the mountain, strong localized downdraft and associated horizontal convergence result in a secondary maximum in precipitation intensity over the lee slope. Currently, numerical simulations are run four times a day at a resolution similar to the study presented here. Features of this kind can thus be followed in real-time for forecasting purposes.

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