CASES OF LARGE FORECAST ERRORS OVER ICELAND

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Abstract: Forty-eight hour numerical forecasts during a period of 5 years are studied with emphasis on cases of false alarms and missed windstorms at 850 hPa. The overall performance of the forecast system is very good. Windstorms from the southwest are very well predicted, there are a few false alarms in southeasterly winds and northeasterly windstorms tend to be underestimated by the forecast model. The false alarms are in many cases associated with fronts, where a slight shift of a position of the weather system in time may give a large difference in the forecasted and observed winds. Yet, the true value of the forecast may be high. We attribute an underestimation in the wind speed in northeasterly windstorms to non-resolved orography, leading to an underestimation of the corner effect SW-Iceland, and possibly to winds that are generated by a pressure gradient at the western side of the Iceland wake.

***Keywords** – forecast error, corner wind, fronts, Iceland, wake, wind veering*

1. INTRODUCTION

Wind speed is undoubtedly the most important element of the weather forecast in Iceland. In this paper we investigate the performance of an operational numerical weather prediction model by comparing observations over Keflavíkurflugvöllur SW-Iceland to 48 hours forecasts of the model. The purpose of the study is to get some insight into the physics of the wrong forecast, rather than to give an assessment of the model. The forty worst cases of overprediction or underprediction of the low-level winds are investigated. Since the orography of Iceland is not well resolved in the model, we look in particular for signs of systematic errors due to non-resolved orography.

The NWP data is from the Arpege forecast system (Courtier et al., 1991), which is used for operational weather forecasts in Iceland as well as for input into forecasting systems for snow on the ground, avalanche danger and lightning. The horizontal resolution varies from being about 20 km over France to about 250 km on the other side of the globe. Over Iceland, the resolution is roughly 50 km. At that resolution, the maximum height of the highest mountains in Iceland is about half of their true value and narrow mountain ranges are simply absent in the model.

2. RESULTS

The overall performance of the Arpège system over Iceland is very good (Arason and Ólafsson, 2005), but here we study the rare cases: (a) where the wind speed at 850 hPa is predicted to be greater than 20 m/s and the forecasted winds turn out to be at least 10 m/s too fast (false alarms) and (b) where the wind speed at 850 hPa is observed to be greater than 20 m/s and the forecast indicated winds at least 10 m/s too weak (missed storms). Figure 1. shows the frequency of wind directions at 500 hPa when the wind at 850 hPa is greater than 20 m/s.

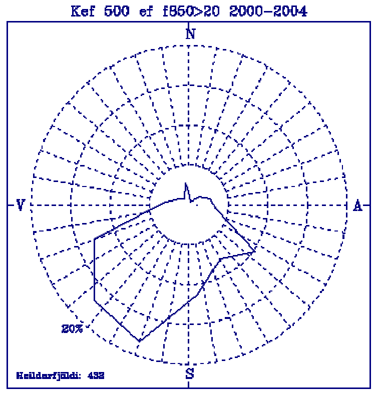

Figure 1. Frequency of wind directions at 500 hPa over Keflavíkurflugvöllur, SW-Iceland when the wind speed at 850 hPa is greater than 20 m/s (2000-2004).

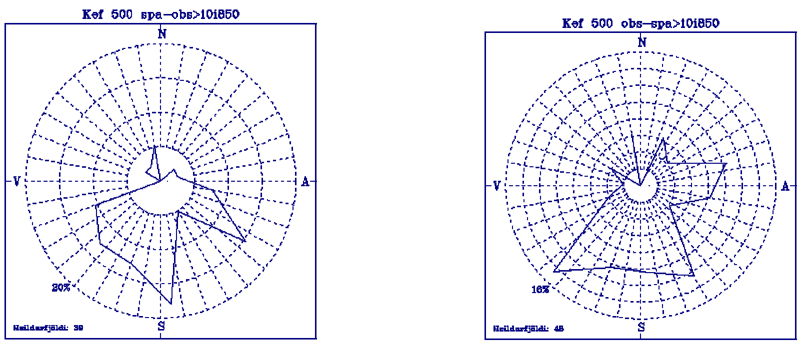

Figure 2. Left: frequency of wind directions at 500 hPa over Keflavíkurflugvöllur, SW-Iceland when the forecasted wind speed at 850 hPa is greater than 20 m/s and the forecasted winds are at least 10 m/s faster than observed winds (false alarms). Right: frequency of wind directions at 500 hPa over Keflavíkurflugvöllur, SW-Iceland when the observed wind speed at 850 hPa is greater than 20 m/s and the forecasted winds are more than 10 m/s weaker than the observed winds (missed storms).

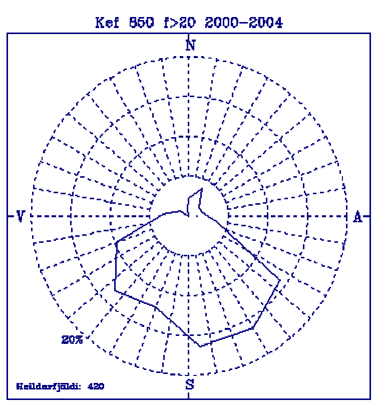

Figure 3. Frequency of wind directions at 850 hPa over Keflavíkurflugvöllur, SW-Iceland when the wind speed at 850 hPa is greater than 20 m/s (2000-2004).

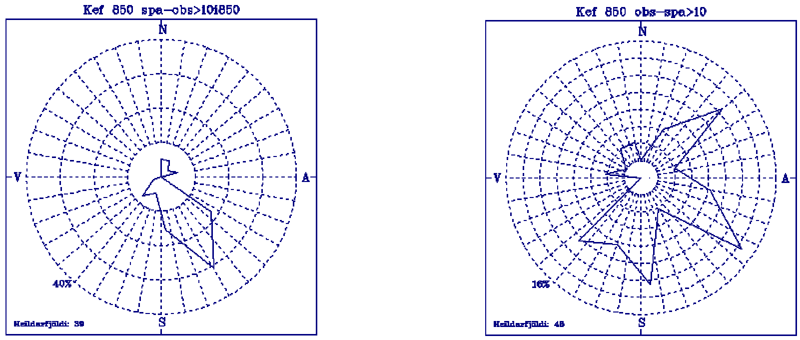

Figure 4. Left: frequency of wind directions at 850 hPa over Keflavíkurflugvöllur, SW-Iceland when the forecasted wind speed is greater than 20 m/s and the forecasted winds are at least 10 m/s faster than observed winds (false alarms). Right: frequency of wind directions at 850 hPa over Keflavíkurflugvöllur, SW-Iceland when the observed wind speed is greater than 20 m/s and the forecasted winds are more than 10 m/s weaker than the observed winds (missed storms).

The winds are predominantly from the southwest, but with a strong contribution from the south and southeast. Looking at the frequency of winds during false alarms (Fig. 2, left), we see quite a similar frequency distribution, but the southeasterly winds are slightly more frequent than in Fig. 1. Figure 2. (right) shows the missed storms. Here, the easterly winds are much more frequent than in the dataset of storms in Fig. 1. Figure 3. and 4. show the corresponding frequency distribution of winds at 850 hPa. Figure 4. shows that most of the windstorms are during winds from the southeast or the south, followed in frequency by the southwesterly winds. The false alarms (Fig. 4., left) include almost exclusively winds from the southeast, while there is a relatively strong contribution of northeasterly windstorms in the set of missing storms (Fig. 4., right).

The twenty worst false alarms and twenty worst cases of missing windstorms have been analyzed. There appears to be a non-systematic spread in the trajectories of the associated weather systems and the mean pressure pattern at the time of the initialization of these wrong forecasts is very much like the mean pressure pattern in the N-Atlantic region (not shown).

4. DISCUSSION

The wind-roses reveal that changes of wind direction with height during low-level windstorms is quite common. These windstorms are associated with baroclinic weather systems, where the low-levels winds at the fronts are typically from the southeast, while the upper flow is from the southwest. The false alarms include almost exclusively winds from the southeast at 850 hPa, but in most of these cases, the wind at 500 hPa is from the south or southwest. The source of the error here lies most likely in the limited horizontal extension and rapid movement of the windstorms. A windstorm that is well forecasted in intensity 48 hours ahead, but passes over the weather station a few hours too early or too late appears on the left panel in Fig. 2 and Fig. 4, but the forecast may yet have been quite successful. It is of particular interest to see that there are practically no false alarms during a period of 5 years when it comes to southwesterly windstorms. Yet, these windstorms count up to about 30% of the total of 420 windstorm observations. The pattern of missing windstorms is quite different. Here, easterly and northeasterly wind directions are overrepresented. A very plausible explanation for this is systematic underestimation of the corner effect in SW-Iceland during northeasterly flow. The wake of Iceland in such flows is also inevitably underestimated by the model, and that should lead to an underestimation of the pressure gradient in SW-Iceland and immediately downstream.

Output from other NWP systems have not yet been evaluated in a manner similar as we do here for the Arpège system, but the nature of the errors is such that a similar character of the error pattern should be expected in a system with similar horizontal resolution.

4. CONCLUSIONS

The forecast error analysis presented here indicates strongly that improved representation of orography with higher horizontal resolution than 40-50 km would lead to substantial improvement in windstorm forecasting. Such efforts have already started with the HRAS project (http://www.vedur.is/~haraldur).

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