Analysis of Forecast Errors in a NWP Model

Þórður Arason[1] and Haraldur Ólafsson[2]

(1) Veðurstofa Íslands - Icelandic Meteorological Office

(2) University of Iceland, Icelandic Meteorological Office, and Institute for Meteorological Research

Reykjavík, ICELAND

arason@vedur.is, haraldur@vedur.is

Institute for Meteorological Research
Reykjavík, Iceland

1 Abstract

We have compared differences between radiosonde observations in SW-Iceland and 48 hour forecast by a numerical weather prediction model over a period of five years (2000-2004).

Temperature and height of the pressure levels of 925, 850 and 500 hPa were compared in search for systematic errors. In the overall mean, the predictions have little error and very limited bias. There are however slight seasonal variations and indications of situations where the model does relatively poorly. At 500 hPa there is a cold bias in the forecasts in late winter, but no such bias in the autumn and early winter. At the lowest level there is a tendency of a cyclonic bias in the forecasted wind direction in northeasterly winds and in westerly flow, there is a warm bias in the forecasts.

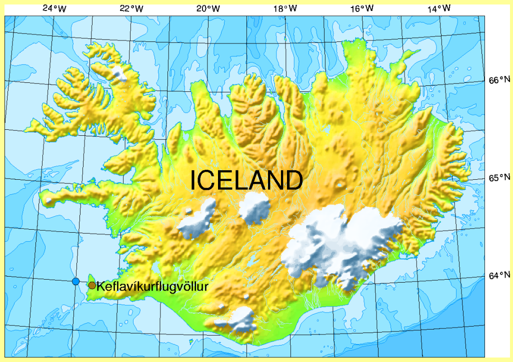
Both of these systematic low-level errors are attributed to non-resolved orography; the bias in the wind direction is most likely due to an underestimation of the deviation of the flow by the mountains and the warm bias appears to be associated with an underestimation of the accumulation of low level cold air upstream of Iceland.

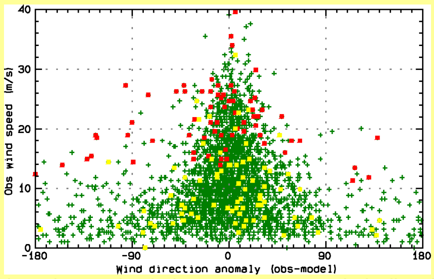
2 Data and Analysis

For this study we used radiosonde observations from Keflavíkurflugvöllur in Iceland, WMO station number 04018, at 63°58.1'N, 22°36.9'W, elevation 38 m a.s.l. The radiosonde data at 00h and 12h UTC from the five year period 2000-2004 were used. The temperature, humidity, wind speed, wind direction and geopotential height at the 925, 850, and 500 hPa pressure levels were extracted from our data base. These were compared to the corresponding 48 hour prediction at 64°N, 23°W of the French numerical weather prediction model, Arpège.

Box 2 shows wind roses for both the observed (solid) and model (dashed) data for the three pressure levels, and a comparison of the wind speeds of the model to the observed. Although there seems to be on average good correspondence there are both too high and too low forecasted wind speeds.

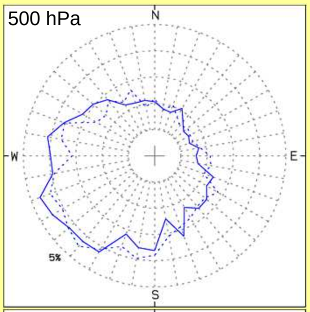
Boxes 5 and 6 show differences between the observed and forecast temperatures, geopotential height and wind speeds versus observed wind direction or time of year.

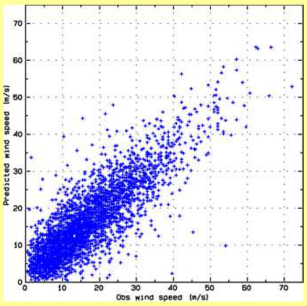


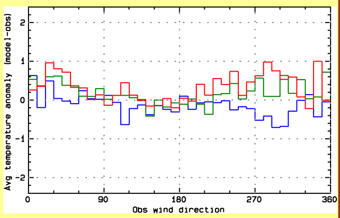


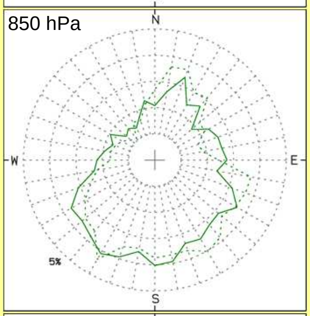
The observed wind speed versus wind direction anomaly, where significant wind speed anomalies are identified with red and yellow dots. Most of the time when wind speeds were high there was not a significant deviation in the wind directions, and also that most of the time when there is a large deviation in wind direction then the wind speed is very low.

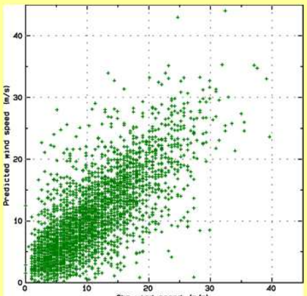
3 Comparison of Observations and 48 Hour Forecasts

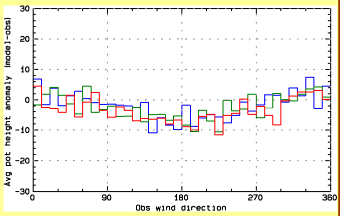


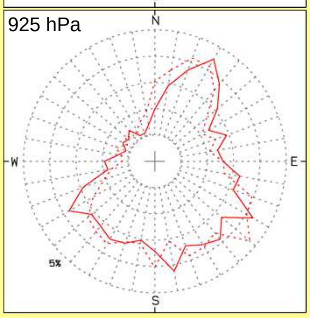


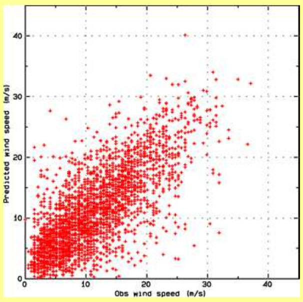


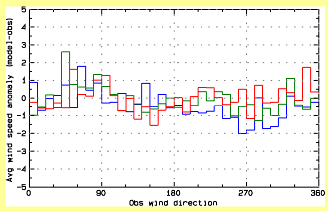












The average values of the data in Box 5 in 10° wind direction bins. It is noteworthy that in general there are no large biases in the difference between the forecast and observations.

4 Conclusions

At least two systematic errors appear to be a direct result of the mountains not being adequately resolved. The warm bias in the temperature prediction at 925 hPa during westerly winds occurs mainly in very stable airmasses and weak winds. The flow at the southwest coast of Iceland is blocked by the mountains and since the height and the steepness of the mountains is underestimated by the model, the magnitude of the blocking can also be expected to be underestimated by our model. The blocking can hamper descent of warmer air from above and it may also lead to some piling up of the cold air in the lowest layers. An underestimation of these effects leads to a warm bias in the predictions.

The low level northerly winds tend to be more northeasterly in reality than in the forecasts. This is explained by the model systematically underestimating the deviation of the flow by the mountains in SW-Iceland.

Five years of 48 hour operational forecasts for Iceland made by the numerical weather prediction model Arpège show very good skill in temperature, wind and geopotential height. Rather small systematic errors can however be detected. Some of the errors can be attributed to subgrid orography, i.e. underestimation of low level blocking in stable southwesterly flow and underestimation of the flow deviation by the mountains in SW-Iceland in northeasterly flow. Although small, these systematic errors should be considered in the interpretation of the numerical forecasts.

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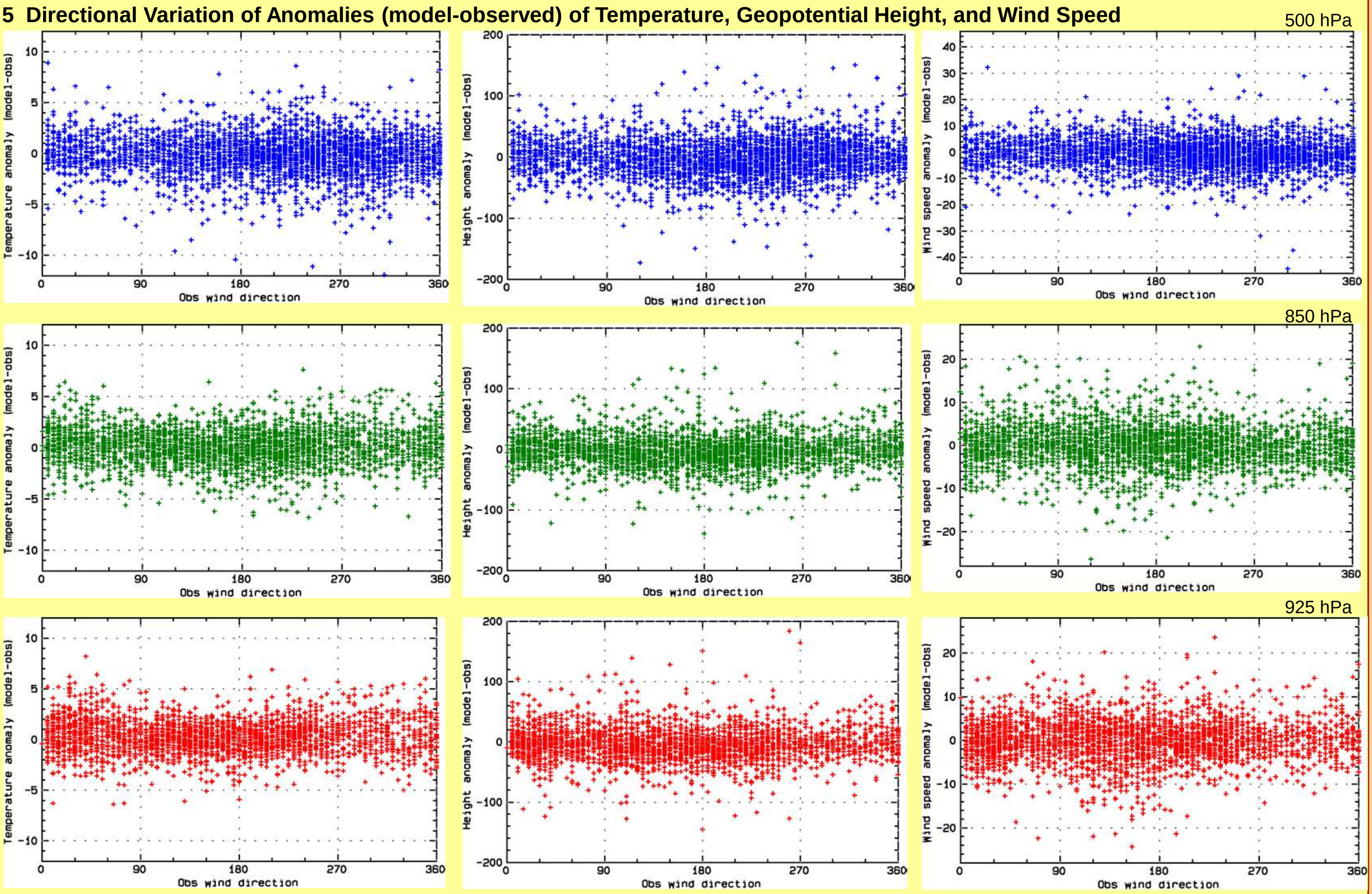
5 Directional Variation of Anomalies (model-observed) of Temperature, Geopotential Height, and Wind Speed



6 Annual Variation of Anomalies (model-observed) of Temperature, Geopotential Height, and Wind Speed