Utility of daily vorticity vs. pressure as predictor in downscaling models

DMI partner report for deliverable D13

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Introduction

In the model based on the weather generator approach originally proposed by DMI, the intention was to use local vorticity at a point near the station as a predictor, i.e. let the parameters of the model be dependent of the vorticity. This was based on heuristic thinking: If the vorticity near a station was high, fronts and low pressure systems were near the stations and the occurrence of precipitation was likely.

A first step in evaluating the utility of vorticity as a predictor is to examine the vorticity as represented in the NCEP/NCAR reanalyses. As we will see, the vorticity field appears quite 'patchy' even in the climatology and we therefore also have to look for alternative circulation predictor candidates. Straightforward is the sea level pressure field

Data

This investigation is based on the MSL pressure fields from the NCEP/NCAR reanalysis dataset, which was downloaded from the CRU/STARDEX website. From this field, the geostrophic vorticity was calculated by applying the Laplacian in spherical coordinates using a five-point formula.

Comparison of MSL vorticity and pressure: results and discussion

The climatology of the geostrophic vorticity is shown in Figure 1. It appears quite unstructured and when inspecting the same field for single days a similar picture arises. The reason for this is probably connected to the spectral representation of the basic fields in the analysis system. Because the representation is truncated at some wave number, sharp gradient give rise to 'ringing' or Gibbs phenomena. This is to some extent true for the MSL pressure field, but when the Laplacian is applied to obtain the geostrophic vorticity field, the problems is significantly worsened. The NCEP/NCAR reanalyses are truncated at T-63 and the smallest wave which can be represented has a wavelength of about 600 km, which corresponds quite well to the scale of the structure seen in Figure 1, e.g. in the trade winds southwest of Spain. In this region the wind is quite stable and Gibbs phenomenon will therefore also be manifest in the climatology. Further north, the wind is more variable from day to day and the phenomenon is not seen in climatology but can nevertheless occur.

Consequently we examined MSL pressure, whose climatology is seen in Figure 2. Also in this field, small wiggles are seen in the trade wind region, however much less prominent than in the vorticity field.

Conclusion

Based on the above, I conclude that the representation of vorticity in the NCEP/NCAR reanalyses is so contaminated by short-wavelength noise that it is unreliable as a predictor. Therefore, I have decided to use SLP pressure as a predictor instead. For the verification of the MSL pressure I refer to other partners report.

Figures

Figure 1: Climatology of MSL geostrophic vorticity for January, calculated from the NCEP/NCAR reanalysis data (1958-2000). Distance between contours is 10^{-5} s^{-1}. Full: positive, stipled: negative, fat: zero.

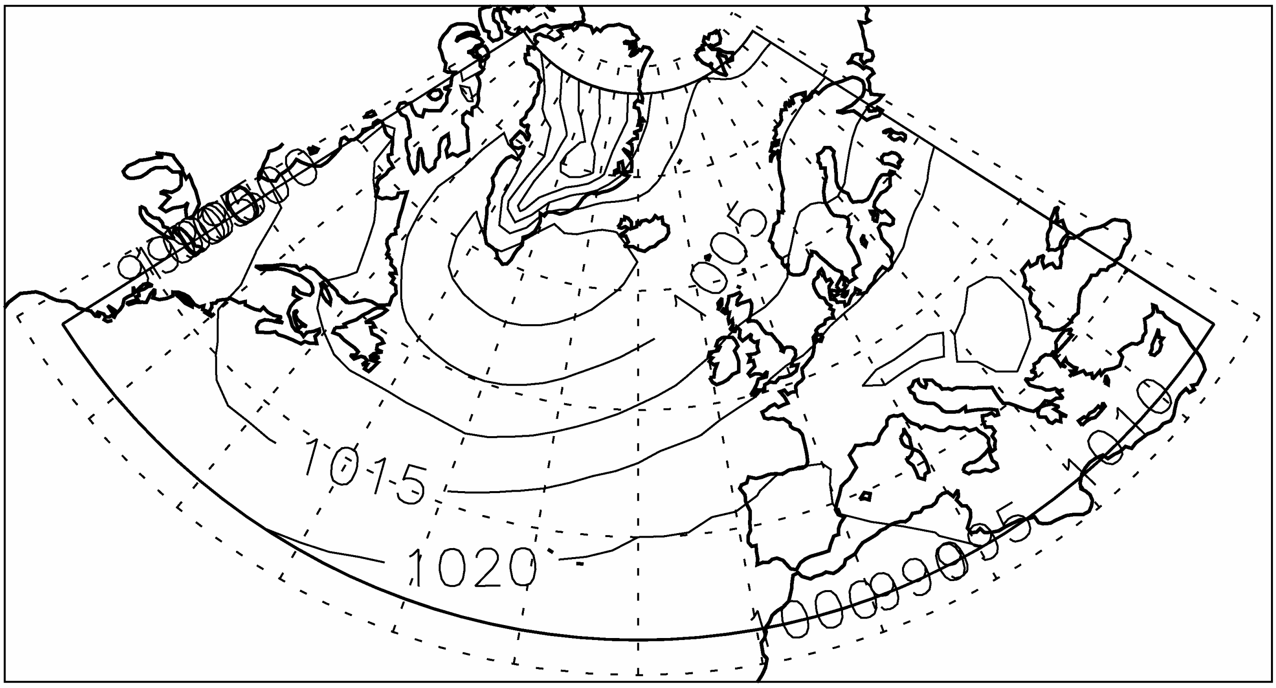

Figure 2: Climatology of MSL pressure for January, calculated from the NCEP/NCAR reanalysis data (1958-2000). Distance between contours is 5 hPa.