Simulation of a Polar Low Case in the North Atlantic with different regional numerical models

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ABSTRACT
In this paper it is shown that regional scale models are able to simulate maritime mesoscale features in general, but there is space for improvement in detail.

INTRODUCTION
From the 14th until the 16th of October 1993 an intense mesoscale cyclone occurred in the North Atlantic fulfilling the requirements of being classified as Polar Low according to Rasmussen and Turner (2003). During its lifetime it moved southward from its developing area in the Norwegian Sea on a track approximately parallel to the Norwegian coastline passing the Shetland Islands and hitting the Norwegian coast in the south on the 16th of October (Nielsen, 1997). In this study the ability of two different numerical regional atmospheric models (grid size about 50 km $\times$ 50 km) to reproduce this Polar Low occurrence was investigated and compared to observational analyses.

DATA
The data used in this study originate from extended simulations with the regional atmospheric model REMO (REgional MOdel) and CLM (CLimate Model) simulations performed at the GKSS with spectral nudging (Feser et al., 2001) and driven by NCEP/NCAR reanalyses data (Kalnay et al., 1996) at the boundaries. Two analyses have been used to evaluate the performance of the two models – the EM3AN analysis prepared by the DWD (German Weather Service) by means of their forecast model HRM (High Resolution Model) and another analysis that has been constructed by the FU Berlin and is commonly known as „Berliner Wetterkarte“.

RESULTS
For comparison in this paper a point in time (Oct. 15th 1993, approx. 6.00 a.m.) is chosen when the Polar Low entered its mature state and output data from all sources is available (fig. 1). All of the figures show a depression in mean sea level pressure and high wind speeds (when vorticity $> 10^5 s^{-1}$) in the area the Polar Low is situated. Thus, the Polar Low is in principle generated correctly, but the simulations deviate with respect to location and depth of the depression. In the analyses and REMO the center of depression is located east of the zero degrees meridian, whereas CLM depicts the center farther west. In the „Berliner Wetterkarte“ sea level pressure falls below 985 hPa, the DWD analysis shows a decrease not exceeding 990 hPa and CLM and REMO not falling below 995 hPa. At this point it cannot be decided whether this is due to a systematic error in CLM or whether there is a lack of reliability in the analyses which are locally based mostly on the the data obtained at weather ship „M“ (as marked in fig. 1(d)). A satellite image taken only seven hours later (AVHRR, Oct. 15th 1993, 13.29 p.m., not shown) suggests a depression center slightly to the west of the meridian closer to the position depicted in CLM.

References

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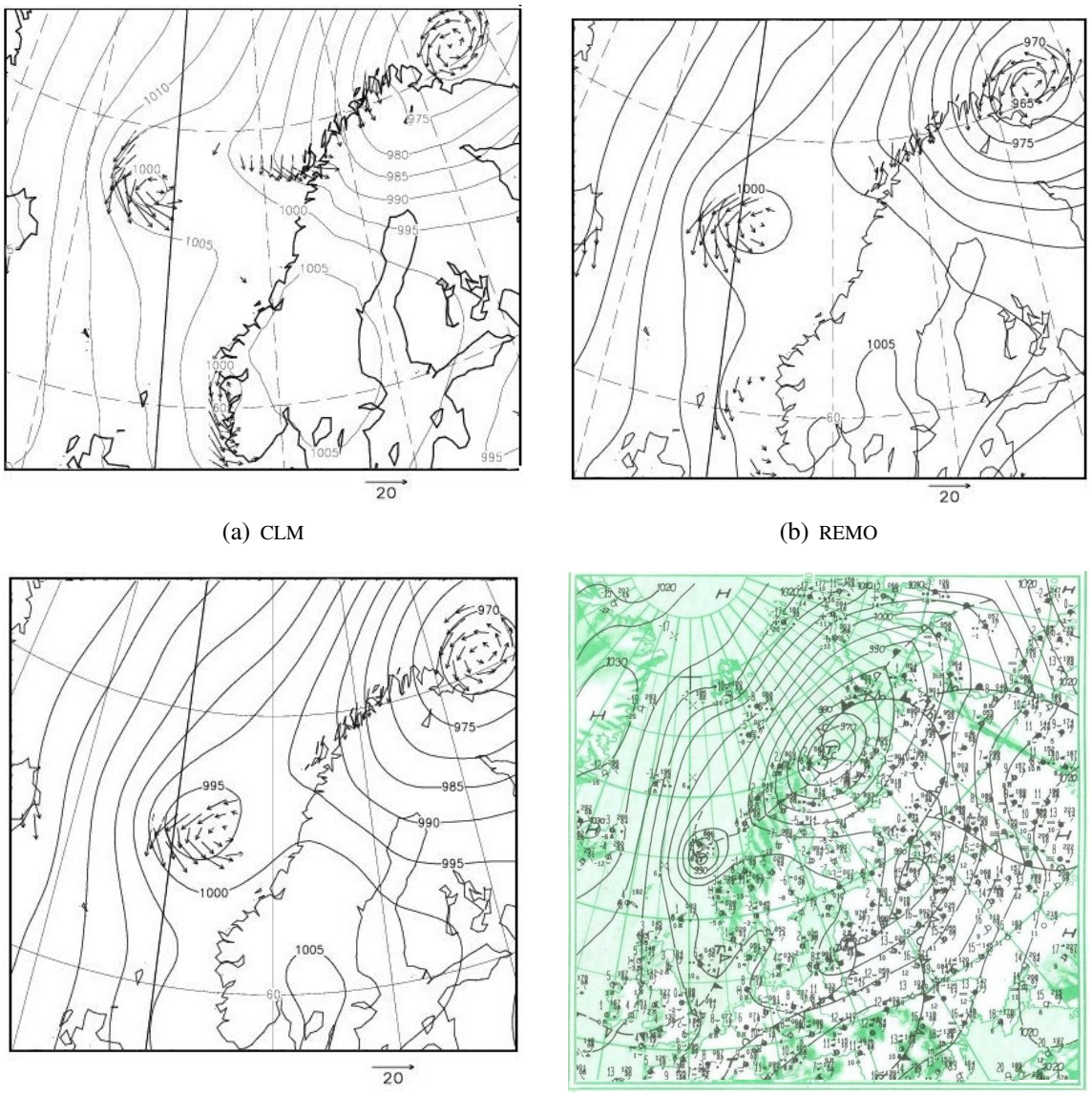

(a) CLM (b) REMO

(c) HRM, DWD (d) BWK

Figure 1: 1(a)- 1(c)10m wind velocity (length of arrows) in areas with an absolute value of relative vorticity $> 10^5 s^{-1}$ and mean sea level pressure from CLM and REMO simulations and HRM analysis, DWD, respectively, at 15/10/93, 6:00, 1(d) surface weather chart FU Berlin at 15/10/93, 7:00