

A Z-Coordinate Version of the Nonhydrostatic Model LM

JÜRGEN STEPPER¹, H.-W. BITZER², Z. JANJIC³, U. SCHÄTTLER¹
P. PROHL¹, J. PARFINIEWICZ⁴, U. DAMRATH¹, E. AVGOUSTOGLOU⁵

¹*Deutscher Wetterdienst, P.O.Box 100465, 63004 Offenbach a.M., Germany*

²*Amt für GeoInformationswesen der Bundeswehr, Gruppe MetBW, Germany*

³*National Center for Environmental Prediction, Washington DC., USA*

⁴*Institute for Meteorology and Water Management, Warsaw, Poland*

⁵*Hellenic National Meteorological Service, Athens, Greece*

The Eulerian version of the LM-Z uses the numeric scheme described in Steppeler et.al. 2002. Mountains are represented by linear splines, as opposed to the step mountain approach of Mesinger et al. (1988) using a representation of the topography by piecewise constant functions. This technique is also known as brick (or Legoland) approach and it was shown by Gallus and Klemp (2000) that there are serious problems with this approach in the presence of wind. In test problems it could be shown that the solution does not converge. The technique used in the LM-Z is free from this error.

A number of idealized and real forecast tests have been performed. The large scale features of clouds are captured by LM-Z and LM. Concerning meso scale cloud structures there are substantial differences between the two forecasts. In particular the distinction between cellular and stratiform clouds is more realistic for LM-Z. A case of low stratus over southern Sweden was forecasted as layered cloud with LM-Z and rather broken with LM.

The case shown here is the 30 h forecast starting from the 28th of March 1997 00 UTC, representing a strong wind situation. The rather interesting differences in the forecast of meso scale cloud structures result in different precipitation forecasts. Fig 1 shows the observed precipitation sum 28 to 29 March 1997 06 to 06 UTC and Fig. 2 the corresponding forecasts of LM and LM-Z. There is a substantial improvement by the LM-Z.

References

- Gallus, W. and J. Klemp, 2000: Behaviour of flow over steep orography. *Mon. Wea. Rev.*, 128, 1153-1164.
- Mesinger, F., Z. Janjic, S. Nicovic, D. Gavrilov and D. Deaven, 1988: The step-mountain coordinate: Model description and performance for cases of Alpine lee cyclogenesis and for a case of Appalachian redevelopment. *Mon. Wea. Rev.*, 116, 1493-1518.
- Steppeler, J., H.-W. Bitzer, M. Minotte and L. Bonaventura, 2002: Nonhydrostatic atmospheric modelling using a z-coordinate representation, *Mon. Wea. Rev.*, 130, 2143-2149.

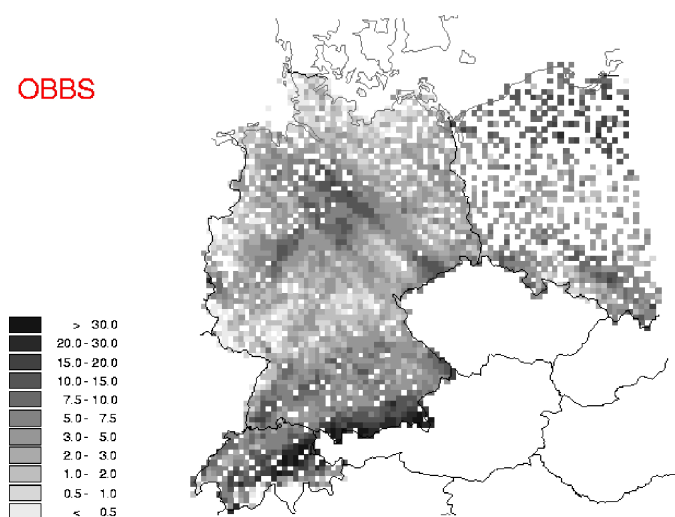


Figure 1: The precipitation sum as observed by the climatological network from 28 March 1997 6 UTC to 29 March 1997 6 UTC. Data from Germany, Switzerland and Poland were used.

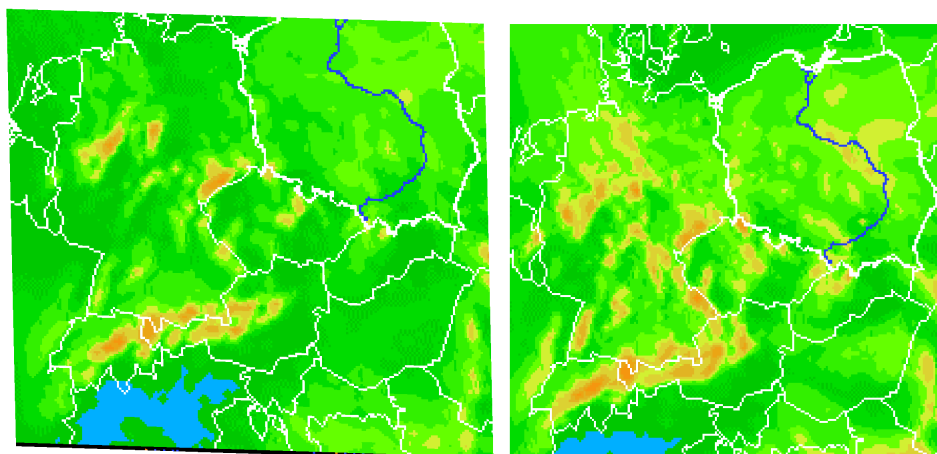


Figure 2: The same as in Fig. 1, but for forecasts of LM (left) and LM-Z (right).