New Developments Concerning the Z-coordinate Version of LM

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The development of the Z_LM is part of the efforts to increase the quality of the prediction of precipitation with the LM (Steppeler et al., 2003).

The prediction of precipitation depends critically on the pattern of vertical velocities and therefore in particular on a proper representation of the gravitational waves near mountains. Another numerical issue in order to achieve this is the development of the two time-level scheme with third order spatial accuracy (Gassmann et al., 2003). The development of the prognostic precipitation scheme is also supposed to have an impact on the quality of precipitation forecast.

The z-coordinate LM uses model z-surfaces as model levels. As a consequence, these cut into the mountains. The principle of this scheme is described in Steppeler et al (2002). Here some recent developments and the current state of this project are reported.

The Z_LM is now available in a three dimensional version and has been tested using the 400 m mountain proposed by Gallus et al. (2000). Other tests have been done using high bell shaped mountains of about 2000 m height. The atmosphere at rest is represented exactly by the Z_LM.

Further tests have been done using the SCANIA test. This test consists of using the orography of Scandinavia together with an idealised flow field of 10 m/sec from the north west. In such tests the physical parameterizations are switched off. Integrations of four hrs have been done and the results were compared with the 30 min integrations reported by Cullen et al. (2000). The false lee effects reported with some models were not observed with the Z_LM.

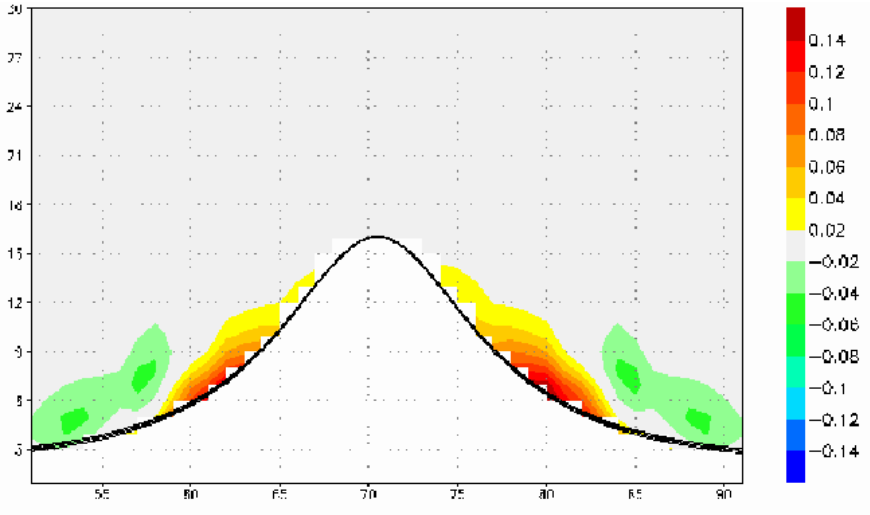

Figure 1: Cross section of the vertical velocity field for a 2 hr forecast starting with the atmosphere at rest. The radiation corresponds to conditions at noon.

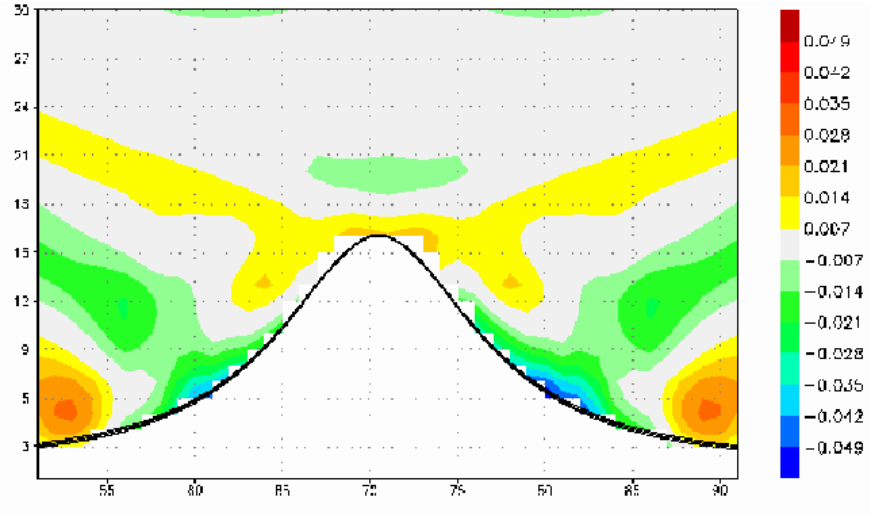

Figure 2: As Fig. 1, for night time conditions.

The inclusion of the physical processes is done on a special grid, which is terrain following. Only the adiabatic part of the Z_LM is done on the Z-grid. Both grids describe the same atmospheric state and transformations are used to ensure this and to update the z-grid fields with the physics tendencies and vice versa. First test integrations have been done, using a mountain of 2300 m height and dry physics routines, that is radiation, surface processes and turbulence, as described by Steppeler et al. (2003). In Fig. 1 a 2hr calculation is given, using the atmosphere at rest as initial values. The radiation represents conditions at noon. Without radiation the atmosphere remains exactly at rest. With radiation a mountain wind appears. During night time the situation is reversed. The result is given in Fig. 2. A valley wind can be seen. The Z_LM can thus correctly represent the wind as it depends on the time of the day. As opposed to this, the LM with terrain following coordinates would create a circulation even without radiation in the model.

References

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