NWP research in Austria

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1. Operational forecast system

Operational limited area weather forecasts in Austria are made using version AL15 of the ARPEGE/ALADIN modelling system. ALADIN forecasts are made on two Central European domains, with horizontal resolutions of 12.1 km and 9.6 km, respectively. The number of levels in the vertical is 37 in both cases. The model is spectral, run in hydrostatic mode, with a semi-implicit, semi-Lagrangian advection scheme. Initial and boundary conditions are taken from the global model ARPEGE. A modified Bougeault scheme is used for deep convection, a first-oder closure for turbulent vertical transports, and the ISBA (Interaction Soil-Biosphere-Atmosphere) scheme is used to represent surface processes. Coupling frequency is 3 hours. Integrations up to +48 hours are performed twice a day.

2. Research

a. Numerical prediction of inversion fog and low stratus

The prediction of low-level cloudiness is a challenge for current NWP models. The underprediction of low stratus (high inversion fog) is a major forecasting problem in areas of eastern central Europe. Here the negative bias in cloud cover is the primary source of error in 2m temperature forecasts during wintertime (Greilberger and Haiden, 2003). Low stratus events are typically of large scale in the horizontal, and quasi-stationary over several days. Radiation and vertical mixing are the dominant cloud forcing mechanisms. According to 1-d and 3-d modelling studies the underprediction of inversion cloudiness is mainly due to a too smooth temperature profile across the inversion. In the case of the ALADIN model the smoothness is not caused by the limited vertical resolution but a side-effect of the specific formulation of the Richardson number dependency of the first-order turbulence scheme. This formulation sets a lower limit to vertical diffusion in the case of very stable stratification in order to avoid a reinforcing feedback loop of very cold air close to the surface. Ongoing work focuses on the development stage of the inversion, and on the comparison of first order and prognostic TKE turbulence closures in the prediction of inversion development. Also, alternative formulations for the cloudiness parameterizations have been tested (Seidl and Kann, 2002). The work is part of COST Action 722 'Short-Range Forecasting Methods of Fog, Visibility and Low Clouds'.

b. Deep convection triggering

On small grid scales (10 km and below) humidity convergence fields computed by a model represent not only synoptic-scale convergence but also meso-scale effects. Furthermore, one cannot expect the assumption of equilibrium between humidity convergence and convection intensity to hold on this scale. Similarly, on the small scale the triggering of convective precipitation should probably not be linked any more to the presence of humidity convergence. Convection should be allowed to become 'active' in the sense that it creates its own humidity convergence. The problem of the diurnal cycle of convective precipitation, i.e. that the precipitating stage is reached too early in NWP models, is well known. Previous studies with ALADIN have shown that using a prognostic deep convection scheme tends to improve the mesoscale precipitation structures but does not solve the timing problem as long as the trigger function is kept unchanged. Simply using CAPE triggering does not solve the problem either. It appears that an improved trigger function needs to address more explicitly the cloud growth from Cu to Cu-cong into Cb. Starting in summer 2003, radar will be used to investigate the problem in more detail, and to test systematically different trigger and closure functions for deep convection.

c. Prediction of cold air pools and katabatic flows

The fact that NWP models usually employ a terrain-following coordinate system at low levels poses a problem in the forecasting of cold air pools in complex terrain. Problems also occur as aresult of the use of envelope orography, such that generally cold air pools contained within alpine basins are not simulated well. Moreover, katabatic flows, which significantly contribute to the build-up of cold air pools in mountain basins, are often too shallow to be realistically simulated in operational NWP models (Haiden and Whiteman, 2002; Zhong et al., 2002). A research initiative has been started to investigate the role of the coordinate system (terrain-following vs. z-coordinate), hydrostatic vs. nonhydrostatic simulation (Haiden, 2003b), model resolution, and turbulence parameterization on the prediction of the stable PBL in complex terrain.

d. Prediction of heavy rainfall

As a response to the August 2002 floods in Central Europe, which severely affected large parts of Austria (Haiden, 2003a), research has started on the potential of combining radar data and model results in the nowcasting of rainfall amounts for hydrological applications.

References

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