NWP research in Austria

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1. Operational forecast system

Operational limited area weather forecasts in Austria are made using version AL25 of the ARPEGE/ALADIN modelling system. ALADIN forecasts are made on a Central European domain, with a horizontal resolution of 9.6 km, and 45 levels in the vertical. The model is spectral, run in hydrostatic mode, with a semi-implicit, semi-Lagrangian advection scheme. Initial and boundary conditions at 3-hourly intervals up to +48 hours are taken from the global model ARPEGE. The model is run twice per day. 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.

2. Research

a. Numerical prediction of inversion fog and low stratus

The underprediction of low stratus capped by an inversion is a major NWP problem in eastern Central Europe. A negative bias in low cloud cover is among the primary sources of error in 2m temperature forecasts during wintertime. An empirical diagnostic inversion cloudiness scheme has been developed which scans the temperature and humidity profiles in the lower atmosphere for characteristic low stratus 'signatures'. If the signature is found, cloudiness is set to 1. Application of the scheme in ALADIN gives significantly improved low stratus forecasts, and, because of cloud-radiation feedback, improved diurnal temperature evolutions (Kann, 2003). With regard to valleys and basins it was found that in addition to using the scheme, horizontal diffusion of temperature must be set to small values in order to obtain a good low stratus forecast. This is because diffusion along sigma-type coordinate surfaces in a valley or basin tends to smooth inversions and allows vertical mixing to dry the PBL (Haiden, 2004a). The work is part of COST Action 722 'Short-Range Forecasting Methods of Fog, Visibility and Low Clouds'.

b. 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 a result of the use of an envelope orography, such that cold air pools contained within alpine basins are generally not simulated well. In an ongoing research initiative, the mechanisms of katabatic flow formation and basin cooling at small scales are investigated in detail, using datasets from recent field experiments (Whiteman et al., 2004a,b; Haiden and Whiteman, 2004, 2005).

c. High-resolution analysis and nowcasting

A new high-resolution analysis and nowcasting system (INCA=Integrated Nowcasting through Comprehensive Analysis) is being developed at ZAMG. The system is three-

dimensional for temperature, humidity, and wind, and two-dimensional for precipitation. Horizontal resolution is 1 km, vertical resolution 100 m (z-type vertical coordinate). The time resolution and update frequency is 1 hour, except for precipitation where it is 15 minutes. The system takes a model forecast (operationally ALADIN) as a first guess. A three-dimensional error field is created by interpolating differences between the model forceast and observations at the station locations. Since there are a number of mountain stations, the error fields can be computed in 3-d mode. The interpolation of the point differences is done via geometric distance weighting in the horizontal, and potential temperature distance weighting in the vertical. The variables used are potential temperature and specific humidity, which are conserved for dry-adiabatic displacements. They will be replaced by liquid water potential temperature and total water content (conserved during pseudo-adiabatic displacements), in order to get good analyses of low clouds intersecting mountain slopes. Precipitation analyses are obtained from a combination of rain gauge and radar data, using a local regression and scaling approach. For the nowcasting of precipitation, motion vectors based on cross-correlation of previous subsequent analyses are used.

d. Limited area ensemble forecasting

Limited are models provide highly structured forecast fields both in space and time. However, often the small-scale features are extremely sensitive to uncertainties of the model and/or initial conditions. To obtain a guidance for the forecaster with regard to this uncertainty, the project "ALADIN Limited Area Ensemble Forecasting" has been started at ZAMG. It is an ensemble forecast system with 11 members, in which perturbed initial conditions are created using a breeding method. In a second step, the ensemble transform Kalman filter (ETKF) technique will be applied to the breeding vectors. The NWP model used is ALADIN with reduced horizontal and vertical resolution (16 km, 31 levels). The domain covers the whole of Europe and large parts of the North Altantic.

References

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