Geophysical Research Abstracts, Vol. 9, 01849, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-01849
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LM-PAFOG: Three-dimensional fog forecast model with parameterized microphysics

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Fog and low stratus have a critical impact on transport safety, air quality and within the climate system. High quality predictions and near-realtime assessments of fog areas are, therefore, of great economical and ecological relevance.

The many physical processes involved in fog formation interact in a complex and highly nonlinear fashion. Valley fog events as well as advection fog events are favoured by the accumulation of cold air and are controlled by horizontal transports. These processes cannot be resolved with one-dimensional approaches and, thus, have to be considered using a three-dimensional model. Bulk microphysical parameterizations of current operational mesoscale models are not able to incorporate the sedimentation of clouds droplets which is an important factor controlling the evolution of a fog episode. Numerical simulations require high horizontal and vertical resolutions combined with adapted cloud microphysics.

A new microphysical parameterization based on the one-dimensional fog forecast model, PAFOG (Bott & Trautmann, 2002), was implemented in the "Lokal Modell" (LM), a nonhydrostatic mesoscale model of the German Weather Service (Steppeler et al., 2003). The implementation of cloud condensation nuclei as a new prognostic variable into the dynamical core of LM integrates the new microphysics into the three-dimensional frame. For the simulations, LM-PAFOG is focused on a domain of 280 x 280 km2 with a horizontal resolution of 2.8 km. The high vertical resolution is concentrated near the ground: 25 of 40 levels are located in the first 2000 meters, ten layers of 4 meters thickness offer a fine detection of fog formation at the ground.

A verification study of LM-PAFOG has been performed around the Lindenberg area (Germany) for the last quarter of 2005. In a first part, the results have been treated by means of a statistical scheme with a set of measurements taken at the Observatory of the German Weather Service to quantify the fog forecast quality. In a second part, the spatial extent of fog patches has been compared with satellite products, on a per-pixel basis (Cermak & Bendix, 2007).

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