Implementation of a Lake Model FLake into the Limited-Area NWP System LM of the German Weather Service: Preliminary Results

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A recently developed lake model (Mironov et al. 2003, 2004) for use in NWP, climate modelling and other numerical prediction systems for environmental applications is implemented into the limited-area NWP system LM (Steppeler et al. 2003) of the German Weather Service (DWD) and first test runs are performed. The lake model, termed FLake, is a bulk model based on a parametric self-similar representation (assumed shape) of the evolving temperature profile. A detailed description of FLake is given in Mironov (2004). Some results from single-column numerical experiments with FLake are presented in Mironov et al. (2003, 2004). The most important finding from the single-column experiments is that the results are not too sensitive to changes in external parameters except for the lake depth.

In order to be incorporated into an NWP system, FLake requires a number of two-dimensional external-parameter fields. These are, first of all, lake fractions (area fraction of a given LM grid box covered by lake water that must be compatible with the land-sea mask used) and lake depths. A two-dimensional lake-fraction field for the LM domain used operationally at DWD is developed on the basis of a Global Land Cover Characterization (GLCC) data set (http://edcdaac.usgs.gov/glcc) with 30 arc sec resolution, that is ca. 1 km at the equator. A lake-fraction field for the DWD LM domain is shown in Fig. 1. A data set containing mean depths of a number of European lakes and of a few lakes from other regions of the world is developed at DWD. On the basis of that data set, the lake-depth external-parameter field is developed for the DWD LM domain (not shown). Since no tile approach is used in LM (i.e. each LM grid-box is characterised by a single land-cover type), only the grid-boxes with the lake fraction greater than 0.5 are treated as lakes. Each lake is characterised by its mean depth. Other external parameters, e.g. optical characteristics of the lake water, are assigned their default values offered by FLake.

Using the above external-parameter fields, an extended version of LM that incorporates FLake is tested through parallel experiments including the LM data assimilation cycle. In the present simplest configuration, the heat flux through the water-sediment interface is set to zero and a layer of snow over the lake ice is not considered. The effect of snow above the ice is accounted for parametrically through changes in the surface albedo with respect to solar radiation (cf. Mironov and Ritter 2004). Surface fluxes of momentum and of sensible and latent heat are computed with the operational LM surface-layer parameterization scheme (Raschendorfer 2001). Optionally, a new surface-layer scheme can be used that accounts for specific features of the surface air layer over lakes. First results from parallel runs (not shown) look reasonable. Further comprehensive testing of FLake and comparison of results from parallel experiments with LM-FLake with observational data are required. The work is underway at DWD.

In the future, efforts should be taken to considerably extend the data set of lake depths that should eventually cover the entire globe. The task is by no means trivial considering the scarcity of available information. A more detailed information on the lake area coverage may also be needed. For example, the land cover type "inland water" used in the GLCC data set does not distinguish between lakes and rivers. Then, river points should be removed from the

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lake-fraction field prior to its use with FLake. A number of such false lake points are seen in Fig. 1. This is not a serious problem for the LM operational at DWD, where the horizontal grid-size is ca. 7 km and no tile approach is used to describe the land cover within a given grid box. The problem will become more serious as the resolution is increased and/or the tile approach is used. The external parameters other than lake fraction and lake depth may also be refined as more information becomes available.

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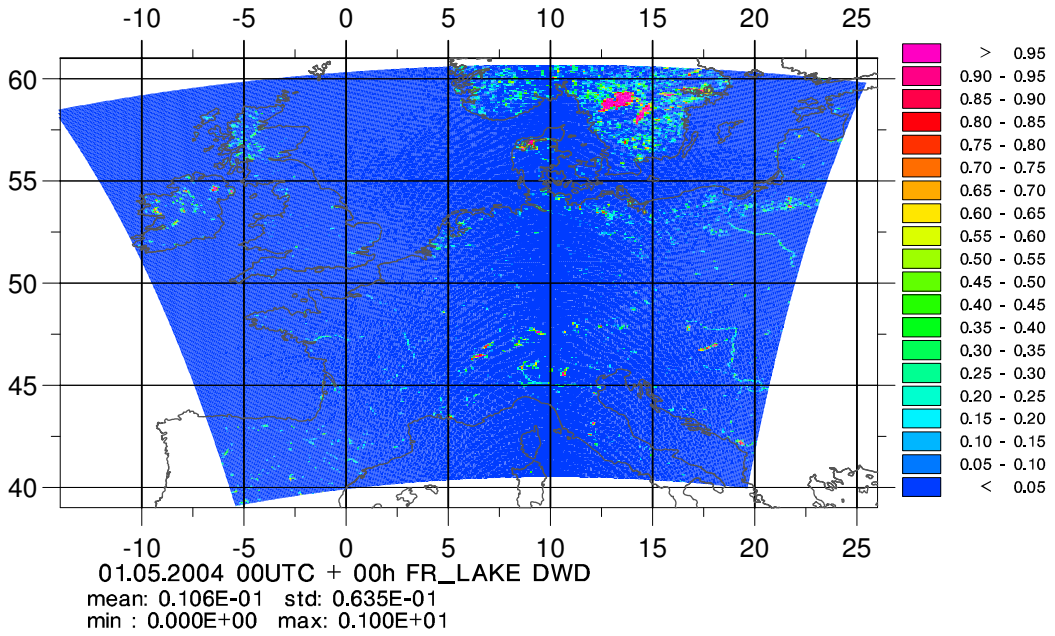

Figure 1. Lake fraction for the LM domain used operationally at DWD.

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