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Lakes representation in a land surface model

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Lakes and other inland water bodies can, in certain areas, compose a large fraction of the land surface. Inland waters have an important role in determining local and regional climates, primarily because of large differences in albedo, heat capacity, roughness, and energy exchange compared to vegetated land surfaces. Despite the radically different physical characteristics of inland waters when compared to their surrounding, most land surface models put more emphasis on the comparatively weaker differences within continental surface types (such as various types of vegetation and bare soil). Thus so far sub-grid lakes have been largely neglected.

The present work describes the incorporation of the lake model FLAKE (Mironov 2008, http://lakemodel.net) into the ECMWF land surface scheme HTESSEL (Balsamo 2008). Results from global offline simulations are presented in order to (i) evaluate the model's performance in different climates and (ii) assess the impact of lakes representation in the surface energy balance. The model was forced by new ECMWF reanalysis product ERA-INTERIM (1989-present) near surface meteorology and surface fluxes (radiation and precipitation) for the entire globe.

Model validation includes lake surface temperatures (global) and lake ice duration (Northern Hemisphere). Lake surface temperatures, derived from the TERRA-MODIS satellite (http://oceancolor.gsfc.nasa.gov/), are compared against simulations for the period 2001-2008, while lake ice duration is validated using data from the Global Lake and River Ice Phenology (Benson and Magnunson, 2007). The impact of the snow insulator effect on lake ice cover duration is also discussed and compared with frozen soil duration in neighbouring areas. The sensitivity of the present analysis to the lake depth, which is important and often unknown lake parameter, is also addressed.

In addition, the implementation of the lake model within the land surface model allows for sub-grid cover variability. The impact on surface fluxes of sub-grid scale lakes in several regions is addressed. Preliminary analysis shows changes in the variation of surface energy storage in high latitude regions, and changes in the partition of surface available energy in equatorial regions. General aspects concerning the incorporation of lake models in GCMs for weather forecast and earth system modelling are discussed.

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