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Adapting a land surface scheme to model lakes: an application to Lake Victoria

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Land surface processes are modelled within global circulation models (GCMs) using Land Surface Schemes (LSSs) which aim to simulate the exchange of energy, momentum, moisture, and carbon dioxide fluxes between the land surface and the atmosphere. As such, they are regarded as one-dimensional: only layers in the vertical direction are considered while the horizontal surface processes and heterogeneity are either ignored or simplified. One of the important horizontal processes is the transport of runoff overland and through rivers, lakes, and wetlands to the seas and global oceans. Here we consider the performance of a LSS for a major lake system

Lake Victoria is centred just to the south of the equator and has an area of 68,000 km2 which makes it the largest fresh water lake in Africa. By virtue of its large storage, Lake Victoria acts as a regulator of the White Nile flows which provides the baseflow component of the main Nile and constitutes the main flow components to a system of lakes and wetlands downstream. The large size of the lake affects the local/regional atmospheric circulation enhancing over-lake rainfall compared to the surrounding basin.

The representation of inland water in the tiled version of the UK Meteorological Office Surface Exchange Scheme (MOSES 2) has been modified to create a specially designed lake tile. This ensures that evaporation from the free water surface remains at the potential rate and modifies the treatment of generated runoff to represent tributary inflows to the lake. Lake evaporation is differenced from rainfall over the lake to calculate net rainfall. Tributary inflows and net rainfall are the inputs to a lake water balance model running at the monthly time step. Initial offline simulations of the

lake levels and outflows indicated that both inputs were underestimated by MOSES. Calibration has been shown to improve the simulation of basin runoff. However, both rainfall inputs and simulated evaporation seem to be underestimated. Enhancing the rainfall by a single correction factor has been shown to enhance the simulation but cannot represent apparent variability on a decadal time scale. It is suggested that simulation of Lake Victoria by MOSES within a GCM will require that lake-scale circulation features and feedbacks have to be captured by the GCM. This remains to be evaluated in coupled simulations.