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The impact of the African Great Lakes on the regional climate in a dynamically downscaled CORDEX simulation

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Owing to the strong contrast in albedo, roughness and heat capacity between land and water, lakes significantly influence the exchange of moisture, heat and momentum between the surface and the boundary layer. To investigate this two-way interaction, a correct representation of lakes within regional climate models is essential. To this end, the one-dimensional lake parameterisation scheme FLake was recently coupled to the regional climate model COSMO-CLM (CCLM).

One region where lakes constitute a key component of the climate system is the African Great Lakes region. In this study, the CCLM CORDEX-Africa evaluation simulation is dynamically downscaled from 0.44° (50 km) to 0.0625° (7 km) over East-Africa, an unprecedented resolution for this region. The performance of different CCLM configurations are compared for the period 1999-2008: in particular, CCLM is tested for its sensitivity to the choice of the lake surface temperature description (SST, FLake, an improved version of FLake and Hostetler) and the land surface model (Terra and Community Land Model).

Model results are evaluated in a three-step procedure. First, the atmospheric state variables near-surface temperature, precipitation, surface energy fluxes, fractional cloud cover and column precipitable water are evaluated using in-situ based and satellite-derived products. Second, a comprehensive set of in-situ water temperature profile observations serves to evaluate the temporal evolution of water temperatures at three sites: Lake Kivu (Ishungu), Lake Tanganyika's northern basin (Kigoma) and southern basin (Mpulungu). Finally, spatial variability of surface temperatures in Lake Kivu and Lake Tanganyika are evaluated on the basis of satellite-derived lake surface temperatures. Subsequently, the preferred model configuration is used to quantify and understand effects by lakes reported for other regions in the world, such as a dampened diurnal temperature range, enhanced evaporation, modified surface layer stability, increased downwind precipitation, stronger winds, and the formation of local circulation patterns. Particular attention is payed to the impact of lakes on extreme night-time convection over Lake Victoria. This is achieved through comparison to a model integration excluding lake effects.