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Lake coupled convection permitting simulations over the Lake Victoria basin with RegCM4.7: What is the benefit of permitting convection?

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The Lake Victoria Basin is home to largest freshwater lake (Lake Victoria; LV) in Africa and second largest in the world. Each year on the order of 1,000 fisherman are lost on LV during intense night-time thunderstorms. Despite this, until recently, understanding of the processes contributing to heavy rainfall events was very limited. In this study we present a 10-year (2006-2015) convection permitting (3km grid-spacing) simulation (CPS) of the Lake Victoria Basin using the RegCM version 4.7.0. A lake model is utilized in order to couple the lake regions with RegCM, which has been shown to be of great importance for simulating a realistic lake surface temperature (LST) over LV. The simulated LST from the CPS shows a general warm bias when comparing to ARC Lake observations, however the annual cycle of LST is well represented by the CPS. In the coarser simulation the LST has a large cool bias because of the absence of any lake coupling and this contributes to a large dry bias over LV. The CPS shows a much-improved seasonal rainfall pattern over LV, however there is a general overestimation of the rainfall by the CPS during the peaks in the rainy seasons (March-May; October-December). The CPS shows an improved ability to produce extreme rainfall (>100mm/day) over the western portion of the lake which is consistently found in satellite and in-situ observations. The distribution of rainrates over LV in the CPS is much closer to satellite derived rainfall observations compared to the coarse simulation, demonstrating the improvements made to the simulation of cloud microphysics processes when moving to convection permitting grid-spacing. Mesoscale circulations associated with the diurnal cycle over LV are an important driver of intense night-time thunderstorms. An analysis of the diurnal rainfall cycle over LV shows that the CPS well represents the timing of nocturnal rainfall over the lake which is associated with a strong landbreeze, however the daytime peak in rainfall over the land surrounding the lake is too early. Extreme nocturnal rainfall events over the lake in satellite observations show a clear migration from the previous daytime peak in rainfall westward onto the lake during the night. This suggests a connection between extreme rainfall events at night and the preceding daytime peak in rainfall over land. In the CPS these daytime peaks over the land occur too early and the lakebreeze circulation appears weak compared to the nocturnal landbreeze which is very prominent. The coarse resolution lake coupled simulation shows a surprisingly robust ability to simulate seasonal and annual rainfall associated with mesoscale lake circulations compared to the CPS. The improvement over the coarser simulation seems to be in the CPS's ability to capture convection scale interactions which may be important for extreme rainfall

events.