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A dynamical climate-driven malaria early warning system evaluated in Uganda, Rwanda and Malawi

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Malaria is a climate-sensitive disease with a significant socio-economic impact in Uganda. As S2S and seasonal dynamical prediction systems have improved their skill in the tropics over recent years, there is now the potential to use these forecasts to drive dynamical malaria modelling systems to provide early warnings of climate-related transmission hazard. A new pilot dynamical malaria prediction system is introduced. Multiple temperature and precipitation forecasts from the ECMWF S2S and seasonal system 4 prediction systems are used to drive the spatially explicit, dynamical malaria model VECTRI that accounts for population density and climate to produce malaria forecasts up to 4 months ahead. The malaria forecasts are started from realistic initial conditions derived from ERAI reanalysis. Forecasts are made on a grid mesh with a spatial resolution of 25km, but are then aggregated at the administrative district level, and normalized to be evaluated using normalized district level incidence data or sentinel site cases (laboratory confirmed) in Uganda. The forecasts are evaluated over a period of four to six years depending on the length of the data record available. Despite an imperfect climate forecast, approximations in the malaria model and the neglect of interventions, and perhaps most importantly large uncertainties in the health data itself, the results show that the malaria forecasts are significantly skilful for over half of the districts in Uganda four months in advance. This is true for districts of both low and higher endemicity, although the system works best in epidemic zones where climate can be a strong driver of inter-annual variability.