Characterization of meteorological drivers for incidences of malaria in South Africa

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We preformed wavelet transform (WT) cross-correlation analysis of two sets of time series of malaria incidence: of daily admissions for the disease from the two large public hospitals in Limpopo Province in South Africa (records taken in the period 2002-2017), and of weekly epidemiological reports from five districts of the same province (for the period 2000-2020). We analyzed these hospital admissions time series in relation to time series of temperature, rainfall and evapotranspiration observational or modelled data from the same geographical area.

For the daily admissions data, we calculated both local (lCWTS) wavelet cross-correlation spectra, to monitor and characterize coincidences in daily changes of meteorological variables and variations in hospital admissions, and corresponding global wavelet cross-correlations (CWTS). All our daily admission records had CWTSs of the power-law type, indicating that those are outputs of complex systems. From the inspection of lCWTSs, we were able to confirm that malaria in South Africa is a seasonal multivariate event, initiated by co-occurrence of heat and rainfall during the summer seasons.

For the analysis of the weekly cases data, we used the WTS superposition of signals rule to delineate WTS peaks that are time lags between the onset of combined meteorological drivers and hospital admissions for malaria. We presumed that all these peaks are characteristic times connected to the periods of development, distribution and survival of either mosquitoes, as disease vectors, or the pathogens they transmit, or are the periods needed for human incubation of the disease. In this way we were able to propose a regression model for the number of admissions cases, and to provide critical values of temperature, rainfall and evapotranspiration that initiate the spread of the disease. Using the developed model, we investigated how future changes of meteorological variables and their combination can affect malaria dynamics, which is the information that can be of use for public health preparedness. This model could be further improved with the analysis of mosquito presence data from vector surveillance records, a part of our current research.