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ENSO forecast using a wavelet-based decomposition

Adrien Deliège (1), Samuel Nicolay (2), and Xavier Fettweis (3)

(1) Department of Mathematics, University of Liège, Liège, Belgium (adrien.deliege@ulg.ac.be), (2) Department of Mathematics, University of Liège, Liège, Belgium (s.nicolay@ulg.ac.be), (3) Department of Geography, University of Liège, Liège, Belgium (xavier.fettweis@ulg.ac.be)

The aim of this work is to introduce a new method for forecasting major El Niño/ La Niña events with the use of a wavelet-based mode decomposition. These major events are related to sea surface temperature anomalies in the tropical Pacific Ocean: anomalous warmings are known as El Niño events, while excessive coolings are referred as La Niña episodes. These climatological phenomena are of primary importance since they are involved in many teleconnections; predicting them long before they occur is therefore a crucial concern.

First, we perform a wavelet transform (WT) of the monthly sampled El Niño Southern Oscillation 3.4 index (from 1950 to present) and compute the associated scale spectrum, which can be seen as the energy carried in the WT as a function of the scale. It can be observed that the spectrum reaches five peaks, corresponding to time scales of about 7, 20, 31, 43 and 61 months respectively. Therefore, the Niño 3.4 signal can be decomposed into five dominant oscillating components with time-varying amplitudes, these latter being given by the modulus of the WT at the associated pseudo-periods. The reconstruction of the index based on these five components is accurate since more than 93% of the El Niño/ La Niña events of the last 60 years are recovered and no major event is erroneously predicted.

Then, the components are smoothly extrapolated using polynomials and added together, giving so several years forecasts of the Niño 3.4 index. In order to increase the reliability of the forecasts, we perform several months hindcasts (i.e. retroactive probing forecasts) which can be validated with the existing data. It turns out that most of the major events can be accurately predicted up to three years in advance, which makes our methodology competitive for such forecasts.

Finally, we discuss the El Niño conditions currently undergone and give indications about the next La Niña event.