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Short-term variability of ENSO indicators during the instrumental period

R. Hesse

Friedrich Schiller University Jena, Department of Geography, Jena, Germany (ralf.hesse@uni-jena.de, *49 3641 948812)

The Southern Oscillation with its opposing modes El Niño and La Niña is considered to be one of the most important aspects of global climatic variability at time scales of 2-10 years and has been the subject of numerous studies. However, the short-term variability of ENSO indicators has so far received only limited attention. This study presents time series of the short-term variability of two principal indicators for the state of the ENSO system, the Southern Oscillation Index (SOI) and the sea surface temperature anomaly (SSTA) of the ENSO 3.4 region. Short-term variability is calculated by applying a linear one-dimensional edge detection filter to the monthly data of the SSTA and SOI. The short-term variability time series are analysed regarding (i) their relationship with El Niño, La Niña and transitional periods, (ii) their relationship with the seasonal cycle and (iii) their behaviour on (multi-)decadal time scales.

While the SOI short-term variability shows a significant seasonal signal and appears to be linked with the state of the ENSO system, SSTA short-term variability does not show a seasonal signal and is only weakly linked with the state of the ENSO system. Both SOI and SSTA short-term variability exhibit significant long-term changes. As implied by the model of ENSO as a chaotic dynamical system, the opposing modes El Niño and La Niña are characterised by lower SOI short-term variability than the intervening periods, with La Niña appearing more stable than El Niño. However, with regards to SSTA short-term variability, El Niño is more stable than La Niña, and intervening periods are characterised by intermediate short-term variability.

The highest SOI short-term variability during the instrumental period occurred from 1881 to 1890 and from 2003 to 2008. Increased SSTA short-term variability characterised the period from 1920 to 1984, i.e. the mid-20th century period of reduced ENSO activity. Thus, while both onset and termination of El Niño as well as La Niña events appear to be related to the seasonal cycle and to increased SOI short-term variability, SSTA short-term variability in the ENSO 3.4 region appears to suppress both El Niño and La Niña events by impeding the build-up of favourable oceanic conditions for event initiation.

While much of the instrumental record is characterised by clear ENSO cycles in one or both indicators, there are periods during which increased short-term variability of either SOI or SSTA indicates a more chaotic behaviour of the system. Because increased short-term variability of SOI and SSTA affects different periods, more than half of the entire record is affected by increased variability of one or the other ENSO indicator. Increased short-term variability of ENSO indicators thus has implications for the prediction of El Niño events.