

# Impacts of the ENSO and IOD phenomena: Long-term analysis in Indonesia region

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Impacts of the El Niño-Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD) events are investigated using meteorological data and the NCEP/NCAR reanalyzing global data. The wavelet analysis is used to extract ENSO and IOD variability in the time-periods, and correlation analysis is implemented on the sea-surface temperature, seasonal rainfall percentage, and wind data. Global wavelet spectra of the ENSO and IOD indices show the strong 2–8 year inter-annual peaks, suggesting that some of the IOD events coincide with the occurrence of the ENSO events. Using scale-averaged wavelet power over the same time span, we find that three of the major positive (warm) ENSO events (i.e., those in 1972, 1982, 1997) are accompanied with positive IOD events.

In several regions in the maritime continent of Indonesia, a high correlation is found between strong El Niño intensities and rainfall below (< 85%) normal conditions, but when the intensities are weak the correlation becomes low. In this latter case other phenomena such as IOD can contribute to drought in Indonesia. The study on seasonal anomaly in rainfall in the Indo-Pacific basin reveals that in contrast to the positive IOD event in 1994, where the dipole was prominent only in the Indian Ocean, a similar phenomenon in 1997 was accompanied by another dipole pattern in the Pacific due to the co-occurrence of the well-known El Niño event.

Our analysis also indicates that during El Niño and positive IOD events, the southeast monsoon (Australian monsoon) over Indonesia is intensified, causing the dry season longer than the rainy season. The positive IOD event affects not only the zonal circulation, but also the meridional circulation. If El Niño and the positive IOD occur simultaneously, as was the case in 1994 and 1997, the drought tendency is reduced in India. These findings indicate that the positive IOD has the opposite effect of El Niño on rainfall in India, and the opposite condition holds in Indonesia.

**Keywords:** NCEP/NCAR reanalyzing data, ground observational data, wavelet analysis, rainfall percentages, ENSO, and IOD.