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# Identifying sudden dynamical shifts in time series with uncertainties

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The identification of sudden dynamical changes in time series is crucially impacted by the level of uncertainty in the data and by whether or not it is incorporated reliably in the analysis. We present here a new representation of time series that inherently take care of uncertainties in all subsequent analyses: Instead of considering a time series as a seqeuence of point-like objects (with or without additional error), we represent time series as a sequence of probability density functions. We show how this can be used to detect sudden changes in the time series using networks that encode the recurrene properties of the system. We first demonstrate the efficacy of our approach on a synthetic example. Next, we apply it to sea surface temperatures from the equatorial central Pacific and identify sudden transitions in the El Niño Southern Oscillation (ENSO) that are then found to be significantly coincident to periods where the ENSO is phase-locked to the Pacific Decadal Oscillation (PDO). This uncovers a new aspect to the modulation of the ENSO by the PDO.