

SYNCHRONIZATION LAGS AS POSSIBLE INDICATORS OF EL NIÑO EVENTS

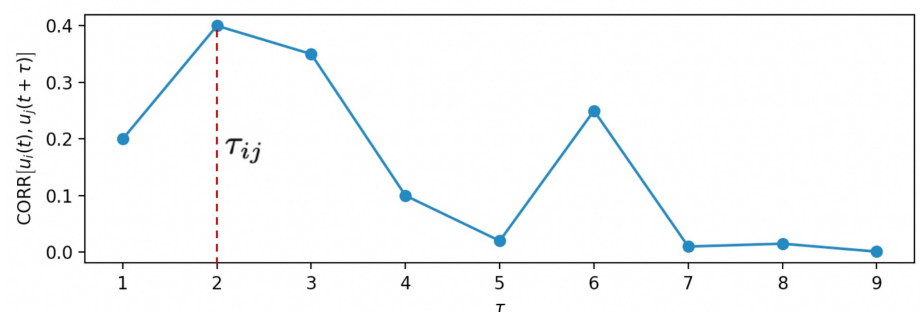
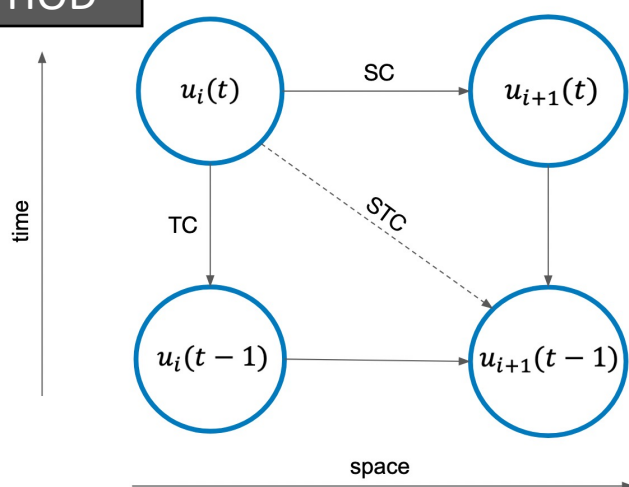
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ABSTRACT

El Niño/Southern Oscillation (ENSO) is the direct cause of a large number of regional extreme events, such as droughts and floods, and influences greatly the Earth's climate. For this reason, a great effort has been put into developing long-term forecasts that could be employed to anticipate the consequences of ENSO fluctuations. In previous works, it has been shown how synchronization can be employed to anticipate the transition of a reaction-diffusion system from a stable state to another when a control parameter is changed (Tirabassi et al 2022). It has also been shown how during El Niño/La Niña events the tropical Pacific SST synchronizes (Gozolchiani et al 2011). Here we want to show how synchronization can be used as a long-lead indicator of positive ENSO events. In particular, the mean of the lags maximizing the cross-correlation rises around one year before an El Niño event, providing an early indicator that could complement the long-term forecasts currently employed.

METHOD



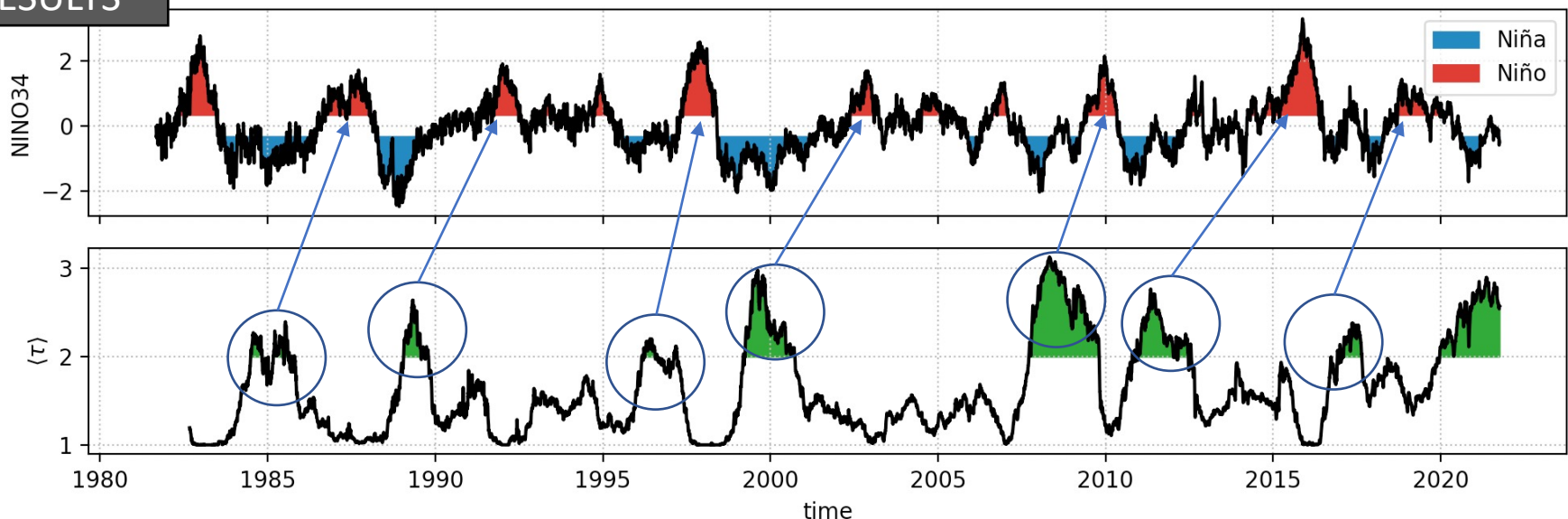
$$\tau_{ij} = \operatorname{argmax}_{\tau} \left(\left| \sum_t u_i(t) u_j(t + \tau) \right| \right)_{1 \leq \tau \leq \tau_{\max}}$$

If two series are close to synchronization, their correlogram will peak at low lags (τ)

Close to transitions, spatio-temporal correlation (STC) increase. Neighbours tend to synchronize

We can measure and monitor the evolution of τ distribution, in particular its first moment. If the mean of tau decreases, the system tends to be more synchronized and a transition might be approaching.

RESULTS



The system is more synchronized during El Niño than during La Niña phases. The maximum of the τ averages seem to precede El Niño phases with some lag. The correspondence between the two peaks needs further investigation.

CONCLUSIONS

- El Niño and La Niña present different levels of local synchronization.
- During La Niña, the equatorial Pacific SST seem less synchronized.
- Peaks in the lags distribution seem to precede El Niño events, but the time difference is not well definite.

