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Ocean climate indices and Total Solar Irradiance: causality over the past few decades and revision of indices uncertainties

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Pearson's correlation is usually used as a criterion for the presence or absence of a relationship between time series, but it is not always indicative for nonlinear systems like climate. Therefore, we implement one of the methods of nonlinear dynamics to detect connections in the Sun-climate system. Here we estimate the causal relationship between Total Solar Irradiance (TSI) and Ocean climate indices over the past few decades using the method of conditional dispersions (Cenys et al., 1991). We use a conceptual ocean-atmosphere model (Jin, 1997) with TSI added as a forcing to calibrate the method. We show that the method provides expected results for connection between TSI and the model temperature. Premixing of Gaussian noise to model data leads to decrease of detectable causality with increase of noise amplitude, and the similar effect occurs in empirical data. Moreover, in the case of the empirical data, we show that the method can be used to independently estimate uncertainties of Ocean climate indices.