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Empirical modeling ENSO dynamics with complex-valued artificial neural networks

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The main difficulty in empirical reconstructing the distributed dynamical systems (e.g. regional climate systems, such as El-Nino-Southern Oscillation – ENSO) is a huge amount of observational data comprising time-varying spatial fields of several variables. An efficient reduction of system's dimensionality thereby is essential for inferring an evolution operator (EO) for a low-dimensional subsystem that determines the key properties of the observed dynamics.
In this work, to efficient reduction of observational data sets we use complex-valued (Hilbert) empirical orthogonal functions which are appropriate, by their nature, for describing propagating structures unlike traditional empirical orthogonal functions. For the approximation of the EO, a universal model in the form of complex-valued artificial neural network is suggested. The effectiveness of this approach is demonstrated by predicting both the Jin-Neelin-Ghil ENSO model [1] behavior and real ENSO variability from sea surface temperature anomalies data [2].
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1. Jin, F.-F., J. D. Neelin, and M. Ghil, 1996: El Ni˜no/Southern Oscillation and the annual cycle: subharmonic frequency locking and aperiodicity. Physica D, 98, 442–465.

2. http://iridl.ldeo.columbia.edu/SOURCES/.KAPLAN/.EXTENDED/.v2/.ssta/