

## Intensive Variability Extraction

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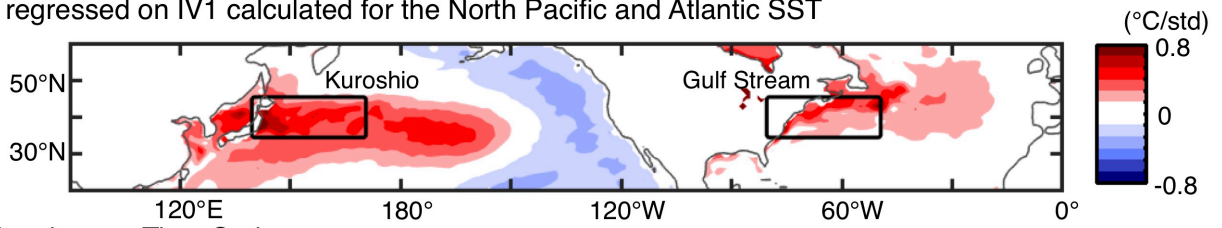
A modified version of the principal component analysis (PCA) is introduced by reconsidering statistical degrees of freedom in spatial dimensions based on spatial auto-correlations. In the conventional PCA, data points that represent equal areas are assumed to have equal amount of information. In our new method, the intensive variability extraction (IVE), data points correlated with less other data points are weighted more before performing PCA. Hence, variability with independent information is emphasized, even if the variability is confined to small areas.

Sea surface temperature (SST) data at each grid in the tropics are shown to have fewer spatial statistical degrees of freedom than that in the extratropics. Tropical SSTs exhibit covariability with large areas, because oceanic equatorial waves and atmospheric gravity waves share temperature information with surrounding areas. As to the extratropics, grids along the western boundaries of oceanic basins are more independent than those in the east, following dynamical requirement of the Earth's rotation.

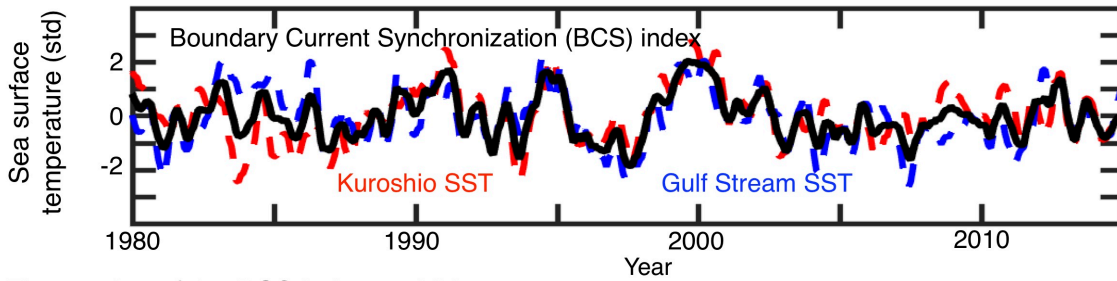
Using IVE, climate modes that involve interscale covariability are extracted. IVE performed for the Pan-Pacific SSTs extracts the Pacific Decadal Oscillation assuming the aforementioned a priori dynamical expectation. Using extratropical SSTs, it is demonstrated that IVE detects synchronicity of small-scale variability between distant narrow regions.

Keywords: Principal Component Analysis, Pacific Decadal Oscillation, Boundary Current Synchronization

a) SST regressed on IV1 calculated for the North Pacific and Atlantic SST



b) Regional-mean Time Series



c) Time series of the BCS index and IV1

