Dynamics and predictability of Asian Monsoon and nonlinear dimensionality reduction

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The Asian summer monsoon is a high dimensional and highly nonlinear phenomenon involving considerable moisture transport into land from ocean, and is critical for the whole region. We have used the European Reanalysis ERA-40 sea-level pressure (SLP) anomalies, with respect to the seasonal cycle, over the region $(50E-145E, 20S-35N)$ to study the nonlinearity of the Asian monsoon using Isomap. We have focussed on the two-dimensional embedding of the SLP anomalies. Unlike the unimodality obtained from the empirical orthogonal function space, the probability density function, within the two-dimensional Isomap space, turns out to be bimodal. A clustering procedure is applied and reveals that the data support three clusters, which are identified using a three-component bivariate Gaussian mixture model. The modes are found to be associated respectively with the break and the active phases of the monsoon in addition to a third phase: the China sea active phase. Using the low-level wind field anomalies the active phase is found to be characterised by a strengthening and an eastward extension of the Somali jet whereas during the break phase the Somali jet is weakened and reversed by an easterly flow emanating from the West Pacific. The effect of large scale seasonal mean monsoon and lower boundary forcing is also investigated and discussed.