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Using Advanced Mathematical Techniques to Quantify Natural and Anthropogenic Influences on Southeast Asian Land-Surface Properties

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Presently, the complexity of the properties of and the changes in the vegetation-land surface in Southeast Asia is not well understood. This lack of understanding inhibits its being modeled sufficiently well so as to be useful for climate-scale studies. A few major reasons for this include: (a) the radiative and hydrological properties of the vegetation-land surface is complex, changing both in time and space in response to the phase on the Monsoon; (b) human disturbance and land use change are widespread and increasing in this region, and involve both clearance and fires; and (c) that there are not sufficient measurements currently available to empirically quantify many of the properties of interest. To better quantify the properties of the land surface at large spatial scales and over a decadal time scale, new quantitative methods of analysis are required, and the purpose of this presentation is to show both the proof-of-concept of one such approach, as well as some initial and interesting results.

In this study, Principal Component Analysis (PCA) was applied to the roughly 13 year dataset provided by the Moderate Resolution Imaging Spectroradiometer (MODIS) Normalized Difference Vegetation Index (NDVI), Enhanced Vegetation Index (EVI), and Leaf Area Index (LAI). PCA is a tool allowing the extraction of the standing modes of a dataset, reducing a complex dataset to small and orthogonal sets that contribute the most variance to the data. Combining this tool with variance and correlation maps between the measured time series and those derived from the PCA, the spatiotemporal structure of the dataset can be elucidated.

This technique allows for different patterns in both space and time over Southeast Asia to be revealed. Comparison using the variance and correlation maps between the time series and the seasonal variations derived from PCA suggest that both the variance and correlation are stronger over Northern Southeast Asia than in Equatorial Southeast Asia. One possible reason is because of the weaker seasonal variation of rainfall at regions near the equator, therefore induces less variation in the vegetation.

Clustering analysis on LAI suggests that regardless of the different timings and lengths of the local wet season, many parts of the region show a crest in the middle of the year for NDVI, EVI, and LAI. Furthermore, spectral analysis of NDVI and LAI show a high annual signal at regions near the equator. Additionally, lag-correlation analysis suggests a different amount of phase shift between the vegetation and the wet season at different areas. These findings possibly suggest anthropogenic factors, in addition to rainfall, are affecting the variability of the vegetation in Southeast Asia, over the timescales studied.