Integrating Statistical and Expert Knowledge to Develop Phenoregions for the Continental United States

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Vegetated ecosystems exhibit unique phenological behavior over the course of a year, suggesting that remotely sensed land surface phenology may be useful for characterizing land cover and ecoregions. However, phenology is also strongly influenced by temperature and water stress; insect, fire, and weather disturbances; and climate change over seasonal, interannual, decadal and longer time scales. Normalized difference vegetation index (NDVI), a remotely sensed measure of greenness, provides a useful proxy for land surface phenology. We used NDVI for the conterminous United States (CONUS) derived from the Moderate Resolution Spectroradiometer (MODIS) every eight days at 250 m resolution for the period 2000–2015 to develop phenological signatures of emergent ecological regimes called phenoregions. We employed a “Big Data” classification approach on a supercomputer, specifically applying an unsupervised data mining technique, to this large collection of NDVI measurements to develop annual maps of phenoregions. This technique produces a prescribed number of prototypical phenological states to which every location belongs in any year. To reduce the impact of short-term disturbances, we derived a single map of the mode of annual phenological states for the CONUS, assigning each map cell to the state with the largest integrated NDVI in cases where multiple states tie for the highest frequency of occurrence. Since the data mining technique is unsupervised, individual phenoregions are not associated with an ecologically understandable label. To add automated supervision to the process, we applied the method of Mapcurves, developed by Hargrove and Hoffman, to associate individual phenoregions with labeled polygons in expert-derived maps of biomes, land cover, and ecoregions. We will present the phenoregions methodology and resulting maps for the CONUS, describe the “label-stealing” technique for ascribing biome characteristics to phenoregions, and introduce a new polar plotting scheme for processing NDVI data by localized seasonality.

Figure: This map shows the 50 phenoregions derived from the MODIS NDVI at 250 m resolution data for years 2000–2012. The phenoregions are colored using a “similarity colors” technique that employs a principle components analysis to produce data-specific combinations of red, blue, and green for every phenoregion in the map.

Keywords: phenology, NDVI, MODIS, phenoregions, label stealing, cluster analysis

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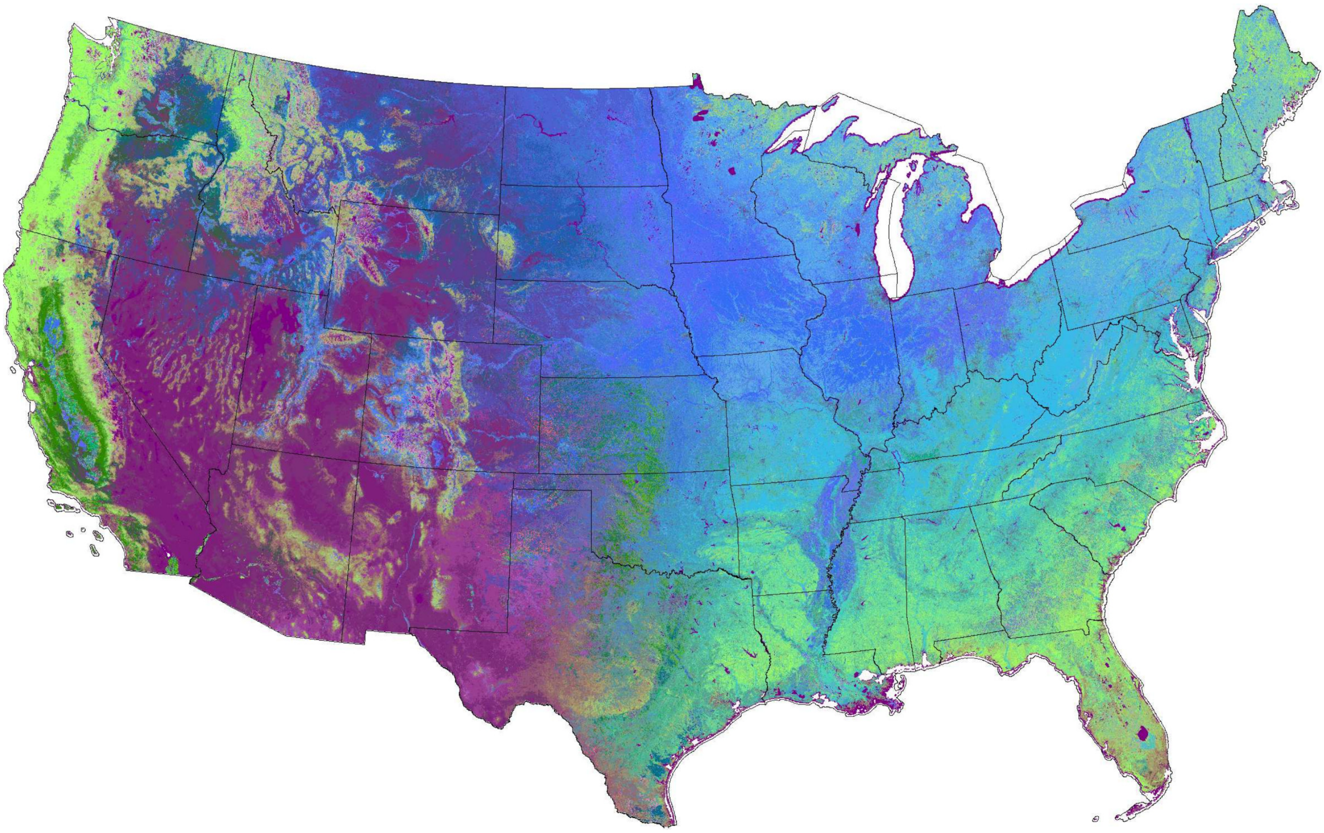

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