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Observing plant phenology from space: what do satellite data tell us about what is really happening on the ground?

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Data products from earth-orbiting platforms such as MODIS and SPOT provide information about vegetation phenology at intermediate spatial scales and temporal resolution, with global coverage. However, there are substantial uncertainties with respect to the correspondence between what is "seen" from space, and the structural and physiological changes that are occurring on the ground. These uncertainties limit our ability to use satellite data to study phenological responses to climate variability and change.

Evaluation of the correspondence—with respect to both spatial and temporal patterns of variation—between remote-sensing derived phenological indices and ground observations is essential for reducing these uncertainties. With the PhenoCam project (http://phenocam.sr.unh.edu), we are archiving and analyzing images of vegetated surfaces from ≈80 webcams located across North America. Color channel analysis of the camera imagery permits objective quantification of the seasonal vegetation dynamics for regions of interest within each scene. Compared with observer-based records of budburst and flowering of individual plants, webcam imagery offers a quantitative, spatially-integrated perspective that is nearly continuous in time.

We will present results comparing MODIS-based estimates of phenology (MOD12Q2 Land Cover Dynamics) with observations from webcam data collected at roughly 30 PhenoCam sites. Our analysis will focus on (1) spatial patterns across sites, as well as (2) patterns of interannual variability at several sites where we have a multi-year image archive. We will also show results documenting relationships between satellite data products and the seasonality of ecosystem processes, as inferred from eddy covariance measurements of surface-atmosphere CO2 exchange at a selection of temperate and boreal FLUXNET sites. Understanding the mutual and complementary information content of remote sensing products, webcam imagery, and eddy covariance measurements will support efforts to integrate these data streams with ecosystem and land surface models using data-model fusion approaches. By extension, this will improve understanding of how phenology mediates regional to global scale carbon, water and energy budgets in a changing world.