PROGRESS ON ESTABLISHING A USA-NATIONAL PHENOLOGY NETWORK (USA-NPN)

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Over the past two years, Julio Betancourt of the Desert Laboratory has been collaborating with Mark D. Schwartz of the University of Wisconsin-Milwaukee and a group of scientists from various disciplines, federal agencies, academic institutions, and environmental networks to develop a wall-to-wall, coast-to-coast phenology observation network for the U.S. By early 2007, an Executive Director and National Coordinating Office will be located at the University of Arizona's Office of Arid Lands, with funding from USGS and the University. Plans are underway for the first set of observations to be made nationwide in growing season 2007.

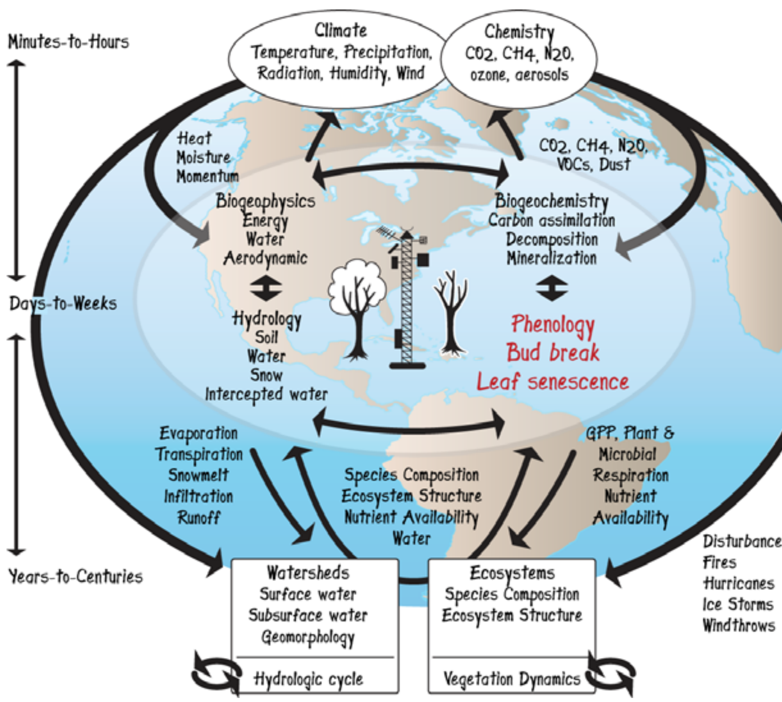

Figure 1. Phenology is an essential component of environmental science. Phenological phenomena interact with biospheric processes at scales from local to global, from minutes to centuries (Adapted from Bonan, G.B. 2002, Ecological Climatology, Cambridge University Press).

Phenology is the study of periodic plant and animal life cycle events that are influenced by environmental changes, especially seasonal variations in temperature and precipitation driven by weather and climate. Important phenophases include the timing of leafing, flowering, and fruiting in plants, agricultural crop stages, insect emergence, and animal migration. Phenology, representing the seasonal cycle on Earth, is a far reaching component of environmental science (Schwartz 2003; Fig. 1). Variations in phenophase affect the abundance and diversity of organisms, their inter-specific interactions, their ecological functions, and their effects on fluxes in water, energy, and chemical elements at various scales. With sufficient observations and understanding, phenology can be used as a predictor for other processes and variables of importance at local to global scales, and could drive a variety of ecological forecast models with both scientific and practical applications. Phenological data and models are used in agricultural production, integrated pest and invasive species management, drought monitoring, wildfire risk assessment, and treatment of pollen allergies. This predictive potential requires a new data resource—*a national network of integrated phenological observations and the tools to analyze them at multiple scales.* This network should include simple and effective means to input, report, and utilize phenological observations, and the resources to provide the right information at the right time for a wide range of decisions made routinely by individual citizens and by the Nation as a whole. Such a network is essential to detect and to evaluate ongoing environmental changes, including an earlier onset of spring (Cayan et al. 2001; Schwartz *et al.* 2006). A phenology network across the U.S. can now capitalize on integration with other networks and remote sensing products, emerging sensor technologies and data management capabilities, formal and informal educational opportunities, and a new readiness of the public to participate in investigations of nature on a national scale.

The idea for a USA-National Phenology Network (USA-NPN) has many instigators. In 1956, Joseph M. Caprio (Montana State University) initiated lilac phenological research in the USA. He developed a network of volunteer observers (~1000, growing to 2500 by 1972) reporting from 12 Western states (Caprio 1966). Caprio's program stimulated development of a similar program in the Eastern USA in 1961, initially under the direction of W.L. Colville (University of Nebraska; ~300 observers in 1970). The Eastern network lost funding in 1986, but was continued at ~40-50 stations by Mark D. Schwartz (University of Wisconsin-Milwaukee). The Western States Phenological Network was terminated upon Caprio's retirement in 1993, but was reactivated at ~ two dozen sites by Dan Cayan and Mike Dettinger to complement their studies on changes in timing of snowmelt discharge (Cayan et al. 2001). Cloned lilacs (and models developed from them) now serve as "anchor points" binding together commonalities among phenological observations from native species in diverse ecoregions, climate data, and remote sensing observations across a continent-wide network. In the absence of other continental phenological monitoring, legacy lilac data provide the most logical tie to the mid-twentieth century before the major inflection in temperature and growing season trends (Schwartz *et al.* 2006).

More recently, Schwartz foresaw the need for a national network that would revitalize and broaden the lilac network, while extending phenological observations to other native and non-native species, drawing in part on co-location with a subset of National Weather Service Cooperative Observer (COOP) stations and cooperation with other existing networks. In summer 2004, Julio Betancourt of the U.S. Geological Survey independently arrived at the same conclusion after co-chairing an AIBS Grand Challenge Workshop (AIBS 2004) that explored the National Ecological Observatory Network (NEON)'s role in studying ecological responses to climate. When it appeared that NEON might be designed around intensively-sampled regional nodes, Betancourt teamed up with Schwartz to begin organizing a spatially-distributed network that would achieve wall-to-wall continental coverage for phenological observations and operate independently but ultimately in collaboration with NEON.

The NPN was initiated by a planning workshop co-organized by Julio Betancourt, Mark D. Schwartz and a steering committee that includes David Inouye, Eric Post, David Breshears, Bradley Reed, Michael Dettinger, and Daniel Cayan. The NPN workshop was funded by NSF, USGS, NPS, Forest Service, and EPA, and held in August 2005 (Betancourt *et al.* 2005) (http://www.uwm.edu/Dept/Geography/npn/meetings/index.html). An Implementation Team of 28 scientists spanning multiple disciplines, institutions and related environmental networks met in March 2006 to identify participating networks and draft short (1-2 yrs), mid (2-5 yrs), and long-term (5-10 yrs) objectives. The list of objectives can be accessed at http://www.uwm.edu/Dept/Geography/npn/meetings/index.html). One of the short-term objectives was to secure base stable support from one or more federal agencies.

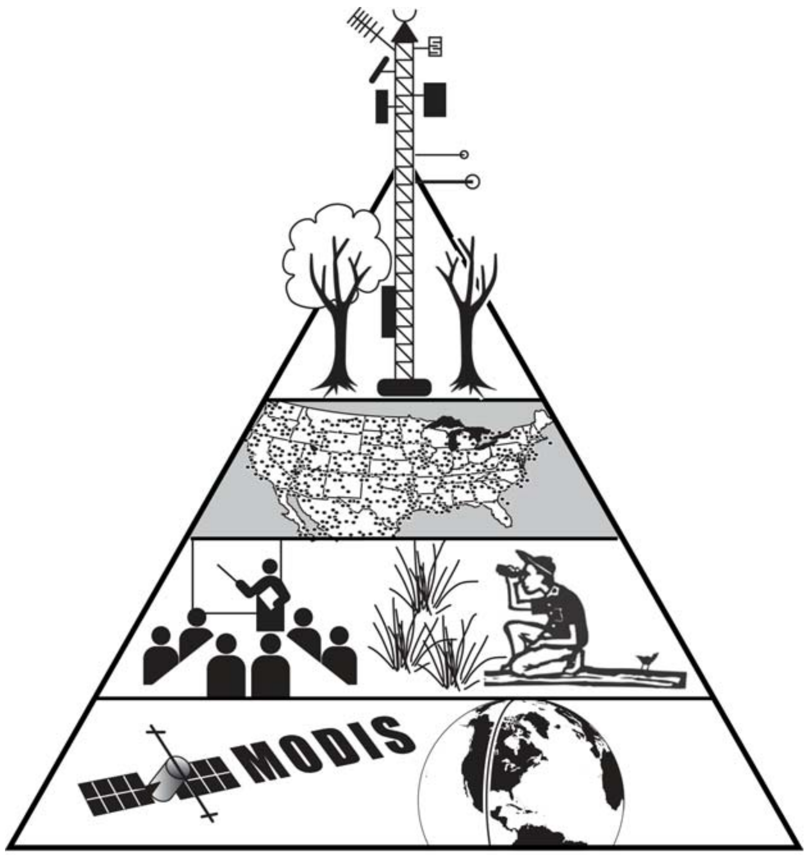

Figure 2. The USA-NPN will consist of four components or tiers, representing different levels of spatial coverage and quality/quantity of phenological and related environmental information: 1) Locally intensive sites focused on process studies (e.g., LTER, AmeriFlux, AgriFlux); 2) Spatially extensive scientific networks focused on large-scale phenomena (e.g., National Weather Service Coop stations, National Park Service Inventory & Monitoring sites); 3) Volunteer and Education Networks (e.g., garden clubs, plant-, bird- and butterfly-monitoring networks, college campuses); and 4) remote sensing products that can be ground-truthed and assimilated to extend surface phenological observations to the continental-scale.

On June 12, 2006 U.S. Geological Survey (USGS) members of the USA-NPN Implementation Team gave a presentation to the USGS Executive Leadership Team in Reston, requesting stable base support for a National Coordinating Office and Executive Director. The USGS Bureau Planning Council (BPC) then tasked the Chief Scientists of all five disciplines (Geology, Water, Geography, Biology and Informatics) to study the issue and make recommendations. These recommendations were then approved by the BPC on August 15, 2006 and efforts are under way to hire an Executive Director. The University of Arizona has been selected by USGS and the NPN Implementation Team as the initial base for the National Coordinating Office. As part of the cost-share with USGS, the University has offered free space, a 5-yr commitment to an Assistant Director/Program Scientist, and the use of its web development, remote sensing, and spatial analytical resources. The National Coordinating Office will be in place by January 2007. A second NPN planning workshop was held in October 2006 to facilitate leveraging the first set of phenological observations across participating environmental networks in growing season 2007.

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