Tracking climate effects on plant-pollinator interaction phenology with satellites and honey bee hives

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Background/Question/Methods

The complexity of plant-pollinator interactions, the large number of species involved, and the lack of species response functions present challenges to understanding how these critical interactions may be impacted by climate and land cover change on large scales. Given the importance of this interaction for terrestrial ecosystems, it is desirable to develop new approaches.

We monitor the daily weight change of honey bee (*Apis mellifera*) colonies to record the phenology of the Honey Bee Nectar Flow (HBNF) in a volunteer network (honeybeenet.gsfc.nasa.gov). The records document the successful interaction of a generalist pollinator with a variety of plant resources. We extract useful HBNF phenology metrics for three seasons. Sites currently exist in 35 states/provinces in North America, with a concentration in the Mid-Atlantic region. HBNF metrics are compared to standard phenology metrics derived from remotely sensed vegetation indices from NASA's MODIS sensor and published results from NOAA's AVHRR.

At any given time the percentage of plants producing nectar is usually a small fraction of the total satellite sensor signal. We are interested in determining how well the 'bulk' satellite vegetation parameters relate to the phenology of the HBNF, and how it varies spatially on landscape to continental scales.

Results/Conclusions

We found the median and peak seasonal HBNF dates to be robust, with variation between replicate scale hives of only a few days. We developed quality assessment protocols to identify abnormal colony artifacts. Temporally, the peak and median of the HBNF in the Mid-Atlantic show a significant advance of 0.58 d/y beginning about 1970, very similar to that observed by the AVHRR since 1982 (0.57 d/y). Spatially, the HBNF metrics are highly correlated with elevation and winter minimum temperature distribution, and exhibit significant but regionally coherent inter-annual variation. The relationship between median of the spring HBNF with the "Green-up" metric from the 500 meter MODIS NDVI phenology product, for sites throughout the Eastern US 2000-2009, is well described by a single linear fit ($r^2 = 0.72$). We conclude that for the tree-dominated areas of the Eastern US at least, the spring HBNF can be tracked very well by MODIS phenology. Analysis of other regions and seasons is presently underway but with more limited data. Spatial patterns in the eastern US and management implications will be presented and discussed.