Geophysical Research Abstracts
Vol. 16, EGU2014-7492-1, 2014
EGU General Assembly 2014

Historical phenological records and applications to global change ecology

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Long-term observational records of phenology provide some of the longest and most species-diverse records available for understanding the ecological impacts of climate change on plant communities. Recent efforts to bring together records from across North America and Europe have shown how such records can help constrain experiments and test hypotheses regarding ecological responses to climate change. Studies have highlighted the underestimate of phenological responses in warming experiments, the importance of vernalization cues for understanding community level phenological trends, differences in phenological strategies between native and non-native species, and the importance of temperature for tropical phenology. Despite these advances, large uncertainties remain, especially regarding the importance of moisture cues for spring phenology in drier systems, controls on phenology in tropical systems, and the reason for divergent responses in experiments versus observations. Many of these issues could be resolved, in part, with better data, but most will require a new approach to temporal dimensions in ecology. Such an approach would draw more information from the available data by building on and developing new methods and techniques that better address temporal scaling issues inherent in combining climate and ecological data.