Dynamic global vegetation: linking Land Surface Phenology and growth limiting factor shifts over the past 30 years

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Suggested sessions (to be decided!):

* Understanding Phenology Across Scales and Improving Linkages to Ecosystem Functions: <https://agu.confex.com/agu/fm15/preliminaryview.cgi/Session8911>
* Remote sensing to support investigation in plant-climate interactions: <https://agu.confex.com/agu/fm15/preliminaryview.cgi/Session8302>
* New Perspectives in Land Ecosystem Atmosphere Processes Research: https://agu.confex.com/agu/fm15/preliminaryview.cgi/Session8630.html

The study of global vegetation dynamics contributes to a better understanding of global change drivers and how these affect ecosystems and ecological diversity. Land-surface phenology (LSP) is a key response and feedback of vegetation to the climate system, and hence a parameter that needs to be accurately represented in terrestrial biosphere models [1]. However, the effects of climatic changes on LSP depend on the relative importance of climatic constraints in specific regions – which are not well understood at global scale.

In this study, we analyzed a Phenology Reanalysis dataset [2] to evaluate shifts in three climatic drivers of phenology at global scale and over the last 30 years (1982-2012): incoming radiation, evaporative demand and minimum temperature. As a first step, we compared LAI as modeled from these three factors to remotely sensed observations of LSP (LAI-3g, [3]) over the same time period. As a second step, we examined temporal trends in the climatic constraints at Start- and End- of the Growing Season.

Our analysis reveals inter-annual variation in the relative importance of the three climatic factors in limiting vegetation growth at Start- and End- of the Growing Season over the last 30 years. We highlight that northern Europe and central Asia have undergone significant changes in dominance between the three controls, particularly in high northern latitudes. We also find that evaporative demand is becoming an increasingly limiting factor for growth globally, in particular in South America and eastern Asia. There was good agreement between modeled and remotely-sensed phenology metrics over the last 30 years, in particular over temperate and dry areas – thus providing confidence in the climatic constraints underlying the modeled data.

[1] Richardson, A. D. *et al.* Terrestrial biosphere models need better representation of vegetation phenology: results from the North American Carbon Program Site Synthesis. *Global Change Biology* **18**, 566-584 (2012).

[2] Stöckli, R., Rutishauser, T., Baker, I., Liniger, M. & Denning, A. A global reanalysis of vegetation phenology. *J. Geophys. Res* **116**, G03020 (2011).

[3] Zhu, Z. *et al.* Global Data Sets of Vegetation Leaf Area Index (LAI)3g and Fraction of Photosynthetically Active Radiation (FPAR)3g Derived from Global Inventory Modeling and Mapping Studies (GIMMS) Normalized Difference Vegetation Index (NDVI3g) for the Period 1981 to 2011. *Remote Sensing* **5**, 927-948 (2013).