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Phenological model-data fusion: how to bridge spatial scales?

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The next round of IPCC model simulations will include the full terrestrial biogeochemical cycle requiring a realistic simulation of global phenological response to climate variability. Largely unknown empirical parameters used in current phenology models generally make them unsuitable for global predictions. We review that satellite-based ensemble data assimilation allows to successfully constrain local-scale phenological parameters especially for areas that have no long-term ground observations.

However, two inter-related problems arise: scaling and mixing. Model parameters that are tuned to local-scale phenological observations are not suitable for global climate models. Further, grid-based phenological predictions and satellite-observed vegetation states are always a mixture of many species-specific phenologies responding to local-scale climatological forcings. How can subgrid-scale phenological variability be included in phenology models and how should species-specific phenological response be discretized?

This study presents one possible solution to these questions. We have extended our ensemble data assimilation scheme with a cost function that minimizes the prediction errors of linearly mixed phenological states encompassing 17 plant functional types and 10 elevation classes per 0.5x0.5 degree geographical region. The quality screened 2000-2008 NASA MODIS MOD15A2 Collection 5 dataset at 1 km serves as the observational constraint. Data assimilation is used to unmix the aggregated satellite observations and derive a global set of phenological parameters for each of the 17 plant functional types. We present first results from this exercise for a variety of climate zones and also discuss the difficulties encountered with this methodology.