Data assimilation for terrestrial ecosystem models: a case study with the particle filter

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Data assimilation is a promissing, but currently underutilized numerical technique to optimize terrestrial ecosystem models. Differing from atmospheric or oceanic models, terrestrial ecosystem models generally have nonlinear or abrupt behaviors that are not appropriate for widely-used data assimilation methods such as emsemble Kalman filter. However, the particle filter, one of the data assimilation methods, is supposed to have enough flexibility to optimize terrestrial ecosystem models at the expense of large computational burden.

In this study, several parameters of the terrestrial ecosystem model SSSEM are simultaneously optimized by the particle filter in order to reproduce phenological patterns of a deciduous forest stand near Fairbanks, Alaska. The satellite-based observation of leaf area index (LAI) is used to fit the model. After the data assimilation, the seasonal pattern of LAI is successfully reproduced. The timings of leaf onset and offset, and the maximum LAI of summer are appropriately estimated (Figure 1).

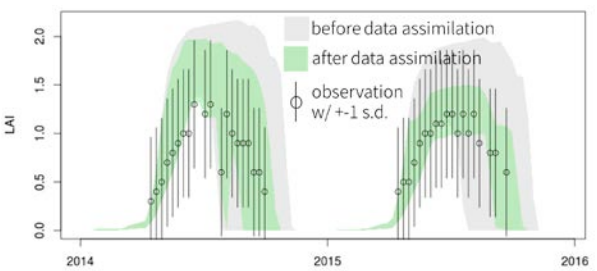

Figure 1: SSSEM simulations: default and optimized results.

Moreover, the parameter set (e.g., light use efficiency, photosynthate allocation to leaf, stem, and root) of the model are successfully optimized by the particle filter. The variance of each estimated parameter is reduced, implying that the probable ranges of parameter estimates are found in this experiment.

This case study showed that nonlinear behaviors of terrestrial ecosystem such as leaf onset and offset can successfully be optimized using data assimilation.