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Carbon cycle data assimilation using satellite-derived FAPAR and a new generic global phenology scheme

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Space-based observations of terrestrial vegetation are one of the best means of characterizing vegetation status over the globe. The most suitable variable for this purpose is FAPAR, the fraction of plant-absorbed photosynthetically active radiation. Data assimilation offers an objective means for the utilization of FAPAR for improving estimates of vegetation water status and photosynthesis, but it requires a suitable phenology scheme. Here, we demonstrate that efficient data assimilation algorithms can be utilized with a new global generic phenology scheme, which has been designed explicitly with the goal of aiding the data assimilation procedure. The scheme thus extends the Carbon Cycle Data Assimilation System (CCDAS) and covers all major functional types of natural vegetation, including both temperature and water-driven leaf development. We show results for six sites with well known vegetation distribution. Optimisation is carried out simultaneously for all sites against 20 months of daily FAPAR from the Medium Resolution Imaging Spectrometer (MERIS), an instrument of the European Space Agency's ENVISAT satellite. 14 parameters related to phenology and 24 related to plant photosynthesis are optimised and their prior and posterior uncertainties determined. We find that the model is able to reproduce the observed FAPAR of all sites spanning boreal, temperate, humid-tropical and semi-arid climates. Assimilation reduced the uncertainty margin of 12 of the 38 parameters. The approach can easily be extended to regional or global studies, or other remotely sensed data products.