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Integration of biomass data in the dynamic vegetation model ORCHIDEE

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Dynamic vegetation models (DVMs) are aimed at estimating exchanges between the terrestrial vegetated surface and the atmosphere, and the spatial distribution of natural vegetation types. For this purpose, DVMs use the climatic data alone to feed the vegetation process equations. As dynamic models, they can also give predictions under the current and the future climatic conditions. However, they currently lack accuracy in locating carbon stocks, sinks and sources, and in getting the correct magnitude. Consequently they have been essentially used to compare the vegetation responses under different scenarii.
The assimilation of external data such as remote sensing data has been shown to improve the simulations. For example, the land cover maps are used to force the correct distribution of plant functional types (PFTs), and the leaf area index data is used to force the photosynthesis processes.
This study concerns the integration of biomass data within the DVM ORCHIDEE. The objective here is to have the living carbon stocks with the correct magnitude and the correct location. Carbon stocks depend on interplay of carbon assimilated by photosynthesis, and carbon lost by respiration, mortality and disturbance. Biomass data can therefore be used as one essential constraint on this interplay.
In this study, we use a large database provided by in-situ measurements of carbon stocks and carbon fluxes of old growth forests to constraint this interplay. For each PFT, we first adjust the simulated photosynthesis by reducing the mean error with the in situ measurements. Then we proceed similarly to adjust the autotrophic respiration. We then compare the biomass measured, and adjust the mortality processes in the model.
Second, when processes are adjusted for each PFT to minimize the mean error on the carbon stock, biomass measurements can be assimilated. This assimilation is based on the hypothesis that the main variable explaining the biomass level at a given location is the age of the forest, i.e. the time elapsed since the last disturbance. Hence, the measured biomass level is used to estimate the time of the last disturbance which is introduced in the simulation. This approach is imperfect as it neglects the differences due to difference in the growth rate with site quality, but it allows considering more precisely the effect of forest regeneration in DVM, which until now either considered ecosystems under equilibrium state, or introduced disturbance randomly. This approach is promising for better locating carbon sinks and sources.

This work is carried out in the framework of the preparation of the space mission BIOMASS, a space-borne platform equipped with a P-band synthetic aperture radar aiming at measuring the forest above ground biomass.