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Improving the Modelled Global Terrestrial Carbon Cycle by Assimilating CO_2 Mole Fractions and FAPAR with the MPI Carbon Cycle Data Assimilation System (MPI-CCDAS)

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Long-term monitoring of ecosystem carbon fluxes and atmospheric CO_2 concentrations provides independent observations of the land's carbon balance at different scales. However, the scale-gap between these observations makes a direct quantification of regional carbon balances based on these data impossible. Here, we describe first results of the MPI Carbon Cycle Data Assimilation System (MPI-CCDAS), designed to use multiple data streams at different scales to constrain parameters in the biosphere model JSBACH.
We constrain the MPI-CCDAS with two complementary data-streams: CO_2 mole fractions observed at a network of atmospheric monitoring stations, and remotely-sensed fraction of absorbed photosynthetically active radiation (TIP-FAPAR). The assimilation procedure greatly improves the representation of the seasonal cycle of atmospheric CO_2, and reduces the global gross primary productivity (GPP) from 160 PgC/year to 118 PgC/year. Applying the MPI-CCDAS separately and jointly on both data streams allows to analyse the contribution of each data stream to the improved global carbon cycle model. Evaluation against independent carbon cycle estimates based on upscaled ecosystem flux measurements corroborates the adequacy of the model improvements, and demonstrates the utility of the CCDAS framework in consistently integrating carbon cycle data.