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Evaluating the carbon cycle components of CMIP5 Earth System Models

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We assess the capacity of several Earth System Models belonging to different international research centres to simulate the land and ocean carbon cycle for the present climate. These models will be used in the next Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5) for climate projections, and such evaluation allows identification of the strengths and weaknesses of individual coupled carbon-climate models as well as identification of systematic biases of the models.
Results show that in general models do correctly reproduce the main climatic variables controlling the land and ocean carbon cycle, as well as the carbon fluxes. Also the seasonal evolution of the variables under examination is well captured by quite a few models. However, some problems still exist reproducing some fields: in particular, considering the land carbon cycle, a general overestimation of photosynthesis and leaf area index is found for most of the models, while the ocean validation shows that models underestimate the primary production.
In addition, we assess whether there is a set of consistently better models for reproducing the land and ocean carbon cycle, and the main climatic variables controlling the carbon cycle. In order to assess the performance of the models over the reference period 1986-2005, averaged seasonal cycles and probability density functions (PDFs) calculated from model simulations are compared with the corresponding seasonal cycles and PDFs from different observed datasets.
Although the metrics used in this study allow identification of some models as better or worse than the average, our ranking is partially subjective due to the choice of the variables under examination, and can be also sensitive to the choice of reference data. In addition, we found that the model performances show significant regional variations.