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Carbon Dioxide Exchange in Complex Topography

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Abstract

On a global scale the budget of carbon dioxide (CO_2) bears a quite substantial uncertainty, which is commonly understood to be mainly due to land-surface exchange processes. In this project we investigate to what extent complex topography can amplify these land-surface exchange processes. The hypothesis is that, on the meso-scale, topography adds additional atmospheric mechanisms that drive the exchange of CO_2 at the surface.

This sensitivity model study investigates an idealized sine shaped valley with the atmospheric numerical model Weather Research and Forecasting (WRF) coupled to the community land model (CLM) to study the effect of complex topography on the CO_2 budget compared to flat terrain. The experiment is designed to estimate the effect of the topography during maximum ecosystem exchange in summer using meteorological and ecosystem conditions at solstice, the 21. of June. Systematic variation of meteorological initial conditions, plant functional types and the topography creates an ensemble that unveils the fundamental factors that dominate the differences of CO_2 between simulations with topography compared to plain surfaces in the model.

The sign and magnitude of the difference between the CO_2 exchange over topography and over a plain simulation are strongly dependent on the CLM plant functional type, the initial temperature, the initial relative humidity, the latitude and the area height distribution of the topography. However, in this model experiment the topography is, in the mean, a sink to the CO_2 budget in the order of 5% per day.