Proposal for a FLUXNET Synthesis publication

Title:
What the eddy-covariance flux measurements tell us about prior errors in CO_2-flux inversion schemes

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Outline:

CO_2 fluxes at the Earth´s surface may be recovered (or *inverted*) from the observed spatial and temporal gradients of the CO_2 concentrations in the atmosphere by applying Bayes´ theorem. In this common approach some prior probability density $p(\mathbf{x})$ about the CO_2 flux variables, jointly called **x** here, is transformed into the posterior probability density $p(\mathbf{x}|\mathbf{y})$ based on the atmospheric measurements, jointly called **y**. The statistically-optimal description of the fluxes, given the available information, corresponds to the maximum of the posterior density $p(\mathbf{x}|\mathbf{y})$. By construction, it critically depends on the prior density $p(\mathbf{x})$. Under the numerically-convenient assumption of a multivariate Gaussian density, describing $p(\mathbf{x})$ consists in assigning its means, its variances and its autocorrelations. The inversion studies published so far have assumed arbitrary distributions centred on flux climatologies, on regional inventory statistics, or on the outputs of numerical flux models. Chevallier et al. (2006) have attempted to shed light on the characteristics of $p(\mathbf{x})$ based on observations. They relied on CO_2 flux measurements made by the eddy-covariance technique at 34 continental sites in the northern hemisphere to underpin $p(\mathbf{x})$. They showed a heavy-tail distribution $p(\mathbf{x})$ that contradicts the usual assumption of a multivariate Gaussian distribution. The error correlations appeared to follow a linear temporal dependency after the second lag day without any particular spatial structure.

This study will continue the work initiated in the 2006 paper to examine the characteristics of $p(\mathbf{x})$ for natural terrestrial fluxes of CO_2, when the maximum of the distribution is

provided by the ORCHIDEE terrestrial biosphere model. It will rely on a detailed statistical analysis of the differences between simulations of ORCHIDEE and the La Thuile CO_2 flux measurements. A statistical model will be designed to upscale the results at any higher resolution in space and time in order to fit the low resolutions of the inversion systems.

Reference:
Chevallier, F., N. Viovy, M. Reichstein, and P. Ciais (2006), On the assignment of prior errors in Bayesian inversions of CO_2 surface fluxes, *Geophys. Res. Lett.*, 33, L13802, doi:10.1029/2006GL026496.

Proposed sites to be involved:

The 2006 paper used 34 continental sites. A key improvement here will be the design of a statistical model of the spatial structure of the prior errors. To do that, access to the denser "Full La Thuile" dataset is requested. All sites containing more than one full year of flux and meteorological data may be considered for this analysis.

Proposed Rules for Co-Authorship:

The rules as proposed in the La Thuile policy will be applied.