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Comparing Ensemble Kalman filter and 4DVar data assimilation systems for CO_2 flux inversions

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Data assimilation systems allow for estimating surface fluxes of greenhouse gases from atmospheric concentration measurements. Good knowledge about fluxes is essential to understand how climate change affects biosystems and to characterize natural feedback mechanisms - one of the big unknown factors of climate change.

Based on more than one year of atmospheric in-situ concentration measurements, we compare the performance of two established data assimilation techniques, Carbontracker and TM5-4DVar, for CO_2 flux estimation. Carbontracker is an Ensemble Kalman Filter method, TM5-4DVar a 4D variational method. Harmonizing the input data allows for analyzing the strengths and weaknesses of the two approaches by direct comparison of the modeled concentrations and estimated fluxes.

We further assess the sensitivity of the two approaches to the density of observations and operational parameters such as correlation lengths. This allows for investigating potential improvements to the flux estimates from adding more measurement sites or observations with a different correlation structure. The next step will be assimilating remote-sensing total-column data from satellite or ground-based soundings.