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Regional scale inversions to estimate Net Ecosystem Exchange in terms of network design.

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Aim and relevance

Long term observations of atmospheric greenhouse gases from measuring stations, located at representative regions over the continent, improve our understanding of greenhouse gas sources and sinks. These measurements (mixing ratios) can be linked to the surface fluxes by atmospheric transport inversions. Within the upcoming years new stations are to be deployed and the development of a decision making tool with respect to the location and the density of the network is crucial. We are developing a method to assess potential greenhouse gas observing networks in terms of their power to recover specific target quantities. As target quantities we use CO_2 fluxes at specific spatial and temporal scales. We introduce a high resolution modeling framework with nominal spatial resolution of 10 km x 10 km. The framework consists of the Lagrangian transport model STILT, the diagnostic biosphere model VPRM and a Bayesian inversion scheme. We aim to retrieve the spatiotemporal distribution of Net Ecosystem Exchange by inverting for linearized Gross Ecosystem Exchange and Respiration scaling factors instead of for the fluxes themselves. Thus the state space includes parameters for controlling photosynthesis and respiration with spatial and temporal flexibility. Initially we perform inversions at the Ochsenkopf tower located in Germany and later on, the inversion framework will be expanded to network design. With this regional inverse modeling tool we address the questions of how well a set of network stations constrains a given target quantity, and we investigate the existence of objective criteria to select an optimal location for a new station. Direct comparison of the optimized fluxes and the assessment of the uncertainty reduction for the targeted quantities will reveal the abovementioned questions.

Uncertainties

Uncertainties in observations and in model-data mismatch representation are introduced in these inversions. Observational uncertainties consists of measurement errors. Model-data mismatch includes atmospheric transport errors by imperfect modelling of the atmospheric circulation, errors in the a-priori flux fields that we use, representation errors describing the difficulty to assign site specific measurements to a gridcell average mixing ratio, and aggregation errors resulting from limited resolution oft he state space. We represent these uncertainties in form of a covariance matrix. We use off-diagonal elements considering temporal and spatial correlations for the errors with an error model following exponential decay. An important key to correctly quantify the uncertainties is to consider aprropriate error statistics for the covariances. Therefore we need to set proper spatial and temporal correlation lengths for the errors. We perform a multimodel – data comparison utilizing a number of flux-stations among Europe and performing a variogram analysis of the residual fluxes at different temporal aggregation scales to reveal spatial and temporal correlations for the a-priori uncertainty covariance matrix.