



Transport model error in inverse modelling: Developments within the ITMS project

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Inverse modelling of CO₂ and CH₄ using atmospheric in-situ data relies on simulations of atmospheric transport that are derived from models used in numerical weather prediction. The relevant time scales for inversions range from hours to decades, which is far beyond the time scales of a few weeks for which NWP models are designed. The strong diurnal and seasonal variations in surface to atmosphere fluxes of CO₂ covary with atmospheric mixing in the boundary layer, as both are solar radiation driven. This way slight seasonal or diurnal biases in the representation of mixing can be amplified. In addition, different atmospheric models show differences in vertical mixing through turbulent mixing and through moist convection, and thus in the representation of vertical gradients in tracers, which results in strong differences in flux estimates from inverse modelling. These facts have been known since several decades by now, but progress in addressing these issues has been slow. Within the atmospheric network of ICOS (Integrated Carbon Observation System) additional meteorological observations are available that provide information on atmospheric mixing heights. Also, IAGOS (In-service Aircraft for a Global Observing System) provides information on vertical gradients which can be related to mixing through turbulence and convection.

ITMS, the Integrated Greenhouse gas Monitoring system for Germany, is implemented in multiple development phases: a first phase with the development of a demonstrator system, followed by the second phase, the development of a first-generation system, and a third and last phase, the transfer to operations. With each phase lasting about four years, the project provides a medium-term framework that allows also addressing some of the longer lasting problems such as transport uncertainty. Within ITMS the CarboScope Regional inversion system (CSR) is used as a reference system for CO₂ and CH₄ inversions, but also as a testbed for model developments. The presentation will provide an overview of recent results obtained within ITMS. This includes evaluating vertical mixing by using additional meteorological profile data or mixing height information, using additional tracers in inversions such as Radon, and confronting vertical profiles from airborne observations with model equivalents.