

Assessing the current capabilities for the national scale monitoring of CO₂ anthropogenic and biosphere fluxes based on OCO-2 XCO₂ and satellite observations of co-emitted species

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NASA's OCO-2 total column CO₂ mixing ratio (XCO₂) observations have been used extensively for large-scale mapping of biospheric CO₂ fluxes and for quantifying CO₂ emission hotspots (e.g., industrial plants, cities) using local transects of the corresponding plumes. However, there is a lack of inverse modelling experiments assessing the potential of OCO-2 data for the regular monitoring of biospheric and anthropogenic CO₂ fluxes at the scale of individual countries. Such a capability would be critical to support the national greenhouse gas emission reporting and reduction policies in the frame of the Paris Agreement. This presentation summarizes the results of three national scale inversions carried out in the framework of the European H2020 CoCO₂ project, which supports the development of the operational global and multi-scale Copernicus CO₂ monitoring service. These three inversion systems include the CHIMERE chemistry transport model at 10 km resolution over France coupled to the Community Inversion Framework (CIF), the ICON-ART model at 13 km resolution over Western Europe coupled to the Carbon Tracker Data Assimilation Shell (CTDAS), and the GEOS-Chem at ~25 km for the whole Europe coupled to an Ensemble Kalman Filter. The three models assimilated surface CO₂ and/or OCO-2 XCO₂ observations from the year 2018 and separately controlled the anthropogenic emissions and biospheric fluxes. GEOS-Chem also assimilated TROPOMI CO observations to assess the potential of this species that is co-emitted with CO₂ during combustion to simultaneously estimate biospheric and anthropogenic fluxes of CO₂. The presentation will highlight various challenges associated with the joint estimation of anthropogenic and natural fluxes of CO₂, the co-assimilation of co-emitted species, the co-assimilation of surface and satellite CO₂ observations, and the representation of uncertainties in the inventories of the anthropogenic emissions of CO₂ and co-emitted species used as prior estimates for the inversions. We found large differences in biogenic CO₂ flux estimates across the different systems, particularly for the annual budgets, but also when assimilating surface versus satellite observations in the same assimilation system. This has not improved on previous studies that used coarser-scale models. We also found that all three models lack of robust control of national-scale anthropogenic CO₂ emissions on monthly to annual timescales when using the existing in-situ and satellite observations. The co-assimilation of CO data did not significantly increase this constraint. There is a stronger and more robust impact of the satellite data assimilation locally. The results obtained here provide guidance for the improvement of current modeling capabilities to monitor the CO₂ anthropogenic emissions. Such an improvement and CO₂M with the associated step-change in XCO₂ data over Europe should radically change our ability to quantify regional anthropogenic emissions of CO₂.

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