On the benefits of using high resolution transport and fluxes to simulate atmospheric CO_2 variability

---

Anna Agusti-Panareda, Sebastien Massart, Mark Parrington, Michail Diamantakis, Joaquin Munoz-Sabater
Gianpaolo Balsamo, Souhail Boussetta, Richard Engelen, Vincent-Henri Peuch,
Frederic Chevallier, Michel Ramonet, Olivier Jossoud, Marc Delmotte,
Josep Anton Morgui, Roger Curcoll,
Thorsten Warneke, Dietrich Feist, Christof Petri ,
Michael Buchwitz, Max Reuter, Jens Heymann, Rob Detmer

The interpretation of observed variability of CO_2 in the atmosphere depends on the accurate representation of transport and surface fluxes by models. The Copernicus Atmosphere Monitoring Service (CAMS) 9-km CO_2 forecast has high skill in representing the day-to-day variability of atmospheric CO_2 because it relies on the ECMWF state-of-the-art Numerical Weather Prediction (NWP) model. To assess the benefit of the high resolution, the simulations at 9 km are compared with lower resolution simulations (80 km) commonly used in meteorological re-analysis (e.g.ERA-Interim) and chemical transport models. The results show how the transport accuracy improves with model resolution, resulting in a 1-day gain in the forecast lead time. The resolution of surface fluxes can also have an additional impact on the representation of the atmospheric CO_2 variability. The benefit of the high resolution is further highlighted by using tagged carbon tracers from anthropogenic, land ecosystems, ocean and biomass burning sources. These tagged tracers show the plumes emanating from the different sources. The plumes are used to assess the overlap of the atmospheric signal associated with separate sources during a 5-day forecast.
Finally, the high resolution forecast also allows to assess the small-scale (< 100 km) variability of atmospheric CO_2 observed by in situ and satellite observations, which cannot be represented by coarser-grid transport models. As these high resolution CAMS CO_2 forecasts are provided in real time, they can be used as boundary conditions for regional modelling studies and for planning field experiments.