Geophysical Research Abstracts
Vol. 21, EGU2019-12897, 2019
EGU General Assembly 2019

A library of nature runs from the global to the local scale to dimension space mission requirements

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To evaluate the implementation and effectiveness of the CO_2 emission reduction targets proposed by each of the signatories of the Paris Agreement, the European Commission has identified a need for an operational CO_2 emission monitoring system. In such a system, a constellation of CO_2 satellites with imaging capability would be a critical element as it would allow CO_2 plumes of individual point sources such as large cities and power plants to be observed and would help constrain emissions at the regional and national scale.

However, such emission quantification faces substantial challenges due to the limited precision of the satellite measurements, systematic biases introduced by incomplete accounting for the effects of aerosols and other factors on the retrieval, the limited spatial and temporal coverage and resolution of the observations, and the difficulty in separating the signals from natural CO_2 fluxes from those from anthropogenic CO_2 emissions.

In the CO_2 Human Emission (CHE) project, we generate a library of realistic CO_2 simulations for present-day and future emission scenarios, so-called nature runs, from the global to the regional and point-source scale to support, in a wider framework, the assessment of the requirements for a future space mission and the challenges introduced by the issues listed above. A first set of simulations for the domain of Europe by one global model (CAMS-IFS) at 9 km resolution and several regional models (WRF-GHG, COSMO-GHG and LOTOS-EUROS) at 5 km will be compared and analysed. Transport model uncertainties will be characterized at scales relevant for emission estimation, notably at country and plume scale. Furthermore, simulations with two different CO_2 inventories (EDGARv4.3.2_FT2015 and TNO-GHGco) with different spatial representations and resolutions of emissions will be analysed for the effect of such differences on the simulated tracer fields. This library of simulations will be used in the future for generating realistic synthetic satellite XCO_2 observations and investigating the influence of aerosols on the CO_2 retrieval in urban plumes, and will serve as a basis for emission estimation studies.