On the challenge posed by the estimation of XCO_2 from OCO-2 observations in near-real time based on artificial neural networks

Cédric Bacour[1], François-Marie Bréon[1], Frédéric Chevallier[1]

1. Laboratoire des Sciences du Climat et de l'Environnement, LSCE/IPSL, CEA-CNRS-UVSQ, Université Paris-Saclay, France.

Contact: cedric.bacour@lsce.ipsl.fr
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We have developed a Neural Network (NN) -based processing chain that operationally retrieves XCO_2 from OCO-2 spectra over land surfaces every day. The training of the NN relies on the combination of real OCO-2 L1b observation and XCO_2 estimated by the CAMS (Copernicus Atmosphere Monitoring Service) global atmospheric inversions. As shown in previous studies, the retrieval accuracy and precision are similar or better than that of the official retrieval algorithm (ACOS, based on a full-physics radiative transfer model inversion and a subsequent empirical bias correction) for soundings included in the time period considered for the NN training. However, for operational processing, the observations are outside of the training period, and the retrievals show a low bias in comparison to other re-analyses of XCO_2.

This artefact stems from the continuous increase of carbon dioxide in the atmosphere, at a rate of about 2.5 ppm per year. Hence, recent soundings may be associated to XCO_2 values larger than those contained in the training dataset, based on older observations by construction.

In addition to the overall ability of the NN retrievals to reproduce large-scale space-time distribution of XCO_2, we also seek to represent small scale features (plumes) that are generated by strong localized emissions and which are not embedded in the CAMS database used for the training. With our NN-based framework, we have observed that the ability to reproduce XCO_2 plumes strongly depends on the spectral information that feeds the NN (i.e. the spectral channels in the O_2 and strong CO_2 bands that are selected).

We will present the NN retrieval approach and compare the performance of the NN-based XCO_2 estimates against that of the ACOS product. We will illustrate the current limitations of the approach and will present current research aiming at mitigating them, in particular regarding the representativity of the training database and the characterisation of the informational content of the spectral features.