Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2020-177-SC1, 2020

Atmospheric Measurement Techniques Discussions

Interactive comment on "XCO2 estimates from the OCO-2 measurements using a neural network approach" *by* Leslie David et al.

François-Marie Bréon

breon@lsce.ipsl.fr

Received and published: 12 July 2020

We thank the reviewer for her/his in-depth analysis of our paper. The present document is not a full answer to his/her review (which we will make when the other review becomes available), but only an answer to the main comment that we have not demonstrated that the ANN primarily uses the spectral information to estimate the XCO2:

"This means it must become clear that the ANN has indeed learned and generalized primarily from the spectral information so that it is able to follow also un-expected CO2 features such as plumes."

As stated in the manuscript, the only variables that are provided to the ANN are the measured spectra and the observation geometry. The observation location, year and

date within the year are NOT input to the ANN, in contrast to what the reviewer's text may suggest (p. C2, l. 4 from bottom). The observation geometry is the solar and view zenith angles, together with the relative azimuth. It does not include the target surface elevation (reviewer's p. C6). The OCO-2 instrument follows a complex attitude pattern with respect to the solar principal plane but it is the same over the longitudes and from one year to the next. Thus, the ANN cannot find any information on the observation longitude and year of observation from the observation geometry. It is then clear that the ANN retrieves XCO2 primarily from the spectral information, as there is nothing else available as input. The XCO2 variations along the longitude, and even more from year to year, are actually much larger than the ANN error that we estimate show on Figure 2. Figure 2 demonstrates that the ANN is able to reproduce variations of XCO2, as it does for the variations of the surface pressure (Figure 1).

We believe this is a clear demonstration that the ANN retrieves XCO2 from the spectral information.

The reviewer requires the demonstration that the NN can detect unexpected XCO2 features such as plumes (p. C3, top). Let us recall that there is no available "truth" for such plume so that it can hardly be a demonstration of the data validity. Indeed, there is evidence of "false" plumes in the ACOS XCO2 dataset that appear to be generated by aerosol or surface albedo features. It is certainly a valid objective to analyse the small-scale variability of the ANN retrievals but it requires the analysis of all footprints rather than a single one (FOV #4) as done in the present paper, and is therefore a forthcoming step.

Also, the reviewer suggest that we should apply the ANN to simulated spectra (p. C3, top). We fully disagree with this suggestion. Although the radiative transfer models are very accurate, as the reviewer writes, they do show significant systematic differences with the observation. The ACOS algorithm uses empirical EOF to account for these differences (in addition to bias correction). The ANN training accounts for these systematic differences (i.e. it is fitted to the measurements, not to some simulated spectra). Applying this ANN to radiative transfer simulations that generate biased spectra can only result in poor results.

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2020-177, 2020.