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Atmospheric Measurement Techniques Discussions

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

Anonymous Referee #1

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"It is then clear that the ANN retrieves XCO2 primarily from the spectral information, as there is nothing else available as input."

I just trained a multi-layer perceptron ANN with a hidden layer of 50 neurons. Input: Solar zenith angle, viewing zenith angle, and azimuth difference of footprint#4 nadir OCO-2 soundings of the year 2015. Output: Latitude, CarbonTracker XCO2. The predicted latitude has a precision of about 6° (correlation 0.98) and the predicted XCO2 has a precision of 1.8ppm (correlation 0.67).

This means that the used observation geometry implicitly includes a lot information on the position (note that one of the largest signals in XCO2 is the latitudinal gradient) and, therefore, also on the typical XCO2 distribution. Without using any spectral information, it is possible to explain about 45% of CarbonTracker's XCO2 variance in 2015. Any

additional information from the spectral bands (even if no CO2 bands are included) has the potential to add context improving the average XCO2 prediction performance.

I'm not saying that the ANN presented in the paper indeed did not learn to retrieve CO2 primarily from the CO2 line depth but the presented material is also not sufficient to prove that it did.

***"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** . . ."*

Please provide a reference if there is a peer-reviewed publication discussing these false plumes. In my review, I already cited the publications of Reuter et al. (2019) and Nassar et al. (2017) showing some plumes. Are there good reasons to consider all these false plumes? They are broadly consistent with model wind fields, S5P NO2, and emission databases. They include observations in nadir mode and are rather data-dense so that the signal should be visible in footprint#4.

***"Also, the reviewer suggest that we should apply the ANN to simulated spectra. We fully disagree** . . ."*

It would be sufficient to select a more or less arbitrary OCO-2 spectrum and simulate only the XCO2 Jacobian and add it to the spectrum. The differences between simulated and measured spectra have a large systematic component (that's why they can be fitted with few EOFs). Therefore, the simulated Jacobian should agree very well with the actual Jacobian. Additionally, it shall be noted, that there are non-NASA full physics algorithms for GOSAT and OCO-2 which produce reasonable results without fitting EOFs. I.e., they deal with the differences between measured and simulated radiances without messing everything up.

References

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Reuter et al. (2019): M. Reuter, M. Buchwitz, O. Schneising, S. Krautwurst, C.W. O'Dell, A. Richter, H. Bovensmann, and J.P. Burrows: Towards monitoring localized CO2 emissions from space: co-located regional CO2 and NO2 enhancements observed by the OCO-2 and S5P satellites, Atmos. Chem. Phys., https://www.atmos-chem-phys.net/19/9371/2019, 2019

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