Atmos. Meas. Tech. Discuss., 5, C687–C689, 2012
www.atmos-meas-tech-discuss.net/5/C687/2012/

Atmospheric Measurement Techniques Discussions

Interactive comment on "A simple empirical model estimating atmospheric CO_2 background concentrations" *by* M. Reuter et al.

Anonymous Referee #2

Received and published: 13 April 2012

This manuscript describes a simple, empirical model,called SECM, which simulates the time and latitude dependence of the CO2 dry air mole fraction, XCO2. This model could be useful as a prior and first guess in retrievals of XCO2. The paper provides a good description of the derivation of the SECM model, and its validation against both the CarbonTracker model, upon which it is based, and the observations from TCCON.

pg 1297, line 16: There is one technical issue with the approach that could improve the value of the model. Currently, SECM uses a vertical profile shape with a fixed pressure cut-off, p_t = 0.2, nominally separating the troposphere and stratosphere. Our group's recent XCO2 retrieval efforts demonstrate a significant sensitivity to the CO2 prior and its assumed covariance in the vicinity of the tropopause. Like our colleagues on the TCCON team, we find that we get much smaller biases in our XCO2 retrievals

if we adopt an a priori CO2 vertical profile and covariance matrix that accurately tracks the tropopause height as a function of season and latitude. Fixing the pressure cut-off at 0.2, and ignoring seasonal variations above this arbitrary boundary will lead to unnecessary errors. It may not be possible to modify the model to include a variable value of p_t, but this source of error should be acknowledged.

pg 1301, line 23: Here, the authors note: "The smoothing error becomes less important if XCO2 retrievals are used in an inverse modeling framework because it will be removed from the retrieval within the assimilation process."

I don't believe that this statement is entirely true. Smoothing errors can be made "less important" by employing an accurate, sounding-by-sounding averaging kernel in a well-conceived inverse modeling framework. However, smoothing errors, especially when combined with regional-scale biases in the CO2 prior, are not "removed from the retrieval" by this process. They are an intrinsic limitation to the accuracy of the retrieval.

Pg 1303, Line 19: I am concerned by the statement "SECM can be used to identify obvious retrieval errors (by monitoring the difference between retrieval and SECM)." In a well-conceived retrieval algorithm, the large differences between the prior and the retrieved values should be scrutinized. However, most such schemes include error statistics and proxy parameters (e.g. sounding SNR, spectral residuals, xhi-squared, aerosol loading, etc.) that are far more reliable than a poor fit to a CO2 field derived from " a simple empirical equation".

Besides these points, my only concern is that the last statement in the conclusions is unnecessary, and seems more like salesmanship than science.

"Moreover, it is remarkable, how well (more than 94% explained variance) a simple empirical equation (depending only on date and latitude) can reproduce atmospheric CO2 concentrations."

I see nothing particularly remarkable about this. As noted earlier, CO2 is a long-lived,

well-mixed gas. When averaged over regional scales (1000 x 1000 km), the largest known changes in XCO2, are no larger than 2-3% from pole to pole, or throughout the seasonal cycle. The authors make no attempt to model the true variability (e.g. CO2 weather), only the zonally-averaged component of the output of a model (CarbonTracker). In spite of this, it still takes a 17-parameter function fit its variability. I suggest that this statement be omitted.

Interactive comment on Atmos. Meas. Tech. Discuss., 5, 1293, 2012.