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Atmospheric Measurement Techniques Discussions

Interactive comment on "First intercalibration of column-averaged methane from the Total Carbon Column Observing Network and the Network for the Detection of Atmospheric Composition Change" *by* F. Forster et al.

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General comments

The authors describe the comparison of retrievals of the column average dry air mole fractions of methane (XCH_4) from near-infrared (NIR) and mid-infrared (MIR) solar absorption spectra acquired nearly simultaneously on Fourier Transform spectrometers at sites in Garmisch (Germany) and Wollongong (Australia). When Garmisch retrievals are corrected to a common a priori seasonally-varying differences in the NIR and MIR

retrievals are reduced and there is a reasonable linear relationship between the corrected NIR and MIR retrievals over a $\sim$50 ppb range in XCH_4. The correlation between corrected NIR and MIR retrievals at Wollongong is much poorer, but there is no discussion or supporting material (e.g. timeseries) given to understand why this might be so (in fact, no correlation analysis is performed).

The authors derive an intercalibration scale factor based on a linear regression of the corrected MIR versus NIR retrievals assuming/forcing a zero y intercept. Thus the estimated scale factor (slope) reflects the mean x, y for the sample, not the within-sample slope (and the uncertainty estimates reflect the scatter of the MIR retrievals (y) about the sample mean). Consequently, these regression estimates may not be the most appropriate characterisation of the intercalibration and the site-to-site consistency. I believe the intercalibration requires demonstration of a strong, common linear relation between the MIR and NIR retrievals over the observed range of XCH_4 (1720-1800 ppb) at the two sites.

The analysis of the relationship between the NIR and MIR XCH_4 retrievals is timely, and of certain interest. I also recognise the work that has been required simply to acquire and analyse the timeseries presented here. Nonetheless, in addition to my concerns above regarding the statistical analysis for the intercalibration, I feel the current manuscript has insufficient detail on several aspects of the analysis detailed below.

Specific comments

Section 2

The description of the MIR and NIR retrieval strategies is very limited for a reader who is not VERY familiar with both NDACC and TCCON retrievals.

The coincidence criteria for the MIR and NIR data is not explained at all. How do we go from NIR and MIR data in a ratio of $\sim$10:1 spectra to the monthly means in the

figures? This must be described in some detail, from temporal coincidence for raw data through to definition/calculation of the monthly means.

Correction to a common a priori

Section 3.1 is entitled 'Eliminating a priori impact', when in fact the correction only eliminates differences due to different retrieval a prioris. After correction to a common a priori x_c, there is still the smoothing term (I-A)($x_c - x_{true}$) whose magnitude depends on the averaging kernel A of the given retrieval. The phrase 'eliminating a priori impact' is used repeatedly in the manuscript, and should be corrected.

The correction described in Equation 1 holds for linear or linearised retrievals. The reader has no idea what the magnitude of the Δx is in Equation 1, or whether the retrievals truely are linear over this change/these changes in x. The comments below assume Equation 1 does hold for the Δx in question.

Similarly, given the intercalibration is dependent on the adjustment to a common a priori, I think some summary of the differences in the NIR and MIR averaging kernels as a function of zenith angle (and the Δx) should be given in graphical form in the paper.

The exact application of the model x_M for the correction to a common a priori is not clear – is the model used 'pointwise' i.e. $x_M(t)$ is used to correct the $XCH_{4,Y}$(t) (Y=NIR,MIR) or is an ensemble mean $< x_{M,Z} >$ used for each site Z? I assume it is the former, but cannot be sure.

I also do not understand why one of the two constant retrieval a prioris was not selected as the common a priori. This would have assisted our understanding of the correction, as the seasonal variation in the correction term would then only be driven by changes in the averaging kernels as a function of zenith angle.

Wollongong

As noted in the general comments, the correlation of the corrected Wollongong retrievals is much poorer than for Garmisch, and requires comment/further analysis. There is a subset of $\sim$5 months where the MIR retrievals are significantly lower than expected from the intercalibration realtion. The discrepancy is $\sim$10 ppb, comparable in magnitude with the amplitude of the seasonal cycle in XCH_4 in the Southern Hemisphere midlatitudes ($\sim$15 ppb peak-to-peak at Lauder), so one would want to understand the origin of the scatter in the Wollongong retrievals shown in Figure 4 if we are to have confidence in the intercalibration. For starters the Wollongong timeseries could easily be added in figures 2 and 3 (the monthly mean XCH_4 at each site do not overlap significantly).

Determination of the intercalibration factor

As described in the general comments above. Additionally, error estimates for NIR (and MIR) retrievals should be accounted for in regression analyses.

Monthly means

Even with correction to a common a priori there is a suggestion of a residual seasonality in the Garmisch timeseries (maximum differences in the early part of 2008 and 2010). It would be interesting to see the raw data differences ($\sim$coincident corrected MIR/NIR) as a function of time and zenith angle at both sites.

Figures

- Figure 1 could be cut without any loss of clarity in the presentation
- Add Wollongong timeseries in Figures 2 and 3.

- An additional figure, summarising $\Delta x(P,t)$ and $\Delta A(P,\chi)$ should be added.

Minor comments

Introduction paragraph beginning l23: This paragraph could be more carefully worded. The contribution of local and remote sources and sinks on surface and column measurements depends on the time scales in question. Given the lifetime of CH_4, information on atmospheric transport is required to interpret both types of measurement.

Technical corrections

Introduction p 1357 l25: In situ measurements are directly traceable (not 'more directly')

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