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Atmospheric Measurement Techniques Discussions

Interactive comment on "

Airborne DOAS limb measurements of tropospheric trace gas profiles: case study on the profile retrieval of O_4 and BrO" *by* C. Prados-Roman et al.

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General Comments:

This well structured paper presents a very nice methodology to retrieve BrO using remotely sensed UV-Vis spectra taken from an aircraft in the Arctic as part of the ASTAR

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campaign. The use of the regularization formalization is a nice advancement in the tropospheric trace-gas remote sensing retrievals. It is beyond the scope of this paper but I wonder what difference one might expect from the use of this approach over using a correlation length to account for smoothing in the vertical?

The retrievals are performed in two steps with the non-linear aerosol retrieval being conducted initially as this is a major sensitivity in tropospheric trace-gas retrievals using scattered light. Using the radiance to constrain this presents also a methodological advancement which, I am sure, will be utilized in future trace gas retrievals of this nature. The second retrieval step involves the familiar trace-gas retrieval with characterization.

This is a nice paper, I do have some technical and semantic comments, which I discuss below and need to be addressed, but I unreservedly recommend publication in AMT.

Specific Comments:

Page 3929, line 22 HOx and NOx are chemical families not species, I would suggest naming the specific species

Page 3930, line 3 Add references for the satellite measurements that show the BrO horizontal extent.

Page 3931, line 24 What is the field of view in the horizontal? i.e. How wide is the slit?

Page 3935, line 23 How can 4% for the measurement error really cover all the errors of the measurement? I would expect that dark current and calibration errors (i.e. systematic) would result in an absolute error quantity. Using a percentage error everywhere means that where the measurements are close to 0 (i.e. close to the reference) the errors are also small and therefore in the retrieval these low measurements are (falsely) regarded as being of a higher quality than measurements with a higher signal to noise.

Page 3936, line 1 The Levenberg-Marquardt approach ensures that convergence takes into account the distance of the forward model results to the measurements – a note to this effect may add to the discussion here.

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Page 3938, line 5 here and elsewhere there is not a clear distinction made between the forward model error and the forward model parameter (FMP) error. Forward model (FM) error includes all errors in the forward model approximation of the true atmosphere (i.e. the physics of the atmosphere can not be always completely described i.e. refraction, Mie scattering approximation) and it includes (but is not limited to) errors of the forward model parameters (such as temp, press, aerosol profile etc). The forward model error unlike the forward model parameter error often cannot be quantified (you can change the temp profile and see its effect on the retrieval (i.e. FMP error), but often you can't know what implications the true physics have over using a Mie scattering approximation in your RTM (FM error)). I would argue that "efrw, the error in the forward model" does not originate from uncertainties of each of the forward model parameters, but rather the FMPs contribute significantly to efrw.

Page 3940, line 11 more than 40% of the forward model error – I think the absolute FM error is unknown, you only know the absolute FMP error.

Page 3943 to 3944 'Validation using O4', I just caution here the use of validation, I do not dispute the use of O4 as a great method for obtaining aerosol and cloud scattering information – but it is not as useful where there is less O4 (i.e. free troposphere and above). This is stated by the authors for the UT/LS region last sentence of section 3.3 but then in section 4 the sentence 'confidence is gained in the novel method to retrieval vertical profile distribution of trace gases in the troposphere' is too strong.

Page 3945 on – why is ppt chosen as the retrieval unit? Is the retrieval of BrO really conducted in ppt? Does this not make the FMP sensitivity to temperature and pressure higher than if the retrieval and AKs were reported for molec.cm-3? Please describe how the retrieval of the trace-gases are performed exactly.

Page 3947, line 23. It would be great if the example of the stratospheric influence was tied more closely to the figure 9. As the paragraph stands it is just stating what one would expect to see if a stratospheric folding event was present, but doesn't commit to

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whether the authors consider it has occurred here.

Page 3948, 3 didn't Fitzenberger et al. see much higher free tropospheric values in the Arctic than are reported here?

Page 3951, $\sim$ 20 could it be that the satellite retrievals do not systematically underestimate BrO because in the study here rather a cloud-free scene is selected for – to reduce complication in the RT?

Page 3952 line 27 on, split the long sentence into two distinct points.

Page 3953, line 17, in the outlook part, some references for the proposed work using DOAS for aerosol retrievals such as Friess, 2006, Wagner 2004, 2009 (referenced earlier in paper but appropriate here too) Langford et al. Atmos. Chem. Phys., 7, 575–586, 2007 and cloud retrievals Daniel et al. JGR, 111, D16208, doi:10.1029/2005JD006641, 2006 and Schofield et al. JGR. 112, D21203, doi:10.1029/2007JD008737, 2007.

Technical Corrections and Typographical Errors:

Page 3928, line 9 delete 'amount of'

Page 3928, line 23 delete 'and rare'

Page 3929, line 1 replace 'just' with 'only'

Page 3929, line 24 'eventually yield scavenge of Hg' should be 'eventually scavenge Hg'

Page 3929, line 25, 'toxic' could be replaced by bio-accumulative or bioactive, because in the polar ecosystem it accumulates but is toxic to humans

Page 3930, line 5 replace 'trigger' with 'motivation'

Page 3938, line 17 and 22 here and elsewhere forward parameter should be forward model parameter

Page 3939, line 14 were measured in situ

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Page 3939, line 18 The aircraft ascent considered here . . .(14:30 UT), flying

Page 3940, line 9-10 deployment studied herein,

Page 3940, line 11 more than 40% of the forward model parameter error

Page 3940 line 28 particles in the size

Page 3948 line 13 aply -> apply

Page 3950 line 29 heights

Page 3952 line 5 large -> high

Interactive comment on Atmos. Meas. Tech. Discuss., 3, 3925, 2010.