Atmos. Meas. Tech. Discuss., 7, C1666–C1670, 2014
www.atmos-meas-tech-discuss.net/7/C1666/2014/

Atmospheric Measurement Techniques Discussions

Interactive comment on "Satellite observations of peroxyacetyl nitrate from the Aura Tropospheric Emission Spectrometer" *by* V. H. Payne et al.

Anonymous Referee #1

Received and published: 11 July 2014

General Comments

The manuscript by Payne et al. titled "Satellite observations of peroxyacetyl nitrate from the Aura Tropospheric Emission Spectrometer" describes the development of a new satellite retrieval product based on TES observations. Routine satellite observations of PAN would enable better understanding of the nitrogen cycle; current satellite products for PAN are limited to limb-sounding instruments which can not see into the troposphere. The manuscript establishes the framework for a PAN product based on TES observations and analyzes a limited number of actual TES PAN retrievals.

Overall, the paper does a thorough job of describing the PAN optimal estimation-based retrieval algorithm and its various components. Results are presented both for simu-

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper

lated retrievals, where PAN concentrations are specified, and for one month of actual TES observations, where the atmospheric PAN concentrations are unknown. The task of developing a PAN product is challenging for several reasons, but mainly because of the weak radiative sensitivity. Rigorously validating the retrieval product is apparently not yet feasible because of the lack of in-situ data.

Since the paper does not report actual validation results, the validity of the algorithm must be judged from a rigorous analysis of possible retrieval errors and from qualitative observations, such as the 'reasonableness' of actual retrieval results in particular contexts. In these two areas, the manuscript should be improved. Specific suggestions are included below.

Specific Comments

p. 5351, l. 14. The meaning of '... close to the true state ...' is unclear. How close is close enough? Can this statement be made more quantitative?

p. 5352, l. 5. Does Sn only represent instrument noise, or does it also represent systematic radiance errors relative to the forward model (e.g., spectroscopic errors)? Are forward model errors represented somewhere else?

p. 5352, l. 8. What is meant by 'relatively linear'?

p. 5352, l. 24. Some justification should be given for assuming linearly varying surface emissivity. Are there at least some materials where surface emissivity in this spectral region are documented?

p. 5354, l. 7. For a given observation location, what are the actual criteria for selecting the a priori category?

p. 5354, l. 12. What is meant by 'entering null space'?

p. 5354, l. 18. Consider deleting 'relatively'

p. 5354, l. 19. Can this a priori variance value be interpreted as a percentage or

AMTD
7, C1666–C1670, 2014

fractional variability? How does this variance value compare to variances for other trace gases retrieved by TES?

p. 5354, l. 21. I recommend revising this paragraph. In optimal estimation theory (i.e., Rodgers' book), the off-diagonal elements of the a priori covariance matrix can not be 'tuned', but really describe the expected or observed a priori correlations in trace gas concentrations at different levels. Setting the off-diagonal elements to 0 is equivalent to assuming a vanishingly small vertical correlation length.

p. 5355, l. 13. Could some vertical information be theoretically possible using different microwindows, or is there a fundamental reason why this is unrealistic?

p. 5356, l. 12. Here it would be helpful to briefly review the physical basis of the effects of clouds on TES retrievals.

p. 5357, Section 3.6. For the retrieval simulations, instead of comparing x_rtv with x_true, it would be more informative to compare x_rtv with the quantity x_a + A(x_true - x_a), as described in Rodgers' book, since this would account for the influence of the a priori.

p. 5357, l. 25. When evaluating the RMS differences between the true and retrieved values for the simulations, these differences should be compared to the RMS differences between the true and a priori values. If the retrieval algorithm has skill, the true/retrieved RMS differences should be substantially smaller than the true/a priori RMS differences.

p. 5358, l. 11. Is it known what surface types (e.g., water, vegetation, etc.) exhibit surface emissivity which varies linearly over the PAN microwindows? Ideally, simulations should be performed where modeled radiances are based on realistic surface emissivity data. Why is this source of retrieval error not included in Table 2?

p. 5359, l. 16. The potential effects of O3 and N2O on the PAN retrievals are not quantitatively investigated. For both gases, it is not clear that the variability of the

AMTD

7, C1666–C1670, 2014

absorption features within the PAN microwindows would somehow prevent retrieval bias. Ideally, this section should include simulations where the O3 and N2O profiles are varied (relative to the assumed profiles in the retrieval), in roughly the same manner that H2O biases were investigated.

p. 5360, l. 2. What is the aggregate uncertainty from all of the sources of retrieval uncertainty?

p. 5360, Section 4. I suggest major revisions to Section 4. The data presented in Figs. 8 and 9 are unconvincing because there is simply no apparent spatial pattern except perhaps a tendency towards high PAN concentrations at high latitudes (and whether or not this pattern reflects actual PAN concentrations is not at all clear). It is also problematic that for the particular TES observations (pixels) where elevated PAN is observed, there is apparently no spatial consistency, i.e. adjacent TES pixels show sharply different PAN concentrations. It would be much more convincing to present a case study based on a single TES overpass of a known biomass burning plume, such as the plume mentioned in Fig. 5. If the PAN retrieval algorithm has actual skill, one would expect that observations over a plume should at least demonstrate a reasonable pattern of low PAN levels outside the plume and high concentrations within the plume. Such a case study would not require in-situ measurements and should be feasible with data that were already processed.

Technical Corrections

p. 5348, l. 11. 'Pacific' without 'Ocean' sounds colloquial

p. 5350, l. 13. 'the the'

p. 5354, l. 17. 'a prior' should be 'a priori'

p. 5356, l. 5. sentence including ' ... were used here for truth here ...' is awkward

p. 5356, l. 25, p. 5359 l. 1, and p. 5360, l. 1 - misspelled 'uncertainty'

AMTD

7, C1666–C1670, 2014

p. 5357, l. 19. misspelled 'evaluate'

p. 5358, l. 14. misspelled 'stability'

p. 5359, l. 6. capitalize 'rms' for consistency

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 5347, 2014.