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Atmospheric Measurement Techniques Discussions

Interactive comment on “On the efficient treatment of temperature profiles for the estimation of atmospheric transmittance under scattering conditions” *by* R. Lindstrot and R. Preusker

Anonymous Referee #1

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Overall Recommendation

The computational demands of radiative transfer calculations are still a limiting factor for many remote sensing application. The authors propose an interesting and inventive method to address this important topic. It is based on dimensionality reduction of temperature profiles via PCA and the assumption that a sufficient similarity exists between transmittance and temperature. This allows to account for realistic temperature profiles in a fast look-up table approach without performing computational expensive (on-line) radiative transfer calculations.

The paper is well written and has an overall clear structure and figures. The topic fits well to the aims and scopes of AMT and I would recommend that the paper is published after addressing the following comments.

General Comments

Introduction: I'm missing a brief overview about existing literature within the introduction. One can find other publications using PCA as short-cut for computational expensive RT calculations (e.g. Natraj et al., 2009, JQSRT, “On the use of principal component analysis to speed up radiative transfer calculations”). Are there important commonalities and how distinguishes the proposed method from existing approaches?
General: The authors highlight that the proposed method “can be applied to any problem including gaseous absorption or emission”. Within the paper, the authors show that the method works extremely well for the O2-A band and instruments with moderate spectral resolution such as MERIS. However, it remains a bit unclear to me if the method will still works for non well-mixed gases such as water vapor or ozone, scattering which significantly “shields” parts of the atmosphere, and for instruments with high spectral resolution which can resolve individual lines with potentially distinctive non-linear temperature/absorption relations. In all such cases, the similarity between temperature and transmission becomes questionable. Please discuss in which cases the assumptions made are violated and the method may fail or discuss why you expect no problems even in cases as those mentioned above.
Sec.2: What do you mean exactly with similarity? Transmittance is a scalar while temperature is a profile. Do you potentially mean $\approx$ linearity between absorption coefficient (profile) and temperature profile? What assumptions have to be made so that Eq.3 gives the “true” transmittance rather than an approximation?

Technical Comments

P4474L23 “Especially if both...”: This statement is too general. Several groups analyze global full time series datasets of SCIAMACHY and GOSAT NIR spectra by fitting RT simulations (including absorption and scattering) see e.g. O’Dell et al., 2012; Reuter et al., 2010; Butz et al., 2009.

P4474L24: molecules or aerosols → molecules, aerosols, and/or clouds

P4475L5: Schneising et al. 2011 (ACP) could be cited as an example for a LUT-approach with higher spectral resolution

P4476L14: Is one day representative for all temperature profiles? The northern hemisphere has much more land masses than the southern hemisphere. Temperature profiles differ from land to sea. Therefore, I would expect that at least 3 days (northern summer, winter, spring/fall) are needed to cover the majority of temperature profiles.

P4476L24: A regular lon/lat grid is not an equal area grid. Therefore, the performed PCA overweights temperature profiles toward the poles. How large are the expected differences of the eigenvectors when changing to, e.g., an equal area grid?

P4477L5: ’#’ is not a common sign for matrix multiplication. A matrix multiplication of $(T - T_m)$ with ν_i is not possible. Use either the matrix multiplication $(T - T_m)^T \cdot \nu_i$ or the dot product of the vectors $(T - T_m)$ and ν_i.

Sec.2.2, Sec.1: The temperature influences not only the line width but also the line intensity by $\exp\left(-\frac{h\,c\,E_0}{k}\left(\frac{1}{T}-\frac{1}{T_0}\right)\right)$. Some lines have large lower state energies $(E_0 > 1000cm^{-1})$ so that this effect becomes important for the calculation of absorption coefficients. Do you expect that the proposed method will produce reliable results also for such lines?

P4480L9: Please give (approximate) numbers for the other error sources.

P4480L9: How accurate are GFS temperature profiles and what is the accordingly expected transmittance error? You could use this as benchmark to determine the maximum number of potentially useful eigenvectors.

Figure8: Please use a color scaling which makes the SZA/VZA dependencies visible.
P4481L21: Please give some numbers what you mean with "no significant". What are the implications for the retrieved surface pressure error (I assume $\approx$5hPa)?
P4482L15 The method will probably fail for pathologic artificial temperature profiles. arbitrary → realistic.
Sec. 3.2: Please clarify that/if L$_{mean}$ depends on AOD (i.e. L$_{mean}$ is different in case a and b).

Interactive comment on Atmos. Meas. Tech. Discuss., 5, 4473, 2012.

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Interactive Discussion

Discussion Paper