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Atmospheric Measurement Techniques Discussions

Interactive comment on "Assessing snow extent data sets over North America to inform trace gas retrievals from solar backscatter" *by* Matthew J. Cooper et al.

Anonymous Referee #2

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Review of "Assessing snow extent data sets over North America to inform trace gas retrievals from solar backscatter" by M.J. Cooper et al.

In the paper, different snow cover data sets are evaluated to identify which is most suitable for TEMPO trace gas algorithms. Additionally, the authors examine the NO2 AMF sensitivity to surface reflectance using radiative transfer (RT) simulations. The paper contains significant original material that can be of interest for the developers of trace gas algorithms for satellite sensors. The paper subject is appropriate to AMT. The abstract provides a sufficiently complete summary of the paper. The manuscript is well organized. The paper can be recommended for publication after the authors address

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Discussion paper

the following comments.

General comments

1. The assessment of different snow cover data sets is carried out for the entire year of 2015. This approach of using the full year data may cause biases in the metrics. The authors admit “All data sets have high accuracy numbers, owing to a high number of true negatives during the summer months” (Line 220). I think that the assessment of the snow cover data sets should be done on a seasonal basis and the metrics for different seasons should be compared. It would be particularly interesting to assess the snow data sets for spring when melting snow occurs.

2. In my opinion, results of the RT simulations shown in Fig. 2 and 3 do not provide new significant information. Effects of surface reflectance on trace gas retrievals have been studied theoretically (see O’Bryne et al., JGR, 2010; Lin et al., ACP, 2015; Vasilkov et al., 2017 and references there). Figure 2 of the manuscript (showing the scattering weights for a single solar zenith angle and a single NO2 profile) is not conclusive because the NO2 sensitivity to surface reflectance substantially depends on tropospheric NO2 profiles (see Fig. 13 in Vasilkov et al., AMT, 2017). Figure 3 compares AMFs for snow-covered and snow-free conditions for January 2013. The snow-free conditions are absolutely unrealistic for January. That is why I doubt that useful information can be derived from this comparison. I think that the text and figures related to the RT simulations can be removed without the loss of significant material. To some extent, this is supported by the title of the manuscript because the RT simulations are not mentioned in the title.

Specific comments

Line 24. The quantity “F” is not defined here.

Line 52. It is worthwhile to mention that uncertainties in surface reflectance also lead to uncertainties in the cloud fraction and pressure retrievals which affect the NO2 re-

trievals (Vasilkov et al., AMT, 2017).

Line 162. Indeed, snow reflectivity is almost spectrally independent in UV/Vis. However, the maps in Fig. 1 include snow-free regions. For such regions, ground reflectivity does depend on wavelength, so reflectivity at 354 nm may not be used for 440 nm.

Line 174. Please clarify “the most reliable source is used”.

Line 185. Please explain why the F score is most relevant for TEMPO.

Line 190. Where does the OMI cloud fraction come from? How is the cloud fraction determined for snow-covered and partially snow-covered scenes?

Line 235. Is it correct that the MODIS products perform better at coarser resolution? Table 1 shows F=0.46 and 0.54 for the 4 km resolution while Table 2A shows F=0.45 and 0.53 for the 25 km resolution.

Reference to McLinden et al., ACP, 2014 is missing.

Figure 1. The capture states “reflectivity at visible wavelengths”. The 354 nm wavelength (used for the upper panel) is not a visible wavelength. The lower panel is not informative because the color scale is not appropriate for it.

Figure 2. The corresponding NO2 profiles should be shown. Surface reflectivities should be specified. What is the viewing zenith angle of observations?

Appendix. Please explain why some numbers for the CMC and NISE data sets are slightly different in Tables A1 and A2. The special resolution of the data sets is same for both tables.

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