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Atmospheric Measurement Techniques Discussions

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Interactive comment on "Radiometric calibration of a non-imaging airborne spectrometer to measure the Greenland Ice Sheet surface" *by* Christopher J. Crawford et al.

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The authors thank Anonymous Referee #3 for comments provided on this AMTD paper. We are confident that we have addressed the concerns raised by Referee #3 in our response below. We have revised the original manuscript to reflect Referee #3's recommendations. As a result, we feel that the paper is much improved based on further clarification and more description of the scientific and technical approach as well as better print production on figure illustrations and connection to the text.

We would like to clarify that the goal of the airborne VSWIR spectrometer suite was to support NASA's ICESat-2 project in their efforts to evaluate possible green laser pulse

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penetration biases into snow and ice; not to validate a lidar prototype (i.e., SIMPL). VSWIR measurements resulting from this airborne mission will help to characterize snow, ice, and liquid water surface optical properties during airborne science flights while also supporting ICESat-2 calibration/validation objectives. This paper is comprehensive in establishing the scientific basis for VSWIR measurements of snow, ice, and liquid water surfaces and their acquisition, and documents both the airborne spectrometer's traceable radiometric calibration and its airborne measurement performance in the Arctic atmosphere using MODTRAN and Landsat 8 OLI references.

We did use Version 3 AERONET data for our MODTRAN predictions of nadir viewing spectrometer and Landsat 8 OLI radiances. We agree that the AERONET component of this paper needed clarification and more description. We have included those revisions in the author changes to the original AMTD manuscript. The authors did use Level 2.0 CIMEL retrievals as inputs to MODTRAN. We mistakenly inserted Level 1.0 CIMEL plots in Figure 12. After further review, we have decided to remove this figure from the paper entirely as there is not much valued added.

The authors prefer to avoid the 'novel' term to describe this research and its contribution to Polar and atmosphere remote sensing science. Atmospheric Measurement Techniques publishes a wide variety of scientific papers on topics surrounding remote sensing and its applications, instrument calibration/validation in both laboratory and field environments, and measurement-model comparisons that incorporate atmospheric measurements of all kinds. Because of the complexities of measuring the Greenland Ice Sheet surface with VSWIR remote sensing in the Arctic atmosphere, particularly airborne, we did rely on well-known and well-vetted laboratory and vicarious calibration/validation methods to quantify uncertainties and measurement sensitivities to atmospheric conditions during flight across a dark-to-bright dynamic range. We have added text to the manuscript that clearly articulates the significance of this paper's contributions in the context of atmospheric measurement techniques. This paper's contributions are best described by the following points:

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(1) Airborne VSWIR measurements with this level of traceability and radiometric calibration are sparse in Arctic regions prior to this mission.

(2) Application of MODTRAN radiative transfer to airborne VSWIR remote sensing of the Greenland Ice Sheet within the Arctic atmosphere breaks new ground for demonstrating its atmospheric modeling capability and performance.

(3) Prior to this study, Landsat 8 OLI's measurement performance over the Greenland Ice Surface had remained largely unknown. While this is only one case study, it establishes a reference baseline for quantifying Landsat 8 OLI's measurement uncertainty when compared to coincident airborne observations and MODTRAN predictions of upwelling radiance that include aerosols, gaseous absorption, and columnar water vapor effects.

(4) The paper draws attention to the importance of instrument radiometric calibration when acquiring airborne VSWIR measurements over snow and ice surfaces in Polar atmospheric conditions. It also helps to establish VSWIR measurement uncertainties using a measurement-model comparison approach with the goal of identifying downstream implications for Polar ice sheet remote sensing of VSWIR surface conditions and properties.

Anonymous Referee #3: Why no lidar information is used for the constraining the atmospheric radiance simulation? It is my understanding that ICESat-2 is not an atmospheric profilers so I assume the lidar airborne version used in this campaign does not have this capability either. I think it would be desirable to clarify why the lidar onboard is not suitable to aerosol applications.

Author Response: This paper does not include analysis of photo counting lidar information from SIMPL. Retrieval of aerosol information from ICESat-2 like or SIMPL measurements is not part of this paper and was not considered as an input to our MODTRAN radiative transfer method for evaluating the nadir viewing VSWIR spectrometer's measurement performance. We acknowledge that aerosol information maybe be help-

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ful to the work at hand; however, doing so would reflect a departure from standard vicarious techniques for optical instruments, and thus, we chose not to pursue this effort at the current time.

Anonymous Referee #3: Through the text all references to figures should specifically to what panel the text refers to. Most of the figures have multiple sub-figures and they are not labeled. Please do so.

Author Response: This has been corrected.

Anonymous Referee #3: Figure 1 does not seem to add information, consider removing it.

Author Response: We removed the Figure 1 from the text.

Anonymous Referee #3: Figures 2 and 3 : not clear figures. Upper right panels all lines look the same have similar colors. Upper left panel: not clear what it is being compared. Please clarify in caption and main text. Bottom panel: not clear the plot means, what do you mean with stability in this case?

Author Response: Referee #2 raised concerns with Figures 2 and 3. We revised these figures for clarity of information and interpretation. These changes have been included in the author changes to the original AMTD manuscript. Stability in this case refers to the nadir viewing spectrometer's repeatable radiometric performance when measuring a stable radiance output from a laboratory NIST traceable source as we show.

Anonymous Referee #3: Figure 9: all 4 figures did not print well. Particularly the right two panels are just not informative because the lack of contrast even when figure is seen in a computer screen. I think the right two panels can be removed.

Author Response: We prefer to keep Figure 9 as constructed. It importantly shows bright and dark target flight segments that we evaluated using our radiative transfer comparisons with MODTRAN and Landsat 8 OLI on 29 July 2015. We attempted to improve the contrast of Figure 9 in the author changes to the original AMTD manuscript.

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Anonymous Referee #3: Figure 11: for consistency with other figures, plot wavelengths in the x-axis.

Author Response: Agreed. We made this change.

Anonymous Referee #3: Figure 12: Aeronet figures from Aeronet website are not publication quality material Please plot the data with adequate plotting software.

Author Response: We originally thought the AERONET plots would be important to show as we did much screening for cloud contamination and evaluation of particulate size distribution. We think the AERONET Version 3 data is better described in the text and have removed Figure 12 from the text.

Anonymous Referee #3: Figure 15: upper right figure has very poor contrast and it does not provide additional information. Consider removing it. Bottom center images: lines are too thin and difficult to tell the different in them.

Author Response: We agree. We removed the upper right panel in Figure 15 and revised the bottom panels to reflect a higher quality print production.

Please also note the supplement to this comment:
https://www.atmos-meas-tech-discuss.net/amt-2018-170/amt-2018-170-AC2-supplement.pdf

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2018-170, 2018.

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