The Cryosphere Discuss.,
doi:10.5194/tc-2017-66-RC1, 2017

The Cryosphere Discussions

Interactive comment on "Impact of impurities and cryoconite on the optical properties of the Morteratsch glacier (Swiss Alps)" *by* Biagio Di Mauro et al.

Anonymous Referee #1

Received and published: 30 May 2017

The authors used field campaigns and satellite hyperspectral data to investigate the effects of impurities and cryoconite on spectral reflectance of snow and ice. They also conducted lab measurements of optical properties of ice and cryoconite samples, which is related to the impurity content in snow/ice. This study provides a good method to characterize the impact of impurities on snow/ice spectral reflectance by combining field, lab, and satellite measurements, which have an important implication for future study. Before this manuscript can be considered for publication, I have a few comments for the authors to address.

General comments:

1. In the methodology section, the authors provided a detailed description of labo-

ratory, field, and satellite measurement processes, which, however, lacks necessary discussions on the uncertainties associated with these measurements. I suggest that the authors add some discussions on this aspect.

2. The authors used the characteristic spectral reflectance of clean and dirty snow/ice to infer the effect of impurities in snow/ice. However, both external (e.g., impurity content) and internal (e.g., snow/ice grain properties) factors can affect the spectral reflectance. For example, Liou et al. (2014) showed that snow grain shape and impurity-snow mixing structures can significantly influence the effects of impurities on snow albedo. He et al. (2017) further found that snow grain packing also plays a critical role in affecting albedos of both clean and dirty snow. Therefore, such internal factors could potentially affect the interpretation of the spectral observations presented by the authors. It would be informative and useful if the authors could include these recent studies and add some discussions on this issue.

Reference:

He, C., Y. Takano, and K. N. Liou (2017), Close packing effects on clean and dirty snow albedo and associated climatic implications, Geophys. Res. Lett., 44, doi:10.1002/2017GL072916.

Liou, K. N., Y. Takano, C. He, P. Yang, L. R. Leung, Y. Gu, and W. L. Lee (2014): Stochastic parameterization for light absorption by internally mixed BC/dust in snow grains for application to climate models, J. Geophys. Res.-Atmos., 119, doi:10.1002/2014JD021665

Specific comments:

1. Page 3, Line 29: "The spectra were all obtained around midday under clear-sky conditions." Are there any specific reasons or advantages to obtain spectra in midday with clear sky?

2. Page 4, Line 4: "solid cryoconite was successively dried at 60°C for 4 hours". Would

this drying process remove some of the organics with relatively high volatility?

3. Page 5, Lines 8–12: What is the percentage of total data points used for SVM training and testing set, respectively?

4. Page 5, Line 30: The indices (narrow- and broad-band) were compared to the impurity concentrations. The indices derived from the Hyperion spectra have a spatial resolution of 30 meters, while the impurity concentration is from point measurement. This is not an apple-to-apple comparison, which may introduce uncertainty. Could the authors discuss this issue?

5. Page 6, Lines 28–29: "The only relevant discrepancy ... where ASD spectra remain almost flat." Are there any possible explanations for this discrepancy at short wavelengths?

6. Page 7, Section 3.2: The authors only presented the concentration of EC and OC in this section, which seems to lack of the descriptions on the linkage between EC/OC concentration and reduced reflectance. This may confuse the readers. It would be helpful if the authors could explicitly articulate the relationship between EC/OC content and albedo reduction, after the description of EC/OC concentrations in this section.

7. Page 2, Lines 5–10: for the authors' information, a recent study (Lee et al., 2016) combined satellite measurements and model simulations to show the reduced snow albedo caused by impurities over the southern Tibetan Plateau, which could be cited here as a useful reference source.

Reference:

Lee, W. L., K. N. Liou, C. He, S.-C. Liang, Z. Liu, Q. Yue (2016): Impact of absorbing aerosol deposition on snow albedo reduction over the southern Tibetan Plateau Based on Satellite Observations, Theor. Appl. Climatol., 1-10, 10.1007/s00704-016-1860-4.

Interactive comment on The Cryosphere Discuss., doi:10.5194/tc-2017-66, 2017.