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Interactive Comment

Interactive comment on "Comparison of UV climates at Summit, Greenland; Barrow, Alaska and South Pole, Antarctica" *by* G. Bernhard et al.

G. Bernhard et al.

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We thank Dr. Cede for the positive review of our manuscript and his constructive suggestions, which we address below.

———————————— Regarding the comment: "The authors claim that 'Additional monitoring sites at high latitudes, particularly in Russia, would be required. . .' (page 4964, lines 22-23). Maybe this part of the conclusion could be exploited a bit more and potential questions like the following ones could be addressed: The additional station Summit did not seem to add any significant new science to the network, other than adding another site, which is important too. Why should more stations be added? Instead (or in addition) to adding new stations: Should the network sites be complemented with other instrumentation, which allows an even better assessment of the polar climate? Instruments measuring aerosol properties or trace gases may add to a more complete picture of the situation and also allow fixing some of the parameters going into the RT model."

One important result of the paper was that measurements of irradiance at 345nm are almost identical at SUM and SPO when data were corrected for the difference in Earth-Sun distance. Since conditions observed at SUM and SPO can be regarded as representative for the Greenland ice cap and Antarctic plateau, we believe that results presented in the paper can be generalized to other locations on the polar plains. We therefore agree with Dr. Cede that adding additional station in the interior of Greenland and Antarctica will likely not lead to significant new science. The situation is different for coastal locations due to the larger variability and influence of albedo, aerosols (e.g. Arctic haze, localized air pollution, forest fires), and clouds. Since albedo is generally lower at the coast, the effect of clouds is more pronounced. Large parts of Siberia are influenced by the confluence of Atlantic and Pacific air masses and consequently experiences a wide range of conditions spanning from pristine to polluted (Uttal et al., 2007). This circumstance provides a natural laboratory for assessing the effects of different aerosols, pollutants, and clouds on solar UV radiation. New science can therefore be expected by measuring UV irradiance also in the Russian Arctic. Moreover, for documenting long-term changes of UV radiation expected from climate change on a more continental scale, additional monitoring sites would be helpful, even when the expected amount of new science is limited.

We also agree with Dr. Cede that complementing UV radiometers with instruments for measuring aerosol properties, trace gas concentrations and other parameters influencing UV is important for the interpretation of UV irradiance measurements. Such instruments exist at SPO and BAR: the NSF network site at BAR is in close proximity to a NOAA Earth System Research Laboratory Global Monitoring Division (NOAA/ESRL/GMD) monitoring site (http://www.esrl.noaa.gov/gmd/), which provides long-term records of atmospheric trace gases, aerosols, solar radiation. In addition, the U.S. Department of Energy's Atmospheric Radiation Measurement (ARM) program

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measures various aerosol and cloud parameters at BAR. We have used some of those observations in a previous publication (Bernhard et al., 2007) for quantifying the effect of aerosol optical depth and single scattering albedo on UV irradiance at BAR. NOAA/ESRL/GMD measures also intensive and extensive aerosol properties at SPO. It is desirable to have similar measurements at SUM, but unfortunately it is beyond the mission of the NSF UV network to perform such observations. We hope that other groups will establish suitable instrumentation in the future.

We will change the last paragraph of the manuscript as follows, and will also include the additional reference (Uttal et al., 2007).

"Additional monitoring sites at high latitudes, particularly in Russia, would be required for a more complete assessment of the Arctic UV climate and long-term changes on a continental scale. For example, large parts of Siberia are influenced by the confluence of Atlantic and Pacific air masses and consequently experiences a wide range of conditions spanning from pristine to polluted (Uttal et al., 2007). This circumstance provides a natural laboratory for assessing the effects of different aerosols, pollutants, and clouds on solar UV radiation. New knowledge can therefore be expected by measuring UV irradiance also in the Russian Arctic. We anticipate that continuance of measurements at SUM will prove helpful in assessing future changes of the Arctic UV levels, in particular with respect to changes in stratospheric temperatures, ozone (column and profile), aerosols, and atmospheric circulation patterns. To meet this goal, it would be desirable if instruments for measuring aerosol properties, trace gas concentrations, and the radiation budget are established at SUM or any additional network sites that may be set up in the future."

———————————— Regarding the comment: This is just an idea: "A very important aspect of global irradiance measurements in the Arctic is the study of the influence of the surface albedo on the radiation budget (not just in the UV), especially considering potential future changes in the Arctic's surface albedo. Figure 4c is a very interesting comparison between all-sky data from Barrow, Alaska, and Summit, Greenland. If the

RT model was used to match the measured ground irradiances by adjusting the input parameters (mostly cloud optical depth), then the modeled backscattered irradiance could be compared with satellite reflectivity data (e.g. from OMI). I think that such an analysis might help to improve our knowledge of what might happen if the surface albedo in the Arctic changes."

Effective surface albedo is routinely calculated from spectral UV measurements for the UVSIMN sites at BAR, McMurdo Station, Palmer Station, and Ushuaia. These measurements have also been compared with satellite reflectivity data (Bernhard et al., 2005; 2006; 2007). Retrievals are only possible for clear cases. Effective surface albedo can in theory also be derived for cloudy scenes (Ricchiazzi et al., 1995). Unfortunately, the spectral signatures of snow reflectance and cloud attenuation are too similar in comparison with the measurement uncertainty of SUV spectroradiometers to decouple the two effects. Albedo from SPO and SUM is not calculated because the variability of albedo at the two sites is smaller than the uncertainty of the retrieval algorithm, which is about +/-0.1. Effective albedo and cloud optical are published at the NSF UVSIMN website at http://www.biospherical.com/nsf/Version2/. We encourage the satellite community to use these measurements for validating reflectivity data from OMI and similar platforms.

We will change lines 22-23 of the first paragraph of Section 3 (Data analysis) as follows:

"All data are available via the web site" www.biospherical.com/NSF/Version2. Data products include full-resolution UV spectra, total ozone, effective albedo and cloud optical depth."

———————————— Regarding the comments: Technical corrections: Title: shouldn't there be a semicolon after Alaska? Figure 1: what does "Volume 14", "Volume 15" etc. mean?

A semicolon will be added to the title.

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The following sentence will be added to the caption of Figure 1: "Data of the NSF UVSIMN are organized in volumes. The volume of each period is indicated in the header of the plots."

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