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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Solar irradiance in the heterogeneous albedo environment of the Arctic coast: measurements and a 3-D-model study" *by* A. Kreuter et al.

Anonymous Referee #2

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The manuscript presents a novel study of clear sky spectral measurements along an albedo gradient in the Arctic and advanced 3D simulations of measurements for different model scenarios. The comparison of spectral observations in the UV and visible part of the sun spectrum reveals a gradient in the effective albedos, with a hysteresis that is depending on the solar zenith and azimuthal angles and the location. Model simulations based on the regional topography, and different scenarios for snow and ice cover, ancillary observations of aerosol optical depth, sky images, influence of tilt of the input optics of the instruments, etc. identifies the influence of these factors on the observations. The overall result is that the model scenarios for the different locations,

and observations of drifting ice and thin clouds for the western location, give plausible explanations for the observations.

The measurements and simulations represent a unique data set for advanced model studies in an arctic environment, with relevance to climate studies, photobiological effect studies, satellite validations etc. The study is well designed, with novel instrumentation and quality control of measurements, supplemented with a large set of ancillary data, and advanced modelling tools. The introduction places the study in a clear context, referring to other relevant studies. It also gives interesting background information on radiative effects, such as sky brightening utilized by seafarers, and introduces the reader to the challenges in measurements and simulations in a heterogeneous albedo environment. The results are well presented and structured.

Specific comments

In chapter 2 (page 4, line 16-18) the three diodearray systems are referred to the publication Kreuter and Blumthaler 2009. This reference is about a straylight correction technique for one of the diode array instruments, whereas I would have expected details for all three instruments. Is there any other relevant publication, or supplementary information on the three systems?

The 3 instruments had the same type of cosine heads, however, how was the possible differences in azimuthal responses, and were the front optic s aligned in a certain direction to minimize this effect? What is the reason that the azimuth error of the global input optic cannot be corrected, when the heads already had their cosine response functions carefully measured? (ref. page 5, line 26-27).

The results and discussions focuses on the irradiance-ratios between the different locations as function of SZA, and the afternoon/ morning ratios for the same location. A hysteresis effect is demonstrated, that is larger than the model simulations, and attributed to the effect of a tilt of the cosine head of one station and thin clouds. However, could this also be attributed to the effect of BRDF of Sastrugis on the fjord ice? See

Figure 3 and East station in figure 9: The east station shows 3% lower irradiances in the afternoon than in the morning (AM-ratio figure 9, 500 nm), supported by the webcam photos in Fig. 3 showing lower brightness of the snow on the fjord ice when the sun is in the east than when the sun is in the west. This is an effect which could be further discussed and perhaps modelled, when considering that the Sastrugis are regularly shaped wave patterns on flat, open fields, like on the fjord ice, which may resemble a blazed grating in a diodearray instrument. One may think of BRDF as an analogue to the diffraction pattern of light, forming a non-symmetric radiance distribution, depending on the location of the sun.

Page 17, lines 22-27: From figure 9, west station, it is not apparent to me that the observed asymmetry (5% 340nm and 10% 500nm) is qualitatively reproduced in the 'standard' model scenario with half the magnitude. For the 'no ice' case and 340nm, yes, but only for the 'tilt' case for 500nm. Please, reconsider this statement.

Technical corrections:

Page 9 line 20, '. . . effective radius of. . .', add droplet or particle after 'effective'

Page 26, legend in Figure 4 and page 27 legend to Figure 6: "The left panels..", should be "The right panels.."

Page 29, legend Figure 9: " The tilt scenario applies to stations West", should be "..applies to station West" (station, not stations)

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 3499, 2014.