Atmos. Meas. Tech. Discuss., 8, C612–C617, 2015
www.atmos-meas-tech-discuss.net/8/C612/2015/

Atmospheric Measurement Techniques Discussions

Open Access

AMTD

8, C612–C617, 2015

Interactive Comment

Interactive comment on "Accounting for the effects of Sastrugi in the CERES Clear-Sky Antarctic shortwave ADMs" *by* J. Corbett and W. Su

J. Corbett and W. Su

joseph.g.corbett@nasa.gov

Received and published: 8 April 2015

We thank the reviewer for taking the time to review our paper and provide useful feedback. Our responses are provided below.

Accounting for the effects of Sastrugi in the CERES Clear-Sky Antarctic shortwave ADMs by J. Corbett and W. Su The manuscript describes 1) improved next-generation angular distribution models (ADM) developed for accounting for the effects of sastrugi and 2) testing them applied to the top-of- atmosphere (TOA) fluxes from CERES radiance measurements over clear Antarctic scenes. The presented results are certainly very interesting. I recommend publishing with minor revision; my comments are as follows.

1.About abstract: “In this paper we created a set of ADMs that account for the sastrugi...” An approach to constructing of the CERES ADMs was described in Su et al., 2014. In this paper the authors focused on details of the ADM development for a specific region of the world - Antarctica taking into account its specificity - the presence of sastrugi.âĂÍI think that this should be noted in the abstract

Author response: The abstract has been changed to better describe the contents of the paper.

2.The effects of sastrugi are wavelength dependent. According observation and simulation results in the solar SW spectrum snow has a much higher absorptance in the near infrared (NIR) wavelengths then in the visible wavelengths. Therefore, the most significant impact of the snow roughness manifests on the 0.86 μm reflectances from MISR cameras. As I understood, exactly these data were used for deriving statistical relationships between radiance from different viewing angles.âĂÍAt the same time, contribution of visible range in SW flux is large. The question arises: how exactly the obtained joint distributions of the standard scores of 0.86 μm reflectances from any two pairs of MISR cameras allow us to estimate the impact of sastrugi on the broadband fluxes (albedo)?âĂÍCould the authors comment this result in more details (may be on the basis of the simulation results?)âĂÍMaybe this is the reason that the decrease in albedo due sastrugi in the papers of Carroll and Fitch, 1981; Leroux and Fily, 1998; Zhuravleva and Kokhanovsky, 2011; Warren et al., 1998 is estimated to be a few per cent, and in this paper, the influence of sastrugi estimated at 10% (over areas close to the South Pole)?

Author response: It is important to note that we are using normalized deviations from the mean to determine the adjustments, not absolute values. This means that it’s the behavior of the NIR radiances, relative to the mean that matters, not their actual values. We used the 0.86 μm (NIR) band to create the adjustment factors as this band has the highest correlation with the broadband radiances (when matching the sza, vza and raz), for the majority of solar zenith angle ranges. These correlations for clear-sky Antarctic scenes are shown in Figure 1.

This result is due to the fact that although the VIS portions of the broadband contain more energy than the NIR portion, they are less sensitive to sastrugi. This means they are not capturing the changes in the broadband radiances from the NIR (and longer wavelengths) part of the spectrum where the energy is less but the sastrugi sensitivity is much higher. Based on the better correlation between the NIR and broadband radiances, compared to the blue, green or red bands, we would expect the NIR to better capture the changes in broadband flux due to sastrugi.

The change in albedo we see near the pole is not a real change but an artifact of the inversion procedure. As noted the change in albedo is $\sim$10% whereas the other studies report observed and modeled changes of $\sim$3%. This sinusoidal shape doesn't arise from using the NIR band of MISR as the albedo here were inverted using the KL05 ADMs, which were either a bright or dark ADM. It arises because the KL05 ADMs do not take into account sastrugi effects on the bi-directional distribution function. This results in a constant anisotropic factor that does not depend on the solar azimuth, which, when applied to reflectance that does depend on solar azimuth (as shown in Figure 6a, red line), creates the sinusoidal albedo. Using MISR to develop the adjustment factors largely removes this dependence.

3. Page 384: "We also do not have any solar zenith angle dependence in the adjustment factors. The standard-scores themselves are calculated in solar zenith angle bins, however we found that the joint-PDFs were largely insensitive to the solar zenith angle, so the decision was made to not include the solar zenith angle dependence in the adjustment factors." It is desirable to see the confirmation of this statement - for example, in a figure.

AMTD

8, C612–C617, 2015

Author response: Figure 2 shows 50th (solid) and 95th (dashed) percentile frequency contours for the Z-scores of the Cf and Df (a) cameras and Da and Df (b) cameras for a range of solar zenith angles. As can be seen the distributions are largely independent of the solar zenith angle. This plot will be added to the paper.

4. Page 378: "where $\theta 0$ is the solar zenith angle, θ is the CERES viewing zenith angle...". Correct index θ - for CERES viewing zenith angle.

Author response: This will be changed in the revised paper.

5. Page 385: "We first calculate the mean and standard deviation of the CERES clear-sky reflectances over Antarctica, using measurements from both the Terra and Aqua satellites." Sastrugi characteristics vary from month to month. It is taken into account when constructing the models?

Author response: No, we do not take the monthly changes into account. As we only have 5 years of RAPS data with which to construct ADMs we do not think there is enough sampling to further divide up the measurements based on the month. However, the adjustment factors are developed based upon MISR observations taken over a wide range of months, they therefore include a whole range of sastrugi characteristics. For an observation in a given month, we used standard score to help us select the appropriate ADMs.

6.Page 388. Formula (3).... where AËĘ is the estimated instantaneous albedo determined using Eq. (3) A(zi , z j) was used previously (page 384) to denote of adjustment factor. The use of similar symbol (A) can be confusing for readers

Author response: We have changed the adjustment factor symbol to be S(z_i,z_j) in order to avoid confusion.

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 375, 2015.

AMTD

8, C612–C617, 2015

Interactive Comment

sza	blue	green	red	NIR	count
50 – 60	0.687	0.788	0.917	0.952	40675
60 – 70	0.859	0.931	0.966	0.971	119394
70 – 80	0.931	0.968	0.979	0.981	105615
80 – 90	0.953	0.976	0.984	0.984	84521

Fig. 1. r2 values between MISR narrowbands and CERES SW instantaneous radiances over clear-sky Antarctica. Viewing zenith and relative azimuth matched to within 3 degrees.

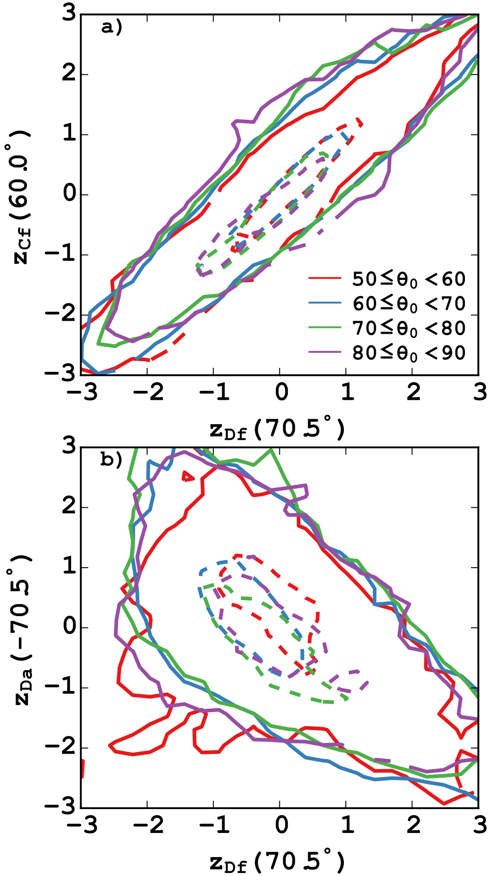

Fig. 2. 50th (solid line) and 95th (dashed line) percentile contours of solar zenith dependent joint PDFs of NIR standard scores between MISR's Df and Cf cameras (a) and between MISR's Df and Da cameras (b)