

## ***Interactive comment on “Airborne hyperspectral surface and cloud bi-directional reflectivity observations in the Arctic using a commercial, digital camera” by A. Ehrlich et al.***

### **Anonymous Referee #2**

Received and published: 31 October 2011

The paper describes measurements of bidirectional reflectance-distribution function with an airborne commercial digital single lens reflex camera. The camera's potential in BRDF is demonstrated with measurements over clouds, sea ice, and open water. These measurements are compared to collocated Spectral Modular Airborne Radiation measurement sysTem (SMART-Albedometer) measurements and model simulations. Results show some good agreements, but there are still some disagreements, which still need to explained. The study succeeds in promoting the use of relatively cheap and accurate alternatives for BRDF measurements, which is critical for remote sensing.

Before the paper can be considered for publication in ACP, the following concerns need

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be addressed:

1. This paper must be edited for grammar and clarity. There are so many grammatical mistakes and unclear statements in nearly every page as shown below in Technical comments.

2. In order for airborne BRDF measurements to have the intended meaning, it's important to do atmospheric correction. BRDF or BRF or HDRF are intrinsic properties of a surface, uncontaminated by atmospheric effects.

3. Radiometric calibration. Describe how calibration coefficients were obtained. Figure 3 demonstrates how the noise was removed, but not how calibration coefficients for each pixel was obtained. Why are the coefficients different for different pixels? Did the authors check linearity of the detectors – at low/high light levels?

4. Geometric correction. Describe how the camera images were corrected for the aircraft roll and pitch, and may be yaw.

5. Figures are too small and difficult to distinguish between the objects being displayed.

Technical comments: 1. Title: too confusing and has no meaning. What do the authors mean by the terms “hyperspectral surface” and “bi-directional reflectivity.”

Page 24592: 1. line 3: The “bi-directional reflectivity” – is not part of the nomenclature for reflectance. Refer to Nicodemus et al. - cited in the references, pg. 24616 – line.

2. line 6 – What does the acronym SMART stand for?

3. lines 6-7: specify the uncertainties of the instruments.

4. line 8 – enclose in brackets: (HDRF).

5. line 9: specify whether “albedo” is broadband or spectral.

6. line 11 – since the bow is over clouds, why not call it “cloud bow” instead of “fog bow”

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7. line 24 – change “reflectivity” to “reflectance”

8. line 25 – add “a” between “As” and “lower”

Page 24593 1. line 1: we don’t have “bi-directional reflectivity distribution function” in the nomenclature for reflectance. May be the authors are talking about “bidirectional reflectance-distribution function.” Refer to Nicodemus et al. or Schaepman-Strub et al –cited in the references, pg. 24616 – line 14 and 23, respectfully.

2. line 28 – delete “a radiance” and replace “inlet” with “system.” Change “a” to “an”

3. line 29 – end the sentence at “view” and begin a new sentence: “The mirror rotates at 100 r min<sup>-1</sup> . . .”

3. line 29 – the sentence “An entire scan of the lower hemisphere is obtained within 2–3 min” is not correct the way it’s written. Replace “scan” with “BRDF measurements”

Page 24594 1. line 6 – replace “area” with “angle”

2. line 7, 21, and 22 – The switch between “BRDF measurements” and “HDRF measurements” is confusing.

3. line 11 - insert "have" between "studies" and "used"

4. line 13 – replace “have been” with “were”

Page 24595 1. Line 2 – replace “employed” with “deployed” 2. line 4 – replace “have been” with “were”

Page 24596 1. Line 1 – add comma after “camera” and replace “and” with “which”

Page 24597 1. Line 13 – the statement “the dark current of the images was determined in the laboratory for different camera settings and environmental conditions and subtracted from the data” – define/specify the environmental conditions. Also, dark current of the images would be different in the field than in the laboratory. How was this taken into account during the processing of the field data?

Page 24598 1. line 7 – I have never heard of “full width of half mean” only “full width at half-maximum”. Check proper definition of FWHM.

2. line 9 – how was “center wavelength” determined.

3. line 23 – The tests where “a series of images was taken while the camera was moved horizontally and vertically” only confirms the camera alignment. But it’s more important to check the angular sensitivity of the camera. How sensitive is the camera to the light coming in at oblique angles? It’s also important to check sensitivity to distance between the camera and the integrating sphere. Measurements were done at two distances from the integrating sphere (5 cm and 15 cm); how were these two distances selected?

Page 24600 1. line 13 – shouldn’t this equation be given an equation number?

2. line 17 – remove hyphen in “bidirectional.” If the authors are following Nicodemus nomenclature for reflectance, then BRDF should be expanded as: bidirectional reflectance-distribution function.

3. line 20 – delete “or layer” – it has no meaning.

4. line 24 - remove hyphen in “bidirectional.”

Page 24601 1. line 1 – delete “sample”

2. line 4 – It’s not clear what’s meant by “With Eq. (4) this equals to”

3. line 6 – This statement needs to be explained or deleted from the text as it’s incorrect: “However, both BRDF and BRF can be measured directly only when an artificial radiation source is applied.” On page 24612, the authors seem to contradict themselves when they say, in line 21, “To obtain the more general surface BRDF, an atmospheric correction has to be applied, which is not done here but planned for future studies.” Where are they going to get the “artificial radiation source” in this case?

4. lines 12-14 –explain what’s done to Eq. (5) to get Eq. (6). A reader would like to

know this.

Page 24602 1. line 3 – Does the 16000 pixels of the camera represent the same view geometry as the SMARTAlbedometer? This needs to be explained.

2. line 8 – what does “exemplary time interval” mean?

3. line 11- what does “temporal course” mean?

4. line 15- the statement “This difference of 4% mainly resulting from the radiometric calibration ranges in the uncertainties of both instruments” is not clear. It seems to imply that the differences are explained only by the radiometric calibration differences. Is this the only reason?

5. line 18 – what does this mean: “spatial allocation?”

6. line 21 – replace “has been” with “was”

7. line 24 – replace “to” with “of”

8. line 26 – this sentence is not clear “As channel 2 shows the lowest deviation to the SMART-Albedometer data and has the lowest electronic noise, ...”

Page 24603 1. line 3 – the function Fglobal with the variables set to zero gives a sense that the measurements were made in a specific direction. Is that the meaning?

2. line 25 – check the spelling of Lambertian

Page 24604 1. Line 1 & 5 – replace “principle” with “principal”

2. line 12 – This sentence is not clear; rephrase: “The maximum ranging outside the camera angle of view (specular reflection for 61...”

3. line 14 – what is the difference between “hot spot” and “sun glint?” The whole sentence “the hot spot is caused by sun glint at the surface waves, ...” does not have clear meaning!

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Page 24605 1. line 6 – the differences between the glory and the fog bow are not clear. The authors need to elaborate.

2. line 13 and 25 – averaging seems to suppress fog bow, but enhances glory features. Why is this?

Page 24606 1. line 4 – replace “avoid” with “ensure.”

Page 24607 1. line 24 – The sentence: “Mainly the surface wind . . .” is too long (run on) and difficult to understand. Also, don’t begin sentences with “Mainly” or “Already . . .” – as was the case on line 4. These are adverbs and are used to modify verbs.

Page 24608 1. line 1-2 – The sentence “For the pigment concentration . . .” mentions default values for pigment concentration and salinity, but it is not clear whether these are the same as the (0.01mgm<sup>-3</sup>) and (0.1 ppt).

2. line 14 – what is “a sun glint hot spot”?

Page 24609 1. line 7 – Are the authors talking about peak reflectance decreasing with wind speed or area of the sunglint decreasing with wind speed?

2. line 10 – rewrite “the simulated 5ms<sup>-1</sup> and 15ms<sup>-1</sup> HDRF differ for these scattering angles” as “the simulated HDRF at 5ms<sup>-1</sup> and 15ms<sup>-1</sup> differ for these scattering angles”

3. line 11 - What’s the meaning of “wind speed ranges . . .”

Page 24610 1. line 10 – delete “to” and replace “be” with “been”

2. line 25 – what’s the meaning of the statement “values measured higher than calculated”

Page 24611 1. line 2 – what’s the meaning of “which is simulated significantly higher than observed ...”

2. line 4- You can’t start a sentence with “Especially . . .”

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3. line 24 – what’s the difference between “surface HDRF” and “cloud HDRF” as implied in the sentence.

Page 24612 1. line 4 – replace “to measure” with “of measuring”

2. line 11. The following statement is not clear “obtain a representative HDRF if the observed scene is inhomogeneous”

3. line 12 – replace “at” with “to be”

4. line 14- the following sentence is vague “With a sampling frequency of one image per 12 s, this corresponds to sampling times of 10 min and 2 min, respectively”

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Interactive comment on Atmos. Chem. Phys. Discuss., 11, 24591, 2011.

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