Review of Bright et al. (2014), for *Biogeosciences Discussions*

**Radiative forcing bias of surface albedo modifications linked to simulated forest cover changes at northern latitudes**

**General Comments**

This study evaluates changes in Nov-May surface albedo and radiative forcings from land cover change in Norway using six land surface models and a radiative transfer model.  The authors identify biases in modeled snow-covered and snow-free albedo for open and forested land cover types relative to MODIS albedo, with consistent positive bias of modeled open area albedo.  Overestimation of the change in albedo from to conversion of forest to open led to overestimation of radiative forcing from land use/land cover change relative to MODIS.  The authors suggest some model-specific improvements that could reduce modeled $\alpha_s$ biases and reduce RF bias relative to MODIS, a strong contribution to the field.

In general, there are a lot of references to the 61-page Supplement in the Discussion section.  With only two figures and one table in the main body of the manuscript, there is plenty of room to bring important Supplement findings into the main manuscript.

**Specific Comments**

(1) Three of the six models used in this study calculate direct-beam and diffuse albedo separately, yet only MODIS direct-beam (black sky) albedo is used as the observational benchmark.  It would be helpful to see some discussion on why this choice was made.  Why not use the full expression of MODIS blue-sky albedo from diffuse (white-sky) and direct-beam (black-sky) to compare all six models on equal ground?  It doesn't seem fair to compare MODIS direct-beam to models that do not provide direct-beam.

(2) In mid-winter, the solar zenith angle at local solar noon in this region would be quite high.  Noted that December values were omitted from the analysis, but isn't SZA greater than 70$^o$ at local solar noon for these sites during much of January and early February?  Previous versions of MCD43A are considered high quality up to SZA of 70$^o$, but beyond that the anisotropic model becomes unrealistic (Lucht et al., 2000, Schaaf et al., 2002, Stroeve et al., 2005 and Liu et al., 2009; Schaaf et al., 2011).  Is this guideline for appropriate use of MCD43A also true for V006?  It would be helpful to see some discussion on the accuracy of MCD43A V006 at high solar zenith angles.

(3) The land surface and radiative transfer modeling workflow needs more detail. From what I could gather, the six land surface models were run offline to calculate $\alpha_s$ of open and forested lands. Top-of-atmosphere radiative forcing was

calculated for each of the three study regions at $1^\circ \times 1^\circ$ horizontal resolution using the 3D four spectral band, eight stream radiation transfer model using observed MODIS and modeled forest $\alpha_s$, and open $\alpha_s$. Is this correct? I thought I would find more detail in the 61-page supplement but I couldn't find any information on how the radiative transfer model was used with the land surface models. This type of information deserves more space in the methods section of the manuscript.

The study regions shown in Figure S1 are much smaller than $1^\circ$ (maybe $0.2^\circ \times 0.4^\circ$ at best?). How was this difference in domain size and resolution of the radiative transfer model reconciled? Is the radiative transfer modeling performed as single $1^\circ \times 1^\circ$ column centered over each of the three domains in Figure S1? Or are the domains rounded to the nearest whole degree? Was the entire grid cell assigned forest $\alpha_s$ and open $\alpha_s$ or were you able to use subgrid parameterization of albedo? A map of the radiative transfer modeling domain for each study region would be helpful for understanding how much existing cropland exists in each grid cell (p. 17344, line 20-21).

(4) The TOA modeling has four spectral bands (undefined) but results are presented for two spectral bands, VIS and NIR. How was this addressed? Is the RF reported only for VIS and NIR? Or does the RF reported also include SWIR? If so, how might this affect the relationship between albedo and RF biases?

(5) In the discussion, I'd like to see a comment on how landscape heterogeneity and surface roughness within the MODIS footprint might also be contributing factors to lower than expected snow-covered albedo over open lands. While gridded at 500 m resolution, the actual observational footprint at high latitudes may include up to 1 km (Wang et al., 2012). Roads, buildings, clusters of trees, uneven snow surfaces and landscape features that cast shadows could all be contributing to lower than expected albedo over open lands in MODIS.

**Technical Corrections**

p. 17340, line 6-7
"Unexpectedly, however, biases of equal magnitude were evident in predictions at open area sites." I am not sure why the authors find this to be unexpected, and do not believe that the data presented in Figure 1e and 1f support the claim for "equal magnitude".

p. 17342, lines 10-19.
Resolution of MCD43A3 used in this study should be stated somewhere in this paragraph. I assumed 500 m.

p. 17342, line 12

Define "winter-spring". I assumed that winter included December through February and spring included March through May. Later in the manuscript winter is defined as January through March (p. 17345, line 18) and November is also included in the analysis. Be clearer in defining "winter" and "spring".

p. 17343, line 8
Change "12 open area sites…" to "Twelve open area sites…"

p. 17345, line 5
This is the first mention of using spectral bands. Please describe bands and wavelengths used for VIS and NIR in the MODIS data section.

p. 17346, line 4
Change "sits" to "sites"

p. 17347, line 18
The authors state, "For JSBACH, the result of having both positive and negative $\Delta\alpha_s$ biases…" could you point to a table or figure that supports this?

p. 17347, line 24
There is no Table 3 in the manuscript. Did the authors intend Table S3? If so, there are two Table S3's in the Supplement. Please correct.

p. 17349, line 6-7
Is there any empirical basis for lowering extinction coefficients from 0.3 and 0.4 for NIR and VIS, respectively, to 0.25 and 0.3 in this region? If so, please cite.

p. 17350, line 28-29
Change "high CC%" to "high canopy cover fraction (CC%)"

p. 17359, Figure 1
The caption references a,b,c…f however the figures lack such labels. Please include labels on the figures and reference Fig 1a, 1b, etc correctly in the main body of the manuscript. No need to state left column, right column if these are labeled correctly. Recommend equation be moved to the text.

p. 17360, Figure 2
The equations at the end of the caption ought to be in the body of the manuscript, not in the caption.

Supplement
Several tables span page breaks without the table headings repeating on the second page. Either keep the tables on a single page or repeat the headings on the second page.

Supplement, Figure S1

This figure and associated text ought to be in the methods section of the manuscript, not the Supplement

Supplement, Table S1
What is H80?

p. Supplement, Figures S17-S20
It appears that CLM4 is missing a large amount of data for the open sites relative to the other models.  Specifically, it looks like a lot of snow-free data is omitted. Why? And how might this have affected the results (assuming it is not a plotting error).

**References:**

Liu et al., 2009.  Validation of Moderate Resolution Imaging Spectroradiometer (MODIS) albedo retrieval algorithm: dependence of albedo on solar zenith angle. Journal of Geophysical Research – Atmospheres, 114 (2009), p. D01106.

Lucht, et al. 2000. An algorithm for the retrieval of albedo from space using semiempirical BRDF models.  IEEE Transactions on Geoscience and Remote Sensing, 38 (2000), pp. 977–998.

Schaaf, et al. 2002. First operational BRDF, albedo, nadir reflectance products from MODIS. Remote Sensing of Environment, 83 (2002), pp. 135–148.

Schaaf et al. 2011. Commentary on Wang and Zender – MODIS snow albedo bias at high solar zenith angles relative to theory and to in situ observations in Greenland. Remote Sensing of Environment, 115(5), pp. 1296-1300.

Stroeve et al., 2005. Accuracy assessment of the MODIS 16-day albedo product for snow: comparisons with Greenland in situ measurements
Remote Sensing of Environment, 94 (2005), pp. 46–60.

Wang et al., 2012. Evaluation of Moderate-resolution Imaging Spectroradiometer (MODIS) snow albedo product (MCD43A) over tundra. Remote Sensing of Environment, 117, pp. 264-280.