

Interactive comment on “The global land Cryosphere Radiative Effect during the MODIS era” by D. Singh et al.

D. Singh et al.

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We would like to thank the reviewer for spending their valuable time reviewing our paper, and providing us with invaluable comments. Here are our responses:

1) Referee Comment: I found the method description to be technically adequate, but I think this paper would benefit from an expanded discussion of relevance and temporal scale of cryospheric response time: while we might lose half the cooling effects of the cryosphere if Antarctica melts- how realistic is that and over what time scales? Even if this is considered outside the scope of this paper, I think it might be useful to relay what the most immediate concern would be and it's associated CrRE.

Our Response: It is true that the component of LCrRE originating from ice sheets

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and glaciers has a much longer inherent timescale of evolution than that of seasonal snow cover. We agree that it is important to communicate these different timescales, and hence have added statements about this to both the Introduction and Results. Changes in the extent of seasonal snow cover and sea-ice can drive large changes in CrRE on sub-decadal timescales, whereas the areal coverage of ice sheets and glaciers tend to evolve on much longer timescales.

2) Referee Comment: The mixed use of LCrRE and CrRE acronyms is confusing, I would suggest using one acronym.

Our Response: Except in the abstract and introduction, we have changed all the acronyms to LCrRE throughout the manuscript. Use of CrRE helps introduce the general concept. Also we did not change the generalized CrRE equation (Eq. 1), which is adapted from Flanner et al., 2011.

3) Referee Comment: 3926, Line 15: You give the timing and peak value for the Northern Hemisphere, but only mention the timing for the Southern Hemisphere- I suggest including both values or neither. Our Response: We included both values. It is -9 W/m^2 for the Southern Hemisphere.

4) Referee Comment: 3927, Line 4: Consider changing 'cryospheric changes', which is vague, to 'changes in cryospheric extent' or, if you also intend to relay albedo feedbacks 'changes in cryospheric extent and reflectivity'. 3927, Sentence ending on Line 5: It sounds as if you are saying here that solely cryospheric changes determine the sensitivity of the climate to anthropogenic and external forcings, while you clarify in the next sentence that it is the third most powerful positive feedback, I would suggest altering this sentence.

Our Response: We have changed “cryospheric changes” to “changes in cryospheric extent and reflectivity”, as suggested. To soften the second statement that is referred to, we changed “determine” to “partially determine”. The subsequent sentence then places the importance of albedo feedback in the broader context of all feedback mech-

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anisms.

5) Referee Comment: 3928, Satellite data description: It wasn't clear to me if the MODIS product used was binary (i.e. snow/no snow), and the snow presence parameter was fractional, or if both were fractional. If the MODIS product was not fractional snow coverage, do you think this spatial and temporal scale has any impact over the inclusion of snow in mountainous terrain, which exhibit high variability over relatively short temporal and small spatial scales? Is there reasoning behind using 16 days vs 8 days?

Our Response: The native MODIS snow presence data are binary, but when aggregated over space and time (into a 16-day product at 0.05 degree resolution) the average of this binary quantity becomes fractional. In our analysis, we assumed that any fraction higher than zero indicates the presence of some snow within the gridcell during the 16-day period. We then assumed that any elevation of albedo over the designated snow-free value was caused by snow. In theory, this approach should capture mountainous snow cover, to the extent that it is detected in the native 500m resolution daily MODIS measurements, but considerable variability in mountain snow cover exists on even smaller spatial scales, and cloud masking renders the effective temporal resolution of these data to be longer in practice. Our definition of LCrRE from mountain glaciers is: "permanent glaciated areas between latitudes of 60°S and 60°N". Since the masks used to define these pixels are not time-evolving, the binary snow presence flag does not impact the calculation of this component of the LCrRE. We used the 16 day products because the snow-free albedo dataset was only available at this resolution.

6) Referee Comment: 3929, Line 3: I would suggest instead of saying you 'apply' snow covered information from NISE, you state explicitly state that you fill missing data with snow covered information from NISE, since this is the title of the next section.

Our Response: That sentence starts with "To derive a spatially and temporally continuous LCrRE record", which we think provides enough indication about how the data

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were used. Also we have not yet started discussion about filling the pixels at this point in the text, so we did not want to jump ahead with technical details.

7) Referee Comment: Section 2.2 title: Consider 'Global Albedo Climatology'

Our Response: We adopted this change.

8) Referee Comment: Section 3.1: It would help for interpreting results to keep the reportage of them consistent- for example, on page 3933, line 5-6, you report a 0.15% contribution of non-glaciated regions in the southern hemisphere to global LCrRE and then a '3.7 time more' contribution of non-glaciated to glaciated regions in the northern Hemisphere what are these absolute values, or percentage of global LCrRE? And then in line 8 it is stated that LCrRE associated with permanent glacier cover in mountain regions is 'clearly visible'- is there a value associated with this?

Our Response: The discussion was presented in this way to offer different perspectives to the readers on the contributions from different regions. In response to this comment and comments from Reviewer #2, however, we have added two sub-tables (1b and 1c) in the manuscript (also attached as supplement here) to clearly indicate the contributions of the different regions to the global LCrRE. We thank the reviewers for this suggestion.

For mountain regions, the last paragraph in the same section separately provides all the associated numbers and discussion. We wanted to keep it as a separate point of discussion because it was not resolved well in the older study.

9) Referee Comment: Flanner et al., 2011 is not in the reference list

Our Response: Added to the list.

Please also note the supplement to this comment:

<http://www.the-cryosphere-discuss.net/9/C1897/2015/tcd-9-C1897-2015-supplement.pdf>

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