Earth Syst. Dynam. Discuss.,
https://doi.org/10.5194/esd-2017-91-RC1, 2018

Earth System Dynamics Discussions

Interactive comment on "Assessments of the north hemisphere snow cover response to 1.5 °C and 2.0 °C warming" *by* Aihui Wang et al.

Anonymous Referee #1

Received and published: 19 January 2018

This study purports to examine the response of Northern Hemisphere snow cover in the Community Earth System Model 1 (CESM1) under 1.5°C and 2.0°C of global mean warming above preindustrial levels. I am unable to recommend further publication of this manuscript as it provides a very cursory examination of the question under discussion and in my opinion, does not reach substantial conclusions that have not been reported elsewhere. The methods used appear reasonable, however the scientific aims and results are poorly communicated throughout the paper. I provide some more specific criticisms below.

The rational for providing Figures 1 and 2 is unclear. Presumably it is to evaluate the simulation of climatological snow cover and its variability for the CMIP5 ensemble and the CESM1 model in particular. These evaluations have been performed elsewhere

for CMIP5 for a variety of seasons (for example, Li et al. evaluate CMIP5 ensemble mean SCF during DJF (Figure 2b), Thackeray et al. evaluate seasonal evolution of SAE in CMIP5, Brutel-Vuilmet et al. evaluate March/April SCF climatologies in CMIP5, and Rupp et al. evaluate springtime SAE variability from the CMIP5 ensemble). These results suggest that snow cover biases change over the course of the season and that annual mean SCF may have lower bias due to compensating differences throughout the year. Regarding CESM, as you note, the bias computed in this paper is in contrast to previous offline evaluation of CESM's component land model, CLM. While it is possible, or even probable that biases in CESM1 precipitation and air temperature are responsible for the differences in SCF, I don't believe the Wang et al. study, which is referenced in the text, examines this bias for CESM's atmospheric model. It would be helpful to confirm any air temperature or precipitation biases in CESM1 compared to the corrected MERRA output used by the Toure et al. study to examine CLM. For Figure 2, the range of correlations between SAE anomalies in the NOAA-CDR and the CESM-LE or CMIP5 ensembles are expected since the specific climate trajectories of the historical ensembles are not constrained by observations. Presumably the positive values obtained for the ensemble mean correlations with the NOAA-CDR result from negative trends in the datasets. Also note that NOAA-CRD has been shown to have erroneous trends in SAE during the fall and potentially during the spring as well (Brown and Derksen, Hori et al., Mudryk et al.); it is unclear to what extent this will affect trends in annual-mean SAE.

Figure 3: These results appear consistent with results in IPCC Fifth Assessment Report (e.g. Figure 12.32 in Chapter 12 of the Working Group I contribution). I don't believe the projections of annual mean SAE from the CESM historical ensemble or low warming ensembles are sufficiently unusual to require an update of these results. In particular the historical ensembles appear consistent with the differences in NH LSAT (colder and more snow cover in CESM-LE than CMIP5) and the projections of SAE for each of the four scenarios reflect the various levels of warming.

Figure 4: The increase in standard deviation of SAE anomalies reflects the spread in CMIP5 model SAE sensitivity (different models lose snow at different rates during the 20th and 21st centuries, probably mostly due to the spread in warming rates over the 21st century, although this latter point is not examined by the authors). For the single model ensembles (CESM-LE hist, 1.5deg and 2.0deg) this spread is not being sampled.

Figure 5 and 6: These are the first figures which deal with the topic of the paper as discussed in the abstract and introduction. It's unclear why CMIP5 models were examined in the preceding portion of the paper given that they are not used here (although I grant there are potential difficulties in comparing model output at a given warming level taken from transient RCP scenarios and partially equilibrated simulations such as the CESM low warming simulations). While the results presented in Figures 5 and 6 appear reasonable, I don't believe they are analyzed sufficiently or novel enough to form the basis of this paper.

"The spatial pattern of SNR for both SCF and LSAT are broadly consistent with each other over snow regions, but their magnitude for SCF is much smaller than that for LSAT." It's not clear to me which aspects of the SNR patterns are consistent between that of SCF and that of LSAT.

Figure 7: Figure 7b is not providing any additional information from 7a. To the level of detail presented, the results do not appear depend to depend on the forcing scenario. No interpretation is provided or discussed regarding the seasonal dependence.

Brown, R., and Derksen, C.: Is Eurasian October snow cover extent increasing? Environmental Research Letters, 8, 024006, doi:10.1088/1748-9326/8/2/024006, 2013.

Brutel-Vuilmet, C., Ménégoz, M., and Krinner, G.: An analysis of present and future seasonal Northern Hemisphere land snow cover simulated by CMIP5 coupled climate models, The Cryosphere, 7, 67-80, https://doi.org/10.5194/tc-7-67-2013, 2013.

Hori, M., Sugiura, K., Kobayashi, K., Aoki, T., Tanikawa, T., Kuchiki, K., Niwano, M., and Enomoto, H.: A 38-year (1978–2015) Northern Hemisphere daily snow cover extent product derived using consistent objective criteria from satellite-borne optical sensors. Remote Sens. Environ., 191, 402–418, Doi:10.1016/j.rse.2017.01.023, 2017.

Li, Y., T. Wang, Z. Zeng, S. Peng, X. Lian, and S. Piao (2016), Evaluating biases in simulated land surface albedo from CMIP5 global climate models, J. Geophys. Res. Atmos., 121, 6178–6190, doi:10.1002/2016JD024774.

Mudryk, L. R., P. J. Kushner, C. Derksen, and C. Thackeray (2017), Snow cover response to temperature in observational and climate model ensembles, Geophys. Res. Lett., 44, 919–926, doi:10.1002/2016GL071789.

Rupp, D.E., P.W. Mote, N.L. Bindoff, P.A. Stott, and D.A. Robinson, 2013: Detection and Attribution of Observed Changes in Northern Hemisphere Spring Snow Cover. J. Climate, 26, 6904–6914, https://doi.org/10.1175/JCLI-D-12-00563.1

Thackeray, C. W., C. G. Fletcher, and C. Derksen (2015), Quantifying the skill of CMIP5 models in simulating seasonal albedo and snow cover evolution. J. Geophys. Res. Atmos., 120, 5831–5849. doi: 10.1002/2015JD023325.

Interactive comment on Earth Syst. Dynam. Discuss., https://doi.org/10.5194/esd-2017-91, 2017.