In this paper, the authors employ daily Moderate Resolution Spectroradiometer (MODIS) fractional snow cover extent (SCE) data to improve streamflow simulations in several Alaskan sub-watersheds of the Tanana River. The study period covers 2000-2010 with simulations with the SAC-SMA conceptual rainfall-runoff model that also incorporates the one-layer SNOW17 model for the representation of snowpack conditions. Runoff simulations that include MODIS-derived snow areal depletion curves (ADCs) in SNOW17 are compared with baseline simulations with the standard model formulation for ADCs in the five sub-basins of the Tanana River. The authors conclude that the assimilation of the MODIS SCE data leads to better representation of snow conditions and runoff simulations in Interior Alaska.

This paper presents interesting results on the potential application of MODIS SCE data in operational models for improved runoff simulations in Interior Alaskan watersheds where in situ data remain sparse. The paper is generally well-written and illustrated, but the paper requires some revisions prior to publication.

Thank you for your positive words and your detailed review. We feel that your suggestions, along with other reviewers, have vastly improved the paper.

The following provides a list of suggestions that may be helpful to the authors in revising their paper:

General Comments:

1) The paper includes non-metric units including feet for elevations and inches for snow water equivalent (SWE). Please convert all non-metric units to metric and adjust Equation (1) accordingly. We added units to the elevation map (m). We have changed the inches to mm as referred to in the text and shown in Figure 6.
2) A considerable amount of effort has been placed into ingesting the MODIS SCE data into SAC-SMA model simulations of runoff in five sub-watersheds of the Tanana River. The authors should be commended for this effort. Nonetheless, the results shown in Figure 9 show little differences between the simulations that incorporate the MODIS data versus those with the standard model formulation. Table 4 confirms there are only very modest gains to be made by ingesting the MODIS data into the runoff simulations. As stated by the authors, more significant gains would be obtained by having more accurate forcing data (air temperature and precipitation) in the remote and complex terrain of these Alaskan watersheds. Further to this, SNOW17 incorporates only one snow layer which may miss some of the snow dynamics at play within the thin snowpack layer than interacts with the atmosphere. As such, why spend so much effort in trying to improve the runoff simulations with the data assimilation strategy when more significant gains may be obtained by improving other aspects of the modeling framework? This is an interesting comment, and it highlights a point regarding the work that isn't necessarily raised in the paper. We went to considerable effort to ingest MODIS data into the modeling framework that is being used operationally in Alaska by the Alaska Pacific River Forecast Center (APRFC). We wanted very much to work closely with the APRFC on the effort, so that our work could feedback to their operational workflow. There was a lot of interest within the APRFC in ingesting remote sensing tools, and this study pointed out that there are some gains to be made, but other efforts (e.g. improved climate station data, and model ensembles, including physical models) should be pursued as well. And, it also points to the need for a more flexible calibration scheme that considers all available ground based and remotely sensed observations, including SWE, fSCA, in addition to streamflow observations. Considering that we have received support to implement the operational stages of this work, and also test a

physically based model in the state, we feel that this effort was an important step and was valued by the stakeholders involved in the project.

3) Why does the study period cover only 2000-2010 when MODIS data are available up to present? Further to this, how are gaps in the MODIS data in-filled? For instance, persistent cloud cover can lead to a significant reduction in the available snowcover data from optical remote sensing. Is any gap-filling procedure used to address this issue (see for example Hall et al., 2010 and Tong et al., 2009). The study period reflects the time when the work was undertaken. Although there is more recent information, we feel that the 2000-2010 time period is sufficient to illustrate our points, and we do not think the message of the paper would change by adding more data to the study. Regarding the infilling of gaps, we have now added more details regarding how we pre-processed the MODIS data outside of CHPS, and within CHPS, in section 2.2 of the paper.

4) Hydrological simulations such as those presented in Figure 9 are averaged over 10 water years. Results for each individual year should also be presented to illustrate the model's ability to represent interannual variability in the discharge patterns. We have generated the figures for each year, and we have included these in the Supplemental. We refer to them in the text ~page 15.

5) The references need to be fully revised and presented in the journal's standard format. We have revised the references as suggested.

6) Note that Déry et al. (2005) used MODIS ADCs to improve their simulations of runoff on the Alaskan North Slope and may be a relevant reference to this study. We have included a reference to Dery et al. (2005) in the paper. This was an oversight on our part, thank you for pointing this out.

Specific Comments:

1) P. 2, Abstract: Include the study period within the abstract. We have included the study period in the abstract.

2) P. 2, lines 5 and 25: Define "US". We now define US in the Abstract and Introduction.

3) P. 2, lines 29/30: Have both snow cover extent and duration in Alaska indeed declined by 18% from 1966 to 2012? We have corrected this line per Reviewer #2 comments to read "Snowpack extents in Alaska have decreased over time by 18% (1966-2012) due to an earlier snow melt, while snowpack duration has also decreased (SWIPA, 2012)."

4) P. 2, line 31: What aspect of permafrost has declined in response to warmer air temperatures in Alaska? Its depth, extent, or other characteristic? We have added thaw to this sentence.

5) P. 2, line 34: Change to "North American". We have made this change. Thank you for pointing this out.

6) P. 3, line 3: "Extremes" should be singular. We have made this change.

7) P. 3, line 16: Delete the extra "model output". We have deleted these words.

8) P. 3, line 20: Define "NOAA". We have added the definition.

9) P. 3, line 30: Change to "these data have". We have changed this to these and has to have.

10) P. 5, line 15: Why does the study period end in 2010 although MODIS data are available up to present? See answer to this question above in general comments.

11) P. 5, line 27: Define "SWE" upon first usage rather than in the following line. We have added the definition. Thank you for pointing this out.

12) P. 5, line 35: Perhaps number the equations, depending on the journal's formatting guidelines. Convert the equation to metric units and ensure the elevation *e* is in meters, not feet.

We have added numbers for the equations. See response to Reviewer #2 comments regarding this equation.
13) P. 6, line 3: Define “SAC-SMA”. SAC-SMA is defined on page 4 of the revised manuscript, in the Introduction.
14) P. 6, line 17: Should the air temperature lapse rate be 0.6°C/100 m? Insert a space in “100 m”. This was an error, we have now corrected it to read 6ºC/1000 m.
15) P. 6, line 23: The journal may prefer dates in a format such as “21 December”. We have changed all dates to adhere to the suggested format.
16) P. 6, line 29: Insert a space in “100 m”. We have made the correction here and elsewhere in the paper.
17) P. 6, line 31: What atmospheric temperature is used to compute incoming longwave radiation with the Stefan-Boltzmann Law?
This part of the text describes the calculation for rain-on-snow in SNOW17. From Anderson (2006, pg A-5, A-6) “T is the air temperature at ground level. Such a relationship typically assumes that the temperature of the cloud base is the same as the surface air temperature during overcast conditions and that there is fairly constant relationship between surface and upper air temperatures when the sky is clear.”
18) P. 6, line 32: Why assume a constant relative humidity (RH) at 90%? Is this relative to a water (and not an ice) surface even when air temperatures are subfreezing? How does RH enter the calculation of the simplified energy balance, through the latent heat flux?
This part of the text describes the calculation for rain-on-snow in SNOW17. “When it is raining, relative humidity can be assumed to be high. With a 90% relative humidity the wet bulb temperature, the assumed temperature of the rain drops, is essentially equal to the air temperature. By making these assumptions, the energy budget equation for melt can be used to compute snowmelt during periods when it is raining” (Anderson, 2006, pg 13).
19) P. 6, line 33: How can wind have units of “mm/mb/6 hr”?
UADJ is the average wind function and has units of mm/mb/6 hr (Anderson, 2006, pg 13). We are not describing wind here. We have moved the units to fall after UADJ so it is clearer.
20) P. 6, lines 34/35: Write “snowpack” as one word. We have corrected this through the paper.
21) P. 8, line 30: Revise to: “Three additional objectives” We have corrected this sentence as suggested.
22) P. 9, lines 1 through 9: Equations numbers run on two lines and are missing for the last three equations. We have removed these equations as suggested by Reviewer #2.
23) P. 9, line 10: The units should be “m3/s”. We have removed the sentence to respond to a suggestion by Reviewer #2.
24) P. 9, line 17: Provide probability values for all correlation coefficients reported in the study. We feel that the correlation coefficients and other statistics provided are sufficient. If the reviewer feels that this is a sticking point, we will calculate it.
25) P. 10, line 18: What are the units for snow density, listed here only as 0.2? The values we are reporting here is not snow density, but negative melt factor, NMF, which is a coefficient used to represent the snow heat deficit. “Snow heat deficit is either negative or positive; the rate of heat loss or gain is based on the amount of energy exchange that occurs when melt is not taking place at the snow surface.” It is defined on page 9. The units for NMF mm/ºC/6 hr). See table 3 and Anderson, 2006.
26) P. 10, line 19: Insert a space in “6 hr”. We have corrected this through the paper.
27) P. 10, line 35: Insert a space in “850 m”. We have corrected this through the paper.
28) P. 10, line 36: Should this be “SNOW17’s”? We have corrected this error. Thank you for pointing this out.
29) P. 11, lines 1 and 11: Write “snowpack” as one word. We have corrected this through the paper.

30) P. 11, line 10: Date format may need to be revised to “15 May 2001”. Please also change to “is shown in Figure 5b”. We have changed all dates to adhere to the suggested format.
31) P. 11, line 13: Change to “watershed’s”. We have adjusted this sentence. Thank you for pointing this out.
32) P. 11, lines 20 to 22: Convert SWE from inches to mm. We have changed these figures and numbers in the text to mm.
33) P. 11, line 33: Change to “improve”. We have changed this as suggested.
34) P. 12, lines 4/5 and 13/15: Avoid sentences that just describe the figures – this is what figure captions are for. We have adjusted the sentences as follows: “The calibration, validation and whole period of record results shown in Figure 3, illustrates that the poorly performing basins,” and we removed the sentence starting with “Here the percent…” and the sentence starting with “Plots illustrate…”. We also adjusted the sentence starting with “Statistics show…”.
35) P. 12, line 35: Delete “Because this.” We have deleted these words.
36) P. 13, line 14: Change to “SNOW17’s”. We have changed this as suggested.
37) P. 13, line 17: Revise to “data are temporally”. We have changed this as suggested.
38) P. 14, line 11: Write “snowpack” as one word. We have changed this as suggested through the paper.
39) P. 14, line 19: Change to “are adding”. We have changed this as suggested. Thank you for pointing this out.
40) P. 14, line 20: Change to “data appear”. We have changed this as suggested.
41) P. 15, line 22: Change to “have improved”. We have changed this as suggested.
42) P. 16, line 11: For consistent language, change to “floods and droughts”. We have changed this as suggested.
43) P. 16, line 27: Delete “to” before “during”. We have changed this as suggested.
44) P. 16, lines 32 to 34: This sentence is long and confusing. Consider revising it and perhaps dividing it into two sentences. We have changed the sentences to read “The observations of rapid change in the Arctic highlight important alterations to hydrological regimes in the subarctic Interior boreal forest of Alaska. These observed, rapid changes and future anticipated alterations introduce a pressing need in Alaska to further understand the anticipated changes through modeling of major climate drivers of streamflow.”
45) P. 17, line 1: Delete the space after the hyphen in “high-quality”. We have corrected this.
46) P. 17, line 8: Change to “Natural Sciences”. We have corrected this.
47) P. 18, line 1: Note that the references do not generally follow the format used by HESS; for instance, journal names should be abbreviated, not listed in full. The year of publication should be listed at the end of the reference, not after the list of authors. We have adjusted the references accordingly.
48) P. 18, line 4: Is this a journal article, technical report or book? Please provide full details of the Anderson (1976) reference. We have corrected this reference.
49) P. 18, line 14: Provide the full range of pages for this article. We have corrected this reference.
50) P. 18, line 16: Add the article # for this reference. We have corrected this reference.
51) P. 18, line 26: Provide the full range of pages for this article. We have corrected this reference.
52) P. 20, lines 8/9: Why is the journal name in italics? We have corrected this reference.
53) P. 20, line 11: Is the French name of the journal needed here? We have corrected this reference.
54) P. 21, line 6: Provide the full range of pages for this article. We have corrected this reference.
55) P. 21, line 8: There is a period missing after “design”. We have corrected this reference.
56) P. 21, line 13: Provide the full range of pages for this article. We have corrected this reference.

57) P. 21, line 31: Is there an appropriate issue number (other than zero) for this article?
58) P. 22, line 9: Provide the range of pages for this article. We have corrected this reference.
59) P. 22, line 19: Use upper case "H" in "Journal of Hydrology". We have corrected this reference.
60) P. 23, line 16: Why is this "Woo et al. (2008a)" when there is no corresponding "Woo et al. (2008b)"? We have corrected this reference. Thank you for pointing this out.
61) P. 24, Figure 1: I presume the upper and lower divisions shown in each catchment are delineated by the black contours? If so, the figure caption should clearly state this. The range of colors is misleading since there does not appear to be elevations above 1000 m. As such, consider using a shorter range of elevations for the map with more distinctive colors.
We have changed the figure's color ramp and included Elevation (m) in the legend title for the elevation zones. We have added the basin divisions to the legend.
62) P. 25, Figure 2: For which year(s) are these results valid for? Is this for a given year or a climatology over the study period? We have added the year to the figure and figure caption.
63) P. 26, Figure 3: Here snow cover extent is expressed as a percentage in the color legend but in Figure 2 it was shown as a fraction from 0 to 1. Use a consistent parameter for the presentation of the results. The range of elevations for each zone should be provided in a table.
We have corrected Figure 2 to be consistent with Figure 3. The range of elevations are provided now in the Figure 3 caption.
64) P. 27, line 27: The date format may need revisions. We have changed all dates to adhere to the suggested format.
65) P. 28, line 34: Same comment. We have changed all dates to adhere to the suggested format.
66) P. 29, Figure 6: Convert the SWE data from inches to mm and redraft the figures accordingly. We have adjusted the units on these figures from inches to mm.
67) P. 30, Figure 7: Provide units for RMSE on the y-axis. Would it be possible to have ovals around the different clusters to identify specific basins on the plot? We have provided units and ovals on the figure.
68) P. 31, line 51: Change to "on the plots". We have changed this as suggested.
69) P. 32, Figure 9: Discharge should be in units of m3/s on the y-axis. Rather than presenting the average results over 10 water years, why not depict results for each ablation season? We have changed the units. We now include the 10 water years in the Supplemental.
70) P. 33, Table 1: For the upper Little Chena, provide the air temperature with one decimal, i.e. "-21.0" for consistency with values reported elsewhere. We have changed this as suggested.
71) P. 34, Table 2: Is the average SWE reported here the annual average, or the average annual peak value? We have changed the caption and the table accordingly.
72) P. 35, Table 3: There are a couple extraneous numbers in the table just under "Max" ("13" and "14", which appear to be line numbers. The maximum MBASE temperature should read "0.00". These line numbers appear in the PDF only. I will make sure they are corrected in the next stage of reviews. The MBASE temperature has been corrected.
73) P. 36, Table 4: Probability values should be reported for the correlation statistics. See response to this comment above.

New References:
Déry, S. J., Salomonson, V. V., Stieglitz, M., Hall, D. K., and Appel, I. 2005: An approach to using snow areal depletion curves inferred from MODIS and its application to land surface modelling in Alaska, Hydrol. Proc, 19, 2755-2774, doi: 10.1002/hyp.5784.
Hall, D. K., Riggs, G. A., Foster, J. L., Kumar, S. V. 2010: Development and evaluation of a cloud-gap-filled MODIS daily snow-cover product, Remote Sens. Env., 114(3), 496-503.

Tong, J., Déry, S. J., and Jackson, P. L., 2009: Topographic control of snow distribution in an alpine watershed of western Canada inferred from spatially-filtered MODIS snow products, Hydrol. Earth Syst. Sci., 13, 319-326.

Thank you for these suggestions. We have added these references to the paper.

References:
Anderson, E., 2006. Snow Accumulation and Ablation Model - SNOW-17. http://www.nws.noaa.gov/oh/hrl/nwsrfs/users_manual/part2/_pdf/22snow17.pdf, NWS NOAA, pp. 44.