**Hydrology and Earth System Sciences Discussions**

## *Interactive comment on* "Topographic control of snow distribution in an alpine watershed of western Canada inferred from spatially-filtered MODIS snow products" *by* J. Tong et al.

**J. Tong et al.**

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Thank you for the constructive comments submitted on our manuscript. We have adjusted the text accordingly and provide below responses to the comments as well as details on the revisions performed in the manuscript. All the figures in this response are available at: http://nhg.unbc.ca/HESS

Response to Referee #2:

Important Issues: 1. I am somewhat confused about exactly how the study was done. As I indicated in the first paragraph, I think that the authors used MOD10A1 (daily MODIS standard product) to develop an 8-day spatially-filtered (SF) product. They

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then compared the SF results with the MOD10A2 (8-day standard product) results. This is fine. The problem is that it does not really read that way, say for example in the Abstract which states in the first line that the SF method is used to reduce clouds in MOD10A2. I suggest re-wording to indicate that MOD10A1 was used to create the SF.

Response: In this paper, the MOD10A1 are only used to calculate the daily cloud coverage to compare with the MOD10A2 and SF products. The SF method is only used on the MOD10A2. (See lines: 24-29) A spatial filter (SF) is used to reduce cloud coverage in Moderate Resolution Imaging Spectroradiometer (MODIS) 8-day maximum snow cover extent products (MOD10A2) from 2000-2007, which are obtained from MODIS daily snow cover extent products (MOD10A1), to assess the topographic control on snow cover fraction (SCF) and snow cover duration (SCD) in the Quesnel River Basin (QRB) of British Columbia, Canada. (See lines: 151-153) However, about 20% cloud coverage remains during winter such that the SF is adopted to decrease the cloud coverage and improve the accuracy of snow mapping of MOD10A2 in the QRB.

2. Can the authors address the significance, hydrologically, of only about a 1 day difference in SD of SCDs which is achieved using the SF method as compared to using MOD10A2?

Response: In a companion paper (Tong et al. 2008), the authors address the hydrological impacts of the SF products compared to the MOD10A2. The 8-day MODIS snow products are then used to assess the relationship between the SCF and river discharge in the Quesnel River Basin. The reduction in standard deviation of snow cover duration by one day is an improvement over MOD10A2, which improves the results between snow and discharge in the QRB. To quote from that paper: "The correlation coefficient between normalized SCE of the SF and normalized streamflow is -0.84 (p<0.001) for snow melt seasons. This is 0.04 higher than that between normalized SCE of MOD10A2 and normalized streamflow owing to the effective reduction of cloud coverage by the SF." (Tong et al. 2008).

3. p.2350, Lines 2 6, The authors have a mis-understanding about the use of the cloud mask in the Collection 4 & 5 standard snow-cover products. They correctly state that a liberal cloud mask was developed, and they reference Riggs et al. (2003). However, later testing revealed that the liberal cloud mask did not provide consistent results globally, though it worked well in some regions. So for Collections 4 & 5 the liberal cloud mask was dropped. The current standard products use a conservative cloud mask. Please also change the Riggs et al. (2003) reference to Riggs et al. (2006) which is the updated User Guide.

Response: See lines: 86-88. The MODIS snow maps use a conservative cloud mask to determine clouds with the MODIS Cloud Mask data product (MOD35_L2) (Riggs et al. 2006).

4. p.2352, Lines 22-24, Can the authors speculate on why the accuracy of the SF data declines with elevation?

Response: See lines: 166-169. However, the accuracy of the SF data declines with elevation, with values of 82.7% at the Boss Mountain Mine (1460 m) and 74.2% at Yanks Peak (1670 m), respectively owing to the more complex slope, aspect, and vegetation at higher elevations.

5. p.2355, line 4 and in Concluding discussion, why are the highest melt rates of SCF always on 14 March?

Response: Since we use the 8-day snow products, the highest melt rates of SCF always occur during the 8-day period around 14 March. Normally, the meteorological conditions change most significantly during the beginning of the snow melt season; therefore, there is the highest melt rate of SCF during the beginning of the snow melt season.

6. p.2356, Line 13, is there some ground data or validation that indicates that the SF method showing a longer SCD is more accurate?

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Response: Unfortunately, the in-situ SD stations are very sparse in the northern mountainous areas of BC. Although beyond the scope of this study, a more complete validation the SF method is conducted in a companion study (Tong et al. 2008).

7. Concluding discussion, lines 6-9, this is a good conclusion, but it would even be better if the authors could show that the 2.5 percentage point reduction in cloud cover using the SF method is significant hydrologically.

Response: In a companion paper (Tong et al. 2008), we address the hydrological impacts of the SF products compared to the MOD10A2. The 8-day MODIS snow products are then used to assess the relationship between the SCF and river discharge in the Quesnel River Basin. To quote from that paper: "The correlation coefficient between normalized SCE of the SF and normalized streamflow is -0.84 ($p < 0.001$) for snow melt seasons. This is 0.04 higher than that between normalized SCE of MOD10A2 and normalized streamflow owing to the effective reduction of cloud coverage by the SF." (Tong et al. 2008).

8. Concluding discussion, line 26, please change "bands" to "band" and "occurs" to "occur" to match the noun which is the word, "rates"

Response: See lines 319-320. However, the highest ablation rates of SCF at every elevation band always occur on 14 March with a maximum value of 38.5% at the 400 m elevation band.

Minor Issues: Abstract, Line 6, I suggest the following change in wording, "The new product developed using the SF method, hereafter referred to as SF, shows larger SCF. . . "; p.2352, Line 1, include the Hall and Riggs (2007) reference after Zhou et al., 2005 p.2352, Line 11 or somewhere appropriate earlier in the paper, perhaps it would be good to say something like, "such that the SF product, hereafter referred to as SF, is adopted to. . . " The reason for this is that it's fine to say SF method or SF product, but elsewhere in the text the authors refer simply to SF which means Spatial Filter when the authors really mean spatial-filter method or product. This is a minor point but it

would make the text read a bit more clearly. p.2356, Lines 8-9, I suggest re-phrasing to the following, ". . exhibits a much larger perennial snow cover than does the original MODIS data" p.2362, "threshold" should be "threshold"

Response: The text has been revised according to all of these constructive comments.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 5, 2347, 2008.

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