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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Charactersing spatio-temporal variability in seasonal snow cover at a regional scale from MODIS data: The Clutha Catchment, New Zealand" *by* Todd A. N. Redpath et al.

Anonymous Referee #1

Received and published: 28 February 2019

General comments:

The authors present a detailed regional snow cover climatology and analysis of spatiotemporal variation for a subset of New Zealand. After creating a cloud-gap-filled daily time series of snow covered area, they extract several SCA derived metrics (snow cover duration, snow line elevation, percent basin at various SCA thresholds) to analyze spatial and temporal patterns and trends in snow. They then compare SCA derived metrics to several climatic metrics and indices (precipitation, temperature, winter air flow, SOI and SAM). The use of rPCA to explore spatial variability of SCD and the use of HYS-

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PLIT to characterize wind trajectories is novel to the regional analysis of SCA patterns. Results show highly variable intra-annual and inter-annual spatiotemporal variability in snow covered area for this catchment with no significant trends in snow covered duration during the record analyzed. rPCA shows utility in identifying modes of spatial variability in snow cover duration with modes relating to both topographic and climatic influences. Temperature appears to be of greater influence at higher elevations in the study area, and precipitation of greater influence lower down, contrasting previous research (MoraÌĄn-Tejeda et al., 2013; Hammond et al., 2018). While climate oscillation indices show little skill in explaining snow variability, easterly winds appear to increase SCD in this region. Figures are of a high quality and effectively communicate major results of the study.

MoraÌĄn-Tejeda, E., LoÌĄpez-Moreno, J. I. and Beniston, M.: The changing roles of temperature and precipitation on snowpack variability in Switzerland as a function of altitude, Geophysical Research Letters, 40(10), 2131–2136, 2013.

Hammond J. C., Saavedra F. A., Kampf S. K.: Global snow zone maps and trends in snow persistence 2001–2016. Int J Climatol, 38, 4369–4383, https://doi.org/10.1002/joc.5674, 2018.

Specific comments:

A few outstanding questions and points remain following the author's summary of their methods and discussion:

Methods:

What is the rationale behind the 77% threshold used to show first 6 principal components?

A brief summary should accompany Jobst references explaining how the datasets were created (temperature: spline interpolation with a lapse rate model, precipitation...) so that the reader doesn't have to go to Jobst publications to figure this out.

How does SCA from MODImLab C6 and MOD10A1 C6 generally compare?

Why use parametric linear regression trend analysis with assumptions below instead of non-parametric Mann kendall analysis? -Linear relationship -Multivariate normality -No or little multicollinearity -No auto-correlation -Homoscedasticity

Why not compare wind trajectories to annual SCD, basinwide SCA %'s instead of comparing to principal components?

Can you conduct correlations between PC's and topographic, climatic metrics to have better understanding of what each PC represents?

Map of annual cloud persistence, longest cloud duration could aid in assessing uncertainty of Dozier et al. (2008) method for cloud-gap filling.

What is the data source for the SAM and SOI time series?

Discussion:

In explaining why easterly winds lead to greater snow in this region, are winds from the east more moisture laden? Associated with cooler temperatures?

Introduction mentions importance of greater understanding of snow distribution, and how it might change, to water resource management. How might the results of this work specifically be used to improve hydrologic modeling of snowmelt in this watershed and within sub-watersheds?

The authors attribute greater sensitivity of SCD to temperature at higher elevations to importance of rain snow threshold and importance of precipitation at lower elevations to precipitation that arrives during cold fronts. This rationale should be flushed out further with examples from other regions with similar divide-specific behavior, as the results contrast the results of previous work in Europe, North America, South America and Asia showing greater importance of precipitation at high elevations and in arid areas and temperature at low elevations (MoraÌĄn-Tejeda et al., 2013; Hammond et al.,

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2018). How does P/PET map across the catchment? Likely relates to solar insolation?

Further discussion of why elevation-snow relationships degrade further away from the main divide would help strengthen this point.

Technical corrections, typing errors, etc.:

Snowmelt and snow melt used in paper, chose one and be consistent

Suggest avoiding “snow persistence” term to describe snow cover duration, as this phrase has become a metric of its own in the past decade

Sentences in abstract could be better interwoven to present results more effectively

End page 1 to start page 2 - Second sentence of introduction - Put references for first part of sentence corresponding to that point before comma, then references for second part of sentence at end. Similar comments on other sentences when all references displayed at end of multi-part sentence

Line 16 page 2. Suggest rephrasing sentence. Also display area normalized annual flow (mm/y) to help reader understand relative amount of flow

Line 31 page 3. First two sentences of this paragraph disjoint, could use topic sentence

Line 26 page 4. Reword to say MODIS useful for snow mapping. MODIS also “particularly” good for vegetation analyses etc...

Line 19 page 9. Mean temperature and total precipitation

Line 10 page 11. “, and .”

Line 5 page 12. “in the catchment At moderate”

Line 7 page 13. “With the inverse being true...” not needed since you have positive (negative)

Line 4 page 15. Sensitivity reduces, but not at a negative rate, suggest rephrasing Line

1 page 18. Remove “by”

Figure 11 - Could be moved to supplemental materials

Figure 14 - Consider another color than yellow for eastern mtn ranges. Yellow not very visible in electronic and printed versions

Figure 15 - What does this plot look like with elevation axis instead of distance to main divide? May help discussion on P vs T importance at different elevations

Figure 18 - Could be supplemental

Tables 1,3,5 - Could be supplemental

Table 2, Figures S9 and S32 from Hammond et al., 2018 may be apt comparisons to this study

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