

Interactive comment on “Uncertainties in the spatial distribution of snow sublimation in the semi-arid Andes of Chile” by Marion Réveillet et al.

Anonymous Referee #1

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(A) General Comments

In the manuscript “Uncertainties in the spatial distribution of snow sublimation in the semi-arid Andes of Chile” Réveillet et al. present results of their study aiming to simulate melt and sublimation rates over the instrumented watershed of La Laguna. They present the relative importance of sublimation versus snow melt using a distributed snowpack model for two meteorologically contrasting years. They detected a large difference in modelled sublimation rates forcing the model with data of Automatic Weather Stations (AWS) and with Weather Research and Forecasting (WRF) model data. This difference is caused by (a) the different meteorological input, particularly in precipitation and temperature, and (b) by the modelled snow cover persistence.

The objective of the study of Réveillet et al. is to assess the uncertainties in melt
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and sublimation arising from modelling snow evolution using AWS and/or WRF-model generated meteorological datasets. Since the seasonal snow cover and glacier melt as processes of the cryosphere have locally a high contribution to available fresh water in this region. The study of Réveillet et al. contributes to gain knowledge of snow depth distribution and snow cover processes in the semi-arid Andes of Chile, and thus the manuscript is in the scope of TC. In general, this study shows again the importance of a critical interpretation of model results with respect to model input data.

The introduction is complete, the applied methods are appropriate and comprehensible, and the results are compared to referenced work. However, the manuscript at its present stage summarizes results of interesting work packages and analysis, but lacks in the overarching aim with a clear problem statement, the research questions and the respective conclusions. This is also obvious in the high number of subsections presenting methods and results which not necessarily contribute to the conclusions. My suggestion is to restructure the manuscript with a clear focus on formulated research questions and to revise the title reconsidering the term “uncertainty”.

(B) Specific Comments

(1) As addressed in the general comments, the manuscript shows an interesting work but without presenting an overarching aim and respective research questions. Forcing the model with different data from AWS and WRF does not result only in differences of sublimation rates, but also differences in e.g. snow covered area, snow persistence and snow melt. So I would suggest that not the uncertainties in the spatial distribution of snow sublimation are shown. Rather the variation of snow related parameters and processes forcing the applied model with different input is presented. Since the weaknesses of the WRF model output are known (cold bias, precipitation overestimation) and the AWS data might be the more appropriate model input, the study shows the error of forcing the model with WRF data for snow parameters (i.e. the overestimation of the snow cover duration by 2 month). The impacts of these errors are particularly obvious in the sublimation rates and ratios, which again are a function of snow cov-

erage, elevation, temperature, etc. If the (model?!) uncertainty in sublimation should be addressed in more detail, I would suggest to show at least one additional figure presenting the calculated and simulated sublimation rates at AWS locations. In my opinion, the manuscript at its present stage presents "Differences in simulated sublimation in a high mountain catchment of the semi-arid Andes of Chile using AWS data and WRF meteorological forcing". Possible research question may address the main differences (errors?) in sublimation simulated using the WRF forcing, the impact of SCA and SCD under/overestimation, and the effect of different meteorological conditions of the two contrasting years on sublimation ratios. This can lead to conclusions about advantages and disadvantages of using the different forcing data. Most of the results are already presented, but the paper should be restructured accordingly to answer the formulated research questions and further drawing the conclusions.

(2) Two years with contrasting meteorological conditions have been chosen for this study. This has the advantage of testing the simulation results, but also seems to be restricted to AWS data availability. To get an overview of the overall climate in this region and to classify the two selected years in a climatological context, please present a short climate overview of the last 30 years from a nearby station, or at least some short statistics for the AWS with the longest data history (La Laguna?)

(3) The downscaling of the WRF data still appears opaque to me. Is the relatively large T difference (Page 13 L22) before or after the adjustment? If before, what is the temperature offset after the adjustment? Please also present some standard deviation of the hourly/daily/monthly T values using the mean monthly gradients. What is about thermo-dynamics considering relative humidity and saturation for calculating lapse-rates. Please give some more detailed information in section 3.2.1. and the results.

(C) Detailed Comments (P = page, L = line)

P1 L23: Please present the longitude in addition to the latitude.

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P1 L23: Here an throughout the text: Above sea level can be abbreviated by "a.s.l."

P1 L23: Are the two years contrasting in hydrology or meteorology (or both).

P1 L27: Replace "increased by 100%" with "doubled"

P2 L3: Replace "cryosphere" with "glaciers(?) and the seasonal snow cover"

P2 L5: "winter months". Please consider to present these months in the introduction (June, July, August?!)

P2 L5: "intermittent": This can also mean at regular intervals, but I think you mean "erratic"?

P2 L24: Delete "evolution"

P3 L6: Revise to one relatively wet and one d

P3 L15: Remove "over time". Instead you can present a date to which the snow cover duration persist (which month/season?)

P3 L18: Add the longitude.

P3 L20: "best instrumented": Please explain in more detail. In contrast to which other catchments? Or just write "well-equipped" or "mounted"

P3 L21: Remove the "~" (also throughout the manuscript)

P3 L23: Remove "clean"

P3 L25: Please use $10 \times \text{m}^3$ instead of Mm^3

P3 L26: Revise "rate" to "mean annual precipitation"

P3 L31: Is "area" the "study site"?

P3/ffP4: This sentence is hard to understand. Are these trajectories "storm paths". Please give some more detail. Also the sentence can be condensed to "The sea-

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sonal variability and frequency of precipitation events is also affected by precipitation trajectories. . ."

P5 L7: Remove "Finally"

P5 L5: Replace "for a specific campaign" by "next to the glacier"

P8 L12: Shift "the" to the front of La Laguna

P8 L13: Shift the reference to Figure one to the sentence before "the La Laguna catchment (Figure 1)"

P9 L9ff: Please consider to remove the subsections and to highlight the sub-model description by paragraphs and the sub-model names by italic font.

P10 L 8: Please unify "T" or "Tair"

P10 L10: Replace "please" by "we"

P10 L28: Add "snow albedo" to "minimum"

P12 L3: Add "sublimation" in front of "rate"

P12 L 19: Since the abbreviations have been introduced, use SWi here. Please check this throughout the text.

P12 L 19: You present absolute values here, but how much is this in % of mean SWi?

P12 L 20: Why is it in agreement? Why are weather conditions with more clouds necessarily colder? Whats about clear sky conditions at night causing very low temperatures?

P13 L1: Is this comparison performed before or after the Barne-downscaling? Please clarify here.

P13 L25: Correct "annual"

P14 L8: Revise this sentence to: "Simulated snow depths using... agreement with

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measured snow depth values.

P15 L1: "forcings indicates": Remove one "s"

P19 L9: Please give more detail ion the time period and spatial extent of the averaged values here

P21 L7: Delete "when the snow. . ."

P25 L5: Revise to: Precipitation is known to be over-estimated using the WRF model

P25 L6: Correct "exist"

P25 L10: Please revise this sentence. Suggestion: Precipitation measurements using rain gauges can be biased towards an underestimation because of an undercatch particularly of snowfall due to wind influence.

P26 L26: Here the sublimation rate (absolute values) should be compared.

P27 L3: There will be no sublimation without a snow cover. Thus, this sentence is redundant. Perhaps you want to say that the snow cover duration SCD has a significant influence on sublimation/melt ratio.

P28 L17: It is rather the mass and energy balance of the snow cover, which includes sublimation.

P29 L19: Precipitation data is not an uncertainty, but the uncertainty of measured/modelled precipitation is.

Figure 1:

- Please include the reservoir and the glacier in the legend. Please adjust the elevation in the legend to the colour transitions.

Figure 3:

- Please unify the units. I would suggest Wm-2 and ms-1

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- Please present in addition the snow depth, since this is an important parameter of this study
- Caption: Since only two years are presented, no "climatic" conditions are shown. Please revise to "meteorological conditions at the. . ."
- Please uniform the radiation abbreviations throughout the figures/manuscript to avoid confusion between incoming (index i) outgoing etc.
- Remove the "s" from "precipitations"

Figure 4

- Caption: Replace 'studied' with "La Laguna"
- Please describe in the caption which output is subtracted from the other for interpretation of the sign on the differences?

Figure 5

- I would suggest to bring the graphs of AWS/WRF-forced SD and observations in one figure for each station, and thus reduce the number of subfigures to 6.

Figure 6

- Please bring the decimal order (10^8) to the label of the y-axes. I suggest to use km^2 like in the RMSE

Figure 7

- Modelled "energy" fluxes are shown

Interactive comment on The Cryosphere Discuss., <https://doi.org/10.5194/tc-2019-31>, 2019.