Review by Marius Schaefer, 31st of august 2019

General comments:

"Revisiting extreme precipitation amounts over southern South America and implications for the Patagonian Icefields" is a modeling study which focuses on the latitudinal range of 44 degrees South and 54 degrees South and a relatively short time period (2010-2016). As input data the ERA-Interim reanalysis dataset is used and one of the main assumptions of the approach is that the drying ratio of this part of Andes Range is fixed in time and space. The input data are compared to measurements at atmospheric sounding data of two stations (and slightly biased corrected, if I understood it right). The model results are compared to relatively large collection of weather station data. Assuming the validity of a linear relationship between precipitation and surface mass balance found by analyzing annual data of Schaefer et al. (2015), the author discusses the implications of his results for the surface mass balance of the Southern Patagonia Icefield. Furthermore potential flow blocking events are studied, based on simulations with the regional climate model WRF and implications of these events for the precipitation patterns in the region are discussed.

Generally I think it is a study which has the potential to make an important contribution to our understanding of precipitation patterns in the study region. However, giving that the results of this study are quite different from previous numerical studies, I am missing are more dedicated search for the reasons of this differences in the discussion section (I am giving some ideas in the specific comments). Furthermore I think that an analysis of the implications of this study for the surface mass balance of the Northern Patagonia Icefield (NPI) would add very much. Here the results could be validated much better against geodetic glacier mass balances since the losses by calving are much better constraint than for SPI (only one tidewater calving glacier on the NPI).
Also readability of the manuscript (especially for not climate modelers) could be easily improved.
Please find more detailed comments below.

Specific comments:

Abstract:

Line11: "volume loss of the Patagonian Icefields, for example, contradicts the reported positive surface mass balances" there is no contradiction if the difference can be attributed to calving fluxes (or other mass losses).Example Antarctica: positive SMB, negative overall MB.

Line11-14: Reformulate: you are using a model in this study (and not only a simple physical argument) and get some results. Describe the model briefly: what are the input data and main assumptions.

Introduction:

<u>Page2:</u>

Line 12/13: up to 30 m w.e. yr -1 are suspected at isolated locations (Lenaerts et al., 2014; Mernild et al., 2017; Schaefer et al., 2013, 2015;Schwikowski et al., 2006).
Revise citations! In Schaefer et al., 2013, 2015 no precipitation of up to 30 m w.e. yr -1 are suspected (I think only Lenaerts et al., 2014 is mentioning this value!).

Line 29-34: to improve readability, I would recommend to leave the assumption ii) shorter. 1-2 sentences. You can explain the technical details in the method section.

Page3:

Line 7: Replace “and critically reviewed (Section 3.4) ” by “limitations of the linear precipitation model are discussed in Section 3.4”

Methodology:

To improve readability I recommend to divide the methods section in three subsections:

2.1 DR-scaling using a constant precipitation gradient

2.2 DR-scaling using the linear precipitation model

2.3 Examination of non-linearities using the Regional Climate Model WRF (new section)

Line 16: “by optimizing (Newton-Raphson algorithm) the vertical precipitation gradient” ¿ how does this optimizing work? Describe in one sentence and give a reference for further reading.

Line17: “determined from the GPM measurement” : determined : how? Or do you mean taken from? Acronym GPM not explained!

Line 18/19: “The optimization resulted in a vertical precipitation gradient of 0.00052 m m -1 (~0.02% m -1), which represents a slightly smaller lapse rate than previously reported (Schaefer et al., 2013)” In Schaefer et al. a precipitation of 5% per 100m was employed. That is more then double the one you used. You could create another scenario using a lapse rate of 5% per 100m!

Line 27: “many processes” : name some (or all)!

Line 31: “it solves two steady-state advection equations” : show the equations or give reference

Line 32: “conversion from cold water to hydrometeors” : cold water IS a hydrometeor? Do you mean cold vapor?

Page4 :

Line 2: “uniform background flow and properties” : properties of what? Which properties do you mean?

Line3: “five parameters” : could explain each parameter in one sentence?

Line 8: “background precipitation is scaled by a constant” : which range of values does this constant take? What happens if you do not force the model to a fixed drying ratio?

Line 10: “C_w and N_m are calculated from 6-hourly ERA-Interim fields” how?

Line 14/15: “produce remarkable similar results” which kind of results? Precipitation fields? You should show that in the results and discussion section!

Results and Discussion

Line 27/28: “Along the coast ...” to which data refers this sentence? ERA-Interim cells located at the coast or measurements in Puerto Montt or Punta Arenas?

Line 29/30 Sentence starting with “There is also clear evidence ...” needs citation. Or are you referring to the data in Puerto Montt?

Page 5

Line 6 : “ The ERA-Interin data ...” : please add these data in Figure2

Line 12: “SSMIS data” : explain! Are these reliable data?

Line 18: “and corrected accordingly” : this means you multiplied the original ERA-interim WVF by 1.1 ?
Line22: “Pre-Cordillera region” add (see Figure 1)

Line29 “.. values agree with precipitation estimates from discharge measurements “ this statement is not true (see table 1)

Line32: “windward side” and “leeward slopes” what is the extend of this regions? Can you indicate them in Figure 1 or 3?

Line 33: “The spatial pattern on the plateau is consistent ...” how can a precipitation pattern be consistent with elevation change measurements? Explain! How do you define “the plateau” ? Indicate this region in Figure 3!

Page 6

Line 3: “Greater deviations” better say “higher overestimations”

Line 7: “Shiraiwa et al. is not a presenting simulations but measurements. Please indicate that clearly!

Line 7 : “ The large ensemble spread” : how much is it? You have to show that!

Line 9-10: “ the responsible mechanisms explaining the significant differences remain unclear.” That’s a very sad statement for a scientific contribution! At least try! Potential candidates are: higher drying ratios or higher precipitation gradients in other studies. You also ran the regional climate model WRF. What drying ratios and precipitation gradients did you get from this simulations? Also different study period could be a candidate.

Line 26-28: “…, we use the significant linear relation (), between **annual precipitation sum and annual SMB derived from data of Schaefer et al. (2015). The relationship is: …**

Line 30/31 “...would result in a mean SMB between 0.56±0.45 m w.e. yr -1 (7.82±6.28 km -3 yr -1, **extreme scenario**) and -0.14±0.39 m w.e. yr -1 (-1.95±5.45 km -3 yr -1, **realistic scenario**) on the SPI (Fig. 4)

Page7:

Line 1-2: “… the mean mass loss due to calving ranges between -1.5±0.64 (-20.95±8.94 km -3 yr -1) and -0.8±0.58 m. w.e. yr -1 (-11.18±8.10 km -3 yr -1)” Are these values realistic considering that recently calving fluxes of up to 3.81 km^3w.e. yr-1 for one single glacier were observed during the study period(2015)?
Citation:
Bown F, Rivera A, Pętlicki M,Bravo C, Oberreuter J, Moffat C (2019). Recentice dynamics and mass balance of JorgeMontt Glacier, Southern Patagonia Icefield.Journal of Glaciology1–13. https://doi.org/10.1017/jog.2019.47

Page8:

More results of the WRF simulation should be presented in the results section: which precipitation gradients, total precipitation values of the icefields and drying ratios do you obtain from these simulations?

Conclusions:

Line 16: “ … simple physical arguments ...” again: you are using a numerical model, not a simple physical argument. Better repeat model essentials.

Line 18: “.. other parameter combinations ...” of the model employed here or generally?

Line20: “ … clearly defined assumptions. “ **add** which are: …

Line22: Shiraiwa et al.,2002 is NOT a modeling study!!!

Line30/31: “WVF changes would result in a glacier surface mass gain of about 0.57±0.06 m w.e. per degree warming. TAKE CARE HERE!!! The relationship between precipitation and SMB you derived from the data of Schaefer et al. 2015 will not be valid forever. Percentage of solid precipitation will decrease for higher temperatures!

Page 9:

Line 4 : “While the change in ice masses ...” to which change are you referring to?

Figures:

Figure1:

I am a bit surprised about the many dots! Can you indicate a list of stations (supplementary material) and indicate to which time span the color coding of the measurements corresponds?

Figure2:

As indicated before, I would like to see the closest ERA-interim gridpoint data added for each station. I would prefer very much absolute data instead of anomalies!

Figure3:

Both plots are qualitatively very similar. Could you better compare the linear prec. gradient approach with the numerical model (using the same drying ratio)?

Figure4:
revise caption! The red, green and orange dots are the results of this study! Schaefer et al. (2013), Mernild et al. (2016) are indicated as red circles.

Figure5: I not very necessarily I find. Better add a nice figure about the model validation at weather stations.

Table 1:

Lenearts et al. (2013) are indicating mean precipitation estimates in gigatons. You can calculated specific values from that. Also revise the max values (I think 30 m was obtained at SPI).

Supplementary material:

A nice graphical representation of Table S2 should be added to the main part of the manuscript.
Results of all scenarios should be validated against station data.
Perhaps you could realize two scatterplots: one for the windward side and one for the leeward side?
Add observation period to the table (or new table, see comment Figure1!).