We appreciate the constructive review and comments by Anonymous Reviewer 1 and Dr Alvaro Ayala. We introduce most of the change and suggestion by both reviewers and tried to address the reviewer's concerns. We kept some sentences despite the suggestions as we consider are related with different styles in redaction. Also, we corrected the manuscript considering the specific comments. We think that these changes improved the manuscript. Here, we provide responses to the comments and technical issues detected by the reviewers (in bold):

Anonymous referee #1

Summary

Thanks to the authors for their thorough responses to the reviewer comments. The analyses of ERA5 ARs and Lagunitas precipitation added in Section 4.1 now provide important long-term context for the January 2021 case study event. Figure 1 is improved from the previous version and is now more useful for understanding the study region.

I do have a number of remaining minor comments and technical corrections, as detailed below. Several of the minor comments are requests for the authors to incorporate helpful information from the reviewer response into the manuscript itself. Provided these comments are addressed, in my assessment this paper is on the right track toward publication.

Follow-ups on previous comments

Note: Unless otherwise noted, all line numbers in these follow-up comments refer to the previous version of the manuscript, in order to preserve the linkage with previous comments and the reviewer response.

- Major comment 2: I was hoping that the analysis of the Lagunitas precipitation data would also give an estimate of the return period of the Jan 2021 event compared to the all-season climatology, in addition to the summer climatology. However, I don't think this is a major issue, and will leave it to the authors' discretion whether they wish to include this analysis in the next version.

The comparison of the dry-season AR2021 PRecip event with all-seasons precip events is not relevant. For all-seasons climatology, the precipitation accumulated in the summer AR2021 PP event is not rare. But it occurs in the dry season, which is extremely dry in the subtropical Andes (only 10% of the annual total see Viale and Garreaud 2014) and glacier normally do not accumulate mass.

- Figure 1: Please clarify in the caption that the blue areas are glaciers, as promised in the reviewer response. These could be mistaken for lakes.

Added

- Figure 3 (previously Figure 2): Please mark the location of the study area on panel a and/or c (I suggest both), and add text to the caption noting this.

Added.

- L153–154: The response to this comment in the reviewer response is helpful for understanding the MODIS snowline data, and would be helpful for readers in addition to reviewers. Please incorporate this text and references into the manuscript itself.

We added part of the answer to the manuscript.

- L179–180: I do not see where any information about the satellite image sources has been added to the supplementary material.

We added the Table in the Supplementary Material. Sorry for the omission.

- L231–232: These specific values of snowline elevation before and after the event are helpful for making the authors' case about the impact of the AR on mass balance. Please incorporate this text from the reviewer response into the manuscript itself.

We added part of the answer to the manuscript.

- L249–251: This is an interesting hypothesis about the different directions the radiosondes likely traveled during versus after the event. I suggest adding the HYSPLIT figure from the reviewer response as a supplementary figure, and adding a sentence to the end of Section 4.3 that incorporates some of this explanation from the reviewer response.

We added the Figure as supplementary material and part of the answer.

- Figure 5 (previously Figure 4): I still think this would be better as a 2-panel figure, with the panels vertically aligned so that the temporal correspondence can still be seen between the high snow accumulation rates and the lower of the 0C isotherm. But I do not feel strongly enough to press the issue further and will leave this to the discretion of the authors.

We understand the observation of the Referee but we prefer to keep it as is, as we look to show the direct relation between precipitation and 0°C isotherm. We think is not so much information for one panel.

- L463–464: Please incorporate some of the text from the reviewer response - about AR projections specific to the study region - into the manuscript itself.

We added part of the answer to the manuscript and the new reference.

Other comments

- Upon re-reading the paper, I feel it is still slightly lacking in insight about the interaction between the zonally-oriented AR and the regional topography that produced the orographic precipitation. Looking at Fig. 1 and at Google Maps for wider context, it appears that the Lagunitas weather station and the Olivares River sub-basin are separated by a ridgeline to the northwest of the Olivares River sub-basin, and there are is also a north-south oriented mountain crest to the west of the Olivares River sub-basin that may block moisture transport from the west. I can also see from Google Maps that the main topographic divide separating Chile and Argentina lies to the east of the sub-basin. I understand that Lagunitas is the nearest station with a long-term record, but I think a better picture of the regional topography would be helpful in interpreting the observations

from this station in relation to conditions on the Olivares Alfa Glacier. I think what would probably be helpful would be to add DEM shading, and shade the ocean in blue, in the bottom inset panel of Fig. 1a to help the reader get their bearings and visualize the interaction of westerly flow with the topography. I apologize for the vague and rambling nature of this comment, I just feel that something is a bit missing.

Thank you for the comment. We kept the Figures as is, as the contour level gives the information about the topography.

- This is a very minor comment, but in the Fig. 1 caption, it would be helpful to point out that the Lagunitas weather station is located near the top left of the large map in Fig. 1a. I had trouble finding the location of the station at first glance, and confused it with the magenta "T5" AWS location marker.

Added.

- L306–324: I am a bit confused by these statements about the melt energy. It looks like the melt energy (black dashed line in Fig. 6) was mostly flat with the exception of a few days (25 Jan, 03 Feb, 04 Feb). Does "typically reaches a mean value of 54 W m-2" refer to the long-term average of melt energy for this time of year? And does the maximum around 150 W m-2 just before the AR event refer to the brief spike in melt energy on 25 Jan?

Thank you for your comment. We clarify in the manuscript that 54 W m-2 refers to the long-term mean and that the maximum of 150 wm-2 observed before the events is a typical peak at this time of the year, so it works as an example.

- L451: I suggest changing "Southern Alps" to "Southern Alps of New Zealand" here. I know the location of Brewster Glacier is mentioned in the introduction, but since this section abruptly switches the geographical context from South America to New Zealand, it would be helpful to remind readers where Brewster Glacier is located.

Added.

- L494: Does "this year" refer to 2016/17 or to 2020/2021?

We reworded this sentence and delete confuse sentence.

Technical corrections

All the technical correction suggested by the Reviewer were include in the new version.

- L23: "typically" --> "typical"

- L40: "between the" --> "between"

- L59–60: Does this sentence mean that AR-related snowfall events are 2.5 times more intense than non-AR snowfall events? Please clarify.

Yes, we clarified this

- L103–104, 116–117: Both these paragraphs have the redundant statement that this is the first AR-glacier impact study in this region. I suggest removing this statement from the sentence in L103–104.

Changed as suggested.

- L107: "extraordinariness" --> "extraordinary nature"

- L141: "darkening their surfaces" --> "surface darkening"

- L143: "divide" --> "divided"

- L151: "historically" --> "climatological"

- L157, 158: "AR" --> "ARs"

- L160: "events at least" --> "events if at least"

- L163: "measure of" --> "measure"

- L164: "evaluating on" --> "evaluating"

- L167: "remark" --> "remark on"

- L170: "in the highlands of this Andes" --> "in this region of the Andes" (?)

- L239: "series" --> "time series"

- L254: The precipitation map is shown in Fig. 3c, not Fig. 3b

- L265: "Reanalysis ERA5" --> "ERA5 reanalysis"

- L265, L489, and elsewhere: After the abbreviation "AR" has been defined in the main text, be consistent with using the abbreviation rather than the full term "atmospheric river" thereafter.

- L273: "75th percentile" --> "the 75th percentile"

- L275: "at" --> "during"

- L277: "Immediately" --> "Immediate"

- L285–299 and check elsewhere: Be consistent with writing "0°" vs "0°C"

- L298: "radiosonde derived" --> "the radiosonde-derived"

- L286: "of January" --> "January"

- L286: "0°C" --> "the 0°C"

- L304: "corresponding" --> "correspond"

- L305: "2°C" --> "the 2°C"

- L306: "fluxes" --> "flux"

- L311: "their" --> "the"

- L315: "the 29" --> "29"

- L322: "the 30" --> "30"

- L322: "fluxes" --> "flux"

- L330: "the 2016/17" --> "2016/17"

- L331: "7-years" --> "7-year"

- L339: "early" --> "earlier"

- L345: "at" --> "during"

- L345: "their" --> "the"

- L408–410: This sentence is confusingly worded. Please rephrase.

We delete a part to avoid confusion.

- L418: "discard" --> "rule out"

- L430: The 2°C isotherm is shown in Fig. 5, not Fig. 4

- L472: "amount" --> "amounts"

- L480: "the equilibrium" --> "equilibrium"

- L484 and elsewhere: Be consistent with how hydrological years are expressed (e.g. 2020/21 vs 2020/2021)

- L505: glacier's --> the glaciers'

- L508: "has" --> "had"

Referee #2 Dr. Alvaro Ayala

Review for egusphere

Title: Unseasonal atmospheric river drives anomalous summer snow accumulation on glaciers of the subtropical Andes

Authors: Bravo, Cisternas, Viale, Paredes, Bozkurt, García-Lee.

PAPER SUMMARY AND RECOMMENDATION

Bravo et al. analyse the impact of an unseasonal atmospheric river (AR) on the annual mass balance of Olivares Alfa Glacier, subtropical Andes of Chile. The AR occurred at the end of January 2021and resulted in a strong precipitation event over central Chile, which is very rare to occur during the austral summer. The authors conducted their analyses using remote sensing products, meteorological observations, and energy and mass balance models. They found that the event produced an accumulation of 164 mm w.e. (measured near the glacier tongue) and lowered the altitude of the 0°C isotherm from typical summer values of 4000-4500 m a.s.l. to 3000-3500 m a.s.l., as well as lowering the snowline to elevations of about 2500 m a.s.l. The authors propose that the annual mass balance of Olivares Alfa Glacier was close to neutral because of the AR and other factors. A statistical analysis based on results for previous seasons indicate that without the event the annual balance of Olivares Alfa would have been negative (between -0.5 and -2.5 m w.e., approximately).

This is the second version of an article that I already revised with positive comments. I had three major comments. I am satisfied with the responses provided by the authors except for a few details that need more clarification in the article. I also have a second round of suggested text changes to improve clarity and flow.

UPDATE ON MY MAJOR COMMENTS

1.

How rare was this event on glaciers?

Thanks for the new analyses. The exceptional occurrence of the event is now much more evident.

2.

Mechanisms that explain the mass balance change

In the revised version, the authors state that (496-498) “It is important to remark that the impact is not solely from the event itself. Two small accumulation events in February and March (Fig. 7b), combined with relatively low air temperature during these months (Fig. S5) reduced the ablation rates towards the end of the hydrological year (Fig 7c)”.

I appreciate that the authors have extended the possible causes that explain the near-neutral mass balance to causes other than the accumulation from the AR. Please add a similar (maybe shorter) statement in the Conclusions and Abstract. I don’t want to reduce the impacts of your findings, but I find these considerations very important.

Moreover, I think it must be clear in the article that, although the event was remarkable and with large impacts across Central Chile, the snow accumulation during the event (0.16 m w.e.) was relatively small in comparison to the typical annual ablation (between 1 and 4 m, Figure 7c). This is why I think that apart from the accumulation (which I agree is remarkable for summer), the increase in surface albedo due to the fresh snow, plus the small events that came later, plus the low temperatures are all responsible for the neutral mass balance.

Thank you for your comments. We add this information in the new version of the manuscript and now also remark this fact in the Conclusion.

3.

Hypothetical scenario ("no event")

Thanks for explaining this exercise more in detail. I see now more clearly what the analysis was, but I think that the methods require a few more clarifications:

212-216: "To further evaluate the impact of this unseasonal precipitation event, we also simulated the 2020/21 hydrological year's mass balance under a hypothetical scenario without the AR's influence, removing the accumulation attributed to the summer-2021 AR. To complete the last two months of the 2020/21 hydrological year, the mass balance time series from previous similar years (i.e., those years with negative mass balance until the end of January) were decomposed to extract the trend for each year (Box et al., 2015). Then, the 2020-2021 mass balance series was detrended, and the average, maximum, and minimum trends derived from previous years, were applied to the analysed hydrological year to hypothesize a scenario range without the occurrence of the AR."

-

"we also simulated": To be fair, you didn't perform new simulations, you use the results from previous years. Please rephrase as it now suggests that you used COSIPY to perform new simulations.

Our approach here was statistical, that´s why we used the word simulation. However, following Reviewer observation in terms that it seems that we perform new COSIPY runs (which is not) we changed this phrase.

"those years with negative mass balance until the end of January": How many years are those, only three? Please mention them explicitly.

Added

"the average, maximum, and minimum trends": Figure 8 shows values of "sigma", is that a standard deviation calculated from only three curves? Did you use standard deviation or a minimum and maximum?

Minimum and maximum. We deleted the sigma in the Figure to avoid confusion.

MINOR COMMENTS

-

Use of the word “rate”

The article uses the word “rate” many times, but I think that it is sometimes superfluous and in other times misleading. Please check the use of this word throughout the article. It seems that many times the authors refer to precipitation totals and not really “a rate”, in the sense that can be understood as an hourly or daily rate. I would say that the important feature of the article was the amount of precipitation and not really a rate, or do the authors refer to a particular hourly or daily rate?

We check this and change when necessary following Reviewer suggestion.

Figure 6

Do these fluxes correspond to the location of the AWS or are averaged over the entire glacier? My guess is that they correspond to the location of the AWS because the snow seems to disappear very quickly. If that is the case, then please reword the caption to: “Glacier energy balance fluxes estimated by COSIPY at the location of the AWS.”

Is the spatial mean, we added this in the caption.

46: citations?

46-48: This knowledge gap contradicts what you asserted in the previous sentence, maybe reword?

We add citations and reword, we eliminate “individual” as the citations added mention the influence of several extreme events along the year and how this modulate the mass balance (e.g. Poveda et al., 2020, section “Southern Tropical Andes”). Then we mention that the individual impact has not be assessed.

48: significance -> magnitude and frequency

Changed

144: Historical satellite images -> from 1955? Those would be aerial and not satellite.

Changed

248: Citations for this sentence?

Added

252: Is the fact that the AR in January 2021 is a Category 1 somehow unexpected? In the Introduction you mention that Category 1 are mainly beneficial.

It is expected, as we mentioned other AR with higher category occur mainly in winter. This AR anyway is characterized because of the unseasonality but the magnitude it is lower that winter AR

446: Why the conditions can’t be generalised?

Basically to different characteristics as surface conditions (e.g. debris) and location (e.g. shadow effects, elevation). Also, some areas are more prone to summer convective storm as Olivares, while other not.

481-482: I don't agree with this sentence. I think that the cold conditions that prevailed during the rest of the summer would have prevented the mass balance to be so negative as in the other years.

We deleted the word "significantly" but after the "no event scenario" we demonstrate that without the event mass balance would be negative anyway.

FIGURES AND TABLES

Figure 4: Can you indicate the event period here?

We added in the caption more detail about the snowline during the event.

Figure S1: Please change the red colour of the ERA5 longwave radiation. It is difficult to distinguish from the black lines.

Changed

Table 2: Define the event period in the caption

Added in the Table.

SUGGESTED TEXT CHANGES

22: glaciers -> basin?

We keep "glaciers", which is the focus of the manuscript.

33: Glaciers are highly sensitive to climatic variations and stand as…

We kept the original redaction

34: Glacier mass balance is a metric that is central to their behaviour and is a critical …

We kept the original redaction

36: Long-term observations, over what period?

We changed "long-term" for "Over the last two decades"

37: Delete "However"

Deleted

37: Embedded in this overall negative mass balance trend there is a large interannual variability in atmospheric conditions that is transferred to the annual mass balance of glaciers.

We deleted "typically" we kept the resto of the sentence.

40: I suggest to reword starting with "The atmospheric interannual variability in the subtropical Andes of Chile and Argentina (between 32S and 36S)…"

We kept the original redaction

42: the Southern Annular Mode….

Added

43: delete “of the subtropical Andes”

Deleted

44: sometimes -> can

Changed

45: modulating annual mass balance -> driving general trends in glacier mass balance

We kept the original redaction

46: modulate -> impact

We kept “modulate” as we use “impact” in the next sentence

56: Delete “Notably”

Deleted

58: Delete “semi-arid”? it is a bit confusing jumping from semi-arid to sub-tropical

Agree

59: “about 50%”?

Added

61: “on mid-latitude glaciers” and delete “mid-latitude glaciers” at the end of the sentence.

Changed

63: dynamics -> mass balance

Changed

65: Suggest rearranging: “…showed that the days with the most intense ablation and largest accumulation rates at Brewster Glacier….”

Changed

71: Suggest rearranging to eliminate the commas, maybe: “Conversely, ARs can trigger substantial snow accumulation events on glaciers located above the 0C isotherm.”?

We think what you suggest change a bit the meaning of the sentence, so we kept it as is.

73: “mid-latitudes, but can also exert a …”

We kept the original redaction

80: notably contributing to glacier albedo changes -> largely increasing the albedo

We kept “changes” as under some conditions, a reduction in albedo could occur. For instances rain-on-snow events.

82: in -> on

Thank you.

83 semi-arid -> sub-tropical? Or define both regions? I would try to stick to one only.

Yes, sub-tropical is used.

85: dynamics -> mass balance

Changed

90: enhances -> can help to enhance

Changed

90: Central Andes? This could be confusing too.

Agree, we changed by “Subtropical Andes”

91-93: Please check the wording an rearrange for a better readability. Viale et al (2018) is cited at the beginning and again at the end.

Viale et al (2018) deleted at the beginning of the sentence.

94: Delete “For example”, this is the main event of the article

Deleted

96: During the event, precipitation in central-southern Chile exceeded…

Added

100: Join both paragraphs

Done

104: marking the first study analysing the impact of an AR on the mass balance of glaciers in the sub-tropical Andes.

We reworded this sentence

106: contextualise the extraordinariness -> describe the exceptional characteristics

We changed “contextualize” by “describe”. The rest was kept it.

106: unusually large precipitation

Added

133: sanitization -> sanitation?

Changed

133: The basin contains…

Changed

134-135: Our analyses focused on the the Olivares Ricver sub-basin (coordinates here), which hosts…

We kept the original redaction

136: These glaciers have experienced the largest ice loss… (“most significant” is not technically correct)

Agree, changes as suggested.

141: they have shown -> their surfaces have shown a trend towards darkening since …

We reworded this sentence

142: We simulate the energy and mass balance of the Olivares….

We kept the original redaction

145: continuous -> larger

We kept continous

146: delete all after “2013”, or why does the loss of area directly indicate fragmentation?

Malmros et al. (2016) quantified a significant glacier area loss of 63% between 1955 and 2013 and indicating a gradual fragmentation of the ice mass over the years.

151: why “extend”? maybe “build a catalogue”? This is the first time that a catalogue is mentioned in the article.

Changed by “to catalogue”

151: “a catalogue of the summertime AR in the Andes”

Previous answer

152: rate or total? Or did the event have a high daily or hourly precipitation rate?

Changed, although rate is also defined “by unit time”

153: “we identify AR conditions on the grid points of the ERA5 reanalysis data representing the coast of Central Chile in the 1941-2023 period”.

We kept the original sentence.

160: “of at least Category 1 conditions that occurred”?

We reworded this sentence adding “if”

163: Please check the verb tenses of all the sections. It seems that this section is in present tense, but the next section is written in Past tense.

Done

163: of AR -> the AR

No change here

164: delete “on”

No change here

165: the available 83-year period

Added

173: Firstly, we estimate if glaciers in the Maipo River Basin were …”

We kept the original sentence.

174: “For this, we utilised…”

Added

180: Delete “Furthermore”

Deleted

183: “1a) to estimate the freezing level.”

Added

183-184: “The freezing level was estimated using a linear regression…”

Added

185: “accuracy and reliability” of what?

Of the estimation of the freezing level.

193: Please provide the simulation period at some point at the beginning of the paragraph.

It is indicated in the paragraph.

195: not only turbulent fluxes, I guess, but the full energy and mass balance

Changed as suggested

196: “To cover the complete simulation period, we derived data before 2016 from the ERA5 reanalysis, after going…”

We kept the original sentence.

198: “incoming shortwave and longwave radiation”

Added

202: delimitations -> outlines?

Chnaged

203: “The model distributes…” This fits better somewhere in the previous paragraph.

Moved

206: “annual approach” is not a very clear term, maybe is better just explain?

“approach” changed by “time-steps”. The explanation is in the next sentence

207: no-snow starting -> snow-free initial

Changed “no” by “free”

208: “The analysed model outputs”

Changed

208: total -> glacier total

Changed

210: was made with that of previous…

Added

212: Please start here a new paragraph

We thing is part of the same overall idea associate to “simulation” We kept the original form.

232: Please check the use of the word “rate”

Changed by “Accumulated precipitation”

233: “costal grid points of Central Chile”

We kept Pacific.

234: rarity -> low frequency?

Changed

236: the total number of AR events during all seasons reached 687

Changed

239: delete “nearby”

We kept it

241: Move “Valenzuela et al. (2022)…” sentence to the end of the paragraph.

We kept original paragraph structure

250: at Lagunitas station

Added

265: “ERA5 reanalysis”

Changed

267: 19 AR summertime (DJF) events

Reworded

275: usually being

Added

277: it -> this value

Changed

279: January 2021 -> Maybe more like December 2020?

We reworded this section following recommendations of Referee 1.

286: the 0C isotherm altitude

Changed

287: isotherm altitude estimates

Added

289: minimum altitude of the 0C

Added

290: “Around this time, … were accumulating snow.”

Changed

293: at the glacier lowest elevations

Changed

294: up -> down?

Deleted

294: “decreased to altitudes similar to those observed in the previous day”

Reworded

296: “On the days after”, How many?

Not changed

298: radiosonde-derived

Changed

302: Time series of the 0C isotherm (left axis) and hourly precipitation (right axis) during the event

Reworded

304: Bars indicate

Added

304: correspond

Changed

307: indicate that the

Added

309: Latent heat fluxes are predominantly negative (), indicating that…

Changed

312: daily mean value?

Reworded

315: in the magnitude of both the net shortwave and longwave

We kept the original sentence

319: decrease of the surface temperature

We kept the original sentence

321: why does the persistent cloud cover reduce the temperature gradient?

Because air temperature decrease, reaching values close to the surface temperature.

326: remove “according to…”?

Removed and changed

328: remove “and the accumulation and ablation”

Removed

329: May-March?

April-March. Thank you

330: wit the mass balance of 2019/20

Added

330: The mass balance in 2018/19 was

Added

330: while the mass balance in 2016/17

Added

331: with a positive value

We kept original sentence

331: maybe add “cumulative” somewhere, to make sure that you don’t refer only to April values. Also, it would be better to say that is “the trend” that is interrupted, I think.

We kept original sentence

336: The mass balance in 2020/21 shows

We kept original sentence

339: earlier than

Changed

345: please reword, the glacier experienced the mass loss, not the years.

Agree. Changed.

347: a sensitivity -> a hypothetical

Deleted

348: delete “negatively”

Deleted.

352: Cumulative glacier mass balance, or why “mean”? is that a spatial average?

It is a spatial mean. We added this information in the caption.

352: delete all “mean”

Previous answer.

353: are -> indicate, represent

Not changed

357: Hypothetical glacier mass balance

Added

362: using a constant lapse rate for air temperature is not realistic.

Added

364: The explanation of the snow albedo parameterization should on “Methods”

We kept here as is listed as uncertainty source and the limitation are discussed.

364: ice albedo is assumed as spatially uniform and spatially constant.

We add spatially constant

365: the ice albedo parameterization

Added

367: of the glacier surface

Changed

368: … penitentes – spiky…- has been noted on the Olivares River sub-basin glaciers.

Changed

370: “Indeed”, repetition

Deleted

372: context of a severe drought

We kept mega-drought

375: the relative impact

Added

377-378: What do you that no direct measurements of energy balance fluxes are available? The other studies use probably the same type of data (AWSs)

The sentence is for Olivares Alfa glacier specifically. We mention that ”…similar modelling and observational analyses have been conducted on nearby glaciers…”

387: those from previous studies

Added

388: such as varying periods, elevation,

Added

391: Geodetic mass balance of Olivares Alfa Glacier for the last 20 years has been negative.

We kept original sentence

393: Can you add the uncertainty of the Hugonnet estimates? I guess it is quite a lot for such a short period

This comparison is qualitative, just to check if our modelling is in the range of previous estimation. To keep it simple we don´t includes uncertainties, which it is possible to look in the sources.

397: Mention somewhere that the monitoring of Echaurren is done in-situ using the glaciological method

Added

397: Not only is reported to WGMS, but is also the reference glacier for the Southern Andes

Agree, but we don't add this information. There are discussions about the representatively of this glacier considering the changes in its characteristics

406: snow accumulation on

Changed

408-410: Can you reword using less commas? It would help the flow of the reading

We delete a part of this sentence

410: The maximum IVT value? Or the mean?

Maximum.

412: the long duration

Added

413: rate of snow accumulation -> snow accumulation values compared to previous summers

We kept the original sentence

416: determine the occurrence of snow accumulation on glaciers

Reworded

435: summer snow accumulation is not unusual. To illustrate this, …

Added

441: "after the event", for how long?

Added

442: , even at the elevation of …

Changed

443: the glacier surface

Added

445: However, these conditions…

Added

447: GEONOR sensor

Added

451-453: Please check the sentence structure

Reworded

459: of incoming longwave radiation

Thank you

459: they represent an energy sink

Added

461-464: Please reword. It is not very clear.

Reworded

475-475: Same here. Please consider splitting the sentence.

We deleted a part of this sentences as we agree was confused

480: The mass balance would have been

Changed

485: Maybe delete “during 1991-2021”, it confuses a bit the sentence

Ok

485: Delete “rate”

Ok

501: orographic summertime precipitation

Deleted “heavy”

503: delete “in the subtropical Andes”

We kept it.

508: has -> had

Changed

511-512: The reduction in the magnitude of energy sinks did not compensate for the decrease in energy inputs.

We kept the original sentence.

519-521: Please reword, not very clear with so many commas.

We reworded this part adding new information.

521: accumulations -> accumulation

Changed.

527-530: Check the verb tenses (all in present)

Ok