

Response to major comments:

L 196. Are these seasonal differences significant? The authors write in the response that they are significant, but it is not enough to just state that they are significant. Please, provide a p- value and which test has been used. That is, specify at what level it is significant to the main text of the article (not suppl. m.) (e.g. $p < 0.05$). If it is not significant, just say that the relationship is weak, because the time series is short, and this is a bit speculative. Provide the r and p-values in the main text.

The significance of this relationship was established using ERA5 by Maclennan et al., (2022). We have cited this paper and also done the P-test that the reviewers requested. For each climatology the p-value for the seasonality test is less than $< .001$ suggesting the seasonal cycle is very significant. We use the permutation test to assess the significance of the seasonal changes in the accumulation climatology at each site. The null hypothesis of this experiment is that the observed seasonality (or periodic pattern) is not statistically significant and could be attributed to gaussian distributed noise. We first compute the autocorrelation function for the original climatological mean and standard deviation of the accumulation time series. We then shuffle the data (randomly permuting the daily accumulation rates independently). This breaks any existing temporal structure or seasonality of the data. We then calculate the test statistic for each permutation repeating this process 10,000 times to build a distribution of the maximum autocorrelation values according to the null hypothesis.

Gaps in record. 2941 days is 8 years, and 3282 days is 9 years. Provide the length as years too, that way it is easier to see how long they are. It is a great record, but it is wrong to describe it as over 10 years of continuous data. What are the gaps caused by storms?

We have stated this more clearly. The total time span of the record is over 10 years, but your point about what that represents is really important. The yearly maintenance required to dig out these systems and replace the power supply is the reason there are gaps in this record, as noted above. Generally, they are not affected by storms, but by losing power when solar panels are buried or when wind generators fail (this could be storm related due to excessive winds or rime accumulation, but they are also more commonly just buried by snowfall if the site is not visited annually).

ERA5 anomalies. “Anomalies were calculated by subtracting the historical seasonal means for the observational period (2009–2022)”. The whole period of reliable data 1979-2022 should be used when you calculate the anomalies, not just 2009-2022.

Previous work suggests that climate has changed significantly in West Antarctica over the observational period (1979-2022). This is why we focus our interpretation of reanalysis (which is done at daily resolution) to the period when we have observations.

I. 13. ...Rosby wave train...

We appreciate the suggestion! Thank you!

I. 26. e.g. not i.e.

We have made the change to e.g. and been more judicious regarding proper use of these phrases throughout the manuscript.

I. 44. Interannual blocking variability has been linked to marine air intrusion and accumulation variability recorded in the Roosevelt Island Ice Core, West Antarctica using automated weather stations. AWSs were indeed used in this study but it doesn't fit here at the end of this sentence.

We have deleted the second part of this sentence.

I. 82. Figures

We have made this plural.

I. 90. Insert a major header for the method section first "2. Methods".

We have added the major heading. We've also changed the results section's major headings. We now have a large results section that includes subsections.

I. 92 The stations' names have already been defined. No need to do it again here. Or at line 199.

The sentence where these stations were first mentioned was very long. We've elected to remove their mention in this sentence and leave them listed as they are in L92. We have removed them from L199. We believe this improves readability, but are happy to make further changes as needed..

I. 125 I would suggest that you don't refer to the figures here. It's enough to say something about the type of result that will come but don't go into too much detail. It is better to wait to refer to the figures in the results.

Sounds good. The reference to the figures has been removed. We appreciate the suggestion.

Figure 2d, is the black line in the time series from a running mean? Is it possible to make the time series less blurry? Capitalize the stations' abbreviations in the legend.

The black line consists of points that represent the median filtered signal.

Are the supplementary figures and tables listed in the order of appearance?

They were not listed in order of appearance. We have corrected this mistake.

Figure 3 caption. Rh not RH?

We have changed the text in the caption to R_h .

I. 164 The B term could be explained earlier, eq. 6?

The B term is now explained in the section where it is first referenced (before equation 6).

I. 155 Could the Metropolis-Hastings algorithm be described as machine learning? I'm not an expert in regards to the GNSS method, but your description sounds like self-learning and I see the cost function in Figure 3. If it is ML maybe write so to boost the search hits for the article.

This is not a machine learning method. It's an optimization method (a more general category that is also shared by ML methods). We have more clearly referred to it now as an optimization algorithm.

I. 176. "Kohler Glacier site is included"

Thank you for the change.

I 192. Check the header structure. The results section should have a new major header (3 Results) and not continue with 2.3.1.

We have made the results section its own header and the subsections that follow have their own subsection headers.

I. 199. "and minimum in November..."

We've made this change and restructured this sentence.

I. 208. Use "meters above sea level (m.a.s.l.)."

We appreciate the suggestion. We've gone with the abbreviated "meters above sea level" as the phrase is used just twice in the article.

Figure 4. The figures don't appear in the order that they are presented in the text. Perhaps it would be easier if you mainly wait to introduce the figures until the results.

We have corrected this with the other changes to the figures. Thanks for the suggestion.

Figure 4. ... height (grey contours)... Fig. 4. ...(cyan-green contour) with the guiding 500 hPa geopotential height (grey contours)... Figure 4. Explain the graph to the right. Shows cumulative accumulation and the vertical dashed line indicates the timing of the atmospheric river event.

Thanks for the suggestion/catch. We have added a sentence that describes the plots with each atmospheric river we detect using the GNSS-IR time series.

Figure 5. capitalize the letters in the station abbreviations.

Letters have been capitalized. Thanks for the catch!

Figure 6. Delete the first part here. Interannual accumulation and t The seasonal accumulation Cycle...

We have deleted the first part of this sentence.

Figure 7 caption. ...500-hPa geopotential height (grey contours)...atmospheric river event (cyan-green contour)

We have made the suggested change. Thank you!

Figure 7 (D, E). Is there any significance to the fitted linear regression lines? I'm not questioning the relationship but it might not be significant for these measurements where there is a fair amount of spread in the data.

The fit is significant and is now accurately cited in the text.

Figure 8 (A, D). Why isn't there any stippling for the blocking frequency? Make the significant test here too.

Blocking frequency requires a bootstrapping approach that was beyond the scope of this study to calculate as blocking itself is a binary field.

I. 231., I. 233., I.293. Remove "spring" since it is not a season that is presented results for.

We do have springtime blocking included in the supplement; this is now referenced more carefully here.

I. 259. "500-hPa pressure level composites were analyzed across the Southern Hemisphere to for the significance of tropical teleconnection"?

We've changed the structure of this sentence to be more accurate and briefer following the reviewer's suggestion.

Figure 11. “the numbering of the days indicates the days before the extreme precipitation events”

We have changed this sentence to respond to the awkward phrasing of the indexed days.

Figure 11. How come there is stippling where the anomaly is close to zero? Perhaps something spurious with the SST anomalies in the sea ice zone near Antarctica. Filter out outliers?

Anomalies close to zero can still be significant if the relationship is weak. We have elected to keep these, but can remove them if the editor wishes to have a threshold tolerance for the relationship.

I. 319. Suggested change “Significant sea surface temperature composite anomalies observed in the Atlantic and western Indian Ocean preceding extreme precipitation using the GNSS-IR record are consistent with the propagation paths of eastward propagating Rossby waves modeled in the Southern Ocean by Li et al., (2015).”

We agree with this change and have made it in the text. Thank you

P. 18-19 Discussion about Rossby wave trains. Check if this part can be written more clearly. Split up long sentences. Can you add some explaining arrows to the plots perhaps to show the direction of the propagation?

We have edited this section and the plots according to the reviewer suggestions.

I. 330. This is a too-sweeping general statement. Perhaps correct for the Thwaites region, the area of investigation here, but not for all Antarctica ice cores. A standard check before (or at least afterward) an ice core site is proposed would be to check for seasonal bias.

Some of these Thwaites sites are closer to WAIS divide than they are to the grounding zone. We agree that these can't be generalized to all Antarctic cores. We do think this applies to WAIS cores, and we also think the GNSS-IR method is a really great way to

I. 335. “Aquifer”?

Yes, thanks for the suggestion. We have made the spelling change.

I. 362. Delete “interrogate”, “investigate” sounds better.

Thanks for the suggestion. We agree.

I. 363. "...that precedes the GNSS extreme..."

We've rewritten the sentence combining extreme precipitation with vapor transport as processes explored using the GNSS-IR accumulation time series.

I. 372. "events"?

Thanks for the catch.

Supplementary material

Table 1. Column 4 name: "days (for which accumulation can be extracted and averaged)". ERA5 anomalies. "Anomalies were calculated by subtracting the historical seasonal means for the observational period (2009–2022)". Please use the whole period of reliable data 1979-2022 when you calculate the anomalies.

We do not use the whole period as there are trends in these data. The mean from the modern period seems more consistent with the anomaly associated with the events that we catalog and is consistent with other observational reanalysis studies.

Move section 3.2. Significance testing into the method section of the main text. Does the test consider autocorrelation? You give a reference for spatial autocorrelation but is regular autocorrelation in time considered?

This is an autocorrelation in time at spatial points closest to each site.

Emanuelsson et al. first established the relationship between high-pressure anticyclones and accumulation with the RICE ice core records. Then they checked the details of the mechanism using the AWS records and ERA-interim reanalysis composites, e.g. using Z500. Then the spatial validity of the relationship was checked by checking the relationship for several West Antarctica sites: WDC, ITASE 2000- 5, and ITASE 2001-5.

We have highlighted this result in the text. The WDC and ITASE 2000-5 and ITASE 2001-5 cores sites are deeper into the interior than these sites that are 100 km closer to the coast. Our records also record snowfall directly and so issues associated with firn densification do not need to be considered.