

Review of the manuscript egusphere-2024-2845 entitled “PDO-driven interdecadal variability of snowfall over the Karakoram and Western Himalaya” by Bharati et al.

Snowfall not only affects the mass balance of glaciers but is also an important source of water resources in arid and semi-arid areas. The Karakoram and Western Himalaya regions are home to numerous high mountain glaciers, serving as the sources for rivers such as the Indus, Tarim, and Amu Darya. The unique characteristics of the Karakoram anomaly have drawn sustained attention from the academic community. This article explores the relationship between the Pacific Decadal Oscillation (PDO) and winter snowfall in the Karakoram-Western Himalaya region, analysing the mechanisms involved. The paper is well-written and presents a clear line of thought. I recommend that the paper be published in Weather and Climate Dynamics following revisions.

#Major

1) Lines 98-104: While these interdecadal factors (PDO, IPO, and AMO) significantly influence global climate, could you explain why this article focuses solely on the impact of the PDO?

Reply: Our decision to investigate the role of the PDO follows from Fig 15 in the recent review of WDs by Hunt et al (2024; doi:10.5194/egusphere-2024-820). There, they perform a correlation between WD activity and SSTs, and highlight the potentially important role of both the PDO and NAO. Similarly, our own Figure 3, where we correlate decadal-filtered SSTs with decadal-filtered WH winter snowfall, shows no signal in either the AMO or IPO. For these reasons, we have focused on the PDO. We have also compute the partial correlation between snowfall in WH and PDO after excluding the ENSO, IPO and AMO influence (explanation mentioned in lines from 220 to 226) in the revised manuscript.

2) Lines 107-109: A published study examines the impact of the PDO on non-monsoon season precipitation in the northwestern Himalayas, highlighting its role in regulating westerly disturbances (Aggarwal et al. 2024, CD). Please introduce it here and emphasize the differences with this work.

Reply: The suggested point has mentioned in the revised manuscript.

3) From Figure 1a, it can be observed that the precipitation values from the reanalysis data are significantly higher than those from the assimilated grid precipitation data. Additionally, the reanalysis data exhibits more pronounced interdecadal variability. What factors contribute to this discrepancy? This article is primarily based on ERA5 data. what impact does this have on the results? Please discuss.

Reply: We agree with the challenges associated with long-term snowfall monitoring in this complex topographical area. The reanalysis datasets overestimate precipitation relative to satellite datasets and some rain-gauge datasets; yet, the seasonal variability of precipitation exhibits comparable variability among all datasets in relation to ERA5. Also, the correlation coefficients between the reanalysis and most satellite and observational datasets is very high as we state in Table 1, implying a very high covariance. Although ERA5 precipitation exhibits biases in its quantity throughout this

region, it has been used in other existing study for analysing seasonal snowfall variability. Our choice of ERA5 thus has almost no effect on the results, except for its longevity.

Following minor point (5) of this reviewer and major point (2) of the other reviewer, we have replaced our simple box-based regional selection with a more accurate boundary for the KH. This further improves the correlation of all precipitation datasets with ERA5 precipitation over the KH.

4) From your analysis, it is clear that there is a significant correlation between PDO, WD, and snowfall. However, the article does not clearly explain how the PDO influences the westerly disturbances in the Karakoram-Western Himalayan region through teleconnection processes. Additionally, is it possible to validate the process by which the PDO affects winter snowfall in the Karakoram-Western Himalayan region through modelling experiments?

Reply: We disagree with the reviewer. We have shown that the negative phase of the PDO leads to more frequent (more intense) WDs at slightly higher latitudes than usual (e.g. into the Karakoram, where the signal is the strongest) by modulating the STJ. The presence of a stronger STJ along with a wave-like pattern of trough (anomalous cyclone) over the northern region of KH, and a ridge (anomalous TP anticyclone) in the upper atmosphere, increases the occurrence of WDs over KH during the PDO-.

5) Additionally, is it possible to validate the process by which the PDO affects winter snowfall in the Karakoram-Western Himalayan region through modelling experiments?

Reply: The mechanisms and atmospheric response of the PDO teleconnection to winter snowfall in the Karakoram-Western Himalayas through modelling experiments constitute part of our planned future studies. This is already mentioned in the future work part in the conclusion of this study.

#Minor

1) Line 76: Add a space before WD.

Reply: Corrected in the revised manuscript.

2) Please include some recent references in the introduction.

Reply: The required references have been added in the revised manuscript.

3) Line 126: The following analysis uses data up to 2023 (Table 1), but here mentions data only up to 2022. Please check.

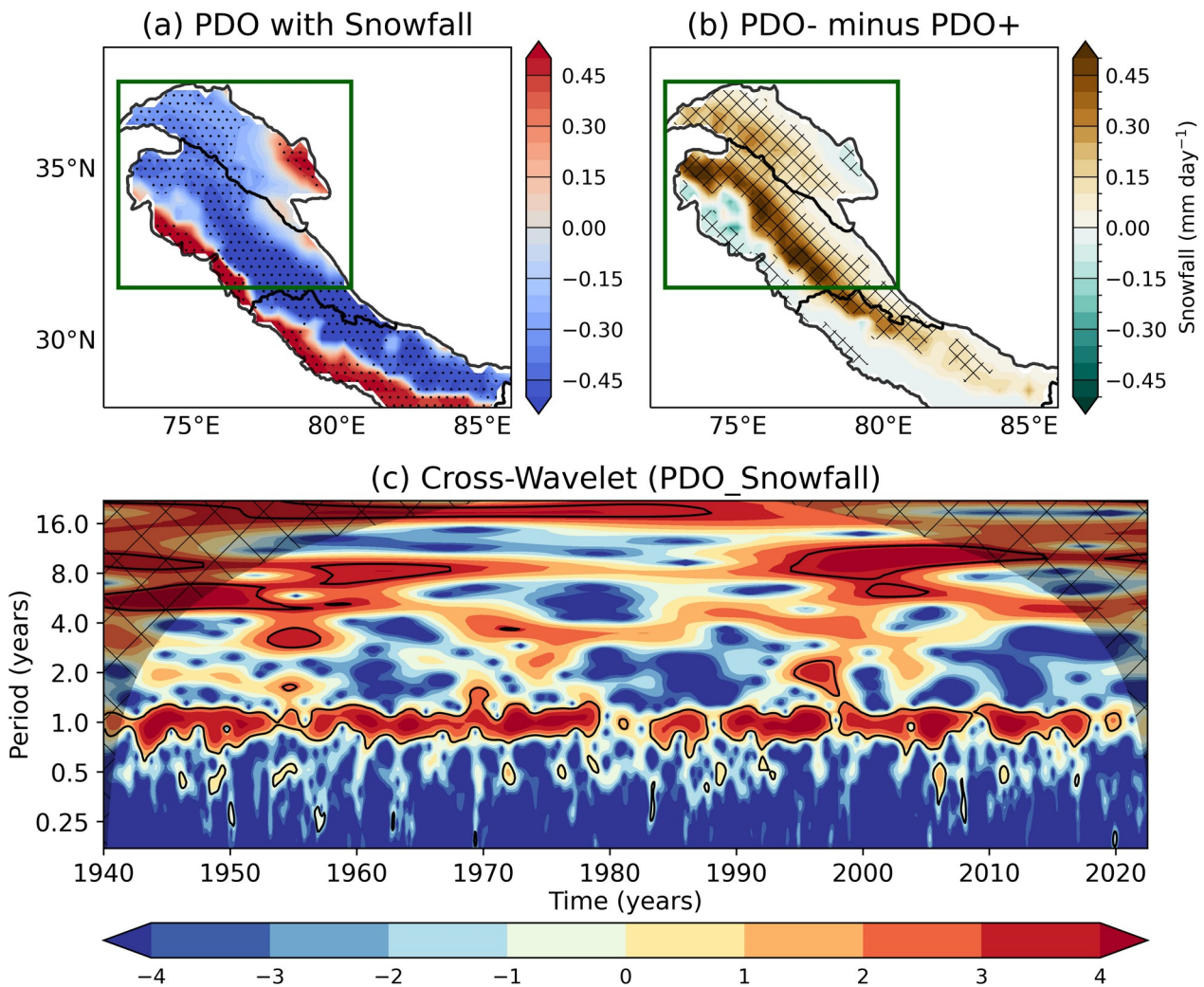
Reply: We have done the analysis from 1940 to 2022. The time period is checked for Table.1 in the revised manuscript.

4) Line 162: Could you clarify the temporal resolution of the data used for the calculations in this section?

Reply: Monthly temporal resolution is used to analyse all meteorological parameters in this study and updated in the revised manuscript.

5) Lines 206-217: When calculating the correlation of snowfall in the Karakoram -Western Himalaya region with other indices, was the part of the region with significantly positive correlation coefficients (Fig 2a) excluded? If not, I recommend excluding it before recalculating, as this will likely yield more reliable results.

Reply: *This is very useful suggestion to improve our results. We have computed the correlation after excluding the regions of significantly positive correlation. Our results have been updated accordingly in the revised manuscript. The updated plots in figure 2 are shown in the revised version as following plots:*



6) Line 453: I did not see any information regarding significance testing, please check. If there isn't any, please add it.

Reply: *The plotted SST are only the significant magnitudes from the correlation and significance testing. The detail about testing has updated in the revised manuscript.*

7) Figure 6, please use the same aspect ratio (width to height).

Reply: *Figure 6 is updated in the revised manuscript.*

Related references:

Aggarwal D, Chakraborty R, Attada R. Investigating bi-decadal precipitation changes over the Northwest Himalayas during the pre-monsoon: role of Pacific decadal oscillations. *Climate Dynamics*. 2024 Feb;62(2):1203-18.

Dimri AP, Pooja, Jeelani G, Mohanty UC. Western disturbances vs Non-western disturbances days winter precipitation. *Climate Dynamics*. 2023 Nov;61(9):4825-47.