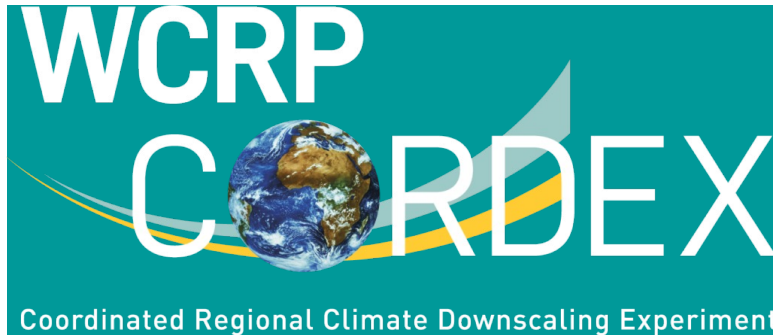


Himalayan glacial anomaly as simulated by a coupled regional **glacier-climate model** and its synoptic-scale drivers

ICRC-CORDEX 2023

International Conference On Regional Climate
25-29 September 2023

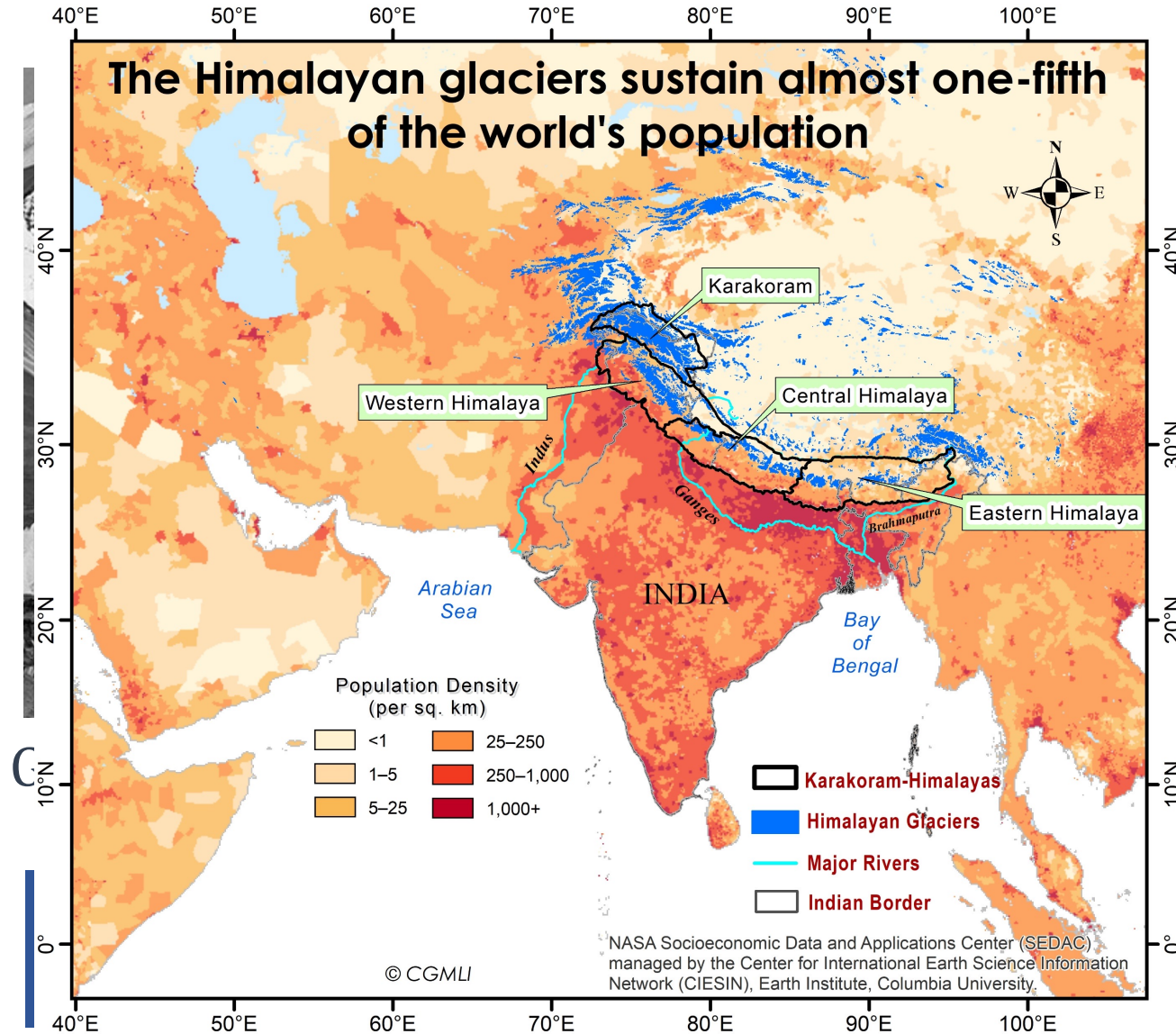


The Abdus Salam
International Centre
for Theoretical Physics

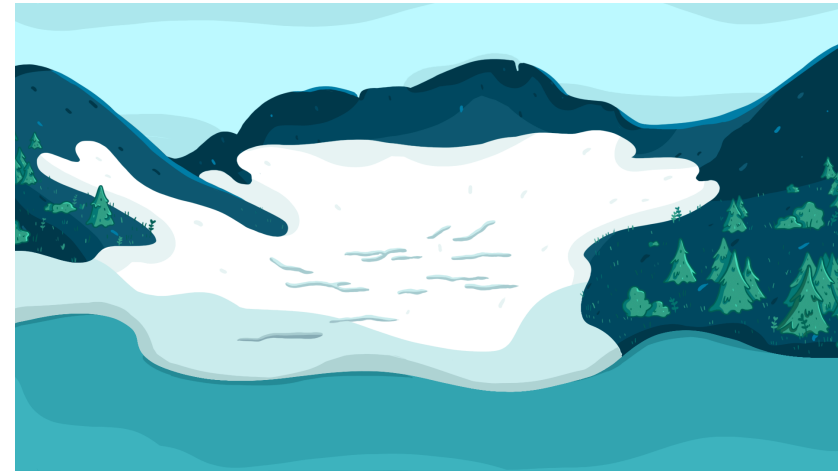
Aaquib Javed

Department of Earth & Environmental Sciences
IISER Bhopal

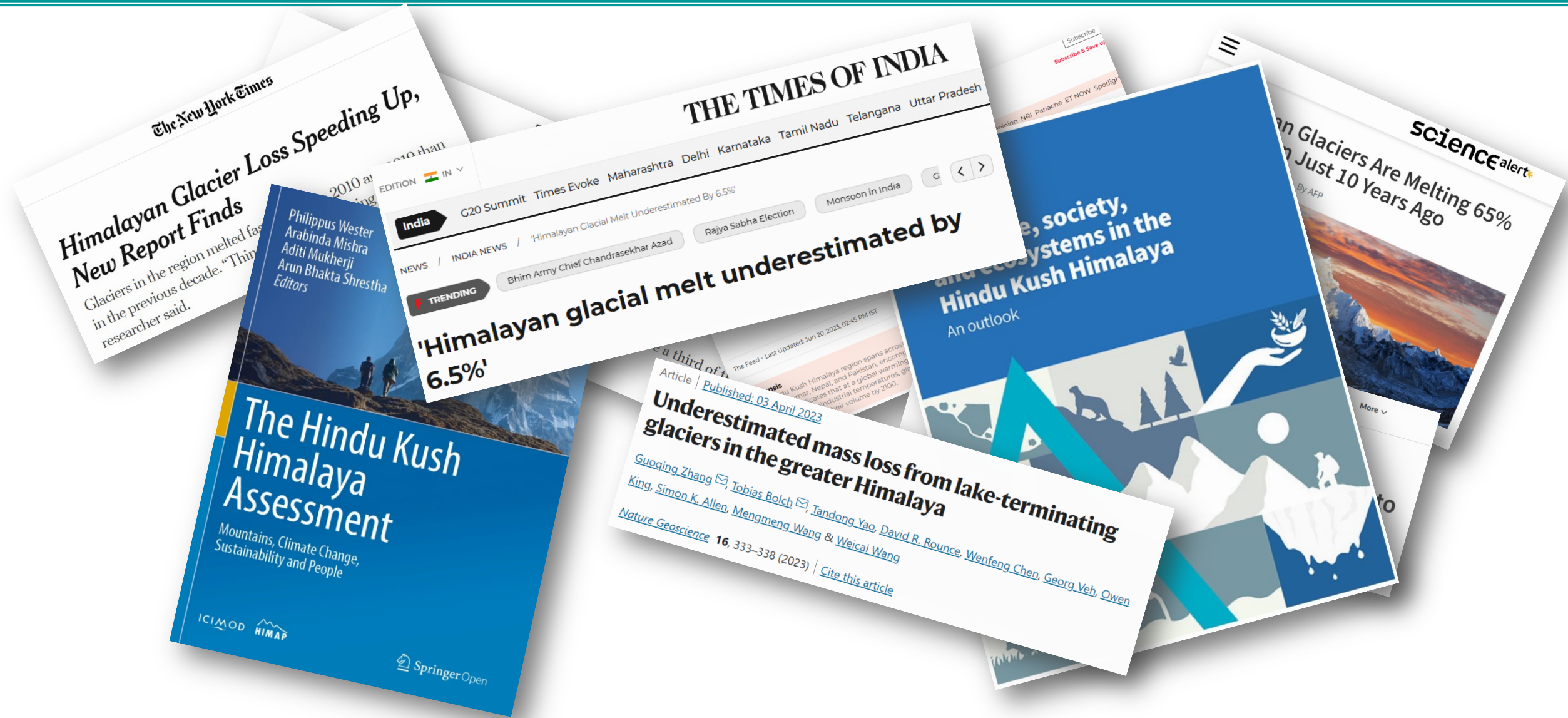
Why care about Himalayan Glaciers ?



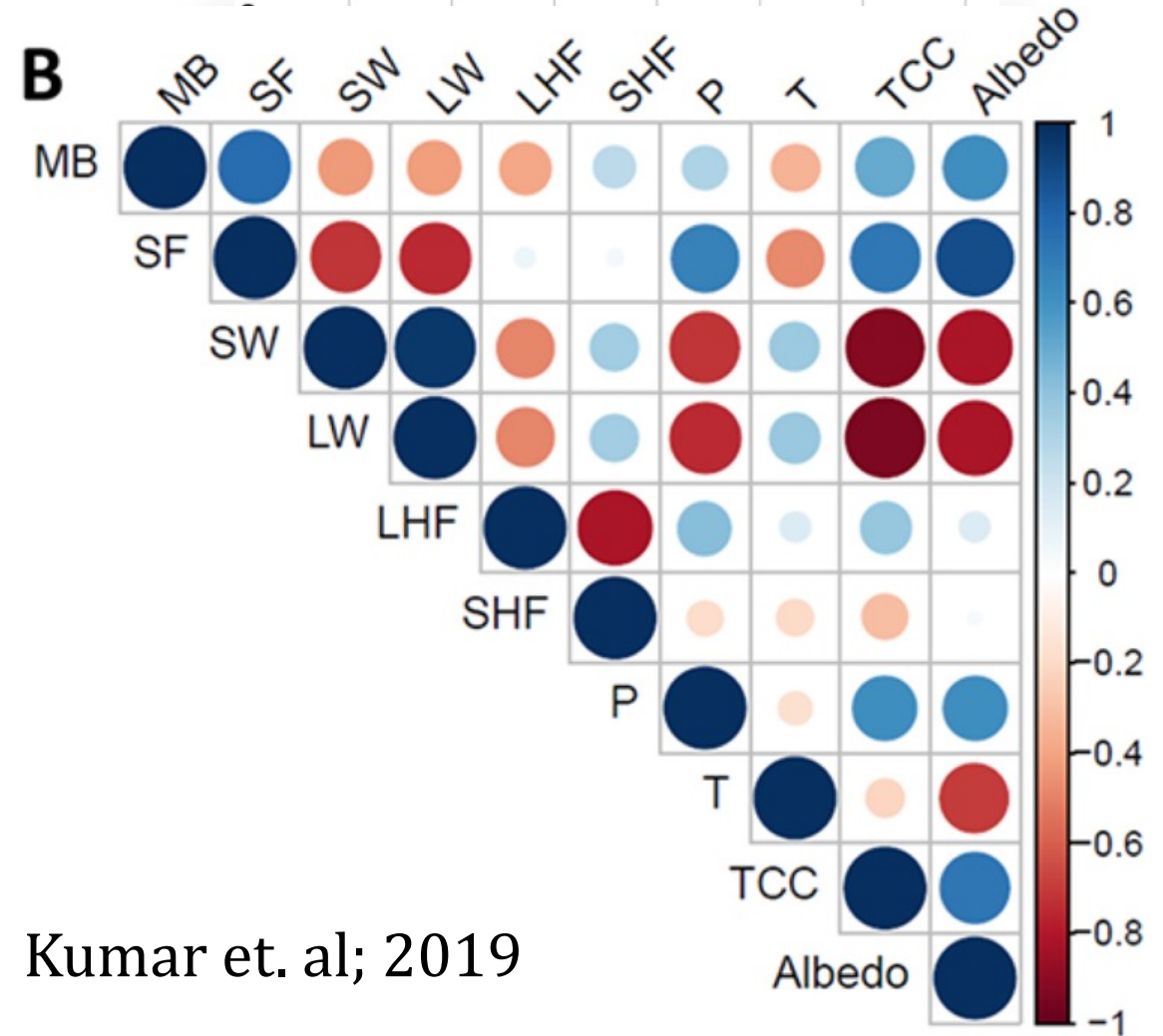
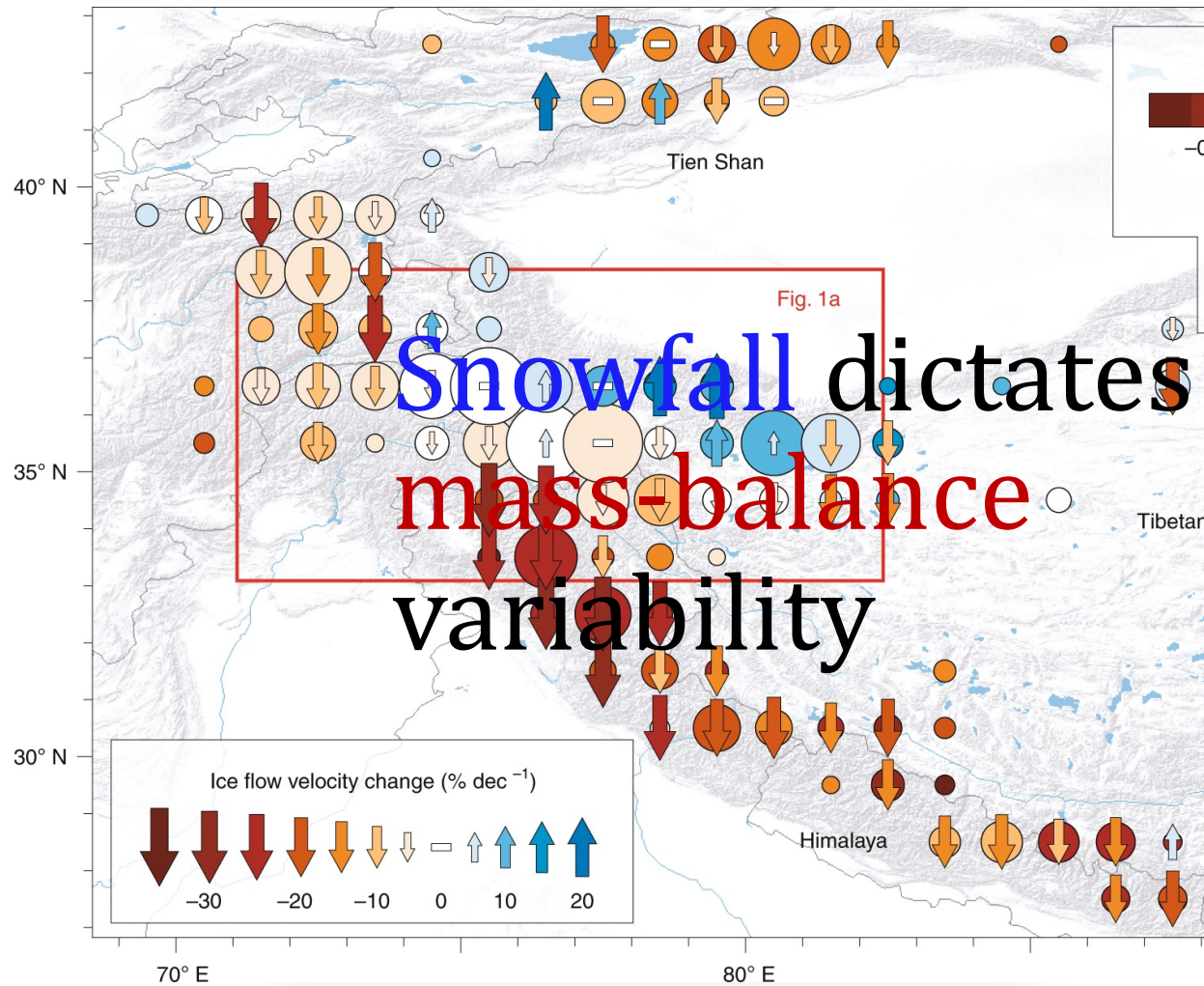
Rising temperatures threatening Himalayan glaciers!



Why care about Himalayan Glaciers ?



Karakoram Anomaly – A silver lining?



Kumar et. al; 2019

REMO_{glacier} for mass-balance studies !

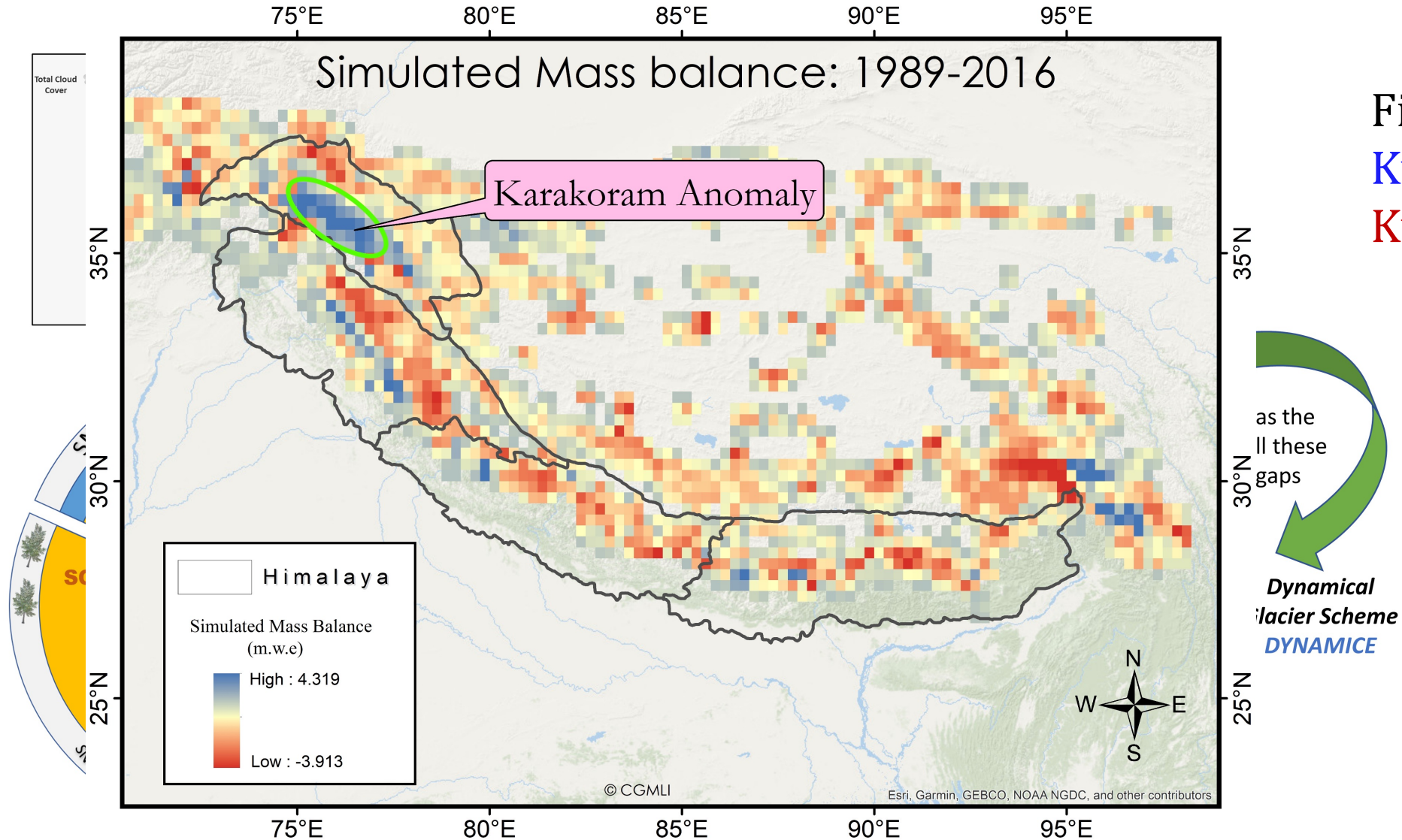
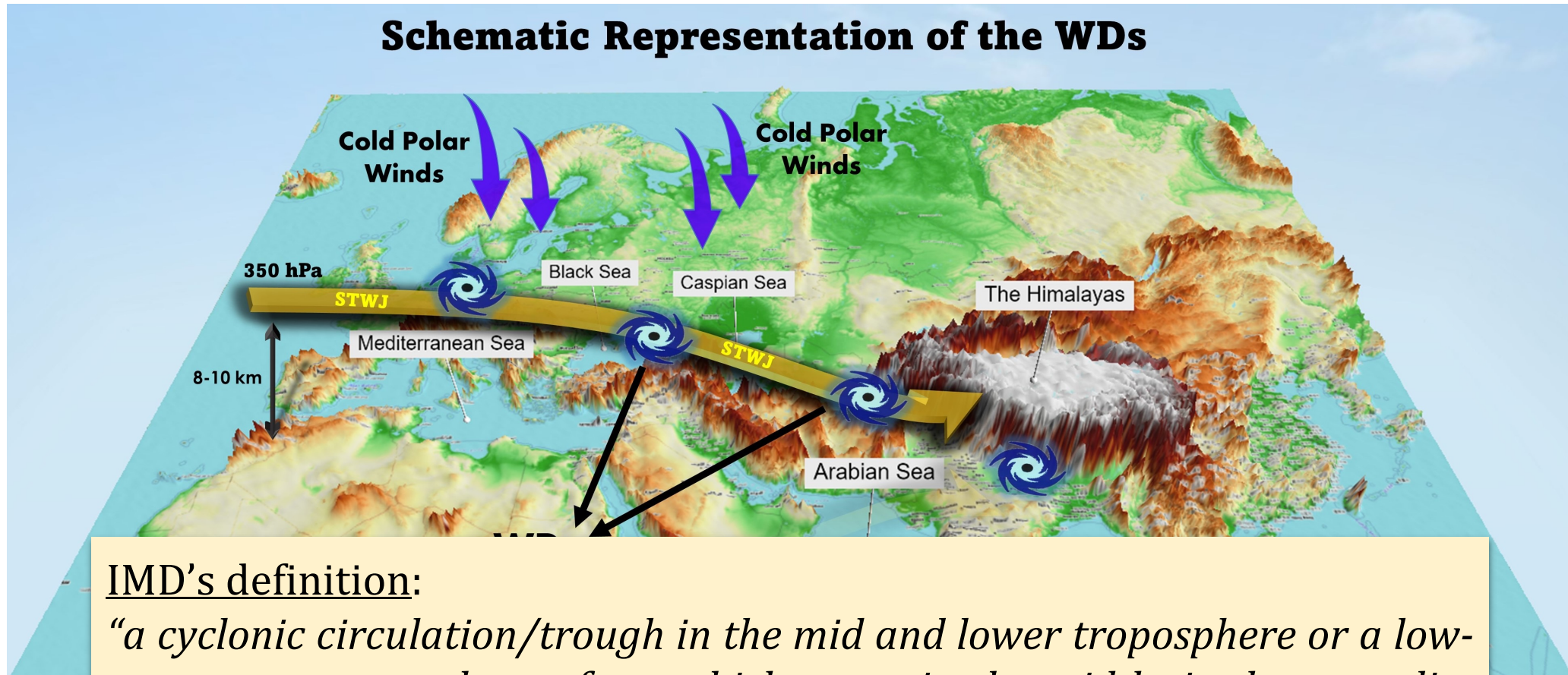


Figure adapted from
Kumar et al., 2015 and
Kumar et al., 2019

What are **Western Disturbances**?

Schematic Representation of the WDs



IMD's definition:

"a cyclonic circulation/trough in the mid and lower troposphere or a low-pressure area on the surface, which occur in the mid-latitude westerlies and originate over the Mediterranean Sea, Caspian Sea, and the Black Sea et stream (STWJ), and move eastwards across north India"

They then

Objectives of the study?

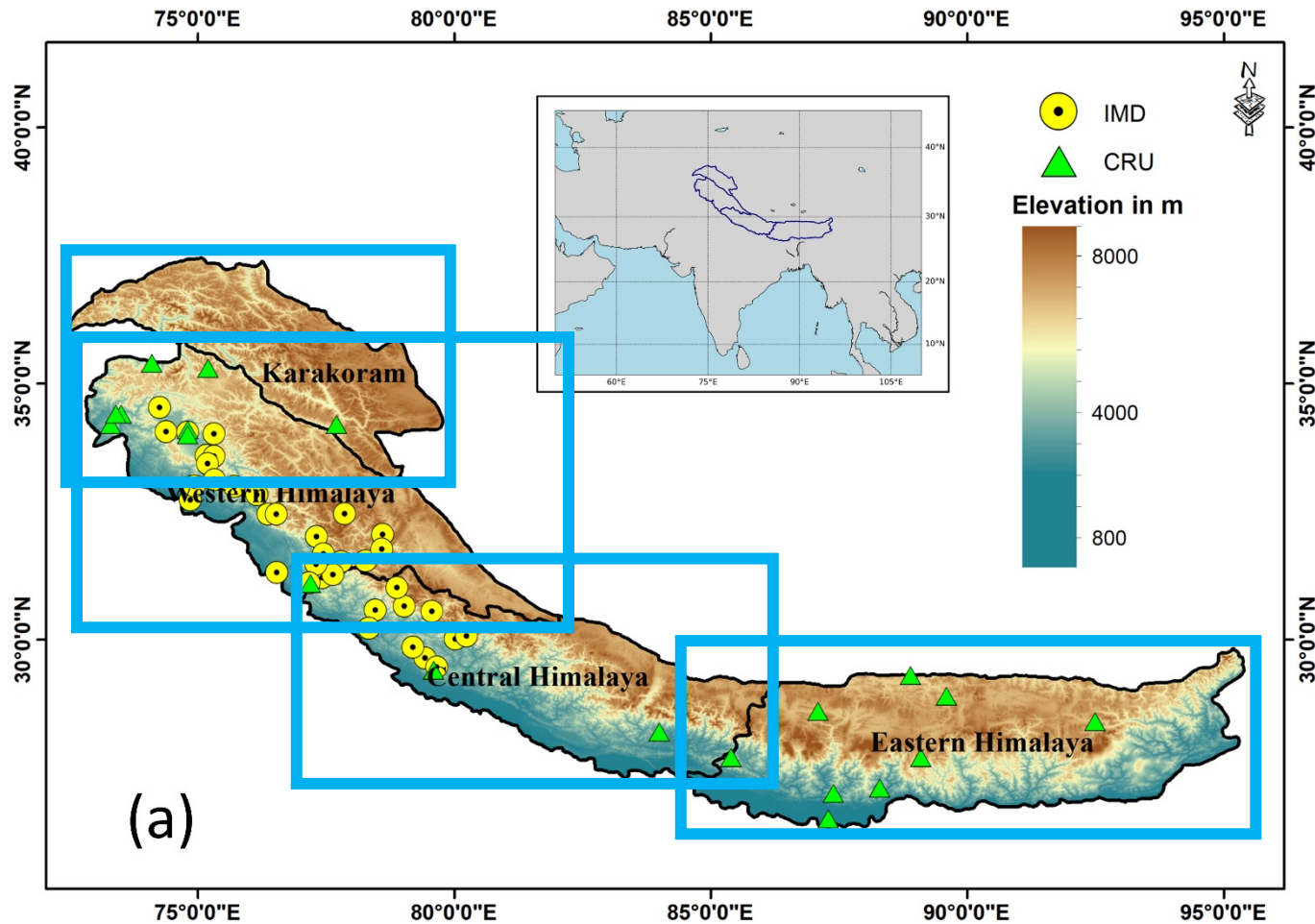
To examine **the role of WDs** in controlling the "Karakoram Anomaly"

Identify the **key behavioral changes** in WD frequency and intensity

Quantify the WD **snowfall contribution** to regional precipitation

Dynamics controlling the formation and propagation of WDs in recent decades

Study Region and Boxes



Extent of Impact Boxes:

- **KR:** 33°N-37.5°N and 72.3°E-80°E
- **WH:** 30.2°N-36°N and 72.6°E-82.2°E
- **CH:** 27°N-31.7°N and 76.8°E-86.5°E
- **EH:** 26°N-30°N and 84.3°E-95.6°E

Extent of Genesis Box:

20°N-50°N and 20°W-60°E

Extent of Himalayan Box:

26°N-37.5°N and 72.3°E-95.6°E

Javed et al., 2022; *Journal of Climate*

Methodology – WDs Tracking Algorithm

- ERA5, MERRA2 and NCEP-CFSR used to generate WD storm tracks for the period 1980-2019 (Nov-Mar).
- “TRACK” developed by Dr. Kevin Hodges (University of Reading)
- Relative vorticity between 400 and 300 hPa levels used.

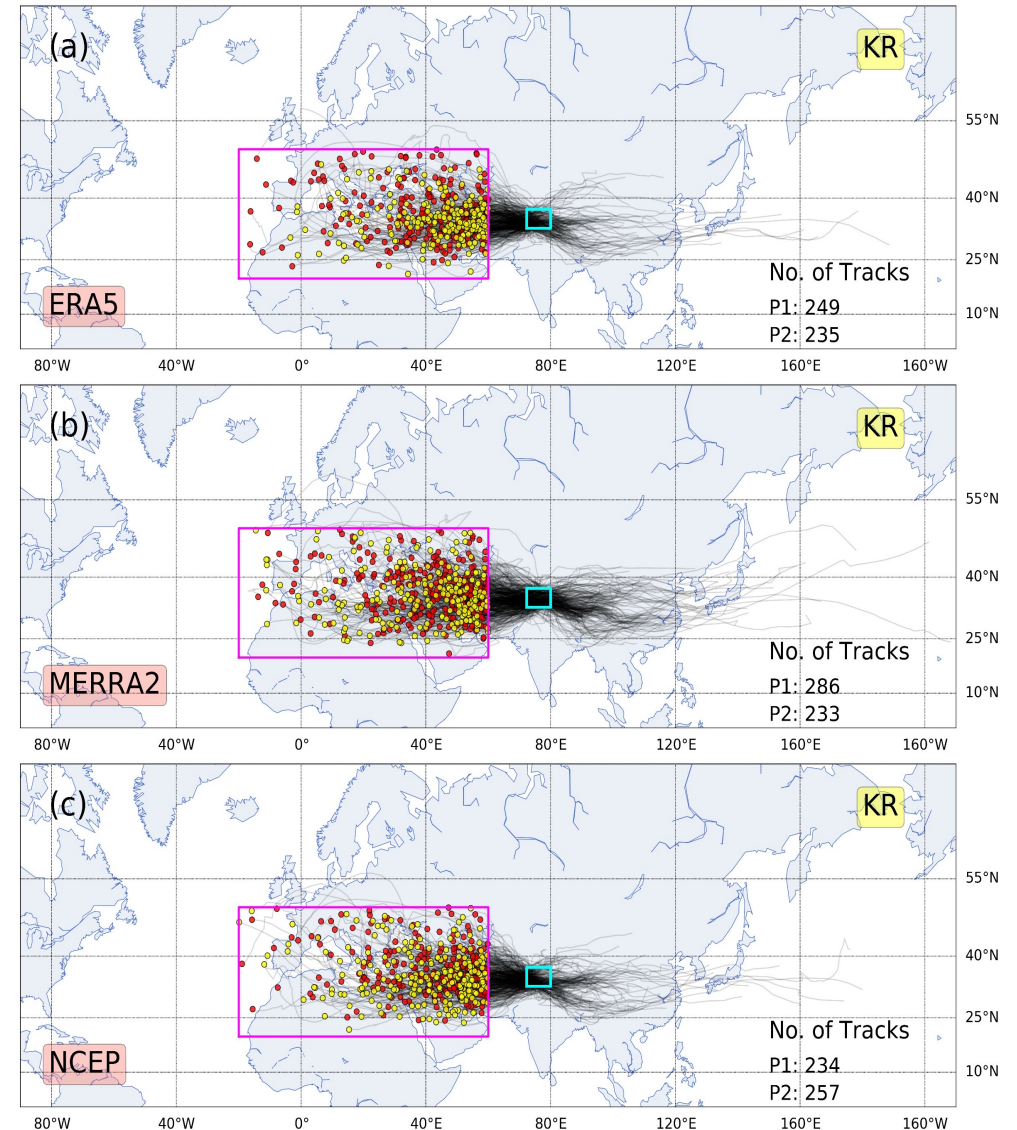
Javed et al., 2022; *Journal of Climate*

The study period divided into two sub-periods:

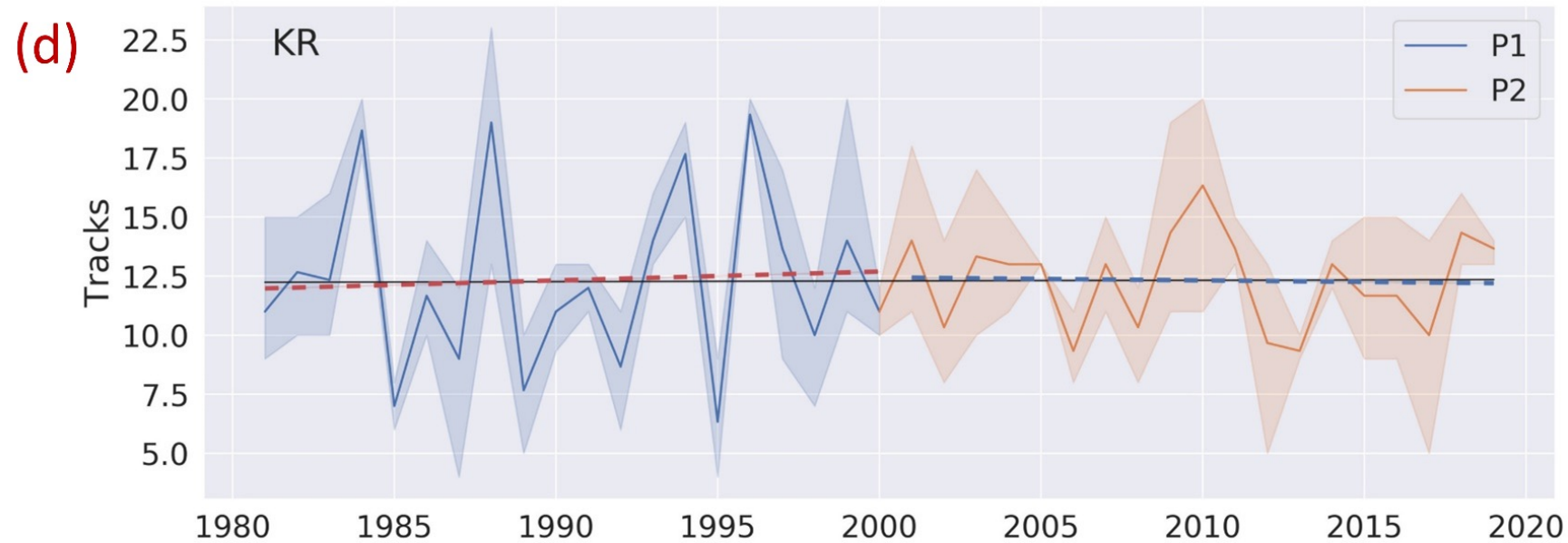
P1 (1980-2000)
P2 (2001-2019)

Filtration:

1. Lifetime > 1 day;
Distance travelled > 1000 Kms.
2. Passes through KR Impact Box.
3. Originate inside the Genesis Box.



Frequency of Karakoram WDs

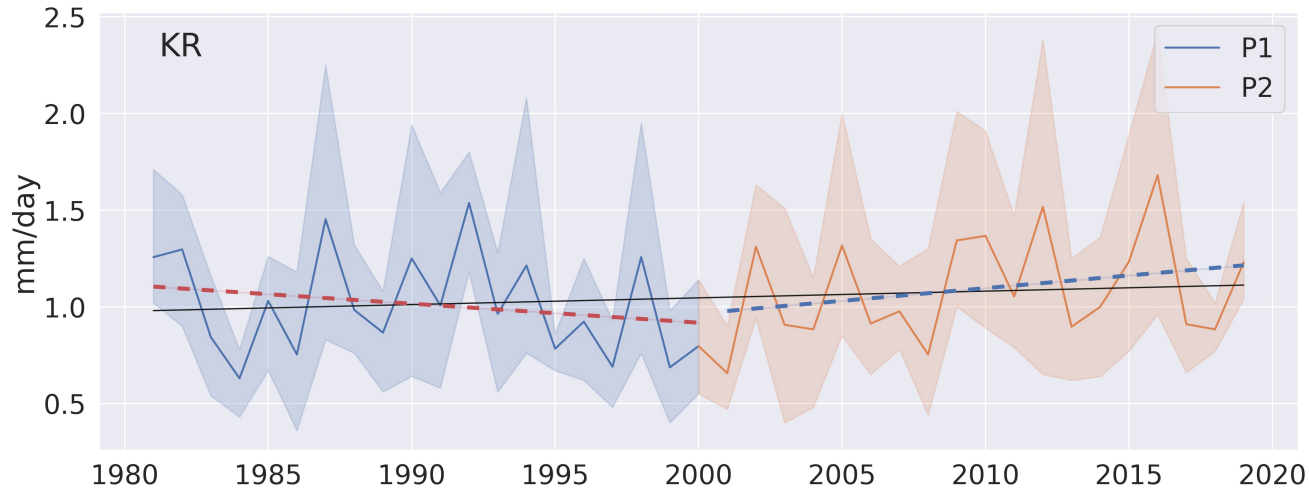


Depicts little to no change in the frequencies of WDs impacting KR.

Javed et al., 2022; *Journal of Climate*

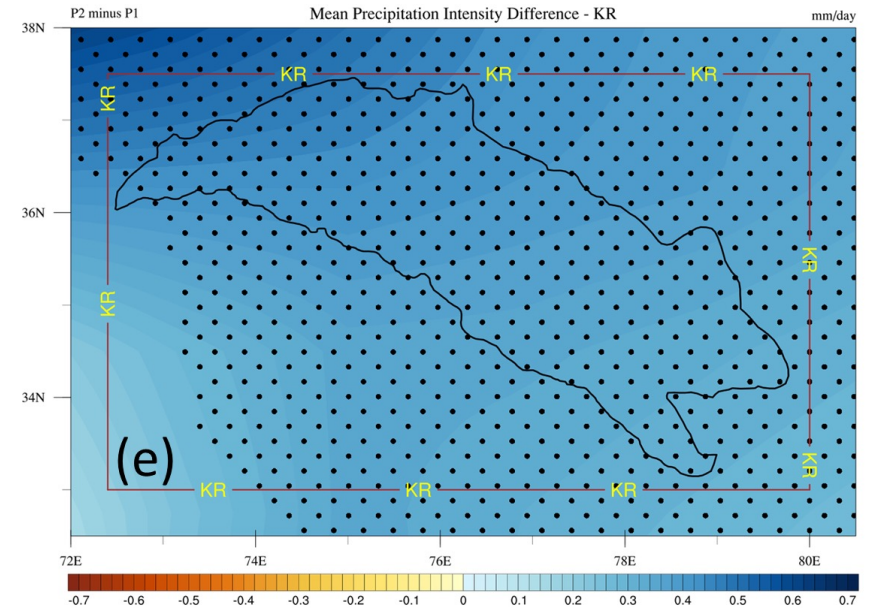
Intensity of WD associated precipitation

Mean precipitation intensity is found to be increasing in P2



KR saw a rise of about **~10%** in mean precipitation intensity

Completely dominated by significant positive differences

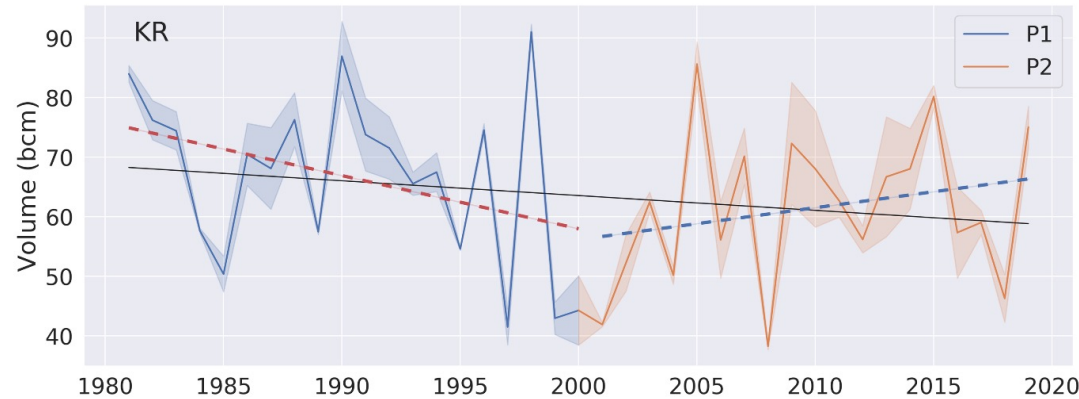


Difference in mean precipitation intensity between P1 and P2

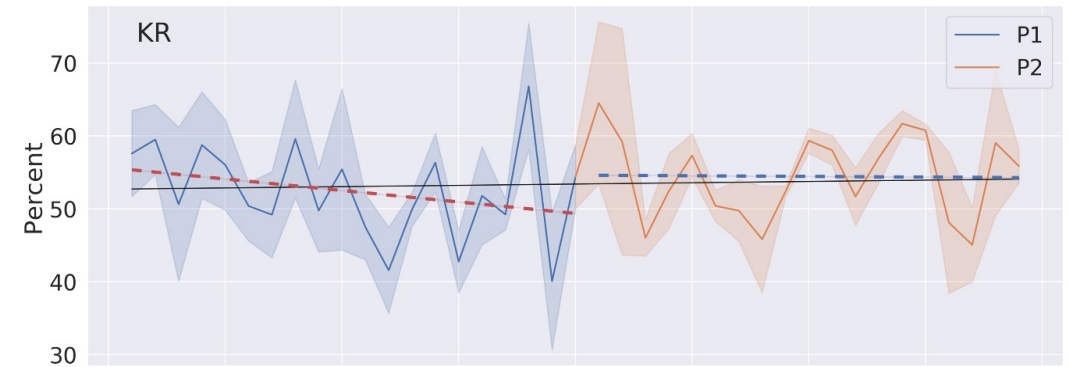
Javed et al., 2022; *Journal of Climate*

Volume of WD associated precipitation

(a) Volume of WD-Snowfall

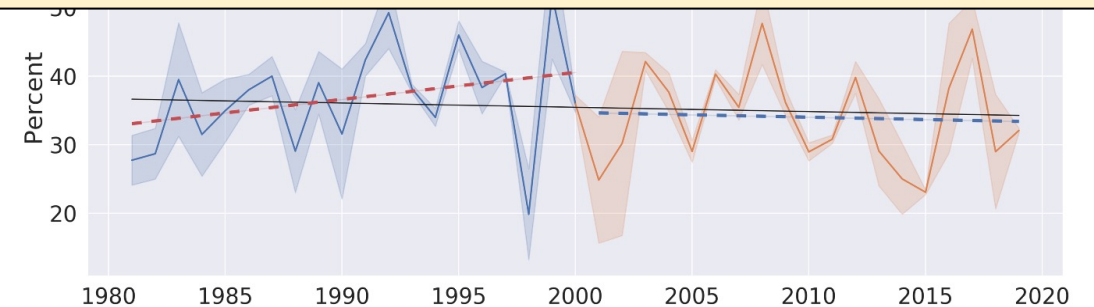
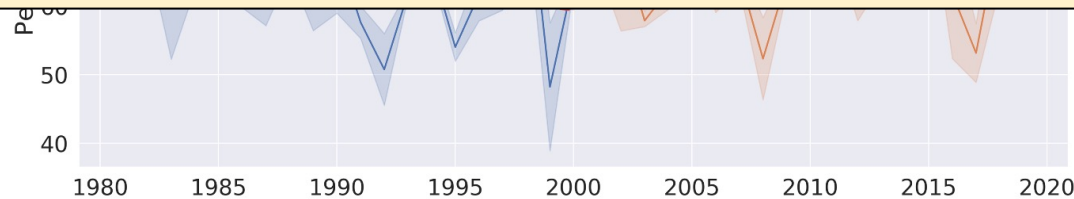


(e) WD-Snowfall Contribution in Total Seasonal Precipitation



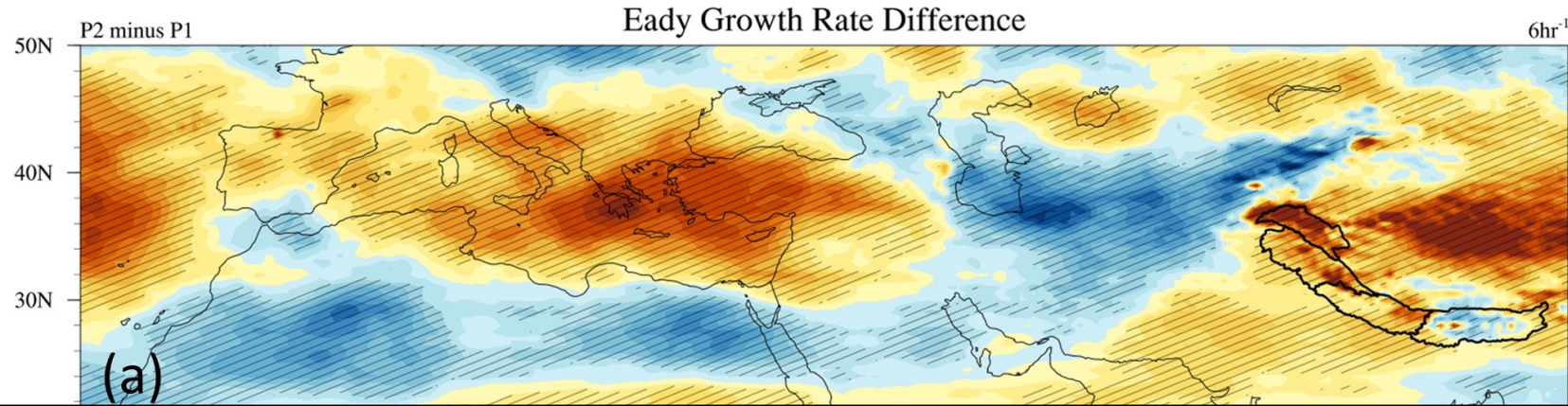
(c) WD-Snowfall Contribution in Total Seasonal Snowfall

A noticeable rise in the contribution of WDs in total precipitation and snowfall was observed for KR along with an statistically significant decline in contribution from non-WD sources. This key finding coincides with the Karakoram Anomaly period.

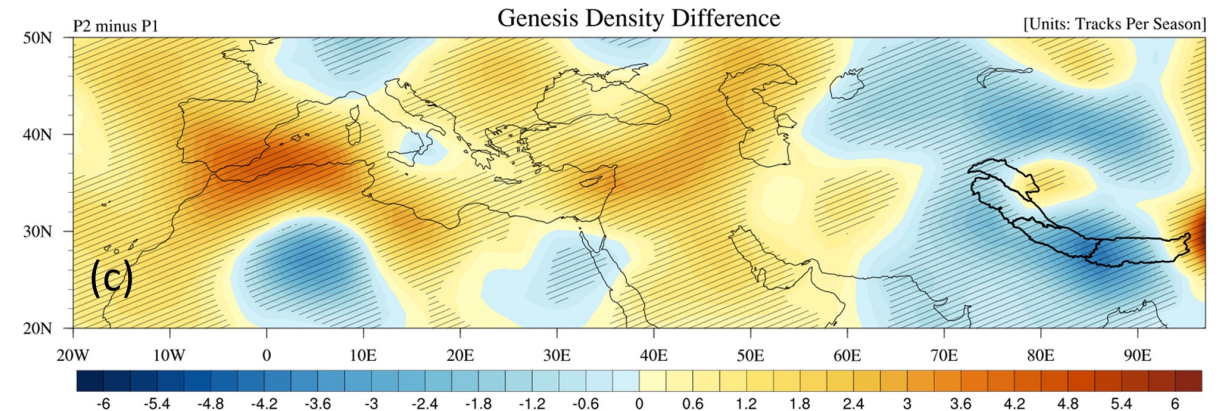
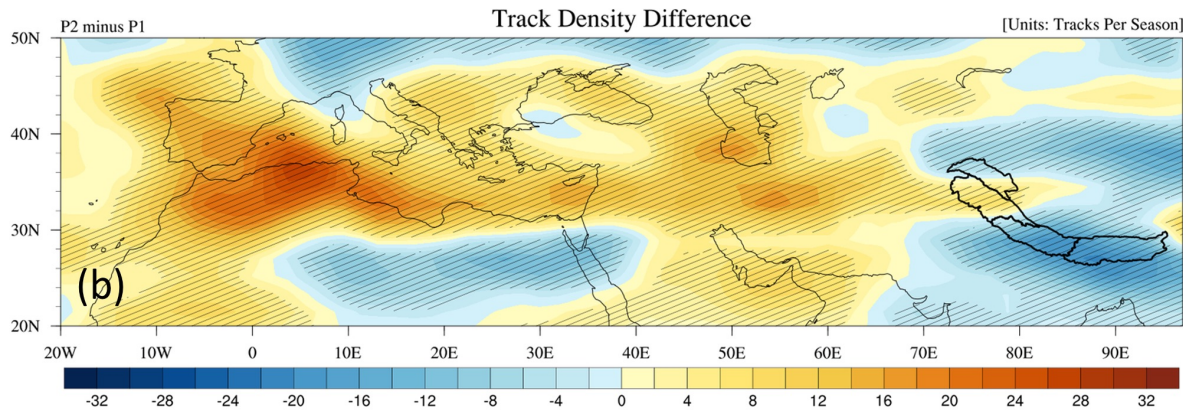


Javed et al., 2022; *Journal of Climate*

Dynamics controlling the genesis of WDs

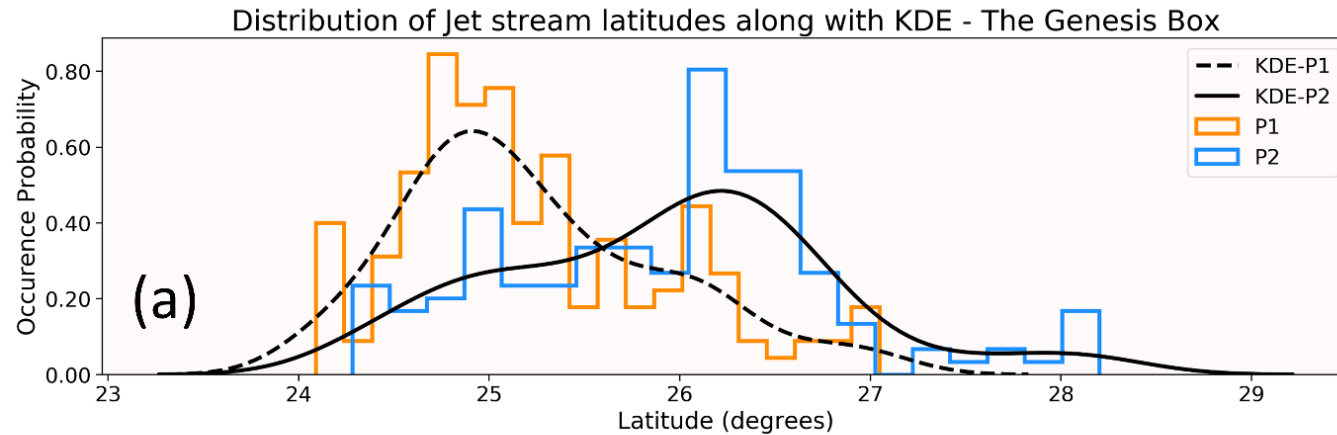


An increase in the upper tropospheric **baroclinic instability** over Mediterranean Sea has been linked to increased genesis activity over the region.

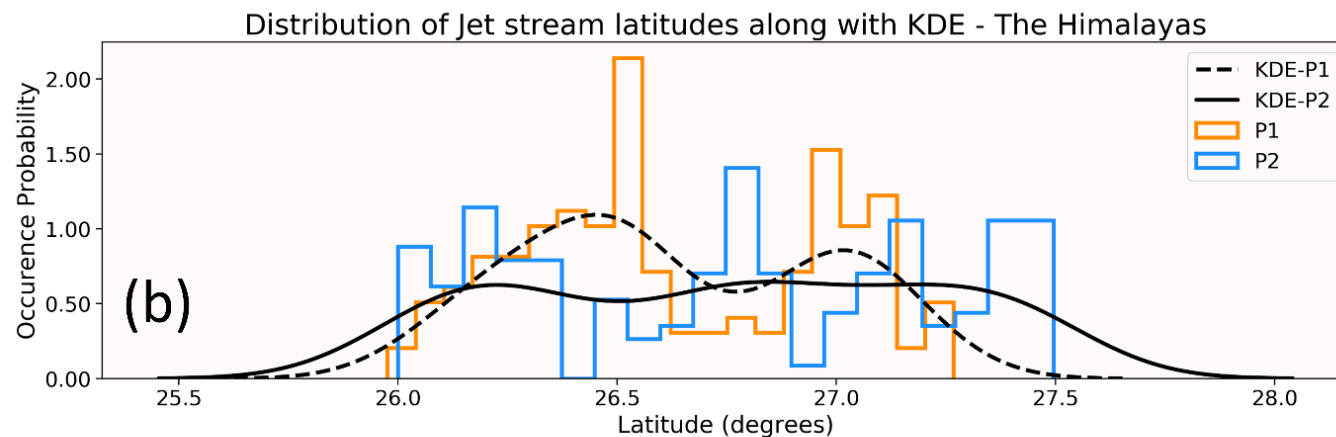


Javed et al., 2022; *Journal of Climate*

Dynamics controlling the genesis of WDs



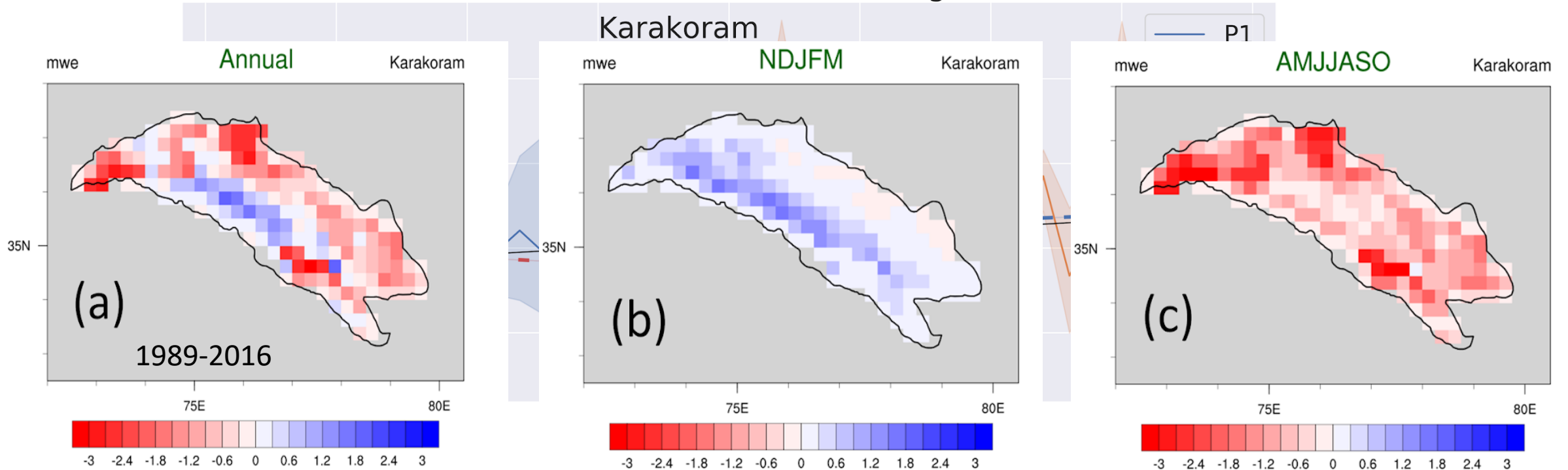
A significant **poleward shift of the jet stream** has facilitated the genesis of stronger WDs, impacting their intensity if not frequency



Javed et al., 2022; *Journal of Climate*

The “Karakoram Anomaly” connection !

Ensemble mean of WDs contribution over glaciated fraction



The ensemble mean contribution of WDs over the glaciated region rose from **~37%** in P1 to about **~47%** in P2, a relative jump of about **~27%**. **estimation for Karakoram.**

budget

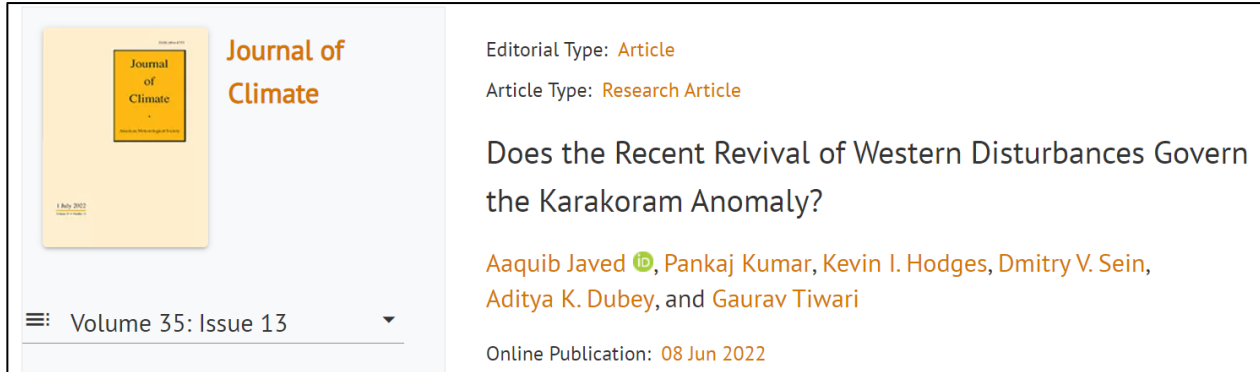
Javed et al., 2022; *Journal of Climate*

Summary & Conclusions

- **No significant change** has been found in the **frequency of WDs** for the region.
- However, the precipitation intensity has seen a **noticeable rise** in P2.
- Contribution of WDs in total precipitation and snowfall **increased in P2**.
- Contribution from non-WD sources has had a **statistically significant decline** for KR.
- **Enhanced baroclinic instability and poleward shift of the jet stream** were found to have facilitated the generation of stronger WDs in the Genesis Box.
- Thus the role of WDs in **establishing and sustaining the “Karakoram Anomaly”** cannot be ruled out and presents itself as one of the important drivers of the phenomena.

Acknowledgement

We acknowledge funding from the Science and Engineering Research Board (SERB), Govt. of India, grant number CRG/2021/001227-G.



The screenshot shows the cover of the Journal of Climate, Volume 35, Issue 13, dated July 2022. The article title is "Does the Recent Revival of Western Disturbances Govern the Karakoram Anomaly?". The authors listed are Aaquib Javed, Pankaj Kumar, Kevin I. Hodges, Dmitry V. Sein, Aditya K. Dubey, and Gaurav Tiwari. The article type is "Research Article" and the online publication date is "08 Jun 2022".



Javed, A., P. Kumar, K. I. Hodges, D. V. Sein, A. K. Dubey, and G. Tiwari, 2022: Does the Recent Revival of Western Disturbances Govern the Karakoram Anomaly?. Journal of Climate, 35, 4383–4402, <https://doi.org/10.1175/JCLI-D-21-0129.1>.

Questions?