Natural Variability of the Himalayan Monsoon Dynamics: Insights into River Hazards

Pratik Kad[1,2], and Kyung-Ja Ha[3,4]

[1]NORCE Norwegian Research Centre, Norway [2]Bjerknes Centre for Climate Research, Norway

[3]Department of Climate System, Pusan National University, South Korea [4]Center for Climate Physics, Institute of Basic Science, South Korea

Background

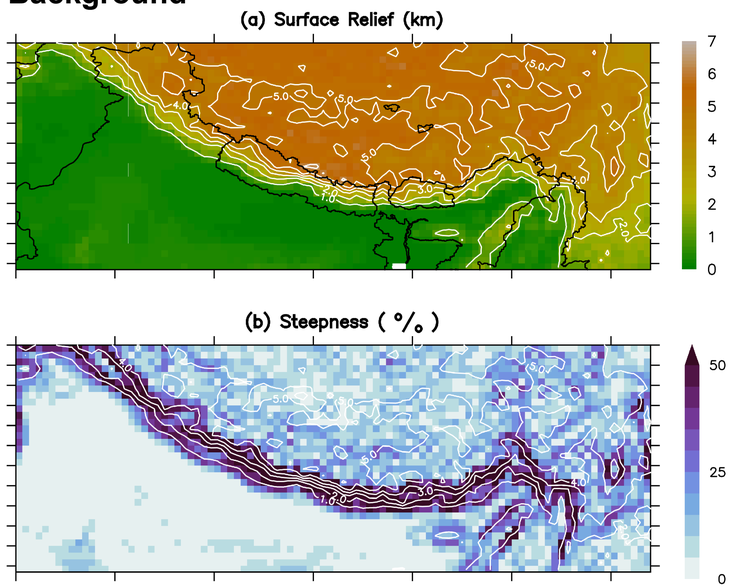

Fig.1. Topographic elevation features of the Himalayan mountain range, (a) shaded surface relief with overlayed national borders in black color and river system in Blue color, (b) shaded steepness with surface relief contours of 1km intervals.

Results

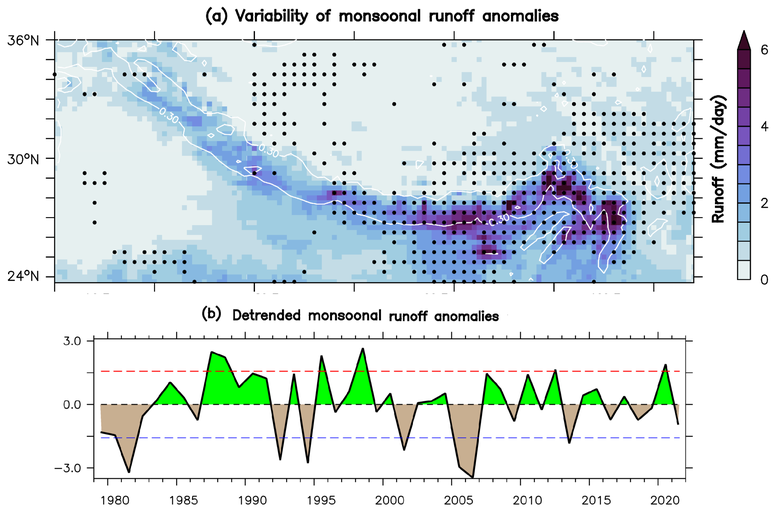

Fig.2. Extreme rainfall variability. (a) Runoff anomalies over high variance region by a steep mountain range dominated over the south-facing slope. (b) mean JJAS rainfall anomalies during the summer monsoon pinpoint extreme dry and wet years

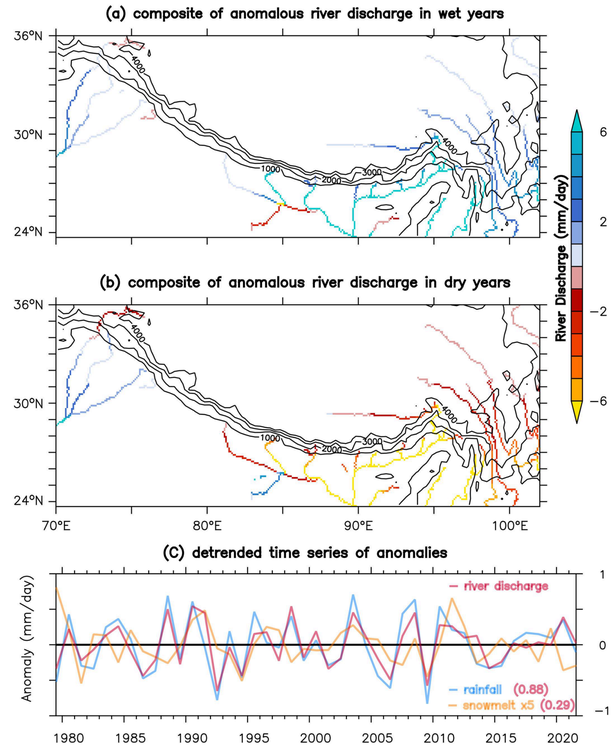

Fig.3 The composite map displays anomalies in river discharge during wet and dry monsoons. In (a), the shaded area represents wet monsoons, while (b) represents dry monsoons. The river discharge data utilized in this analysis is obtained from GloFAS-ERA5, a widely used global river discharge data set. Here black contour represents surface relief intervals. Figure (c) detrended anomalies of the water budget, with the blue line representing rainfall, the orange line representing snowmelt (multiplied by a factor of 5), and the maroon line representing river discharge. Additionally, correlation coefficients are provided with river discharge.

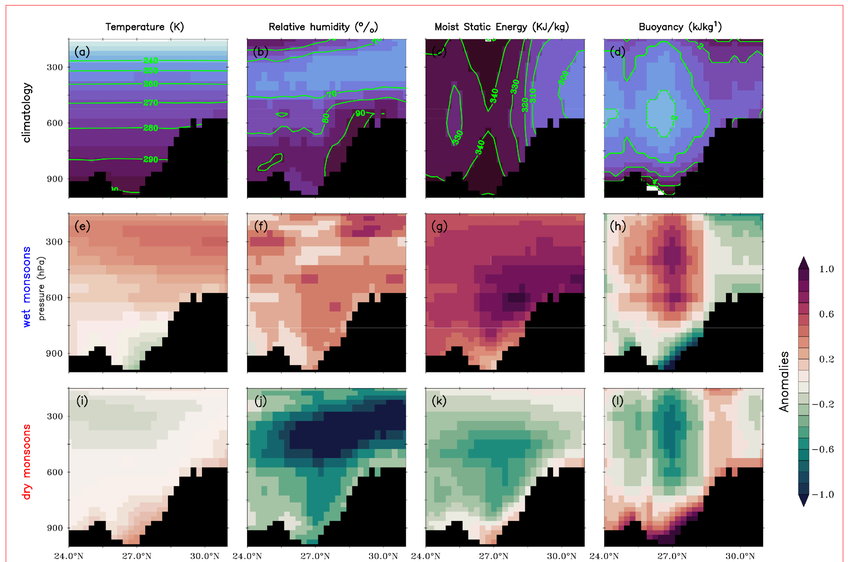

Fig.4. Thermal structure of climatology, anomalous wet and dry monsoon. The Eastern Himalayas region holds high anomalies

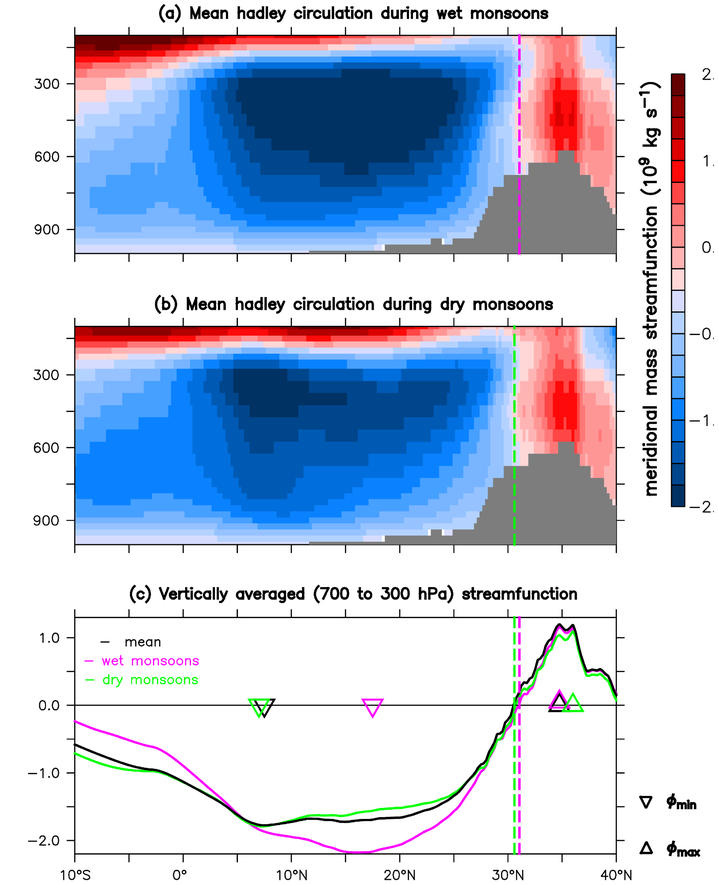

Fig.5 Mean local Hadley circulation in wet and dry monsoon years. The zonal mean meridional mass stream function averaged over the range of 70°E to 102°E indicates the local monsoonal circulation. Panel (a) shows the stream function for composite wet years, while panel (b) shows it for composite dry years. Negative values indicate counterclockwise circulation, while positive values indicate clockwise circulation. The gray color represents masked regions of elevation topography (averaged over 70°E to 102°E). In panel (c), the vertically averaged zonal mean meridional stream function is shown from 700 to 300 hPa. The dashed line represents the location of the ITCZ, while the upper and lower empty triangles indicate the latitudinal points of maxima and minima.

References

Kad, P., & Ha, K. J. (2023). Recent Tangible Natural Variability of Monsoonal Orographic Rainfall in the Eastern Himalayas. Journal of Geophysical Research: Atmospheres, 128(22). https://doi.org/10.1029/2023JD038759

Acknowledgments

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korean government (MSIT) (Grant No. 2020R1A2C2006860). PK acknowledges NORCE Norwegian Research Centre.