Precipitation and temperature projections for the Indus River basin of Pakistan during 21st century using statistical downscaling

Session CL4.17

(Mountain Climatology and Meteorology)

By

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EGU2020- Sharing Geosciences online

4th May 2020, Vienna-Austria

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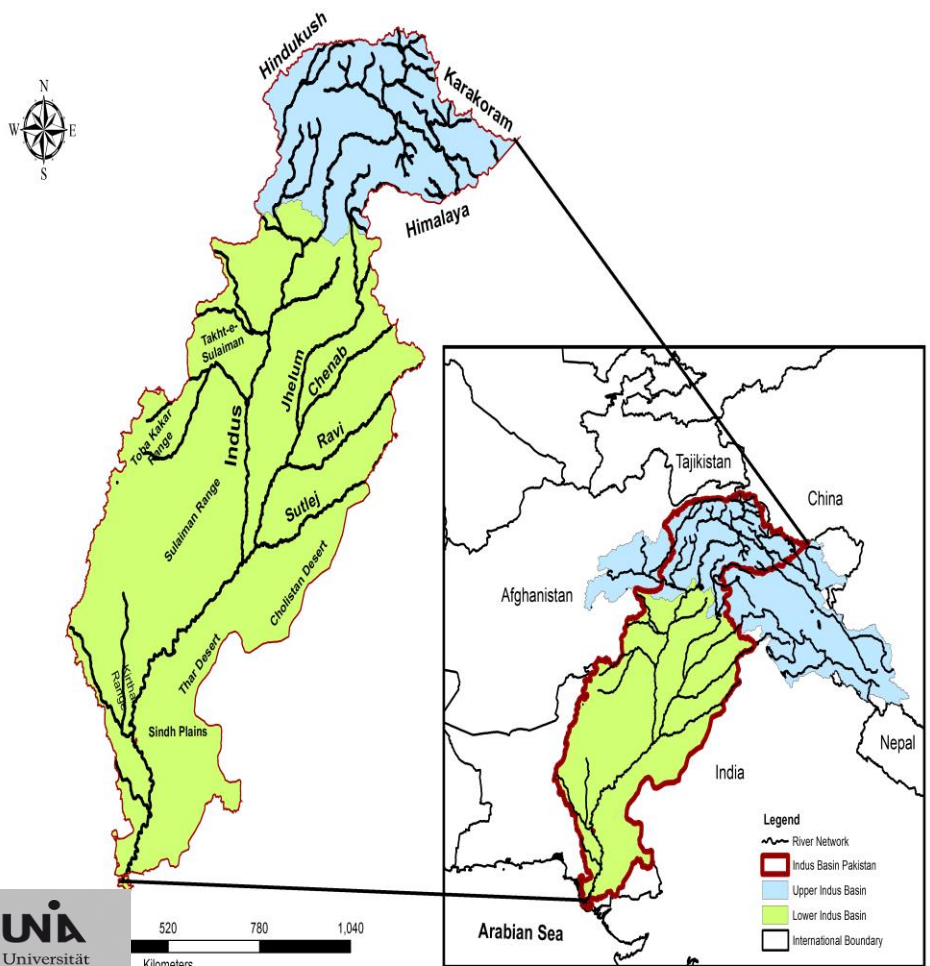
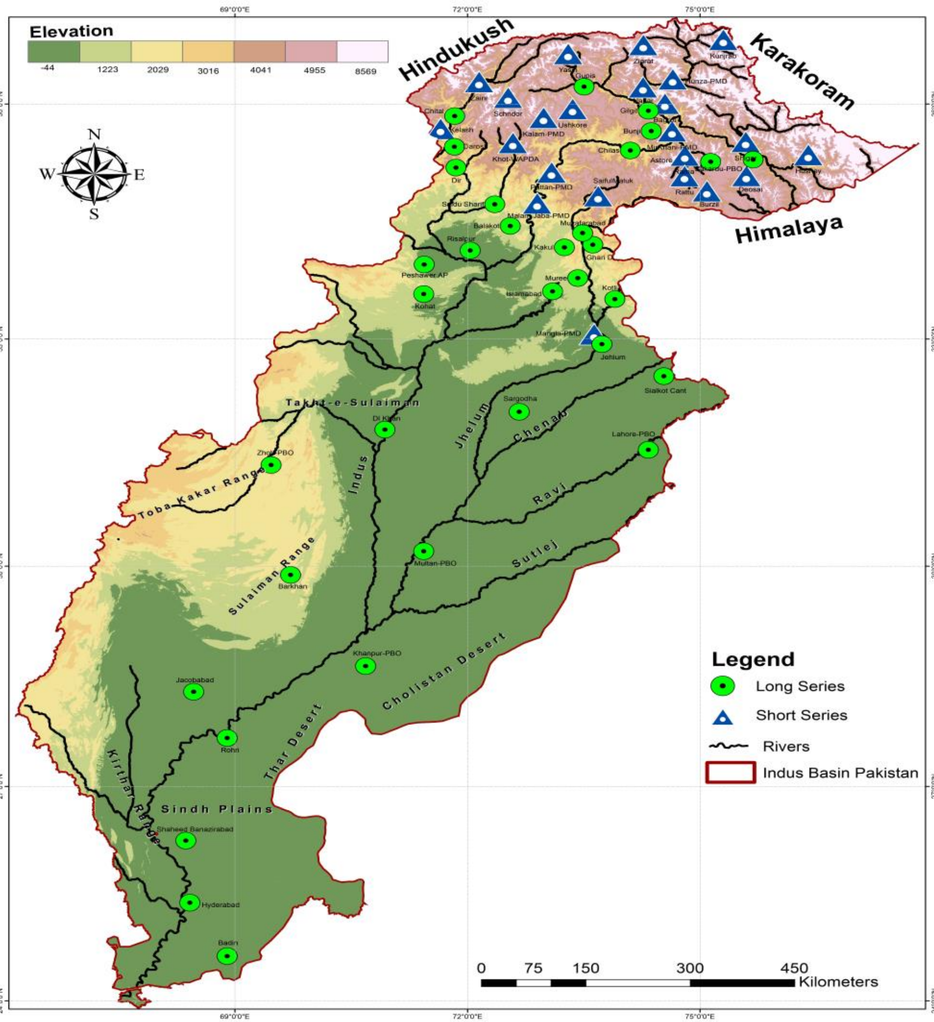
The Indus River Basin: A Complex Climate Hotspot

Can relatively-low altitude stations explain orographic climate structure within the UIB? What observations tell us?

IRB and Study area



Study stations



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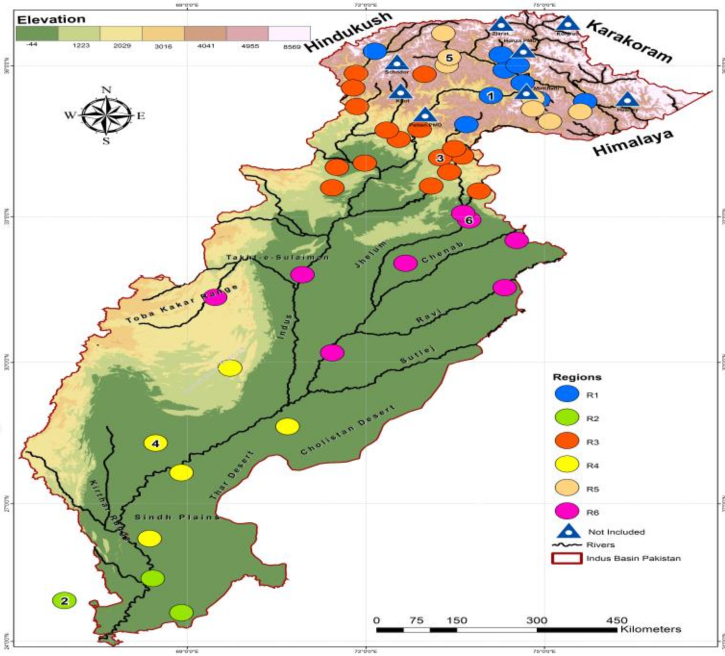
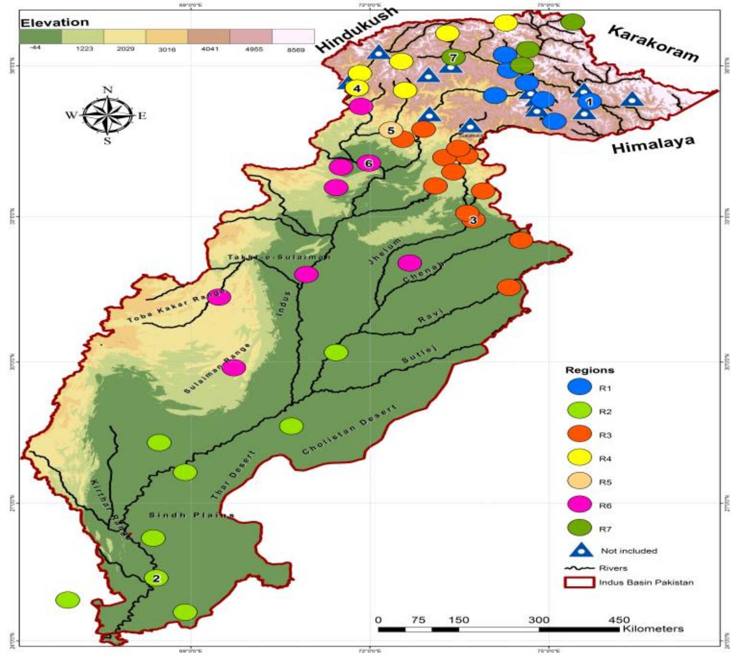
K-Means Precipitation Clustering using Correlation

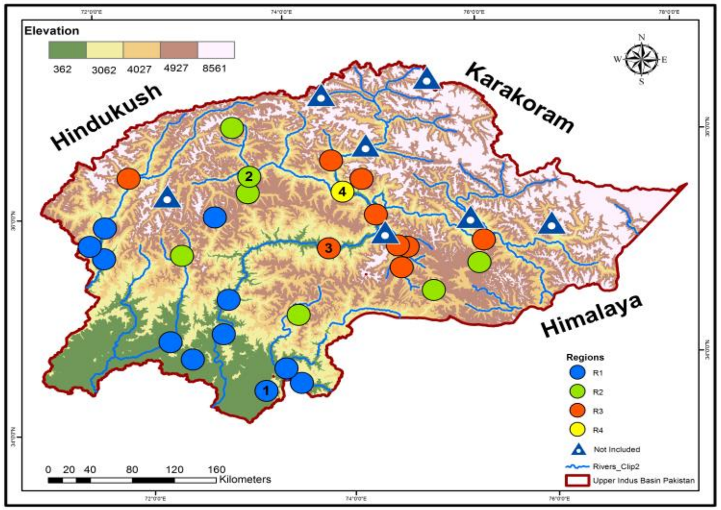
Clustering of HA stations around low-altitude stations

Basin-wide regionalization

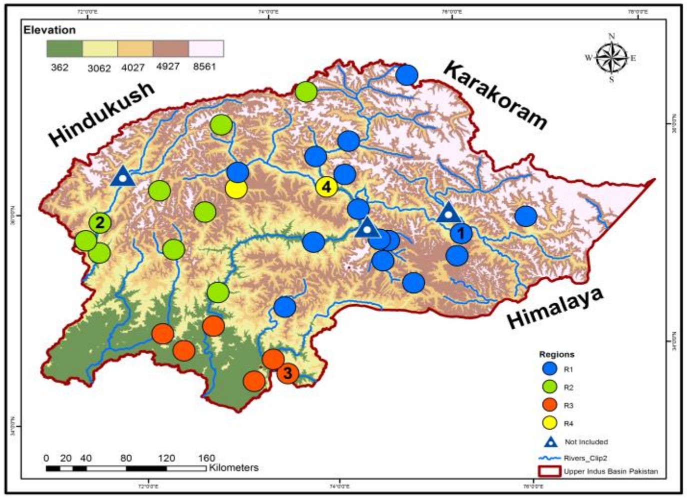




HA-UIB regionalization



WS-DJFM)



MS-JAS)

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Predictand-Predictor Modeling and Performance

- *Time-series of selected regionally representative stations serve as **Predictands***
- *GLM with gamma and Tweedie distributions used for precipitation regression models within a robust cross- validation framework by minimizing (maximizing)errors (MSESS) in 1000 random iterations.*
- *MLR for modeling Tmax and Tmin on seasonal scales.*

- *PC scores derived from S-mode PCA on selected dynamic and thermodynamic predictors of a reanalysis serve as **Predictors***

Precipitation Modeling performance

Season Spatial Scale	No. of Regions	Avg. Val. MSESS (Range) in %)
MS (UIB)	5	**32.73** (20.71 to 52.541)
MS (LI)	2	**36.19** (32.06 to 40.32)
PMS (UIB)	4	**43.90** (28.83 to 50.42)
PMS (LI)	2	**38.88** (37.64 to 40.11)
WS (UIB)	3	**34.69** (26.10 to 49.57)
WS (LI)	2	**32.69** (28.75 to 36.63)

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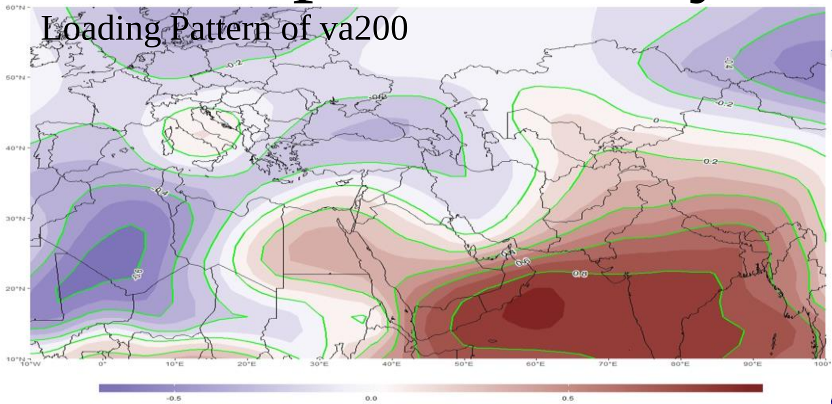
Anomalous MS Precipitation: Physical Mechanisms

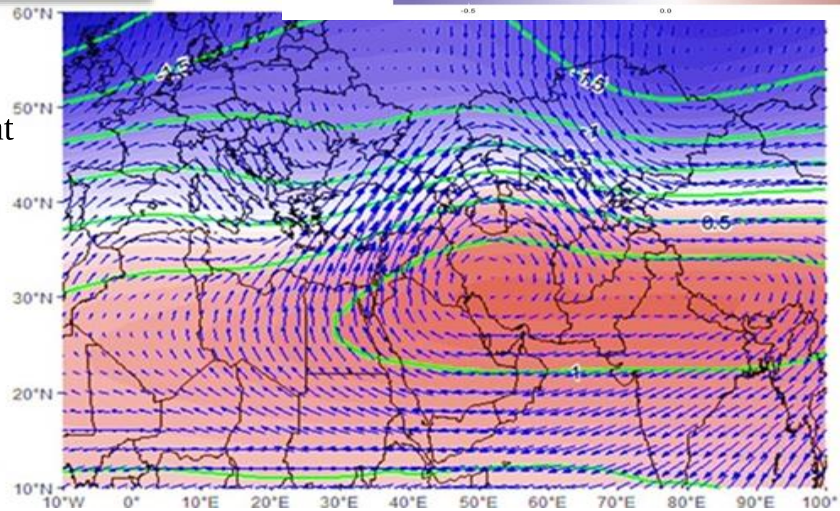


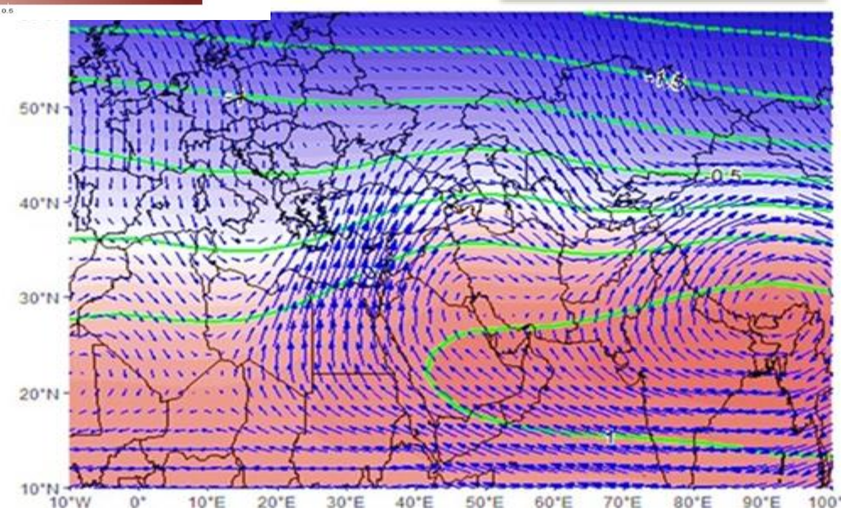
a) 181 mm/m

a) 344 mm/m

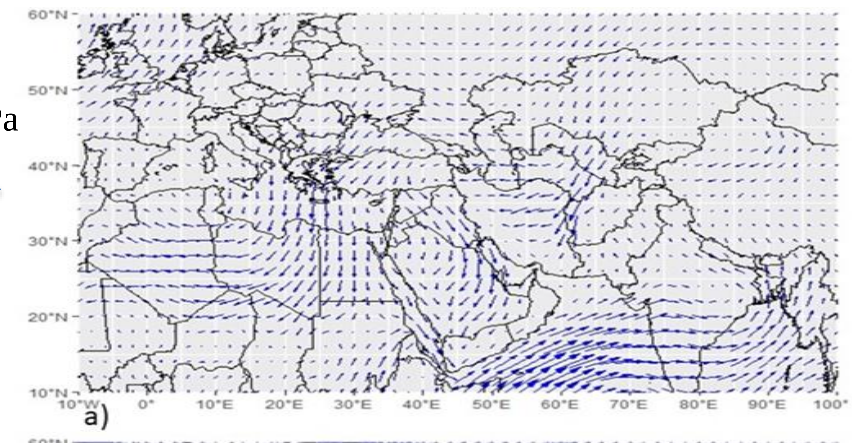
b) 69 mm/m

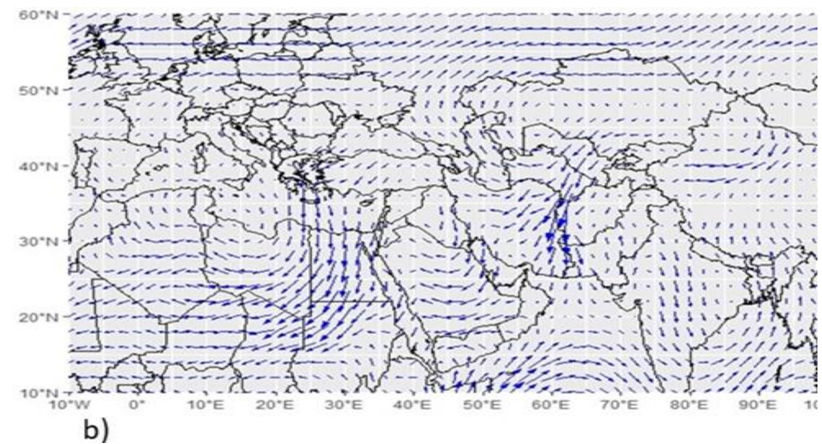
wind and zg at 200hPa





wind at 850hPa





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Circulation-based Reference and Model Uncertainties and the GCM Selections

- We used precipitation governing circulations for computing reference uncertainty by comparing these with circulations of ERA5 and NCEP-NCAR-II.

- Loading patterns of circulations after performing S-Mode PCA are compared through Taylor diagrams for reference uncertainty.

- The reference uncertainty for MS ranges from 16 % to 28% and for the WS it was 16 to 26% for the UIB

- Similarly we compared circulations of CMIP5-GCMs to select models for simulations over the basin.

- CMCC-CMS perform best for MS and MPI-ESM-LR showed best correspondence during the WS.

Impact of Model Weights on Precipitation (MME) Signals

- We used weights of model to compute the MME signals.

- Better performing models (models with higher weights) further strengthen the change signals. MS changes were most prominent

- The most wet part of the basin in observations along foothills of the southern Himalayans will remain stable to positive in all the seasons.

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Conclusions

- Relatively low-altitudes stations can explain orography within the UIB
- Atmospheric circulations can resolve observed (fine-scale) patterns, explain governing mechanisms and help to select GCMs
- Precipitation during the WS (MS) increases but decreases during the PMS (over northwestern regions) and better performing models intensify these signals
- Spatial patterns suggest more northward penetrations of westerlies and MS regimes under RCP8.5 particularly over the central Karakoram
- Basin will warm, but increase in Tmin is more profound- a decrease in DTR. The WS (PMS) will warm significantly and follow EDW in UIB.
- ***A large portion of UIB will show MS cooling*** with less warming over the HA of the UIB.
- LI will exhibit more demand (rise in temp) in future for all seasons.
- *A new dimension for future regional research*

- ***Further details in Pomee MS, Ashfaq M, Ahmad B and Hertig E (2020). Modeling Regional Precipitation over the Indus River Basin of Pakistan using Statistical Downscaling. TAAC accepted article DOI: 10.1007/s00704-020-03246-9***

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