WCRP CORDEX
Coordinated Regional Climate Downscaling Experiment
ICRC-CORDEX 2023

Evaluation of Extreme Precipitation Climate Indices over HKH in CMIP5 and CMIP6 Models

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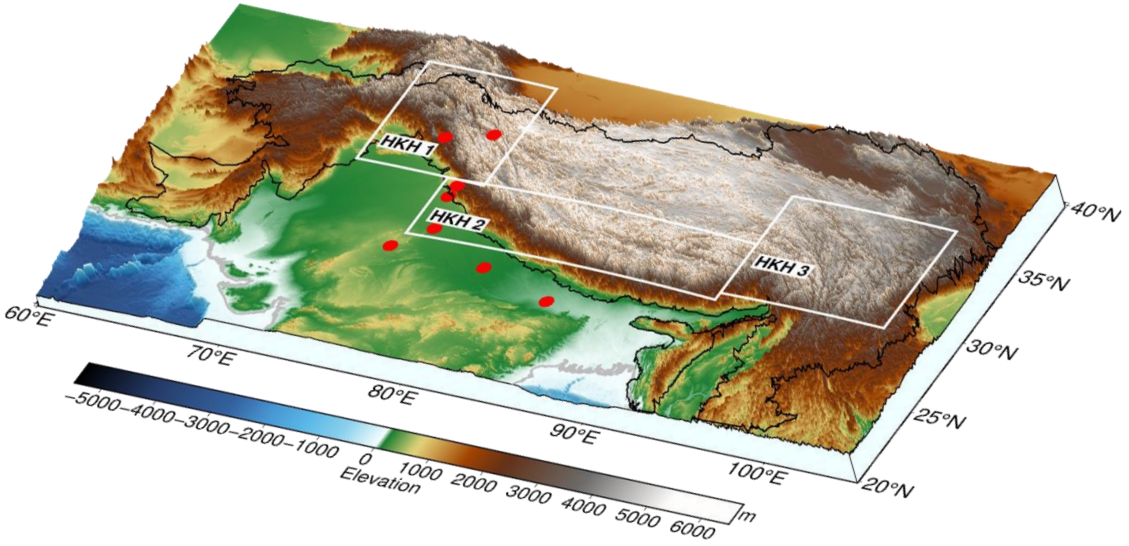
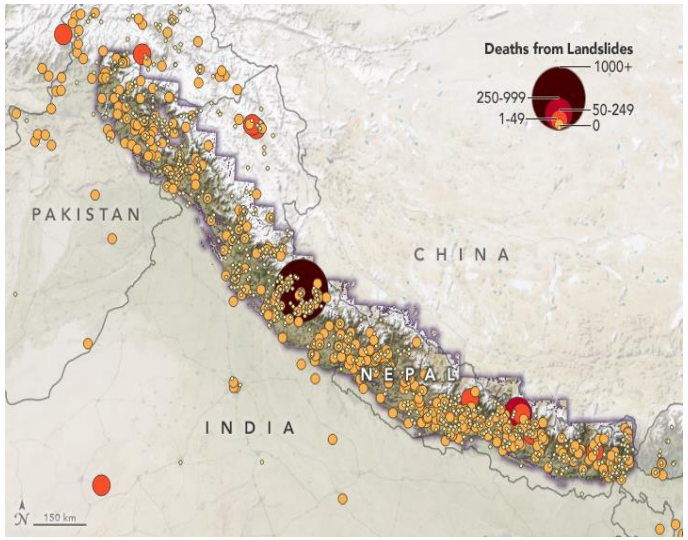
Background and Motivation

- **Highly complex system** – Mountainous terrain
- **Water tower of Asia** – sources major Asian rivers
- **Glacier (Third pole)** – Permanent ice cover with a varying degree of topographic complexity
- **Unique geographical setting** with steep southern slopes and, bare and gentle northern slope
- **Orographic barrier** separating the wet Indian subcontinent from the arid Tibetan Plateau
- Modulates **global weather patterns** and is a climate regulator for much of Asia via interaction between atmosphere and topography





Credits: NASA's Earth Observatory/Joshua Stevens

Climate warming enhances snow avalanche risk in the Western Himalayas

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Changes in western disturbances over the Western Himalayas in a warming environment

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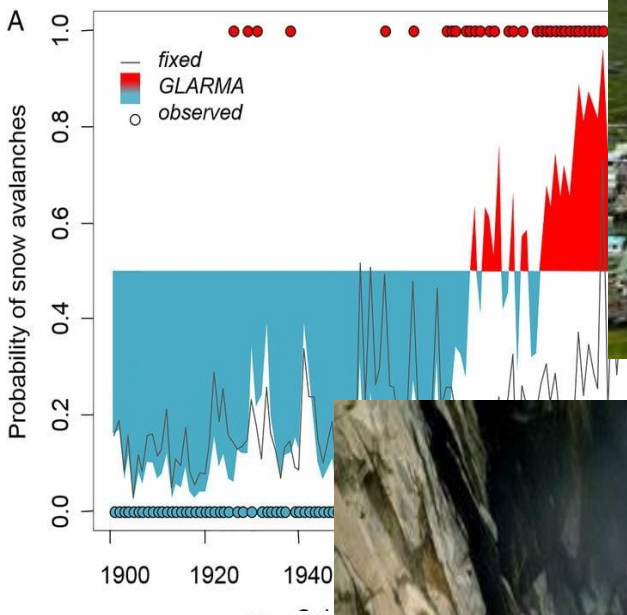
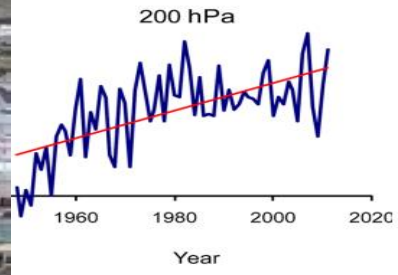
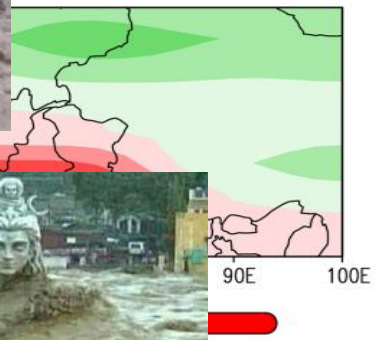






Time-series meridional temperature difference (30N– 35N minus 50N–55N) (K) averaged over the Eurasian longitudes (20E–100E) for the DJFMA season a 500 hPa, b 200 hPa, c Map showing the difference of baroclinic instability index (C) between the second half (1980–2011) and the first half (1948–1979)

Kulkarni et al. (2018)

...ird Pole

...nalayan glacial catchments

Data, Models, Methodology

PRCPTOT	Annual wet-day precipitation (mm) Annual total precipitation in wet days
R95p	Very wet days (mm) Annual total precipitation from days >95th percentile
RX1day	Max 1-day precipitation (mm) Annual maximum 1-day precipitation
RX5day	Max 5-day precipitation (mm) Annual maximum consecutive 5-day precipitation
SDII	Simple daily precipitation index (mm/day) The ratio of annual total precipitation to the number of wet days
R20mm	Number of very heavy precipitation days (days) Annual count of days when daily precipitation ≥20 mm
CDD	Consecutive dry days (days) Maximum number of consecutive dry days
CWD	Consecutive wet days (days) Maximum number of consecutive wet days

CMIP5 - 34 CMIP6 - 32

CMIP
The World Climate Research Programme's Coupled Model Intercomparison Project

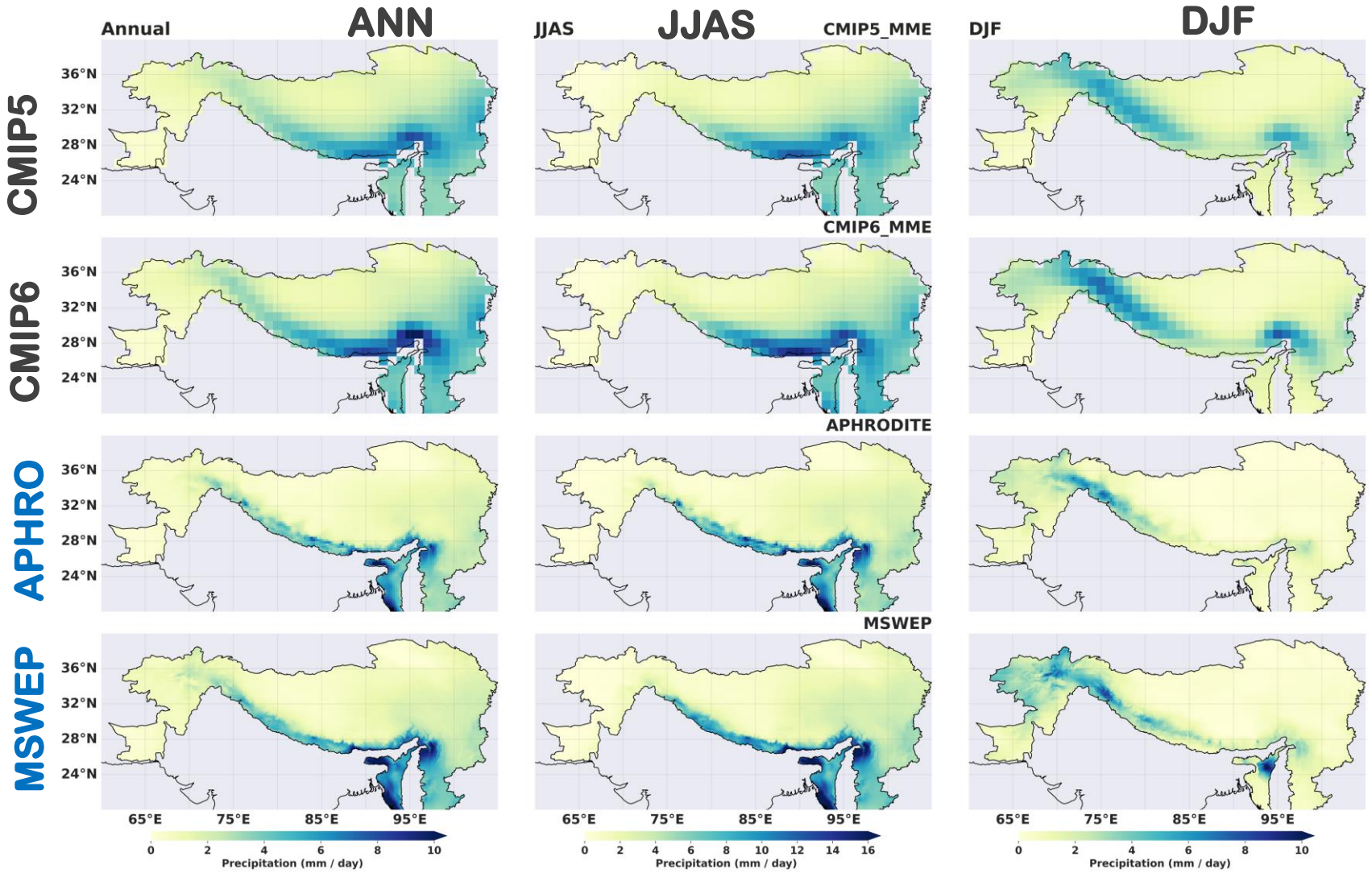
Reference Data
APHRODITE

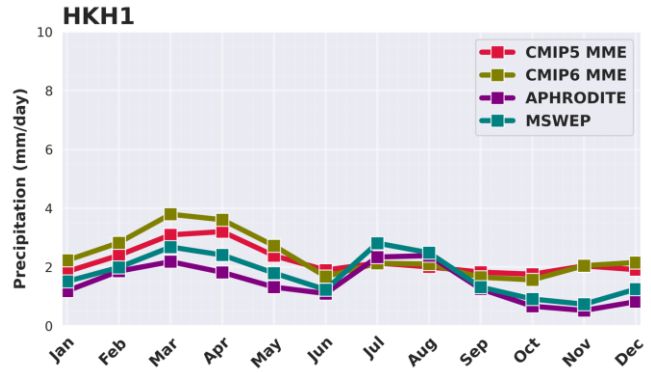
Taylor skill score (TSS) was used in ranking the models.

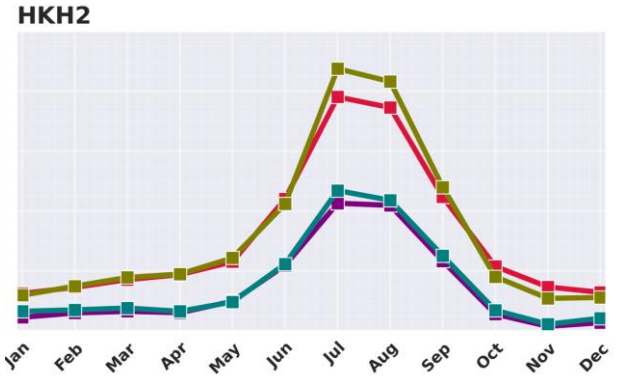
$$TSS = \frac{4(1+PCC)^2}{\left(\frac{\sigma_{Model}}{\sigma_{Observation}} + \frac{\sigma_{Observation}}{\sigma_{Model}}\right)^2 (1+R_0)^2}$$

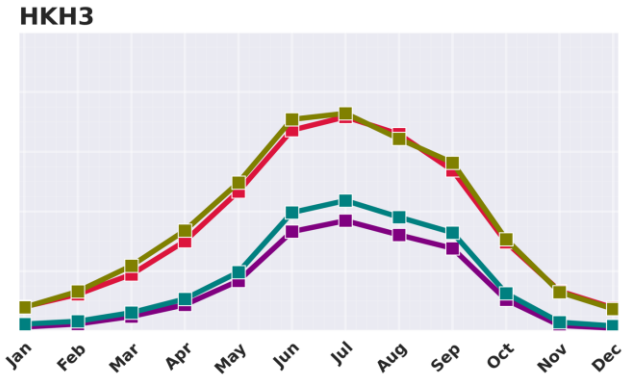
Extremes indices, defined by the Expert Team on Climate Change Detection and Indices (ETCCDI)

Mean Precipitation and Annual Cycles





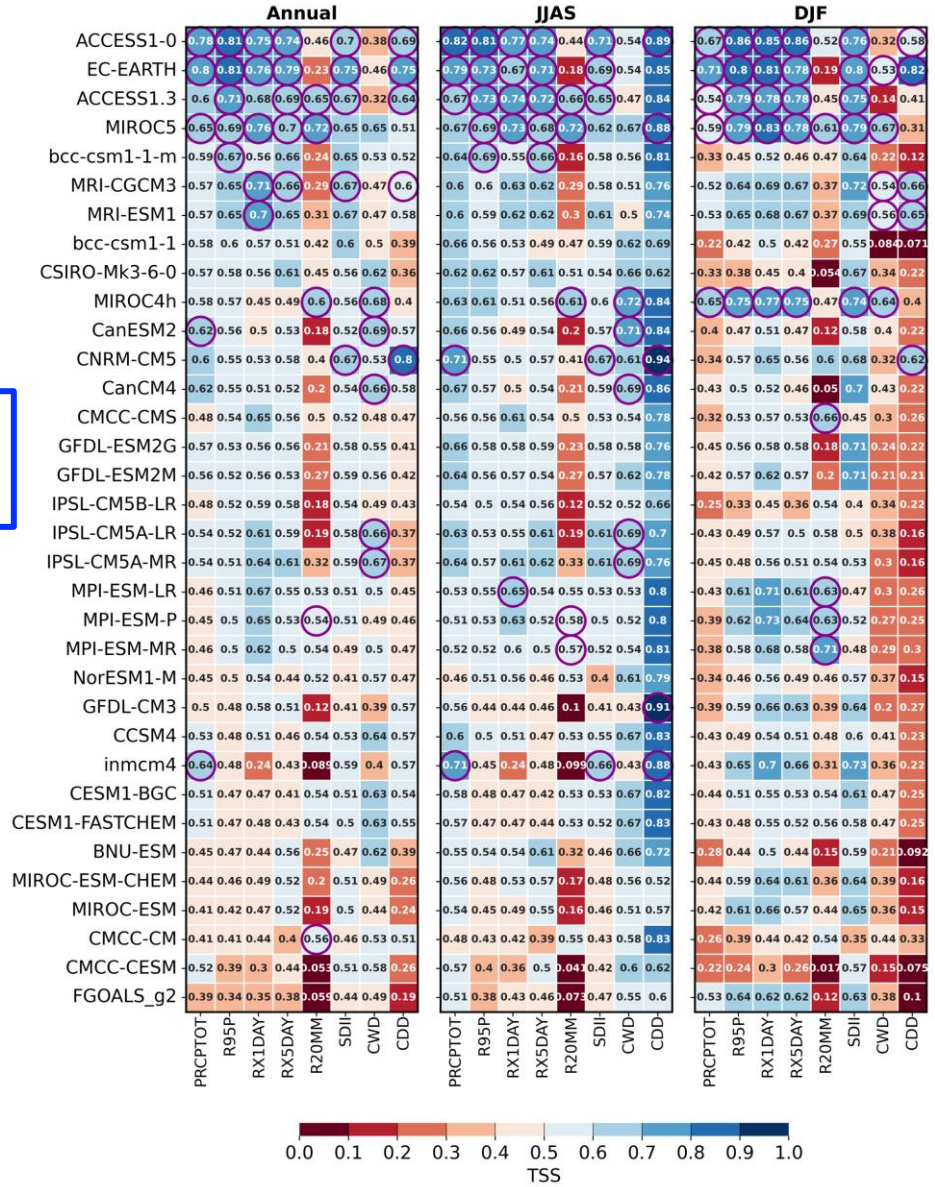




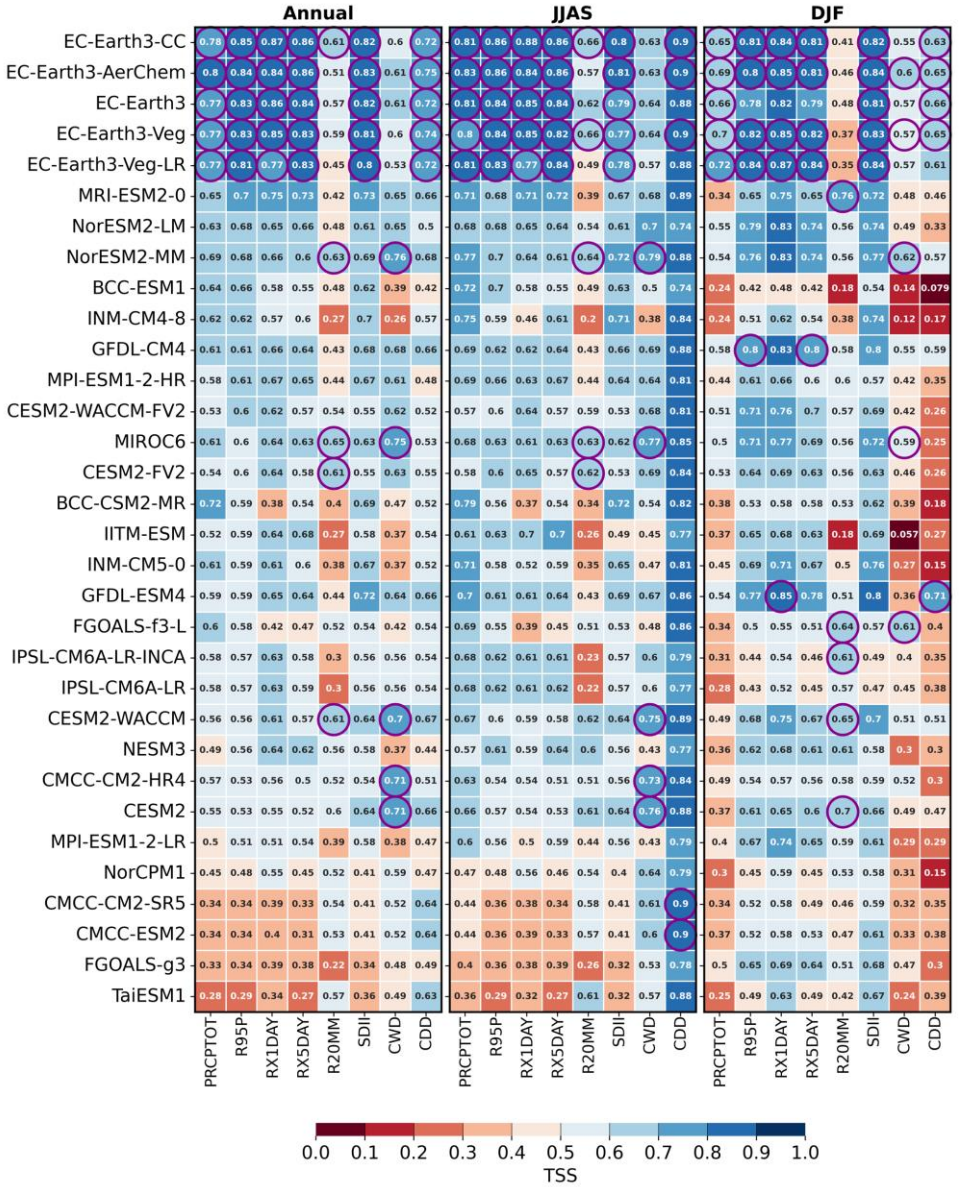
The CMIP6 and CMIP5 model ensembles generally reproduce the overall pattern of the seasonal evolution of precipitation in the HKH.

Statistical performance for annual and seasonal extreme precipitation climate indices

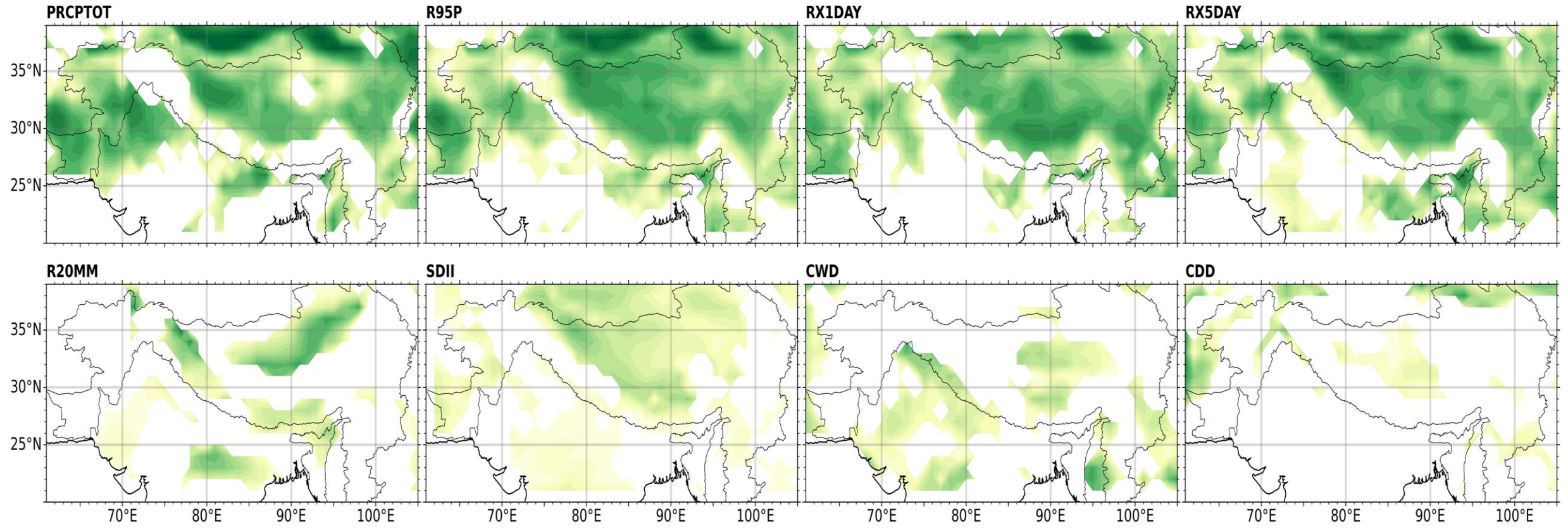
CMIP5 Models



CMIP6 Models



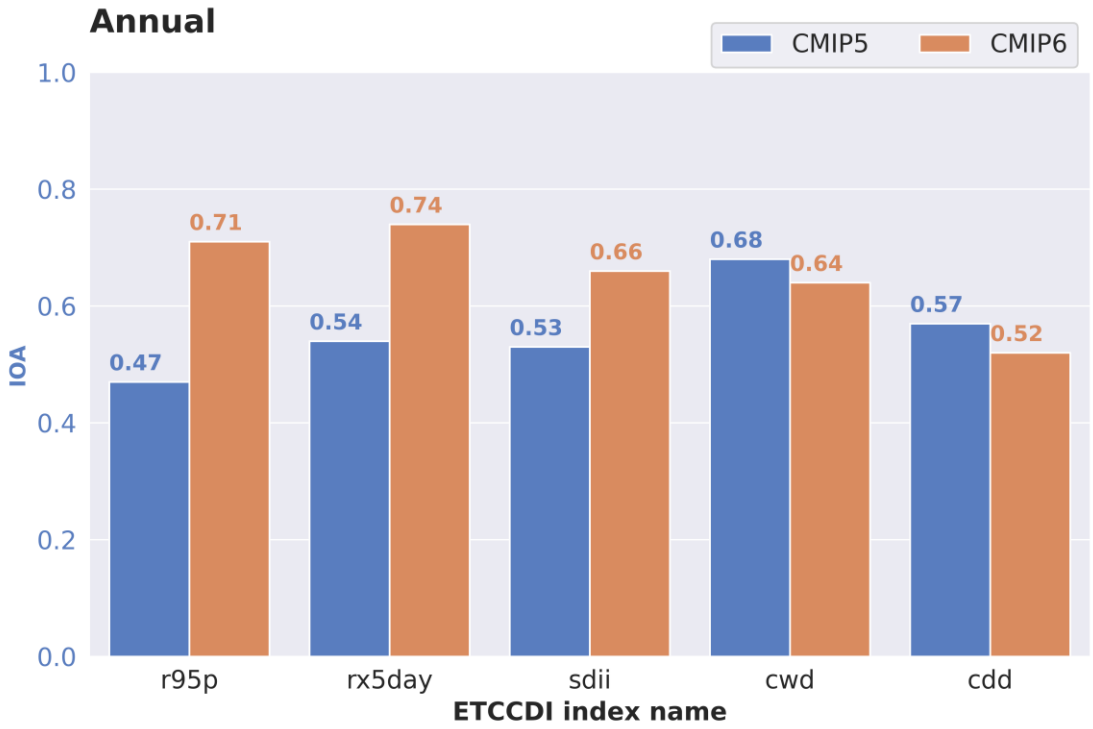
Improvement (%) in CMIP6 over CMIP5 Vs APHRODITE



Improvement Parameter (IP)

$$IP = 1 - \left(\frac{RMSE_{CMIP6}}{RMSE_{CMIP5}}\right)$$

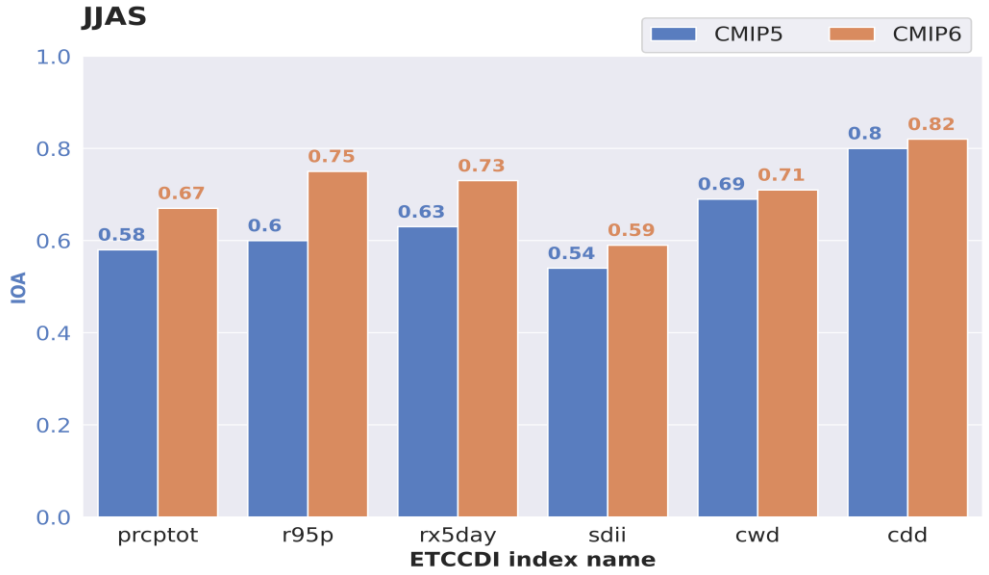
Statistics of CMIP5 and CMIP6 for Climate Indices

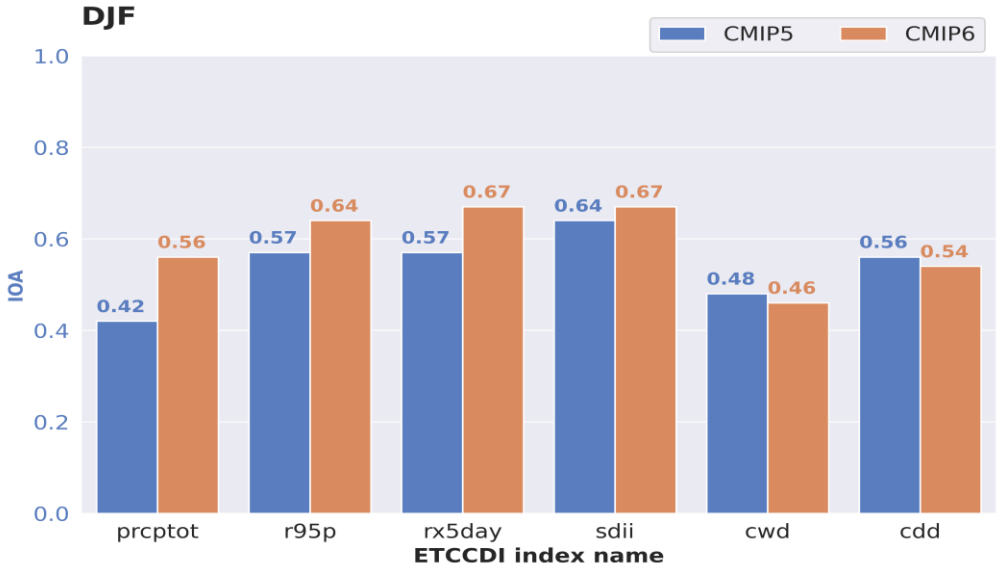


(C. J. Willmott et al., 2012)

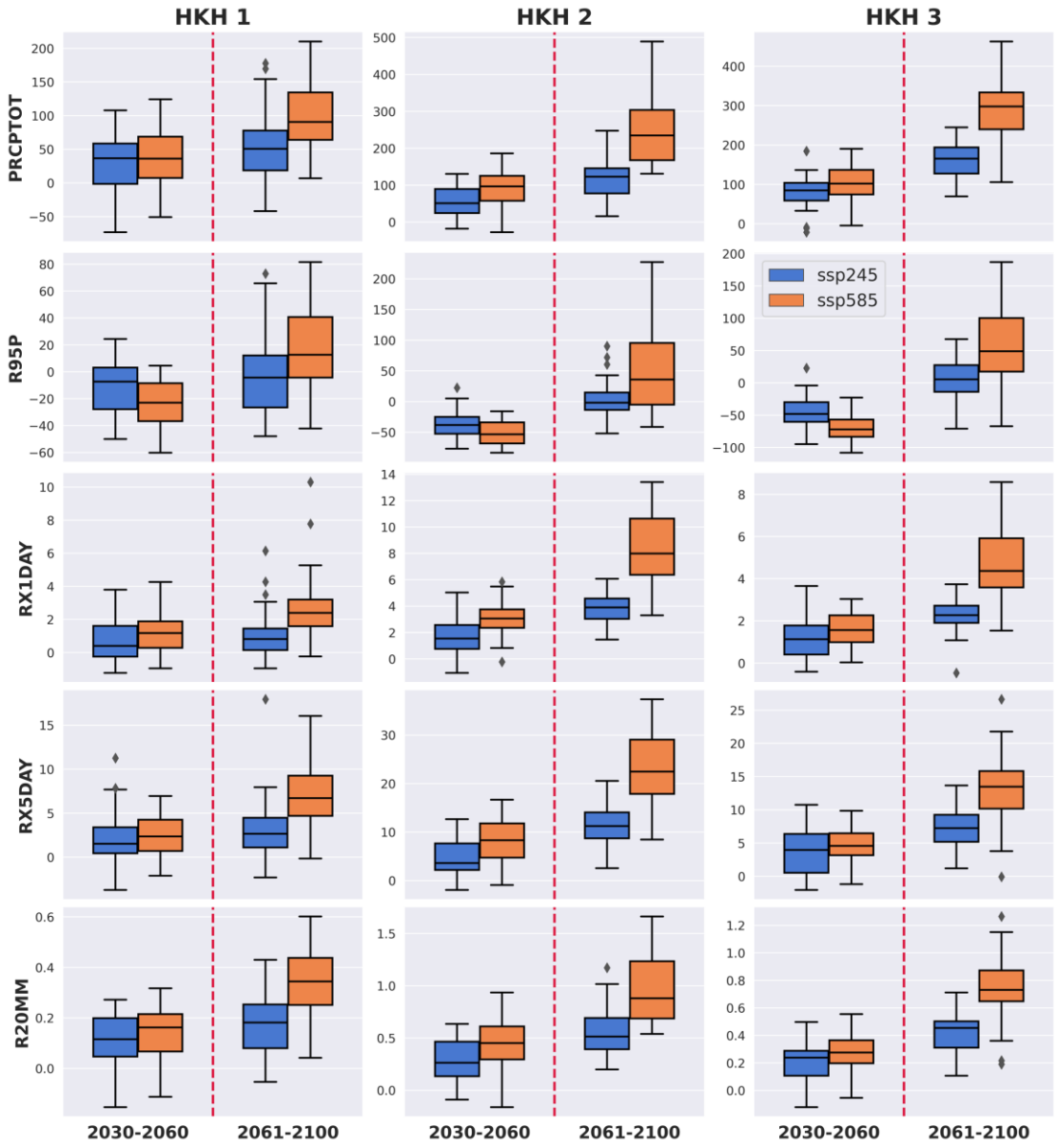
Index of Agreement (IOA)

$$d_r = \begin{cases} 1 - \dfrac{\sum_{i=1}^{n} |P_i - O_i|}{c \sum_{i=1}^{n} |O_i - \overline{O}|}, & \text{when } \sum_{i=1}^{n} |P_i - O_i| \le c \sum_{i=1}^{n} |O_i - \overline{O}| \\ \dfrac{c \sum_{i=1}^{n} |O_i - \overline{O}|}{\sum_{i=1}^{n} |P_i - O_i|} - 1, & \text{when } \sum_{i=1}^{n} |P_i - O_i| > c \sum_{i=1}^{n} |O_i - \overline{O}| \end{cases}$$

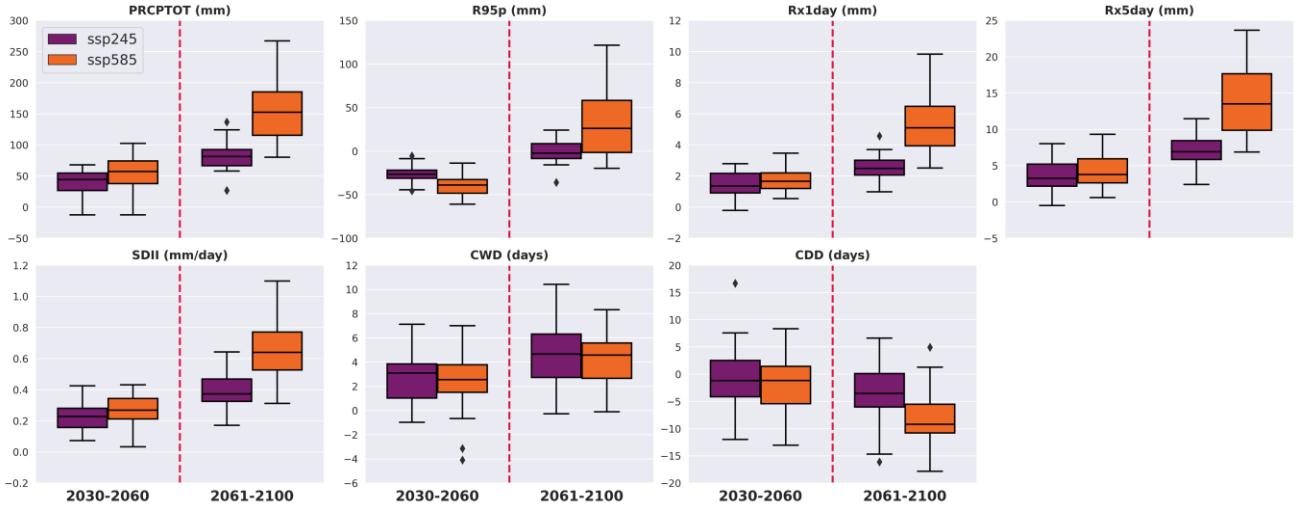




Box plots for best multi-model mean changing rates in future times over the historical period



Historical period (1980-2005)

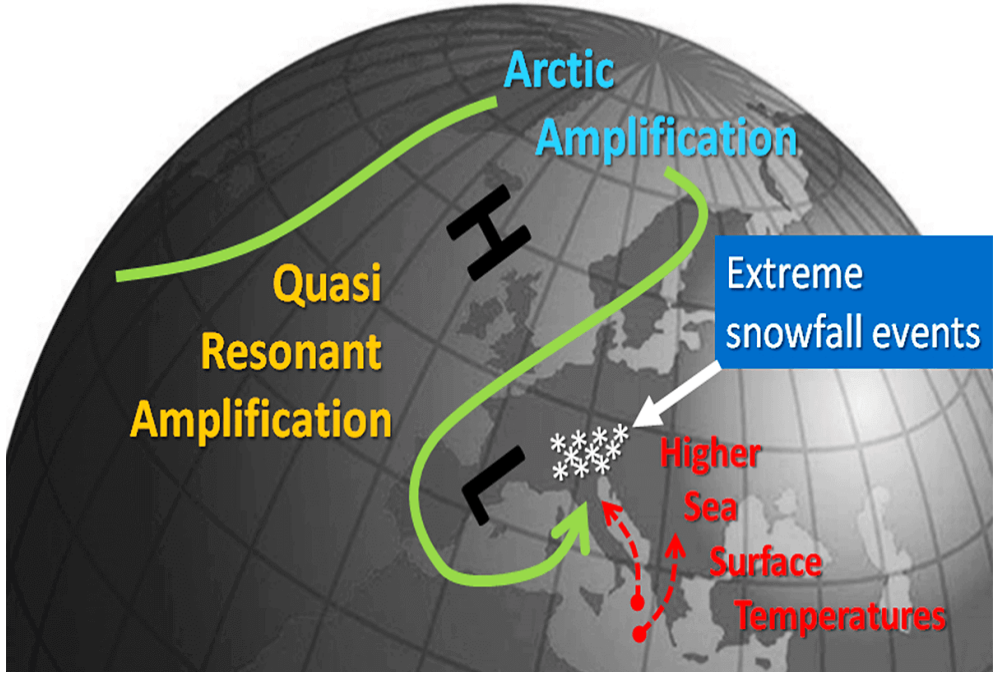


Entire HKH

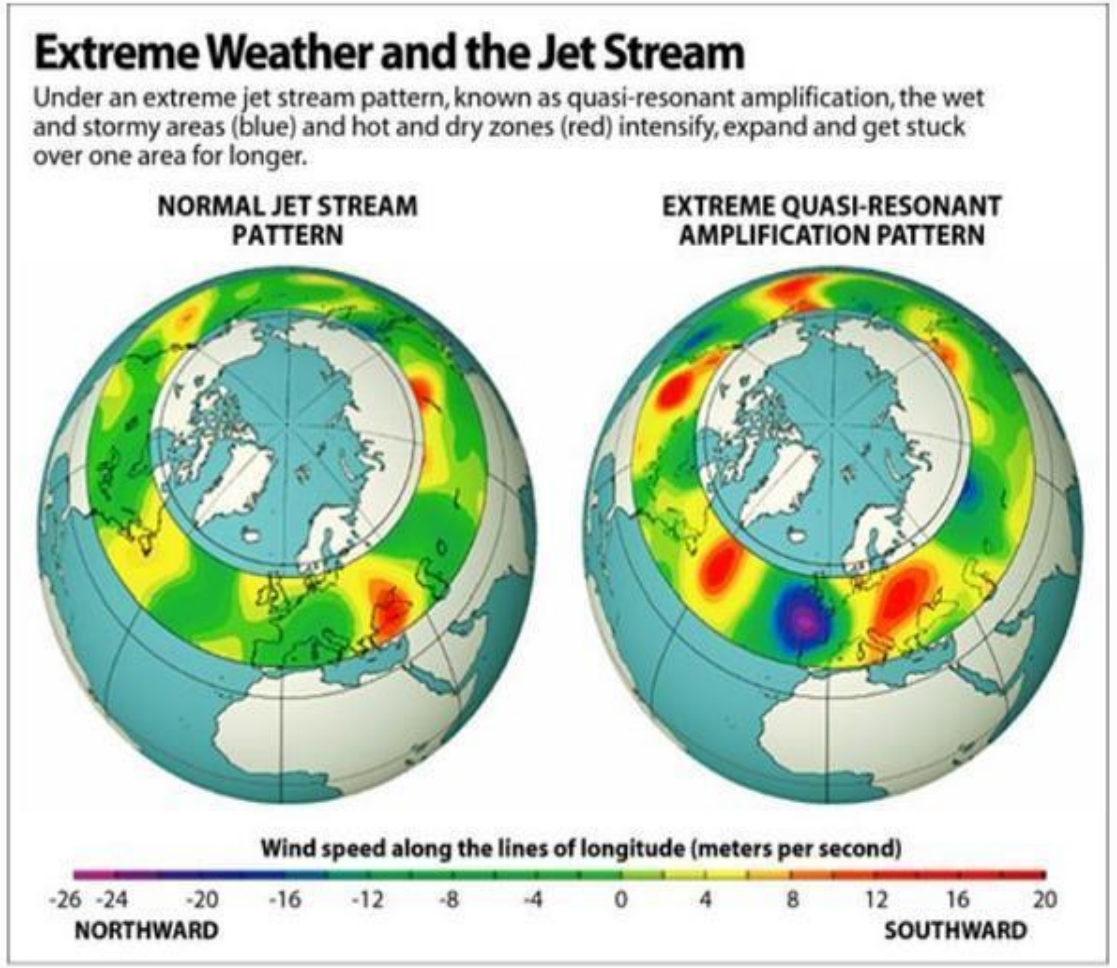
Quasi-resonant Amplification – Linkages with EPEs ?

Extreme events are linked with the slow-moving amplified Rossby waves, known as quasi-resonant amplification (QRA)

- Kornhuber et al. (2019), Mann et al. (2018) and Coumou et al. (2014)



https://www.severe-weather.eu/cryosphere/extreme-snowfall-future-winters-alps-glaciers-challenging-global-warming-rrc/



https://www.digitaljournal.com/tech-science/the-impact-of-burning-fossil-fuels-on-today-s-extreme-weather/article/535974

https://sites.google.com/view/wcmgiiserm/home

For Posdoctoral Program

Who can apply?

- Students with a PhD degree (or have submitted their PhD thesis)
- An applicant should have a **PhD degree** in Atmospheric Sciences/ Earth and Environmental Sciences/ Physics/ Geophysics/ Meteorology/ Hydrology/ Climate Sciences/ Mathematics/ Remote Sensing/ Computer Sciences/ Artificial Intelligence/ Data Sciences.

How to apply?

- Interested candidates may contact Dr.Raju Attada and e-mail their resume (with one-page summary of research pursued) and a brief write-up on research proposal (<1,000 words) to **rajuattada@iisermohali.ac.in.**
- We strongly encourage the interested candidates to apply for fellowships from **IISER Mohali**

Acknowledgements: MoES, World Climate Research Programme's Working Group on Coupled Modelling - CMIPs