

# **Future Changes in Precipitation Extremes over base Himalayan Uttarakhand region during Southwest Monsoon**

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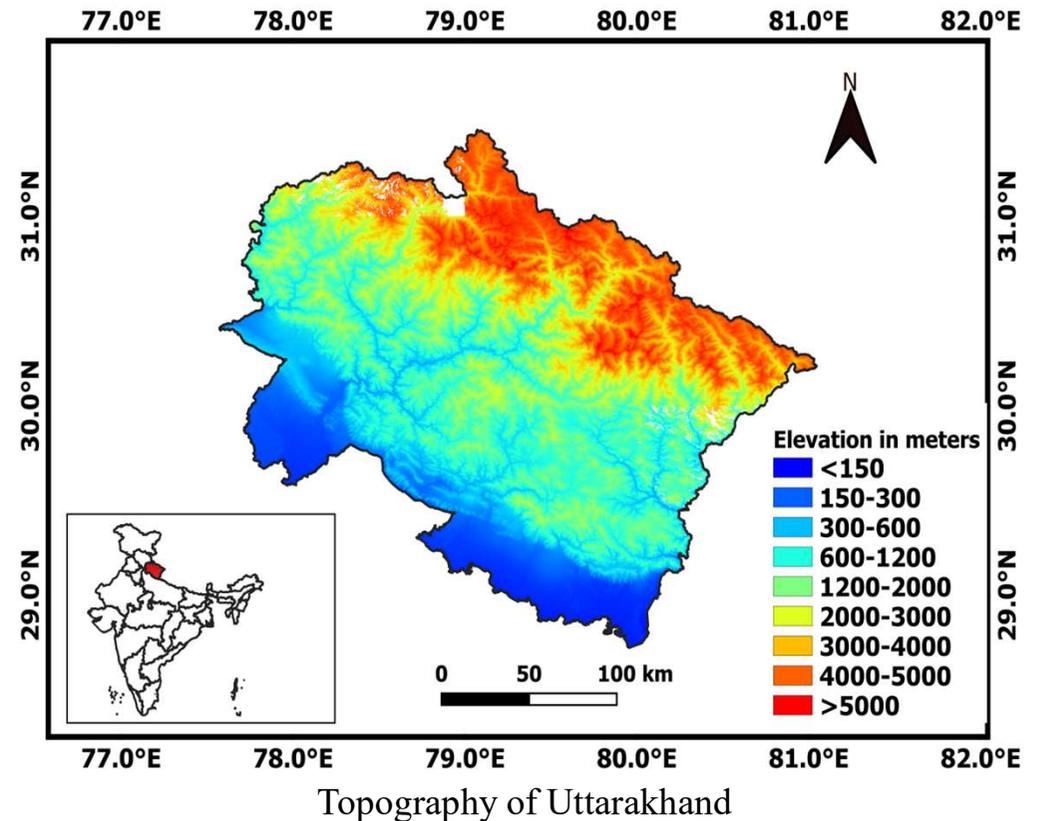
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# Objectives

- Evaluation of 20 NASA Earth Exchange Global Daily Downscaled Projections (NEX-GDDP) models for SW monsoon
- Projection of future changes in SW monsoon rainfall
- Projection of future changes in precipitation extremes



## Data Used

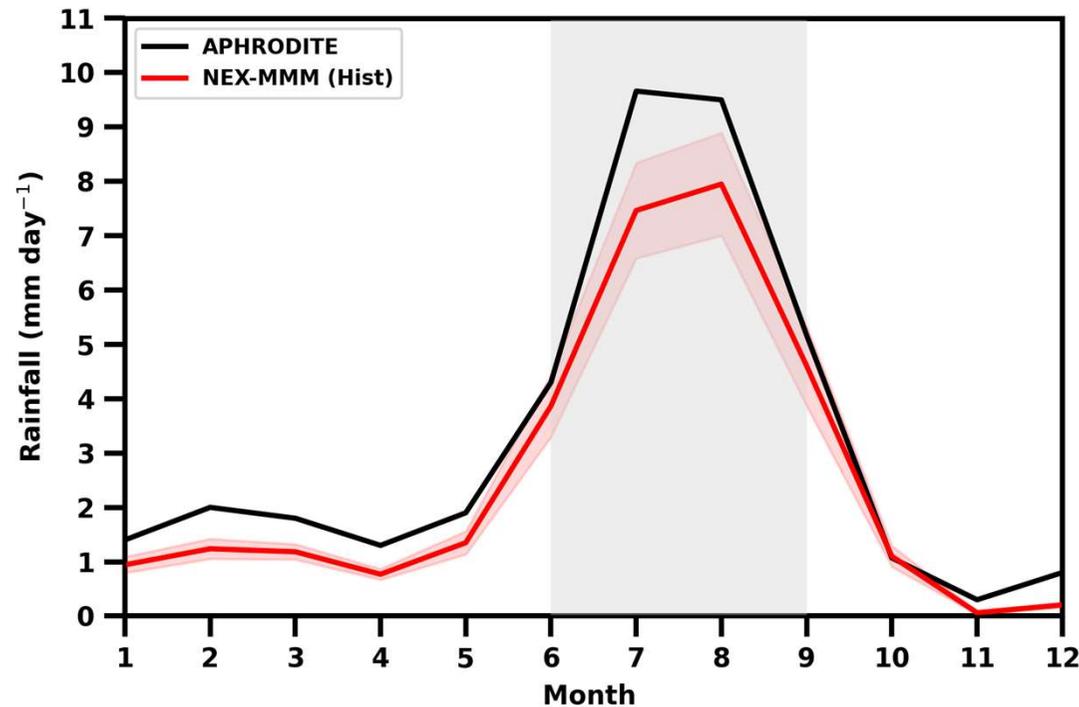
Data	Temporal Resolution	Spatial Resolution	Time Period
APHRODITE	Daily	0.25° x 0.25°	1950 to 2005
NEX-GDDP	Daily	0.25° x 0.25°	1950 to 2099

Emission scenarios	
RCP 4.5	RCP 8.5

## 20 NEX-GDDP Models

- ACCESS1.0
- BCC-CSM1.1
- BNU-ESM
- CanESM2
- CCSM4
- CESM1/CAM5
- CNRM-CM5
- CSIRO-Mk3.6.0
- GFDL-ESM2G
- GFDL-ESM2M
- INM-CM4
- IPSL-CM5A-LR
- IPSL-CM5A-MR
- MIROC-ESM
- MIROC-ESM-CHEM
- MIROC5
- MPI-ESM-LR
- MPI-ESM-MR
- MRI-CGCM3
- NorESM1-M

# Temporal variation of monthly rainfall over Uttarakhand



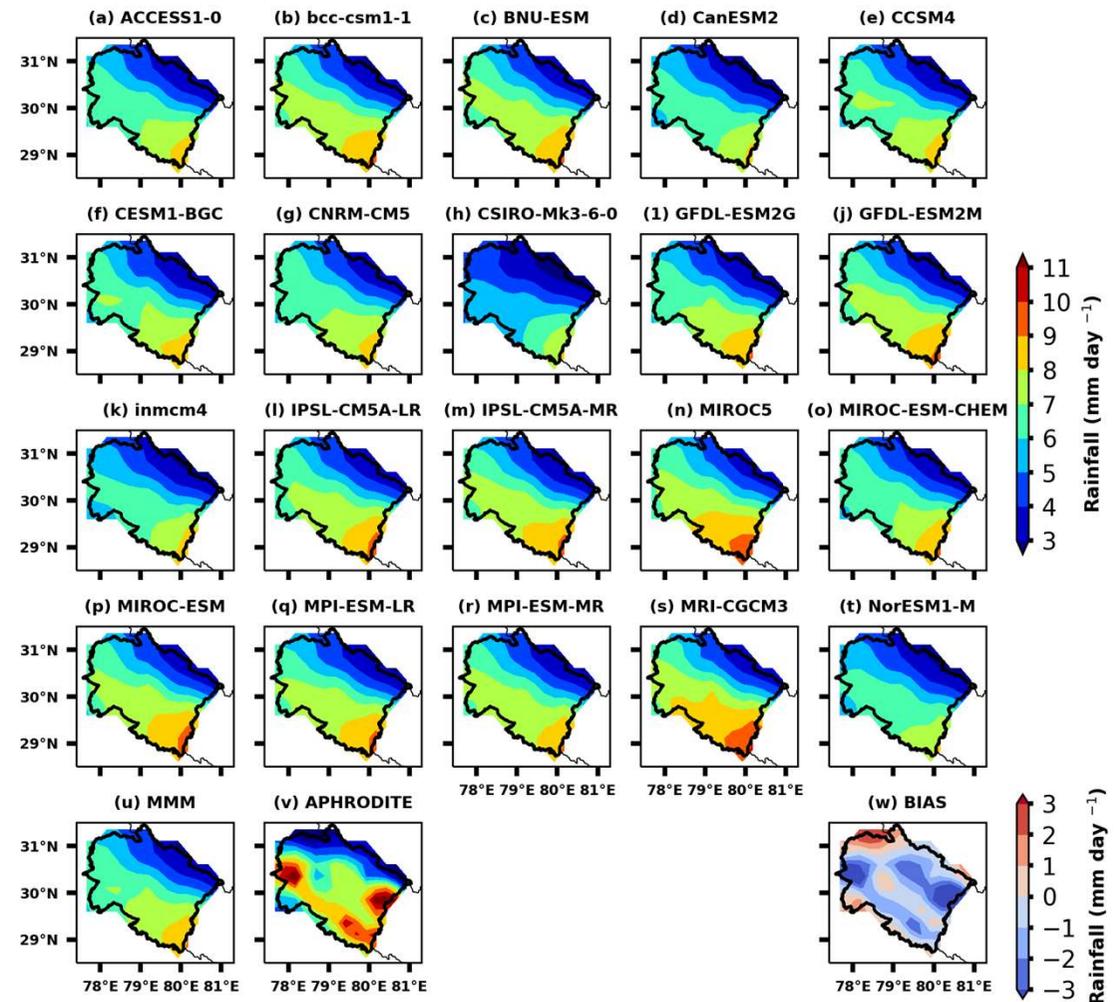
## Highlights:

- The models fairly simulate the monthly variation of rainfall
- There is underestimation of values
- Peak shifted from July to August

# Spatial variation of mean monsoon rainfall over Uttarakhand

## Highlights:

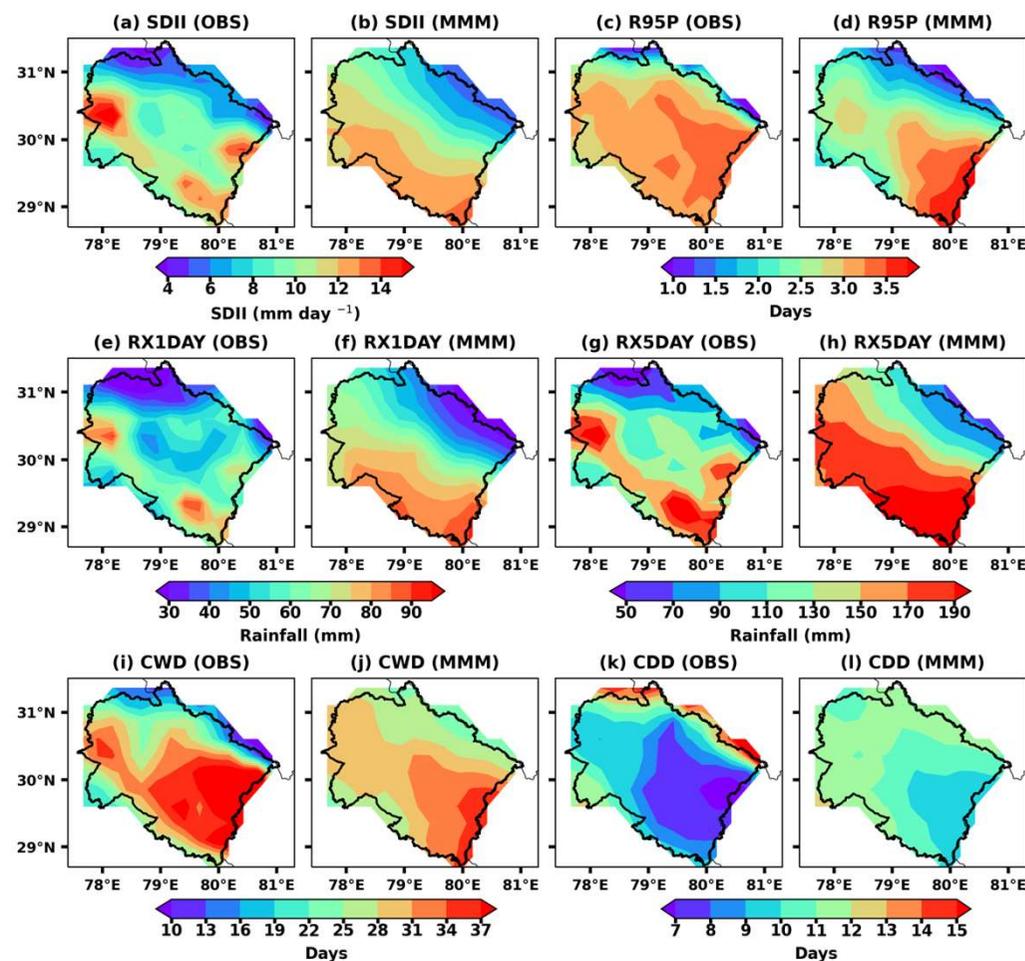
- Southernmost parts receive **8-10 mm/day** rainfall
- Northernmost regions record **2-4 mm/day or less** rainfall
- All models could capture the spatial variation
- The models underestimate the rainfall



# Simulation of rainfall extremes over Uttarakhand (Historical period: 1976-2005)

## Highlights:

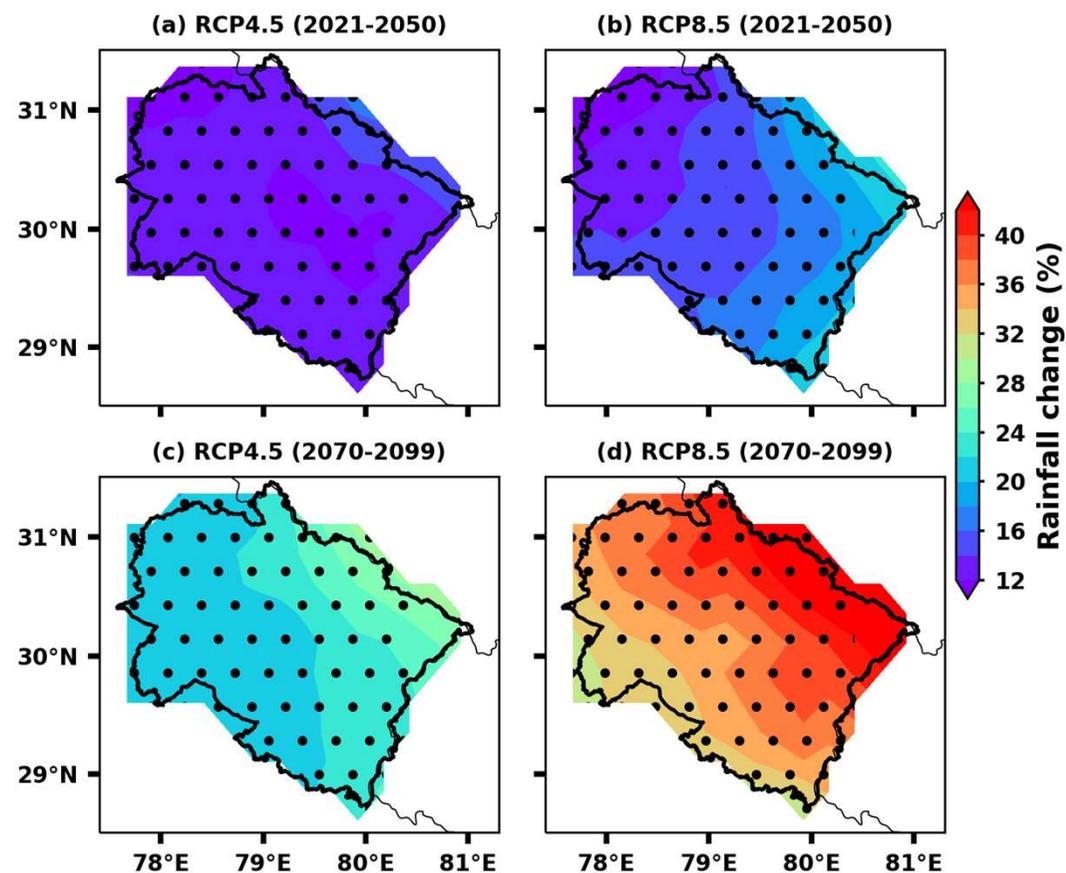
- The MMM could capture the **spatial variation** of rainfall extremes
- The MMM **overestimates** the rainfall extremes



# Projected changes in mean monsoon rainfall For near (2021-2050) and far (2070-2099) future

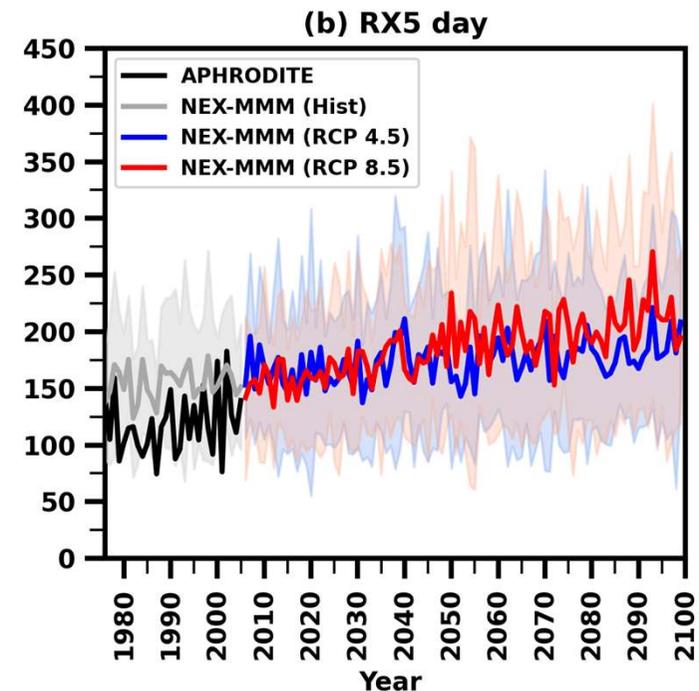
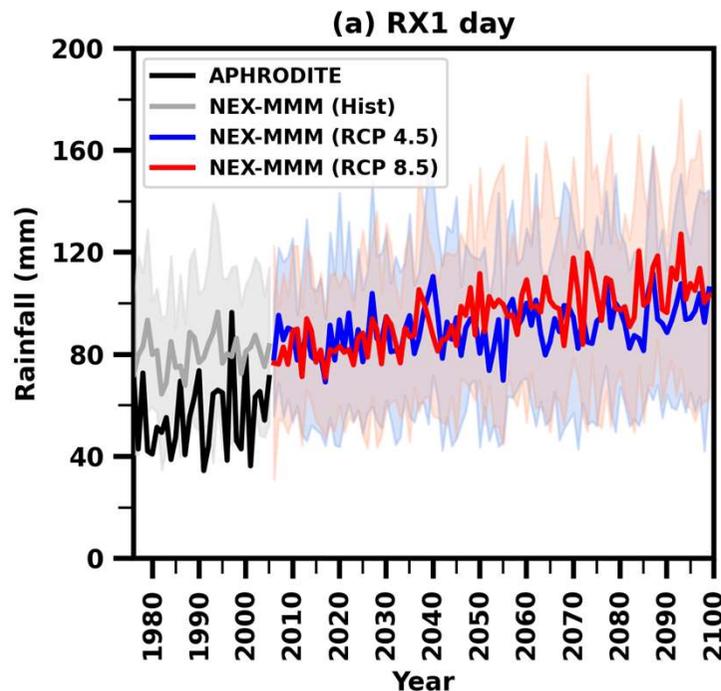
## Highlights:

- Under RCP 4.5, the mean monsoon rainfall is projected to increase by
  - 10-28% in the near and far future.
- Under RCP 8.5, the same is projected to increase by:
  - 10-22% in the near future
  - 34-43% in the far future.



# Variability of One day (RX1DAY) highest rainfall and consecutive Five day (RX5DAY) highest rainfall

	RCP 4.5	RCP 8.5
RX1 DAY	1.4 mm/decade	3.3 mm/decade
RX5 DAY	2.8 mm/decade	7 mm/decade



## Highlights:

- For historical period:
  - The models **overestimate** the rainfall extremes
- For future period:
  - All models project an increase in RX1DAY and RX5DAY rainfall

# Conclusions

- NEX-GDDP models could capture the spatial variation of rainfall mean and extremes reasonably well.
- Models underestimate the mean rainfall and overestimate rainfall extremes.
- The projections suggest an increase in rainfall in the near and far future.
- RX1DAY and RX5DAY rainfall are projected to increase.
- This can lead to an increased frequency of floods, especially flash floods.

**Thank You**