

# Projected changes in Irrigation Water Demand in the Ganges Basin

Harsh L. Shah and Vimal Mishra

Department of Civil Engineering, Indian Institute of Technology (IIT) Gandhinagar, Gujarat, India

## 1 Introduction

- Irrigation plays an important role in improving food security problem.
- Irrigated area increased by 4 times from 1951-1995 over India (FAO).
- The Indo-Gangetic plain contains 40% of the population of India and 50% of irrigated area.
- Shah H., Mishra V. et al. (in preparation) found increasing trend in irrigation water demand in post monsoon season over the Ganges basin.

## 2 Science Question

- What are the projections of water budget components evapotranspiration (ET), total runoff (TR) and surface temperature (ST) and irrigation water demand (IWD) in the Ganges basin?

## 4 Results

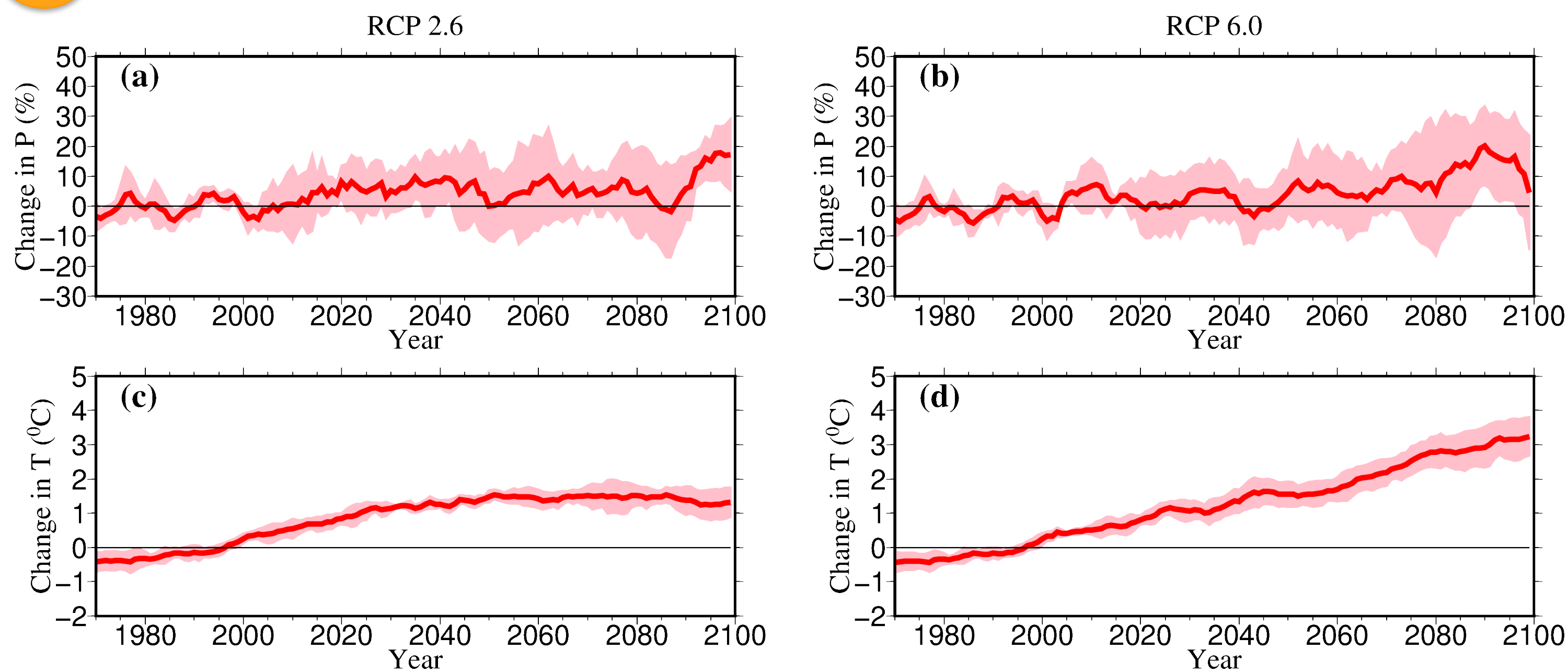


Figure 1. Basin averaged ensemble mean of GCM's Precipitation and Temperature.

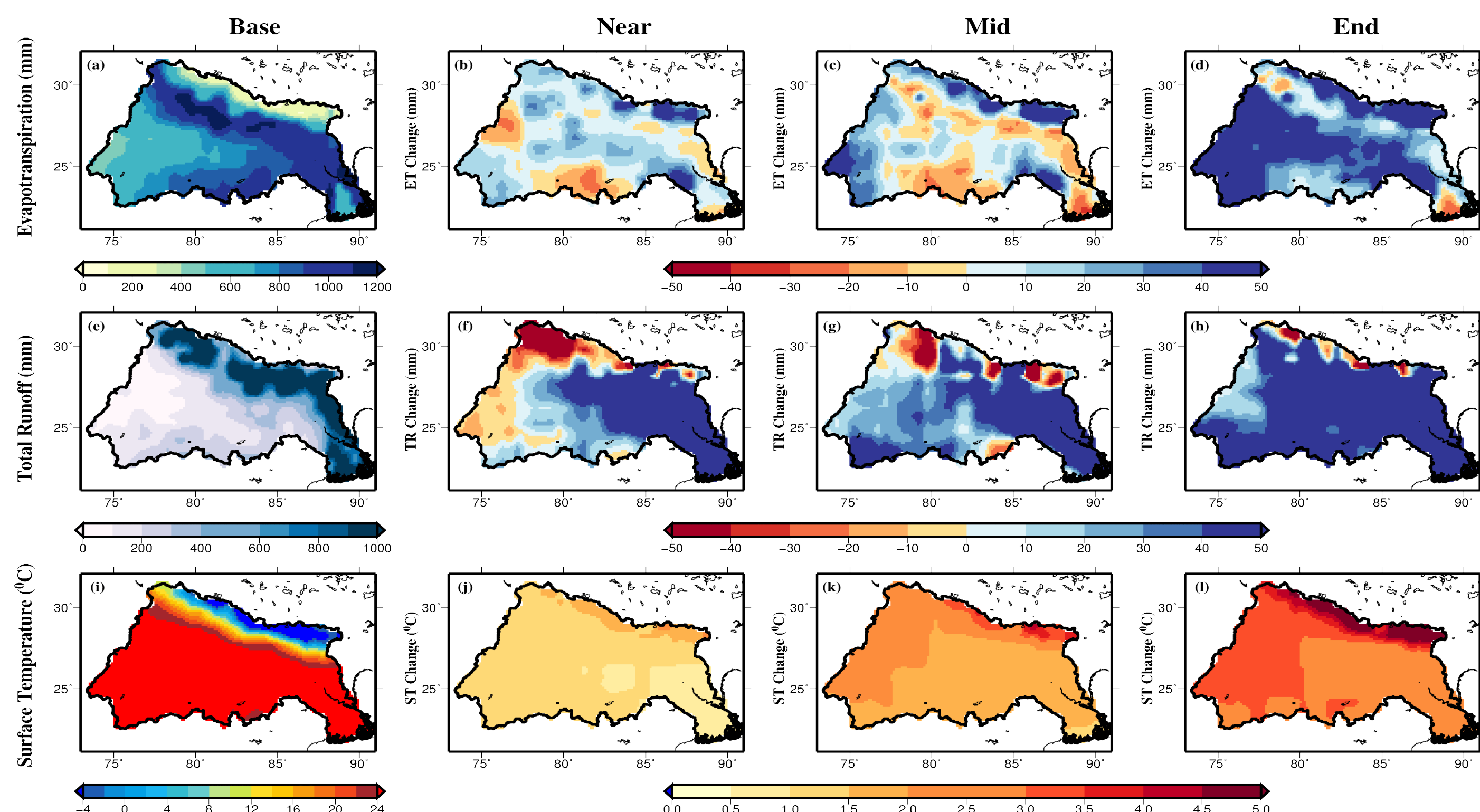


Figure 2. Under RCP6.0, change in water budget components in Near, Mid, and End term against Base (1970-1999) period.

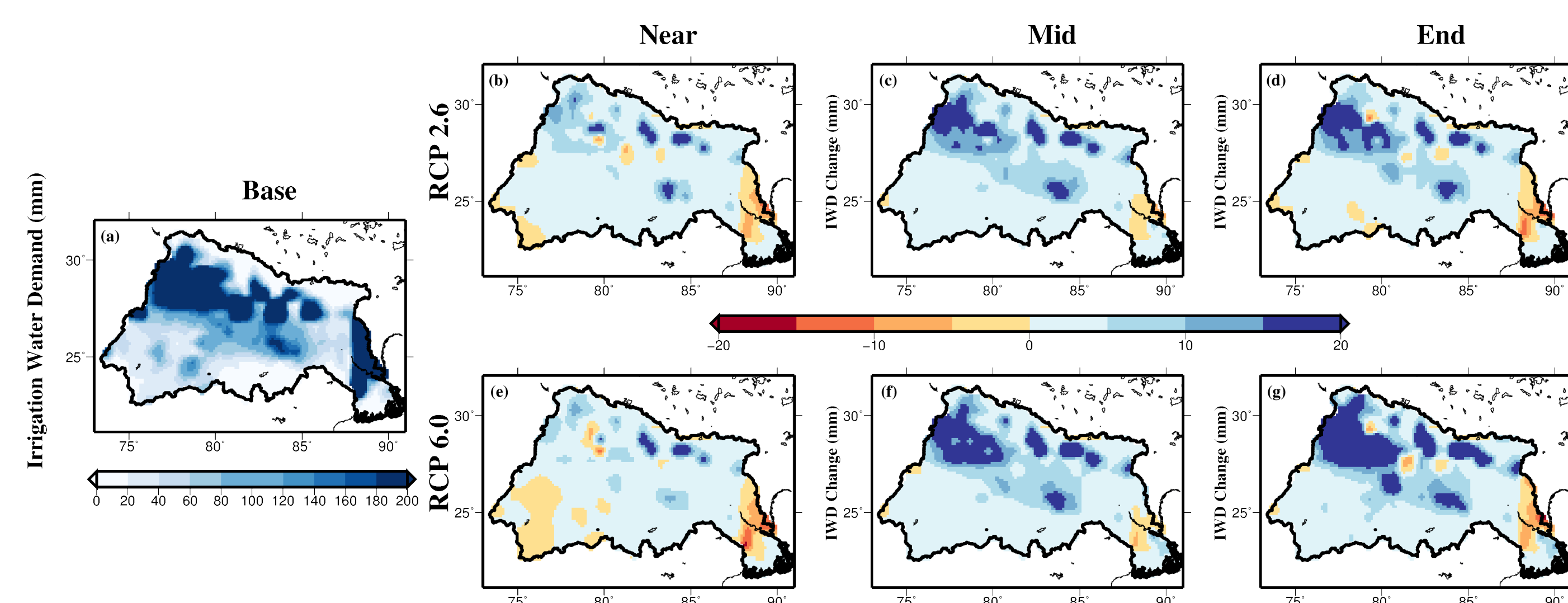
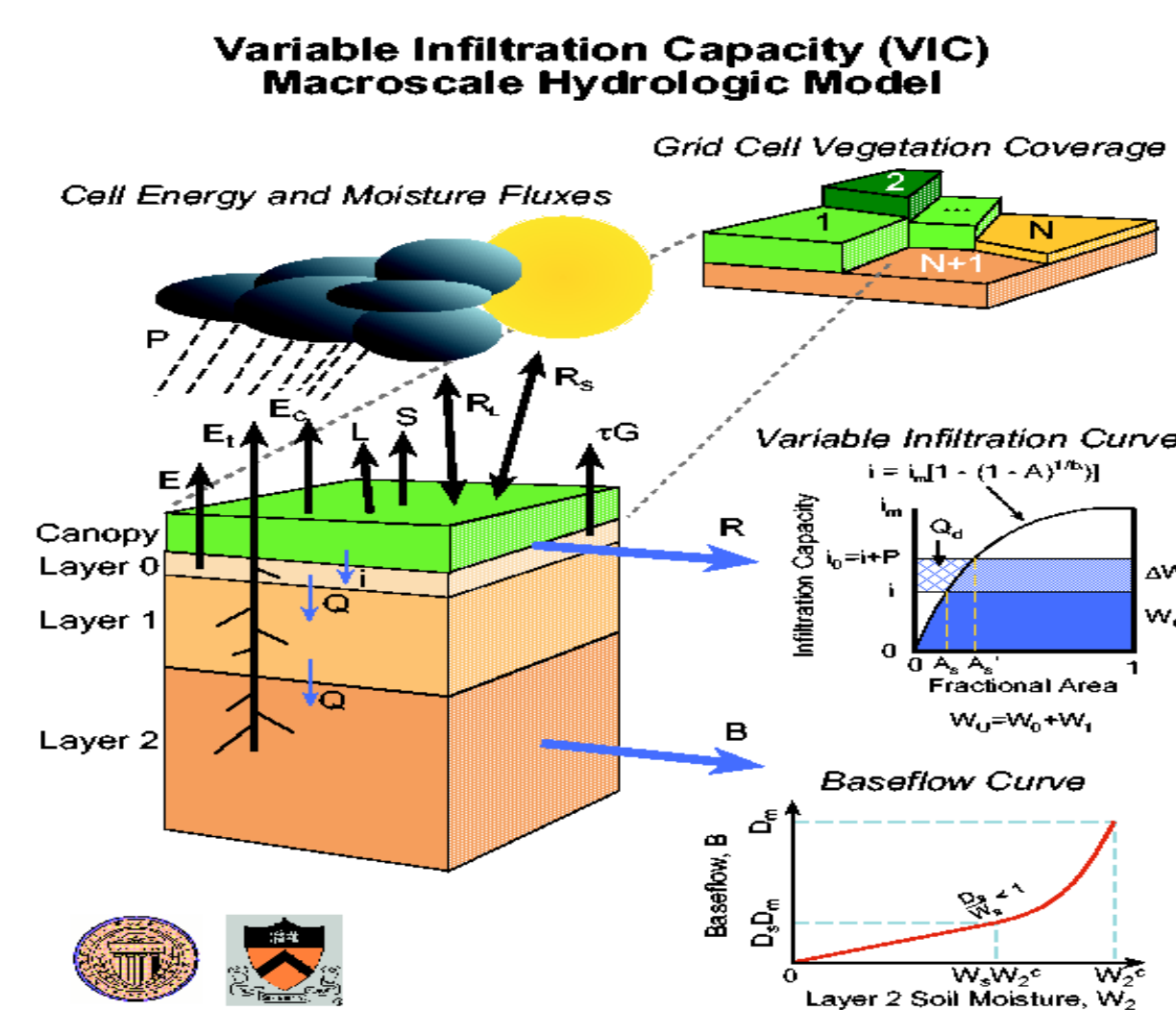


Figure 3. Under RCP2.6 and RCP6.0, change in IWD in Near, Mid, and End term.

## 3 Methodology



- Solves energy and water balance over grid cells (Liang et al., 1994).
- Sprinkler irrigation starts when soil moisture drops below the level where transpiration becomes limited, and continues until soil moisture reaches field capacity. (Haddeland et al., 2006).

- We have calibrated VIC (irrigation module included) simulated streamflow against observed data using EWEMBI forcing data.
- The calibrated VIC model was used to understand changes in water budget components and IWD using the climate forcing from the four CMIP5 models for the Near (2010-2039), Mid (2040-2069), and End (2070-2099) periods.

GCMs

Modeling Center	Model Name
NOAA-GFDL	GFDL-ESM2M
MOHC	HadGEM2-ES
IPSL	IPSL-CM5a-LR
MIROC	MIROC5

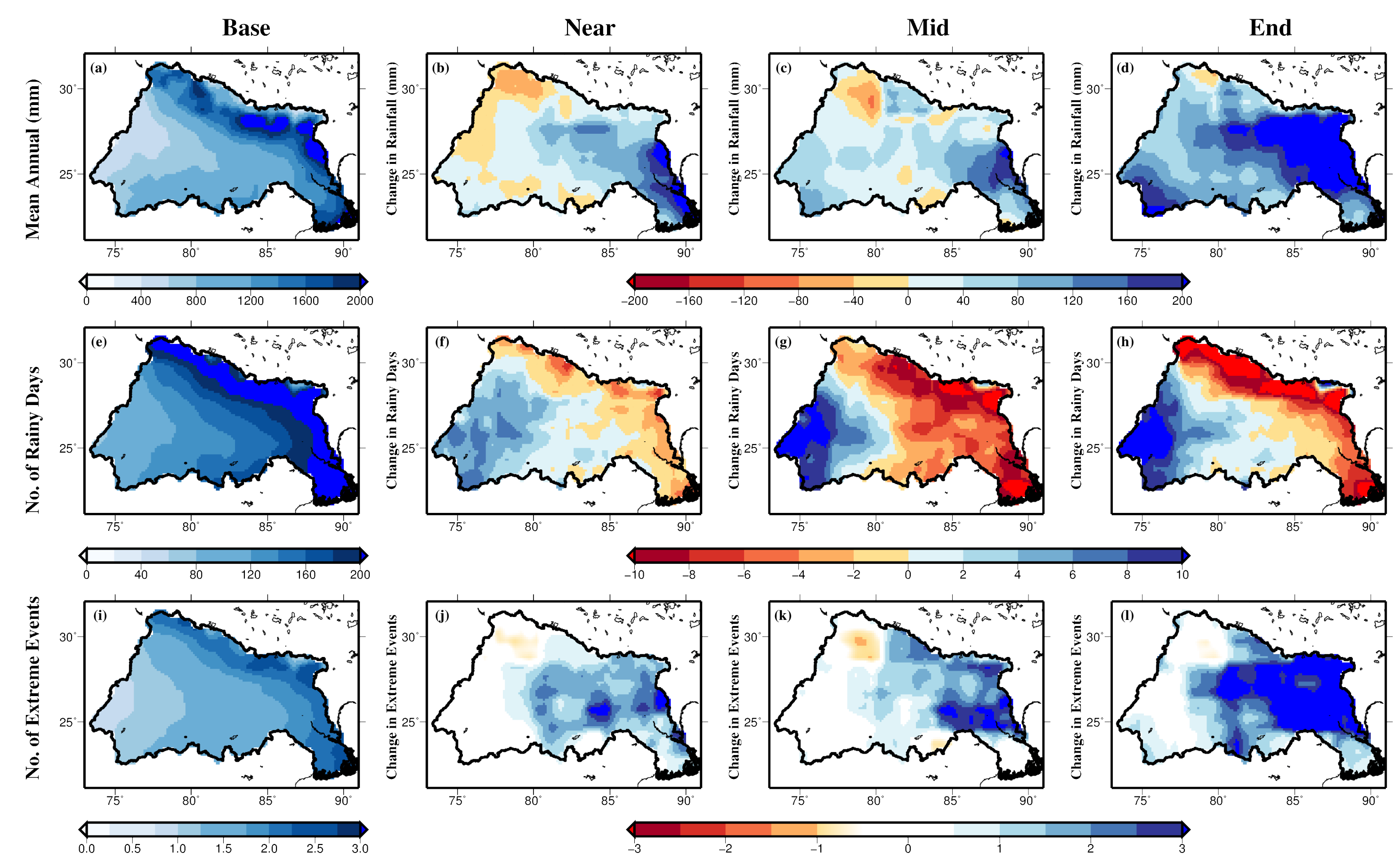


Figure 4. Change in mean annual Precipitation, Numbers of rainy days and Number of extreme events under RCP6.0 scenario.

- Large uncertainty in precipitation projections was found under both RCP scenarios.
- Under both the RCPs, mean annual precipitation and mean temperature are projected to increase over the Ganges basin.

- ET, TR and ST are projected to increase from near – end term period.
- IWD is projected to increase by 5-15%.
- Mean annual precipitation is increasing, numbers of rainy days are decreasing and extreme events are increasing.

## 5 Conclusion

- The precipitation and temperature are projected to increase in 21<sup>st</sup> century. As a results, ET (5-10%), TR (10-20%) and surface temperature (1-5 °C) are projected to increase in over the Ganges basin.
- Mean annual precipitation is increasing, number of rainy days are decreasing and extreme events (threshold above 95<sup>th</sup> percentile of rainy days event magnitude) are increasing, which results in increase (5-15%) in irrigation water demand by the end of 21<sup>st</sup> century.

## 6 References

- Haddeland, I., D. P. Lettenmaier, and T. Skaugen, 2006: Effects of irrigation on the water and energy balances of the Colorado and Mekong river basins. *J. Hydrol.*, **324**, 210–223.
- Liang, X., D. P. Lettenmaier, E. F. Wood, and S. J. Burges, 1994: A simple hydrologically based model of land surface water and energy fluxes for general circulation models. *J. Geophys. Res. Atmospheres* **1984–2012**, **99**, 14415–14428.
- Shah H., Mishra V., et al (in preparation) : Water cycle in Indian sub-continental river basins: Non-irrigated vs. Irrigated.

## 7 Acknowledgement

- I am thankful to MHRD and IIT Gn for providing scholarship and computational facilities; ISIMIP for providing data and travel funding