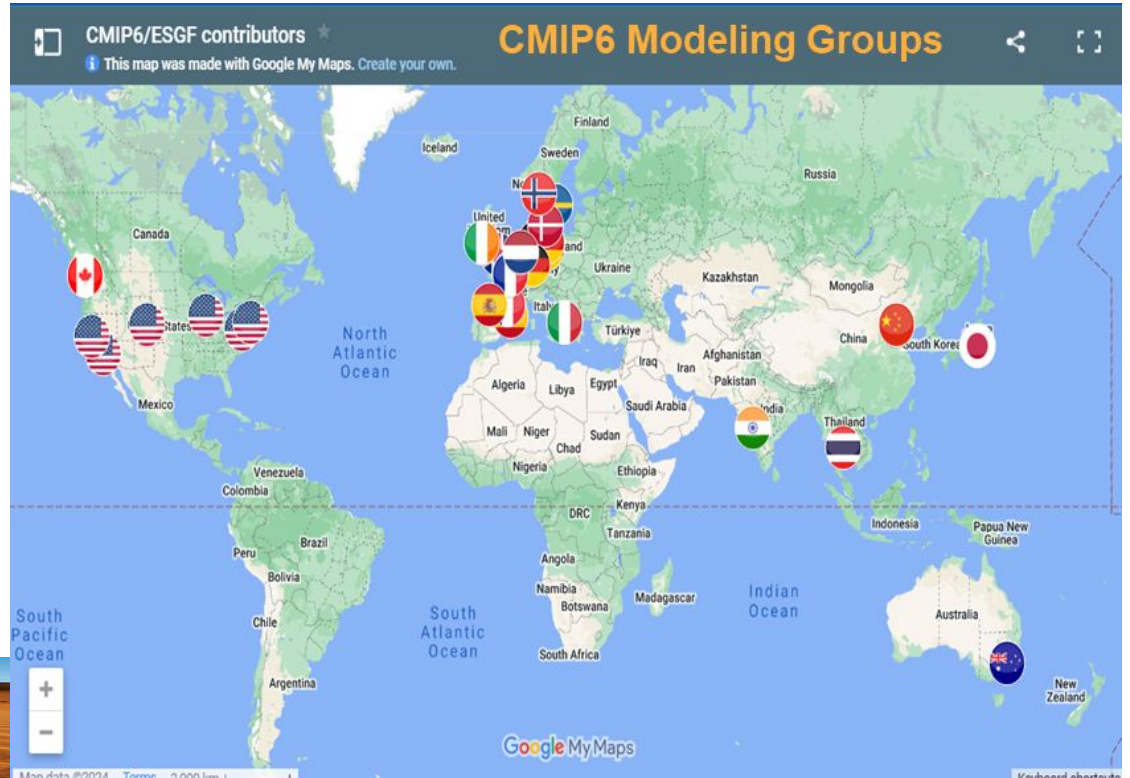
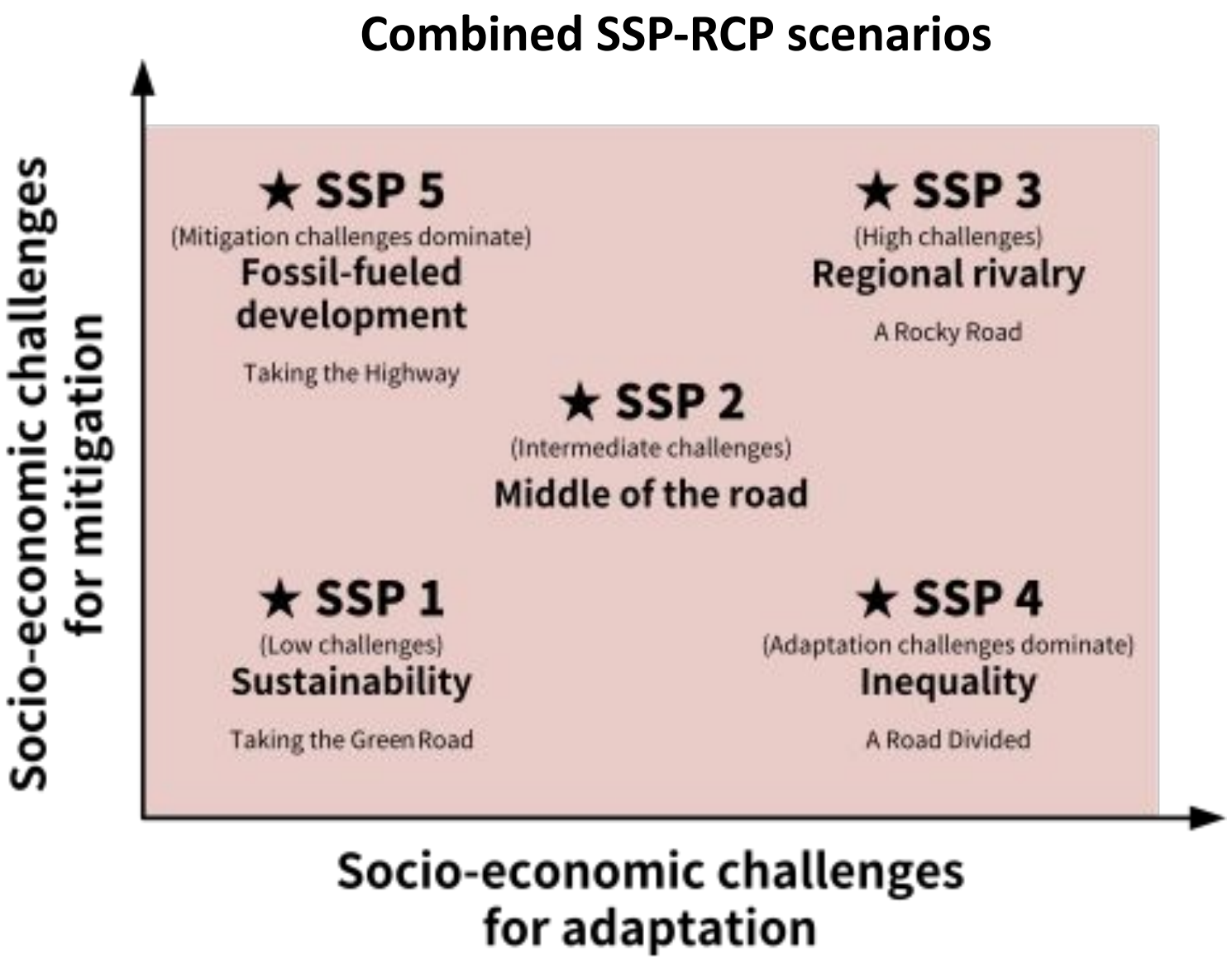
Climate Change impact assessment in Agriculture



Climate change Impact assessment in agriculture

- CC- biggest and most complex challenge in agri-food systems
- Expected significant crop yield losses, increase with time
- Tropical and developing countries more vulnerable (IPCC, AR5).
- Understanding its potential impacts and identifying possible solutions requires understanding how biophysical and socioeconomic processes interact in multiple locations over time.
- CC impact assessments use biophysical process-based models to project the likely impact of CC on future yields

Climate models and scenarios for impact assessment



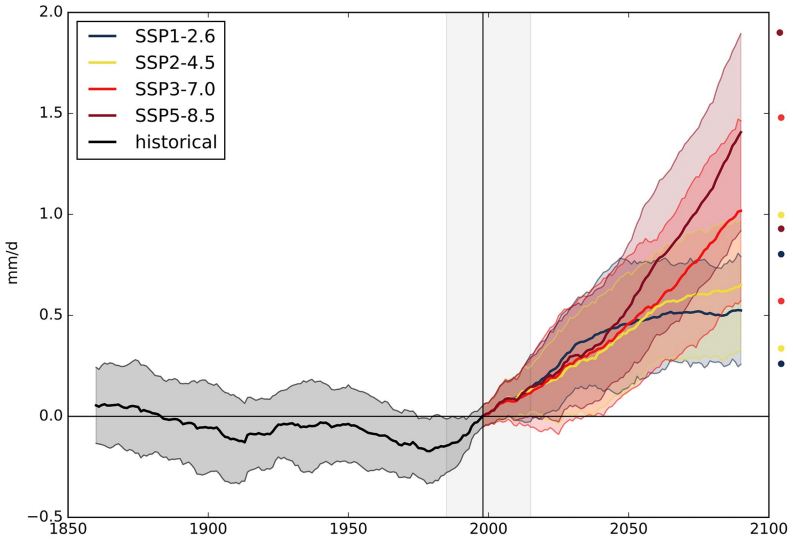
- IPCC AR5 – CMIP5, RCPs (RCP 2.6, 4.5, 6, 8.5)
- IPCC AR6 – CMIP6, combined SSP-RCP scenarios
- The SSPs are baseline narrative scenarios
  - socio-economic assumptions
  - geopolitical assumptions
  - economic and technological trends

Climate models - CMIP6- GCMs

	Models	Country		Models	Country
1	ACCESS-CM2	Australia	16	GFDL-ESM4	USA
2	ACCESS-ESM1-5	Australia	17	GISS-E2-1-G	USA
3	BCC-CSM2-MR	China	18	HadGEM3-GC31-MM	UK
4	CAMS-CSM1-0	Europe	19	HadGEM3-GC31-LL	UK
5	CESM2	USA	20	INM-CM5-0	Russia
6	CESM2-WACCM	USA	21	IPSL-CM6A-LR	France
7	CIESM	China	22	KACE-1-0-G	S. Korea
8	CNRM-CM6-1-HR	France	23	MCM-UA-1-0	USA
9	CNRM-ESM2-1	France	24	MIROC-ES2L	Japan
10	CanESM5	Canada	25	MIROC6	Japan
11	EC-Earth3	Europe	26	MPI-ESM1-2-HR	Germany
12	EC-Earth3-Veg	Europe	27	MRI-ESM2-0	Japan
13	FGOALS-f3-L	China	28	NESM3	China
14	FGOALS-g3	China	29	NorESM2-MM	Norway
15	FIO-ESM-2-0	China			

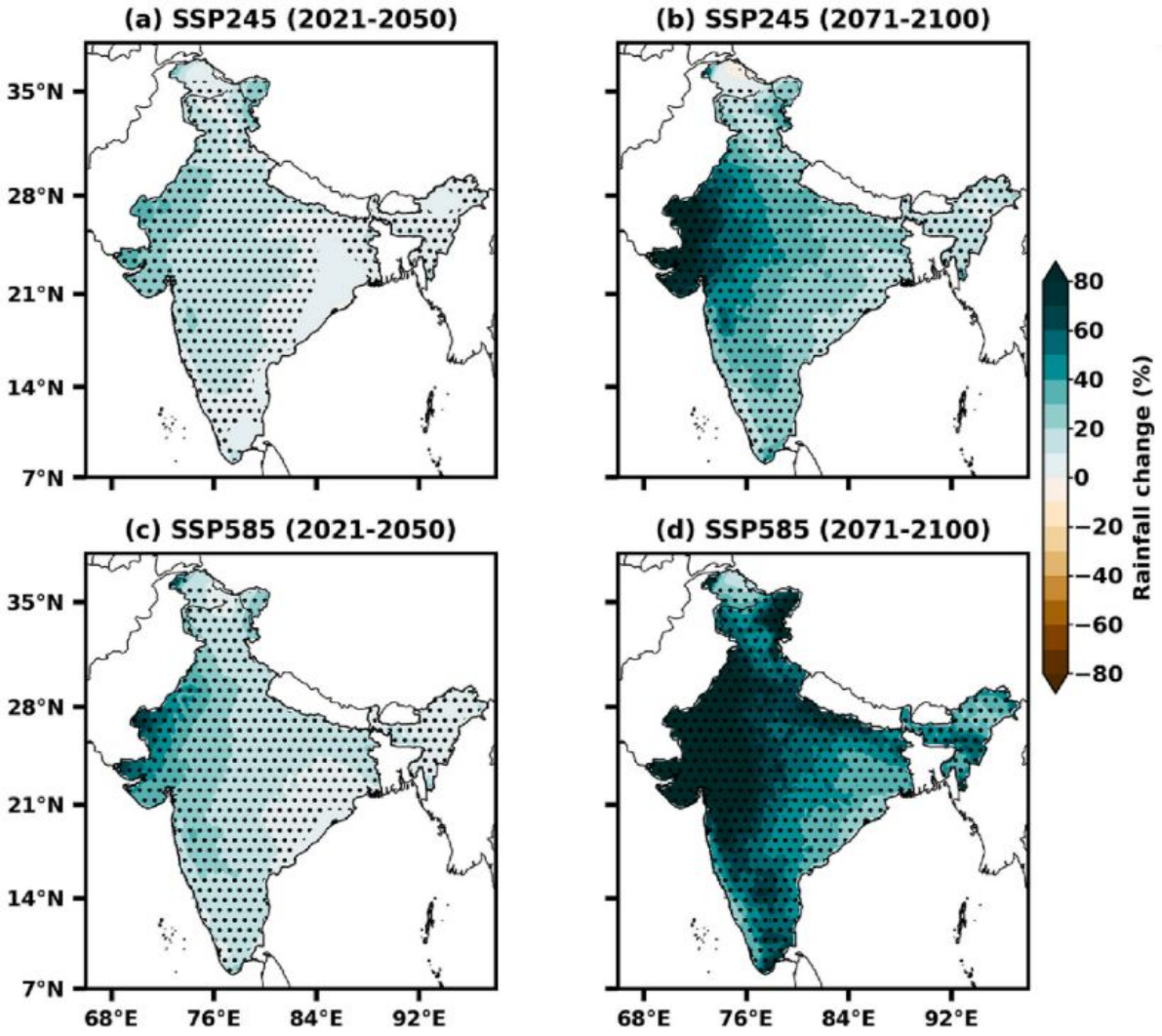
CMIP6 - India's future climate

- The bias-corrected CMIP6 models (13 model ensemble mean) suggested that the rainfall is increased significantly over many regions of India in the SW and peninsular Indian regions in the NE monsoon season by the end of the 21st century.
- The rainy days' during SW monsoon season is reduced by 10% per year in the northeastern parts and Himalayan region of India, while it is around 5% during NE monsoon by 2100 under the SSP5.8.5 scenario.
- Warming results from the rise in Tmax/Tmin are around 4.5°C/5°C in northern parts of India during the summer/winter seasons.
- The increase in temperature is seen from mid-century, suggesting that the traditional summer season is expected to start earlier, last longer, and become more intense.
- Under the SSP2-4.5 and SSP5-8.5 scenarios, average temperatures and precipitation are expected to increase rapidly from mid-century onwards, with continued significant, rapid increase throughout the century.

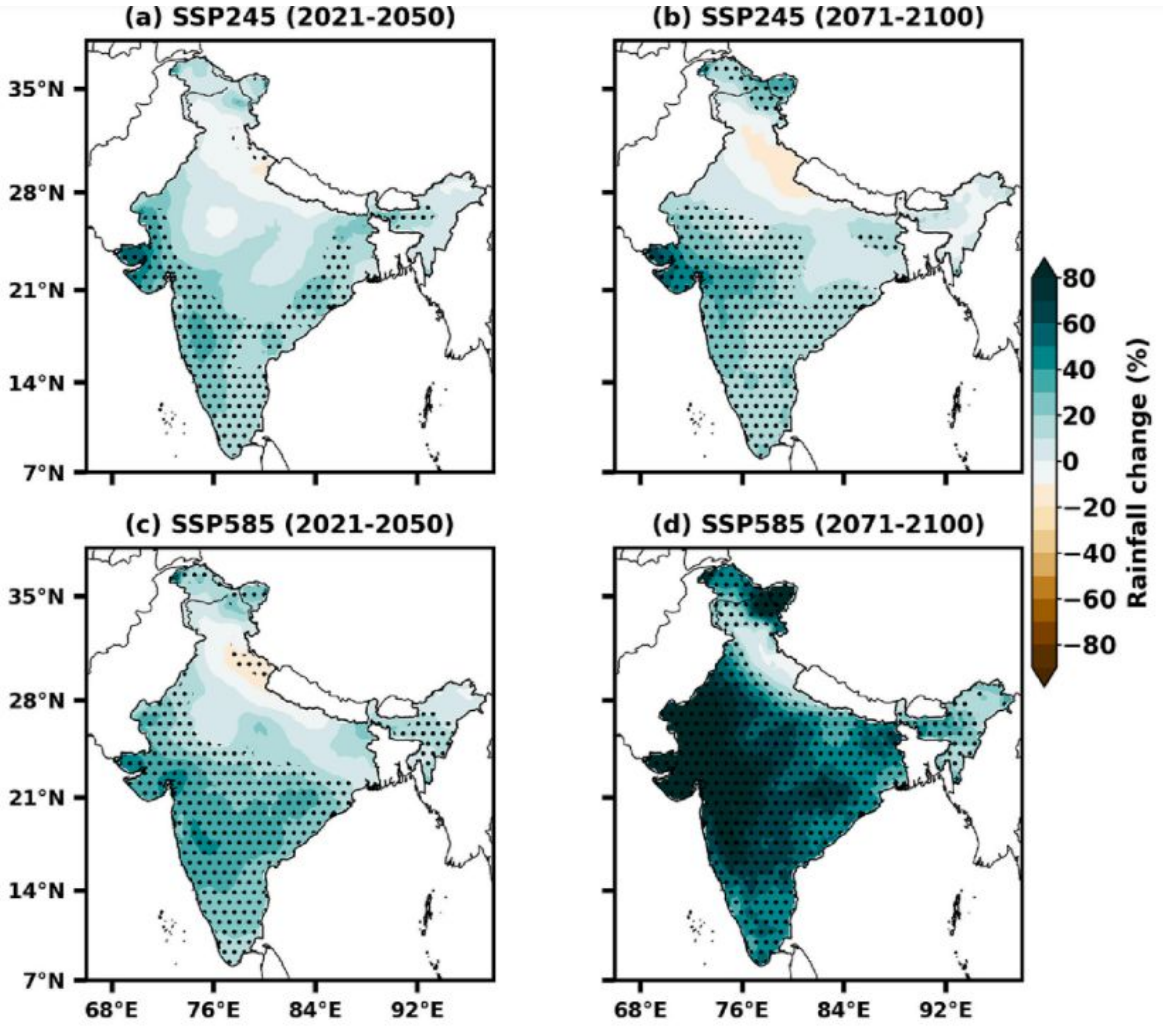


Multi-model mean of Indian summer monsoon rainfall (mm d^{-1}) in comparison to 1985–2015.

Projected changes in SW monsoon rainfall (%)

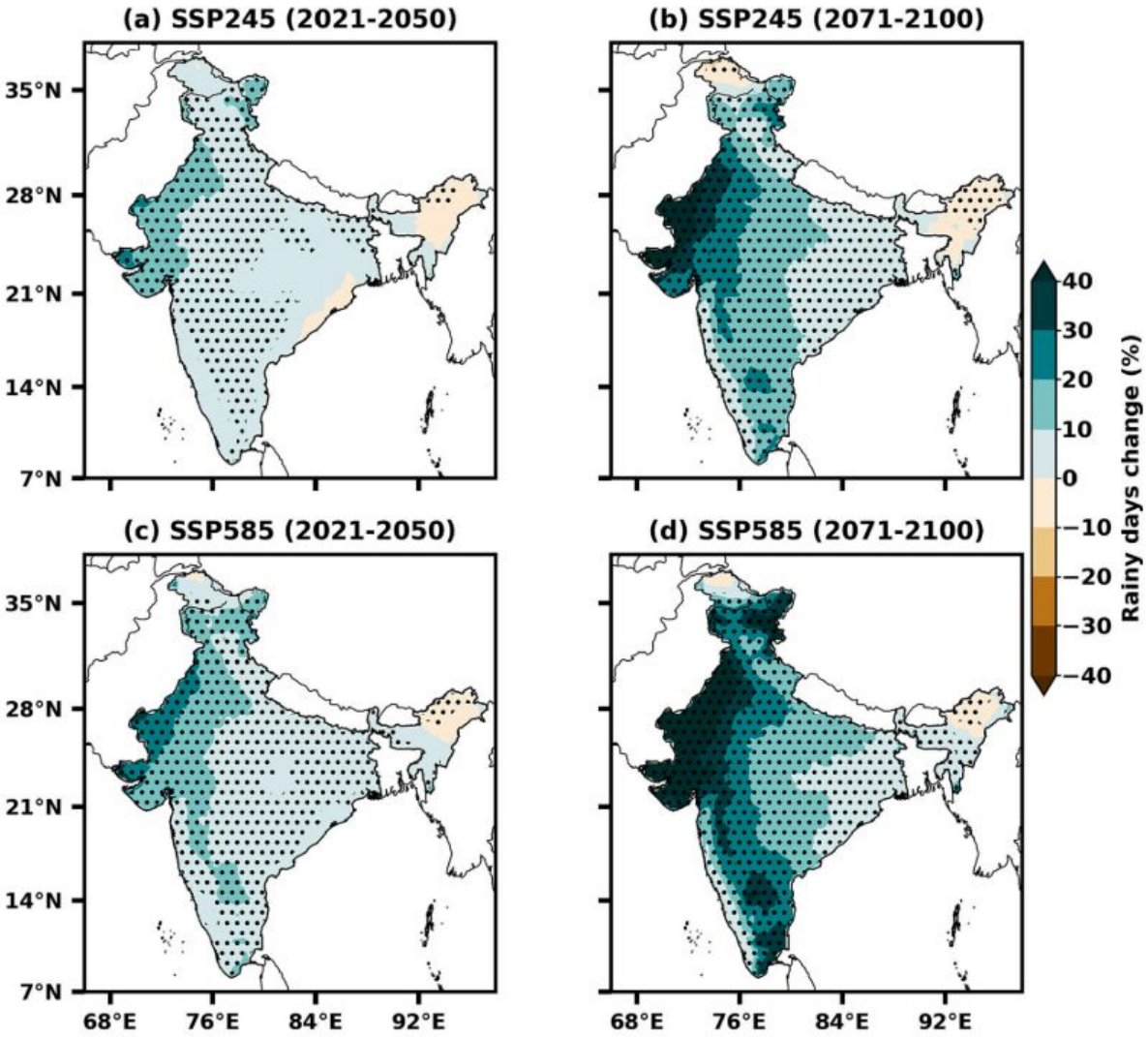


Projected changes in NE monsoon rainfall (%)

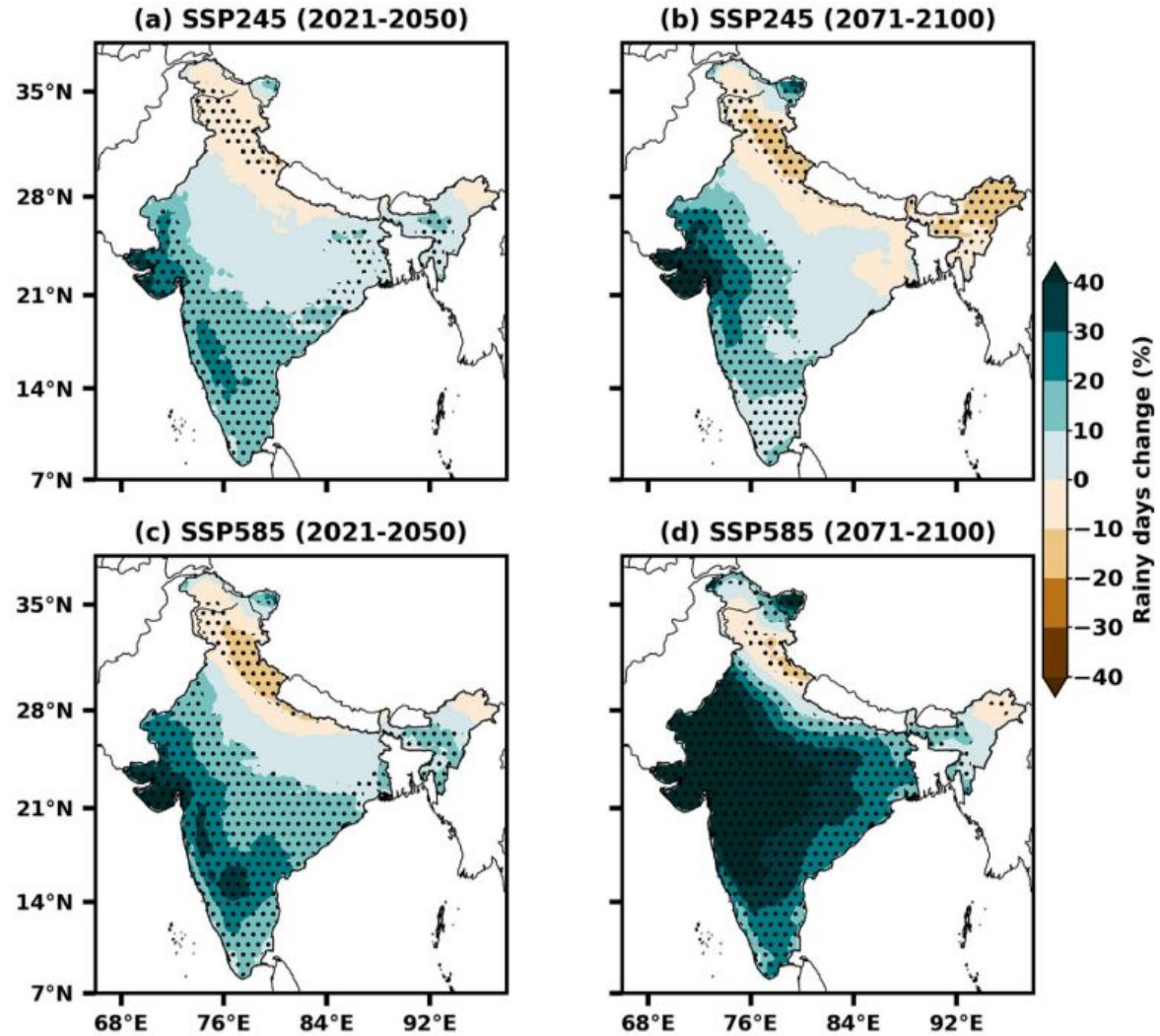


The stippling (dotted) regions represent the changes are statistically significant at 95% confidence level.

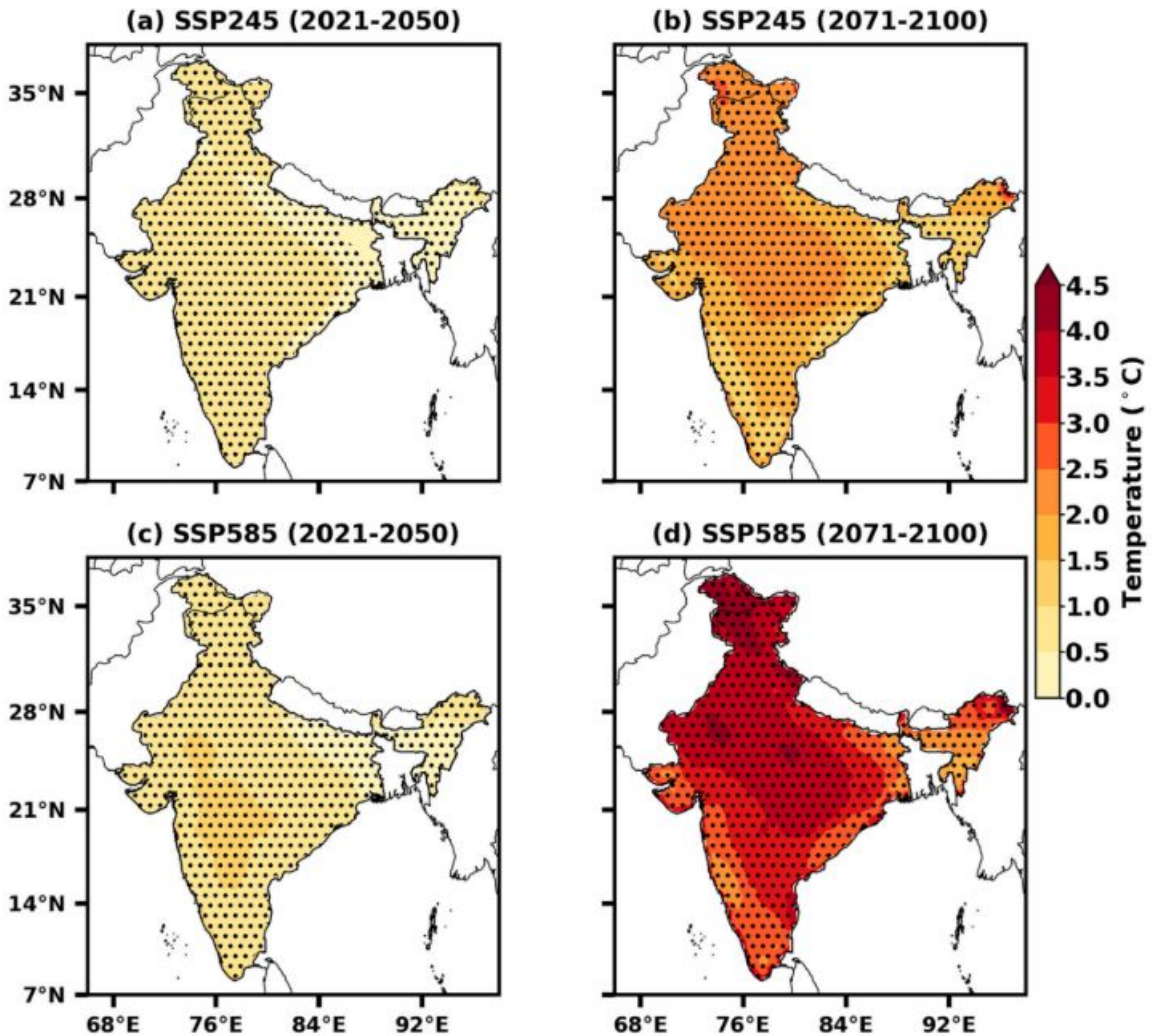
Projected changes in number of rainy days (%) during SWM



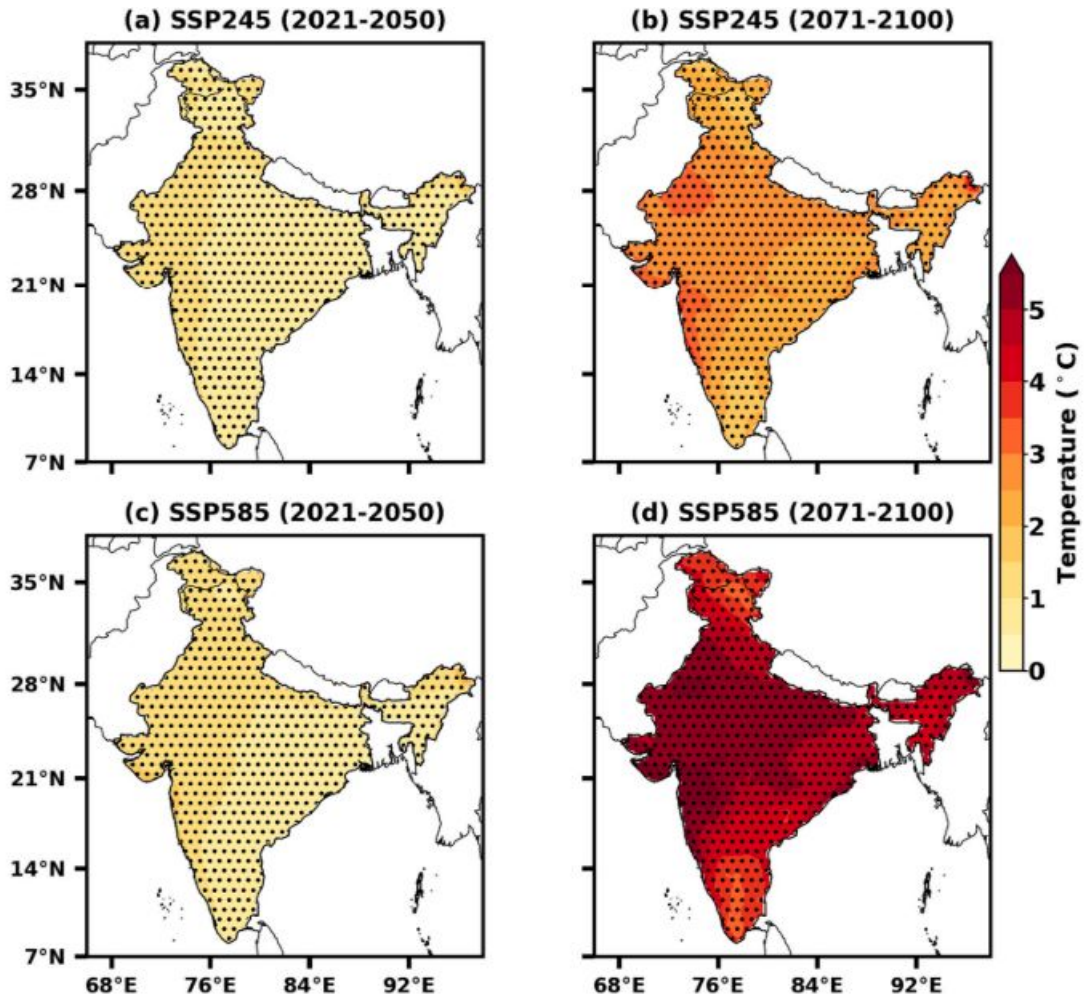
Projected changes in number of rainy days (%) during NEM



Projected changes in summertime Tmax (◦C)



Projected changes in wintertime Tmin (◦C)



Impact assessment models

- **IMPACT - International Model for Policy Analysis of Agricultural Commodities and Trade - by IFPRI**
  - Linking **climate, crop, water, and economic models** to explore alternative futures for food sstem
  - Analyse long-term challenges and opportunities for food, agriculture, and natural resources **at global and regional scales**
- **MOSAICC by FAO -** an integrated package to understand potential CC impacts, to help policymakers in developing adaptation strategies, programmes, projects and investments.
  - **It assesses crop production systems, water and forest resources and the national economy under changing climatic conditions**.
- **Agricultural Model Inter-comparison and Improvement Project (AgMIP).**
  - **Regional integrated Assessment** with **Multi-models** approach to reduce uncertainty
  - Inclusion of **RAPs** and **Stakeholders' integration**
  - **Multiple global gridded crop models (GGCMs)**

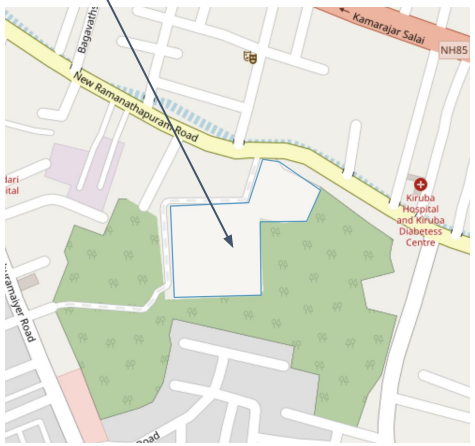
Impact assessment – HOLOS

- **Geo-spatial high-resolution crop simulation modelling using HOLOS platform**
  - HOLOS is the geo-spatial automation platform that efficiently utilizes the availability of high-spatial temporal information on soil and weather and makes any number of simulations at any spatial-temporal resolution in less time.
  - Used to simulate crop yields at the regional, national, sub-national and global scales.
  - It is a powerful tool for seasonal crop yield forecasting, climate change impact assessment and designing potential adaptation options
- **Integration of crop simulation models and remote sensing information for crop yield estimation**

Holos System Architecture: Climate Change Impact Study

GIS Input UI

Draw region of interest



Provide farm practices, cultivar details, initial soil conditions

Select climate change specific input

- Time period
- GCM CMIP6 model
- SSP scenario
- Atmos CO2 level
- Sub-block size

Holos Cloud Platform

Automatic ingestion

Weather NASA Power/CMIP6 -GCMS

Localize NASA Power for baseline

Soil Harvard Dataverse

Automatic spatially gridded

Execute DSSAT

- ML driven soil profile selection
- Automatic spatially gridded
- Execution for multiple planting dates for adaptation

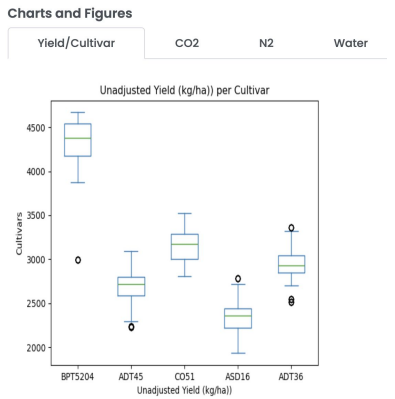
Automatic Analysis

Customizable Analytics:

- Climate Change Impact on production
- Climate change adaptation strategies

Chart/Map Email

Output UI



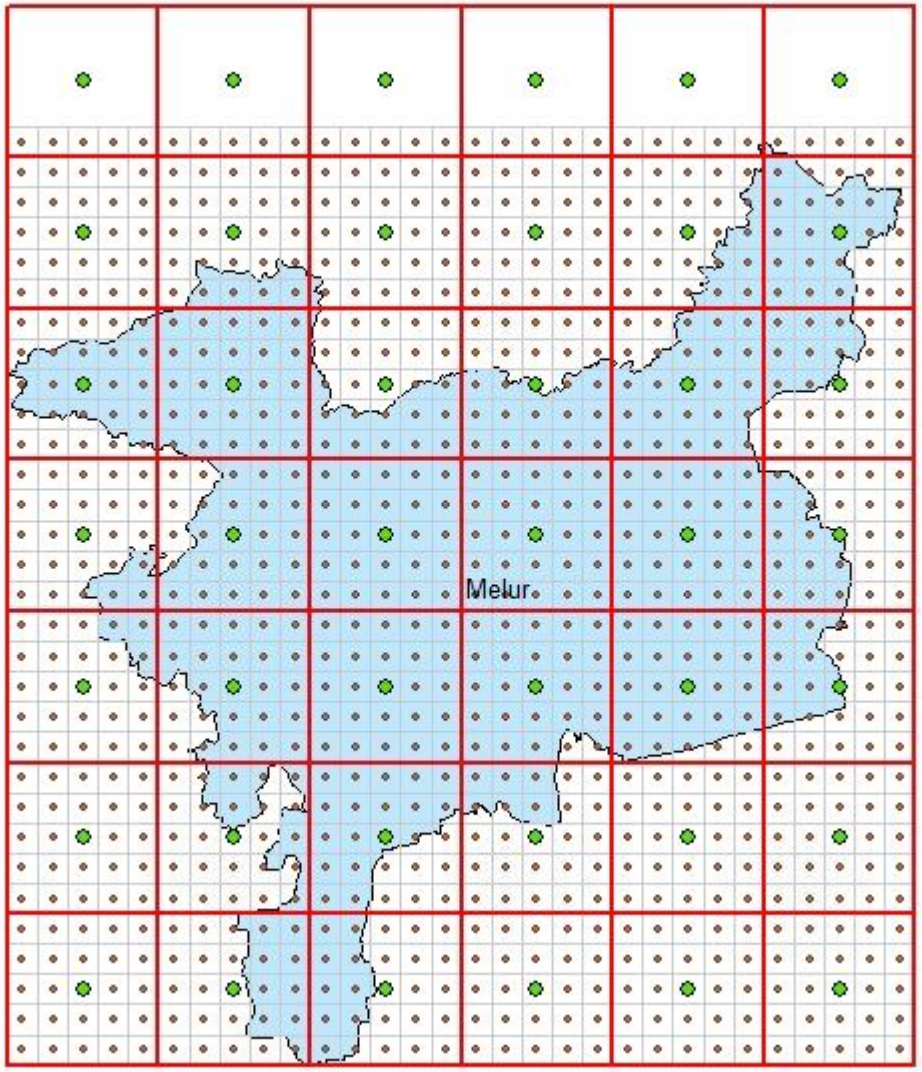
Climate Change impact/adaptation strategies

Box plots, Trend, Heatmaps, Map overlays of various crop metrics

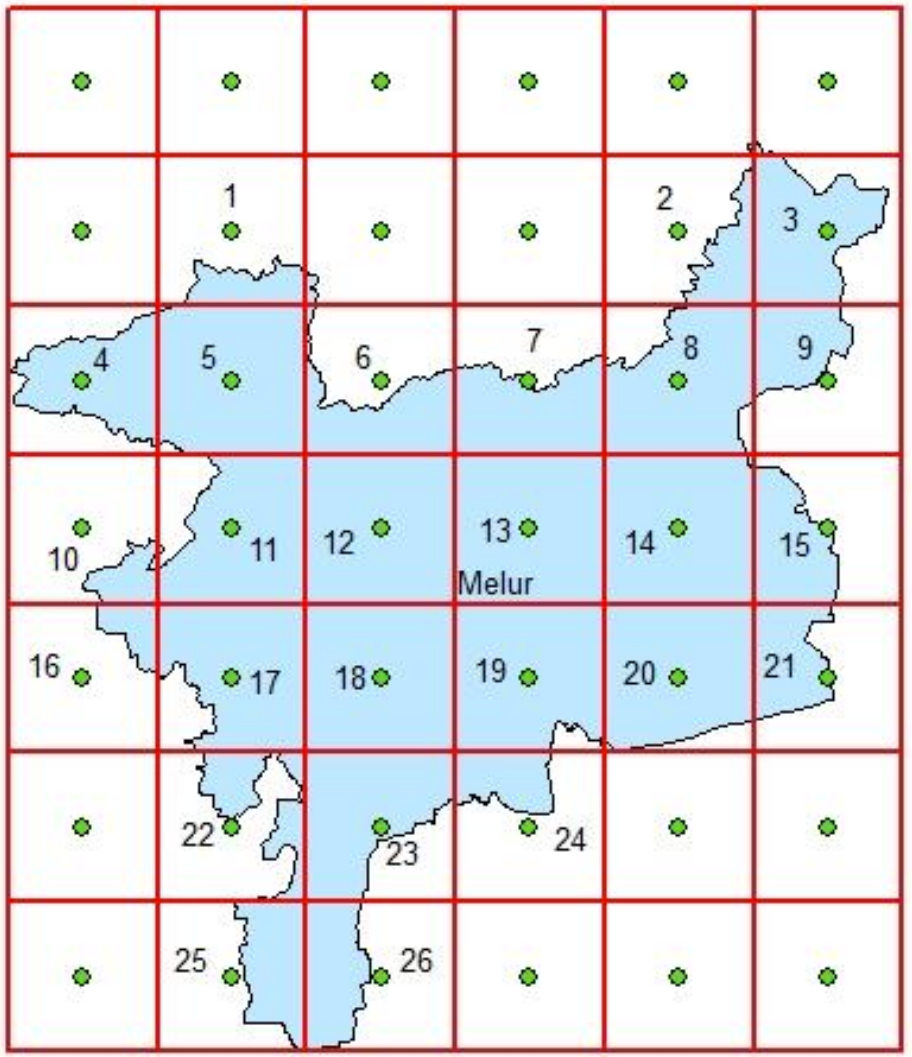
Madurai - Melur Block

- Total area : 36026 ha ; Cultivable area: 10354 ha (28.74 % of total area)
- Paddy area: 8571 ha (82.78 % of cultivable area and 23.8 % of the total area)

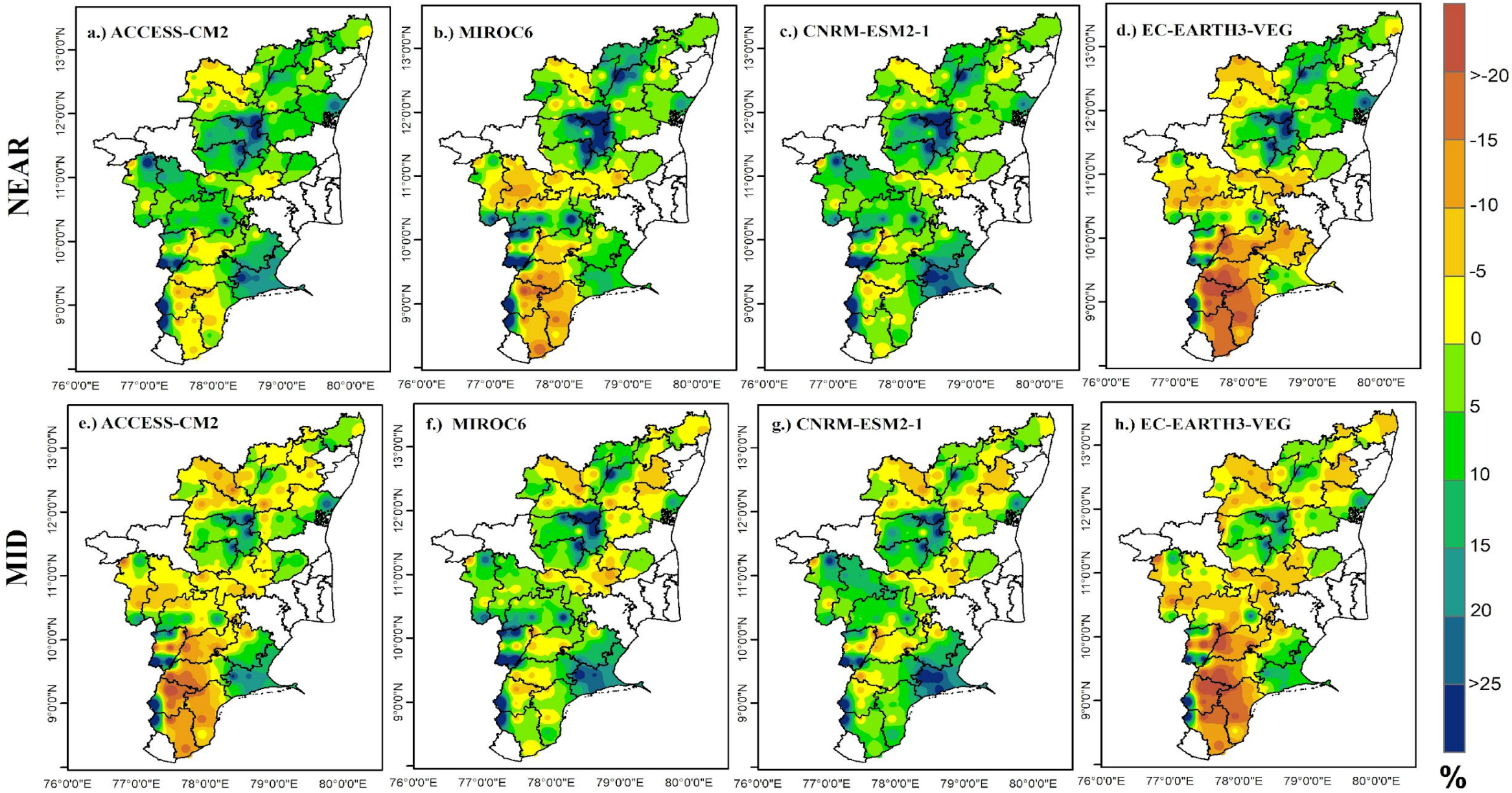
1 Km grid



5 Km grid

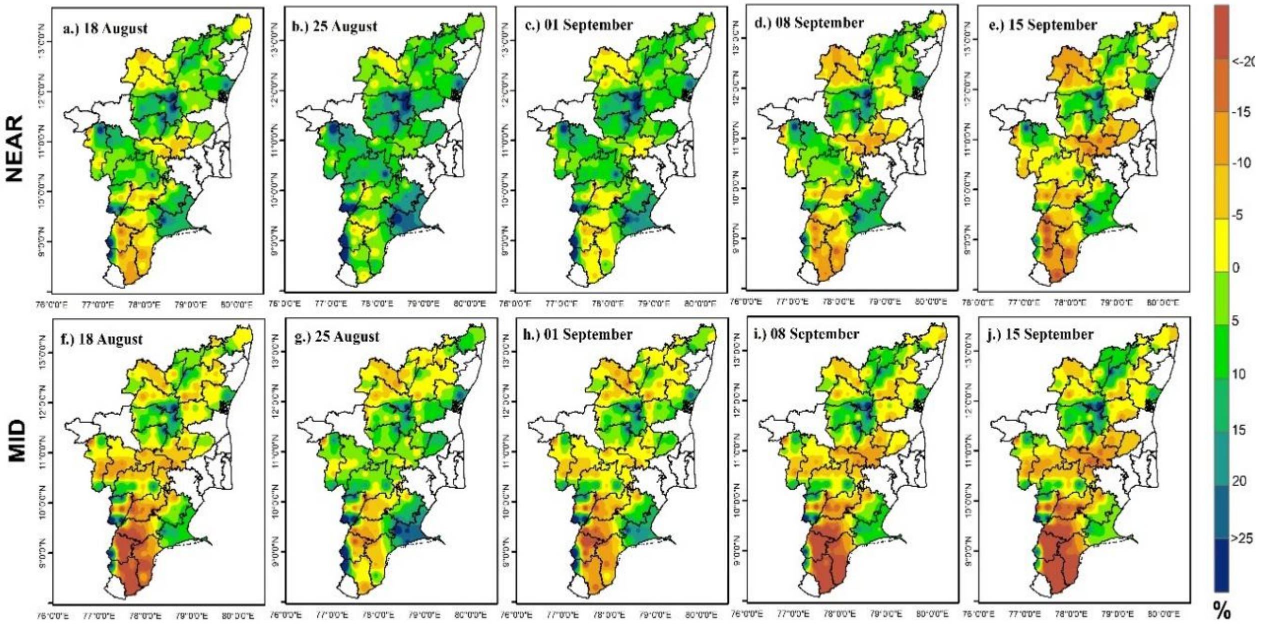


Spatial response of rainfed sorghum to climate change

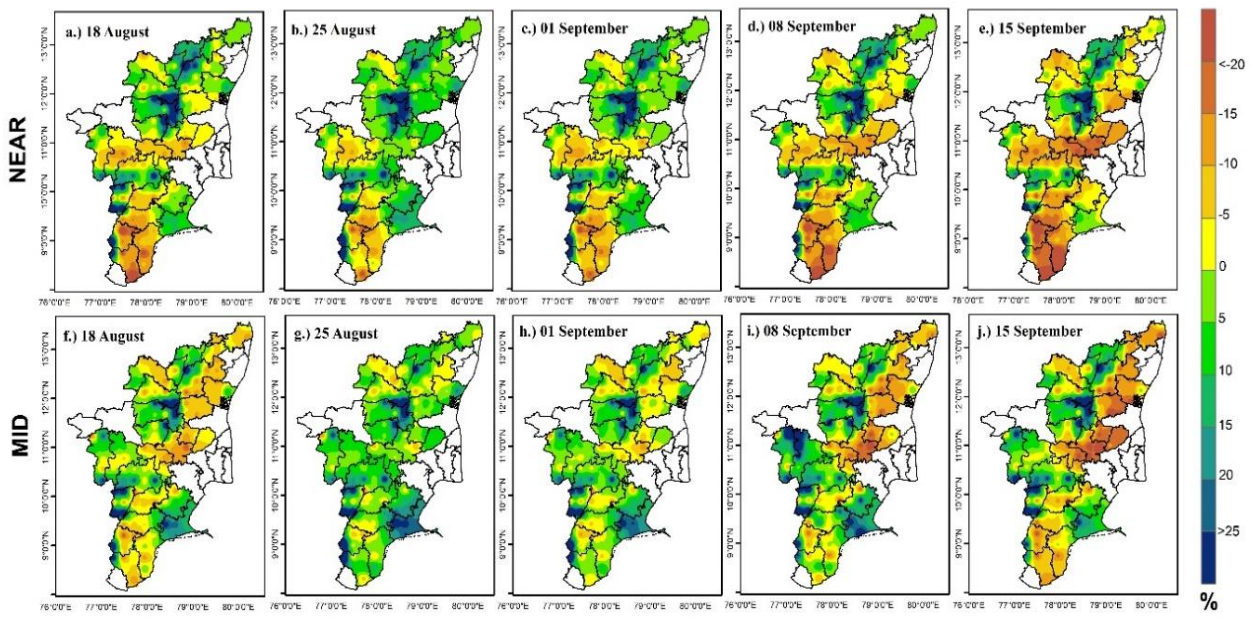


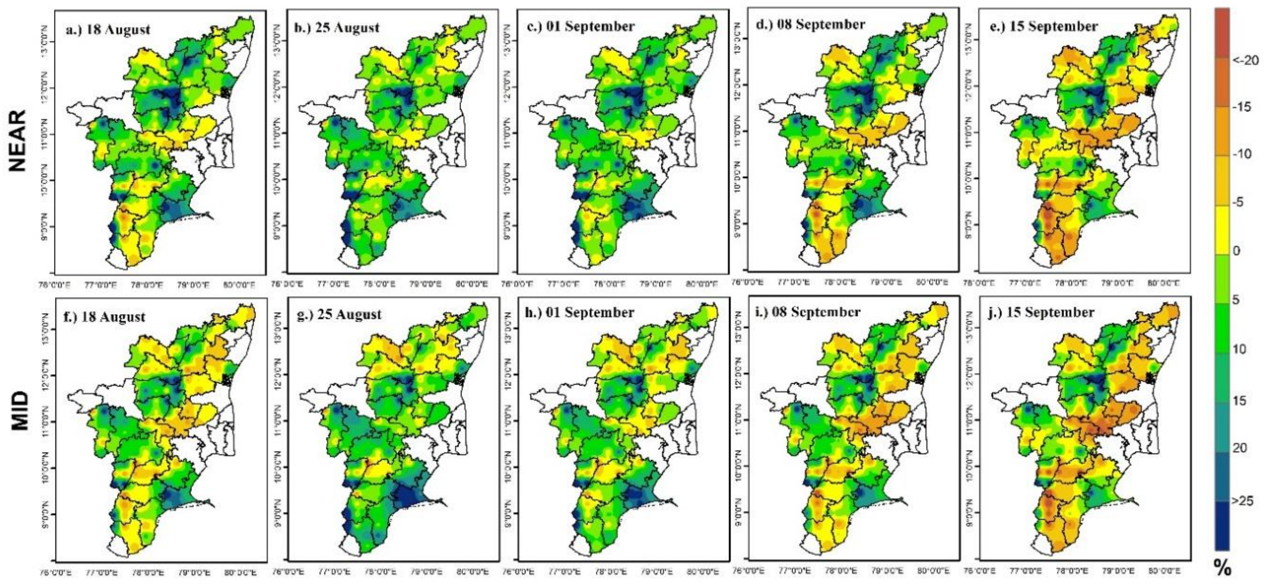
Impact of climate change on sorghum yield under different sowing dates

ACCESS-CM2

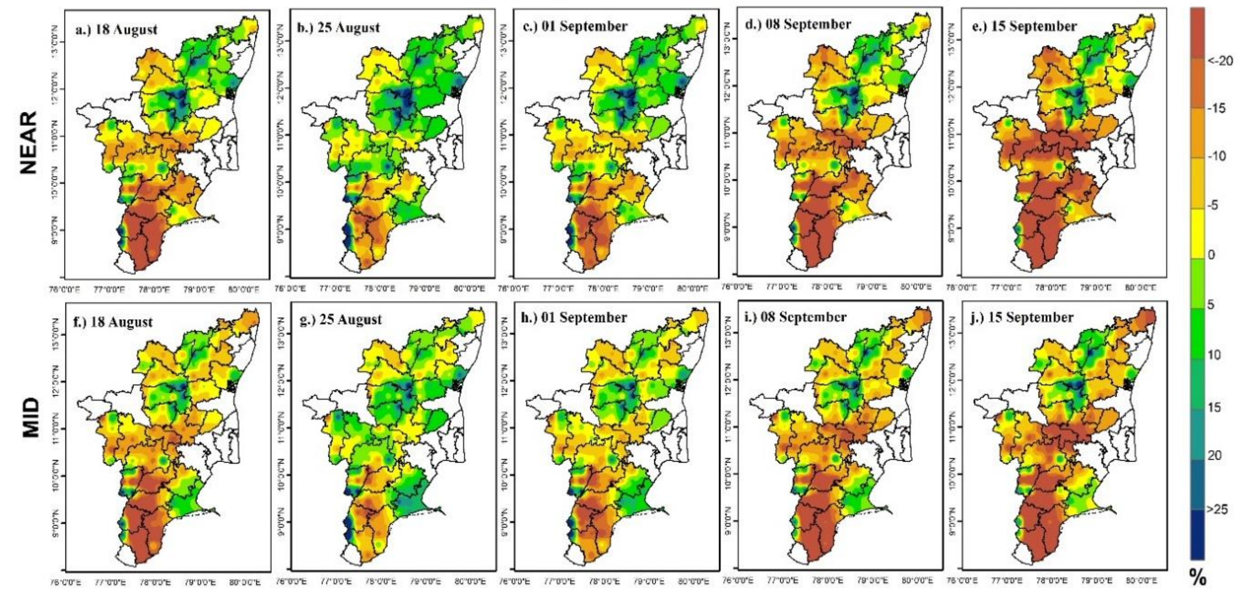


MIROC-ES2L



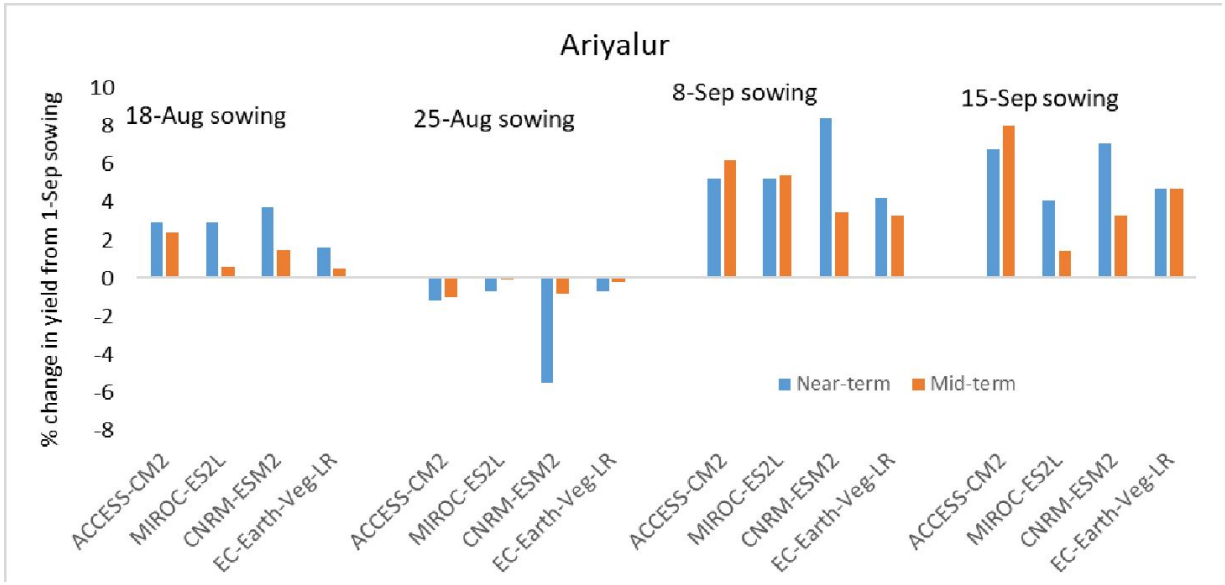


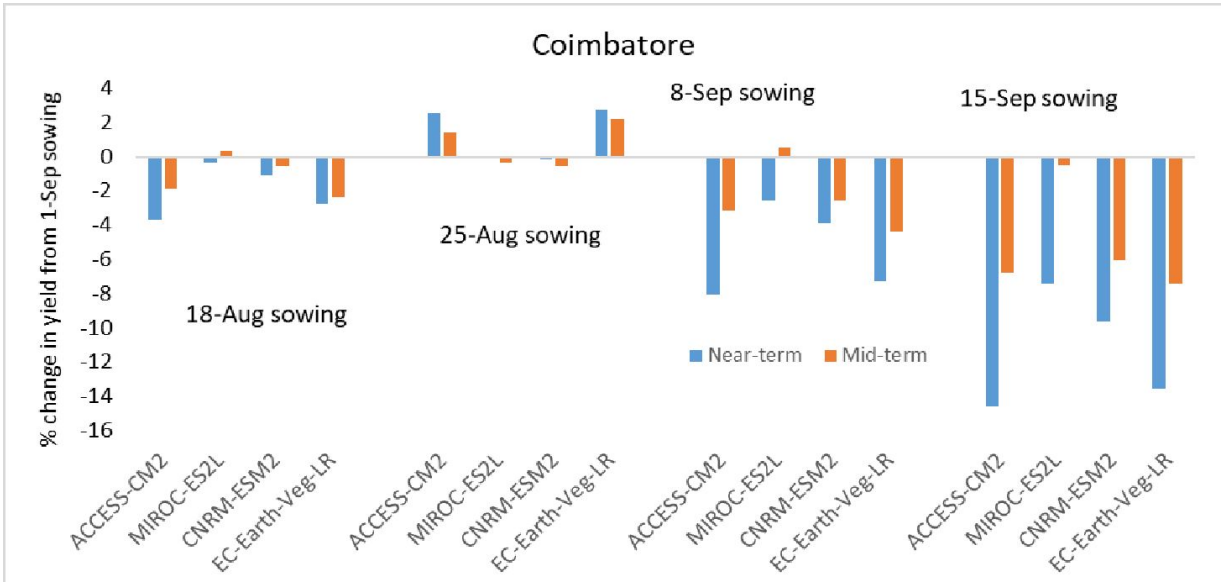
CNRM-ESM2

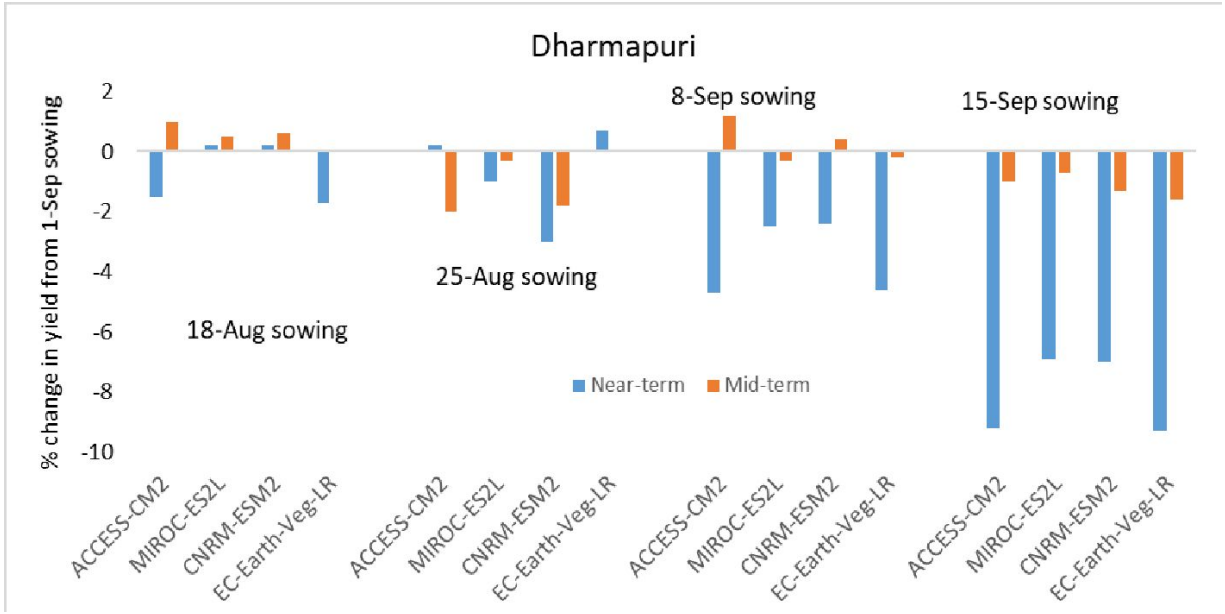


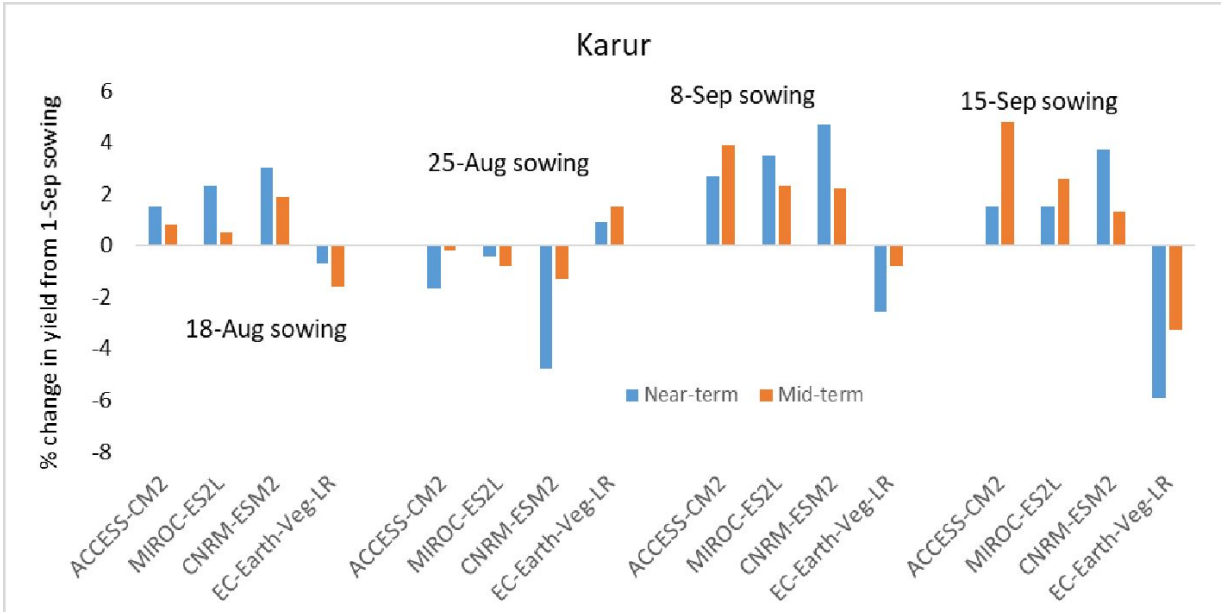
EC-Earth-Veg-LR

Influence of alternate sowing in the near and mid-term future in different major sorghum growing districts

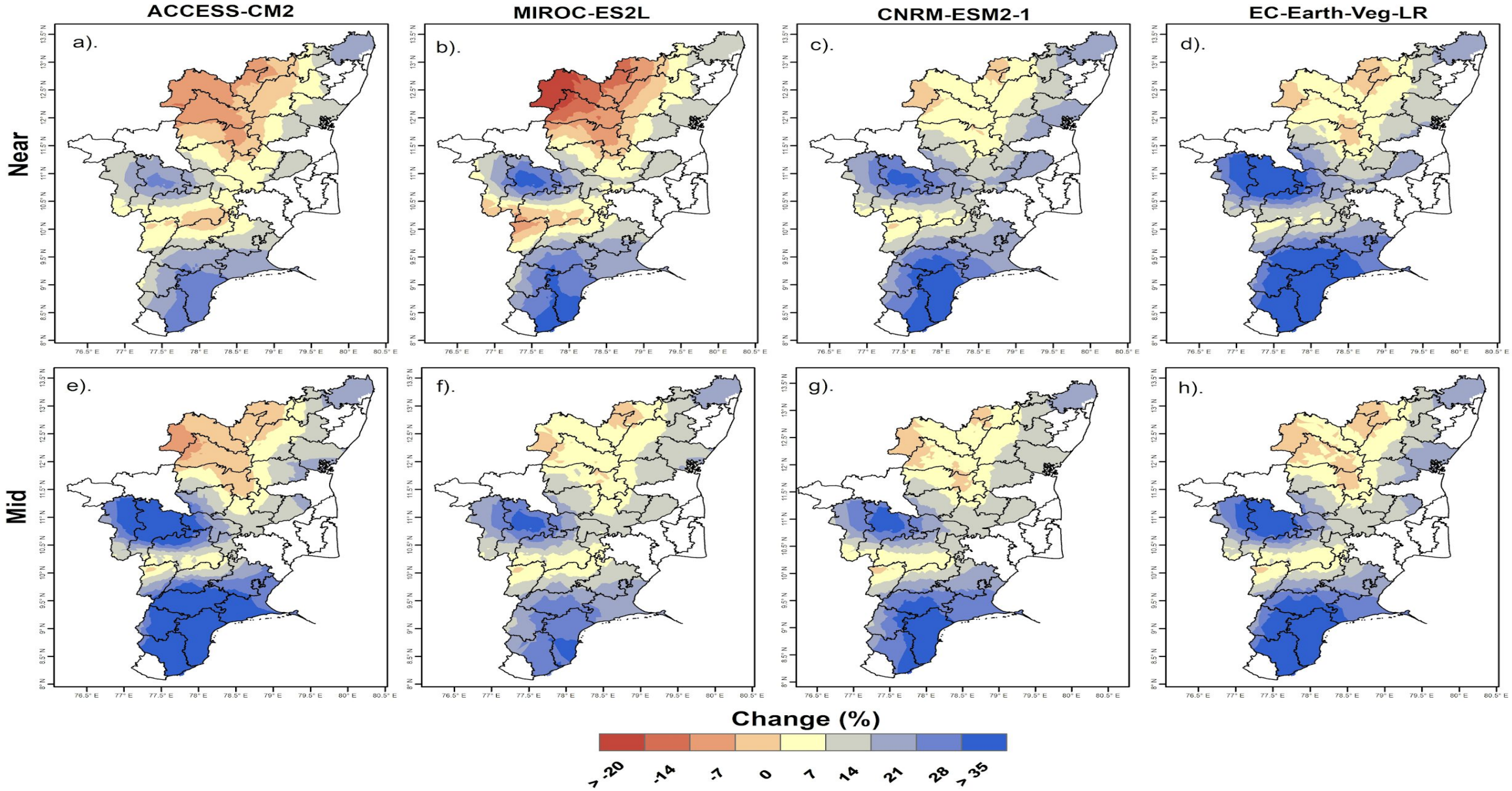




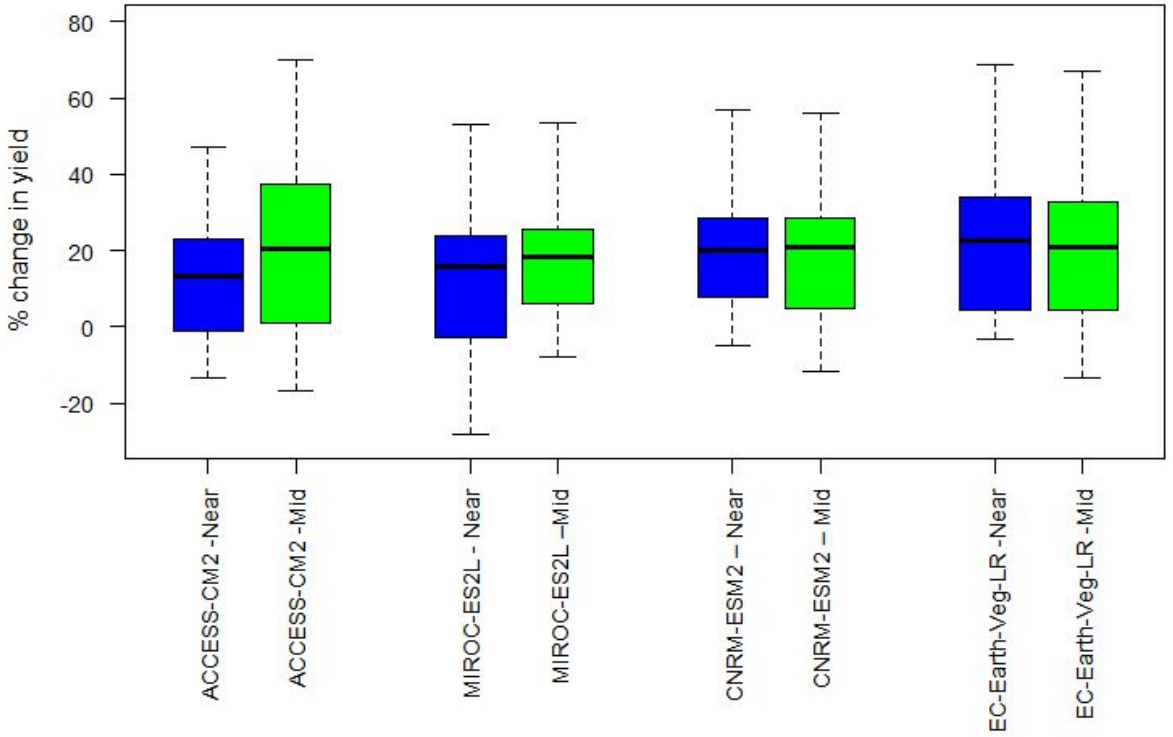




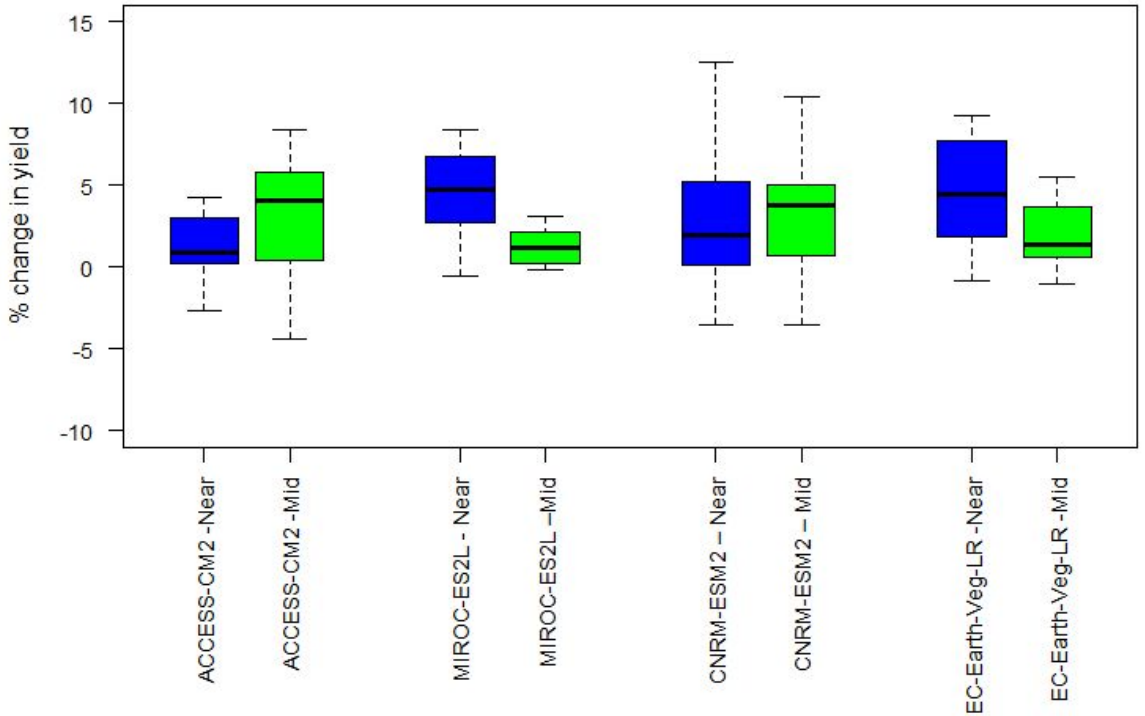
Response of sorghum to increased split of nitrogen application in the near and mid-term future



Effect of the increased number of splits in the N application on sorghum



Effect of the increased number of splits in the N application on sorghum



Effect of application of the increased nitrogen dose on sorghum

Conclusions

- **Climate is changing** and is impacting agriculture
- **Huge uncertainty exists in climate model projection –** selection of model for impact assessment is crucial
- **Include multiple models and scenarios** to explore uncertainty and impact
- **Multi-disciplinary approach** will help in understanding the problems and finding out the solutions
- **Scaling up framework** is needed to have realistic figures on impact as well as befits due to adaptation