



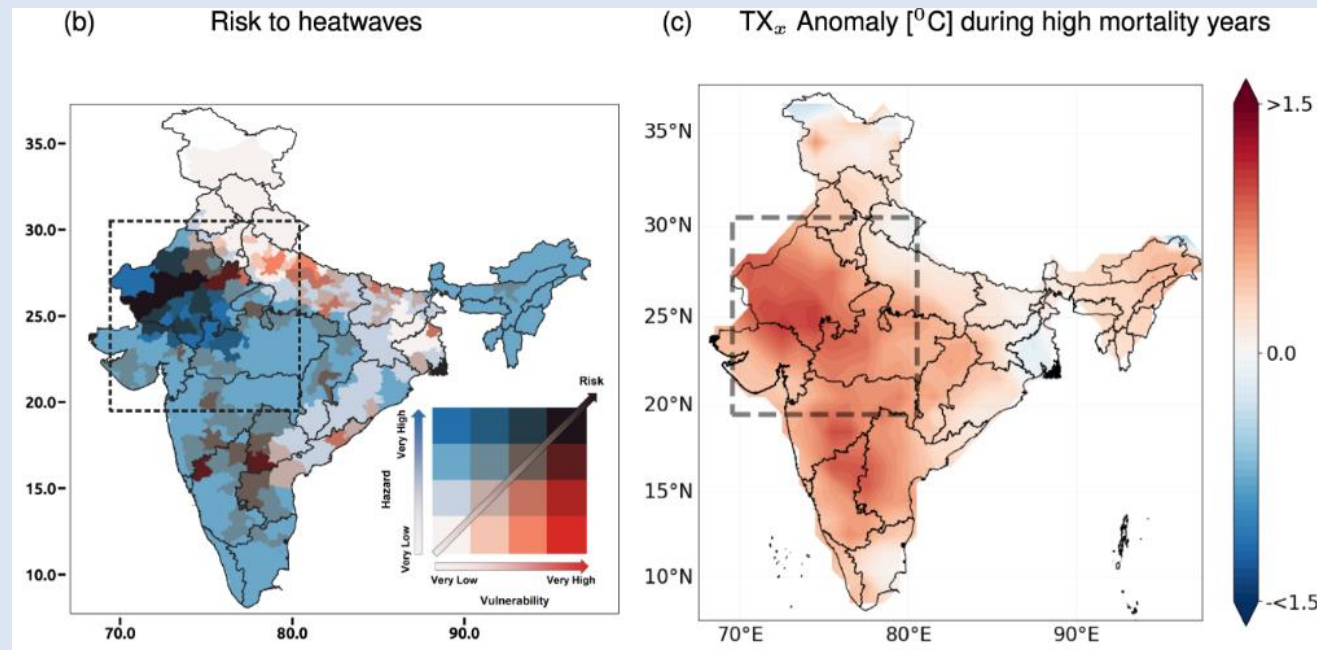
Heatwaves over India

Observed changes,
future projections,
and compound risks

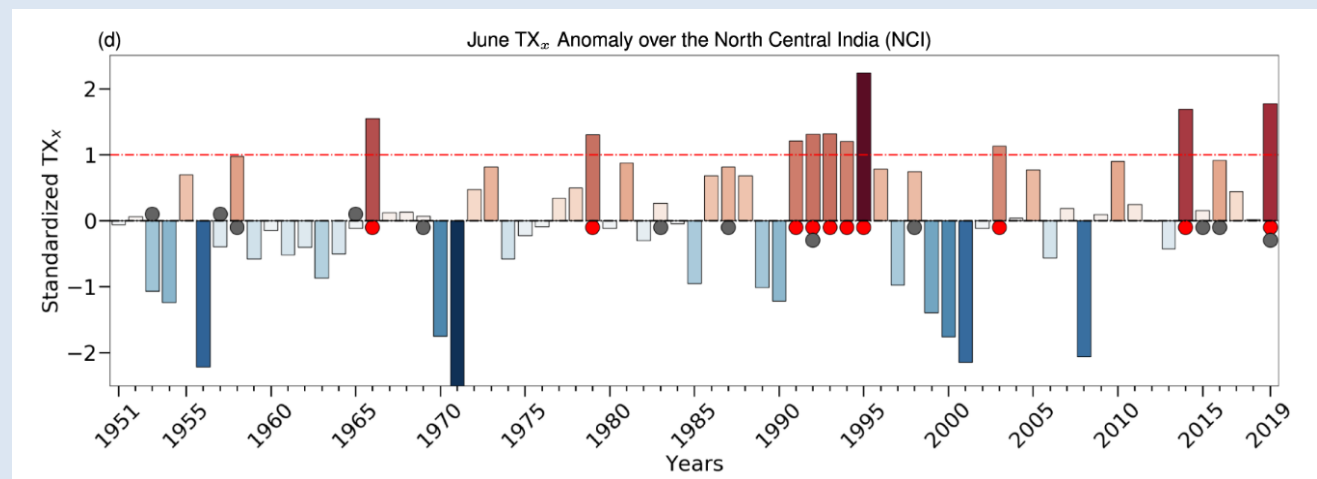


Roxy Mathew Koll
Centre for Climate Change Research
Indian Institute of Tropical Meteorology
Ministry of Earth Sciences, India

HEATWAVES | El Niño Links



North Central India is a high heatwave risk prone region.

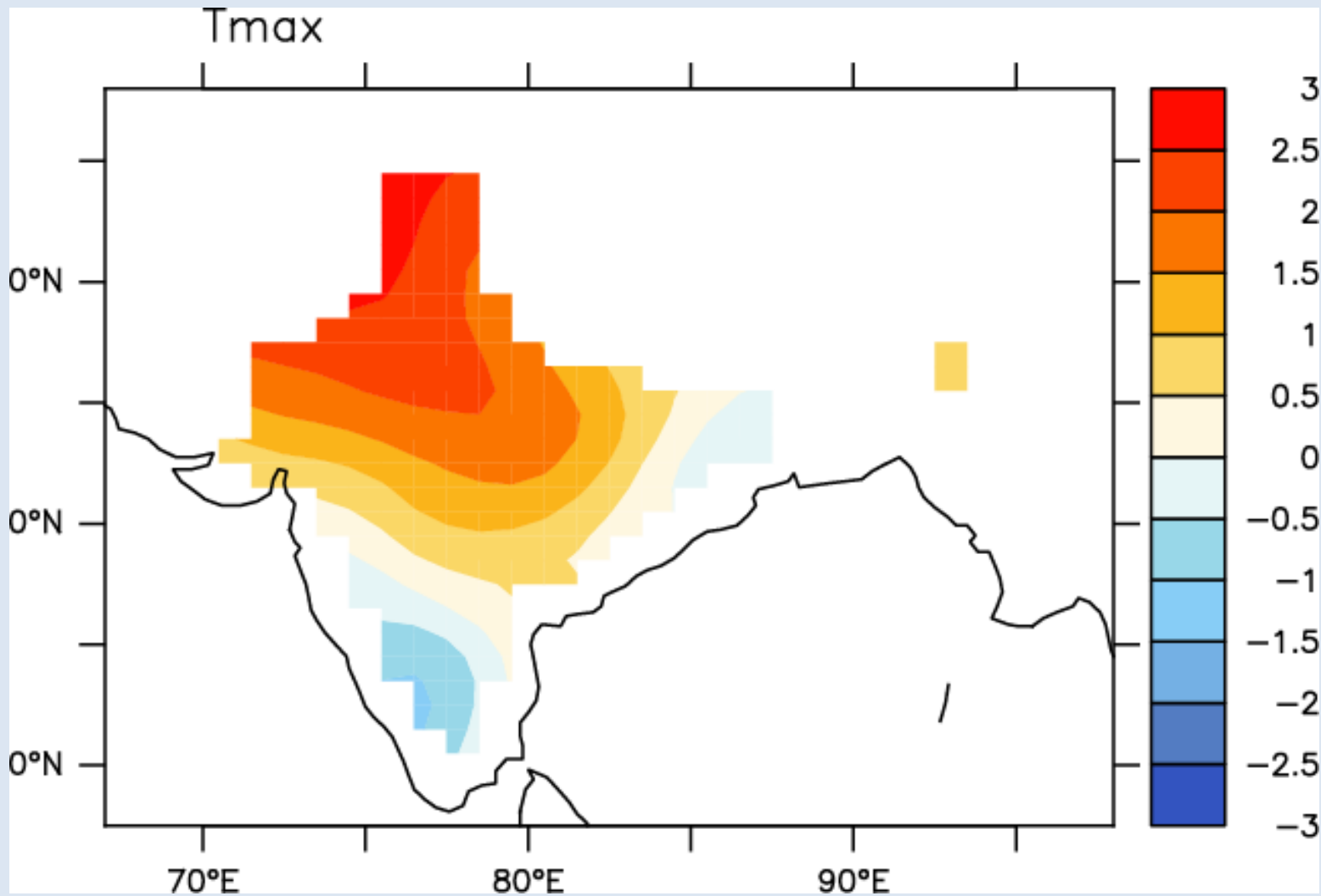


El Niño years are not necessarily when the risk for heatwaves are largest for India.

The red dots represent the major heatwave years. Black dots, on the other hand, depicts the years with strong El Niño.

Hari, Ghosh et al. 2022

HEATWAVES | Temperature Trends



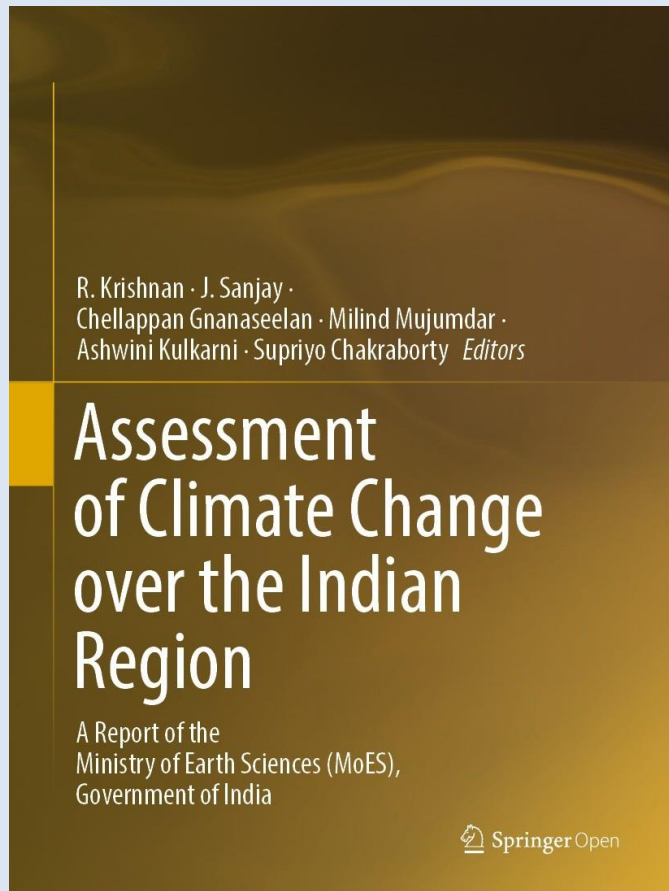
Trends during 1981-2020

Maximum temperatures have increased diagonally across India, with the largest trends in the northwest.

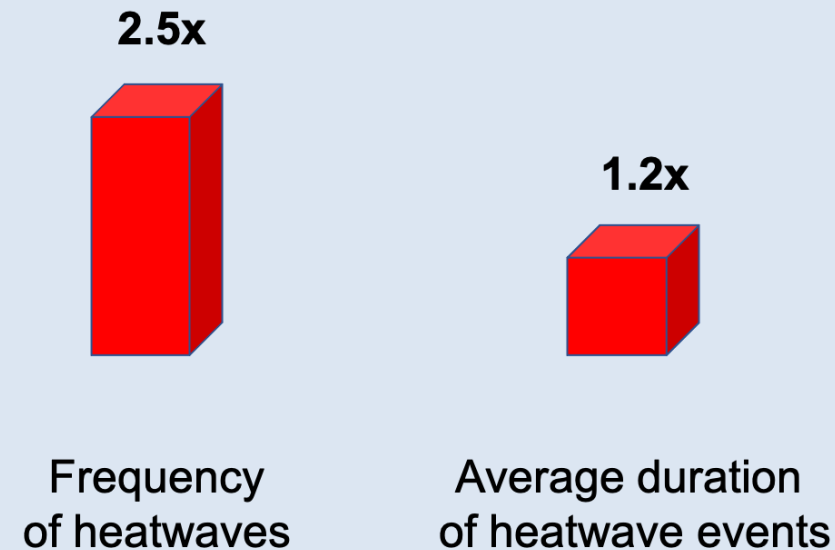
Roxy et al. 2024



The report projects an increase in the frequency of heat waves by mid-century by a factor of 2.5 compared to the recent past (1976–2005 average)



Projections of summer heatwaves over India

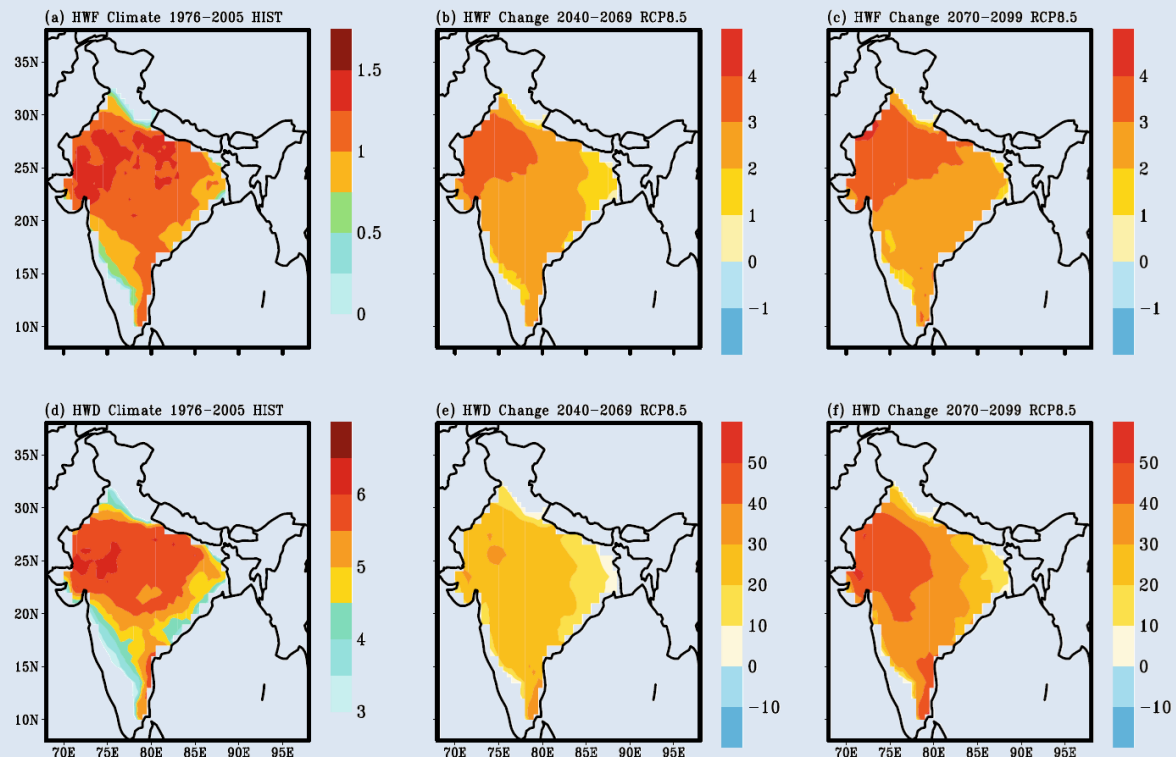
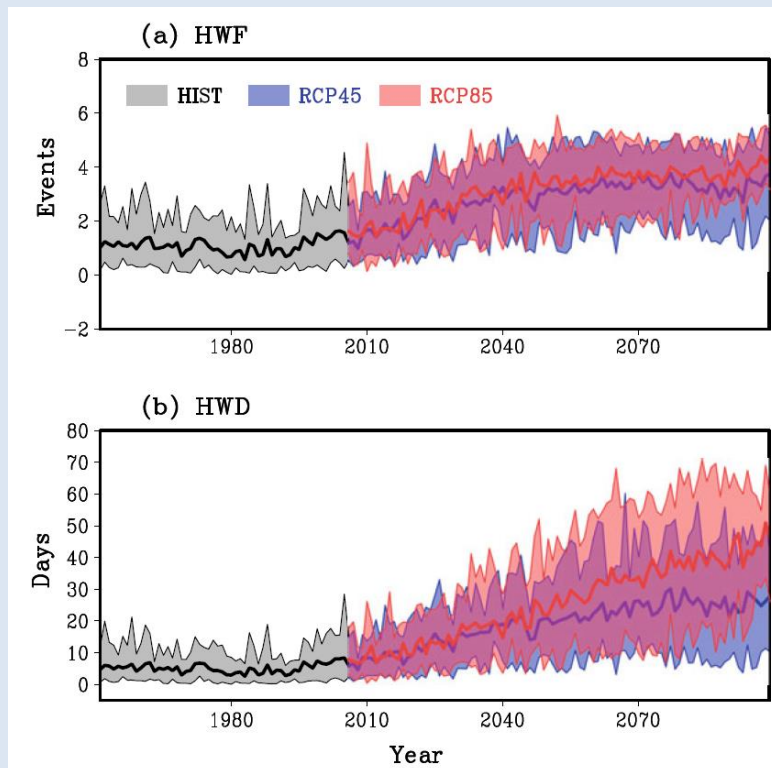


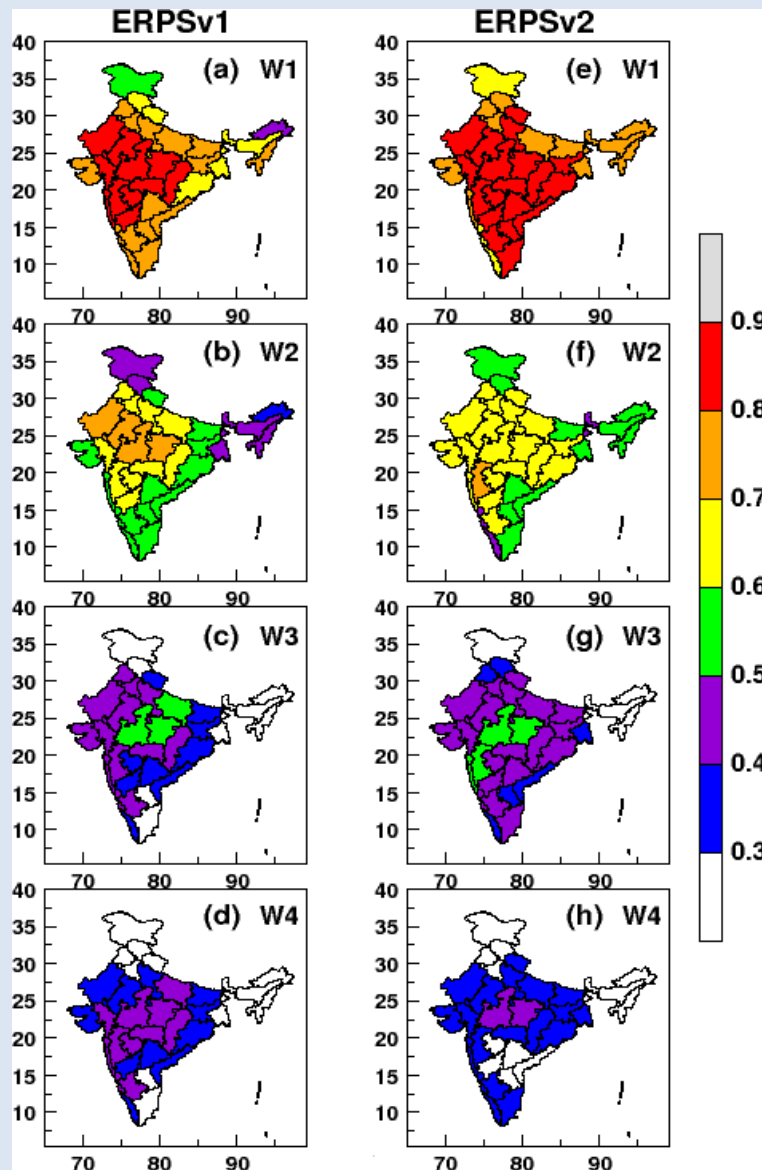
Mid-century projections under RCP4.5 relative to 1976 – 2005 (all India average).

HEATWAVES | Future Projections



- All India averaged frequency of summer heatwaves are projected to increase to about 2.5 events per season by 2040–2069, with a further slight rise to about 3.0 events by 2070–2099 under the IPCC RCP4.5/SSP2 emission scenario.
- Average total duration of summer heatwaves are projected to increase to about 15 (by 2040–2069) and 18 days (by 2070–2099) “per season” during these future periods under RCP4.5/SSP2 emission scenario.

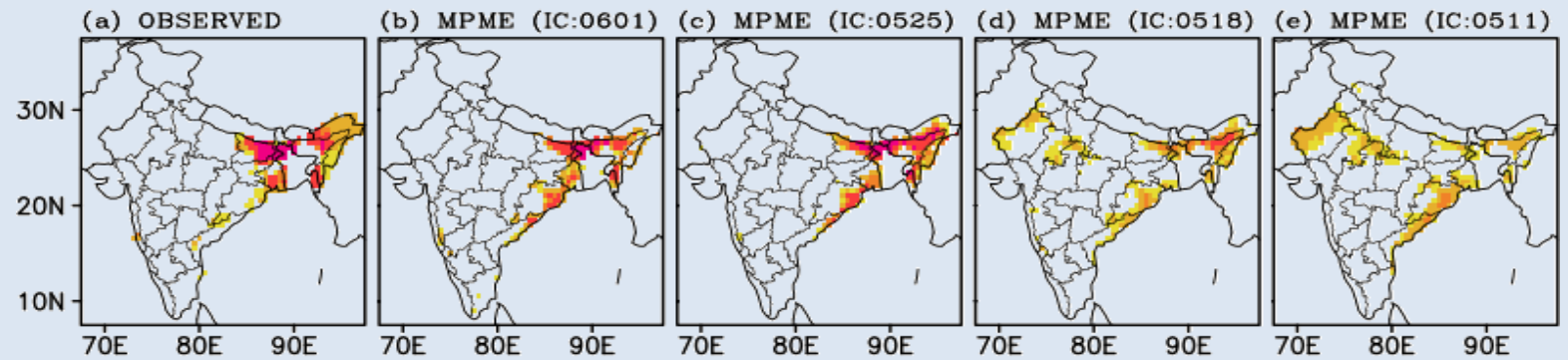




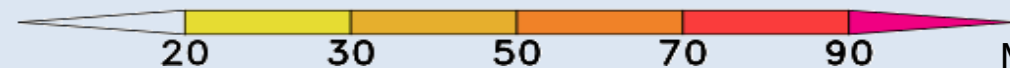
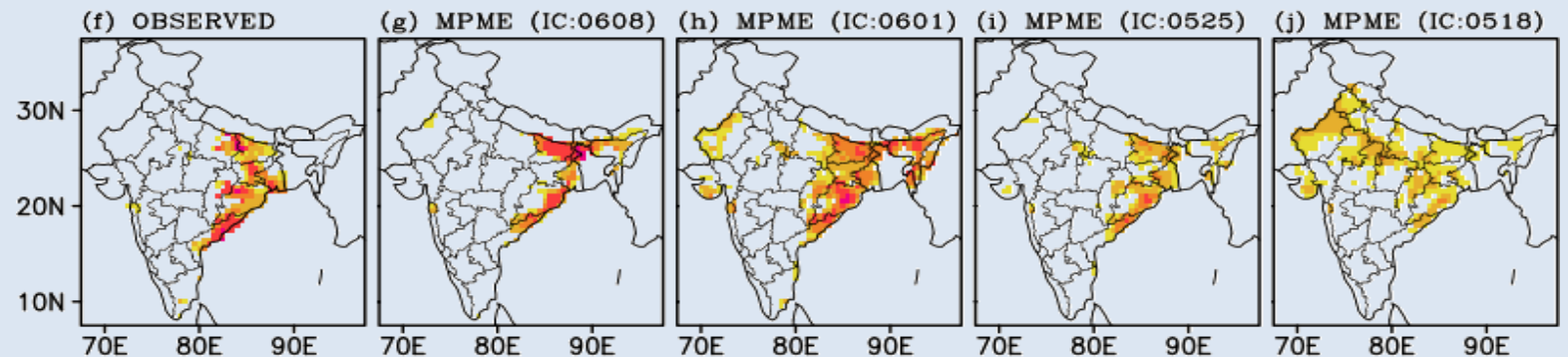
IITM-IMD forecast system has high skill at a lead-time of 2 weeks over most parts of the heatwave prone regions

e.g., Forecast with validation

HW probabilities for the target week: **02–08Jun 2023**



HW probabilities for the target week: **09–15Jun 2023**



HEATWAVES | Compound Risks — Humidity, Exposure & Vulnerability



| | | | |
|----|---------------------------|--------|----|
| 1 | Tulashiram Bhau Wagad | Male | 58 |
| 2 | Jayashree Jagannath Patil | Female | 54 |
| 3 | Mahesh Narayan Gaykar | Male | 42 |
| 4 | Kalawati Siddhram Waychal | Female | 46 |
| 5 | Manjusha Krushna Bhogade | Female | 51 |
| 6 | Bhima Krishna Salavi | Male | 58 |
| 7 | Savita Sanjay Pawar | Female | 42 |
| 8 | Swapnil Sadashiv Keni | Male | 32 |
| 9 | Pushpa Madan Gaykar | Female | 63 |
| 10 | Vandana Jagannath Patil | Female | 62 |
| 11 | Minakshi Mohan Mestri | Female | 58 |
| 12 | Gulab Baban Patil | Female | 55 |
| 13 | Vinayak Haldankar | Male | 57 |
| 14 | Swati Rahul Vaidya | Female | 34 |

Names of the victims, obtained from the District Collector's office.

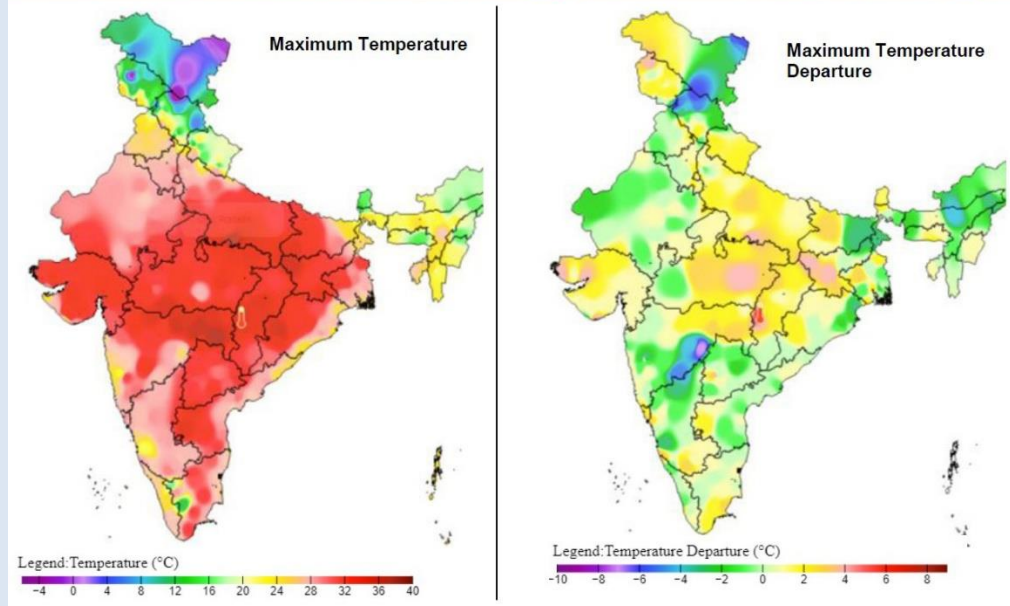
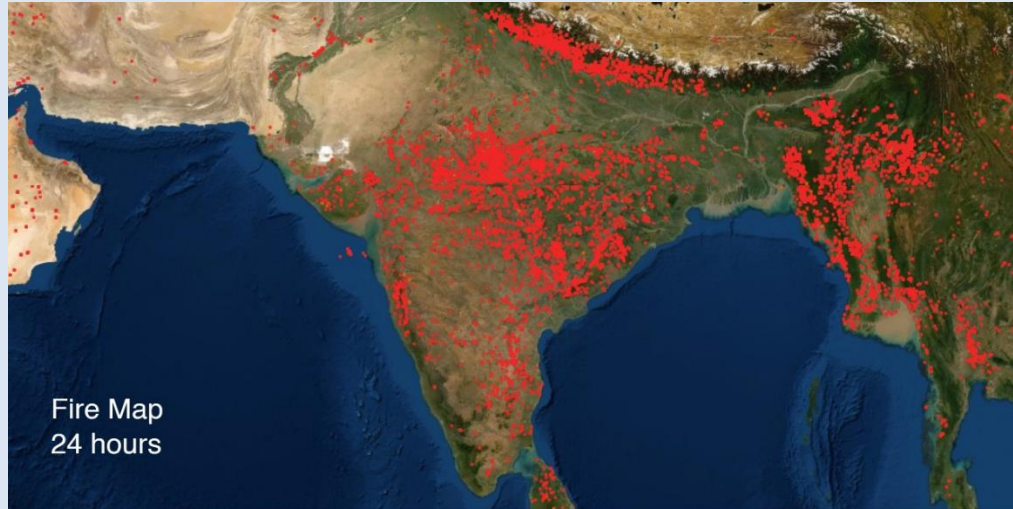
April 2023

Lesson for Lok Sabha Elections 2024

- On the day of the incident, the closest meteorological observatories recorded a maximum temperature of 34-38°C, along with a relatively high **humidity** (45%), exacerbating the impact of the heat.
- People are advised to stay indoors during such peak heat hours.
- When the air has high levels of humidity along with the heat, the body fails to regulate its internal temperature via sweating as it does not evaporate fast enough. This can result in a heat stroke, leading to multiple organ failure and deaths.
- Though the heat is blamed, it is the lack of basic precautions that saw them die. Hazards like heatwaves become lethal when the most **vulnerable sections of the population** are exposed to it for prolonged periods.



9 April 2021



- The heat maps show that the fires are over regions experiencing high temperatures.
- Most fires are set by humans, but rising temperatures and increasingly erratic monsoon have led to a “drying” or “browning” of vegetation in central India, creating conditions in which fires can spread easily.
- What can we do? Temperature/rain forecasts can be used to predict potential fires. If we take precautions, we can prevent these fires!

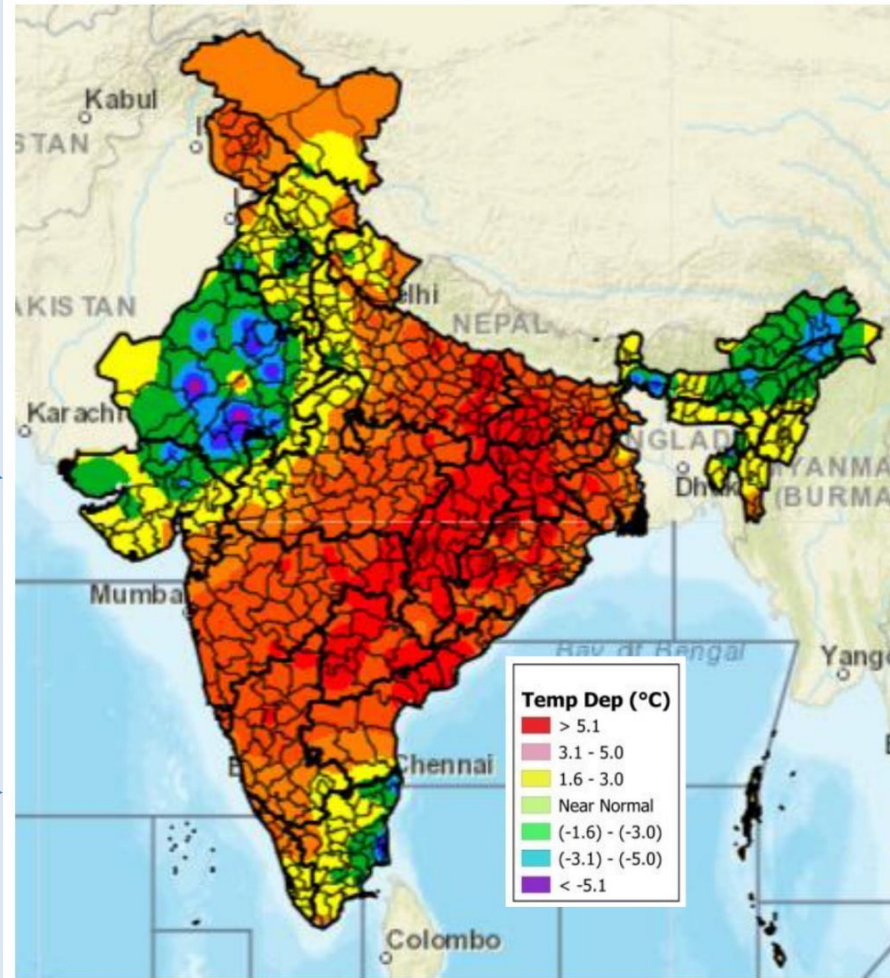
HEATWAVES | Compound Risks — Monsoon Deficit



Cyclone Biparjoy landfall cooled the northwest

June 2023
Heatwaves over India in red

Maximum Temperature Departure dated 18/06/2023



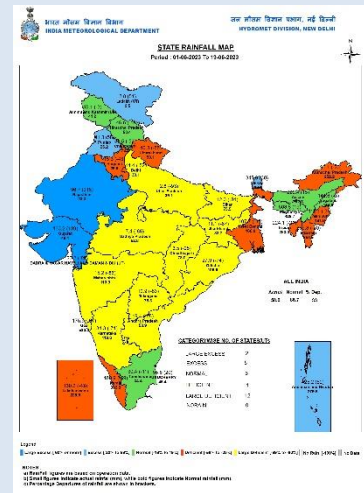
delayed monsoon onset pulled the heatwave south

54 DIE IN 1 HOSP

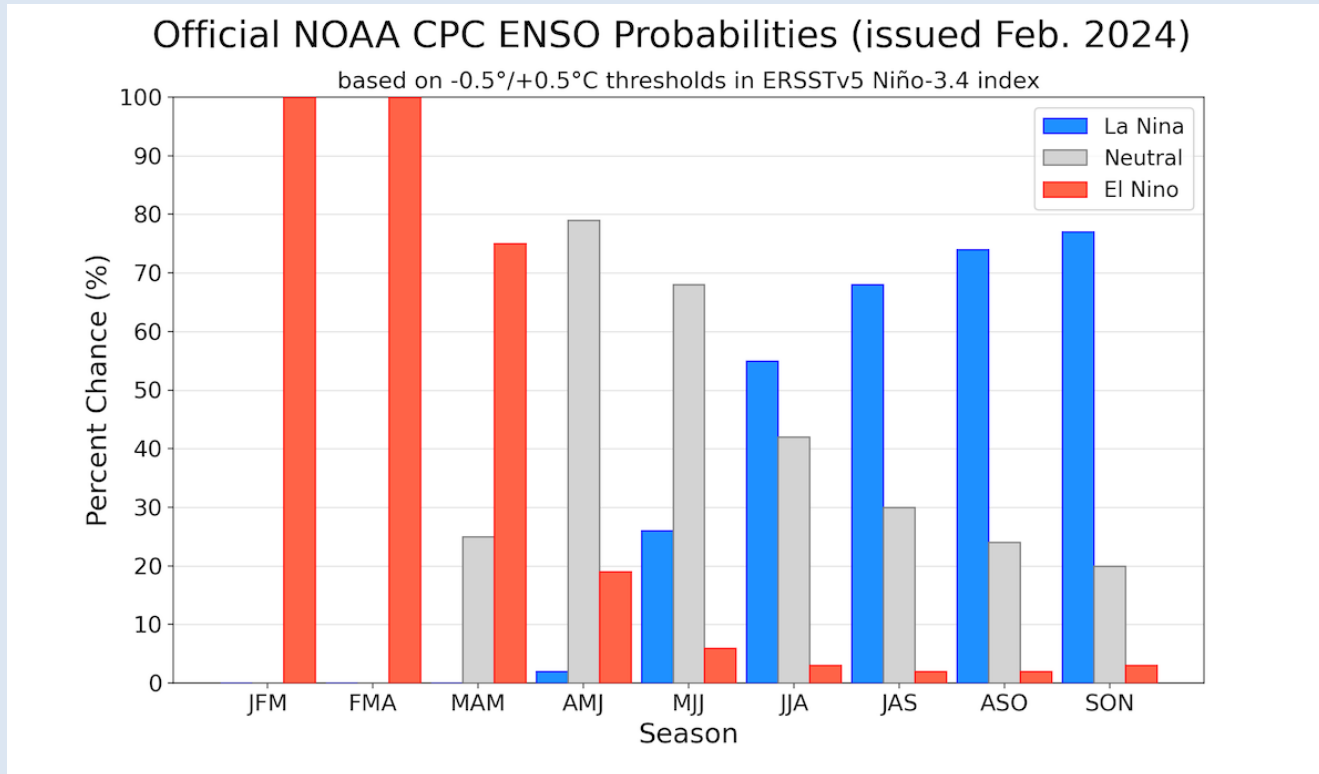
- ▶ Ballia district hospital in east UP reports 54 deaths in three days (June 15-17)
- ▶ 42 heat-related deaths in Bihar, including 35 from two hospitals in Patna
- ▶ 45.3°C on Sunday in Bhojpur. Heatwave in 15 Bihar districts including severe heatwave in 10

heavy rains-floods kept the northeast relatively cool

matches the rainfall pattern



HEATWAVES | ENSO Forecasts for 2024

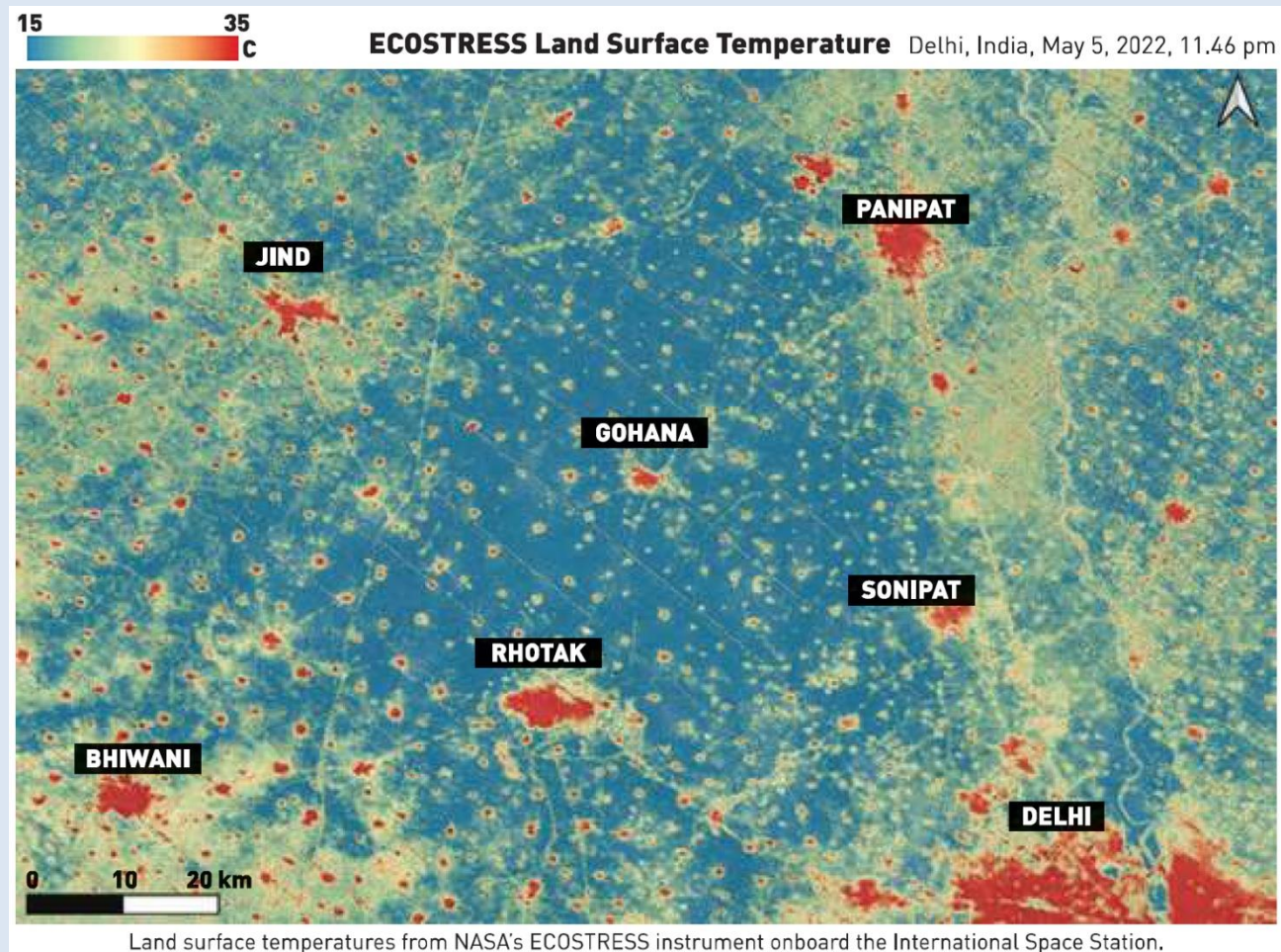


- The El Niño is set to weaken by April–May and transition to La Niña conditions by June.
- The El Niño is still active, and global/India temperatures may continue to be high at least until May-start.
- The effects of La Niña are asymmetrical compared to the El Niño. Recent La Niña years were hot and had some of the strongest heatwave events.
- Chances of a delayed monsoon are generally less if the La Niña teleconnection is strong.

HEATWAVES | Urban Heat Islands



Night-time temperatures in Delhi and its surroundings in the month of May. The difference is stark and stunning—up to 20°C between urban and rural areas.

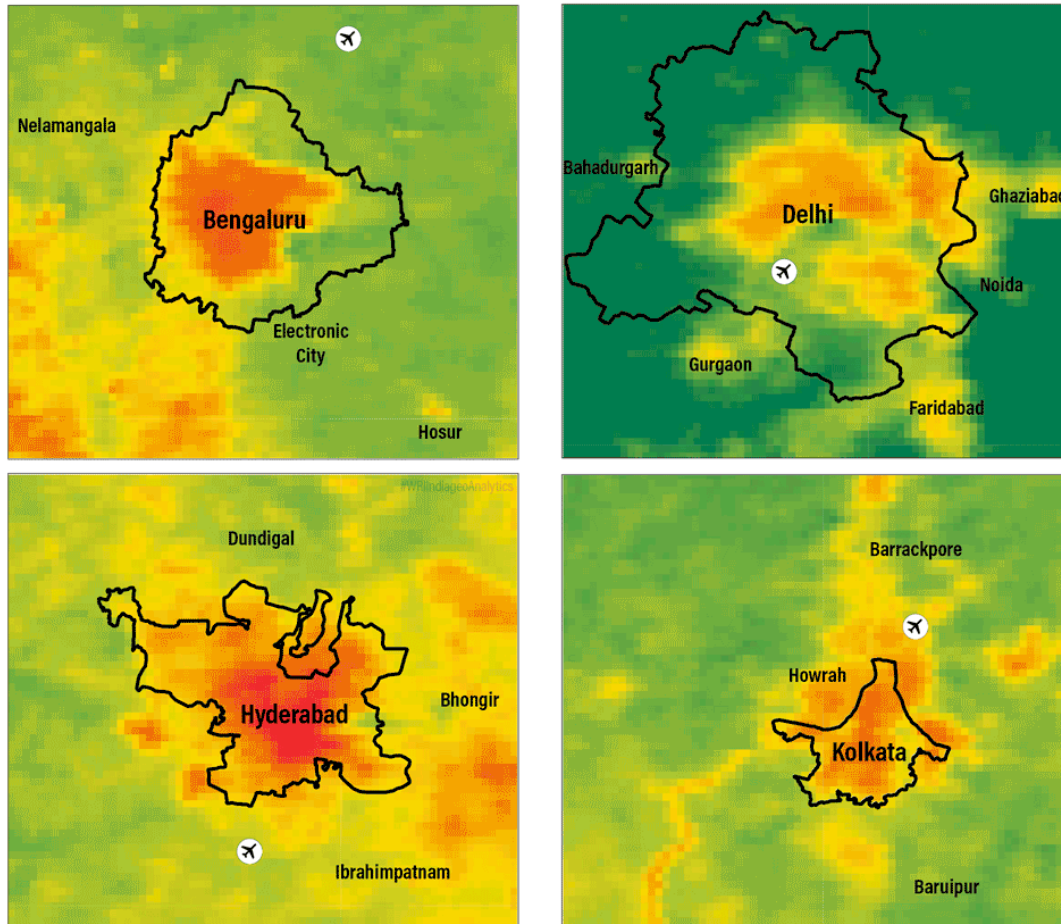


- High-rise buildings and concrete structures in the cities do not let the excess heat escape at night.
- During the day, the sun's rays reach as shortwave radiation and heat up the earth's surface. At night, the heat escapes as longwave radiation.
- While shortwave radiation can easily penetrate and reach the earth's surface, the longwave gets trapped by concrete and clouds.
- Open green spaces and natural environment with trees can help release the heat faster during the night

HEATWAVES | Urban Heat Islands



Urban Heat Island Effect across Indian Cities from 2001 to 2021 **2001**

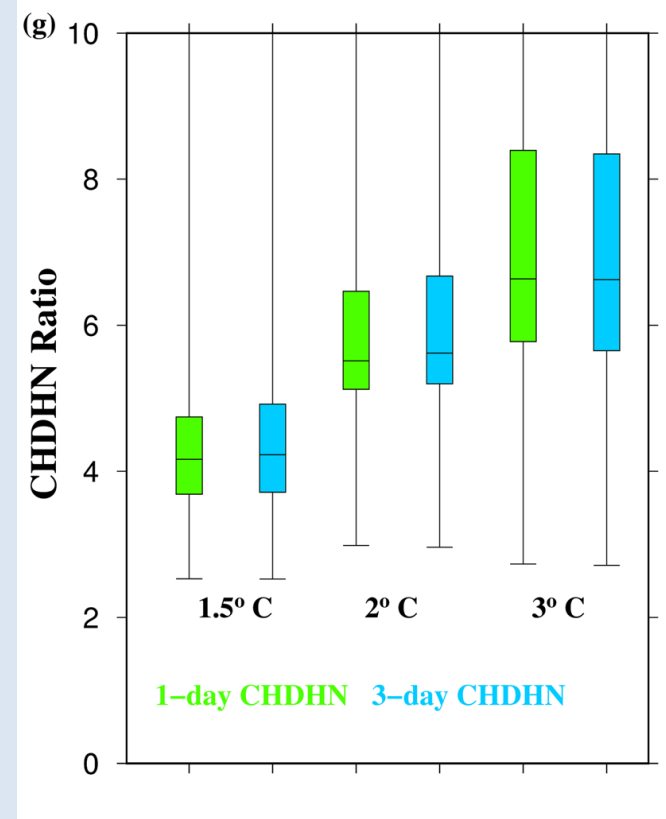


Night-time Land Surface Temperature - Annual Average: ■ +16°C ■ +24°C

□ Municipal Corporation boundaries

Source: WRI Geo-Analytics; MODIS 2001, 2021; Processed using Google Earth Engine

Concurrent hot day and hot night (CHDHN) events are projected to increase by 4, 6, and 8 folds of the current level in India under the 1.5, 2, and 3 °C warming worlds, respectively





- Heatwaves are projected to increase in intensity, frequency, duration, and area covered.
- **Night-time temperatures** are important for understanding **urban heat islands**.
- **Compound risks**. Add the overlapping factors — humidity, rainfall deficit, wildfire, air pollution.
- We have the models and data to identify heatwave/compound hotspots. Hotspot districts should have policies to **cut down working hours in the peak season**. This should be applicable for those working out in the sun (construction, agriculture, traffic police, etc.) and commuting during peak hours (schools).
- Policies that prioritize **ecosystem-based urban-scaping** that can keep cities and towns cool, architecture and building codes that keep our indoors cool at work and home, and improved healthcare infrastructure fostering community resilience.
- Early warning and Policies. It is possible to **predict climate sensitive diseases and heat related incidences well in advance**, by training forecast models with the past climate and health data. The same strategy can be used to foresee the potential changes in heat related health impacts for the next few decades since we have an idea of how the overall climate is going to change in the future. These predictions can save lives and livelihoods but is feasible only if we have access to health data.