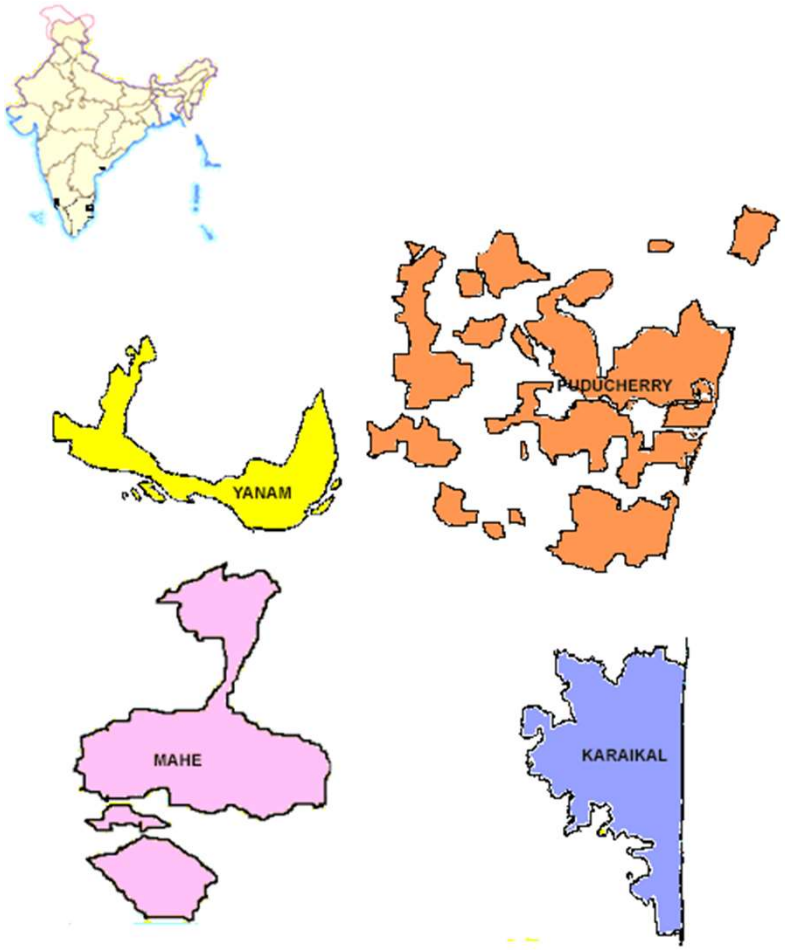


Climate Change perspective for Puducherry UT

Workshop on Integrating Climate Action in the Development Planning of Puducherry Union Territory
Govt. of Puducherry, DSTE
5th May 2022

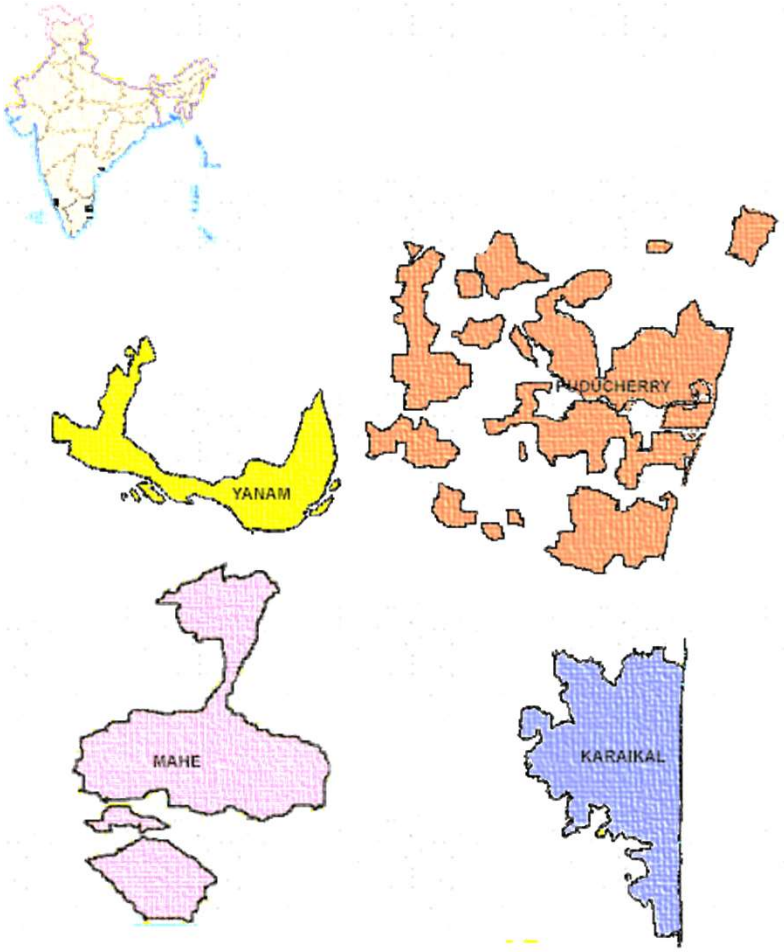
teri | The Energy and Resources Institute
Creating Innovative Solutions For A Sustainable Future

Saurabh Bhardwaj,
Sr. Fellow, ESCC

ENERGY AGRICULTURE ENVIRONMENT HABITAT RESOURCE SECURITY CLIMATE HEALTH & NUTRITION

Flow of presentation

- Context/Theory
  - Definitions
  - Causes
  - Attribution
- Evidences & projections
  - India/Coasts
- Work for Policy Makers
  - Types of policy making
  - How modelling helps
- Results for Puducherry



nriol.com/india-statistics/Puducherry/districts.asp

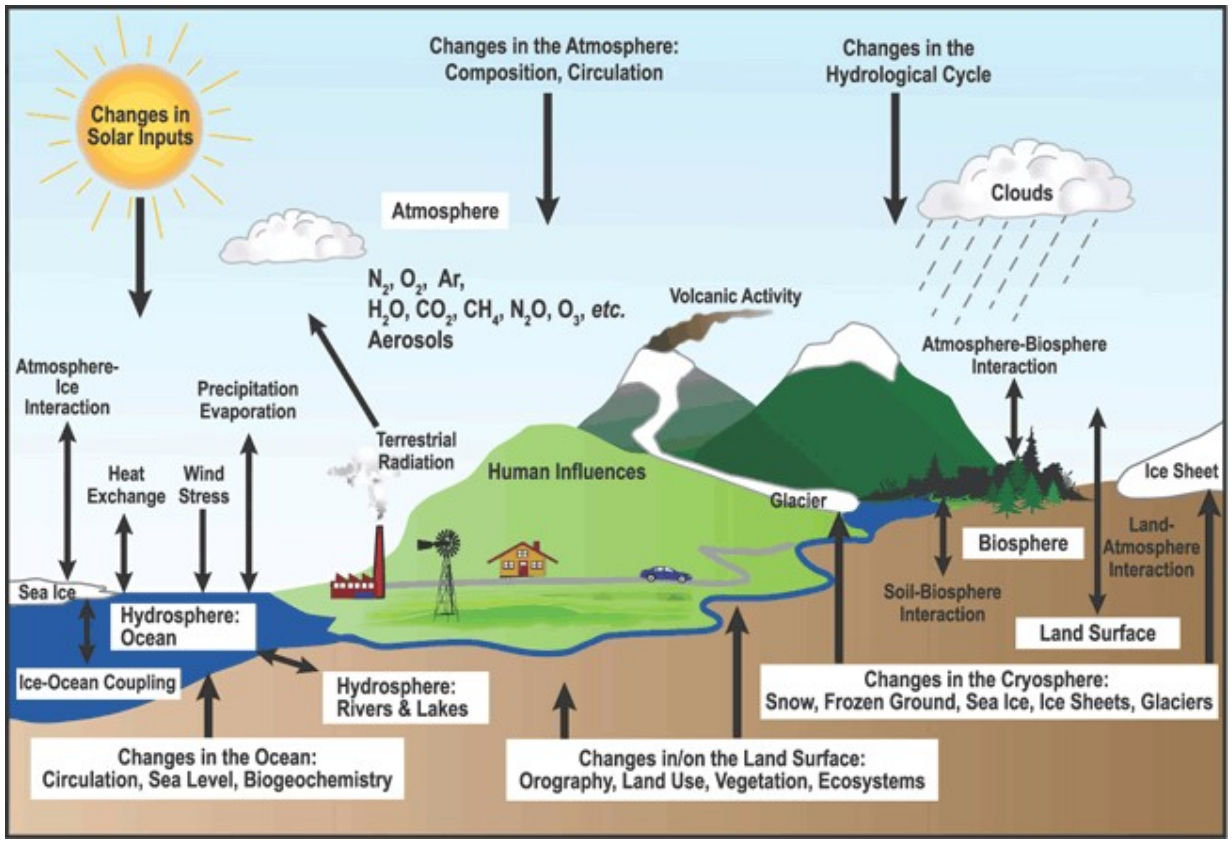
Basic Definitions

- **Weather** is the state of the atmosphere—its temperature, humidity, wind, rainfall and so on—over hours to weeks.
  - It is influenced by the oceans, land surfaces and ice sheets, which together with the atmosphere form what is called the 'climate system'.

- **Climate**, in its broadest sense, is the statistical description of the state of the climate system.

- **Climate change** is a change in the statistical properties of the climate system that persists for several decades or longer—usually at least 30 years.
  - These statistical properties include averages, variability and extremes.

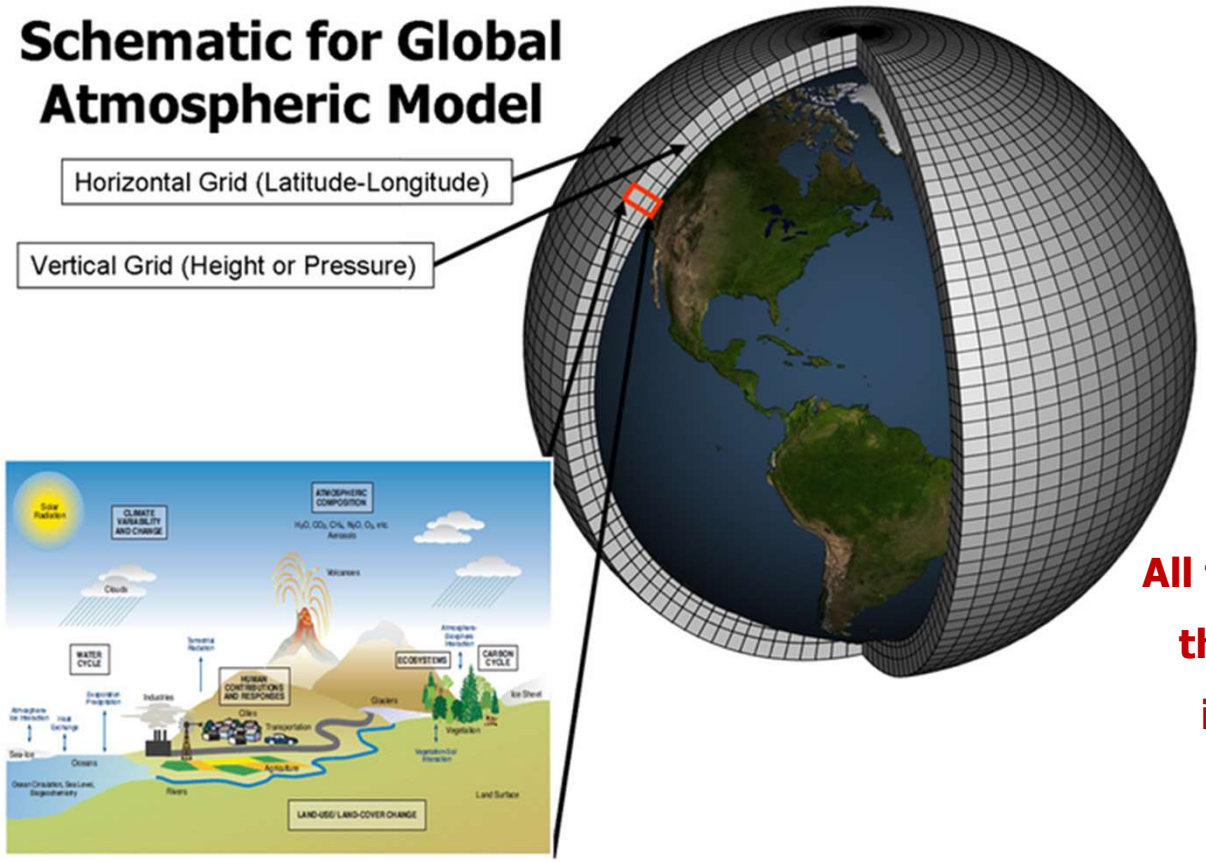
Interactions



The non-linear interaction among the components leads to climate variability at a range of spatial and temporal scales

Pic . NOAA

Numerical Solution: Time steps and Grid boxes

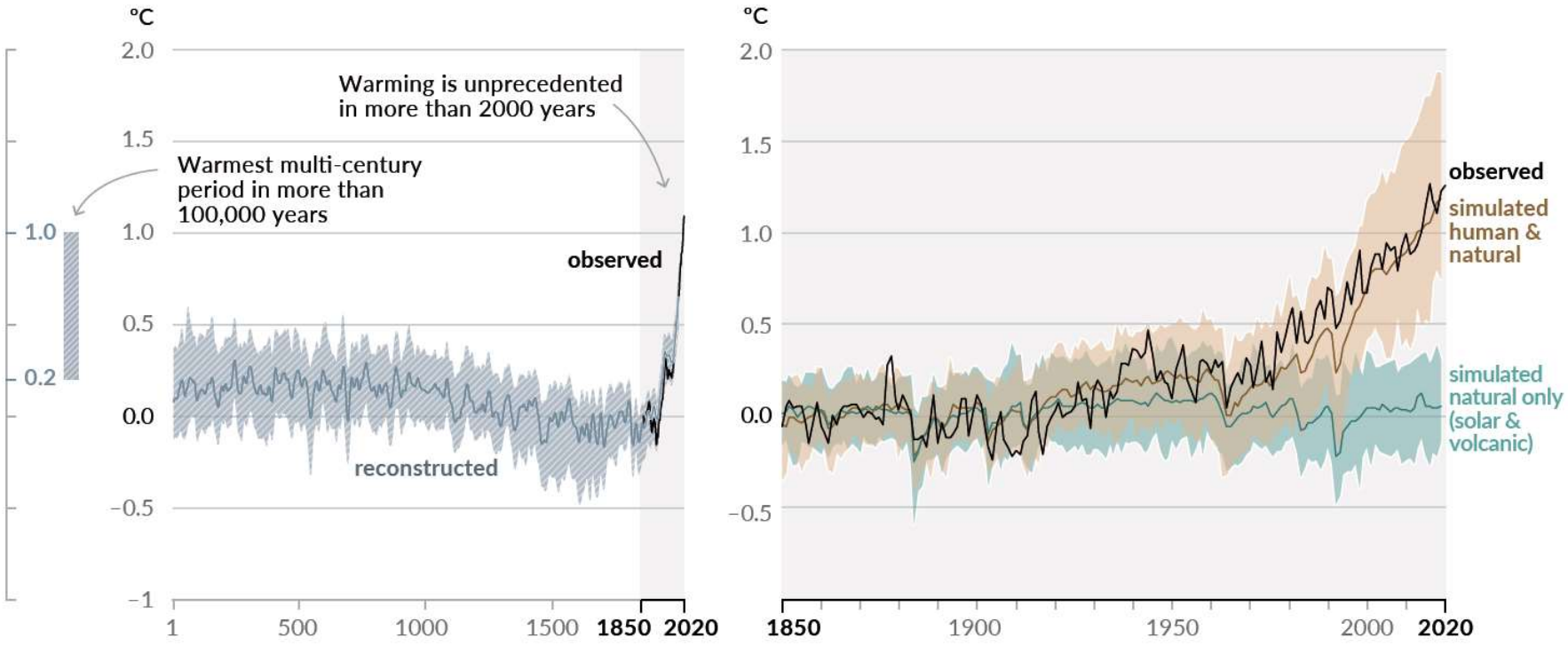


All the physical processes occurring in the climate system are resolved at individual grid and the coupling occurs at these grids.

Source: NASA

Human influence has warmed the climate at a rate that is unprecedented in at least the last 2000 years

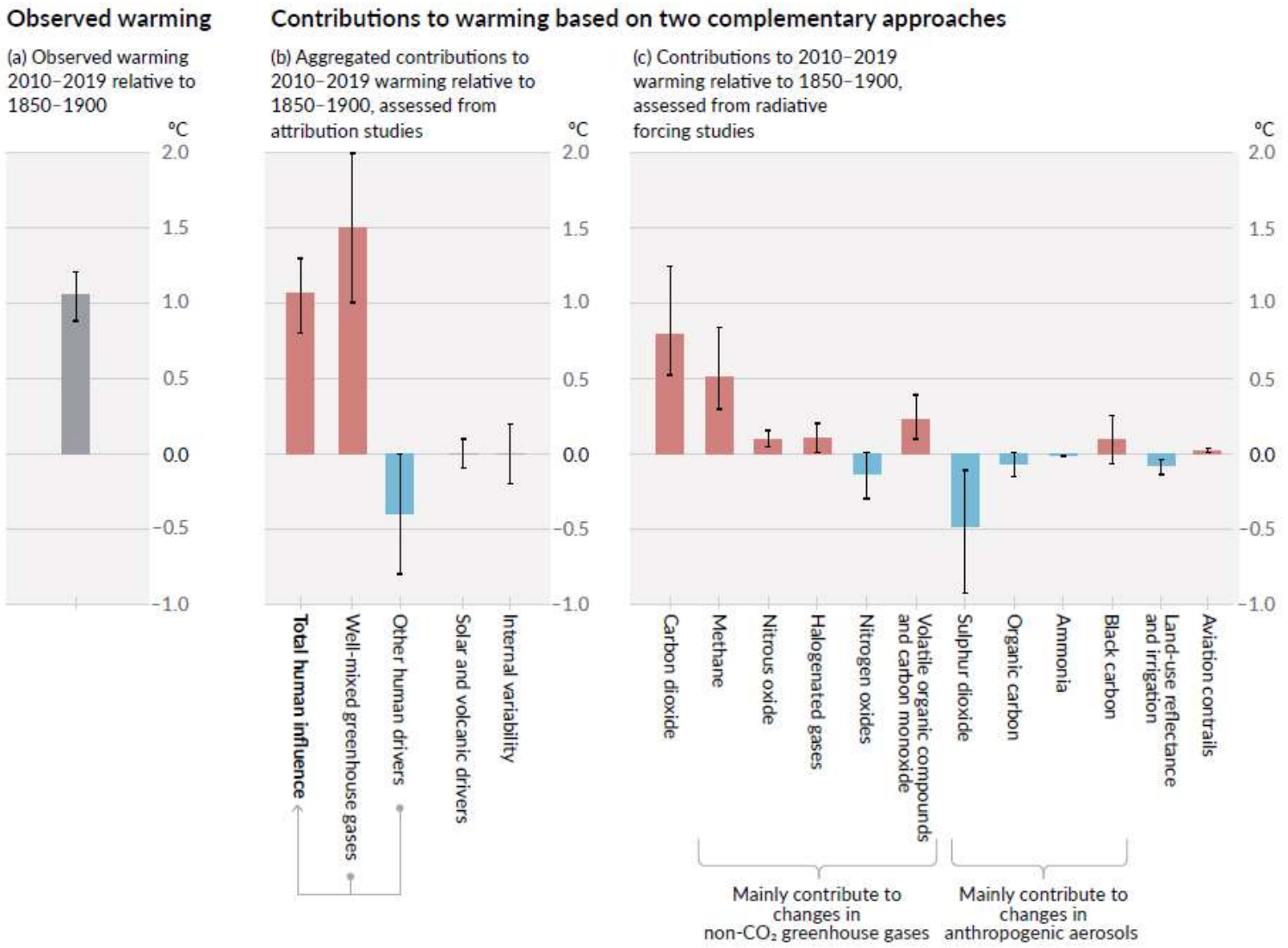
Changes in global surface temperature relative to 1850–1900



Source: IPCC AR6 SPM

Observed warming is driven by emissions from human activities, with greenhouse gas warming partly masked by aerosol cooling

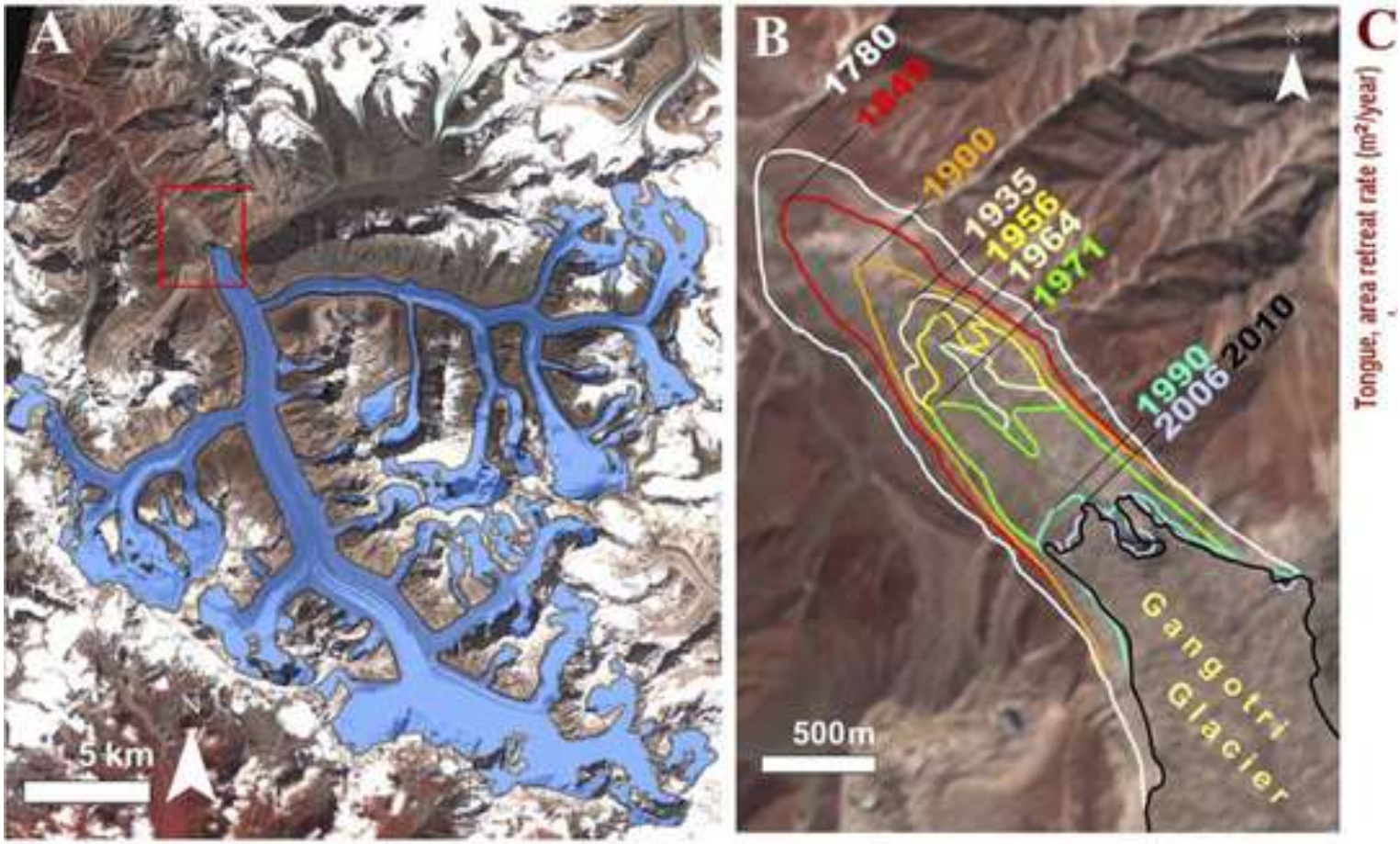
Carbon dioxide is causing the bulk of the forcing. On average, it lives more than a hundred years in the atmosphere and therefore affects climate over long time scales.



Source: IPCC AR6 SPM

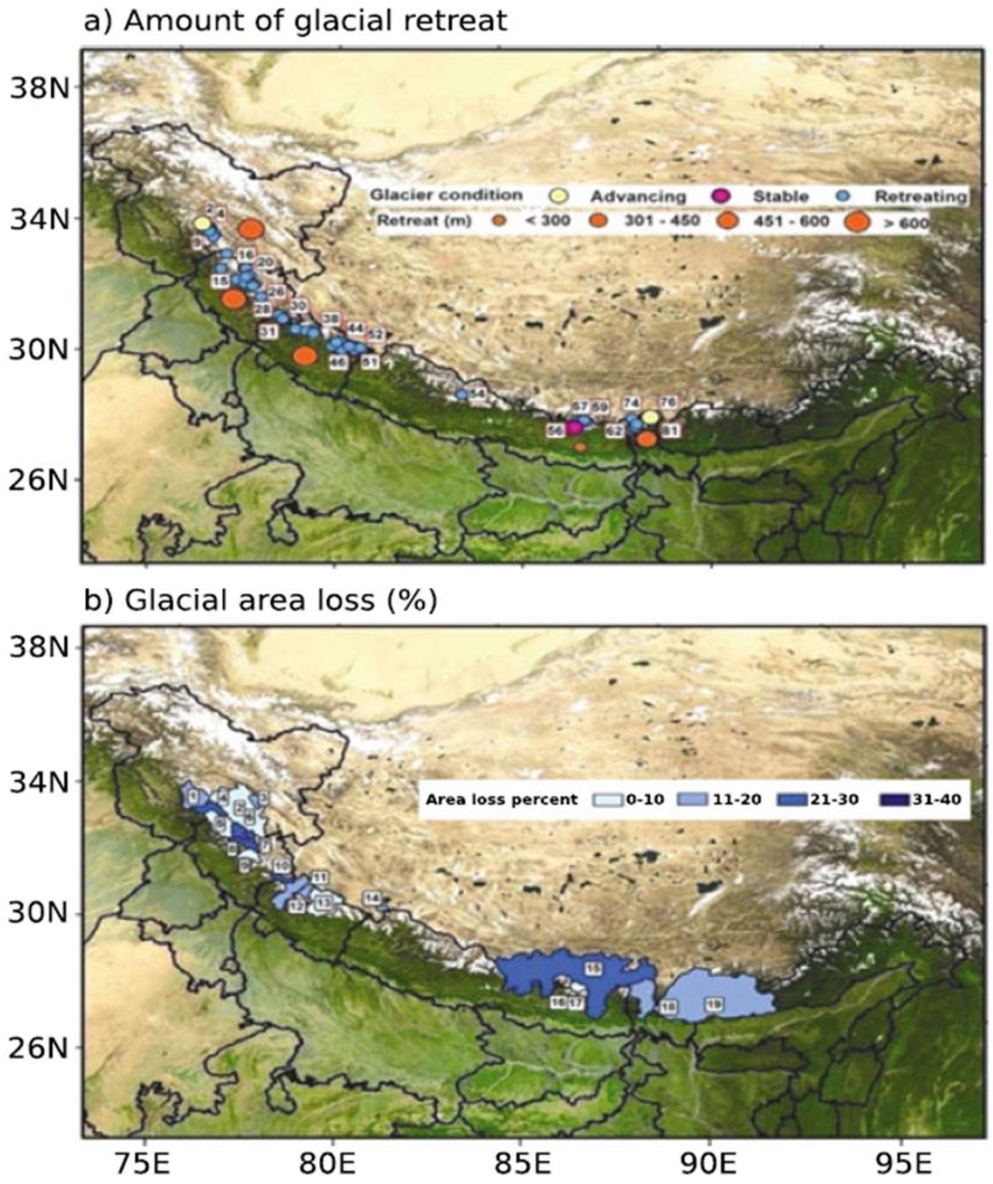
Evidences and Indicators of climate change (India context)

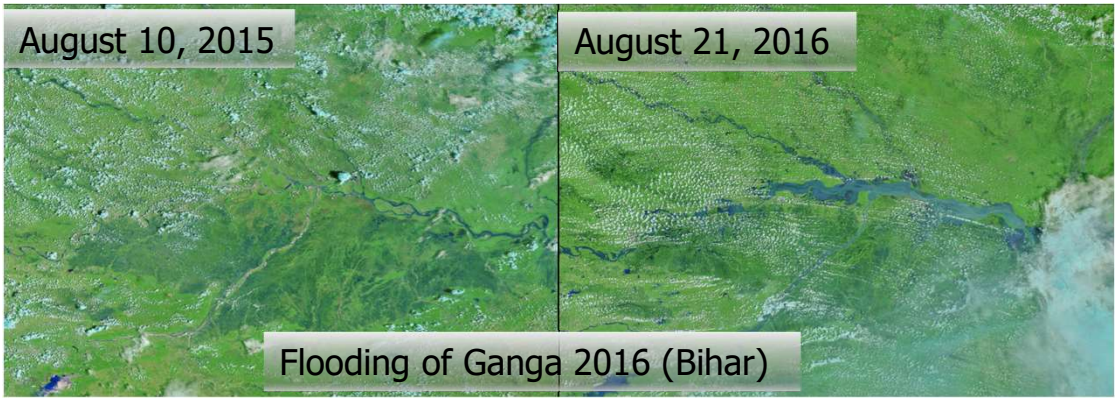
Gangotri Glacier



Kargel et al 2011

Glacial Retreat And Loss

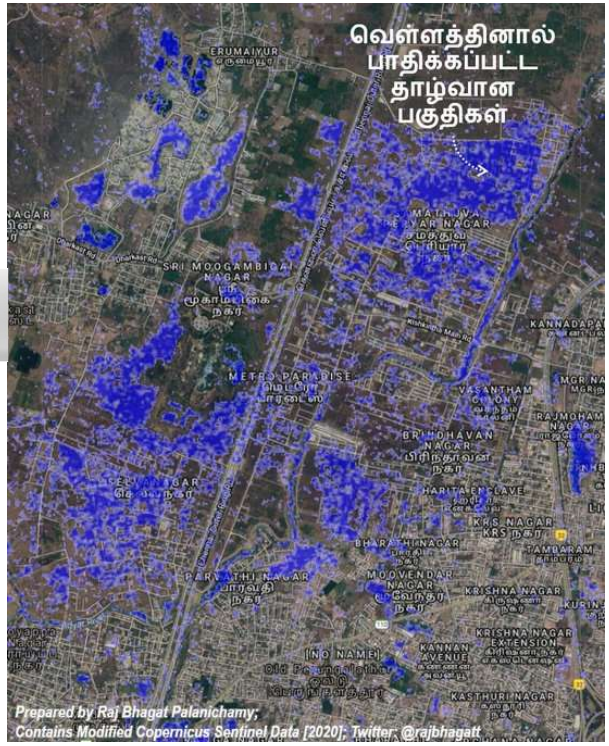




Flooding of Ganga 2016 (Bihar)

Flooding in Kerala (Aug 2018)

Adyar river flooding 2020 (Chennai)

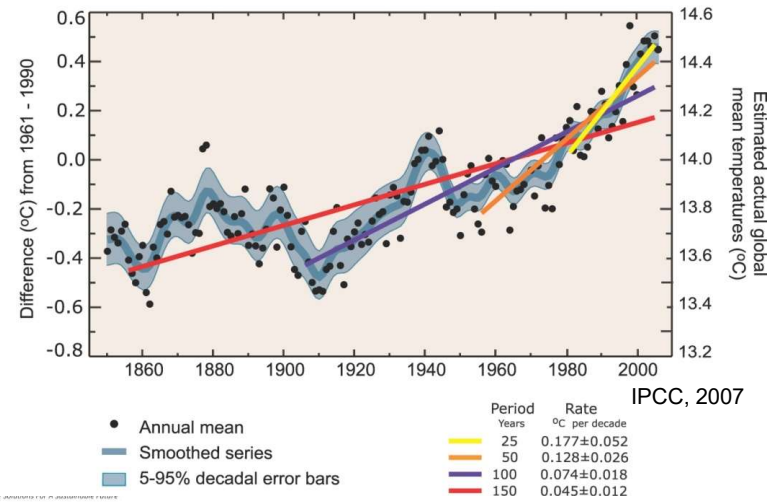


Pallikaranai wetland (flood buffers) being lost as built areas.

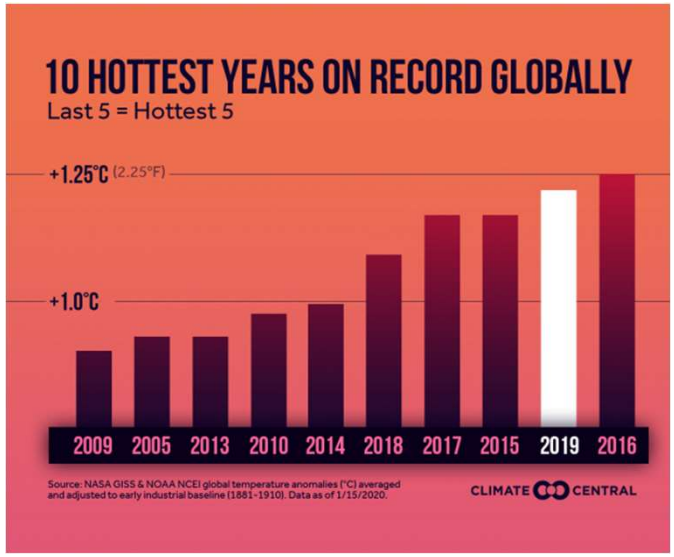
Headlines

The five warmest years in the global record have all come in the 2010s
The 10 warmest years on record have all come since 1998
The 20 warmest years on record have all come since 1995

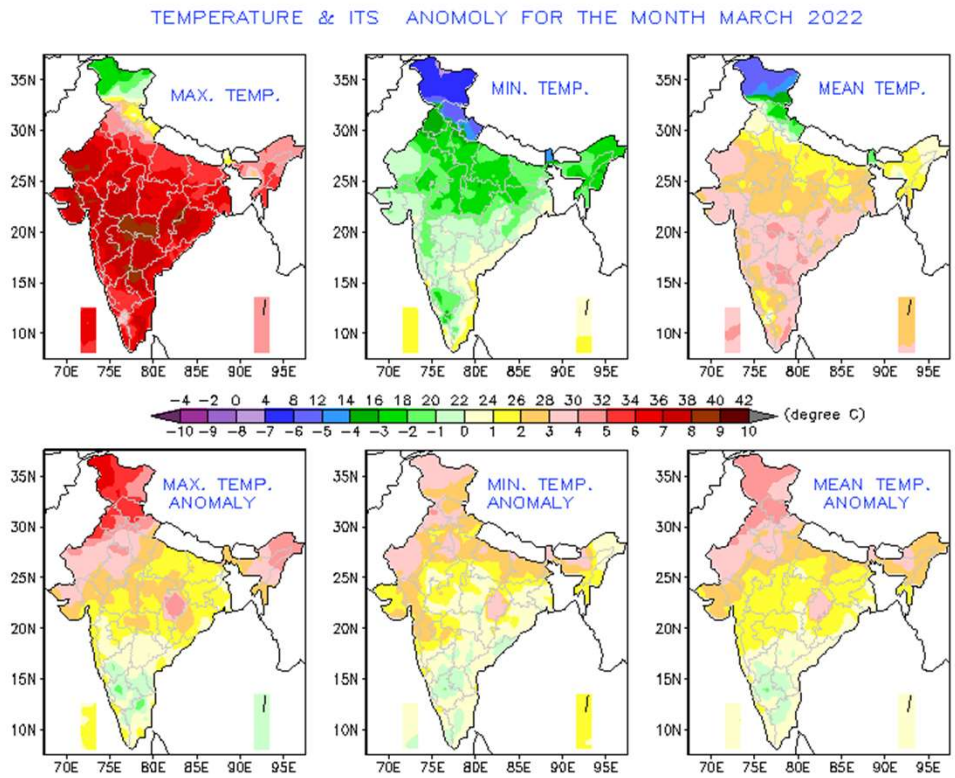
India: Thirteen out of the 15 warmest years since 1901 were the past 15 years (2002-2016) and the last decade (2001-2010/ 2007-2016) was also the warmest on record



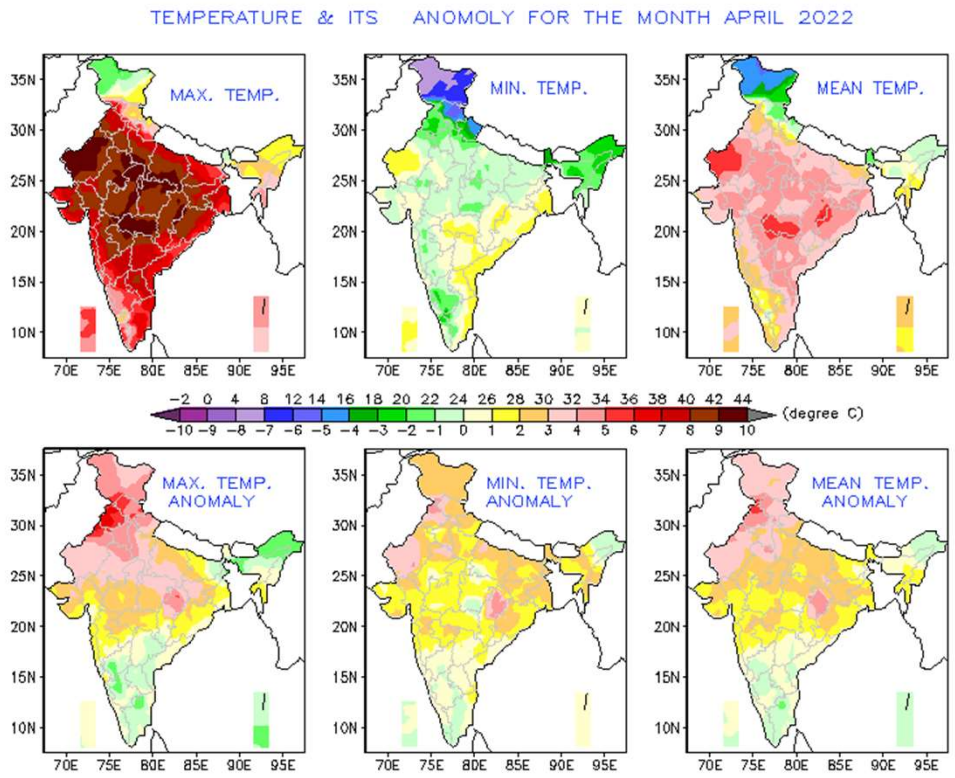
IPCC, 2007



India in 2022

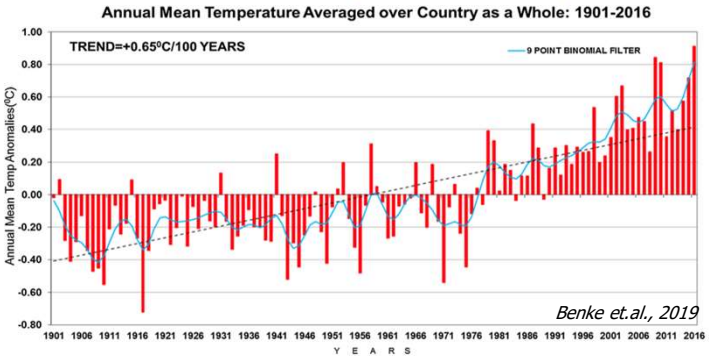


March: 122yr record warmest



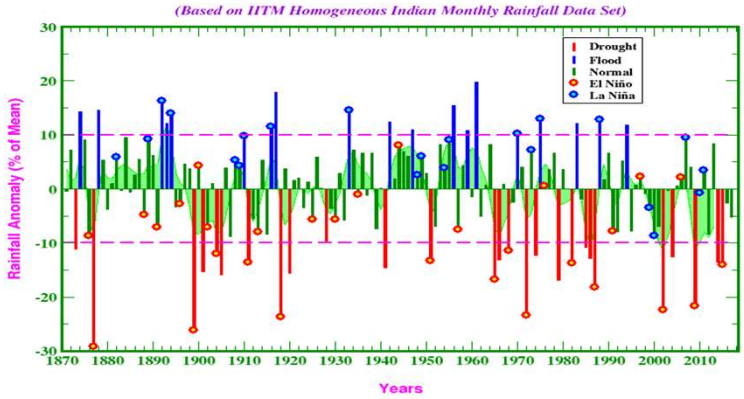
April: 72yr record warmest

All India Mean Annual Temperature Anomalies (1901-2016)



The trend of warming in recent past (1971-2016) is higher over India and comparable to global trend in warming

All India Summer Monsoon from 1871-2017



All-India monsoon season rainfall time series shows NO long term trends. It is marked by large year to year variations.

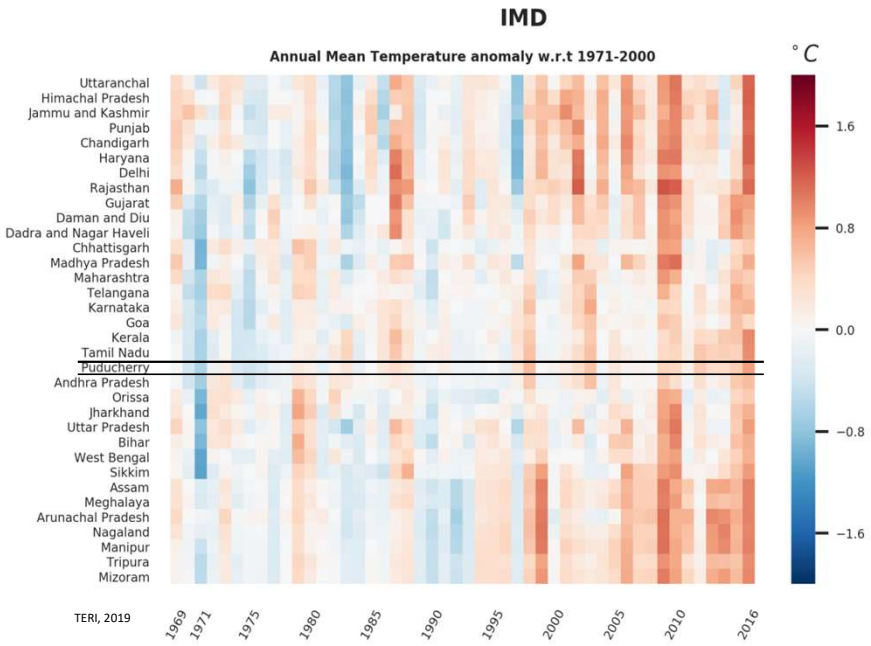
Thirteen out of the 15 warmest years since 1901 were the past 15 years (2002-2016) and the last decade (2001-2010/ 2007-2016) was also the warmest on record.

Sea level along the Indian coast has been rising at the rate of about 1.3mm/year on an average and projected to rise due to influences from global rise and regional effects.

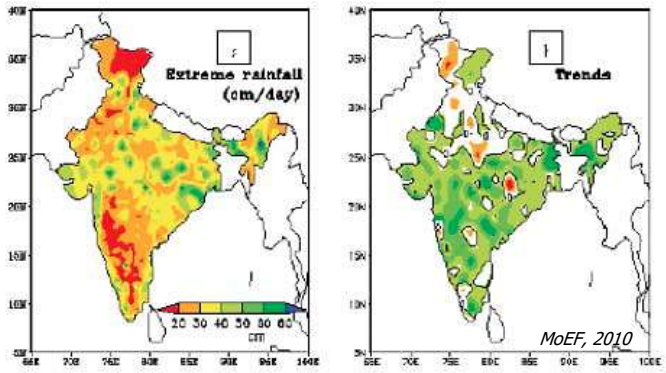
Increasing SLR and intense cyclones have caused coastal flooding due to storm surges in the past. The trend will continue in the future with higher surge heights making coastal inundation a big concern.

MoEF 2010, SREX, 2012

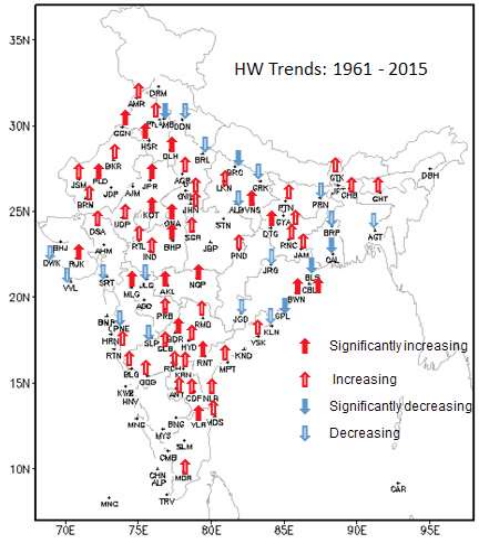
All India Annual Mean Temperature Anomalies (1969-2016) (Base: 1971-2000)



Regional Trends are high with higher warming in recent past.

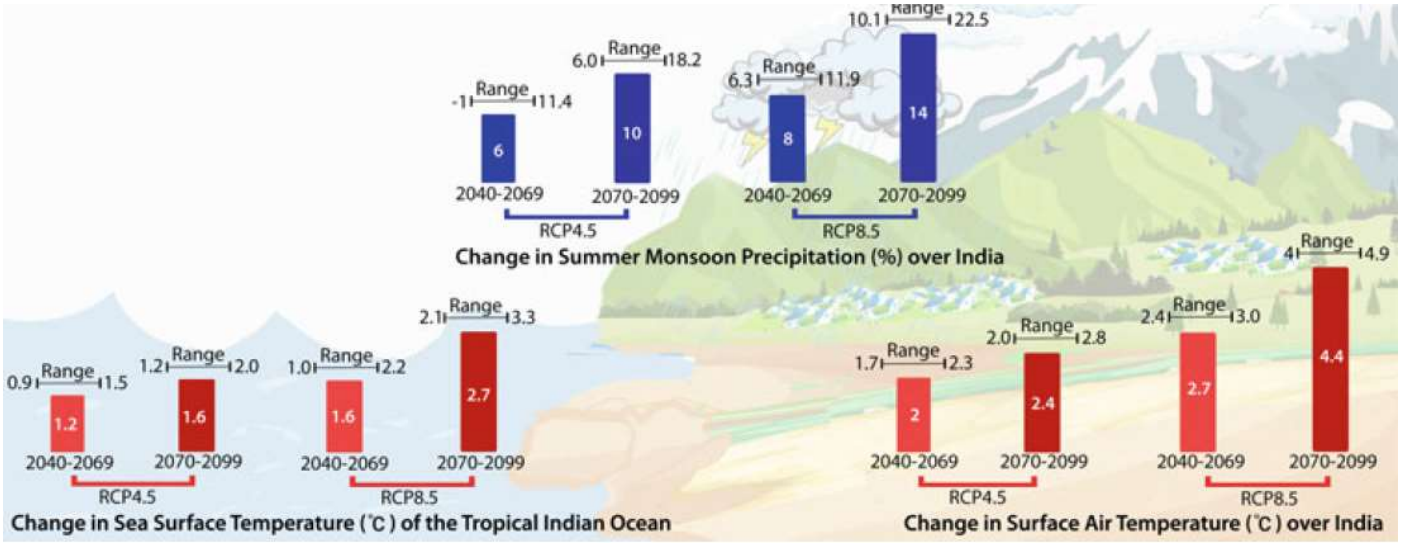


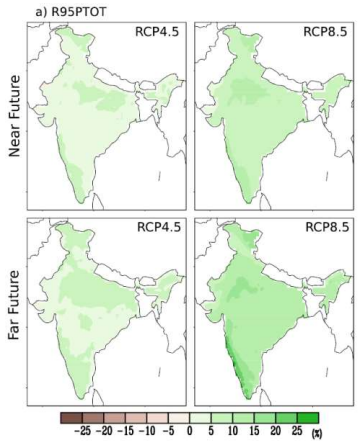
The extreme rainfall have increased over India with positive trends over most places

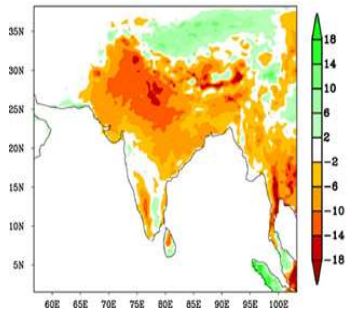


Significant evidences and analysis on increasing extremes.

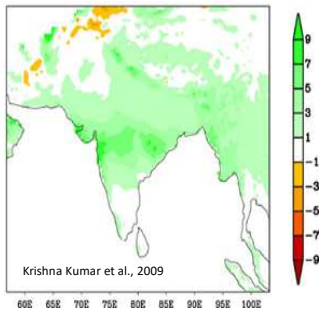
PROJECTIONS FOR INDIA







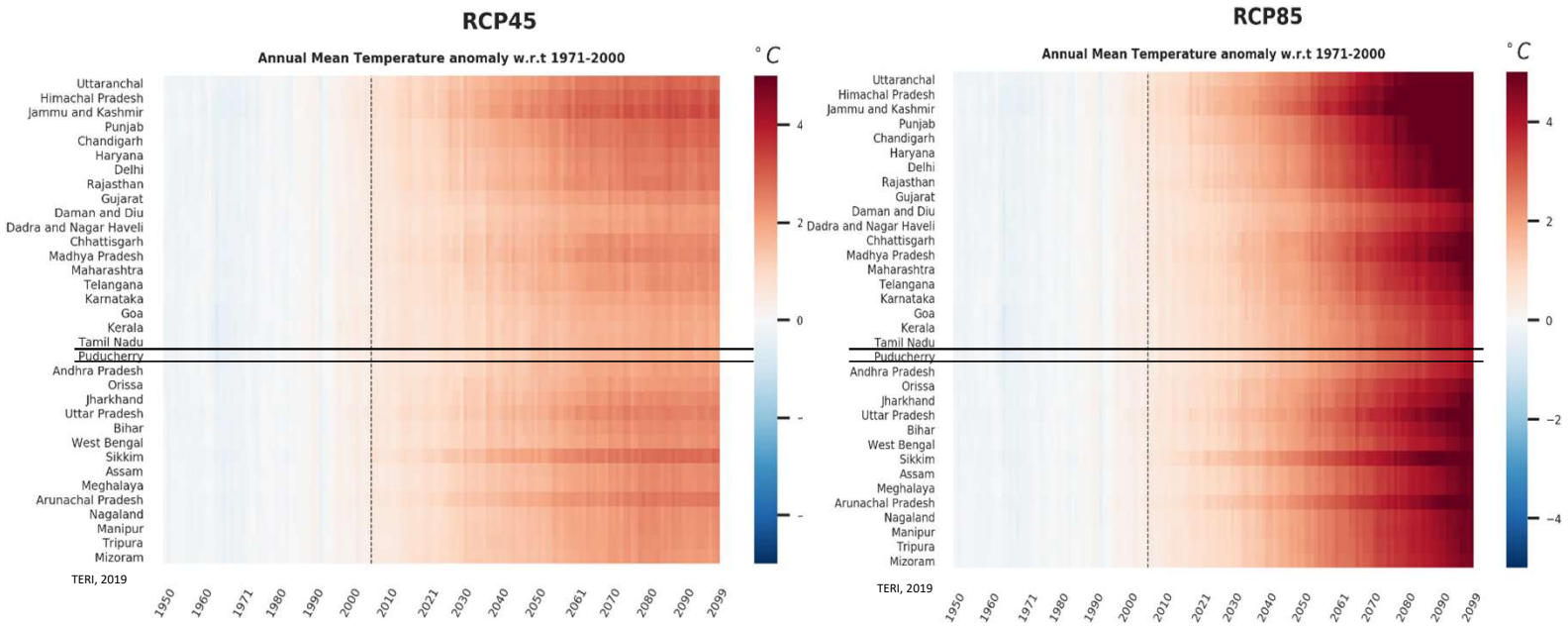
Projected future change in number of rainy days (rainfall >2.5 mm) during monsoon season (JJAS).



Projected change in the intensity (mm/day) of rainfall on a rainy day.

MoES, 2020

India context for future

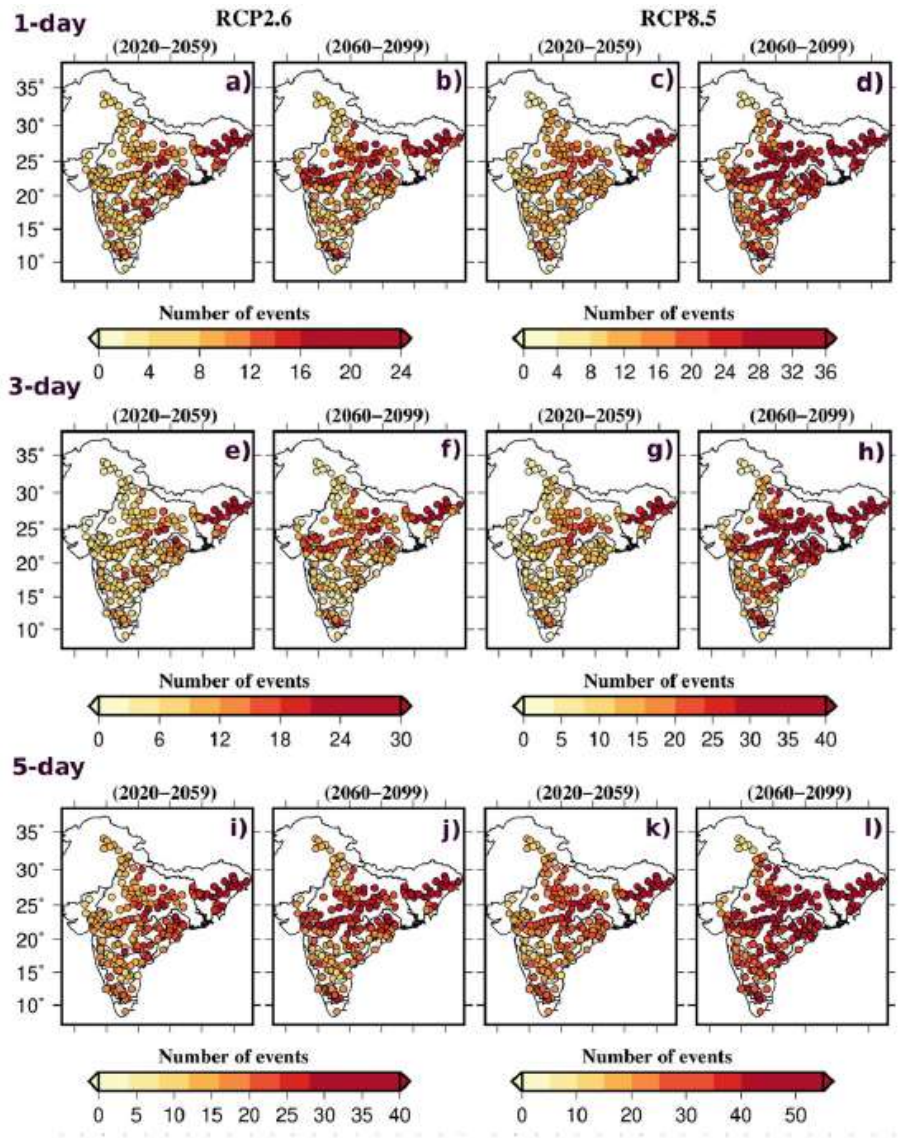


Significant evidences and analysis on increasing extremes in future on India wide / homogeneous scale

Future Flooding

Models indicate an increase in frequency of urban and river floods, under different levels of warming, 1.5 and 2.0 °C, as in association with an expected rise in heavy rainfall occurrences

Flood frequency and associated risk are projected to increase over the major river basins of India, with a higher risk for the Indus-Ganges-Brahmaputra river basins



Expected Effects over India

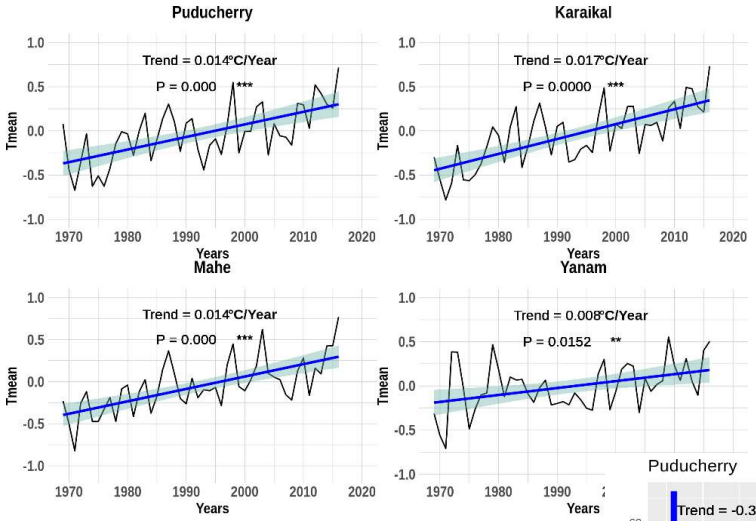
- **Temperature:** Rise between 1.7^{o} to 2.0^{o}C by 2030s and 3.5^{o} to 4.3^{o}C by 2080s
  - on avg. 27 more hot days (>45^{o}) each year and around 1.3 more consecutive hot days (heat waves) events each year for next 30 years.
- **Precipitation:** Highly variable and unpredictable, avg. 0.3%-15% all India by 2030s and 9-15% by 2080s.
  - with around 4 – 18 more days of very high rainfall in near future (till 2050s).
- **Extremes:** Both temp and rainfall extremes to increase in future:
  - higher minimum temperatures and more intense rainy days as well as more drier days
- **Cyclones:** A decrease in projected number of cyclonic disturbances along both the coasts by 2030s but intensity to increase.
- **Storm Surges:** 5%-20% increase in 100-year return periods of storm surges over East coast in 2030s.
- **Sea Level Rise: Sea Level Rise:** At the end of the twenty-first century, steric sea level in the NIO is projected to rise by approximately 300 mm relative to the average over 1986–2005 under the RCP4.5 scenario

Climate analysis over Puducherry

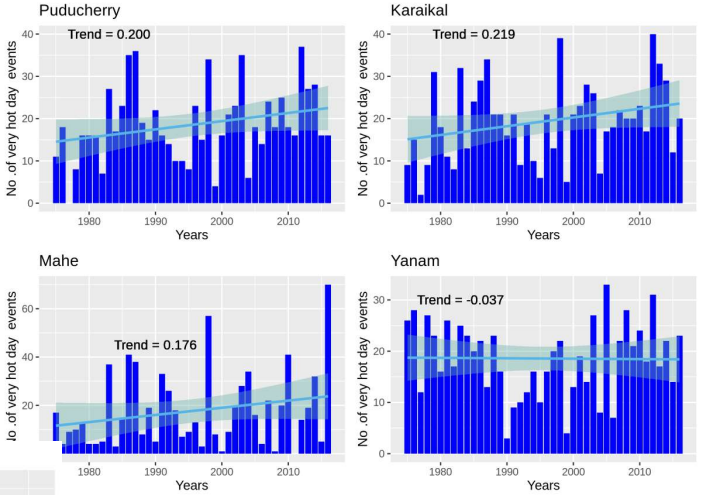
- Data used in this study is from IMD for historical analysis and NEX-GDDP data for future study.
- IMD rainfall data (1951-2016) at 0.25^{o}X0.25^{o} & temperature data 1^{o}X1^{o} (1969-2016). NEX-GDDP @0.25^{o}
- To reduce the uncertainties in future change projections, a robust model selection methodology has been followed to select the best performing models over Puducherry out of the 21 NEX-GDDP models for the multimodal ensemble mean.
- Multimodal Ensemble mean of five best performing NEX-GDDP dataset has been used to assess the projected changes towards Mid-Century period (2021 – 2050)
- The change has been calculated as a difference between the 30 year average of mid-century (2021-2050) with respect to baseline (1975-2005).

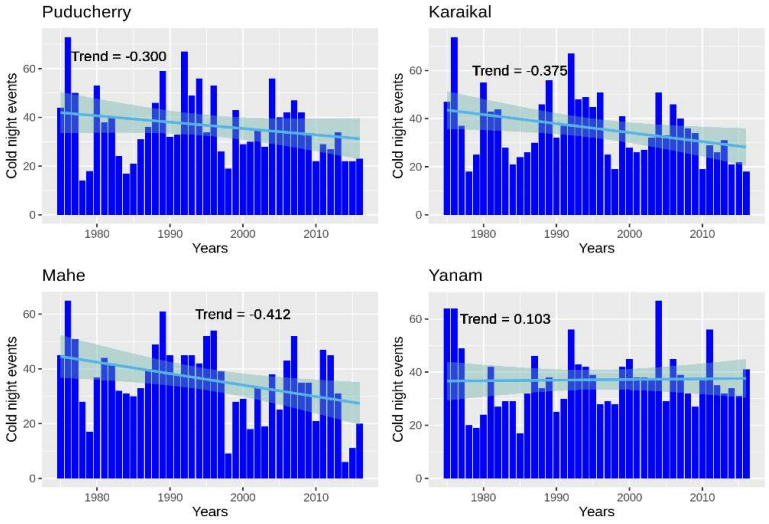
Historical Analysis (temp)

Annual Mean Temp Anomaly 1969-2016



Annual Very hot day events (>95th %tile)

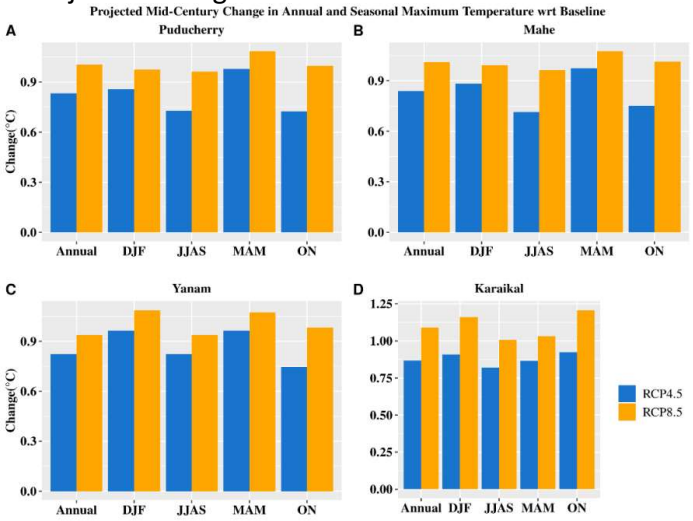




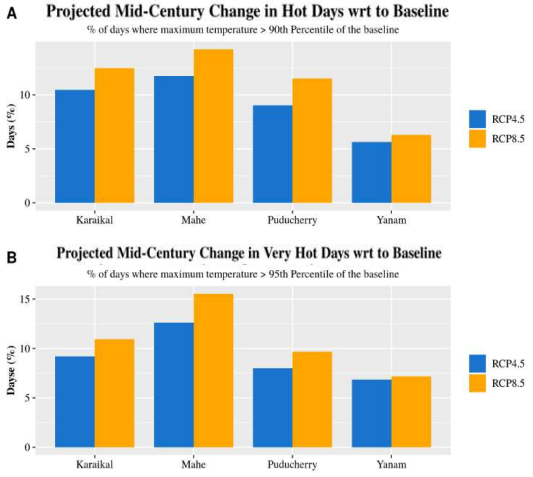
Annual cold nights (<10th %tile)

Future Climate Analysis (temp 2021-2050)

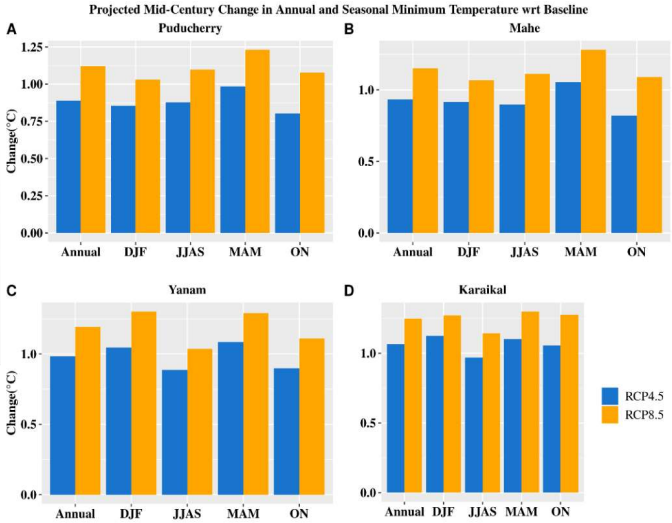
Projected change in MaxT over UT wrt 1975-2005



- Annual/Seasonal warming for the UT under both RCPs
- Change in MinT more than MaxT
- Extremes Temp also show increase in future with Mahe showing the most changes.

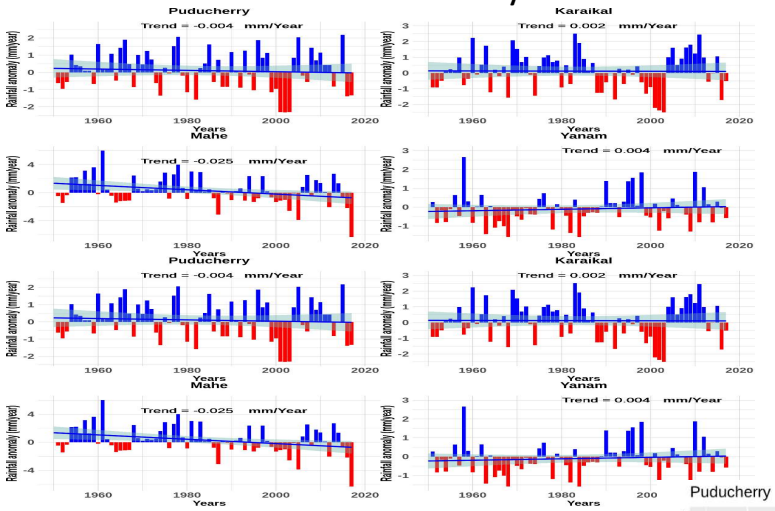


Projected change in MinT over UT wrt 1975-2005

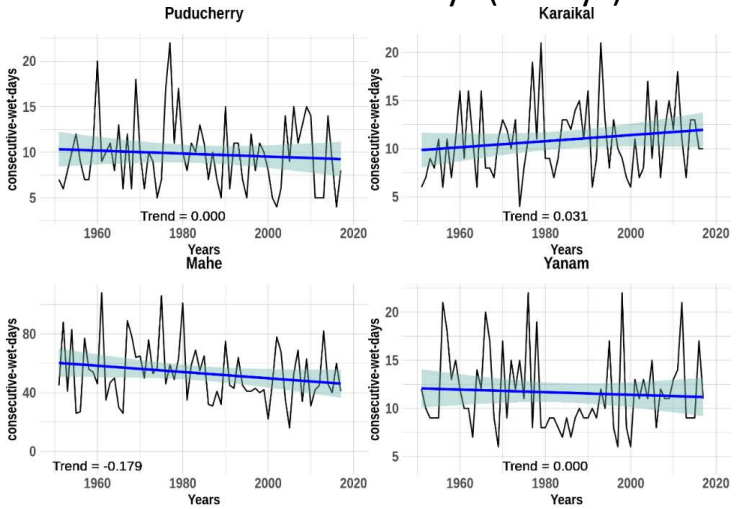


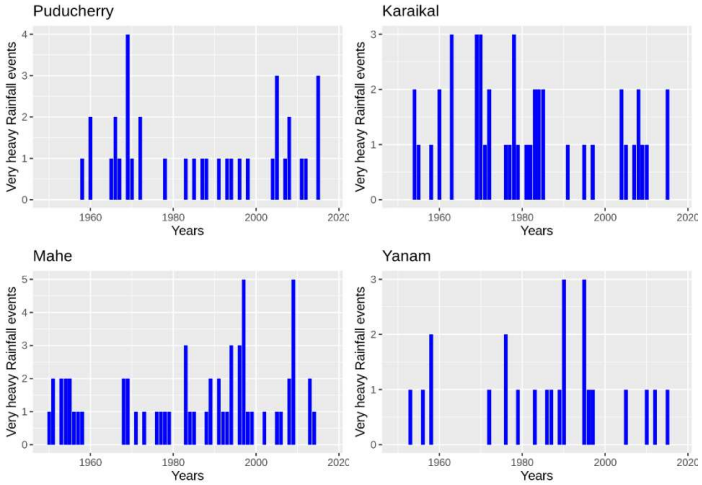
Historical Analysis (rainfall)

Annual Mean rainfall Anomaly 1951-2016



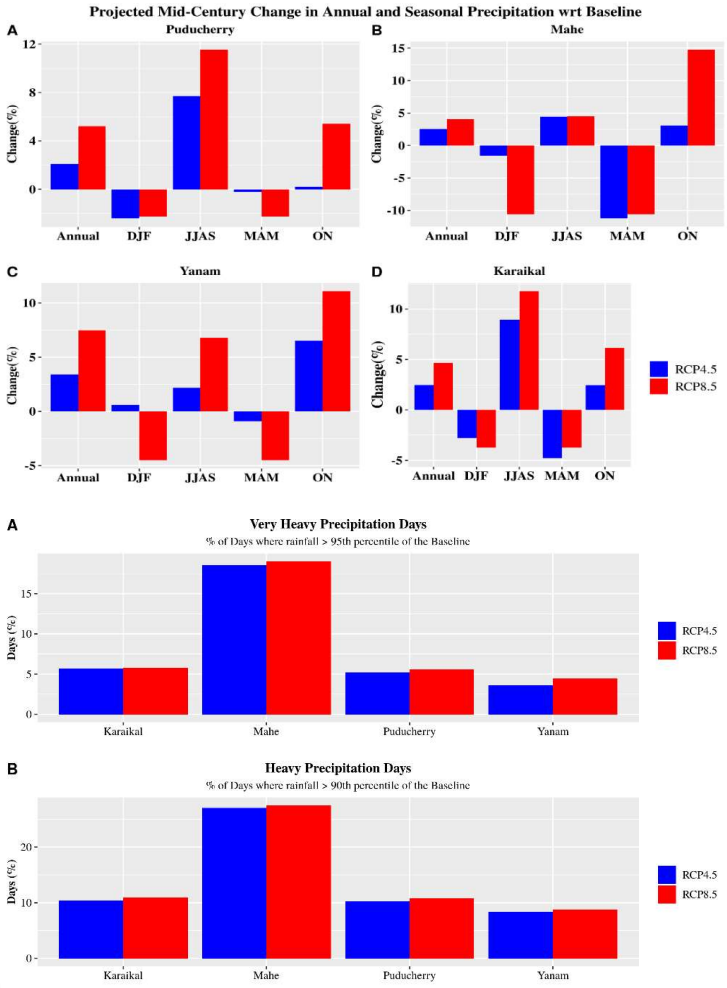
Consecutive wet days (>3days)





Very Heavy rainfall events (>124.4mm/day)

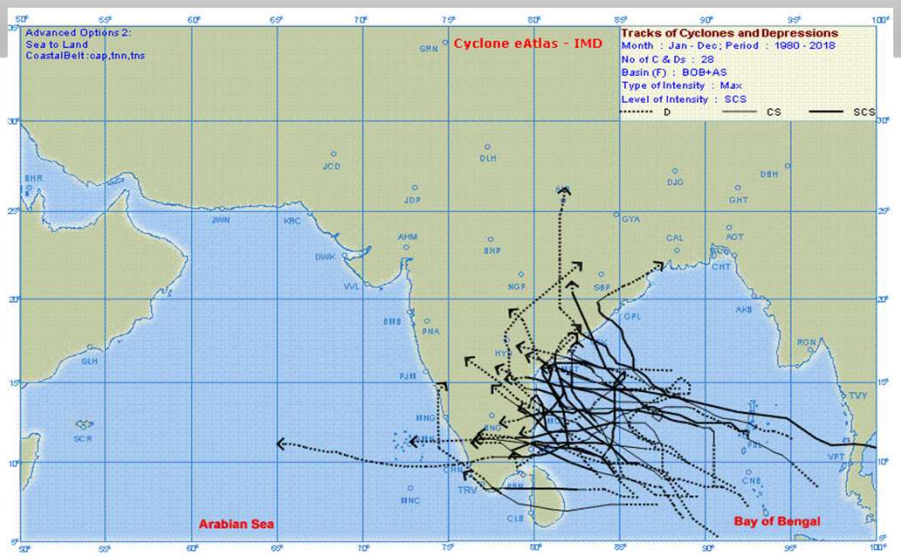
Future Climate Analysis (Rainfall 2021-2050)



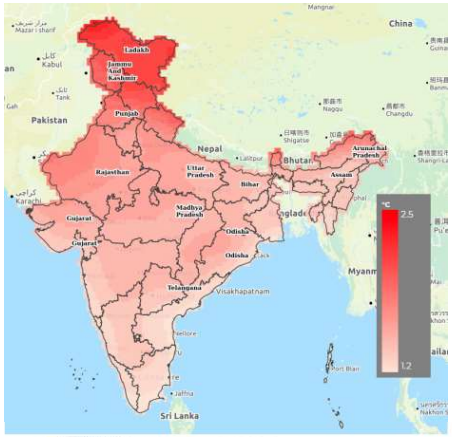
- **Annual average and Monsoon rainfall is projected to increase for all the districts** in the UT of Puducherry for both RCP4.5 and RCP8.5 scenarios for the 2021-2050
- **Puducherry** shows a projected change in annual rainfall of **2% and 6%** for RCP 4.5 and RCP8.5.
- **Mahe** shows a projected change in annual rainfall of **2% and 4%** for RCP4.5 and RCP8.5.
- **Yanam** shows a projected annual change of **3% and 7%** for RCP4.5 and RCP8.5.
- **Karaikal** shows a projected increase in rainfall of **3% and 4%** for RCP4.5 and RCP8.5.
- Heavy and very heavy precipitation are projected to increase over all the districts of the UT of Puducherry .
- Wet days and dry days also shows high variability but overall it shows increase for most of the UTs for the future.

Tropical Cyclones

- During 1980-2018 (38 years): 44 TC have crossed the Bay of Bengal Basin to A.P. & T.N. coastal belt, of which 28 were severe SCS.
- During OND season the TC occurrence are more frequent.
- The Bay of Bengal TC more often strike Odisha-West Bengal coast in October, Andhra coast in November and the Tamil Nadu coast in December.
- More intense CS projected for future however no evidence of increasing frequency in long dataset.



Climate Services and tool



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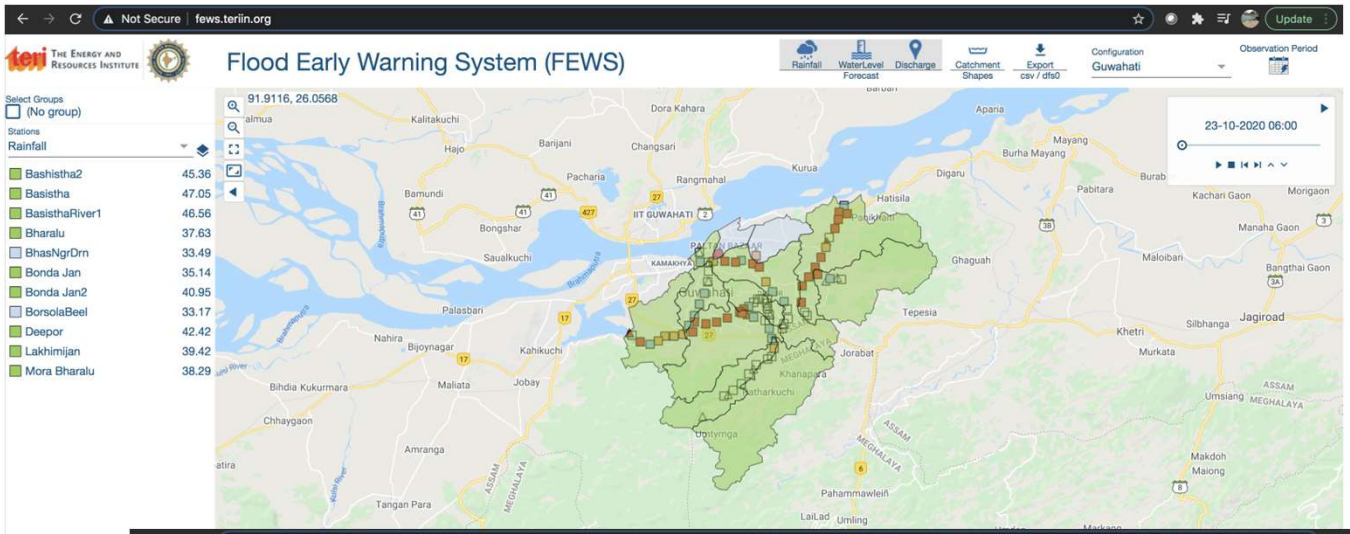
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The Energy and Resources Institute
Flood Early Warning System (FEWS)
Rainfall
WaterLevel
Discharge
Forecast
Catchment
Shapes
Export
csv / dfs0
Configuration
Guwahati
Observation Period
Select Groups
(No group)
Stations
Rainfall
Bashistha2 45.36
Basistha 47.05
BasisthaRiver1 46.56
Bharalu 37.63
BhasNgrDrn 33.49
Bonda Jan 35.14
Bonda Jan2 40.95
BorsolaBeel 33.17
Deepor 42.42
Lakhimijan 39.42
Mora Bharalu 38.29
91.9116, 26.0568
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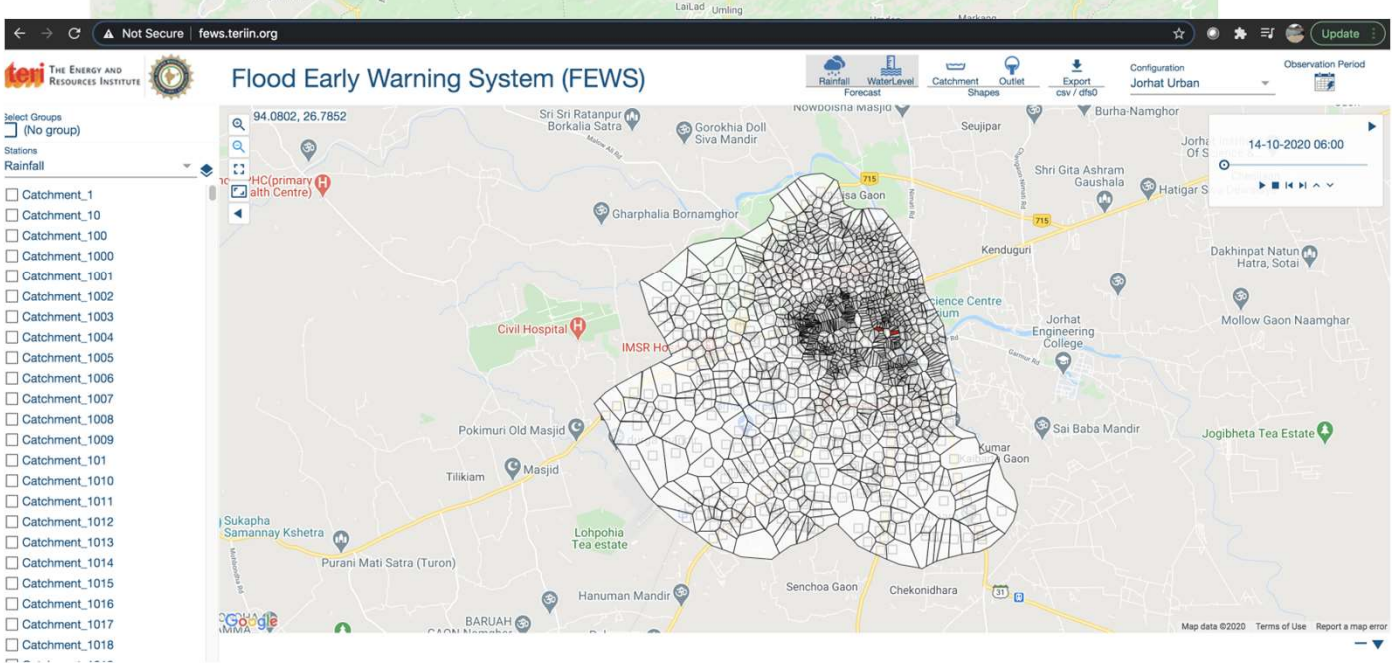
Kalitakuchi
Hajo
Barijani
Changsari
Dora Kahara
Aparia
Mayang
Burha Mayang
Digaru
Kurua
Pacharia
Rangmahal
Barnundi
Bongshar
Hatisila
Pabitara
Kachari Gaon
Morigaon
Manaha Gaon
Maloibari
Bangthai Gaon
Saualkuchi
IIT GUWAHATI
KAMAKHYA
Ghaguah
Palasbari
Nahira
Bijoynagar
Kahikuchi
Tepesia
Silbhanga
Jagiroad
Khetri
Murkata
Jorabat
Khanapara
Patharkuchi
Bihdia Kukurmara
Maliata
Jobay
Umsiang
ASSAM
MEGHALAYA
Chhaygaon
Amranga
Umtyrnga
Makdoh
Maiong
Pahammawlein
Tangan Para
Lailad
Umling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Rainfall
WaterLevel
Forecast
Catchment
Shapes
Outlet
Export
csv / dfs0
Configuration
Jorhat Urban
Observation Period
Select Groups
(No group)
Stations
Rainfall
Catchment_1
Catchment_10
Catchment_100
Catchment_1000
Catchment_1001
Catchment_1002
Catchment_1003
Catchment_1004
Catchment_1005
Catchment_1006
Catchment_1007
Catchment_1008
Catchment_1009
Catchment_101
Catchment_1010
Catchment_1011
Catchment_1012
Catchment_1013
Catchment_1014
Catchment_1015
Catchment_1016
Catchment_1017
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14-10-2020 06:00
Sri Sri Ratanpur Borkalia Satra
Gorokhia Doll Siva Mandir
Seujipar
Burha Namghor
Shri Gita Ashram Gaushala
Hatigar
Gharphalia Bornamghor
Kenduguri
Dakhinpat Natun Hatra, Sotai
Mollow Gaon Naamghar
Civil Hospital
Jorhat Engineering College
Pokimuri Old Masjid
Sai Baba Mandir
Jogibheta Tea Estate
Tilikiam
Masjid
Sukapha Samannay Kshetra
Purani Mati Satra (Turon)
Lohpohia Tea estate
Hanuman Mandir
Senchoa Gaon
Chekonidhara
BARUAH
Google
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Thank you for your attention

Questions?