Centre update

From Monsoon Mission to Mission Mausam – The Next Chapter in India's Weather–Climate Enterprise

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(with inputs from colleagues from IITM & MoES)

पृथ्वी विज्ञान मंत्रालय
Ministry of Earth Sciences
सत्यमेव जयते

A mission mode program started in 2012 -- to improve Monsoon forecasts

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The primary aim was to establish a dynamical modeling framework in India.
Bring together four MoES institutes to build a strong national framework for weather, sub-seasonal, and seasonal forecasts.

Short & Medium range Prediction	*Extended range Prediction*	*Seasonal Prediction*
Short (3-5 days) and Medium (5-15 days) ranges	Extended range (10-30) days	Seasonal scale with lead times of up to 3 months

IITM-ESMv3
GFS Tco ~67 km
MOM4 ~25 km
SIS + Noah + LULC
+ Aerosol + BGC

ERPv2
Multi-physics framework:
~50 km
GFS + MOM4 + SIS + Noah

Monsoon Mission Coupled Forecast System version 2.0 (MMCFSv2)
GFS-SL **~38 km**
MOM6 0.5° x 0.25°
CICE5
Noah

BharatFS ~6 km
Triangular Cubic-octahedral based GFS

Monsoon Mission has enabled India's preparedness across scales– building a weather-ready nation!

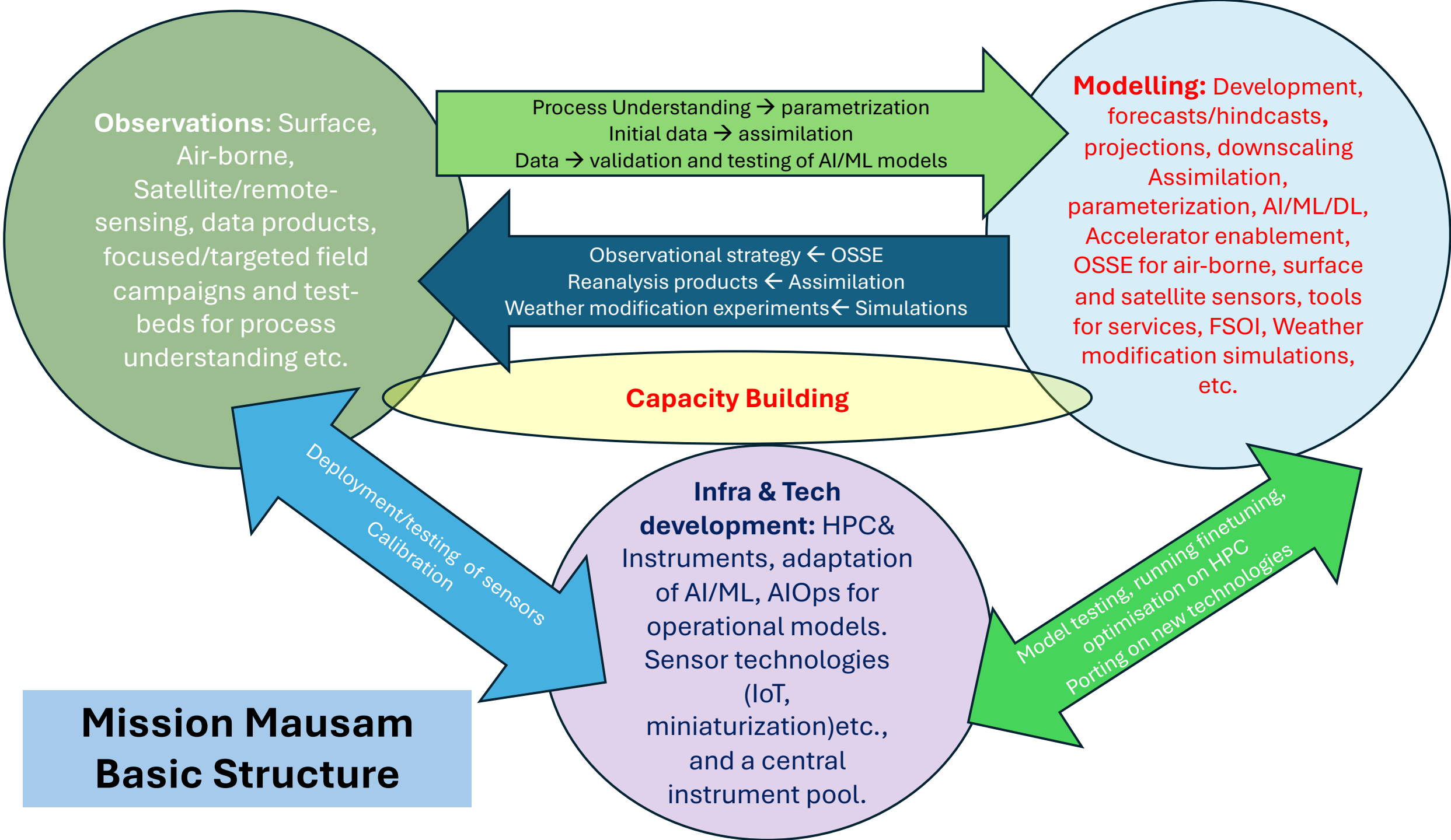
But more needs to be done!

Demands from Stakeholders are increasing: Hyperlocal, extreme evets and sector specific

Challenges remain in predicting extreme events, understanding processes, observations and better initialization of models.

Expand applications to economy, renewable energy, health, and agriculture – reach out to every sector!

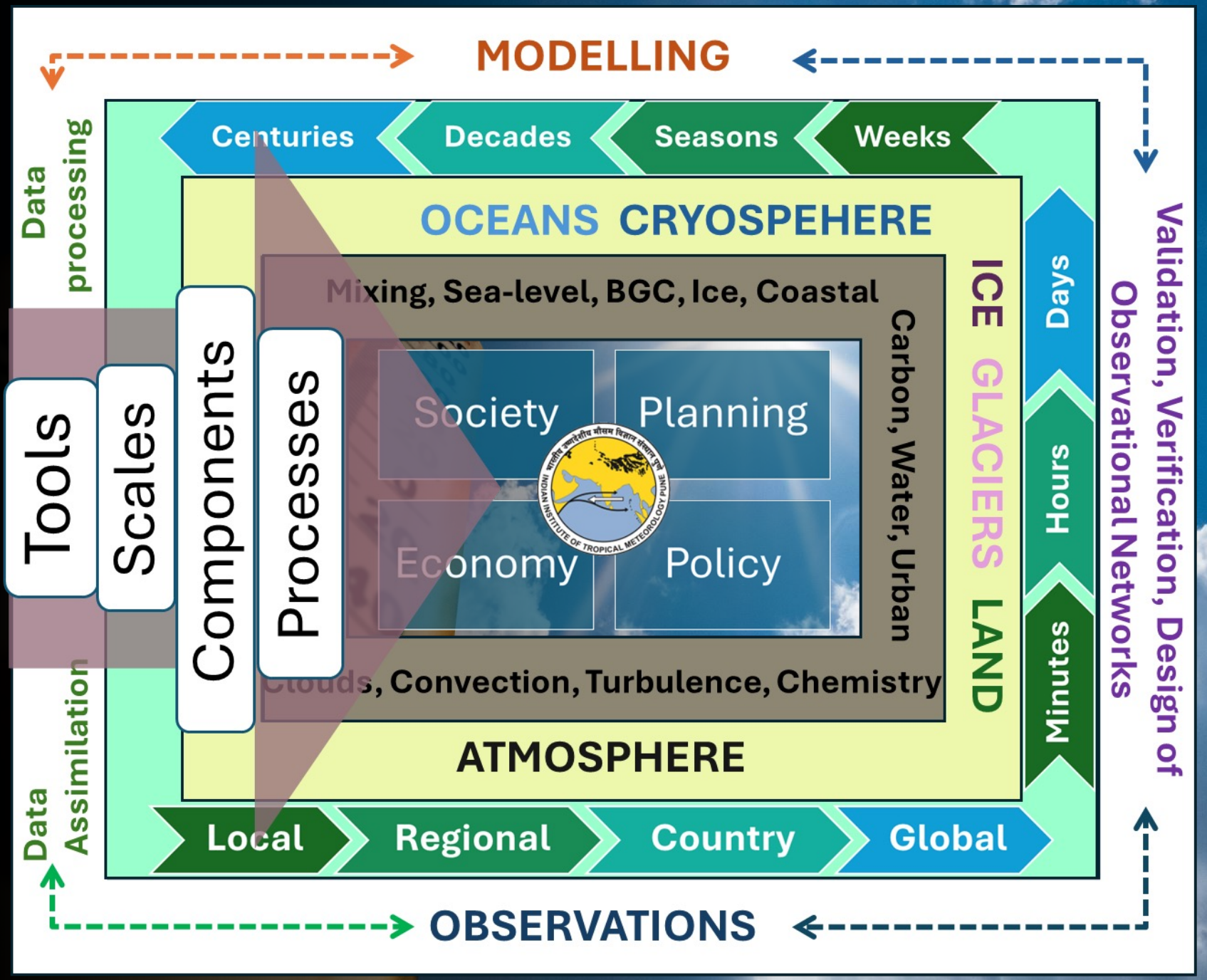
Use of AI/ML, hybrid models, and emulators. The field is evolving rapidly!


Observations: Surface, Air-borne, Satellite/remote-sensing, data products, focused/targeted field campaigns and test-beds for process understanding etc.
Process Understanding → parametrization
Initial data → assimilation
Data → validation and testing of AI/ML models
Modelling: Development, forecasts/hindcasts, projections, downscaling Assimilation, parameterization, AI/ML/DL, Accelerator enablement, OSSE for air-borne, surface and satellite sensors, tools for services, FSOI, Weather modification simulations, etc.
Observational strategy ← OSSE
Reanalysis products ← Assimilation
Weather modification experiments ← Simulations
Capacity Building
Deployment/testing of sensors
Calibration
Infra & Tech development: HPC& Instruments, adaptation of AI/ML, AIOps for operational models. Sensor technologies (IoT, miniaturization)etc., and a central instrument pool.
Model testing, running finetuning, optimisation on HPC
Porting on new technologies
Mission Mausam
Basic Structure

The grand challenge of weather and climate prediction requires a deeper understanding

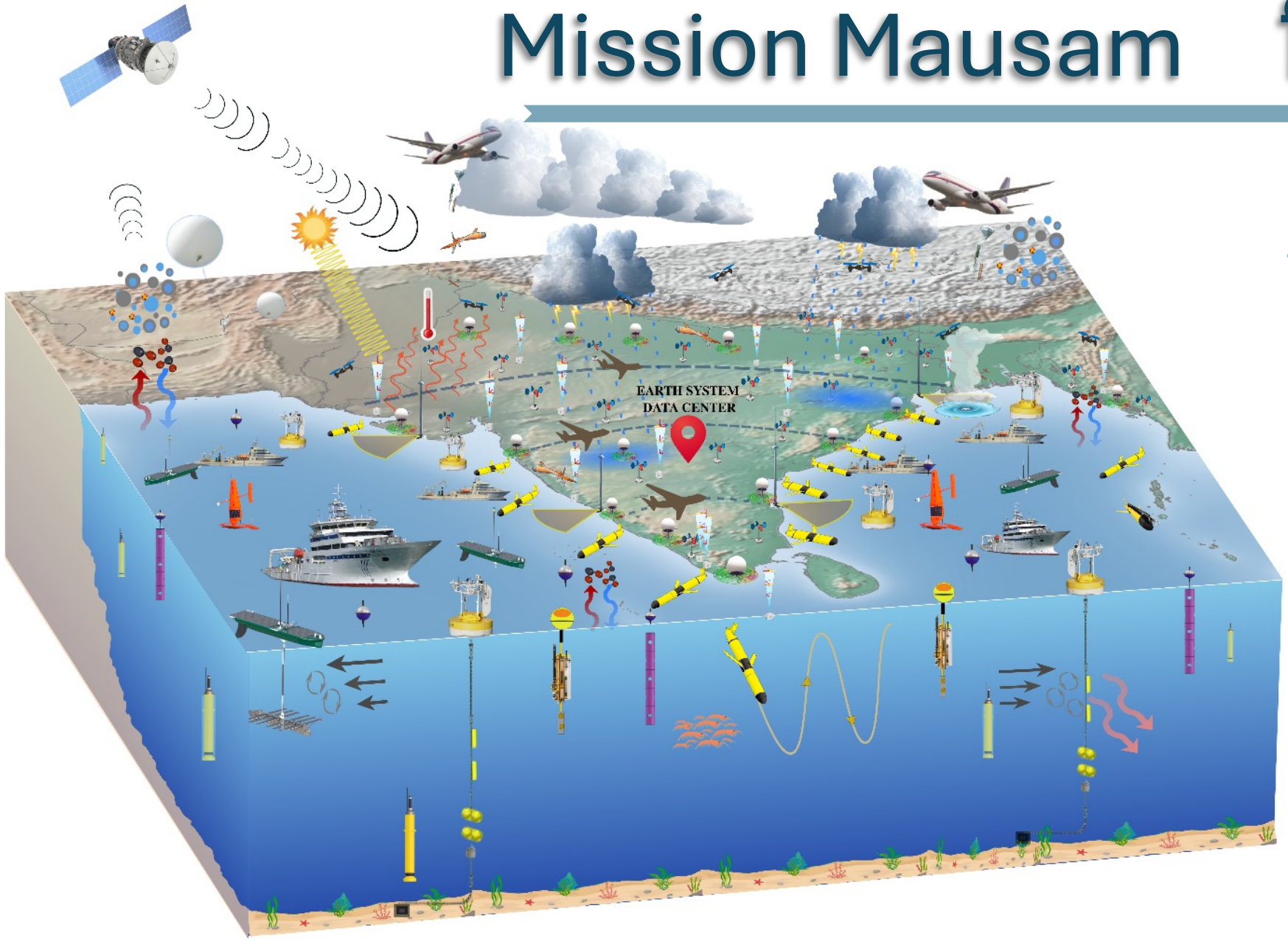
–

Need for a weather-climate Enterprise!



Enterprise noun
en·ter·prise ˈen-tər-ˌprīz ˈen-tə-ˌprīz
: a project or undertaking that is especially difficult, complicated, or risky

Mission Mausam मिशन मौसम



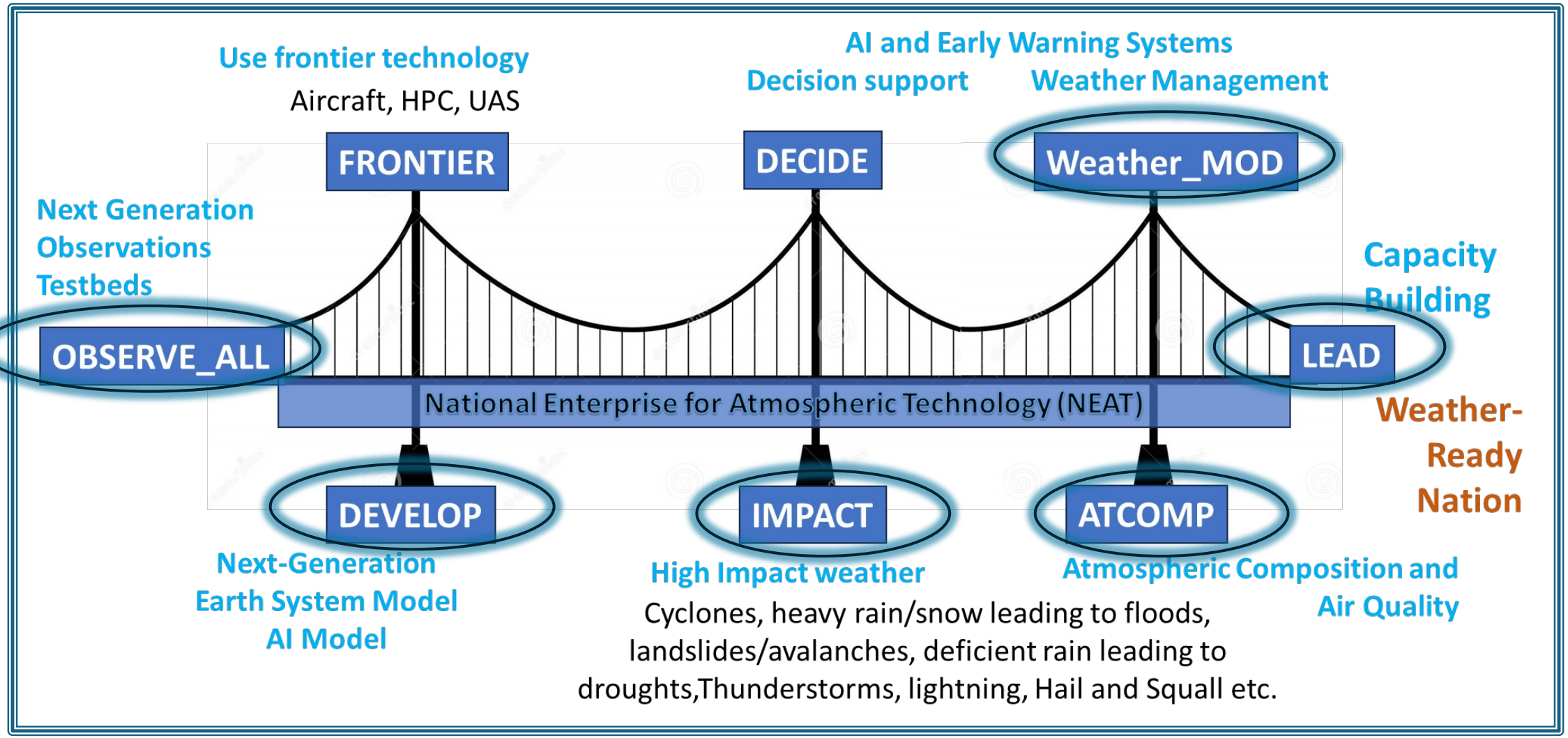
A transformational MoES initiative for a weather-ready Nation

INCOIS

NIOT

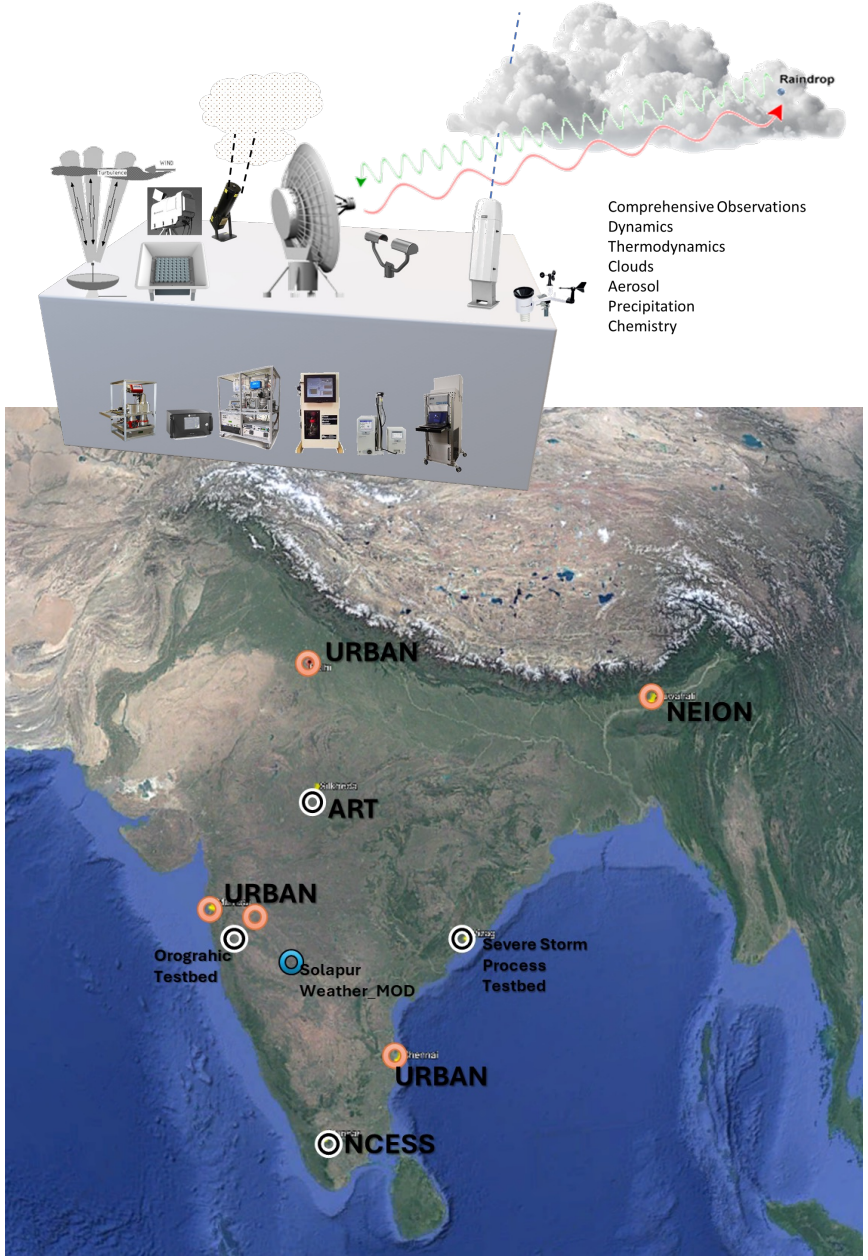
NCPOR

NCCR



The concept and different verticals of the Mission Mausam

Mission Mausam (IITM) +NCESS



Testbeds are intense observational sites to document the complete four-dimensional structure of the atmosphere for Earth system observations

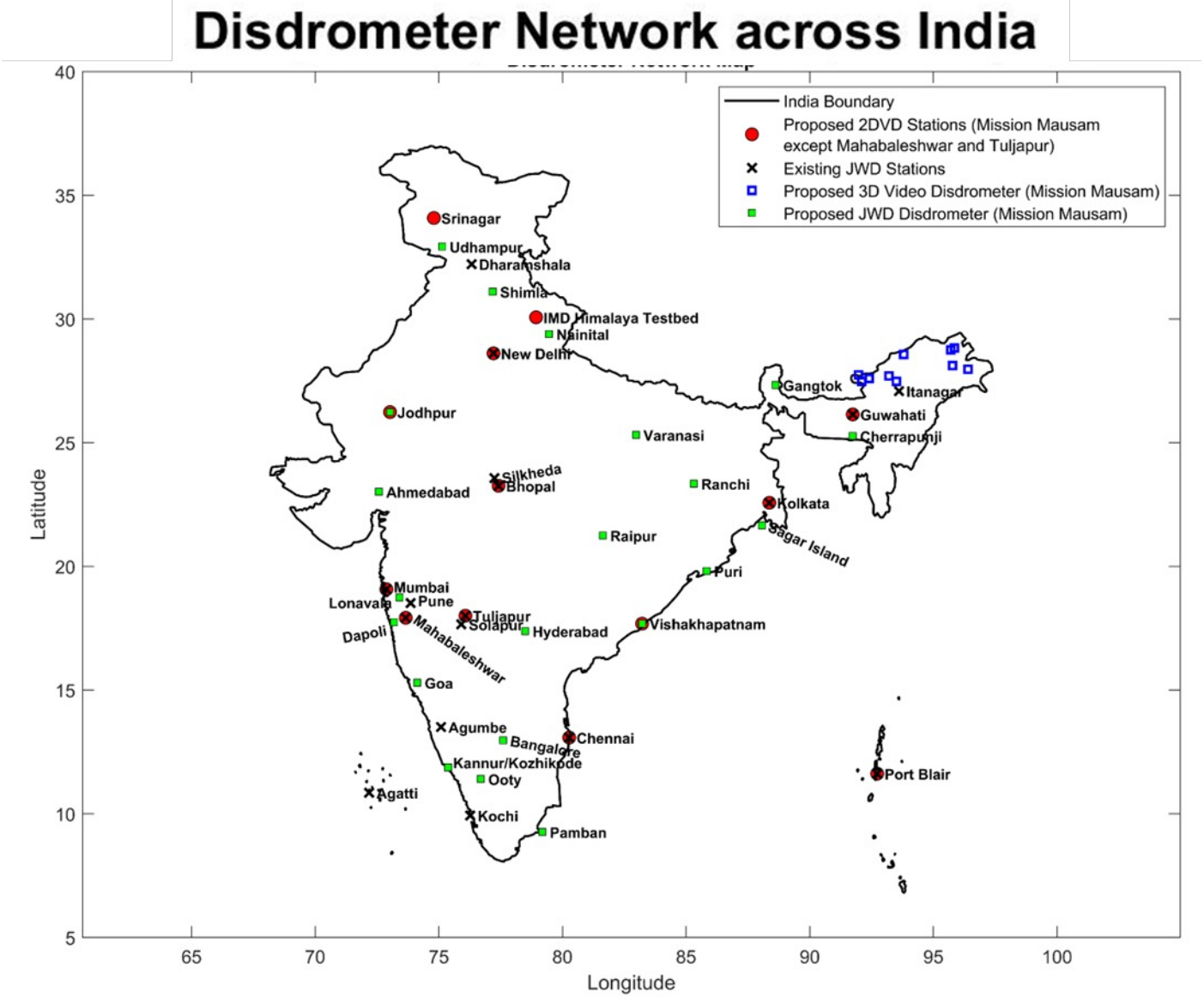
Phased Array Radar, Cloud Radar and Storm Following Radars to capture the rapid development of the storms	Aerosol physical and chemical properties with mass spectrometers, cloud condensation, and ice nucleation and BC measurements	Aerosol vertical profiles with lidars, Cloud base, cloud thickness and properties with ceilometers
Rain drop measurements with disdrometers, micro rain radars	GHG measurements to document the fluxes of water vapour, CO_2 and other gases, volatile organic compounds, and isotopic measurements	Three-dimensional winds with lidars, vertical profiling of winds, temperature and relative humidity with wind profilers and radioemeters respectively
Mobile observations with mobile observatories on campaign mode	Aircraft and drone-based measurements in campaign mode	Network of AWS and soil moisture measurements

Mission Mausam (IITM) / Observe_ALL

Mission Mausam is setting up a disdrometer network across India, which will be used to derive quantitative precipitation estimates from Radars

This includes

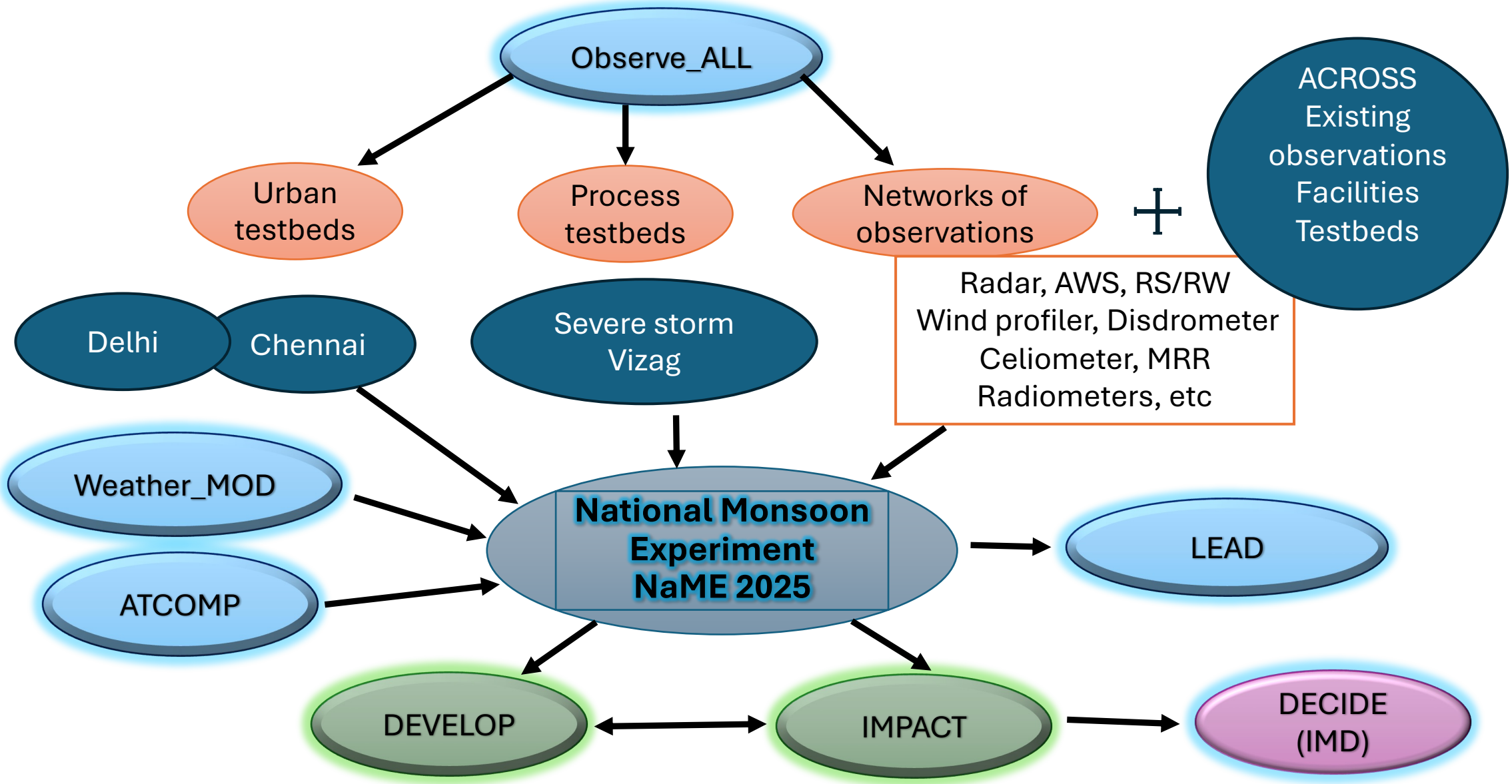
- **2D Video disdrometers**
- **3D Video optical disdrometers**
- **Impact disdrometers**



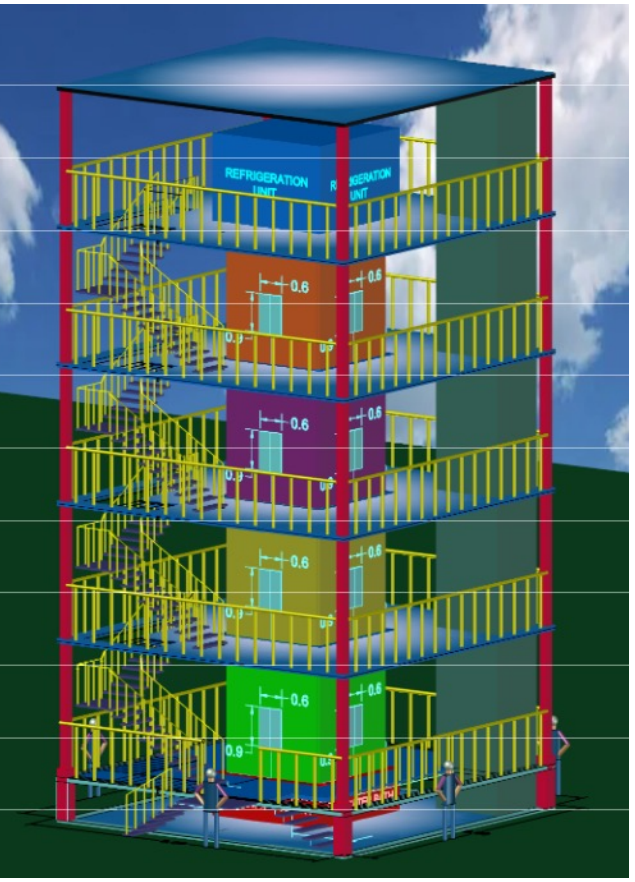
Observing networks

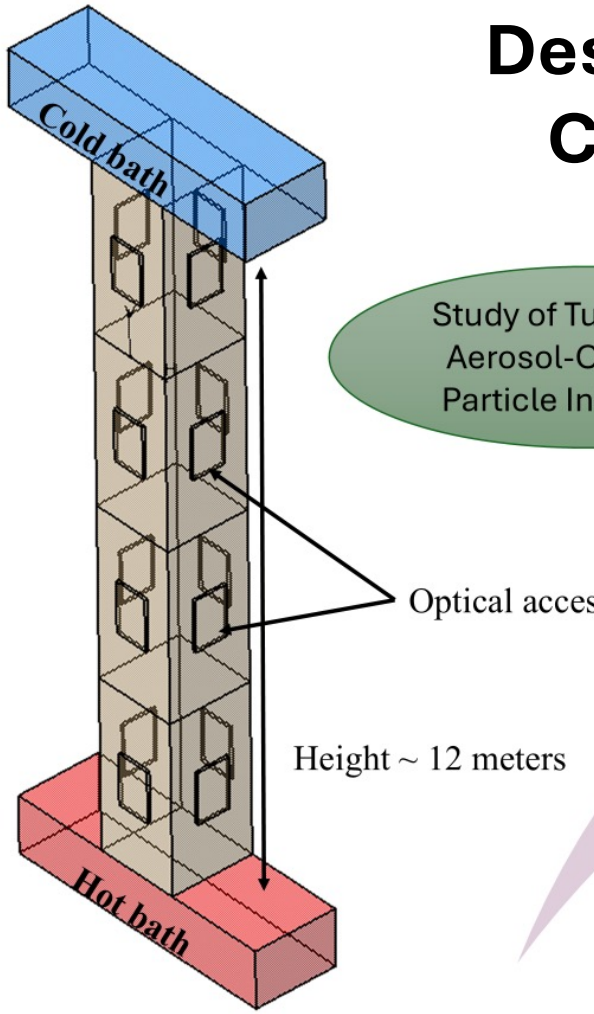
Mission Mausam (IITM)

Workflow and Pathways



Design and Development of the Cloud Chamber Research Facility at IITM





Proposed Design of Cloud Chamber

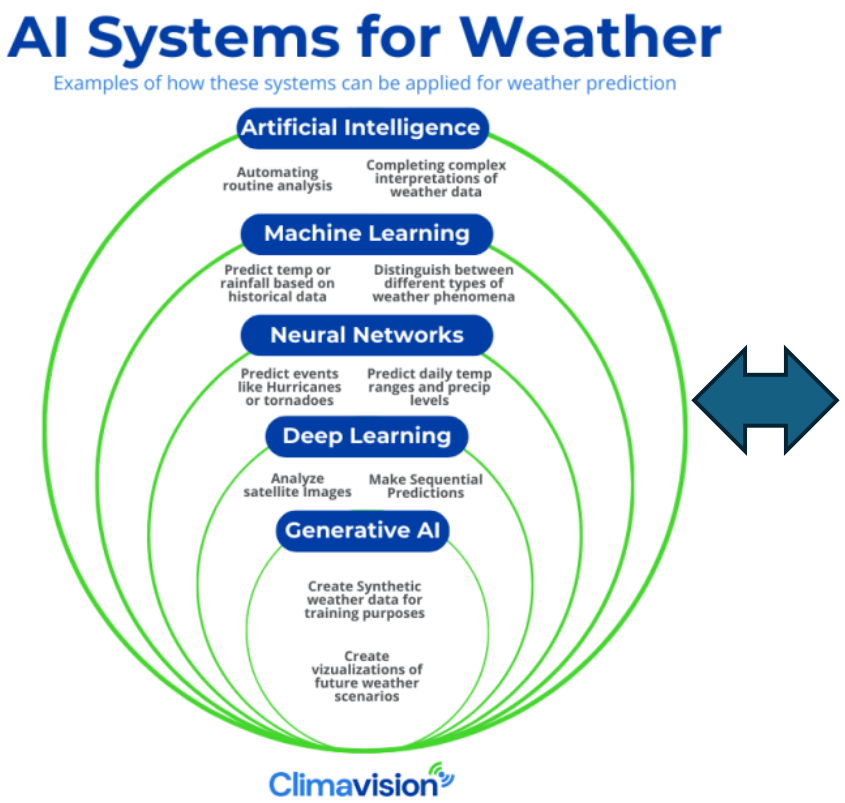
Study of Turbulence-Aerosol-Cloud-Ice Particle Interaction

- Nov 2024: Visit to Pi-Chamber, MTU, USA
- Dec- Jan 2025: Visit to IISc to see laboratory setups and explored make in India possibilities
- Feb 2025: Visit to IIT Madras
- March 2025: Formulated EoI
- May 2025: Advertisement of tender

Specification

- 12 m tall tube
- 1.5 x 1.5m wide
- Hot bath below
- Cold bath above
- Optical access windows for sampling

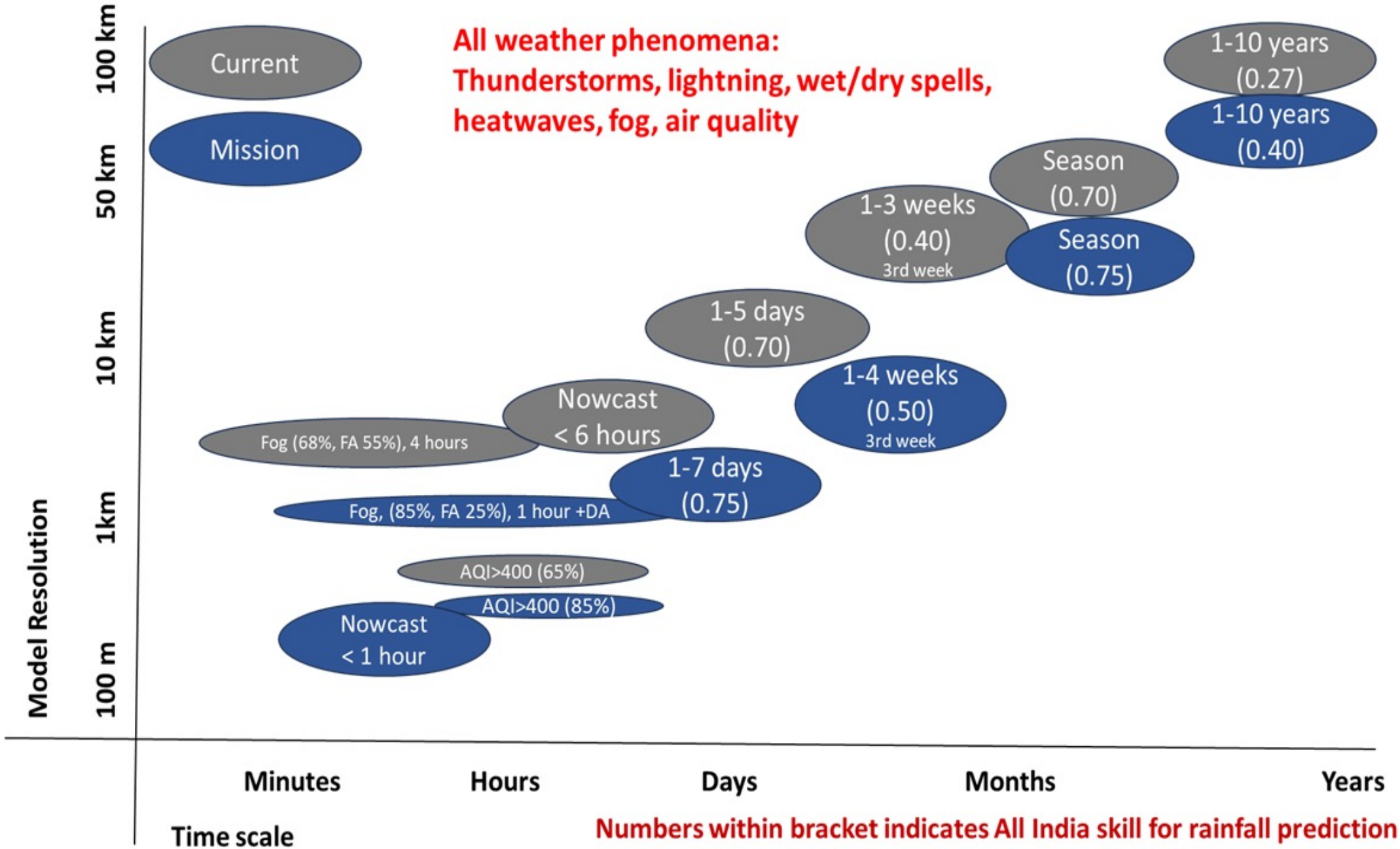
National Research Facility



Short	Extended	Seasonal	Decadal	Climate
GFS-based Tco	ERPASv2 CFS-EL MOM4	MMCFSv2 GFS-SL MOM6 CICE5 Noah	IITM-ESM GFS-EL MOM4 - SIS Noah	IITM ESMv2 Tco based GFS-EL MOM4 - SIS Noah

Modelling Strategy in Mission Mausam

Mission Mausam (Develop & IMPACT)

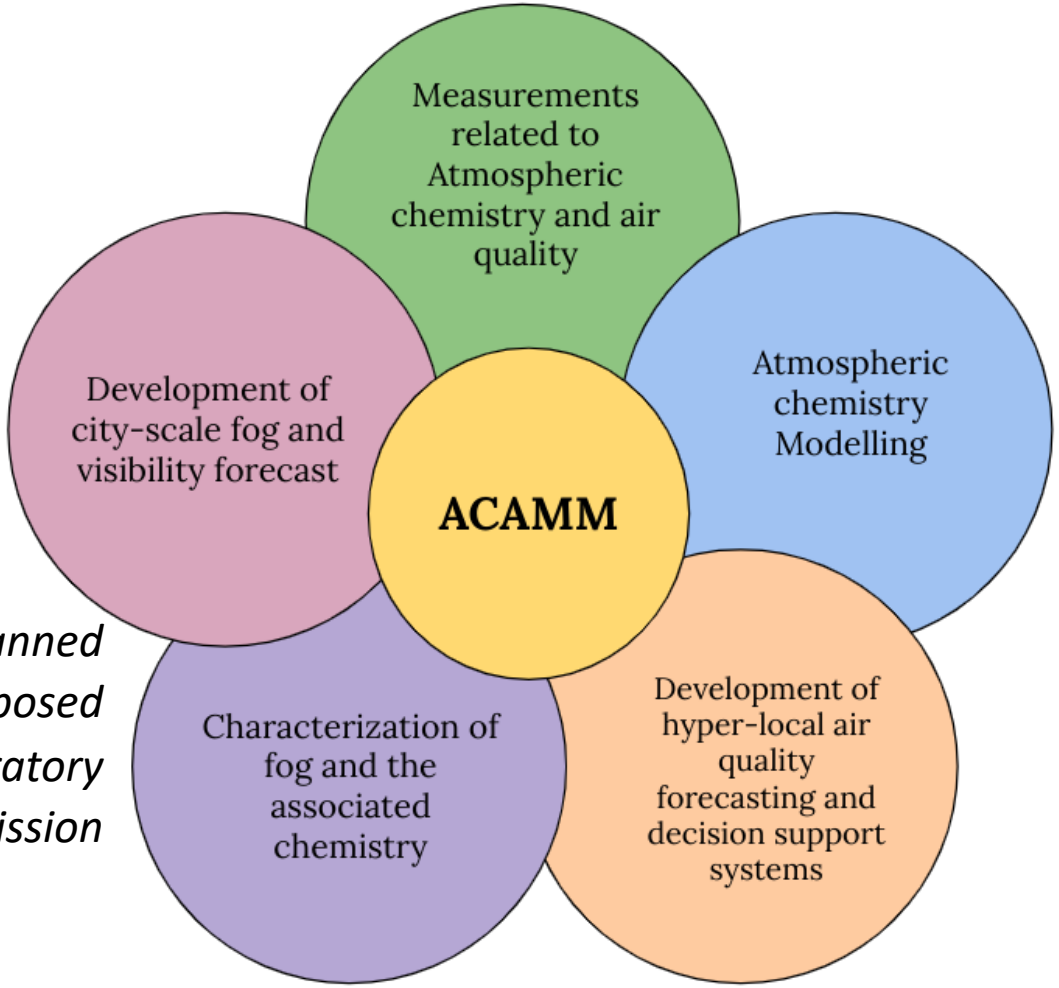

All weather phenomena:
Thunderstorms, lightning, wet/dry spells,
heatwaves, fog, air quality
Current
Mission
1-10 years
(0.27)
1-10 years
(0.40)
Season
(0.70)
1-3 weeks
(0.40)
3rd week
Season
(0.75)
1-5 days
(0.70)
1-4 weeks
(0.50)
3rd week
Nowcast
< 6 hours
Fog (68%, FA 55%), 4 hours
1-7 days
(0.75)
Fog, (85%, FA 25%), 1 hour +DA
AQI>400 (65%)
AQI>400 (85%)
Nowcast
< 1 hour
Model Resolution
100 km
50 km
10 km
1km
100 m
Minutes
Hours
Days
Months
Years
Time scale
Numbers within bracket indicates All India skill for rainfall prediction

Mission Mausam (IITM) / ATCOMP

ATmospheric Composition mOnitoring, Modelling and Prediction (ATCOMP)

- **Establishing an Advanced Atmospheric Chemistry Laboratory** for understanding the complex atmospheric chemical processes
- **Air quality forecasting and decision support system** for air quality management
- Develop a **fully interactive aerosol-chemistry module for the earth system model.**
- **Process level understanding of aerosols, chemistry, and climate**
- **Pollutants impact on the Asian Monsoon** and regional and global climate
- **Local and transboundary air pollution.**

Activities planned under the proposed ACAMM laboratory under the Mission Mausam



Costal Research Testbed at Visakhapatnam: A Key Component of OBSERVE_ALL

Visakhapatnam has been a high-risk zone for cyclonic activities resulting in widespread damage to infrastructure

→ Crucial site for monitoring & understanding coastal hazards such as cyclones & depressions

→ Research testbed provides "collaborative workspace" for observational and modelling scientists to work together

→ Integrating OBS & models to improve understanding and representation of various processes in models

↓

Provide statistics of quantities over long period and many "real life" conditions

← Generate integrated products depicting dynamics, microphysics, land surface, convection thermodynamics

← Around 30 instruments planned (in-situ, profiling, remote sensing): Conduct regular OBS and focused IOPs

← At testbed, gather concurrent and collocated multi-instrument observations

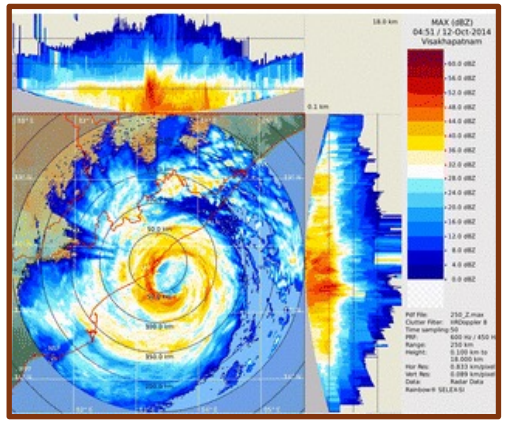
↓

Integration among observational needs, understanding physical processes and parameterization

← Approach for execution of Research Testbed

← Generate large number of cases for testing and evaluating cloud-resolving and global models

Cyclone Hudhud in 2014 captured by Doppler radar at Vishakhapatnam



We will Use Artificial Intelligence and Machine Learning!

Transformation from Monsoon Mission to Mission Mausam

	Monsoon Mission	Mission Mausam
Focus	Focused on Dynamical Models	All aspects of Weather and climate forecast including projections.
Observations	Focused process-based observations like OMM, INCOMPASS, SWAMI, BoBBLE etc.	Sustainable long-term observations with focus on processes, severe weather and regular monitoring.
Management of Weather	---	Major Component: Fog, Hail, Rain suppression etc.
State-of-the-art satellite observations	---	Wind profiles from Satellites and other missions like INCUS etc.
Dissemination	Through APPS and Web Pages	AI based Mausam GpT

The success of Monsoon Mission will be seamlessly subsumed under the broader and more ambitious framework of Mission Mausam, which aims to carry forward and expand its achievements.

Thankyou!