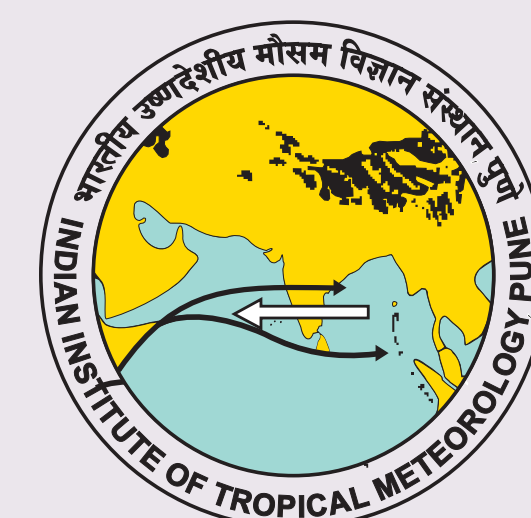


EARTH SYSTEM SCIENCE ORGANISATION (ESSO) MINISTRY OF EARTH SCIENCES INDIAN INSTITUTE OF TROPICAL METEOROLOGY (IITM)



HIGH PERFORMANCE COMPUTING SYSTEM (HPCS)

Understanding the Earth's climate and its variability has been a challenge for several centuries. Several complex processes take place in Earth's climate system (Fig 1). To understand the climate variability, prediction and its changes is one of the major goals of MoES.

In order to model the climate system, meteorology scientists world wide use dynamical models (solving physical/chemical/ Biological equations). To simulate one day weather, the scientists integrate/solve model equations which run in to order of (depending on model) 5-10 Teraflops ($\times 10^9$ Floating Point Operations) with a resolution of 110x110 km (Fig. 2).

Simulations and prediction are expected to be more accurate if one uses high resolution models. Scientists at MoES use very high resolution (38 km to 25 km) models to simulate and predict ocean, atmospheric systems individually as well as a coupled systems.

Hence, considering the need of high computational power, MoES regularly augments its computational resources in a phased manner. Majority of MoES scientists have access to HPC infrastructure since 2009 and housed as shown in table (TF: Teraflops).

Institute	2009	2011	2015	2018
NCMRWF	22TF	22TF	350TF	2.8PF
IITM	7TF	70TF	790TF	4.0PF
IMD	14TF	14TF	—	—
INCOIS	7TF	7TF	7TF	—

Since managing HPC systems at different constituent units is a herculean task, MoES has decided in 2014 that it will manage and augment HPC facility only at two Institutions, viz. IITM & NCMRWF.

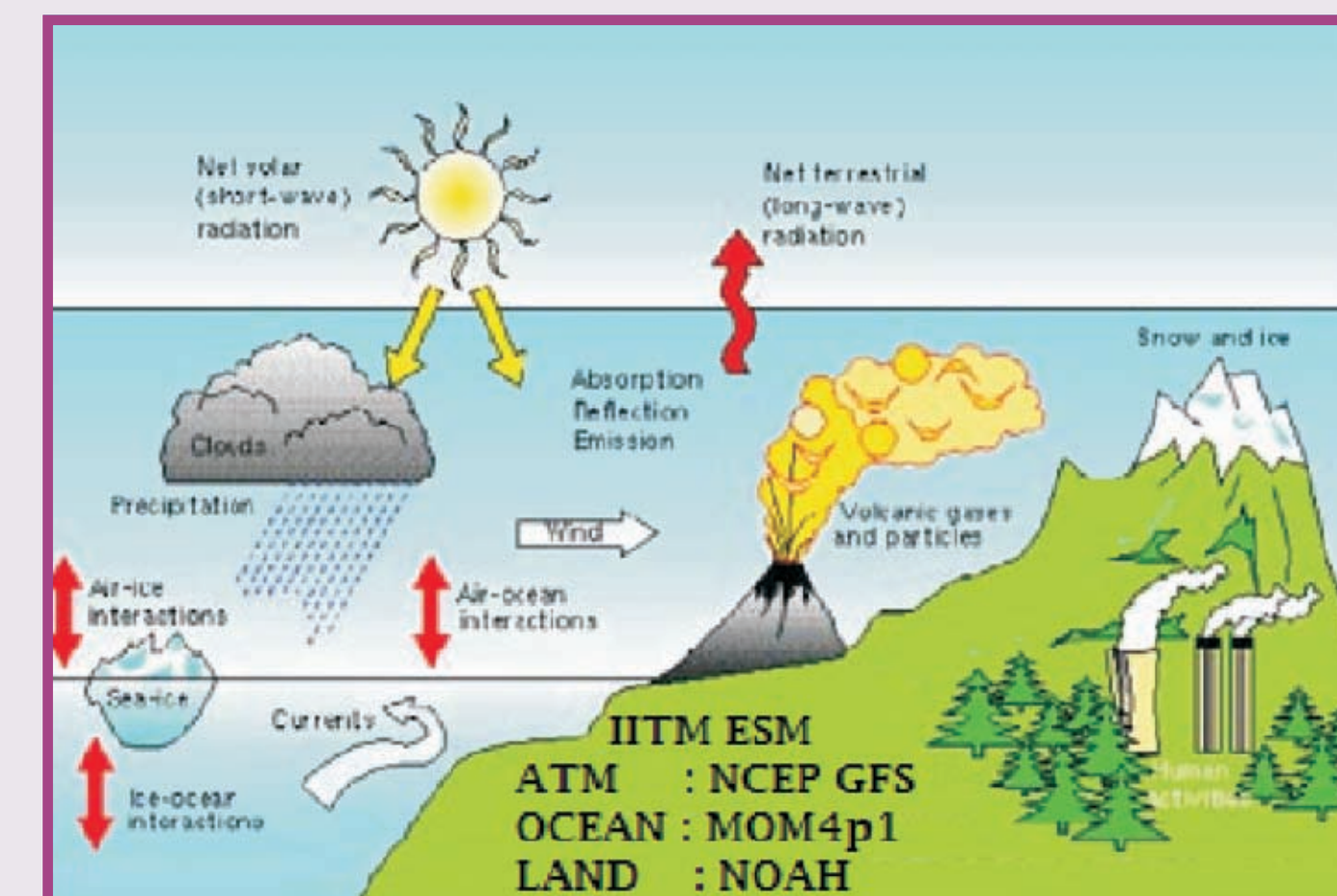


Fig. The coupled ocean-atmosphere-land model with interactive ocean bio-geochemistry developed at CCCR, IITM to study long term changes in climate with special emphasis on Asian Monsoon.

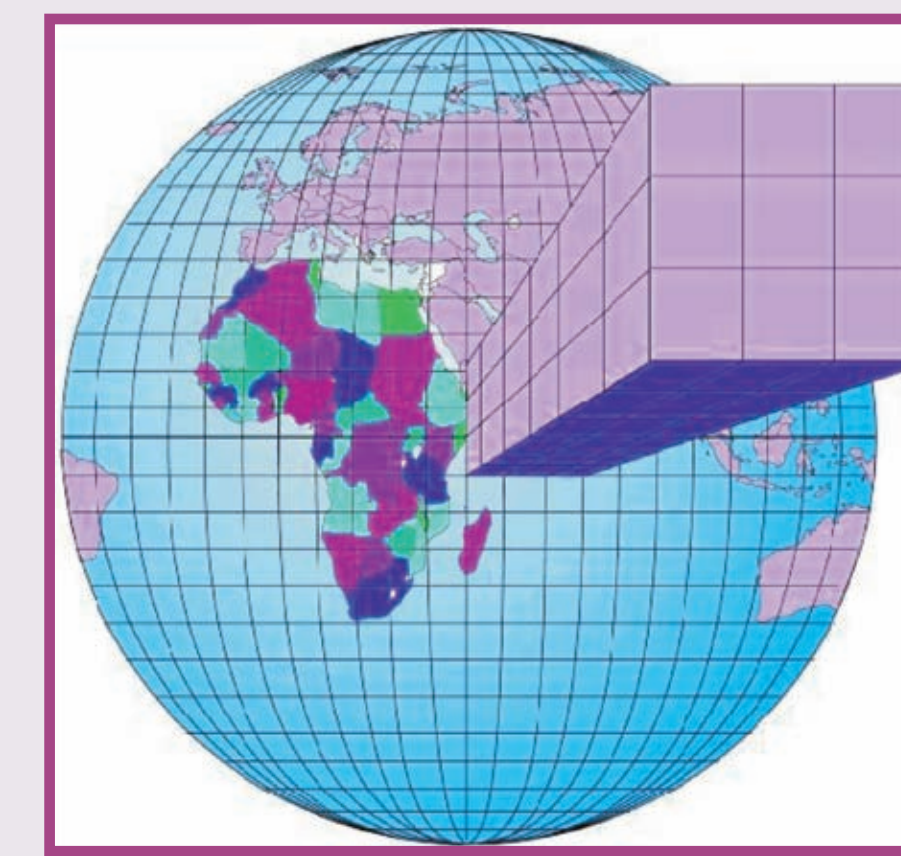


Fig.2: The illustration of high resolution model grids.

PRATYUSH HPC FACILITY

- PRATYUSH is installed at IITM, Pune in December 2017 and inaugurated on 8th January 2018.
- The system architecture is based on Cray XC40, with Aries interconnect, Intel's Broadwell processors, along with Sonexion storage and archival system.
- The peak capacity of the system is a 4 Petaflops in compute, 9 Petabytes of storage capacity and almost 30 Petabytes of archival.
- Total number of nodes are 3331, out of which 3315 are pure CPU & 16 nodes are Intel KNL.
- Memory of each node is 128 GB and the total memory of the whole system is 419TB.
- The software stack is composing of Cray linux and programming environment, Intel parallel studio, PBS pro as the job scheduler, luster parallel file system, and debuggers such as allinea and total view.
- Apart from the 4 Petaflops, the system also includes a standalone research and development XC50 system based on Intel Skylake processors along with GPU's.
- The capacity of system at NCMRWF, Noida is 2.8 PF in compute, 6PB storage and about 18PB archival.

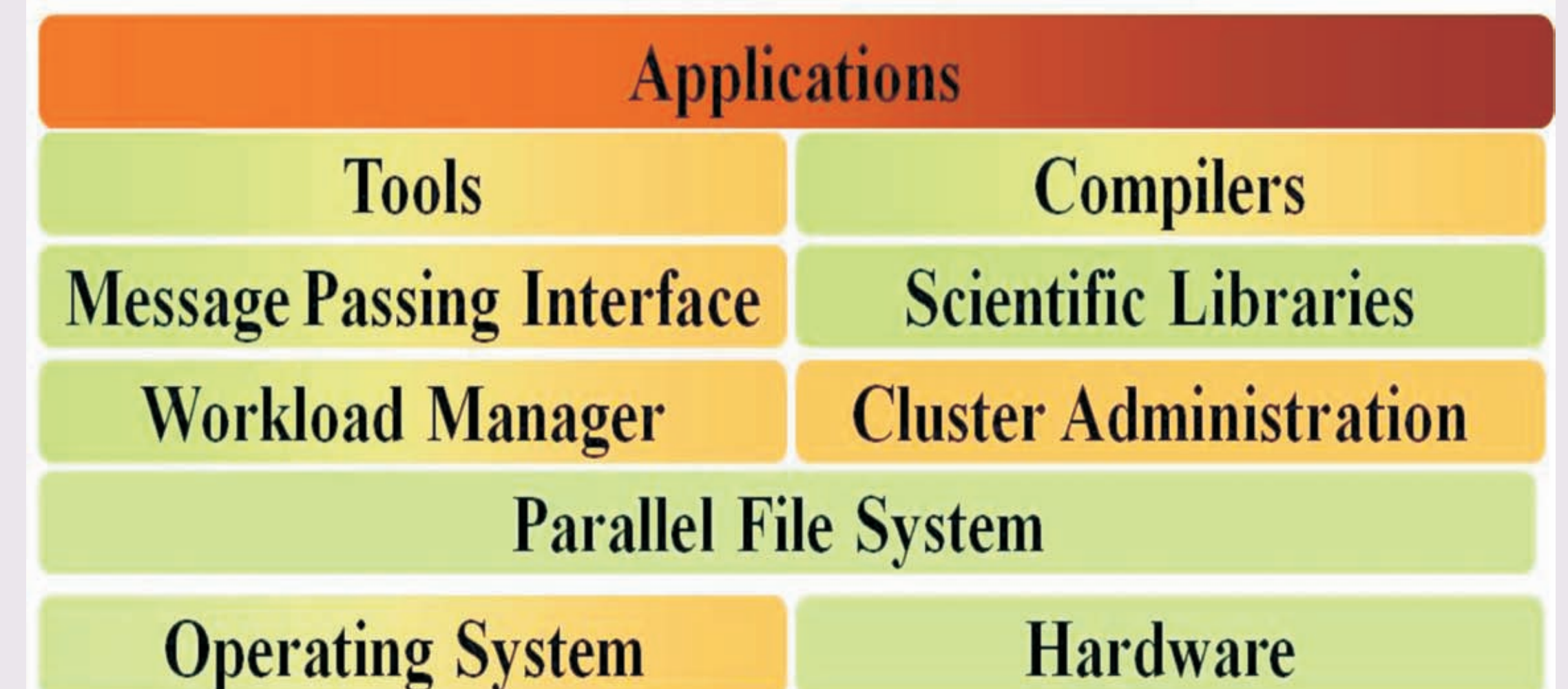
USAGE OF PRATYUSH

In order to provide useful services, MoES runs several computationally intensive applications on High performance computers (HPC). In last 10 years, the HPC infrastructure at MoES institutes has grown from 40 Tera flops in 2008 to 1 Peta flops in 2013/14. As a result of providing HPC infrastructure to MoES scientists, in addition to its constant research activity, MoES stands tall in weather and climate sciences community worldwide for providing the best services to the country. Some highlights of the services provided by MoES institutes to the country are:

- Best weather/climate prediction system in terms of accuracy/skill for monsoon climate.
- Operational forecasts at a very high resolution of 3 km at regional scale and 12 km at global scale for weather forecasts at par with any other leading weather/climate forecast center in the world.
- Fastest Tsunami alert/advisory to the stakeholders in Asia/Pacific region.
- Advisories on Potential fishing Zones, operational ocean wave/weather watch forecasts and air quality forecasts, climate projections are provided regularly to the citizens of India.

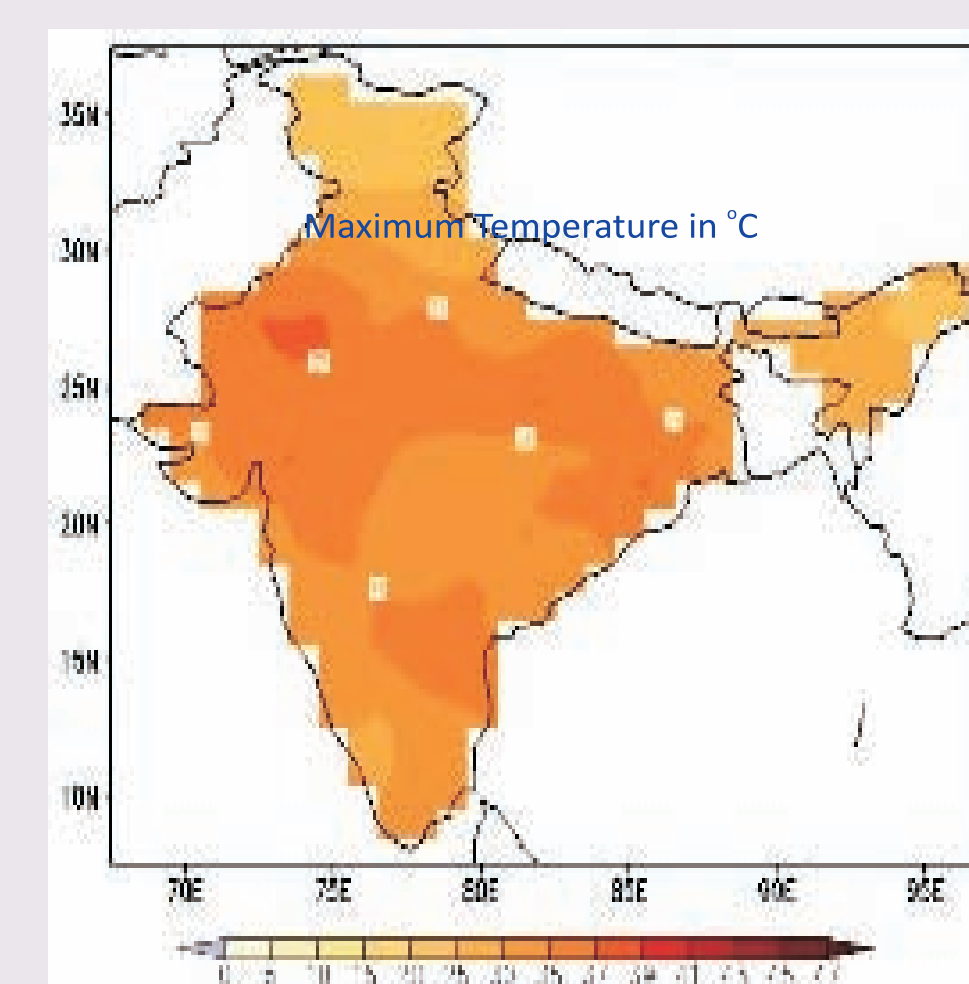
All these above activities are being carried out using following numerical models

- Climate Forecast System (CFS)
- Global Forecast System (GFS)
- Weather Research & Forecast (WRF)
- IITM Earth System Model (IITM-ESM)
- Global Ocean Data Assimilation (GODAS)
- Modular Ocean Model (MOM)
- Direct Numerical Simulation (DNS)
- ECHAM6 model: Global Climate Model
- Grid Point Statistical Interpolation (GSI) model
- Large Eddy Simulation (LES) from WRF
- Regional Ocean Model System (ROMS)
- Wave Watch III (WWIII)



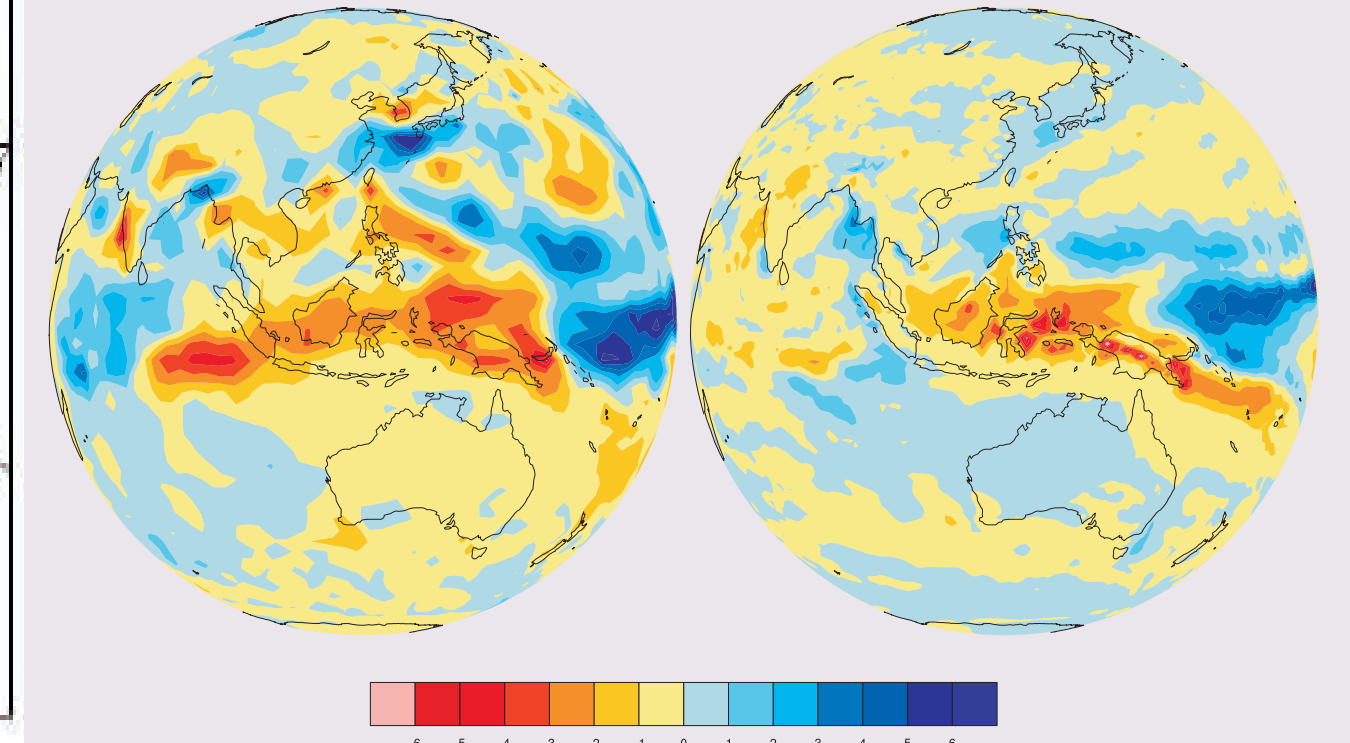
PRATYUSH HPC @ IITM, PUNE

MME, Forecast Valid Time = 00Z17 APR 2015

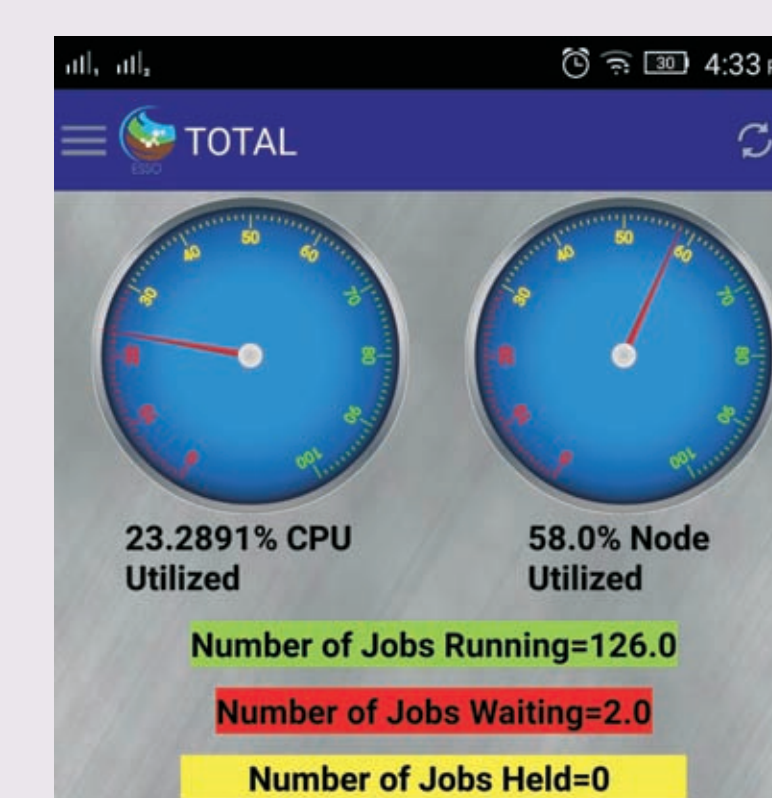


Seasonal Prediction of Rainfall

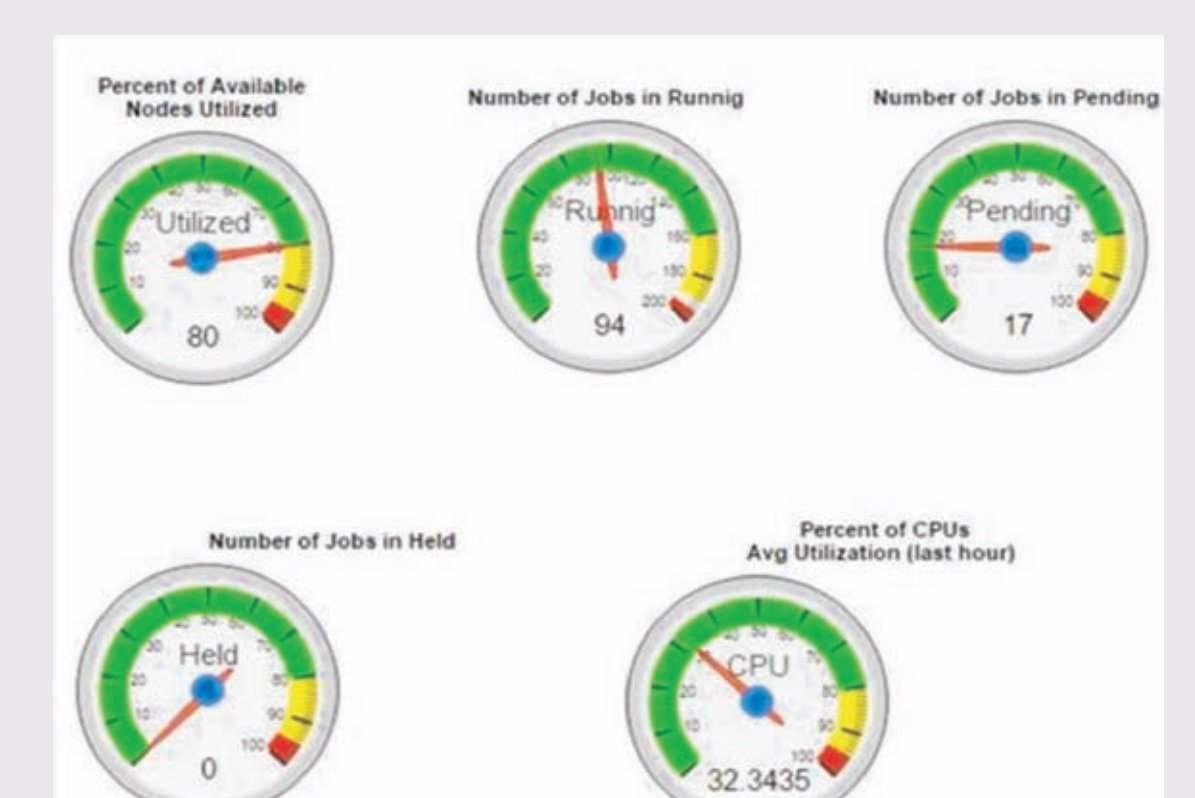
Observed ISMR 2015 Predicted ISMR 2015



Extended range prediction for temperature.



Mobile app for Job Monitoring



Pratyush Job Monitor

<http://pratyush.tropmet.res.in>