

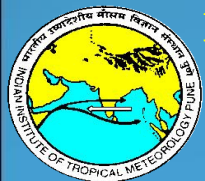
Improvements in IITM Earth System Model and Plans for CMIP6



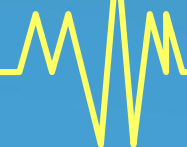
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V. Ramesh, K. Kulkarni, B. Preethi, S. Manmeet and M. Aditi**



19th WGCM Session, Croatia, 19th-20th October 2015

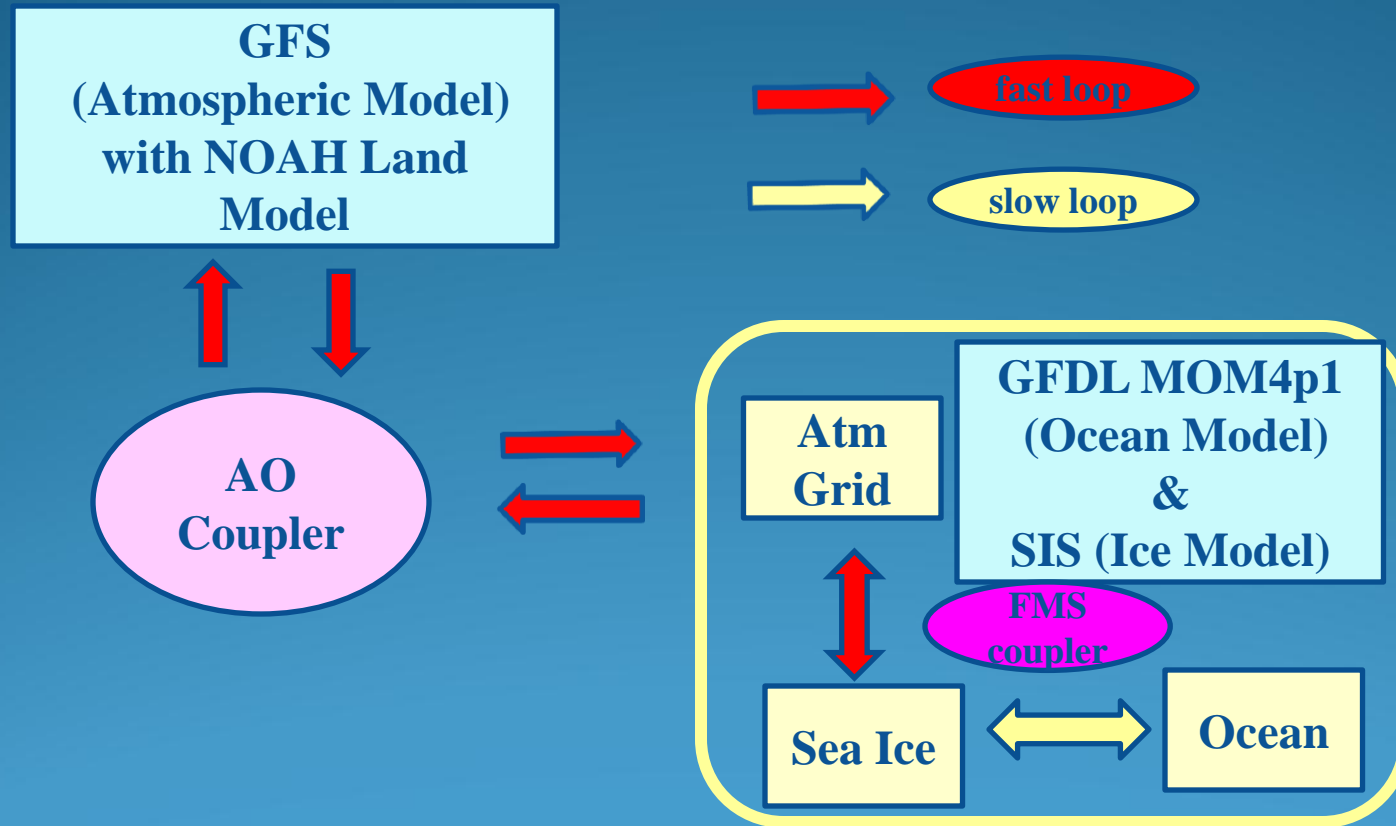


IITM Earth System Model (IITM ESMv1.1)

Based on Coupled Forecast System (CFS) T62L64

- The **NCEP CFS** Components
- Atmospheric **GFS (Global Forecast System)** model
 - T62 ; vertical: 64 sigma – pressure hybrid levels
 - Model top 0.2 mb
 - **Revised Simplified Arakawa-Schubert convection (Han & Pan)**
 - Non-local PBL (Pan & Hong)
 - SW radiation (Chou, modifications by Y. Hou)
 - Prognostic cloud water (Moorthi, Hou & Zhao)
 - LW radiation (GFDL, AER in operational wx model)
 - Land surface processes (Noah land model)
- Interactive Ocean: **GFDL MOM4p1** (Modular Ocean Model-4p1)
 - 1.0 deg poleward of 10°N and 10°S; and 0.33 deg near equator (10°S – 10°N)
 - 50 levels
 - **Interactive sea-ice**
 - **Interactive ocean biogeochemistry**

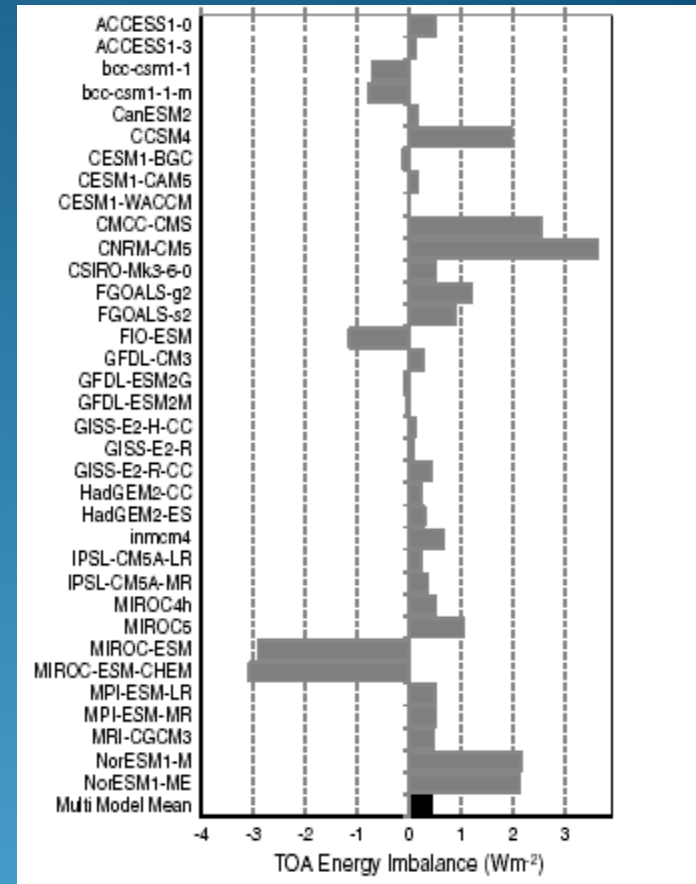
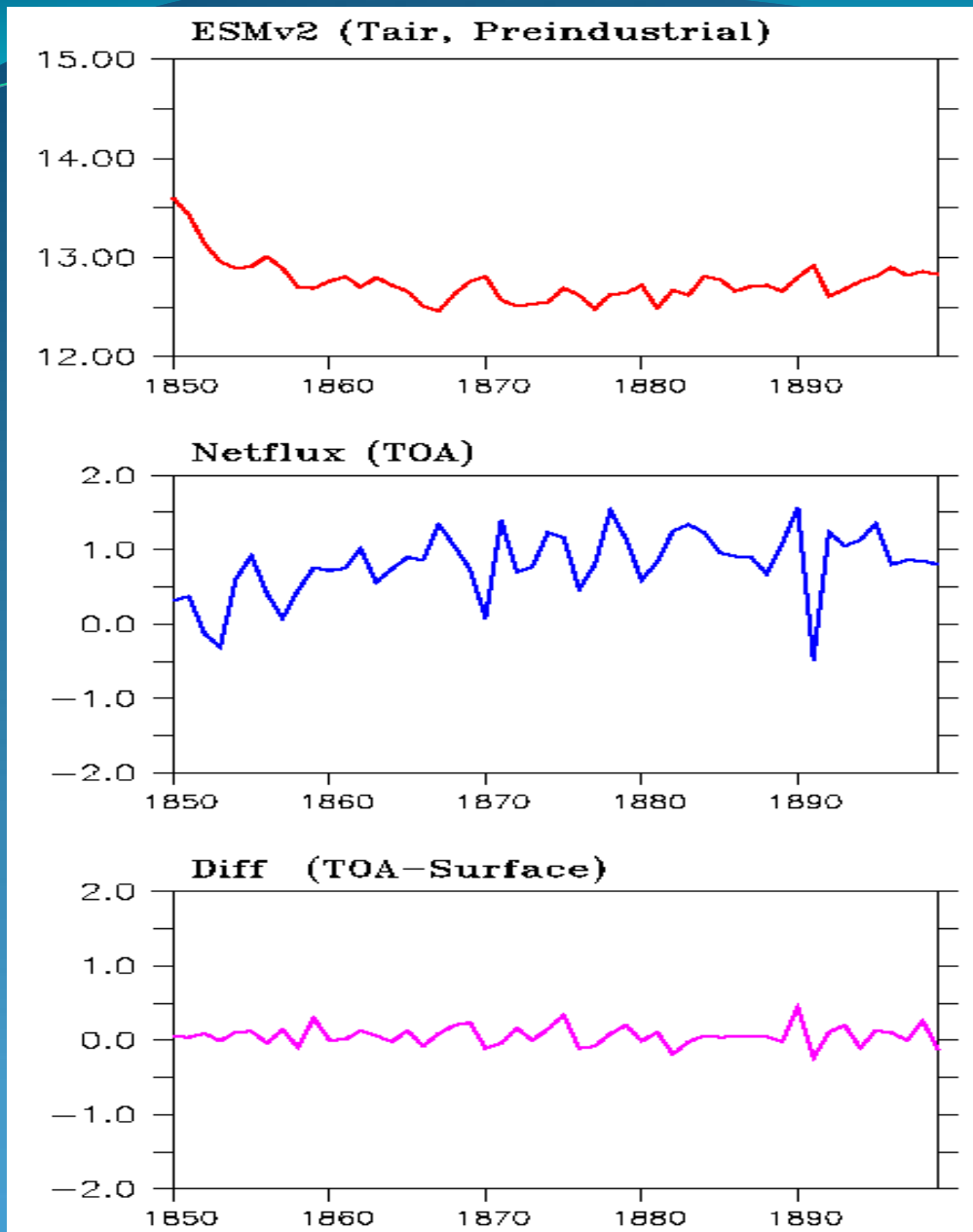
Schematic of IITM ESM



Scalability : 8 SYPD

Energy Balance in IITM ESM

TOA Energy Imbalance (CMIP5 Models)



Preindustrial TOA (Wm^{-2})
Energy imbalance for CMIP5
Models (Forster et al., 2013)

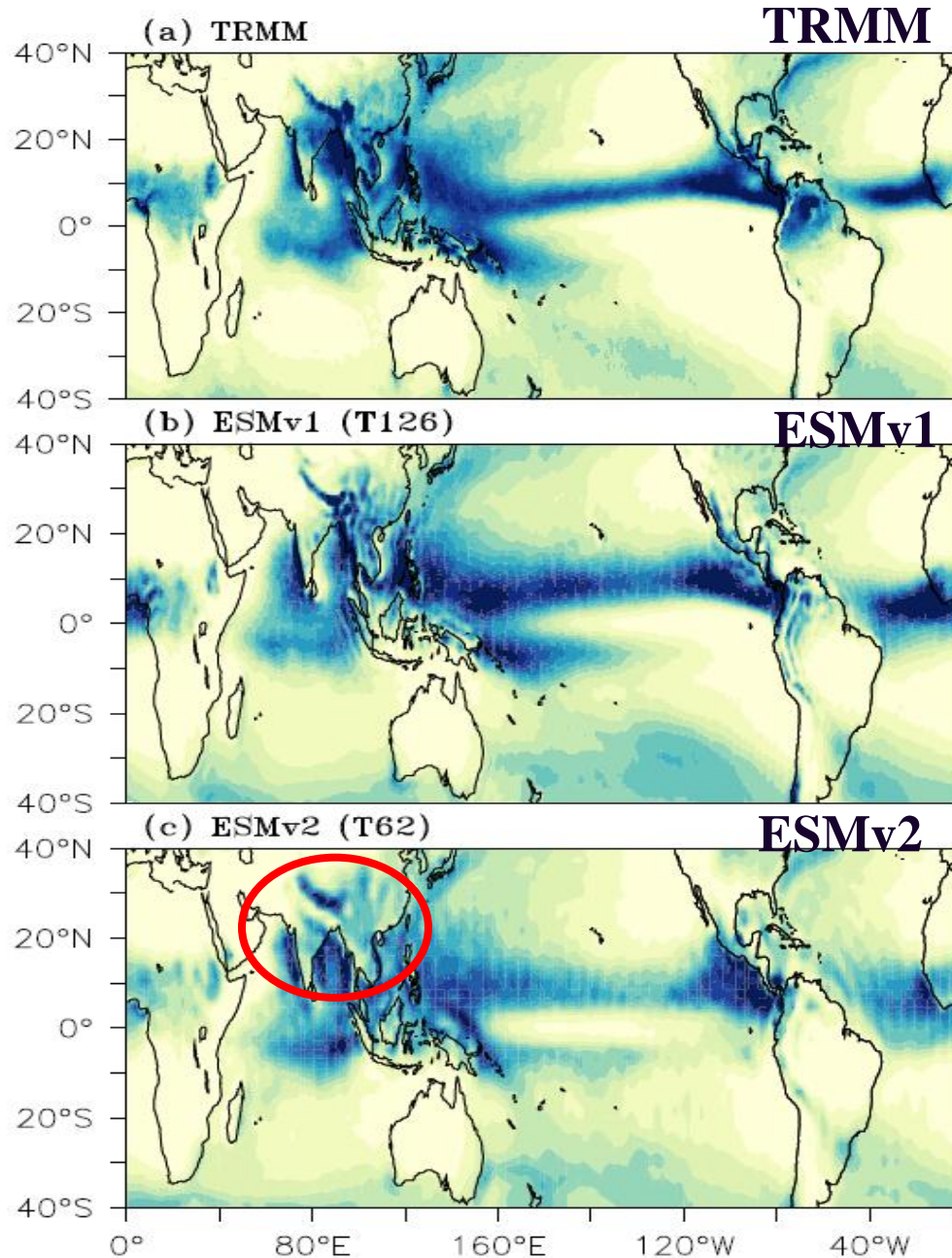
Energy Balance in IITM ESM

	Net flux TOA (W m ⁻²)	Net Flux Surface (W m ⁻²)	Differenc e (W m ⁻²)
ESMv1 (T126) & CFSv2	6.6	1.2	5.4
ESMv2 (T62)	0.8	0.74	0.06

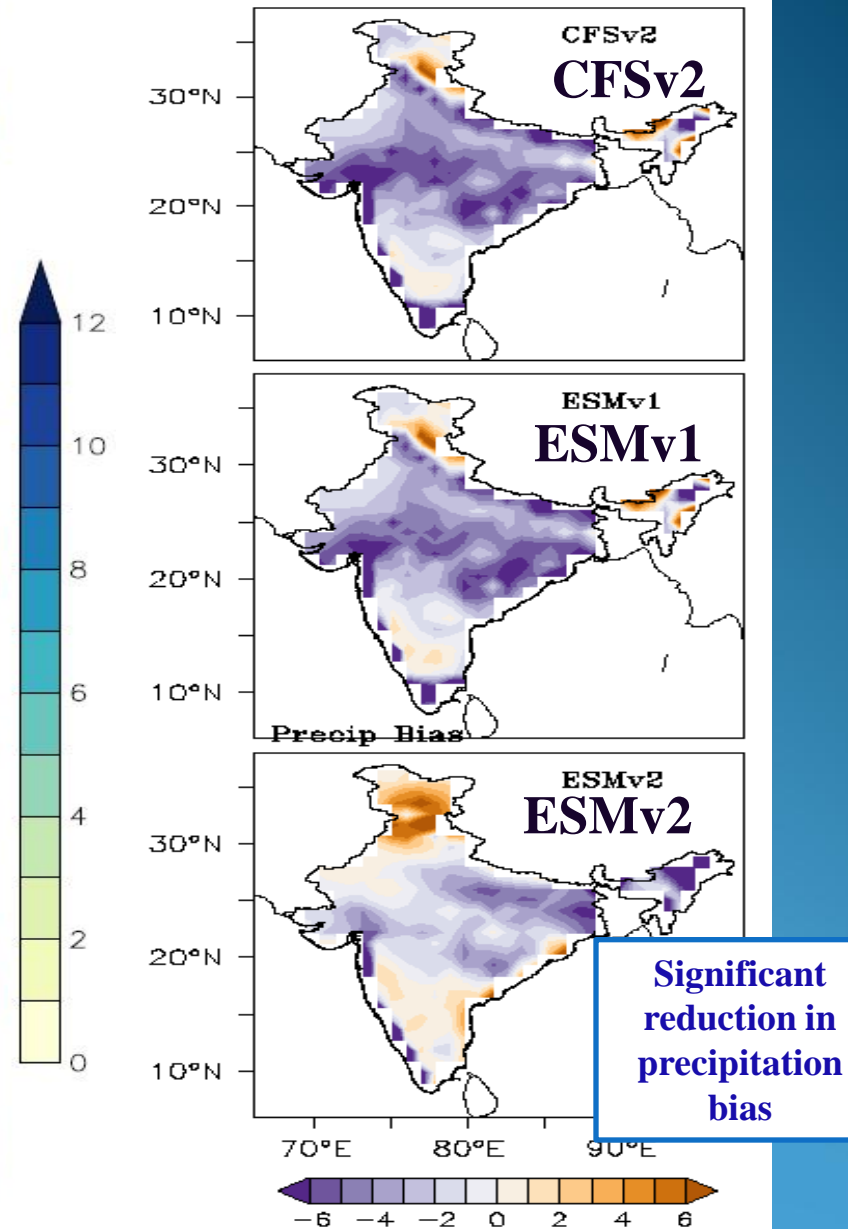
Improved Energy Balance in IITM ESMv1.1: Reduction of positive net radiation bias

- Better coupling of Sea-ice model
- Including TKE dissipative heating, correction of error from spectral dynamical core, surface flux computation on partial grids
- New cumulus convection scheme increases deep convection in tropics

Boreal summer monsoon (JJAS) precipitation (mm day⁻¹)

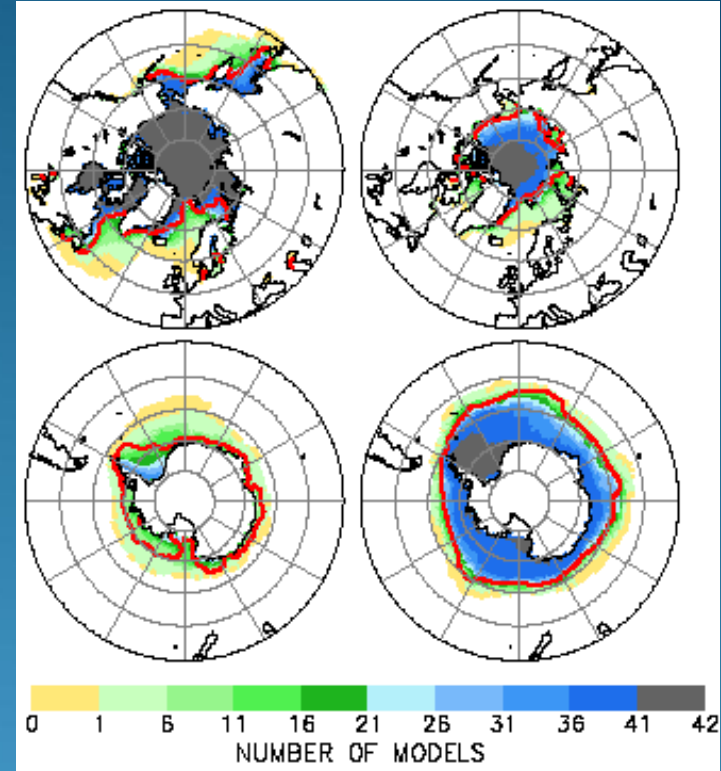
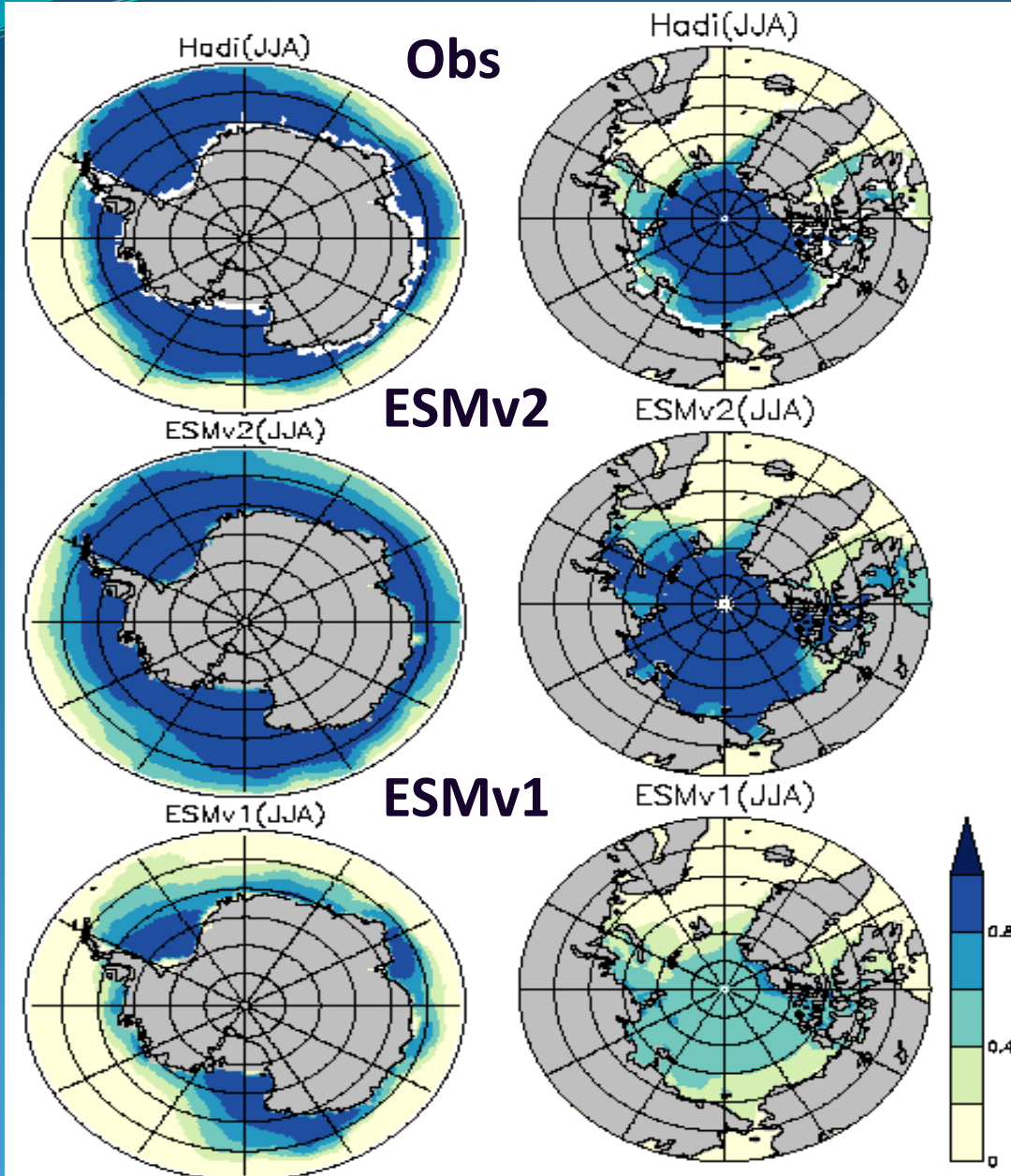


Bias (Model-Obs)



Sea-Ice concentration (%) in IITM ESMv2

Sea-Ice in CMIP5 models
(IPCC AR5 Report)



Depletion of NH sea-ice
during Jan-Mar has reduced

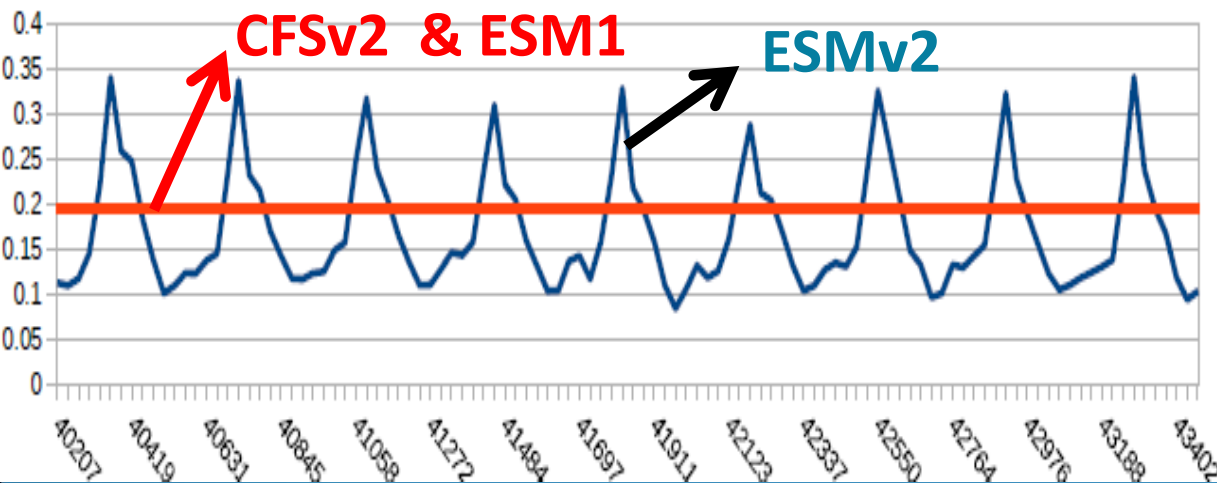
SH sea-ice conc. during Jun-
Aug has improved

Water balance in ESMv2

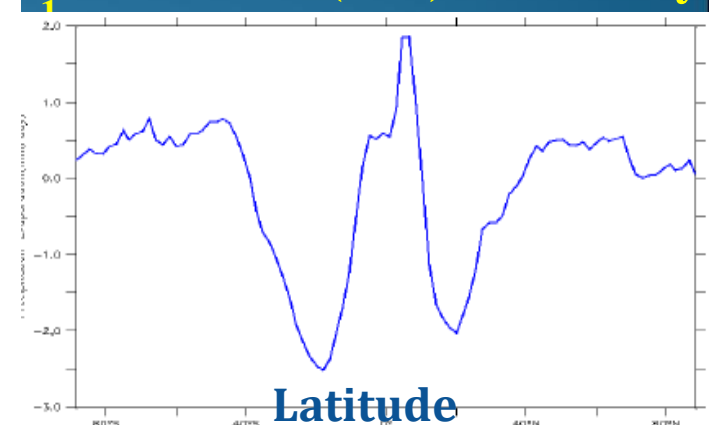
CFSv2 and ESMv1: Constant value of runoff was used in the Ice Model

ESMv2: Runoff calculated from Land Model & discharged into the nearest ocean point

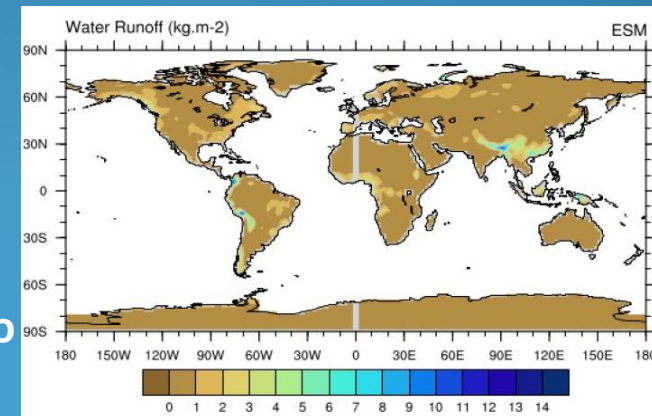
Runoff ($\text{kg m}^{-2} \text{s}^{-1}$)



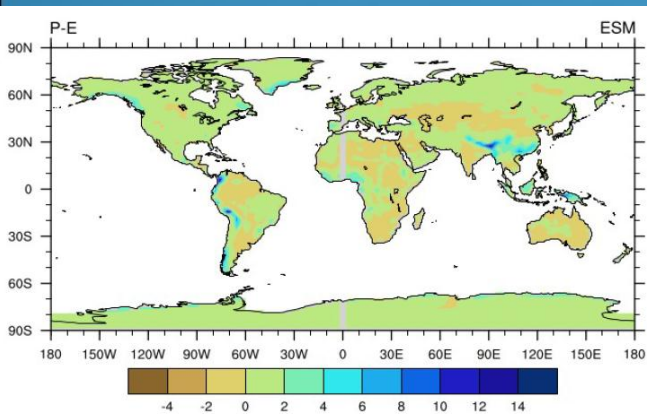
Zonal mean (P-E) in mm day⁻¹



Runoff from Land Model



Precipitation minus Evaporation



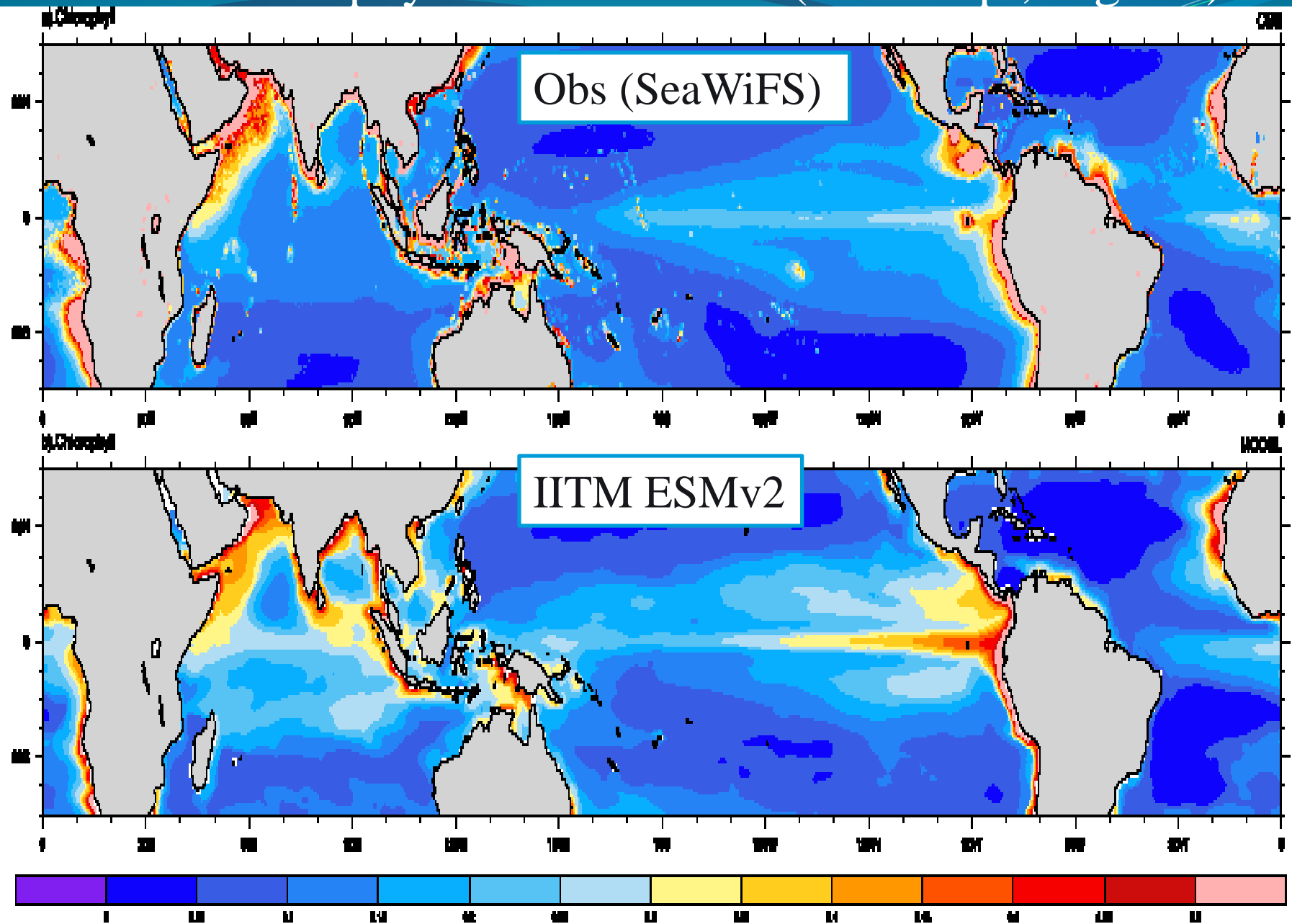
Hydrology statistics

Total Runoff from
Land = $1.06 \times 10^9 \text{ kg s}^{-1}$

Total Water Discharge into
Ocean = $1.06 \times 10^9 \text{ kg s}^{-1}$

Courtesy: Sandeep, CCCR

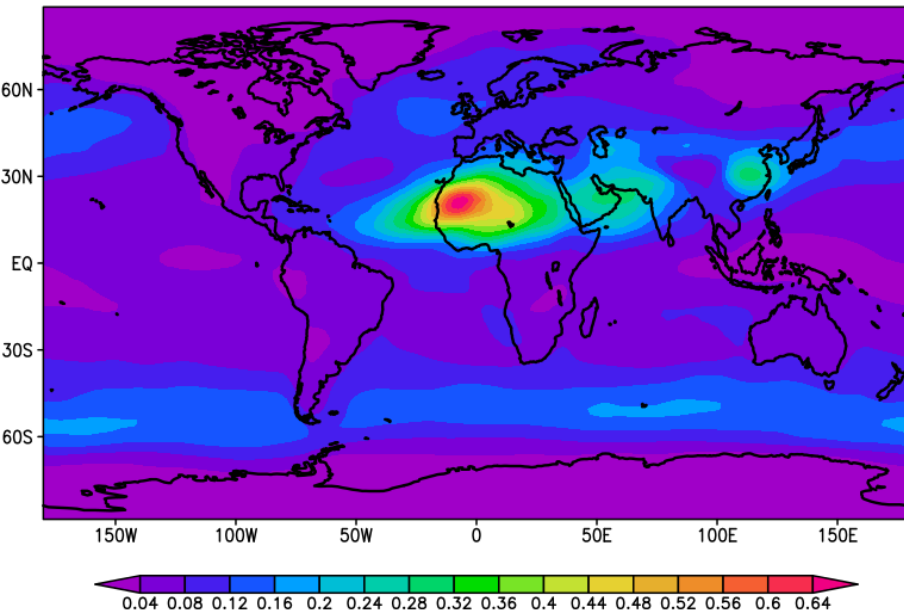
Chlorophyll Concentration (June-Sept, Mg m⁻³)



Courtesy: Sandeep, CCCR

Prescribed time-varying aerosol distributions in IITM ESM from CMIP

550nm AOD

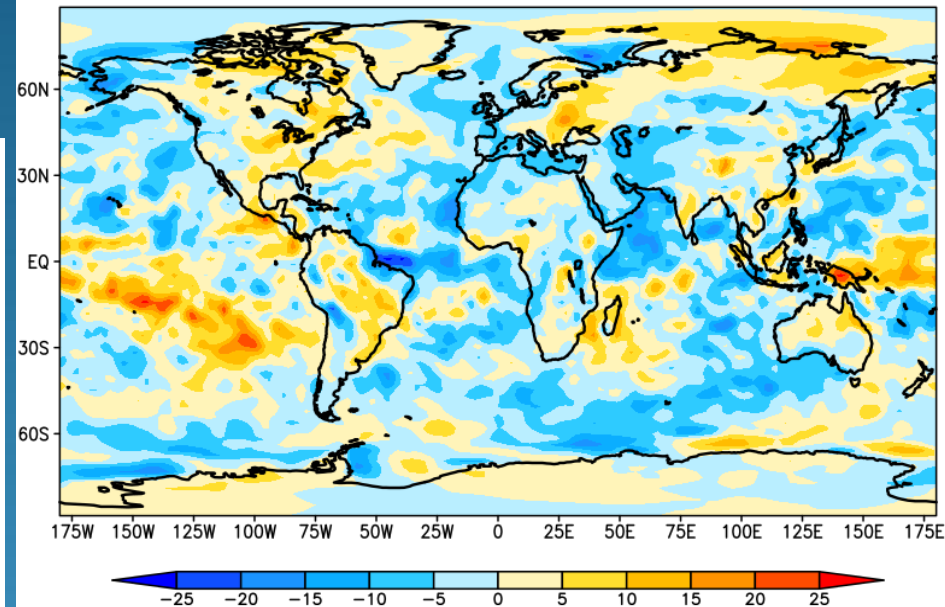


Data Courtesy : Bjorn Stevens, Stefan Kinne
(Max Planck)

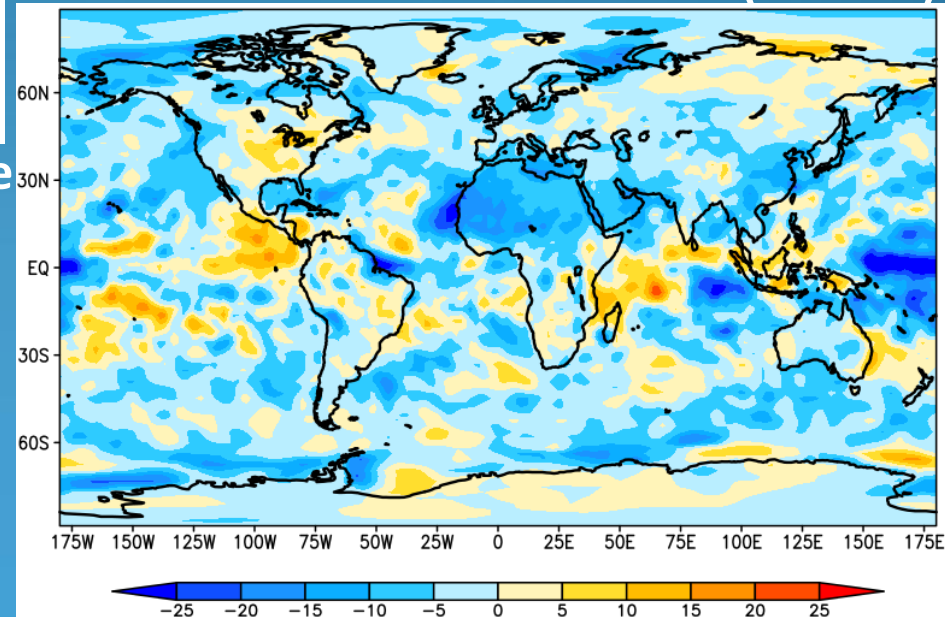
Aerosol TOA forcing (total sky) = -0.9

Courtesy: Ayantika, CCCR

Aerosol_forcing_TOA



AF (Surface)



Summary

IITM ESM_{v1}

- The first version of ESM has been successfully developed at CCCR-IITM by incorporating MOM4P1 (with ocean biogeochemistry) component in CFS_{v2}. Major improvements are seen in the ESM simulation vis-à-vis CFS_{v2} :

- **Significant reduction of cold bias of global mean SST by $\sim 0.8^{\circ}\text{C}$**
- **ENSO & PDO are robust and spatially more coherent in IITM ESM**
- **ENSO and monsoon links are well-captured**
- **The IITM Earth System Model: Transformation of a Seasonal Prediction Model to a Long Term Climate Model. Swapna et al. (BAMS, 2015).**

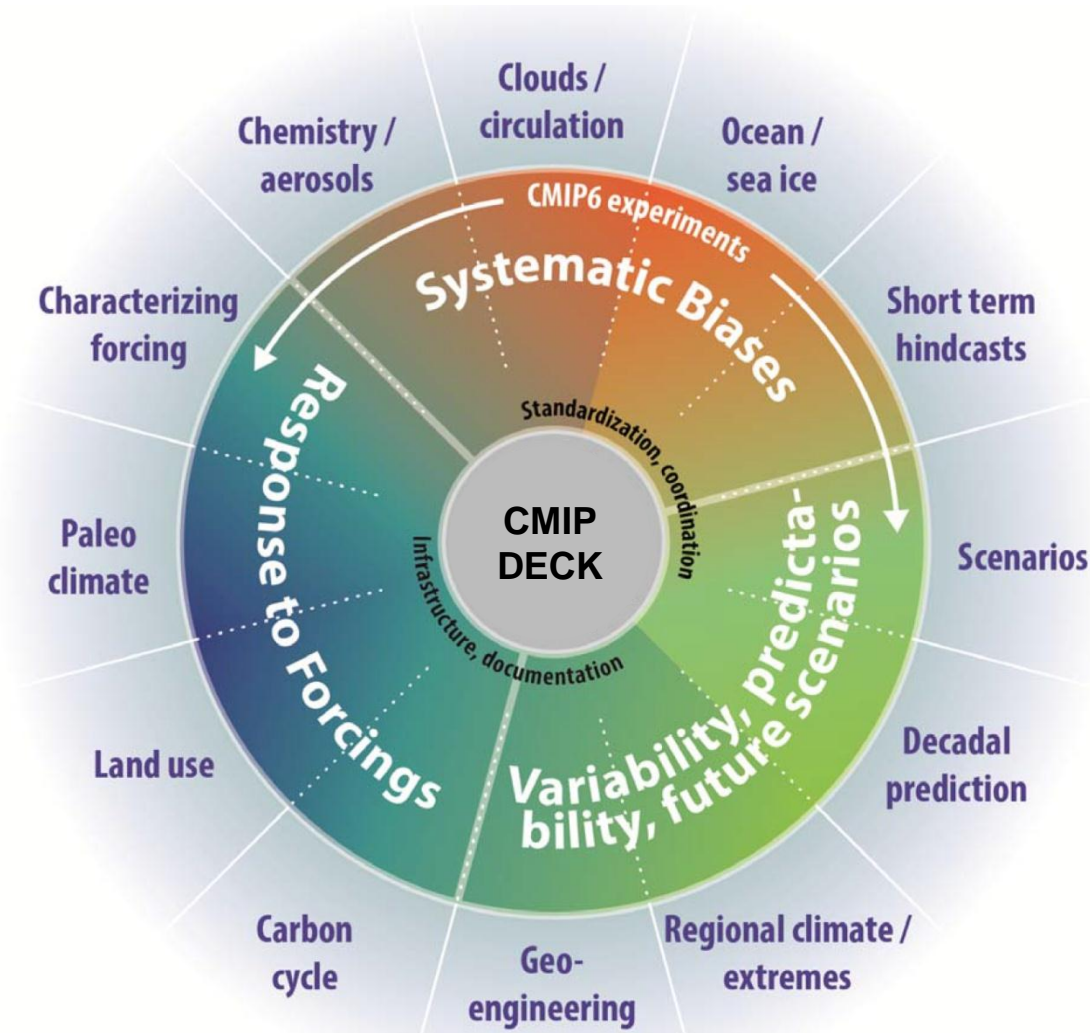
Improvements in IITM ESM_{v1.1}

- **Reduced the TOA energy imbalance**
- **Improved the mean precipitation over Asian region**
- **Improved the sea ice distribution**
- **Included time-varying aerosol concentration**
- **Corrected the hydrology imbalance**
- **Improved representation of ocean BGC**

CMIP6 Schematic

CMIP6 experimental design

Meehl et al., 2014: Climate Model Intercomparisons: Preparing for the Next Phase, Eos Trans. AGU, 95,77-84.



CMIP6 Concept:

A Distributed Organization under the oversight of the CMIP Panel

“DECK”:

Development

Evaluation

Characterisation of

Klima (German for ‘climate’)

Plan for CMIP6

Plan for CMIP6 Exp : IITM will be contributing to the DECK & CMIP6 experiments:

1. a multi-hundred year pre-industrial control simulation;
2. a 1%/yr CO₂ increase simulation to quadrupling to derive the transient climate response;
3. an instantaneous 4xCO₂ run to derive the equilibrium climate sensitivity;
4. CMIP6 historical simulations
5. AMIP run

Global Monsoon MIP (T126 Atm; 0.5 deg Ocean)

Thank you