

International Cooperation in Earth Observations – MoES, India

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Ministry of Earth Sciences

Earth Commission

Earth System Science Organization

Centre for Marine Living Resources and Ecology - KOCHI

National Centre for Seismology - DELHI

India Meteorological Department - DELHI

National Centre for Medium Range Weather Forecasting - NOIDA

National Centre of Coastal Research - CHENNAI

National Centre for Antarctic and Ocean Research - GOA

Indian National Centre for Ocean Information Services - HYDERABAD

Indian Institute of Tropical Meteorology - PUNE

National Institute of Ocean Technology - CHENNAI

National Centre for Earth Science Studies - TRIVANDRUM

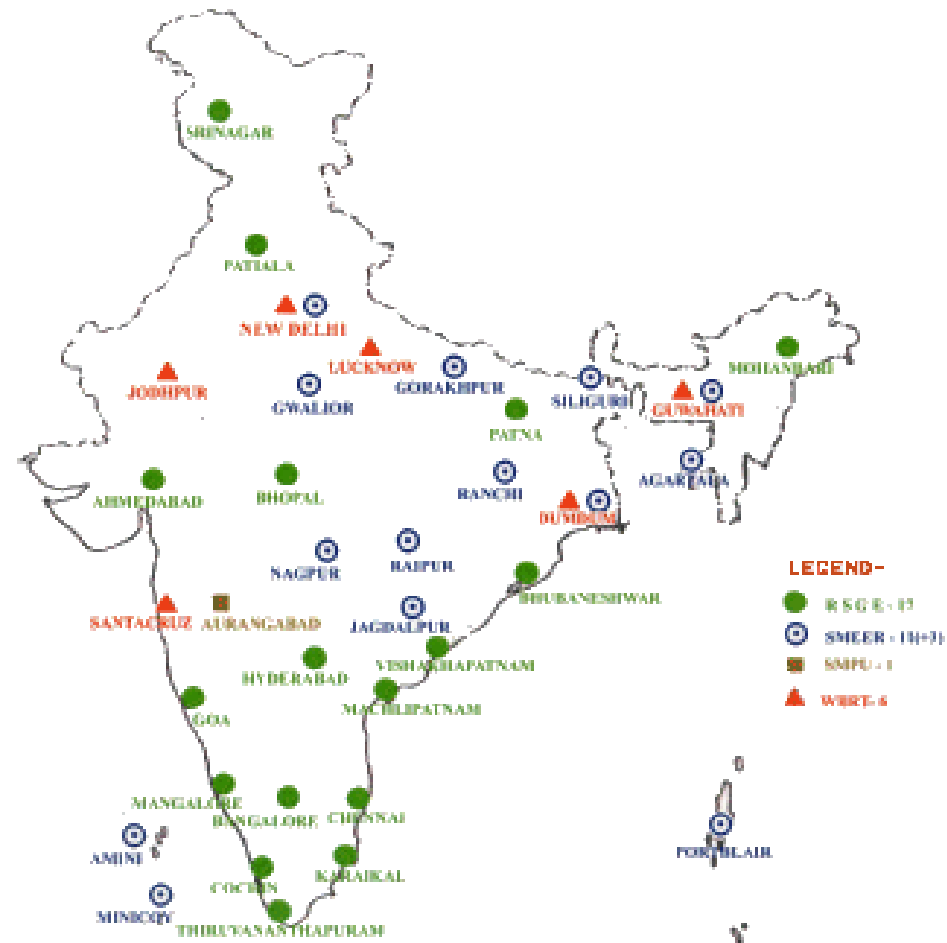
Centre for Advanced Training in Earth System Science and Climate

Centre for Climate Change Research

IMD observational Network

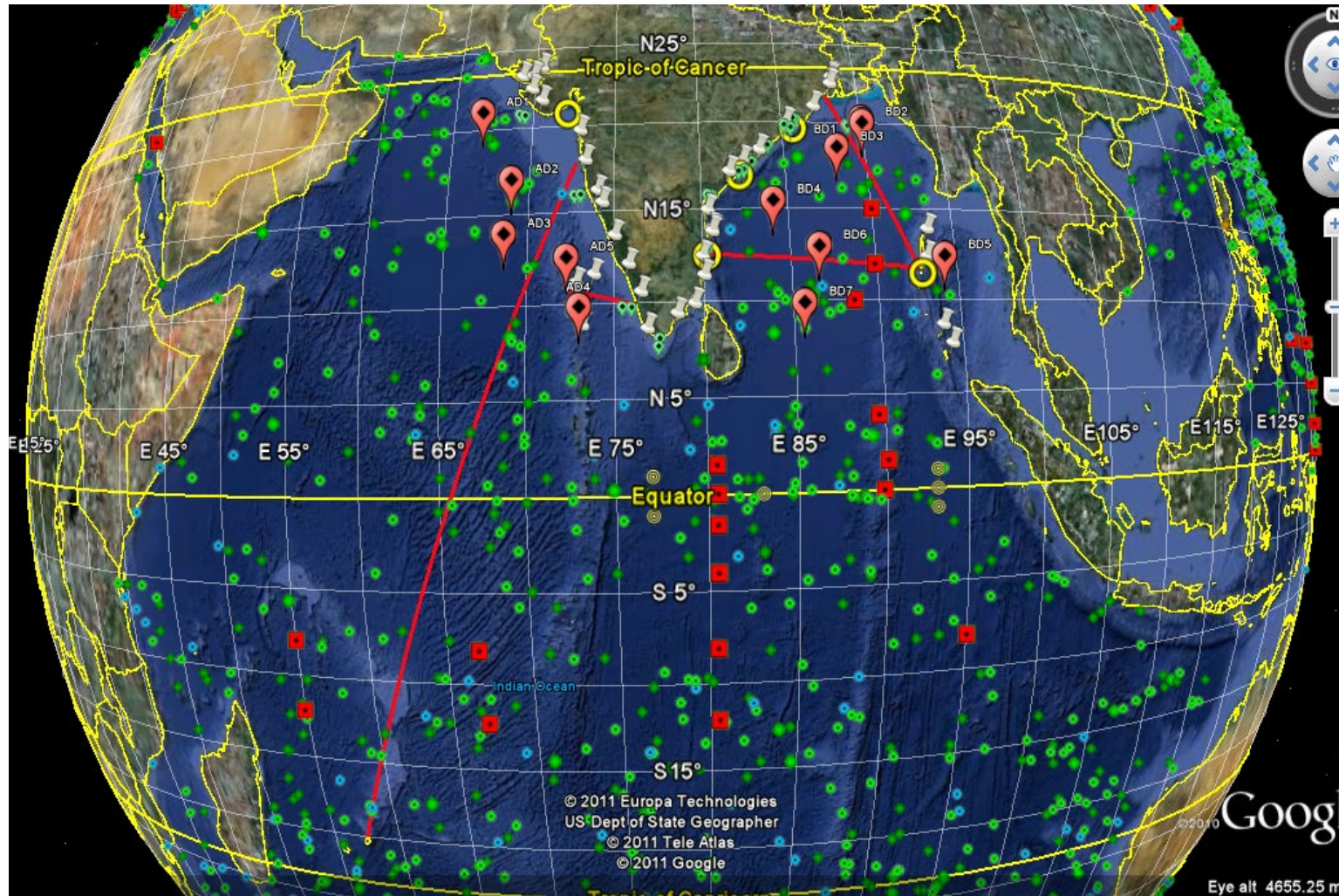
RS/RW obs. Stations

	Type of Observation	No of Stations
1	RS/RW	42
2	Pilot	60
3	Surface Observatories	~700
4	ARG+AWS	573+1351
5	AGRO met	123
6	Radar	24



INSAT Processing chain, 3 HRPT stations

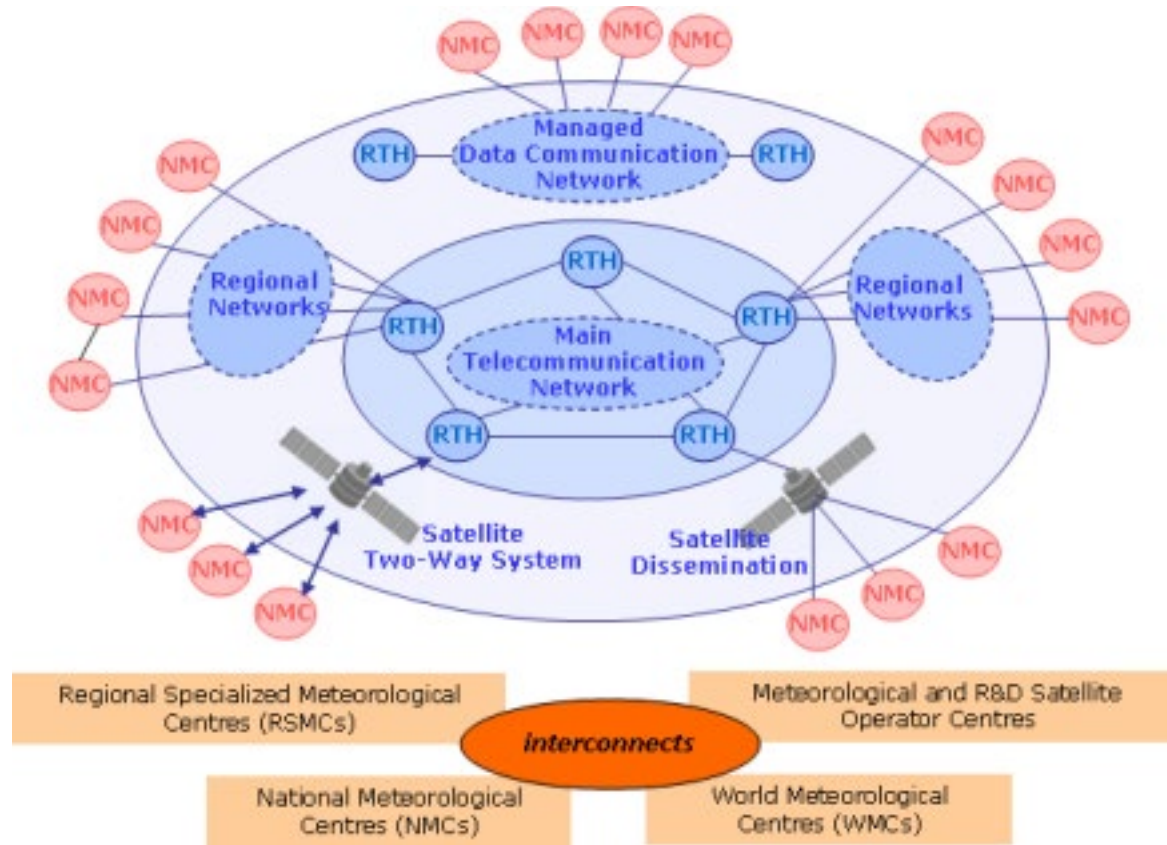
Indian Ocean Observing System



- Green – Argo,
- Red line – XBT,
- Blue – Drifters,
- Red square – RAMA,
- Yellow- CODAR,
- Green_oval- ADCP,
- Red_oval – Moorings,
- White mark - TG

847 ARGO, 30 drifters, 3 wave rider buoys, AWS, Servicing current meter moorings (ADCP & Deep), operate coastal CTD using Ships of Opportunity, 5 pairs of HF radar
Satellite Data Reception & Processing System

WMO Global Telecommunication systems (GTS)



MTN links 3 WMC's (Melbourne, Moscow and Washington)

6 RTMNS connecting - [Africa](#), [Asia](#), [South America](#), [North America](#), [Central America and the Caribbean](#), [South-West Pacific](#), [Europe](#) & [Antarctic](#)

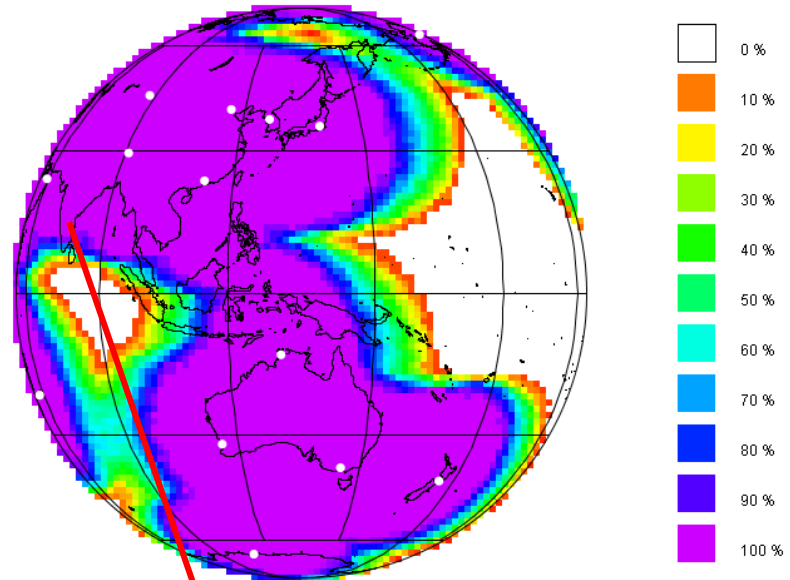
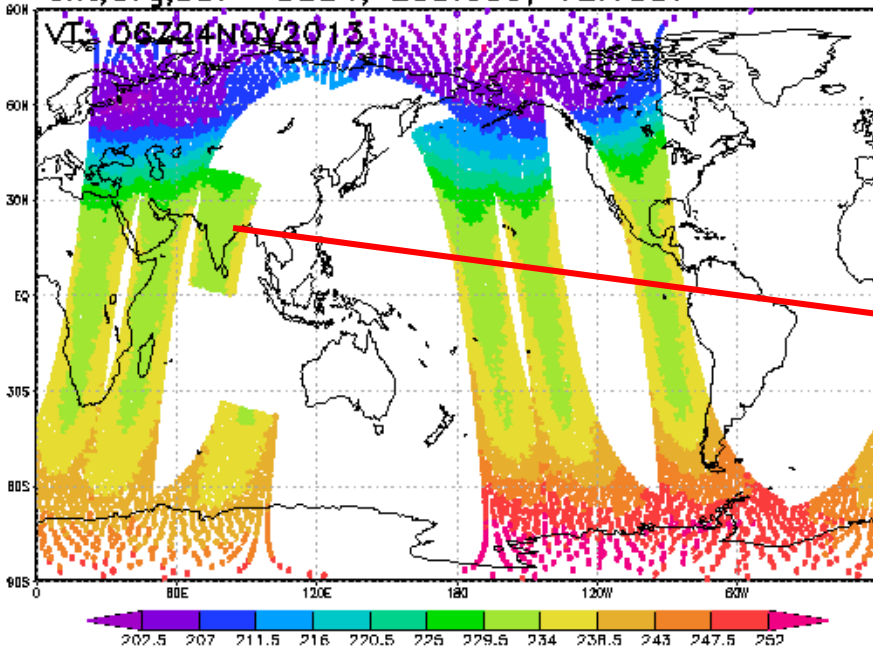
15 RTNS (Algiers, Beijing, Bracknell, Brasilia, Buenos Aires, Cairo, Dakar, Jeddah, Nairobi, New Delhi, Offenbach, Toulouse, Prague, Sofia and Tokyo)

Source: http://www.wmo.int/pages/prog/www/TEM/GTS/index_en.html

Emphasis on improving timelines of getting regional data

Special efforts are being made to improve availability and timeliness of time critical polar orbiting satellite data over our region by becoming member in Asia-Pacific RARS group.

platform: amsua metop-a
variable: channel 12 observation (K)
cnt,avg,sdv= 9884, 230.659, 12.1007



Asia –Pacific RARS

Data from 3 IMD HRPT stations data are being operationally used now. IMD Chennai HRPT station data is critical to RARS group as it covers data gap area

CALIBRATION & UTILIZATION

- Calibration
- For calibrating and validating Ocean color (OCM-2) sensor [Karvratti super observation site](#) was established with multiple observational platforms.
- Developed a radiometrically stable land based cal-val site for INSAT-3D & other Satellites
- Utilisation of Satellite data in NWP
- ESSO is mandated to issue deterministic / probabilistic forecasts over India using Global Data Assimilation and forecasting (GDAF) system. In this data assimilation system , data sets from various [operational Meteorological and Oceanographic satellite data](#) are used apart from the conventional data sets coming through GTS. To receive satellite data on real time ESSO [established direct data access](#) with [NOAA-NESDIS](#) ,[ISRO](#) and [EUMETCAST](#) Terrestrial broadcasting system.

In order to validate different satellite Sensors in the Indian Ocean region, ESSO has established many different in-situ platforms and also maintains Scientific research vassals –'ORV Sagara Kanya'.



Established Stations at
Antarctic & Arctic

Annual Scientific expeditions
To Antarctic

Third Station at the Larsmann Hill





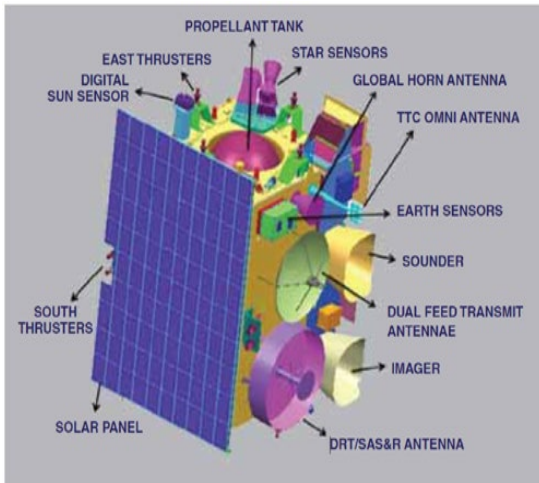
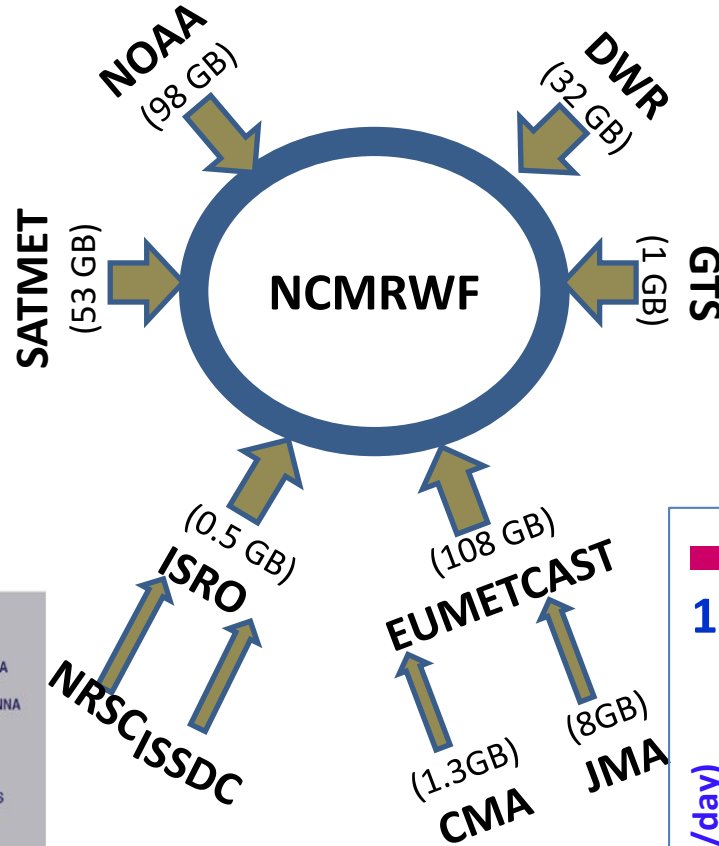
Data Reception System at NCMRWF



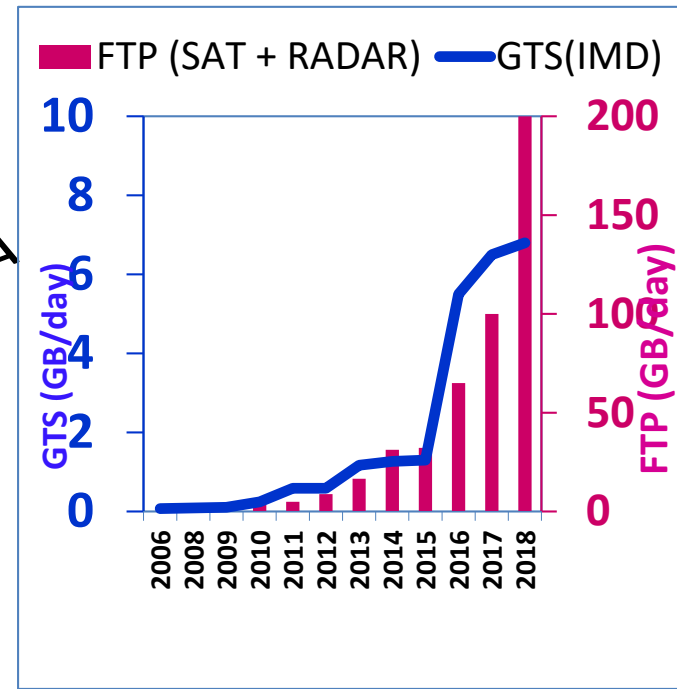
MeghaTropiques
SAPHIR & ROSA



ScatSat



INSAT3D & 3R



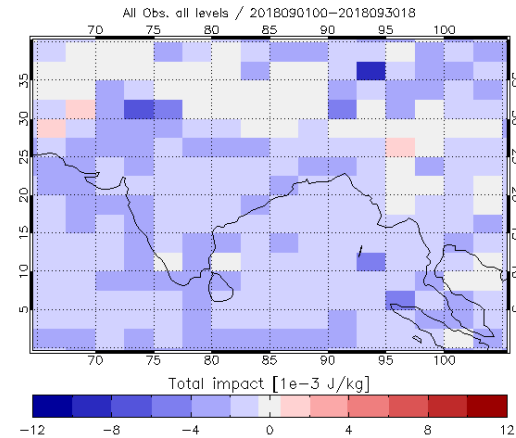
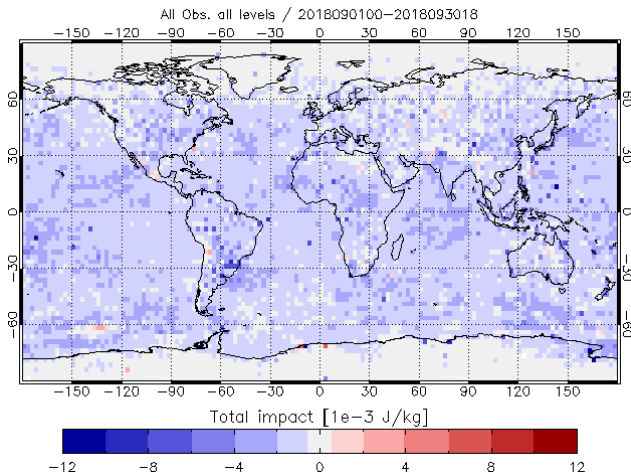
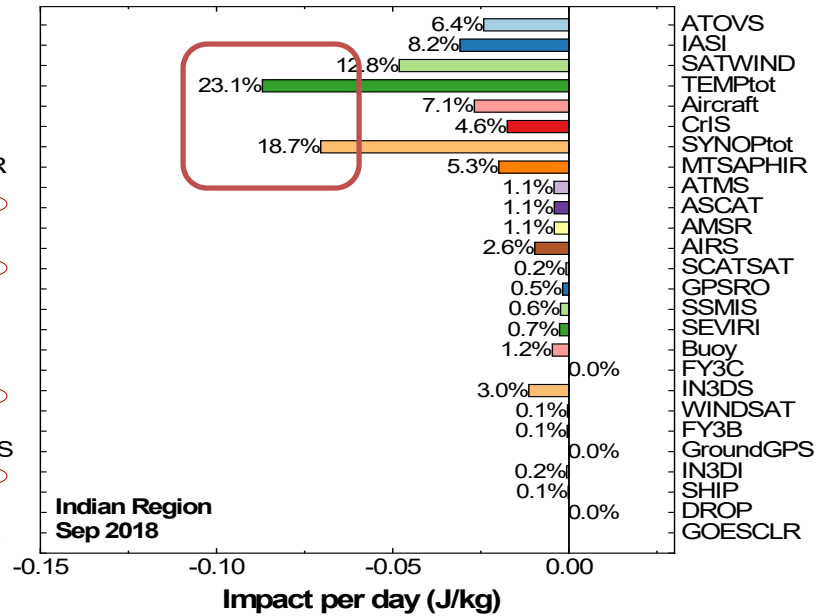
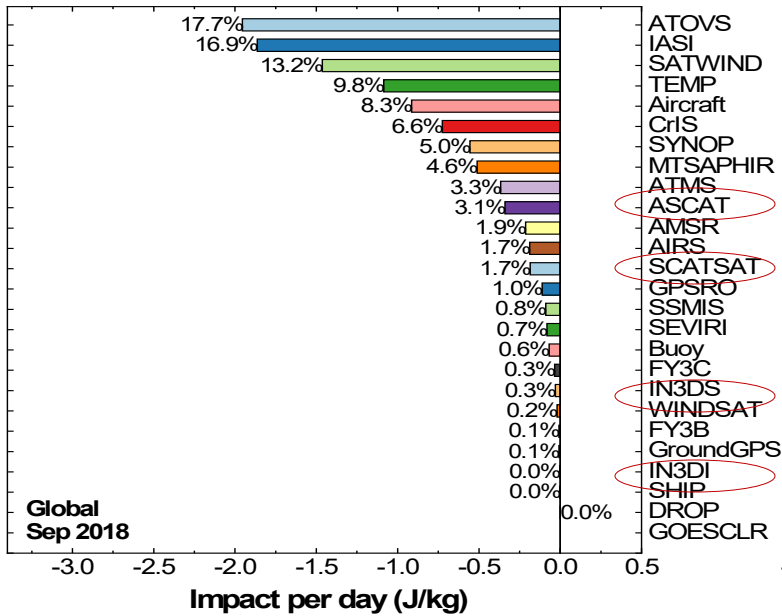
Observations Assimilated in the New NCUM Global DA System

Conventional Observations	Satellite Observations						
	Satellite Winds		Scatterometer winds	Satellite radiances			GPSRO
	Geostationary	LEO		Geostationary	LEO		LEO
				IR	IR (Hyperspectral)	MW	Bending Angle
Surface: Land SYNOP, Ship, BUOY, BOGUS SONDE: PILOT, TEMP, WindProfiler, DropSonde, Radar VAD winds Aircraft: AMDAR, AIREP	1. INSAT-3D	1.NOAA-15	1.ASCAT (MetOp-A)	1.INSAT-3D Sounder	1.IASI (MetOp-A)	1.AMSU-A (MetOp-A)	1. COSMIC-6 (monitoring)
	2.Meteosat-8	2.NOAA-18	2.ASCAT (MetOp-B)	2.SEVIRI (Meteosat-8)	2.IASI (MetOp-B)	2. AMSU-A (MetOp-B)	2.GRAS-A
	3.Meteosat-11	3. NOAA-19	3. Scatsat	3.SEVIRI (Meteosat-11)	3.AIRS (AQUA)	3. AMSU-A (NOAA-18) (2	3. GRAS-B
	4.GOES-15	4.MetOp-A	4. Windsat (Coriolis)	4.GOES Imager (GOES-15)	4.CrIS (SNPP)	4. AMSU-A (NOAA-19)	4. ROSA (MT)
	5.HIMAWARI-8	5.MetOp-B		5.AHI (HIMAWARI-8)		5. AMSU-A (NOAA-15)	5. TanDEM-X
		6.GOES-16	6. AQUA		6.INSAT-3D Imager	5.AMSU-B (MetOp-A)	6. TerraSAR-X
			7. TERRA			6. AMSU-B (MetOp-B)	
			8. SNPP			7. AMSU-B (NOAA-18)	
						8. AMSU-B (NOAA-19)	
						10. MT-SAPHIR (
						11.ATMS (SNPP)	
						12.SSMIS (DMSP-F17)	
						13. AMSR (GCOM-W1)	
						14.MWHS (FY3C)	
						15. GMI (GPM)	

Newly added observation types/instrument in NCUM DA

Impact of Observations on Forecasts (High Resolution FSO)

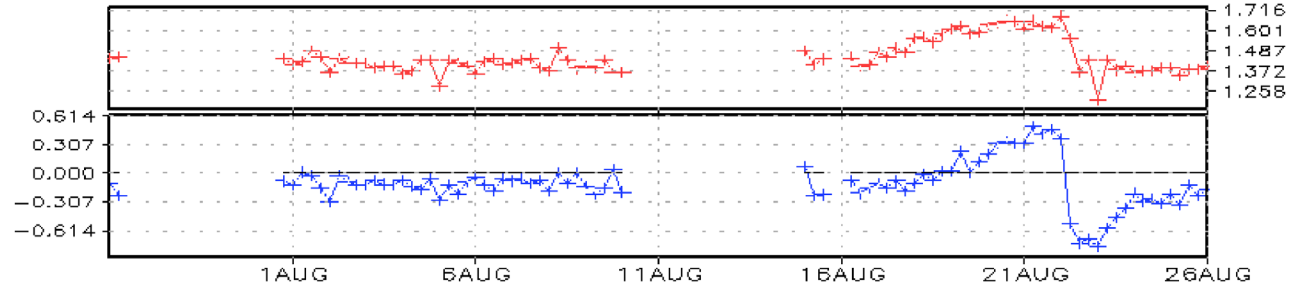
September 2018



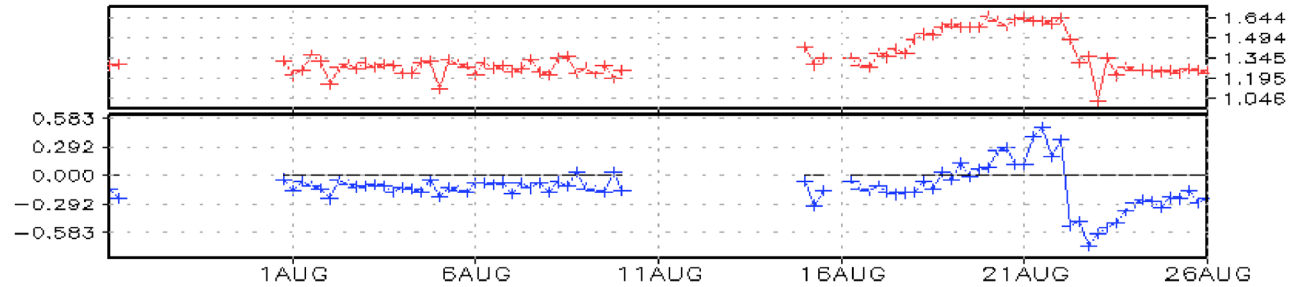
Beneficial impact of Indian satellite observations on global forecasts is ~6.6%

platform: saphir_meghat
region: global (180W-180E, 90S-90N)
variable: ges_(w/bias cor) - obs (K)
valid: 00Z27JUL2018 to 00Z26AUG2018

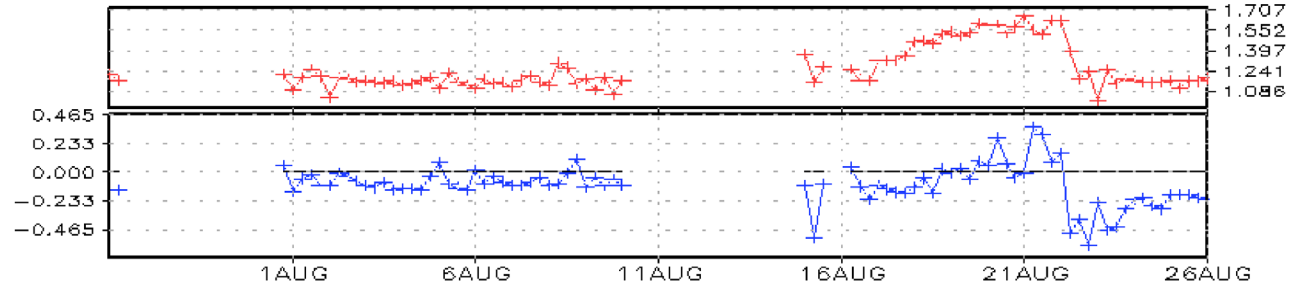
channel 1
 χ 1.2503
f 183.31 GHz
 λ 1635.44 μm
avg: -0.108
sdv: 1.452



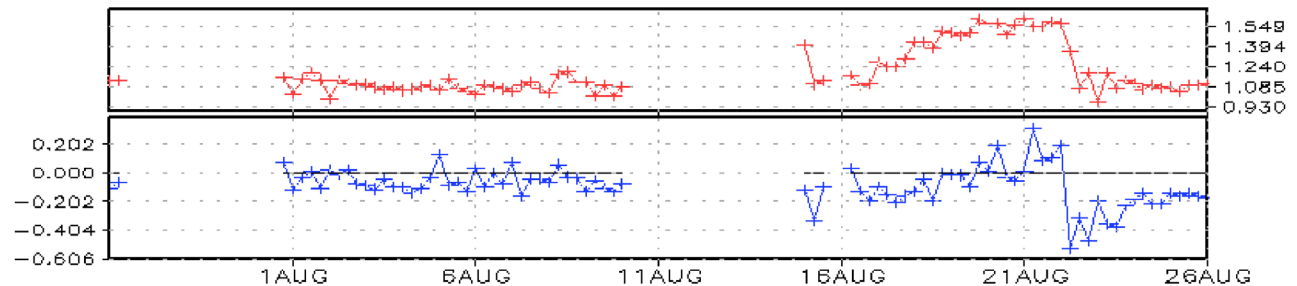
channel 2
 χ 1.3368
f 183.31 GHz
 λ 1635.44 μm
avg: -0.118
sdv: 1.346



channel 3
 χ 1.3302
f 183.31 GHz
 λ 1635.44 μm
avg: -0.102
sdv: 1.259

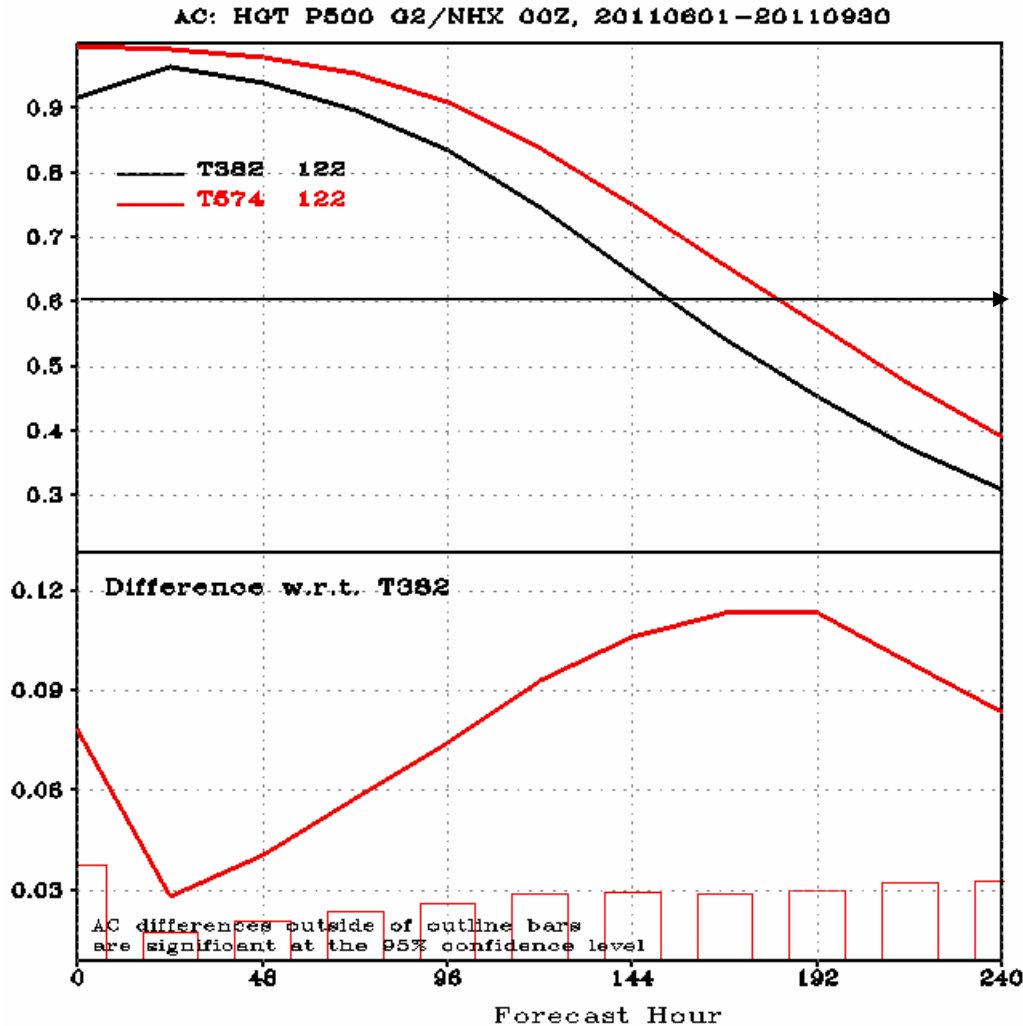


channel 4
 χ 1.3228
f 183.31 GHz
 λ 1635.44 μm
avg: -0.087
sdv: 1.198



One day gain in model forecast skill T382 → T574

Anomaly correlation of 10 day forecasts of 500 hPa Geopotential Height over the Northern Hemisphere from the T382 (black line) and T574 (red line) GFS

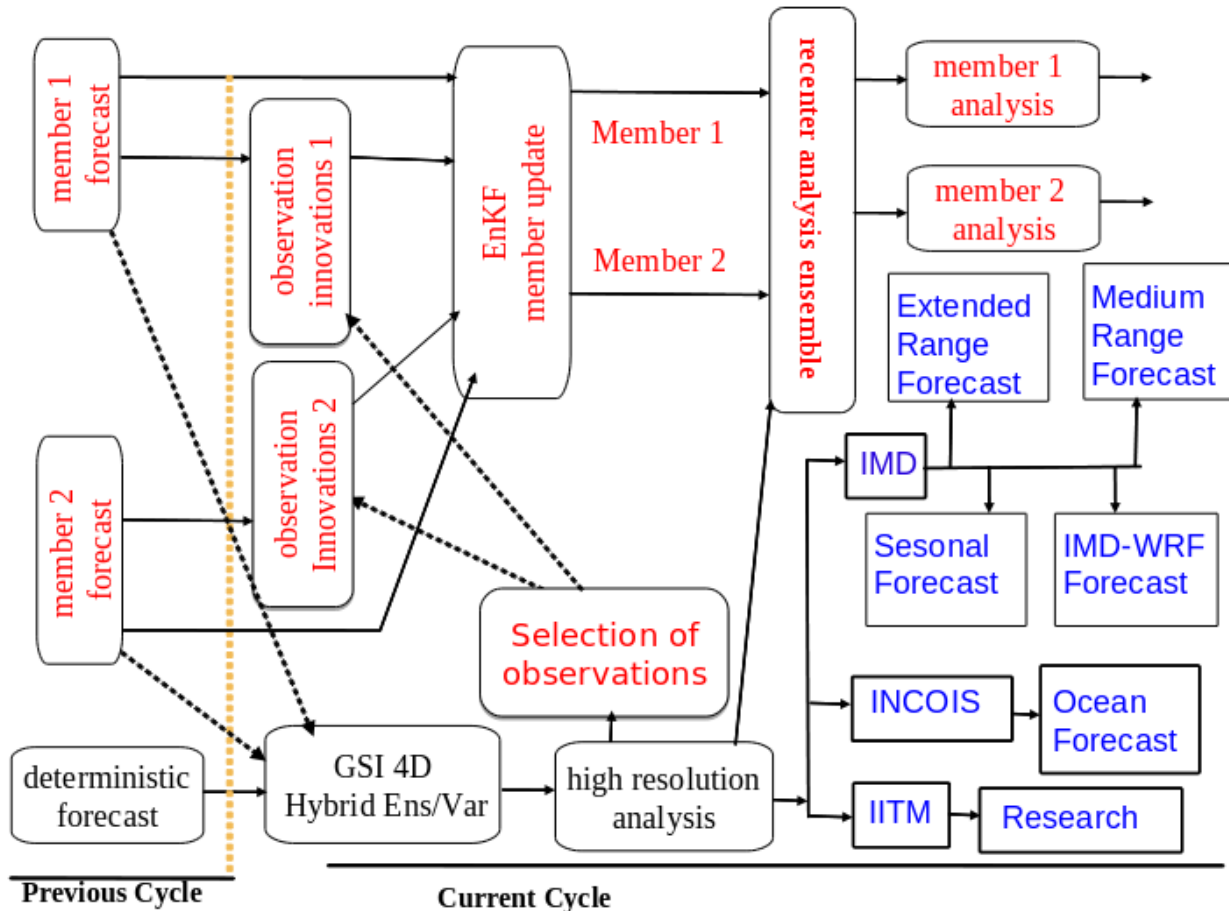


The anomaly correlation values are comparatively higher in the T574 GFS with a gain of 1 day in the skill of the forecasts.

In the lower panel the line plot depicts the difference of the forecasts of Geopotential Height of the T574 GFS from the T382 GFS.

The difference values outside the histograms are statistically significant at 95% level of confidence.

GFS based Forecasting system using 4D-Ens-VAR



Plans to increase ENKF resolution from T-574 to 1534. Generating and using NSST Analysis instead of RTG-SST , use of new ABI,AHI, Cris (full resolution), NPOES and COSMIC-2 IMD is working retrospective forecast using NCMRWF reanalysis data for seasonal forecasting.

NCMRWF Unified Model (NCUM)

330 m Delhi Fog Model
up to 36 hr forecast

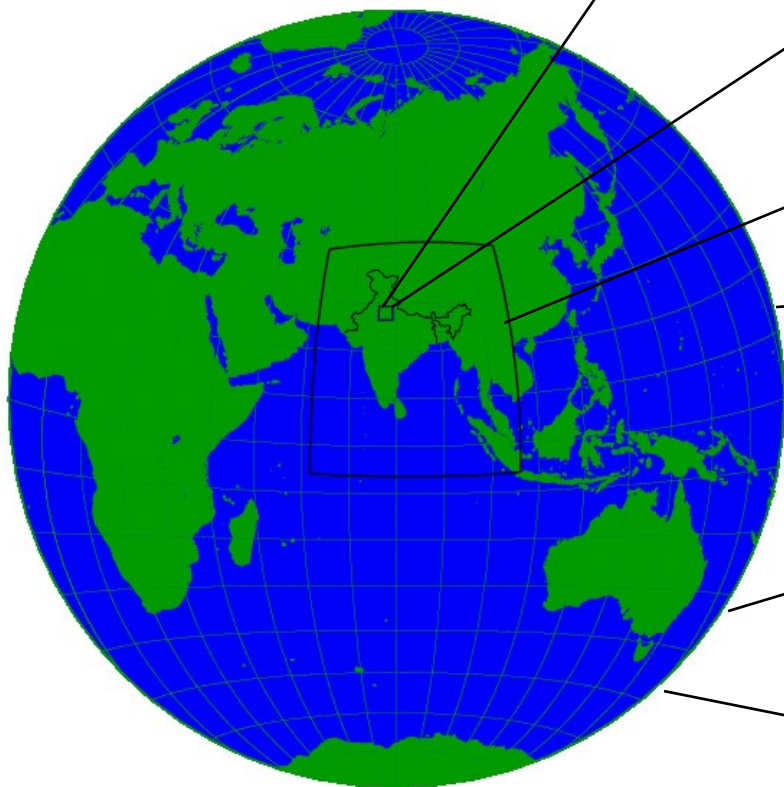
1.5 km regional model
up to 48 hr forecast

4 km regional model
up to 72 hr forecast

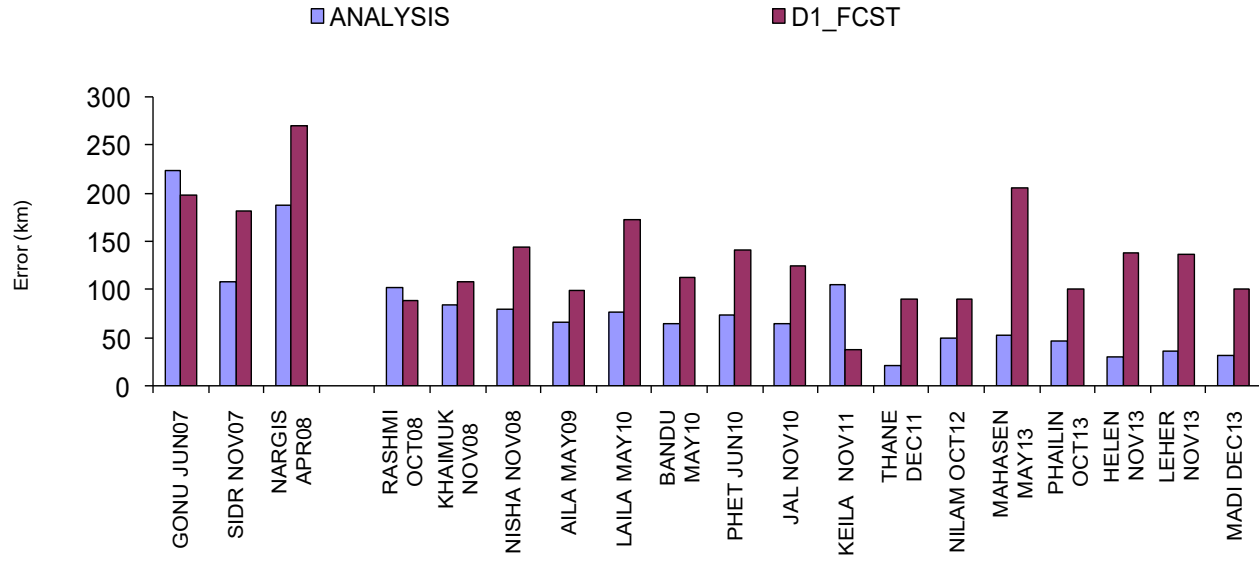
12 km global model
up to 10 Day forecast

Global Ensemble Prediction
System – 12 km with 22
members up to 10 Days

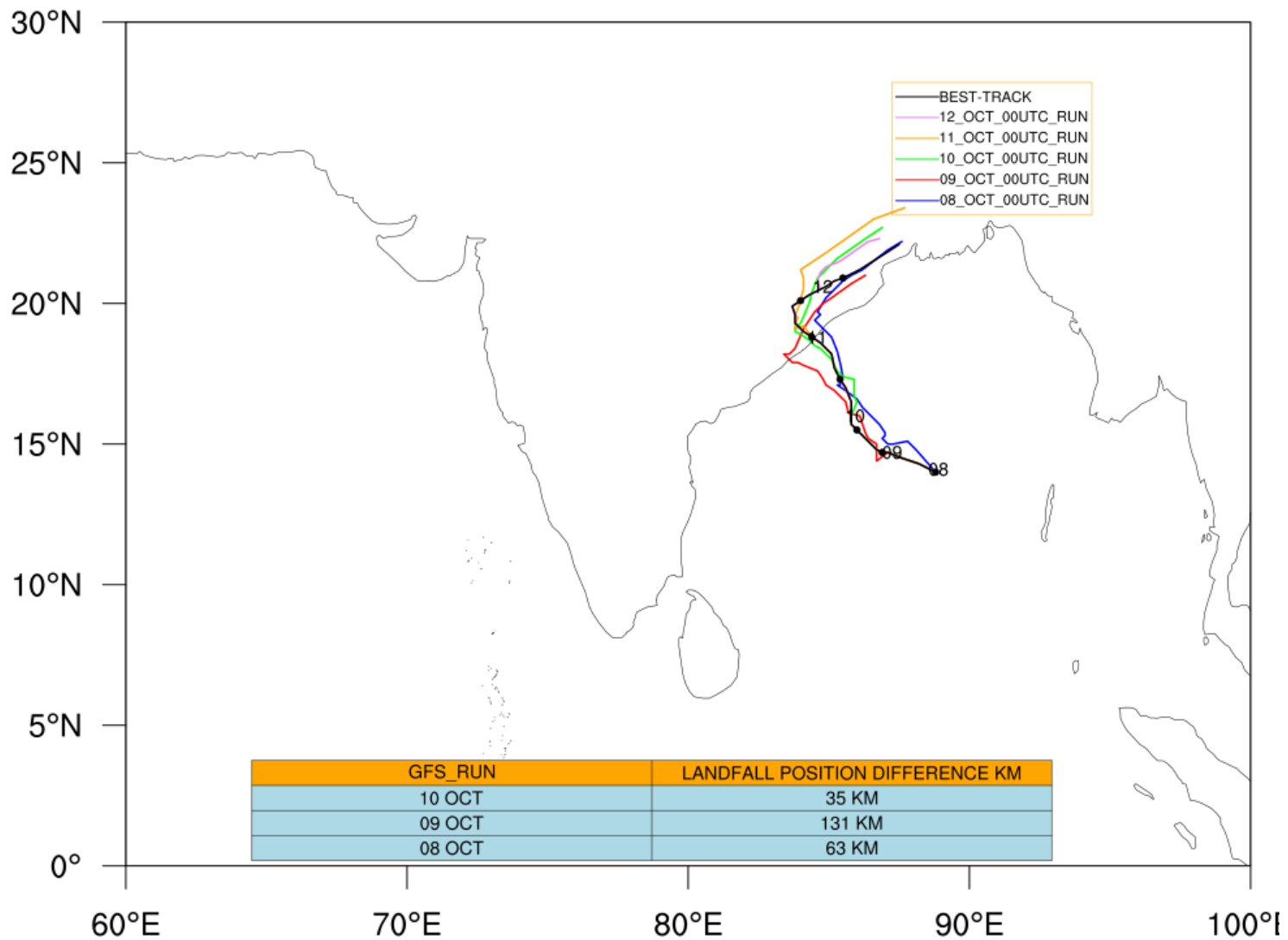
Coupled Model N216
(NCUM+JULES+NEMO+CICE)
One Month Real-Time



Track errors of Tropical Cyclone in Indian Seas, before and after TC-Relocation Procedure Implementation (OCT' 2008)



TITLI TRACK BASED ON OOUTC GFS RUN

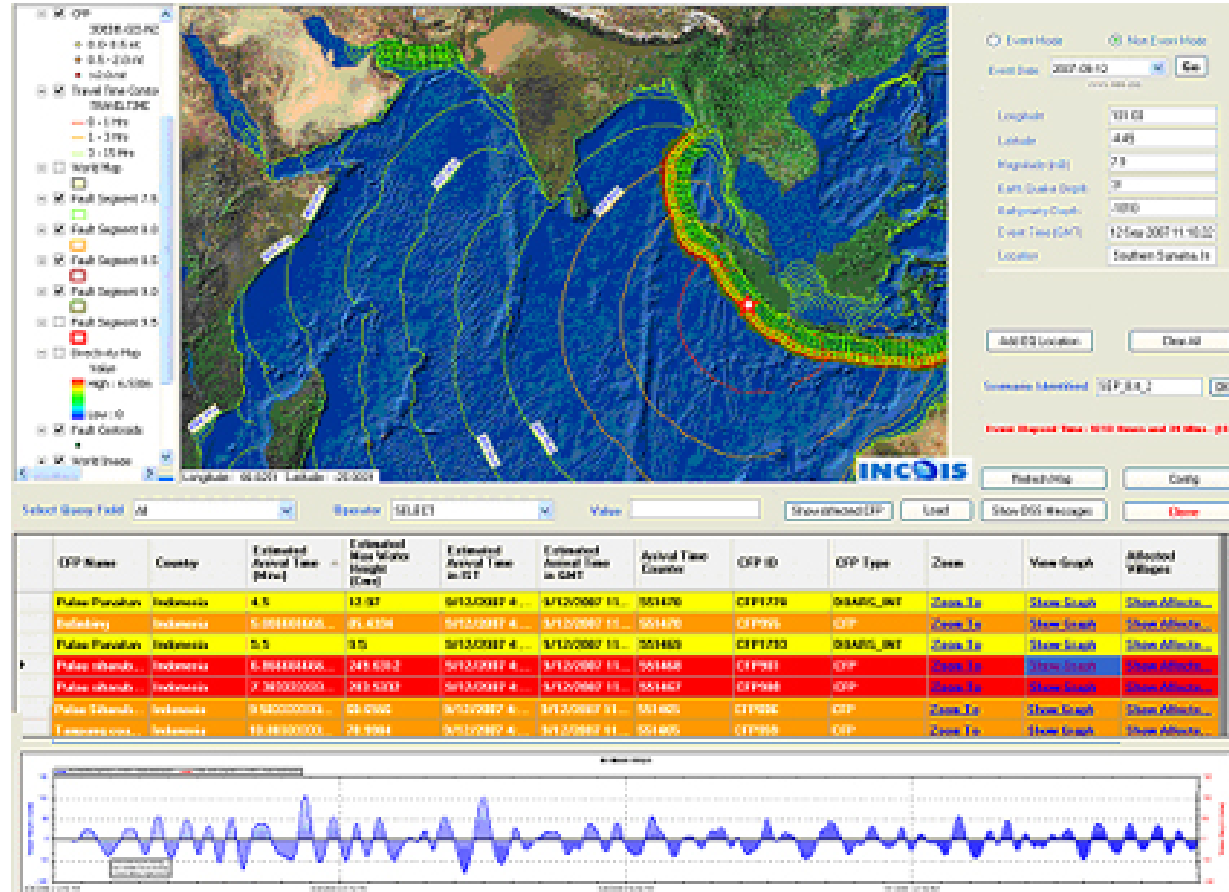


Ocean Models

Scenario database of 50,000 scenarios

Ocean Models

- HOOFS
- HYCOM
- INCOIS-GODAS
- MOM
- Tsunami
- Storm Surge



Capacity Building

- Meteorological Training Institute, Pune, IMD is a WMO Recognised Regional Training Center
- International Training Centre for Operational Oceanography (ITCOcean), INCOIS, Hyderabad.

The Intergovernmental Oceanographic Commission (IOC/UNESCO) will support ESSO-INCOIS for capacity building activities in the field of operational oceanography through ITCOcean.

- Center for Advanced Training in Earth system Science and Climate, IITM, Pune.

International Collaborations

- INDO-NOAA (USA)
IA on different Rama buoy, Climate modeling, Tropical cyclone and Tsunami & ocean modeling.
- INDO-NERC (UK)
changing water Cycle, Earth science
- INDO-Korean
Joint Committee (JC) having members from both the countries
- MoES_RCN (Norway)
- India-Mauritius
- BELMONT FOURM, CEOS, CGMS etc.
- The NCUM system is based on the Unified Model (UM) developed under the UM Partnership by Met Office, UK, BoM/CSIRO, Australia, KMA, South Korea, NIWA, New Zealand and MoES/NCMRWF, India



THANKS