

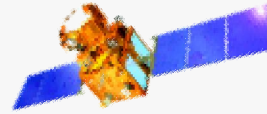
Short Range Weather Predictions using NWP model

Prashant Kumar
ASD/AOSG/EPISA
SAC (ISRO)

Indian EO Programme: Dimensions

Space Infrastructure

- Launch vehicles (PSLV, GSLV)
- Spacecrafts (LEO, GEO and beyond)
- Sensors (optical/microwave)



Ground Segment

- Data Acquisition and Processing
- International Ground stations
- Cal-Val Programme
- TTC Network

Applications

- Large number of applications towards national development
- Advanced R&D for land-atmosphere-ocean interactions
- Synergy between EO, Satellite Communication & Navigation



Institutionalization

- National Natural Resources Management System (NNRMS)
- Involvement of stake-holders from the planning level
- State Remote Sensing Centres

Capacity Building

- Formal education through CSSTEAP, IIRS, IIST....
- On-the job training



International Cooperation

- Bilateral and multilateral cooperation with various countries and international Organisations

EARTH OBSERVATION SATELLITES

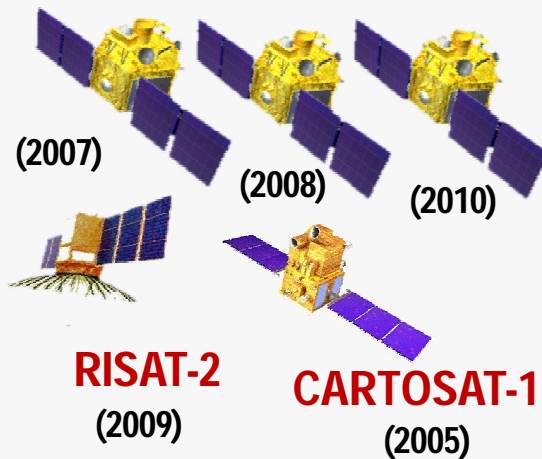
LAND & WATER

RESOURCESAT-2
(2011)



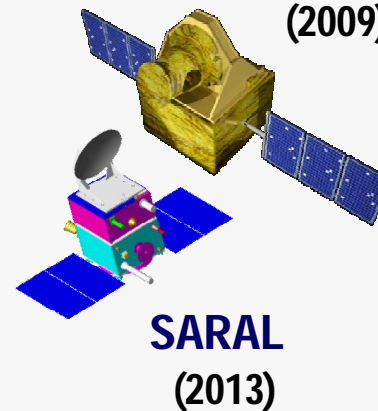
HIGH RESOLUTION

CARTOSAT-2; 2A; 2B

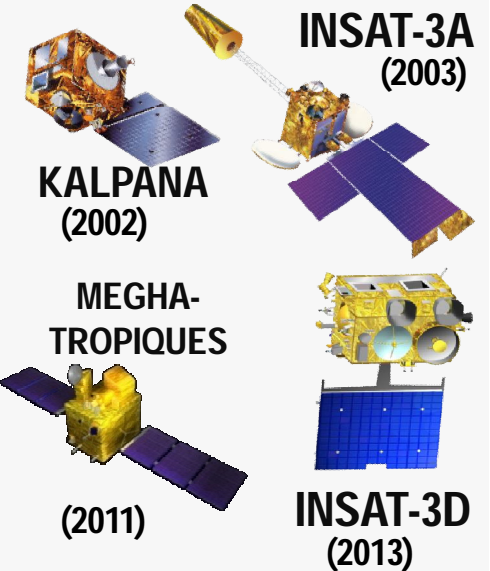


OCEAN

OCEANSAT-2



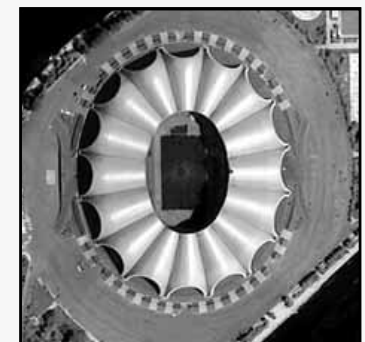
WEATHER; CLIMATE



1 KM ←

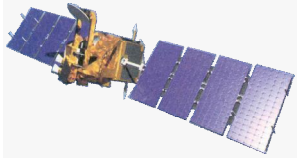
IMAGING CAPABILITY

→ 0.8 M



Resourcesat-2A, SCATSAT-1, RISAT-1, Cartosat 2C/2D/2E, Cartosat-3, Oceansat-3, INSAT-3DR, GISAT being added during 2015-19 for continuity of services and new capability.

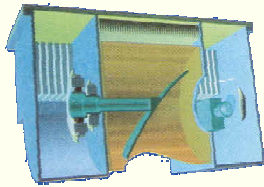
LEO SATELLITES: Megha-Tropiques



For studying water cycle and energy exchanges to better understand the life cycles of the tropical convective system. The satellite is contributing to Global Precipitation Mission (GPM)

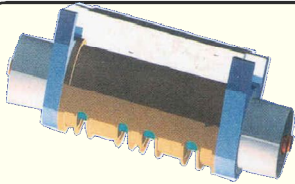
Launch: 2011

SAPHIR



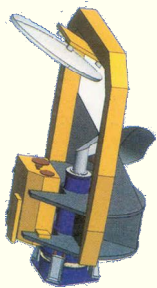
- Water vapour profile
- Six atmospheric layers upto 12 km height
- 10 km Horizontal Resolution

SCARAB



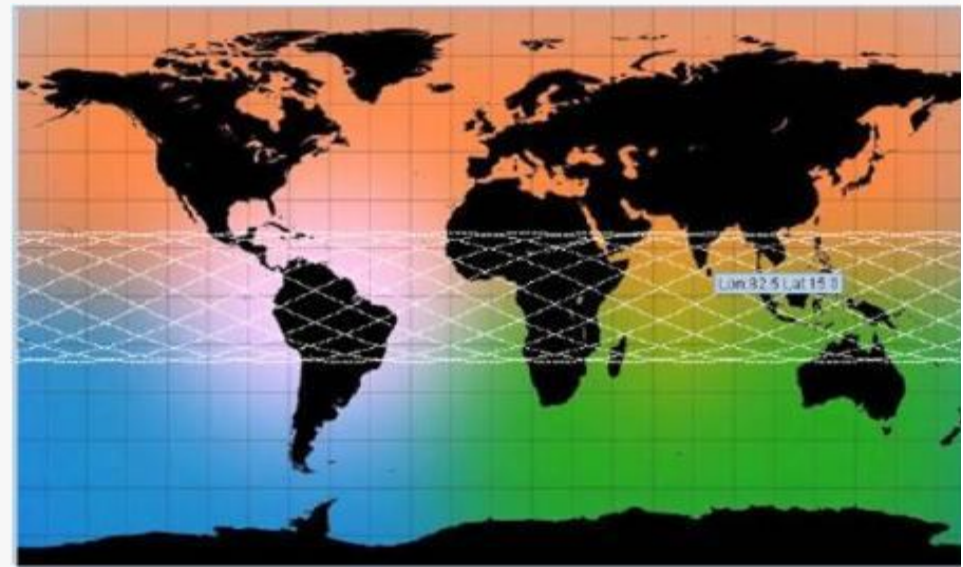
- Outgoing fluxes at TOA
- 40 km Horizontal Resolution

MADRAS



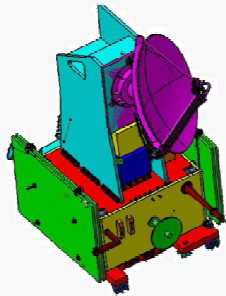
- Precipitation and Cloud properties
- 89 & 157 GHz: Ice particles in cloud top
- 18 & 37 GHz: Cloud Liquid Water and precipitation; Sea Surface Wind speed
- 24 GHz : Integrated water vapour

- SAPHIR and SCARAB data products are available operationally.
- MADRAS payload functioned for 18 months and the data is available.



LEO SATELLITES: (SCATSAT-1)

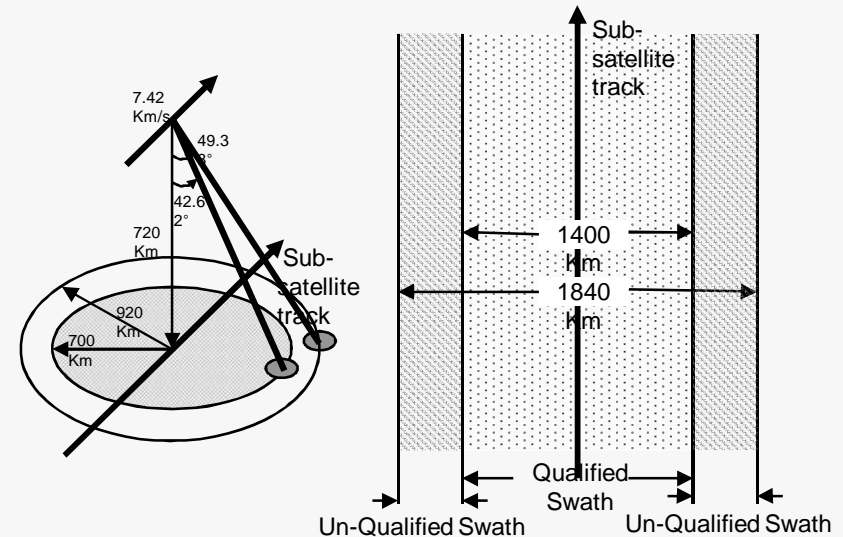
SCATSAT-1 is planned as an in-orbit replacement for the Scatterometer carried onboard Oceansat-2, which is non-functional after 4 ½ years of service.



Orbit : 720 km in sun-synchronous

LAUNCH: End 2016

- IMS-2 Bus
- Ku-Band (13.515 GHz) Pencil beam Scatterometer
- Ground resolution: 50 km x 50 km
- Swath: 1440 Km
- Polarization: HH and VV
- Wind Direction: 0 to 360 deg with accuracy of 20 deg
- Wind Speed: 4 to 24 m/s with accuracy of 10% or 2m/s

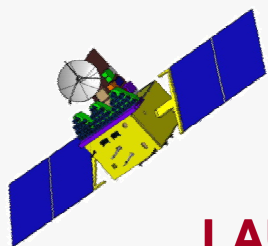


Objectives:

- To provide global wind vector data for national and international user Community.
- To provide continuity of weather forecasting services to the user communities.
- To generate wind vector products for weather forecasting, cyclone detection and tracking.

FUTURE LEO SATELLITES: (Oceansat-3)

OCEANSAT-3 is a global mission and is configured to cover global oceans and provide continuity of ocean colour data with global wind vector and characterization of lower atmosphere and ionosphere.



LAUNCH: 2018

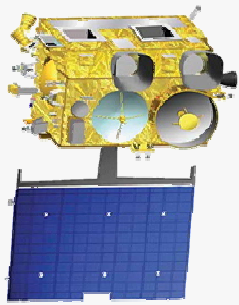
Payloads:

- 13-band Ocean Colour Monitor (OCM) - 400-1010 nm range; 360 m resolution; 1400 km swath
- 2-band Long Wave Infra Red (LWIR) around 11 and 12 μm
- Ku-Band Pencil beam SCATTEROMETER

Objectives:

- Continuity of ocean colour data with improvements to continue and enhance operational services like potential fishery zone and primary productivity.
- To enhance the applications by way of simultaneous Sea Surface Temperature (SST) measurements, in addition to chlorophyll, using additional thermal channels.
- Continuity of wind vector data through repeat of Scatterometer for cyclone forecasting and numerical weather modelling.
- The mission, in tandem with Oceansat-2 (on availability), will improve the repetivity of ocean colour measurements to every 24 hour and wind vector measurements to every 12 hour.

GEO SATELLITES: INSAT - 3D/3DR



LAUNCH: 2013/2016

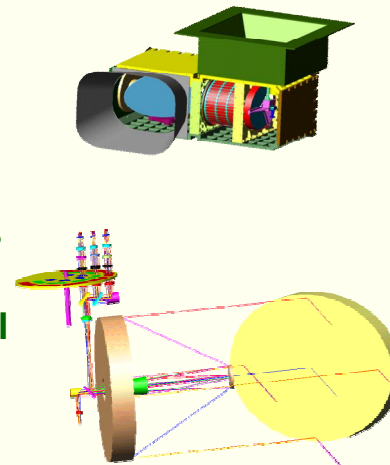
6 Channel IMAGER



- Spectral Bands (μm)
 - Visible : 0.55 - 0.75
 - Short Wave Infra Red : 1.55 - 1.70
 - Mid Wave Infra Red : 3.70 - 3.95
 - Water Vapour : 6.50 - 7.10
 - Thermal Infra Red – 1 : 10.30 - 11.30
 - Thermal Infra Red – 2 : 11.30 - 12.50
- Resolution : 1 km for Vis & SWIR
4 km for MIR & TIR
8 km for WV

19 Channel SOUNDER

- Spectral Bands (μm)
 - Short Wave Infra Red : Six bands
 - Mid Wave Infra Red : Five Bands
 - Long Wave Infra Red : Seven Bands
 - Visible : One Band
- Resolution (km) : 10 X 10 for all bands
- No of simultaneous : 4 sounding per band



FUTURE GEO SATELLITES: (GISAT)

Launch Schedule: 2018, Geostationary orbit, 83E

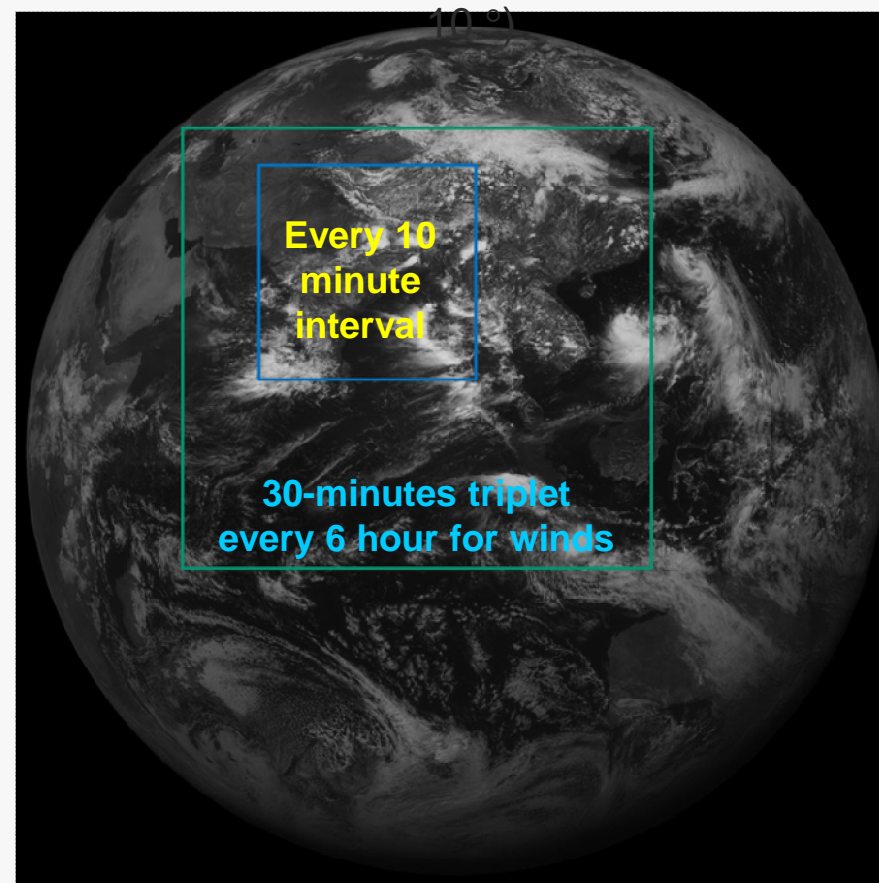
MX-VNIR: Multispectral - Visible Near Infrared, HySI-VNIR: Hyperspectral Imager - Visible Near Infrared,

HySI-SWIR: Hyperspectral Imager - Short Wave Infrared, MX-LWIR: Multispectral - Long Wave Infrared.

GISAT Scan scenario

Scan area for two scan scenario (5° & 10°)

Band	Ch	SNR/NEdT	IFOV (m)	Range (μm)	Channels (μm)
MX-VNIR	4	> 200	50	0.45 - 0.875	B1: 0.45-0.52 B2: 0.52-0.59 B3: 0.62-0.68 B4: 0.77-0.86 B5N: 0.71-0.74 B6N: 0.845-0.875
HyS-VNIR	60	> 400	500	0.375 - 1.0	$\Delta\lambda < 10$ nm
HyS-SWIR	150	> 400	500	0.9 - 2.5	$\Delta\lambda < 10$ nm
MX-LWIR	6	NEdT < 0.15K	1500	7.0 - 13.5	CH1: 7.1-7.6 CH2: 8.3-8.7 CH3: 9.4-9.8 CH4: 10.3-11.3 CH5: 11.5-12.5 CH6: 13.0-13.5





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**GSLV-F05 successfully placed
INSAT-3DR,
an advanced weather satellite
into a Geostationary Transfer Orbit
on Sept 08 2016
6 channel Imager
19 channel Sounder**

[First Day Images of INSAT-3DR](#)



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Visualisation of Earth Observation Data and Archival System

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Mobile based Data Collection

RAPID

Special Products

Village Level Vegetation



Earth

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NDVI Profile over Haryana

A Five-days training programme on "Agriculture Applications in Remote Sensing" The training programme is planned from February 5-9, 2018

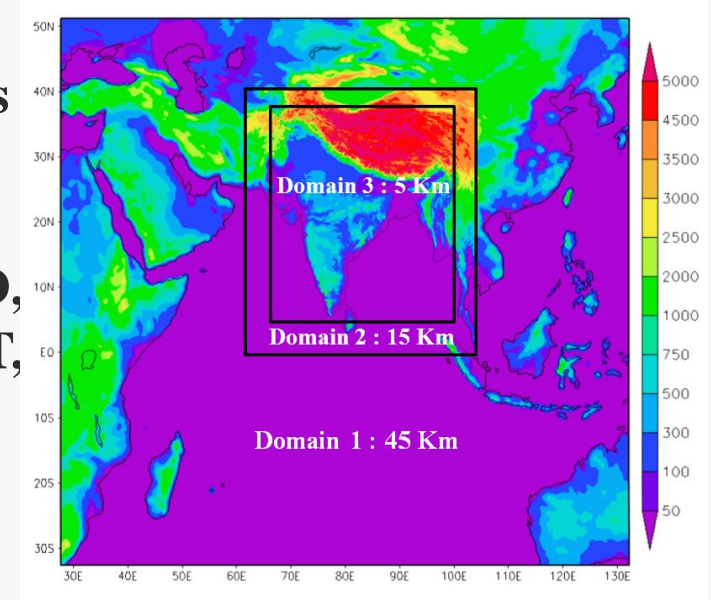
g multicriteria analysis

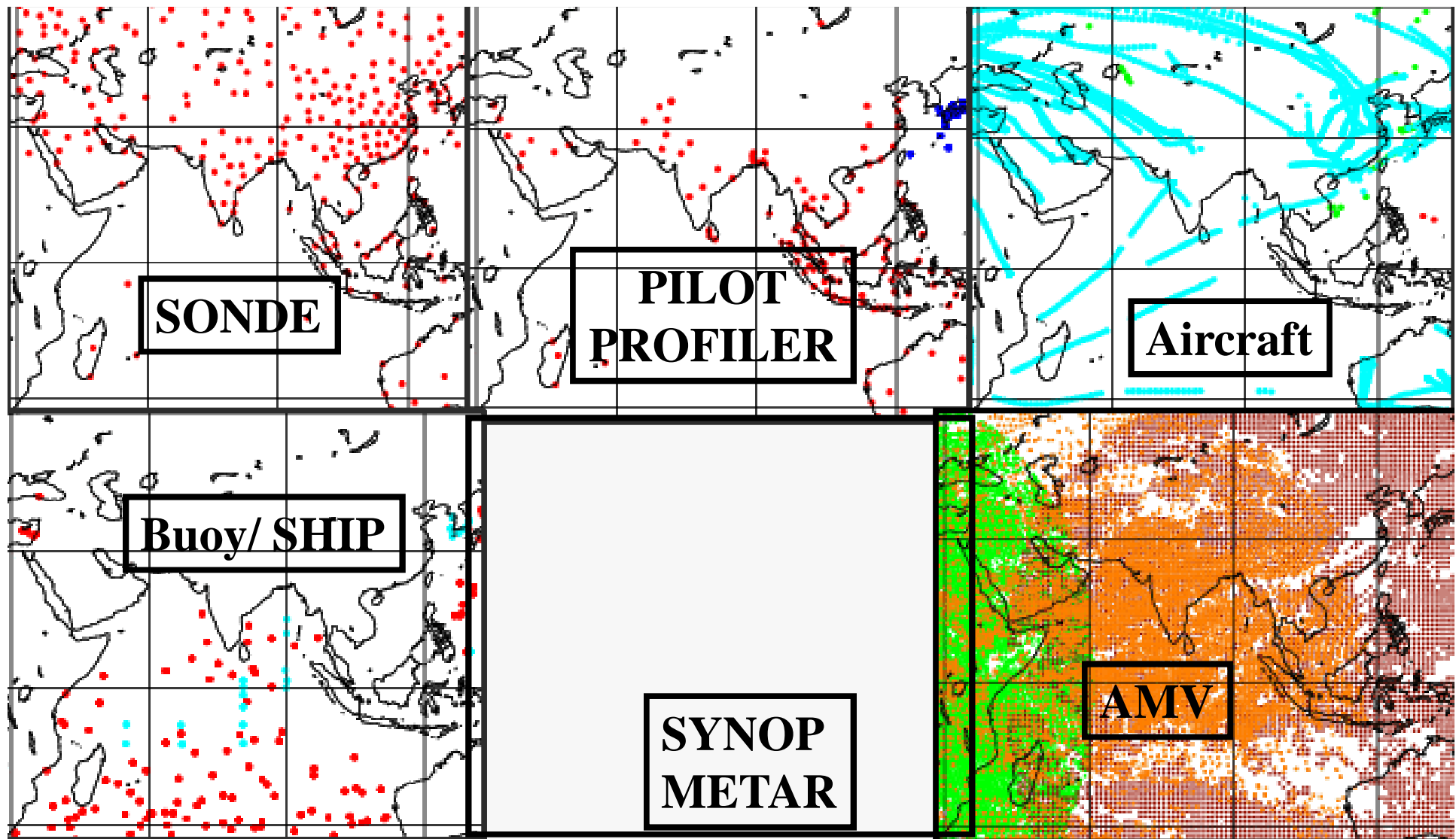
Operational Weather Forecast from



- Temperature
- Relative Humidity
- Cloud
- Wind
- Rain
- Fog

Model : WRF Version 3.9
Forecast Length: 72 hours
Assimilation Method: 3D-Var
Data used: INSAT-3D, SAPHIR, SCATSAT, KSNDMC & GTS
Major Users: KSNDMC, SCI, NIWE, MP Forest, Agriculture





SAPHIR Radiance, SCATSAT-1 Winds
 INSAT-3D Imager and Sounder Radiances
 INSAT-3D AMVs
 KSNDMC ground observations

Time Window : ± 2 hour



Government of India



Meteorological and Oceanographic Satellite Data Archival Centre

Space Applications Centre, ISRO

M O S D A C

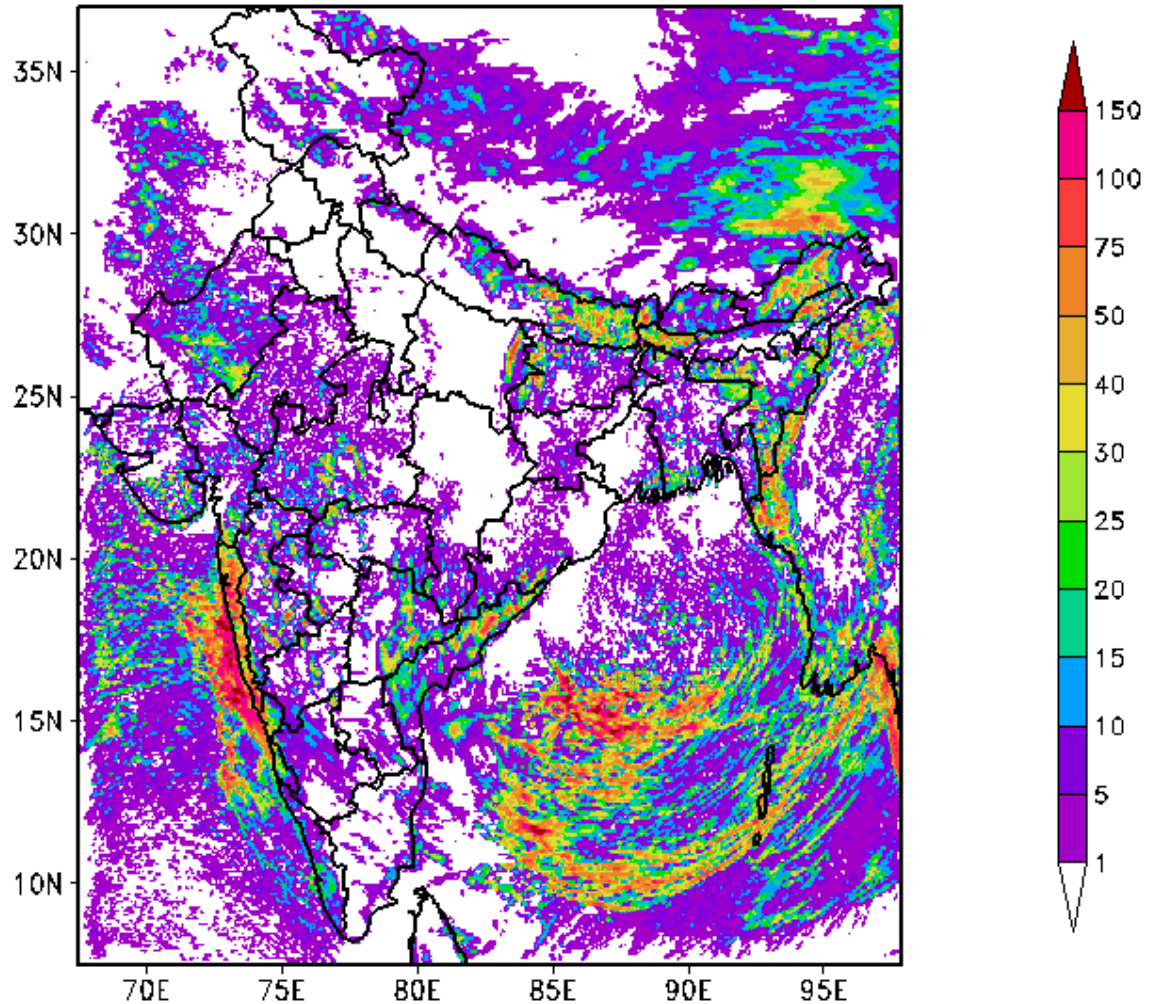
All India Experimental Short Range Weather Forecast

- Location Forecast
 - India
 - North India
 - Western India
 - Eastern India
 - South India
 - A & N

- Forecast Map
 - Temperature
 - Relative Humidity
 - Rain
 - Surface Wind
 - 850 hpa Wind
 - 200 hpa Wind
 - Cloud

- Gridwise Weather Forecast
 - Ahmedabad
 - Bangalore
 - Delhi
 - Hyderabad
 - Mumbai

(a) Day1 accumulated rain (mm) between 00Z 08JUN - 00Z 09JUN2017





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Gridwise Weather Forecast of Ahmedabad

Location Forecast

- India
- North India
- Western India
- Eastern India
- South India
- A & N

Forecast Map

- Temperature
- Relative Humidity
- Rain
- Surface Wind
- 850 hpa Wind
- 200 hpa Wind
- Cloud

Gridwise Weather Forecast

- Ahmedabad
- Bangalore
- Delhi
- Hyderabad
- Mumbai

Close

3 hourly forecast

Forecast for Selected Region

(08:30 IST 08-06-2017 to 05:30 IST 09-06-2017)

Temperature(deg C)	38.9/29.5
Humidity(%)	71.5/33.4
Accumulated Rain(mm)	Light Rain(4.59)

Forecast for Selected Region

(08:30 IST 09-06-2017 to 05:30 IST 10-06-2017)

Temperature(deg C)	40.6/29.8
Humidity(%)	72.8/30.4
Accumulated Rain(mm)	No Rain

Forecast for Selected Region

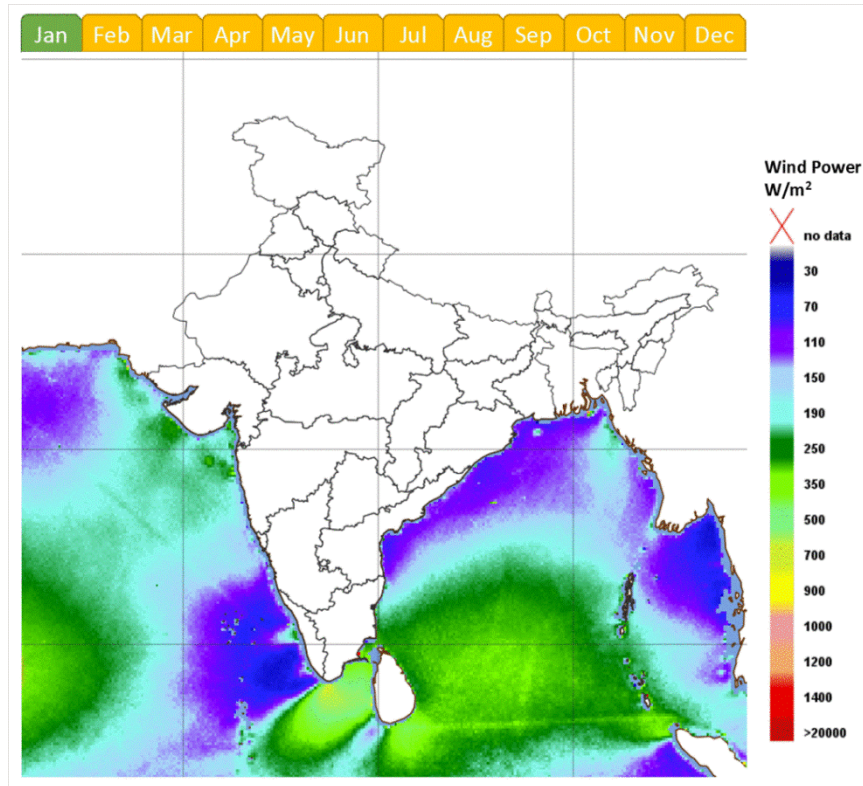
(08:30 IST 10-06-2017 to 05:30 IST 11-06-2017)

Temperature(deg C)	41.2/29.9
Humidity(%)	71.0/29.3
Accumulated Rain(mm)	No Rain

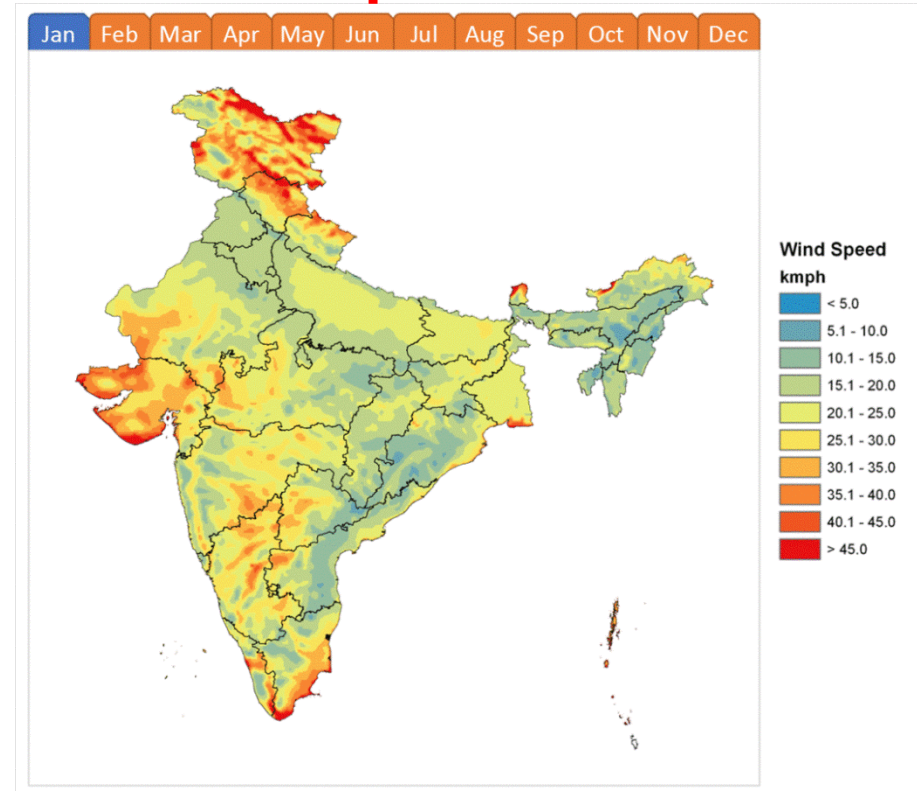


Wind Energy

Off-shore Wind Power



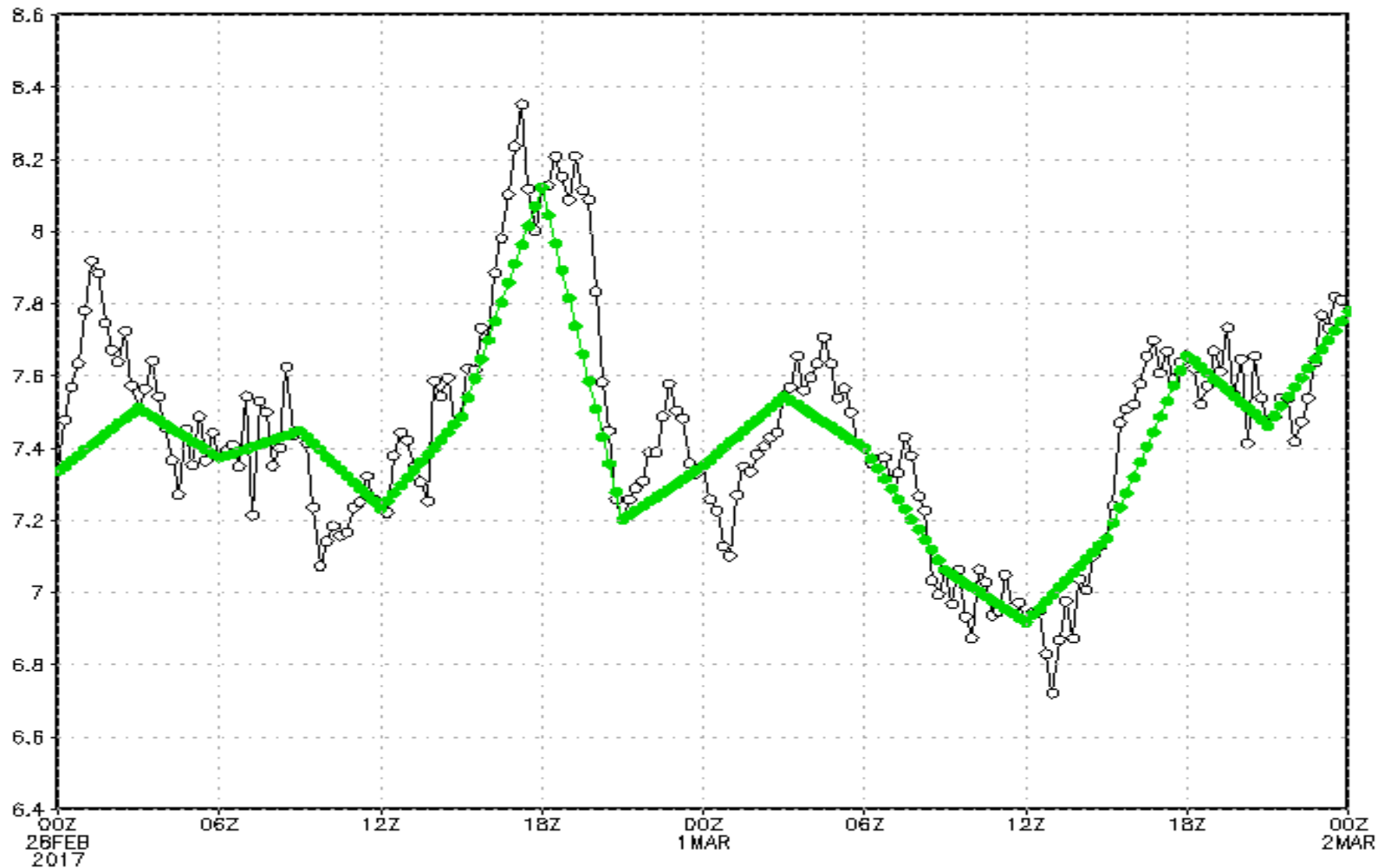
Wind Speed



- Offshore wind energy potential computed using 15 yrs scatterometer data
- Model-generated monthly average wind speed estimated for wind energy potential assessment
- Two-days ahead predictions at 15 min interval being provided for all wind energy installations across India

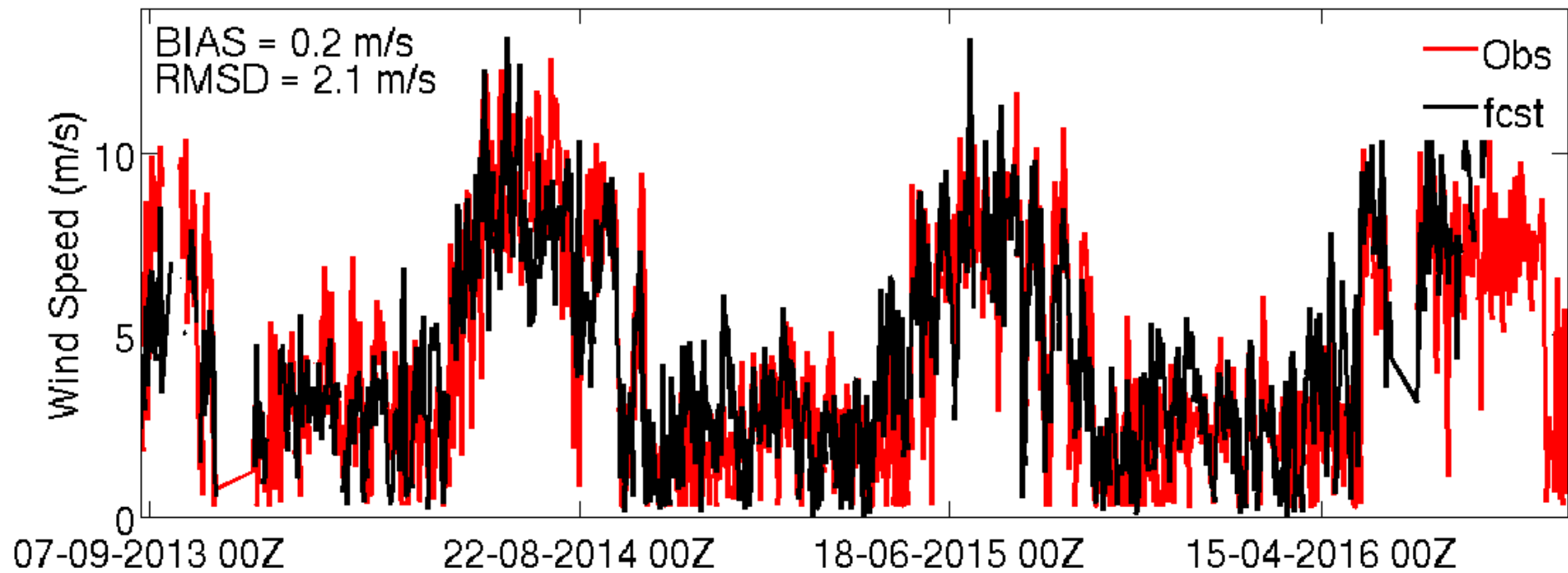
Dr. Raj Kumar

Plot of 15 min and 3 hours wind speed forecasts from the WRF model

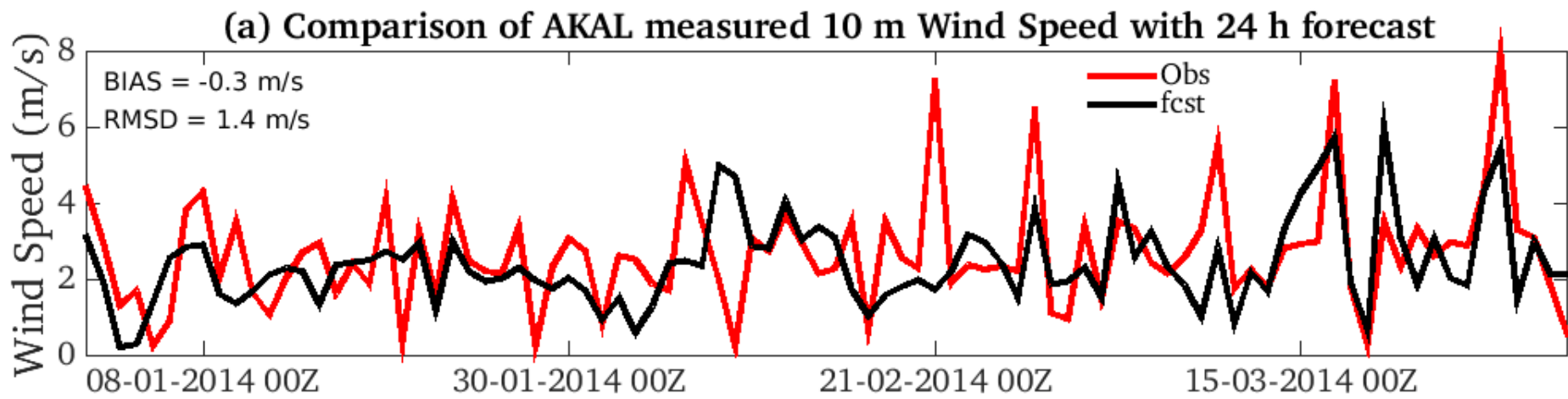
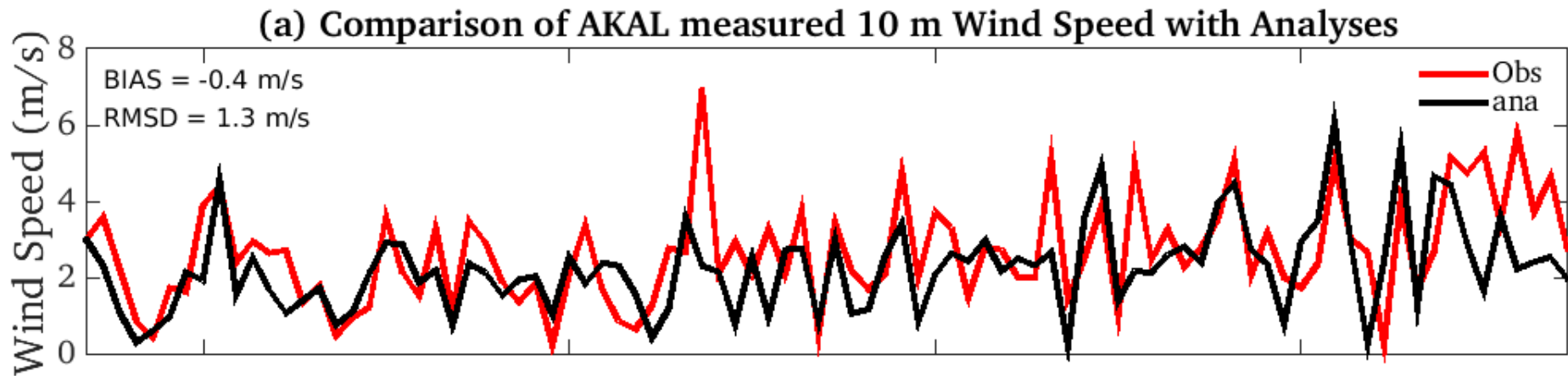


Verification of WRF model 24 hours wind speed forecasts with KAYATHAR measurements

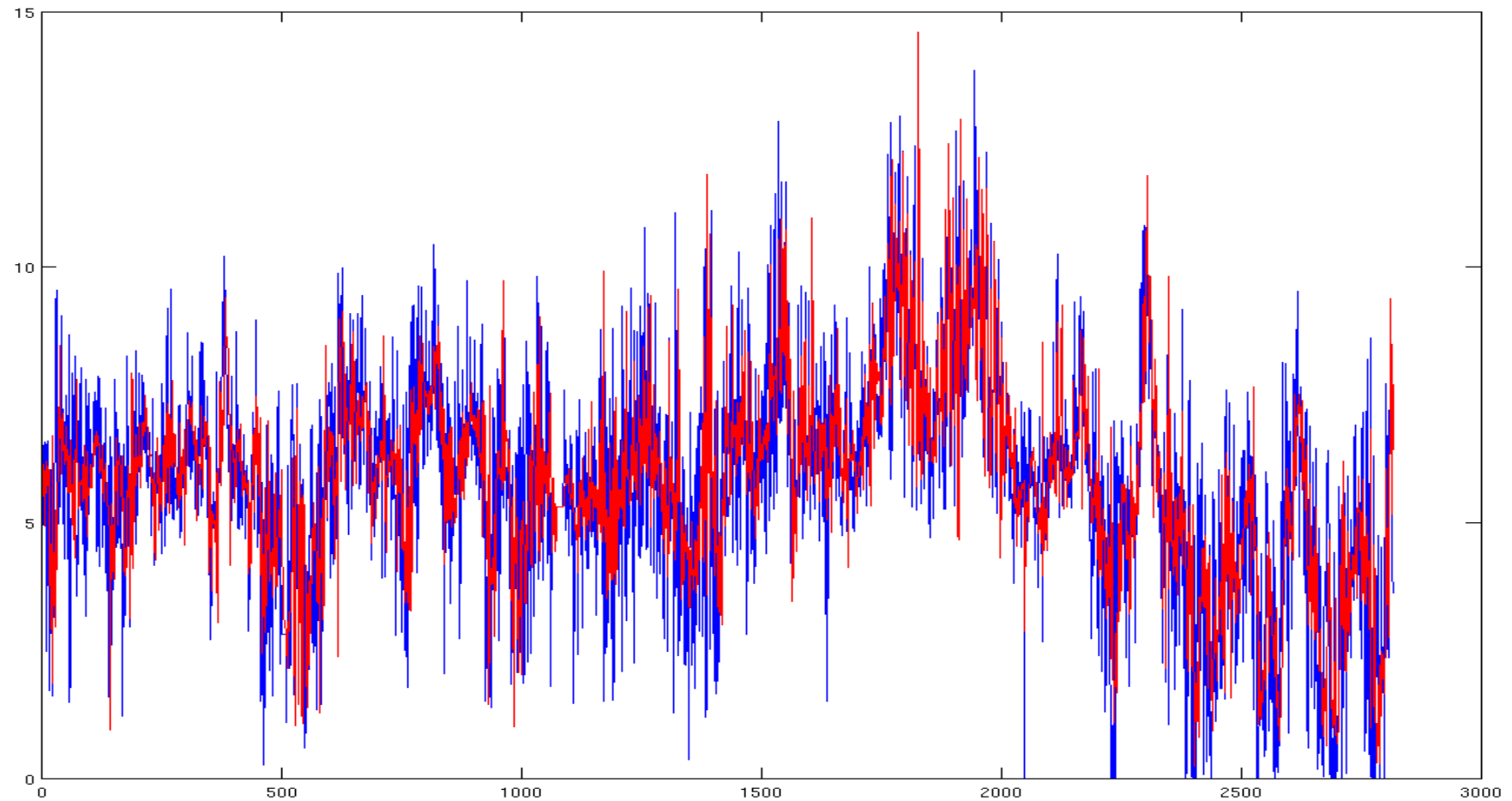
Comparison of KAYATHAR measured 10 m Wind Speed with WRF Forecasts



Verification of WRF model simulated wind speed analysis and forecasts with ground data



Station Specific Bias Correction of the WRF Wind Speed Forecasts



1/29/2018

Thank you