Ministry of Earth Sciences (MoES)
Summary of Important Developments –November, 2016

1. Important policy decisions taken and major achievements during the month: Provided in Annex I.

2. **Important policy aspects / matters held up on account of prolonged Inter- Ministerial consultations/ delays, etc.:** Nil

3.   **Compliance of COS decisions:**

S.No.	Number of COS decisions pending for compliance	Proposed action plan/timelines	Remarks
1.	Dt 14/08/2014 PROPOSAL FOR KRILL FISHING MoES, in collaboration with MEA, will study the experience of different countries showing varied interest in krill fishing so that India could learn from their experiences.MEA, in collaboration with MoES, will examine and identify the countries with which India can collaborate for krill fishing. MoES will ascertain the interest of Indian industry in krill fishing and also explore the feasibility of Indian companies collaborating directly with foreign companies MoESwill study legislations enacted by other member countries before finalising the draft legislation as part of international convention obligations. MoES will bring out a paper on krill fishing giving a detailed account of demand analysis, financial viability, interest of industry, experiences of other countries, criteria for fishing license, existing knowledge gap, etc. Thereafter, the CoS will meet again to decide whether India should engage in commercial krill fishing.	The Ministry has examined the aspect of Krill fishing. Japan & Norway have developed expertise and these countries have been tentatively identified for collaboration on Krill fishing. Their experiences have been obtained. Indian Industries have been approached for Krill fishing to ascertain their interests. However, so far we have not received any response. The draft paper is prepared and suggestions of Cabinet Secretariat have been obtained.	There is no response from the private industries for a long time. Accordingly, it is proposed to close this item for monthly reporting. As and when the response is received, the same will be reported.

4.   **Cases of sanction for prosecution pending in the Ministry for more than three months:** Nil

5.   **Particulars of cases in which there has been a departure from the Transaction of Business rules of established policy of the Government:** Nil

6.   **Status of implementation of e-Governance :** Under process/ being implemented

7.   **Status of Public grievances:**

No. Of Public Grievances redressed during the month	No. Of Public Grievances pending at the end of the month
20	45

8. Information on the specific steps taken by the Ministry/Department for utilization of the of the Space Technology based tools and applications in Governance and Development: Potential Fishing Zone advisories are generated using the satellite derived parameters viz. Sea Surface Temperature, and Chlorophyll. Further, data from Global satellite data are used on continuous basis for generating short range and medium range weather forecasts.

Important policy decision taken and major achievements:
1)   The Cyclonic Storm "NADA" over Bay of Bengal (BOB) was closely monitored and warnings were issued periodically during 29 Nov.-02 December, 2016 till the landfall on the Tamil Nadu coast.

2)   A dedicated Fog experimental campaign was launched at Indira Gandhi International Airport, New Delhi for collection of observations with a view to enhance fog prediction capability. The observation would be used to improve the Fog Prediction model, which will be made operational by 2017-18 winter season.

3)   Review of ongoing programmes of the Ministry of Earth Sciences were completed by Independent Committee of Experts and the details of continued programmes have been finalized. In addition, 5 different Independent Committees set up by the Ministry also evaluated the objectives and the progress of 5 autonomous institutions of the Ministry and recommendation have been submitted.

Minimum Government, Maximum Governance:
Agromet Advisories are being communicated to 254 lakh farmers of the country through mobile SMS.
Adverse weather SMS warning are being sent through mobiles to State Govt. officials / Disaster related officials /Central Govt. Organization/Common men.
Daily forecast along with warning and city forecast for many cities are disseminated through email to all users including state authorities, electronic and print Medias.

Atmospheric Observation Systems Network

Observation Type	Target	Commissioned up to November, 2016	Data reporting
Automatic Weather Station (AWS)	675	682	301
Automatic Rain Gauge(ARG)	1350	1341	473
GPS Sonde	10	43	43
Doppler Weather Radar(DWR)	23	20	20
Ozone	17	15	5
Black Carbon Monitoring Systems (Aethalometer)	16	16	16
Other Rain Gauges excluding ARG and AWS @	-	-	2526
Aviation	--	72	72
Agro-meteorology	267	264	160

@ Data received from various agencies viz. Air Force, Railways, Central Water Commission, State Agriculture, State Irrigation and ESSO-India Meteorological Department (IMD)

Atmospheric Processes, Modeling and Services
Monthly Weather Summary (November, 2016)
Depression over Bay of Bengal (BOB) during 02-06 November 2016: A depression formed over southeast Bay of Bengal (BOB) in the midnight of 2nd November. It moved initially west-northwestwards and then northwestwards to westcentral BOB till evening of 4th November. Thereafter, it recurved east-northeastwards and reached southeast Bangladesh coast close to Kutubdia in the afternoon of 6th. It weakened into a well marked low pressure area over southeast Bangladesh and adjoining northeast BOB in the evening of 6th.

Cyclonic Storm "NADA" over Bay of Bengal (BOB) during 29 Nov. - 02 December, 2016: A depression formed over southeast BOB in the evening of 29th November. It moved initially northwestwards and intensified gradually into cyclonic storm (CS) "Nada" over southeast BoB in the morning of 30th. It maintained its intensity till the evening of 1st December while moving west-northwestwards. It weakened into a deep depression (DD) in the noon of 1st December and further into a depression in the same midnight. Continuing to move west-northwestwards, it crossed north Tamil Nadu coast near Nagapattinam (about 20 km south of Karaikal) during

0400-0500 hours IST of 2nd December. Continuing to move westwards, it further weakened into a well marked low pressure area over interior Tamil Nadu in the forenoon of 02nd Dec. 2016

Snowfall: Nine (9) Western Disturbances(WD) approached western Himalayan region during the month. Out of 9, three (3) WDs caused light snowfall over the high reaches of Jammu & Kashmir.

Heavy rainfall: Heavy to very heavy rainfall occurred at isolated places over Tamilnadu on some of the days and over Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Gangetic West Bengal, Odisha and Coastal Andhra Pradesh on one or two days during the month.The forecast performance in term of skill scores for these events is given in following Table:

Rainfall Forecast(Percent correct)

Lead Time	No. of heavy Rainfall (Events)		
	16	5	21
	Heavy Rainfall (64.5 to 115.5mm)	Very Heavy Rainfall (>115.5mm)	Overall (>64.4mm)
24 Hour	98%	99%	98%
48 Hour	98%	99%	98%
72 Hour	98%	98%	98%

Most parts of the country experienced dry weather conditions outside south Peninsular India & northeastern states.

Fog: Dense fog was observed at isolated places over south Assam, Meghalaya, Nagaland, Manipur, Mizoram & Tripura on some of the days and over Uttar Pradesh, Punjab, Haryana   (including Delhi) on one or two days.

Rainfall in November, 2016
Rainfall during the month of November, 2016 was excess in 1, normal in 2, deficient/scanty in 20 and no rain in 13 of 36 meteorological sub- divisions. The rainfall for the country as a whole for the month has been recorded as 7.5 mm (-75%) against the normal rainfall for the month as 29.7 mm.

Impact of weather on Agriculture in the country during November 2016: Considering the forecast of heavy to very heavy rain very likely at isolated places over coastal Odisha and coastal West Bengal on 4th & 5thand heavy rain very likely at isolated places over north Coastal Andhra Pradesh on 4th, over Assam and Manipur on 5th and 6th, over Mizoram and Tripura on 4th, 5th and 6th Nov., advisories have been issued for adequate drainage in standing crop fields to avoid water stagnation with postponement of harvesting of *kharif* crops and sowing of mustard, green pea and nursery raising of cole crops in Odisha and sowing of mustard and raising of seedling of late varieties of cauliflower. In Rayalaseema, due to dry weather, moisture stress has been observed in castor (capsule development stage) and cotton (boll formation to boll bursting) crops in Ananthapuram district and irrigation to protect the crops from moisture stress was suggested.

Taking advantage of the dry weather during the month, harvesting of rice in Maharashtra, Chhattisgarh and Jharkhand, maize, moong and black gram in East Rajasthan, rice and pulses in Himachal Pradesh, Jammu & Kashmir and Uttarakhand, harvesting of *Aman* rice in West Bengal, *Sali*rice in Assam, harvesting of rice in Chhattisgarh,Odisha and Jharkhand is carried out.

Atmospheric Research
A high resolution coupled modelling system was implemented and tested for few cases at National Centre for Medium Range Weather Forecasting(NCMRWF). This coupled modelling system has an atmosphere model at 25 km horizontal /L85 vertical resolution and ocean at 25 km/L75 resolution with OASIS3 coupler and interactive sea-ice modules.

The runs of global ocean initialization system (25 km horizontal and L75 vertical resolution) based on NEMOVar, (variational data assimilation software for the NEMO ocean model) for the period June-October 2016 was completed and the near real-time runs of the system was started from 1st November 2016.

The 4 km mesoscale version of NCMRWF Unified Model (NCUM) running operationally was upgraded to more stable, reproducible and advanced version with 80 hybrid levels replacing the previous 70 levels. The operational nested model is optimized with the latest Intel compiler and with advanced parallelism. This upgrade had helped in improved efficiency of the system (50 % reduction in the wall Clock Time).

NCUM based city-scale model was set up at 330 m resolution for Delhi nested to 1.5 km convective scale model with initial and boundary conditions from 17km Global NCUM model. The 330m domain is tuned and tested for fog forecasting applications.   Preliminary tests reveal that the model predicted visibility (both timing and magnitude) is quite comparable with observations.

The latest high resolution (T382 spectral resolution) research version of the coupled model (CFS Version 2) has been used to generate the experimental forecast for the 2016 North-East (NE) Monsoon season rainfall (over Indian region) using the October initial conditions with 42 ensembles. Predictions are made available at http://www.tropmet.res.in/monsoon/seasonal/ .

The experimental real-time extended range prediction based on 22nd November 2016 initial condition has been generated & made available at http://www.tropmet.res.in/erpas/. Rainfall, Maximum & Minimum temperatures, MJO forecast, soil moisture (0-10cm), Relative humidity and cyclogenesis predictions are also available in the same link.

Monsoon Weather Reports, Maps and Crop Yield Forecast
Daily All India Weather Summary and Weekly Weather Reports are being brought out on routine basis.
Four (4) weekly and cumulative Standardized Precipitation Index (SPI) maps were prepared for the weeks ending 2nd, 9th, 16th, 23rd & 30th November 2016.
Four (4) Drought Outlook Maps based on Aridity Anomaly Index for drought monitoring for the weeks ending 4th, 11th,18th & 25th November 2016 has been prepared and five (5) Weekly Aridity Anomaly maps & reports were prepared for the week ending 26th Oct., and 2nd, 9th ,16th, 23rd November 2016 were prepared.
Two (2) biweekly aridity maps and reports for the period 22 Oct. to 04 Nov. & 05-18 November 2016 has been prepared.
Climate Diagnostics Bulletin of India for September, June-September (Monsoon Season) and October 2016 were brought out.
Enso bulletin for the month of November 2016 & Seasonal Outlook for South Asia for October, 2016 were issued.

Geoscience Research

Seismological Observational Network

Observation Type	Target for XII Plan	Commissioned so far	Data reporting during the month
Seismic stations	130	99	69
GPS stations	40	28	22

Earthquake and Tsunami monitoring
Earthquake: 22 earthquakes were monitored in the Indian region out of which 2 events were greater than magnitude (M) of 5.0.

Tsunami: 5 major seabed earthquakes(M> 6) with a potential to generate tsunami were monitored. This information was provided within 12 minutes of occurrence of all the events.

Ocean Observation System

Type of Platform	Target	Commissioned till November, 2016	Data received during November, 2016
Argo Floats	200	283	132
Drifters	150	98	8
Moored Buoys	16	19	17
Tide Gauges	36	30	23
High Frequency(HF) Radars	10	10	7
Current Meter Array	10	11	5
Acoustic Doppler Current Profiler(ADCP)	20	21	18
Tsunami Buoys	7	9	6
Wave Rider Buoy	16	15	15

*The remaining floats/drifters have completed their life time and as such no data can be received from them.

Ocean Science Services

No	Types of forecasts	No. of advisories issued during the month
1	Integrated Potential Fishing Zone (PFZ) advisories (Sea Surface Temperature(SST), Chlorophyll., wind)	31
2	Tuna Fishing Advisories	31
2	Ocean State Forecast(OSF)-Wave, Wind, Currents, SST, MLD and D20 forecasts	31
3.	Near Real time global ocean analysis (5-day averaged)	6
4.	Real time global ocean analysis (daily)	10
5.	Coral Bleaching Alert System	25

Rough sea alert was issued for Kerala, Southern Tamil Nadu and West Bengal during November 4- 8, 2016. Ttidal flooding alerts (for Indian coastline as well as for Sri Lanka, Maldives, Seychelles) were also issued during November 12-16, 2016 in connection with the Perigean Full Moon of November 14, 2016

Ocean Technology

As a part of the collaborative programme with Central Institute of Brackishwater Aquaculture a square type floating cage system with 40 m^3 cultivable volume was developed and deployed in Venangupattu backwaters for growing seabass fingerlings.

Coastal Zone Management

Biophysical vulnerability of coastal areas to climate change was carried out for three coastal states namely Andhra Pradesh, Odisha and Maharashtra . The coastal vulnerability index (CVI) for every 1Km of the coastal stretch was calculated for different scenarios to identify the highly vulnerable coastal stretches. Based on model outputs, coastal stretches with high CVI were identified for coastal protection measures.

Swath Bathymetric Survey of Exclusive Economic Zone

An area of 47,800 sq km was surveyed with acquisition of bathymetric data.

Capacity Building and Outreach

On request from Ministry of New and Renewable Energy(MNRE), NCMRWF has organized training on "Basic NWP, data and methods to use the Numerical Weather Prediction(NWP) data for renewable energy applications" for 27 MNRE officials during 03-07 October 2016.

The Hon'ble Chief Minister of Kerala inaugurated the one day workshop on Climate Variability in Kerala: Climate Change Perspectives on 21st November 2016 convened under the joint collaboration of IMD, Institute of Climate Change Studies (ICCS), Thiruvananthapuram and State Disaster Management Authority (SDMA), Kerala.

A training course was organized on "Indian Ocean Currents: Data, Processing and Applications" during November 7-11, 2016. Twenty (20) participants attended this course from various national institutes. Faculties were drawn from CSIR-National Institute of Oceanography, Goa, National Institute of Ocean Technology, Chennai and INCOIS, Hyderabad and CODAR,USA.

A training programme on Marine Weather forecasting for Merchant Navy Officers was conducted in collaboration with AMET University, Chennai on 16 November 2016 to have wide out-reach and usage of the Ocean State Forecast products by the officers of passenger and cargo ships. Sixty two (62) Merchant Navy and related officers attended the training.

A workshop on "Eddy Covariance and GHG Flux Estimation" was organized at Indian Institute of Tropical Meteorology(IITM) during 7-12 November 2016 to train young people involved in different aspects of Green House Gases (GHGs) research in India. About Twenty Junior Research Fellow and early career scientists having diverse background ranging from greenhouse gas emission in crops, agro-forestry, net ecosystem exchange, surface energy flux, etc participated in this workshop.

A Workshop on Aviation Weather Observation and Forecast Procedures & Recent Development was organised during 08-09 November 2016 at Kolkata.

World Meteorological Organisation (WMO) group training course on Instrument Maintenance and calibration commenced from 15 November,2016 for 8 participants from different countries.

On request from Tamil Nadu Fisheries University, five days training programme on "RS and GIS applications in fisheries and CZM" was carried out from Nov 28-Dec 2, 2016 for their BFSC students and about 45 trainees participated in the programme.

Vigilance Awareness Week was observed during 31.10.2016 to 06.11.2016. Slogan competitions and essay competitions were arranged on the theme "Public participation in promoting integrity and eradicating corruption" in the Ministry and organisations under the administrative control.

Utilization of Ocean Research Vessels during the month

Vessel	Days at Sea / Utilization	Maintenance/ Inspection /Scientific Logistics / Cruise Preparation	No. of Cruise	No. of Port Calls / Port Stay/ Statutory survey
Sagar Nidhi	26	4	2	-
Sagar Manjusha	0	30(Dry Dock)	0	0
Sagar Purvi	0	30(Dry dock)	0	0
Sagar Kanya	20	10	1	-
Sagar Sampada	28	2	2	0

Publications in Science Citation Index(SCI) journals and PhDs awarded

Subject	Publications			Ph.Ds		
	April-October,2016	November, 2016	Total	April-October,2016	November, 2016	Total
Atmospheric Sciences	109	11	120	3	-	3

Ocean Science and Technology	35	6	41	1	-	1
Polar Sciences	24	-	24	-	-	-
Geosciences and resources	7	-	7	-	-	-
Total	175	17	192	4	-	4