Ministry of Earth Sciences (MoES)
Summary of Important Developments –December, 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 prlonged 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
52	23

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.

Annex-I

Important policy decision taken and major achievements:

The Cyclonic Storm "VARDAH" over Bay of Bengal (BOB) rated as "Very Severe"' was closely monitored and warnings were issued periodically during 6-13 December, 2016 till the landfall on the Tamil Nadu coast.

Seasonal outlook for the temperatures during cold weather season (December 2016 to February 2017) indicates that during the coming Cold Weather Season (December 2016 to February 2017), warmer than normal maximum and minimum temperatures are likely in all the meteorological sub-divisions of the country and warmest temperature anomalies are likely in majority of the subdivisions from northwest & northeast India. Below normal Cold Wave (CW) conditions are very likely over core cold weather zone (North India) during the season.

Minimum Government, Maximum Governance:

Agromet Advisories are being communicated to 194 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 media.

Atmospheric Observation Systems Network

Observation Type	Target	Commissioned up to December, 2016	Data reporting
Automatic Weather Station (AWS)	675	682	361
Automatic Rain Gauge(ARG)	1350	1341	485
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 @	-	-	2454
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 India Meteorological Department (IMD)

Atmospheric Processes, Modeling and Services

Monthly Weather Summary (December, 2016)

Very Severe Cyclonic Storm "VARDAH" over Bay of Bengal (06-13 December 2016): A depression (D) developed over southeast Bay of Bengal (BOB) in the afternoon of 6th December moving northwestwards initially and northwards thereafter, it intensified into a deep depression (DD) in the midnight of 7th December, later into a cyclonic storm (CS) "**VARDAH**" in the morning of 8th and into a severe cyclonic storm (SCS) in the midnight of 9th. It then moved west-northwestwards and intensified further into a very severe cyclonic storm (VSCS) over westcentral and adjoining south BOB in the evening of 10th December. It then moved nearly westwards and reached its peak intensity of about 130 kmph on 11th December evening and maintained the same intensity till noon of 12th December. It weakened into an SCS and crossed north Tamil Nadu coast near Chennai during 1500-1700 hrs IST of 12th December 2016 with a wind speed of 100-110 kmph gusting to 120 kmph. Isolated extremely heavy rainfall over Chennai, Kancheepuram, Tiruvallur, andVillupraum districts of Tamil Nadu. Heavy to very heavy rainfall occurred at a few places over Vellore, Krishnagiri, Tiruvannamalai districts of Tamil Nadu, Nellore district of coastal Andhra Pradesh and Chittor, Anantapuram & Cuddapah districts of Rayalaseema. During genesis stage, cyclone Vardah caused heavy to very heavy rainfall at a few places over Andaman and Nicobar Islands on 7-10th December with isolated extremely heavy rainfall on 8th December. In addition, heavy to

very heavy rainfall occurred at isolated places over Tamilnadu and Andaman & Nicobar Islands and over Rayalaseema, Coastal Andhra Pradesh on one or two days during the month. The performance in term of skill of spatial warnings 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 over Peninsular India; some parts of western Himalayan region, northeastern states and adjoining east India.

Fog: Dense/very dense fog was observed at many/few places over Indo-Gangetic Plains on many days and few/isolated places over Assam, Meghalaya, Nagaland, Manipur, and Mizoram & Tripura on few days. The skill performance in terms of spatial warnings is provided below:

Lead Time	Skill (% correct)
24 Hour	87%
48 Hour	85%
72 Hour	85%

Rainfall in December, 2016

Rainfall during the month of December, 2016 was excess in 5, normal in 0, deficient/scanty in 18 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 8.3 mm (-50%) against the normal rainfall for the month as 16.6 mm.

Atmospheric Research

Based on the operational 33km/44-member Global Ensemble Prediction System(NGEPS) of National Centre for Medium Range Weather Forecasting(NCMRWF), provides probabilistic forecasts of daily Maximum (*Tmax*) for three thresholds of temperature less than 25, 20 and 15 degree Celsius and Minimum (*Tmin*) Temperatures less than 15, 10 and 5 degree Celsius during winter months of December to February. A higher resolution (17 km) version of NCMRWF Global Ensemble Prediction System (NGEPS) was developed and successfully tested with 22 members.

NCUM based city-scale model set up at 330 m resolution for Delhi for fog forecasting applications has been made operational by NCMRWF.

A high resolution (4 km) regional assimilation system has been set up for the Indian region and radial wind observations from various Indian Doppler Radars are assimilated experimentally.

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 7th , 14th, 16th, 21st,& 28th December 2016.

Five (5) Drought Outlook Maps for drought monitoring & five (5) Weekly Aridity Anomaly maps & reports were prepared for the weeks ending 2nd , 9th,16th& 23rd& 31st December 2016.

Three (3) biweekly aridity maps and reports for the period 19 Nov to 02 Dec.,3-16 and 17-31December 2016 have been prepared.

Geoscience Research

Seismological Observational Network

Observation Type	Target for XII Plan	Commissioned so far	Data reporting during the month
Seismic stations	130	99	59
GPS stations	40	28	22

Earthquake and Tsunami monitoring

Earthquake: 19 earthquakes were monitored in the Indian region out of which 1 event was greater than magnitude (M) of 5.0.

Tsunami**:** 8 major seabed earthquakes(M> 6) with a potential to generate tsunami were monitored. This information was provided within 12 minutes of occurrence in respect of 6 events and between 12 to 15 minutes of occurrence in respect of remaining 2 events.

Ocean Observation System

Type of Platform	Target	Commissioned till December, 2016	Data received during December, 2016
Argo Floats^	200	288	137
Drifters*	150	98	6
Moored Buoys	16	19	15
Tide Gauges	36	30	24
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)	30
2	Tuna Fishing Advisories	30
2	Ocean State Forecast(OSF)-Wave, Wind, Currents, SST, MLD and D20 forecasts	30
3.	Near Real time global ocean analysis (5-day averaged)	6
4.	Real time global ocean analysis (daily)	30
5.	Coral Bleaching Alert System	10

Polar Science

36th Indian Scientific Expedition team left for Antarctica to pursue multidisciplinary studies. The Southern Ocean expedition for studying polar ocean ecosystem in the context of regional and global climate variabilities is being separately launched.

Ocean Technology

A patent has been awarded to National Institute of Ocean Technology(NIOT) for the invention of a broad band underwater transducer for Marine applications.

Swath Bathymetric Survey of Exclusive Economic Zone

An area of about 37,000 sq km swath was surveyed with acquisition of bathymetric data.

Vigilance

Two Independent External Monitors were appointed to ensure transparency, and integrity in the tender process for the tenders exceeding value of Rs. 5 crore in Ministry and all the organisations/attached/subordinate offices of the Ministry.

Capacity Building and Outreach

India – UK water centre organised workshop on developing Hydro-climatic services for water security from 29 November – 1st December, 2016 in Indian Institute of Tropical Meteorology(IITM)..

Ministry and its organizations participated in India International Science Festival held at National Physical Laboratory, New Delhi held from 7-11 December, 2016. Various exhibits including the Air Quality Monitoring System installed on Mobile van were displayed alongwith a quiz on earth science for the students. Earlier, the Ministry participated in the India International Trade Fair at Pragati Maidan, New Delhi.

Centre for Advanced Training, IITM Pune organized three days National Workshop on "Numerical Weather Prediction(NWP) on Probabilistic Forecast" during 6-8 December, 2016 at IITM Pune.

A workshop on " The Air Quality Index: Laying the Foundation for Effective Air Pollution Health Risk Communication" was organized in Ahmedabad on 13-14 December 2016 by *Natural Resources Defense Council* (*NRDC*) and Indian Institute of Public Health, Gandhinagar (*IIPH*) , in collaboration with Ahmedabad Municipal Corporation (AMC) and IITM, to discuss the way to strengthen health risk communication and develop a city air plan for Ahmedabad and to review ongoing installation work of air quality monitoring systems in Ahmedabad and Gandhinagar city.

IMD in collaboration with Indian Institute of Technology (IIT), Bhubaneswar organised a Colloquium on Tropical Cyclones at Bhubaneswar during 14-16 December 2016.

A refresher course on Application of ensemble Prediction System for Short and Medium Range Weather Forecasting was co-organised by IITM, IMD and NCMRWF at IITM Pune during 6-8 December 2016.

A five-day workshop on Doppler Radar was conducted at Chennai during 05-09 December 2016 for Indian Air Force personnel.

Indian Meteorological Society in association with IMD organised Tropmet-2016: National Symposium on Tropical Meteorology, Climate Change and Coastal Vulnerability during 18-21 December 2016 at Bhubaneswar.

Sixteen Naval Meteorological Observers from School of Naval Oceanology & Meteorology were given on-job-training (OJT) at IMD HQ during 26-31 December 2016.

The final phase of Student Autonomous Underwater Vehicle(AUV) Competition SAVe 2017 was held on 14thDecember 2016 NIOT, Chennai Six teams from various Institutes demonstrated their working AUVs. Indian Institute of Technology Bombay was awarded the First Place.

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	27	4	2	-
Sagar Manjusha	-	31(Dry Dock)	-	-
Sagar Purvi	1	30(Dry dock preparation)	-	-
Sagar Kanya	22	9	2	-
Sagar Sampada	24	7	2	-

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

Subject	Publications			Ph.Ds		
	April-November,2016	December, 2016	Total	April-November,2016	December, 2016	Total
Atmospheric Sciences	120	15	135	3	1	4
Ocean Science and Technology	41	2	43	1	1	2
Polar Sciences	24	2	26	-	-	-
Geosciences and resources	7	1	8	-	-	-
Total	192	20	212	4	2	6