Ministry of Earth Sciences
India Meteorological Department
Cyclone Warning Division, New Delhi

FDP (Cyclone) NOC Report Dated 29th November, 2021

Time of Issue: 1200 UTC

Synoptic features (based on 0900 UTC analysis):

- Yesterday's cyclonic circulation over Comorin area & adjoining Sri Lanka coast, extending upto 1.5 km above mean sea level persisted over the same region at 0900 UTC of today, the 29th November.
- A Low Pressure Area (LPA) is likely to form over south Andaman Sea around 30th November, 2021. It is likely to move west-northwestwards and concentrate into a Depression over Southeast & adjoining Eastcentral Bay of Bengal (BoB) during subsequent 48 hours.
- A trough at mean sea level runs from southeast Arabian Sea (AS) to Eastcentral AS off Karnataka coast and extends upto 1.5 km above mean sea level.
- Another Low Pressure Area is likely to form over Eastcentral AS off Maharashtra coast around 01st December, 2021.

Dynamical and thermo-dynamical features

Parameter	Bay of Bengal (BoB)	Arabian Sea (AS)
Sea Surface Temperature (SST) °C	29-31°C over entire BoB region.	28-29°C over eastern parts of AS. 26-27°C over western parts of AS off Somalia, Yemen & Oman coasts.
Tropical Cyclone Heat Potential (TCHP) kJ/cm^2	(a) 120-130 over Gulf of Thailand, eastern equatorial Indian Ocean and adjoining south Andaman Sea & southeast BoB. (b) 60-90 over major parts of central & north BoB with gradual decreasing trend towards the coastline of India	(a) 50-60 over eastern parts of AS (b) It is less than 50 over western parts of AS and along & off Oman, adjoining Yemen & Somalia coasts.
Cyclonic Relative vorticity at 850 hPa (X10^{-6}s^{-1})	100 over Gulf of Thailand with vertical extension upto 500 hpa level. Another zone of positive vorticity about 50-60 over south China Sea. 40-50 over equatorial Indian Ocean to the south of Sri Lanka and Comorin area with vertical extension upto 500 hPa level.	Small pockets of 30-40 over southeast AS and adjoining southwest AS extending upto 500 hPa.

Low Level convergence ($X10^{-5}$ s^{-1})	About 30 over Gulf of Thailand . 05-10 over south Andaman Sea.	05-10 over southeast AS off Kerala-Karnataka coasts. Another pocket of 05-10 over southeast AS.
Upper Level divergence ($X10^{-5}$ s^{-1})	A large extended zone of 05-30 over Gulf of Thailand, Andaman Sea and southeast BoB.	A large extended zone (north-south oriented) over Comorin upto north Andhra Pradesh. It is also extending westwards over south AS & adjoining equatorial Indian Ocean.
Vertical Wind Shear (VWS knots)	Moderate (15-20) over Gulf of Thailand, north Andaman Sea and central BoB.	Low to moderate (05-20) over Comorin Area, southeast and adjoining southwest AS.
Wind Shear Tendency (knots)	Decreasing over Gulf of Thailand, north Andaman Sea and central & adjoining north BoB.	Decreasing over southeast AS, and Comorin Area.
Upper tropospheric Ridge	Along 15.0°N	Along 15.0°N.
Trough in Westerlies		A trough lies near 12^0N/55^0E over westcentral AS.

Satellite observations based on INSAT imagery (0900 UTC):

(b) Bay of Bengal & Andaman Sea:
At 0900 UTC, scattered low & medium clouds with embedded intense to very intense convection lay over south Andaman Sea. Minimum cloud top temperature is minus 90 deg C. Scattered low & medium clouds with embedded moderate to intense convection lay over westcentral and south BoB and north Andaman Sea.

(b) Arabian Sea
At 0900 UTC, scattered to broken low & medium clouds with embedded intense to very intense convection lay over south AS and Comorin area. Minimum cloud top temperature is minus 80 deg C.

M.J.O. Index:
MJO index is currently in Phase 5 with amplitude close to 1. It will remain in same phase during next 1 day. Thereafter, it will move to phase 6 with amplitude becoming more than 1 from 1st December onwards. Thus, MJO phase is conducive for enhancement of convective activity and hence cyclogenesis during next 2-3 days.

Storms and Depression over South China Sea/ South Indian Ocean:
2 intense convective areas are seen over Gulf of Thailand and adjoining South China Sea. The invest zone is located near 7.9N/106.6E. The convection has organized over the region during past 24 hours. Total precipitable water imagery at 0735 UTC indicates warm moist air incursion into the core of system.

NWP Input for FDP Cyclone based on 0000 UTC for the next 7 days

Model	BoB	AS
IMD-GFS	Indicates a broad-scale low over Gulf of Thailand and adjoining south China Sea on 29th, its rapid intensification into a **Depression** over east coast of Thailand during the night of 30th, its emergence over **south Andaman Sea** and intensification into a **Cyclonic Storm** (CS)	Indicates a broad-scale low over southeast AS off Lakshadweep area on 30th November, getting amplified as a trough of Low from

	at 18 UTC of 30th, persistence over south Andaman Sea on 1st December, its rapid intensification into an Extremely Severe Cyclonic Storm (ESCS) over southeast & adjoining east-central BoB on 2nd December, over east-central & adjoining west-central BoB on 3rd, over west-central BoB, very close to north Andhra Pradesh coast on 4th, moving northeastwards, skirting north Andhra Pradesh coast and crossing south Odisha coast with very severe intensity around 0600 UTC of 4th , weakening and as a Severe Cyclonic Storm (SCS) over southern parts of Gangetic West Bengal on 5th.	southeast to east-central AS on 1st December, upto north Maharashtra coast on 2nd and dissipation on 3rd .
IMD-GEFS	Same as above. (Based on the 1200 UTC run of 28th November)	Same as above(Based on the 1200 UTC run of 28th November)
IMD-WRF	An extended Low over south Andaman Sea and adjoining Thailand on 30th November, an LPA over south Andaman Sea on 1st December & rapid intensification into a CS over southeast BoB and adjoining Andaman Sea on 2nd December (0000 UTC)	An extended Low over Lakshadweep and adjoining southeast AS on 29th November, an LPA over southeast AS on 30th November and as a broad-scale Low over southeast AS and adjoining Equatorial Indian Ocean (EIO) on 2nd December.
NCMRWF-NCUM(Global)	Indicates an LPA over Malacca strait on 30th November, over south Andaman Sea and adjoining Malacca strait on 1st December, as a Well Marked Low (WML) over Andaman Sea & adjoining Islands on 2nd, as a Depression over east-central & adjoining southeast BoB on 3rd, as a CS over west-central BoB off Andhra Pradesh coast on 4th and as an SCS over northwest & adjoining west-central BoB off south Odisha - north Andhra Pradesh coasts on 5th.	An LPA over southeast AS off Lakshadweep area on 30th, as an extended Low over southeast & adjoining east-central AS on 1st December and weakens into a trough of Low over the same region on 2nd December.
NCMRWF-NEPS	Similar to NCUM-G	Similar to NCUM-G
NCMRWF-UM (Regional)	An LPA over Malacca Strait on 30th November, a WML over south Andaman Sea on 1st December and a Depression over southeast BoB and adjoining Andaman Sea on 2nd.	An extended Low over southeast AS and adjoining Lakshadweep area on 30th November, over southeast & adjoining east-central AS on 1st December and over east-central & adjoining northeast AS off north Maharashtra – Gujarat coasts on 2nd.

ECMWF	An LPA over south Andaman Sea off Thailand coast at 1500 UTC of 30th November, an LPA over south Andaman Sea on 1st December, as a WML over southeast BoB and adjoining Andaman Sea on 2nd, as a Depression over southeast BoB at 1500 UTC of 2nd, as a Deep Depression (DD) over west-central BoB at 2100 UTC of 3rd and very close to Andhra Pradesh coast at 00 UTC of 4th, further intensification into a CS with a very small core over the same region at 06 UTC of 4th , crossing south Odisha – north Andhra Pradesh coasts around 1500 UTC of 4th and weakening into a Depression over south coastal Odisha at 00 UTC of 5th.	Indicates an extended Low over southeast AS off Lakshadweep area on 29th November, over southeast AS on 30th November, as an LPA over east-central AS on 1st December, as a WML over east-central AS off north Maharashtra coast on 2nd and weakening on 3rd.
ECMWF-EPS	90-100 % probability of cyclogenesis / strike over Andaman Sea & southeast BoB on 2nd December, over Andaman Sea, southeast & west-central BoB on 3rd, 90-100 % over southeast & central BoB and 70-80% over north coastal Andhra Pradesh on 4th and 90-100 % over west-central BoB and 80-90% over south coastal Odisha on 5th.	80-90% genesis & strike probability over east-central AS on 2nd December, over east-central & northeast AS on 3rd , 60-70 % over east-central & northeast AS and north Maharashtra – south Gujarat coasts on 4th.
NCEP-GFS	Indicates an LPA over Gulf of Thailand on 30th November, as a Depression over Andaman Sea on 1st Dec., as a CS over southeast BoB and adjoining Andaman Sea on 2nd December, as a Very Severe Cyclonic Storm (VSCS) over west-central & adjoining east-central BoB on 3rd, as an ESCS over west-central & adjoining northwest Bob off north Andhra Pradesh – south Odisha coasts on 4th and moving along Odisha coast and weakening into a WML over northwest BoB off west Bengal coast on 5th.	Indicates an extended Low over southeast AS and adjoining Lakshadweep area on 30th Nov., as a trough of Low from southeast to east-central AS on 1st December, from east-central to northeast AS on 2nd and weakening on 3rd.
IMD-GPP	Potential zone (very small) over equatorial Indian Ocean (EIO) to the south of Sri Lanka on 29th, over south Andaman Sea & adjoining Gulf of Thailand on 30th November, over south Andaman Sea on 1st December, over southeast BoB & adjoining Andaman Sea on 2nd , over west-central & adjoining southwest BoB on 3rd, over northwest BoB off Odisha coast on 4th and over northwest BoB off West Bengal coast on 5th.	Potential zone over southeast AS to the west of Comorin area on 30th November.

GPP- Genesis Potential Parameter based on Dynamical Statistical model developed by IMD.

Summary and Conclusion:

1. **For the Bay of Bengal**: All the models indicate formation of a Low Pressure Area (emergence of a Low Pressure system from Gulf of Thailand) over south Andaman Sea around 30th with initial west-northwestward movement, deepening into a Depression around 2nd night (1500 UTC) or 3rd December early morning (0000 UTC), and continued west-northwestward movement towards west-central Bay of Bengal and further intensification into a Cyclone of severe category. However, GFS group of models are indicating cyclogenesis

around 1st December (IMD GFS, even prior to that) over Andaman Sea itself. However, still there is large diversity in the temporal phase of intensification as well as the speed of movement. The timing of the Depression formation varies from 1800 UTC of 30th November (as in IMD GFS) to 1800 UTC of 3rd December (as in NCUM & NEPS). Location of formation of Depression also varies from south Andaman Sea (IMD GFS) to west-central BoB (NCUM & ECMWF). Peak intensity ranges from a CS (by ECMWF) to ESCS (IMD GFS). The major change noticed based on the 00 UTC runs of 29th November is the deviation from the consensus regarding Landfall. A few of the models are indicating that the system may skirt Andhra Pradesh – Odisha coasts on 4th & 5th (as in NCEP-GFS, GPP & NCUM & NEPS), a few others like IMD GFS and ECMWF continue to indicate crossing south Odisha – north Andhra Pradesh coasts(ranging from 0600 to 1500 UTC of 4th December).

2. **For the Arabian Sea**: No cyclogenesis is indicated buy any of the models during next 7 days.

It may thus be concluded that,

1. Emergence of a Low pressure system from Gulf of Thailand into south Andaman Sea is likely on 30th November. It is likely to move west-northwestwards with gradual intensification during 1st & 2nd December. Further it could continue to move west-northwestwards and concentrate into a Depression over southeast & adjoining east-central Bay of Bengal during 2nd night (1500 UTC) to 3rd December early morning (00 UTC). Owing to the temporal variation in the period of formation of the Depression by different models, we are assigning a 'LOW' probability starting from the 48- 72 hrs forecast period itself.
2. No significant development is likely over the Arabian Sea, apart from the probable amplification of a trough of Low along the west coast of India and formation of an embedded Low over east –central Arabian Sea off north Maharashtra coast around 1st December & an in-phase interaction with a mid-latitude trough in the mid & upper tropospheric westerlies during 1st – 2nd December.

Probability of cyclogenesis (formation of depression and above intensity systems) over the Bay of Bengal and Andaman Sea during next 168 hours:

24 HOURS	24-48 HOURS	48-72 HOURS	72-96 HOURS	96-120 HOURS	120-144 HOURS	144-168 HOURS
NIL	NIL	LOW	MODERATE	HIGH	HIGH	LOW

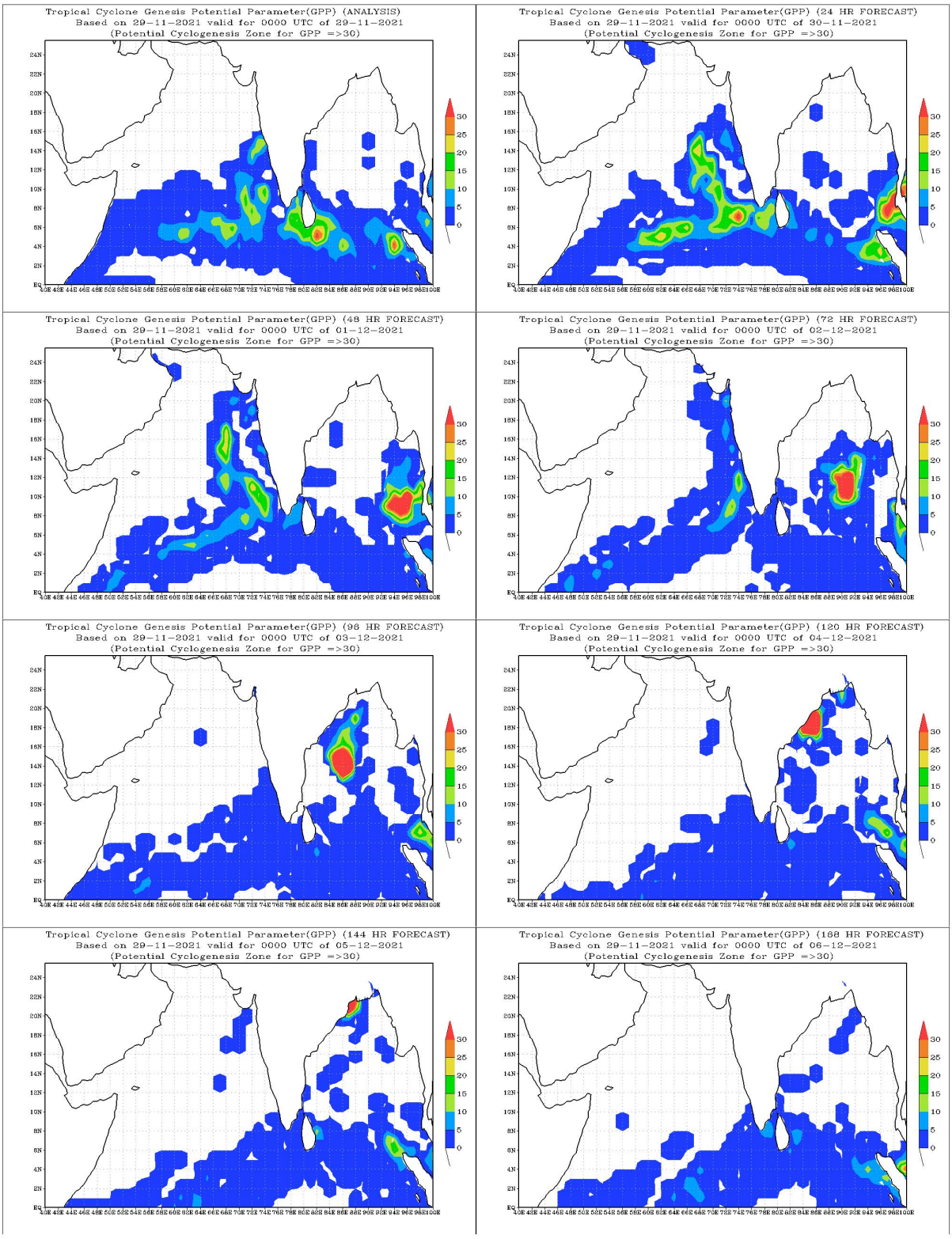
Probability of cyclogenesis (formation of depression and above intensity systems) over the Arabian Sea during next 168 hours:

24 HOURS	24-48 HOURS	48-72 HOURS	72-96 HOURS	96-120 HOURS	120-144 HOURS	144-168 HOURS
NIL	NIL	NIL	NIL	NIL	NIL	NIL

Advisory: The emergence of a Low pressure system from Gulf of Thailand to Andaman Sea as a Low pressure area around 30th November and it's subsequent intensification and movement to be monitored regularly.

IOP is suggested for Andaman & Nicobar Islands on 30th November & 1st December and for Andhra Pradesh coast on 4th December.

Annexure


Tropical Cyclone Genesis Potential Parameter(GPP) (ANALYSIS)
Based on 29-11-2021 valid for 0000 UTC of 29-11-2021
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (24 HR FORECAST)
Based on 29-11-2021 valid for 0000 UTC of 30-11-2021
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (48 HR FORECAST)
Based on 29-11-2021 valid for 0000 UTC of 01-12-2021
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (72 HR FORECAST)
Based on 29-11-2021 valid for 0000 UTC of 02-12-2021
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (96 HR FORECAST)
Based on 29-11-2021 valid for 0000 UTC of 03-12-2021
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (120 HR FORECAST)
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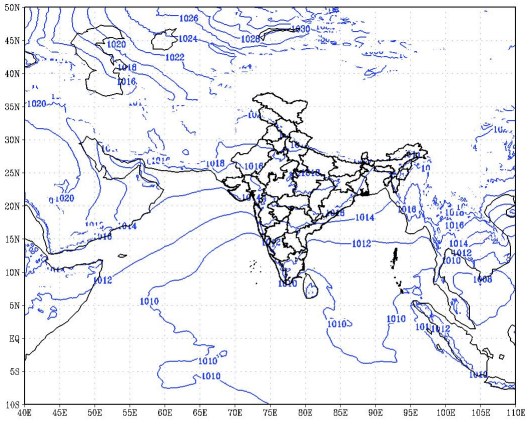
Tropical Cyclone Genesis Potential Parameter(GPP) (144 HR FORECAST)
Based on 29-11-2021 valid for 0000 UTC of 05-12-2021
(Potential Cyclogenesis Zone for GPP =>30)
Tropical Cyclone Genesis Potential Parameter(GPP) (168 HR FORECAST)
Based on 29-11-2021 valid for 0000 UTC of 06-12-2021
(Potential Cyclogenesis Zone for GPP =>30)

IMD :GFS MODEL(12 Km) MSL Pressure (hPa) FORECAST (00 HR)
based on 00 UTC of 29-11-2021 valid for 00 UTC of 29-11-2021



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IMD GFS (T1534) 10m WIND (kt) AND 2m RH (%) FORECAST (00 HR)
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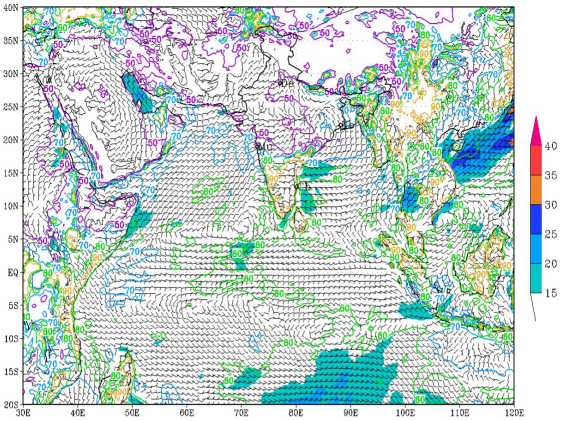

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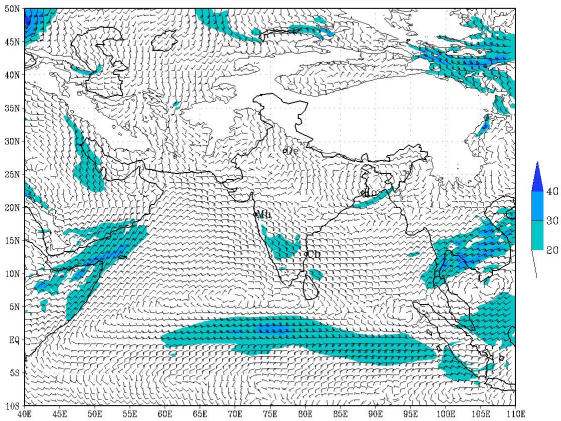

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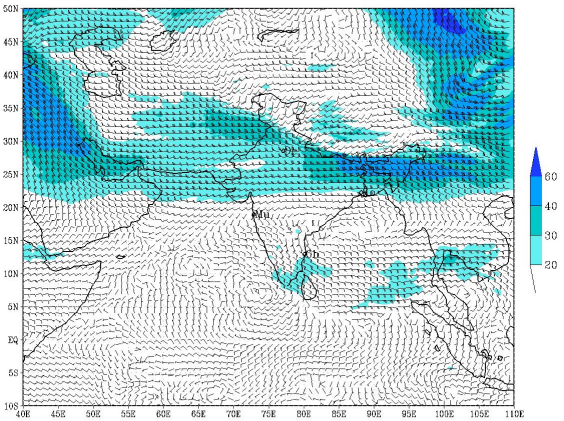

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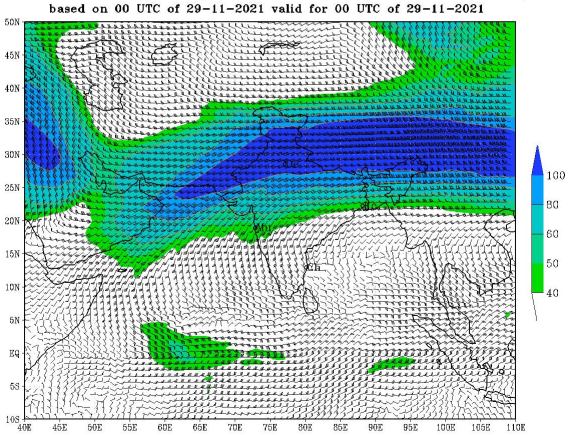

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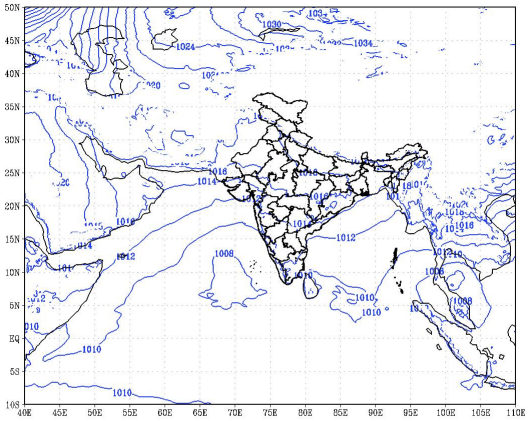

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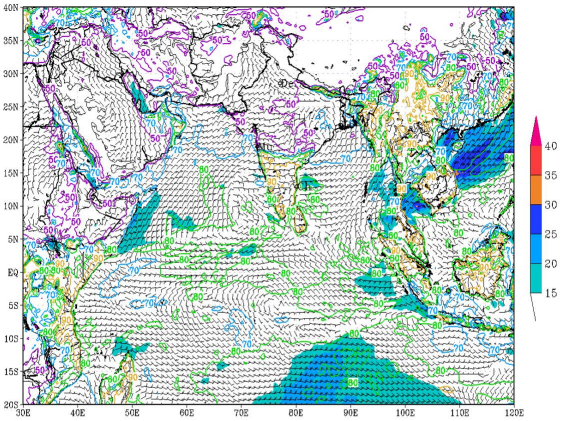
IMD GFS (T1534) 10m WIND (kt) AND 2m RH (%) FORECAST (24 HR)
based on 00 UTC of 29-11-2021 valid for 00 UTC of 30-11-2021



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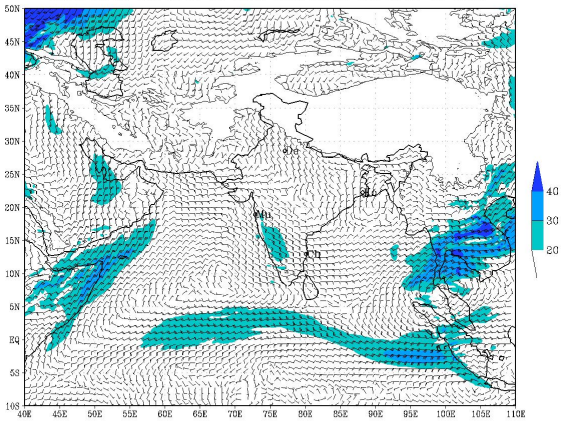

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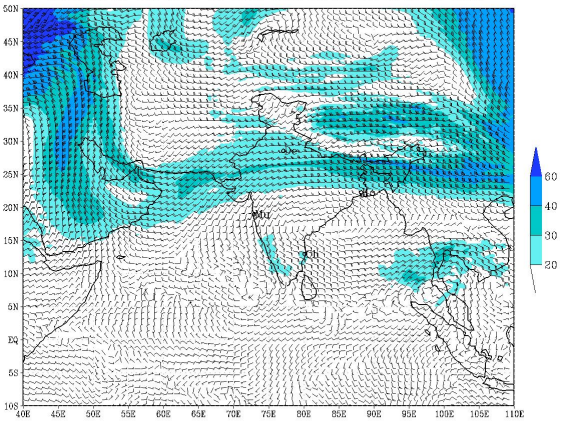

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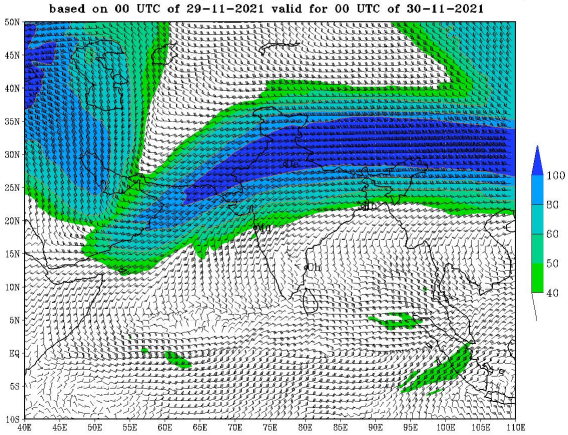

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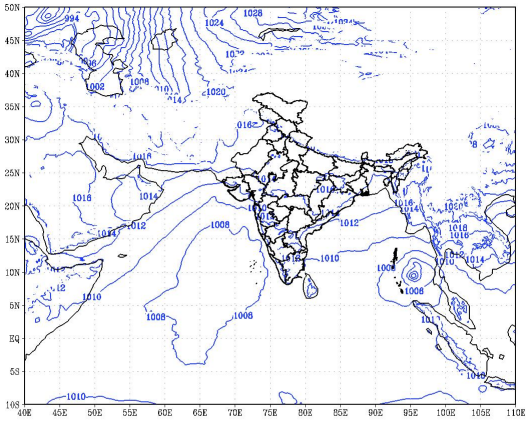
IMD :GFS MODEL(12 Km) MSL Pressure (hPa) FORECAST (48 HR)
based on 00 UTC of 29-11-2021 valid for 00 UTC of 01-12-2021



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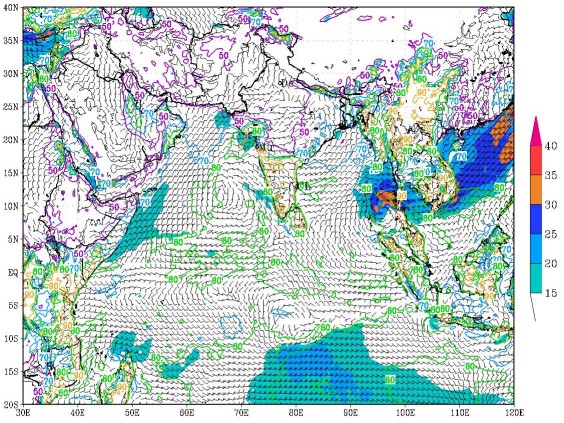
IMD GFS (T1534) 10m WIND (kt) AND 2m RH (%) FORECAST (48 HR)
based on 00 UTC of 29-11-2021 valid for 00 UTC of 01-12-2021



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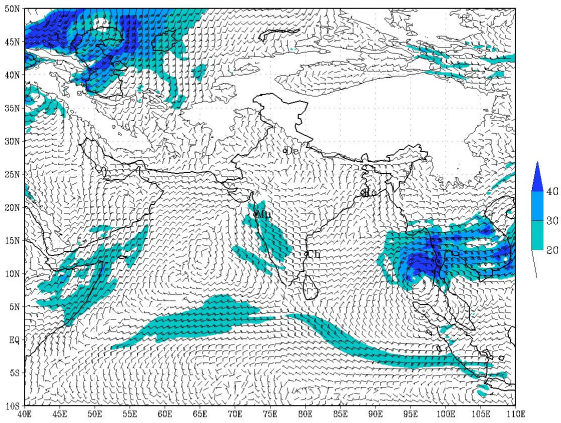

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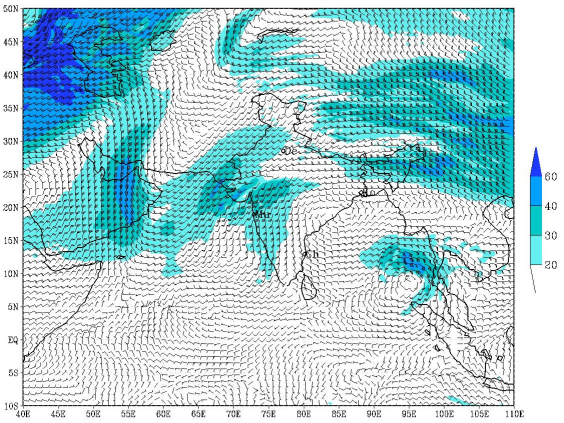

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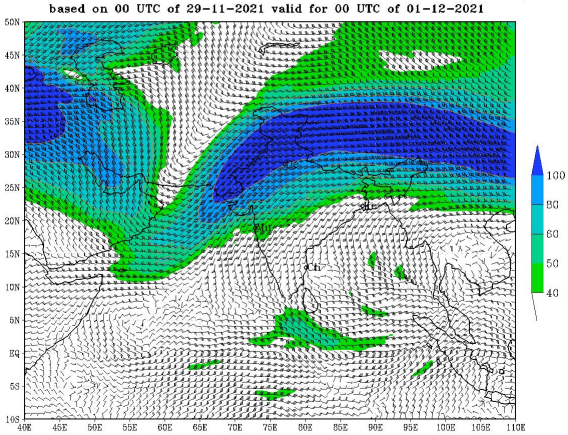

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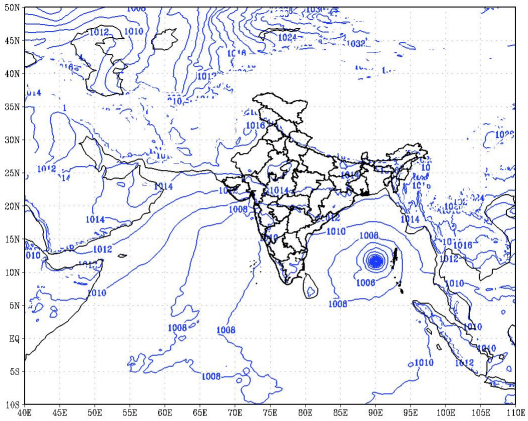

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IMD GFS (T1534) 10m WIND (kt) AND 2m RH (%) FORECAST (72 HR)
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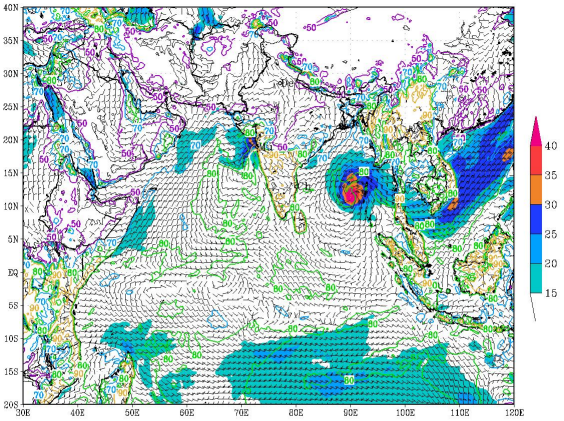

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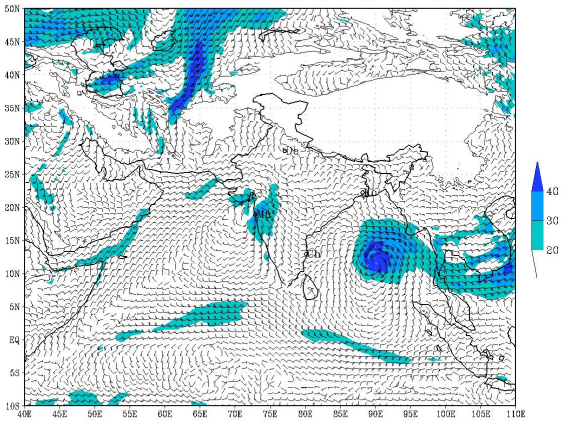

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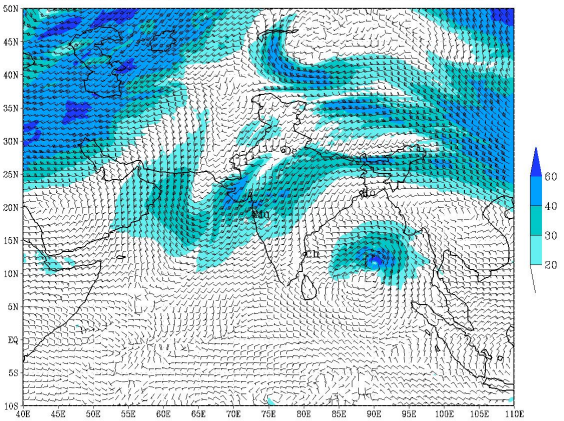

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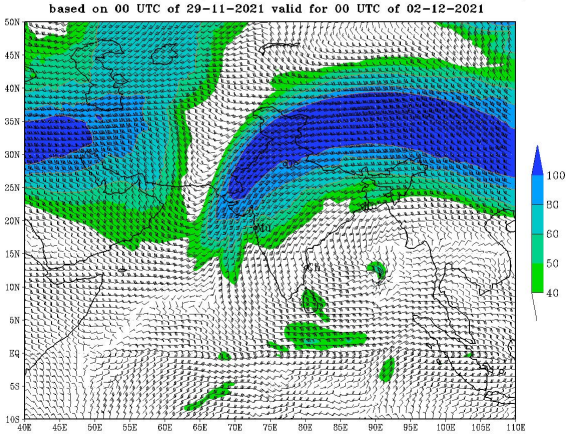

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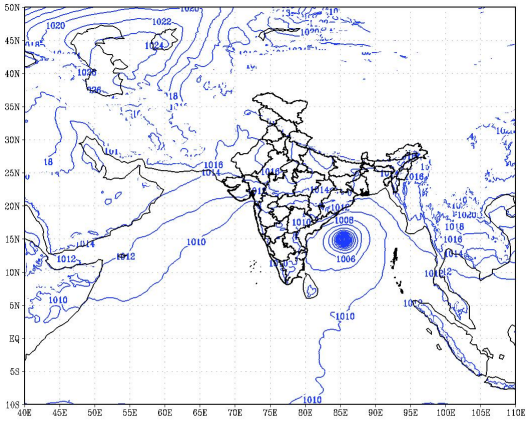

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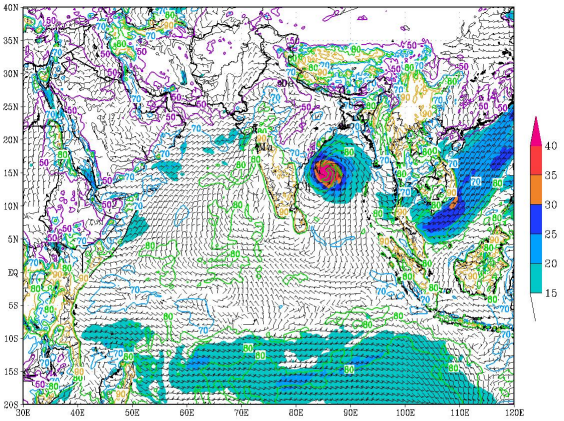
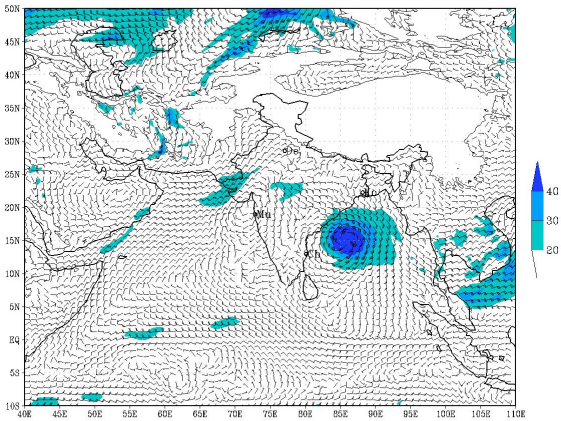
IMD GFS (T1534) 10m WIND (kt) AND 2m RH (%) FORECAST (96 HR)
based on 00 UTC of 29-11-2021 valid for 00 UTC of 03-12-2021



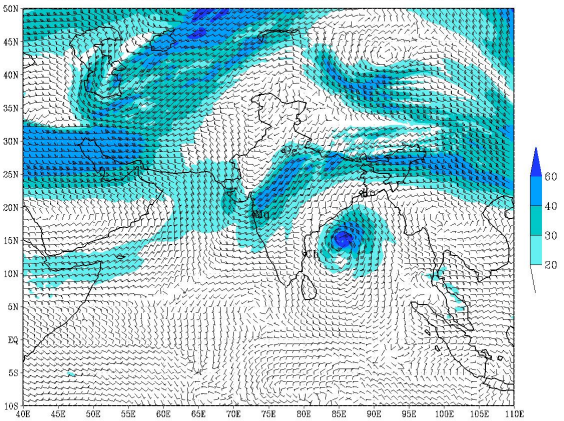
(Background does not depict political boundary)

IMD:GFS MODEL(12 Km) 850 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 29-11-2021 valid for 00 UTC of 03-12-2021



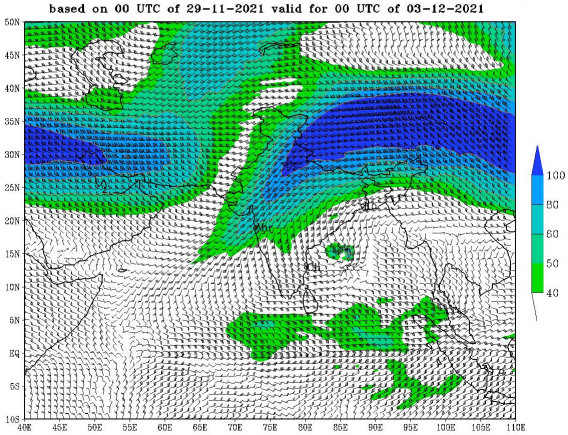
(Background does not depict political boundary)

IMD:GFS MODEL(12 Km) 500 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 29-11-2021 valid for 00 UTC of 03-12-2021



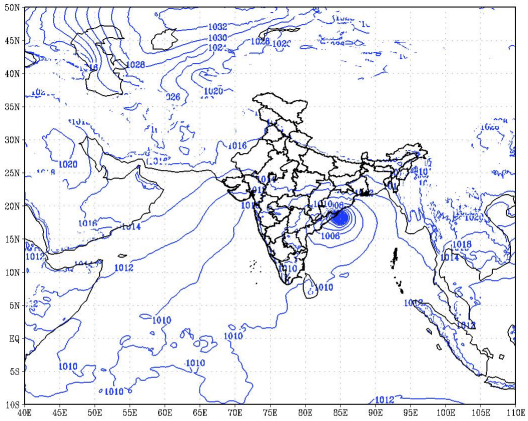
(Background does not depict political boundary)

IMD :GFS MODEL(12 Km) 200 hPa WIND (kt) FORECAST (96 HR)
based on 00 UTC of 29-11-2021 valid for 00 UTC of 03-12-2021



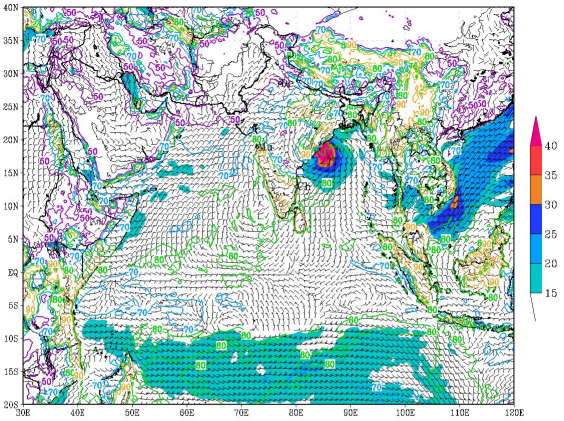
(Background does not depict political boundary)

IMD :GFS MODEL(12 Km) MSL Pressure (hPa) FORECAST (120 HR)
based on 00 UTC of 29-11-2021 valid for 00 UTC of 04-12-2021



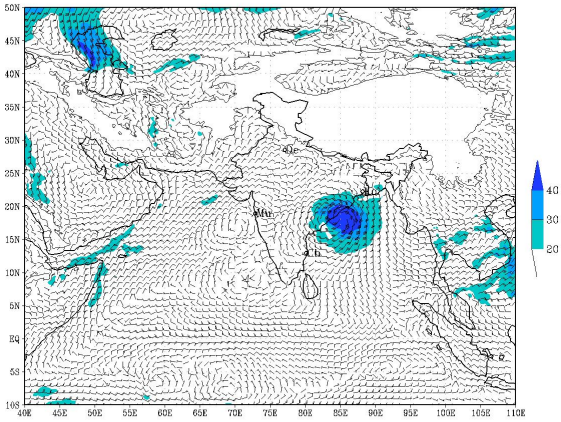
(Background does not depict political boundary)

IMD GFS (T1534) 10m WIND (kt) AND 2m RH (%) FORECAST (120 HR)
based on 00 UTC of 29-11-2021 valid for 00 UTC of 04-12-2021



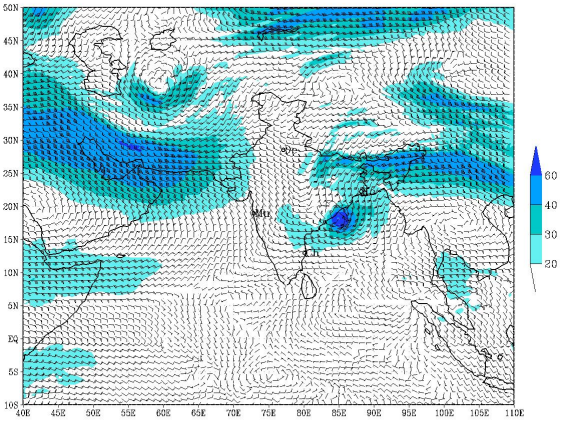
(Background does not depict political boundary)

IMD:GFS MODEL(12 Km) 850 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 29-11-2021 valid for 00 UTC of 04-12-2021



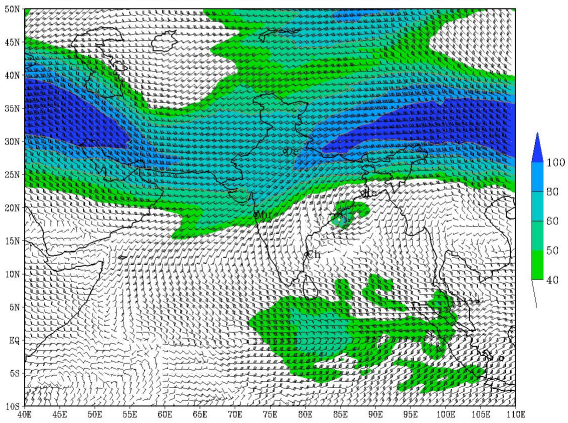
(Background does not depict political boundary)

IMD:GFS MODEL(12 Km) 500 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 29-11-2021 valid for 00 UTC of 04-12-2021

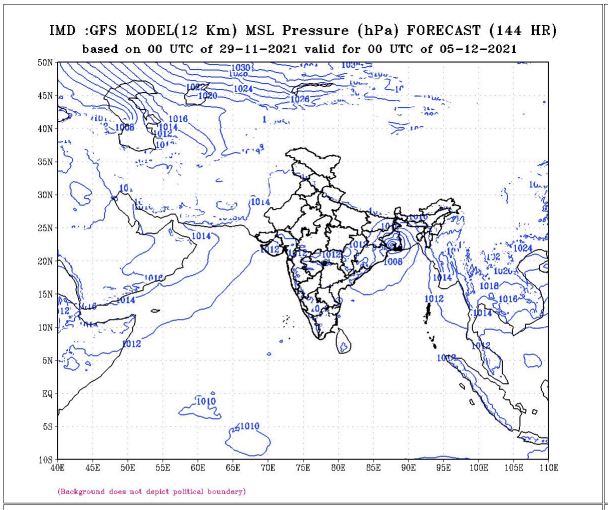


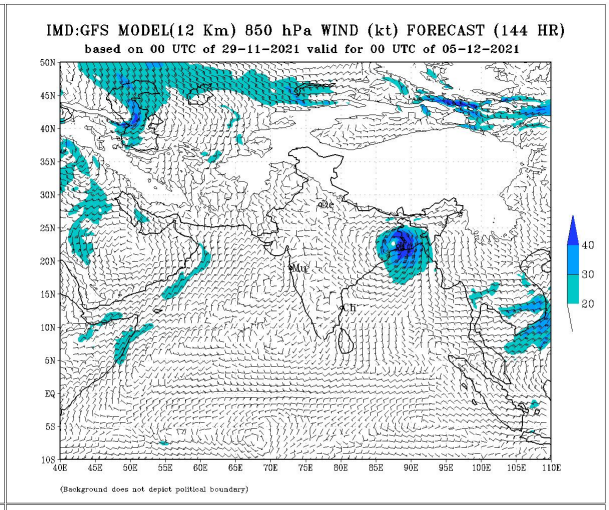
(Background does not depict political boundary)

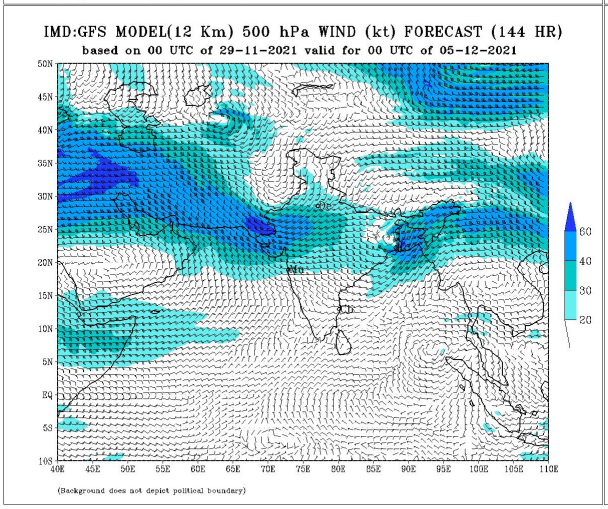
IMD :GFS MODEL(12 Km) 200 hPa WIND (kt) FORECAST (120 HR)
based on 00 UTC of 29-11-2021 valid for 00 UTC of 04-12-2021



(Background does not depict political boundary)


IMD :GFS MODEL(12 Km) MSL Pressure (hPa) FORECAST (144 HR)
based on 00 UTC of 29-11-2021 valid for 00 UTC of 05-12-2021
(Background does not depict political boundary)


IMD:GFS MODEL(12 Km) 850 hPa WIND (kt) FORECAST (144 HR)
based on 00 UTC of 29-11-2021 valid for 00 UTC of 05-12-2021
40
30
20
(Background does not depict political boundary)


IMD:GFS MODEL(12 Km) 500 hPa WIND (kt) FORECAST (144 HR)
based on 00 UTC of 29-11-2021 valid for 00 UTC of 05-12-2021
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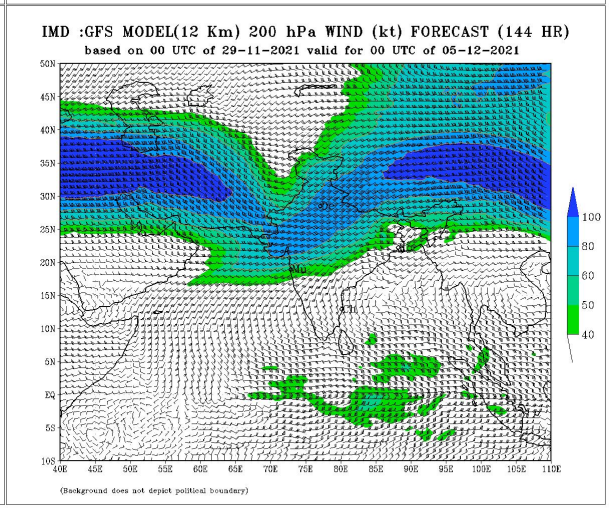
30
20
(Background does not depict political boundary)


IMD :GFS MODEL(12 Km) 200 hPa WIND (kt) FORECAST (144 HR)
based on 00 UTC of 29-11-2021 valid for 00 UTC of 05-12-2021
100
80
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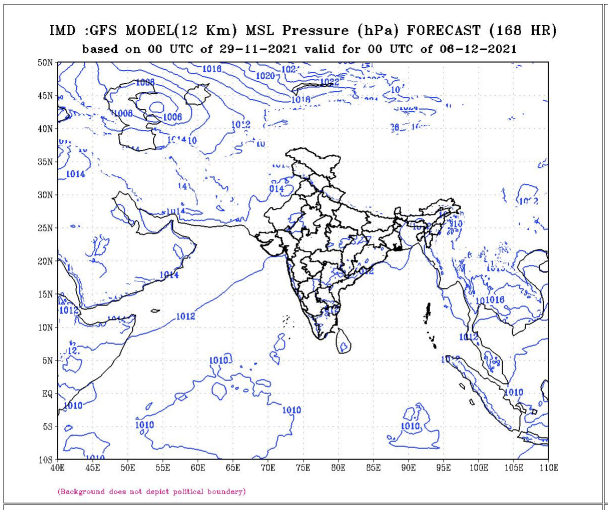
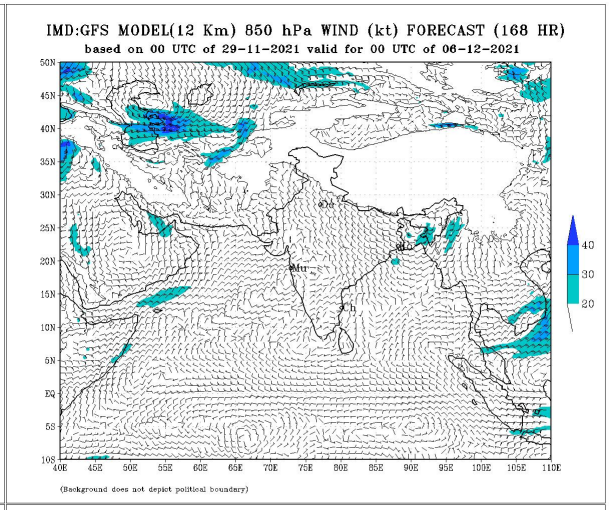
40
(Background does not depict political boundary)


IMD :GFS MODEL(12 Km) MSL Pressure (hPa) FORECAST (168 HR)
based on 00 UTC of 29-11-2021 valid for 00 UTC of 06-12-2021
(Background does not depict political boundary)


IMD:GFS MODEL(12 Km) 850 hPa WIND (kt) FORECAST (168 HR)
based on 00 UTC of 29-11-2021 valid for 00 UTC of 06-12-2021
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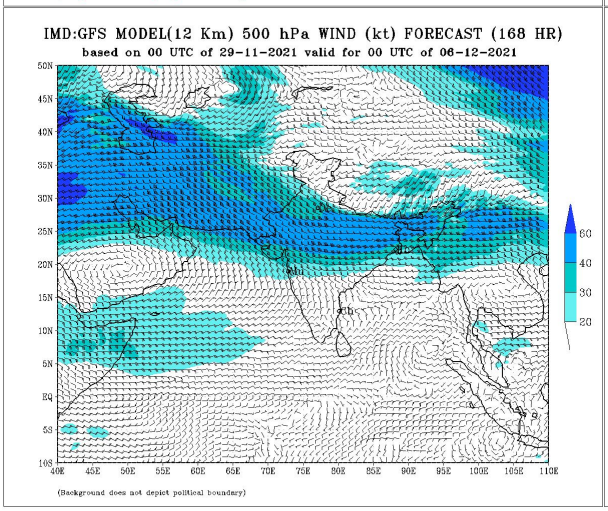
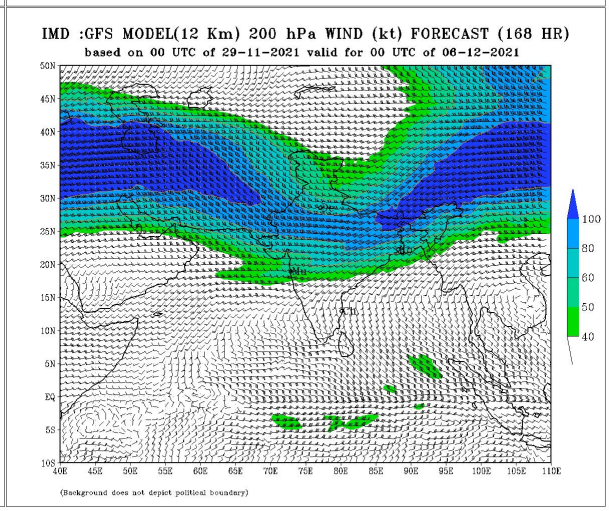
20
(Background does not depict political boundary)


IMD:GFS MODEL(12 Km) 500 hPa WIND (kt) FORECAST (168 HR)
based on 00 UTC of 29-11-2021 valid for 00 UTC of 06-12-2021
60
40
30
20
(Background does not depict political boundary)


IMD :GFS MODEL(12 Km) 200 hPa WIND (kt) FORECAST (168 HR)
based on 00 UTC of 29-11-2021 valid for 00 UTC of 06-12-2021
100
80
60
50
40
(Background does not depict political boundary)