

The 10th GEOSS Asia-Pacific Symposium

Hanoi, Vietnam, 18-20 September 2017



Many countries are vulnerable to rising seas.



Department of Meteorology
Sri Lanka

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Every human, animal and plant depends on Water for their survival !



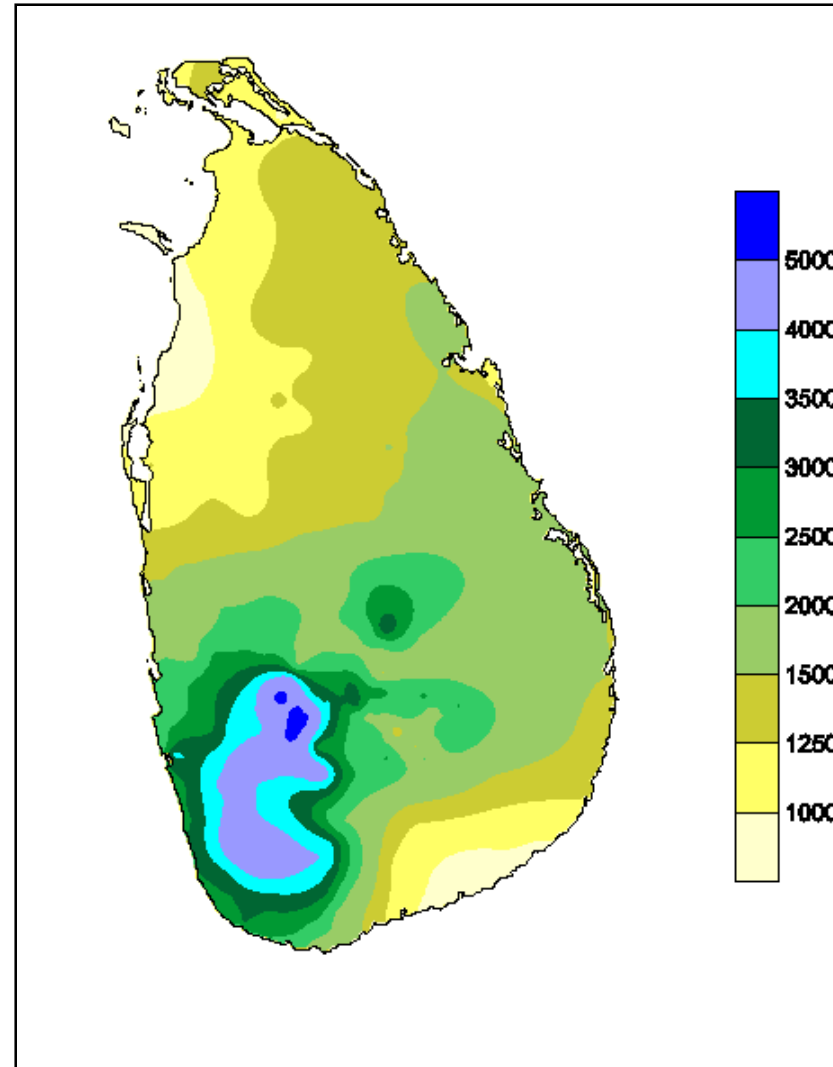
nearly one third of the countries (or one billion people) lack adequate quantities of safe water to meet their minimum requirements.

By 2025, nearly 60 % of the countries in the world are expected to be water stressed.

Sri Lanka

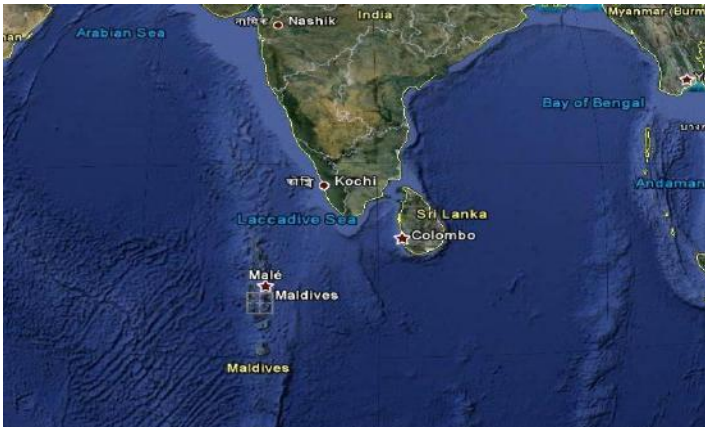
Annual rainfall varies
between
950 mm to 5500
millimeters
with an average of
1861.0 mm

Annual Rain Volume - 122 km³

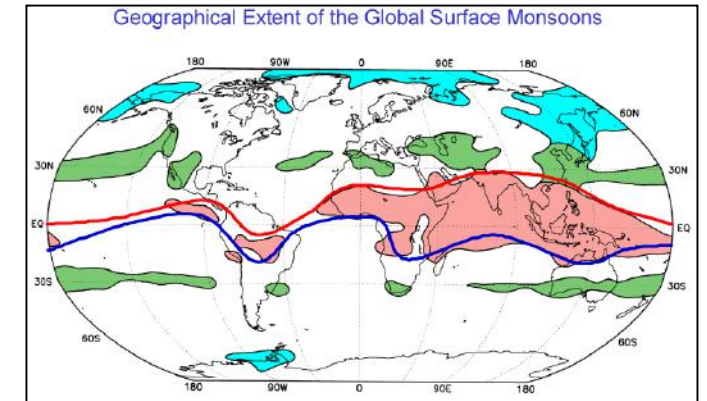


Climate of Sri Lanka

Tropical and Monsoonal

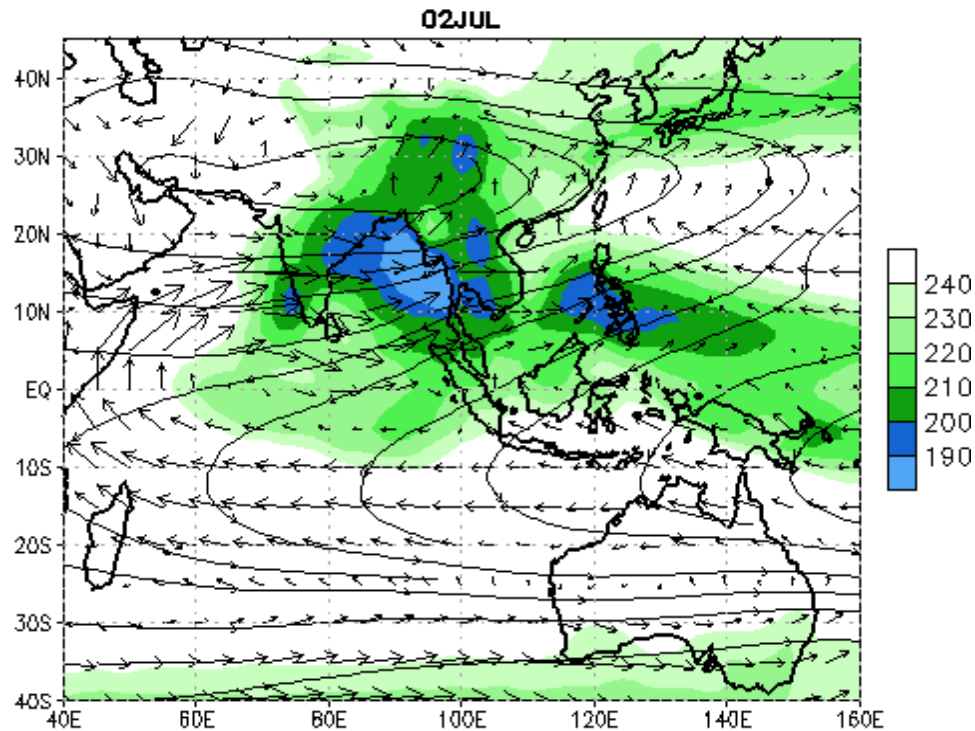


Sri Lanka is an island in the tropics



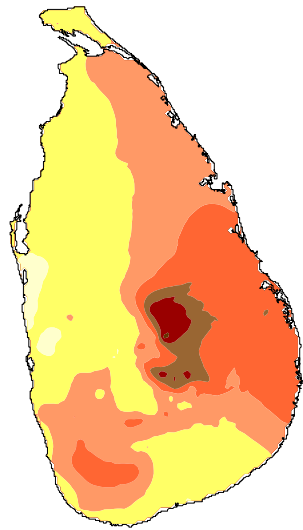
Monsoon region in the world

QLR, 200-hPa Streamlines and 850-hPa Wind Clim (1979-1995)



Changing Wind Flow during the year by 180 degrees across the Country

Seasonal Rainfall Distribution of Sri Lanka

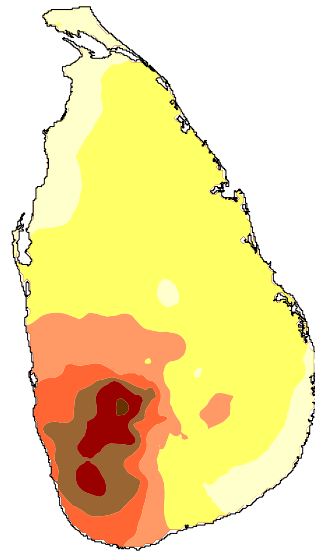
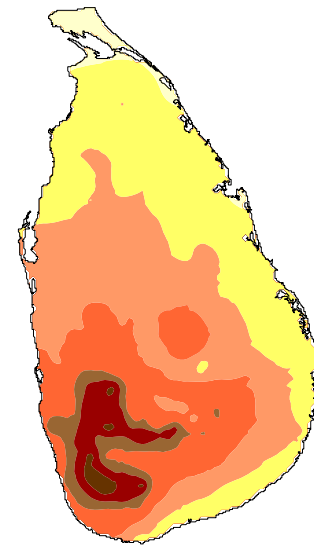


Northeast Monsoon
December to February
479 mm

26%

First Intermonsoon
March-April
268 mm

14%

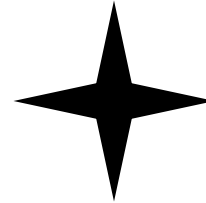
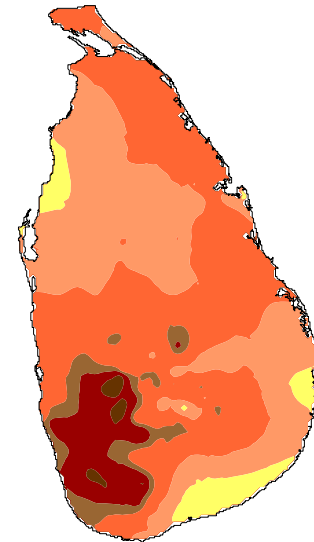


Southwest Monsoon
May to September
556 mm

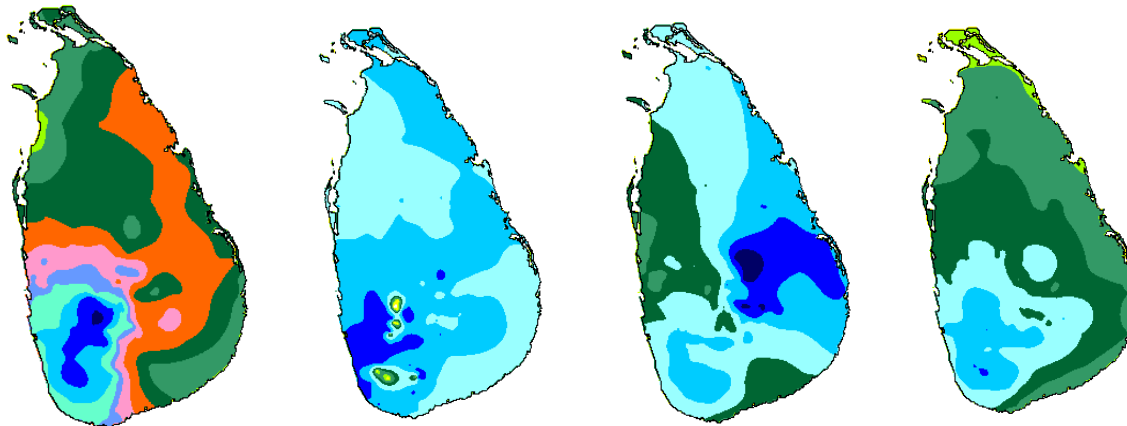
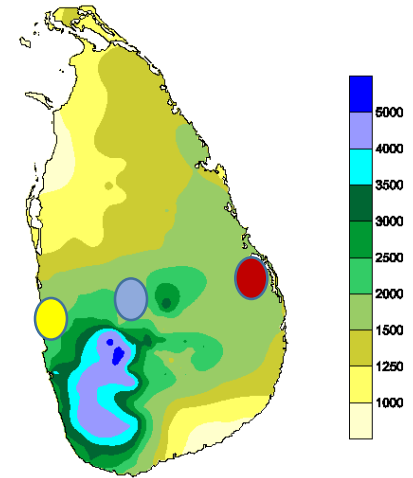
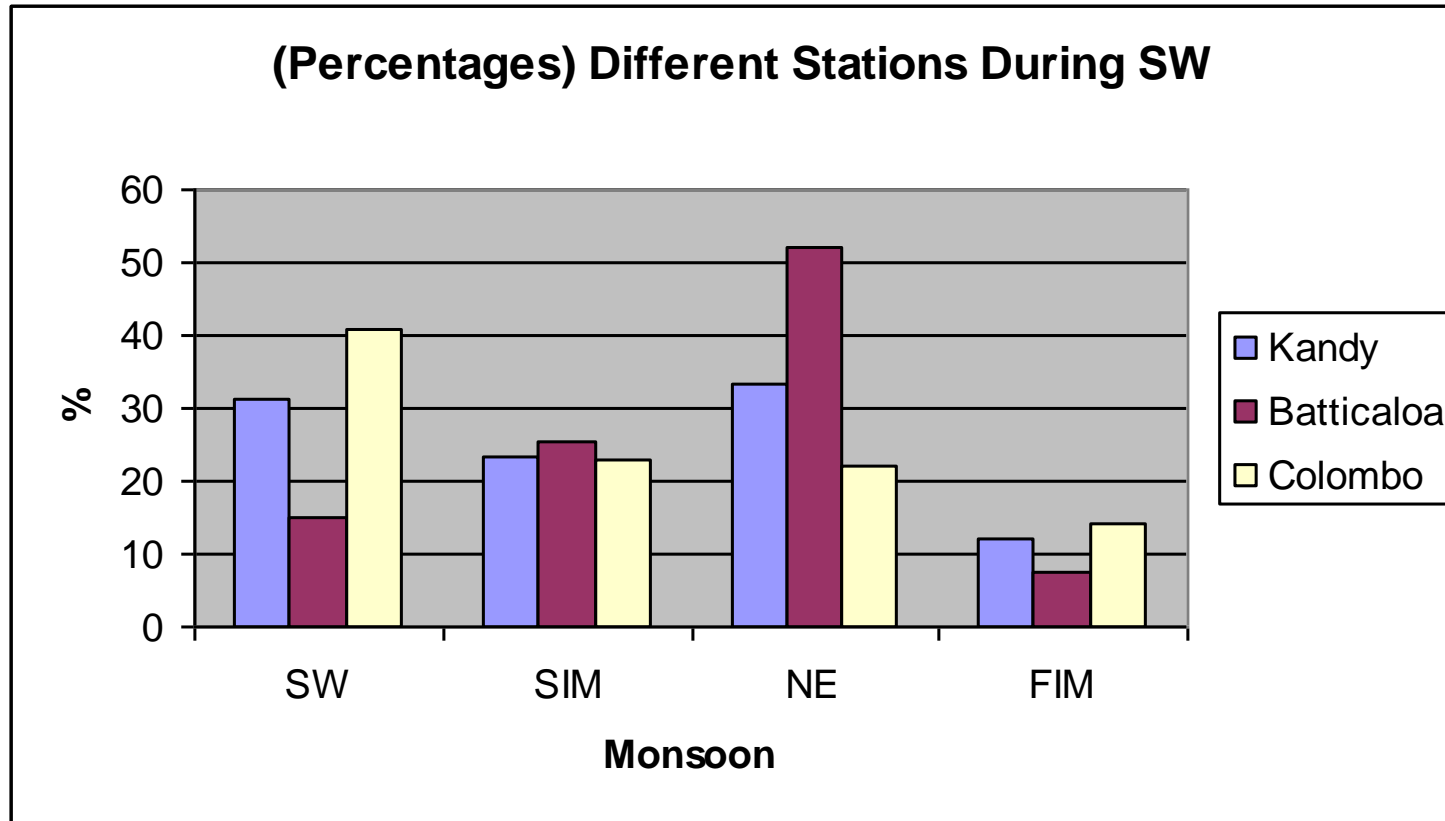
30%

Second Intermonsoon
October to November
558 mm

30%



..... The percentages is varied from place to place



Water Withdrawals – Sri Lanka

Climatic zones of Sri Lanka

Agricultural sector	-	85%
Domestic	-	6%
Industrial and other	-	9%

NWRA,
2003

**Average per capita domestic withdrawals
– 31 liters/person/day**

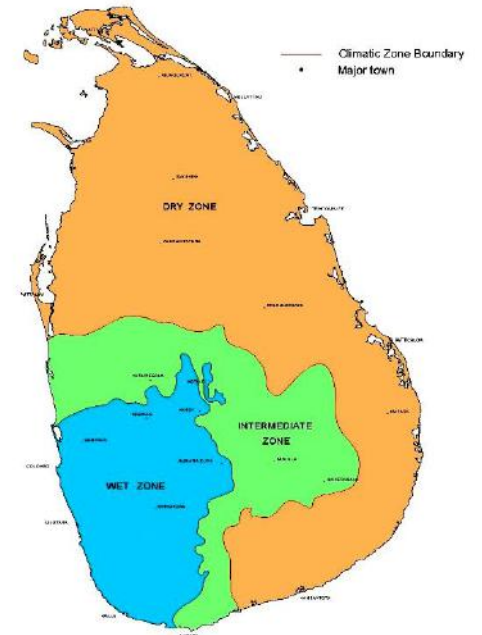
ESCAP,
1995

Average Rainfall

Dry zone
< 1,750 mm

Intermediate zone
1,750-2,500 mm

Wet zone > 2,500
mm

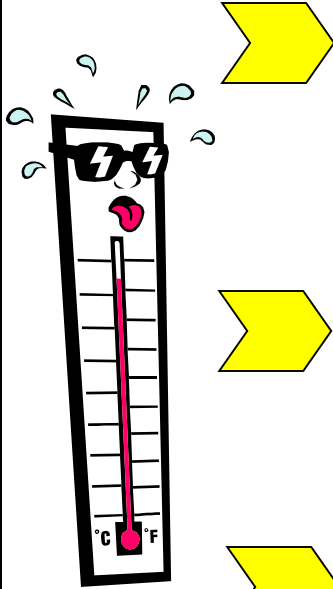


Very high spatial variability of rainfall

46 Agro-ecological regions

Climate Change Impacts on Water Resources

According to the latest estimates, global average temperature is expected to rise by between 1.4 to 5.8 °C during the period 1990-2100.



Increased Temperature

Changes in Rainfall

Sea level rise

Rainfall



**increase of the
variability of
rainfall**

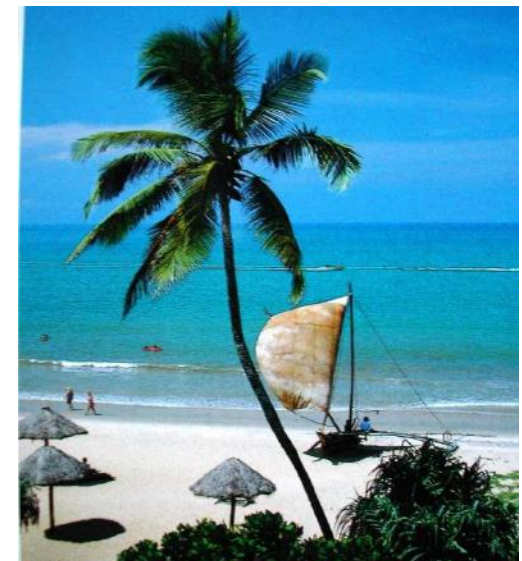
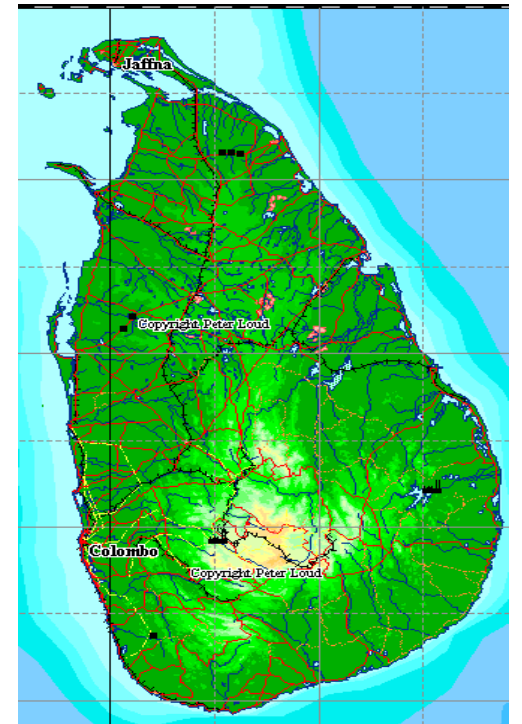
**increase in the
frequency of
extreme events**

Sea Level Rise

• Sri Lanka

- Has a long coastline of 1660 km
- Coastal zone contains 24% of land
- 32% population
- 80% tourism
- commercial ports and fishery harbors
- principal road and rail infrastructure
- richest areas of bio-diversity - coral reef, lagoons, angroves

- **During the period 1860 – 2000, the global mean sea level has risen by between 10-20 cm**
- **During the next century global mean sea level is expected to rise by between 9 – 88 cm.**



Possible weather related hazards during monsoon period in Sri Lanka

Flash flood



Strong winds



Coastal erosion



River flood



Land slides



Thunder/lightning/Downdraft



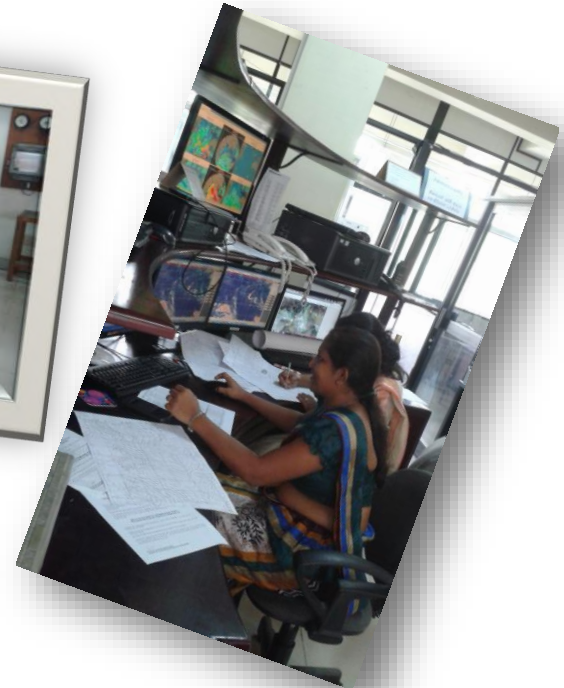
MAIN DIVISIONS - (WATER & DISASTERS)

❖ Forecasting

- Weather forecasting, advisory and warning issue and Tsunami monitoring
- Marine forecasting
- Numerical weather prediction

❖ Observation

❖ Communication Centre



RESPONDING TO USER REQUIREMENTS: FORECAST OF VARIOUS TIMESCALES



DEVELOPMENT OF FORECAST OF DIFFERENT TIMESCALES IN SRI LANKA BASED ON

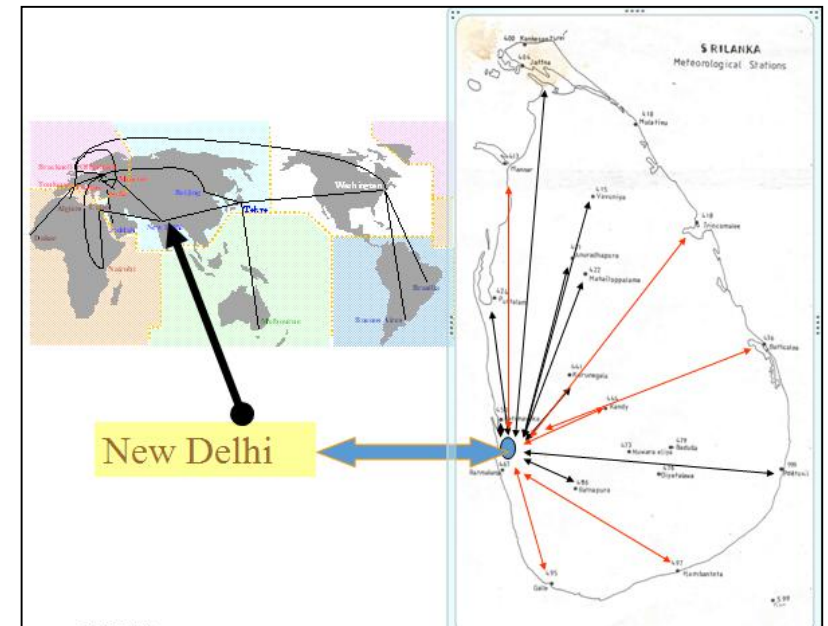
Analyze synoptic data , Study model forecasts, Rainfall forecast, ECWMF model – extreme weather forecast, Total precipitable water, Analyze satellite images (eg: [Himawari 8](#), [FY2G](#), [ASCAT](#), ect.), Numerical Weather Predictions (NWP)

ENHANCEMENTS IN SPATIAL RESOLUTION WERE ALSO INTRODUCED BY DOM; FORECAST FOR SPECIFIC SECTORS EVOLVED

Communication Centre

- ❖ Receive synoptic data collected from other **22 main Meteorological stations** around the country **every 3 hours**.
- ❖ Upload synoptic data to Global Telecommunication System (**GTS**)
 - **Synoptic data** collected from all the Meteorological stations in the region by **New-Delhi regional center**
 - **Send back regional data through GTS**
- ❖ Receive daily rainfall data from **rainfall stations (500)**
- ❖ Send **shipping reports, fleet reports** etc.
- ❖ Download weather charts for Meteorologists
- ❖ Fax **weather advisory/warnings** to **media** and other stakeholders

STATION	TIME	TEMP	WIND	WIND DIR	WIND SPC	WIND DIR	WIND SPC	WIND DIR	WIND SPC	WIND DIR	WIND SPC
11	1100	28.0	10	110	10	110	10	110	10	110	10
12	1200	28.5	10	110	10	110	10	110	10	110	10
13	1300	29.0	10	110	10	110	10	110	10	110	10
14	1400	29.5	10	110	10	110	10	110	10	110	10
15	1500	30.0	10	110	10	110	10	110	10	110	10
16	1600	30.5	10	110	10	110	10	110	10	110	10
17	1700	31.0	10	110	10	110	10	110	10	110	10
18	1800	31.5	10	110	10	110	10	110	10	110	10
19	1900	32.0	10	110	10	110	10	110	10	110	10
20	2000	32.5	10	110	10	110	10	110	10	110	10
21	2100	33.0	10	110	10	110	10	110	10	110	10
22	2200	33.5	10	110	10	110	10	110	10	110	10
23	2300	34.0	10	110	10	110	10	110	10	110	10
24	0000	34.5	10	110	10	110	10	110	10	110	10
25	0100	35.0	10	110	10	110	10	110	10	110	10
26	0200	35.5	10	110	10	110	10	110	10	110	10
27	0300	36.0	10	110	10	110	10	110	10	110	10
28	0400	36.5	10	110	10	110	10	110	10	110	10
29	0500	37.0	10	110	10	110	10	110	10	110	10
30	0600	37.5	10	110	10	110	10	110	10	110	10



Observations

❖ Carry out 3 hour observations at the Colombo station



■ Web updating

❖ Plotting synoptic data received from the out stations



Public Weather Forecasts

www.meteo.gov.lk/index.php?option=com_content&view=article&id=124&lang=en

Department of Meteorology
Sri Lanka

Weather / Climate Services

Warnings
Weather
Seasonal Forecast
Climate
Maritime Forecast

Information Services

Astronomy
New Department Internal Examinations - 2016
Education
Procurement Notice (Tenders)
Recruitment
Services
Weather Summary

Public Weather Forecasts

WEATHER FORECAST FOR 23rd January 2016
(issued at 1200 noon on 22nd January 2016)

A slight change in the prevailing dry weather over the island, particularly in the Northern and Eastern parts of the country, is expected.

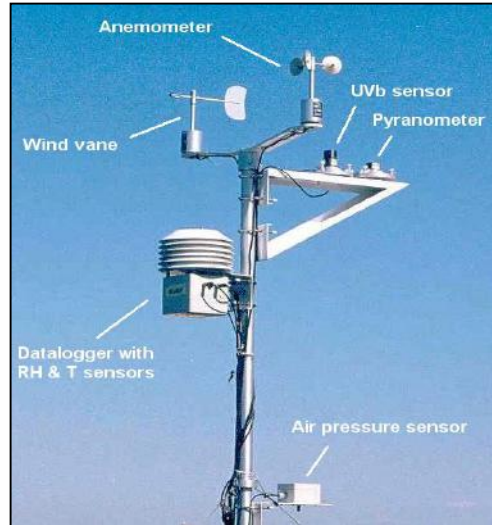
Several spells of showers will occur in the Northern, Eastern and Uva provinces and in Hambantota district.

Showers or thunder showers will occur at several places elsewhere after 2.00p.m.

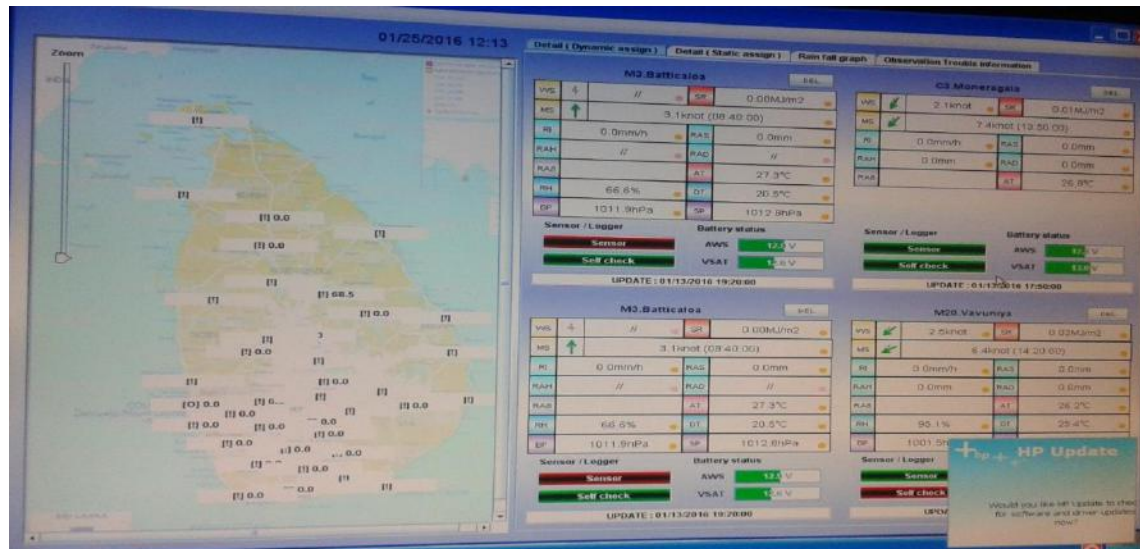
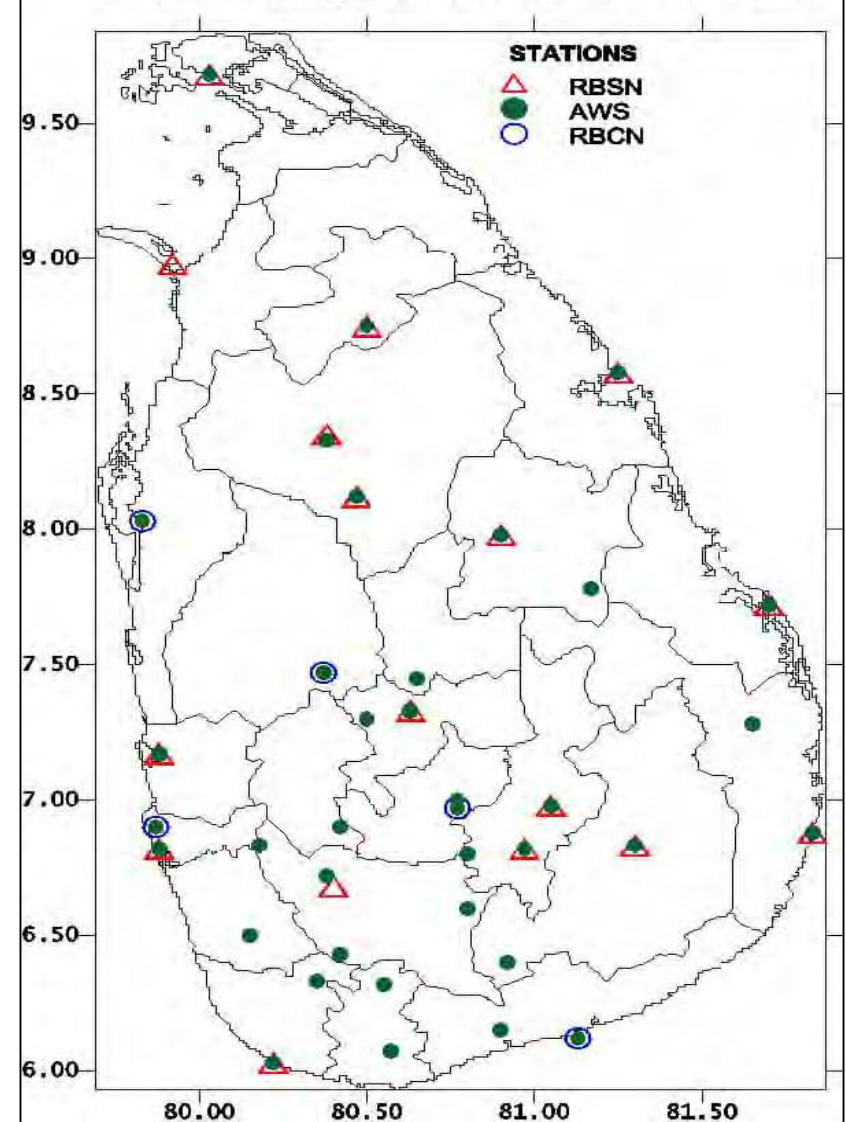
There may be temporary localized strong winds during thundershowers. General public is kindly requested to take adequate precautions to minimize damages caused by lightning activity.

Last Updated: 22 January 2016

Monitor Automated Weather Stations (AWS)



Meteorological Stations Network

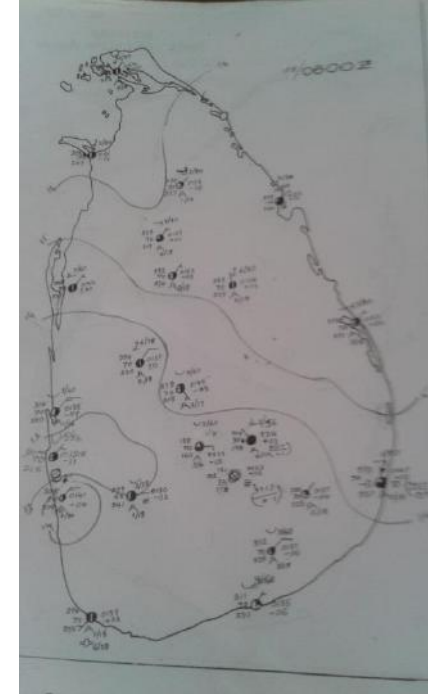
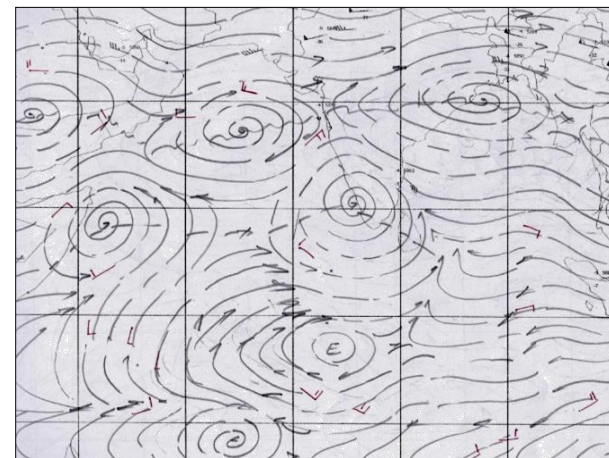
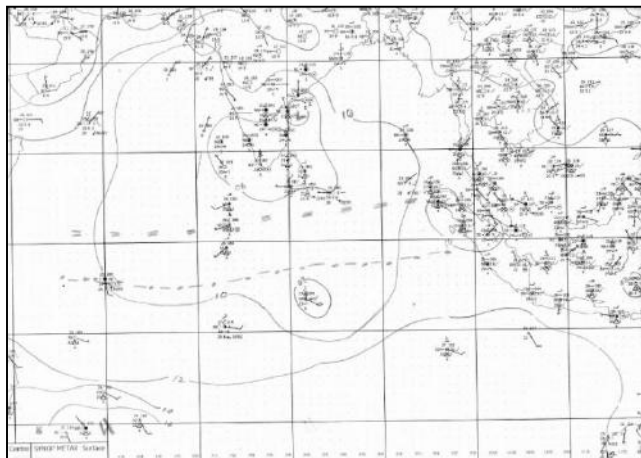


Weather Forecasting

❖ Issue weather forecasts (0530, 1200 & 1600 hrs)

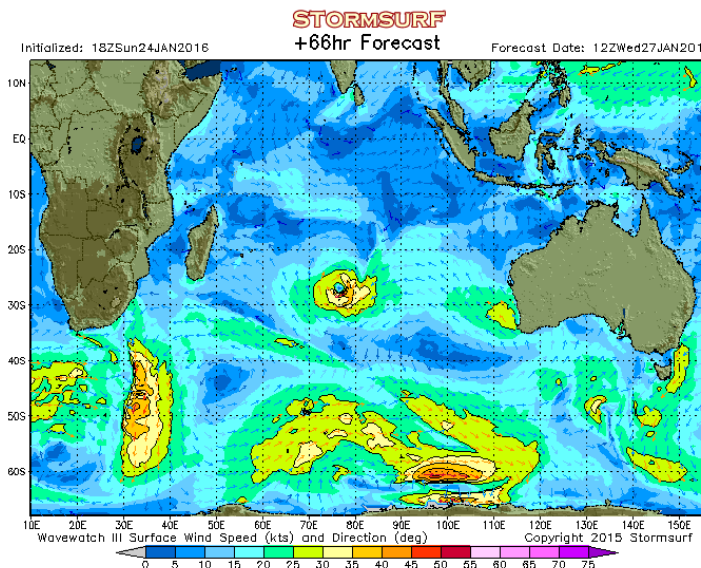
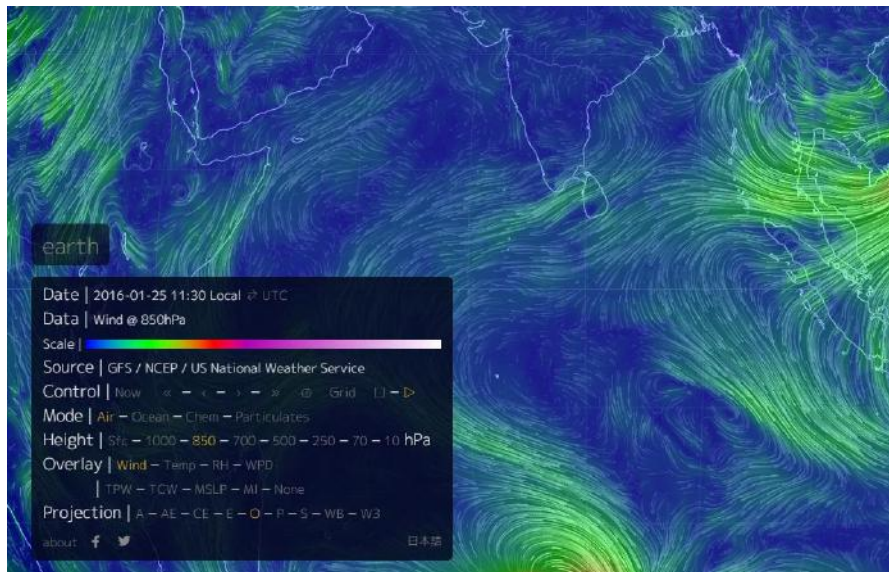
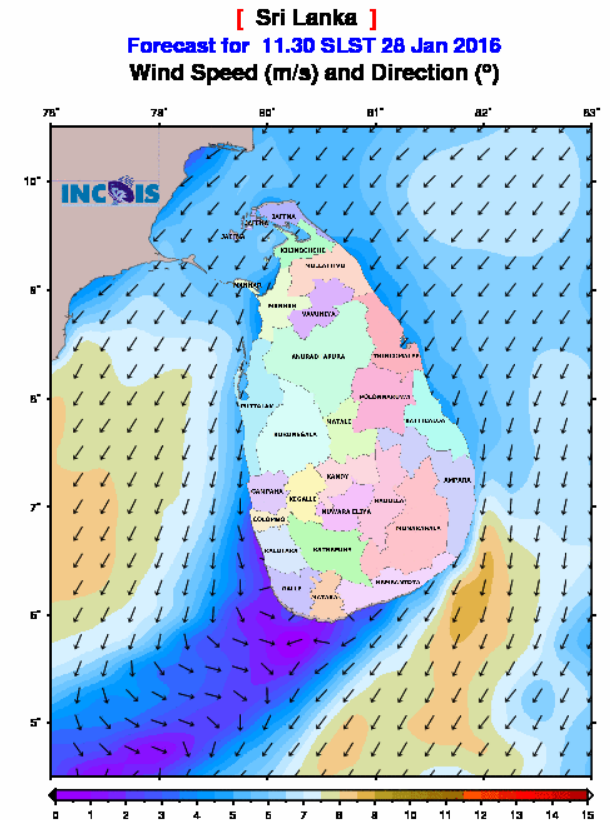
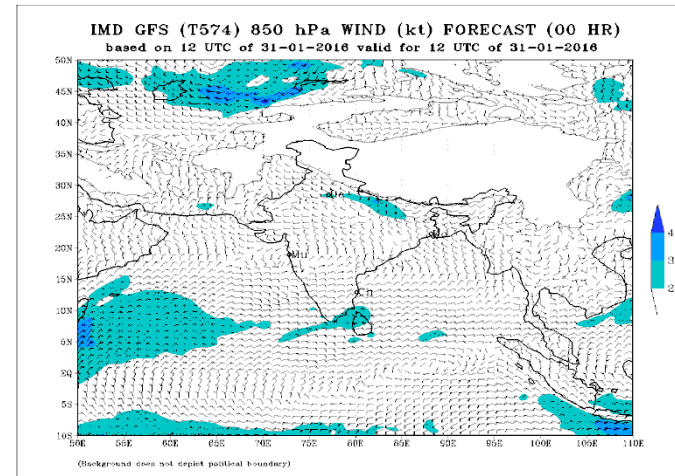
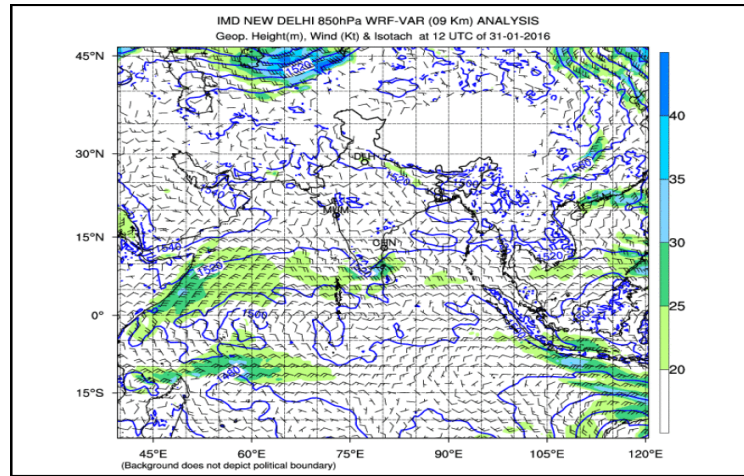
❖ severe weather advisory and warnings

- Analyze synoptic data collected 3 hourly by the Observers
- Analyze regional surface charts and upper wind (850 mb, 700 mb, 500 mb, 300 mb and 200 mb) charts uploaded to GTS system by New-Delhi regional Centre



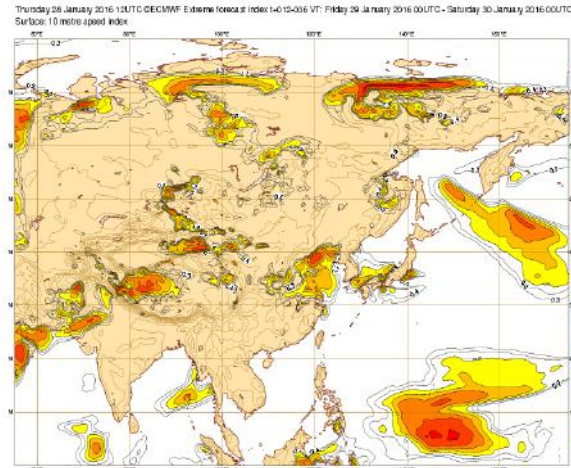
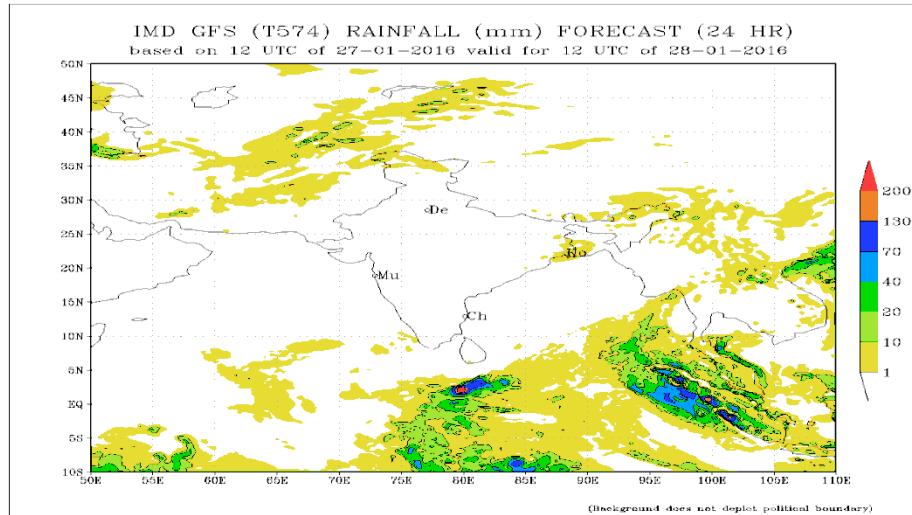
Study model forecasts (eg: [Stormsurf](#), [Earth nullschool](#), [India meteorological website](#), [INCOIS](#) etc.)

Wind forecast models

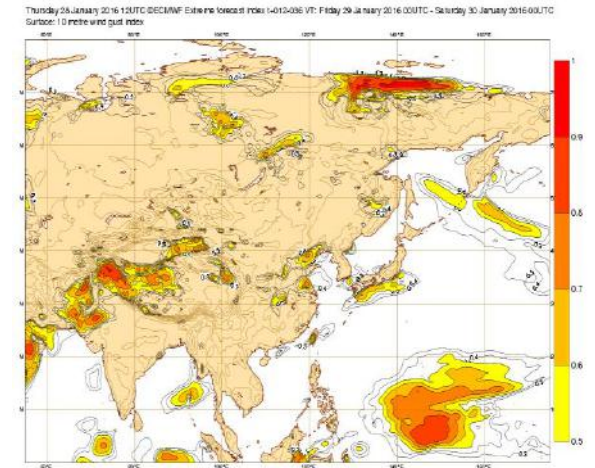


Rainfall forecast

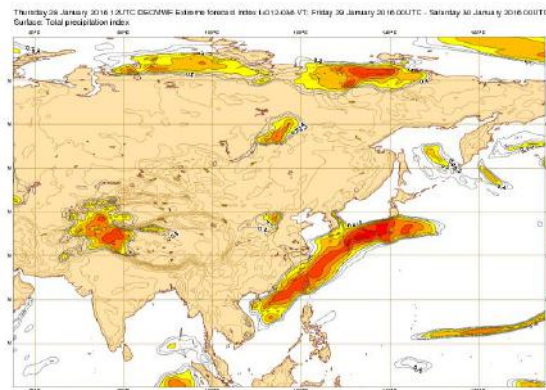
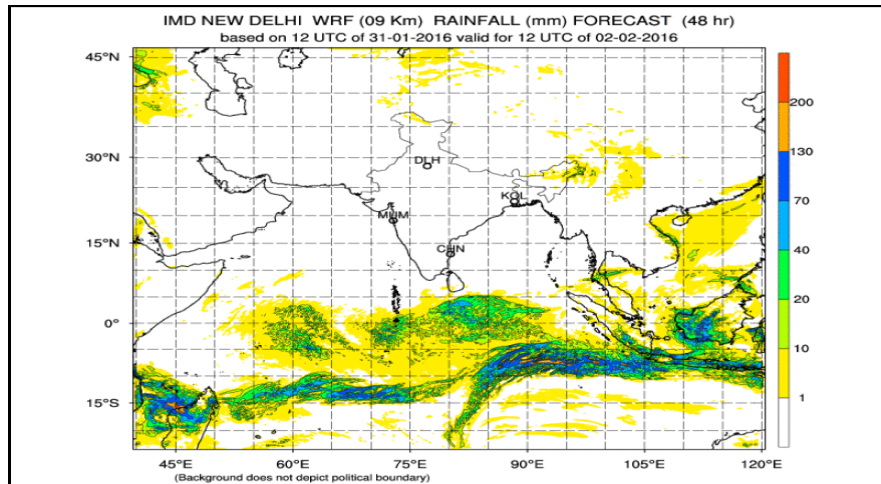
ECWMF model – extreme weather forecast



Wind speed

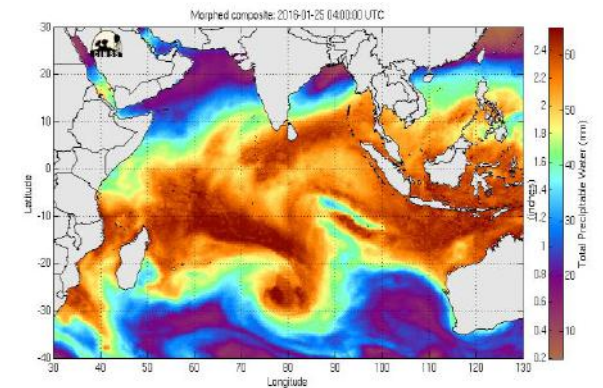


Wind gust



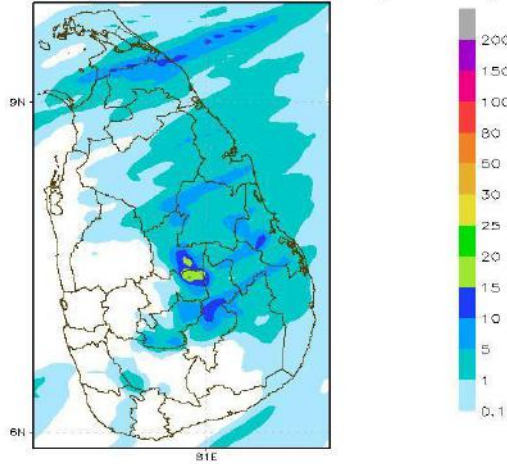
Precipitation

Total precipitable water

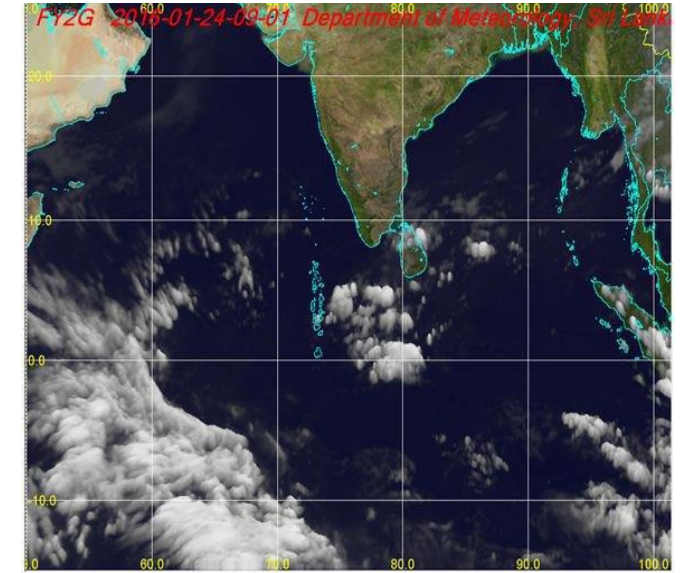
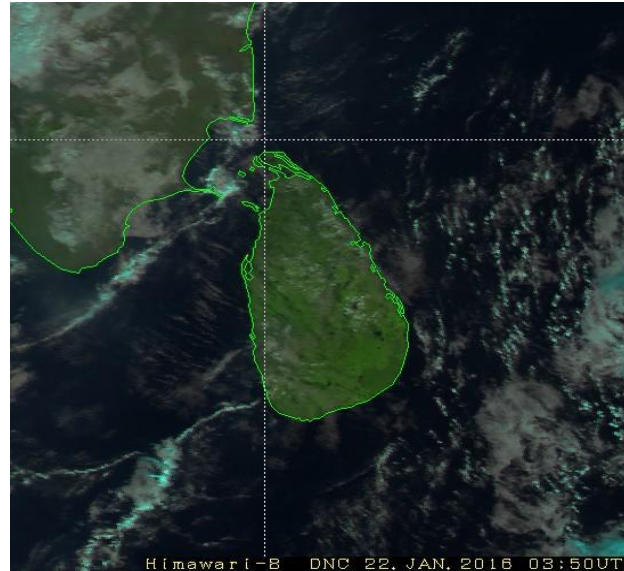


Numerical Weather Predictions (NWP)

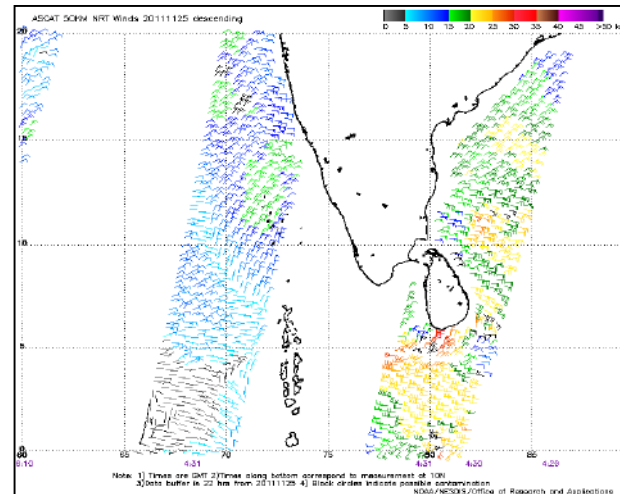
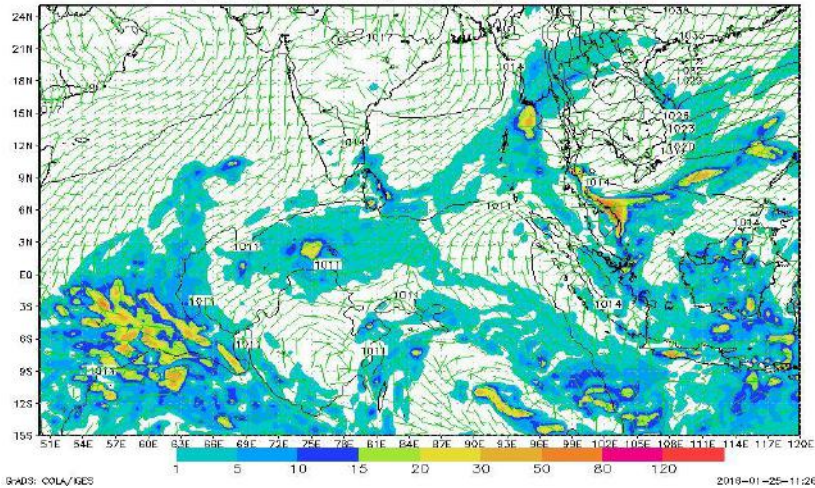
WRFDA(5KM) Rainfall(mm) valid 03UTC 24/01/2016 (24Hours)



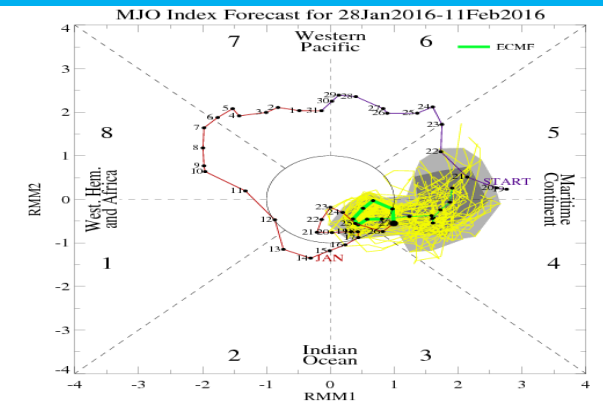
Analyze satellite images (eg: [Himawari 8](#), FY2G, [ASCAT](#), ect.)



12_Hours RainFall(Region)_12Z25JAN2016



Madden - Julian Oscillation monitoring



Note: 1) Times are GMT 2) Times along bottom correspond to measurement of 10h
3) Data buffer is 20 km from 22.5N 75E 4) Black circles indicate possible convection
NOG/NEOS/Office of Research and Applications

Samples of weather forecasts and severe weather advisory/ warnings

WEATHER FORECAST FOR NEXT 36 HOURS (ISSUED AT 1600 HOURS ON 07th JUNE 2013)

Gradually increasing of rain in the South-western parts and windy condition over Sri Lanka and neighbouring sea areas are expected.

Showers will occur at times in the Western, Sabaragamuwa, Central and Southern provinces. Showers may extend to Puttalam and Kurunegala districts too.

Southwestern monsoonal winds will be strengthened at times over the island and neighborhood.

Sea Conditions –

Naval and fishing communities are requested to be vigilant as deep and shallow sea areas off the coast extending from Mannar to Pottuvil via Colombo and Galle will be rough with strong southwesterly wind upto 80kmp/h.

දිවයිනේ නිරිත දිග කොටසේ ක්‍රමයෙන් වැසි වැඩි වීමක් සහ දිවයින සහ අවට මුහුදු ප්‍රදේශවල සුළං වැඩි වීමක් අපේක්ෂා කෙරේ.

දිවයිනේ බස්නාහිර, සබරගමුව, මධ්‍යම සහ දකුණු පලාත් වල විටින් විට වැසි ඇති වේ. සුත්තලම සහ කුරුණෑගල දිස්ත්‍රික්ක වලට ද මෙම වැසි පැතිර යා හැක.

දිවයින හරහා සහ අවට ප්‍රදේශ වල විටින් විට නිරිත දිගින් හමන තරමක තද සුළං ඇති විය හැක.

මුහුදේ තත්ත්වය :-

මන්නාරම සිට කොළඹ සහ ගාල්ල හරහා පොකුණිල් දක්වා වෙරළට ඔබ්බෙන් වන ගැඹුරු සහ නොගැඹුරු මුහුදු ප්‍රදේශ රළු වන අතර පැකි. 80 පමණ දක්වා සුළං ඇති වන නිසා ඒ පිළිබඳව විමසිලිමත් වන ලෙස නාවික සහ ධීවර සහ නාවික ප්‍රජාවගෙන් ඉල්ලා සිටිනු ලැබේ.

අයහපත් කාලගුණය පිළිබඳ නිවේදනය

2013 මැයි මස 13 දින ඉදිරිපැය 12 සඳහා, පෙ.ව. 05.30 ට නිකුත් කරන ලදී.

(කාලගුණවිද්‍යා දෙපාර්තමේන්තුවේ, ස්වභාවික විපත් පිළිබඳ පූර්ව අනතුරු ඇඟවීමේ මධ්‍යස්ථානය)

නිරිත දිග බෙංගාල බොක්ක ජර්දේශයේ පවතින සුළිකුණාටුව (තවමත් ජර්බල නොවන) 2013 මැයි මස 13 වන දින පෙ.ව. 05.30 වන විට (උතුරු අක්ෂාංශ 11.5 හා නැගෙනහිර දේශාංශ 87.0 පමණ) තීරකුණාමලය සිට ඊසාන දෙසින් කි.මී. 650 ක් පමණ දුරින් කේන්ද්‍රගතව පැවතුනි. මෙම පද්ධතිය බොහෝ දුරට එහි කේන්ද්‍රයේ සිට උතුරු දෙසට, දිවයිනෙන් ඉවතට ගමන් කරනු ඇත.

මෙම පද්ධතියේ බලපෑම මත මන්නාරම සිට තීරකුණාමලය සහ යාපනය හරහා මඩකලපුව දක්වා වෙරළට ඔබ්බෙන් වන මුහුදු ජර්දේශ රළු වන අතර, නිරිතතර වැසි සහ තද සුළං (පැ.කි. 70ට වැඩි) ඇතිවිය හැක.

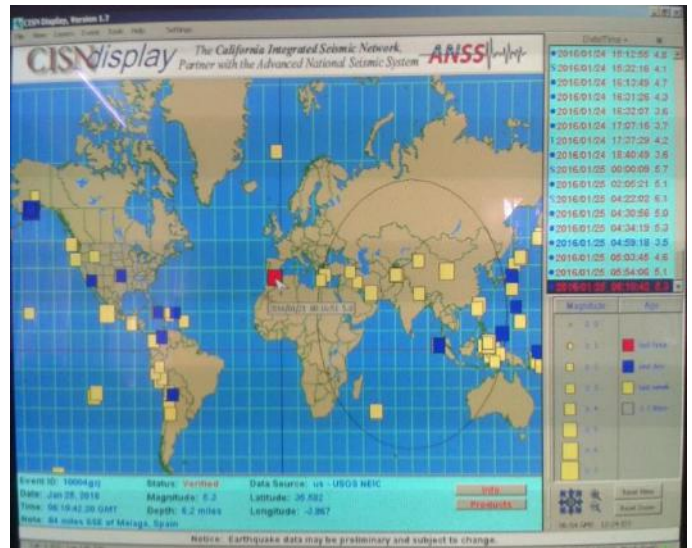
නැගෙනහිර සහ උතුරු වෙරළට ඔබ්බෙන් වන මුහුදු ජර්දේශවල ධීවර හා නාවික කටයුතු වල යෙදීමෙන් වළකින ලෙස ධීවර හා නාවික ජර්ජාවගෙන් කාරුණිකව ඉල්ලා සිටී.

දිවයින සහ අවට ජර්දේශ වල නිරිත දෙසින් හමන තරමක් තද සුළං (පැ.කි. 60 පමණ) අපේක්ෂා කල හැක.

දිවයිනේ බොහෝ ජර්දේශ වල අහස වලාකුලින් බරව පවතී. යාපනය, කිලිනොච්චි සහ මුලතිව් දිස්ත්‍රික්ක වල නිරිතතර වැසි ඇති වේ. ඇතැම් ස්ථාන වල මි.මී. 200 ට වඩා වැඩි තද වැසි ඇති වේ.

මධ්‍යම, සබරගමුව, බස්නාහිර, නැගෙනහිර සහ දකුණු පලාත්වල විටින් විට වැසි ඇති විය හැක. ඇතැම් ස්ථාන වල මි.මී. 100 ට වඩා වැඩි තද වැසි ඇති වේ. අනෙකුත් ජර්දේශ වලද තැනින් තැන වැසි ඇති විය හැක.

Tsunami and Earth Quack monitoring



Weather Forecast for Main Cities					Date: 08/06/2013
City	Temperature (°C)		Relative Humidity		Weather
	Max	Min	Max	Min	
Anuradhapura	32	25	86%	76%	Mainly fair.
Batticaloa	34	26	86%	76%	Mainly fair.
Colombo	29	25	95%	80%	Showers at times.
Galle	29	26	95%	80%	Showers at times.
Jaffna	32	25	86%	76%	Mainly fair.
Kandy	27	22	95%	80%	Showers at times.
Nuwara Eliya	17	13	95%	80%	Showers at times.
Ratnapura	29	23	95%	76%	Showers at times.
Trincomalee	33	26	86%	76%	Mainly fair.
Mannar	31	27	95%	76%	A few showers.

ප්‍රධාන නගර සඳහා කාලගුණ අනාවැකිය				දිනය : 08/06/2013	
නගරය	උෂ්ණත්වය (සෙ. අංශක)		සාපේක්ෂ භ්‍රමණතාව		කාලගුණය
	උපරිම	අවම	උපරිම	අවම	
අනුරාධපුරය	32	25	86%	76%	සුදුසු වාතයක් වැඩි නොවේ යහපත්.
බත්තලම	34	26	86%	76%	සුදුසු වාතයක් වැඩි නොවේ යහපත්.
කොළඹ	29	25	95%	80%	විටින් විට වැසි.
ගාල්ල	29	26	95%	80%	විටින් විට වැසි.
කොළඹ	32	25	86%	76%	සුදුසු වාතයක් වැඩි නොවේ යහපත්.
කන්දිය	27	22	95%	80%	විටින් විට වැසි.
බණ්ඩාරනායක	17	13	95%	80%	විටින් විට වැසි.
රත්නපුරය	29	23	95%	76%	විටින් විට වැසි.
ත්‍රිකුණාමලය	33	26	86%	76%	සුදුසු වාතයක් වැඩි නොවේ යහපත්.
මන්නාරම	31	27	95%	76%	වැඩි වැසි වේ.

කාලගුණ දිනක (Duty Meteorologist),
කාලගුණ දින දෙපාර්තමේන්තුව (Department of Meteorology).

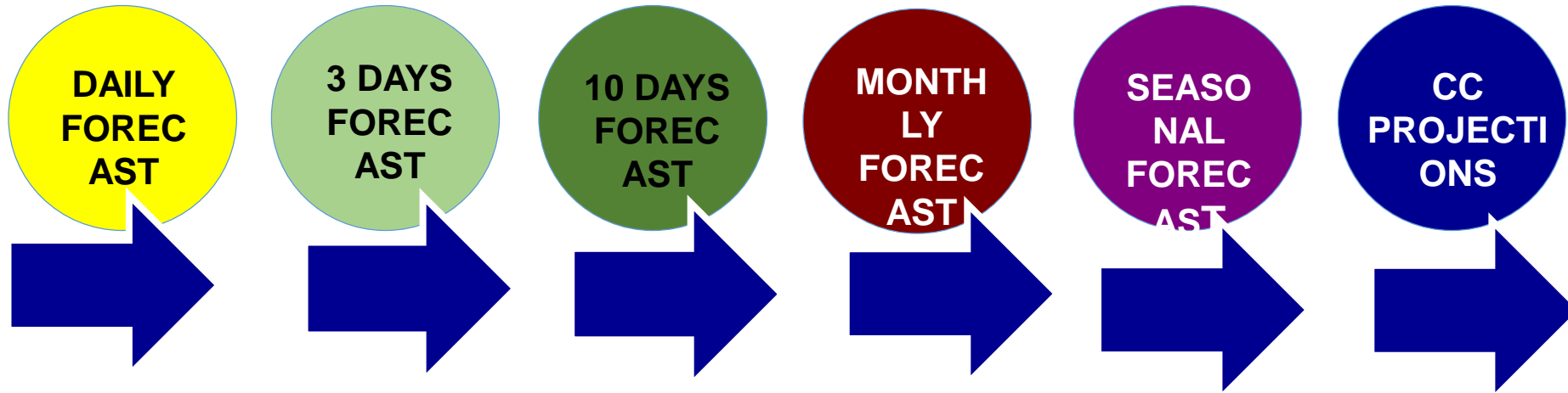
The Monsoon Forum

- Convened by the Department of Meteorology (DOM),
- facilitation from the Regional Integrated Multi-Hazard Early Warning System (RIMES) and support from the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP)
- the National Monsoon Forum has been a dynamic seasonal platform for informed planning and decision-making by various key economic and disaster management sectors in Sri Lanka
- utilizing information of different timescales (observed, daily, 10 days, monthly and seasonal information), for both resources and risks management.
- The Monsoon Forum – a cyclical, regular process that develops a culture of preparedness
- information generation by DOM
- utilization of information by stakeholder institutions, for seasonal and sub-seasonal planning and decision-making
- sharing of institutional experiences (good practices, challenges, lessons learnt) in utilizing information and articulating recommendations for addressing gaps in both forecast generation and application
- responding to recommendations through applied research, products testing further improvements/customization, as necessary

All Relevant institutions in the country

- *Agriculture*
- *Water Resources*
- *Irrigation*
- *Fisheries*
- *Disaster Risk Management*
- *Other Relevant Organizations*

RESPONDING TO USER REQUIREMENTS: FORECAST OF VARIOUS TIMESCALES



DEVELOPMENT OF FORECAST OF DIFFERENT TIMESCALES IN SRI LANKA BASED ON MONSOON FORUM STAKEHOLDER DEMANDS

ENHANCEMENTS IN SPATIAL RESOLUTION WERE ALSO INTRODUCED BY DOM; FORECAST FOR SPECIFIC SECTORS EVOLVED

Recommendations

The following are recommendations collated from stakeholder presentations and discussions during the Monsoon Forum:

Information generation

For further enhancing forecast application in the agriculture sector, a priority recommendation is for DOM to generate forecast of finer spatial resolution, based on agro-ecological zones. For application in power generation, seasonal/monthly outlook customized for hydro catchment areas is required

Information Communication

Seasonal outlook and sub-seasonal updates have to be communicated to stakeholders as soon as they are available. Among the stakeholders, CEB requires highest lead time, for planning operational requirements. Due to limitations, however, in generation of long-range forecasts, a balance between accuracy and lead time has been considered.

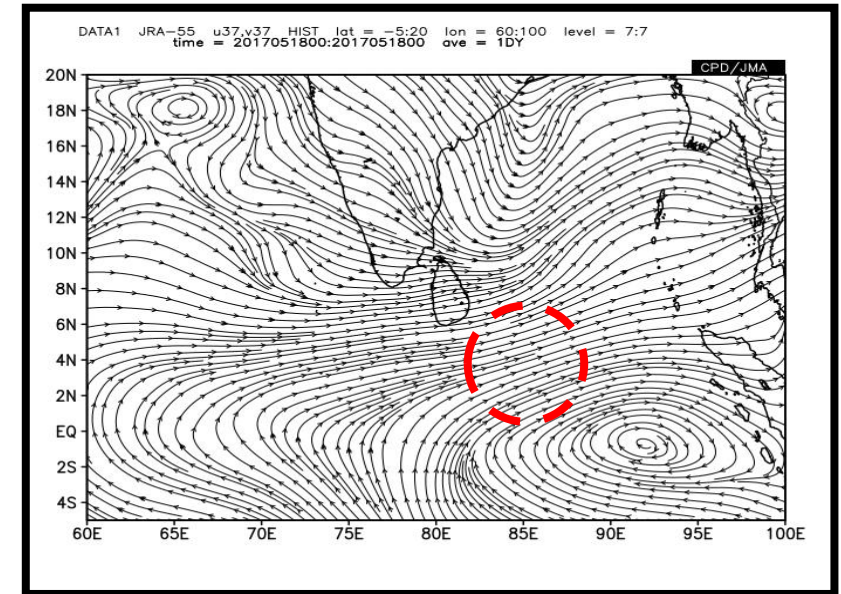
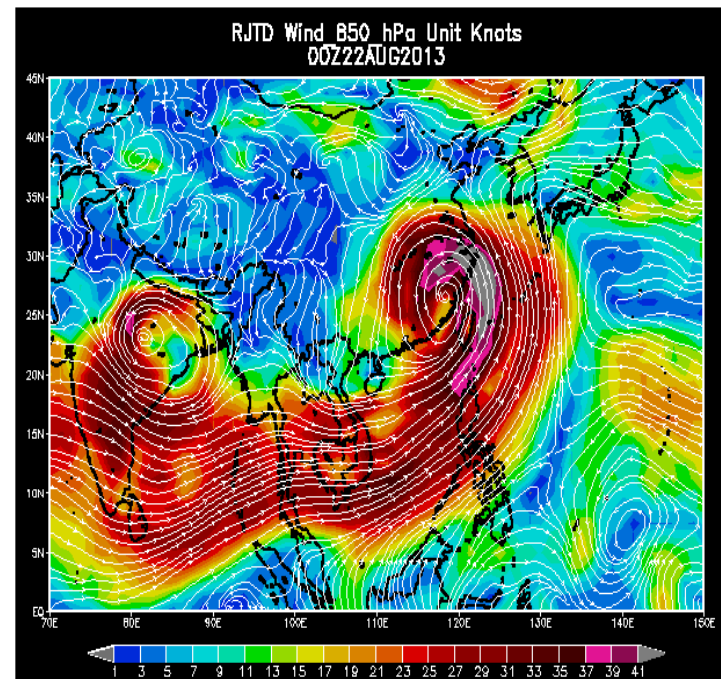
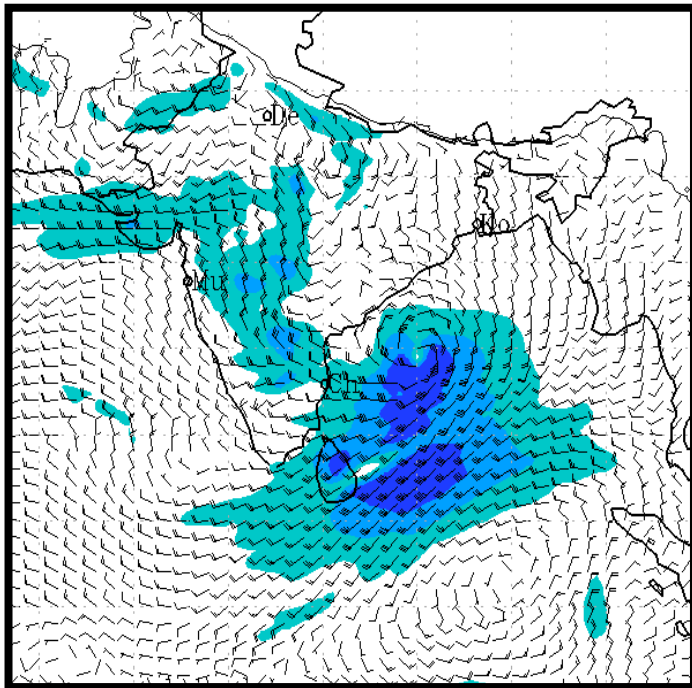
Monsoon Forum Process Evolution

- Stakeholders were unanimous in recommending that institutional mechanisms for taking forward national institutional decisions.
- cascading preparedness actions down to end-users level, have to be forged, through the Monsoon Forum process.
- Further, participation, in the Monsoon Forum, of more relevant officials/staff from stakeholder institutions have to be ensured (e.g. Research and Development Division in RRI).

Outlook for Southwest monsoon 2017

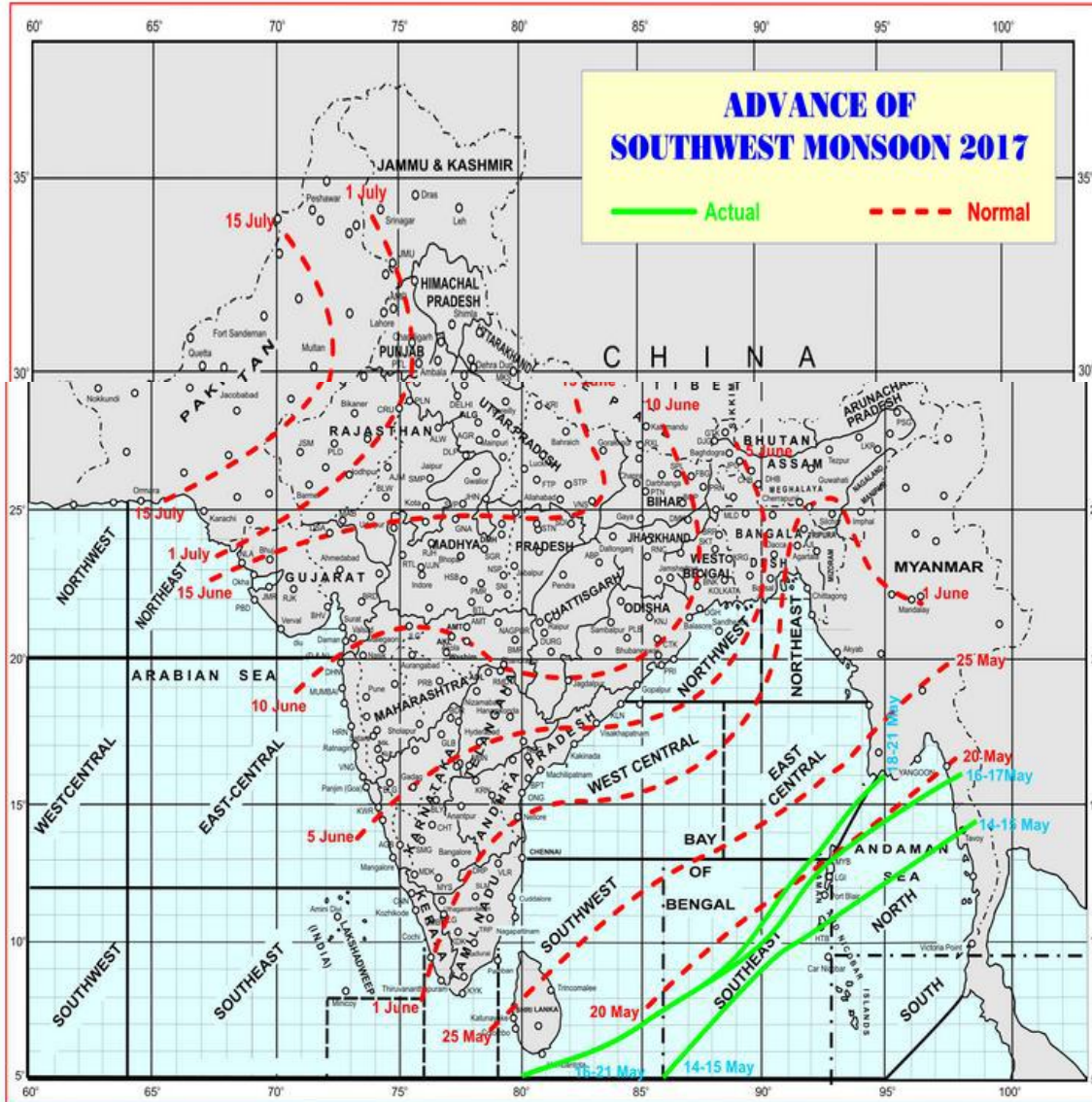
Windy and showery condition can be enhanced by cyclones in the Bay of Bengal and Typhoons in Pacific ocean

Windy and showery condition can be enhanced by wind convergence /trough to the west/southwest



18th May 2017

SW Monsoon onset Criteria



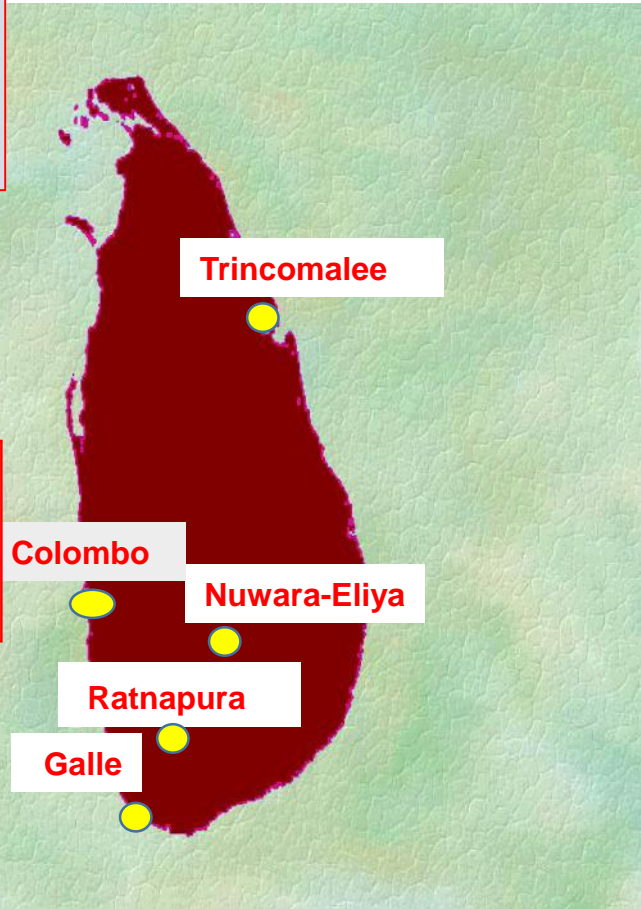
1. At least 2.5 hpa pressure gradient (from Colombo to Trincomalee) in the southwesterly direction.

2. Extending of Southwesterly winds from surface to at least 18000 feet

3. Occurrence of rain at least two consecutive days at Galle, Colombo, Ratnapura, and Nuwara-Eliya

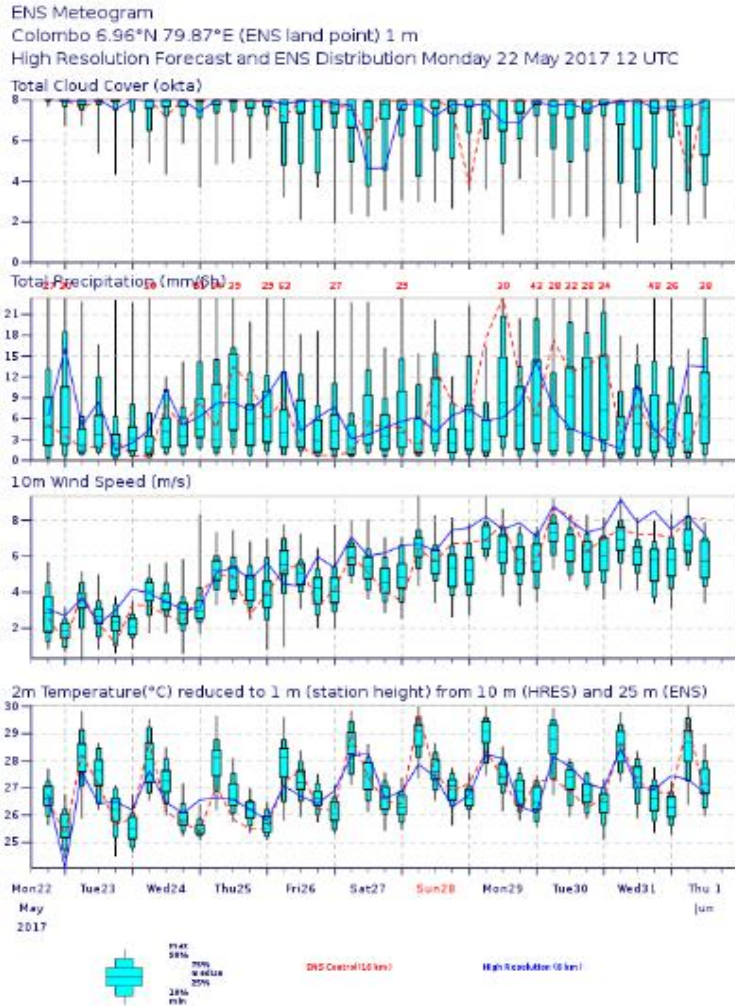
4. Formation of surface low or low tropospheric vortices in the vicinity of the island or in the Southwest Bay of Bengal

5. About 5- 10 days after the first appearance of Tropical Easterly Jet (over 40kts) around Sri Lanka latitudes.

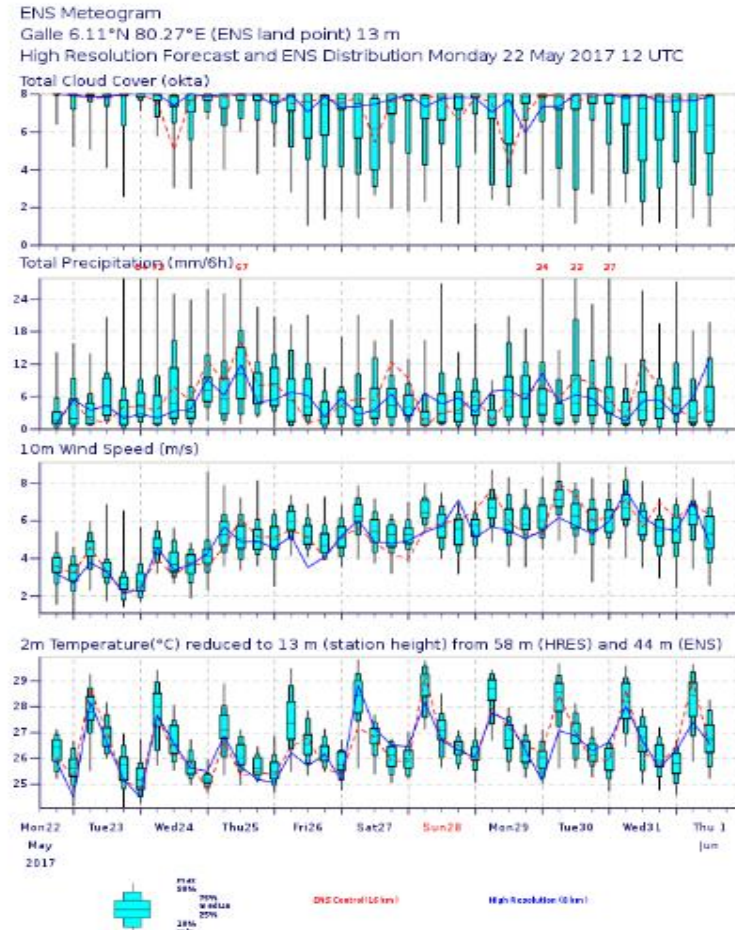


Source-IMD

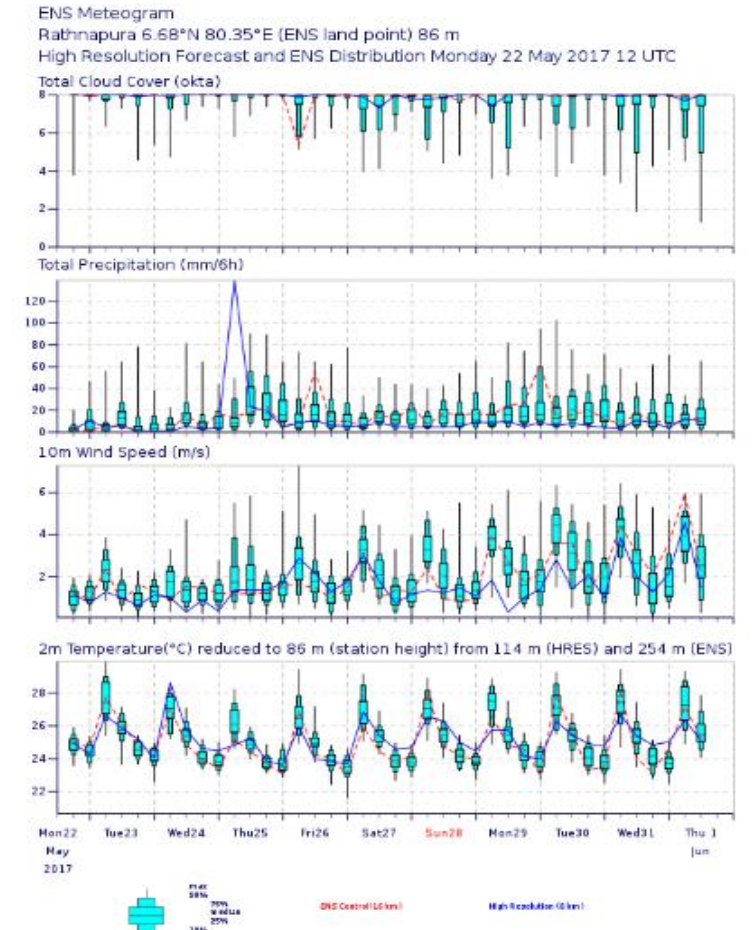
Onset of SW monsoon 2017-10 day forecast from ECMWF



Colombo

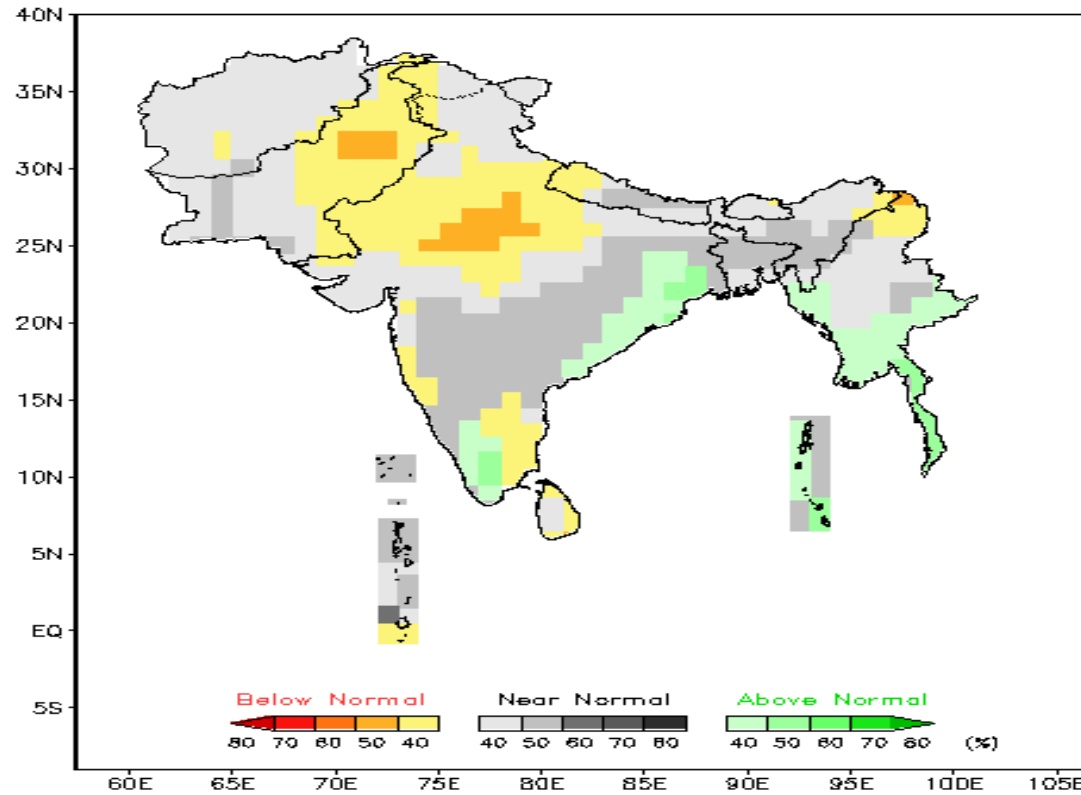


Galle



Rathnapura

Rainfall probability Forecast for June-September 2017 –SASCOP-



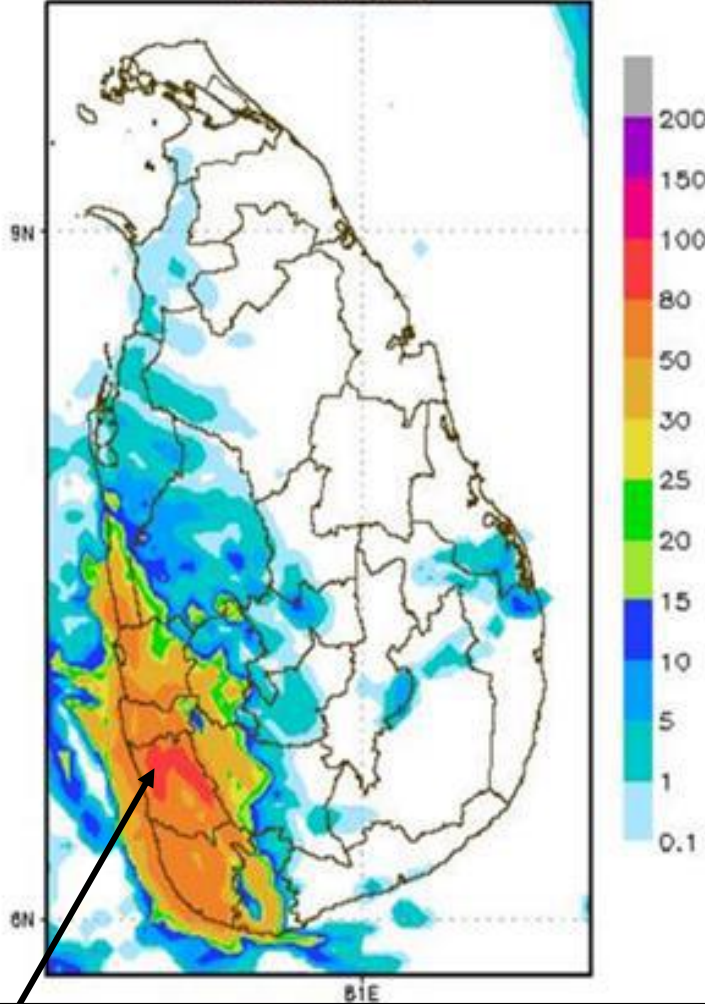
Consensus outlook for 2017 Southwest Monsoon Rainfall over South Asia

Near normal/ a little below normal

Probability of the most likely category for the **2017 Southwest Monsoon** Rainfall over South Asia based on this consensus statement. The consensus probability forecast map was prepared based on subjective assessment of individual country forecasts from various sources.

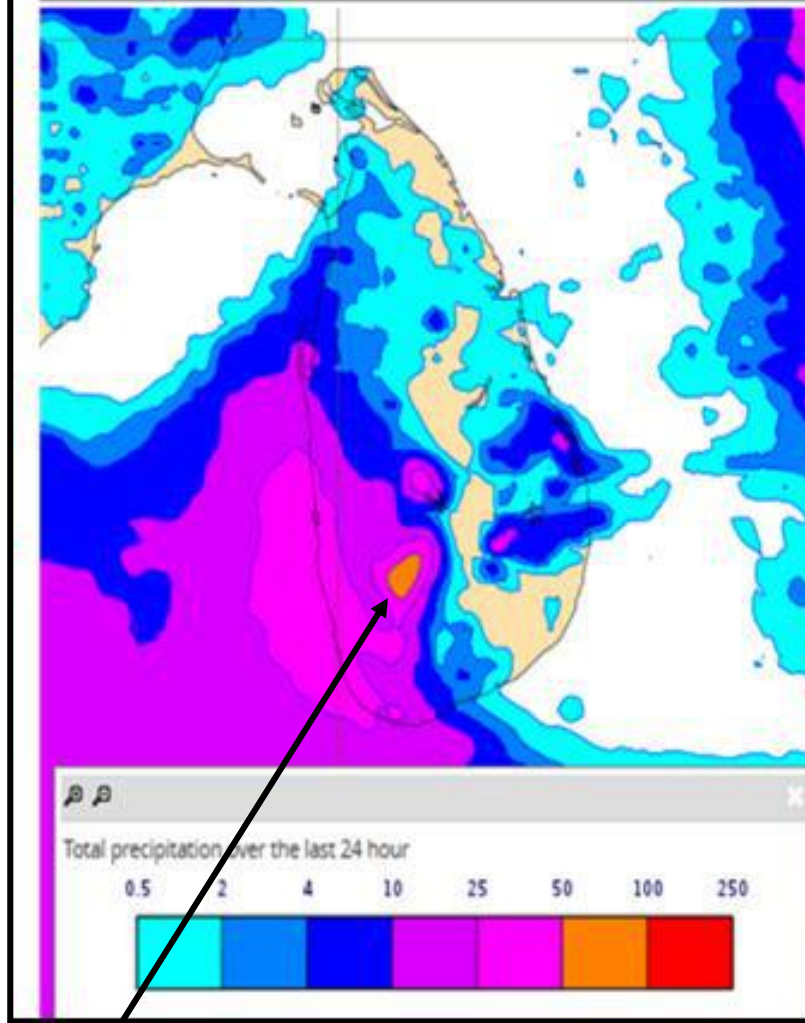
Forecast (WRF)

Precipitation (mm)



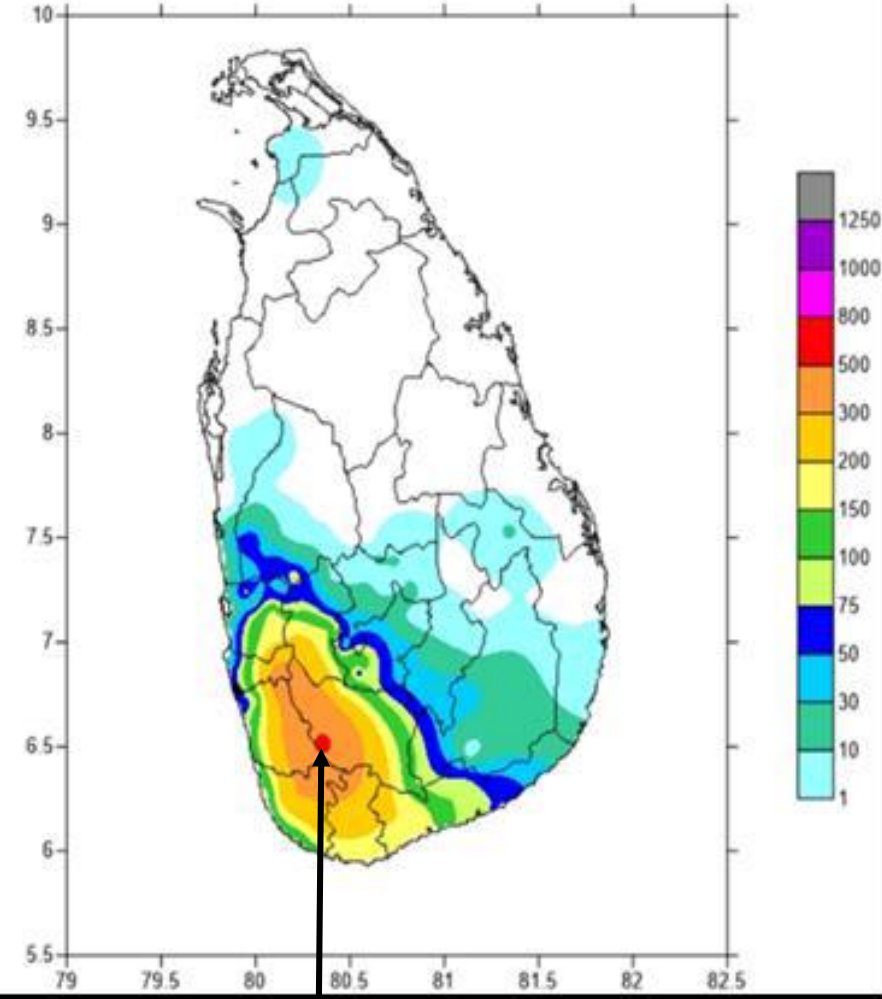
**Predicted Maximum rainfall for 25th
80-100 mm**

Forecast (ECMWF)



**Predicted Maximum rainfall for 25th
50-100 mm**

Observation 2017-05-25

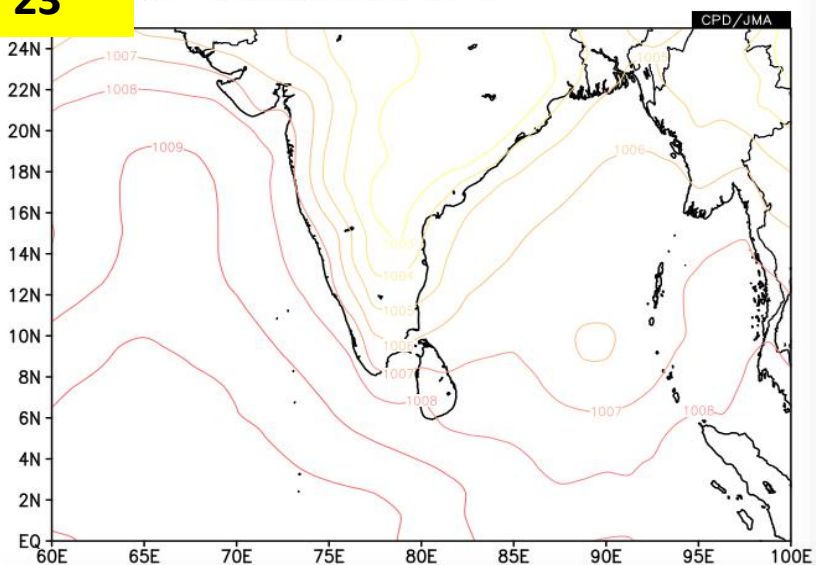


**Observed rainfall on 25th
553.5 mm**

Surface pressure during 23-28th May 2017

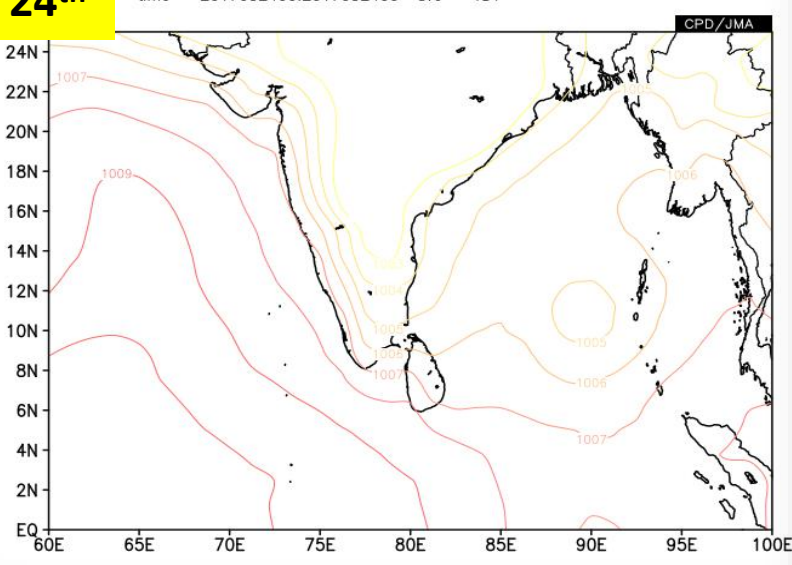
23rd

-55 slp_HIST lat = 0:25 lon = 60:100 level = 1:1
time = 2017052300:2017052300 ave = 1DY



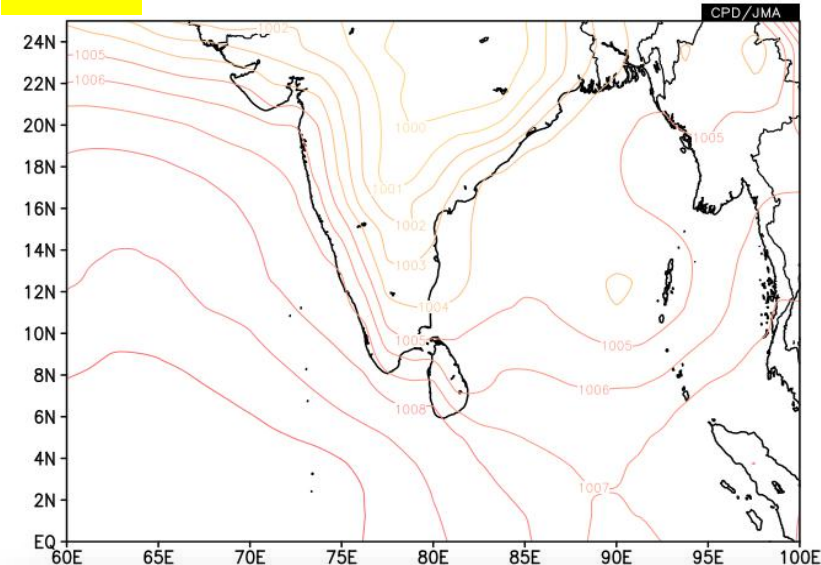
24th

RA-55 slp_HIST lat = 0:25 lon = 60:100 level = 1:1
time = 2017052400:2017052400 ave = 1DY



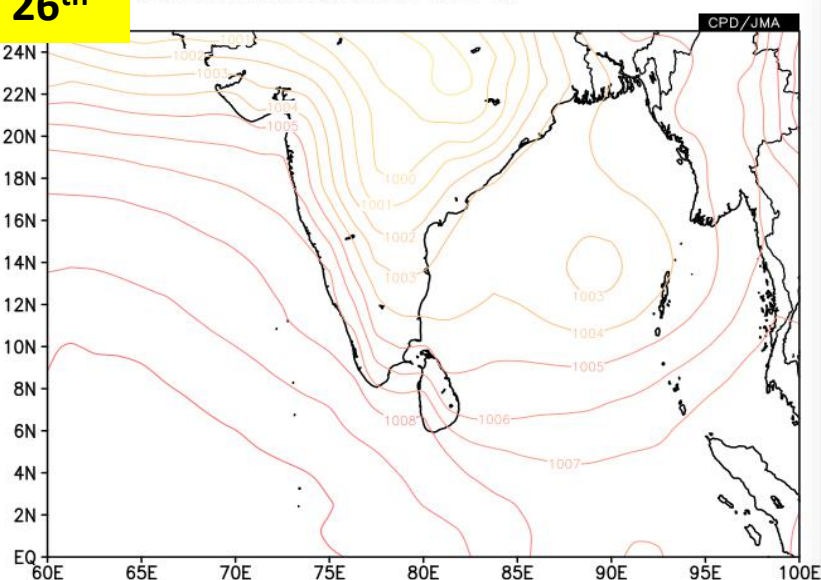
25th

A-55 slp_HIST lat = 0:25 lon = 60:100 level = 1:1
time = 2017052500:2017052500 ave = 1DY



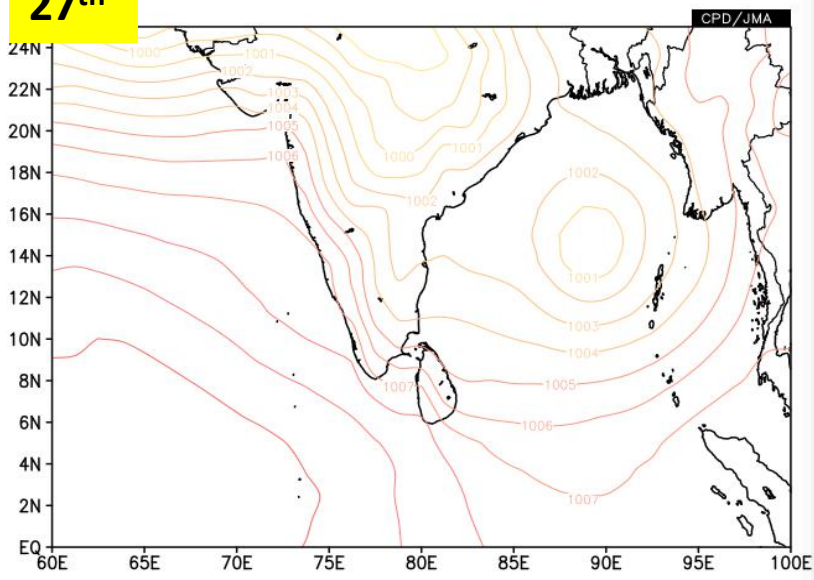
26th

-55 slp_HIST lat = 0:25 lon = 60:100 level = 1:1
time = 2017052600:2017052600 ave = 1DY



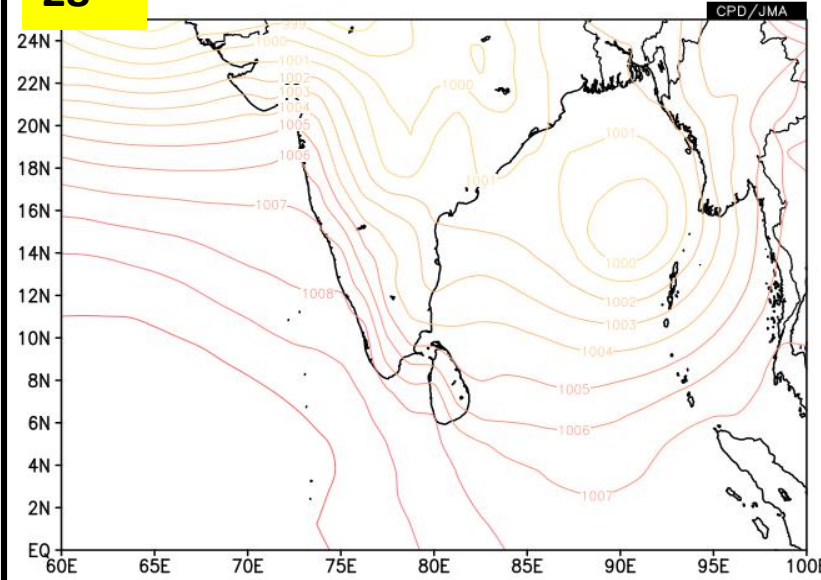
27th

-55 slp_HIST lat = 0:25 lon = 60:100 level = 1:1
time = 2017052700:2017052700 ave = 1DY



28th

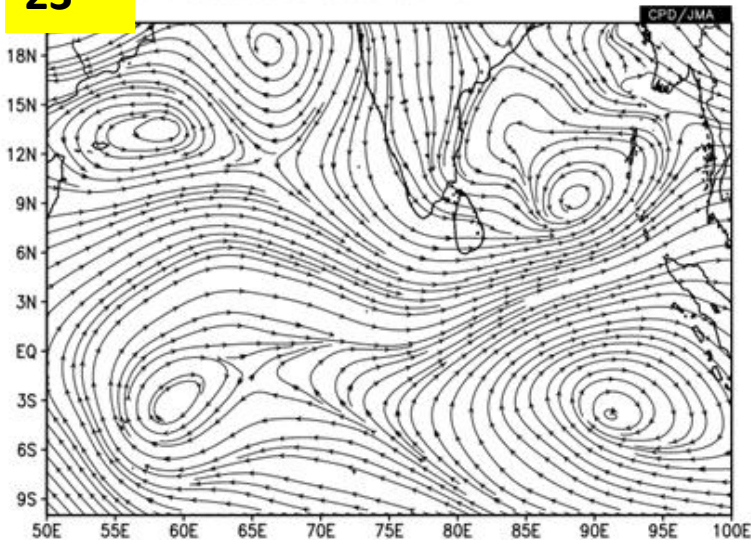
-55 slp_HIST lat = 0:25 lon = 60:100 level = 1:1
time = 2017052800:2017052800 ave = 1DY



Upper wind pattern (850hpa) during 23-28th May 2017

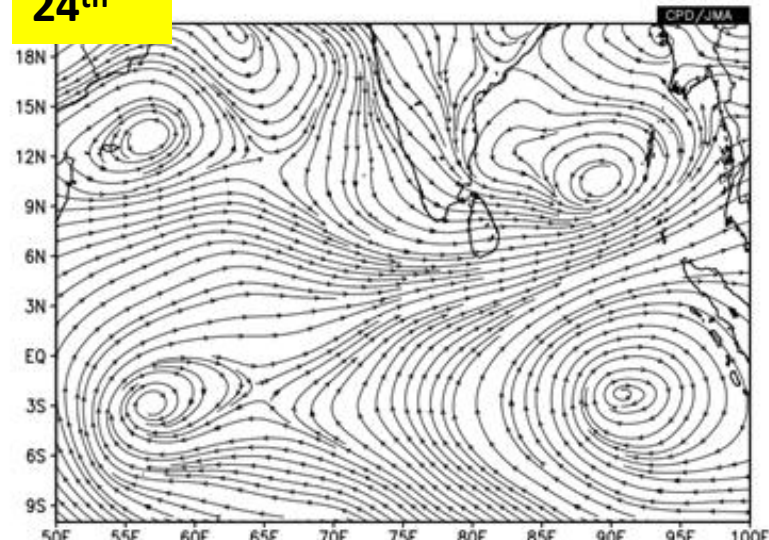
23rd

-55 u37,v37 HIST lat = -10:20 lon = 50:100 level = 7:7
time = 2017052300:2017052300 ave = 1DY



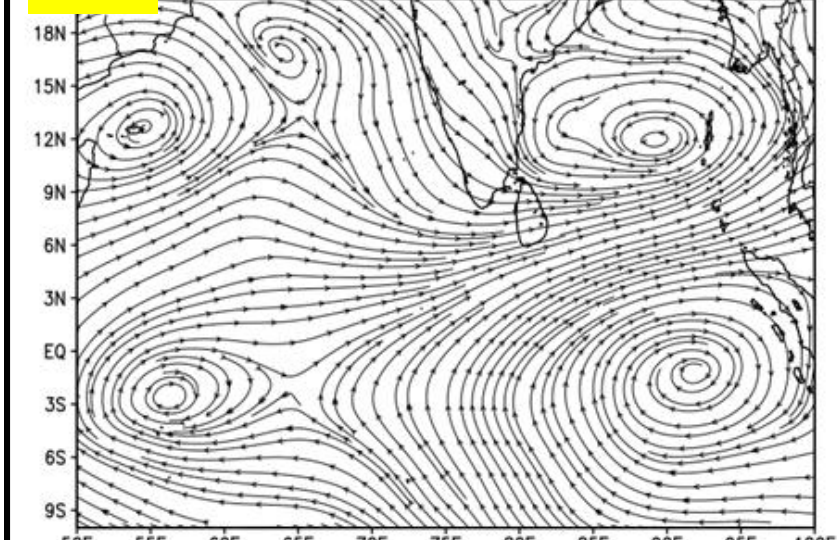
24th

u37,v37 HIST lat = -10:20 lon = 50:100 level = 7:7
time = 2017052400:2017052400 ave = 1DY



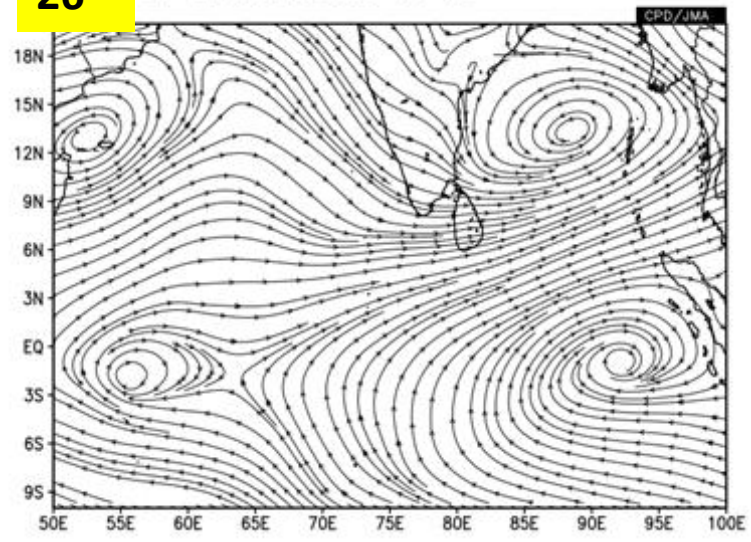
25th

-55 u37,v37 HIST lat = -10:20 lon = 50:100 level = 7:7
time = 2017052500:2017052500 ave = 1DY



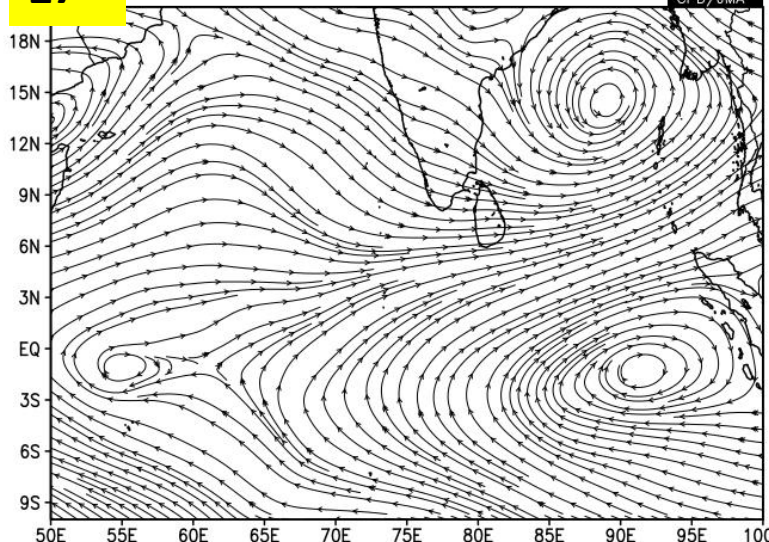
26th

-55 u37,v37 HIST lat = -10:20 lon = 50:100 level = 7:7
time = 2017052600:2017052600 ave = 1DY



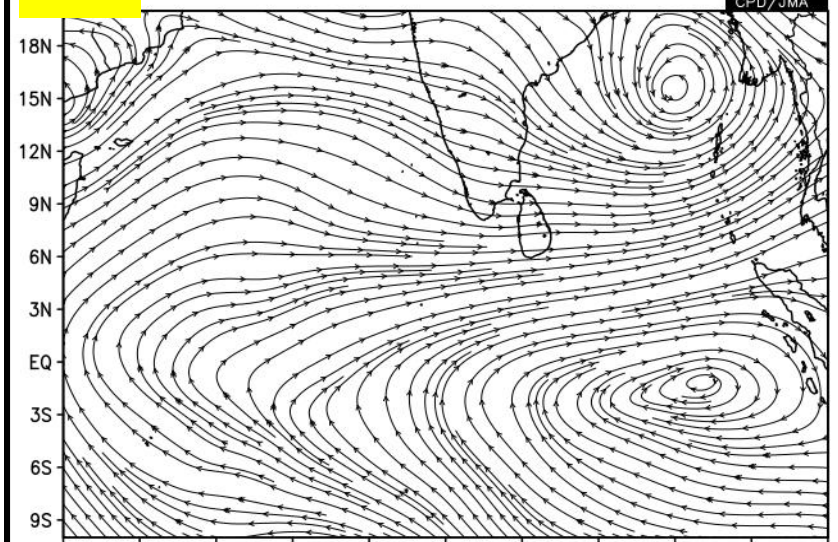
27th

-55 u37,v37 HIST lat = -10:20 lon = 50:100 level = 7:7
time = 2017052700:2017052700 ave = 1DY

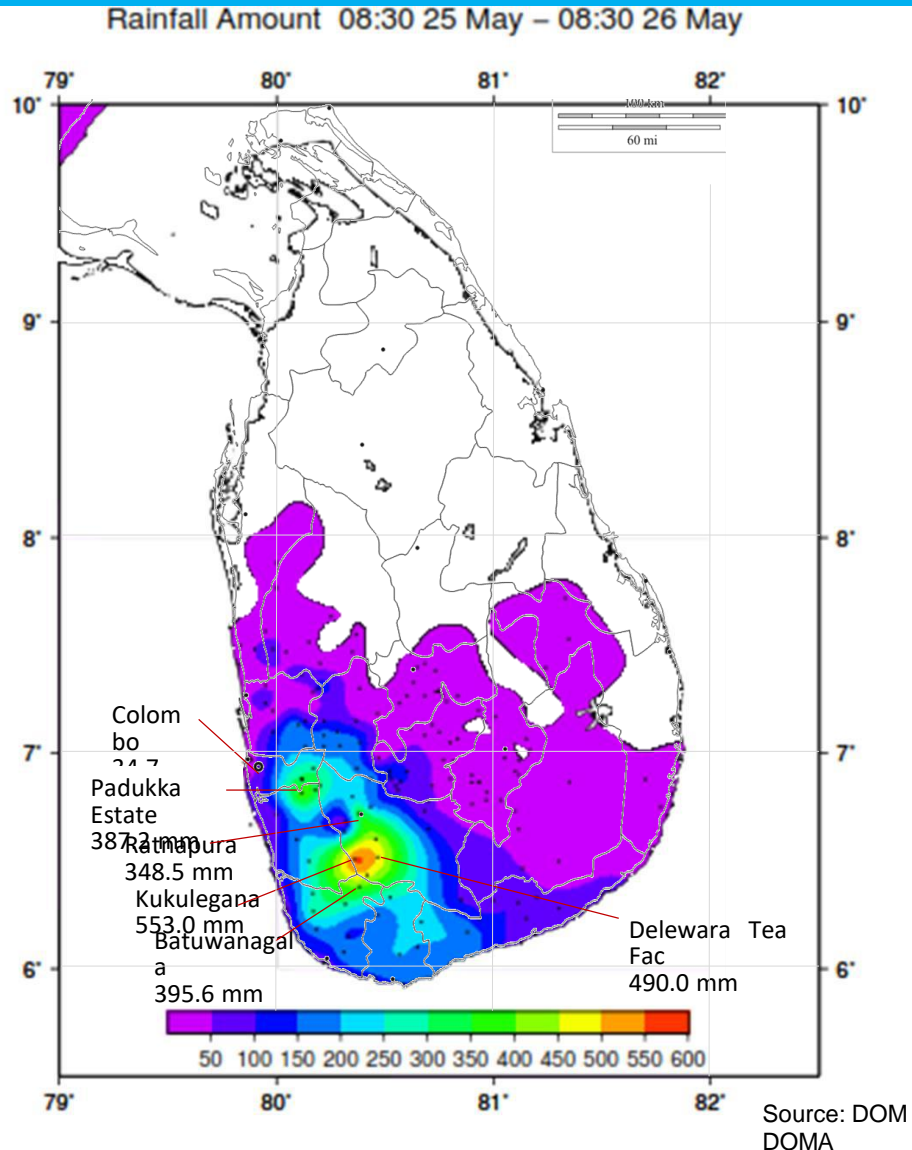


28th

-55 u37,v37 HIST lat = -10:20 lon = 50:100 level = 7:7
time = 2017052800:2017052800 ave = 1DY



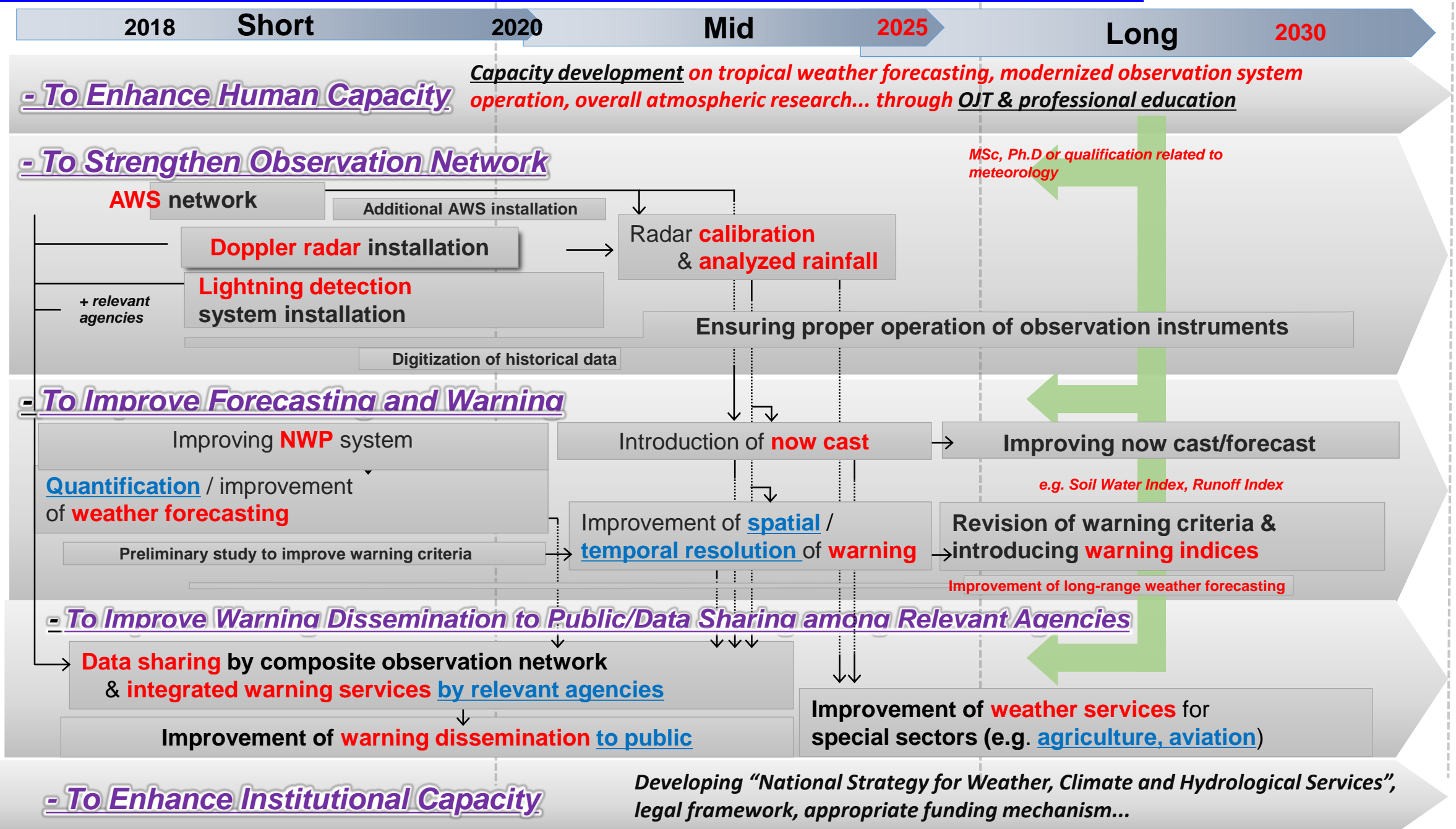
Since 24th May 2017, the unprecedented heavy rainfall caused severe floods and landslides



According to the Government of Sri Lanka as of June 3, 2017

- ❖ **211 People have died**
- ❖ **96 People have been missing**
- ❖ **Nearly 704000 People have been affected**
- ❖ **2545 houses were completely destroyed**
- ❖ **15897 houses were partially damaged**

Image of Action Plans - Weather Forecasting





Thank you