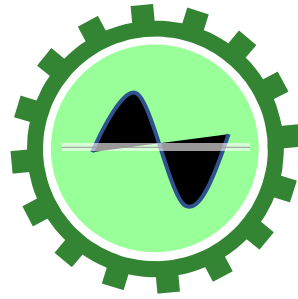
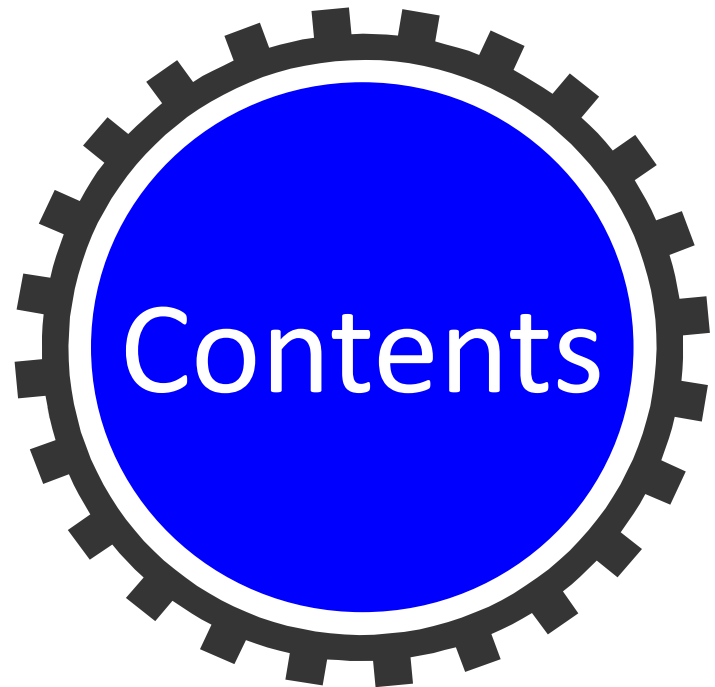




Maldives Meteorological Service
Republic of Maldives

Role of Satellite Products in Nowcasting Early Warning

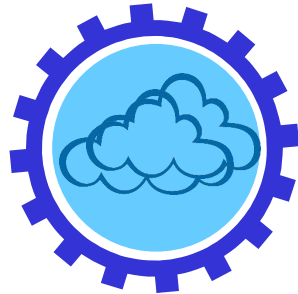
Abdulla Hafiz A.S.Ali
Meteorologist
Weather Watch Office
National Meteorological Center
Abdulla.Hafiz@met.gov.mv



Monsoonal & seasonal weather patterns in the Maldives



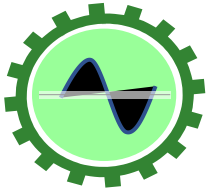
Nowcasting Early Warning



Nowcasting products & challenges in the Maldives



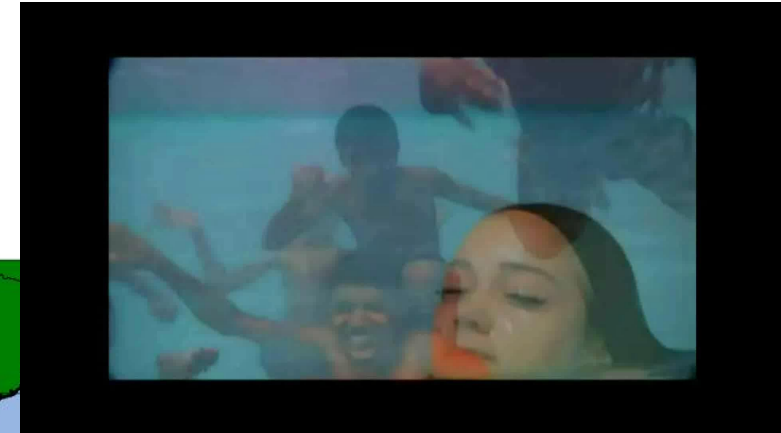
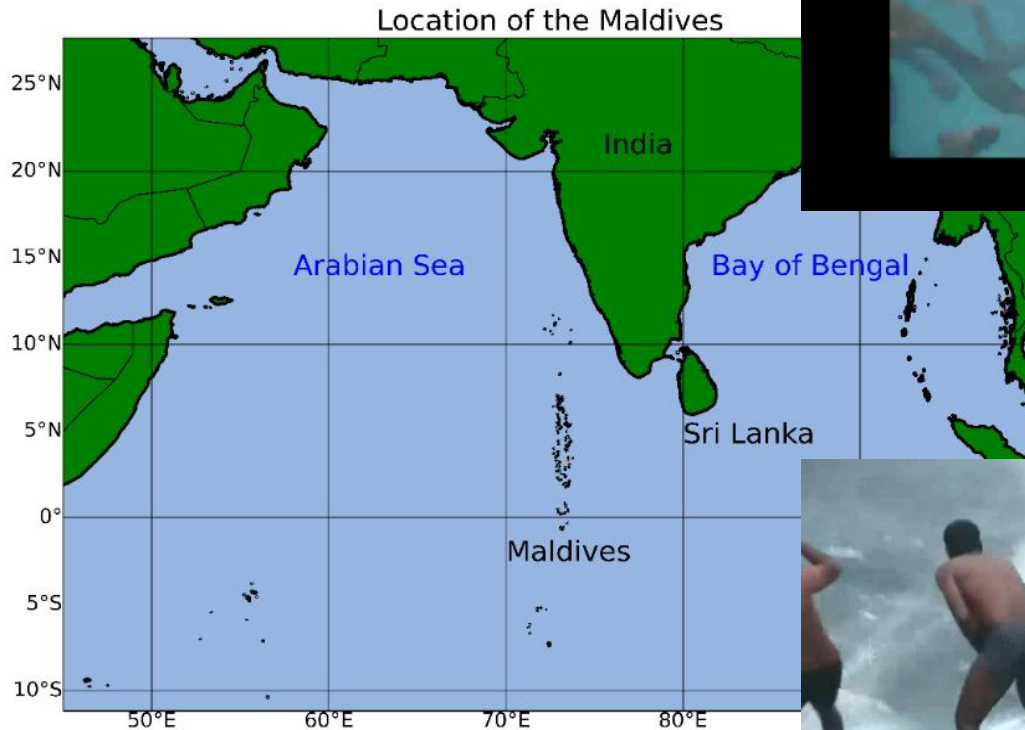
Expectations for improvements to overcome the challenges

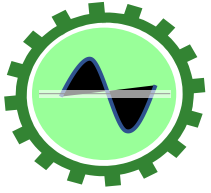


Monsoonal & seasonal weather patterns in the Maldives

The Maldives being an equatorial country, is surrounded by the warm Indian Ocean.

Like other South Asian countries, the Maldives also experience a monsoonal climate.





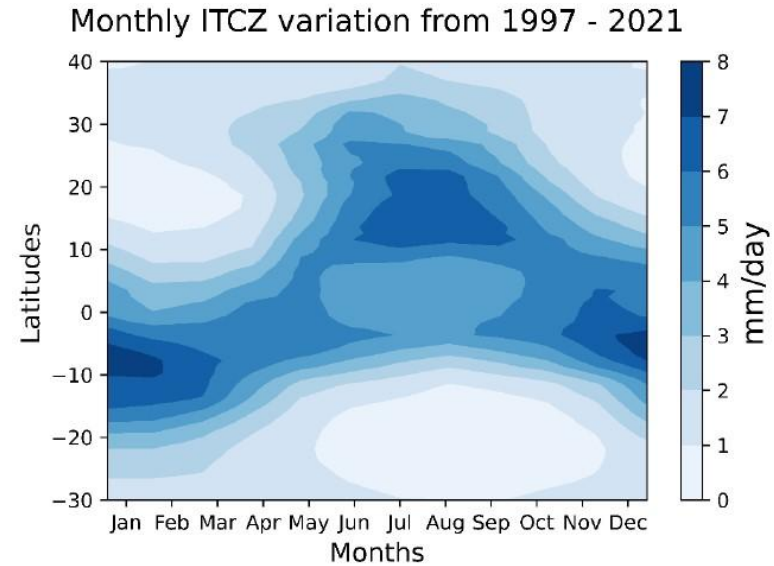
Monsoonal & seasonal weather patterns in the Maldives

- *continues*

Maldives is geographically well located, where the seasonal migration of the intertropical convergence zone (ITCZ) is felt.

Two distinct seasons, NE (dry) and SW (wet), based on the mean wind direction and rainfall amount.

Transitional period (April and December), deep convective activities plays a significant role in severe weather over the Maldives.



GPCP daily $1^\circ \times 1^\circ$ gridded average monthly precipitation and the migration of ITCZ (30° S - 40° N & 30° E - 140° E)



Satellite images of ITCZ migration over the year



Nowcasting Early Warning in the Maldives

Remote sensing plays a vital role in monitoring and tracking severe convection.

- Satellites (GEO & LEO)
- Doppler Weather Radar Network
- High Performance Numerical Models (NWP)
- Automatic Weather Stations (AWS)



Nowcasting products & challenges in the Maldives



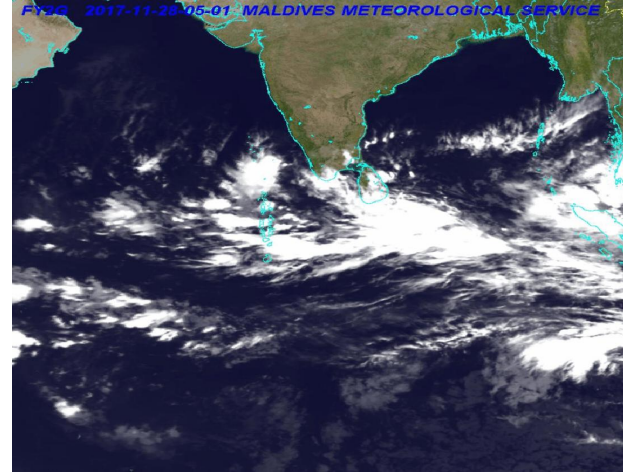
Changing climate, hazards, vulnerability & risks for the Maldives

- **Global warming**

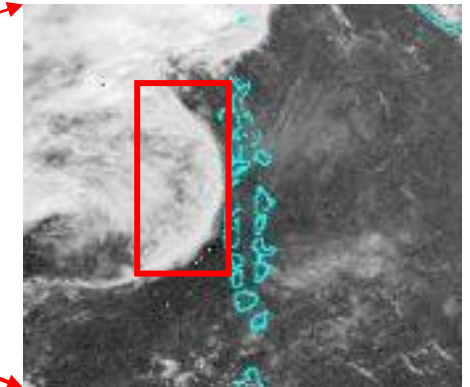
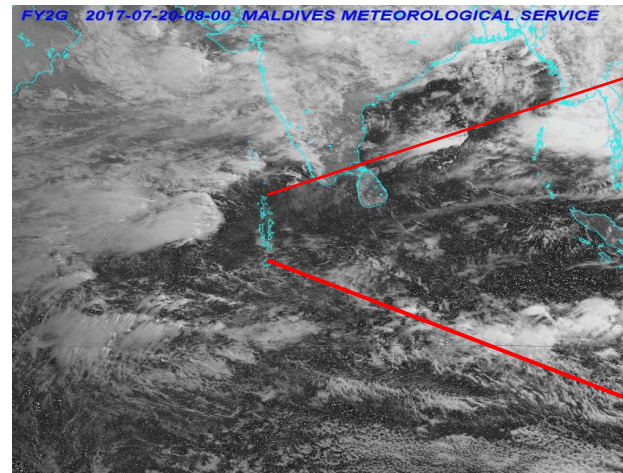
- Surface temperature rise
- Sea-level rise
- Coral bleaching

- **Meteorological hazards**

- Enhanced in severe weather events
- Flooding
- Wave surges
- Hot days
- Enhance in particulates



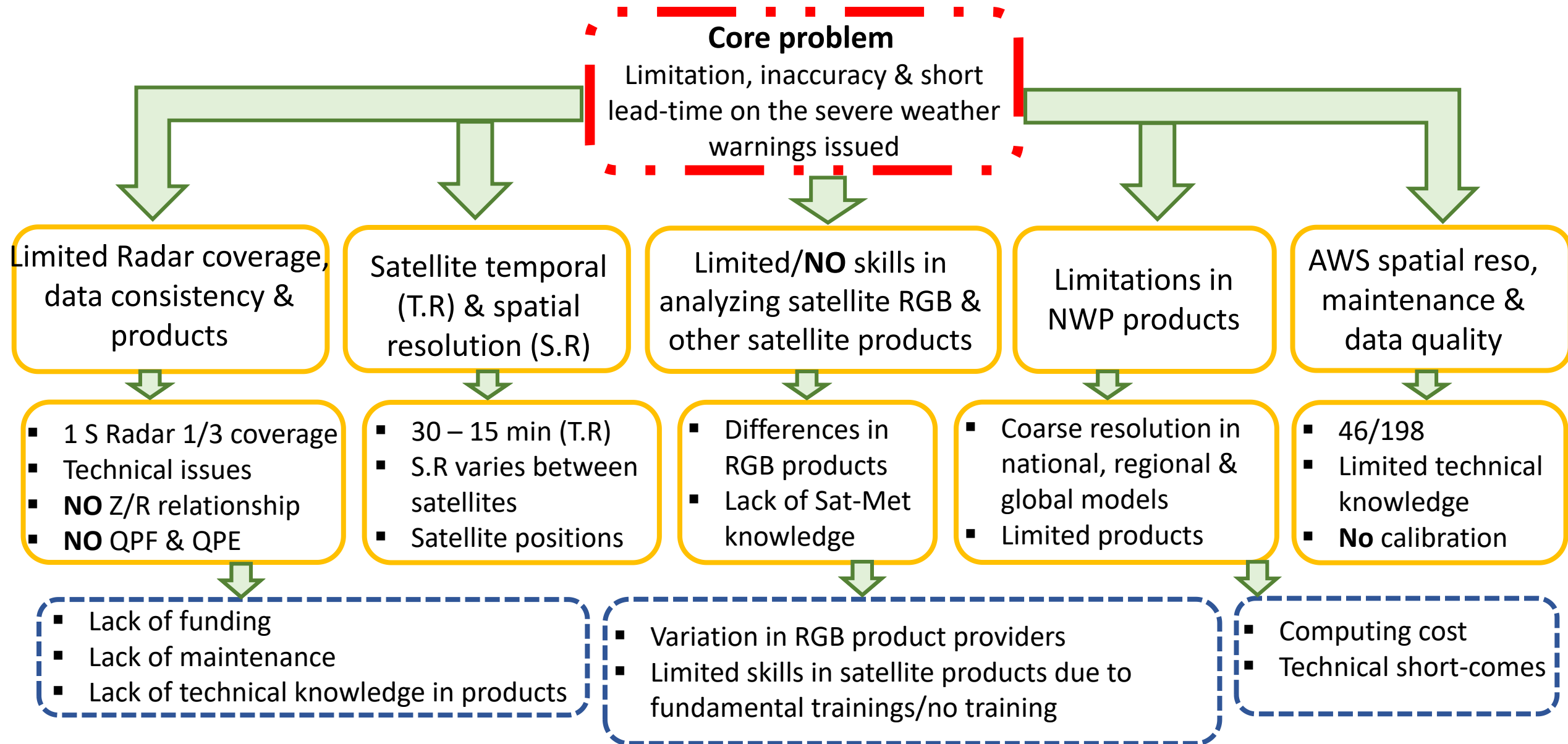
Tropical Cyclone “Ockhi” formed over southwest of Sri Lanka and moved towards to west, in to the Arabian Sea. This cyclone traveled very close (north) of Maldives.



1230 local time (squall line)

20th July 2017, squall line moving from west to east of Maldives

Problems Analysis: General public, aviation sector & first responders affected by the severe weather (challenges in MMS)



Objectives Analysis: General public, aviation sector & first responders not affected by the severe weather (challenges in MMS)

Core problem
Enhanced accuracy & improvement in lead-time on the severe weather warnings issued

Full Radar coverage, data consistency & additional products

- 4 S Band Radar
- No technical issues
- Z/R relationship
- QPF & QPE

Enhancement in satellite T.R & S.R

- 10 min (T.R)
- 1-3 min rapid scanning
- Nadir point observation

Skills in analyzing satellite RGB & other satellite products

Enhanced in Sat-Met knowledge on different RGB & other Sat products

Enhancement in NWP products

- Finer resolution in national, regional & global models
- More NWP products

AWS full coverage, maintenance & data quality improved

- 198/198 installed
- Well trained technical personals
- Calibrated

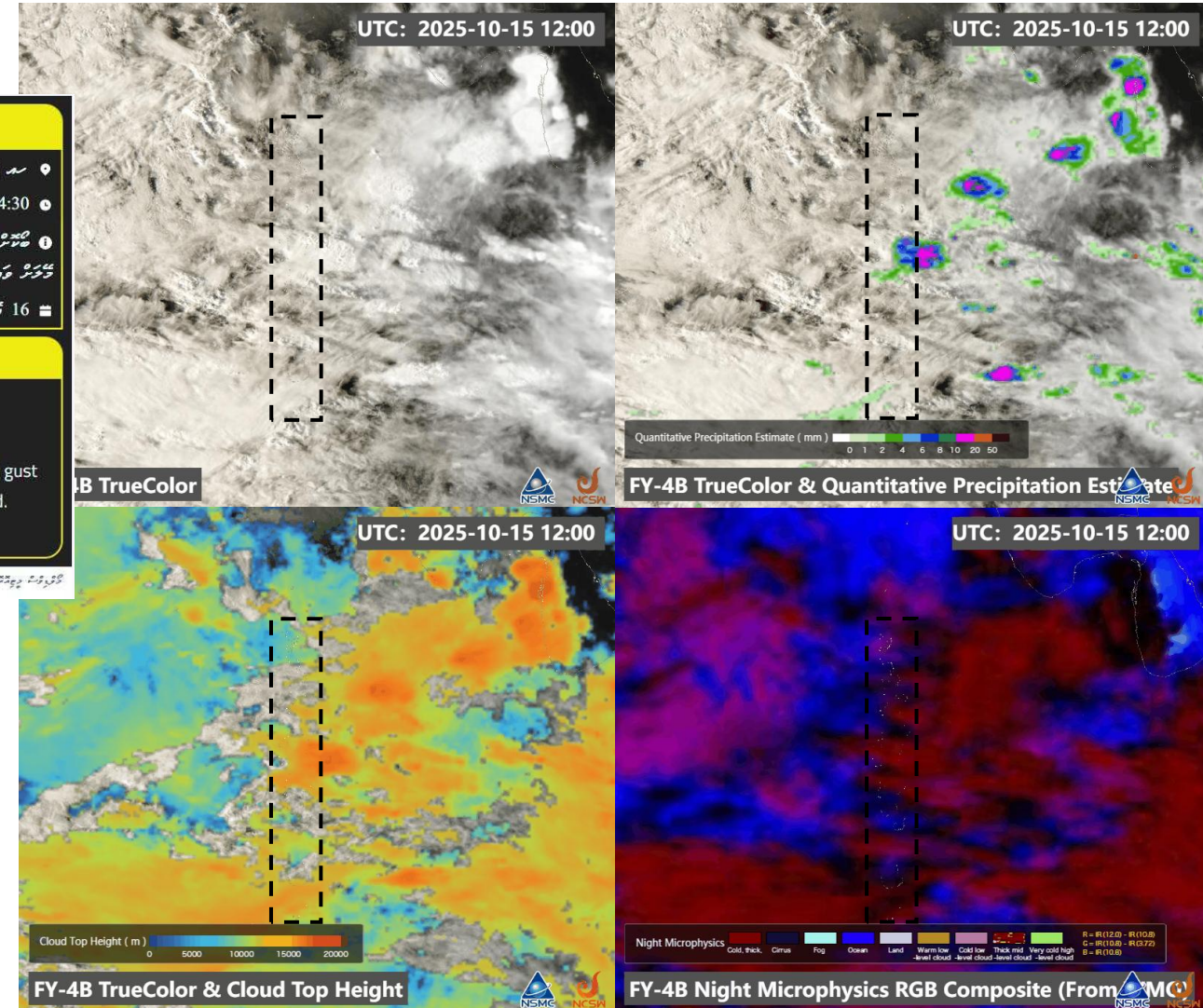
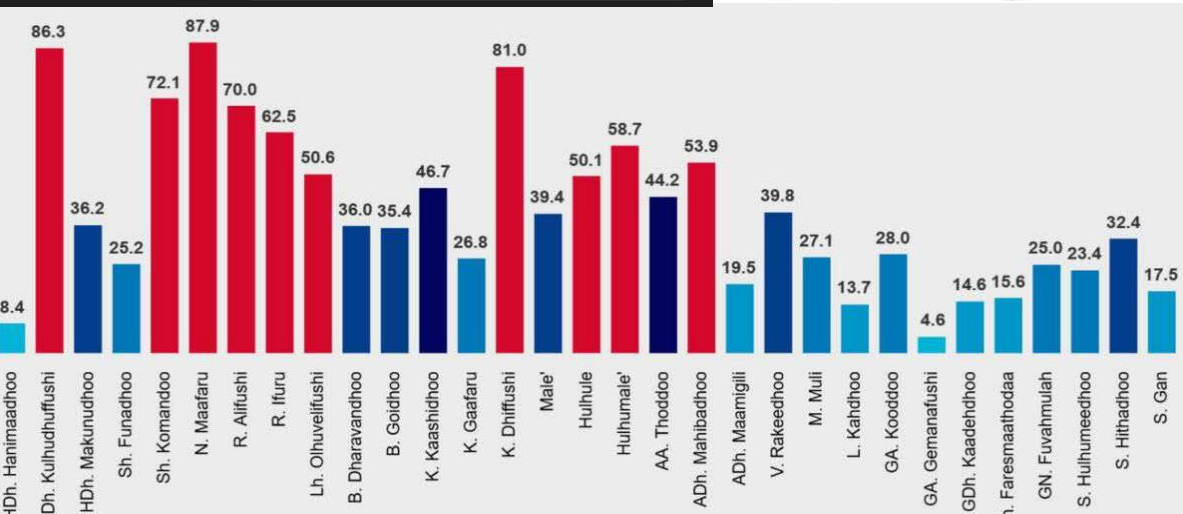
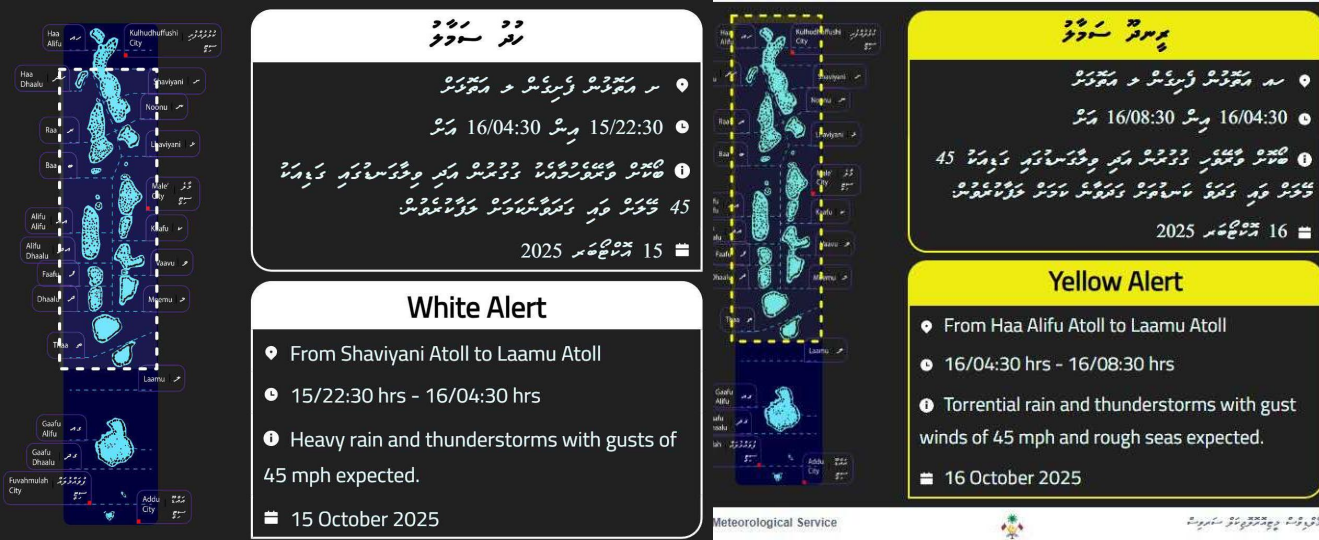
- More funding for more Radars
- Well maintained Radar network
- Technical knowledge in Radar products

- Enhanced knowledge in all RGB products.
- Enhanced skills in satellite products and regular trainings for operational personals
- All operational staffs with RGB training

- High performance Computer
- **NO** Technical short comes

Why enhancing skills in analyzing satellite RGB & other satellite products is important with limited tools at MMS

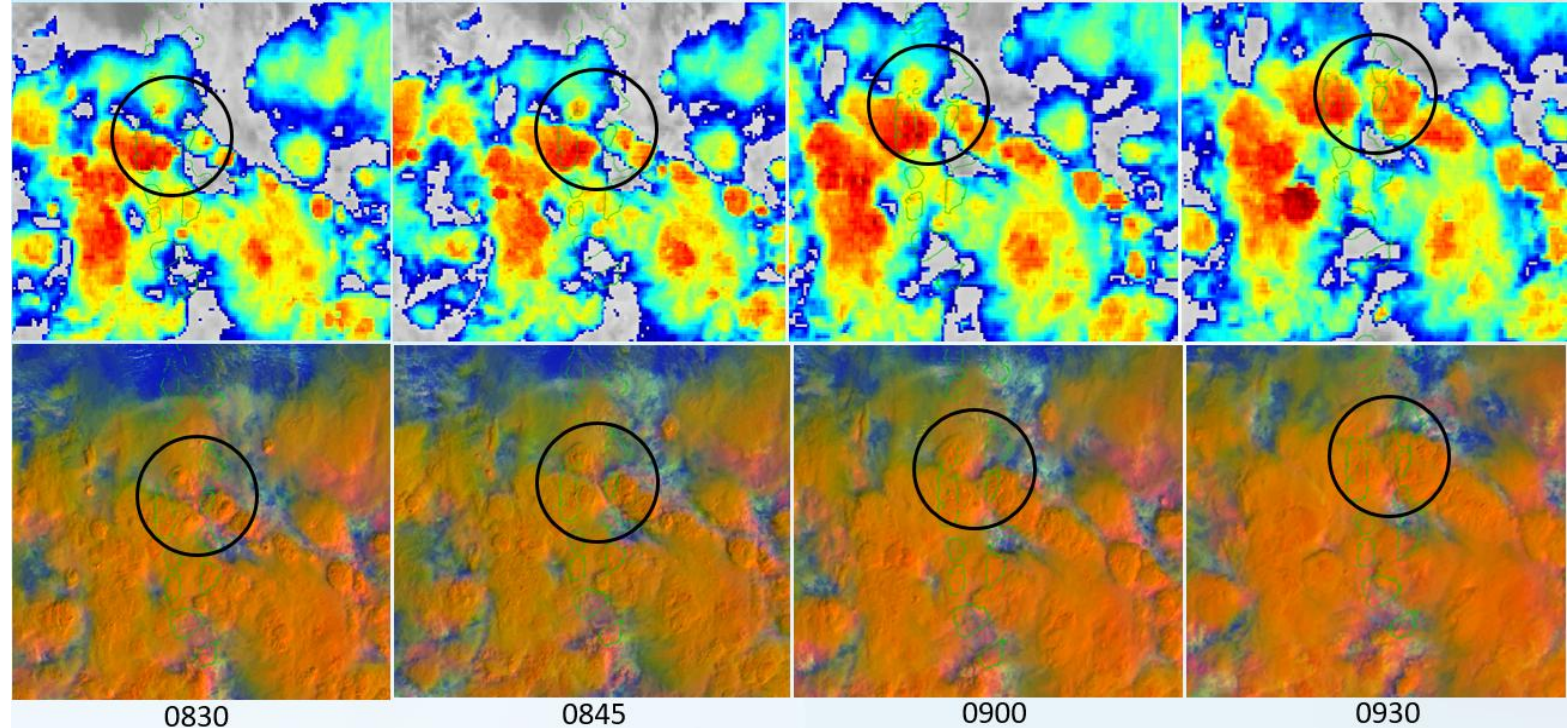
- Satellite RGB & other products plays are pivotal in Nowcasting early warming



Why enhancing skills in analyzing satellite RGB & other satellite products is important with limited tools at MMS

On the 12th of January 2024, due to enhanced convective activities over east of the central atolls, heavy downpour, which resulted severe flooding in Male' and some other islands in the central atolls.

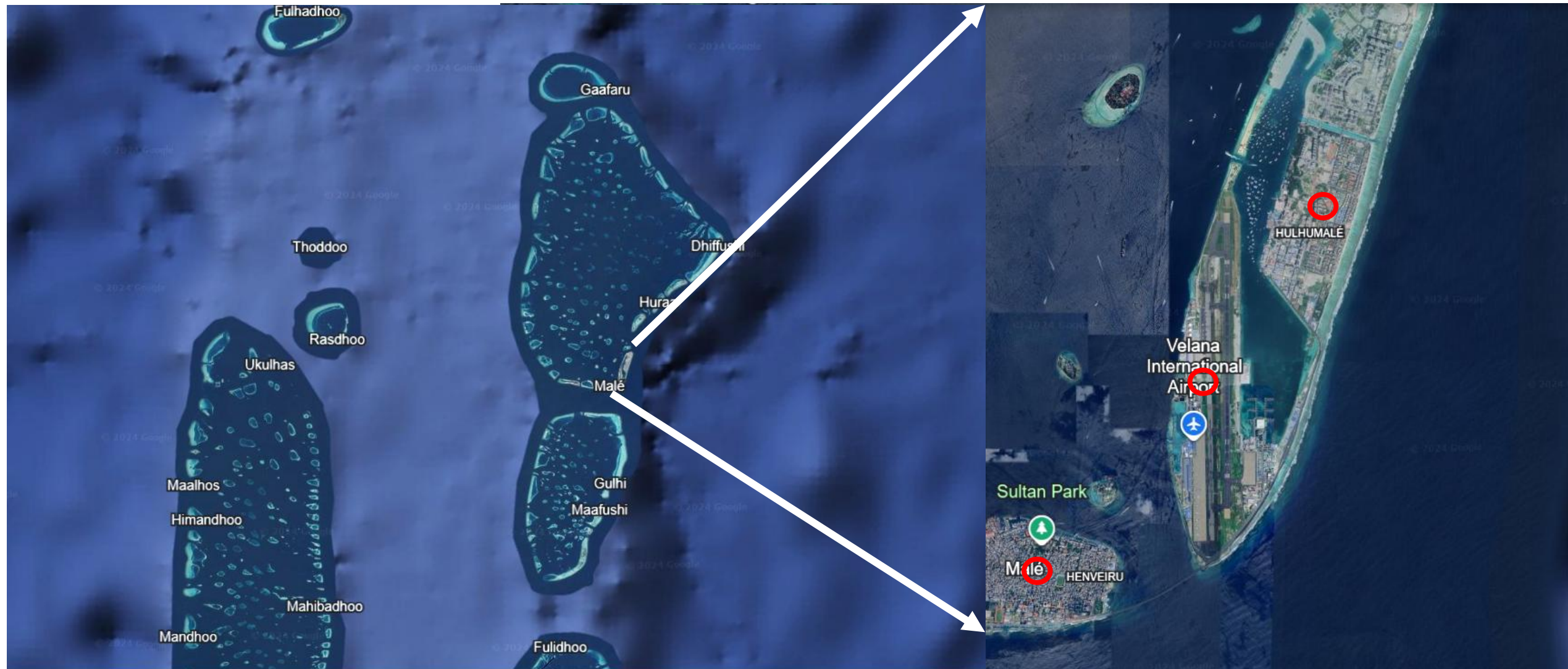
INSAT (Indian National Satellite System) series satellites (INSAT 3D 82° E and INSAT 3DR 74° E) was used extensively in monitoring severe weather and disseminating weather warnings to the first responders in the Maldives.



Top left to right, INSAT 3 series satellites Infrared Channel images (Spatial resolution 2 km) at local time. Bottom left to right, INSAT 3 series satellites Day micro-physics images (Spatial resolution 2 km) at local time.

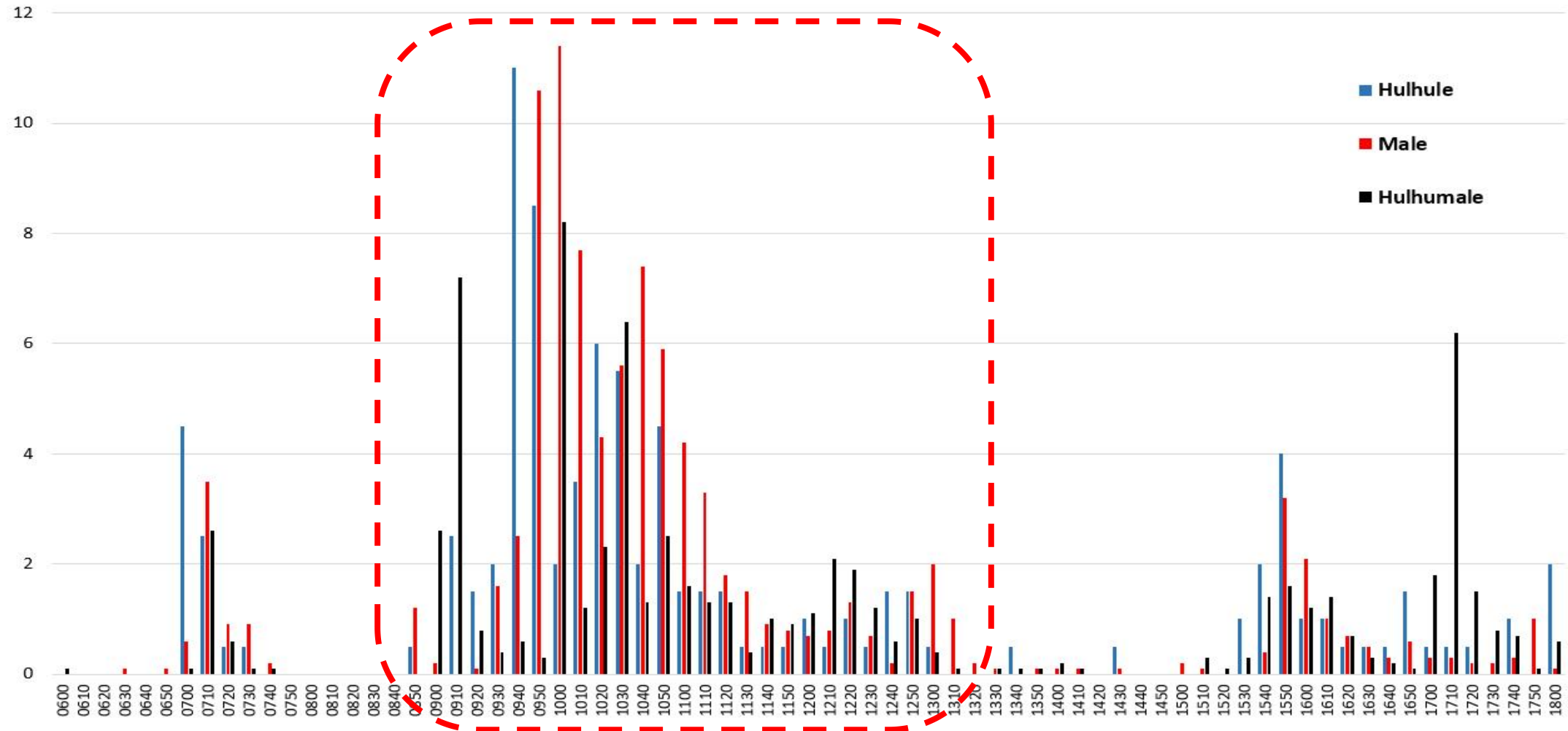
Source - <https://rapid.imd.gov.in/r2v/>

Why enhancing skills in analyzing satellite RGB & other satellite products is important with limited tools at MMS



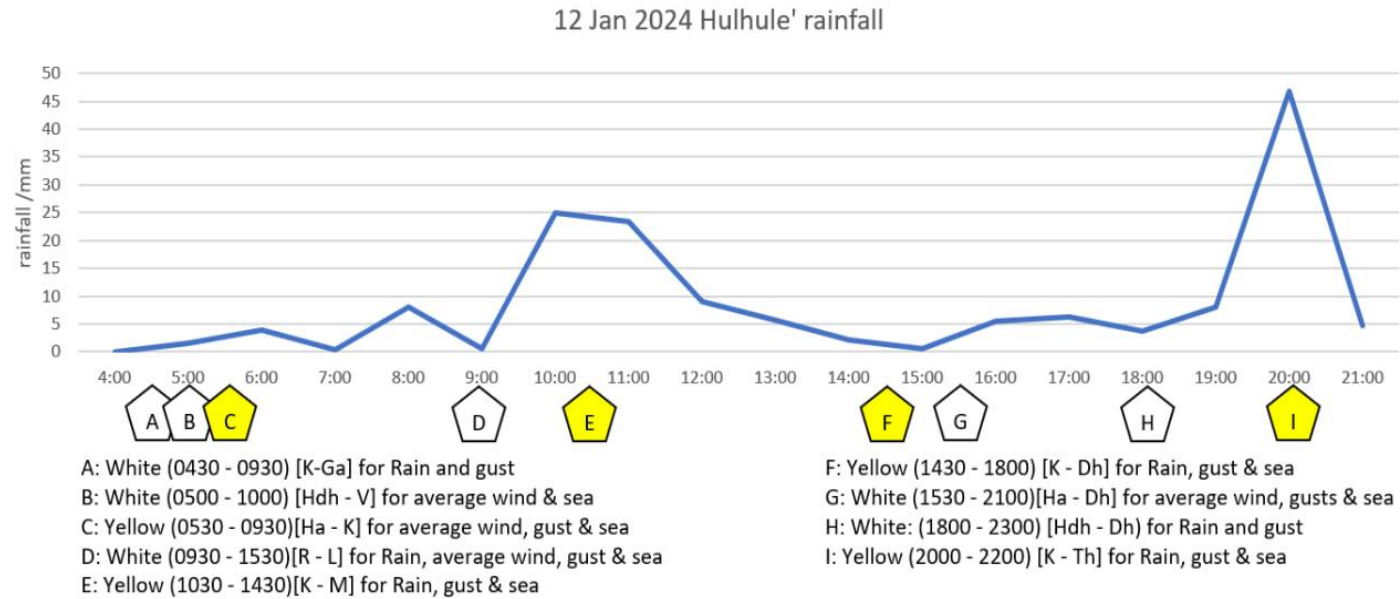
Why enhancing skills in analyzing satellite RGB & other satellite products is important with limited tools at MMS

10 minutes interval accumulated rainfall (mm) from 0600 - 1800 on 12th January 2024

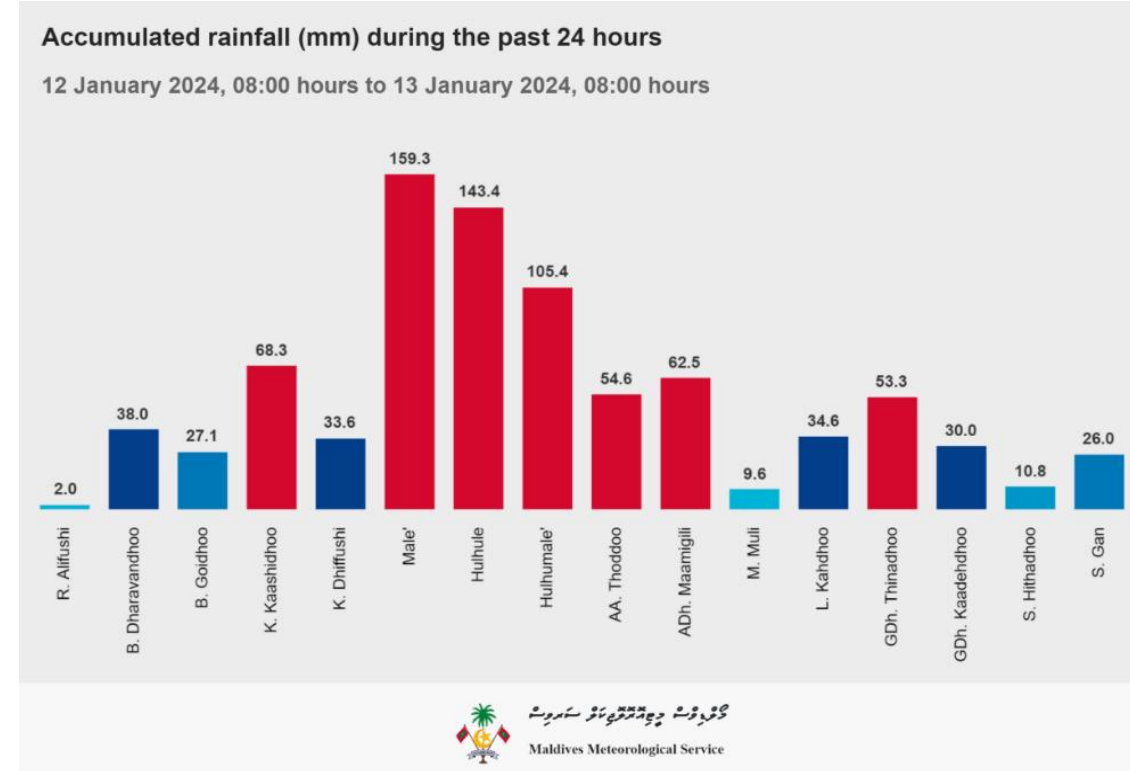


Automatic rain gauges, 10 minutes interval accumulated rainfall (mm) at K.Hulhul (blue), K.Male (red) and K.Hulhumale (black) from 0600 am to 0600 pm on 12th January 2024.

Why enhancing skills in analyzing satellite RGB & other satellite products is important with limited tools at MMS



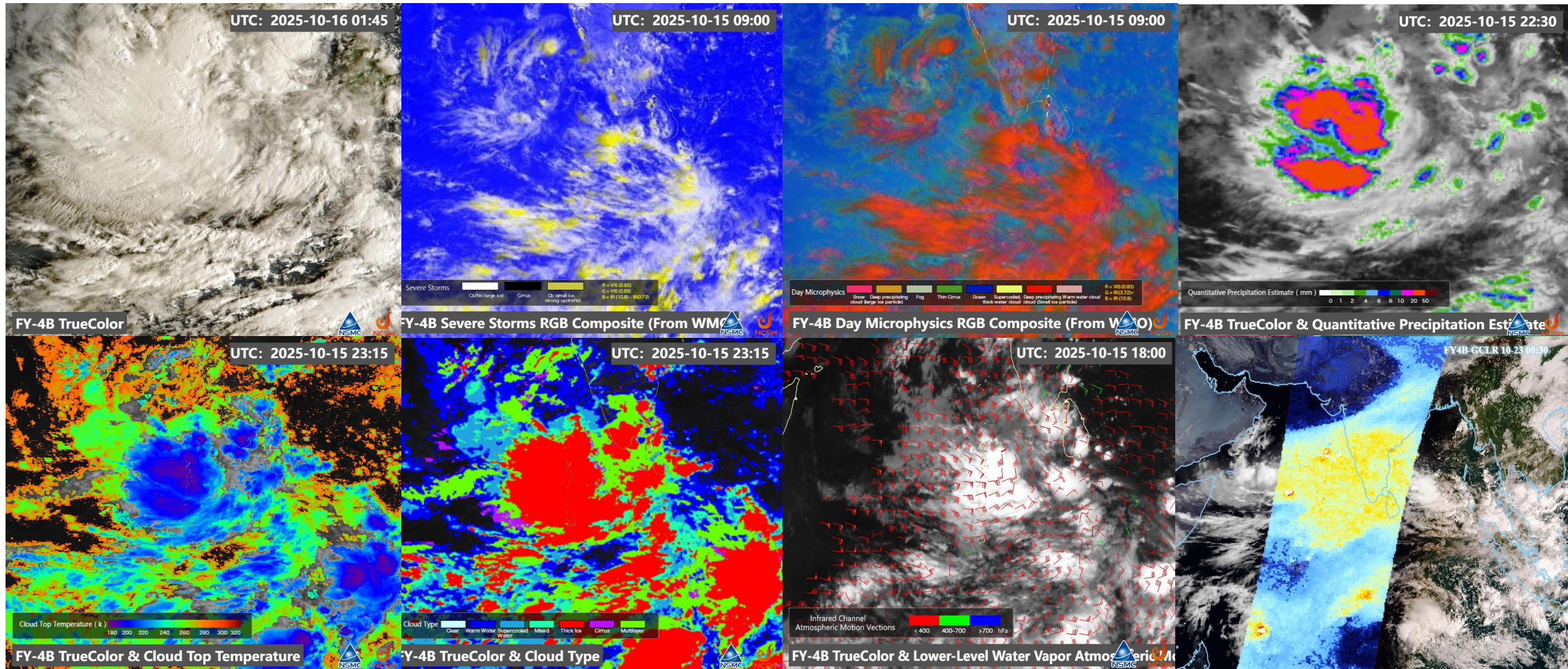
Graphical representation of accumulated rainfall and corresponding alerts issued on 12th January 2024



Accumulated rainfall records for 12th January 2024

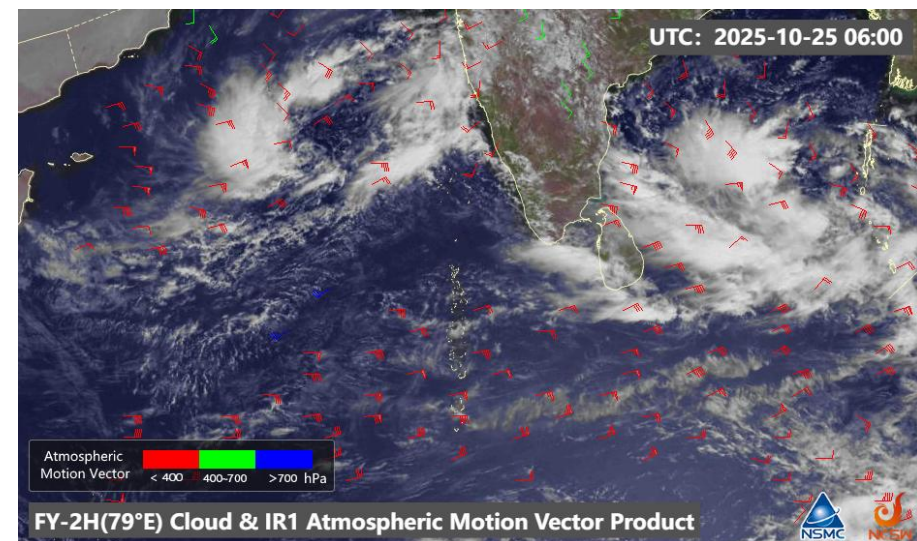
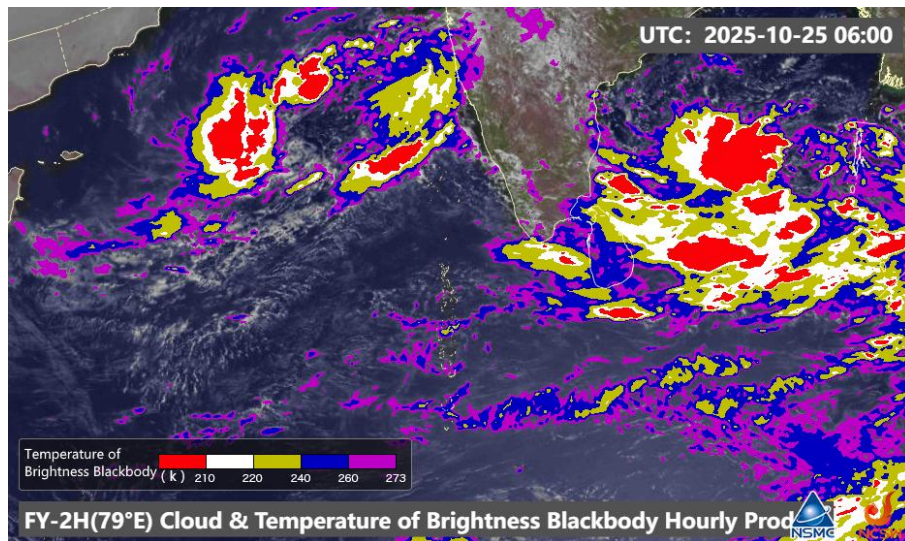
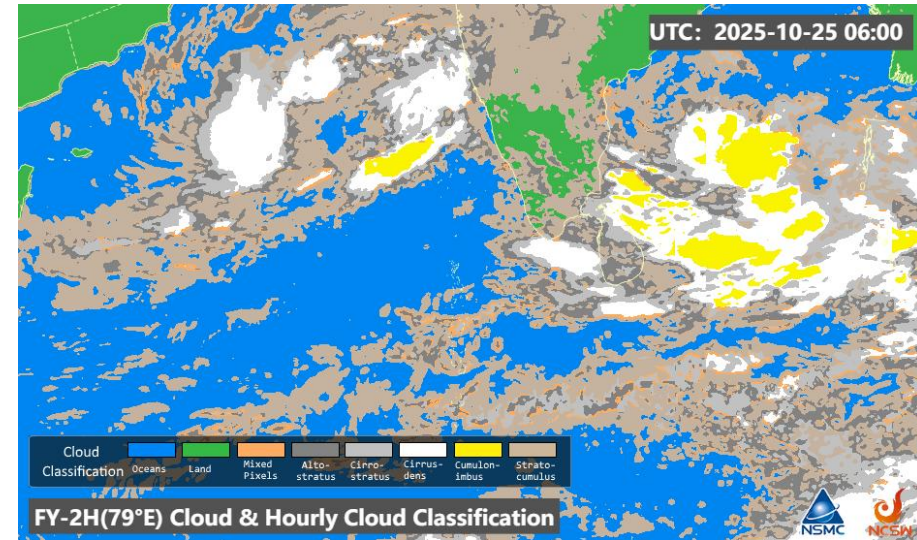
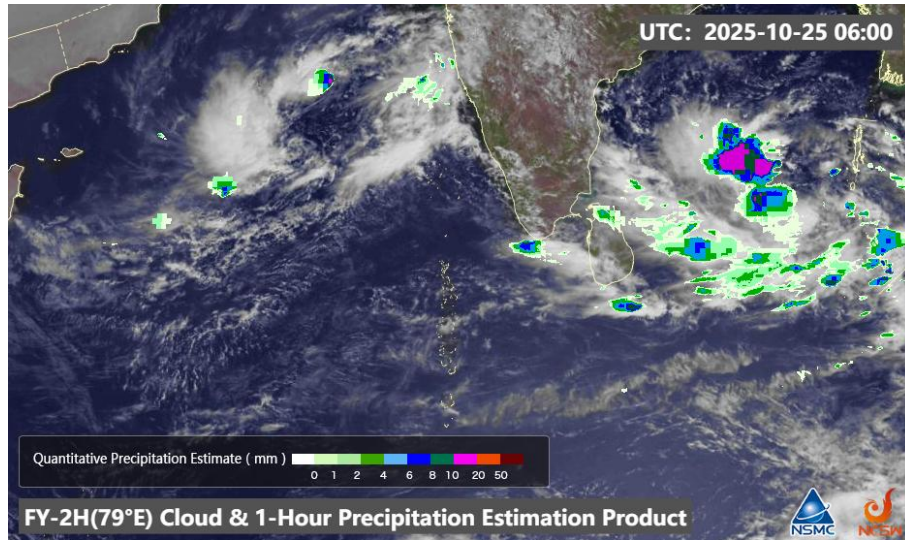


Nowcasting satellite products (FY4B - 105°E)



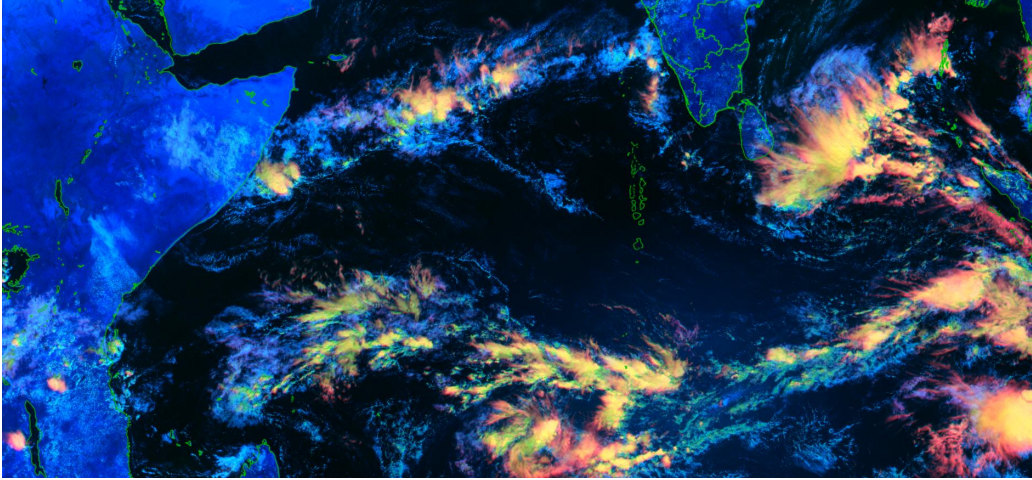


Nowcasting satellite products (FY2H - 79°E)

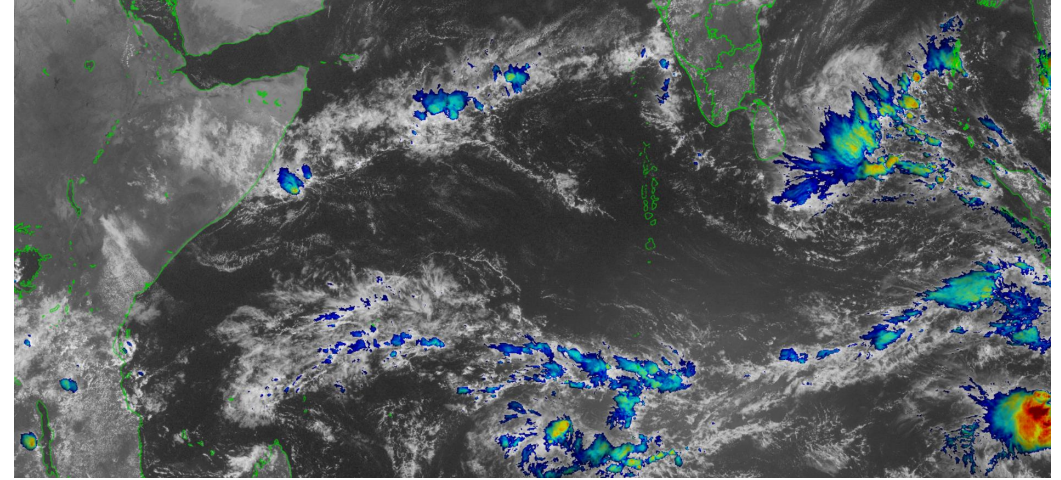




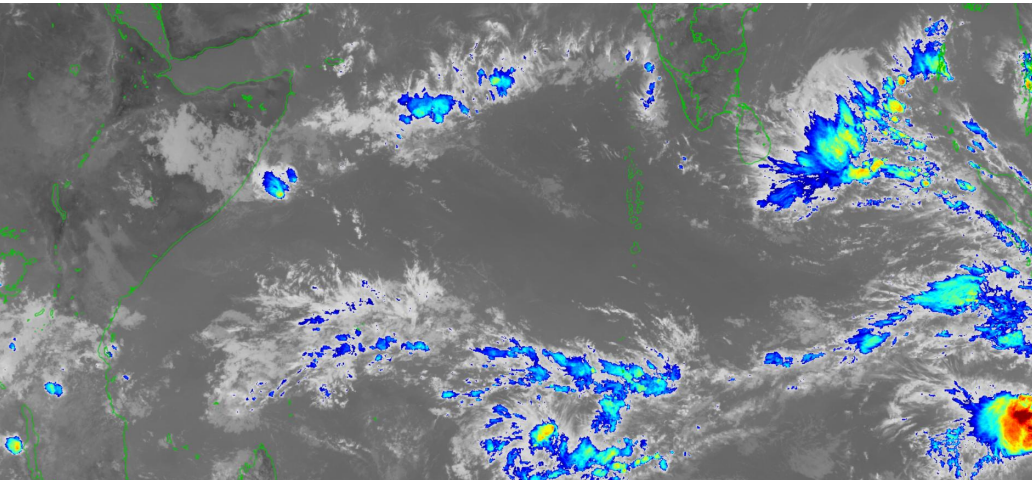
Nowcasting satellite products (INSAT 3DR - 74°E)



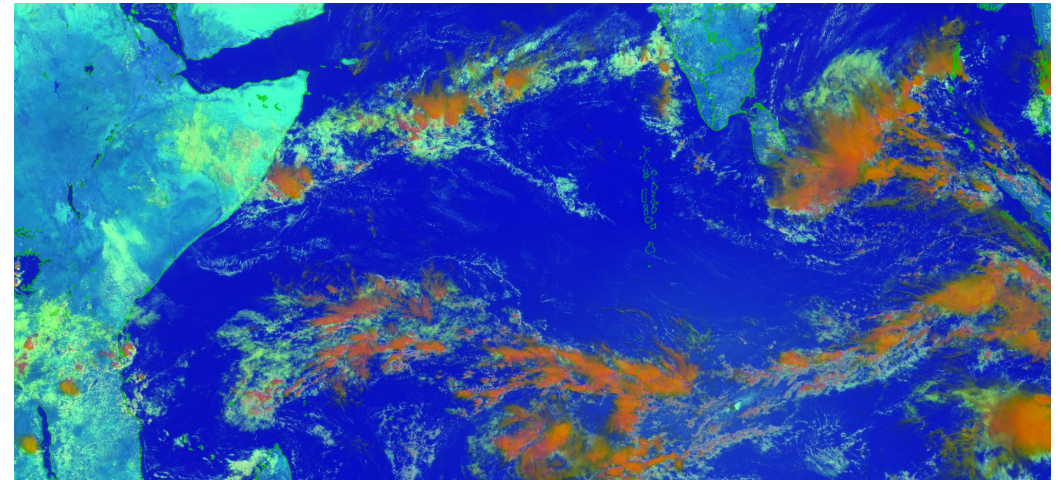
Cloud Phase Distinction



Sandwich RGB



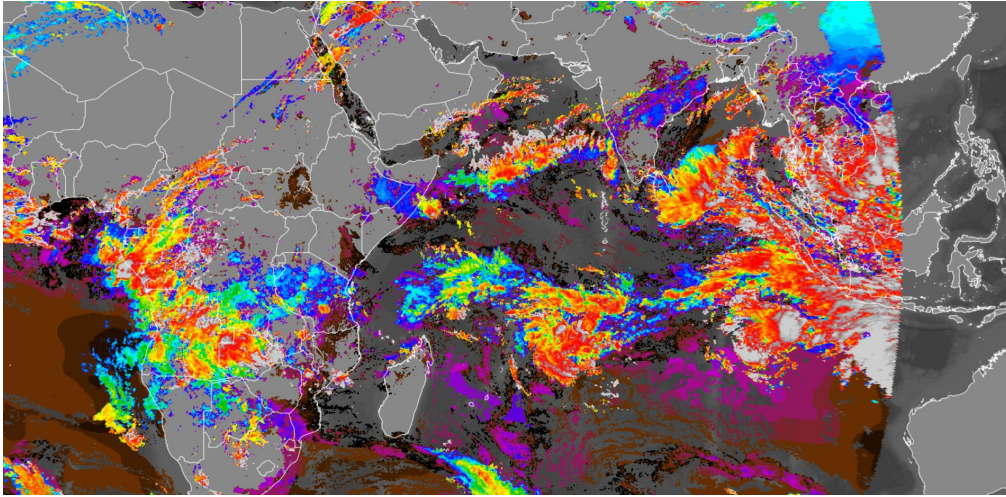
Colorized IR Clouds



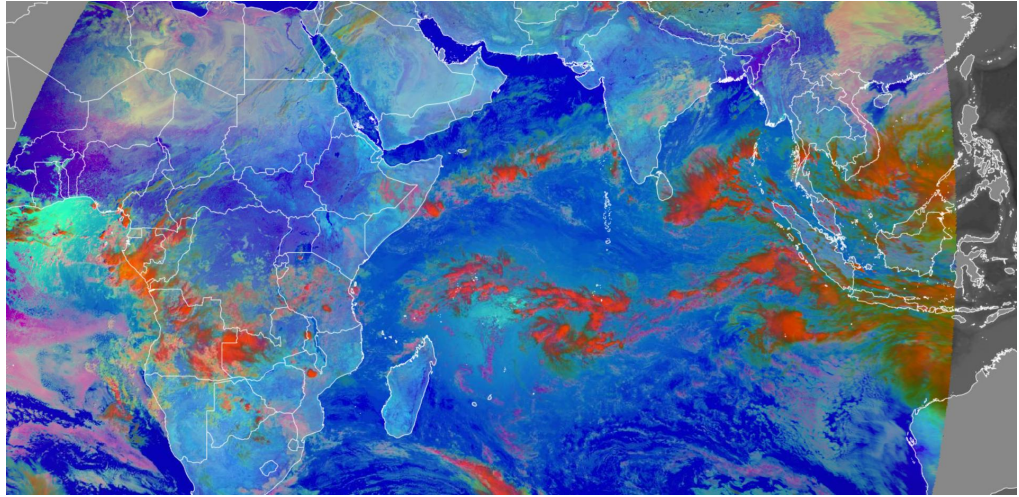
Day micro-physics



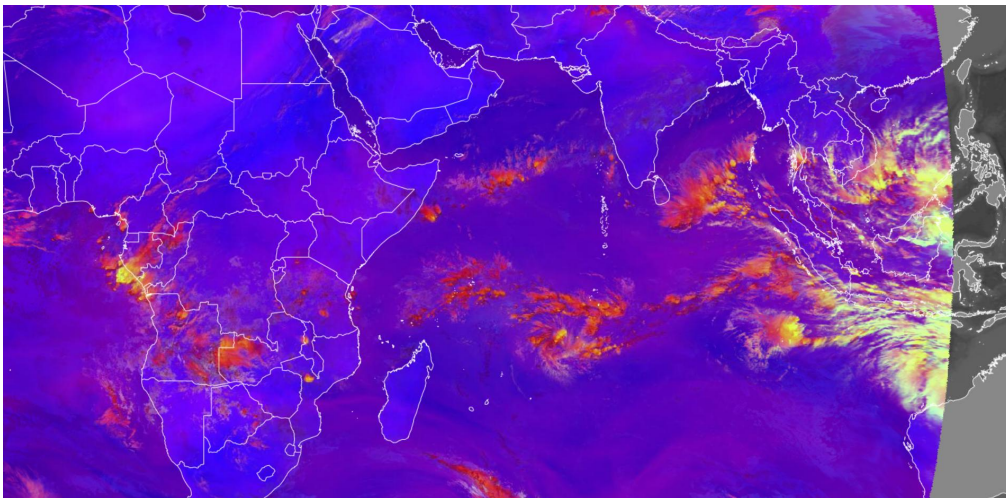
Nowcasting satellite products (EUMETSAT MetoSAT 9 – 44.5°E)



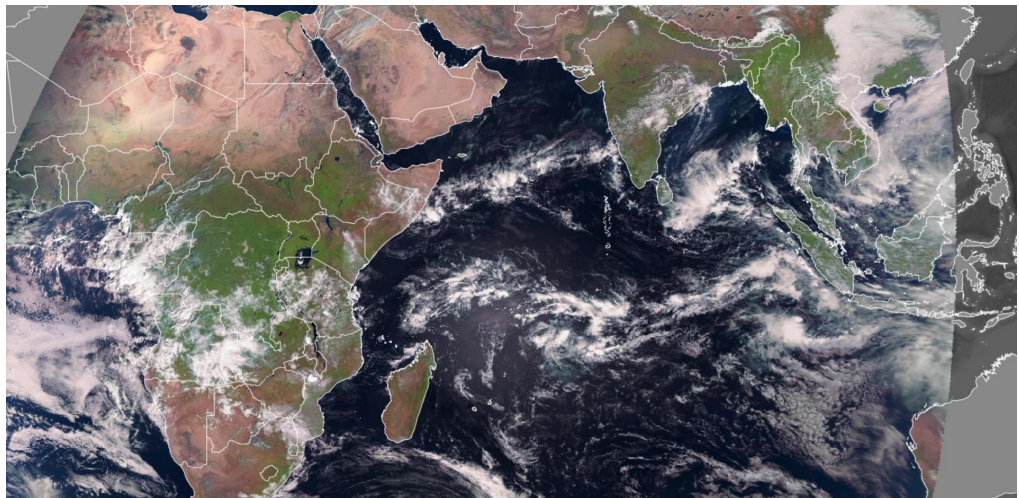
Cloud Top Height (m)



Day micro-physics RGB (opacity 0 – 100 %)



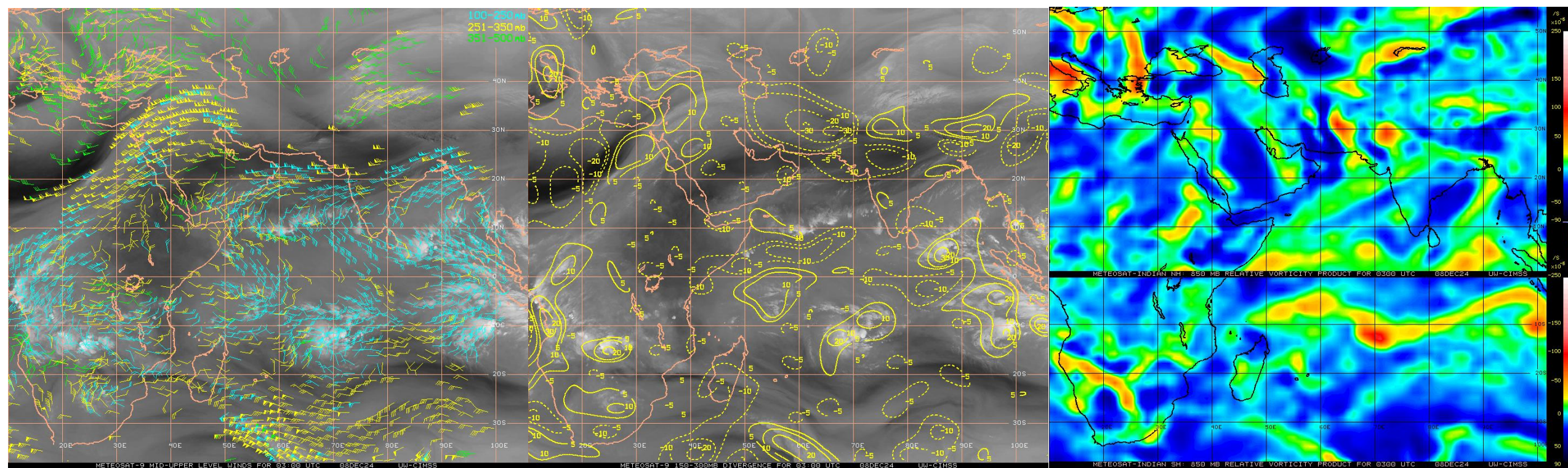
Convection RGB (opacity 0 – 100 %)



Natural Colour Enhanced (opacity 0 – 100 %)



Nowcasting Satellite products (EUMETSAT MetoSAT 9 – 44.5°E)



Upper-level winds (AMV)

Upper-level divergence

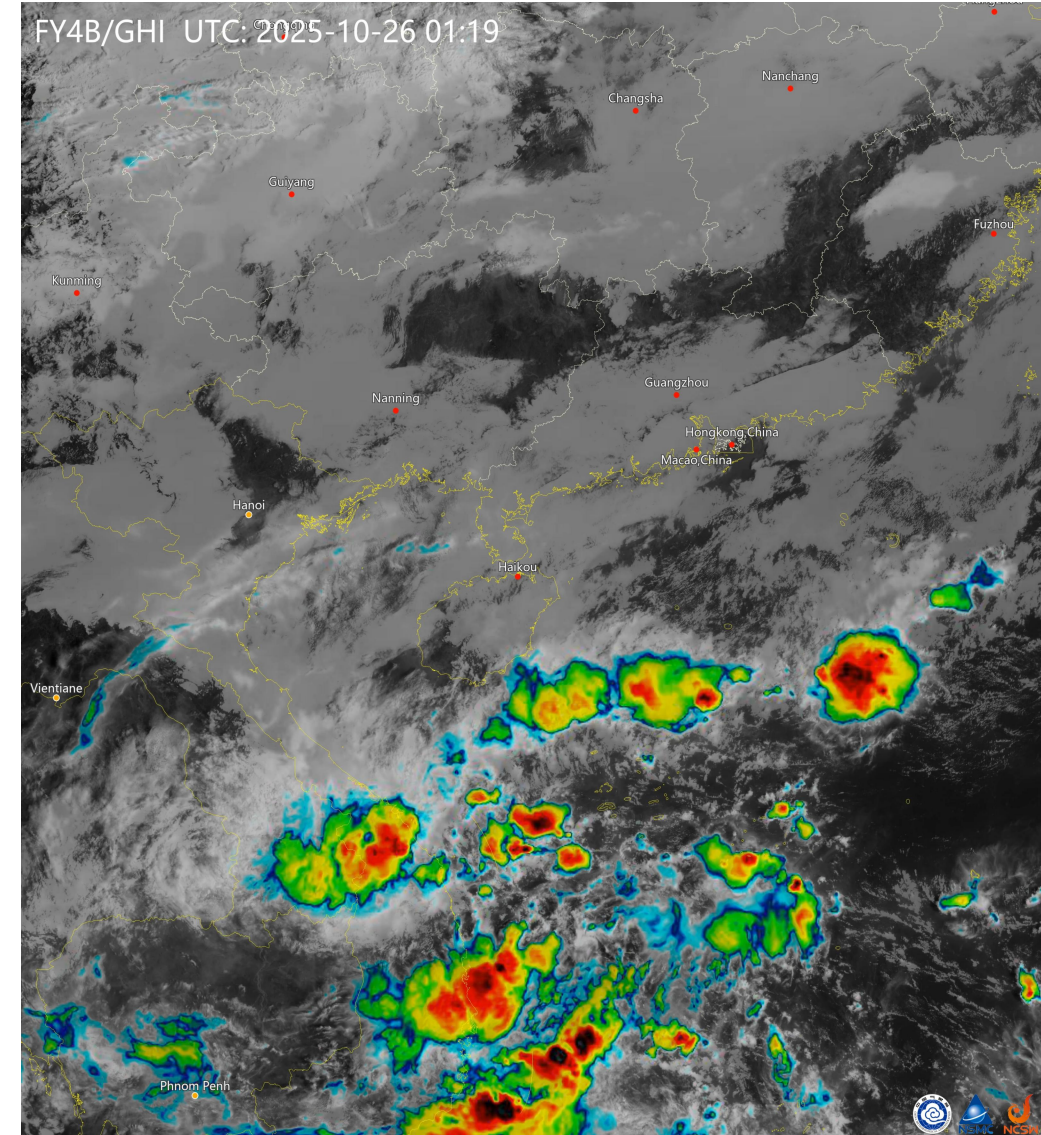
850 hPa Vorticity



Expectations for improvements to overcome the challenges

Rapid scanning & future satellite products over the Maldives region

- Temporal resolution 1 – 2 minutes during severe weather events.
- Spatial resolution enhancement.
- Additional RGB products for the night observation.
- FY-4M satellite products.

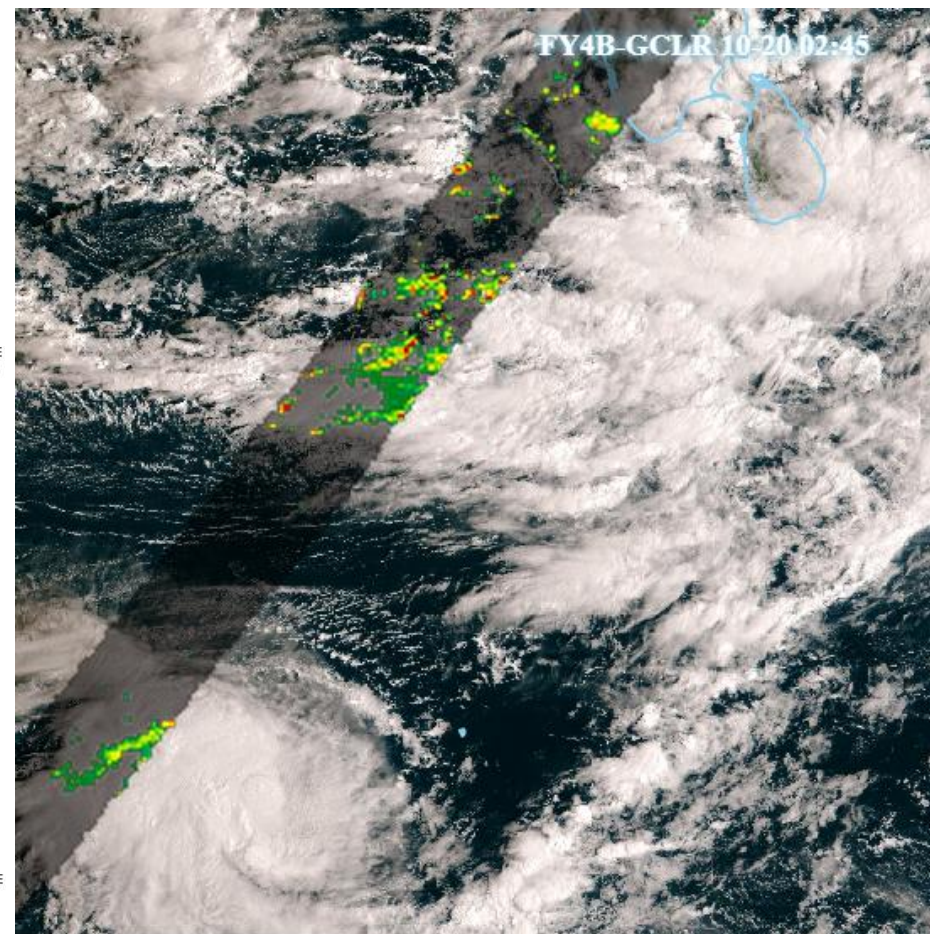
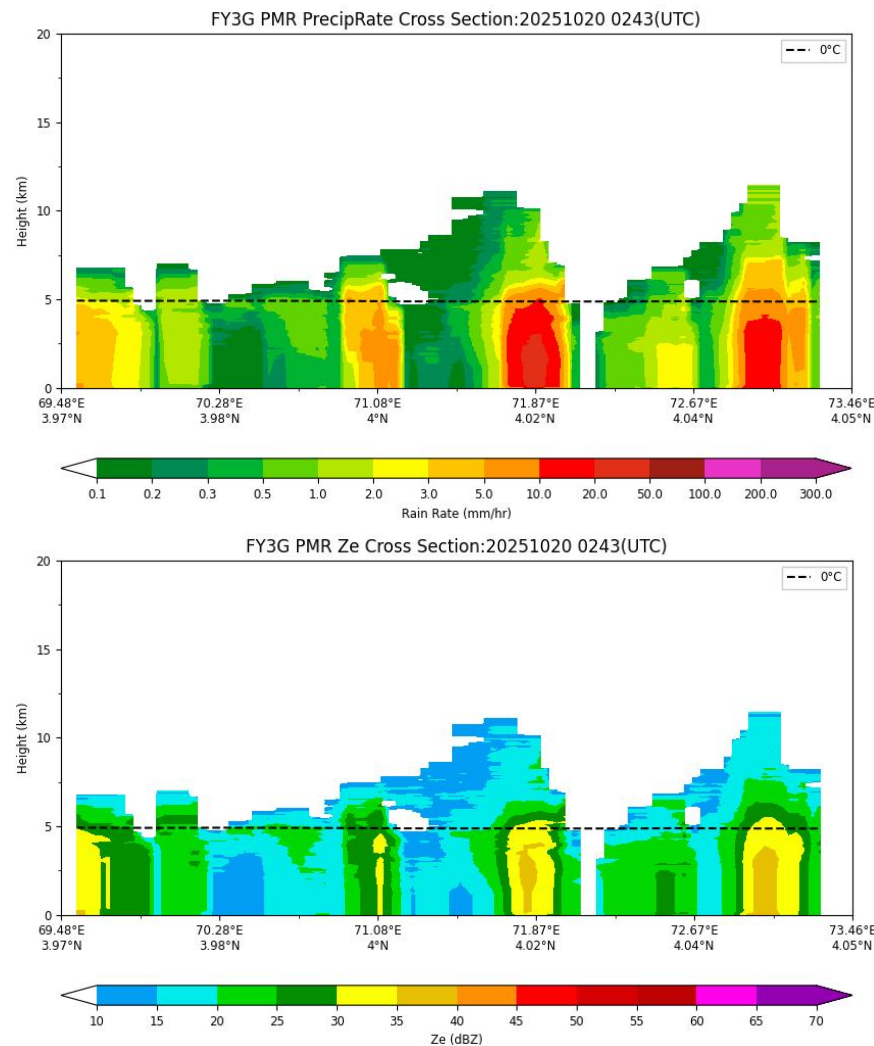




Expectations for improvements to overcome the challenges

Obtain ground verification

- ✓ Z-R relationship
- ✓ QPE



Thank You