

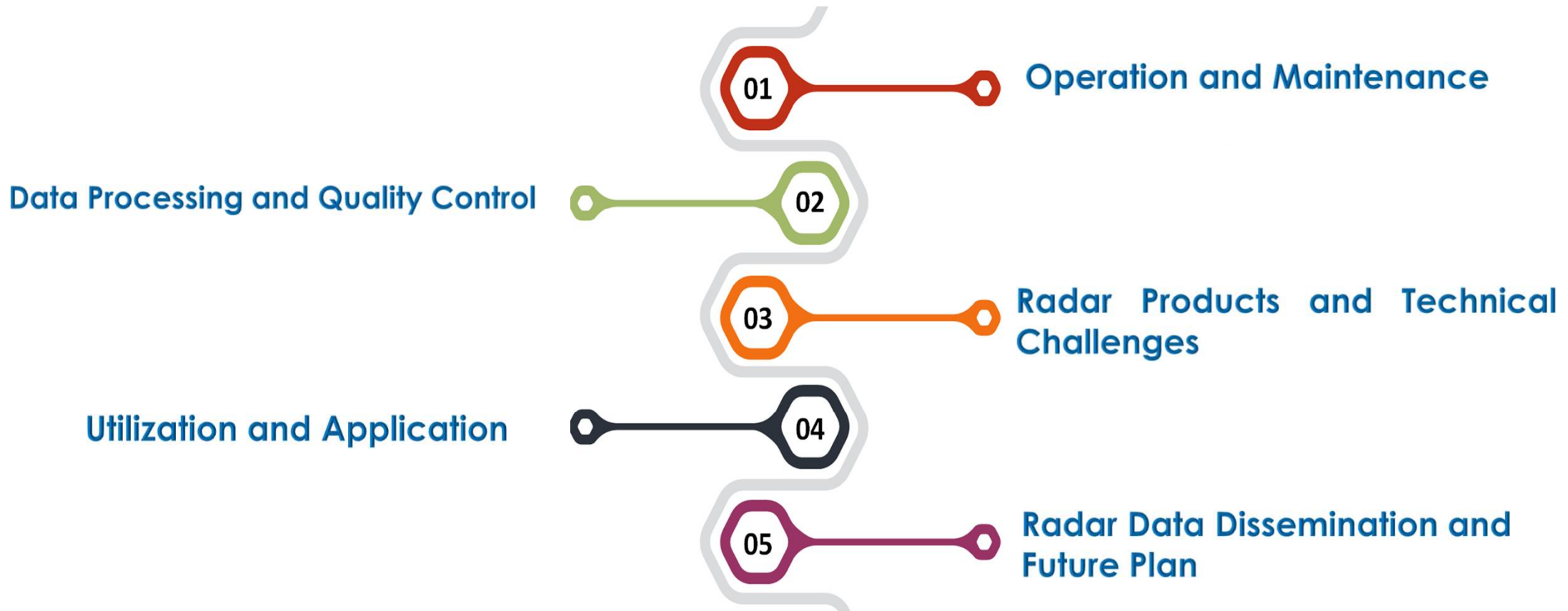


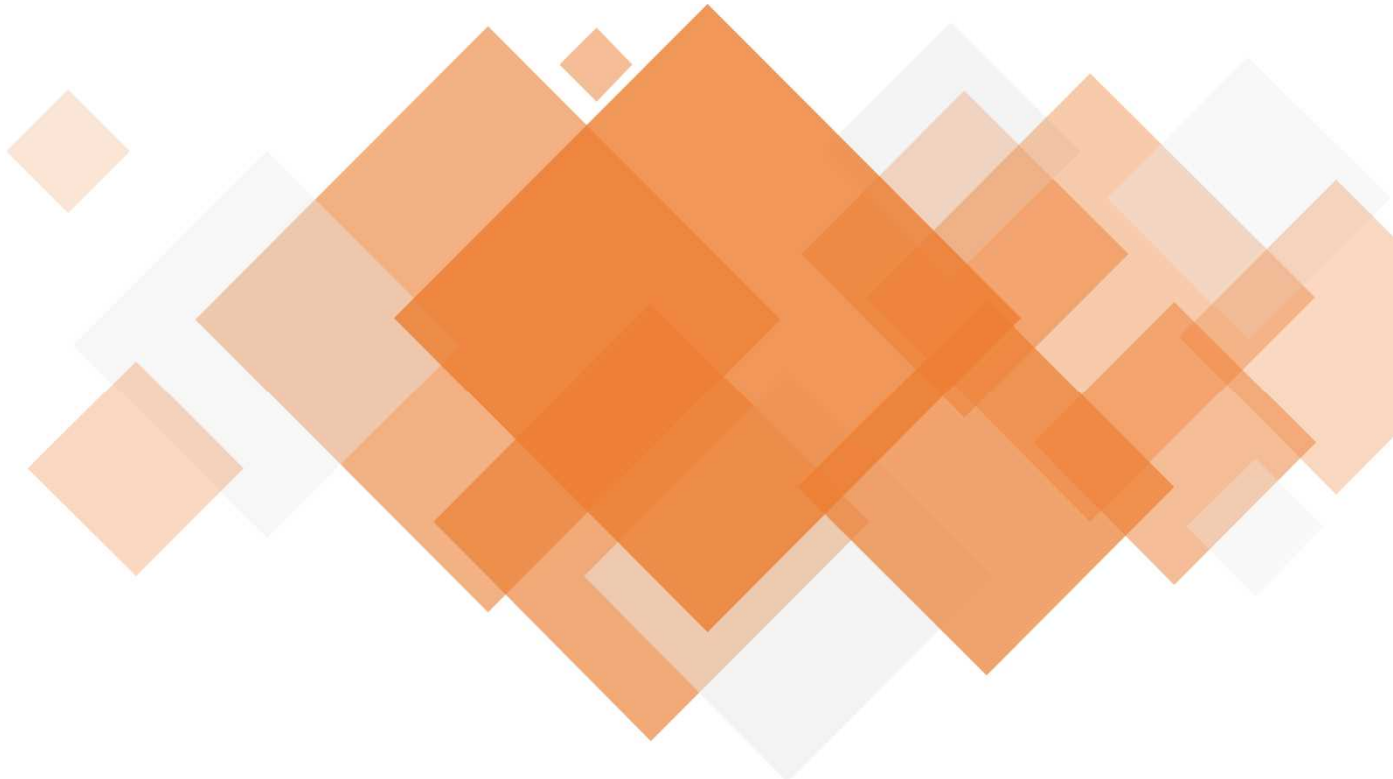
WMO/ASEAN TRAINING WORKSHOP ON WEATHER RADAR QUALITY CONTROL AND RADAR DATA EXCHANGE

**BANGKOK, THAILAND
29 JAN 2024 – 2 FEB 2024**

**MALAYSIAN METEOROLOGICAL DEPARTMENT
(MET Malaysia)**












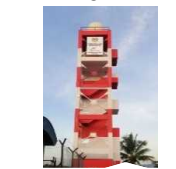






OUTLINES





Operation and Maintenance

MET Malaysia's WEATHER RADAR NETWORK

GEMATRONIK TXS 1000: 2016	EEC + GEMATRONIK (Antenna) TXS 600 2010	EEC DWSR8500S 2005	EEC DWSR8500S 2005	METEOR 700SDP10 2022	METEOR 700SDP10 2022	METEOR 700SDP10 2022	EEC WF100-5/93C 2000	EEC WF100-5/93C 2001	EEC WF100-5/93C 2000	EEC WF100-5C 2001
										
KLIA	Subang	Alor Setar	Kluang	Kota Bharu	Kuantan	Miri	Kuching	Bintulu	K. Kinabalu	Sandakan
METEOR 60DX 2021	METEOR 60DX 2021	METEOR 60DX 2022								
										
Kuala Krai	Temerloh	Cameron Highlands								
METEOR 1700SDP10: 2022	METEOR 1700SDP10: 2022	METEOR 1700SDP10: 2023								
										
Rompin	Marang	Kuala Gula								
METEOR 1700SDP10: 2023										
										
Sibu										

18 DOPPLER WEATHER RADARS

- S-Band dual-pol (9)
- S-Band single-pol (2)
- X-Band dual-pol (3)
- C-Band single-pol (4)

WEATHER RADAR HISTORY IN MALAYSIA

Conventional Radar (8)

- ~ Kota Bharu (1963)
- ~ Subang (1972)
- ~ Kuantan (1974)
- ~ Bayan Lepas (1979)
- ~ Kota Kinabalu (1981)
- ~ Kluang (1982)
- ~ Butterworth (1985)
- ~ Kuching (1988)

Upgrade Existing Radars to Doppler Radar (12)

- ~ Kota Bharu
- ~ Subang
- ~ Kuantan
- ~ Miri
- ~ Kota Kinabalu
- ~ Kluang
- ~ Butterworth
- ~ Kuching
- ~ KLIA
- ~ Bintulu
- ~ Sandakan
- ~ Alor Setar



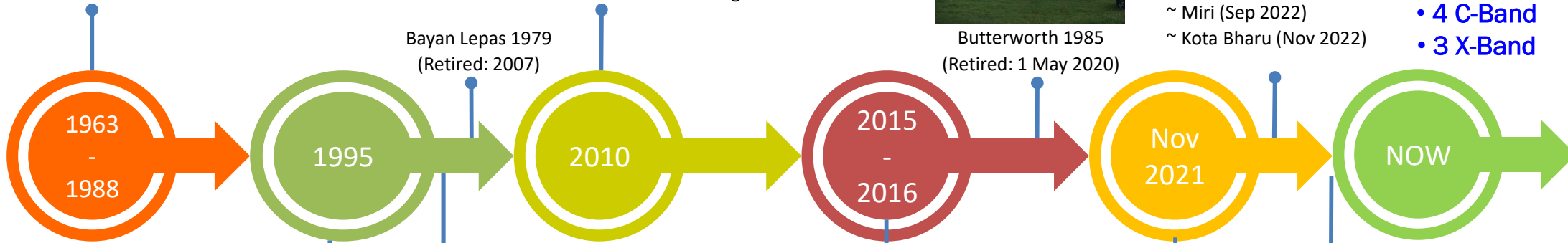
Butterworth 1985
(Retired: 1 May 2020)

Upgrade to Dual-Pol (3)

- ~ Kuantan (Aug 2022)
- ~ Miri (Sep 2022)
- ~ Kota Bharu (Nov 2022)

18 Doppler Weather Radars (12 Dual-Pol):

- 11 S-Band
- 4 C-Band
- 3 X-Band



Kota Bharu

Integrated Radar Network

Additional Single-Pol Radar (4)

- ~ KLIA (1997)
- ~ Bintulu (2001)
- ~ Sandakan (2001)
- ~ Alor Setar (2005)

Upgrade to Dual-Pol Radar (2)

- ~ Subang (2015)
- ~ KLIA (2016)



Subang



KLIA

New X-Band Dual-Pol (3)

- ~ Temerloh (Nov 2021)
- ~ Kuala Krai (Nov 2021)
- ~ Cameron Highlands (Mar 2022)

New S-Band Dual-Pol (4)

- ~ Marang (Nov 2022)
- ~ Rompin (Dis 2022)
- ~ Sibul (Jan 2023)
- ~ Kuala Gula (April 2023)

RADAR TECHNICAL SPECIFICATION

Radar	Transmitter	Radar Type	Doppler Mode	Frequency (MHz)	Peak Power (kW)	Pulse Length (μs)	PRF (Hz)	Antenna Diameter (m)	Beam Width (°)	Detection Range (km)
Subang	Magnetron	S-Band (dual-pol)	Yes	2820	640	0.8 & 2	600 / 250	8.4	1	300
KLIA	Klystron	S-Band (dual-pol)	Yes	2874	740	0.5, 1.0 & 2.0	1000 / 300	8.4	1	480
Alor Setar, Kluang	Magnetron	S-Band	Yes	2850, 2801	660, 525	0.8 & 2	600 / 250	8.4	2	300
Kuching, Bintulu, Kota Kinabalu, Sandakan	Magnetron	C-Band	Yes*	5625, 5602, 5625, 5625	250	0.8 & 1.8	740 / 250	4.2	1.7	300
Kota Bharu, Kuantan, Miri	Magnetron	S-Band (dual-pol)	Yes	2759, 2900, 2897	800	0.5, 1.0 & 2.0	600 / 450	8.4	1	300
Rompin, Marang, Sibul, Kuala Gula	Klystron	S-Band (dual-pol)	Yes	2705, 2830, 2740, 2795	850	0.5, 1.0 & 2.0	600 / 450	8.4	1	300
Cameron Highlands, Temerloh, Kuala Krai	Magnetron	X-Band (dual-pol)	Yes	9375, 9430, 9400	150	0.5, 1.0 & 2.0	1200 / 960	2.4	1	100

All radars are operating 24/7

WEATHER RADAR MAINTENANCE



Radar maintenance conducted by appointed local contractor which has required technical competency and technical support from OEM.



Scope of maintenance:
Hardware and software (inspection, cleaning, testing, calibration)



Method of maintenance:
~ Preventive
~ Corrective (ad-hoc)



Preventive Maintenance:
~ Quarterly
~ Semiannually
~ Annually

Quarterly Maintenance

- **Weather radar system** (transmitter, receiver, antenna, antenna servo, radome, waveguide, dehydrator)

Semiannual Maintenance

- **Software** (Application management system, database server, workstation)

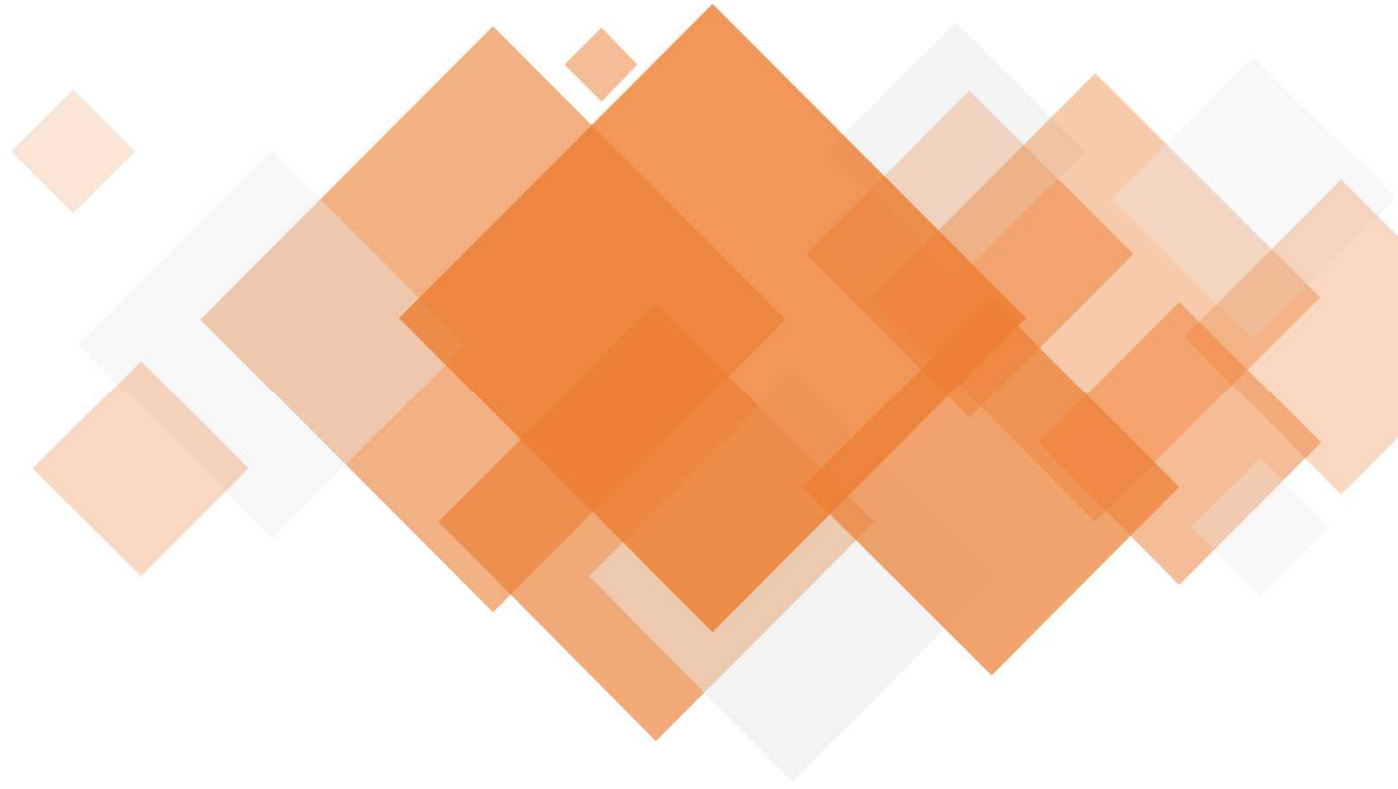
Annual Maintenance

- **Weather radar system** (more comprehensive & detail maintenance conducted by radar expert from OEM)

Role of Meteorological Radar & Satellite Div. in radar maintenance:

- ~ data and product management (scanning strategy, configuration, calibration, QC)
- ~ Radar operation monitoring (24/7)
- ~ First level troubleshooting (24/7)

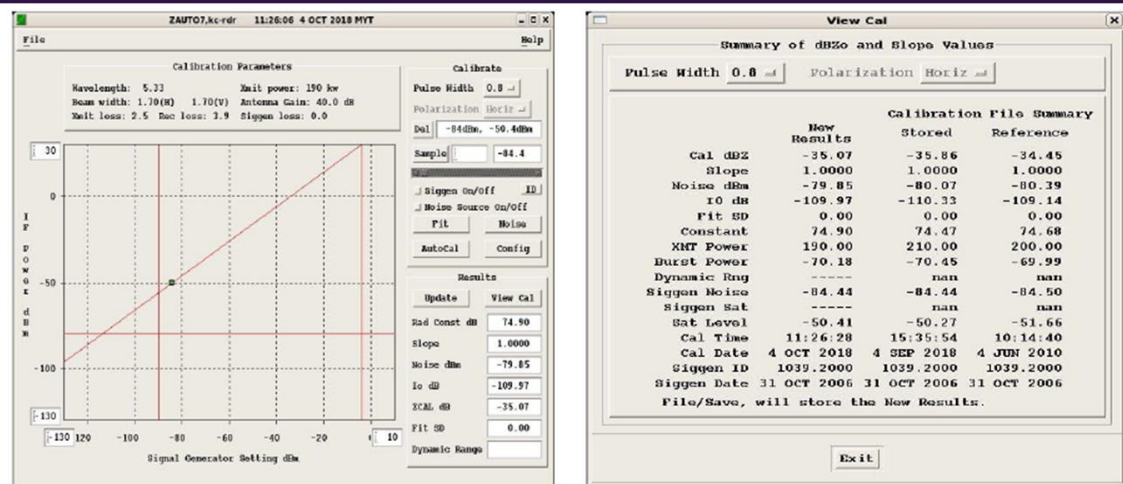




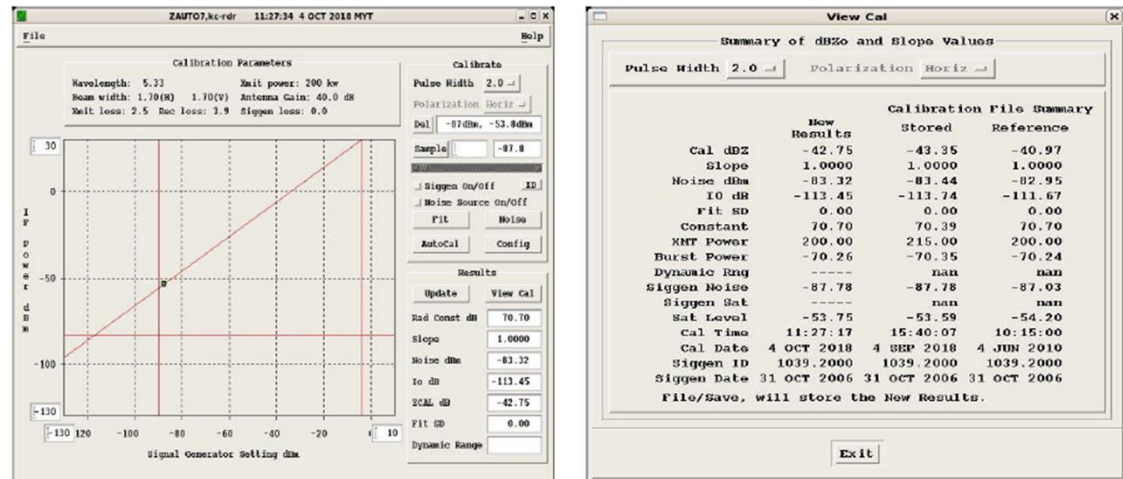
Data Processing and Quality Control

DATA PROCESSING & CALIBRATION

IRIS Radar Software

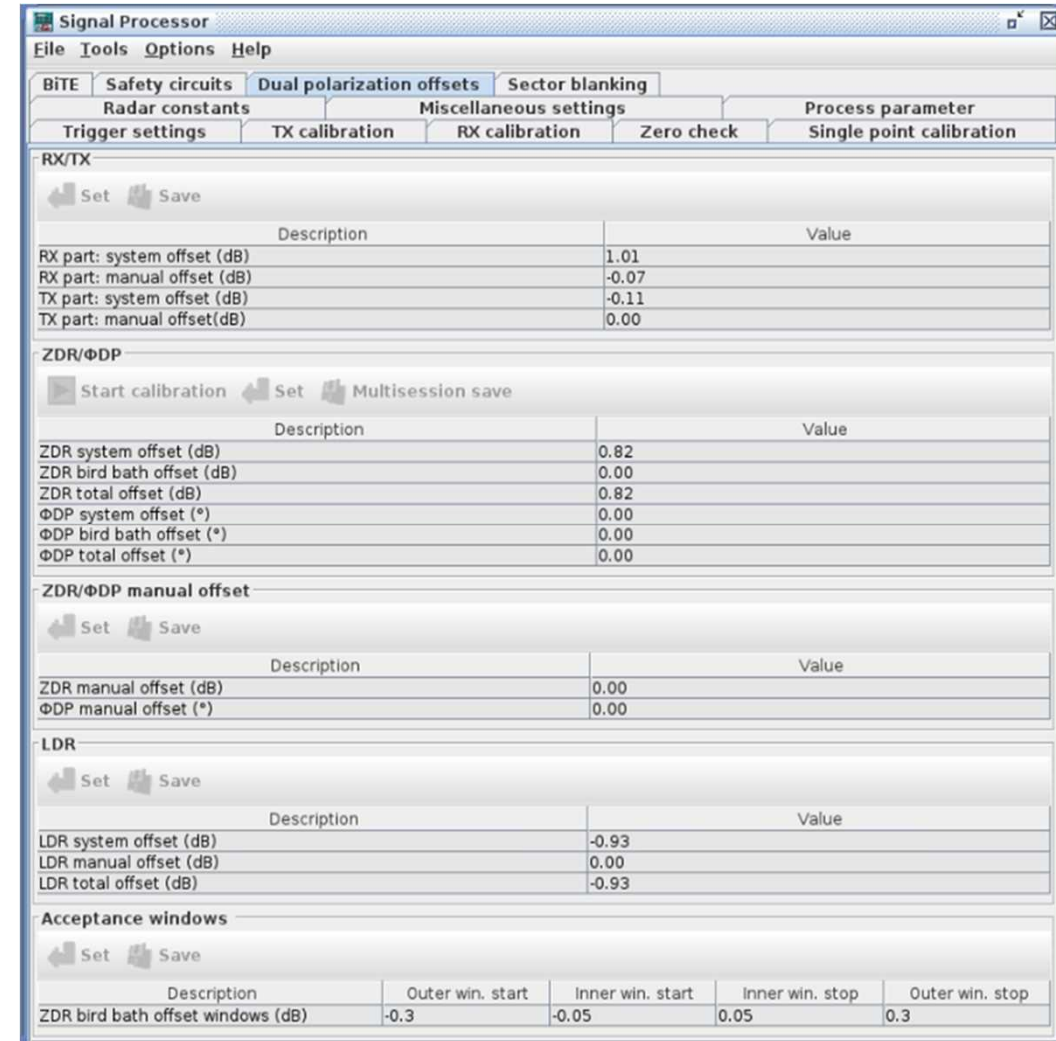


ZAUTO- 0.8 μs



ZAUTO- 2.0 μs

RAINBOW Radar Software



BIAS MONITORING

1) Online Calibration every one hour

RainLOG - File: 20231003

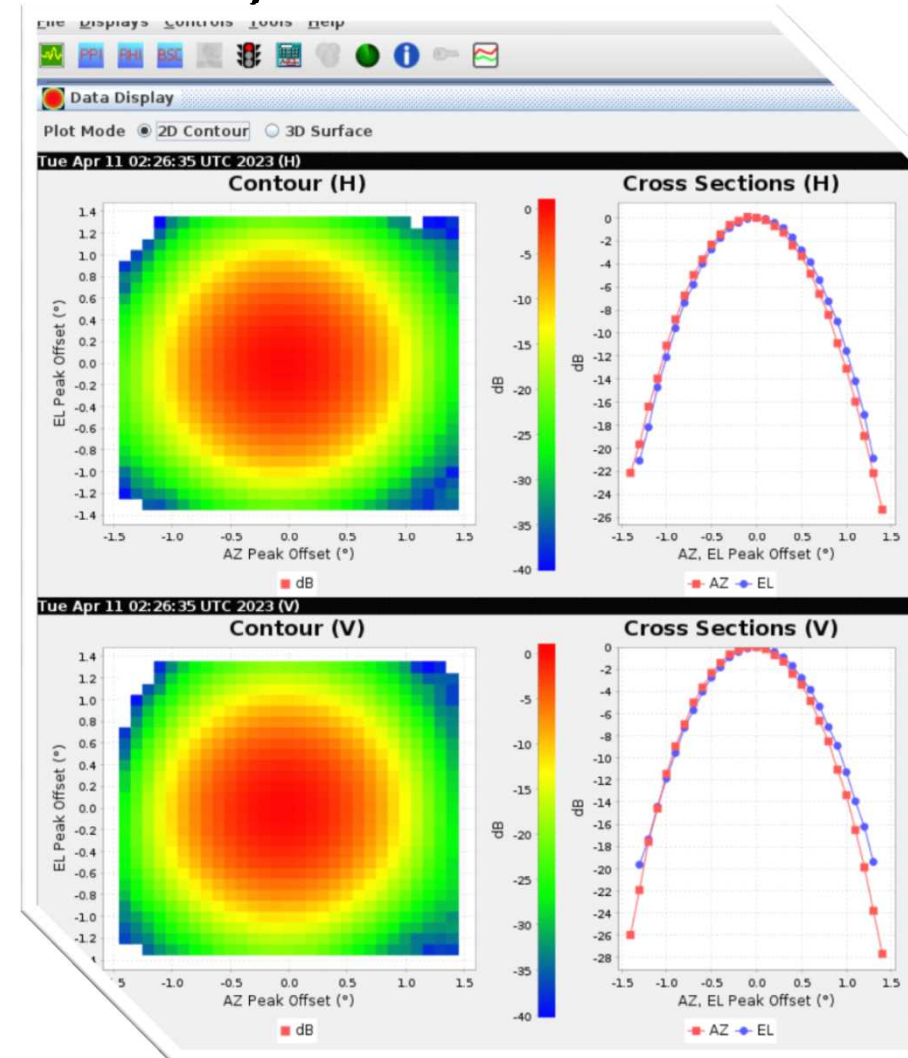
Date	Sensor Application Text
2023-10-03 00:19:00Z	KGU RainCONN BITE common 2023-10-03 00:19:00Z - SEQUENCER.SCHEDULER: Packet 'Zerocheck' started.
2023-10-03 00:19:00Z	KGU RainCONN BITE common 2023-10-03 00:19:00Z - SEQUENCER.SCHEDULER: Script volume of packet 'Zerocheck' started.
2023-10-03 00:19:00Z	KGU RainCONN BITE common 2023-10-03 00:19:00Z - SEQUENCER.SCHEDULER: Script '{AllInOneCalib.GDRX5-1-3659}' of packet 'Zerocheck' started.
2023-10-03 00:19:00Z	KGU RainCONN BITE common 2023-10-03 00:19:00Z - SEQUENCER.EXECUTOR: Script volume ID 41011- name AllInOneCalib.GDRX5 received and script definition successfully read.
2023-10-03 00:19:00Z	KGU RainCONN BITE common 2023-10-03 00:19:00Z - GDRXSP.SPSCRIPTPR: Start script file:/home/gdrx/Abacus_3.6.3/GDRX_SP/SignalProcessor/resources/scriptpr/go/dynamicCalibrationScheme/AllIn...
2023-10-03 00:19:16Z	KGU RainCONN BITE common 2023-10-03 00:19:16Z - GDRXSP.DYNAMICCALIBRATIONRESULTMANAGER: Calibration method: NOISE (high channel)
2023-10-03 00:19:16Z	KGU RainCONN BITE common 2023-10-03 00:19:16Z - GDRXSP.DYNAMICCALIBRATIONRESULTMANAGER: Calibration method: NOISE (low channel)
2023-10-03 00:19:16Z	KGU RainCONN BITE common 2023-10-03 00:19:16Z - GDRXSP.DYNAMICCALIBRATIONRESULTMANAGER: Calibration method: NOISE (high channel)
2023-10-03 00:19:16Z	KGU RainCONN BITE common 2023-10-03 00:19:16Z - GDRXSP.DYNAMICCALIBRATIONRESULTMANAGER: Calibration method: NOISE (low channel)
2023-10-03 00:19:18Z	KGU RainCONN RCL script execution successfully completed.
2023-10-03 00:19:18Z	KGU RainCONN BITE common 2023-10-03 00:19:18Z - GDRXSP.SPSCRIPTPR: Finished script AllInOneCalib.GDRX5 with success
2023-10-03 00:19:17Z	KGU RainCONN BITE common 2023-10-03 00:19:17Z - SEQUENCER.EXECUTOR: Script volume ID 41011- name AllInOneCalib.GDRX5 finished.
2023-10-03 00:19:17Z	KGU RainCONN BITE common 2023-10-03 00:19:17Z - SEQUENCER.SCHEDULER: Script '{AllInOneCalib.GDRX5-1-3659}' of packet 'Zerocheck' successfully finished.
2023-10-03 00:19:17Z	KGU RainCONN BITE common 2023-10-03 00:19:17Z - SEQUENCER.SCHEDULER: Script volume of packet 'Zerocheck' successfully finished.
2023-10-03 00:19:17Z	KGU RainCONN BITE common 2023-10-03 00:19:17Z - SEQUENCER.SCHEDULER: Packet 'Zerocheck' finished.
2023-10-03 00:19:18Z	KGU RainCONN Scheduler Execution Stopped

Minor Information from RainCONN : BITE common 2023-10-03 00:19:16Z - GDRXSP.DYNAMICCALIBRATIONRESULTMANAGER. Calibration method: NOISE (high channel)

Msg Type: RCP-Info (common) with Information
Sensor: KGU
Date: 2023-10-03 00:19:16Z

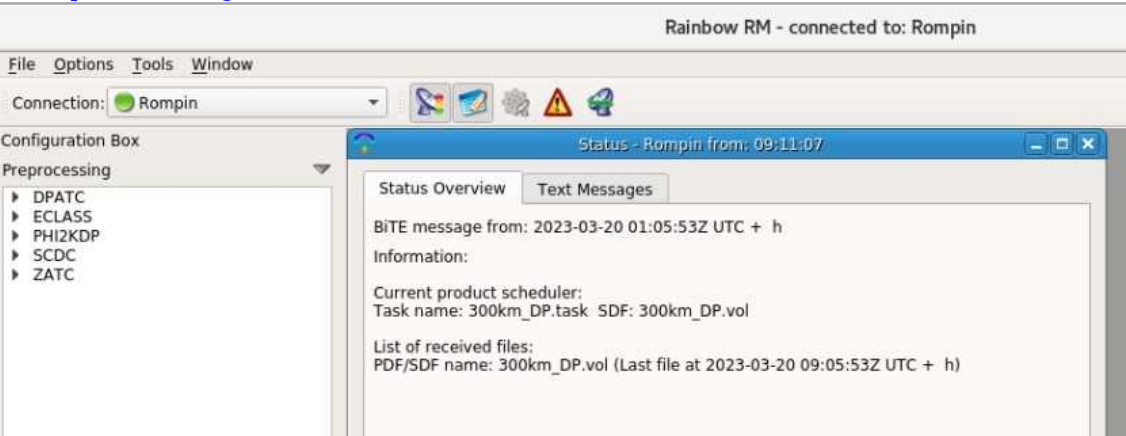
BITE common 2023-10-03 00:19:16Z - Polarization: H
 Source: system noise- ref. BW 1.0MHz
 Measurement value 2.8261433 inside outer acceptance window
 New measurement is used operationally.

2) Sun Calibration

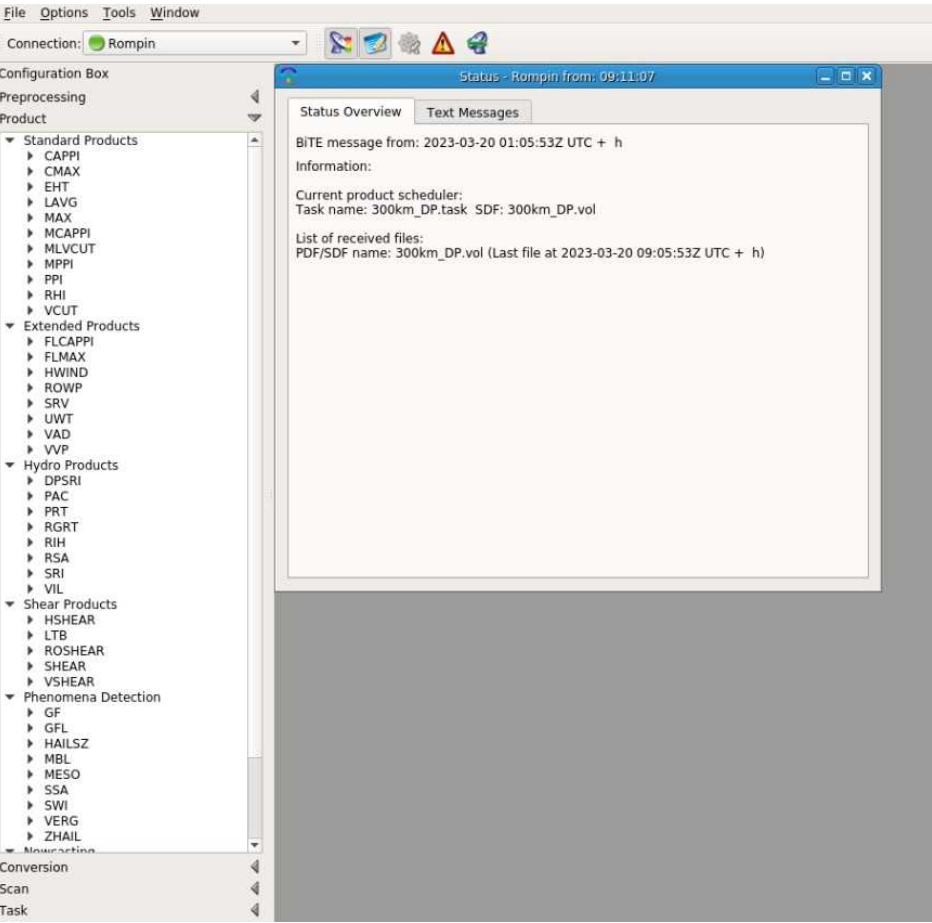


DATA PROCESSING RAINBOW SOFTWARE

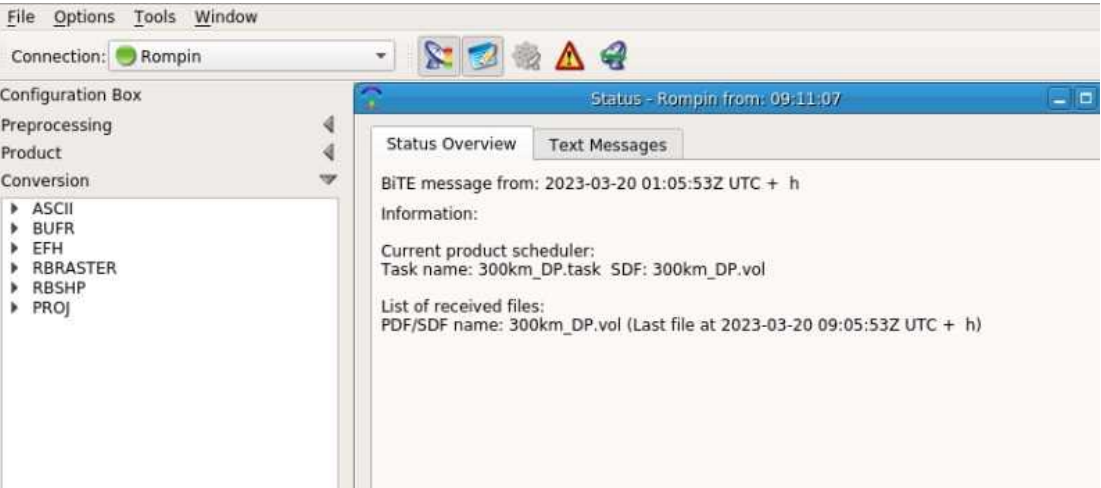
Pre-processing



Product Processing

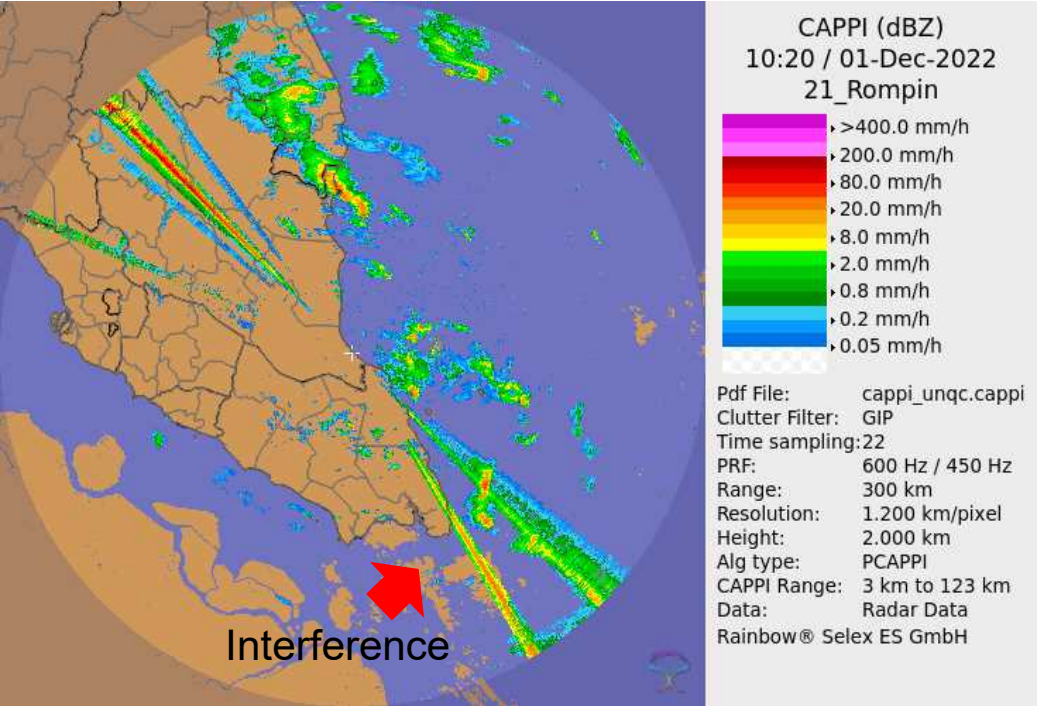


Data Conversion

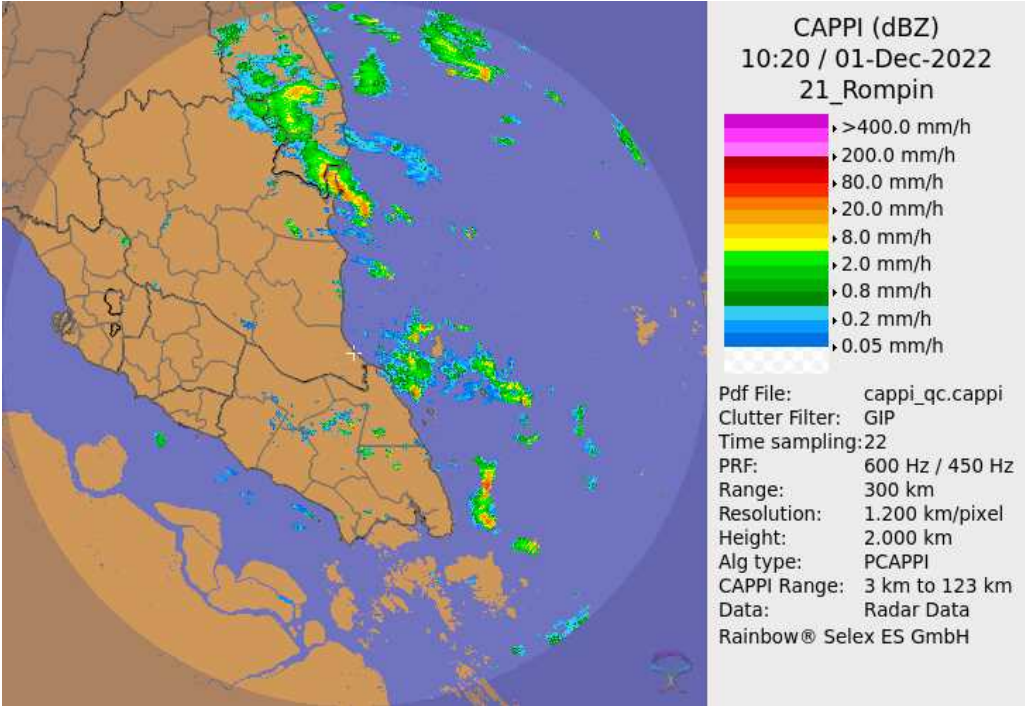


QUALITY CONTROL PROCESS

Example : ECLASS (Hydrometeor Classification)



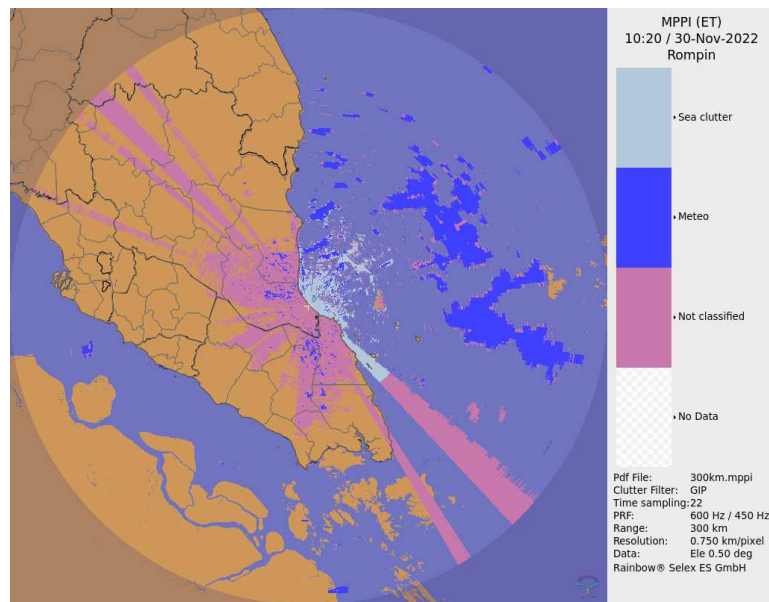
Before pre-processing quality control



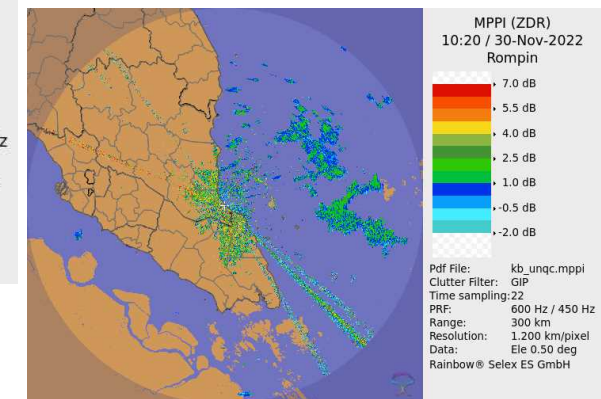
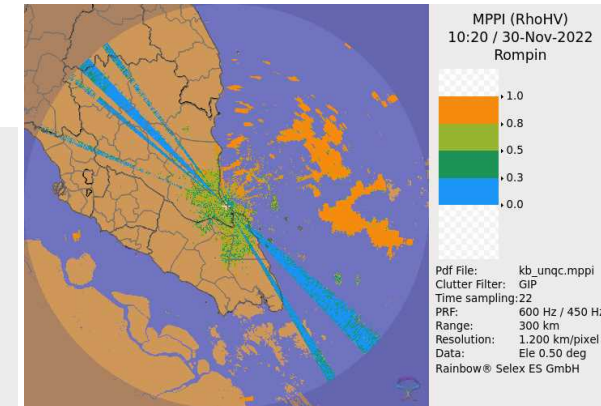
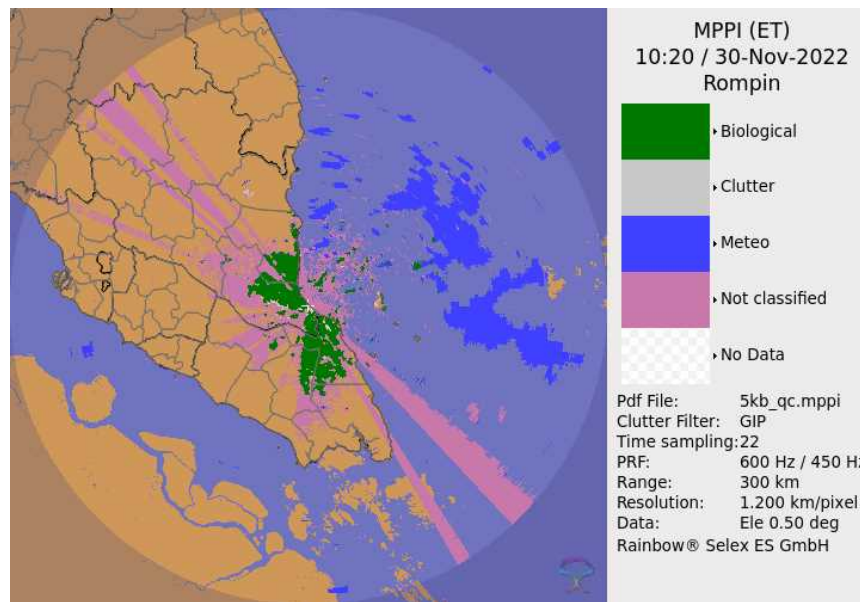
After pre-processing quality control

QUALITY CONTROL PROCESS

Pre-processing SCDC (Sea clutter detection and Correction)



Pre-processing ECLASS (Hydrometeor Classification)

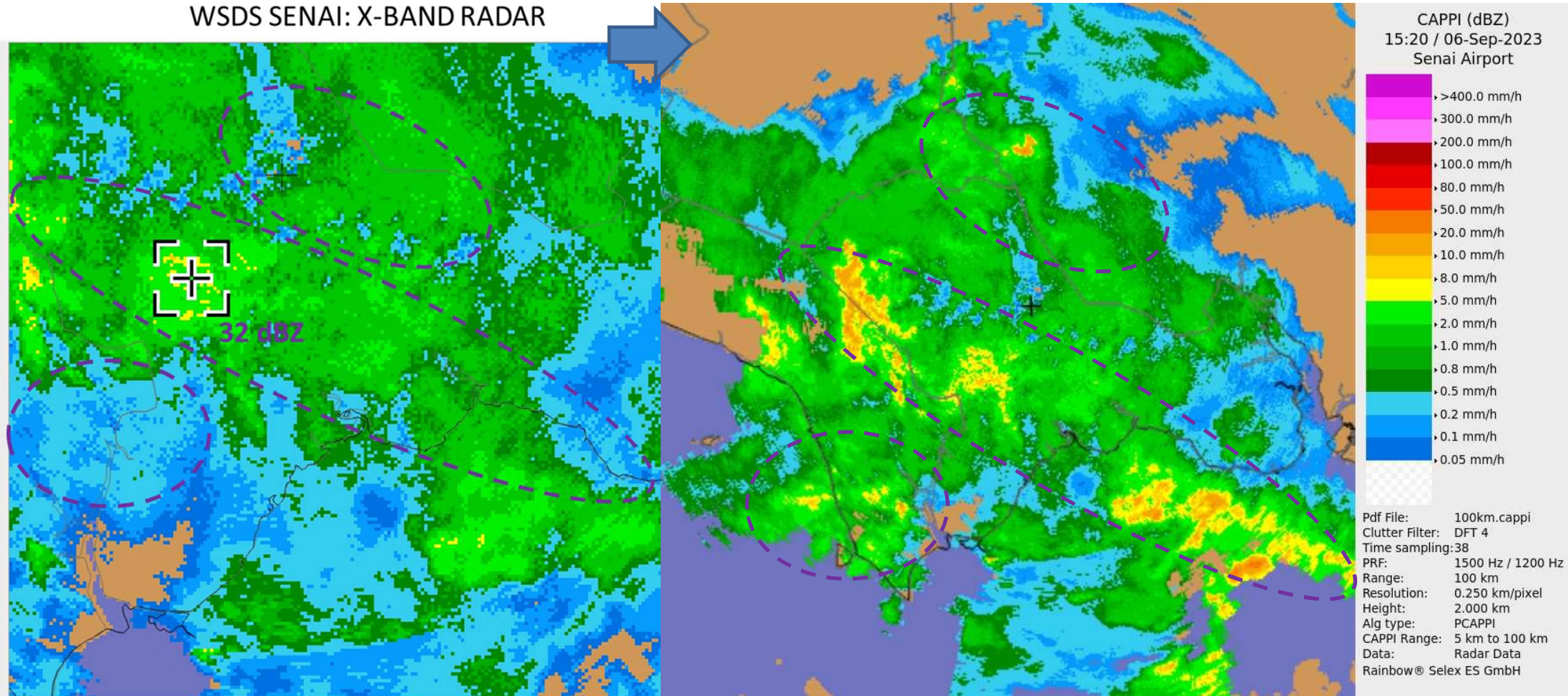


- Dual polarization is beneficial in the quality control process.
- It can distinguish non-meteorological target and meteorological target.

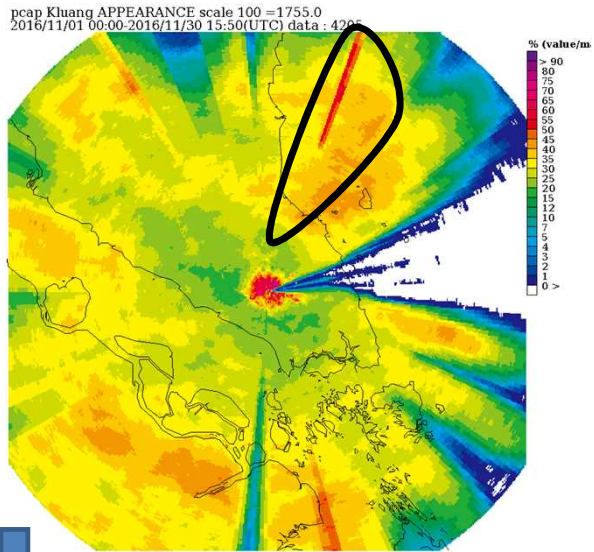
QUALITY CONTROL PROCESS

Example : DPATC (Dual Polarization Attenuation Correction)

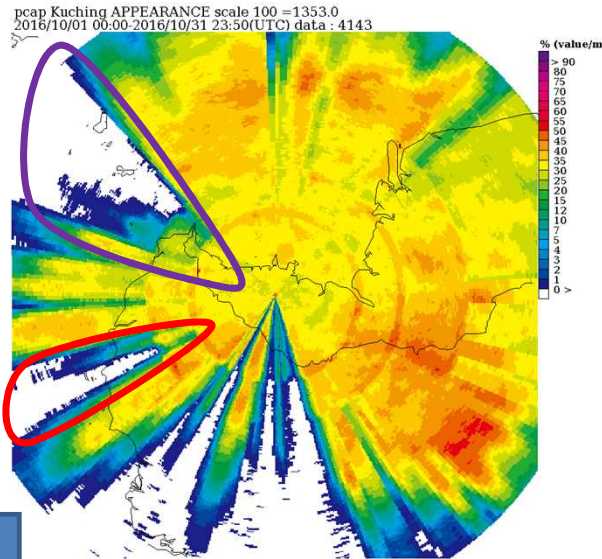
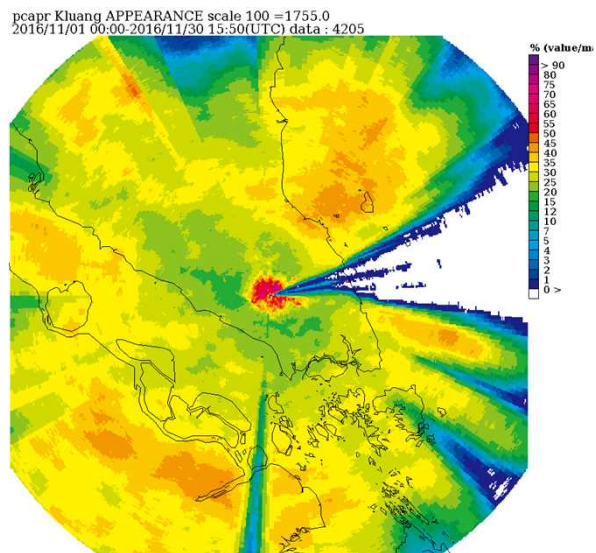
WSDS SENAI: X-BAND RADAR



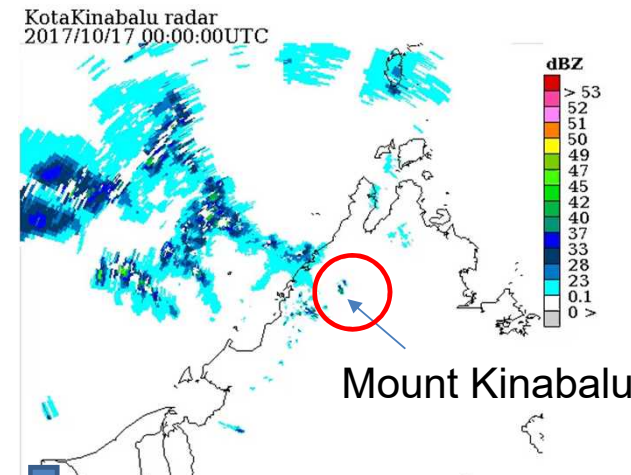
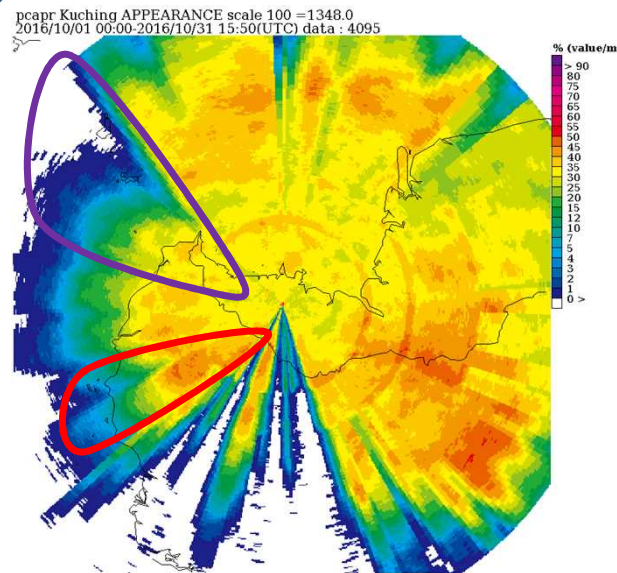
RADAR QC FROM JMA SOFTWARE



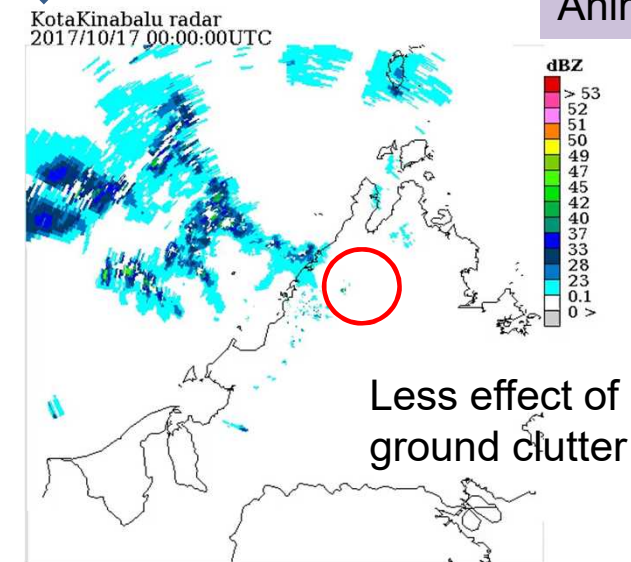
Remove interference



Beam blockage adjustment



Permanent ground clutter

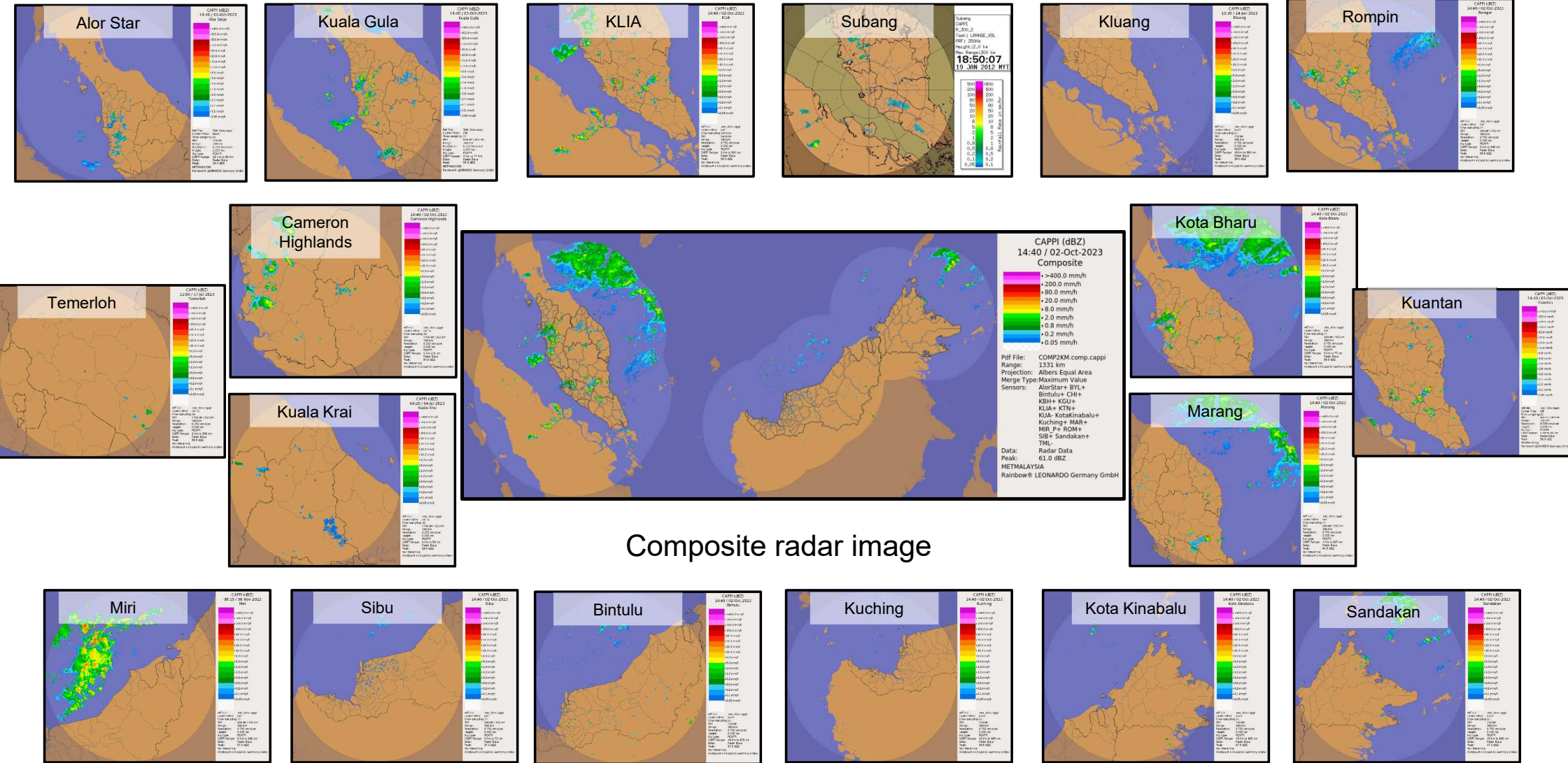


Less effect of ground clutter

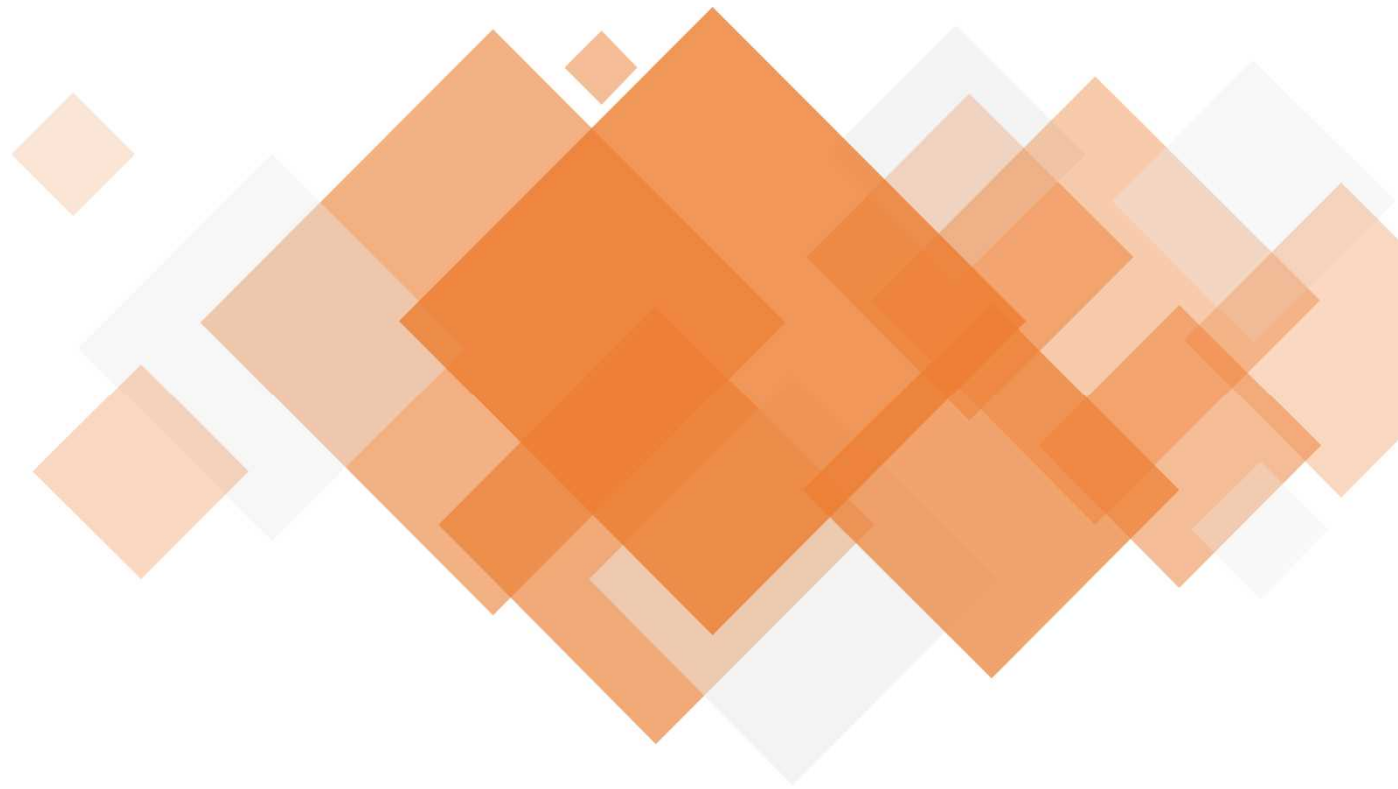
Animation

Maximum technique: Interval every 10 minutes

RADAR COMPOSITE



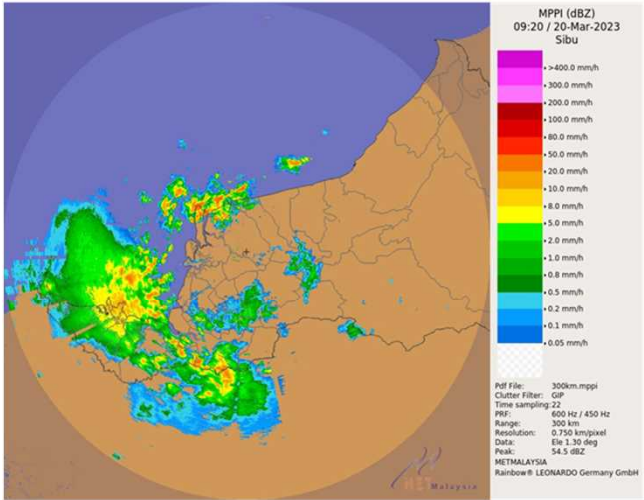
Composite radar image



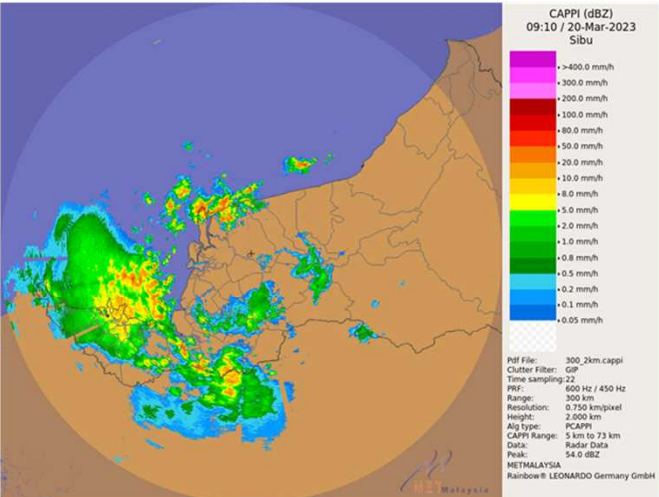
Radar Products and Technical Challenges

RADAR PRODUCTS USED IN OPERATIONAL

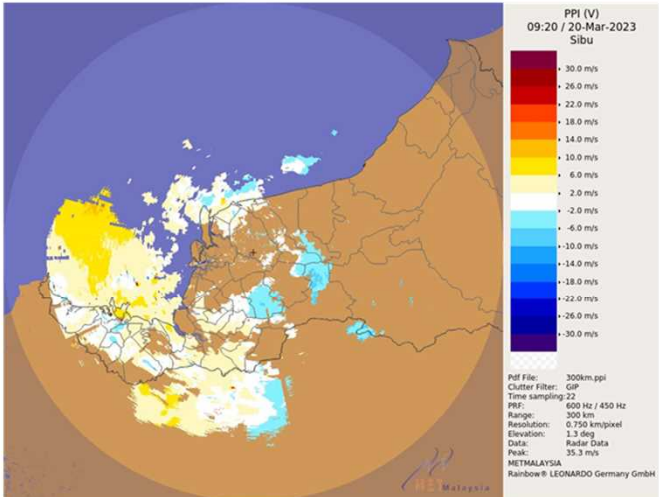
PPI



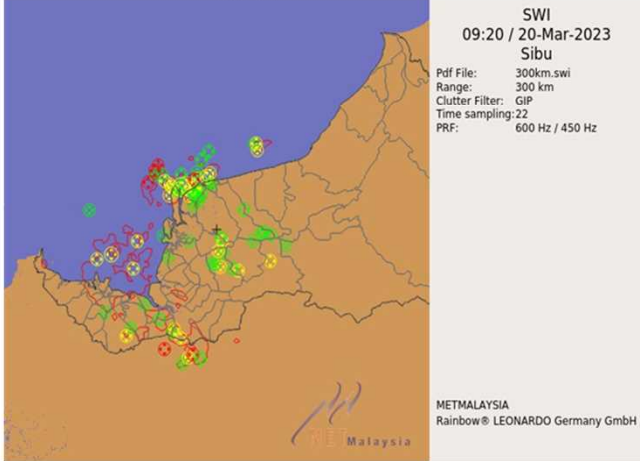
CAPPI



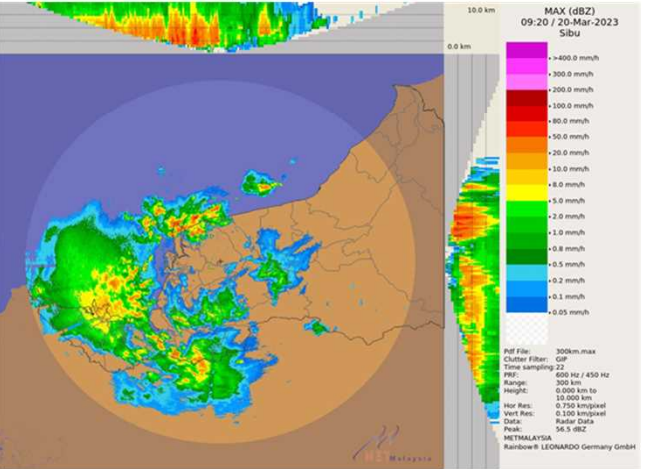
VELOCITY



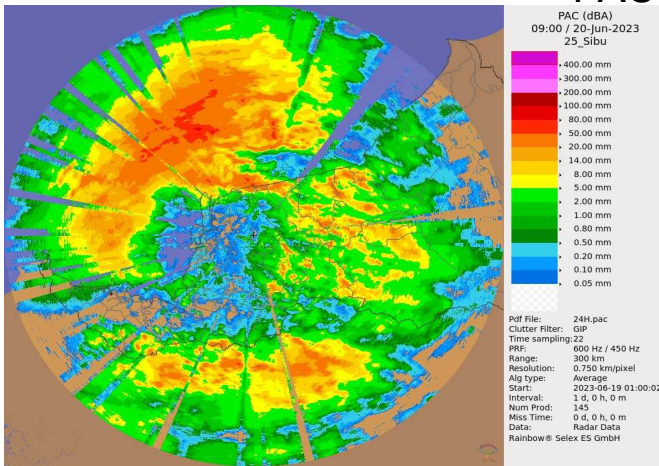
SWI



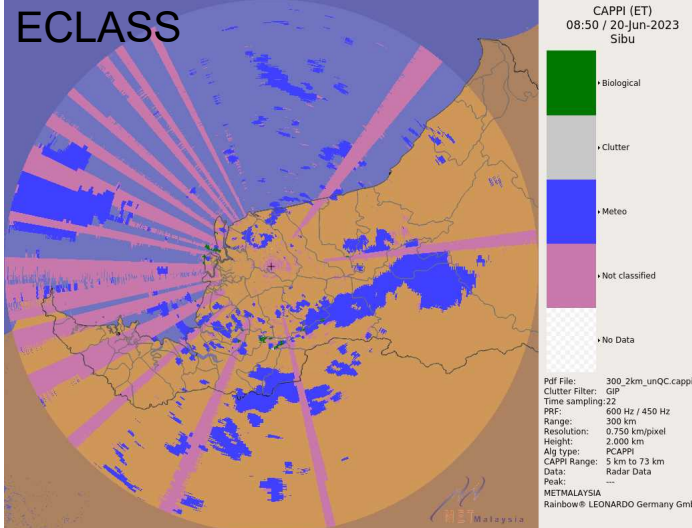
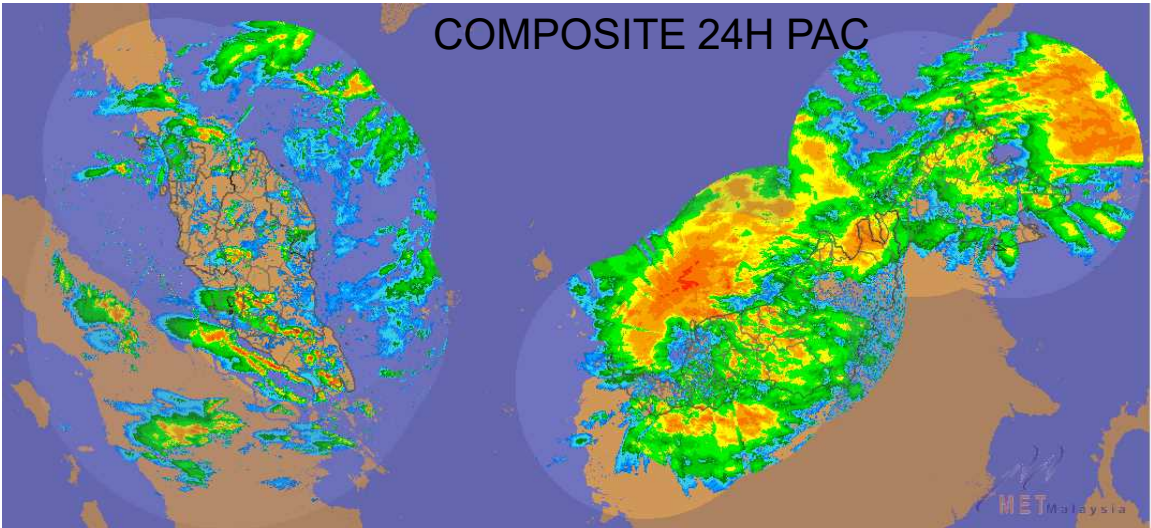
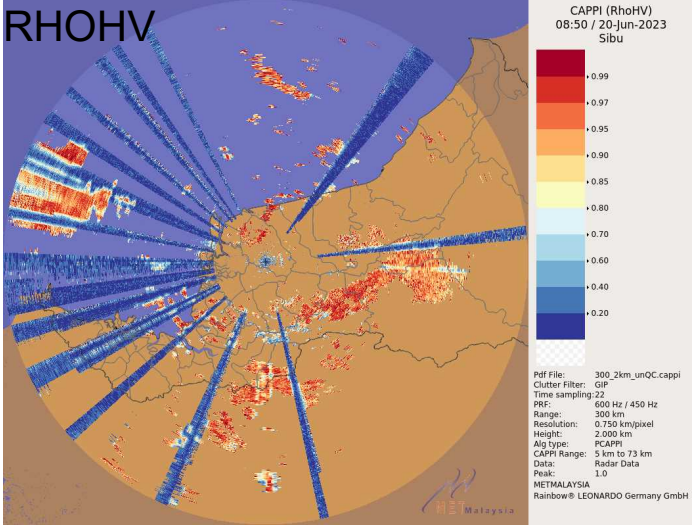
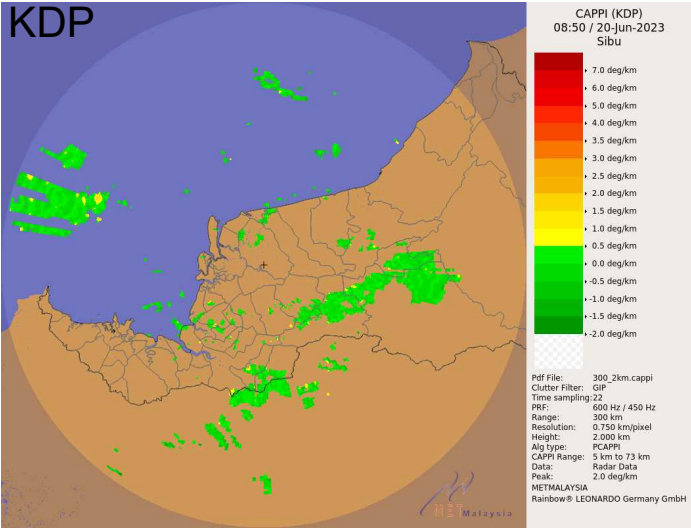
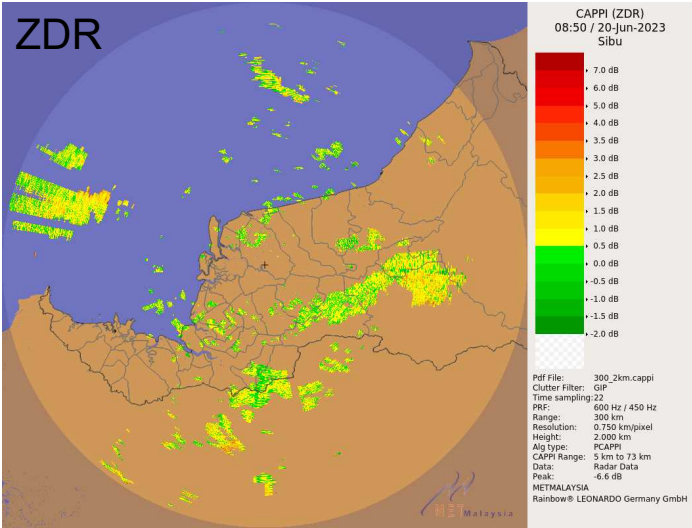
MAX



PAC

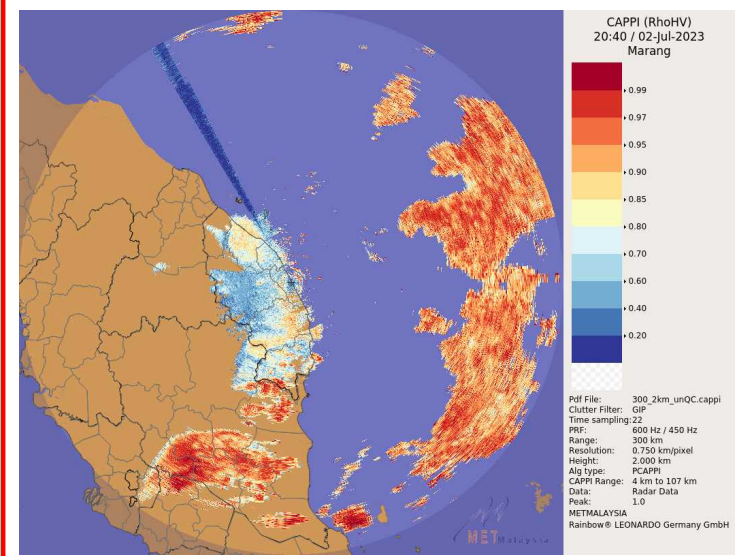
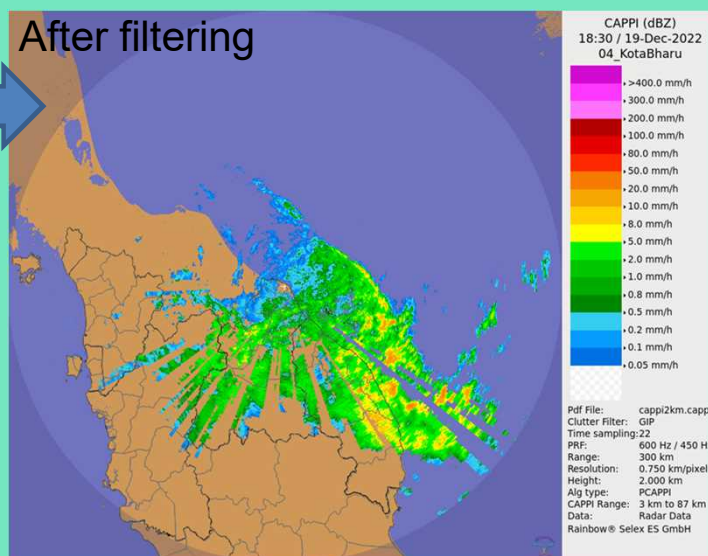
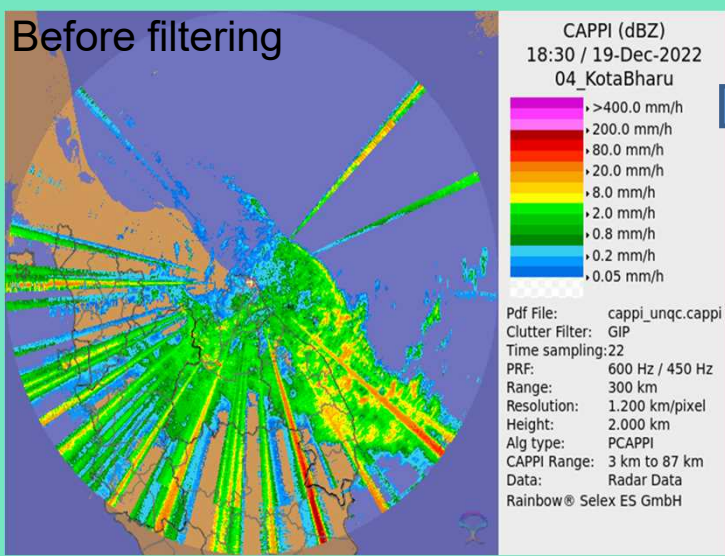
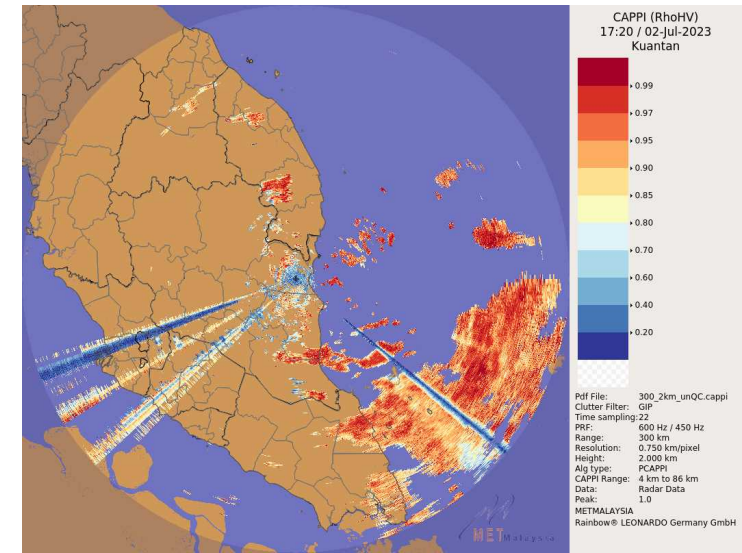
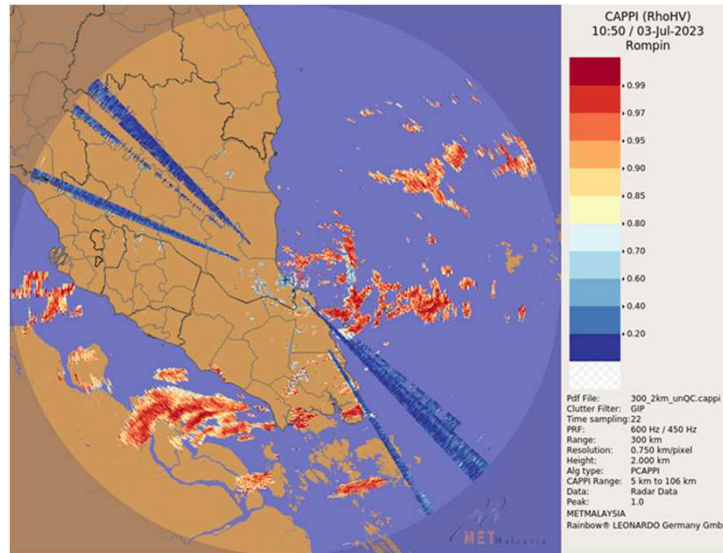
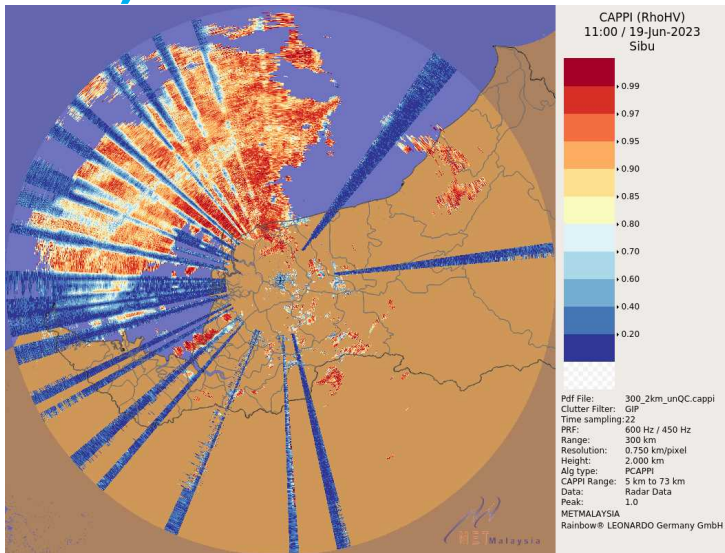


RADAR PRODUCTS USED IN OPERATIONAL



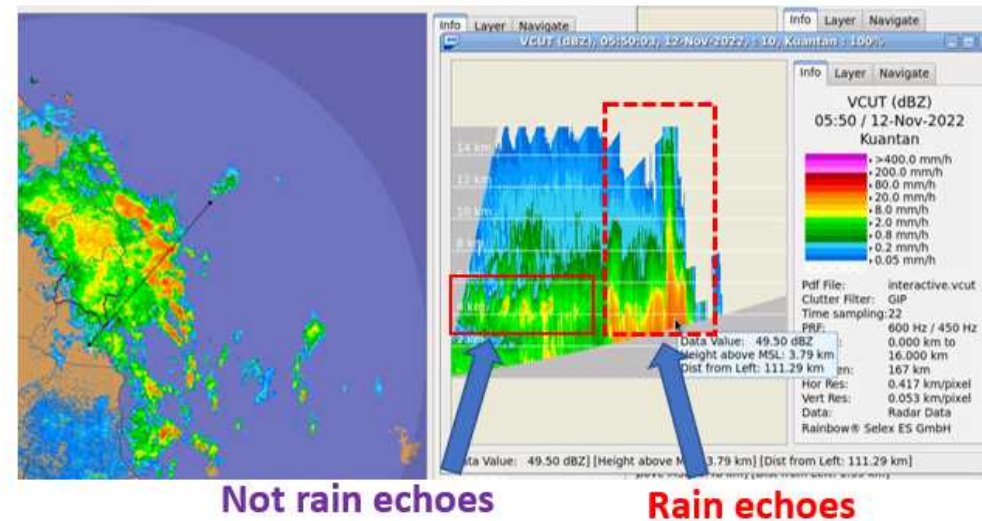
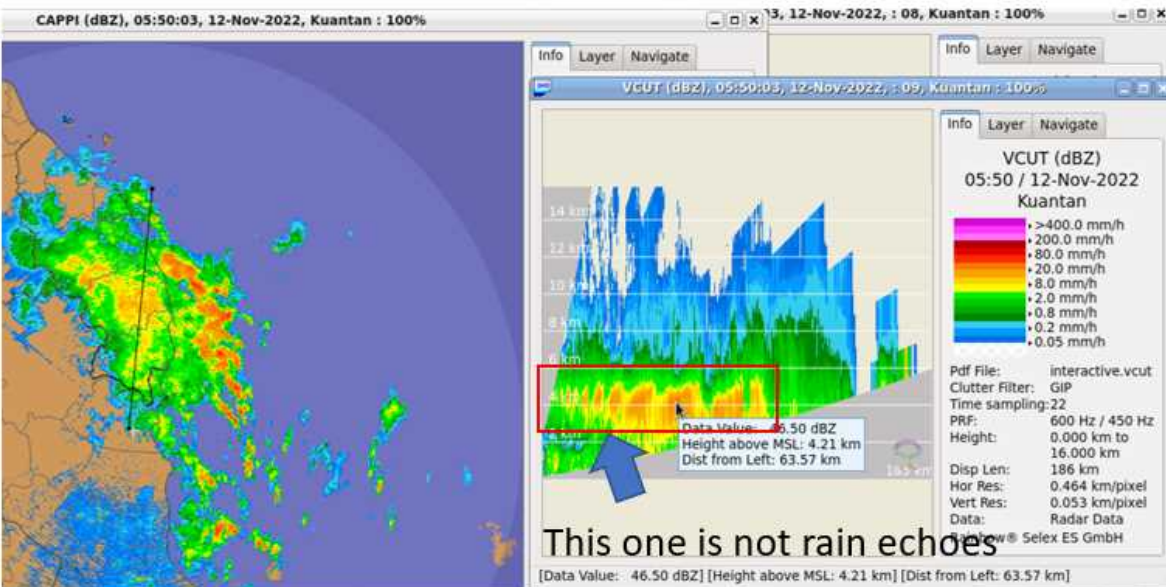
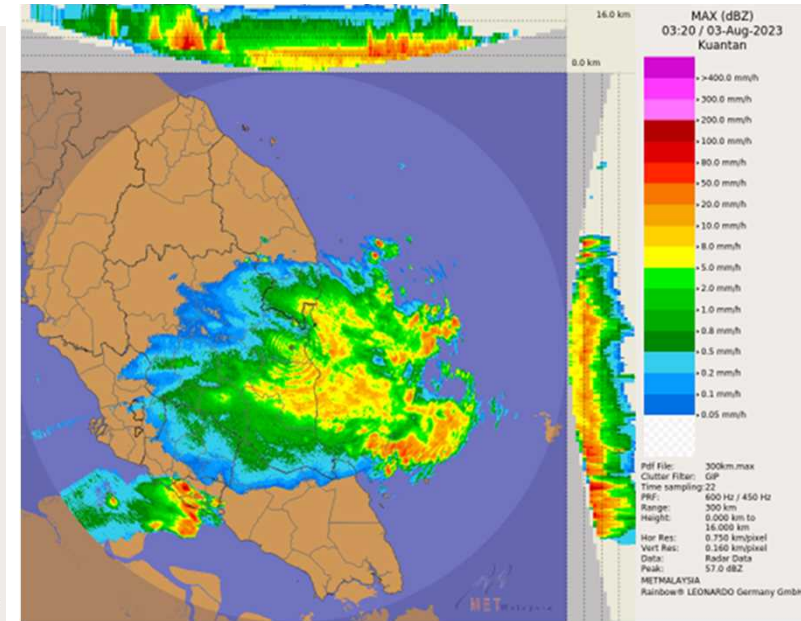
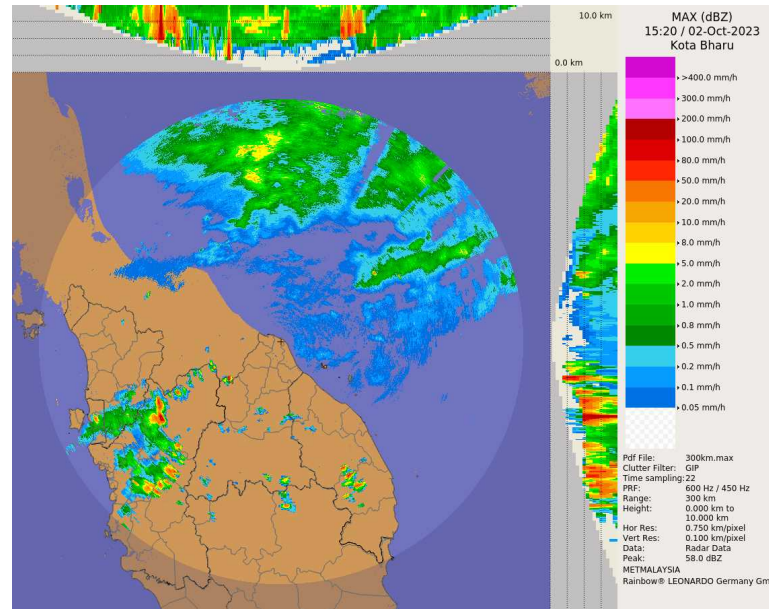
1) Interference issues on S-band radar

TECHNICAL PROBLEM



2) Bright band

- Often occurs during stratiform cloud
- Misinterpretation to the forecasters



Issues

Overestimation and misinterpretation to forecasters

Frequency interferences

Quality control and bias monitoring

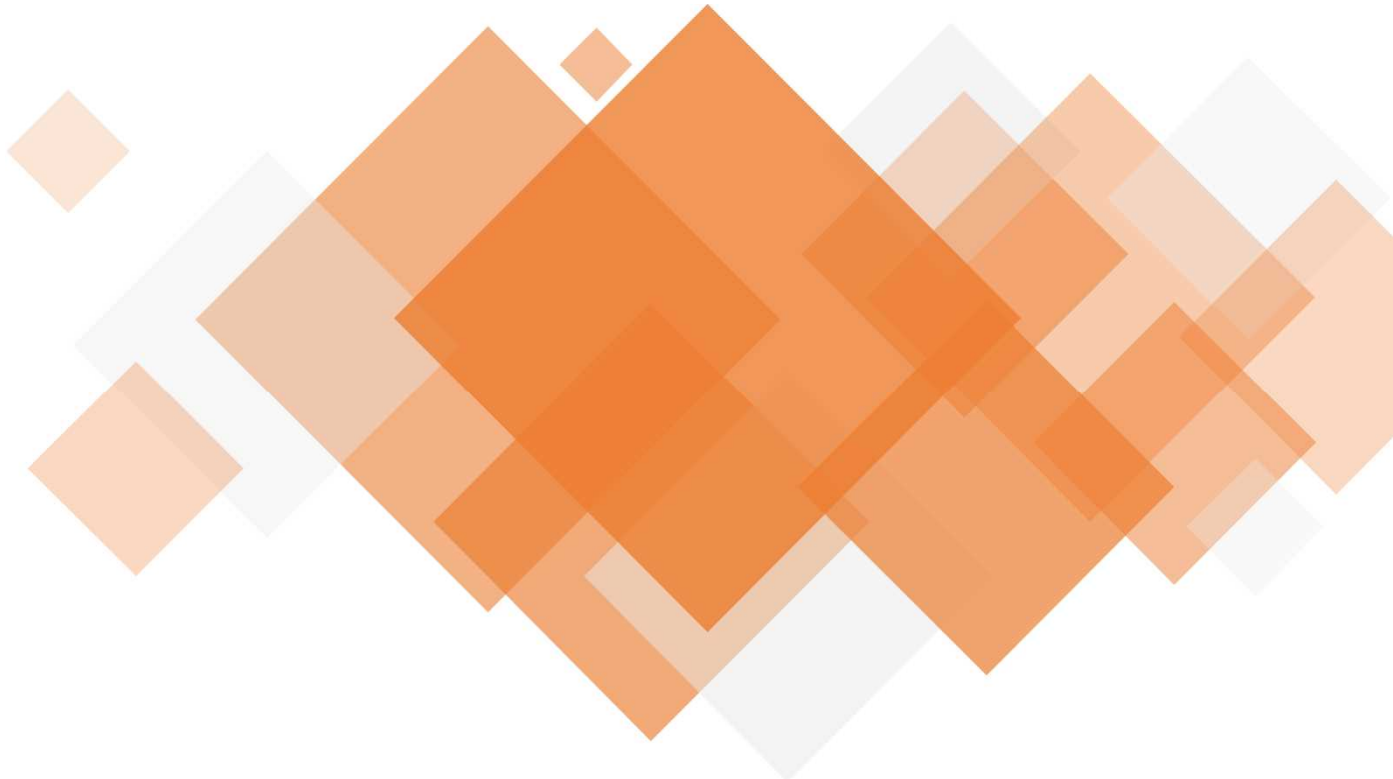
On-site radar

Power failure

Air conditioning malfunction

Internet interruption

Spare parts management (Long lead time, obsolete components)

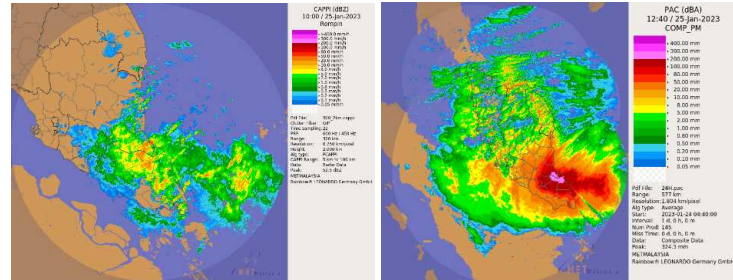


04

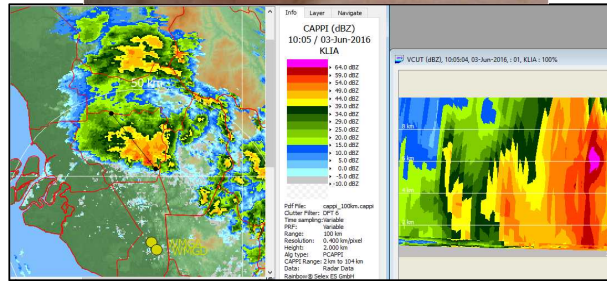
Radar Products Utilization and Application

MAJOR METEOROLOGICAL PHENOMENON OBSERVED BY RADAR

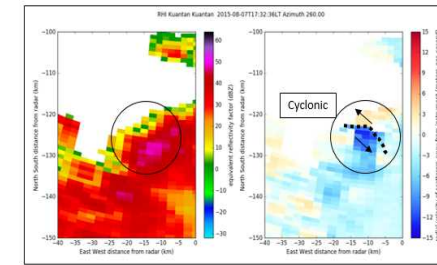
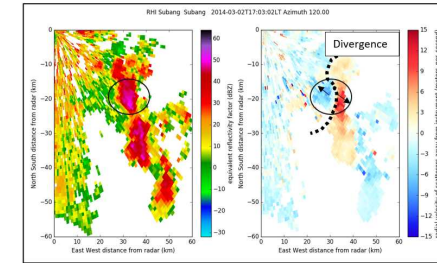
Monsoon Rain



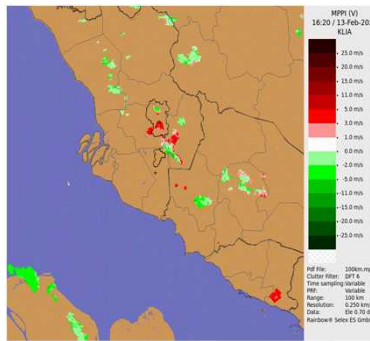
Hail



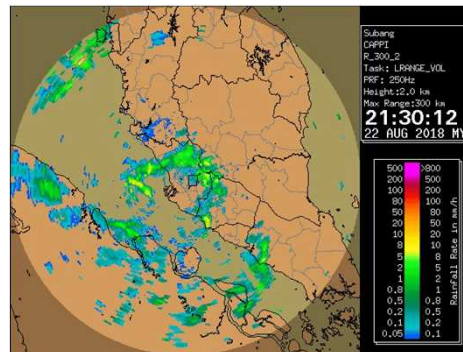
Mesocyclone Signatures (Landspout/Waterspout)



Thunderstorms



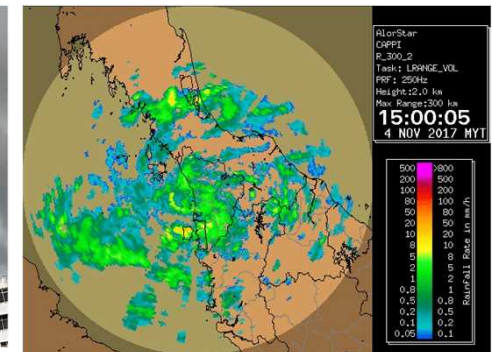
Squall Line



Rotation



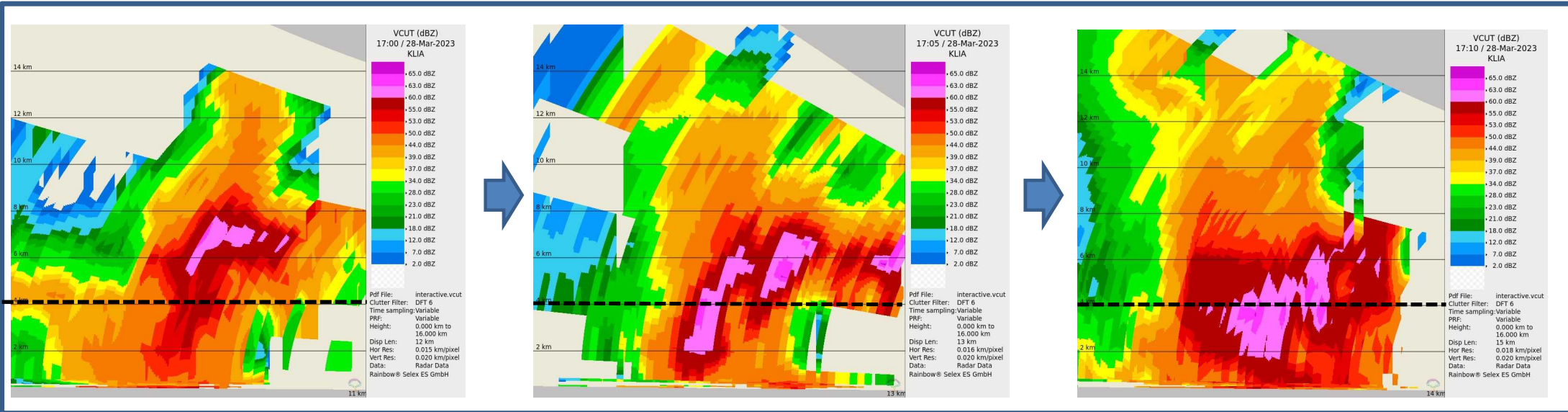
Low Pressure System



Cross section of radar reflectivity (dBZ)

Hail Phenomenon

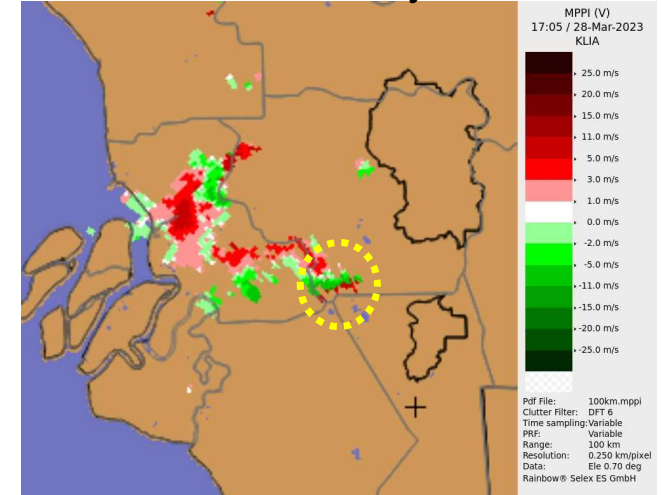
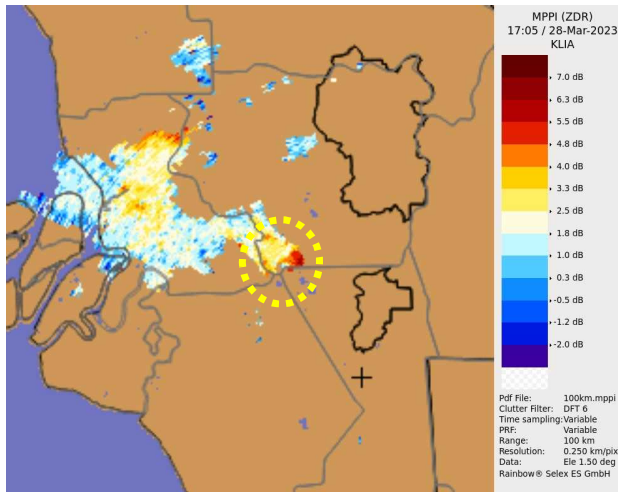
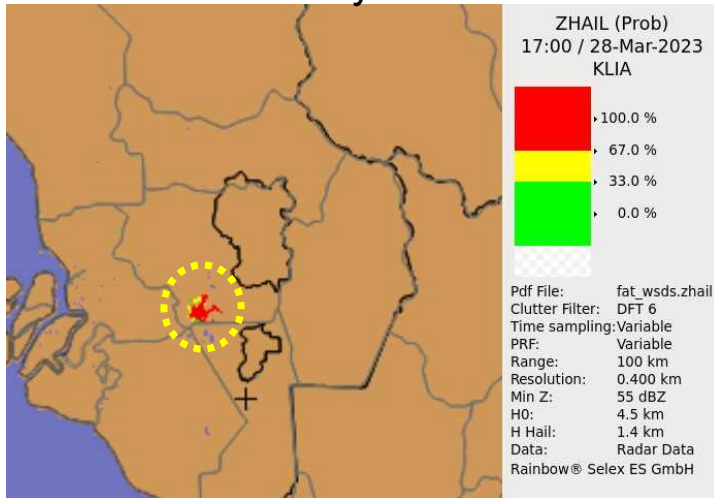
FEATURE ANALYSIS



Probability of Hail

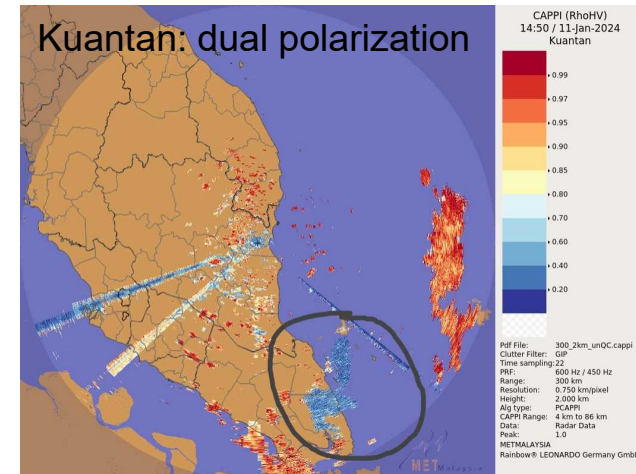
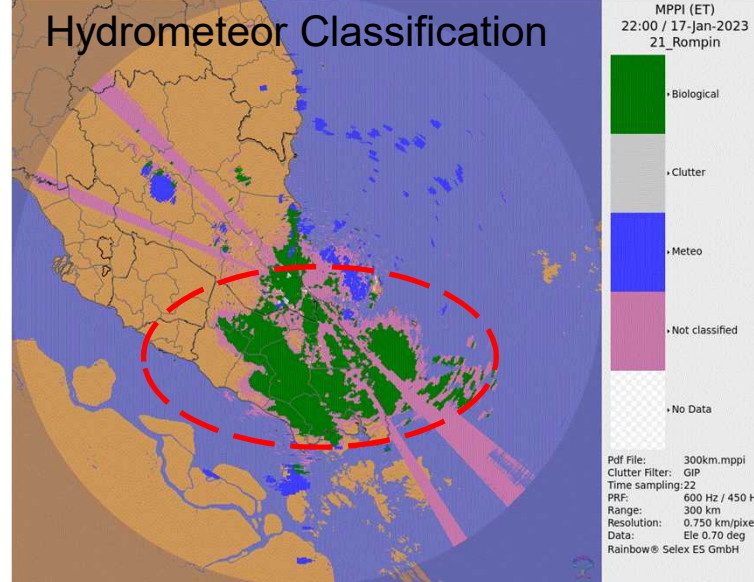
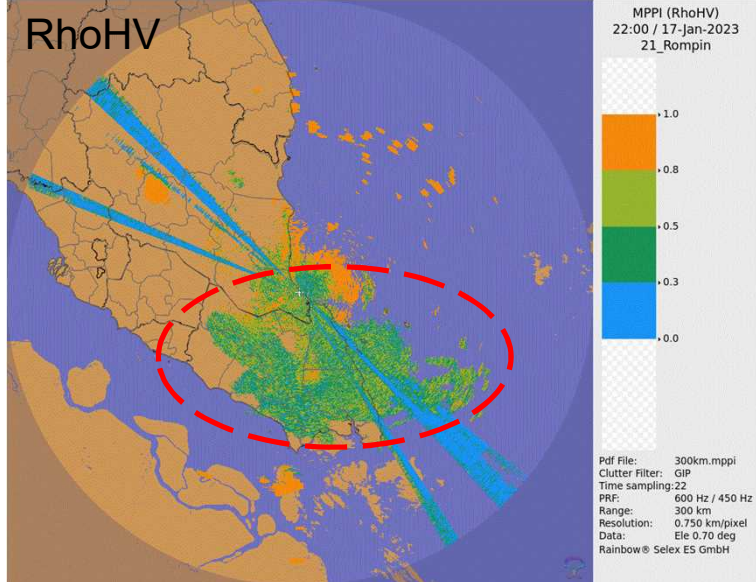
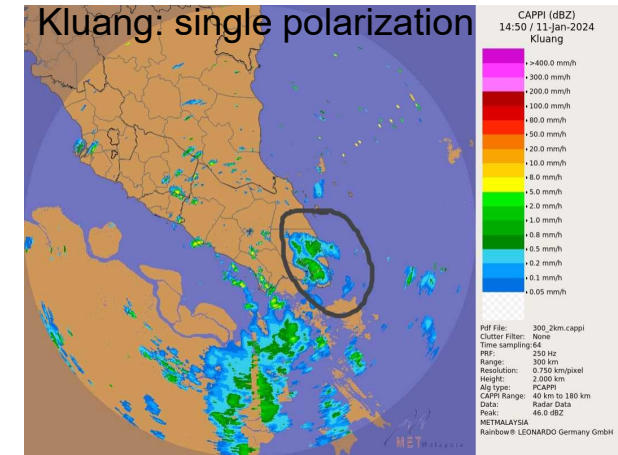
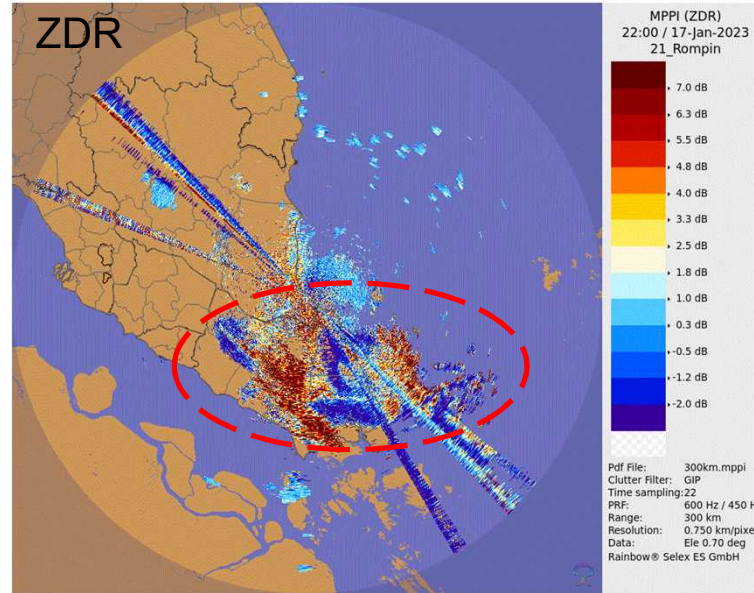
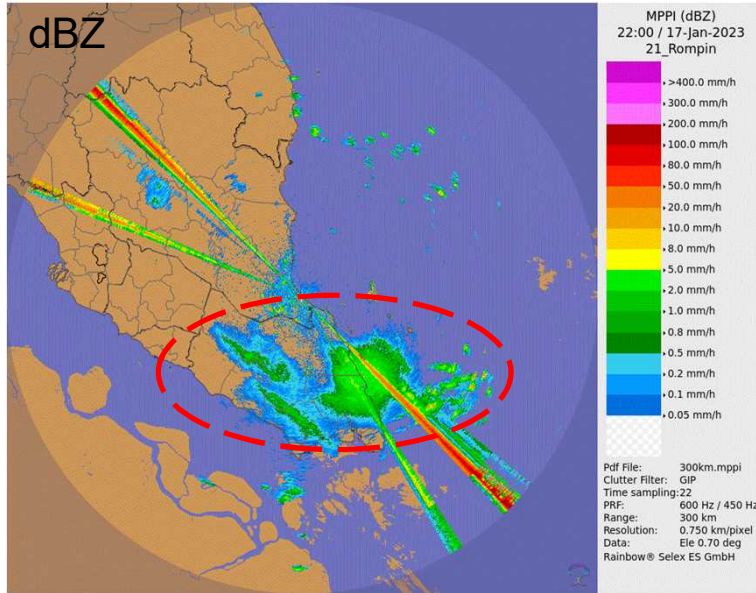
ZDR

Velocity

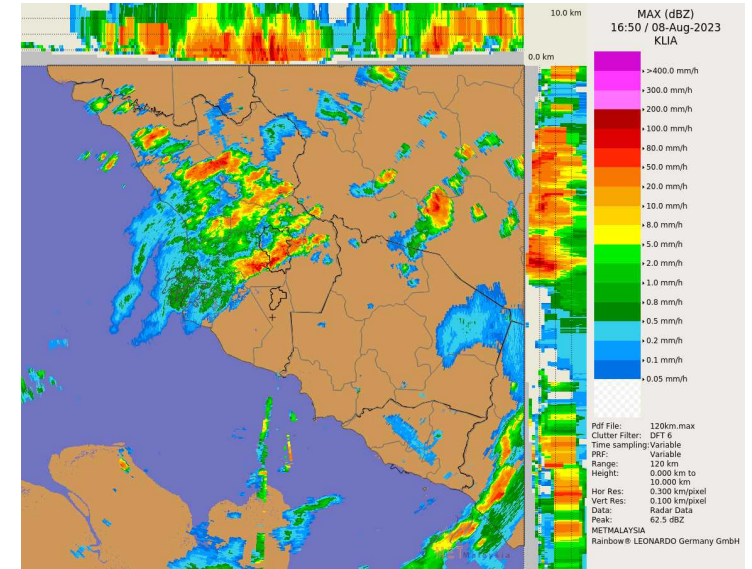
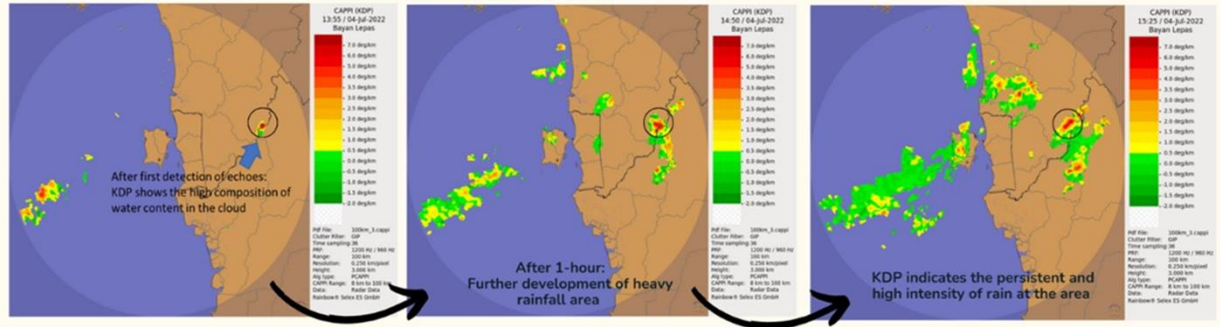


FEATURE ANALYSIS

Detection Non -Meteorological Target



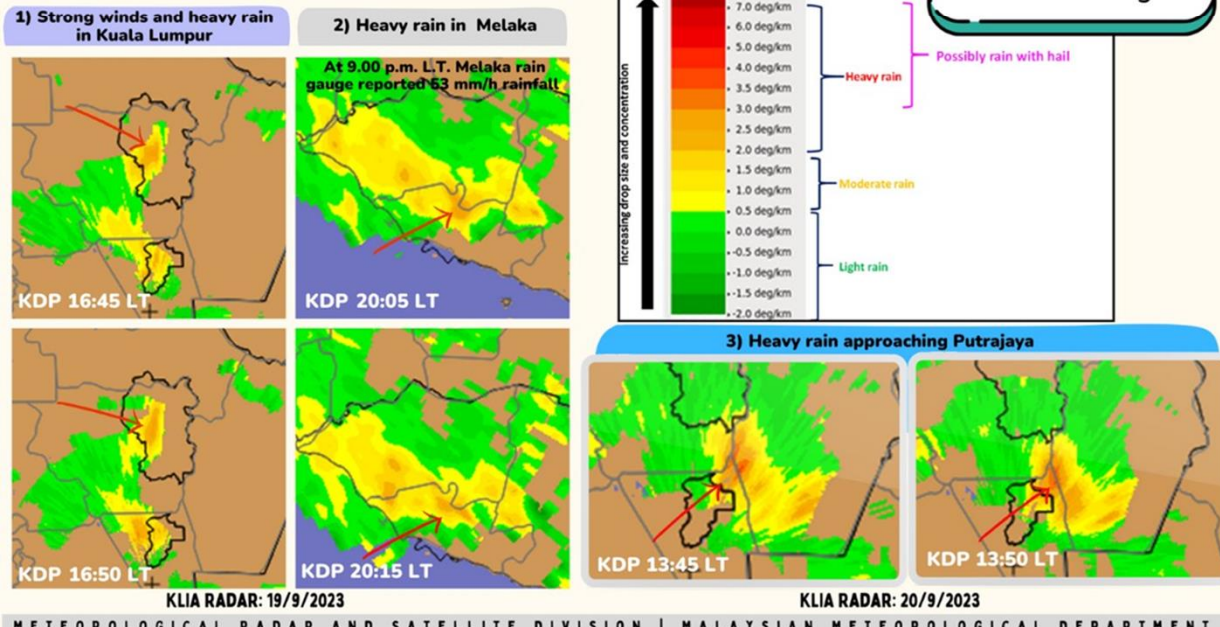
Example: Flood in Baling, 4th July 2022



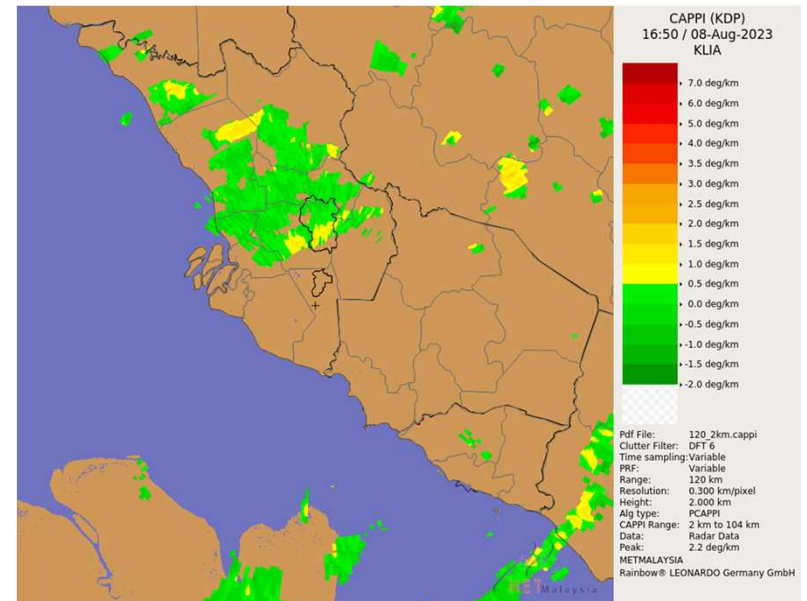
KDP PRODUCT APPLICATION FOR HEAVY RAIN OBSERVATION (OBSERVED ON 19 & 20 SEPT 2023)



Refer to KDP Legend



Example: Heavy Rain at Kuala Lumpur (8th August 2023)

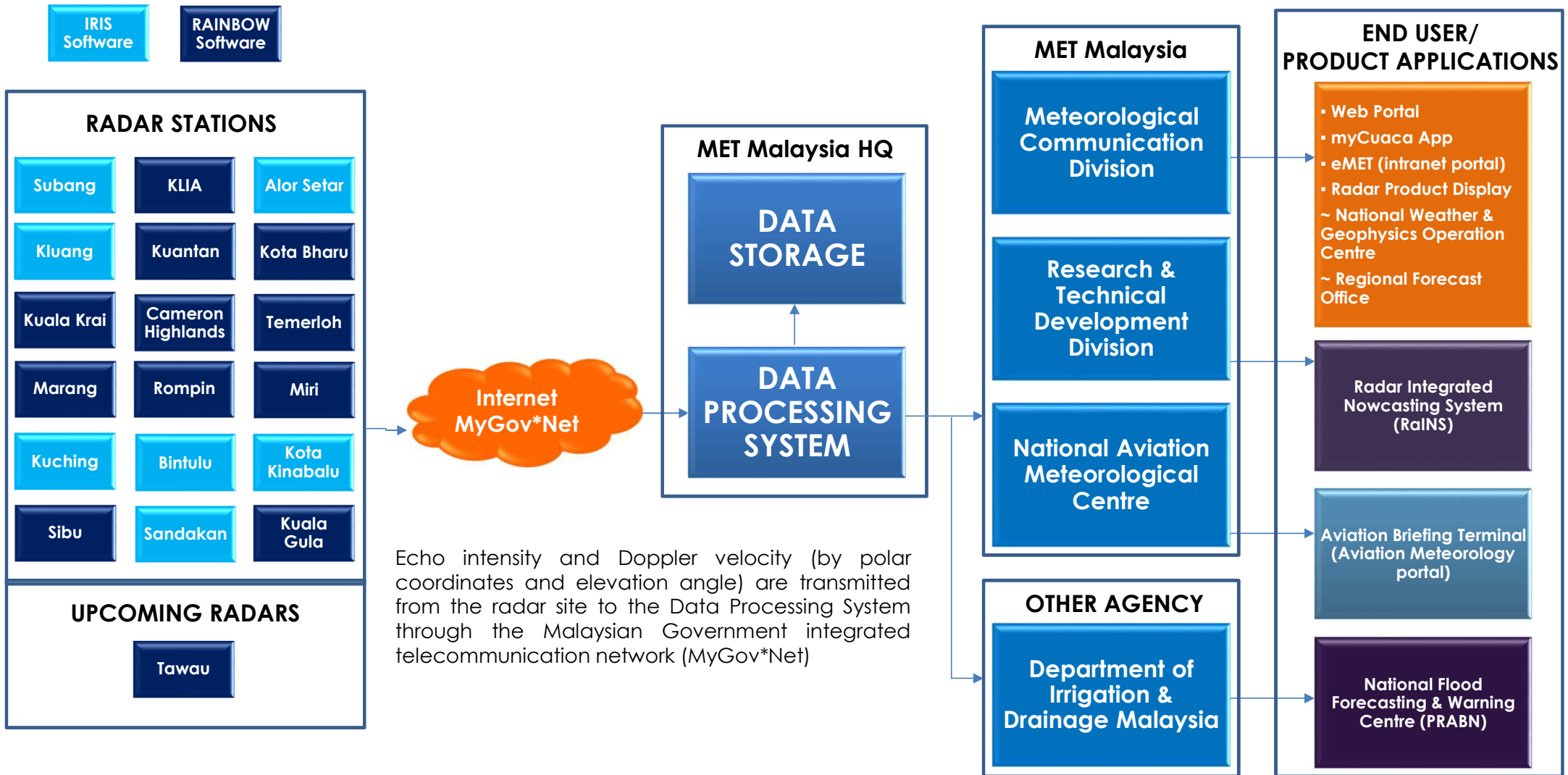




05

Radar Data Dissemination and Future Plan on Weather Radar

RADAR DATA DISSEMINATION AND APPLICATIONS

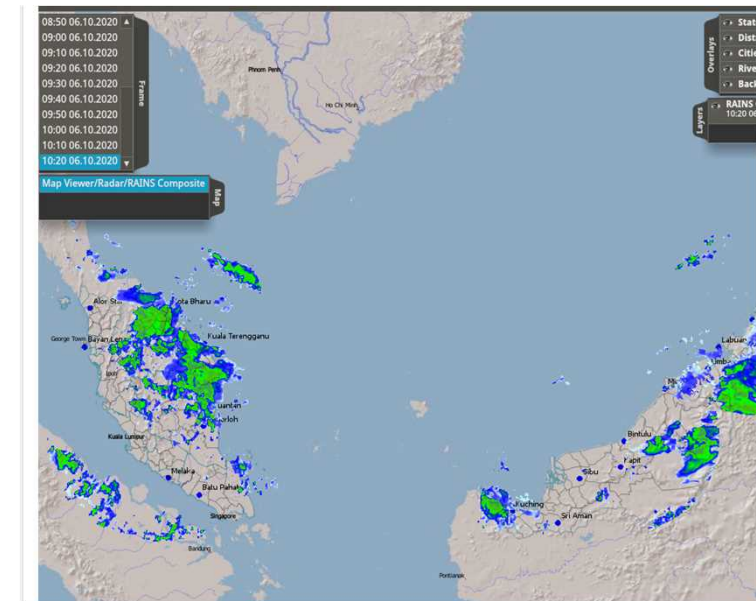
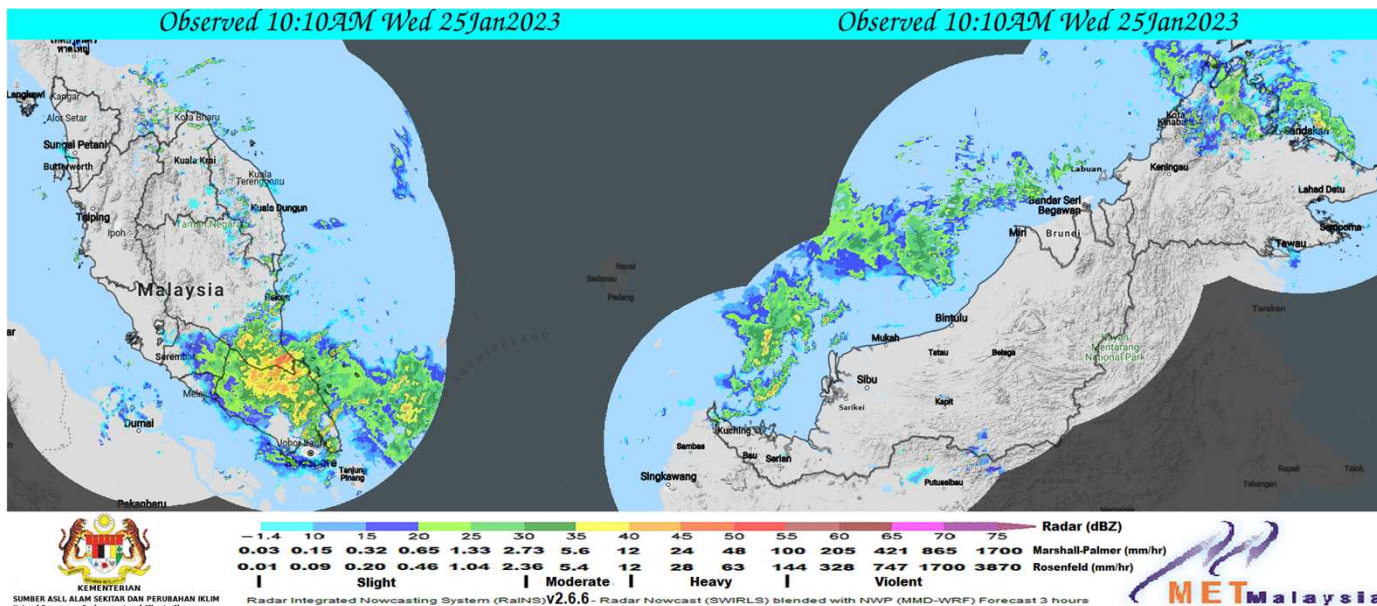


RADAR DATA SERVICES

RADAR INTEGRATED NOWCASTING SYSTEM (RaINS)

(Developed and operationalized by MET Malaysia's Research & Technical Development Division)

- Blends radar nowcast (SWIRLS) with WRF-1km output
- Forecast up to 3 hours (every 10 minutes)
- Able to predict the growth and decay of rain areas in radar nowcasting



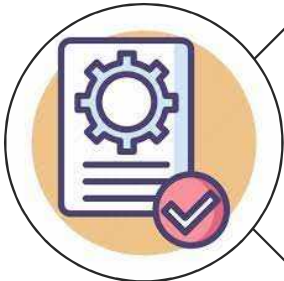
ideas.met.gov.my & myCuaca mobile app
(animated gif and png)

emet.met.gov.my
(geospatial display)

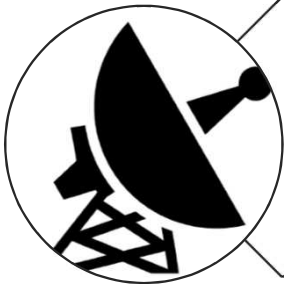
FUTURE DEVELOPMENT PLANS



To acquire further **technical skills and knowledge** on the configuration, calibration and improvement of dual-pol radar products.



Quality Control (QC): To improve the quality control of the data and its accuracy including the monitoring of bias



QPE & R-KDP: Exploring and efficiently utilize dual-pol radar data to improve QPE and R-KDP relationship in order to support severe weather detection, warning and forecasting.



TERIMA KASIH ~ THANK YOU

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