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MINISTRY OF ENERGY, SCIENCE, TECHNOLOGY, ENVIRONMENT & CLIMATE CHANGE

MET Malaysia

MODELING HEAVY RAINFALL EVENTS: A CITY SCALE PERSPECTIVE

Muhammad Firdaus Ammar Abdullah
Malaysian Meteorological Department

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SCOPE

- A Changing Climate
- Drivers for Weather & Climate Services
- Business Architecture of METMALAYSIA
- City Scale Modeling : The NUOF Project
- Concluding Remarks

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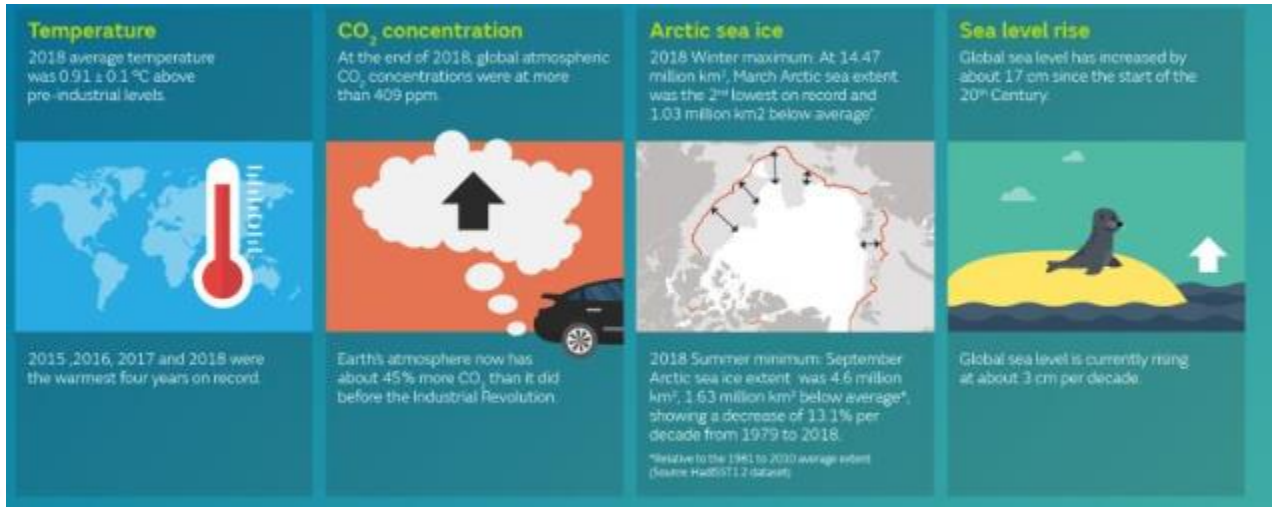
The Climate is Changing

Emphasis in climate science shifting:

- Is the climate warming?
  Warming of the climate system is unequivocal
- Is warming due to greenhouse gases?
  Warming largely due to greenhouse gases
- Emphasis is now on *climate services*:
  Actionable advice for decision makers



Source: UKMO

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Drivers for weather and climate services

Typhoon Lekima: 28 dead and a million evacuated in China

11 August 2019 Share

Dramatic rescues after typhoon Lekima causes floods in China

UN Photo/OCHA/Mark Garten

In The Bahamas, Guterres sees impact of 'Category Hell' hurricane, 'powered by climate change'

14 September 2019 | Americas

The UN chief saw for himself the deadly power of Hurricane Dorian on the shattered islands of Abaco and Grand Bahama on Saturday, describing it as more like a "Category Hell" disaster, than the official Category 5 designation used by meteorologists.

17ª Brigada de Inf

We are 'burning up our future', UN's Bachelet tells Human Rights Council

9 September 2019

The Human Rights Council opened in Geneva on Monday with a warning from the UN's top rights official that, with forest fires raging in the Amazon, "we are burning up our future, literally".

Fani Threatens India

May 2, 2019 JPEG

As Tropical Cyclone Fani bore down on the eastern coast of India, the storm gained significant strength over the past 24 hours.

Hurricane Dorian: Bahamas lists 2,500 people as missing

11 September 2019 Share

Hurricane Dorian

Search teams comb through debris left by Hurricane Dorian

UNDP Chad/Jean Damascene Hakuzim

World food security increasingly at risk due to 'unprecedented' climate change impact, new UN report warns

8 August 2019

More than 500 million people today live in areas affected by erosion linked to climate change, the UN warned on Thursday, before urging all countries to commit to sustainable land use to help limit greenhouse gas emissions before it is too late.

Audio - 10'41" + Playlist

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MONSOONS AND EXTREME WEATHER


Banjir Monsun

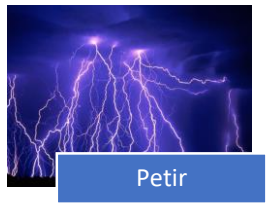

Angin Kencang


Laut Bergelora

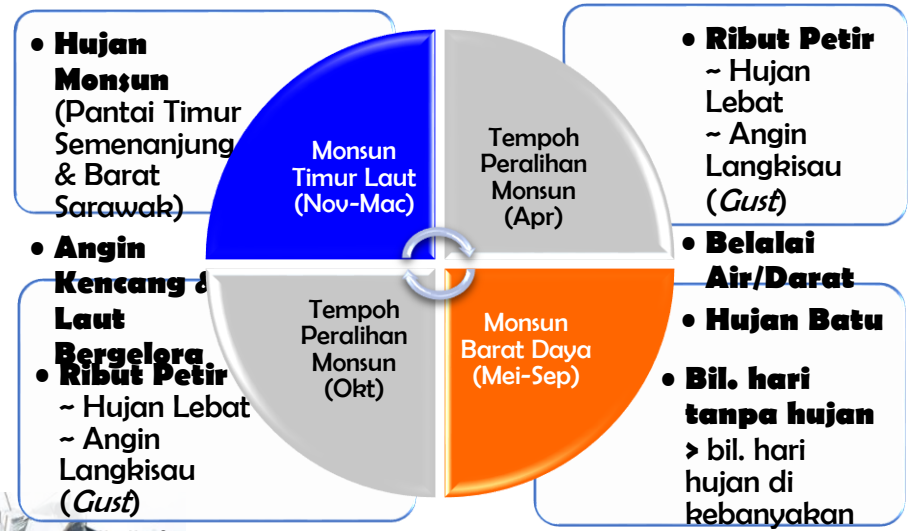

Banjir Kilat

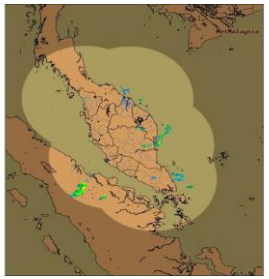

Pokok Tumbang

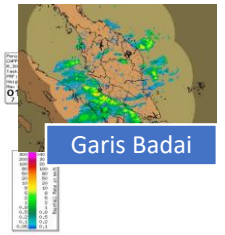

Bumbung Terbang

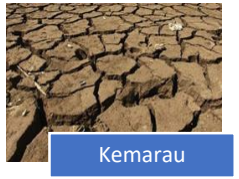

Petir


Tanah Runtuh

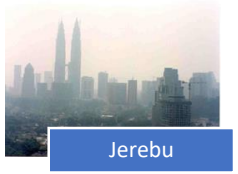





Garis Badai


Kemarau


Kebakaran Hutan


Jerebu

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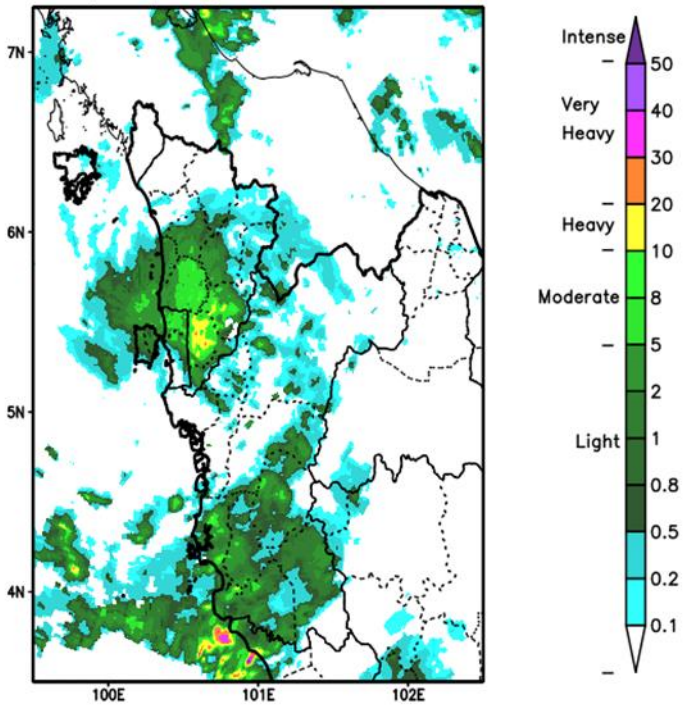
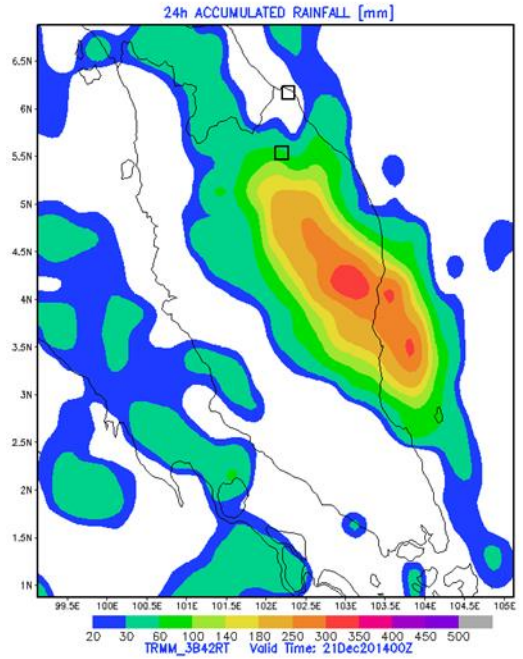
Drivers for weather and climate services

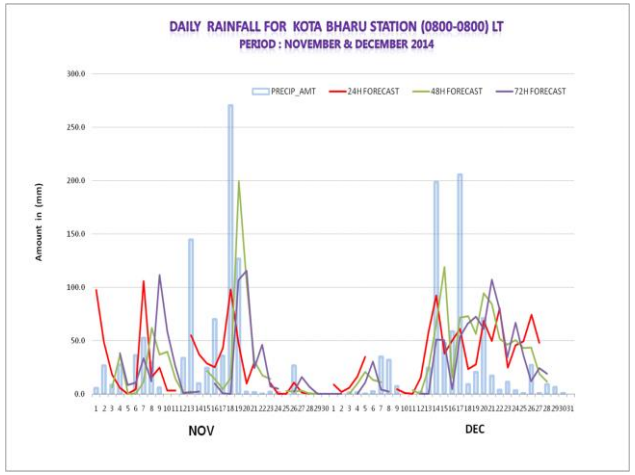
A stationary vortex in Penang for almost 30 hours (18Z 03 Nov – 06Z 05 Nov 2017).

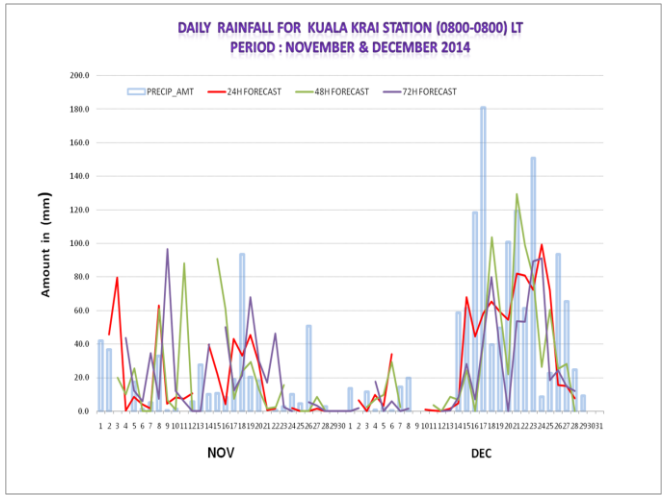
Radar Observation (mm/hr) at Sun Nov 5 06:00:00 2017



Devastating Floods during NE Monsoon (2014).







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Drivers for weather and climate services

Sustainable Development Goals

UN's vision for the world in 2030 - apply to all countries
Weather and climate provide pervasive threats and hazards

METMALAYSIA'S BUSINESS ARCHITECTURE

OBSERVATION


RADAR SATELIT

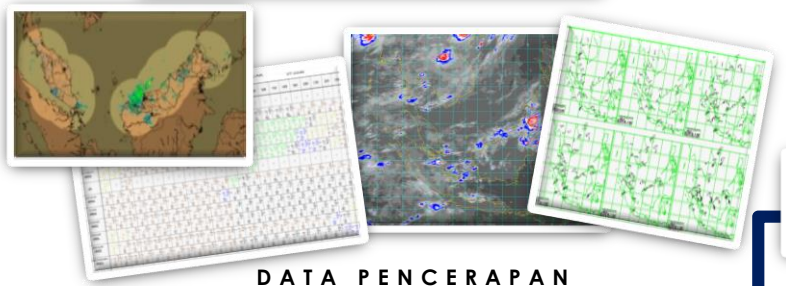

STESEN MET.


AWS


BOYA


STESEN PASANG SURUT

DATA COLLECTION

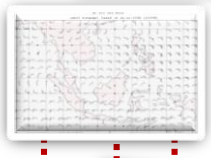

DATA PENCERAPAN

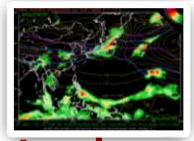
ANALYSISS

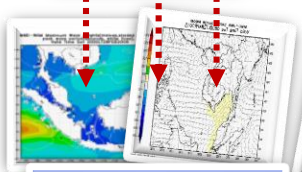
WEB SERVER

HIGH PERFORMANCE COMPUTING

NWP






MARINE MODELS


NWP MODEL

eMET
Welcome to eMET

NATIONAL WEATHER & EATHQUAKE OPERATIONS CENTRE

NADMA

SOCIAL MEDIA

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www.met.gov.my

RakanMET
rakanmet.met.gov.my

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1-300-22-1638

PUBLIC


AVIATION


MEDIA

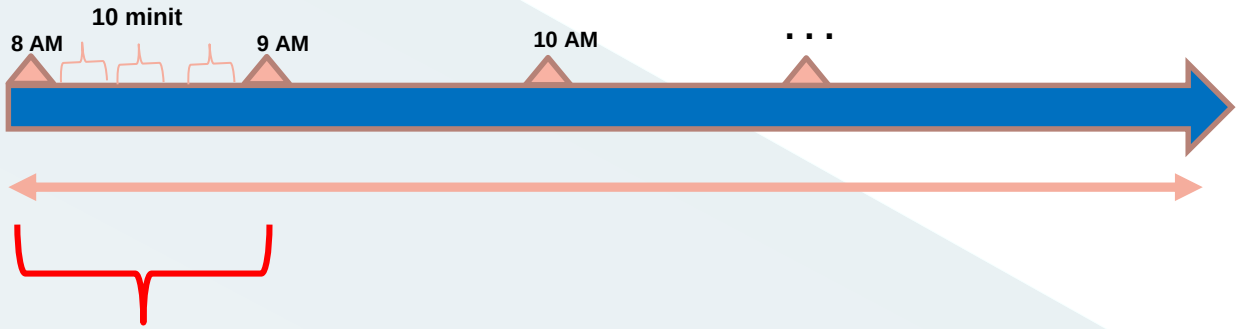

FISHERIES


DEFENSE

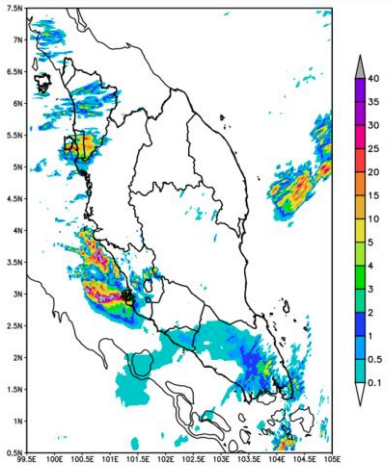

OIL & GAS

NWP MODEL FORECASTING SYSTEM AT METMALAYSIA

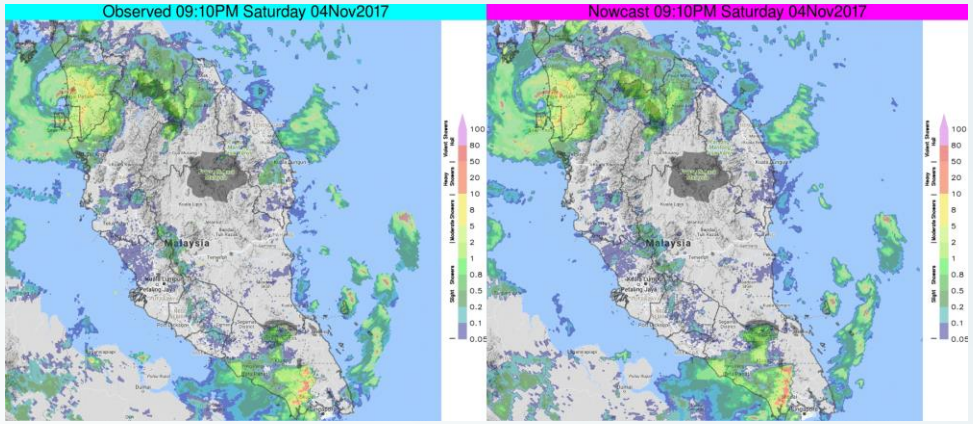
7-Day Lead Time Forecast



1-KM MODEL FORECAST



Overlapping 3-hour lead time nowcasting ***Radar Integrated Nowcasting System*** (***RaiNs)*** at 10-minute interval



RaiNS

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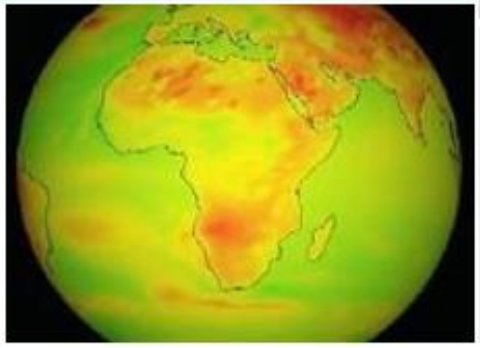
A NETWORK OF ORGANISATIONS CENTERED ON A SHARED CHALLENGE

The risks associated with weather and climate **transcend national boundaries** and require a network of domestic and international partnerships that draw together the expertise, knowledge and experience required to **accelerate progress** in addressing this **shared challenge**.



Our ability to tackle this challenge rests on our ability to **work collaboratively** towards a **shared goal**, deploying our skills, experience and resources to **accelerate scientific progress** and development of **innovative solutions.**

Innovate UK | MiGHT Malaysian Industry-Government Group for High Technology | Newton-Ungku Omar Fund | SCIENCE to ACTION | NADMA

UNIVERSITY OF CAMBRIDGE | BGS British Geological Survey NATURAL ENVIRONMENT RESEARCH COUNCIL | seadpri | UNIVERSITY OF MALAYA | MET Malaysia | JMG | Jabatan Alam Sekitar Malaysia

UCL | CERC | UKM PAKARUNDING | CORE Expert Systems | GMT Geomapping Technology Sdn Bhd

JBA consulting | Cuesta | GEOLOGICAL SOCIETY OF MALAYSIA | Asian Network on Climate Science and Technology (ANCST)

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Innovate UK MiGHT Malaysian Industry-Government Group for High Technology Newton-Ungku Omar Fund SCIENCE to ACTION MET Malaysia

Disaster Resilient Cities: Forecasting Local Level Climate Extremes and Physical Hazards for Kuala Lumpur

PROJECT LEADERS

Prof. Joy Jacqueline Pereira, SEADPRI-Universiti Kebangsaan Malaysia &

Prof. Julian C.R. Hunt, University Of Cambridge

THE CONSORTIUM

10 organisations from Malaysia

5 Research Organisations: Universiti Kebangsaan Malaysia, SEADPRI-UKM; University of Malaya, UM; Meteorology Department of Malaysia, MMD; Minerals and Geoscience Department of Malaysia, JMG; Department of Environment Malaysia, DoE;

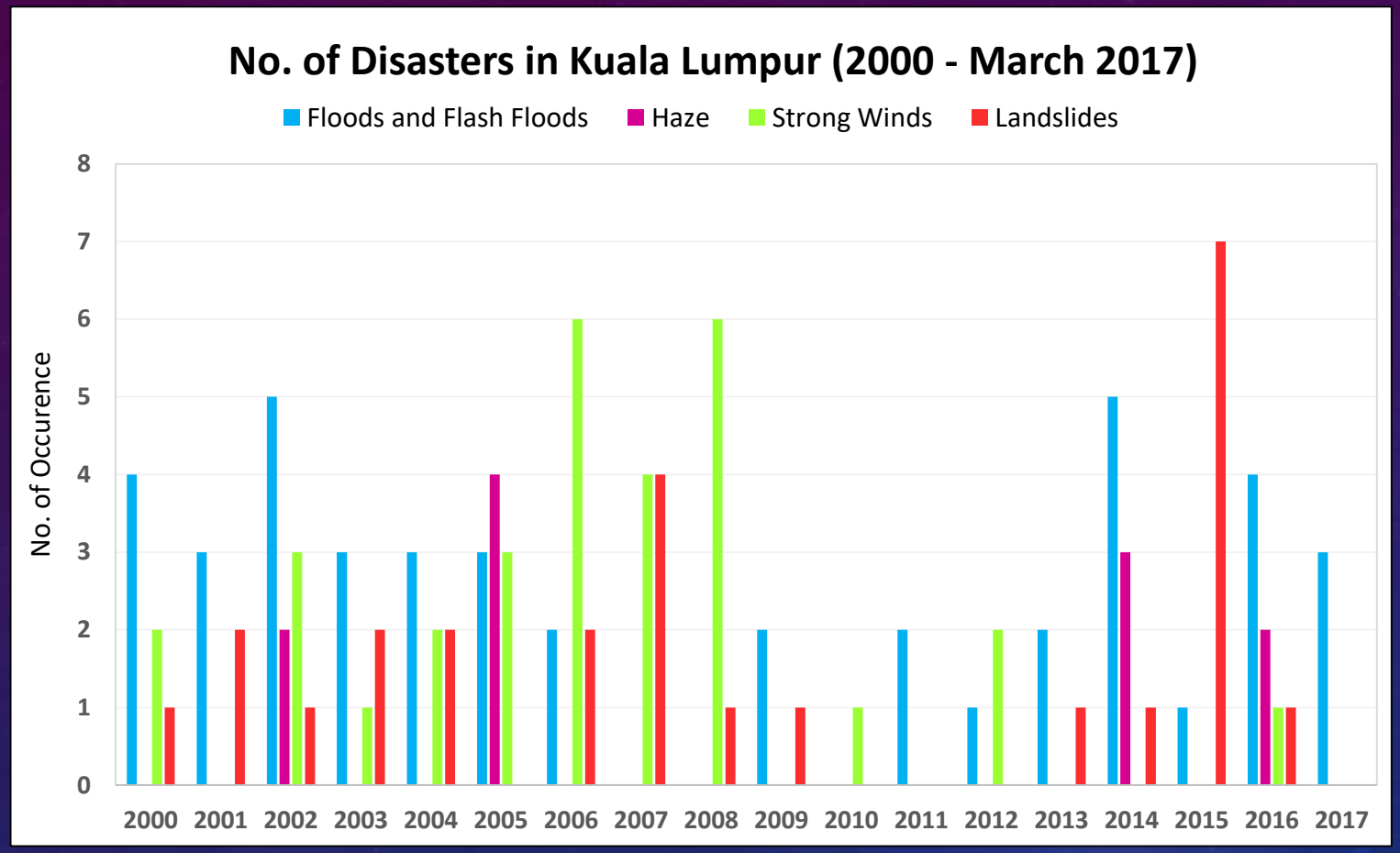
5 Business Partners: UKM Pakarunding Sdn. Bhd., UKMP; Geomapping Technology Sdn. Bhd.; Param Agricultural Soil Surveys (M) Sdn. Bhd; Geological Society of Malaysia; CoRE Expert Systems Sdn. Bhd.;

6 organisations from the UK:

3 Research Organisations: University of Cambridge, UoC; British Geological Survey, BGS; University College London, UCL;

3 Business Partners: Cambridge Environmental Research Consultants, CERC; Cuesta Consulting and JBA

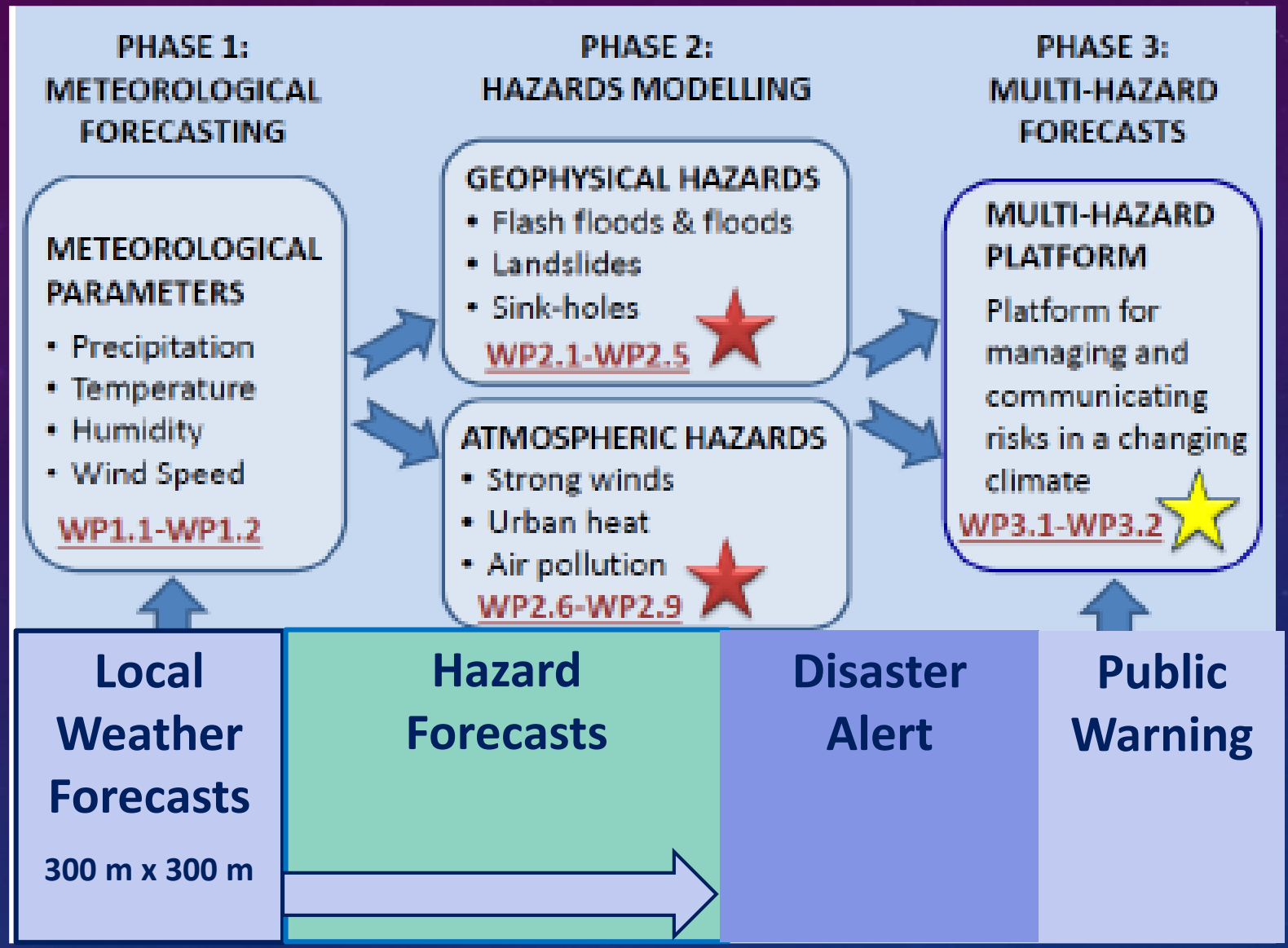
MOTIVATION



IPCC 2014 (AR5): The First step in Adaptation to future climate change – Reduce Vulnerability and Exposure to present Climate Variability

Kuala Lumpur and adjacent areas have experienced flash floods, landslides, sinkholes, strong winds and air pollution in the form of haze (Source: SEADPRI-UKM). With climate change, such hazards are expected to increase and urban heat will be an emerging issue. The improvement of forecast would contribute greatly to the enhancement of hazard models in Malaysia, where none are currently available at the local level (detailed scale). In conjunction with improvements in seasonal forecasts, emergency preparedness will be enhanced in the city. Hazard models that are brought together onto a common platform for city managers, insurers and other stakeholders are a powerful tool for managing and communicating risks in a changing climate.

Approach and Innovation Features



Work Package 1.1

Mesoscale Weather Forecasting Model

Work Package 1.2

Seasonal Forecasting

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HARNESSING RESOURCES

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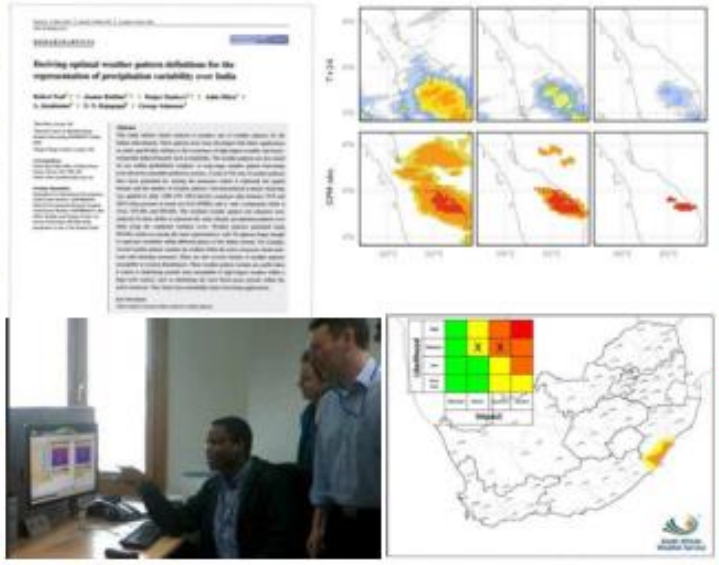
How **we** can tackle the weather & climate

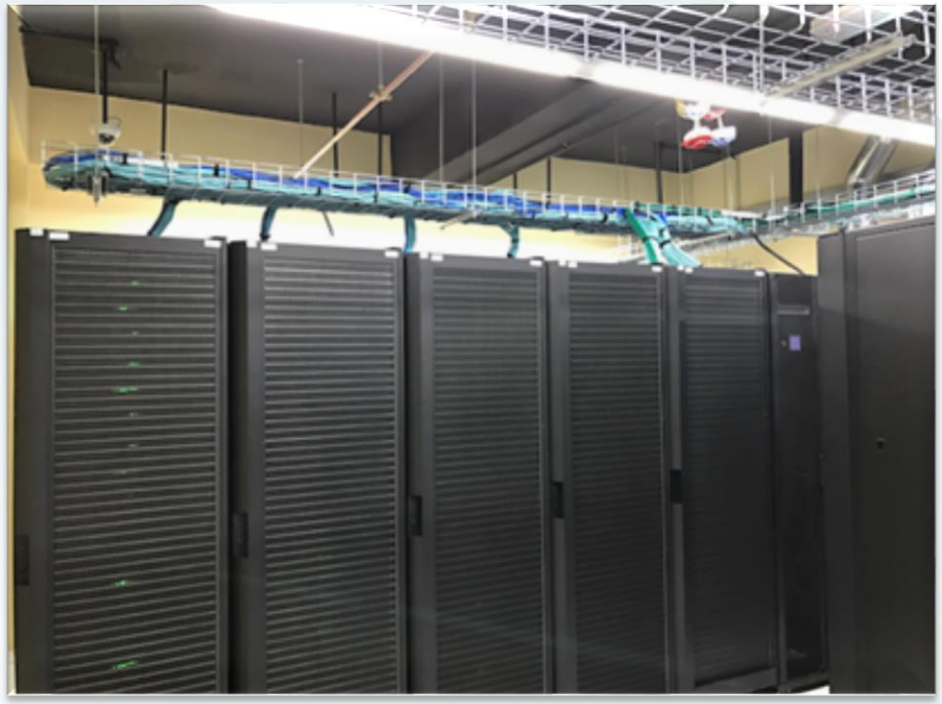
Infrastructure

Regional Expertise

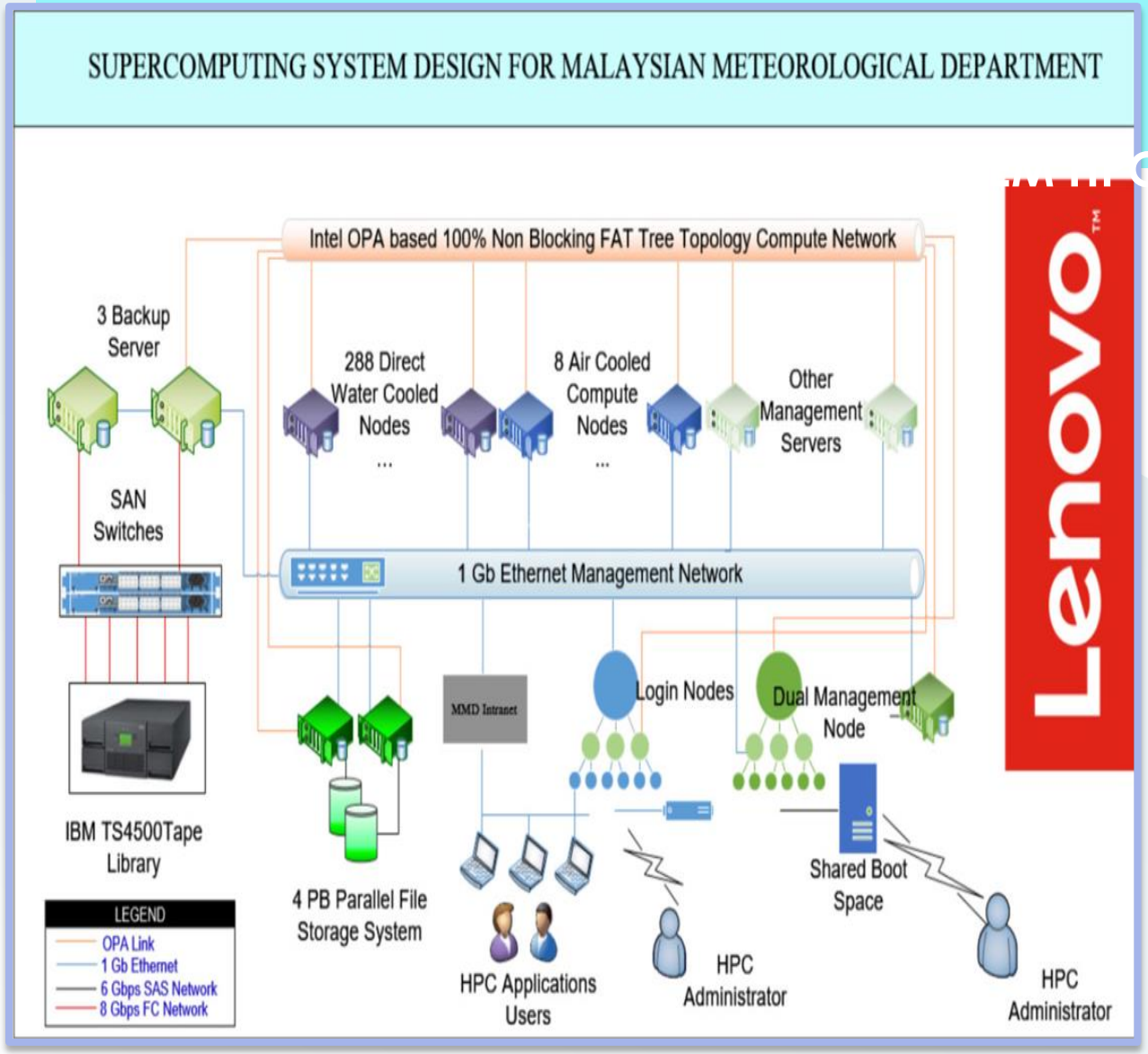


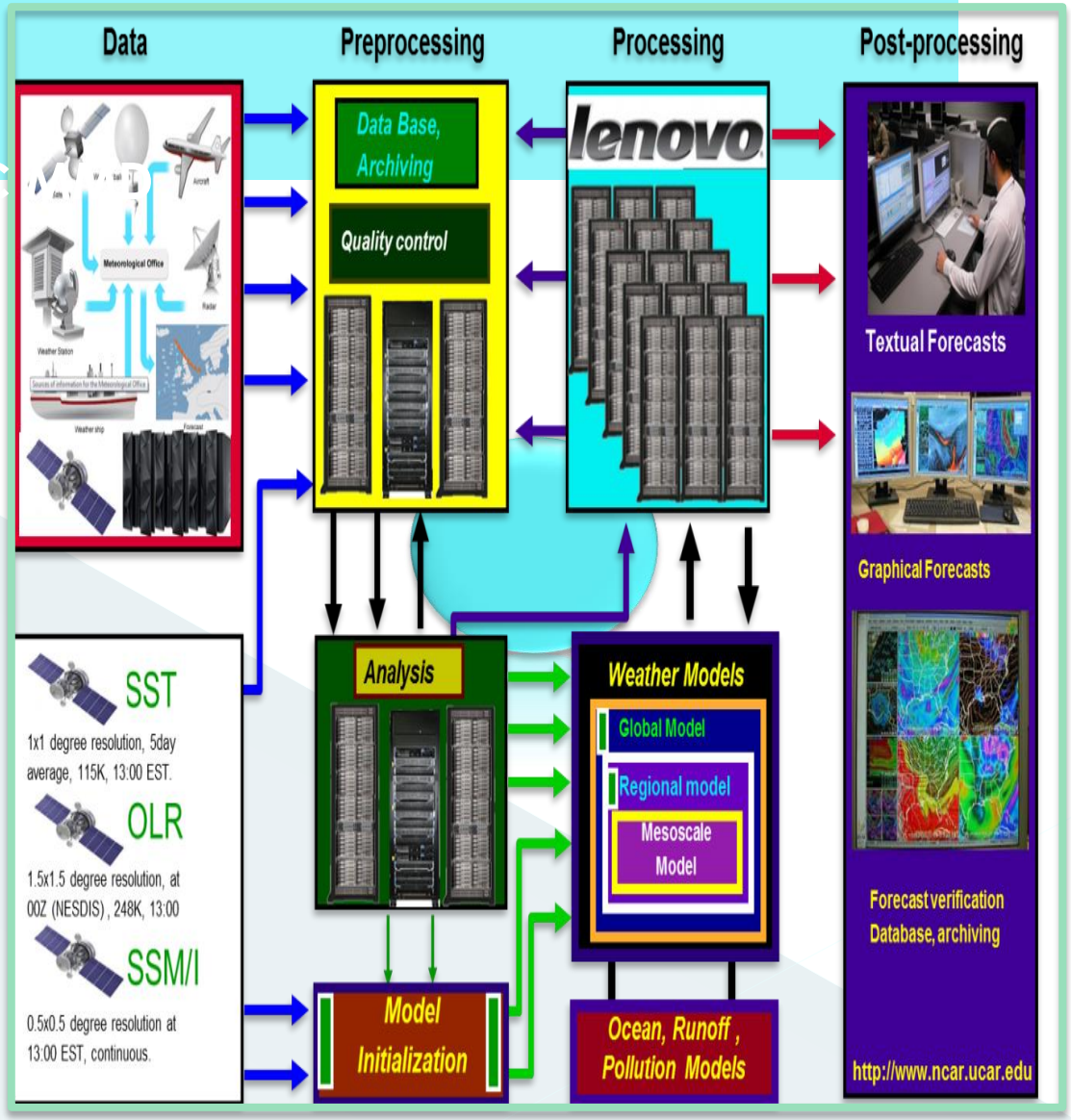
Working in Partnership

METMALAYSIA'S HIGH PERFORMANCE COMPUTING SYSTEM



HIGH PERFORMANCE COMPUTING SYSTEM





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OPERATIONAL MODEL CONFIGURATION

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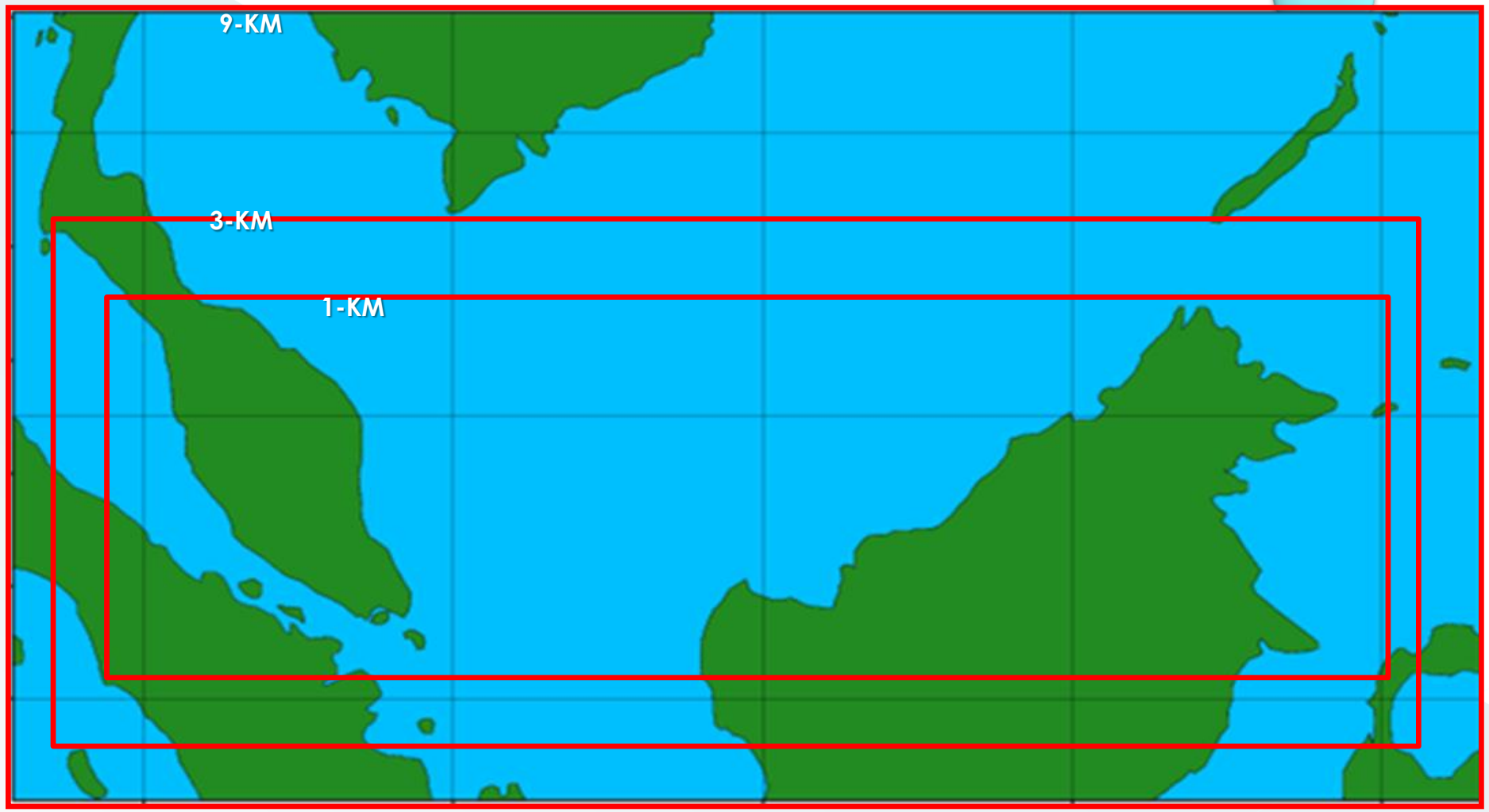

Physical processes	Domain 1 (9 km)	Domain 2 (3km)	Domain 3 (1 km)	Remarks
Dimensions	368 X 368 (with 51 vertical levels)	526 X 523 (with 51 vertical levels)	706 X703 (with 51 vertical levels)	Arakawa-C Grid Non-hydrostatic WRF v3.9.1.1 model Mercator projection Hourly forecast for a forecast range of 60 hours
Time interval (Δt)	36 - 108 sec (Adaptive Time step)	12 -36 sec (Adaptive Time step)	4 - 12 sec (Adaptive Time step)	
Cumulus Parameterization	New Tiedtke	New Tiedtke	Explicit	
Microphysics	THOMPSON(6 Moment)	THOMPSON	THOMPSON	
PBL	YSU scheme	YSU scheme	YSU scheme	
Radiation	RRTM / Dudhia scheme	RRTM / Dudhia scheme	RRTM / Dudhia scheme	
Land Use	MODIS 5 minute	MODIS 2 Minute	MODIS 30 Sec	
Surface-Physics	5-layer Thermal Diffusion Scheme	5-layer Thermal Diffusion Scheme	5-layer Thermal Diffusion Scheme	
Initial and Boundary data	GFS (30-km)	WRF 9 km	WRF 3 km	

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PRECIPITATION: GPM Satellite compared to forecasts Northeast Monsoon 2014/2015

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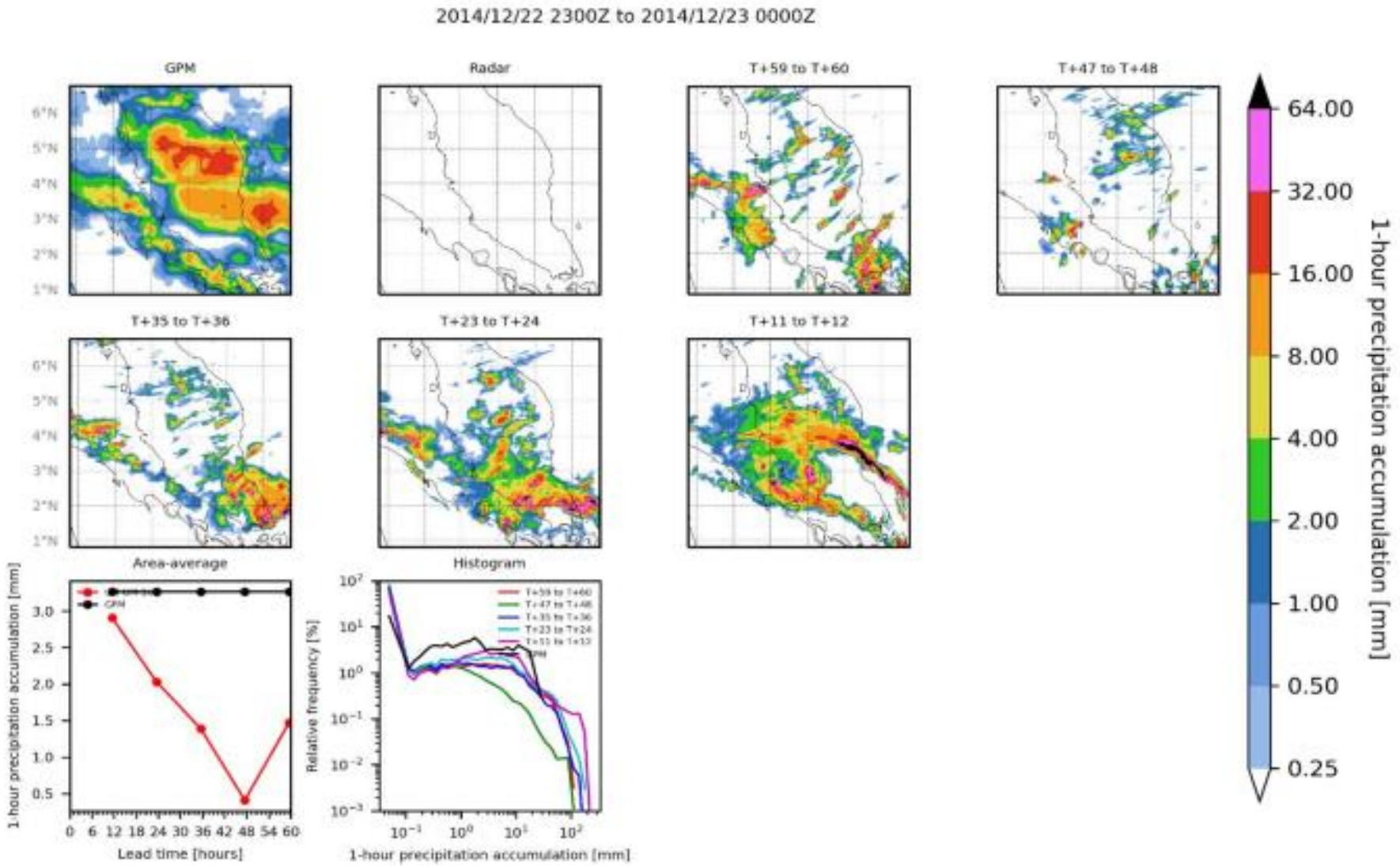
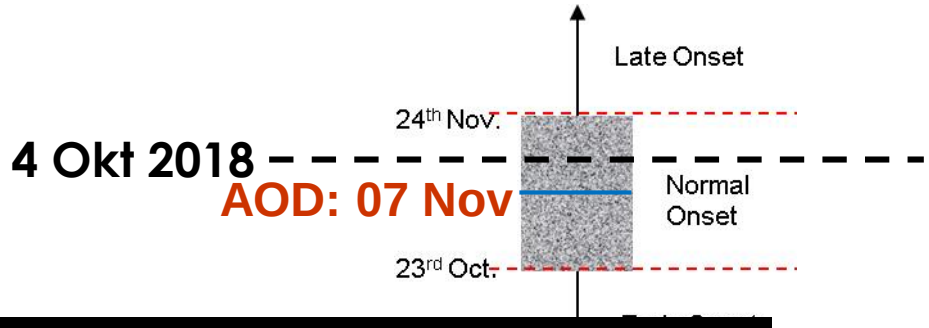
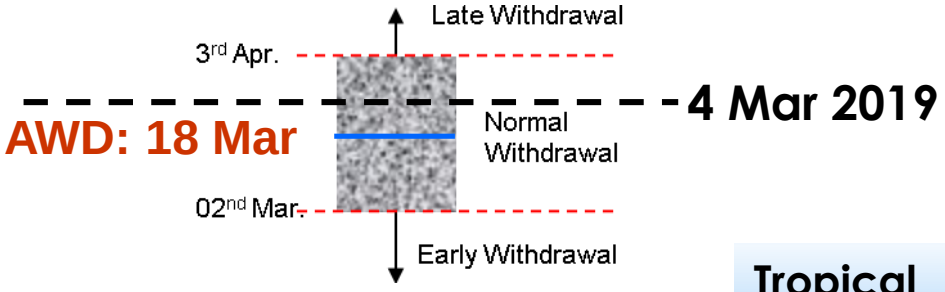
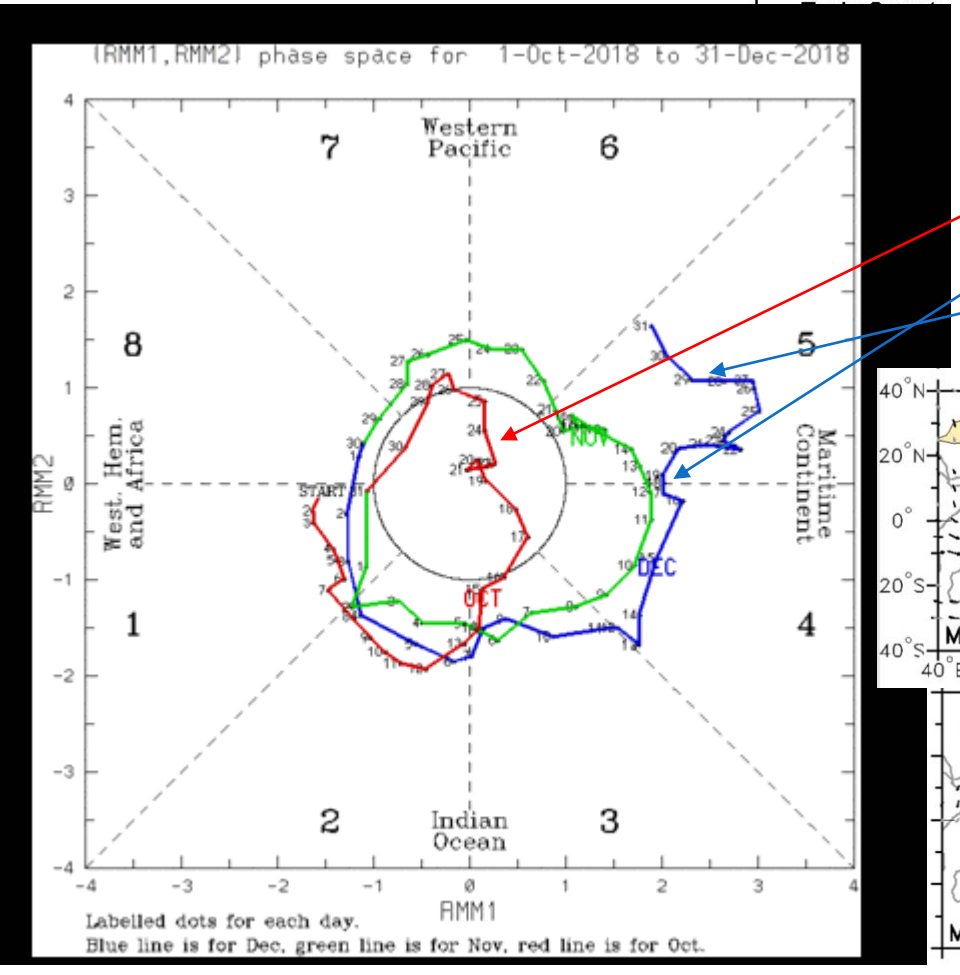


Summary of the NEM 2018/2019



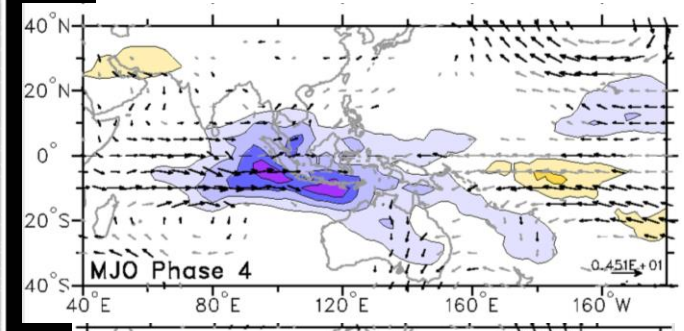


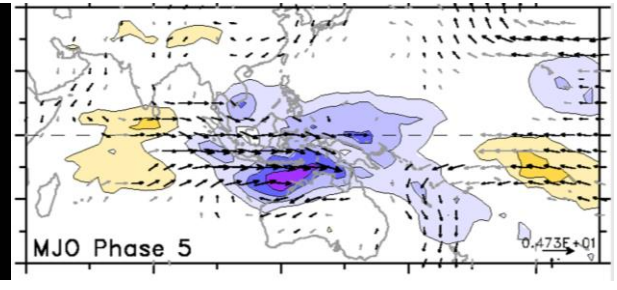
Tropical Storm Pabuk : December 31, 2018 – January 4, 2019



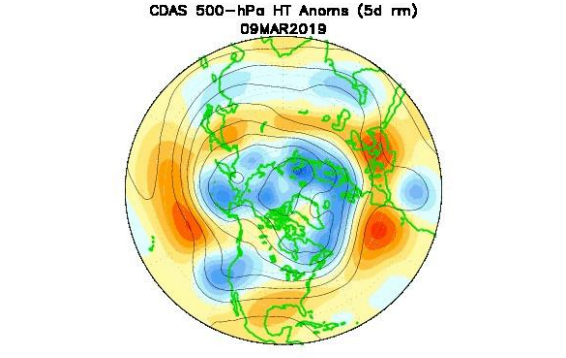
Total of 4 surges

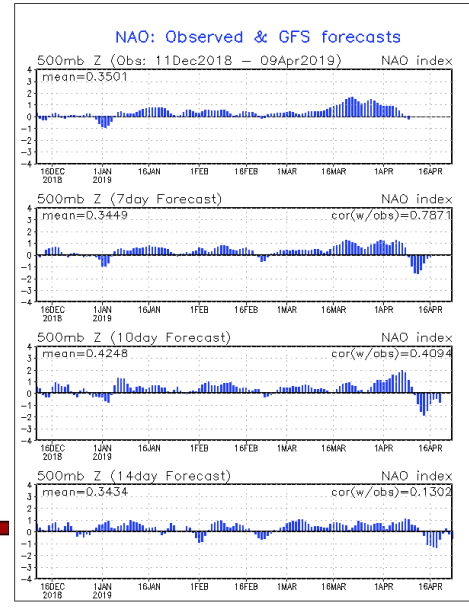
1. 27 -31 Oct 2018 (Meridional surge)
2. 07-17 Dec 2018 (easterly Surge)
3. 27 Dec - 5 Jan 2019 (mix surge - Meridional+ easterly)
4. 21 Jan-23 Jan (Meridional surge)



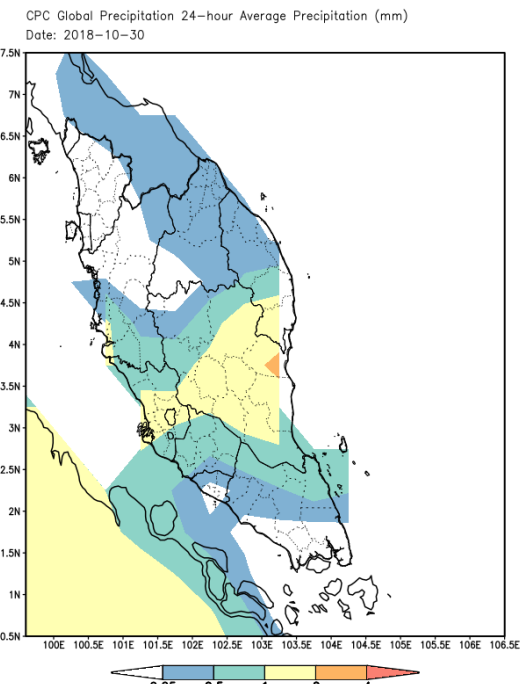


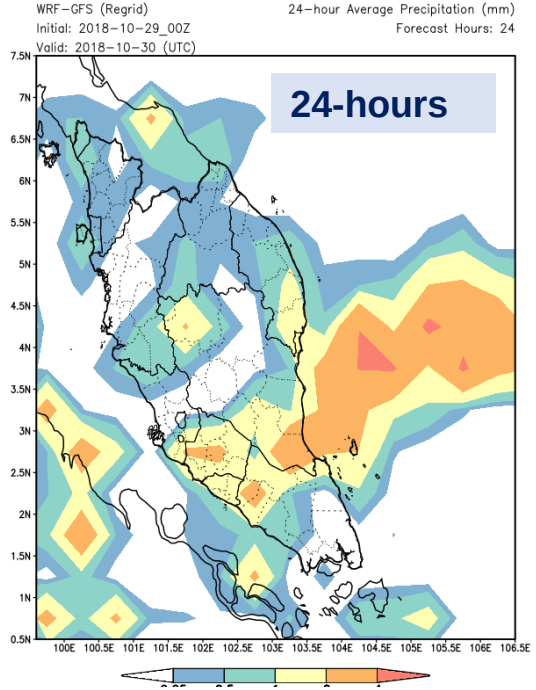
Not much of Blocking

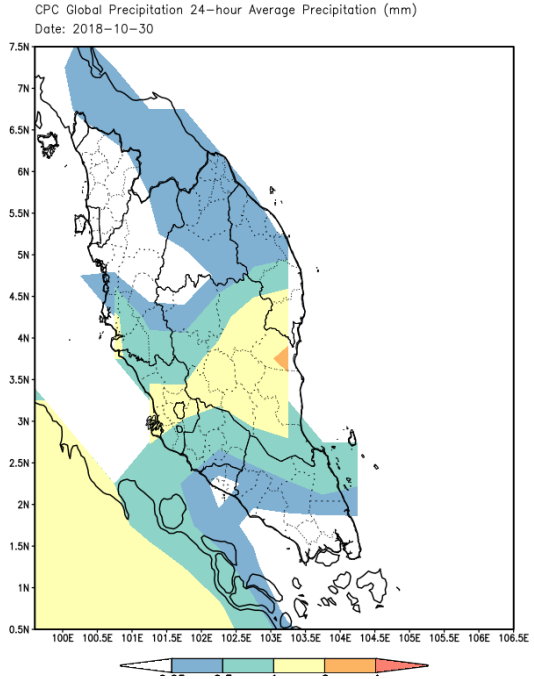


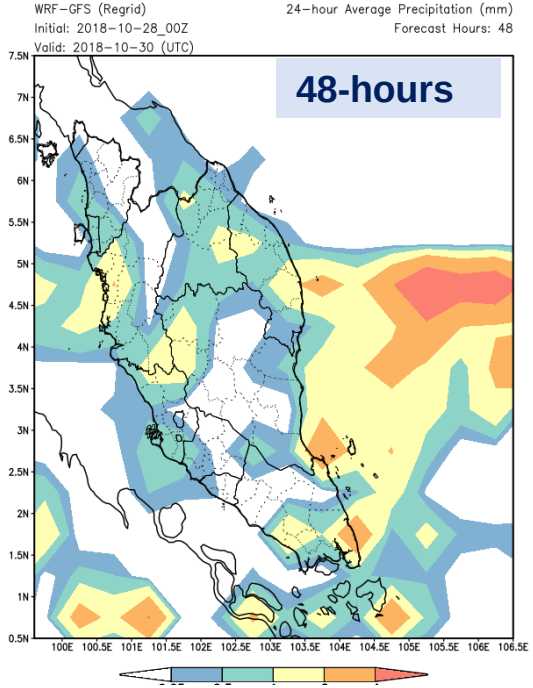


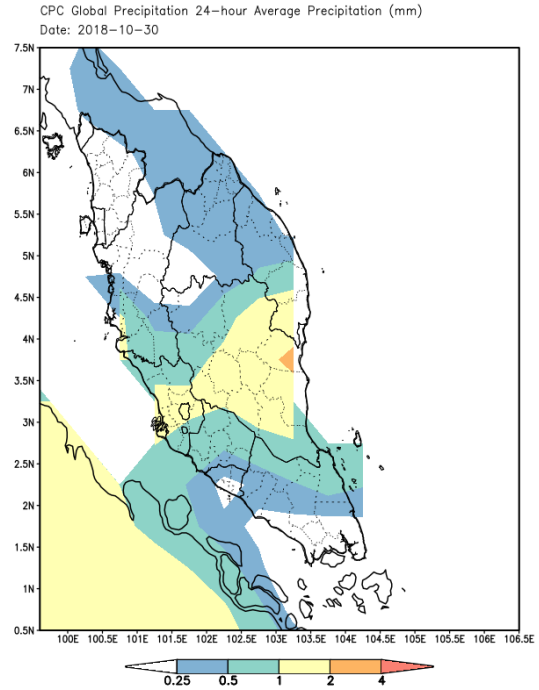
FIRST SURGE : 27 -31 OCT 2018 (MERIDIONAL SURGE)

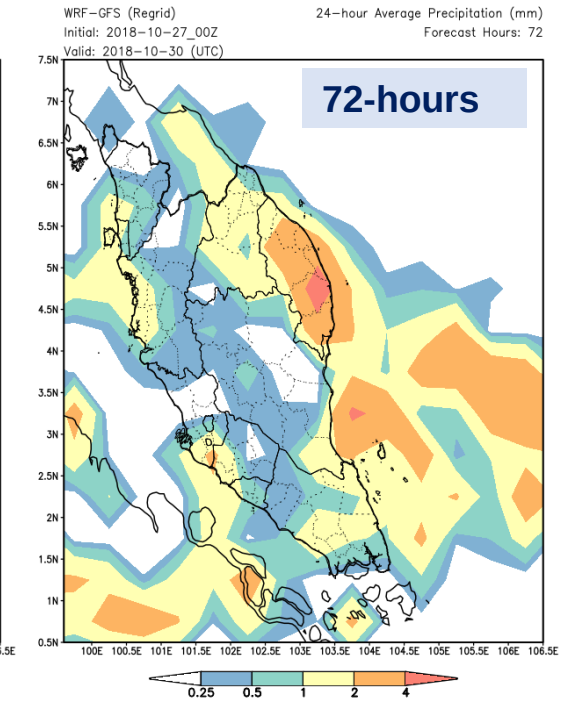


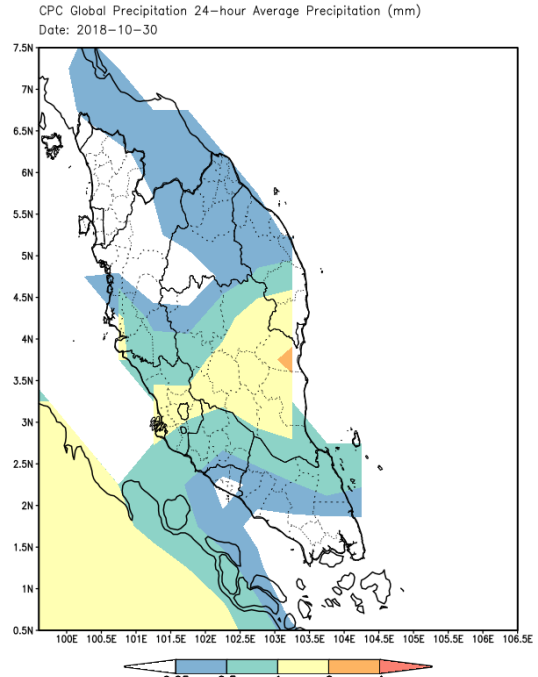


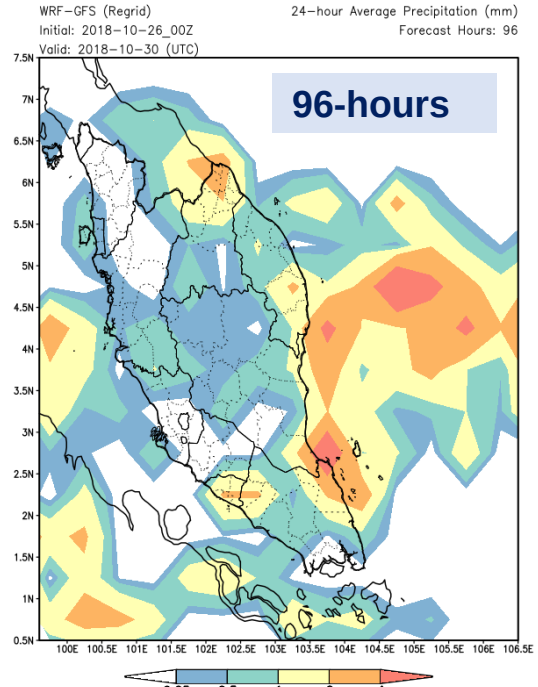


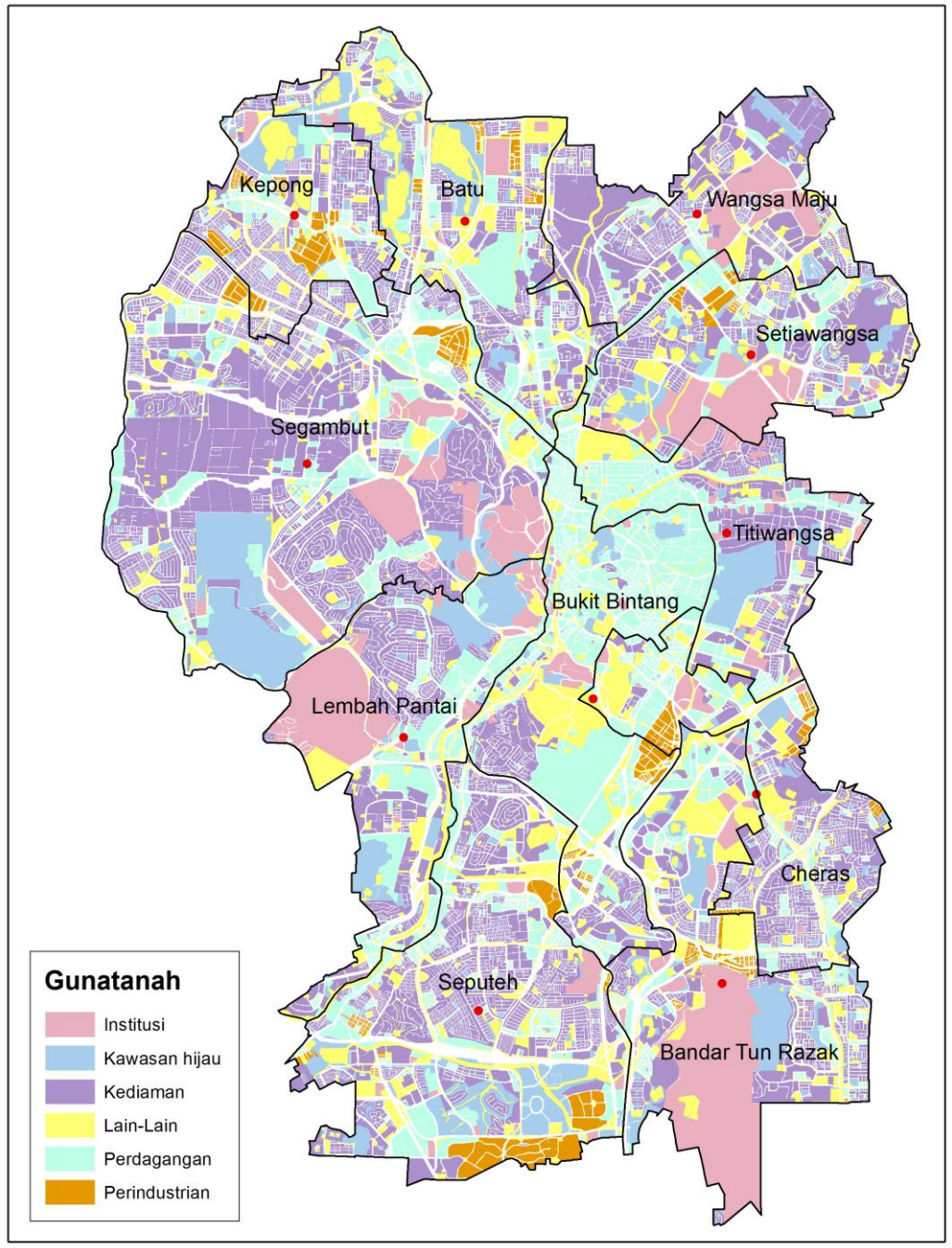


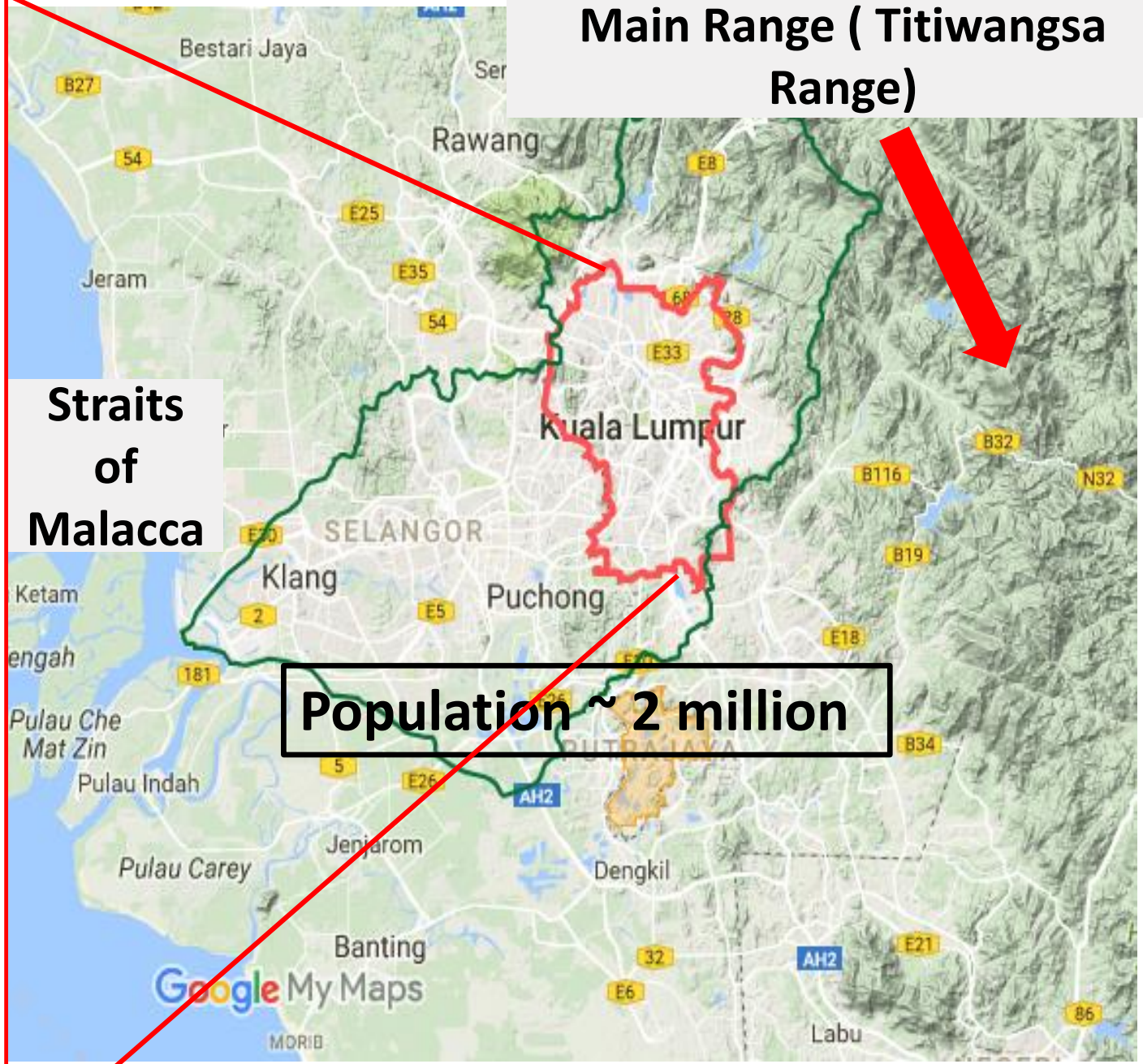









Kepong
Batu
Wangsa Maju
Setiawangsa
Segambut
Titiwangsa
Bukit Bintang
Lembah Pantai
Cheras
Seputeh
Bandar Tun Razak
Gunatanah
Institusi
Kawasan hijau
Kediaman
Lain-Lain
Perdagangan
Perindustrian


Main Range (Titiwangsa Range)
Straits of Malacca
Population ~ 2 million
Bestari Jaya
Rawang
Jeram
Kuala Lumpur
SELANGOR
Klang
Puchong
Ketam
Pulau Che Mat Zin
Pulau Indah
Pulau Carey
Jenjarom
Dengkil
Banting
Labu
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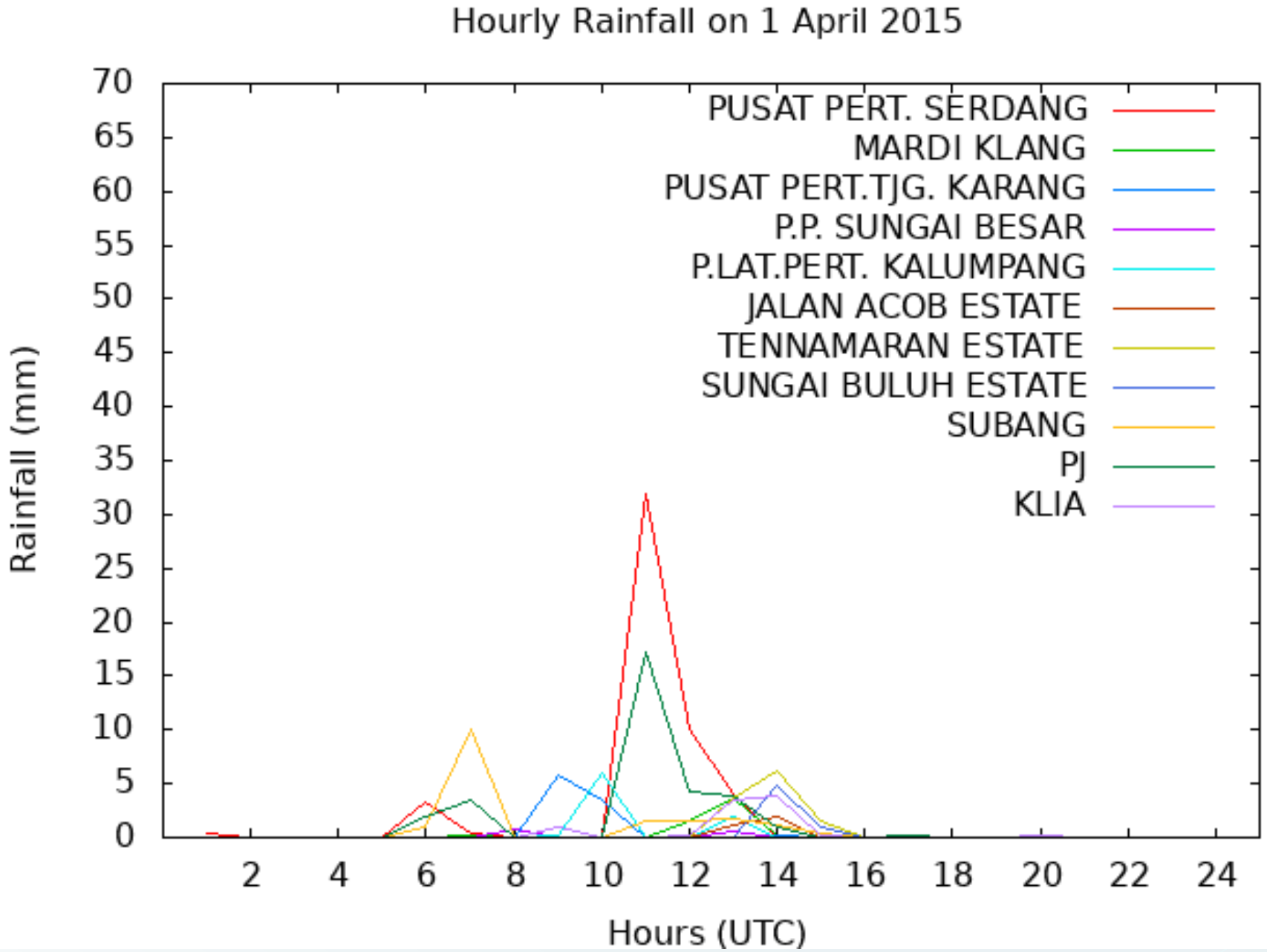
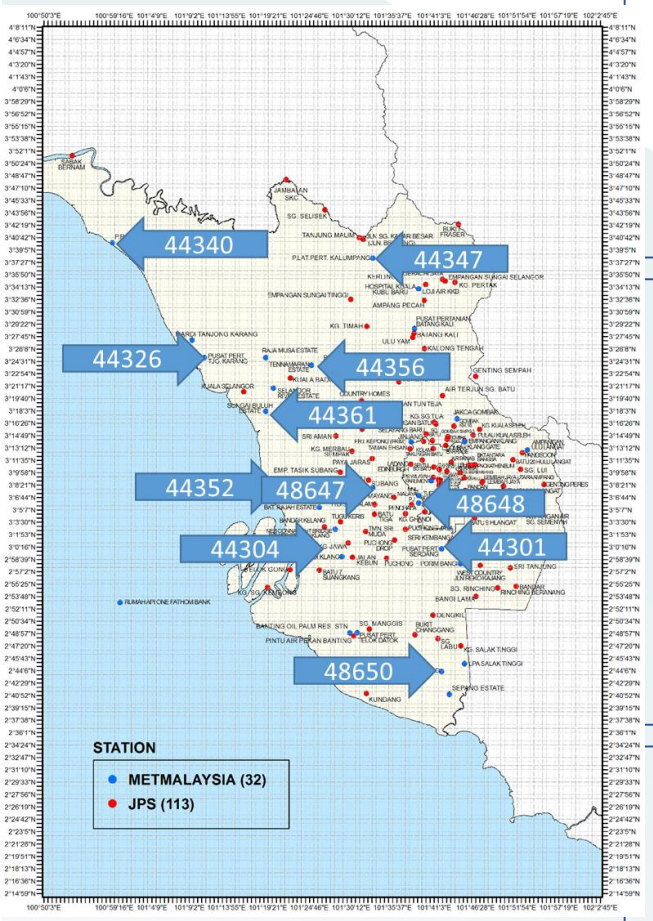
MET Malaysia

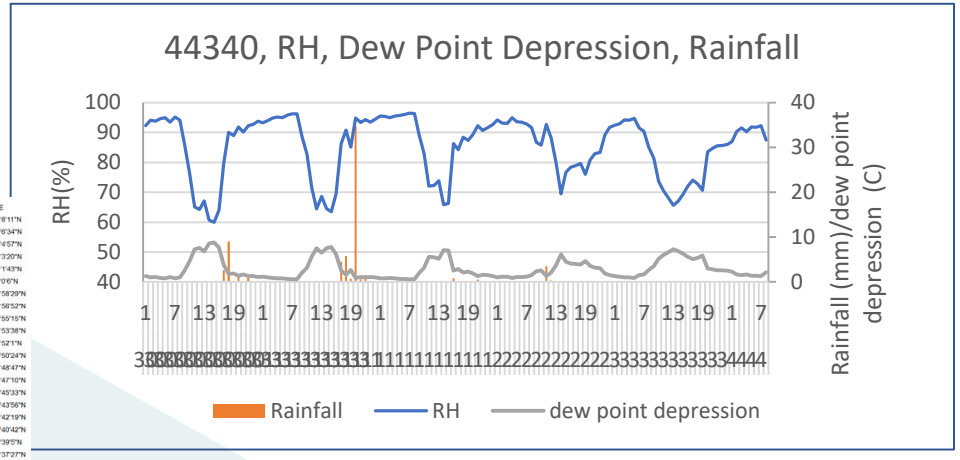
Cases were selected from 2010 – 2016).Definition of extreme events in Kuala Lumpur based on 90th percentile (1-day, hourly, 3-hourly accumulated rainfall)

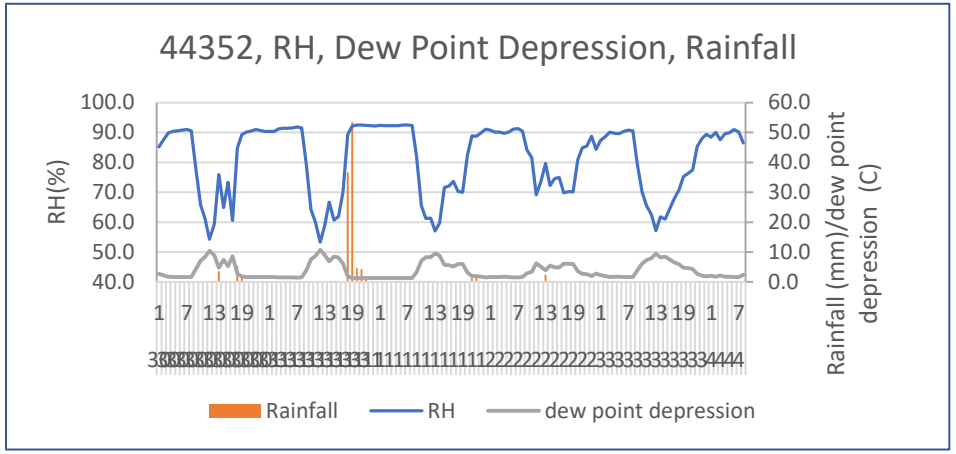
Date	Daily rainfall	Hourly rainfall	3-Hourly	Morning (0300-12.00)	Early Afternoon (12.01-14.00)	Afternoon (14.01-16.00)	Late Afternoon (16.01-18.00)	Evening (18.01-21:00)
01/04/2015	44301>95%	48647 >75% 48648>80%	44301>95%				1800	
05/04/2015	44352>90%	48648>95%					1600	
12/05/2015	44361,44326>95%	48648>90%				1500		
02/06/2015	44347,44304>95%	48647>85%	48647->90%				1700	
13/08/2015	44312>95%		44312>95%				1600	
21/09/2015	44333,44356>95%		44333,44356>95%			1400		
01/11/2015	44301,44304,44312>95%	48647>85%	44312>95%				1700	
16/11/2015	44312,44347>95%	48648>95%				1500		
17/11/2015	44304>90%	48648>85%	48948->90%			1500		

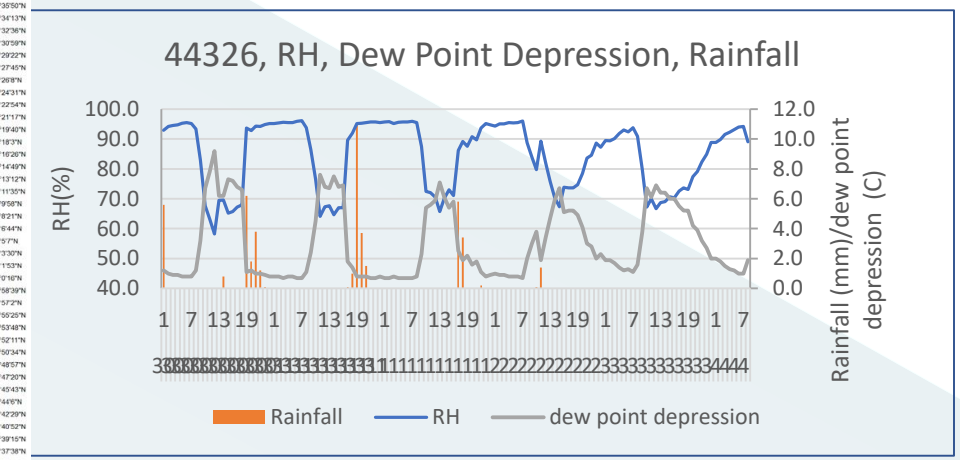


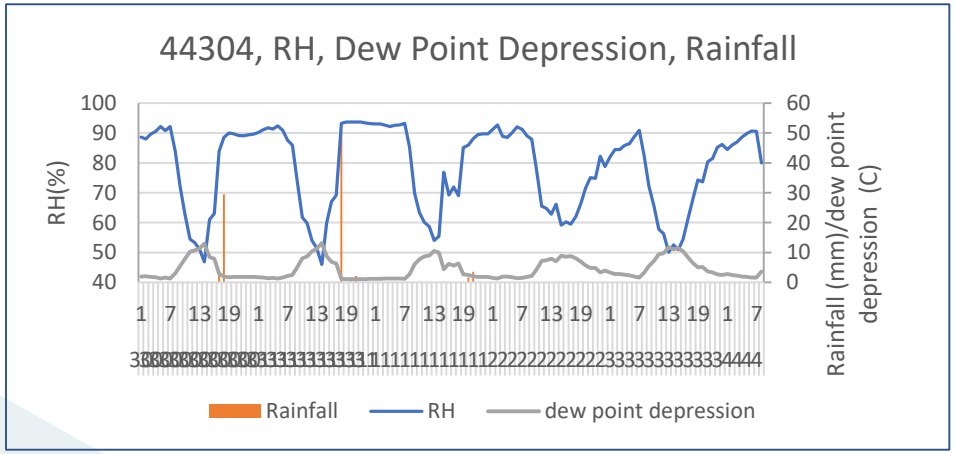
10 12 14 16 18 20 22 00 02 04 06
08 LT

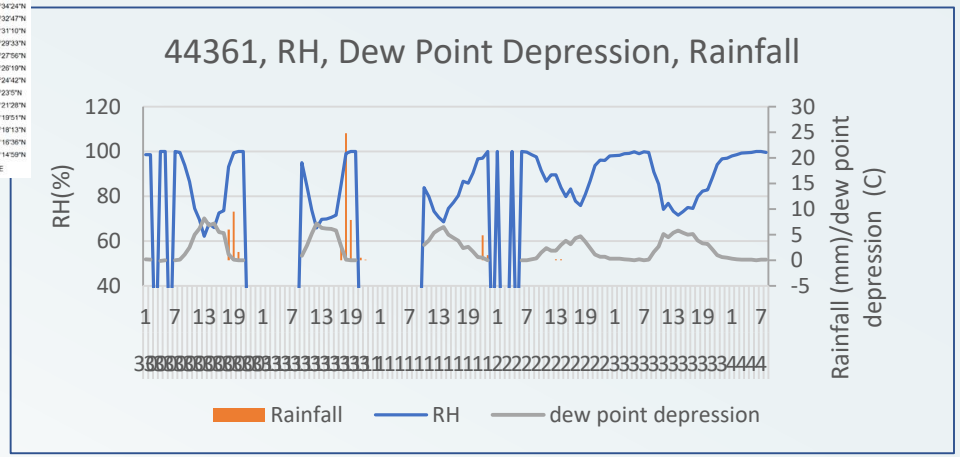

44340
44347
44326
44356
44361
44352
48647
48648
44304
44301
48650
STATION
METMALAYSIA (32)
JPS (113)


44340, RH, Dew Point Depression, Rainfall
RH(%)
Rainfall (mm)/dew point depression (C)
Rainfall
RH
dew point depression


44352, RH, Dew Point Depression, Rainfall
RH(%)
Rainfall (mm)/dew point depression (C)
Rainfall
RH
dew point depression

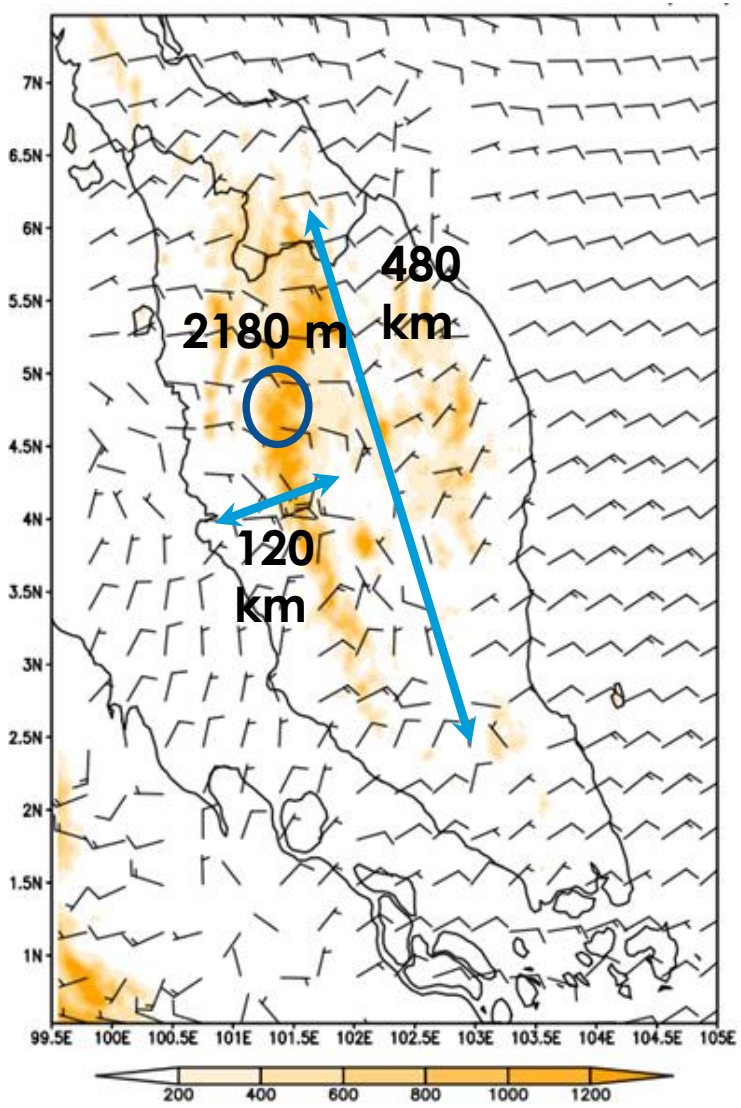

44326, RH, Dew Point Depression, Rainfall
RH(%)
Rainfall (mm)/dew point depression (C)
Rainfall
RH
dew point depression


44304, RH, Dew Point Depression, Rainfall
RH(%)
Rainfall (mm)/dew point depression (C)
Rainfall
RH
dew point depression

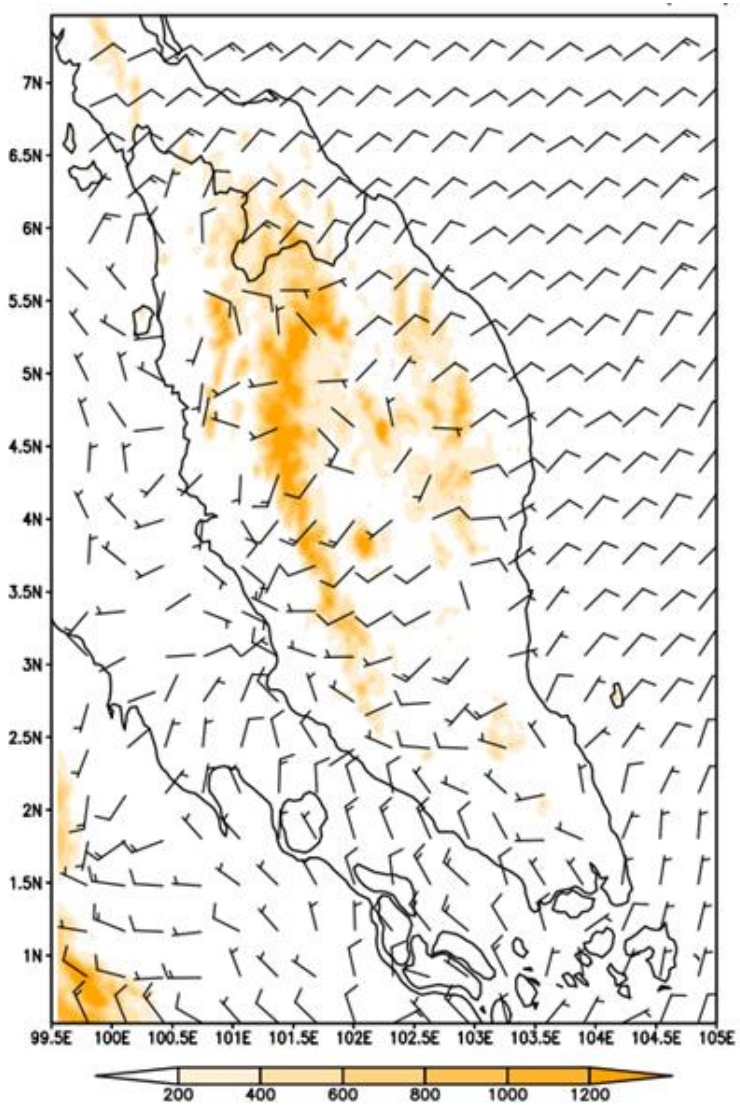

44361, RH, Dew Point Depression, Rainfall
RH(%)
Rainfall (mm)/dew point depression (C)
Rainfall
RH
dew point depression

OBSERVED WIND PATTERN DURING THE PERIOD 29 March – 1 April 2019

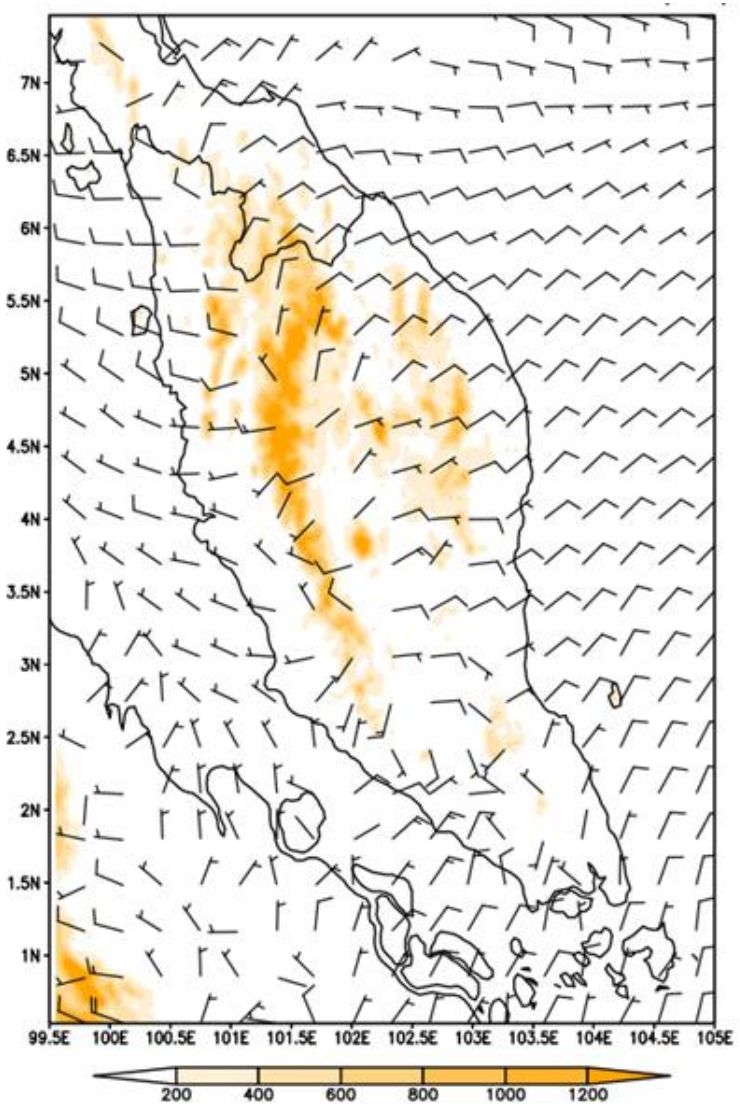
29 March 2015

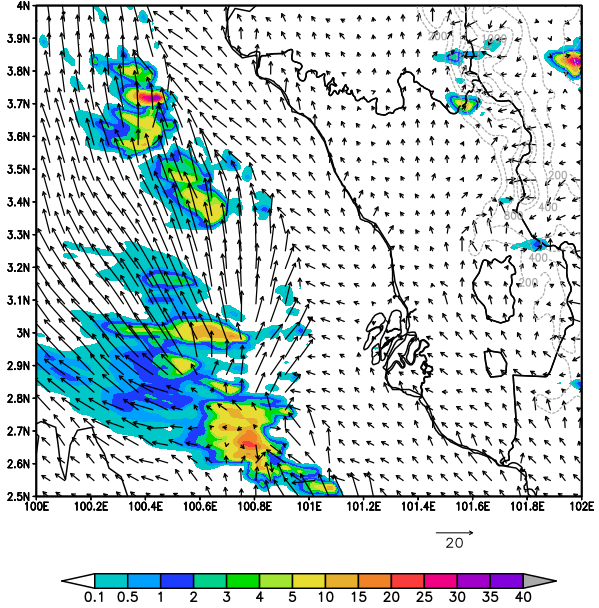


31 March 2015

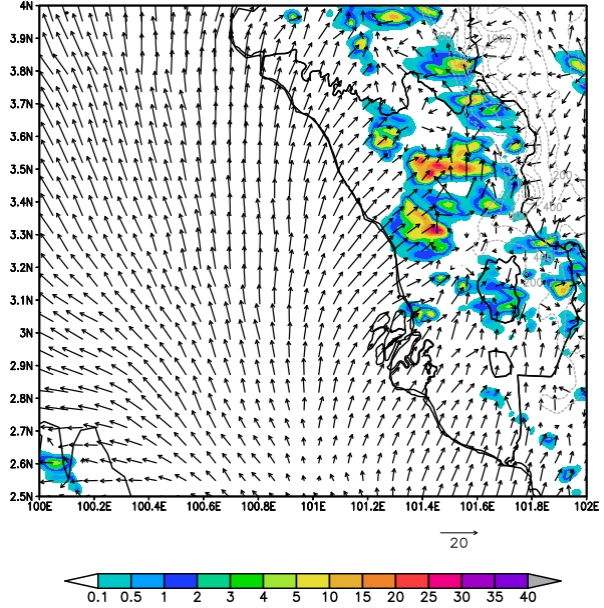


1 April 2015

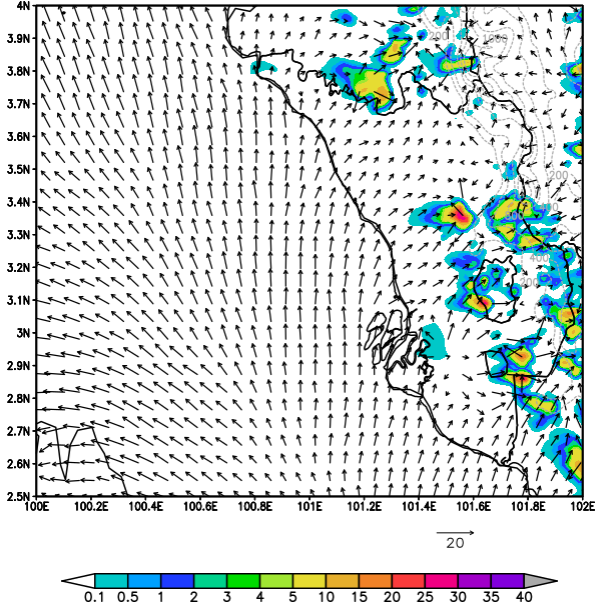




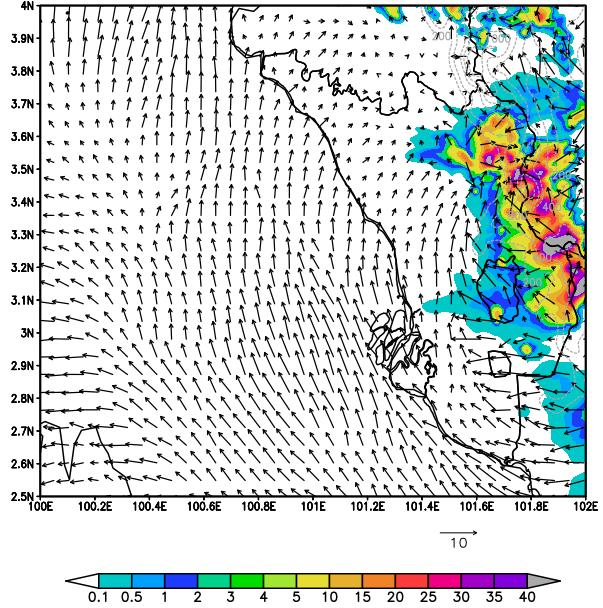
12LT



15LT

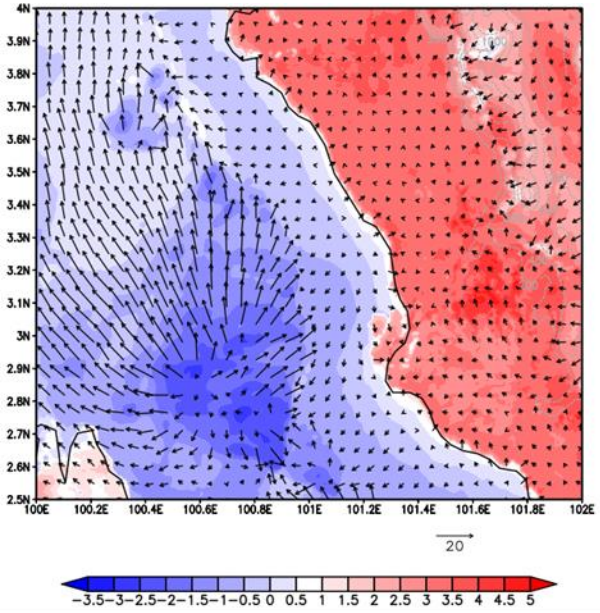


18LT

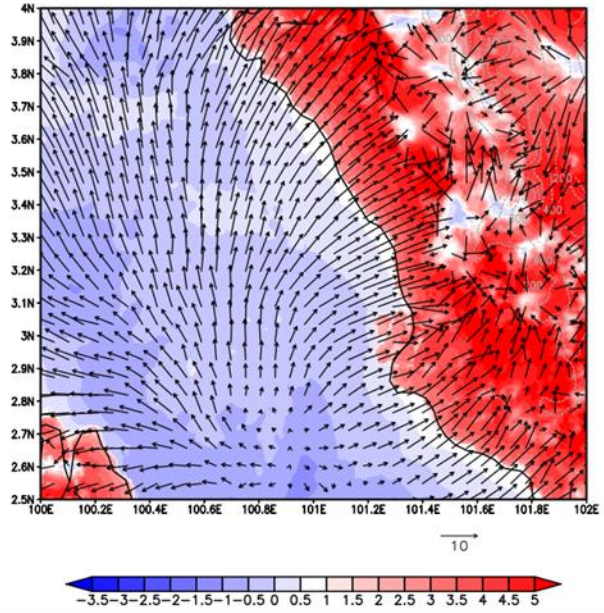


21LT

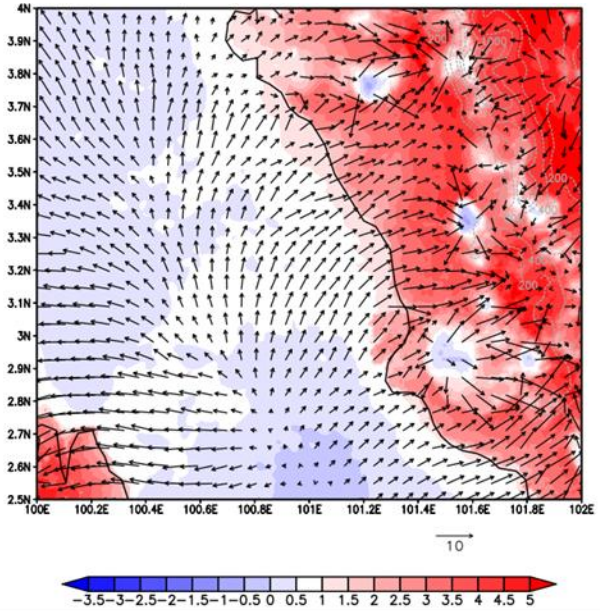
terrain



12LT



15LT



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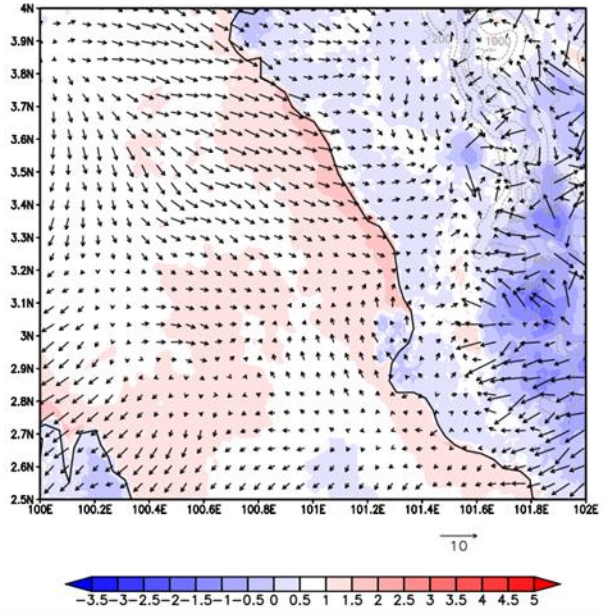

21LT

terrain

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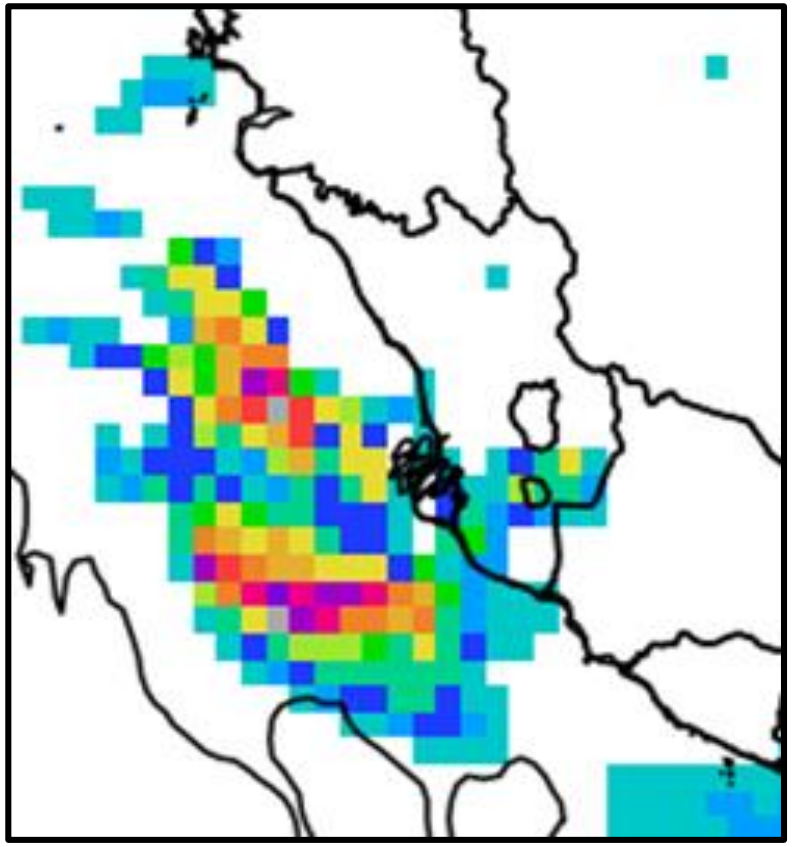
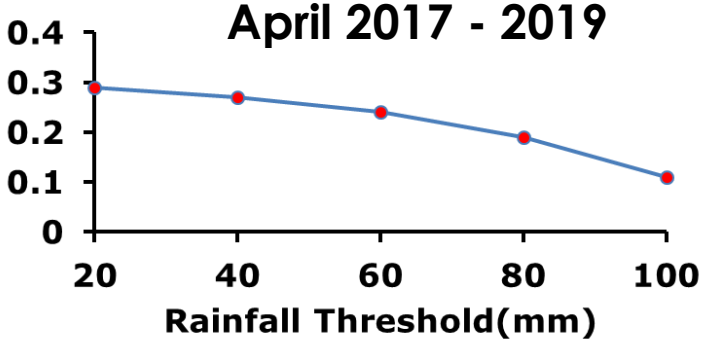
METMalaysia

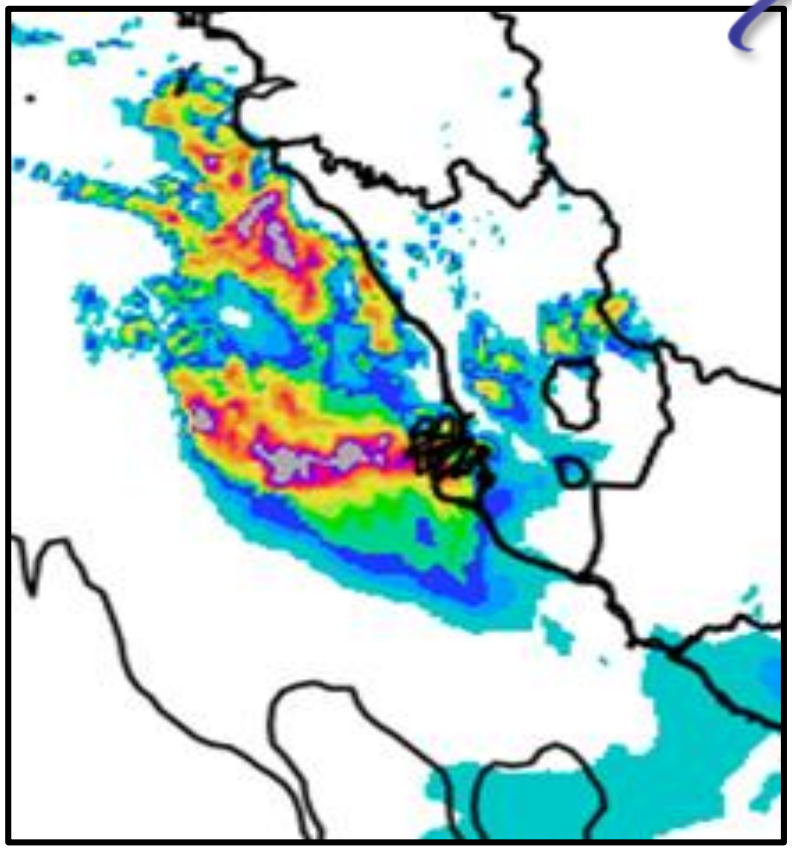
VERIFICATION RESULTS

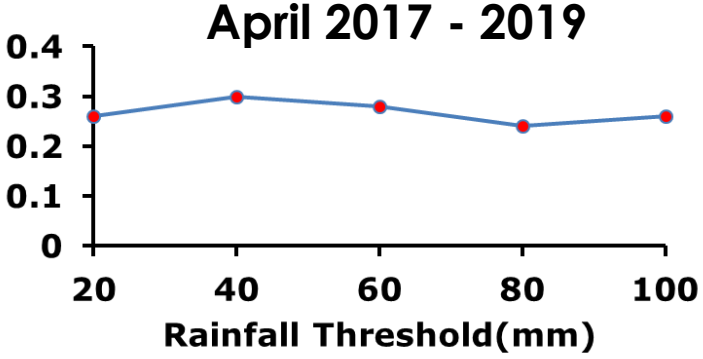
(A) 1-km





(B) 333m





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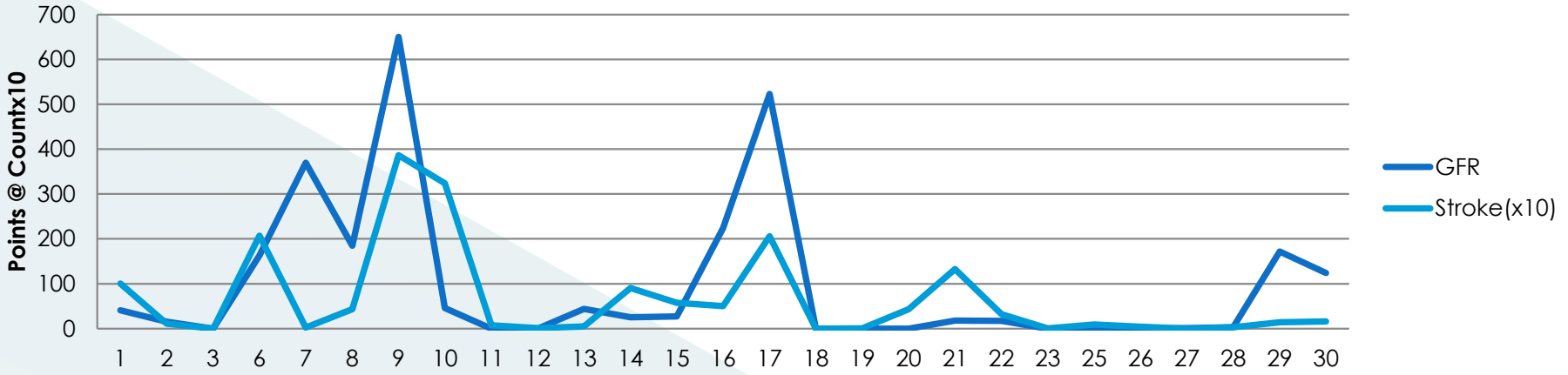
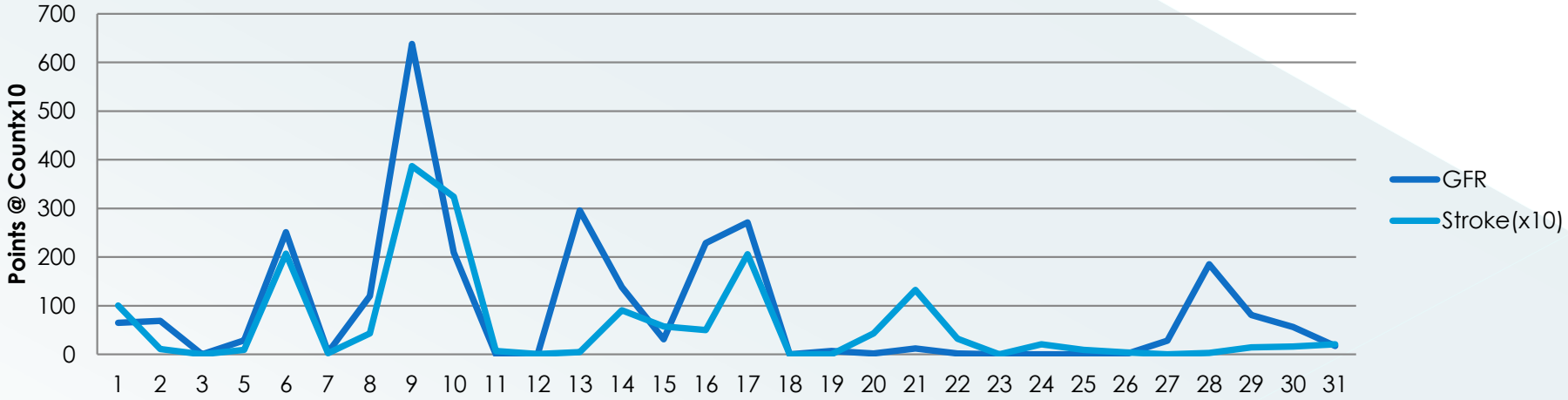
MET Malaysia

Comparison between Number of Points of Graupel Flux Rate (GFR) Forecast (3 days before, 00Z) from 2 to 6PM and Stroke Count on January 2019

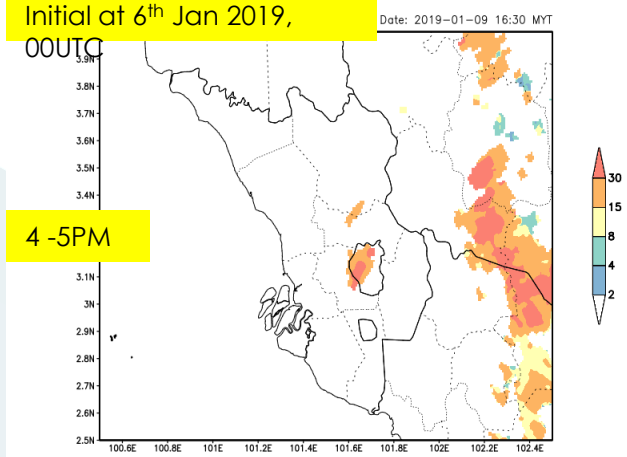


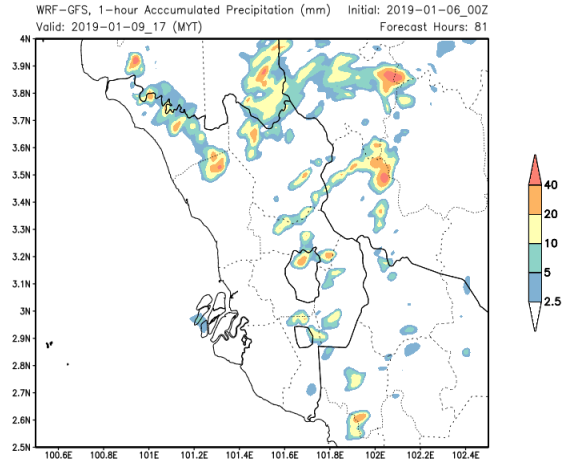
Comparison between Number of Points of Graupel Flux Rate (GFR) Forecast (3 days before, 12Z) from 2 to 6PM and Stroke Count on January 2019

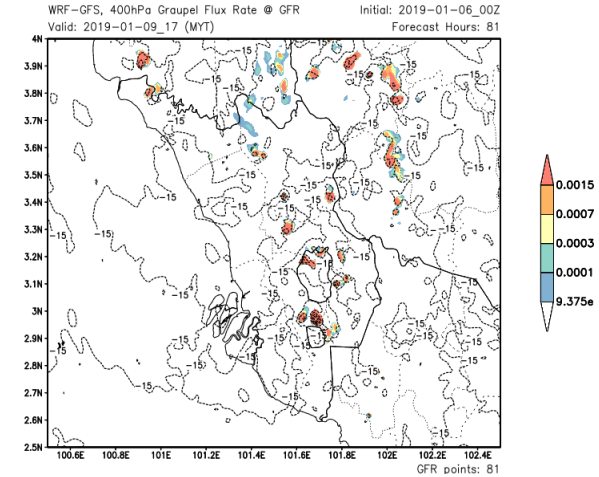


Initial at 6th Jan 2019, 00UTC

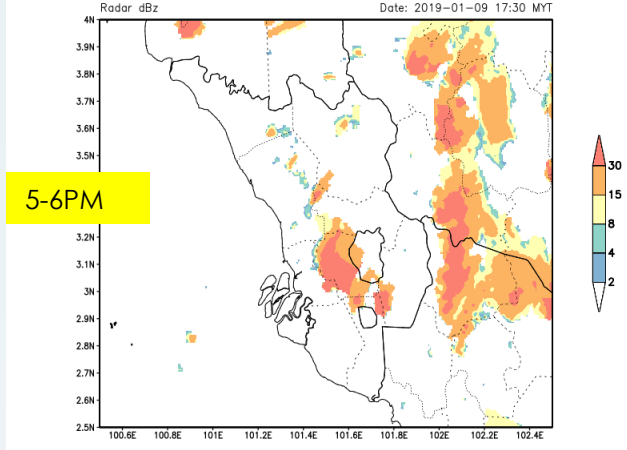
4 -5PM

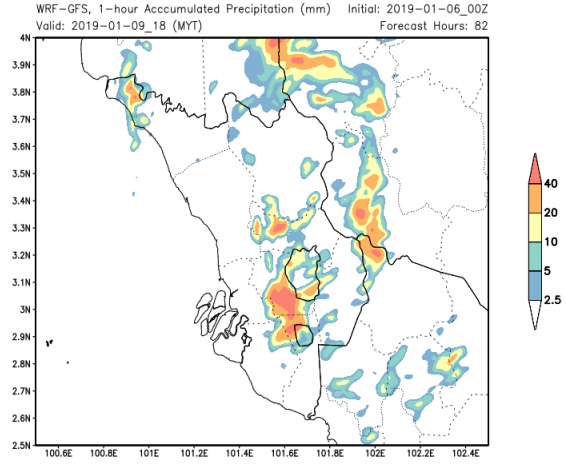


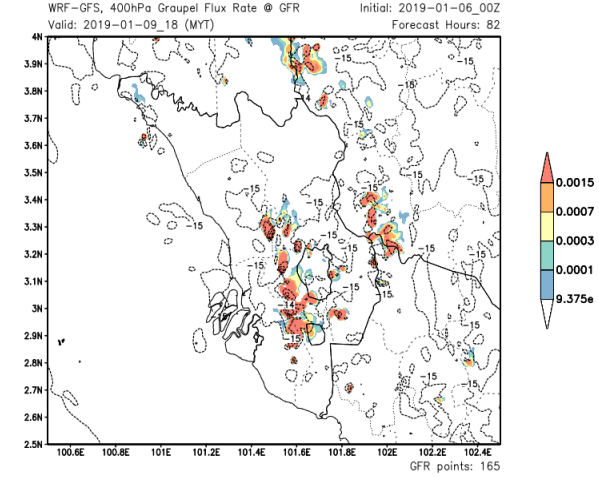




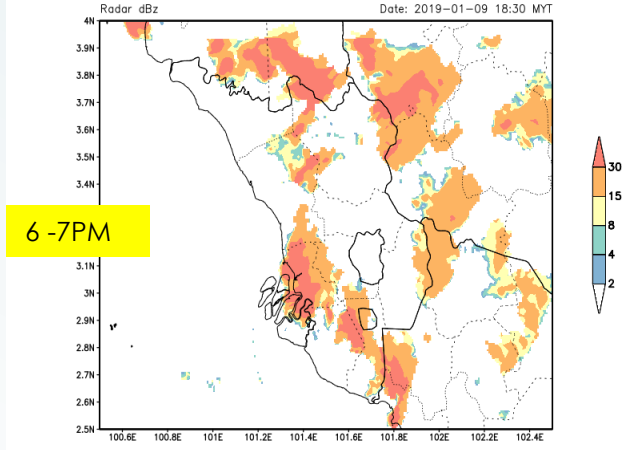
5-6PM

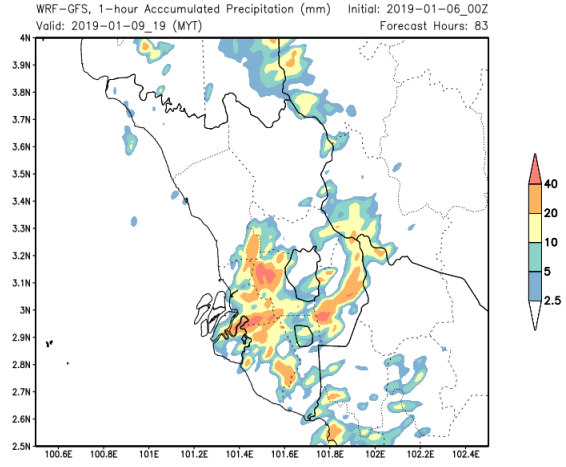


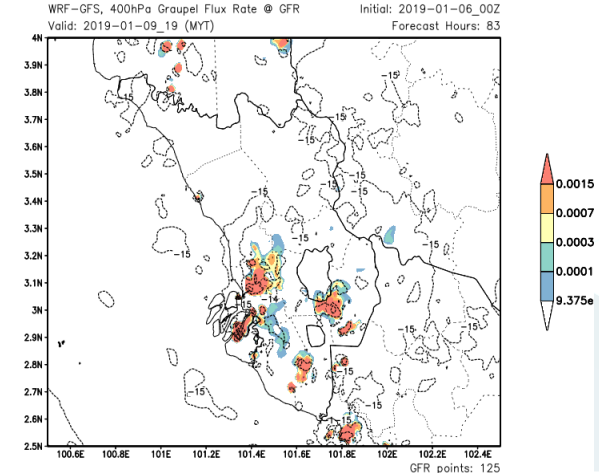




6 -7PM





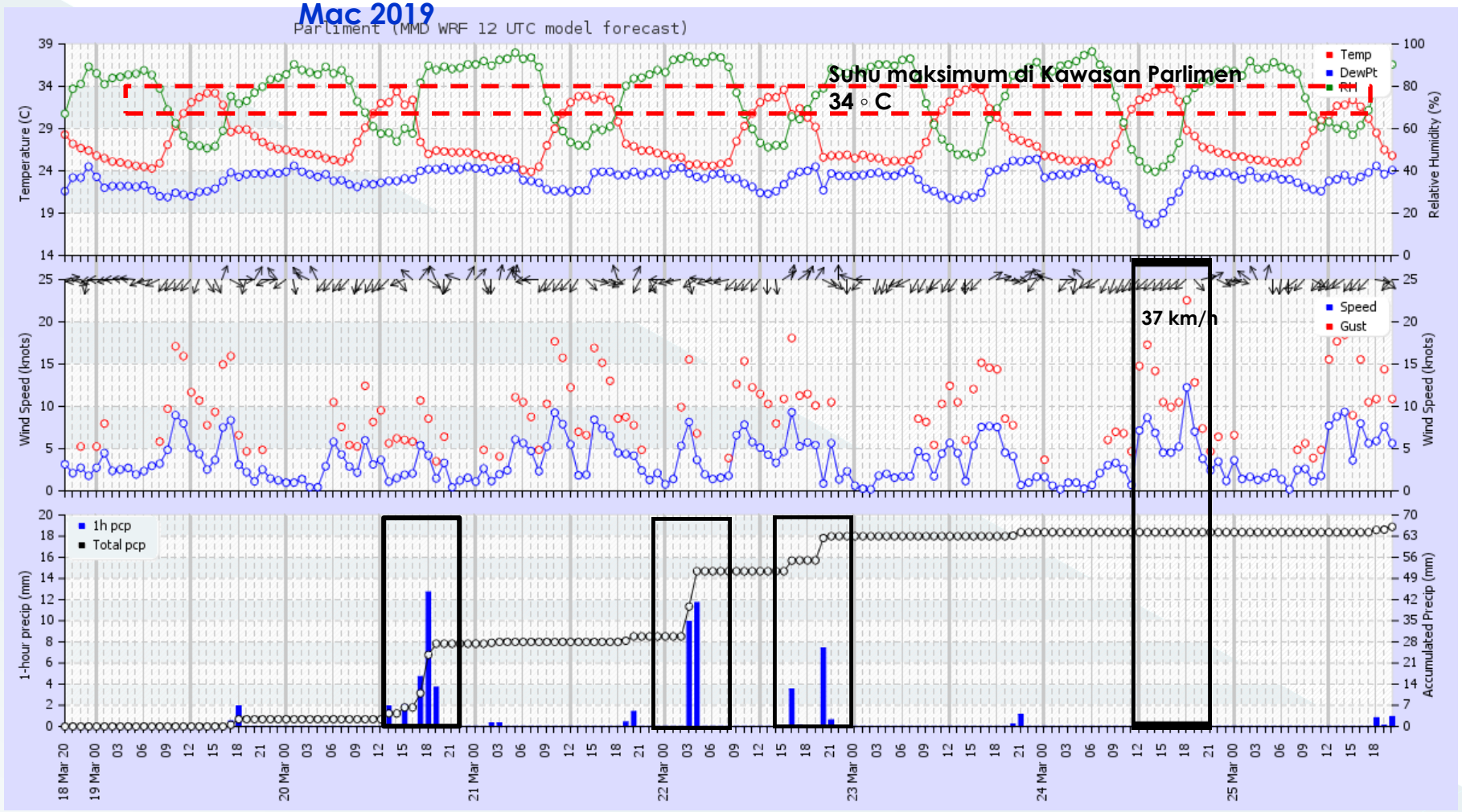


PILOT STUDY METEOROLOGICAL PRODUCTS

Local level forecast model that projects rainfall, wind & temperature in Kuala Lumpur (dynamic forecasts)

RESULTS

Ramalan untuk kawasan Parlimen pada bermula 18 sehingga 25 Mac 2019

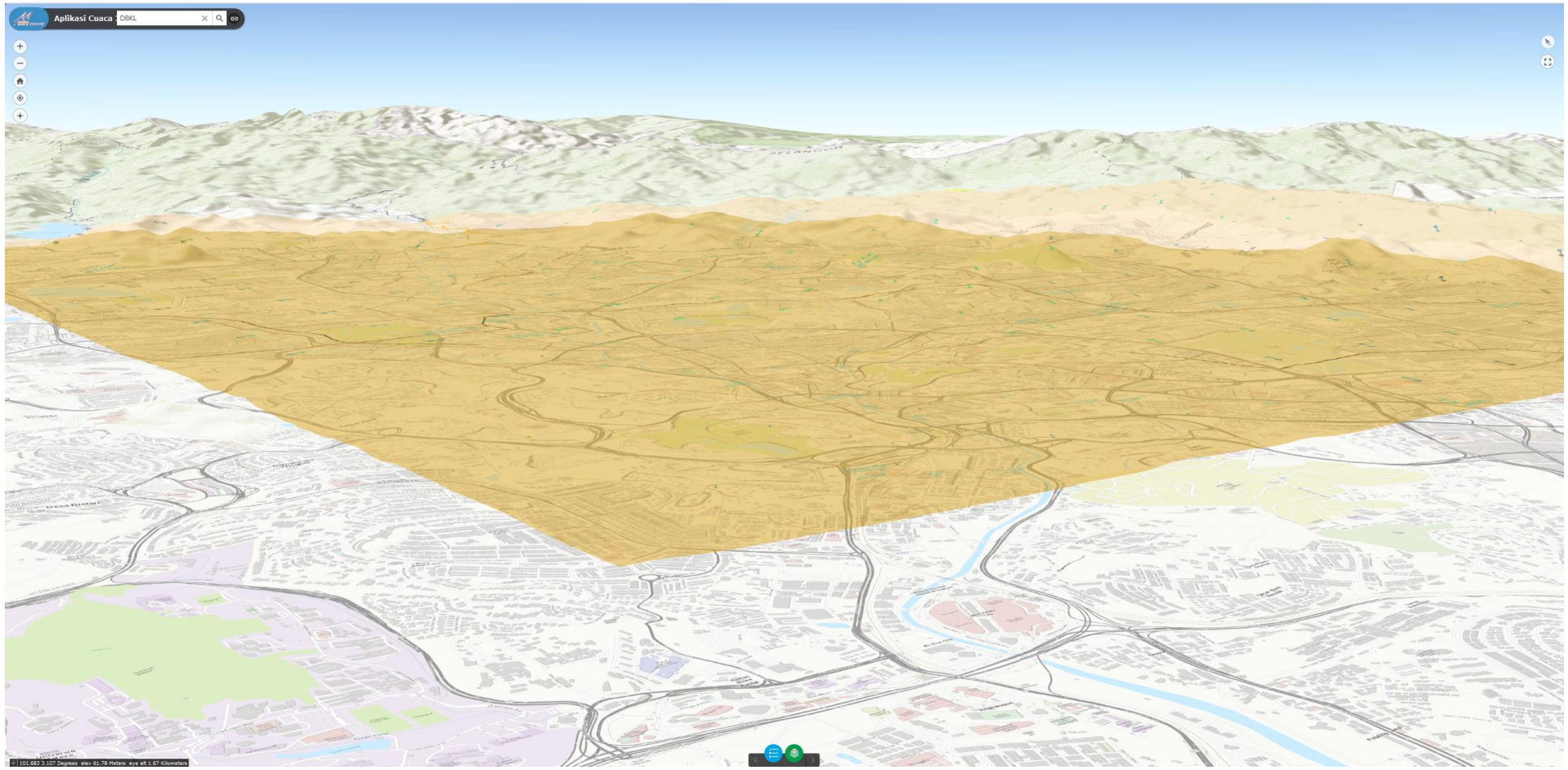


PILOT STUDY METEOROLOGICAL PRODUCTS

Local level forecast model that projects rainfall, wind & temperature in Kuala Lumpur (dynamic forecasts)

RESULTS

Paparan 3D Suhu Bandaraya Kuala Lumpur pada 2 petang , 22 Mac 2019



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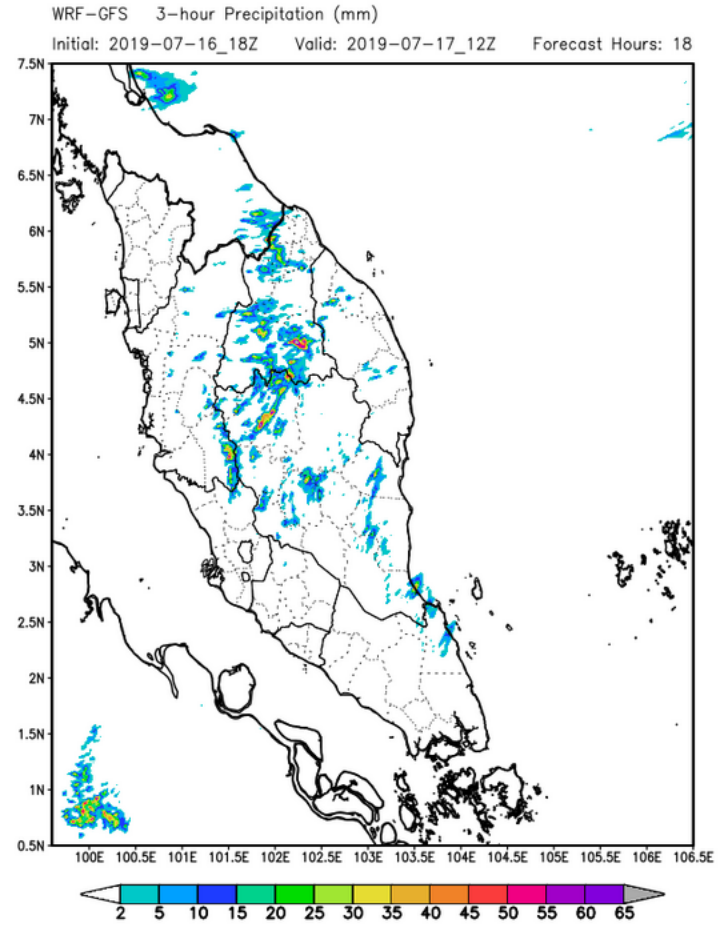
nwp1.met.gov.my/gfs-ukmo/#2019/07/16/18Z 50% Search

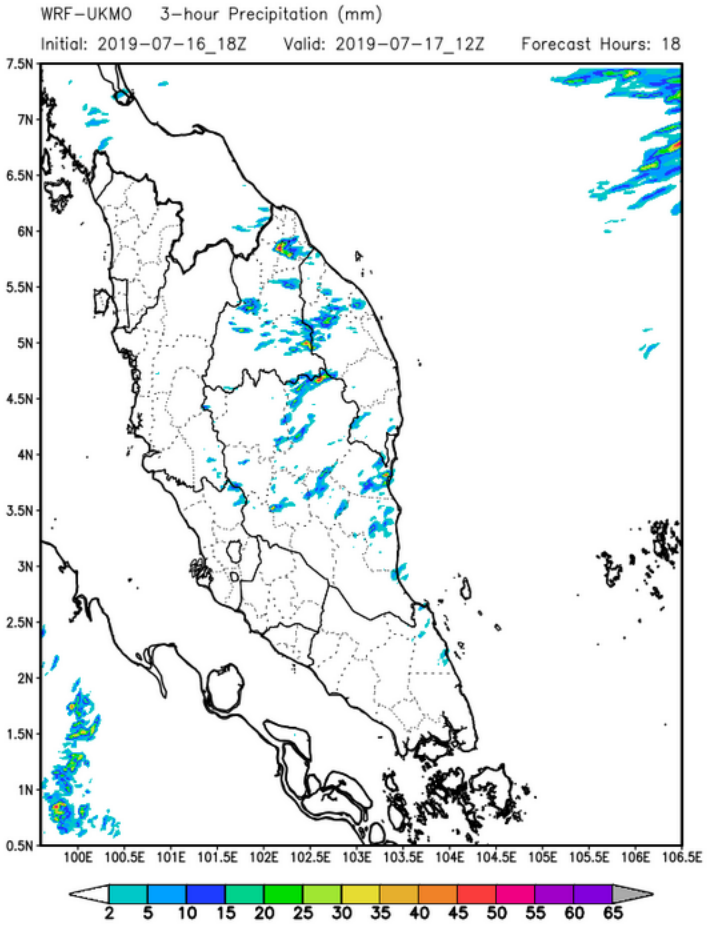
2019/7/16/18Z | 1KM(Peninsular) | Precipitation | 3 Hourly | Level | Overlay | < | > | ◄ | ▮▮ | ► | << | >> | Image Opacity | Overlay image Opacity

Precipitation (mm) Initial: 2019-7-16 18Z Valid: 2019-7-17 12Z (2019-7-17 20MYT) Forecast Hours: 018

WRF-GFS



WRF-UKMO



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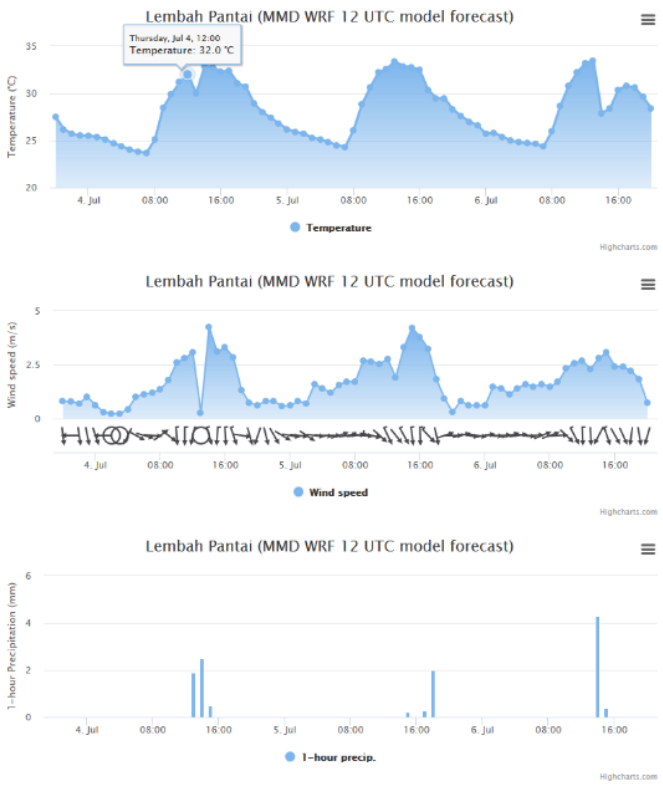
NUO



Meteograms

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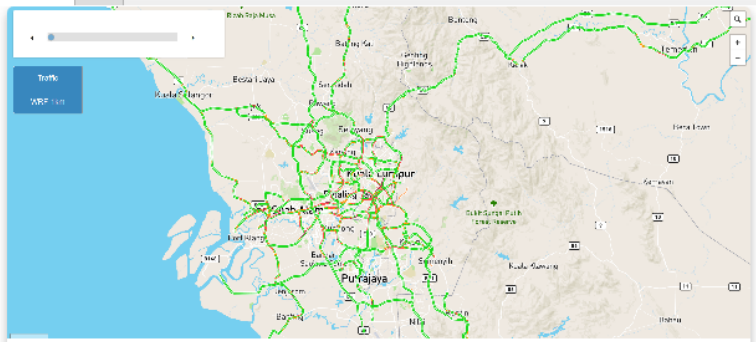

2D Map Viewer

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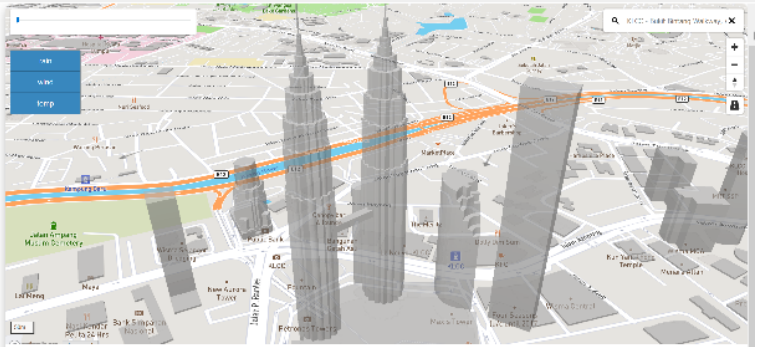

3D Map Viewer

READ MORE

CONCLUDING REMARKS

- The distribution of the deep mesoscale convective systems in this monsoonal region is strongly influenced by its unique topographic orientation and thus can differ significantly from those of other regions. Determining Convective initiation is an difficult task.

- This is a data-sparse sea area, and the lack of long and comprehensive land data records pose severe limitations to our understanding of the key physical processes and the ability to provide reliable forecasts.

- Need for an improved systematic observation network and better understanding of fundamental science to distinguish Atmospheric Convection such as Local circulation (ex. diurnal cycle), Large-scale Disturbances (ex. ENSO, MJO, equatorial waves) as well as the Monsoon onset/break

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Thank you