The Fourth Joint Meeting of RA II WIGOS Project and RA V TT-SU for RA II and RA V NMHSs
(18 November 2022, online)

COUNTRY REPORT FOR SINGAPORE

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WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

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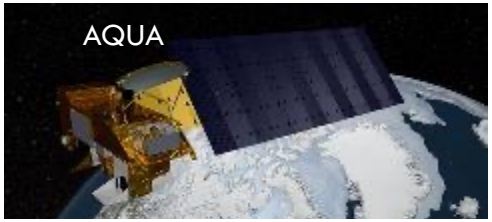
World Meteorological Organization
Organisation météorologique mondiale

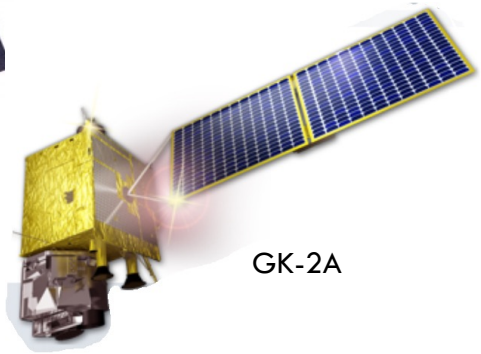
LEO and GEO Satellite Data



LEO Satellites

- NOAA-18/19/20
- SUOMI-NPP (SNPP)
- METOP-B/C
- NASA EOS AQUA & TERRA

Himawari-8



GK-2A

GEO Satellites

- Himawari-8 (H8)
- Geo-Kompsat-2A (GK2A)

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Satellite Reception System

GEO Satellites

HimawariCAST

LEO Satellites

X/L Band Tracking Antenna

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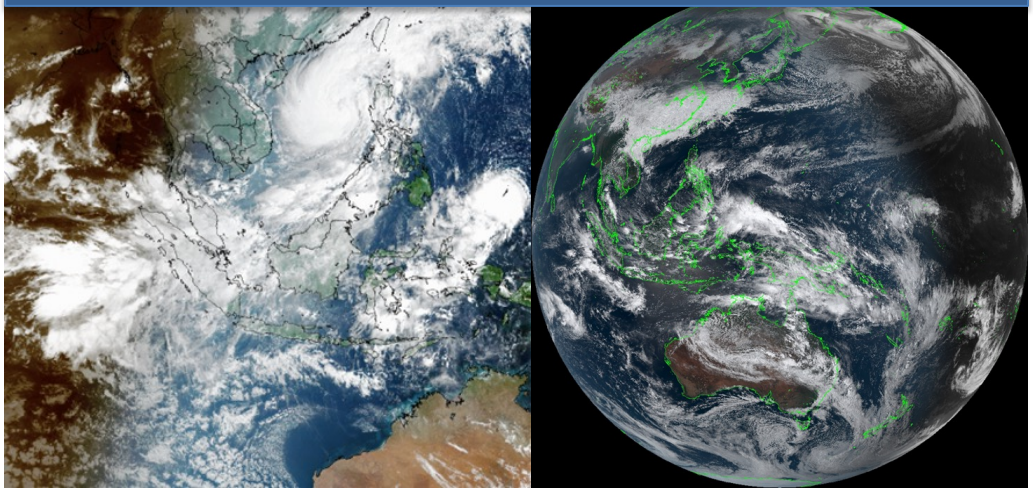
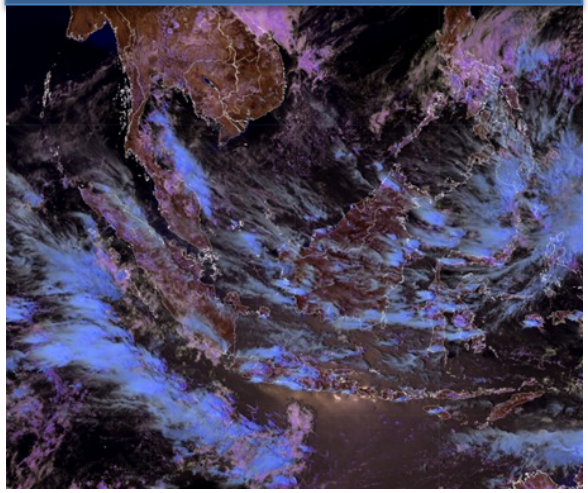
Satellite Data Product Used (GEO)

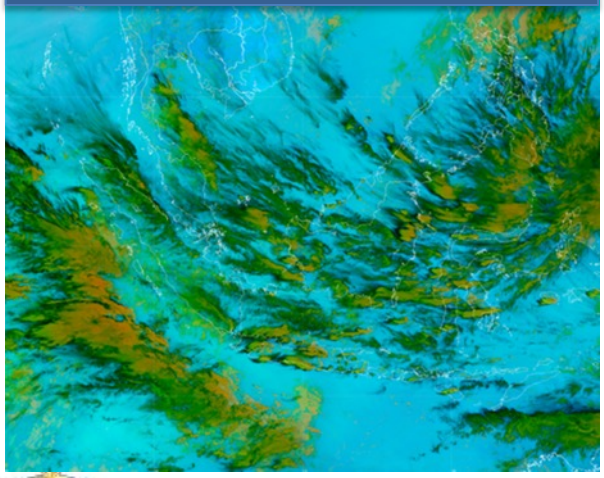
True Color



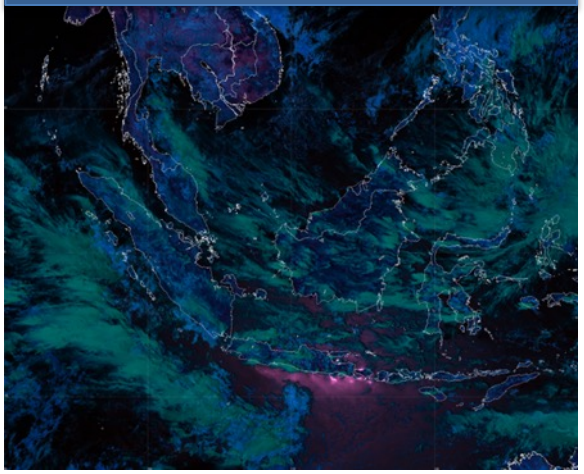
Microphysics



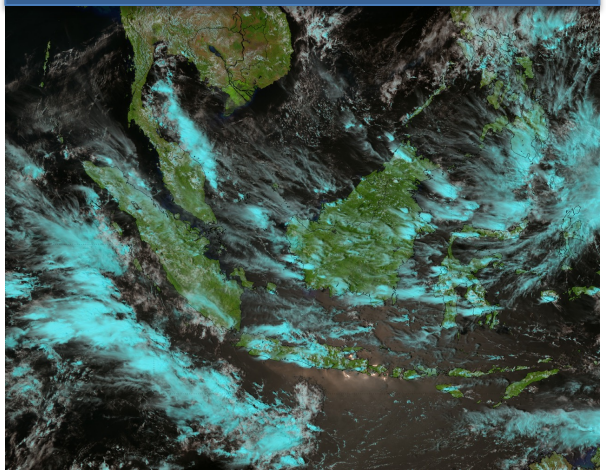
Volcanic Ash



Fire Temperature



Natural Color



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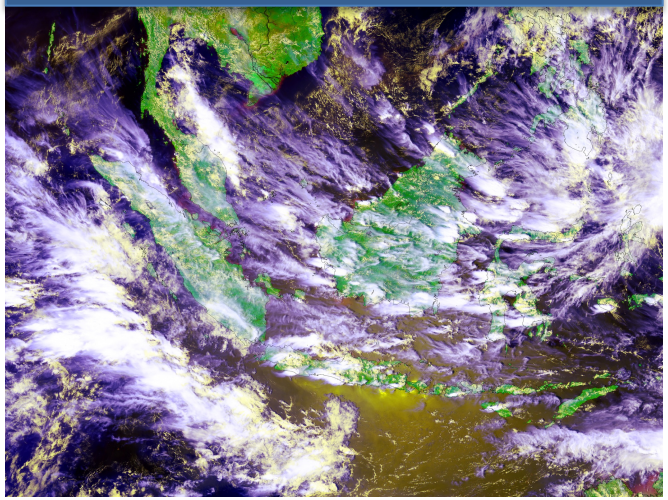
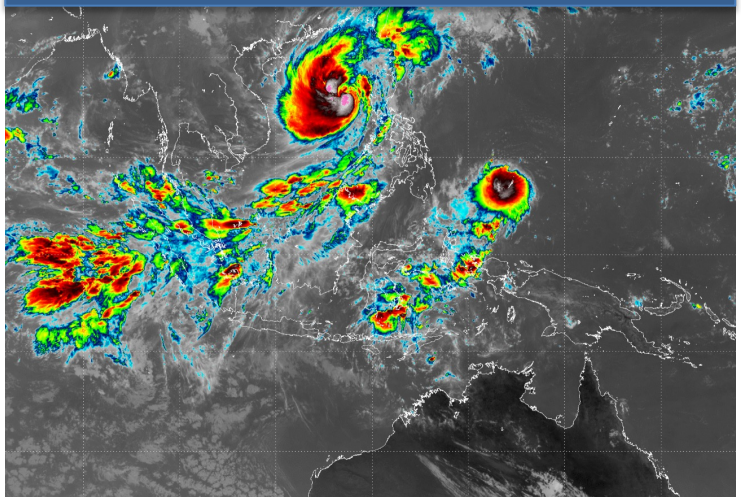
Satellite Data Product Used (GEO)

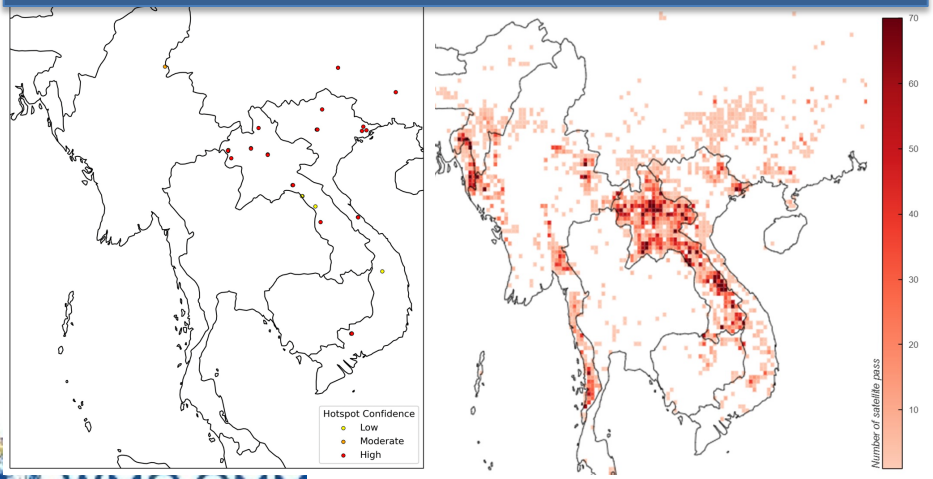
Low Cloud & Smoke Haze



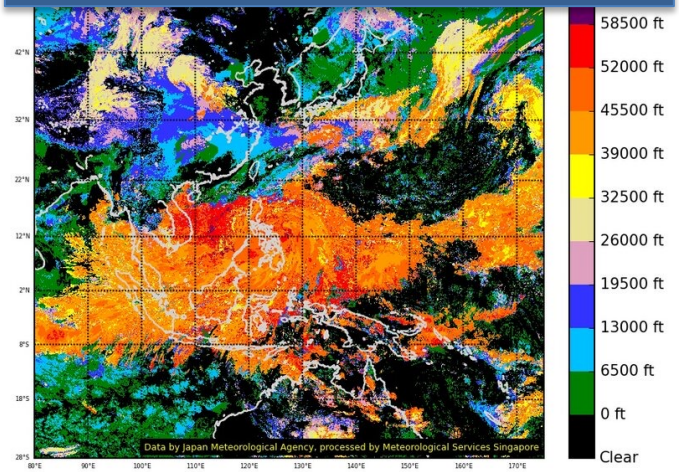
Color Enhanced IR



Active fire classifications



Cloud Top Height/Classifications



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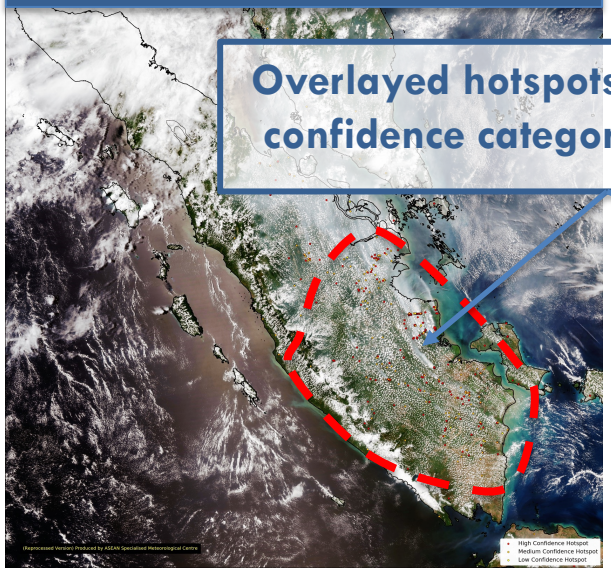
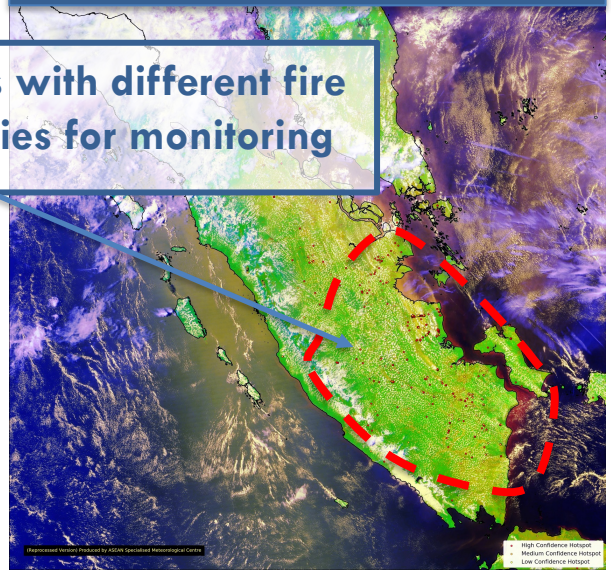
Satellite Data Product Used (LEO)

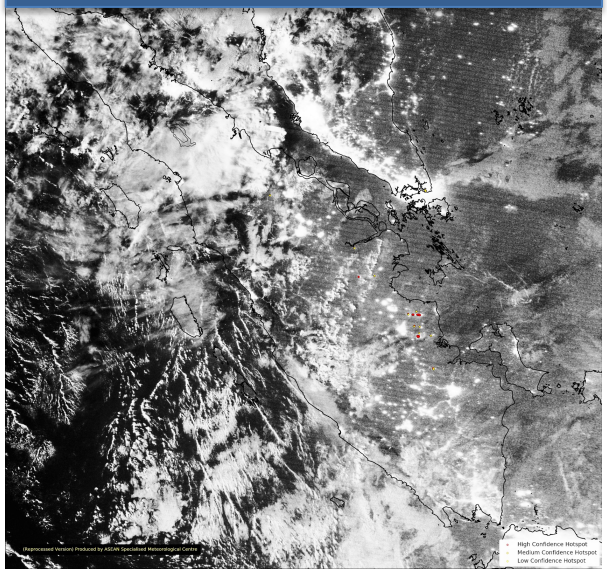
N20/SNPP True Color



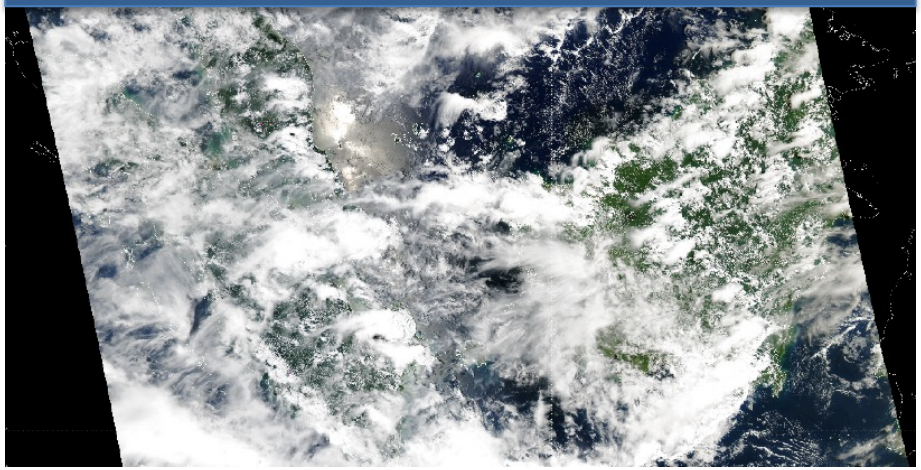
N20/SNPP False Color



N20/SNPP Day Night Band (DNB)



MODIS True Color



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Satellite Data Product Used

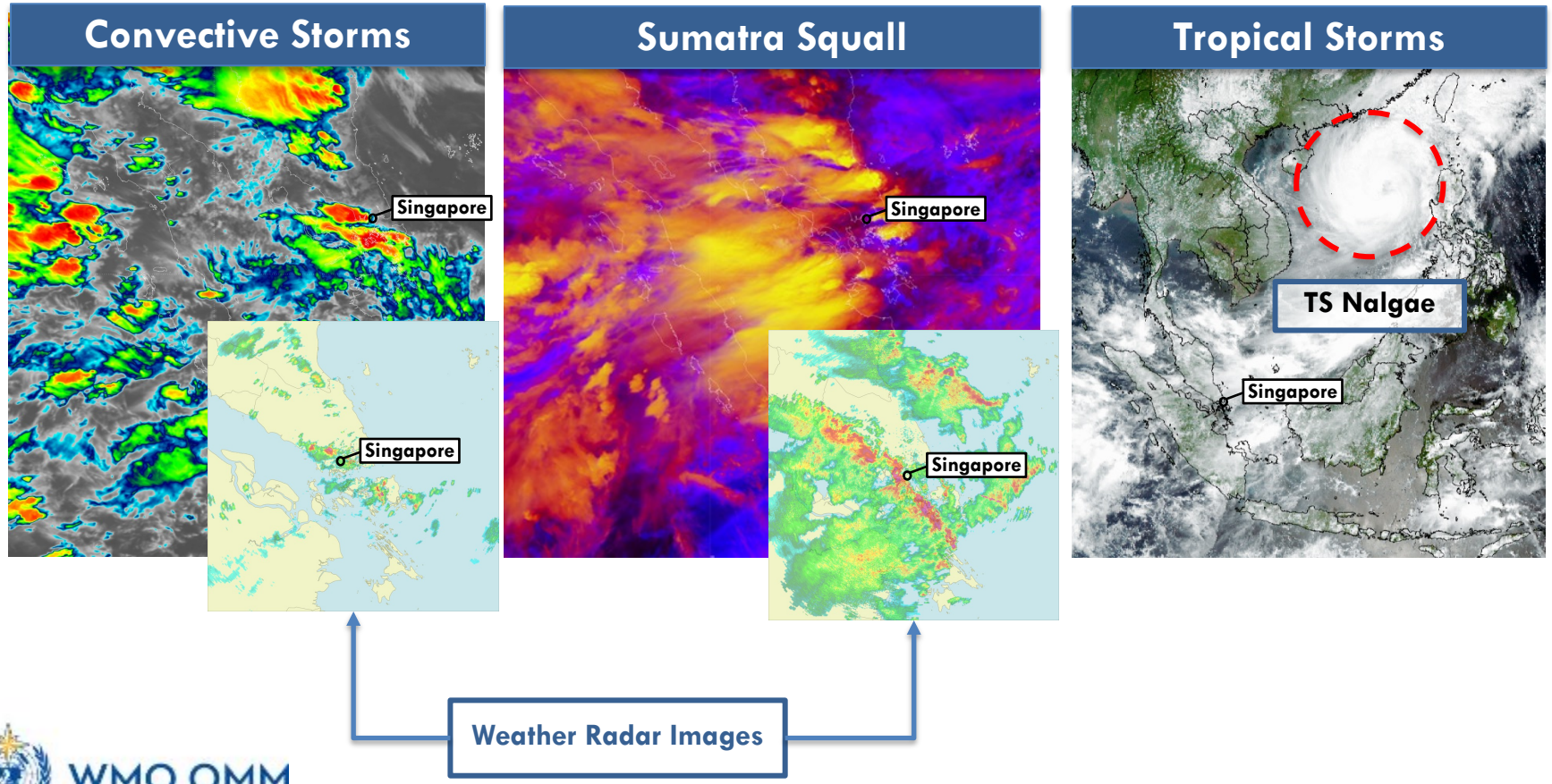
External Level-2 Satellite Products

- High Resolution Cloud Analysis (HCAI) Data from Himawari-8
- N20/SNPP VIIRS "Nightfire" (VNF) from NOAA National Geophysical Data Center (NGDC)
- Himawari-8 Fire Radiative Power (FRP) product from King's College London

Access/Usage of Satellite data

Weather and Environmental Monitoring

- Monitoring of weather systems over and around Singapore



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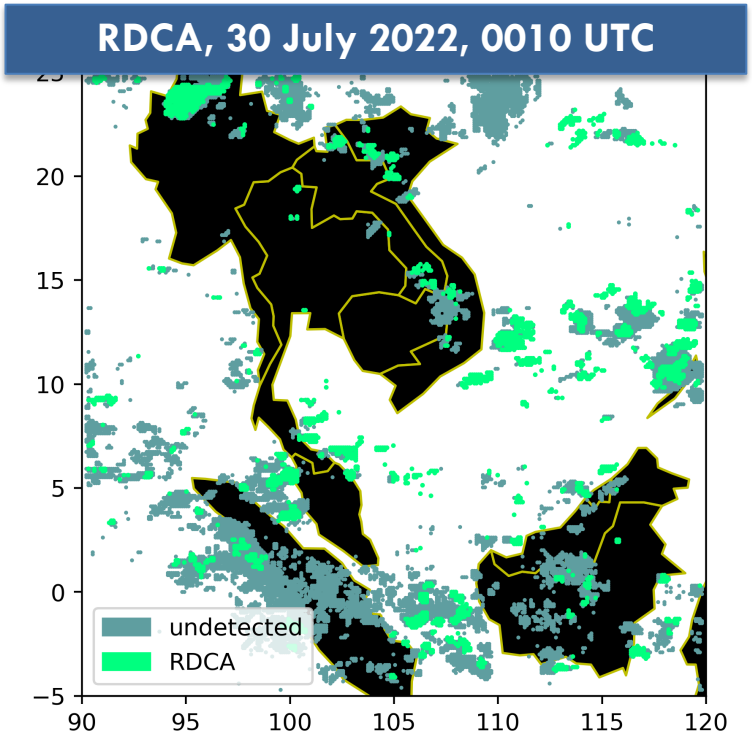
Access/Usage of Satellite data

Weather and Environmental Monitoring

- Implementation of Rapidly Developing Cumulus Area (RDCA) products over the Southeast Asia region.
  - RDCA Algorithm provided by Japan Meteorological Agency (JMA)
- Currently validating RDCA against lightning data



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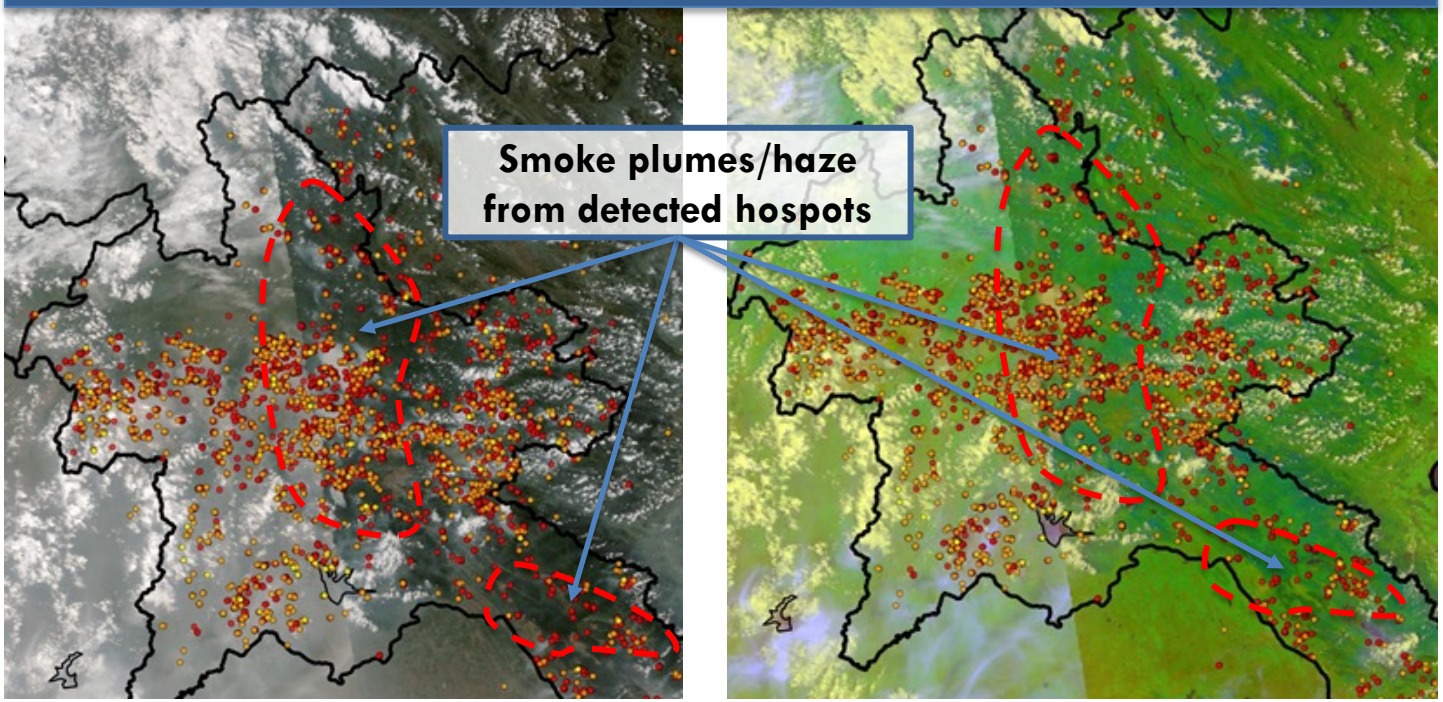
Access/Usage of Satellite data

Weather and Environmental Monitoring

- Hotspot and smoke haze monitoring in the region

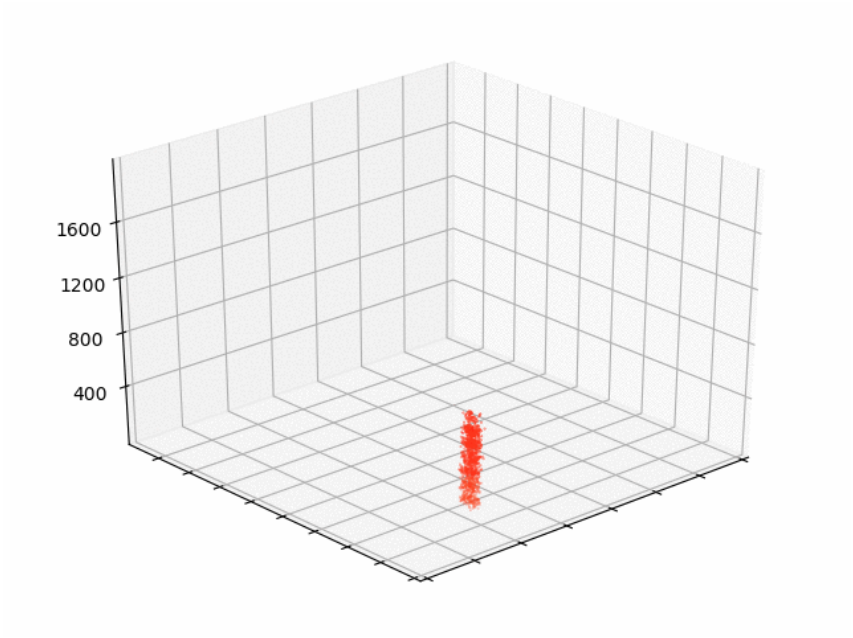
N20 True Color (Left) and Smoke Haze (Right) RGB (overlayed with detected hotspots)

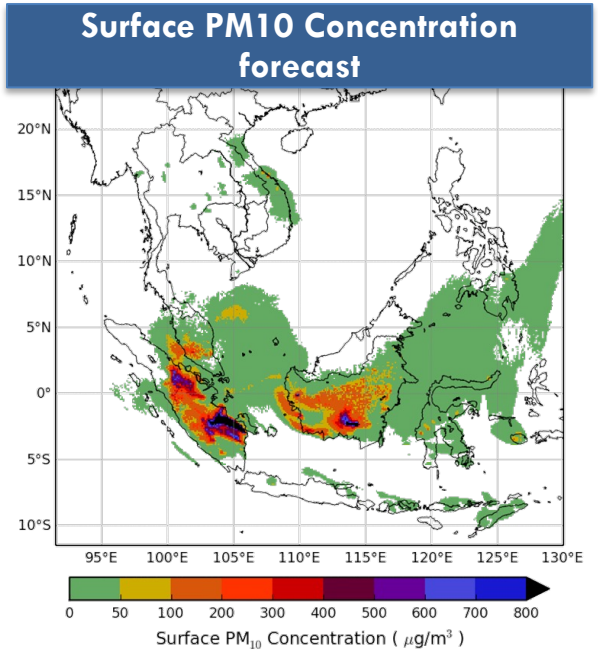


Access/Usage of Satellite data

Dispersion Modelling

- Fire hotspot data (e.g. Fire Radiative Power) is used to estimate emission of particulate matter from land and forest fires
- Together with Numerical Weather Prediction (NWP) model inputs, the dispersion of particulate matters are simulated





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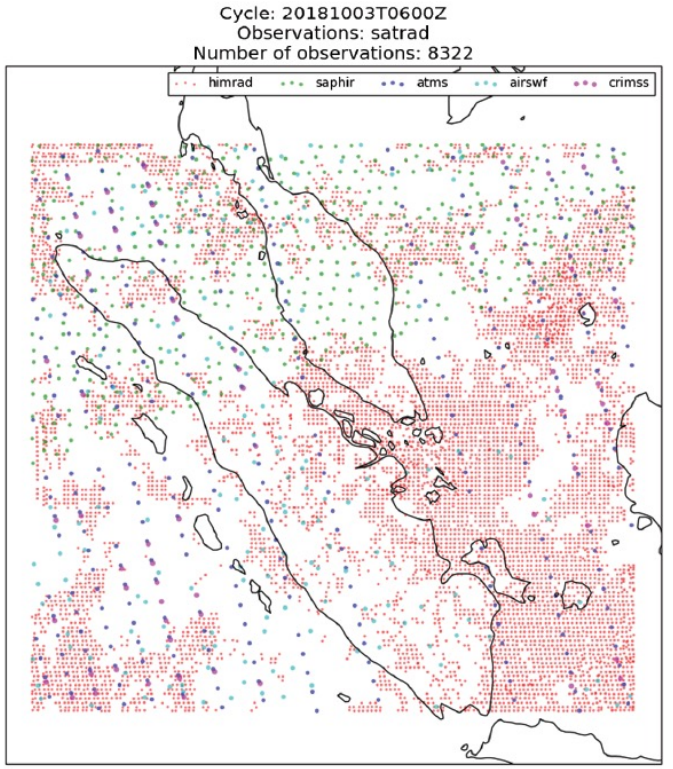
Access/Usage of Satellite data

Satellite Data Assimilation for Very High-Res NWP

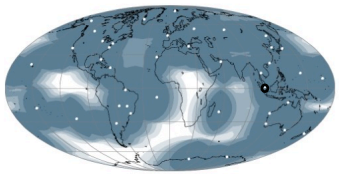
- Singapore is developing 1.5km convective scale NWP for tropical weather forecast: SINGV-DA
- Satellite data improves the performance of SINGV-DA
- Examples of satellite data assimilated
  - Himawari-8 radiances
  - Himawari-8 atmospheric motion vector
  - ASCAT ocean winds



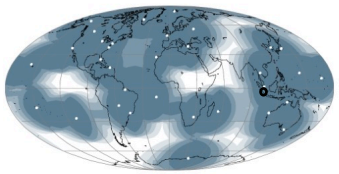
Access/Usage of Satellite data

Contribution to WMO DBNET

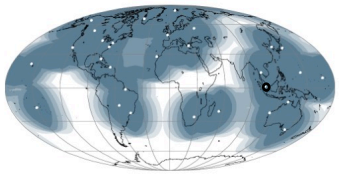
- Singapore contributes operational satellite data to WMO DBNET via Regional ATOVS Retransmission Services (RARS)
- RARS are operational arrangements under the World Meteorological Organization to provide NWP centers with ATOVS data received at RARS direct readout stations within 30 minutes of observation



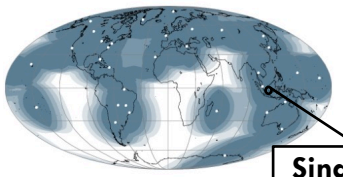
DBNet-ATOVS coverage in November 2020



DBNet-ATMS coverage in November 2020



DBNet-CrIS coverage in November 2020



DBNet-IASI coverage in November 2020

Singapore's Contribution to DBNET						
Satellite	Instrument					
	AMSU	MHS	HIRS	IASI	CRIS	ATMS
NOAA-18	Y	NA	Y	NA	NA	NA
NOAA-19	Y	NA	Y	NA	NA	NA
NOAA-20	NA	NA	NA	NA	Y	Y
SUOMI-NPP	NA	NA	NA	NA	Y	Y
METOP-B	Y	Y	Y	Y	NA	NA

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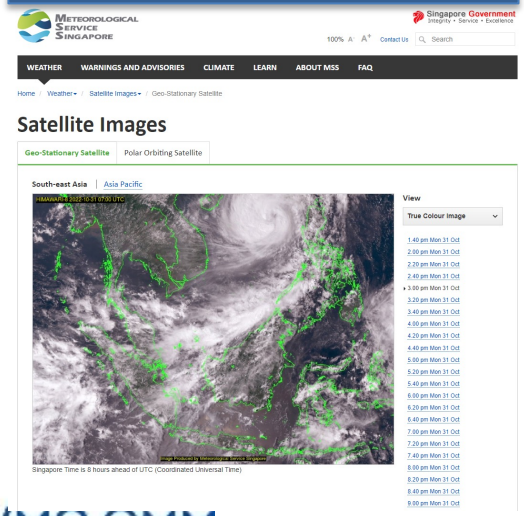
Access/Usage of Satellite data

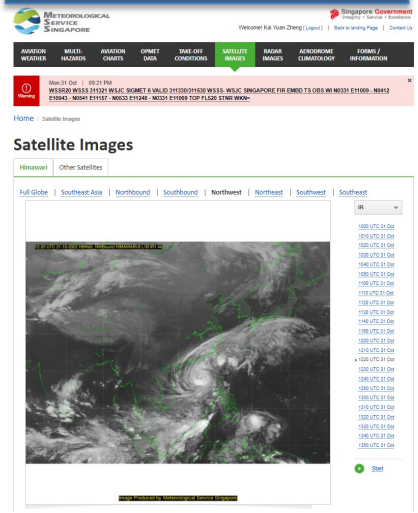
Dissemination to Stakeholders

- Satellite products are disseminated to various stakeholders via website platforms
  - Public
  - Aviation
  - Regional (Singapore hosts the ASEAN Specialised Meteorological Centre(ASMC))

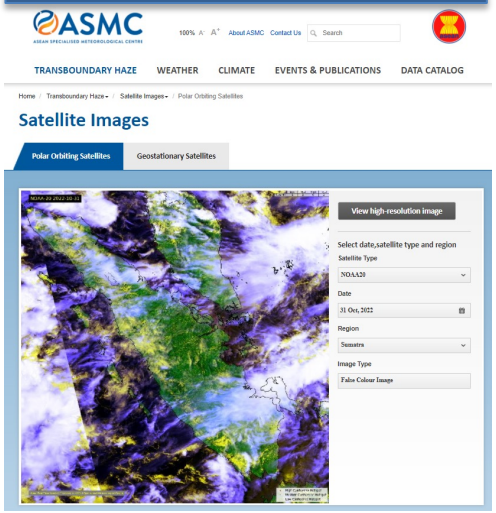
MSS Public website



MSS Aviation website



ASMC Website



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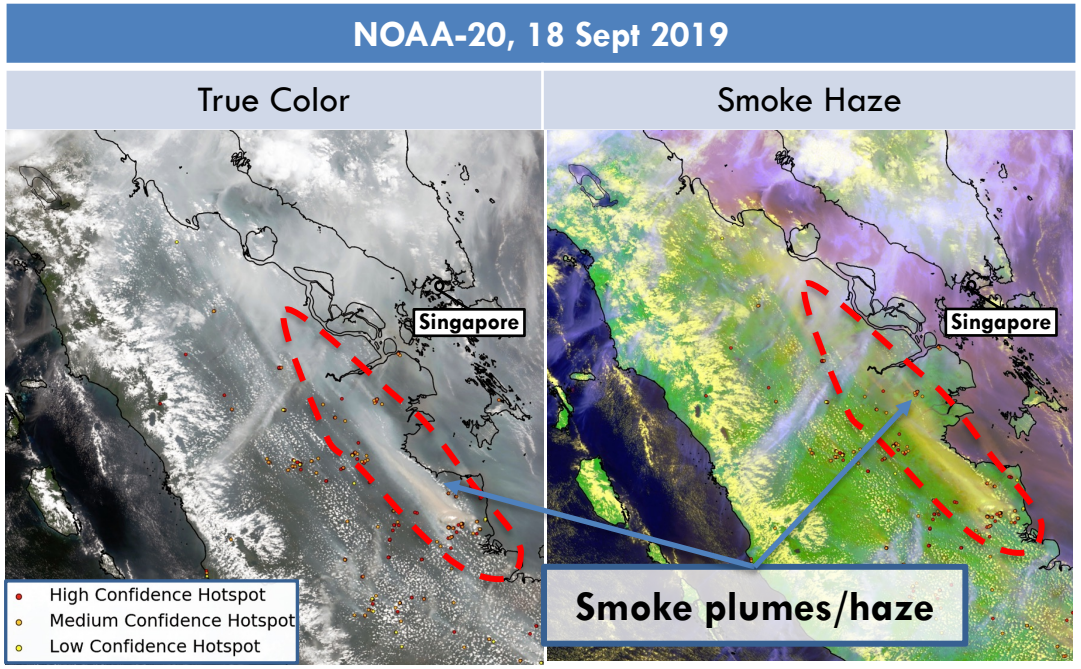
Satellite Data to Address Regional Challenges

Monitoring Land & Forest Fire and Haze

- Satellite observation is crucial especially over area where ground observations are sparse
- Latest LEO satellite (N20, SNPP) are able to deliver imagery with better spatial resolution for day & night
- Leverage RGB images to better distinguish smoke haze



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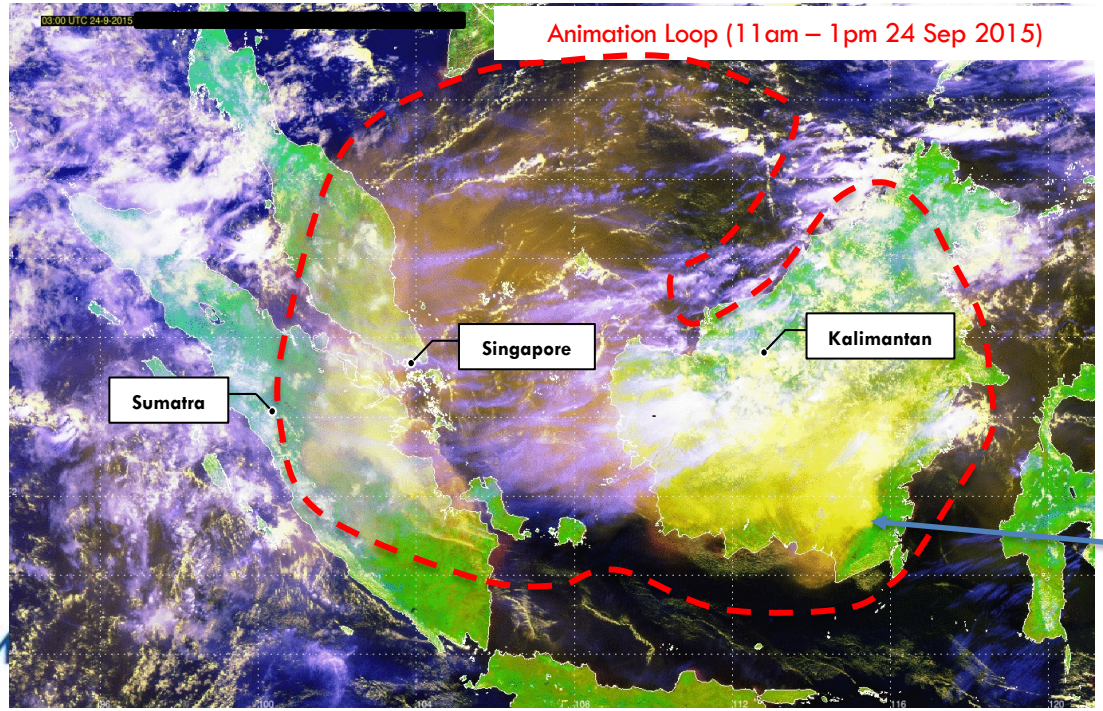
Satellite Data to Address Regional Challenges

Monitoring Land & Forest Fire and Haze

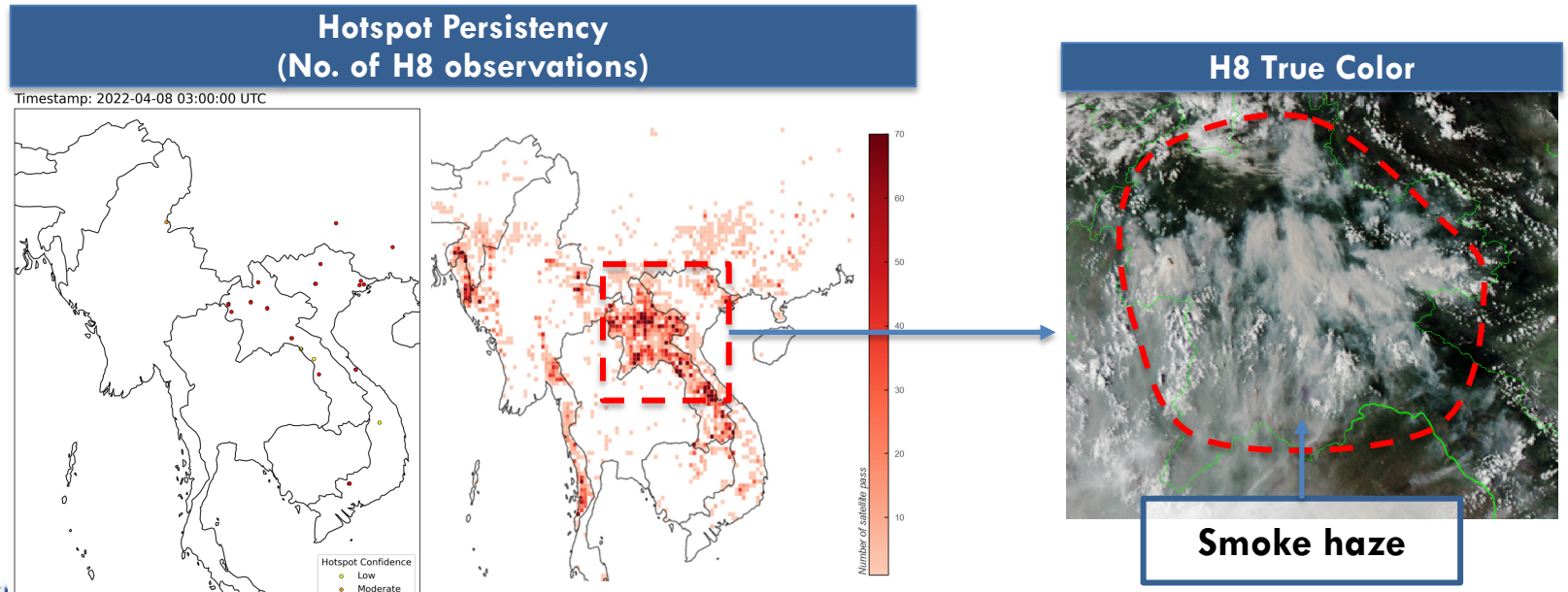
- Advancement of GEO satellite allows observations at higher frequency (e.g. every 10 mins) with higher spatial resolution and capture more spectral bands
- RGB images made possible to capture and track the movement and evolution of smoke haze



Satellite Data to Address Regional Challenges

Monitoring Land & Forest Fire and Haze

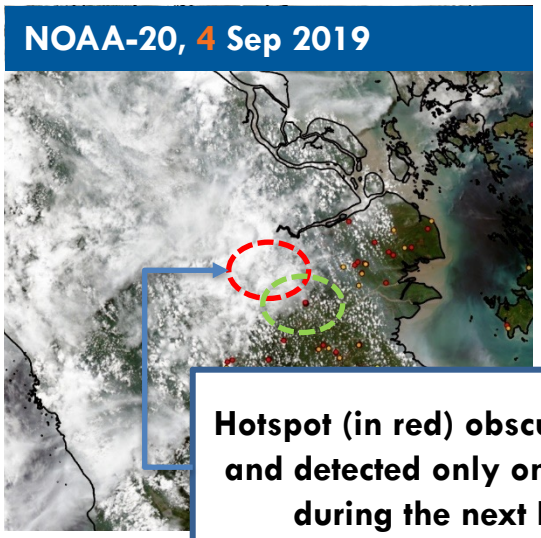
- More spectral bands means active fire classification algorithm can be implemented on GEO satellites
  - Fire monitoring every 10-mins on Himawari-8
- Aggregation of data from multiple time intervals allows an assessment of the persistency of hotspots throughout the day

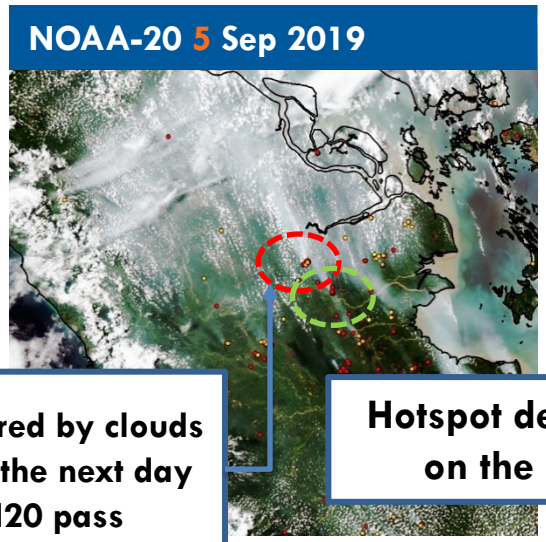


Satellite Data to Address Regional Challenges

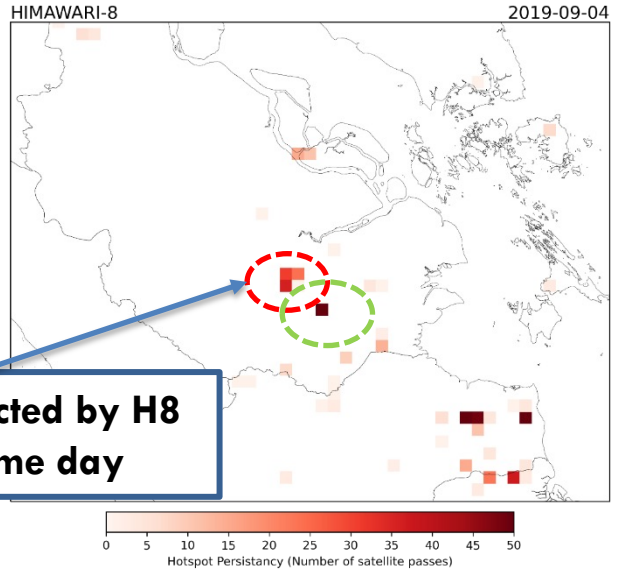
Monitoring Land & Forest Fire and Haze

- Infrequent passes from LEO satellite (~2 passes per day) can result in undetected hotspots obscured by cloud cover
- Higher frequency active fire classification from GEO satellite may still detect these fires when clouds move away/dissipate





Hotspot (in red) obscured by clouds and detected only on the next day during the next N20 pass



Hotspot detected by H8 on the same day

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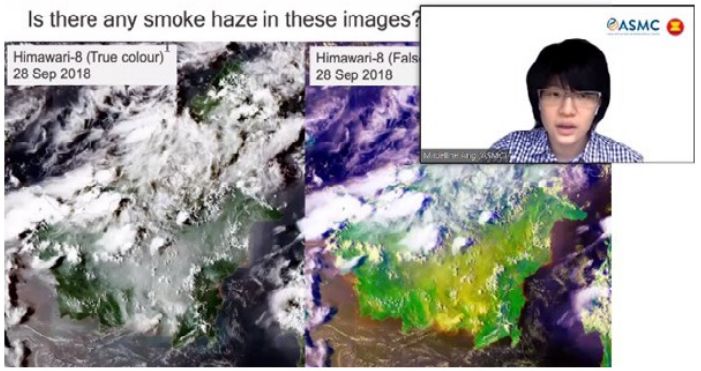
Capacity Building and Training Needs

Regional Capacity Building Activities

- Singapore, through ASMC, conducts a series of training programmes tailored to ASEAN National Met Services, government agencies and end users from various sectors, including training on the use of remote sensing for hotspot and haze monitoring (e.g. H2A workshop)



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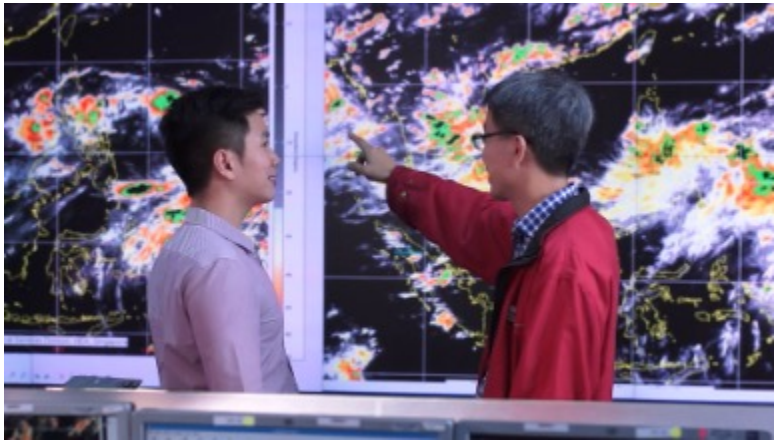
ASMC
ASEAN SPECIALISED METEOROLOGICAL CENTRE

Capacity Building and Training Needs

Local Capacity Building Activities

- Training by in-house experts on the use of satellite data for meteorological and environmental monitoring
- Tap on training material from other leading centres (e.g EUMETSAT, SSEC, NOAA, CIRA, JMA, BoM)
- Self-guided learning materials created for junior meteorologist to learn at their own pace



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Local Capacity Building Activities

Challenges	(Structured) Training Needs
▪ Could benefit from more subject matter experts to focus on training and education	▪ RGB recipes and the theoretical basis behind them so as to know how to tune them for certain domain areas (e.g. tropics)
▪ Continuous and life-long upgrading of knowledge and skills due to rapidly evolving satellite technology	▪ Trainings on community satellite data processing software (e.g. CSPP, AAPP, OPS-LRS, RT-STP, etc)
	▪ Keeping up-to-date with the latest and upcoming LEO and GEO satellites and L2 satellite data products

Technical Infrastructure Challenges

- Direct Broadcast signal may be subjected to interference due to the highly urban nature of Singapore

WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

THANK YOU

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Organisation météorologique mondiale