Overview of the Meteorological Service Singapore (MSS)

William Liew
Deputy Director
Strategy and Partnerships

Fourth Leadership and Management Programme for Senior Management of National Meteorological and Hydrological Services

6 September 2023

Outline

- Overview of MSS
- Weather & Climate Services
- Systems and Infrastructure
- Research
- International Engagements

MSS' Position in the Government

Stanley Loh
Permanent Secretary

Ministry of Sustainability and the Environment
SINGAPORE

PUB SINGAPORE'S NATIONAL WATER AGENCY

Wong Kang Jet
CEO

National Environment Agency
Safeguard · Nurture · Cherish

Singapore Food Agency

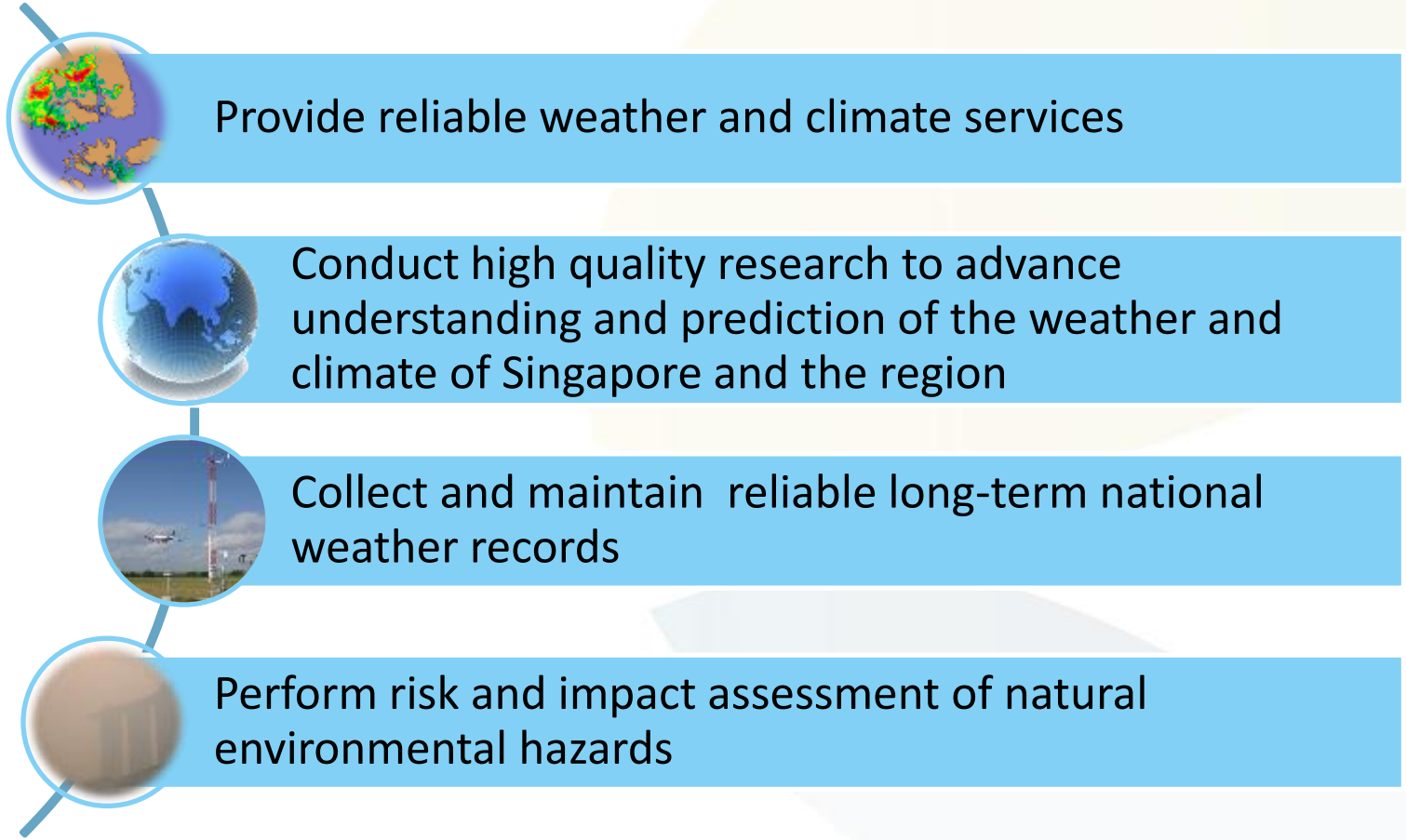
- Environmental Protection
- Public Health
- Meteorological Services & Radiation Protection
- Planning, Corporate & Technology

Meteorological Service Singapore

MSS is the National Authority for Weather and Climate

MISSION

To observe and understand the weather and climate affecting Singapore and to provide services in support of national needs and international co-operation



METEOROLOGICAL SERVICE SINGAPORE

Director-General
Wong Chin Ling

Asst. Chief Executive
Koh Li-Na

Weather Services Division

Forecast Application Development Department

Forecast Operations Department

- Weather Forecast Services (Aviation, military, public, agencies etc)
- Weather Application Development

Meteorological Observations and Systems Division

Meteorological Observations Department

Meteorological Systems Department

- Systems Applications
- Meteorological Observations

Centre for Climate Research Singapore

Department of Climate Research

Department of Weather Research

- Research into climate and weather
- National climate projections

Business and Strategy Division

Business Management Department

Strategy and Partnerships Department

- Strategy, outreach and business management
- International relations

International Scientific Advisory Panel (ISAP)

Chaired by Dr Michel Jarraud, Sec-Gen Emeritus, WMO

ASEAN Specialised Meteorological Centre (ASMC)

Our Key Milestones

1869 — Start of climate records for rainfall

1929 — First weather Station built at Mount Faber & start of climate records for temperature

1937 — First Forecast Office set up at Kallang Aerodrome

1953 — Commencement of Upper Air Sounding

1966 — Singapore joined the World Meteorological Organization

1968 — Met Service Singapore set up as a department under Ministry of Communications

1971 — Installation of first weather radar

1972 — Commencement of meteorological satellite data reception

1989 — Installation of first supercomputer

1993 — Establishment of ASEAN Specialized Met Centre (ASMC)

2001 — ISO certified for Aviation, Shipping and Climatological services

1997 — Installation of national seismic network

2002 — MSS becomes part of NEA under Ministry of the Environment & Water Resources

2008 — Operationalisation of tsunami warning system

2013 — Establishment of MSS Centre for Climate Research Singapore (CCRS)

2015 — Completion of V2 – Singapore's climate change projections

2017 — Opening of WMO Regional Office for Asia and the South-West Pacific

2019 — Operationalisation of MSS' convective-scale NWP model "SINGV"

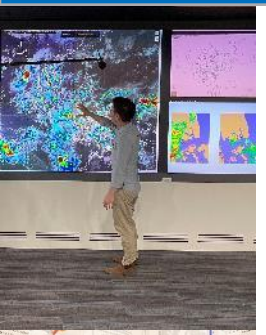
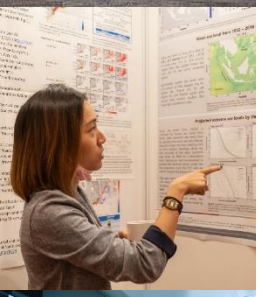
MSS Facilities


Central Forecast Office


Changi Met Station
(Aeronautical and climate station)

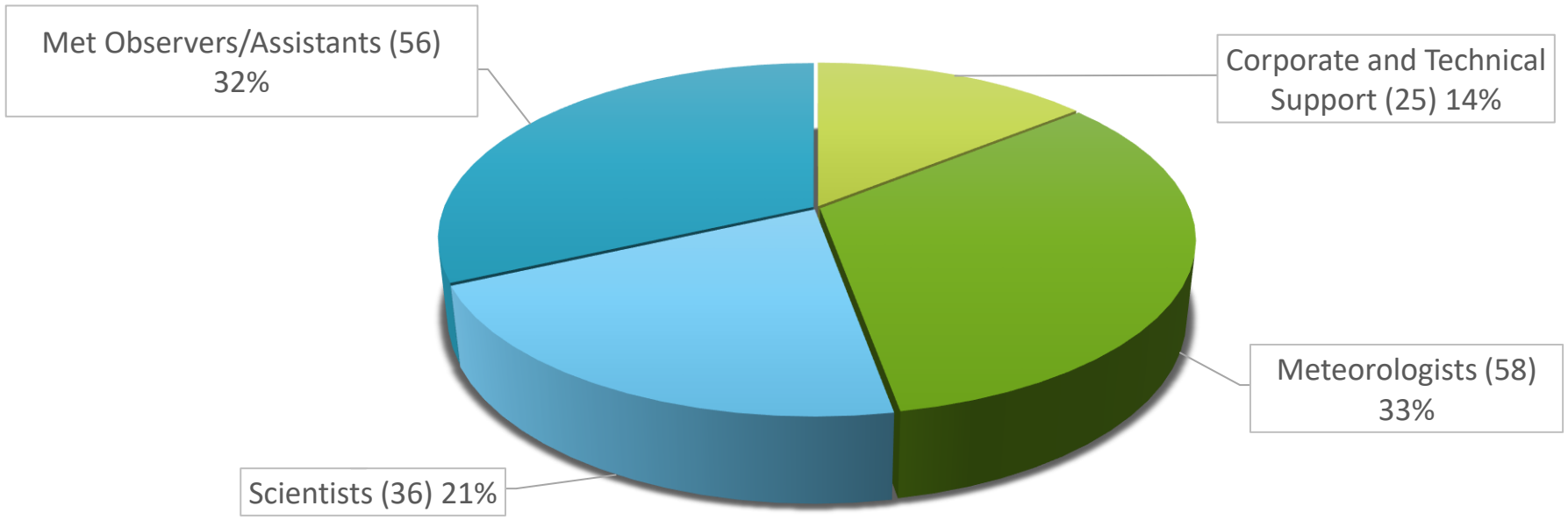

Centre for Climate Research Singapore

Manned Weather Stations

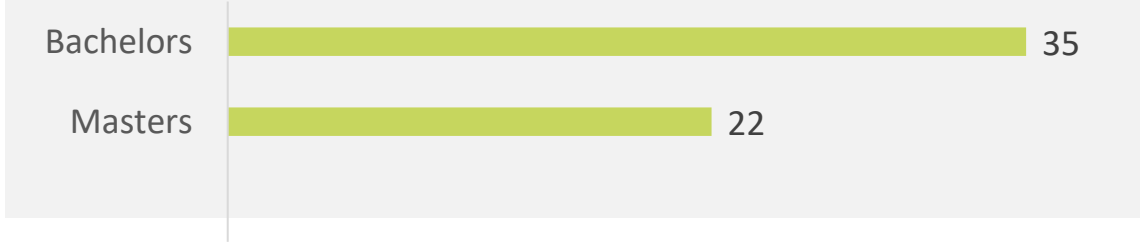



MSS Staff Profile

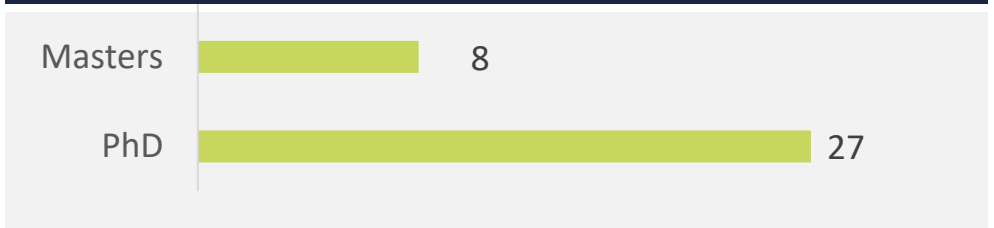
Staff strength (as at Jul 2023): 175



Meteorologists



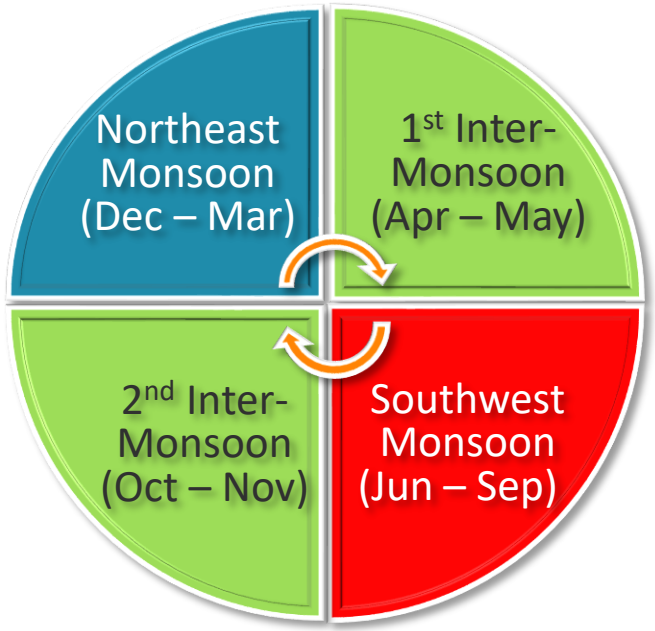
Scientists



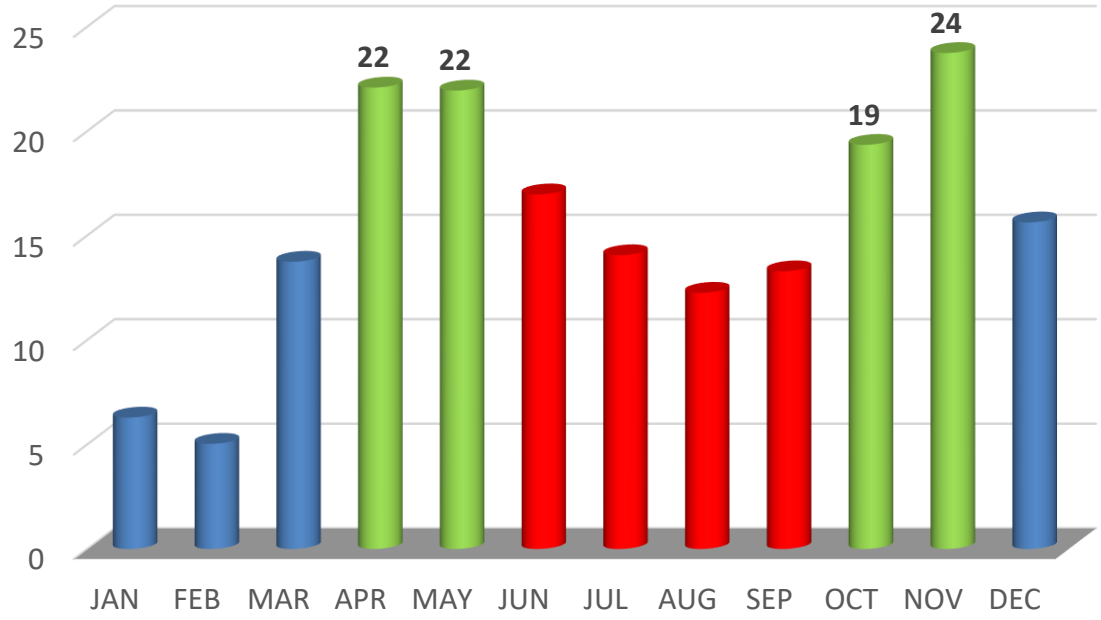
WEATHER & CLIMATE SERVICES

Weather and Climate of Singapore

- Singapore is a small island state:
  - Highly urbanised environment
  - Experiences weather characteristic of the deep tropics

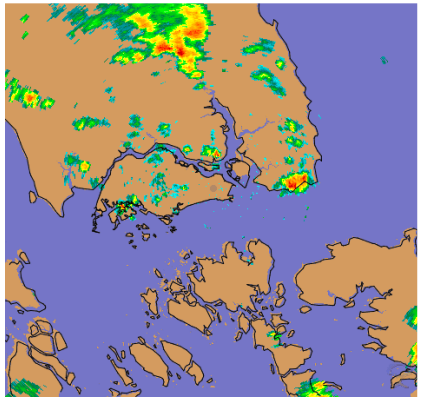


Lightning Days

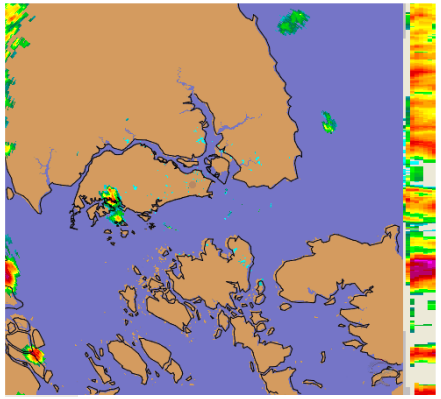


- Main meteorological and environmental hazards:
  - Heavy rain/flash floods;
  - Lightning; strong winds (from thunderstorms)
  - Prolonged dry spells
  - Extended warm spells
  - Transboundary haze

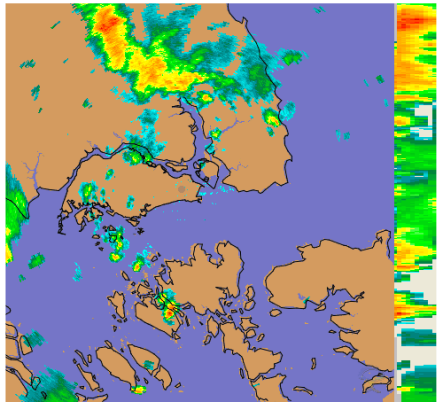
Main weather systems:



Localized convective thunderstorms



“Sumatra” squalls



Monsoon surges

Key Operational Services

Weather Forecast and Warning Service

Civil aviation

Government agencies (e.g. water, defence)

Climate resilience

Public

Businesses (shipping, construction etc.)

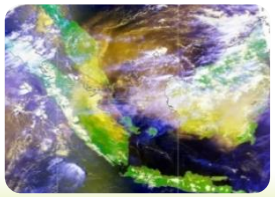
Monitoring and Early Warning of Multi-Hazards

Tropical cyclone

Volcanic eruption

Earthquakes / Tsunami

Radioactive fallout



Transboundary haze

Key Customers

Civil Aviation Authority of Singapore

- 24h observations, forecasts and warnings for aerodrome, approaches and holding stacks
- Enroute weather info for FIR (SIGMET)
- Broadcast weather bulletins (VOLMET)

Ministry of Defence (MINDEF)

- 24h weather watch, forecasts and warnings for air and naval bases
- Pre-flight briefings to pilots

PUB, Singapore's National Water Agency

- Heavy rain warnings
- Prolonged dry weather conditions
- Monthly rainfall forecasts to guide water resource management and planning

Other Customer Groups

Customised Lightning Watch Service

Golf Courses | Govt Agencies | Aviation | Rail Transport | Others

Public Weather Services

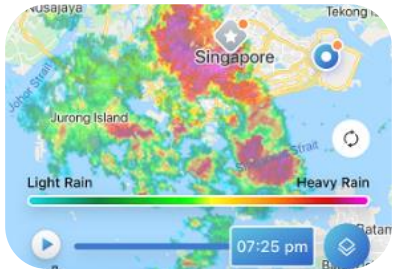
Weather Information, Forecasts and Warnings

- Nowcast (2-hr), 24-hr and 4-day Forecasts
- Heavy Rain Warnings
- Fortnightly Weather Outlooks
- Lightning Information Service
  - Real-time detected lightning information
  - Forecast of thundery showers
  - Display of real-time weather radar images (rain areas)
- UV Index readings
- Heat wave, monsoon advisories

Meteorological Data

- Current observations (rainfall, temperature, wind, humidity)
- Past Climate Data

NEA/MSS Website

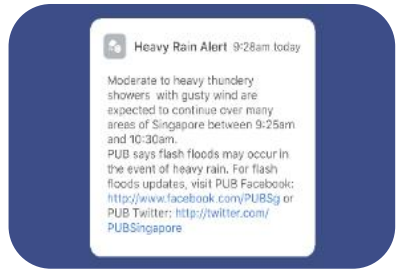


myENV

Data.gov.sg

Interactive Voice

Twitter, Facebook



SMS (Heavy Rain Alerts)

Aviation Weather Services

24/7 weather support to Air Traffic Services, Airlines and the Airport

LOCAL

- Aerodrome/approach observations, forecasts and warnings
- Lightning watch services

REGIONAL

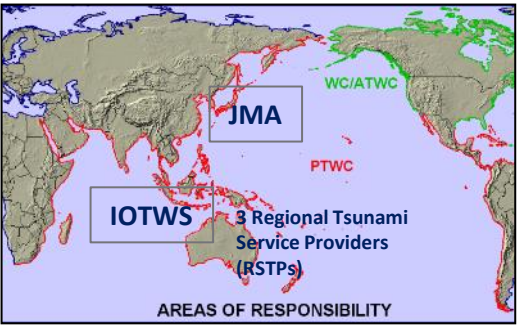
- Enroute hazardous weather
- Support for search and rescue ops
- VOLMET Centre, Regional Broadcast Centre for OPMET data

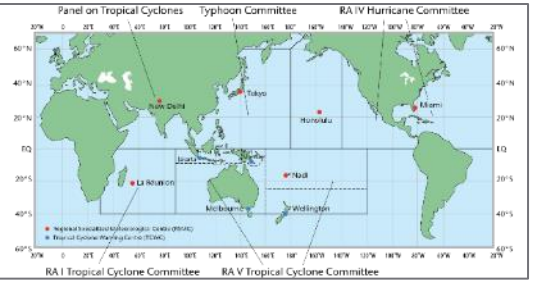
INTERNATIONAL

- Inter-regional OPMET gateway (Asia & Europe)
- Member of ICAO Met Panel

Monitoring and Early Warning of Hazards

Volcanic Ash Advisory Centres

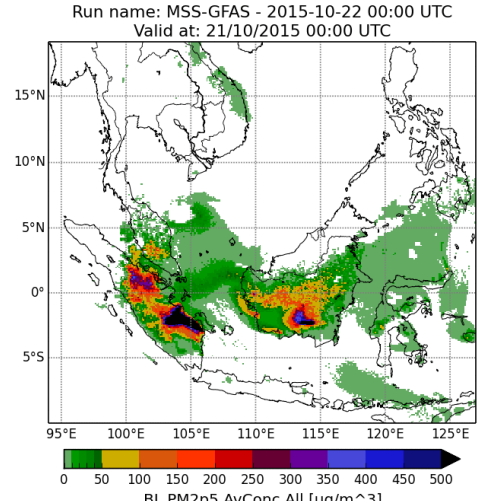




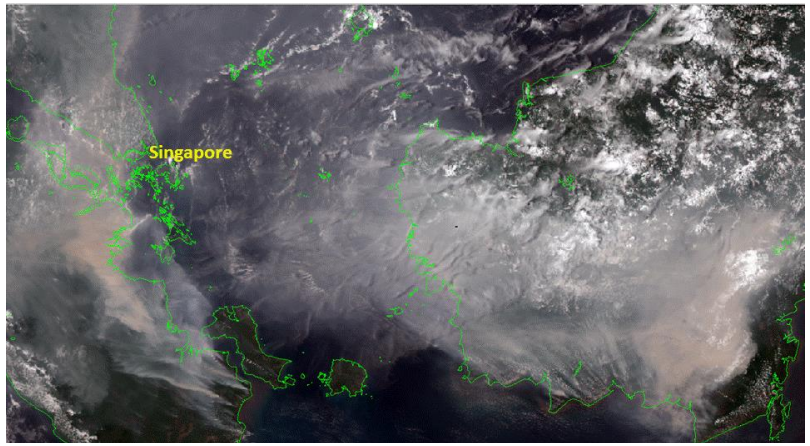
Tropical Cyclone Advisory Centres

- Hazards monitored:
  - Transboundary haze
  - Volcanic eruptions
  - Earthquakes/Tsunami
  - Tropical cyclones
  - Radiological fallout
- Hazards are assessed using in-house tools and guided by advisories from WMO/ICAO* advisory centres
- Alerts/advisories are issued to agencies and the public

*WMO: World Meteorological Organization
*ICAO: International Civil Aviation Organization



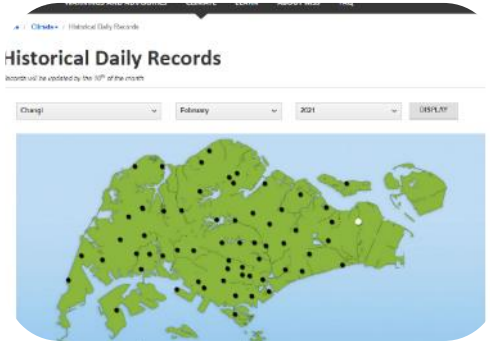
Haze Episode (24 Sep 2015)



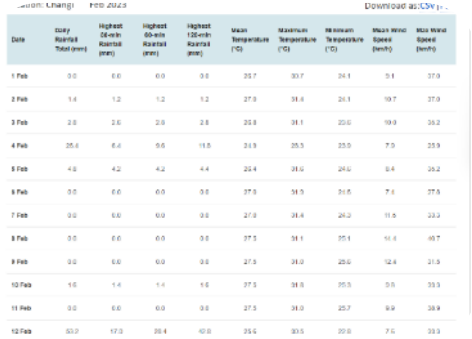
Satellite images and dispersion models are utilised in monitoring and forecasting regional haze

Climate Information Services

Oldest Meteorological Register (1929)



Climate Data Management (National Climate Database)



Customised Local Climate Data

Weather Assessments

- Climate observations from manned/automated weather stations are used for analysis of long-term climate trends
- Climate data and weather assessments are used by agencies, building and construction/ engineering companies, legal firms, adjusters and insurance companies

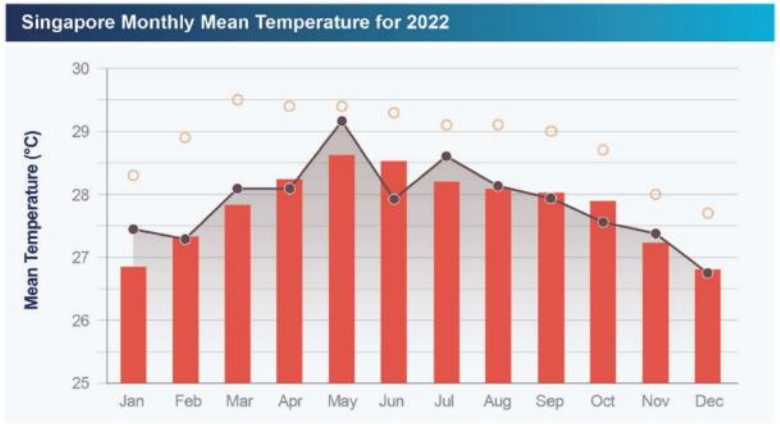


Figure 2: Changi climate station monthly mean temperature for 2022 (solid line), long-term average (bars, 1991 – 2020) and the corresponding historical extremes (circle).

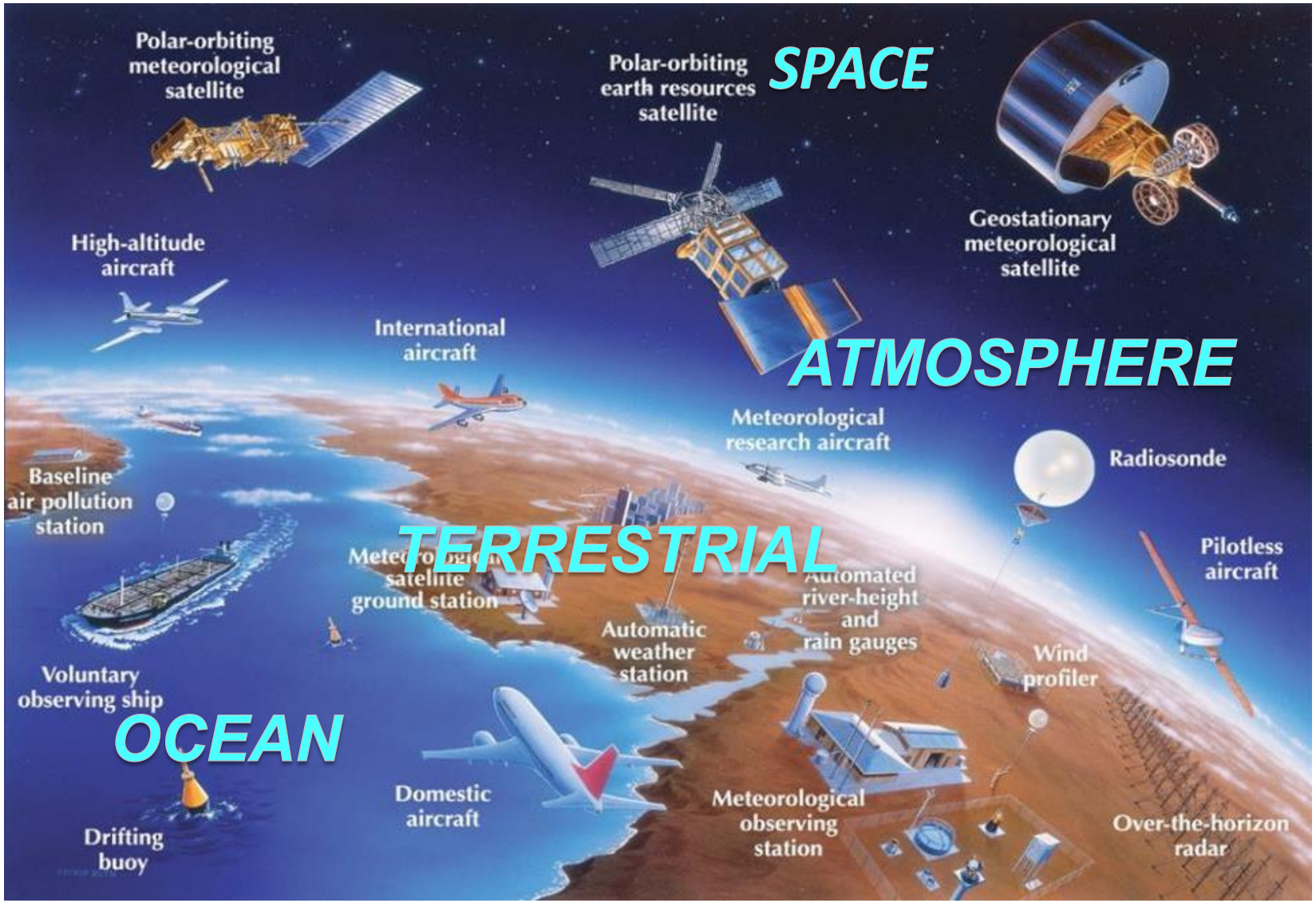
SYSTEMS AND INFRASTRUCTURE

Meteorological Observation Network

Manned Observation Stations | Automatic Weather Stations | WBGT Sensors | Weather Radar

Lightning Sensors | Upper Air Sounding & LIDAR | Satellite Ground Stn | Seismic Stations | All

WMO Integrated Global Observing System (WIGOS)

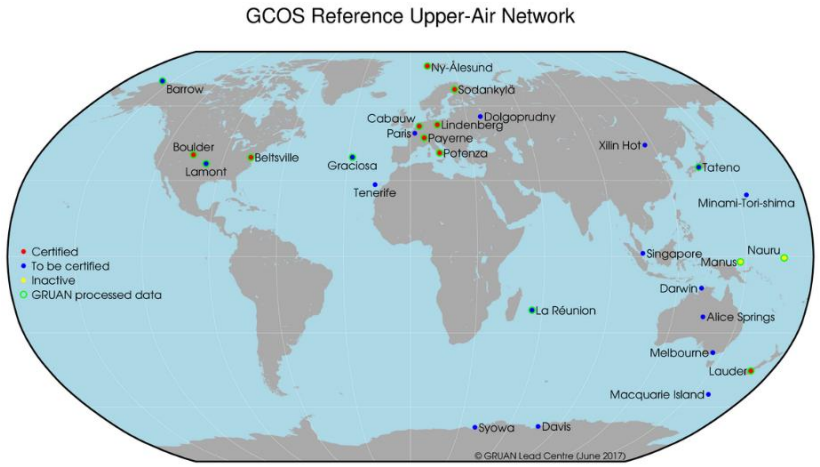


- WMO global framework for collecting and sharing surface- and space-based environmental observations

- Singapore contributes our observation data from the **Changi (Airport) Met Station** and the **Upper Air Station** at Kim Chuan, and in turn receives data from the rest of the world through the **free and unrestricted** international exchange of data

Upper Air Observatory – GRUAN Certification

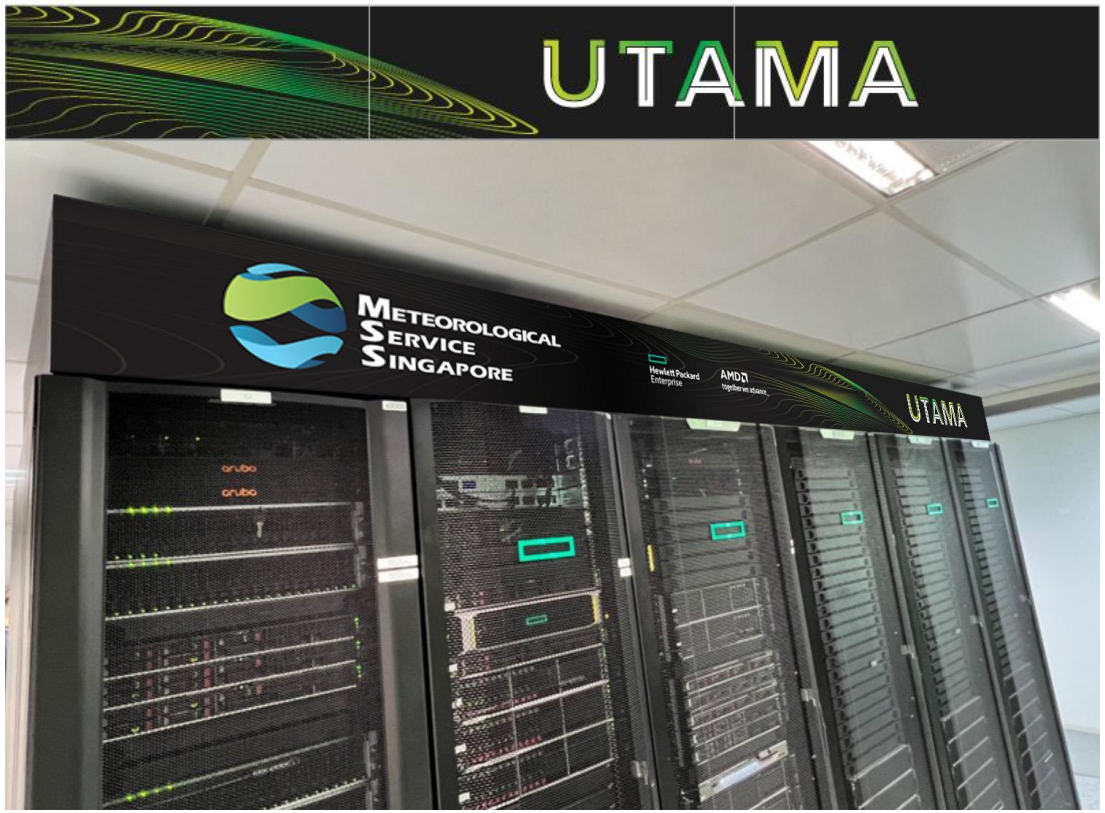
- Upper Air Observatory located in the Centre for Climate Research Singapore
- Part of the RBSN and Global Climate Observing System (GCOS) Upper-air Network (GUAN)
- Certified as a GCOS Reference Upper-air Network (GRUAN) station in May 2019



CCRS High-Performance Computing (HPC) System

HPE Cray EX – "Utama"

- Commissioned on CCRS' premises in Aug 2022, replacing previous in-house "Athena" supercomputer
- 98 compute nodes, **400 tera-flop** peak performance (*Twice the compute capability of Athena*)
- Used mainly for operational weather modelling, incorporating capabilities such as
  - Coupled ocean-atmosphere prediction
  - New forecast postprocessing techniques, utilising the latest in AI to improve forecast quality
- Complemented by up to **1.2 peta-flops** of external HPC resources from the National Supercomputing Center (NSCC) channelled towards CCRS' research applications

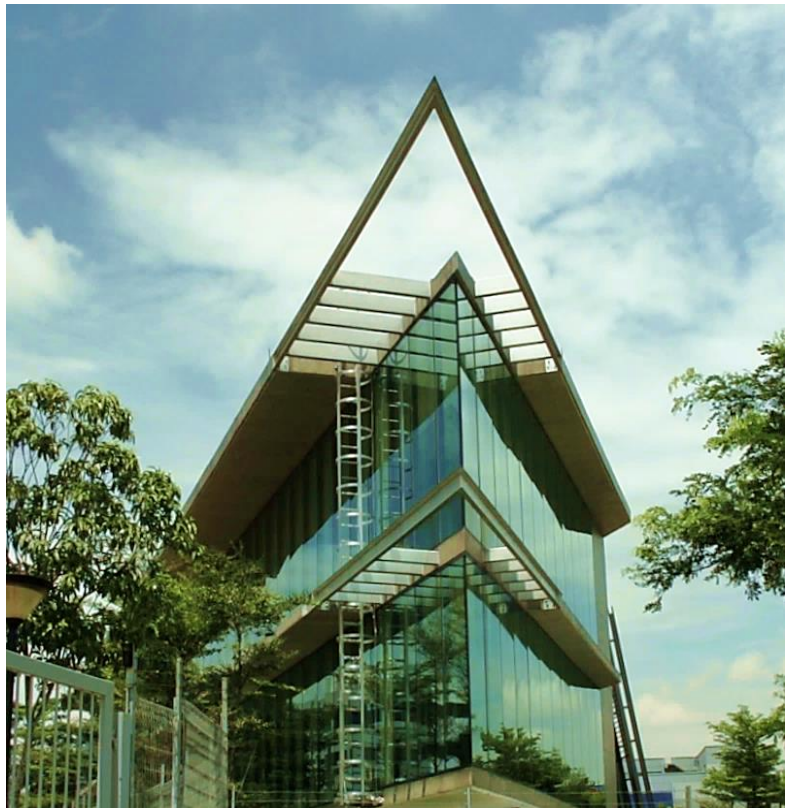


RESEARCH AND DEVELOPMENT

Centre for Climate Research Singapore (CCRS)

MISSION

To advance scientific understanding of **tropical climate variability and change** and its associated weather systems **affecting Singapore and the wider Southeast Asia region,** so that the knowledge and expertise can **benefit decision makers and the community**.



Officially opened in March 2013

Translating Research to Applications

Numerical Weather Prediction

Develop convective-scale NWP models with data assimilation, and support service delivery through ensemble

Applied Modelling

R&D of downstream applications utilising NWP information (e.g. dispersion modelling)

Climate Projections

Production of climate scenarios for Singapore to support whole-of-government climate adaptation

Subseasonal & Seasonal Predictions

Use of dynamical/statistical model outputs for national and regional seasonal and subseasonal outlooks

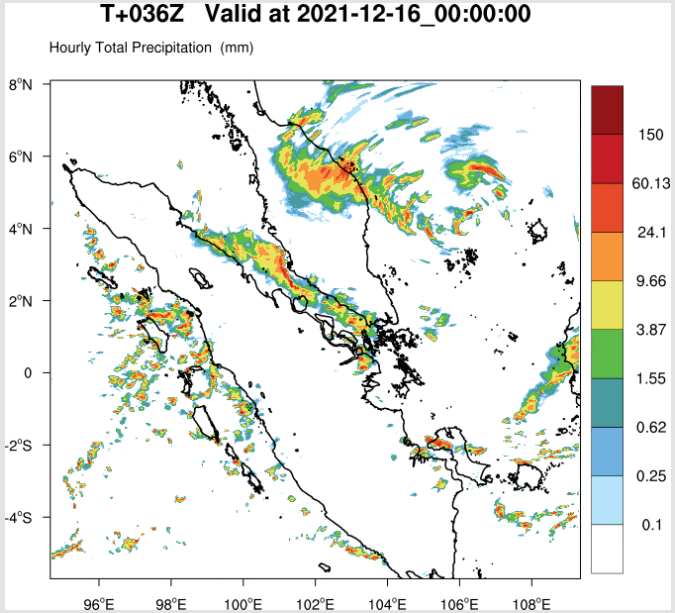
Climatology and Climate Studies

Monitoring and assessment of the climate of Singapore

Weather Research

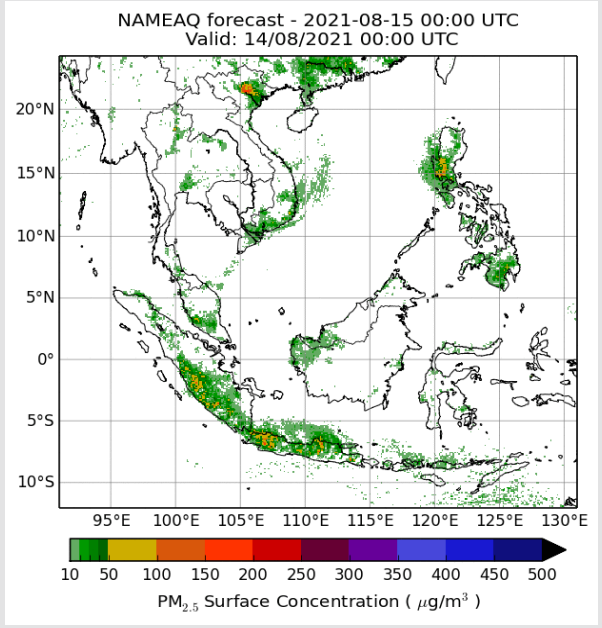
SINGV: MSS's Operational Real-time NWP system

- Regional 48-hour forecasts eight times a day.
- Driven by ECMWF lateral boundary conditions four times a day.
- 1.5 km horizontal resolution, 80 vertical levels up to 38.5 km.



Air quality pollutant models

- Model dispersion of atmospheric pollutants
- Experimental AQ forecasting system now running in real-time
- 2-day forecasts of smoke haze, pollutants (e.g. volcanic ash)

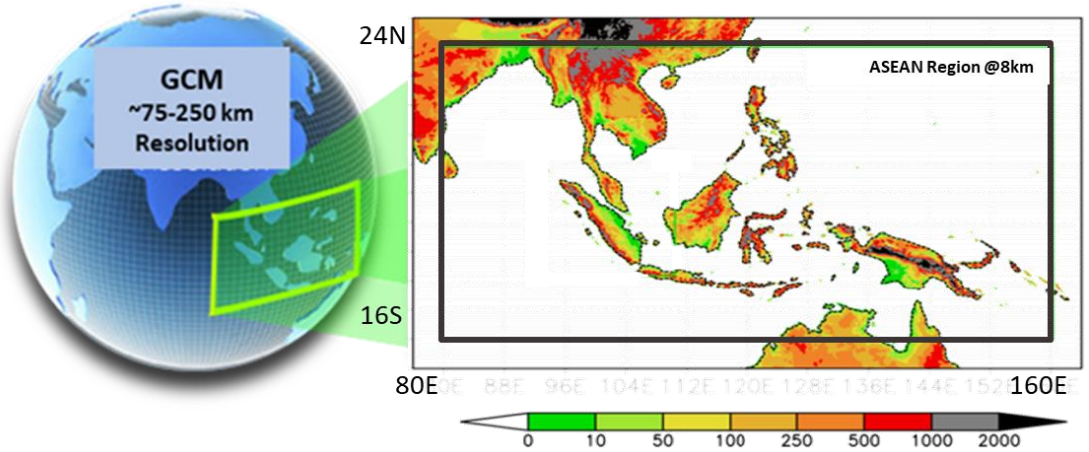


Climate Science and Projections

Singapore's National Climate Change Studies: These studies guide government agencies in their long-term adaptation plans for addressing the effects of climate change on Singapore's physical environment

Third National Climate Change Study (2023)

- Work underway at CCRS; to be completed by end-2023
- To contextualise findings from IPCC AR6 and study its impact on Singapore.
- To provide localised and high-resolution climate projections derived from the latest climate models.
- Applies CCRS's SINGV as a regional climate model at 8 km/2km resolution up to 2100



- Temperature
- Humidity
- Sea Level Rise
- Wind Speed
- Precipitation

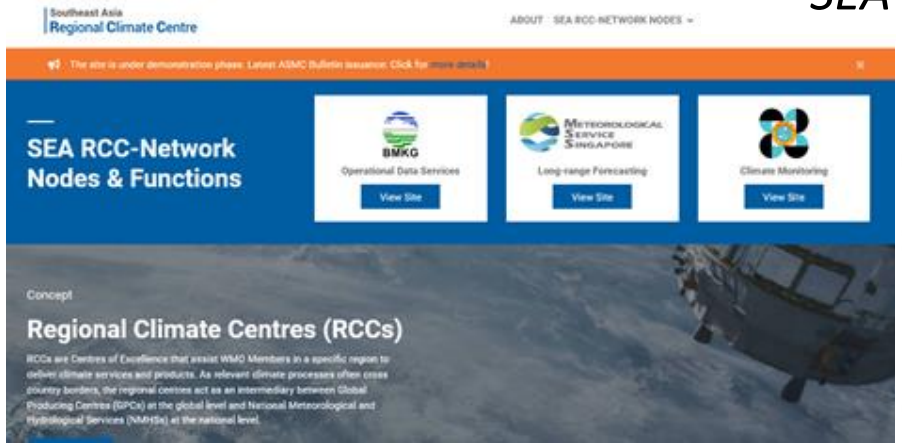
Tapping on the Subseasonal to Seasonal Forecast Skill to Develop Cutting-Edge Applications

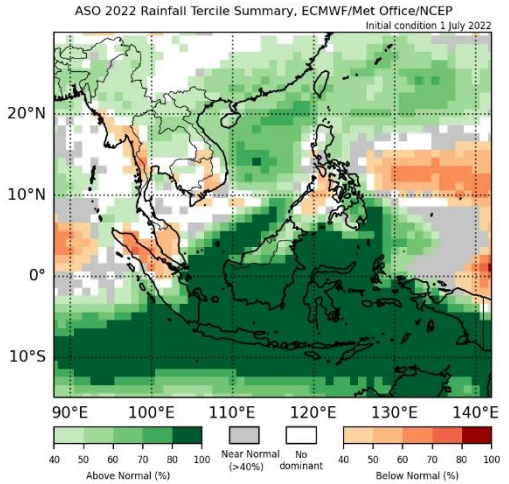
Growing suite of regional products
-WMO Southeast Asia Regional Climate Centre, ASMC website

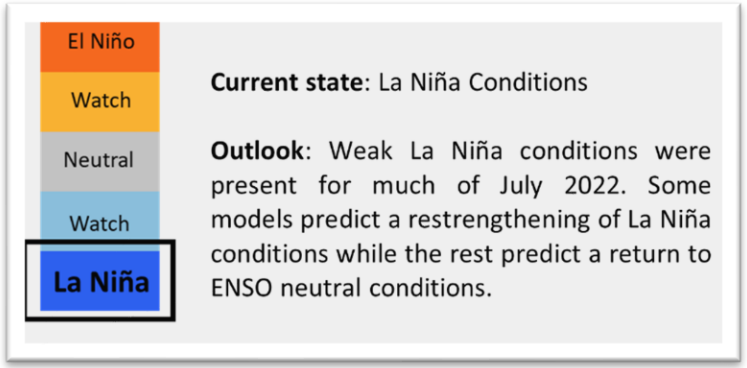
Developing locally relevant key climate monitoring indices
-El Niño Southern Oscillation (ENSO) monitoring system
-Indian Ocean coming soon
No single way to measure the important drivers for our weather/climate

Promoting use of products to national stakeholders

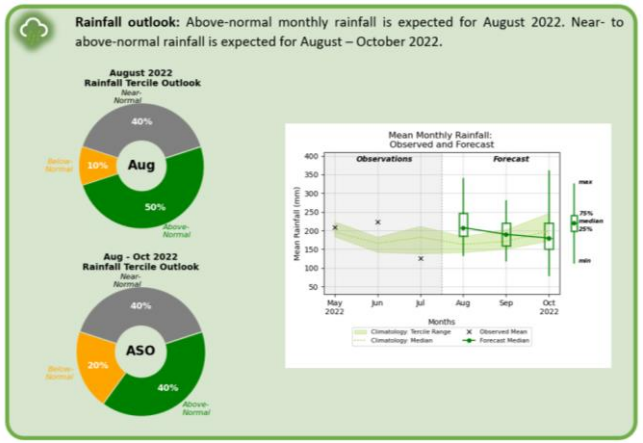
SEA RCC rainfall outlook







ENSO system



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INTERNATIONAL ENGAGEMENTS

Key international and regional partners

International

WORLD METEOROLOGICAL ORGANIZATION

United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

ICAO • OACI • ИКАО 国际民航组织 • ايكاو

ipcc INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP

Regional

asean

ESCAP/WMO Typhoon Committee

ASMC ASEAN SPECIALISED METEOROLOGICAL CENTRE

International Cooperation with WMO

Singapore has been a member of the WMO since 1966

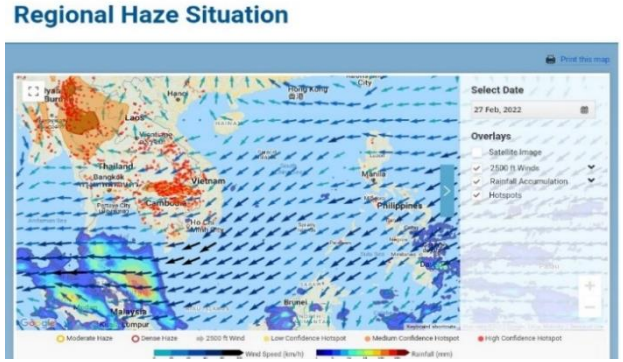
WMO Regional Office for Asia and the South-West Pacific (RAP)

- Hosted by Singapore since 2018

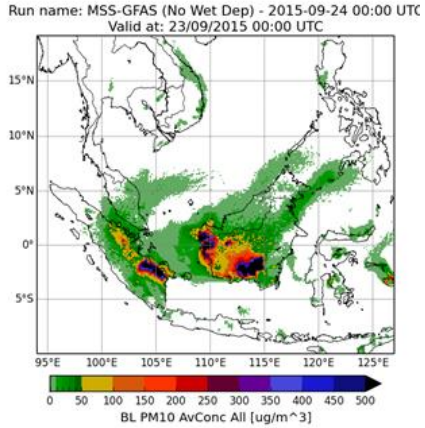
Working with WMO on global and regional initiatives

- SEA RCC-Network *(MSS leads the long-range forecasting node)*
- Subseasonal-to-Seasonal Predictions for Southeast Asia (S2S-SEA)
- Training on Aeronautical Meteorology for the South-West Pacific Island States
- ASEAN Climate Outlook Forum (ASEANCOF)
- ASEAN Regional Climate Data, Analysis and Projections (ARCDAP)

ASEAN Specialised Meteorological Centre



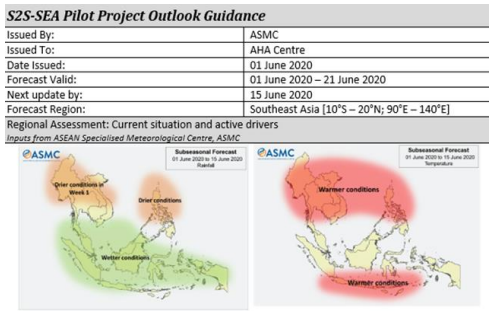
Regional weather, hotspot and haze monitoring and assessment



Atmospheric Dispersion modelling

Alert Levels	Conditions/Trigger Points
Alert Level 1	• Dry Season
Alert Level 2 Alert Level 3	• High hotspot counts detected on 2 consecutive days with dense smoke plumes • Dry weather conditions persisting • Hotspot distribution in critical areas • Prevailing winds blowing towards ASEAN countries

Alerts and early warning for transboundary haze



S2S-SEA Pilot Project Outlook Guidance

Issued By:	ASMC
Issued To:	AHA Centre
Date Issued:	01 June 2020
Forecast Valid:	01 June 2020 – 21 June 2020
Next update by:	15 June 2020
Forecast Region:	Southeast Asia [10°S – 20°N; 90°E – 140°E]

Regional Assessment: Current situation and active drivers

Inputs from ASEAN Specialised Meteorological Centre, ASMC

Sub-seasonal to seasonal prediction for various user sectors

ASMC
ASEAN SPECIALISED METEOROLOGICAL CENTRE

asean

- MSS hosts and funds the ASMC, which serves the 10 Member States of the Association of Southeast Asian Nations (ASEAN).
- ASMC was first established in 1993, and its remit covers:
  - Weather and climate prediction services;
  - Transboundary smoke haze monitoring and early warning;
  - Regional capability development
    - » *e.g. ASMC Scientist Attachment Programme*

Key ongoing initiatives include the **Regional (ASEAN) Climate Outlook Forum** and **Subseasonal-to-Seasonal Prediction for Southeast Asia**


METEOROLOGICAL
SERVICE
SINGAPORE