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HONG KONG OBSERVATORY

The 5th Meeting of the Coordinating Group of the RA II WIGOS Satellite Project

21 October, Vladivostok city, Russky Island, Russia

Far Eastern Federal University

Hong Kong, China

Mr. C.K .So, Scientific Officer

Hong Kong Observatory

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Outline

1. Introduction
2. Short description of HKO
3. Current Observational system overview
4. Satellite data collection and processing capabilities
5. Observations for forecasts and warnings
6. Future Work

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1. Introduction

1. Country overview

I. Basic information of Hong Kong, China

- Area: 1 104 km^2;
- Population: 7. 389 m (as of mid-2017)
- Sub-tropical climate

II. Major historical meteorological disaster events

- Typhoon and storm surge
- Flooding and landslide due to severe thunderstorms and rainstorms

III. Major national economic sectors relying on Met Services

- The whole economy, including financial, public utilities, shipping, transportation, tourism, ...

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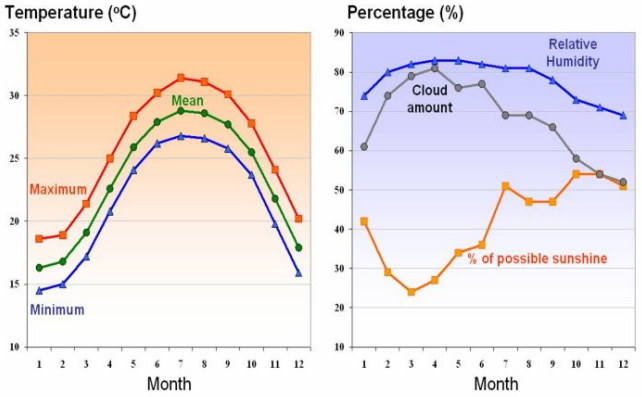
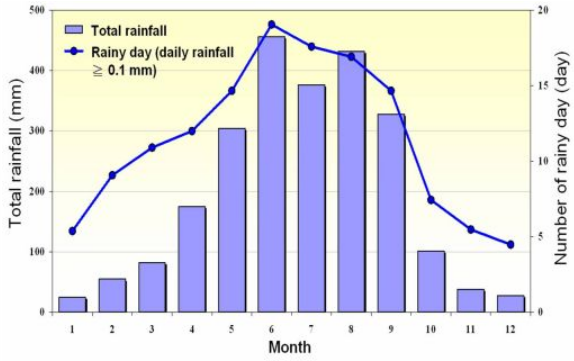
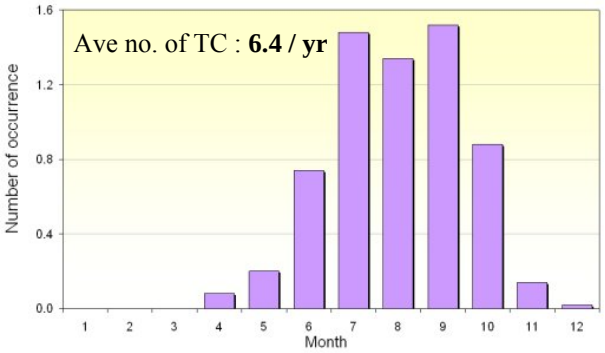
Weather of Hong Kong



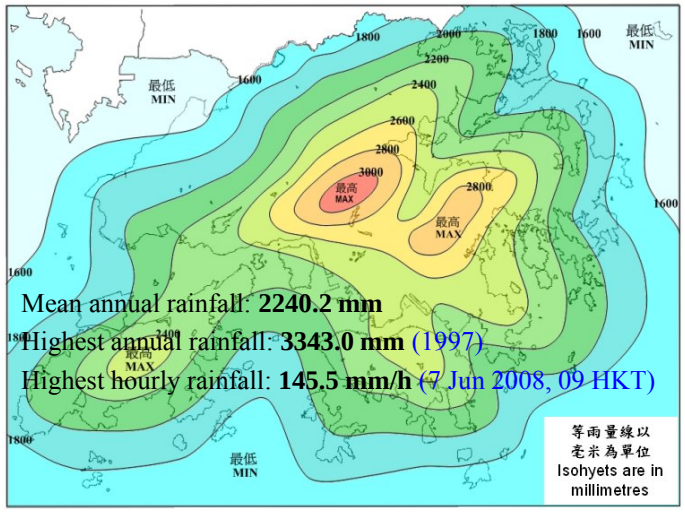
Monthly means of daily maximum, mean and minimum temperature (left), relative humidity, cloud amount recorded at the Hong Kong Observatory and percentage of possible sunshine at King's Park (right) between 1981-2010



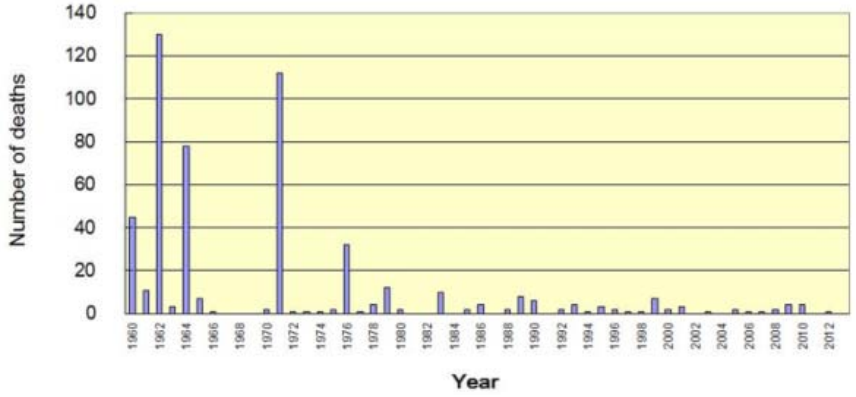
Monthly means of total rainfall and number of rainy day recorded at the Hong Kong Observatory between 1981 and 2010.



Monthly mean number of occurrence of Tropical Cyclones affecting Hong Kong (1961-2010)



Mean annual rainfall: **2240.2 mm**
Highest annual rainfall: **3343.0 mm** (1997)
Highest hourly rainfall: **145.5 mm/h** (7 Jun 2008, 09 HKT)



Recent typhoon casualties (after 1960)
(but >10,000 deaths in 1906 and in 1937, >2,000 in 1874)

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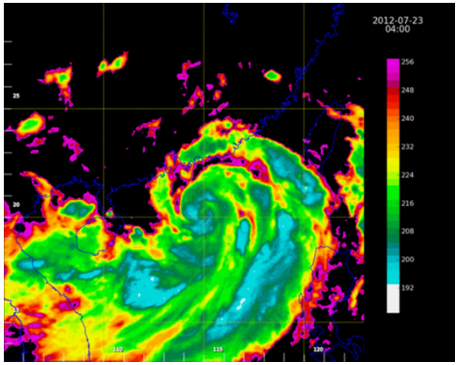
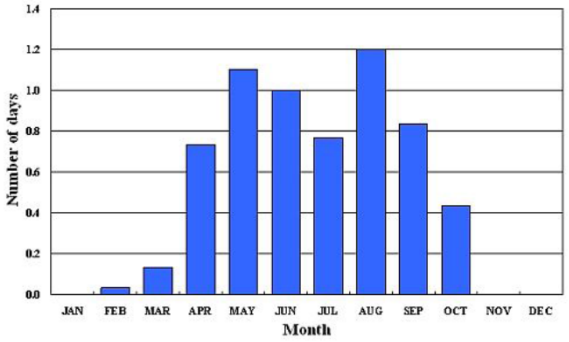
Top hazardous weather of concern in HK (monitored by satellites)

- Tropical cyclones

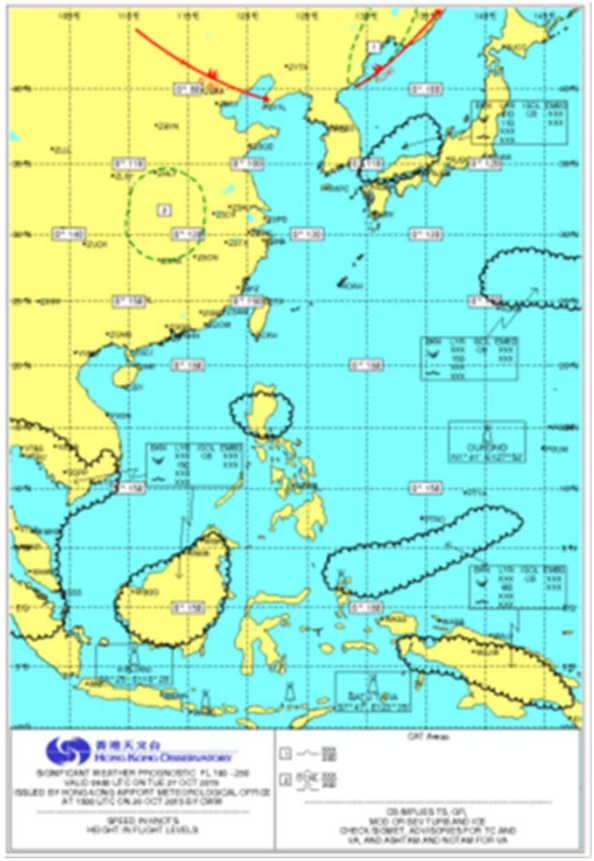


- Severe thunderstorms and rainstorms



Average number of heavy rain days with hourly rainfall ≥ 30 mm in each month (1971-2000) – flooding and landslides

- Aviation safety



- thunderstorms
- tropical cyclones
- turbulence
- icing
- mountain wave
- volcanic ash

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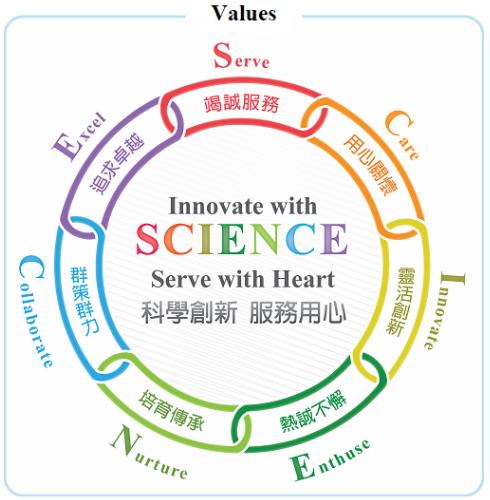
2. Mission and Short Description of NMHS

a) HKO's Mission, Mandate

- Weather services and warnings
- Climatological services
- Aviation weather services
- Marine weather
- Radiation monitoring and assessment
- Geophysical service, i.e. Astronomy and tide, earthquake and tsunami
- Time standard

Vision-Mission-Values



Serve	Care	Innovate	Enthuse	Nurture	Collaborate	Excel
竭誠服務	用心關懷	靈活創新	熱誠不懈	培育傳承	群策群力	追求卓越

Vision

Be a model of excellence
in protecting lives and building together a better society
through science.

Mission

To provide people-oriented quality services in meteorology and related fields,
and to enhance the society's capability in natural disaster prevention and response,
through science, innovation and partnership.

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2. Mission and Basic Info of NMHS

b) Historical development of observing networks

- Hong Kong Observatory established in 1883
- Routine surface observations began in 1884
- Break during WWII
- Upper-air sounding operation since 1950s
- Satellite reception since early 1960s
- AWS introduced in 1984
- Since 1985 – collaboration with Guangdong Met Bureau to set up AWS in offshore islands beyond HK territory
- Nowadays, HKO operates a wide variety of observation networks, including radars, satellite reception stations, lidar, microwave radiometer, wind profilers, upper-air station, AWS, tide gauges, lightning network, solar radiation station, visibility metres, evaporation pans and lysimeters, CO_2 measurement, radiation monitoring network .....

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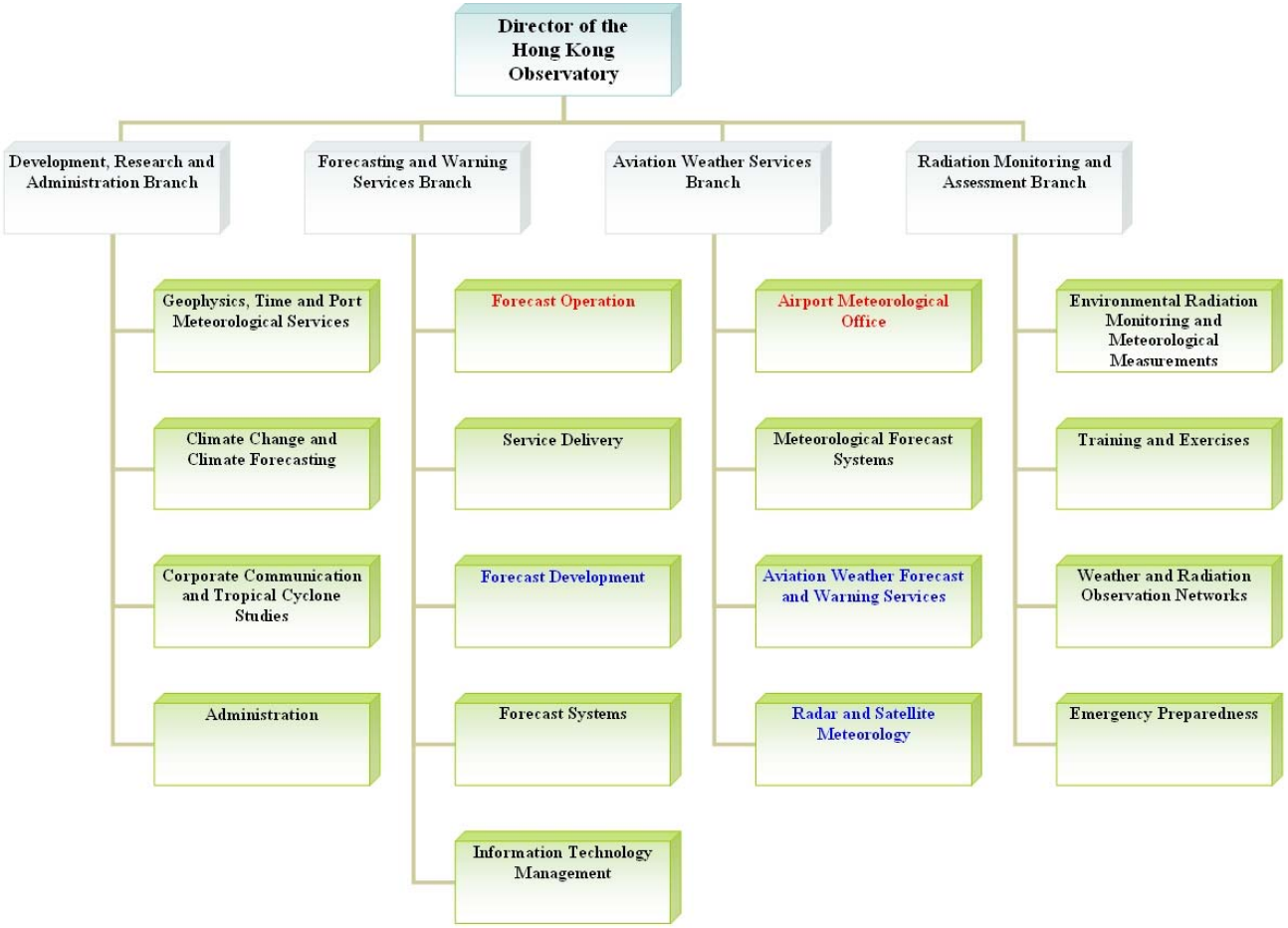
c) Staff composition



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c) Staff composition

Director - Mr SHUN Chi-ming
4 - Assistant Directors

54 - Scientific Officer Grade
Fulfil requirement of WMO's Basic Instruction Package for Meteorologists [BIP-M]
46 - Experimental Officer Grade [BIP-M]
94 - Scientific Assitant Grade [BIP-MT]
25 - Radar Specialist Mechanics Grade

+ other staff (a total of about 300 staff)

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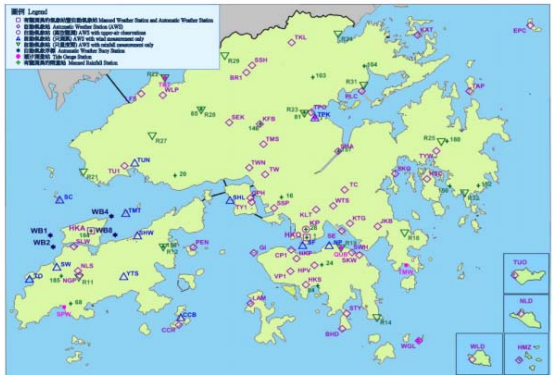
3. Network of Observations of HKO

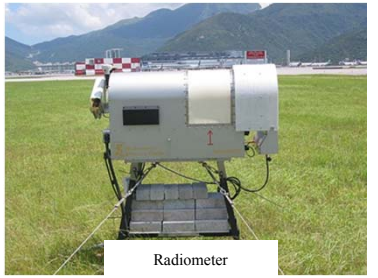
3.1 Surface stations, upper-air, remote sensing, etc



Locations of Weather stations, Rainfall and Tide Gauge Station as at 31 Dec 2013

LIDAR for windshear detection

Wind profiler



Radiometer

Automatic sounding station

Lightning network

Tide gauge station

Weather buoy

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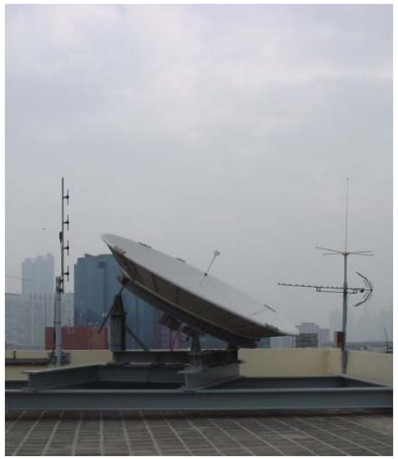
Satellite Reception

MTSAT/HimawariCast antenna at the HKOHQ

HimawatiCloud

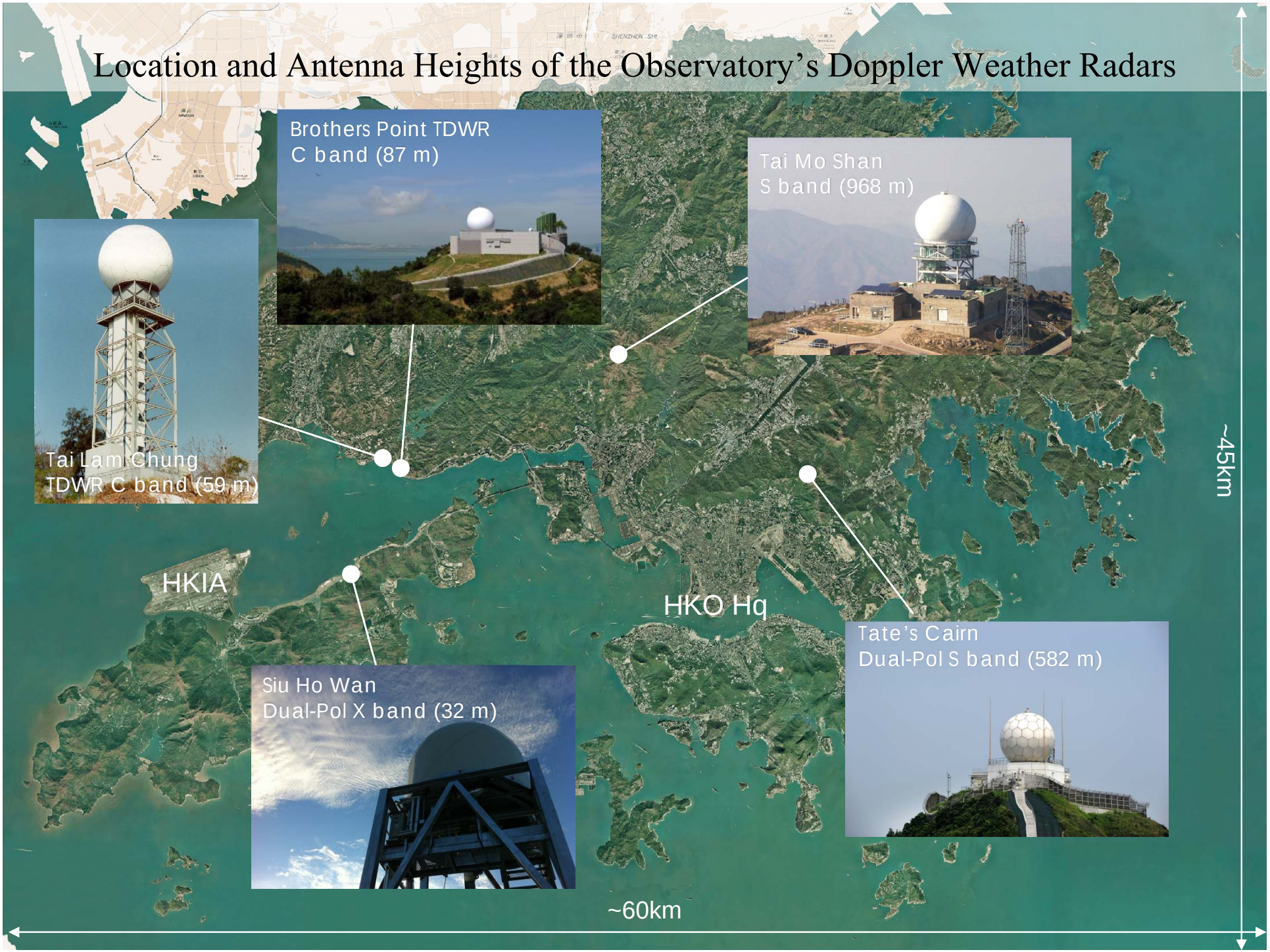
FY-2 antenna at the HKOHQ



CMACast Reception antenna at HKOHQ

Tracking antenna for MODIS/POES at King's Park Meteorological Station

Location and Antenna Heights of the Observatory's Doppler Weather Radars



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4. Satellite data collection and processing capabilities

4.1 Satellite Data Sources

- Himawari-8 Reception System (since 2015)
  - HimawariCast (upgrade of MTSAT system), receiving 14-band HRIT satellite data from JCSAT-2B
  - HimawariCloud - Internet download of 16-band Standard Data (HSD) from JMA
- FYCast/CMACast Reception System (since 2008/2012)
  - Re-broadcast satellite data from AsiaSat4, including FY2E/FY2G, FY2F (rapid scan), NOAA-series, MODIS, METEOSAT and GOES-series satellite data
- MTSAT Reception System (since 2007)
  - HRID, HRIT data from MTSAT (cease operation Mar 2016)
  - VISSR data from FY-2G
  - Himawari-8 HRIT data converted from HSD download from JMA as backup
  - COMS-1 data from KMA
- MODIS Reception System (since 2004)
  - AQUA and TERRA + NPP
- POES Reception System (since 2002)
  - NOAA + Metop
- Haiyang-2A Reception System (since 2013)
  - Internet download from CNSA and VSAT

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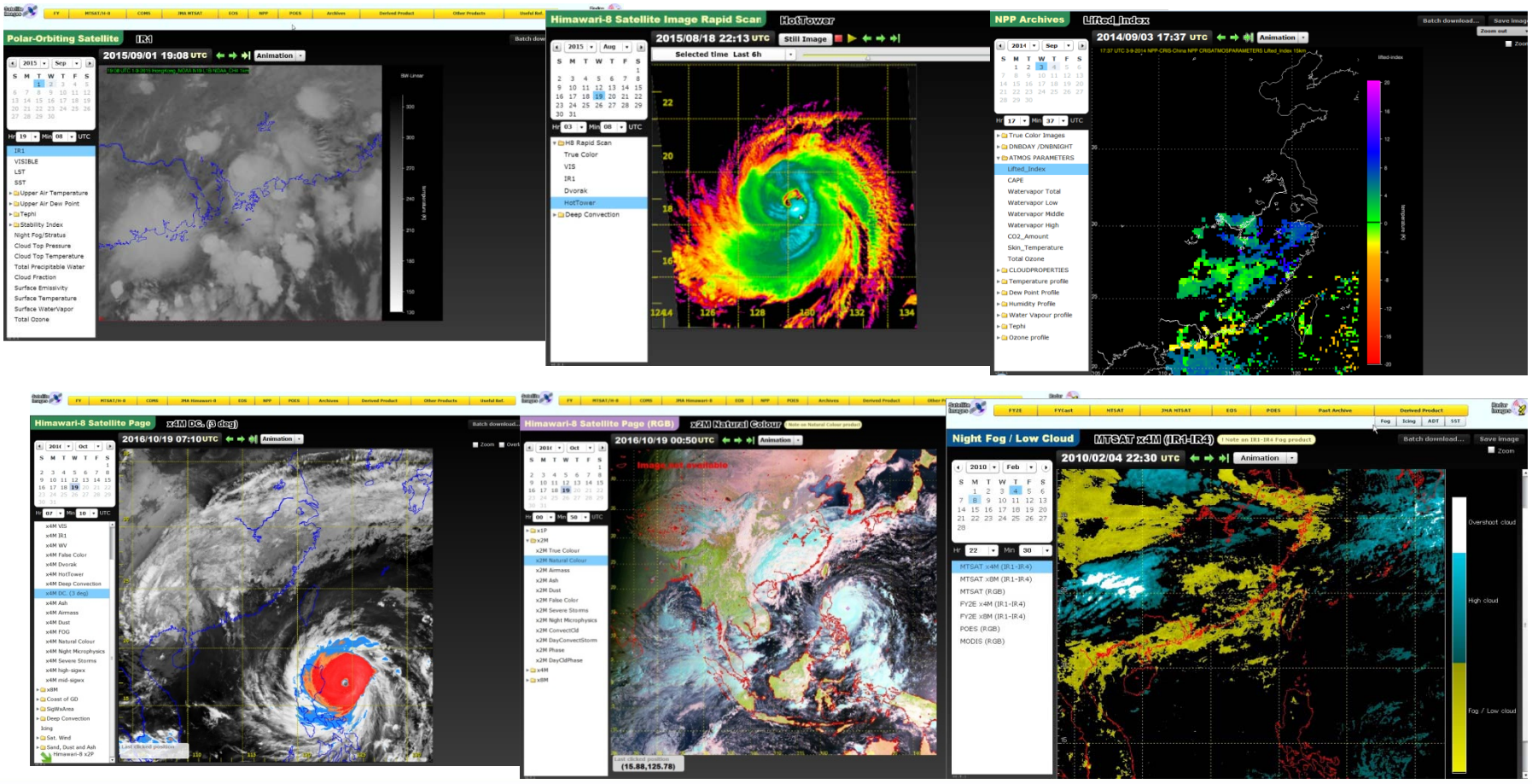
4.3 Data visualization and processing

4.3.1 Display of satellite image all-in-one on intranet



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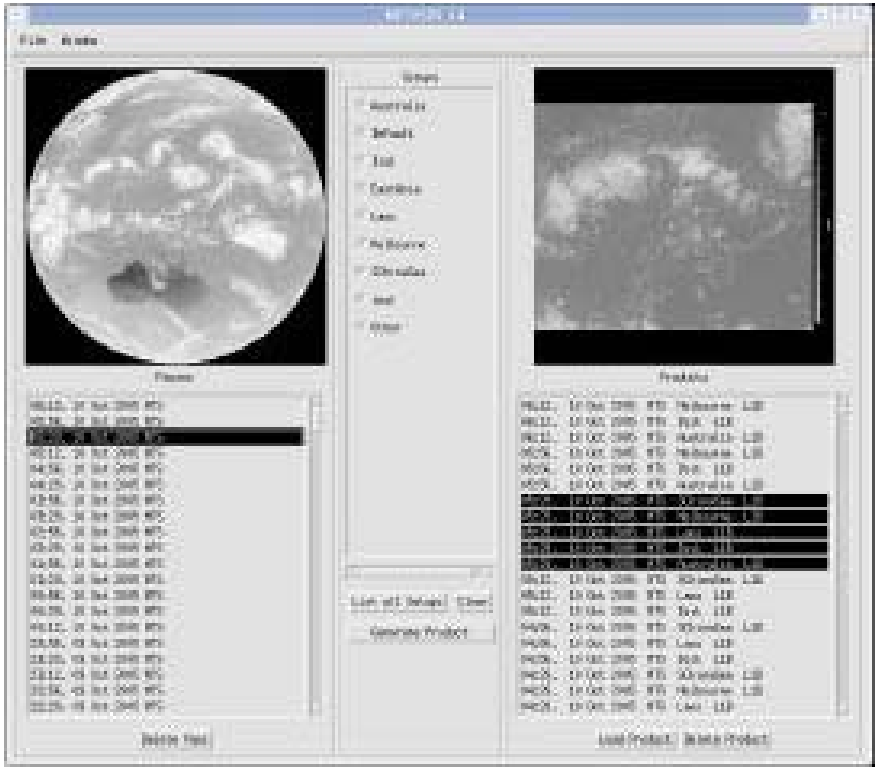
4.3.2 Dedicated display for forecaster



METEOR is used to display and analyse the satellite image products.

Provides a range of display and analysis functions, including:

- zoom and pan;
- histogram equalisation;
- manual brightness and contrast controls;
- distance and bearing between two points;
- define and load new colour tables;
- RGB and channel combination.

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4.4 Satellite data applications

4.4.1 Himawari-8 images and data are used for weather monitoring and warning services, nowcast and numerical models:

(i) Single channel images
(ii) Rapid scan images
(iii) RGB composite images
(iv) ADT (Auto-Dvorak)
(v) Cloud property products
(vi) Atmospheric products
(vii) Land and sea surface products
(vii) Rapid Thunderstorm Development (RTD) based on SAF
(viii) Convection Initiation (CI) based on SAF
(ix) Volcanic ash, dust and sand detection
(x) AOD, etc

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4.4 Satellite data applications

4.4.2 POES and MODIS satellites are mainly for atmospheric and environmental monitoring and research studies:

(i) Profile temperature and dew points
(ii) Cloud properties
(iii) Chlorophyll Concentration
(iv) Vegetation index
(v) AOD
(vi) SST, and etc

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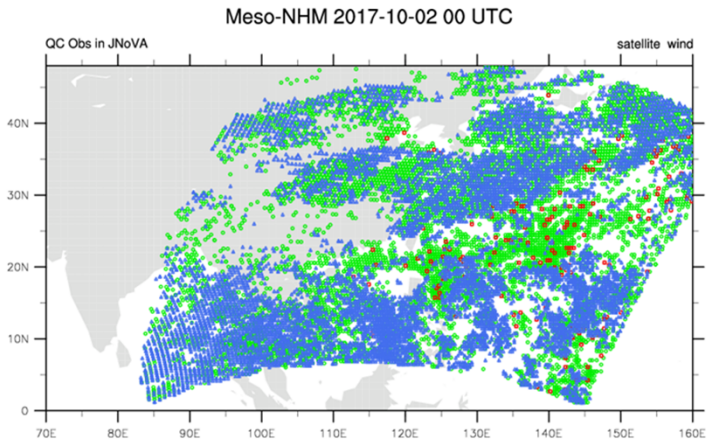
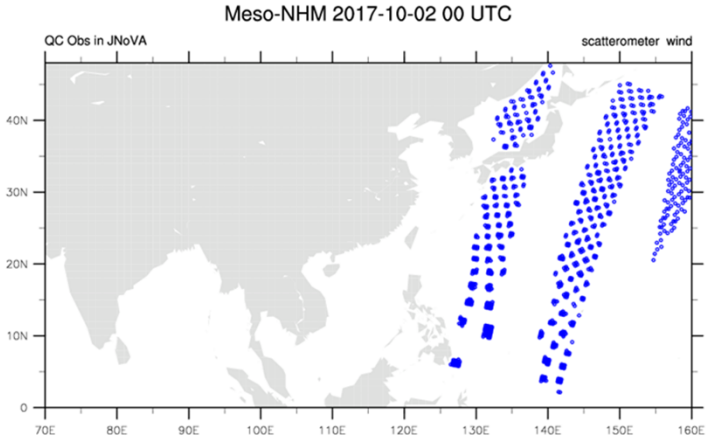
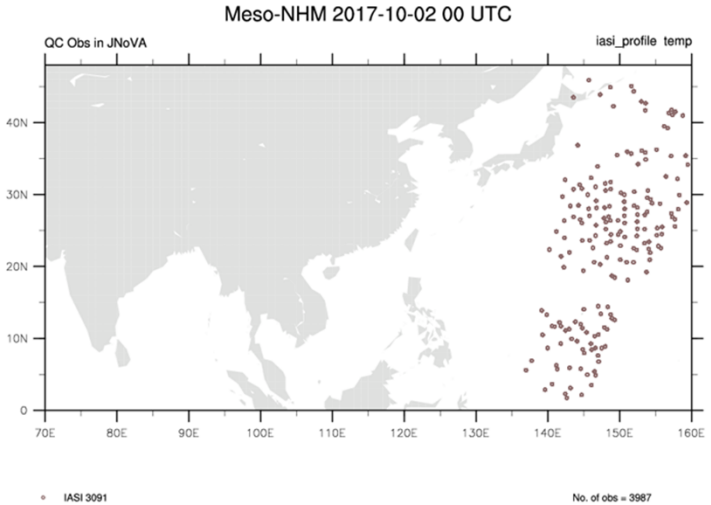
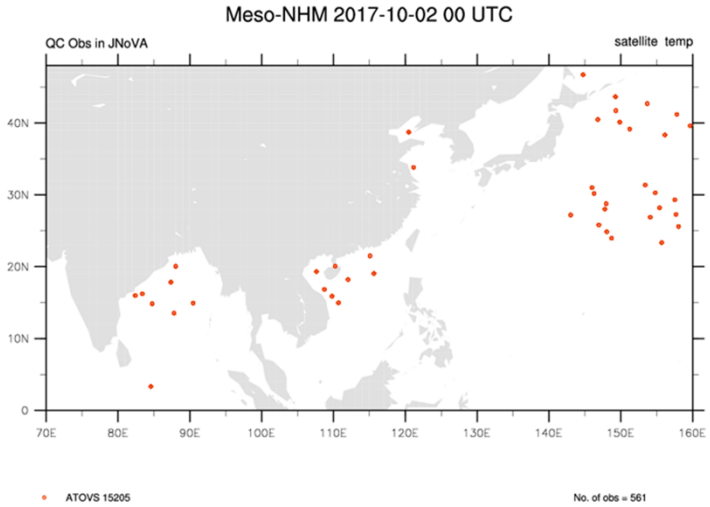
4.4 Satellite data applications

4.4.3 NWP Data Assimilation :









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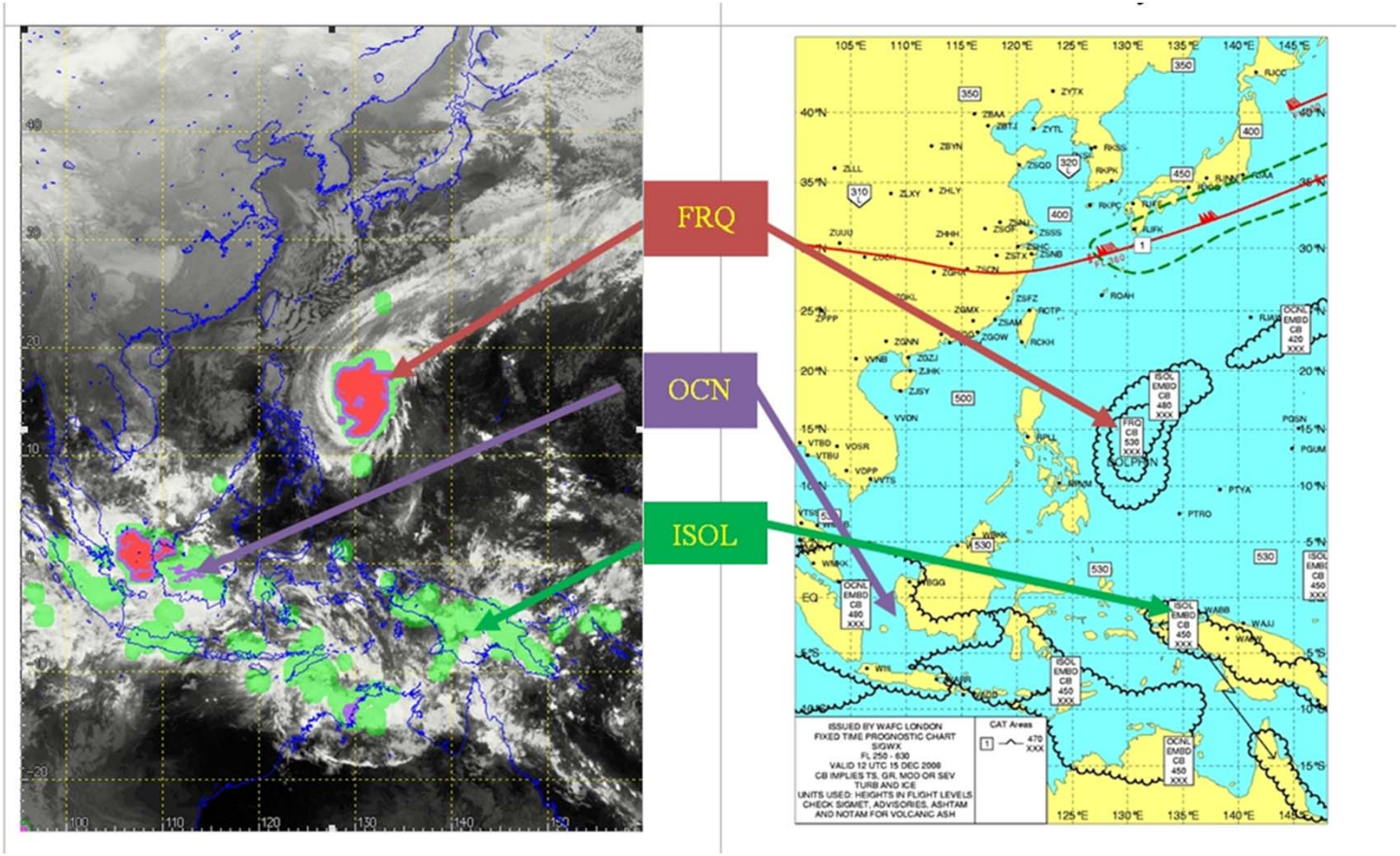
4.5 Satellite data applications examples

4.5.1 Deep convection classification



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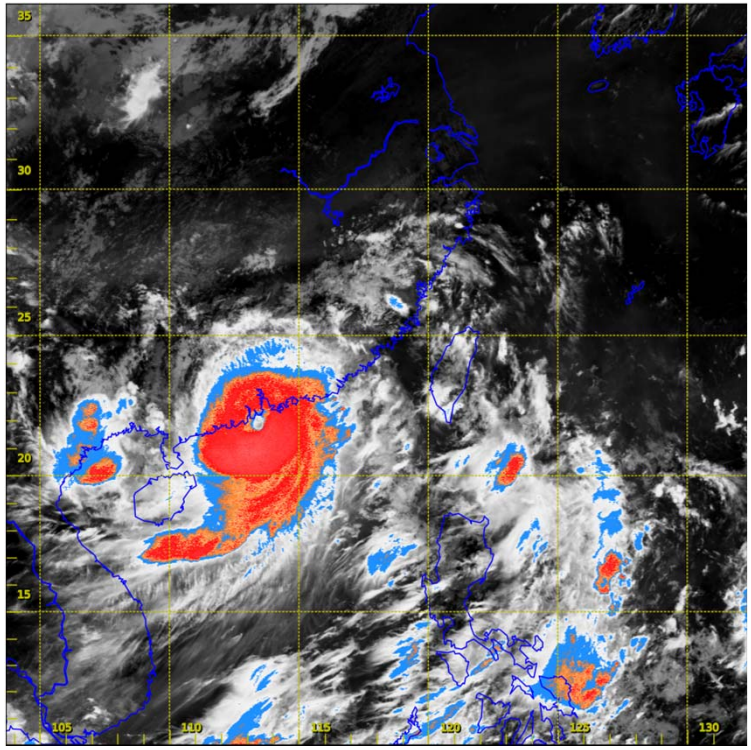
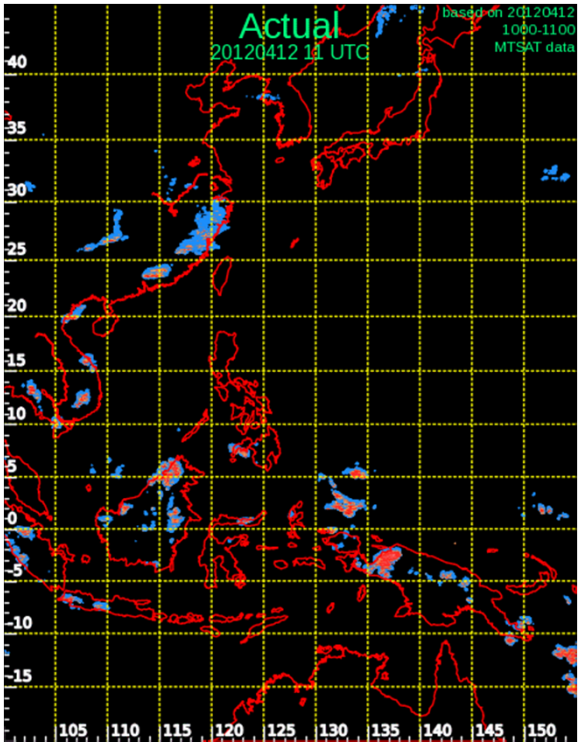
4.5 Satellite data applications examples

4.5.2 Deep convection monitoring and forecast

Infrared satellite image with highlighted areas of deep convection.



Convection forecast up to 10 hr, based on Full Multi-grid Optical Flow Algorithm (MuGOF)



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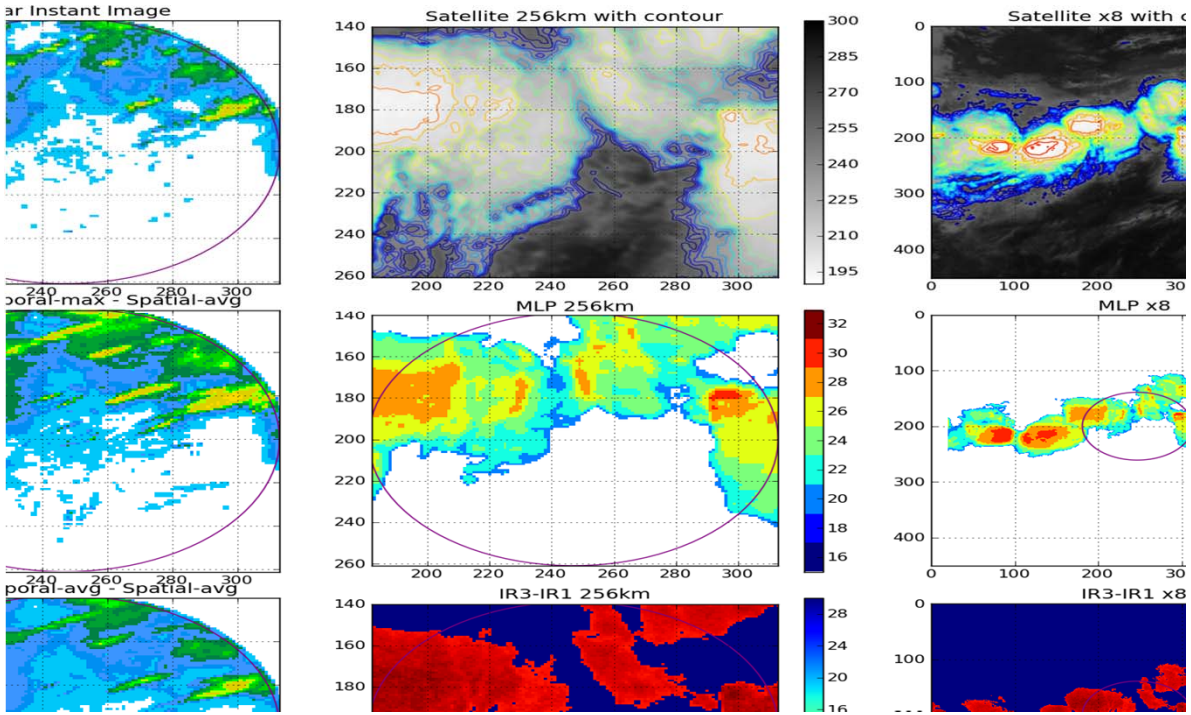
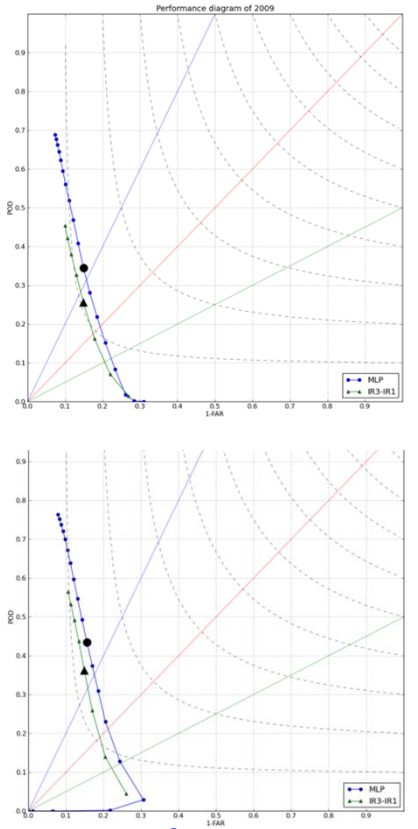
4.5 Satellite data applications examples

4.5.3 Convective System Identification using Multilayer Perceptron (MLP) (supervised artificial neural network algorithm)



Himawari-8 data (IR1, IR2, IR3) as a source of training data

dBZ from radar as target of regression



MLP outperforms IR3-IR1
Describes more exact to the heavy rain (> 27dB)

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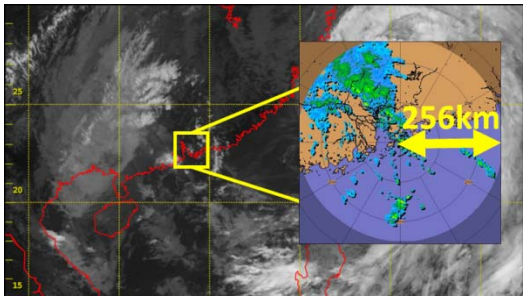
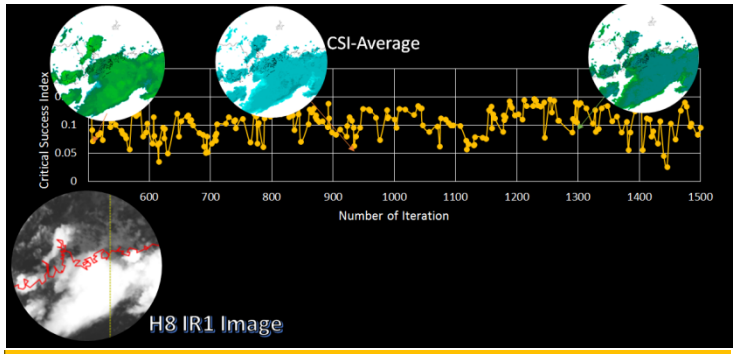
4.5 Satellite data applications examples

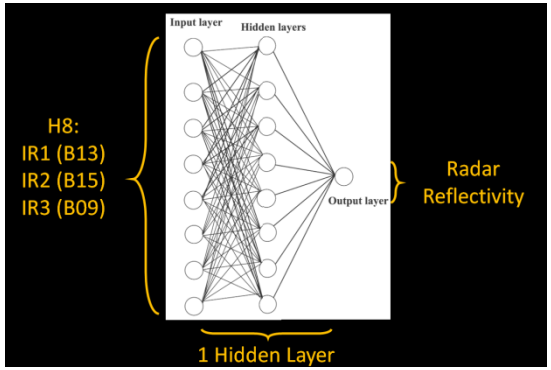
4.5.3 Himawari-8 Satellite derived Reflectivity using Multi-layer perceptron artificial neural network(MLPANN)



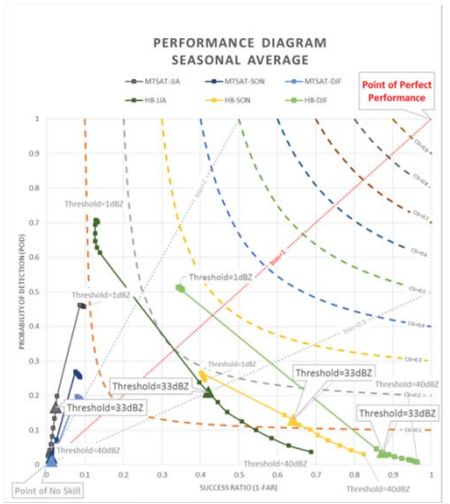


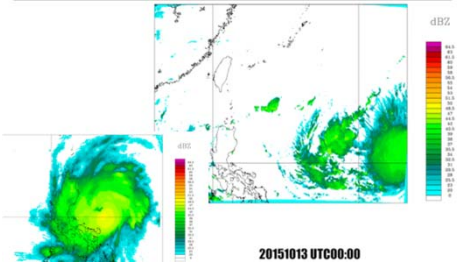
Channel Include	Neural Network Inner Structure	Temporal Resolution	Performance optimized at proportion of iteration
9,13,15	(13,1)	60 min. (00) 24 hours	90%
9,13,15	(13,15,1)	60 min. (00) 24 hours	77%
9,13,15	(13,15,7,1)	60 min. (00) 24 hours	27%

Best performed algorithm



- High Temporal Resolution (10mins per snapshot) of satellite data →alleviate dependent on Extrapolation
- Increase accuracy in deriving motion field and short-range forecast
- Provide Precipitation Observation for other regions
- Ability to provide higher spatial coverage Rainfall Reflectivity Map





20151017 UTC00:00
Typhoon Koppu
2015 Mid October

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5. Observations for forecasts and warnings

Tropical Cyclone Warning Signals

- T1 — Standby Signal No.1
- 3 — Strong Wind Signal No.3
- 8 NW 西北 / 8 SW 西南 — Gale or Storm Signal No. 8
- 8 NE 東北 / 8 SE 東南 — Gale or Storm Signal No. 8
- 9 — Increasing Gale or Storm Signal No. 9
- 10 — Hurricane Signal No. 10

Rainstorm Warning Signals

Other Warnings

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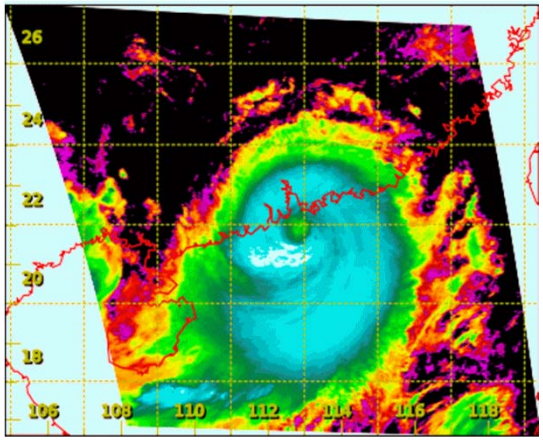
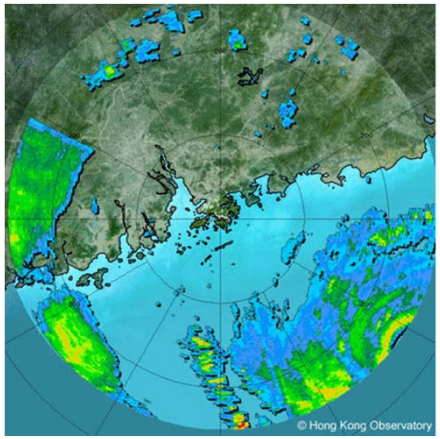
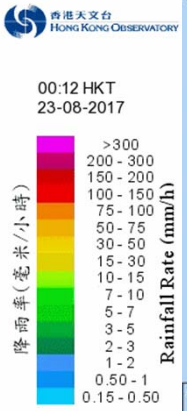
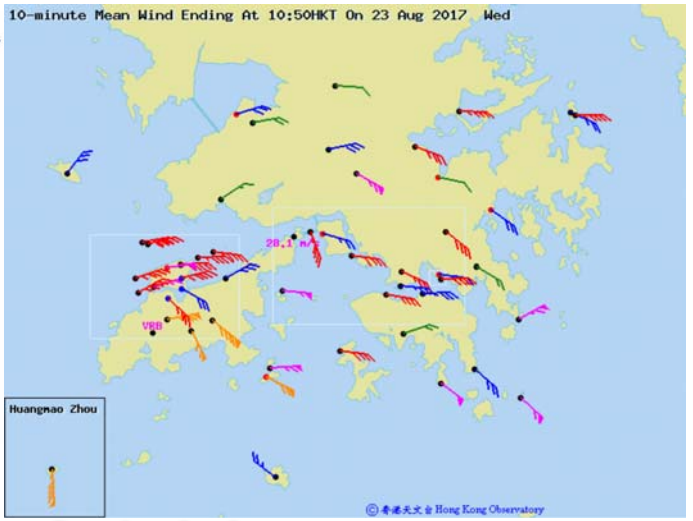
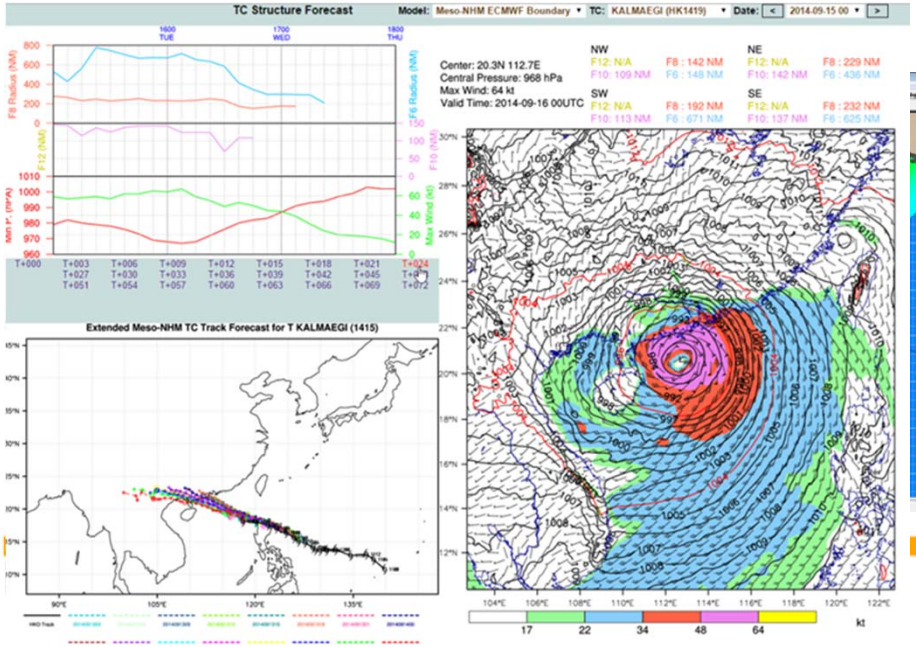
6. Observations for forecasts and warnings

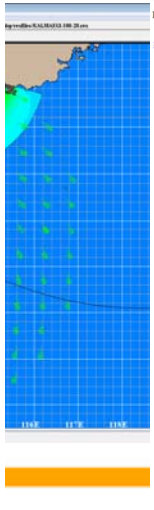


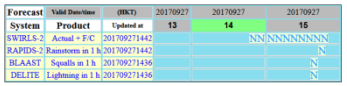


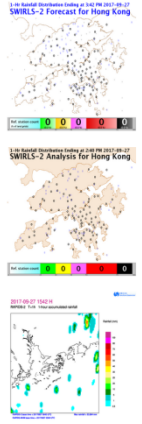


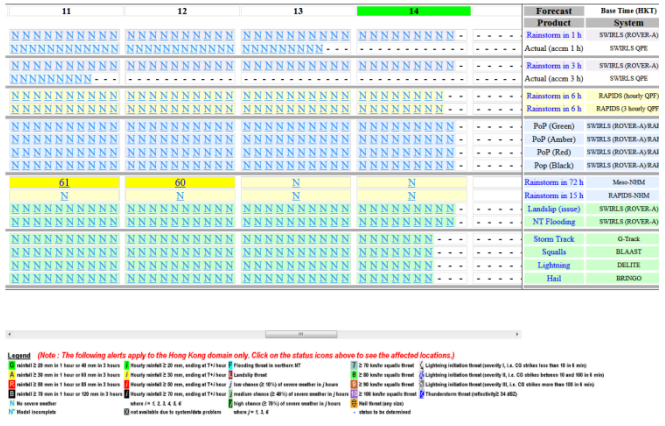












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5. Observations for forecasts and warnings

Information for the public and special users via different channels – multi-media, Internet, Mobile Apps

Apps on mobile devices

Severe Weather Information Centre
operated on behalf of WMO by HKO

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6. Future Work

- Implement FY4A Satellite Reception System
- Reception of new generation satellites, e.g. GEO-KAMSAT, etc
- To develop new products taking advantage of the high spatial and temporal resolution data of new satellites.
- Carry out experiments and works on ingesting data from different variety of satellites for improving model forecasts
- To participate in scientific conference/meeting with focus of new generation satellite data.

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Thank you!