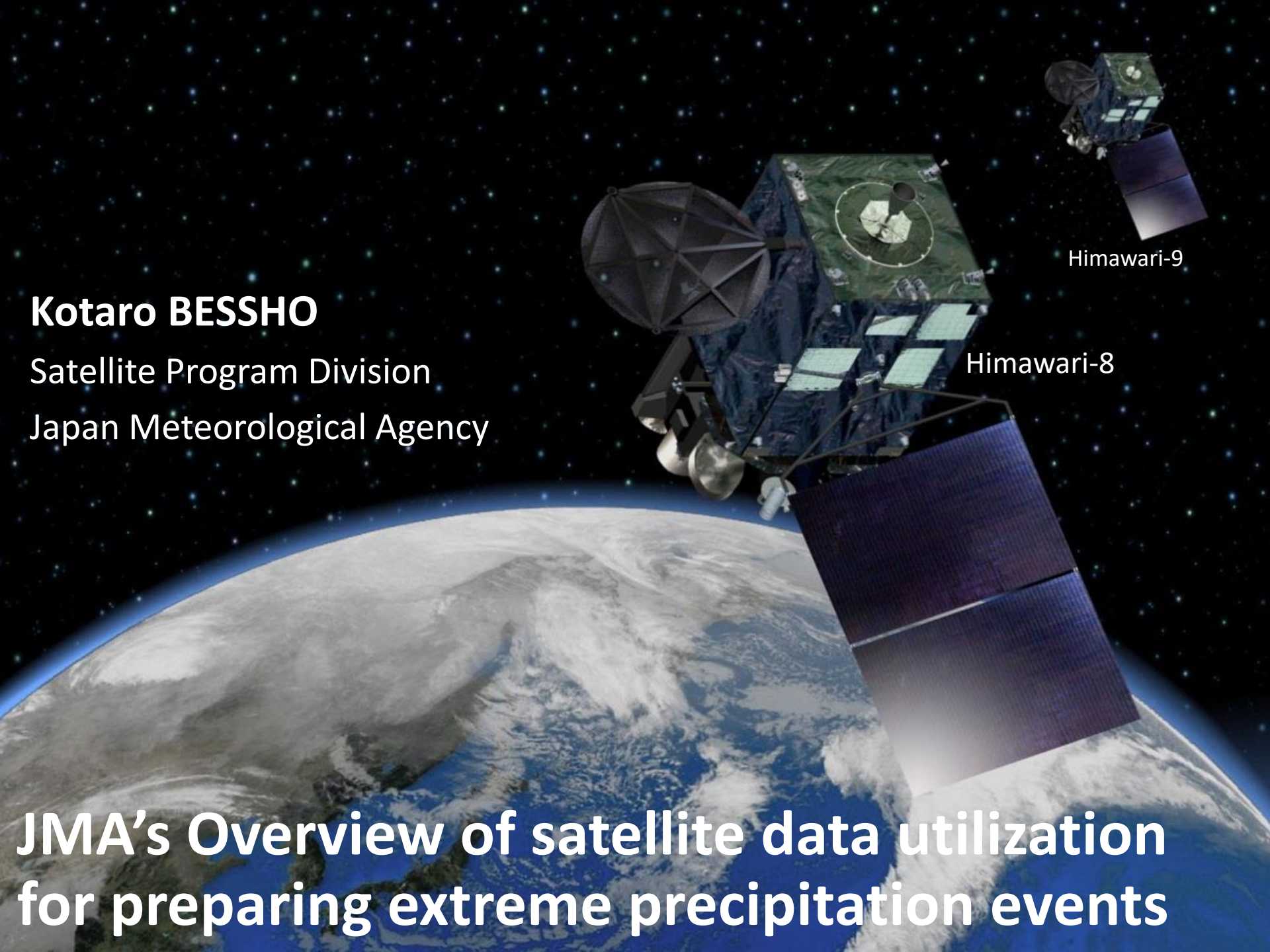
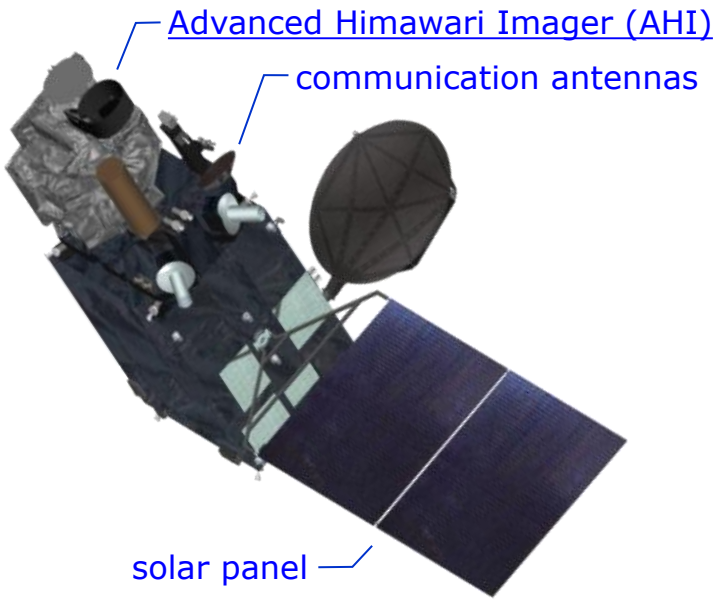


Kotaro BESSHO
Satellite Program Division
Japan Meteorological Agency

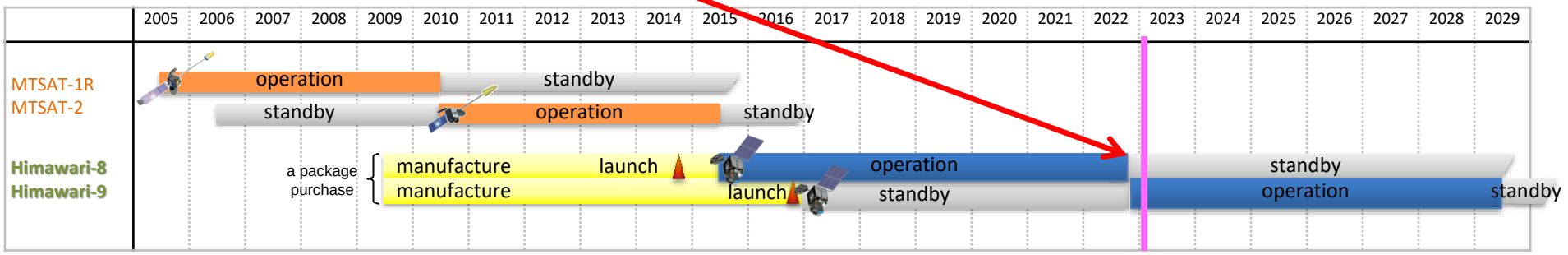
JMA's Overview of satellite data utilization for preparing extreme precipitation events

Himawari-8/9

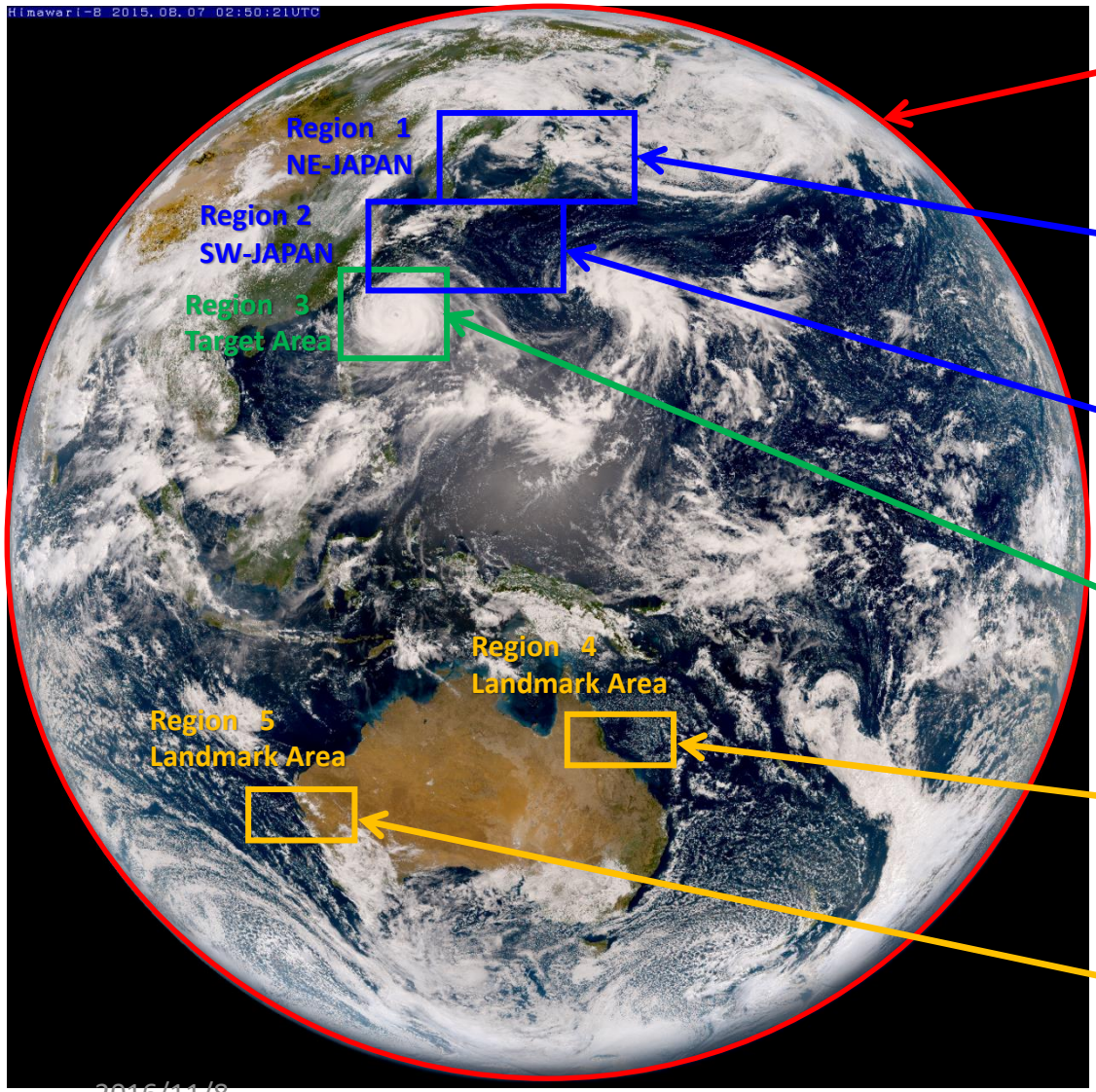


Geostationary position	Around 140.7° E
Attitude control	3-axis attitude-controlled geostationary satellite
Communication	1) Raw observation data transmission Ka-band, 18.1 - 18.4 GHz (downlink)
	2) DCS (Data collection System) International channel 402.0 - 402.1 MHz (uplink) Domestic channel 402.1 - 402.4 MHz (uplink) Transmission to ground segments Ka-band, 18.1 - 18.4 GHz (downlink)
	3) Telemetry and command Ku-band, 12.2 - 12.75 GHz (downlink) 13.75 - 14.5 GHz (uplink)

Himawari-9 began operation on 13 Dec. 2022, replacing the previous Himawari-8 operational satellite



AHI Observation Modes



Full disk

Interval : **10 minutes** (6 times per hour)

Region 1 JAPAN (North-East)

Interval : **2.5 minutes** (4 times in 10 min)

Dimension : EW x NS: 2000 x 1000 km

Region 2 JAPAN (South-West)

Interval : **2.5 minutes** (4 times in 10 min)

Dimension : EW x NS: 2000 x 1000 km

Region 3 Target Area

Interval : **2.5 minutes** (4 times in 10 min)

Dimension : EW x NS: 1000 x 1000 km

Region 4 Landmark Area

Interval : **0.5 minutes** (20 times in 10 min)

Dimension : EW x NS: 1000 x 500 km

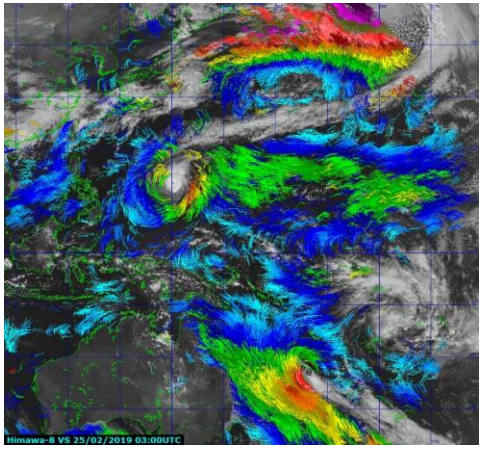
Region 5 Landmark Area

Interval : **0.5 minutes** (20 times in 10 min)

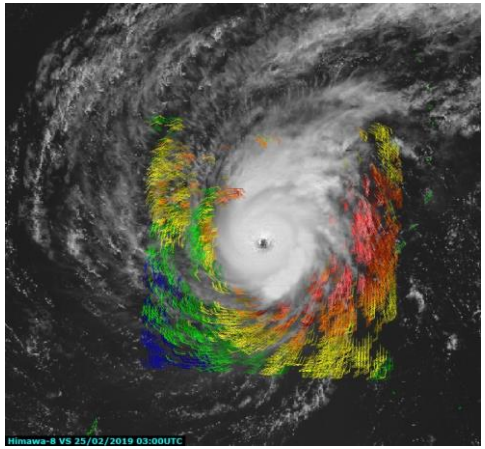
Dimension : EW x NS: 1000 x 500 km

AMV-based Sea surface Winds (ASWinds)

- JMA produces Atmospheric Motion Vectors (AMVs) based on the cloud movement using consecutive Himawari-8 imagery. JMA has used the AMV-based Sea-surface winds ("ASWinds") for estimating sea surface winds near tropical cyclones since July 2017.
- Algorithm and verification results are reported in Nonaka et al. (2019) (https://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/techrev/text21-3.pdf).



ASWinds from Full-Disk imagery at 0.64 µm (Visible) band (0300 UTC on 25 Feb. 2019)

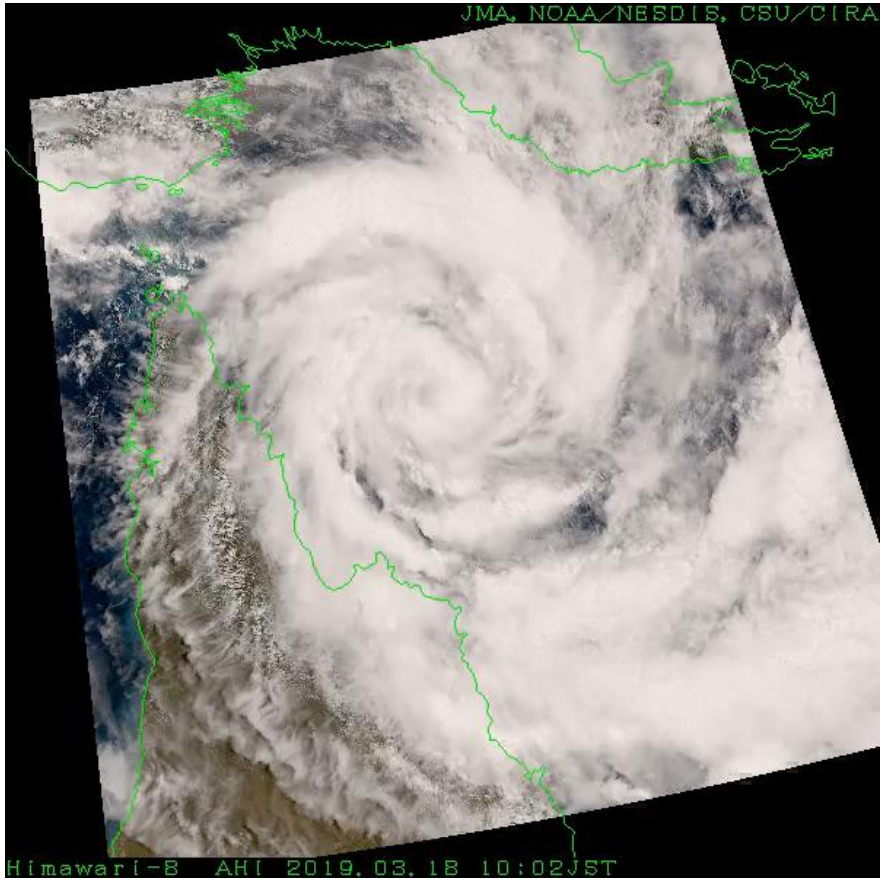


ASWinds from small domain around a typhoon. (0300 UTC on 25 Feb. 2019).

- ***Method :*** Simple linear regression estimation using low-level AMVs around tropical cyclones
- ***Time Interval :*** 30 min (Full-Disk), 10 min (Small domain around typhoon)
- ***Spatial Resolution :*** 20 km (Full-Disk), 4 km (Small domain around typhoon)
- ***Imagery bands*** : 0.64 µm, 3.9 µm and 10.4 µm

HimawariRequest

- HimawariRequest was started from January 2018 in cooperation with Bureau of Meteorology (BoM), Australia.
- International service for NMHSs in Himawari-8/9 coverage area to request Target Area observation (***1,000 x 1,000 km area every 2.5 minutes***).
- JMA expects this service to support ***disaster risk reduction activities in the Asia Oceania*** region.
- Status as of 17 Feb. 2023
  - Registration: **22** NMHSs
  - **166** requests implemented for TC, volcanic eruption, wild fires, etc.



HimawariRequest from BoM on 13-19 Mar. 2019

Recent disaster events in Japan

- In Japan, disasters caused by heavy rainfall occur almost every year.
- Many lives have been lost due to these disasters. (~100 people/year)
- In many cases, **Stationary Linear Mesoscale Convective Systems (SLMCS)**, cause floods, inundation and landslides.

Photo from 2020 Kyushu floods

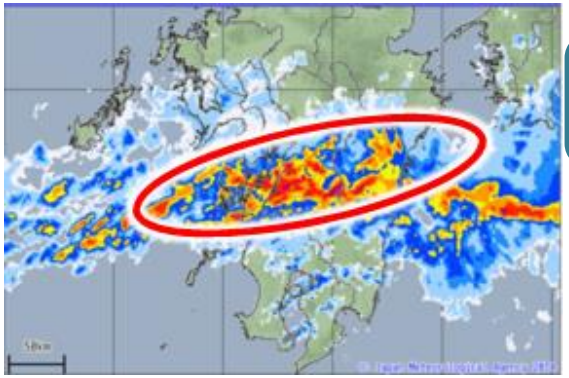
Houses submerged by the Kuma River (MLIT)

Extreme weather events that caused disasters (2020~)

events	period	damage
Heavy rainfall by Typhoon “TALAS”	September 2022	Land slide, flood and inundation
Storm and heavy rain by Typhoon ”NANMADOL”	September 2022	Storm surge, flood, landslide
Heavy rainfall in August, 2022	August 2022	Flood and inundation
Heavy rainfall by stationary front	August 2021	Flood and inundation
Heavy rain in July, 2021	July 2021	Landslide and flood
Heavy snowfall and storm	January 2021	
Heavy snowfall	December 2020	
Storm and heavy rain by Typhoon “HAISHEN”	September 2020	Storm surge, windstorm
2020 Kyushu floods	July 2020	Flood

Mechanism of SLMCS and challenge for prediction

Stationary linear mesoscale convective systems



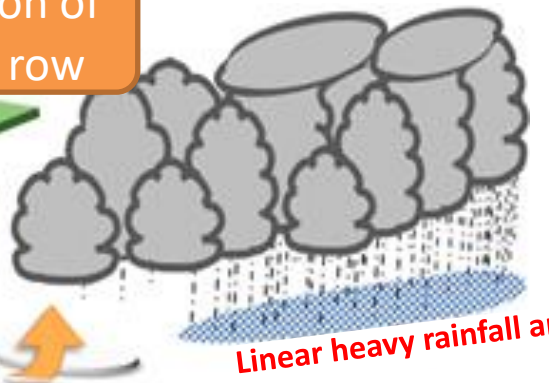
Radar observation, 4 July 2020

4. Upper winds supporting formation of multiple cumulonimbus clouds in a row

3. Unstable conditions supporting cumulonimbus development

1. Continuous flow of warm ***humid air over the sea***

2. Atmospheric lifting from local fronts or orographic effects to generate clouds



Challenge to improve prediction accuracy of SLMCS

(1) Accurate observation of water vapor inflow

(2) Improving prediction (NWP models) performance

(3) Provision of information on probability of occurrence

Strengthen/acceleration of initiatives for improving prediction accuracy of SLMCS

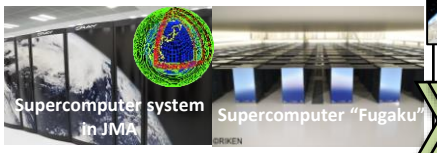
Observation

- Ground observation ・・・ Microwave radiometer, AMeDAS (add Hygrometer), Radiosonde system (Automatic Baloon Launcher)
- Satellite observation ・・・ Polar orbiting receiving system, Hyperspectral IR sounder(GEO)
- Heavy rain monitoring ・・・ Weather radar (add dual pol capability)
- Marine observation ・・・ Ship replacement of R/V “Ryofu-maru”, Water vapor observation with GNSS by ships

Follow-on Himawari (To be launched in JFY2028)

Prediction

- Procurement of JMA supercomputer system for advanced weather prediction system
- Intensive observation plan during rainy season, installment of experimental facility
- Prediction technology development using supercomputer “Fugaku” developed by RIKEN

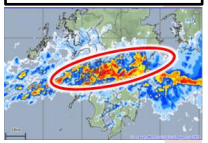


Reflection in order

Information

Announce the possibility of SLMCS

JFY2021
Information on occurrence of SLMCS



Display area of SLMCS as ellipse

“Early Evacuation in daylight hours” ・・・ Narrowing the **targeting area** on a step-by-step basis

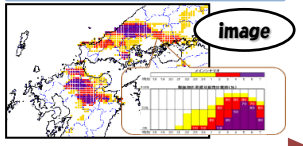
JFY2022~
Forecast half a day in advance **in a region**

JFY2023~
Near real-time forecast (goal: 30 minutes before)

JFY2024~
Forecast half a day in advance for **each prefecture**

JFY2026~
Near real-time forecast from earlier (goal: 2~3 hours before)

JFY2029~
Publication of information using risk maps half a day in advance for **each municipality**

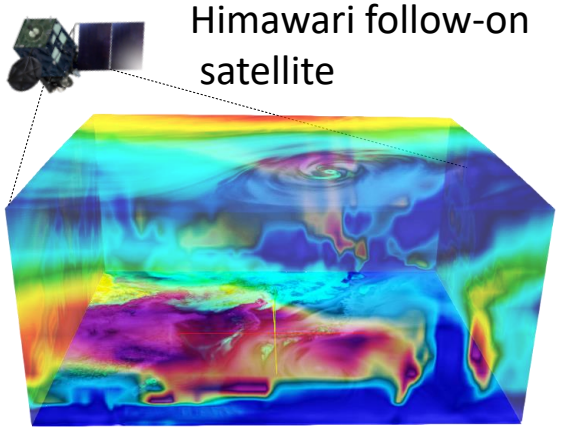


“Evacuation immediately from approaching disaster” ・・・ Extending the **forecast time** gradually

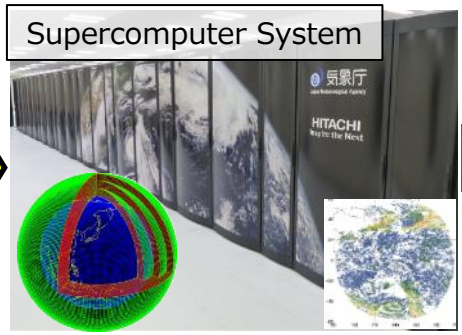
Display of rainfall area due to SLMCS

What is new sensor for predicting extreme precipitation events?

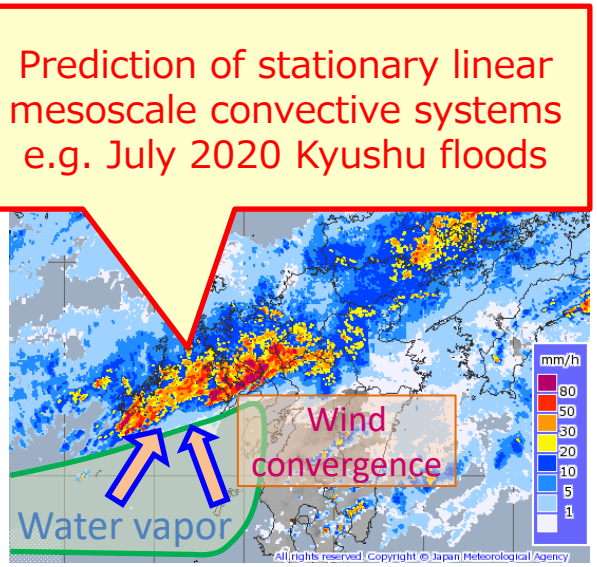
- Essential understanding of the mechanics behind atmospheric humidity causing hazardous precipitation
- Current “Himawari-8/9” just can observe two-dimensional spread of clouds and water vapor
- Important role of <u>three-dimensional humidity information</u> from a hyperspectral IR sounder in geostationary orbit



3-D humidity Observation

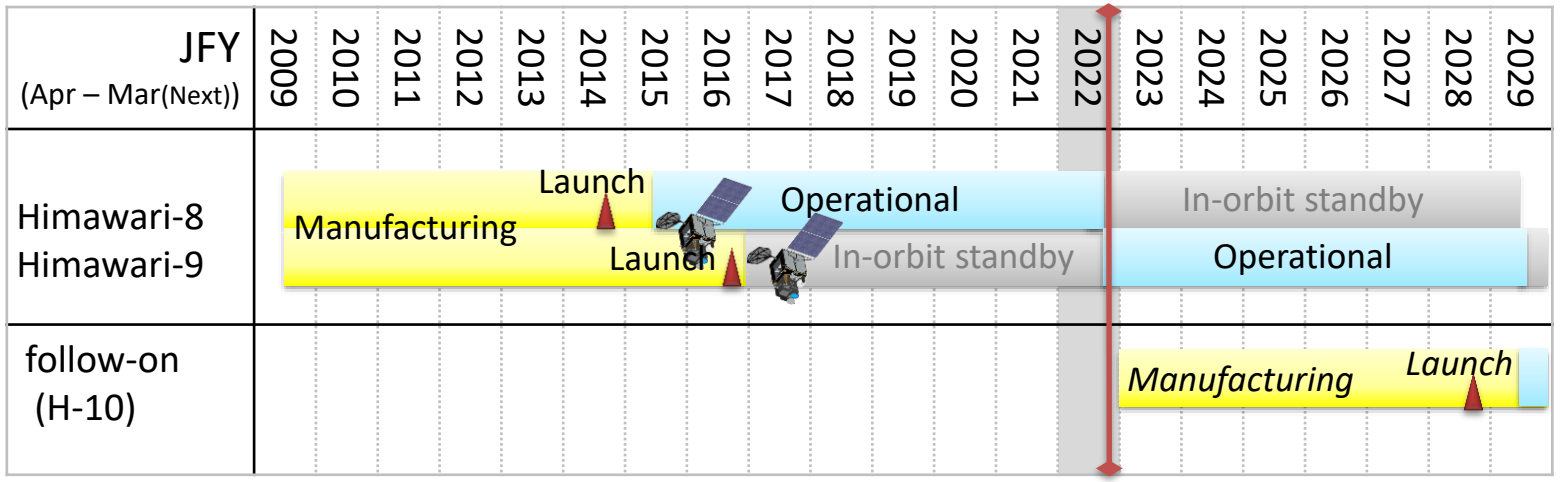


Calculate the condition of atmosphere



Himawari Follow-on Program

- JFY2018: JMA has started to consider the next GEO satellite (Himawari-10) program.
  - "By *JFY2023* Japan will start manufacturing the Geostationary Meteorological Satellite that will be the successor to Himawari-8/9, aiming to *put it into operation in around JFY2029*"
    Japan's "Basic Plan on Space Policy" (June 2020)
  - JMA will pursue seamless GEO satellite system by considering CGMS baseline and WMO Vision for WIGOS in 2040 to contribute the establishment of Geo-Ring observation.
- JFY2019: Worldwide Technology Trends Survey on Future Satellites/Instruments
- JFY2020: OSSE of hyperspectral IR sounder on JMA NWP systems was implemented.
- JFY2021: Internal, domestic and international user requirements will be summarized.
- **JFY2022: RFI, RFP and Start of manufacturing of H-10 using supplemental budget**
- JFY2028: Launch of Himawari-10
- JFY2029: Start of operation of Himawari-10



Concept of Himawari-10

- **Mission Instrument(s)**
  - AHI-class or FCI-class VIS/IR imager (with optional improved capabilities)
  - New instruments
    - ✓ Hyperspectral IR sounder
    - ✓ Space Environmental Suite by MIC/NICT as hosted payloads
- **Orbital location**
  - Around 140 degrees East
- **Design lifetime**
  - 15 years (10-year in-orbit operation and 5-year in-orbit storage)
- **Communication subsystems**
  - Ka-band (18 GHz) for mission raw data downlink
  - Ku-band (12-14 GHz) for telemetry, tracking & command
  - Data Collection System (collection of in-situ meteorological data)

Thank you!!

The first image of Himawari-9
02:40 UTC, 24 Jan. 2017

True Color Reproduction imagery

This imagery was developed on the basis of collaboration between the JMA Meteorological Satellite Center and the NOAA/NESDIS GOES-R Algorithm Working Group imagery team.