The Bureau of Meteorology

AOMSUC-13 Training Event Session T 15

"Early Warning of Hazardous Weather based on Satellite Data"

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Point of Contact, Australian VLab Centre of Excellence

Topics to be presented

- The motivation for this presentation
- The Hazardous Weather examined here
- Application of satellite data in anticipating Hazardous Weather.
- What resources are available.
- What techniques are available.

The motivation for this presentation

1. Utilise resources pertaining to the detection of Hazardous Weather on the Australian VLab CoE Regional Focus Group archive.

2. Present feedback provided by colleagues from Japan (JMA), South Korea (KMA), the USA, BMKG Indonesia, Samoa and Singapore.

3. Investigate the timelines of delivery of satellite data when monitoring Hazardous Weather.

4. Attendees can access some of the available resources.

5. Attendees can try some useful techniques for monitoring Hazardous Weather.

6. Obtain feedback from attendees regarding their ability to utilise satellite data for early warning of Hazardous Weather.

Using the Socrative cloud-based learner response system to enhance interaction

1 On your computer or smartphone type in <u>Link 1</u>

b.socrative.com

choose **Student login**

then Room Name

AOMSUC13TE

Please give some information about yourself.
Choose all the options that apply below

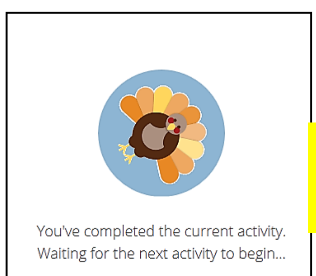
- A — My most recent qualification is a University Undergraduate degree
- B — My most recent qualification is a Masters degree
- C — My most recent qualification is a PhD
- D — I am fascinated by satellite data
- E — Satellite data is ok, but I prefer other meteorological data
- F — I am not particularly interested in satellite data
- G — I am not sure about the use of satellite data within meteorology. Tell me more.

2 Answer the question

SUBMIT ANSWER

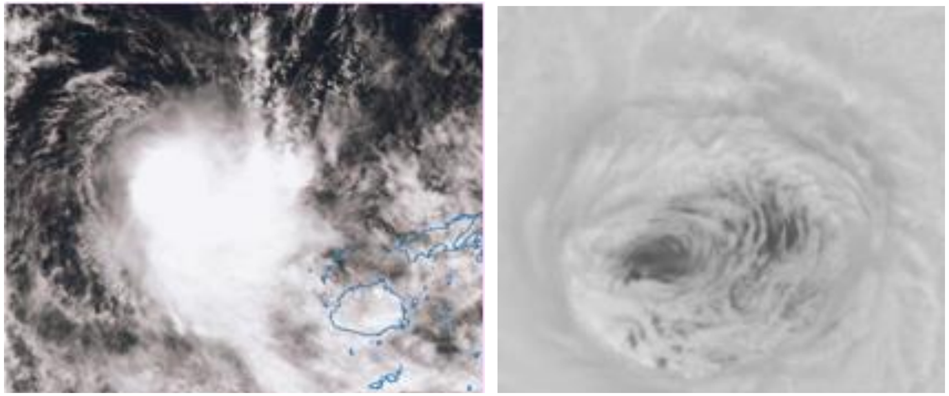
SUBMIT ANSWER

3 Submit the Answer

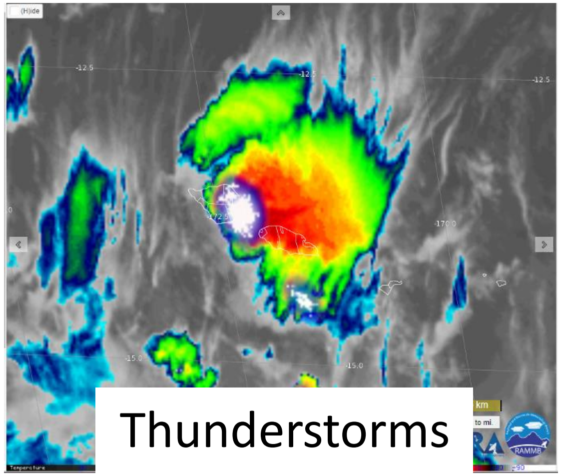


4 Please wait for the next question

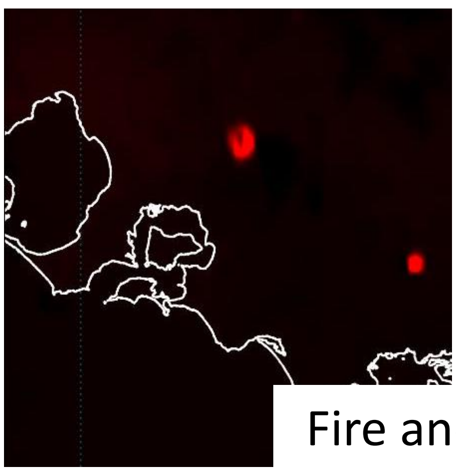
What Hazardous Weather is examined here?



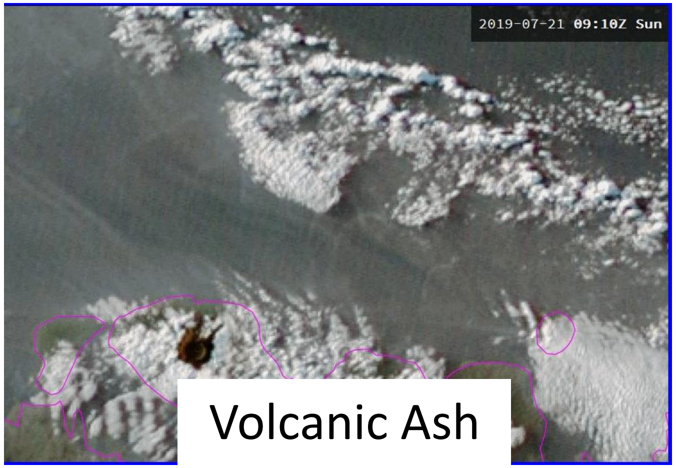
Tropical Cyclones / Typhoons / Hurricanes



Thunderstorms



Fire and Smoke

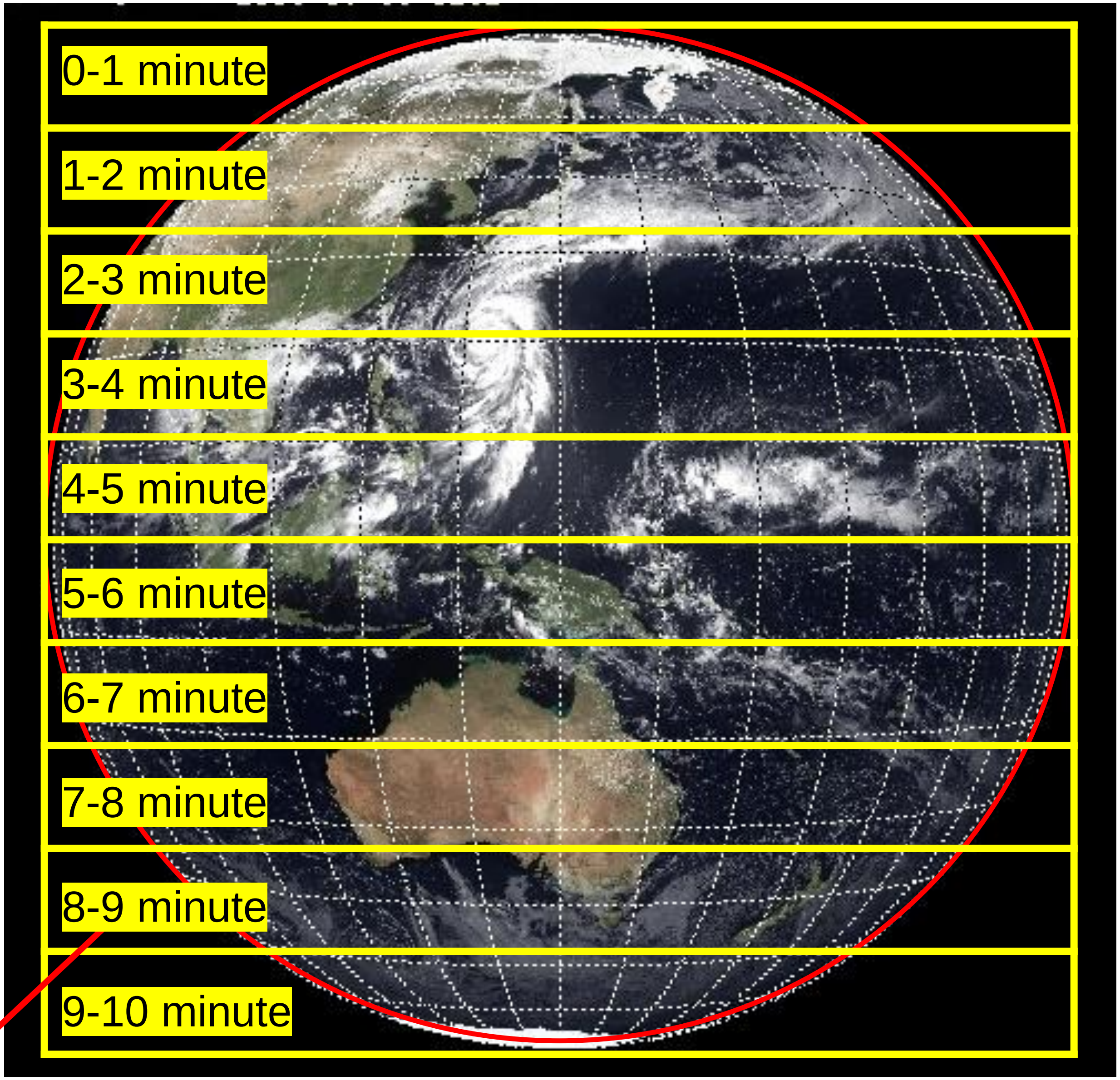


Volcanic Ash

Please answer Socrative Question 1

Application of satellite data in anticipating Hazardous Weather.

- Satellite data latency, compared to latency of other observational data including RADAR, lightning data etc.
- Rapid scan data, for long lived hazardous weather events:
  - Giving reduced latency of receipt of data.
  - Better in capturing rapid changes in Hazardous Weather.
- Satellite data and data products that can predict the development of Severe Weather and verification of this.



Full disk

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

Himawari-9 scanning

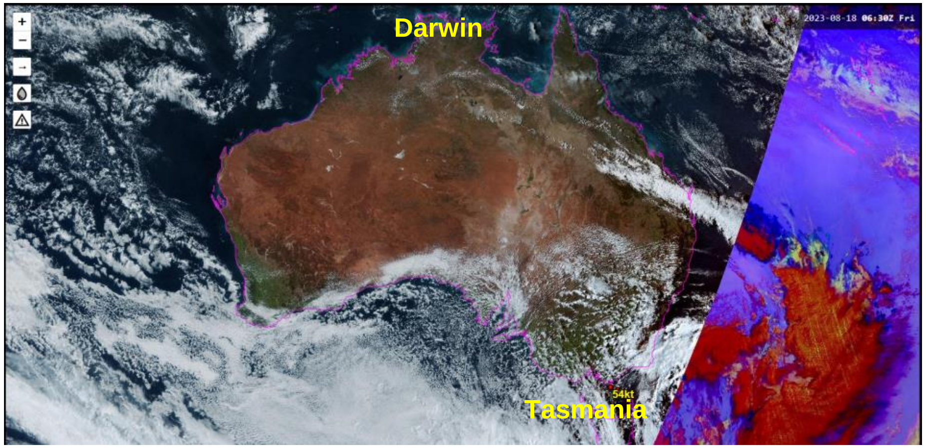
Data is scanned from west to east, starting at the north pole.

10 segments compose a full disk scan of 10-minute duration.

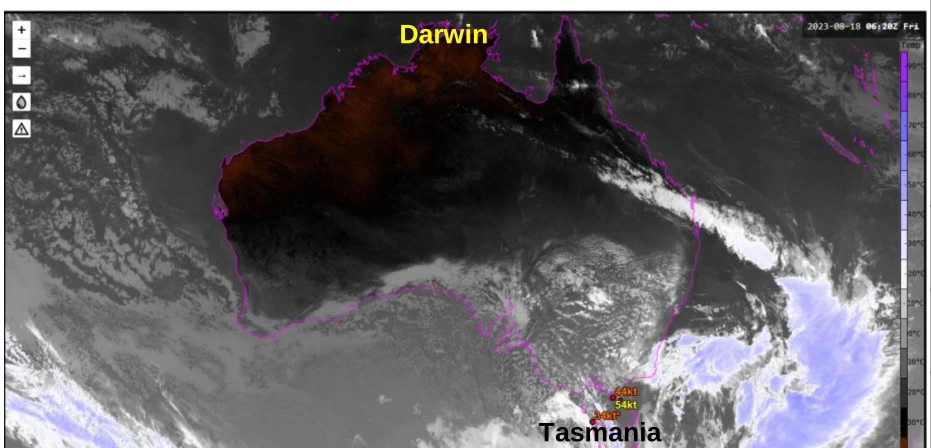
The date / time stamp of the images refers to the start of the scan

Image from "Status of Current and Future Satellite Programs of Japan Meteorological Agency" K. Bessho

images courtesy JMA / Bureau of Meteorology



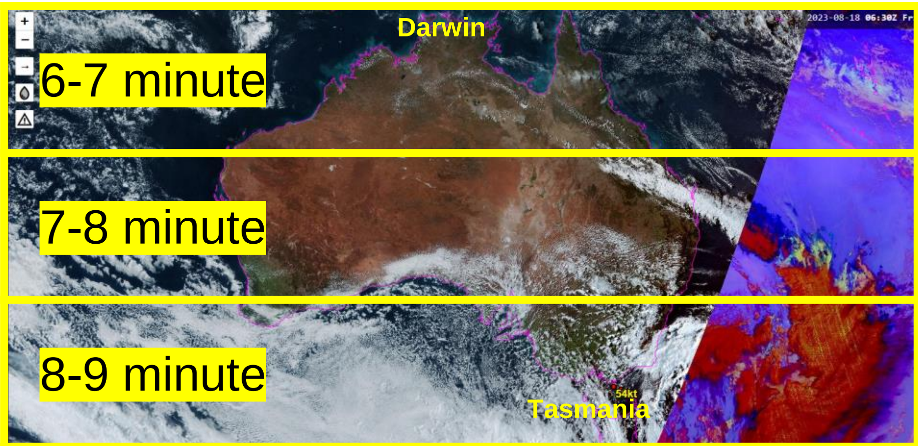
Evaluating the delay in the receipt of real-time 10-minute Himawari-9 data at the Bureau (18th August 2023)



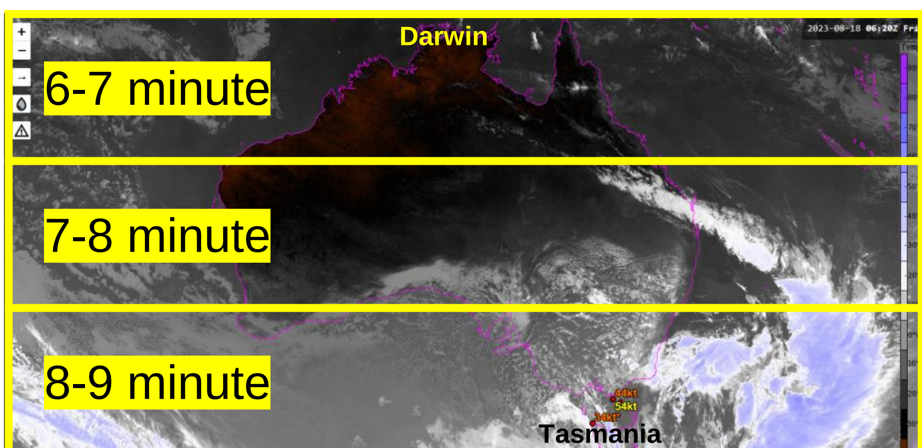
UTC timestamp on 10 minute image	Local time receipt of image into "Panther" visualisation software (UTC +10)	time delay (minutes) for True Colour RGB image
0620	1637 LST	17
0630	1646 LST	16
0640	1957 LST	17

UTC timestamp on 10 minute image	Local time receipt of image into "Panther" visualisation software (UTC +10)	time delay (minutes) for IR (Band 13) image
0620	1635 LST	15
0630	1644 LST	14
0640	1654 LST	14

images courtesy JMA / Bureau of Meteorology



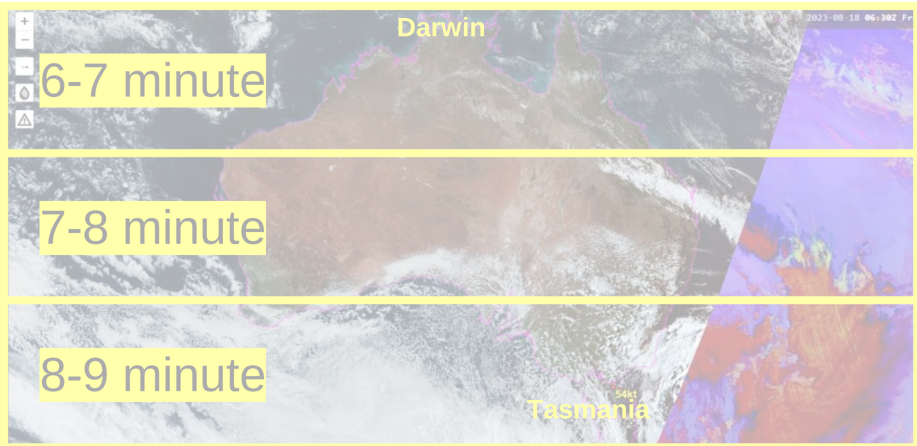
Evaluating the delay in the receipt of real-time 10-minute Himawari-9 data at the Bureau (18th August 2023)



Overpass time over Australia (UTC)	Local time receipt of image into "Panther" visualisation software (UTC +10)	time delay (minutes) for True Colour RGB image
0626-0629	1637 LST	8-11
0636-0639	1646 LST	7-10
0646-0649	1957 LST	8-11

Overpass time over Australia (UTC)	Local time receipt of image into "Panther" visualisation software (UTC +10)	time delay (minutes) for IR (Band 13) image
0626-0629	1635 LST	6-9
0636-0639	1644 LST	5-8
0646-0649	1654 LST	5-8

images courtesy JMA / Bureau of Meteorology

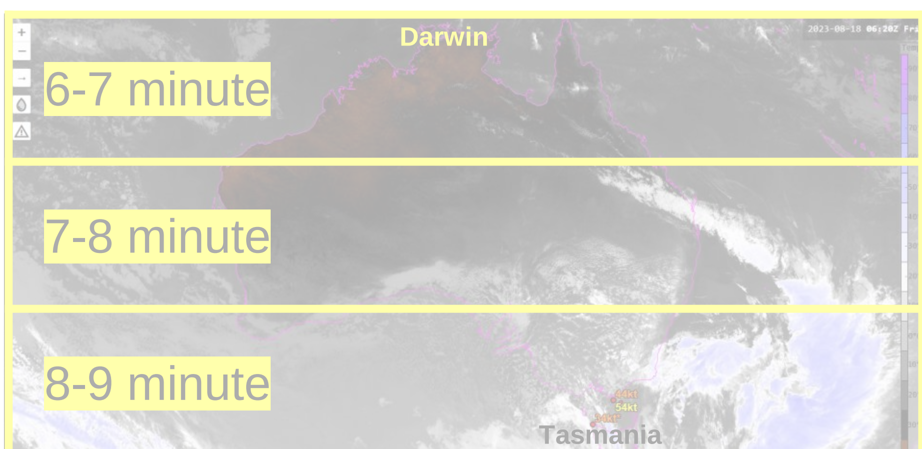


Overpass time over Australia (UTC)	Local time receipt of image into "Panther" visualisation software (UTC +10)	time delay (minutes) for True Colour RGB image
0626-0629	1637 LST	8-11
0636-0639	1646 LST	7-10
0646-0649	1957 LST	8-11

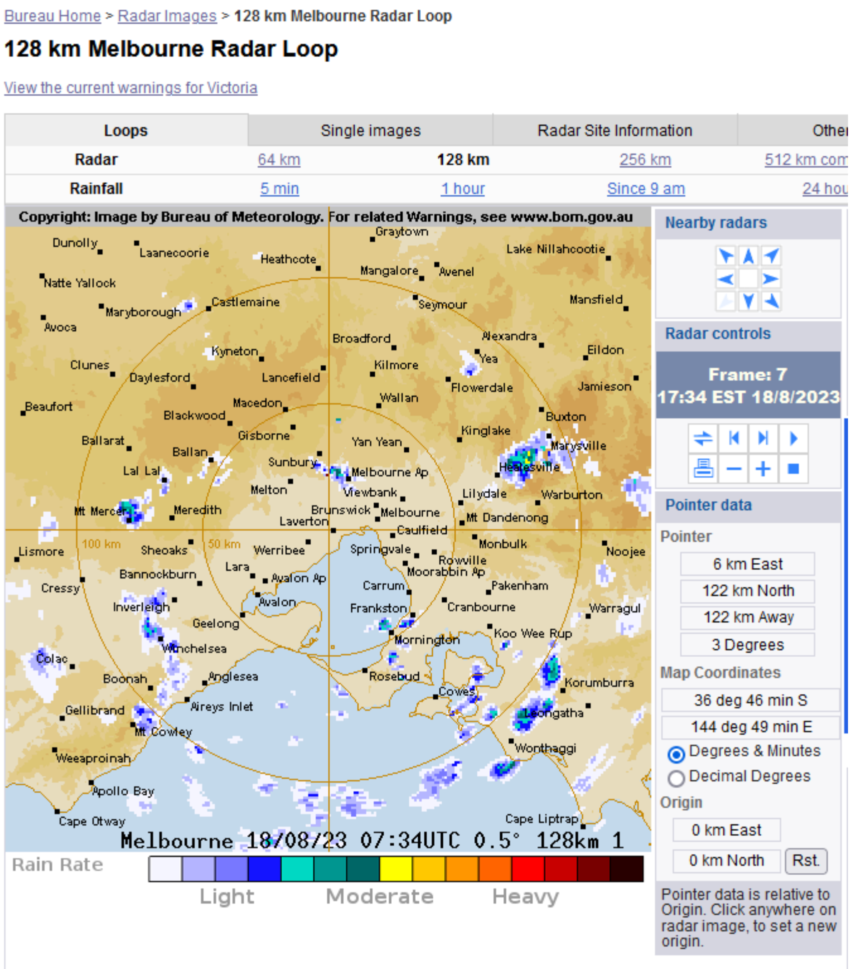
Evaluating the delay in the minute Himawari-9 data at the Bureau (18th August 2023)

Please answer Socrative Question 2

Overpass time over Australia (UTC)	Local time receipt of image into "Panther" visualisation software (UTC +10)	time delay (minutes) for IR (Band 13) image
0626-0629	1635 LST	6-9
0636-0639	1644 LST	5-8
0646-0649	1654 LST	5-8



Refreshing of the RADAR loop on the Bureau of Meteorology external web site (Melbourne RADAR)



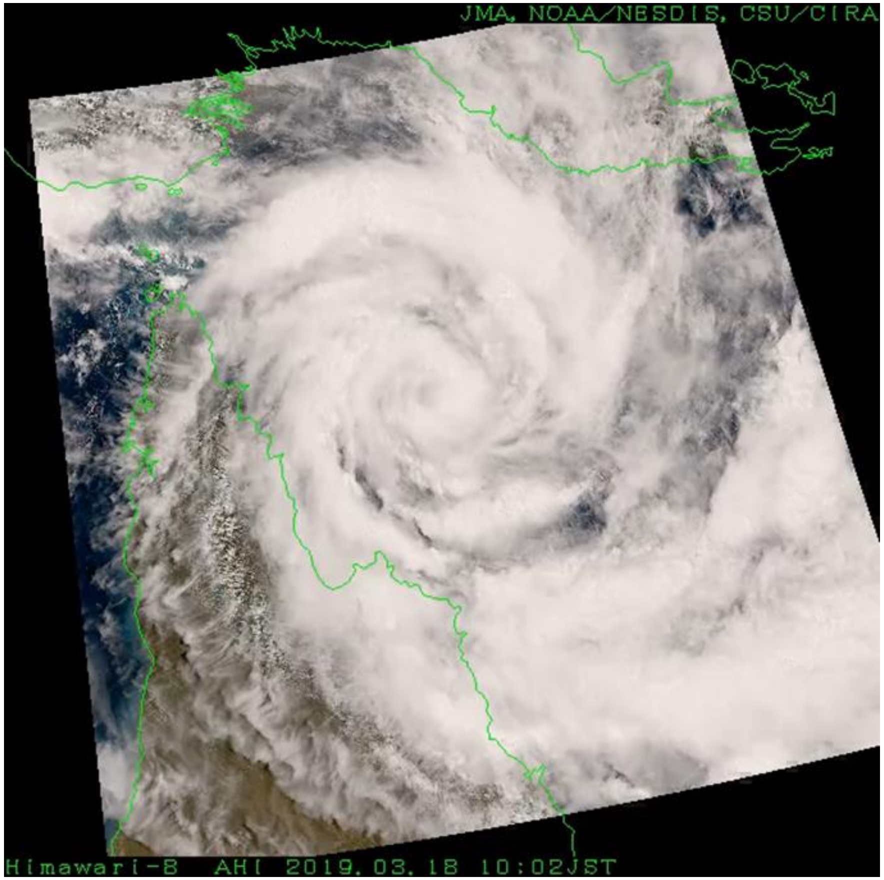
UTC timestamp on the RADAR image	Local time receipt of image onto (UTC +10)	time delay (minutes) for IR image
0734	1736 LST	2
0739	1741 LST	2
0744	1746 LST	2
0749	1754 LST	5
0754	1758 LST	4
0759	1803 LST	4

Note: Timestamp on the RADAR image corresponds to the end of the observation period / the scan. (Leon Majewski, 23rd August 2023). Each scan takes 5 minutes.

image courtesy Bureau of Meteorology

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 08 September 2023
  - Registration: 22 NMHSs
  - **185** requests for TC, volcanic eruption, wildfires, etc.

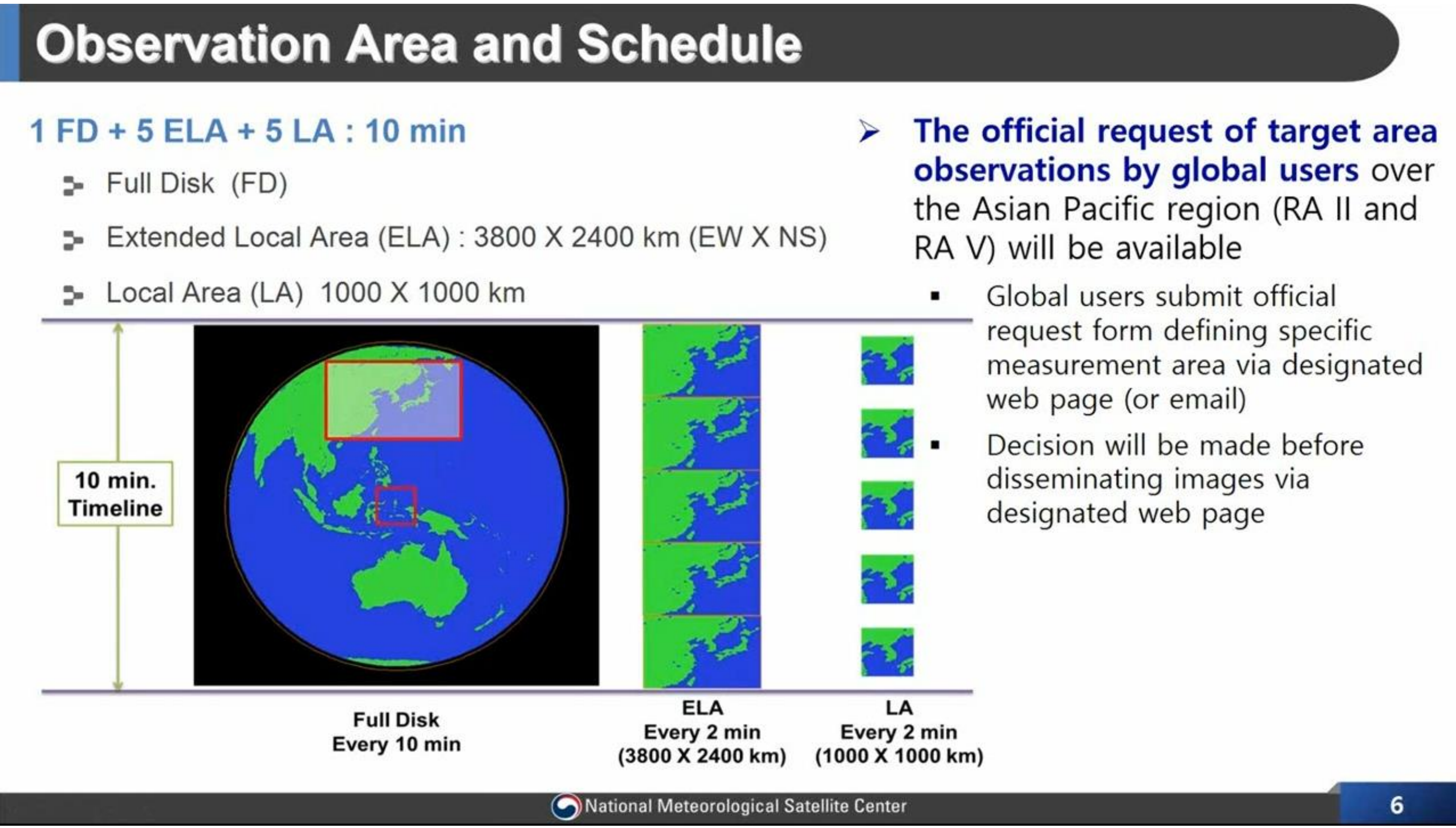


HimawariRequest from BoM on 13-19 Mar. 2019

slide kindly forwarded to me by Mr Hiroshi Suzue, Japan Meteorological Agency

Request driven GEO-KOMPSAT-2A rapid scan (2-minute) data

(slide from Dr Sung-Rae Chung's presentation at the joint Korea Australia VLab CoE's Regional Focus Group meeting of 29th October 2019)



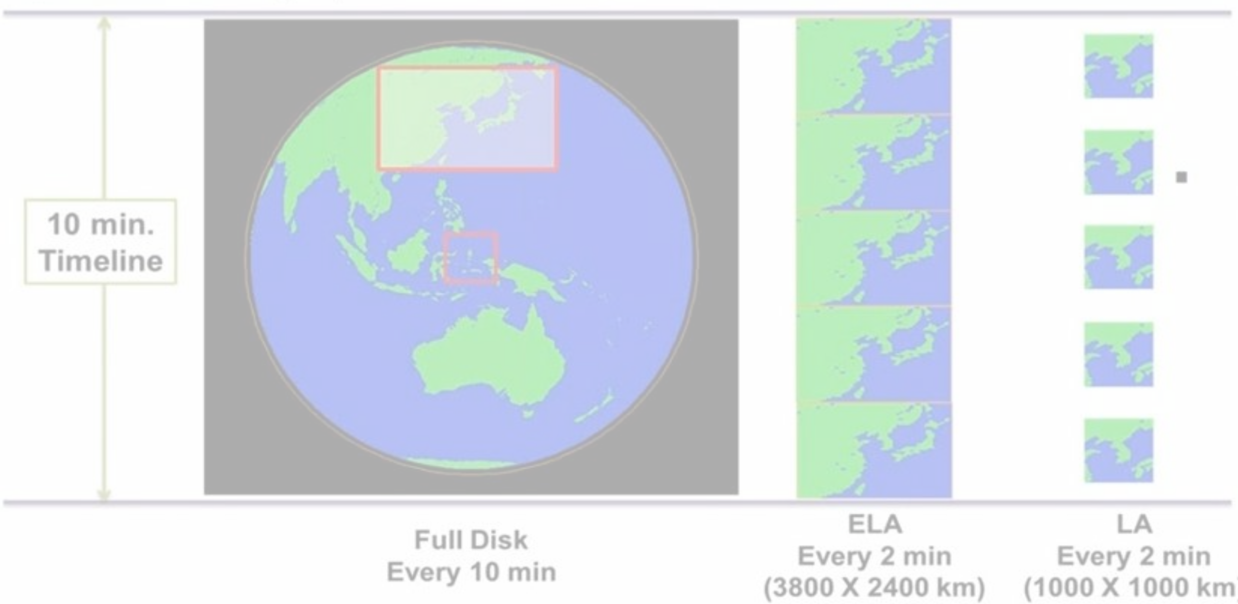
Request driven GEO-KOMPSAT-2A rapid scan (2-minute) data

(slide from Dr Sung-Rae Chung's presentation at the joint Korea Australia VLab CoE's Regional Focus Group meeting of 29th October 2019)

Please answer Socrative Question 3

1 FD + 5 ELA + 5 LA : 10 min

- Full Disk (FD)
- Extended Local Area (ELA) : 3800 X 2400 km (EW X NS)
- Local Area (LA) 1000 X 1000 km



- **The official request of target area observations by global users** over the Asian Pacific region (RA II and RA V) will be available
  - Global users submit official request form defining specific measurement area via designated web page (or email)
  - Decision will be made before disseminating images via designated web page

Request-based high frequency regional observations

(https://www.jma.go.jp/jma/jma-eng/satellite/ra2wigosproject/ra2wigosproject-intro_en_jma.html)

Request-based high frequency regional observation

FY ESM (CMA)

Emergency Support Mechanism of FENGYUN Satellite (FY ESM) [CMA]

China Meteorological Administration (CMA) introduced the Emergency Support Mechanism of FENGYUN (FY) Satellite (FY ESM) in 2018, open to international users who made a request once visited by such extreme events as typhoon, heavy rain, severe convection, forest or grassland fire and sand and dust storm. In this case, the on-duty FY satellite is activated to initiate highly frequent observation of a given area at an interval of up to 5 minutes, processing and generating images and quantitative products, which are provided through such channels as CMACast, Internet and direct satellite broadcasting, to inform the processes of disaster preparedness, mitigation and relief in a timely fashion.

URL: https://fy4.nsmc.org.cn/service/en/emergency/index.html

HimawariRequest (JMA)

HimawariRequest [JMA]

The HimawariRequest service enables registered NMHS users to request particular Target Area observations in order to leverage this flexibility on an international scale. The service stems from a WMO RA II (Asia) regional project to develop support for NMHSs in satellite data, products and training in collaboration with WMO RA V (South-West Pacific) Members.

JMA expects the HimawariRequest service to support disaster risk reduction activities in the region based on the monitoring of extreme events such as tropical cyclones and volcanic eruptions.

URL: https://www.jma.go.jp/jma/jma-eng/satellite/HimawariRequest.html

Geo-Kompstat-2A AMI ARS Service (KMA)

Geo-Kompsat-2A AMI Rapid Scan (ARS) Service[KMA]

The Advanced Meteorological Imager (AMI) on board Geo-Kompsat-2A (GK2A) is capable of frequent and flexible observation, providing full disk images of the Earth every 10 minutes and regional images at shorter intervals. Full disk and other regional observations have spatial resolutions of 0.5 to 2 km and spectral coverage incorporating 16 channels.

The GK2A AMI Rapid-Scan (ARS) service allows National Meteorological and Hydrological Services (NMHSs) to request particular Target Area observations by leveraging the location flexibility on an international scale.

URL: http://datasvc.nmsc.kma.go.kr/datasvc/html/special/specialReqMain.do#

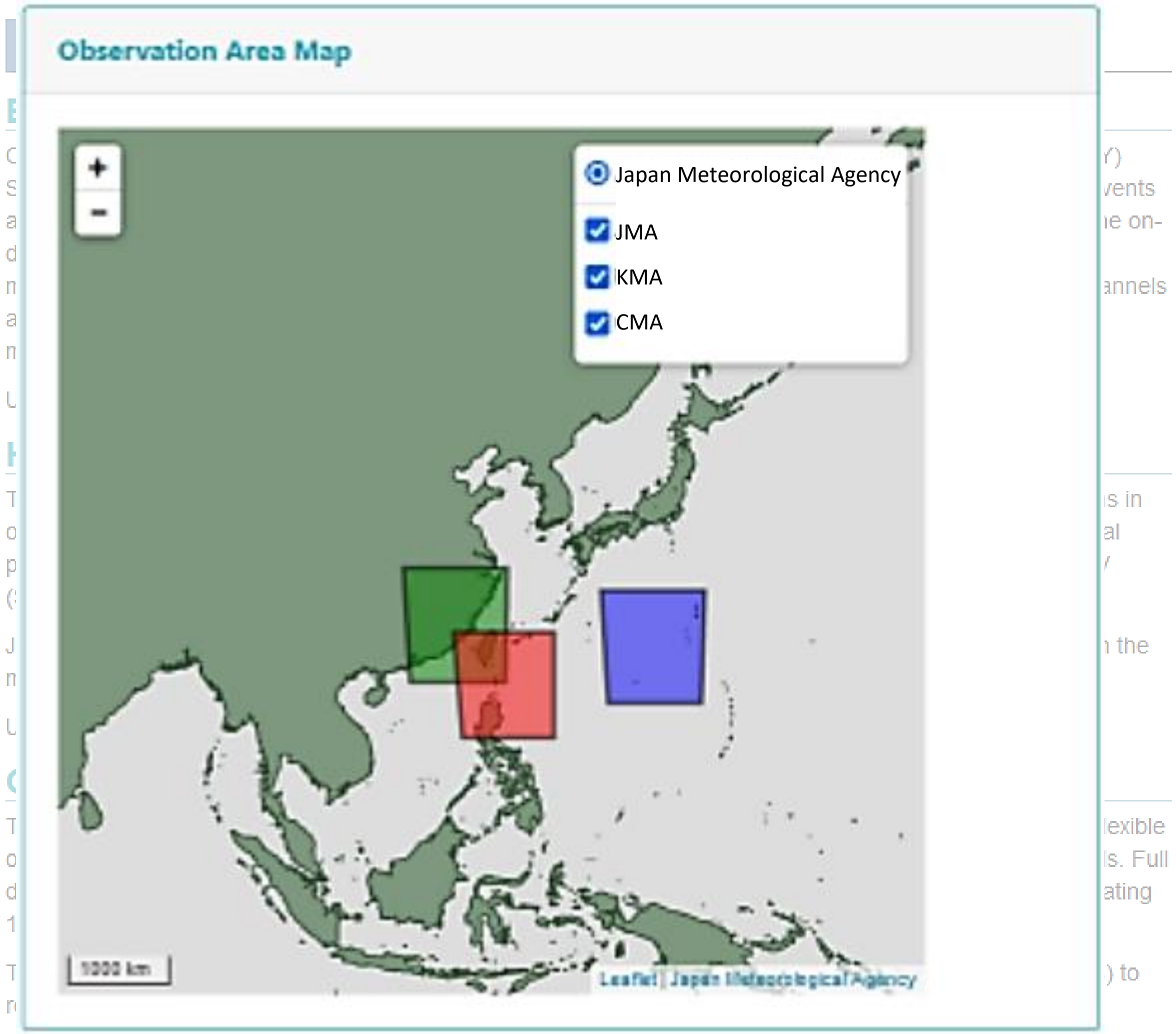
Request-based high frequency regional observations

image forwarded by Yamada Kazutaka Japan Meteorological Agency

FY ESM (CMA)

HimawariRequest (JMA)

Geo-Kompsat-2A AMI ARS Service (KMA)



URL: http://datasvc.nmsc.kma.go.kr/datasvc/html/special/specialReqMain.do#

Resources for the detection of developing convection

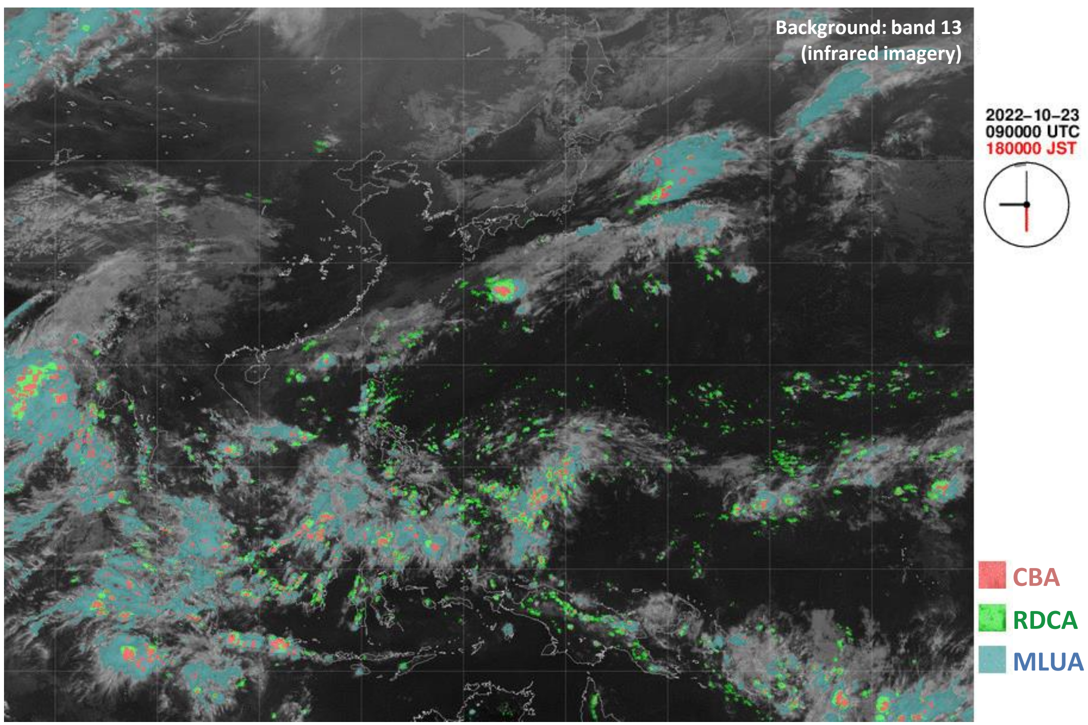
- JMA's Rapidly Developing Cumulus Area (RDCA) product
  - Use by BMKG Indonesia.
- KMA's Convection Initiation (CI) product.
- LightningCast Probabilities from the USA
  - Example from the VLab Regional Focus Group meeting
- Simple RGB composite image analyses

JMA use of the RDCA product for the monitoring and warning of convective cloud development

(content as presented by K.Bessho at the EUMETSAT Meteorological Satellite Conference 2023)

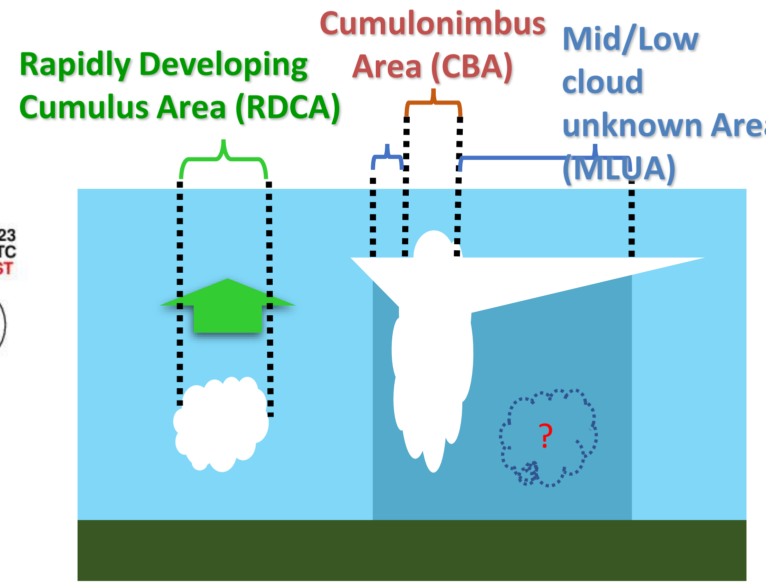
Convective Cloud Information (CCI)

— CB, RDCA and MLUA



From 0900 UTC on 23 October 2022
To 0900 UTC on 24 October 2022

https://www.data.jma.go.jp/mscweb/technotes/msctechrep62-2.pdf



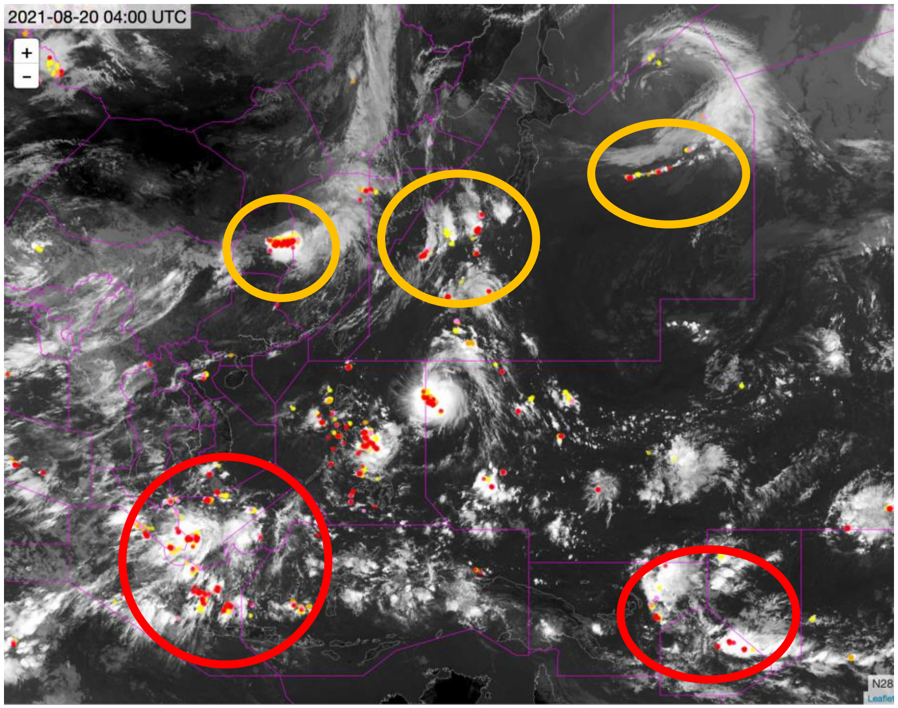
CCI for Asia & Western Pacific area

- Utilized bands of Himawari-8/9 AHI:
  - B03, B08, B10, B11, B13, B15, B16 for RDCAs
  - B03, B13, B15 for CBs & MLUAs
- Horizontal resolution:
  - 0.1° for RDCAs
  - 0.04° for CBs & MLUAs
- Temporal resolution: 10 min.

Verification of JMA's RDCA product

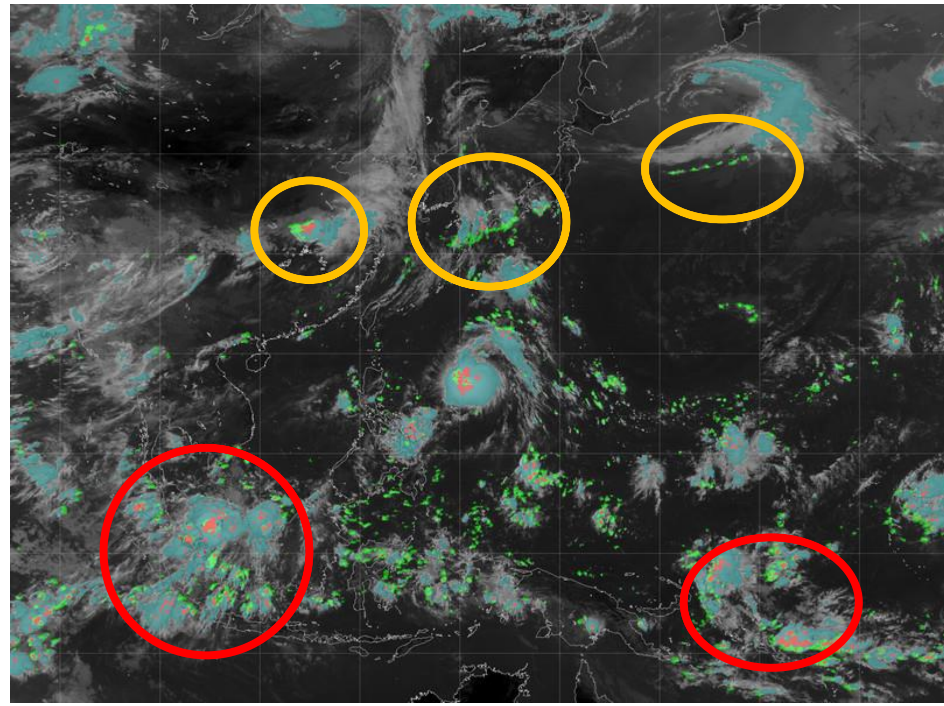
(content as presented by K.Bessho at the EUMETSAT Meteorological Satellite Conference 2023)

Lightning Observation (WWLLN)



A(0-10分)	B(10-20分)	C(20-30分)	D(30-60分)
0350-0400UTC	0330-0340UTC	0340-0350UTC	0300-0330UTC

Convective Cloud Information

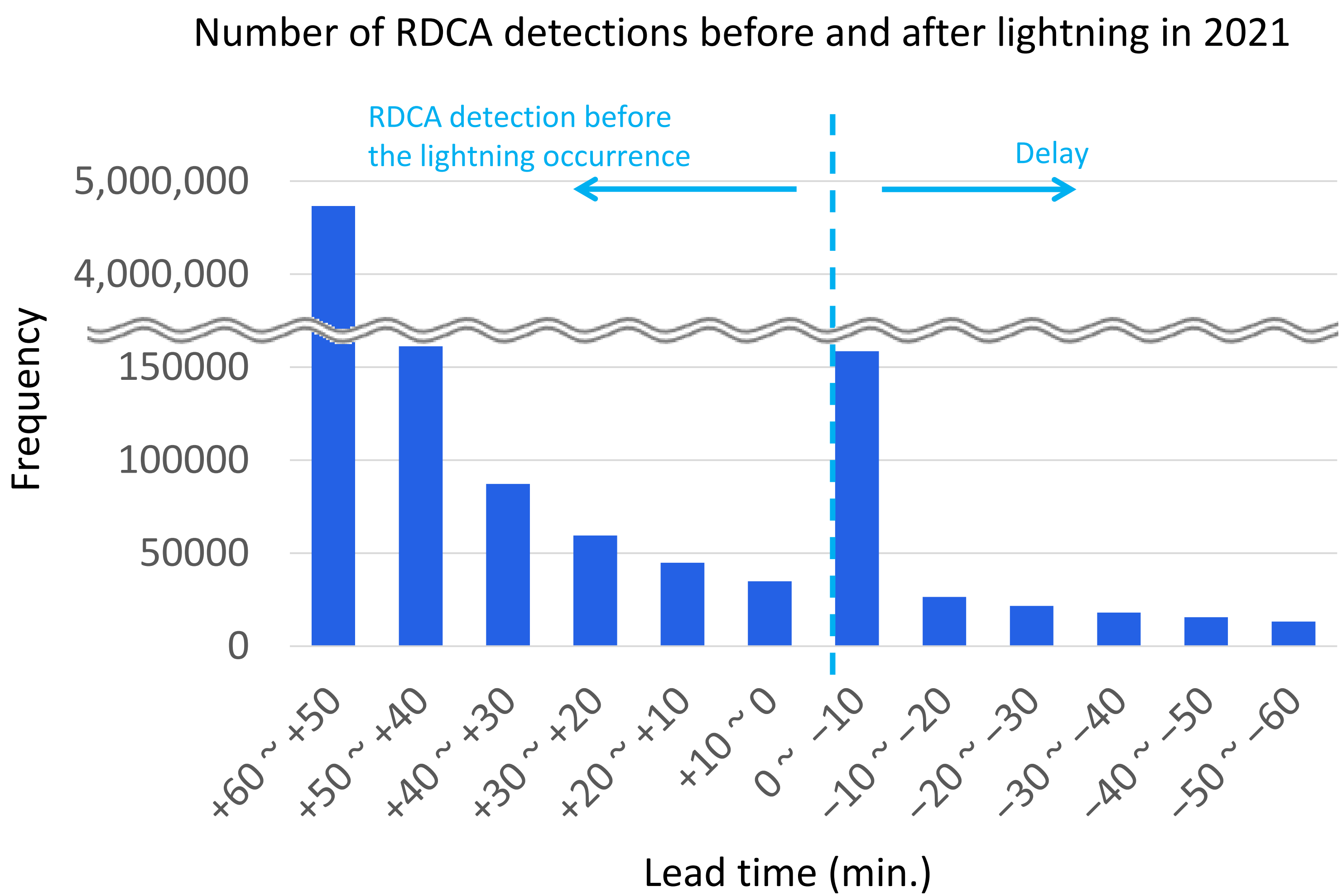


0300 UTC on 20 August 2021

RDCAs and CBs were detected in areas where lightning was observed in the tropics (red circle) and mid-latitudes (orange circle).

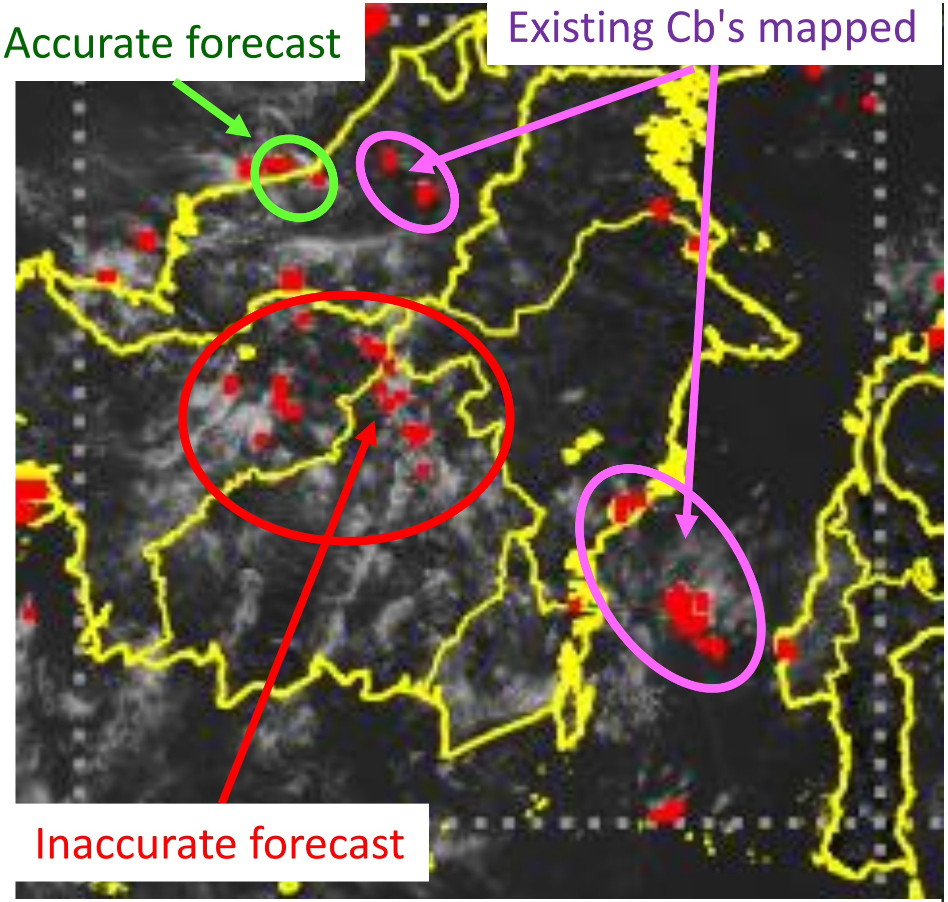
Verification of JMA's RDCA product

(content as presented by K.Bessho at the EUMETSAT Meteorological Satellite Conference 2023)



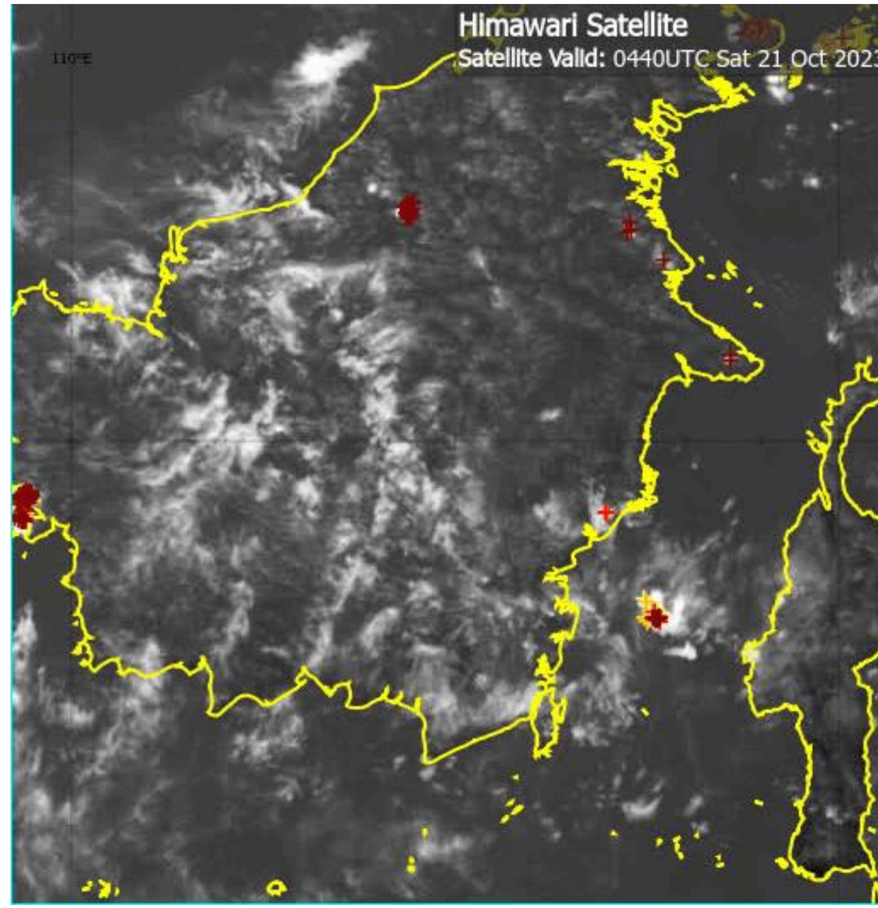
Animation: Checking the performance of the RDCA algorithm as applied to Kalimantan. 21st October 2023

image courtesy JMA / BMKG Indonesia



0440UTC H-9 Band 13 image. Red crosses show cumulus clouds that have the potential to become cumulonimbus clouds in the next hour (by 0540UTC).

animation courtesy JMA / Bureau of Meteorology.
Lightning data courtesy Weatherzone



Himawari-9 (H-9) Band 13 loop from 0440UTC to 0540UTC, including Weatherzone 10 minute lightning data.

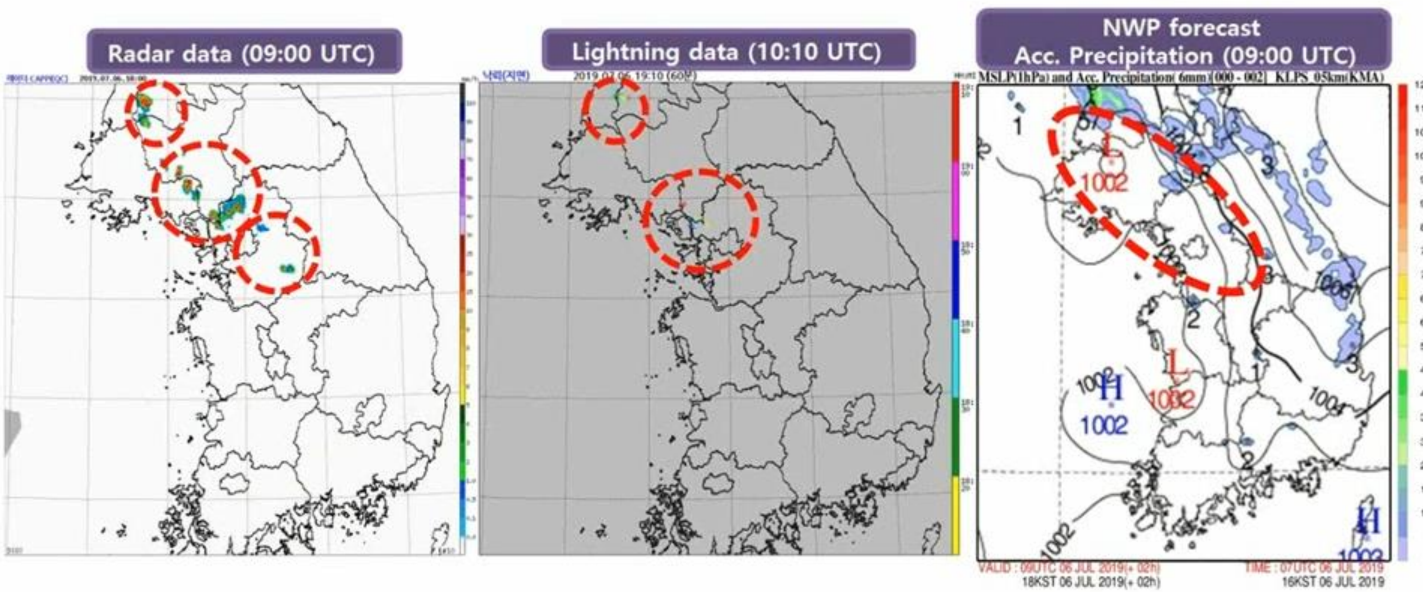
KMA's Convective Initiation product for the monitoring and warning of convective cloud development

(slide from Dr Sung-Rae Chung's presentation at the joint Korea Australia VLab CoE's Regional Focus Group meeting of 29th October 2019)

Convective Initiation (CI)

6 July 2019

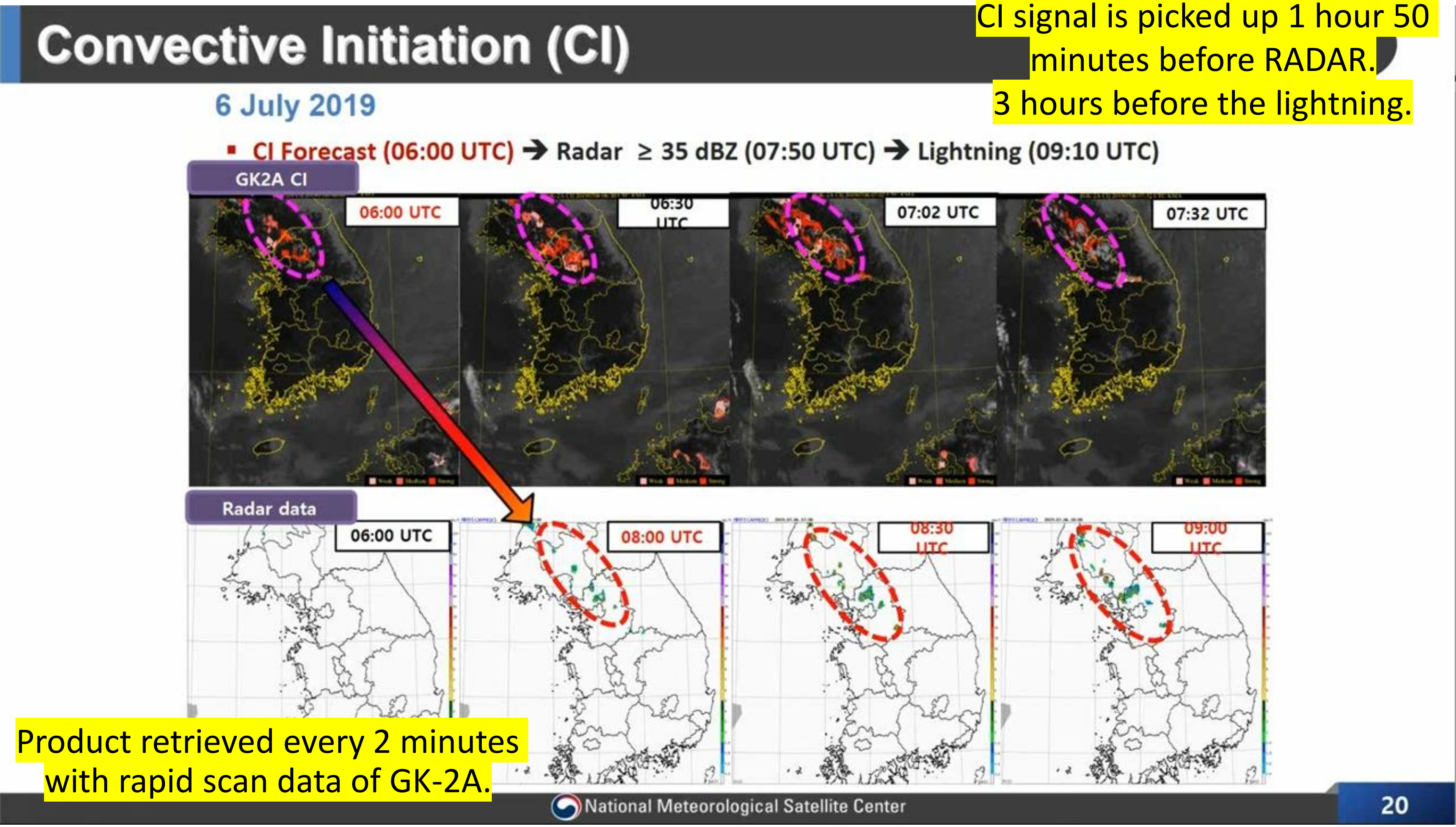
- Convective clouds occurred between 06:00 UTC and 09:00 UTC
- Atmospheric instability due to the inflow and convergence of easterly winds in the lower atmosphere
- NWP model did not predict convective cloud.



Convective Initiation product as applied to developing storms over Korea; case study of 6th July 2019

(slide from Dr Sung-Rae Chung's presentation at the joint Korea Australia VLab CoE's Regional Focus Group meeting of 29th October 2019)

CI signal is picked up 1 hour 50 minutes before RADAR.
3 hours before the lightning.



Product retrieved every 2 minutes with rapid scan data of GK-2A.

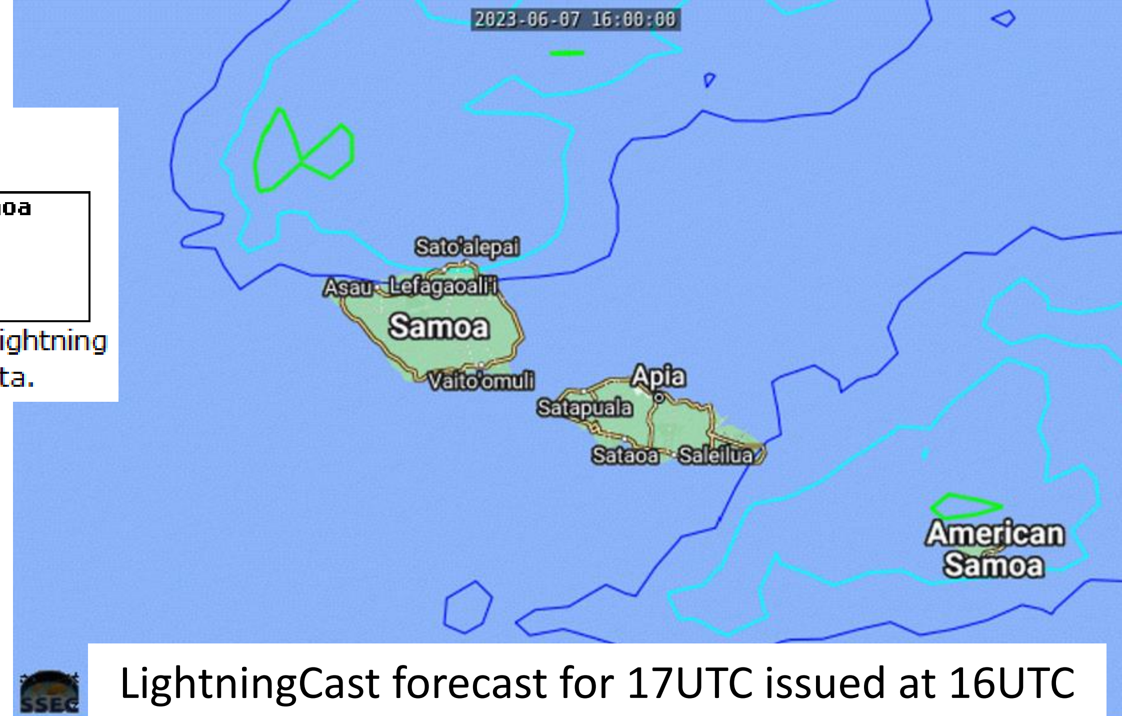
image courtesy SSEC University of Wisconsin-Madison

LightningCast GOES-West American Samoa

ID:PLTGGOESWestRadFUSSAMOA

Legend: LightningCast GOES-West American Samoa
- 10%
- 25%
- 50%
- 75%

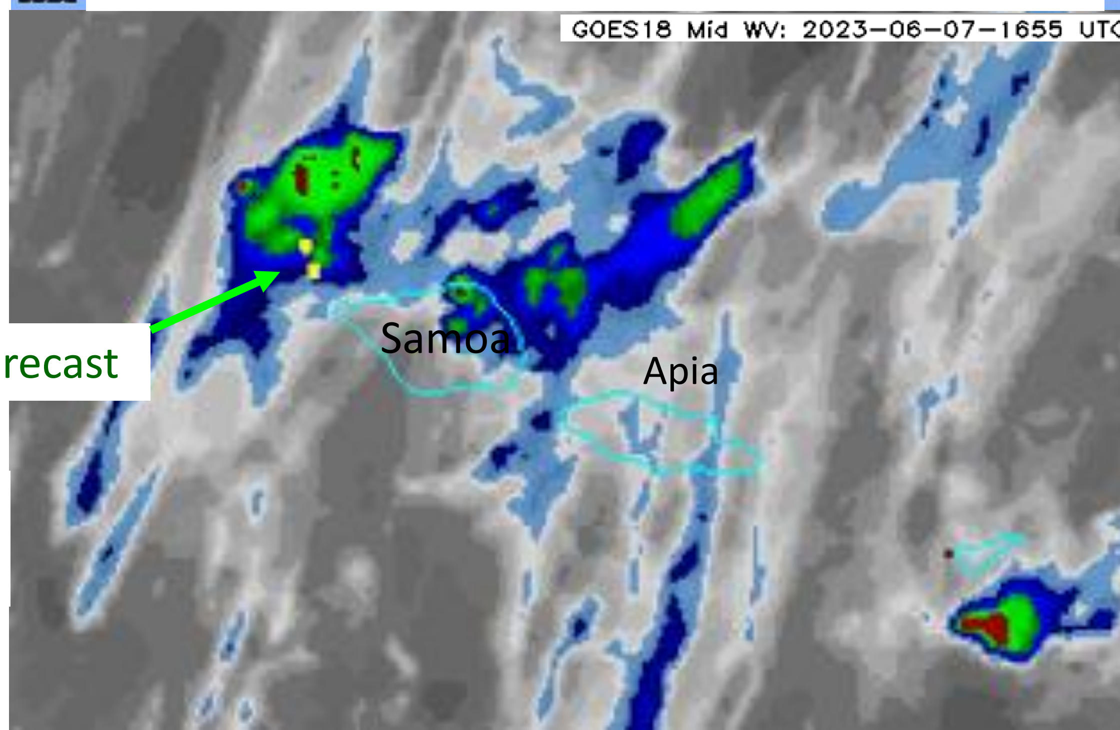
Description: An AI model that predicts the probability of lightning in the next 60 minutes using GOES-R ABI data.



LightningCast forecast for 17UTC issued at 16UTC

LightningCast Verification over Samoa, 7th June 2023

(from the Australian VLab CoE Regional Focus Group meeting of 29th August 2023)



Verification of Lightning forecast

GOES-18 WV and GLM lightning data, 1655UTC

image courtesy Weathernerds.org

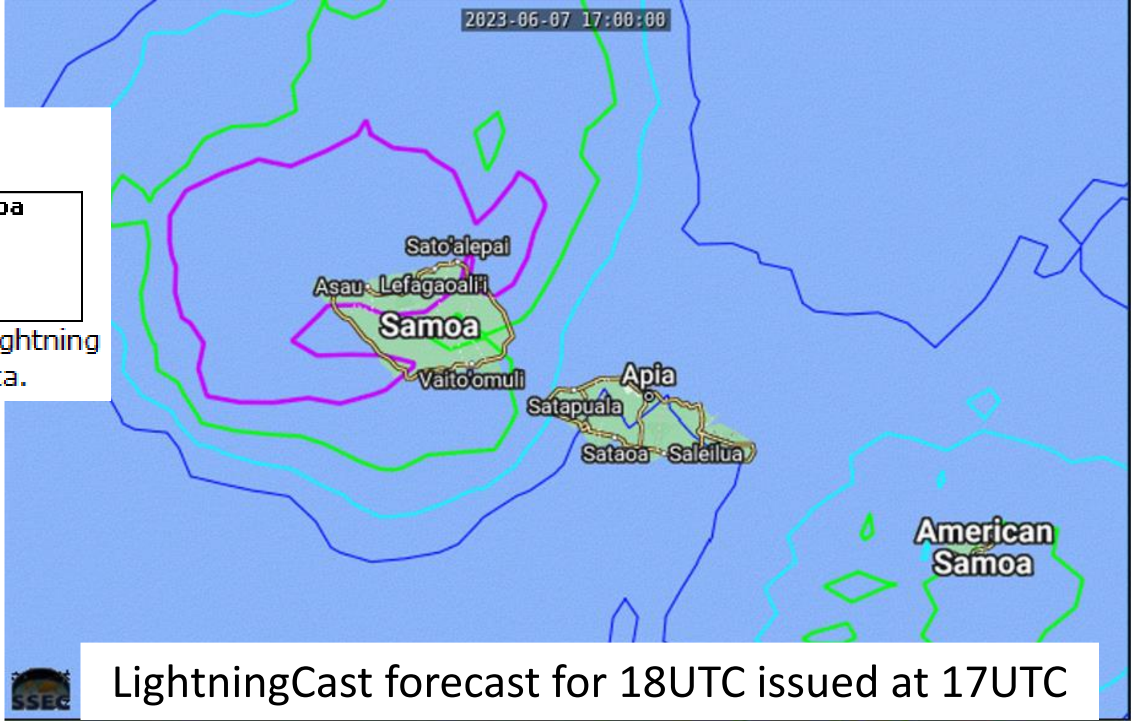
image courtesy SSEC University of Wisconsin-Madison

LightningCast GOES-West American Samoa

ID:PLTGGOESWestRadFUSSAMOA

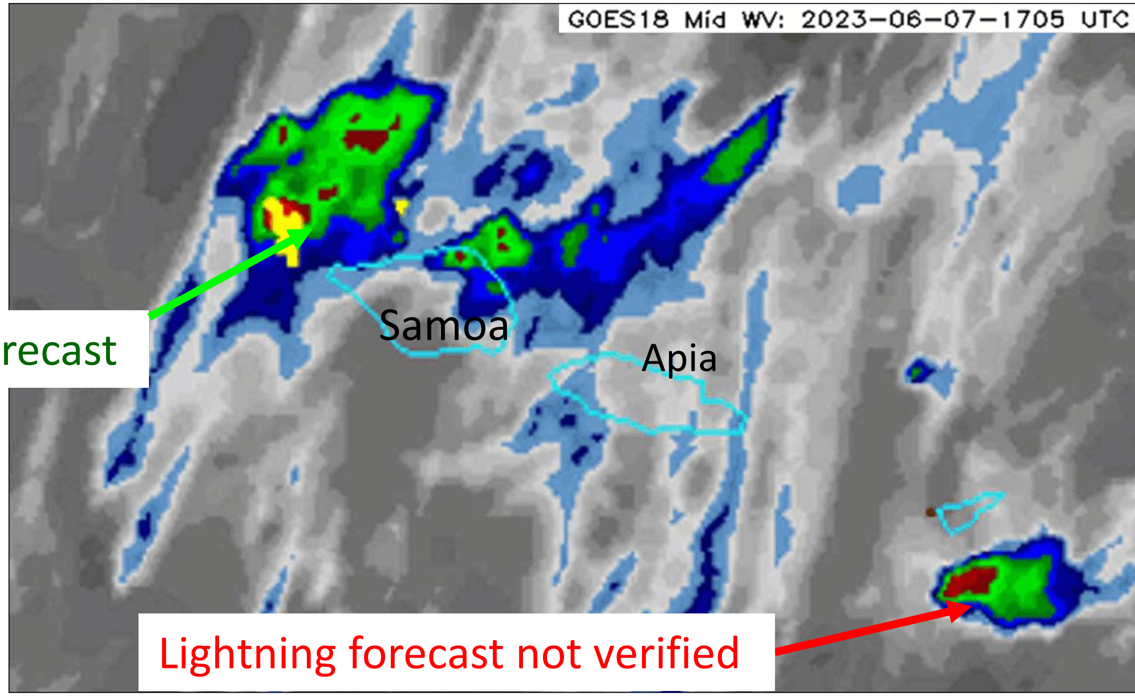
Legend: LightningCast GOES-West American Samoa
- 10%
- 25%
- 50%
- 75%

Description: An AI model that predicts the probability of lightning in the next 60 minutes using GOES-R ABI data.



Animation: LightningCast Verification over Samoa, 7th June 2023

(from the Australian VLab CoE Regional Focus Group meeting of 29th August 2023)



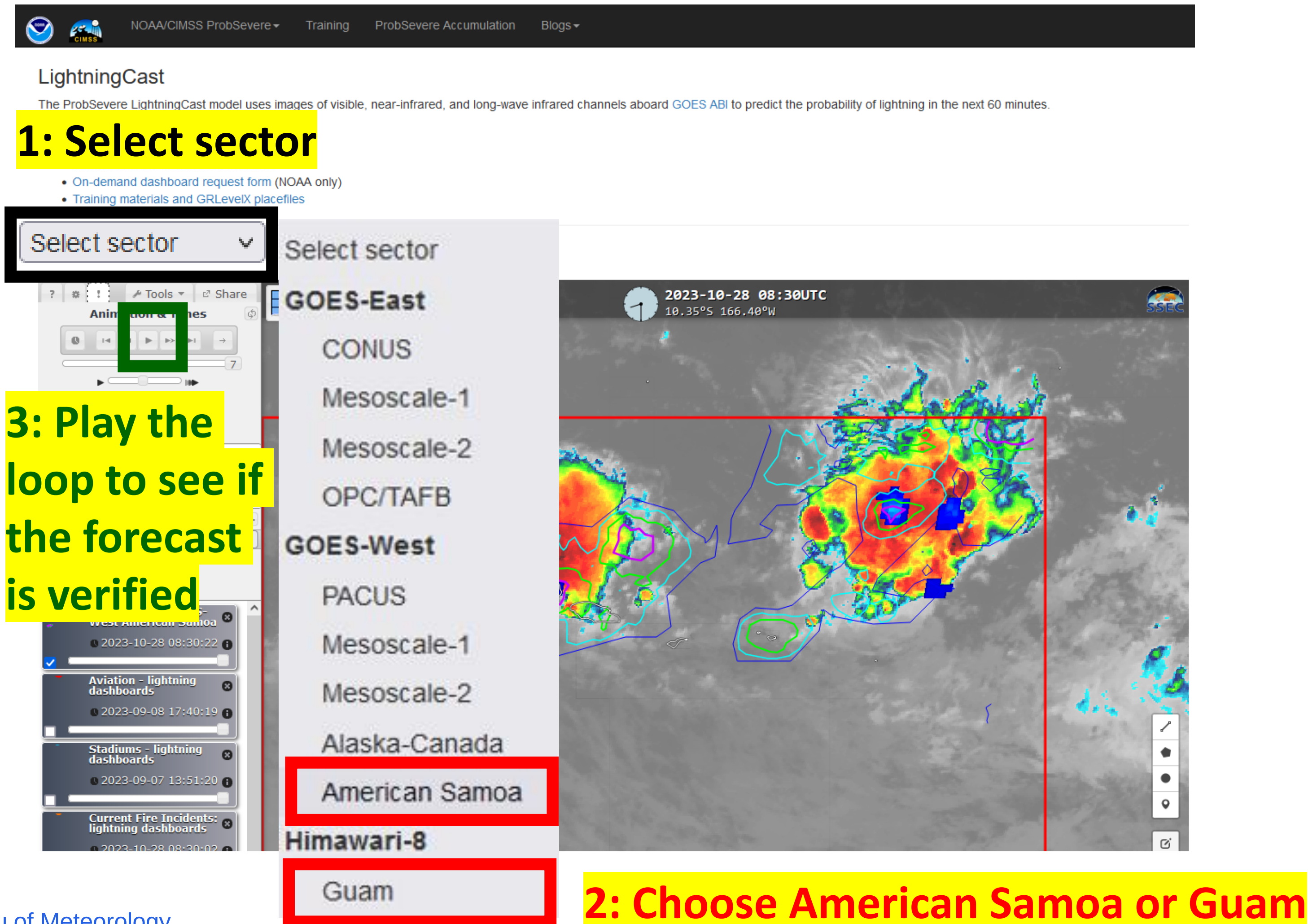
Animation: GOES-18 WV and GLM lightning data, 1705-1805UTC

animation courtesy NOAA / Weathernerds.org

Exploring the LightningCast output over Samoa

Link 2 kindly provided by Scott Lindstrom SSEC

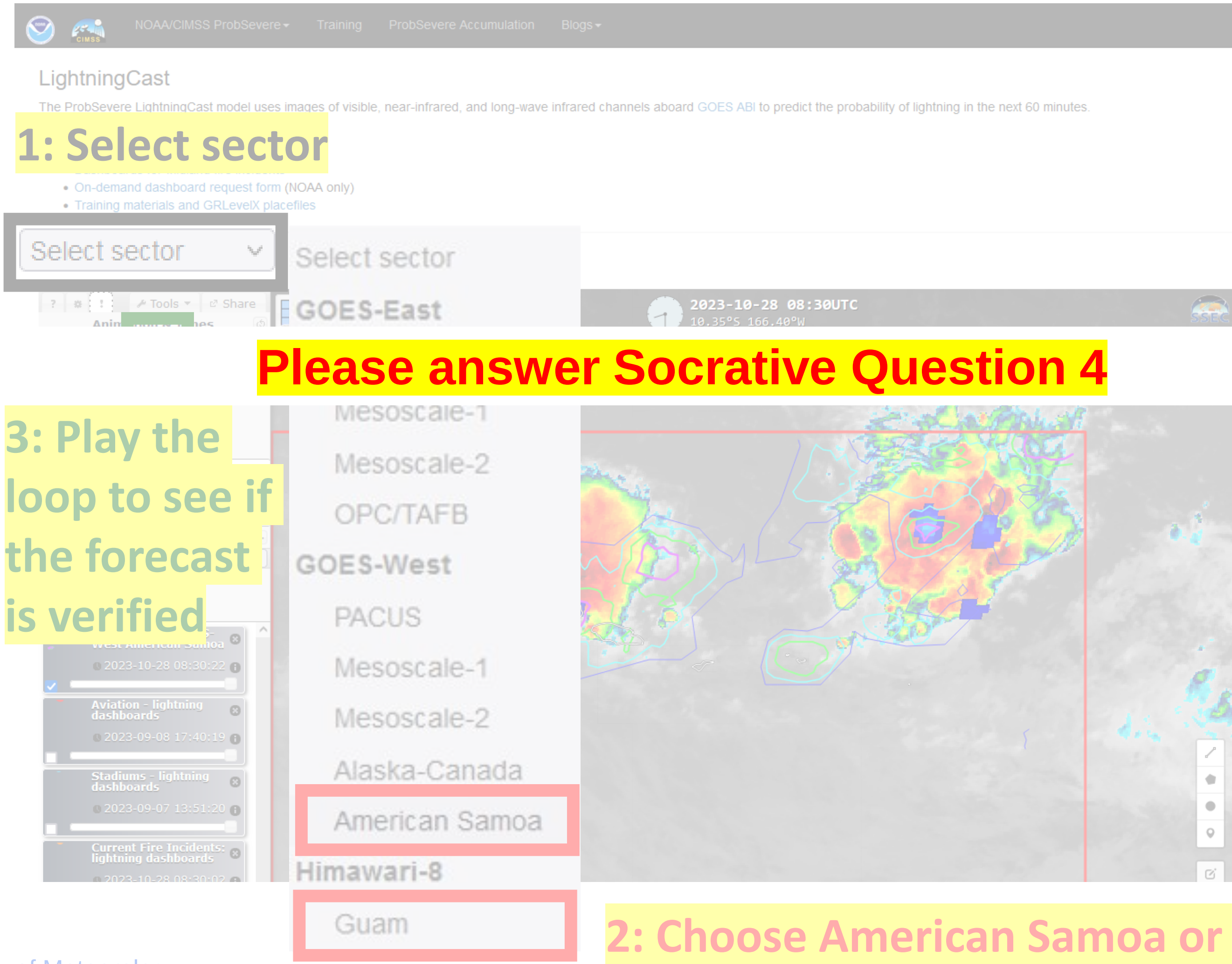
https://cimss.ssec.wisc.edu/severe_conv/pltg.html



Exploring the LightningCast output over Samoa

link kindly provided by Scott Lindstrom SSEC

https://cimss.ssec.wisc.edu/severe_conv/pltg.html



1: Select sector

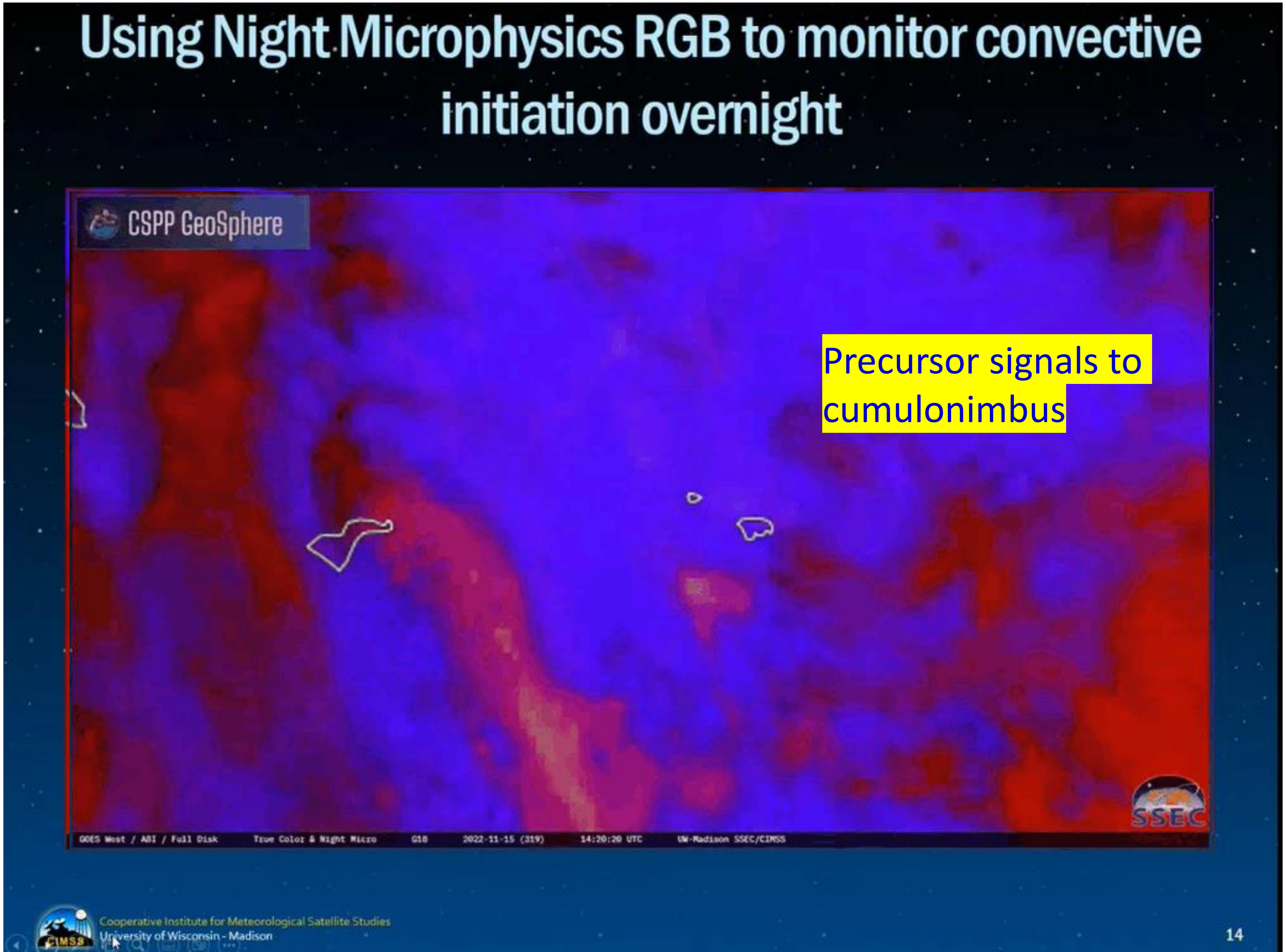
Please answer Socrative Question 4

3: Play the loop to see if the forecast is verified

2: Choose American Samoa or Guam

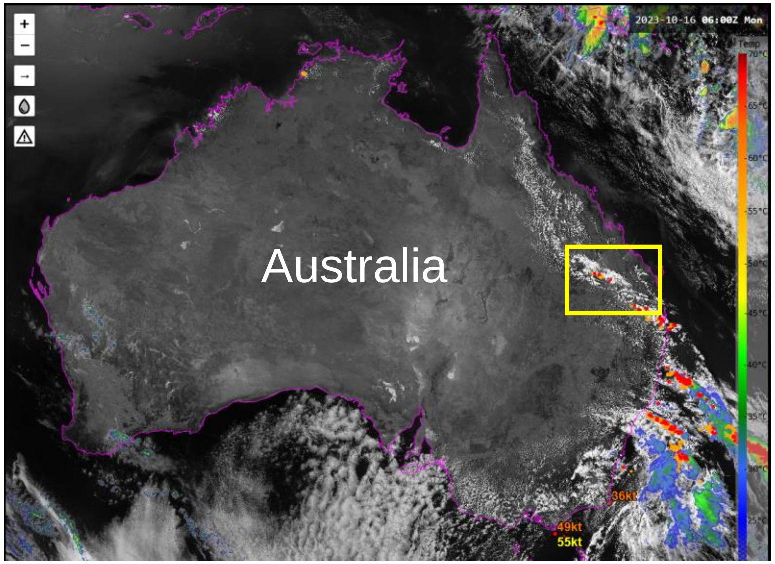
Simple RGB composite image analyses

(slide from Scott Lindstrom's Australian VLab CoE Regional Focus Group meeting of 15th December 2022. Location is American Samoa)

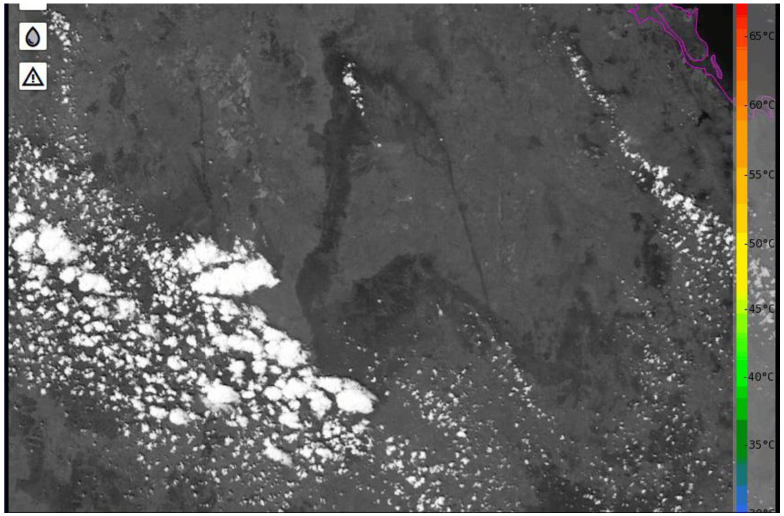


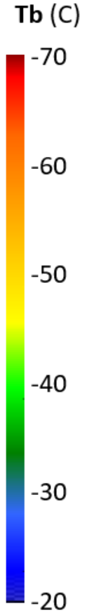
satellite data display courtesy JMA / Bureau of Meteorology, lightning data courtesy Weatherzone

Animation: Australian example from the 16th October 2023.



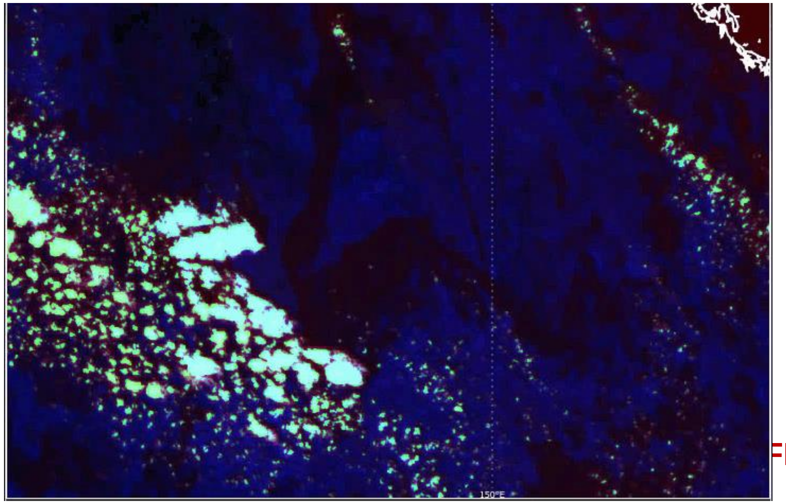
Sandwich Product, 0250UTC to 0640UTC



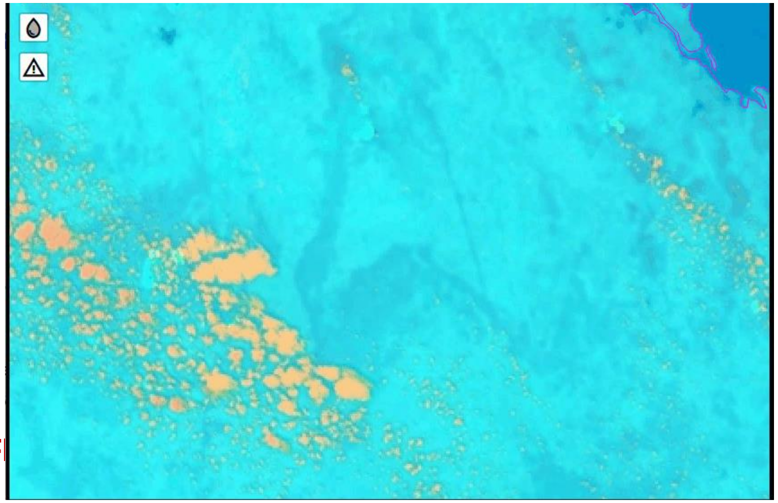


Cloud Phase RGB (SA tuning)
Valid Mon, 16 Oct 2023 02:50 UTC

Cloud Phase RGB, 0250UTC to 0640UTC



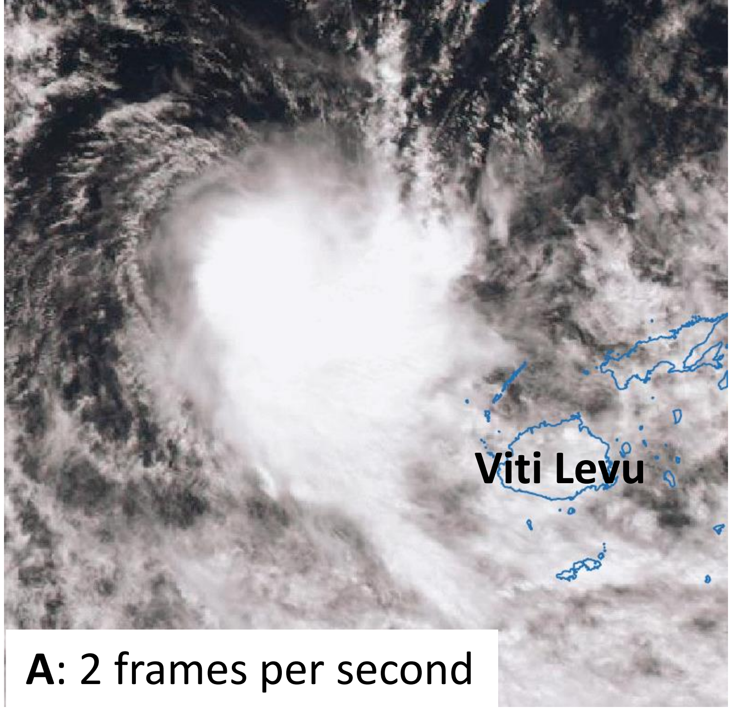
Day Microphysics RGB, 0250UTC to 0640UTC



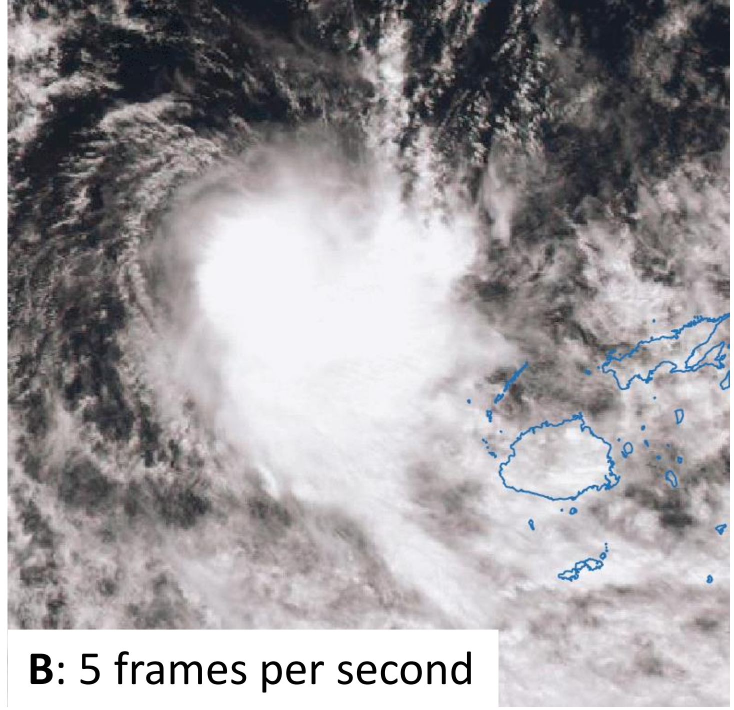
What simple techniques are available to assist in the prediction of and monitoring of Hazardous Weather?

- Varying the image animation speed and the activation of "persistence of vision"

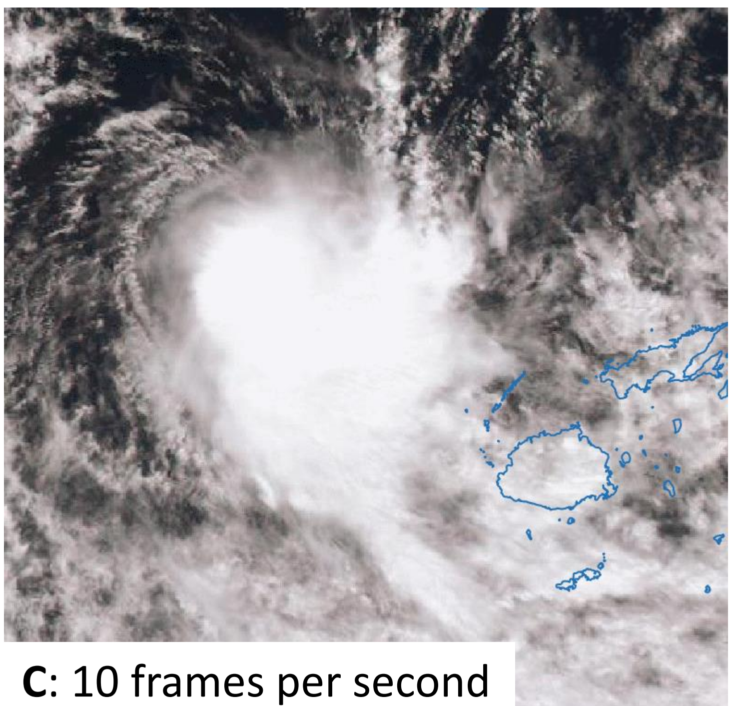
- Rocking animation, such as can be generated by the CIRA SLIDER viewer.



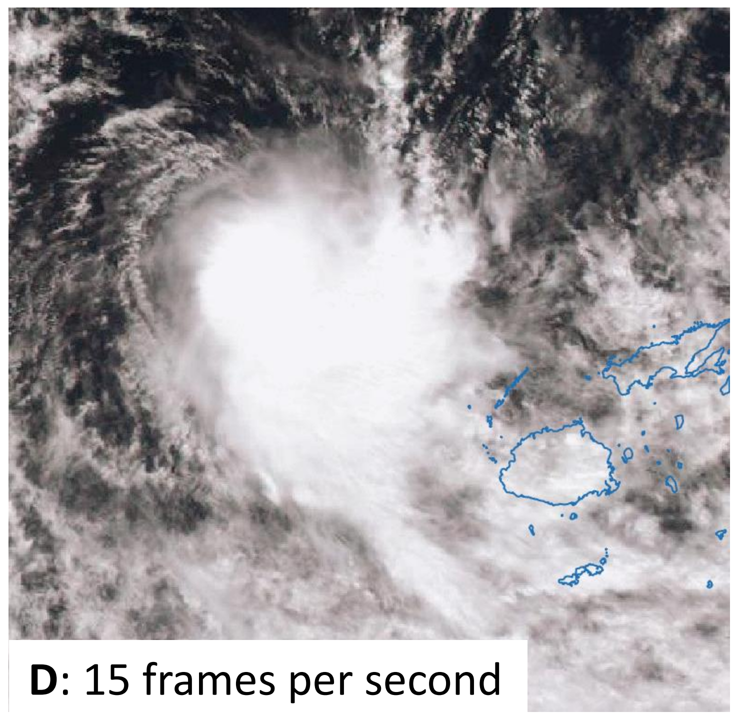
A: 2 frames per second



B: 5 frames per second



C: 10 frames per second



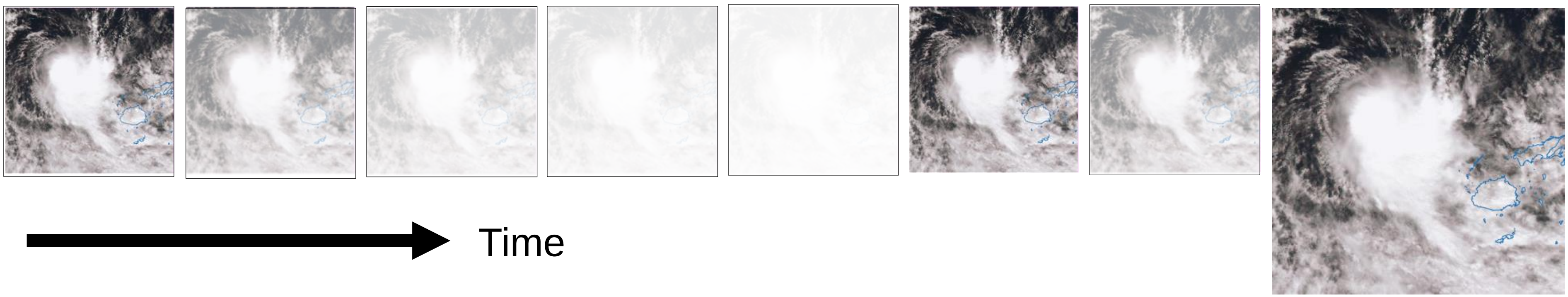
D: 15 frames per second

Animation: Varying the speeds of animation

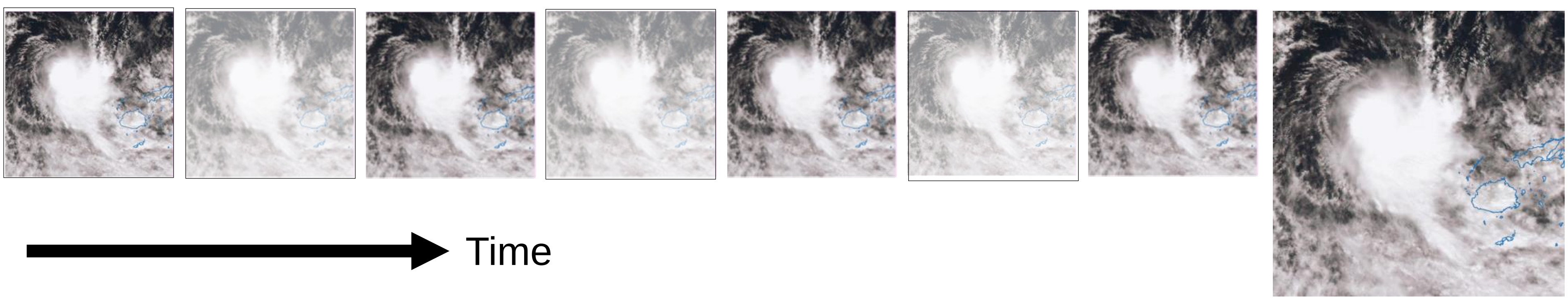
Low near Fiji, 17th October 2015
10 minute data

animations courtesy
JMA/Bureau of Meteorology

Persistence of Vision



Above: slow animation, e.g. 2 FPS. Perception of an object fades with time.



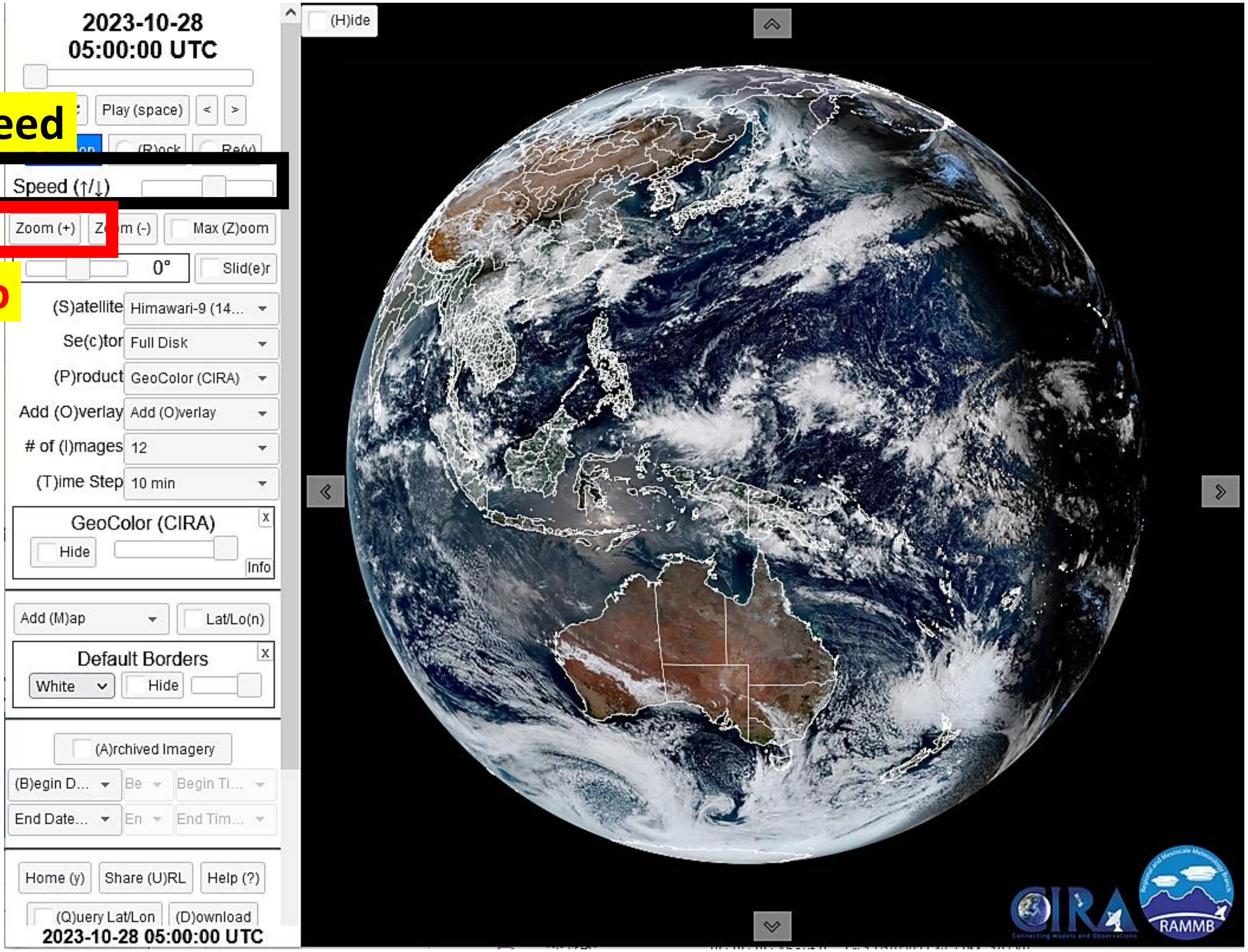
Above: fast animation, e.g. 15 FPS. Perception of an object fades with time but is refreshed by a new image. This creates the illusion of continuity/motion

Let's try speeding up the animation in CIRA SLIDER

try Link 3 https://rammb-slider.cira.colostate.edu/

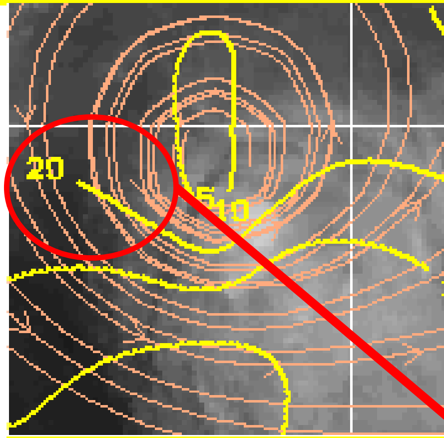
2: increase speed of animation

1: Zoom (+) into area of interest

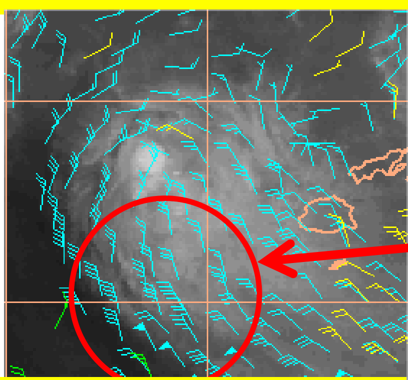


Animation: Low near Fiji, 17th October 2015

Better estimation of the system centre



System moving into an area of increased shear

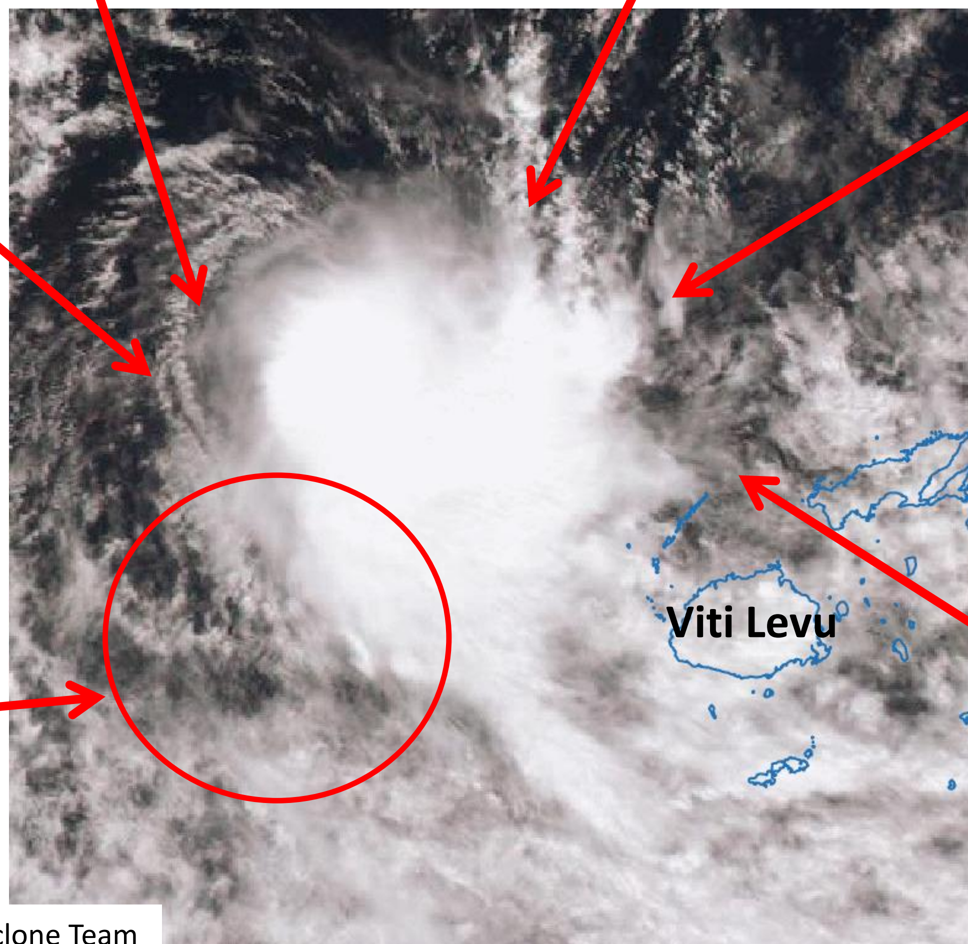


Upper level flow

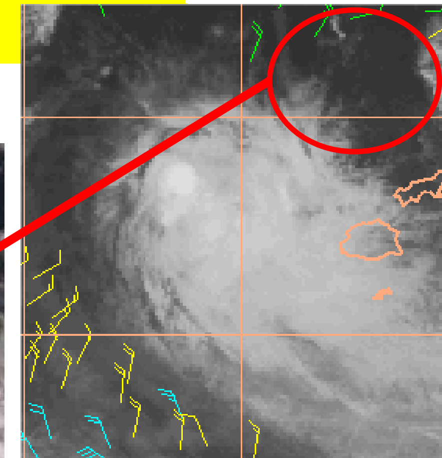
images courtesy CIMSS Tropical Cyclone Team

Confluent flow monitored better – possible convergence and origin of storms on the SE flank of system

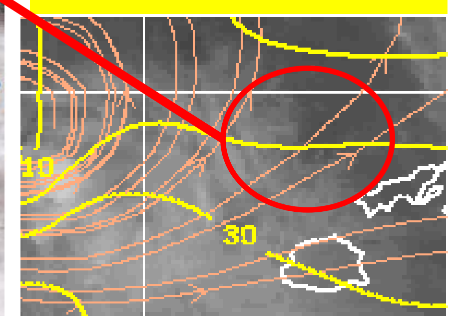
animation courtesy Bureau of Meteorology/JMA



images courtesy CIMSS Tropical Cyclone Team



Region of strong low-upper level atmospheric shear revealed



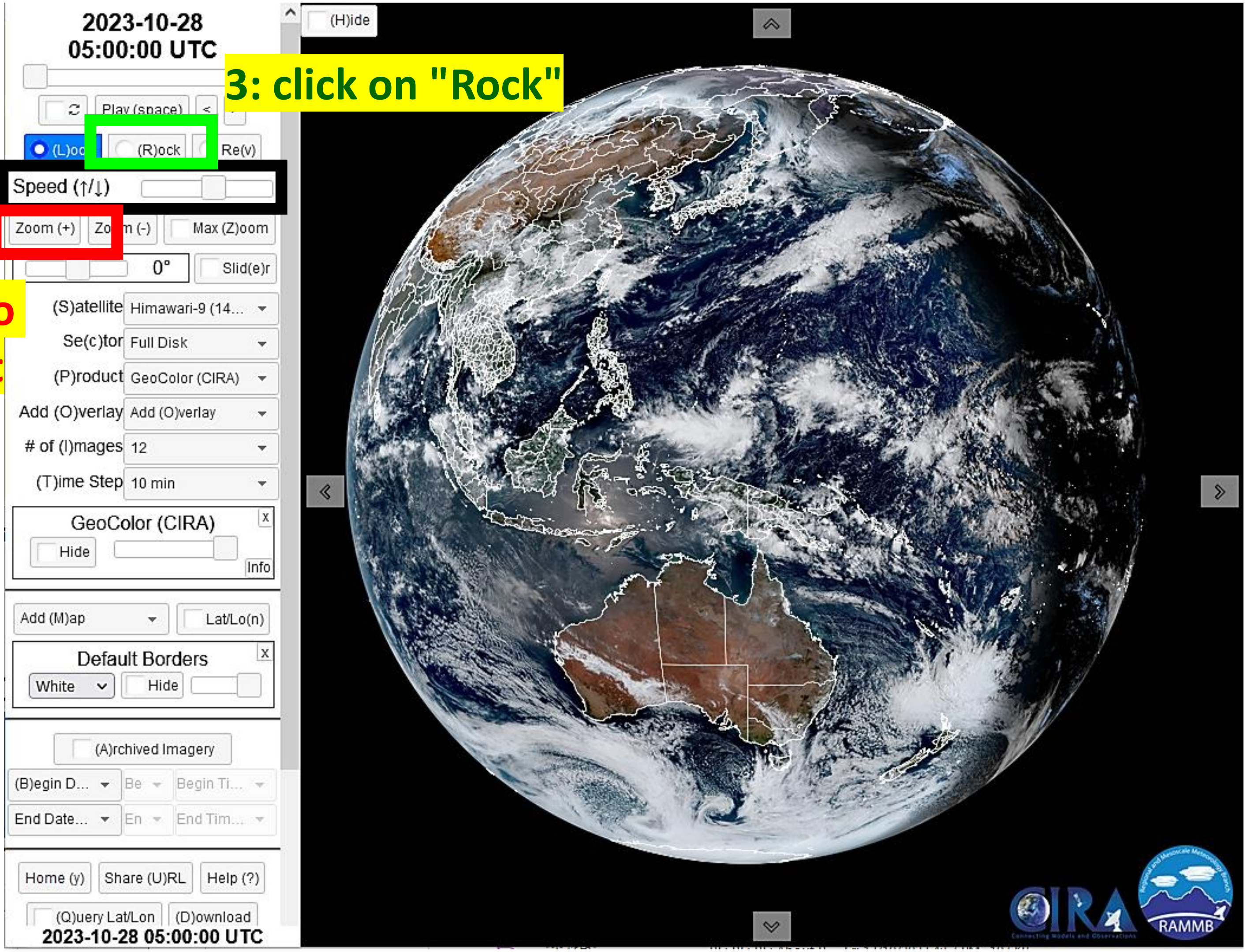
Let's try CIRA SLIDER in "rock and roll" mode

https://rammb-slider.cira.colostate.edu/

2: increase speed of animation

1: Zoom (+) into area of interest

3: click on "Rock"



Animation: Australian smoke event, 2nd March 2019

Bunyip fires 0300-0730UTC 2nd March 2019

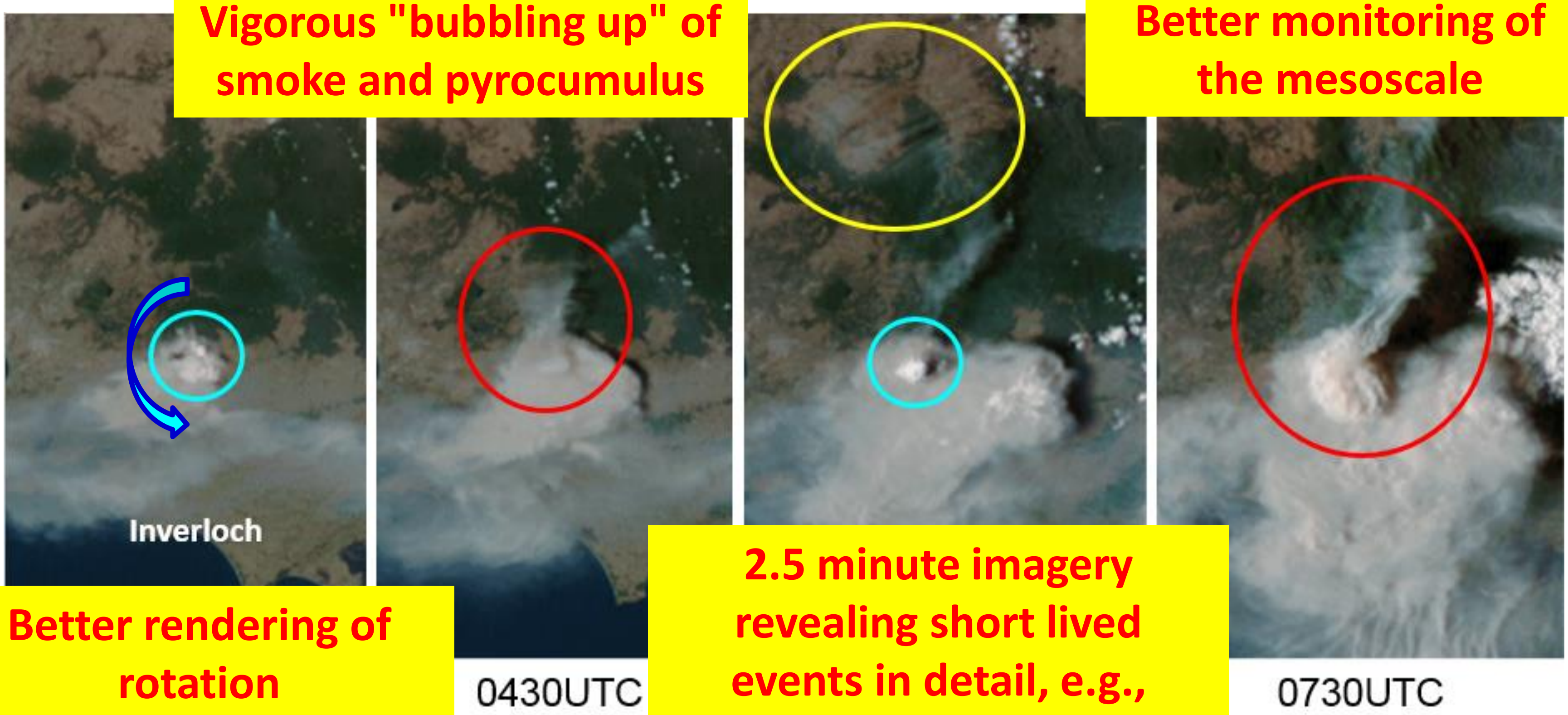
2.5 minute, 10 frames per second (FPS)

HimawariRequest Rapid Scan data animation of the True Colour RGB in "rocking mode"

2.5 minute, 50 frames per second(FPS)

Animation: Australian smoke event, 2nd March 2019

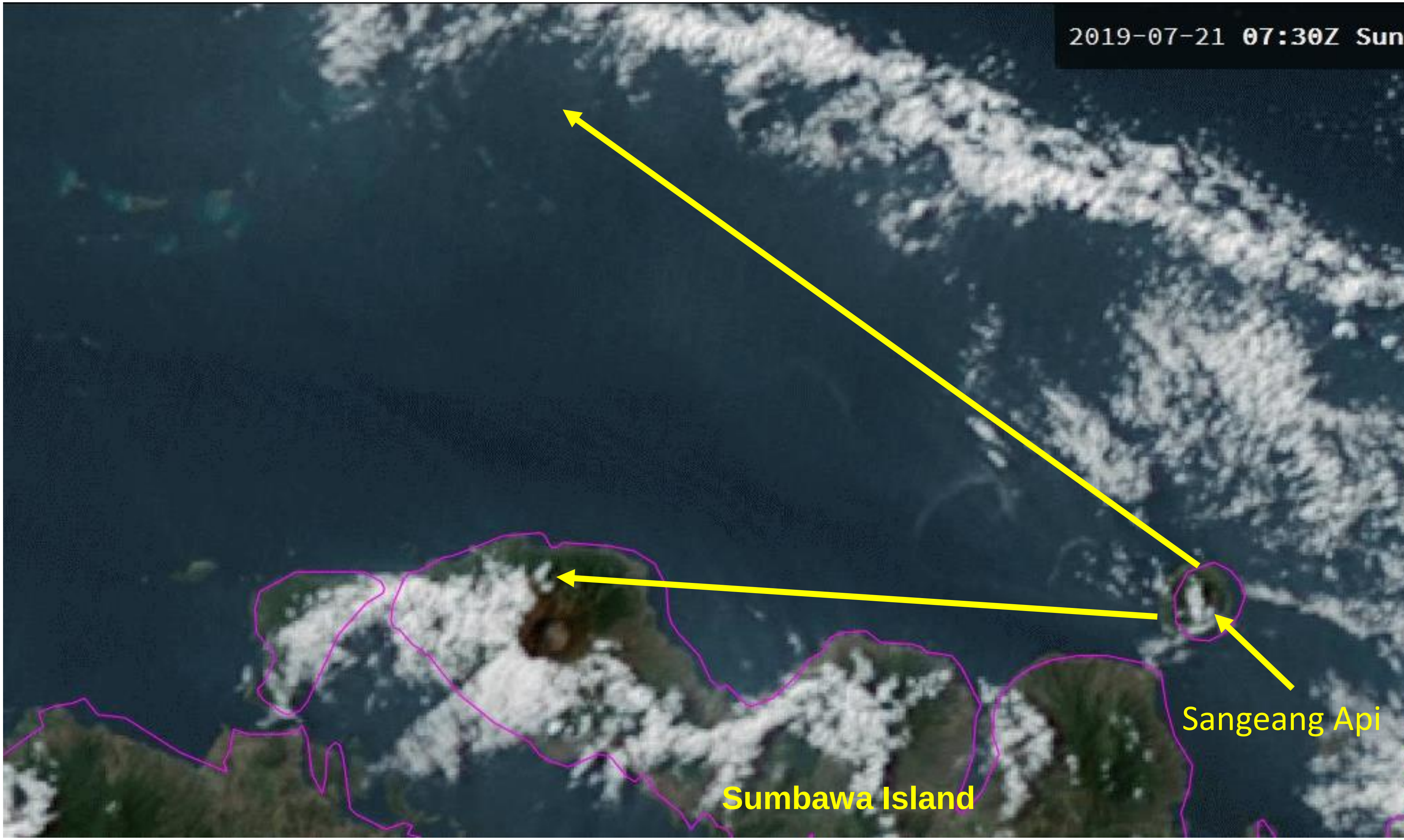
Bunyip fires 0300-0730UTC 2nd March 2019



Development of enhanced episc … UTC and 06UTC within the blue circle, the associ … mulus cloud and the injection of smoke above FL250 within the red and yellow circle.

Animation: Rapid animation in rocking mode

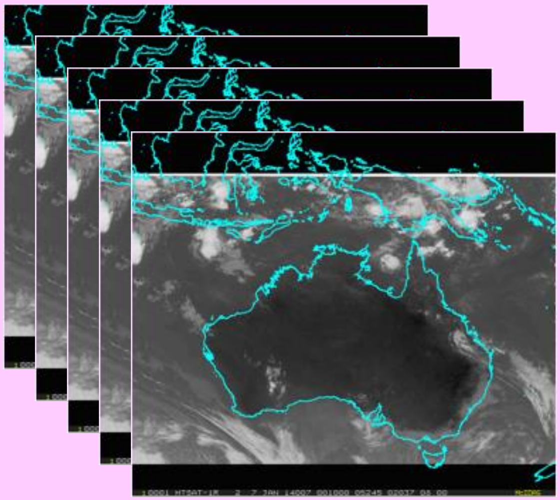
Sangeang Api ash emissions 10 FPS, rocking animation 0730 to 0920UTC 21st July 2019

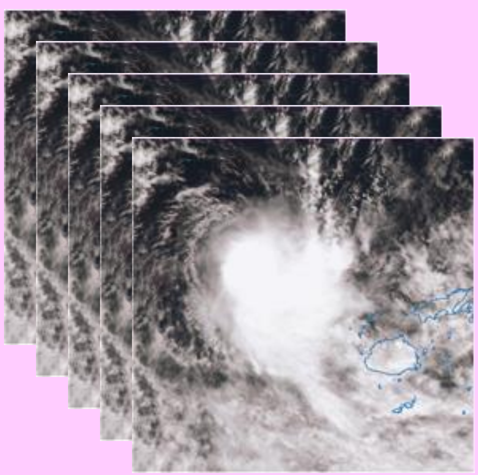


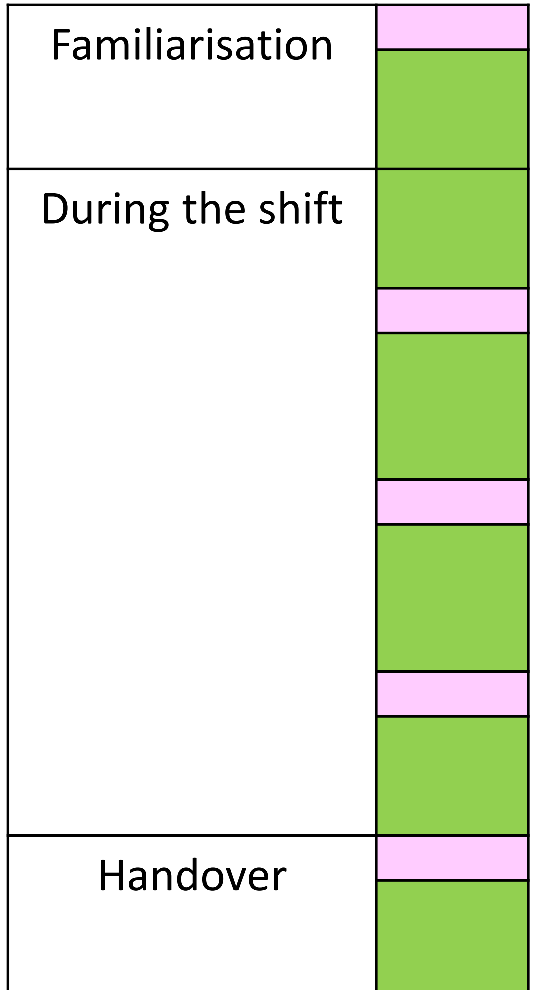
animation courtesy JMA/Bureau of Meteorology

Forecaster use of fast and normal satellite image animations during the shift (from Zeschke et al. 2019)

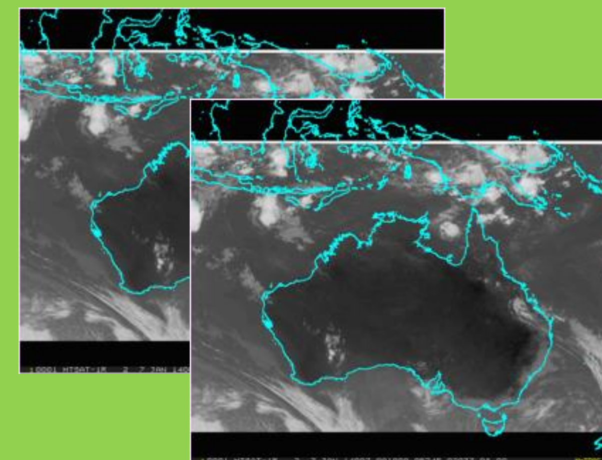
Rapid animation (10 frames per second)

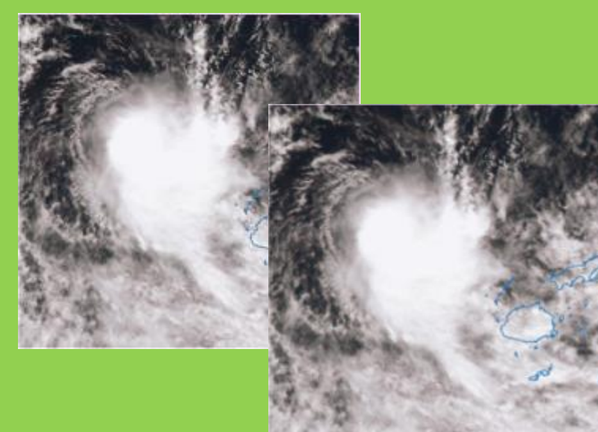






Normal animation (2 frames per second)

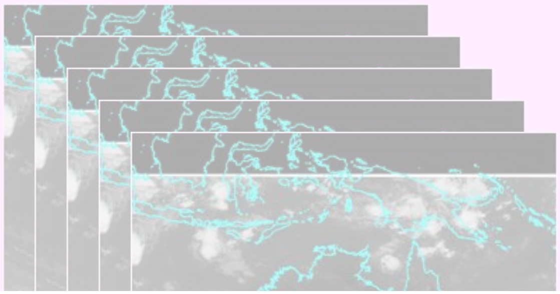




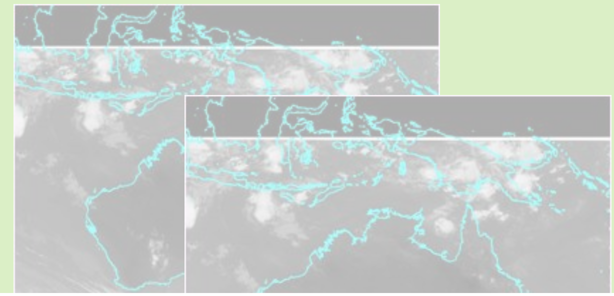
images courtesy JMA/Bureau of Meteorology

Forecaster use of fast and normal satellite image animations during the shift (from Zeschke et al. 2019)

Rapid animation (10 frames per second)



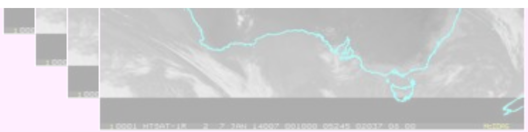
Normal animation (2 frames per second)

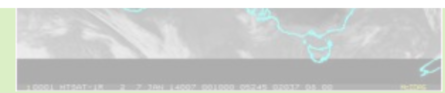


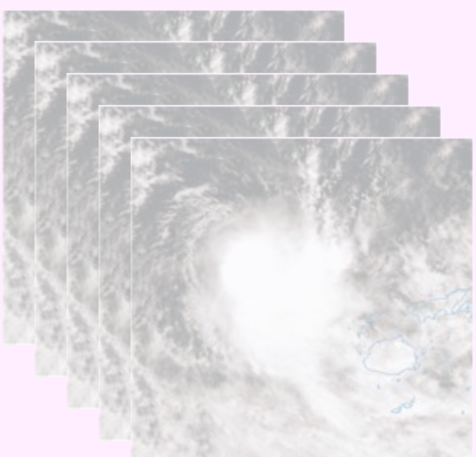
Familiarisation

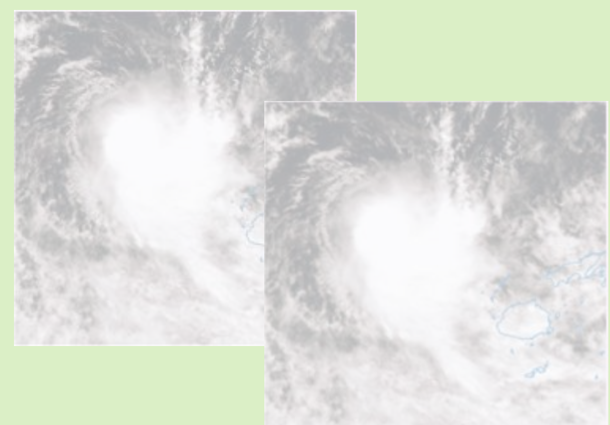
During the shift

Please answer Socrative Question 5









Handover

images courtesy JMA/Bureau of Meteorology

Summary

- Have given the motivation for this presentation.
- Have examined satellite data and data products for anticipating and monitoring hazardous weather related to Tropical Cyclones, Thunderstorms, Smoke and Volcanic Ash.
- Have investigated the time delay in receipt of satellite data and how to compensate for this.
- Have presented resources for anticipating convective development, with some verification.
- Have investigated techniques that take advantage of "persistence of vision".

The Bureau of Meteorology

Thank You ☺

Bodo Zeschke