Australian VLab Centre of Excellence

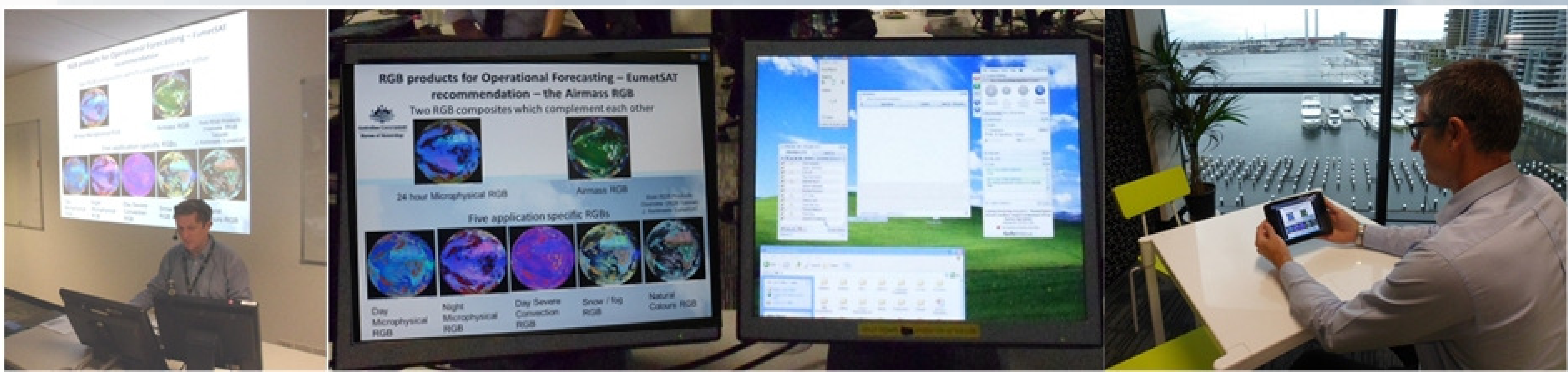
Science Week 2015

Australian Government

Bureau of Meteorology

Exploring the potential of the high temporal and spatial resolution Himawari-8 data

(Facilitator: Bodo Zeschke, BMTC)



Reminder – web links with animations for this session

http://www.virtuallab.bom.gov.au/events/science-week-2015/science-week-2015-pre-course-activities/

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Animation 1 (third animation on this CIMSS Blog link)

Animation 2 (size 15Mb)

Animation 3 (size 23Mb)

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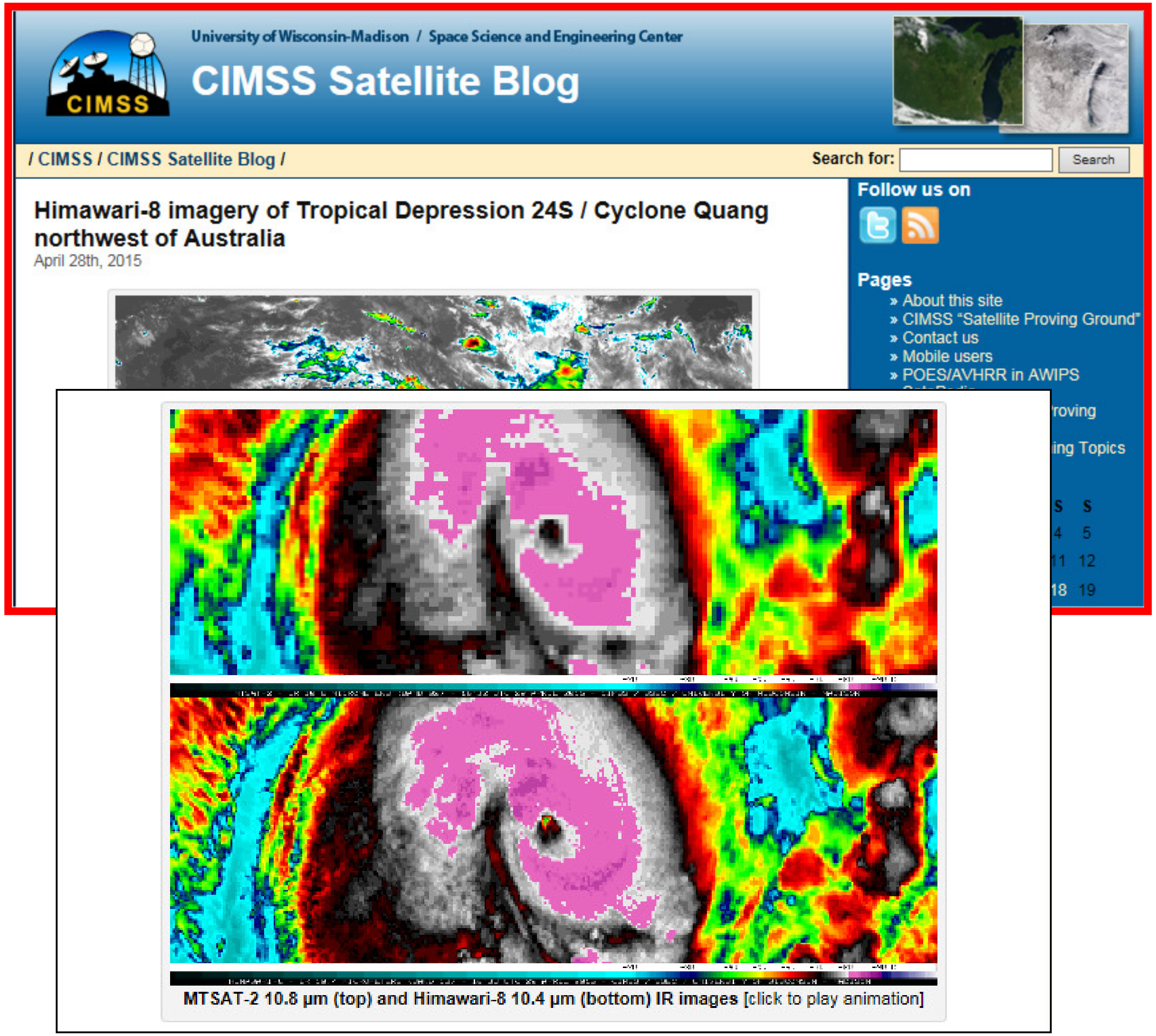
Questions to the presenter



Content

Temporal and spatial resolution of the Himawari-8 satellite data .

Exploring the potential of the high temporal and spatial resolution Himawari-8 data for the detection, monitoring and nowcasting of:

- Tropical Cyclones
- Thunderstorms, including organised thunderstorms
- Fog and low cloud
- Fire and smoke
- Volcanic ash
- Mountain waves and associated atmospheric turbulence.

Useful web resources

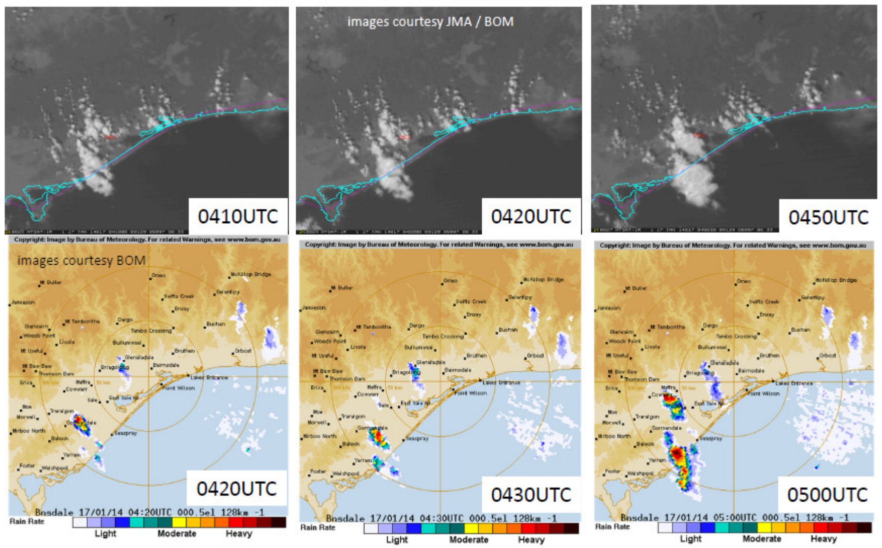
Reminder – the "How Forecasters can use the Himawari-8 data effectively" resource

How Forecasters can use the new Himawari-8 data effectively

Click on the links below to see how Forecasters can use the new Himawari-8 data effectively for the nowcasting and forecasting of the respective meteorological phenomena. Note that this is an evolving resource and your feedback and additional material is welcome.

General Comments	Broadscale / Synoptic Scale	Tropical Cyclones	Thunderstorms
Fog / Low Cloud	Fire and Smoke	Volcanic Ash	1
Turbulence	Other Features (to be added)	Other Features (to be added)	Other Features (to be added)

Thunderstorm formation East Sale 17 January 0500UTC. Rapid scan data versus East Sale RADAR (part 2)



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Home > Training > National Himawari-8 Training Campaign > Introduction Resources and Case Studies > Thunderstorms

Australian VLab Centre of Excellence
National Himawari-8 Training Campaign

Effective use of Himawari-8 data in Thunderstorm detection, monitoring and forecasting

General comments

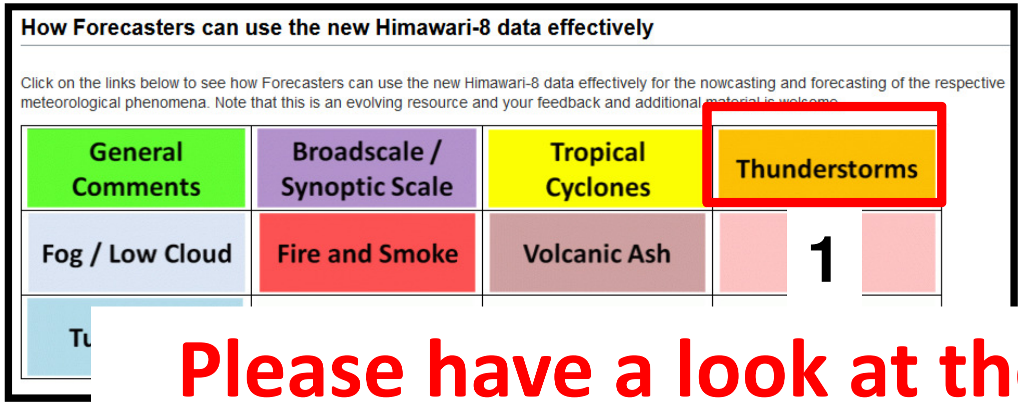
Below are summarised ways in which the increased spatial and temporal resolution and the additional channels of Himawari-8 can assist the Forecaster in detecting, nowcasting and forecasting of this meteorological phenomenon. Further information including case study animations etc. can be obtained for those points highlighted in **bold** in the below table.

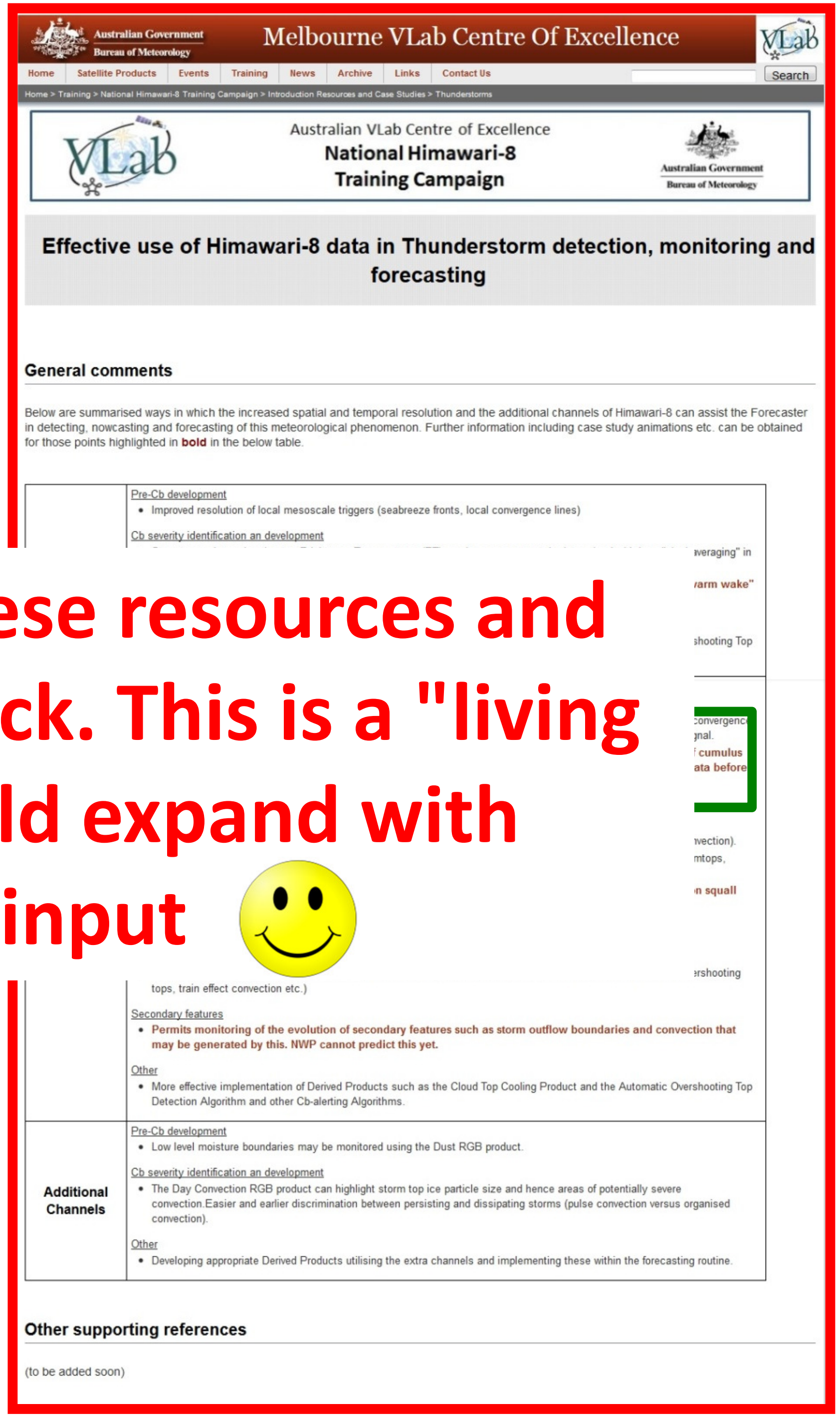
Spatial Resolution	Pre-Cb development • Improved resolution of local mesoscale triggers (seabreeze fronts, local convergence lines) Cb severity identification an development • Stormtop and overshooting top Brightness Temperatures (BT) can be more accurately determined with less "pixel averaging" in the high resolution satellite data. • **The satellite data will provide a clearer picture of storm top signatures such as overshooting tops, the "warm wake" or "enhanced V" (thermal couplet) that are often associated with severe storms.** Other important implications • More effective implementation of Derived Products such as the Cloud Top Cooling Product and the Automatic Overshooting Top Detection Algorithm.
2 **Temporal Resolution**	Pre-Cb development • Permits better determination of the areas where convection may develop (eg. moist low level regions) • Better detection and monitoring of Synoptic / Mesoscale triggers to convection (dry lines / seabreeze fronts, local convergence lines). It is possible to detect these features in the 10 minute satellite data before they are apparent in the radar signal. • **Better identification and monitoring of cumulus development that may transition into Cb (ie. clumping of cumulus and development of towering cumulus). It is possible to detect these features in the 10 minute satellite data before they are apparent in the radar signal.** • **Rapid infrared-based cloud top cooling rates corresponding to developing Cb can be better monitored.** Cb severity identification an development • Easier and earlier discrimination between persisting and dissipating storms (pulse convection versus organised convection). • Better monitoring of the movement and organisation of storms (eg. near-continuous monitoring of overshooting stormtops, splitting of supercells, organisation of storms into squall lines) • **Permits very short term forecasting of rapidly moving and potentially short lived convection (eg. monsoon squall lines).** • Better monitoring of steering flow by examining the movement of the storms in the high resolution imagery. • Better monitoring of shear and its effect on the convective development. • More readily able to detect rotation in Cb clouds. • Better able to monitor storms associated with potentially intense rain rates (slow moving storms with persisting overshooting tops, train effect convection etc.) Secondary features • **Permits monitoring of the evolution of secondary features such as storm outflow boundaries and convection that may be generated by this. NWP cannot predict this yet.** Other • More effective implementation of Derived Products such as the Cloud Top Cooling Product and the Automatic Overshooting Top Detection Algorithm and other Cb-alerting Algorithms.
Additional Channels	Pre-Cb development • Low level moisture boundaries may be monitored using the Dust RGB product. Cb severity identification an development • The Day Convection RGB product can highlight storm top ice particle size and hence areas of potentially severe convection.Easier and earlier discrimination between persisting and dissipating storms (pulse convection versus organised convection). Other • Developing appropriate Derived Products utilising the extra channels and implementing these within the forecasting routine.

Other supporting references

(to be added soon)

Reminder – the "How Forecasters can use the Himawari-8 data effectively" resource



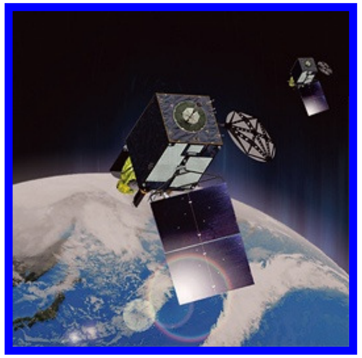


Please have a look at these resources and forward me some feedback. This is a "living resource" which should expand with stakeholder input

MTSAT-2 versus Himawari 8/9 increased resolution

気象庁
Japan Meteorological Agency

Band	Central Wavelength [μm]	Spatial Resolution
1	0.43 - 0.48	1Km
2	0.50 - 0.52	1Km
3	0.63 - 0.66	0.5Km
4	0.85 - 0.87	1Km
5	1.60 - 1.62	2Km
6	2.25 - 2.27	2Km
7	3.74 - 3.96	2Km
8	6.06 - 6.43	2Km
9	6.89 - 7.01	2Km
10	7.26 - 7.43	2Km
11	8.44 - 8.76	2Km
12	9.54 - 9.72	2Km
13	10.3 - 10.6	2Km
14	11.1 - 11.3	2Km
15	12.2 - 12.5	2Km
16	13.2 - 13.4	2Km



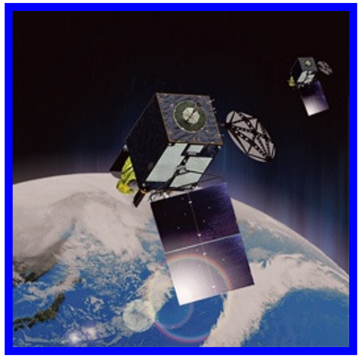
Himawari 8

MTSAT 2

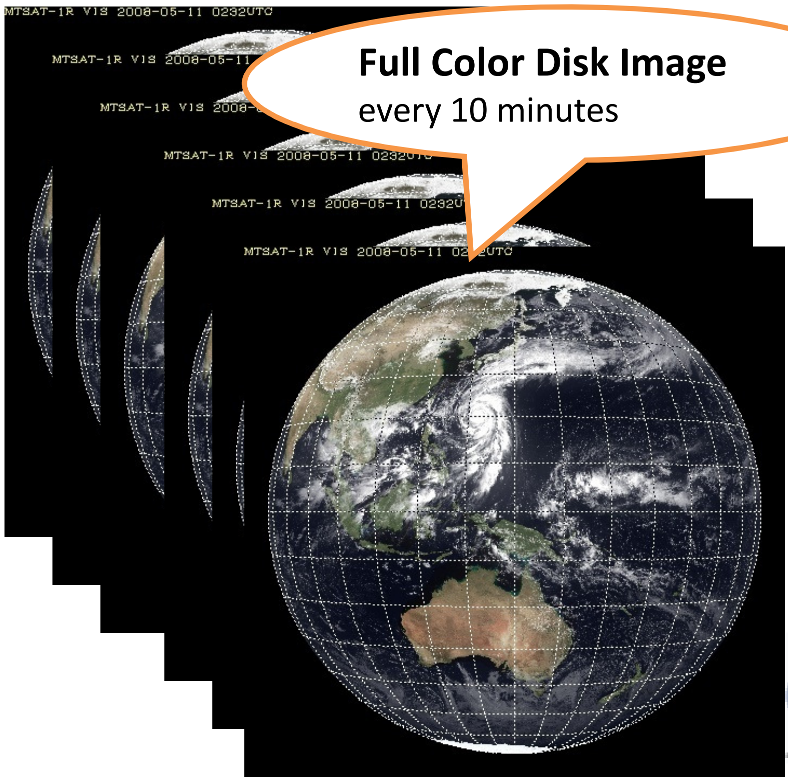
Band	Central Wavelength [μm]	Spatial Resolution
1	0.55 – 0.90	1Km
2	3.50 – 4.00	4Km
3	6.50 - 7.00	4Km
4	10.3 – 11.3	4Km
5	11.5 – 12.5	4Km

MTSAT-2 image courtesy JMA, Himawari-8 image courtesy NASA

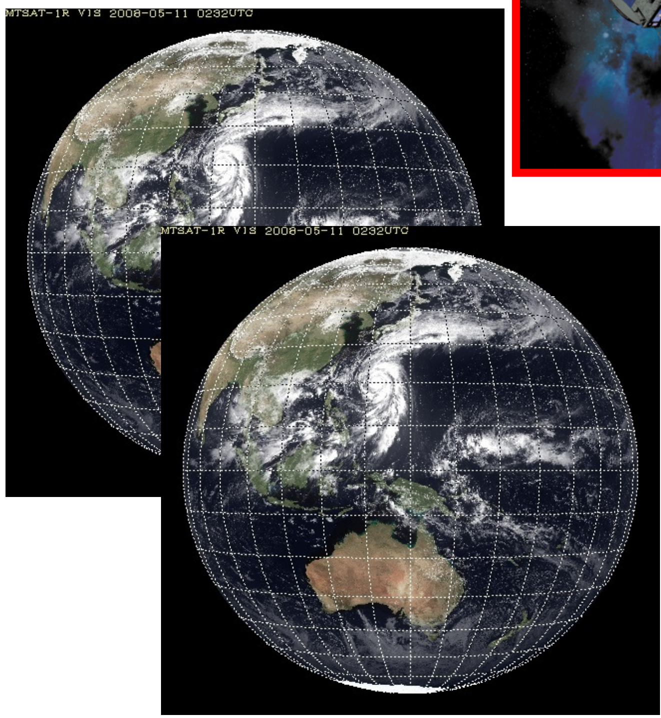
MTSAT-2 versus Himawari 8/9 increased data frequency



Himawari 8



MTSAT 2



Hourly / half hourly images

気象庁
Japan Meteorological Agency

MTSAT-2 image courtesy JMA, Himawari-8 image courtesy NASA

Please start the first animation

http://www.virtuallab.bom.gov.au/events/science-week-2015/science-week-2015-pre-course-activities/

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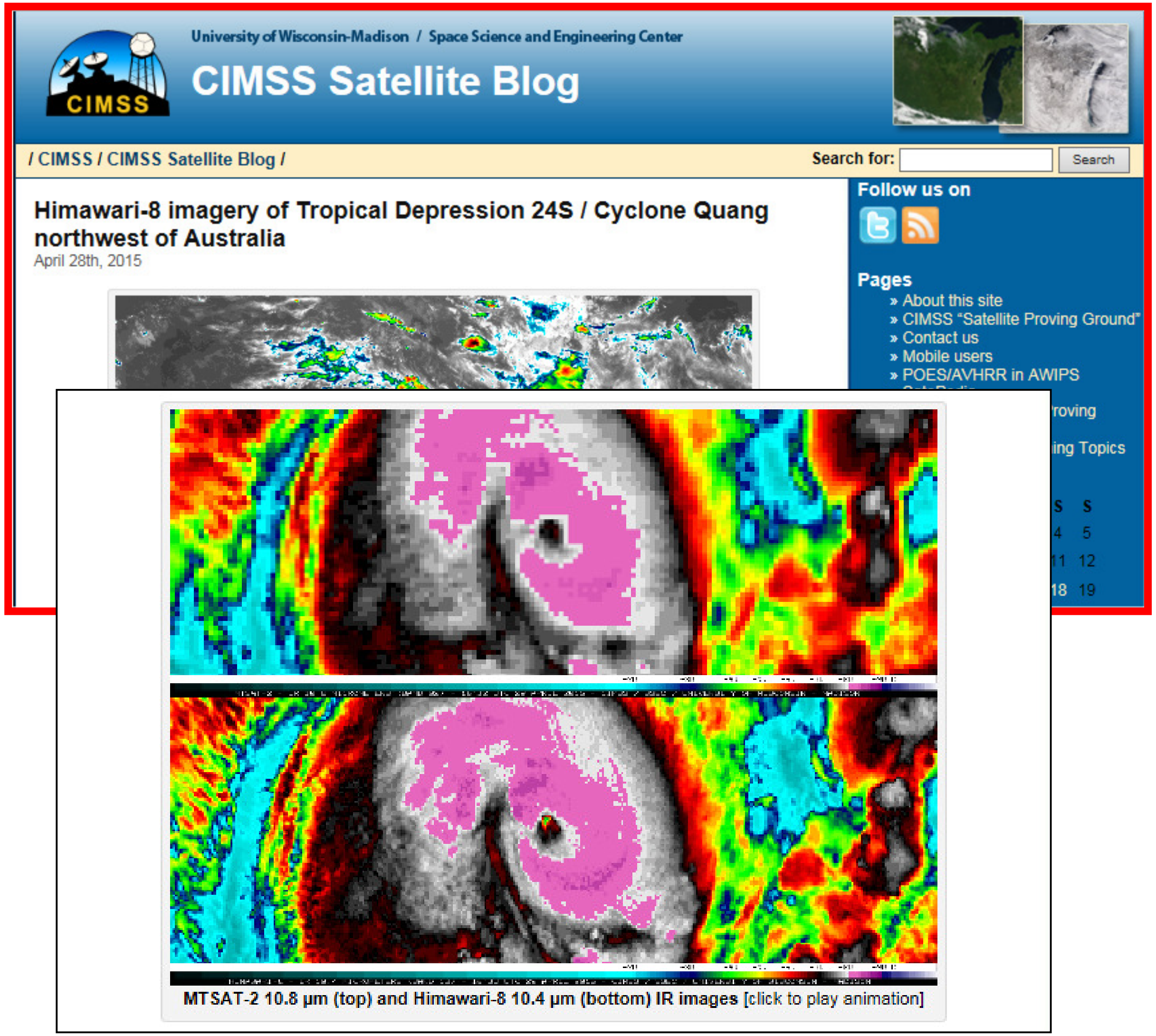
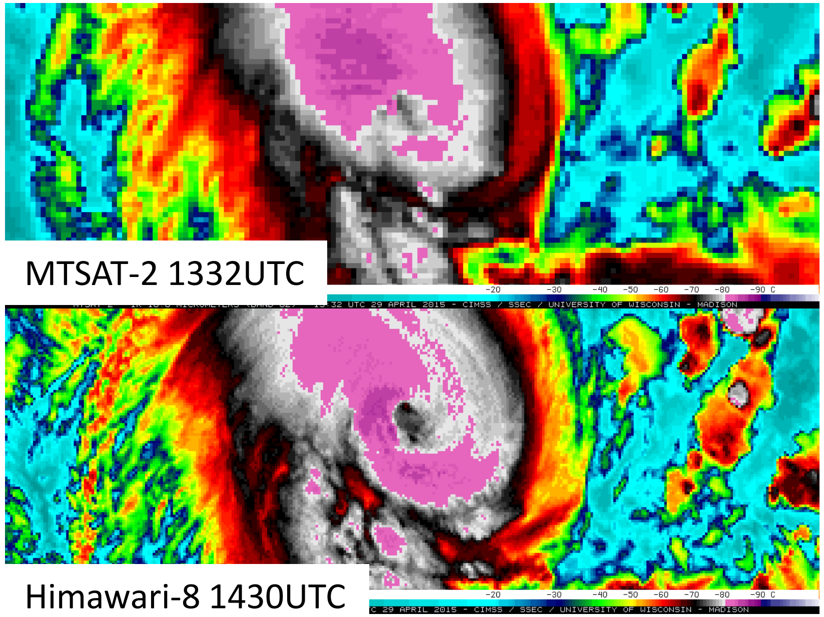
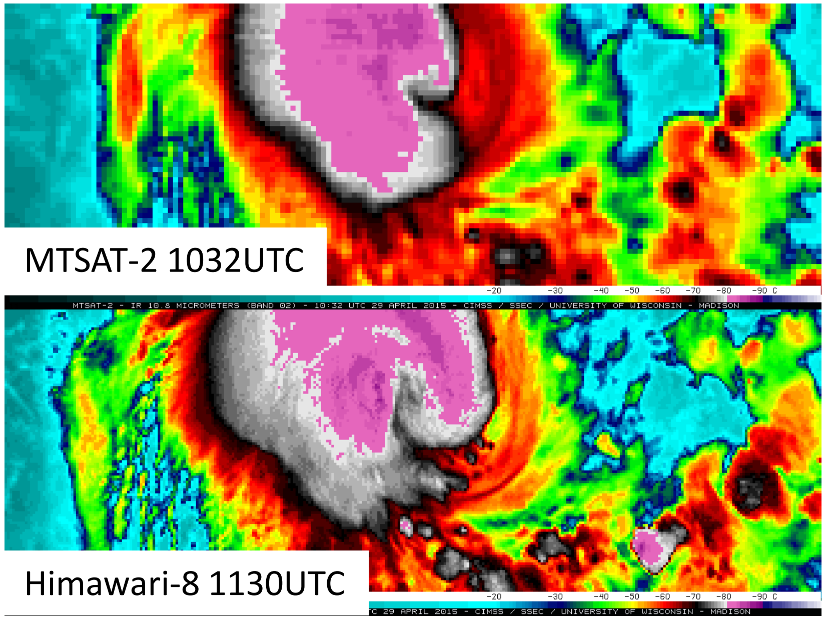


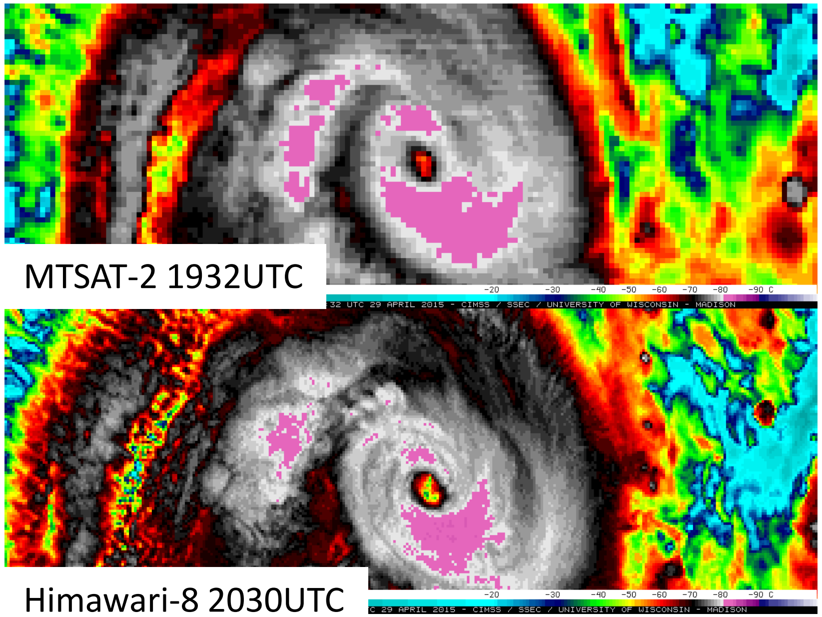
Exercise

Annotate features of interest that the Himawari-8 data can show you

How are the Himawari-8 images an advantage over the MTSAT-2 images

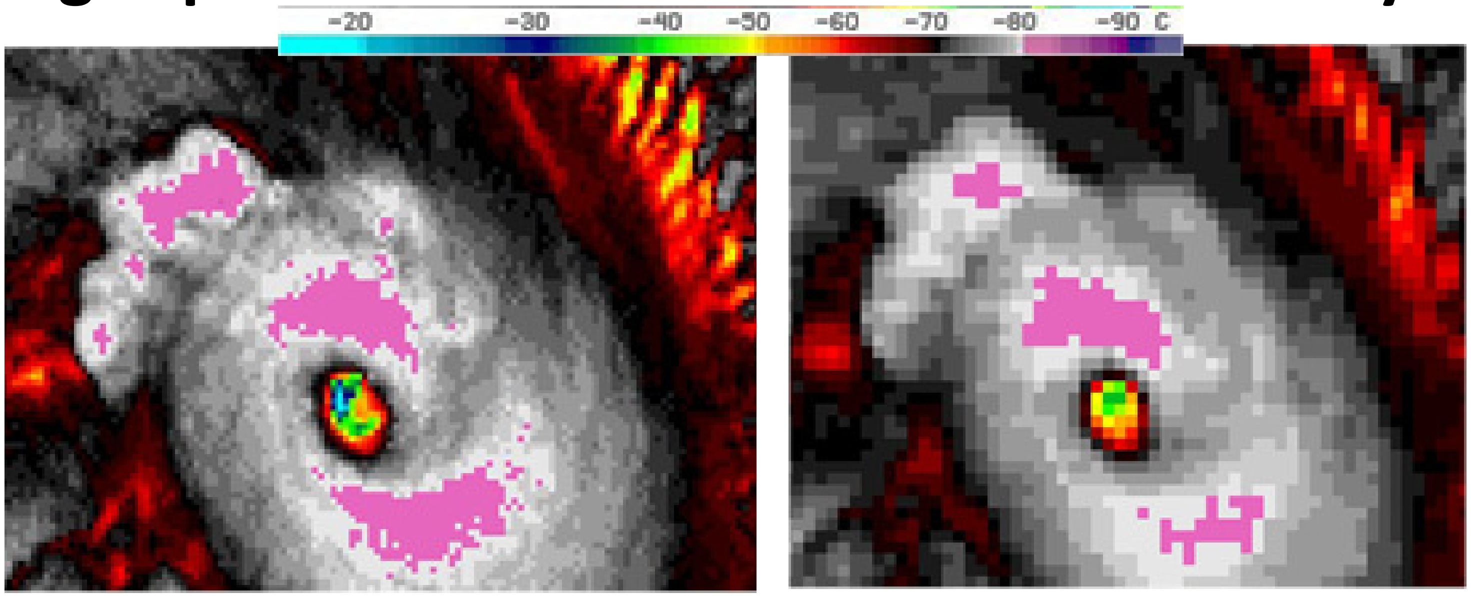






images from the JMA / CIMSS Himawari-8 Blog site "Himawari-8 imagery of Tropical Depression 24S / Cyclone Quang northwest of Australia"

High spatial resolution data and Dvorak Analysis



Eye Temperature

No Minimum width Surrounding Ring Temperature

	WMG	OW	DG	MG	LG	B	W
OW	0	-0.5					
DG	0	0	-0.5				
MG	0	0	-0.5	-0.5			
LG	+0.5	0	0	-0.5	-0.5		
B	+1.0	+0.5	0	0	-0.5	-0.5	
W	+1.0	+0.5	+0.5	0	0	-1.0	-1.0
CMG	+1.0	+0.5	+0.5	0	0	-0.5	-1.0

Not for large (⩾ 45 n ml) or elongated (short axis 2/3 long) eyes

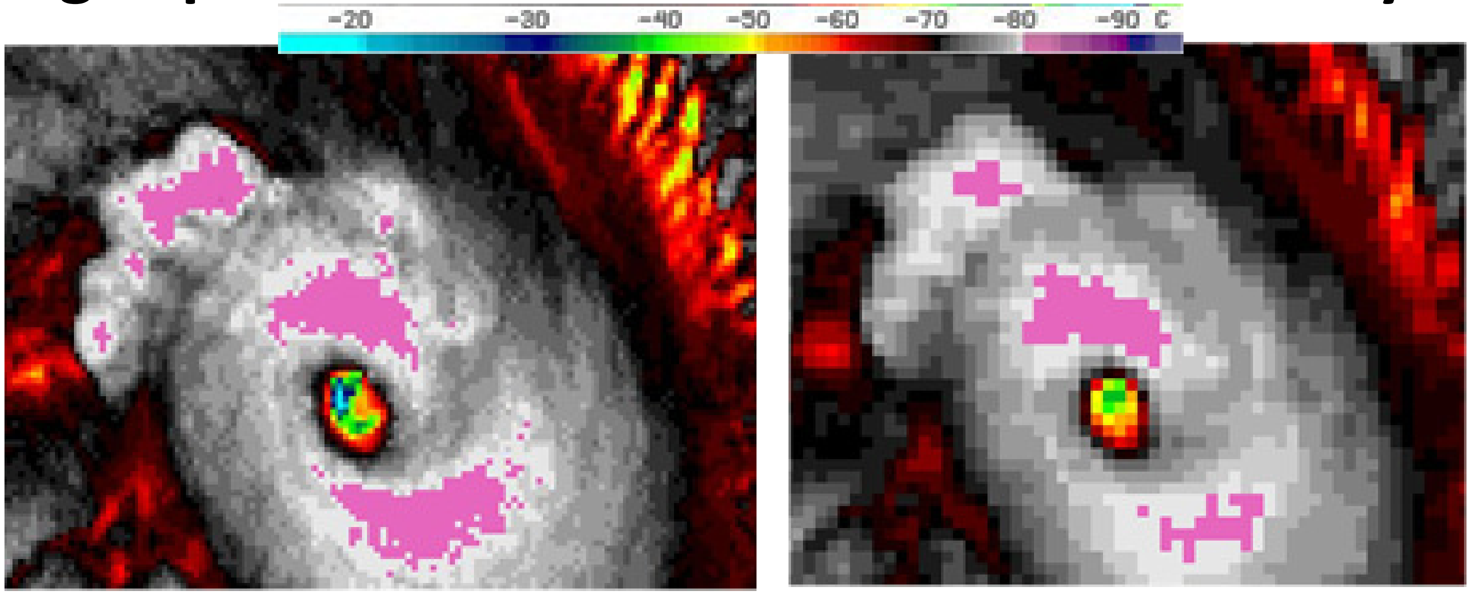
Elongated eyes when E no. ⩾ 4.5 subtract 0.5 if no previous subtraction made

Dvorak "Eye" Pattern rules

	30nm	30	30	24	24	18	18	Nautical Miles
Narrowest Width	⩾ 0.5	⩾ 0.5	⩾ 0.5	⩾ 0.4	⩾ 0.4	⩾ 0.3	⩾ 0.3	Degrees Latitude
Surrounding grey shade	CMG	W	B	LG	MG	DG	OW	EIR Colour (BD Curve)
	E6.5	E6.0	E5.5	E5.0	E4.5	E4.5	E4.0	

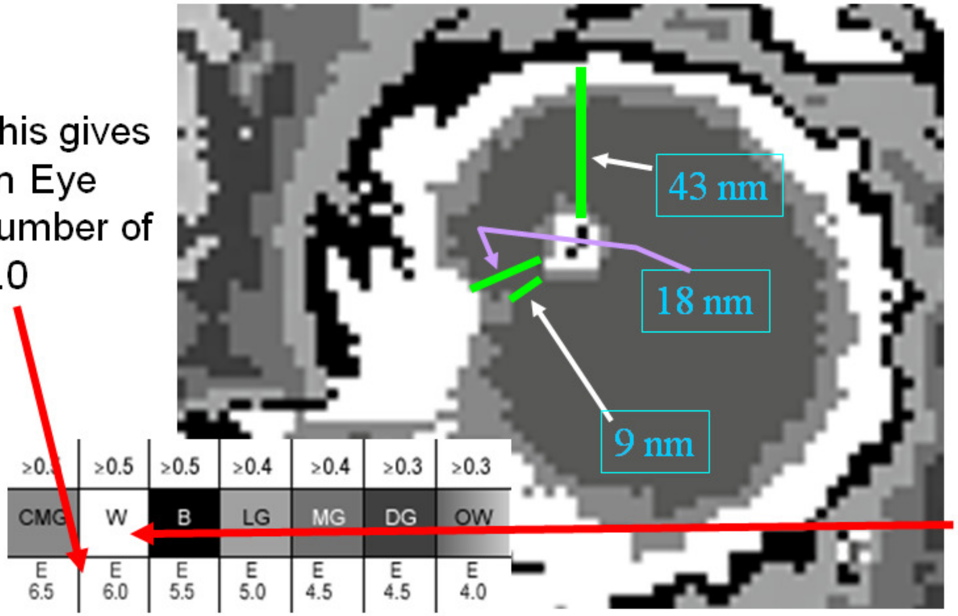
images from the JMA / CIMSS Himawari-8 Blog site "Himawari-8 imagery of Tropical Depression 24S / Cyclone Quang northwest of Australia"

High spatial resolution data and Dvorak Analysis



Dvorak "Eye" Pattern

This gives an Eye number of 6.0



Here, only the white enhancement is wide enough

SATAID image courtesy JMA

Another useful CIMSS Himawari-8 Satellite Blog post

University of Wisconsin-Madison / Space Science and Engineering Center

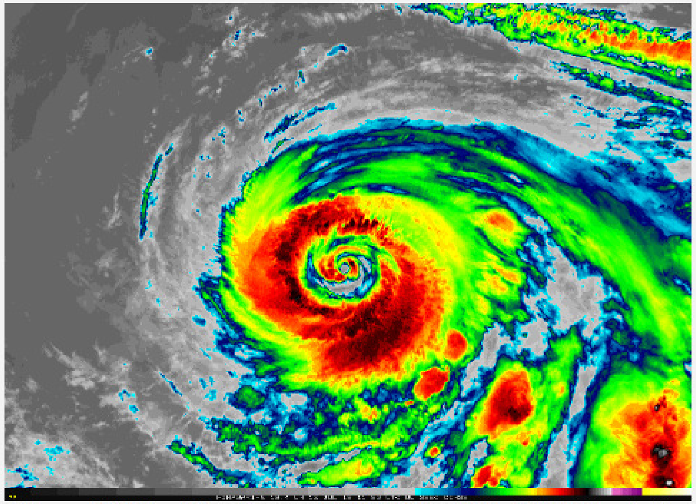
CIMSS Satellite Blog

/ CIMSS / CIMSS Satellite Blog /

Search for: Search

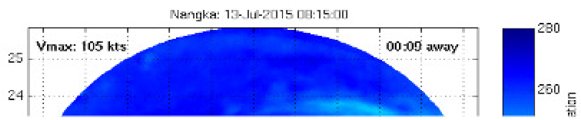
Unusual Double Eyewall structure in Himawari-8 Infrared Imagery of Typhoon Nangka

July 13th, 2015



Himawari-8 10.35 μm infrared imagery, 0540-1540 UTC on 13 July 2015 (click to animate)

Himawari-8 10.35 μm infrared imagery showed an unusual (for infrared imagery) double-eyewall structure in Typhoon Nangka over the western Pacific Ocean on 13 July 2015. For such a feature to appear in infrared imagery, the secondary circulations of both the inner and outer eyewall need to be intense enough to support the downdraft/cloud-clearing necessary to create the "moats" between them. Microwave imagery of the storm, below, viewed via MIMIC (from this site), also showed the double eyewall structure quite well. This double-eyewall signature typically indicates that a tropical cyclone is experiencing an eyewall replacement cycle (ERC), which signals that a (temporary) decrease in intensity is soon to follow.



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July 2015

M	T	W	T	F	S	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

« Jun

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- » Fire detection
- » Fog detection
- » General interpretation
- » GOES sounder
- » GOES-10
- » GOES-11
- » GOES-12
- » GOES-13
- » GOES-14
- » GOES-15

Summary: Improvements to TC monitoring using rapid scan, high-resolution Himawari-8 data

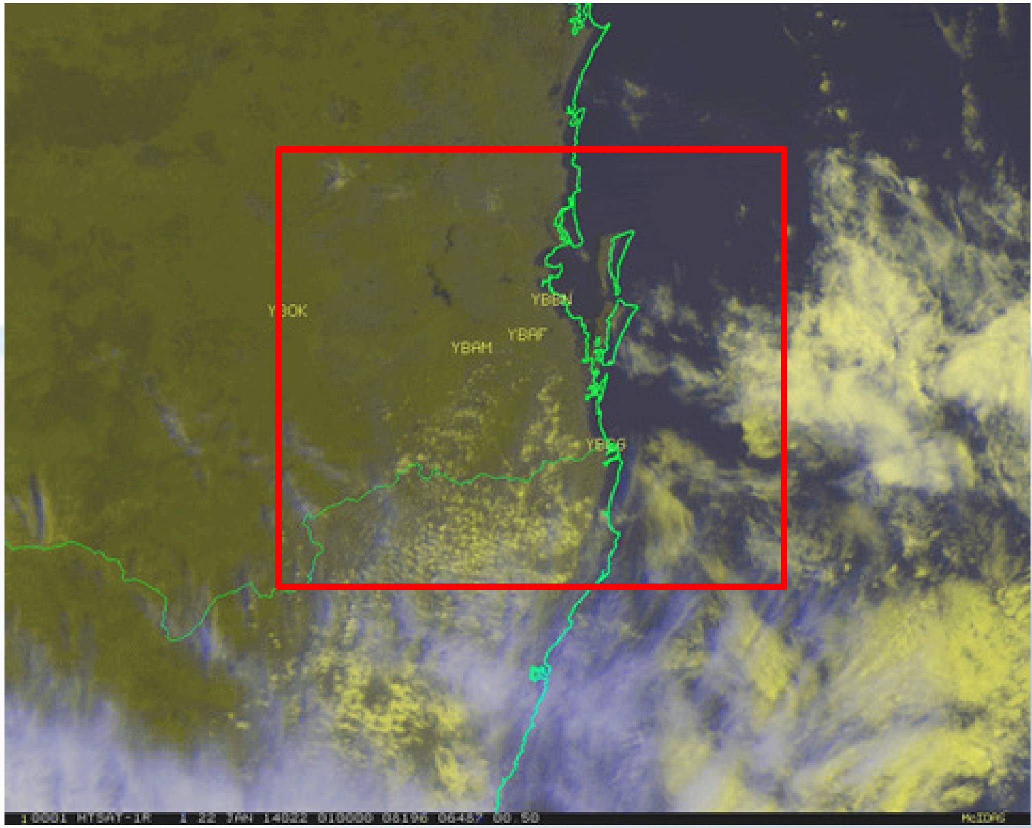
Higher spatial resolution	TC cloud top features resolved in more detail (convective blow-ups, gravity waves, outflow channels, midget TC's)
	Better brightness temperature resolution in the IR. Assists in Dvorak analysis
Higher temporal resolution	Better monitoring the centre of a sheared system with a Central Dense Overcast (low level cloud lines)
	Better monitoring of rapid changes (eye development, midget TC development, eye replacement cycle, gravity waves development, convective development, development of outflow channels etc.)
	Better fix on the system centre. Central circulation may be tied to the RADAR signal. Mesovortices within eye monitored.
	Track of the TC better monitored and compared with NWP
	False eyes are more easily detected
	Better monitoring of the effects of atmospheric shear on TC development
	Higher density Cloud Drift Winds (CDW) associated with TC
	Higher density of data into NWP. Improved NWP output

Please play "Animation 2"

Australian Government
Bureau of Meteorology

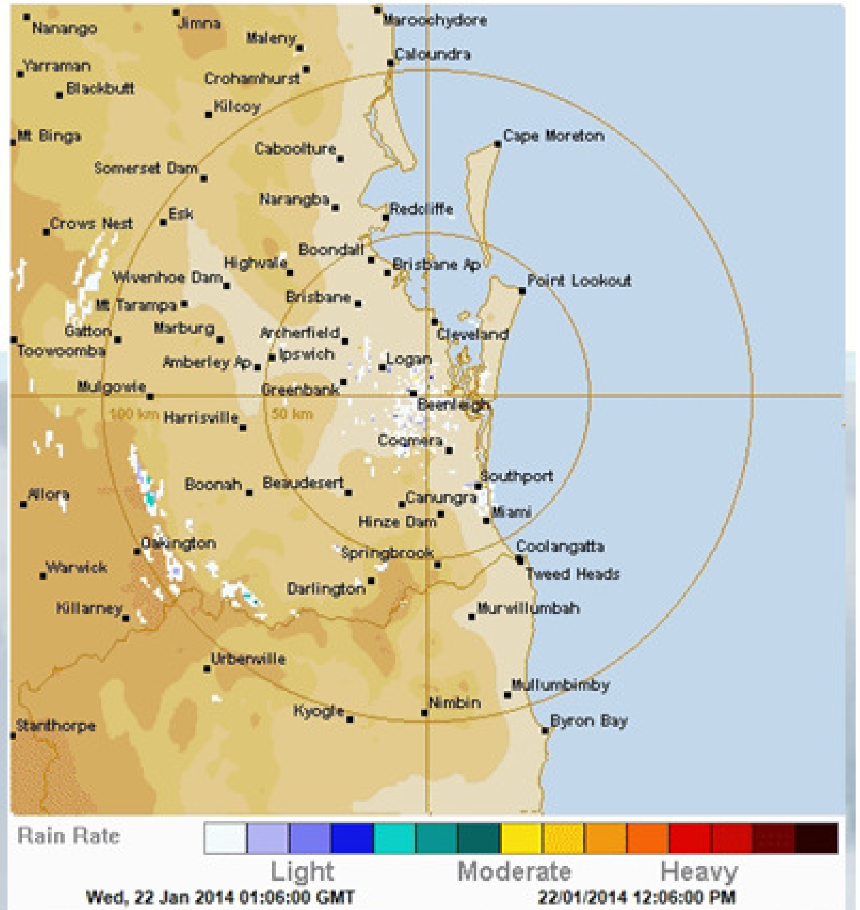
Thunderstorm Case Study: Rapid Scan (10 minute) satellite data compared to RADAR

animation courtesy BOM



animation courtesy JMA / BOM

10 minute satellite data, MTSAT-1R



Brisbane (Mt Stapylton) RADAR data

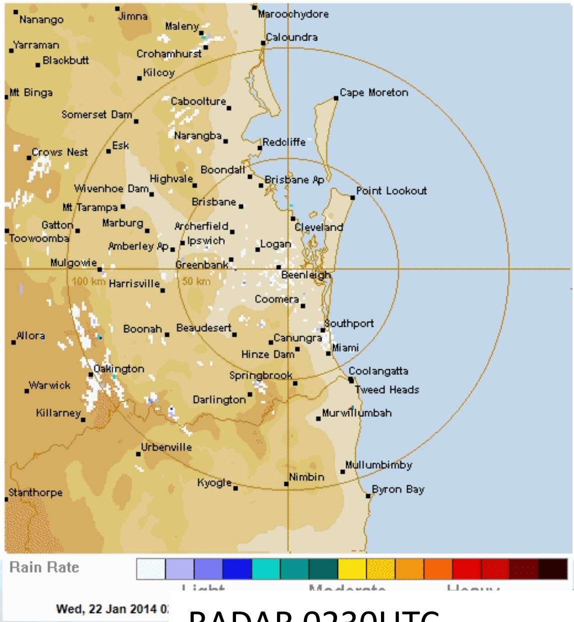
Severe Thunderstorms, SE Queensland, 22nd January 2014

Exercise – early stage development (at time of reception by Forecaster)

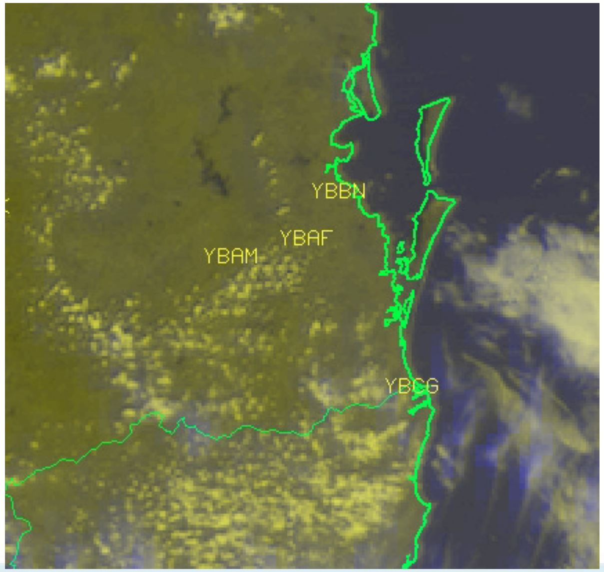
Annotate features of interest that the MTSAT-1R rapid scan data can show you

How is the MTSAT-1R rapid scan data an advantage over the RADAR data?

How is the RADAR data an advantage?



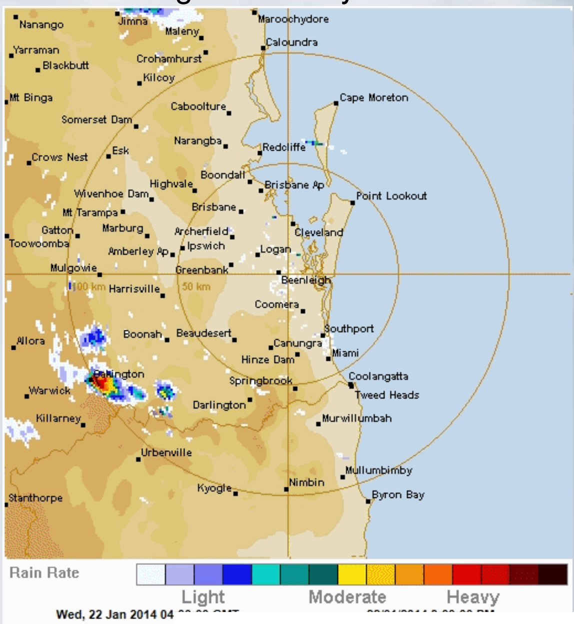
RADAR 0230UTC



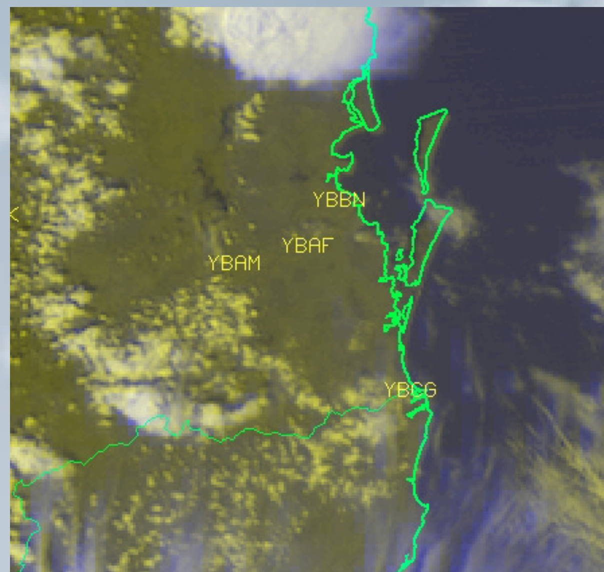
MTSAT-1R 0220UTC

images courtesy BOM

images courtesy JMA / BOM



RADAR 0402UTC



MTSAT-1R 0351UTC

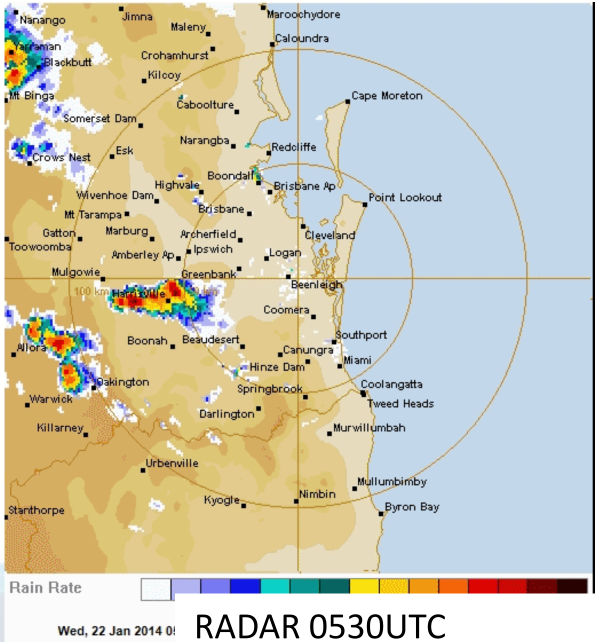
Exercise – late stage development

(at time of reception by Forecaster)

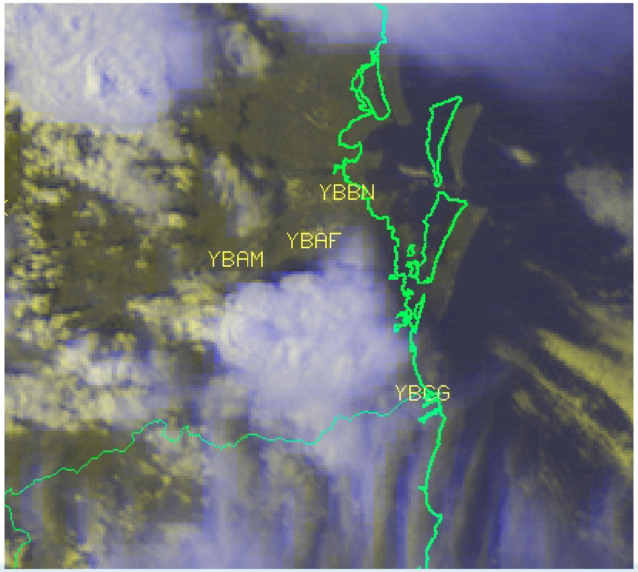
Annotate features of interest that the MTSAT-1R rapid scan data can show you

How is the MTSAT-1R rapid scan data an advantage over the RADAR data?

How is the RADAR data an advantage?



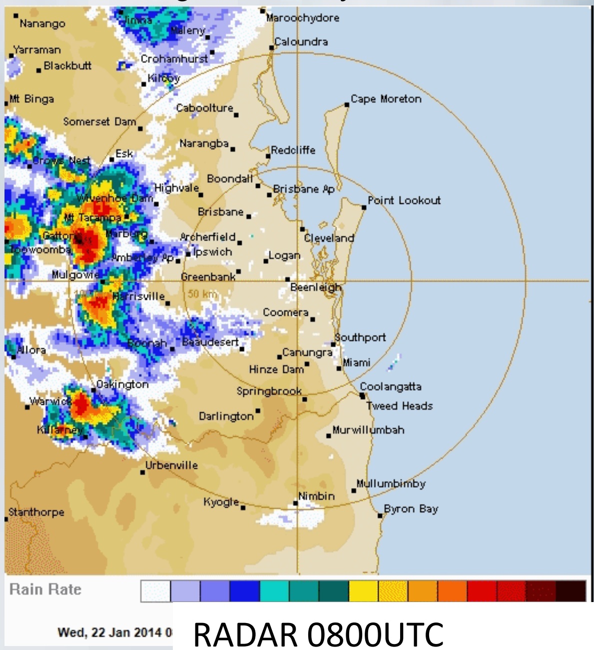
RADAR 0530UTC



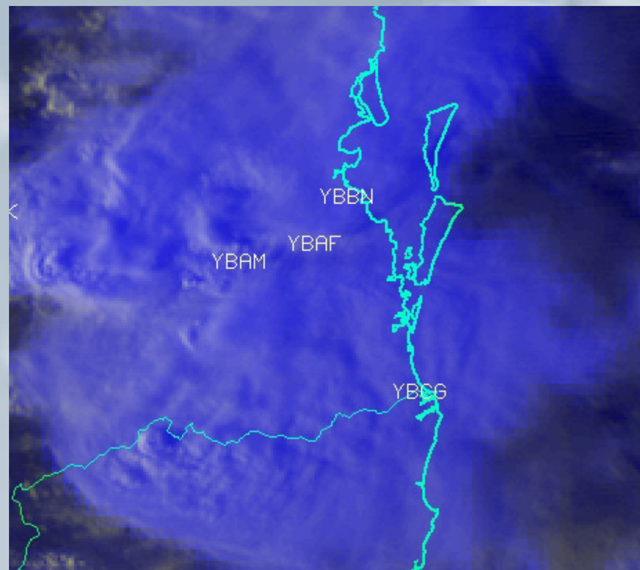
MTSAT-1R 0520UTC

images courtesy BOM

images courtesy JMA / BOM



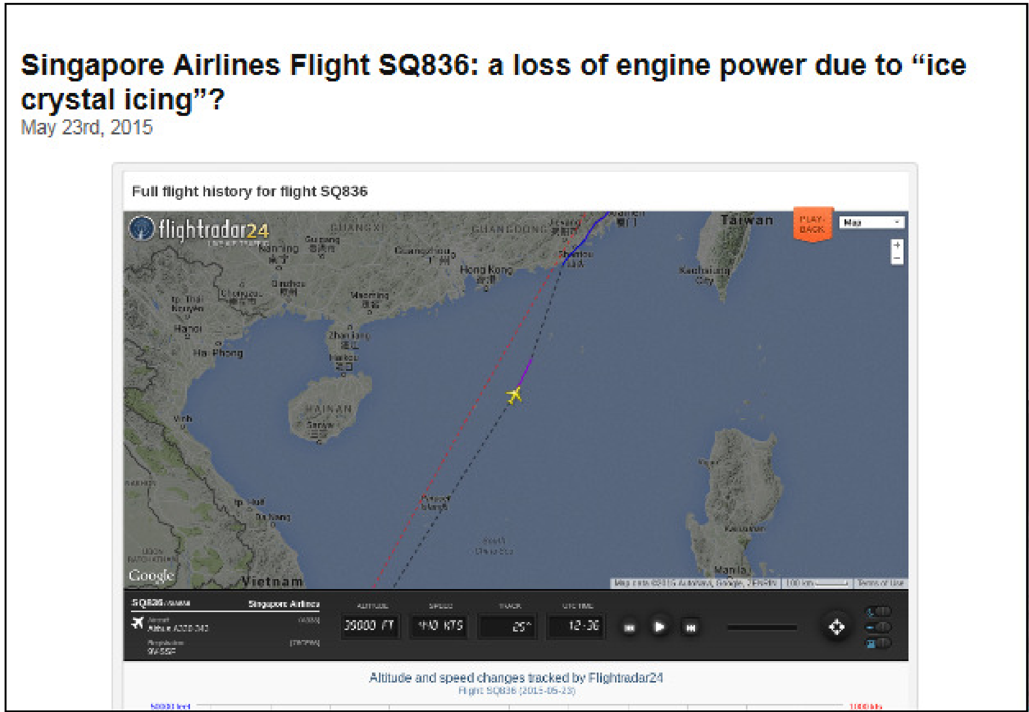
RADAR 0800UTC

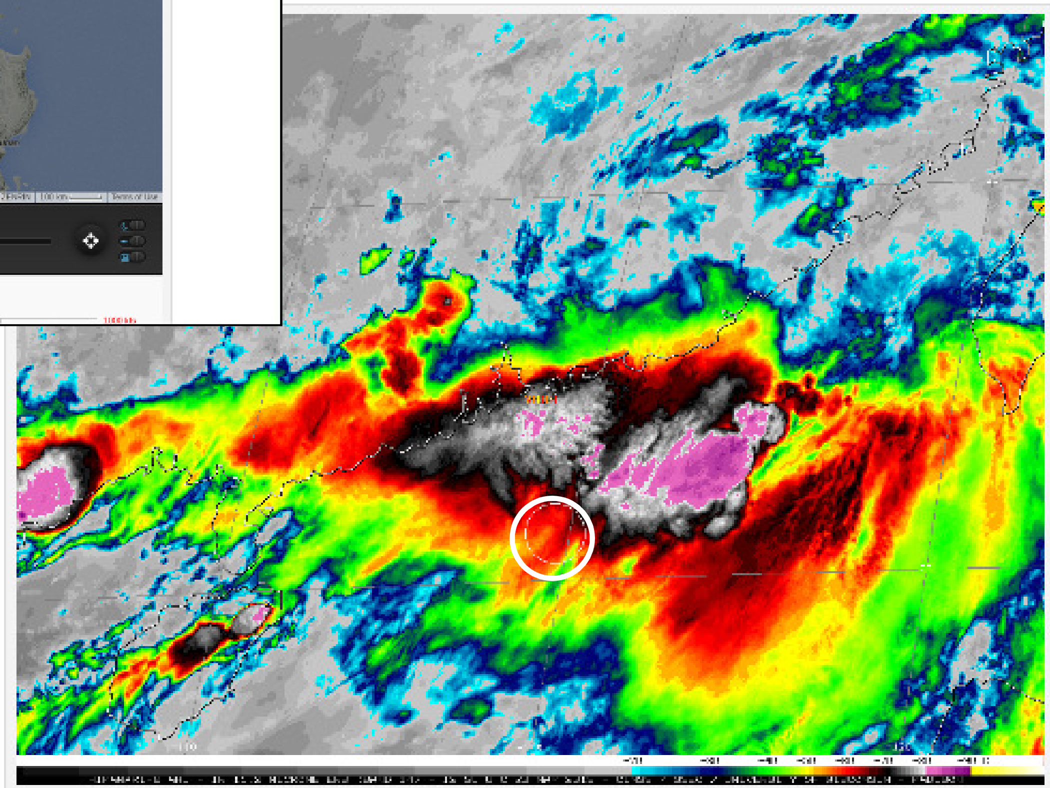


MTSAT-1R 0751UTC

Another useful CIMSS Himawari-8 Satellite Blog post

http://cimss.ssec.wisc.edu/goes/blog/archives/category/himawari-8/page/2

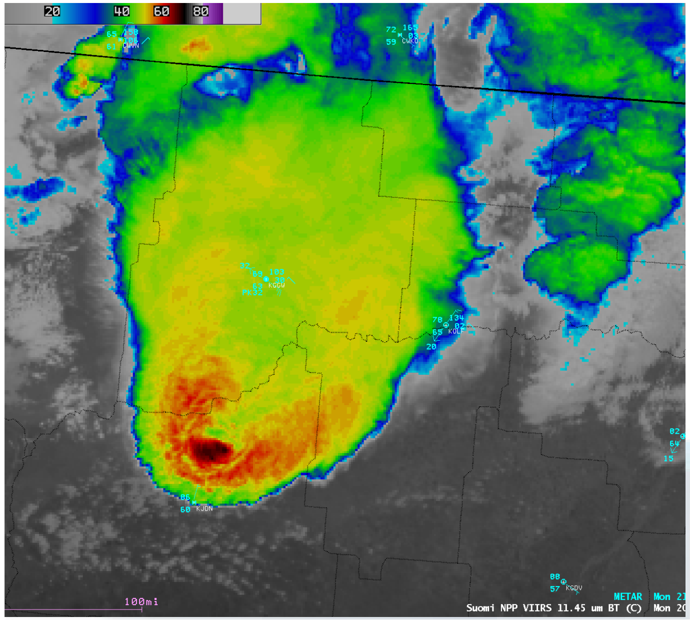


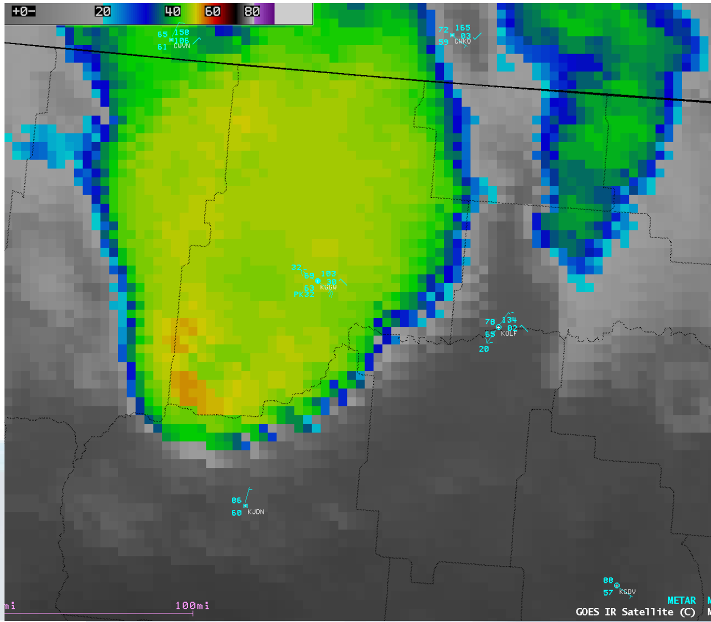


Himawari-8 11.2 um IR channel images (click to play animation)

Thunderstorm example

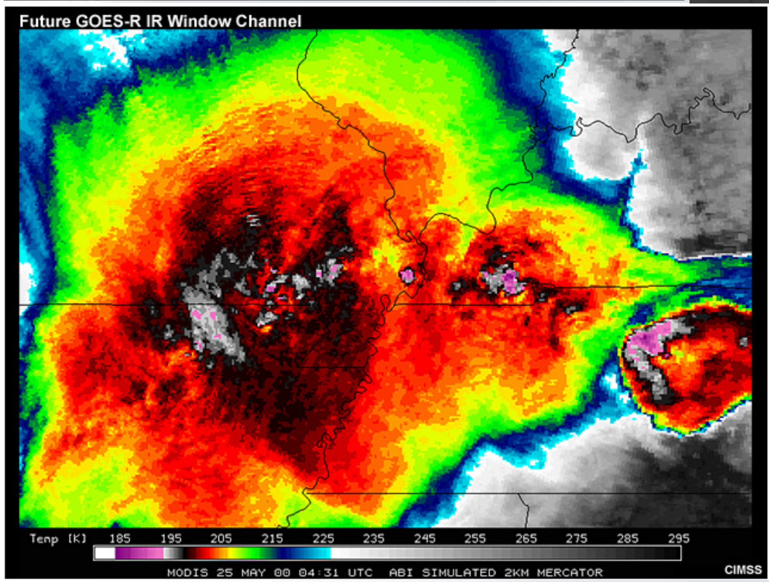
images courtesy CIMSS Satellite Blog "Severe thunderstorms in northwestern Kansas"

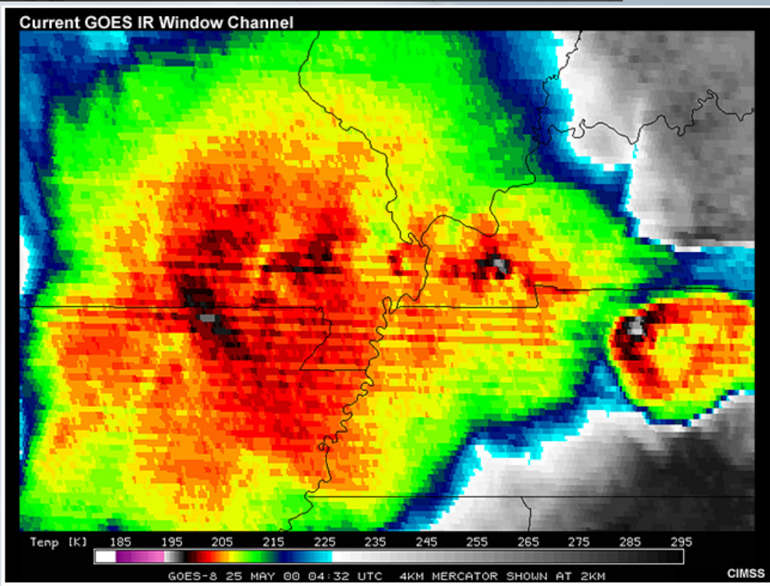




Severe Thunderstorms, NW Texas, 5th August 2013

1 km enhanced infrared satellite data, Soumi NPP (LHS) 4km satellite data, GOES-13 (RHS)



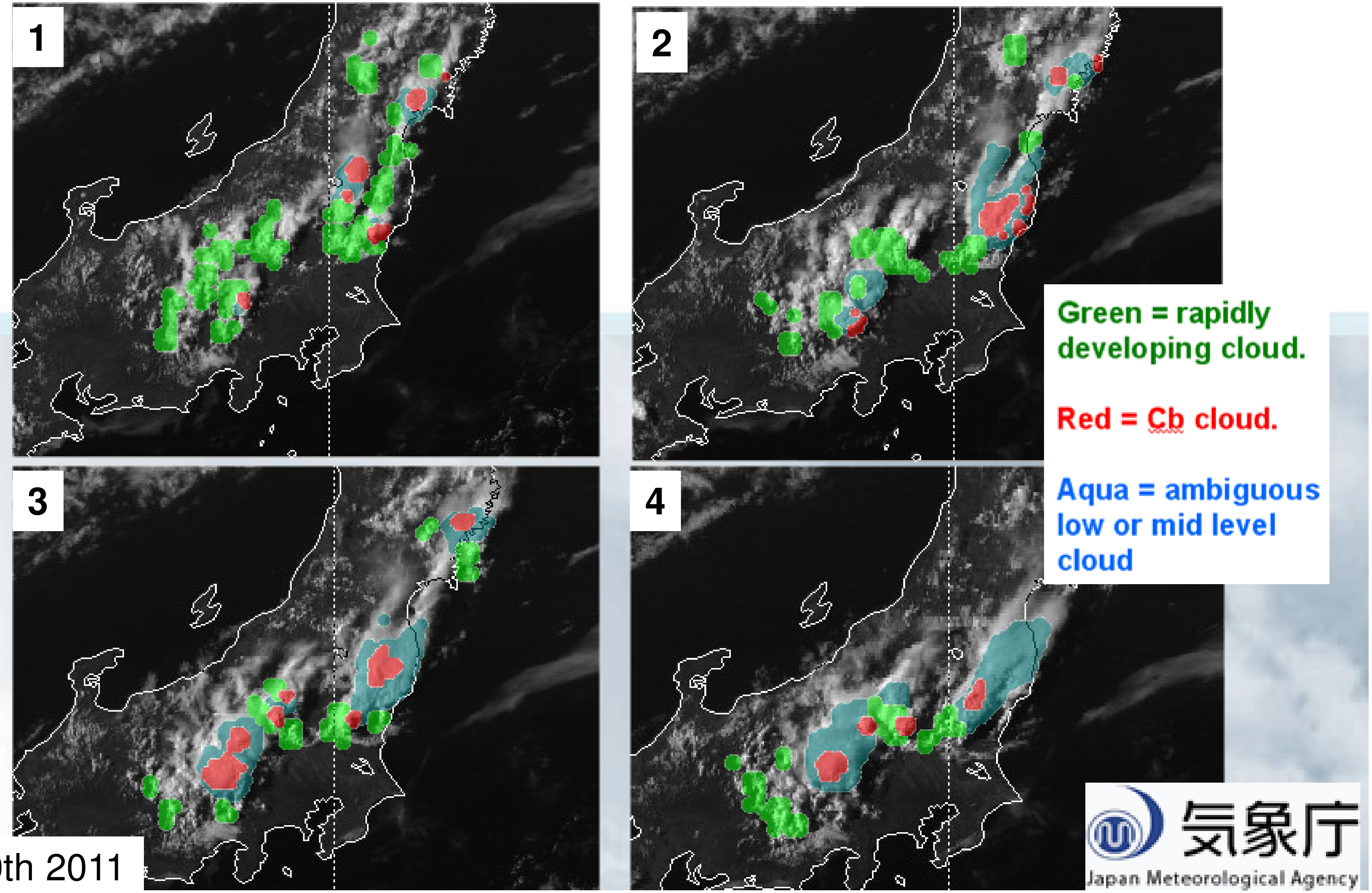


Severe Thunderstorms, USA, 25th May 2000

2 km enhanced infrared satellite data, MODIS (LHS) 4km satellite data, GOES-8 (RHS)

images courtesy COMET

RDCA convective cloud detection algorithm (JMA)



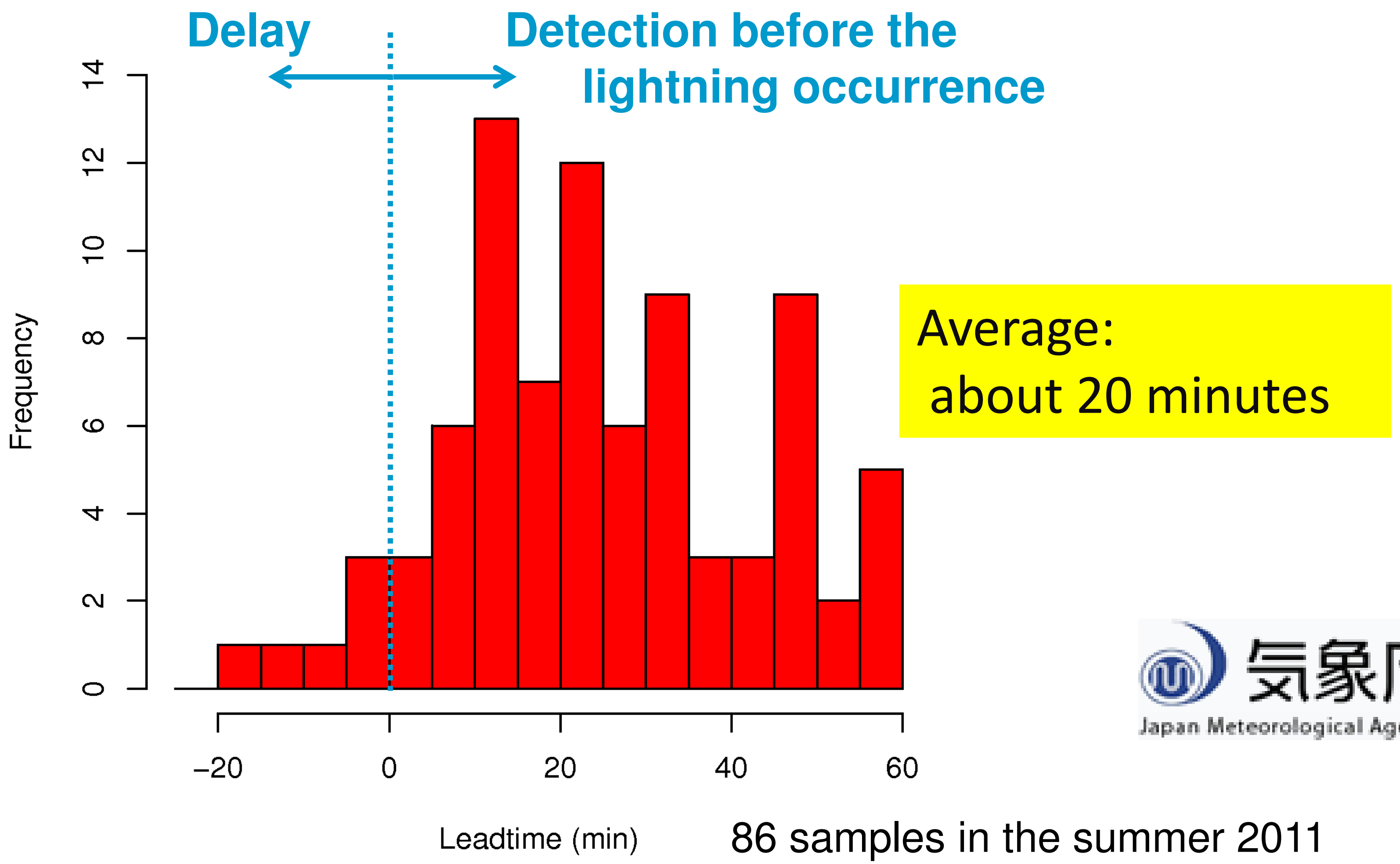
These files were provided by Himawari-6 (MTSAT-1R) Rapid Scan Observations. These were performed for the sake of aviation users. Japanese Meteorological Agency

Rapidly Developing Cumulus Areas product

No.	Diagnostic Parameters	Main objective
1	*VISR	To detect optical thick cloud (mainly for **Pre-detection)
2	Difference between maximum and minimum of VISR	To detect a roughness in developing cloud
3	Standard deviation of VISR	
4	Difference between maximum and minimum of 10.8μm ***BT	
5	Standard deviation of 10.8μm BT	
6	Difference between 10.8μm and 12μm BT	To exclude optically thin cloud (cirrus) (mainly for Pre-detection)
7	Difference between 6.8μm and 10.8μm BT	To detect the potential to develop
8	Slope index (relation between 10.8μm BT and effective radius of cloud top estimated from 3.8μm)	To evaluate cloud microphysical structure
	Time / trend parameters (cloud motion is considered)	
9	Time differential of maximum of VISR	To evaluate vertically developing trend of developing cloud
10	Time differential of averaged VISR	
11	Time differential of minimum of 10.8μm BT	
12	Time differential of averaged 10.8μm BT	
13	Pinpoint fall down of 10.8μm BT	

気象庁 Japan Meteorological Agency

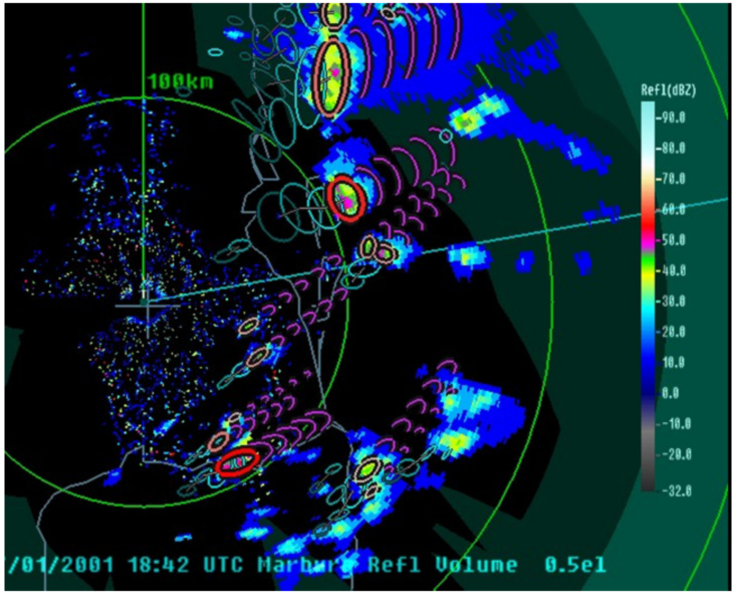
“Lead time” for Lightning (5 minute rapid scan)



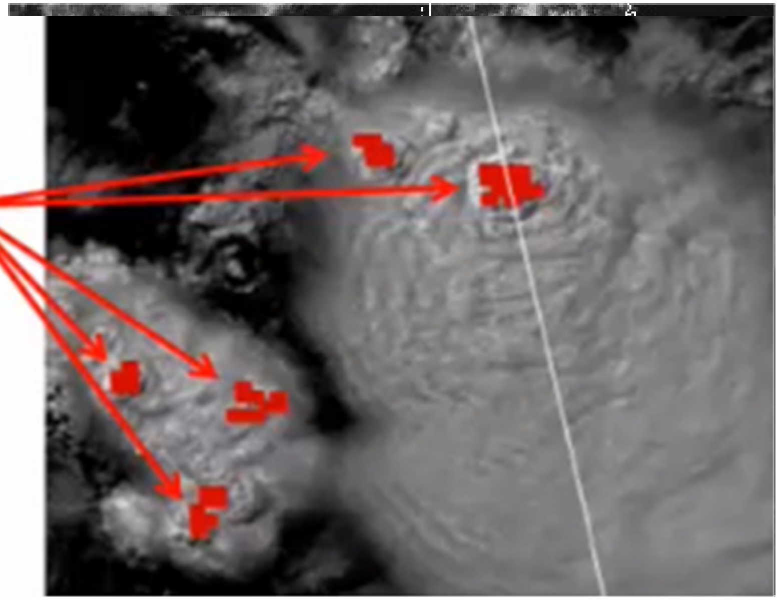
86 samples in the summer 2011

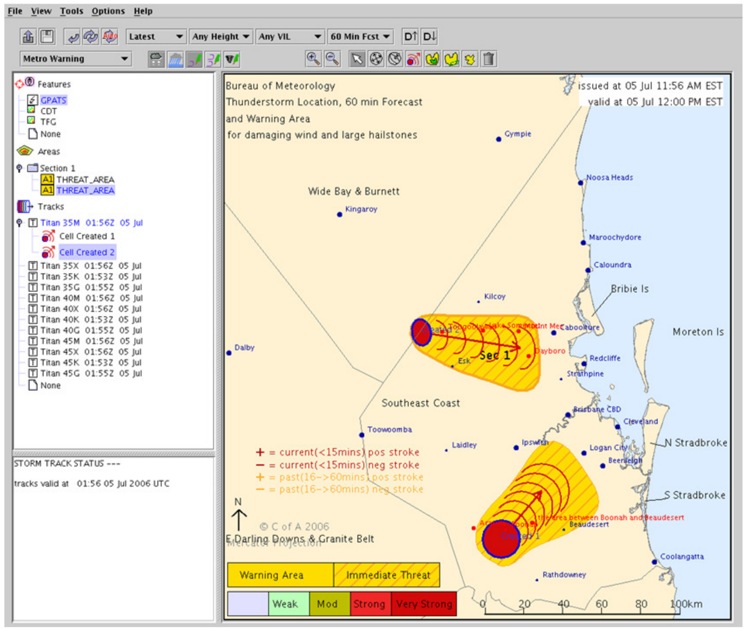
Slide taken from “Status of Japanese follow-on Geostationary Meteorological Satellites HIMAWARI-8/9”, Toshiyuki KURINO Meteorological Satellite Center (MSC), JMA; Joint Australian - Japanese Himawari-8/9 Symposium 22 May 2013, Canberra, Australia

Current RADAR Alerts compared to thunderstorm detection algorithms



Severe Storm Algorithm thresholds (Bedka et al.)



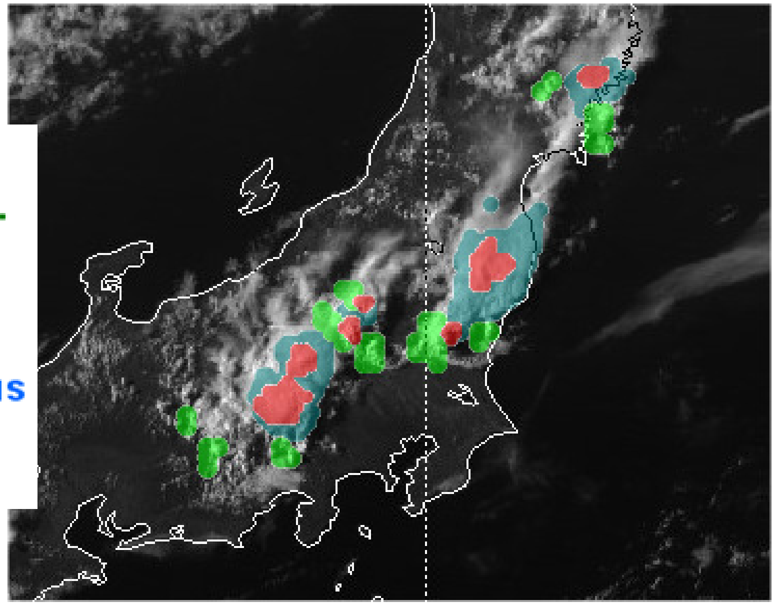


RDCA method

Green = rapidly developing cloud.

Red = Cb cloud.

Aqua = ambiguous low or mid level cloud



Please play "Animation 3"

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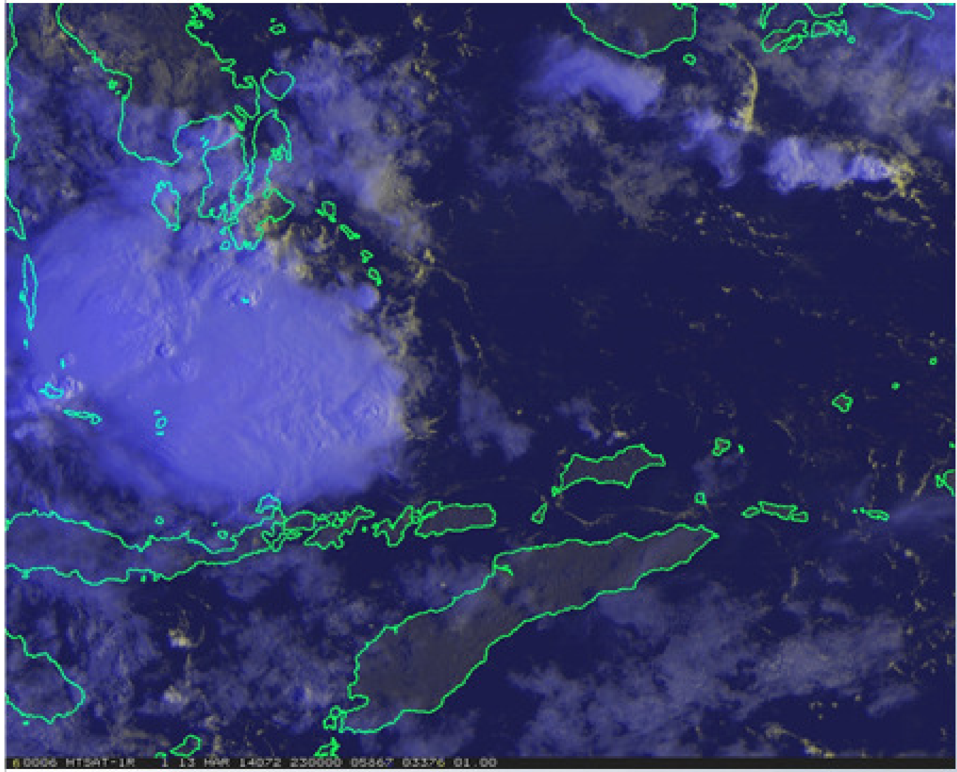
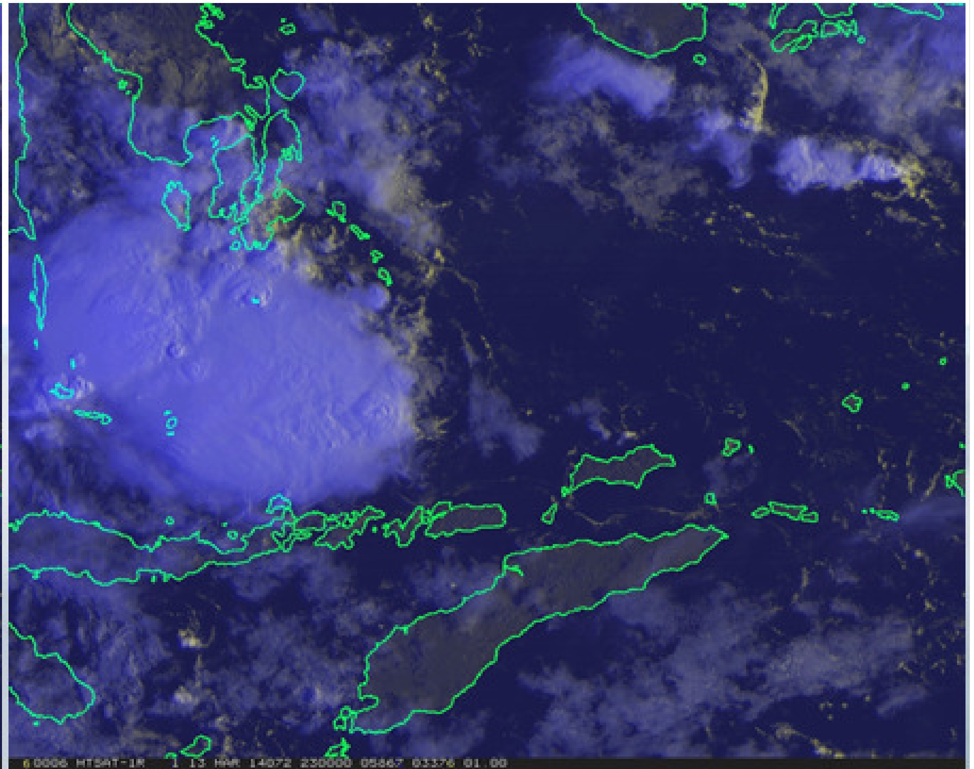
Bureau of Meteorology

Organised thunderstorm example

animations courtesy JMA / BOM



10 minute satellite data, MTSAT-1R



Hourly satellite data, MTSAT-1R (RHS)

Flores/Banda Sea convection, 14th March 2014 (VIS/IR RGB)

Increased resolution in NWP and overcoming "Cumulus Parametrisation" – ACCESS RUC

Increased resolution in NWP (eg. ACCESS RUC)

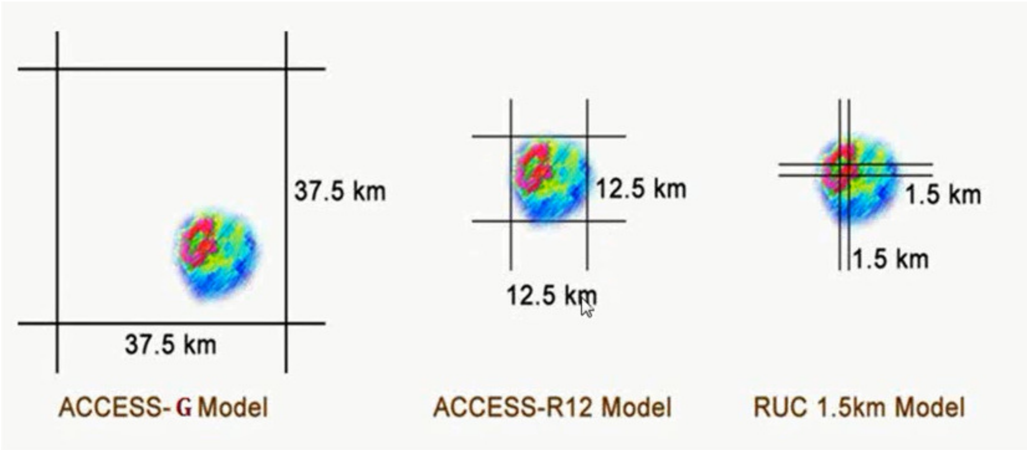
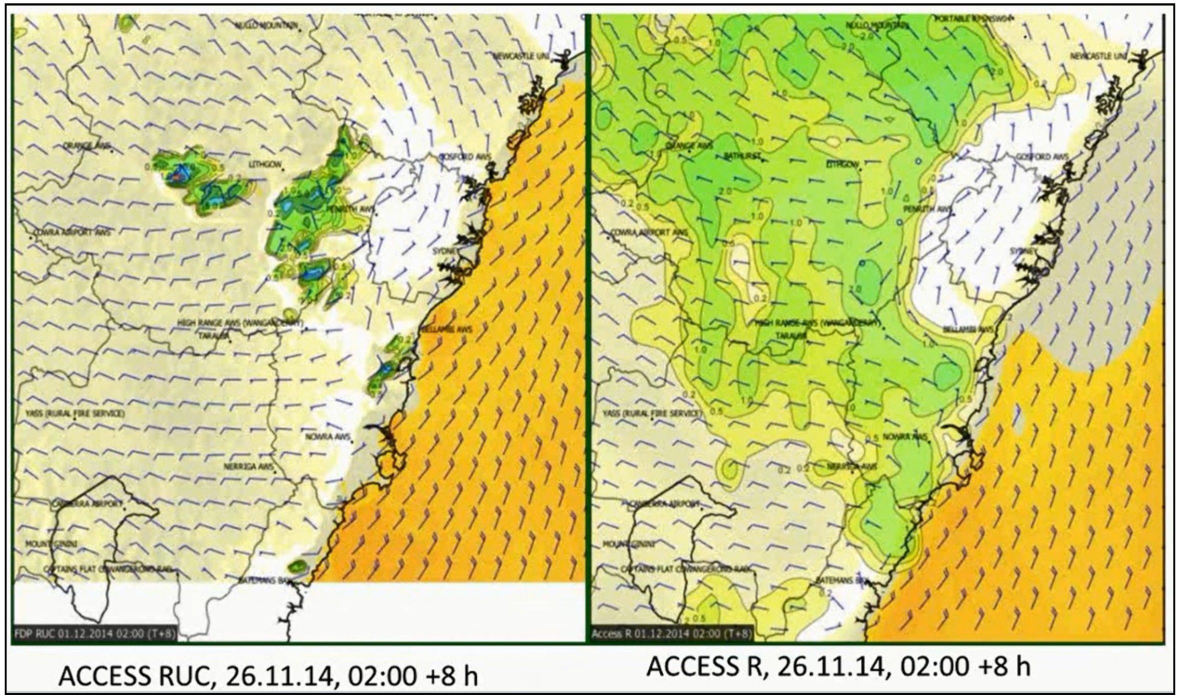


image courtesy Aurora Bell, BOM



Model forecasts of precipitation and winds, Blue Mountains and Lithgow. 26 November 2014.

High resolution (1.5km) ACCESS RUC model (LHS), ACCESS R model (12.5km) (RHS)

images courtesy Aurora Bell, BOM

Summary: Improvements to TS monitoring using rapid scan, high-resolution Himawari-8 data

Higher spatial resolution	Resolution of mesoscale triggers to convection.
	Stormtop features better revealed (including higher resolution of stormtop temperatures)
	Contributes to effective implementation of severe storm detection algorithm
Higher temporal resolution	Identifies mesoscale triggers to convection earlier. Earlier development of "cumulus clumping" (VIS). Better monitoring of cloud top cooling in pre-Cb stage(IR)
	Earlier discrimination between isolated and organised convection
	Near continuous monitoring of overshooting tops.
	Better monitoring of short-lived convection
	Better monitoring of rotation of storms
	Better monitoring of secondary features (gust fronts etc.)
	Better monitoring of storm steering flow. Also atmospheric shear
	Contributes to effective implementation of severe storm detection algorithm

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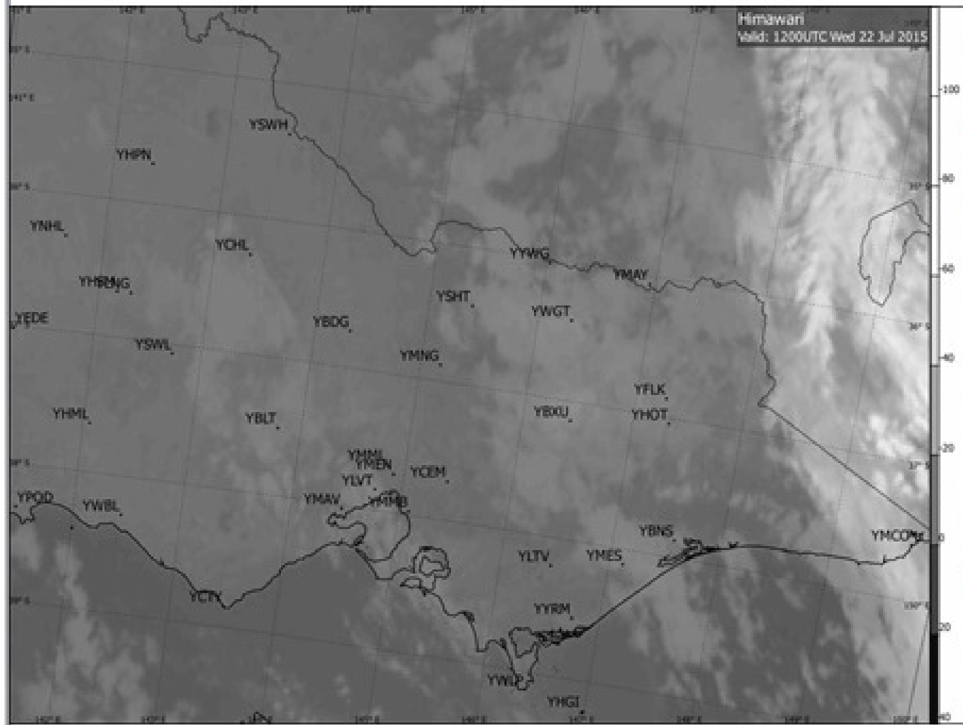
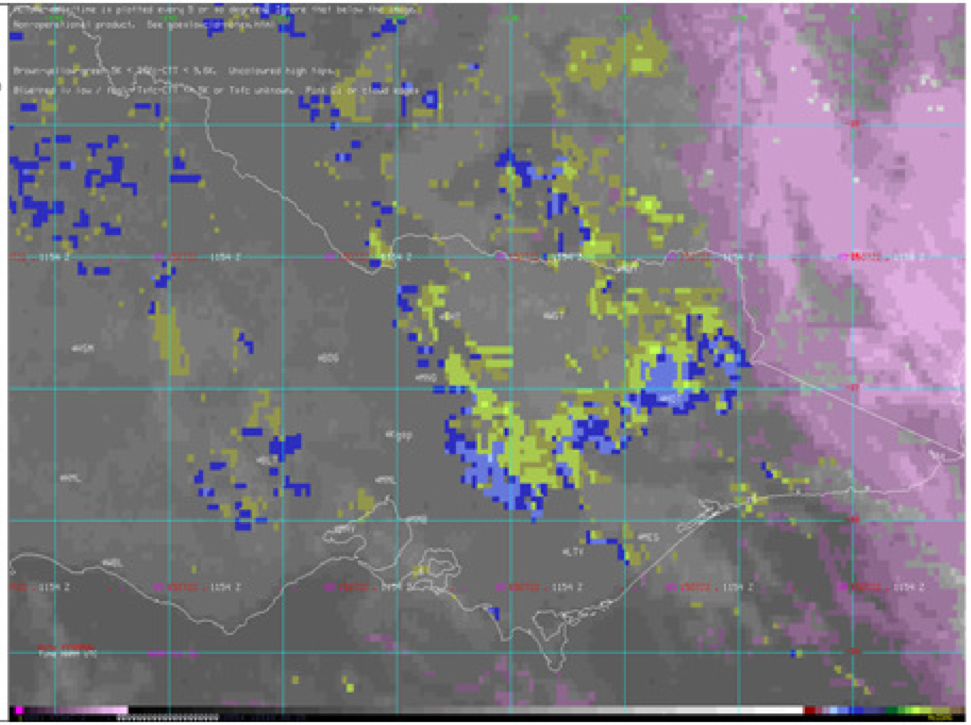
Please play "Animation 4"

Fog/low cloud example
Victoria, Australia; 22nd July 2015

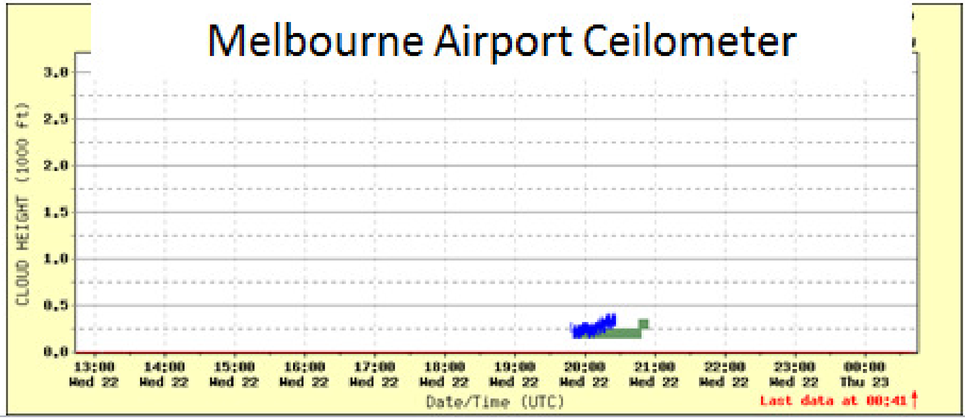


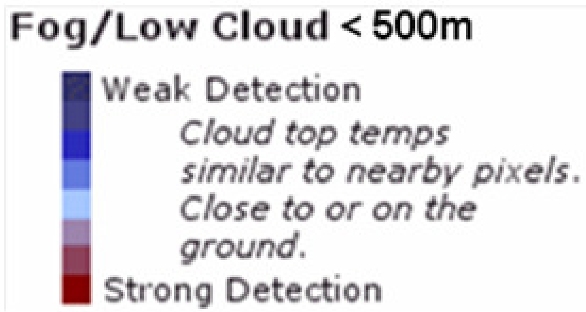


Rapid Scan (10 minute) IR / VIS satellite data

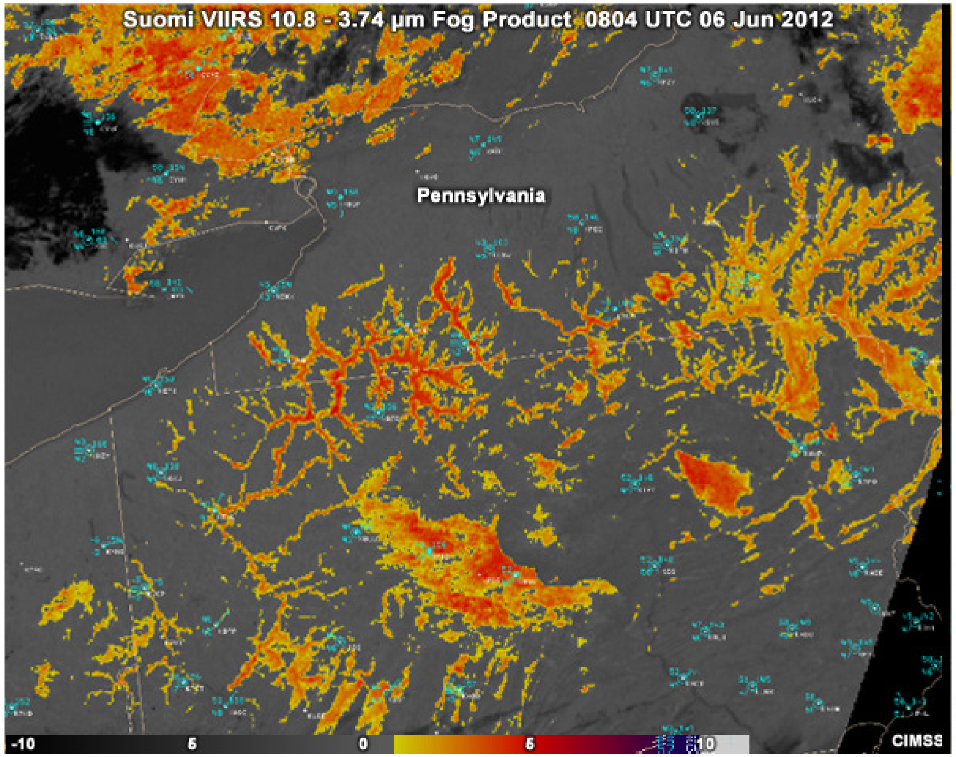
Hourly IR-NIR /VIS data

animations courtesy JMA/BOM

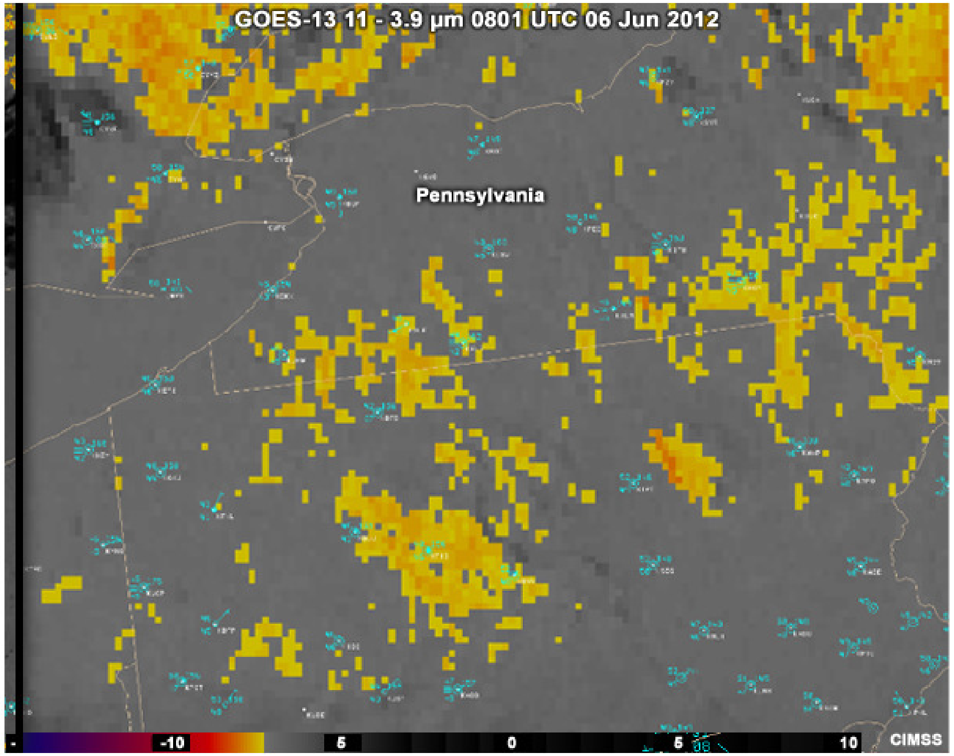




Higher spatial resolution and fog identification



Suomi VIIRS Fog Product (1km resolution)



GOES-13 fog product (4km resolution)

Fog in valleys, USA, 6th June 2012

images courtesy COMET

Summary: Improvements to fog/low cloud monitoring using rapid scan, high-resolution Himawari-8 data

Higher spatial resolution	Better definition of the outline (edge or boundary) of the fog / low cloud
	Better discrimination between small scale fog (valley fill) and signal noise
Higher temporal resolution	Better monitoring of fog / low cloud formation and early development
	Better monitoring of the rate of fog / low cloud extension and clearance.
	Better monitoring of thin fog
	Better able to monitor fog / low cloud developing under higher cirrus cloud

Please play "Animation 5"

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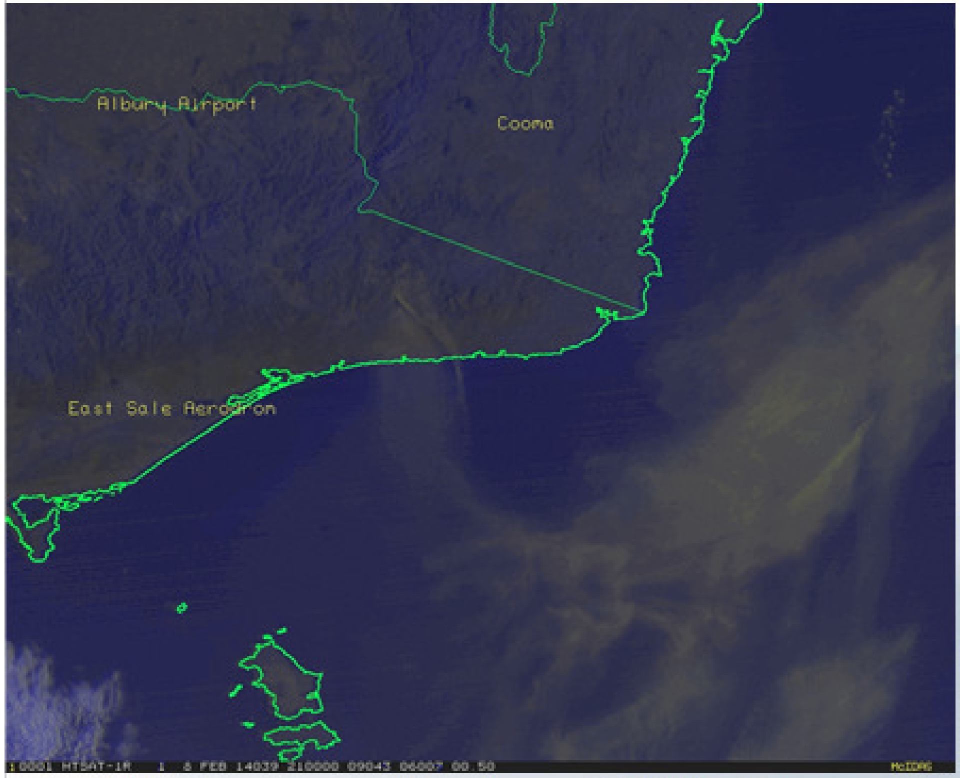
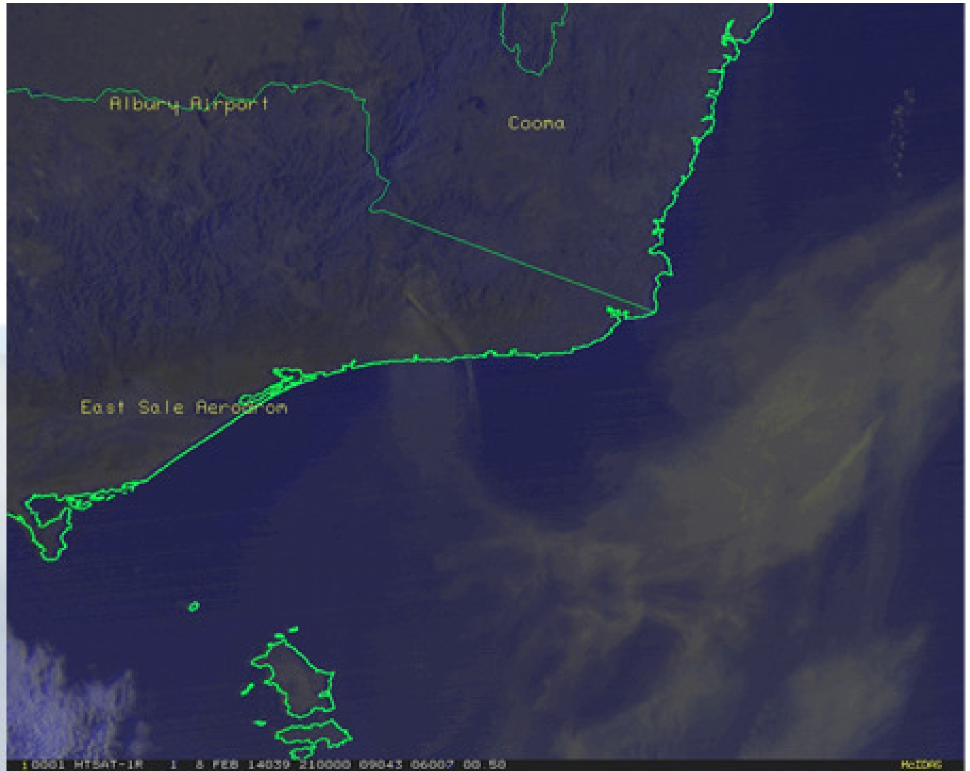
Fire/Smoke example

animations courtesy JMA / BOM



10 minute satellite data, MTSAT-1R

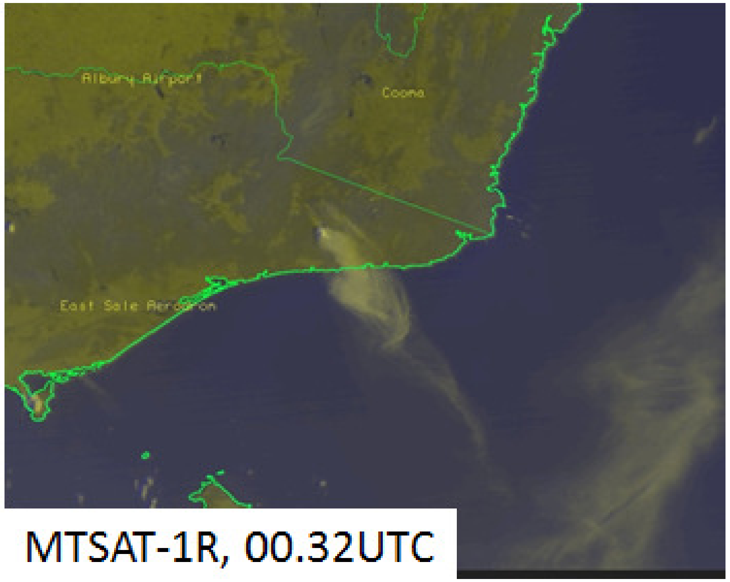


Hourly satellite data, MTSAT-1R (RHS)

Fire development and the passage of a shallow cold front SE Victoria, 9th February 2014 (VIS/IR RGB)

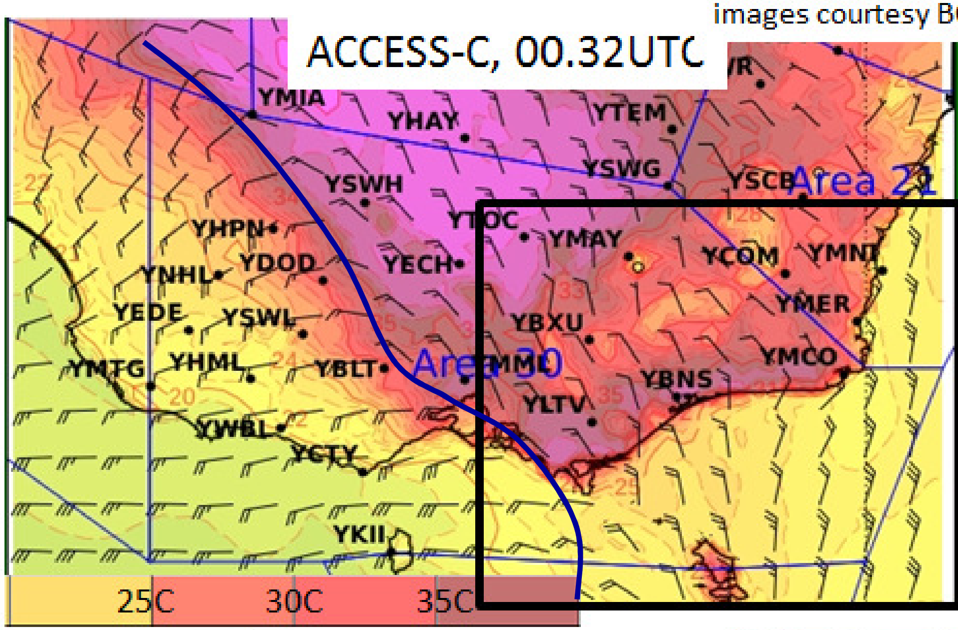
Fire development and cold front SE Victoria, 9th February 2014

(MTSAT-1R rapid scan vis/vis/ir RGB product, ACCESS-C 10m wind and temperature)

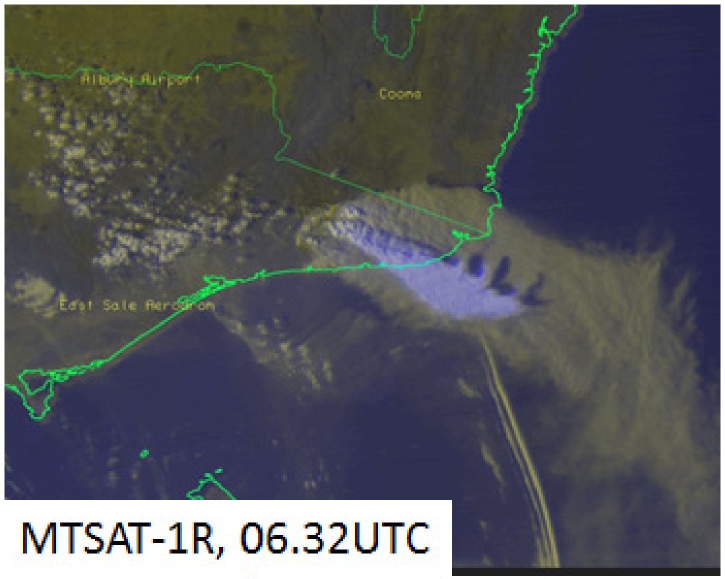


MTSAT-1R, 00.32UTC

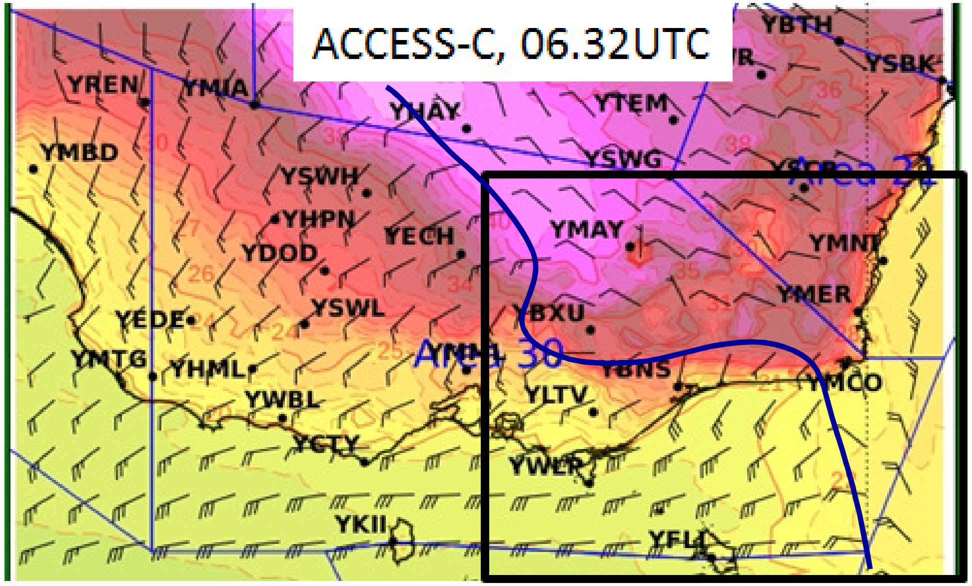
images courtesy BOM



ACCESS-C, 00.32UTC



MTSAT-1R, 06.32UTC

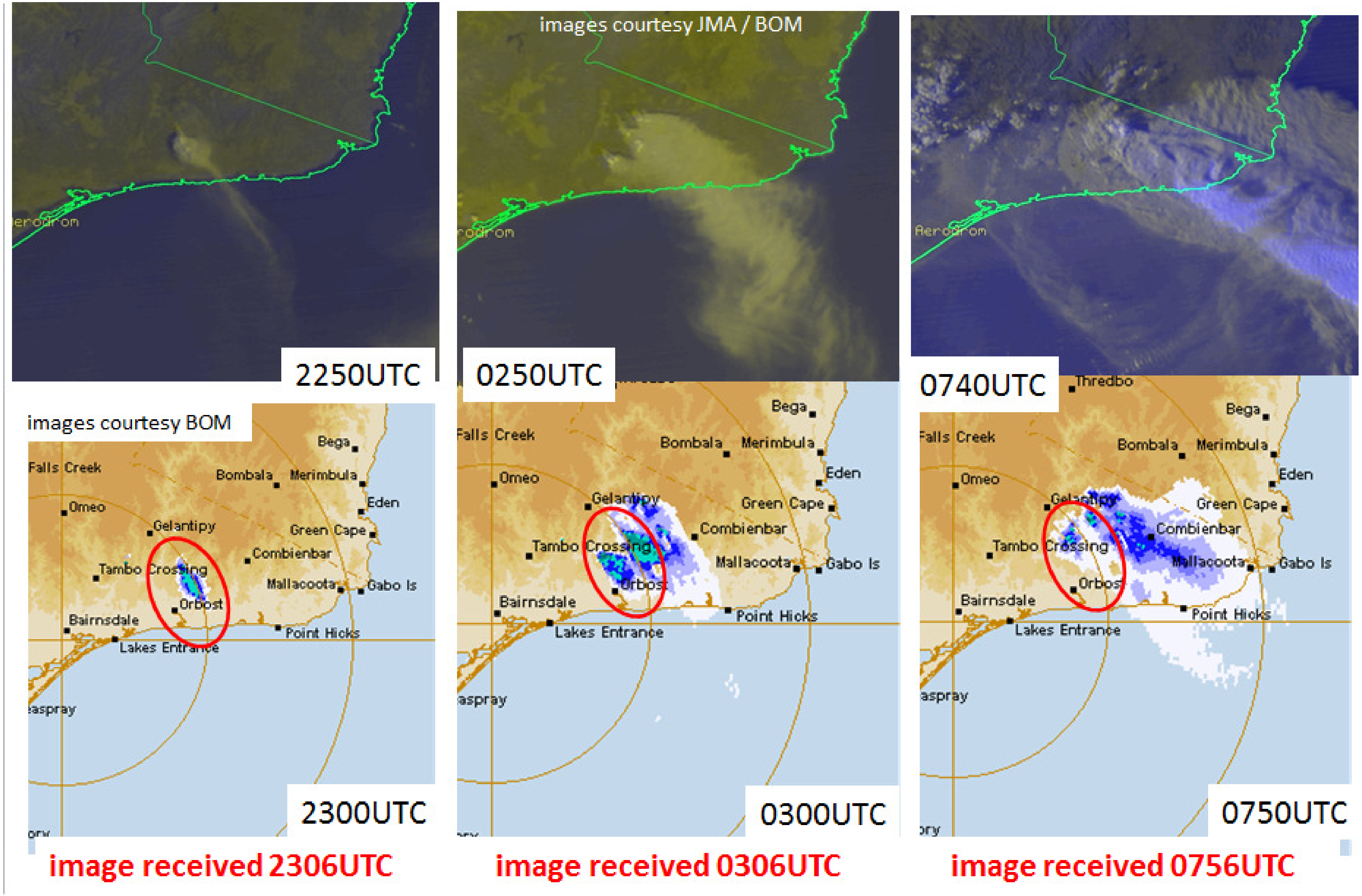


ACCESS-C, 06.32UTC

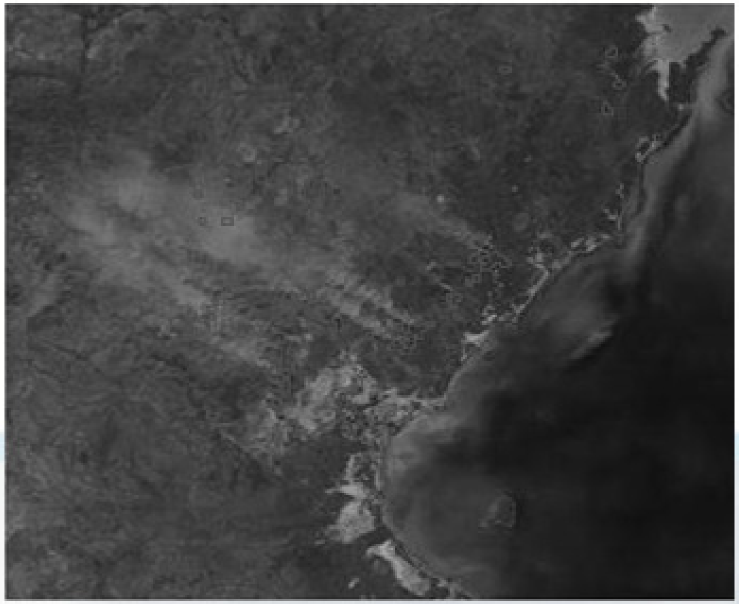
images courtesy BOM / JMA

Fire development and cold front SE Victoria, 9th February 2014

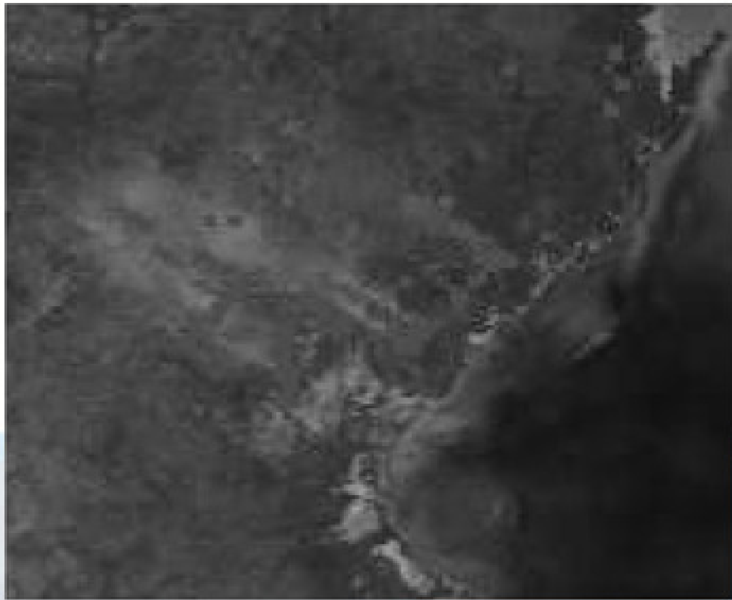
(MTSAT-1R rapid scan vis/vis/ir RGB product, RADAR data received at the same time)



Fire / Smoke – increased resolution and hotspots



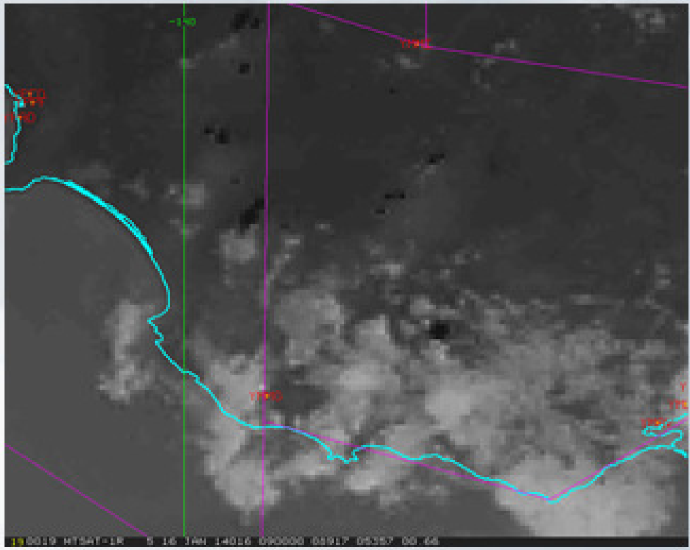
(0.5km resolution)



(1km resolution)

Fires, Northern Territory of Australia, 11th July 2015 0445UTC (vis) MODIS satellite

images NASA/GSFC, MODIS Rapid Response



animation courtesy JMA / BOM

10 minute 3.9 micron satellite data, MTSAT-1R

Summary: Improvements to smoke/fire monitoring using rapid scan, high-resolution Himawari-8 data

Higher spatial resolution	More detailed view of vegetation conditions (curing)
	Monitoring of smaller fires with higher resolution 3.9 micron data ?
	Better detection and monitoring of small / thin plumes
	More detailed geographical analysis of burned areas
Higher temporal resolution	Better determination of vegetation conditions
	Better near-continuous monitoring of hotspots.
	Better monitoring of wind changes that may impact fire behaviour
	Better determination of the smoke trajectory
	Better monitoring of "dry slots" in the water vapour imagery that may cause "flare ups" in the fire activity
	More timely detection of smoke transitioning into pyrocumulus.
	Able to use this data to verify high resolution NWP

Please play "Animation 6" (first animation on the CIMSS Blog link)

CIMSS – Himawari-8 Blog

http://www.virtuallab.bom.gov.au/training/hw-8-training/

University of Wisconsin-Madison / Space Science and Engineering Center

CIMSS Satellite Blog

/ CIMSS / CIMSS Satellite Blog /

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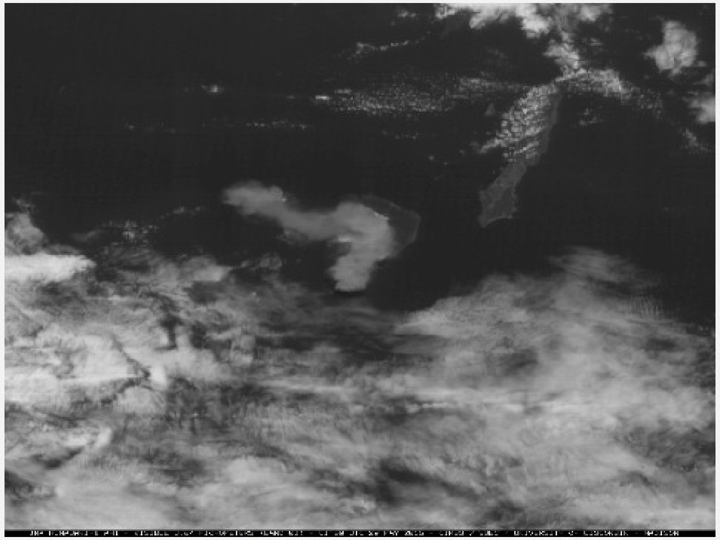
Eruption of the Kuchinoerabu-jima volcano in Japan

May 29th, 2015



Himawari-8 AHI 0.64 μm visible channel images (click to play animation)

The Kuchinoerabu-jima volcano in Japan experienced a violent eruption beginning around 00:59 UTC on 29 May 2015 — the expanding volcanic cloud was captured by 0.5-km resolution Himawari-8 AHI 0.64 μm visible channel images ***(above; click image to play animation; also available as an MP4 movie file)***. A mid-layer volcanic cloud was seen moving to the west-northwest, while a high-altitude plume spread out as it moved east-southeastward.

About an hour after the eruption, Terra MODIS products at 0205 UTC from the SSEC Volcanic Cloud Monitoring site are shown below. Retrieved volcanic Ash Probabilities were very high for both cloud segments; for the southeastern cloud segment, the maximum volcanic Ash Height was in the 10-12 km range, volcanic Ash Loading was high, and the largest Ash Effective Radius values were in the 8-10 um range.

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July 2015

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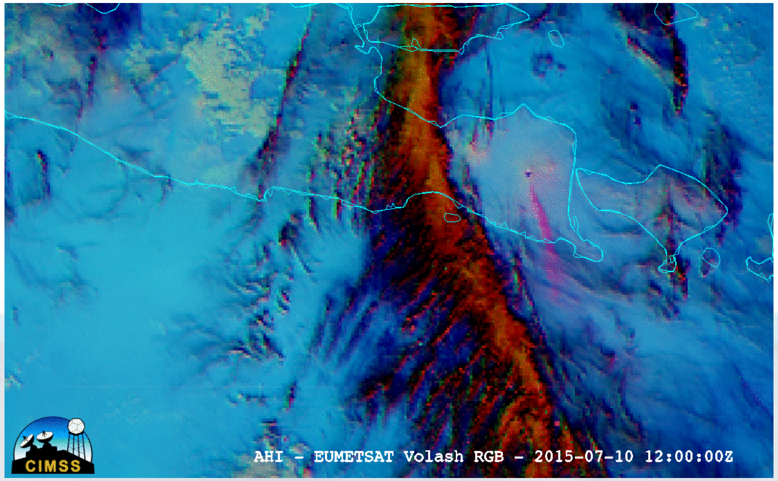
» DMSP
» Fire detection
» Fog detection
» General interpretation
» GOES sounder
» GOES-10
» GOES-11

Raung Plume, Java (10th July 2015, 1130-1200UTC)

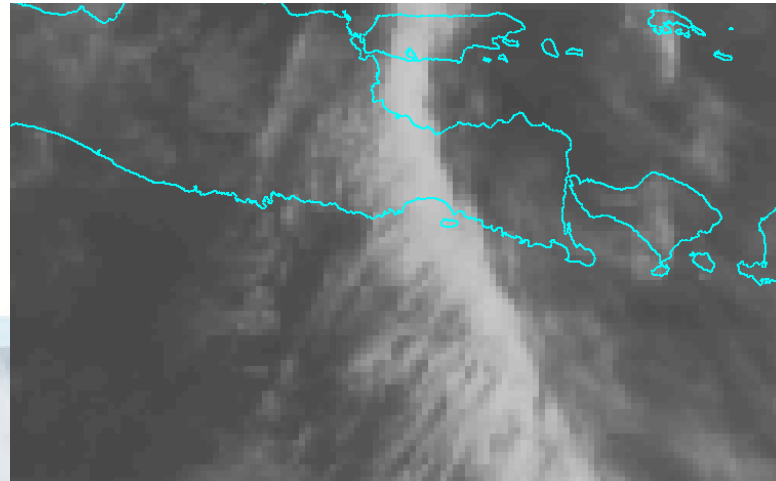
Himawari-8 product courtesy JMA/CIMSS, kindly forwarded by Jochen Kerkmann, EUMETSAT

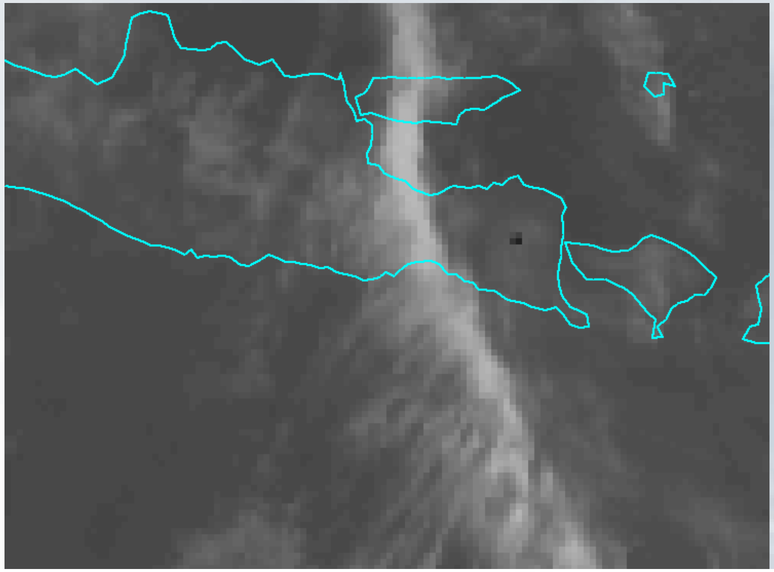
MTSAT images courtesy JMA/BOM

Ash RGB Himawari-8 data (2km resolution)

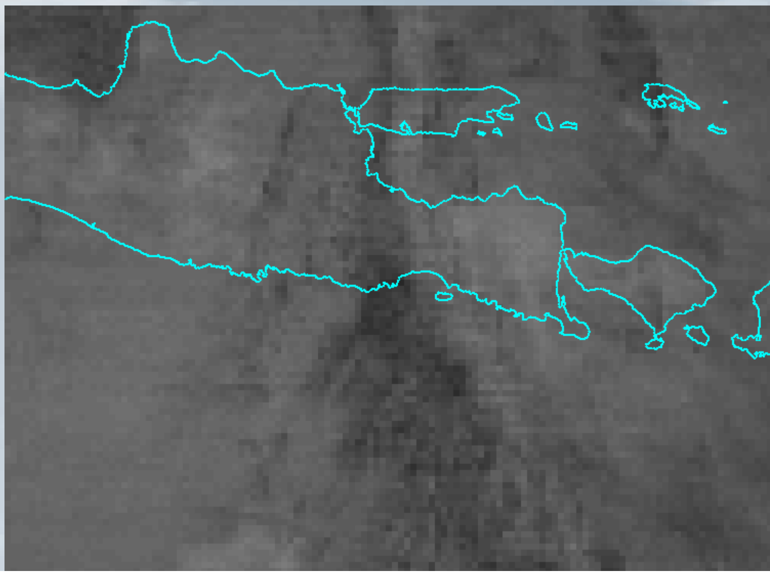


11 micron IR MTSAT data (4km resolution)





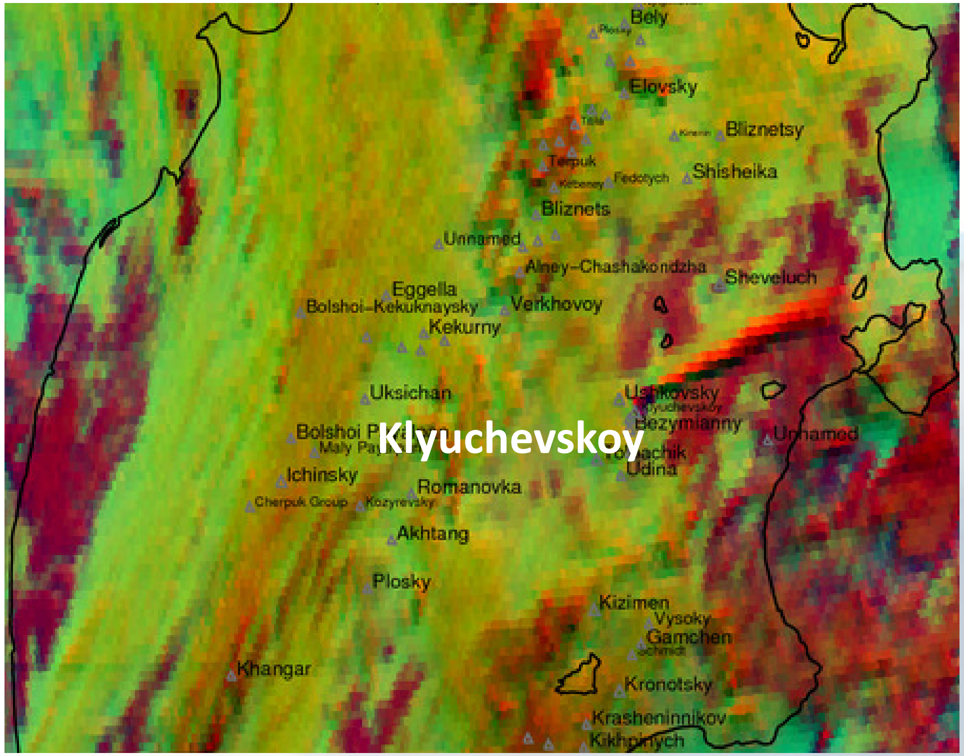
3.7 micron NIR MTSAT data (4km resolution)



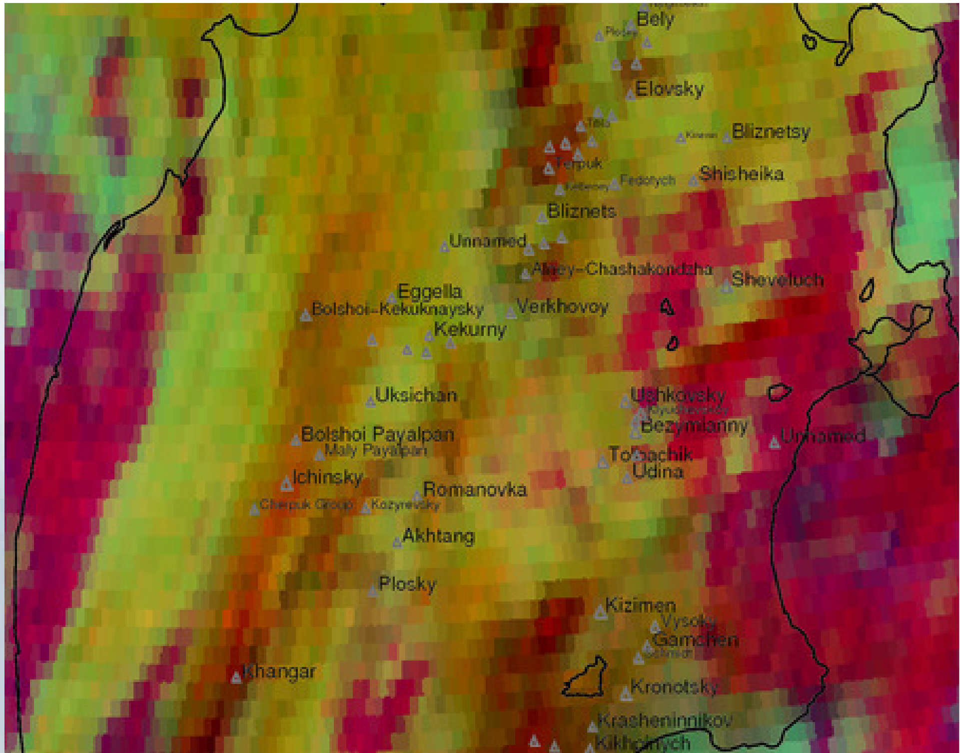
11-12 micron IR MTSAT data (4km resolution)

Klyuchevskoy Plume, Kamchatka Peninsula, Russia.
25th January 2015

images courtesy M.Pavolonis (NOAA/NESDIS)



Himawari-8 data (2km resolution)



MTSAT data (5km resolution)

False colour imagery (12-11 microns, 11-3.9 microns, 11 microns)

Summary: Improvements to volcanic ash monitoring using rapid scan, high-resolution Himawari-8 data

Higher spatial resolution	Resolution of small thin ash plumes
	Better "hotspot detection" of a suspect volcano with higher resolution 3.9 micron data ?
	Tenuous volcanic ash cloud better detected.
	Features such as "warm donut", gravity waves in the ash plume more readily resolved.
Higher temporal resolution	Earlier detection and verification of an eruption
	Hotspot detection and monitoring enhanced?
	Better able to track the volcanic ash cloud (esp. if it is dispersing or if there are clouds in the vicinity)
	Features such as "warm donut", gravity waves in the ash plume more readily detected.

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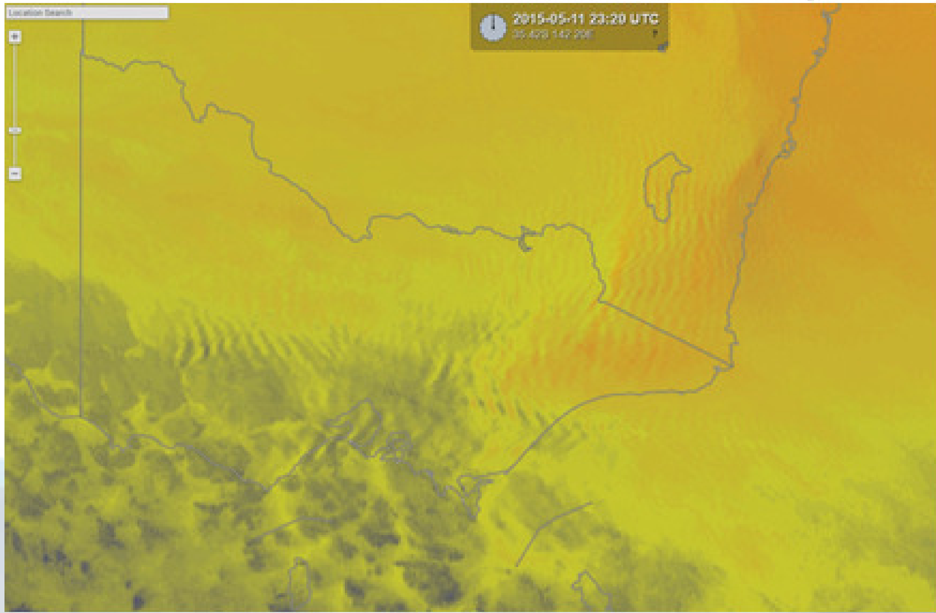
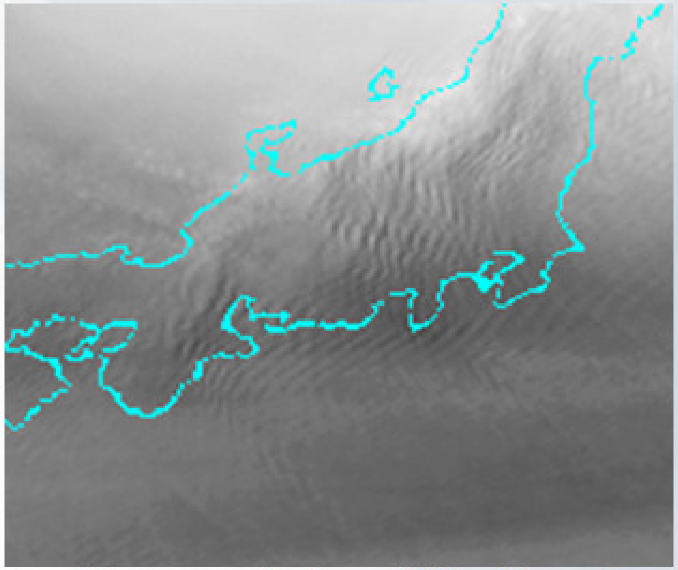
Please start the PowerPoint Slide Show to activate the animations

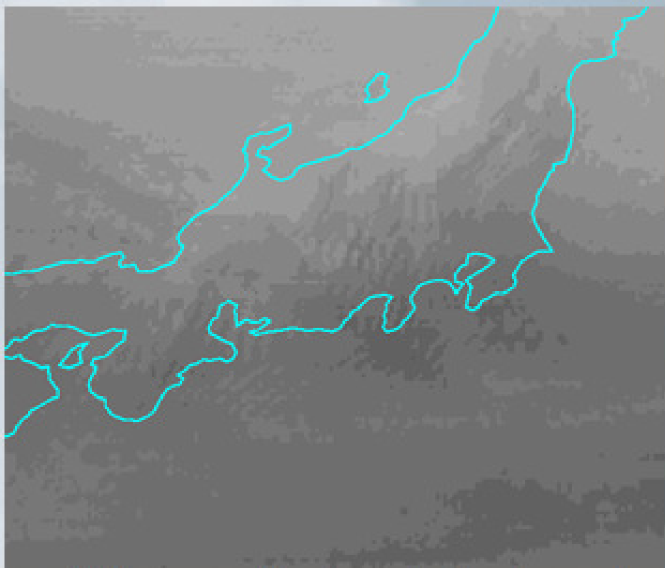
Turbulence example



animations courtesy JMA / CIMSS

Mountain waves, South-eastern Australia, 12th May 2014 (7.3 micron, 10 minute Himawari-8 satellite data)


(2km resolution, 6.2 micron)


(5km resolution, 6.7 micron)

Mountain Waves, central Japan, 18th December 2014

Himawari-8 (LHS)
MTSAT-2 (RHS)

images courtesy JMA / BOM

Summary: Improvements to mountain waves (turbulence) monitoring using rapid scan, high-resolution Himawari-8 data

Higher spatial resolution	Able to detect more mountain waves using this high resolution data
	Detection and monitoring of detailed wave features (herringbone interference wave patterns)
Higher temporal resolution	Earlier detection and better nowcasting of rapidly developing wave features, banding that NWP may not resolve
	Better nowcasting of the geographical area (and changes in this) affected by the turbulent features.
	Low amplitude gravity wave pattern better monitored due to continuity in the high frequency temporal data.

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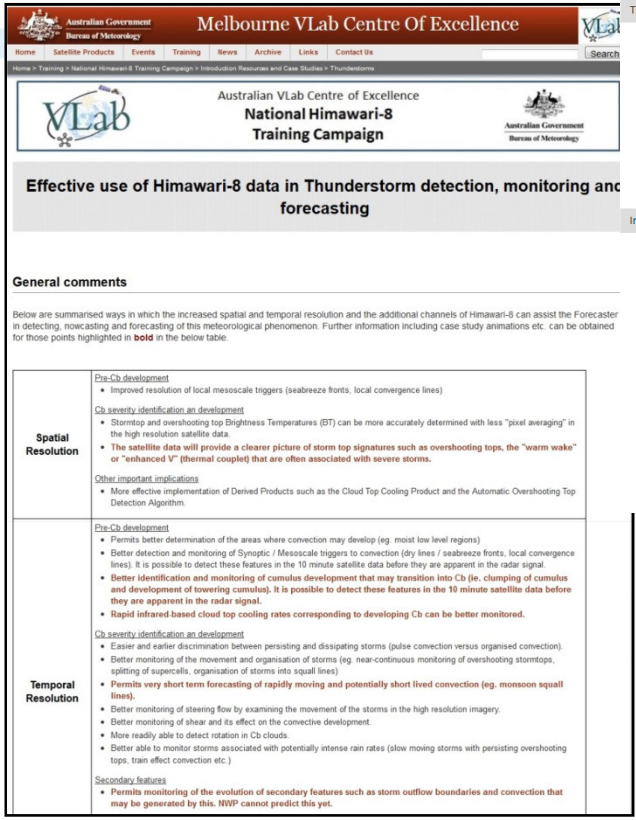
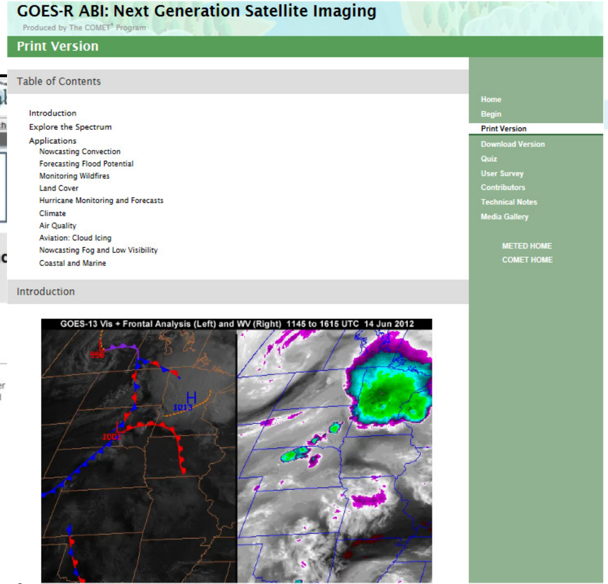
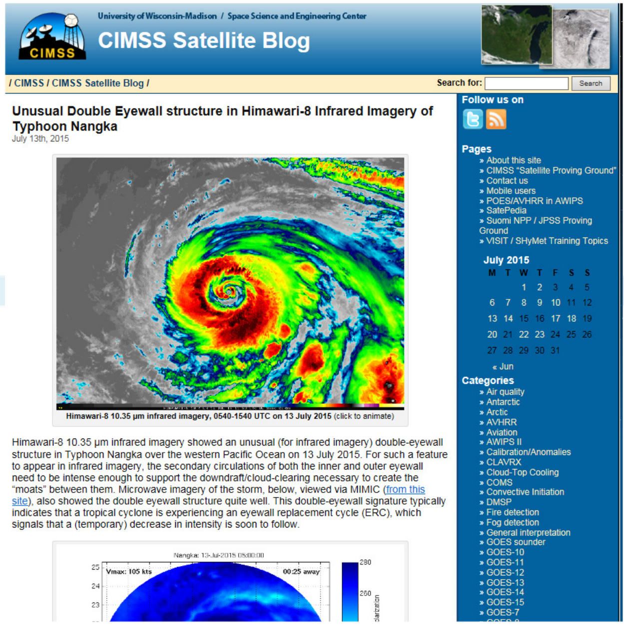
Useful references



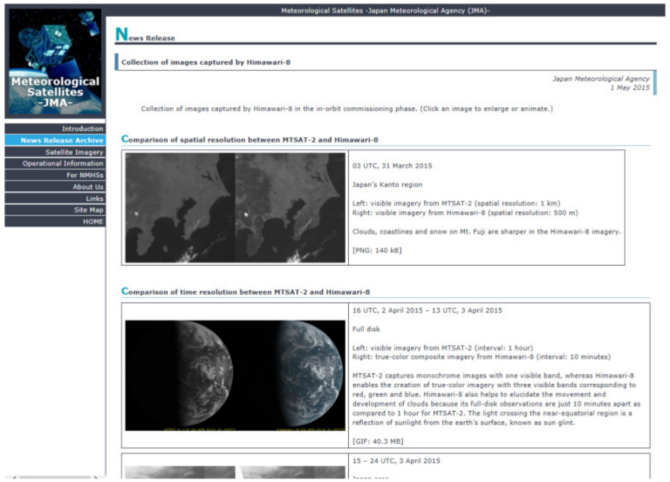
National Himawari-8 Training Campaign
http://www.virtuallab.bom.gov.au/training/hw-8-training/introduction-resources-and-case-studies/



GOES-R Comet Module
https://www.meted.ucar.edu/goes_r/abi/print.php



CIMSS Himawari-8 Satellite Blog
http://cimss.ssec.wisc.edu/goes/blog/archives/category/himawari-8



Collection of images captured by Himawari-8
http://www.jma.go.jp/jma/jma-eng/satellite/news/himawari89/20150501_himawari8_sample_data.html

Australian Government
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Summary

Temporal and spatial resolution of the Himawari-8 data .

Have explored the potential of the high temporal and spatial resolution Himawari-8 data for the detection, monitoring and nowcasting of:

- Tropical Cyclones
- Thunderstorms, including organised thunderstorms
- Fog and low cloud
- Fire and smoke
- Volcanic ash
- Mountain waves and associated atmospheric turbulence.

Have shown useful web resources