AOMSUC-10

2–7 December 2019
Melbourne, Australia

10TH ASIA-OCEANIA METEOROLOGICAL SATELLITE USERS' CONFERENCE

Future developments: Multiple geostationary satellite platforms

Exploring "limb effects" and 3D stereo satellite imagery

Bodo Zeschke
Bureau of Meteorology Training Centre
Australian VLab Centre of Excellence

How to access and answer the Socrative Questions

1 On your computer or smartphone open up a new window in your browser

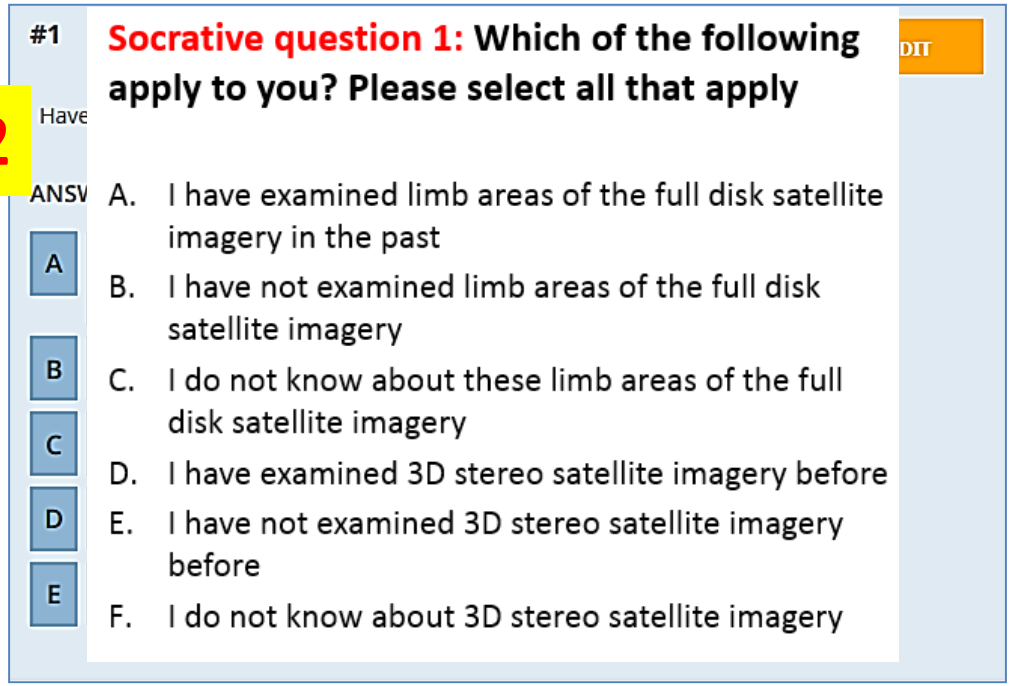
type in **b.socrative.com**

Choose "**LOGIN**" (top RHS)

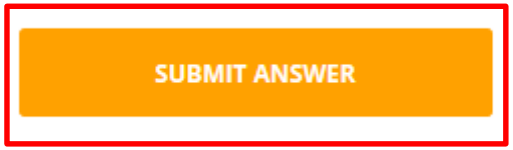
choose "**Student Login**"

Then Room Name "**AOMSUC10**"

2

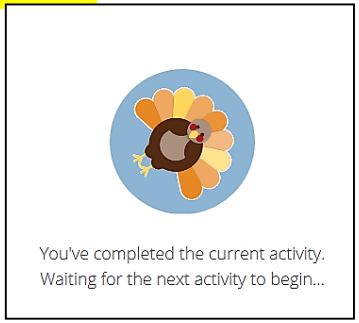


3 Answer the question



4

5



Socrative question 1: Which of the following apply to you? Please select all that apply

A. I have examined limb areas of the full disk satellite imagery before
B. I have not examined limb areas of the full disk satellite imagery
C. I do not know about these limb areas of the full disk satellite imagery
D. I have examined 3D stereo satellite imagery before
E. I have not examined 3D stereo satellite imagery
F. I do not know about 3D stereo satellite imagery

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Content of this session

- The constellation of geostationary satellites over our region
- Utilising limb effects for enhanced forecaster monitoring
- Introducing the 3D stereo satellite imagery utilising Himawari-8, Geo-KOMPSAT 2A, GOES-16 and 17 data

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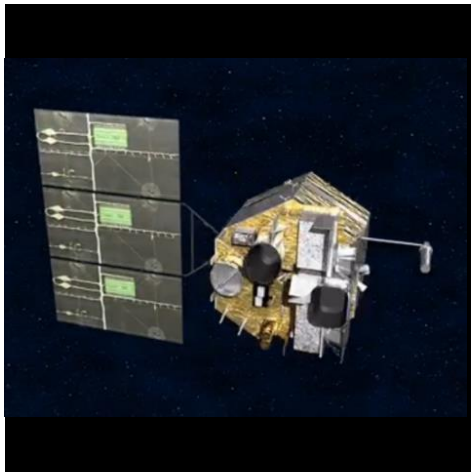
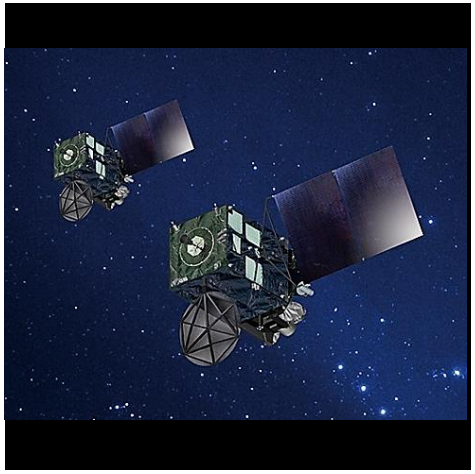
Full earth disk view of the geostationary satellites over the Asia-Oceania (AOMSUC) region



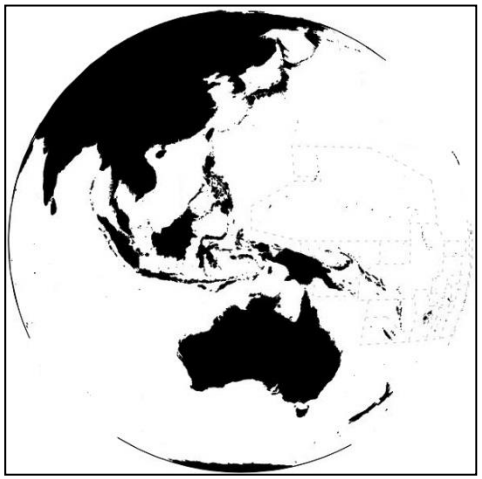
Feng-Yun-4A
(105E)

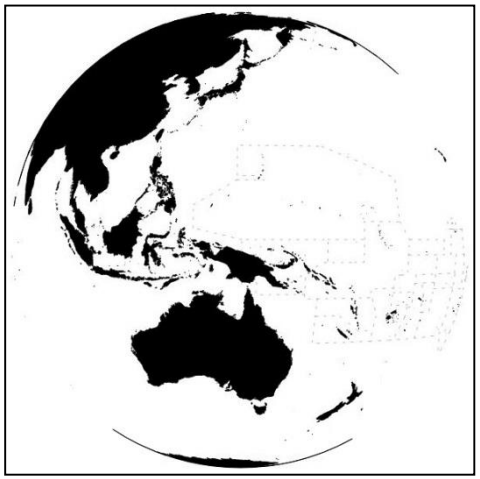
GEO-KOMPSAT-2A
(128.2E)

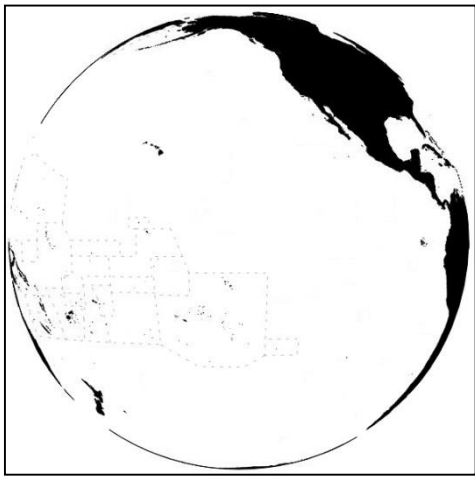


Himawari-8
(140.7E)

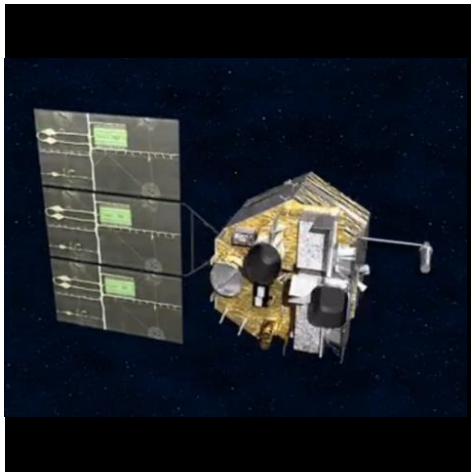
GOES-17
(137.2W)





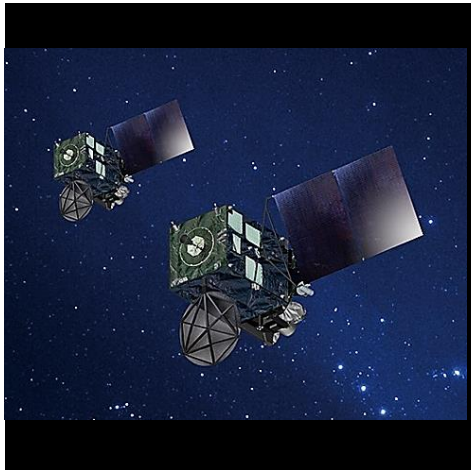


Full earth disk view of the geostationary satellites over our region and "limb regions" as defined by Elmer (2019)



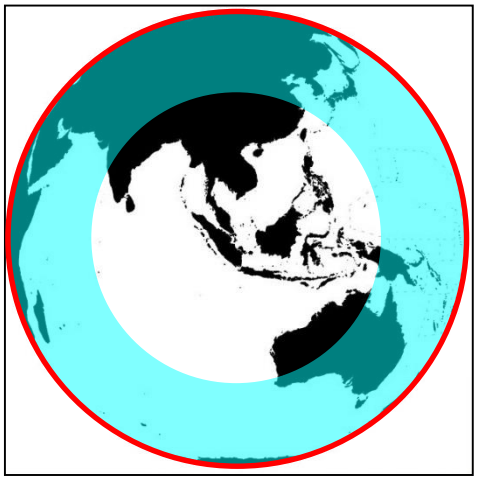
Feng-Yun-4A
(105E)

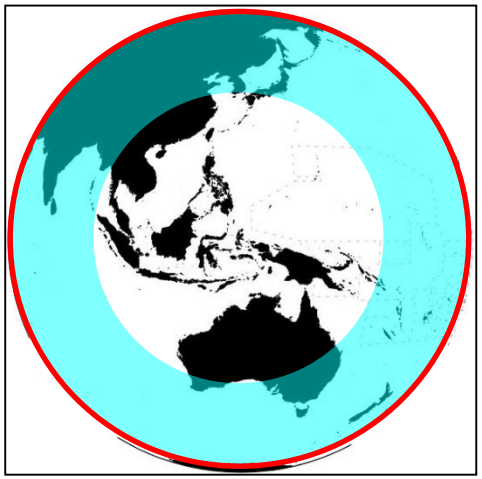
GEO-KOMPSAT-2A
(128.2E)

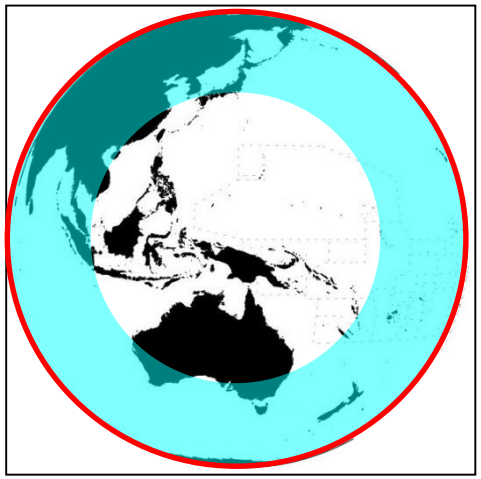


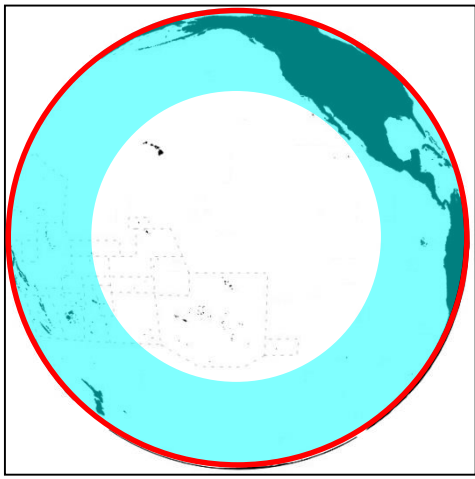
Himawari-8
(140.7E)

GOES-17
(137.2W)









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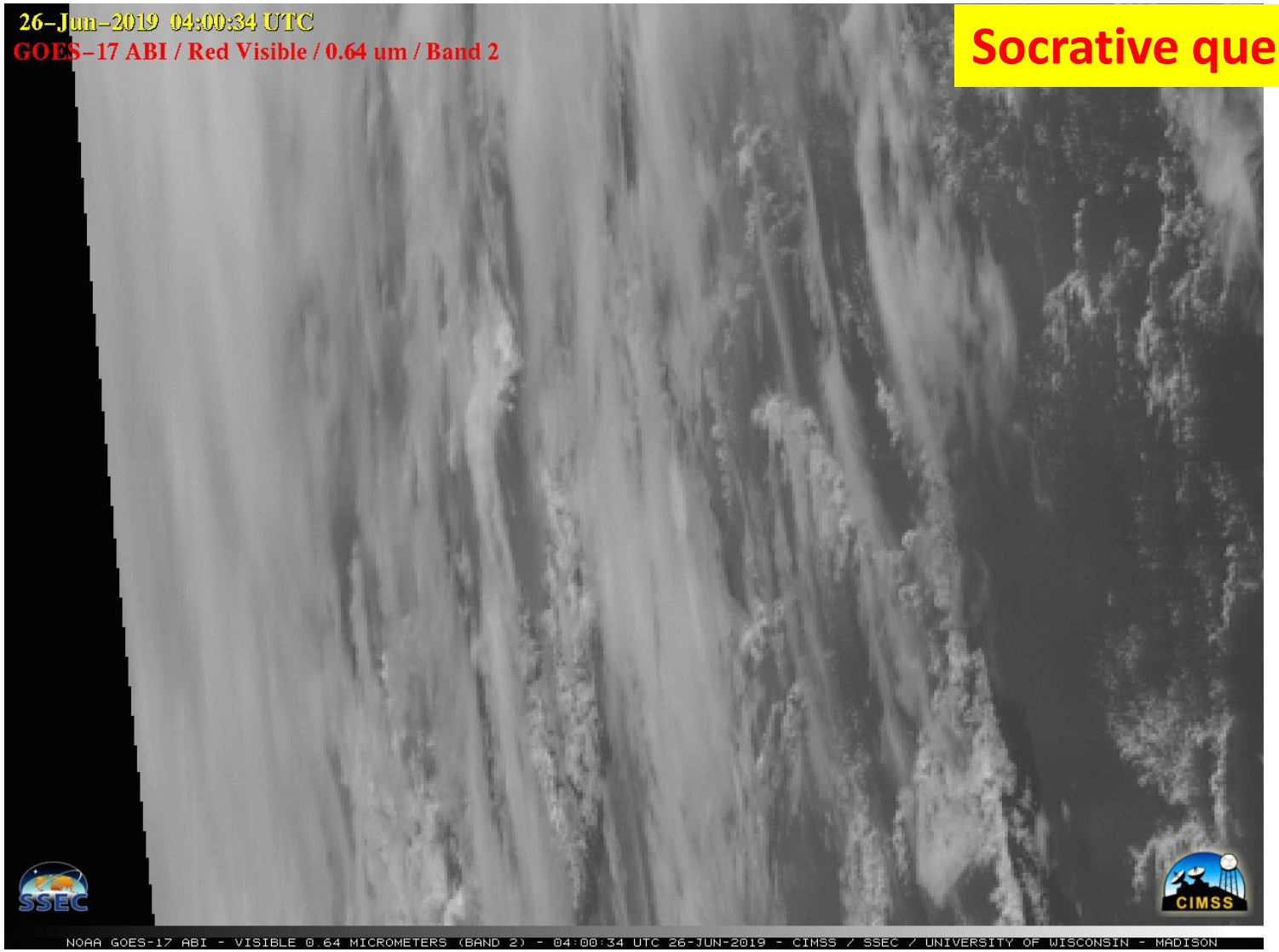
Please start the Power Point Slide Show to activate the animation

Animation 1: The Ulawun eruption (PNG) rendered in the GOES-17 visible (Band 2) data 26th June 2019, Red Visible / 0.64 micron 0400 – 0740UTC



Socrative question 2

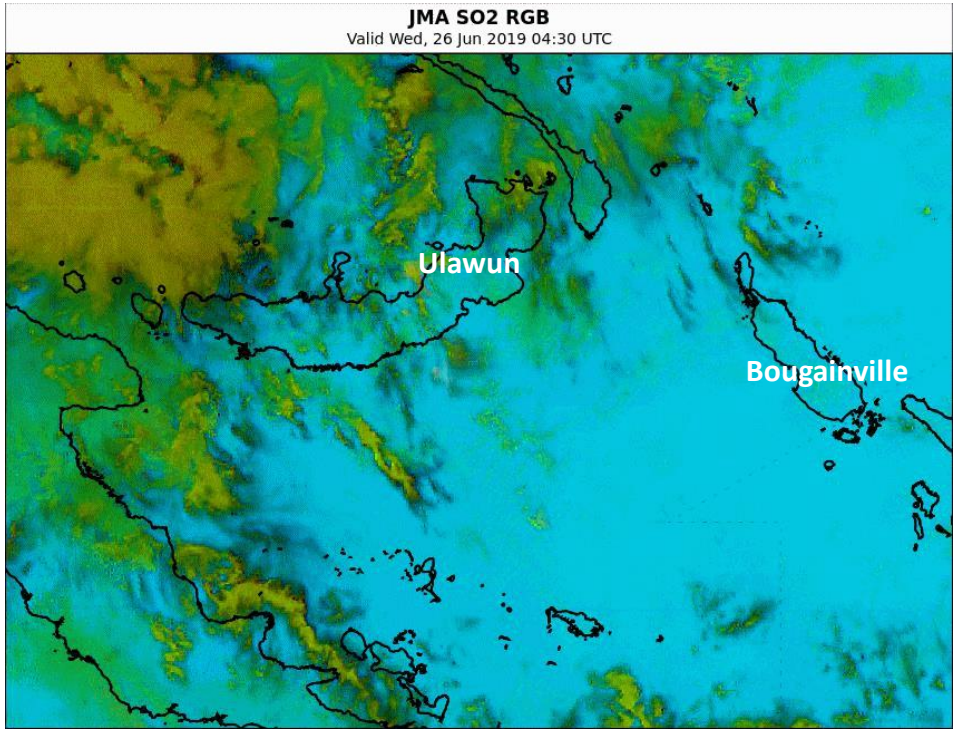
animation courtesy Scott Bachmeier SSEC Wisconsin

Socrative question 2: What additional information is the earth full disk limb animation giving you?

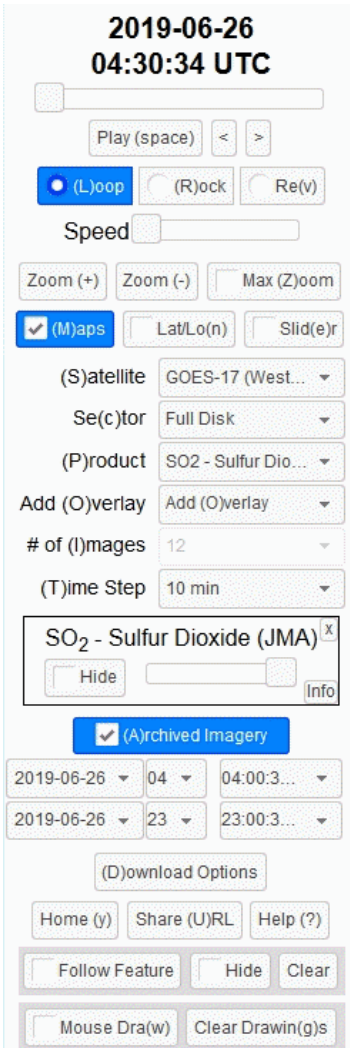
Write in your answers here.

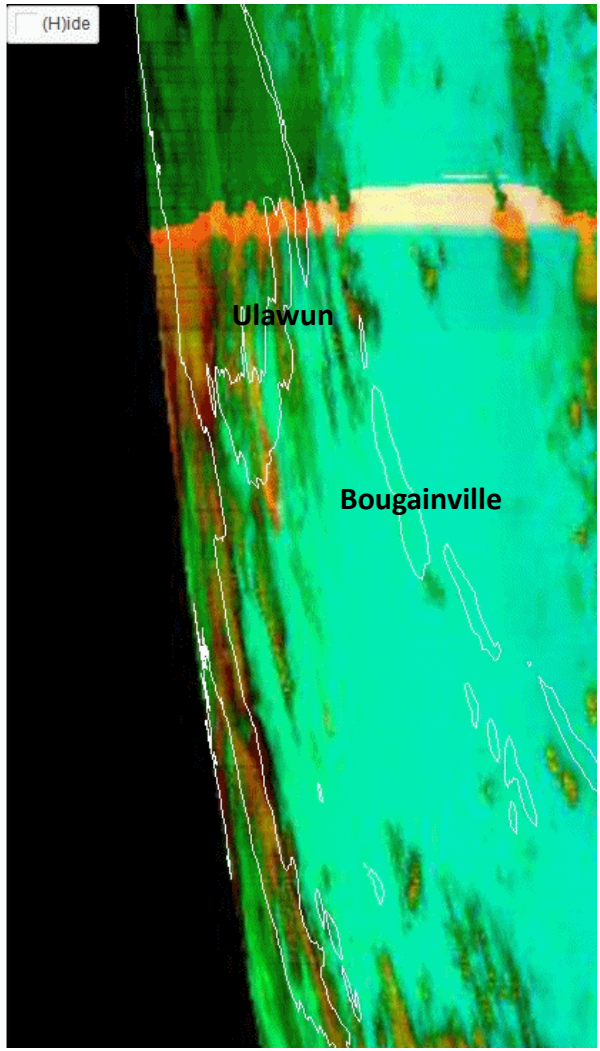
Animation 2: Comparing the JMA SO2 RGB composite utilising Himawari-8 and GOES-17 data: the Ulawun eruption; 0430UTC to 2300UTC 26th June 2019

Please start the Power Point Slide Show to activate the animation



Himawari-8





GOES-17

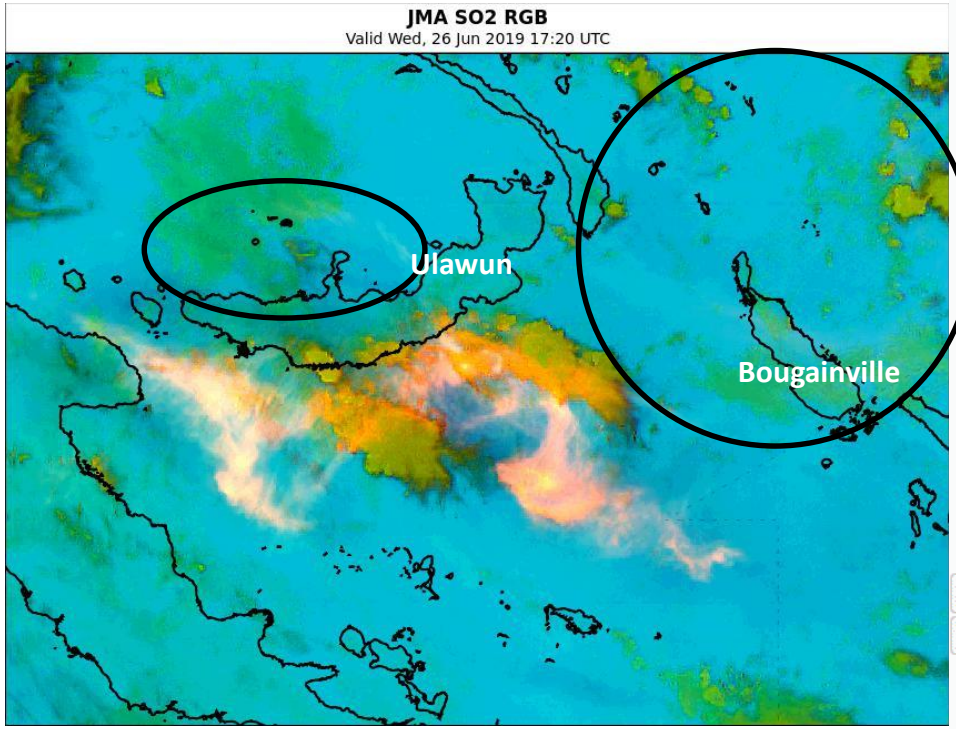
animation courtesy JMA/BOM

animation courtesy RAMMB/CIRA @ CSU

Comparing the JMA SO2 RGB composite utilising Himawari-8 and GOES-17 data:

the Ulawun eruption;
1720UTC 26th June 2019

Additional information provided by the GOES-17 satellite due to the limb effect

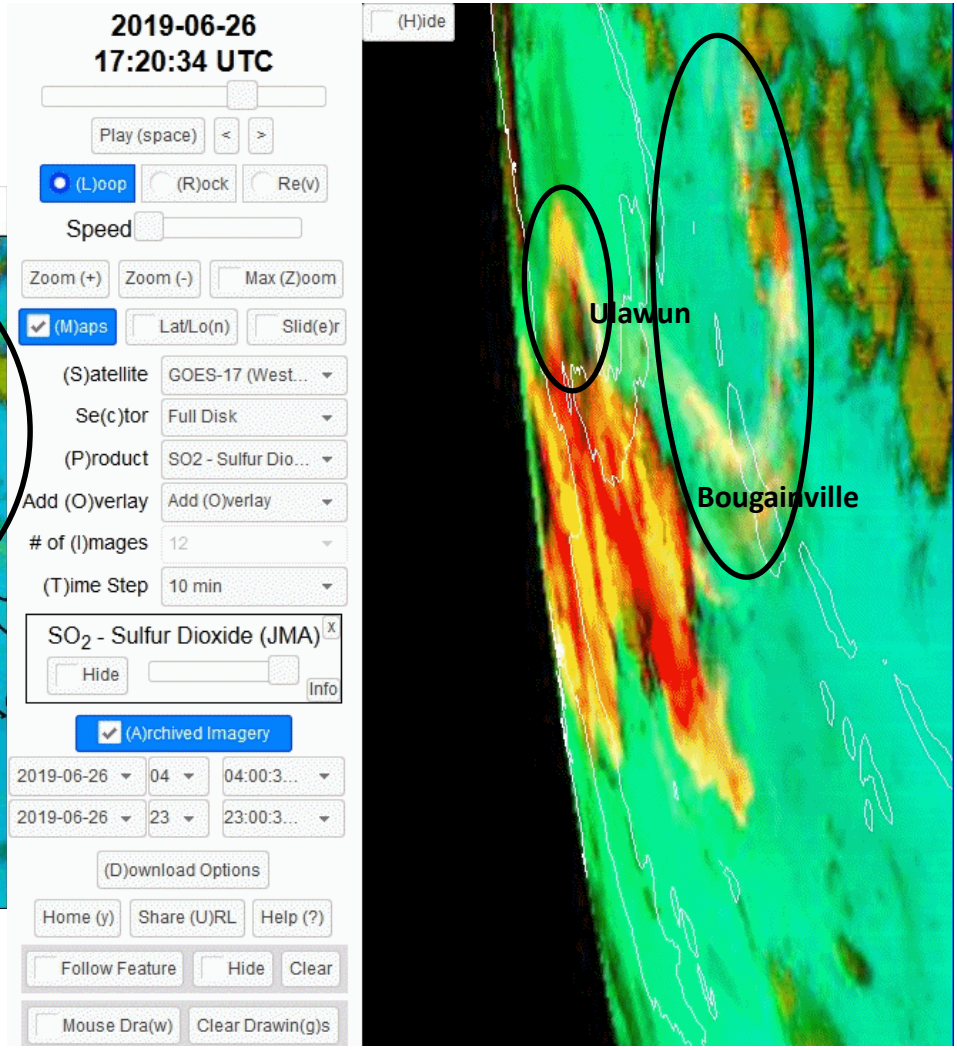


Himawari-8

Thick SO2 cloud

Upper layer SO2 cloud

image courtesy JMA/BOM

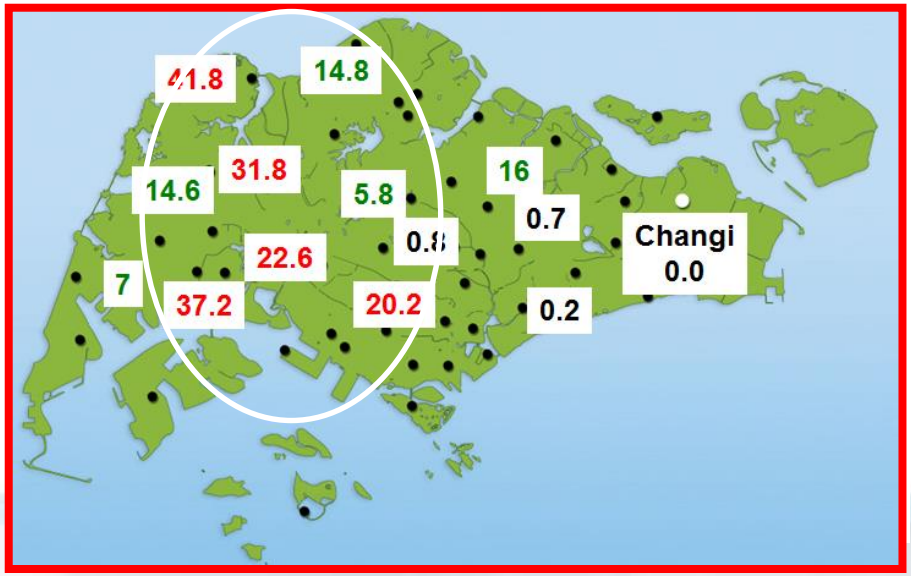


GOES-17 as displayed in RAMMB/CIRA SLIDER

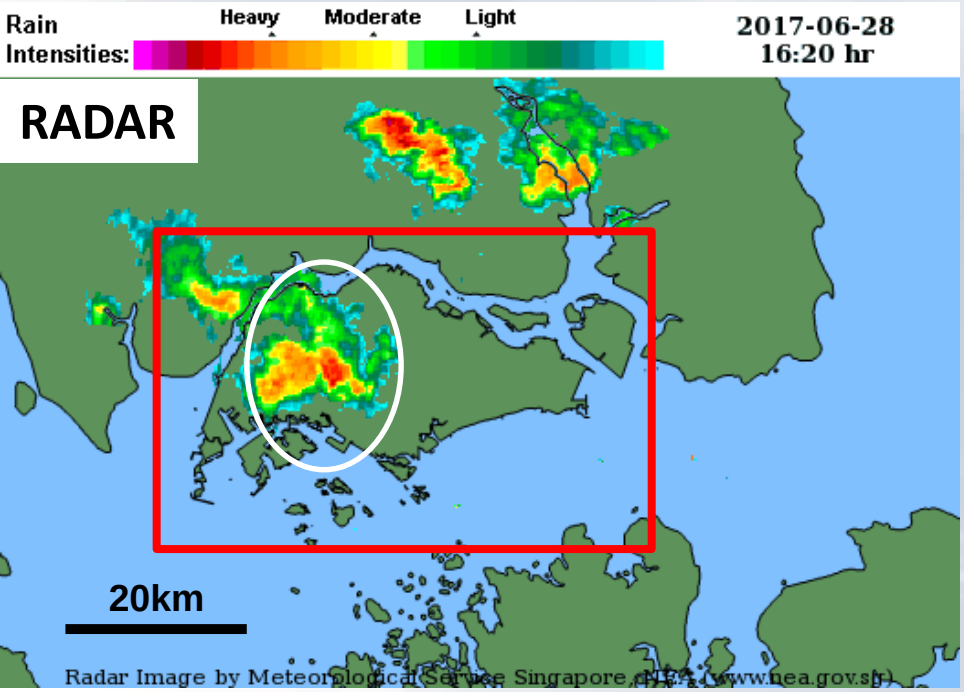
image courtesy RAMMB/CIRA @ CSU

satellite data courtesy BOM/JMA, lightning data from Weather Zone

24 hour precipitation (mm)



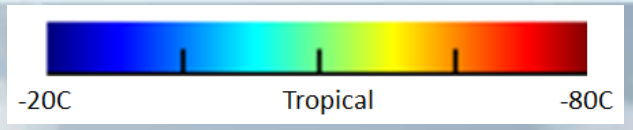
RADAR and precipitation data courtesy NEA Singapore



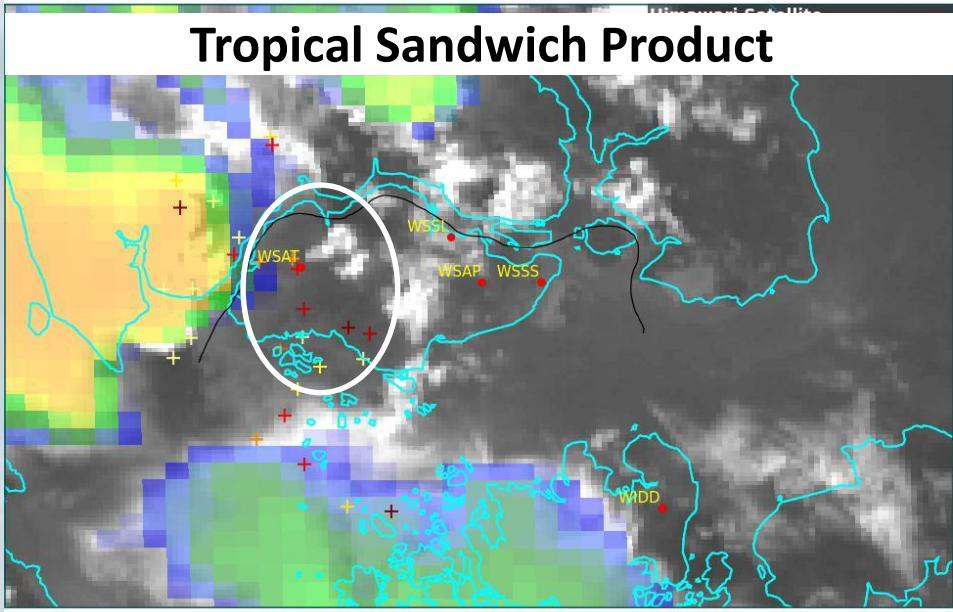
Parallax error issues near the limb

Singapore thunderstorm event, 0810UTC 28th June 2017

Satellite, RADAR and surface observations



Tropical Sandwich Product



Limb effects in some of the RGB composites

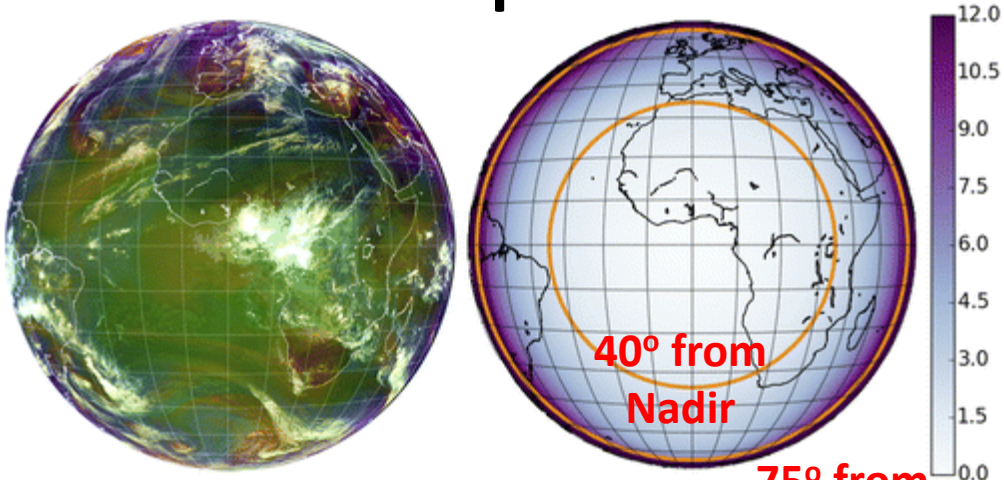
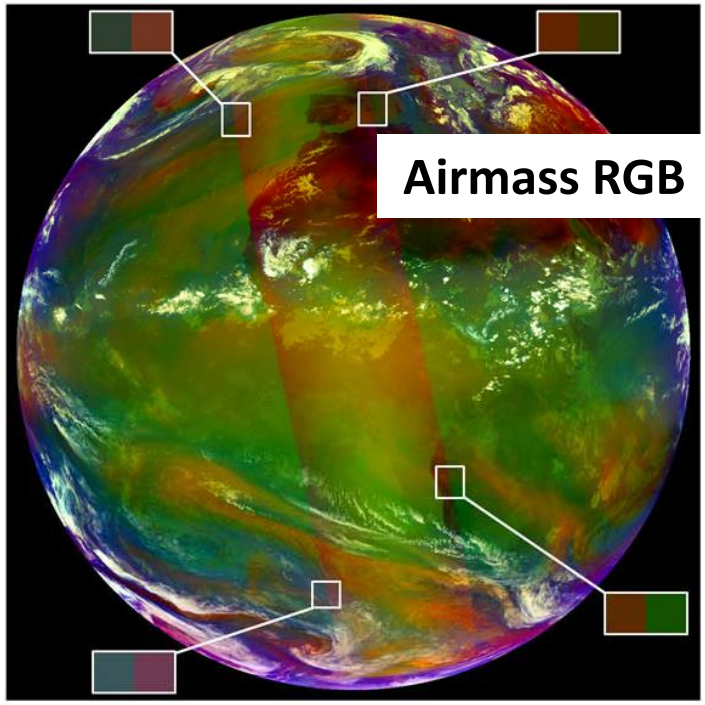


image from Elmer 2019



Airmass RGB

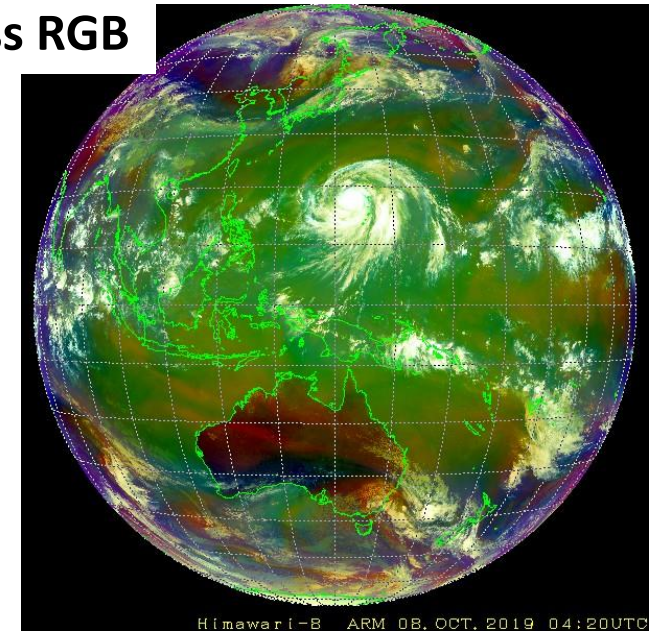


image from JMA

Dust RGB

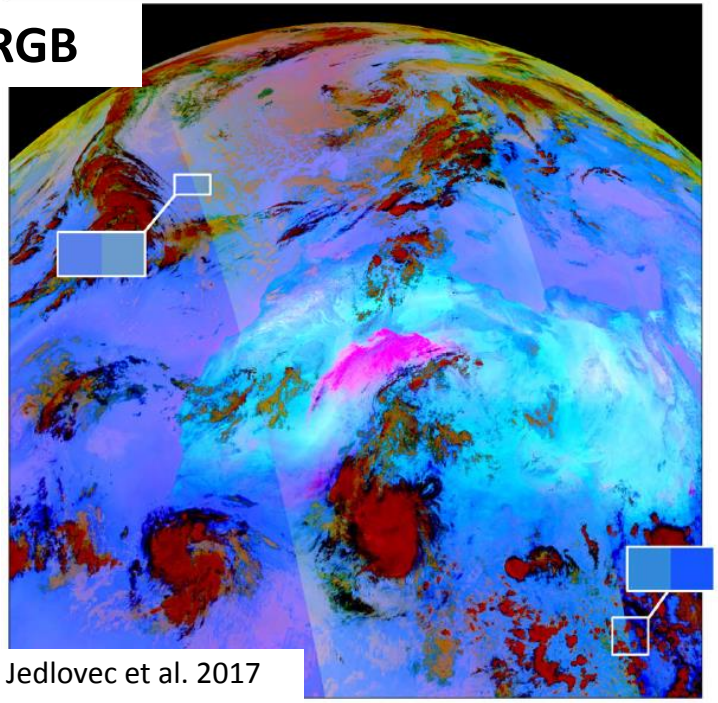


image from Jedlovec et al. 2017

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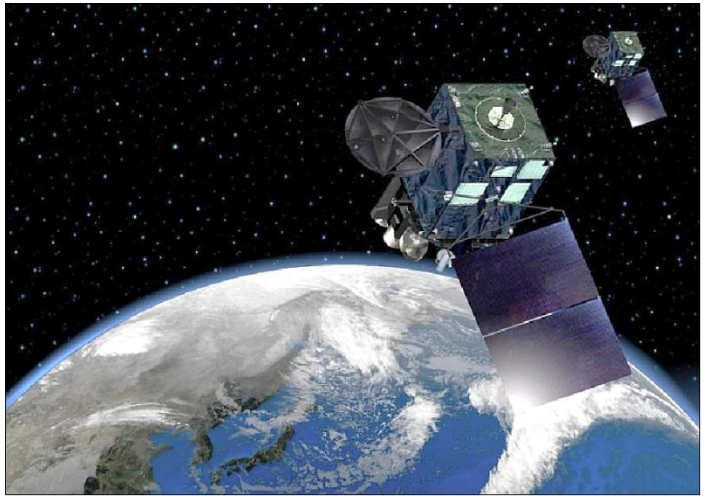
Motivation: utilisation of Himawari-8 and GEO-KOMPSAT-2A data in combination

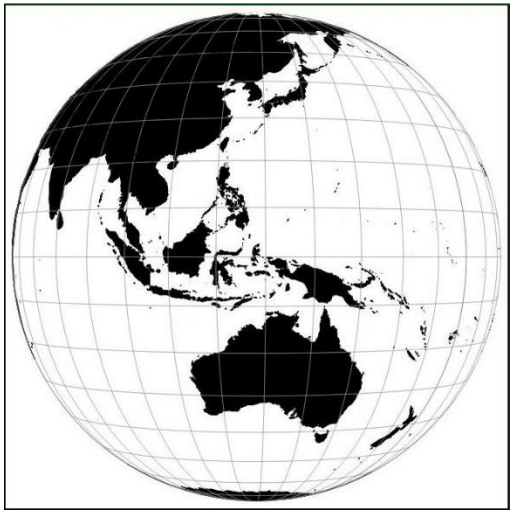
image from KARI

GEO-KOMPSAT-2A located at 128.2E

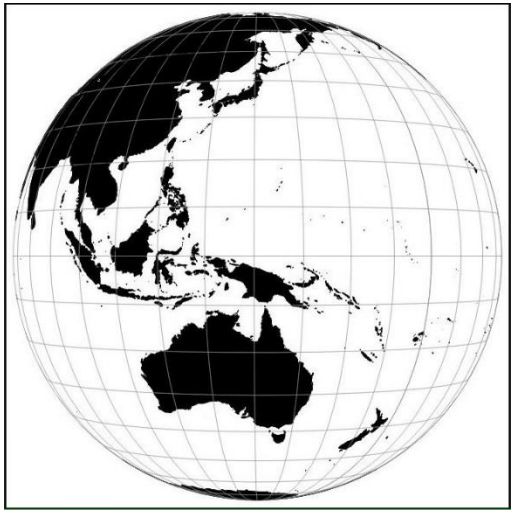
image from JMA



Himawari-8 located at 140.7E,



Separation of 12. 5 degrees



The Pioneers: GOES-16 / GOES-17 (in check out phase) compared to GEO-KOMPSAT-2A and Himawari-8 separation

GOES-17

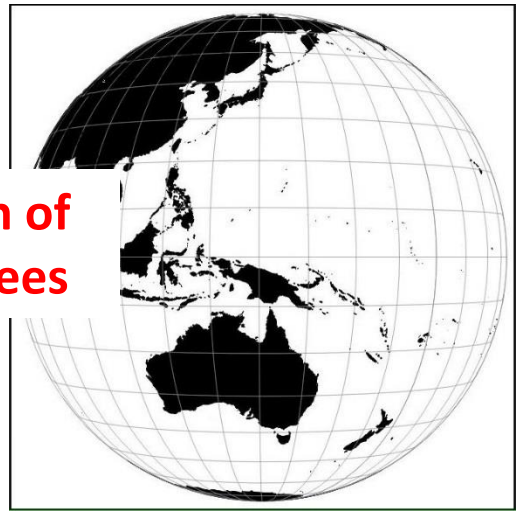
Separation of 14. 3 degrees

GOES-16

GOES-17 in **test position** at 89.5º W during 2018, GOES-16 at 75.2º W

GEO-KOMPSAT 2A

Separation of 12. 5 degrees

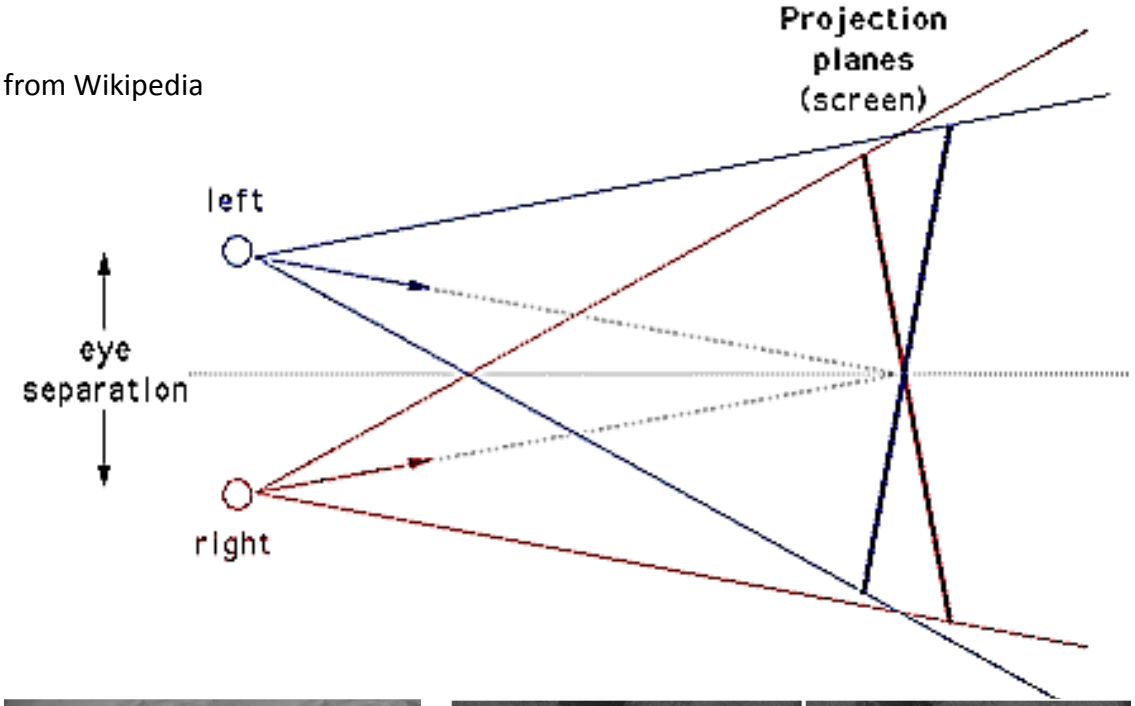


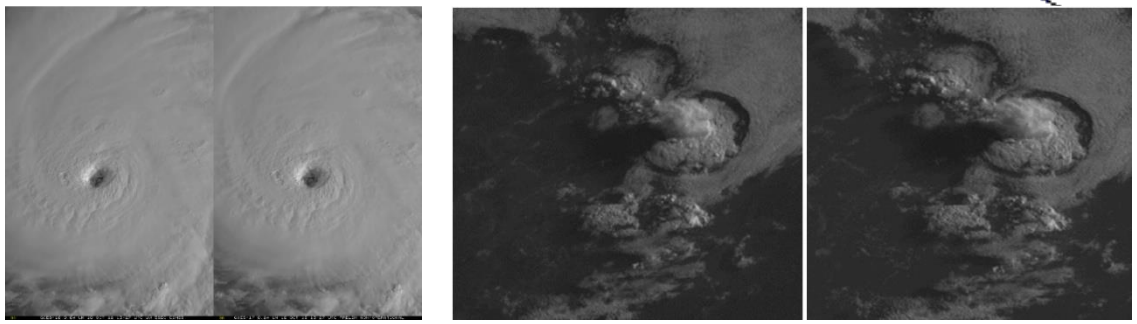
HIMAWARI-8

Himawari-8 is located at 140.7E, GEO-KOMPSAT-2A is located at 128.2E

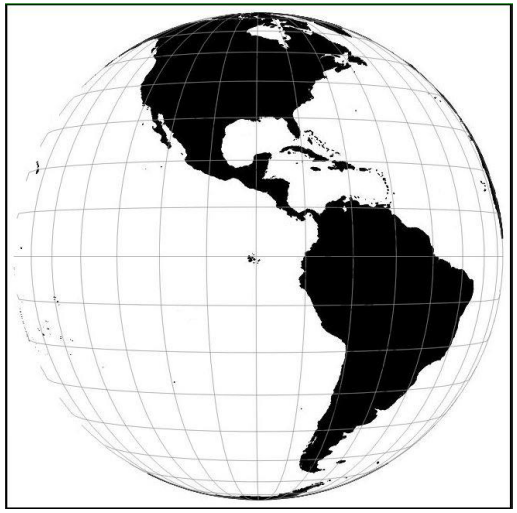
Stereo vision presentation of satellite images – GOES-16 and 17

image from Wikipedia

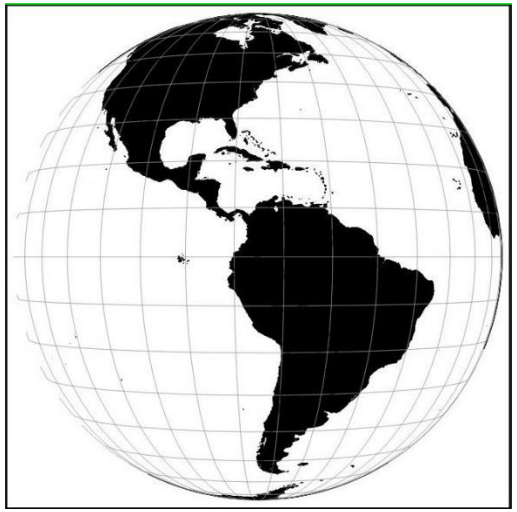




images from CIMSS Satellite Blog, case studies produced by Scott Lindstrom SSEC



GOES-16

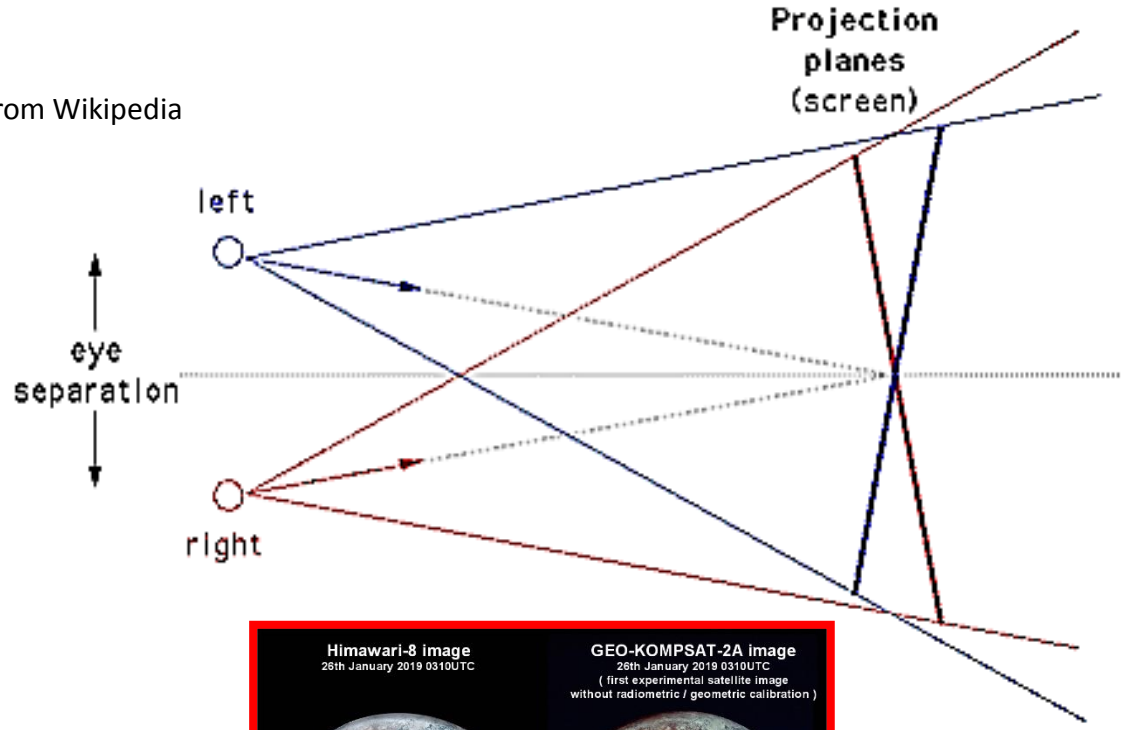


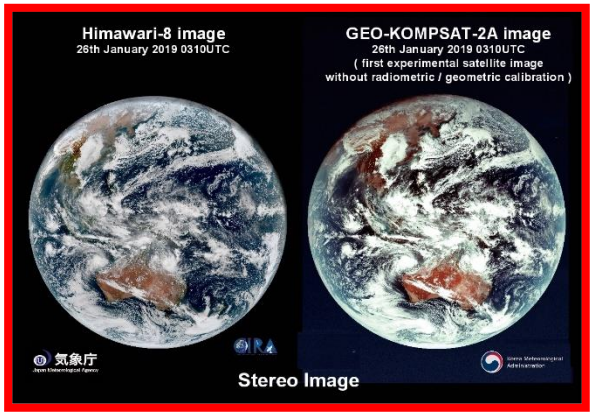
GOES-17

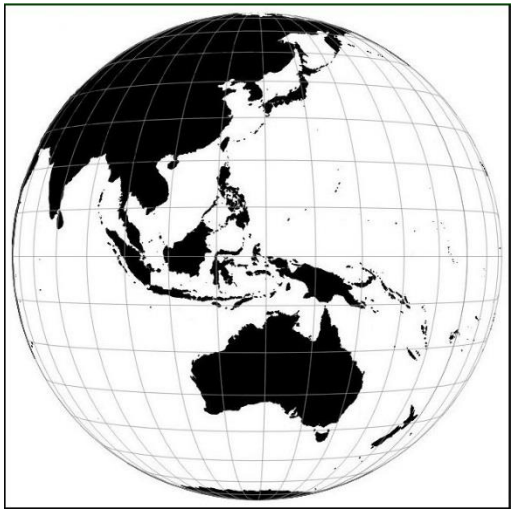
Stereo vision presentation of satellite images

Creating the worlds first GEOKOMPSAT-2A / Himawari-8 stereo image

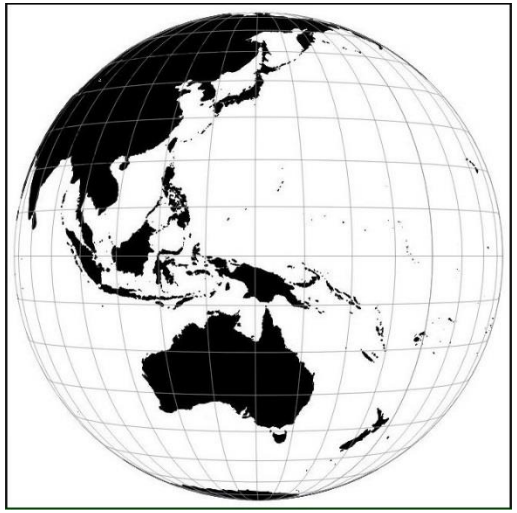
image from Wikipedia







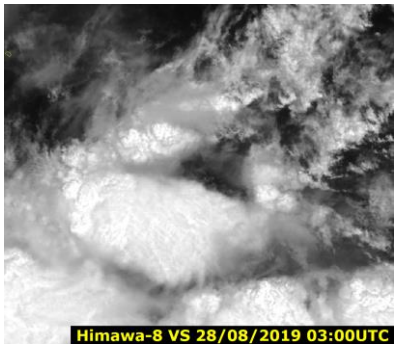
GEOKOMPSAT-2A



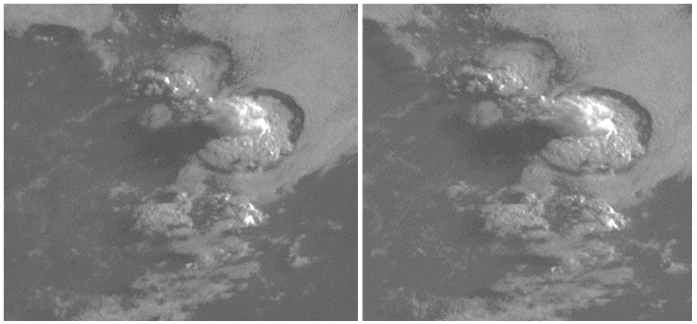
Himawari-8

images from CIMSS Satellite Blog, image produced by B.Zeschke in collaboration with JMA and KMA

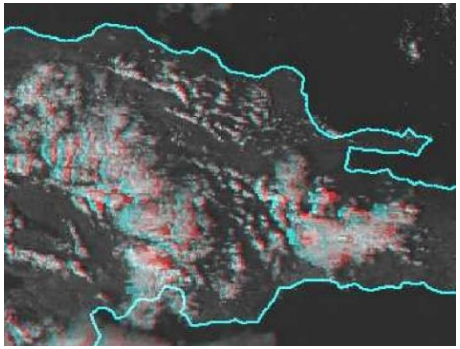
Various ways of presenting 3D stereo satellite imagery



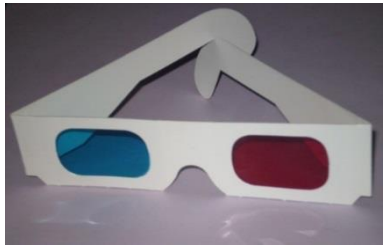
1: "3D Wiggle" animation



2: Stereo pair images
(cross eyed viewing method)



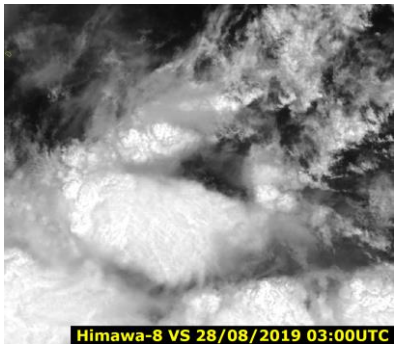
Anaglyph glasses



3: "Anaglyph"animation
(requiring viewing glasses)

4: 2 panel image animation played on Smartphone and rendered in a viewer
(eg. Google Cardboard).

Various ways of presenting 3D stereo satellite imagery



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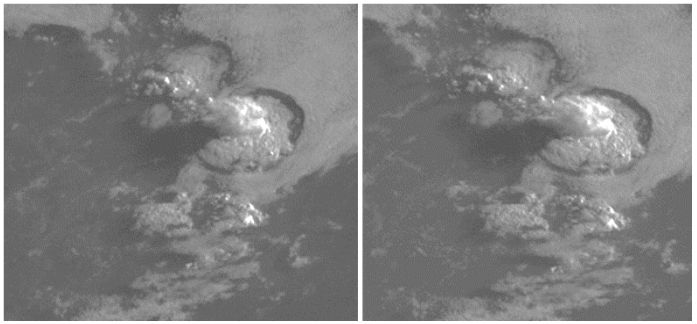
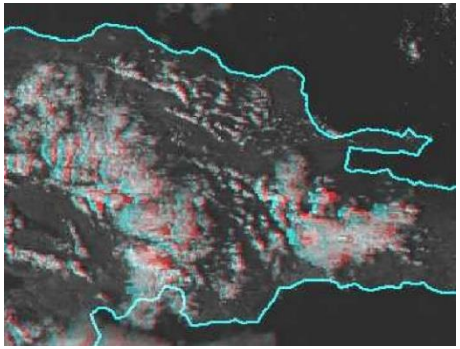
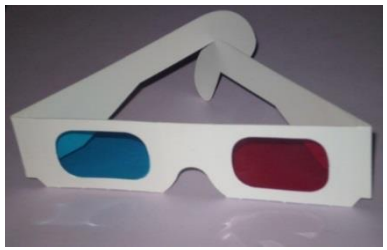


2: Stereo pair images
(cross eyed viewing method)



Anaglyph glasses



3: "Anaglyph"animation
(requiring viewing glasses)

4: 2 panel image animation played on Smartphone and rendered in a viewer
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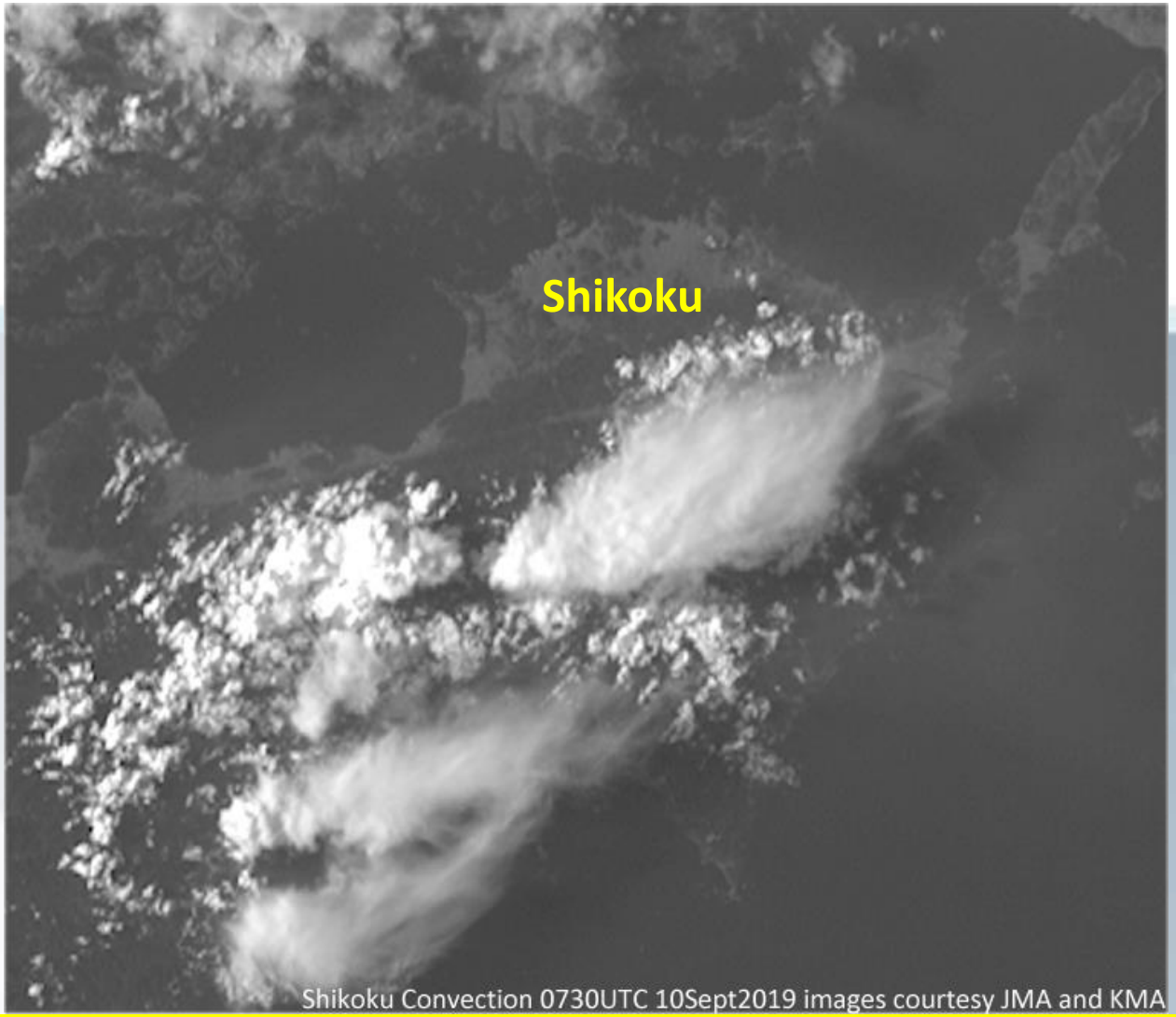
animation courtesy Korea Meteorological Administration / Japan Meteorological Agency

Animation 3: Demonstrating the stereo effect in GK-2A / H-8 data.

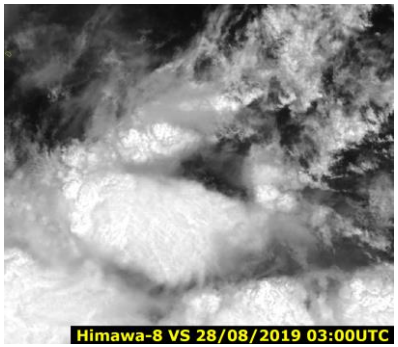
Shikoku thunderstorms, 0730UTC 10th September 2019 (2 frames per second Wiggle 3D animation)

Please view this animation carefully and desist if it feels uncomfortable

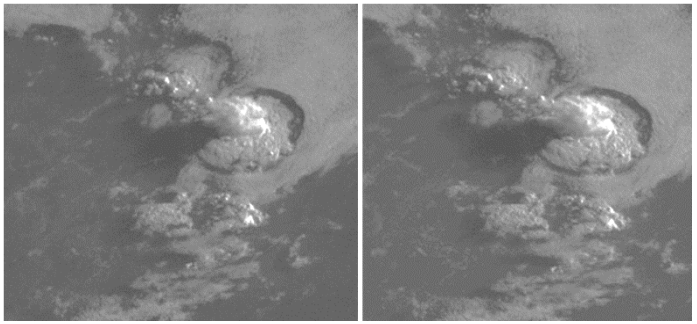


Please start the Power Point Slide Show to activate the animation

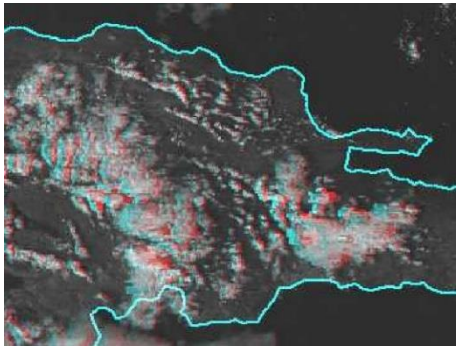
Various ways of presenting 3D stereo satellite imagery



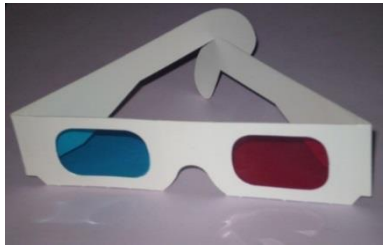
1: "3D Wiggle" animation



2: Stereo pair images
(cross eyed viewing method)



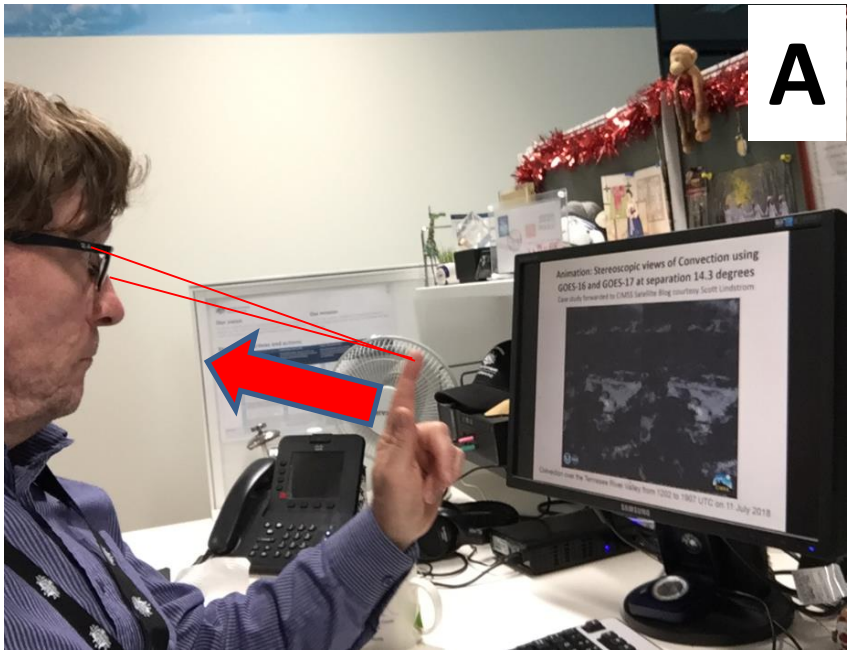
Anaglyph glasses

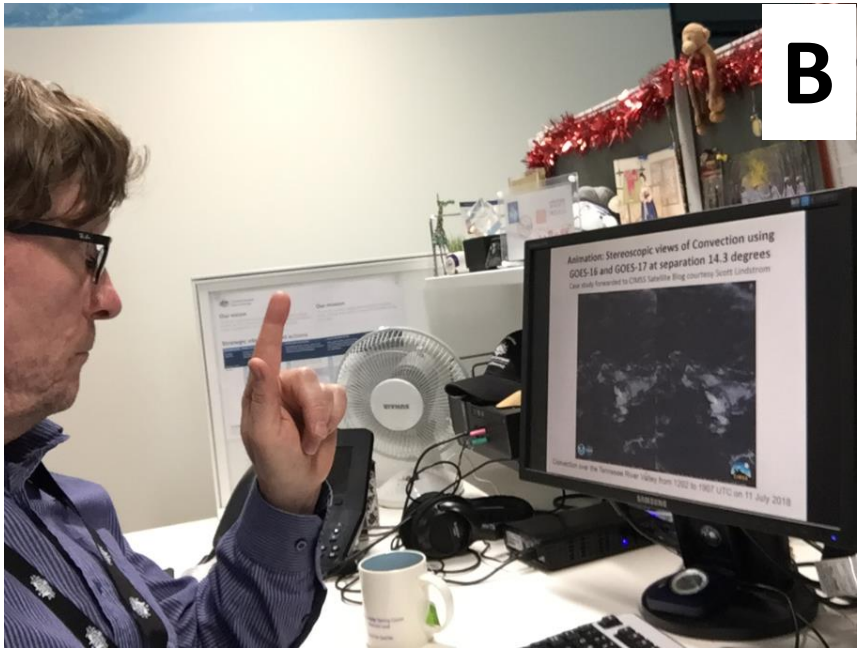


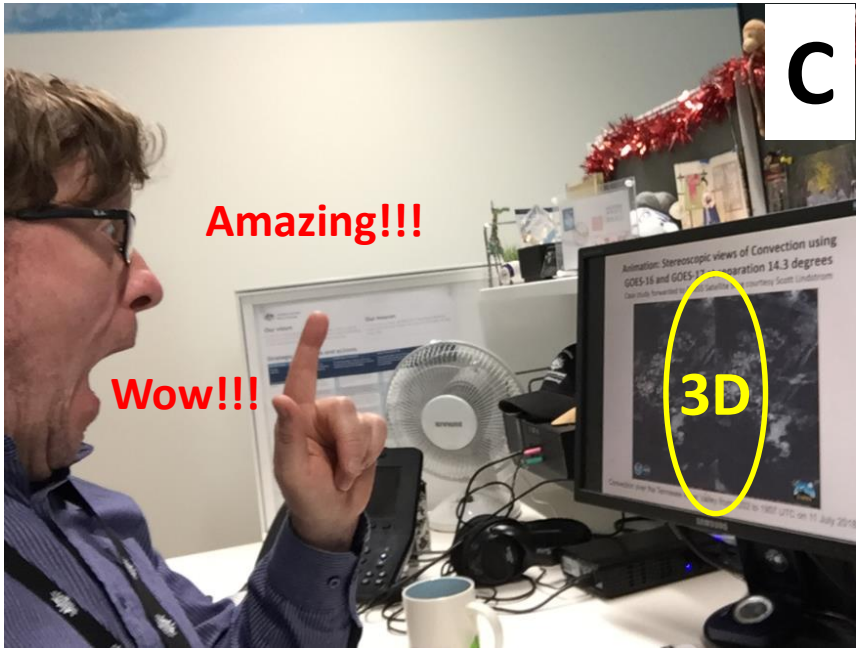
3: "Anaglyph"animation
(requiring viewing glasses)

4: 2 panel image animation played on Smartphone and rendered in a viewer
(eg. Google Cardboard).

How to directly view the 3D two panel animations



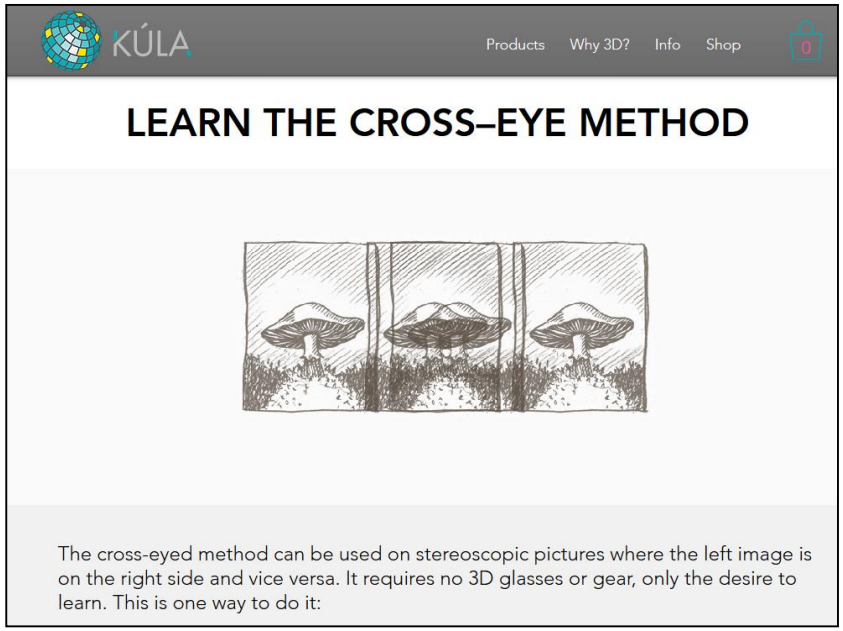


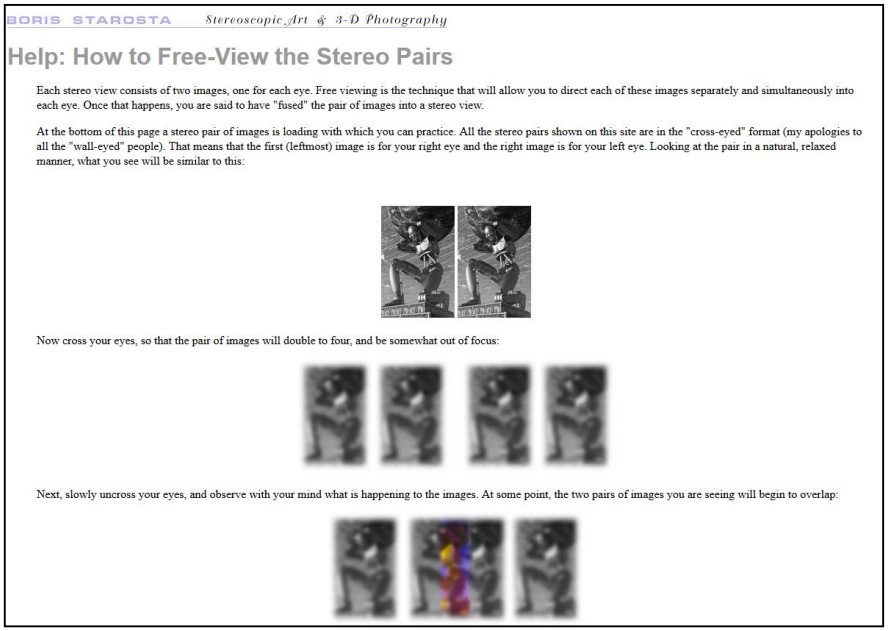


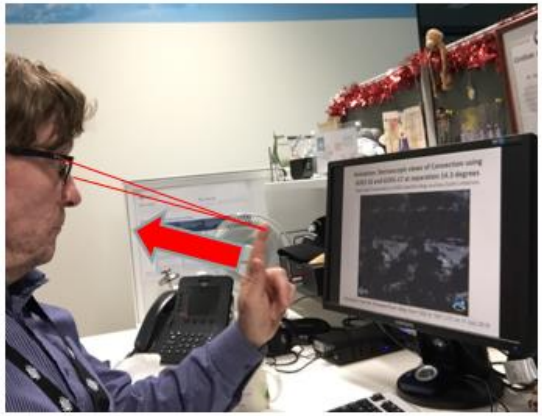
How to view stereo-pairs references

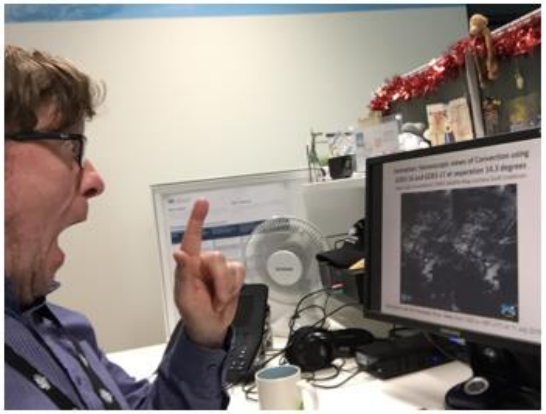
https://www.kula3d.com/how-to-use-the-cross-eyed-method

http://www.starosta.com/3dshowcase/ihelp.html









Socrative question 3

The worlds first GEO-KOMPSAT-2A / Himawari-8 stereo image!

joint effort between Dr Hyesook Park (KMA), Bodo Zeschke (BMTC) and Akihiro Shimizu (JMA)

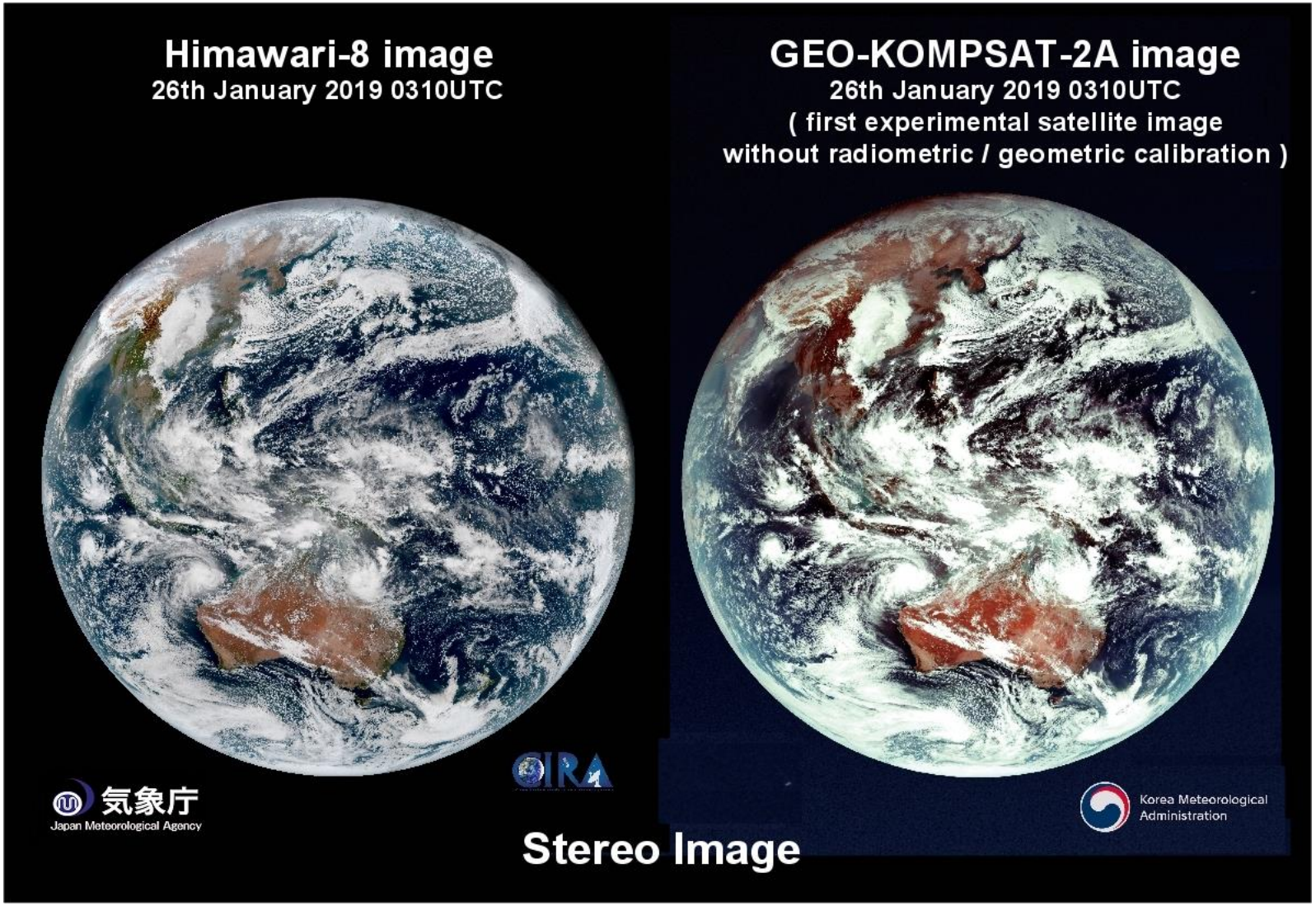


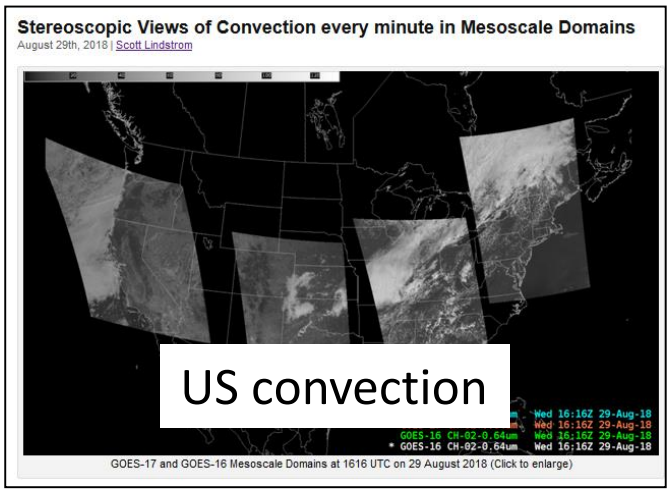
image pair courtesy Bodo Zeschke, Australian Bureau of Meteorology ; Himawari image courtesy JMA ; GK2A image courtesy KMA and Dr. Hyesook Park. GEOKOMPSAT-2A is also known as Chollian-2a

Socrative question 3: Can you see the "round" earth using the cross-eyed method?

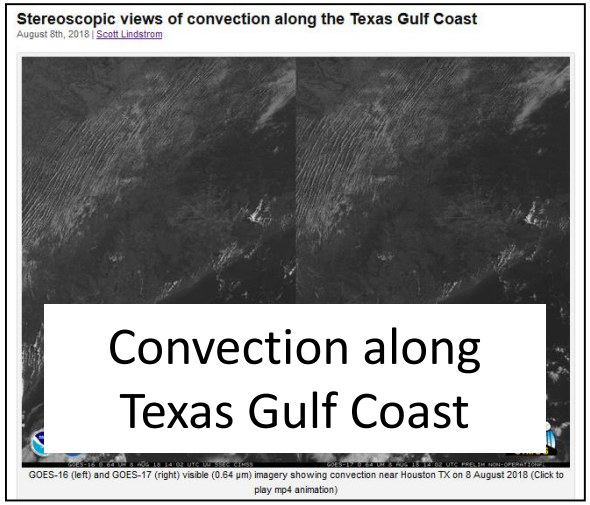
A. Yes I can. It shows the 3D stereo effect well
B. Yes I can. But I cannot see the 3D stereo effect very well.
C. It is so-so (ok).
D. No I cannot.
E. No I cannot. It is uncomfortable to look at.

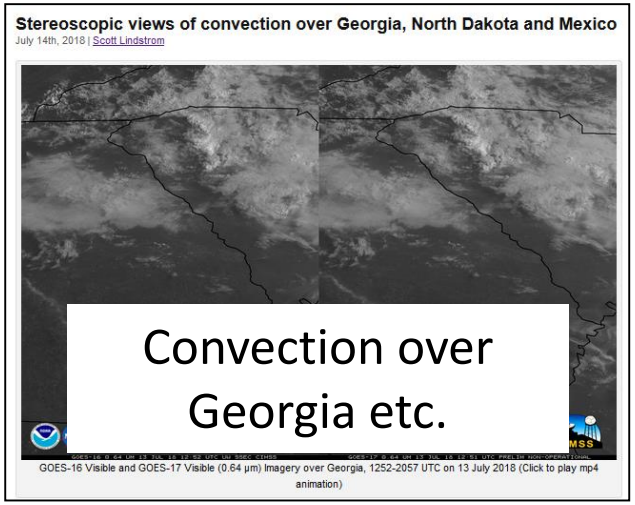
Some additional 3D case studies on the CIMSS Satellite Blog web site utilising GOES-16 / GOES-17 imagery.

Case studies forwarded to CIMSS Satellite Blog courtesy Scott Lindstrom

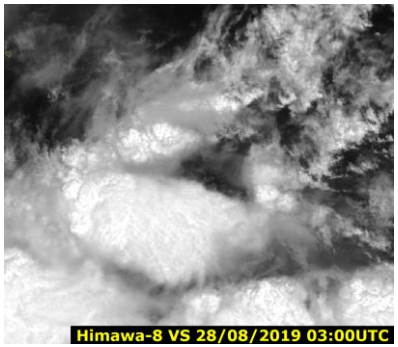


https://cimss.ssec.wisc.edu/goes/blog/?s=stereo

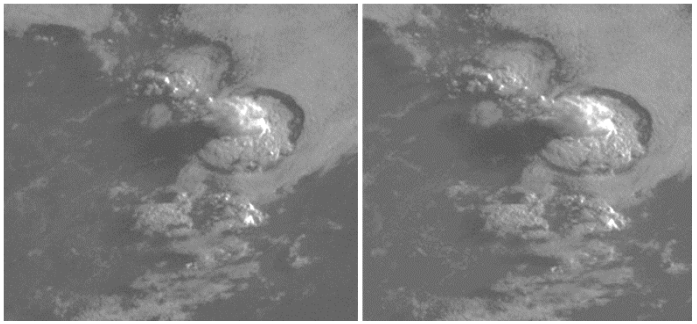




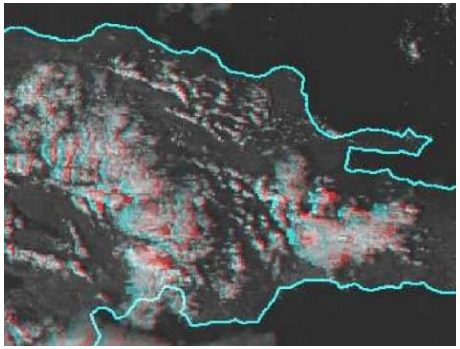
Various ways of presenting 3D stereo satellite imagery



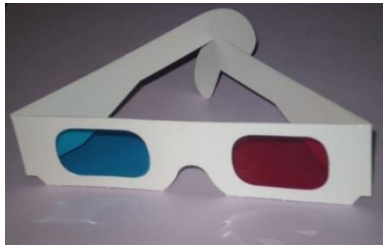
1: "3D Wiggle" animation



2: Stereo pair images
(cross eyed viewing method)



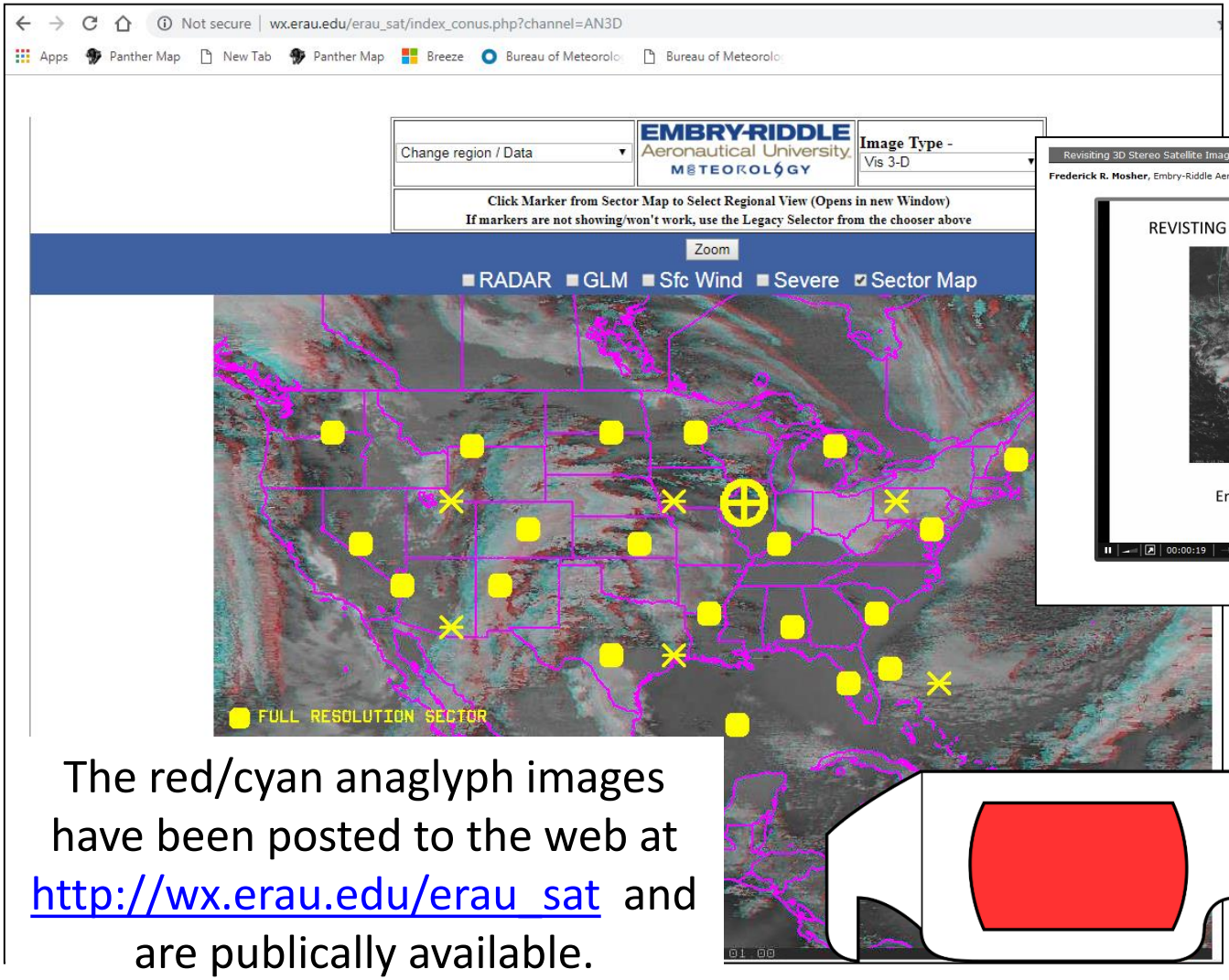
Anaglyph glasses

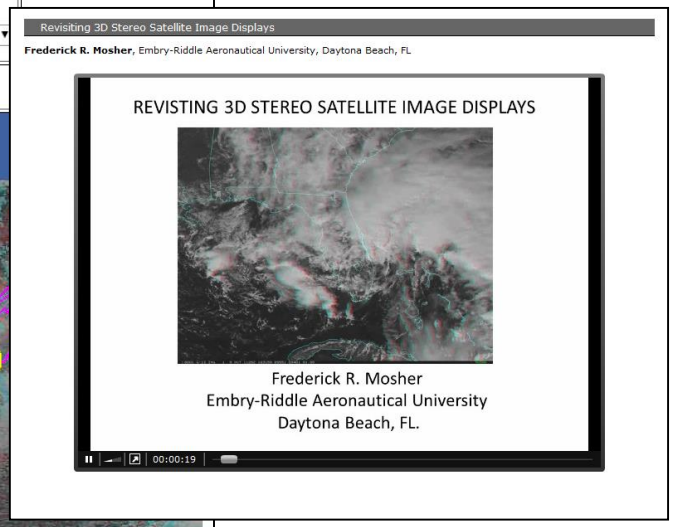


3: "Anaglyph"animation
(requiring viewing glasses)

4: 2 panel image animation played on Smartphone and rendered in a viewer
(eg. Google Cardboard).

An online source of 3D "anaglyph" images over the CONUS domain, from Embry-Riddle Aeronautical University website





The red/cyan anaglyph images have been posted to the web at http://wx.erau.edu/erau_sat and are publically available.

A good example of an Anaglyph image

(the moon's limb as taken from Apollo 11)

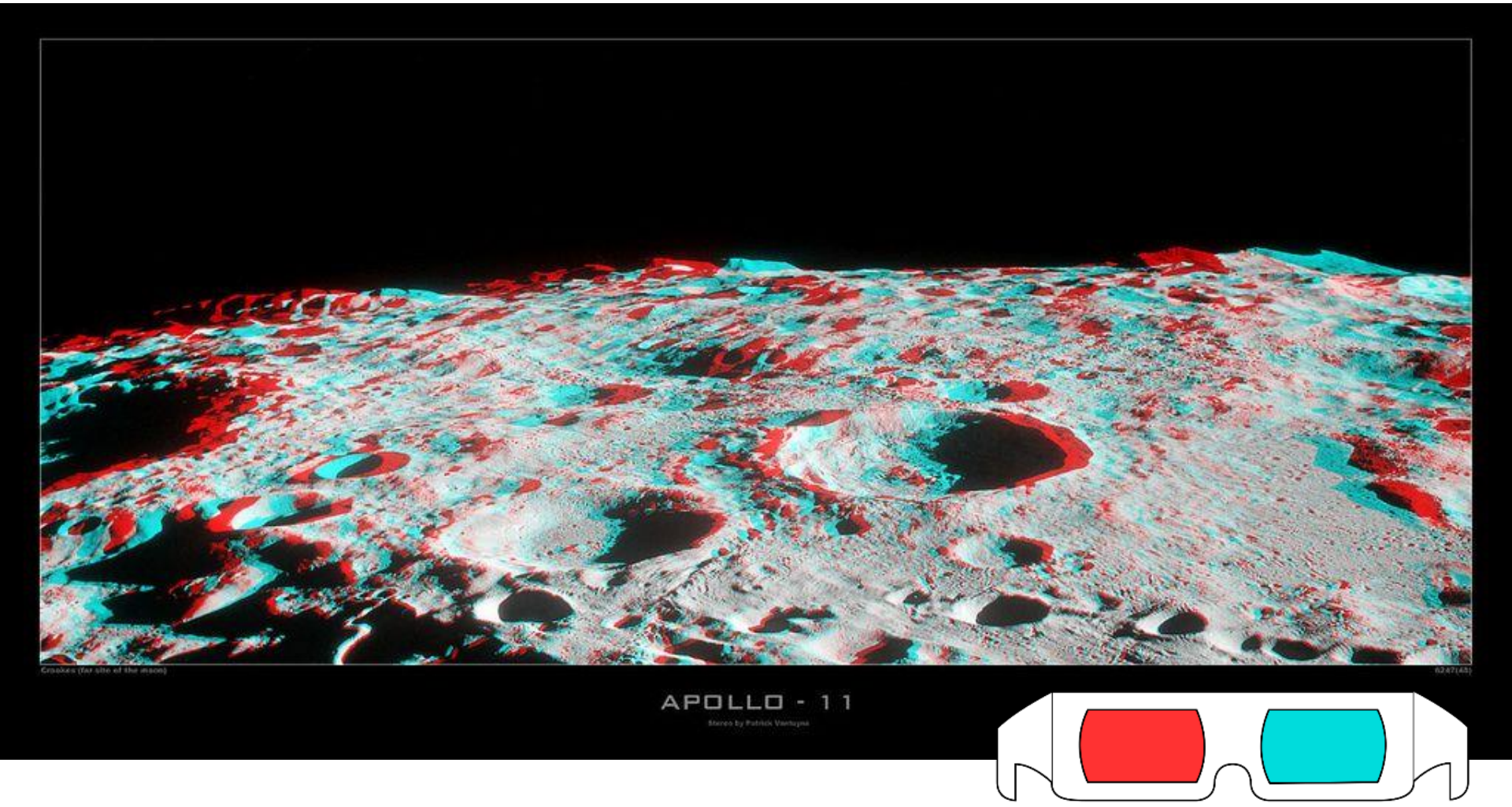
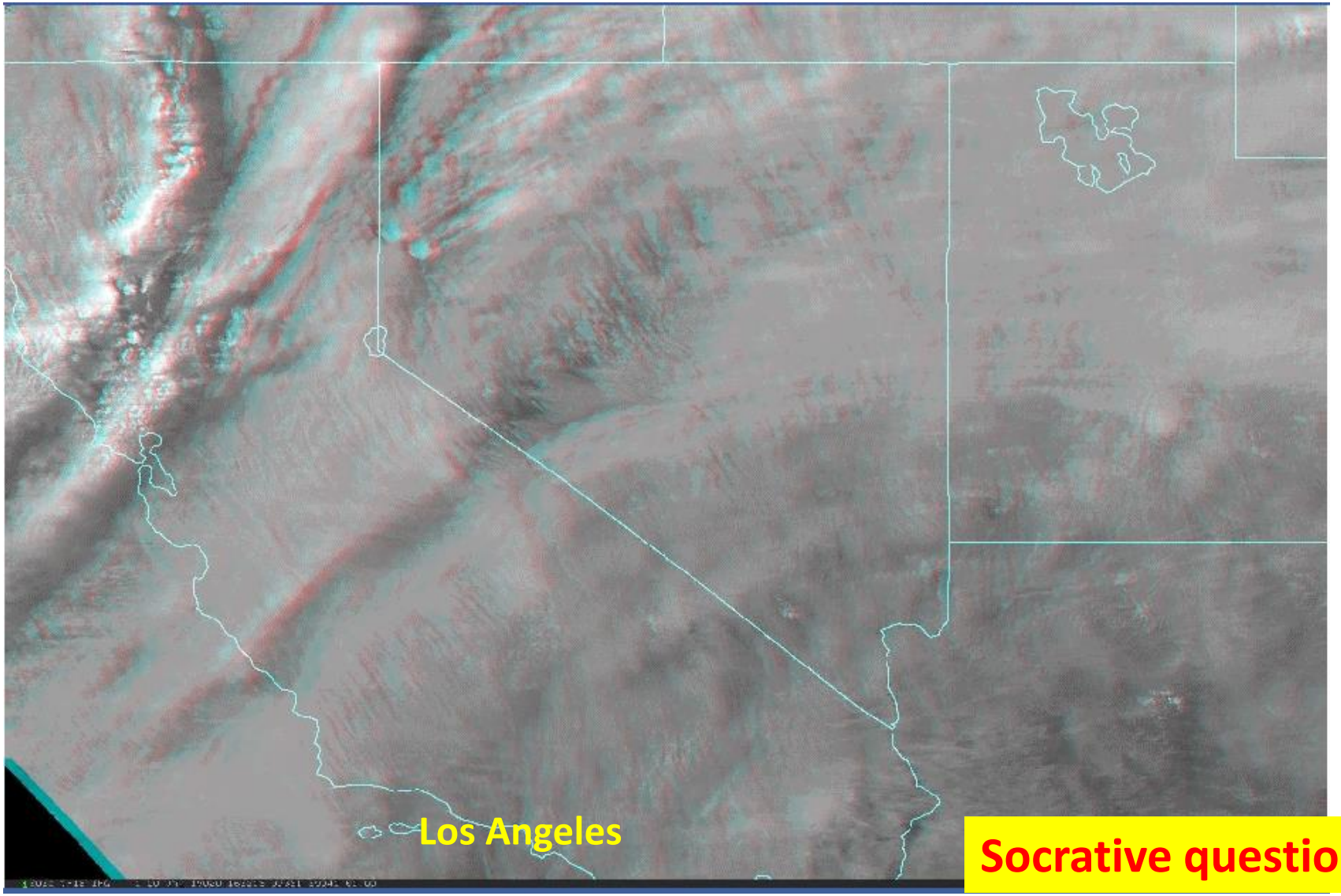


image from Wikipedia

Animation 4: Clouds clearing over Nevada, USA

January 2019 (5FPS rocking animation)



Socrative question 4

animation from CONUS imagery presented by Embry-Riddle Aeronautical University

Socrative question 4: Can you see the 3 dimensional effect of this example using the anaglyph glasses?

A. Yes I can. It shows the 3D stereo effect well
B. Yes I can. But I cannot see the 3D stereo effect very well.
C. It is so-so (ok).
D. No I cannot.
E. No I cannot. It is uncomfortable to look at.

REFERENCE

Animation 5: Low over the central United States of America

2002UTC 13th March to 0002UTC 14th March 2019 anaglyph images (5 FPS animation)

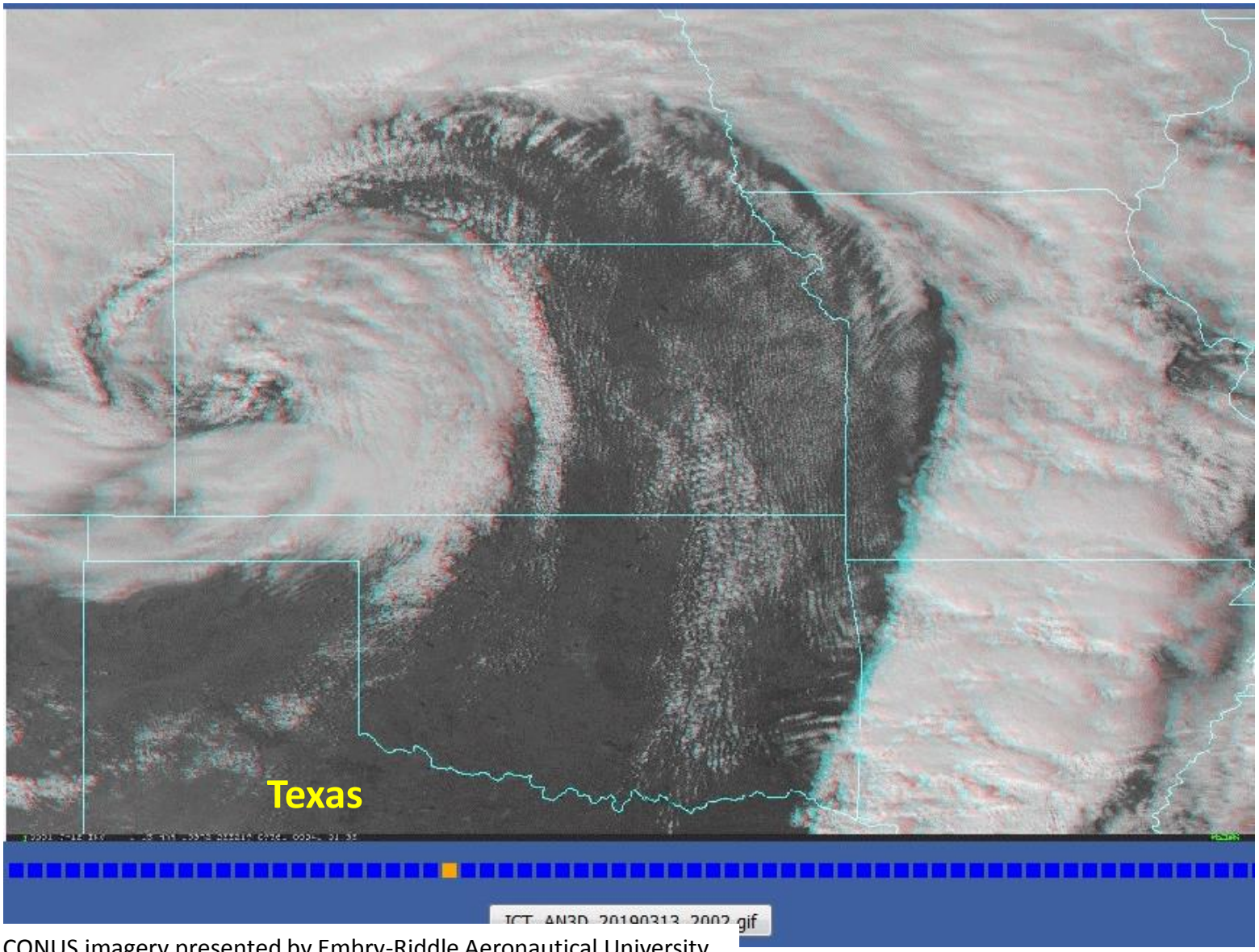
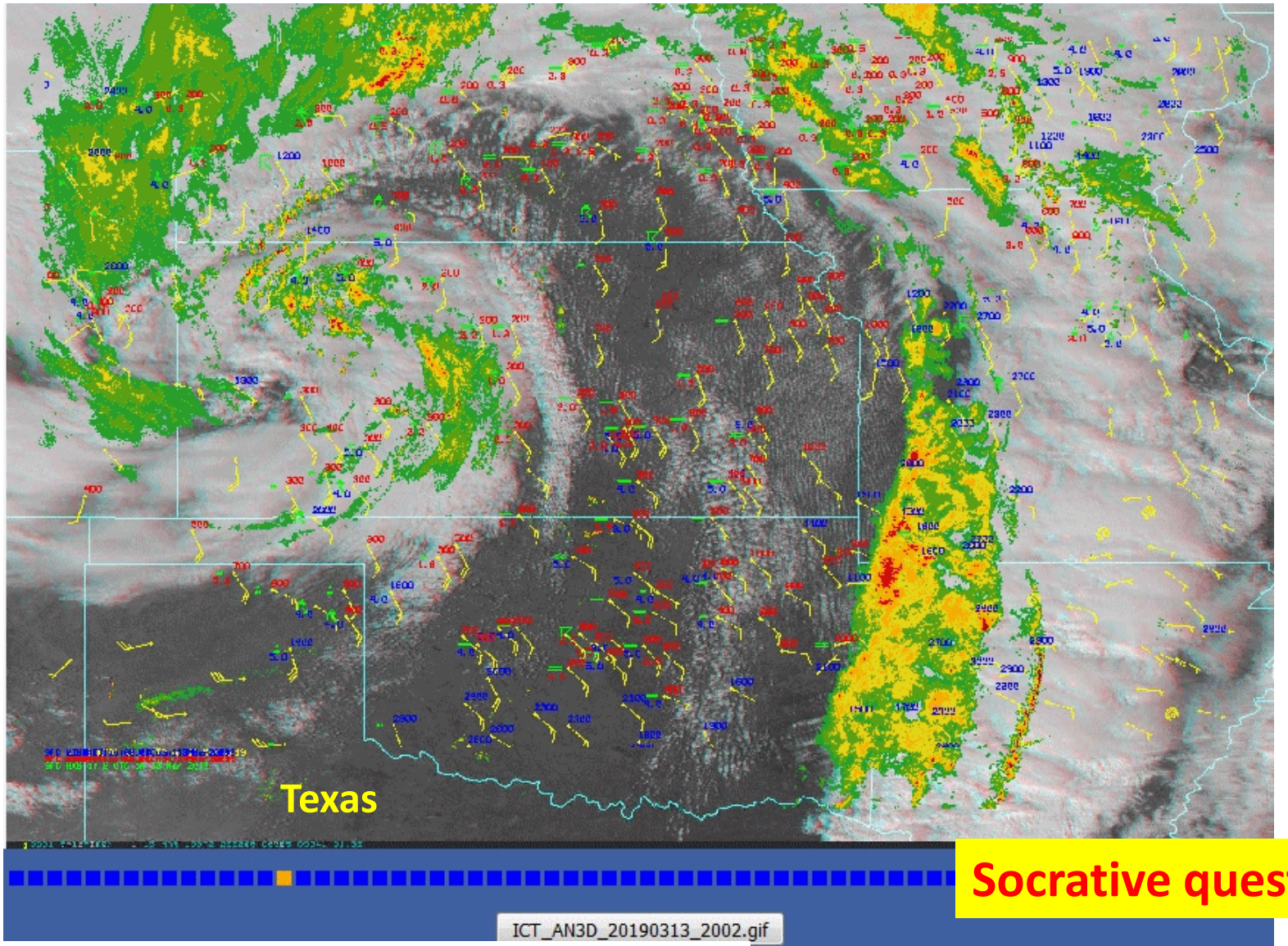


image from CONUS imagery presented by Embry-Riddle Aeronautical University

Animation 6: Superposition of RADAR and surface observations on 3D anaglyph satellite data (5 FPS animation)



Socrative question 5

image from CONUS imagery presented by Embry-Riddle Aeronautical University

Socrative question 5: How well do the anaglyph 3D satellite, RADAR and surface observations render the 3D stereo effect?

A. The superposition of the observational data enhances the 3D stereo effect
B. The superposition of the observational data substantially reduces the 3D stereo effect.
C. There is no difference between the two animations.
D. I cannot see the 3D stereo effect in either animation

Some additional anaglyph 3D case studies for you to examine with your anaglyph glasses

http://www.virtuallab.bom.gov.au/events/aomsuc-training/aomsuc-10-training-event-presentations-and-resources/

Additional Anaglyph Animation 1

Additional Anaglyph Animation 2

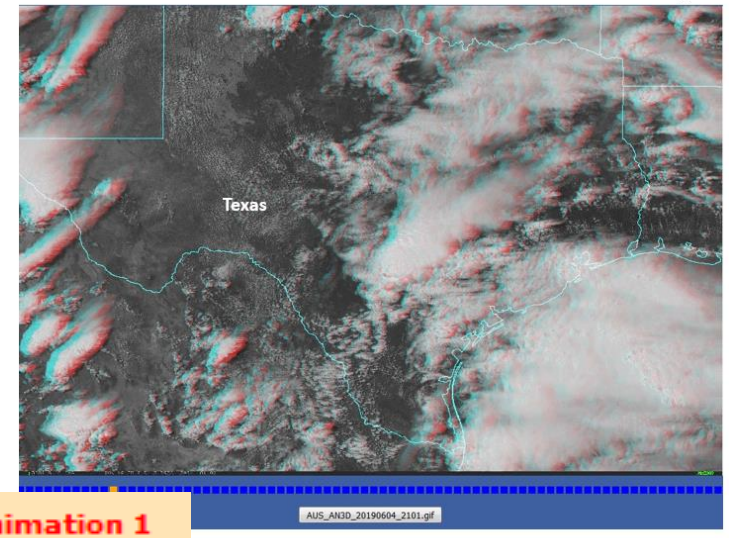
Additional Anaglyph Animation 3

Please start the Power Point Slide Show to activate the animation

Animation: Texas Convection anaglyph imagery

2101UTC 4th June to 0301UTC 5th June 2019 (5frames per second)

image from Wikipedia



d by Embry-Riddle Aeronautical University

Please start the Power Point Slide Show to activate the an

Animation: Thunderstorms north of Puerto

2002UTC 15th February to 0047UTC 16th February 201

(5FPS rocking animation, visible to enhanced infrared transition)

image from Wikipedia

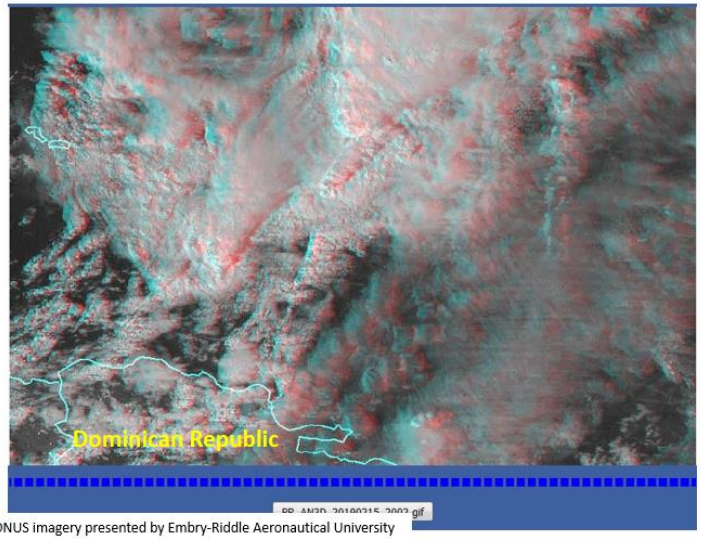


image from CONUS imagery presented by Embry-Riddle Aeronautical University

tart the Power Point Slide Show to activate the animation

lf of Mexico Thunderstorms

o 2242UTC 23rd January 2019

(5FPS rocking animation, visible to enhanced infrared transition)

image from Wikipedia

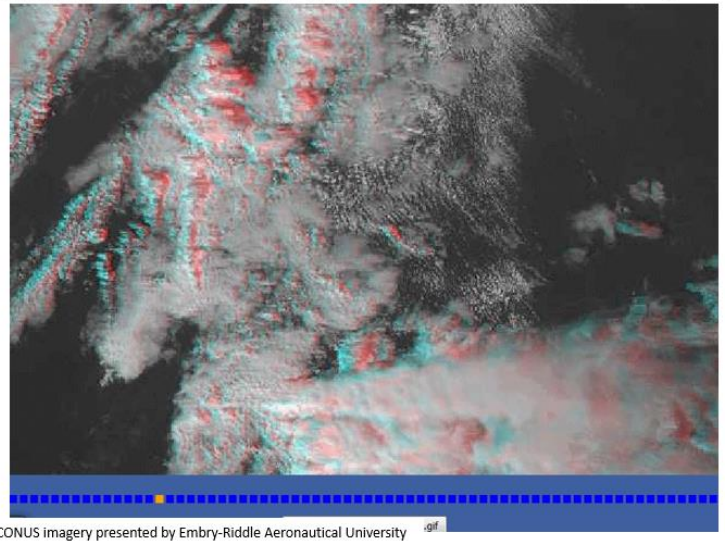
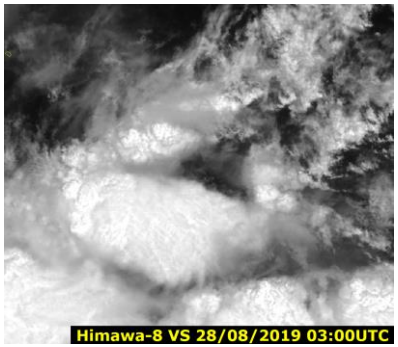


image from CONUS imagery presented by Embry-Riddle Aeronautical University

Various ways of presenting 3D stereo satellite imagery



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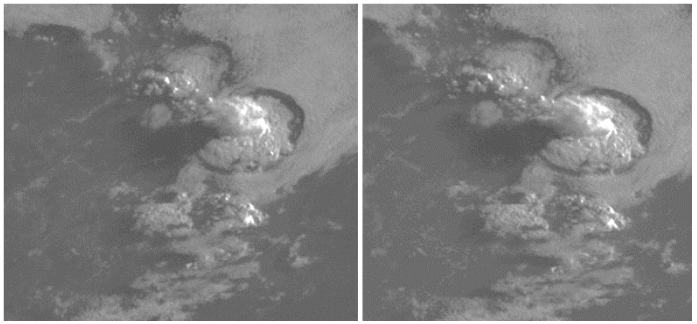

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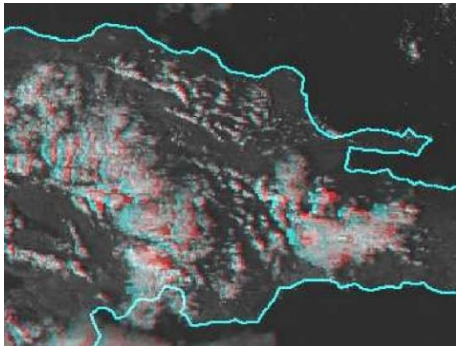

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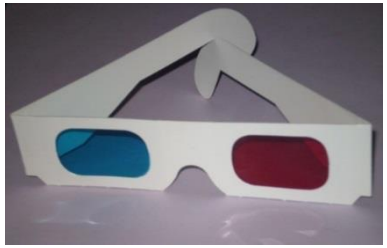

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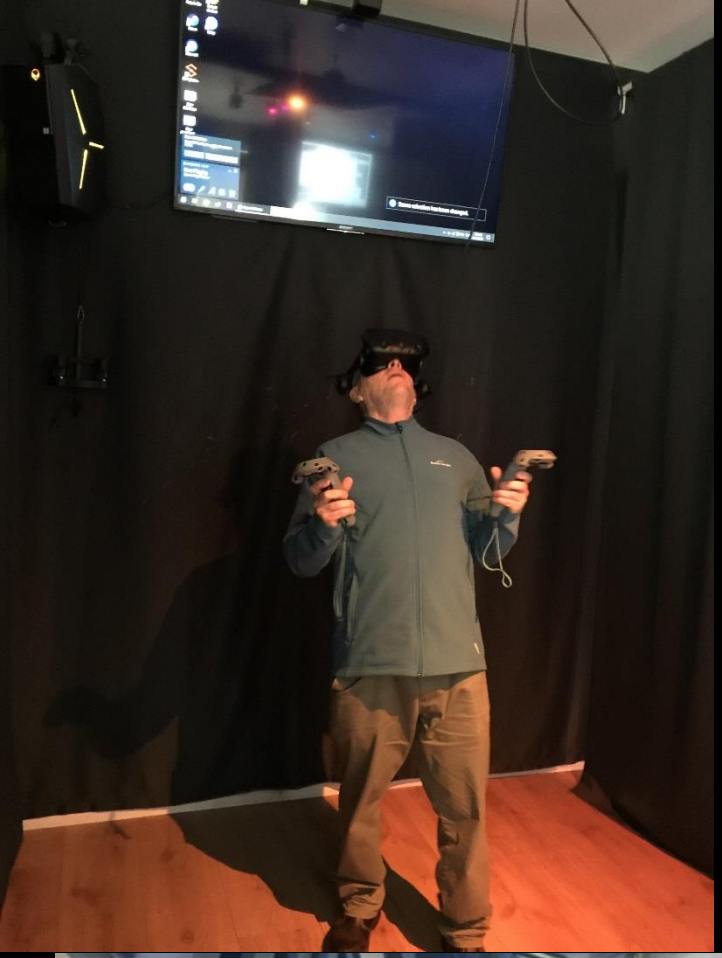


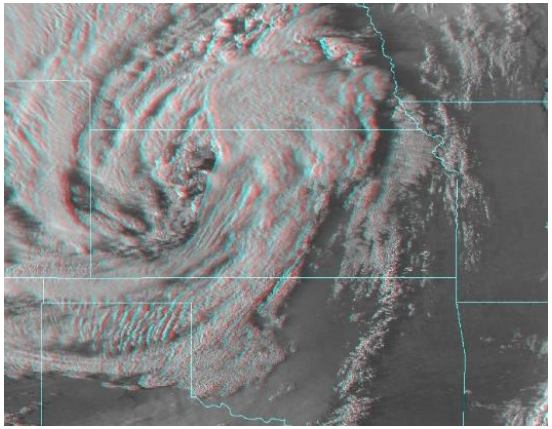
image from Google Earth

Method 4 analogy: Virtual Reality exercise

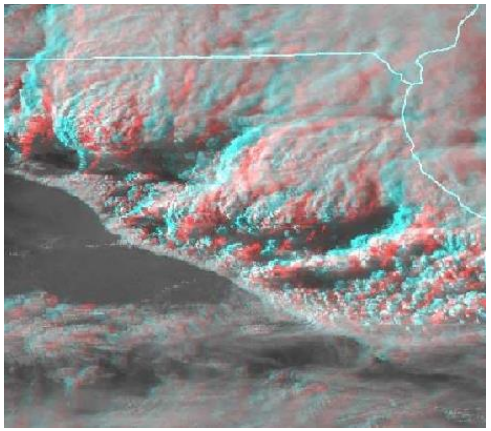
image from Viri Virtual Reality Melbourne facebook post

anaglyph images from CONUS imagery presented by Embry-Riddle Aeronautical University

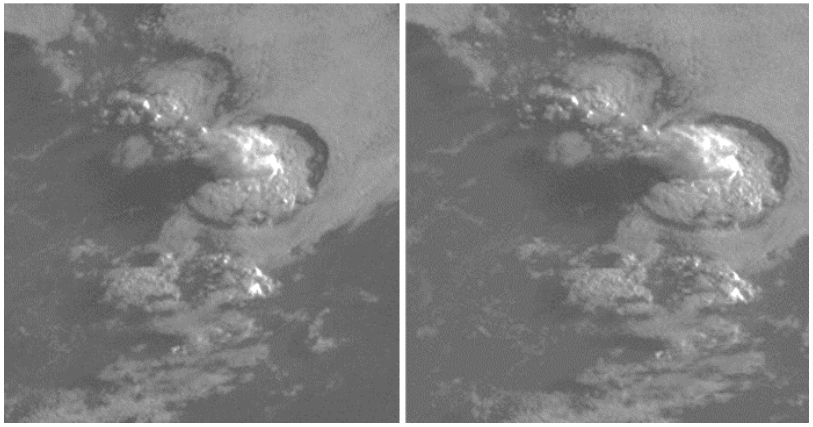
Advantages in using 3D stereo satellite imagery



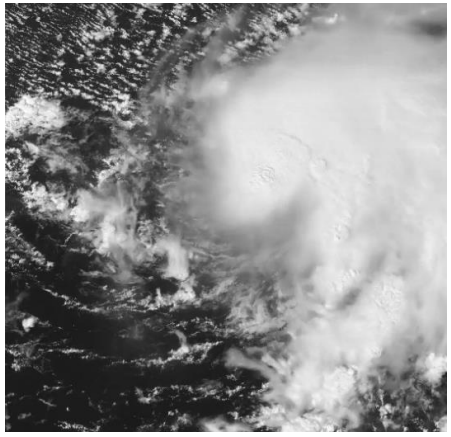
Analysing multilayer cloud, superior AMV's



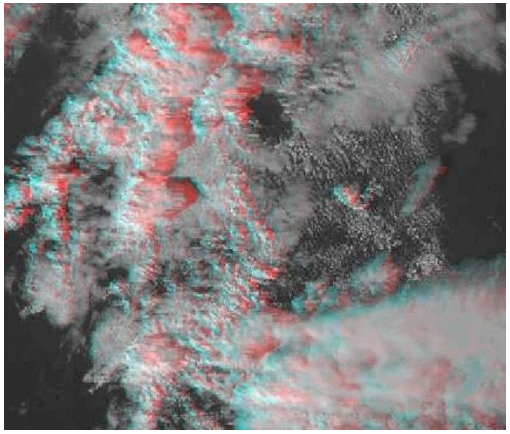
Analysing the interaction between low and upper levels of the atmosphere



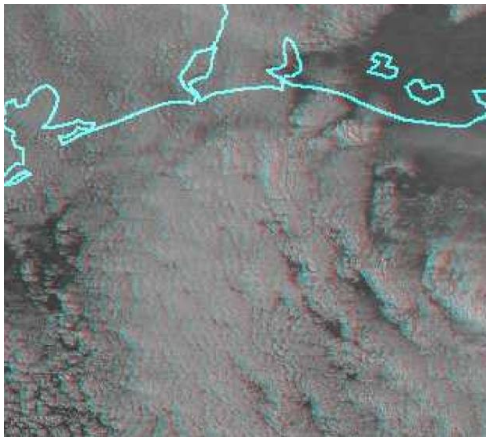
Analysing vertical motion of developing thunderstorms



Analysing atmospheric shear and trends in these



Better monitor low cloud below broken higher cloud

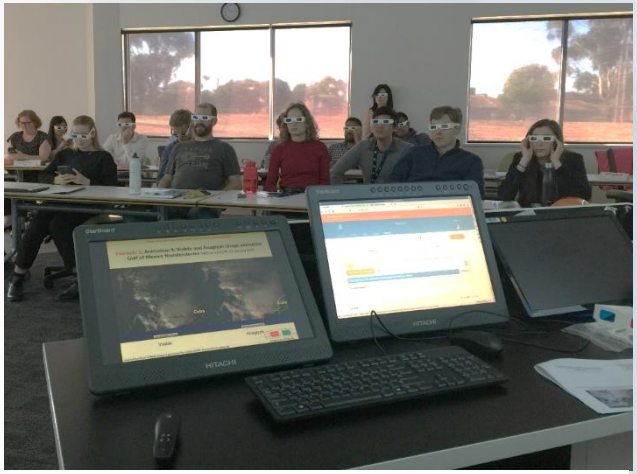


Detection of minor variations in height for oceanic cellular convection

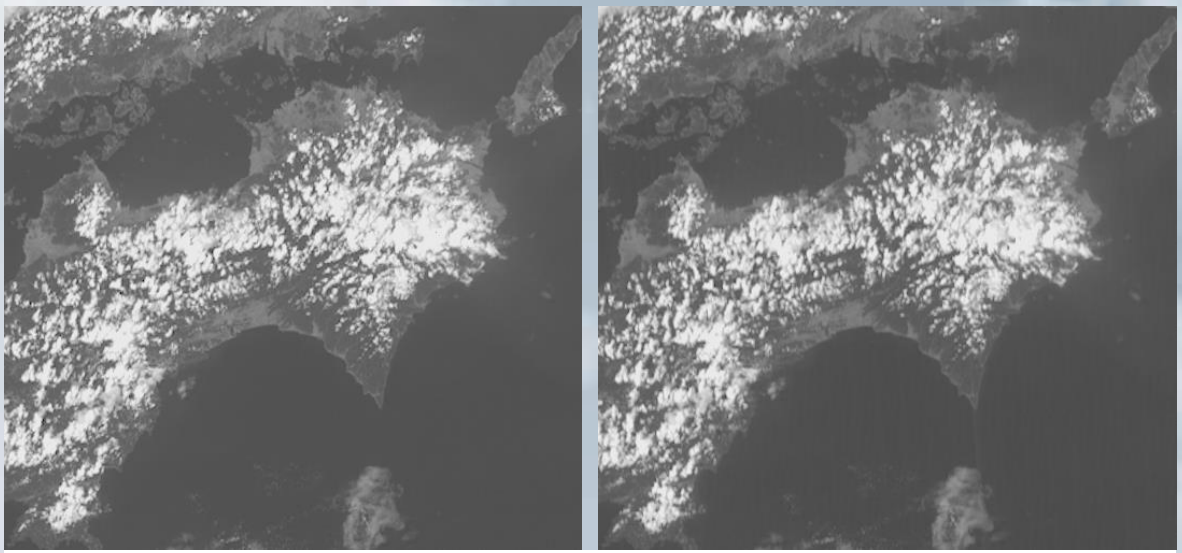
Non-anaglyph images from CIMSS Satellite Blog, case studies produced by Scott Lindstrom SSEC

Suggested use of 3D stereo satellite imagery within a meteorological forecasting / training centre

Selective use by severe weather forecasters to gain greater insight into a difficult situation



Enhanced teaching of meteorological principles to Trainee Meteorologists



Normal animation and Wiggle 3D animation in two panel display

Australian Government
Bureau of Meteorology

Summary

- The constellation of geostationary satellites over our region
- Utilising limb effects for enhanced forecaster monitoring
- Introducing the 3D stereo satellite imagery utilising Himawari-8, Geo-KOMPSAT 2A, GOES-16 and 17 data