Australian VLab Centre of Excellence Regional Focus Group meeting
30 March 2021

Summary of work conducted on 3D stereo satellite imagery by the Australian VLab CoE

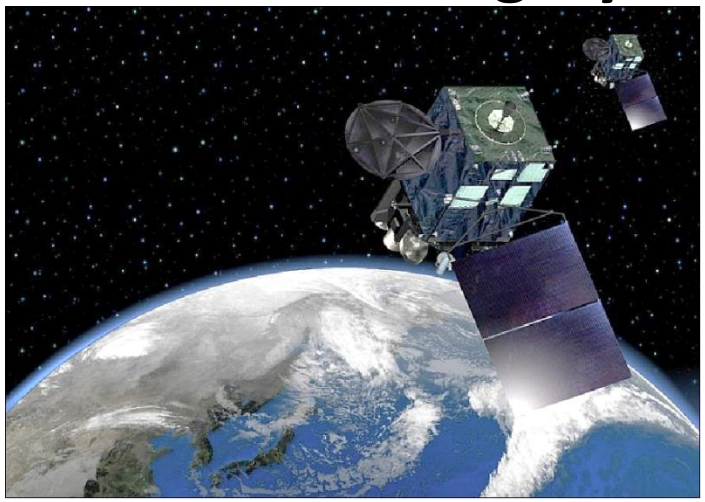
Bodo Zeschke Australian VLab Centre of Excellence Point of Contact

…some slides not shown…

Utilisation of Himawari-8 and GEO-KOMPSAT-2A data in combination for 3D stereo satellite imagery

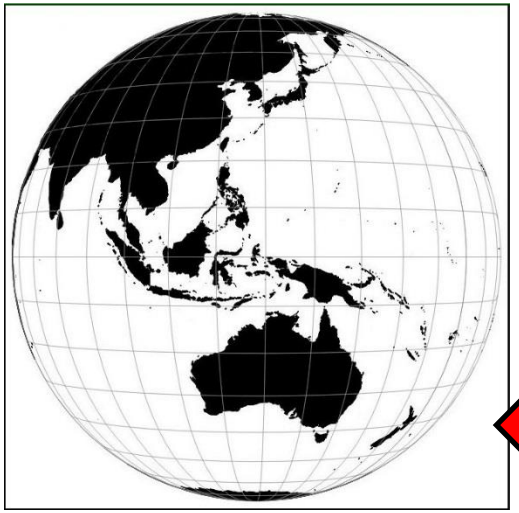
image from JMA

image from KARI



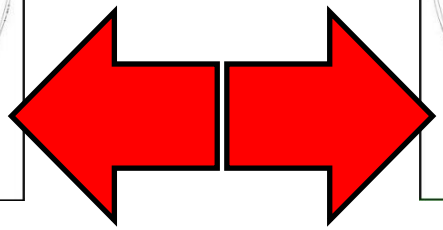
GEO-KOMPSAT-2A located at 128.2E

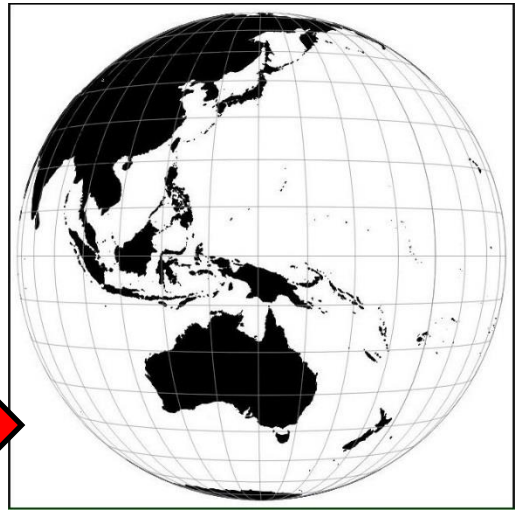
Himawari-8 located at 140.7E,



Separation of

12. 5 degrees





…some slides not shown…

Himawari-8 and Feng-Yun 4A satellite images

High resolution visible band, thunderstorms, Queensland, 0545UTC 5th Feb 2021

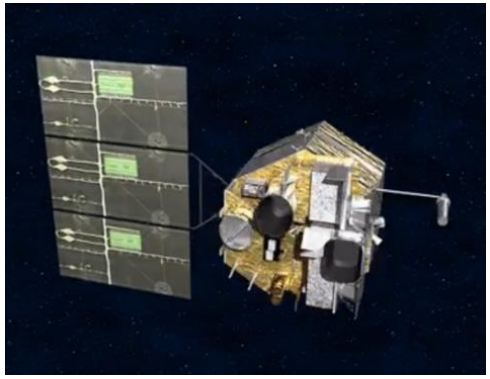


image from CMA

Feng-Yun 4A

Himawari-8

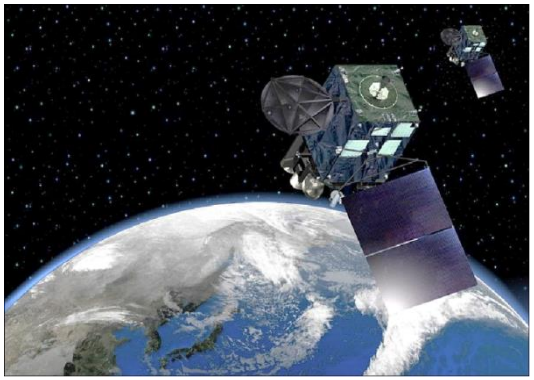
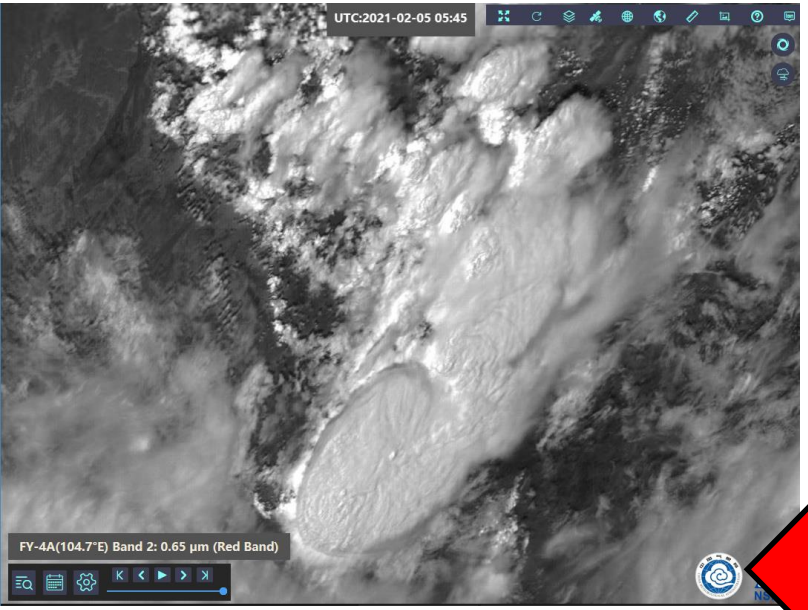


image from JMA



Separation of

35.7 degrees

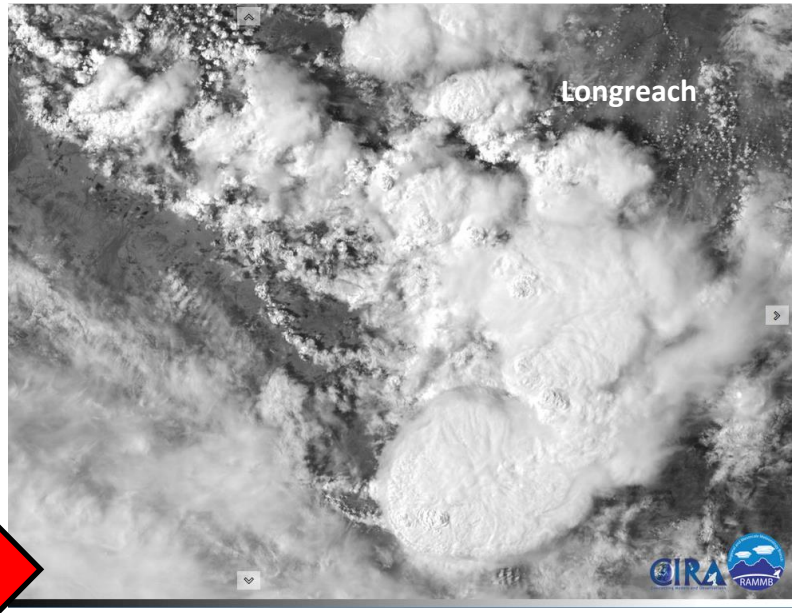


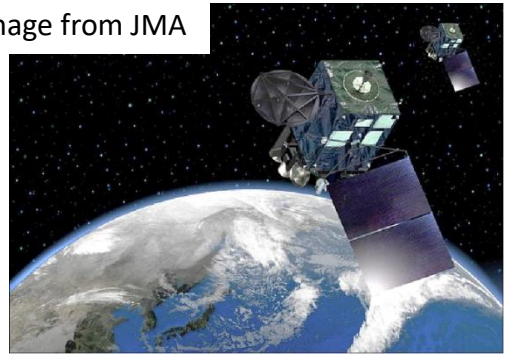
image courtesy China Meteorological Administration (CMA)

image courtesy Japan Meteorological Agency / RAMMB / CIRA

…some slides not shown…

Utilisation of Himawari-8 and GOES-17 data in combination for 3D stereo satellite imagery

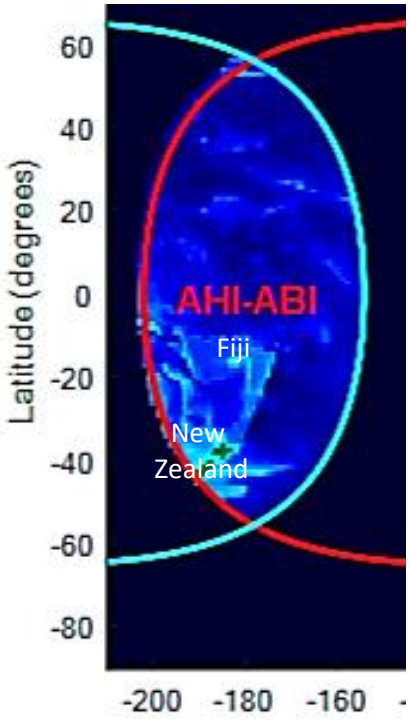
image from JMA

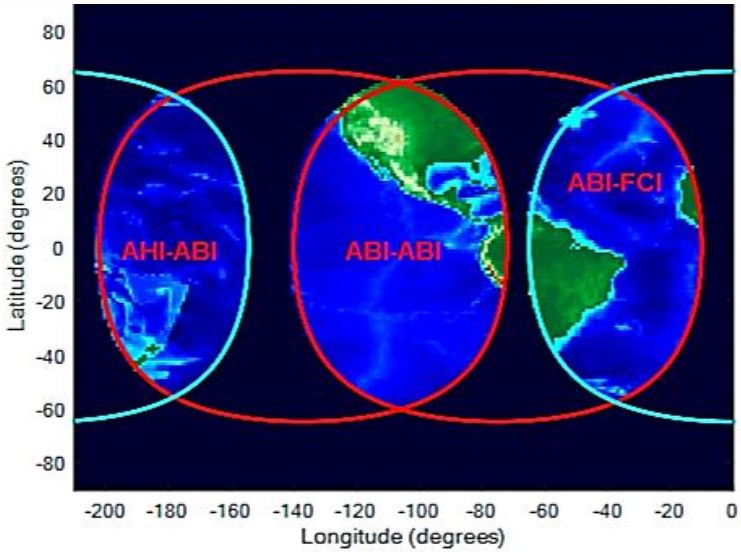


Himawari-8,

GOES-17

image from NOAA/NASA

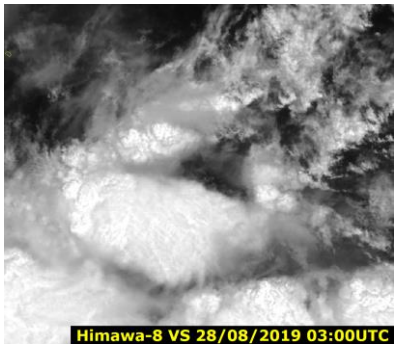




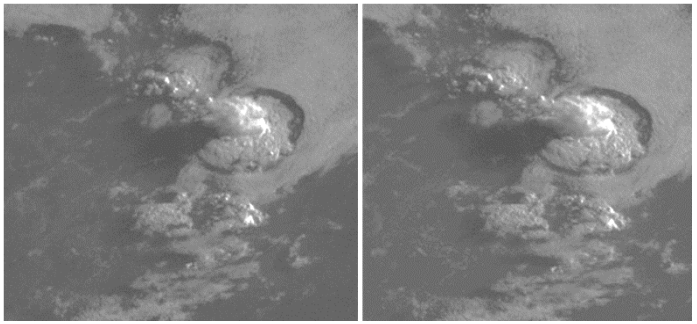
Geostationary stereo wind products are possible for the overlaps between coverage circles for each GEO (Figure 1)

Figure 1 from GEO–GEO Stereo-Tracking of Atmospheric Motion Vectors (AMVs) from the Geostationary Ring: James L. Carr, Dong L. Wu, Jaime Daniels, Mariel D. Friberg, Wayne Bresky and Houria Madani. Remote Sens. 2020, 12, 3779; doi:10.3390/rs1222377

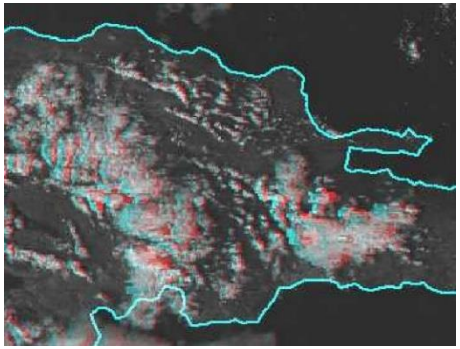
Various ways of presenting 3D stereo satellite imagery



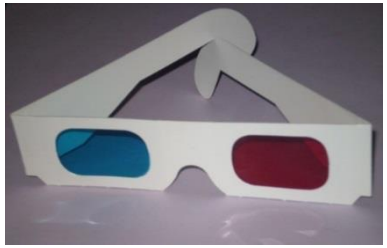
1: "3D Wiggle" animation



2: Stereo pair images
(cross eyed viewing method)



Anaglyph glasses



3: "Anaglyph"animation
(requiring viewing glasses)

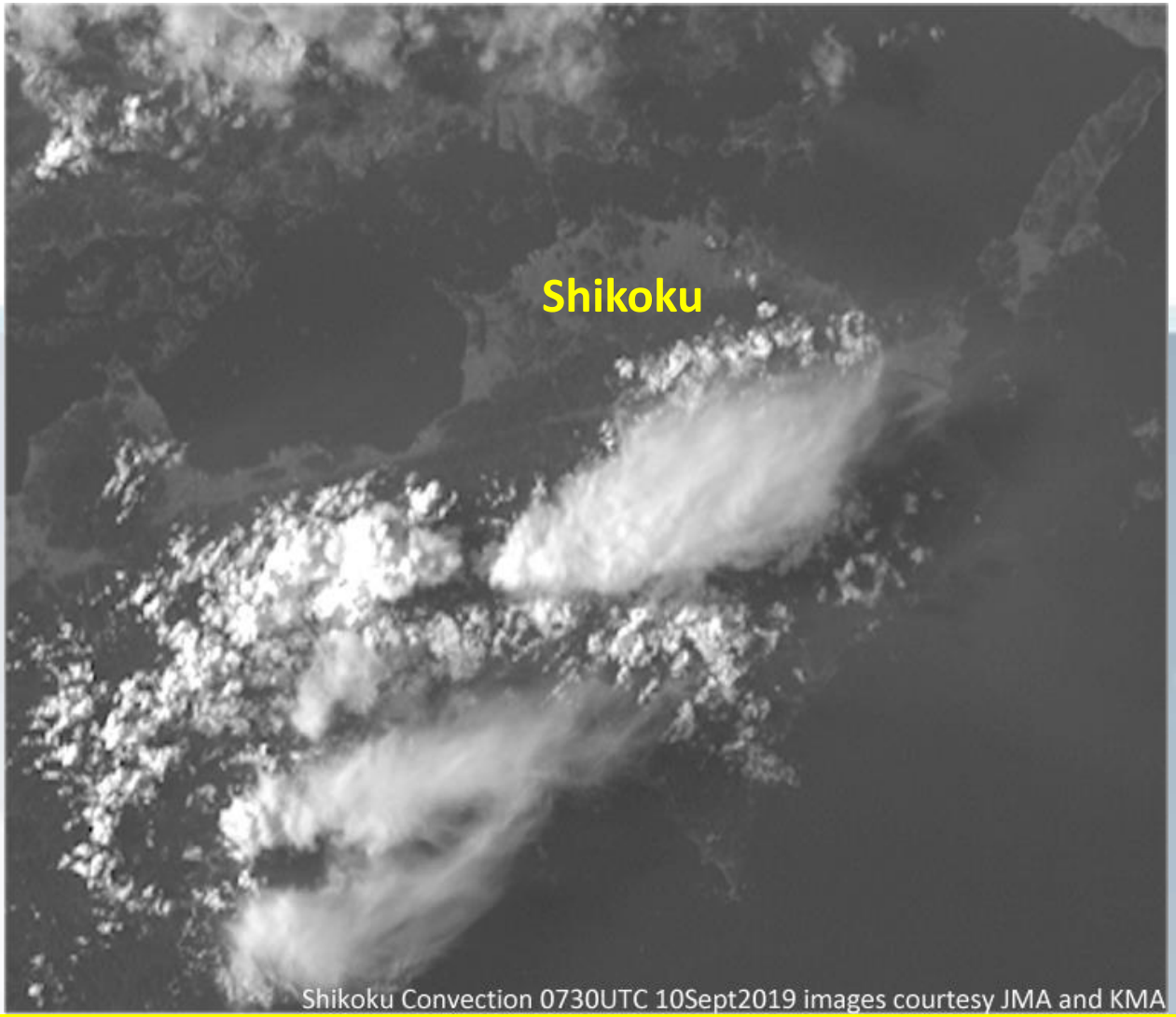
4: 2 panel image animation played on Smartphone and rendered in a viewer
(eg. Google Cardboard).

animation courtesy Korea Meteorological Administration / Japan Meteorological Agency

Animation: 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

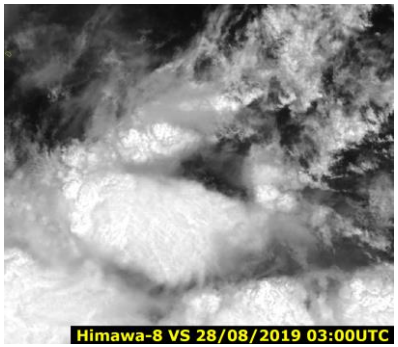


animation at

http://www.virtuallab.bom.gov.au/index.php/download_file/view/1458/301/

Please start the Power Point Slide Show to activate the animation

Various ways of presenting 3D stereo satellite imagery



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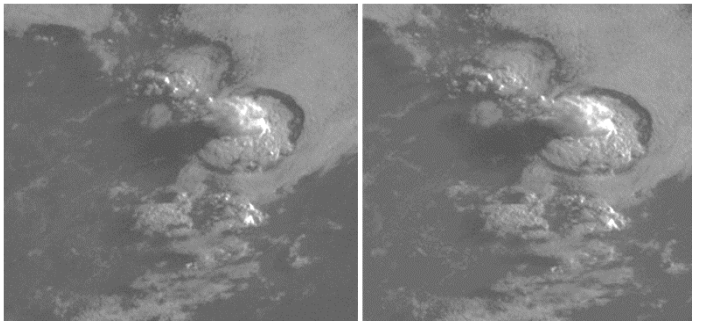

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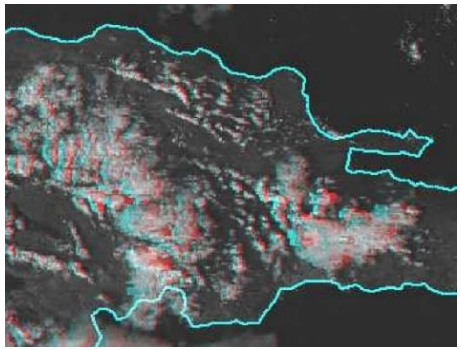
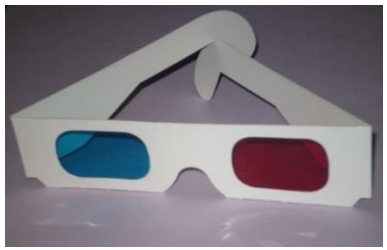


Anaglyph glasses



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

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

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

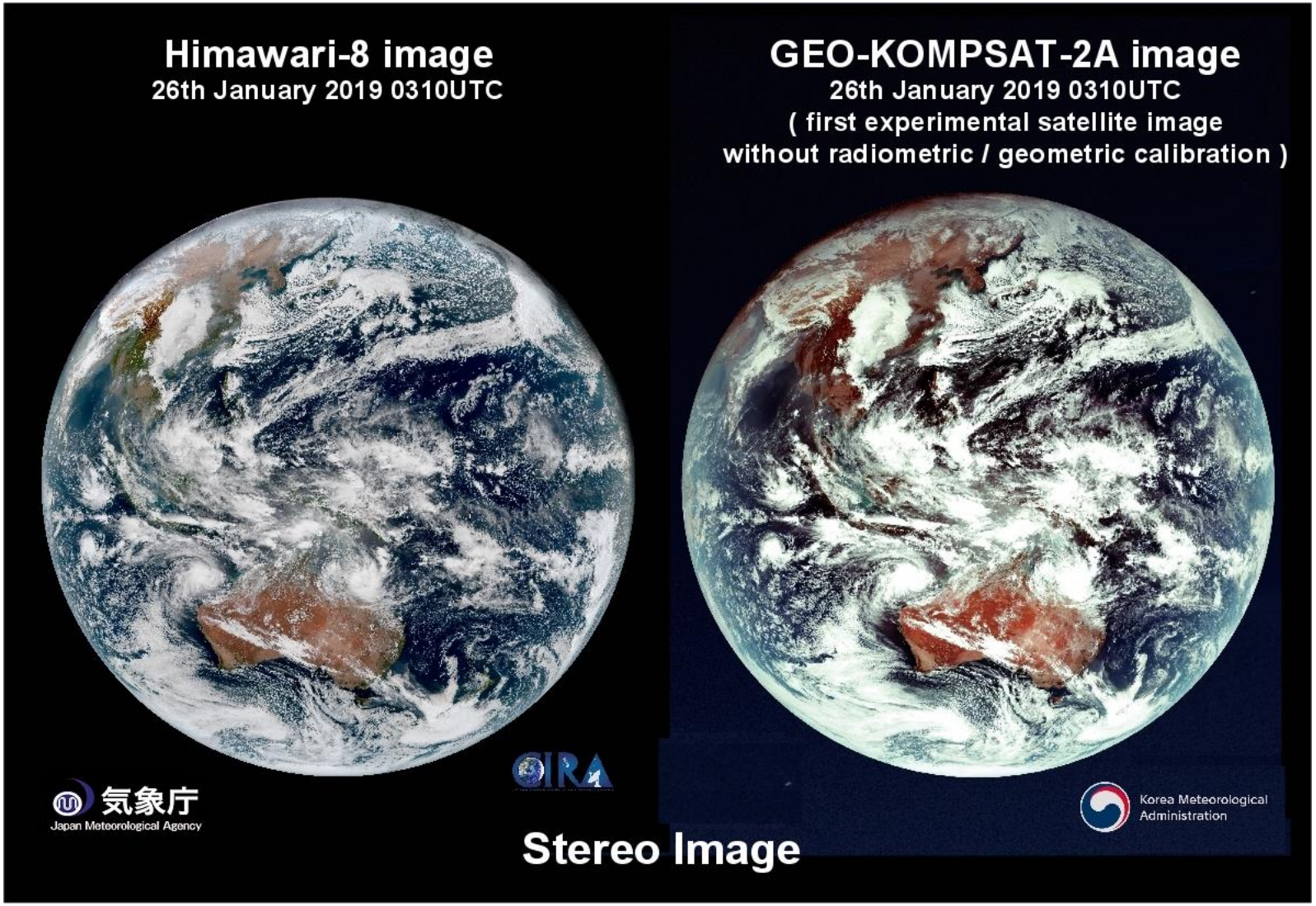
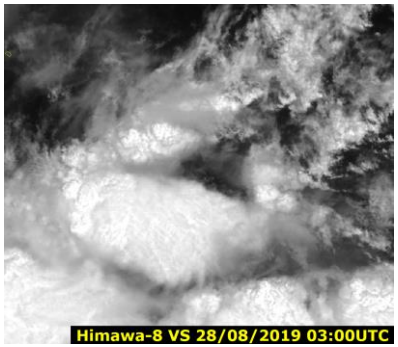


image pair courtesy Bodo Zeschke, Australian Bureau of Meteorology ; Himawari image courtesy JMA ; GK2A image courtesy KMA and Dr. Hyesook Park. GEOKOMPSAT-2A is also known as Chollian-2a

Various ways of presenting 3D stereo satellite imagery



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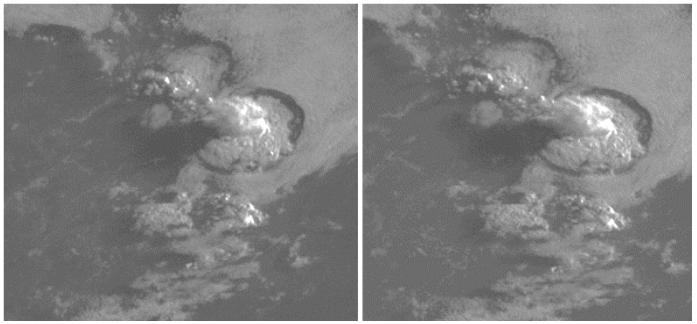

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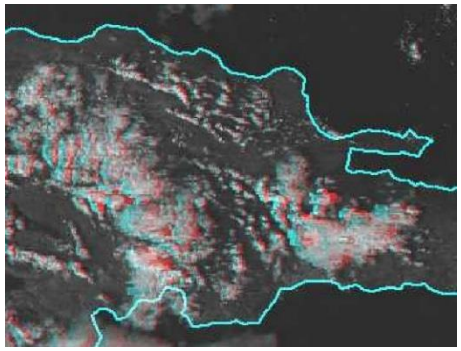
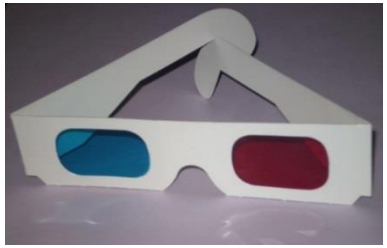


Anaglyph glasses

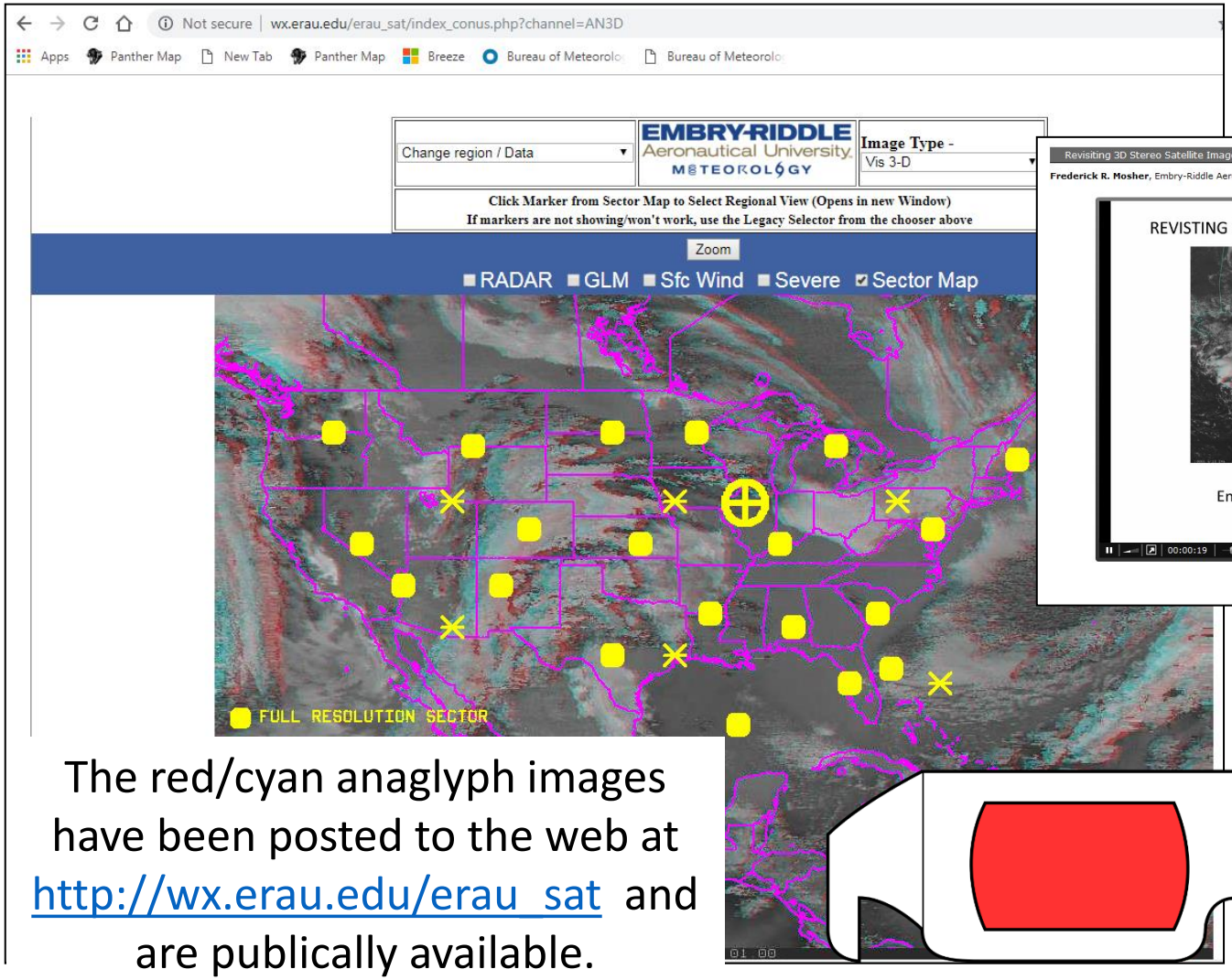


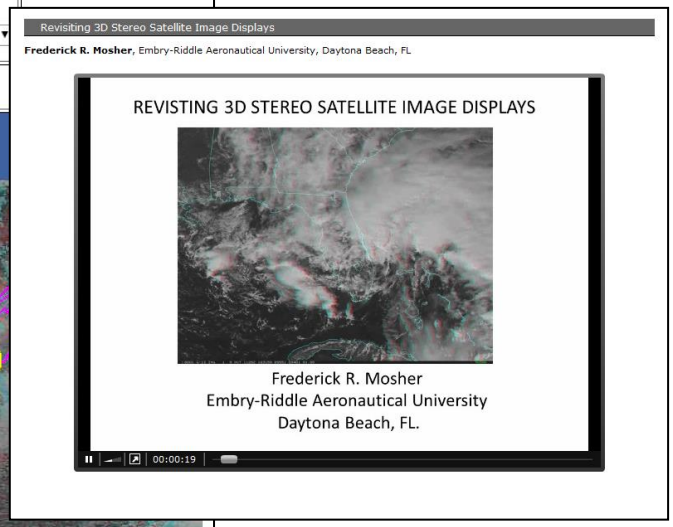
3: "Anaglyph"animation
(requiring viewing glasses)

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

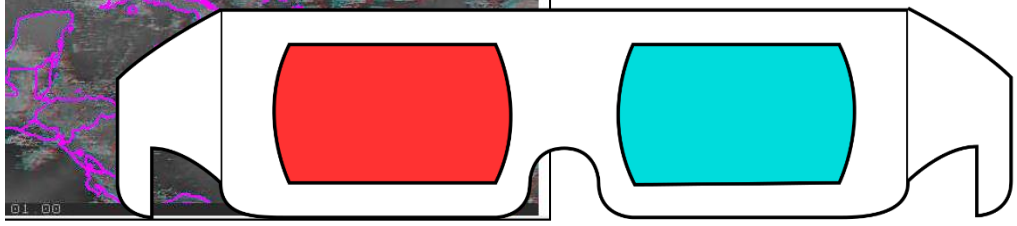
An online source of 3D "anaglyph" images over the CONUS domain,

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.



Examples of these types of Stereo Satellite Imagery

"3D Wiggle" animation **(please view these animations carefully and desist if it feels uncomfortable)**

http://www.virtuallab.bom.gov.au/index.php/download_file/view/1458/301/

http://www.virtuallab.bom.gov.au/index.php/download_file/view/1543/278/

Stereo pair images (cross eyed viewing method)
https://cimss.ssec.wisc.edu/satellite-blog/archives/31559
https://cimss.ssec.wisc.edu/satellite-blog/archives/28920

"Anaglyph"animation (requiring viewing glasses)
http://www.virtuallab.bom.gov.au/index.php/download_file/view/1461/301/
http://www.virtuallab.bom.gov.au/index.php/download_file/view/1464/301/
http://www.virtuallab.bom.gov.au/index.php/download_file/view/1465/301/

RESERVE

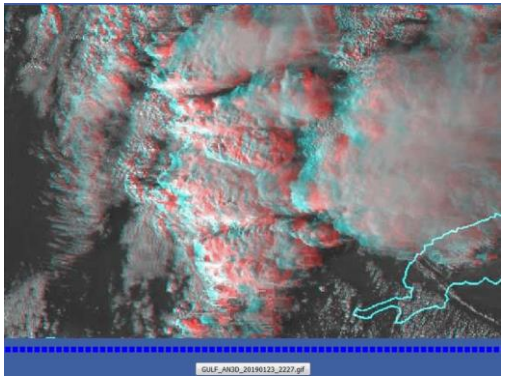
…some slides not shown…

BMTC Student and Forecaster feedback

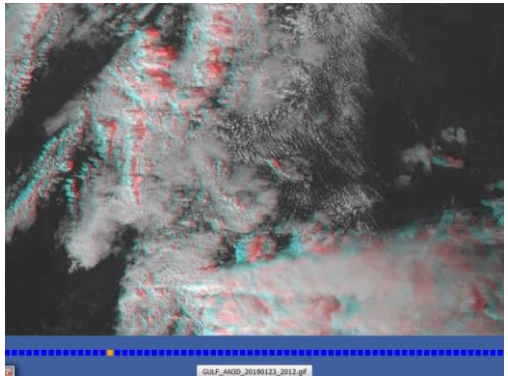
- The Anaglyph imagery was the most popular
- The stereo pair image cross-eyed viewing method was the least popular.
- Fast animations using the Wiggle 3D imagery can induce "Flicker Vertigo" (the Bucha effect)
- The Most students preferred the more rapid animation of 5 frames per second in rocking motion for viewing the stereo imagery.
- It is useful to have the Wiggle 3D image animation next to a normal 2d animation of the same scene.
- Animations best viewed from some distance away using anaglyph glasses.
- For Anaglyph imagery: A good technique is to close the left eye to see the flat image in blue and then open eye and see the contrast between 2D and 3D.

BMTC Student and Forecaster feedback

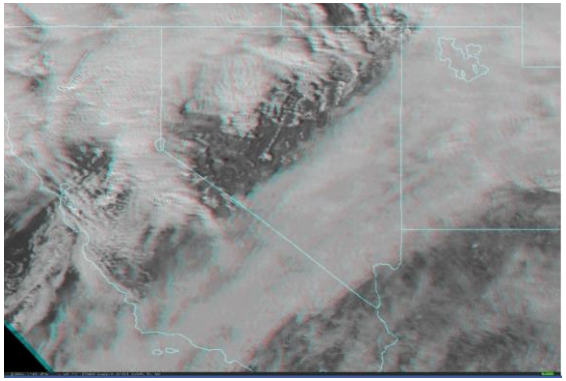
Feedback included examination of the following anaglyph image animations of the CONUS and adjacent regions.



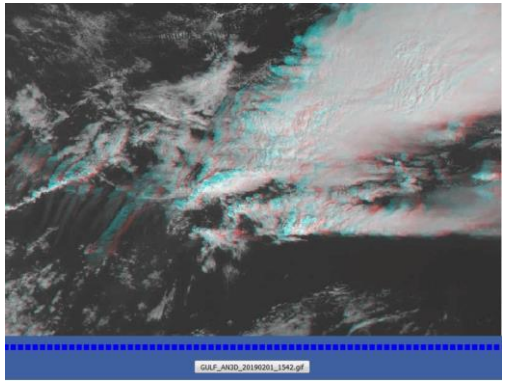
Example 1: Anaglyph image animation
Gulf of Mexico thunderstorms
1902 to 2247UTC 23 January 2019



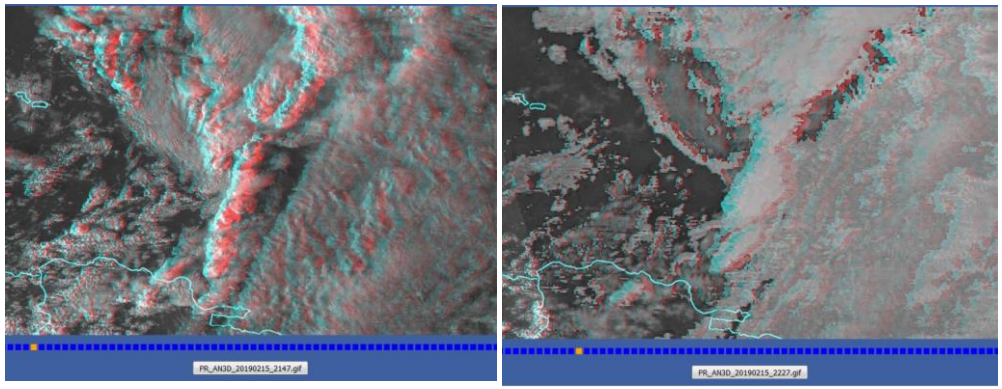
Example 2: Anaglyph image animation
Gulf of Mexico thunderstorms
2012 to 2242UTC 23 January 2019



Example 3: Anaglyph image animation of stratiform cloud with frontal feature intruding. California, Nevada January 2019



Example 4: Anaglyph image animation
Gulf of Mexico thunderstorms
1st February 2019



Example 5: Anaglyph image animation, visible to infrared image transition, thunderstorms north of Puerto Rico
2002UTC 15th February to 0047UTC 16th February 2019

from the Embry-Riddle Aeronautical University Meteorology Vis 3-D near real time animations of the CONUS and adjacent areas.
Website at http://wx.erau.edu/erau_sat/index_conus.php?channel=AN3D

BMTC Student and Forecaster feedback:
Advantages in using 3D imagery (part 1)

of the CONUS and adjacent regions.

A better definition of the vertical structure of the atmosphere, for example:

- **A better rendering of the relative heights of clouds and other atmospheric features when these are animated,**
- **Quicker subjective estimation of relative heights of clouds**
- **Recognition of the "stacking of clouds"**
- **Improved detection of layered features along cloud boundaries and gust fronts,**
- **See the sides of clouds and not just the tops**
- **Improved detection of the sharpening of cloud boundaries.**
- **Better defines edges and bits of cloud, tiny cloud elements.**

Gulf of Mexico thunderstorms
1st February 2019

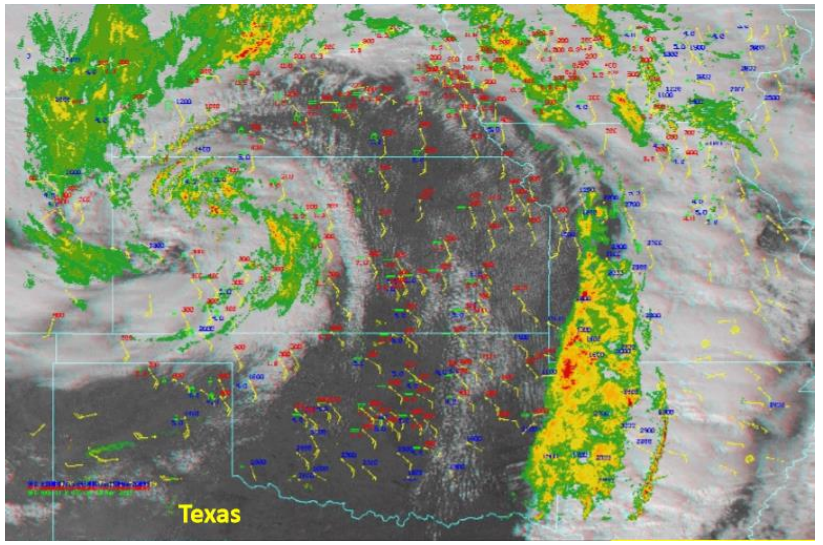
transition, thunderstorms north of Puerto Rico
2002UTC 15th February to 0047UTC 16th February 2019

from the Embry-Riddle Aeronautical University Meteorology Vis 3-D near real time animations of the CONUS and adjacent areas.
Website at http://wx.erau.edu/erau_sat/index_conus.php?channel=AN3D

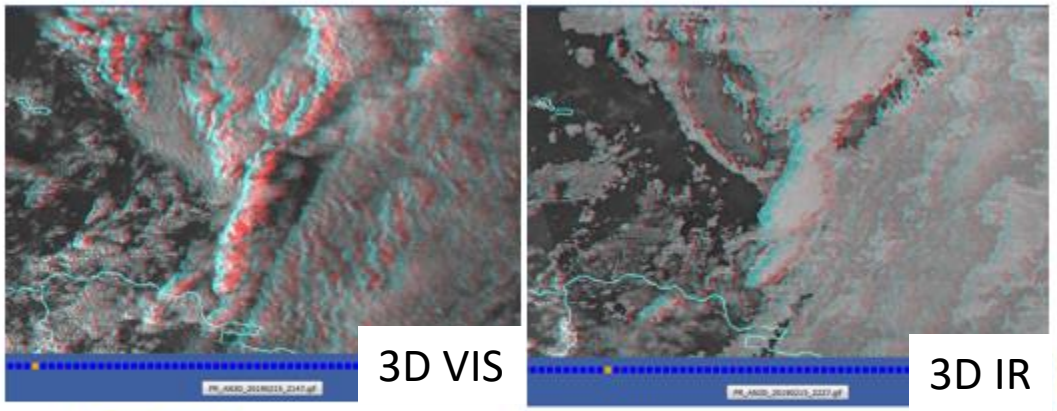
…some slides not shown…

BMTC Student and Forecaster feedback:
Challenges and limitations in using 3D imagery (part 2)

- **Superposition of 2D rendered NWP and RADAR data onto the 3D stereo satellite data and loss of the 3D effect of the imagery.**



- **IR imagery having distinct greyscale thresholds and rendered in 3D stereo view:** Imagery appears like "stacked pancakes" rather than 3D entities.



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