The 101st Australian VLab Centre of Excellence Regional Focus Group meeting

28th June 2022

Bodo Zeschke Australian VLab Centre of Excellence Point of Contact

The Future of the VLab: what will the 200th Australian VLab CoE Regional Focus Group meeting, tentatively scheduled for January 2031, be like?

Contents

- Constructing a "time capsule" for the year 2031
- Important developments likely to impact Satellite Meteorology teaching in 2031
- How might the 2031 Regional Focus Group (RFG) meeting be prepared and presented?
- What topics might be presented at this RFG meeting?

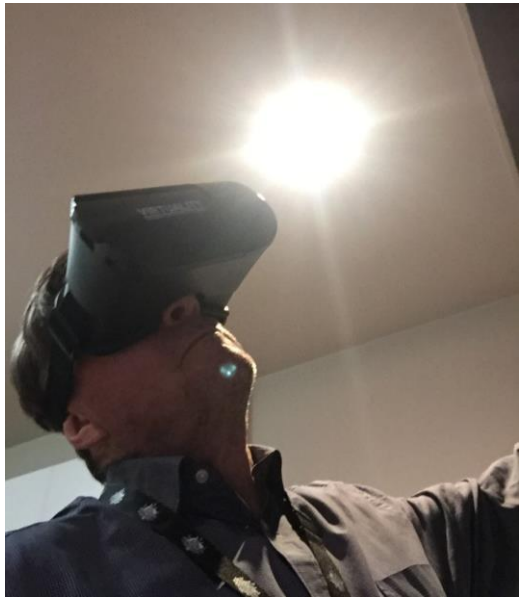
The Future of the VLab: what will the 200th Australian VLab CoE Regional Focus Group meeting, tentatively scheduled for January 2031, be like?

Contents

Constructing a "time capsule" for the year 2031: Feedback from the audience via an anonymous Socrative survey.

Conducting the RFG meeting within Virtual Reality

feedback statistics obtained from attendees



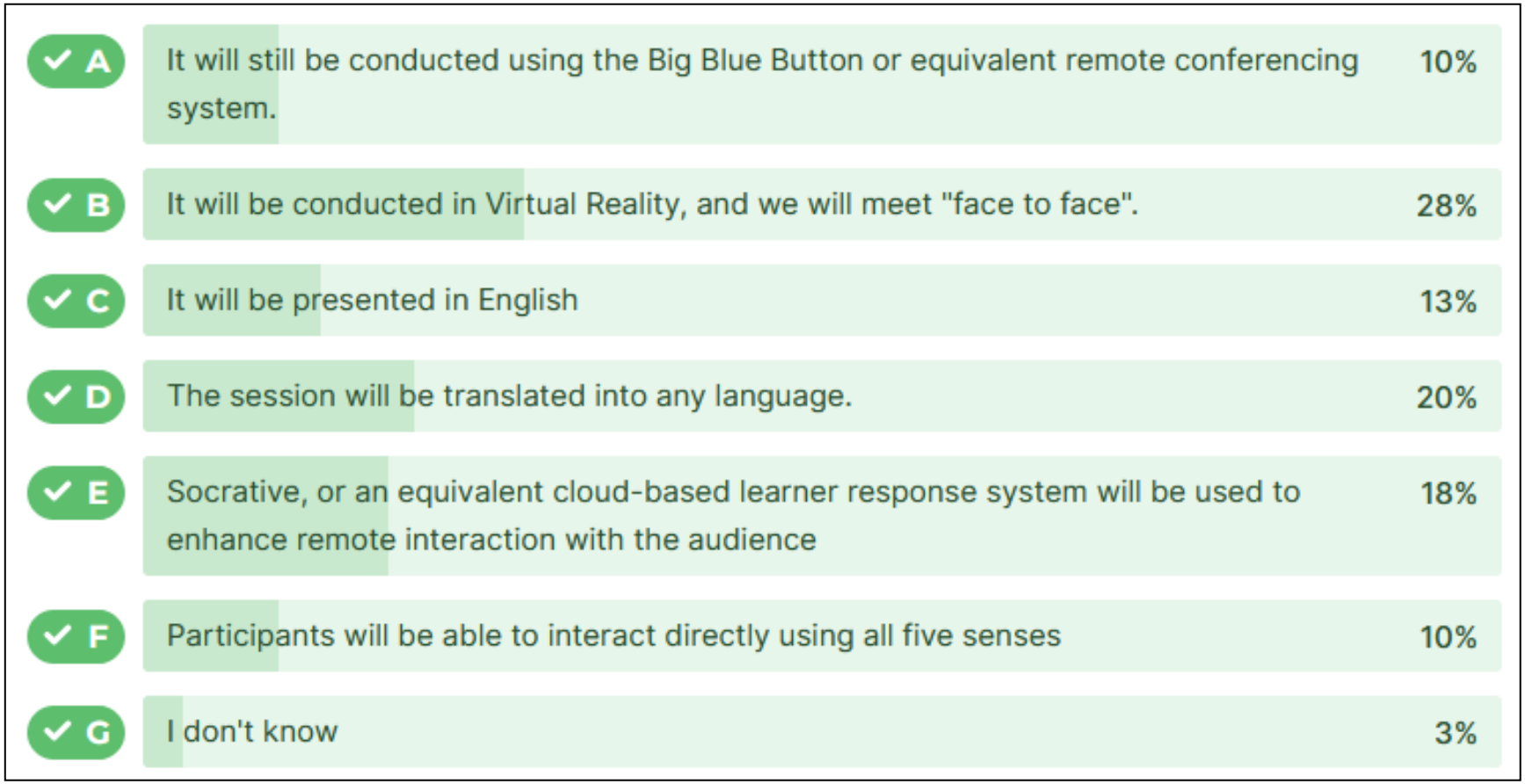
images from vTime https://vtime.net

Question: is this a realistic scenario for the year 2031?

✓ A	Yes	62%
✓ B	No	23%
✓ C	I don't know	15%

What will the **Regional Focus Group meeting in 2031** be like? Choose all that you think apply

feedback statistics obtained from attendees



Images courtesy NASA

Now for some "Apollo thinking"

"I believe that this Nation should commit itself to achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to Earth." J.F. Kennedy 1961

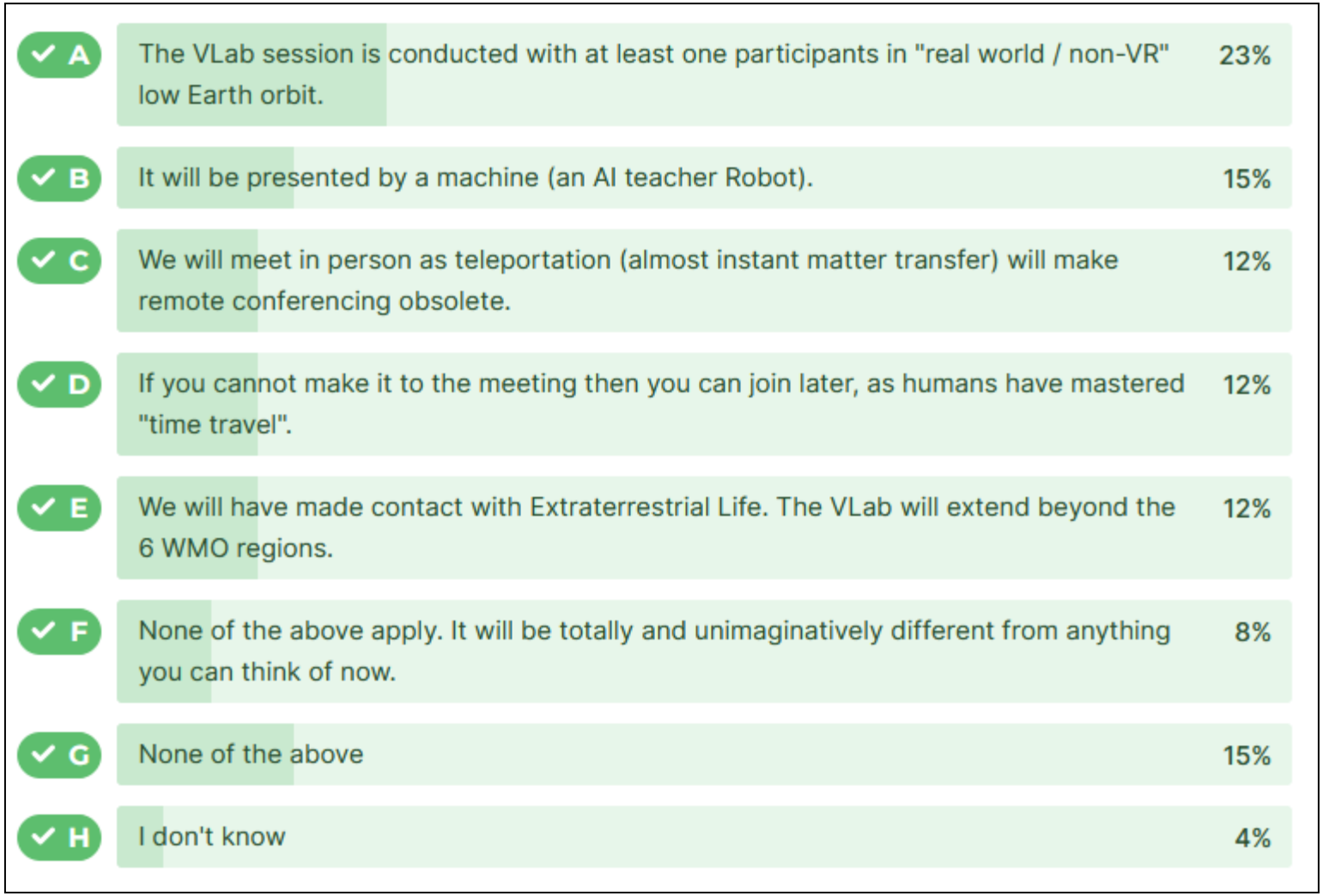
Explanation slide: the reasoning for the following very ambitious question

- I noted that the time frame of JF Kennedy's speech in 1961 and the end of the decade is about the same as the time from now to 2031.
- In this context:
  - The first two options are extensions of current developments i.e., opening space up to private citizens and the increasing role of AI and robotics in our world
  - The next two options aim to free us from the "shackles of space and time". For reference, I note that the Apollo venture aimed to free astronauts from the "shackles of our Earth's gravitational field".
  - The fifth option challenges our perception that "we are all alone in the universe".
  - The sixth option leaves open the possibility of unpredictable happenings in worldly affairs that may occur between 2022 and 2031.

REFERENCE

What will the **Regional Focus Group meeting in 2031** be like? Choose all that you think apply

feedback statistics obtained from attendees



The Future of the VLab: what will the 200th Australian VLab CoE Regional Focus Group meeting, tentatively scheduled for January 2031, be like?

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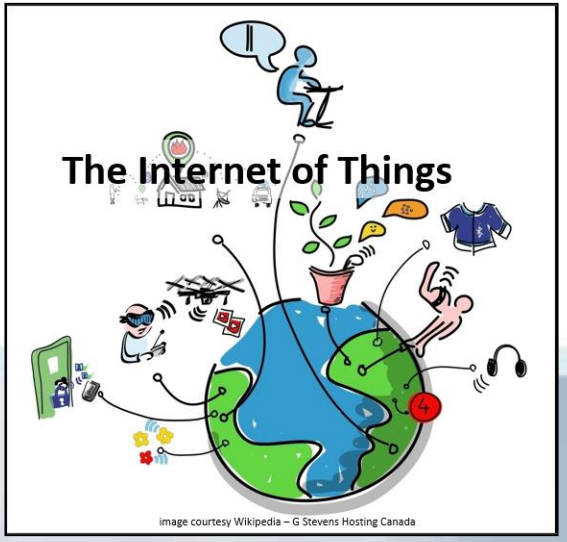
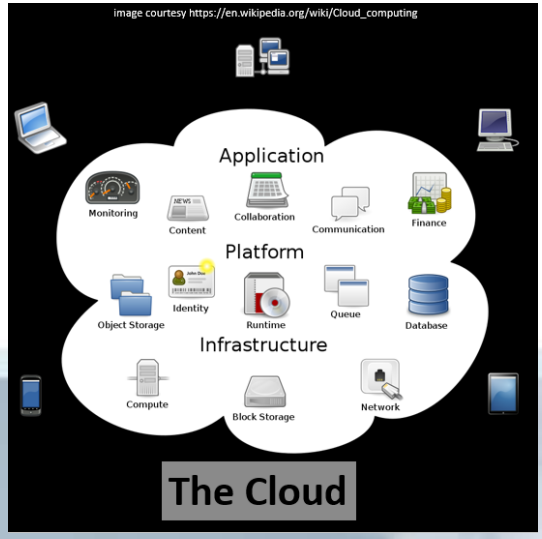
- Constructing a "time capsule" for the year 2031
- **Important developments likely to impact Satellite Meteorology teaching in 2031**
- How might the 2031 Regional Focus Group (RFG) meeting be prepared and presented?
- What topics might be presented at this RFG meeting?

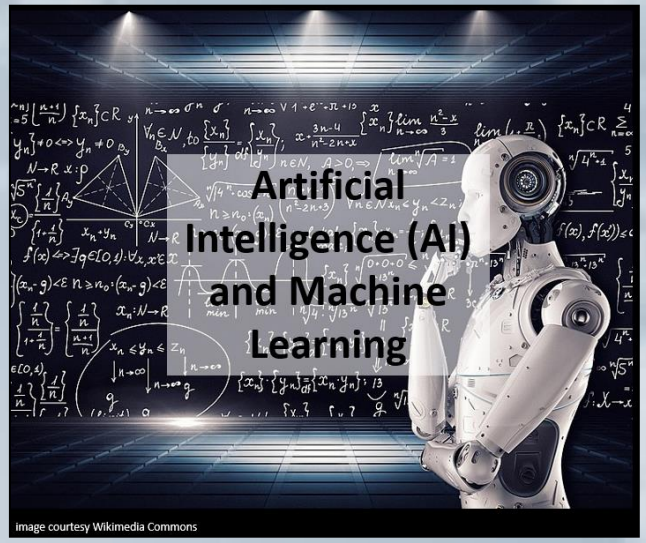
Resources referenced for this Presentation

- **Vision for WMO Integrated Global Observing System (WIGOS) in 2040** https://library.wmo.int/index.php?lvl=notice_display&id=21716
- **Five-Year Strategy for the WMO-CGMS Virtual Laboratory for Education and Training in Satellite Meteorology** http://www.wmo-sat.info/vlab/wp-content/uploads/2012/02/VLab-Strategy-2020-2024.pdf
- **VLab presentations 11th June 2020, 30th March 2021** http://www.virtuallab.bom.gov.au/archive/regional-focus-group-recordings/
- **Feedback from VLab colleagues**
- **Research papers, AOMSUC 9 and 10 contributions**
- **Internet resources, including LinkedIn and Wikipedia articles**
- **YouTube videos including TED talks**
- **My BMTC experience**
- **My own imagination!**

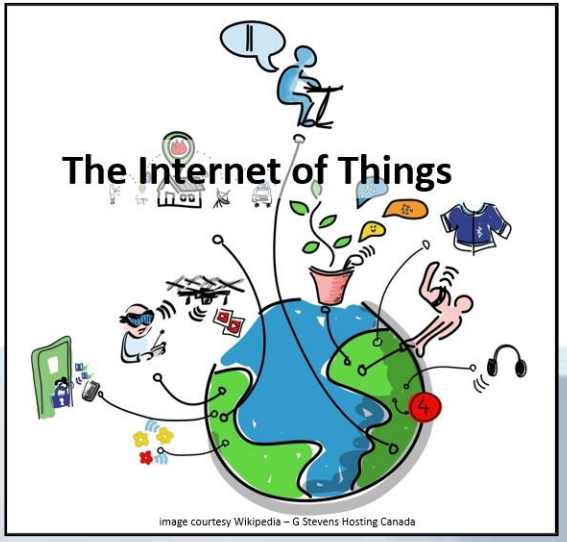
Important developments likely to impact Satellite Meteorology teaching and the VLab between now and 2031

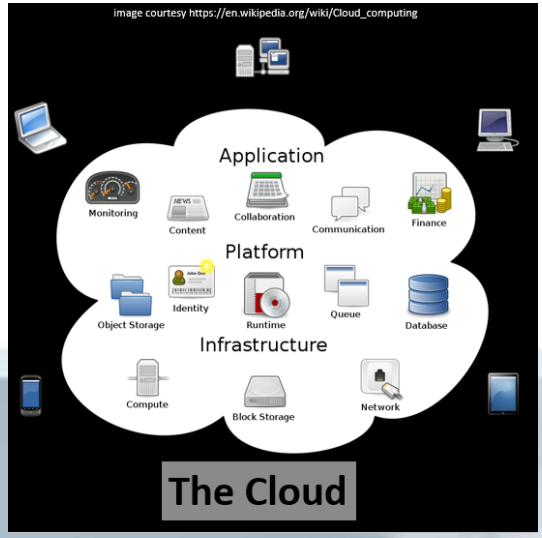


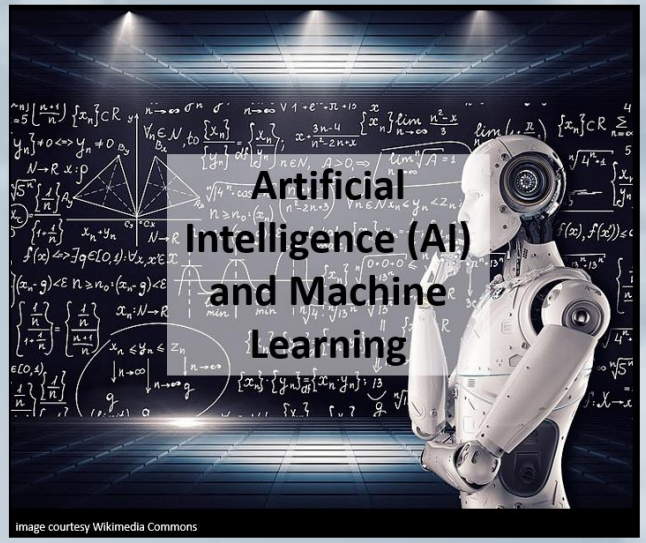




Important developments likely to impact Satellite Meteorology teaching and the VLab between now and 2031



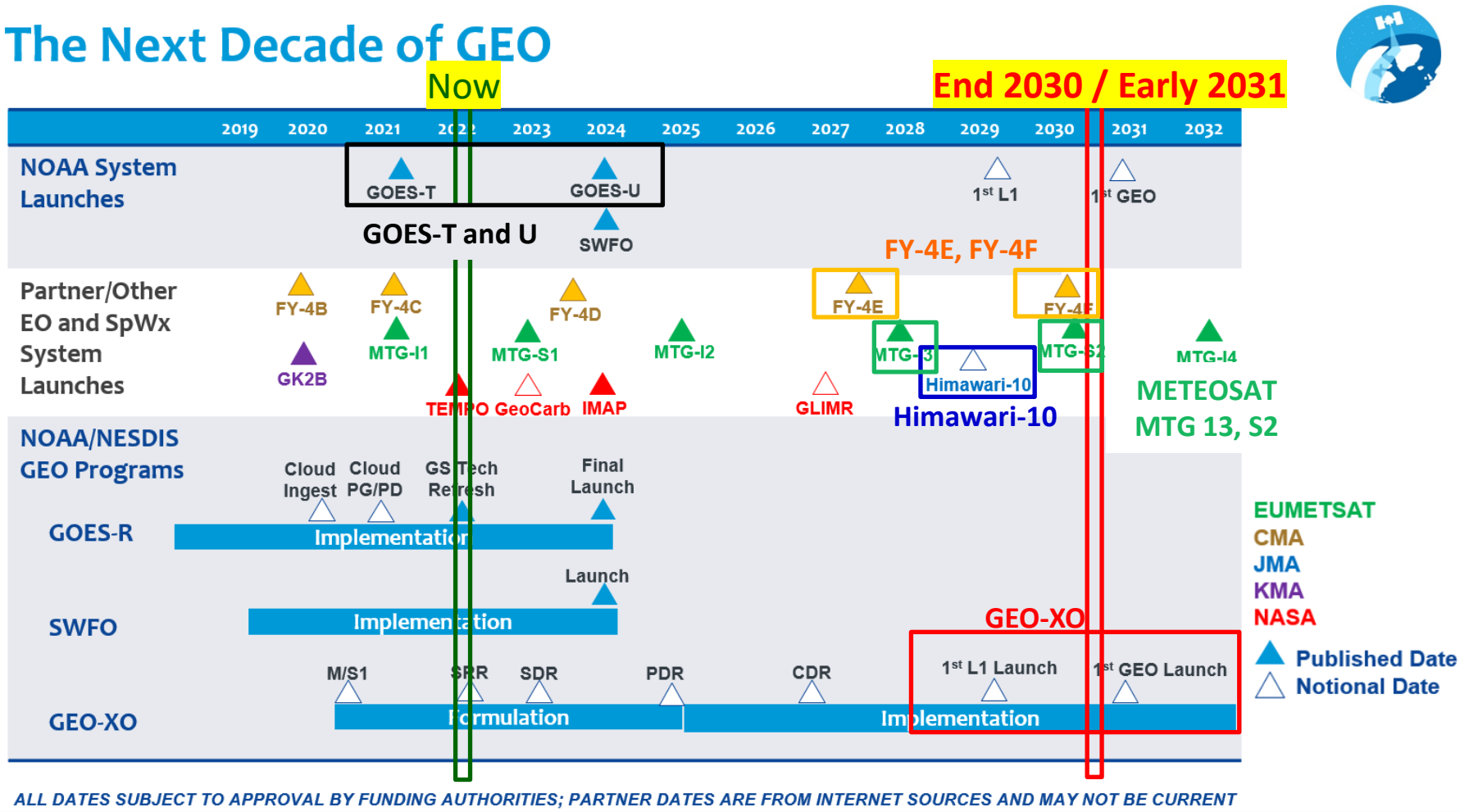




The Next Decade of GEO

(Regional Focus Group meeting June 2020, presentation by Dan Lindsey, NOAA).

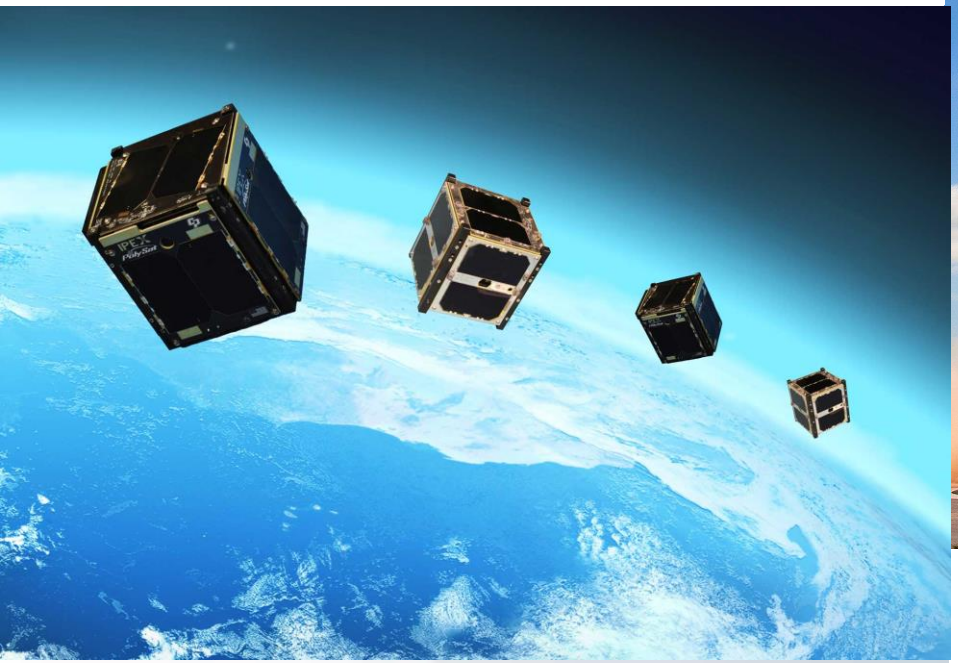
A brief summary of the Technical Interchange Teleconference between NOAA, JMA and BOM 6/7th April



http://www.virtuallab.bom.gov.au/index.php/download_file/view/1525/227/

Additional developments in satellites
Leading to a great increase in satellites

Swarms of CubeSats could be anchored by a single "hub" -- a powerful central spacecraft



CubeSats (image courtesy NASA / JPL)

Increasing involvement by the Private Sector: reducing costs

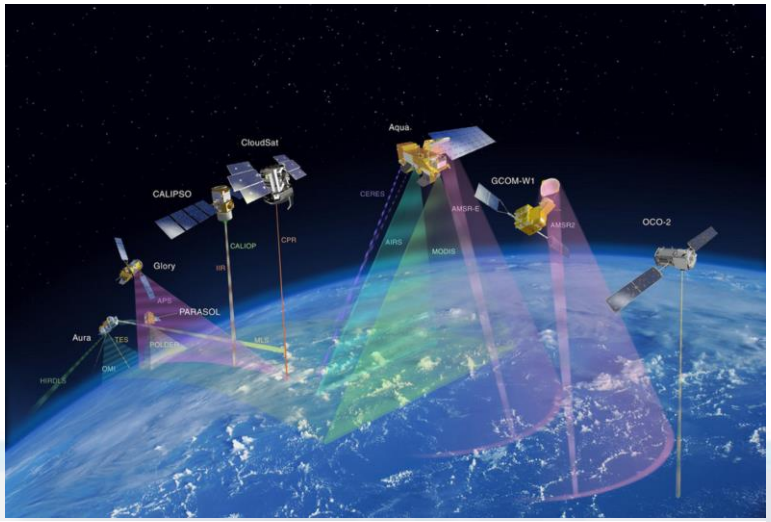
(image courtesy Wikipedia)

Explanation slide: the Next Decade of GEO and additional developments in satellites

- These slides show the proposed GEO / XO satellites that are planned for the time to 2031 and beyond. Also, the trend for Smallsats / CubeSats and the involvement of the private sector in launching and deploying satellites.
- "For more complex missions, swarms of CubeSats could be anchored by a single "hub" -- a powerful central spacecraft that can handle complex computational tasks and data transmission back to Earth" NASA Jet Propulsion Laboratory https://www.jpl.nasa.gov/topics/cubesats
- Some estimates show that more than 100,000 satellites could orbit our planet by 2030. https://astronomy.com/news/2021/06/the-future-of-satellites-lies-in-giant-constellations
- Many of these satellites will carry instrumentation such as sounders (IR hyperspectral, UV/VIS/NIR nadir and limb), Lidar (Doppler and dual/triple frequency backscatter), sub mm imagery, RADAR altimetry, Precipitation RADARs and cloud RADARs https://library.wmo.int/index.php?lvl=notice_display&id=21716

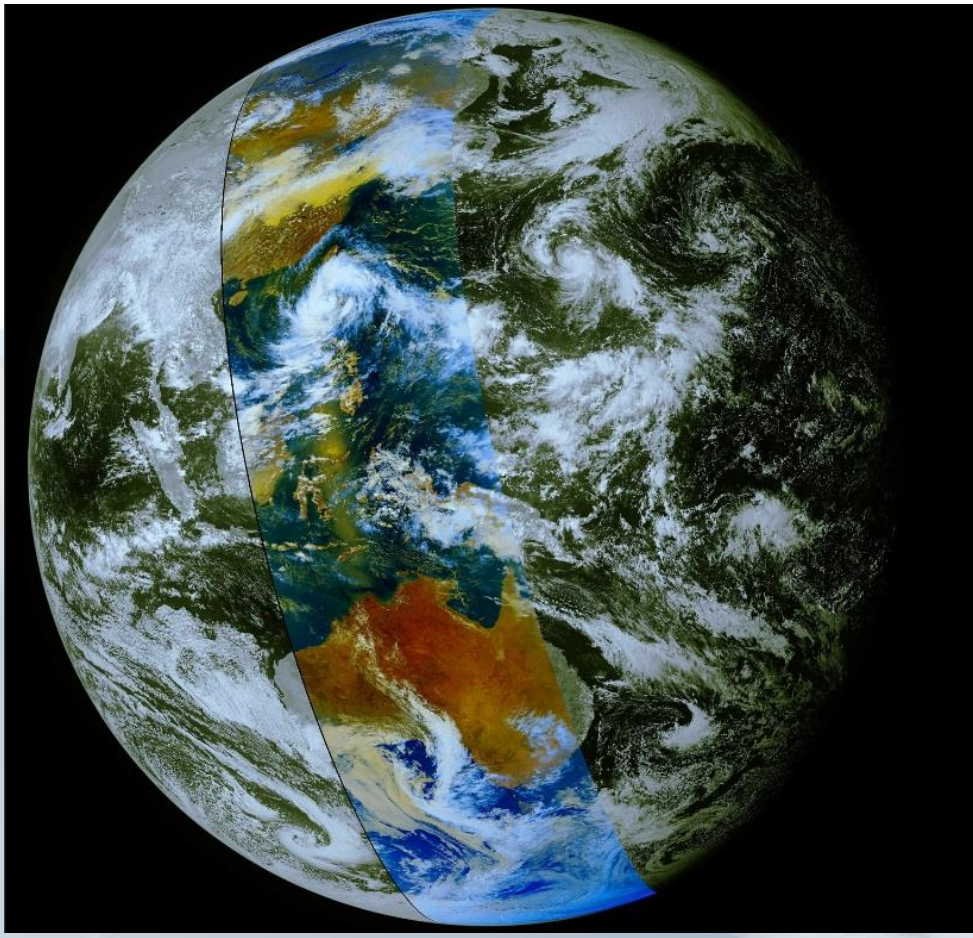
REFERENCE

Geostationary-type coverage from Low Earth Orbit (LEO)

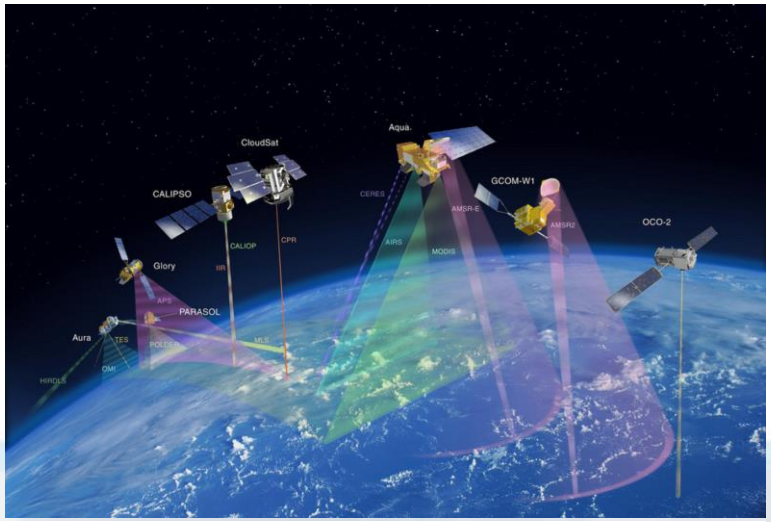


Satellite Constellations

CubeSats (image courtesy NASA / JPL)



Increased 3D stereo coverage from LEO



Satellite Constellations

CubeSats (image courtesy NASA / JPL)

Existing 3D stereo imagery utilising Geostationary satellite data

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

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

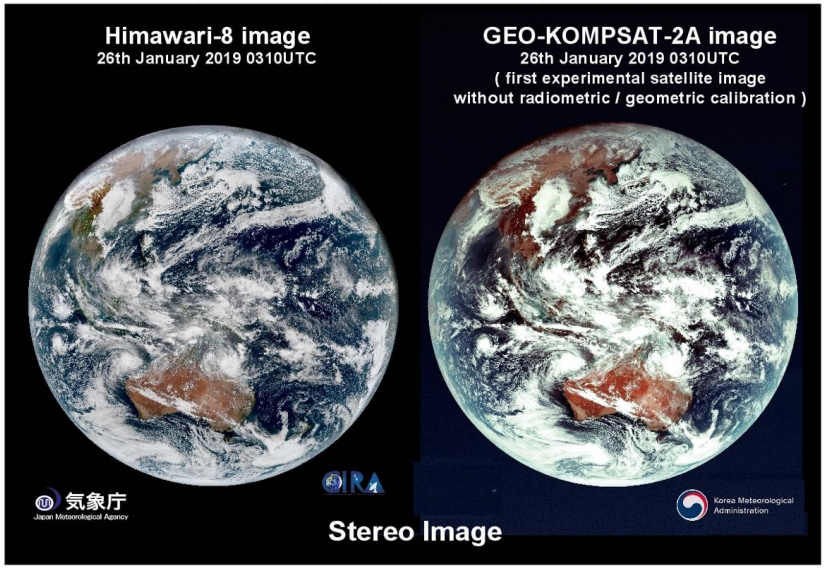
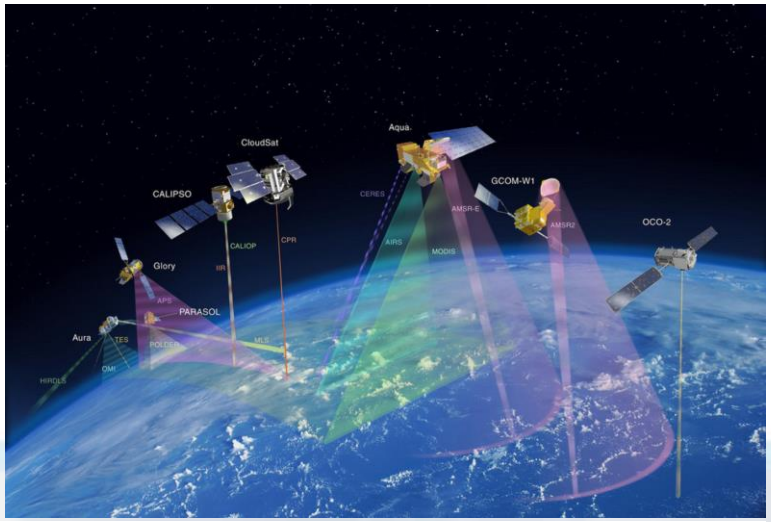


image pair courtesy Bodo Zeschke, Australian Bureau of Meteorology ; Himawari image courtesy JMA ; GK2A image courtesy KMA and Dr. Hyesook Park. GEOKOMPSAT-2A is also known as Chollian-2a

Himawari-8 / GEO-KOMPSAT-2A stereo image, AOMSUC-10 presentation

http://www.virtuallab.bom.gov.au/index.php/download_file/view/1463/301/

Increased examination of the Earth's limb from LEO



Satellite Constellations

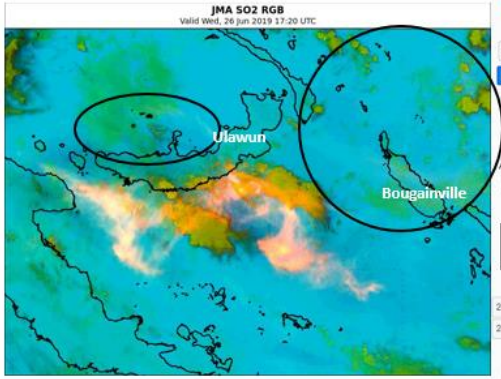
CubeSats (image courtesy NASA / JPL)

Existing Limb viewing utilising Geostationary satellite data

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

the Ulawun eruption;
1720UTC 26th June 2019

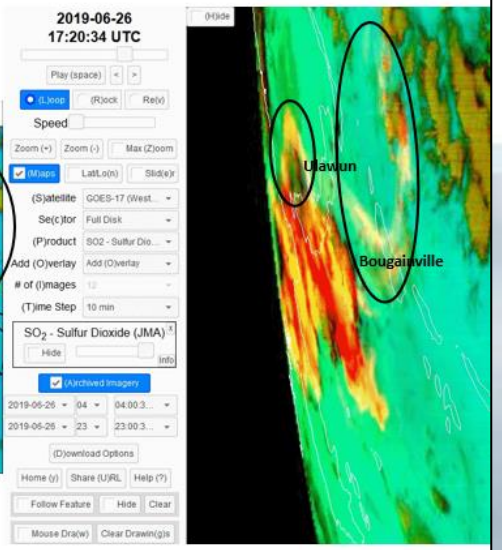
Additional information provided by the GOES-17 satellite due to the limb effect



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

Limb viewing using Geostationary Satellite imagery, AOMSUC-10 presentation

http://www.virtuallab.bom.gov.au/index.php/download_file/view/1463/301/

A potential complication:
The Kessler Syndrome

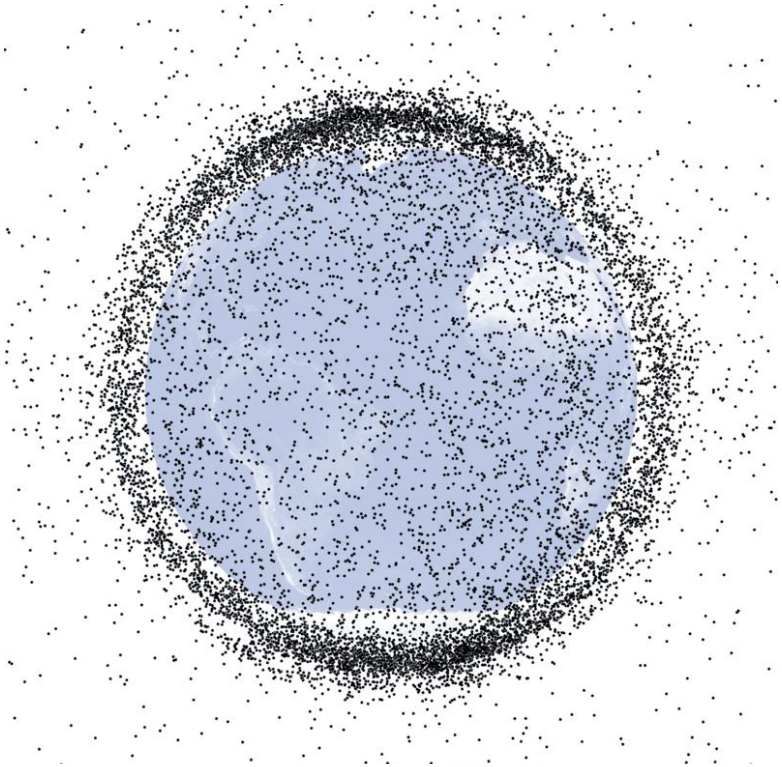
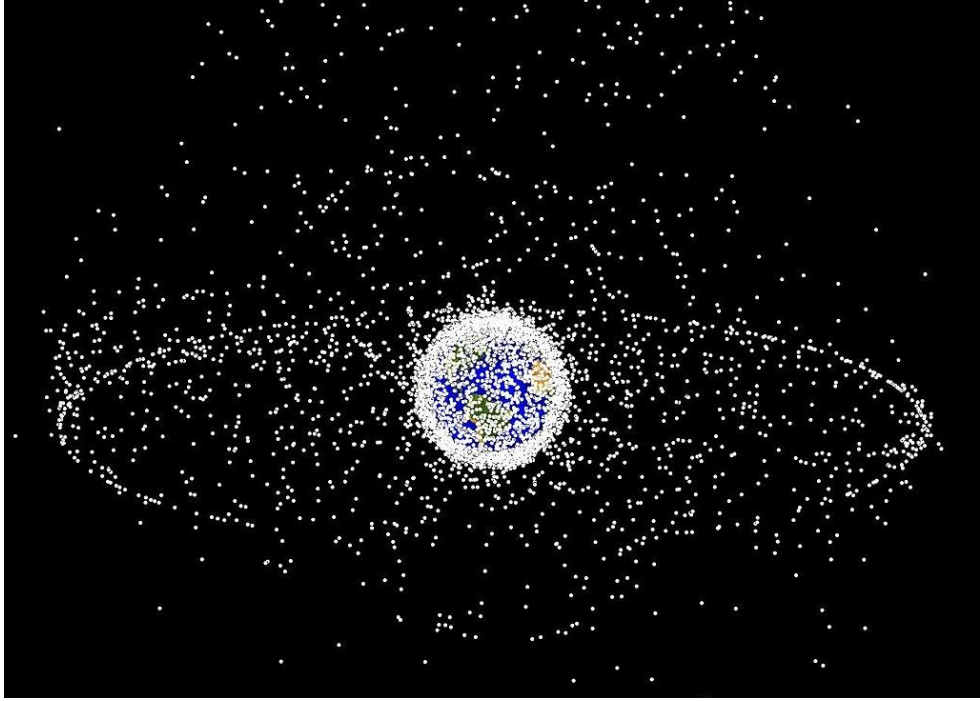


Image made from models used to track debris in Earth orbit as of July 2009

image courtesy Orbital Debris Program Office NASA Earth Observatory



Space debris populations seen from outside geosynchronous orbit (GSO).

image courtesy Orbital Debris Program Office NASA Earth Observatory

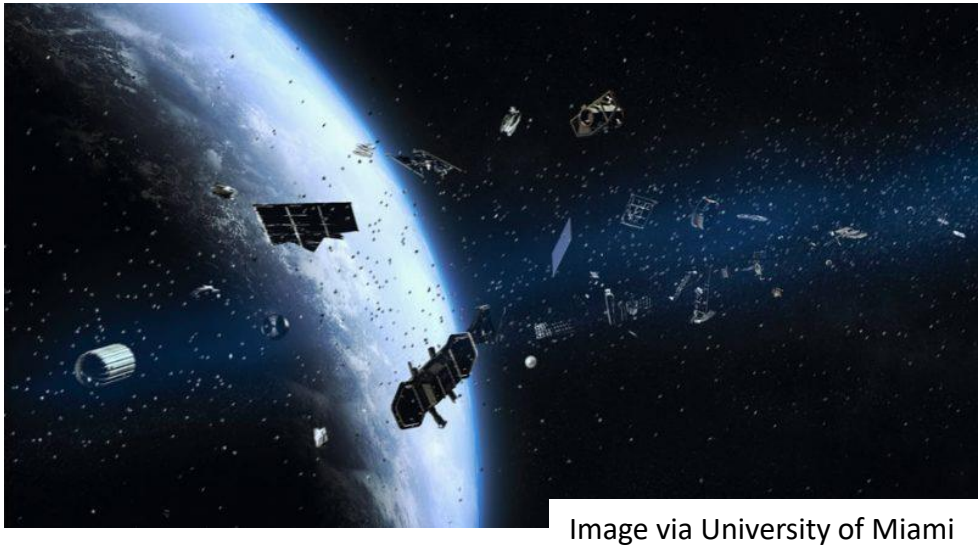


Image via University of Miami

Explanation slide: the Kessler Syndrome (1)

"More satellites in orbit also increases the odds of collisions. Two spacecraft smashing into each other at speeds of tens of thousands of miles an hour might lead to the dreaded Kessler Syndrome, a feedback loop of destruction that could render Earth orbit a no-fly zone for decades.

The process is simple: An initial collision creates a cloud of thousands of pieces of debris whipping around the planet. Some of these pieces hit other spacecraft, creating more debris, and the result is a cascade of satellite mayhem.

REFERENCE

The resulting cloud of debris might be dense enough that any spacecraft put into orbit would be destroyed, putting a premature end to the satellite era." Nathaniel Scharping, Astronomy Magazine https://astronomy.com/news/2021/06/the-future-of-satellites-lies-in-giant-constellations

"In today's world we rely on satellites more than ever before, from communications to security, from GPS to the internet. If our current satellites are destroyed with no way of replacing them, the modern world as we know it cannot exist, causing an unparalleled economic and humanitarian crisis." Alex Thompson, National Space Centre https://spacecentre.co.uk/blog-post/the-kessler-syndrome/

Explanation slide: the Kessler Syndrome (2)

One of the attendees to the RFG meeting, Scott Lindstrom, mentioned that "something along the lines of OSAM-1 might be developed to collect debris to combat Kessler."

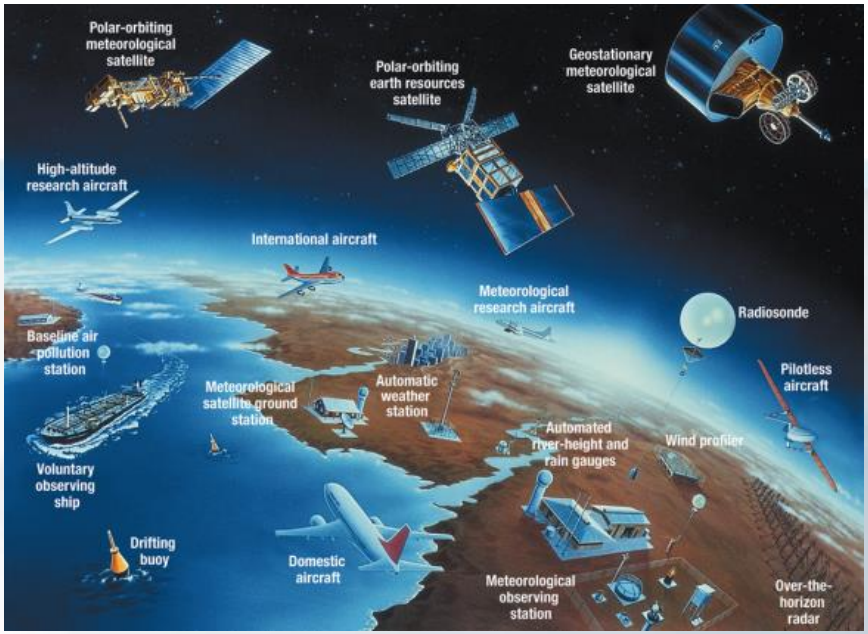
For information about OSAM
https://www.nasa.gov/feature/goddard/2022/nasa-s-robotic-osam-1-mission-completes-its-critical-design-review

According to https://www.smithsonianmag.com/science-nature/can-worlds-first-space-sweeper-make-dent-orbiting-debris-180978515/ a private company has just completed the first successful test of its first "Space Sweeper".

In 2018 a British satellite ClearSpace-1 captured debris using a net and a harpoon-object as a part of the RemoveDebris project lead by the University of Surrey https://spacecentre.co.uk/blog-post/the-kessler-syndrome/

REFERENCE

Integrating information from satellites and other sources of data: Crowdsourcing example



WIGOS 2040 – integrating Global Observation Systems

(image courtesy WMO)

image from AccuWeather, presented by IDG Communications

AccUcast

Crowd Sourcing using personal smartphone

(image courtesy Wikimedia Commons)

Explanation slide: Crowdsourcing for meteorological data

- According to the Five-Year Strategy for the WMO-CGMS Virtual Laboratory for Education and Training in Satellite Meteorology, growth in social/crowd created projects and increased volume of co-creation content is one of the strategic drivers of the VLab. http://www.wmo-sat.info/vlab/wp-content/uploads/2012/02/VLab-Strategy-2020-2024.pdf
- "Millions of smartphones possess relatively accurate pressure sensors and the expectation is that these numbers will grow into the hundreds of millions globally during the next few years. The availability of millions of pressure observations each hour from smartphones has major implications for high-resolution numerical weather prediction." Mass and Madaus, 2014 https://journals.ametsoc.org/view/journals/bams/95/9/bams-d-13-00188.1.xml
- Apps such as WeatherSignal and PressureNet can measure barometric pressure https://www.computerworld.com/article/2977526/crowd-sourced-weather-apps-claim-accuracy-but-watch-the-sky-anyway.html
- AccUcast is a crowdsourcing weather feature in the AccuWeather universal iOS app https://www.computerworld.com/article/2977526/crowd-sourced-weather-apps-claim-accuracy-but-watch-the-sky-anyway.html

REFERENCE

Satellite Constellations

Private Sector Satellites

CubeSats and Hubs

Integrating Global Observation Systems

Aeroplane RADAR

Small inexpensive sensors, mass produced and installed on a variety of platforms

More advanced GEO/LEO/XO satellites

Drones

Crowdsourcing

Conventional situ surface and atmospheric observations

Increasing density of data to interrogate the mesoscale / microscale

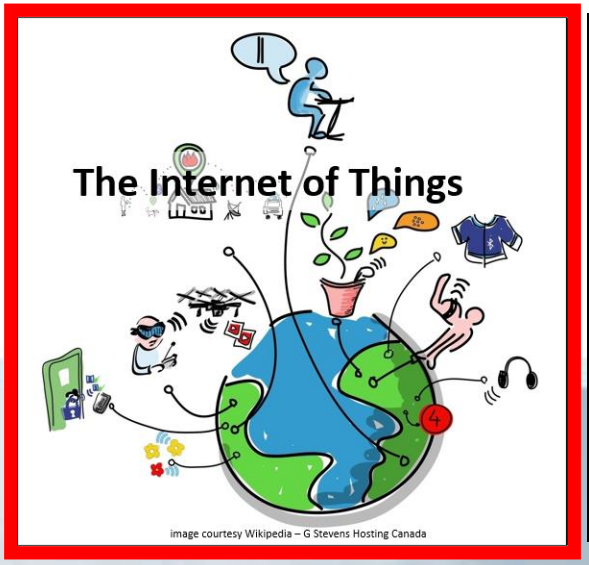
Explanation slide: Integrating Global Observation Systems: additional sensor platforms

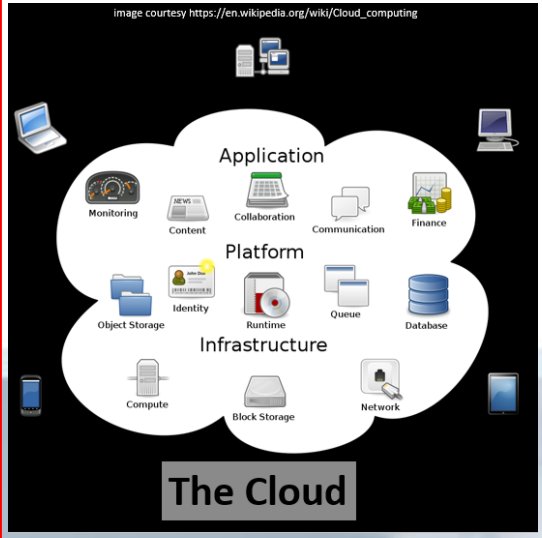
According to the Vision for the WMO Integrated Global Observing System in 2040 document https://library.wmo.int/index.php?lvl=notice_display&id=21716 , important trends and issues in the observing system component include:

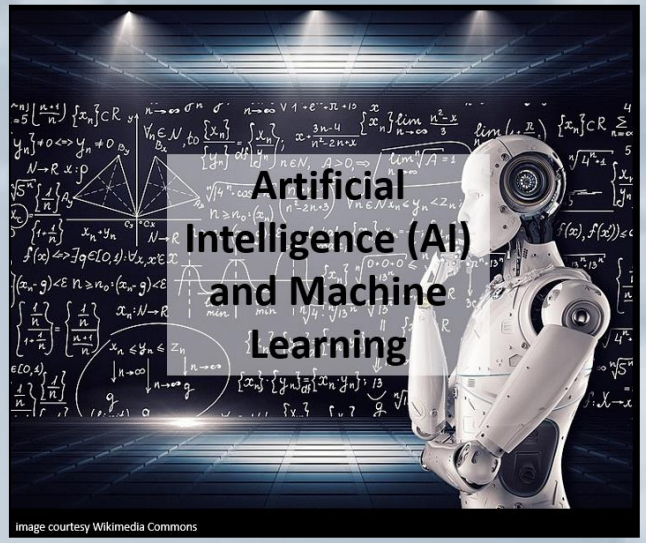
- Small inexpensive sensors that are mass produced and installed on a variety of platforms. Observations from these devices will be communicated automatically to central servers / databases
- Aircraft weather RADAR data will be downloaded to Aircraft Based Observation systems to supplement weather RADAR
- Drones will be used to measure the lower atmosphere and impassable areas

REFERENCE

Important developments likely to impact Satellite Meteorology teaching and the VLab between now and 2031







The Internet of Things is "the connection of devices within everyday objects via the internet, enabling them to share data".

Oxford Dictionary https://www.oxfordlearnersdictionaries.com/

The Internet of Things

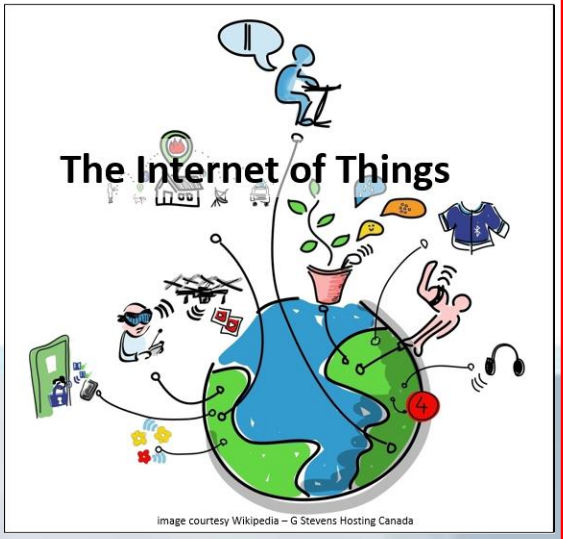
Some feedback about the use of the IoT from Marcial Garbanzo, TSO - WMO-CGMS Virtual Laboratory

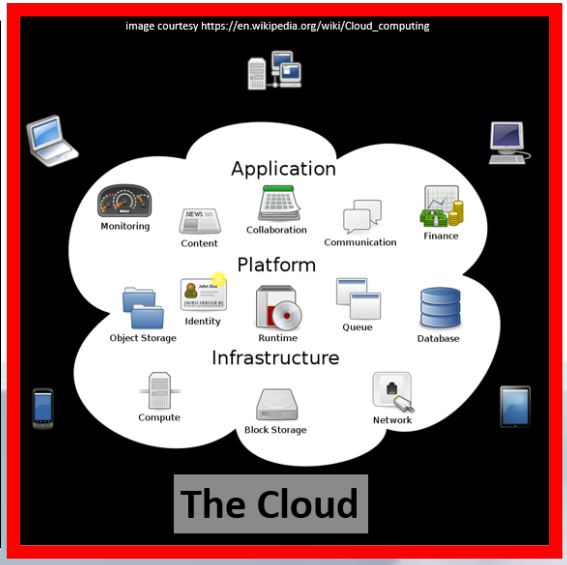
"We are using Scientific programming along with IoT technology to teach Atmospheric Physics and Meteorology at UCR.

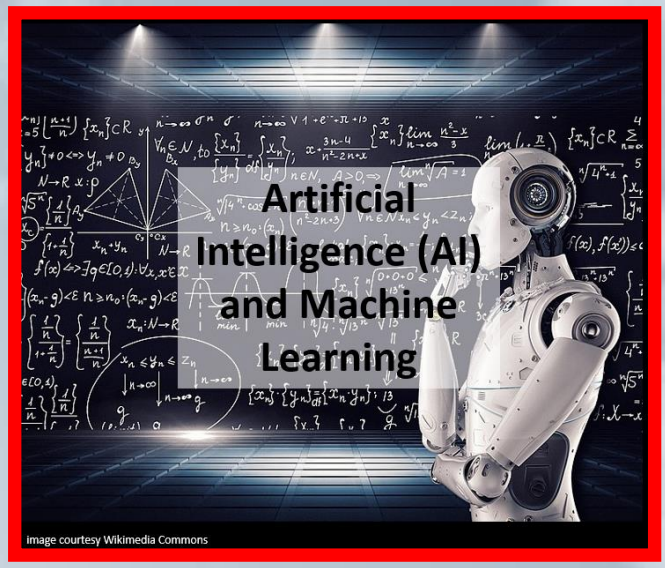
At this moment we are traveling to Monteverde (rain forest) to learn about installing and maintaining meteorological instruments directly in the field and this is joined together with radar imagery and satellite products to nowcast our own conditions for these two days."

image courtesy Wikipedia – G Stevens Hosting Canada

Important developments likely to impact Satellite Meteorology teaching and the VLab between now and 2031





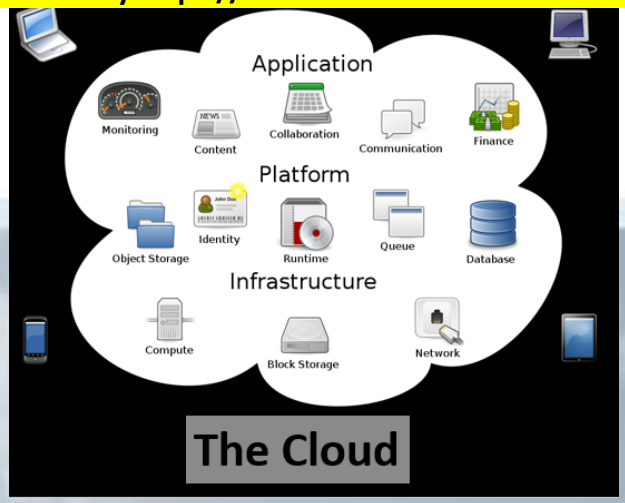


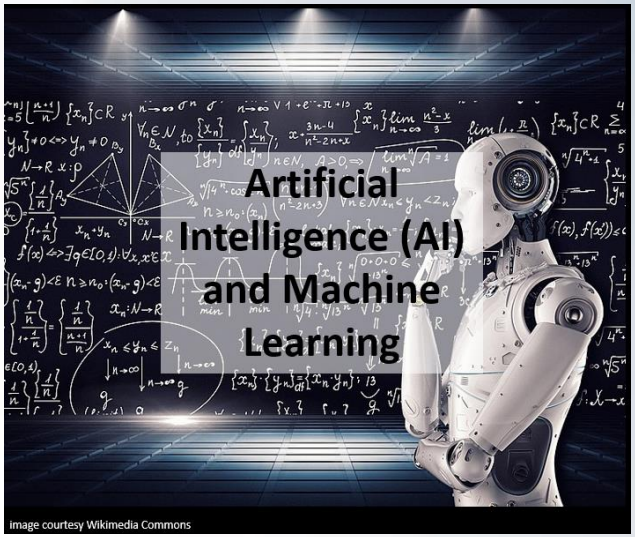
Big Data are sets of information that are too large or too complex to handle, analyse or use with standard methods

Oxford Dictionary https://www.oxfordlearnersdictionaries.com/

The Cloud is a network of servers (computers that control or supply information to other computers) on which data and software can be stored or managed and to which users have access over the internet

Oxford Dictionary https://www.oxfordlearnersdictionaries.com/





AI is an area of study concerned with making computers copy intelligent human behavior Oxford Dictionary https://www.oxfordlearnersdictionaries.com/

Machine Learning is a type of artificial intelligence in which computers use huge amounts of data to learn how to do tasks rather than being programmed to do them Oxford Dictionary https://www.oxfordlearnersdictionaries.com/

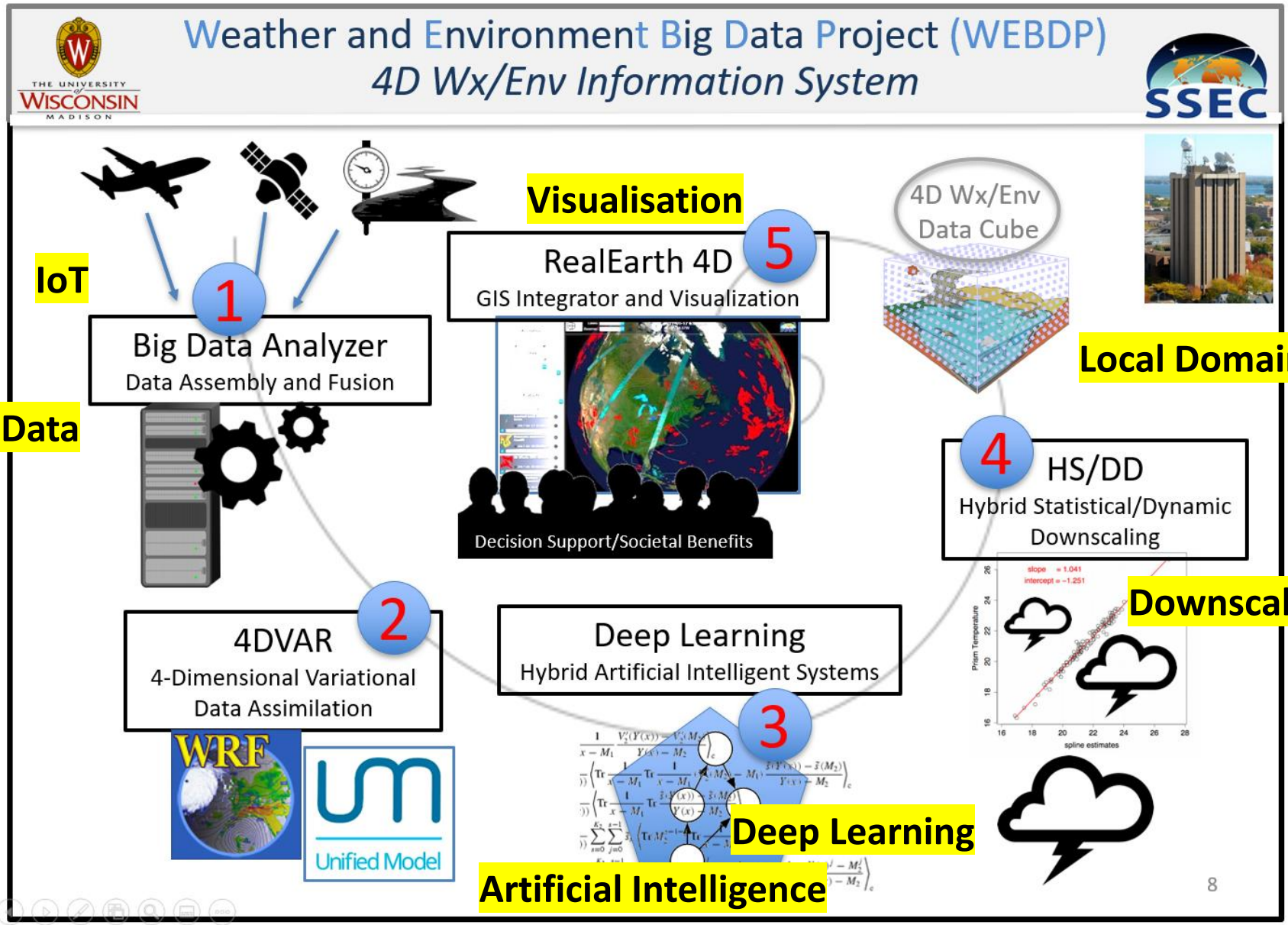
Explanation slide: Making data accessible, processing and storing data, Big Data and The Cloud

- Over 80% of the time spent in AI (Artificial Intelligence) projects are spent dealing with and wrangling data from Dr Allen Huang's presentation at AOMSUC-9
- WMO recognises the importance of accessing this ever-increasing data, anticipating the following automation and technology trends:
  - Increased standardization of instrumentation and observing methods
  - Automatic / autonomous calibration systems for these sensor / database systems
  - Growing reliance on reference networks
    https://library.wmo.int/index.php?lvl=notice_display&id=21716
- How do you deal with large amounts of standardized and calibrated data?
  - Highly compressed data https://library.wmo.int/index.php?lvl=notice_display&id=21716
  - Storing data on a single atom https://www.nytimes.com/2007/08/31/technology/31ibm.html
- There is an internet resource that summarises IoT, Big Data and The Cloud at
  https://www.mckennaconsultants.com/relationship-between-iot-big-data-and-the-cloud/

REFERENCE

An Example: The WEBDP 4D Wx/Env Information System

from Dr Allen Huang's presentation at AOMSUC-9



Explanation slide: An Example: The WEBDP 4D Wx/Env Information System

- Here is an example showing the utilisation of IoT, Big Data, AI and Deep learning in the generation of the 4D Weather/Environment Cube. This utilises observational input data, Big Data Intelligence and integrates the output into the NexGen 4-D Information System. This slide was presented by Dr Allen Huang at the 9th Asia Oceania Meteorological Satellite User Conference held in Bogor Indonesia in 2018. http://aomsuc9.bmkg.go.id/presentations/

REFERENCE

AI makes big data analytics simpler by automating and enhancing data preparation, data visualization, predictive modelling, and other complex analytical tasks that would otherwise be labour-intensive and time-consuming.

Dr Allen Huang presented CSPP-AI during AOMSUC-10

http://www.bom.gov.au/research/aomsuc-10/presentations/S4-P5-HUANG.pdf

Artificial Intelligence (AI) and Machine Learning

In 2030, adaptive learning software will replace direct instruction. Adaptive learning software is computer software that uses AI to move students up and down through a grade level's content based on student performance on assessment questions.

https://www.linkedin.com/pulse/heres-what-school-could-look-like-2030-mike-yates

image courtesy Wikimedia Commons

AI makes big data analytics simpler by automating and enhancing data preparation, data visualization, predictive modelling, and other complex analytical tasks that would otherwise be labour-intensive and time-consuming.

Dr Allen Huang presented CSPP-AI during AOMSUC-10

NOAA JPSS (Joint Polar Satellite System) The Community Satellite Processing Package (CSPP) supports the Direct Broadcast (DB) meteorological and environmental satellite community through the packaging and distribution of open source science software. CSPP supports DB users of both polar orbiting and geostationary satellite data processing and regional real-time applications through distribution of free open source software, and through training in local product applications.

In 2030, adaptive learning software will replace direct instruction. Adaptive learning software is computer software that uses AI to move students up and down through a grade level's content based on student performance on assessment questions.

https://www.linkedin.com/pulse/heres-what-school-could-look-like-2030-mike-yat

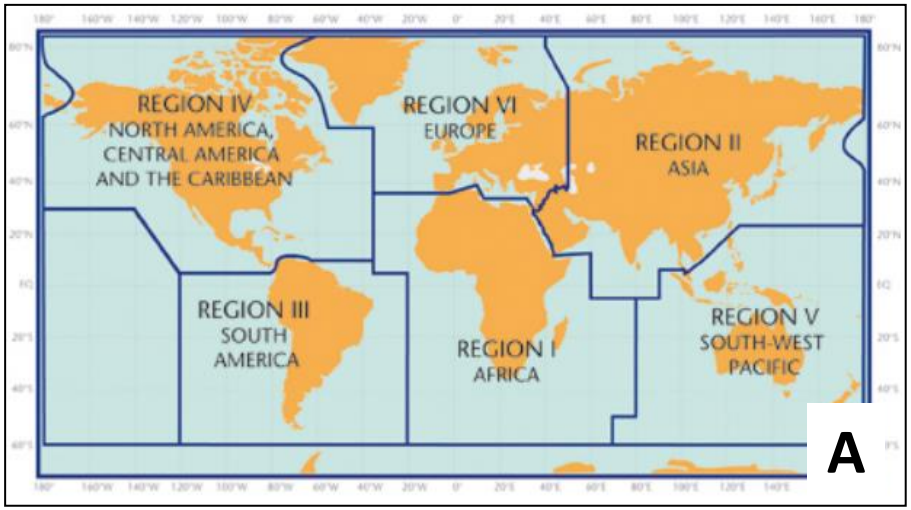
REFERENCE

image courtesy Wikimedia Commons

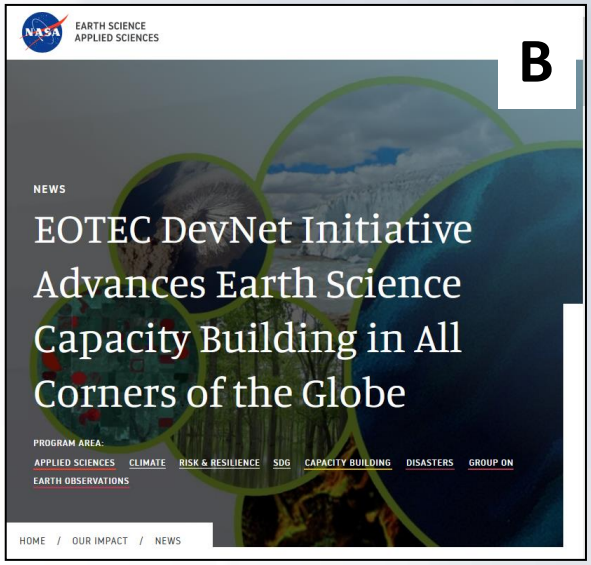
The Future of the VLab: what will the 200th Australian VLab CoE Regional Focus Group meeting, tentatively scheduled for January 2031, be like?

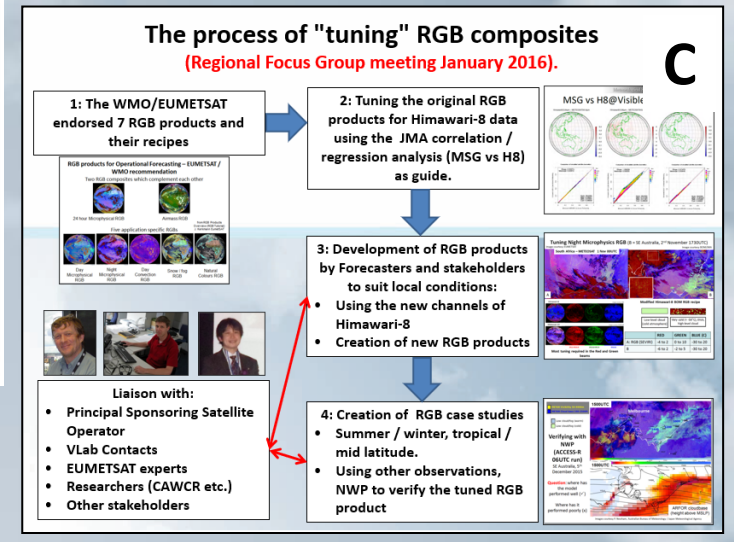
Contents

- Constructing a "time capsule" for the year 2031
- Important developments likely to impact Satellite Meteorology teaching in 2031
- **How might the 2031 Regional Focus Group (RFG) meeting be prepared and presented?**
- What topics might be presented at this RFG meeting?



Getting access to the Resources: some ideas





Explanation slide: Getting access to the resources (1)

A: WMO Global Campus: Collaboration and sharing on education and training for capacity development.

The WMO Global Campus is the collaborative network of WMO Member institutions and National Meteorological Hydrological Services involved in the development and delivery of education and training. Its goal is to address the evolving global priorities for learning. It is the fruit of the synergies, sharing and cooperation within this community of institutions. The WMO Global Campus was approved by WMO Congress 18 with Resolution 72.

https://public.wmo.int/en/resources/training/wmolearn

REFERENCE

B: What is EOTEC DevNet?

https://ceos.org/ourwork/other-ceos-activities/eotec-devnet/

A network of networks created in 2020 to bring the power of satellite-derived Earth information to more users around the globe.

Our aim: Make Earth observation-related capacity building more accessible and relevant. EOTEC DevNet's goal is to increase the use of Earth information in decision-making on climate change and disaster management.

Explanation slide: Getting access to the resources (2)

C: "Giving back" to the data providers: An important component in gaining access to this data will be "giving back" to the data provider, in order to drive the Science.

The Australian VLab Centre of Excellence operates in this manner. For example, over the past 100 Regional Focus Group meetings we have:

- Collaborated with our Principal Sponsoring Satellite Operator, the Japan Meteorological Agency (JMA) in tuning the original EUMETSAT RGB Composites for Himawari-8 data by creating regional case studies and disseminating the result to JMA and the VLab community
- Conducted the National Himawari Training Campaign during 2014-2016 to assist JMA in implementing the Himawari data and to encourage the use of this data within WMO RAV
- Developed case studies showcasing JMA's Himawari-Request Service during the RFG meetings of December 2018, March 2019, May 2019, August 2019.

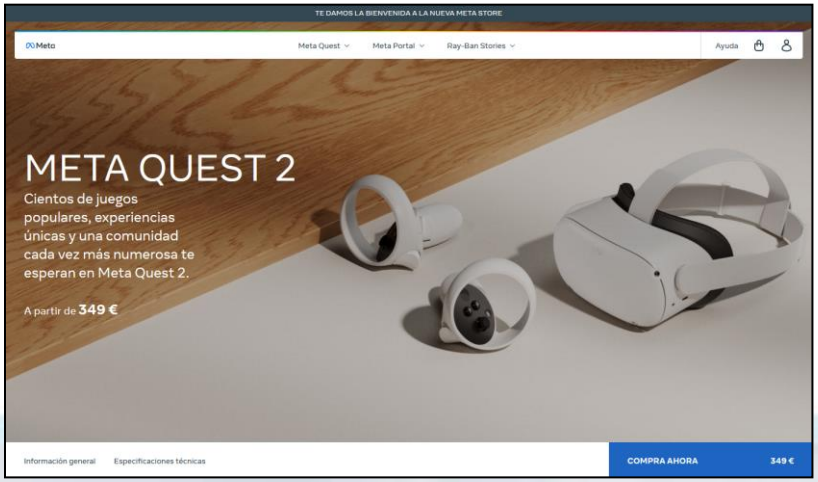
REFERENCE

Preparing and Extracting Case Studies

images from vTime https://vtime.net

- Engaging with your "AI Assistant" to extract the case study from the Big Data located in the Cloud.
- You engage with AI in virtual reality. You construct the presentation there. You rehearse it there.
- You can control the Computer with your mind in creating the case study. https://techviral.net/microsoft-details-tech-control-pc-using-mind/
- **Using AI to create training material for Meteorologists is great! Can you imagine personalized, unique and cheat proof trainings?** (Marcial Garbanzo)

The visualisation of the RFG meeting



Virtual Reality

Holography

https://news.mit.edu/2021/3d-holograms-vr-0310

Light Field Displays

https://www.holoxica.com/light-field-displays

Augmented Reality

https://www.youtube.com/watch?v=d-HRgfJbPvk

Explanation slide: the visualisation of the RFG meeting (1)

- Virtual Reality: images and sounds created by a computer that seem almost real to the user, who can interact with them by using sensors Oxford Dictionary https://www.oxfordlearnersdictionaries.com/
- "Despite years of hype, virtual reality headsets have yet to topple TV or computer screens as the go-to devices for video viewing. One reason: VR can make users feel sick. Nausea and eye strain can result because VR creates an illusion of 3D viewing although the user is in fact staring at a fixed-distance 2D display. The solution for better 3D visualization could lie in a 60-year-old technology remade for the digital world: holograms" Daniel Ackerman MIT News Office. https://news.mit.edu/2021/3d-holograms-vr-0310
- From the experimental work in 3D stereo vision as conducted at the Bureau of Meteorology (BOM) and the Meteorology Training Centre (BMTC) it was found that a proportion of staff and students were not comfortable in viewing anaglyph imagery using anaglyph glasses. http://www.virtuallab.bom.gov.au/index.php/download_file/view/1572/227/

REFERENCE

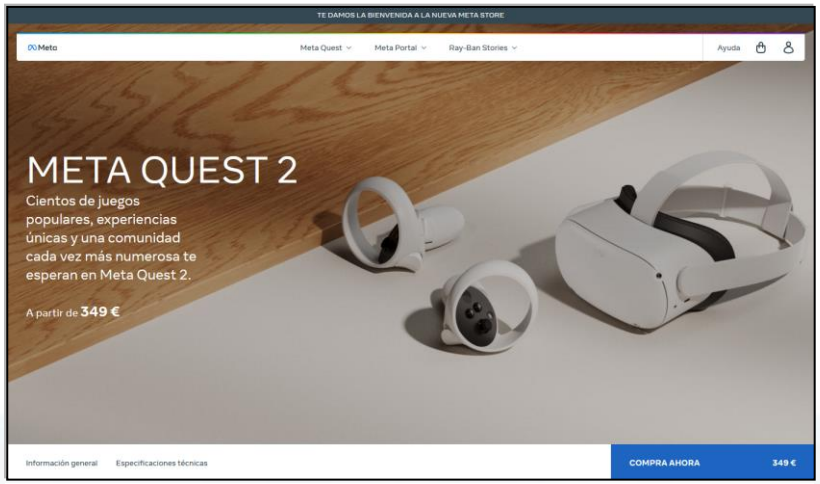
Explanation slide: the visualisation of the RFG meeting (2)

- Other ways of viewing imagery in 2031 include:
  - Using AI to generate 3D holograms in real time
  - Light field displays, projecting 4D images directly onto retina.
  - Augmented Reality a technology that combines computer-generated images on a screen with the real object or scene that you are looking at. Oxford Dictionary https://www.oxfordlearnersdictionaries.com/

- This means that there may be varying degrees of "involvement" and "immersion" by participants in the VLab RFG meeting of 2031, depending upon the visualisation participants are comfortable with.
- Finally, there may be difficulty in translating traditional teaching material into VR. Some of the rules for designing traditional teaching material may not be applicable to VR teaching https://www.youtube.com/watch?v=d-HRgfJbPvk

REFERENCE

The visualisation of the RFG meeting



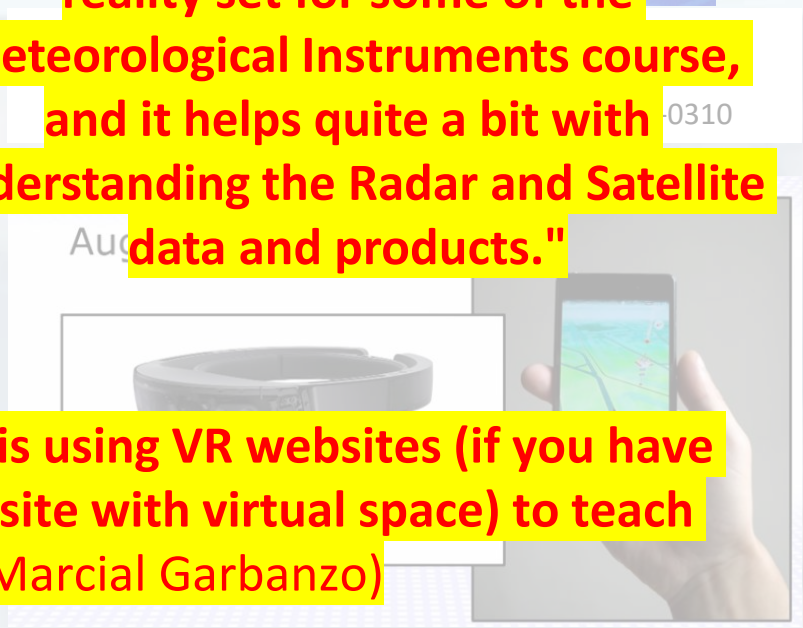
Virtual Reality

Some feedback about the use of VR from Marcial Garbanzo, TSO - WMO-CGMS Virtual Laboratory

"We are using the Quest 2 virtual reality set for some of the Meteorological Instruments course, and it helps quite a bit with understanding the Radar and Satellite data and products."

Light Field Displays

https://www.holoxica.com/light-field-displays



Augmented Reality

https://www.youtube.com/watch?v=d-HRgfJbPvk

"Wen Bo mentioned yesterday that CMA is using VR websites (if you have not used VR it is hard to explain, but is a site with virtual space) to teach meteorologists in China" (Marcial Garbanzo)

Investigating the potential of 3D stereo satellite imagery utilising GEO-KOMPSAT-2A and Himawari-8 data.

(Regional Focus Group meetings January, February, October 2019, March 2021).

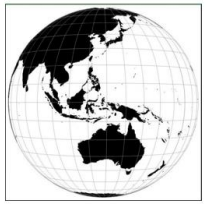
Motivation: utilisation of Himawari-8 and GEO-KOMPSAT-2A data in combination

image from KARI

GEO-KOMPSAT-2A located at 128.2E

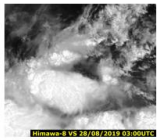
image from JMA

Himawari-8 located at 140.7E,

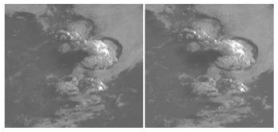


Separation of 12. 5 degrees

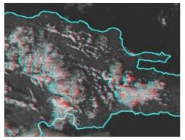
Various ways of presenting 3D stereo satellite imagery



1: "3D Wiggle" animation



2: Stereo pair images
(cross eyed viewing method)

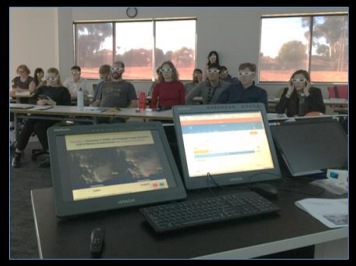


Anaglyph glasses

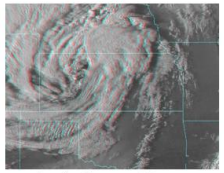
3: "Anaglyph"animation
(requiring viewing glasses)

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

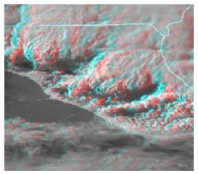
Testing 3D stereo satellite imagery in the classroom with Dr Hyesook Park (2019)



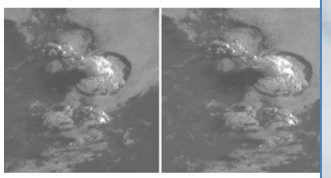
Advantages in using 3D stereo satellite imagery



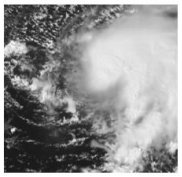
Analysing multilayer cloud, superior AMV's



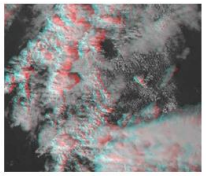
Analysing the interaction between low and upper levels of the atmosphere



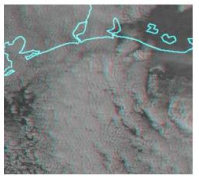
Analysing vertical motion of developing thunderstorms



Analysing atmospheric shear and trends in these

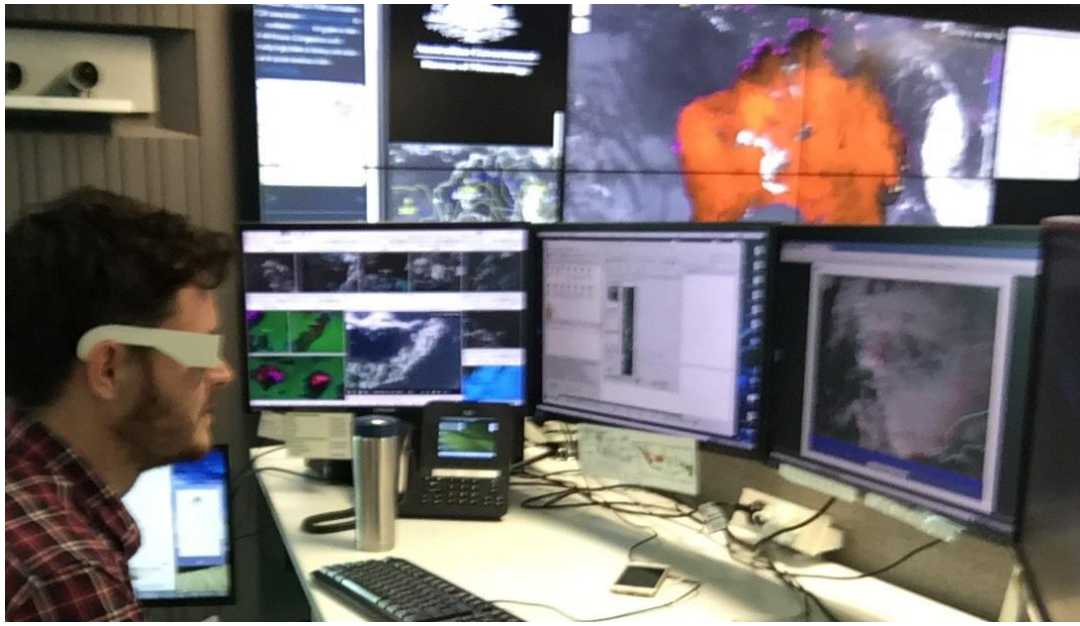


Better monitor low cloud below broken higher cloud



Detection of minor variations in height for oceanic cellular convection

Virtual Reality / 3D imagery is "visceral"



Explanation slide: Virtual Reality / 3D imagery is "visceral"

- From the experimental work in 3D stereo vision as conducted at the Bureau of Meteorology (BOM) and the Meteorology Training Centre (BMTC), a number of Operational Forecasters and a majority of 2019 BMTC Graduate Diploma of Meteorology students found this anaglyph satellite imagery fascinating. Indeed, on at least one occasion a staff member would try to "grab at the clouds displayed in the 3D imagery" rendered this way.
- Because the VR / 3D imagery is so "immersive", so the normal distractions experienced in traditional classroom and 2D remote learning can be reduced. If additional senses, e.g., the sense of touch could also be engaged then this would really accelerate practical learning.
- This "immersive" nature of VR / 3D is demonstrated when this is used by patients in hospitals. VR in hospitals appears to reduce the pain medication required https://www.youtube.com/watch?v=d-HRgfJbPvk
- "AR/VR and mixed reality will immerse students in the learning resulting in deeper understanding of the content they study." Mike Yates, LinkedIn https://www.linkedin.com/pulse/heres-what-school-could-look-like-2030-mike-yates

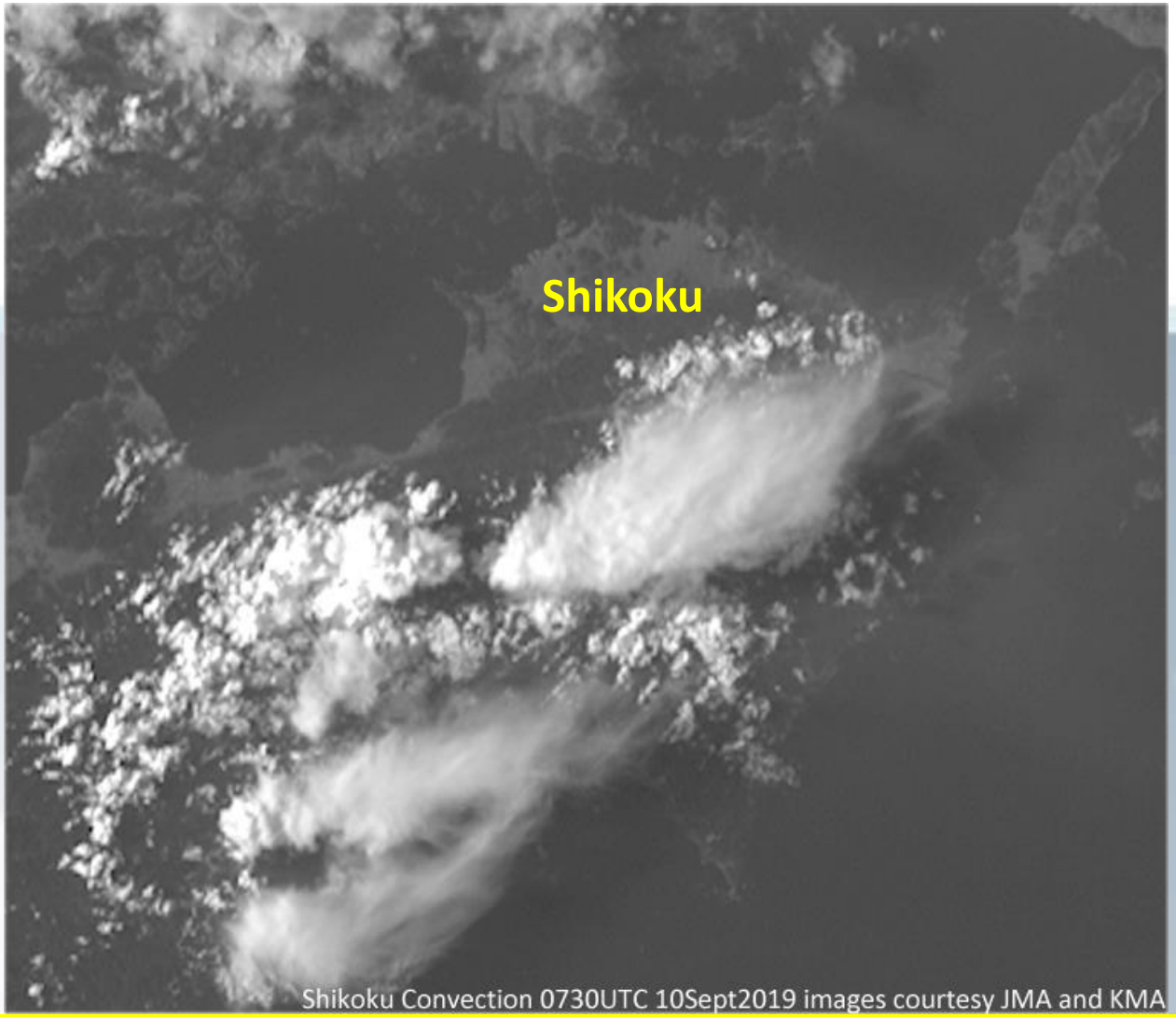
REFERENCE

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)

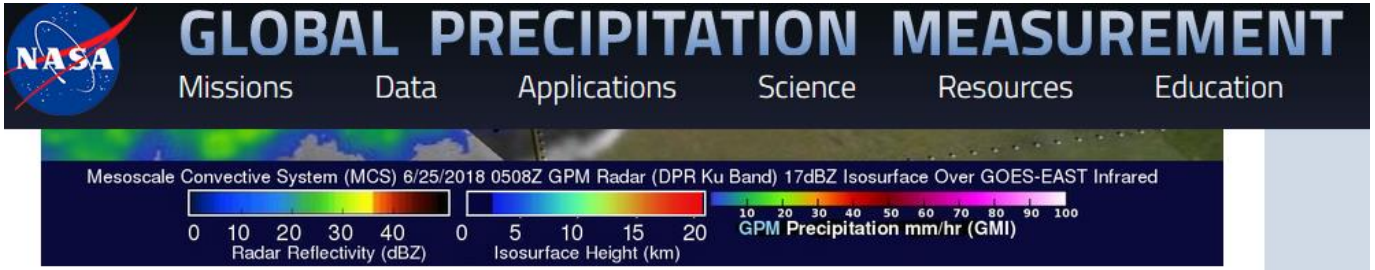
Please view this animation carefully and desist if it feels uncomfortable



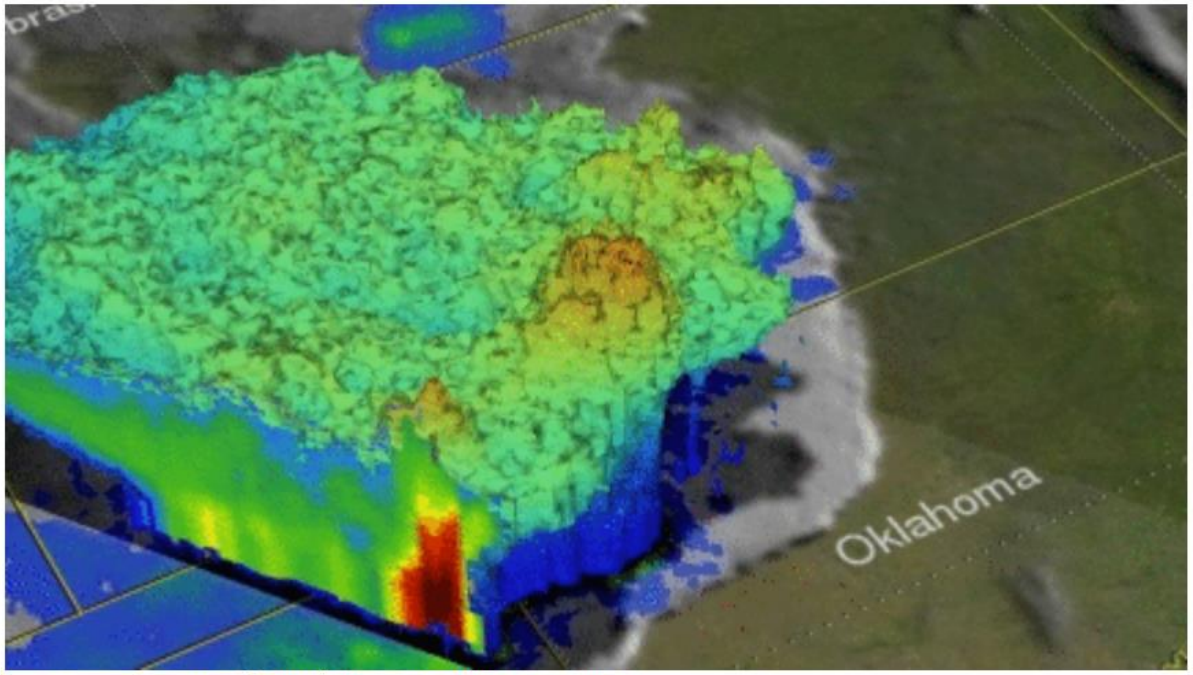
Please start the Power Point Slide Show to activate the animation

Neat Visualisation of precipitation data in 3D

https://gpm.nasa.gov/extreme-weather/oklahoma-mesoscale-convective-system-mcs-examined-gpm



The GPM core observatory satellite's radar data (DPR ku Band) were used here to reveal the 3-D structure of precipitation within the storm system. GPM's radar revealed that that a few storm tops in this MCS were reaching heights of over 9.5 miles (15.4km).



Images and caption by Hal Pierce (SSAI/NASA GSFC)

Explanation slide: Neat Visualisation of precipitation data in 3D

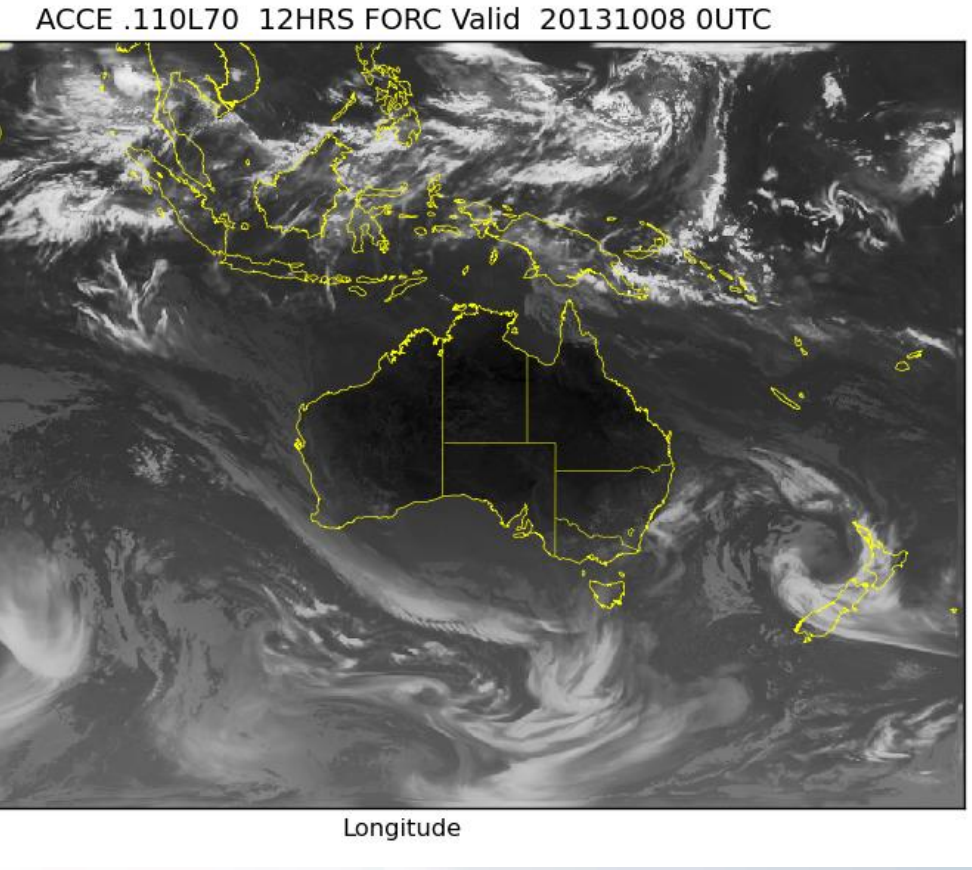
- This animation by Hal Pierce of (SSAI/NASA GSFC) is an example of how a meteorological feature might be examined in virtual reality. Note the 3D rendering of his thunderstorm complex. Note also how the angle of view changes during the video, simulating how it is possible to interrogate the data by "flying around" within virtual reality.
- Some feedback given by Marcial Garbanzo, TSO - WMO-CGMS Virtual Laboratory, as follows; "GPM 3D products to view precipitation datasets. Students love to use it as it bring the data to a different level. Instead of looking at 2D slices of data and trying to “connect it in the head”, they get to see the rain falling, drop size distribution and air currents (among others)".

REFERENCE

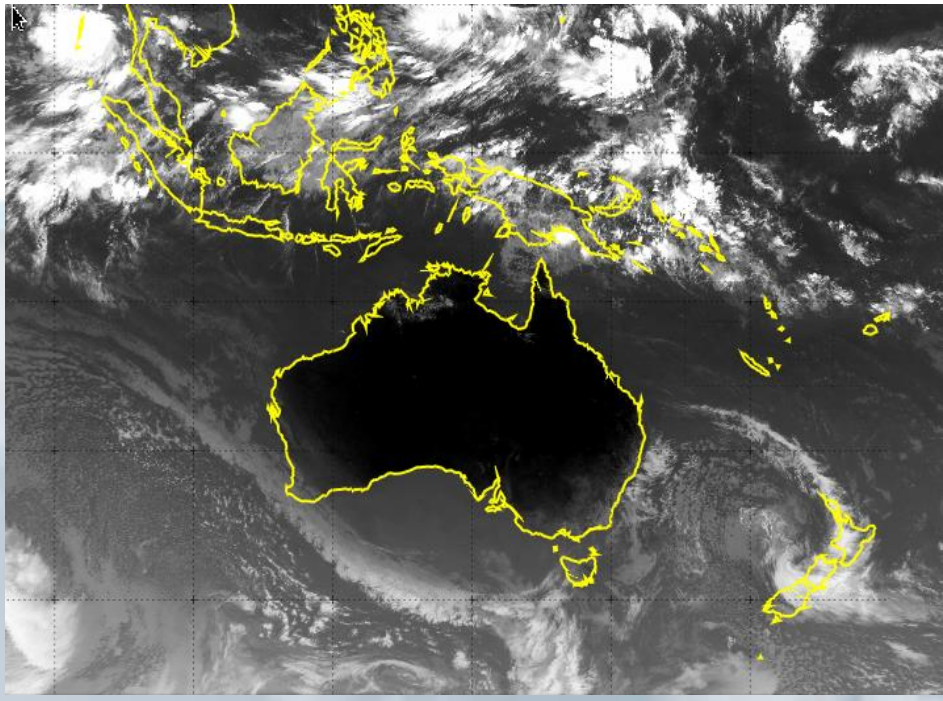
Synthetic satellite image courtesy L.Rikus, BOM

Switching between "Real" and "Computer Generated"

From the first Regional Focus Group meeting, October 2013: Synthetic satellite image vs MTSAT IR image



Synthetic IR satellite Image
(ACCESS G model derived)
Forecast for 00UTC 8th October



MTSAT image
00UTC 8th October

Explanation slide: Switching between "Real" and "Computer Generated"

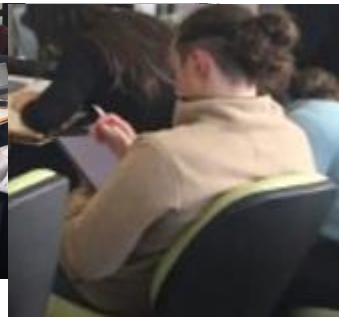
- Here is a 2D example of this "integrated" data rendering as shown during our first Regional Focus Group meeting back in October 2013. This slide demonstrates how synthetically generated NWP model data can be made to look like observational data.
- The primary motivation for looking at synthetic imagery is that you can see many processes in an integrated way compared with looking at numerous model fields and integrating them mentally. This is similar to the feedback given by Marcial Garbanzo in the previous slide.
- Because the synthetic imagery is rendered to look like the satellite image therefore this permits easier comparison across the two data, either by a human or by an AI algorithm having pattern recognition.

REFERENCE

But why in the "classroom", or indeed in any "room" at all:

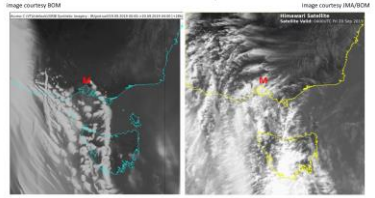
Taking the teaching "outside" …

Tablet drawing



Comparing Synthetic IR ACCESS-C forecast with Himawari IR imagery

04UTC 20th Sept



ACCESS-C forecast
Analysis time 00UTC 19th September

Himawari-8 Band 13 image

Reviewing the Forecast over refreshments

3. Any comments about the difference between forecast weather conditions for Broadmeadows for the Friday afternoon brainstorming session and what actually occurred?

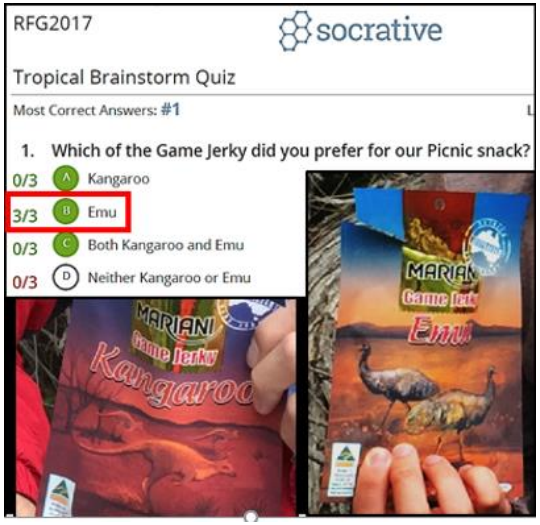
Anon anon2511325e3d414115
Weather was abit windy .

Anon anoncc14e480438d4b78
i was expecting too much of winds.. but this is too good. winds did allow for some fun time

Anon anonddbee9aadf9341c3
No significant difference, some cloudy skies but otherwise fine weather

Outdoor discussion

Socrative Quiz



Explanation slide: But why in the "classroom", or indeed in any "room" at all: Taking the teaching "outside" … (1)

- The use of VR increases involvement and "immersion" into the learning. It also reduces the amount of "abstraction" that is required on the part of the student / participant to translate what is delivered by the teacher / presenter. VR replaces the "conventional classroom" with an environment where the participants are much more intimately connected to the topic that is being taught / presented.
- At BMTC we sometimes "escape" from the "conventional classroom" and include outdoor teaching sessions. Typically:
  - Prior to the outdoor session, the students would investigate the latest research papers pertaining to the subject in the classroom.
  - The students and teacher then venture outside. Individual students then summarise important content of the research papers in front of their peers and the teacher, with questions and feedback encouraged.

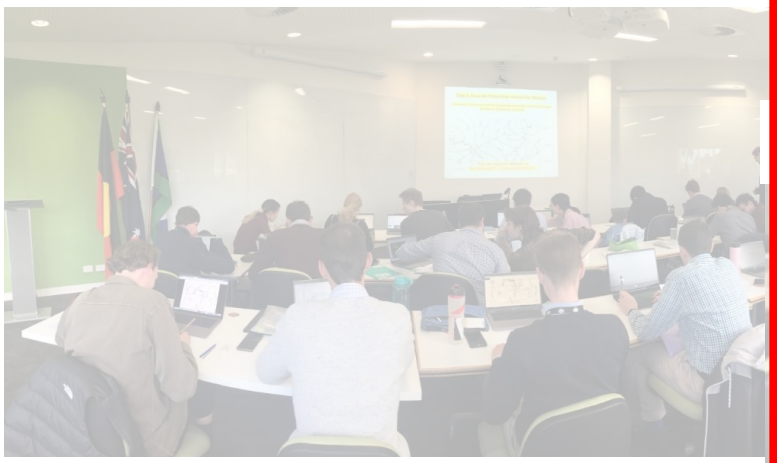
REFERENCE

Explanation slide: But why in the "classroom", or indeed in any "room" at all: Taking the teaching "outside" … (2)

  - The group would partake in a picnic, as this improves the social bonding and stimulates further discussion.
  - Afterwards the student presentations would continue before the group returns to the Training Centre classrooms.
- The Socrative cloud based learner response system https://www.socrative.com/ was used to further enhance interactivity during these outdoor sessions. The teacher has a Socrative PRO licence for added functionality. Results are shown on the next two slides
- Prior to the outdoor session, the students would be asked to recommend the best day for this session based on their forecasts.
- This "direct experience" of the verification of the "forecast for the day" gives the students a greater depth of understanding. The students directly experience the consequence of their previous forecast.

REFERENCE

But why in the "classro
indeed in any "room" at
the teaching outsid



RFG2017

socrative

Tropical Brainstorm Quiz

Most Correct Answers: #1

1. Which of the Game Jerky did you prefer for our Picnic snack?

0/3 A Kangaroo

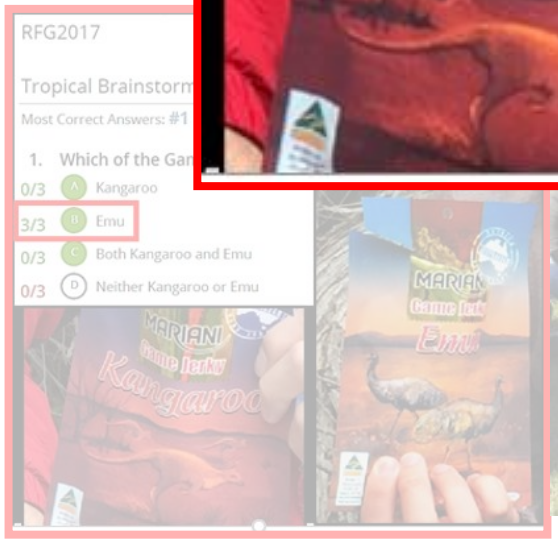
3/3 B Emu

0/3 C Both Kangaroo and Emu

0/3 D Neither Kangaroo or Emu

Socrative Quiz

Outdoor discussion

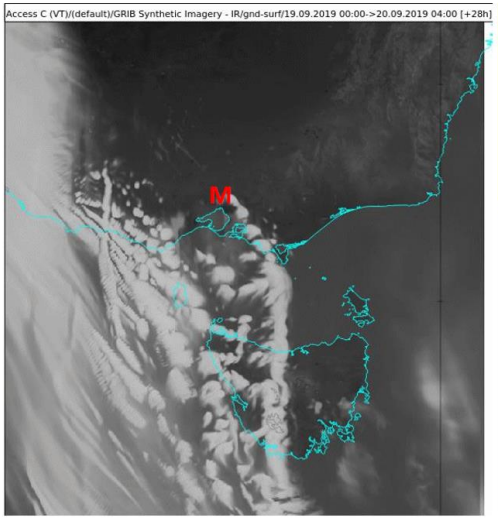


But why in the "classroom", or indeed in any "room" at all: Taking

Comparing Synthetic IR ACCESS-C forecast with Himawari IR imagery

04UTC 20th Sept

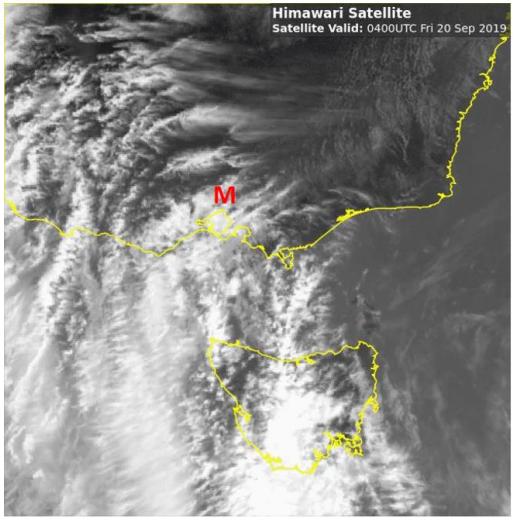
image courtesy BOM



ACCESS-C forecast

Analysis time 00UTC 19th September

image courtesy JMA/BOM



Himawari-8 Band 13 image

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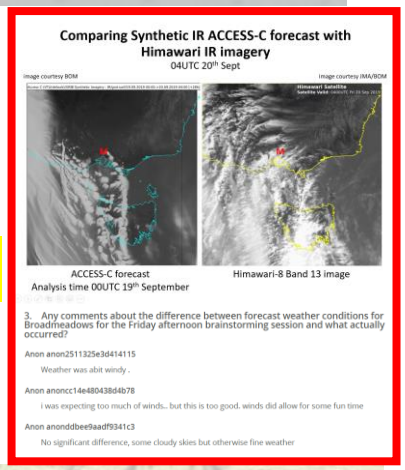
No significant difference, some cloudy skies but otherwise fine weather

Reviewing the Forecast over refreshments



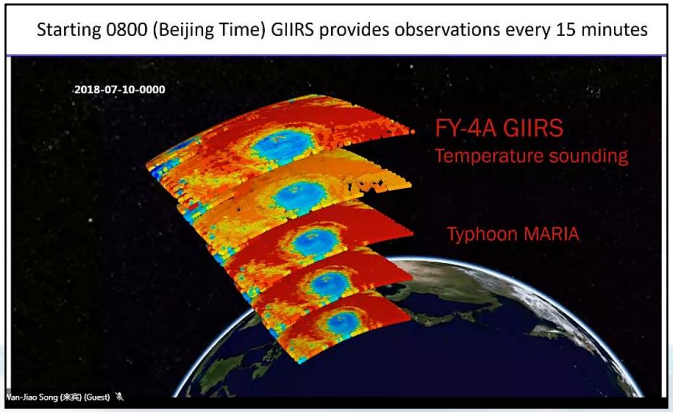
The Future of the VLab: what will the 200th Australian VLab CoE Regional Focus Group meeting, tentatively scheduled for January 2031, be like?

Contents

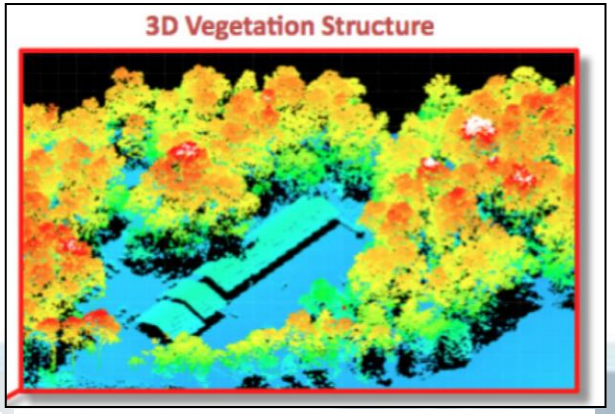
- Constructing a "time capsule" for the year 2031
- Important developments likely to impact Satellite Meteorology teaching in 2031
- How might the 2031 Regional Focus Group (RFG) meeting be prepared and presented?
- **What topics might be presented at this RFG meeting?**

Image courtesy Wan-Jiao Song CMA from https://www.mdpi.com/2072-4292/5/8/4045

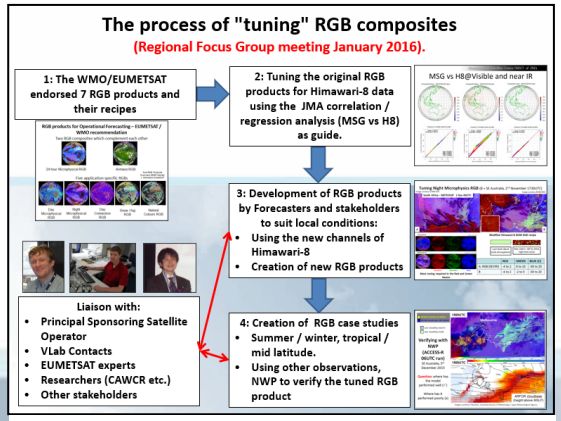
What topics might be presented at the January 2031 Regional Focus Group meeting?



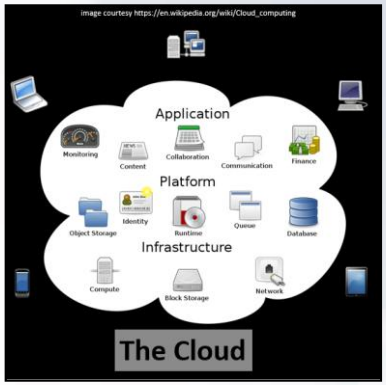
3D rendering of Earth Atmosphere system

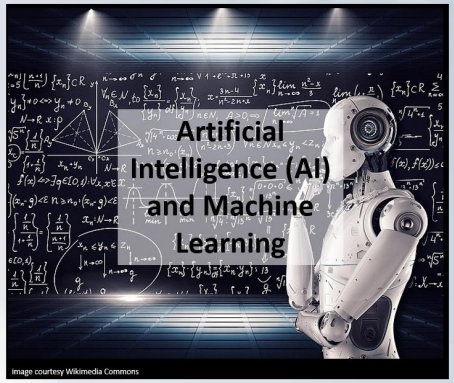


Case studies include Mesoscale / Microscale



Feedback on testing new observational resources



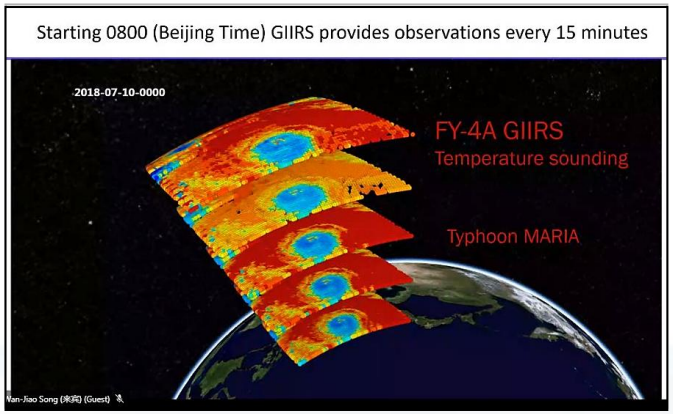


Advertising Cloud Resources, and results in utilising the "AI Assistant"

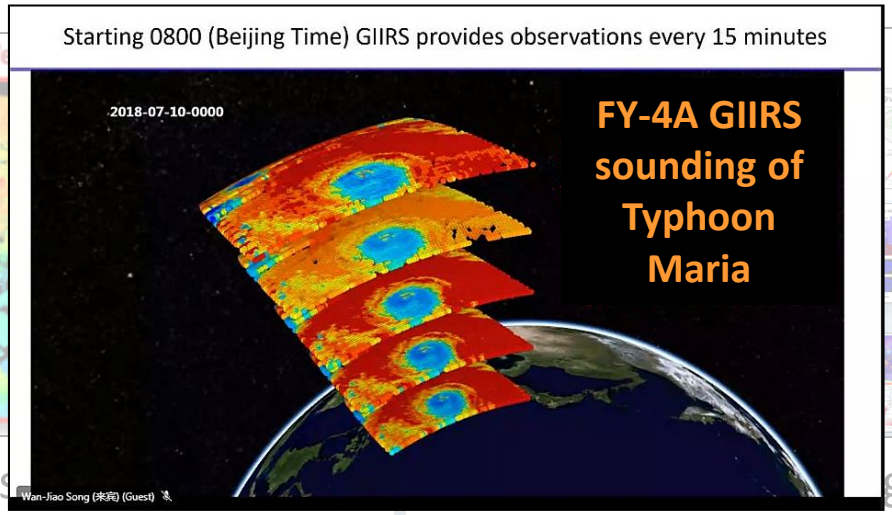
Providing feedback on effective VLab teaching using new and traditional teaching…

image courtesy Wikipedia. image courtesy Wikimedia Commons image from vTime https://vtime.net

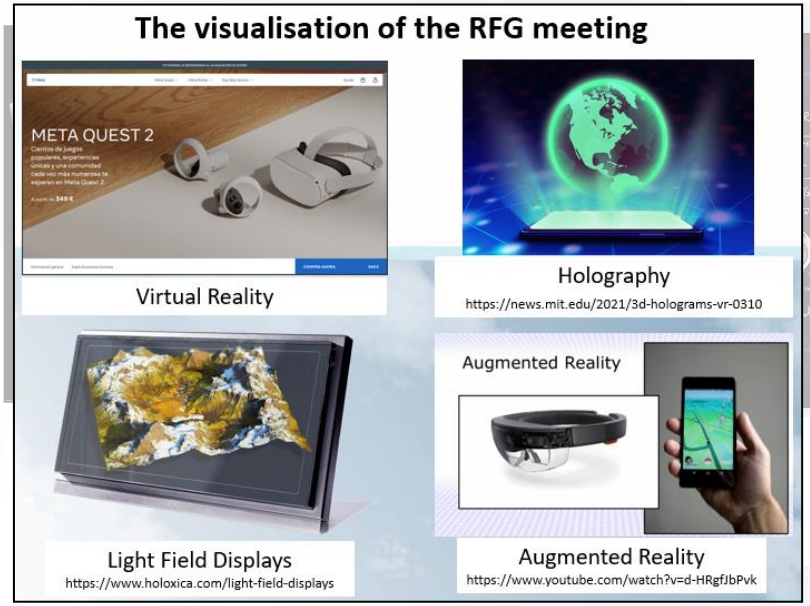
What topics might be presented at the January 2031 Regional Focus Group meeting?



3D rendering of atmosphere



AOMSUC-11 presentation by Wan-Jiao Song CMA



Immersive Virtual Reality VLab sessions that simulate an emergency during a Hazardous Weather Event.

With "AI Assistant" in attendance.

This will help to train the human response.

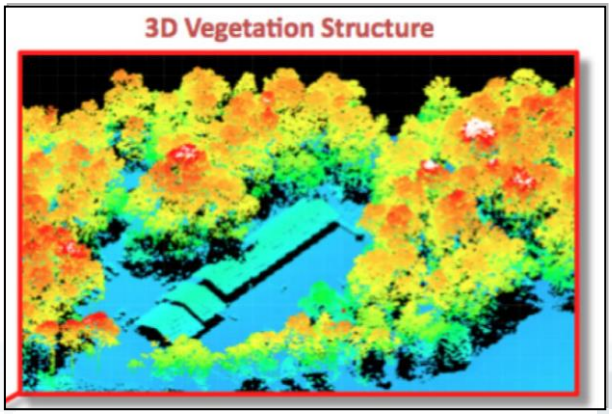
This will help to "sharpen" human / "AI Assistant" interaction

from https://www.mdpi.com/2072-4292/5/8/4045 image courtesy Wikimedia Commons

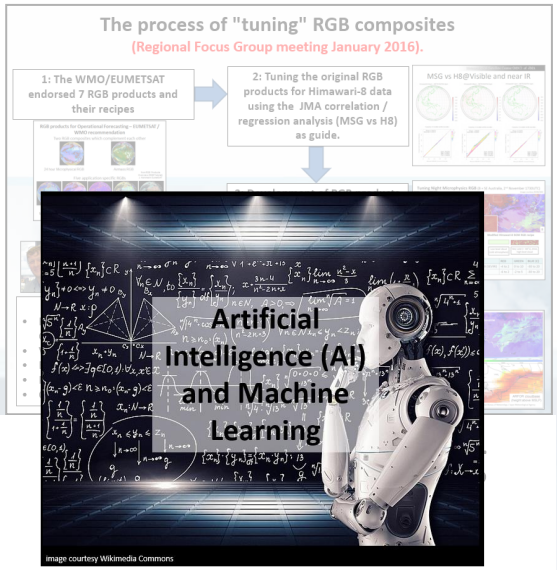
What topics might be presented at the January 2031 Regional Focus Group meeting?

VLab Strategy 2020-2024: Growth in social/crowd created projects and increased volume of co-creation content

FIVE-YEAR STRATEGY FOR THE WMO-CGMS VIRTUAL LABORATORY FOR EDUCATION AND TRAINING IN SATELLITE METEOROLOGY



Case studies include Mesoscale / Microscale



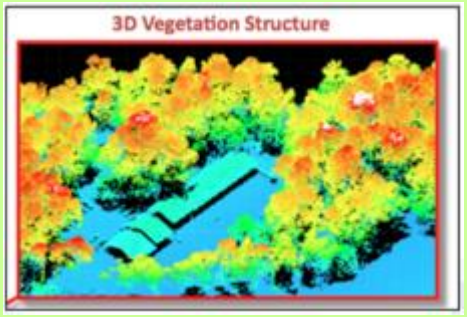
Some feedback provided by Dr Jim Purdom, Co-Chair AOMSUC ICSC

Satellite and radar mesoscale climatology's (that are formulated according to boundary layer flow) in nowcasting and short range forecasting.

The use of exceptionally high resolution local scale model output with observational data such as routine rapid scan satellite imagery that is placed into priority band combinations from your AI assistant.

Explanation slide: What topics might be presented at the January 2031 Regional Focus Group meeting?

- "Today, weather forecasting is taken to a whole other level of application and capability due to the ability to create high resolution or micro-forecasts. These abilities are further enhanced when combined with other data on traffic, vegetation, and topology". Smart Cities and the Weather, Minnovation Technologies https://minnovation.com.au/smart-cities-and-the-weather/



REFERENCE

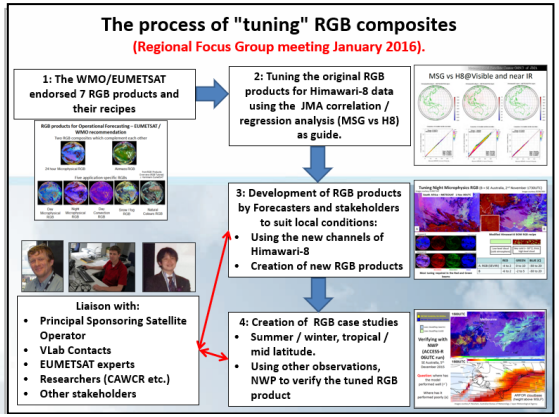
- Above: First coincident acquisition of passive optical, thermal and LiDAR data with G-LiHT (14 July 2011; 37.1839°N 76.5291°W) and key measurement characteristics of the instruments. Spectral and structural differences between a forest, river, golf course and buildings demonstrate the synergistic potential of data fusion for airborne remote sensing of ecosystem composition, structure, function and health. FOV, field of view; NETD, Noise Equivalent Temperature Difference. https://www.mdpi.com/2072-4292/5/8/4045

What topics might be presented at the January 2031 Regional Focus Group meeting?

VLab Strategy 2020-2024: Increased range of resources available for user training, and the challenges users and trainers have in efficiently finding and repurposing these resources;

Cloud based satellite access platforms. Learning how to access these and how they can be used in application training

FIVE-YEAR STRATEGY FOR THE WMO-CGMS VIRTUAL LABORATORY FOR EDUCATION AND TRAINING IN SATELLITE METEOROLOGY



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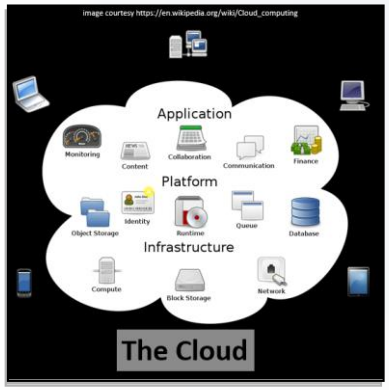

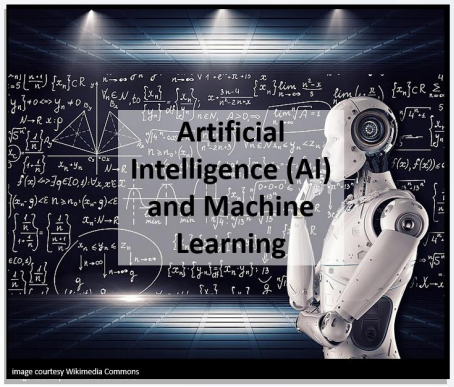

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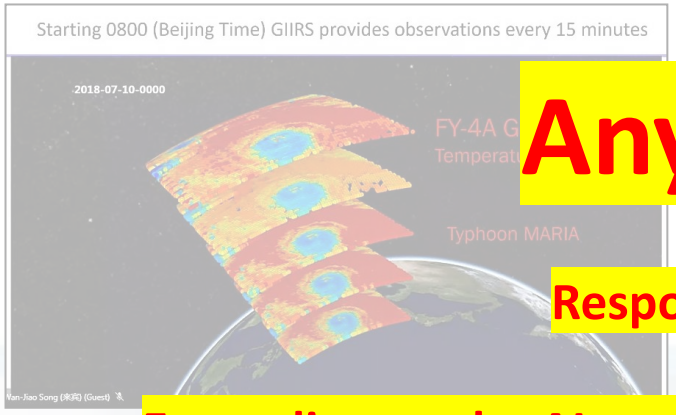
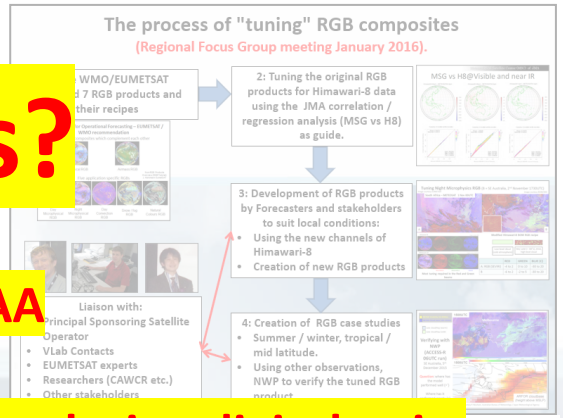
image courtesy Wikipedia. image courtesy Wikimedia Commons image from vTime https://vtime.net

What topics might be presented at the January 2031 Regional Focus Group meeting?

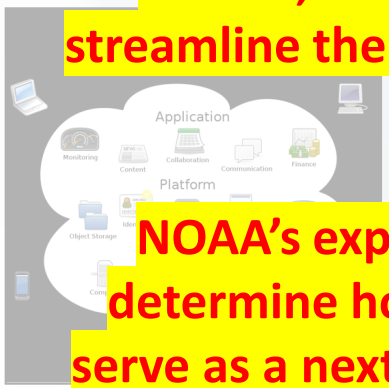


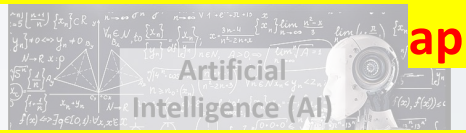


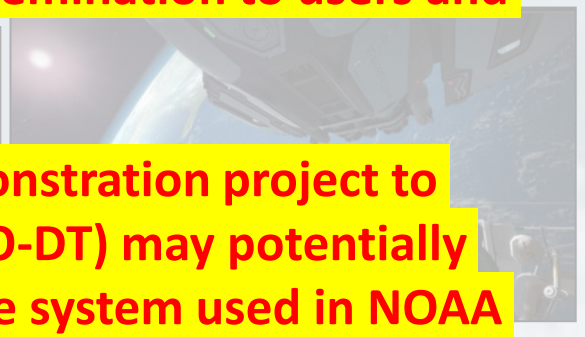
Any other topics?

Response from Jordan Gerth, NOAA

Expanding on the AI concept, NOAA is interested in exploring digital twin technologies to allow us to enhance our ability to process, monitor, quality-control, consolidate, fuse, and assimilate environment observations and streamline the satellite data ground processing and dissemination to users and applications.







NOAA's expectation is to use the results of this demonstration project to determine how an Earth Observations Digital Twin (EO-DT) may potentially serve as a next-generation ground processing enterprise system used in NOAA operations and interfacing with the Earth System approach modelling effort being undertaken at NOAA.

Taking the teaching directly to anywhere on Earth… wherever there is interesting weather…

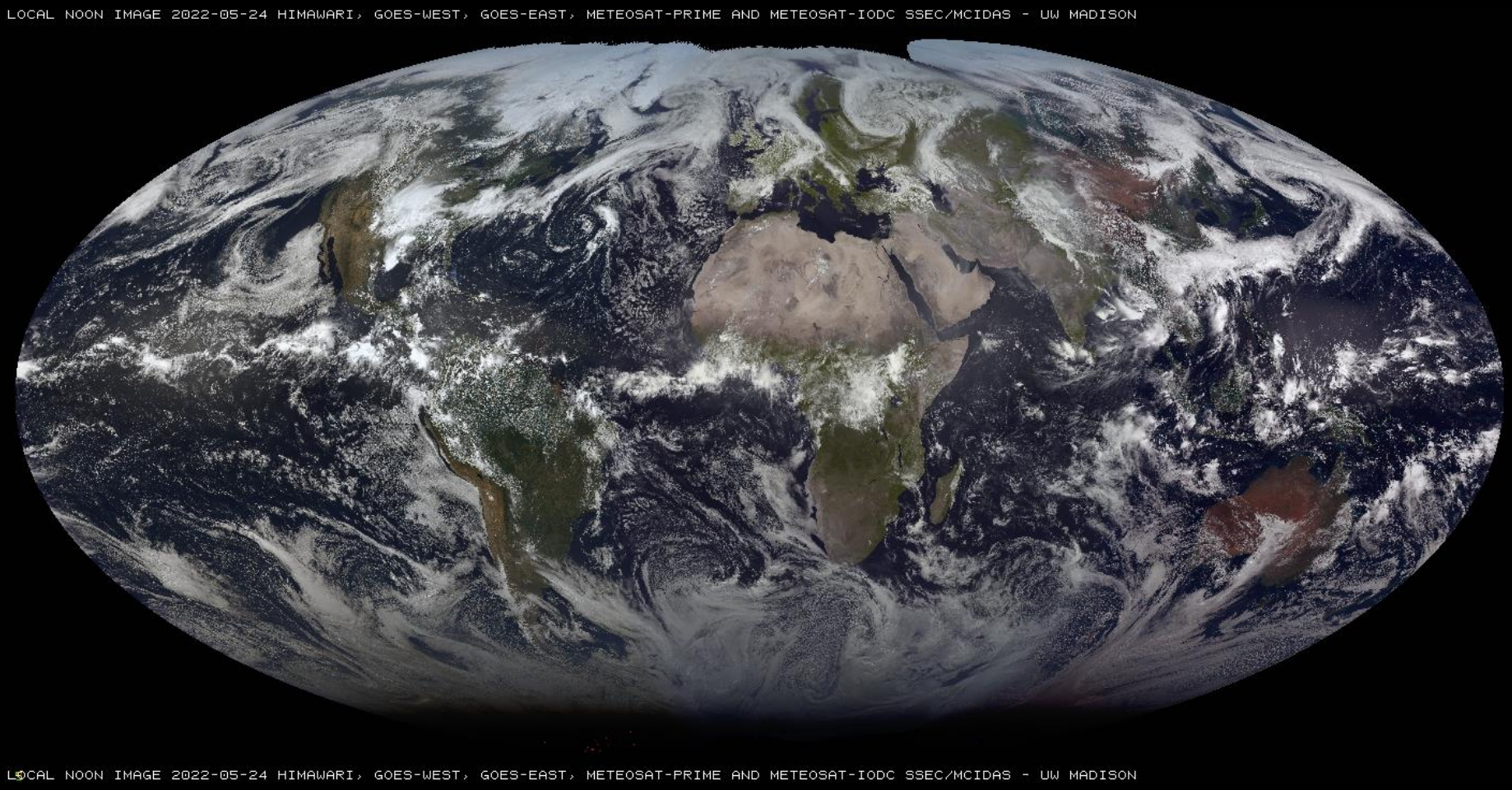


image courtesy Space Science and Engineering Centre, University of Wisconsin-Madison

The 101st Australian VLab Centre of Excellence Regional Focus Group meeting, 02UTC 28th June 2022

Contents

- **The Future of the VLab: what will the 200th Australian VLab CoE Regional Focus Group meeting, tentatively scheduled for January 2031, be like?** (Bodo Zeschke, Australian VLab Centre of Excellence)

The next Regional Focus Group meeting is scheduled to be held during July 2022