

Minutes of the 2024 Joint Meeting of the CEOS Working Group on Information Systems & Services (WGISS) & Working Group on Calibration & Validation (WGCV)

Chaired by USGS and ESA
Sioux Falls, South Dakota, USA

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Day 1: Tuesday 15th October 2024

Session A: Opening Session

A.1 - Logistics and Overview of Agenda

Tom Sohre (USGS, WGISS Chair) and Philippe Goryl (ESA, WGCV Chair) reported [\[slides\]](#):

- Welcomed all to Sioux Falls and thanked those who have joined online.
- The last time the two Working Groups met was in Tokyo in 2022.
- Tom and Philippe thanked USGS EROS for hosting the joint meeting, noting the importance of the centre for the history and development of remote sensing.
- Philippe welcomed the idea of hosting more joint WGCV/WGISS joint meetings again in the future. WGCV are confident in producing uncertainties but need the expertise of WGISS to communicate it.

A.2 - Welcome from USGS

Peter Doucette (EROS Director) reported [\[slides\]](#):

- The shared mission by the EO community is to study the Earth's surface to support the safeguarding of life, limb, property and natural resources.
- EROS' organisational structure includes satellite operations, data management, science applications, and new missions. USGS EROS have a \$130M FY24 budget.
- A key question is about how we are going to use AI in data management activities, including for multi-modal applications.



- New and planned land imaging satellite missions from the US Government cover electro-optical, thermal, and SAR domains. An emphasis is placed on harmonising multimodal datasets.
- There is a growing trend towards commercial missions, which should be considered in the various harmonisation efforts.
- Landsat Next is proposed to have 26 imaging bands, allowing for cross-comparison with many other missions including Sentinel-2 and commercial missions.
- The Harmonised Landsat-Sentinel (HLS) product is a good example of a multi-modal product. To achieve this, the Sentinel-2 product currently needs to be downsampled, with spectral band matching and bandpass adjustments, as well as BRDF corrections.
- An effective set of six bands is integrated for the time-series for HLS: Blue, Green, Red, NIR, SWIR1, and SWIR2 at 30 m spatial resolution.
- The ultimate goal is to be able to densify the observations using multiple satellites.
- A transformer with the self-attention approach conveys meaning implicitly through context, by assigning weights between every word pair. It also makes use of self-supervised learning by masking and multimodal text inputs.
- Multimodal text inputs can be transformed into a high-dimensional (100s-D) numerical feature space from which to draw inference.
- EROS is developing a Generalist Foundation Model for EO Data Imputation and Forecasting, which uses multimodal inputs: HLS indices, Land Surface Temperature (LST) & Elevation. To what extent can we use transformers to forecast responses?.
- With this approach, transformers represent a new approach to implicit multimodal geodata integration. For a set of EO datasets fed into a multimodal transformer, less manipulation and preparation is required, compared to HLS. This can serve climate, socioeconomic, and other geodata applications.
- EROS is investigating how EO data can be used to support public health, including future pandemics. By mapping land use and land use change, we can help understand how diseases spread from animals to humans (zoonotic disease spread), and map risk factors. A number of risk factor drivers feed into the spread of these diseases, and land use change is one of them.
- Many of the 2024 Nobel Prize winners had work relating to AI and neural networks. This demonstrates the impact of AI across different scientific disciplines.

Discussion

- Steve Convington (USGS) asked how AI will impact the definition of future collection processing like Landsat Collection 3.
- Peter didn't think it would change anything right now as it's not mature enough yet, but it may have an effect a little down the road. The Quality Control part of what we do will be of value regardless, including analytical modelling for atmospheric corrections and learning the correction process numerically. Combining the two would be a no-brainer.
- Tim Stryker (USGS) noted data volumes will only continue to grow with future missions such as Landsat Next and Sentinel-2 Next Generation. Can AI help CEOS Agencies manage these data volumes?
- Peter responded that the data volume challenge will continue. AI is not proposing to address how to better manage growing volumes, and the deep learning algorithms still require more training data. Increased volume across modalities will make algorithms more capable or better trained.
- Katie Baynes (NASA) asked what role governmental entities play in quantifying uncertainty. What is the goal of the governments to understand when products are appropriate for certain applications, and how do we communicate that?
- Peter recalled that this was a key question for WGISS and WGCV, as mentioned earlier. Creating visual ways to communicate the uncertainty would be helpful. What methods are available to understand the uncertainty and how it propagates through derived products?
- Peter Strobl (EC-JRC) noted that our models are only as good as we can train them. Who provides the training data?
- Peter Doucette noted that it has been up to the data producers to decide who is responsible to ensure data quality. Transformers tend to be more resilient to noisy data, but their outputs require validation. One of the biggest criticisms of neural networks is their nature as a 'black box'.
- Peter Cornillon (University of Rhode Island) sees AI for processing as important as a large language interface.
- Ken Casey (NOAA) via chat: *"We can talk about how LLMs play a role when we discuss Knowledge Graphs on Thursday in WGISS"*.

A.3 - CEOS Executive Officer Report

Steven Ramage (CEOS Executive Officer) reported [\[slides\]](#):

- SIT Technical Workshop 2024 was held recently in Sydney, Australia, from September 17-19, 2024.
- CEOS consists of over 60 member organisations. The Executive Officer is working with WGCapD to help broaden the membership of developing countries within CEOS, to help them learn from the more established agencies.
- Steven works closely with the SEO team and SIT Chair, which both report to the CEOS Chair. The 2024 CEOS Chair is the Canadian Space Agency, who are hosting the CEOS Plenary next week in Montreal, Canada. Their key theme is EO for Biodiversity.
- Commercial engagement is something CEOS needs to think carefully about. Many Working Groups already have successful engagement with the commercial sector.
- CEOS Plenary will most likely see a Biodiversity study team put together. The recent WGDIsasters meeting looked at nature-based solutions in response to disasters, and approaches like these will be explored by the study team.
- The incoming chair is the UK Space Agency (UKSA), working under the general theme of 'Unlocking EO For Society', which is looking at bridging the gap to the public service, including for the Global Stocktake (GST) of the Paris Climate Agreement, and the Global Methane Pledge.
- USKA is also planning a Youth Summit for school-aged children for the 2025 CEOS Plenary, to engage the younger generation in EO.
- One key role of CEOS Executive Officer is to liaise with GEO. Steven argued that nearly everything done by GEO is thanks to CEOS.
- The CEOS Work Plan has 130 open deliverables, which include roadmaps, strategies, and pilot projects. Both WGCV and WGISS both have a number of open deliverables, many of which have due dates for Q4 2024. These items will be discussed in detail over the coming days.
- From the SIT Technical Workshop onwards, the CEOS Executive Officer will support the WGISS interoperability team with CEOS engagement, including a focus on how the interoperability handbook is shared. There are agencies unaware of what CEOS documentation includes and provides.
- CEOS has a number of activities relating to the commercial sector. The CEOS Secretariat is working to develop some guidance for commercial companies on the CEOS website, to describe how they can be engaged at the working level.

- The first SIT-39 action called for the Executive Officer to understand where the various entities of CEOS are contributing to the work plan, and the impact.
- With the UN Ocean Decade, there is stress on in situ observations and not EO. COAST would like the CEOS Executive Officer to better promote and engage EO for the ocean community.
- CEOS has established a GitHub organisational account, which is a growing resource to help gather contributors from outside the regular contributors.
- The SEO has established the CEOS Analytics Lab, which is available for all CEOS entities to collaborate at a technical level.
- There are a number of items up for decision at CEOS Plenary next week. The Executive Officer is hoping to make recent publications from CEOS more findable and accessible.
- The CEOS Communications Team has partnered with CEOS Agencies to develop a 40th anniversary video, hearing from CEOS Principals about the past, present and future of CEOS. A new history page has also been put together for the CEOS Website.

A.4 - WGISS Chair Report

Tom Sohre (USGS, WGISS Chair) reported [\[slides\]](#):

- The WGISS-54 / WGCV-51 joint meeting was held in 2022 in Tokyo, Japan, hosted by JAXA. This was the first in-person meeting since the pandemic, and it provided insights into potential areas of collaboration.
- The joint session in 2022 was quite short, so for this week's joint meeting, two days have been put aside for joint discussions, as there are many topics which overlap.
- WGISS-57 was held earlier this year from March 4-7 2024 in Sydney, Australia, hosted by CSIRO and Geoscience Australia.
- For WGISS-58, the goals are to start discussing new topics, as well as review completed and ongoing work. WGISS would like to develop efficient and effective communications with stakeholders.
- WGISS is leading the coordination for the interoperability activities, which also includes WGCV and other groups from across CEOS. The interoperability topic is key in many areas, and will require collaboration, change, and compromise.
- Technology is evolving very quickly, and WGISS is trying to understand how to ensure documentation is developed alongside, to ensure it does not become out of date.

- It can be valuable to incorporate the lessons learned of non-CEOS organisations while learning from our successes and challenges.

Discussion

- Tim Stryker was glad to hear about interoperability and ARD, and personally sees the Working Groups as the engine room of CEOS that help us better connect and coordinate to achieve its objectives. Interoperability, data quality and accuracy are all important issues that CEOS plays an important role in. How might we all better illicit other external inputs and coordination on these topics? What can we do within Working Groups and outside them to make progress?
- Tom noted that we need to prioritise work and understand the key activities with limited resources. We should encourage collaboration with not only Working Groups but LSI-VC and SEO, which play big roles in these topics. Getting the outside perspective is new within CEOS, and is valuable but difficult. Distilling that down is a challenge, maybe AI can offer a solution.
- Philippe Goryl (ESA, WGCV Chair) recognised it is fundamental to reinforce discussion with the Virtual Constellations, in particular for CEOS-ARD. JACIE and VH-RODA are fundamental to get user feedback regarding CEOS-ARD. The concept of ARD outside CEOS is not well understood, so we need better contact with users.
- Steven Ramage (CEOS Executive Officer) noted that the ISO/OGC ARD standards activity was not well aligned with the CEOS-ARD approach
- Tim Stryker (USGS) noted the ISO/OGC effort was a good example to step back and understand how CEOS interacts with the community on standards and guidelines. Maybe CEOS-ARD wasn't mature enough just yet, or perhaps there wasn't enough engagement from the commercial sector. What the SEO team is doing with new interactions will be very helpful.
- Peter Strobl (EC-JRC) added that STAC is an interesting example, as it shows what happens when the stakeholders beat the providers. If CEOS doesn't organise a common approach, the industry may develop their own approach.

A.5 - WGCV Chair Report

Philippe Goryl (ESA, WGCV Chair) reported [\[slides\]](#):

- WGCV-53 was in Cordoba, Argentina from 5-7 March 2024, and was hosted by CONAE. Outcomes included developing a radiometric matchup database that can be used by New Space providers to validate their missions; development of the FRM Assessment

framework; coordination with WMO GSICS for the Preflight Calibration Workshop, which will be held in November 2024; and the SITSat Task Team's kick-off.

- The Infrared and Visible Optical Sensors Subgroup (IVOS) held their annual meeting a couple of weeks ago in Japan. RadCalNet is an operational service provided by IVOS, which is crucial for global data quality. TIRCalNet is under development, and intends to have an operational network in a few years.
- The Terrain Mapping Subgroup (TMSG) is working on a Digital Elevation Model intercomparison exercise (DEMIX), comparing various DEMs available with a few publications released. The group is also working on a ground control points intercomparison exercise (GCPIX).
- The Microwave Sensors Subgroup (MSSG) is working on a new activity around GNSS-R and GNSS-RO, which is popular within the commercial sector.
- The Synthetic Aperture Radar (SAR) Subgroup is holding a workshop in India next month. They are developing a network for SAR Calibration and Validation (SARCalNet) and would like to improve the representation of altimetry within the SAR subgroup and WGCV in general.
- The Atmospheric Composition Subgroup (ACSG) provides important contributions to the CEOS-CGMS GHG Task Team, and the definition of FRMs for atmospheric missions, including for the CEOS-FRM Assessment Framework.
- The Land Product Validation (LPV) Subgroup is working to expand to include evapotranspiration and GPP/NIPP land product focus areas.
- The SITSat Task Team is a joint activity between WGCV and GSICS, and is represented on the Cal/Val portal and GSICS site.
- The programme for the Preflight Calibration workshop has been published online. The workshop's objectives align well with the introduction of New Space and will show the importance of calibrating these missions' measurements.
- Recent work on the CEOS-FRM Assessment Framework include the reference paper (2023), updates to the FRM guidelines, the maturity matrix tool, and new exercise reports.
- The Best Practices for Surface Reflectance Intercomparison Exercise for Vegetation (SRIX4Veg) will be endorsed later this week, and is aimed at users of UAV-mounted instruments capable of validating surface reflectance products.

- The Best Practices Protocol For The Validation Of Aerosol, Cloud, And Precipitation Profiles of ACSG will also be endorsed.
- A recommended list of sites has been developed within IVOS for agencies to acquire data to compare quality between missions.
- There was a recommendation regarding the improvement of Cal/Val to follow metrology principles to better understand measurements and their uncertainties. This led to the development of FRMs and dedicated calibration networks and a push to share information on the portal.
- Nigel and Peter presented at CIPM STG-CENV in Sevres France in September, which saw the addition of 29 actions that WGCV will contribute to.

Discussion

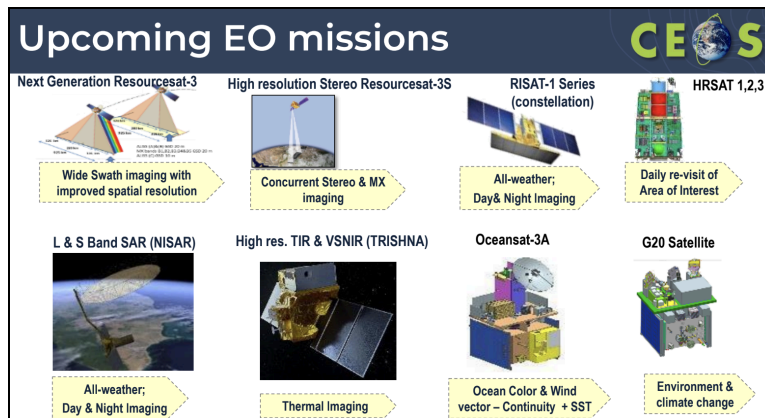
- Steven Ramage (CEOS Executive Officer) noted that WGCV has addressed ECVs, and wondered if CEOS should also look at EAVs.
- Michael Cosh (USDA, LPV Chair) noted that the LPV Subgroup has engaged with ECVs and EAVs, however it relies on a motivated person to lead the engagement. LPV is now looking at these other declared variables beyond ECVs, and hopes they are similar. LPV is also engaged with GEOGLAM.
- Peter Doucette (EROS Director) asked where CEOS should be going regarding uncertainty. What is the priority subtopic for uncertainty for the community?
- Philippe noted that per-pixel uncertainties have advanced, particularly for new missions. Providing uncertainty is becoming standard practice. The difficulty is how to provide information to the user. How the information can be provided to the user without exponentially increasing data size is important.

Session B: Agency Reports

B.1 - ISRO

Sai Kalpana (ISRO) reported [\[slides\]](#):

- INSAT-3D launched in February 2024, a geostationary meteorological satellite with a 6 channel imager and 19 channel sounder.
- EOS-08 launched on 16 August 2024 and has three payloads.



- The [MOSDAC portal](#) stores Indian Meteorological and Oceanographic Satellite Data, with near real time visualisation and analysis.
- ISRO is developing Bhuvan NextGen, which will include:
 - o Sub-meter Satellite data for the entirety of India
 - o Vector tiles for thematic data filtering
 - o AI/ML driven value added services
 - o Seamless radiometry across varied sensor resolutions
 - o OCM mosaic as satellite global base layer
 - o Free data downloads as per the ISRO Data Policy 2022.
 - o Visualisation of base layers, administrative boundaries, infrastructure & polarimetric data.
- ISRO's EO Data Hub, Bhoonidhi, is a data repository for remote sensing satellites, including data from both Indian and foreign remote sensing sensors, and facilitates the dissemination of satellite data products to online users on web.
- Bhoonidhi API is being developed for machine-to-machine data access, and is currently in beta testing.
- Priced data ordering has been handled through NSOL since May 2024. Many new data products have also been released through the data hub.

B.2 - JAXA

Akihiko Kuze (JAXA) reported [[slides](#)]:

- ALOS-3 was lost due to a launch failure in March 2023. In February 2024, the second test flight of the H3 rocket successfully launched. EarthCARE launched in May 2024 (a

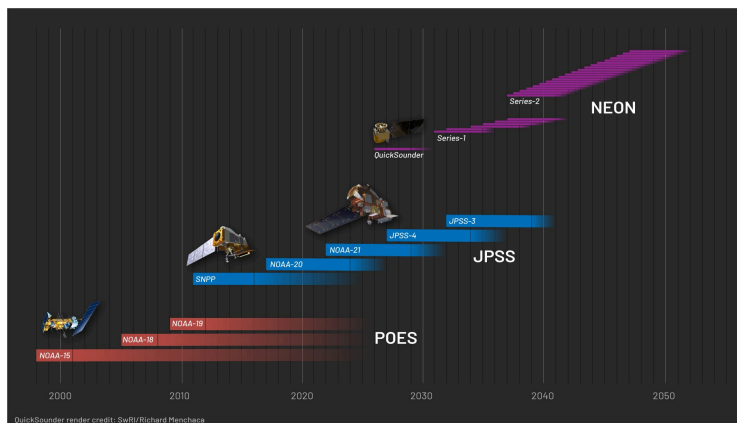
joint mission with ESA), and ALOS-4 launched in July. GOSAT-GW is scheduled for launch before March 2025.

- EarthCARE Level 1 and Level 2 data will be released in January and March 2025, respectively.
- One of four sensors on board EarthCARE, the Cloud Profile and Rain radar (CPR), is provided by JAXA. It is sensitive to thick clouds, while ATLID is sensitive to thin clouds. Combining the two sheds light on a wide range of cloud types. The instrument has demonstrated the capture of vertical distributions on Doppler velocity for tropical cyclones.
- JAXA has partnered with NASA for the Atmospheric Observing System (AOS) for the Precipitation Measuring Mission (PMM). Together with AOS-Storm, PMM will observe storms regardless of time or day.
- GOSAT-GW carries AMSR3, developed by JAXA, to gather solid precipitation retrievals and water vapour analysis. Planned for launch before March 2025.
- GCOM-C features a six-year dataset consistent with other instruments. GIRO performs monthly SGLI Lunar calibration.
- ALOS-4 has shared first light imagery and demonstrated the fastest optical inter-satellite communication.

B.3 - NOAA

Slawomir Blonski (NOAA) reported [[slides](#)]:

- NOAA currently has the JPSS satellites, with the first launch of the next generation of polar-orbiting satellites, NEON (Near-Earth Orbit Network), QuickSounder, planned for 2026.



- In the future, NOAA's vision is to incorporate larger constellations of smaller satellites.
- JPSS-2 launched in November 2022 and carries four instruments. Also known as NOAA-21, it is now the primary satellite for the constellation. JPSS-1 (NOAA-20) is the secondary satellite.
- Suomi-NPP is the tertiary satellite for the constellation, as the CrIS instrument has degraded to cover a limited spectral range.
- There are two further JPSS satellites planned for launch. JPSS-4 will be launched in 2027 and will house the same JPSS instruments apart from Libera, the CERES replacement. The satellite's testing is planned for 2025 and 2026. JPSS-3 has been built and will enter long term storage before launching in 2032.
- NOAA-21 (JPSS-2) was commissioned last year. Everything went well for VIIRS except for the SWIR band response, which was mitigated with the 2nd mid-missing outgassing (MMOG-2) in February 2024. There was also an issue with biases, so adjustments were applied.
- NOAA's Sahara site was used for VIIRS Reflective solar bands (RSB) Pseudo-invariant Calibration Sites (PICS) comparisons. RSB observations of PICS compared favourably from NOAA-21 and -22 to Suomi-NPP.
- Thermal Emissive Bands (TEB), especially the MWIR ones, were also affected by the response degradation like the SWIR bands, but to a much smaller extent. This has been mitigated by MMOG-2.
- There is good agreement between NOAA-20 and -21, except for in the fire detection band at 4 micrometres. The main differences are explained by the change in spectral response. Previously on Suomi-NPP, the response was shifted to a longer wavelength. On NOAA-22, it was shifted to a longer wavelength to avoid the CO2 line. The same will be done on JPSS-3 and JPSS-4.
- GOES-U, the fourth and final satellite in the Geostationary Operational Environmental Satellites (GOES) – R Series, launched on June 25, 2024. It was renamed to GOES-19 after launch.
- GeoXO is the next generation of geostationary NOAA satellites. The satellites will orbit in three orbital positions, with imaging (GX1), sounding (GXS), atmospheric composition, lightning and ocean colour sensors.
- Migration to cloud computing comes with JPSS SDR and VIIRS Imagery EDR was moved to AWS Pub Cloud in September 2024.

- NOAA Open Data Dissemination will see JPSS products migrated to the cloud (AWS and Google Cloud).

B.4 - Geoscience Australia

Medhavy Thankappan (GA) reported [\[slides\]](#):

- Dr. David Hudson was recently named as the branch head of the Satellite Land Imaging division, and the Digital Earth branch is now headed by Leyla Alpaslan.
- GA has joined the international Landsat Next Partnership. Although GA has been a partner with Landsat over the last 50 years, this partnership represents a large step in investment and cooperation from Australia.
- Key elements of the Landsat Next Partnership include the enhanced capacity of the Alice Springs Ground station, permanent Cal/Val facilities, the Indo-Pacific Regional Data Hub, the Operational Data Quality and Integrity Monitoring Facility, first nations technical training and research programmes, new analytics technology, field data collection programmes, and interoperability engagement and uplift.
- The Copernicus data hub will be expanded to support the Indo-Pacific, and include many more datasets, including from Landsat and commercial missions.
- Quality, consistency and trust have been highlighted across a number of reports as crucial to the Australian EO sector.
- The Landsat 8/9 under fly campaign was supported by GA, and allowed for the revisiting of the methodology used to validate surface reflectance products.
- Using overlapping zones between Landsat and Sentinel that progress eastward, in situ data was collected for validating surface reflectance (SR) products for both Landsat and Sentinel.
- All data collected for SR validation is available from the [National Spectral Database](#).
- GA continues to support the Queensland Corner Reflector Array (QCRA), which is an array of 40 corner reflectors with regular maintenance and surveying.
- 1.5 m permanent corner reflectors have been established at Yarragadee, Australia as one of the few fundamental geodetic co-location stations in the world.
- GA also supported the SRIX4Veg campaign, and have recently published a paper detailing the concept of a satellite cross-calibration radiometer.

B.5 - ESA

Mirko Albani (ESA) reported [\[slides\]](#):

- ESA has recently launched four satellites:
 - o EarthCARE (with JAXA) on 28 May 2024: the largest Explorer built by ESA, looking at clouds and aerosols.
 - o Arctic Weather Satellite (AWS) on 16 August 2024: demonstration mission for a constellation of polar orbiting satellites for monitoring weather over the Arctic.
 - o Phisat-2 on 16 August 2024: a 6U Cubesat, with a multispectral imager and onboard processing capabilities
 - o Sentinel-2C on 5 September 2024.
- Swarm provided data on the recent solar activity, which is at its highest in 20 years.
- ESA has a dedicated programme for heritage missions to support the production of long time series.
- ESA is looking at the CEOS Analysis Ready Data (CEOS-ARD) specifications in their reprocessing of archived data.
- The agency is also working on advanced data access with a new mechanism for mission data, as well as an analysis platform for Biomass that is already operational.
- The Copernicus mission family has a lot of members, and additional Sentinels will be launched in the coming years. The expansion missions will address additional requirements unfilled by existing missions. The Next Generation Sentinel missions are also in development.
- Sentinel-1A undergoes quasi-nominal operation, and Sentinel-1C is planned to launch by the end of the year.
- Sentinel-2, -3, and -5P are undergoing nominal operations.
- Examples of recent Sentinel observations include Multi-temporal imagery of floods across Europe (Sentinel-1), and NO₂ plumes in Riyadh (Sentinel-2).

B.6 - CNES

Hugo Fournier (CNES) reported [\[slides\]](#):

- CNES has been working to improve the usability and interoperability of their data.

- A new data hub and services platform called GEODES is being developed, which currently hosts Sentinel-1 and -2 data with plans to add more in the next year. The platform includes on-demand processing and Datalabs tools.
- GEODES provides data in cloud-optimised formats (COG and ZARR), and will be integrated with OpenEO via a backend. GEODES will be included as an OpenEO data provider.
- The Digital Twin Factory (DTF) seeks to develop a set of highly specialised local digital twins with high precision (on the scale of metres), in contrast to global digital twins that operate at a coarser resolution (on the scale of kilometres).
- CNES is collaborating with national and international agencies and working groups (ESA DCB, OGC, Pangeo), particularly in regard to the platform and digital twin federations, and the OpenEO implementation group.

B.7 - UKSA

Robert Fletcher (UKSA) reported [\[slides\]](#):

- Beth Greenaway is being joined by Lauren Newell as a joint head of Earth Observation and Climate at UKSA.
- The UK's EO investment programme includes 18 projects and £274m in funding between 2022-2025. The investment seeks to mitigate the economic impact of non-association to Copernicus, support the UK EO sector, and preserve EO capabilities.
- UKSA is currently funding 12 projects, including six flagships, four Fast Tracks, and two Pathfinders.
- Earth-I Ltd has been granted £70,610.40 for its MuSeReCo project, which focuses on enhancing the accuracy and interoperability of EO data. This project will aim to develop a tool that can automatically and accurately co-register data from multiple satellites, regardless of their formats, resolutions or geo-referencing standards.
- GMV NSL Limited has been granted £16,400 for its forward-thinking project "Data Processing as a Service". This project aims to position the UK as a leader in EO data processing.
- TRUTHS will provide a benchmark reference of the optical radiation state of the planet. The goal is to host the TRUTHS ground segment in the UK, to build and develop the UK's capabilities for the end-to-end delivery of a complex space mission. TRUTHS is scheduled to launch in 2030.

- MicroCarb is a joint mission between UKSA and CNES that will launch in 2025 to characterise GHG fluxes and gauge how much carbon is being absorbed by oceans and forests.
- EO data support from UKSA includes ESA's Digital Earth Twin, Copernicus, the NCEO EO data hub, and the ESA Collaborative Ground Segment.
- A year-long pilot was run for Geospatial Commission in the UK to evidence the value of satellite-derived EO data, with findings and recommendations expected soon.
- UKSA will be the chair of CEOS for 2025, and aims to bridge the data gap to transform public services and grow data-fuelled businesses, which is an ongoing challenge faced by many countries. As CEOS Chair, UKSA will also host the first CEOS Youth Summit, inspiring the next generation.

B.8 - GISTDA

Prayot Puangjaktha (GISTDA) reported [\[slides\]](#):

- GISTDA has the mission to develop space and geo-informatics technology, and to deliver the value of space to Thai society and the global community.

GISTDA operates two optical satellites: THEOS-1 (launched in 2008) and THEOS-2 (launched in October 2023). THEOS-2A is planned to launch in the first quarter of 2025.



- The Si Racha ground station receives data from many international satellites.
- GISTDA is actively engaged in Cal/Val, performing radiometric and geometric calibration over THEOS Test Sites.
- GISTDA's future plans include:
 - o Improving GISTDA's Cal/Val processes in accordance with ISO/TS 19124 standards.

- Developing THEOS-1 and THEOS-2 satellite products in CEOS-ARD format, in line with CEOS-ARD Surface Reflectance standards.
- Developing an Open Data Cube system for the efficient distribution of satellite imagery.
- Improving GISTDA satellite services to fully comply with CEOS Data Management and Stewardship guidelines.
- Exploring collaboration opportunities within CEOS Cal/Val and WGISS networks.
- GISTDA have already completed CEOS-ARD self-assessments, which have outlined areas for improvement, and welcome any feedback on these areas to improve satellite capabilities.
- GISTDA will host the Thai space week next month, and is looking forward to hosting WGISS-59 in Bangkok next year.

Session C: Maturity Matrices

C.1 - WGCV Maturity Matrix

Philippe Goryl (ESA, WGCV Chair) reported [\[slides\]](#):

- The WGCV Maturity Matrix aims to understand the quality of a dataset.
- The number of commercial missions continue to grow in size with an increasing importance of hyperspectral data.
- NASA & ESA have established projects to assess datasets: CSDA and EDAP. The maturity matrix is a tool for these teams to help these assessments.
- The data needs to be trustable and fit for purpose, and is often questioned by potential customers.
- CEOS is developing an increasingly comprehensive definition of mission quality, through CEOS-ARD, FRMs and other WGCV activities.
- The assessment framework consists of reviews of mission quality, accompanying products, observation quality, and fitness for purpose.
- The framework is in the process of being consolidated for the atmospheric domain.

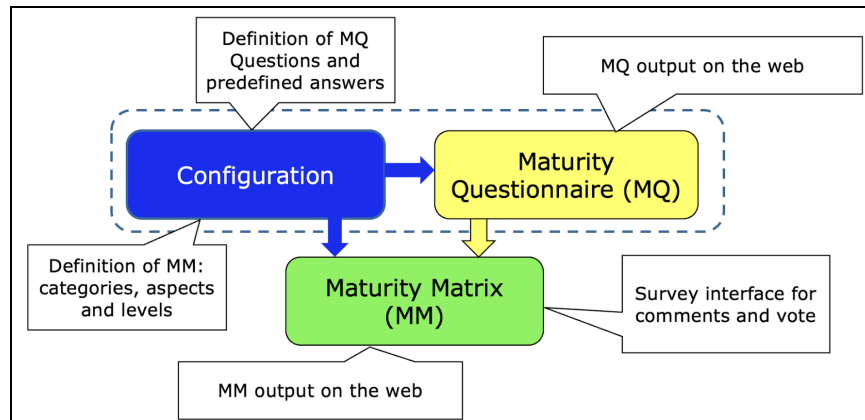
Data Provider Documentation Review			Validation Summary	Key
Product Information	Metrology	Product Generation		Not Assessed
Product Details	Radiometric Calibration & Characterisation	Radiometric Calibration Algorithm	Measurement Validation Method	Not Assessable
Availability & Accessibility	Geometric Calibration & Characterisation	Geometric Processing	Measurement Validation Results Compliance	Basic
Product Format, Flags & Metadata	Metrological Traceability Documentation	Retrieval Algorithm	Geometric Validation Method	Good
User Documentation	Uncertainty Characterisation	Mission-Specific Processing	Geometric Validation Results Compliance	Excellent
	Ancillary Data			Ideal
				Not Public

- An uncertainty should be associated with each step of the processing chain.
- The assessment process is an interactive activity between assessors and missions. Fostering communication between the data provider and assessor is important for maintaining the quality of calibration.
- How the Cal/Val maturity matrix can be integrated into the overall WGISS maturity matrix is being explored. The main issue in this exercise is defining the goals and target audience.
- CEOS-ARD isn't strictly a maturity matrix, but it is an additional tool to understand data.

C.2 - WGISS Data Management and Stewardship Maturity Matrix (DMSMM)

Paolo Castracane (ESA/Starion) and Iolanda Maggio (ESA/Starion) reported [\[slides\]](#):

- The DMSMM was developed from the GEO Maturity Matrix and the GEOSS data management principles. Now it is being incorporated into the Cal/Val matrix from the quality aspect.
- The matrix is grouped into five elements, each with several components. It gives an overview of how many tasks are needed to achieve the highest level of maturity.
- The new version of the white paper includes a section on how to compile the matrix, as opposed to doing so manually.
- ESA has developed a maturity matrix tool to simplify the assessment process.



- The tool has been exploited for different domains, including the Cal/Val and CEOS-FRM matrices.
- The questionnaire assigns levels based on selections, and presents a tabular summary at the end to make any adjustments. The colours are a legend that relate the maturity of the different selections.
- Admins can compare different assessments to show progress.
- There are a number of items which still need work on the tool, including verification for independent assessors, automatic CEOS FRM classification and an assessment report.
- The testing phase is almost finalised, with a few new functionalities and issues to be resolved.
- The idea with the tool is that it can be more easily implemented in the future, such as for the planned Interoperability Maturity Matrix.

C.3 - Interoperability Maturity Matrix

Nitant Dube (ISRO, WGISS Vice Chair) reported [[slides](#)]:

- The Interoperability Maturity Matrix is still in the early stages, with the concept still under definition.
- In developing the handbook, WGISS should provide a tool to measure the maturity level.
- The matrix will be used as an assessment tool to help users measure the effect and progress of interoperability factors and their implementation.
- The maturity is divided into five levels:

0	INITIAL	Processes are ad-hoc, chaotic, and success depends on individual effort
1	REPEATABLE	Basic management processes are established, and successes can be repeated
2	DEFINED	The organization develops a standard process that is documented, standardized, and integrated into all processes
3	MANAGED	The organization monitors and controls its processes through data collection and analysis
4	OPTIMIZED	Processes are constantly improved through feedback and by introducing new ideas and technologies.

- The maturity matrix tool can be tuned based on individual requirements. The framework has been defined according to five factors: Policy, Vocabulary, Architecture, Interface, and Quality.
- The handbook in development will contain recommendations against each of the five factors. These will then be incorporated into the Maturity Matrix.
- Open data is provided on an ad hoc basis, and defined as documented, discoverable, and disseminated based on standards.
- Once a user has selected all maturity levels in each recommendation of the interoperability factors, the outcome can be displayed in a radar chart to visualise the strengths and weaknesses.

C.4 - Maturity Matrices Discussion

- Tom Sohre (USGS, WGISS Chair) asked if CEOS envisions for assessments like this to be self-assessments, or should organisations such as CEOS be documenting them?
- Doug Newman (NASA) suggested self-assessment be a first step. Nitant Dube (ISRO, WGISS Vice-Chair) agreed, as there's a big overhead needed to do the assessments.
- Philippe Goryl (ESA, WGCV Chair) noted that the matrices all have a different purpose, and wondered if there is a need to make them work together, and how CEOS can use these matrices to improve the trust in data.
- Peter Strobl (EC-JRC) noted that standards are good models. ISO/OGC models usually don't come with an authority who approves them, and comes with a self-explaining document to check their compliance. Standards organisations are pushing for compliance checks to be documented and everyone to add their respective label.
- There are three main types of 'quality': quality of documentation (metadata, describing data), how 'good' is the data (what is the performance of instruments and do they fulfil the expectations), and the fitness for purpose (applications come with certain requirements).

- Philippe noted that the Earthnet Data Assessment Project (EDAP) is in the process of evolving the assessment to understand fitness for purpose as well.
- Authenticity is also important. At a certain point we need to confirm that the data is real. People are asking for certification, so we're trying to build up mechanisms to do this.
- Steven Ramage (CEOS Executive Officer) has worked with OGC on the compliance programme, and noted there is a lot of different experience out there which CEOS can learn from. EShape, an EO maturity model, is now being used by GEO.
- Mirko Albani (ESA) noted that different aspects are covered by different matrices, but should consider how they can be integrated as well. The WGISS Maturity Matrix is complementary to the WGCV one with a focus on data stewardship. Interoperability then takes the next step.
- A common format and levels should be used across the board.
- Tom suggested that combining them into a 'meta matrix' may not be a good idea as it could overcomplicate.
- Jean-Christopher Lambert (IASB-BIRA) noted that improving the trust in the data can stem from producing and documenting according to known methods. Fitness for purpose is more complicated. Shouldn't CEOS establish guidance, with basic quality indicators that accompany the data? The quality indicators would assess the abilities of the data.
- Nigel Fox (UK NPL) suggested the matrices should include values to define what is appropriate for particular applications.
- Michael Cosh (USDA, LPV Chair) doesn't think it is CEOS' job to improve trust in data, but rather to define trustworthy data. CEOS shouldn't be involved in declaring a dataset as trustworthy.
- Peter Cornillon (University of Rhode Island) noted that trust in data and fit for purpose are two separate questions. Documentation and accessibility of the documentation is also important. For example, for AVHRR data, finding how it was calibrated is documented somewhere, but can be hard to find.
- Cody Anderson (USGS, WGCV Vice-Chair) asked who the audience is for the Maturity Matrices? What questions should be answered with them?
- Nigel noted that at some point, someone has to judge the quality of the data, or make it easier for users to make that judgement. What is 'good enough' has to be judged by

community consensus, and CEOS is likely the only organisation with the skills and resources to do so.

- Nancy Ritchey (NOAA) noted that as we move toward open science, a machine will get the data most fit for a user’s purpose, not a human. These matrices can help drive that open science and machine actionability. However, the more matrices available, the more difficult it will be for potential users to choose which matrix or set of matrices are needed to define if data is fit for their purpose.

WGCV-WGISS -2024-01	<p>The WGCV Maturity Matrix and WGISS Data Management and Stewardship Maturity Matrix teams should define their target users, and ensure their tools are fit for purpose. The Interoperability team should also consider this when developing their matrix.</p> <p>Action Lead: Paolo Castracane, Iolanda Maggio</p>	Q2 2025
WGCV-WGISS -2024-02	<p>The WGISS, WGCV and Interoperability Maturity Matrices should follow a common format, including definitions for the levels of maturity. The teams should also follow the development of the GEO Earth Intelligence Readiness Matrix, and reference/coordinate where necessary.</p> <p>Action Lead: Paolo Castracane, Iolanda Maggio, Nitant Dube</p>	Q4 2025

Session D: CEOS Analysis Ready Data (ARD)

D.1 - CEOS-ARD Progress

Chris Barnes (USGS, LSI-VC Co-lead) reported [\[slides\]](#):

- The CEOS-ARD (formerly CARD4L) Strategy is being updated for 2024, reflecting on process to date and future direction.
- The ultimate goal is for a broad portfolio of CEOS-ARD compliant products that are easily discovered, accessed and publicly used.
- The strategy has six broad themes:
 1. CEOS-ARD Availability, Product Diversity, and Representation
 2. CEOS-ARD Framework and Specification Advancement (activities relevant for WGCV & WGISS)
 3. Discovery, Access, Utilisation, and Interoperability (activities relevant for WGISS)

4. Community Engagement
 5. Research, Test Cases, and Pilot Activities (activities relevant for WGCV)
 6. Commercial Engagement (activities relevant for WGCV)
- Nine data providers have now become CEOS-ARD compliant.
 - Chapter 3 has the most relevance for WGISS, with a number of aspects which could be supported by CEOS.
 - CEOS-ARD comes with a branding to indicate that the product has gone through the specification review.
 - Chapter 5 includes the Surface Reflectance Quality and Consistency project.
 - Chapter 6 describes development 'Sprints', which have successfully been employed in the past by EROS.
 - The strategy document is open for feedback before endorsement at CEOS Plenary next week.

Medhavy Thankappan (GA) reported on the CEOS-ARD Product Assessments [\[slides\]](#):

- The original CEOS-ARD assessment process was altered to reduce the burden on the review team, now only requiring a panel review when the self-assessment is submitted for Goal level certification.
- For any threshold level submissions, a panel for review of the product is no longer required. The other change is that once assessments have been reviewed by the point of contact, the acceptance doesn't have to go through a voting process.
- Once the assessments are done based on data provider interactions, the outcome is notified to the data provider and the LSI-VC point of contact, as well as WGCV.
- There are five products currently under peer review from DLR, AIR-CAS, NASA/JPL, Catalyst/PCI and ISRO.
- A guide to the self-assessment process can be found online to simplify the review process.

D.2 - GitHub and modular approach to CEOS-ARD PFS

Chris Barnes (USGS, LSI-VC Co-lead) reported [\[slides\]](#):

- At LSI-VC-16 in September 2024, there was unanimous agreement that the best way forward to develop transparency, version control and consistency across CEOS-ARD Product Family Specifications (PFSs) is via GitHub. This platform allows the tracking and collection of community feedback.

- The highest priority action is to establish the roles and responsibilities of GitHub.
- A workflow will be established with tools and building blocks of PFSs, moving away from Word Documents and utilising the version control abilities of GitHub. Handling historical compliance of older PFS versions is also important.
- The LSI-VC Secretariat and Co-leads are defining a GitHub roadmap to be drafted ahead of the next LSI-VC meeting in April 2025.
- Matt Paget and Matthias Mohr, supported by the SEO, will set up this GitHub environment and bring in the PFSs. It will initially be done with the SAR PFS, and then brought across to Optical PFSs as well.
- Optical PFS includes Surface Temperature, Surface Reflectance, Aquatic Reflectance, and Nighttime Reflectance. The activity to combine these is led by USGS, and the first draft has been completed.
- The SEO will lead the GitHub training for LSI-VC. Any input and guidance from WGCV and WGISS is welcomed.

Discussion

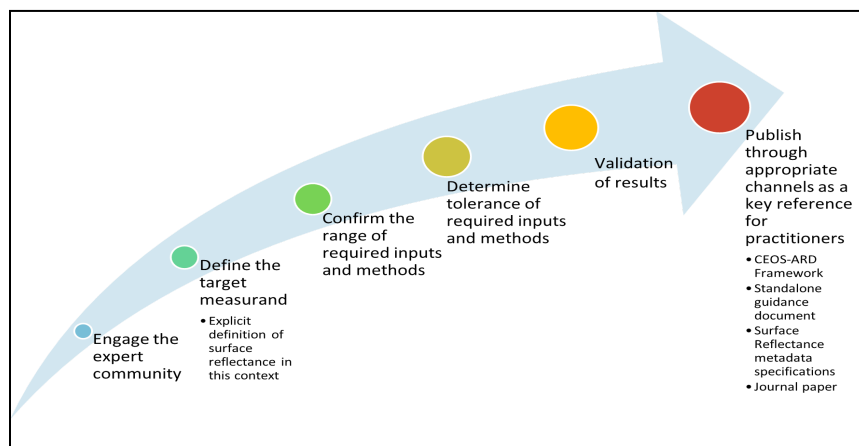
- Doug Newman (NASA) suggested that Google Docs may be a better way to go about this collaboration.
- Chris was resistant to using GitHub at first, and the PFS have been traditionally developed using Google Docs. However, the number of issues and comments has become unmanageable.
- Brian Terry (SEO) noted GitHub has the ability to open issues, and has complete traceability of release history, as well as publishability. The learning curve is steep but short.
- Katie Baynes (NASA) asked whether this means the PFS will be moved to markdown?
- Chris noted the PFS were converted to markdown, however in the new modular approach, they may be converted to a similar markup format. The PFS will be line-editable in git, and extensive coding knowledge will not be required.
- These questions led LSI-VC to decide a governance framework is needed to manage the GitHub repository.
- Tim Stryker (USGS) asked whether the 2024 CEOS-ARD Strategy 2024, which is going for Plenary endorsement next week, will evolve into a governance framework?

- The strategy covers the CEOS-ARD initiative as a whole, of which GitHub is a part. The GitHub governance framework will form a part of this.

D.3 - Surface Reflectance Quality, Equivalency and Consistency

Simon Oliver (GA) reported [\[slides\]](#):

- The issue being discussed is that CEOS-ARD tolerates different approaches for deriving surface reflectance (SR).
- There are many approaches to defining a SR product, which limits the ability to use them together.
- The need for compatibility of SR measurements is demonstrated by NASA's Harmonised Landsat and Sentinel (HLS) product and ESA's Sen2Like. ARD is only the first step in an interoperability continuum.
- Harmonising data across providers and sensors complements datasets and helps to fill measurement gaps. Where Sentinel-2 doesn't provide clear pixels, Landsat-8 can fill the gap. Harmonisation also provides better insights into seasonal phenology and transient phenomena.
- The project plans to build on CEOS-ARD achievements so far, and unambiguously characterise the SR quantity in the context of ARD. Identifying a set of inputs, corrections, parameters, and tolerances would grant consistent time series across sensors, a focused effort on value adding, and reduced duplication.
- The Atmospheric Correction Intercomparison Exercise (ACIX) evaluated and compared the performance of several atmospheric correction processes, while SR quality and consistency allows for differences in approaches and focuses on defining the SR quantity for measurement harmonisation.



- The activity was kicked off in March this year, and fortnightly meetings of an expert group are held to produce a guidance document. This document intends to serve as a reference for providers considering reprocessing EO collections of moderate resolution passive optical data.
- The document is titled: "Achieving consistent quality for harmonising land surface reflectance measurements across like-sensor bands in the solar reflective region".
- The surface reflectance consistency was defined as: *"Surface reflectance measurements from different (satellite)s or sensors can be considered consistent when if, for an invariant target and within a predefined range of conditions, they produce comparable results which fall within their measurement uncertainties for the same target under predefined conditions."*
- The guidance document draws the line of consistency at harmonisation, and does not go as far as homogenisation.
- Parameter tolerances as well as the SR measurand definition are current works in progress.

Discussion

- Katie Baynes (NASA) asked if each CEOS-ARD PFS should have an accompanying type of activity and be documented in the GitHub?
- Medhavy Thankappan (GA) noted the team wanted to start with something bite sized to see how this goes, and will consider extending in future.
- Peter Strobl (EC-JRC) noted that the activity is parameter specific. Many parameters in other PFSs won't be affected by this uncertainty definition. However when specifications for other domains such as precipitation are developed, this type of activity may need to be considered.
- Katie noted CEOS-ARD is very land-centric at the moment. Libby Rose (WGISS Secretariat) noted that CEOS-ARD and the Interoperability Framework were included in the GHG roadmap, which is also up for endorsement at CEOS Plenary next week.
- Steven Ramage (CEOS Executive Officer) asked if the team is engaging with the commercial sector. He recently had a call with Planet and noted they have been struggling with the current PFS.
- Chris noted that moving to GitHub will allow each issue to be addressed individually, without changing the compliance of existing products.
- The process to develop aquatic PFS is also bringing up questions for the SR PFS.

- Brian Terry (SEO) recognised the effort is about being consistent with harmonisation as well as using the right vocabulary. Will there be pushback if the HLS product is labelled as harmonised, but not following the guidelines?
- Medhavy noted that community agreed definitions of each of these terms is needed.

WGCV-WGSS-2024-03	Interoperability Handbook team to connect with the Surface Reflectance Quality and Consistency project team to consider how the ongoing work of the project might fit as an example within the interoperability handbook. Action Lead: Nitant Dube, Simon Oliver	Q4 2025
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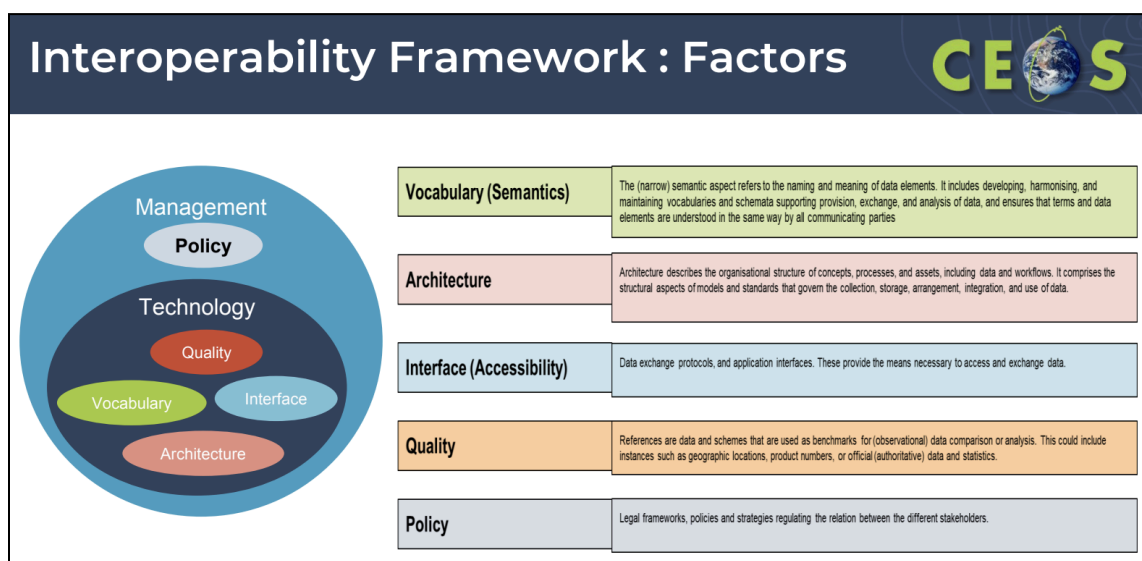
Day 2: Friday 18 October 2024

Session E: Interoperability

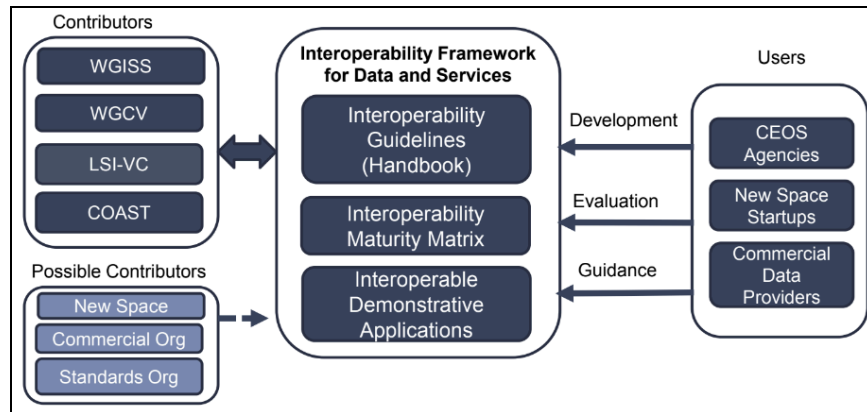
E.1 - CEOS Interoperability Handbook v2.0 Status

Nitant Dube (ISRO, WGISS Vice-Chair) reported [\[slides\]](#):

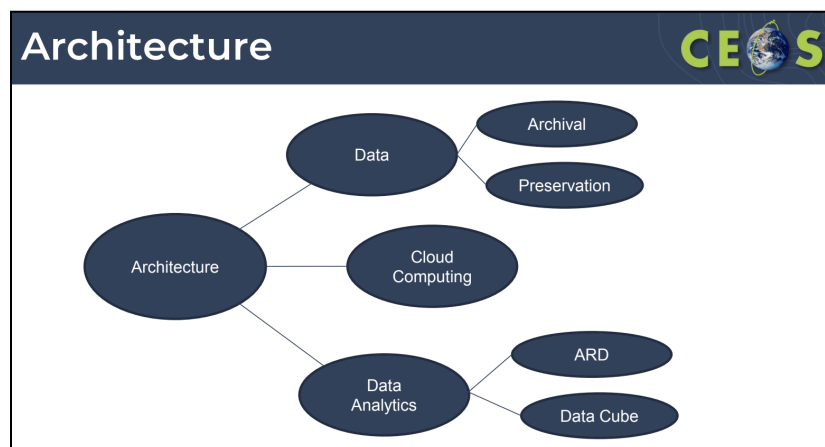
- WGISS is leading the development of Version 2 of the Interoperability Handbook, which aims to provide guidance to organisations for the development of interoperable data and services and to help them measure maturity levels.



- The Interoperability Handbook will give an overview of existing capability with CEOS to help data providers develop interoperable data and services.



- Commercial space and standards organisations should be included in the development of the handbook, but it's not clear on how to interact and cater to these organisations. The Handbook team is looking for possible contributors.
- Maturity matrices will help the end users or data providers to measure how mature their systems are against the recommendations of the handbook.
- Chapter 6 will be led by WGCV.
- For Chapter 7, the CEOS SEO and Exec officer teams could be involved to explore what different types of policies that exist within organisations can help in making data and services interoperable.
- Two ISO standards are recommended for implementing vocabulary, with ISO 25964-1, 2011 to develop a thesaurus and ISO 25964-2, 2013 to ensure interoperability with other vocabularies. The CEOS Common Online Dictionary can be used as a reference. The terms should be interrelated with clear relationships between them (parent, sibling, child, etc.).



- CEOS-ARD specifications are aimed as a starting point for interoperability analysis and the development of interoperable architecture.
- The Open Data Cube (ODC) can be taken as a reference for Data Cube implementation.
- Data cubes should support spatial or temporal dimensions, and abstract the underlying data storage architecture to support hybrid data and interoperability among different types of data cubes.
- Cal/Val recommendations can be hosted on the Cal/Val Portal as a reference site for ensuring interoperability with WGCV.
- Policy recommendations will include utilising the CEOS MIM Database for publishing information about current and future missions and instruments, as well as encouraging open science, open data, open software and open standards.
- The handbook is available on GitHub.

Discussion

- Steve Covington (USGS) asked if interoperability in CEOS-ARD should be encouraged in the handbook as a specification on data procurements between CEOS Agencies and commercial companies. Procurement actions requiring CEOS-ARD compliance can help with adoption. Nitant suggested that CEOS-ARD compliance could be referenced in the policy section.
- Tom Sohre (USGS, WGISS Chair) noted the challenge might be the procurement approaches and rules, as we'd need to establish guidelines and common language.
- Steve Covington noted that the PFSs were intended to be a fuller description of a product without specifying what the product actually was.
- Steven Ramage (CEOS Executive Officer) noted that there's an online debate calling interoperability 'the boring part of EO', despite being fundamental. There is a massive communication opportunity to bring these people in.
- Brian Terry (SEO) suggested advertising these points with GitHub where issues can be raised. The SEO should develop some guidelines to help outsiders understand how to contribute. Nitant added that GitHub provides important tools for tracking, version control, contribution, and transparency to documentation.
- Peter Strobl noted that CEOS-ARD only goes to Level 2 at the moment. At higher levels, ARD are more important than at lower levels, as it's the data non-EO experts want.
- Steve Covington warned against overloading ARD, as it isn't equivalent to interoperability and that ARD was only meant to enable interoperability.

- Philippe added that top of atmosphere (TOA) products are very popular, so we should be interoperable at Level 1 as well. Tom suggested that the Interoperability Handbook describes recommendations to achieve this.
- Nitant noted that preprocessing has lots of proprietary information available. If there is someone ready to provide this information then the team is happy to input it to Level 1 product development.

<p>WGCV-WGISS -2024-03</p>	<p>Interoperability Handbook team to consider including recommendations for procured datasets to be CEOS-ARD compliant in the policy section of the Interoperability Handbook, or perhaps as an appendix.</p> <p>Action Lead: Nitant Dube</p>	<p>Q4 2025</p>
<p>WGCV-WGSS- 2024-04</p>	<p>Interoperability Handbook team to connect with the Surface Reflectance Quality and Consistency project team to consider how the ongoing work of the project might fit as an example within the interoperability handbook.</p> <p>Action Lead: Nitant Dube, Simon Oliver</p>	<p>Q4 2025</p>
<p>WGCV-WGISS -2024-05</p>	<p>SEO to develop some 'Contributor Guidelines' for the CEOS GitHub to help outsiders contribute to the Interoperability Handbook and other repositories.</p> <p>Action Lead: Brian Terry</p>	<p>Q1 2025</p>
<p>WGCV-WGISS -2024-06</p>	<p>Interoperability Handbook team to ensure interoperability of level 1 data is not excluded in the architecture factor, noting that existing CEOS-ARD specifications focus on level 2.</p> <p>Action Lead: Nitant Dube, Matt Paget, Alex Leith</p>	<p>Q4 2025</p>

E.2 - Quality Factor

Cody Anderson (USGS, WGCV Vice-Chair) reported [\[slides\]](#):

- The quality factor definition should be updated to better reflect the requirement for data providers to describe their own quality and indicate the trustworthiness of their data.

- The proposed framework is: *Indicators (parameters, metrics, etc.) for informing users of the trustworthiness (accuracy, uncertainty, consistency, etc.) of the data provided (measurands, measurements, observations, etc.)*
- The quality factor will include descriptions of the measurand, sensor and sensor characteristics, observation and target characteristics, and uncertainty (including traceability).
- Without understanding the effect of the sensor from these, one can't explain or understand how to use one dataset with another dataset.
- Most of the quality and other factors are directed at single datasets, which is against interoperability.
- There is no intent to define thresholds within this framework.
- One question is whether a data description factor fits within architecture?
- Another question is where does gridding/tiling/projections get addressed? There is no group within CEOS currently addressing these.

Discussion

- Peter Strobl (EC-JRC) noted that if you have a definition with three terms - indicators, trustworthiness, and data, explaining the definition with examples leaves a lot of room for interpretation.
- Nigel Fox (NPL) suggested that the chapter spells out what is needed as a minimum, and that the proposed definition is kept as a shorthand definition.
- Tom Sohre (USGS, WGISS Chair) noted that data providers would be the main stakeholder for this document. The intent to create a maturity matrix was to help data providers understand their maturity level with respect to interoperability.
- Steve Covington (USGS) asked if the measurand of maturity is the uncertainty? The more you cover all these characteristics of the measurement quality, they determine the uncertainty. Nigel responded that it's not the value of the uncertainty, but the quantification of knowledge such that it can be fit for purpose.
- Peter noted that as a threshold, we need enough information to understand quality, but it's not necessary to have a threshold on the value.
- Brian Terry (SEO) proposed a secondary audience of product producers. If you're producing a product and knowing you're engaging data at the right level, knowledge of where you should be pulling from and at what level is important.

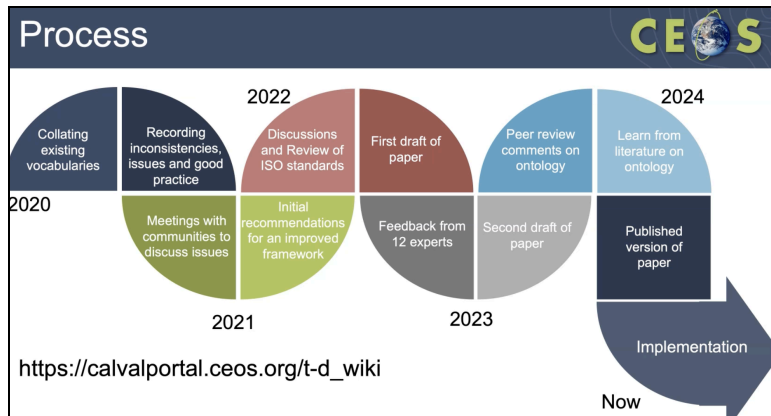
- Tom suggested including a data description factor within data architecture. Nitant noted that metadata would be part of the interface factor.

<p>WGCV-WGISS -2024-07</p>	<p>Cody Anderson to submit the proposed definition for the Quality Factor of the Interoperability Handbook via the GitHub repository, for review and comment by WGCV and the Interoperability team.</p> <p>Action Lead: Cody Anderson</p>	<p>Q4 2024</p>
<p>WGCV-WGISS -2024-08</p>	<p>Interoperability Handbook team to ensure the Architecture chapter includes measurand/measurement/observation descriptions (data content). These terms should be properly defined and their relation to data made explicit. The team should also be wary of the length/size of the Architecture Factor chapter.</p> <p>Action Lead: Nitant Dube, Matt Paget, Alex Leith</p>	<p>Q4 2025</p>
<p>WGCV-WGISS -2024-09</p>	<p>Peter Strobl to accept/reject the nomination of Tom Maiersperger (USGS) as TMSG co-chair for WGCV. TMSG Co-chairs should also ensure gridding/tiling/projections get addressed in the Interoperability Handbook, within the Architecture chapter.</p> <p>Action Lead: Peter Strobl, Nitant Dube, Matt Paget, Alex Leith</p>	<p>Q4 2024</p>

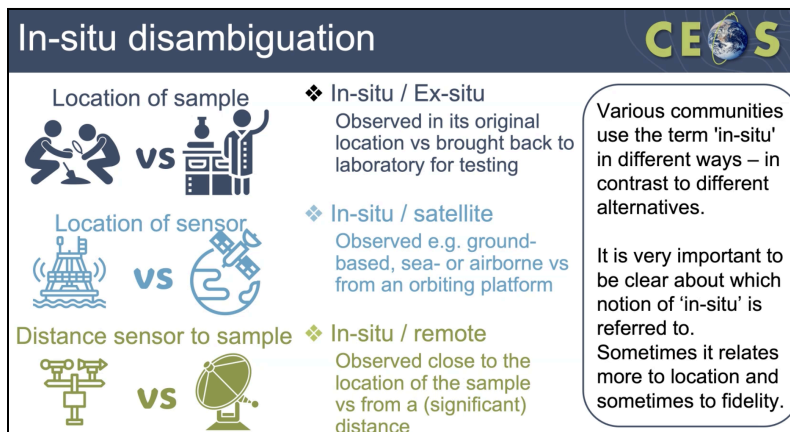
E.3 - Common Dictionary/Vocabulary

Peter Strobl (EC-JRC) reported [\[slides\]](#):

- The Common Dictionary activity was started in 2021 as a joint initiative of WGCV, WGISS and LSI-VC, as an effort to reduce the number of glossaries published across the industry.



- The effort sought to consolidate existing vocabularies and identify what was helpful to start building recommendations. ISO was an important element as it has a lot of standards on developing vocabularies.
- A paper was written after feedback rounds within WGCV and WGISS, which was submitted for review by the end of last year.
- It was found that PDFs were hard to explore, and there were large areas of formal ontologies which were elaborate in the formal sense but had poor readability.
- Observation definitions across many different domains become superficial, like 'Interoperability' and 'Data Cube'. Both definitions have become meaningless as there is no commonality between them.



- The commonly agreed definition of interoperability is very vague and unhelpful.
- The paper was published two weeks ago, titled *“Lost in translation: The need for common vocabularies and an interoperable thesaurus in Earth observation sciences”*.
- The suggested approach is to start with a formal thesaurus, with explicit relationships between terms. The approach to thesauruses and glossaries needs to be changed as

well. A list shouldn't be included in each document, but instead should link to a central reference.

- A good thesaurus is consistent, interrelated, understandable, educational, and updateable. The educational aspect is particularly important to help communicate complex concepts. It needs to be an easy read.
- The suggested practical approach includes:
 - o Build on all the existing, excellent work and invite all stakeholders
 - o It has to become a proper project with the right tools. GitHub could be the solution.
 - o Getting more participation - the vocabulary effort started off with a dozen people. Everyone needs to be speaking the same jargon.
- Mark Dowell of the European Commission in Brussels asked for the creation of the Knowledge Centre on Earth Observation Glossary ([KCEO Glossary](#)). This perhaps could become a bigger glossary under the ownership of CEOS.
- Peter encouraged all to join the effort on the GitHub in the discussion framework.

Discussion

- Tom Sohre (USGS, WGISS Chair) asked how we should communicate this via CEOS. Currently on the CEOS site we have the Cal/Val Terms and Definition Wiki, should this be replaced?
- Peter noted that it's currently under the JRC repository. The Cal/Val Terms and Definitions Wiki content could be transferred over to the JRC repo.
- Tom added that someone has to decide how links are published off the main domain CEOS page into another thesaurus.
- Steve Covington (USGS) asked if it would require someone within CEOS to make a comparison before making the switch. Peter suggested a stepped approach to make adoption decisions.
- Tom noted that to adopt this glossary, it would have to be endorsed at the Plenary level. Cody added that this would be a good joint WGCV/WGISS Plenary action.
- Tom suggested adding something to the Work Plan for both working groups to jointly focus on this.
- Steven Ramage (CEOS Executive Officer) noted that if it came as an output from this meeting, the interim phase would be SIT-40 where the Work Plan is presented for the following year.

- Peter suggested giving a set of definitions that can be built from. More formality will be required if the effort expands, such as five minute videos on how to make a new term and propose changes.
- Brian Terry (SEO) asked if knowledge graphs and ontologies will be included, and noted that ESIP has a whole group on ontologies. Peter recognised that those that can be made interoperable, should be. CEOS shouldn't stop other organisations from having their own glossaries.
- Tom asked, in the long term, who actually gets to decide when suggestions don't align? Katy Baynes (NASA) noted that dictionaries have solved this with several definitions under one term.
- Cody Anderson (USGS, WGCV Vice Chair) wondered if this should feature in WGCV's Plenary presentation. Philippe agreed that the WGCV report can highlight this. The resultant action would be to formalise it for SIT discussion and work plan inclusion.
- Peter welcomed renaming the glossary to the CEOS/KCEO Glossary, with the approval of CEOS next week at CEOS Plenary.

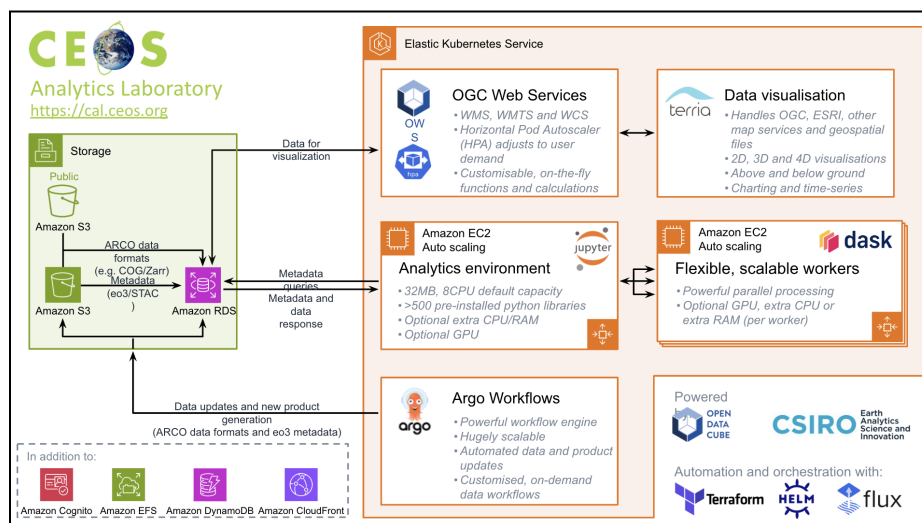
WGCV-WGISS -2024-10	<p>WGISS & WGCV to create a joint deliverable for the 2025-2027 CEOS Work Plan regarding the development of the CEOS/KCEO Glossary. Both working groups should ensure enough people are engaged, including from other CEOS groups, as well as from the external community. WGCV & WGISS Chairs to include this in their respective Plenary presentations, to solicit support to brand the glossary as the 'CEOS/KCEO Glossary'.</p> <p>Action Lead: Cody Anderson, Tom Sohre</p>	Q4 2024
WGCV-WGISS -2024-11	<p>SEO to discuss with Paolo Castracane & Peter Strobl (and perhaps NOAA Knowledge Graph team) about transferring the current Cal/Val Portal Terms & Definition Wiki to GitHub KCEO repository, considering the appropriate format.</p> <p>Action Lead: Brian Terry, Paolo Castracane, Peter Strobl</p>	Q1 2025

Session F: CEOS Analytics Lab

F.1 - CEOS Analytics Lab

Jonathan Hodge (SEO) reported [\[slides\]](#):

- The CEOS Analytics Lab (CAL) is supported by the SEO, and supports the data and processing needs of the different Working Groups of CEOS. In particular, today the team would like to understand how it could support Cal/Val and interoperability efforts.
- CAL is based on the same technology as Digital Earth Australia and Africa.
- There is a lot of public data in Amazon Web Services (AWS) including data from Landsat and Sentinel-2. These existing cloud environments can be leveraged for their analysis-ready and cloud-optimised formats and metadata, particularly EO3 or stack metadata.



- CAL uses Analysis Ready Cloud Optimised data (ARCO), which is an evolution of ARD.
- CAL allows for the scaling of a project from the pilot to operational phase, using computational scaling options. There are a range of example notebooks included in CAL to demonstrate the use of the platform.
- CAL is actively working with COAST-VC and EETT, and are using COAST as guinea pigs to develop training sessions and support new data and processing needs.
- The team is working on bringing SAR data together in support of SARCalNet. There are processing workflows available for public SAR products from missions like ALOS-2 and Sentinel-1, as well as for analysing products from Capella and Umbra in cloud-native formats.
- There could be an opportunity to connect the GCP database with cloud-native vector capabilities and improve interoperability.
- CAL has recently added PALSAR-2 ScanSAR data thanks to Ake Rosenqvist and JAXA. There are links on the CAL website for requesting SAR datasets and support.

- GPU capabilities will shortly be added, including Machine Learning images and new datasets from Sentinel-1, Sentinel-3, MODIS, VIIRS, and commercial SAR.
- CEOS SEO welcomes requests from all CEOS groups to expand and improve the capabilities of CAL, including data requests, python packages, etc, and are available to support one-on-one training.

Discussion

- Filippo Marchesi (ESA/Solenix) noted that under interoperability, there are other tools within CEOS, IDN, and FedEO which have been discussed previously with Dave Borges and Matt Paget regarding their integration. Is there any progress?
- Jonathan noted a recent interruption, but is in the process of setting up a new agreement with SEO, which can include points on connecting CAL more broadly into CEOS interest.

WGCV-WGISS -2024-12	SEO to discuss with WGISS DAIG regarding connecting IDN & FedEO to CEOS Analytics Lab. Action Lead: Brian Terry, Jonathan Hodge, Michael Morahan, Yves Coene	Q2 2025
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- Filippo discussed with Brian Terry (SEO) the requirement for federated identification and authorisation for CEOS, and the need for dedicated login for all CEOS tools. An action was opened at WGISS-57 on this topic. Brian is happy to explore this further.
- Jonathan recalled similar discussions with COAST. They have various systems and tools, and are wondering how to connect them across CEOS.

F.2 - GCP Match Up Database and Radiometry Database

Peter Strobl (EC-JRC) reported on the GCP Match Up Database [\[slides\]](#):

- The GCP (Ground Control Point) Match-Up database came out of interaction with the commercial sector for georeferencing and geometric quality assessments, to ensure interoperability and integration/analysis of multi-source and multi-temporal datasets.
- The idea was to collect GCPs within CEOS and develop an intercomparison exercise that checks them for consistency and find out if references are within uncertainties. The Ground Control Point Intercomparison eXercise (GCPIX) is a collaboration between the WGCV Subgroups IVOS and TMSG with the objective to develop a harmonised global CEOS GCP Database.

- GRIs (Geometric reference images) were used to stay within desired pixel shifts. Over two million GCPs were extracted and packed into 1 degree by 1 degree tiles, each containing 500 GCPs.
- This 1 degree tiling however led to a densification in the North. When you remap them into smaller DEMIX tiles, it leads to an increase in density of GCPs in the North than at lower latitudes. When a database is put together, these gaps need to be filled especially for commercial providers with very small scenes.
- Strange patterns appear when generating these automatically, which could be due to artefacts from slight changes in radiometry between sensors. Overlapping orbits can also create issues.
- The GCPIX team hopes to define protocols for the suitability and sharing of GCPs, and harmonise existing sources towards a unified database.

Cody Anderson (USGS, WGCV Vice-Chair) reported on the Radiometry Database [[slides](#)]:

- The Radiometry database started from the same genesis. An action was taken out of JACIE and VH-RODA for getting test data from commercial providers.
- US intelligence agencies are the primary customer of commercial providers, so they should be included.
- Railroad valley and Gobabeb are RadCalNet sites, Lake Tahoe is for TIR emissive sensors, and Libya 1, 4, and Algeria 3 are pseudo calibration sites.
- Spatial sites are needed to understand the true ground resolution. For medium resolution satellites (e.g. Landsat, Sentinel), bridge targets are used. For higher resolution satellites there are defined target sites.
- Some sites are only applicable for certain missions. The effort to cover a large number of sites while limiting the requests for commercial providers led to a recommendation from WGCV.

Discussion

- Steve Covington (USGS) asked if there were any issues due to the selected sites being fairly narrow in terms of latitude. Not all commercial satellites have the same orbital control. Cody responded that cross-calibration radiometers are posed as a solution to this.
- Similar issues are found when selecting polar sites, even though they should be able to be acquired more often.

- Peter Strobl noted that all of these are bright sites, and asked if darker sites should also be explored.
- Cody has studied Amazonian and Congolese rainforests, which are pretty homogeneous but often obscured by clouds.
- Philippe Goryl (ESA, WGCV Chair) suggested two lines of development: simple and operational, or comprehensive (dark targets).
- Cody added that vegetative targets could potentially be explored within RadCalNet. There are lots of signal to noise issues in darker scenes.
- Brian Terry (SEO) was surprised that there were regular collections of data over the CSCA data, and that there's also a resolution gap so assessing between bridges and other sites was difficult.
- Tom Sohre (USGS, WGISS Chair) asked if there were any lessons learned that came out of those capabilities? Brian noted that on the commercial side, there are difficulties in searching and finding data. Best Practices for STAC would help this.
- Philippe noted that the main difficulty is making sure that the commercial data providers can acquire data over the sites, and in checking their accuracy. There are some commercial providers who want to share their data, and others who don't.

F.3 - RadCalNet API

Philippe Goryl (ESA, WGCV Chair) reported [\[slides\]](#):

- WGCV has started to have discussions with SEO to see how to exploit RadCalNet's work.
- RadCalNet is a very successful activity put together by many colleagues across WGCV. It is an operational service providing data for calibration and validation that has been used for calibration by New Space in particular.
- WGCV is discussing with SEO how to facilitate access to data, matchup processing, and take the service a step further. An initial discussion led to a few actions defined.
- The team is considering the development of a Jupyter Notebook in GitHub to facilitate access.
- WGCV also discussed with SEO about reinforcing the link between the Cal/Val Portal and SEO resources.

Discussion

- Brian Terry (SEO) noted that within CEOS Analytics Lab (CAL), we can get data accessible within a Jupyter Notebook and have an open source project in the CEOS GitHub to develop tools to enable people to take advantage of the data they're providing.
- Philippe thought that this can be an example for working with the GCP radiometry databases.
- Kurt Thome (NASA) noted that the first beta testing concluded that users preferred that datasets were more amenable to APIs. The sticking point for users are not the RadCalNet datasets, but doing similar approaches with imagery. New datasets require a relearning process, and APIs might be able to help with interoperability.
- Paolo Castracane (ESA) found the CAL single-process workflow very interesting. Brian added that the goal of CAL is to go from concepts to workflows. ARGO workflows are available and defined.
- Philippe noted that if RadCalNet is a success, TIRCalNet and SARCalNet will follow.

Session G: Joint WGISS/WGCV Topics

G.1 - SI Traceable Satellites (SITSats)

Nigel Fox (UK NPL, SITSat Task Team Co-lead) reported [\[slides\]](#):

- The SITSat Task Team is a joint CEOS-GSICS activity co-chaired by Yolanda Shea (NASA) and Nigel Fox, the mission leads of the two first SITSats in development (CLARREO Pathfinder and TRUTHS, respectively).
- SITSats were developed from a response to initiatives in the international arena calling for an in-orbit traceability reference, with data provided at an uncertainty level commensurate with the needs of climate data.
- The simple definition of a SITSat is:
 - o *"A SITSat is a space-based instrument making measurements of the Earth that can transparently evidence their metrological traceability to the international system of units (SI) with an uncertainty commensurate with the most demanding needs of climate. When used as a reference to calibrate other satellites its uncertainty should be at least half that of the satellite under test."*
- SITSats will enable the detection of trends earlier by improving uncertainty.
- The satellites will serve as a cross-calibration reference in non-Sun-synchronous orbit, and will cross over satellites multiple times. TRUTHS will link with Sentinel-2A to provide direct near-simultaneous observations. Both TRUTHS and CLARREO Pathfinder

(CLARREO-PF) can make angular measurements as well to build up calibration coefficients for the satellites.

- CLARREO-PF (NASA) is due to launch to the ISS in 2027. TRUTHS (ESA) will launch in the 2030 timeframe, and the launch of LIBRA (CMA) is TBC.
- SITSats will make FRMs from space to detect small changes and provide robust, traceable evidence of uncertainty demonstrated in-orbit at the point of measurement.
- They will provide support to a system of systems, an integrated EO system, and support ARD fundamentally, bringing trust and longevity of data to the Earth observing system.
- The SITSats aim to provide a level playing field, with traceability to constellations from different time zones and observational timeframes. Mimicking the calibration methodologies of other terrestrial technologies, data should be traceable in the same way as every other terrestrial activity.
- The Task Team seeks to improve the recognition and visibility of this instrument class to CEOS and the wider EO community.
- The SITSat Task Team hopes to work with WGISS and others on how to store, transfer, and provide information to users.
- Deliverables of the group include a clear definition of SITSats, a white paper on what a SITSat enabled observing system looks like, data sharing based on a systems approach, and a communications strategy.
- The communications strategy surrounds defining SITSats and evidencing traceability. The COVE tool will be used as it is supported for all sensors.
- Next steps include hosting three half-day, virtual meetings a year plus one in person, establishing the Cal/Val portal page and wiki, and developing the task team membership.

Discussion

- Libby Rose (SEO Comms Team) noted that the SEO will have an exhibition booth at LPS and VH-RODA, which could display SITSat content where applicable. The SITSat Task Team should reach out to the Comms Team (Libby and Dave Borges) once the messaging has been defined.
- Nigel was conscious that the understanding of what a SITSat constitutes is unclear, and wants to have both comprehensive and simplified definitions.

G.2 - WGCV Cal/Val Portal

Paolo Castracane (ESA/Starion) reported [[slides](#)]:

- The CEOS Cal/Val portal (<https://calvalportal.ceos.org/>) serves as the main forum for the exchange and sharing of information for WGCV.
- It provides access to agreed good practices and Cal/Val protocols to the wider Earth Observation community. It connects users to reference data and networks and provides reliable, up-to-date and user-friendly information for Cal/Val tasks.
- The portal has pages for each WGCV subgroup, and has more than 1200 registered numbers.
- WGCV-53 actions called for additions to the portal regarding the MDPI Open Access publication on solar spectral irradiance models, and for WGCV's contribution to climate / GCOS-IP, which have both been completed.
- The SITSat Task Team has a page on the portal as well as a dedicated repository and forum. There is also a repository for WGCV's contribution to the Space Agency response to the 2022 GCOS Implementation Plan.
- The portal provides information on upcoming meetings, such as the SAR Cal/Val Workshop 2024, which will be hosted in Ahmedabad, India.
- The IVOS Subgroup page has recently been updated with a new repository and content on the solar irradiance spectrum work.
- A [Newsletter](#) for the CEOS Cal/Val Portal was published in October 2024 and shared via CEOS communication channels.
- The Cal/Val Portal can support the Maturity Matrices from WGISS, as well as the Vocabulary work under the Interoperability Handbook.

Discussion

- Tom Sohre (USGS, WGISS Chair) noted that other communications channels should be explored aside from the Cal/Val portal. The CEOS Terms and Definitions Wiki is linked from a high level on the CEOS website, as well as within the Cal/Val portal.
- Cody Anderson (USGS, WGCV Vice Chair) asked how users should be educated on uncertainty. There are two audiences: technical people and data users. Libby Rose (SEO Comms Team) noted that this would form two separate communications exercises to address each.

- Steve Covington (USGS) wondered if uncertainty rolls into a more generic utility score as a part of spectral and spatial characteristics. If you want to make a more accessible remote sensing product and publication, it needs to be communicated effectively.
- Philippe Goryl (ESA, WGCV Chair) noted that space agencies are the key audience. Attaching the uncertainty to a product can double or triple its size. The practical problem is how we provide this information to the user.
- Peter Cornillon (University of Rhode Island) highlighted the importance of accuracy and precision, although precise information is hard.

G.3 - Discussion: Expressing Uncertainty Information

Cody Anderson (USGS, WGCV Vice-Chair) reported [\[slides\]](#):

- Data should be weighted according to their uncertainty, from an Artificial Intelligence / Machine Learning (AI/ML) perspective. Commercial satellites often have higher uncertainty.
- Multiple data sources are very important to address gaps in data records. The rise of the commercial and New Space sector now dwarfs government agencies, so the commercial sector needs to be engaged and utilised more.
- There was a half-day uncertainty workshop at JACIE in March 2024 with high levels of engagement. The workshop focused on Radiometric Uncertainty of Top of Atmosphere (TOA), passive, reflective, optical imagery. The workshop covered prelaunch characterisation, vicarious calibration, processing chain, and cross calibration.
- There are many types of measurement uncertainties, including definitional, standard, combined, relative, target, and expanded measurement uncertainties.
- Uncertainty can come from many different points along the data collection and processing chain.
- What level of accuracy of uncertainty is needed? Uncertainty can be broken down into steps, and 125 steps requires 7 bits per pixel. Is this too much? Can a tool be used to calculate?
- Increasing data volumes for hyperspectral missions with already massive data volumes will be troublesome.

Discussion

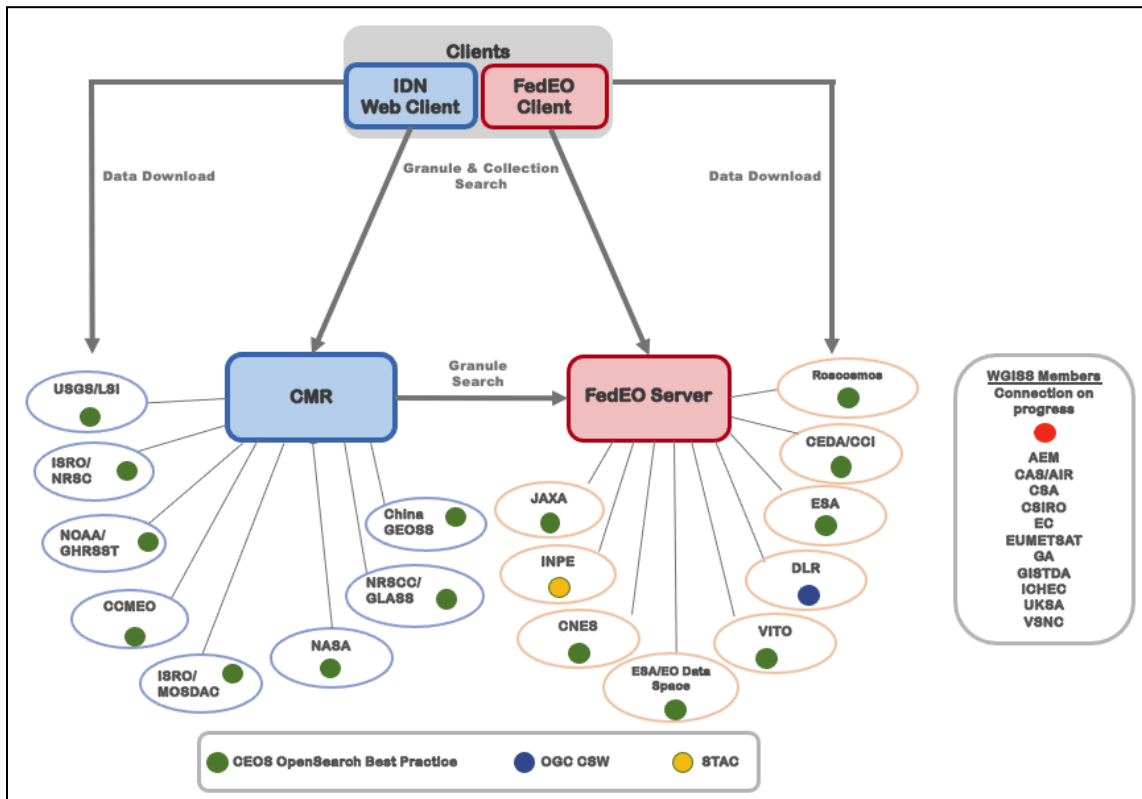
- Tom Sohre (USGS, WGISS Chair) asked how many users will really use per-pixel information? Brian Terry (SEO) noted that a measurement without an uncertainty is meaningless.
- Yolanda Shea (NASA) added that adding uncertainty at pixel level doubles the data size, and SITSats will also include random and systematic uncertainties.
- Users are likely to download a data product to their own system and use it. If capital users are encouraged to do their analysis in a cloud environment, it simplifies the process a little, and there's not a huge egress cost.
- Steve Covington (USGS) noted that EROS developed a tool to project a cost for computing, storage, and egress, and the storage costs dwarfed the others.
- Brian Terry (SEO) added that doubling data volume on the per pixel basis would require several measurements to quantify the uncertainty.
- Yolanda explained that an uncertainty image is a summary or collection from recent captures. One wouldn't need to include every piece of information that goes into each per-pixel measurement. The systematic and random uncertainty are the baseline for each measurement.
- Kurt Thome (NASA) noted that people like Amy Graverman of NASA JPL are working on this for missions like OCO-2 & -3. There's still a lot to do on the uncertainty side, and it may be premature for WGISS to understand how to store and share the data.
- Cody asked what is needed from a core data product in CEOS-ARD, and what can be done through a tool. Per-pixel uncertainty is one of the requirements for CEOS-ARD.
- Doug Newman (NASA) noted that if NASA doubled the size of their data, it would cost \$3.7M, which is not feasible.
- Philippe Goryl (ESA, WGCV Chair) asked if MODIS has per-pixel uncertainty. Kurt noted that the SBG Mission hyperspectral imager has per-pixel uncertainty for all high level data products, and takes a vectorised approach.
- Peter Strobl (EC-JRC) noted that the crucial thing is to not resample, and it depends on all the neighbourhoods that you weight. Uncertainty in the resampling chain is difficult.
- Brian noted that if the data is large and uncertainty is crucial, one solution is to have a pointer where the uncertainty can be retrieved. Medhavy suggested a DOI landing page.
- Nitant Dube (ISRO, WGISS Vice-Chair) via chat: *"Can a RPC model be developed on the lines similar to RPC for orthorectification for representing per-pixel uncertainty?"*. Cody confirmed that this direction is being considered.

WGCV-WGISS -2024-13	WGCV to provide guidance on what uncertainty information should be packaged within a dataset. WGISS should then add guidance on how this information can be provided to the user. This should be fed back to add into the CEOS-ARD specifications. Action Lead: Cody Anderson, Tom Sohre	Q2 2025
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G.4 - WGISS Connected Data Assets Overview

Filippo Marchesi (ESA/Solenix), Michael Morahan (NASA/KRB) and Yves Coene (ESA/Spacebel) reported [\[slides\]](#):

- Connected Data Assets are intended as the CEOS Agencies' data collections that are connected via CEOS tools (FedEO and IDN) that implement WGISS BP, which allows independent clients to search and access their unrestricted data.
- The goal is to ensure all users have easy and efficient ways of discovering and accessing CEOS datasets.



- INPE datasets are now connected to FedEO via the STAC Interface.

- The list of agencies on the right of the diagram are encouraged to contact the team so their datasets can be included in the Connected Data Assets.
- New CEOS data access resources include Jupyter Notebook, STAC, and Opensearch.
- The CEOS IDN (International Directory Network) is working on a solution to ingest USGS STAC collections.
- Many changes were made to the CWIC (CEOS WGISS Integrated Catalogue) page, including updating material, videos, and documents.
- The CEOS IDN Page has the addition of links to pages on CEOS Providers and the CEOS Missions, Instruments, and Measurements (MIM) Database. CEOS MIM Database keywords have been mapped to related IDN Search Portal queries. CEOS data providers can review their current listings in IDN to ensure accuracy.
- FedEO now has 252 million granules (up from 223 in March 2024). New collections have been provided by INPE, VITO, ESA and Copernicus.
- The webpage for FedEO has an updated Services section, which includes the OpenSearch client and STAC.
- The preliminary SKOS Representation of the MIM-GCMD mapping can be found [here](#). The end result would allow the user to open the client related to each keyword, and allows browsing by ESA/GCMD SKOS keywords.
- Changes made to the FedEO OpenSearch Client include support for Service & Tools discovery (by November 2024), the ability to search by organisation, platform, free text ect, the inclusion of CEOS SW Tools Survey and Jupyter Notebook metadata, and access via STACBrowser.
- Updates to online documentation include the Client Partner Guide's migration to GitHub, the usage of Jupyter Notebook, and FedEO API additions of the OpenSearch and STAC APIs.
- The team is regularly updating and improving the services, and ensuring the datasets are represented correctly. The team can be contacted at Access-SysTeam-Help@wgiss.ceos.org.

Discussion

- Robert Fletcher (UKSA) asked what is meant by discoverable. Damiano Guerrucci (ESA) noted that at the granule level, links have been made through to the data providers page to download the data. This also concerns the federation of the access, such that multiple logins are not necessary to access data.

- Steve Covington (USGS) saw links to various assets like ESA Third Party Mission (TPMs) and Copernicus Data Space Ecosystem (CDSE), and wondered if there is access to them via FedEO?
- Yves Coene (ESA/Spacebel) noted that there aren't links to these in the latest version of CDSE, but there is ongoing work to make the STAC version available. CSDE STAC implementation is inline with the CEOS STAC best practices, so there should be a seamless integration.

Session H: Closing Session

H.1 - Joint meeting action review

Libby Rose (WGISS Secretariat) reported:

- 13 actions were taken from the two days of joint meeting.
- Paolo Castracane (ESA) noted that regarding action 2, we will need to find references for the GEO Earth Intelligence Readiness Matrix.

H.2 - Closing remarks

Tom Sohre (USGS, WGISS Chair) and Philippe Goryl (ESA, WGCV Chair) reported:

- The commercial sector was something not discussed this week, but is something that should be kept on the forefront as work continues.
- It's important to find where the interaction that both groups have with the sector lies, and to incorporate lessons learned.
- Tom thanked all for participating in the meeting this week, and for travelling to Sioux Falls.
- Philippe thanked USGS for hosting the meeting at the home of Landsat.
- There are various domains of cooperation between WGISS and WGCV which should be continued to be explored.
- This was Philippe's last meeting as WGCV Chair. Medhavy Thankappan (GA) thanked Philippe for his term as WGCV Chair and for his contributions to the group.

Appendix A: List of Participants

In-person participants

Affiliation	Name
CAS	Li Limin
CAS	Shi Ruixiang
CEOS Executive Officer	Steven Ramage
CNES	Hugo Fournier
CNES	Richard Moreno
CEOS Executive Officer	Steven Ramage
EC-JRC	Peter Strobl
ESA	Damiano Guerrucci
ESA/Solenix	Filippo Marchesi
ESA	Mirko Albani
ESA	Paolo Castracane
ESA	Philippe Goryl
ESA/Rhea	Iolanda Maggio
ESA/Solenix	Filippo Marchesi
ESA/Spacebel	Yves Coene
GA	Medhavy Thankappan
GISTDA	Prayot Puangjaktha
IASB-BIRA	Jean-Christopher Lambert
ISRO/NRSC	Sai Kalpana
JAXA	Akihiko Kuze
JAXA	Kazuhisa Tanada
JAXA	Yousuke Ikehata
NASA	Doug Newman
NASA	Katie Baynes
NASA	Kurt Thome
NASA	Michael Morahan
NASA	Yolanda Shea
NOAA	Slawomir Blonski
NPL	Nigel Fox
SEO/AMA	Brian Terry
University of Rhode Island	Peter Cornillon

Virtual Participants

Affiliation	Name
ASI	Antonio Montuori
CSA	Joey Martin
CSIRO	Ian Christopher Lau
CSIRO	Jonathan Hodge
CSIRO	Matt Paget
DLR	Jonas Eberle
ESA	Sabrina Pinori
ESA/Solenix	Paolo Sacramento
GA	Simon Oliver
ISRO	Nitant Dube
LSI-VC Secretariat	Matt Steventon
MYSA	Adhwa Bin Amir Tan
MYSA	Wayne Ng Su Wai
NOAA	Ken Casey
NOAA/NCEI	Nancy Ritchey
NOAA	Sarah Menassian
STFC UKRI	Esther Conway
USGS	Kelly Bruno
USGS	Tom Maiersperger
USGS	Danika Wellington

Affiliation	Name
UKSA	Robert Fletcher
USDA	Michael Cosh
USGS	Cody Anderson
USGS	Gregory Stensaas
USGS	Peter Doucette
USGS	Thomas Maiersperger
USGS	Timothy Stryker
USGS	Tom Sohre
USGS/KBR	Christopher Barnes
USGS/Aerospace	Steven Covington
VNSC	Nguyen Tien Cong
WGCV Secretariat	Harvey Jones
WGISS Secretariat	Libby Rose

Appendix B: Actions

WGCV-WGISS -2024-01	<p>The WGCV Maturity Matrix and WGISS Data Management and Stewardship Maturity Matrix teams should define their target users, and ensure their tools are fit for purpose. The Interoperability team should also consider this when developing their matrix.</p> <p>Action Lead: Paolo Castracane, Iolanda Maggio</p>	Q2 2025
WGCV-WGISS -2024-02	<p>The WGISS, WGCV and Interoperability Maturity Matrices should follow a common format, including definitions for the levels of maturity. The teams should also follow the development of the GEO Earth Intelligence Readiness Matrix, and reference/coordinate where necessary.</p> <p>Action Lead: Paolo Castracane, Iolanda Maggio, Nitant Dube</p>	Q4 2025
WGCV-WGISS -2024-03	<p>Interoperability Handbook team to consider including recommendations for procured datasets to be CEOS-ARD compliant in the policy section of the Interoperability Handbook, or perhaps as an appendix.</p> <p>Action Lead: Nitant Dube</p>	Q4 2025
WGCV-WGSS- 2024-04	<p>Interoperability Handbook team to connect with the Surface Reflectance Quality and Consistency project team to consider how the ongoing work of the project might fit as an example within the interoperability handbook.</p> <p>Action Lead: Nitant Dube, Simon Oliver</p>	Q4 2025
WGCV-WGISS -2024-05	<p>SEO to develop some 'Contributor Guidelines' for the CEOS GitHub to help outsiders contribute to the Interoperability Handbook and other repositories.</p> <p>Action Lead: Brian Terry</p>	Q1 2025
WGCV-WGISS -2024-06	<p>Interoperability Handbook team to ensure interoperability of level 1 data is not excluded in the architecture factor, noting that existing CEOS-ARD specifications focus on level 2.</p> <p>Action Lead: Nitant Dube, Matt Paget, Alex Leith</p>	Q4 2025

WGCV-WGISS -2024-07	<p>Cody Anderson to submit the proposed definition for the Quality Factor of the Interoperability Handbook via the GitHub repository, for review and comment by WGCV and the Interoperability team.</p> <p>Action Lead: Cody Anderson</p>	Q4 2024
WGCV-WGISS -2024-08	<p>Interoperability Handbook team to ensure the Architecture chapter includes measurand/measurement/observation descriptions (data content). These terms should be properly defined and their relation to data made explicit. The team should also be wary of the length/size of the Architecture Factor chapter.</p> <p>Action Lead: Nitant Dube, Matt Paget, Alex Leith</p>	Q4 2025
WGCV-WGISS -2024-09	<p>Peter Strobl to accept/reject the nomination of Tom Maiersperger (USGS) as TMSG co-chair for WGCV. TMSG Co-chairs should also ensure gridding/tiling/projections get addressed in the Interoperability Handbook, within the Architecture chapter.</p> <p>Action Lead: Peter Strobl, Nitant Dube, Matt Paget, Alex Leith</p>	Q4 2024
WGCV-WGISS -2024-10	<p>WGISS & WGCV to create a joint deliverable for the 2025-2027 CEOS Work Plan regarding the development of the CEOS/KCEO Glossary. Both working groups should ensure enough people are engaged, including from other CEOS groups, as well as from the external community. WGCV & WGISS Chairs to include this in their respective Plenary presentations, to solicit support to brand the glossary as the 'CEOS/KCEO Glossary'.</p> <p>Action Lead: Cody Anderson, Tom Sohre</p>	Q4 2024
WGCV-WGISS -2024-11	<p>SEO to discuss with Paolo Castracane & Peter Strobl (and perhaps NOAA Knowledge Graph team) about transferring the current Cal/Val Portal Terms & Definition Wiki to GitHub KCEO repository, considering the appropriate format.</p> <p>Action Lead: Brian Terry, Paolo Castracane, Peter Strobl</p>	Q1 2025
WGCV-WGISS -2024-12	<p>SEO to discuss with WGISS DAIG regarding connecting IDN & FedEO to CEOS Analytics Lab.</p>	Q2 2025

	<p>Action Lead: Brian Terry, Jonathan Hodge, Michael Morahan, Yves Coene</p>	
<p>WGCV-WGISS -2024-13</p>	<p>WGCV to provide guidance on what uncertainty information should be packaged within a dataset. WGISS should then add guidance on how this information can be provided to the user. This should be fed back to add into the CEOS-ARD specifications.</p> <p>Action Lead: Cody Anderson, Tom Sohre</p>	<p>Q2 2025</p>