Minutes

18th Meeting of the CEOS Virtual Constellation for Land Surface Imaging (LSI-VC)
2-5 September 2025
Hosted by the European Commission Joint Research Centre (EC-JRC)
Via E. Fermi, 2749, 21027 Ispra VA, Italy
Room 305, Building 102

Participants

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ESA	Ferran Gascon, Leonardo De Laurentiis*, Clement Albergel*, Fabrizio Niro*, Paolo Castracane*, Georgia Doxani*
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USGS	Chris Barnes, Tim Stryker*, Cody Anderson*, Sally Roberts*, Evan Neuwirth*, Jeffrey Clauson*, Chris Crawford*, Jim Vrabel*

virtual participants

Day 0: Tuesday, September 2

CEOS-ARD Building Blocks and GitHub Development Workshop

Introduction

- Matthias Mohr (SEO) recalled decisions from past LSI-VC meetings regarding the proposal to introduce CEOS-ARD workflows in Github, as an open collaborative space for CEOS-ARD PFS development.

- The proposed Building Blocks approach aims to consolidate CEOS-ARD PFS requirements, definitions, references, and editorial content. Dedicated tooling is planned to support document generation, editing, self-assessments, and review.

GitHub

- Training for the CEOS-ARD community on the GitHub PFS workflow was discussed, potentially with tutorials. This should be presented alongside established and announced CEOS-ARD GitHub governance, as CEOS-ARD document editing transitions away from Google Documents and into GitHub.

Discussion

- Tim Stryker (USGS) highlighted the need to communicate and manage external user expectations, and suggested conducting a campaign to get people active on GitHub. Many issues end up in the CEOS-ARD GitHub issue tracker with no clear path forward. Active teams to address GitHub issues need to be established for each PFS.

- Dave Borges (SEO) shared the draft [CEOS Organisational Github Governance framework](#), for feedback. Once the organisational GitHub has been set up with CEOS-ARD reference material, dedicated training meetings can be organised in collaboration with WGCapD.

- The three potential pathways were proposed for opening issues within the GitHub Building Block approach. These should be incorporated into the GitHub Governance Framework.

    - Contribution from externals lead to opening issues

    - Seeking to engage external contribution

    - Flagging changes to a PFS that will impact another PFS

- Matt Steventon (LSI-VC Secretariat) noted that one reason these issues have accumulated is the implied revision of the Surface Reflectance PFS. The updated general metadata requirements from the AR PFS V2.0 are planned to be incorporated to the SR PFS.

LSI-VC-18-01	Dave Borges to share the CEOS Organisational GitHub Framework for feedback from the LSI-VC team and for awareness to help shape the complementary rules specifically for the CEOS-ARD repository.	**October 2025**

Document Generation

- The CEOS-ARD CLI (command line interface) compiles metadata requirement building blocks and generates the PFS document as PDF, DOCX, and HTML formats. This allows the generation of PFS by users, tailored to a self assessment specific to their requirements, such as displaying only the

NRB requirements of the SAR PFS. The CEOS-ARD team would support providers in self-assessment through PFS generated by the tool.

- The CLI supports the generation of individual and combined PFS documents, each with its own changelog between endorsed versions. Providers compliant with an older version of a PFS who want to update their compliance should easily be able to see how the requirements have changed.

- There were some changes needed to fit the existing SAR PFS into the new building block framework. These changes are not changes to the requirements themselves, but related to the document layout and formatting such as switching from requirement numbers to text descriptors.

- The document glossary and references are generated automatically based on their usage. The glossary should be rooted where possible to the CEOS EO Glossary.

Discussion

- The CEOS Terminology Task Force identified the need for a consolidated source of definitions in a paper published last year. The tool was developed at JRC in collaboration with KCEO. CEOS adopted the glossary and it has been moved to the CEOS organisational GitHub account. WGISS should be the long term stewards of the glossary.

- Nitant Dube (ISRO) shared that WGISS is ready to support the operationalisation of the GitHub Glossary. Some components are related to the WGISS archival and metadata standards glossary, which is currently being migrated to the WO Glossary.

- The ordering of the PFS requirements was discussed, particularly with the proposed replacement of numbered requirements with textual identifiers, as well as the plan for combined CEOS-ARD PFS.

- The combined SAR PFS was developed to accommodate providers capable of multiple measurements, saving them from making multiple self-assessment submissions. The tooling capability to combine any PFS now exists in GitHub.

- Dave proposed that CEOS will only have individual endorsed PFS, which may be combined for individual data products. All endorsed PFS can be combined during the review process for self-assessment and review purposes.

- The PFS should feature an import from the CEOS EO Glossary, with links to the glossary for each term. If specific CEOS-ARD definitions are desired, terms could be defined in the PFS documents.

- Terms are cited and embedded in the generated PFS based on their usage, with the aim to align with the CEOS EO Glossary and link to the corresponding pages.

- The new self-assessment approach will incentivise providers to generate metadata file(s) for their product. In the future, the tool should be able to map requirements and products to auto-fill requirements, making use of standard semantics.

- PFS accreditation should be captured in the individually-endorsed PFS. Dave proposed removing the authors section from the editors tool. Individual PFS will retain lists of authors, and the combined PFS should feature a general acknowledgement section referring to the individual PFS. The document history section is also not required for the combined PFS.

- Ake Rosenqvist (JAXA) suggested revising the version numbers for individual PFS, and noted that the SAR and AR PFS have metadata requirements to identify the version of CEOS-ARD compliance.

LSI-VC-18-02	LSI-VC Leads to coordinate an update of the CEOS-ARD Governance Framework to cover CEOS-ARD GitHub Governance, including the following aspects: ● Section on the PFS semantic versioning convention, major release procedure and cadence, and changelog publishing. ● Process and roles/permissions for endorsing pull requests and maintaining the main branch as the authoritative version of the PFS / building blocks. ● Protocol for what becomes an issue and how to open issues within the building block framework (e.g., covering input from external contributors, permissions to make direct pull requests versus opening issues, using issues as a means to facilitate discussion, etc.).	**October 2025**
LSI-VC-18-03	Matthias Mohr to follow up with the KCEO/EOGlossary team ([Dominik Weckmueller](#); [Peter Strobl](#)) on the addition of a JSON output format for the dictionary.	**October 2025**
LSI-VC-18-04	Ake Rosenqvist and Matthias Mohr to generate the various combinations of SAR PFS using the building block process and manually confirm there are no major issues with the ordering of requirements.	**October 2025**

Product Family Specifications

- The terms 'Threshold' and 'Goal' are not well understood outside the CEOS-ARD community. The two requirements for mandatory (threshold) and aspirational (goal) requirements will remain in CEOS-ARD, but the wording of these terms is open for discussion.

Discussion

- Ake noted that 'Source' and 'Product' metadata are not interchangeable. Source metadata includes only the first and last e.g. acquisition time, so you know the product's envelope. For each data take, you have the acquisition time.
- Peter Strobl (EC, LSI-VC Co-lead) noted that we want to develop reusable requirements for different metadata. The example of acquisition time is not treated well in the standards community, affecting all EO products. The main idea is to make the building blocks small enough to be reusable.
- Dave noted that renaming the term 'threshold' to 'required' would provide clarity for the external community. Switching from 'Target' to 'Goal' was decided as the most common term in the sensor development community.

- For CEOS-ARD to become a legal ARD standard in some timeline, changing its terminology to something standards bodies accept is necessary. We're not creating ARD for the upstream community.

Metadata specifications

- For XML and STAC metadata, a mapping between requirements and metadata specifications will be used to create metadata files and validate them in the self-assessment review process. If no mapping exists in the existing metadata, the providers should include one. STAC mapping should be provided by CEOS-ARD in the future in response to community engagement. The intended provider for metadata mapping, CEOS or the provider, is left open at current.

Editors and Assessors

- Tools will be developed for the assessment and editing of the PFS, that allow the proposal of edits to the PFS and the submission and review of self-assessments. Alex Brooks (GA, CEOS-ARD peer review team) is developing an intermediate tool to assist with CEOS-ARD assessments, aligning metadata with the self-assessment. As mapping files/tags are built, more automation can be implemented.

AOB

- Peter noted that one key decision within these updates regards the categorisation of building blocks, e.g. for general, source, and product metadata. These will form the structure of the future PFS.

- The first step required in the GitHub building block migration is to convert the existing PFS to building blocks in a 1:1 mapping, so that we can begin editing them. A meeting between PFS leads should be held to review and agree on requirements shared by the PFS.

- Champion subject matter experts should also be identified and maintained for the PFS, along with secretariat support and surrounding contributors.

CEOS-ARD Oversight Group Meeting
Main points:

- Matt Steventon (LSI-VC Secretariat) reviewed the items discussed during the CEOS-ARD Building Blocks and GitHub Development Workshop, and presented the following decisions:
  - The CEOS-ARD PFS will adopt semantic versioning, to be detailed in the CEOS-ARD Governance Framework (e.g., x.x.x -> major.minor.patch). Compliance could be assigned against the major PFS versions only (e.g. 1.x.x) in order to simplify currency of assessments.
  - The CEOS-ARD Governance and GitHub Governance Framework will remain separate for now, since there is a need to make clarifications to CEOS-ARD procedures now and the GitHub governance is still nascent.
  - It was agreed that the population of the CEOS-ARD GitHub with optical building blocks and supporting structures proceed immediately.

- ○ Once the GitHub migration and equivalence checks are completed, the PFS will be re-generated and issued a minor increment in version number and announced to the CEOS-ARD community. The community will be informed of the process and notified that the changes do not affect the substance of the requirements / conformity of existing products.
- ○ It was agreed that a counterpart optical XML metadata specification is not planned, in favour of developing a STAC extension.
- ○ It was agreed that the order of major development priorities is as follows:
  - All endorsed CEOS-ARD PFS will be migrated to GitHub as they are (i.e., all optical and the InSAR specification; Combined SAR PFS already migrated)
  - Development of the editor tool
  - Development of assessor tool
- The full appendix of the CEOS-ARD Building Blocks / GitHub Workshop meeting can be read [here](#).

Day 1: Wednesday, September 3

Session 1: Welcome and Introductions

1.1: Welcome from Ivan Kulis (EC)

Ivan Kulis and Peter Strobl (EC, LSI-VC Co-lead) welcomed participants to the LSI-VC-18 meeting. The Joint Research Centre is the scientific body of the Commission providing support to European policy with scientific advice. Starting with using Landsat 1 data 50 years ago for agricultural yield measurements, EO is still seen as a catalyst for policy transition.

1.2: Welcome

Presenters: LSI-VC Co-leads, LSI-VC Secretariat

- Peter Strobl (EC, LSI-VC Co-lead) welcomed LSI-VC-18 participants to JRC Ispra.
- Matt Steventon (LSI-VC Secretariat) led a *tour de table* and reviewed the meeting agenda and objectives*.*

1.3: Summary of outcomes from 'Day 0' CEOS-ARD Building Blocks and GitHub Development Workshop

Presenters: Matt Steventon (LSI-VC Secretariat) and Matthias Mohr (SEO)

- Matt reviewed the actions and decisions taken during the CEOS-ARD Building Blocks and GitHub Development Workshop. The effort aims to modernise CEOS-ARD, open its development to the community, and increase collaboration.
- Matthias summarised the features of the CEOS-ARD Building Blocks and GitHub page.
  - Development of the PFS is being migrated to GitHub. Combined PFS will no longer be endorsed, but can be constructed in the PFS Editor Tool.
  - Glossaries and references will be generated based on term usage in the PFS, sourcing from the CEOS EO Glossary.
  - Existing product compliance will not be broken with the transition to GitHub. Individual requirements will become more general, combining like requirements into reusable building blocks.
  - Two user-facing tools will be available, an editor that abstracts the complexities of GitHub and allows editing of PFS, and an assessor tool that facilitates self-assessment and review of CEOS-ARD submissions.

Session 2: Thematic Land Surface Imaging Topics and LSI-VC Subgroup Reports

2.1: Copernicus Land Monitoring Service (CLMS)

Presenter: Andreas Brink (EC) [slides]

- Copernicus aims to develop European information services based on satellite EO and in-situ data. The three key elements of Copernicus are opportunity, capacity, and partnerships. The programme addresses policy needs, such as the European green deal, legislations, and several of the SDGs. The Sentinels are the building blocks of Copernicus, providing full, free, and open data.
- The six distinct Copernicus services are land, marine, atmosphere, emergency, security, and climate change. The CDSE platform provides access to Copernicus satellite data, products, and services across these domains.

- CLMS covers land cover and use mapping, priority area monitoring, satellite data, biogeophysical parameters, ground motion monitoring, and reference and validation data. CLMS supports SDG 15.3.1 for land degradation with the 2008-2023 Land Productivity Degradation (LPD) map. SDG 6.6.4 on water use efficiency is supported through Sentinel-3 evapotranspiration data.
- Since 2015, CLMS has provided 100 m layer Global land cover products at yearly intervals. From 2020, the land cover forest monitoring product suite provides annual maps at 10 m resolution, pan-tropical tree cover density and change, and sub-annual products aiming for NRT latency.
- For ARD-level products, CLMS is processing global mosaics for Sentinel-2 and Sentinel-1 land cover products, with the aim to produce them at a higher levels in the future.

Discussion

- Chris Barnes (USGS, LSI-VC Co-lead) recognised CLMS efforts to get disparate datasets in one environment for ease of user access and interoperability. Given the range of derived data products from observations, how do you determine which algorithms are put into operations for these products?
- Andreas noted that the operational part of Copernicus has development phases to test which algorithm best fits needs. It's a challenge as continuity for operations is important.
- Peter Strobl (EC, LSI-VC Co-lead) noted challenges in providing continuity alongside improvements and the inevitability of back processing in some cases.
- The licensing of ESA's TPM and CCM programmes was discussed, with potential connections to CEOS identified through the Interoperability Handbook's Policy Factor. For data to be interoperable, agencies must establish a clear path for licensing and compatibility. Moreover, data can only qualify as ARD if it is shareable, with this clearly indicated in the metadata.
- The use of non-European data for policymaking was discussed. EC's support to the SDGs encourages use of in-country data in a collaborative approach, in line with the Copernicus design principle of openness.
- CLMS are looking into using HLS and Sen2Like data. The Global Surface Water Explorer is fully Landsat based with plans to integrate with Sentinel, although there are issues associated with incompatible ARD. Tim Stryker (USGS) noted that future US-Europe collections and mission specifications seek to discuss these issues further, connecting closely to the mission of LSI-VC.

2.2: Wetlands and the Ramsar Convention

Presenter: Ake Rosenqvist (JAXA) [slides]

- The Ramsar Convention on Wetlands was established in 1971 in Ramsar, Iran, and has 172 contracting parties which attend dedicated Conferences of Parties (COPs) every three years. The convention aims to safeguard wetlands to ensure their sustainable use, address drivers of their loss and degradation, as well as to manage and implement the Ramsar Site Network.
- A fraction of Ramsar parties fulfil their reporting requirements. There is a critical need for information on wetland extent and inventory, with global data gaps creating a major impediment to the effective implementation of the convention.
- The 15th Ramsar COP was hosted at Victoria Falls, Zimbabwe, from 24-31 July 2025, with over 2000 attendees. STRP (Ramsar's SBSTA) organised a consultation with the EO community last year, interviewing space agencies engaged in Ramsar to kickstart a new activity using EO in the next triennium to help fill these gaps.
- The new STRP work plan was approved, with a new task to advance development and use of technology especially through EO for dynamic wetland mapping, assessment, and monitoring. The synoptic view of EO provides very useful information for wetlands. This is a great

opportunity for CEOS to step up and provide information for countries and their wetlands, as many countries are overwhelmed with their reporting requirements.

- The GEO Wetlands Exhibition booth aimed to promote the initiative and inform ongoing EO initiatives relevant to wetlands. GEO Wetlands aims to advance EO to support wetland inventory, monitoring, and assessment, identify essential wetland variables (EWVs) that capture the state and dynamics of wetland ecosystems, and capacity building for wetlands inventories.
- A lot of wetland information is available to map from space, and is most valuable as set measurables. The ALOS-2 forested wetlands inundation project addresses difficulties of below-canopy inundation mapping with long wavelength SAR observations.

2.3: CEOS Agriculture, Forestry, and Other Land Use (AFOLU) Roadmap

Presenters: Takeo Tadono (JAXA), Clement Albergel (ESA), Neha Hunka (ESA) [slides]

- The CEOS AFOLU Roadmap actions are categorised by presently available data, actions to develop new or improved products, and actions to better interact with the CEOS GHG Roadmap. The roadmap's implementation is progressing within the LSI-VC Forests and Biomass Subgroup.
- The roadmap proposes a strategic plan to coordinate AFOLU data, with strong focus around the UNFCCC GST process, improving GHG inventories, enhancing collaboration, and addressing data gaps and needs. Select roadmap actions were reviewed, which aim to support efforts in biomass harmonisation, GEO-TREES, GFOI R&D, GCOS (with NRT ECVs), observation campaigns from natural GHG sources, grassland and rangeland mapping, WorldCereal, and RECCAP 2.
- The low engagement from CEOS Agency in GEO-TREES was raised. Agencies could support the initiative by coordinating analysis of the multi-source EO dataset currently provided.
- The GFOI R&D group has picked up some of the gaps left by the SilvaCarbon programme, with a dedicated capacity building programme aiming to assess satellite data needs and reporting system integration. Success stories using EO for AFOLU will be published on the GFOI website at the end of the year.

Discussion

- The implementation and organisation of the roadmap activities was discussed, in the context of increasing coherence. The need to better engage with agencies behind each activity was noted.
- Richard Lucas (Uni of Aberystwyth) advocated for the FAO Land Cover Classification system, which has produced 35 years of maps from 1988 in Australia, Wales, DEAfrica and Asia, with ARD-based descriptors. Scene characteristics are stripped from an observation, leaving environmental descriptors and desired classes that are mapped to 'impact pressure' categories. The system was put forward in the AFOLU Roadmap as a demonstration, and would be a good capability to highlight.
- Peter Strobl suggested moving away from land cover/use categories into a finite and interoperable set of observable layers derived from sensor data. Richard emphasised the FAO approach's scalability, with the propagation of uncertainty-associated ARD and integration with IPCC.
- Digital twins take this approach, where they are not communalised and run thematically isolated. This is somewhere we can step in.

Session 3: Agency / Company Reports

3.1: KARI

Presenter: Woosung Park (virtual) [slides]

- KARI continues to engage with LSI-VC and WGCV, and participates in the annual VH-RODA and JACIE workshops. The agency has seen a growing demand for efficient data utilisation alongside wider use of EO sensors. "K-ARD" for KOMPSAT data is being developed, aligned with CEOS-ARD, to meet KARI's requirements on high resolution imagery. CEOS-ARD focuses mainly on medium to low resolution imagery, whereas the high resolution KOMPSAT series requires a tailored ARD framework.
- K-ARD specifications will be established taking into account characteristics of currently provided KARI satellite imagery, and will support applications in time series analyses, land cover and use mapping, climate change monitoring, hydrological studies, and disaster detection.
- The KOMPSAT SAR products have been compared to the requirements of the CEOS-ARD SAR PFS. All requirements can be satisfied in the future through the tailored ARD module development. All threshold requirements for the optical PFS can be met, except for Geometric correction.
- K-ARD for SAR is classified into NRB, ORB, POL, and GSLC products. K-ARD products are delivered in regular sizes based on the MGRS tiling system and subgrids are selected according to the GSD of the satellites. Next steps for K-ARD include software integration and development for ARD processing.

Discussion

- Ake Rosenqvist (JAXA) noted that VHR SAR is being discussed in the SAR group. Radiometric terrain correction is required for many SAR products, but DEMs are not typically available at a comparable resolution.
- The CEOS-ARD geometric correction metadata requirement was discussed, in the context of KARI's approach. KARI were invited to join WGCV's GCP Intercomparison Exercise (GCPIX).
- Matt Steventon (LSI-VC Secretariat) encouraged KARI to work with the CEOS-ARD team to better address image quality issues, aligning the specifications better with K-ARD.

LSI-VC-18-05	Ake Rosenqvist to connect with the KARI team (via Taeheon Kim) regarding KARI participation in the development of the CEOS-ARD PFS for very high resolution SAR.	**September 2025**

3.2: CONAE

Presenters: Homero Lozza (virtual), Dadamia Danilo (virtual) [slides]

- CONAE has submitted a self-assessment for the SAOCOM L1 SAR NRB product. The imagery is processed with Python and the SNAP interface and packaged into an XML file that includes imagery and auxiliary data. The ARD product can be ordered from the SAOCOM catalogue. Data access for SAOCOM products across Europe is available through access agreements. Commercial users can access data through CONAE's commercial arm, VENG.
- CONAE is developing the SABIA-Mar mission, which will launch from 2027 to study the oceans and will carry a VIS-NIR sensor (200 m resolution regionally, 800 m globally), NIR-SWIR sensor (400 m, nadir regionally only), and a High Sensitivity Camera (HSC) for night lights detection.
- CONAE's spatial data infrastructure has become an important data source for users, and aims to make geospatial data accessible to everyone in open and interoperable formats. It includes GeoPortal, providing non-expert users ability to grasp insights from data, the GEOCatalogue of metadata, and GEOServices OGC-WMS.

Discussion

- Ake asked if only the NRB product is being submitted for CEOS-ARD assessment, noting that SAOCOM makes POL measurements too. Homero clarified that CONAE is currently only seeking to comply with NRB requirements. The mission has full POL capabilities, but the XML ARD format has only been developed for the NRB product.

3.3: USGS

Presenter: Tim Stryker (virtual) [slides]

- Tim expressed USGS' strong support for LSI-VC and CEOS-ARD, referencing the Landsat Collection 2 Surface Reflectance and Surface Temperature datasets compliant with CEOS-ARD. USGS currently co-chairs CEOS LSI-VC, and chairs WGISS and WGCV.
- The USGS mission areas are water resources, core science systems, natural hazards, ecosystems, and energy and minerals. The National Land Imaging Program aims to deliver EO to users, and includes Landsat development and operations, applied science, R&D, national civil applications, education, and outreach. Internationally, USGS aims to provide a comprehensive, worldwide, and operational environmental monitoring system supported through international partnerships.
- The Landsat-8 and Landsat-9 missions, launched in 2021 and 2013 respectively, remain operational and collect 750 scenes over 10 million square miles daily. Landsat-7 was retired in 2025 and lowered into a storage orbit.
- Landsat Next is currently studying potential architecture restructure options, which aim to reduce cost and maintain continuity of operations and services. A superspectral triplet of instruments is continuing its development.

3.4: ISRO

Presenters: P.V. Jayasri (virtual) [slides]

- ISRO's EO programme covers optical, SAR, infrared, and hyperspectral EO sensors, as well as communications, weather, and airborne systems. Jayasri overviewed the programme's satellite life cycle, from conceptualisation to end of life.
- ISRO is compliant with the CEOS-ARD SAR NRB PFS, with the EOS-04 (RISAT-1A) mission's L1B and India Mosaic products. The mission's POL products are currently being assessed against the SAR PFS' POL requirements.
- The NISAR mission is proposing three L2 products for POL, GSLC, and InSAR data. NISAR is the world's first dual frequency satellite mission, which uses the advanced SweepSAR technique. It is capable of capturing high resolution dynamic events with polarimetric and interferometric data across a wide swath. A 12 day revisit will be achieved to monitor the land, cryosphere, and ocean Earth systems. NISAR aims to assess insights in a suite of Level 4 products related to forests and agriculture, coastal and ocean, himalayan and polar, hydrology and soil moisture, natural hazards and disasters, and solid earth deformation target application areas.
- Level 0 NISAR data are the raw science products; Level 1 is radar-coordinated RSLC and interferometric products; Level 2 is processed to geographic coordinates and includes GCOV, GCLS, GOFF, and GUNW products; Level 3 data are large area mosaics, and Level 4 are science products. NISAR data will be available through the Bhoonidhi data portal.
- CEOS-ARD compliance will be proposed for NISAR's Level 2 GSLC, GNUW, and GCOV products. An India Mosaic ARD product will be developed, combining L and S band data from NISAR, and C-band data from EOS-04.

Discussion

- ISRO's strong engagement and compliance with the CEOS-ARD specifications was noted, and the addition of NISAR to the ISRO CEOS-ARD product suite was welcomed. The multi-frequency mosaic product is the interoperable data we want.
- Usha Sundari (ISRO) noted that the NISAR Acquisition Strategy is being developed jointly with JPL. ISRO has identified targets for its own science applications, and JPL is developing the global plan.

Session 4: Land Surface Imaging Data Assessment and Procurement

4.1: Unlocking Commercial EO Archives for Public Good

Presenter: Maggie Arnold (GA) [[slides](#)]

- A concept note was presented at LSI-VC-17 (14-16 April 2025; Tsukuba, Japan) proposing the development of a catalogue of archived EO data buy-out opportunities for LSI data. This would help CEOS identify what is available, as well as provide a central record or prior acquisitions and value in archived data. CEOS can facilitate access to these archives, maximising scientific and societal impact.
- Recommendations were made to include the WGISS EO Data collection appraisal procedure, as well as information on ESA's Third Party Missions licensing.
- LSI-VC should facilitate, not purchase, agree on approaches for negotiation, encourage consistency, collaboration and transparency, raise awareness of opportunities, and align with CEOS' vision for free and open data. Potential risks include the industry response to the 'buy once for all' model, limited access in subscription models and value for scientific use, and varying licensing requirements.
- LSI-VC could consider an annual or bi-annual compilation of opportunities and acquisitions, drawing on quality assessment standards like CEOS-ARD. Points to consider include incentivising the commercial sector to make data available, finding a host/purchaser for archived data, and identifying who will make these datasets ARD compliant.

Discussion

- Matt opened a discussion on LSI-VC's role in reporting opportunities of purchasing archived data. In addition to cataloguing opportunities, LSI-VC might provide recommendations to approach providers, e.g. asking for an ARD format when purchasing data.
- Incentivisation for the private sector would come from a value proposition. Datasets could be tagged depending on their level of ARD compliance. Having CEOS recognition for a commercial product would increase its value and trustworthiness.
- US licensing for commercial operations requires that authored copies of data are disposed to the US Government. Some companies dispose of data they don't want to maintain, but don't want to share it for free nor would they want to process it to another level. Most commercial value is in the timeliness of data, which diminishes over time. NASA CSDA is trying to increase acquisitions for public licensing. Some companies do provide free data, e.g. Planet, Maxar, and Umbra.
- Peter suggested first getting a sense of what agencies already hold under license, and finding what is at risk of being thrown away. When offering to take this data, the first approach would be 'Give us whatever you have.' An assessment phase may need to be sponsored, before bringing the data into the public domain interoperably.

- Jonathon Ross (GA, LSI-VC Co-lead) noted links to WGISS Purge Alert for data that might get deleted. He suggested starting with an awareness piece to communicate incentives, making full use of the WGISS tools and guidance available.
- A study conducted by the CEOS SEO into open SAR data archives highlighted the limited duty cycle, coverage, and utility of commercial data. Expecting commercial providers to process their data to CEOS-ARD is a long shot. There is a big gap in radar data formats between the intelligence and ARD communities, a crosswalk between requirements would be worthwhile. Feedback from the commercial sector has highlighted that they want things to be more prescriptive.
- Transparency was emphasised as a key factor. Anastasia Sarelli (Ororatech) noted that taking into account algorithm intellectual property into different layers of CEOS-ARD compliance would be great.
- Dave Borges (CEOS SEO) suggested that CEOS encourages companies to adopt licensing such as Umbra's CC by 4.0, which becomes publicly available after purchase. The Interoperability Handbook Policy Factor relates to this discussion.
- Dana Ostrenga (NASA CDSA) noted that CSDA now requires ATBD provided for every product. Multiple vendors have licensing that allow for public licensing, although there is an associated cost. A lot of vendors don't hold data indefinitely. CSDA is also trying to promote commercial open data catalogues and facilitate integration into the Earthdata Search and Discoverability Tool.

LSI-VC-18-06	SEO team to establish and populate a new CEOS mailing list for the purpose of allowing CEOS Agencies to announce commercial data buy opportunities and news.	October 2025

4.2: ESA Third Party Missions (TPM) and Copernicus Contributing Missions (CCM) Programme Overviews

Presenter: Peggy Fischer (ESA) [slides]

- ESA procures EO data for its own purposes or on behalf of other institutions through the TPM and CCM programmes. ESA TPM supports R&D and science needs, distributing data to various research institutions in Europe and globally. The Earthnet TPM programme features initial data assessments from established and emerging data suppliers through the Earthnet Data Assessment Project (EDAP) and coordination with NASA CSDA. For CCMs, data is purchased in support of operational needs of the Copernicus Programme services.
- ESA has onboarded a wide portfolio of TPMs across domains, including hyperspectral, TIR, atmospheric composition, and RF. The programme has existed for over 45 years, offering data from over 50 international and commercial missions. Some commercial data is constrained (not free and open), requiring the submission of project proposals for the TPM team and mission managers to review. Any publication resulting from TPM data must cite ESA TPM.
- CCMs are funded by EC and managed by ESA, offering improved revisit times, higher spatial resolution, and complementary spectral capabilities to the Copernicus Sentinel Programme. They have major contributions to the marine, land, emergency and security Copernicus services.
- Over 25 contracts have been placed over the last two years across different procurement categories. Category 1 CCMs consist of emerging European EO data suppliers, Category 2 refer to established European EO data suppliers, and Category 3 CCMs are suppliers for miscellaneous EO

data needs. CCM data can be accessed from the CDSE or Copernicus CCM Rapid Response Desk. CCM-RRD enables 24/7 tasking, user support, and rapid on-demand data in support of disasters.

- A potential evolution of the European EO space capacity to 2030 was shared.

Discussion

- The interactions between ESA procurement teams and commercial vendors was discussed. Commercial companies value the support and expertise ESA provides across different areas, including data quality, Cal/Val, and applications.
- In note of the prior discussion on data purges, Peggy shared that the CCM license is focused on the needs of the Copernicus Services. It could be cost effective to add clauses for older (10-20 years) data, which may be an appropriate route for historical missions. The TPM Programme keeps a copy of all requested data, but the archives are quite scattered
- Catharina Bamps (EC) noted that the CCM user license is perpetual. It cannot become fully free, open and available, which would require a renegotiation with the data provider. Very high resolution data are commonly requested for security purposes and would not be made free and open. The CCM license is standardised, but must adhere to national laws.

4.3: ESA-NASA Joint Quality Assessment Framework and CEOS-ARD Connections

Presenters: Dana Ostrenga (NASA) and Leonardo De Laurentiis (ESA) [slides]

- Within EDAP, ESA and NASA have established a project related to the assessment of commercial EO data, and proposed a Cal/Val maturity matrix with a set of guidelines for independent assessors to grade the quality of commercial products. EDAP represents a long collaboration with NASA, with USGS joining, aiming to simulate interoperability between CCM and Sentinel missions.
- In 2025, the first ESA-NASA Joint EO mission QA framework agreement for SAR was signed, with optical guidelines currently under development. CSDA, EDAP, and USGS produce Cal/Val maturity matrices to evaluate data quality for Category 1 CCMs.

- In the atmospheric domain, EDAP has coordinated with CEOS on the common practices for atmospheric GHG column measurements and Cal/Val, as well as the Methane Common Practices.
- Validation methods and sites typically employed for flagship missions will be used for CCMs and new methods will be set up for emerging domains (e.g. hyperspectral and high-res TIR sensors).
- Making use of the EDAP and CEOS-ARD stamps could offer a value proposition for CCMs, who need to justify the cost for additional data processes. New startup companies are looking for assessments to demonstrate to investors that they are meeting certain quality benchmarks. Currently, assessments are against the mission stated requirements, not against any specific a priori requirements. CEOS-ARD's 0.5 pixel RMSE geometric requirement would not be compatible with this approach.
- A 'partial reverse' approach could include an independent ARD assessment covering the ESA-NASA assessment metrics, although this may introduce issues as the only required metric for independent ARD assessment is geometric accuracy. Another more direct approach would be to have ESA-NASA assessments fully covering ARD, with a more thorough and fully independent validation of radiometry, geometry, and image quality. Some missions in the New Space domain reach target requirements for geolocation (e.g. subpixel), but their data is unusable. There is no point of geometric interoperability if the data cannot be used. To ensure interoperability in ARD, the processing suite should bring everything to the same processing measurand, level, and grid.
- The development of big constellations is here - ARD should propose something requiring on-the-fly processing, e.g. L0-to-ARD processed onboard. We're not prescribing any specific processing in ARD, but if we don't specify common methods, best practices, or ancillary data, we might not get something fully interoperable.
- Areas missing from the CEOS-ARD PFS were noted, including PSF/MTF, SNR, and Fire (in the ST PFS), and requirements on processing provenance should be reinforced in terms of traceability and uncertainty budgets. Is ARD *only* about data format, metadata, sub-pixel accuracy, and well-documented SI-traceability? Or should it encompass other measurands, absolute requirements, and the same processing chain for all missions? This could satisfy a climate or flagship-class CEOS-ARD compliance.

Discussion

- Peter Strobl (EC, LSI-VC Co-lead) noted links to previous attempts to put maturity matrices and ARD together. It doesn't lead to the desired result and is based on many different concepts. He highlighted the difference between quality as a descriptor for what you have, and as something that describes 'how good it is'. The latter is fitness for purpose, which means you can't assess anything without purpose. Many data we want to cover with an ARD seal will have many different purposes. The same is true for geometry, there is no absolute reference on Earth. There are a lot of things to improve, done by separating concepts of what we want to achieve with these different matrices and benchmarks.
- Ferran Gascon (ESA) acknowledged the clear need for assessment in the data quality domain of CEOS-ARD. The next generation CEOS-ARD Strategy should highlight this notion. We should include what we want for practical interoperability of datasets, involving the data quality teams from ESA-NASA and the commercial sector.
- Anastasia Sarelli (Ororatech) noted the company's products and user base for Wildfire applications. Through CCM, Ororatech is collaborating with universities and institutions as sources to validate data and identify improvements. A primary reference point for data validation would be very useful.

LSI-VC-18-07	LSI-VC Leads and Secretariat to review feedback from Leonardo De Laurentiis, Dana Ostrenga and Melissa Yang Martin on the ESA-NASA Joint Quality Assessment Framework and potential CEOS-ARD connections (LSI-VC-18 item 4.3) and prepare a thorough response to each and reflect feedback, where relevant, in the Future of CEOS-ARD Concept Note.	**October 2025**

4.4: Specific ESA EDAP Updates

Presenter: Leonardo De Laurentiis (ESA) [[slides](#)]

- EDAP is currently assessing a number of missions from high resolution optical, high resolution SAR, atmospheric, and AIS and RF domains.
- Two sets of guidelines have been developed for ATM and TIR assessments. TPM assessments currently ongoing include SPIRE, HotSat-1, and GAPMAP-0.
- The first experimental freeboard ice map has been produced using Cryosat and ICESat-2 data. ESA and NASA are also developing altimetry guidelines, with sub-guidance for inland waters, sea ice, and land ice.
- The Vodafone in situ data network launched an idea to use their network to build an atmospheric data network across Europe and Africa, providing real time and high resolution data for climate mitigation measures. EDAP assessed the network and delivered a technical note with validation results, as well as capacity building and improvement recommendations.
- ESA is developing an AI assistant dedicated to answering data quality and Cal/Val questions.

4.5: Specific NASA Commercial Satellite Data Acquisition (CSDA) Updates

Presenter: Melissa Yang Martin (NASA) [[slides](#)]

- The NASA CSDA Programme facilitates access to multi source and frequency satellite data, complementing the existing US fleet with shorter revisit times, higher spatial resolution, and complementary measurements. CSDA currently has 15 vendors on contract.
- Data evaluation criteria include accessibility, accuracy, quality of user support services, usefulness, and quality of data. Attributes for data quality assessments include geolocation and radiometric accuracy, and platform intercalibration, following ESA-NASA evaluation guidelines.
- All new business is on-ramped via an Indefinite Delivery Indefinite Quality (IDIQ) process, with competitive task orders issued for vendors to propose under the established three-tier end EULAs: public release, US federal government plus, and US federal government. NASA's preference is to hold long term archives of data.
- Stakeholder engagement is facilitated through the CSDA monthly webinar series, which discuss access to commercial data tools, improvements to the CSDA website, and conference engagements. The next one will take place from 28-29 October 2025.

Session 2 (continued): Thematic Land Surface Imaging Topics and LSI-VC Subgroup Reports

2.4: LSI-VC GEOGLAM (Agriculture) Subgroup

Presenter: Alyssa Whitcraft (GEOGLAM) [[slides](#)]

- The GEOGLAM Subgroup held a workshop dedicated to Essential Agriculture Variables (EAVs) from 13-15 May 2025 at JRC Ispra, Italy. Agreements were reached on the scope objectives of GEOGLAM's EAV work, which aims to provide consensus, use case-agnostic definitions for measurements and quality assessments of agriculture state, change, and forecast.
- The 'EO for ag' community goal aims to better represent the expertise of the community moving forward in GEOGLAM requirements and EAVs. The EAVs will include a definition, observability comments, measurement unit, overlap with other EAVs, recommended typology, accuracy assessment guidelines, lead steward, participants, and uses.
- GEOGLAM would like to deepen its relationship with WGCV LPV in the context of good practice guidance and links to the EAVs. Each EAV will have its own inventory, stocktake, and gap analysis.
- The satellite observation component needs refinement for small fields, where geometric accuracy and insufficiently fine resolution leads to missed fields. Agency input is required to document all satellites and products.
- By 2025 CEOS Plenary, the GEOGLAM Subgroup requests review of its Terms of Reference, and appointed contributors from CEOS Agencies.
- The main actions asked by GEOGLAM at SIT Technical Workshop 2025 are to provide ToR feedback and appoint PoC to the subgroup (or at least the 6 variable stocktake), host a WGCV Workshop for ET Workshop, include an agriculture component in the CEOS MIM Database, and hold a WGCV 'Green-light' Workshop.

Day 2: Thursday, September 4

Session 5: Land Degradation Neutrality (LDN)

5.1: GEO Land Degradation Neutrality (LDN) Flagship

Presenter: Neil Sims (CSIRO) [slides]

- The GEO Land Degradation Neutrality (LDN) Flagship is centred around the UN Sustainable Development Goal Indicator 15.3.1: Proportion of land that is degraded over total land area. The GEO LDN framework has produced a good practice guidance document to help countries implement techniques, methods, and datasets to assess LDN and aid global reporting.
- The UN mandates for freely available global coverage from its default datasets, each of which are provided for the land cover and change, land productivity, and carbon stocks sub-indicators.
- Applications of LDN indicators include areas with low vegetation cover, as NDVI doesn't work well over bright backgrounds and areas with gaps in vegetation. The fractional cover product provides an intuitive and stable assessment of vegetation cover change, and could be used for LDN in hyper-arid areas. High cloud cover over Pacific islands makes LDN difficult to interpret with optical imagery, alongside differing capacity building requirements for different islands. Dialogue forums exist across different countries to define their LDN, such as the GEO-LDN Dialogue forum.
- GEO-LDN has two working groups, one dedicated to data, standards, and analytics, and another to capacity development and decision support. A toolbox has been developed to help countries assess their LDN through a curated suite of datasets and tools.
- The CEOS SDG Coordination Group developed a support sheet for SDG indicator 15.3.1. It sets data and minimum quality standards for LDN data. The LDN GPG document also provides decision trees for sub-indicators to help countries identify their best datasets. The OGC Geospatial Reporting Indicators Working Group is using 15.3.1 as a test case alongside its effort to 'rescue the SDGs with EO data.'

- Particularly in relation to UNCCD's letter of enhanced support, CEOS can provide support to small countries through high spatial resolution data and guidance. A number of new technologies are becoming available to support LDN, including data from hyperspectral, high frequency, thermal, and SAR sensors. Despite this, there is an associated challenge to intercompare datasets across sensors and time periods.
- Target 2 of the UNCBD uses indicator 15.3.1 as a baseline to track progress. GEO-LDN is working with the CEOS BST to ensure the LDN and biodiversity activities within CEOS are aligned. The recommended areas for CEOS to support are in data harmonisation, methods for assessing land cover in areas of low vegetation cover, and SAR for LDN. Integration of different wavelengths to look at different foliage profiles, looking at change over time to assess LDN and would help overcome the problem with clouds.

Discussion

- The measurement of soil organic carbon (SOC) was discussed. It is often measured by proxy, with given land covers multiplied by productivity and activity factors. It's highly variable in space and time. Situations of too much soil carbon. Land cover type with weed infestations can restrict restoration activities for the original vegetation. Open GEO is doing some interesting work on soil carbon.
- Ake noted that multi-frequency SAR is an alternative option to optical data, as it is sensitive to different structures and can extract a lot of information.
- Richard noted that the recent ESA CCI Biomass Meeting found that global maps from 2005 through 2025 show good trends.
- Conceptually, LDN aims to balance development with restoration, conservation, and preservation activities, and is trying to get degraded countries back to where they were in 2015. The climate element is important to include for future estimates.
- Jonathon acknowledged GEO-LDN's example of connecting key science to stakeholders, and asked what level of forecast skill is desirable. Neil noted the WCRP Coupled Model Intercomparison Project (CMIP), and the proposal for a Land MIP.

LSI-VC-18-08	LSI-VC Leads and Secretariat to review feedback from Neil Sims on Land Degradation Neutrality (LSI-VC-18 item 5.1) and prepare a thorough response to each input and reflect feedback, where relevant, in the Future of CEOS-ARD Concept Note. Notes will also be added to LSI-VC's input to the 2025 CEOS SIT Technical Workshop regarding observation gaps, etc.	**October 2025**

Session 6: Analysis Ready Data Standards

6.1: Discussion on topics related to the standardisation of 'Analysis Ready Data' and formulation of CEOS positions/strategies

Presenter: Dave Borges (SEO) [slides]

- The history of the OGC ARD Maturity Report was shared. Maggie Arnold (GA) made an intervention in the recent OGC Member Meeting, noting that the motion could not be supported as was proposed. The report will be up for endorsement again at the next OGC Member Meeting.

- The OGC/ISO ARD Standards Working Group (SWG) has been strategically paused and has not met since August 2024. The ARD SWG could be converted to a domain working group (DWG). DWGs cannot move through formal processes to create new OGC standards. Decision is required on the DWG transition with an understanding of the risks and opportunities of each.
- The ARD Working Group has since been renewed as a preliminary work item (PWI) under ISO 19176, with a vote towards Stage 1 planned for May 2026. The voting stages differ depending on if the PWI becomes an international standard or technical specification.
- CEOS representation in OGC matters needs to be strengthened.

Discussion

- Maggie Arnold (GA) noted that GA is a member of OGC and ISO TC211 through corporate memberships to OGC and ISO. Standards Australia is responsible for voting. GA membership applications have been submitted for Matt Adams and Maggie Arnold. They will join the IT-004 subcommittee to vote on standards of interest and support an official position on CEOS-ARD.
- The OGC ARD maturity report mischaracterises CEOS-ARD as a maturity matrix.
- The CEOS position remains that standardising ARD is premature and the SWG should remain paused.
- Sufficient CEOS-connected voting members need to be ensured in OGC and ISO.
- The timeline for ISO standard development and approval was discussed. An ARD standard should focus on the process for developing and endorsing the PFS. Ororatech and Constellr noted the limited utility of standards with long development times for commercial sector application. There is little concern of where the standard comes from, so long as requirements are agreed upon and made clear.
- Matthias Mohr (SEO) suggested an approach through OGC to adopt CEOS-ARD as a 'Community Standard'. The governance and strategy could form the first part of the standard, with the individual PFS as subsequent parts.
- Decisions and actions for this session were deferred to agenda item 6.2.

Session 7: Surface Temperature CEOS-ARD Specification

7.1: Background on the Surface Temperature (ST) CEOS-ARD Product Family Specification

Presenters: Darren Ghent (University of Leicester) and Harvey Jones (LSI-VC Secretariat) [slides]

- The CEOS-ARD Surface Temperature PFS was first initiated in 2017, and most recently updated in 2020 with Version 5.0. Version 3.2 removed the component for surface brightness temperature (SBT), as it was concluded that there was no clear user base for SBT. Other versions have followed, implementing fairly minor changes since then.
- The currently compliant datasets with the ST PFS (V5.0) are Landsat 8 ST (AIR-CAS), Landsat Collection 2 (USGS), and Landsat Collection 2 U.S. ARD. Products under CEOS-ARD development are AVHRR LST (DLR) and ERS ATSR (ESA), and products for future compliance include LSTM L2 products. Following the close of Session 7, SatVu and Ororatech were added to the list of datasets currently under development.
- An analysis of CEOS Agency missions capable of measuring land surface temperature was generated from the CEOS MIM Database and shared, noting some missions to consider for compliance assessment with the PFS.

- Darren noted that ERS ATSR is ready for compliance assessment. Originally within ESA EOP, development of the missing component was passed on to the CCI team to complete. S3 SLSTR also on its way.
- Noted the rapidly growing commercial sector involvement in the infrared domain. Missions and recent launches include Ororatech (2025), Constellr (2025), SatVu (2023), EarthDaily (2025), Aistech Space (2022), Hydrosat (2024), Albedo Space (2025), Planet (derived from AMSR-2 & Sentinel-2), and Satlantis (SuperSharp).
- The current ST PFS applies to:
  - data collected with multispectral sensors operating in the thermal infrared (TIR) wavelengths. These typically operate with ground sample distance and resolution in the order of 10-100m; however, the Specification is not inherently limited to this resolution.
  - At present, surface temperature measurements tend to be provided as either surface brightness temperature (SBT) or as land surface temperatures (LST) requiring the SBT to be modified according to the emissivity of the target. This specification identifies the Surface Temperature (ST) as being the minimum or Threshold requirement for analysis ready land surface data. Nevertheless, both SBT and LST are land measurements, requiring atmospheric corrections.
- The definitions of LST and SBT were recalled from The CEOS WCCV Land Surface Temperature Best Practice Protocol (2018). There was some debate on the suitability of these definitions.
- An updated PFS should consider re-introducing compliance for SBT products, as well as updates to the LST requirements to ensure consistency with needs of the ECVs:

ECV	Product	Horizontal resolution	Temporal resolution	Timeliness	Temporal extent	Required measurement uncertainty	Stability
Land Surface Temperature	*Land Surface Temperature*	G: < 1 km B: < 1 km T: 1 km	G: < 1 hour B: 1 hour T: 6 hours (Very nearly met by day/night temporal resolution from polar orbiting satellite, which satisfies 70% of climate users in survey)	G: - B: 2 days T: 30 days	-	G: < 1 K B: < 1 K T: < 1 K (total uncertainty per pixel combining the four groups of uncertainty components)	G: 0.1 K B: 0.2 K T: 0.3 K

- Currently, stability is not represented in the PFS. The stability figures above refer to decadal temporal extents, which would likely exclude non-climatic elements.
- Questions for discussion:
  - Do we re-introduce a CEOS-ARD compliance for SBT
    - As a threshold requirement in the existing ST PFS?
    - Or as a new SBT PFS, similar to the SAR nested PFS approach?
  - New requirement for ECV stability?
  - What types of users do we foresee?
  - Are LST and SBT the preferred measurands? Are there others better suited?
  - Inclusion of Sea Surface Temperature?
  - Updates for consistency with AR PFS V2.0?

● How do we update the PFS, and where do we start?

Discussion

- Ferran Gascon (ESA) noted that the scope should be beyond LST, and favoured keeping the PFS generic. Jonathon Ross (GA, LSI-VC Co-lead) added that this would be a good opportunity to collaborate with CEOS SST-VC. Darren noted that there shouldn't be anything specific to land in the PFS that would prevent this.
- Mark Dowell (EC) noted the need to link between CEOS-ARD and stability to enable alignment with CDR baseline dataset needs. Stability needs to be a discussion more broadly across the PFS.

LSI-VC-18-09	Siri Jodha Khalsa and Peter Strobl to propose definitions of 'Land Surface Temperature' and 'Surface Brightness Temperature' for the CEOS EO Glossary so they can be referenced in future development of the updated CEOS-ARD Surface Temperature PFS.	**November 2025**
LSI-VC-18 Decision 03	The update of the CEOS-ARD surface temperature specifications should not be limited to land but also consider sea surface temperature. The CEOS SST-VC will be consulted and invited to participate.	

7.2: Copernicus Land Surface Temperature Monitoring (LSTM) Mission Update

Presenter: Ferran Gascon (ESA) [slides]

- LSTM is planned for launch in the 2030 timeframe, with two units foreseen. The ESA mission will be part of the Copernicus Programme. The primary mission objective is agriculture for evapotranspiration at European field scale, with resolution better than Landsat, capturing surface temperature in general, allowing more robust estimates of field-scale water productivity.
- L1C products will produce radiometrically and geometrically calibrated TOA radiance, with a latency goal of three hours with high priority for Europe and Africa.
- L2A products will provide BOA surface temperature, emissivity, and reflectance, as well as water vapour and a cloud mask, with six hours latency with the same area priority at L1C. The L2A product format follows the EOPF specification, containing high level groups for measurements, quality, and conditions, stored in Zarr format.
- The LSTM is coordinating product harmonisation between the upcoming NASA SBG and CNES-ISRO TRISHNA missions.

Discussion

Mark Dowell (EC) asked if fires are a driver behind latency requirements. Ferran noted that the mission advisory group's primary latency concern is agriculture only. Products will be available for watering decisions the next morning and once launched, there will be pressure to prioritise fire monitoring. There is an emphasis to support food security across the whole of Africa.

7.3: SatVu

Presenter: Daniel Evans [slides]

- SatVu's Hotsat-1 mission was launched in June 2023, although an onboard failure resulted in its end of life in December 2023. HotSat-2 and -3 are planned to launch within the next six months,

aiming to form an eight-satellite constellation. Later satellites will move toward mid-inclination orbits, complementing SSO observations.

● The HotSat payload is a frame imager designed for targeted imaging. It has separate day and night filters to measure emitted thermal radiation, with a 3.5 m GSD at nadir across a 4 km footprint.

● SatVu conducts radiometric calibration using SST and ice analysis paired with buoy and other mission data. VIIRS was found as the only agency mission with MWIR converted to temperature data, with similar atmospheric corrections and emissivity between bands as HotSat. HotSat also has a similar overpass time to several VIIRS satellites such that HotSat's SBT can be matched with VIIRS MWIR bands. HotSat's radiance is found to be within 10% of VIIRS.

● The current product offering consists of a L1 product of each acquisition frame, and a L2 visual product optimised for photo interpretation and SBT. Use cases include industrial asset monitoring, change/anomaly monitoring, urban heat analyses, and verification of emissions claims.

● SatVu conducted a self assessment against V5.0 of the ST PFS, and commented on select metadata requirements:
   ○ Data collection time - how widely can it be interpreted?
   ○ 3.2: have considered in self assessment to consider surface brightness temperature and radiance. Currently in favour of SBT.
   ○ 2.6 cloud shadow: Does not seem well suited to non-reflectance products? Cloud shadows are not easy to detect from emitted thermal only.
   ○ 2.8 solar and viewing geometry: Are per pixels helpful to users over a 4km FOV? Seems aimed at wider swath missions.
   ○ 4.1 Geometric correction: sub pixel georeferencing gets challenging as pixel size shrinks. Sub-pixel uncertainty is very challenging at this resolution. No thermal based map of the world, so use Sentinel-2's shorter bands, so are limited by the quality of the base map.
   ○ Pros of SBT: Unknown emissivity disincentivises providers from making bad LST products, user provided emissivity can be used to update estimates, and SBT is a more achievable variable.
   ○ Cons of SBT: The measurand is not standard across sensors, and stronger atmospheric interference in the MWIR region makes SBT product intercomparisons difficult.

Discussion

● Regarding SatVu's self-assessment, Darren noted that the product has been assessed only against relative measurement uncertainty, not an absolute source. The relative source itself has an uncertainty.

● Jamie agreed that the relative VIIRS measurement will have its own uncertainty. If we can demonstrate agreement with multiple other satellites, e.g. Sentinel-2 and SEVIRI, it provides confidence against VIIRS biases. SatVu supported the approach of a separate PFS requirement for SBT. It is likely that the only requirement not common between SBT and LST is 3.2: Corrections for atmosphere and emissivity.

● Peter noted that this issue will be addressed by the GitHub modularisation initiative. We can commit to endorse PFS at the level of a single measurand.

7.4: Constellr

Presenter: Andreas Brunn [slides]

- Shared insights provided by Constellr's thermal imagery such as early anomaly detection (pre-visible), e.g. overheating, leakages, energy losses, and agricultural aspects. Constellr's HiVE Constellation aims to provide reliable 24/7 data.
- Nighttime imagery will be limited in geometric and temperature accuracy. Temperature is a surface insight, not just an image. Optical imagery shows how a surface looks, but with infrared we get an early warning system that can, for example, inform farmers exactly when to irrigate their fields. Domains enabled by HiVE include agriculture, security and defence, infrastructure, urban planning, logistics, and supply chain.
- Satellites sensitive in the TIR region include high temporal and low spatial resolution GEO satellites, mid range Sentinel and Landsat satellites, and higher spatio-temporal resolutions of future missions such as TRISHNA, SBG, and LSTM. Constellr is currently flying two satellites, launched in January and July 2025 into SSO. They provide 30 m GSD for LWIR and 10 m for VNIR bands, attempting to mimic Sentinel-2 bands.
- HiVE produces a 13 m resolution LST product with high temperature sensitivity. The complete constellation will provide up to sub-daily revisit and will be time series ready. The LST*zoom* product is upscaled to 10 m resolution with NIR bands. LST*fusion* resamples all available thermal information into an individual 30 m product. LST*precision* expects temperature precision between 1-2 K.
- Cal/Val is performed against CEOS networks such as RadCalNet and TIRCalNet. A customer web portal and API was released in August 2025. The SkyBee-3 satellite is planned to launch next year.
- Data formats in an ideal world: amidst the many existing data formats and requests, it would be ideal if metadata standards were standardised, with product bundle and performance requirements clearly defined, alongside affordable performance testing.

7.5: Ororatech

Presenters: Anastasia Sarelli, Josephine Wong [slides]

- Ororatech was founded in 2018, and currently has 150 employees across 5 continents, 300 users in 20 countries, and ten satellites in orbit. The company is developing thermal cameras, a unique constellation for NRT data, onboard processing, and a visualisation API. They have won contracts to monitor wildfires across Greece and Canada, and is an emerging ESA CCM member.
- Since 2022, three prototype satellites have been launched, and in 2025, the wildfire monitoring satellite constellation began launching with OTC-P1. The constellation aims to fix the 'afternoon gap' in the TIR industry, monitoring peak burn periods between 13:00-19:00 for better wildfire monitoring insights. The SAFIRE-2 payload provides a 200m GSD over a 410 km swath, and aims to provide a 30 minute revisit time with the full constellation.
- The data product suite includes L3 and L4 wildfire data, onboard-processed L2 NRT active fire, as well as LST, SST, and FRP. LST is provided in netCDF and GeoTIFF formats.
- Cal/Val activities include on ground MTF, radiometric calibration and characterisation, in-flight lunar calibration, deep space acquisitions, flatfielding, and automated cross overpass tasking and validation. Ororatech is collaborating with the ESA CCM MPC, which regularly assesses data products.
- The CEOS-ARD surface temperature requirements were reviewed, some of which can be reached for Threshold and Goal and levels, and some needing clarification. There were concerns over ATBD availability and release. Suggestions for interoperability were also shared, including to explore universal resampling grids to enhance consistency across missions.

7.6: Discussion

- The group agreed to start exploring updates to the ST PFS in a dedicated working group, which should ensure that the commercial sector feedback is incorporated. The effort will run in parallel to the CEOS-ARD Building Block GitHub migration. The need to find a subject matter expert to lead the update effort was highlighted.

LSI-VC-18-10	LSI-VC Secretariat to ensure PFS and requirements feedback from presentations to LSI-VC-18 are transferred to the GitHub issue tracker.	**September 2025**
LSI-VC-18-11	LSI-VC Secretariat to review input from commercial providers that presented to LSI-VC-18 and ensure their perspectives are included in the 'Increasing Commercial Relevance' section of the Future of CEOS-ARD Concept Note.	**September 2025**
LSI-VC-18-12	LSI-VC Secretariat to convene a working group to explore updates to the thermal specifications of CEOS-ARD (i.e., the existing Surface Temperature PFS and potential new Surface Brightness Temperature and Sea Surface Temperature specifications). The following nominations / expressions of interest have already been received: ● ESA: Silvia Scifoni ● USGS: Name TBD ● SatVu: Jamie McMillan ● Constellr: Andreas Brunn ● OroraTech: Josephine Wong, Anastasia Sarelli ● EarthDaily: Name TBD ● Siri Jodha Khalsa ● Darren Ghent LSI-VC Secretariat will initiate a few initial meetings but a solution is needed for sustainment. The LSI-VC Secretariat will follow up with other relevant companies (e.g., Aistech Space, Albedo, IHI Corporation?) and CEOS agencies such as CSA and ECCC (WildfireSat), and CNES and ISRO (TRISHNA). SST-VC and COAST-VC should also be asked to nominate representatives.	**September 2025**
LSI-VC-18 Decision 04	LSI-VC Secretariat will convene a working group to explore updates of the thermal CEOS-ARD specifications, including for Land Surface Temperature (LST), Surface Brightness Temperature (SBT), and Sea Surface Temperature (SST). The updates will be implemented using the CEOS-ARD building block framework as a trial implementation. The LSI-VC Secretariat will initiate a few initial meetings but a solution is needed for sustainment of the activity.	

Session 8: Future CEOS-ARD

8.1: Overview of the Future of CEOS-ARD initiative

Presenter: Ferran Gascon (ESA, CEOS-ARD OG Lead) [slides]

- The goals for 2025 toward the Future of CEOS-ARD initiative are to gather community feedback on the current state of CEOS-ARD, understand priorities for future development, and present a concept note for the 2026 CEOS-ARD Strategy at 2025 CEOS Plenary. The overall aim is to ensure CEOS-ARD is working for the broadest group of stakeholders.
- CEOS-ARD has caused a significant and positive paradigm shift in the EO community, making data more transparent and easy to use, providing a basis for interoperability and a benchmark for non-CEOS data providers, encouraging a more thoughtful approach to data provision, and democratising EO.
- The EO sector has seen changing technology, an evolving user base and expectations, and increasing demands for interoperability. The CEOS-ARD Oversight Group is tasked to maintain the CEOS-ARD Strategy, with updates every two years. A community engagement campaign was conducted in 2025 to understand needs, with presence at events such as ESA LPS, IGARSS, IAC, and WGCV-55. Findings from this engagement will be presented to CEOS Principals to justify the need for the updated strategy.
- Plans for an ARD Workshop in 2026 tied to CEOS SIT-41 were discussed, with a favour to hold a dedicated CEOS-ARD session at JACIE 2026.
- The representation and involvement of other thematic areas from the CEOS Virtual Constellations in CEOS-ARD was discussed, which concluded that a CEOS-ARD Oversight Group meeting should be held at the joint WGCV-56/LSI-VC-19 meeting in April 2026.

LSI-VC-18-13	LSI-VC Secretariat and SEO team to coordinate the CEOS-ARD presence at VH-RODA 2025. Medhavy Thankappan (GA), Paolo Castracane (ESA), Cody Anderson (USGS), and Peter Strobl (EC) are planning to attend.	**September 2025**
LSI-VC-18-14	LSI-VC Secretariat and Leads to explore the possibility of a dedicated CEOS-ARD session at JACIE with Cody Anderson/USGS. Specifically targeting Friday, April 17, which is the day after SIT-41 and the week before LSI-VC-19.	**October 2025**
LSI-VC-18-15	LSI-VC Secretariat to organise a dedicated CEOS-ARD Oversight Group day during the joint WGCV/LSI-VC meeting week in April 2026 at USGS EROS. The purpose will be to focus on development of CEOS-ARD Strategy 2026, following planned SIT-41 confirmation of the strategic direction that will enable subsequent technical decisions to be taken. The meeting will also be an opportunity to connect with the commercial sector and consider outcomes from JACIE.	**March 2026**
LSI-VC-18 Decision 05	A CEOS-ARD workshop in California after SIT-41 will not be pursued in favour of organising a CEOS-ARD session on the Friday of JACIE week (April 13-17, 2026, in Reston, Virginia).	

LSI-VC-18 Decision 06	Organise a dedicated CEOS-ARD Oversight Group day during the joint WGCV/LSI-VC meeting week in April 2026 at USGS EROS.
LSI-VC-18 Decision 07	For SIT-41, identify policy questions to put to CEOS Principals that will provide guidance for the 2026 CEOS-ARD Strategy development sessions that will follow the week after at the joint WGCV/LSI-VC meeting. That is, seek to have SIT-41 confirm the strategic direction to enable subsequent technical decisions to take place at the joint WGCV and LSI-VC meeting the week after and make writing of the CEOS-ARD Strategy more certain.

8.2: Overview of "Future of CEOS-ARD Survey" Results

Presenter: Matt Steventon (LSI-VC Sec) [slides]

- The Future of CEOS-ARD polls data producers, users, and distributors on characteristics of ARD datasets, what they value most, future priorities, formal vs community standards, AI/ML readiness, barriers to use, datasets they'd like to see endorsed, opportunities for uptake, and any self-assessment plans.
- It aimed to find out if we could be more ambitious, gather feedback on the value proposition and CEOS-ARD, consider minimum data quality and fitness for purpose requirements, and how we can be more interoperable. Over 100 responses have been received to the survey, which mainly targeted the commercial sector. CEOS Agency responses were not large.
- Barriers to uptake of the CEOS-ARD Framework (providers) or products (users) found a large lack of awareness. There was good turnout and engagement to the CEOS-ARD webinars. Training and outreach was identified as the most voted for opportunity. Providers were strongly in favour of automated validation tools, which means that CEOS-PVP could be very useful for sample ARD datasets.
- Participants filled out multiple choice characteristics for ARD, ranking consistent metadata specifications at the top, followed by machine-readability, interoperability through time, FAIR compliance, and consistency (spatio-temporal consistency). 'Quality' as a keyword was mentioned six times in the free text field. The relation between ARD and AI/ML needs some more analysis. A lot of free text responses didn't see the AI/ML applicability to ARD. Participants requested CEOS-ARD for MODIS, PlanetScope, PACE, and NISAR.

Discussion

- There was a discussion around the prioritisation of data end users, tooling, machine and human readability, data quality characteristics, and geometry, as well as the rigour of AI algorithms replacing physics-based retrievals.

LSI-VC-18-16	LSI-VC Secretariat to investigate the following aspects of the CEOS-ARD survey: • Confirm if 'unclear benefits or added value' was a question posed to data users. • Determine who noted that they are planning/undertaking CEOS-ARD self assessments and seek to add these to the ceos.org/ard datasets table.	**2025 CEOS Plenary**

	● Summarise the additional CEOS-ARD datasets that respondents requested of CEOS Agencies and ensure this feedback is presented to the 2025 SIT Technical Workshop and CEOS Plenary. ● Further segment the survey multiple choice results by 'data provider' and 'data user'.	

8.3: Discussion: Draft Future CEOS-ARD Concept Note

Moderator: Matt Steventon (LSI-VC Sec)

- Feedback received at LPS, IGARRS, WGCV, LSI-VC, and CEOS engagements has been compiled into the Future CEOS-ARD Concept Note, with categorised alongside survey responses into 15 headings.
- Regarding 'Capturing Use and Impact,' we should commit to presenting regularly to CEOS Principals specific examples of end user feedback with a describable impact. Suggested contacting Matt Adams to provide input to an Australia case study.
- Jonathon Ross (LSI-VC Co-lead) noted that this effort aims to reinforce why we started CEOS-ARD. Democratising EO is a key piece. We're trying to support more users to integrate data from multiple sensors - most products today are highly tailored to one sensor.
- Ake Rosenqvist (JAXA) noted that one starting point for CEOS-ARD was to broaden communities to use satellite data.
- Peter Strobl (EC, LSI-VC Co-lead) noted issues within WGCV to guarantee quality, which is more to do with calibration. Quality control is not a specific problem to LSI.

LSI-VC-18-17	● LSI-VC Secretariat to reflect discussion from items 8.2 and 8.3 of LSI-VC-18 into the Future of CEOS-ARD Concept Note. This should include reinforcing wording around the purposes of CEOS-ARD, noted below. ● *Note: "CEOS-ARD is not intended to be the solution to every problem. If we make it too generic and encompassing, it becomes meaningless. This is about reinforcing why we started CEOS-ARD. Democratision is a key piece. We're trying to support users in their attempts to analyse data without the need for additional processing and to integrate data from multiple sensors. Most products today are highly tailored to one sensor. One starting point for CEOS-ARD was to broaden communities' use of multiple sources of satellite data. Many different applications for users. Broadening the community to more non-experts is important to highlight."*	**2025 CEOS Plenary**
LSI-VC-18-18	LSI-VC team to review the Future of CEOS-ARD Concept Note and confirm that the high level categories and sub-issues/risks/opportunities/dependencies (to be added as dot points) are complete and correct.	**2025 CEOS Plenary**

8.4: EarthDaily

Presenters: Chris Rampersad, Miriam Cabero [slides]

- Earthdaily (EDA) works in both the data sales and applications worlds, with 250 staff across France, Australia, Canada, and the US. Ten satellites are planned to launch between 2025 and 2026, each of which have 215 kg mass, designed to operate in a fixed orbit locked with Sentinel-2.
- The EarthDaily Constellation will image 97% of the Earth's land mass every day. The mission payload houses 22 bands, observing visibly at 5 m resolution,in SWIR at 95 m, and TIR at 120 m. ESA-NASA principles are followed for science-quality spectral coverage, accuracy, and redundancy. Set bands are dedicated for methane, data quality, and crop health, future-proofed with Landsat Next bands for interoperability, cross compatibility and intercomparisons
- EDA has developed its surface reflectance product in line with the CEOS-ARD Surface Reflectance PFS.
- In order to validate its approach, RadCalNet SR measurements are used as a ground truth to compare EDA's BOA derived from S2 L1C against ESA's S2 L2A product. AERONET sites are used to compare spatio-temporal consistency against Sen2Cor, with good agreement.
- With a focus on change detection, EDA wants to ensure consistency in its data particularly for haze correction. EDA is getting close to human level performance for cloud masks, which are crucial for accurate agriculture products.
- The progress of EDA's self-assessment against the SR PFS was shared, noting compliance at the Threshold level and barriers to achieving the Goal level. One issue concerned the sensor calibration metadata requirement, as these are proprietary parameters with some auxiliary data not available for download.

Discussion

- Regarding cloud screening, Ferran shared details of the CEOS Cloud Mask Intercomparison Exercise (CMIX), and recommended checking out the updated Sentinel-2 algorithms.
- Jonathon noted that proprietary information such as sensor calibration parameters do not need to be open to everyone.
- The stringency of the geometric correction goal requirement for high resolution missions was discussed.

LSI-VC-18-19	Ferran Gascon to share Cloud Masking Inter-comparison eXercise (CMIX) contact details with Chris Rampersad and Miriam Cabero (EarthDaily)	**September 2025**
LSI-VC-18-20	LSI-VC team to respond to EarthDaily's questions resulting from their Surface Reflectance Goal-level self-assessment, particularly items 1.11 and 1.14, which likely need to be revised in future iterations of the PFS.	**September 2025**

Session 3 (continued): Agency / Company Reports

3.5: CATALYST

Presenter: Griffin Williams [slides]

- Catalyst (aka PCI Geomatics) aims to simplify Earth data, making actionable Earth intelligence information available to decision makers. Its core development principles are modular workflows, cross-platform, and sensor agnostic.

- Over 750+ algorithms have been developed by CATALYST. On the image processing side, science and software are implemented to data production pipelines. e.g. orthorectifying L1A imagery and applying atmospheric corrections. The company is often working with satellite imagery providers and the public sector. Milestones include work with SANSA to generate a SPOT archive data complaint with CEOS-ARD, developing time series products compliant to CEOS-ARD, and supporting SmallSats through data production and processing pipelines.
- CATALST is proud to be the first commercial company to produce CEOS-ARD data for both SAR and optical sensors (SPOT-5 SR and Sentinel-1 NRB).
- On the radiometric side, CATALYST has done spectral normalisation to MODIS, and recently developed atmospheric correction technology built off the 6S radiative transfer model, using RadCalNet data to validate against SmallSat data.
- Catalyst has been deeply embedded in the global EO network for many years, with major support to Canada among other countries.

3.6: Landsat Collection 3 update

Presenter: Chris Crawford (USGS)*

- The Landsat archive was reprocessed to Collection 2 in late 2019, and includes L1 calibrated products. USGS also included the L2 atmospheric corrected products for Landsat 4-9 (SR and ST) made available globally for the first time.
- The distributed product architecture processes data to Level 1 after acquisition data. The U.S. ARD product is among the L2 products. ECV products produced include fractional snow, burnt area, and DSWE for the US, along with global in-demand products for ET and AR.
- Over 12.4 million unique Landsat Level 1 scenes have been distributed across the 53+ year archive, since Landsat became freely available in 2008. There have been more than 26 billion Landsat data accesses over the past year. Demand for Landsat, starting with pre-collection data (before 2016), has increased in terms of active users and data volume.
- Switching to a new collection may be disruptive to the user community due to the time it takes to understand the new archive.
- Collection (C3) will be fully cloud-enabled, and is anticipating the integration of LNext observations to the archive, with the emerging science observations and new measurements required. The public release for C3 is planned for December 2028.
- C3 will include geometric improvements such as COPDEM, flagging shutter intrusion events, improving pixel alignment with Sentinel-2. Radiometric improvements will include recalibration to Landsat-9 for absolute radiometric calibration, improvements to surface reflectance and temperature, and accommodating and correcting for issues. USGS will work with partners like GA for applying BRDF correction.

Day 3: Friday, September 5

Session 9: CEOS-ARD Framework

9.1: Optical CEOS-ARD PFS Requirements Consolidation updates

Presenter: Chris Barnes [slides]

- The decisions taken in the CEOS-ARD Building Blocks Workshop were recapped, which agreed to migrate all the PFS to GitHub. Chris will confirm the equivalence in their translation. Semantic versioning was proposed for the PFS versioning convention.
- A mapping of metadata requirements was shared, highlighting those common between PFS and the need to coordinate requirements between the optical PFS and terminology between all of them. The general metadata changes made in the Aquatic Reflectance V2.0 update were reviewed.
- Chris shared a notional WGCV-56/LSI-VC-19 meeting format, in the week of 20 April 2026:

    ○ Day 1: Dedicated ARD OG day, inviting others to join.

    ○ Day 2: Half day joint between WGCV/LSI-VC

    ○ Day 3 and 4: individually focused days

    ○ Day 5: joint, special topics.

Discussion

- Ferran Gason (ESA) noted that terrain occlusion should be included in the Surface Temperature and Aquatic Reflectance PFS.
- Siri Jodha and Peter noted that emissivity and atmospheric corrections should not be kept together in the ST PFS.
- Peter suggested finding what is generic across the group and organising them accordingly. Ideally, general and per-pixel metadata would be closer together. General metadata can be a matrix of compressed per-pixel data that holds the same value everywhere.

- Regarding general harmonisation, Ake considered a requirement that all products are provided in a cloud optimised format. We are moving towards cloud computing and storage. It's currently a goal requirement for SAR but it should be a threshold. The format aspect is driven by the CEOS Interoperability Handbook

LSI-VC-18 Decision 08	Agreed LSI-VC-19 will take place during the week of April 20 at USGS EROS. Use the full 5 days for a combination of LSI-VC specific sessions, joint with WGCV, and broader Oversight Group topics where we can engage other WGs and VCs. Exact structure to be refined by LSI-VC Sec and Leads (Chris primary).	
LSI-VC-18-20	LSI-VC team to respond to EarthDaily's questions resulting from their Surface Reflectance Goal-level self-assessment, particularly items 1.11 and 1.14, which likely need to be revised in future iterations of the PFS.	**September 2025**
LSI-VC-18-21	Ake Rosenqvist to create an issue in the CEOS-ARD GitHub regarding cloud-optimised formats becoming a Threshold requirement in future iterations of the CEOS-ARD PFS, and to reflect the same in the Future of CEOS-ARD Concept Note. *Note: This is not regarding prescribing a particular format, but rather the overall concept of requiring cloud-optimised formats. Note also the relation to the WGISS Interoperability Handbook v2.0 recommendations.*	**September 2025**

9.2: CEOS-ARD Framework update to include a new product level classification / taxonomy

Presenter: Peter Strobl

- The CEOS-ARD initiative needs a more practical framework to provide structure, support consistency, increase efficiency, facilitate orientation, and enable modularity. The PFS do not describe input data; only the product. Input data should have their own specification.
- When describing these inputs, it should be abstracted to observation basics such as location and orientation, signal type, and phenomenon time and property. Starting with each individual sample (observation), a single pixel, and its uncertainty. This is the core element of data.
- The PFS should consider typologies, different measurand, sensor, and signal types, target interaction, and signal source. Starting a new measurand PFS against this typology would aid the assigning of requirements.

Geometry \ Measurand	M/0 - raw	M/1 - sensor calibrated	M/2 - target calibrated	M/3 - homogenised	M/4 - derived
G/A - raw	DATA				
G/B - georeferenced		L1B	L2B	L3B	?
G/C - georectified		L1C	L2C	L3C	L4C
G/D - regridded1		L1D	L2D	L3D	L4D
G/E - regridded2				L3E	L4E

ideal   tolerable   critical

- The ISO-proposed top-level UML includes measurand type, sensor type, thematic product, and modelling product.
- To get modularity, we need a structure in how we line up the products according to value. A logical and modular chain of products is achieved by dividing the value chain of observation processing into levels. This would range from raw sensor measurements to harmonised and interoperable versions that take out sensor specifics, deriving information that is clean and independent of the original observations.
- Geometry in current processing levels is dealt with in an awkward way. Geospatial data needs to be localised, but the way they are spatially represented is independent of what they are in individual measurement quality.

Discussion

- There was a discussion around regridding, and the additional uncertainty introduced by shifting samples to a different location to achieve homogeneity. CEOS-ARD requires map projection but does not address requirements for regridding directly, opening the door to inconsistencies.
- Target calibration presents you with values that you could have measured at the target with no medium in between (essentially in-situ). The homogenised step takes out the effects of the sensor. Sensor agnostic is a very important level for ARD.
- Making clear these levels in the CEOS-ARD framework would increase its rigour. It makes sense to categorise the PFS according to this typology.
- The typology also links to existing terminology and architecture activities in CEOS. It was agreed that the typology would be adopted in CEOS-ARD as a first step, starting with an update to the CEOS-ARD governance framework.

- The typology could also be applied to the other CEOS Virtual Constellations, providing visualisation to where they sit in the processing value chain.

LSI-VC-18-22	Dave Borges and Peter Strobl will share the newly adopted CEOS-ARD typology and product level conventions at the next Earth Science Information Partners (ESIP) meeting – for strategic awareness of this community that was discussing product level definitions recently.	**Next ESIP Meeting**
LSI-VC-18-23	Peter Strobl and LSI-VC Secretariat to propose an update to the CEOS-ARD Governance Framework to adopt the typology and product level conventions proposed by Peter at LSI-VC-18. Note the connection to LSI-VC-18-02.	**October 2025**
LSI-VC-18 Decision 09	Agreed that adopting the typology and product level conventions proposed by Peter Strobl (item 9.2) in the CEOS-ARD Framework would be beneficial.	

9.3: Surface Reflectance Quality and Consistency

Presenters: Josh Sixsmith, Medhavy Thankappan (GA) [slides]

- CEOS-ARD provides a strong basis for interoperability, but tolerates different approaches that affect the harmonisation of multi-sensor products. The SRQC project aims to consolidate surface reflectance (SR) methods and produce guidance on corrections to develop harmonised products and richer timeseries, enable a wider range of users, and make multi-sensor data complimentary.
- Users need to remain aware of fundamental statistical assumptions. NASA HLS and ESA Sen2like demonstrate the need to improve compatibility of SR across providers, and major incoming collection updates provide an opportunity to better align SR products. CEOS-ARD is the first step in an interoperability continuum.
- HLS 2.0 demonstrates that using multiple sensors in a harmonisation and homogenisation process provides a time series with better insights. SRQC aims to build on existing CEOS-ARD datasets to enable multi sensor interoperability. We need to identify an unambiguous characterisation of the measurand. The project aims to assure users they can uncover better insights to their data, providing cost savings, reduction in effort, increased algorithm compatibility, and higher return on investment.
- The project's original proposal was first presented at the ARD23 workshop, and is now part of the CEOS Work Plan. The team is currently developing a guidance document, sourcing input from the expert and user community. Existing SR literature has been categorised into themes, shedding light on common problems and barriers for analysis. Volunteers to participate in the group are welcomed.

Discussion

- Jonathon Ross (GA, LSI-VC Co-lead) noted that when looking at the next generation of CEOS-ARD, in the PFS we could introduce a subset of fitness for purpose requirements for higher level applications.

- Ferran Gason (ESA) noted that ARD is mainly focused on interoperability in terms of geometry, with no time series requirements on the radiometric side. The possibility for HLS certification for CEOS-ARD was discussed.
- Peter Strobl (EC, LSI-VC Co-lead) noted that SR is not a measurand; it describes a whole category of interactions between surface and signal. Defining the measurand is the crucial step.
- Medhavy Thankappan (GA) recalled the SRQC Measurand Description Workshop held in early 2025 that wasn't able to make any progress. The proxy way to do this is to agree on a way to define the SR in the CEOS-ARD context.

Session 6 (continued): Analysis Ready Data Standards

6.2: ARD Standards Decisions and Actions Revisit

- Dave Borges (CEOS SEO) proposed a set of decisions and actions encapsulating the agreed CEOS position and way forward following agenda item 6.1: *Discussion on topics related to the standardisation of 'Analysis Ready Data' and formulation of CEOS positions/strategies.*
- An OGC community standard submission can take any format. The STAC community standard was submitted as a combined Markdown document of all the Markdown documents in the respective GitHub repository. Space agencies in support could write in justifications on why CEOS-ARD is crucial, noting OGC's requirement that the maturity of community standards are evidenced within the community.
- There was discussion on what CEOS-ARD puts forward for standardisation. The standard itself would refer to the CEOS-ARD Governance and GitHub repository, and the PFS as published. Yearly updates at TC meetings could bring in new PFS/versions.
- CEOS will support the ARD SWG-DWG conversion, noting the SWG's inactivity, and will vote accordingly when required. A co-chair for the DWG needs to be identified.

LSI-VC-18 Decision 10	CEOS will not support the OGC ARD Maturity Report and will move/second at the 133rd OGC Member Meeting that OGC should not endorse the report unless it goes through a review and revision in the OGC ARD SWG/DWG.
LSI-VC-18 Decision 11	CEOS supports, and joint CEOS/OGC members will vote accordingly when required, to convert the Joint ISO/OGC ARD SWG to a new OGC ARD DWG.
LSI-VC-18 Decision 12	CEOS agrees that given the ISO/OGC ARD SWG has been inactive for more than one year, and in light of the (proposed) conversion to a DWG, new DWG leadership is warranted and a formal vote should be requested. CEOS will consider nominations for these co-chair positions (ideally one CEOS Agency and one industry person).
LSI-VC-18 Decision 13	CEOS will initiate the OGC Community Standards process to make CEOS-ARD an OGC Community Standard, socializing and incorporating feedback into this process through the new OGC ARD DWG. The Community Standard would be a multi-part approach, with just Part 1 (Process / Governance) now to start with, documenting the high level CEOS-ARD process, rather than individual PFS (which would be subsequent parts).

LSI-VC-18 Decision 14	ISO 19176-1 WG 6 Imagery ARD Project (Stage 0 Preliminary Work Item) should remain a Stage 0 PWI until CEOS-ARD has officially become an OGC Community Standard, after which, a Stage 1 vote should occur to allow ISO ARD Project development based upon the OGC CEOS-ARD Community Standard.
LSI-VC-18 Decision 15	CEOS-ARD will (in due time) pursue OGC Community Standard certification with expectation that the process will take approximately 12 months.

LSI-VC-18-24	Dave Borges to prepare for the ARD SWG meeting at the OGC 133rd Member Meeting a statement regarding CEOS's non-concurrence with the OGC ARD Maturity Report and a motion to convert the Joint ISO/OGC ARD SWG to a new OGC ARD DWG.	**OGC 133rd Member Meeting (October 28 to 31, 2025)**
LSI-VC-18-25	Dave Borges to schedule a meeting with Scott Simmons of OGC to discuss the specifics of transitioning the OGC ARD SWG to a Community Standard approach built on CEOS-ARD, including new versioning scheme details.	**Before OGC's 133rd Member Meeting (October 28 to 31, 2025)**
LSI-VC-18-26	LSI-VC team to consider nominations for Co-Chair of the OGC ARD SWG / DWG (if transitioned).	**Before OGC's 133rd Member Meeting (October 28 to 31, 2025)**
LSI-VC-18-27	Dave Borges and LSI-VC Secretariat to compile a list of voting members in frame of OGC and ISO (TC211 WG6 ARD Project). *Note: Additional votes and national standards bodies connections are needed. Andreas Brunn (Constellr) should be consulted regarding German national standards bodies contacts.*	**Before OGC's 133rd Member Meeting (October 28 to 31, 2025)**

Session 3 (continued): Agency / Company Reports

3.7: GISTDA

Presenter: Pawarin Kuha [slides]

- GISTDA was established in 2000 to develop, study, and provide space technology and geoinformations to Thai society. GISTDA has operated the THEOS-1 satellite mission since 2008, and THEOS-2 since 2023. THEOS-2A has been developed and is planned to launch in early 2026. THEOS has primary applications in agriculture, disaster monitoring, urban planning, natural resources, and national security.
- Satellite data from GISTDA and partners is archived in Thailand's National Space Data Center (NSDC). THEOS imagery can be accessed through the AWAGAD platform, published in September 2025. Future THEOS missions include THEOS-3 (VNIR & SWIR) , -4 (SAR) and -5 (high resolution).

- After satellite acquisition, GISTDA will process ARD data and store it in the national archive. Pawarin shared examples of THEOS data processed against the CEOS-ARD SR PFS, as well as GISTDA's self-assessment for CEOS-ARD compliance.
- GISTDA's ARD processing is currently limited by the availability of GCPs only over Thailand, as well as the stringent sub-pixel geometric accuracy requirement for high resolution sensors like THEOS-2.
- Peter referred GISTDA to the CEOS GCPIX activity at the WGCV-55 meeting to access and share GCP information.
- This year, GISTDA will develop THEOS-2 Multispectral and THEOS-1 PAN products for CEOS-ARD submission. They are currently exploring ways to process the pansharpened product, since the payloads have different GSDs. Next year, GISTDA will focus on enhancing its geometric and radiometric accuracy, develop an automated ARD production system and STAC catalogue, and support future CEOS-ARD development particularly for high resolution data.

3.8: Marble Imaging

Presenters: Gopika Suresh, Meghna Sengupta [slides]

- Marble Imaging was founded in 2023, aiming to develop a VHR satellite constellation for EO and geospatial intelligence. The company is part of ESA's InCubed programme, utilises a DLR platform, and has industry partners across Europe. It was also appointed a Category 1 ESA CCM this year.
- The European data market has gaps in optical and multispectral data. A constellation of 20 satellites is planned to be operational by 2028, providing tasking and continuous imaging, and laser terminals for data downlink. Its spectral bands are similar to Sentinel-2's, with a harmonised product for SWIR bands.
- Marble Imaging aims to respond to needs for time critical data, and is looking at mid-inclination and sun-synchronous orbits to enable hourly revisit times. A resolution of 70 cm is targeted, to monitor critical events across the land and sea, national security events, hazards, and disasters.
- The company is developing its own processing chain and would be keen to have CEOS-ARD involved. Gopika presented an overview of the tools and services being developed for marine and terrain monitoring applications.
- Marble Imaging is developing synthetic assimilated data using current high resolution satellites and Sentinel-2. It is at an early stage of data provision, so not currently ready for CEOS-ARD self assessment. The company would like to get involved in CEOS and contribute to activities such as GEO4SGDs.

Discussion

- Regarding CEOS-ARD self assessment, Matt suggested making an attempt before launch, noting that DLR did their self assessment for EnMAP before its launch.
- Peter discussed the saturation of geolocation requirements at high spatial resolution, noting that the CEOS-ARD SR PFS was incepted at times when nothing finer than 10m Sentinel-2 existed. There are some exceptions for urban areas, e.g. high rise buildings which would need sub metre elevation to meaningfully arrive at orthorectification.
- Marble Imaging has capability to complement Sentinel-2, providing a degraded resolution fill-in to gaps in time series. Having reference missions is mandatory to enable a lot of these industry endeavors. These frameworks provide a guarantee for interoperability. Ferran recommended using GRI (geometric reference) to ensure coherence with Sentinel-2.

LSI-VC-18-28	Peter Strobl to share GCPIX connections with Gopika Suresh of Marble Imaging.	**September 2025**

Session 9 (continued): CEOS-ARD Framework

9.4: Discrete Global Grid System (DGGS)

Presenter: Ferran Gascon (ESA) [slides]

- DGGS is a spatial reference system that uses a hierarchical sequence of equal area discrete global grids to model partitions and address the globe. The globally consistent framework is a combination of raster, vector, and point cloud data integrated into a common and consistent framework. It is compatible with big data analyses, cloud computing, and data sharing, bringing a common spatial reference in one flow, with no need to convert spatial reference systems.
- HEALPIX was added to the DGGS comparison, which offers a good shape and area preservation. At LPS25, a dedicated session was held on DGGS, offering different solutions and demonstrators. Two new solutions presented were the ISEA Projection & Indexing and the Triangular DGGS with Parallel I/O.
- DGGS establishes a paradigm shift, standardisation for interoperability, technical innovations, and integration for ecosystems and tools. DGGS is moving from research to operations through refined methods, standards, and tools, delivering efficiency, scalability, and interoperability for next-gen EO. Its adoption will require continual tool development and engagement, but will be a cornerstone for global EO data analysis. This has been seen within Coperncius and DestinE. A DGGS comparison table was shared:

Features	H3	rHealPix	ISEA7H	ISEA4T/D	ISEA3H / ISEA9R	Triangular DGGS
Cell	Hexagon	Multiple	Hexagon	Triangle/Diamond	Hexagon and rhombs in dual relationship	Triangle
Aperture	7	9	7	4	3 hexagonal tessellation and 9 for rhombic	4
Projection	Gnomonic	Custom (EA)	ISEA	ISEA	ISEA with a proposed interoperable orientation (0.05° W shift) for consistency	Icosahedral geodesic subdivision
Shape/Area preservation	Great shape preservation High area distortions	Good shape preservation by shape group Very low area distortion	Great shape preservation Great area preservation	Low shape preservation (lower than ISEA7H) Great area preservation	-	-
indexing	Dual indexing: Axis and hierarchical	Z space filling curves	Sequential id	Sequential id	Compact, hierarchical indexing scheme with deterministic ordering	Dual indexing: Sequential and Hierarchical
Children extend fully contained in Parent	No	Yes	No	Yes		
Software support	Excellent (Multi-language support, DBs support, Cloud extensions, …)	Limited (implemented in the Proj.4 Cartographic Library)	Good (DGGRID + bindings)	Good (DGGRID + bindings)	Ongoing work	Ongoing work

Discussion

- Jonathon asked if Sentinel-2 data going into DGGS has already been projected. Ferran noted that the data starts from being unprojected in L1B geometry, and is resampled once into DGGS. The

original radiometry is not touched. The data is geolocated but not orthorectified. A Sentinel-2 DGGS archive will be set up and in time the old version will be retired.
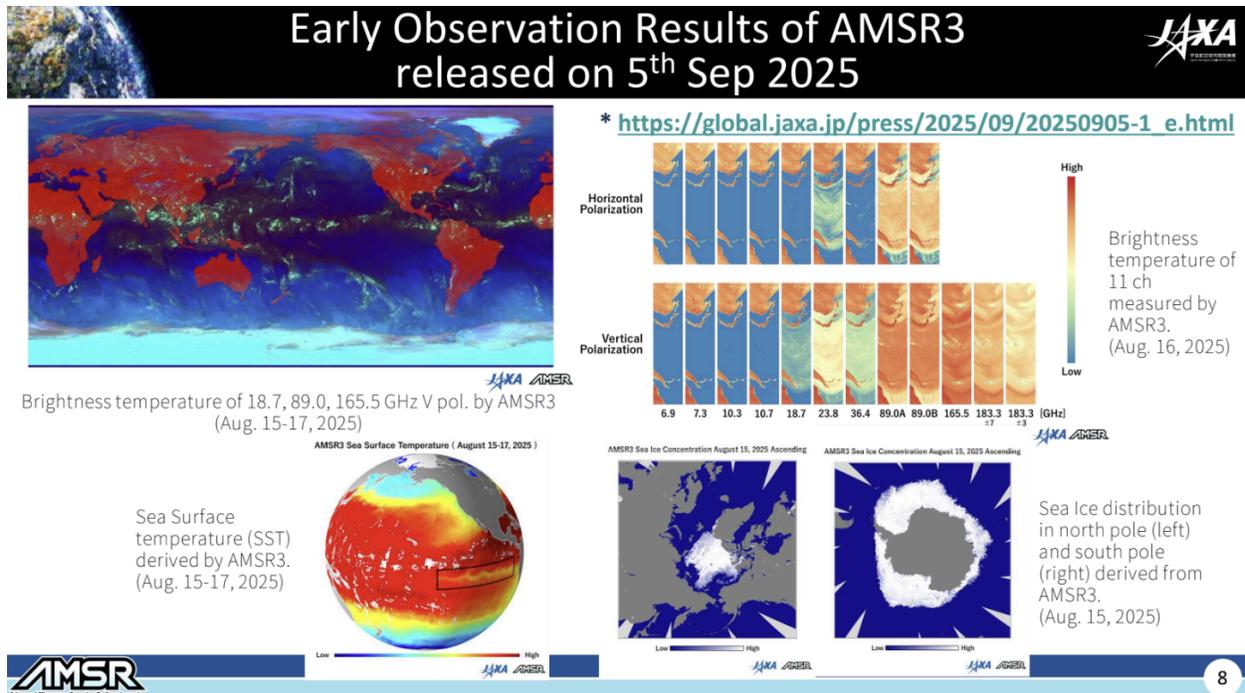
- There was a discussion comparing geolocated data to point clouds, highlighting unresolved distinctions between point clouds, data cubes, and regularised data cubes. While DGGS can support various spatial representations, software development is needed to balance user accessibility, distortion, and spatial accuracy through optimal compromises between equal area, distance, and shape criteria.
- Jonathon and Ferran suggested developing a CEOS best practice for DGGS. Peter recalled the long history of support for a globally adopted grid system, and Tim Stryker (USGS) added the desirability of coming to a CEOS-endorsed projection approach, particularly for Landsat Collection 3.

Session 3 (continued): Agency / Company Reports

3.9: JAXA

Presenter: Takeo Tadono (JAXA) [slides]

- GOSAT-GW launched on 29 June 2025, carrying the AMSR-3 and TANSO-3 instruments. The mission aims to provide AMSR continuity from ADEOS-II, Aqua, and GCOM-W missions, with observations of SST, sea ice, water vapour, rainfall, wind speed, snow depth and soil moisture. New products include snowfall, water vapour over land, and high resolution SST and sea ice concentration. The mission's critical operations phase completed on 1 July 2025, and is planned to operate for seven years.
- First light imagery from AMSR3 released 5 September 2025, including global brightness temperature, SST, and sea ice distribution.

- The ALOS-4 mission launched in July 2024, and began data distribution from July 2025. The PALSAR-3 instrument continuously conducts operational Cal/Val; some blind spots have appeared within the observation width under fixed pulse repetition frequency operation.

- Ake noted that the blind spots can be moved by changing the PRF. NISAR will also introduce a variable PRF.

Session 10: Other Topics

10.1: Discussion: ICGS-SAR and Biodiversity VC Positions

Moderator: Matt Steventon (LSI-VC Secretariat)

B-VC

- Matt shared that the CEOS Biodiversity Study Team has been tasked to come to the 2025 CEOS Plenary with a proposal for sustained biodiversity presence in CEOS, concluding that a Virtual Constellation is the preferred option. The idea for a LSI-VC Subgroup was explored, but not deemed a good fit as they want to cover the marine ecosystems.
- Although the BST may be better suited to a Working Group, the WG reporting and meeting requirements were too onerous. The BST initial proposal will be submitted at 2025 CEOS Plenary and finalised at SIT-41 in April.
- Tim Stryker (USGS) noted that the CEOS Working Groups are more functionally oriented compared to Virtual Constellations, and an external interface with a VC would be better.
- Jonathon Ross (GA, LSI-VC Co-lead) noted that B-VC will be fed a lot of land data, and should collaborate with LSI-VC to identify observations and high level products required. Their inputs could also inform the CEOS-ARD PFS.
- Peter noted that the criteria for which these CEOS groups are created are largely opportunistic and not systematic, leading to gaps and overlaps. It is good practice to build categories and discretise groups.
- LSI-VC supported the B-VC proposal and welcomed an interface to it. There are synergies that should be explored between the groups.

ICGS-SAR

- The International Coordination Group for Spaceborne Synthetic Aperture Radar (ICGS-SAR) is a collection of CEOS Agencies operating SAR missions. The JAXA SIT Chair Team recognised the turbulent year in terms of organisational structure in CEOS and the activity was tabled. There is no immediate need to establish SAR-VC.
- Ake Rosenqvist noted that the best fit for SAR would be a VC, although it goes against the thematics of a VC with its sensor base. ICGS meets in-person every two years, with the groups and thematic areas within that meet regularly. ICGS leaves out cal/val to reduce duplication with the WGCV SAR Subgroup.
- Dave Borges (SEO) noted the idea of CEOS Associate membership for ICGS-SAR, though they all have the same core membership as CEOS. The next ICGS-SAR meeting will be organised for Spring 2026.

Session 2 (continued): Thematic Land Surface Imaging Topics and LSI-VC Subgroup Reports

2.2 (continued): Wetlands and the Ramsar Convention

Presenter: Ake Rosenqvist (JAXA) [slides]

- The Ramsar STRP conducted a survey of parties to identify data gaps, where they'd need help, and where EO can fit in. There is an absence of comprehensive wetland data, including extent, boundaries, ground truthing, and cal/val.
- Looking at the environment with microwave sensors shows different things than optical sensors. SAR sees things larger than the wavelength. The majority of tree biomass is contained within the tree trunk, which is what P-band sees radars can observe.
- Inundation from forested wetlands is measured by SAR, due to the different scattering surface it can distinguish from rough ground to specular water surface. A time series of data over a year can map flooding extent through time. JAXA has observed the entire pan-tropical belt with data from JERS and ALOS-2. Full blanket coverage is achieved nine times a year. Different years can be compared to see the influence of el nino and climate change events.
- The last three years have seen catastrophically low water levels in the Amazon rainforest. Inundation extent is a potential essential wetland variable not found amongst other essential variables. This information can extract the change in water extent for water related ecosystems, (sdg 6.1.1), ecosystem stratification and habitat mapping, input to regional GHG emission models, and assessment of annual dynamics.
- CEOS Analytics Lab has been used to speed up processing, using data from the Amazon AWS S3 bucket.

Discussion

- Peter Strobl (EC, LSI-VC Co-lead) asked if data had been compared to the P-band Biomass mission? Ake noted that cross calibration is a topic in the Biomass calibration team. Little change is expected between the ALOS L-band and Biomass P-band.
- Dave added that providing data in unzipped files is a recommendation from the CEOS Interoperability Handbook. JAXA has provided this greatly simplified the processing chain, processing AWS data through CAL in the same environment.

Session 11: Closing

11.1: Wrap up

LSI-VC Secretariat and Co-Leads

- LSI-VC-19 will take place during the week of April 20 at USGS EROS in Sioux Falls, South Dakota, US. The full five days will combine sessions between LSI-VC and WGCV, and the ARD Oversight Group.
- Peter Strobl thanked all participants for participating at LSI-VC-18, both in person and online, for contributing towards a productive meeting.