Working Group on Calibration and Validation (WGCV)

CEOS
Committee on
Earth Observation Satellites

Medhavy Thankappan (GA), Vice-Chair
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CEOS WGCV Role

The CEOS Working Group on Calibration & Validation (WGCV) :

- Ensures **long-term confidence** in the **accuracy** and **quality** of satellite-based EO data and products

- Provides a **forum** for the **exchange** of information about calibration and validation and associated **coordination**, and **cooperative** activities

- **Six subgroups** in WGCV: Infrared Visible Optical Sensors, Land Product Validation, SAR, Terrain Mapping, Atmospheric Composition, Microwave Sensors

- Works closely with other CEOS entities



WGCV Plenary Meetings at USGS-EROS, CONAE

WGCV Subgroups

❖ Atmospheric Composition SubGroup (ACSG)

❖ Infrared Visible Optical Sensors (IVOS)

❖ Land Product Validation (LPV)

❖ Microwave Sensors (MSSG)

❖ Synthetic Aperture Radar (SAR)

❖ Terrain Mapping SubGroup (TMSG)

WGCV Coordinated Activities

To facilitate interoperability of EO data, WGCV supports coordination of:

- **Terminology and References**: to ensure common vocabulary and standards

- **Fiducial Reference Measurements and supersites**: to work towards enhanced Cal/Val data quality

- **Inter-comparison exercises**: to characterise differences between methods/algorithms

- **Protocols**: to establish community-agreed good practices for Cal/Val

- **Networks**: to enable global operational satellite calibration and product validation

- **Database and tools**: to facilitate uptake of Cal/Val data and methods
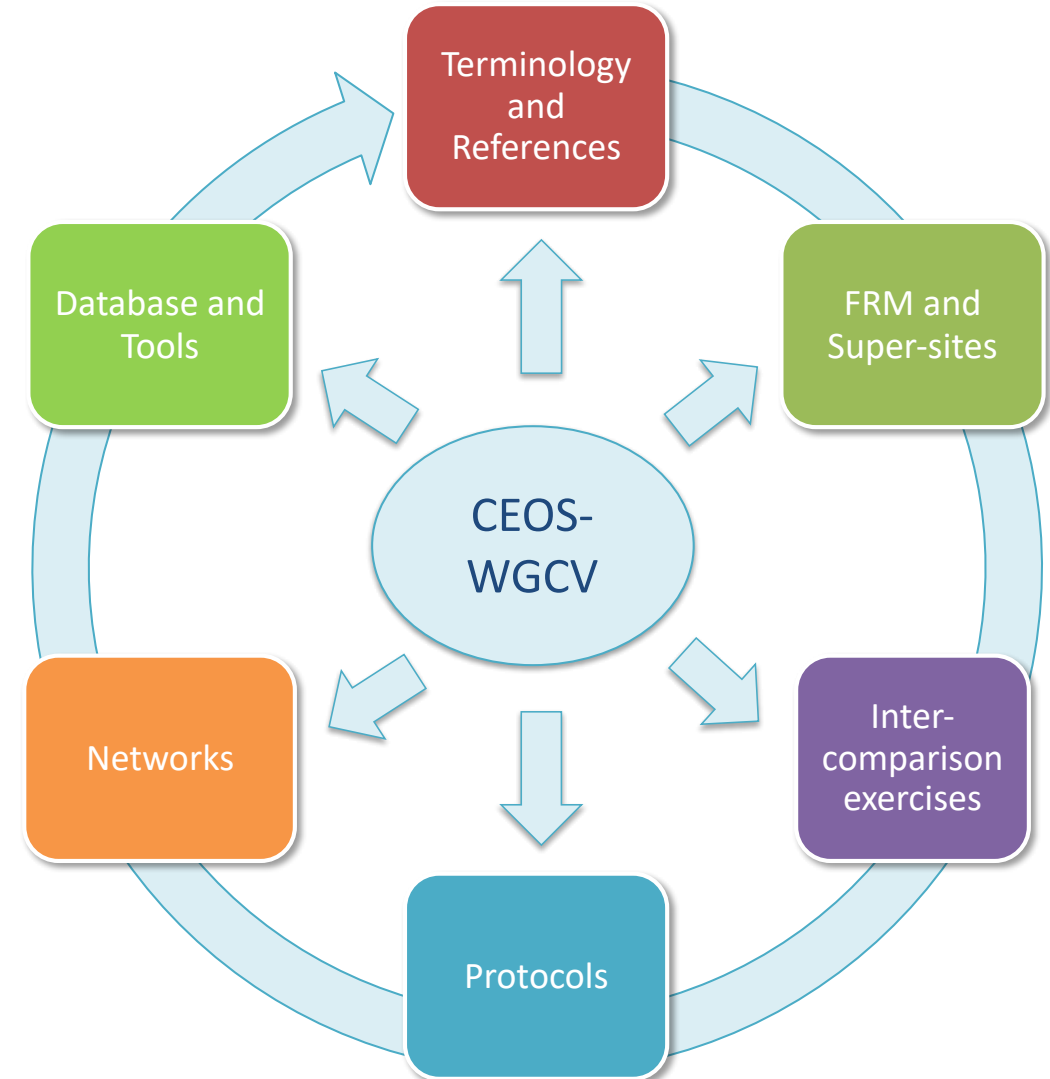
# Terminology and References

Vocabulary

- Dedicated CEOS task team working on estabishing agreed **terminology**

Reference Solar Spectrum

- In March 2022, the **TSIS-1** HSRS (Coddington et al, 2021 and 2023) was recommended as the new solar irradiance reference spectrum

Reference Lunar Model

- Collaboration IVOS/GSICS to enhance absolute accuracy and inter-compare current **lunar models** (ROLO, GIRO, ESA/LIME)
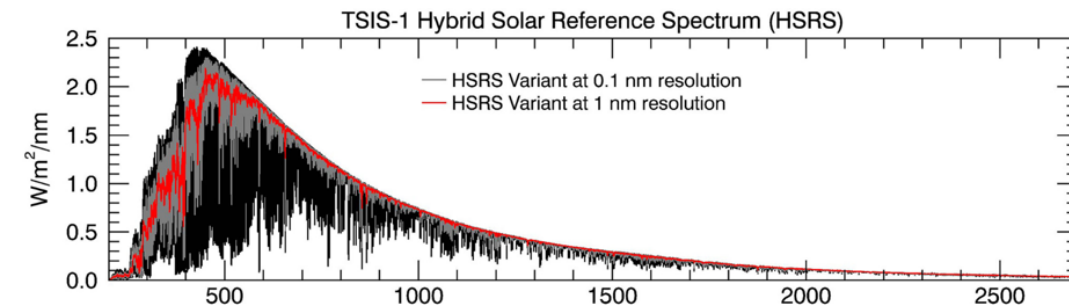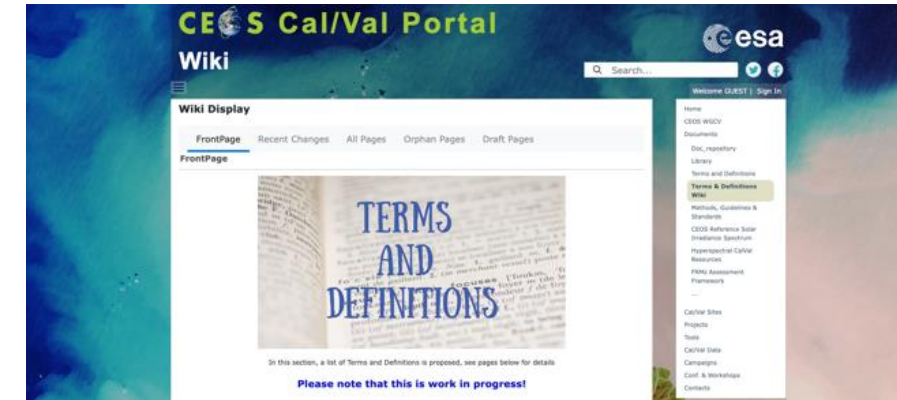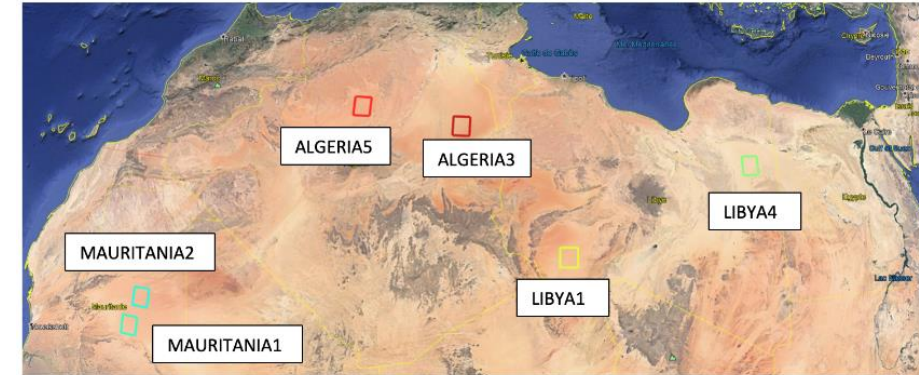
FRM and Supersites

Fiducial Reference Measurements (FRM)

- A suite of **independent, fully characterised, and traceable** ground measurements that follow the principles outlined by QA4EO

- WGCV works in collaboration with GSICS to define **Pseudo-Invariant Earth and Planetary Targets** and methods for vicarious calibration and cross-calibration

Supersites

- Characterised sites following established **protocols** for the **validation** of satellite land products

- Active, **long-term operations**, supported by appropriate funding and by airborne **LIDAR** and **hyperspectral acquisitions**
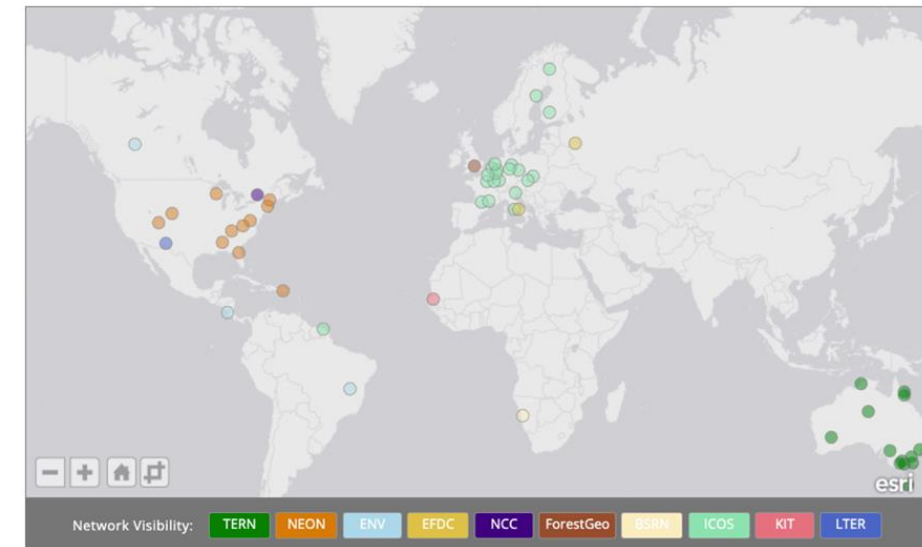
Intercomparison Exercises

Intercomparison Exercise	Description
ACIX	**Atmospheric Correction** scheme intercomparison
CMIX	**Cloud Masking** scheme intercomparison
DEMIX	**DEM** intercomparison and impact on orthorectification process
BRIX	Intercomparison of **Biomass algorithm** retrieval
SRIX4Veg	Intercomparison of **Surface reflectance** for vegetation

Validation Protocols

The LPV subgroup within WGCV works on developing :

- Community-agreed **protocols** for field sampling, upscaling approaches, uncertainty estimate

- Standardised **approaches** and **tools** for global validation

- Common reporting about land product quality and maturity level (**validation stage**)

Best Practice Protocol For The Validation Of Aerosol, Cloud, And Precipitation Profiles

➢ Evaluates the need for common practice capturing lessons learned from profiler missions.

➢ Optimisation of Cal/Val techniques in terms of instrumentation, validation, sampling strategies and scenarios, and intercomparison methodologies.

➢ https://www.isac.cnr.it/en/projects/acpv-esa-noa-best-practice-protocol-validation-aerosol-cloud-and-precipitation-profiles
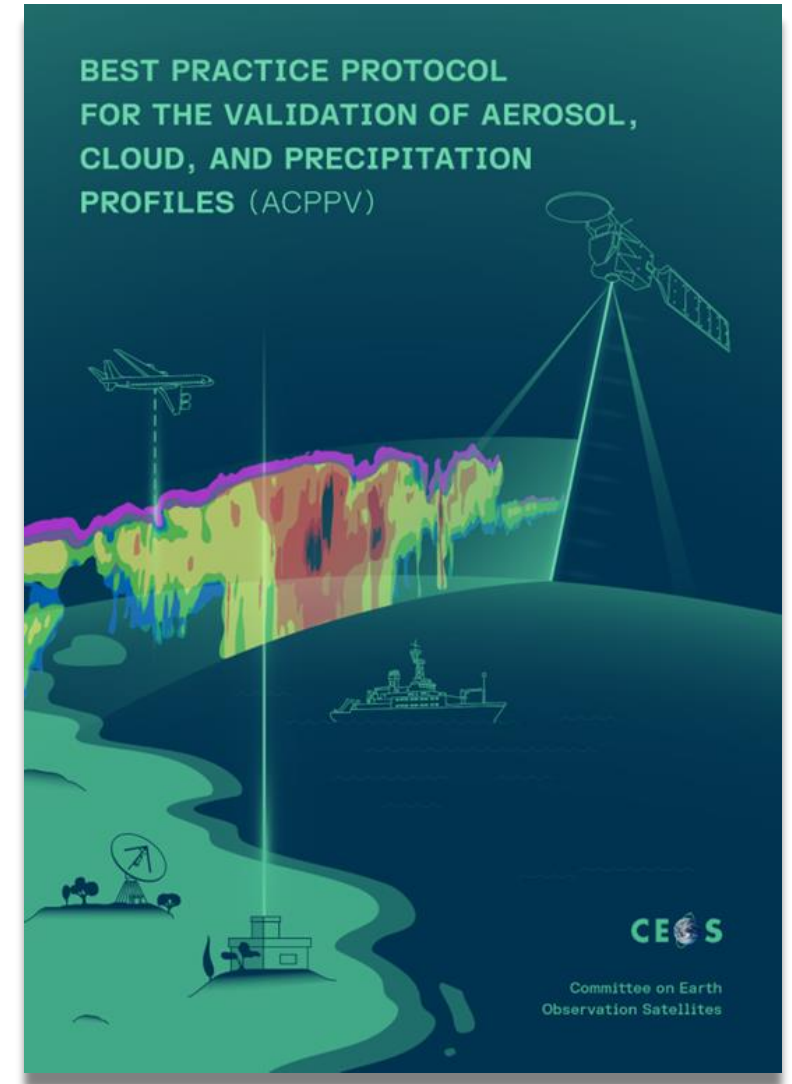
Best Practice Surface Reflectance Intercomparison Exercise for Vegetation (SRIX4Veg)

fiducial reference measurements for vegetation

➢ Best Practices protocol for validating satellite surface reflectance products using UAV spectroradiometers.

  ➢ https://frm4veg.org/2025/02/24/good-practice-guidelines-for-uav-based-surface-reflectance-validation/

➢ Originated from SRIX4Veg intercomparison campaign in July 2022 in Barrax, Spain and March 2024 in Calperum, Australia.

➢ Aimed at users of UAV-mounted instruments capable of validating surface reflectance products.

Committee on Earth Observation Satellites
Working Group on Calibration and Validation

Good Practice Guidelines for UAV-based Surface Reflectance Validation

Authors: Origo, N., Kalacska, M., Arroyo-Mora, J.-P., Soffer, R., Smigaj, M., Brede, B., De Los Reyes, R., Koehler, C., Pflug, B., Niro, F., Sinclair, M., Ong, C., Lau, I., Byrne, G., Morris, H., Suomalainen, J., Kooistra, L., Brell, M., Randall, C., Latini, D., Wilk, J., Raqueno, N., Gerace, A., Dash, J., Camacho, F., Sanchez-Zapero, J., Martinez, E., Brown, L., Morrone, R., Mota, B., Gillespie, J., Merrington, A., Van der Zee, J., Petracca, I., Thankappan, M., Ormane, R., Scholes, M., Honkavaara, E., Broomhall, M. & Boccia, V.

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Cover page design: Rasma Ormane

Calibration Networks

Calibration Networks	Description
RADCalNet	Provides SI-traceable **TOA reflectances** for post-launch radiometric cal/val of optical sensors. https://www.radcalnet.org/
SARCalNet	Network of selected curated sites for **SAR cal/val**. https://www.sarcalnet.org/
TIRCalNet	Dedicated to **TIR** optical sensors cal/val. (Proposed)

The RadCalNet sites

Today 5 sites (+2 more in preparation)

Databases and Tools

The CEOS Cal/Val portal is the main platform for exchange and information sharing for the CEOS Working Group on Calibration and Validation

It provides a **repository** of documents, tools and datasets for Cal/Val, e.g. :

- **MTF reference dataset** for inter-comparing different methods of MTF estimation

- **LPV Direct v2.1 dataset** for validation of land biogeophysical products (LAI, fAPAR, Fcover)

- **SALVAL Tool** to benchmark albedo products against ground-based data and reference satellite products

CEOS Database - Missions, Instruments, Measurements and Datasets (MIMS)

Consolidated Ground Control Point database, Radiometric and Spatial Matchup database

https://calvalportal.ceos.org/
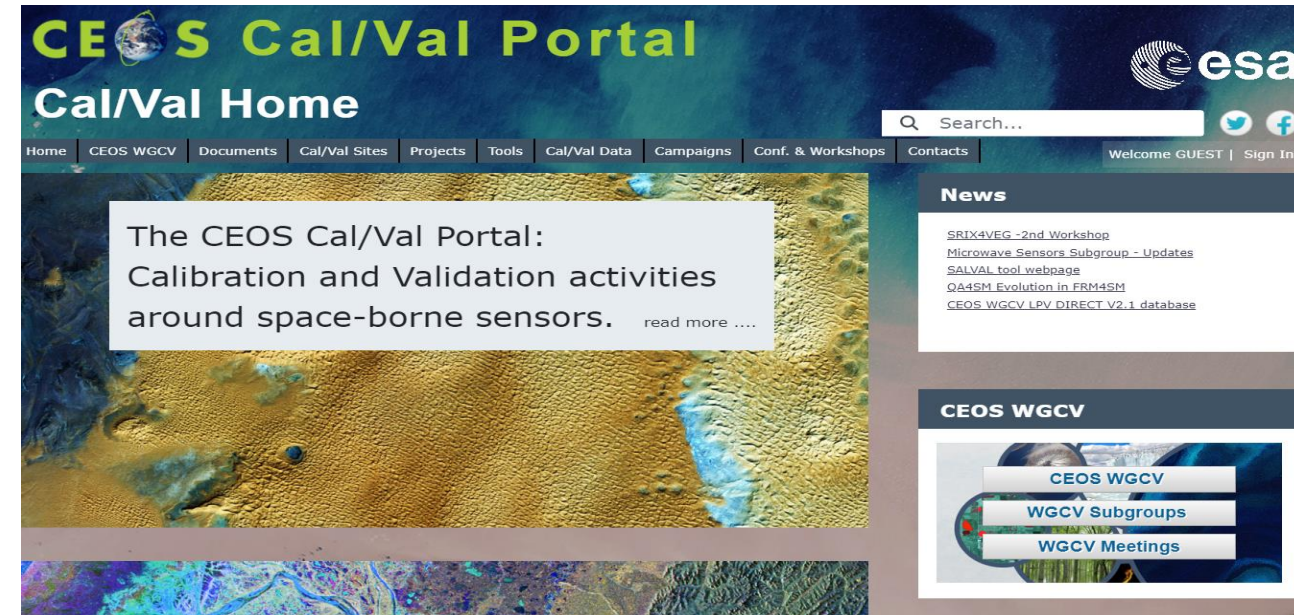
WGCV + WGISS Meetings

Held from 15-18 October 2024 at USGS EROS, Sioux Falls, South Dakota, USA
Joint meeting with WGISS

Outcomes:

- Uncertainty expression
- ARD / interoperability
- Maturity Matrix
- CalVal Matchup Database, coordination SEO, Newspace
- Coordination with WMO-GSICS, Preflight Calibration Workshop, SITSat Task team

WGISS & WGCV to create a **joint deliverable for the 2025-2027 CEOS Work Plan** regarding the development of the CEOS/KCEO Glossary. Both working groups should ensure enough people are engaged, including from other CEOS groups, as well as from the external community. WGCV & WGISS → solicit support to brand the glossary as the 'CEOS/KCEO Glossary'.
* *KCEO = Knowledge Centre on Earth Observation (EU)*

Analysis Ready Data: LSI-VC

CEOS-ARD and beyond

- Led by LSI-VC supported by WGCV
- ARD Oversight Group for governance

Next steps to enhance interoperability of CEOS-ARD data – Surface Reflectance Quality and Consistency

CEOS Interoperability Framework

- Led by WGISS

https://ceos.org/ard/

Product	CEOS-ARD Type	PFS Version	Agency	Mission / Instrument(s)	Threshold Specification	Target Specification	Access (DOI)	Info	Self Assessment	Peer Review	Sample Products
ALOS-2 PALSAR-2 Global Mosaics (RTC)	Normalised Radar Backscatter	v5.5	JAXA	ALOS-2 PALSAR-2	🟢 100%	Not assessed	Link	Link	DOC	DOC	Link
ALOS-2 PALSAR-2 25m ScanSAR NRB	Normalised Radar Backscatter	v5.5	JAXA	ALOS-2 PALSAR-2	🟢 100%	Not assessed	Link	Link	DOC	DOC	Link
EnMAP	Surface Reflectance	v5.0	DLR	EnMAP	🟢 100%	Not assessed	TBA	Link	PDF	PDF	Link
Landsat Collection 2	Surface Reflectance	v5.0	USGS	Landsat 4, 5, 7, 8, 9	🟢 100%	🌙 81%	Landsat 4-5, 7, 8-9	Link	PDF	PDF	Link
Landsat Collection 2	Surface Temperature	v5.0	USGS	Landsat 4, 5, 7, 8, 9	🟢 100%	🌙 83%	Landsat 4-5, 7, 8-9	Link	PDF	PDF	Link
Landsat Collection 2 U.S. ARD	Surface Reflectance	v5.0	USGS	Landsat 4, 5, 7, 8, 9	🟢 100%	Not assessed	Link	Link	PDF	PDF	Link
Landsat Collection 2 U.S. ARD	Surface Temperature	v5.0	USGS	Landsat 4, 5, 7, 8, 9	🟢 100%	Not assessed	Link	Link	PDF	PDF	Link
NovaSAR-1 RTC	Normalised Radar Backscatter	v5.5	CSIRO	NovaSAR-1	🟢 100%	Not assessed	Link	Link	ZIP	ZIP	See self-assessment docs
PROBA-V L3 (0.1/0.333/1 km) TOC	Surface Reflectance	v5.0	VITO / ESA	PROBA-V	🟢 100%	Not assessed	Link	Link	PDF	PDF	Link
Sentinel-1 RTC	Normalised Radar Backscatter	v5.5	Sinergise & Digital Earth Africa	Sentinel-1 (A, B)	🟢 100%	Not assessed	Link	Link	PDF	PDF	Link
Sentinel-2 Level-2A	Surface Reflectance	v5.0	ESA	Sentinel-2A, 2B	🟢 100%	Not assessed	Link	Link	PDF	PDF	Link

CEOS-ARD Compliant Datasets

Pre-flight Calibration Workshop

CEOS

CEOS WGCV and **CGMS-GSICS** jointly organised a Workshop on Pre-flight Calibration and Characterisation of Optical Satellite Instruments for Earth Observation from 19-22 November at ESA-ESTEC

Experts and developers of instruments from industry, academia and new space, gathered to discuss **pre-flight calibration approaches** for instrument types and applications

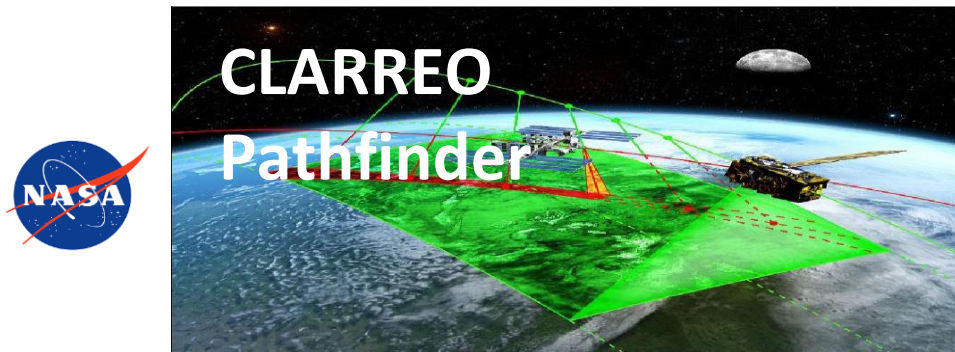https://atpi.eventsair.com/pre-flight-calibration-workshop/

SI-Traceable Satellites (SITSat)

- SITSat missions such as **CLARREO Pathfinder** from NASA and **TRUTHS** from the European Space Agency are designed to deliver **highly accurate climate monitoring** data, with SI-traceable radiometric **uncertainties well below 1%** to qualify them as 'metrology laboratories in space.' As a reference benchmark, they can be used to **cross-calibrate other satellites in orbit**

- A dedicated **Task Group** was defined within **CEOS-WGCV** to work with **Global Space-based Intercalibration System (GSICS)** and coordinate the development and exploitation of multi-system SITSat data

CLARREO Pathfinder

TRUTHS

Thank you

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