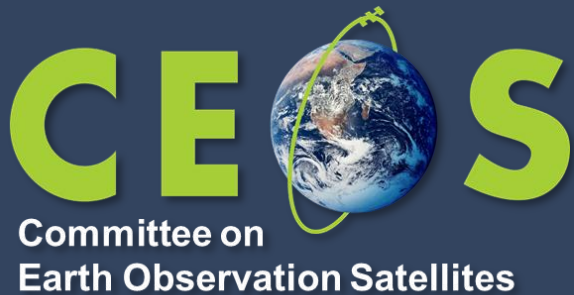


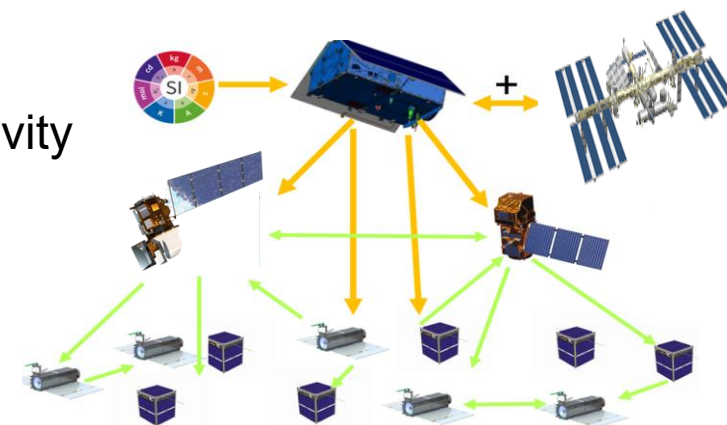
FRMsat (formerly SITSat) Task Group

Nigel Fox, NPL/UKSA
Yolanda Shea, NASA



- ❖ **Desire for ‘Reference/Fiducial’ data that enable unequivocal change detection in relatively short time-scales and mitigate ‘data gaps’ (*particularly for climate*)**
 - Robust, transparent quantified evidence of traceability to a reference (ideally SI) - ‘QA4EO’
 - Small comprehensively evaluated uncertainties
 - Allowing ‘stability’ criteria for climate to be robustly tied to invariant reference (SI)
- ❖ **‘System of systems’ Integrated EO data, interoperable/harmonised knowledge of/removal of biases**
 - ARD
 - SI-Traceability provides unambiguous trust, space agency agnostic, longevity
- ❖ **New space – reliance on post-launch calibration, no on-board calibration**
 - Reduced cost, complementary observations (*temporal/spatial coverage*)
 - Level playing field, maximal utilisation of investments and assets
- ❖ **CEOS/GSICS initiatives to establish international references and SI-Traceability**
 - Coherent, comprehensive/flexible, reliable anchor to well-established methods
 - Mimics calibration methodologies of all terrestrial ‘industries’
 - Provides a clear label of a specific sensor property but generic to ‘application’

Space-based Intercalibration



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Scott (Xiuqing) Hu	CMA
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Kurt Thome	NASA
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Thomas August	ESA
Philippe Goryl	ESA
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Martin Bachmann	DLR
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Cheng-zhi Zou	NOAA
Jason (Taeyoung Choi)	NOAA
Lawrence Flynn	NOAA
Ruben Urraca	EC
Jack Xiong	NASA
Manik Bali	NOAA
Lingling MA	AIRCAS

Co:chairs: Nigel Fox UKSA, Yolanda Shea NASA

1. Establish clear definitions of what constitutes a FRMsat and minimal requirements needed to evidence this status.

1. Serve as a forum for agencies developing/planning FRMsat missions to share experiences and knowledge.

- Create common messaging, Communication of benefit to all stakeholders, (website)

1. Discuss collaboration opportunities, joint cal/val activities, campaigns, data sharing, etc.

1. Provide an opportunity for mission coordination, gap analyses, efficient tasking, acquisition planning, etc.

1. Facilitate coordination on technical topics, reporting of uncertainty and traceability information, interoperability, methods of dissemination, etc.

1. Aim for a systems-based approach, rather than having missions being developed and operated in isolation, along the lines of a CEOS Virtual Constellation.



SITSat: SI-traceable Satellites



Joint **CEOS-WGCV** and **WMO-GSICS**
initiative



Home

What is a SITSat

Expected Impact

Vision

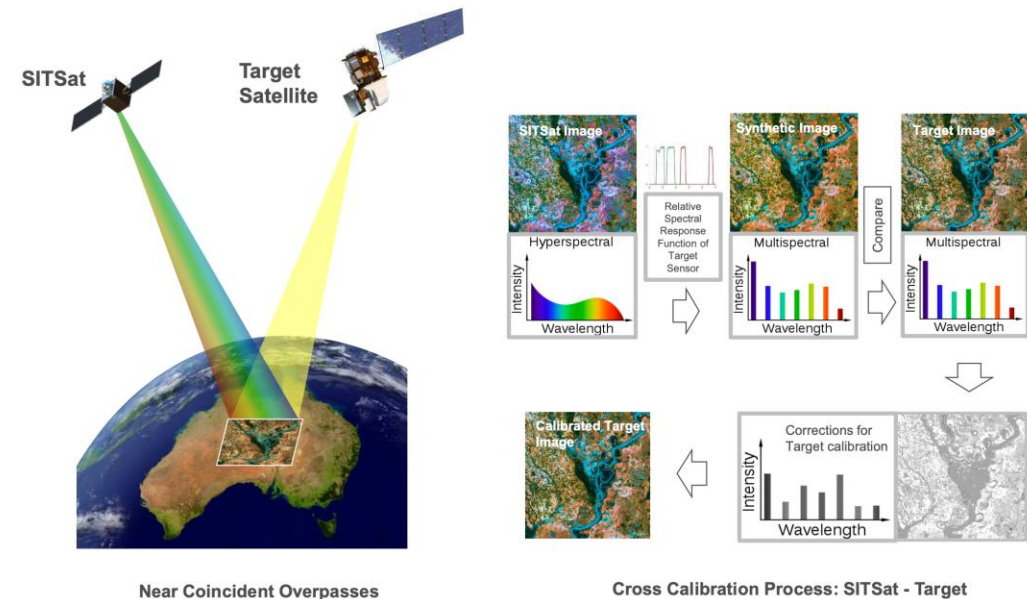
Contacts

Background

With the emergence of a number of SI-Traceable Satellite missions (SITSats) the CEOS WGCV has considered the need for a group to coordinate on issues of common interest and to foster mutual benefits. SITSats have great potential to increase the accuracy of climate and other Earth observation records and can also serve as high quality references for both CEOS Agency missions and the commercial sector. The WGCV has proposed the establishment of a joint Task Team with the Global Space-based Intercalibration System (GSICS) which will include representatives from agencies operating, developing and utilising these missions, and others as interested, as a means to promote dialogue and coordination.

SITSat Concept of Operation

Simultaneous Nadir Observation with Target



Name!



Reasons to consider changing the name:

SI-traceability may not be sufficient to distinguish the reference sensors we're describing,

Evidenced by questions folks have gotten about why "x" sensor wouldn't be considered a SITSat

Opportunity to devise a name (acronym or otherwise) that may better invoke the qualities of these reference sensors

Reasons to keep SITSat

There is also already fairly widespread recognition of the term and its meaning

Literature (peer-reviewed and presentations) already contains several references to term SITSat

It is easy to convey a collection/class of satellite sensors, rather than just one mission.

Its short and easy to pronounce (from discussion forum)

- ❖ Enables pluralisation to ensure the sensor class distinction can be made.
- ❖ The underpinning criteria to define the sensor class shouldn't change, but just the name.
- ❖ Keen to keep 'SI' somev



·liner definition.

BUT

The **reference satellite** term is widely used

Land imaging missions such as Landsat and Sentinel 2 as references for commercial satellites
GSICS uses the term in a definition for their in-orbit calibration system.

Our repurposing RefSat/reference satellite would refer to the high accuracy sensors (i.e. SITSat), but it may dilute the intent/messaging because of how it's used elsewhere

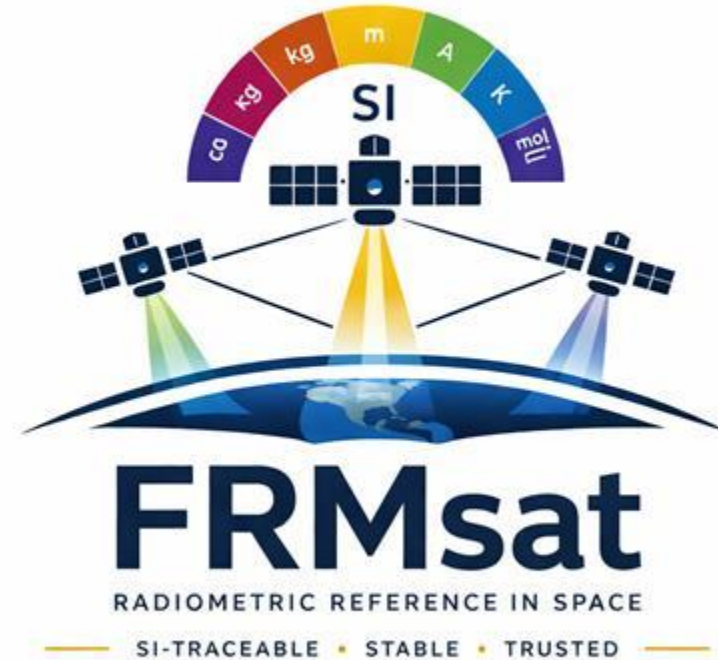
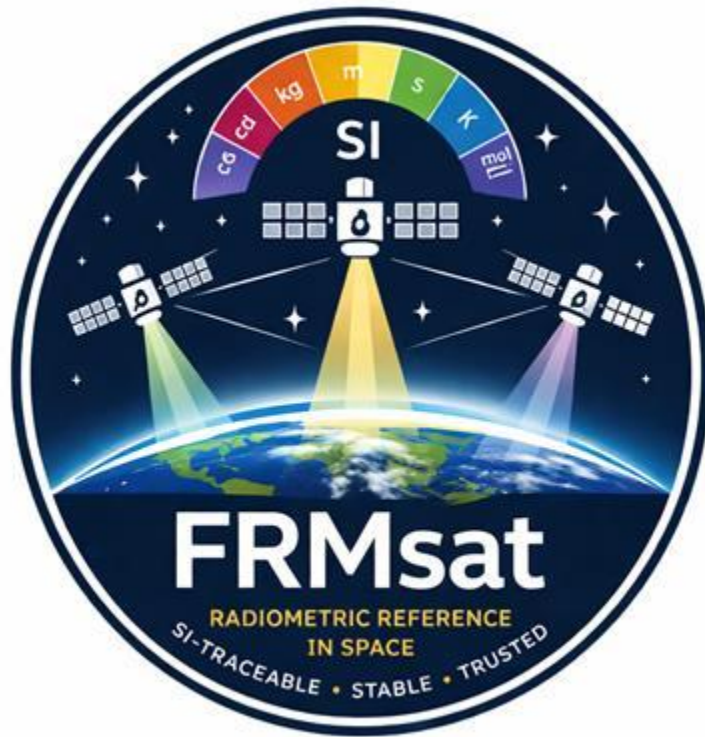
❖ FRMsat – Fiducial Reference Measurement Satellite

A New Suggestion: FRMsat



- ❖ Opportunity to also define Fiducial Reference Measurement for audiences
- ❖ FRM a good generic definition works for what we are striving to achieve
 - Currently mainly refers to ground-based cal/val measurements because it has been challenging to justify previous/current satellite missions as FRM.
- ❖ FRMs are required to have an uncertainty commensurate with the stated application
 - In our case the application is to provide a satellite-based reference that is of climate quality.
- ❖ Link to existing FRM definition as this is already achieved together with a compliance assessment framework enabling CEOS endorsement
- ❖ From the CEOS-FRM Assessment Framework guidelines

WGCV agreed to rename to FRMsat



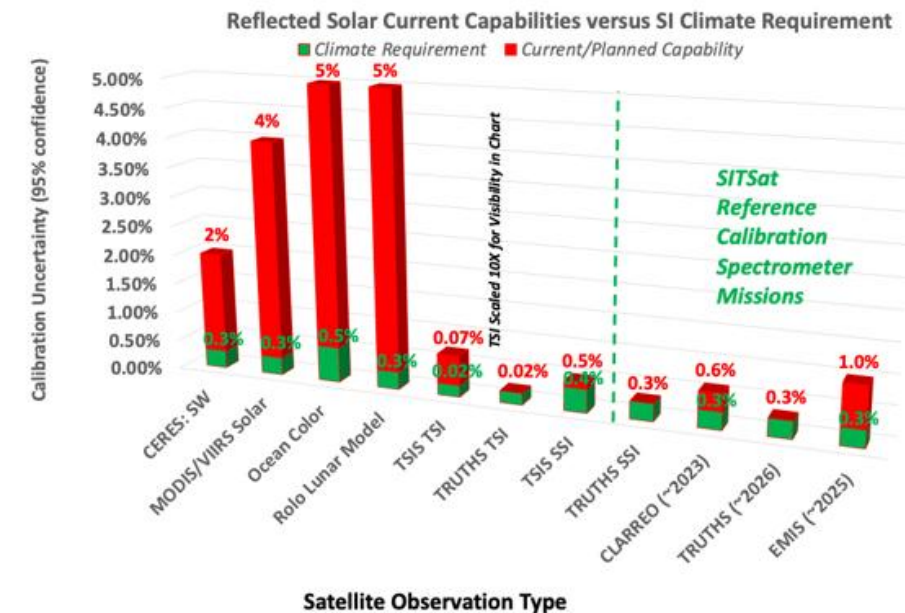
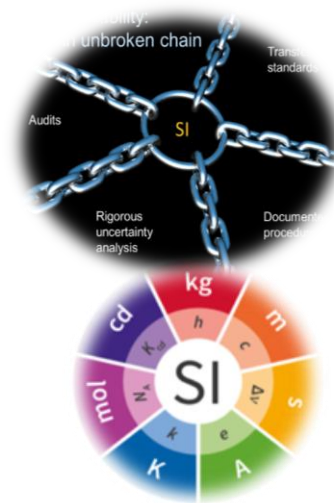
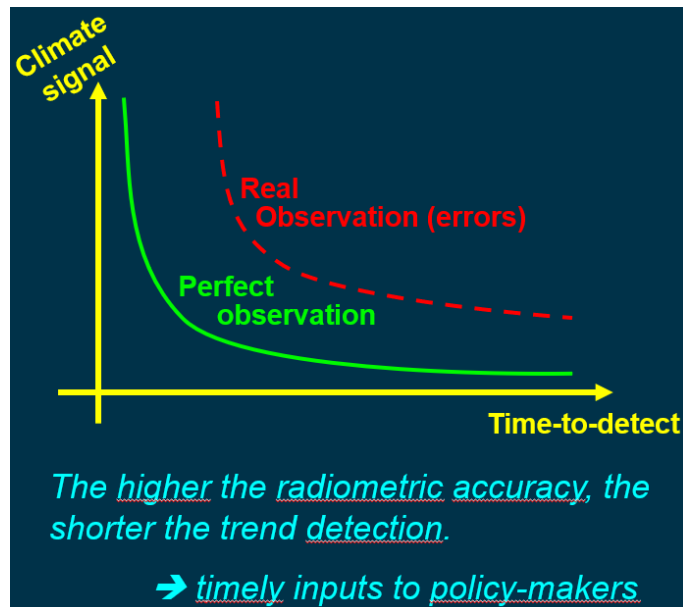
A **FRMsat** is a satellite-based sensor which can provide and **verifiably evidence**, in a fully open and transparent manner, all significant contributions to the uncertainty of its measurements, **metrologically traceable to the international system of units, SI**, at the location and time from where they are made. In addition, this uncertainty must be at a level that is considered by the community to be of ‘**Fiducial reference**’ quality, i.e., that for a defined spectral domain/application it can be considered ‘state-of-the-art’ and able to unequivocally serve as a reference for similar measurements from other sensors. The **uncertainty** of a **FRMsat** should be expected to reach or at least **approach that required for key climate science objectives** such as those identified in the “SI-Traceable Space-based Climate Observing System: a CEOS and GCICS Workshop” (<https://doi.org/10.47120/npl.9319>). When used as a reference a **FRMsat** would be expected to have a measurement uncertainty of <0.5 compared to that of its non-**FRMsat** peers **and be of CEOS-FRM Class A quality**.

Note:

- 1/ If used as a reference, the method used to compare with other sensors and its associated uncertainty to SI, should also be fully documented and evidenced.
- 2/ The nominal threshold uncertainty to be considered a **FRMsat** for a particular type of measurement/application may increase or reduce over time commensurate with scientific consensus, currently this requires 2-10x improvement over current sensors. Although desirable in the long-term, it is not essential to have a **FRMsat** for all applications and sensor domains and thus the assignment of the classification to a sensor should only be made when the maturity and technology of a particular domain justifies it. **However, other satellites may still be able to justify delivery of FRM quality observations.**
- 3/ A **FRMsat** peer group would constitute ALL sensors making similar measurements (e.g., spatial and spectral range)

A FRMsat is a space-based instrument making measurements of the Earth that can transparently evidence their metrological traceability to the international system of units (SI) with an uncertainty commensurate with the most demanding needs of climate <https://doi.org/10.47120/npl.9319> and be classified as a class A CEOS-FRM

When used as a 'reference to calibrate other satellites its uncertainty should be at least half that of the satellite instrument under test and similar instruments.



2026 Goals



1. Website
2. Communications Strategy
 1. Rebadge name?)
 2. Refining Content for presentations/agency and org leadership (30 second and 2 min elevator overview)
 3. Create a baseline public website (summer)
 4. Noting the current status of planned FRMsats: (TRUTHS?, CPF) to build a clear messaging platform
3. First Objective within ToR: **“Establish clear definitions of what constitutes a FRMsat and minimal requirements needed to evidence this status.”**