The SMOS Mission and its Future

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2nd Workshop on SMOS for Space Weather, University of Alcalá

27/10/2023

smos

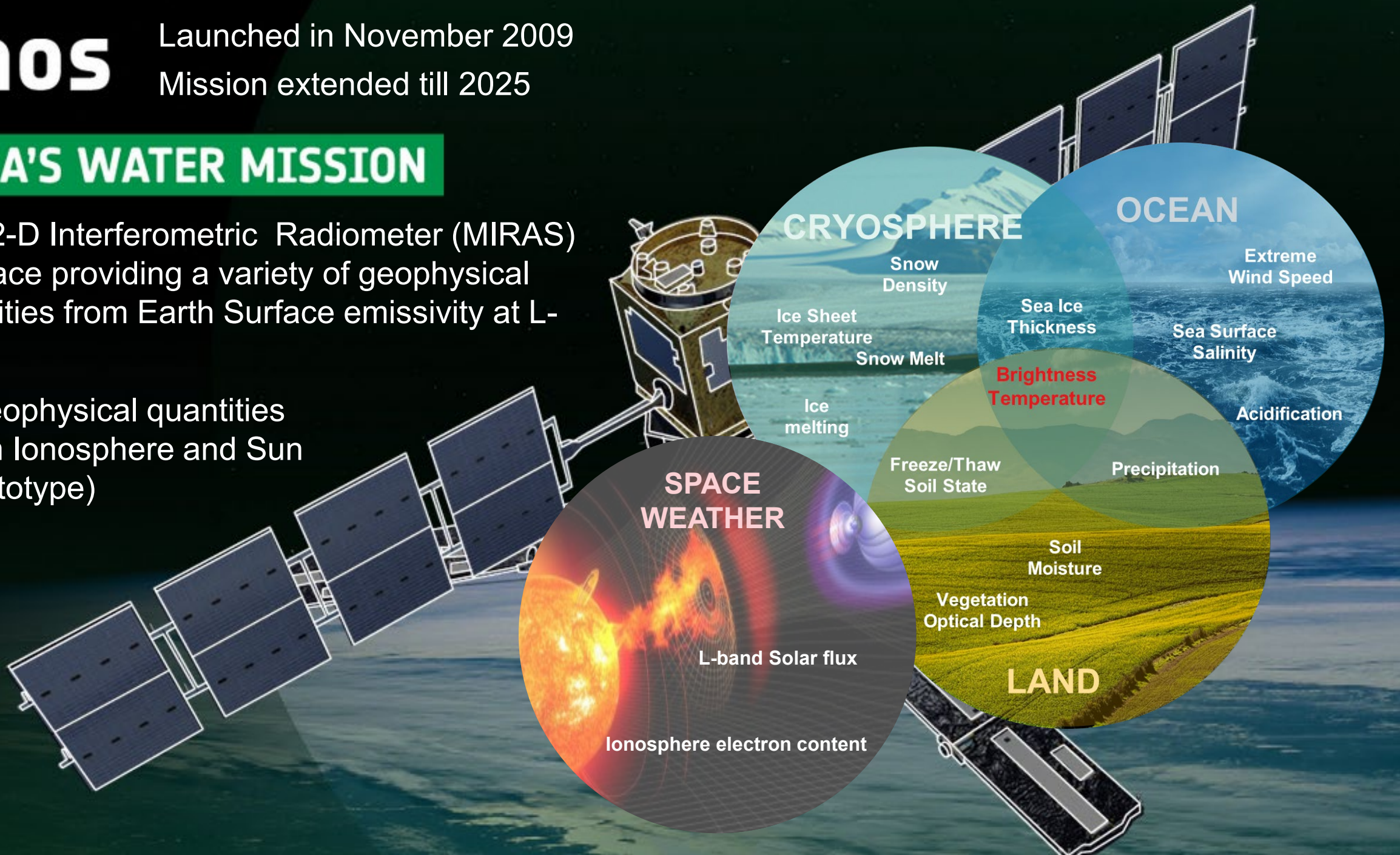
Launched in November 2009

Mission extended till 2025

→ ESA'S WATER MISSION

First 2-D Interferometric Radiometer (MIRAS) in Space providing a variety of geophysical quantities from Earth Surface emissivity at L-band

+ geophysical quantities from Ionosphere and Sun (prototype)



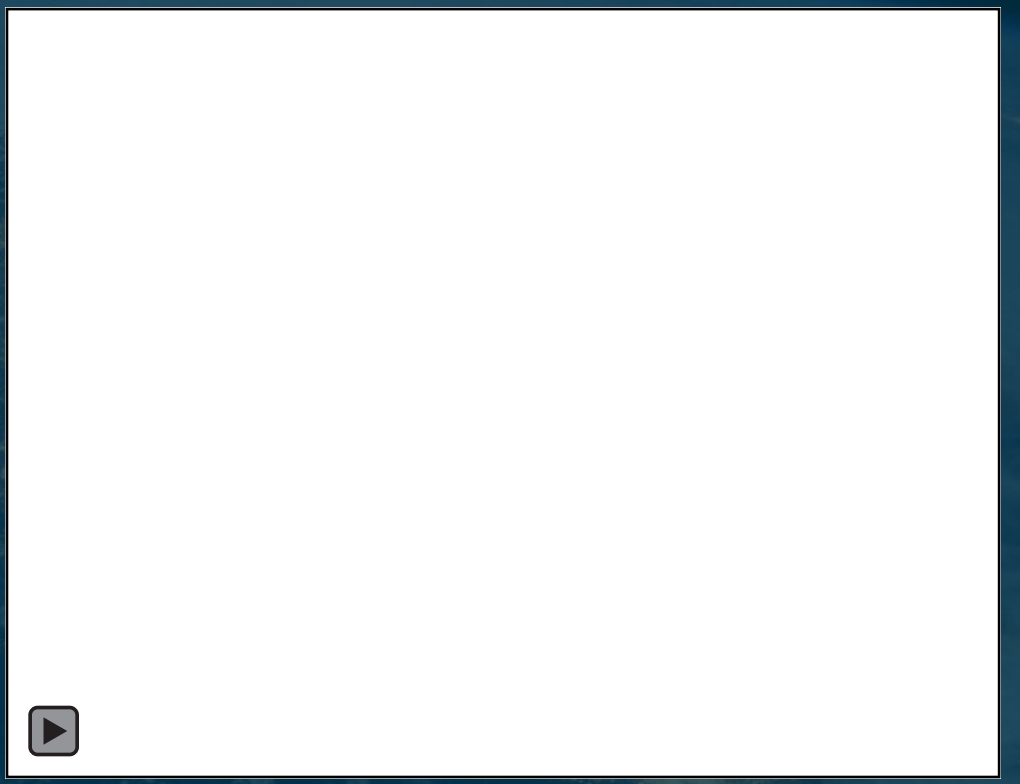
SMOS orbits and MIRAS payload

The SMOS mission is based on a **sun-synchronous** orbit (dusk-dawn **6 am / 6 pm**) with a mean altitude of **758 km** and an inclination of 98.44°.

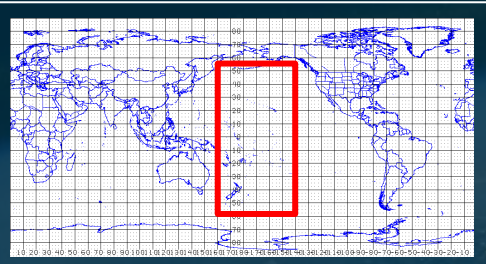
The payload of **SMOS** consists of the Microwave Imaging Radiometer using Aperture Synthesis (**MIRAS**) instrument, a passive microwave **2-D interferometric full polarization radiometer**, operating at **1.413 GHz**.

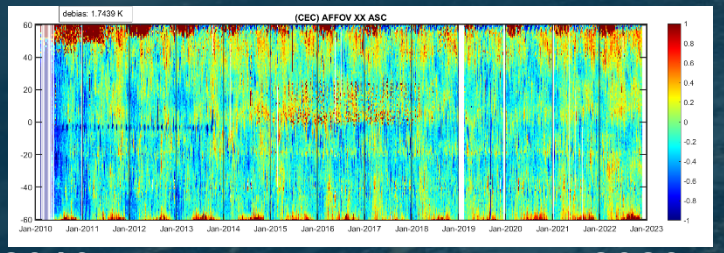
The **MIRAS** instrument antenna array is formed by three arms 120° apart, with 23 equally spaced **LICEF** (Lightweight Cost-Effective Front-end) receivers each.

A full **polarimetry** measurement is acquired in four integration period i.e. 4.8 seconds.



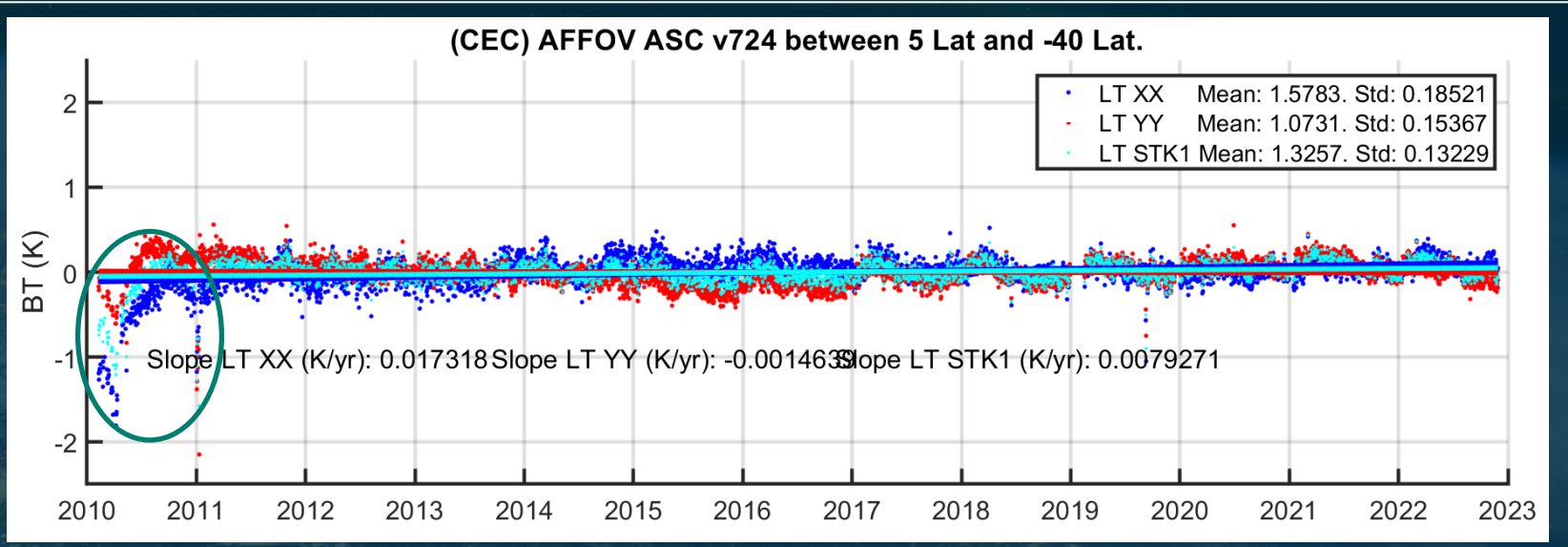
Brightness Temperature performances (Ocean)

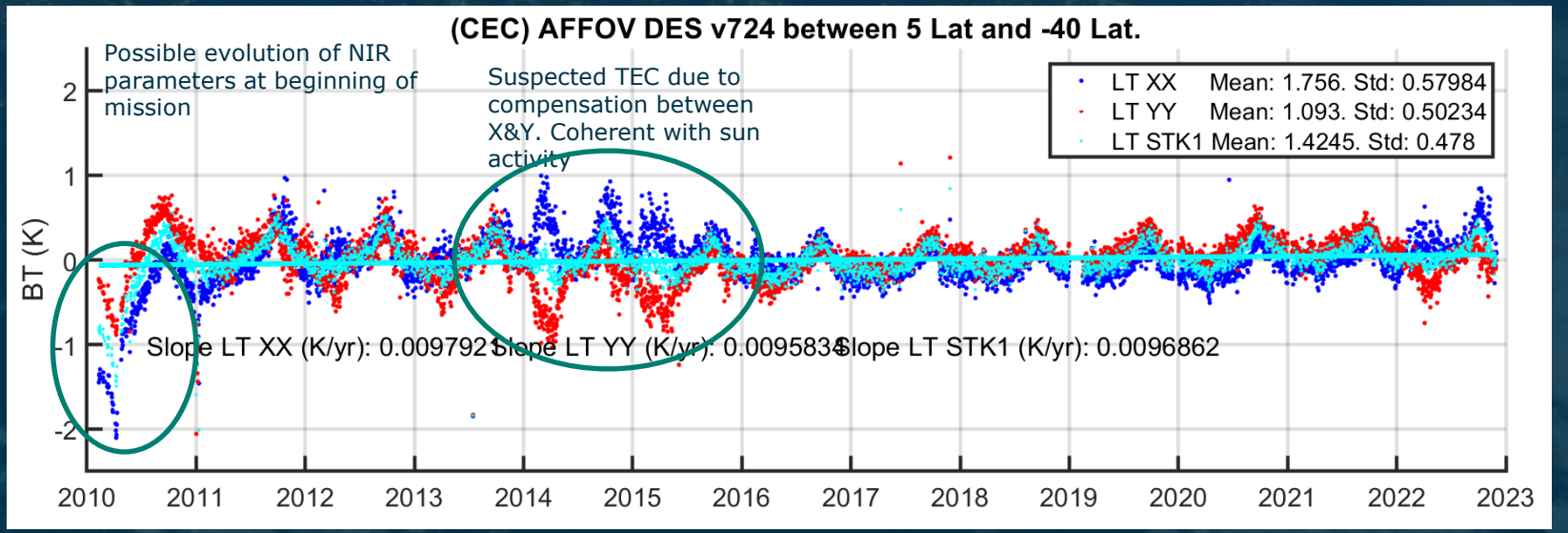




2010 2023

- Bias between BT from Ocean Forward Model and SMOS over a selected Pacific Ocean area
- Salinity model: ISAS up to Sep21, WOA09 onwards



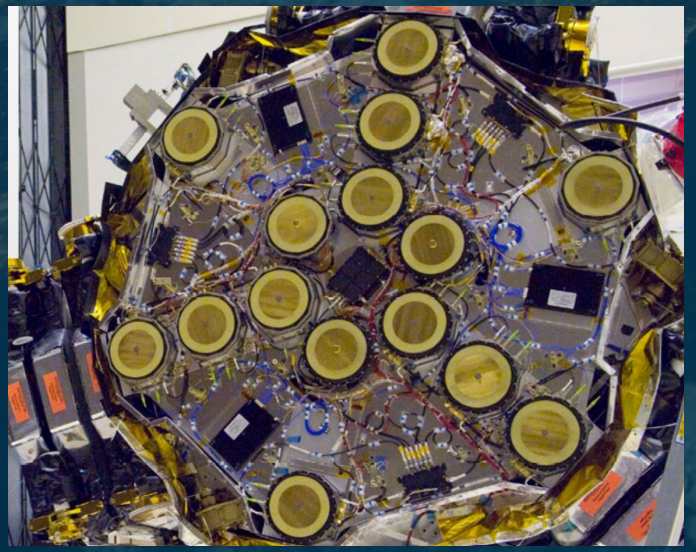


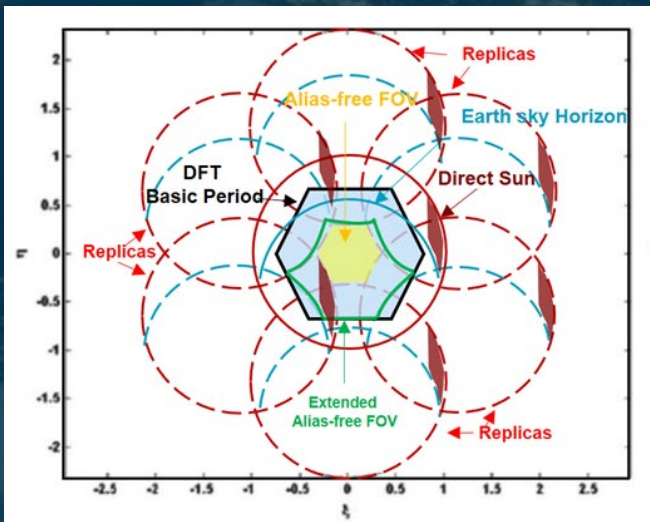
SMOS mission status

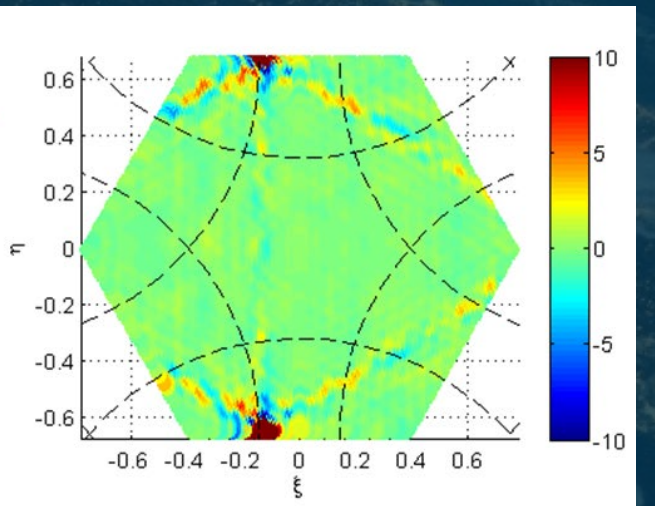
1. After nearly 14 years in orbit, SMOS still remains in very good shape.
2. All housekeeping telemetry parameters remain very well within limits.
3. Payload and ground segment operations are very smooth and well optimised.
4. SMOS provides a stable, reliant and high quality data flow to users with an exceptional data availability typically >99%, NRT for >95% of data.
5. Some first sign of aging:
   - Arm-A temperature increase. It is stable as confirmed during last eclipse season in winter 2022/2023
   - CCU temperature is increasing (+1.5C from 2022) but far from hard limit.

SMOS is more than an Earth Explorer

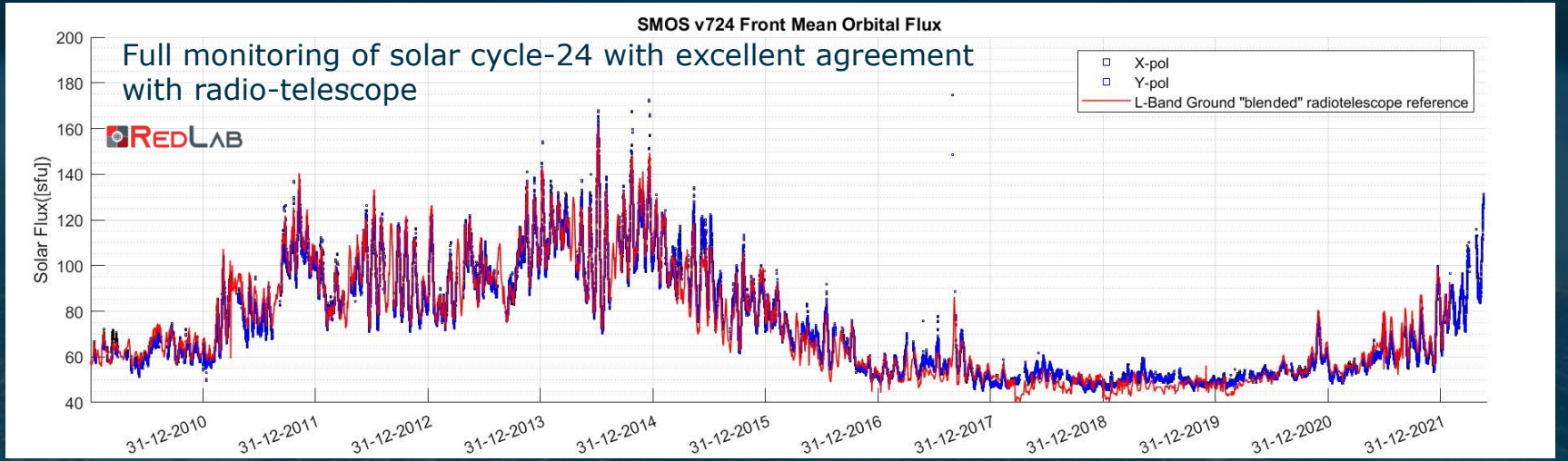
Due to antenna size (diameter equal to 16.5 cm) and frequency wavelength (21 cm at L-band) the instrument's field of view (FoV) is large and includes full **Earth-disk** and part of the surrounding **Sky**. Part of the FoV is affected by **aliasing**. Direct **Sun** signal appears as a replica in the SMOS image.

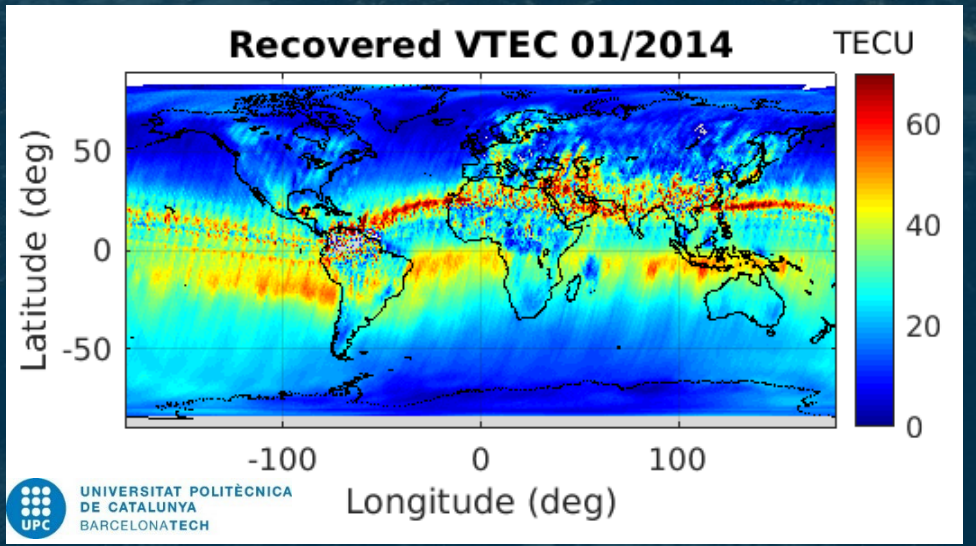


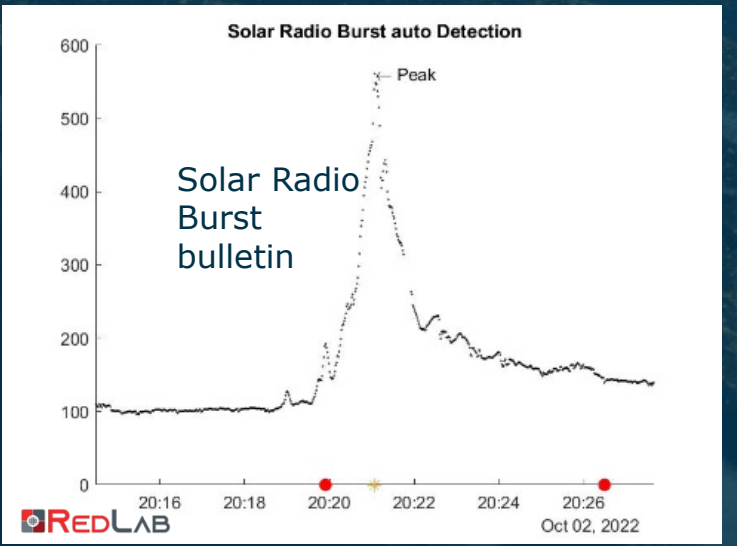


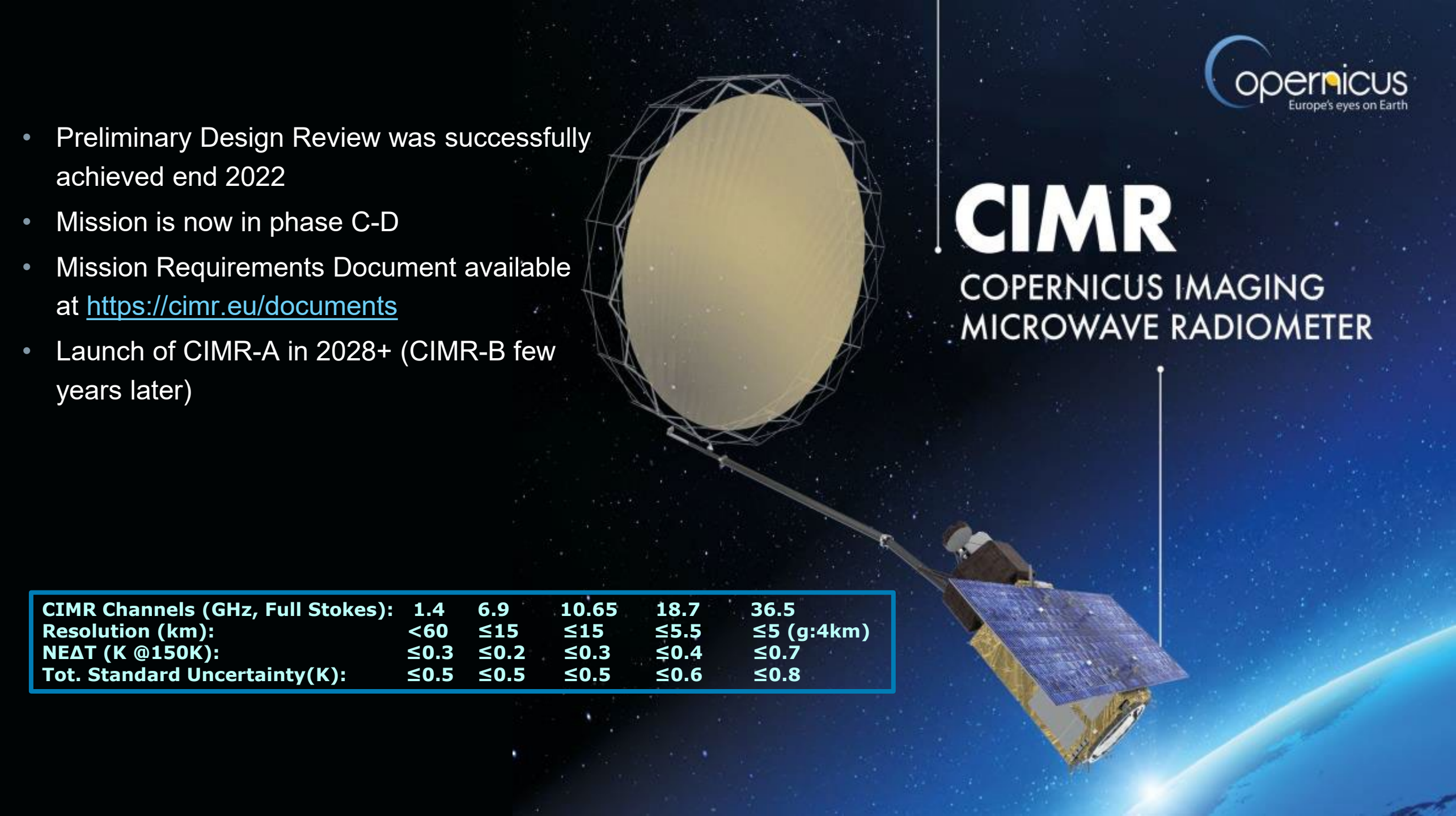


Emerging SMOS products for Space Weather









- Preliminary Design Review was successfully achieved end 2022
- Mission is now in phase C-D
- Mission Requirements Document available at https://cimr.eu/documents
- Launch of CIMR-A in 2028+ (CIMR-B few years later)

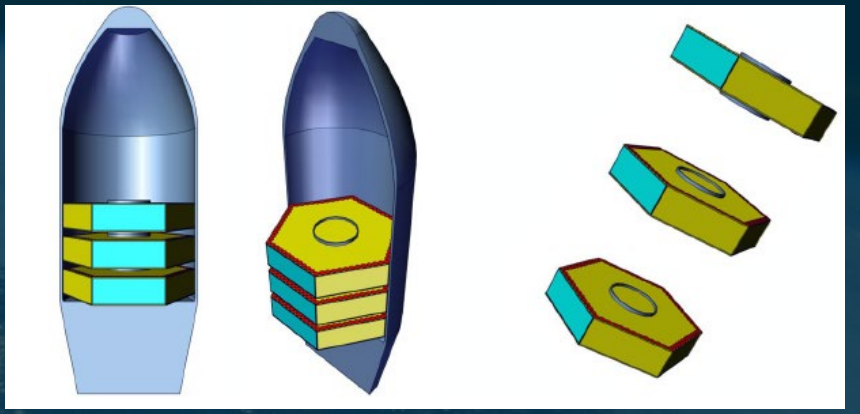
CIMR Channels (GHz, Full Stokes):	1.4	6.9	10.65	18.7	36.5
Resolution (km):	<60	≤15	≤15	≤5.5	≤5 (g:4km)
NEΔT (K @150K):	≤0.3	≤0.2	≤0.3	≤0.4	≤0.7
Tot. Standard Uncertainty(K):	≤0.5	≤0.5	≤0.5	≤0.6	≤0.8

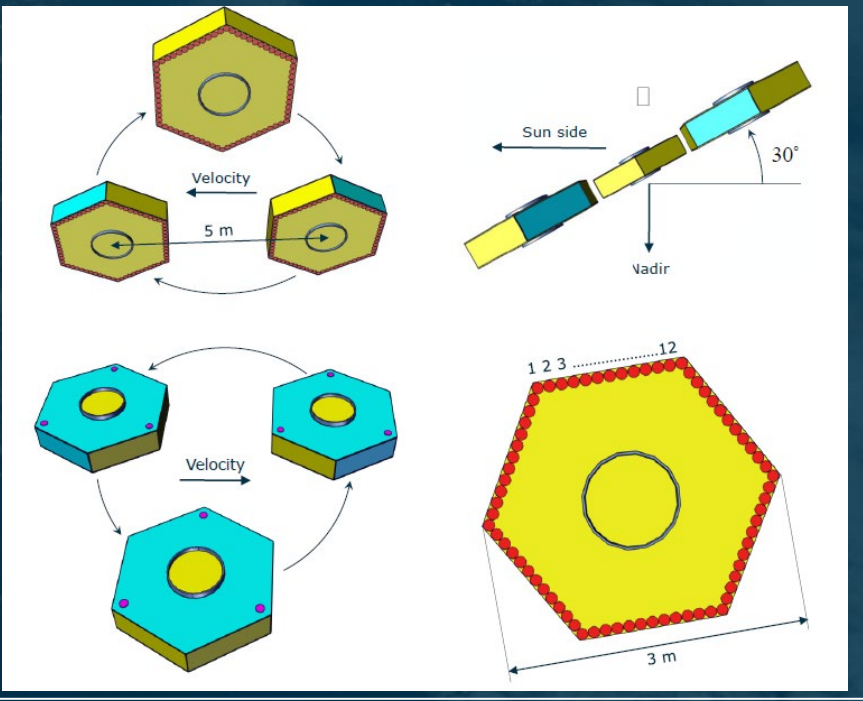
TriHex concept

1. TriHex is a technological concept to achieve high resolution passive L-band observations

2. It is being developed by ESA, based on SMOS experience and industrial contracts

3. TriHex combines four major ingredients to achieve high resolution (~15 km):
   - formation flying of 3 spacecraft at very close range (5 to 7.4 meters apart)
   - General Circular Orbits
   - Alias-free imaging
   - Low orbital altitude (around 500 km)





Outlook

1. SMOS is a true Earth Explorer that continuously provides new science paving the way for innovative applications and future missions.

2. Mission is currently funded until end 2025. Good chances to extend the mission operation until 2028.
   - Mission is in excellent technical condition, no limiting factors
   - It continues to provide innovative science
   - Extension process will start Q4 2024

3. Space Weather Applications is a unique asset and a key element for the current mission phase and to justify a future extension.

SMOS Future Space Weather Activity

1. Science

- Improve and validate SMOS Solar Radio Burst detection.
- Correlation analysis of Solar Radio Burst (SRB) detected by SMOS with high degree of circular polarization with associated Coronal Mass Ejection (CME) emission, to characterize the CME properties.
- Solar activity forecast (polarimetry long term analysis, identify possible SWE proxies).
- SMOS VTEC prototype and validation with in-situ, satellite (GNSS, SWARM).

2. Application

- Correlation analysis of SRB detected by SMOS with GNSS fading events.
- Ionosphere modelling.
- Preliminary analysis of usage of NRT SMOS solar flux / VTEC for L2 operational products.
- Orbit prediction / determination correlation with solar flux and air-drag modelling.
- Air Traffic radar anomaly monitoring.

3. Development

- NRT solar flux product.

MISSIONS STUDYING THE SUN

esa

smos

Launched together !

- Solar Orbiter — 2020
- Solar wind Magnetosphere Ionosphere Link Explorer (SMILE) — 2023
- Ulysses — 1990 2009
- Yohkoh — 1991 2001
- Wind — 1994 Present
- Solar and Heliospheric Observatory (SOHO) — 1995 Present
- Advanced Composition Explorer (ACE) — 1997 Present
- Transition Region and Coronal Explorer (TRACE) — 1998 2010
- Cluster — 2000 Present
- Reuven Ramaty High Energy Solar Spectroscopic Imager (RHESSI) — 2002 Present
- Double Star — 2003 2008
- Solar Terrestrial Relations Observatory (STEREO) — 2006 Present
- Hinode — 2006 Present
- Project for Onboard Autonomy-2 (Proba-2) — 2009 Present
- Solar Dynamics Observatory (SDO) — 2010 Present
- Interface Region Imaging Spectograph (IRIS) — 2013 Present
- Parker Solar Probe — 2018 Present

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