ESA passive microwave activities - GSICS 2025 report

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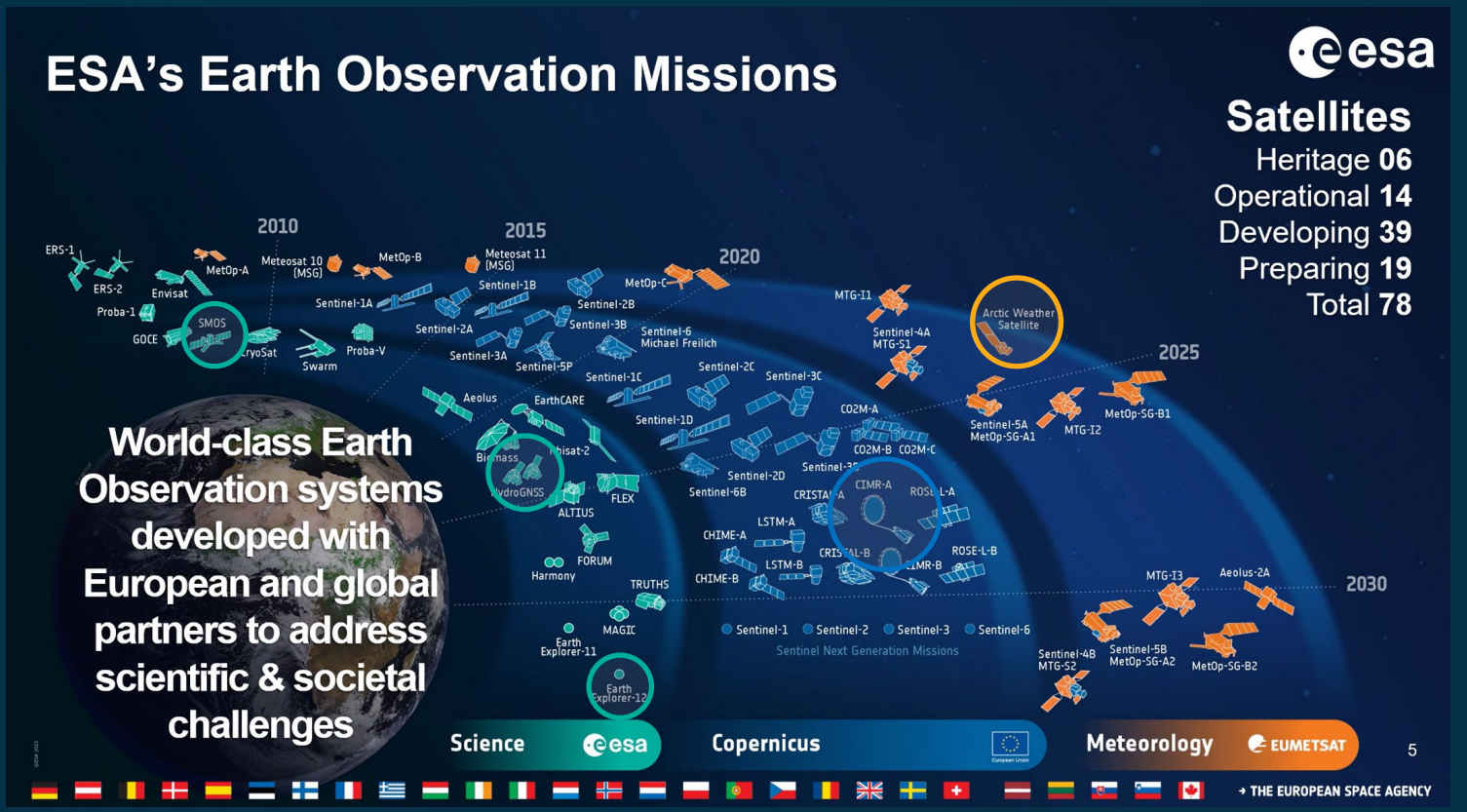
ESA ESRIN

19/03/2025

Content



SMOS Status

SMOS Launched on 2nd November 2009

After 15 years in orbit, SMOS is fully operational.

Full confidence to operate SMOS for many years to come with plan for mission extension [2026 – 2028]

- Unique, longer time series measurements (L-band) for climate monitoring (RZSM, SM, SSS, SIT)
- keep L-band clean and address the issue of RFI; not only for SMOS, but for all other missions.
- Follow the ESA Science Strategy, there are plenty of opportunities including synergies with other missions. (SWOT, BIOMASS, FLEX, AMSR3, CIMR).

Great deal of motivation sensed in the community. Even after 15 years!

ESA SMOS Geophysical L2, L3, L4 Products

Land (primary mission objective)

- L2 Soil Moisture (*)
- L3 Freeze/Thaw soil state
- L2 Vegetation water content, Vegetation optical depth

Ocean (primary mission objective)

- L2 Sea Surface Salinity (*)
- L3 and L4 Sea Ice Thickness
- L2 Extreme Sea Surface Wind Speed and wind radii

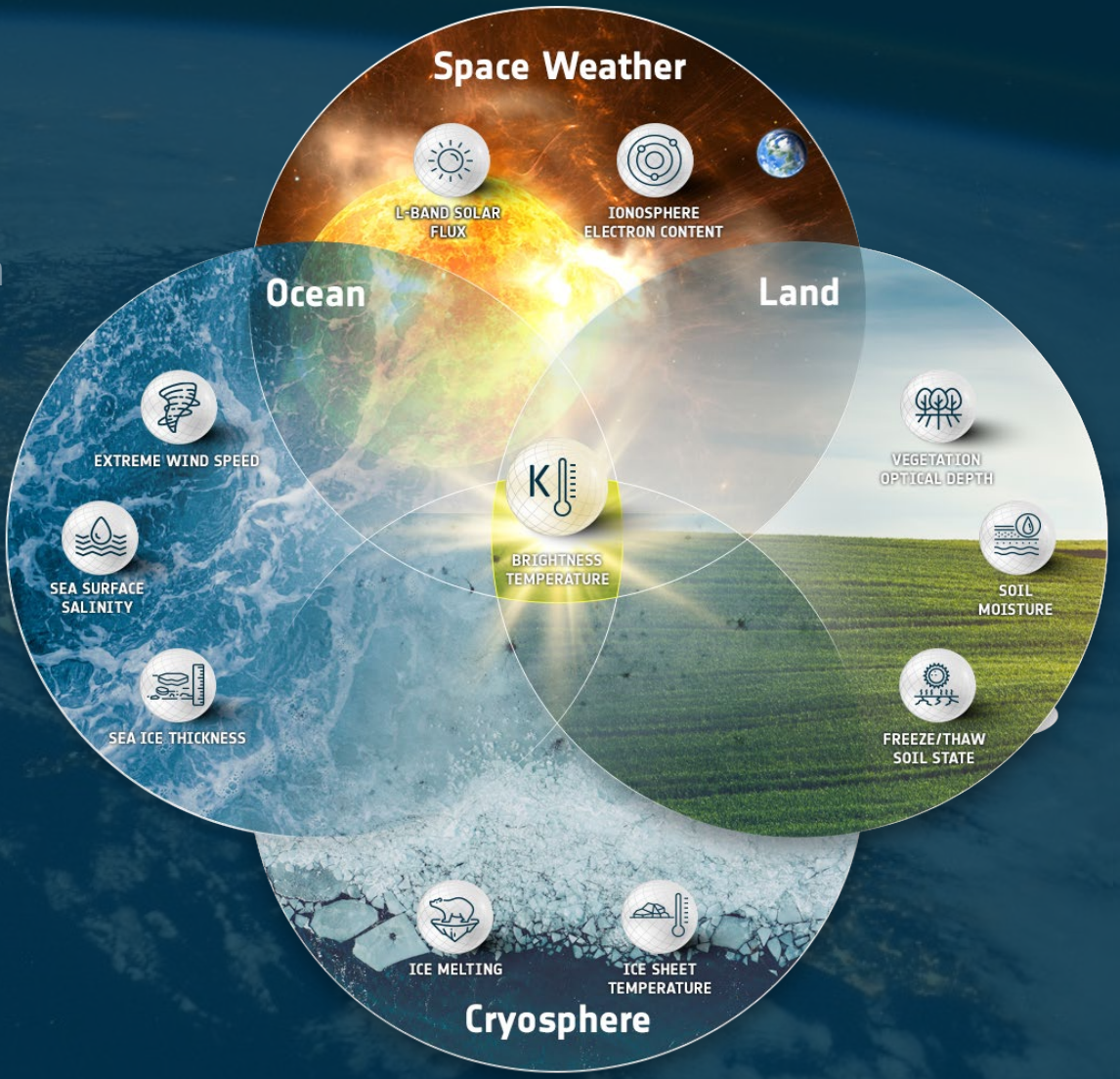
Cryosphere (secondary mission objective)

- L3 Ice Melting
- L4 Ice Sheet Temperature

Space Weather (novel mission application)

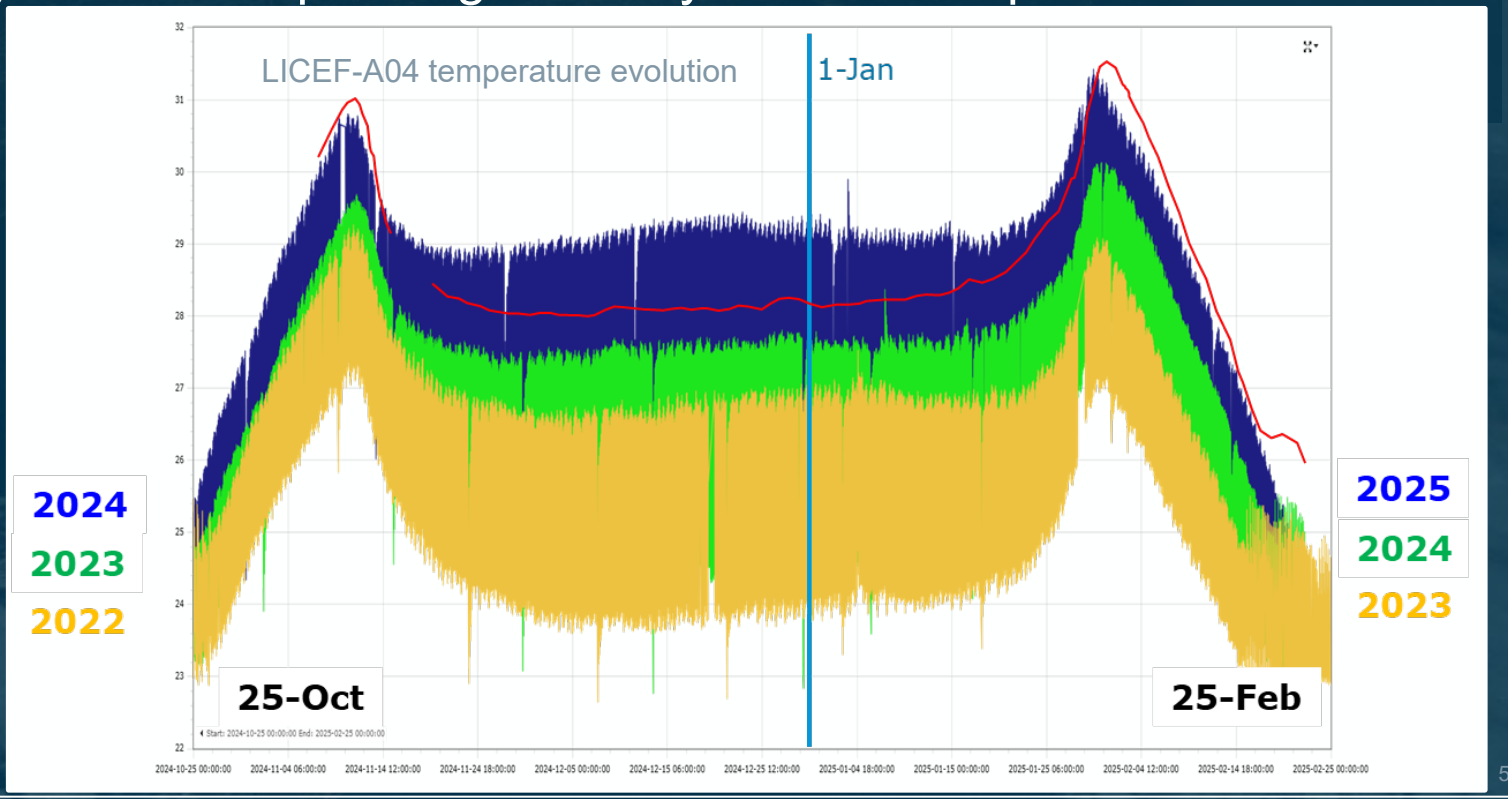
- Solar Flux, TEC

(*) Mission data reprocessing by end 2025, including L1



MIRAS SMOS Payload status

1. After more than 15 years in orbit, MIRAS still remains in very good shape.
2. All housekeeping telemetry parameters remain very well within limits.
3. Payload operations are very smooth and well optimised.
4. All known anomalies are covered by their corresponding recovery actions and procedures
5. Minor concerning issues:
   - Arm-A temperature increase. It is slightly increased in 2024/2025 (+1C)



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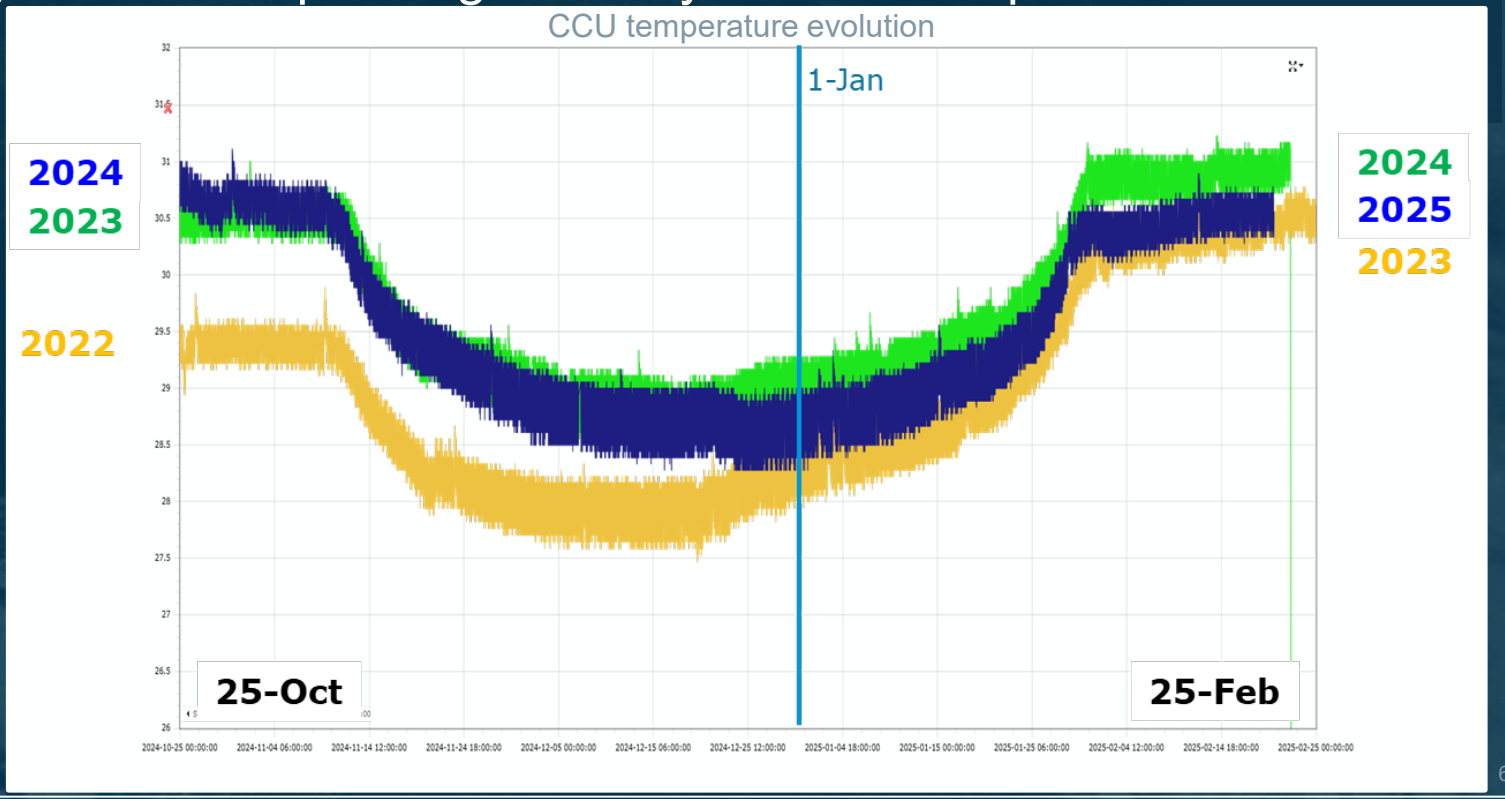

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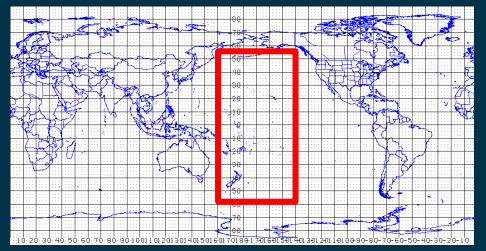
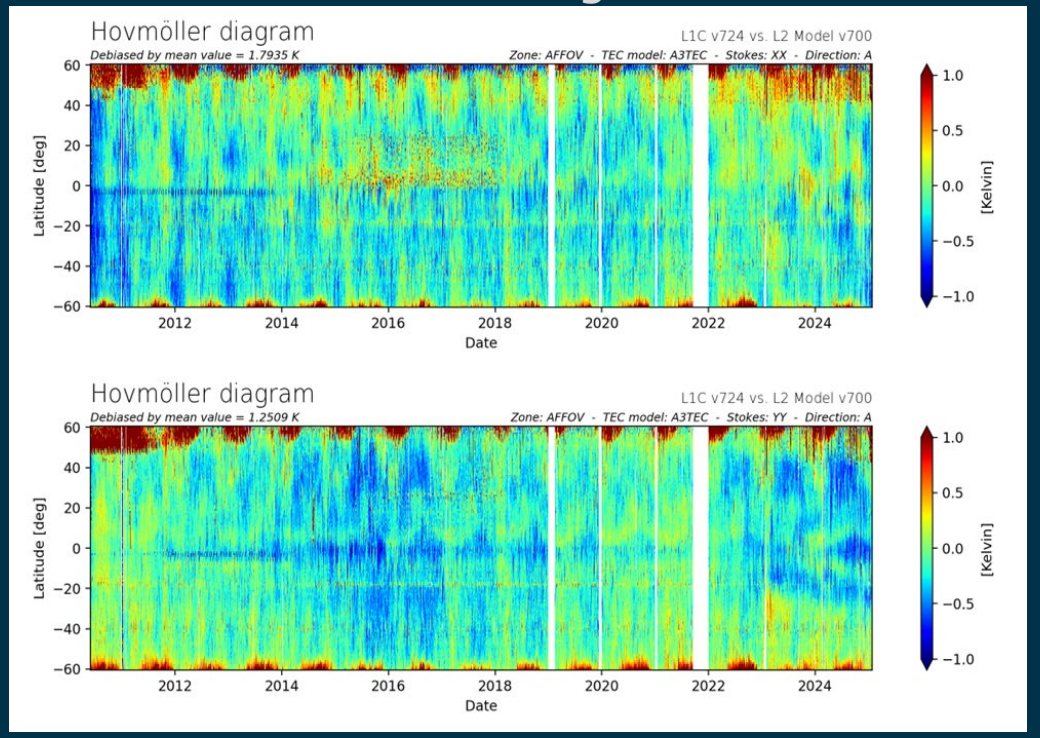
- Arm-A temperature increase. It is slightly increased in 2024/2025 (+1C)
- CCU temperature has been stabilized with slightly decrease in 2024/2025 (-0.5C)
- Proteus reduced mode due to GPS jamming signal (GPS time information is taken from Proteus local oscillator). Time drift must be corrected on ground

SMOS Brightness Temperature (BT) performances (Ocean)

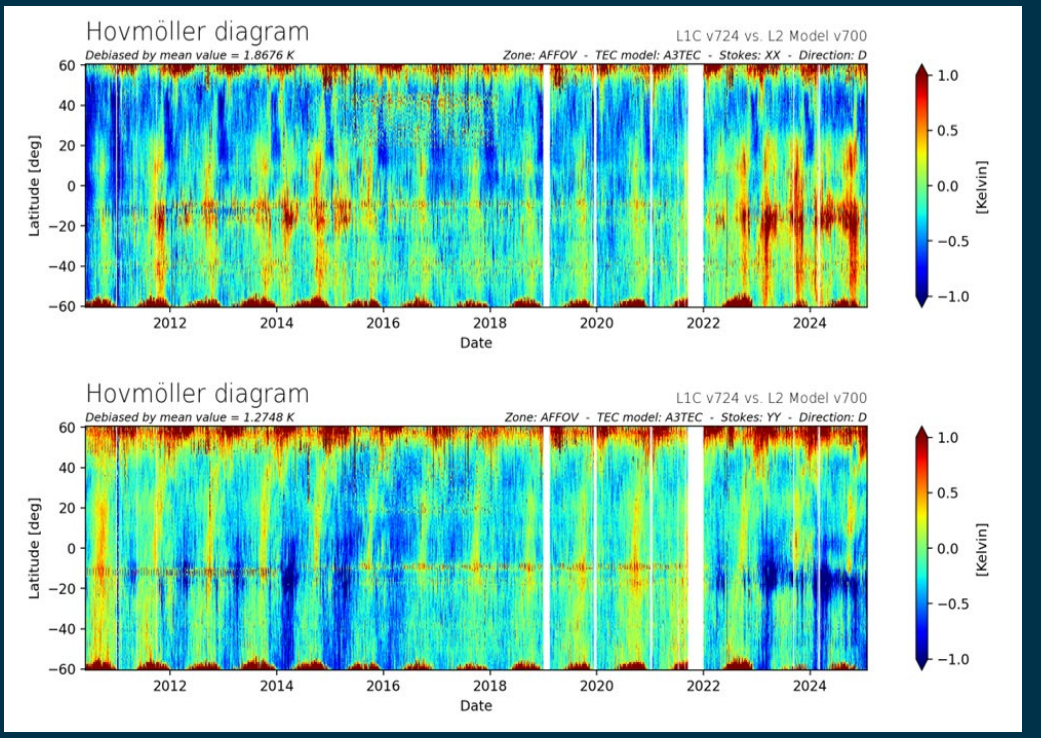


- Bias between BT from Ocean Forward Model and SMOS over a selected Pacific Ocean area
- Salinity model: ISAS up to Dec 22, WOA09 onwards
- Others geophysical parameters from ECMWF forecast

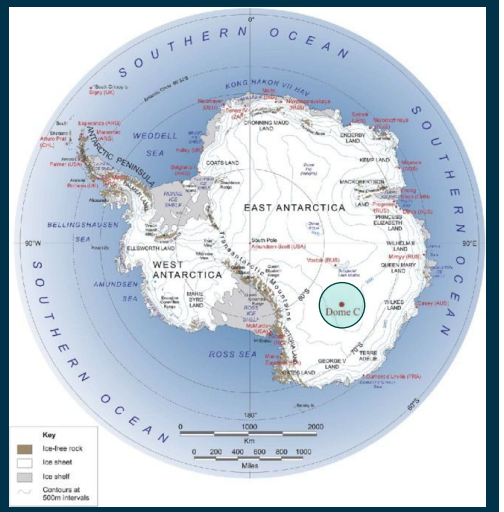
Ascending

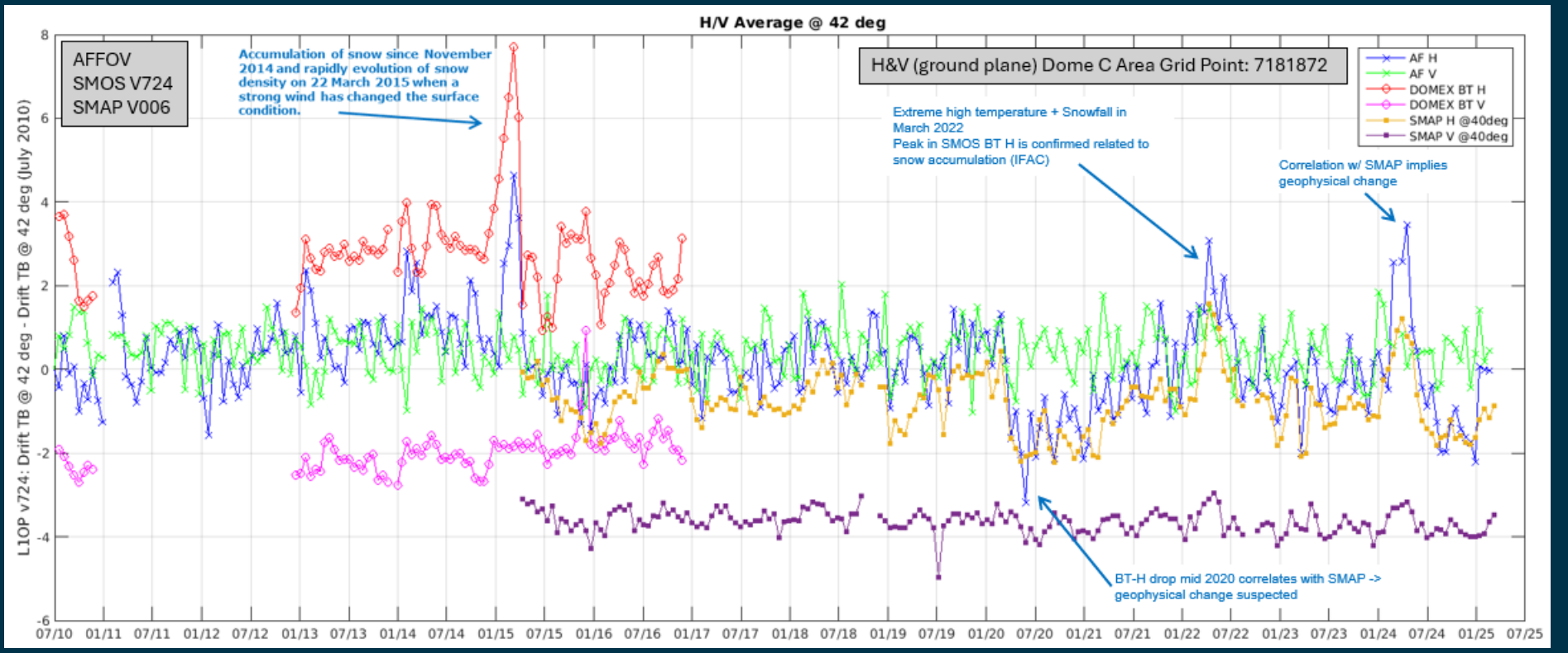


Descending



SMOS Brightness Temperature (BT) performances (Antarctica)





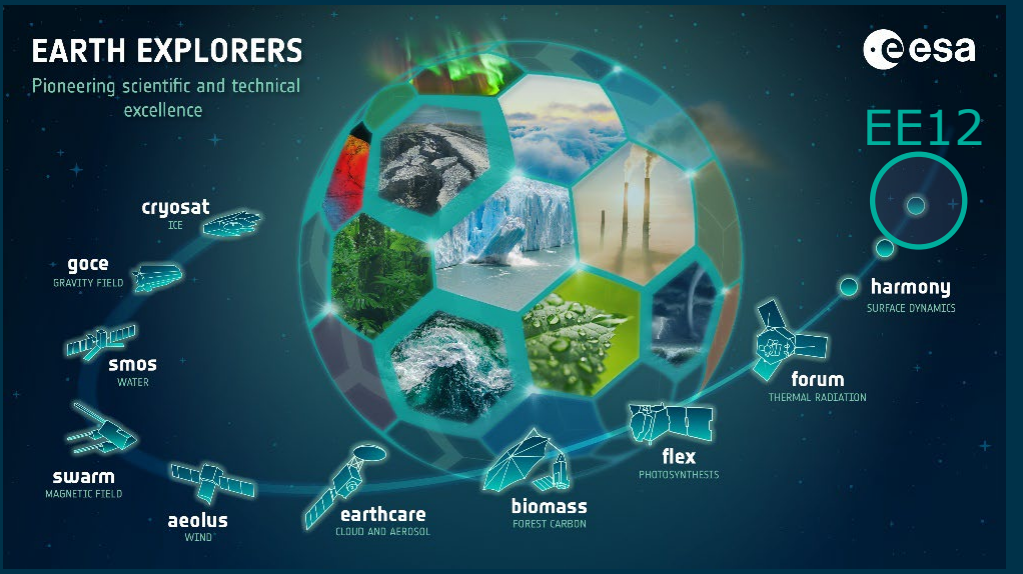
- Data is extracted from the MIR_SCLF1C products for the Dome-C point (e.g Grid Point ID: 7181872)
- Average and STD of BT are computed each 18 days for HV for the different FOV areas: AFFOV and entire FOV.
- Average value in June 2010 has been subtracted from each statistics in order to highlight the variation.
- Comparison with Domex data and SMAP data is also available.

Measuring L-band from Space what next

EE12 Proposals:

- The Fine Resolution Explorer for Salinity, Carbon and Hydrology (**FRESCH**): a mission to study ocean-land-ice interfaces
- Sea-Air-Ice-Land INteractions (**SAILIN**) mission: A candidate mission for the European next Earth Explorer 12
- A new mission concept for improved SSS estimate in cold water: **CryoRad** a low frequency wideband radiometer (0.4 – 2.0 GHz)

- CryoRad selected for 18-months Phase-A study



CryoRad would fill an important gap in observations of the cryosphere through the direct measurement of low-frequency passive-microwave brightness temperatures using a novel broadband radiometer. From these novel measurements key parameters such as the temperature profile of ice shelves, sea-ice thickness and sea-surface salinity in cold waters can be determined to improve our understanding of key processes in the polar regions. The mission would complement the upcoming Copernicus CIMR, CRISTAL and ROSE-L missions.

ESA - ESA selects four new Earth Explorer mission ideas

Copernicus Space Evolution

PROGRAMME OF THE EUROPEAN UNION

co-funded with esa

CHIME

Copernicus Hyperspectral Imaging Mission for the Environment

- soil properties
- crop health
- raw materials
- biodiversity
- water quality

ROSE-L

L-band Radar Observing System

- geohazards
- polar ice
- forest management
- food security
- maritime surveillance

LSTM

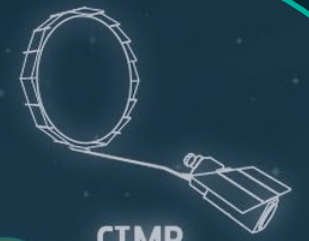
Land Surface Temperature Monitoring

- sustainable agriculture
- water resources management
- drought
- urban heat islands

Food Security and Water Management

Monitoring Land and Natural Resources

- sea-ice concentration
- sea-surface temperature
- polar maritime security
- global ocean and cryosphere
- soil moisture and vegetation



CIMR

Copernicus Imaging Microwave Radiometer

(https://cimr.eu/

CO2M

Copernicus Anthropogenic Carbon Dioxide Monitoring

- carbon dioxide and methane from human activity

Combatting Climate Change

Strengthening Copernicus Space Component with Copernicus Sentinel Expansion Missions

Safeguarding the Arctic

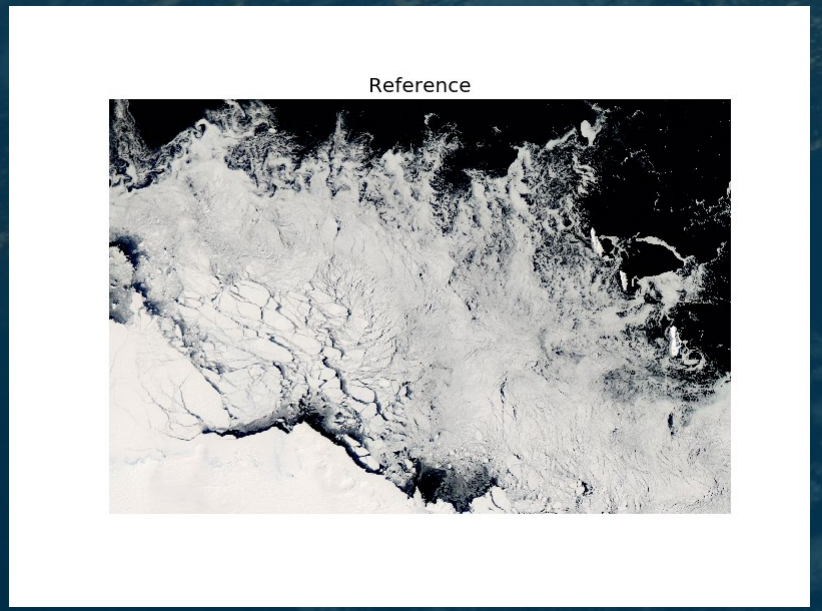
- coastal and inland waters
- polar oceanography
- ice sheets and glaciers
- snow
- sea-ice thickness

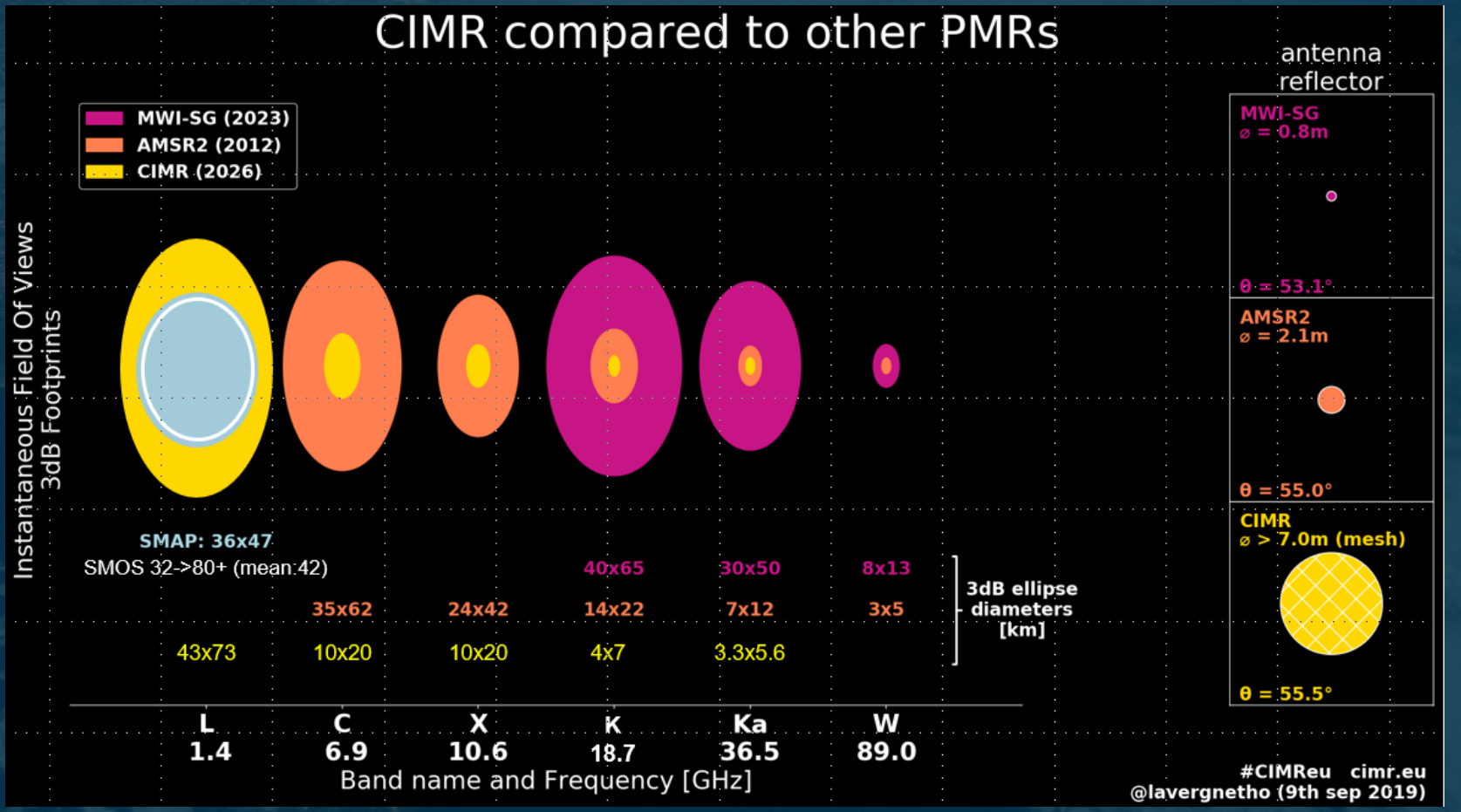
CRISTAL

Copernicus Polar Ice and Snow Topograph Altimeter

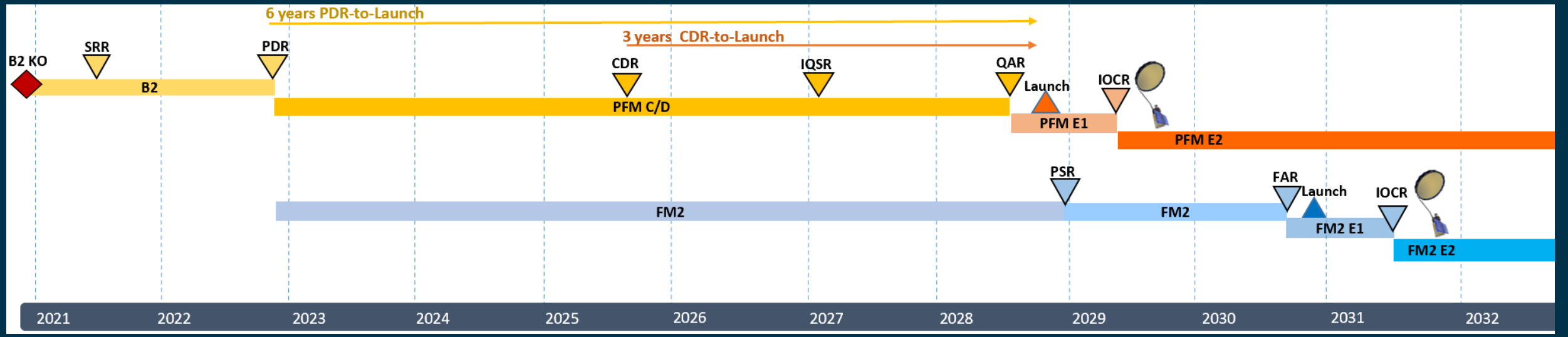
CIMR (https://cimr.eu/)

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





CIMR schedule and status



CIMR Mission is now in full C/D phase – industry is starting to building hardware

- robust **DESIGN** is established
- **PERFORMANCES** compliant to (very challenging) requirements

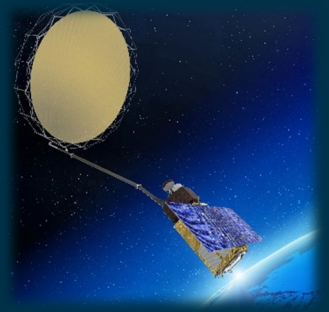
Some activities on-going

- CIMR Level 1 end to end simulator (L1E2E) to generate products from low-level instrument simulation
- CIMR Scientific End-to-end Prototype Simulator (SCEPS) to evaluate CIMR mission performance
- CIMR Level 2 Product and Algorithm Development (L2 PAD) to define geophysical retrieval algorithms and L2 validation plan

and others more (see back slides).

ESA and EUMETSAT: cooperation and responsibilities

ESA and EUMETSAT cooperation in the CIMR Mission



Space Segment: ESA is responsible for the payload design, the development and operation of the satellite

Ground Segment: ESA is responsible for the ESA Ground segment, the Mission Operations and Management

Level-1: ESA will be responsible for the system performances and all L1 products quality through the mission

ESA will be responsible for development and operations of Level-2 Polar Regions and Land products

EUMETSAT will be responsible for development and operations of Level-2 Global Ocean and Global Atmosphere

During all phases of the Mission, ESA and EUMETSAT will cooperate.

For what concerns Level-2, cooperation on

- *Level-2 algorithm definition*
- *performance monitoring*
- *Level-2 products validation activities*

CIMR validation approach

Scientific Calibration and Validation Concept Document

- CIMR uncertainty model
- techniques for the quantification and propagation of uncertainty in the data products

CIMR Multi-Matchup System and Database

to collect and organize reference data together with a match up system to extract subsets of reference collocated in space and time

Others more ...

CIMR-Air

Airborne instrument demonstrator of CIMR

In-flight Level-2 Validation Plan

validation methodologies for the key variables in the ESA CIMR Level-2 products maintaining traceability into Mission requirements

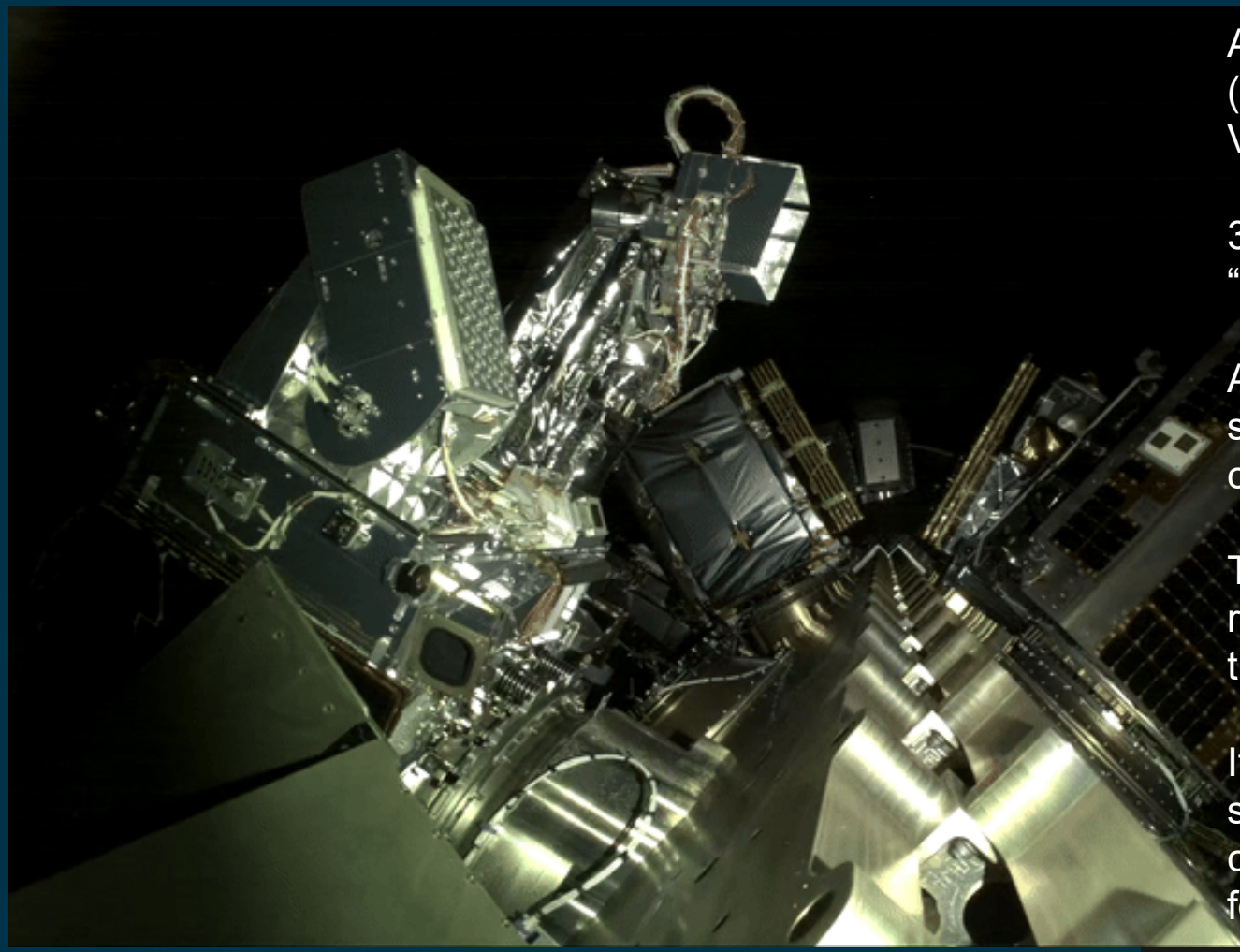
Synergies with other Copernicus Expansion Missions

multi-sensor intercomparison and validation with CRISTAL and ROSE-L

Building on heritage

Fiducial Reference Measurements for Soil Moisture (FRM4SM)

Arctic Weather Satellite (AWS) ESA - Arctic Weather Satellite



Arctic Weather Satellite separate transporter, image credits: SpaceX

AWS was lofted into orbit on 16 August 2024 at 20:56 CEST (11:56 local time) aboard a SpaceX Falcon 9 rocket from the Vandenberg Space Force Base in California.

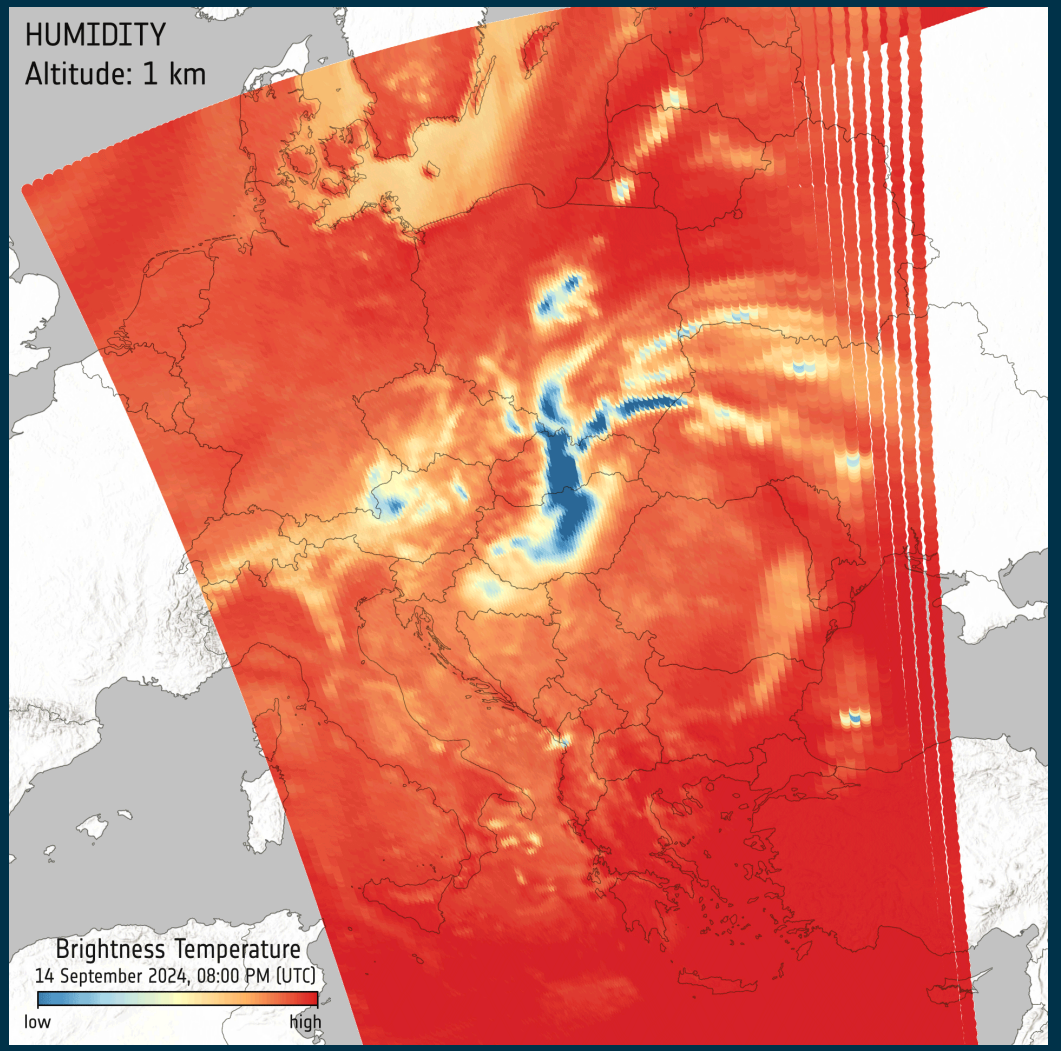
3-years to develop, build and launch the satellite thanks to “New space approach”

AWS provides high-resolution humidity and temperature soundings (vertical profiles) of the atmosphere in all weather conditions.

The payload is 19-channel cross-track scanning microwave radiometer (heritage of the Microwave Sounder developed for the MetOp Second Generation satellites).

It can be replicated for a potential constellation of similar satellites (EPS-Sterna) that would provide an almost continuous stream of data for very short-term weather forecasting, or ‘nowcasting’, for the Arctic and beyond.

Arctic Weather Satellite (AWS) ESA - Arctic Weather Satellite



On 14 September 2024 as part of the commissioning phase, AWS has captured a first image over storm Boris.

The animation presents Brightens Temperature values at different altitude ranging from 1 Km to 7 Km above Earth's surface. Lower values (dark blue) indicated higher humidity level.

The torrential rainfall from Storm Boris is especially evident as dark blue regions low in the atmosphere over Hungary, Slovakia, and Poland.

Arctic Weather Satellite, Brightness Temperature, image credits: ESA

HydroGNSS https://www.hydrognss.org/

SURREY SATELLITE TECHNOLOGY LTD

Scout 2 HydroGNSS Calibration Validation Plan

Cal/Val plan finalized for phase E1 and E2
6-months commissioning

Liftoff is planned for end 2025.

Orbiting Earth 180 degrees apart, the two identical satellites will use Global Navigation Satellite System (GNSS) reflectometry to measure important climate variables

Domain	Lead	Site/Source	Type
Soil Moisture	Sapienza	ISMN SMAP (SMOS, CYGNSS)	In-situ (global) Satellite Satellite
Freeze/Thaw soil state	FMI	SMOS, SMAP (selected permafrost regions) Sodankylä, Finland ISMN	Satellite In-situ In-situ (global)
Inundation	IEEC	GLOFAS or JRC GSW	Model
Forest biomass	IFAC	GEOCARBON or ESA CCI BIOMASS (?)	Model Satellite
Ocean wind speed, Sea Ice extend	NOC	ERA 5 ocean wind speed OSISAF or NSIDC sea ice extend	Data assimilation model

DOMEX: 2025 updates

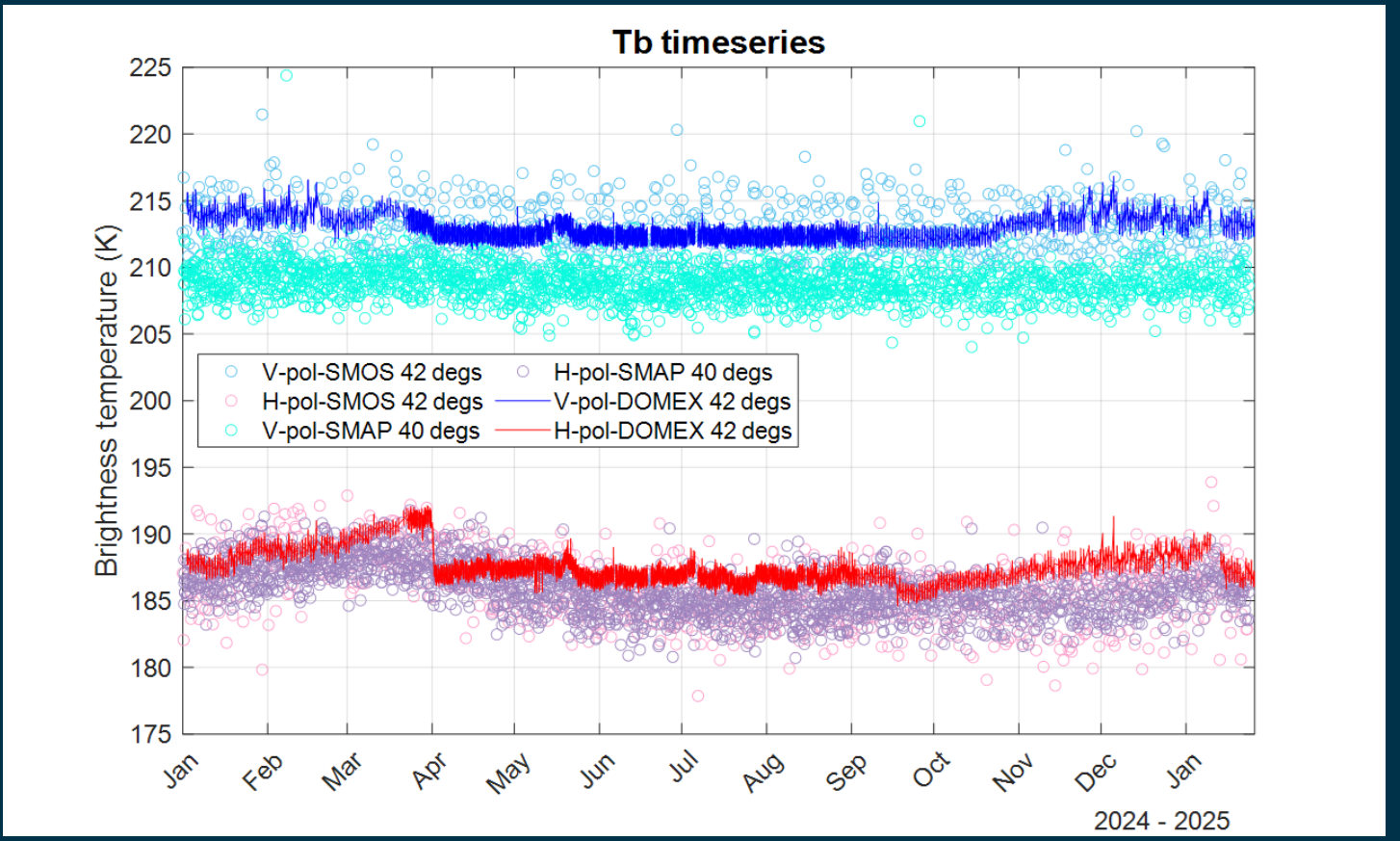
Domex-3 logistics and maintenance have been refunded for another two years until August 2026

New proposal to the Italian PNRA 2024 call for activities based on Concordia which include Radomex have been submitted. In case of success the Radomex will be on the field until 2029-30.

Experimental campaigns proposed [2026-27]:

LoMIRad (0.4 – 2 GHz) radiometer at Concordia station from the American Tower and on PistenBully (PB100) from traverses centered on Concordia with a radius of 20 Km.

image credits: IFAC



Continuous acquisition by Domex during the last year shows a good agreement wit satellite measurements. image credits: IFAC

Summary

- SMOS Mission (https://earth.esa.int/eogateway/missions/smos)
  - Platform and Payload in good condition, no criticality despite few recent GPS anomalies.
  - SMOS long term calibration monitoring is stable
  - SMOS – SMAP Brightness Temperature inter-comparison continues to show good agreements between the two sensors
  - Preparation for full mission reprocessing (4th) in 2025 is on-going (revisit L1 calibration, L2 retrieval algorithms and auxiliary files)
- FRESH, SAILIN (SMOS follow on) proposed as EE 12
- CryoRad selected as EE12 candidate
- CIRM mission (https://cimr.eu/) is now in full C/D phase – industry is starting to building hardware. Science simulator, L1 and L2 prototype algorithm under development.
- AWS (ESA - Arctic Weather Satellite) launched 16 August 2024, first image acquired commissioning is done.
- Hydro-GNSS, (https://www.hydrognss.org/) ready to launch by end 2025, Cal/Val plan finalized
- Domex campaign refunded until 2026
- Backup slides:
  - Validation platforms for soil moisture (QA4SM: https://qa4sm.eu/ui/home) and sea surface salinity (PiMep: https://www.salinity-pimep.org/) have been upgraded check backup-slides (e.g. new products and functionalities)
  - RFI monitoring and reporting has continued (https://rfi.smos.eo.esa.int/) check backup slides
  - More information on RFI, CIMR and Domex

Acknowledge

- Manuel Martin-Neira (ESA)
- Michele Scagliola (ESA)
- Roberto Sabia (ESA)
- Francesco Montopoli (IFAC)
- ESA SMOS RFI team
- SMOS Calibration team
- ESA SMOS Expert Support Laboratories

Thank you for your attention

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Backup slides

Pilot-Mission Exploitation Platform (Pi-MEP) Salinity

Web-based environment to visualize, validate, monitor, assess and exploit **Satellite Salinity data** (SMOS, SMAP, Aquarius)

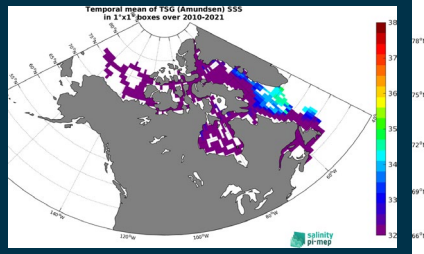
Broad variety of online Tools to extract, inter-compare datasets and compute relevant statistics

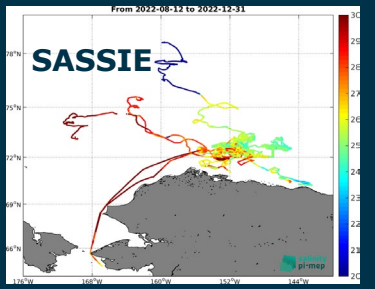
www.salinity-pimep.org

Major achievements since GSICS 2024:

Operations

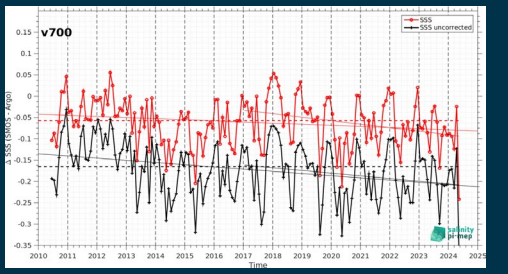
Inclusion of new in-situ datasets: updates to SAMOS, Amundsen, Lauge-Koch, SASSIE



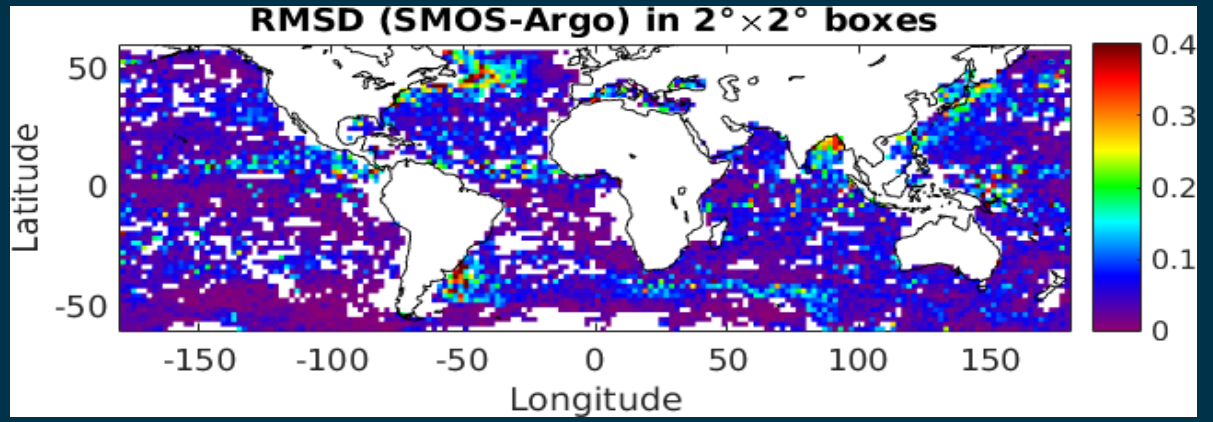


Production of metrics to support **Operational QC:**

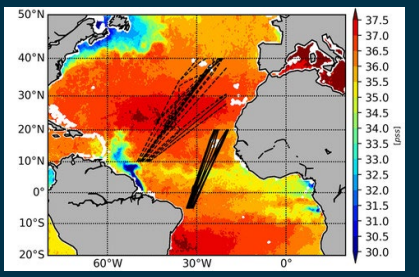
Towards QC-controlled TSG data: contributions from Gael Alory (LEGOS)



Characterization of **temporal, horizontal and vertical sampling** impact when comparing in-situ & satellite SSS



Spatial resolution contents of SSS products by comparison with high-resolution TSG lines



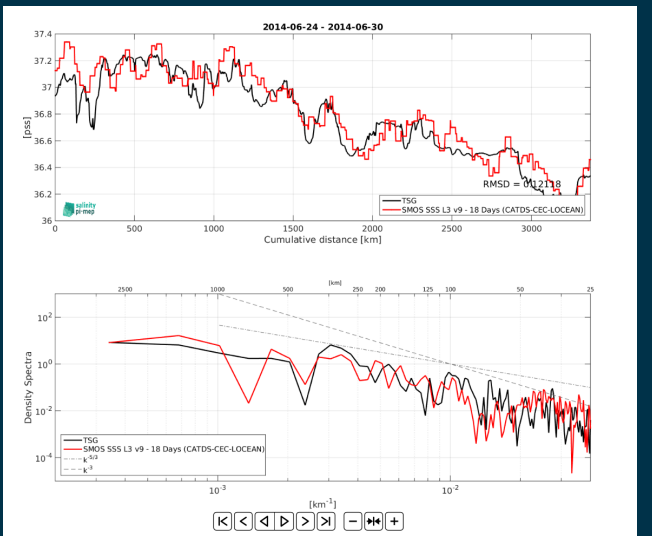
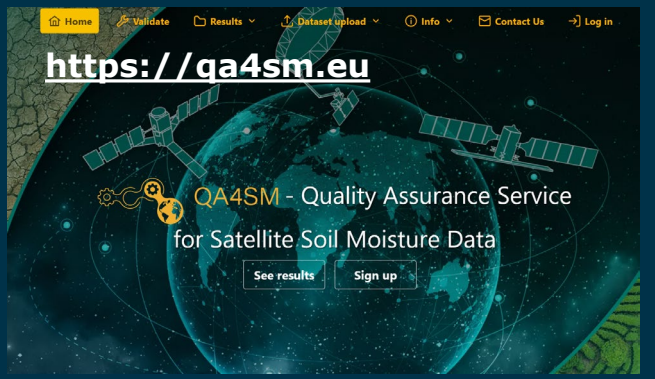
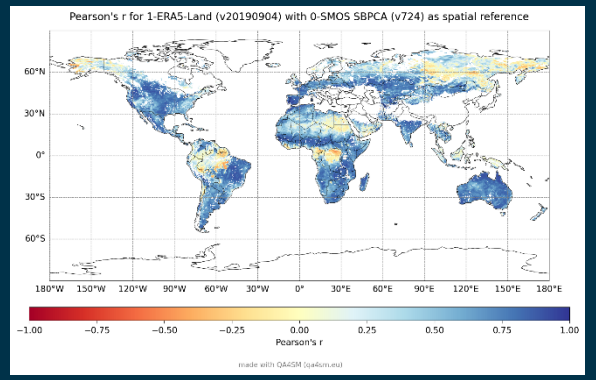
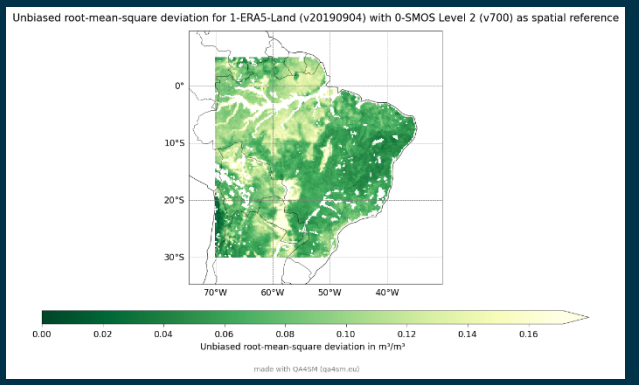


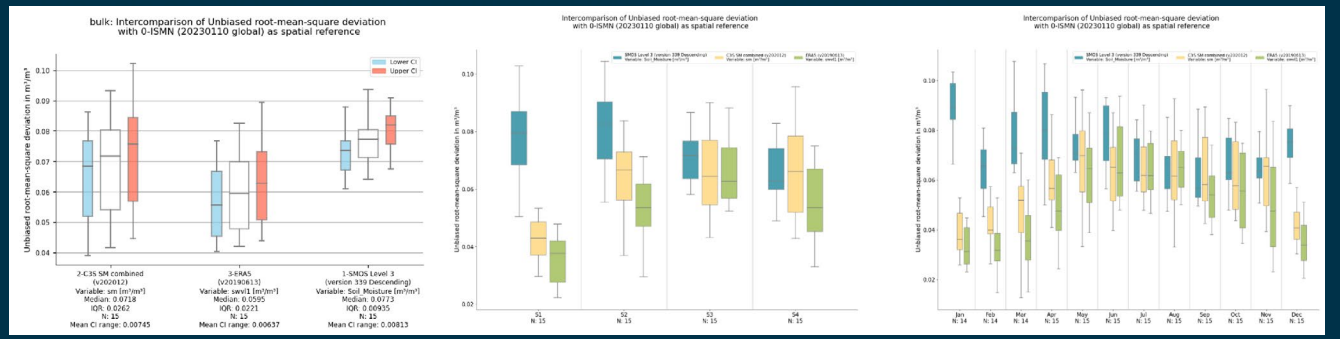
Figure 28: SSS as a function of the cummulative distance over the TSG transect (black line) and collocated SMOS SSS L3 v9 - 18 Days (CATDS-CEC-LOCEAN) Satellite product (red line)

Fiducial Reference Measurements for Soil Moisture (FRM4SM)









New release v3.0 in February 2025 including temporal stability metrics

FRM4SM Objectives:

- defining procedures and protocols to qualify in situ soil moisture measurements as "FRMs"
- addressing specific concerns intrinsic to the satellite soil moisture validation strategy (e.g. in situ measurement's spatial representativeness, and the identification of committed areas for satellite soil moisture validation

The Quality Assurance for Soil Moisture (QA4SM) online validation service is developed as part of FRM4SM implementing qualified R&D outcomes.

QI idea	Literature review/ talking to experts	Receiving / fetching needed data	Data evaluation	Outcome status (possible, not possible)	Creation of classification / thresholds	Forwarded to ISMN / QA4SM	Update shedule proposed	Expected completion
Representativeness QI	✓	✓	✓	✓	✓	✓	✓	completed
Soil texture heterogeneity QI	✓	✓	✓	×				completed
Land cover heterogeneity QI	✓	✓	✓	×				completed
Vegetation spatial scale QI	✓	✓	✓	×				completed
Water body fraction spatial scale QI	✓	✓	✓	×				completed
topography spatial scale QI	✓	✓	✓	×				completed
Temporal scale related QI	✓	✓	✓	✓	✓	✓	✓	Oct 2024

✓ finished
() ongoing
× deemed infeasible

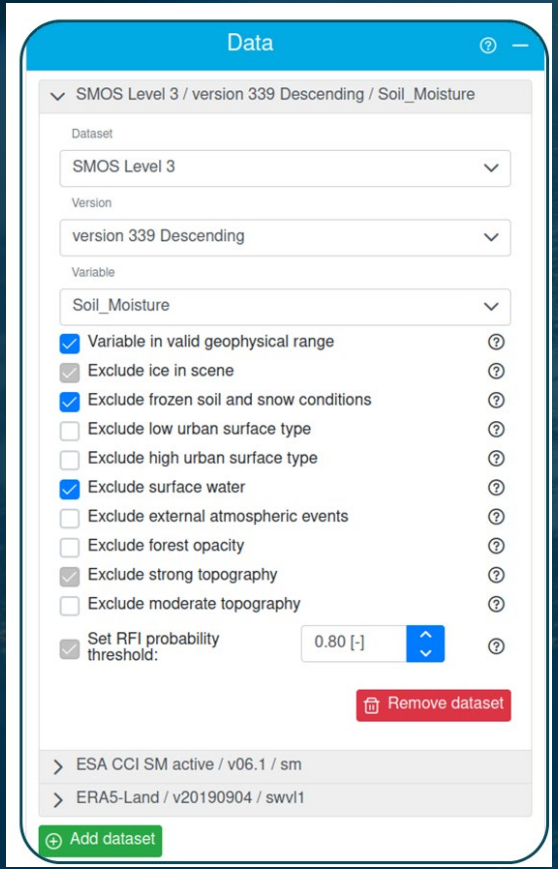
Main achievements since GSICS 2024:

- New quality indicators,
- Automated Report
- Seasonal metrics, Temporal stability metrics implemented in V3.0
- Research paper "Estimating the uncertainties of satellite derived soil moisture at global scale, Science of Remote Sensing" https://doi.org/10.1016/j.srs.2024.100147
- Stakeholders' collaboration: Joint proposal for the EURAMET Green Deal 2024 Selected Research Topic: "Metrology for soil moisture: from ground reference sites towards coherent and traceable global data products"

Phase-2 from 2025 to 2026 including focus on high resolution satellite soil moisture validation

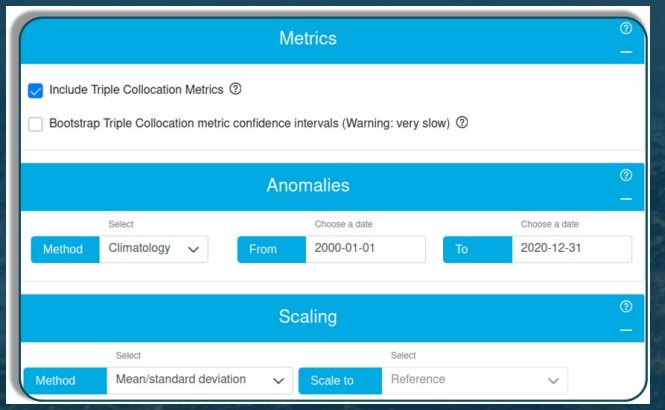
QA4SM Workflow https://qa4sm.eu

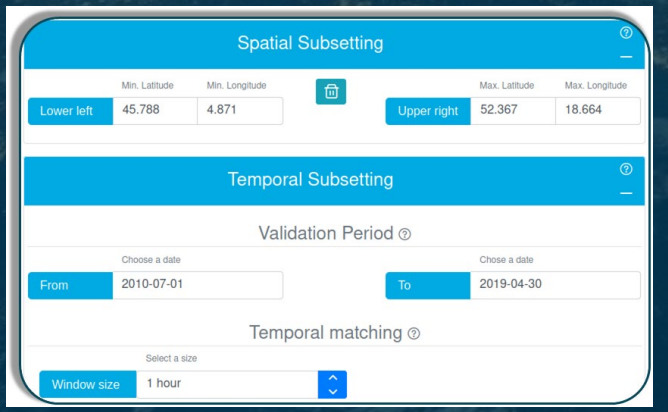
1) Data Selection



Up to 5 satellites + 1 reference

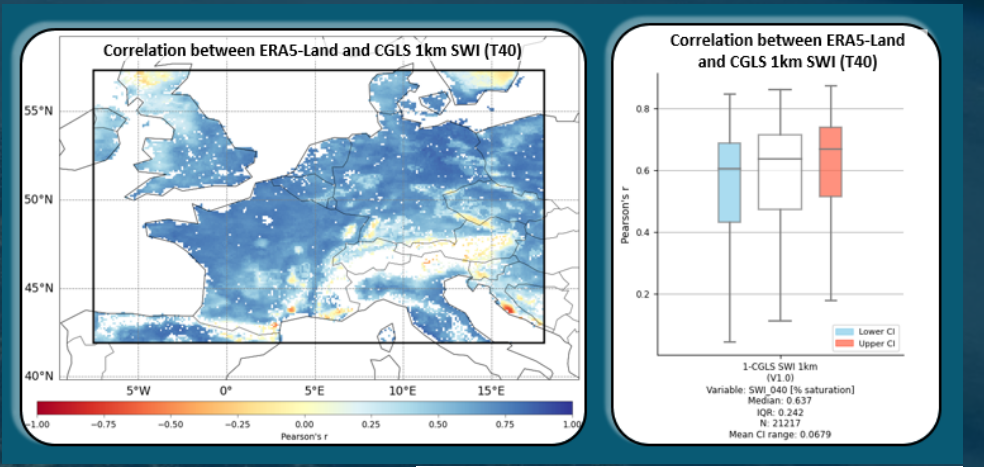
2) Customize Settings





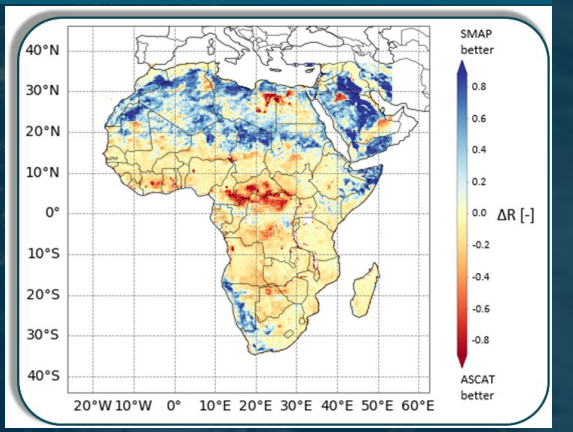
Temporal / spatial subsets, validation metrics + CIs, anomaly computation, ...

3) Process, visualize, share & download



Validation metrics ↑
tables, maps, box plots,...

Comparisons →
difference maps,
ISMN metadata based comparisons, ...

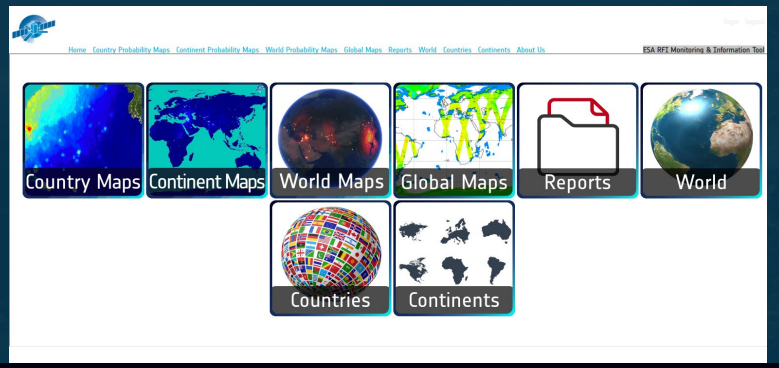


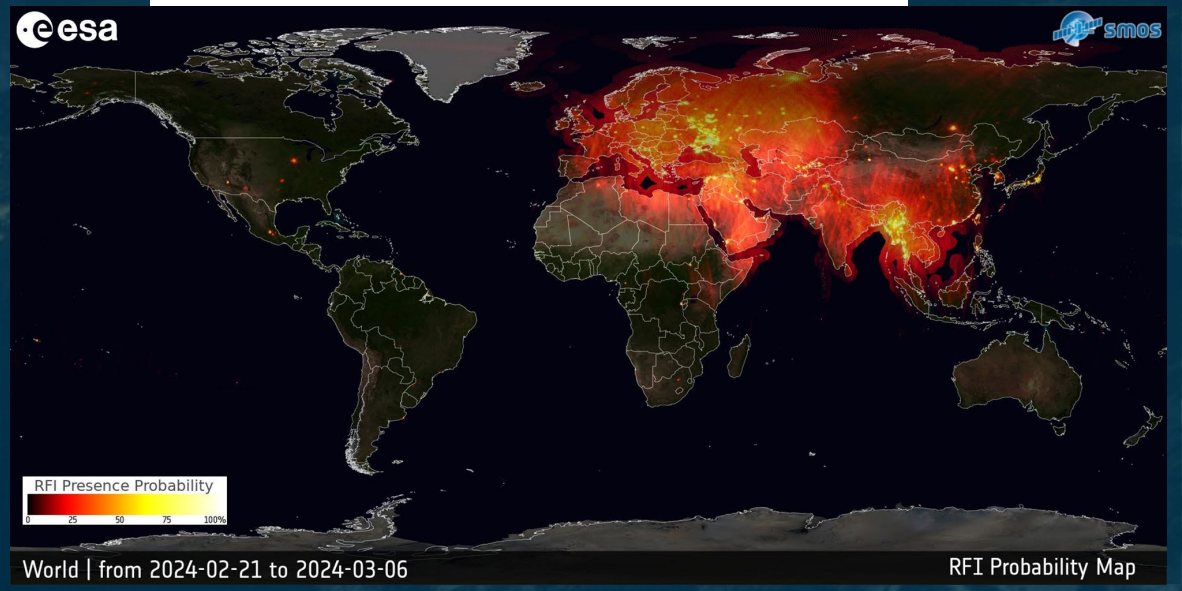
Public example: Published Validation of ESA CCI (C3S) Soil Moisture with ERA5 https://qa4sm.eu/ui/validation-result/e9a9d43a-deac-4ea5-bbcb-855065fbbeb8

ESA RFI Monitoring, Reporting and Detection

RFI monitoring and information tool (ERMIT)

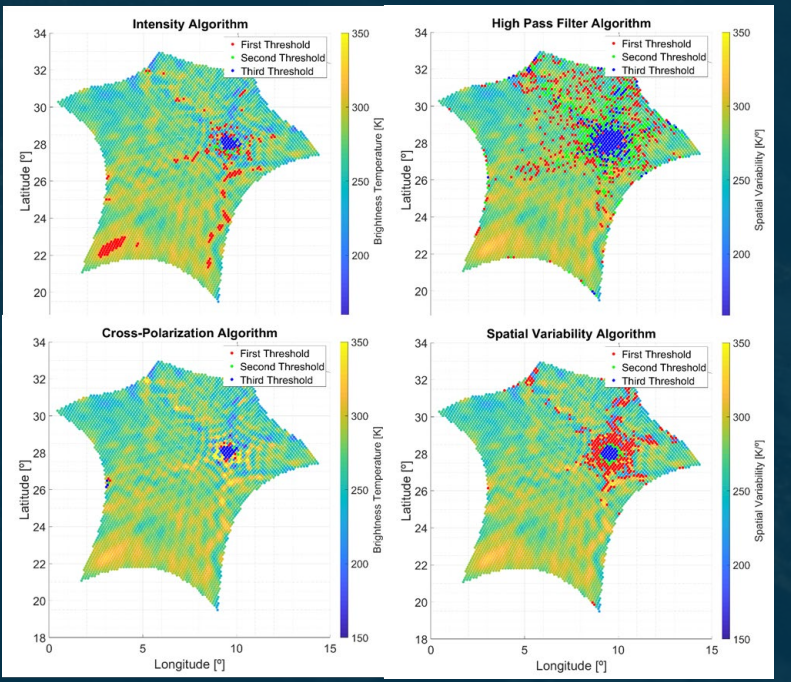
https://rfi.smos.eo.esa.int/





Ground RFI Detection System (GRDS)

GRDS is an on-ground system whose purpose is to detect and remove RFI from EO data. The system has been developed with a flexibility in the design to be able to ingest data from **any EO passive microwave** mission. It applies several thresholds at once, to customise for each user's needs (see figure below as an example applied to SMOS image).



RADOMEX: L-band microwave radiometer @ Concordia

Temp in winter: -90°C
Temp in summer: -20°C

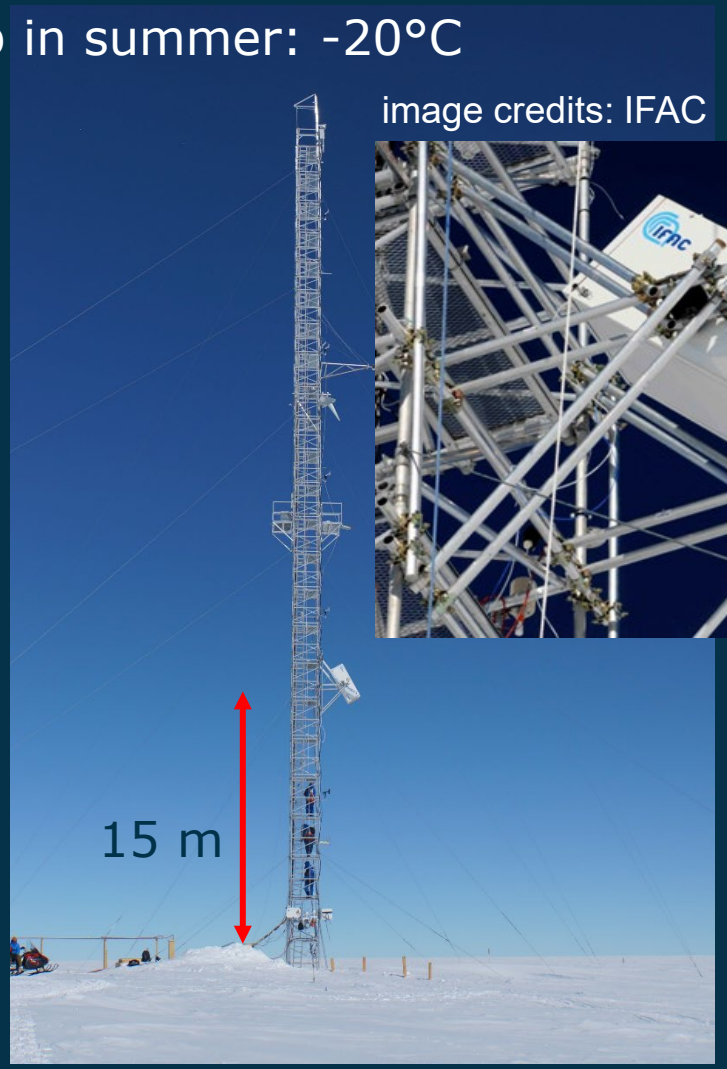


image credits: IFAC

From the launch of the SMOS mission particular attention was paid to the region of Dome-C, Antarctica, with the aim of characterizing this area as a potential extended target for calibrating and monitoring low frequency microwave radiometers.

Why Dome –C ?

- High penetration of e.m. waves in the ice sheet and high temporal stability in the physical properties (including temperature below 10 m). It is theoretically expected that Tb remains stable in time.
- Well covered by SSO satellites (SMOS, SMAP, etc.)
- Spatial homogeneous and small slopes at satellite footprint scale
- Infrastructure (Concordia station) and ancillary data available

Experiments (DOMEX) that include ground-based L-band radiometer (RADOMEX) measurements were conducted at Concordia Station since 2004 and **continuously since 2012** supported by ESA and PNRA. The long-term experiment was recommended in order to provide a continuous independent data record of ground-based radiometric measurements covering the SMOS – Aquarius – SMAP era thus verify target stability over time and monitor changes in target characteristics that may affect the long-term reference signal.

The Copernicus Imaging Microwave Radiometer CIMR

The European Commission and the High Representative of the Union for Foreign Affairs and Security Policy issued to the European Parliament and the Council, on 27 April 2016, a joint communication that **proposed "An integrated European Union policy for the Arctic"**

Polar Oceans are fundamental to understanding the global environment

CIMR is designed to:

- **Prevent the anticipated Gap in capability**
- **Be "ready" for an ice free Arctic**
- **Key variables:** *Sea Ice Concentration, Sea Surface Temperature, thin Sea Ice Thickness, Sea Surface Salinity, Wind Speed, soil moisture…*
- Low frequency/High Spatial resolution (5–15 km)
- **Measurements every ~6 hours** in the Polar regions, no hole at the pole
- 95% global coverage every day for **application in all Copernicus Services**

Directly addresses the EU Arctic Policy.

- **A 'Game Changer' for Copernicus**

CIMR channel selection

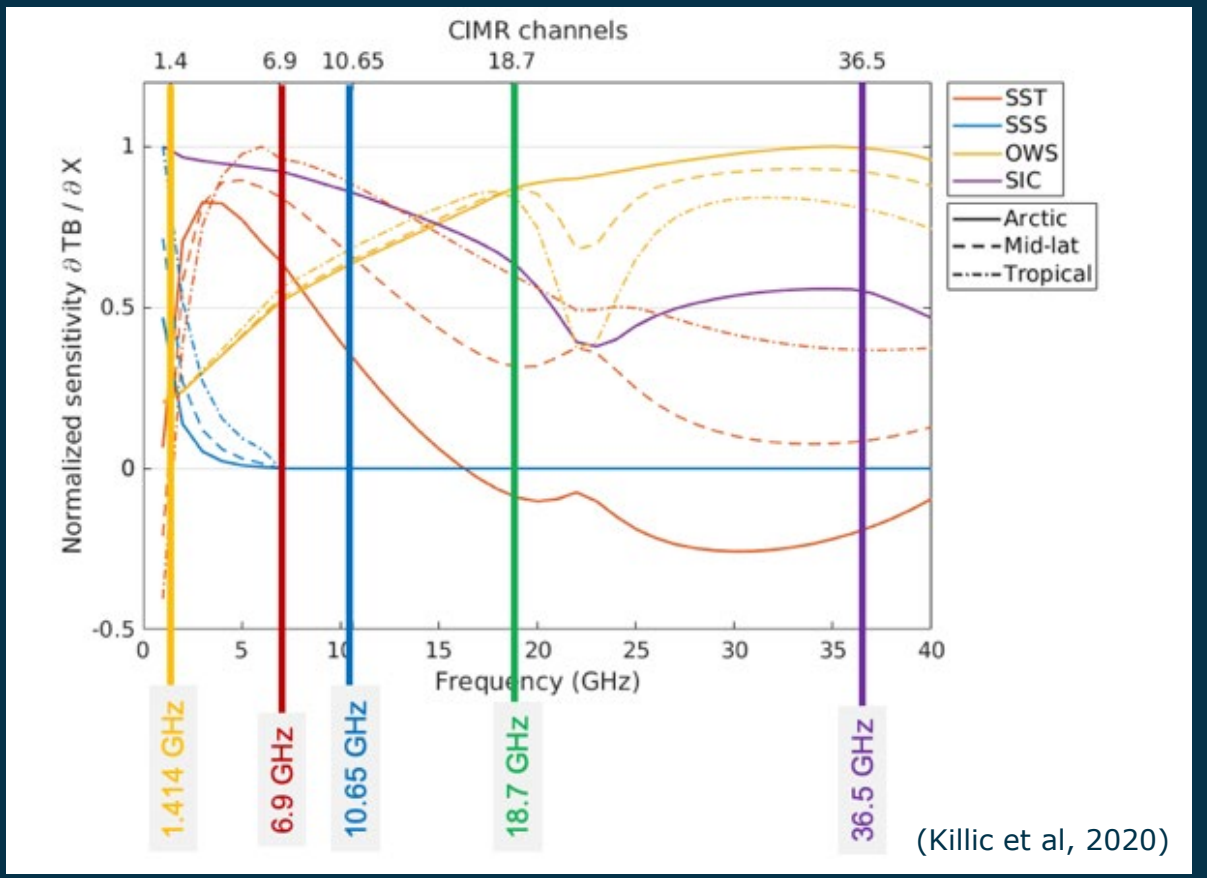
1.4135 GHz: SIT, SIC, SSS, WS, SM, SD

6.9 GHz: SIC, SST, SIT, IST, WS, SID, SM, SD

10.65 GHz: SST, PCP, WS, SD, SM

18.7 GHz: TCWV, LWP, PCP, SIC, SD, SM, SID

36.5 GHz: SIC, SST, LWP, TCWV, PCP, SIC, SWE, SD



(Killic et al, 2020)

SIC = Sea Ice Concentration,
SST = Sea Surface Temperature, SIT = Sea Ice thickness,
SSS= Sea Surface Salinity,
WS = Wind speed,
LWP = Liquid Water Path,
TCWV = Total Column-liquid Water Vapour,
SD = Snow Depth,
SM = Soil Moisture,
SWE = Snow Water Equivalent,
SID = Sea Ice Drift,
PCP=precipitation

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

CIMR status

DEVALGO is a study dedicated to piloting several baseline algorithms for use in the SCEPS scientific simulator in support of the CIMR Critical Design Review (CDR). An innovative approach to use Jupyter books, python notebooks is used for a set of key L2 variables (not all). The algorithms to develop were selected to make sure that all of the CIMR functionality could be tested at CDR. The study makes use of open source tools and is unique at this point. On-line resource (ATBD) see https://github.com/CIMR-Algos. Algos V2.0 finalized. Project closed. Project results as input to L2PAD

MACRAD (Metrological Analysis of CIMR Radiometry) Foundation is the propagation of uncertainties starting from input variables, their statistical distribution, and relationships. Based on BIPM Guide to Uncertainty Modelling (GUM). We are using the COMET Toolkit to do the work (open-source community code developed by NPL). Project closed. Project results as input to L2PAD.

CIMR RGB regridding toolbox. It includes a library function to allow remapping of CIMR data to different grids and projections. The tool takes L1b inputs and have flexible modular capability to provide L1c options and L1r products (remapping products that are specific to L2 retrieval chains). Project Final Review 1 April 2025. Project results as input to L2PAD.

L2PAD is the definition of operational L2 Product algorithms . KO 21st November 2023. Activity is to define the ESA L2 algos and uncertainties for ESA L2 products. The study provides L2 test data products to the community and inputs to the pre-flight and consider all of the Polar and Land products in the MRD that are under development now. Expert User group to evaluate the progress and approach in 1.5 years from now. Successfully Preliminary Design Review on 27 November 2025

CIMR-AIR status

CIMR-AIR airborne instrument. The study KO was in October 2023 to develop CIMR-AIR.

CIMR-AIR is an instrument that includes the full 5-frequency bands in H&V in a compact form that can be flown on a research aircraft. The intent is to collect pre-launch data to support algorithm developments and for in orbit valuation of CIMR.

The instrument is a side looking configuration with a single beam per frequency at same OZA of CIMR. The system has its own Position, Velocity and Time (PVT) information (additional to the aircraft) and includes a fully functional user interface with some basic L2 processing to confirm that the instrument is working.

CIMR-AIR will operate on aircraft (Twin Otter) to cover the large distances of CIMR footprints in a time short enough to allow a meaningful validation. A visible and a thermal infrared camera will be also present on-board. We have maximum altitude ceiling of procured; but the reference altitude (for performances and specifications) is at 1000m.

CIMR-AIR will fly circular patterns to mimic CIMR footprints to a certain degree.

Critical Design Review close out in January 2025. Functional flight scheduled in November 2025.

CIMR Level-2 Product Families

Level-1 (independent of coverage domain)

L1a | L1b | L1c

ESA
EUMETSAT

Level-2 (families as function of coverage domain and timeliness)

Polar

NRT1H	NRT3H	NTC
SIC	SIC	SIC
SIED	SIE	SIE
SID	SST	SST
OWS	SIT	SIT
	SIED	SIED
	SID	SID
	ITY	ITY
	SND	SND
	SIST	SIST
	SSS	SSS
	OWV	OWV

Global Land

NRT3H	NTC
TSA	TSA
SWE	SWE
LSWT	LSWT
LIC	LIC
FT	FT
LST	LST
SM	SM
MMVI	MMVI
SWF	SWF

Global Ocean

NRT3H	NTC
SST	SST
SSS	SSS
OWV	OWV

Global Atmosphere

NRT3H	NTC
PCP	PCP
LWP	LWP
TCWV	TCWV

CIMR status (https://cimr.eu/)

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

- Preliminary Design Review system and instrument 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)

Copernicus mission (active/passive) commonalities

ROSE-L

- Deformation, Landslides and urban subsidence
- Flooding
- Forest Biomass and structure
- Land over and land cover change
- High resolution soil moisture
- Sea ice characterization
- Ice sheets and glacier velocity
- Grounding line
- Snow Water Equivalent
- Permafrost thawing and extent
- Ocean surface wind vectors
- Swell properties
- Iceberg location, size and drift
- Vessel location, size and velocity
- Oil spill location and morphology

CRISTAL

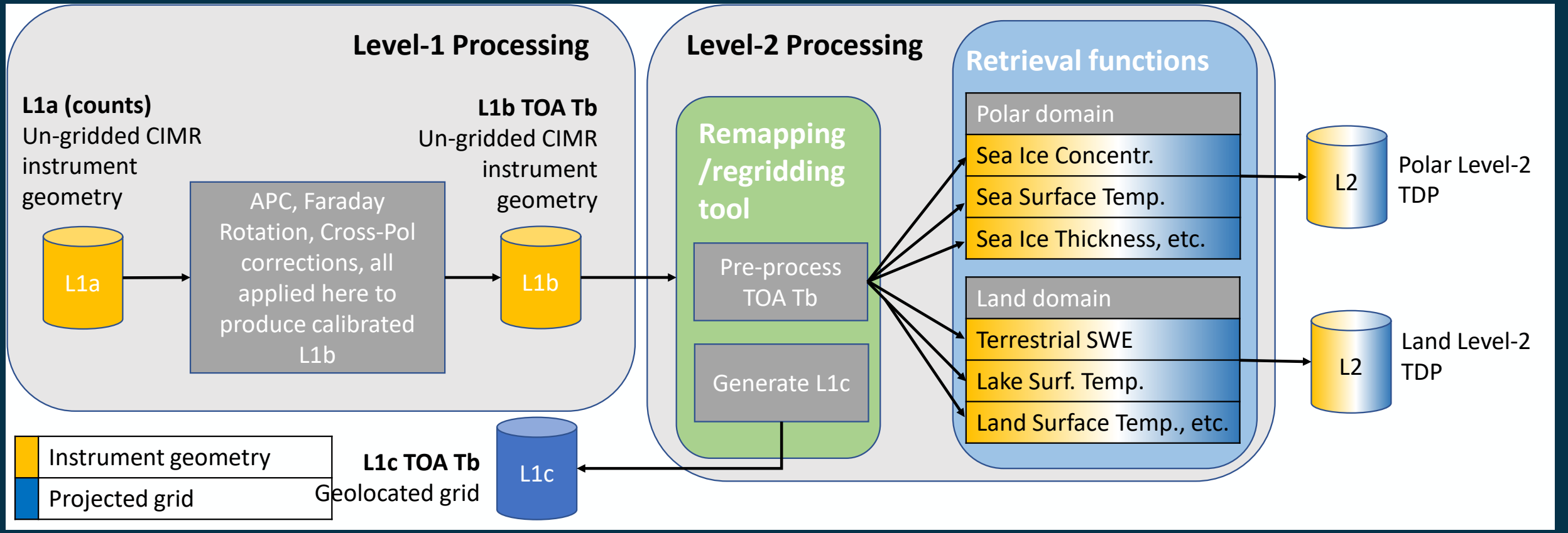
- Sea-Ice thickness and snow depth
- Ice sheets surface elevation and changes
- Polar glaciers surface elevation and changes
- Ice caps surface elevation and changes
- Grounding line migration
- Global ocean topography
- Observation of water level at coasts, rivers and lakes
- Snow cover and permafrost
- Iceberg detection and change
- Ice shelf volume and change

CIMR

- Sea-Ice Concentration
- Sea-Ice Extent
- Sea-Ice, sea and land Temperature
- Sea-Ice Drift Vectors
- Thin Sea-Ice thickness
- Ice type/Stage of development
- Snow depth on Sea-Ice
- Total Snow Area
- Snow Water Equivalent
- Sea Surface Salinity
- Wind speed over ocean
- Soil moisture
- Freeze/thaw state
- Precipitation over ocean
- Terrestrial surface water extent
- Vegetation indices

CIMR Level-1 and Level-2 Processing chain

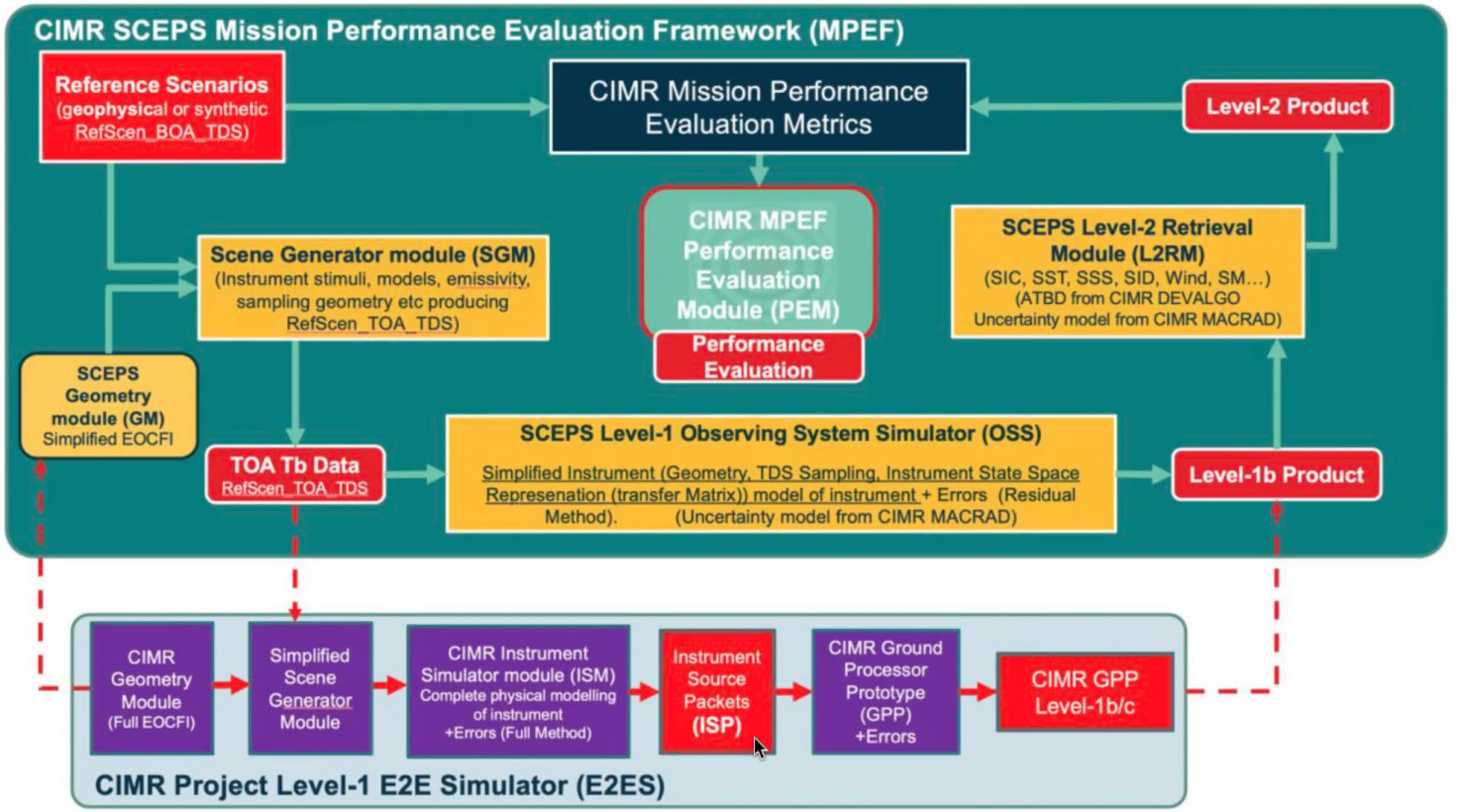
The high level design for the CIMR Level-1 and Level-2 processing chain is presented here



CIMR ESA/EUMETSAT responsibilities

- ESA will operate the CIMR Mission and generate Level-1a, Level-1b and Level-1c products.
- For Polar Regions and Global Land product families, ESA will develop Level-2 pipelines for all relevant products.
- EUMETSAT will develop separate pipelines for Global Ocean and Atmosphere product families starting from ESA Level-1 products.
- The ESA and EUMETSAT pipelines at Level-2 are thus independent by design.
- Validation and quality control aspects are thus the responsibility of each respective Agency with respect to Level-2 Mission Requirements.

Overview- Mission Performance Evaluation Framework



Overview- Mission Performance Evaluation Framework