

ESA's Soil Moisture and Ocean Salinity Mission

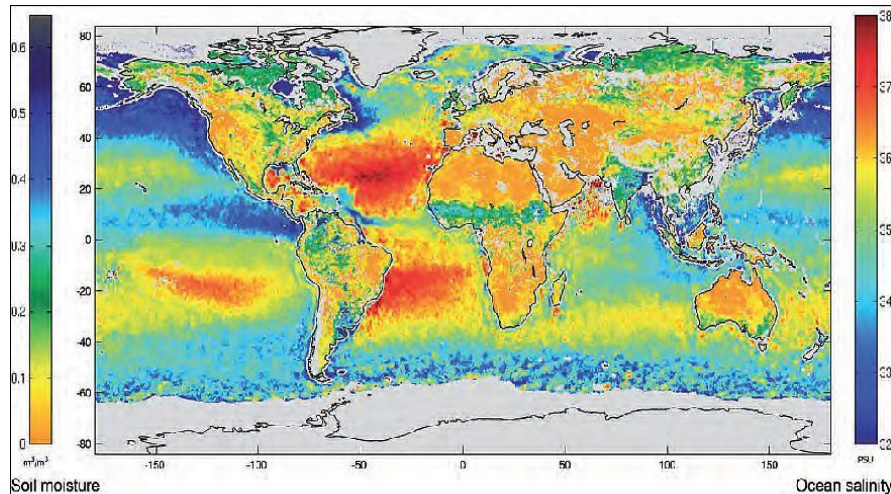
Current status and continuity of observations

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on behalf of SMOS operations teams



STATUS

- ❑ SMOS is in excellent technical conditions: High data availability ~99%
- ❑ No technical limits exist to operate the mission beyond 2017.
- ❑ SMOS mission operations confirmed until 2017 by ESA & CNES (current funding under EOEP-4). EOEP-5 will cover continued SMOS operations.



SOME NEWS

- ✓ Data products up to level 2 generated continuously, including data products in NRT (L1 brightness temperatures and L2 soil moisture, available from ESA and EUMETCAST)
- ✓ New Level 2 Ocean Salinity and Soil Moisture reprocessed data set (version 6) available since March 2016.
- ✓ Improved salinity product (correcting for land-sea contamination currently reprocessed – available beginning 2017.
- ✓ New operational processor for severe wind speed over ocean planned – to be available 2017.
- ✓ RFI contamination worldwide much reduced (but still present in middle East and Asia): 72.1% of known sources do not operate anymore in the protected band.

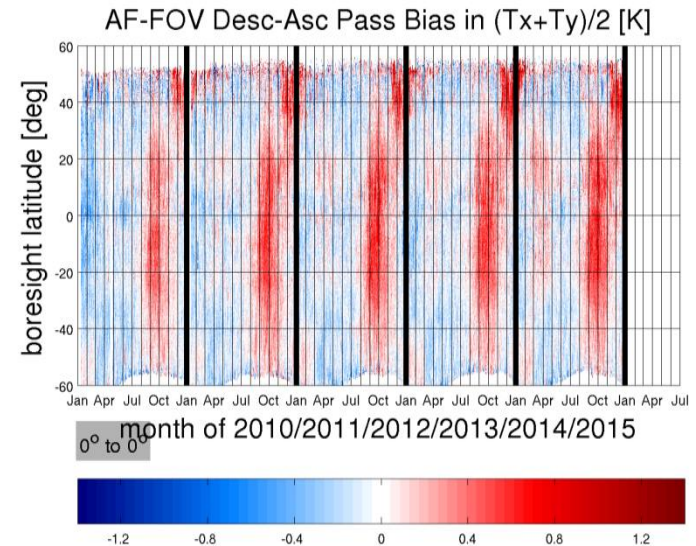
IMPORTANT IMPROVEMENTS AT LEVEL 1 v6
 (current version in operations since May 2015, full reprocessed data set available on <https://smos-ds-02.eo.esa.int/oads/access>)

- ❑ Significant improvements regarding drifts/stability and spatial biases in new Level 1 processor.
- ❑ New processor implements correct computation of the 4th Stokes parameter and improved RFI flagging.
- ❑ Remaining problem: land-sea contamination

Future improvements focus on (Level 1 v7 operational and reprocessed data available end-2017)

- ❑ Further reduce image spatial biases and land sea contamination ("Gibbs-2" image reconstruction)
- ❑ Simplification of instrument calibration (ALL-LICEF mode)
- ❑ Improvement in SUN correction (direct / glint)
- ❑ Further improvement in RFI flagging

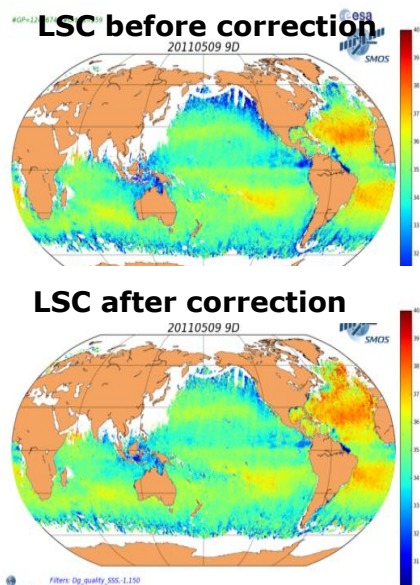
$(T_x + T_y) / 2$	Previous Level 1 (V5)	Current Level 1 (V6)
Orbital stability, latitudinal slope	6.9 mK/lat deg	4 mK/lat deg
Seasonal stability	0.38 K	0.16 K
Long term stability: yearly drift	-0.18 K/year	-0.03 K/year



Reduced brightness temperatures biases along orbit and seasonal

SMOS DATA QUALITY: LEVEL 2 SEA SURFACE SALINITY

Mission objective over ocean - To provide global ocean salinity estimates with an accuracy of 0.1 practical salinity scale units for a 10-30 day average for an open ocean area of 200 x 200 km² → **product accuracy constantly improved and approaching targeted values**



(Status April 2016)

2010-2015	Ascending passes				Descending passes			
	v5		v6		v5		v6	
Coast dist. > 800 km	mean	std	mean	std	mean	std	mean	std
Global	-0.12	0.31	-0.07	0.29	0.02	0.35	-0.03	0.32
45N - 45S	-0.12	0.31	-0.07	0.29	0.02	0.35	-0.03	0.32
Tropical 30N - 30S	-0.14	0.29	-0.08	0.28	0.03	0.31	-0.08	0.30
SPURS - N. Atlantic	-0.10	0.19	0.01	0.18	0.04	0.22	-0.20	0.22

Current Version 6 (operational since May 2015, full reprocessed data set available since May 2016) improvements

- ✓ Improved data filtering (RFI and Sun)
- ✓ Improved TEC characterisation
- ✓ Improved bias correction

In between: Major improvements in currently reprocessed (delta) Level 2 Sea Surface Salinity (available beginning 2017):

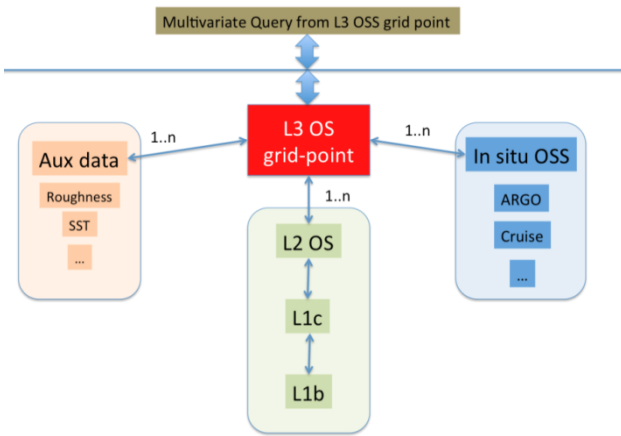
- Corrected Land-Sea contamination
- Single sea roughness model
- Anomaly field included
- Improved data filtering (RFI and Sun)

Future Version 7 (2017+ for deployment and reprocessing)

- ✓ Characterization of a SMOS-based climatology to estimate a de-biased SSS anomaly
- ✓ Improved Sun glint correction strategy
- ✓ Improved Galactic noise correction model
- ✓ Improved wind speed characterization in retrieval scheme

QUALITY MANAGEMENT TOOL

Pi-MEP Salinity



- ❑ **Common platform for** super-users (e.g. ESL) and wider oceanographic community to serve as **enhanced validation platform**
- ❑ **Matchup** in-situ (ISAS, Argo, TSG etc.), SMOS (L1 TB, L2 SSS, L3 SSS) and additional satellite data (e.g. SST, WS, current, rain rates etc.) to enable process studies
- ❑ Systematic comparisons with **Aquarius and SMAP** SSS products
- ❑ Further investigation **horizontal and vertical salinity variability** (Boutin et al, BAMS, 2015):
- ❑ Assessment data quality over shorter **time periods** (100 km and 10 days) and different **spatial scales**
- ❑ Ability to show delta in reprocessing and new processors versions
- ❑ User-oriented scientific environment (**web interface**)

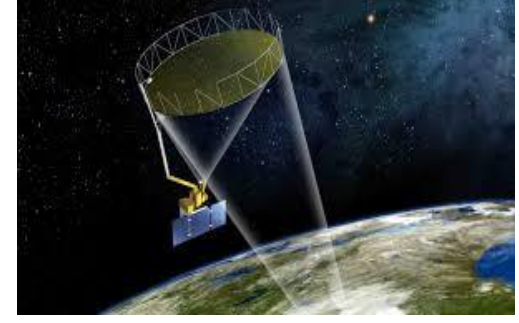
Status

- ❑ Procurement process closed, Negotiation on-going with IFREMER, KO date November 2016

SSS _{L3_1}	SSS _{L3_2}	SSS _{L3_3} ...
Argo/ISAS	TSG	Drifters, mooring ...
100 km/1m	100 km/10dd	50 km/1m ...
L3	L2	L1 ...
Filtering and collocation criteria	Other filtering and collocation criteria	Other filtering and collocation criteria ...
SMOS	Aquarius	SMAP ...
Statistics (mean, std, RMS)	Other Statistics (median, mode, correlation)	Other Statistics (skewness, kurtosis) ...

Conceptually, the revised validation protocol is only a "vector" of the Pi-MEP "matrix" (enhanced validation platform)

ESA's and NASA's L-band missions

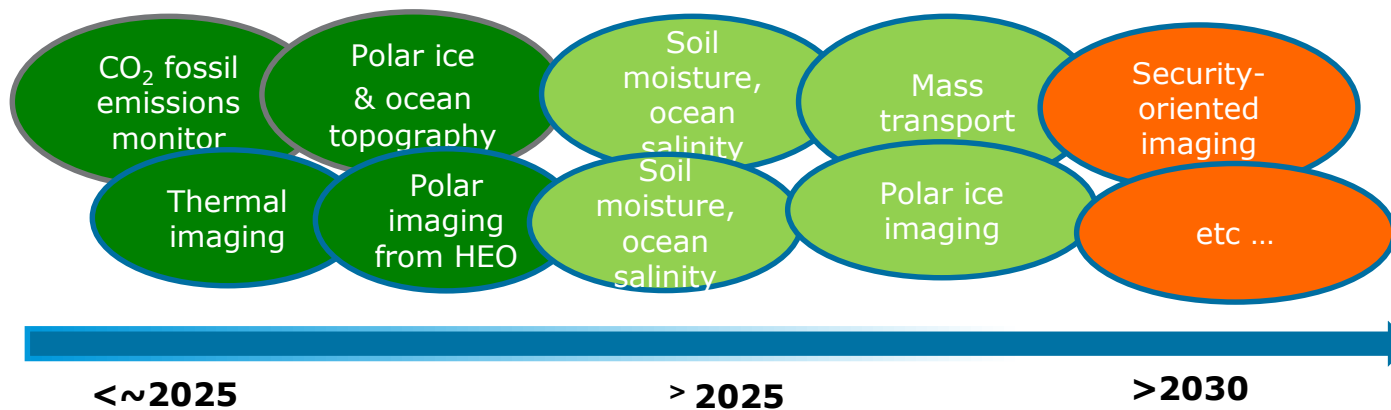


	SMOS	Aquarius	SMAP
Observational goal	Soil moisture, Ocean salinity	Ocean salinity	Soil moisture
Instrument	L-Band interferometric radiometer	L-Band radar and radiometer (three beams)	L-Band radar (till July 2015) and radiometer (fixed incidence angle)
Mission Lifetime	2009 - today	June 2011 – June 2015	January 2015 - today
Spatial resolution	35-50 km	70-90 km	~40 km
Temporal coverage	1-3 days (2.5 days equatorial)	Global 8 days at 100 km	1-2 Day polar; 2-3 days equatorial
Observational requirements	SM: 4%, 50 km, 2.5 days OS: 0.1 psu, 200 km, 10 days	0.2 psu, 200 km, 8 days	4%, 40 km, 3 days

What comes next?

To ensure continuity of L-Band observations users need to voice their requirements and engage with funding and implementing agencies NOW.

- ❑ The current Sentinel generation will have to be replaced by a next generation of satellites before the end of the last units' lifetimes (first missions to be launched before 2030) → **Sentinels extension**
- ❑ EC initiated process to define the evolution and next-generation of Copernicus, encompassing activities of user requirements collection, gap analyses, service specifications,.. → User Requirements (UR) Document to ESA in mid-2017
- ❑ The European Commission is currently gathering the user requirements for the next-generation Copernicus Space Component via an online survey <http://www.copernicus.eu/copernicus-call-for-interest>
- ❑ **Mission Concepts and Thematic Areas proposed as high priority are:**
 - ❑ CO₂ Monitoring
 - ❑ Polar ice/ocean interfer. Altimetry
 - ❑ Other polar (Arctic) observations
 - ❑ Land thermal imaging
 - ❑ **Soil moisture, ocean salinity**
 - ❑ Hyperspectral land imaging



Work Shops



11th Copernicus Committee

- ★ **The following observation needs will be further investigated for environmental observations:**
- ★ **Priority 1:**
 - ★ **Greenhouse gas monitoring**, specifically on anthropogenic CO2 emissions, for which currently no satellite observations are available
- ★ **Priority 2:**
 - ★ **Monitoring the Polar regions**, specifically the arctic for sea ice and weather
 - ★ **Monitoring Agriculture**, specifically on parameters, which potentially could be addressed through thermal infrared observations
- ★ **Priority 3:**
 - ★ Mining, biodiversity, soil moisture and other parameters, requiring observations in additional bands, currently not available

11th Copernicus Committee, 7/10/2016

Space

Hugo ZUNKER, EC DG-GROW, I2



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SMOS relevant user requirements expressed

Selected feedback



3rd Satellite Soil Moisture Validation and Application Workshop, New York, NY , 21-22 Sept 2016, New York City, NY

"The workshop participants recommend the continuity of passive microwave L-band measurements as a part of a constellation of satellites, i.e. complementing the ASCAT and AMSR series and the Sentinel-1s."

Polar and Snow Cover Applications – User Requirements Workshop, 23 June 2016, Brussels: Position paper prepared by representatives of CMEMS

"Sea ice thickness is a very important indicator of climate change in the Arctic. In view of the uncertainty in the freeboard to sea ice thickness inversion, a Cryosat-3 type mission is an attractive option, preferably in combination with a laser altimeter. ... However, for operational sea ice monitoring, input to sea ice models and sea ice charting, satellite measurements of the thin sea ice below 0.5 m (SMOS- like) is indeed also required."

Needs more feedback from user community to EC

Special Issue on ESA's Soil Moisture and Ocean Salinity Mission after 6 years in orbit – Achievements and novel applications – released now on

<http://www.sciencedirect.com/science/journal/00344257/180>

THANK YOU

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