SMOS Arctic SSS L3 V2 maps produced by LOCEAN Expertise Center

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Overview

LOCEAN and ACRI-ST have derived improved level 3 (L3) SMOS Sea Surface Salinity (SSS) maps over the Arctic Ocean. With respect to SMOS ARCTIC SSS L3 V1.0, main changes in version 2.0 are as follows:

-9-day and 18-day maps are provided over the **June 2010 to August 2023** period,

-the methodology originally derived by *Supply et al.* [2020] and implemented in SMOS ARCTIC SSS V1 maps has been revisited,

-a temporal optimal interpolation with a bias removal depending on the SMOS observation geometry (see a general description in [*Boutin et al.*, 2018]) has been added,

-comparisons with independent in situ datasets, conducted in CEC LOCEAN and in PIMEP, indicate a clear improvement (reduction of std difference by ~a factor 2 and systematic increase of r^2); with V2.0 r^2 is greater than 0.8 with 40% of the data sets considered at PIMEP.

As in version 1, SSS maps are provided on an Equal-Scalable Earth Grid 2 (EASE, https://nsidc.org/data/ease) with a Northern Hemisphere Azimuthal projection and a resolution of 25km.

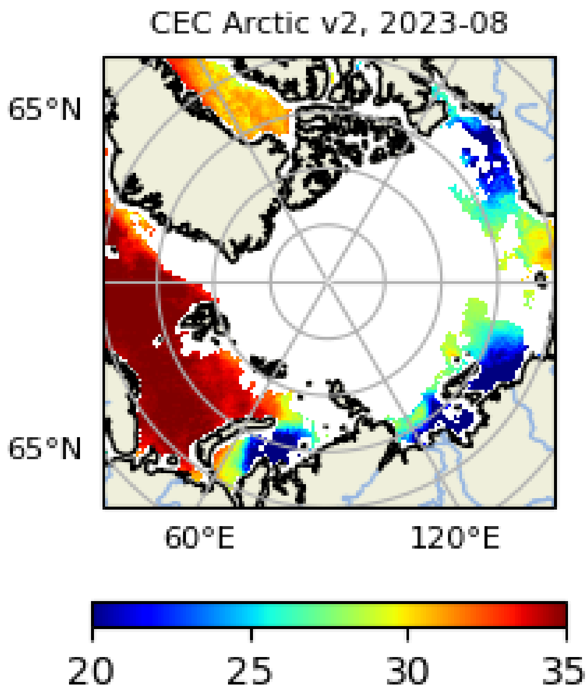

Figure 1 : SMOS SSS from CATDS CEC ARCTIC V2.0 in August 2023.

LOCEAN and ACRI-st work as Ocean Salinity Center of Expertise for CATDS (CATDS CEC-OS) in order to improve methodologies to be implemented in the future in the near real time CATDS processing chain (CATDS-CPDC). **Feedbacks from users about the quality of these new products are very welcome, as they are experimental.**

Introduction:

The challenges of Arctic salinity processing are as follows:

- Redundant daily revisits at high latitudes are not present in the daily ascending and descending L3 CATDS SSS fields. It is therefore necessary to switch back to half-orbit ESA SMOS Level 2 (L2) products, which do not eliminate daily revisits.

- The global EASE grid used at CATDS for global SSS fields is not suitable for very high latitudes, due to its latitudinal sampling, which is too loose on the global grid.

-The sensitivity of the brightness temperatures to SSS is much reduced in cold water.

-Ice and land are much more emissive than the sea. The large emissivity discontinuities at the land-sea and ice-sea transitions contaminate SMOS signals from coast and from ice that necessitate corrections that depend on the grid point location and on the SMOS measurement geometry. But with respect to the corrections applied for generating global fields, in the Arctic Ocean:

-the extent of the contamination is up to ~1200km from the transition, so that given the particular geometry of the Arctic Ocean, land and ice contamination are superimposed,

-the ice edge is moving with a strong seasonality.

Summary of the methodology

The dataset is derived using the pseudo dielectric constant (ACARD parameter) retrieved by the ESA SMOS v700 level 2 ocean salinity processor (see a description of the algorithms in https://earth.esa.int/eogateway/documents/20142/37627/SMOS-L2OS-ATBD.pdf). The relationship between ACARD and the SSS is non linear [*Boutin et al.*, 2021]. Hence, an iterative process has been applied to derive SSS from level 2 ACARD, using the [*Boutin et al.*, 2023] dielectric constant model.

The ice edge is determined from a threshold put on ACARD averaged over 5days (ACARD < 40) and on the SST (8°C).

A systematic correction has been derived that depends on the grid point location and on the SMOS measurement geometry, following a methodology similar to the one described in [*Boutin et al.*, 2018] but without applying a seasonal correction.

An uncertainty estimate is derived from the propagation of the SMOS ESA L2 uncertainties. However, since this propagation does not consider the natural SSS variability within the considered temporal window, this uncertainty is overestimated.

Comparison with in situ measurements

The SMOS ARCTIC CATDS V2 SSS (9-day fields) have been compared with the in situ salinities used by *Supply et al.* [2020] to validate SMOS ARCTIC CATDS V1.1 SSS (weekly fields). The standard deviation of the difference is reduced from 2.13 to 1.19 with V2.0, while the correlation with the in situ dataset increases (r^2 V1.1 = 0.89 & r^2 V2.0 = 0.93) (Figure 2).

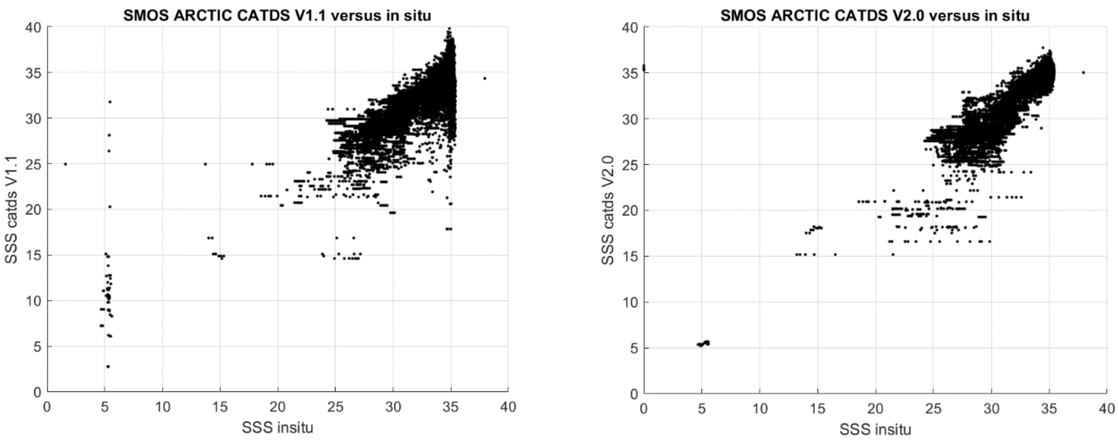

Figure 2 : Comparison between SMOS ARCTIC CATDS and in situ salinities (same database as in), left) V1.1, weekly ; right) V2.0, 9-day.

Comparisons with various datasets performed at the Salinity Pilot-Mission Exploitation Platform (PIMEP, see Table 1 below) also reveal much improved statistics, with r^2 larger than 0.8 for 40% of the datasets. Users are welcome to visit the PIMEP web site (https://www.salinity-pimep.org) for detailed validations.

Table 1: Statistics of ΔSSS (Satellite - *in situ*)

in situ database	#	Median	Mean	Std	RMS	IQR	r^2	Std*
argo	28443	-0.01	0.00	0.64	0.64	0.69	0.839	0.51
tsg-legos-dm	56172	0.00	-0.02	0.59	0.59	0.70	0.858	0.52
tsg-gosud-research-vessel	9955	-0.20	-0.10	0.57	0.58	0.61	0.649	0.45
tsg-gosud-sailing-ship	67849	-0.20	-0.74	1.97	2.10	2.03	0.839	1.23
tsg-samos	21674	-0.22	-0.40	1.85	1.89	1.97	0.751	1.42
mammal	876	0.09	-0.31	1.43	1.47	0.93	0.839	0.62
drifter	11036	0.03	0.11	0.49	0.50	0.47	0.098	0.34
tsg-polarstern	54922	-0.04	-0.02	0.95	0.95	0.97	0.719	0.72
saildrone	112935	-0.24	0.01	2.78	2.78	1.23	0.201	0.92
ices	61202	-0.05	0.02	0.64	0.64	0.71	0.208	0.52

References

Boutin, J., J.-L. Vergely, E. P. Dinnat, P. Waldteufel, F. D'Amico, N. Reul, A. Supply, and C. Thouvenin-Masson (2021), Correcting Sea Surface Temperature Spurious Effects in Salinity Retrieved From Spaceborne L-Band Radiometer Measurements, *IEEE Transactions on Geoscience and Remote Sensing*, *59*(9), 7256-7269, doi:https://doi.org/10.1109/tgrs.2020.3030488.

Boutin, J., J. L. Vergely, F. Bonjean, X. Perrot, Y. Zhou, E. P. Dinnat, R. H. Lang, D. M. L. Vine, and R. Sabia (2023), New Seawater Dielectric Constant Parametrization and Application to SMOS Retrieved Salinity, *IEEE Transactions on Geoscience and Remote Sensing*, *61*, 1-13, doi:10.1109/TGRS.2023.3257923.

Boutin, J., J. L. Vergely, S. Marchand, F. D'Amico, A. Hasson, N. Kolodziejczyk, N. Reul, G. Reverdin, and J. Vialard (2018), New SMOS Sea Surface Salinity with reduced systematic errors and improved variability, *Remote Sensing of Environment*, *214*, 115-134, doi:https://doi.org/10.1016/j.rse.2018.05.022.

Supply, A., J. Boutin, J.-L. Vergely, N. Kolodziejczyk, G. Reverdin, N. Reul, and A. Tarasenko (2020), New insights into SMOS sea surface salinity retrievals in the Arctic Ocean, *Remote Sensing of Environment*, *249*, 112027, doi:https://doi.org/10.1016/j.rse.2020.112027.

Dataset Reference

Boutin J. and Vergely J.-L. (2024). SMOS ARCTIC SSS L3 V2 maps produced by CATDS CEC LOCEAN. SEANOE. https://doi.org/10.17882/98769

Data policy

The CATDS data are freely distributed. However, when using these data in a publication, please use the following reference and acknowledgement :

Boutin J., Vergely J.-L. and D. Khvorostyanov (2024). SMOS ARCTIC SSS L3 V2 maps produced by CATDS CEC LOCEAN. SEANOE. https://doi.org/10.17882/98769

"SMOS ARCTIC SSS L3 V2.0 maps have been produced by LOCEAN/IPSL (UMR CNRS/SU/IRD/MNHN) laboratory."

Acknowledgements:

This work was supported by CNES-CATDS and CNES-TOSCA "SMOS-Ocean" projects. We thank S. Guimbard and the PIMEP project for providing in-depth comparisons with various in situ datasets.