Arctic+ Salinity

Sea Surface Salinity measurements from space for improving the freshwater estimates in the Arctic Ocean

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2024 European Polar Science Week

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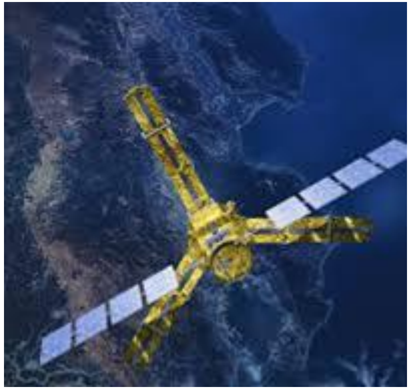
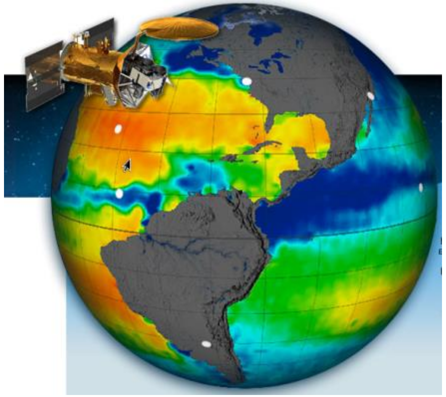
Satellite Sea Surface Salinity product development

Salinity in-situ measurements are very sparse therefore **satellite data is a great tool for monitoring Sea Surface Salinity in the Arctic Ocean**

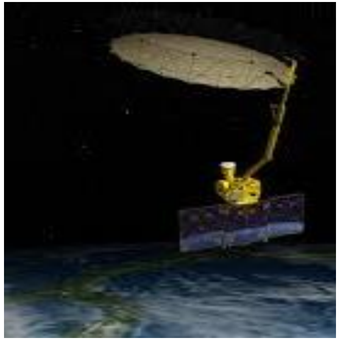
SMOS ESA 2009-now



Aquarius NASA/CONAE 2012-2015



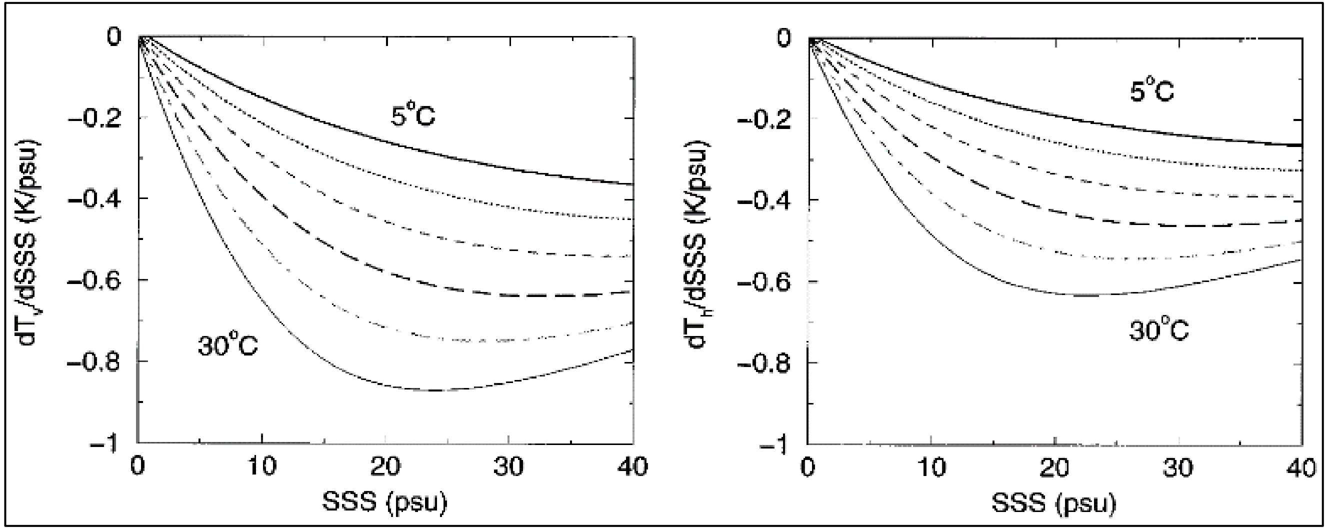
SMAP NASA 2015 - now



Satellite SSS challenges in Arctic Ocean

However there are several challenges that hamper the satellite salinity retrieval in the Arctic Ocean:

- **Low sensitivity of TB to salinity at cold waters**:

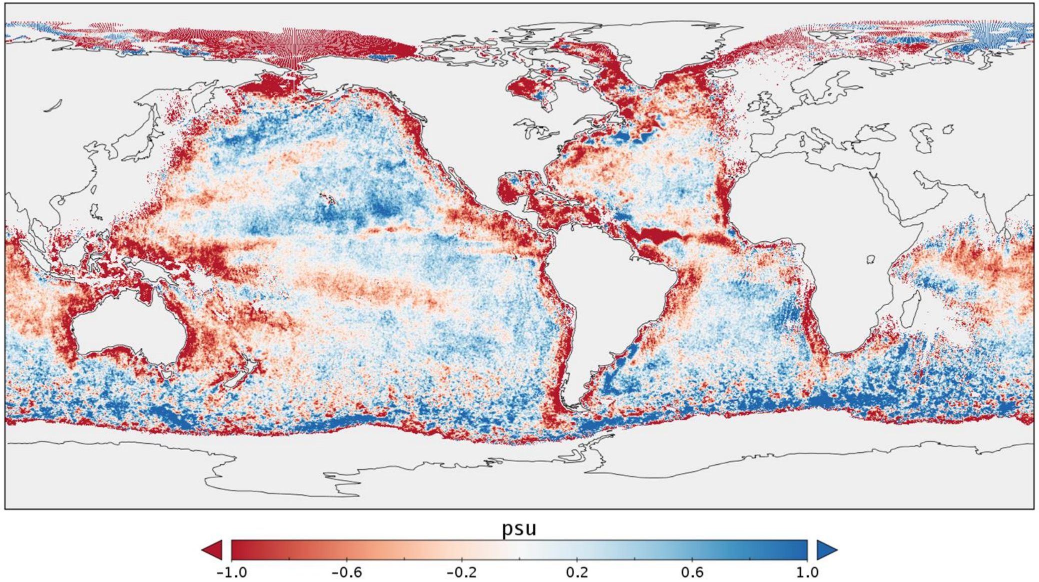


Yueh et al. 2011

Satellite SSS challenges in Arctic Ocean

However there are several challenges that hamper the satellite salinity retrieval in the Arctic Ocean:

- **Land-sea contamination (LSC) and ice–sea (ISC) contamination and contamination by RFI**



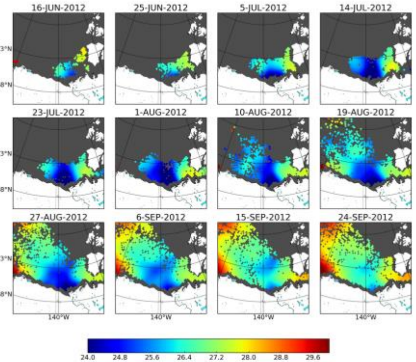
Satellite SSS challenges in Arctic Ocean

However there are several challenges that hamper the satellite salinity retrieval in the Arctic Ocean:

- **Lack of in-situ measurements:** Limitation for validation: Measurements are not equally distributed and lack of data in some regions.

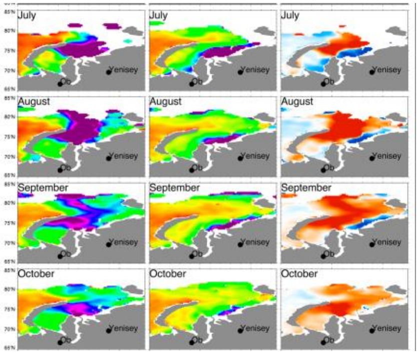
First SSS satellite products in the Arctic Ocean

SMOS - BEC v2.0



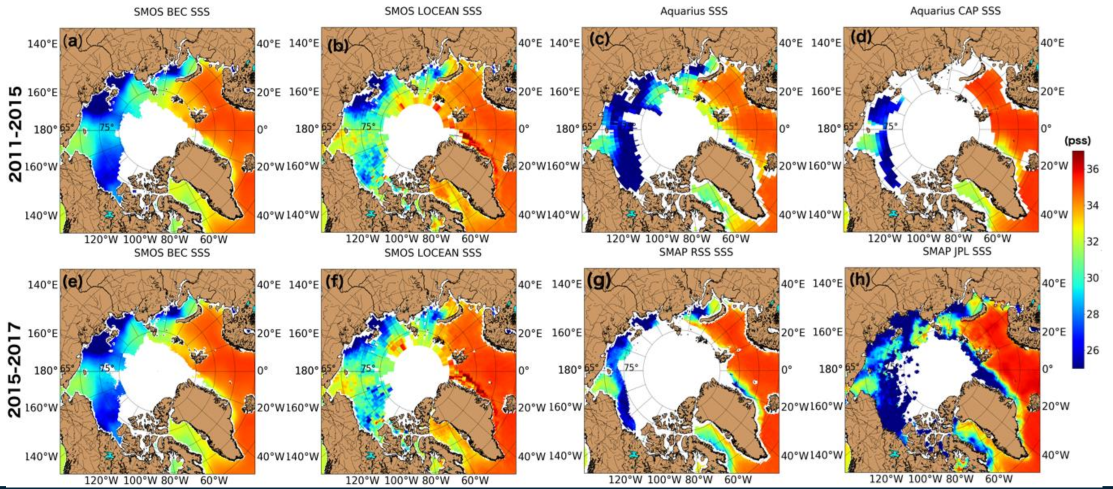
Olmedo et al., 2018

SMAP - JPL



Tang et al., 2018

Fournier et al. 2019 showed consistency between the different satellite products for describing large-scale SSS dynamics



ESA initiative to improve the Arctic SMOS SSS products

ARCTIC + Salinity project

BEC
Barcelona Expert Center

Arctic+ Salinity

lead by C. Gabarró

esa

2018	2019	2020	2021	2022	2023	2024

Phase 1 (2019–2021)

CCN (2023–2024)

Satellite Sea Surface Salinity product development

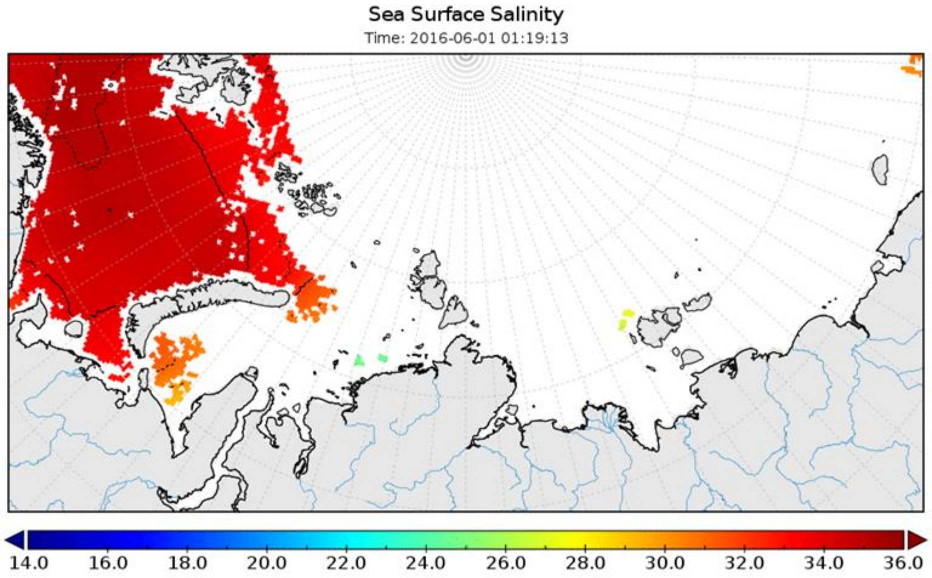
Photo: ESA

Science Applications

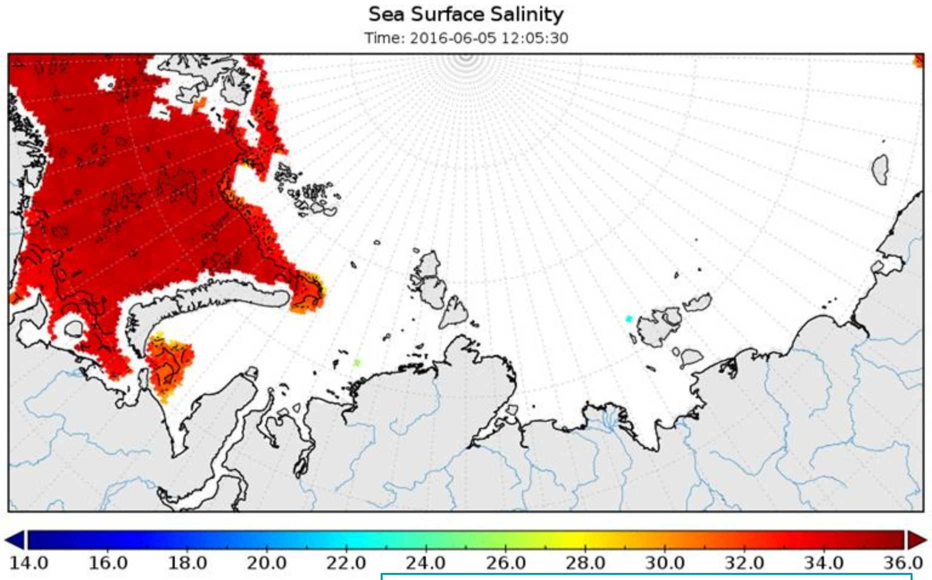
First Salinity product from Arctic+ salinity project

The main objective of the first product developed in Arctic+ salinity project was to increase the effective spatial resolution.

BEC v2



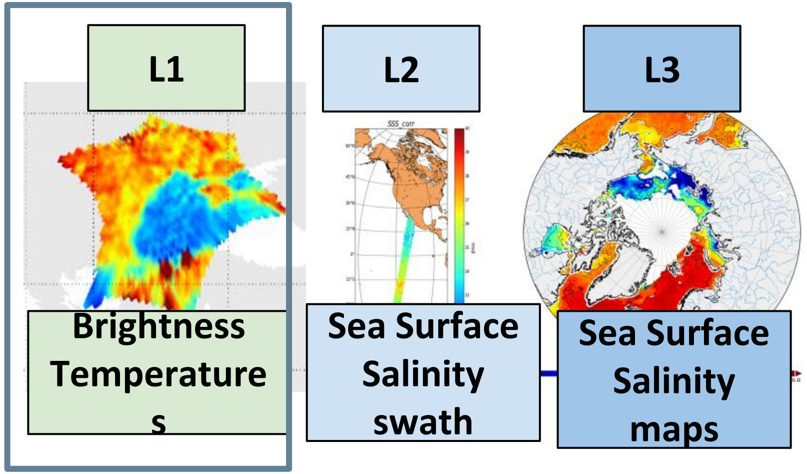
BEC v3.1

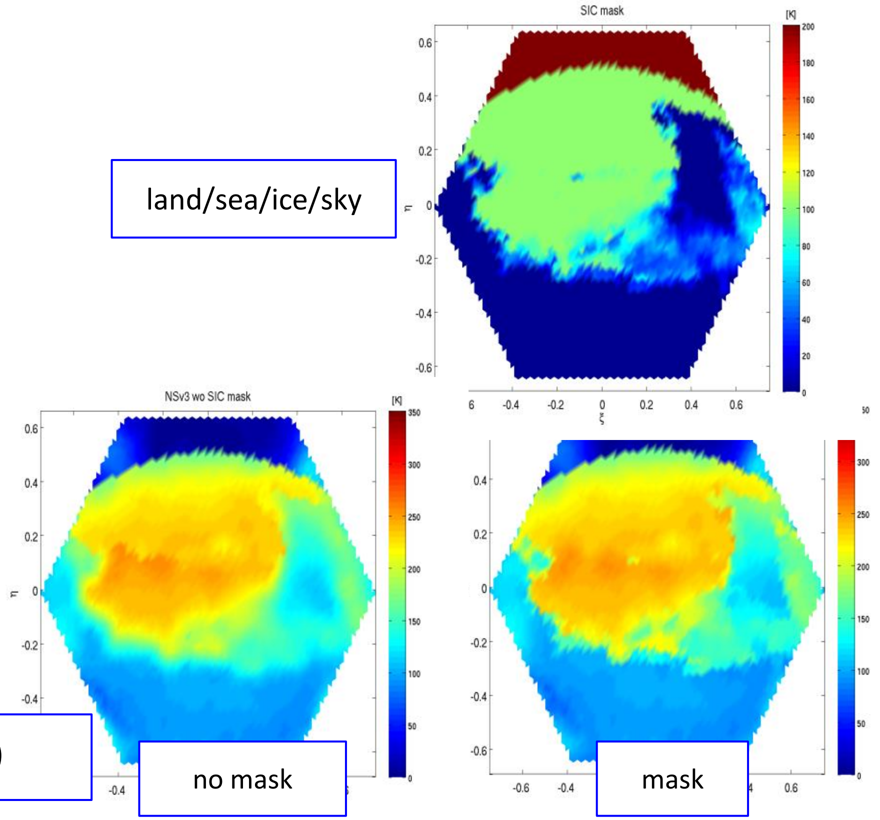


J. Martínez, et. al. 2022

Second Salinity product from Arctic+ salinity project

The main objective of the second product developed in Arctic+ salinity project is to decrease the Sea-Ice Contamination



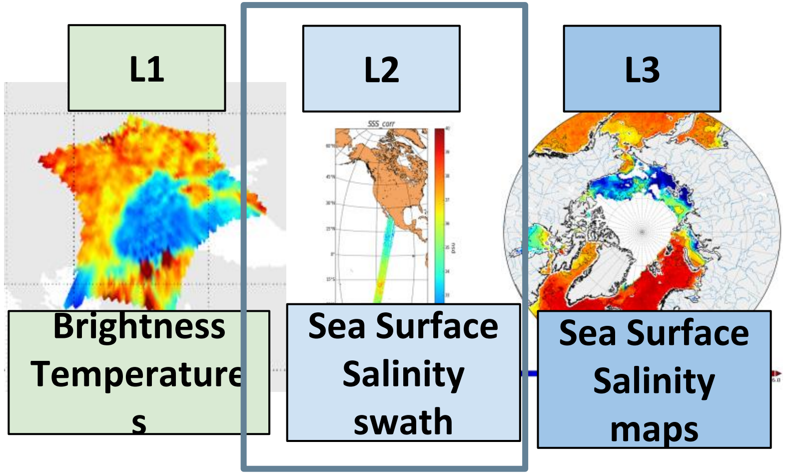


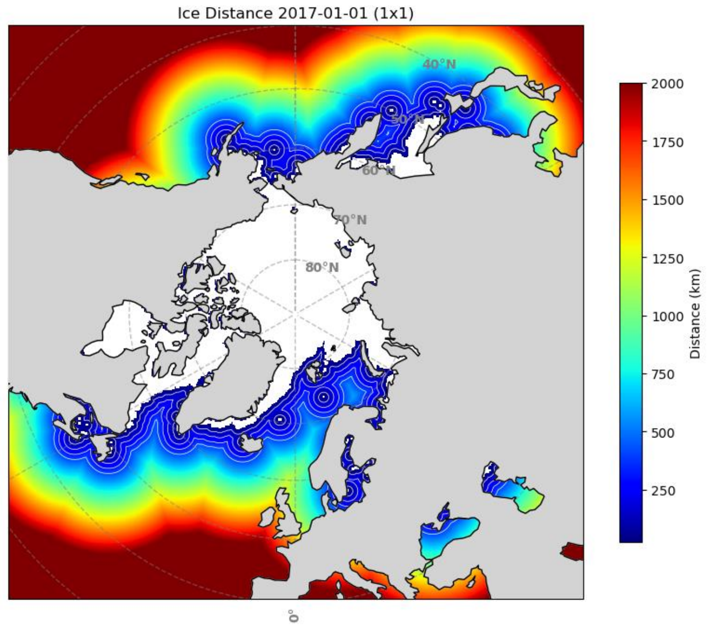
González-Gambau et al. 2016, 2016b, ***2024 (in prep.)***

Second Salinity product from Arctic+ salinity project

The main objective of the second product developed in Arctic+ salinity project is to decrease the Sea-Ice Contamination

Characterizing, correcting and filtering sea surface salinities as function of the acquisition conditions and distance to the ***ice edge***

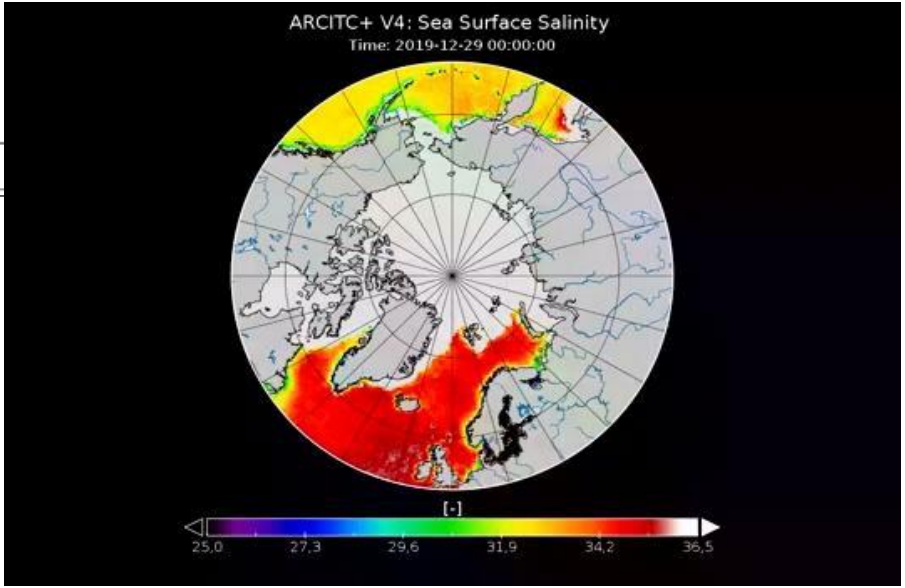




Olmedo et al. 2017, González-Gambau et al. ***2024 (in prep.)***

Final Arctic+ SSS v4.0 products

Arctic+ L3 SSS product v4	
Geographical coverage	$180^\circ W$ -> $180^\circ E$; $45^\circ N$ -> $90^\circ N$
Temporal coverage	2011-02-01 to 2023-12-31
Spatial resolution	25km x 25km
Coordinates reference system	EASE-NL 25km
Temporal resolution	9-day maps generated daily
Version	4.0



Citation:

García Espriu, Aina; González Gambau, Verónica; Olmedo, Estrella; Gabarró, Carolina; 2024; "Arctic Ocean Sea Surface Salinity Level 3 maps (V.4.0) [Dataset]"; DIGITAL.CSIC; https://doi.org/10.20350/digitalCSIC/16251

Quality assessment of Arctic+ SSS v4.0

We have compared with different in situ datasets (Argo, ICES, drifters,Marine mammals, Saildrone, TSG Amundsen, Polarstern' GOSUD sailing, LEGOS)

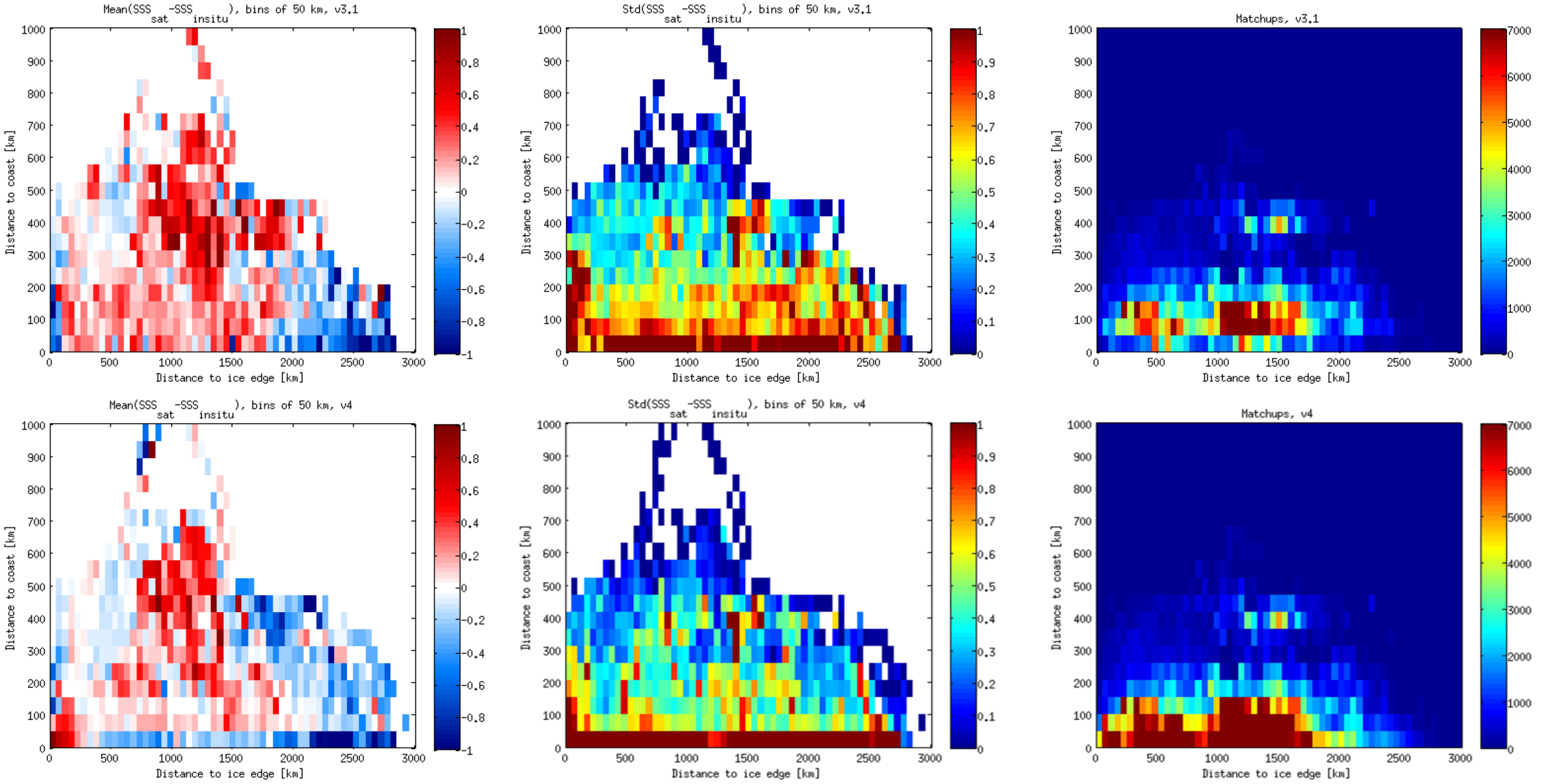
We compare the performance wrt to the previous version (v3.1) of the product by using all match-ups and the common ones

Differences as a function of distance to ice & land

Significant reduction of **biases**, & **standard deviation** close to ice edges and coasts, **increase of the matchups** in the first 150 km!

v3.1

v4

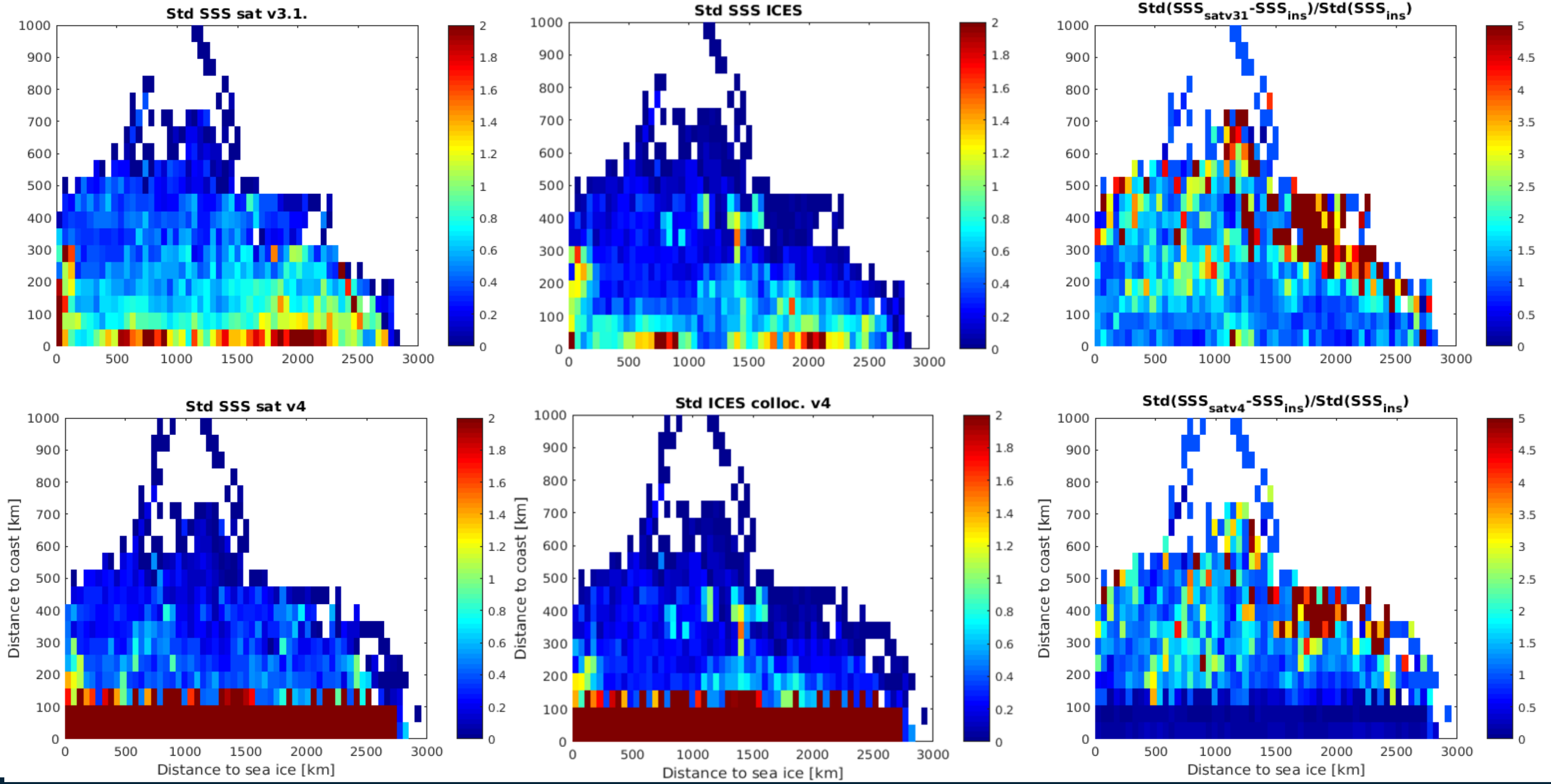


Differences as a function of distance to ice & land

STD sat. | STD in situ | STD sat. relative to in situ

v3.1

v4



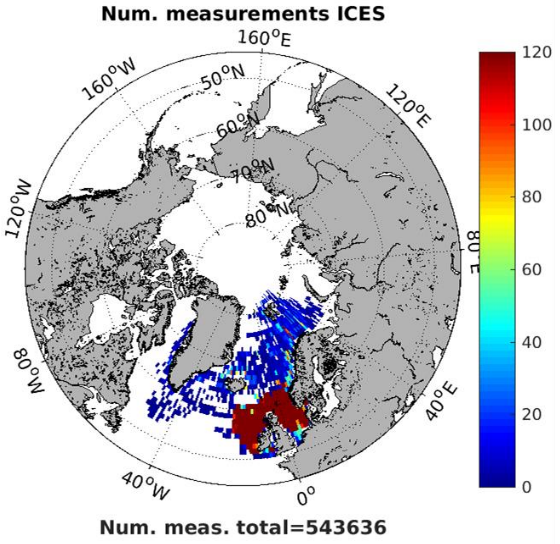
Comparison with ICES (same number of match-ups)

CLEAR IMPROVEMENT

	Mean	Std	RMS	Correl.
3.1- in situ points: 543636	0.2409	0.7673	0.8042	0.3554
4.0- in situ	0.0963	0.5830	0.5909	0.3914
3.1 - in situ <100km ice points: 2104	0.0267	1.0936	1.0936	0.5141
4.0- in situ <100km ice	0.0473	0.7057	0.7071	0.7088

26%

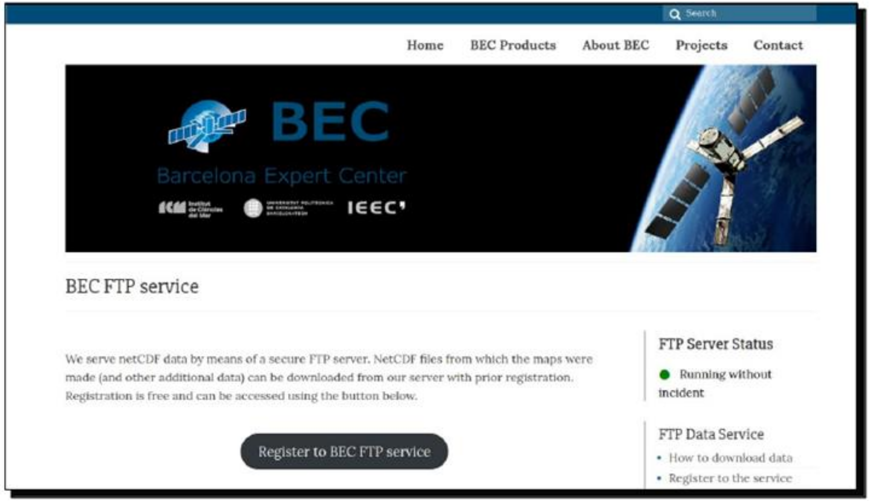
35%



Arctic+ SSS v4.0 products freely available!

Available through BEC FTP server

How to access:
bec.icm.csic.es/bec-ftp-service

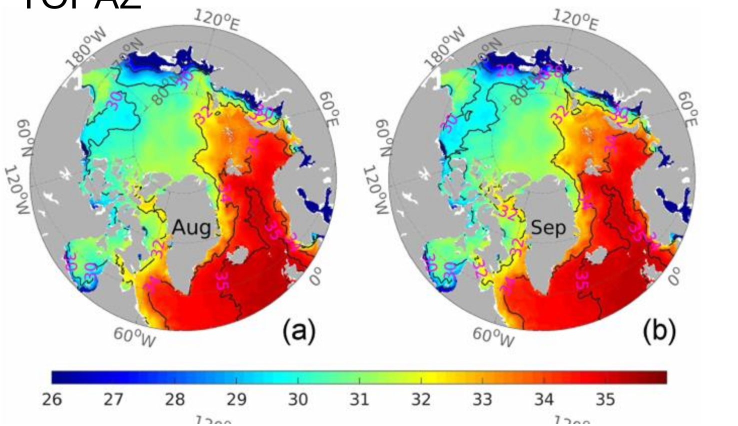


Will also be available soon at the ESA Open Science Data Catalogue

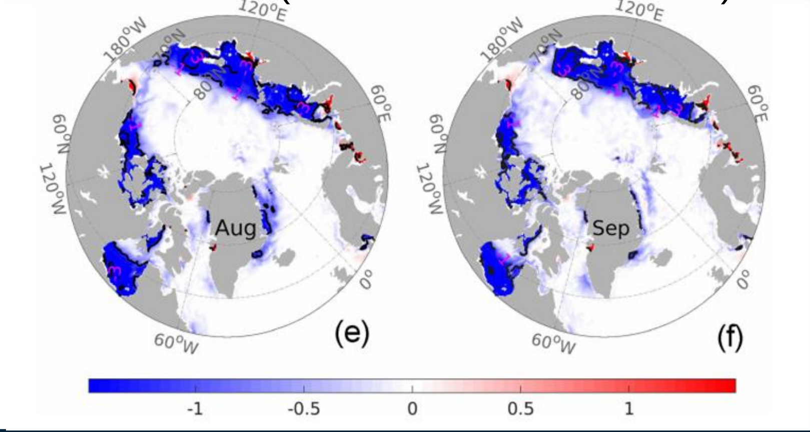
opensciencedata.esa.int

Scientific Impact: Assimilation SMOS BEC v3.1 into TOPAZ

TOPAZ

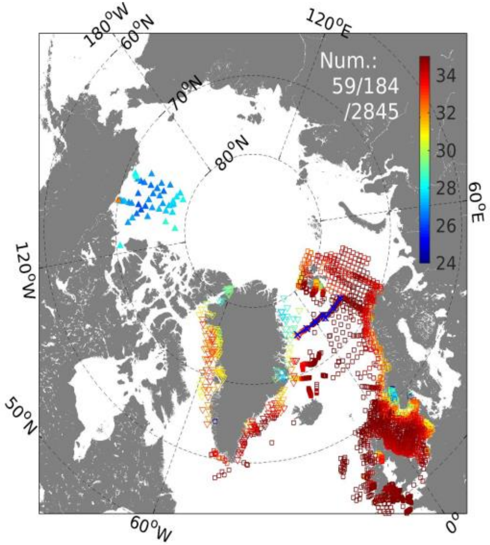


TOPAZ - (TOPAZ+**SMOS-BEC v3.1**)



Validation against independent SSS from in situ profiles

1) Beaufort Gyre: BGEP, WHOI: **Bias reduced** by **29%**;
2) Ocean Melt Greenland: OMG, NASA: **Bias reduction 17.3%**
3) North Sea – Barents Sea: ICES: **Bias reduction 20%**



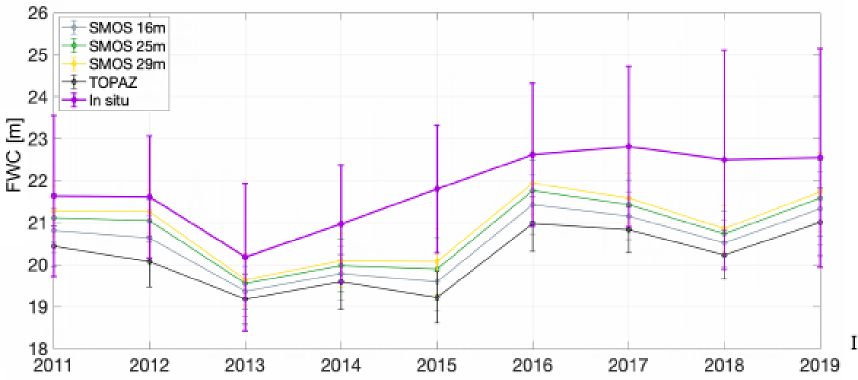
J. Xie, et. al. 2023

Scientific impact: Some scientific studies using SMOS SSS

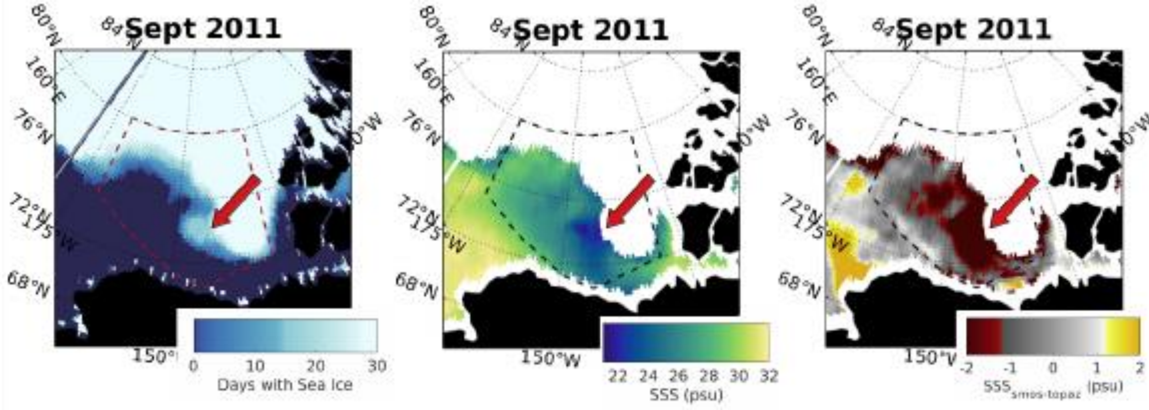
Characterization of the Freshened Surface Layer in the Kara and Laptev Seas: Umbert et al. 2021

Improving Fresh Water Content Estimate in the Beaufort Gyre by using SMOS SSS: Umbert et al. 2024

Characterization of the meltwater lenses in the Beaufort Gyre by using SMOS SSS De Andrés et. al. under review.



For more details: visit **poster Umbert. et al:** “Contribution of SMOS Sea Surface Salinity Data to the estimation of Liquid Freshwater Content and Sea Ice Meltwater in the Beaufort Sea”



Conclusions

The quality of the SMOS SSS products in the Arctic Ocean have been significantly improved since the beginning of the mission

The new Arctic+ SSS v4.0 introduces algorithm changes addressed the issue of the sea-ice contamination (Nodal Sampling with dynamic sea ice mask, correction of systematic spatial biases depending on the distance to sea-ice).

The **quality assessment reveals that final version of Arctic+ SSS (v4.0) product has significantly improved the quality close to ice edges and coasts with respect to the previous version v3.1.**

- Very significant improvement in terms of biases and standard deviation, especially, in the first 100 km from sea ice edges and coasts
- Very significant increase in the coverage

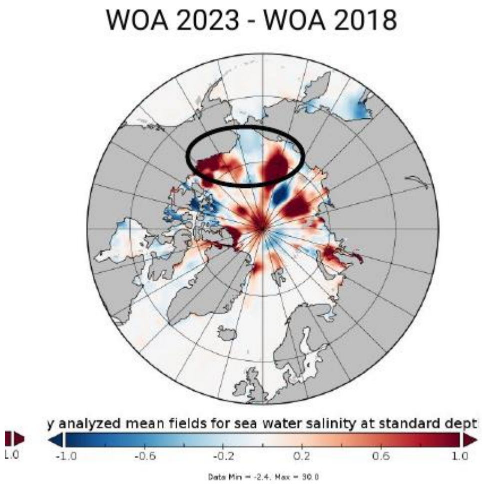
Arctic+ SSS v3.1 has been shown to be useful for:

- Improving the performance of models after assimilation
- Improving the estimates of FWC in the Beaufort Gyre
- Monitoring meltwater lenses

New exciting science studies are coming soon with the Arctic SSS v4!

Recommendations

- **To improve the quality of the climatologies in the Arctic Ocean**
- **To improve the coverage of in situ measurements in some regions of the Arctic Ocean**
- **Promote the use of satellite SSS**
  - Assimilation in models
  - Scientific studies
- **Ensure the continuity of the satellite SSS time series**, crucial to understand drivers of the very recent changes
  - Continuity of high-resolution L-band missions is crucial



THANK YOU VERY MUCH FOR YOUR ATTENTION!

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