

SST products and SMOS SSS retrieved in the Arctic Ocean.

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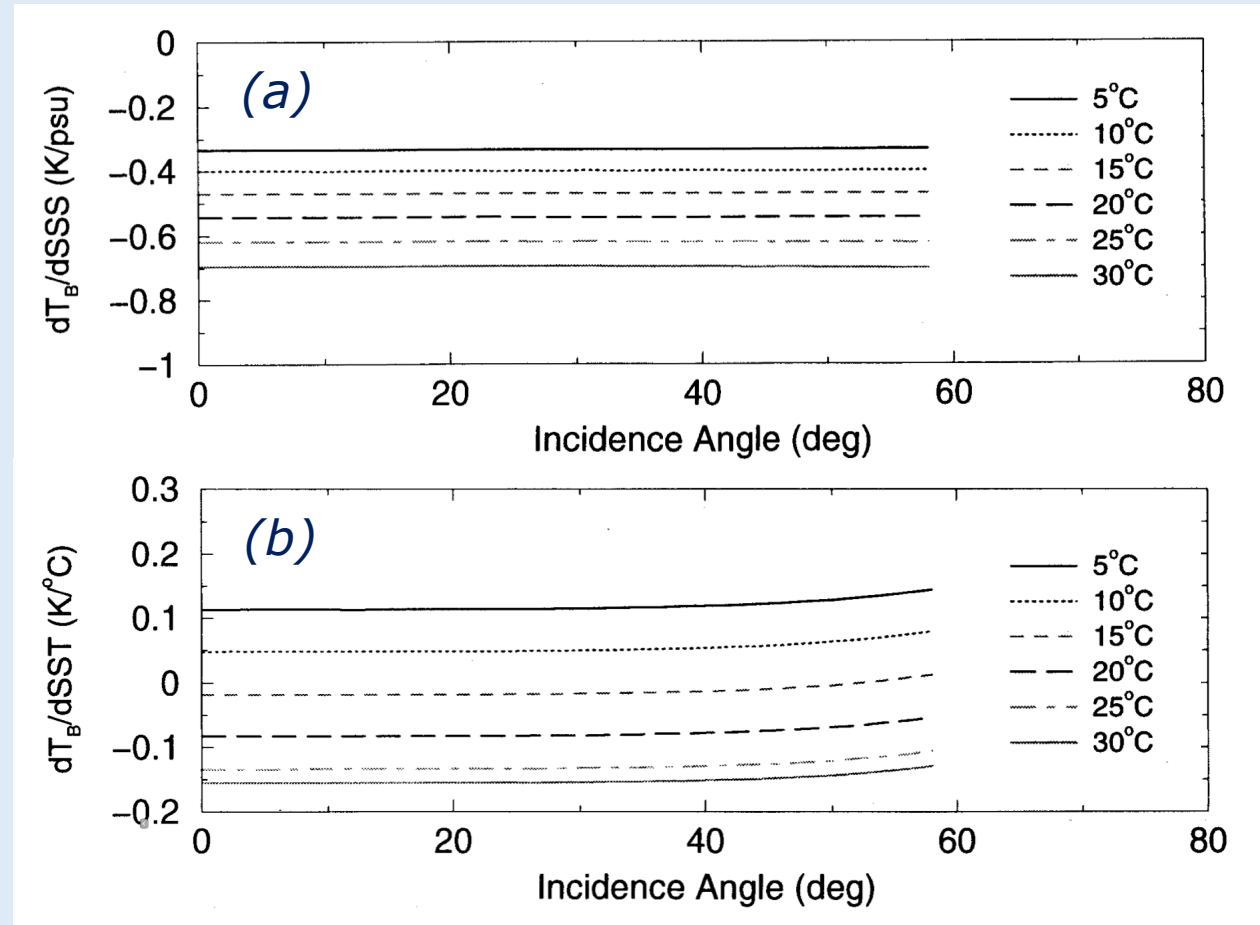
*A Reference Quality Model For Ocean Surface
Emissivity And Backscatter From The
Microwave To The Infrared.*

First meeting - 20-22 November 2019

Introduction

- SSS retrieval in the Arctic Ocean is particularly challenging due to low SST and to the presence of sea ice (Meissner et al. 2016, Tang et al. 2018).
- Deriving and validating IR SST in the Arctic Ocean is complicated by clouds, variability of the sunlit time and the lack of in-situ data (Minnett et al. 2019).
- Using an accurate SST is critical in order to retrieve SSS with a minimum level of uncertainty.
 - **What is the impact of an error on the SST product used as a prior for SSS_{SMOS} retrieval ?**
 - **Is it possible to correct for this impact ?**

The sensitivity of sea surface brightness temperatures to water salinity (a) and water temperature (b) versus incidence angle, for a salinity of 35 psu.



Yueh et al. 2001

- ***Dataset***
- ***SMOS SSS products in the Arctic Ocean***
- ***SST products differences***
- ***A case study : Laptev Sea***
- ***Correction performances for Arctic ocean***

Dataset

Satellites data

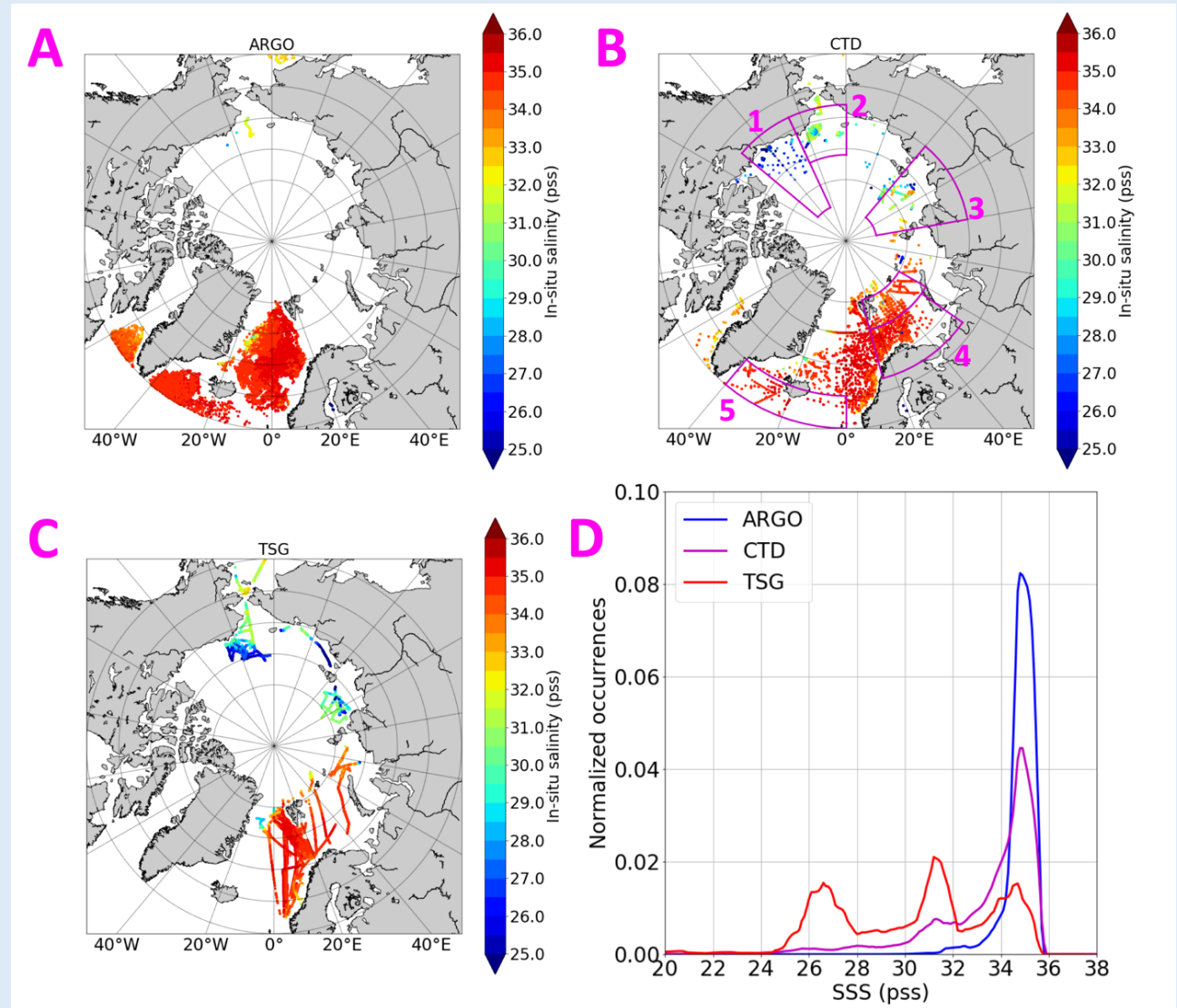
- SMOS weekly SSS
- ECMWF SST (*SMOS prior*)
- REMSS SST (MW & MW+IR)

In-situ measurements (2011 – 2017)

- Argo profiles (A)
- CTD profiles (B)
- Underway TSG (C)

Model reanalysis

- SIC from TOPAZ reanalysis



Dataset

Satellites data

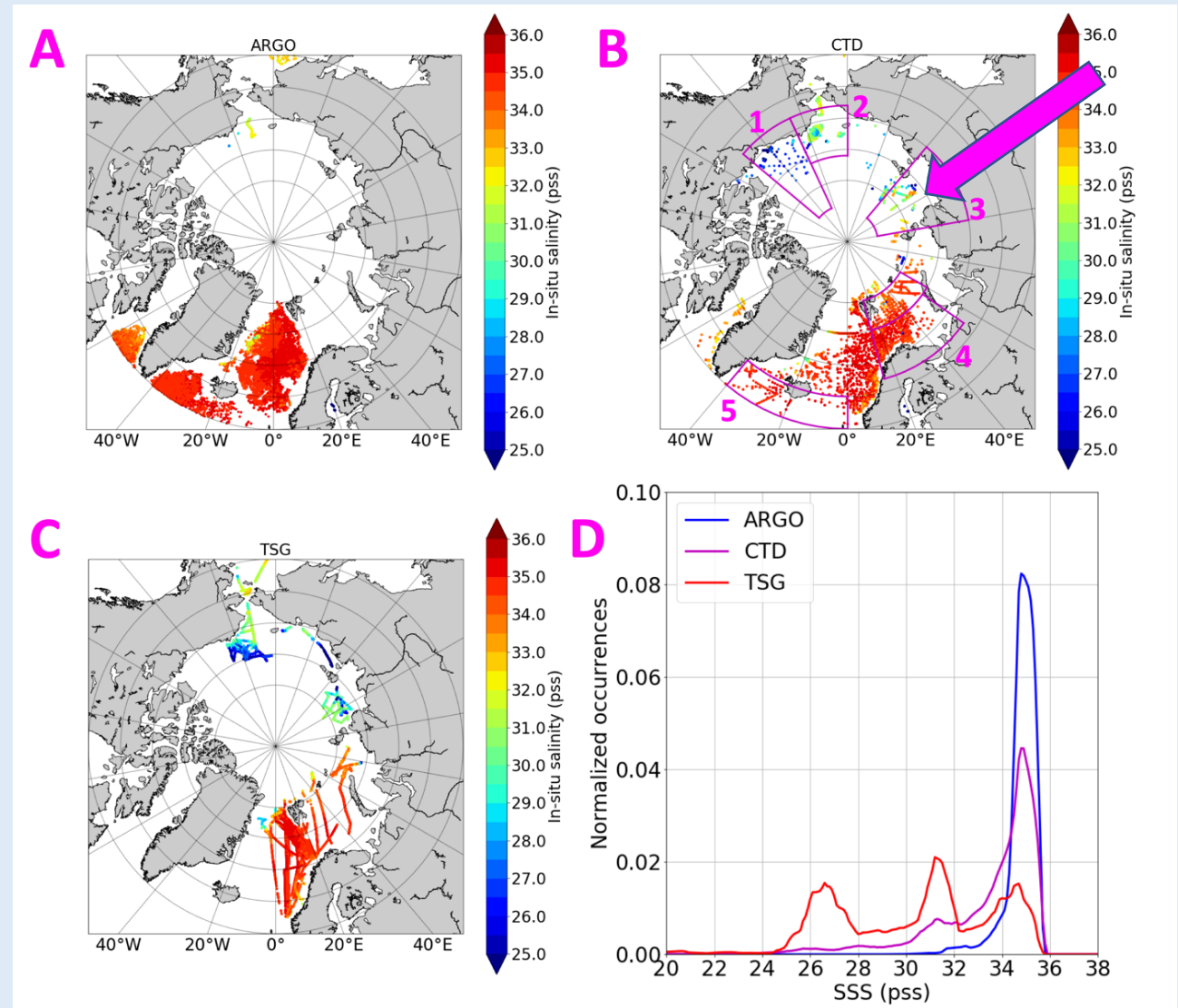
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SMOS SSS products in the Arctic Ocean

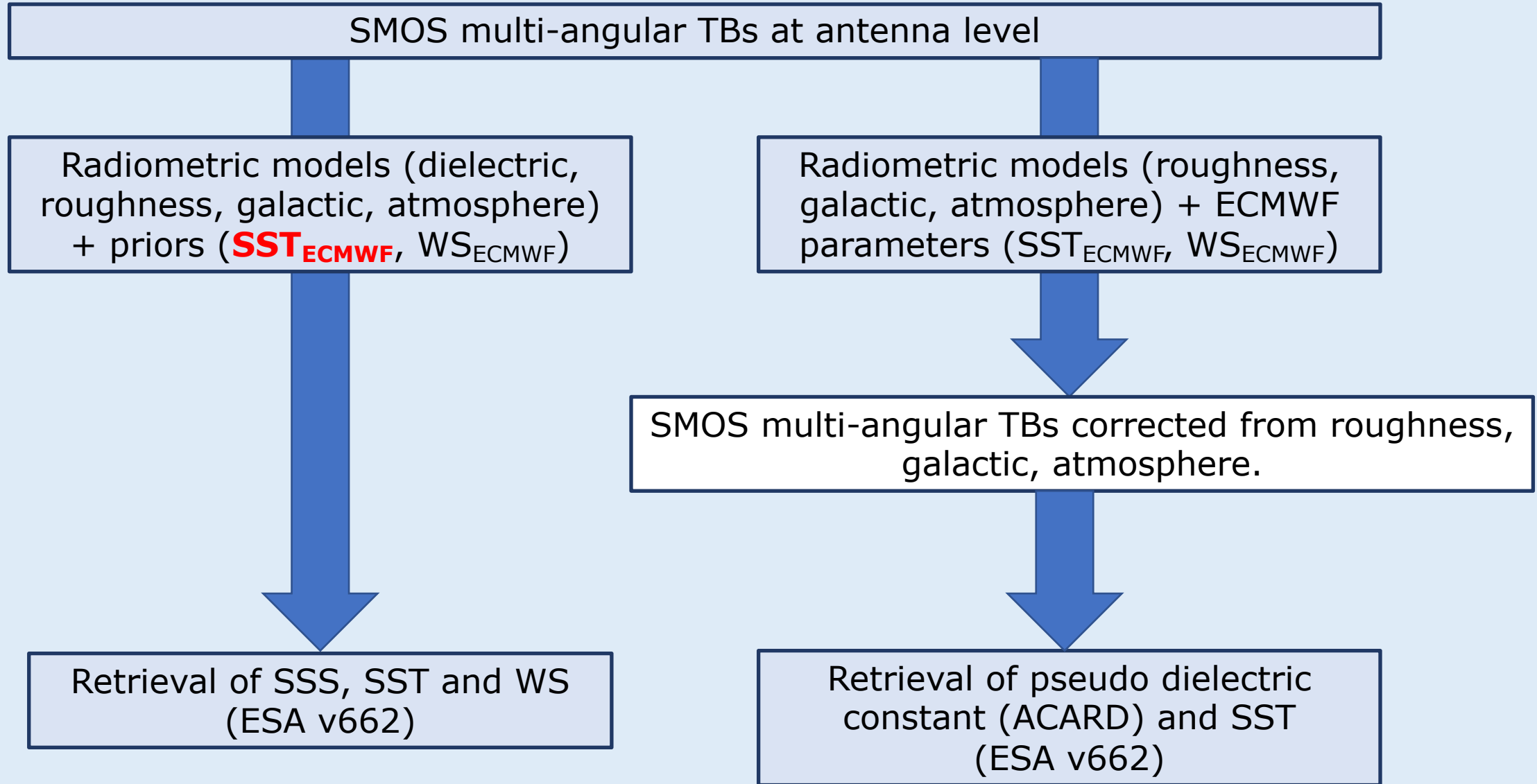
SMOS multi-angular TBs at antenna level

Radiometric models (dielectric, roughness, galactic, atmosphere)
+ priors (SST_{ECMWF} , WS_{ECMWF})

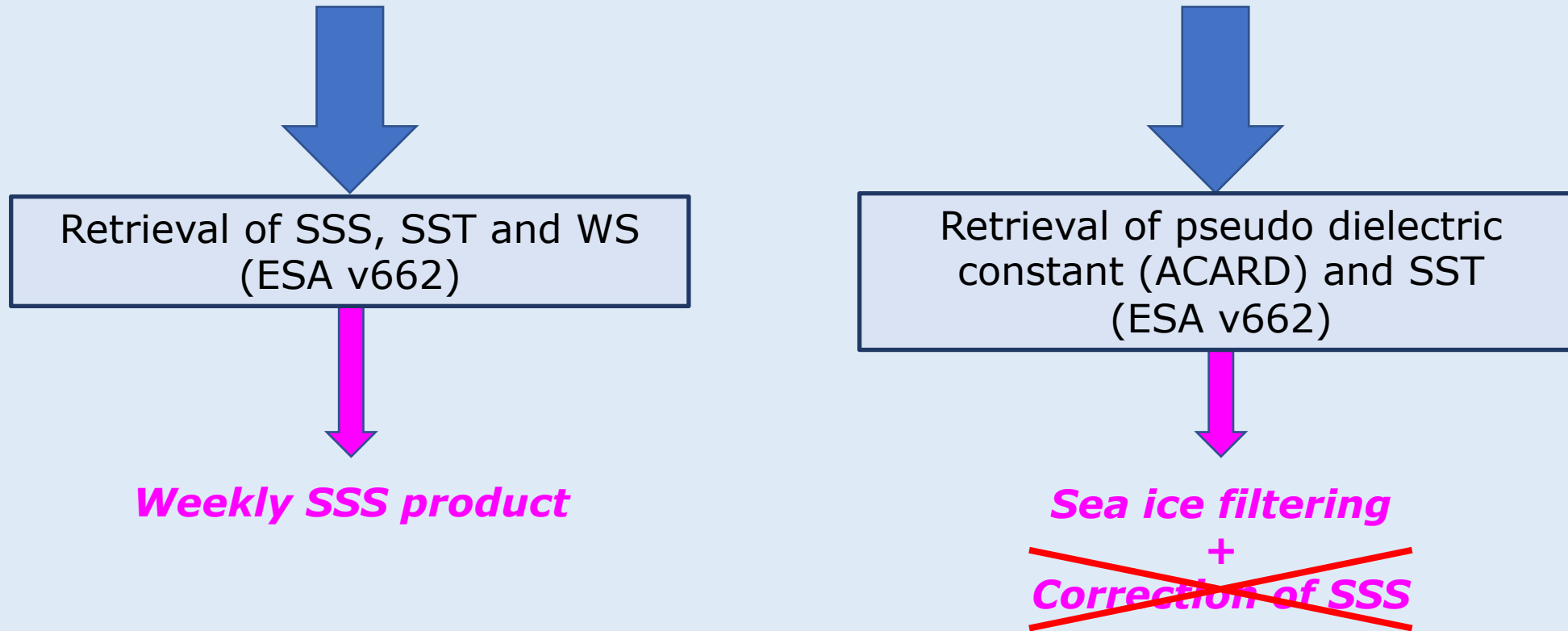
*SST_{ECMWF} coming from ECMWF CY41R2 forecast (**OSTIA d-1** analyses field).*

Retrieval of SSS, SST and WS
(ESA v662)

SMOS SSS products in the Arctic Ocean



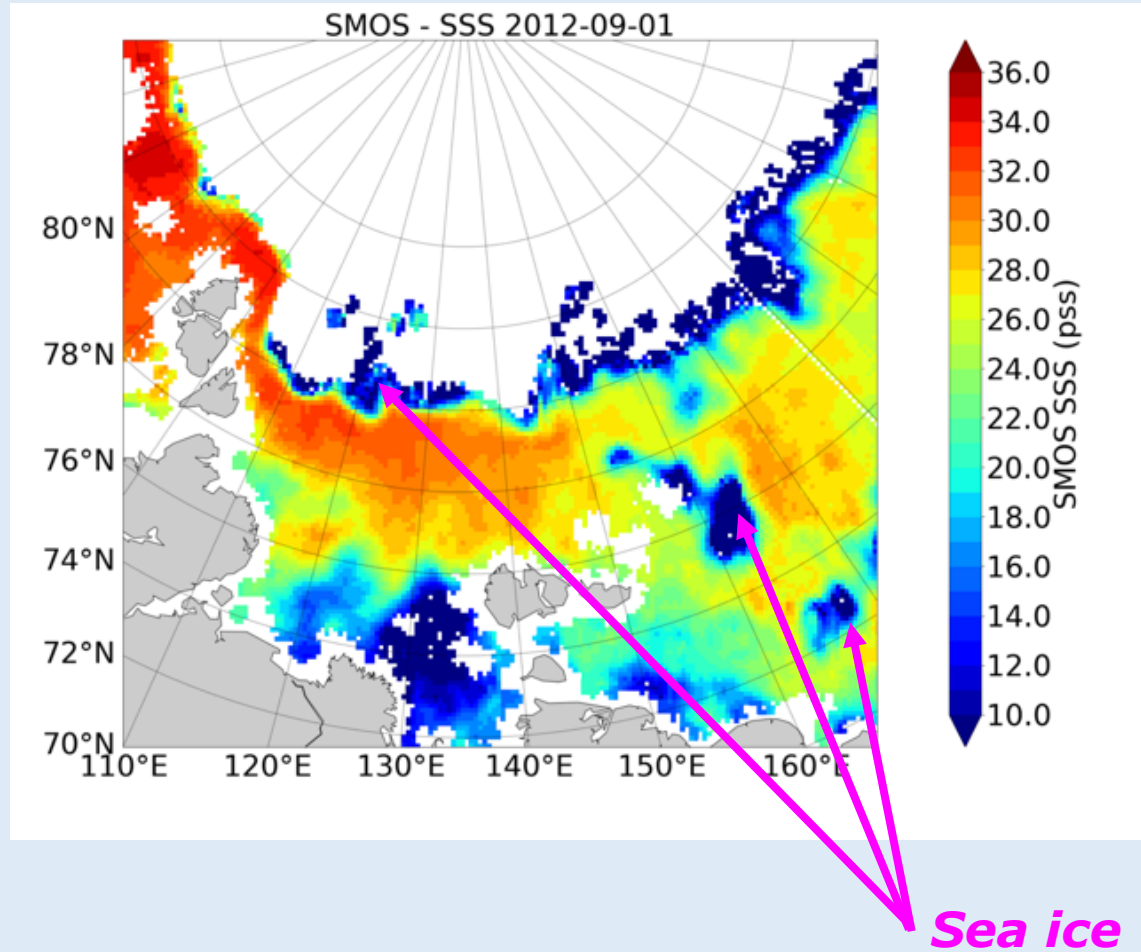
SMOS SSS products in the Arctic Ocean



SMOS SSS products in the Arctic Ocean

Sea ice filtering

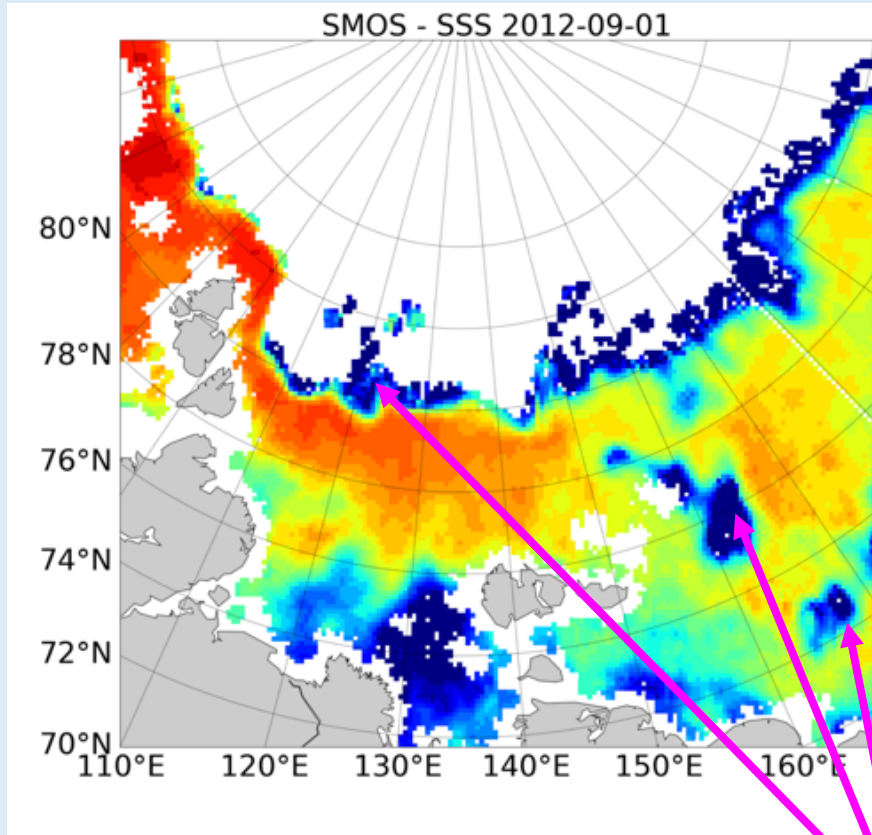
BEFORE sea ice filtering



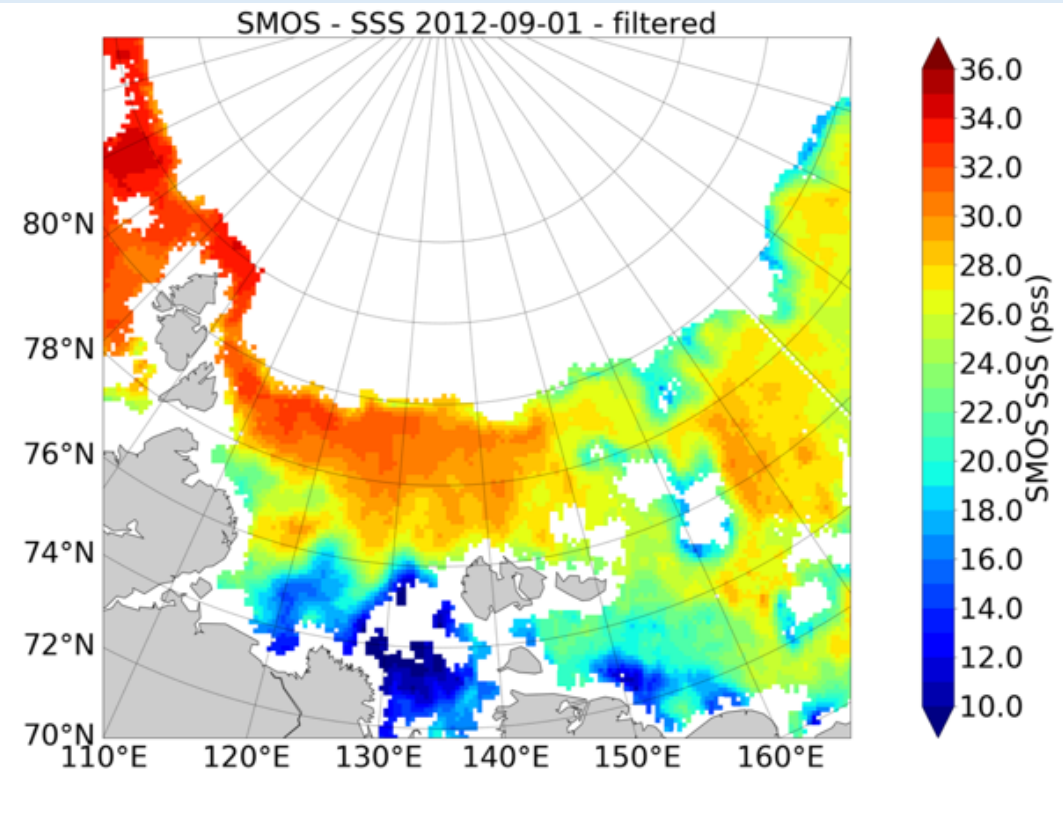
SMOS SSS products in the Arctic Ocean

Sea ice filtering

BEFORE sea ice filtering



AFTER sea ice filtering

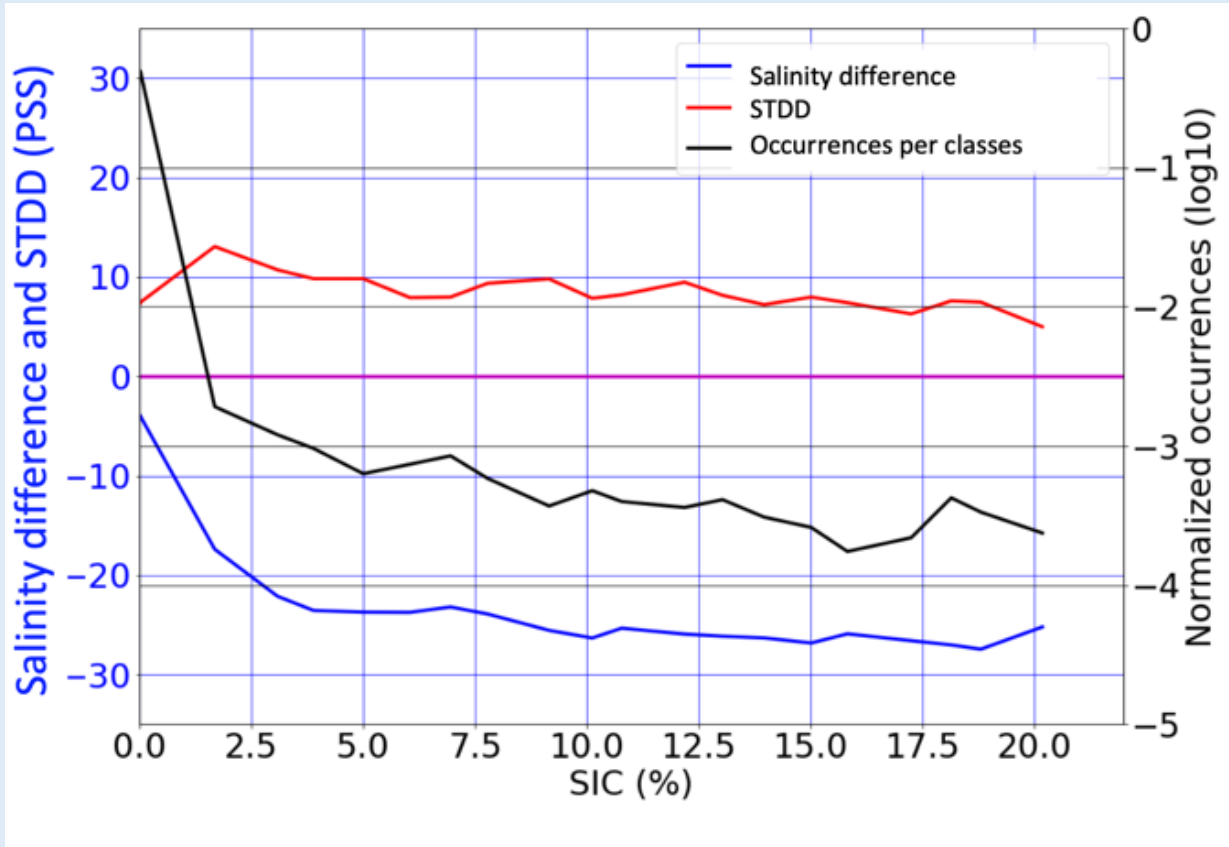


Sea ice

SMOS SSS products in the Arctic Ocean

Sea ice filtering

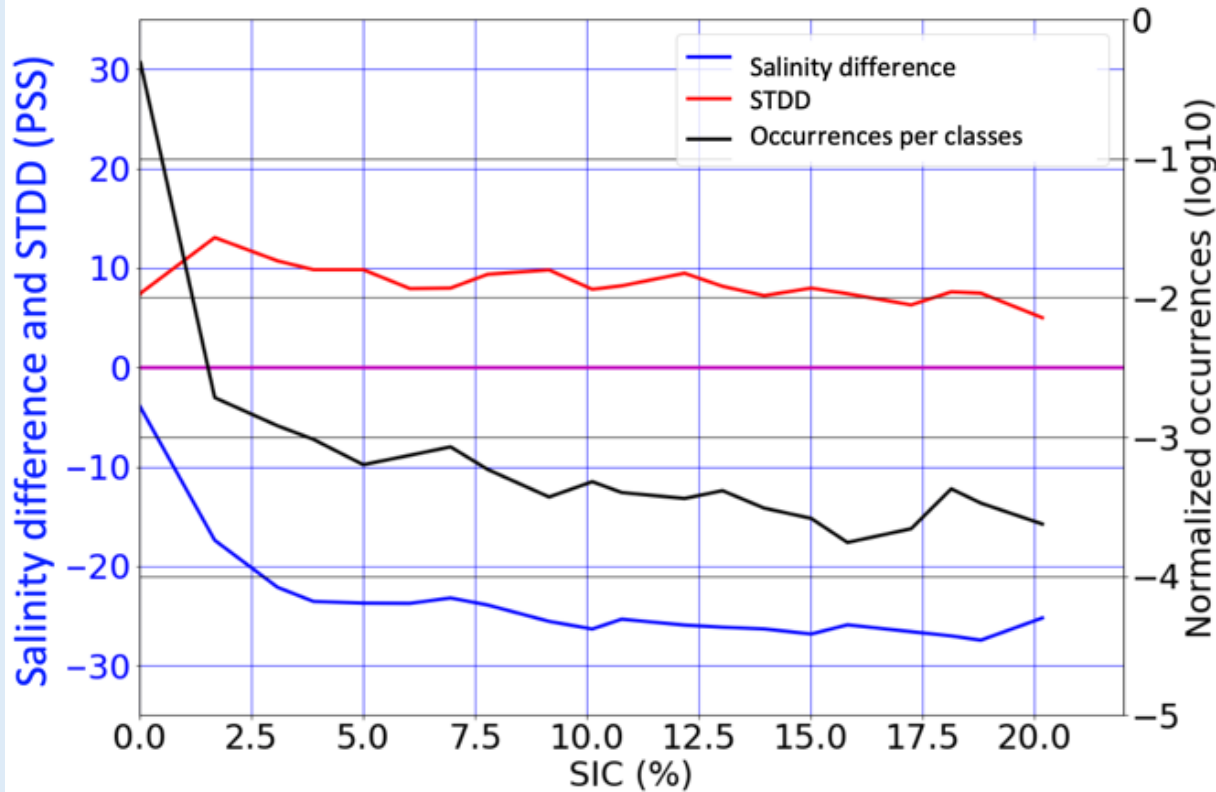
BEFORE sea ice filtering



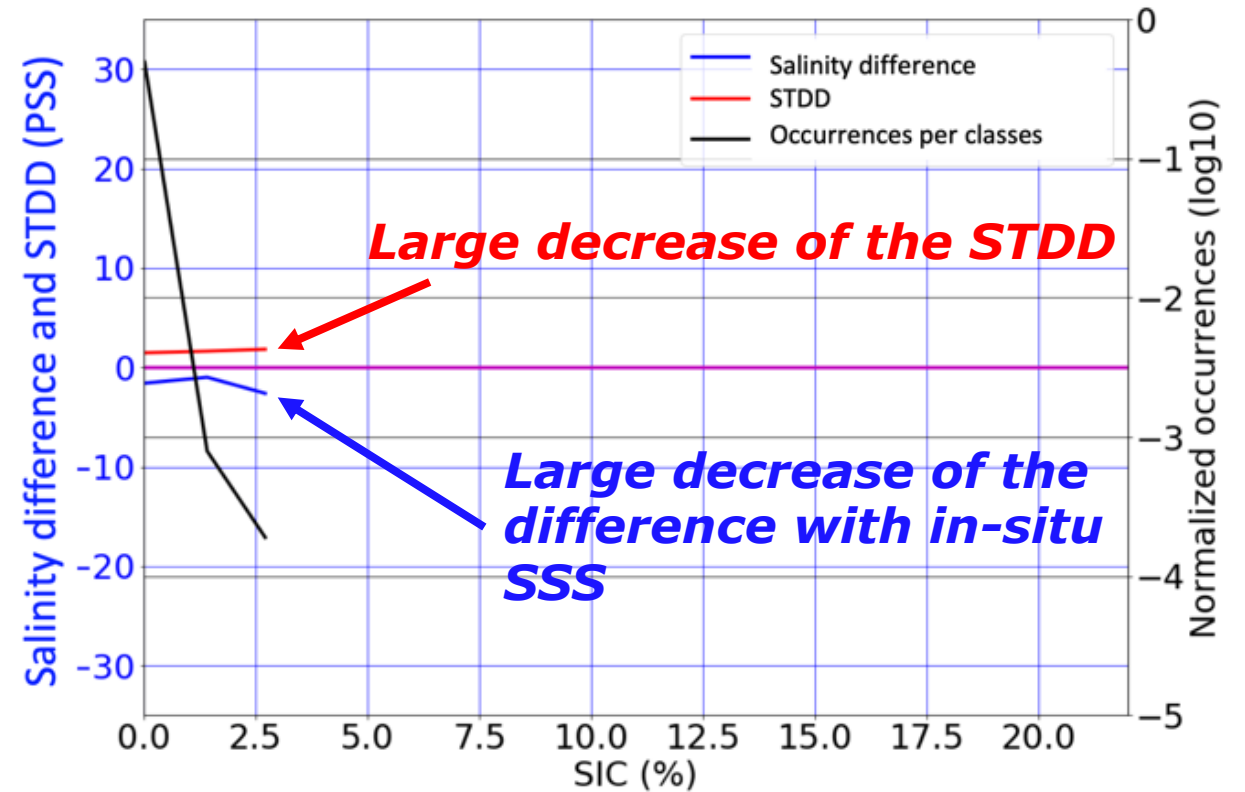
SMOS SSS products in the Arctic Ocean

Sea ice filtering

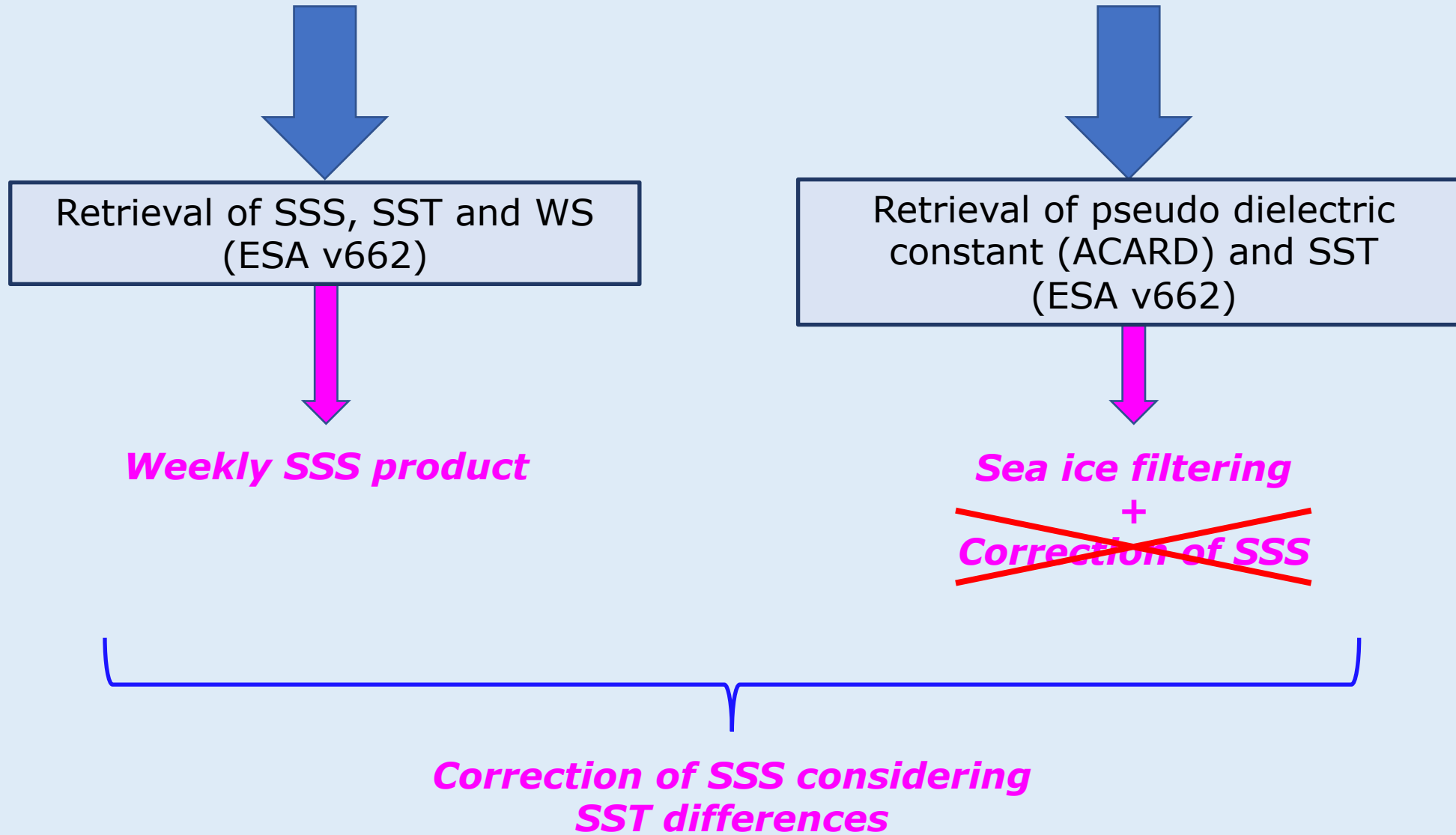
BEFORE sea ice filtering



AFTER sea ice filtering

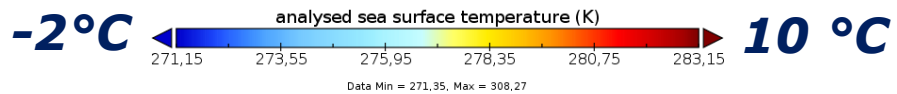
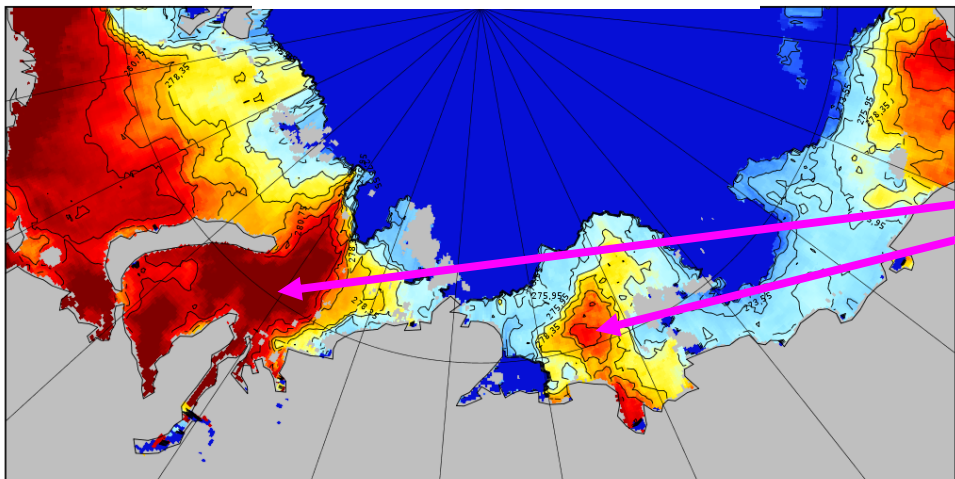


SMOS SSS products in the Arctic Ocean



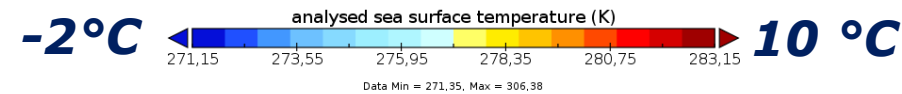
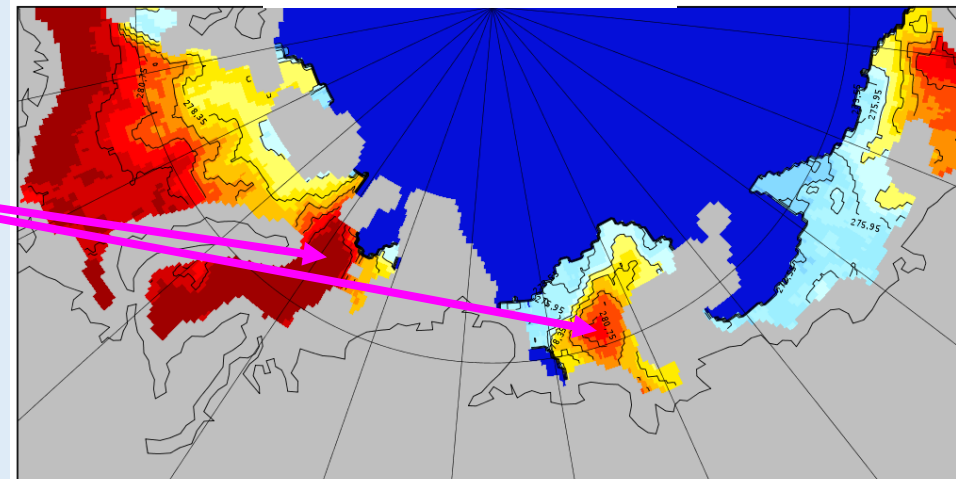
SST products differences

REMSS SST MW+IR

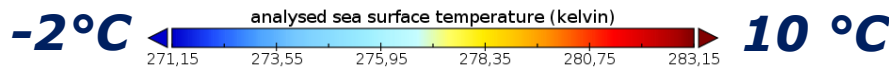
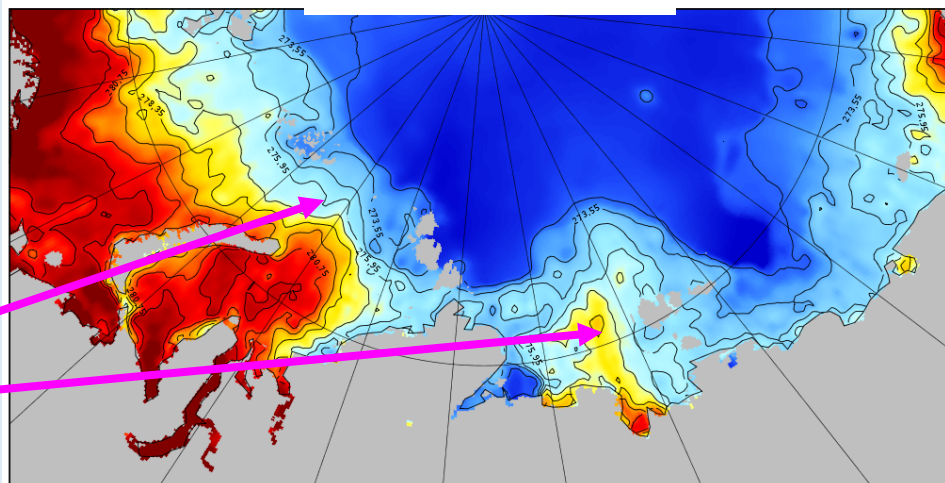


River plumes
warmer waters

REMSS SST MW



OSTIA SST

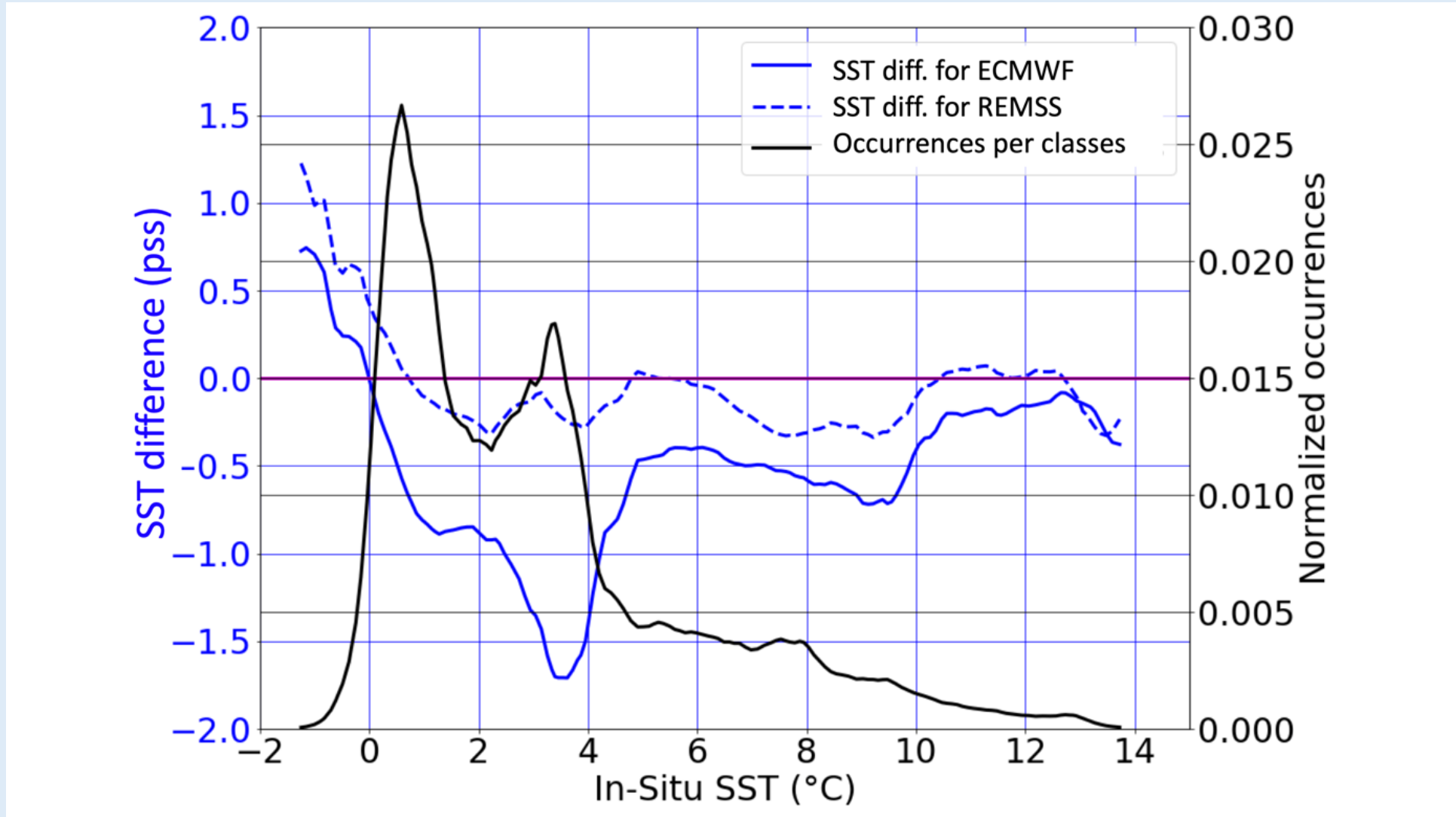


Underestimate
of SST in river
plumes in
comparison
with REMSS
SST

2015/08/15

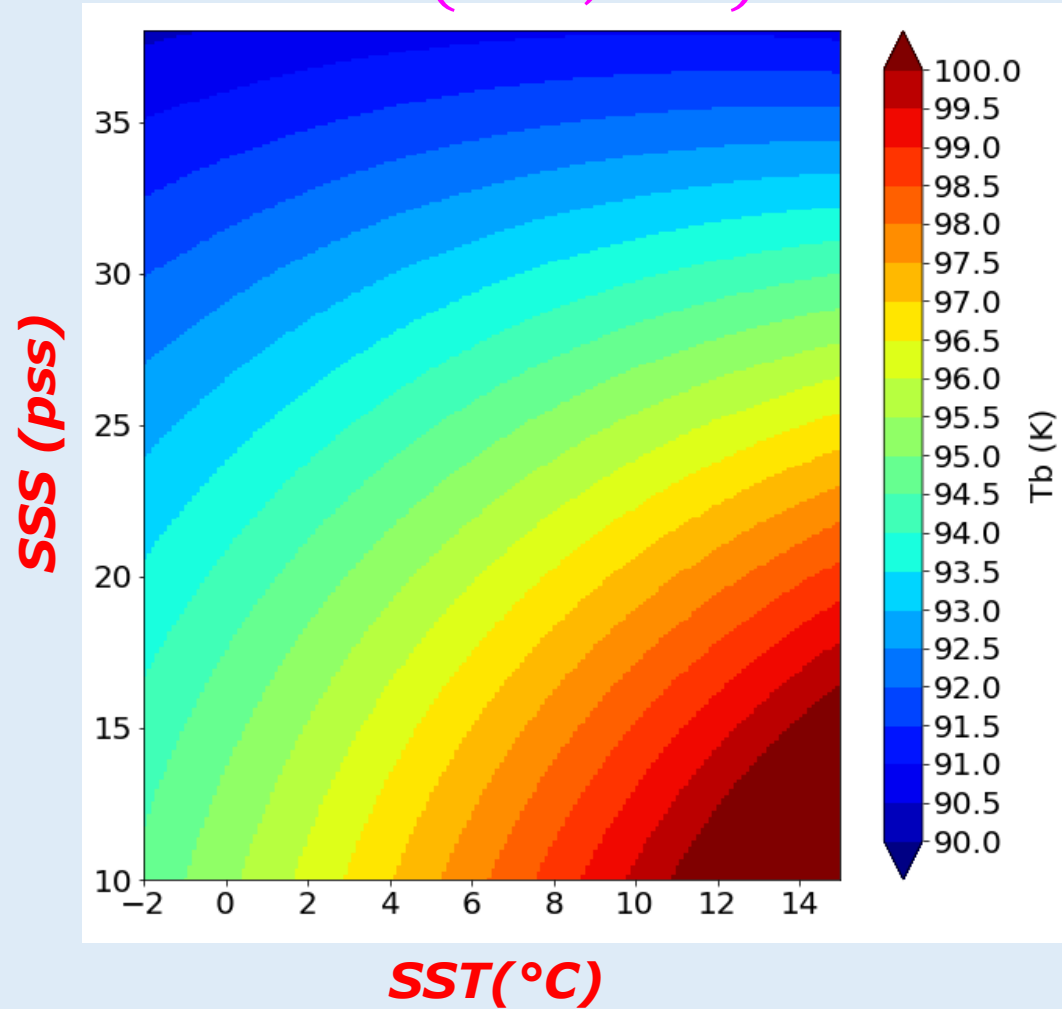
SST products differences

SST differences between satellite SST and in-situ SST



SST products differences

TB(SST, SSS)



Klein and Swift model (1977)

Correction of SSS considering SST differences



What is the SSS error induced by a SST error ?

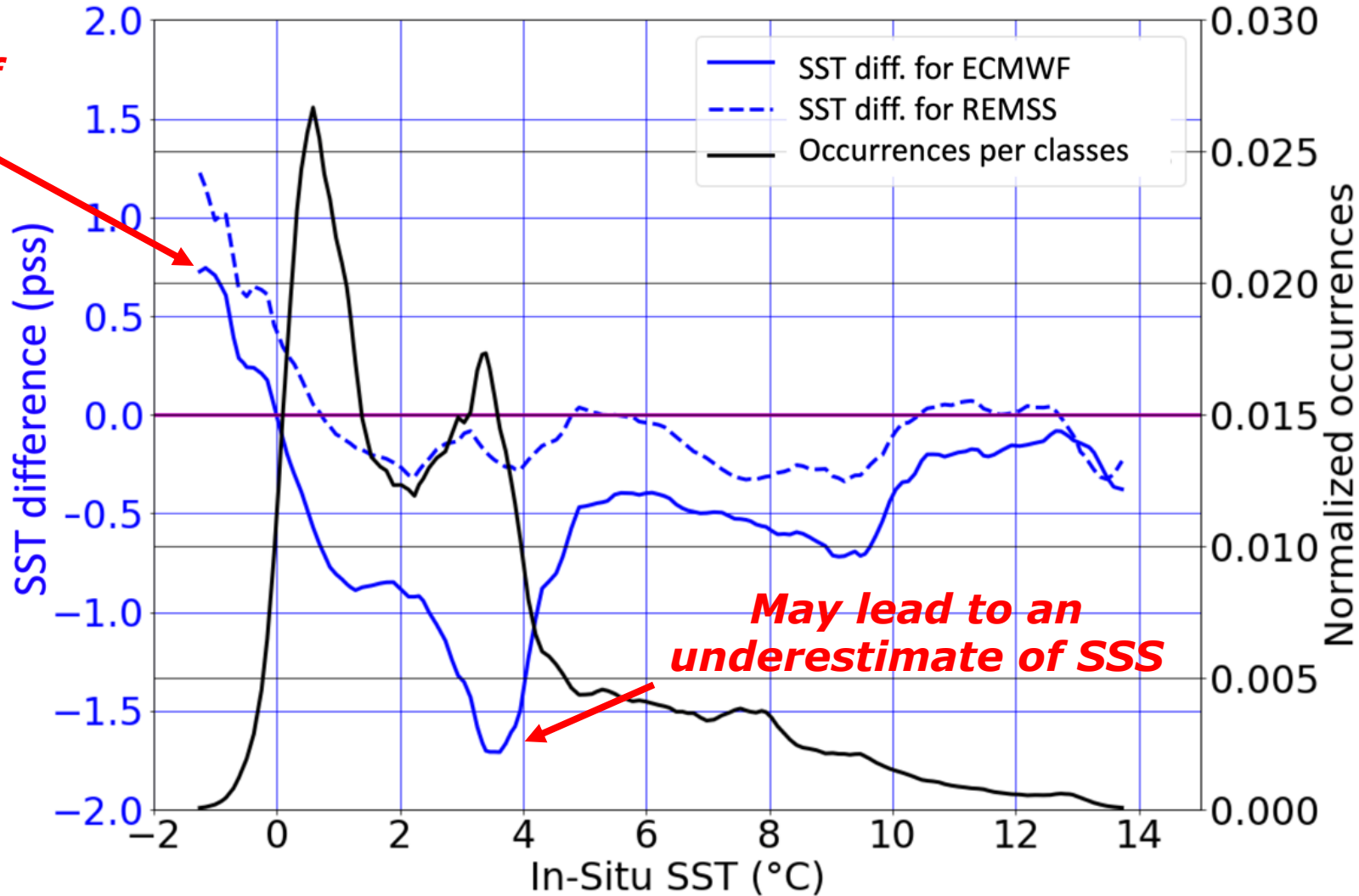
$$\text{SSS}_{\text{SMOS}} + \frac{\gamma(\text{SST}_{\text{ECMWF}}, \text{SSS}_{\text{SMOS}})}{\beta(\text{SST}_{\text{ECMWF}}, \text{SSS}_{\text{SMOS}})} (\text{SST}_{\text{ECMWF}} - \text{SST}_{\text{REMSS}}) = \text{SSS}_{\text{SMOS}} \text{ corrected}$$

where $\beta(\text{SST}, \text{SSS}) = \frac{d\text{TB}(\text{SST}, \text{SSS})}{d\text{SSS}}$ and $\gamma(\text{SST}, \text{SSS}) = \frac{d\text{TB}(\text{SST}, \text{SSS})}{d\text{SST}}$

SST products differences

SST differences between satellite SST and in-situ SST

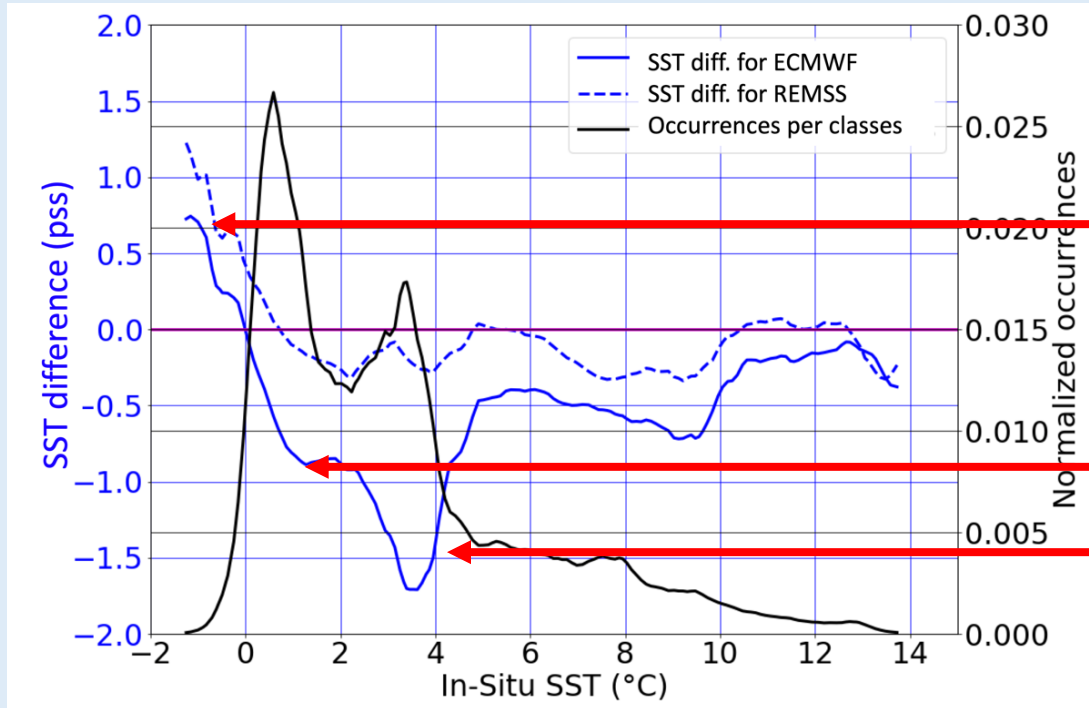
May lead to an overestimate of SSS



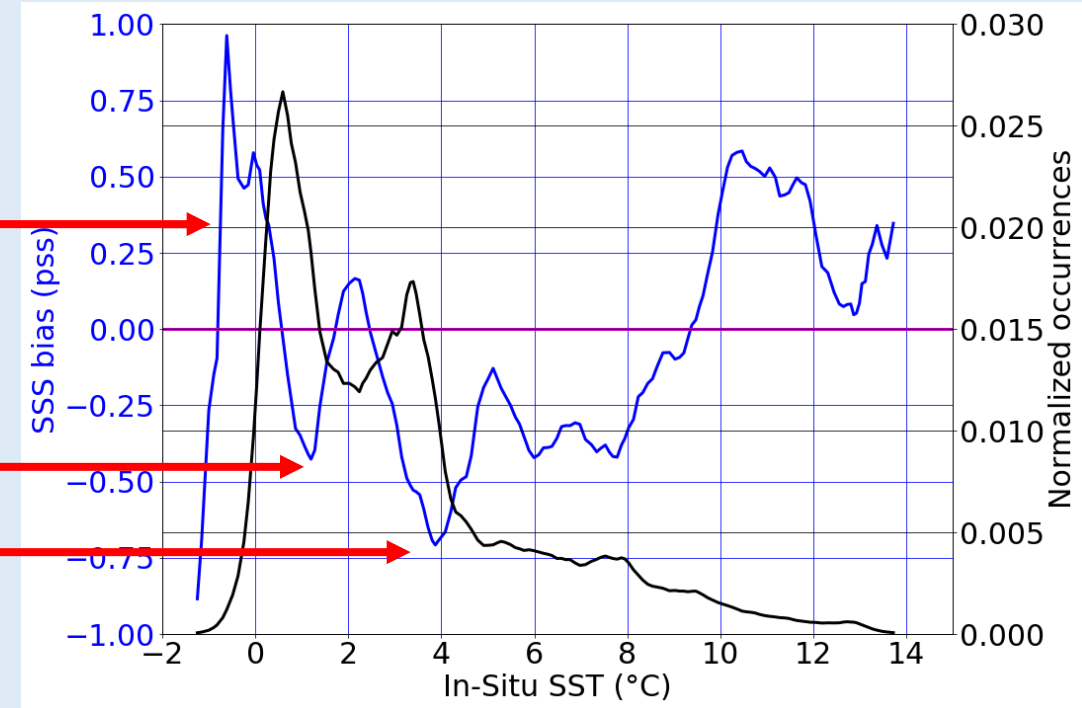
May lead to an underestimate of SSS

SST products differences

SST differences between satellite SST and in-situ SST



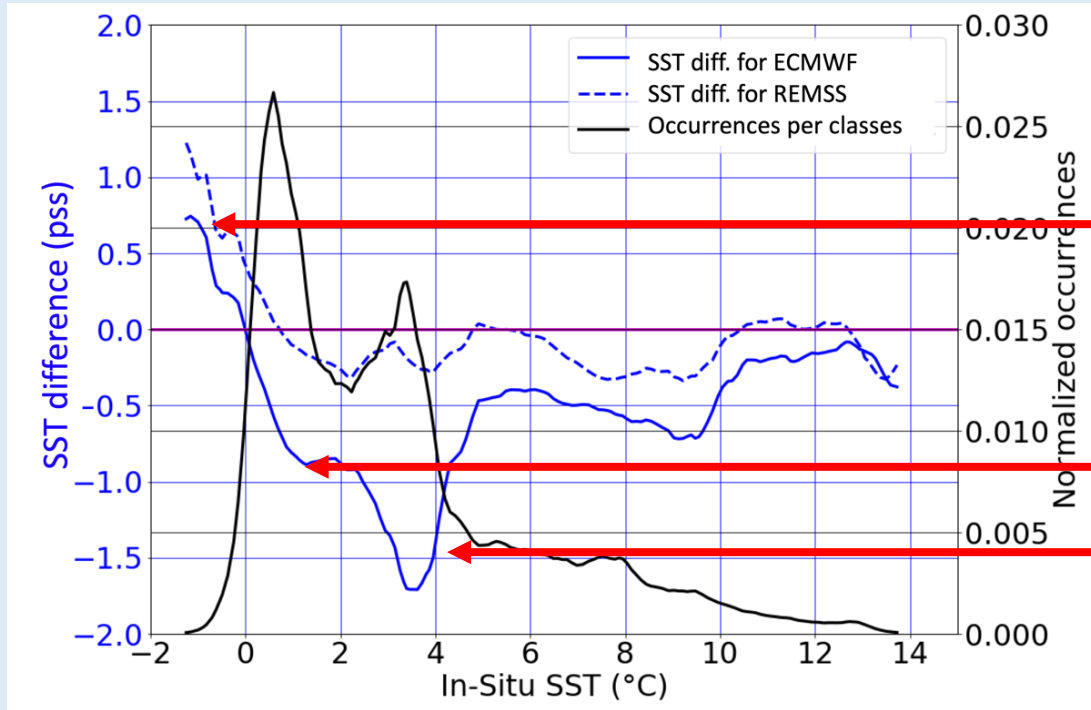
SSS differences between satellite SSS and in-situ SSS



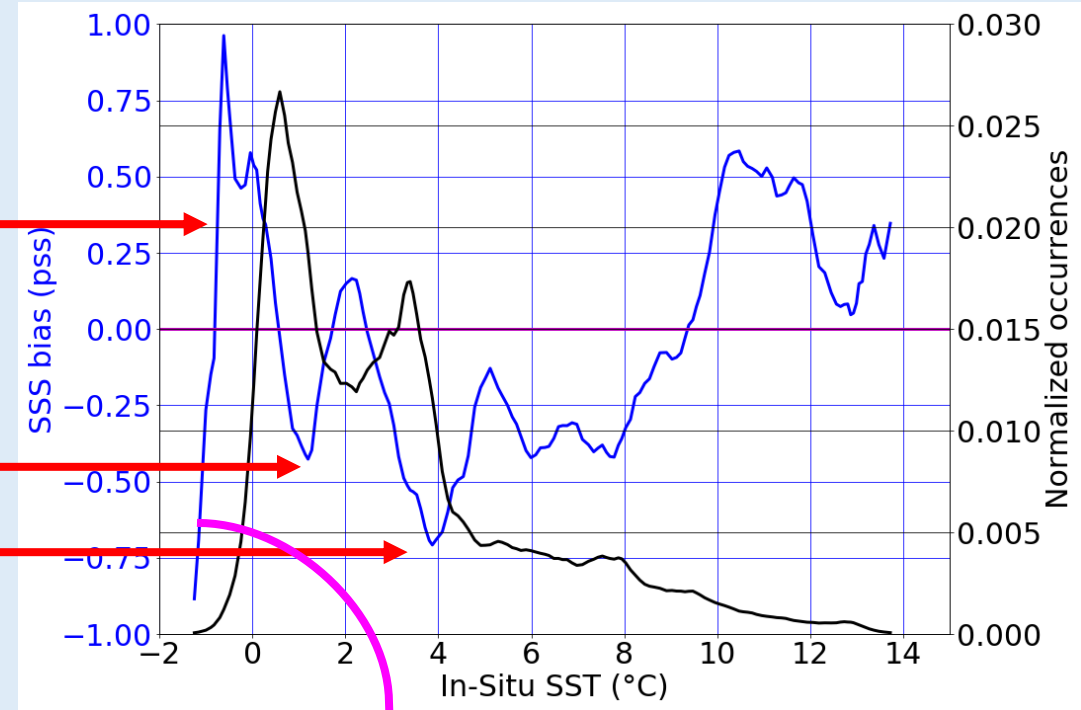
SST differences induce SSS differences

SST products differences

SST differences between satellite SST and in-situ SST



SSS differences between satellite SSS and in-situ SSS



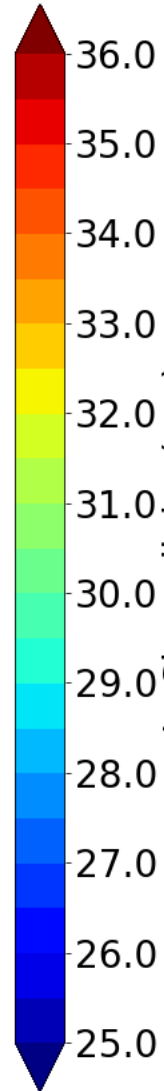
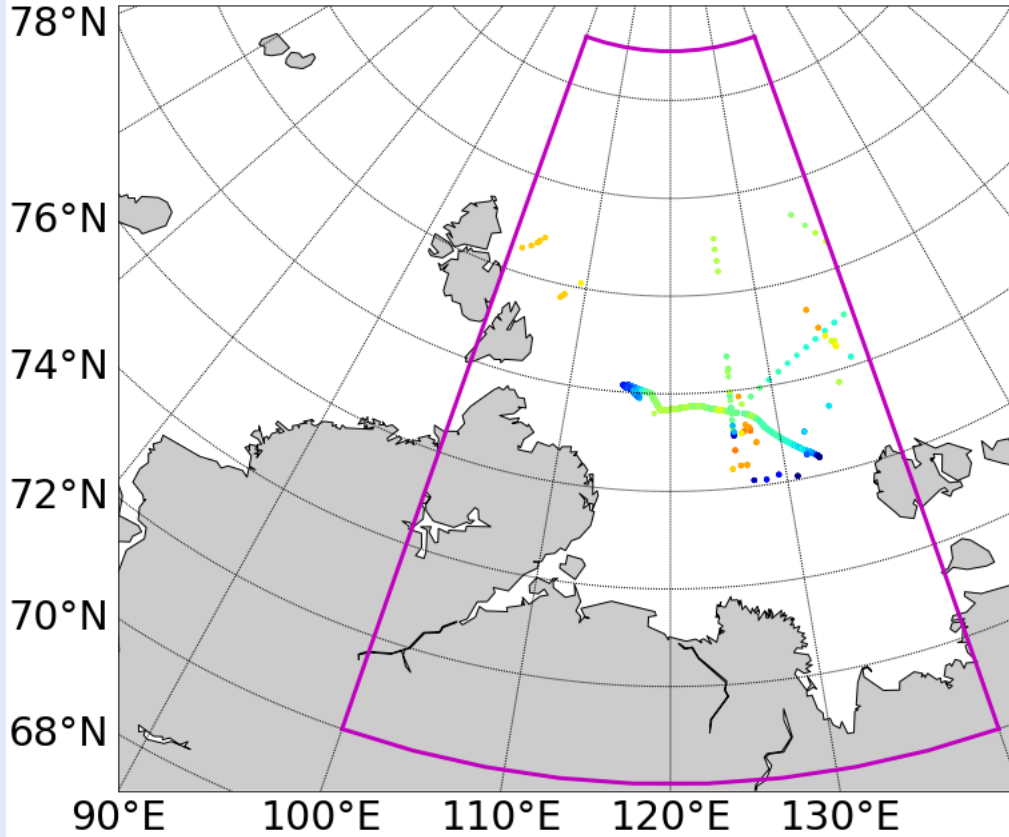
SST differences induce SSS differences

Remaining sea ice

A case study : Laptev Sea

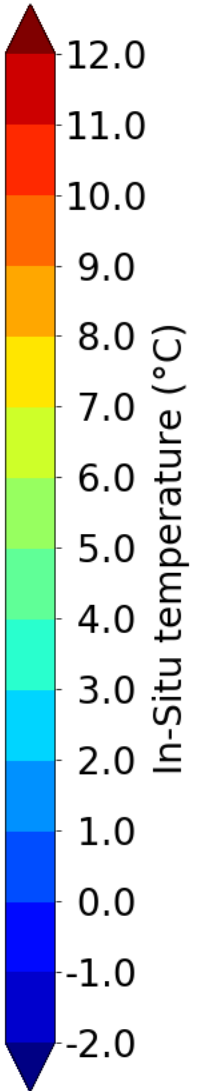
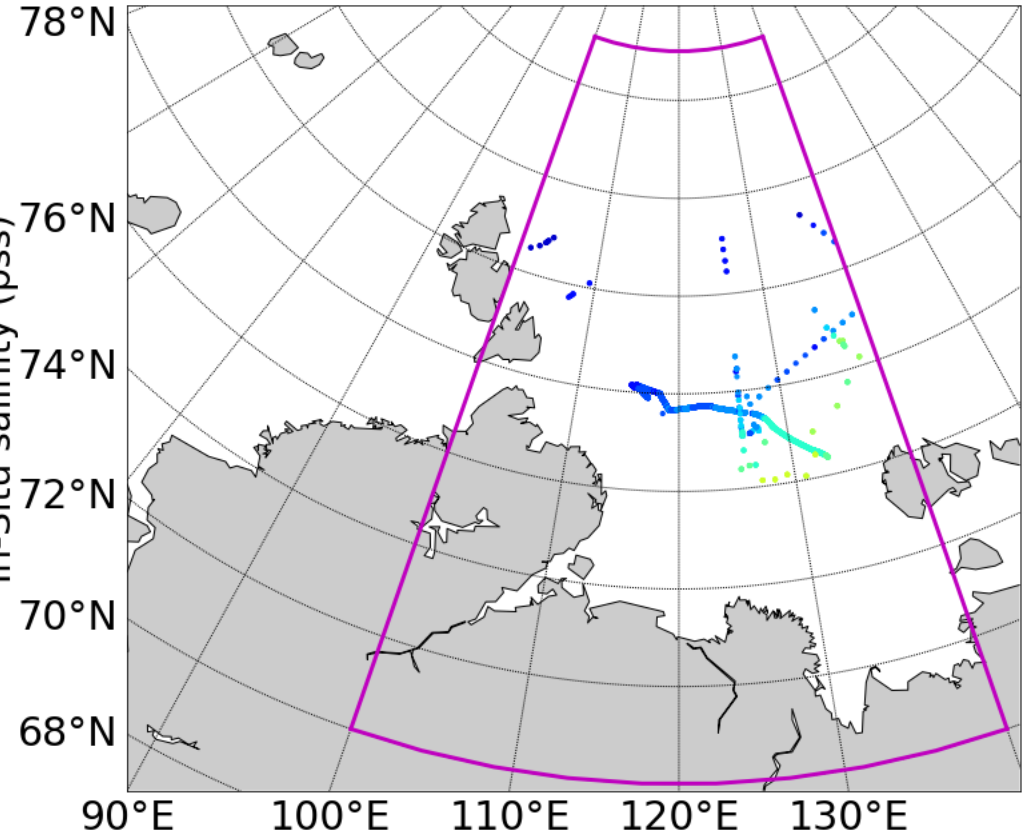
in-situ SSS

LAPTEV SEA

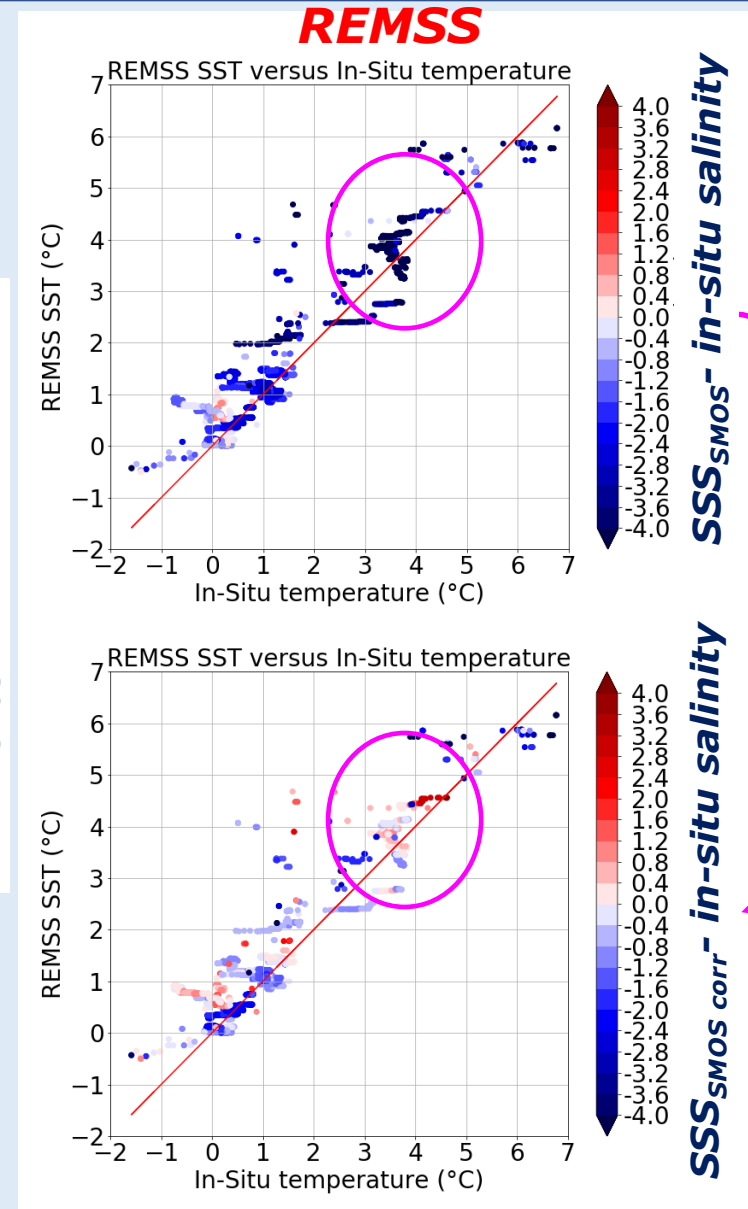
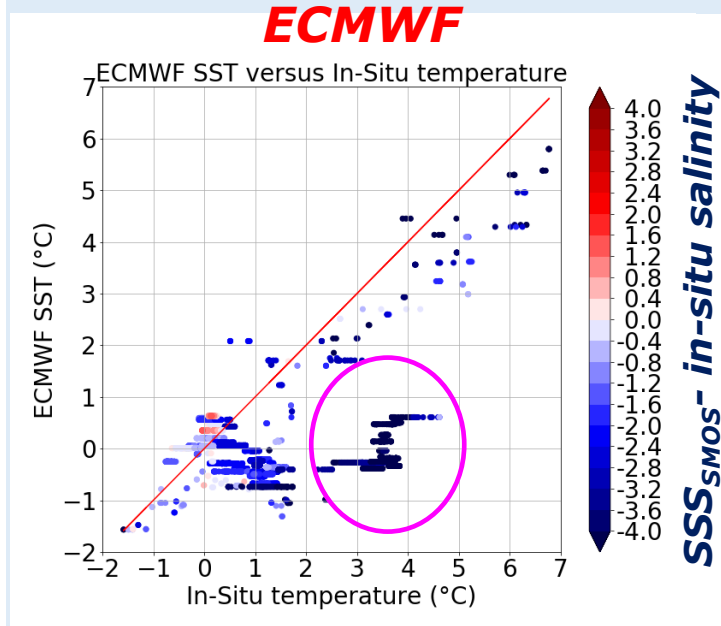
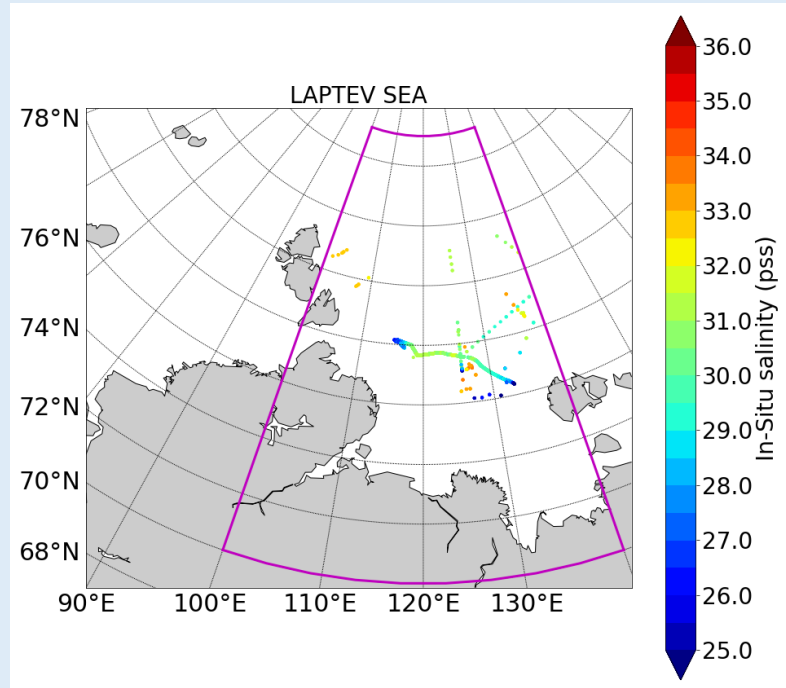


in-situ SST

LAPTEV SEA



A case study : Laptev Sea

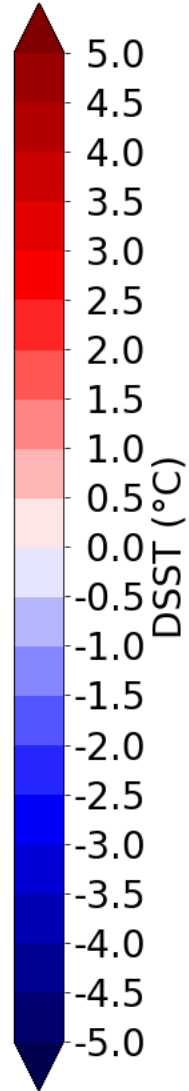
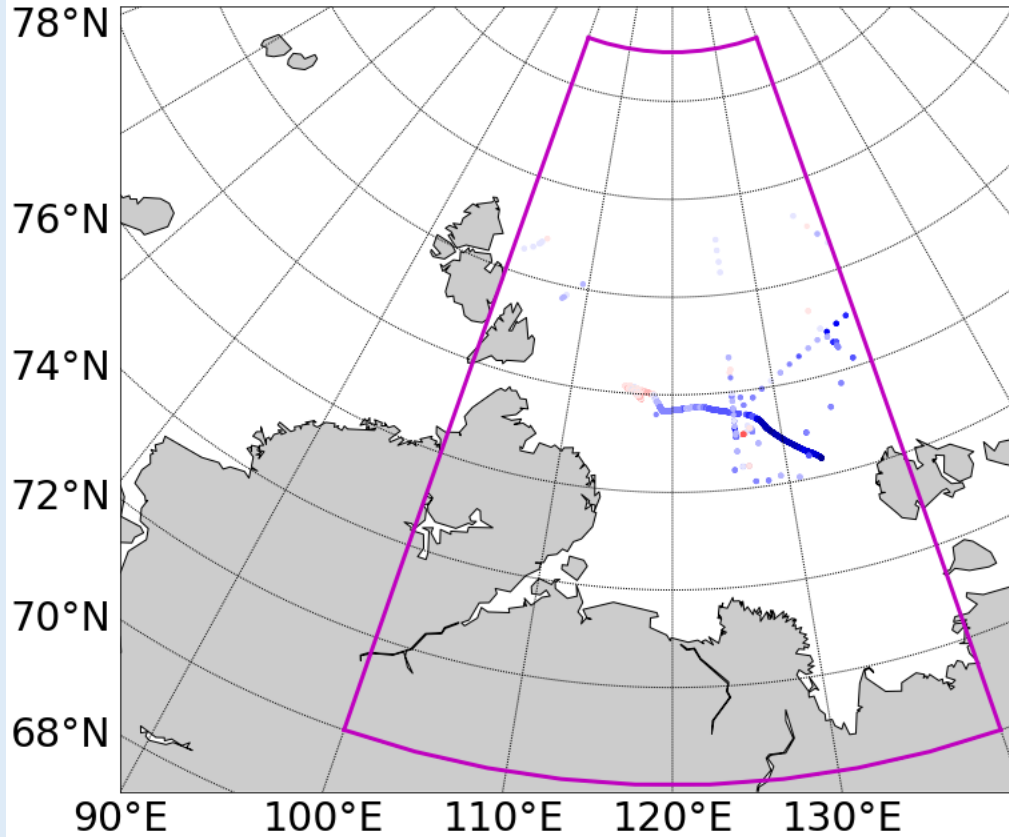


SSS correction using SST REMSS

A case study : Laptev Sea

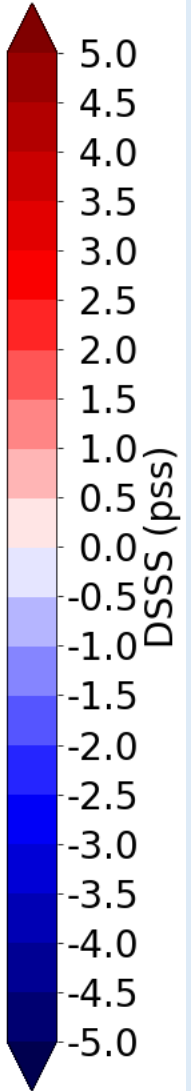
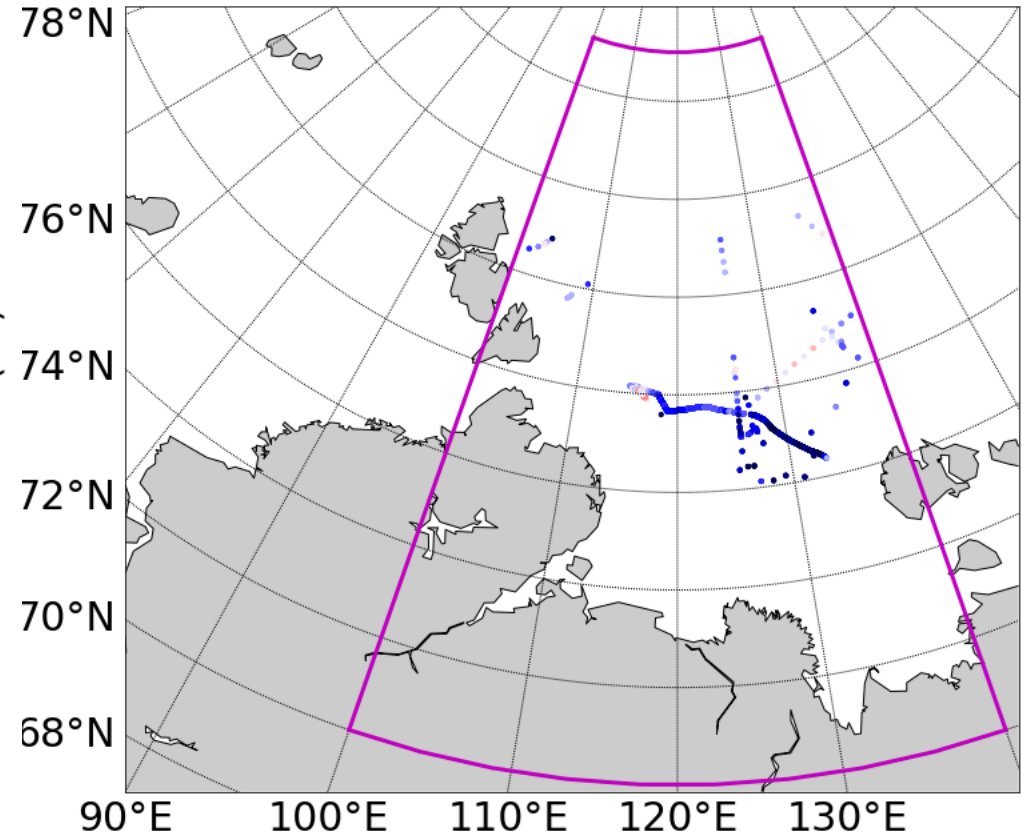
SST ECMWF - SST in-situ

LAPTEV SEA



SSS SMOS - SSS in-situ

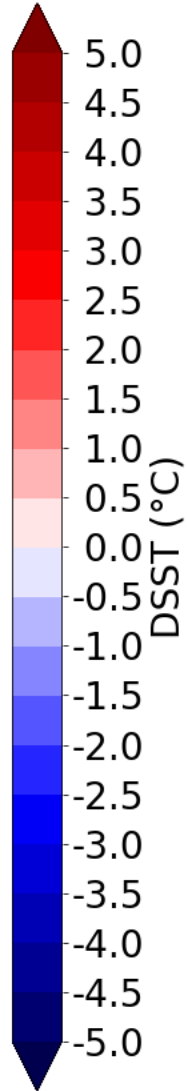
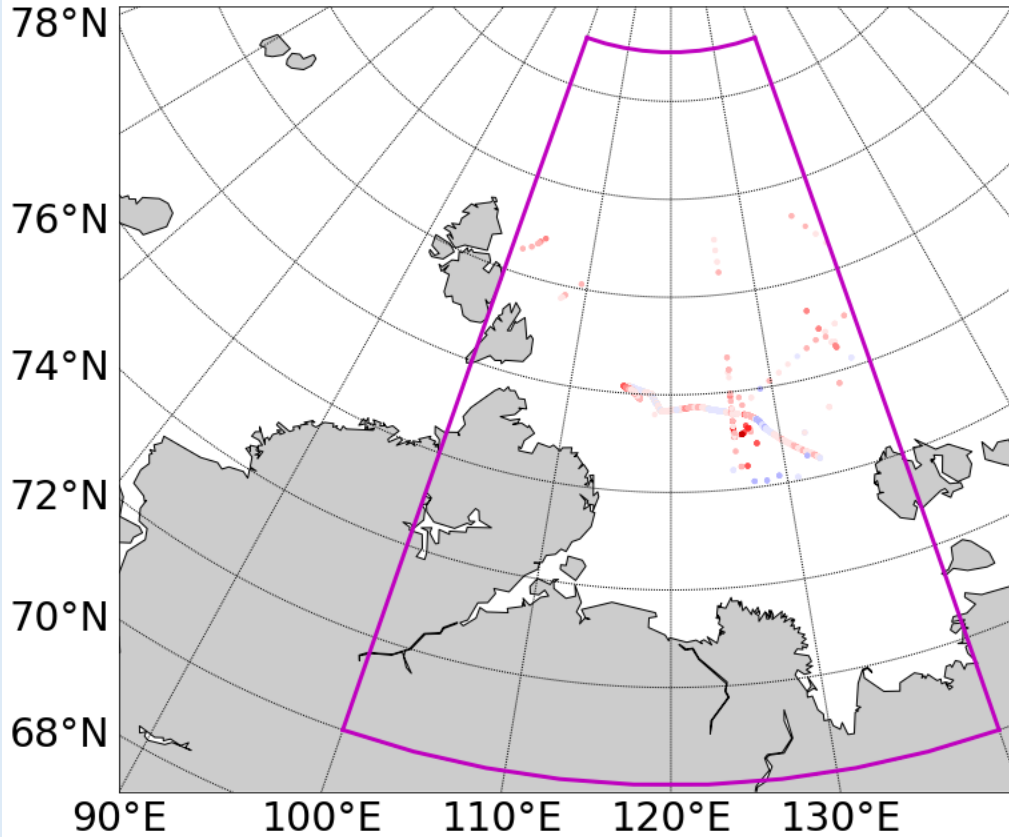
LAPTEV SEA



A case study : Laptev Sea

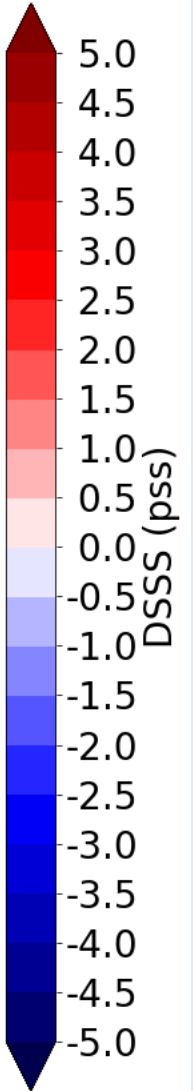
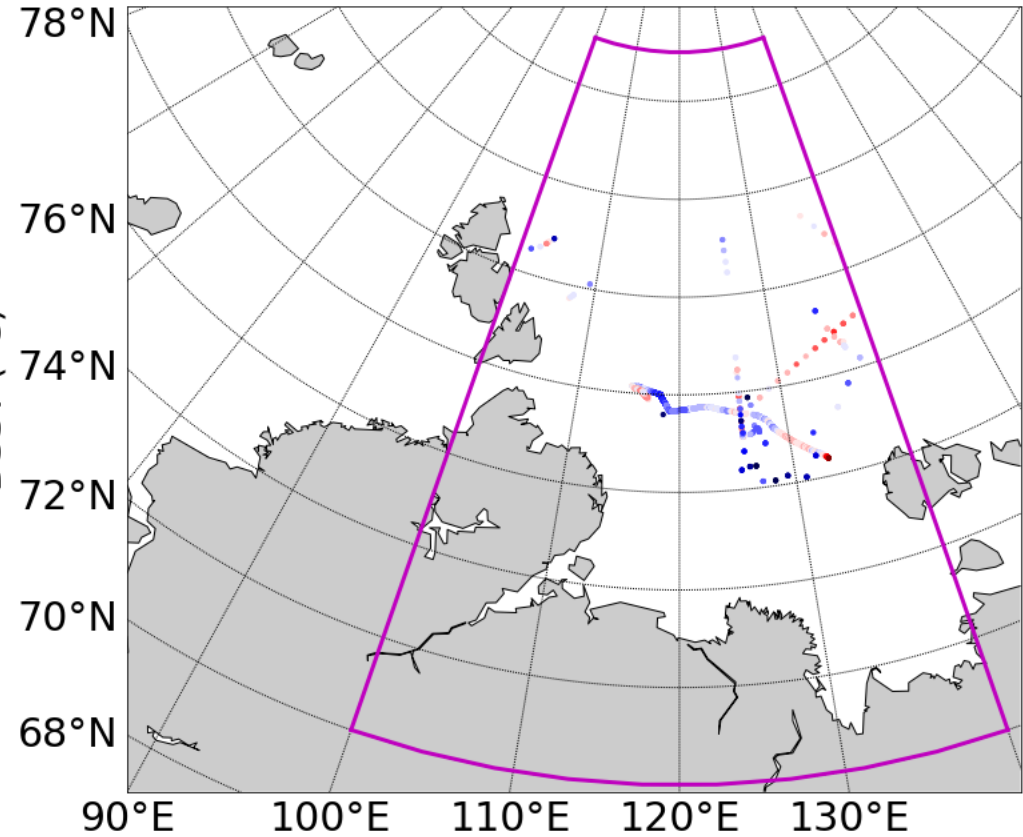
SST REMSS - SST in-situ

LAPTEV SEA

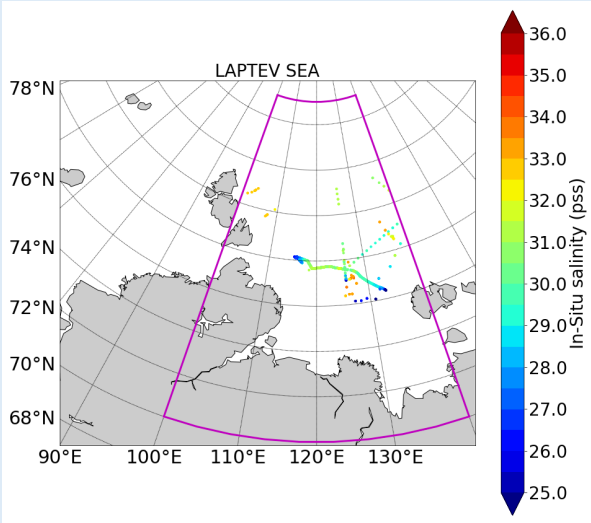


SSS SMOS corr - SSS in-situ

LAPTEV SEA



A case study : Laptev Sea



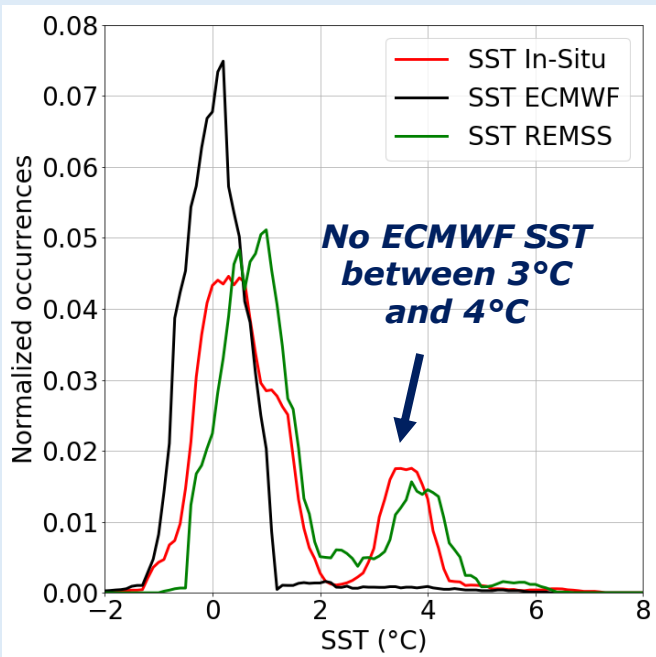
Before SST correction

MoD = -1.97 pss
STDD = 1.82 pss
R=0.53
N=4048

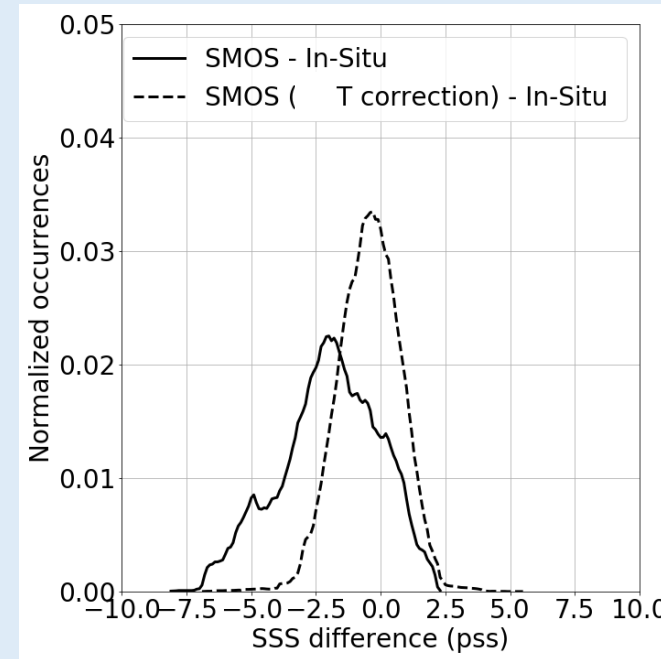


After SST correction

MoD = -0.14 pss
STDD = 1.07 pss
R=0.80
N=4048

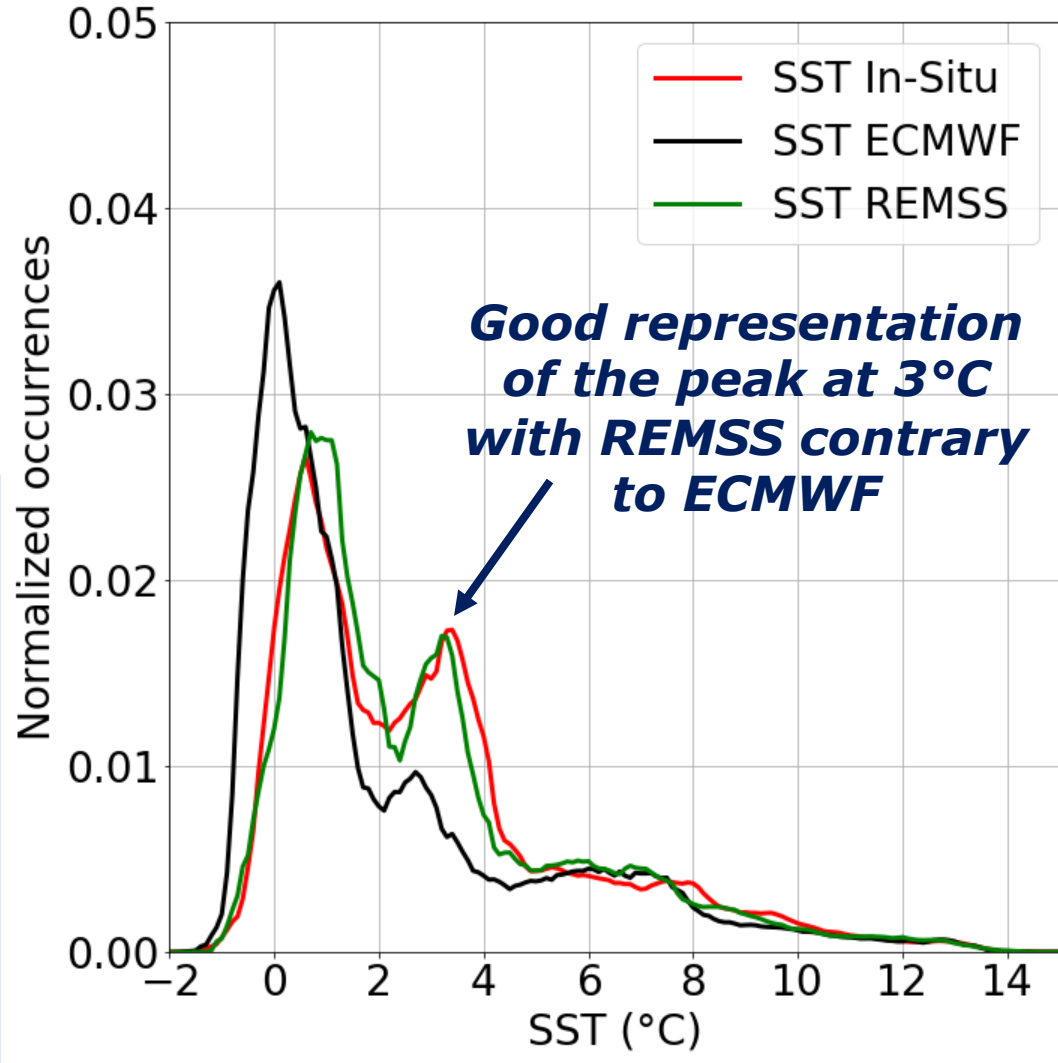
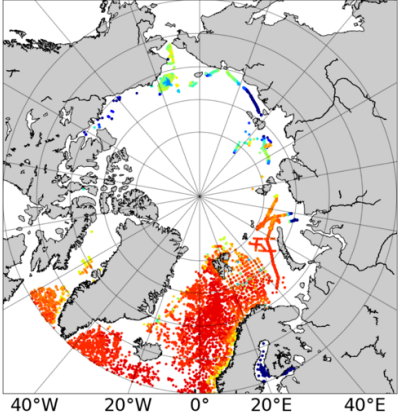


Taking into consideration differences between REMSS SST and ECMWF SST



Correction performances for Arctic ocean SST distribution

All devices in-situ salinity between 1-m and 3-m



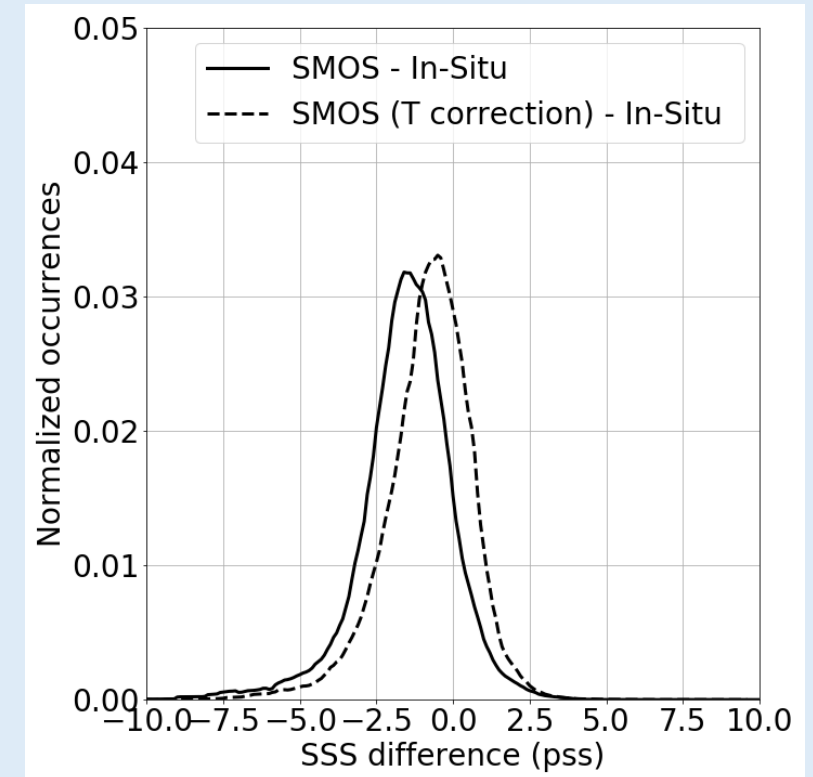
Before/After SST correction

MoD = -1.54 pss / -0.81 pss

STDD = 1.46 pss / 1.32 pss

R = 0.92 / 0.93

N = 148678



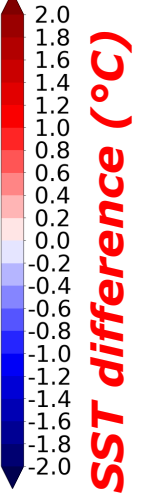
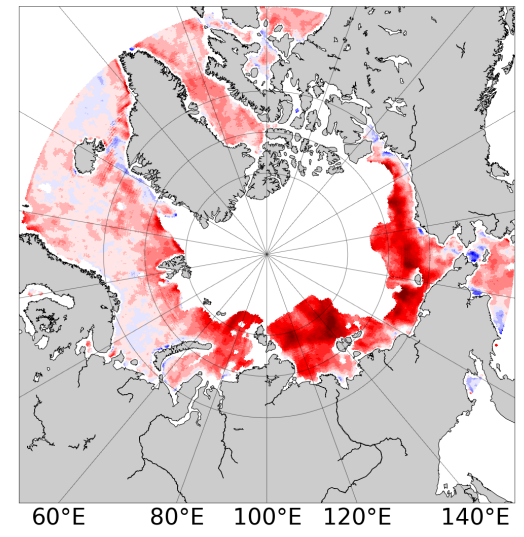
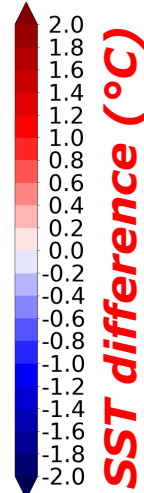
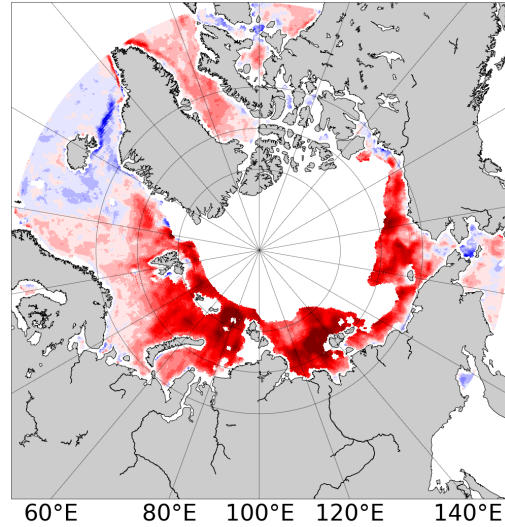
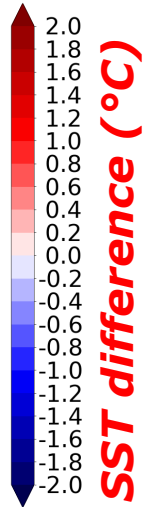
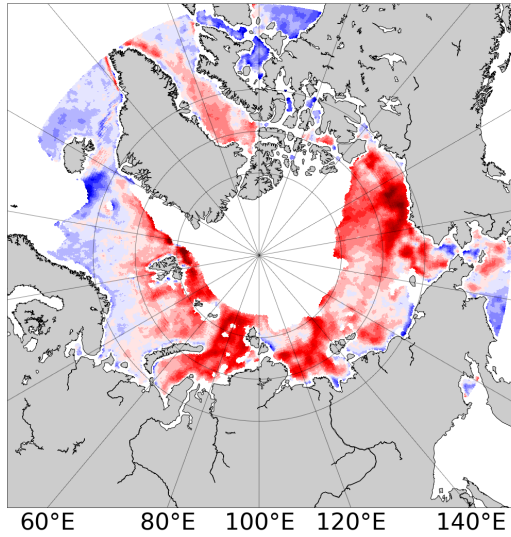
Correction impact on monthly SSS

Sept. 2012

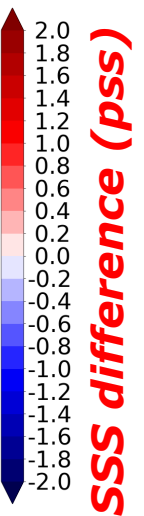
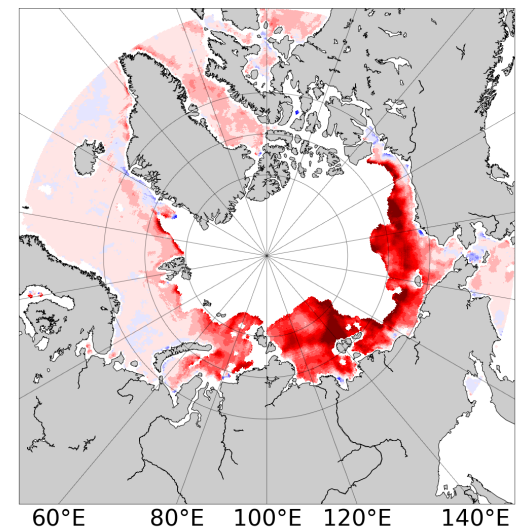
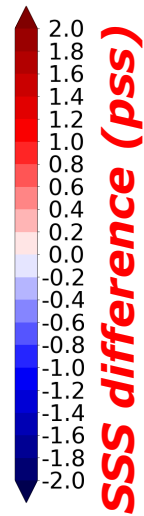
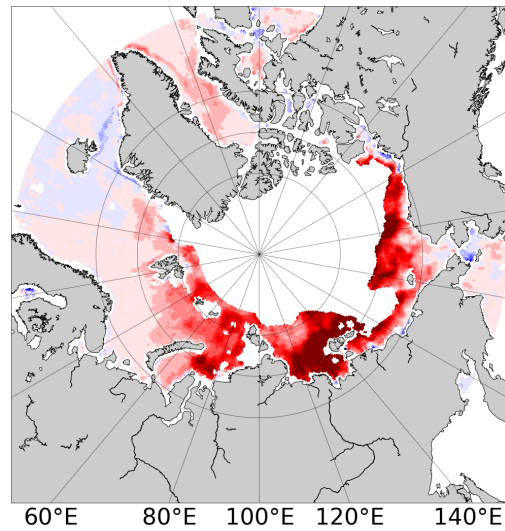
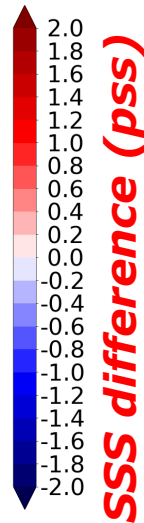
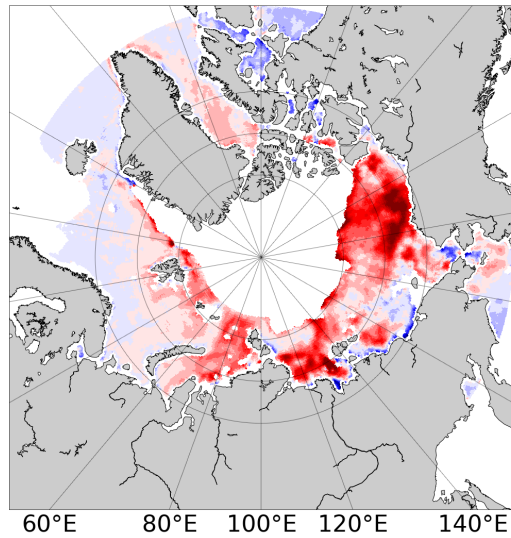
Sept. 2013

Sept. 2014

$SST_{REMSS} - SST_{ECMWF}$



$SSS_{SMOScorr} - SSS_{SMOS}$



Conclusion

- **SSS_{SMOS}** derived with **SST_{ECMWF}** as a prior are strongly underestimated at monthly scales in river plumes areas.
- A new **SSS_{SMOS}** product is developed for Arctic Ocean using a new sea ice filtering methodology and an SST-related correction.
- In the Arctic Ocean, use of **SST_{REMSS}** to correct **SSS_{SMOS}** enables to improve SSS estimates with respect to in-situ SSS:
 - Mean differences reduced by 50% (0.8pss);
 - STDD reduced in river plumes areas (from 1.8 to 1.1 pss in the Laptev Sea).
- This study highlights the importance of using an SST prior consistent with L-Band radiometric measurement for retrieving SSS in the Arctic Ocean.

Supply et al. 2019, submitted to RSE.



Thank you