→ ATLANTIC FROM SPACE WORKSHOP

23–25 January 2019
National Oceanography Centre
Southampton, UK

Arctic and North Atlantic Sea Surface Salinity retrieval.

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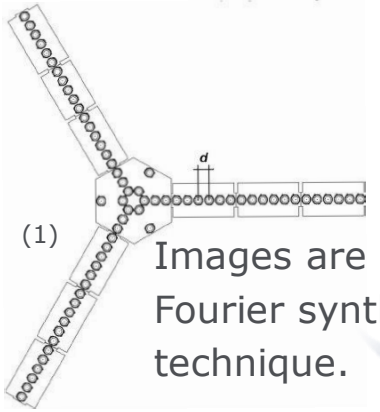
SMOS mission 2009-Today
Soil Moisture and Ocean Salinity

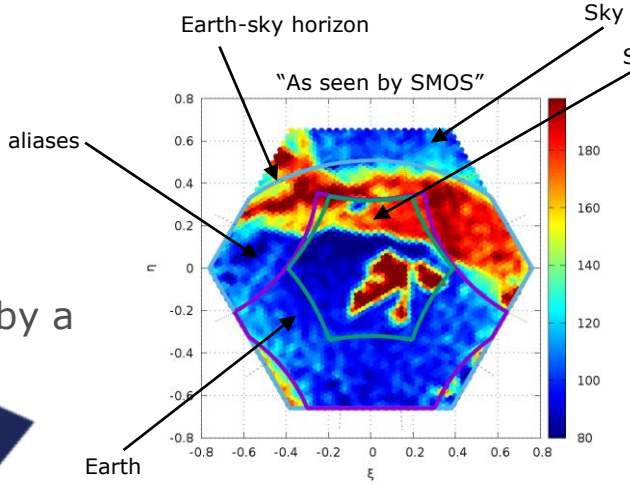
2D interferometric passive microwave sensor operating in L-band (1.413GHz)

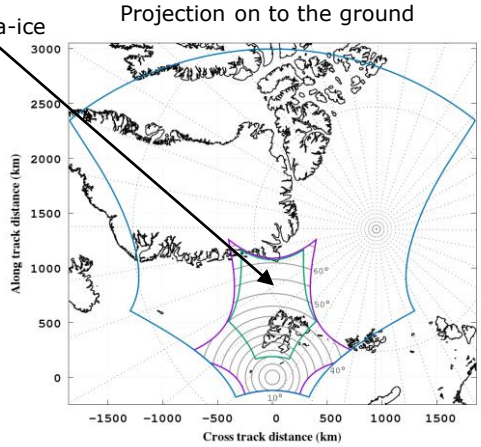
- Synthetic aperture radiometer (incidence from 0 to 68º), full-pol.
- Polar orbit (8.4º): 6AM/6PM, 3-day repeat, 9-day total coverage
- Orbit of around 750 km above the Earth



(1)

Images are formed by a Fourier synthesis technique.

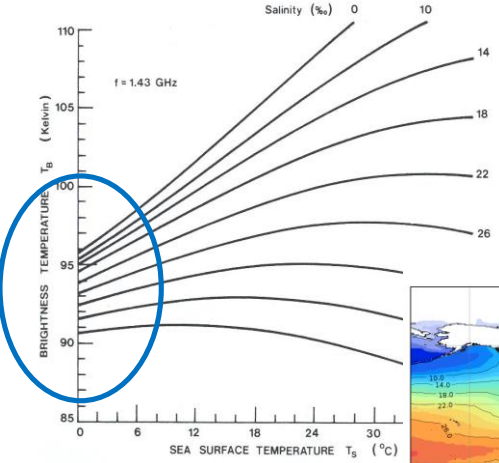




(1) *Image from Camps et al, 2008, IEEE TGRS 46(1): 146-158*

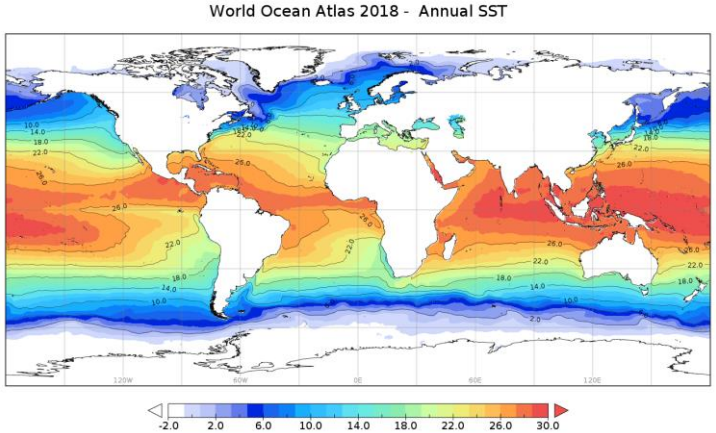
L-band & cold waters

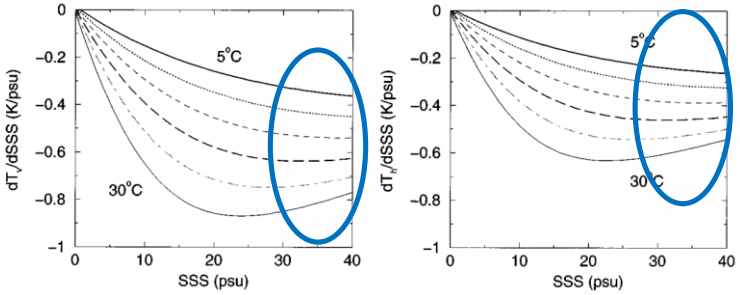
from Klein & Swift, 1977,
IEEE Trans. Antenna and Prop. 25(1): 104-111



Lower sensitivity in cold waters

The derivative of T_B with respect to SSS reduces to about **0.6 K/psu at 30ºC** water temperature and about **0.3 K/psu at 10ºC** water temperature.





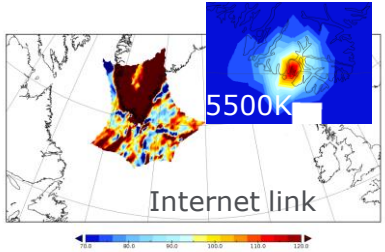
from Yueh et al, 2001, IEEE TGRS 39(5): 1049-1059

RFI & Land-Sea contamination

from Oliva et al, 2013, IEEE TGRS. 51(10): 4999 - 5007

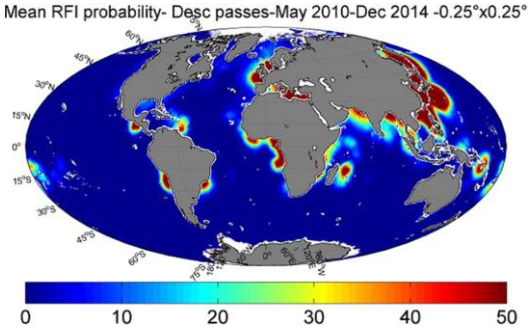
Radio Frequency Interferences

1400 - 1427 MHz is a protected band used in radio astronomy: spectral line observations 21cm hydrogen



Coast is specially affected by RFI of human origin.

Effects can be noted up to 3000 km from origin



Land-Sea contamination

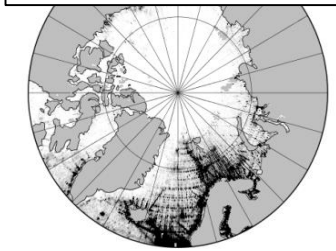
T_B jump in coast (T_B land~300K, sea~100K) ⟶ Gibbs effect

These effects increase T_B measured value providing low salinity

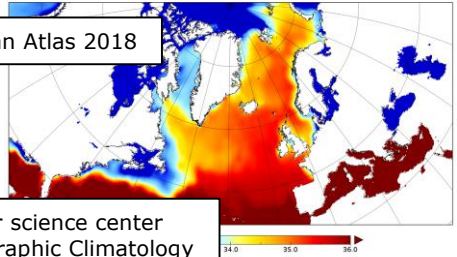
State of the Art

World Ocean Atlas 2013
Salinity observations
(2018 unavailable due to
U.S. government shut down)

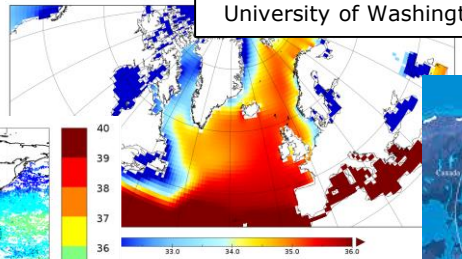
Low number of in-situ measures of sea surface salinity at high latitudes



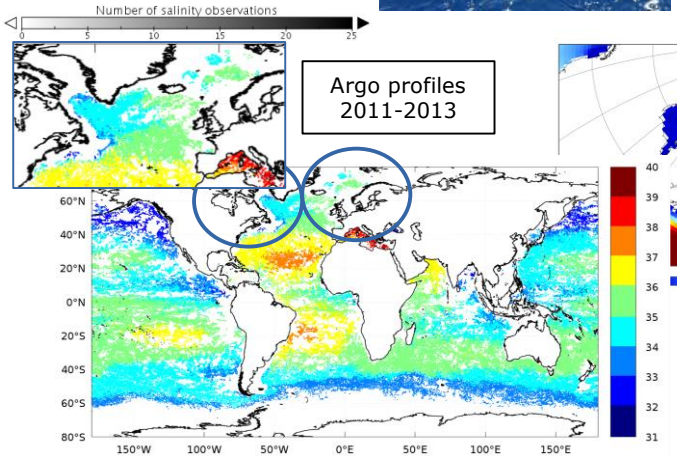
World Ocean Atlas 2018



Polar science center
Hydrographic Climatology
(PHC3.0)
University of Washington



Argo profiles
2011-2013



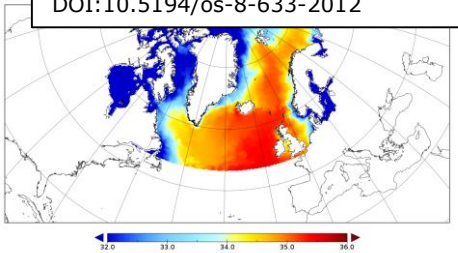
TARA expedition
2013

EN4 – Met Office

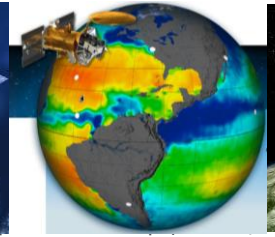
coupled ocean-sea ice data assimilation system

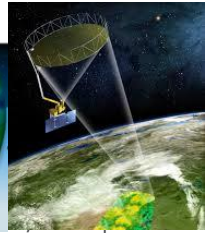
TOPAZ4
ocean-sea ice data assimilation system for the North Atlantic and Arctic

Sakov et al, 2012 Ocean Sci., 8, 633-656
DOI:10.5194/os-8-633-2012



Remote sensing L-band
SMOS (ESA) – Aquarius & SMAP (NASA)



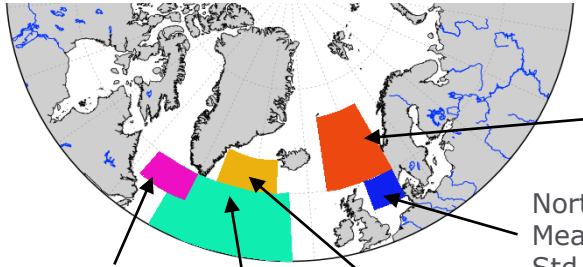


BEC Arctic V2.0
Comparison with TSG

"Seven years of SMOS Sea Surface Salinity at High Latitudes: Variability in Arctic and Sub-Arctic Regions"

Olmedo et al, 2017, Remote Sensing 2018, 10(11), 1772

Regional comparison SMOS-TSG



Norwegian Sea
Mean 0.02
Std 0.67

Northern Sea
Mean 0.16
Std 0.99

Labrador Sea
Mean 0.14
Std 0.71

North Atlantic
Mean 0.19
Std 0.45

Denmark Strait
Mean 0.22
Std 0.28

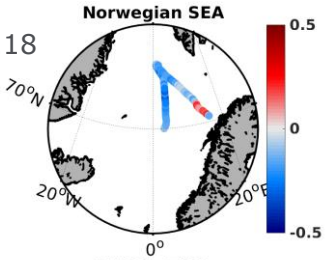
Available at http://bec.icm.csic.es

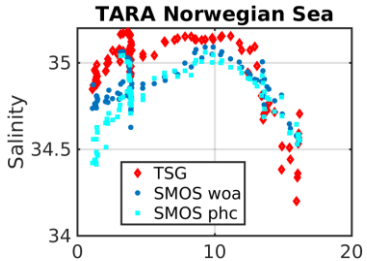
soon at pimep-test.oceandatalab.com

SMOS pilot-mission exploitation platform

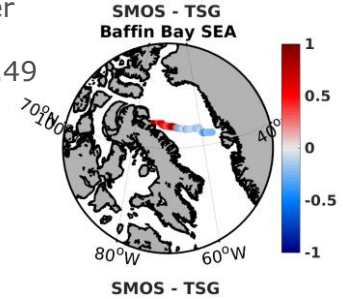
TARA Oceans Polar Circle Expedition

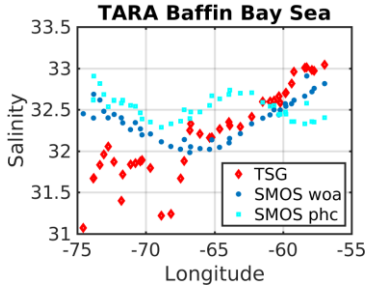
June
2013
RMS 0.18
R 0.73



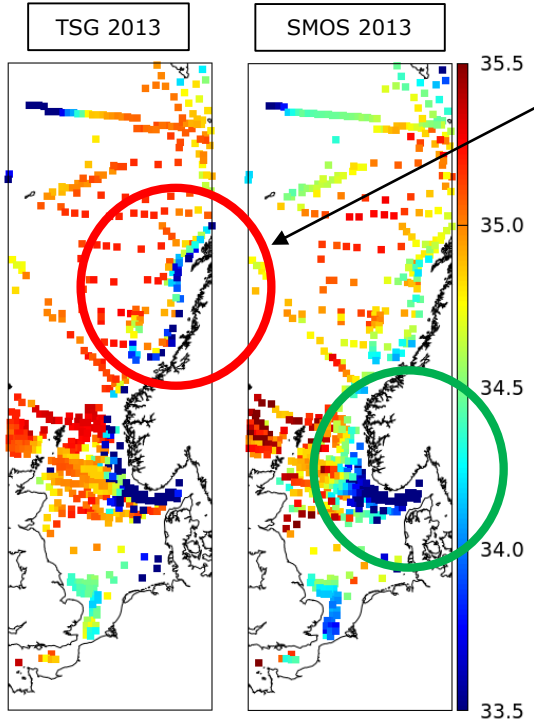


October
2013
RMS 0.49
R 0.51



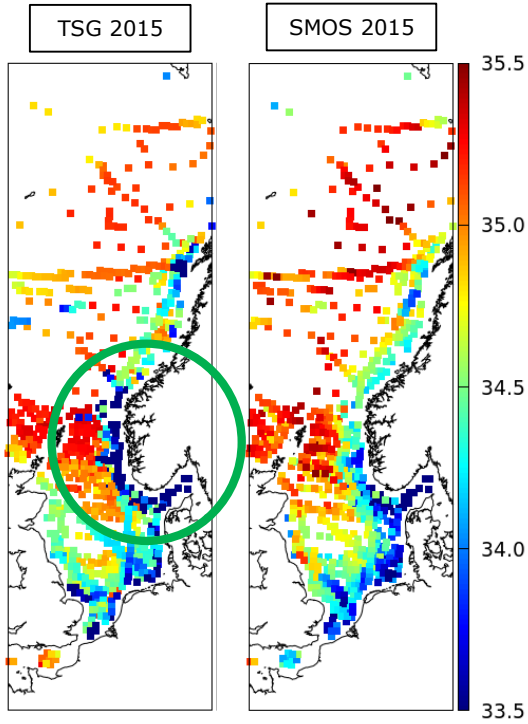


BEC Arctic V2.0
Comparison with TSG



TSG capture strong salinity gradients. Objectively analyzed BEC Arctic product can not fully capture such dynamics.

Fresh waters in the southern part of Norway are well captured

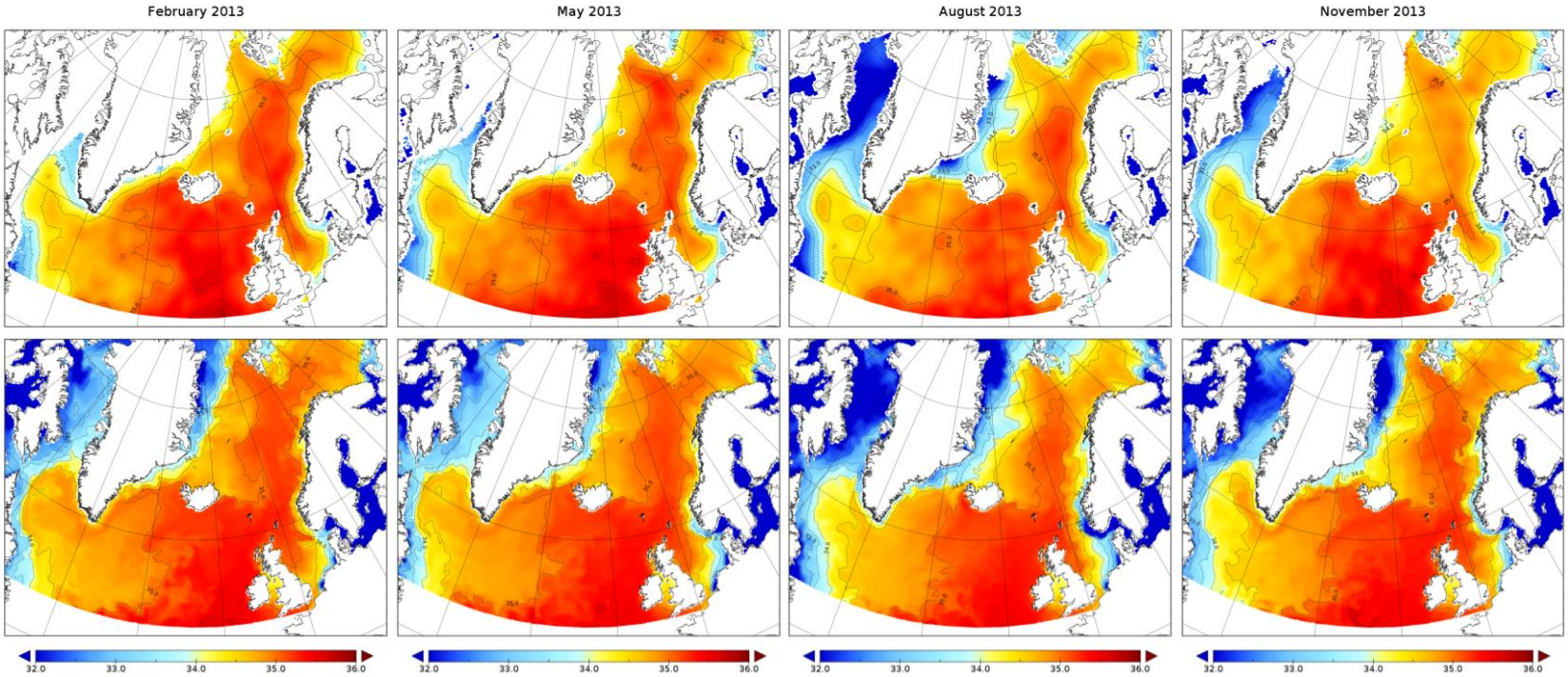


BEC Arctic V2.0
Comparison with TOPAZ4

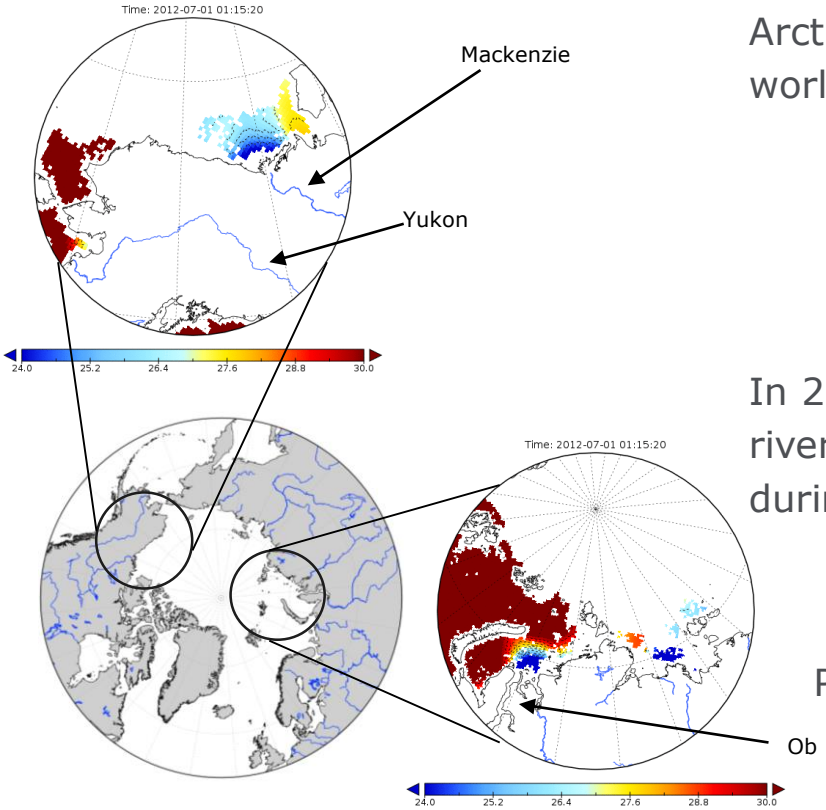
Monthly average

BEC Arctic product

TOPAZ4 reanalysis



BEC Arctic V2.0
Rivers discharge



Arctic rivers account for the 10% of the total flow from the world's rivers

CliC/AMAP/IASC, 2016.
The Arctic Freshwater System in a Changing Climate.
WCRP Climate and Cryosphere (CliC) Project,
Arctic Monitoring and Assessment Programme (AMAP),
International Arctic Science Committee (IASC).

In 2014, the combined discharge of the eight largest Arctic rivers was 10% greater than their average discharge during 1980-1989 period

Jeffries et al, Arctic Report Card 2015, NOAA Reports

Provides valuable information about fleshwater fluxes

ESA's Arctic+ salinity project

arcticsalinity.argans.co.uk

Nov. 2018 – Jun. 2020

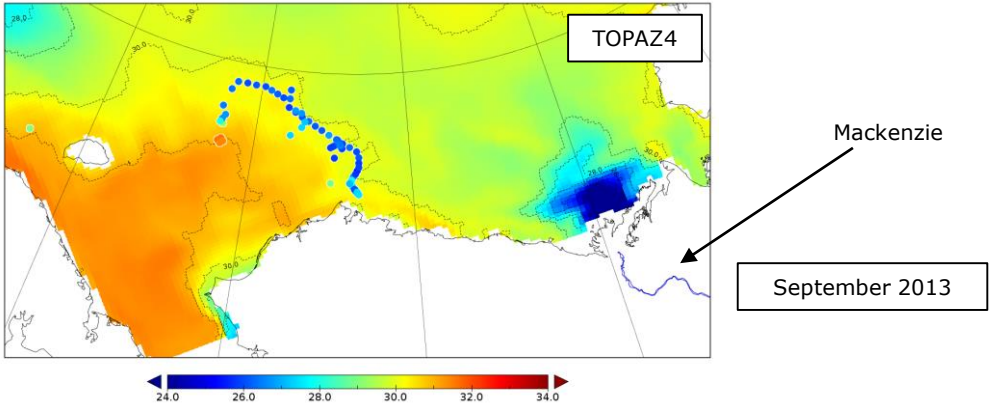
- Improve **algorithm** to produce the best quality Arctic SSS product.
- Combine **SMOS and SMAP** data to improve the accuracy and characterize the product biases and stability.
- Generate a **long term salinity dataset (starting at 2011)**
- Assess the **relation between the dynamics of SMOS salinity with land and ocean freshwater fluxes** (Greenland and glacier flows & rivers and E-P). Quantify the freshwater fluxes with SSS products.
- Assess the **impact** of the **new data in a data assimilation system** (the **TOPAZ4** system, both in forecast and reanalysis mode). If assimilation of Arctic+ products leads to an improvement of TOPAZ it will become the new Arctic reanalysis and forecast products on the **CMEMS portal**.

Argans Ltd

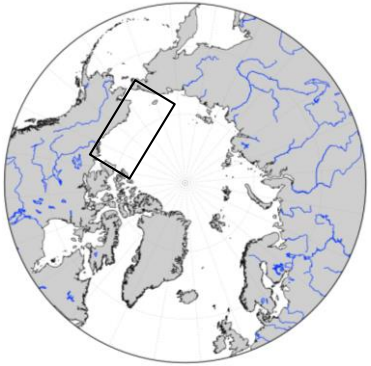
Barcelona Expert Center
Institute of Marine Sciences

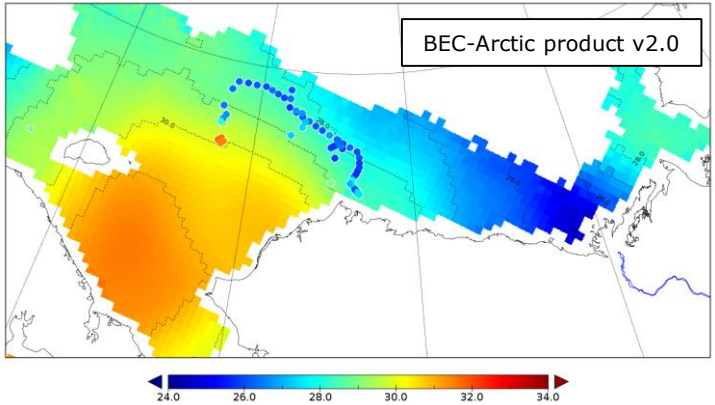
Nansen Environmental and Remote Sensing Center

Arctic+ salinity



BEC Arctic product better describes the dynamics close to river mouths. Assimilation of the BEC Arctic product could lead to an improvement on TOPAZ4 system.





Improve gradients is one of the targets of Arctic+ salinity product.

Conclussions & future work

- Measuring Arctic salinity from space has **special interest due to the lack** of a wide network **of in-situ data**.

- SMOS has shown the **capability of describe salinity variability** of Arctic and Sub-Arctic regions

- ESA's Arctic+ salinity project is aimed at **improving Arctic and sub-Arctic salinity retrieval**

- It is expected that Arctic+ salinity project will provide **a better SMOS product** and an **improvement of TOPAZ4 system** by assimilating the new product.