SEA-ICE SIGNATURE IN SWIM OFF-NADIR ECHOES

Sea-ice flagging

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SWIM Science Team Meeting – 18 March 2021
09:45

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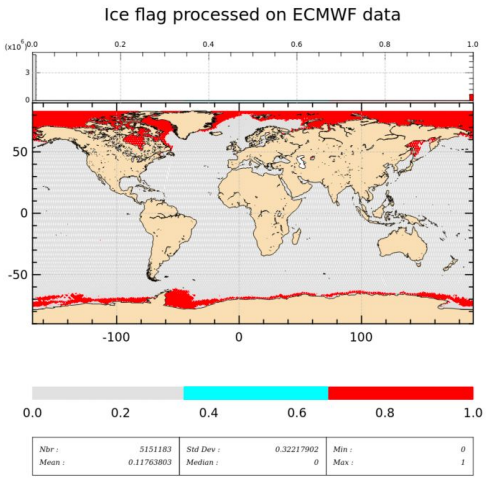
Context

Current status:

No component SWIM ↔ sea-ice in CWWIC (CNES)

SWIM processing chains



SWIM Cycle 34 (01/2020)

While…

- Sea ice can “pollute” wave field retrieval
- Wave measurements in sea ice regions of potential interest

While…

- Previous SWIMSID study over GPM data

Objective:

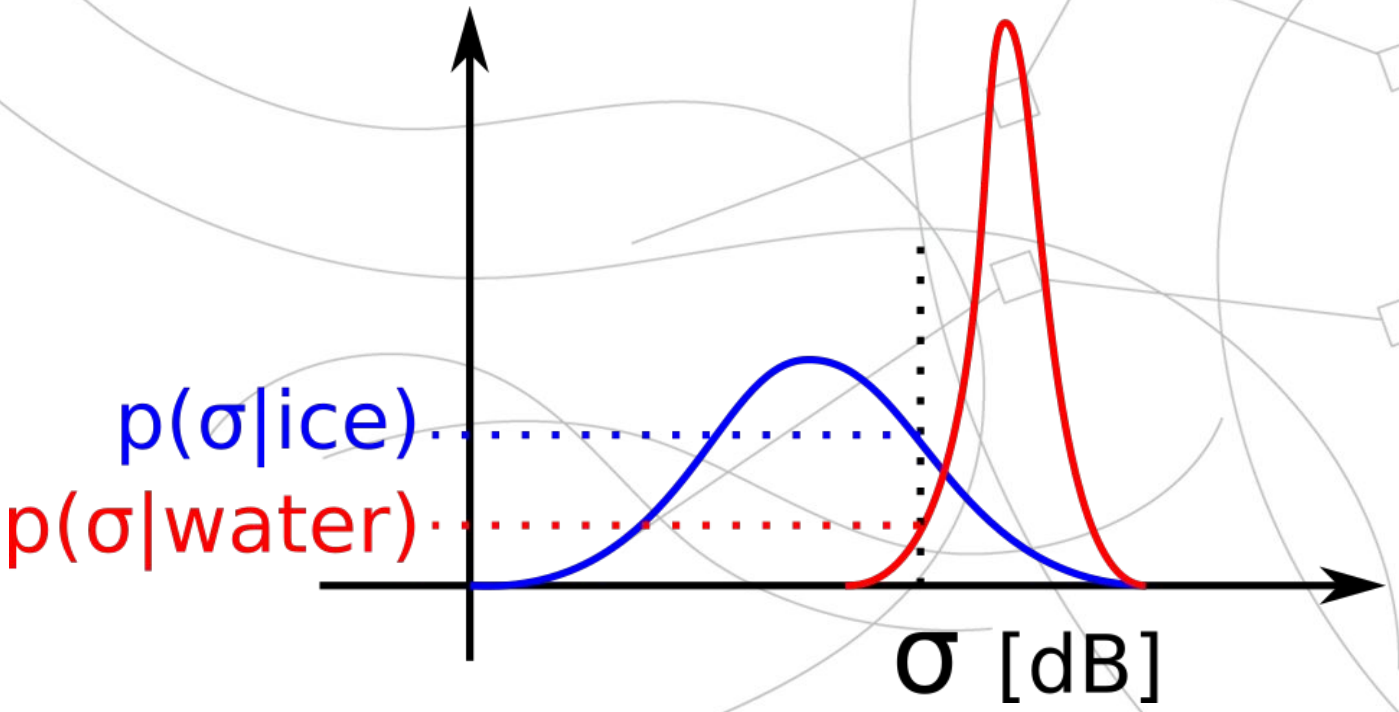
With CFOSAT now flying, commissioned and data validated,

1) design a sea ice flag at the L1a level
2) prototype sea ice products from SWIM data (L1a, L2 … ?)

Sea-ice flag definition

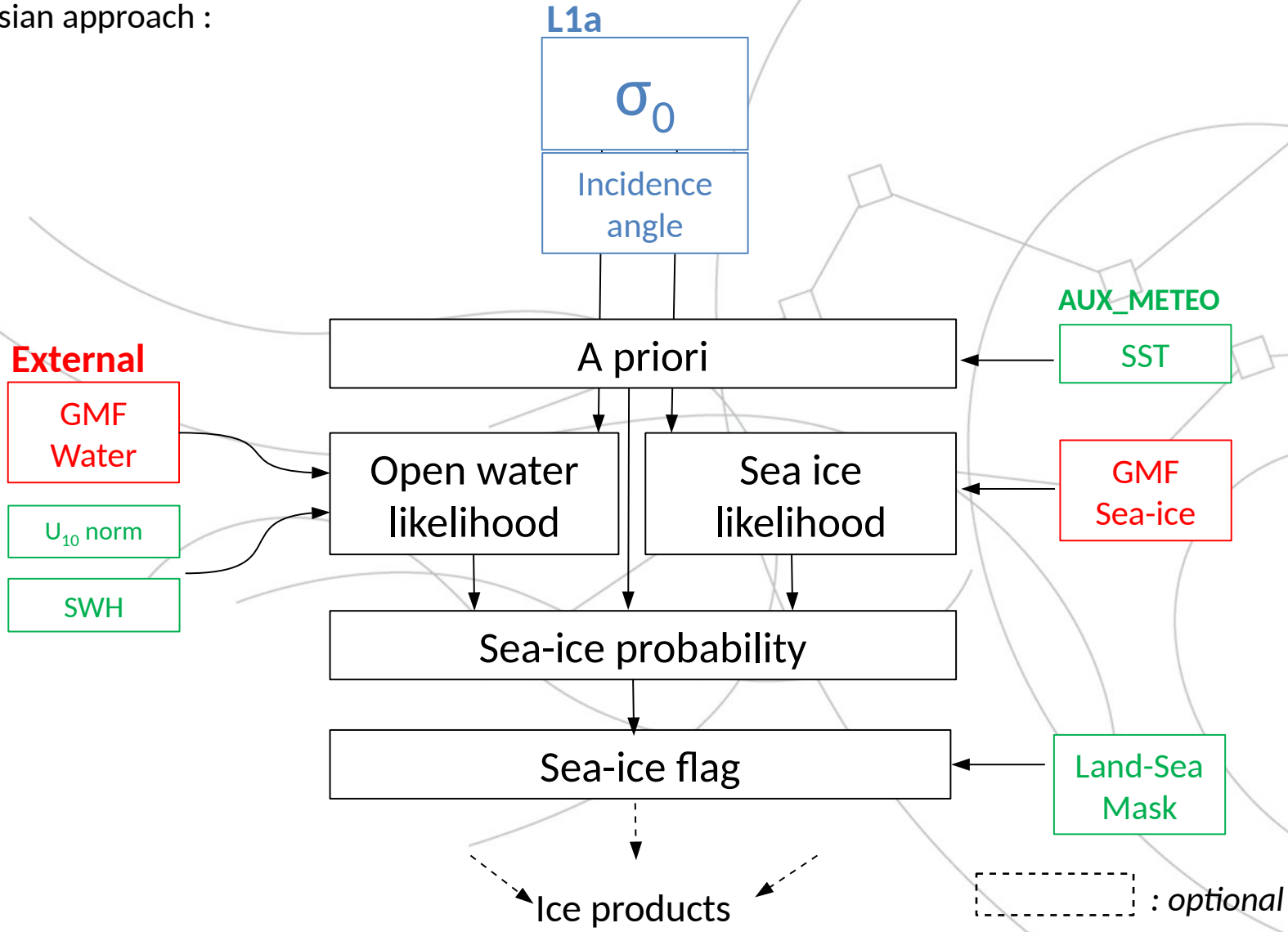
- Flag = 1 if sea-ice
- Flag = 0 else

- Log-likelihood



Algorithm overview

Bayesian approach :



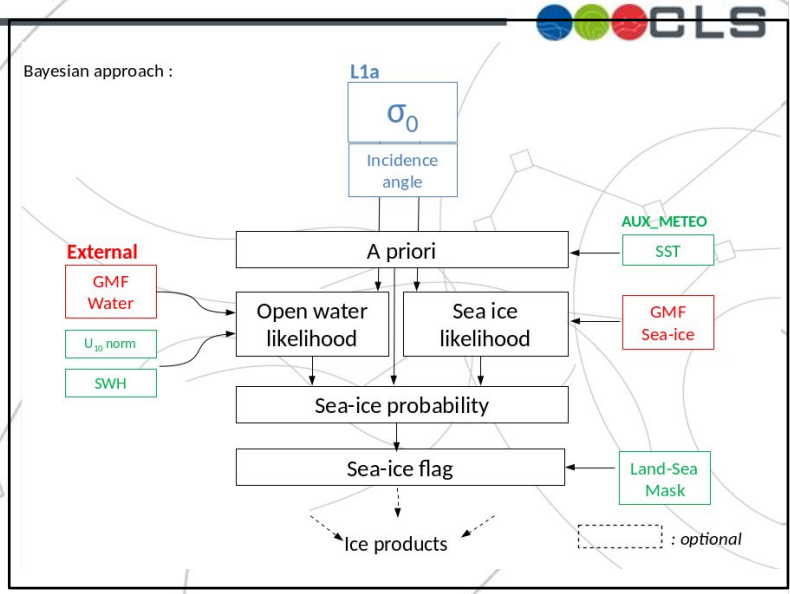
Algorithm overview

A probability is defined where land-sea mask = 0 :

$$P(\text{ice}) = \frac{p(\text{ice}|\sigma_0)}{p(\text{ice}|\sigma_0) + p(\text{water}|\sigma_0)}$$

≥ 0.5 → ***SI flag = 1***

< 0.5 → ***SI flag = 0***



which compares A Posteriori probabilities (Bayes)

$$p(\text{ice}|\sigma_0) = \frac{p(\sigma_0|\text{ice})p(\text{ice})}{p(\sigma_0)}$$

Likelihood ***A Priori***

$$p(\text{water}|\sigma_0) = \frac{p(\sigma_0|\text{water})p(\text{water})}{p(\sigma_0)}$$

Likelihood ***A Priori***

where likelihoods are derived from L1a GMFs :

$$p(\sigma_0[\text{dB}]|\text{ice}) \sim \mathcal{N}[\text{GMF}_{\text{ice}}(\theta), \Delta\sigma_{\text{ice}}(\theta)]$$

$$p(\sigma_0[\text{dB}]|\text{water}) \sim \mathcal{N}[\text{GMF}_{\text{water}}(\theta, U_{10}, H_S), \Delta\sigma_{\text{water}}(\theta, U_{10})]$$

GMFs

In brief :

2 fully analytical GMFs (+ standard deviations)

- Open water
- Sea-ice (SIC >0.9 and no land)

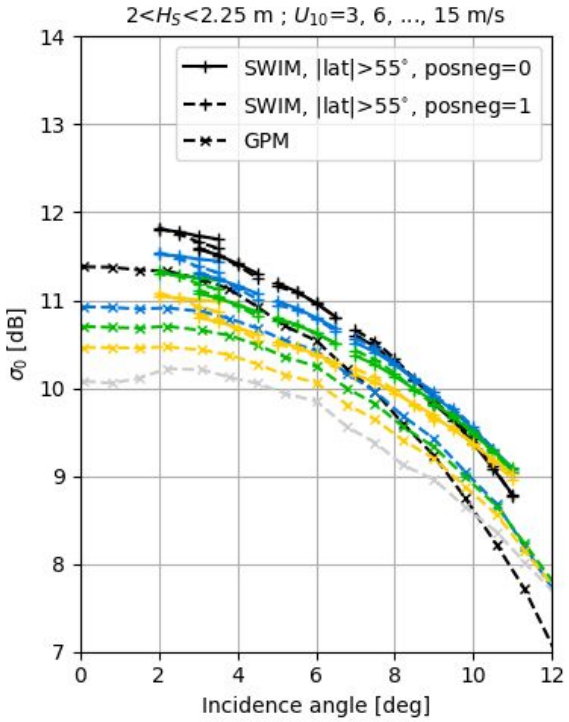
Estimated from **L2** mini-profiles at latitudes above 50°N and below 50°S

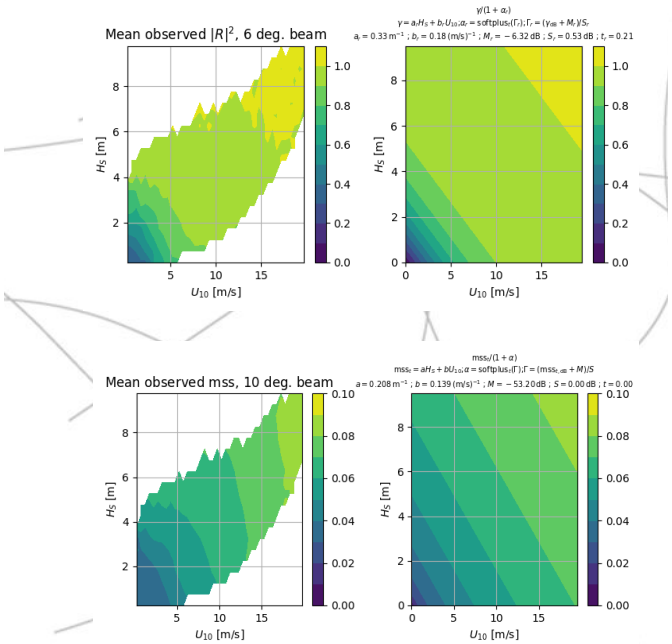
- 1 year (11/2019 to 11/2020) for sea-ice GMF
- 4 months (07/2020 to 11/2020) for open water GMF

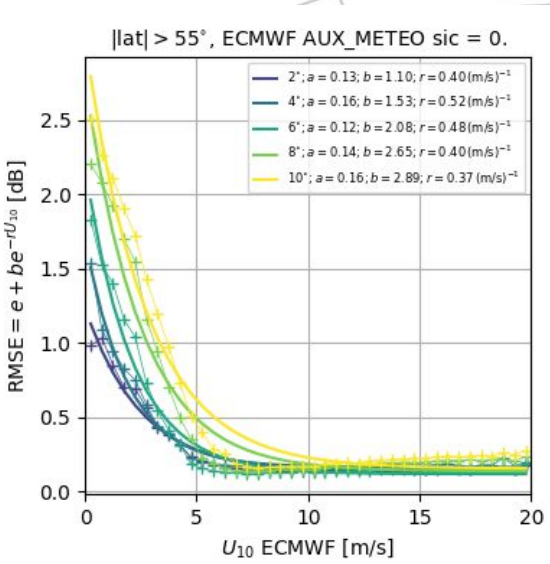
and converted back to **L1a** GMFs

Open water GMF

- U_{10}, H_S, incidence angle and beam number as variables
- Based on classical geometric optics, with physics-based parameterizations, and compared against GPM
- Fully analytical parametrizations in order to be applicable in all types of (H_S,U_{10}) conditions

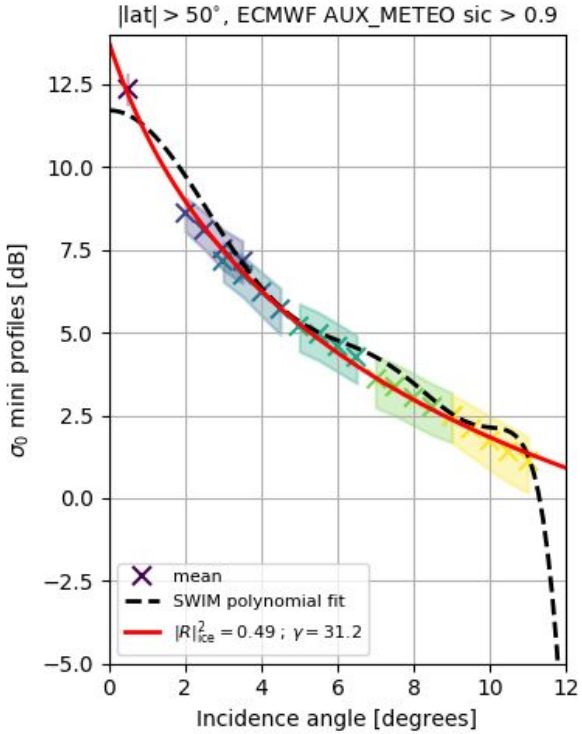


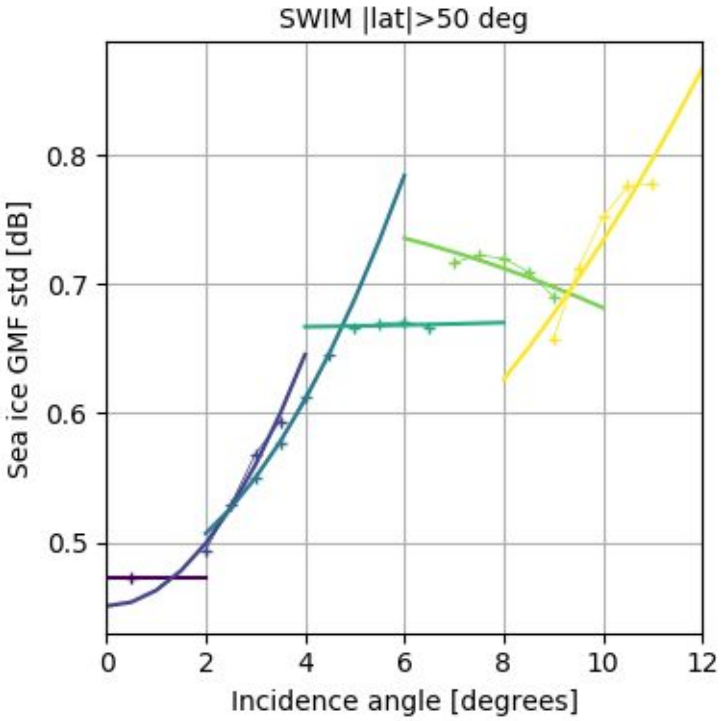




Sea-ice GMF

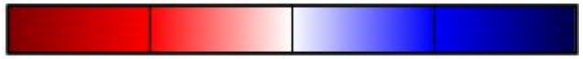
- Incidence as the only variable
- Based on previously proposed GMFs for exponentially correlated surfaces

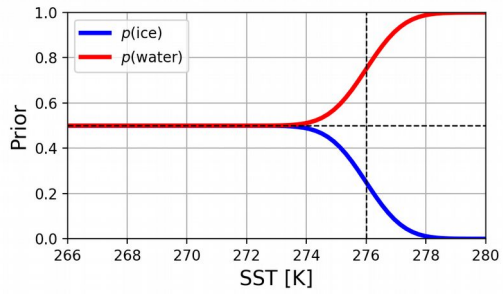


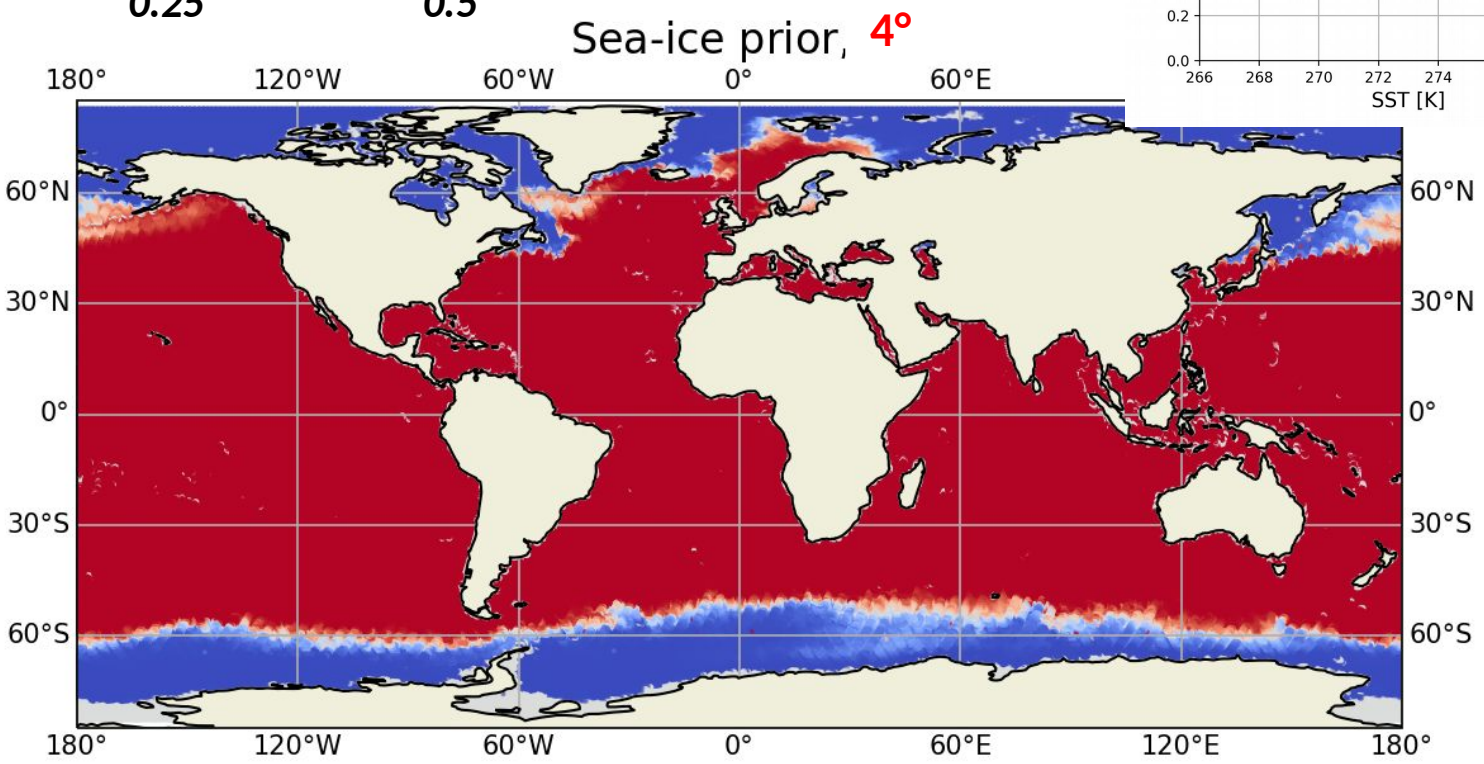


A priori

Useful in order to avoid outliers far from polar regions







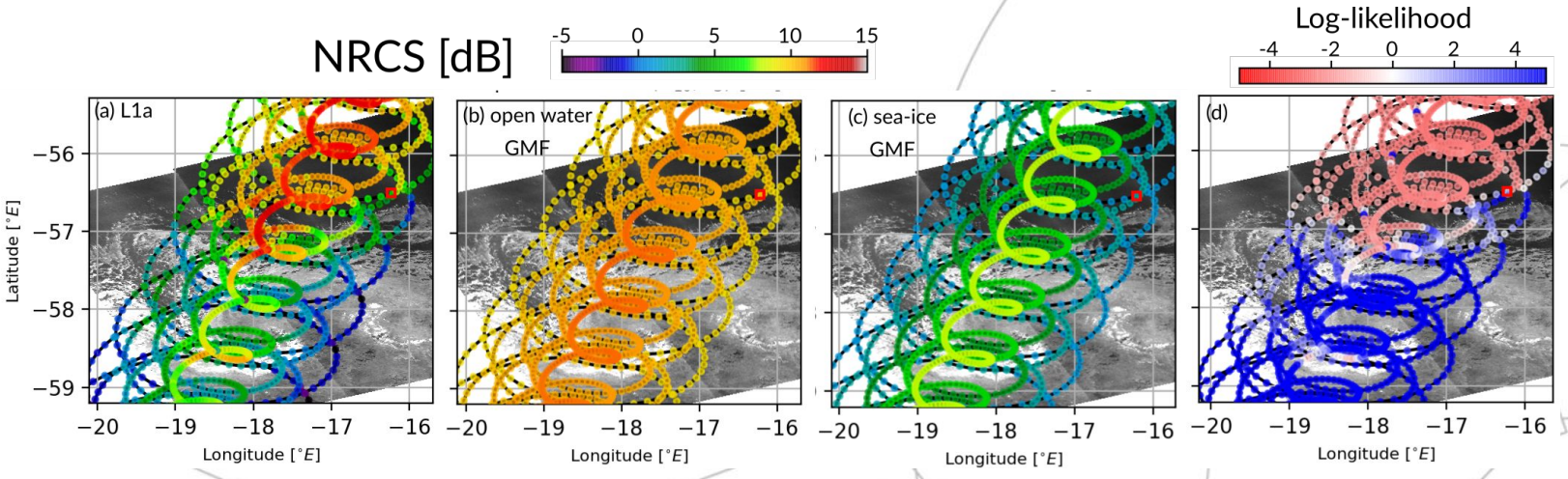
Processed over L1a
24/02/2021 to 09/03/2021

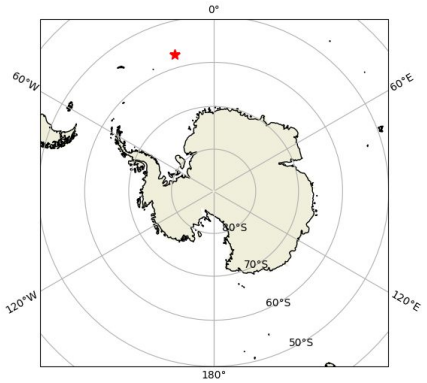
Mid latitude outliers are penalized while cold SST areas are not favorized

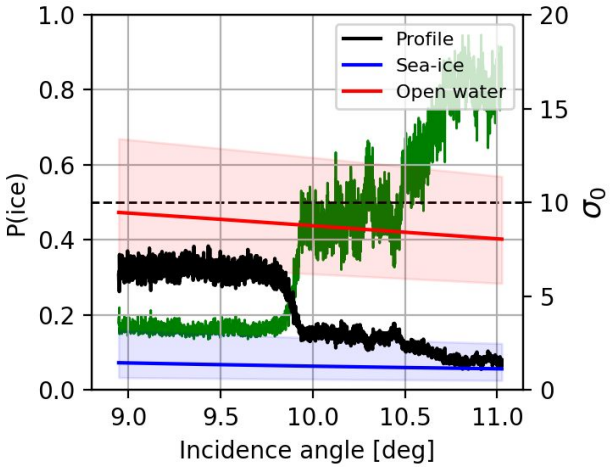
Test case

Colocated with Sentinel 1 on 07/10/2020

S1B_EW_OCN__2SDH_20201007T202743_20201007T202837_023711_02D0EF_E580.SAFE, HV channel



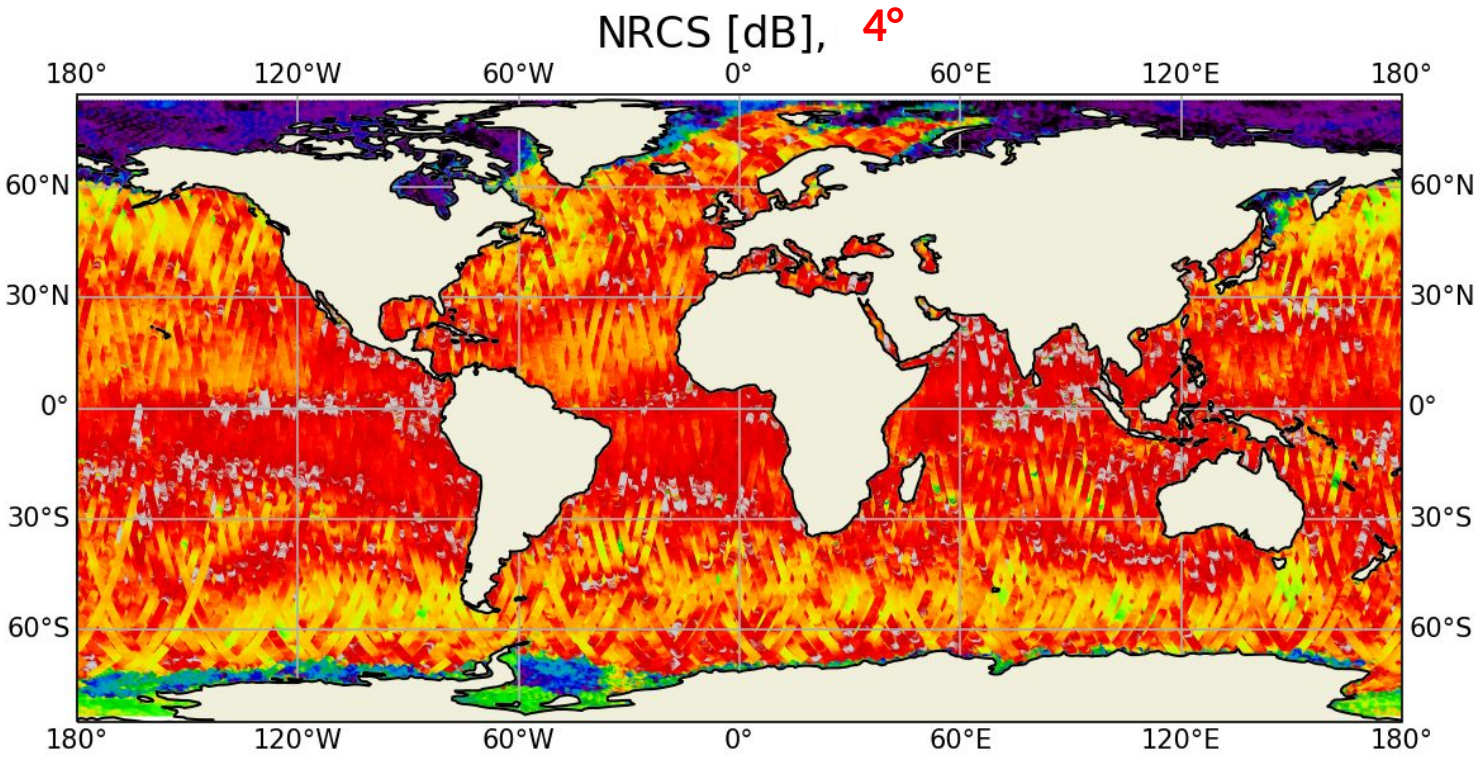




Example output - NRCS

Averaged over individual profiles

Processed over L1a
24/02/2021 to 09/03/2021



Example output – mean P(ice)

Averaged over individual profiles

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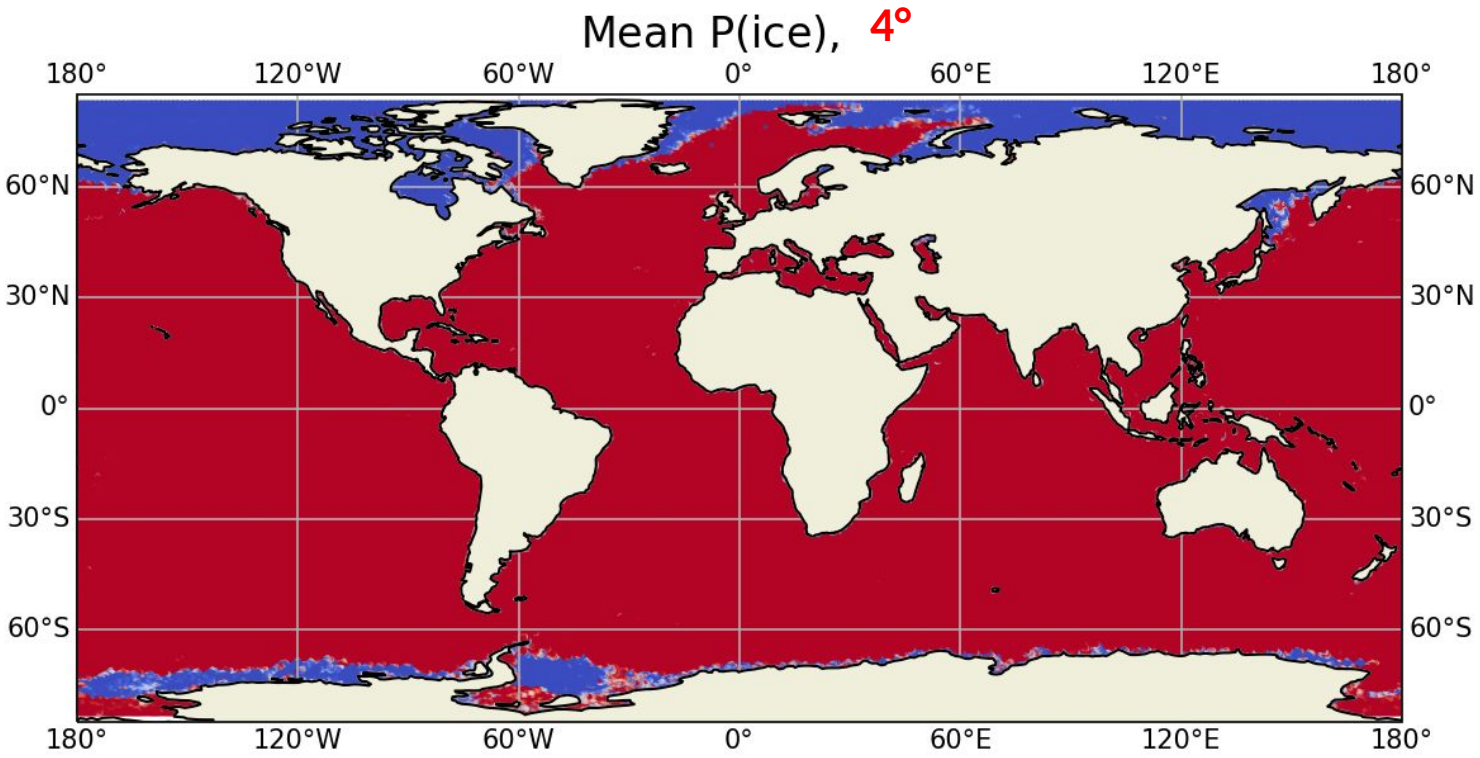
24/02/2021 to 09/03/2021



Example output – max. P(ice)

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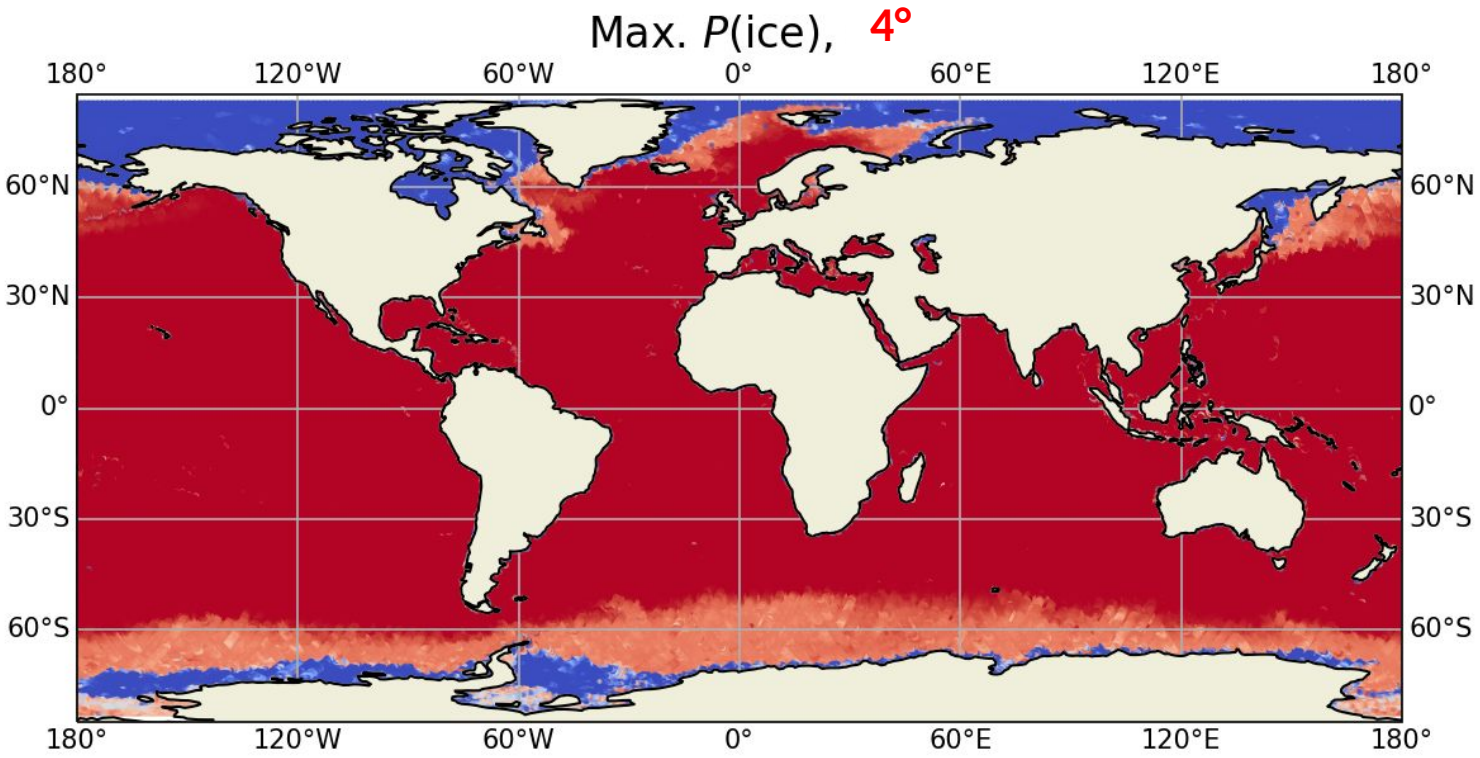


Example output – comparison with SSMI

Averaged over individual profiles

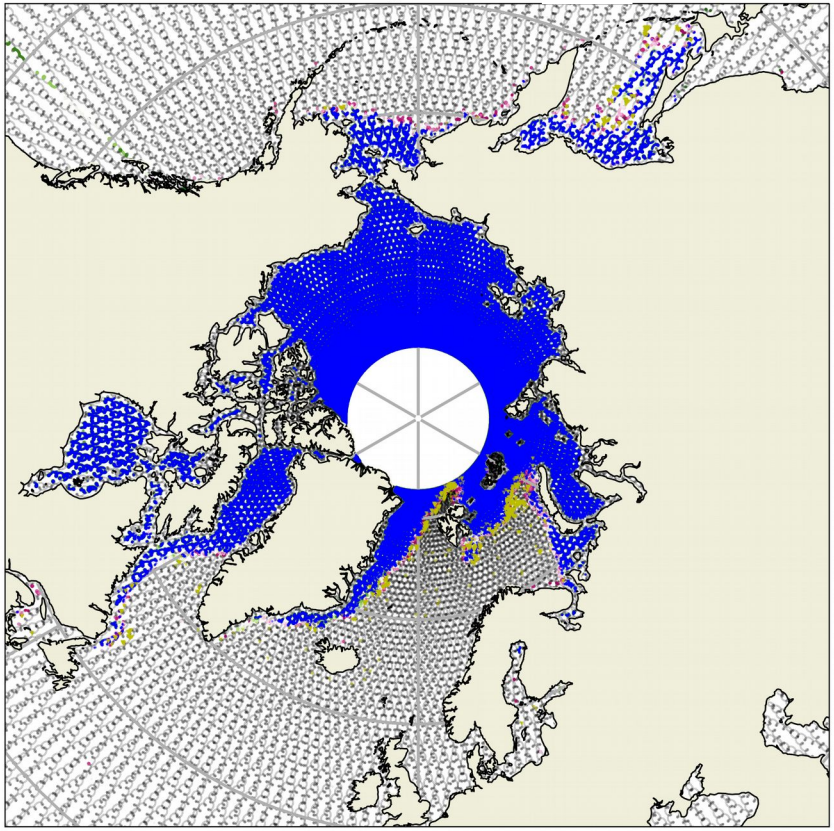
Processed over L1a
24/02/2021 to 09/03/2021

False negative SSMI (12km) concentration

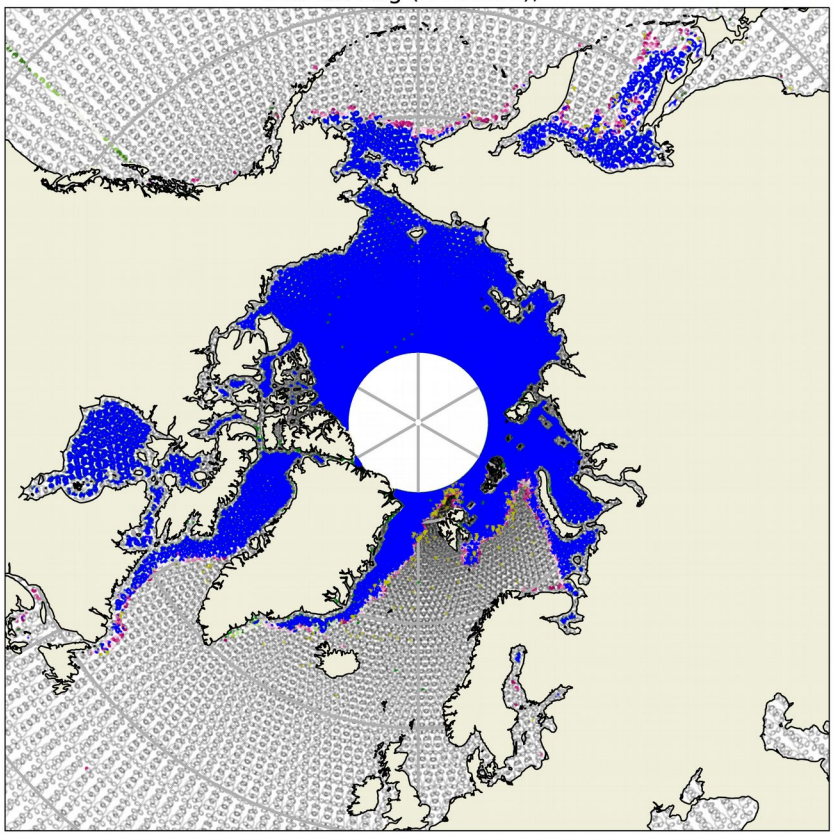
0 0.5 1

● True positive detections ▲ False positive detections

Sea-ice flag (L2 beam), 2°



Sea-ice flag (L2 beam), 4°



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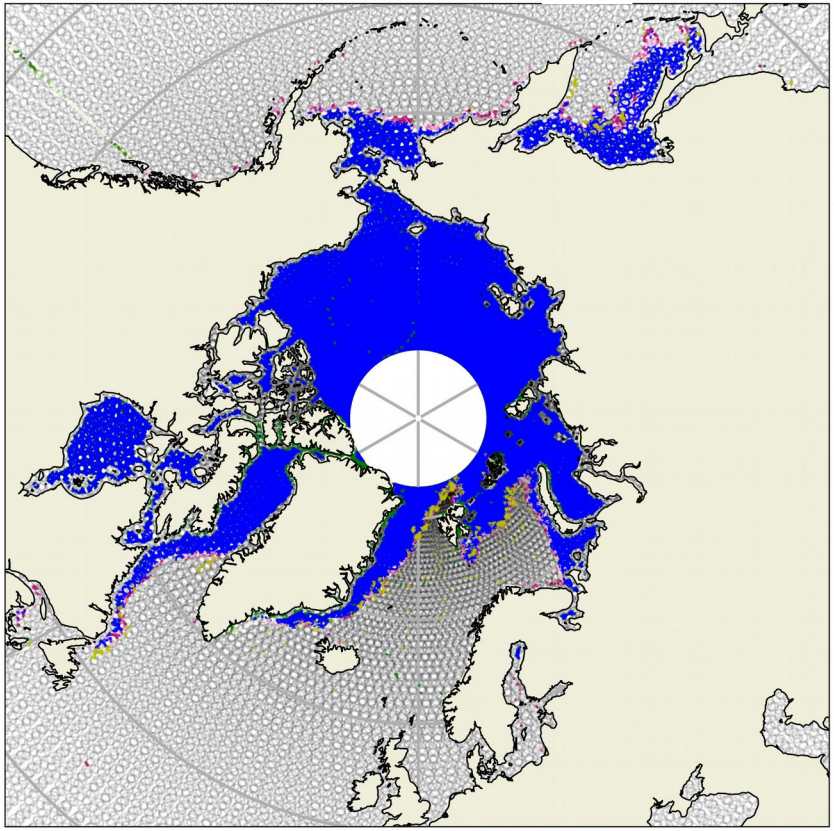
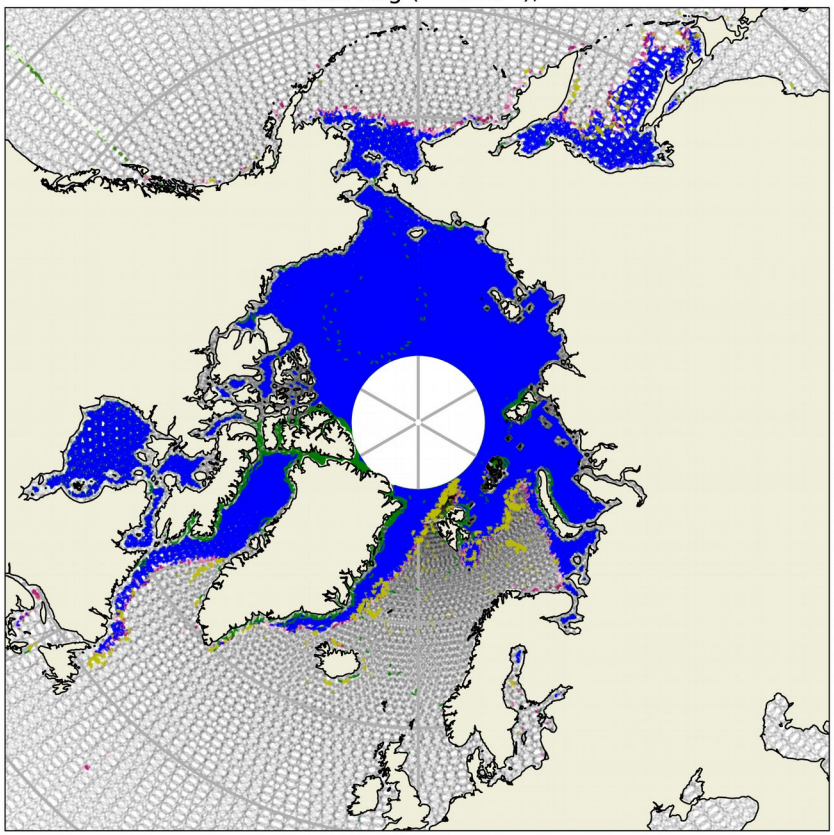


Sea-ice flag (L2 beam), 8°



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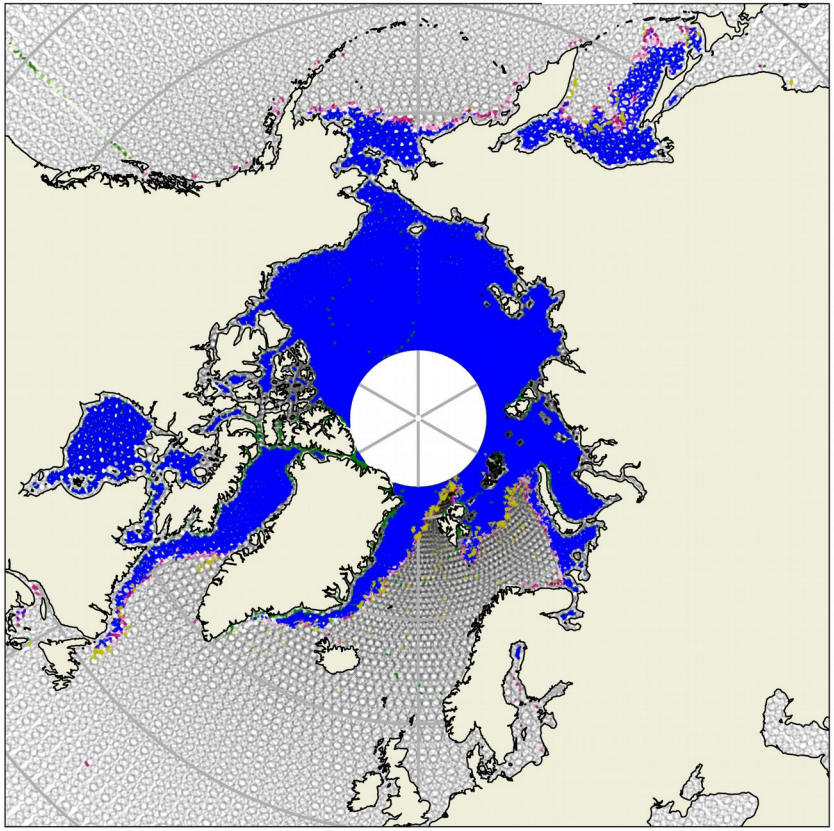
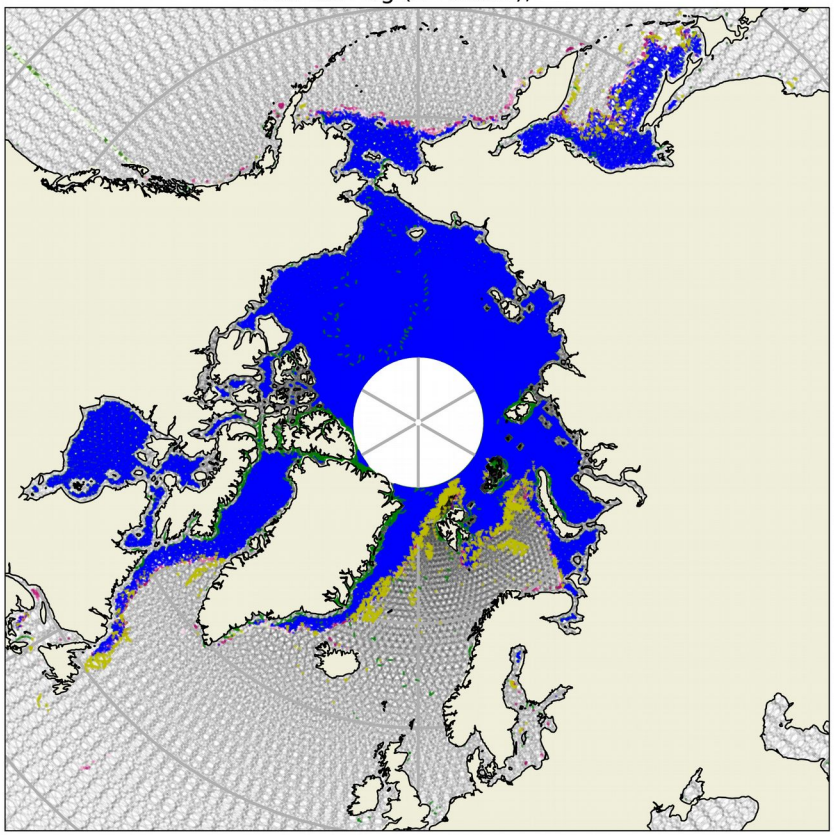


Sea-ice flag (L2 beam), 10°



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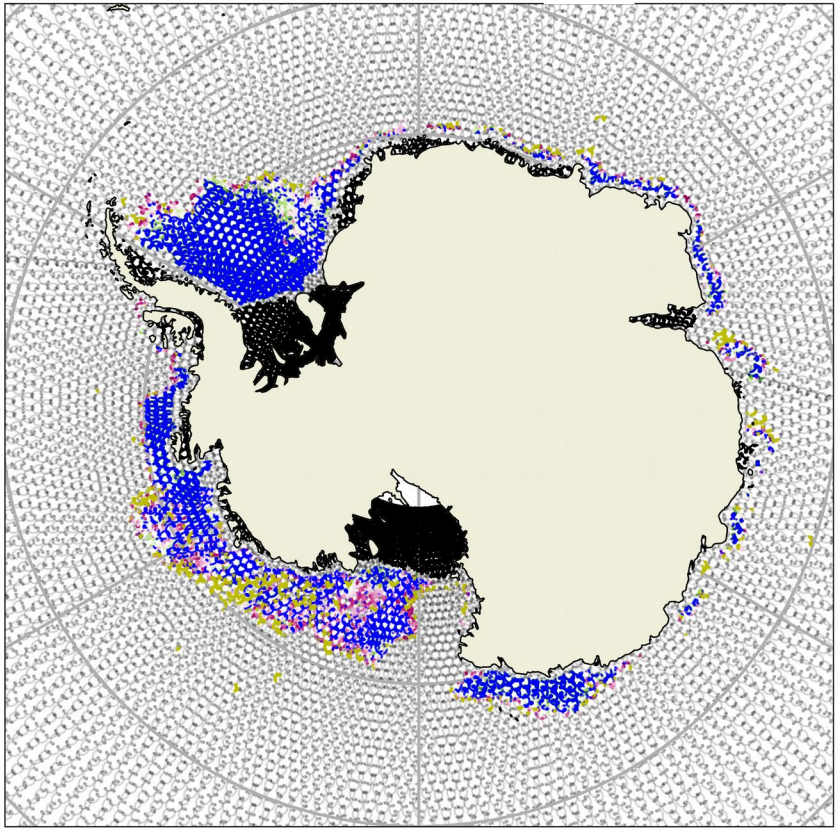

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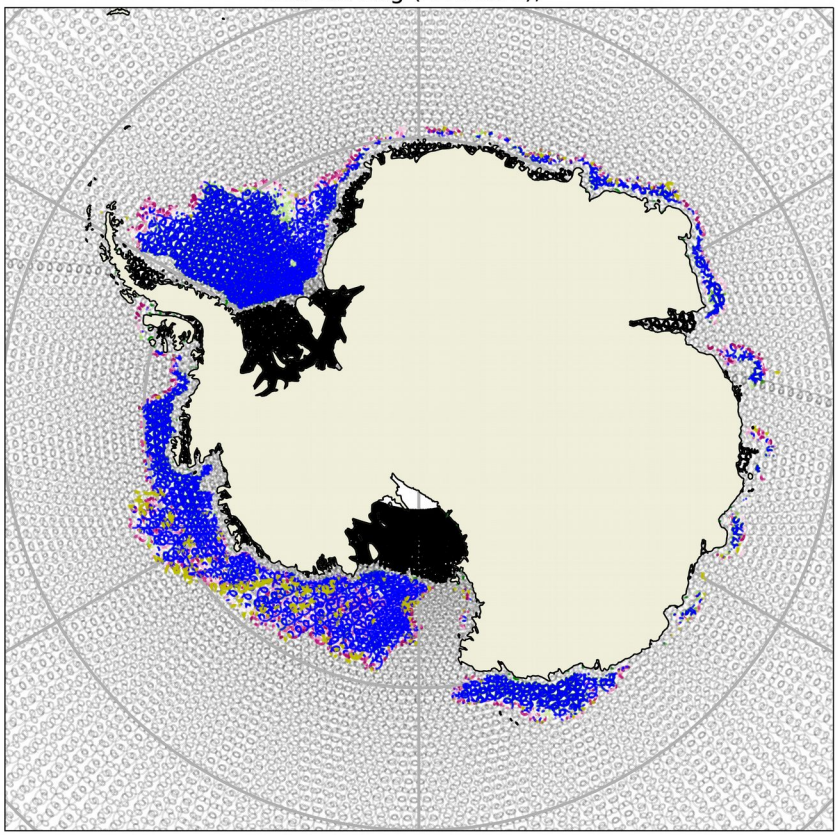

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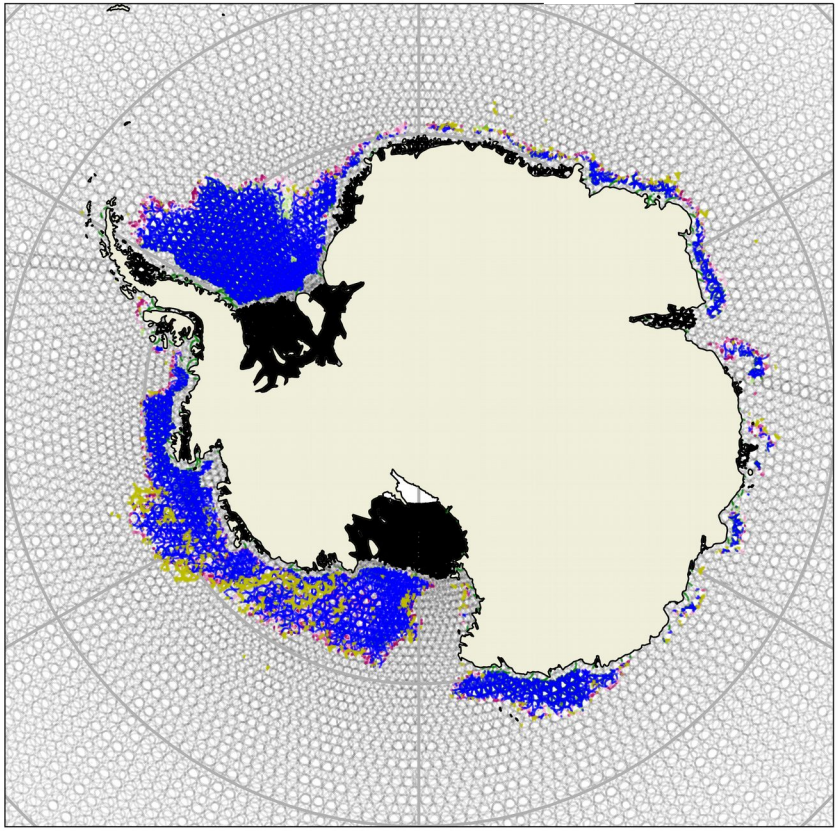

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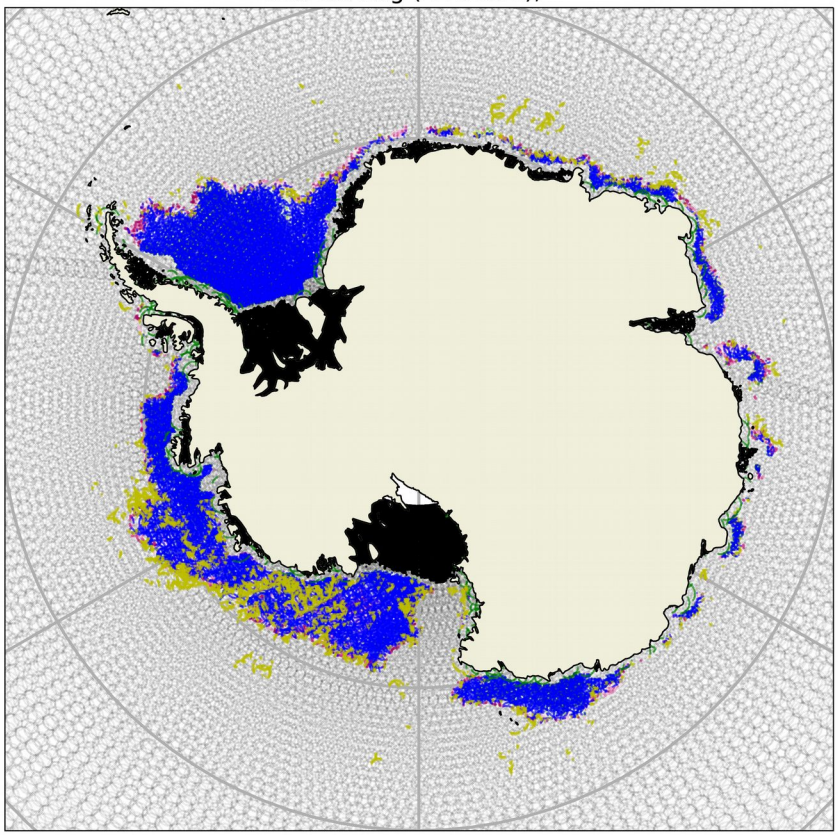

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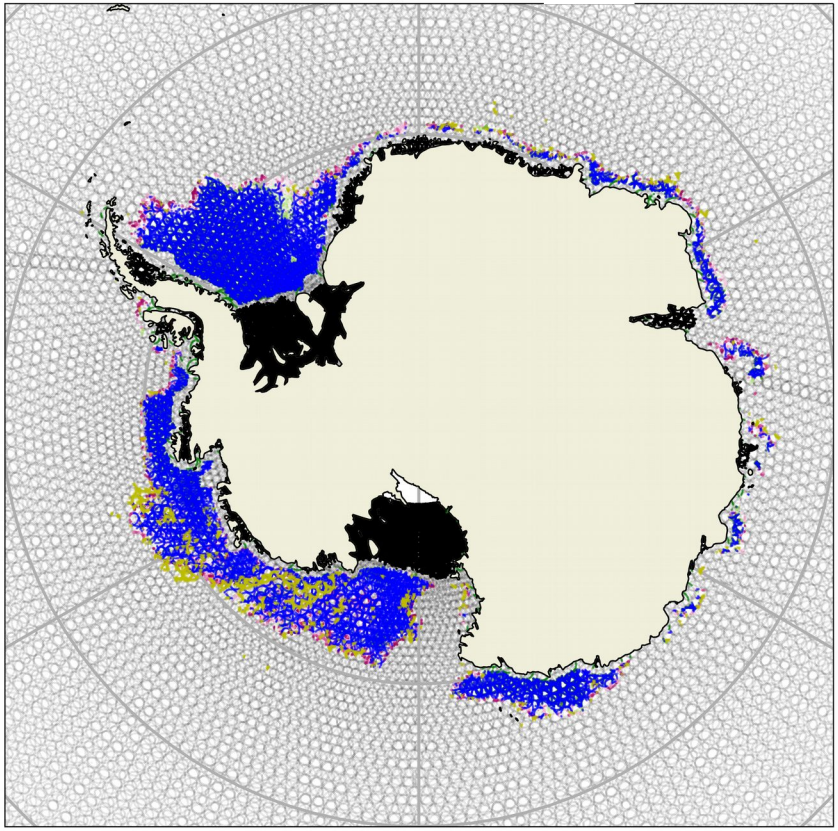

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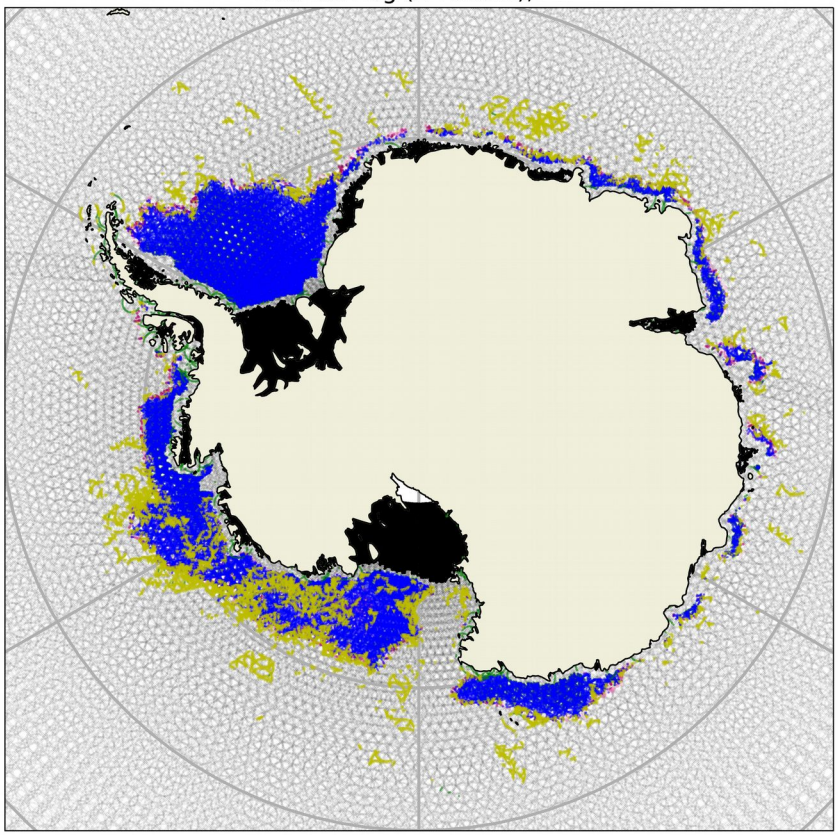

Conclusions

Mature open water & sea-ice GMFs

- Fully analytical
- Comparison with GPM

Sea-ice flag with good performances

- No pollution of low latitudes
- Compared with SSMI
- Performances from beam to beam being qualified

Possible improvements

- Sea-ice derived products
- Potential for further improvements and better characterization of sea-ice (GMF)

→ Publication to be submitted for CFOSAT special issue