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TAKING THE PULSE OF OUR PLANET FROM SPACE

Super-resolution of sea ice thickness from satellite data

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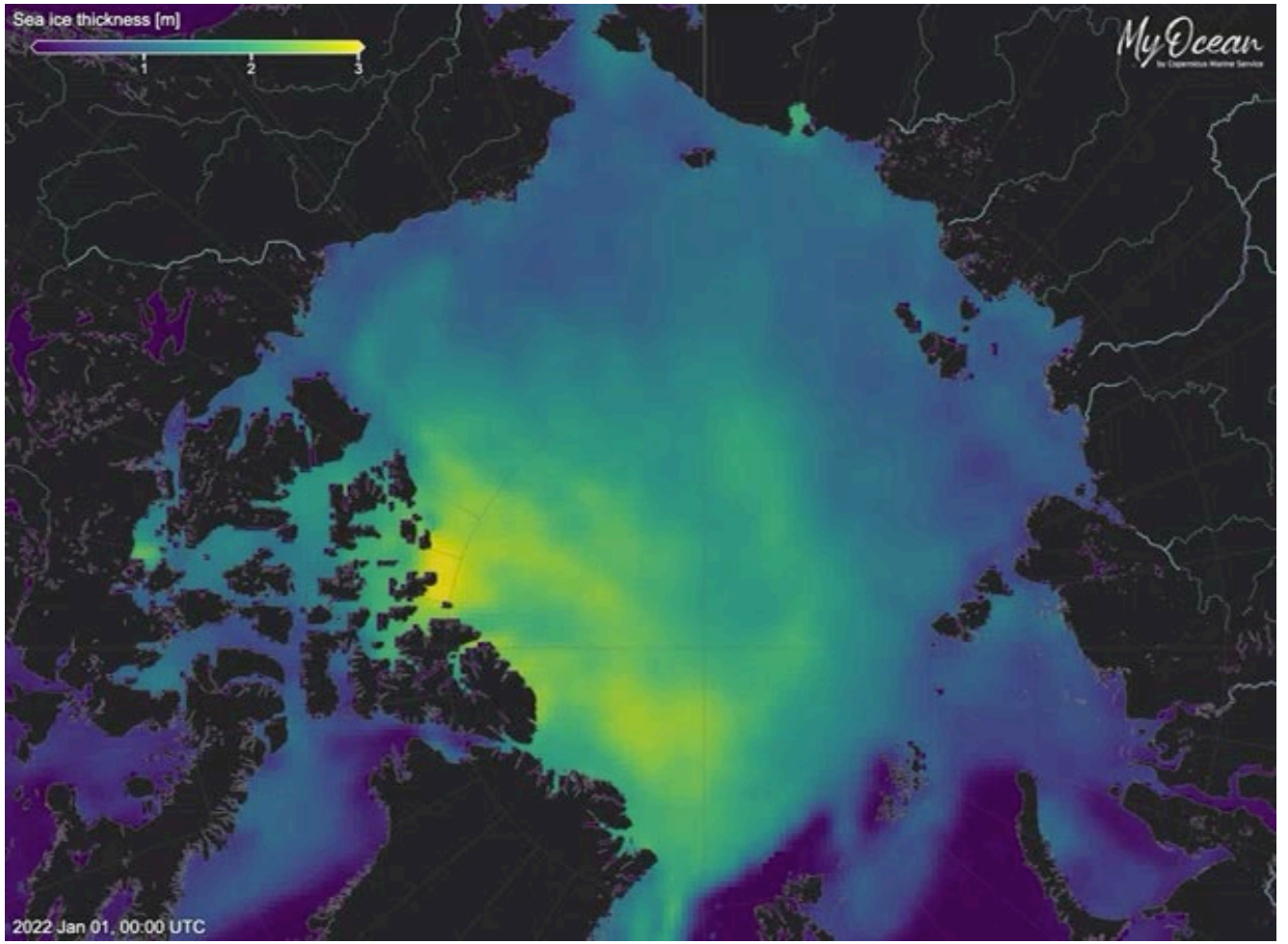
Sea-ice thickess from satellite

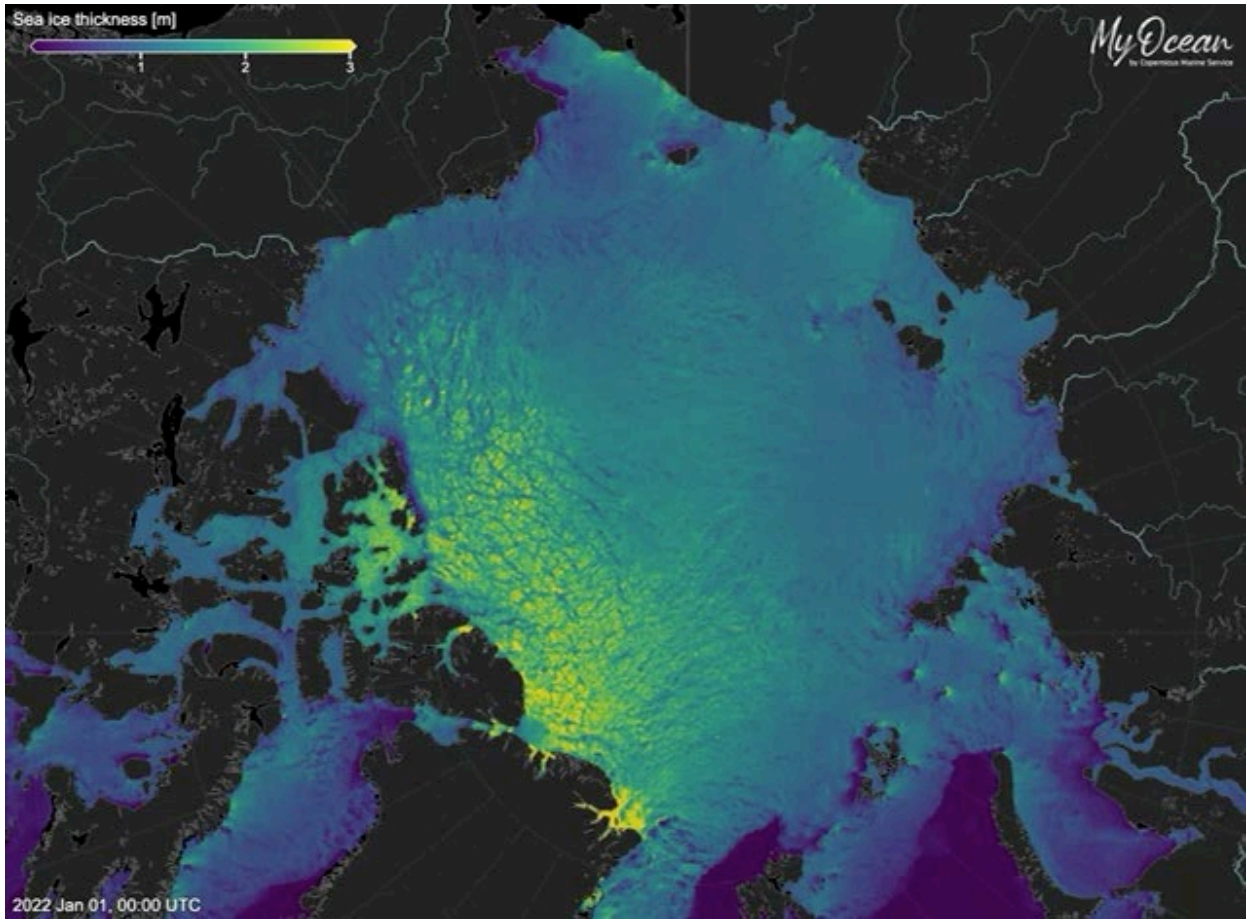
Observation product from merging CryoSat-2 and SMOS

AWI / CMEMS



1-31 January 2022

Simulation of a realistic sea-ice model

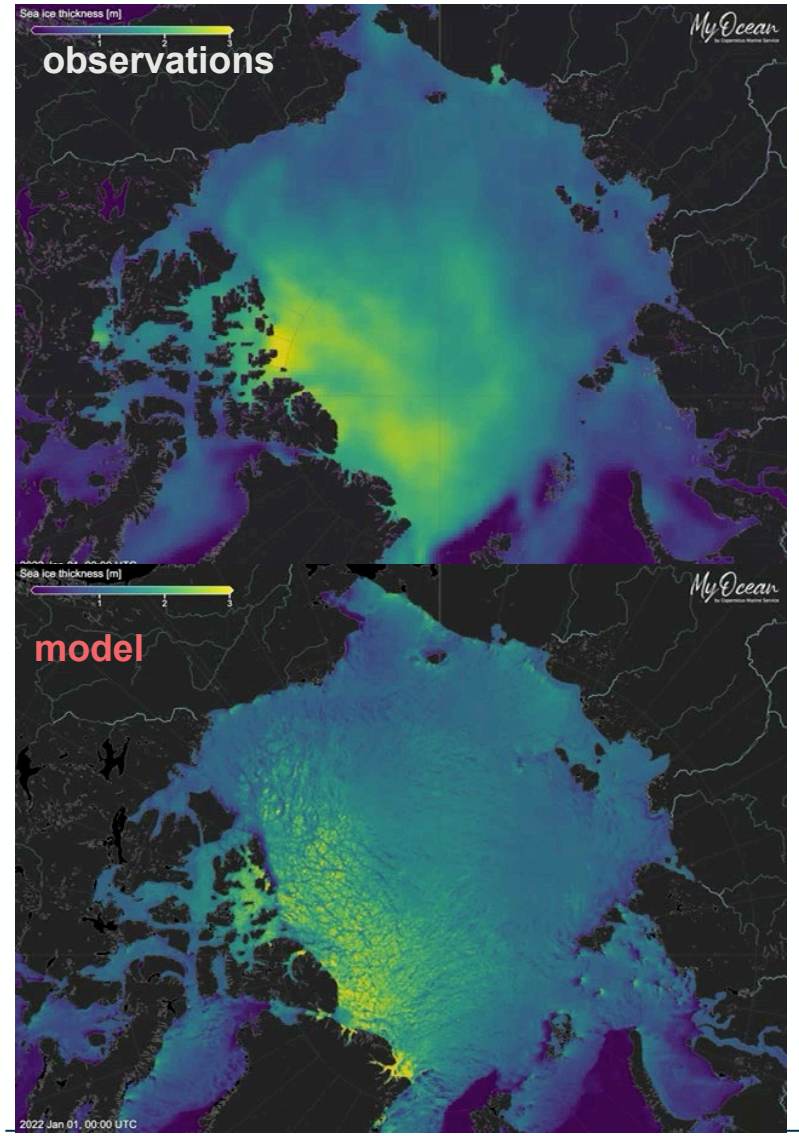


1-31 January 2022

Simulation from the **model**

NextSIM
NERSC/CMEMS

Small scales are not resolved by the satellite product

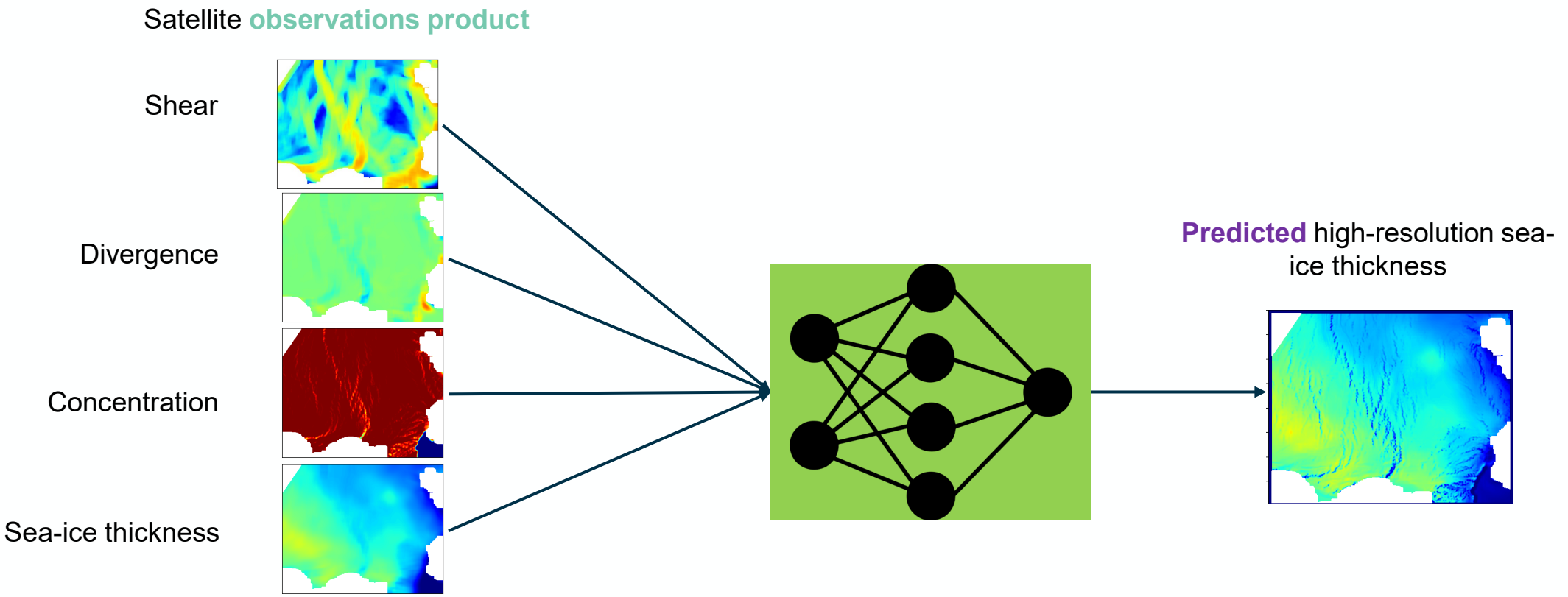


Small scales are important:

- Predictability of the sea-ice
- Estimation of heat flux through the ice
- …

Our approach

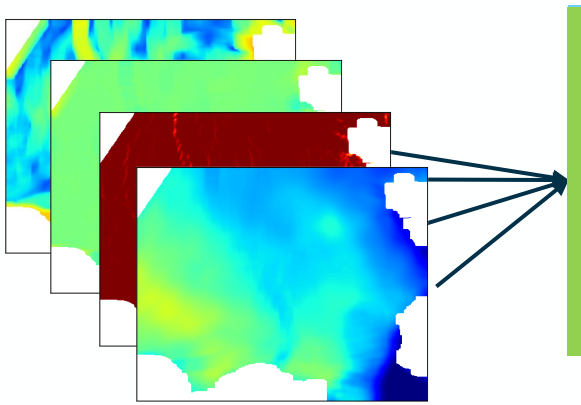
We train a neural-network that takes low-resolution satellite observations in input and predict high-resolution sea-ice thickness

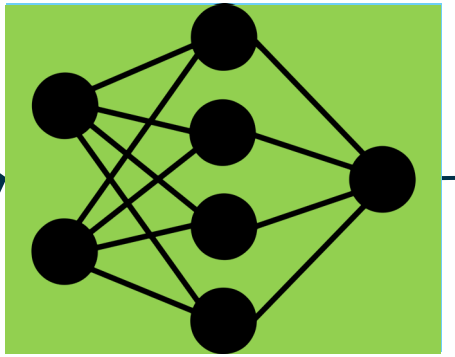


Two-phases algorithm

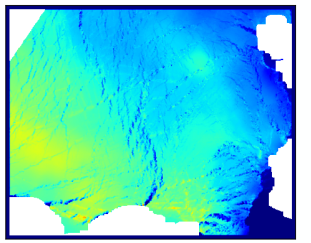
1. Training phase

Smoothed observable **model** variables



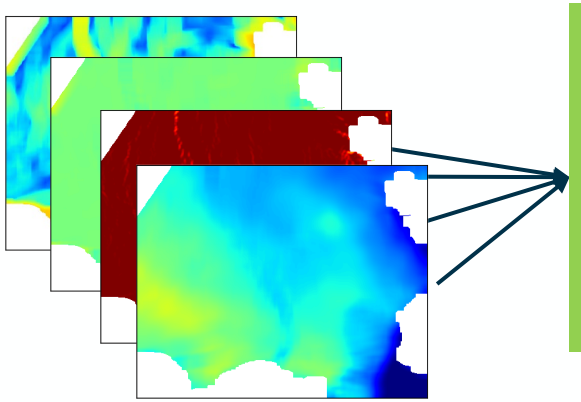


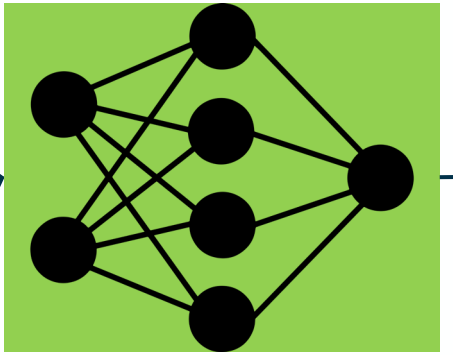
Model High-resolution sea-ice thickness



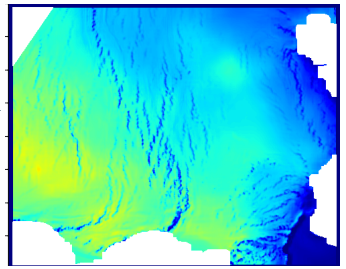
2. Operational phase (inference)

Satellite **observations**

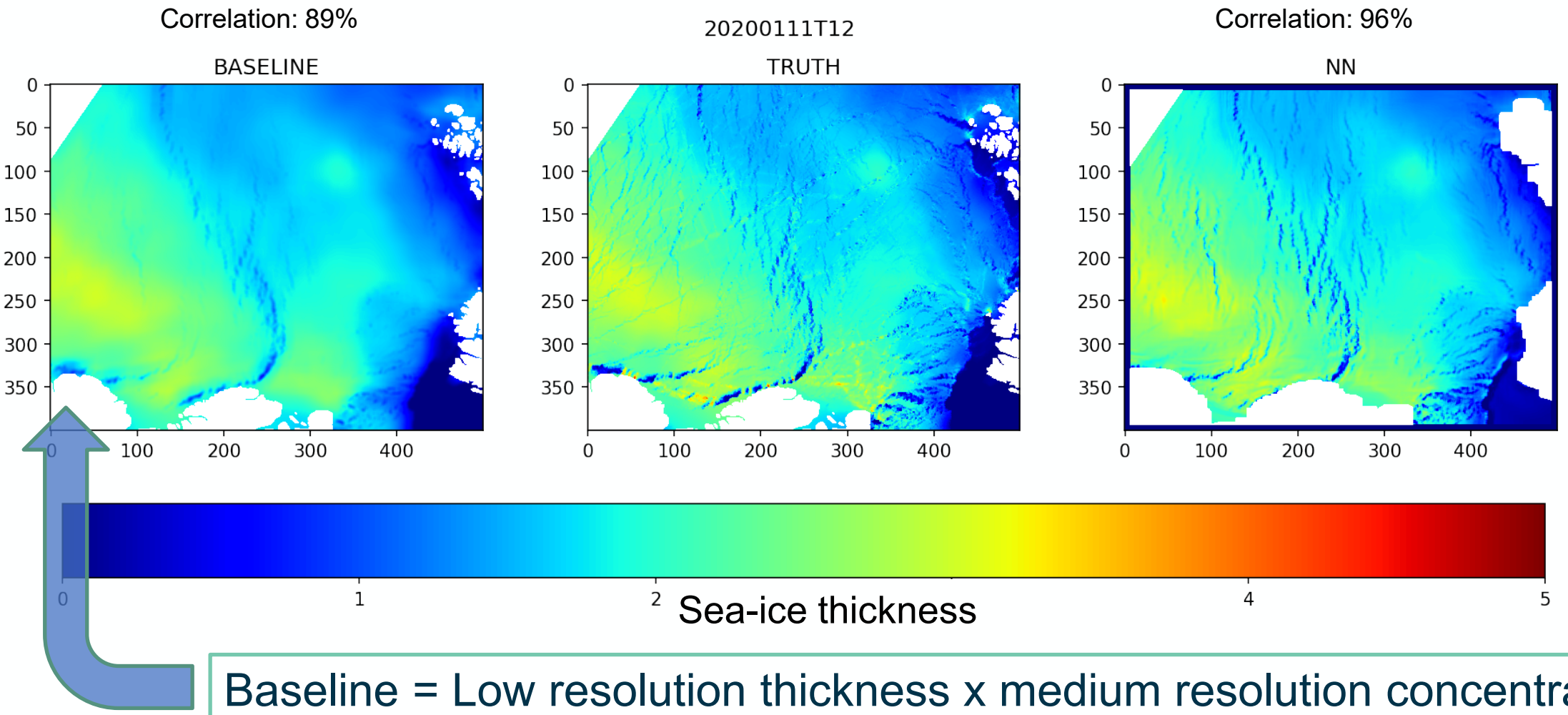




Predicted high-resolution sea-ice thickness

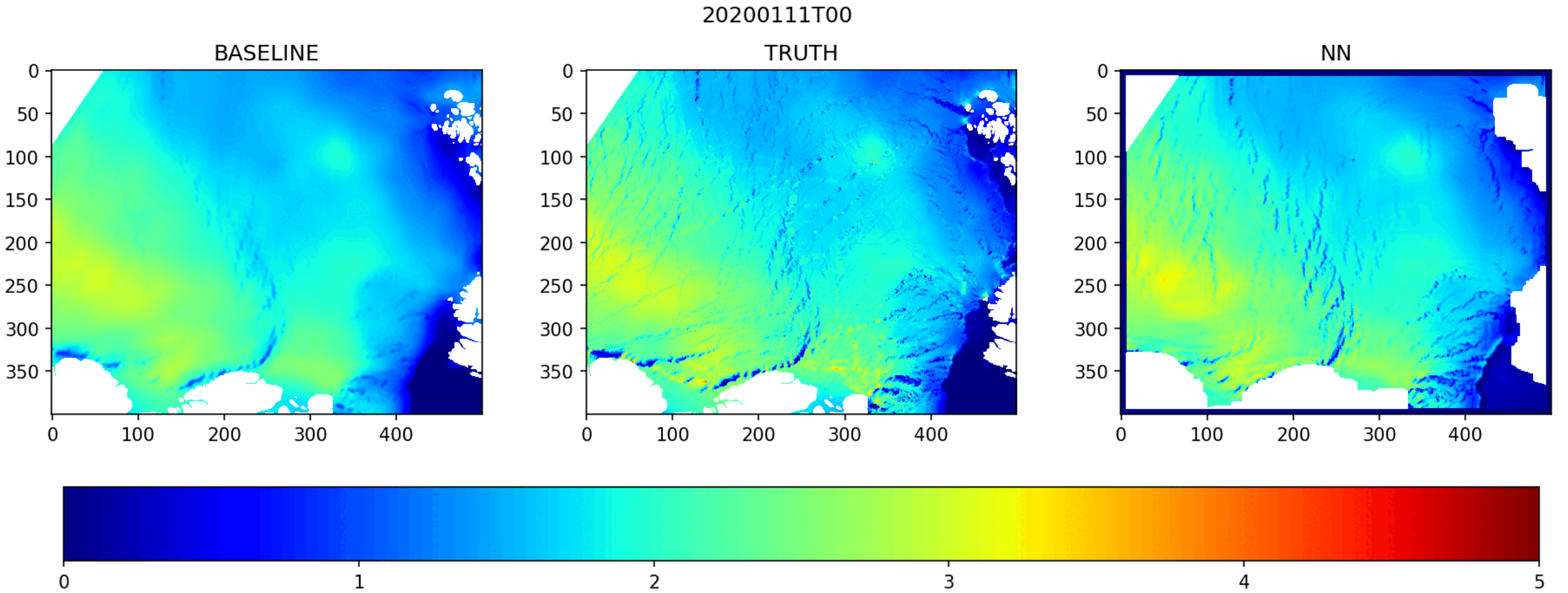


Results on a synthetic image

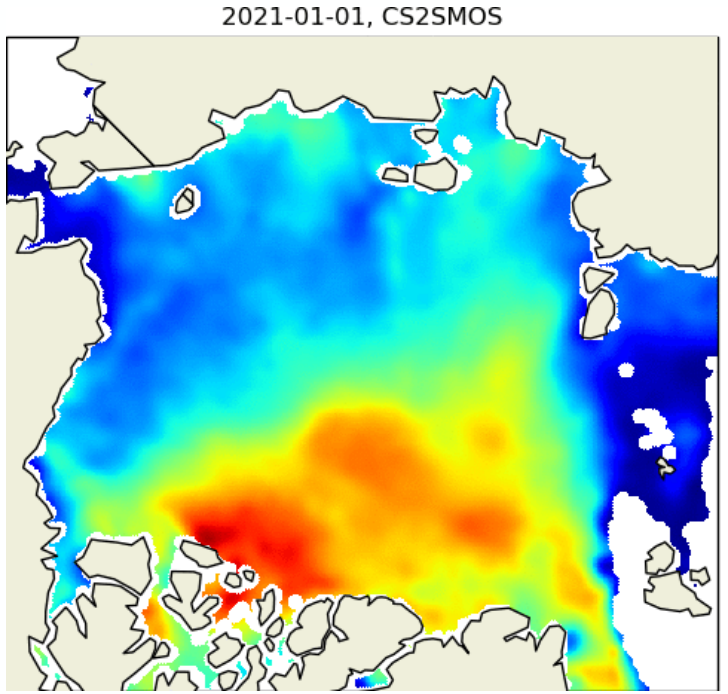


Baseline = Low resolution thickness x medium resolution concentration

Results on a synthetic image

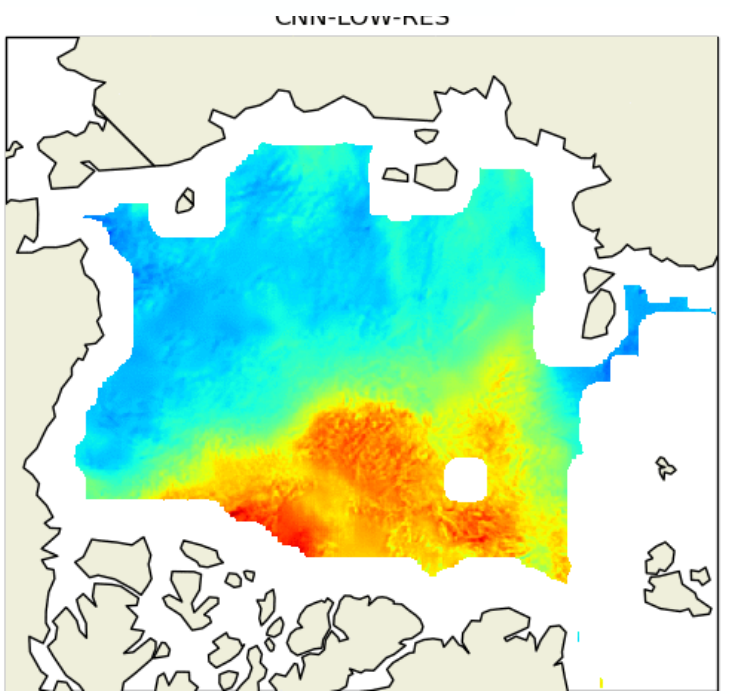


Result on satellite products



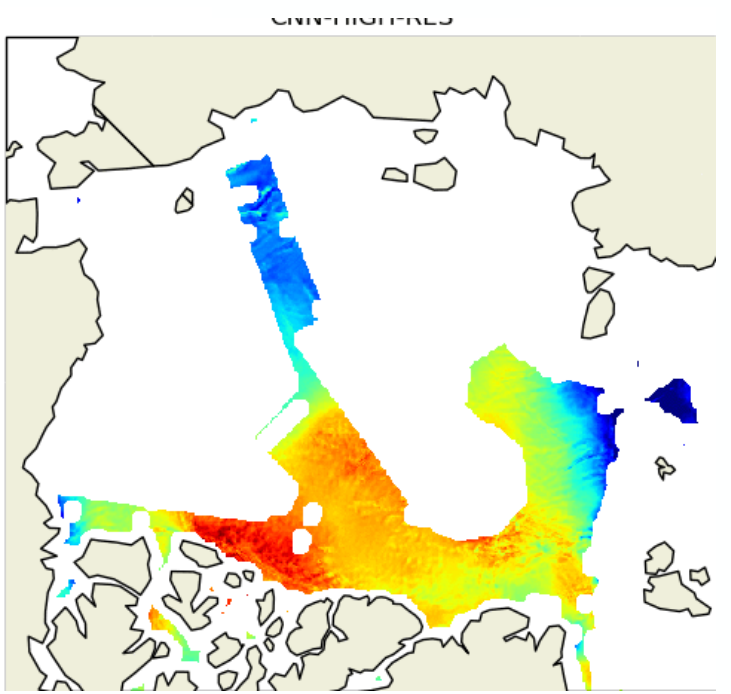
current satellite product

CNN-LR

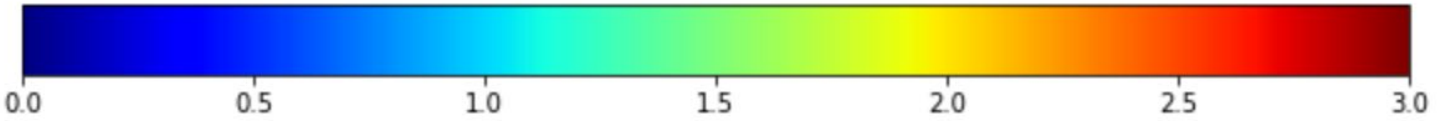


Neural Net for Passive microwave ice drift

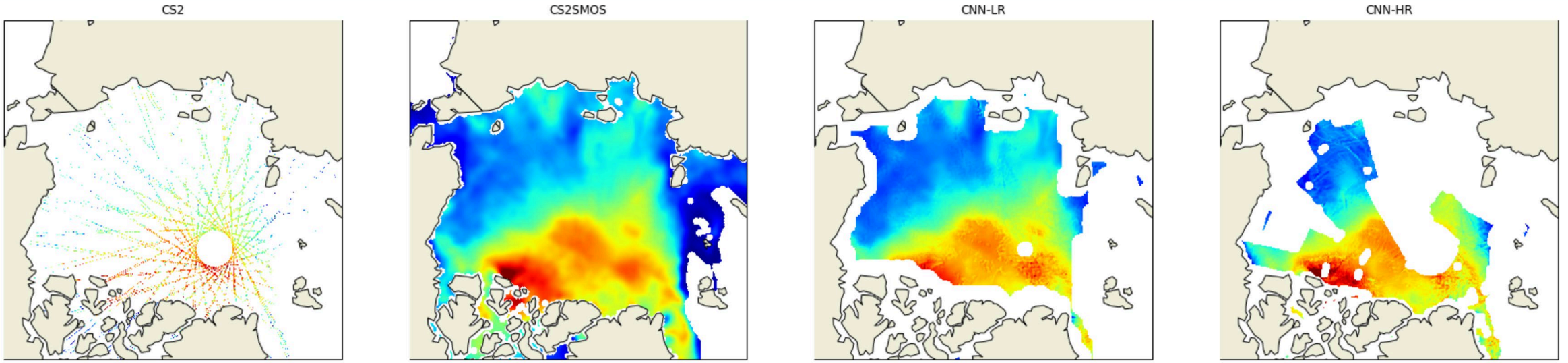
CNN-HR

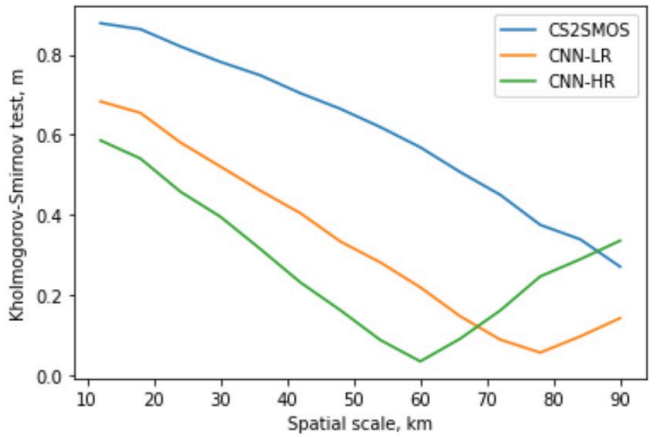


Neural Net for SAR ice drift



Validation against Cryosat-2





- Anomalies are computed at different spatial resolutions for **CryoSat-2** and the products **CS2SMOS**, **CNN-LR**, **CNN-HR**
- The **distribution of anomalies** are compared against CryoSat-2 distribution using statistical metric (Kolmogorov-Smirnov)

Conclusion

The variability of **sea ice thickness** anomalies **has been improved** by the neural network (up to a 60 km resolution for CNN-HR and 80 km for CNN-LR)

Conclusion

- A neural network approach trained on **model data** is able to enhance **satellite** resolution and can be used to better estimate sea ice distribution.
- Results have been validated against Cryosat2 data

Potential applications:

- Assimilation of sea-ice thickness distribution within each grid cell
- Localisation of cracks in numerical models
- Better estimation of heat flux from satellite