SuperIce - Super-resolution of sea ice thickness by combining machine learning and physical-based approach

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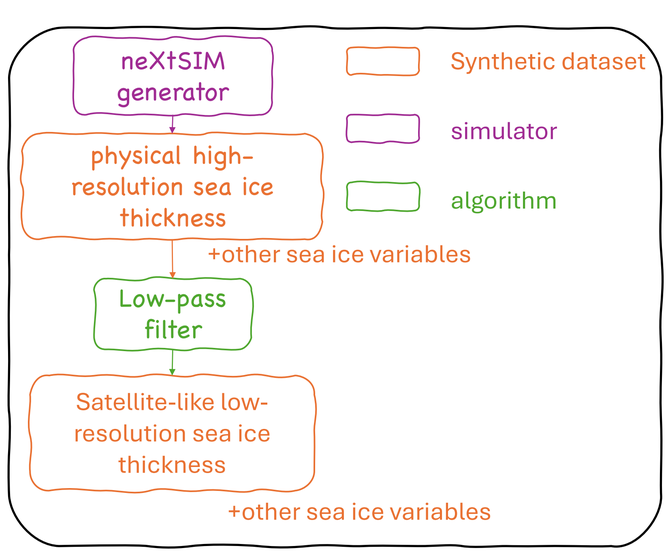
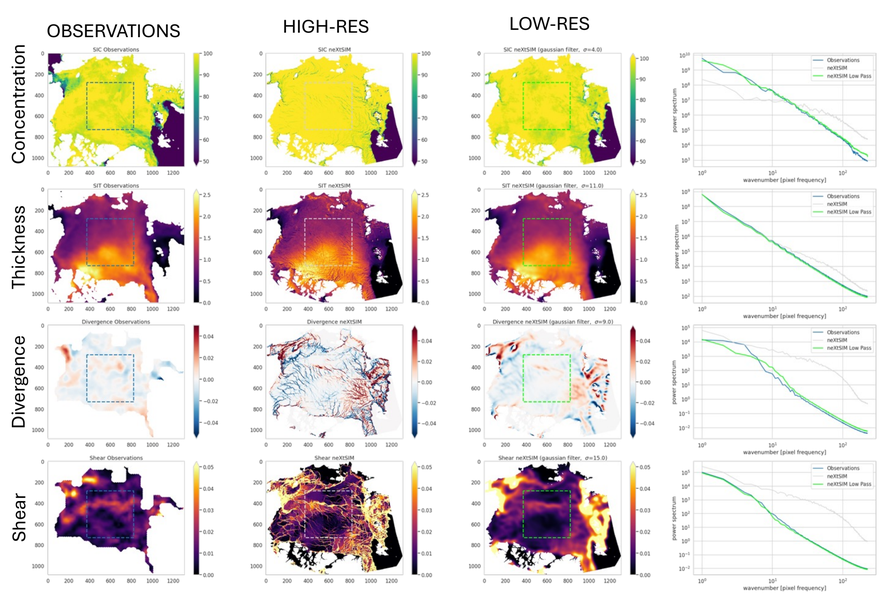
Motivation	✓ **Arctic Sea-ice thickness (SIT) satellite observations have insufficient resolution** ✓ It can degrade the initialization of seasonal forecast ✓ It leads to underestimated surface heat fluxes
Objective	✓ Produce a high-resolution Sea-ice thickness product using a combination of physical modelling and artificial intelligence
Method	✓ High-resolution simulation with the NeXtSIM sea-ice model ✓ AI super-resolution with diffusion models

STEP 1: CREATE THE DATASET





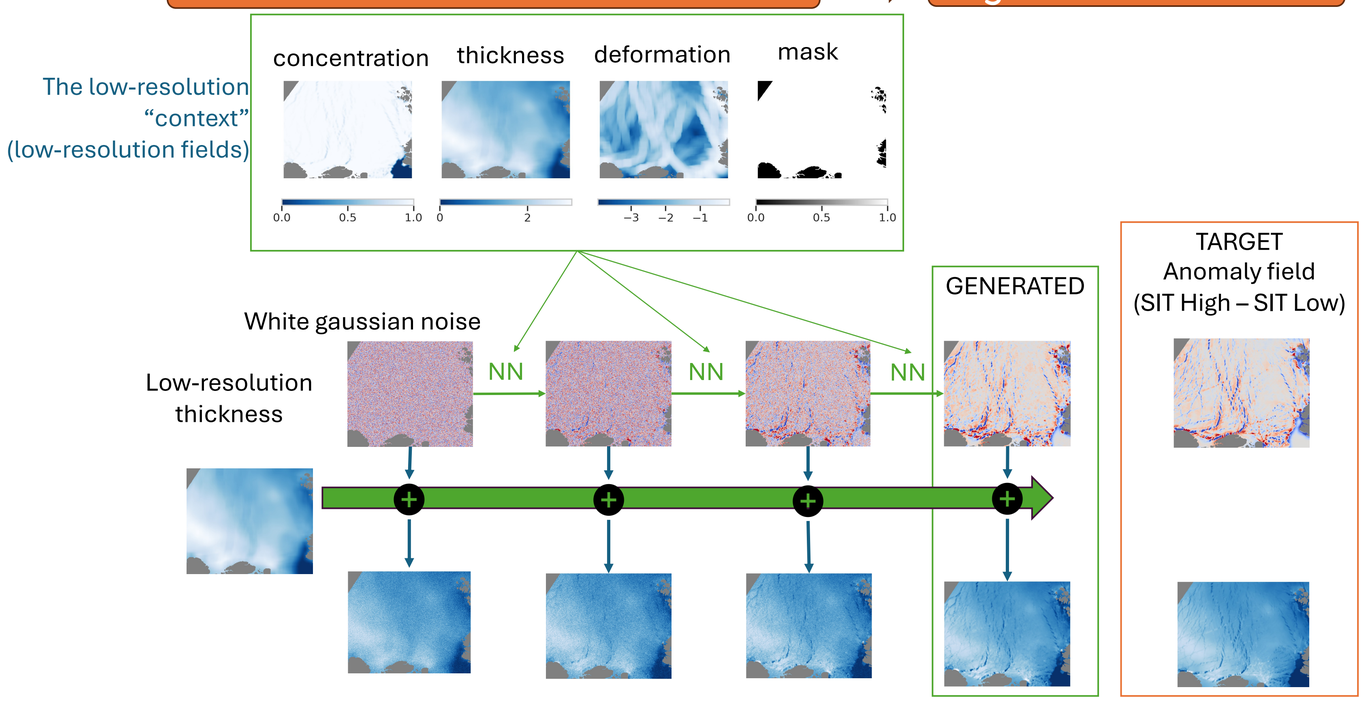
- ✓ High-resolution dataset produced by the physical model NeXtSIM (Olason et al., 2022)
- ✓ Filtering and physically realistic noise was added to mimic low-resolution satellite data
- ✓ Matching high-res/low-res fields are available for every winter 2013-2023 https://archive.norstore.no/pages/public/datasetDetail.jsf?id=10.11582/2024.00126

Download the dataset

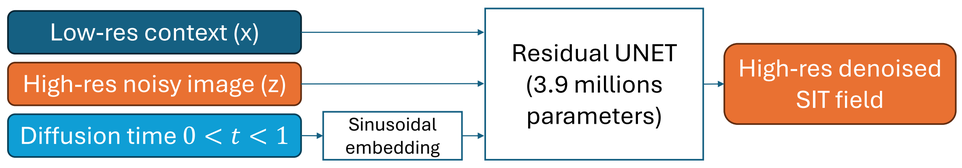
STEP 2: TRAIN THE MODEL

Principle of the diffusion model

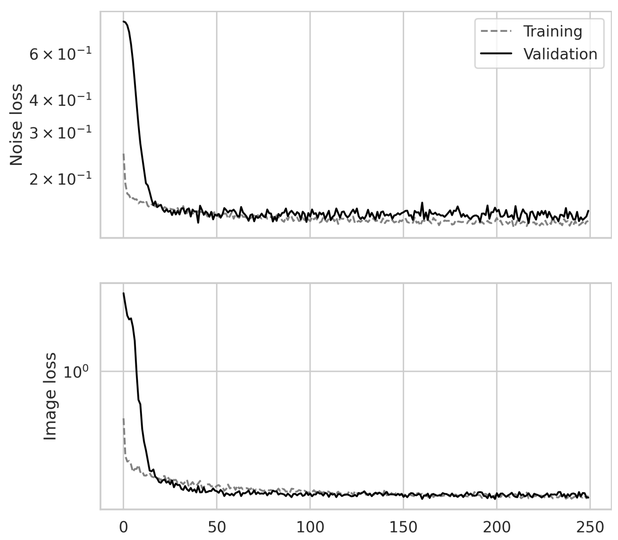
Observable low-resolution fields → high-resolution fields



Neural net architecture

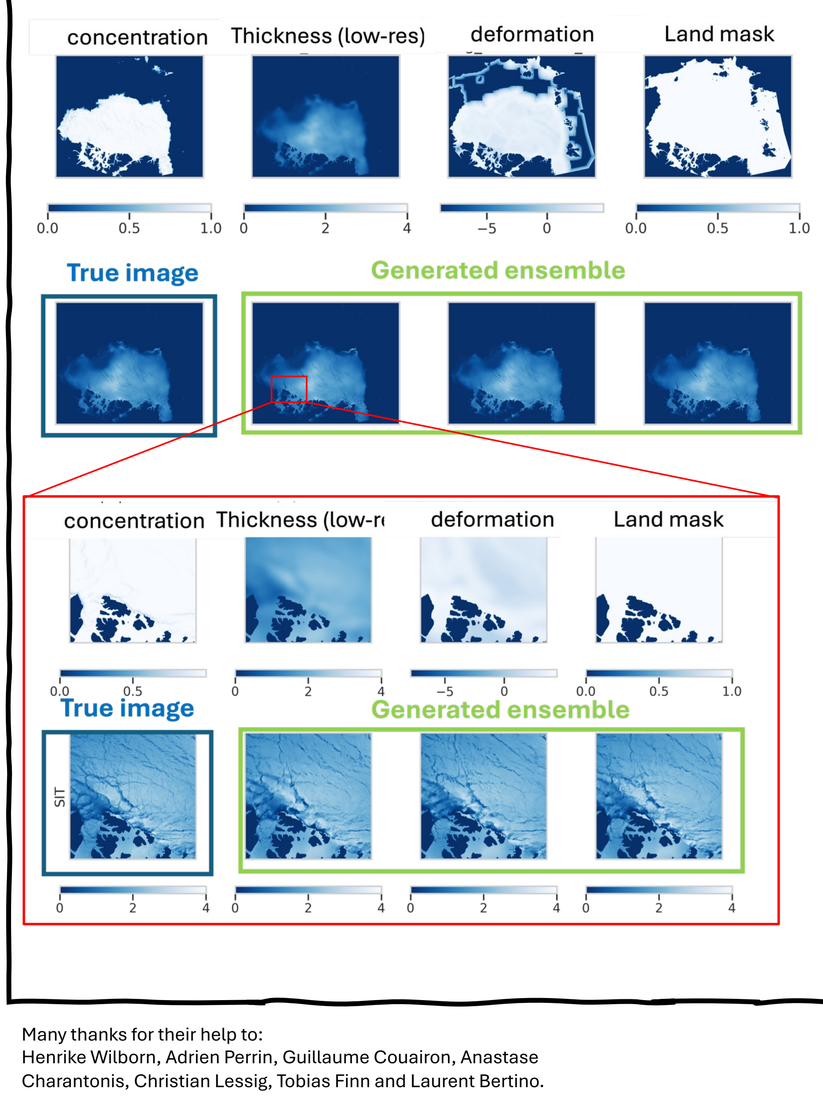


Training

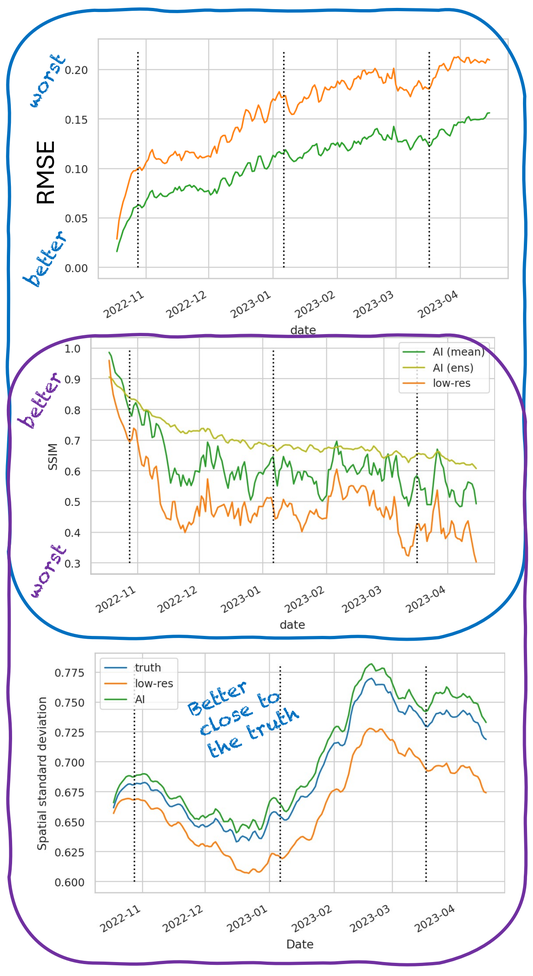


STEP 3: ASSESS

Generated field 23/10/2020



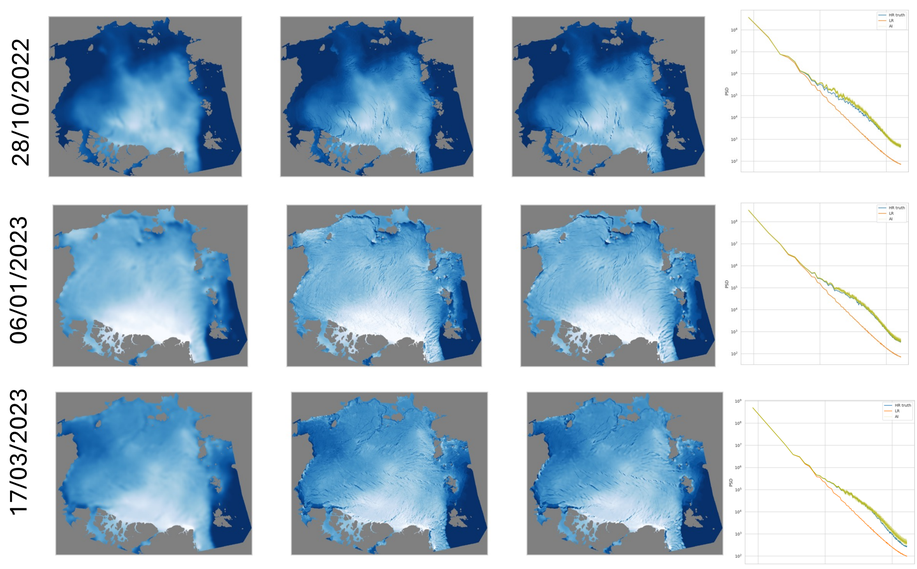
Metrics over the test set (2022-2023)



Metrics used:

- ✓ **Accuracy:** Root-mean square error (**RMSE**), Structural similarity index measure (**SSIM**)
- ✓ **Realism:** **spatial standard deviation**, SSIM, Power spectral density (**PSD**)

Examples of generated SIT



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More on the SuperIce project: https://nansencenter.github.io/superice-nersc/