Deep learning can correct model errors from the subgrid-scale **for sea-ice dynamics**

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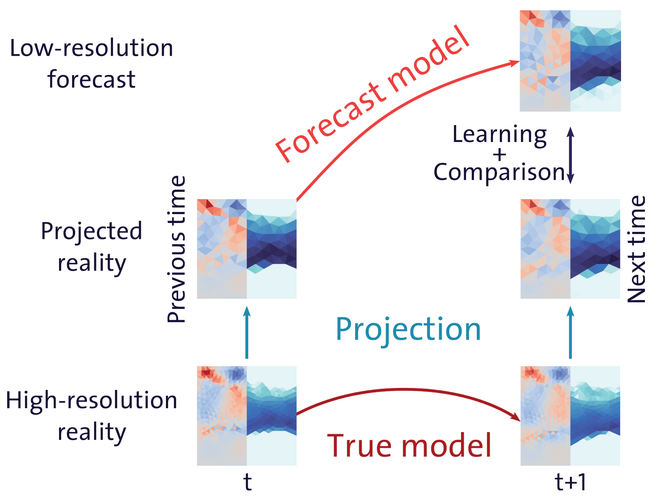
Motivation

Unresolved subgrid-scale processes make sea-ice predictions difficult.

Sea ice induces new issues for deep learning methods by the marginal ice zone, multifractality, and anisotropy.

Method should be scalable to arctic-wide simulations with neXtSIM (Rampal et al., 2016).

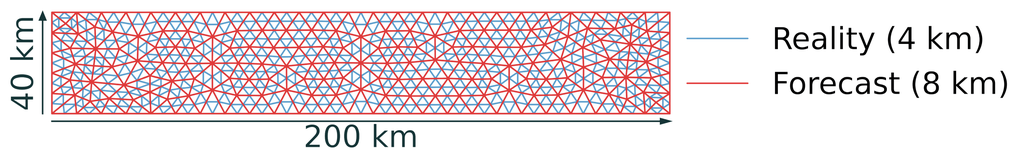
Twin experiments



Training dataset with samples to correct forecast errors with lead time of around 10 minutes.

Samples		
4800 Training	960 Validation	2400 Testing

Model setup



Channel-like setup in a regional sea-ice model (Dansereau et al. 2016, 2017, 2021) that accounts for sea-ice dynamics only.

Examples of rapid transitions, by imposing a wave-like wind forcing.

Conclusions

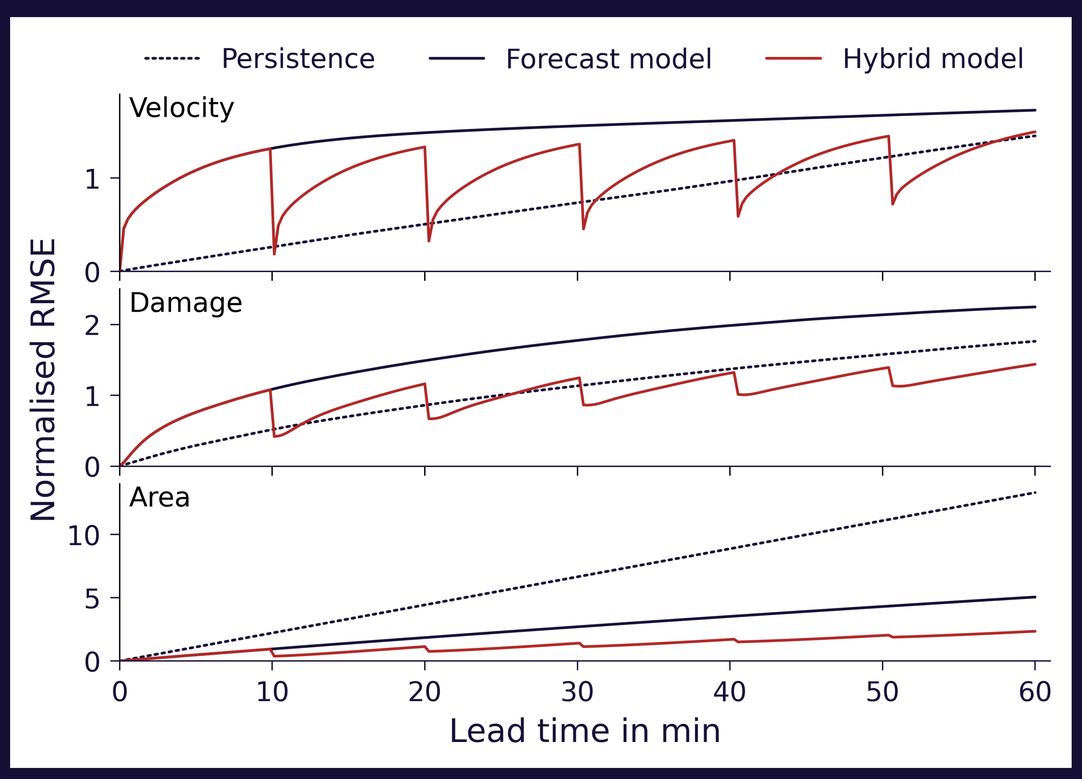
One deep neural network can parametrise subgrid-scale processes for all prognostic model variables at the same time.

Although only trained at first update, network can be cycled with model for continuous correction.

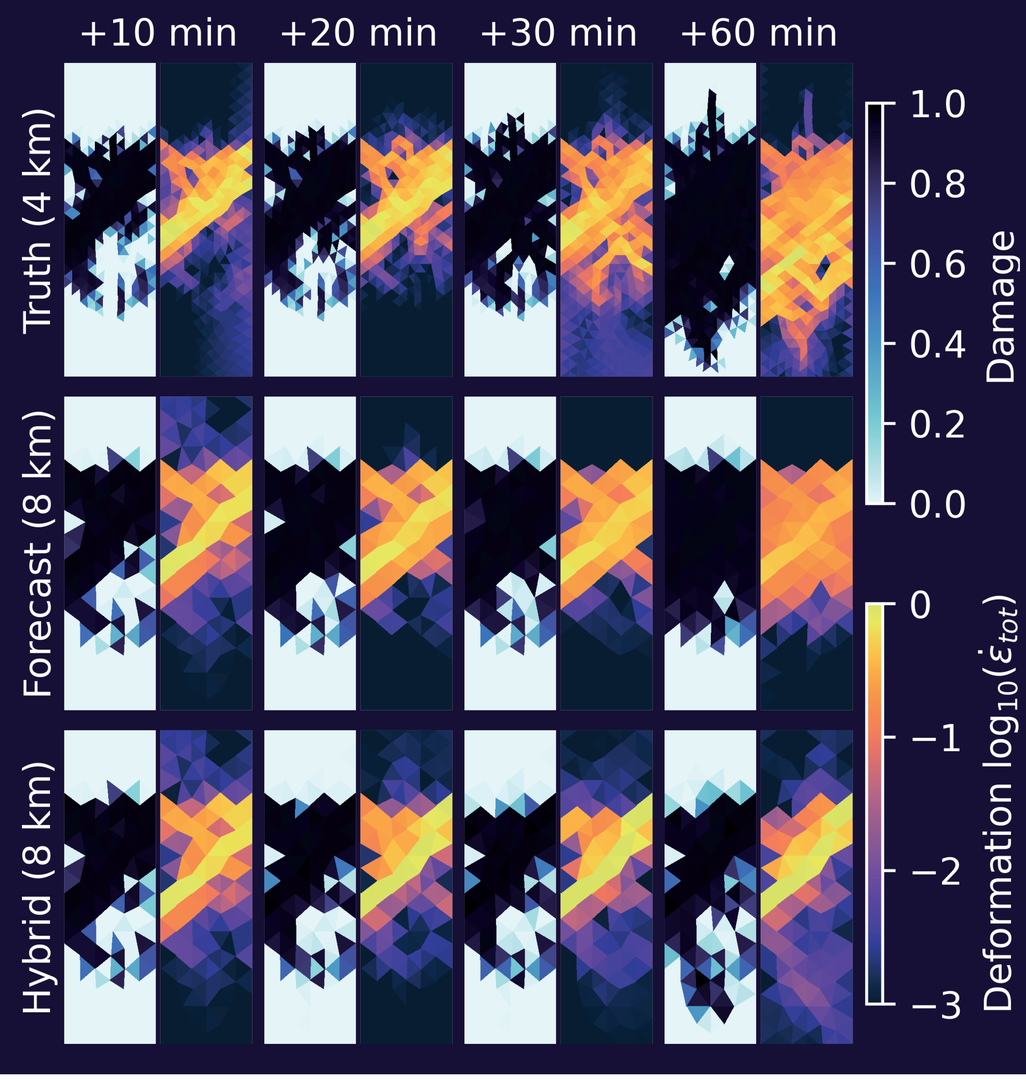
The model error correction for sea-ice dynamics has to be formulated as post-processing step after the prediction.

Outlook: Working on learning model error correction from temporally sparse "observations" from neXtSIM simulations.

Cycling improves the short-term forecast



The hybrid represents the dynamics better



Discussion paper for *The Cryosphere* →

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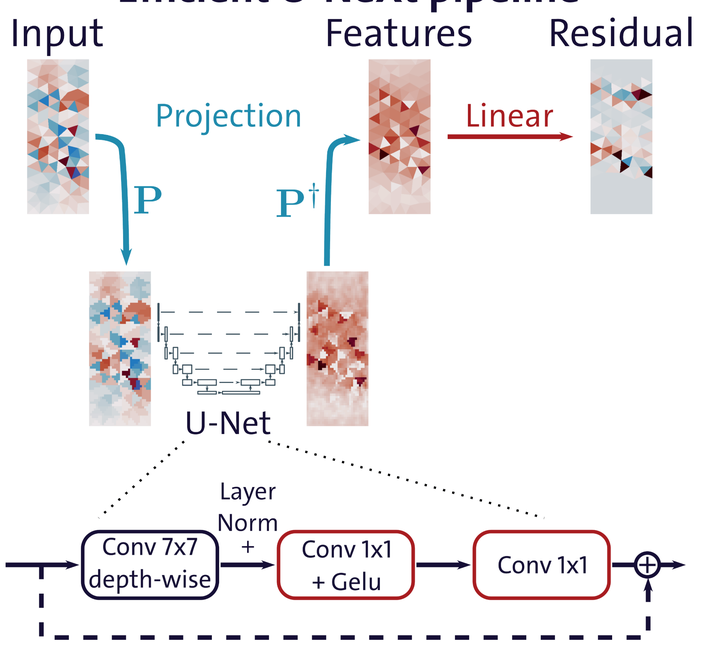
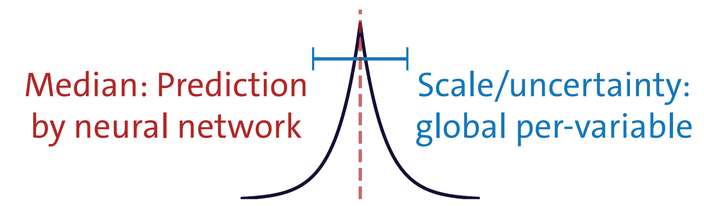
Efficient U-NeXt pipeline

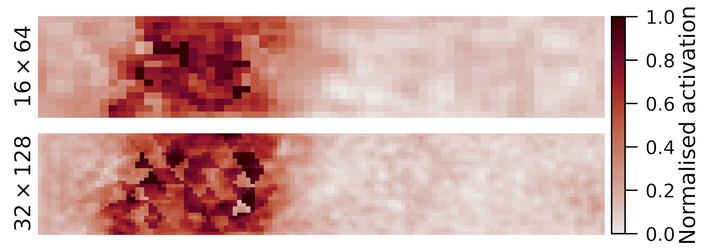


Maximum likelihood with Laplace distribution

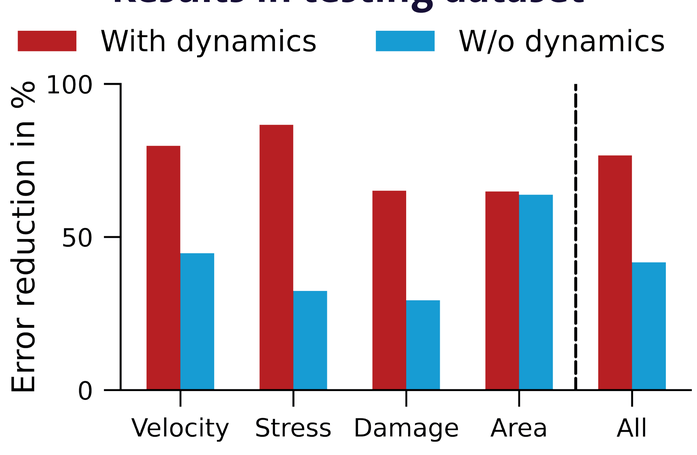
$$\mathcal{L}_{tot} = \sum_{i=1}^{9} \frac{1}{\text{scale}_i} \mathcal{L}_i + \log(2\,\text{scale}_i)$$



Influence of Cartesian resolution



Results in testing dataset



Original title:
Deep learning of subgrid-scale parametrisations for sea-ice models