

Towards Deep Learning Models for Global Coastal Sea Level Prediction

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Introduction

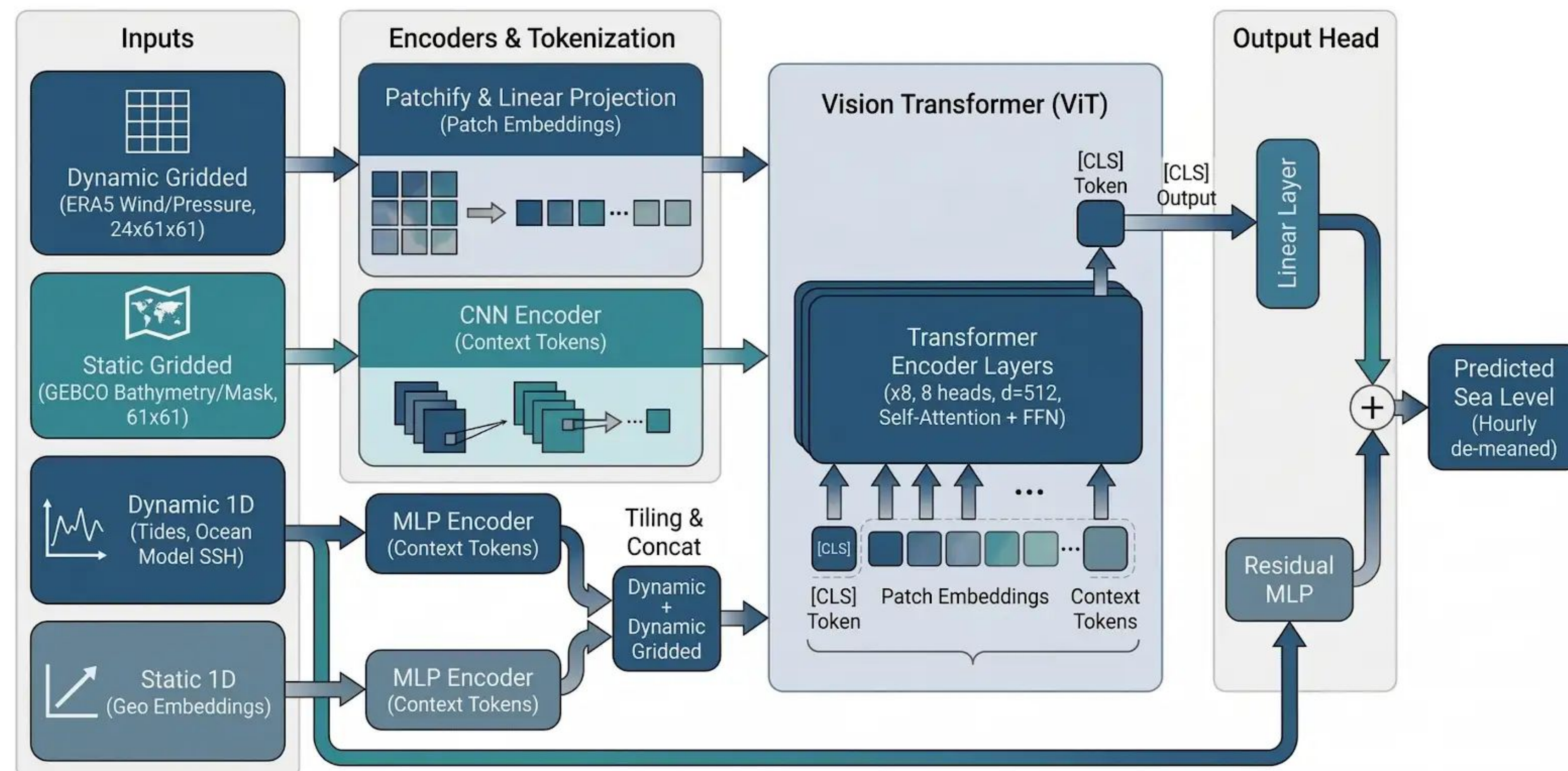
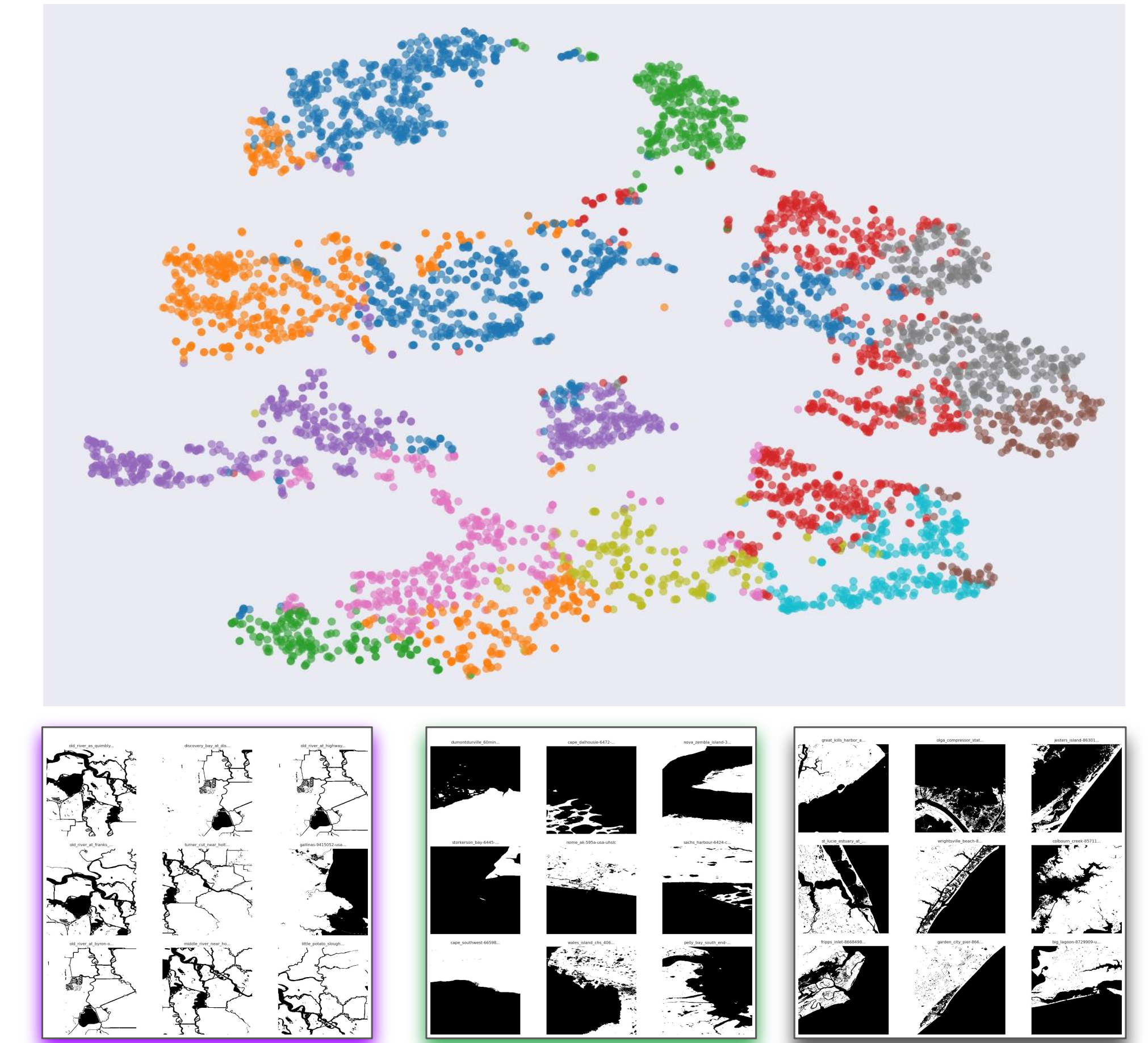
- Millions are endangered by coastal floods, risk increases with sea level.
- Numerical hydrodynamic models are computationally expensive, operational usage oftentimes focuses on particular parts of the world.
- Deep Learning automates feature engineering, lowers inference cost and allows ensembling – potentially improving warnings and saving lives.
- **This contribution:** a global, data-driven coastal sea level forecasting model forced by 2 km inputs and predicting at hourly resolution.

Method

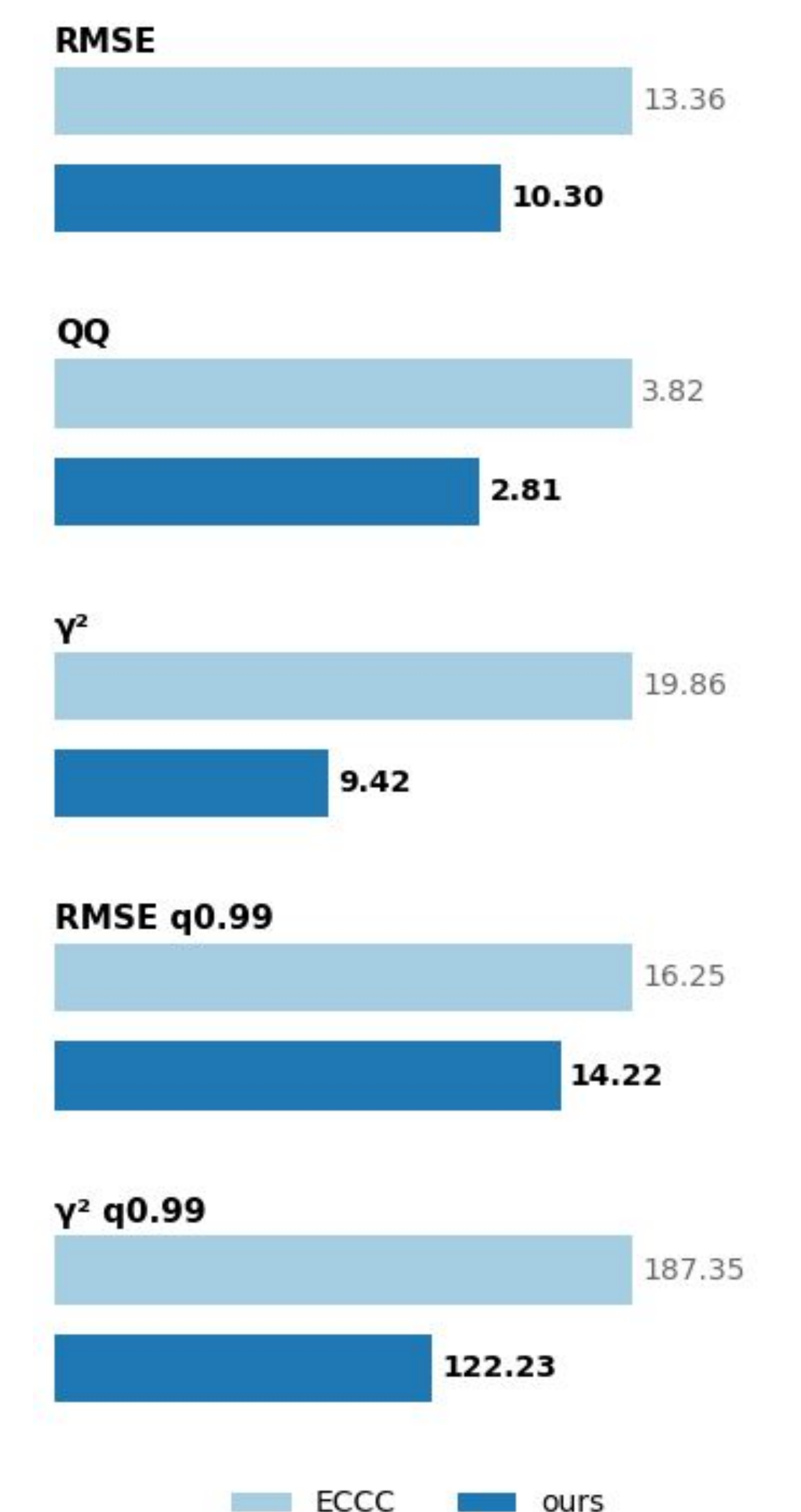
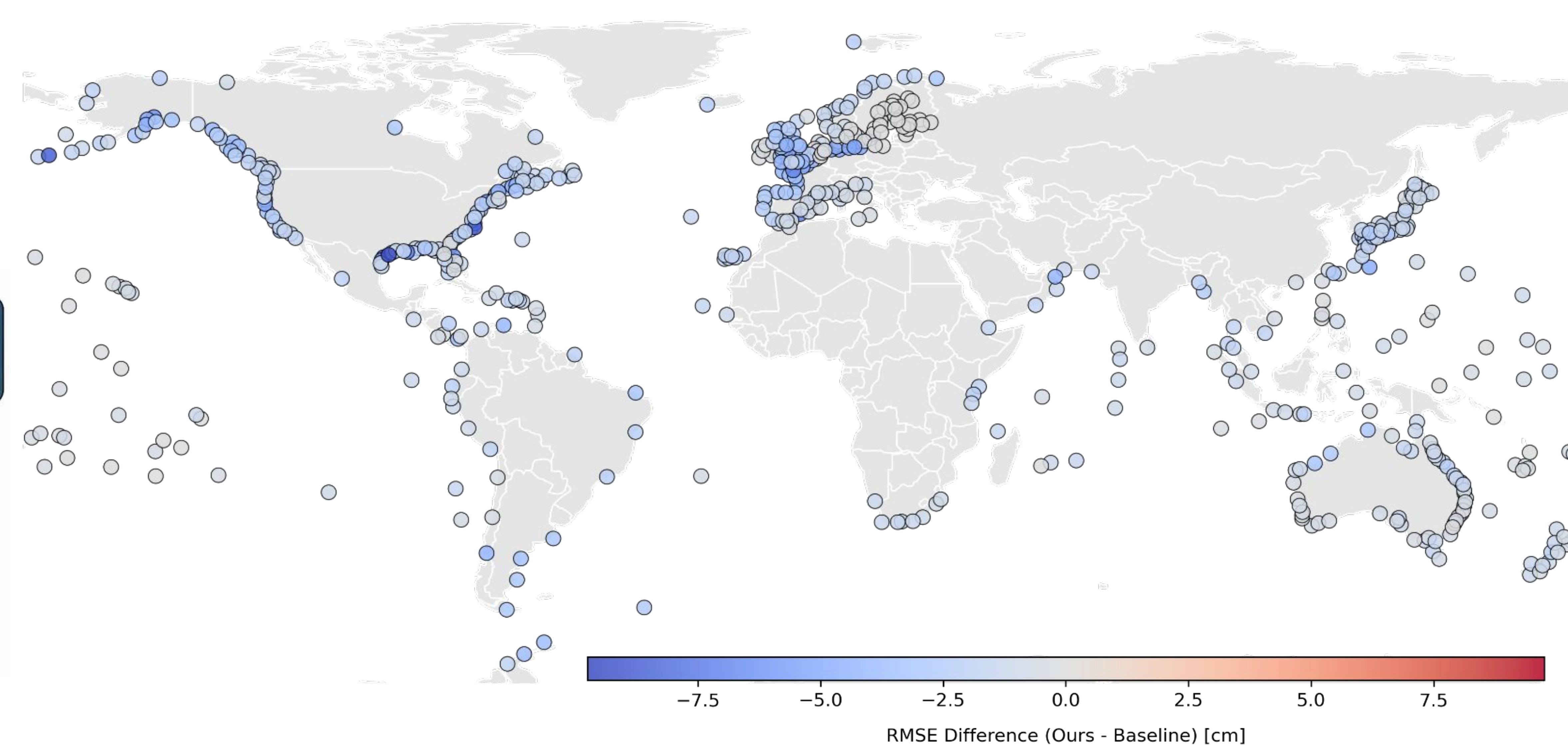
- **Multi-variate encoders:** static, dynamic, 1D and 2D features are encoded separately via dedicated modules.
- **Processor:** Vision Transformer with self-attention.
- **Decoder:** Residual MLP & linear layer predict next-hour sea level.
- **Other:** AlphaEarth geo-embeddings [1] inform about coastal topology. Visual analysis highlights semantics of feature space.

Results

- **Experimental setup:** Training 1980 - 2012, Testing 2013 - 2018. Evaluating with 550 globally distributed GESLA3 tide gauges [2] within SurgeMIP challenge setup [3].
- **Outcomes:** Compared with the ocean model run by Environment and Climate Change Canada (ECCC) [4]. Our model improves RMSE by about 30 %.
- **Future Work:** Open challenges include circumventing data scarcity, improved generalization to ungauged sites and better evaluation of extremes



Station-wise Performance Improvement



References

- [1] Brown et al. 2025 <https://deepmind.google/blog/alphaearth-foundations-helps-map-our-planet-in-unprecedented-detail/>
 [2] Haigh et al. 2022 <https://doi.org/10.1002/gcdj.3.174>
 [3] Bernier et al. 2024 <https://doi.org/10.1016/j.wace.2024.100689>
 [4] Wang et al. 2025 <https://doi.org/10.1016/j.wace.2025.100805>