Towards Deep Learning Models for Global Storm Surge Prediction

Martin Gauch
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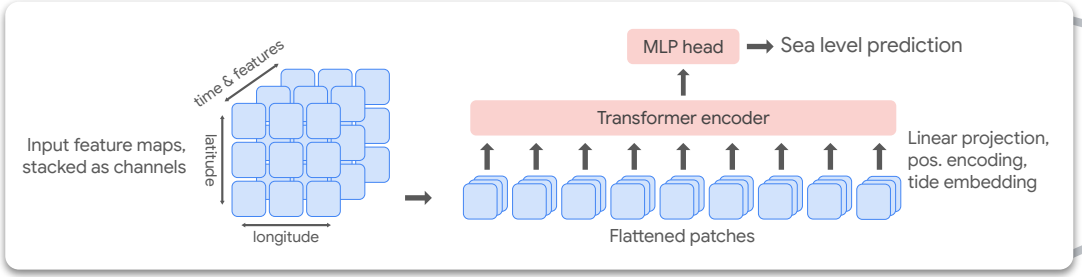
Google Research

Methods: Vision Transformer



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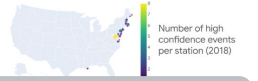
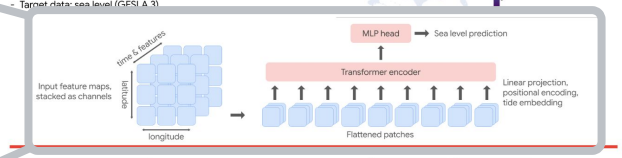
Introduction

- Deep learning has proven highly capable in various environmental sciences
- First studies show promising results for storm surge prediction, but are often spatially limited
- We train a model for global sea level prediction, built around the hypothesis that deep learning can benefit from global data, transferring knowledge across space
- Input data:
  - Meteorological data (ERA5 wind, pressure)
  - Bathymetry map (GEBCO) & land–sea mask
  - Tide estimate (FES)
- Target data: sea level (GESLA 3)

Methods

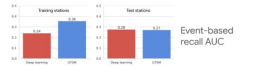
- Model: Vision Transformer (ViT)
- Evaluation:
  - Comparing sea level predictions from ViT and GTSM reanalysis baseline with GESLA ground truth
  - Event-based evaluation through NOAA storm events: recall of predictions above a threshold defined by the event with the lowest sea level



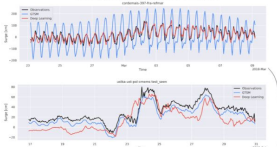


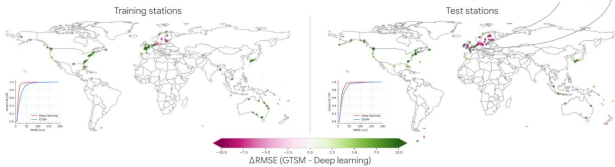
Results & discussion

- Globally the deep learning model is very competitive, including during extreme events
- Poor performance especially in the Baltic Sea region
- Predicting sea level works better than predicting surge
- Future work:
  - Integrate remote sensing data (e.g., SWOT)
  - Train/evaluate on larger datasets (discarding fewer stations), expand the events database beyond the US
  - Use real-time weather data towards an actual forecasting system with lead times (as opposed to the current ERA5-based reanalysis)

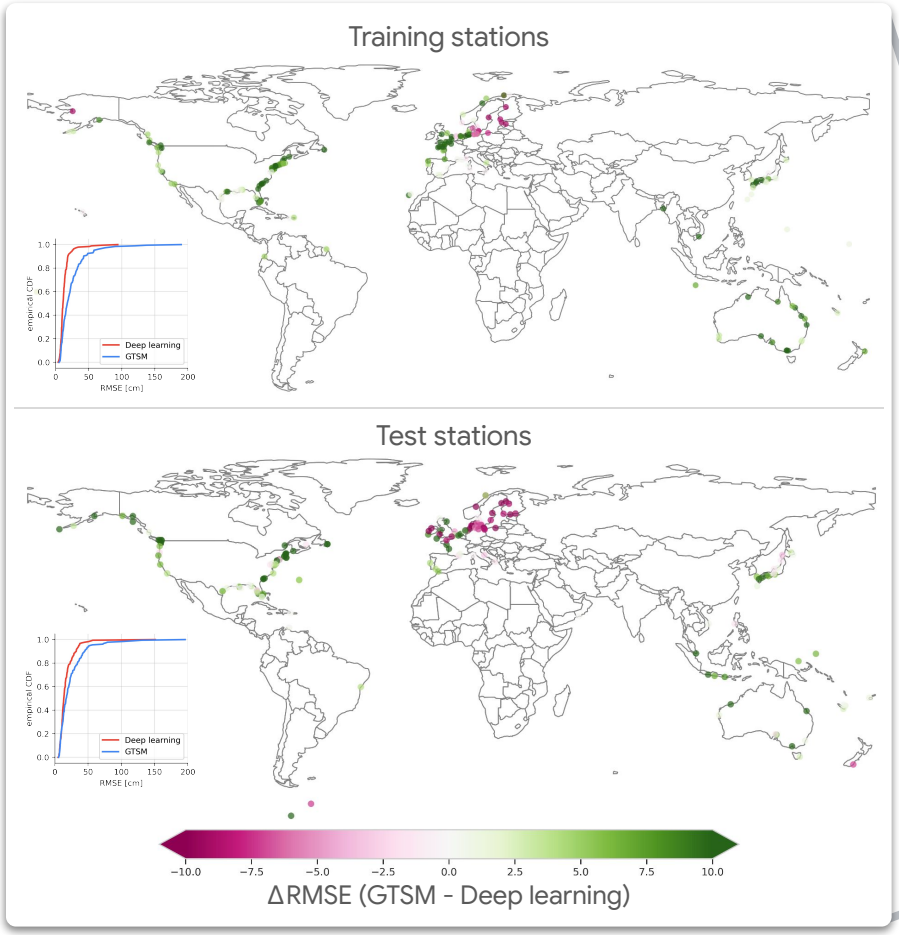


Example time series of predictions





Results



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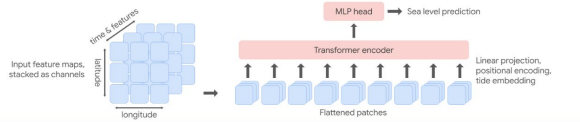

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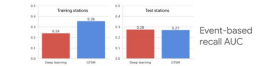

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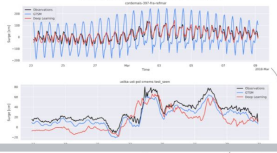

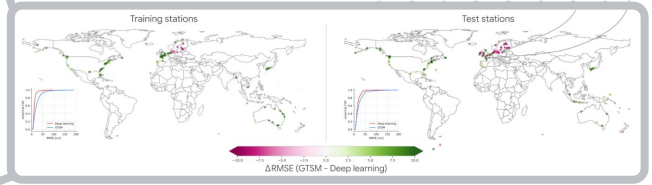

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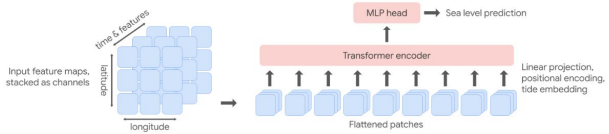
Number of high confidence events per station (2018)



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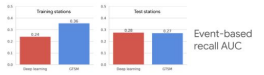

Event-based recall AUC

Example time series of predictions