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PREDICTING MINIMUM ARCTIC SEA ICE EXTENT

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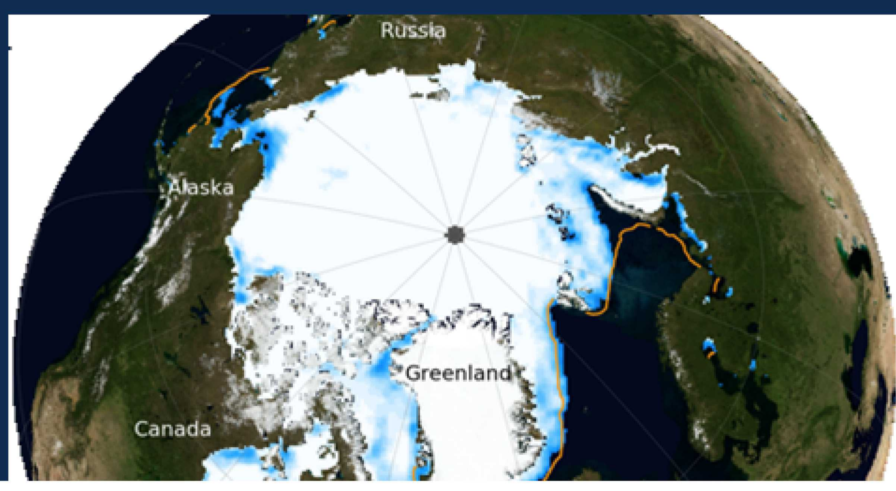
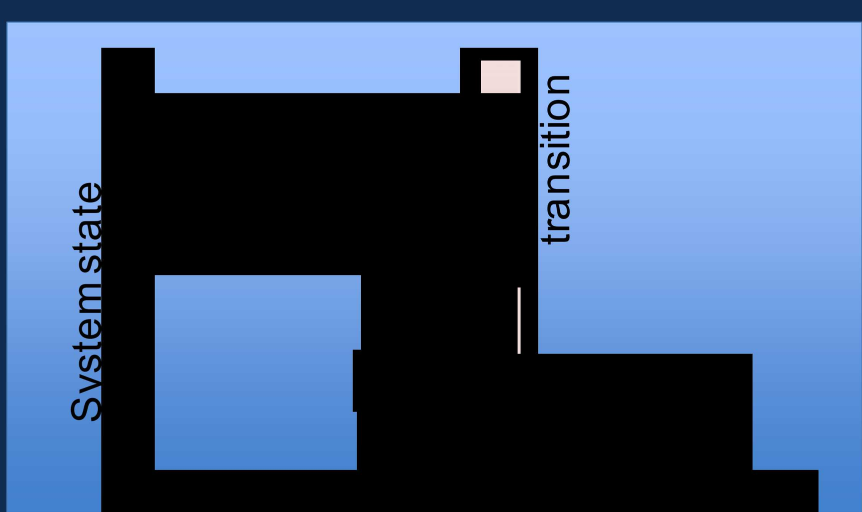
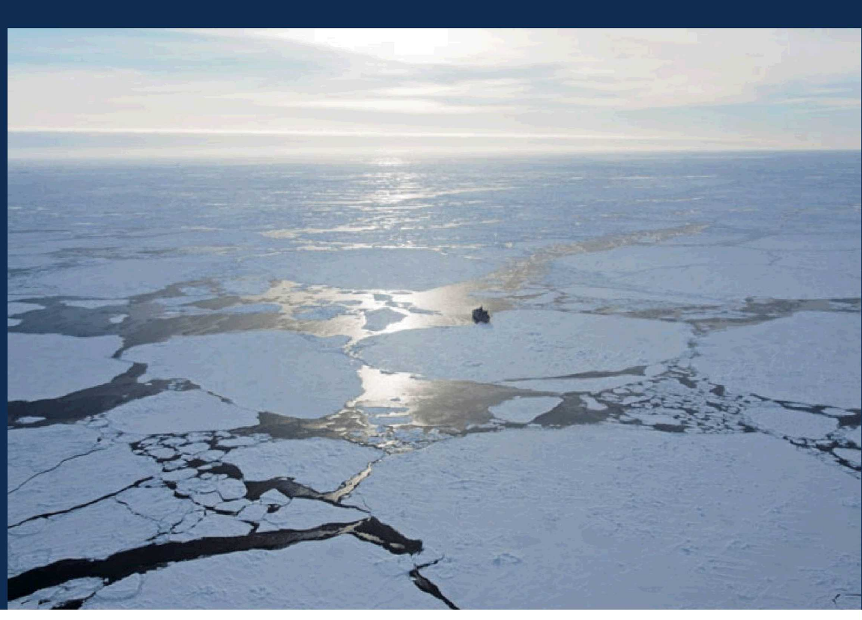


Climate change effects are most pronounced at high latitudes.



Tipping Point concepts describe a qualitative, locally irreversible state change in a system, such as the climate.



Since the beginning of the Satellite Era (1979), the Arctic has lost 95% of its oldest ice [1].

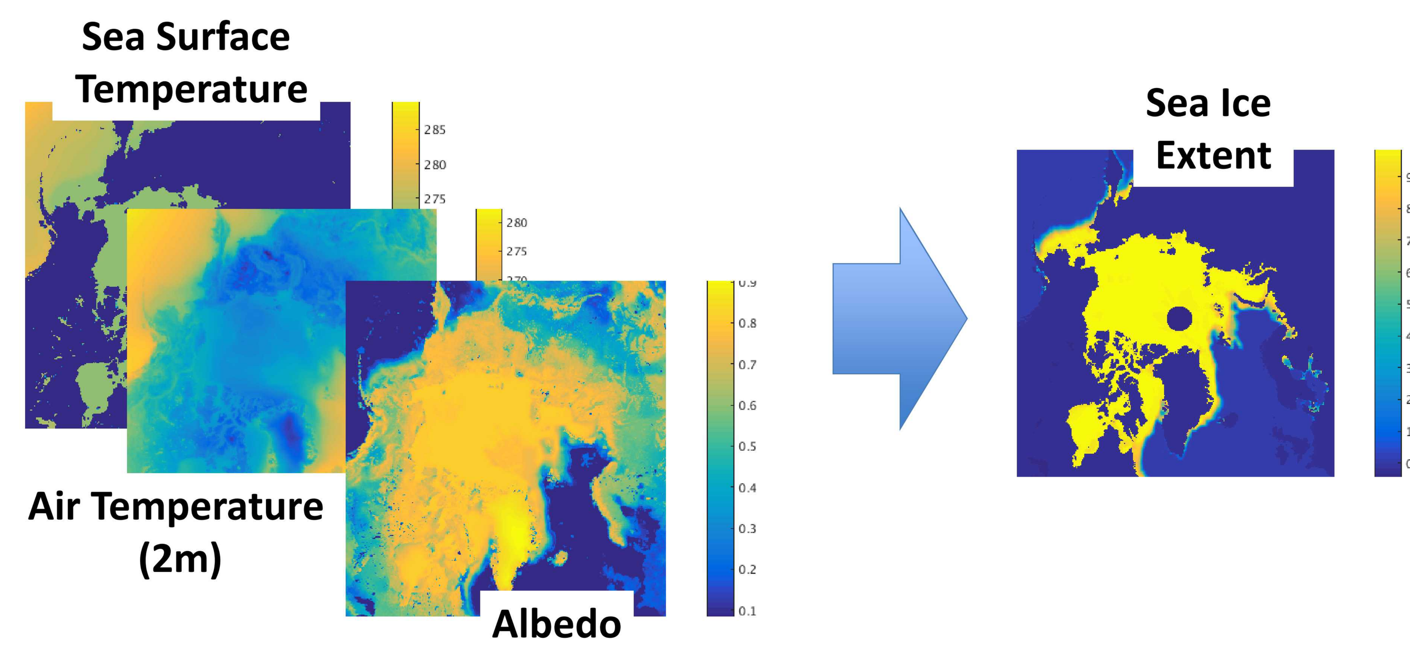
Background

The Arctic is warming at more than twice the rate of the rest of the globe [2]. Arctic physical and biological systems are strongly coupled and feedbacks may be driving the Arctic to tipping events that could have critical downstream impacts for the rest of the world [3].

Interactions between the atmosphere, ocean, land, and ice can lead to feedbacks potentially accelerating warming. Understanding the behavior of specific components (*e.g.*, sea ice) in the context of the fully coupled modeled system is critical in making accurate predictions.

Objective

Develop methods to rigorously predict Arctic sea ice extent. Combine data and coupled modeling to gain understanding of important feedbacks and evaluate the stability of the Arctic system.



Approach

Data analytics

- Develop data-driven, predictive models for sea ice concentration in the summer season using historical data for ice, ocean, atmosphere, and land quantities [4,5].
- Compare quantitative relationships among observable variables in the predictive model to interactions in the coupled simulation models.
- Investigate whether predictive models provide new insights into coupled simulation.

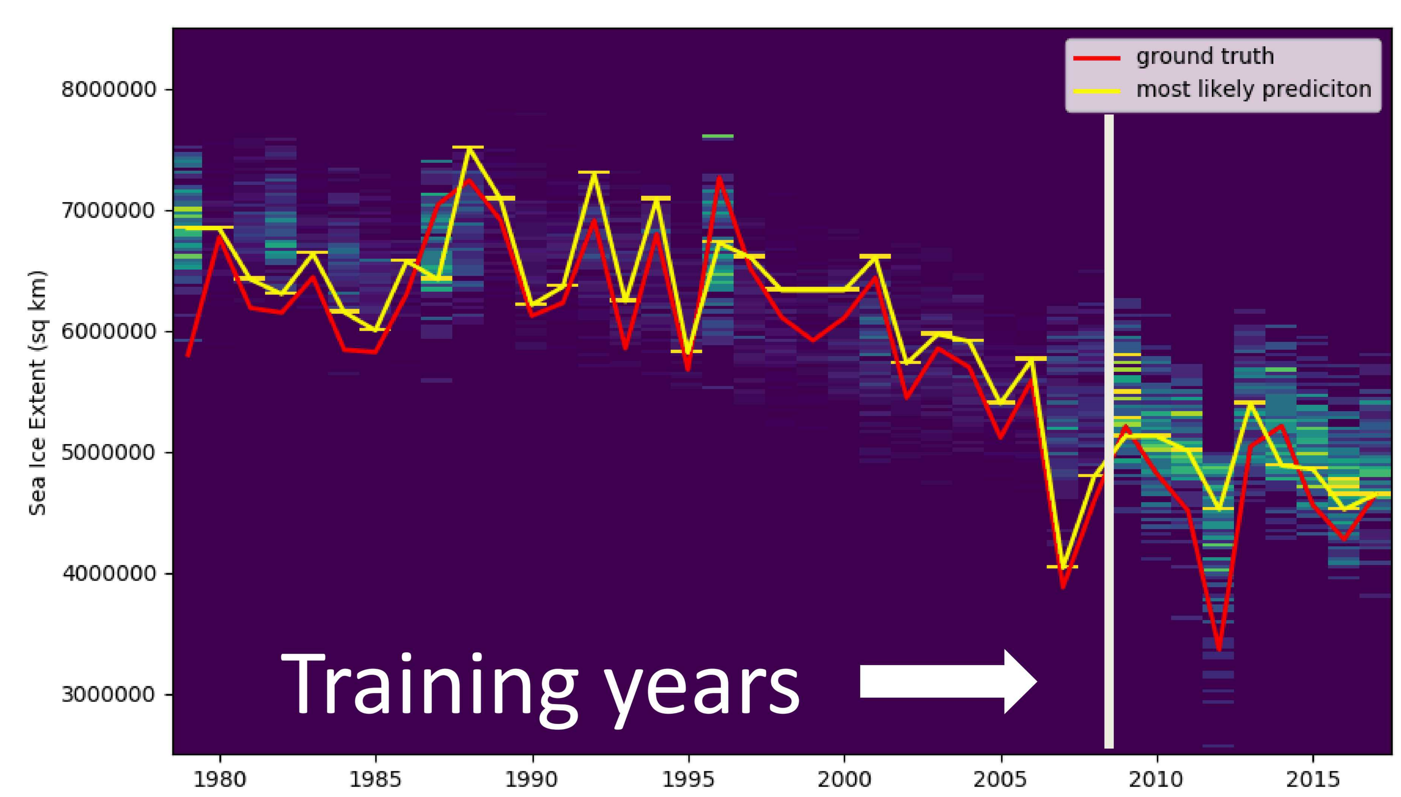
Impact

- Analysis will provide a deeper understanding of Arctic system feedback mechanisms and sea ice stability.
- Successful combination of multi-fidelity simulation and observation-based data-driven modeling will enable more accurate predictions of Arctic change and downstream impacts.
- Data-driven predictive models will directly inform questions about Arctic navigability of critical importance to U.S. Navy and Coast Guard.

Results

Current status

- Explored using various models for predicting Sea Ice Extent
  - Linear Regression
  - Support Vector Regression (SVR)
- Created Ensembles of models to gain better predictions and incorporate Uncertainty Quantification (UQ)



Future Work

- Compare models trained on observational data to models trained on the simulated data
- See where they differ so that we can see where the climate simulations need more dependencies

References

1. NOAA Arctic Report Card 2018 (https://arctic.noaa.gov/Report-Card/Report-Card-2018).
2. Snow, Water, Ice and Permafrost in the Arctic (SWIPA) 2017, Arctic Monitoring and Assessment Programme (AMAP), Oslo,(2017).
3. Bathiany *et al*. Beyond bifurcation: using complex models to understand and predict abrupt climate change", DSCS (2016).
4. Meier, W., F. Fetterer, M. Savoie, S. Mallory, R. Duerr, and J. Stroeve. 2017. *NOAA/NSIDC Climate Data Record of Passive Microwave Sea Ice Concentration, Version 3*. Boulder, Colorado USA. NSIDC: National Snow and Ice Data Center. doi: https://doi.org/10.7265/N59P2ZTG.
5. ASRv2: National Center for Atmospheric Research/University Corporation for Atmospheric Research, and Polar Meteorology Group/Byrd Polar Research Center/The Ohio State University. 2017. Arctic System Reanalysis version 2. Research Data Archive at the National Center for Atmospheric Research, Computational and Information Systems Laboratory. http://rda.ucar.edu/datasets/ds631.1/.

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