ENVIRONMENTAL INTELLIGENCE | LAB

ARCTIC SEA ICE DYNAMICS FORECASTING THROUGH INTERPRETABLE MACHINE LEARNING

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INTRODUCTION

Machine learning has become an increasingly popular tool to model the evolution of sea ice in the Arctic region.

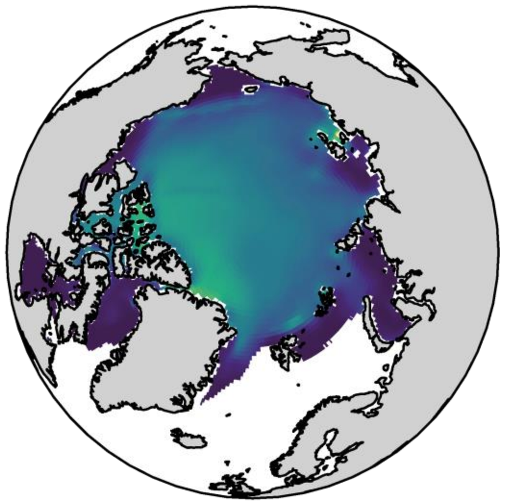
high accuracy

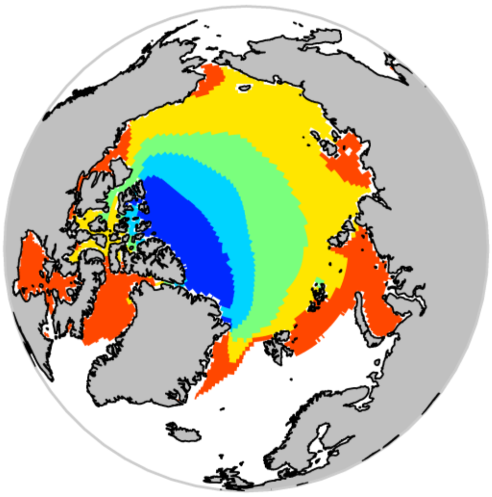
computational efficiency

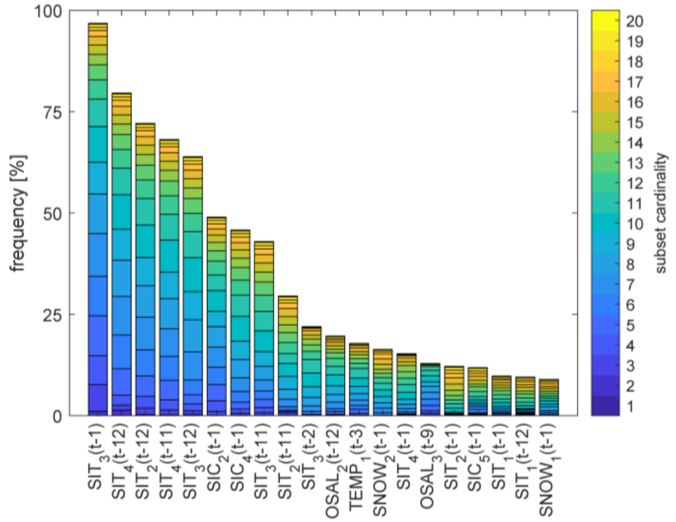
lack of physical interpretability

INTERPRETABLE MACHINE LEARNING FRAMEWORK

We present a 2-step framework to model Arctic sea ice dynamics with the aim of balancing high performance and accuracy typical of machine learning and result interpretability.





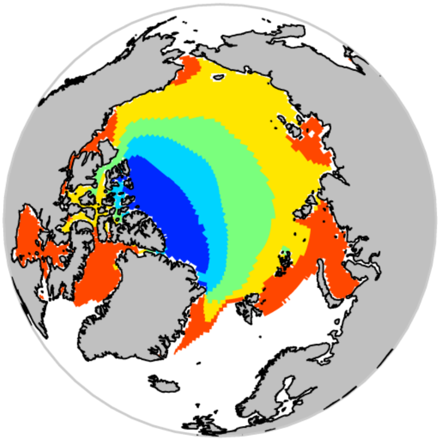


Step 1
Time series clustering

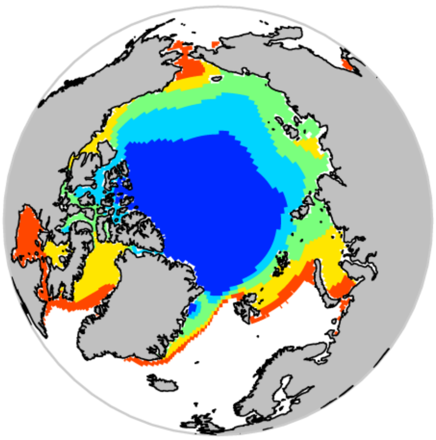
Step 2
Feature selection

TIME SERIES CLUSTERING

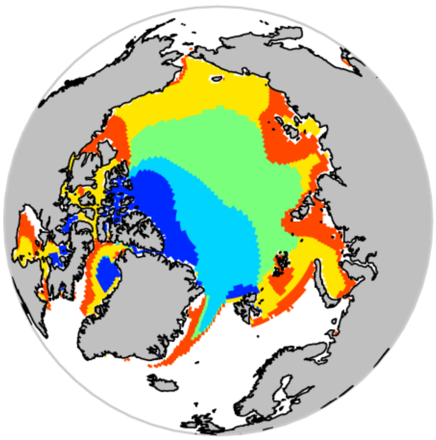
Time series clustering is used to obtain homogeneous subregions considering the spatiotemporal variability of each variable.



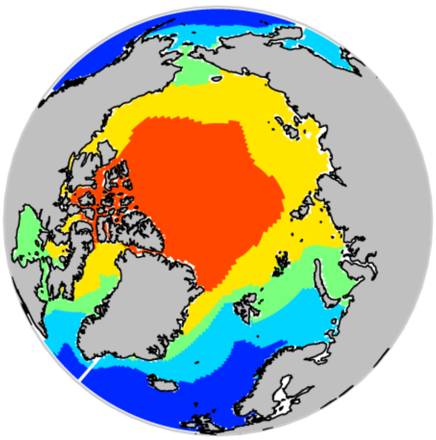
sea ice thickness



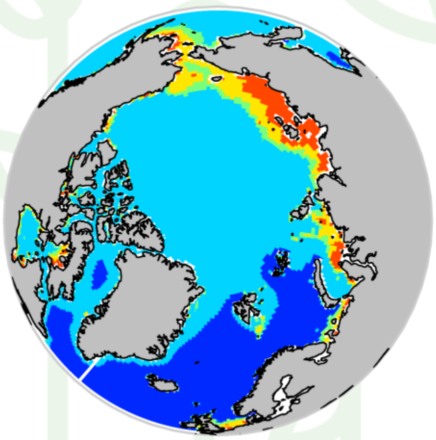
sea ice cover



snow water equivalent



surface temperature



ocean salinity

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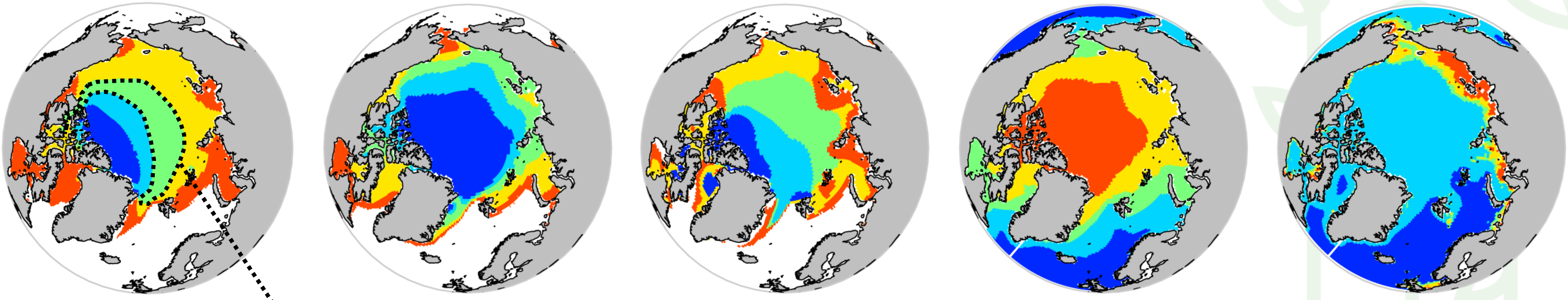
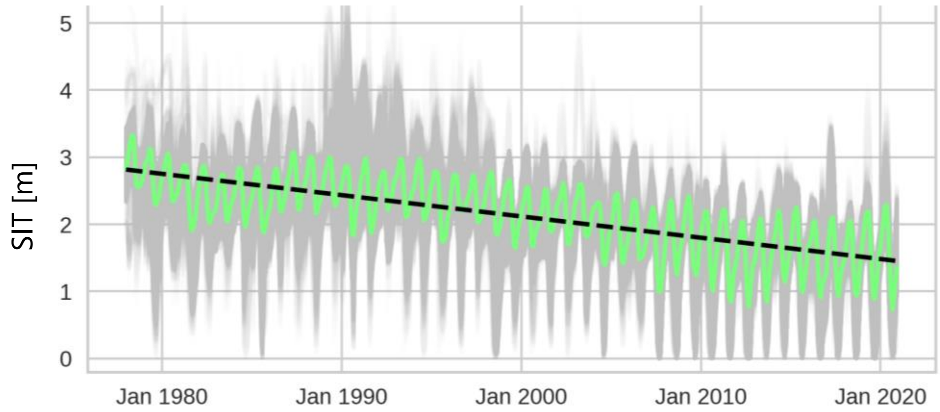


sea ice thickness | sea ice cover | snow water equivalent | surface temperature | ocean salinity



For each subregion, we can compute a time series representative of its dynamic.

FEATURE IMPORTANCE ANALYSIS

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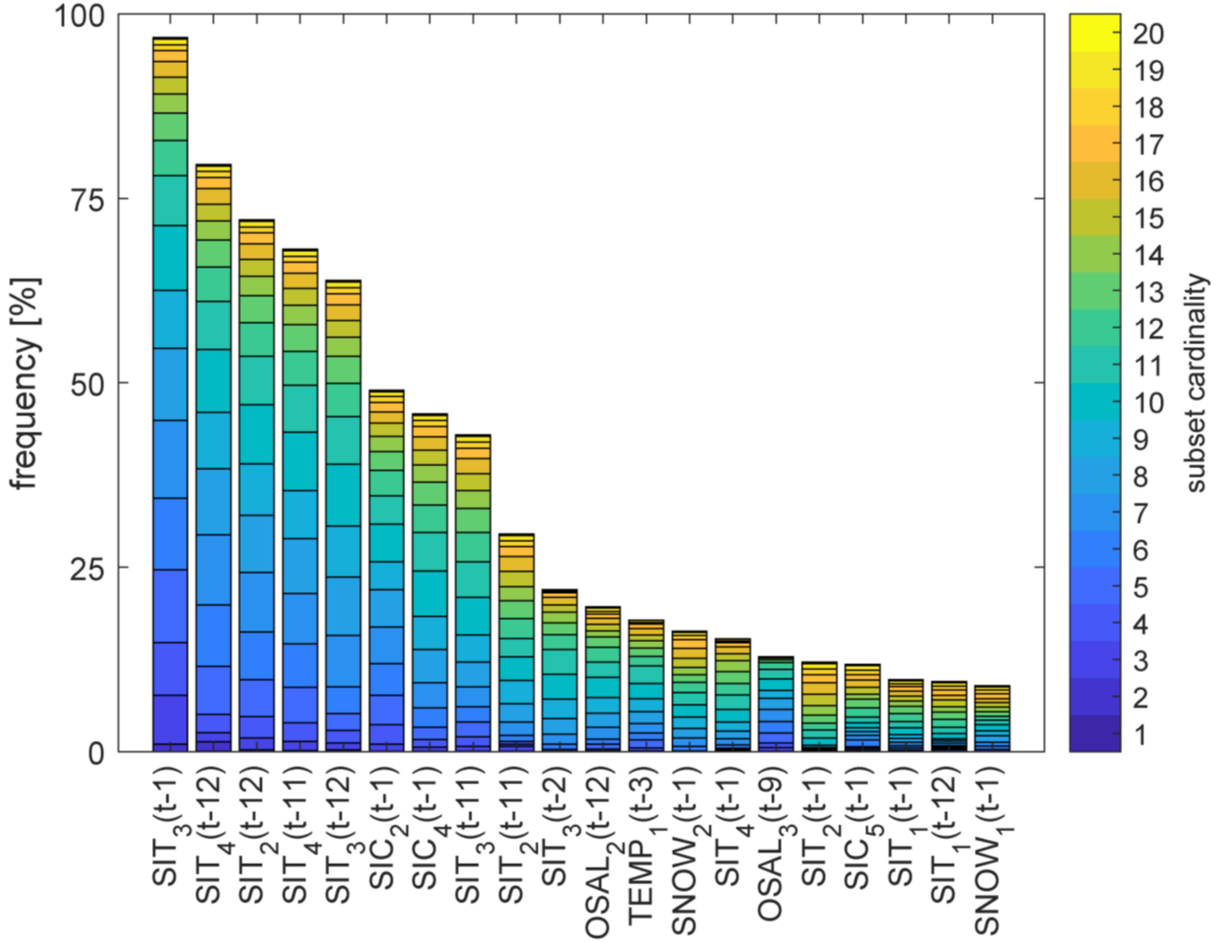
Feature selection by W-QEISS (Wrapper for Quasi Equally Informative Subset Selection*) extracts the most relevant variables for modelling the future evolution of the sea ice.



Example:

Output

$SIT_3(t)$

Input set

- 5 variables
- 5 clusters
- 12 past months

* Taormina, R., et al. An information theoretic approach to select alternate subsets of predictors for data-driven hydrological models. *Journal of Hydrology*, 2016, 542: 18-34.

CONCLUDING REMARKS

1. **Sea ice thickness and cover** have a key role in the short term (derivative) as well as the long term (periodicity)

2. **Ocean salinity** along the Siberian coast is frequently selected as a key driver, especially with a one-year lag

3. **Sea surface temperature** has a stronger effect in the clusters with thinner ice

4. **Snow depth** is relevant with a one-year lag in cluster #1 (thinner ice), only in the short term for the thicker clusters

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