Seasonal forecast of mean salinity stratification and freshwater content in the Baltic Sea

Summary

Climate warming has resulted in the intensification of the global hydrological cycle, which might have impact on the salinity stratification and freshwater content in the coastal seas worldwide. The Baltic Sea ecosystem is strongly impacted by changes in the freshwater content and salinity stratification. The spatial extent and volume of the oxygen deficient zones in the Baltic Sea is directly related to the strength of vertical salinity stratification. Main aim of the research is to prepare seasonal forecasts of the salinity stratification and freshwater content in the Baltic Sea using deep machine learning models. The data used for the study consists of model reanalysis and seasonal forecast data from the Copernicus Marine Service database, ERA5 climate reanalysis database and ECMWF seasonal forecasting system's SEAS5 data.

Research field:	Earth sciences
Supervisor:	Prof. Dr. Urmas Raudsepp
Availability:	This position is available.
Offered by:	School of Science Department of Marine Systems
Application deadline:	Applications are accepted between June 01, 2023 00:00 and June 30, 2023 23:59 (Europe/Zurich)

Description

Climate warming has resulted in the intensification of the global hydrological cycle. The increase of net precipitation over land and sea areas, decrease of the ice cover and increase of river runoff are the main components of the global hydrological cycle that increase freshwater content in the ocean and decrease ocean salinity. In the brackish Baltic Sea, vertical salinity stratification is determined by the location of the halocline above which is the well-mixed surface layer and below lies the weakly stratified layer. The long- term salinity of the Baltic Sea is determined by saline water inflows from the North Sea (wind forcing) and its dilution with freshwater originating from numerous rivers across the Baltic coast and from the net precipitation. The changes of the freshwater content anomaly can be used as a marker of the water cycle change.

The importance of subseasonal and seasonal weather predictions is continuously increasing worldwide. Machine learning methods are rather extensive and the topic is evolving very rapidly, which provides a ground for the development of machine learning models suitable for seasonal prediction of the salinity stratification and freshwater content in the seas. Combination of convolutional neural networks and long short-term memory models have been shown to be able to predict the characteristics of the Earth system components. Therefore, these methods will be used for the seasonal forecast of mean salinity stratification and freshwater content of the Baltic Sea.

Responsibilities and (foreseen) tasks:

- Processing of the Copernicus Marine Service model reanalysis data, ERA5 climate reanalysis database and ECMWF's fifth generation seasonal forecasting system's SEAS5 data. Calculation of spatially mean monthly salinity profiles for different subregions of the Baltic Sea. Analysis of the ERA5 climate reanalysis data for net precipitation, winds and sea surface temperature. Preparation and analysis of the sea ice volume data and river runoff data for the Baltic Sea. Calculation of the ocean freshwater content of the Baltic Sea.
- Implementation, testing and validation of the machine learning clustering algorithms for the categorization of the dynamical regions of the Baltic Sea based on the mean salinity profiles and ocean freshwater content. Analysis of the climatology of ocean freshwater content of the Baltic Sea subregions and the statistical relationships with global and local atmospheric and oceanographic drivers. Analysis of the SEAS5 seasonal forecast data as drivers of the mean salinity stratification and monthly freshwater content of the Baltic Sea.

- Selection, testing, validation and application of deep machine learning models for the seasonal prediction of the ocean freshwater content in the Baltic Sea subregions. Evaluation of the predictions, improvement and finalisation of the models. Preoperation implementation of the machine learning model for the freshwater content predictions in the Baltic Sea.

Applicants should fulfil the following requirements:

- a master's degree in physics, oceanography, data analysis or mathematics
- a clear interest in the topic of the position
- excellent command of English
- strong and demonstrable analytical skills
- capacity to work both as an independent researcher and as part of an international team

The following experience is beneficial:

- Basic knowledge of numerical modelling
- Basic knowledge of machine learning
- Programming in Matlab or Phyton
- Some experience of working with big data
- Some experience in HPC

We offer:

- 4-year PhD position in one of the leading research departments in oceanography and related numerical modelling in Estonia
- The chance to do high-level research in cooperation with European research institutes in the framework of the Copernicus Marine Service
- Opportunities for conference visits, research stays and networking with leading universities and research centers in the fields of oceanography

About the research group

Research Group on Modelling and Remote Sensing of Marine Dynamics, Tallinn University of Technology, School of Science, Department of Marine Systems.

The research group is conducting oceanographic process research based on scientific analysis to find cause-and-effect relationships. Innovative (operational) methods for monitoring the marine environment and analyzing changes are being developed, incl. weather forecasting and climate models applied to supercomputers, to elucidate the mechanisms of atmospheric and ocean interactions; and machine learning based algorithms for satellite image processing and model data analysis. The research group has a long experience in developing applications / methods of operational oceanography, the outputs of which are information provided to the public and public authorities on water level variability, ice conditions and other parameters of marine physics. The research group is making a significant contribution to the pan- European Copernicus program. In scientific process research and applied research, the strength of the research team is the use of big data (mass processing) for climate studies and statistical analysis of the properties of the marine environment, as well as for finding dynamic relationships.

Additional information

For further information, please contact Prof. Urmas Raudsepp, urmas.raudsepp@taltech.ee

To get more information or to apply online, visit https://taltech.glowbase.com/positions/672 or scan the the code on the left with your smartphone.