Seasonal prediction of the marine heatwaves

Summary

Marine heatwaves have become an important research topic during the last decade. The frequency and intensity of marine heatwaves have increased over time so that their impact on marine ecosystems has increased. The importance of subseasonal and seasonal weather predictions is continuously increasing worldwide. Main aim of the research is to prepare seasonal predictions of marine heatwave area extent and intensity in the Baltic Sea using deep machine learning models. The data used for the study consists of model reanalysis and satellite reprocessed data from the Copernicus Marine Service databases and ERA5 climate reanalysis database.

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

Marine heatwaves are specific event type phenomena, whose importance as a climate warming indicator and research topic concurrently has increased recently. Usually marine heatwaves are detected during summer, and researched because of their impact on the marine ecosystem. Due to global warming, marine heatwaves can be detected also during winter.

Marine heatwaves have mainly been detected at the sea surface because satellite remote sensing imagery has been used for their detection. With the improvement of the quality of model reanalysis data subsurface marine heatwaves have become a research topic. The area of the marine heatwaves has been one of the significant characteristics, but having knowledge on the subsurface heatwaves enables calculation of the water volume of marine heatwave. The latter has a potentially higher impact on the marine environment than the surface heatwaves.

Marine aquaculture products are potentially affected by marine heatwaves. Lately, marine aquaculture has gained a significant role in the blue economy. Therefore we could expect that seasonal forecasts of marine heatwaves facilitate development of mitigation strategies for marine aquaculture being affected by marine heatwaves.

In general, seasonal weather and marine predictions are needed for the economy and society. Therefore, the main aim of the study is to prepare seasonal predictions of marine heatwave area extent, water volume and intensity in the Baltic Sea. The data used for the study consists of model reanalysis and satellite reprocessed data from the Copernicus Marine Service databases and ERA5 climate reanalysis database. Recent bursting developments in the field of artificial intelligence provide opportunities for making seasonal predictions of the weather and marine events with a high accuracy. Therefore deep machine learning models will be studied and implemented for seasonal predictions of marine heatwave characteristics in the Baltic Sea with the extension to the world ocean.

Responsibilities and (foreseen) tasks:

- Processing of model reanalysis and satellite reprocessed data from the Copernicus Marine Service databases and ERA5 climate reanalysis database. Calculation of marine surface heatwave characteristics: frequency, duration, spatial extent and intensity from model reanalysis and satellite data. Inter-comparison of the heatwave characteristics calculated from the model and satellite data. Calculation of marine subsurface heatwave characteristics from model reanalysis data. Analysis of the climatology of marine heatwaves in the Baltic Sea. Analysis of the statistical relationships of the marine heatwave characteristics and global and local atmospheric and oceanographic drivers.
- Implementation, testing and validation of the machine learning clustering algorithms for the categorization of the dynamical regions of the Baltic Sea based on the marine heatwave characteristics and global/local drivers.

- Selection, testing, validation and application of deep machine learning models for the seasonal prediction of the characteristics of marine heatwaves in the Baltic Sea. Evaluation of the predictions, improvement and finalisation of the models. Preoperation implementation of the machine learning model for the marine heatwave predictions in the Baltic Sea.

Applicants should fulfil the following requirements:

- a master's degree in oceanography, data analysis, physics 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 machine learning
- Programming in Matlab or Phyton
- Basic knowledge of numerical modelling
- 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

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