

# Characteristics of Extreme Natural Events and Their Impact on Coastal/Offshore Sector Summary

# Summary

Coastal regions are increasingly vulnerable to extreme weather events due to climate change, leading to significant socio-economic and environmental impacts. The PhD project is dedicated to examining oceanographic and atmospheric 4-dimensional data (coastal measurements, Earth Observation and model re-analysis) in the Baltic Sea region with the aim of assessing the impact of natural extremes events (storms, sea ice dynamics, storm surges, wave) on coastal regions in general (incl. coastal and offshore constructions). The underlying aim of the project is to advance the data analysis methods for Digital Twin Ocean (DTO) applications. The project has a scientific and a practical objective: (a) to retrieve scientifically sound information about coastal and offshore extreme events using diverse input data and novel data analytics approaches; (b) to develop and implement data processing methods for operational implementation in DTO's to support decision making processes of coastal/ offshore industry.

Research field:	Earth sciences
Supervisors:	Dr. Rivo Uiboupin
	Aarne Männik
Availability:	This position is available.
Offered by:	School of Science
	Department of Marine Systems
Application deadline:	Applications are accepted between June 01, 2025 00:00 and June 30, 2025 23:59 (Europe/Zurich)

# Description

# The research

There is a growing need for new environmental data analytics and modelling methods to be implemented in various sectoral DTOs for decision support. Among other activities it is essential to manage maritime space and coastal regions more sustainably and to help tap into the growing potential of offshore renewable energy. The ambitious economical, climate, and environmental objectives in the Baltic Sea region can be achieved if the decision making is governed by accurate and comprehensive understanding of the processes over the coastal and sea areas, which relies on interpretation of environmental big data records that have been made available. Currently a large amount of oceanographic data is provided by EU programmes (Copernicus, EmodNet) and national authorities. However, the full potential of the available data (coastal measurements, remote sensing, model re-analysis, climate projections, forecast services) is not exploited for the benefit of decision-making process. Current PhD project is targeted at analyzing the environmental geospatial data in the Baltic Sea region with the aim of describing and understanding the impact of coastal extreme events to advance the DTO applications for the decision support. The rising number of data-journals and open data repositories provide good platform to disseminate the data derivatives of the big data. **Responsibilities and (foreseen) tasks:** 

- Development of a database for coastal observations (incl. sea level and atmospheric parameters)
- Development, validation and analysis of sea level from Earth Observation data (altimetry missions).
- Generate projections of extreme events from climate scenario modelling output
- Development and testing of big data analytics methods for statistical analysis (e.g. Correlation analysis, EOF analysis, Wavelet analysis, Clustering) of geospatial 4D oceanographic and atmospheric data.
- Implementation of the data mining and environmental big data multivariate analysis to explore meaningful patterns in the data cubes.
- · Generate advanced statistical analysis of coastal sea level events
- Investigation of the re-analysis datasets to reveal statistics of extreme events in the marine environment (spatio-temporal extent, frequency, nature of extreme).
- Preparing research papers and publishing the value-added datasets in data repositories as well as promoting the use of new data products in decision-making processes i.e. in DTOs.



## Applicants should fulfil the following requirements:

- A master's degree in one of the following subjects: Natural Sciences (Earth Sciences, Oceanography, Physics etc), Data Science or Computer Science.
- A clear interest in the topic of the position.
- Good skills in one of the following computer languages Python, MatLab, R. Previous experience in analyzing geospatial data (remote sensing imagery, structured- and unstructured model fields).
- Excellent command of English.
- Strong and demonstrable writing and analytical skills.
- Capacity to work both as an independent researcher and as part of an international team.

#### The following experience is beneficial:

- Knowledge about Linux/Unix systems.
- Previous experience with data bases (i.e Copernicus), data mining, implementation of machine learning methods.

### We offer:

- 4-year full time (fully funded) PhD position in an outstanding Baltic Sea research institutions with a large portfolio of ongoing pan-European and national public sector applied research projects.
- Opportunity to participate in applied research projects funded by European Commission (e.g. Horizon Europe, LIFE programme), European Space Agency (ESA) and European Centre for Medium-Range Weather Forecasts (ECMWF).
- Opportunities for conference visits, research stays and networking with globally leading universities and research centers in the fields of oceanography.

#### About the department

Tallinn University of Technology (TalTech), the only technological university in Estonia, is the flagship of Estonian engineering and natural sciences. Here the synergy between different fields (technological, natural, exact, economic and health sciences) is created and new ideas are born. The Department of Marine Systems at TalTech is a lead-ing oceanographic and meteorological R&D unit in the Baltic Sea region. We focus (1) on oceanographic process research based on scientific analysis to find cause-and-effect relationships and (2) on developing marine monitoring and forecasting services. The implemented methods include machine learning based algorithms for satellite image processing and for model data analysis as well as development of innovative (operational) methods for monitoring the marine environment and analyzing the changes. We have long-term experience in developing applications and methods for operational oceanography, the outputs of which are information products provided to the general public and to various authorities on water level variability, ice conditions and other parameters of marine physics. We are contributing significantly to the pan-European Copernicus program (CMEMS) and Destination Earth (DestinE) initiative. **(Additional information)** 

For further information, please contact Rivo Uiboupin rivo.uiboupin@taltech.ee or Aarne Männik aarne.männik@tal-tech.ee.



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