Synthetically generated low-pressure systems to support studies of sea level extremes

Mika Rantanen, Jani Särkkä, Jani Räihä, Matti Kämäräinen, and Kirsti Jylhä
Finnish Meteorological Institute, Helsinki, Finland (mika.rantanen@fmi.fi)

Extremely high sea levels on the Finnish coast are typically caused by close passages of extratropical cyclones (ETCs), which raise the sea level with their associated extreme winds and lower air pressure. For coastal infrastructure, such as nuclear power plants, it is crucial to study physically possible sea level heights associated with ETCs. Such sea levels are not straightforward to determine from observational datasets only, because tide gauge records cover about 100 years and do not necessarily capture the most extreme cases having return periods longer than 100 years.

In this study, a method for generating an ensemble of synthetic low-pressure systems is being developed to investigate the extreme sea level heights on the Finnish coast of Baltic sea. As input parameters for the method, the point of origin, velocity of the center of the cyclone and depth of the pressure anomaly need to be given. Based on the input parameters, the method forms an idealized low-pressure system using a two-dimensional Gaussian function. In order to find extreme, but still reasonable values for the input parameters, cyclone tracks from ERA5 reanalysis data will be analysed.

The ensemble of synthetic low pressure systems (i.e. the wind and pressure data) is used as an input to a numerical sea level model. As a result, we have an ensemble of simulated sea levels, from which we can determine the properties of the ETCs that induce the highest sea levels on a given location on the coast. The preliminary simulation results show that this method works well, forming a basis for studies on extreme sea levels.