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Drivers of sea level variability in the Baltic/North/Nordic Seas using neural networks

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Sea level is rising, threatening coastal population and infrastructures. While the causes for global sea level rise are relatively well determined and the projections can be made based on most likely climate scenarios, sea level changes in coastal regions are far less understood. Apart from the global temperature rise and the melting of ice sheets and glaciers, coastal areas are also affected by the spatio-temporal temperature and salinity variations, atmospheric conditions, and even vertical land motions, such as those due to glacial isostatic adjustment. It is therefore necessary to determine which factors contribute most to the sea level change in each specific region, in order to mitigate the effect sea level changes will have on local infrastructure.
We here use long short-term memory (LSTM) neural networks to find the connection between the sea level variations and its many potential drivers in the Baltic, North, and Nordic Seas, at daily to decadal scales. We test all the different combinations of local atmospheric (surface pressure, wind, and precipitation from reanalysis) and oceanic (temperature and salinity, from in-situ observations), along with the remote ones (e.g. Greenland ice sheet runoff, large scale water mass circulation) to predict sea level variations at selected locations that have uninterrupted long-term (>50 years) tide gauge observations.
By comparing the quality of sea level prediction from these different combinations, we find that the long-term sea level trend and low-frequency variations at most locations in our region of interest are mainly driven by the temperature rise, both local and remote, while the higher frequency variations are predominantly driven by the changes in local wind. As expected, northern locations are also affected by glacial isostatic adjustment, which counteracts the sea level rise. Precipitation, even during major storm events, seems to play an insignificant role in our region. The exception is the Baltic Sea, where wind plays less of a role, and the sea level is more affected by the influx of fresh water. While most regions are affected by sea level rise to some extent, because the causes for the local sea level changes vary, the protection from flooding and the warning techniques have to be adapted for each location.