

## **Variability of the water temperature in the western Wadden Sea on seasonal to centennial time scales: global or local warming?**

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The temperature of the sea is a dominant non-biological factor for marine ecosystem performance. The seawater temperature of the Marsdiep tidal inlet is representative for the water temperature of the Dutch coastal waters, and is measured daily since the summer of 1860, nearly years ago. To explain the observed inter-annual SST variations the North Atlantic Oscillation index has often been used as large-scale proxy for the atmospheric forcing. Only for the winter and spring a significant correlation is found between temperature and the winter index. However, this correlation is so strong that also the annual mean temperature is correlated significantly with the North Atlantic Oscillation ( $R = 0.5$ ). At time scales, from decadal to centennial, large temperature variations are observed, of the order of  $1.5^{\circ}\text{C}$ . These could not be linked directly with long-term changes of the North Atlantic oscillation. An alternative multiple linear regression model has been developed, using persistence from season to season, a single seasonal wind component, and for the spring and summer seasons the sun hours per day, representing cloudiness. This model is based on physics, performs much better than the NAO, and leads to correlations between observations and simulation of about 0.9 for the annual mean temperature. The model also performs well for other tidal inlets, the Vliestroom, New Waterway, and Western Scheldt. A large part of the annual mean SST increase since 1982 is explained with this model, indicating the importance of persistence, long-term changes of the atmospheric circulation, and cloudiness for the temperature of Dutch coastal waters. Direct changes of the long wave radiation budget due to the increase of green house gasses is not incorporated explicitly in the model, but may hide in the persistence term.