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Winter atmospheric circulation signature for the timing of the spring bloom of diatoms in the North Sea

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Analysing long-term diatom data from the German Bight and observational climate data for the period 1962–2005, we found a close connection of the inter-annual variation of the timing of the spring bloom with the boreal winter atmospheric circulation. We examined the fact that high diatom counts of the spring bloom tended to occur later when the atmospheric circulation was characterized by winter blocking over Scandinavia. The associated pattern in the sea level pressure showed a pressure dipole with two centres located over the Azores and Norway and was tilted compared to the North Atlantic Oscillation. The bloom was earlier when the cyclonic circulation over Scandinavia allowed an increased inflow of Atlantic water into the North Sea which is associated with clearer, more marine water, and warmer conditions. The bloom was later when a more continental atmospheric flow from the east was detected. At Helgoland Roads, it seems that under turbid water conditions (= low light) zooplankton grazing can affect the timing of the phytoplankton bloom negatively. Warmer water temperatures will facilitate this. Under clear water conditions, light will be the main governing factor with regard to the timing of the spring bloom. These different water conditions are shown here to be mainly related to large-scale weather patterns. We found that the mean diatom bloom could be predicted from the sea level pressure one to three months in advance. Using historical pressure data, we derived a proxy for the timing of the spring bloom over the last centuries, showing an increased number of late (proxy-) blooms during the eighteenth century when the climate was considerably colder than today. We argue that these variations are important for the interpretation of inter-annual to centennial variations of biological processes. This is of particular interest when considering future scenarios, as well to considerations on past and future effects on the primary production and food webs.