The biological pollutant pump. How a phytoplankton bloom alters the concentrations of organic chemicals in the marine environment

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In the present research we performed a large-scale analysis based on three decades of field observations in the North Sea. By using additive models, we inferred spatiotemporal concentration trends of chlorophyll a (n = 440), sediment organic carbon (n = 146) and of concentrations of polychlorinated biphenyls (PCBs) in mussels (n = 3,055) and sediments (n = 1,139). By doing so, we separated the interannual changes of PCB concentrations from the seasonal variability. Using the inferred seasonal variability, we demonstrated a strong positive relation between the chlorophyll a concentrations and the organic carbon content in the sediment ($r = 0.56$; $p < 0.01$) and between the chlorophyll a concentrations and the PCB concentrations in the sediment ($r = 0.57$; $p < 0.01$). Indeed, we found that the timing of phytoplankton blooms in spring and autumn correspond to the annual maxima of the organic carbon content and the PCB concentrations in sediment. However, the PCB concentration in sediment was negatively correlated with the PCB concentration in the blue mussel ($r = -0.33$; $p = 0.01$). The inferred relationships are likely to be driven by the cleansing of the dissolved PCB phase by sinking organic matter during phytoplankton blooms (i.e. biological pump). These results demonstrate the role of seasonal phytoplankton dynamics in the environmental fate of PCBs at large spatiotemporal scales. Hence, the spatiotemporal variability of PCBs (and potentially other organic compounds) should be considered when monitoring the marine environment...a practice which is currently largely neglected.

From this study we concluded that phytoplankton blooms in spring and autumn alter the concentrations of organic chemicals in marine sediments and mussels.

Keywords: additive modelling; environmental fate; marine; organic chemicals; phytoplankton