Concentration Variations of Anthropogenic and Biogenic Organic Substances in the German Bight due to Changing Meteorological Conditions

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UDC 551.464.7; North Sea

Summary

Short time concentration variations of different organic pollutants have been investigated in the German Bight during six cruises between November 1988 until May 1989. The data set which includes halogenated phenols, organophosphates, low-volatile halogenated hydrocarbons, and high-volatile halogenated hydrocarbons supplies experimental evidence that changing meteorological and oceanographic conditions may give rise to concentration variations of pollutants by nearly one order of magnitude. However, concentration variations of that order of magnitude which may possibly cause additional stress to the marine ecosystem are supposed to be confined to North Sea areas that are sufficiently close to the "sources" of the respective pollutants. For comparison, the concentration variation of a biogenic halogenated substance produced by algae, bromoform, will be discussed herein.

Die Konzentrationsänderung anthropogener und biogener organischer Substanzen in der Deutschen Bucht in Abhängigkeit von wechselnden meteorologischen Bedingungen (Zusammenfassung)


1 Introduction

The concentration variation of organic substances in the North Sea and, in particular, in the German Bight has been subject of considerable debate. Long term observations by Ernst, Boon, and Weber [1988], Gaul (personal communication), and by Weber, Balint, and Hühnerfuss [1992] allow some conclusions with regard to the development of hexachlorocyclohexane-concentrations [HCH] during nearly one decade: In comparison to investigations of 1979, an increase in the γ-HCH levels ("Lindane") and a decrease in the α-HCH levels have been observed in the Southern North Sea, while in the Central and the Northern North Sea the changes were less significant. Apart from the HCH-isomers no long term data of other pollutants are available which allowed similar clear conclusions thus far.
As for the seasonal variability of the concentration of pollutants in the North Sea, Hüchnerfuss and Weber [1992a] recently presented results about HCH-concentrations in the North Sea measured during a cruise in summer 1986 and winter 1987. In the case of γ-HCH, the authors observed significantly larger concentrations in coastal areas during the summer 1986 campaign compared to the winter 1987 campaign. This holds, in particular, in the estuaries of the river Elbe, the river Weser, the river Humber, the British Channel, and in the Skagerrak. In the Central, Northern, and North-Western North Sea, however, the concentrations of γ-HCH remained relatively constant within the error limits of the method and appeared to be independent of the season. Therefore, it can be assumed that the seasonal variation of the biological activity is not reflected in a comparable variability of the γ-HCH concentration. The significant increase in the γ-HCH concentration in coastal areas during early summer rather expresses the seasonal agricultural application of Lindane, a considerable part of which is being transported to the North Sea by the rivers.

Regarding the seasonal variation of the α-HCH concentration similar conclusions have been drawn by Hüchnerfuss and Weber [1992a]. The main sources of α-HCH inflow into the North Sea have been determined to be off the Norwegian coast. In the sea area close to these α-HCH sources, an increase in α-HCH has been observed in the early summer 1986, while other parts of the North Sea which are further away from the α-HCH sources remain unaffected by seasonal variations of the biological activity.

Data about short time concentration variations of pollutants in the North Sea due to changing meteorological conditions are however lacking. Therefore, recent theoretical approaches by Hainbucher, Pohlmann, and Backhaus [1987] have led to a controversial debate: the authors performed calculations with the help of a simple Lagrangian transport model for a simulation period between 1969 to 1982 assuming conservative substances, which have well-determined sources. The calculations were carried out in order to get estimates of both the low-frequency flow in the North Sea and the resulting dispersion of substances within the sea. The authors concluded that changing meteorological conditions may give rise to concentration variations of pollutants by nearly one order of magnitude (see Fig. 1). This was completely in contradiction to all data thus far determined by marine chemists.

Fig. 1 Time series of the concentration of a conservative chemical compound in the German Bight area corresponding to ICES Box 5a (after Hainbucher et al. [1987])