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Climate-physics-chemistry-biology: connected changes in the Black Sea regimes.

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The ratio of nutrients in the water is a significant regulator of community structure. This control is very important, both in coastal waters that are exposed to river runoff and in the open Sea, where the development of the phytoplankton community depends on the intensity of the vertical exchange. This is valid also for the northeastern Black Sea. Since there are no big rivers in this region, vertical mixing becomes the main process that supplies nutrients from the nutrient-rich deep layers to the surface layer. Vertical mixing depends on winter cooling and is characterized by a cold intermediate layer (CIL) temperature. Since 1984, both the sea-surface and CIL temperatures have shown a tendency to increase, which leads to relatively weak winter mixing. The coldest winters during last two decades were observed in 2006 and 2012, when the CIL temperature decreased to 7.3oC and 6.8oC, respectively. According to the observed density dynamic, the maximum elevation of cold, high density water occurred in the second half of May. In 2012, the waters from the upper part of the CIL reached a depth of 20–30 m. All the other years were characterized by a weak winter mixing, with the CIL temperature varying from 7.8oC to 8.3oC, and CIL waters raised to the depths no shallow than 60 m. Elevation of CIL waters resulted in an increase in nutrient concentration in the surface layer from the end of March to the beginning of June, before the thermocline starts to form, with maxima in May. An increase in the nutrient concentrations is more pronounced for silicon and phosphorus and less for nitrogen. After a severe winter, the silicon concentration can reach 8 μM, whereas after warm ones, only 4 μM. For phosphorus, this amounts to 0.4 and 0.1 μM, respectively. This leads to decrease of N/P ratio below the Redfild theoretical value after a severe winter. It was found that variation in N/P ratio is the main regulator of phytoplankton community structure in the NE Black Sea. At low N/P ratio, <16, coccolithophores are a dominant species, at N/P>16 diatoms dominate in the system. The years 2006 and 2012, years with coldest winters and intensive vertical mixing, were characterized by a very high concentration of phosphorus and a low N/P ratio during most of the year, especially in 2012. This followed by massive boom of coccolithophores during these years. Years 2007 and 2008 showed an opposite situation – a low phosphorus concentration, high N/P ratio and diatoms as dominant species only. Thereby during the last decade in the NE Black Sea the main forcing is climate that determines the hydrophysical regime, vertical mixing, that affected the hydrochemical regime, the supply of nutrients to the surface layer, that controls the hydrobiological regime, the structure of phytoplankton community.