Unraveling hypoxia events in a context of climate change in the Bay of Vilaine, France

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Abstract

Climate change will have important effects on hydrodynamics and physical processes (Duvall et al. 2023) especially at regional or local scales. Even if the effects of climate change on eutrophic and hypoxic coastal waters remain unclear (Ni et al. 2019), the increase of extreme events can be considered as a major risk in summer due to heatwaves and thunderstorms causing surface seawater to warm up, flash floods and strong winds. These sudden events can have a major impact on oxygen concentrations in coastal ecosystems by supporting stratification and so, limiting the vertical diffusive transport of oxygen. These hypoxic conditions can caused ecological disruption which can have considerable socioeconomic repercussions.
In a context of increasingly frequent extreme events during summertime, it is now important to seek new hypoxia alert tools for better management of shellfish farming and fish nurseries areas (Kemp et al. 2009). Indicators need to be developed not only in areas where steadily hypoxia are observed for long periods but also in areas subjected to intermittent (few hours) or episodic (days to weeks) hypoxia. According to Conly et al. (2007), a long anoxia event can be less impactful for benthic communities than repeated episodic and rapid hypoxic events.
Our study explores the emergence of episodic hypoxia in a shallow coastal ecosystem under the direct influence of river plumes with high nutrient inputs. It is located in the bay of Vilaine, which is known for being one of France's main shellfish-growing regions and for its recurrent hypoxic events since the 1980s (Merceron, 1984; Chapelle et al., 1994). By using high frequency measurements of temperature, salinity, dissolved oxygen, chlorophyll recorded in subsurface and bottom waters, we examine the interactions between surface phytoplankton blooms, stratification and hypoxic events. We also highlight the environmental conditions that are most favorable to the implementation of stratification and thus to hypoxia. We finally use a 3D model to simulate extreme event scenarios to assess the increased risk of hypoxia in different parts of the bay in the coming years.

Keywords

Hypoxia, Dissolved oxygen, Coastal waters, Stratification, Climate change, Extreme events.