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## 21st century nutrient and oxygen dynamics in the Gulf of Bothnia

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The Gulf of Bothnia is the only sub-basin of the Baltic Sea with no serious eutrophication. However, long-term observations have shown degradation of the water quality over the past years, indicating warning signals for the future. Here, we use a high resolution ocean circulation model including biogeochemistry to study 21st century nutrient and oxygen changes in the Gulf of Bothnia. We analyze ensembles for 5 different scenarios; a historical (1975-2005) and 4 future projections (2006-2100). For the projections, two atmospheric  $p\text{CO}_2$  trajectories are used, RCP4.5 and RCP8.5, and two settings for nutrient loads are applied to each RCP scenario: one following the Baltic Sea Action Plan (BSAP) and the other assuming business as usual. We also test a historical scenario but with no local nutrient loads to better understand the biogeochemical influence of the lateral open boundary. The comparison of observations with the historical scenario shows that oxygen trends are well captured by the model despite a small bias in nutrient concentrations. Our results suggest that the Bothnian Bay is more sensitive to river loads than the Bothnian Sea, which is primarily affected by the inflows from the Baltic proper. All future projections show a decrease in phosphate concentrations and an increase in nitrate concentrations due to lower/higher input of phosphate/nitrate from the Baltic proper. Oxygen concentrations in bottom waters of the Gulf of Bothnia are not susceptible to become hypoxic in the future. However, when business as usual is applied for nutrient loads, oxygen concentrations decrease significantly over the entire future period and short episodes of low oxygen conditions in bottom waters (with less than 5 ml  $\text{O}_2/\text{l}$ ) become more frequent and more pronounced in the Bothnian Sea, especially towards the end of the century.