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How phosphorus limitation can control climatic gas sources and sinks

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Since the 1950's, anthropogenic activities severely increased river nutrient loads in European coastal areas. Subsequent implementation of nutrient reduction policies have considerably reduced phosphorus (P) loads from mid-1980's, while nitrogen (N) loads were maintained, inducing a P limitation of phytoplankton growth in many eutrophied coastal areas such as the Southern Bight of the North Sea (SBNS). When dissolved inorganic phosphorous (DIP) is limiting, most phytoplankton organisms are able to indirectly acquire P from dissolved organic P (DOP). We investigate the impact of DOP use on the importance of phytoplankton production and atmospheric fluxes of CO_2 and dimethylsulfide (DMS) in the SBNS from 1951 to 2007 using an extended version of the R-MIRO-BIOGAS model. This model includes a description of the ability of phytoplankton organisms to use DOP as a source of P. Results show that primary production can increase up to 70% due to DOP uptake in limiting DIP conditions. Consequently, simulated DMS emissions double while CO_2 emissions to the atmosphere decrease, relative to the reference simulation without DOP uptake. At the end of the simulated period (late 2000's), the net direction of air-sea CO_2 annual flux, changed from a source to a sink for atmospheric CO_2 in response to use of DOP and increase of primary production.