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Fe(II) availability for phytoplankton in a future Southern Ocean

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The Southern Ocean is important for marine biogeochemical cycles and global air-sea CO_2 fluxes. While it is rich in nitrogen and phosphorus, it is often limited in iron (Fe) which is vital for primary production. Of the two species of dissolved Fe available for phytoplankton uptake (dFe(II) and dFe(III)), dFe(III) is thermodynamically favored in oxygenated oceans, while dFe(II) is more accessible to phytoplankton. However, the oxidation rate of dFe(II), and thus its half-life is dependent on pH and temperature. Ocean acidification (OA) and global warming will modify these parameters dramatically in our future.

A projected increase in the sea surface temperature should promote the oxidation of dFe(II), shortening its half-life, whereas OA from pH 8 to 7.7 extends its half-life. Here, we present data obtained during controlled oxidation observations of dFe(II) and incubation experiments. Our results demonstrate an extended half-life of dFe(II) in future ocean scenarios under acidified conditions (pH 7.7) under three different temperatures (5°C, 10°C, 15°C).

Together with a modelling approach, we show that dFe(II) half-life is shortened by a change in temperature from 5°C to 15°C and extended by a pH decrease of 0.4 units in coastal and oligotrophic Southern Ocean waters. Our results revealed that acidification and increase of temperature will be of crucial importance for the availability of dFe(II) for phytoplankton, as this has implications for ocean carbon storage.