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Spatial-temporal development of iron stress in the sub-polar North Atlantic

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Primary production is vulnerable to limitation by iron (Fe), which is an essential micronutrient regulating nitrogen fixation and carbon sequestration in the ocean [1]. This is particularly true in the sub-polar North Atlantic (SPNA) during spring and autumn blooms, where phytoplankton drive substantial nutrient drawdown, leading to insufficient Fe in surface waters [2][3]. However, it is unclear how Fe stress develops during the annual phytoplankton cycle and is distributed across the SPNA. Addressing this, we conducted bioassay Fe addition experiments on cruises in spring and autumn in the SPNA expanding from shelves to open ocean. These experimental results thus provide a semi-time series of *in-situ* response to Fe addition. We observed that emergence and intensification of Fe stress during the spring bloom coincided with decreasing surface dissolved Fe concentrations. Such Fe stress persisted into autumn but was moderate compared to late spring, alongside slightly increased surface dissolved Fe concentrations in the SPNA. During autumn an increase in Fe stress was observed moving away from the shelves to open ocean SPNA as a result of decreasing Fe supplies and short residence time of dissolved Fe in seawater. Our results provide a first sight of the seasonal cycle and spatial distribution of Fe stress in the SPNA. This not only advances comprehensive understanding of Fe stress development in the ocean but also paves the way for future work on ecosystem dynamics between phytoplankton growth and loss.

References

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