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Two years of iron and manganese cycling in the North Pacific Subtropical Gyre

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Time-series observations of nutrient and carbon cycling have been crucial for validating ocean biogeochemical models, but time-resolved observations of iron and other bioactive metals that can influence these cycles remain extremely rare. We will present two years of seasonal dissolved and particulate trace metal distributions from 14 Hawaii Ocean Time-series cruises to Station ALOHA in the North Pacific Subtropical Gyre. We observe remarkable seasonality and interannual variability in particulate Fe, driven by variations in atmospheric deposition. However, the labile component of particulate Fe pool – accounting for 49 ± 19 % (1SD) of total particulate Fe – is surprisingly steady, suggesting that ecosystem recycling exerts a more significant control than seasonal changes in atmospheric deposition. Based on material collected in sediments traps at the base of the euphotic zone, we estimate that sinking particulate Fe is ~20% labile over the annual cycle. Under steady state, this value should equal the solubility of Fe supplied by aerosol dust deposition, but is considerably higher than estimated aerosol solubilities from past surveys, as well as typical values derived from atmospheric models. This could indicate either a sizable source of highly soluble anthropogenic Fe to the North Pacific Subtropical Gyre, or a more aggressive chemical and/or ecosystem processing of lithogenic Fe than is captured in aerosol-leaching experiments. Beyond Fe, we observe cycles of particulate manganese accumulation and loss in the mesopelagic ocean, likely due to seasonal differences in the photoreduction of particulate manganese oxides. Overall, our results highlight the value of multi-year time-series measurement in investigating and quantifying the biogeochemical cycles of trace elements.