

Direct experimental evidence for nutrient co-limitation from the South Atlantic GA08 GEOTRACES expedition

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Simultaneous nutrient co-limitation—where multiple nutrients concurrently restrict the growth of primary producers—might be prevalent in the upper ocean yet there is little direct experimental evidence to support this.

On the recent GA08 German GEOTRACES cruise we conducted full factorial nutrient amendment experiments in the South East Atlantic and found extensive regions where supplying nutrients individually resulted in no significant phytoplankton growth. However, adding multiple nutrients simultaneously increased chlorophyll-a concentrations by >40-fold and led to diatom proliferation. Key nutrients stimulating phytoplankton growth included cobalt and cobalt-containing vitamin B₁₂.

A resource ratio framework based on measured initial seawater (micro)nutrient concentrations allowed qualitative—and even quantitative—prediction of observed phytoplankton responses to given nutrient combinations. This suggests potential for reconciling phytoplankton elemental stoichiometry and measured (micro)nutrient concentrations with patterns of proximal/co-/secondary nutrient limitation on ocean scales. Such understanding also lends itself towards better resolving nutrient limitation in the past and future ocean.