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Which Processes Sustain Biota in Open-Ocean Deep Chlorophyll Maxima?

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Deep chlorophyll maxima (DCM) are productive layers widespread throughout the global ocean. In the DCM, marine phytoplankton are adapted to low light conditions at the cost of elevated cellular iron (Fe) requirements, leading to Fe deficient growth. To sustain productivity, nutrient demands must be met by sources such as the dissolution of sinking lithogenic particles, recycling of biogenic particles and physical transport from below. The *GEOTRACES* programme has expanded the global ocean datasets for a suite of trace metals and also noble gases. Here, we exploit helium measurements to derive a vertical flux estimate of nitrate (NO_3), phosphate (PO_4), silica (Si) and Fe into the DCM in the subtropical North Atlantic and equatorial Pacific. We apply the Si* relation to show differences in nutrient deficiency between waters in the DCM and the upward flux into the DCM. The offset in Si* between the DCM and upward flux may be enhanced or reduced by the dissolution of sinking particles or internal recycling. We show that the upward Fe flux to the DCM is of similar magnitude to Fe supplied through regeneration. In contrast, we show that the upward Fe flux outweighs estimates of Fe supplied to the DCM via recycling or lithogenic particles in the subtropical North Atlantic. The muted role of lithogenic particles in our estimates leads to the question: what assumptions must be made about aeolian deposition to increase the relevance of lithogenic particles at the DCM?