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On the relationship between Southern Ocean eddies and phytoplankton

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Effects on phytoplankton in the Southern Ocean are crucial for the global ocean nutrient and carbon cycles. Such effects potentially arise from mesoscale eddies which are omnipresent in the region. Eddies are known to affect phytoplankton through either advection and mixing, or the stimulation/suppression of growth. Yet, the climatological relationship between Southern Ocean eddies and phytoplankton has not been quantified in detail.
To provide an estimate of this relationship, we identified more than100,000 eddies in the Southern Ocean and determined associated phytoplankton anomalies using satellite-based chlorophyll-a (*chl*) measurements. The eddies have a very substantial impact on the *chl* levels, with eddy associated *chl* differing by more than 10% from the background over wide areas. The structure of these anomalies is largely zonal, with positive anomalies north of the Antarctic Circumpolar Current (ACC) and negative anomalies within the circumpolar belt of the ACC for cyclonic eddies. The pattern is similar but of opposite sign for anticyclonic eddies. The seasonality of this signal is weak north to the ACC, but pronounced in the vicinity of the ACC. The spatial structure and seasonality of the signal can be explained largely by advection, i.e., the eddy-circulation driven lateral transport of anomalies across large-scale gradients. We conclude this based on the shape of local *chl* anomalies of eddies and ambient *chl* gradients. In contrast, ACC winter anomalies are consistent with an effect of eddies on the light exposure of phytoplankton. The clear impact of eddies on *chl* implies a downstream effect on Southern Ocean biogeochemical properties.