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TITLE: Chlorophyll variability in the oligotrophic gyres: mechanisms, seasonality and trends

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ABSTRACT:

A 16-year (1998-2013) analysis of trends and seasonal patterns was conducted for the five subtropical ocean gyres using satellite data: chlorophyll-a (Chl-a) retrievals from ocean color, sea surface temperature (SST), and sea-level anomaly (SLA). Trend analysis was also performed on mixed-layer data derived from ocean model gridded temperature and salinity profiles (1998-2010). The Chl-a monthly composites were constructed from the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) and Moderate-resolution Imaging Spectroradiometer (MODIS) on Aqua using two different algorithms: the standard algorithm (STD) that has been in use since the start of the SeaWiFS mission in 1997, and a more recently developed Ocean Color Index (OCI) algorithm with improved accuracy in low Chl-a waters. Trends were obtained for all gyres using both STD and OCI algorithms, which demonstrated generally consistent results. The North Pacific, Indian Ocean, North Atlantic and South Atlantic gyres showed significant downward trends in Chl-a, while the South Pacific gyre has a much weaker upward trend with no statistical significance. Time series of satellite-derived net primary production (NPP) showed downward trends for all the gyres, while all five gyres exhibited positive trends in SST and SLA. The seasonal variability of Chl-a in each gyre is tightly coupled to the variability in mixed layer depth (MLD) with peak values in winter in both hemispheres when vertical mixing is more vigorous, reaching depths approaching the nutricline. On a seasonal basis, Chl-a concentrations increase when the MLD approaches or is deeper than the nutricline depth, in agreement with the concept that vertical mixing is the major driving mechanism for phytoplankton photosynthesis in the interior of the gyres. The combination of surface warming trends and biomass reduction over the 16-year period has the potential to reduce atmospheric CO2 uptake by the gyres and therefore influence the global carbon cycle.

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