Geophysical Research Abstracts
Vol. 21, EGU2019-11478, 2019
EGU General Assembly 2019

Phytoplankton community temporal and spatial scales of decorrelation

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Phytoplankton communities are shaped by local and non-local processes. Local processes (e.g., heat fluxes and surface wind mixing) affect community structure by modulating environmental variables which determine in situ growth rates, whereas non-local processes (e.g., advection and mixing) mediate the dispersal of the organisms themselves. Understanding the scales over which phytoplankton communities vary in time and space provides insights into the relative contributions of local and non-local processes on phytoplankton distributions. Here, in the context of a complex global ocean ecosystem model, we quantify decorrelation time and length scales for a wide range of phytoplankton phenotypes, with a range of functional traits and body sizes. Our goal is to gain new insights into regional contributions of physical dispersal in shaping the phytoplankton community structure, and how this varies across different phenotypes. In essence, we ask: 1. Over what timescales do perturbations in phytoplankton biomass persist? and 2. Over what distance do phytoplankton populations vary in synchrony? We find that decorrelation timescales are short where strong currents disperse phytoplankton. Conversely, in the large ocean subtropical gyres, phytoplankton biomass anomalies persist for long periods. The spatial correlation fields, which are used to measure length scales, are elongated near ocean fronts and narrow boundary currents, reflecting the path of the flow affecting it. Lastly, we find nearly isotropic spatial correlation fields where current speeds are small, or where mixing disperses phytoplankton roughly equally in all directions. Our results offer a quantitative, synoptic estimation of the scales of variability in phytoplankton communities.