Effects on ocean biology induced by El Niño-accompanied positive freshwater flux anomalies in the tropical Pacific

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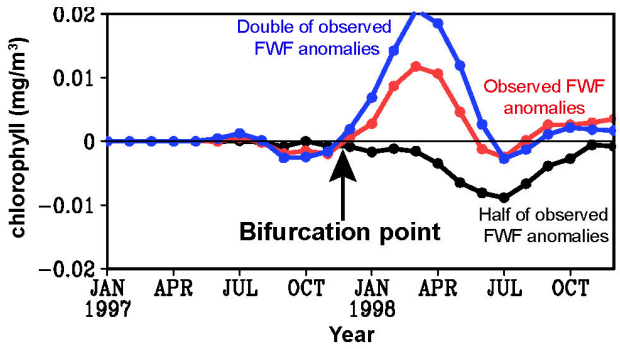
The El Niño and Southern Oscillation (ENSO) can induce large perturbations in freshwater flux (FWF, defined as precipitation minus evaporation) and ocean ecosystem in the tropical Pacific. However, how El Niño-induced FWF can affect the tropical Pacific ecosystem (e.g., chlorophyll) is still unknown. Here, a series of ocean-only experiments are performed using a coupled ocean-physical biogeochemistry model forced by prescribed climatological wind stress. Interannual FWF anomalies observed during the 1997-1998 El Niño event are imposed onto the ocean model and the related positive FWF anomalies are specified to be varying in the tropical Pacific, and the corresponding sensitivity experiments are performed to examine the ocean ecosystem response. In general, chlorophyll increases with the intensities of the El Niño-induced positive FWF anomalies at a certain strength, but decreases when the positive FWF forcing is under-represented (e.g., specified to be its half intensity). Additionally, chlorophyll in the eastern tropical Pacific keeps almost steady during the increasing stage of the El Niño-induced interannual FWF forcing, and then rapidly increases after the peak stage of the FWF forcing. The phytoplankton budget and diagnostic analyses are conducted to understand the behavior of chlorophyll in response to varying intensities of FWF forcing. Chlorophyll response to varying intensities of FWF forcing depends on the iron concentration in the mixed layer, suggesting that the ocean ecosystem response may be shifted from one regime to another when FWF forcing reaches a certain intensity. These results offer insights into biophysical interactions and chlorophyll-induced feedback effects on ENSO.

Keywords: El Niño, freshwater flux, ocean biology, chlorophyll, threshold, response

(a) Chlorophyll response to varying freshwater flux forcing



(b) Processes involved in chlorophyll response to FWF anomalies