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Surface chlorophyll patterns in the tropical Pacific during recent El Niño events - a multi-sensor analysis

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While warm SST anomalies were observed from the Central American coast to the central Pacific basin in 1997-1998, the warming pattern was confined in the central Pacific during the more recent events. These two situations illustrate the so-called Eastern Pacific El Niño (EPEN) and Central Pacific El Niño (CPEN) warming patterns. In this study, we analyze the surface chlorophyll signature of El Niño-Southern Oscillation (ENSO) by applying an Agglomerative Hierarchical Clustering method to monthly maps of satellite-derived chlorophyll anomalies between September 1997 and December 2010. We identify five typical ENSO structures representative of the lonely 1997-1998 EPEN of the period, the four CPEN, two La Niña situations and intermediate conditions. Other satellite measurements (sea level anomaly, wind) and satellite-derived surface currents allow suggesting processes at work during ENSO phases.

During the strong 1997-1998 EPEN, a large eastward shift of the oligotrophic warm pool, a deep nutrient pool (elevated sea level anomaly) and a reduction of equatorial upwelling (due to reduced trade winds) result in negative chlorophyll anomalies east of 170°E between 10°S and 10°N.

During the following four CPEN events (2002-2003, 2004-2005, 2006-2007, and 2009-2010), eastward advection of the oligotrophic waters of the warm pool in the western basin combined with westward surface currents in the central basin contribute to the confinement of the negative chlorophyll anomalies between 160°E and 160°W in the equatorial band. This negative anomaly core corresponds to a region of elevated sea level anomaly indicating deep nutrient (nitrate and iron) sources. Negative chlorophyll anomalies that extend eastward from the equatorial anomaly core probably result from reduced upward iron fluxes linked to the deepening of the Equatorial Undercurrent. Two other narrow bands of negative chlorophyll anomaly follow the position of enhanced eastward countercurrents.