Oceanic and Atmospheric Evidence for abrupt North Pacific Oceanographic Changes After 1998

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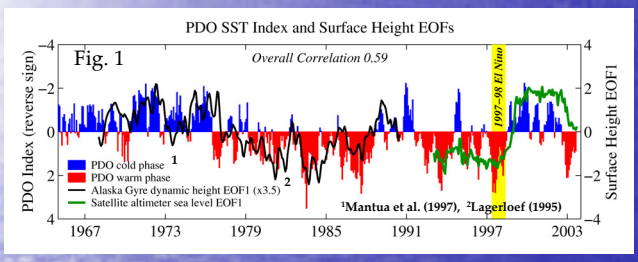
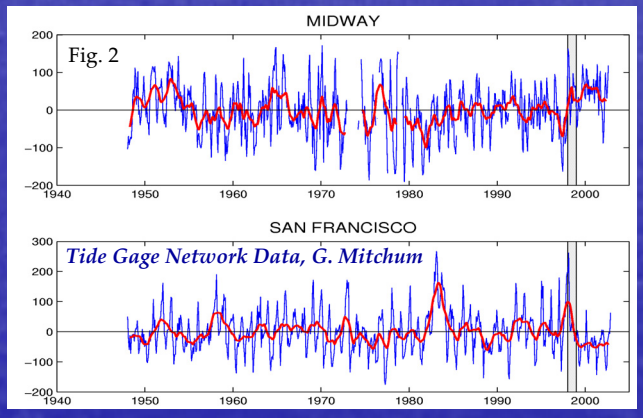
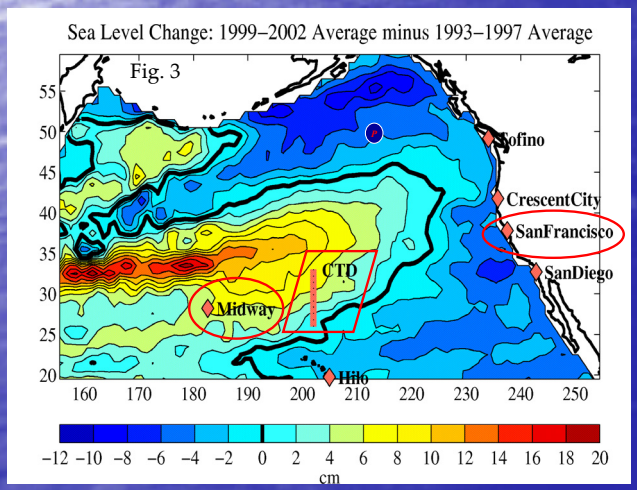
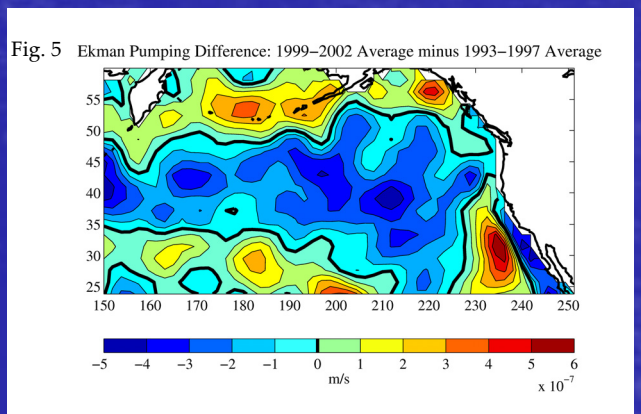
ABSTRACT

North Pacific sea level anomalies from satellite altimeter (Fig. 1) and western North American tide stations (Fig. 2) indicate an abrupt step-like transition during 1998. The spatial pattern coincides with the Pacific Decadal Oscillation (PDO) sea surface temperature (SST) index (Fig. 1), and includes an elongated band of maximum sea level change (15-20 cm) between 32N-35N extending zonally from 150E to about 150W (Fig. 3). Variations of this magnitude indicate vertical ocean pycnocline displacements of tens of meters as also seen in available oceanographic sections north of Hawaii during this time (Fig. 4). Ekman pumping anomaly differences match the broad sea level change pattern when time-averaged for the same multi-year periods before and after the 1998 transition (Fig. 5), providing strong evidence that the ocean pycnocline depth responded primarily to interannual basin-wide wind stress curl changes (Fig. 6). The large scale sea level and SST anomalies matched the PDO warm phase prior to 1998 and the cold phase thereafter (Fig. 1,3), and persisting for the subsequent four years. These events evolved in the aftermath of the large 1997-1998 El Nino (Fig. 1) and the subsequent persistent La Nina in the tropics, and the PDO cold phase is known to resemble the north Pacific La Nina teleconnection response. This pattern weakened in early 2003 following the mild 2002-2003 El Nino. The PDO cold phase is likely to persist beyond 2003 if there is a restoration of La Nina conditions in the tropics.









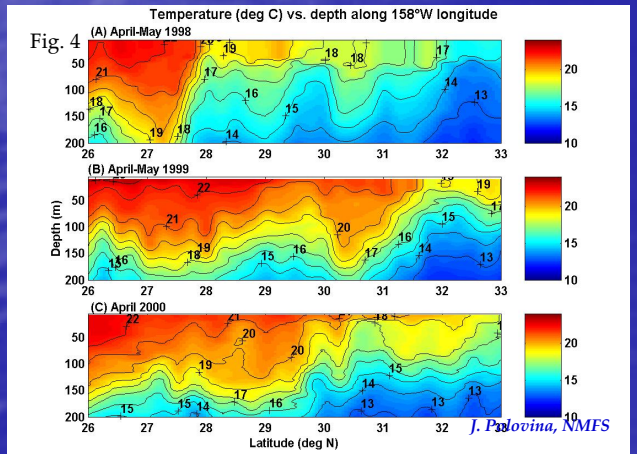


Fig. 6: Pycnocline displacement

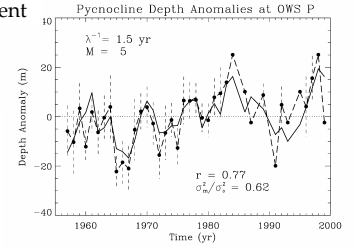
$$\frac{\partial h}{\partial t} = -W_E - \lambda h$$

h is pycnocline depth

W_E is Ekman pumping velocity

λ^{-1} is the dissipation time scale; ~1.5-2 years

Cummins and Lagerloef (2002)



References:
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Lagerloef, G. (1995) *J. Phys. Oceanogr.*, **25**, 2242- 2258.
Mantua, N. J. et al. (1997) *Bull. Am. Met. Soc.*, 78, 1069- 1079.