An Open-Circuit and a Short-Circuit in the Pacific Ocean Subtropical-Tropical Exchange

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Water mass exchange between subtropic and tropic regions of the Pacific Ocean has been hypothesized as being part of a mechanism controlling inter-decadal changes in the nature of ENSO. The pathway of this exchange is analyzed using model estimates from 1980 to 2001 of the Consortium for Estimating the Circulation and Climate of the Ocean (ECCO; http://www.ecco-group.org).

A novel implementation of a passive tracer and its adjoint is employed to trace the origin and destination of tropical water masses. On average, water mass of the Nino3 region can be traced back to eastern subtropical thermocline waters of the northern (27%) and southern hemispheres (39%). The Nino3 water subsequently returns to these subtropical latitudes in the upper ocean. But in contrast to the hypothesized "Subtropical Cell" (STC), this circulation is an open-circuit with water returning to the western regions of the two hemispheres (subtropical gyres) and to the Indian Ocean. Average transit time between the subtropics and the tropics is 10-15 years.

Temporal variability causes the tropical circulation inferred from a time-mean state to differ significantly from the average circulation. In particular, non-seasonal, intra-annual variability significantly enhances the magnitude of the so-called interior pathway relative to that of the circuitous western boundary pathway. Such short-circuit in the subtropical-tropical exchange may help better explain observed tracer distributions. Significant differences in circulation pathways are also identified that are associated with El Nino and La Nina events. The strength of the subtropical-tropical water mass exchange is found to have weakened during the 1990s.