Nearshore circulation during upwelling inferred from the distribution of dissolved cadmium off the Oregon coast

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ABSTRACT: The effectiveness of dissolved cadmium (Cd) as a tracer of coastal upwelling is demonstrated by comparing its water column distribution to that of traditional upwelling indicators, in particular phosphate (P) and salinity, as well as equatorward wind forcing at the Oregon coast. Cd and P concentrations in samples collected on board ship on 17-27 August 1995 between 3 and 100 km from the coast offshore of Cape Blanco, Oregon, ranged between 0.2 and 0.9 nmol kg^{-1} and <0.1 and 2.5 μmol kg^{-1}, respectively. Both tracers behaved conservatively during onshore transport at depth; linear Cd-salinity and P-salinity relations in offshore source waters were preserved in bottom waters over the shelf. Following upwelling to the surface, however, Cd and P distributions diverged, with Cd remaining essentially constant while P was taken up by phytoplankton, predominantly diatoms. The Cd content of nearshore water collected from the beach inshore of the cruise area was very similar to that of upwelling source waters sampled from the ship, suggesting efficient exchange of waters between the shelf bottom layer and the very nearshore region, including the surfzone. A simple box model, in which onshore Ekman transport occurs through a well-mixed bottom layer extending from the edge of the continental shelf to the very nearshore region, illustrates a close link between upwelling-favorable wind forcing and very nearshore Cd concentrations. The close agreement between Cd time series generated by the model and surfzone Cd sampled every 2-4 weeks during 1994-1996 suggests that the effectiveness of Cd as a tracer of wind-driven coastal upwelling off the Oregon coast is due in large part to conveyor-like circulation and the remarkably efficient mixing of newly upwelled water into the very nearshore region.