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Observations of internal waves, mixing, and plume dynamics in the vicinity of the Columbia River using AUVs and shipboard echosounder

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We present preliminary results and interpretation of September 2009 field observations in the vicinity of the Columbia River plume, an important oceanographic feature of the Eastern North Pacific. Observations were conducted as part of a field campaign of the Center for Coastal Margin Observation and Prediction (CMOP) and were designed to study mixing and cross-shelf exchange processes. Our primary observations were made using two REMUS-100 AUVs (Hydroid, Inc.) equipped with SBE-49 CTDs (Seabird-Electronics, Inc.) and upward/downward looking ADCPs. Supporting measurements from the R/V Point Sur include a boom mounted 120 kHz echosounder (Biosonics, Inc.) and an ADCP. Daily forecasts of plume circulation were used for mission planning. The shipboard echosounder was used to identify signatures of water column turbulence. The ship followed the ascending/descending AUVs at a distance of approximately 500 m. Multiple AUV missions were conducted during the cruise. In one mission, we sent an AUV approximately 17km offshore, letting it cross through the plume front. The echosounder shows details of mixing and turbulence at the plume front and in the entraining layer behind the plume front extending shoreward. During a repeat cross shelf transect, covering a distance of approximately 7km per leg and five legs, we saw evidence of bottom internal waves on the shelf at the interface of denser saltier ocean waters and fresher overlying residual plume waters. The internal waves lap the shelf as the density interface moves on- and off-shore. Mixing near the sea floor dilutes the saltier waters with the overlying fresher waters as evidenced by cross shelf isopycnals curving down towards the sea floor. There is some indication that during rapid offshore retreat of the bottom waters, some of these diluted bottom waters detach from the bulk of the retreating bottom waters and are left upslope. When the deeper ocean waters again move shoreward, they push the detached diluted waters further shoreward, in effect pumping deeper ocean water up the shelf, with potential ecological implications.

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