

Iron Cycling within the Columbia River plume: The role of tidal mixing and upwelling.

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The Columbia River plume provides a large source of iron to the coastal waters of the Pacific Northwest. In addition to the river source and of equal importance, is the benthic supply of iron from sediments outside the river mouth which can be entrained into the Columbia River plume and transported offshore. However, the supply of iron is highly variable depending on the river flow, coastal upwelling and the tidal state.

Wind-driven coastal upwelling results in cold nutrient-rich waters at or near the surface which, in combination with the riverine source and tidal state resulted in higher dissolved iron concentrations within the plume. Iron (II) and iron (III) were determined inside and outside the estuary over 5 tidal cycles. The tidal time series showed dissolved iron concentrations varied markedly with significantly higher levels observed during spring tides. Surface dissolved iron concentrations during the spring tide, in upwelling conditions ranged from 6 to 23 nM, while at depth concentrations of up to 750 nM were observed. During neap tides dissolved iron concentrations in surface waters ranged from 1 to 6 nM with highest concentrations observed at depth 8-17 nM. Iron (II) accounted for 60-80% of total dissolved iron during spring tides but only 10-20% during the less energetic neap tides.

Determining the source of iron potentially available to phytoplankton is critical to understanding the factors influencing plankton productivity. An important reservoir of iron is associated with semi-labile phases adsorbed onto or incorporated within abiotic and biotic particles. Correlations between the dissolved and leachable iron concentrations were observed both in the near and far-field Columbia River plume. The concentration of strong-iron binding ligands plays an important role in solubilising the leachable particulate iron within this system, which effectively controls the dissolved iron (III) concentrations within surface waters. The additional benthic source of iron along with the supply of macronutrients from the river and/or upwelling enables the periodic high productivity observed in satellite images.