

MIXING OF A CONTAMINANT-LADEN FRESHWATER PLUME ACROSS OSAKA BAY'S TIDAL FRONT NEAR THE AKASHI STRAIT, JAPAN

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Osaka Bay is an estuary that is separated by a tidal front into a stagnant, stratified section to the east of the front, and an energetic, well-mixed section to the west. Freshwater entering the eastern section from the Yodo River is laden with contaminants, so the fate of this water is important. Due to the size of the head of Osaka Bay, the freshwater circulates as a geostrophic gyre (instead of diverging in the manner typical of estuarine circulation), resulting in little flux of freshwater across the tidal front (Nakatsuji et al, 2000). However, very strong tidal currents exist near the Akashi Strait. During the westward tide, these currents entrain much of the Yodo River's freshwater out of Osaka Bay. During the eastward tide, rapid currents create a strong horizontal eddy in the lee of the Akashi headland (Fujiwara et al, 1994), which also entrains freshwater from eastern Osaka Bay, and transports it across the tidal front to the western region of the bay.

Via a field study using an ADCP and a CTD, we investigated the amount of freshwater entrained by this eddy (figure 1 displays the fraction f_2 of Yodo River freshwater, which is mixed with a fraction $f_1=1-f_2$ of seawater, comprising each observed water parcel). The amount of Yodo River water transported across the front in this manner exceeds 25% of the Yodo River's outflow. Along with advection of Yodo River water to the Harima Sea through the Akashi Strait during the westward tidal current (estimated via application to Osaka Bay of the numerical model ODEM), the mass balance of freshwater in eastern Osaka Bay is approximately closed. This indicates that the region near the Akashi Strait is where most of the Yodo River's freshwater leaves eastern Osaka Bay. Throughout the rest of Osaka Bay, therefore, very little freshwater likely crosses the tidal front, confirming the theory of previous researchers that eastern Osaka Bay is in geostrophic equilibrium.

Keywords: Osaka Bay; Akashi Strait; Tidal jet; Eddy; River plume; Front; Stratification

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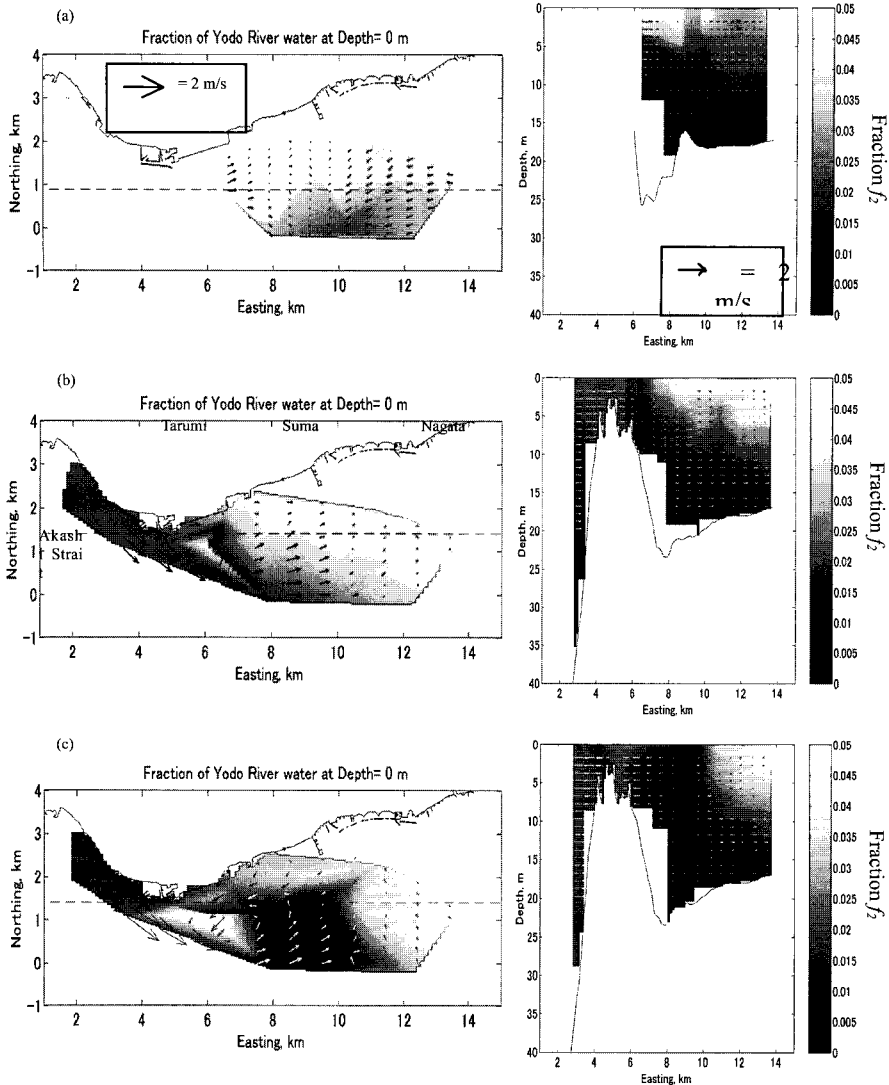


Fig. 1 Velocity vectors and fraction f_2 of Yodo River water present during the survey. Dark shading indicates cool, salty seawater, while light shading indicates warmer, fresher water from eastern Osaka Bay. Left-hand side plots are results near the surface, while right-hand side are vertical cross-sections at a northing of 1.5 km (indicated by the dashed line in each left-hand side figure). (a) At the beginning of eastward flow in the Akashi Strait. (b) Before maximum eastward flow. (c) After maximum eastward flow