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# The impact of ambient stratification on freshwater transport in a river plume

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The purpose of this study is to delineate the influence of stratified ambient water on river plume structure and freshwater transport in the plume. The Regional Ocean Modeling System (ROMS) is applied to conduct a parameter study, where the inflow salinity anomaly, ambient stratification and the bottom slope are varied systematically. Ambient water is thermally stratified. Temperature is set uniform in the top 15 m layer and then decreases linearly, while in the non-stratified case temperature remains constant at its surface value. The results show that in all non-stratified cases an anticyclonic bulge at the mouth and a parallel coastal current further downstream form. On the other hand, under stratified conditions, an inflow with a lower salinity anomaly causes the formation of a frontal disturbance at an earlier stage downstream of the plume bulge, with more eddies developing later in time along the density front. These eddies grow rapidly in both offshore and downstream directions and move with the downstream current. In extreme cases, they spread 100 km offshore by the end of the model run (60 days), which is triple the offshore extension in non-stratified cases. Under the same fresh water input, more eddies develop either when the inflow salinity anomaly is smaller or when the stratification is stronger. Eddies form later, grow at a slower rate and are less developed offshore with a gentler slope. All the eddy forming plumes are bottom advected plumes. Under stratified conditions the density front detaches from the bottom at a shallower depth but spreads further offshore at the surface. Reconstructed alongshore velocities based on geostrophic balance prove that the different distributions of isopycnals cause differences in alongshore velocity fields. Higher salinity anomaly inflows form surface advected plumes which perform similarly to non-stratified cases, without eddy formation. Freshwater fluxes are calculated in both downstream and offshore directions to quantify the difference between stratified and non-stratified cases under low salinity anomaly conditions. The rapid growth of eddies traps a large amount of freshwater which substantially (up to 35%) reduces the downstream freshwater flux compared to the non-stratified case. As eddies pass through the fixed transect, the downstream freshwater flux fluctuates up to 30% of a corresponding value in the non-stratified case. The offshore freshwater flux estimated 30 km from the coast is several times higher due to the presence of frontal eddies when compared with corresponding non-stratified case. Energy transfer diagnostics indicate that frontal eddies are likely to be produced through the barotropic instability of the buoyancy-driven current.