Carbon enhancement and retention in a large temperate semi-enclosed estuary and surface extremes in pH and mineral saturation states

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It is anticipated that, in the coming decades, climate change will have a significant effect upon hydrologic cycles, in turn influencing circulation, seasonal pH, and surface mineral saturation states in estuarine environments. In this context, we examine biogeophysical processes in the Salish Sea, a large (> 400 m deep), relatively fresh, temperate, semi-enclosed estuarine sea on the Pacific coast of North America. Relative to the adjacent Pacific Ocean, the Salish Sea is enriched in total dissolved inorganic carbon and, as a result, is undersaturated throughout the water column with respect to aragonite during the winter months. Despite its high carbon load, the mean surface layer (upper 5–10 m) in the Salish Sea experiences moderate to high pH (> 8.0) during the summer months. However, extreme surface conditions may occur during all seasons over spatial and temporal scales that are relevant to near shore ecology.

Using SalishSeaCast [https://salishsea.eos.ubc.ca/nemo/], a high resolution, fully stratified, 3-dimensional model of the Salish Sea, we explore the natural and anthropogenic mechanisms responsible for the overall carbon enhancement in the estuary. To investigate the effects of rivers on potential surface extremes, a field sampling program was carried out to characterize the inorganic carbon and nutrient chemistry of 12 rivers entering the Salish Sea including the free-flowing, glacial fed Fraser River, which exerts a strong seasonal control over circulation and biogeochemistry within the estuary.

Results of this work are discussed with respect to the current state of the system and in the context of possible shifts in regional hydrologic cycles.