A Three-Dimensional Oceanographic Model of Gulf St. Vincent, South Australia: Flushing Times and Mechanisms.

Roger Matthews, 2010, Flinders University

Abstract

Seasonal currents, temperatures, salinities and the flushing time of Gulf St Vincent (GSV, an inverse estuary), Investigator Strait (IS) and Backstairs Passage (BP), South Australia, were investigated using the COHERENS 3D numerical model with forcing data from the South Neptune Island and Adelaide Airport meteorological stations and the World Ocean Atlas.

In the head of the gulf temperatures, salinities and densities ranged from ~11.5°C (winter), 38.5 (spring) & 1027 kgm-3 (spring), to ~23°C (summer), 42 (autumn) & 1031 kgm-3 (autumn), while the T, S & σT of water entering IS & BP varies between 16°C (Jun), 35.6 (Nov) & 25.9 kgm-3 (Dec), to 18°C (Jan), 36.4 (May) & 26.8 kgm-3.

Thus the temperature gradient reverses seasonally while the down-gulf salinity and density gradients are maintained throughout the year and increase strongly in late autumn and winter when cold and salty density currents leave the gulf. Low salinity water enters, predominantly at the surface, through southern BP and northern IS, while higher salinity water leaves through northern BP and southern IS, predominantly at the bottom, with less stratification in BP due to the strong tidal mixing there.

During winter there is a clockwise circulation within the gulf but during the summer there is a clockwise circulation in the western gulf and an anti-clockwise circulation in the eastern gulf. Inflows occur into W GSV, predominantly from N IS (all year but strongest in winter with the W & NW winds then), but also from S BP (more in summer with the SSE & SE winds then). The outflow exiting from SE GSV separates into one leaving through N BP & the other from S IS, these density outflows are guided by the bathymetry and are tidally “pulsed”. The greater width and sill-depth, and consequently weaker tidal currents and mixing, of IS than BP allows more stratification in IS, so that the increased stratification in IS during neap tides is not as great as the sudden increases in stratified flow during neaps in BP. Also resulting from the strong tidal currents in BP is a tidal-residual flow westwards through BP & IS. A flushing time for GSV of 7½ months was found under average conditions, but was reduced to 5¾ months with stronger than average NW – SW winds such as those in strong cold-fronts.