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Modelling flow dynamics in an active submarine channel

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A novel 2.5D shallow water model, incorporating vertical stratification of flow density and velocity, has been developed to investigate the hydro- and morphodynamics of submarine meandering systems. Successfully verified against rigorous analytical and numerical test cases, the model has been applied to investigate the flow dynamics within an active submarine channel, formed at the exit of the Strait of Bosphorous in the SW Black Sea. Further, the model has been verified by comparing predicted flow hydrodynamic conditions, including velocity, density and stratification, to equivalent data directly observed within the Black Sea submarine channel.

Development of the model has highlighted the importance of stratification as a primary control on submarine flow hydrodynamics. Data obtained from the Black Sea submarine channel system, and the model presented herein, demonstrates that in submarine systems density stratification acts to keep the majority of the flow bounded within the channel system, with a dilute mixing layer forming above the channel boundaries. As stratification diminishes, flow overspill from the channel increases, suggesting a degree of topographic control of flow stratification not accounted for in current empirical models of submarine flow dynamics. We also highlight the fundamental differences in flow dynamics between poorly stratified saline density currents and highly stratified turbidity currents. Specifically, we suggest that flow stratification enables turbidity currents to be contained more readily within their channel systems and therefore to develop over longer distances than equivalent saline density currents.