Secondary circulation in tidal inlets and straits

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Secondary flows in tidal inlets and straits were studied using numerical simulations performed with the unstructured-grid hydrodynamic model SCHISM. The results are assessed against ADCP measurements in the Danish Straits and the tidal inlet Otzumer Balje situated in the German Bight. Similarities and differences between the in-/outflows in the Danish Straits and flood/ebb flow in the Otzumer Balje are analyzed. Contrary to the tidal straining in the tidal inlet, the straits feature substantial differences in the stratification stability during the outflow and inflow phases. In the tidal inlet of German Bight, isopycnals appear strained during ebb and mixing increases during flood. In the Danish Straits, a reversed situation occurs, where the inflow of saline water near the bottom enhances the stratification. Such a distinct feature is mainly to attribute to the fundamental differences between the straits and a typical tidal inlet, as the former has an irregular external forcing acting at longer time scales, and a funnel-shaped geometry from two instead of one direction. The variety of the strait morphology leads to high variability in the appearance of secondary circulation. Comparing to a fine resolution model, the coarser-resolution model overestimates the stratification and misrepresents the transport balance. In the tidal inlet of the German Bight, secondary circulation appears in the form of bipolar counter-rotating cells. These differences are explained by missing secondary circulation when the coarse resolution is used, along with the resulting changes in mixing along the straits.