Geophysical Research Abstracts
Vol. 20, EGU2018-2337, 2018
EGU General Assembly 2018
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Internal solitary wave generation by tidal flow over topography

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Oceanic internal solitary waves are typically generated by barotropic tidal flow over localised topography. Wave generation can be characterised by the Froude number $F = U/c_0$, where U is the tidal flow amplitude and c_0 is the intrinsic linear long wave phase speed, that is the speed in the absence of the tidal current. For steady tidal flow in the resonant regime, $\Delta_m < F - 1 < \Delta_M$, a theory based on the forced Korteweg-de Vries equation shows that upstream and downstream propagating undular bores are produced. The bandwidth limits $\Delta_{m,M}$ depend on the height (or depth) of the topographic forcing term, which can be either positive or negative depending on whether the topography is equivalent to a hole or a sill. Here the wave generation process is studied numerically using a forced Korteweg-de Vries equation model with time-dependent Froude number, $F(t)$, representative of realistic tidal flow. The response depends on $\Delta_{max} = F_{max} - 1$, where F_{max} is the maximum of $F(t)$ over half of a tidal cycle. When $\Delta_{max} < \Delta_m$ the flow is always subcritical and internal solitary waves appear after release of the downstream disturbance. When $\Delta_m < \Delta_{max} < \Delta_M$ the flow reaches criticality at its peak, producing upstream and downstream undular bores that are released as the tide slackens. When $\Delta_{max} > \Delta_M$ the tidal flow goes through the resonant regime twice, producing undular bores with each passage. The numerical simulations are for both symmetrical topography, and for asymmetric topography representative of Stellwagen Bank and Knight Inlet.