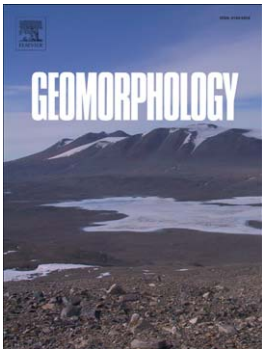

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Residual flow, bedforms and sediment transport in a tidal channel modelled with variable bed roughness

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Abstract

The frictional influence of the seabed on the tidal flow in shelf seas and estuaries is usually modelled via a prescribed, spatially/temporally invariant drag coefficient. In practice, the seabed exhibits considerable variability, particularly spatially, that should in principle be included in simulations. Local variations in the seabed roughness (k_s) alter the flow strength and, hence, local sediment transport rates. The effect of using a spatially/temporally varying k_s is assessed here with reference to a tidal channel (Menai Strait, N. Wales) in which the variability of the bedforms has been monitored using multi-beam surveying. The channel not only exhibits strong tidal flow, but also a residual induced flow that is used here as diagnostic to assess various bed roughness formulations tested in a Telemac model. Tidal simulations have been carried out with both constant and temporally/spatially variable k_s, and the predicted residual flow is shown to be sensitive to these representations. For a mean spring-neap (SN) cycle with variable k_s, the average residual flow is calculated to be 525 $m^3 s^{-1}$, consistent with observations. This residual flow can be recovered using imposed, constant values of k_s in the range 0.15 m to 0.3 m. The results suggest that the overall, effective roughness of the seabed is less than half of the maximum local roughness due to the dunes in mid-channel, but more than the spatially-averaged k_s value in the channel as a whole by about 50%. Simulations carried out with an M_2-alone tide using variable k_s produce a somewhat smaller (by 7%) residual flow of 491 $m^3 s^{-1}$. The use of an 'equivalent