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Tide propagation in branching estuaries

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Several estuary systems consist of different tidal branches that form a network where the propagation of the tide shows peculiar characteristics. The tidal wave travels with a celerity which depends on channel geometry and hydrodynamic features (depth, convergence, friction). Depending on the length of the branches, different patterns of water levels and velocity may appear in the estuary. For instance, when two waves travel landward through two tidal branches, at the junction of these branches the phases of the two waves can be different. This may force the first wave to slow down and wait for the second wave to catch up before proceeding further.

Such behaviour is observed in a number of estuaries where phase lag measurements are available (Incomati, Mekong). In this work we present the phenomenon and exploit an analytical solution to show the main dynamics involved. The analytical solution is derived for the case of linear waves in a one-dimensional framework, where we retain the effects of convergence of both varying width and depth. In the nodes of the system a continuity condition is applied together with a compatibility condition of the water levels. As a result, significant jumps in the phase lag of velocity and in characteristics times (high water slack, low water slack) can be reproduced.