EGU22-5678
https://doi.org/10.5194/egusphere-egu22-5678
EGU General Assembly 2022

Identification and analysis of channel connectivity in rivers and estuaries

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The channel patterns in rivers and estuaries range from meandering single-thread channels to complex channel networks comprising looping, branching, and offshoot structures through which water, resediment, and nutrients are transported. Representing channelized systems as networks provides a mathematical framework for analyzing transport and has become increasingly common in hydrology and geomorphology. However, several challenges remain: 1) the automatic extraction of multi-channel networks from topography has historically been a major challenge; 2) the relative importance of individual channels in the identified network; and 3) the issue of transport direction in channel networks, especially where bi-directional flows dominate in estuarine environments. This presentation discusses recent work addressing these three challenges with the introduction of a novel algorithm for extracting topology and geometry from digital elevation models of braided rivers and estuaries and by quantifying structural and dynamical connectivity in two flow directions for estuaries around the world. In both efforts, networks are constructed with network links representing channels and networks nodes representing channel confluences, bifurcations, inlets, and outlets. Across estuaries and braided rivers, scale asymmetry iis detected n links downstream of bifurcations, indicating geometric asymmetry which point to bifurcation stability. Estuaries tend to organize around a deep main channel whereas the channel networks of braided rivers are more evenly distributed across channel size. Analyses of flow direction in estuaries reveal that flood direction fluxes are more broadly distributed across the channel network, while ebb direction fluxes are more localized to the individual channels. The estuaries studied contain signatures of mutually evasive flood and ebb channels that are typical of alluvial estuaries, but also exhibit characteristics of branching or converging patterns typical of deltas and tidal networks, respectively. Finally, this presentation will offer perspectives on the state of the science for network analyses of channelized environments and present challenges for future research.