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Connectivity along river corridors: A tale of harmony and discordance

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River channels and their adjacent hyporheic zone, floodplain, and ponded waters continually exchange mass and energy. When these exchange processes are in harmony, we expect an amplification of their biogeochemical effects, and therefore a more prominent role modulating water quality at the local and watershed scales. Discordance, on the other hand, is expected to attenuate the effects of connectivity. In this work, we used the model Networks with EXchange and Subsurface Storage (NEXSS) to assess when and where these exchange processes are in harmony along rivers within the continental United States. Using a simple routing scheme, we translate estimates of fluxes and residence times into a cumulative measure of river corridor connectivity at the watershed scale, differentiating the contributions of hyporheic zones, floodplains, and ponded waters. We find that the relative role of these exchange subsystems changes seasonally, driven by the intra-seasonal variability of discharge. Also, we find that the interplay between exchange processes varies with location, typically characterized by discordance in low-order streams and harmony in high-order rivers. Understanding the competing nature of exchange processes is critical to represent connectivity in physics-based models for water quality and to design, implement, and evaluate sustainable water management practices at the scale of the nation.