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The effect of flow-regime variability on hydrologic connectivity and biogeochemistry within a coastal aquatic landscape: assessment using a 3D coupled ecohydrology-hydrodynamic-biogeochemical model

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The nature of nutrient transformations and redistribution in complex aquatic landscapes varies in response to short- and long-term changes in hydrologic connectivity. Whilst our ability to characterize these dynamics and model them has advanced, it remains unclear the degree to which changes in connectivity brought about by flow regulation and climate change can influence the resilience of systems to perform critical biogeochemical functions associated with carbon and nutrient metabolism. In this study, we have aimed to develop a novel model approach able to accommodate spatial heterogeneity and connectivity between diverse sub-systems in a complex river-wetland-estuary system in order to understand the complex processes linking hydrology, biogeochemistry and aquatic habitat. Our model approach links a terrestrial ecohydrology model and a hydrodynamic-biogeochemical model together on a high-resolution unstructured mesh, for a region of the lower Murray River (Australia) from the ocean to 200km inland, spanning an estuary, hypersaline coastal lagoons, brackish lakes and a river reach with complex floodplain-wetland interactions. The model system captured the biogeochemical transitions along the landscape gradient and results were then aggregated to the sub-system level to explore the signatures of connectivity that emerged during a decadal scale drought and subsequent flow recovery period. The results highlight the distinct links between hydrology and biogeochemistry that each sub-system within the landscape displays. Significant disruptions to functions that maintain water quality and habitat coincided with extreme changes in connectivity that occurred during drought, highlighting the importance of maintaining flow regimes to these systems in times of stress.