Analytical representations of the Residence Time Distribution associated with hyporheic exchange beneath dune-like bedforms for different normalized sediment bed depths and groundwater underflow velocities.

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May 12, 2022

Abstract

The hyporheic exchange below dune-shaped bedforms has a great impact on the stream environment. One of the most important properties of the hyporheic zone is the residence time distribution (RTD) of flow paths in the sediment domain. Here, we evaluate the influence of dimensionless sediment depths d b * = 2 π d b / λ where λ is the dune wavelength and different values of dimensionless groundwater underflow values u b * (similar to dune migration celerity), on the shape of the hyporheic exchange RTD. Empirical RTDs were generated, over a range of combinations between d b * and u b * values, from numerical particle tracking experiments in which 10000 particles were released over a flat domain. These empirical RTDs are represented by different distributions over the range of d b * and u b * . A Fréchet RTD is the best fit for deep beds (d b * >3.2) and negligible underglow (u b * <0.1). A LogNormal RTD is often the best representation for u b * [?] 0 . 8 , while a Gamma RTD performs better for larger values of u b * . In general, a LogNormal RTD provides a good representation of the empirical RTDs in all cases, as it is identified as either the best or the second-best fitting distribution according to the Anderson-Darling test. The parameters of these analytical distributions vary with d b * and u b * , and this dependence is graphically represented in this work. These results contribute to our understanding of the physical and mixing processes underpinning hyporheic exchange in streams and paves the way for a quick evaluation of its potential impact on nutrient and contaminant processing (e.g., based on the magnitude of the Damkohler number).

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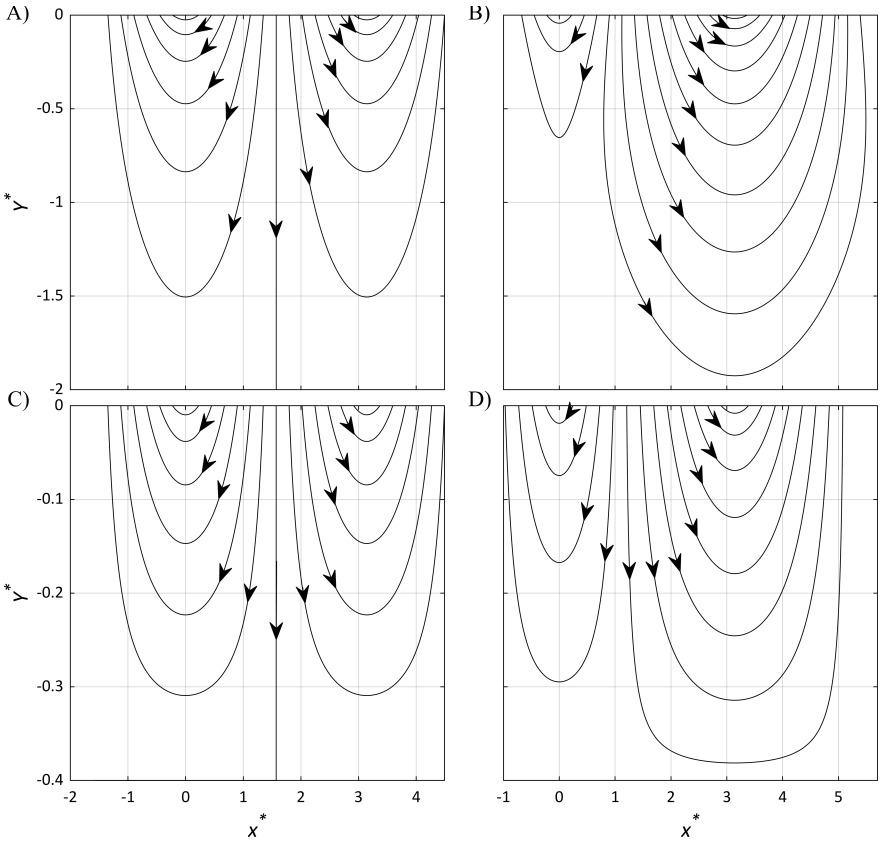

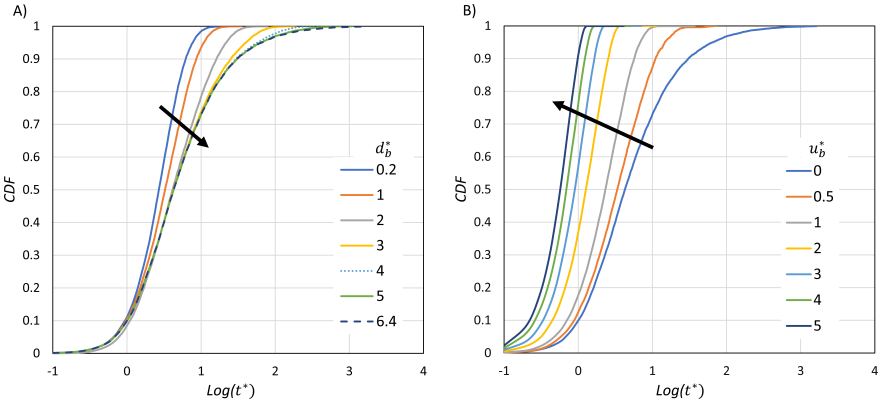

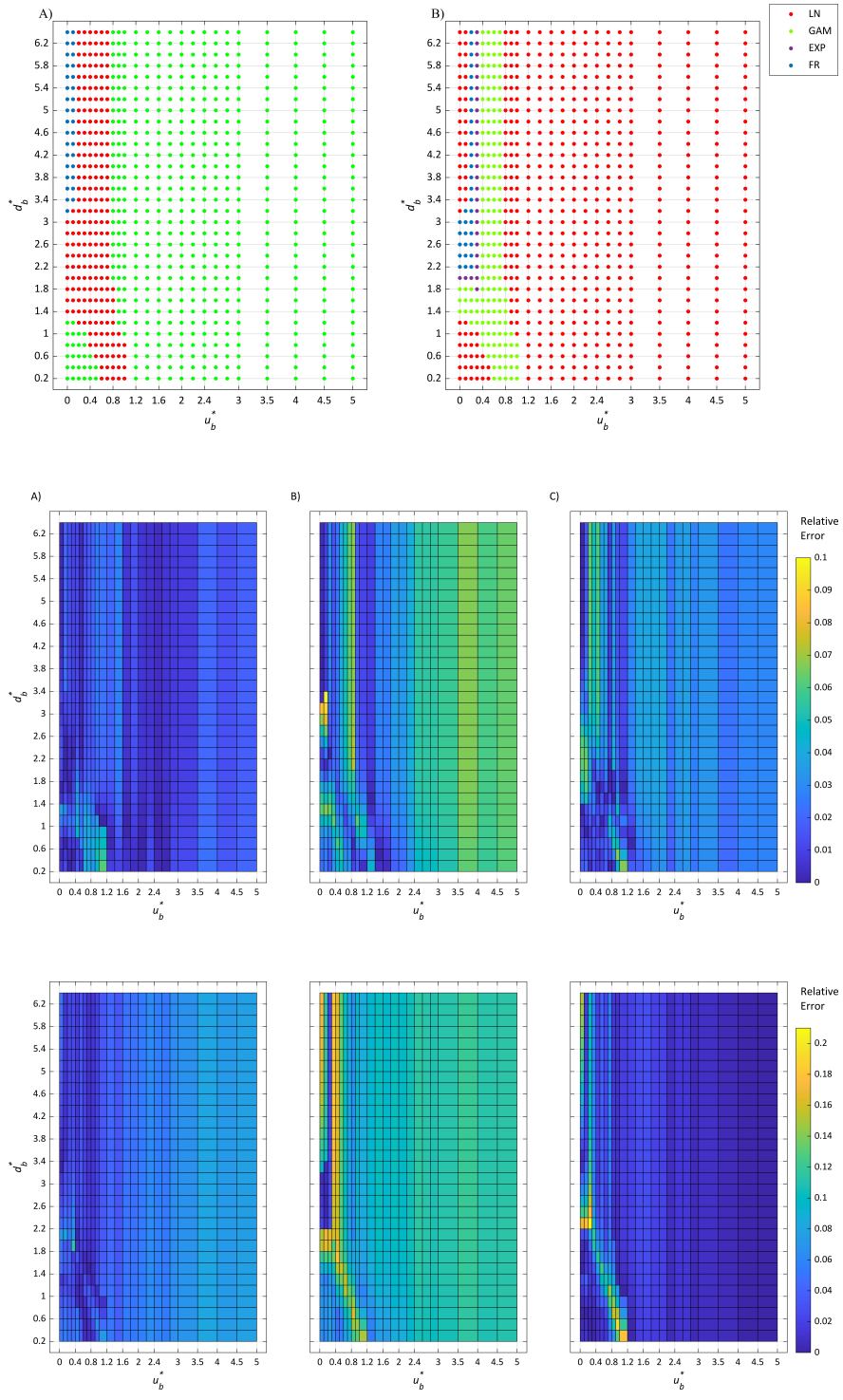

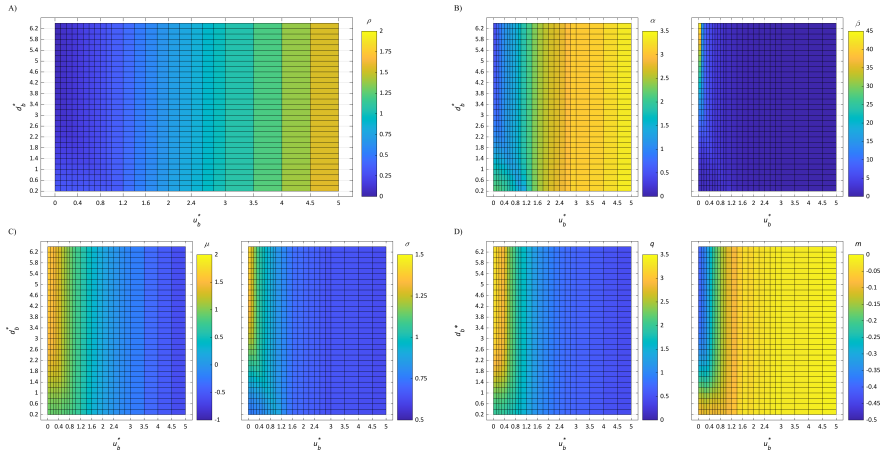

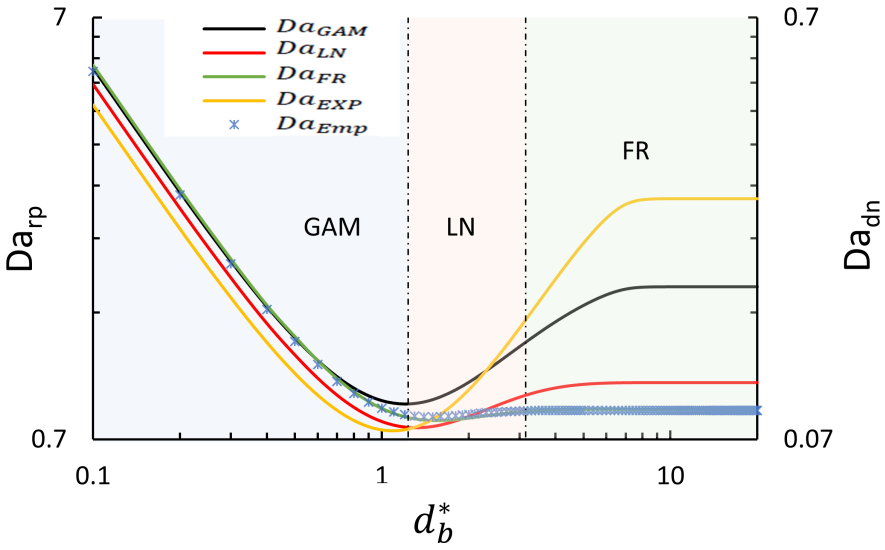

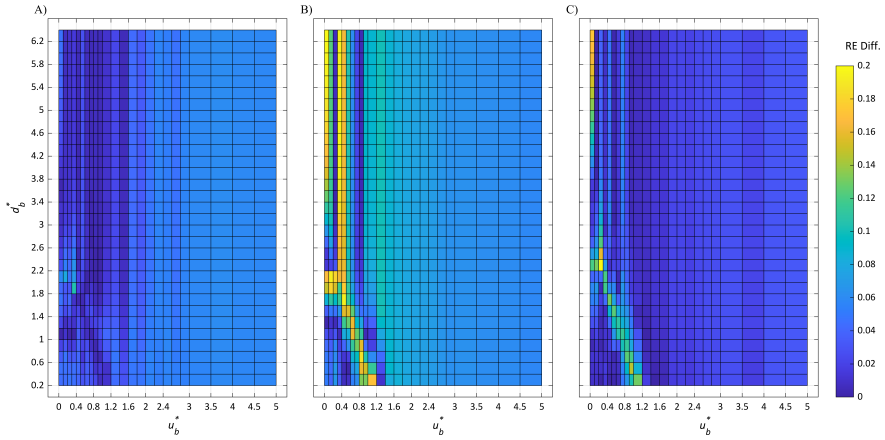

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