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# The role of nonlinear overtides on the backwater hydrodynamics in the Yangtze estuary

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As river flow debouches into the sea, it is affected by the fluctuation of tide at the estuary mouth, resulting in a backwater zone where the residual water level (averaged over a lunar day) tends to rise in landward direction. It is known that backwater hydrodynamics, especially the variation of residual water level, is controlled by the river-tide interaction, while it follows the traditional stage-river discharge relation in the upstream river-dominated region. However, the contribution made by tidal asymmetry due to the generation of overtides and their interplay with river flow is poorly understood. In this study, we aim to understand the impact of nonlinear overtides on the rise of residual water level in the Yangtze estuary, which is characterized as substantial fresh water discharge and meso-scale tide. The numerical results from a well-calibrated 2D hydrodynamics model have been used to extract the continuous time series records of velocity along the Yangtze estuary, which are then decomposed into temporal changes of residual velocity and tidal properties as a function of freshwater discharge and ocean tidal range using a nonstationary tidal harmonic analysis (NS_TIDE). Since the residual water level slope is mainly balanced by the subtidal friction in the subtidal momentum balance, thus we subsequently decomposed the subtidal friction into different components representing contributions by the river flow alone, the river-tide interaction, and the tidal asymmetry due to overtides. Finally, we explore the role of nonlinear overtides on the backwater hydrodynamics over a wide range of fresh water discharge conditions.