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Self-validating deep learning of continental hydrology through satellite gravimetry and altimetry

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Space-borne observations of terrestrial water storage (TWS) are an essential ingredient for understanding the Earth's global water cycle, its susceptibility to climate change, and for risk assessments of ecosystems, agriculture, and water management. However, the complex distribution of water masses in rivers, lakes, or groundwater basins remains elusive in coarse-resolution gravimetry observations. We combine machine learning, numerical modeling, and satellite altimetry to build and train a downscaling neural network that recovers simulated TWS from synthetic space-borne gravity observations. The neural network is designed to adapt and validate its training progress by considering independent satellite altimetry records. We show that the neural network can accurately derive TWS anomalies in 2019 after being trained over the years 2003 to 2018. Specifically for validated regions in the Amazonas, we highlight that the neural network can outperform the numerical hydrology model used in the network training.

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