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Scaling characteristics of mountainous river flow fluctuations determined using a shallow-water acoustic tomography system

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Abstract

The aim of this study is to investigate the scaling exponent properties of mountainous river flow fluctuations by detrended fluctuation analysis (DFA). Streamflow data were collected continuously using Fluvial Acoustic Tomography System (FATS), which is a novel system for measuring continuous streamflow at high-frequency scales. The results revealed that river discharge fluctuations have two scaling regimes and scaling break. In contrast to the Ranting Curve method (RC), the small-scale exponent detected by the FATS is estimated to be 1.02±0.42% less than that estimated by RC. More importantly, the crossover times evaluated from the FATS delayed approximately by 42±21 hr ≈2-3 days than their counterparts estimated by RC. The power spectral density analysis assists our findings. We found that scaling characteristics information evaluated for a river using flux data obtained by RC approach might not be accurately detected, because this classical method assumes that flow in river is steady and depends on constructing a relationship between discharge and water level, while the discharge obtained by the FATS decomposes velocity and depth into two ratings according to the continuity equation. Generally, this work highlights the performance of FATS as a powerful and effective approach for continuous streamflow measurements at high-frequency levels.

Keywords: Detrended fluctuation analysis, Streamflow, FATS, Rating curves, River flow fluctuations, Scaling characteristics, crossover time.

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