Geophysical Research Abstracts
Vol. 20, EGU2018-9989, 2018
EGU General Assembly 2018

Estimating dominant spatial scales in cross-sectional velocity data

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Flow velocity measurements in rivers and coastal areas are often collected at cross-sections where velocity is measured at multiple locations and over certain period of time. Subsequent data processing often involves temporal averaging and spatial smoothing of the raw velocity data. This process of spatial smoothing and temporal averaging is motivated by spatial and temporal behavior we expect to be present in the data, such as coherent velocity patterns at the scale of the water depth and temporal coherence at the scale of for instance tides. The process of smoothing and averaging, however, is often arbitrary, and the consequences of averaging windows in space and time on the resulting velocity patterns are often obscure.
In this contribution we investigate a method based on spectral analysis to analyze the spatial patterns in a cross-section. This allows to identify the dominant spatial patterns that are present in the velocity data leading to a more grounded choice for spatial smoothing. Furthermore, the choice of basis function allows to include some physically based constraints such as no-slip at the bed and banks. The method consists of computing the components and location of the velocities measured in a cross-section. These locations are transformed to a normalized coordinate system. For each velocity component a set of basis function is selected and higher order function are progressively included and fitted to all the velocity data measured at a cross-section. The process is repeated until there is no spatial structure in the residuals.
The method is applied to velocity measurements collected in a sharp bend. The analysis allows to identify dominant spatial patterns present in the data and results in continuous functions that describe the velocity field in detail, and that meet the requirement of no slip at the boundaries. Future work will extend the analysis to include different of basis functions, to include more physical constraints, such as continuity.