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Geomorphometric attributes of the global system of rivers at 30-minute spatial resolution

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Abstract

In this paper we explore the geomorphometric characteristics and integrity of a 30′ (longitude × latitude) spatial resolution representation of the global system of potentially-flowing rivers. We quantify several geomorphometric attributes of digital, Simulated Topological Network (STN-30p) depicting potential flow pathways across the entire non-glacierized surface of the Earth. This data set was examined with respect to several metrics describing individual grid cells, river segments, and complete drainage systems. Nearly 60,000 grid cells constitute the global non-glacierized land mass. The cells are organized into more than 30,000 distinct river segments belonging to approximately 6200 drainage basins. STN-30p flow paths and drainage basins are classified as order one through six using the classification system of Strahler. STN-30p flow pathways depict rivers draining a global land area of 133.1×10^6 km^2. These pathways show a total length of 3.24×10^6 km at 30′ spatial resolution. The relationships between STN-30p order and interior river segment numbers, accumulated sub-basin areas, and accumulated length within individual basins yield high correlation coefficients (average $r^2 > 0.96$ for continents and globe). Mean values across individual continents and river orders for the bifurcation ratio (3.15 to 4.44), drainage area ratio (3.74 to 5.77), and basin length ratio (2.02 to 3.27) fall well within the ranges tabulated at finer spatial scales. A basin shape index, $S_b = L/A^{0.5}$, defined as a function of potential mainstem length and drainage area, varies between 1.0 and 5.0 for basins >25,000 km^2 and shows a global mean of 2.12. The structure of STN-30p potential river systems is consistent with those of rivers analyzed at finer spatial scales as demonstrated by the numerical similarity of the several geomorphometric indices analyzed. However, for a particular basin, indices from STN-30p will be based on a condensed set of river orders relative to those derived at finer scales. A first order STN-30p river is roughly equivalent to an order five-to-six river derived from 1:62,500 scale maps. While 30′ spatial resolution was found to represent well the 522 basins with areas >25,000 km^2 that drain 82% of the land mass, it cannot be used with high confidence in characterizing the geomorphometry of the remaining smaller basins. For global climate and biogeochemical studies, a composite of the 30′ resolution and finer spatial resolutions appears to be necessary.

Keywords: Rivers; Drainage basins; Geomorphology; Hydrosphere

1. Introduction

The geomorphology of drainage basins and the organization of stream networks has been well-established for several decades (see Jarvis and

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