

Online Supplement

Hydroclimatic regimes: A distributed water-balance framework for hydrologic assessment and classification

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S1 Hydrologic units: additional explanation of terminology, with links to data sources

As described in Appendix A, hydrologic units (Fig. 1a) may be defined as bounded landscape units, or control volumes, that are free to receive inflow from either the atmosphere as precipitation (P) or from upgradient hydrologic units as landscape (i.e., groundwater + surface-water) inflow (L_{in}). Hydrologic unit boundaries may be defined arbitrarily, for example by use of rectangular grids (Döll et al., 2003; Oki and Kanae, 2006), or by topographically defined landscape units that drain to particular stream reaches (Seaber et al., 1987; McCabe and Markstrom, 2007). In the USA, mapping of hydrologic units has been facilitated by development of the Hydrologic Unit Code (HUC) system (<http://water.usgs.gov/GIS/huc.html>)

which divides the USA into a hierarchically nested, georeferenced system of topographically defined hydrologic units. Advances in geographic information systems (GIS) have fostered the development of several networked, finer-scale hydrologic unit datasets for the USA, including the River Reach File used in the present paper:

(<http://water.usgs.gov/GIS/metadata/usgswrd/XML/erf1.xml>) (~55,000 hydrologic units; ~140 km² average area); the Watershed Boundary Dataset (<http://nhd.usgs.gov/wbd.html>) (~160,000 hydrologic units; ~57 km²); and the National Hydrography Dataset-Plus (<http://www.horizon-systems.com/nhdplus/>) (~2.61 million hydrologic units; ~2.4 km²). A similar, hierarchically nested system of hydrologic units has recently been created for Australia (<http://www.hydrol-earth-syst-sci-discuss.net/10/15433/2013/hessd-10-15433-2013.pdf>) (Stein et al., 2013) (~1.09 million hydrologic units; ~7.1 km²). At the global scale, the HydroSHEDS dataset provides detailed stream networks and nested catchments for the world's non-glaciated land surface (<http://worldwildlife.org/pages/hydrosheds>) (Lehner et al., 2008).

S2 Landscape flows (L_{in} , L_{out}): additional explanation of terminology

We introduce the terms L_{in} and L_{out} (landscape inflow and outflow) to maintain consistency with the output of existing, spatially distributed, continental-to-global scale water-balance models (e.g., Vörösmarty et al., 2000; Döll et al., 2003; Milly et al., 2005; Oki and Kanae, 2006; Röst et al., 2008; Hoff et al., 2010). Such models typically generate runoff as the residual of precipitation and evapotranspiration, ($P - E_T$), averaged over the area of a hydrologic unit, or model cell, over the time period of interest (e.g., Vörösmarty et al., 2000). This lumped residual represents combined groundwater and surface water runoff from the unit, and is assumed to be greater than or equal to zero. This residual may also be routed in a cumulative fashion over a set of topographically defined hydrologic units or gridded model cells (e.g., total runoff integrating pathways, or TRIP; Oki and Kanae, 2006). The widespread availability of gridded climate and land-surface elevation data, and the relative scarcity of data concerning land surface and

subsurface properties, make this approach attractive for global- and continental-scale water-balance modeling. Note, however, the main limitation of the lumped approach: confined groundwater flow systems, as well as unconfined groundwater flow systems (local, intermediate, and regional) may be incongruent spatially and hydrologically with the overlying topography, surface-water flow network, and their associated hydrologic units—at the spatial scale of discretization used in a particular modeling effort.

This limitation may be addressed in two basic ways. Traditionally, the groundwater and surface-water components of L_{in} and L_{out} are differentiated and analyzed separately (e.g., Lent et al., 1997; Weiskel et al., 2007), while making due acknowledgment of the importance of groundwater/surface-water interactions at the boundaries of the respective ground- and surface-water flow systems. However, modeling tools have recently become available for fully coupled—as opposed to either lumped or separate—simulations of groundwater, surface-water, and vadose-zone flow systems, their interactions, and their interactions with climate (Markstrom et al., 2008). At present, limited data availability will likely dictate, in most cases, the continued use of lumped approaches at continental and global scales, and restrict the application of fully coupled models to the catchment or basin scale. Use of the landscape flow (L_{in} , L_{out}) terminology introduced in this paper is one way to make explicit the fact that a lumped approach is being used in a particular analysis.

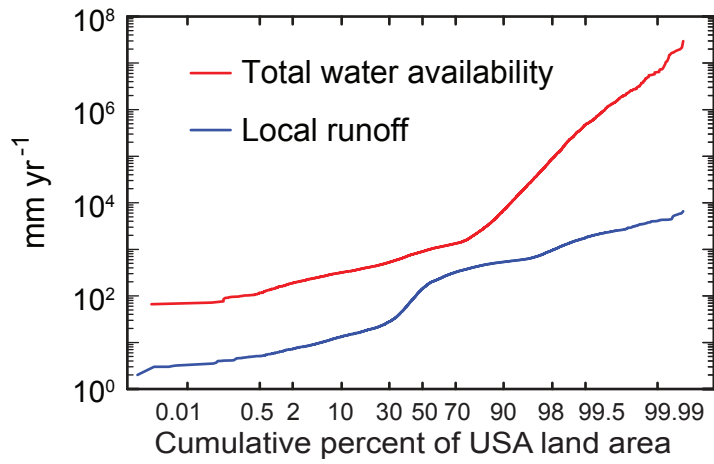
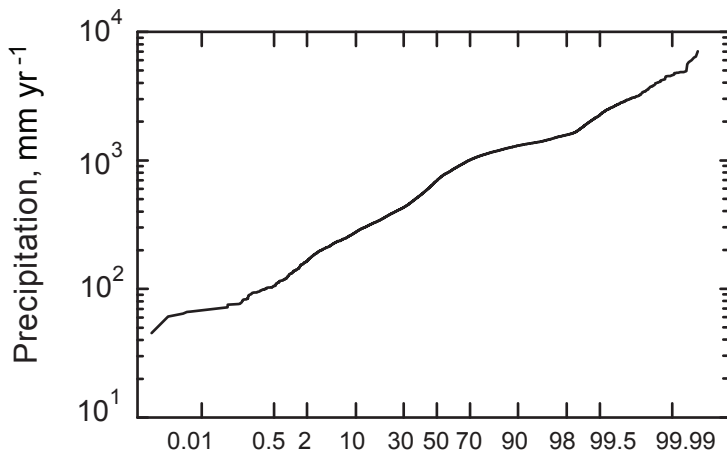
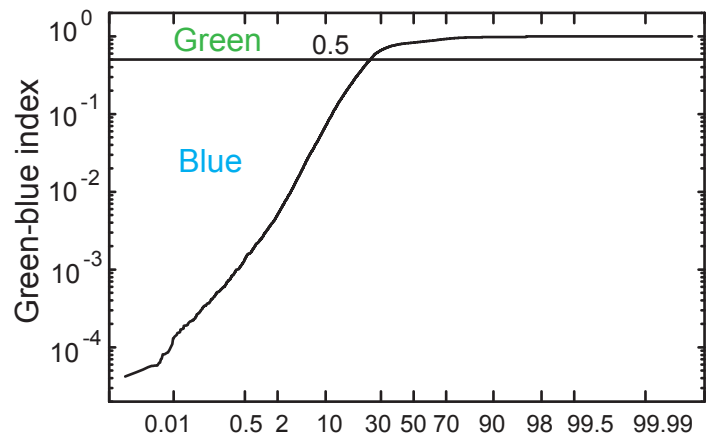
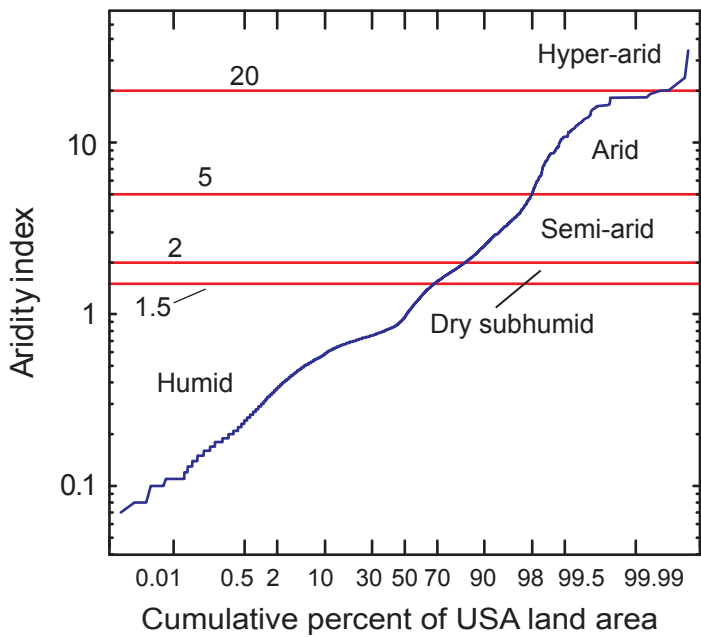
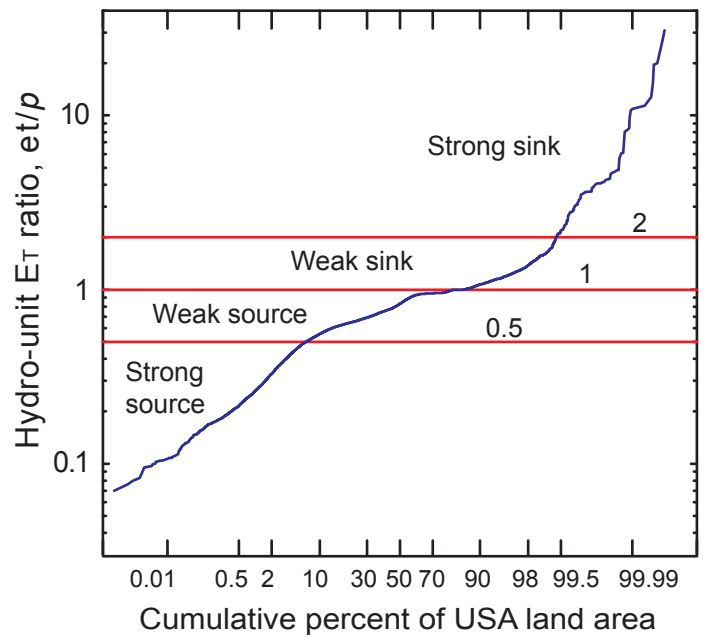
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Figure caption:

Figure S1. Area-weighted percentile plots for 53,400 networked hydrologic units of the conterminous USA, on a mean-annual basis for 1896-2006. (a) Total water availability (m yr^{-1}), and local runoff (mm yr^{-1}), (b) Precipitation (mm yr^{-1}), (c) Green-blue index (dimensionless), (d) Aridity index (dimensionless), and (e) Hydrologic-unit evapotranspiration ratio (et/p , dimensionless). See text and Table 2 for indicator definitions.

a**b****c****d****e****Figure S1**