New design criteria for low distortion projections

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Abstract

Low distortion projections (LDPs) produce mapping grids formulated so that distances obtained by inversing grid coordinates match as best as possible the equivalent horizontal distances observed at elevation. The need for LDPs arises in places at high elevations, such as in the mountainous western region of the United States, where the enlargement of distances due to elevation can exceed mapping accuracy tolerances. We present a method of *defining*, *understanding*, and *analyzing* LDPs. We promote an agenda with the following items. (i) An LDP's *definition* must explicitly include an "elevated reference surface," being the selection of a surface to represent the shape of the Earth at elevation. Here we focus on a surface of constant ellipsoid height, although there are many alternatives. Choosing an elevated reference surface allows for a rigorous definition of "horizontal distances at elevation," and,

in fact, of "horizontal distances" in general. (ii) Choosing an elevated reference surface allows for the *understanding* of an LDP because the meaning of "horizontal distance" becomes explicit, which, together with the choice of a map projection and accompanying values for its parameters, completely defines the LDP. (iii) A suitable elevated reference surface permits the mathematical *analysis* of the LDP's properties, which notably includes conformality. Our methodology leads to four LDPs that are successive improvements on the agenda to construct a conformal projection of the constant-h surface, and are analyzed in turn. LDP Method 2 is promoted as the solution most likely to meet users' requirements for simplicity and geodetic integrity.