Global, high-resolution precipitation grids for the 1961-1990 climate normal period

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Abstract

Interpolated grids of historical climate normal data serve as an important reference point for any research that investigates observed or projected climate change. While normals for temperature variables are relatively easy to model, as they vary with elevation due to adiabatic lapse rates, interpolating precipitation from weather station data is more difficult. Most widely used interpolation methods have severe shortcomings in predicting rain shadows and precipitation due to orographic lift. Some expert systems have these capabilities, but they are not easily replicable by other researchers and lack global coverage. Here, we contribute a modeling approach that uses wind speed, wind direction, slope, and aspect to arrive at an exposure metric that is suitable to predict orographic lift on the windward side and rainshadows at the leeward side of mountain ranges. This exposure metric is used in addition to elevation as covariates to predict precipitation with a thin-plate spline method. Statistics for independent validation with a withheld set of weather stations match or exceed other currently available climate normal products for precipitation. Our weather station data collection and the climate normal surfaces from this study are publicly available.

(Selected Figures and Tables provided below, for more information, contact the author)

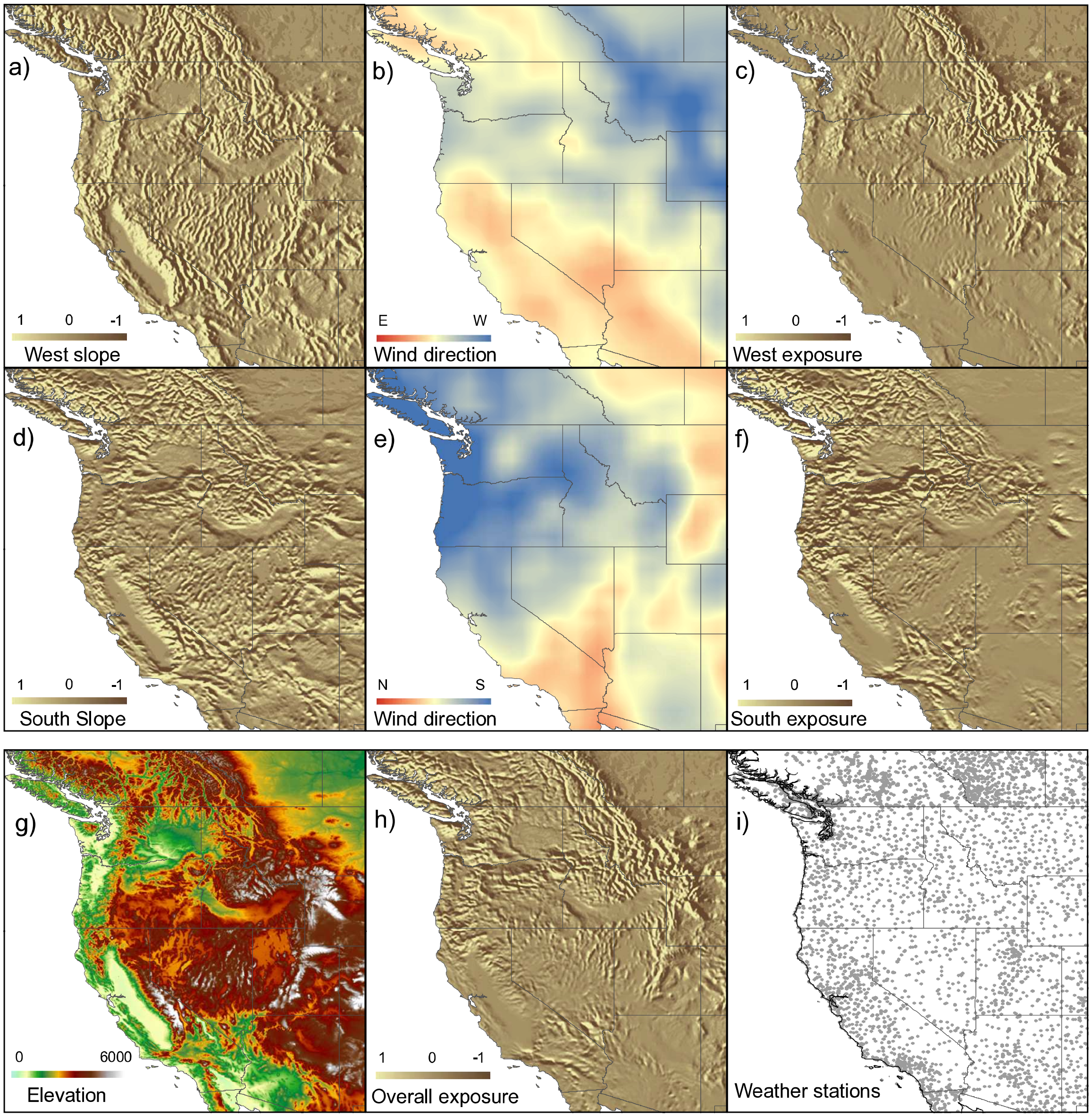

Figure 1. Creating an exposure layer from topography and wind speed and direction by multiplying a west slope layer (a), scaled from -1 (maximum east slope) to +1 (maximum west slope) with a layer of wind speed in east-west wind direction (b) to result in a west exposure layer (c). The same procedure is repeated for north-south exposure (d-f). A digital elevation model (g) and an average of west and south exposure (h) are used as covariates for the interpolation of weather station data (i). Separate exposure layers are generated for each month, with January wind speed, wind direction, and exposure layers shown in this example.

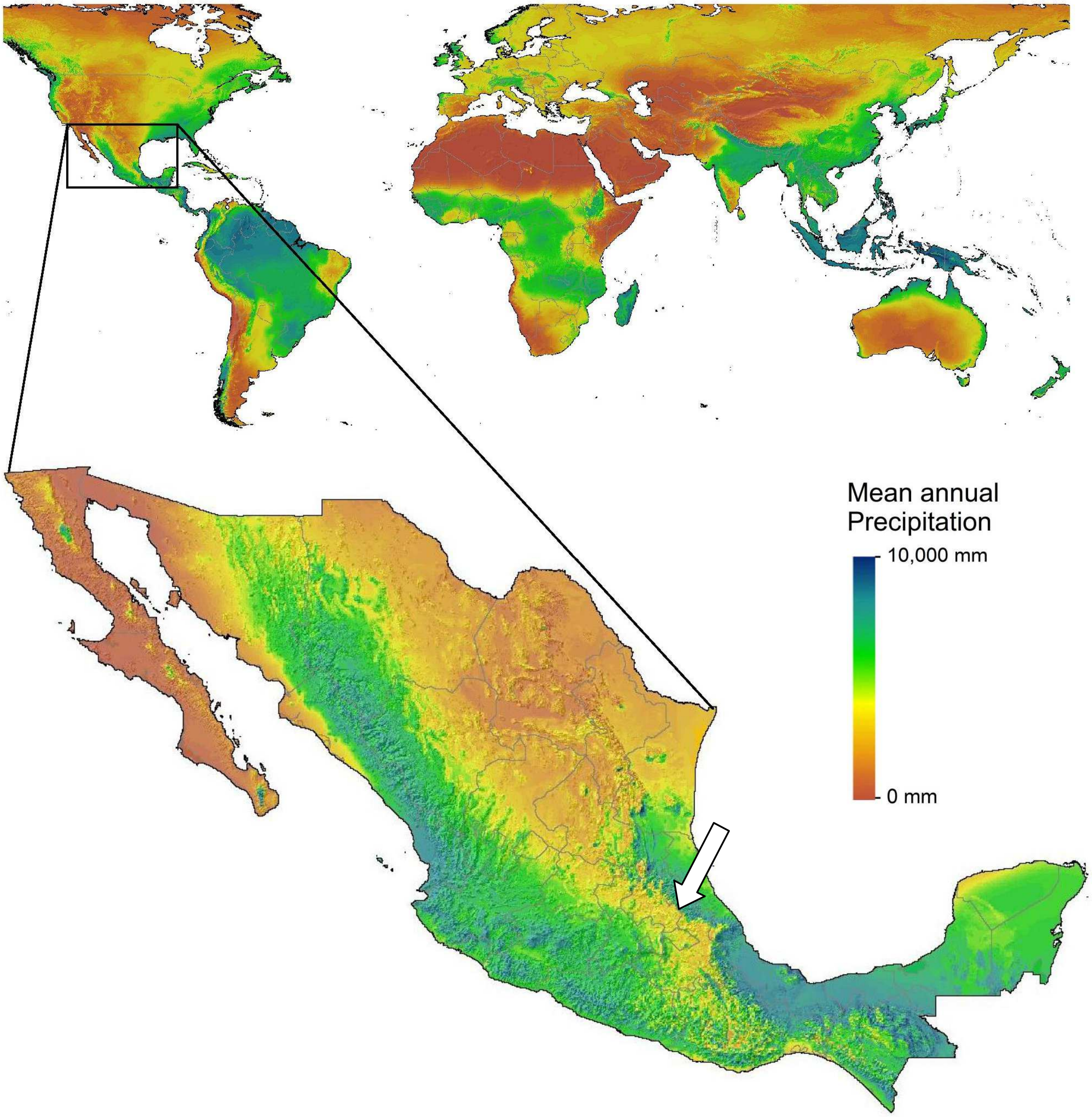

Figure 2. Mean annual precipitation from thin plate spline methodology with a global coverage, including a detailed map for Mexico. Abrupt rain shadows west of the cordillera mountain ranges that are driven by easterly winds from the Gulf of Mexico during the hurricane season are well defined (arrow).

Table 1. Mean absolute error (MAE) of interpolated surfaces in mm and also expressed as median percentage of observed precipitation values in parentheses. Values are reported for a non-independent validation, including all stations as training data, and for a cross-validation that excludes 33% of stations for validation.

Continent	33% for validation			All stations		
	Monthly	Seasonal	Annual	Monthly	Seasonal	Annual
Asia	24 (20%)	64 (16%)	215 (12%)	14 (13%)	37 (10%)	128 (8%)
Africa	12 (20%)	30 (15%)	100 (8%)	5 (10%)	13 (8%)	44 (4%)
Europe	10 (9%)	28 (8%)	104 (7%)	4 (5%)	12 (4%)	44 (4%)
North America	10 (10%)	27 (8%)	92 (6%)	5 (6%)	14 (5%)	46 (4%)
Oceania	13 (12%)	34 (10%)	120 (7%)	5 (6%)	12 (5%)	42 (4%)
South America	25 (21%)	67 (17%)	236 (13%)	13 (12%)	35 (10%)	122 (7%)