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Space-Time Analysis of Precipitation Reanalysis Data for the Island of Crete using Gaussian Anamorphosis with Hermite Polynomials

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Societies seek to ensure sustainable development in the face of climate change, population increase, and increased demands for natural resources. Understanding, modeling, and forecasting the spatiotemporal patterns of precipitation are central to this effort [1-3]. Spatiotemporal models of precipitation with global validity are not available. This is due to the non-Gaussian distribution of precipitation as well as its intermittent nature and strong dependence on the geographic location and the space-time scales analyzed. Herein we investigate the spatiotemporal patterns of precipitation on a Mediterranean island using geostatistical methods.

We use ERA5 reanalysis precipitation products from the Copernicus Climate Change Service [4]. The dataset includes 31980 values of monthly precipitation height (mm) for a period of 492 consecutive months (January 1979 to December 2019) at the nodes of a 5 × 13 spatial grid that covers the island of Crete (Greece). This results in an average spatial resolution of approximately 0.28 degrees (corresponding to an approximate grid cell size of 31 km).

We construct a spatial model of monthly precipitation using Gaussian anamorphosis (GA). GA employs nonlinear transformations to normalize the probability distribution of the data. It is extensively used in various environmental applications [5-6]. The methodology that we follow involves (i) normalizing the precipitation data per month using GA with Hermite polynomials, (ii) estimating spatial correlations and fitting them to the Spartan variogram family [6], (iii) ordinary kriging (OK) of the normalized data in order to generate precipitation estimates on a denser map grid, and (iv) application of the inverse GA transform to generate monthly precipitation maps. We also use cross-validation analysis to determine the kriging interpolation performance, first using the untransformed precipitation data and then the Hermite-polynomial GA approach outlined above. We find that Hermite-polynomial GA significantly improves the cross-validation measures.

Keywords: Gaussian anamorphosis, Hermite polynomials, Mediterranean island, non-Gaussian, ordinary kriging, Spartan variogram

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