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PARAMETER ESTIMATIONFOR SHORT-RANGE ENSEMBLE PRECIPITATION GENERATION

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1. INTRODUCTION

In the accompanying paper by Seo et al. (1998), the Ensemble Precipitation Processor (EPP) is introduced: EPP inputs the Probabilistic Quantitative Precipitation Forecast (PQPF) (Krzysztofowicz 1998) in the first 24 hours at the spatial aggregation scale of approximately 4,000 km^2, and outputs ensemble traces of 6-hr precipitation at the spatial aggregation scale of approximately 16 km^2. In this paper, some of the components of EPP are further described, and aspects of parameter estimation in the operational context are described.

2. SPATIAL SIMULATION

Two techniques are used in EPP to perform spatial simulation of precipitation fields; the Gaussian transformation approach and the conditional simulation approach. The former is described in some detail in the following subsection. The latter is a straightforward conditional-simulation (see, e.g., Deutsch and Journel 1992) implementation of Seo (1998a) (Seo 1998b, for space-time simulation), and is not described here.

2.1 Gaussian Transformation Approach

One approach to formulate a stochastic model for daily rainfall is first to transform the observed precipitation variable, P(x), into a standardized Gaussian variable, z(x).

$$z(x) = F_G^{-1}(F_P(P(x))) \quad (1)$$

The transformation uses the marginal distribution, $F_P(P)$, of daily precipitation that varies spatially to account for first order inhomogeneity. It is assumed that the marginal distribution properties, $F_G(z)$, of the standardized Gaussian variable, z, are, therefore, homogeneous. This approach to modeling precipitation is motivated in part by its simplicity and in part because the theory of multivariate normal processes applies to z(x). Similar approaches have been taken by Bell (1990) and Bardossy (1995).

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Because precipitation is spatially intermittent, some elements of P may be zero. Therefore it is not possible to know the corresponding elements of z for observed precipitation events. On the other hand, if z is generated by a stochastic model, then values of z less than some threshold level $z_0(x)$ correspond to areas where P = 0. The threshold z_0 is defined by

$$F_G(z_0) = \text{Prob}\{P=0\} = 1 - \text{Prob}\{P>0\} \quad (2)$$

where $F_G(z)$ is the cumulative distribution function of the standardized normal distribution.

The spatial correlation properties of z can be estimated from observed data using only observed precipitation pairs in areas where precipitation occurs. To approximate the fractal structure of precipitation, the spatial correlation function of z(x) is assumed to be a composite of weighted exponential functions with different decorrelation distances. The parameters of this function can be estimated either directly from sample correlation functions or they may be implied by matching important spatial scaling properties of observed and generated precipitation events.

2.2 Spatial Disaggregation

If the estimation domain is large, direct simulation of precipitation traces at the HRAP grid may be computationally too intensive to be operationally viable. For this reason, EPP provides CPU-reducing options in which, e.g., precipitation traces are generated at a coarser (than HRAP) grid, and then spatially disaggregated to the HRAP scale. This subsection describes the technique used for spatial disaggregation in EPP.

The statistical subgrid-scale parameterization of rainfall is based on the hypothesis that multiscale standardized rainfall fluctuations (defined as rainfall wavelet coefficients divided by the corresponding-scale rainfall averages) show scale invariance over the range of scales. Multiscale standardized rainfall fluctuations are parameterized by a Gaussian distribution, a scale-invariant parameter *H* and a scale-dependent standard deviation σ. The parameter σ relates to the variability of the