A scale-separation verification approach which accounts for the uneven spatial density of station observation networks

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Forecasts defined over spatial domains are characterized by a coherent spatial structure and the presence of features. Traditional point-by-point verification approaches do not account for the intrinsic spatial correlation existing between nearby grid-points. This leads to issues (such as double penalties), and an overall limited diagnostic power (e.g. traditional scores do not inform on distances or timing errors, and are insensitive to the scale-dependence of predictability). The last decade has witnessed the development of several new spatial verification approaches, which have been grouped in four classes: scale-separation, neighborhood, feature-based and field-deformation techniques. The spatial verification approaches address these scientific gaps, however they often rely on the availability of gridded model-independent observations. When station observations are used for the verification, spatial verification becomes particularly challenging.

This study introduces a scale-separation verification approach which accounts for the inhomogeneous spatial distribution and variation in scale representativeness of station observation networks across the domain. A wavelet-based approach to reconstruct a precipitation field from sparse gauge observations is introduced. The reconstructed field preserves the observed value at the observation location, represents the coherent spatial structure characterizing the field, and accounts for the network density, so that more details are shown where the observation network is more dense. The wavelet reconstructed fields are used to perform a scale-oriented verification. Different scale components are isolated by a 2D Haar wavelet transform. Scales not represented in the observations are disregarded in the forecast prior to verification. Continuous verification statistics are then evaluated on each scale. Forecast and observation scale structure, the scale-dependence of the MSE and bias, and the no-skill to skill transition scale are analyzed. The sensitivity of the scale-separation verification statistics to the network density, and the effects of including satellite clear-sky data in the wavelet reconstruction are also illustrated.