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Hydro-meteorological evaluation of downscaled global ensemble rainfall forecasts

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Ensemble rainfall forecasts are of high interest for decision making, as they provide an explicit and dynamic assessment of the uncertainty in the forecast (Ruiz et al. 2009). However, for hydrological forecasting, their low resolution currently limits their use to large watersheds (Maraun et al. 2010).
In order to bridge this gap, various implementations of the statistic-stochastic multi-fractal downscaling technique presented by Perica and Foufoula-Georgiou (1996) were compared, bringing Environment Canada's global ensemble rainfall forecasts from a 100 by 70-km resolution down to 6 by 4-km, while increasing each pixel's rainfall variance and preserving its original mean. For comparison purposes, simpler methods were also implemented such as the bi-linear interpolation, which disaggregates global forecasts without modifying their variance.
The downscaled meteorological products were evaluated using different scores and diagrams, from both a meteorological and a hydrological view points.
The meteorological evaluation was conducted comparing the forecasted rainfall depths against nine days of observed values taken from Québec City rain gauge database. These 9 days present strong precipitation events occurring during the summer of 2009. For the hydrologic evaluation, the hydrological models SWMM5 and (a modified version of) GR4J were implemented on a small 6 km2 urban catchment located in the Québec City region. Ensemble hydrologic forecasts with a time step of 3 hours were then performed over a 3-months period of the summer of 2010 using the original and downscaled ensemble rainfall forecasts.
The most important conclusions of this work are that the overall quality of the forecasts was preserved during the disaggregation procedure and that the disaggregated products using this variance-enhancing method were of similar quality than bi-linear interpolation products. However, variance and dispersion of the different members were, of course, much improved for the variance-enhanced products, compared to the bi-linear interpolation, which is a decisive advantage.
The disaggregation technique of Perica and Foufoula-Georgiou (1996) hence represents an interesting way of bridging the gap between the meteorological models' resolution and the high degree of spatial precision sometimes required by hydrological models in their precipitation representation.

References

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