Towards spatially inhomogeneous stochastic simulations for flow-dependent nowcasting of orographic rainfall

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The Short-Term Ensemble Prediction System (STEPS, Bowler *et al*., 2006) is an operational ensemble nowcasting system based upon the Lagrangian extrapolation of weather radar images. To reproduce the dynamic scaling of rainfall, radar fields are decomposed into a multiplicative cascade with 8 levels which stochastically evolves in time according to a hierarchy of Lagrangian auto-regressive models of order 1 (AR(1)). The estimation and update of the cascade parameters is performed in real-time. This allows the parameters to change in time, but assumes that they are uniform over the forecast domain.

The presence of orography locally modifies the space-time statistical properties of rainfall and can increase its predictability due to the persistent large scale uplift of air masses. Consequently, we expect the cascade parameters and forecast errors to be spatially inhomogeneous according the relative positioning of orographic features with respect to the flow direction.

For the analyses we used data from the weather radar composite of eastern Victoria, Australia, a 500 km domain at 10 min, 2 km resolution, covering the period from February 2011 to October 2012. The apparent motion of the rainfall was estimated using the optical flow technique of Bowler *et al*. (2004). A k-means clustering algorithm was used to classify the optical flow fields into 6 main regimes and to stratify the evaluation of statistics.

STEPS nowcasts of 60-min accumulations show systematic biases on the upwind and downwind slopes of terrain features, which can be used to infer rainfall growth and decay processes due to orography. The Lagrangian AR(1) lifetime of rainfall features is approximately a factor two longer on the upwind compared with the downwind slope. This provides opportunities to perform spatially inhomogeneous stochastic simulations which better represent forecast uncertainty in complex orography.

The results indicate that the spatial variability of the cascade parameters and forecast skill is significant. At this stage, it is not altogether clear what is the relative importance of the spatial variability compared to the temporal variability and to what extent the classification into flow regimes also accounts for the temporal variability. The spatial inhomogeneity of the scaling exponent of the variance of the cascade levels is the subject of ongoing research.

The computation of rainfall and verification statistics is performed by using an online update strategy. This philosophy allows the design of an operational nowcasting system that automatically improves with experience as more data are collected.

References

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