Stochastic multiscale nowcasting with high resolution radar data

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Short term quantitative precipitation forecasting plays a more and more important role in both meteorological and hydrological risk management, especially with respect to heavy rainfalls in urban areas. Although the resolution of deterministic weather forecast models have significantly increased in the recent years to reach a few kilometre scales, most small scale physical processes, in particular precipitation, are still parameterised by rather ad-doc sub-grid modelling. Furthermore, small weather radars give access to higher resolution and the spin-up time of these models remain prohibitive for very short term forecasts.

A stochastic alternative is physically based on the paradigm of multiplicative cascades, which is perceptible on any radar scan (such as the figure of this communication): higher and higher rainrate cells concentrate into smaller and smaller fractions of the physical space and form an embedded hierarchy of rain cells whose life-time scales with their size. The slow decay of large cells introduces thus a strong memory effect, whereas the rapid distortion of small cells generates an inverse cascade of impredictability (Schertzer and Lovejoy, 2004). Successive developments of multifractal cascade models with continuous scales, scaling anisotropy and causality have enabled them to forecast in the aforementioned predictability limits (Schertzer and Tchiguirinskaia, 2017, 2018).

In this communication, we present tests of two versions of a such a forecast model using polarimetric data of our X-band radar (Paz et al., 2018) during 3 events of 2018 over the Greater Paris. Both versions of this Fractionaly Integrated Flux model consider the rain rate as resulting from a fractional integration of a conservative flux that is strictly scale invariant and therefore require only a very limited number of parameters that can be either theoretically or empirically obtained. The difference stems from the use of Doppler estimates of the displacement, which turn out to be sensitive.

References

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