Multivariate-multiobjective equivalence from a Bayesian perspective of spatial data assimilation

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Abstract: A Bayesian perspective of state-space modelling provides a unified framework for the treatment of both spatially-explicit and multi-variable data assimilation (DA) problems. Under certain assumptions, it is easily shown that spatial DA, where model states are represented as multivariate random variables encapsulating all the modelling cells in the geographic region of interest, is mathematically equivalent to the assimilation of multiple observations (multi-objective DA). While this perspective facilitates a generic approach to solving DA problems, it can lead to some issues that are not typically addressed in hydrological modelling. Namely, a spatially multivariate/multi-objective framework necessitates:

- the treatment of high dimensionality (in terms of computational challenges and data uniqueness);
- the consideration of spatial correlation on observation error structure;
- dealing with localisation and the control long-range artificial dependencies; and
- careful attention to the collinearity between multiple observations.

The intention of this talk is to start a discussion on the relevance and importance of these issues in the context of spatial hydrological DA. We present the mathematical structure to the DA problem, and summarise what has been done, and what can be done to address the above. We present our arguments addressing the above with the view that their importance will grow especially as spatial modelling progresses towards higher resolution, and the range of observations available to constrain model estimates will increase.

Keywords: *Spatial data assimilation, Bayesian statistics, multivariate*