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Model error components coming from reduced representations of multi-scale systems with 2-way interactions

Javier Amezcua (1,2) and Peter Jan van Leeuwen (1,3)

(1) University of Reading, Department of Meteorology, Reading, United Kingdom (j.amezcuaespinosa@reading.ac.uk), (2) National Centre for Earth Observation, United Kingdom, (3) Colorado State University, Fort Collins, United States (Peter.vanLeeuwen@colostate.edu)

Many dynamical systems have variables with different scales in both space and time, and often not all these variables can be represented explicitly by a forecast model. The use of a reduced model is a source of error which encompasses components with different characteristics.
We take the case of a simple linear dynamical system with two sets of variables with different characteristic timescales (slow and fast). We illustrate how the existence of 0-way, 1-way, and 2-way interactions yield components of model error with diverse behaviours. We use path-graph representations to illustrate the propagation and interactions of these components. We show the effects of these components in the evolution of the mean and covariance of a random variable. Finally, we propose some manners in which the different components of model error can be treated in the data assimilation problem.