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Dynamically informed covariance modelling in data assimilation

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Data assimilation systems are progressively getting better, resulting in improved analyses and forecasts. One important reason for this is thought to be the improved representation of the multivariate PDF of a-priori errors seen by the assimilation. This means that observations can influence the trajectory/ies of the numerical model in more physically meaningful ways. While some improvement is gained by modelling deviations of the PDF from Gaussianity, and by statistical modelling of Gaussian covariances with ensembles, there is still scope to improve the structure of the `B-matrix' used in pure and hybrid versions of 3D/4D-Var.

Our hypothesis is that a good B-matrix for geophysical data assimilation applications should have multivariate structure functions that reflect the dynamics of the underlying physical system. So, if the underlying system is close to some balanced manifold, then the assimilation should not disturb that property. Existing practice is to impose any balances explicitly, but this is difficult when the balances are weak or difficult to determine, such as in convective-scale or tropical applications, etc. In this talk we look at how such covariances can be modelled, including an approach that uses the normal modes of the underlying dynamics.