Correlation operators based on the iterative solution of an implicitly formulated diffusion equation

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Correlation operators are used in variational data assimilation (VDA) for defining background error covariance models and in hybrid ensemble-VDA for localizing, via a Schur product, low-rank sample estimates of background error covariance matrices. This presentation describes new approaches for defining correlation operators based on diffusion operators. The starting point is a two dimensional (2D) implicitly formulated diffusion operator on the sphere, which has been shown in previous works to support symmetric and positive definite smoothing kernels that are closely related to those from the Matern correlation family. Different iterative and preconditioning methods are proposed for solving the 2D implicit diffusion problem, and are compared with respect to their efficiency, accuracy, memory cost, and parallel properties on high-performance computers. The algorithms described in this presentation are evaluated in a global ocean VDA system.