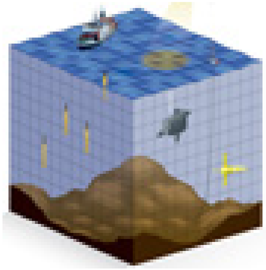

Contribution ID: **5** Type: **Oral presentation**

Invited talk: Gaussian approximations in filters and smoothers for data assimilation

Monday, 17 May 2021 13:50 (30 minutes)

We present mathematical arguments and experimental evidence that suggest that Gaussian approximations of posterior distributions are appropriate even if the physical system under consideration is nonlinear. The reason for this is a regularizing effect of the observations that can turn multi-modal prior distributions into nearly Gaussian posterior distributions. This has important ramifications on data assimilation (DA) algorithms because the various algorithms (ensemble Kalman filters/smoothers, variational methods, particle filters (PF)/smoothers (PS)) apply Gaussian approximations to different distributions, which leads to different approximate posterior distributions, and, subsequently, different degrees of error in their representation of the true posterior distribution. In particular, we explain that, in problems with 'medium'nonlinearity, (i) smoothers and variational methods tend to outperform ensemble Kalman filters; (ii) smoothers can be as accurate as PF, but may require fewer ensemble members; (iii) localization of PFs can introduce errors that are more severe than errors due to Gaussian approximations. In problems with 'strong'nonlinearity, posterior distributions are not amenable to Gaussian approximation. This happens, e.g. when posterior distributions are multi-modal. PFs can be used on these problems, but the required ensemble size is expected to be large (hundreds to thousands), even if the PFs are localized. Moreover, the usual indicators of performance (small root mean square error and comparable spread) may not be useful in strongly nonlinear problems. We arrive at these conclusions using a combination of theoretical considerations and a suite of numerical DA experiments with low- and high-dimensional nonlinear models in which we can control the nonlinearity.

Which theme does your abstract refer to?

Data assimilation methods (algorithmic developments in variational, ensemble and hybrid DA, covariance modelling, etc)

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Session Classification: Theme 3: Data assimilation methods

Track Classification: Data assimilation methods