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Mathematical Physics

Conditions for successful data assimilation

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We show that numerical data assimilation is feasible in principle for an idealized model only if an effective dimension of the noise is bounded; this effective dimension is bounded when the noises in model and data satisfy a certain natural balance condition. If this balance condition is satisfied, data assimilation is feasible even if the number of variables in the problem is huge. We then analyze several data assimilation algorithms, including particle filters and variational data assimilation. We show that a particle filter can successfully solve most of the data assimilation problems which are feasible in principle, provided the particle filter is well designed. We also compare the conditions under which variational data assimilation can be successful with the conditions for successful particle filtering. We draw conclusions from our analysis and discuss its limitations.

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