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Issues in Lagrangian data assimilation

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Lagrangian data contain time-integrated information of the velocity field as successive positions of 'tracers' along their trajectories. Successive tracer positions can be given by the Lagrangian instruments such as atmospheric balloons and ocean balloons or extracted by following distinct features in the flow field such as cloud and moisture. Assimilation of such Lagrangian data naturally inherits challenges associated with highly nonlinear nature of tracer dynamics observed in the atmosphere and oceans.

We present and discuss the issues essential to assimilation of Lagrangian data. By removing the necessity for commonly used approximation in assimilating the Lagrangian data, the Lagrangian data assimilation (LaDA) method has shown to offer a variety of advantages. Success of LaDA depends on properly estimating the flow-dependent error correlation between the model variables and tracer positions within the augmented state space. However, the estimation process may fail when the tracer passes (Lagrangian) saddle point of the flow that is intrinsically undetectable in the instantaneous (Eulerian) model state. We present a robust and efficient quality control scheme for dealing with this saddle problem cased by the chaotic tracer dynamics. When the Lagrangian data lack the vertical information, LaDA automatically handles them without requiring any height or depth assignment. If handled properly, Lagrangian data can help improve atmospheric and oceanic assimilation problems significantly.