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A sequential variational analysis approach for mesoscale data assimilation

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In mesoscale data assimilation, it is important to analyze narrow zone boundary layer convergence (or "boundaries") for thunderstorm development and evolution. Since these nonlinear boundaries are usually absent from a background field, observations become a main source for analyzing these features in a data assimilation system. When observation networks are increasing, it is critical for a data assimilation approach to provide analyses of these boundaries when they can be well observed. In this presentation, a variational analysis approach is examined using dense surface observations. It is a 3DVAR analysis of horizontal surface plus time instead of height and is called Space and Time Mesoscale Analysis System (STMAS). A recursive filter is used to approximate the background covariance. It is found that an empirical recursive filter cannot deal with the mesoscale nonlinear boundaries well. A sequential analysis approach greatly improves the variational analysis on nonlinear mesoscale features. Similar to a successive correction, a sequence of 3DVAR with its previous analysis as a background is solved with gradually decreasing influence radius of the covariance or recursive filter. Numerical experiments are presented here to show its improvement from conventional 3DVAR. The numerical results demonstrate its ability of handling multi-scale nonlinear boundaries, such as cold front or bore. As an alternative, wavelets are used to replace the recursive filters to improve its efficiency and its analysis near a domain boundary.