

Handling of Position Errors in Variational and Hybrid Ensemble/Variational Data Assimilation Using Image Registration

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It is hard to forecast the position of localized weather phenomena such as clouds, precipitation, and fronts. Moreover, cloudy areas are important since this is where most of the active weather occurs. Position errors, also known as phase or alignment or displacement errors, can have several causes; timing errors due to deficient model physics, inadequate model resolution, etc. Furthermore, position errors have been shown to be non-additive and non-Gaussian, which violates the error model most data assimilation methods rely on.

Remote sensing data contain coherent information on the weather development in time and space. By comparing structures in radar or satellite images with the forecast model state it is possible to get information about position errors. We use an image registration (optical flow) method to find a transformation, in terms of a displacement field, that aligns the model state with the corresponding remote sensing data. The estimated displacement field is used differently in variational and in hybrid ensemble/variational data assimilation.

In the variational setting the displacement field is used as a mapping function to obtain a new, better aligned, background state from the old one by means of interpolation (warping). To reduce the effect of imbalances, the aligned first guess is not used as is. Instead it is used for generation of pseudo observations that are assimilated in a first step to get an aligned and balanced first guess. This step reduces the non-additive errors due to mis-alignment and is followed by a second step with a standard variational assimilation to compensate for the remaining additive errors.

In the hybrid ensemble/variational data assimilation a displacement field is estimated for each ensemble member and is used as a distance measure. In areas where a member has a smaller displacement (smaller position error) than the control it is given an increased weight in the subsequent assimilation. It is also possible to first obtain an aligned and balanced background state based on variational assimilation of superobservations from a composite consisting of information from the best member (least position error) in each grid point.

Results are presented from experiments done with both variational and ensemble data assimilation systems using satellite data from the SEVIRI instrument.