# A revised Ensemble Forecast Sensitivity to Observation Impact (EFSOI) method in hybrid data assimilation

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## Abstract

Ways of estimating the observation impact in numerical weather prediction (NWP) that avoid the need to rerun many data-denial experiments have been developed for years. Forecast Sensitivity to Observation (FSO) was first proposed in the adjoint-based framework for variational systems, and Ensemble Forecast Sensitivity to Observation (EFSO) was later developed for ensemble data assimilation systems, which does not require the adjoint model. While the EFSO method has also been straightforwardly used in hybrid data assimilation systems in several studies, it has become apparent that the incompatible assimilation settings between the ensemble-variational (EnVar) and EnKF solvers can cause some issues that might limit the usability of the EFSO in the hybrid systems. Recently, a mixed approach was proposed by Buehner at al. (2018) by combining both approaches, in which the observation impact is solved by iterative minimization but the adjoint model is still not needed. This approach is believed to be able to provide more accurate estimates of observation impacts for the hybrid EnVar data assimilation systems.

Similar to Buehner at al. (2018), the goal of this study is also to obtain better estimates of observation impacts in hybrid data assimilation when the adjoint model is not available. Instead of using the approach by Buehner at al. (2018) that requires more development work, a revised EFSO method is proposed to be more suitably used in hybrid data assimilation systems, which requires only slight modifications to the computation procedure of the original EFSO method. The method is implemented in Central Weather Bureau (CWB)'s global NWP system that uses GSI-based hybrid data assimilation. Experimental results show that the underestimation of the impact of satellite data by the original EFSO method can be approximately resolved by the revised method.

Keywords: EFSOI, hybrid data assimilation