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Estimation of observation impact on forecast error reduction using the dual formulation of the EC operational 4D-Var

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The 3D-Var at the Environment Canada (EC) has been re-implemented recently as a collection of basic transformation operators acting on objects defined in various spaces. This modular approach enabled the development of various assimilation formulations and tools that help diagnose the impact of the different components of our data assimilation system. This presentation will review how we make use of the adjoint of the EC Global Environmental Multiscale (GEM) model and the dual formulation (3D/4D-PSAS) of the data assimilation system to compute observation sensitivity vectors and to measure the impact of arbitrary partitioning of observations on the skill of short term forecasts. The adjoint-based technique developed by Laroche et al. (2002) in the context of sensitivity analysis has been extended, following Langland and Baker (2004), for ascertaining the value of observations assimilated by the 4D-Var. The resulting adjoint-based Observation Impact (OI) measurement technique is used in this study to show the increasing impact of observation with the time of their introductions in the assimilation window. When compared in terms of OI, the 4D-Var is shown to be more sensitive to the data availability at the end of the assimilation period than a 3D-FGAT. This point is discussed in the context of the operational constraint of cut-off time for the reception of observations. It has been shown recently, in the context of key analysis, that energy norm based adjoint sensitivity of short-term forecast errors is characterized by strong dynamical imbalance. The effect of such imbalance on OI measurement technique will also be discussed.