Upper Atmospheric Data Assimilation with an Ensemble Kalman Filter

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Recent availability of global observations of ionospheric parameters, especially from GPS receivers on low Earth orbiting platforms, has motivated a number of attempts at assimilating ionospheric data. However, assimilation of sparse, irregularly distributed thermosphere observations to global models remains a daunting task. In this presentation we demonstrate the utility of ensemble Kalman filtering (EnKF) techniques to effectively assimilate a realistic set of space- and ground-based observations of the thermosphere and ionosphere into a general circulation model. An EnKF assimilation procedure has been constructed using the Data Assimilation Research Testbed (DART) and the Thermoshere-Ionosphere-Electrodynamics General Circulation Model (TIEGCM), two sets of community software offered by NCAR. An important attribute of this procedure is that the thermosphere-ionosphere coupling is self-consistently treated both in a forecast model as well as in assimilation schemes [1]. It effectively facilitates solving the inverse problem of inferring unobserved variables from observed ones, for instance, thermospheric states from better observed ionospheric states. We demonstrate this point using specific observations including (i) neutral mass densities obtained from the accelerometer experiment on board the CHAMP satellite [2], and (ii) electron density profiles obtained from the COSMIC/FORMOSAT-3 mission [3]. Furthermore, we discuss some of the issues specific to upper atmospheric EnKF applications and the roles of auxiliary filtering algorithms, such as adaptive covariance inflation and localization of covariance, to cope with these issues.

References

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