



4D-Var assimilation experiments with CHAMP GPS radio occultation measurements

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A one-dimensional bending angle observation operator for assimilating GPS radio occultation (RO) measurements has been integrated into the ECMWF 4D-Var assimilation system. We have performed forecast impact experiments with 60 days of CHAMP RO measurements, in addition to the latest set of conventional and satellite data that are assimilated operationally, including radiances from the Atmospheric Infrared Sounder, AIRS. It is demonstrated that the CHAMP measurements provide extremely good temperature information in the upper-troposphere and lower-stratosphere. In the southern hemisphere (SH), they produce a clear, statistically significant improvement in the root-mean-square (RMS) forecast fit to radiosonde measurements over the day-1 to day-5 forecast-range, at 300, 200, 100 and 50 hPa. An improved RMS fit to radiosondes is also evident at 100 hPa in the tropics. However, the observations degrade the 500 hPa geopotential height (500Z) field in the SH. This appears to be mainly caused by erroneous surface pressure increments in Antarctica. As a result, we have modified the GPS tangent-linear and adjoint routines, prior to the evaluation of the model level pressures and geopotential heights, in order to remove the sensitivity of the model geopotential height values to the surface pressure. This improves the SH 500Z forecast scores, although a small degradation is still evident at the day-1 and day-2 forecast-range.

A simple method for estimating the degrees of freedom for signal (DFS) of a large variational assimilation system is noted and applied to estimate the DFS of the CHAMP measurements assimilated during a 12 hour assimilation window.