Well-designed OSSEs can be very informative since they are not restricted by presently existing observation types and the simulated truth is precisely known, both properties being a consequence of the simulated context of the experiments. Although most often motivated by the first property, the second can also be exploited to better understand the behavior of data assimilation systems. Essentially, analysis and background error can be explicitly calculated without invoking questionable assumptions about their character. Another consequence of this simulated context, however, is that what is learned from the OSSE only applies to the assimilation of real observations to the degree that the OSSE is realistic. Validation of any OSSE framework using a variety of metrics is therefore critical to its useful applications.

The OSSE framework recently developed at the GMAO has been validated using several informative metrics that have not been examined in previous OSSEs. These include statistics of innovations (both variances and correlations), analysis increments, observation impacts (estimated using model and data assimilation adjoints), and forecast errors. It was relatively easy to match innovation variances by adding random errors to the observations, but in order to match innovation correlations and analysis increment variances, these errors had to be channel or spatially correlated. For most observation types, tuning of these errors was fairly easy.

After presenting a sample of validation results, application of the OSSE to estimate analysis and background error characteristics will be presented. This will include direct calculation of error variances and spatial correlations, error spectra, and the percentages that background errors are reduced during the assimilation of observations. A typical value of the latter for most fields at most locations is only 10-20%, as can be expected from theoretical consideration of the Kalman filter. Error reductions primarily occur at synoptic scales (spherical harmonic wave-number n<30). The divergent wind is relatively poorly analyzed at most vertical levels and horizontal scales. Horizontal and vertical scales of background error correlations are very different than what is estimated using the NMC method; i.e., using statistics of 48 minus 24-hour forecast errors verifying at the same time as proxies for background error statistics. The usual dry, forecast skill metrics in the OSSE context are rather insensitive to a reasonable range of observation error characteristics, rendering it difficult to tune the OSSEs realism regarding such metrics. This is partly due to the influence of model error on forecast error but also due to the effectiveness of present data assimilation algorithms at filtering observation errors.

Most applications of the GMAO OSSE thus far have concerned its aid in understanding the behavior of the data assimilation system by validating against truth itself. Results from some additional studies of this kind will be presented as well as plans for the future.