# Assimilating long-duration balloon data using a Partial OSSE

Michael Keil
*Met Office, London Road, Bracknell, UK, RG12 2SZ*
*michael.keil@metoffice.com*

Stratospheric long-duration balloons offer a potentially abundant supply of in-situ data. Various projects, such as the Global Air-ocean IN-situ System (GAINS) and the Ultra-Long Duration Balloon (ULDB), are currently planning to regularly fly balloons in the stratosphere, with the ultimate aim of constructing a global network of balloons. Balloon platforms can host an array of instruments enabling a wide range of atmospheric constituents and behaviour to be monitored. It is important that the impact on NWP from assimilating data from balloon constellations is understood before they become part of the global observation network.

To estimate the performance of a constellation of long-duration stratospheric balloon data, it is necessary to simulate balloon observations. A hybrid experiment, which is a cross between an Observation Systems Experiment (OSE) and an Observation System Simulation Experiment (OSSE), called a Partial Observation System Simulation Experiment (POSSE) was developed. POSSEs allow a mix of real and simulated data to be assimilated. Data from balloon constellations were simulated from a nature analysis, in this case provided by ECMWF. The simulated data was subsequently assimilated into the Met Office Stratospheric 3D-Var system along with a degraded set of real observations. The volume of ATOVS data was deliberately reduced in the real observation set, thus ensuring that atmospheric information was contained within the simulated data. A similar procedure to the POSSE, called an Observation System Replacement Experiment (OSRE), has been performed at Deutscher Wetterdienst to test the effect of assimilating lidar wind data (Wergen, 2000). Horizontal wind data for five different configurations of simulated balloon constellations were assimilated for January 2001. The networks consisted of 410, 205, 103 and 52 drifting balloons, plus a static constellation containing 410 balloons, all flying at an altitude of 30hPa.

Analyses and forecasts from the POSSE and control runs were verified against the nature run. Overall, the POSSE produced a measurable improvement in the rms horizontal windspeeds in all cases at the balloon flight level, 30hPa. This can be seen in figure 1, where increasing the constellation density increases the accuracy of the analysis. There is no clear evidence in this experiment to suggest whether it is more beneficial to have drifting or static balloon constellations. Figure 2 shows the fractional (normalised) rms benefit at all vertical levels. The global average, in the left hand plot of figure 2, is dominated by the signal from the tropics. The largest rms horizontal windspeed improvement was found in the in tropics, although the benefit had limited vertical extent. In the extra-tropics, right hand plot in figure 2, the vertical extent of the windspeed benefit was much greater, with the whole depth of the stratosphere affected. The results from the POSSE are very encouraging and indicate that adding a permanent constellation of stratospheric balloons to the global observing system would be beneficial to the NWP community.

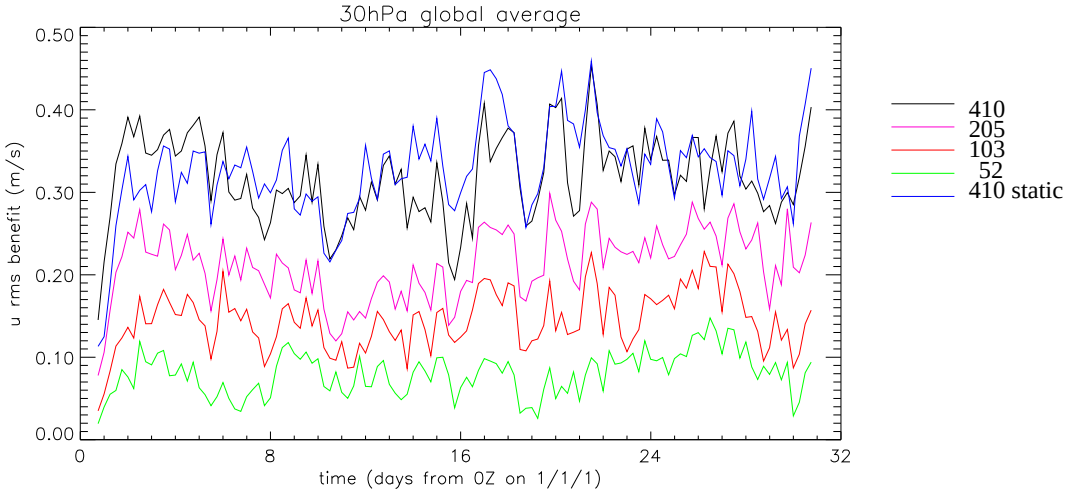


Figure 1: Timeseries of the rms benefit (rms control - rms POSSE, relative to nature) in the zonal wind field at 30hPa. Positive values indicate the POSSE is closer to the nature run.

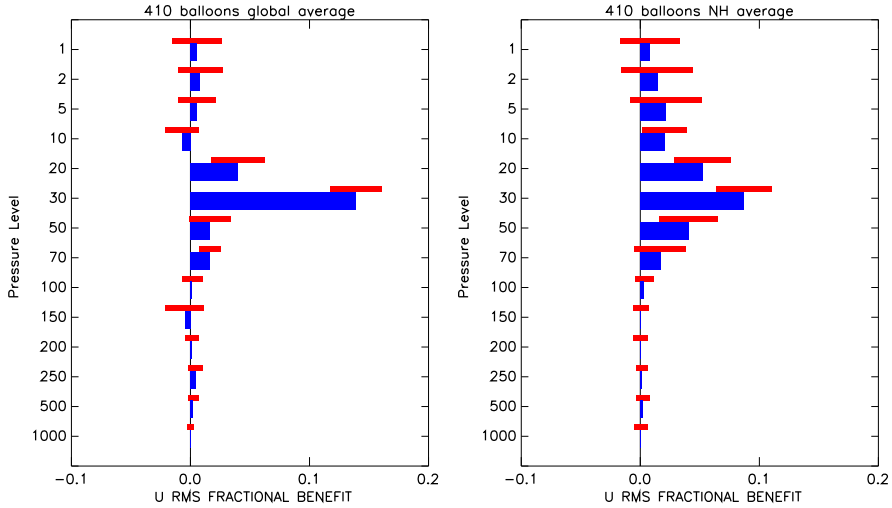


Figure 2: Histograms of the fractional zonal wind rms benefit for the 410 balloon constellation (thick rectangles). The thin rectangles represents the $\pm 1\sigma$ error bounds. The left hand plot is a global average and the right hand plot is a NH average (30°N-90°N).

Wergen, W., Impact studies for a proposed European space-borne wind lidar instrument, *Proceedings of the second CGM/WMO workshop on the impact of various observing systems on numerical weather prediction, Toulouse, France, 6 -8 March 2000, World Weather Watch Technical Report No. 19, WMO/TD No. 1034*, 199 - 202, 2000.