Geophysical Research Abstracts
Vol. 20, EGU2018-10616-1, 2018
EGU General Assembly 2018

The Optimization of the Global Observing Systems: A Dream or Reality?

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In the future, Numerical Weather Predictions (NWP) will play an increasing role in mitigating the effects of weather on a wide range of human activities. NWP forecasts are initialized from the best estimate of the state of the natural system. The quality of weather forecasts critically depends on that of the initial state, influenced in turn by the type, number, quality, and distribution of observations, as well as errors in short range forecasts used as first guess fields in observational data assimilation schemes.

Among a variety of tools available to assess the impact of changes in observing systems on the quality of analyses and forecasts, Observing System Experiments (OSEs) are considered as a standard reference. The effect of observational noise, however makes OSE and also related OSSE (Observing System Simulation Experiment) results prone to large sampling errors, while the large computational costs seriously limit the range of observing system experiments that can be conducted. To significantly reduce computational costs and the noise in OSE-type impact assessments, a novel statistical approach is proposed for the Prediction of Observing System Impacts (POSI).

POSI analyzes output from a baseline operational (e.g., NCEP's GFS/GSI) or simulated (i.e. OSSE) forecast system over a period of time. Based on a grid point-wise analysis of the behavior of error variances in the data assimilation - forecast cycle, POSI estimates the time mean Extracted Observational Information (EOI) derived from all available observations in the baseline configuration by a data assimilation system. After quantifying the expected relative impact of each observing system based on its presence in, or proximity to each point in the 3D space of the analysis grid (Observing System Indicator fields - OSIs), the contribution of each observing system to the overall EOI of all observations is statistically assessed. The resulting measures (e.g., correlation coefficients between individual OSIs and the overall EOI) are then used to predict how analysis error variance will change due to any variation in the baseline configuration of the different observing systems.

The new method is tested and evaluated in simulated perfect model data assimilation – forecast experiments using a quasi-geostrophic model. Results indicate that POSI provides significantly more accurate observing system impact predictions than what is feasible with the traditional OSE approach, and at a fraction of the cost of OSE experiments. The presentation concludes with recommendations on the use of POSI in the assessment of the current, and the optimization of future observing systems.