Observation Impact on Tropical Cyclone Forecasts: An Adjoint Approach

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Using the adjoints of the data assimilation system and NWP forecast model, the impact of individual observations can be estimated for some function of the model forecast state. The Navy currently uses this technique to assess the impact of observations on the 24-hour forecast as measured by a global energy-based error norm [1]. In this study, this system is adopted for monitoring the impact of observations on the 24-hour tropical cyclone (TC) forecast for selected cases in the 2012 hurricane season, by restricting the verifying area over the location of the TC and adopting a TC intensity response function rather than an energy-based error norm cost-function.

An examination of observation impact on TC forecasts indicates that a very small minority of high-impact observations within the TC's environment is responsible for the bulk of the impact on TC intensity, following a power-law-like distribution. This is in stark contrast to the observation impact on the global error norm, which is contributed to mostly by the integrated impact of many low-impact observations, while high-impact observations contribute little overall. In addition, the relative importance of various observing systems to TC intensity can vary strongly from forecast to forecast, based on the context of the TC's environment. For example, land observations can be of relatively low importance compared to satellite-derived winds while the TC is remote from land, but this relationship can shift dramatically as the TC approaches landfall.

References

[1] R. H. Langland and N. L. Baker. "Estimation of observation impact using the NRL atmospheric variational data assimilation adjoint system." ***Tellus*****, 56A, pp. 189-201, April 2004. (Journal Article)**