FORECASTING LENGTH-OF-DAY USING NUMERICAL WEATHER PREDICTION MODELS

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ABSTRACT. A new approach to forecasting changes in length-of-day (Δl.o.d) with lead times from one to ten days is examined. The approach is based on the high correlation that has been shown to exist between high frequency changes in l.o.d. and those in the atmosphere's angular momentum (M). Because forecasts of tropospheric values of M can be calculated from the zonal wind fields produced by operational numerical weather prediction models, it seems worth investigating whether these forecasts are sufficiently skillful to use to infer the evolution of Δl.o.d. Here, we examine the quality of M forecasts made by the Medium Range Forecast (MRF) model of the U.S. National Meteorological Center (NMC). By comparing these forecasts against those based on a simple model of persistence, we find that skillful forecasts of M are being achieved on average by the MRF, although there has been much month-to-month variability in forecast quality. Overall, our results indicate that for prediction lead times of 1-10 days, dynamically-based forecasts of Δl.o.d. represent a viable alternative to the empirical approaches currently in use.

SUMMARY OF RESULTS

Time series of errors in M made by the MRF chosen for forecast lead times of 2, 5 and 10 days during December 1985 - August 1986 are plotted in Fig. 1, along with comparable series of errors made by a persistence-based prediction scheme, i.e., where forecasted $M(t_o+\Delta t)$ = observed $M(t_o)$ for each forecast lead time Δt. Although persistence appears to be a rather simple model against which to measure the performance of the MRF, there is some evidence to suggest that the statistical behavior of M resembles a random walk process on the time scales of interest here, in which case persistence would represent the optimal statistical forecast model.

A. K. Babcock and G. A. Wilkins (eds.), The Earth's Rotation and Reference Frames for Geodesy and Geodynamics, 285–286.

Although on occasion the performance of the MRF is not so good as persistence, on average the r.m.s. errors of the MRF forecasts (σ_{MRF}) are smaller than those of the persistence forecasts (σ_p) for all three lead times. This result is depicted in Fig. 2, in which σ_{MRF} and σ_p are plotted for all forecast lead times between 1 and 10 days including the three shown in Fig. 1. Over our entire study period, the improvement of the MRF over persistence exceeds 20% for 2-5 day forecasts and remains as large as 10% even for 10-day predictions.

The results summarized here are discussed more extensively in a manuscript submitted for formal publication.

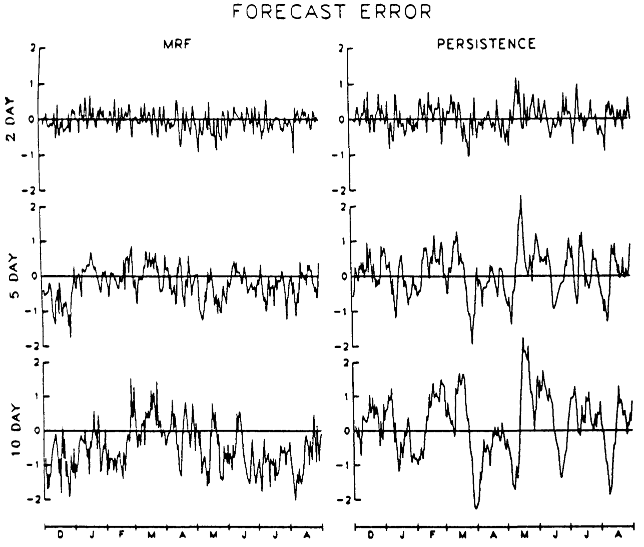

Figure 1
Time series of the difference, MRF forecasted values minus observed values of M, for forecast lead times of 2, 5, and 10 days (left side); and the difference, persistence-based M forecast values minus observed values of M for the same forecast lead times (right side). Units are 10^{25} kg m^2 s^{-1}.

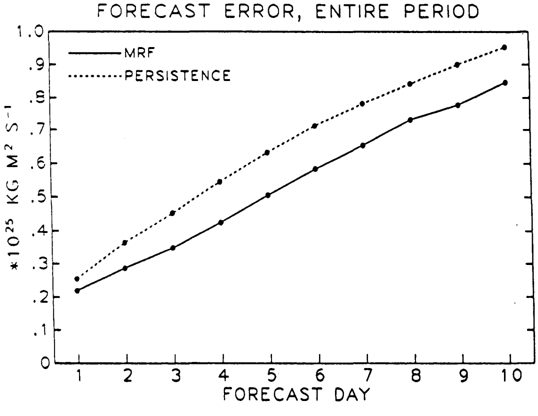

Figure 2
The r.m.s. difference between observed values of M and those forecasted by the MRF (solid line) and between observed values of M and those forecasted by persistence (dashed line) as a function of forecast lead time for the entire study period.