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## 1. INTRODUCTION

Between 1976 and 2001, over 5000 official (OFCL) position forecasts were issued by the National Hurricane Center for tropical cyclones in the Atlantic basin. From these, 708 landfall position and timing forecasts were compiled for storms that threatened to strike the U. S. including Puerto Rico and the U. S. Virgin Islands (PR/USVI). Of all forecasts issued for the basin, about 13 % are for actual landfalling storms and 2 % are for "near misses" (storms initially forecast to landfall in the U. S. before turning out to sea). During this period, on average, 219 forecasts are issued each year for 10 storms, with three landfalls in the U.S. and one "near miss". Position errors were defined in accordance with a study of 24 h landfall forecasts during 1970-1979 by Neumann and Pelissier (1981). The difference between the forecast and observed location (by great circle distance) and time of landfall were tabulated for 1976-2000 by Powell and Aberson (2001). This paper will update their results by including landfall forecasts for the 2001 season.

## 2. RESULTS

In 2001, only 13 verifying landfall forecasts were issued for Tropical Storms Allison (0), Barry (10), and Gabrielle (3). Tropical Storm Allison made landfall shortly after development hence no landfall forecasts were issued. Landfall position and time forecasts are skillful relative to CLIPER at all time periods before landfall and demonstrate skill levels 5-10% higher than Atlantic basin track forecasts. Landfall position forecasts are most accurate for slow storms moving perpendicular to the coast. Standard deviations of the landfall timing errors suggest similar uncertainties of 11 h at 24 and 36 h before predicted landfall, suggesting the potential to issue warnings about 12 h earlier (at 36 h rather than 24 h before predicted landfall) without substantial loss of lead time accuracy (although warning areas necessarily would be larger). An early bias of 1.5-2.5 h is noted within 30 h of landfall which may be associated with conservative forecasts to account for possibility of storm accelerations.

Position errors compiled for the 1970-1998 Atlantic basin forecast population at similar time periods by McAdie and Lawrence (2000) suggest a dramatic improvement of 1-2% per year. Aberson (BAMS 2001) documented similar improvements in the ensemble of numerical forecast models guidance from 1976-1998. In 2001, CLIPER landfall forecasts performed well so the adjusted position errors are relatively large, resulting in trend lines (Fig. 1) similar to those presented in Powell and Aberson (2001). Despite commendable improvements in basin-wide track forecasting during the last 26 years, after adjustment for forecast difficulty relative to CLIPER, no statistically significant improvement or degradation is noted for landfall position forecasts. Time of landfall forecasts indicate no degradation at any period and significant improvement for the 19-30 h period.

Since no significant improvement trend is noted for landfall position forecasts, research/operational goals to reduce warning areas based on transferring basin-wide forecast improvements to landfall forecasts may be unrealistic. Goals associated with increasing lead time are achievable but should be tempered by the fact that the price of advanced lead time is the costly increase in warning area.

## 3. REFERENCES

- McAdie, C. J. and M. B. Lawrence, 2000: Improvements to tropical cyclone track forecasting in the Atlantic basin, 1970-1996. *Bull. Amer. Met. Soc.*, **81**, 989-999.
- Neumann, C. J. and J. M. Pelissier, 1981: An analysis of Atlantic tropical cyclone forecast errors, 1970-1979. *Mon. Wea. Rev.*, **109**, 1248-1266.
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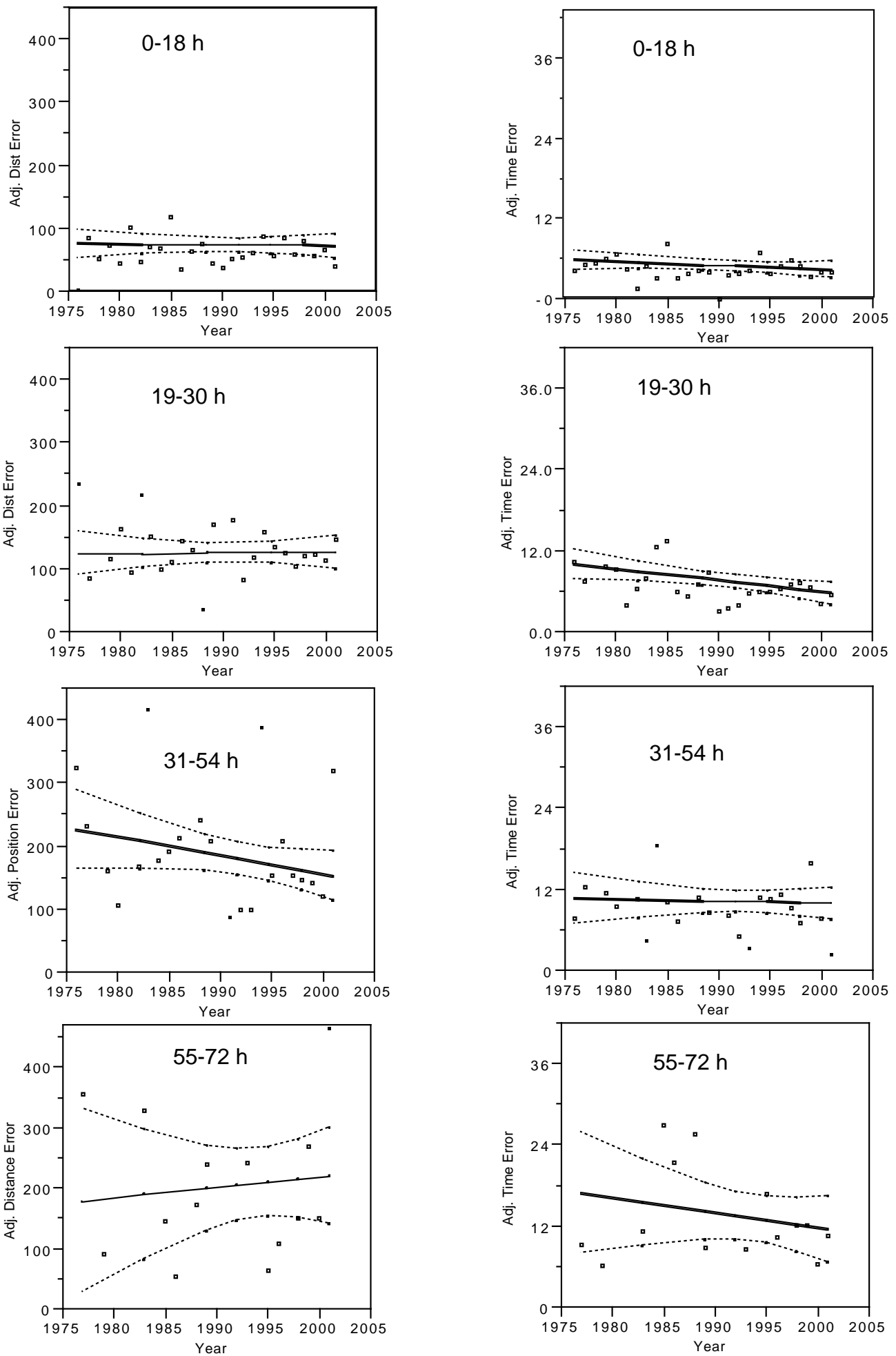


Fig. 1 Trends in landfall position (left column, km) and time (right column, h) forecast errors from 1976-2001 as a function of time before predicted landfall. Lines are weighted least squares fits with 95% confidence bands.