P.1.23 STATISTICAL FORECASTING OF PACIFIC AND INDIAN OCEAN TROPICAL CYCLONE INTENSITY USING 19-, 37-, AND 85- GHZ BRIGHTNESS TEMPERATURES

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1. Introduction

Advances in tropical cyclone intensity forecasting have lagged behind those in tropical cyclone track forecasting. Statistical methods are among the tools that provide useful guidance for intensity forecasting. Current approaches include the Statistical Hurricane Intensity Prediction Scheme (SHIPS; DeMaria and Kaplan 1994, 1999) and Statistical Typhoon Intensity Prediction Scheme (STIPS; Knaff et al., 2004). These approaches involve multiple linear regression of environmental (e.g., vertical wind shear, sea surface temperature) and climatological/persistence (e.g., prior intensity change, current intensity, storm motion) parameters, regressed against subsequent intensity change. The research presented here adds passive microwave brightness temperatures to the list of input parameters in such regressions. Primary focus has been on the Atlantic basin, with initial results reported by Jones (2004) in this volume. This paper describes initial results for other basins.

Passive microwave imagers - specifically, Special Sensor Microwave / Imager (SSM/I) and Tropical Rainfall Measuring Mission (TRMM) Microwave Imager (TMI) - provide information about the spatial distribution of rainfall, precipitation ice, deep convection, and water vapor. The results presented here rely most heavily on 19 GHz brightness temperatures, which respond to microwave emission by liquid water and water vapor. Brightness temperatures at 37 and 85 GHz are also used; these higher frequencies are increasingly sensitive to scattering of the upwelling radiation by precipitation, especially graupel and hail.

The passive microwave observations are used to represent the vertical motion and latent heating in a tropical cyclone's inner core. Several previous studies have exploited relationships between microwave brightness temperatures, rainfall, latent heating, and tropical cyclone intensity (e.g., Cecil and Zipser (1999); Rao and McCoy (1997); Rodgers and Pierce (1995)).

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This study uses statistical description of the tropical cyclone inner core (the brightness temperatures) and its surrounding environment (the SHIPS and STIPS parameters) to examine tropical cyclone intensity change, and to provide guidance for intensity change forecasts.

2.Methodology

The methodology used for the Atlantic basin is described by Jones (2004), following DeMaria and Kaplan (1994, 1999). The Eastern North Pacific basin is treated similarly. A different set of environmental predictors is used for the Western North Pacific and Southern Hemisphere, following Knaff et al. (2004). Key differences include the treatment of maximum potential intensity (MPI). It is computed from sea surface temperature, using different empirical formulae for each basin. For the Atlantic and Eastern North Pacific, current intensity is subtracted from MPI. MPI and current intensity are treated separately for the other basins. The same set of passive microwave inputs is used in each basin, using data from 1997-2002 (2001 for Southern Hemisphere). The sample size is not large enough to treat the Australian region and Southern Indian Ocean separately; they will be treated separately after inclusion of recent seasons. The results presented here are based on regressions which include areal mean brightness temperatures at 19, 37, and 85 GHz, averaged over a 100 km radius from the center of the tropical cyclone. In some cases, regressions which use more information from only a single channel produce slightly better forecasts.

3. Regression results

In each basin, the important predictors include MPI, current intensity, prior intensity change, vertical wind shear, and mean brightness temperature. The preferred microwave frequency differs from one basin to another. Mean absolute errors from jackknife regressions are plotted for each basin in Fig. 1.

To represent forecast skill while accounting for forecast difficulty, the mean absolute errors are plotted relative to those from a simple climatology and persistence regression in Fig. 2. The climatology and persistence regressions are based on the same set of tropical cyclones as the microwave regressions; they are not based on long-term samples. The regressions using microwave and environmental predictors improve upon those using climatology and persistence. The improvement ranges from 7-21%. The improvement is greatest for the Eastern North Pacific at forecast durations up to 36 hours; it is greatest for the Atlantic basin beyond 36 hours. The least improvement is seen for the Southern Hemisphere, which has 7-10% improvement.

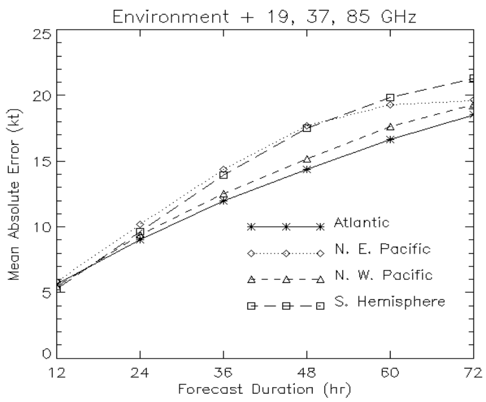

Figure 1. Mean absolute errors of intensity change from regression using 19-, 37-, and 85- GHz mean brightness temperature in addition to environmental, climatology, and persistence predictors.

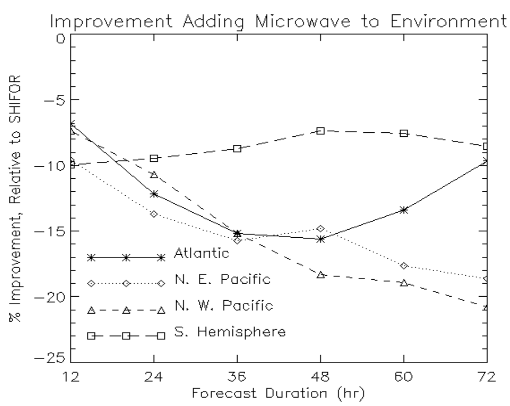

Figure 2. Improvement of mean absolute errors with respect to a regression based on climatology and persistence only. Negative values indicate skillful forecasts.

Mean absolute errors are plotted relative to those from regressions which use environmental (but not microwave) inputs in Fig. 3. Forecast improvements of up to 6% result from including the microwave data. Improvement is greatest for the Atlantic and Eastern North Pacific basins. Improvement is almost negligible for the Southern Hemisphere. Our greatest emphasis has been on the Atlantic basin, with the least emphasis on the Southern Hemisphere. We look forward to feedback and suggestions from Southern Hemisphere specialists. This is very much a work in progress, and the results presented here are preliminary.

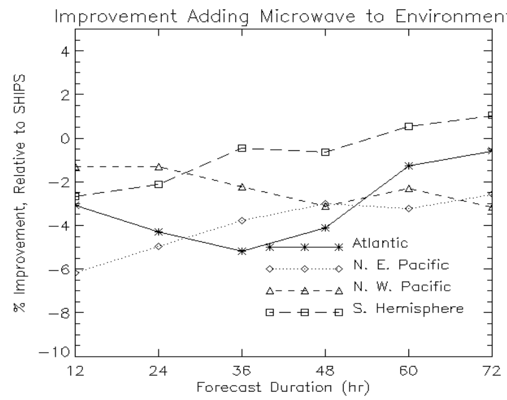

Figure 3. Improvement of mean absolute errors with respect to a regression based on climatology and persistence and environmental predictors.

4. Acknowledgements
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5. References

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