4D.7 ASSESSMENT OF THE POTENTIAL FOR PREDICTION OF TROPICAL CYCLONE FORMATION IN THE NAVY GLOBAL MODEL

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## 1. INTRODUCTION

Some of the recent increase in skill of tropical cyclone track predictions has been attributed to increased accuracy of guidance from global dynamical models. Indeed, as the skill in dynamical predictions has been extended into the medium ranges, requirements for five-day track predictions are being contemplated. However, a tropical cyclone may form, intensify, and move a long distance in five days to become a serious threat to maritime activities and coastal locations.

One of the common characteristics of dynamical model tropical cyclone track predictions is that the errors are larger in the early stages of the life cycle when the storm is at tropical storm or tropical depression strength. The larger track errors have been attributed to a variety of factors, such as mislocations of the weak circulation so that the initial position and initial motion vector are inaccurate. Also, various physical features such as the initial vortex structure, precipitation distribution, cloud distribution, and air-sea interactions may be poorly represented in the model. All of these factors would also impact the accuracy of dynamical predictions of tropical cyclone formation by global models.

Some of the success of the systematic approach to tropical cyclone track forecasting has been attributed to the ability to recognize likely errors associated with specific dynamical models (Carr et al. 2001). Model error traits were identified after assessing the skill associated with an exhaustive set of dynamical model forecasts. This study is an extension of the systematic approach to forecasts of tropical cyclone formation via identification of model error characteristics associated with forecasts of tropical cyclone formation. A primary objective is to examine successful and failed model predictions of developing and non-developing circulations to identify characteristics that distinguish the conditions represented in the model fields that correspond to a correct prediction of tropical cyclone formation.

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## 2. METHOD

An algorithm has been developed to detect and track circulations in dynamical models. The detection of circulation centers in model analysis and forecast fields is based on the existence of a closed 850 hPa relative vorticity isopleth with a magnitude of at least 1.0 x $10^{-5}$ $s^{-1}$. For this study, 1 deg. lat./long. fields from the Navy Operational Global Atmospheric Prediction System are used. To identify the circulation and various physical characteristics associated with the circulation, a multivariate normal probability distribution is used to fit an ellipse to the vorticity field (Fig. 1)

A recent study by DeMaria et al. (2001) assessed the potential of tropical cyclone formation over a region in which African waves pass and potentially intensify

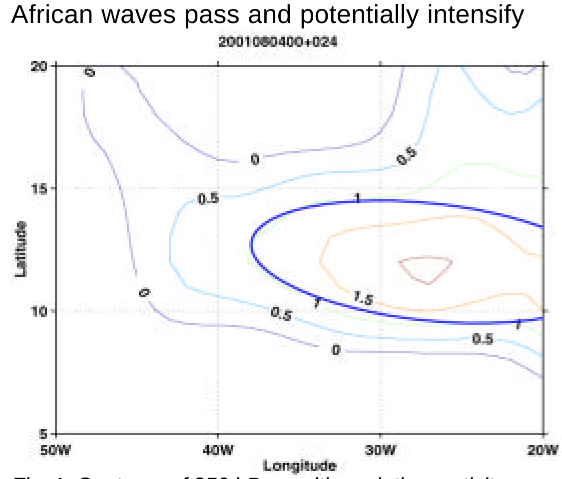


*Fig. 1 Contours of 850 hPa positive relative vorticity ($10^{-5}$ $s^{-1}$) from a 24 h forecast of a circulation (C in Fig. 2) over the eastern North Atlantic. The ellipse representation of the circulation is defined by the thick line*

if three environmental factors averaged over the prior five days are favorable. In the current study, a set of environmental parameters (Table 1) is defined relative to the ellipse representation of the circulation. Therefore, the potential for tropical cyclone formation can be assessed relative to the various environmental factors defined for developing and non-developing circulations.

*Table 1. Model parameters defined for every circulation center that meets the tracking criterion.*

| |
|---|
| relative vorticity at 850 hPa($10^{-5}$ $s^{-1}$) |
| sea-level pressure (hPa) |
| latent heat flux (surface) (W $m^{-2}$) |
| shallow vertical wind shear (500–850 hPa) (m $s^{-1}$) |
| deep layer vertical wind shear (200–850 hPa) (m $s^{-1}$) |
| geopotential height thickness (1000–200 hPa) (gpm) |
| 1000 – 500 hPa temperature difference (K) |
| vertical motion (Pa $s^{-1}$) |
| total precipitation (kg $m^{-2}$) |
| vapor pressure at 500 hPa (Pa) |

## 3. EXAMPLE

Circulation and environmental characteristics have been identified for all North Atlantic vorticity centers that satisfied the amplitude criterion between 25 July – 31 October 2001. Although a large set of environmental characteristics can be defined from the ellipse representation of each analyzed and forecast circulation center, only a brief example will be given here of the model characteristics associated with three non-developing circulations that moved off the western coast of Africa between 30 July and 4 August 2001 (Fig. 2). All three circulations dissipated after moving off the African coast. The ability of NOGAPS to predict the formation (first appearance in the analysis) of each of these circulation centers is defined in Fig. 3. For all three cases, there were several forecasts that were made well ahead of the actual formation time. However, the formation time was forecast to be too early for circulations A and B, and too late for circulation C. Various physical characteristics associated with advanced forecasts that verify too early or too late can be examined from the extensive data sets that are captured with respect to the ellipse representation of each circulation center. Likewise, parameters associated with forecasts that never verify (false alarms) or circulations that were never forecast (missed centers) may be examined to identify characteristic traits associated with NOGAPS predictions of circulation development.

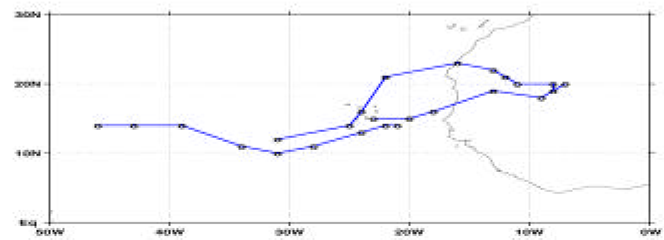


*Fig. 2 Analyzed tracks of three vorticity centers (A is farthest north, B is the southern circulation over Western Africa, and C is the farthest west) that occurred between 30 July – 4 August 2001.*

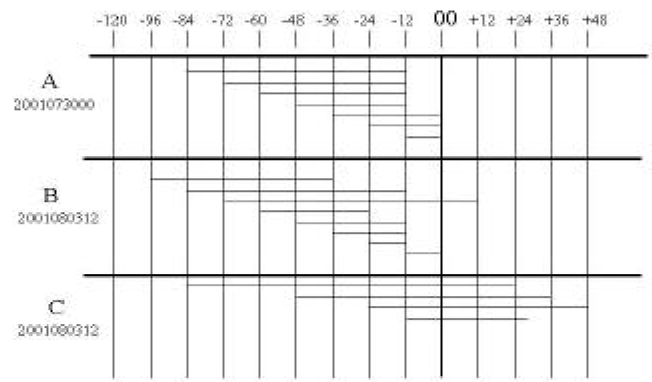


*Fig. 3 Forecast history of the detection of the three vorticity centers in Fig. 2 The time relative to the first analysis time (00) is given along the top. The start of each horizontal line marks when a forecast of the circulation formation was made. The end of each horizontal line indicates the time at which the circulation was forecast to appear. The length of the line denotes the matching forecast interval. For example, the top horizontal line for center A indicates that 84 h prior to the first analyzed position a 72-h forecast was made that defined formation to occur 12 h earlier than it actually occurred.*

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