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Development of a Probabilistic Tropical Cyclone Genesis Prediction Scheme

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Accomplishments:

1. Complete development of the Dvorak Database and incorporate disturbance positions, T-numbers, and CI numbers into the TCGI database

This element of the proposal effort (led by Co-I Cossuth) involved developing a database of all Dvorak analyses (including T-number, CI number, and position) that were conducted by TAFB for the Atlantic basin from 2001-2010 (Cossuth et al. 2012). Information was gathered from tropical cyclones (TCs) before genesis was achieved, invests that did not develop into TCs, and a small number of disturbances not classified as invests. Dvorak analyses were generated for these latter systems when a NHC hurricane specialist or TAFB analyst requested a center and intensity estimate, but there was not enough interest for creating an invest. In all, there were 345 unique systems during this time period, 159 of which achieved genesis and became a TC. Each system was cataloged with a unique identification, which consists of its ATCF number as well as the date and time of the initial Dvorak classification. Every entry is comprised of the date and synoptic time of Dvorak analysis, the location of the system's center, the final T-number, the CI number, and whether the system was considered tropical or sub-tropical. Due to their small sample size, sub-tropical cases were not analyzed. Further, if the disturbance did undergo genesis, the date/time/position of genesis and the TC's name is listed.

Using only the Dvorak dataset, a basic climatological genesis may be created. Figure 1 (previously illustrated in the original proposal submission) shows genesis rate of disturbances using a 2005-2010 subset of the data. There is a clear pattern of genesis likelihood scaling with the Dvorak intensity of disturbances. Systems analyzed as being more intense have a higher probability of achieving genesis. In general, tropical disturbances in a pre-genesis state have CI values less than 2.5 and can be sometimes deemed too weak to classify (TWTC). However, since forecasters were interested enough in the system to label it as an "invest", such TWTC systems were retained and defined with a CI number of 0.5 (to differentiate them from those disturbances with stronger satellite signatures). Figure 1 indicates that Dvorak classifications (even TWTC) contain valuable information regarding future genesis probability. This figure also supports the methodology to assign TWTC systems a non-zero T-number/CI number in the TCGI database.

The now-completed 2001-2010 Atlantic Dvorak database will provide two vital components to TCGI project: 1) the positions (i.e. nearly-complete tracks) for all invests that will

be analyzed in the TCGI database; 2) a potentially robust TCGI predictor (i.e. Dvorak T-numbers and/or CI numbers) that will be evaluated against other possible TCGI predictors (see Table 1).

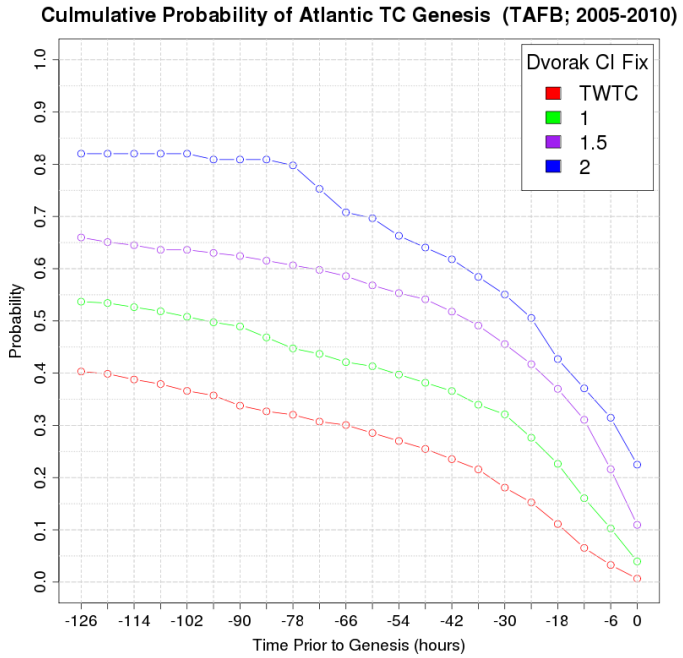

Figure 1: Climatological probabilities of genesis using only the Dvorak CI-number of a tropical disturbance from TAFB, 2005-2010 (omits sub-tropical classifications). The prediction lead-time is found on the abscissa, probability of genesis on the ordinate, and the color of the curve represents the Dvorak CI-number.

2. Complete identification/development of TCFP TCGI environmental predictors into the TCGI database

Co-PI Schumacher is leading the following elements of the proposed effort. The TCGI project requires a complete set of forecast positions out to five days for every Dvorak database disturbance at each 6-hourly synoptic time. Unfortunately, the dataset described above contains discontinuities and missing values, especially for entries in which the disturbance does not eventually form into a TC. To fill these missing forecast positions, a combination of Best Track and Dvorak positions and a BAMM type model were used.

A set of potential TC genesis predictors has been identified for use in the TCGI (Table 1). Predictors identified for testing in this new genesis scheme were chosen based on 1) their established relevance to TC formation (i.e., successful use in other genesis prediction schemes) and 2) their ability to be computed in a disturbance-centric framework. The predictors chosen include most of those used by the NESDIS Tropical Cyclone Formation Probability (TCFP) product. In addition, a few of the predictors used in the Statistical Hurricane Intensity Prediction Scheme (SHIPS) may also be important for TC genesis and have been included in the potential predictor list for the TCGI. Currently, work is underway to generate a developmental dataset of the predictors listed in Table 1 for each entry in the filled-in Dvorak dataset.

Potential Predictor	Data	Source
850-200 mb vertical shear	GFS analyses	TCFP
850-mb vorticity	GFS analyses	TCFP
MSLP	GFS analyses	TCFP
Vertical instability parameter	GFS analyses	TCFP
850-mb horizontal divergence	GFS analyses	TCFP
Sea surface temperature	Reynold's weekly SST	TCFP
Latitude	Dvorak dataset	TCFP
Distance to land	Dvorak dataset	TCFP
% pixels colder than -40 C	GOES-East water vapor	TCFP
Cloud-cleared brightness temperature	GOES-East water vapor	TCFP
Climatological TC formation probability	Dvorak dataset / HURDAT / Best Track	TCFP
Distance to existing TC	Dvorak dataset / HURDAT / Best Track	TCFP
Shear direction	GFS analyses	SHIPS
Potential intensity	GFS analyses / Reynold's weekly SST	SHIPS
200-mb temperature	GFS analyses	SHIPS
700-500 mb relative humidity	GFS analyses	SHIPS
700-850 mb temperature advection	GFS analyses	SHIPS
Total Precipitable Water	Microwave Satellite-derived	SHIPS/RI Index
Dvorak T-number	Dvorak dataset	TCFP
Dvorak CI number	Dvorak dataset	TCFP

Table 1. Potential predictor list for the TCGI.

3. Current/Future year-1 efforts:

With the completion of the Dvorak database and subsequent building of complete tracks for all 2001-2010 pre-genesis disturbances, the evaluation of the potential TCGI predictors outlined in Table 1 has now begun. This element of the proposed effort will be followed by the sequence of Year-1 efforts listed below:

Feb 2012	Complete identification/development of TCFP TC GI environmental predictors into the TCGI database
Feb 2012	Begin to develop/incorporate the TPW predictor into the TCGI database
March 2012	Present year-1 results at IHC
June 2012	Complete identification/development of TPW & Dvorak T-number/CI value TCGI predictors
June-Nov 2012	Begin sensitivity testing for optimal combination of TCGI predictors (0-48h & 0-120h)

References

Cossuth, J., R. D. Knabb, D. P. Brown, and R. E. Hart, 2012: Tropical cyclone genesis guidance using pre-development Dvorak climatology. *Wea. and Forecasting*, in preparation.