NOAA Joint Hurricane Testbed (JHT)
Project Progress Report, End of Year 1

Date:	September 5, 2012
Project Title:	Development of a Probabilistic Tropical Cyclone Genesis Prediction Scheme
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1. Long-term Objective and Specific Plans to Achieve Them:

The main goal of this project is to develop a disturbance-following tropical cyclone (TC) genesis index (TCGI) to provide forecasters with an objective tool for identifying the 0-48hr and 0-120hr probability of TC genesis in the North Atlantic basin. This new scheme will utilize Dvorak T-number / CI value estimates, environmental and convective parameters currently used in the NESDIS TC Formation Probability (TCFP) product (fixed grid scheme), environmental parameters from the Statistical Hurricane Intensity Prediction Scheme (SHIPS) that are relevant to TC genesis, and total precipitable water (TPW) retrievals from microwave satellites. Details about specific efforts that will be taken to achieve this goal can be found in Section 3.

2. Accomplishments:

a. Completed identification/development of all TCGI predictors, including TCFP and SHIPS environmental predictors, TPW predictors, and Dvorak T-number/CI value predictors.

The development of a training dataset for the new TCGI has been completed. This dataset contains potential predictor values at each location/time in the 2001-2010 Atlantic tropical disturbance dataset (developed in the first half of Year-1 by Co-I Cossuth). A complete list of potential predictors can be found in Table 1. A total of 54 potential predictors have been identified and computed for analysis; 13 from the NESDIS TCFP, 13 from SHIPS, 6 Dvorak T-number / CI predictors from the 2001-2010 Atlantic tropical disturbance dataset, 21 TPW predictors, and longitude and latitude. Most environmental predictors from the TCFP and SHIPS were averaged over a radius of 500-km about the disturbance center.

In order to determine which predictors might be expected to have the most skill in differentiating disturbances that developed from those that did not, a preliminary analysis of predictor averages was conducted. This first look (Table 2) suggests that the Dvorak T-number / CI value predictors and their 12-hr and 24-hr tendencies may provide the best discrimination between developing and non-developing disturbances. In addition, environmental parameters from the TCFP such as 850-mb horizontal divergence, 850-mb relative vorticity, 850-200mb vertical shear and mid-level relative humidity may provide predictive value. This preliminary analysis will help guide the sensitivity testing for optimal combination of TCGI predictors in Year-2.

Abbrev	Description	Source
LAT	Latitude	Disturbance Dataset, BAM
LON	Longitude	Disturbance Dataset, BAM
CNUM	CI number	Disturbance Dataset
DC12	12-hr change in CI number	Disturbance Dataset
DC24	24-hr change in CI number	Disturbance Dataset
TNUM	T-number	Disturbance Dataset
DT12	12-hr change in T-number	Disturbance Dataset
DT24	24-hr change in T-number	Disturbance Dataset
CPRB	Climatological TC formation probability	TCFP (HURDAT)
PLND	Land cover	TCFP (GFS land/sea mask)
VSHD	850-200 mb vertical shear	TCFP (GFS analyses)
RVOR	850-mb relative vorticity	TCFP (GFS analyses)
HDIV	850-mb horizontal divergence	TCFP (GFS analyses)
MSLP	Mean sea level pressure	TCFP (GFS analyses)
MLRH	600-mb relative humidity	TCFP (GFS analyses)
TADV	850-mb temperature advection	TCFP (GFS analyses)
THDV	Vertical instability parameter	TCFP (GFS analyses)
RSST	Reynold's weekly SST	TCFP (Reynolds weekly)
BTWM	Mean cloud-cleared brightness temperature	TCFP (GOES water vapor)
PCCD	Cloud (<-40C) cloud pixel coverage	TCFP (GOES water vapor)
DNST	Distance to nearest TC (max = 1000)	TCFP (HURDAT)
CSST	Climatological SST	SHIPS (climatology)
D20C	Climatological depth of 20C isotherm	SHIPS (climatology)
D26C	Climatological depth of 26C isotherm	SHIPS (climatology)
HCON	Climatological ocean heat content	SHIPS (climatology)
EMPI	Emanuel's MPI	SHIPS (GFS analyses)
TMPI	Empirical MPI (function RSST only)	SHIPS (Reynolds SST)
DV12	12-hr GFS vortex tendency	SHIPS (GFS analyses)
DV24	24-hr GFS vortex tendency	SHIPS (GFS analyses)
RD20	Depth of 20C isotherm	SHIPS (Satellite altimetry)
RD26	Depth of 26C isotherm	SHIPS (Satellite altimetry)
VSDD	850-200 mb shear vector (N = 0, E = 90, etc.)	SHIPS (GFS analyses)
RHCN	Ocean heat content, from altimetry	SHIPS (Satellite altimetry)
STPW1	TPW, azimuthally avg r=0-100km	CIRA TWP archive
STPW2	TPW, azimuthally avg r=100-200km	CIRA TWP archive
STPW3	%TPW less than 45 mm, r=0-200km, N quadrant	CIRA TWP archive
STPW4	%TPW less than 45 mm, r=0-200km, W quadrant	CIRA TWP archive
STPW5	%TPW less than 45 mm, r=0-200km, S quadrant	CIRA TWP archive
STPW6	%TPW less than 45 mm, r=0-200km, E quadrant	CIRA TWP archive
STPW7	%TPW less than 45 mm, r=400-600km, N quadrant	CIRA TWP archive
STPW8	%TPW less than 45 mm, r=400-600km, W quadrant	CIRA TWP archive
STPW9	%TPW less than 45 mm, r=400-600km, S quadrant	CIRA TWP archive

STPW10	%TPW less than 45 mm, r=400-600km, E quadrant	CIRA TWP archive
STPW11	%TPW less than 45 mm, r=0-200km, front quadrant	CIRA TWP archive
STPW12	%TPW less than 45 mm, r=0-200km, left quadrant	CIRA TWP archive
STPW13	%TPW less than 45 mm, r=0-200km, back quadrant	CIRA TWP archive
STPW14	%TPW less than 45 mm, r=0-200km, right quadrant	CIRA TWP archive
STPW15	%TPW less than 45 mm, r=400-600km, front quadrant	CIRA TWP archive
STPW16	%TPW less than 45 mm, r=400-600km, left quadrant	CIRA TWP archive
STPW17	%TPW less than 45 mm, r=400-600km, back quadrant	CIRA TWP archive
STPW18	%TPW less than 45 mm, r=400-600km, right quadrant	CIRA TWP archive
STPW19	%TPW less than 45 mm, 90° quadrant centered upshear	CIRA TWP archive
STPW20	TPW averaged r=0-500km, 90° quadrant centered upshear	CIRA TWP archive
STPW21	TPW averaged r=0-500km	CIRA TWP archive

Table 1. Final list of TCGI predictors that will be tested for use in the new TCGI in Year-2.

Predictor	Non-Developing	Developing	Dev - Non-Dev (sd units)
TNUM	0.85	1.38	1.06
DT24	-0.06	0.47	1.02
CNUM	0.89	1.41	1.00
DC24	-0.04	0.48	0.98
DT12	-0.06	0.32	0.97
DC12	-0.04	0.32	0.92
HDIV	-0.08	-0.23	-0.75
DV12	-0.16	0.03	0.68
DV24	-0.34	0.02	0.65
RVOR	1.54	2.31	0.64
VSHD	18.85	13.02	-0.61
MLRH	61.94	70.25	0.58
CPRB	0.27	0.43	0.55

Table 2. Mean predictor values for developing and non-developing tropical disturbances from 2001-2010. "Dev-Non-Dev" is the difference between "developing" and "non-developing" values divided by the pooled standard deviation, and represents the distance between the group means in standard deviation units. Only the 12 predictors with the largest absolute difference between developing and non-developing sample means are shown.

b. Presented Year-1 results at IHC

Results from the first half of Year-1 were presented at the 66th Interdepartmental Hurricane Conference on 5-8 May 2012 in Charleston, SC. The online presentation can be found at http://www.ofcm.gov/ihc12/Presentations/02a-Session/08-dunion_tcgi_2012.pdf.

3. Plans for Year 2:

With the completion of the TCGI predictor database, sensitivity testing for optimal combination of TCGI predictors outlined in Table 1 has now begun. Code is currently being written to process the data from the newly created file (see Sec. 2a) that contains both genesis and non-genesis cases for the period 2001-2010 so that average predictor magnitudes can be computed for the 0-24-h, 24-48-h, 48-72-h, 72-96-h, 96-120-h, 0-48-h, and 0-120-h time increments in preparation for the development of a TCGI for the 0-48 and 0-120-h lead times. To accomplish this, statistical tests will be performed to identify the predictors for which statistically significant differences in the mean predictor magnitudes exist between the genesis and non-genesis samples. Those predictors for which statistically significant differences are found to exist at the 95% level based upon a 2-sided t-test will then be fed into a modified version of the code that is currently used to derive the SHIPS Rapid Intensification Index. This code utilizes algorithms that are based upon the method of linear discriminant analysis to determine the optimal set of predictors to use for the new TCGI that is being developed to provide estimates of the probability of a system undergoing genesis during the 0-48-h and 0-120-h time periods. This element of the proposed effort will be followed by the sequence of Year-2 efforts listed below:

June-Nov 2012	Begin sensitivity testing for optimal combination of TCGI predictors (0-48h & 0-120h)
Dec 2012	Develop code for running real-time TCGI (0-48h and 0-120h)
March 2013	Present Year-2 results at IHC
June-Aug 2013	Perform real-time tests of TCGI (0-48h and 0-120h) either on NESDS computers at CIRA with output being made available via an ftp site or on JHT computers
Aug 2013	Final TCGI code for computing new TC genesis scheme will be made available and could be installed on the IBM as part of operational SHIPS/LGEM guidance suite.