Development of a Probabilistic Tropical Cyclone Genesis Prediction Scheme

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NHC Points of Contact: Robbie Berg, Dan Brown, John Cangialosi, & Chris Landsea

Discussion Outline

Motivation

- Explore utility of an objective, disturbance-centric scheme for identifying the probability of TC genesis for the NATL;
- Credit NHC's visiting scientist program & a quiet night in the tropical NATL

NHC's Tropical Weather Outlook (TWO)

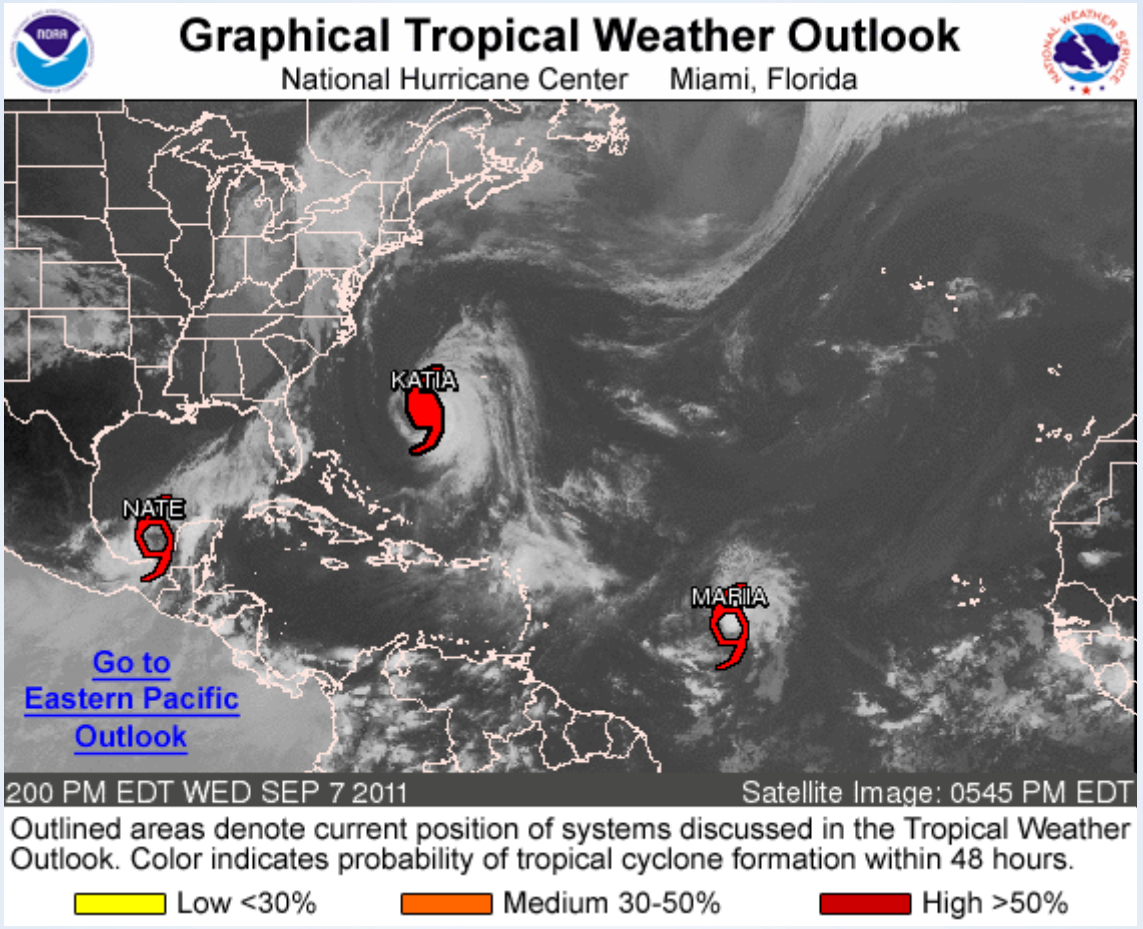
Tropical Cyclone Genesis Index (TCGI*)

- Year-1 efforts (completed)
- Year-2 efforts (ongoing and upcoming)
- Preliminary Results

Conclusions & Future Work

* 1st Runner-up: **G**enesis **o**f **N**ascent **F**orming **S**torms and **H**urrica**n**es (GoNFSHn)

NHC's Tropical Weather Outlook



- Highlight areas of disturbed weather & the potential for TC genesis (0-48 hr);
- 0-120 hr currently produced "in house" ("public": summer 2013);
- "Middle ground" probabilities (~40-70%): most challenging;
- Semi-subjective process: limited objective tools for providing guidance;

Timeline: Year-1
(Completed Tasks)

Feb 2012:

- Complete identification/development of genesis predictors into the TCGI database (CIRA TCFP/SHIPS/Rapid Intensity Index);
- 60 potential predictors for testing (0-48 hr and 0-120 hr);

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;
- Develop a complete, continuous "Invest Best track" from a 10-yr Dvorak dataset: TAFB Dvorak fixes/Interpolation/Special BAMM);

Timeline: Year-2

June-Nov 2012 (nearing completion):

- Begin sensitivity testing for optimal combination of TCGI predictors (0-48h & 0-120h);
- Utilize RI Index methodologies (Kaplan et al.)

Dec 2012 (ongoing):

- Develop code for running TCGI in real-time (0-48 h and 0-120 h);

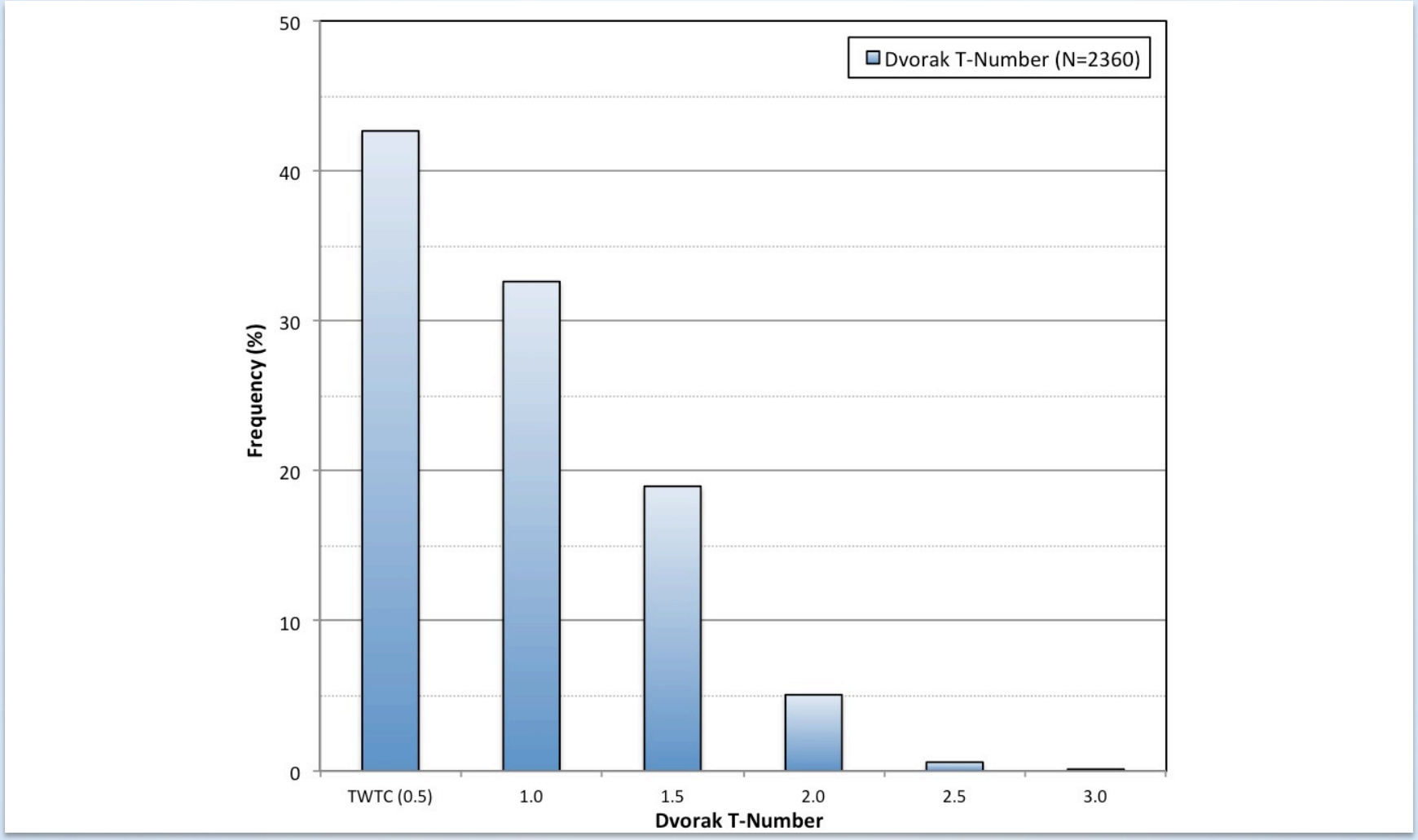
Jun-Aug 2013 (upcoming):

- TCGI real-time tests (0-48 and 0-120 h);
- Utilize NESDIS computers at CIRA (output via ftp site) or JHT computers;

Aug 2013 (upcoming):

- Final TCGI code will be made available;
- Possible installation on the IBM >> operational SHIPS/LGEM guidance suite (if project is accepted);

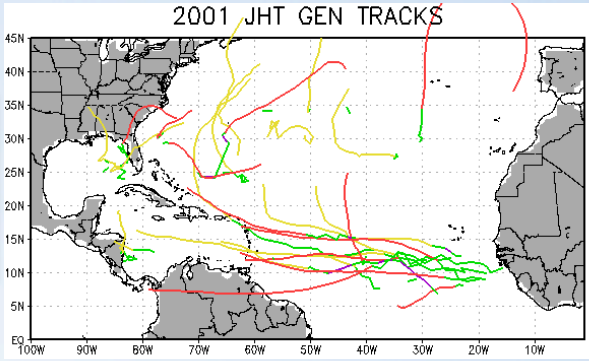
TC Genesis Index (TCGI)
TAFB Dvorak Fixes: Pre-Genesis Locations

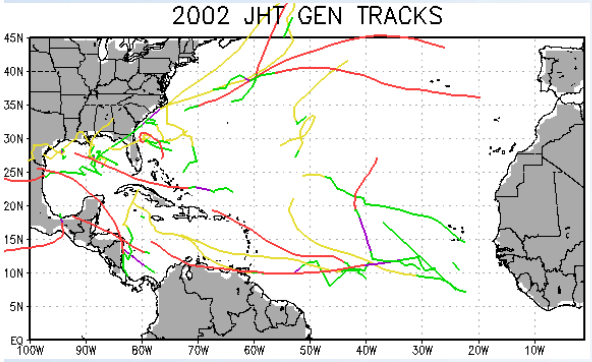


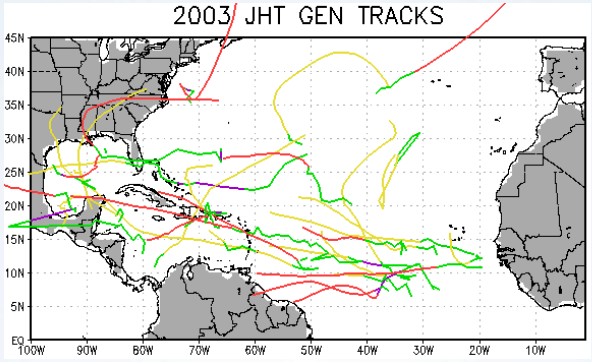
TC Genesis Index

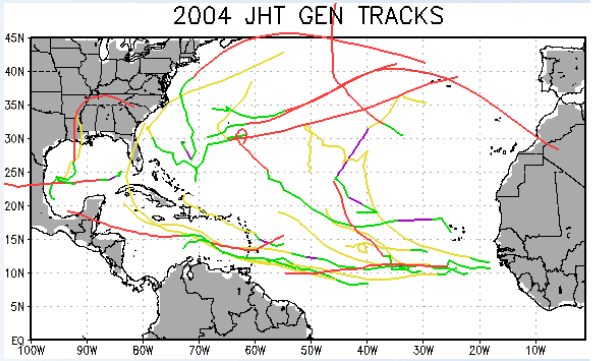
Invest Tracks (2001-2010)

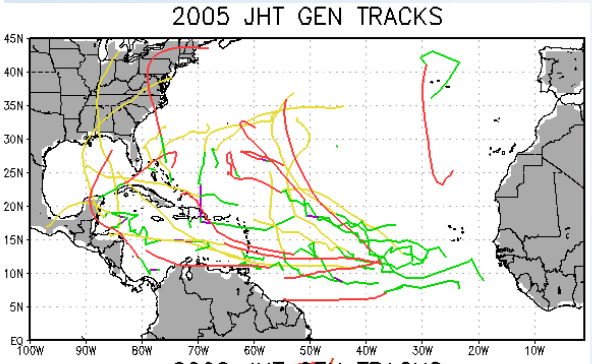
- Dvorak Fixes
- Interpolation
- Best track (post-gen)
- Special BAMM

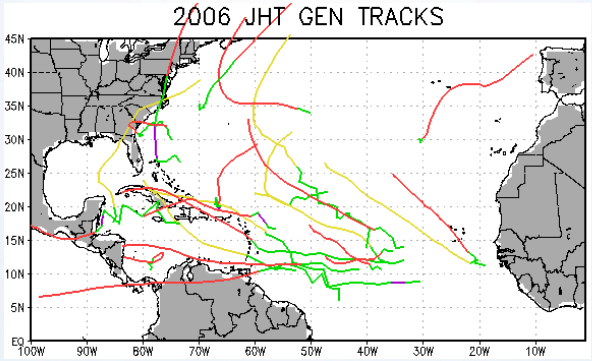


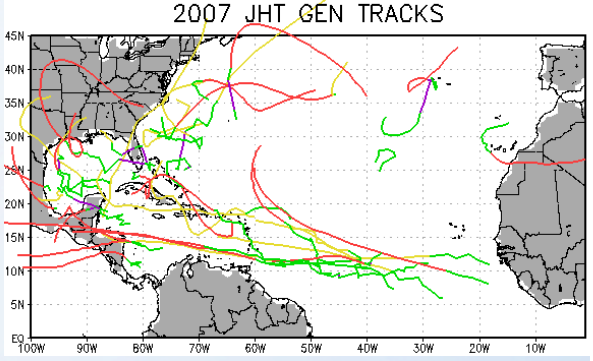


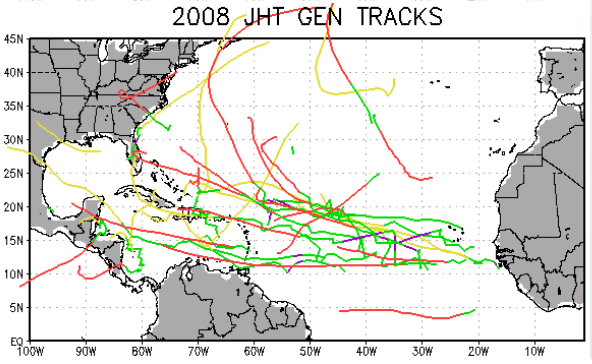


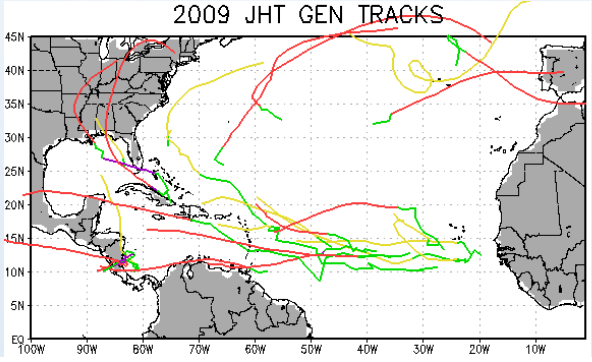


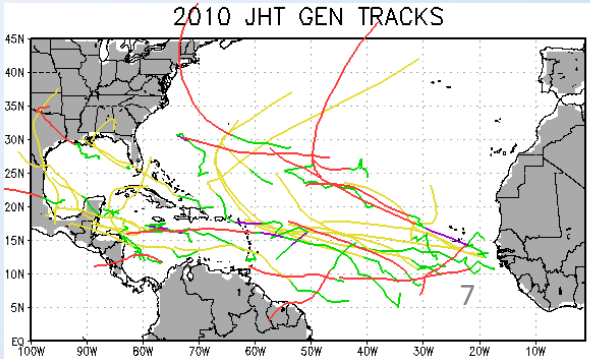












TC Genesis Index (TCGI)
Predictor Development

Methodology (Kaplan et al. 2010, RI Index)

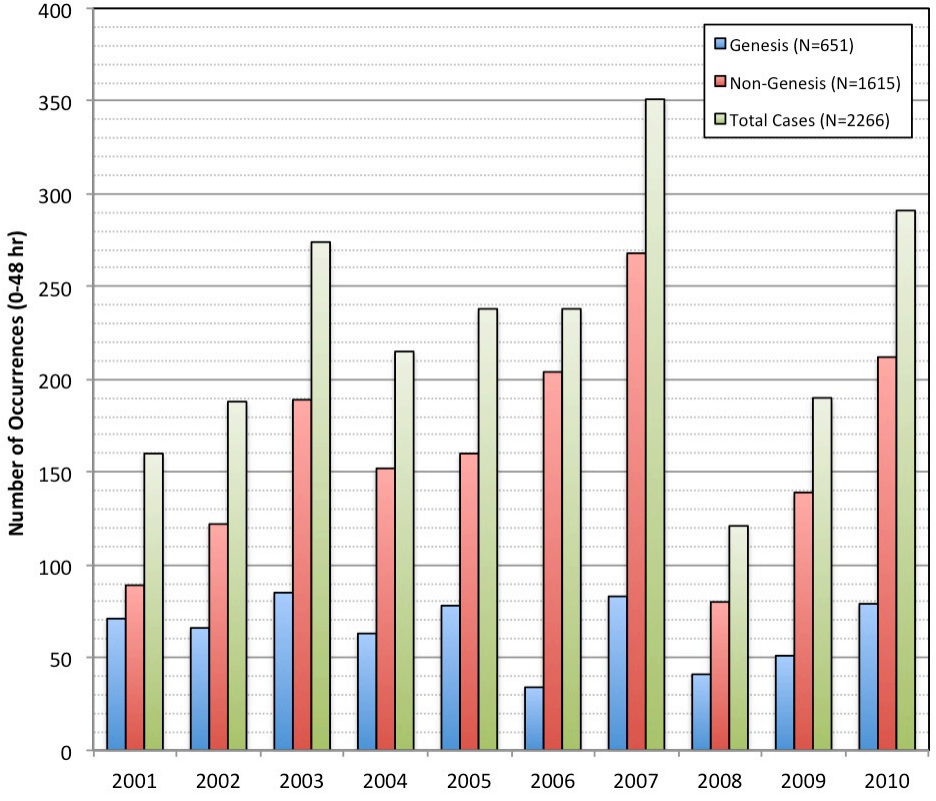
1. Examine potential TCGI predictors (60 total);

2. Predictor Selection: significant at the 99.9% level;

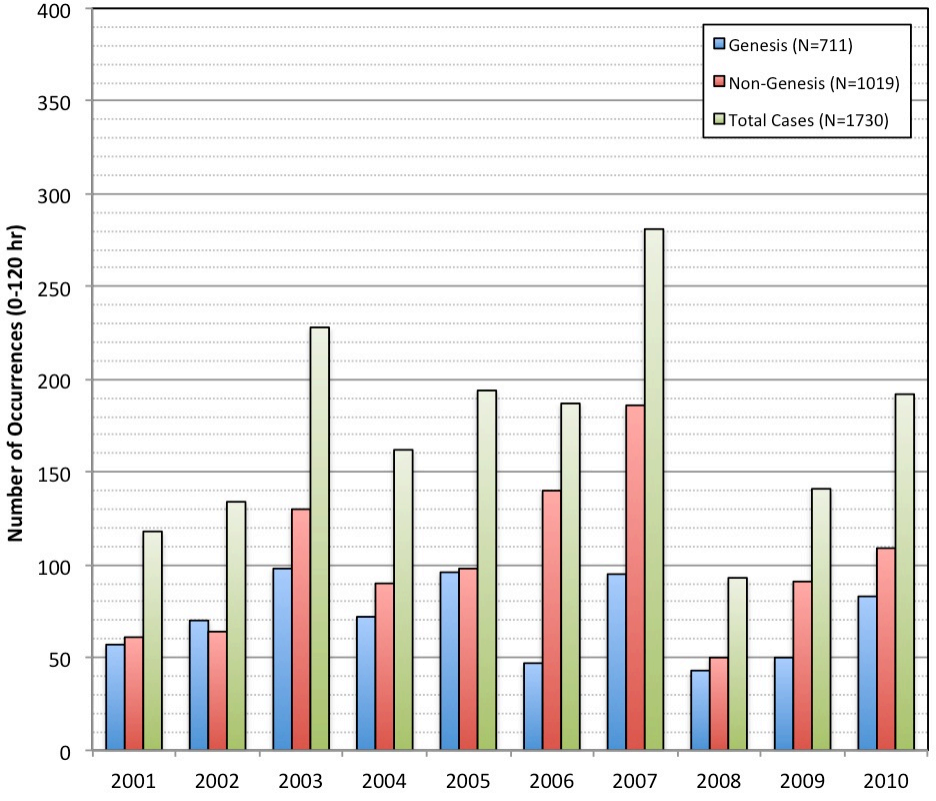
3. Magnitude of each predictor >> evaluated for (0-48h & 0-120h) for all 2001-2010 cases;

4. Sensitivity tests >> determine which combination of predictors yields the most skillful genesis forecasts
   - 0-48 h and 0-120 h;
   - linear discriminant analysis;

TC Genesis Index (TCGI)
2001-2010 Genesis vs Non-Genesis

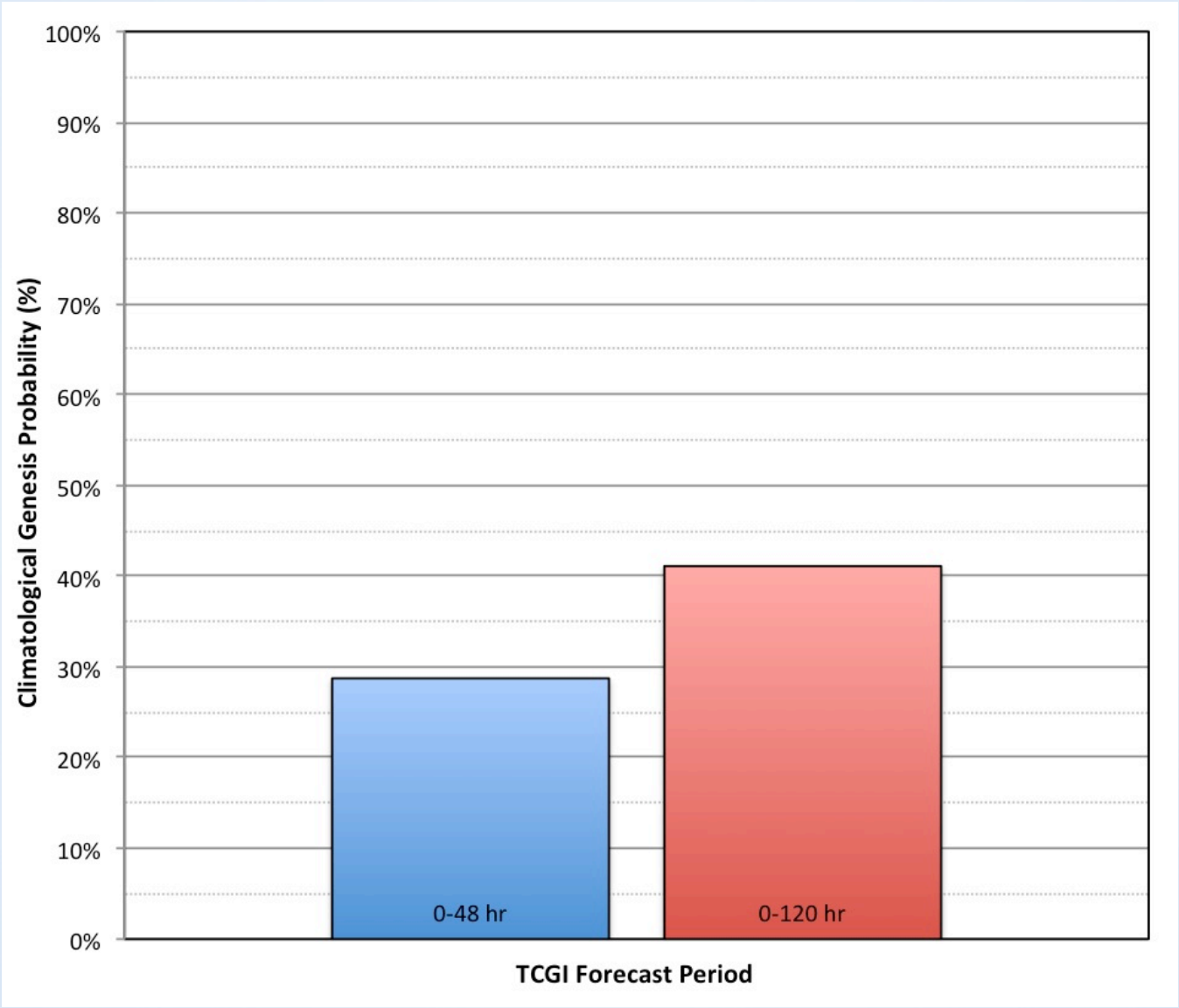


TCGI (0-48 hr)

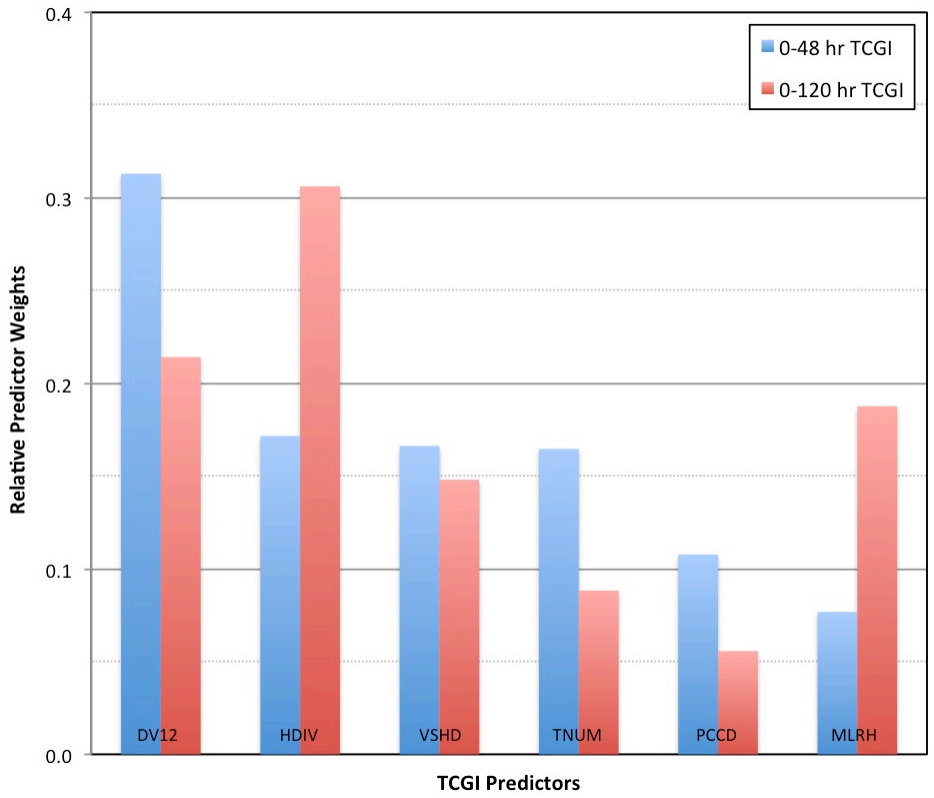


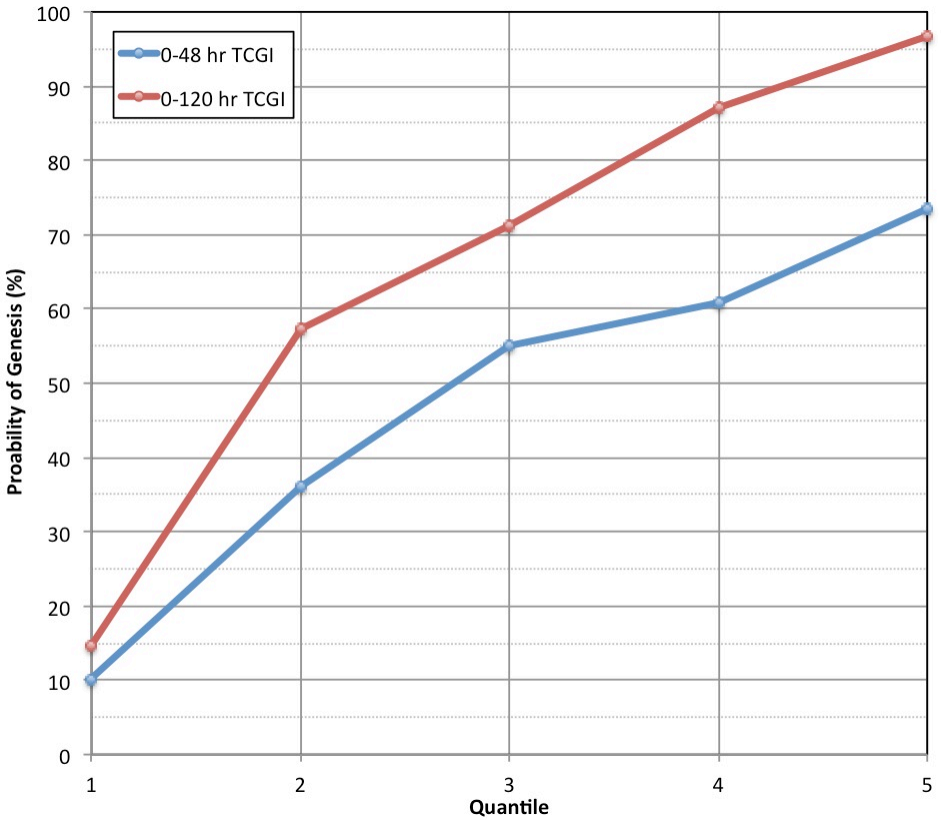
TCGI (0-120 hr)

TC Genesis Index (TCGI)
2001-2010 Invest Genesis Probabilities



TC Genesis Index (TCGI)
Predictors/Probabilities/FAR





DV12: GFS 12-hr Vortex Tendency (t=+12hr – t=0hr; 0-500 km)

HDIV: 850 hPa Divergence (0-500 km)

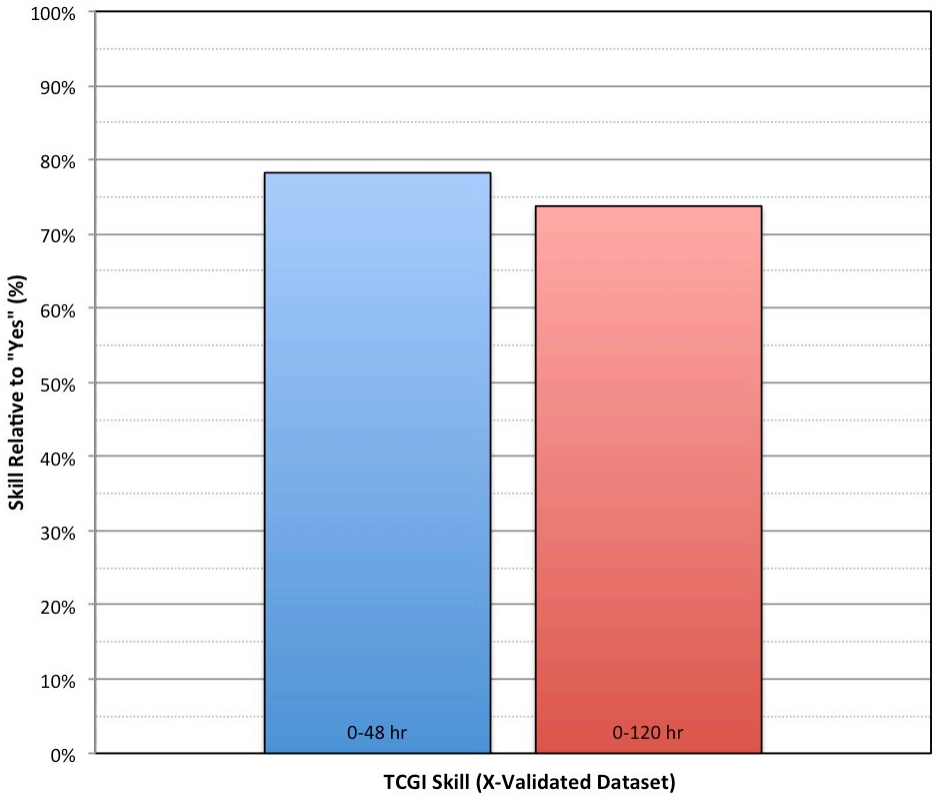
VSHD: 200-850 hPa Vertical Wind Shear (0-500 km; Vortex Removed)

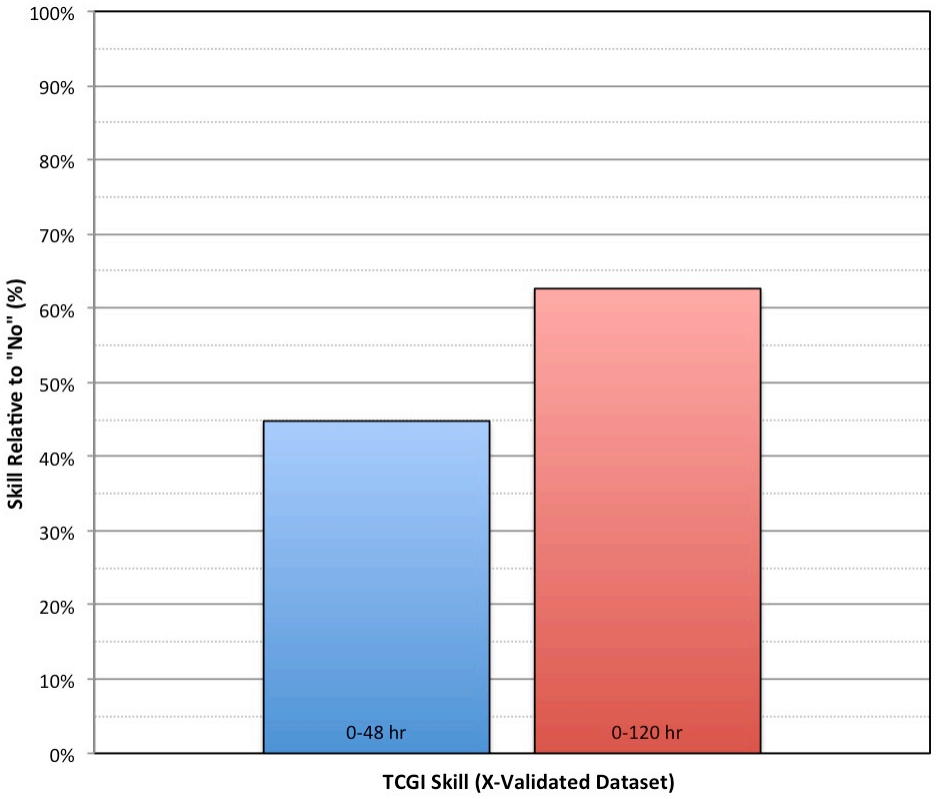
TNUM: Dvorak T-Number (t=0hr)

PCCD: GOES Cold Cloud (<-40 C) Pixel Coverage (R=0-500 km)

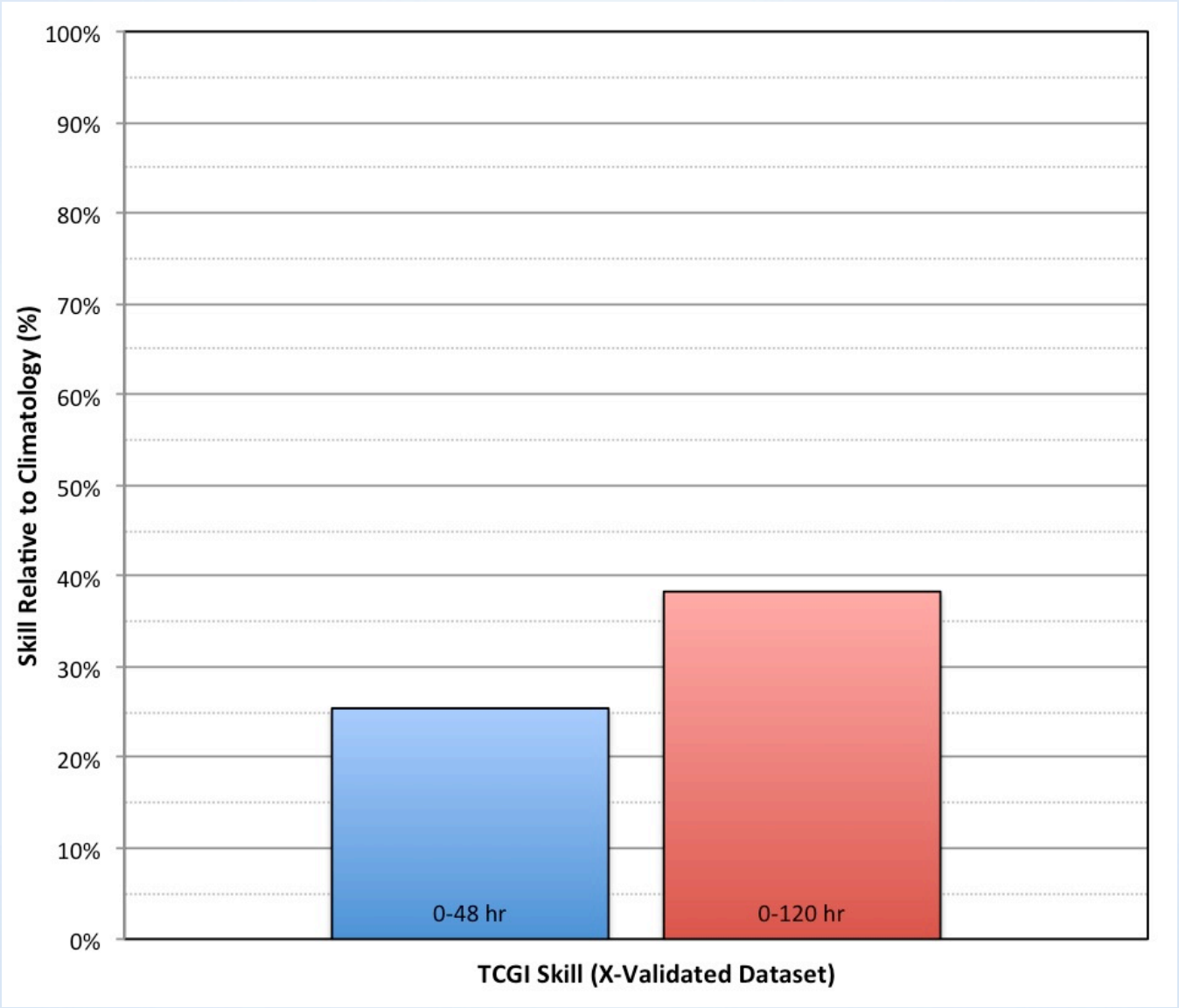
MLRH: 600-mb RH (R=0-500 km)

TC Genesis Index (TCGI)
Skill Relative to "Yes" and "No"





TC Genesis Index (TCGI)
Skill Relative to Climatology



TC Genesis Index (TCGI)

Possible Output Format

* ATLANTIC SHIPS INTENSITY FORECAST *
* GOES AVAILABLE, OHC AVAILABLE *
* INVEST AL972012 08/20/12 12 UTC *

TIME (HR)	0	6	12	18	24	36	48	60	72	84	96	108	120
V (KT) NO LAND	30	34	38	43	48	58	69	80	86	87	89	92	90
V (KT) LAND	30	34	38	43	48	58	69	62	43	43	45	48	46

** 2012 ATLANTIC TCGI AL972012 INVEST 08/20/12 12 UTC **

850 MB DVG (10**-7s-1):	0.3	Range:-0.87 to	0.5	Scaled/Wgted Val:	0.8/ 2.4
12-HR VORTEX TENDENCY :	0.6	Range:-1.23 to	0.8	Scaled/Wgted Val:	1.1/ 2.3
850-200 MB SHEAR (KT) :	5.7	Range: 26.2 to	3.2	Scaled/Wgted Val:	0.9/ 1.7
600 MB RH :	50.5	Range: 12.5 to	89.6	Scaled/Wgted Val:	0.6/ 0.7
% <-40C GOES IR PIXELS:	70	Range: 0.0 to	99.9	Scaled/Wgted Val:	0.8/ 1.2
DVORAK T-NUM :	1.0	Range: 0.5 to	2.5	Scaled/Wgted Val:	0.7/ 2.2

Prob of Genesis (0-48 hr) = 70% is 2.5 times the sample mean (28%)
Prob of Genesis (0-120 hr) = 90% is 2.2 times the sample mean (41%)

LAT (DEG N)	14.3	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x	xx.x
LONG(DEG W)	54.9	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x	xxx.x
STM SPEED (KT)	18	18	18	18	16	13	11	10	10	10	9	8	7
HEAT CONTENT	68	76	66	70	81	70	69	84	77	56	23	48	33

FORECAST TRACK FROM OFPI INITIAL HEADING/SPEED (DEG/KT):275/ 18 CX,CY: -17/ 2
T-12 MAX WIND: 25 PRESSURE OF STEERING LEVEL (MB): 604 (MEAN=623)
GOES IR BRIGHTNESS TEMP. STD DEV. 50-200 KM RAD: 20.9 (MEAN=14.5)
% GOES IR PIXELS WITH T < -20 C 50-200 KM RAD: 71.0 (MEAN=65.0)

Conclusions & Future Work

TC Genesis Index (TCGI)

- Disturbance-centric/objective/probabilistic
- 0-48 hr and 0-120 hr forecasts
- 60 predictors were evaluated
- 6-predictor prototype scheme has been developed
- Skill (relative to climatology): ~25% (0-48 hr); ~42% (0-120 hr)

Year-1 Efforts: completed

- Development of Dvorak "Invest Best track" & TCGI predictors

Year-2 Efforts: on-going

- Testing optimal combination of TCGI predictors: nearing completion
- Real-time code development: beginning
- TCGI real-time tests (0-48 and 0-120 h): June-Aug 2013

Future Direction

- Microwave imagery (e.g. 37 & 85 GHz)
- Ensemble model information
- Automated scheme for identifying Invests
- Expand TCGI to other basins