Online appendix B to

Experimental Ensemble Forecast Products for Hurricanes

by

Thomas M. Hamill[1], Michael J. Brennan[4], Barbara Brown[2], Mark DeMaria[3], Edward N. Rappaport[4], and Zoltan Toth[5]

[1] *NOAA Earth System Research Lab, Physical Sciences Division, Boulder, Colorado*

[2] *NCAR, Research Applications Lab, Boulder, Colorado*

[3] *NOAA NESDIS, Ft. Collins, Colorado*

[4] *National Hurricane Center, Miami, Florida*

[5] *NOAA Earth System Research Lab, Global Systems Division, Boulder, Colorado*

This appendix provides examples of probabilistic guidance products available to the US National Hurricane Center forecasters.

Satellite and GFS analysis based genesis probabilities

The Cooperative Institute for Research in the Atmosphere (CIRA) developed a product to estimate probabilities of tropical cyclogenesis in the 0-24 hour time frame in the Atlantic and eastern North Pacific basins. The product is based on the following input parameters: cold infrared channel cloud top coverage and water vapor brightness temperature from geostationary satellite; analyzed atmospheric parameters from the GFS model including 850-200 hPa vertical wind shear, vertical instability, and 850-hPa circulation; climatology, and proximity to land and other active TCs. This product is available to NHC forecasters via the Internet on a 5° x 5° grid. The product is run by NESDIS operations, and is being upgraded to extend to 48 h and longer time intervals.

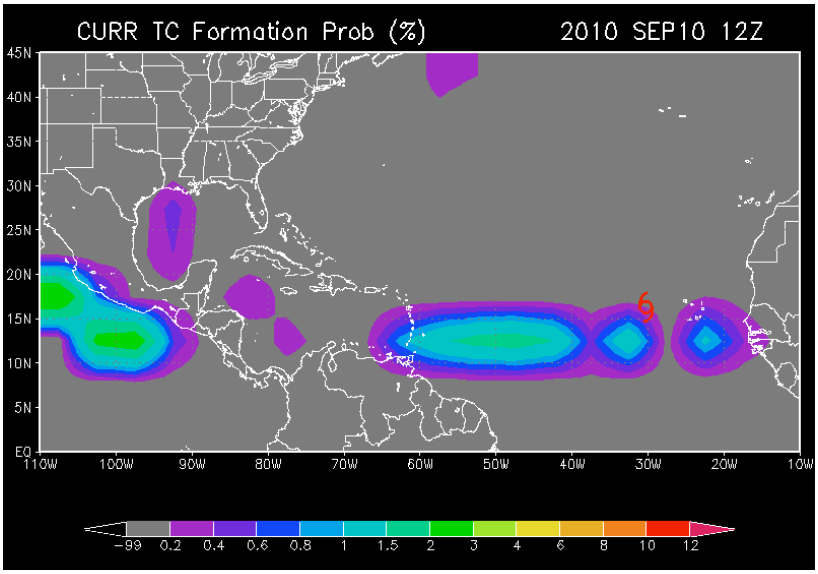

Figure B1. Tropical cyclone formation probability (shaded) for the Atlantic basin during the 48-h period beginning at 1200 UTC 10 September 2010. The position of Tropical Storm Igor is indicated by the tropical storm symbol.

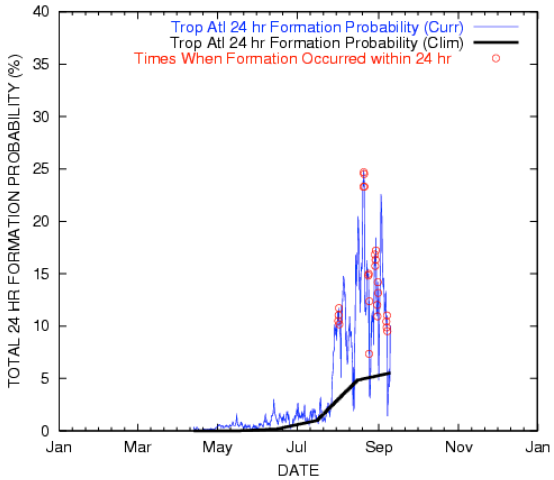

Figure B2. Climatological (black line) and current (blue line) 24-h tropical cyclone formation probabilities for the Tropical Atlantic sub-basin through 10 September 2010. Times when tropical cyclone formation occurred with 24 hours are indicated by red circles.

Goerss Predicted Consensus Error (GPCE)

GPCE estimates track error based on the spread of the members of the multi-model TVCN track consensus, which is currently composed of at least two of the following TC track models: GFS, ECMWF, UKMET, NOGAPS, HWRF, GFDL, and GFDN. The dominant predictors include the spread of the TVCN members around the consensus along with initial and forecast TC intensity. GPCE is designed so that the verifying position of the TC at the forecast valid time will be inside the GPCE circle about 70% of the time. GPCE provides NHC forecasters with an objective measure of confidence of consensus track forecast, and is depicted by circles of varying radius when NHC forecasters prepare their track forecast in real-time on the Automated Tropical Cyclone Forecast (ATCF) System workstations.

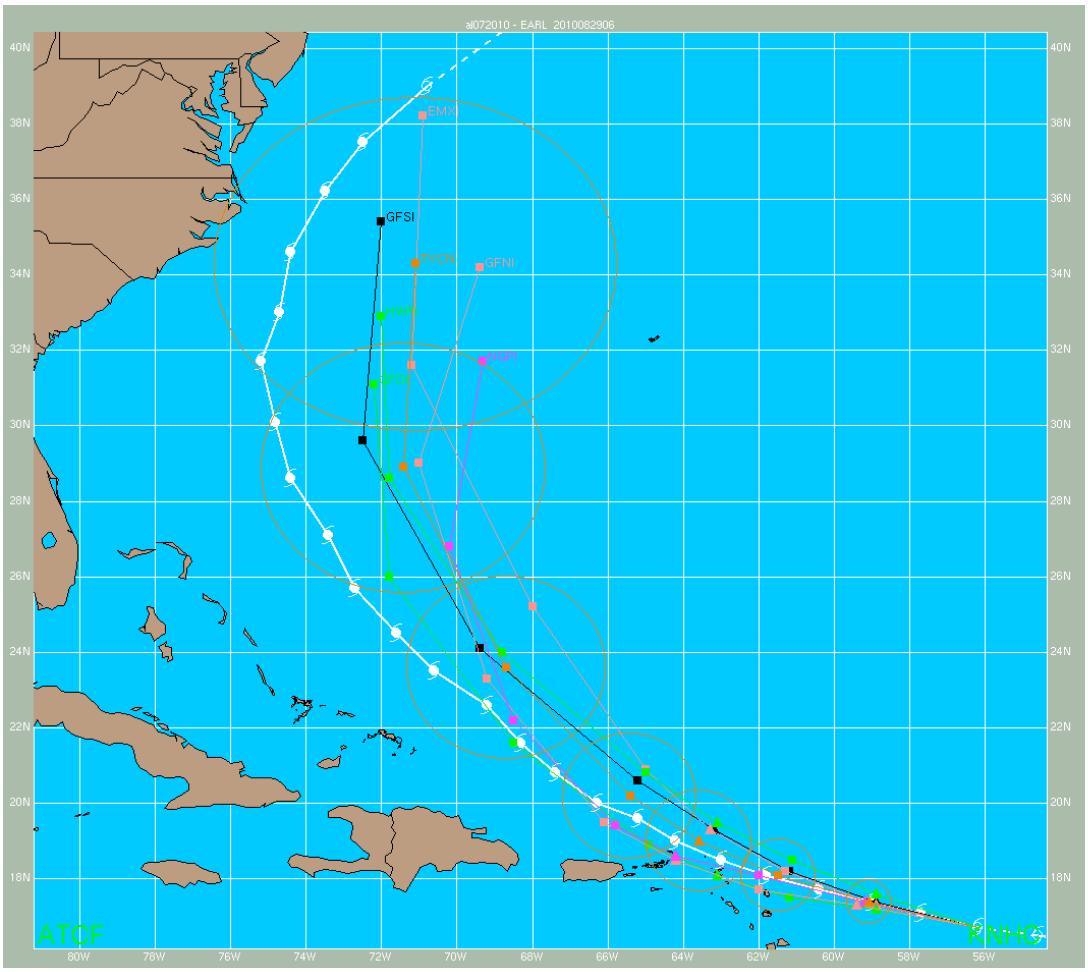

Figure B3. GPCE circles and TVCN consensus model members for Hurricane Earl for the 0600 UTC 29 August 2010 forecast cycle. The track of Earl recorded operationally is indicated by the white line. Forecast points and associated GPCE circles shown for the 12, 24, 36, 48, 72, 96 and 120 periods.

Ensembles (fields and ATCF trackers)

NHC receives ensemble prediction system output from the GEFS, ECMWF, and CMC ensemble systems. This output includes ensemble mean and spread fields, low cluster plots, "spaghetti" diagrams and model trackers for display in ATCF.

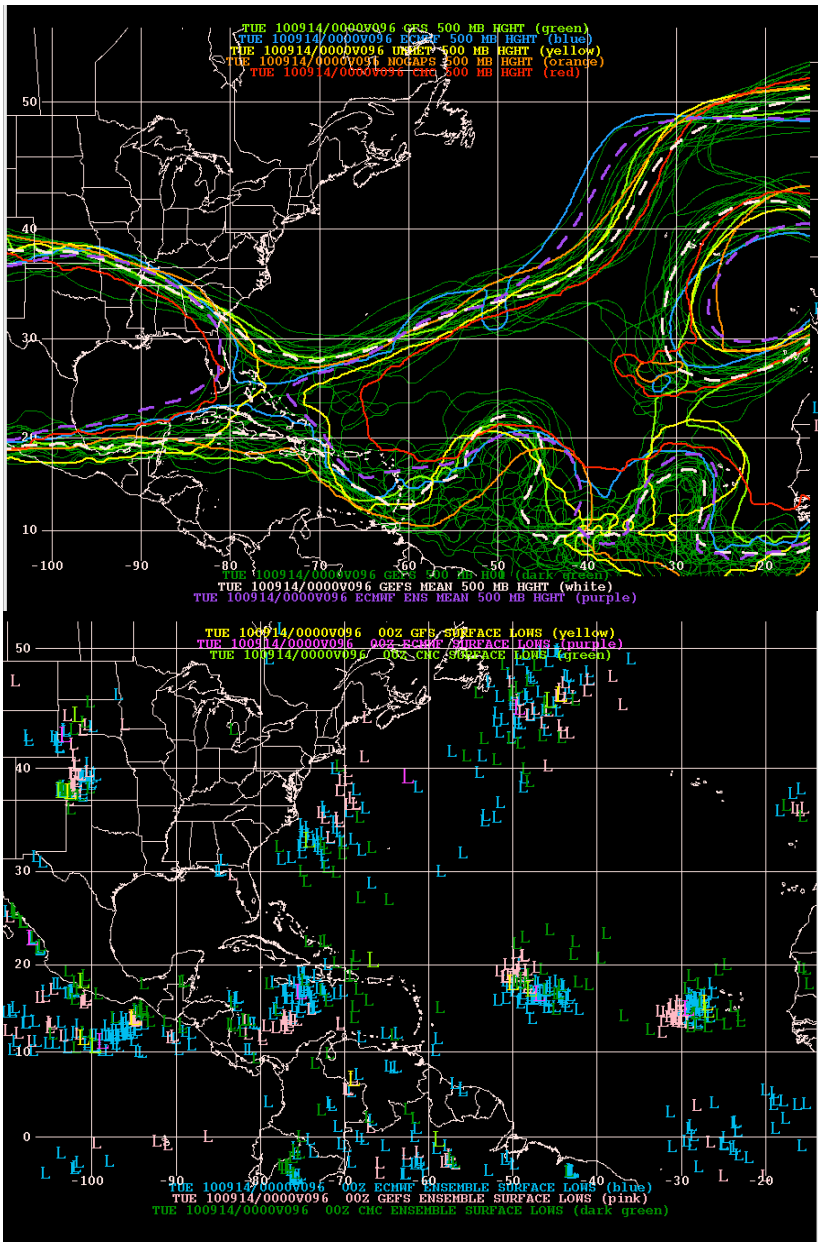

Figure B4. Ensemble output from the 0000 UTC cycle on 10 September 2010 showing 5880-m 500-hPa geopotential height contour (top) and surface low clusters (bottom) from a variety of deterministic and ensemble model system output valid at 0000 UTC 14 September 2010.

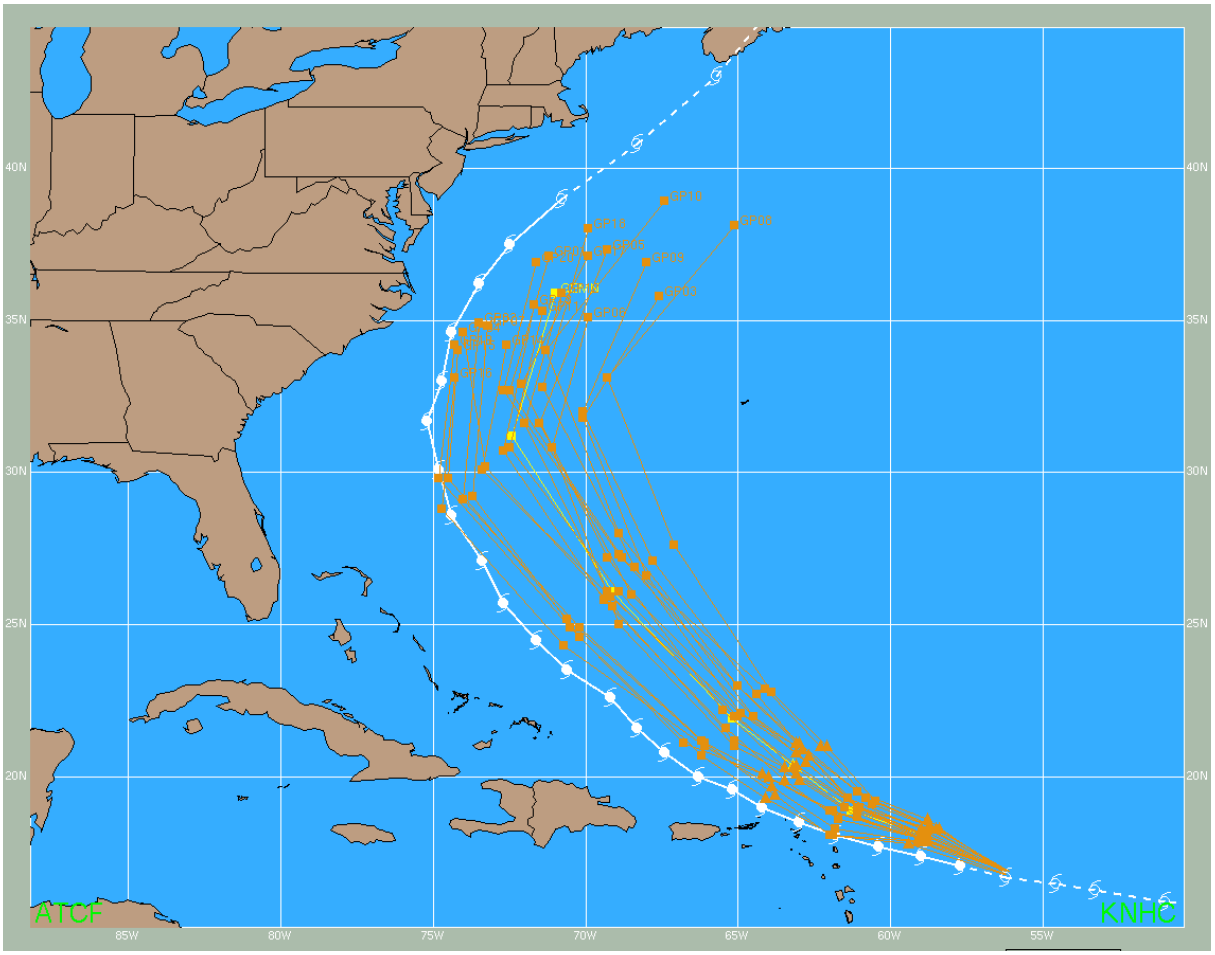

Figure B5. GEFS ensemble members (orange lines) and ensemble mean (yellow line, partially hidden) for Hurricane Earl for the 0600 UTC 29 August 2010 forecast cycle. The track of Earl recorded operationally is indicated by the white line.

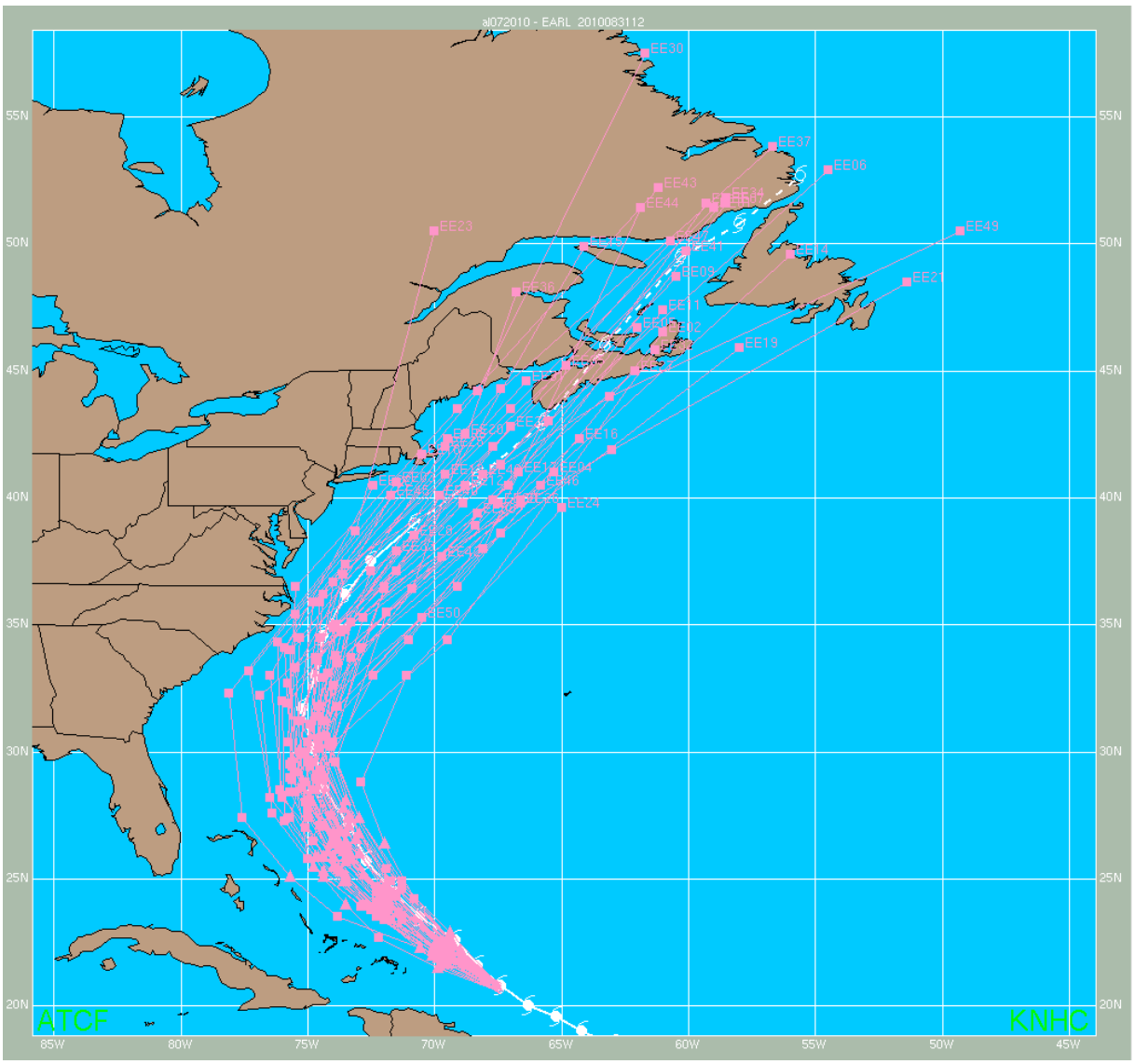

Figure B6. ECMWF ensemble members (pink lines) for Hurricane Earl for the 1200 UTC 31 August 2010 forecast cycle. The track of Earl recorded operationally is indicated by the white line.

SHIPS Rapid Intensification Index

The SHIPS Rapid Intensification (RI) Index provides statistical guidance for rapid intensification, with thresholds of 25, 30, 35, and 40-kt intensity increase in the next 24 hours. The SHIPS RI index uses a discriminant analysis technique with eight predictors that include characteristics of the TC itself, satellite data, and the analyses of atmospheric and oceanic variables:

1) Previous 12-hour intensity chance of the TC
2) Difference between the current intensity of the TC and its Maximum Potential Intensity
3) 200-hPa divergence
4) 850-200 hPa vertical wind shear
5) 850-700 hPa relative humidity
6) Upper-ocean heat content
7) Standard deviation of IR brightness temperature (convective symmetry)
8) Coverage of cloud tops with brightness temperatures < -30°C

```
          ** 2010 ATLANTIC RI INDEX AL072010       EARL 08/31/10  18 UTC **
                   ( 30 KT OR MORE MAX WIND INCREASE IN NEXT 24 HR)

 12 HR PERSISTENCE (KT):   0.0 Range:-45.0 to  30.0 Scaled/Wgted Val:  0.6/  1.3
 850-200 MB SHEAR (KT) :  14.3 Range: 26.2 to   3.2 Scaled/Wgted Val:  0.5/  0.6
 D200 (10**7s-1)       :  76.8 Range:-21.0 to 140.0 Scaled/Wgted Val:  0.6/  0.9
 POT = MPI-VMAX (KT)   :  39.6 Range: 33.5 to 126.5 Scaled/Wgted Val:  0.1/  0.0
 850-700 MB REL HUM (%):  61.2 Range: 56.0 to  85.0 Scaled/Wgted Val:  0.2/  0.1
 % area w/pixels <-30 C: 100.0 Range: 17.0 to 100.0 Scaled/Wgted Val:  1.0/  0.1
 STD DEV OF IR BR TEMP :   5.6 Range: 30.6 to   3.2 Scaled/Wgted Val:  0.9/  1.5
 Heat content (KJ/cm2) :  67.4 Range:  0.0 to 130.0 Scaled/Wgted Val:  0.5/  0.0

 Prob of RI for 25 kt RI threshold=    22% is   1.8 times the sample mean(12.6%)
 Prob of RI for 30 kt RI threshold=    18% is   2.2 times the sample mean( 8.1%)
 Prob of RI for 35 kt RI threshold=    15% is   3.1 times the sample mean( 4.8%)
 Prob of RI for 40 kt RI threshold=     1% is   0.3 times the sample mean( 3.4%)
```

Table B1. Output of the 2010 Atlantic SHIPS RI index for Hurricane Earl for the 24-h period beginning at 1800 UTC 31 August 2010.