Joint Hurricane Testbed: Mid-year Progress Report, Year 2

Objective and Automated Assessment of Operational Global Forecast Model predictions of Tropical Cyclone Formation and Life Cycle

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TASK: Integration into NMAP2 for eventual operational use at the National Hurricane Center (NHC)

BACKGROUND: One of the primary results from an initial meeting at NHC was the need to have the output of the tropical cyclone vortex tracking program (TCVTP) integrated into the NMAP2 display system that is used operationally at NHC. There are two primary components to the TCVTP output system. One is the day-to-day tracking and catalog of tropical vortex characteristics in each operational global forecast model. It is this component that should be integrated into NMAP2 such that Hurricane Specialists may monitor daily tropical vortex activity in the context of analyzed and forecast tracks. The second output component is the statistical analysis of the catalog produced by the day-to-day operation of the TCVTP system. As the TCVTP data base expands throughout a period of time (i.e., season, month, etc.), then the statistical analyses will be applied to broadcast model performance traits associated with several tropical vortex characteristics.

PROGRESS: This task has essentially been completed as a test integration into NMAP2 was performed at the Naval Postgraduate School (NPS). For integration into NMAP2, several modifications to the NMAP2 table definition structures were made. These were transferred to NHC where they were tested in the NHC NMAP system. The tests were successful pending some minor corrections to visual characteristics. An example of the NMAP2 displays (Fig. 1) illustrates the identification and forecasts of tropical vortices that exist in the current analyses (red) and are forecast to occur during the current model (GFS) integration (green tracks with a forecast label).

Testing of the TCVTP system at NPS has been facilitated by transfer of operational global model fields that are used at NHC to NPS via DVDs. This has provided tests to be conducted on the exact same data sets that are received at NHC.

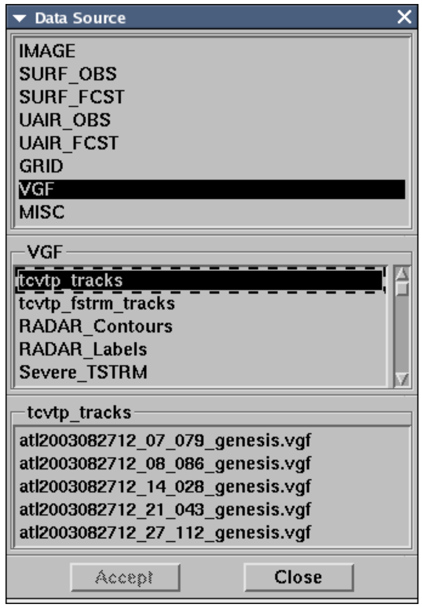


Fig. 1a Display of the NMAP2 data source table in which the names of all vortices that exist in the current GFS model analysis are listed.

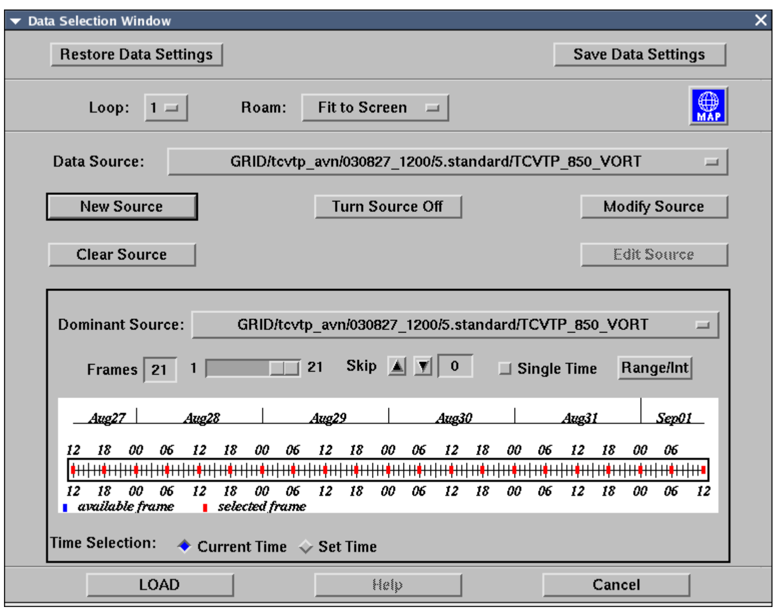


Fig. 1b Display of the Data Selection Window in NMAP2 that identifies the number of forecast fields available for display. For each forecast interval, the forecast 850-hPa winds and relative vorticity fields are plotted with the vortex track (see Fig. 1c)

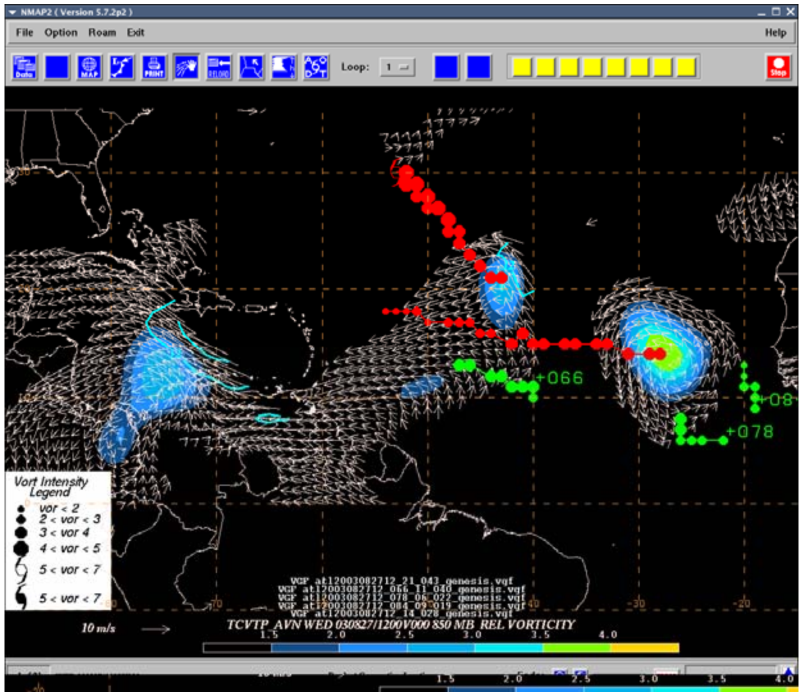


Fig. 1c A NMAP2 display of the 850-hPa winds, relative vorticity (shaded) and tracks of vortices that exist in the current analysis (in red) and those that are forecast to occur (in green). The numbers associated with the green tracks identify the forecast interval in which the vortex is forecast to appear. Winds are only displayed where relative vorticity is cyclonic.

Other tasks that resulted from meetings at NHC include specification of a set of criteria to be used to identify when the model representation of a tropical vortex as evolved into a tropical cyclone. This will allow a more strict tabulation of false alarms, missed forecasts and timing errors associated with forecast tropical cyclone formation. These criteria are built into the catalog procedure such that the display will reflect that the model vortex has evolved into a tropical cyclone. The current list of criteria is contained in Table 1. These have been evaluated during the 2004 tropical cyclone season and will continue to be evaluated during the 2005 season.

Table 1. A set of criteria to identify when a tropical vortex in an operational global forecast model has evolved into a tropical cyclone.

One degree temperature anomaly at 500 hPa
Presence of a closed mean sea-level pressure isobar at a 4 hPa interval
An 850-250 hPa thickness value that is equivalent to a temperature anomaly of 0.5^{o}C
A relative vorticity maximum at either 700 hPa or 600 hPa.

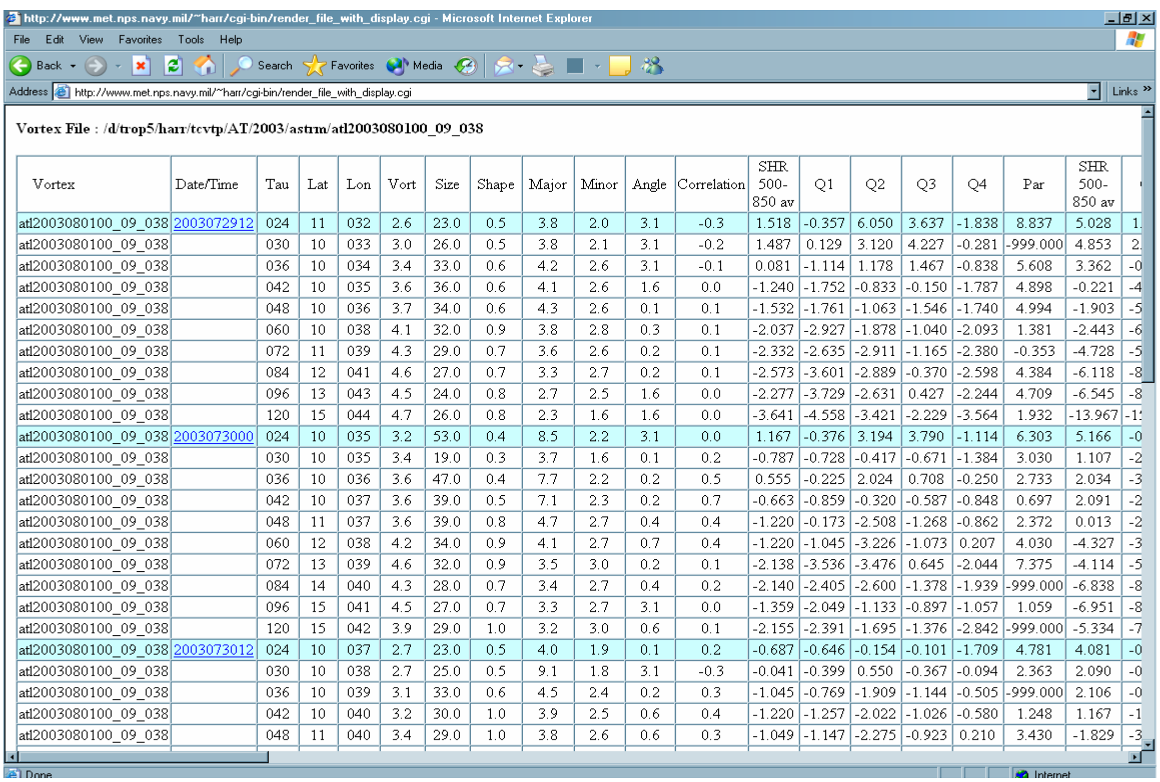
In the test configuration of the TCVTP at NPS, input data consist of GRIB formatted fields for GFS and NOGAPS data that were received at the Naval Postgraduate School (NPS). This has been changed to utilize model fields in GEMPAK format as received operationally at NHC. Table 2 identifies all of the variables extracted from the GEMPAK files.

Table 2. Analyzed and forecast quantities used to identify physical characteristics associated with each circulation. Ellipse-average values are computed along with quadrant (defined by ellipse major and minor axes) averages. Also, relative maxima or minima are recorded if they exist.

850 hPa relative vorticity	Sea-level pressure
Shallow vertical wind shear (500-850 hPa)	Deep vertical wind shear (200-850 hPa)
850-250 hPa geopotential height thickness	1000-500 hPa temperature difference
Vertical motion	Total precipitation
700-400 hPa Vapor pressure	500 hPa temperature difference between the area inside the ellipse and outside the ellipse
Latent Heat Flux	

TASK: Statistical analysis of TCVTP data bases.

TCVTP writes to two data bases that change with each model time. The data assigned to all vortices forecast to begin (i.e. do not exist in the current analysis) during the current model integration are written to the Forecast Data Base. Here, the data wait



Vortex File : /d/trop5/harr/tcvtp/AT/2003/astrm/atl2003080100_09_038

Vortex	Date/Time	Tau	Lat	Lon	Vort	Size	Shape	Major	Minor	Angle	Correlation	SHR 500-850 av	Q1	Q2	Q3	Q4	Par	SHR 500-850 av	
atl2003080100_09_038	2003072912	024	11	032	2.6	23.0	0.5	3.8	2.0	3.1	-0.3	1.518	-0.357	6.050	3.637	-1.838	8.837	5.028	1.
atl2003080100_09_038		030	10	033	3.0	26.0	0.5	3.8	2.1	3.1	-0.2	1.487	0.129	3.120	4.227	-0.281	-999.000	4.853	2.
atl2003080100_09_038		036	10	034	3.4	33.0	0.6	4.2	2.6	3.1	-0.1	0.081	-1.114	1.178	1.467	-0.838	5.608	3.362	-0
atl2003080100_09_038		042	10	035	3.6	36.0	0.6	4.1	2.6	1.6	0.0	-1.240	-1.752	-0.833	-0.150	-1.787	4.898	-0.221	-4
atl2003080100_09_038		048	10	036	3.7	34.0	0.6	4.3	2.6	0.1	0.1	-1.532	-1.761	-1.063	-1.546	-1.740	4.994	-1.903	-5
atl2003080100_09_038		060	10	038	4.1	32.0	0.9	3.8	2.8	0.3	0.1	-2.037	-2.927	-1.878	-1.040	-2.093	1.381	-2.443	-6
atl2003080100_09_038		072	11	039	4.3	29.0	0.7	3.6	2.6	0.2	0.1	-2.332	-2.635	-2.911	-1.165	-2.380	-0.353	-4.728	-5
atl2003080100_09_038		084	12	041	4.6	27.0	0.7	3.3	2.7	0.2	0.1	-2.573	-3.601	-2.889	-0.370	-2.598	4.384	-6.118	-8
atl2003080100_09_038		096	13	043	4.5	24.0	0.8	2.7	2.5	1.6	0.0	-2.277	-3.729	-2.631	0.427	-2.244	4.709	-6.545	-8
atl2003080100_09_038		120	15	044	4.7	26.0	0.8	2.3	1.6	1.6	0.0	-3.641	-4.558	-3.421	-2.229	-3.564	1.932	-13.967	-1
atl2003080100_09_038	2003073000	024	10	035	3.2	53.0	0.4	8.5	2.2	3.1	0.0	1.167	-0.376	3.194	3.790	-1.114	6.303	5.166	-0
atl2003080100_09_038		030	10	035	3.4	19.0	0.3	3.7	1.6	0.1	0.2	-0.787	-0.728	-0.417	-0.671	-1.384	3.030	1.107	-2
atl2003080100_09_038		036	10	036	3.6	47.0	0.4	7.7	2.2	0.2	0.5	0.555	-0.225	2.024	0.708	-0.250	2.733	2.034	-3
atl2003080100_09_038		042	10	037	3.6	39.0	0.5	7.1	2.3	0.2	0.7	-0.663	-0.859	-0.320	-0.587	-0.848	0.697	2.091	-2
atl2003080100_09_038		048	11	037	3.6	39.0	0.8	4.7	2.7	0.4	0.4	-1.220	-0.173	-2.508	-1.268	-0.862	2.372	0.013	-2
atl2003080100_09_038		060	12	038	4.2	34.0	0.9	4.1	2.7	0.7	0.4	-1.220	-1.045	-3.226	-1.073	0.207	4.030	-4.327	-3
atl2003080100_09_038		072	13	039	4.6	32.0	0.9	3.5	3.0	0.2	0.1	-2.138	-3.536	-3.476	0.645	-2.044	7.375	-4.114	-5
atl2003080100_09_038		084	14	040	4.3	28.0	0.7	3.4	2.7	0.4	0.2	-2.140	-2.405	-2.600	-1.378	-1.939	-999.000	-6.838	-8
atl2003080100_09_038		096	15	041	4.5	27.0	0.7	3.3	2.7	3.1	0.0	-1.359	-2.049	-1.133	-0.897	-1.057	1.059	-6.951	-8
atl2003080100_09_038		120	15	042	3.9	29.0	1.0	3.2	3.0	0.6	0.1	-2.155	-2.391	-1.695	-1.376	-2.842	-999.000	-5.334	-7
atl2003080100_09_038	2003073012	024	10	037	2.7	23.0	0.5	4.0	1.9	0.1	0.2	-0.687	-0.646	-0.154	-0.101	-1.709	4.781	4.081	-0
atl2003080100_09_038		030	10	038	2.7	25.0	0.5	9.1	1.8	3.1	-0.3	-0.041	-0.399	0.550	-0.367	-0.094	2.363	2.090	-0
atl2003080100_09_038		036	10	039	3.1	33.0	0.6	4.5	2.4	0.2	0.3	-1.045	-0.769	-1.909	-1.144	-0.505	-999.000	2.106	-0
atl2003080100_09_038		042	10	040	3.2	30.0	1.0	3.9	2.5	0.6	0.4	-1.220	-1.257	-2.022	-1.026	-0.580	1.248	1.167	-1
atl2003080100_09_038		048	11	040	3.4	29.0	1.0	3.8	2.6	0.6	0.3	-1.049	-1.147	-2.275	-0.923	0.210	3.430	-1.829	-3

Fig. 2 An example of a catalog for a vortex being tracked by the TCVTP.

until they are matched to an analyzed vortex. If they are never matched, they remain in this data base and are a potential false alarm. All data that pertain to a current analyzed vortex are stored in the Analyzed Data Base. The catalogs remain here until the vortex is no longer identifiable in an analysis. At this time, the catalog is written to the Final Circulation Catalog. Various summaries may be executed on the data, but these will not be discussed here as this is mainly a description in the TCVTP configuration.\

To facilitate the analysis of the data bases, major changes were made in the TCVTP structure such that the data bases are now in a MySQL format. Interaction with the data bases occurs via PHP scripts that may query the data bases based on a user web interface (Fig. 3)

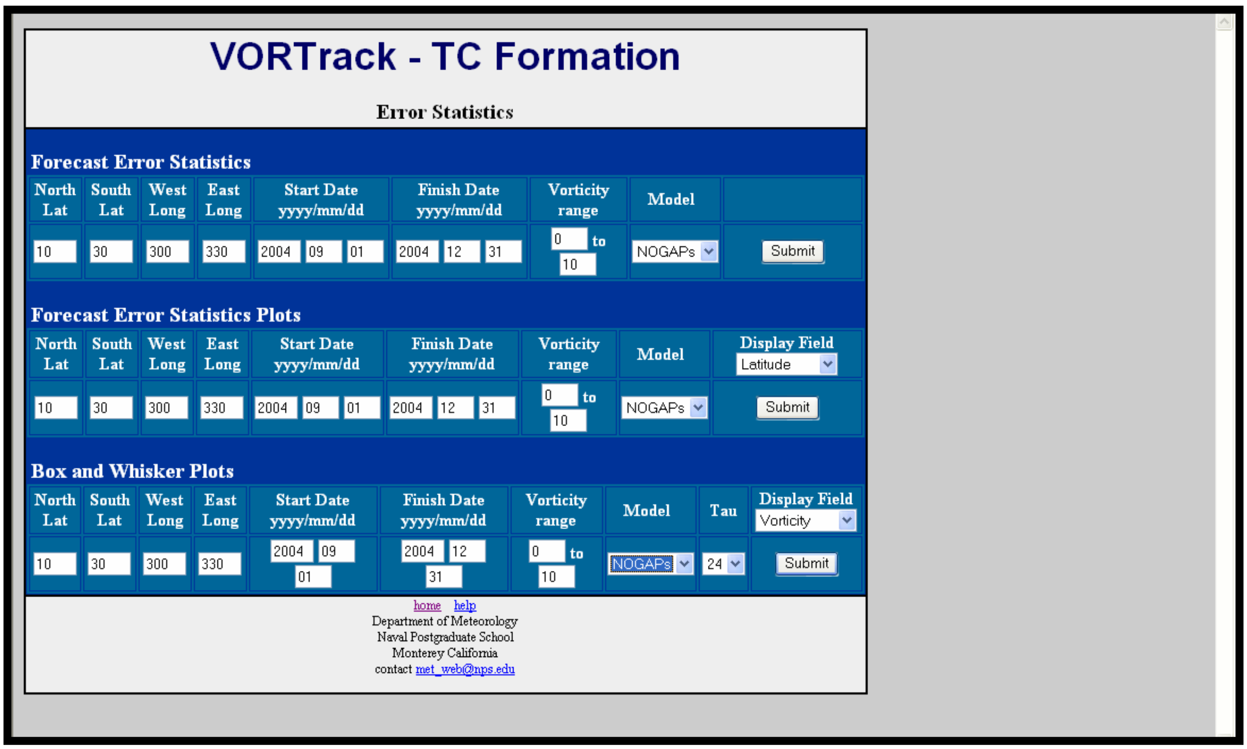


Fig. 3 A sample page from the statistical analysis section of the web interface to the TCVTP data bases.

The advantage to the data base environment is that a user may construct queries such as a geographical location, vorticity range, model, forecast interval, or environmental field. All of these options correspond to buttons in the web interface. Based on the chosen query, a table or plot of error statistics will be displayed (Fig. 4). Therefore, the user may choose to construct a statistical summary of model forecast performance that best fits the current situation.

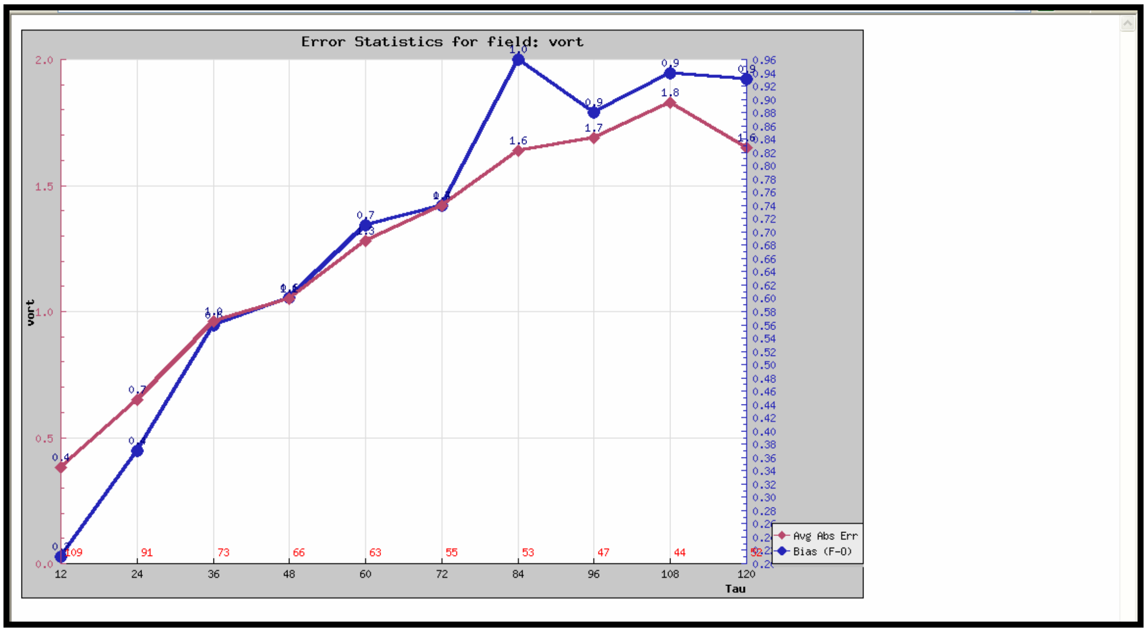


Fig. 4 A sample plot for vorticity forecast errors associated with all tropical vortices in the data base at the time of the query. The query was constructed by choosing appropriate options as displayed in Fig. 3.

TASK: Future plans for coordination at NHC.

PROGRESS: The PI visited NHC during January 2005. At that time, the NMAP2 displays were examined by the Hurricane Specialists and recommendations were made for some modifications, which will be implemented. A visit to NHC is planned for late April to coordinate transfer of software and facilitate the basic operation of the TCVTP system at NHC. This will start the catalog procedure of the TCVTP data bases and NMAP2 displays.

A visit to NHC is planned for June to facilitate the MySQL data base and interface portion for the statistical analysis portion of the TCVTP. This will be run during the 2005 Hurricane Season.

A final visit to NHC is planned for Fall, 2005 to examine the results and coordinate a summation of the operation at NHC.