Joint Hurricane Testbed: Mid-year Progress Report

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

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TASK: Implementation of a prototype system at the Naval Postgraduate School and processing of 2002-2003 model analysis and forecast data.

PROGRESS: This task has been completed. Results of the initial findings based on the application of the Tropical Cyclone Vortex Tracking Program (TCVTP) to the NCEP GFS model and FNMOC NOGAPS operational fields will be presented at the Interdepartmental Hurricane Conference.

In this report, details of the implementation and current configuration of the TCVTP and its output are provided as a guide for eventual implementation at the National Hurricane Center. Although the components have not changed since the original proposal, there are additional details supplied here. The primary components of the TCVTP are defined in Fig. 1, which has not changed since the original proposal.

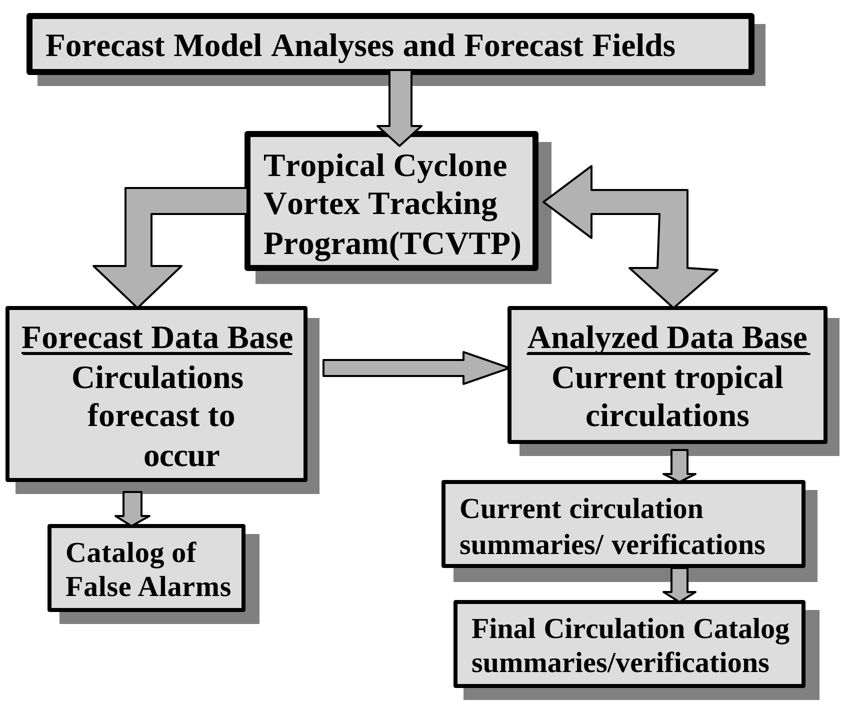


Fig. 1 Schematic of the components of the total system designed to identify, track, catalog, and summarize tropical circulations that may or may not become tropical cyclones (see text for details).

Descriptions of each module are provided to aid in eventual implementation at NHC.

INPUT DATA: FORECAST MODEL ANALYSES and FORECAST FIELDS

In the current configuration, input data consist of GRIB formatted fields for GFS and NOGAPS data that are received at the Naval Postgraduate School (NPS). In the processing, the GRIB fields are converted to FORTRAN binary files, which are read by the TCVTP program. The GRIB data are 1^{o} lat. /long. and all processing remains on this grid. During conversion from GRIB to binary, a global tropical strip is saved that extends from 40^{o}S to 60^{o}N. This allows the fields to be applied to all tropical cyclone basins.

Table 1 identifies all of the variables extracted from the GRIB files. This has not been changed from the original proposal. The conversion uses the utility WGRIB, which is a standard GRIB utility. On a Silicon Graphics (SGI) UNIX workstation, scripts are created for the desired date, model, and basin that define the GRIB files to be converted and stored. All scripts are created in FORTRAN programs that execute on the SGI UNIX workstation.

Table 1. 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.

<table>
<tr><td>850 hPa relative vorticity</td><td>Sea-level pressure</td></tr>
<tr><td>Shallow vertical wind shear (500-850 hPa)</td><td>Deep vertical wind shear (200-850 hPa)</td></tr>
<tr><td>1000-200 hPa geopotential height thickness</td><td>1000-500 hPa temperature difference</td></tr>
<tr><td>Vertical motion</td><td>Total precipitation</td></tr>
<tr><td>700-400 hPa Vapor pressure</td><td rowspan="2">500-200 hPa temperature difference between the area inside the ellipse and outside the ellipse</td></tr>
<tr><td>Latent Heat Flux</td></tr>
</table>

Also during the conversion step, graphics images (in gif format) of select model analysis and forecast fields are created. The fields are 850 hPa vorticity, SLP, 200 hPa winds, 850 hPa winds, 200-850 vertical wind shear, precipitation, and 500 hPa heights. These fields are stored for animation on the TCVTP web site (see below). Also computed and stored as graphics images are forecast error fields for the above parameters and forecast intervals 12 – 120 h in 12-h increments.

All graphics files are created in GRADS. GRADS scripts are created in FORTRAN programs, and then executed in GRADS. GRADS metafiles are created, converted to postscript, then to gif. Once the gif images are created, the metafile and postscript files are deleted.

TCVTP PROGRAM

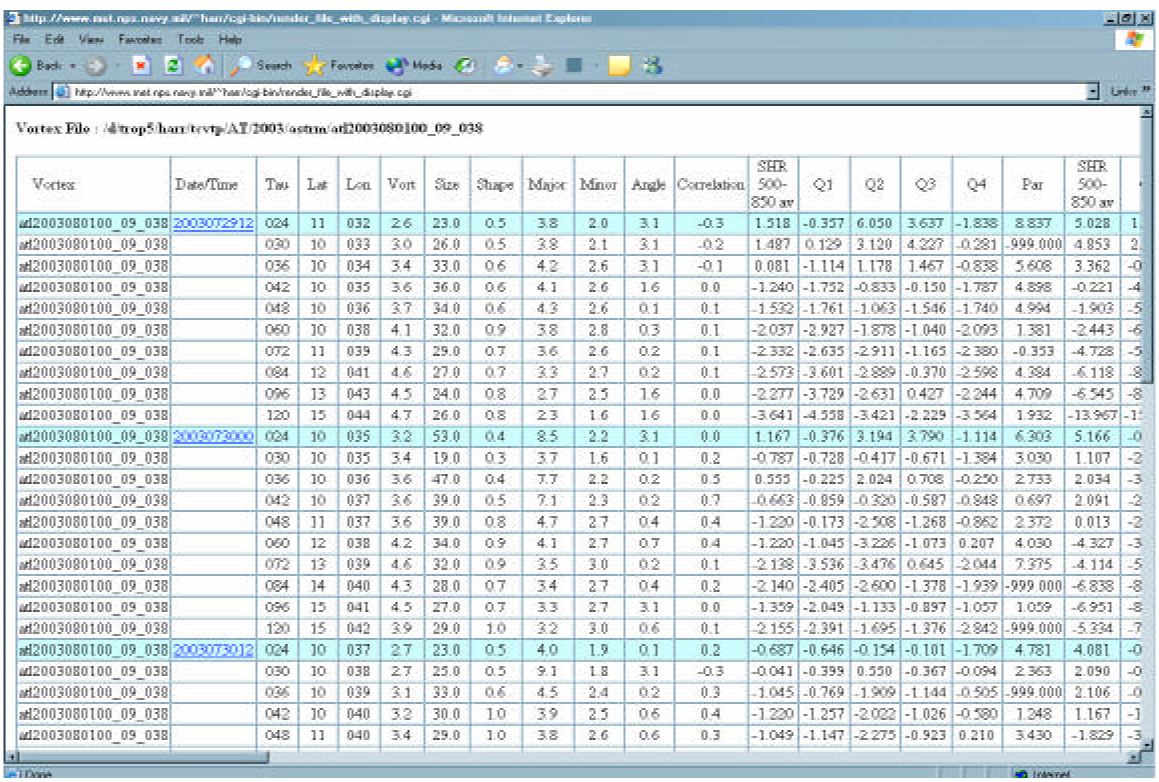
This program is responsible for identifying and tracking vorticity centers in the model analysis and forecast fields. Additionally, the model environmental fields are used to extract the parameters in Table 1 that are identified with each vortex. TCVTP is a stand-alone FORTRAN program that executes on a Silicon Graphics UNIX workstation.

Input to the TCVTP program consists of the model fields and output from the previous TCVTP operation. Other than the model fields, all input and output files are ASCII text files that may be viewed in a standard text editor.

Output of the TCVTP program consists of catalogs of the tracked vortices. The catalog contains the unique vortex name, and the history of forecast and analysis fields associated with the vortex. Each model initiation time is labeled a group and a group consists of lines that contain the data for one forecast time during the entire run. The partial catalog in Fig. 2 contains several groups that correspond to model initiation times at 2003072912, 2003073000, etc. In both of these groups, there are lines that represent the +24, +30, +36,… parameters for this vortex. In the group for 2003072912, the first line is at +24, which indicates that this vortex does not exist in the current 2003072912 analysis but is forecast to occur at 2003073012.

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/at2003080100_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	
at2003080100_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.
at2003080100_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.
at2003080100_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
at2003080100_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
at2003080100_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
at2003080100_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
at2003080100_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
at2003080100_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
at2003080100_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
at2003080100_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
at2003080100_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
at2003080100_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
at2003080100_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
at2003080100_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
at2003080100_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
at2003080100_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
at2003080100_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
at2003080100_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
at2003080100_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
at2003080100_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
at2003080100_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
at2003080100_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
at2003080100_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
at2003080100_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
at2003080100_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.

TCVTP INTERFACE

The interface to the TCVTP is via a series of web pages. The top web page (Fig. 3) is a list of valid dates that have already been processed and are available for viewing. By clicking on a valid date, the representative date page (Fig. 4) is accessed.

On the date page, the top table provides access to animation of several fields. The View TCVTP Fields (Fig. 5) link contain 850 hPa winds plotted only over regions where the relative vorticity is positive. Relative vorticity is shaded and tracks of all vortices being tracked by the TCVTP are displayed. The fields animate from +00 through +120. The animation is based on a self-contained JAVASCRIPT animation package that is freely available.

The View Current Model Fields contain an animation (Fig. 6) of the model fields over the North Atlantic as defined above. The animation is done via the software package ANIS available from the University of Wisconsin and commonly used for meteorological applications. This package was chosen for its ability to overlay fields.

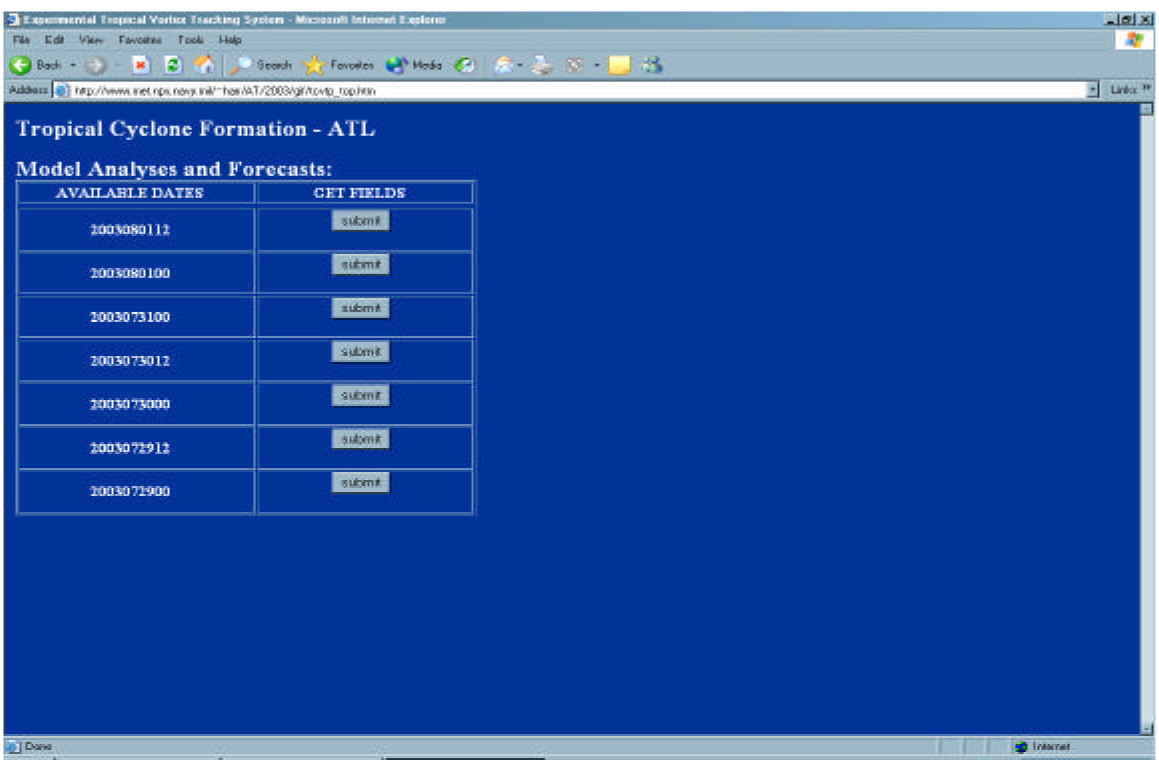


Fig. 3 The TCVTP top web page.

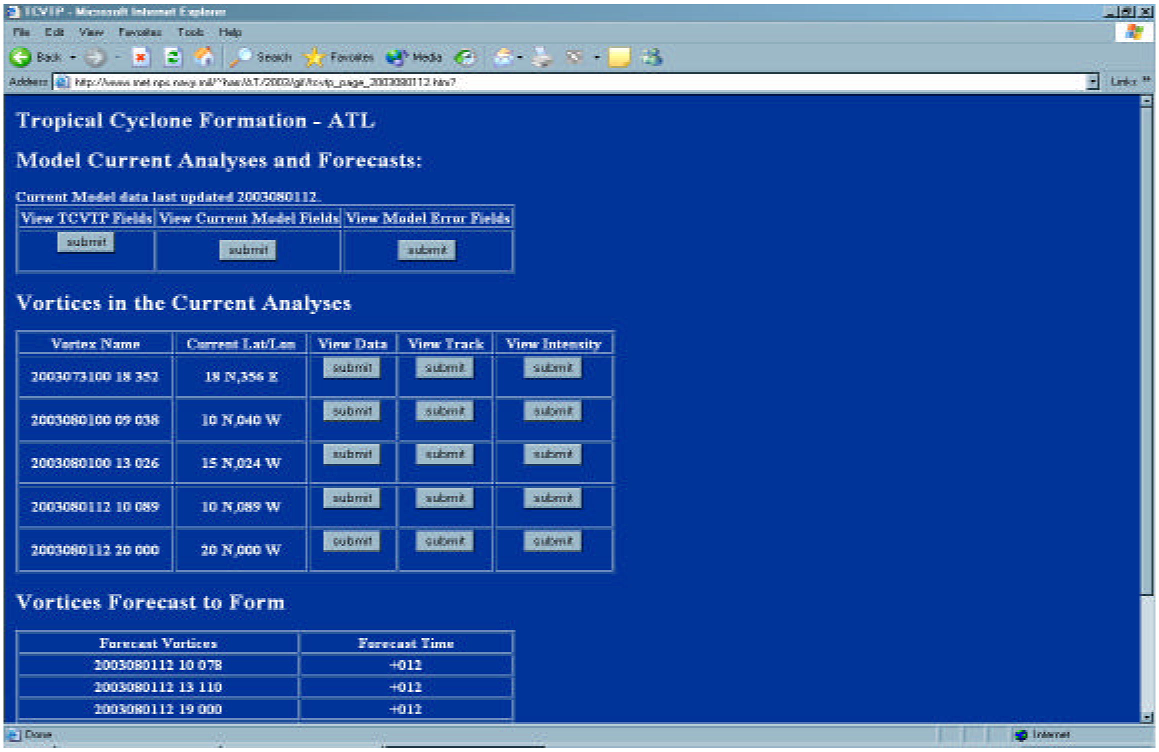


Fig. 4 TCVTP date page

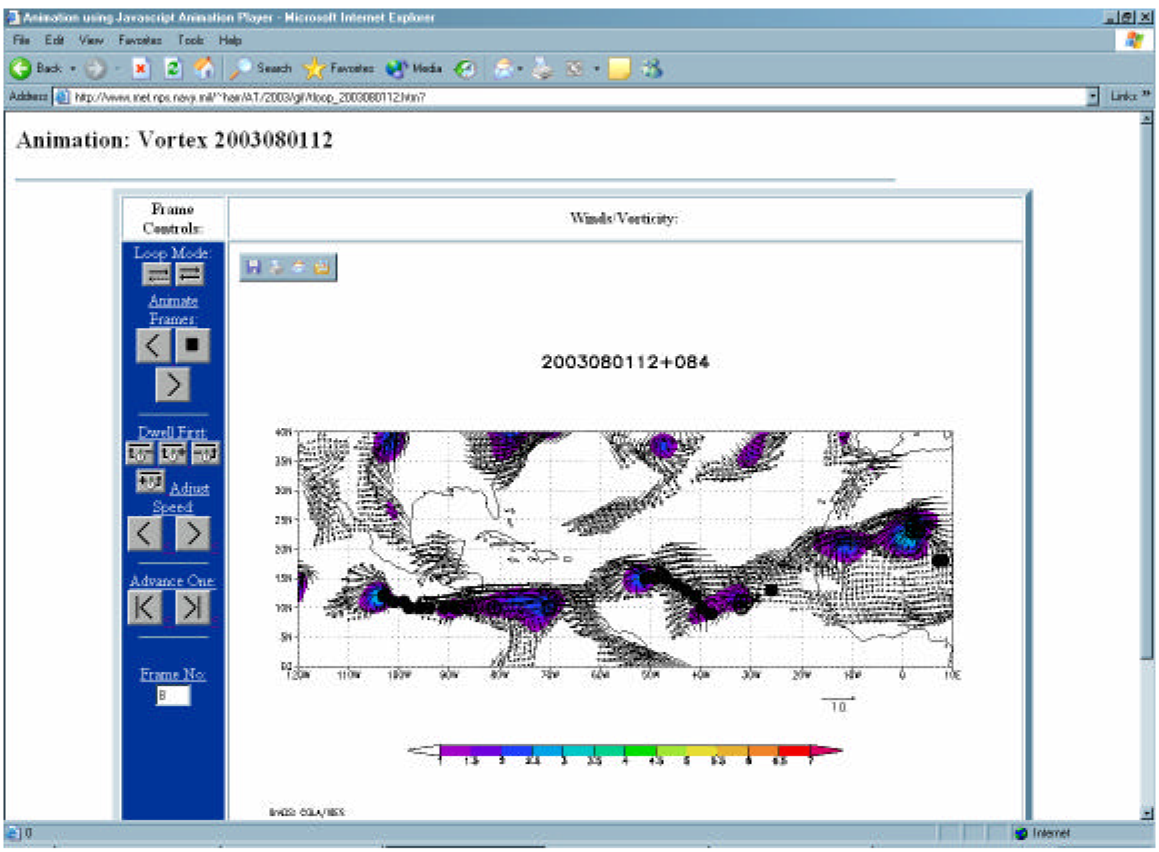


Fig. 5 TCVTP track animation.

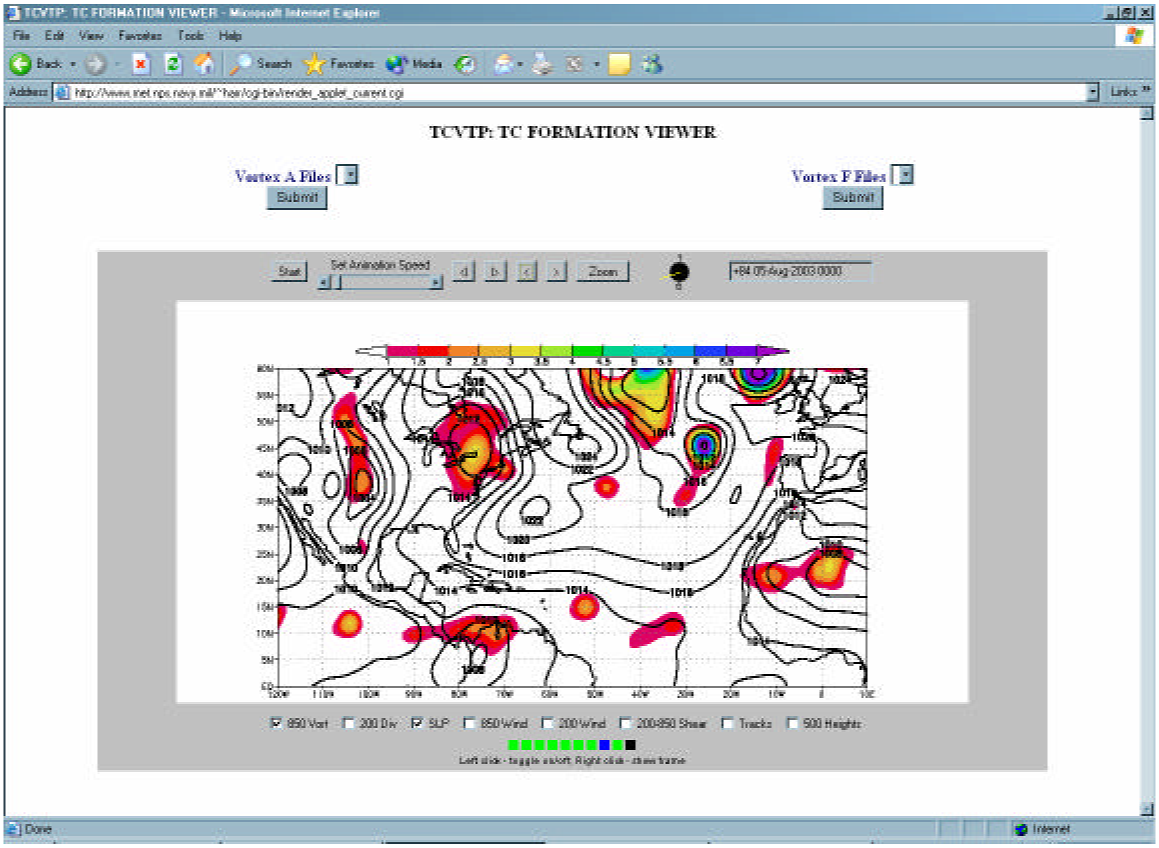


Fig. 6 TCVTP field animation page.

In the View Model Error Fields link, a display similar to Fig.6 is provided except model error fields are animated (not shown).

In the middle table (Fig. 4), a summary of all vortices currently being tracked is provided. The name of the vortex is given in column 1. The current location is in column 2. In column 3, there is a button to view a listing of the current state of the catalog (Fig. 2). In the view track column, a plot (Fig. 7) of the up-to-current analyzed track and all forecasts is provided. Finally, in the view intensity column, a plot (Fig. 8) of the up-to-date analyzed vorticity and all forecasts is provided.

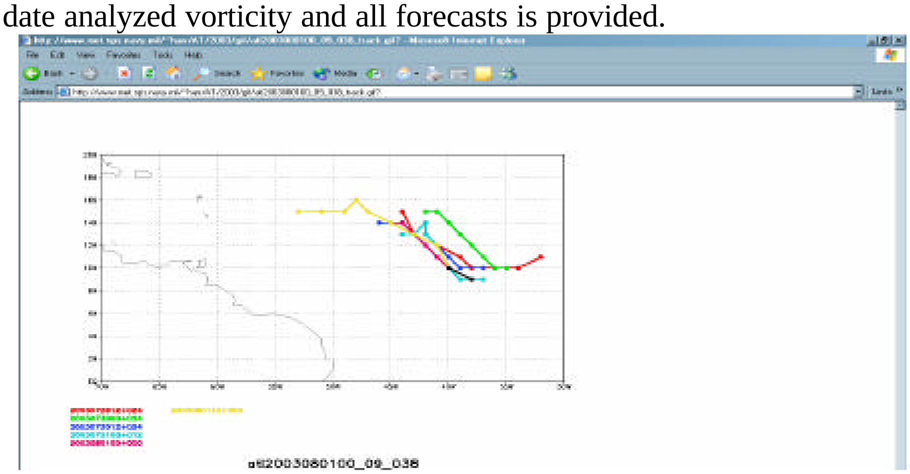


Fig. 7. TCVTP current track plot.

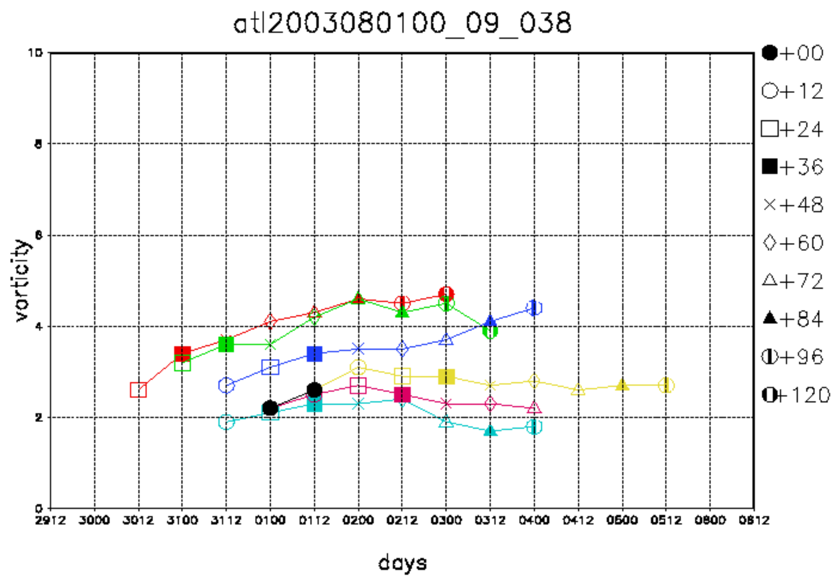


Fig. 8 TCVTP current vorticity plot.

At the bottom of the TCVTP date page is a list of the vortices that were forecast to begin during the current model integration. The list contains the unique vortex name and the forecast time at which the catalog exists. These catalogs are written to the Forecast Data Base.

This concludes the basic operation of the TCVTP that would be initiated for each model time. The web pages provide an interface to the output of the daily activity. Once the data are generated, various summaries or statistical analyses may be conducted. Examples of these will be presented at the IHC.

The current software configuration includes GRIB files and the WGRIB software, FORTRAN, GRADS and ANIS. Although not implemented in the daily execution of the TCVTP, there are some plotting and analysis functions that have been done in MATLAB. Finally, current modifications are exploring the import of GEMPAK (N-AWIPS) files as an alternative to GRIB files.

TASK: Visit to NHC.

PROGRESS: The original proposal contained one visit to NHC prior to the start of the 2004 Atlantic tropical cyclone season. This was modified during definition of the timeline to include an additional trip this winter. This is currently planned for the week immediately following the IHC. A second trip will then occur in late spring (May) or early summer (June). It would be convenient to spend some time immediately after or before the AMS Conference. However, I am not sure I can be away from my teaching duties for more than one week at a time during the Spring Quarter. If this is so, then I could visit in mid-June to finalize use of the TCVTP prototype during the remainder of the Atlantic hurricane season.