ADT – Advanced Dvorak Technique
USERS' GUIDE

Version 9.1

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1.) Description of the ADT Algorithm

The Advanced Dvorak Technique (ADT) algorithm is a computer-based technique, developed at the University of Wisconsin-Madison/Cooperative Institute for Meteorological Satellite Studies (UW/CIMSS), to objectively determine tropical cyclone intensity using geostationary satellite infrared imagery. The ADT can be used to classify storm intensity beginning from storm formation from development to dissipation.

The ADT is patterned after the Subjective Dvorak Enhanced Infrared 'EIR' Technique (SDT) (Dvorak, 1975, 1984) which made use of various pattern identification schemes and rules to determine tropical cyclone intensity. The ADT has been developed to closely mimic the SDT methodology in terms of intensity determination protocol and the incorporation of various rules and analysis methods. Some of the original SDT rules have been modified in the ADT as determined by in depth statistical analysis of ADT performance during application of these rules. Additionally, some intensity relationships have been modified within the ADT using regression based methods, further advancing the ADT beyond the scope of the SDT and previous versions of the ADT (ODT and AODT).

The ADT was originally derived from previous objective satellite estimation algorithms developed at the University of Wisconsin/Space Science and Engineering Center and Colorado State University/Cooperative Institute for Research Applications. Significant modifications and additions have been made to the ADT, resulting in an algorithm that bears little if any resemblance to its forerunners in terms of methodology, functionality, and content. The primary modifications from previous digital Dvorak methods include the addition of a history file (containing previous intensity estimates obtained during a storm lifecycle), utilization of a time-weighted averaging scheme, new definitions and determinations of various environmental temperature values, the implementation of various SDT rules governing the variability of the intensity estimates, and the modification of various intensity estimates away from the SDT methodologies towards the use of several regression-based equations utilizing various measured environmental parameters. These changes have led to more stable and statistically sound estimates of intensity.

The current release of the ADT has been modified to work with all current and upcoming satellites, including MTG, Him-9, and GOES-18 and 19. The main upgrade with this version of the ADT is the implementation of the python-based ARCHER (Section 6) automated storm center determination processing system to derive the storm center position. This analysis is performed prior to the execution of the ADT and is applied within the ADT via a new command-line keyword entry.

For greater detail about the development process and statistical accuracy obtained with the current ADT algorithm, please refer to Olander and Velden (2019). This will document other major upgrades related to the ADTV9 series. For historical reference, you can also refer to Velden et al. (1998), Olander et al. (2004, 2002), and Olander and Velden (2007 and 2016) for various older versions of the the ADT algorithm, including the ODT and AODT algorithms. You can find many of these on the CIMSS Tropical Cyclone webpage at https://tropic.ssec.wisc.edu/misc/adt.

2.) System Requirements

The ADT was originally developed within the Man-computer Interactive Data Access System (McIDAS) architecture. The algorithm utilizes McIDAS library functions and routines to ingest infrared satellite data, display textual and graphical results, read various input data files, and write various output files. The ADT has been tested and operated on a wide variety of UNIX/LINUX operating systems. Use of the GNU "gfortan" FORTRAN-compiler is recommended.

The ADT can also be used in "non-McIDAS" mode using various keywords to utilize netCDF imagery data instead of McIDAS AREA files. The programs that read any input netCDF files can be modified from the provided netCDF routines in the ADT source library, although certain ADT McIDAS execution options may not be available.

The ADT and ARCHER routines and scripts will be implemented within various subdirectories within the top level directory called ADTV91. Various README files are included in the top level ADTV91 directory and "src" (ADT source) and "ARCHER" subdirectories to provide information about the directory contents.

Processing scripts to run the ADT and the ARCHER routines are provided as samples for the user. These scripts were written in Korn-shell (ksh) and they will need to be modified to work in the user's environment. These are provided as a guide and may not be applicable to all users. It is up to the ADT user to obtain any external geostationary and microwave (MW) data used in the ADT and ARCHER algorithms.

If the ADT is to be compiled in the "non-McIDAS" mode (Section 7), the netCDF/HDF libraries (and all dependency libraries) must be installed on the local system to allow for the utilization of this type of data. This will require that the local system contains the netCDF version 4.0 with HDF4/5 capability. A netCDF program to read HURSAT data, as well as a more "generic" netCDF file, are included with the ADT library as a guide. If another netCDF/HDF image data format is to be used, it is up to the user to modify one of these routines or write a new routine to read the local satellite data and pass the information to the ADT routines correctly.

The ADT code libraries can be ported into other systems utilizing the various API (application programming interface) routines provided within the ADT package. Non-McIDAS systems can replace the McIDAS-specific functions with their own system functions to access the satellite imagery and provide their own graphical user interface (GUI) to replace the McIDAS command line and image display interface. Programs to read non-McIDAS image files and run the ADT in "non-McIDAS" mode are provided to aid users in this process.

3.) ADT Acquisition and Installation

The current version (9.1) of the ADT algorithm can be obtained via the UW-CIMSS ADT web page, along with the Users' Guide. The ADT overview web page is located at:

https:/tropic.ssec.wisc.edu/misc/adt

A registration process has been implemented to obtain the ADT code. In order to obtain the ADT code from the webpage it is now required that a License Agreement is signed along with filling out the online registration form. The new download website, containing instructions on how to download the ADT, can be found at:

https:/tropic.ssec.wisc.edu/misc/adt/download

Once the registration process has been approved and the ADT tar file is obtained, the tar file can be uncompressed and unpacked using the following sample commands:

gunzip ADTV91_mmddyy.tar.gz
tar -xvf ADTV91_mmddyy.tar

The resulting subdirectory "ADTV91" will contain the following:

- ARCHER : directory - ARCHER source code and sample files and scripts
- scripts : directory - sample processing scripts for ADT execution
- src : directory - ADT source code
- tests : directory - contains various test and sample data files
- README : file - informational text file

Within the src directory, the following directories and files will appear:

- inc : directory - include files
- lib : directory - library files
- odtapi : directory - application program interface (API) routines
- odtappl : directory - main application routine
- odtlib : directory - ADT library routines
- odtmcidas : directory - McIDAS specific routines
- odtnetcdf : directory - sample ADT netCDF specific routines
- odtwindrad : directory - 2D surface wind radii routines
- adtenv : file - environment argument setup file (Section 4C)
- compileall : file - compile script
- Makefile_MC : file - UNIX makefile (for McIDAS)
- Makefile_noMC : file - UNIX makefile (for non-McIDAS)

The ADT src directory is structured in a function library format that not only allows for quicker installation of ADT updates, but also improves integration of the ADT code within non-McIDAS graphical interface platforms. Interface between the ADT library functions and any user interface are controlled by the odtapi functions.

Prior to installation of the ADT for use within the McIDAS, the current libmcidas.a library file must be located and linked to within the lib directory. The ADT requires this file for all text and graphical output within the McIDAS user interface windows as well as for all satellite navigation and calibration routines. The use of the McIDAS nav/cal routines replaces the included nav/cal routines provided in older ADT versions, making compiling a bit easier and allowing for more frequent and accurate updates of the navigation and calibration routines as new satellites are launched and made operational. The libmcidas.a file should reside in the ~mcidas/lib directory.

The actual linking is performed within the "compileall" script using the variable MCLIB to define the location of the libmcidas.a file. The MCLIB variable should be modified in this script to reflect its location on the machine where the ADT is being installed. Note the entire path name must be used instead of the "~mcidas/lib" designation (e.g. /home/mcidas/lib). Once the MCLIB variable has been defined, the ADT algorithm can be compiled using the "compileall" script file using the following command (to assure that the ADT is compiles with all necessary McIDAS dependencies):

compileall mcidas

Please refer to Section 7 for information about compiling and using the ADT outside of the McIDAS environment.

The ADTV9.1 includes the new python ARCHER storm center determination scheme, which is a stand-alone process run prior to the execution of the ADT. Various output files and ADT command line keywords will control the information and graphical displays produced by this application package and how it is passed into the ADT. More specific information about the ARCHER process is provided in Section 6, with keyword usage information provided in Section 4A1.

Use of the Extratropical (ET) and Subtropical (ST) adjustment schemes within the ADT are also controlled using specific command line keywords. The ST adjustment currently relies on the specific subtropical storm indicator flags provided in the ATCF Best Track "b-deck" files provided by NHC, CPHC, and JTWC. See Section 5Q for more information on the ADT ST adjustment and Section 5J for ATCF Best Track files.

The ET adjustment scheme relies on access to specific "cyclone phase space" information developed at Florida State University (http://moe.met.fsu.edu/cyclonephase). Currently the FSU phase space information utilized by the ADT routines is provided in real-time from NOAA/NESDIS at:
https://ftp.ncep.noaa.gov/data/nccf/com/ens_tracker/prod/gfs.<date>/<hour>/tctrack
(use the "avnop" files; where <date> is in format yyyymmdd and <hour> is 00, 06,12, 18). Please refer to Section 5R for more information on the ADT ET adjustment scheme.

The two-dimensional surface wind field (Knaff et al., 2016) analysis routines are provided via John Knaff at NOAA/NESDIS/RAMMB. These routines rely on derived ADT parameters and operational forecasts for necessary inputs to the derivation algorithms. More information on this can be found in Section 5S.

4.) Using the ADT

The ADT algorithm operates within the McIDAS architecture, utilizing the McIDAS text and graphics/image windows for command line input, data access, and image analysis. Runtime status and final analysis text output are displayed within the McIDAS text window, with image display and graphical output displayed within the McIDAS graphics/image window.

Use of the ADT algorithm is initiated via the McIDAS command line structure using a selection of keywords to control various functions of the ADT algorithm. All ADT keywords are defined in Section 4A1, with examples provided in Section 4A2.

A.) Command Line Structure and Keywords

The ADT is initiated and controlled with the following command line structure within a McIDAS-X command window:

ADT *<parameters> <keywords>*

To run the ADTV9.1 within a shell script, the "naodt" command or a McIDAS-X command linked to the naodt executable in the local ~/mcidas/bin directory (such as adtv91.k) can be used.

Various input parameters control different aspects of the ADT algorithm, many of which can be used in combination with specific keywords to perform particular tasks. A short description of use for each parameter and keyword, along with several examples, will be presented in the following sections.

1.) Description of Use

```
ADT -- Advance Dvorak Technique
  ADT <keywords>
  ADT history_file <keywords>
  ADT history_file DATSET=src_dataset local_dataset <keywords>
  ADT AUTO format fcst_file history_file <keywords>
  ADT DEL history_file DATE=
  ADT EDIT history_file date time "comment
  ADT LIST history_file <keywords>
  ADT PLOT history_file TEM/WIN <keywords>
```

Parameters:

AUTO	Allows for automated ADT estimate to objectively determine position of storm center (see Section 5J2 and 5S)
DEL	Deletes history file record; Must be used with DATE= keyword to define date/time limits

EDIT Allow user to add or modify a comment to history file record(s). ***An important note regarding the use of the EDIT parameter when utilizing the MW keyword and/or PMW data information is in the Remarks section.***

LIST Lists contents of history file (see Remarks)

PLOT Plots intensity estimates from history file (see Remarks).

history_file History file to be used (def=path defined in environmental variable ODTHISTORY)

format Format of forecast file valid options (see examples in Section 5K):
ATCF – Automated Tropical Cyclone Forecast record format
DISC – TPC WTNT4* or WTPZ3* storm specific discussions
PACWARN – JTWC WTPN3* tropical cyclone warning
RSMC – RSMC ICAO format (FK?? or WT??) format
ICAO – WTIO30 FMEE (MeteoFrance) format
AXAU – Tropical Cyclone Warning Center tech bulletin (AXAU*) format
BEST – ATCF "b-deck" Best Track format
HURDAT2 – NHC "Hurricane Database" Best Track Data format
GENERIC - see remarks for example format
(def=ATCF)
Note: Value can be "X" when using in non-McIDAS mode and using the NETCDF keyword and HURSAT file type option.

fcst_file File name containing forecast information for AUTO option; directory location defined by environmental variable ODTAUTO (no AUTOFIX).
Note: Value can be "X" when using in non-McIDAS mode and using the NETCDF keyword and HURSAT file type option.

day Adds comment to specified day in history file (no default)

time Adds comment to specified time in history file (no default)

comment Comment to add to history file for specified day and time (no default)

TEM/WIN Used with PLOT Parameter; WIN will plot intensity as maximum wind speed (knots) instead of default MSLP. TEM will plot eye, cloud, and coldest/warmest temperature values (deg C). Speed and MSLP values are derived from the empirical relationship to CI number defined in Dvorak (1984) and Shwechuck and Weir (1980) unless using CKZ keyword, when plot will be values derived with CKZ MSLP values (if available).

Keywords:

2DWIND=YES filename

Derive four-quadrant, two-dimensional surface wind radii estimates (34kt, 50kt, 64kt) using Knaff algorithm. If filename is provided, the four quadrant radii values for the three different wind speed thresholds will be output to the "filename" file (in directory defined with ODTOUTPUT environmental parameter). (def=NO)

ARCHER=FILE filename threshold

or

=VALUE value latitude longitude threshold

Utilize externally derived ARCHER tropical cyclone position estimate contained within either a file named in "filename" (directory path name defined using ODTARCHER environmental parameter) or using direct imput of the ARCHER alpha value (along with the ARCHER latitude and longitude position values). If threshold value is defined, the position will only be used if the ARCHER alpha value for the current record exceeds the input threshold value (def=12.0). Must be used with the AUTO command line parameter, including an input forecast/best track file. Note: if the ARCHER keyword is defined, it will override the use of the original ADT automated storm center determination scheme defined in Section 6. (def=NO).

ATCF=stormID sourceID rawT finalT

Produces ATCF formatted listing for current ADT estimate or entire history file (or portion of file using DATE= keyword). See remarks.

- stormID=annual tropical cyclone number/basin value; valid basin values:
    - L=Atlantic
    - E=East Pacific
    - C=Central Pacific
    - W=West Pacific
    - A=North Indian Ocean
    - B=South Indian Ocean
    - S=Australian Region (90E-135E)
    - P=Australian Region (east of 135E)
    - U=Southern Hemisphere
    - R=Southern Hemisphere
    - F=Southern Hemisphere
- sourceID = WMO identifier (e.g., NHC, PGTW, etc.)
- rawT = flag determining raw T number output:
    - 0=adjusted raw T number; 1=unadjusted raw T number
- finalT = flag determining final T number output:
    - 0=3-hour linear average

(def=-1 XXXX 0 0)

CKZ=YES gale_radius pressure_env

Utilize Coutney/Knaff/Zehr wind speed/pressure derivation technique to determine mean sea level pressure estimate value (Section 5P). Must input 34-knot wind/gale radius value (in nmi) and environmental pressure value (in mb). If 34-knot wind/gale radius is not available, the radius of last closed isobar (in nmi) can be used but value must be multiplied by -1. (def=NO)

COLor=CI MSLP FinalT Adj-RawT UnAdj-RawT outline text

Defines graphic color levels of plotted parameters (def=1 2 0 0 0 6 7; 0 to not display)

DATE=beg_day beg_time end_day end_time

Defines range of dates and times for LIST, PLOT and DEL options; can be any valid McIDAS date/time format or ADT date format
yyyy/mm/dd, yyyy-mm-dd, dd/mon/yyyy, dd-mon-yyyy, yyyymondd
yyyy=year, dd=date (1-31)
mm=integer month (1-12), mon=character month (min 3 characters)

DATASET=src_dataset local_dataset

- src_dataset = ADDE dataset name and position; specific alias.position or group/descriptor.position format must be used, a position number greater than zero represents an absolute position in the dataset, and zero or a negative number represents a relative position in the dataset based on image time, with 0 being the most recent, -1 the second most recent, etc.; no default value for this parameter.
- local_dataset = ADDE dataset name and position or specific McIDAS area file name (AREAxxxx, where xxxx is area file number; path determined from ODTDATA environmental variable); specific position value must be used if ADDE format; lat/lon image center location is determined using cursor position or forecast interpolation; area file is 480x640 pixels; no default value for this parameter.

(See Section 4D7 for more information)

DOMAIN=ATL/PAC

Defines domain for CI to MSLP conversion; valid options: ATL or PAC, see Remarks (def=computed)

ET=ON value

Flag value indicates to utilize ADT Extratropical adjustment for analysis of current storm (Section 5R). Value input is current “Beta Value” from FSU Tropical Cyclone Phase Space analysis. (def=OFF)

LAND=NO

Applies ADT land interaction rule (def=YES)

MW=score date time

Passive Microwave (PMW) eye information input. See Section 6 for more details on this process. The score value is obtained using the external ARCHER PMW eye score derivation program. The overpass date value must be in YYYYmonDD format (YYYY=year, mon=three letter ID for month, DD-day), with the overpass time value in HHMMSS format. Also see the Remarks section for an important note on a **known bug** when utilizing PMW information and editing history files.

NETCDF=YES filename HURSAT/McIDAS/NOAA/GENERIC

Allows a user to define the name of the netCDF-format image data file when the ADT is compiled and executed in **non-McIDAS mode**. The directory location of the file is defined using the ODTDATA environmental variable. The format type can be "HURSAT", "McIDAS", "NOAA, or "GENERIC". For HURSAT, the location provided by the netCDF varibles CentLat and CentLon will be used as the final storm location, while for McIDAS, NOAA and GENERIC, an interpolated position or "pre-ARCHER" derived position will be utilized. See Section 7 for more info on the "non-McIDAS" mode. (def=NO)

OUTPUT=loc filename

Defines location of LIST option output; valid options are SCREEN or FILE. SCREEN sends the LIST output to the current text window and FILE sends the output to a file (def=ODTDUMP.ASC) where the directory is defined by the environmental variable ODTOUTPUT or TFILE, where the output is sent to both the window and a file (def=SCREEN)

OVER=YES

Allows a user to interactively override the automated scene type; cannot be used with AUTO option and is **only available in McIDAS mode** (def=NO)

RMW=value

Manual input value for radius of maximum wind distance (in km). Value is used in order to override automated RMW determination technique and aid in pinhole eye determination (no default). Positive value will indicate usage of value.

RAWT=init_rawt

Allows a user to override the initial raw T intensity value as defined by the subjective Dvorak rules; see Remarks (def=1.0)

SEARCH=NO

Performs search for maximum curved band location if ADT estimate has determined a CURVED BAND scene (def=YES).

SUBTROP=YES

Flag value to indicate current storm being analyzed has a Subtropical classification (Section 5Q) by a Tropical Cyclone Forecast Center and to use the ADT Subtropical adjustment. (def=NO)

VOUT=ONE/TEN

List either one or ten minute averaged wind speed value in bulletin or storm history listing output.) Ten minute wind speed is equal to 0.88 * one-minute wind speed value. (def=ONE)

Remarks:

The units for pressure/wind are shown in millibars/knots for both the LIST and PLOT options. If the LIST option is used with ATCF keyword, the output file will be in fixed DVTO format.

When using the DOMAIN= keyword, ATL should be used for storms within the North Atlantic and East Pacific basins, while PAC should be used for storms within the Western Pacific and other basins. Domain selection will affect Raw T intensity estimates and corresponding CI pressure values (empirical CI number/pressure relationship).

If the value for RAWT= keyword is set to 0.0, the derived Raw T will be displayed. If using ATCF keyword during an ADT estimate, an output file is created in the directory defined by the environmental variable ODTOUTPUT using the following naming convention:

CIMSS_DVTO_yyyymmddhhmm_ssbasin_FIX

where:		
	yyyy	- year
	mmdd	- month (01-12) and day (01-31)
	hhmm	- UTC time (12:15 UTC = 1215)
	ss	- stormID
	basin	- sub basin

When using the NETCDF keyword option in non-McIDAS mode, the "format" and "fcst_type" forecast type parameters can be listed as "X" when using the HURSAT file type option. These values are not needed since the ADT will utilize the CentLat and CentLon values provided within the HURSAT file as the default storm center position.

IMPORTANT NOTE

A known bug currently exists either when the EDIT parameter is used or a new record is inserted (not at the end) within an existing history file and PMW data information is stored in the history file. If a record(s) is/are inserted/modified/deleted from the ADT history file, the PMW data information for all history file entries following the modified record(s) will be incorrectly modified. It is STRONGLY recommended at this time to NOT UTILIZE the EDIT parameter to modify/delete records within a history file. Also it is recommended TO NOT INSERT an ADT analysis anywhere but at the end of an existing ADT history file since the PMW information within the history file for any subsequent records may/will be improperly modified.

2.) Examples

ADT

Perform abbreviated ADT analysis on current image. Only the current Raw T# will be displayed, with no time averaging or application of any being performed. Output will not be written to any history file.

ADT OPAL.ODT

Perform ADT analysis and add record to history file OPAL.ODT. All rules will be applied as necessary. If this is the first analysis in the OPAL.ODT history file, the initial Raw T# value classification will be set to 1.0.

ADT OPAL.ODT RAWT=2.5

Perform ADT analysis on the first record within the OPAL.ODT history file, however the initial intensity estimate (first record in history file) within the history file will be set to 2.5.

ADT OPAL.ODT ATCF=13L NHC 0 1

Perform ADT analysis and add record to history file OPAL.ODT. All rules will be applied as necessary. Output file containing intensity estimate for current analysis in ATCF format will be created with annual tropical cyclone ID of 13L, Fix Center of NHC, Adjusted Raw T# value, and 3-hour linear averaged Final T# value displayed.

ADT OPAL.ODT OVER=YES

Perform ADT analysis and add record to history file OPAL.ODT. User will be presented with the evaluated ADT Scene Type and prompted to accept or change this value.

ADT PLOT OPAL.ODT COLOR=3 4 5 1 2 X X

Display graph of contents of history file OPAL.ODT in current graphic image using color level 3, 4, 5, 1, and 2 for the CI#, Adjusted MSLP, Final T#, Adjusted Raw T#, and Unadjusted Raw T# plots, respectively. Graph boundary and wording will utilize the default values. No intensity analysis is performed.

ADT PLOT OPAL.ODT WIN COLOR=5 7 0 4 0 7 7

Display graph of contents of history file OPAL.ODT in current graphic image using color level 5 and 4 for the CI#, and Adjusted CI# (Adjusted MSLP will not be plotted with the WIN Parameter). Units will be in in knots. Graph boundary and wording will utilize the color level 7. No intensity analysis is performed.

ADT LIST OPAL.ODT

List contents of history file OPAL.ODT within McIDAS text window. No intensity analysis is performed.

ADT LIST OPAL.ODT ATCF=13L NHC 0 1

List contents of history file OPAL.ODT within McIDAS text window in ATCF format. No intensity analysis is performed

ADT LIST OPAL.ODT OUTPUT=FILE OPAL.TXT

Do NOT perform ADT analysis; provide listing of history file OPAL.ODT to output file OPAL.TXT within directory defined with the ODTOUTPUT environment argument.

ADT DEL OPAL DATE=1995/10/03 151500

Delete only the 3 October 1995 at 15:15:00UTC record from the history file OPAL.ODT. No intensity analysis is performed, but all subsequent records in the history file are modified following the deleted record.

ADT DEL OPAL DATE=03/OCT/1995 15:15:00 03/MAR/1995 19:15:00

Delete all records between 3 October 1995 at 15:15:00UTC and 3 October 1995 at 19:15:00UTC from the history file OPAL.ODT, inclusive. No intensity analysis is performed, but all subsequent records in the history file are modified following the deleted records.

ADT LIST HISTORY=OPAL DATE=03-Oct-1995 1500

List all records between 3 October 1995 at 00:15:00UTC and the end of the history file OPAL.ODT. No intensity analysis is performed.

ADT LIST OPAL DATE=X X 1995OCT03 3:15:00

List all records between the beginning of the history file OPAL.ODT and 3 October 1995 at 3:15:00UTC. No intensity analysis is performed.

ADT AUTO PACWARN wp2698.txt 26W1998.ODT

Perform automated ADT analysis and add record to history file 26W1998.ODT. ADT will read JTWC Tropical Cyclone Warning file wp2698.txt for forecast information, and is located in the directory defined by the ODTAUTO environment argument.

ADT OPAL.ODT DATASET=EASTS/NH.-1 ALL.9990

Perform manual ADT analysis on the second most recent image position in the ADDE remote dataset server group EASTS/NH. A subset of the displayed image will be copied to the ADDE local dataset server group (alias) ALL in the 9990 position. See Sections 4C and 4D7 for more details.

ADT OPAL.ODT CKZ=YES 85 1002

Perform manual ADT analysis utilizing the Courtney/Knaff/Zehr wind speed/pressure relationship to derive MSLP estimate using 85 nmi as the 34 knot wind/gale radius and 1002mb as the environmental pressure value.

ADT OPAL.ODT CKZ=YES -180 1008

Perform manual ADT analysis utilizing the Courtney/Knaff/Zehr wind speed/pressure relationship to derive MSLP estimate using 1008mb as the environmental pressure value and -180 as the proxy value for the unavailable 34 knot wind/gale radius (radius of outer closed isobar = 180 nmi).

ADT AUTO PACWARN wp26forecast.txt 26W.ODT MW=mwdata/latest/latest_26W YES

Perform automated ADT analysis using PMW eye score analysis using JTWC Discussion file *wp26forecast.txt* and PMW image file *latest_26W* stored in directory mwdata/latest. Output history file will be 26W.ODT and data files for PMW graphical analysis displays will be produced.

ADT 26W.ODT MW=26.2 2012OCT03 182136

Perform manual ADT analysis using direct input of PMW eye score information. Eye score value of 26.2 will be input into history file at record immediately following the input date/time value (October 3rd 2012 @ 18:21:36UTC). History file records will be modified as needed.

ADT EDIT OPAL.ODT 1995OCT03 81500 "Great Estimate

The comment "Great Estimate" will be added to the 1995OCT03/08150 UTC intensity analysis record in the OPAL.ODT history file.

ADT 15L.ODT SUBTROP=YES

The Subtropical adjustment will be applied to the current ADT analysis.

ADT 22W.ODT ET=ON 15.5

The Extratropical adjustment will be utilized for the current ADT analysis. The adjustment criteria have been met and the current value is 15.5.

ADT AUTO BEST bep042018.dat 04E.ODT ARCHER=FILE output/ARCHER_listing.best.04E.txt 10.5

The current ARCHER position is passed into the ADT via the file ARCHER_listing.best.04E.txt in the $ODTARCHER/output/ directory. The threshold alpha value for utilization of the position must exceed 10.5. If the

ARCHER alpha value does not exceed 10.5, the best track interpolation position, determined from the file bep042018.dat, will be used as the storm center position at the input image date/time.

ADT AUTO BEST bep042018.dat 04E.ODT ARCHER=VALUE 20.6 15.6 124.5 10.5

Same as the above example, but the current ARCHER value and position is passed into the ADT directly. The threshold alpha value for utilization of the position exceeds 10.5, so the position provided will be utilized as the final storm location.

ADT AUTO FCST fep042018.dat 04E.ODT NETCDF=YES HS_20180405_09300.nc NOAA

This will utilize the ADT in automated, non-McIDAS mode (see Section 7) and the input "NOAA" type netCDF file HS_20180405_093000.nc. The forecast file fep042018.dat will be used as a first guess, with the original, "pre-ARCHER" methodology also used to provide an adjusted storm center position, if available.

ADT AUTO X X 07W.ODT NETCDF=YES 2017200N26162.NORU.2017.07.31.0000.27.HIM-8.hursat-b1.v07.nc HURSAT

This will utilize the ADT in automated, non-McIDAS mode (see Section 7) and the input "HURSAT" type netCDF file 2017200N26162.NORU.2017.07.31.0000.27.HIM-8.hursat-b1.v07.nc will be used. Note no auto-centering forecast format and forecast file are defined (X is used for both) since the storm position is provided within the HURSAT netCDF file using the CentLat and CentLon variables.

B.) History File

The ADT history file is an ASCII format file containing ADT intensity estimates, locations, and other specific information for each image analysis. The ADT algorithm utilizes records in the history file for the determination of the intensity estimate values as well as the application of various rules utilized within the intensity estimate routines. Each analysis stored in the history file will contain the following values:

Value 1	: date (YYYYMMMDD format : YYYY=year, MMM=month, DD=day)
Value 2	: time (hhmmss format)
Value 3	: Julian day and partial day
Value 4	: raw T# unadjusted
Value 5	: raw T# adjusted by Rule 8 rules
Value 6	: final T# value (3-hour average)
Value 7	: final CI# value
Value 8	: eye region temperature (°C)
Value 9	: mean cloud region temperature (°C) – movable annulus
Value 10	: mean cloud region temperature (°C) – set region (old method)
Value 11	: "coldest-warmest" cloud region temperature (°C)
Value 12	: storm center latitude (+/- = North/South Hemisphere)
Value 13	: storm center longitude (+/- = West/East Hemisphere)
Value 14	: eye diameter, CDO size, or shear distance (in km)
Value 15	: eye region temperature standard deviation value
Value 16	: cloud region symmetry value
Value 17	: satellite ID value
Value 18	: eye region scene type (original value)
Value 19	: cloud region scene type (original value)
Value 20	: eye region scene type (original value if user override performed)
Value 21	: cloud region scene type (original value if user override performed)
Value 22	: Dvorak Weakening (Dvorak EIR Rule 9) flag
Value 23	: Dvorak Constraint Limits (Dvorak EIR Rule 8) flag
Value 24	: latitude bias application flag
Value 25	: rapid dissipation flag (east pacific only)
Value 26	: land/ocean flag
Value 27	: eye region FFT value
Value 28	: cloud region FFT value
Value 29	: curved band analysis – BD curve gray scale value
Value 30	: curved band analysis – convection curvature amount (out of 25)
Value 31	: distance from center to "coldest-warmest" temperature value
Value 32	: automated center determination flag
Value 33	: MSLP latitude bias adjustment value
Value 34	: radius of maximum wind (in km)
Value 35	: input or derived passive microwave (PMW) "eye score" value
Value 36	: PMW date (YYYYMMMDD format; see Value 1 above)
Value 37	: PMW time (hhmmss format; see Value 2 above)
Value 38	: input 34 knot wind/gale radius value for CKZ (in nmi)
Value 39	: input environmental pressure value for CKZ (in mb)

Value 40	: satellite viewing angle (in degrees)
Value 41	: ET flag
Value 42	: ET beta value
Value 43	: ST flag
Value 44	: user comment – if available

History files should not be modified directly. Any modifications, such as reanalysis or removal of individual records, should only be done using the ADT command line entry with select keywords, such as DELETE and DATE, in order to assure correct modification to the remaining history file entries (except when using the MW keyword, when modification of the ADT history file is strongly discouraged).

C.) UNIX Environment Variables

In order to provide more control regarding various ADT input/output file and directory definitions, the ADT utilizes six UNIX environment variables to define specific definitions used within the ADT algorithm. The variables are defined in the file "*adtenv*" located in the main ADT scripts directory.

Variable	Description
ODTHOME	Top level directory location for ADT code
ARCHERHOME	Top level directory location for ARCHER code/scripts
ODTAUTO	Directory for forecast files for ADT auto mode
ODTDATA	Directory where local AREA files are stored
ODTHISTORY	Directory where ADT history files are stored
ODTOUTPUT	Directory for LIST/ATCF/2DWIND output
ODTTOPO	Directory where TOPOHRES topography file is located
ODTARCHER	Directory where ARCHER files are stored

The default location for the base directory is defined using the ODTHOME parameter, which is defined on line one of the *adtenv* file. The default location of this variable is the top directory of the ADT directory tree. Any variable names not defined in the *adtenv* file explicitly will default to the $HOME environment variable value.

The ODTDATA variable is the directory location where either the McIDAS AREA files or HURSAT netCDF files are stored on the local machine (e.g. $HOME/mcidas/data). This value will be used with the local_dataset value with the DATASET keyword to define where the downloaded image will be stored.

The ARCHER input data, if utilized, should be in the directory defined by the ODTARCHER environmental parameter. This can be defined as the top level ARCHER directory (e.g. ARCHERHOME parameter). Several other ARCHER environmental parameters are specifically defined in the adtenv file also.

To utilize these variables within the UNIX environment, use the following command on the UNIX command line:

. adtenv

D.) Algorithm Output

During ADT operation the algorithm will display various text outputs within the McIDAS text window, consisting of various runtime information and error messages, interactive prompts for user override options, and the final intensity estimate bulletin.

1.) Full ADT Analysis

Full ADT analysis of an image requires the use of a history file and may use various combinations of specific keywords. Below is sample intensity bulletin output:

```
=====    ADT-Version 9.1 =====
USING ADT RMW OF  16.6
      R34    R50    R64
NE : 155.0   85.0   45.0
SE : 170.0   90.0   50.0
SW : 170.0   90.0   50.0
NW : 150.0   85.0   40.0
Storm Info : Speed=  1.1 kts Direction= 242.0 Vmax= 102.0 kts Method= 2
Using USER INPUT PMW Eye Score information
Utilizing history file /home/adt/ADTV91/tests/history/08S.ODT
Performing full ADT analysis
Utilizing forecast file /home/adt/ADTV91/tests/forecasts/FORECAST.08S
Using AUTO-SELECTED center position -- LAT: -19.90 LON:  -42.78
CURRENT ANALYSIS TIME : 25/JAN/2023  1600UTC
        DATE       TIME      LAT       LON
T0  25/JAN/2023  1200UTC   -19.90    -42.90
T1  25/JAN/2023  1500UTC   -19.90    -42.80
T2  26/JAN/2023  0000UTC   -20.00    -42.70
T3  26/JAN/2023  1200UTC   -20.40    -42.30
T4  27/JAN/2023  0000UTC   -21.30    -41.60
FORECAST INTERPOLATION successful -- LAT: -19.90 LON:  -42.78
Utilizing image data file /home/adt/mcidas/data/AREA9905
Using AUTO-SELECTED center position -- LAT: -19.55 LON:  -43.05
Will utilize RING/SPIRAL COMBINATION position -- LAT: -19.55 LON:  -43.05
Image Time Resolution 30 defined Automatically
Ocean basin automatically selected as PACIFIC
Utilizing image data file /home/adt/mcidas/data/AREA9905

****************************************************

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              ADVANCED DVORAK TECHNIQUE
                    ADT-Version 9.1
         Tropical Cyclone Intensity Algorithm

             ----- Current Analysis -----
     Date :  25 JAN 2023    Time :   160000 UTC
      Lat :   19:33:13 S     Lon :   43:02:45 E

                CI# /Pressure/ Vmax
                5.5 / 941.0mb/102.0kt

             Final T#  Adj T#  Raw T#
                5.5     5.4     5.4

     Latitude bias adjustment to MSLP :  +0.0mb

 Estimated radius of max. wind based on IR : 30 km
```

```
 Center Temp : +12.4C    Cloud Region Temp : -56.6C

 Scene Type : EYE

 Subtropical Adjustment : OFF

 Extratropical Adjustment : OFF

 Positioning Method : RING/SPIRAL COMBINATION

 Ocean Basin : INDIAN
 Dvorak CI > MSLP Conversion Used : PACIFIC

 Tno/CI Rules : Constraint Limits : NO LIMIT
                    Weakening Flag : OFF
            Rapid Dissipation Flag : OFF

 Satellite Name :    MSG2
 Satellite Viewing Angle : 23.1 degrees

****************************************************

ADDED RECORD TO END OF HISTORY FILE /home/adt/ADTV91/tests/history/08S.ODT
WROTE 186 RECORD(S) TO HISTORY FILE /home/adt/ADTV91/tests/history/08S.ODT
Successfully completed ADT analysis
```

The first section of the ADT intensity bulletin output includes the runtime messages, which provide general information about the history file being used and various other parameters used in the derivation of the current intensity estimate.

The first information listed in the above example lists the output from the 2-Dimensional Surface Wind Field (Section 5S) analysis, including the input or derived RMW (Section 5N) value and the derived values (in nautical miles) for each critical wind radii value (34, 50, and 64 knots wind values) in each of the four quadrants. The storm speed, direction, and current intensity value are listed next (along with the indicator value for the determination of the storm vector derived from: 1=ADT history file or 2=storm forecast file).

The history file utilized will be displayed next, and thus a full ADT analysis will be performed on the image. This will be indicated by the following message:

```
  Performing full ADT analysis
```

The exact output displayed in the runtime messages will depend upon how the ADT is executed. The above example shows the output when using the ADT in automated mode; displaying the forecast file information, forecast interpolation status, and any automated storm center determination method output (either from the ARCHER input or derived using the original ADT automated storm center determination scheme). In this example the "AUTO-SELECTED" value listed first is the interpolated forecast position.

The path and file name of the current image file being analyzed will be listed prior to the intensity estimate bulletin. In this example the locally stored image file is named AREA9905. The path to this image is defined by the $MCPATH environment variable, and is defined in the local ".mcenv" file. For an example of remotely stored data, and its corresponding output messages, see Section 4D7.

The last information in the runtime messages section displays that the automated storm location determination was modified using the "pre-ARCHER" Ring/Spiral Combination method along with the final storm center position used by the ADT. A time resolution value will be displayed along with the ocean basin being used for the determination of the T# values (Section 5H and 5I).

Within the intensity estimate bulletin, all vital information relating to the current image analysis will be displayed. The date, time, and location are presented first, followed by the four intensity estimate values; the current unadjusted Raw T#, adjusted Raw T#, Final T# (3-hour average), and CI#.

The "Raw T#" value is the unadjusted Raw "DT" number determined using the current scene type and measured environmental parameters (Section 5B and 5C) for the selected scene type (cloud curvature, eye/cloud temperatures, etc.). The "Adj T#" value represents the current intensity of the storm after any Constraint Limit (Dvorak "Rule 8") rules have been applied (see Section 5F). The "Final T#" value is the average of the current and previous three hour analyses values (see Section 5D). Finally, the "CI#" value represents the 3-hour averaged value after various ADT rules and constraints governing its variability, listed next to the Constraint Limits and Weakening Flag labels at the end of the intensity bulletin, have been applied. For more details on these rules, see Sections 5E, 5F, and 5G.

Adjacent to the "CI#" value are the corresponding estimated mean sea level pressure (MSLP) and maximum wind (Vmax) values (see Sections 5I and 5P, depending upon method used). The MSLP value displayed for the derived CI# intensity estimate may have been modified by a latitude bias adjustment, which is a linear regression-based equation which adjusts the original CI# based upon the current storm latitude, or the Courtney/Knaff/Zehr (CKZ) adjustment (Section 5P).

If the Latitude Bias Adjustment methodology is used (not shown above), the amount of any adjustment will be listed below the CI#/Pressure/Vmax information next to the "Latitude Bias Adjustment to MSLP" label (see Section 5M). A positive/negative adjustment will increase/decrease the MSLP value obtained from the specific CI#/MSLP relationship for the scene being investigated. Please see Sections 5I and 5M for more information on this process.

If the CKZ MSLP determination method is used, a section at the bottom of the intensity bulletin will display the two input parameters used in the calculation (the Average 34 Knot Radii distance, in km, and the Environmental MSLP value, in mb). See Section 5P for more information.

Following the eye and cloud temperature information (Section 5C), the specific Scene Type. The example above obtained a CLEAR EYE scene for a manually selected storm center location. The scene type will be determined automatically using various image analysis methods (see Section 5B).

If the scene type of the current analysis is an EYE, PINHOLE EYE, or a LARGE EYE, an estimate of the Radius of Maximum Wind (RMW) will be also be provided in the intensity bulletin. For information on the RMW value derivation see Section 5N.

If the Subtropical or Extratropical adjustments are utilized in the ADT intensity analysis, their respective flags in the intensity bulletin will indicate “ON”. See Section 5Q and 5R, respectively, for more information on these adjustments.

The storm center selection method is provided in both the intensity bulletin and the preceding runtime messages section. A discussion of an automatically selected storm center location will be provided in Sections 4D4, 5J, and 6. Manual selection of the storm scene type can be performed using the OVER keyword described in Section 4A1.

The ocean basin in which the storm is located will be displayed next. This value will either be ATLANTIC, PACIFIC, or INDIAN. Following the ocean basin designation, the empirical T# to MSLP relationship method used to determine the MSLP value for the given T#/CI# is presented. This value will either be listed as ATLANTIC or PACIFIC, indicating the Atlantic or West Pacific empirical relationship conversion is used. The conversion will automatically be determined unless manually overridden using the DOMAIN keyword. See Section 5I for more information on the automatic ocean basin determination process and T# to MSLP conversion relationship. The ocean basin is also used to determine which regression equation is used in the determination of the Raw T# value. See Section 5H for more information.

The final three “Tno/CI Rules” entries inform the user whether the SDT “Rule 8” and/or “Rule 9” T#/CI# adjustments are being utilized. Constraint Limits will list which Raw T# constraint limit (T# change per time period) is being applied, if it has been exceeded, to derived the Adjusted Raw T# value (see Section 5F). The Weakening Flag indicates will be either OFF, WKN, or ON, indicating which CI# determination scheme is being followed (see Section 5E). Finally, the Rapid Dissipation Flag value will either be ON or OFF, indicating a further adjustment to the Weakening Flag (Section 5G) application.

At the end of the bulletin, the satellite name and viewing angle information will also be displayed.

Once the intensity analysis has completed, the current analysis information will be written to the history file. In this example the current analysis was appended at the end of the history file 08S.ODT and was the last of 186 records written to the history file.

Most frequently an intensity analysis will be performed on the most current image available. If analysis of a missed image or reanalysis of a previously examined image is performed, one of the following message groups will be displayed, respectively:

```
Inserting record X in history file <history file>
Modified X subsequent records in history file <history file>
Wrote X record(s) to history file <history file>
```

or

```
Overwrote record X in history file <history file>
Modified X subsequent records in history file <history file>
Wrote X record(s) to history file <history file>
```

When a record is overwritten or inserted into an existing history file, all subsequent records after the current analysis will be automatically recalculated as needed.

2.) Abbreviated ADT Analysis

If a history file is not specified on the command line when utilizing the ADT, an abbreviated analysis will be performed. Much of the output will be the same; however, a few modifications to the runtime messages and intensity bulletin will exist. First, the intensity bulletin will contain only one intensity estimate value. This estimate will be listed at the "CI#", representing the intensity estimate at the analysis time only. Second, the two "Rule Flags" values will not be listed since they are only utilized when a history file is present. A sample abbreviated output is presented below:

```
=====    ADT-Version 9.1 =====
Not using PMW Eye Score information
Performing abbreviated ADT analysis
Utilizing forecast file /home/adt/ADTV91/tests/forecasts/FORECAST.08S
Using AUTO-SELECTED center position -- LAT: -19.90 LON:  -42.78
CURRENT ANALYSIS TIME : 25/JAN/2023  1600UTC
        DATE        TIME       LAT       LON
T0  25/JAN/2023  1200UTC   -19.90    -42.90
T1  25/JAN/2023  1500UTC   -19.90    -42.80
T2  26/JAN/2023  0000UTC   -20.00    -42.70
T3  26/JAN/2023  1200UTC   -20.40    -42.30
T4  27/JAN/2023  0000UTC   -21.30    -41.60
FORECAST INTERPOLATION successful -- LAT: -19.90 LON:  -42.78
Utilizing image data file /home/adt/mcidas/data/AREA9905
Using AUTO-SELECTED center position -- LAT: -19.55 LON:  -43.05
Will utilize RING/SPIRAL COMBINATION position -- LAT: -19.55 LON:  -43.05
Ocean basin automatically selected as PACIFIC
Utilizing image data file /home/adt/mcidas/data/AREA9905

****************************************************

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              ADVANCED DVORAK TECHNIQUE
                    ADT-Version 9.1
         Tropical Cyclone Intensity Algorithm

             ----- Current Analysis -----
     Date :  25 JAN 2023    Time :   160000 UTC
      Lat :   19:33:13 S     Lon :   43:02:45 E

                CI# /Pressure/ Vmax
                5.4 / 945.0mb/ 99.6kt

     Latitude bias adjustment to MSLP :  +1.4mb

 Estimated radius of max. wind based on IR : 30 km

 Center Temp : +12.4C    Cloud Region Temp : -56.6C

 Scene Type : EYE

 Subtropical Adjustment : OFF

 Extratropical Adjustment : OFF

 Positioning Method : RING/SPIRAL COMBINATION

 Ocean Basin : INDIAN
 Dvorak CI > MSLP Conversion Used : PACIFIC
```

```
 Satellite Name :    MSG2
 Satellite Viewing Angle : 23.1 degrees

****************************************************

Successfully completed ADT analysis
```

3.) Land Interaction

If the storm center is over a land region (as defined in Section 5A) a warning will be presented in the runtime output and intensity bulletin. No intensity estimate will be calculated unless explicitly requested by the user with the LAND keyword. A sample output for a storm center over land is presented below:

```
Performing abbreviated ADT analysis
Using USER-SELECTED center position : LAT: 22.93 LON:  66.04
Ocean basin automatically selected as ATLANTIC
Utilizing image data file /home/adt/mcidas/data/AREA2010
Tropical cyclone is over land

****************************************************

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                 ADT - Version 9.1
         Tropical Cyclone Intensity Algorithm

             ----- Current Analysis -----
     Date :  12 SEP 1999     Time :  124500 UTC
      Lat :   22:56:18 N      Lon :  66:02:56 W

              TROPICAL CYCLONE OVER LAND
              NO ADT ANALYSIS AVAILABLE

****************************************************
```

4.) Original Automated Storm Center Determination

The ADT algorithm can be executed in a completely automated mode, utilizing an interpolated tropical cyclone forecast and the original, "pre-ARCHER" storm center determination analysis technique to obtain a completely objective storm intensity estimate. See Section 5K for specific information on the formats allowed for the input forecast files.

The automated storm center location is determined using one of the following methods; polynomial interpolation of a forecast, linear extrapolation of previous history file positions, or a combination analysis approach using a Spiral Centering (SC) or eye Ring Fitting (RF) scheme to determine the best storm center location. The polynomial interpolation scheme determines the current position of the storm using three positions (the current, 12 hour, and 24 hour forecast positions) from a TPC/NHC, JTWC, or RSMC forecast (in ATCF, discussion/warning text, or ICAO format) in conjunction with two previous positions from the history file (6 and 12 hour old positions), if available. If the forecast interpolation scheme fails, a linear extrapolation of the previous 12 hours of storm positions stored in the history is determined.

If the Final T# value for the previous entry in the history file is greater than 3.5 and either the interpolation or extrapolation methods are successful, a full objective analysis search for the storm center location is performed using a combination of three image analysis routines. The first method is a Spiral Centering analysis centered at the interpolation/extrapolation position. Once completed, an eye Ring Fitting analysis, which attempts to fit different size rings to cloud temperature gradients, is performed. Once both methods have been completed, an empirically based determination scheme selects the center point from the two methods (or a combination of the SC and RF routines). For a more detailed discussion of the entire auto-location methodology, refer to Section 5J2.

In the following examples, an ATCF format forecast was used in the polynomial interpolation scheme as a first guess. The data points used in the polynomial interpolation scheme are displayed prior to the interpolated position. In this example a strong eye region was found, using the combined Ring Fitting/Spiral Centering analysis maximum value position as the final tropical cyclone location:

```
Utilizing forecast file /home/adt/ADTV91/tests/forecasts/FORECAST.08S
Using AUTO-SELECTED center position -- LAT: -19.90 LON:  -42.78
CURRENT ANALYSIS TIME : 25/JAN/2023  1600UTC
        DATE        TIME       LAT       LON
T0  25/JAN/2023  1200UTC   -19.90    -42.90
T1  25/JAN/2023  1500UTC   -19.90    -42.80
T2  26/JAN/2023  0000UTC   -20.00    -42.70
T3  26/JAN/2023  1200UTC   -20.40    -42.30
T4  27/JAN/2023  0000UTC   -21.30    -41.60
FORECAST INTERPOLATION successful -- LAT: -19.90 LON:  -42.78
Utilizing image data file /home/adt/mcidas/data/AREA9905
Using AUTO-SELECTED center position -- LAT: -19.55 LON:  -43.05
Will utilize RING/SPIRAL COMBINATION position -- LAT: -19.55 LON:  -43.05
```

As mentioned previously, the automated center determination scheme cannot be used in conjunction with the manual override capability. If both the AUTO and OVER keywords are entered on the same command line, the override capability will be disabled, and the following message will be presented:

```
OVER and AUTO keywords cannot be used at same time
Disabling override ability
```

5.) ARCHER Storm Center Input and Usage

If the externally derived ARCHER position is utilized by the ADT instead of the original methodology discussed in the section above, much of the output will be the same since the ARCHER routine will be rejected if the alpha value associated with the current ARCHER storm location does not exceed the threshold value (either manually input with the ARCHER command line keyword or the default value of 12.0). If the ARCHER value is used, the storm bulletin output will indicate this in the final positioning information line, which will be similar to the following example:

```
=====    ADT-Version 9.1 =====
Not using PMW Eye Score information
Utilizing history file /home/adt/ADTV91/tests/history/08S.ODT
Performing full ADT analysis
Utilizing forecast file /home/adt/ADTV91/tests/forecasts/FORECAST.08S
Using AUTO-SELECTED center position -- LAT: -19.90 LON:  -42.78
CURRENT ANALYSIS TIME : 25/JAN/2023  1600UTC
        DATE        TIME      LAT       LON
T0  25/JAN/2023  1200UTC   -19.90    -42.90
T1  25/JAN/2023  1500UTC   -19.90    -42.80
T2  26/JAN/2023  0000UTC   -20.00    -42.70
T3  26/JAN/2023  1200UTC   -20.40    -42.30
T4  27/JAN/2023  0000UTC   -21.30    -41.60
FORECAST INTERPOLATION successful -- LAT: -19.90 LON:  -42.78
Utilizing image data file /home/adt/mcidas/data/AREA9905
Using AUTO-SELECTED center position -- LAT: -19.60 LON:  -42.90
Will utilize ARCHER POSITIONING position -- LAT: -19.60 LON:  -42.90
Image Time Resolution 30 defined Automatically
Ocean basin automatically selected as PACIFIC
Utilizing image data file /home/adt/mcidas/data/AREA9905

****************************************************

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                    ADT-Version 9.1
         Tropical Cyclone Intensity Algorithm

             ----- Current Analysis -----
     Date :  25 JAN 2023    Time :   160000 UTC
      Lat :   19:36:00 S     Lon :   42:54:00 E

                CI# /Pressure/ Vmax
                5.5 / 941.0mb/102.0kt

             Final T#  Adj T#  Raw T#
                5.5     5.5     5.5

     Latitude bias adjustment to MSLP :  +0.0mb

 Estimated radius of max. wind based on IR : 30 km

 Center Temp : +12.4C    Cloud Region Temp : -58.8C

 Scene Type : EYE

 Subtropical Adjustment : OFF

 Extratropical Adjustment : OFF
```

```
 Positioning Method : ARCHER POSITIONING

 Ocean Basin : INDIAN
 Dvorak CI > MSLP Conversion Used : PACIFIC

 Tno/CI Rules : Constraint Limits : NO LIMIT
                   Weakening Flag : OFF
          Rapid Dissipation Flag : OFF

 Satellite Name :    MSG2
 Satellite Viewing Angle : 23.1 degrees

****************************************************

ADDED RECORD TO END OF HISTORY FILE /home/adt/ADTV91/tests/history/08S.ODT
WROTE 186 RECORD(S) TO HISTORY FILE /home/adt/ADTV91/tests/history/08S.ODT
Successfully completed ADT analysis
```

If the ARCHER methodology is not utilized, the information line above will indicate that the forecast interpolation (or history file extrapolation) position was used as the final storm location. The original ADT storm center determination methodology will NOT be attempted if the ARCHER method fails.

The original automated storm center methodology will be utilized if the ARCHER methodology (using the ARCHER keyword) is not specified with the AUTO parameter. If ARCHER is to be used, it must be explicitly specified with the ARCHER keyword (and the ARCHER is run successfully prior to execution of the ADT).

6.) User Override Function

The user override function allows the user to manually modify the automatically determined scene type classification prior to the ADT storm intensity estimate calculation when the McIDAS compile option has been utilized (see above in Section 3). This can be performed utilizing mouse button inputs to toggle through the various scene types. After the scene type has been automatically determined, the user will be prompted either accept or modify the scene type. If the user desires to modify the scene type, a sequence of scene type classifications will be presented to the user. Once the desired scene type is chosen, the program will proceed with the determination of the current storm intensity estimate using the user-selected scene type. Two example sessions are below:

- The user agrees with the scene type:

```
ADT has classified the EYE SCENE as EYE
Do you agree with this scene classification?
TOGGLE : Press MIDDLE mouse button
ACCEPT : Press RIGHT  mouse button
  <user presses RIGHT mouse button>
CLOUD AND EYE SCENES have not been changed
User accepted scene type
```

- The user does not agree with the scene type:

```
ADT has classified the EYE SCENE as EYE
Do you agree with this scene classification?
TOGGLE : Press MIDDLE mouse button
ACCEPT : Press RIGHT  mouse button
  <user presses MIDDLE mouse button>
Change eye scene to PINHOLE
  <user presses MIDDLE mouse button>
Change eye scene to LARGE
  <user presses MIDDLE mouse button>
Change eye scene to NONE
  <user presses RIGHT mouse button>
Change cloud scene to UNIFORM CDO
  <user presses MIDDLE mouse button>
Change cloud scene to EMBEDDED CENTER
  <user presses RIGHT mouse button>
CLOUD SCENE has been changed to EMBEDDED CENTER
User modified scene type
```

In the second example, the user selected NONE for the eye scene. The scene types switched from eye scene to cloud (no-eye) scenes, and the user resumed scrolling through the different cloud scene type options until the desired scene was presented. The opposite switch can be performed, from cloud to eye scene types, by selecting the cloud scene type of EYE during the override process.

Note that the original and user override values for the scene type are both stored in the history file for the storm being analyzed. The override values will be used, if the scene was manually changed for the specific history file record, in any history file listings or intensity estimate recalculations if previous record(s) is/are modified/inserted/deleted.

The capability to override the automatically determined storm center location has been disallowed since it defeats the purpose of executing the ADT in fully automatic mode (without manual intervention). Thus, the concurrent use of the OVER and AUTO keywords is not allowed, resulting in a runtime text error message and the disabling of the override capability for the analysis being performed.

7.) Remote Server Data Access

The ADT has the ability to utilize remotely stored and displayed McIDAS imagery. The ADT will assume the data is stored locally unless the keyword DATASET is used. The DATASET keyword utilizes two entries to describe the remote and local McIDAS ADDE dataset server names and images. The dataset names can be listed using a group/descriptor.position or alias.position format.

If a remotely stored McIDAS image is analyzed by the ADT, a subsection of the image displayed within the McIDAS image display window will be copied to the local machine. The keyword entry must describe the remote dataset server name within the first variable in the DATASET keyword, and it must be in ADDE format. The second variable in the DATASET keyword will be used to define the location and name where the image will be copied and should also be in McIDAS ADDE format. The size of the image copied will be 480x640 pixels and will be centered at the user-selected (manual mode; cursor position) or forecast interpolated (automated mode) storm center position. An example output text message when using the DATASET keyword follows:

```
DOWNLOADING REMOTE IMAGE EAST/NH.5 TO LOCAL IMAGE ALL.7777
  WITHIN LOCAL DIRECTORY AT /home/adt/mcidas/data/AREA7777
Utilizing image data file /home/adt/mcidas/data/AREA7777
```

In the example above, the ADT user was investigating a remotely stored image within the ADDE dataset name of “EAST/NH” at position “5”. It was copied to the local server defined with the ADDE dataset name (alias) of “ALL” into position 7777. The local ADDE image in this example was saved in the /home/adt/mcidas/data directory in the file AREA7777. The directory where the ADT will copy the local image to is defined using the ODTDATA environmental parameter in the *adtenv* file. The ADT algorithm then utilized this image in the derivation of the intensity estimate.

8.) ATCF Record Output

An ATCF Fix File format record can be produced for each individual intensity estimate using the ATCF keyword. The output file location will be automatically determined using the ODTOUTPUT environmental variable. The file name will also be automatically determined using the date and time information of the image being investigated. See Section 4A1 for more information about the file naming structure. If an ATCF file is produced, an information message such as the following will be displayed:

```
WROTE ATCF OUTPUT TO FILE /home/adt/output/CIMSS_DVTO_199909102115_08L_FIX
```

Any or all records of a history file can be displayed in ATCF format, which is a format various TCFCs utilize and are accustomed to. The ADT utilizes the ATCF Version 3.3 "Fix File" data format and the "DVTO Fix Type" for its output ATCF files. Specific information about the ATCF and these formats can be found at: http://www.nrlmry.navy.mil/atcf_web/docs/database/new/database.html

The output can be displayed in the standard output window or sent to an output file. A sample ATCF format file is displayed below:

```
===== ADT-Version 9.1 =====

AL, 08, 199909081515,  20, DVTO,        I,  , 1581N,  5006W,     , 3,  45, 2, 1000, 2, DVRK,  ,  ,  ,  ,  , , , , , ,  ,  , ,  NHC, AUT,    I, 30,
2, 30,   6, T, 30, -158, -276, SHER,   ,  GOES8, T,
AL, 08, 199909081615,  20, DVTO,        I,  , 1585N,  5027W,     , 3,  45, 2, 1000, 2, DVRK,  ,  ,  ,  ,  , , , , , ,  ,  , ,  NHC, AUT,    I, 30,
2, 30,   6, T, 31,  -61, -288, SHER, R8,  GOES8, T,
AL, 08, 199909081715,  20, DVTO,        I,  , 1590N,  5050W,     , 2,  45, 2, 1000, 2, DVRK,  ,  ,  ,  ,  , , , , , ,  ,  , ,  NHC, AUT,    I, 30,
2, 30,   6, T, 30,  -55, -338, ICDO, R8,  GOES8, T,
AL, 08, 199909081815,  20, DVTO,        I,  , 1596N,  5072W,     , 2,  45, 2, 1000, 2, DVRK,  ,  ,  ,  ,  , , , , , ,  ,  , ,  NHC, AUT,    I, 30,
2, 29,   6, T, 29, -199, -365, ICDO, R8,  GOES8, T,
AL, 08, 199909081915,  20, DVTO,        I,  , 1602N,  5095W,     , 3,  45, 2, 1000, 2, DVRK,  ,  ,  ,  ,  , , , , , ,  ,  , ,  NHC, AUT,    I, 30,
2, 29,   6, T, 30, -415, -340, CBND,   ,  GOES8, T,
AL, 08, 199909082015,  20, DVTO,        I,  , 1606N,  5118W,     , 2,  45, 2, 1000, 2, DVRK,  ,  ,  ,  ,  , , , , , ,  ,  , ,  NHC, AUT,    I, 30,
2, 29,   6, T, 29, -293, -354, ICDO, R8,  GOES8, T,
AL, 08, 199909082115,  20, DVTO,        I,  , 1662N,  5175W,     , 3,  45, 2, 1000, 2, DVRK,  ,  ,  ,  ,  , , , , , ,  ,  , ,  NHC, AUT,    I, 30,
2, 29,   6, T, 30, -349, -451, CBND, R8,  GOES8, T,
<records deleted from listing>
AL, 08, 199909101445,  20, DVTO,        I,  , 1956N,  5963W,     , 2,  77, 2,  975, 2, DVRK,  ,  ,  ,  ,  , , , , , ,  ,  , ,  NHC, AUT,    I, 45,
2, 45,   6, T, 45, -651, -685,  CDO,   ,  GOES8, T,
AL, 08, 199909101545,  20, DVTO,        I,  , 1950N,  5947W,     , 2,  77, 2,  975, 2, DVRK,  ,  ,  ,  ,  , , , , , ,  ,  , ,  NHC, AUT,    I, 45,
2, 45,   6, T, 45, -601, -648, EMBC,   ,  GOES8, T,
AL, 08, 199909101645,  20, DVTO,        I,  , 1965N,  6004W,     , 2,  77, 2,  975, 2, DVRK,  ,  ,  ,  ,  , , , , , ,  ,  , ,  NHC, AUT,    I, 45,
2, 45,   6, T, 45, -655, -646,  CDO,   ,  GOES8, T,
AL, 08, 199909101745,  20, DVTO,        I,  , 1993N,  5988W,     , 2,  77, 2,  976, 2, DVRK,  ,  ,  ,  ,  , , , , , ,  ,  , ,  NHC, AUT,    I, 45,
2, 44,   6, T, 45, -664, -656,  CDO,   ,  GOES8, T,
AL, 08, 199909101815,  20, DVTO,        I,  , 1986N,  5984W,     , 2,  77, 2,  975, 2, DVRK,  ,  ,  ,  ,  , , , , , ,  ,  , ,  NHC, AUT,    I, 45,
2, 45,   6, T, 46, -612, -658, EMBC,   ,  GOES8, T,
<records deleted from listing>
AL, 08, 199909131015,  20, DVTO,        I,  , 2400N,  7105W,     , 1, 127, 1,  935, 1, DVRK,  ,  ,  ,  ,  , , , , , ,  ,  , ,  NHC, AUT,    I, 65,
1, 65,   6, T, 65,  194, -704,  EYE,   ,  GOES8, T,
AL, 08, 199909131115,  20, DVTO,        I,  , 2404N,  7127W,     , 1, 127, 1,  935, 1, DVRK,  ,  ,  ,  ,  , , , , , ,  ,  , ,  NHC, AUT,    I, 65,
1, 64,   6, T, 64,  191, -698,  EYE,   ,  GOES8, T,
AL, 08, 199909131215,  20, DVTO,        I,  , 2407N,  7151W,     , 1, 127, 1,  935, 1, DVRK,  ,  ,  ,  ,  , , , , , ,  ,  , ,  NHC, AUT,    I, 65,
1, 64,   6, T, 63,  194, -683,  EYE, R9,  GOES8, T,
AL, 08, 199909131315,  20, DVTO,        I,  , 2412N,  7173W,     , 1, 127, 1,  935, 1, DVRK,  ,  ,  ,  ,  , , , , , ,  ,  , ,  NHC, AUT,    I, 65,
1, 63,   6, T, 61,  191, -658,  EYE, R9,  GOES8, T,
AL, 08, 199909131415,  20, DVTO,        I,  , 2417N,  7194W,     , 1, 127, 1,  935, 1, DVRK,  ,  ,  ,  ,  , , , , , ,  ,  , ,  NHC, AUT,    I, 65,
1, 62,   6, T, 61,  187, -654,  EYE, R9,  GOES8, T,
<records deleted from listing>
AL, 08, 199909152245,  20, DVTO,        I,  , 3179N,  7841W,     , 1, 109, 1,  960, 1, DVRK,  ,  ,  ,  ,  , , , , , ,  ,  , ,  NHC, AUT,    I, 58,
1, 54,   6, T, 56,   28, -607,  EYE, R9,  GOES8, T,
AL, 08, 199909152345,  20, DVTO,        I,  , 3209N,  7837W,     , 1, 109, 1,  960, 1, DVRK,  ,  ,  ,  ,  , , , , , ,  ,  , ,  NHC, AUT,    I, 58,
1, 54,   6, T, 56,   20, -602,  EYE, R9,  GOES8, T,
AL, 08, 199909160015,  20, DVTO,        I,  , 3234N,  7833W,     , 1, 109, 1,  960, 1, DVRK,  ,  ,  ,  ,  , , , , , ,  ,  , ,  NHC, AUT,    I, 58,
1, 53,   6, T, 49,  -77, -608,  EYE, 89,  GOES8, T,
AL, 08, 199909160145,  20, DVTO,        I,  , 3279N,  7826W,     , 1, 109, 1,  961, 1, DVRK,  ,  ,  ,  ,  , , , , , ,  ,  , ,  NHC, AUT,    I, 58,
1, 51,   6, T, 48,  -72, -602,  EYE, R9,  GOES8, T,
```

E.) History File Output

1.) Text Output

a.) Original Format Listing

A listing of the history file contents can be displayed within the McIDAS text display window or written to an output file using the LIST parameter with the DATE and OUTPUT keywords. An example of an original format listing is provided below:

```
=====  ADT-Versio =====
               ----Intensity--- -Tno Values-- --------Tno/CI Rules-------- -Temperature-
          Time        MSLP/Vmax   Fnl Adj Ini   Cnstrnt Wkng Rpd   ET   ST   Cntr   Mean   Scene  EstRMW   MW   Storm Location  Fix
   Date   (UTC)   CI  (CKZ)/(kts)  Tno Raw Raw   Limit  Flag Wkng Flag Flag Region  Cloud  Type    (km)  Score   Lat     Lon    Mthd   Sat   VZA  Comments
2012OCT14 033000  3.0 1001.4  45.0  3.0 3.0 3.0  NO LIMIT  OFF  OFF  OFF  OFF -70.36 -53.39  UNIFRM   N/A   -0.0   14.22  114.16  FCST  GOES15 29.2
2012OCT14 040000  3.1 1000.2  47.0  3.1 3.2 3.2  NO LIMIT  OFF  OFF  OFF  OFF -73.66 -57.29  UNIFRM   N/A   -0.0   14.23  114.21  FCST  GOES15 29.2
2012OCT14 043000  3.1 1000.2  47.0  3.1 3.2 3.2  NO LIMIT  OFF  OFF  OFF  OFF -73.66 -60.37  UNIFRM   N/A   -0.0   14.25  114.26  FCST  GOES15 29.2
2012OCT14 050000  3.1 1000.2  47.0  3.1 3.3 3.3  NO LIMIT  OFF  OFF  OFF  OFF -74.66 -62.27  UNIFRM   N/A   -0.0   14.27  114.31  FCST  GOES15 29.1
2012OCT14 053000  3.2  998.9  49.0  3.2 3.3 3.3  NO LIMIT  OFF  OFF  OFF  OFF -69.46 -63.78  UNIFRM   N/A   -0.0   14.29  114.36  FCST  GOES15 29.1
2012OCT14 060000  3.2 1000.9  49.0  3.2 3.3 3.3  NO LIMIT  OFF  OFF  OFF  OFF -55.66 -64.01  UNIFRM   N/A   N/A    14.30  114.41  FCST  GOES15 29.1
2012OCT14 063000  3.2 1000.9  49.0  3.2 3.2 3.2  NO LIMIT  OFF  OFF  OFF  OFF -48.46 -63.51  UNIFRM   N/A   N/A    14.32  114.45  FCST  GOES15 29.0
2012OCT14 070000  3.2 1000.9  49.0  3.2 3.2 3.2  NO LIMIT  OFF  OFF  OFF  OFF -40.06 -62.27  UNIFRM   N/A   N/A    14.34  114.49  FCST  GOES15 29.0
2012OCT14 073000  3.2 1000.9  49.0  3.2 3.2 3.2  NO LIMIT  OFF  OFF  OFF  OFF -40.76 -60.92  EMBC     N/A   N/A    14.36  114.53  FCST  GOES15 29.0
2012OCT14 080000  3.2 1000.9  49.0  3.2 3.1 3.1  NO LIMIT  OFF  OFF  OFF  OFF -46.46 -59.31  UNIFRM   N/A   N/A    14.39  114.57  FCST  GOES15 29.0
2012OCT14 083000  3.2 1001.0  49.0  3.2 3.1 3.1  NO LIMIT  OFF  OFF  OFF  OFF -58.76 -51.62  IRRCDO   N/A   N/A    14.26  114.46  FCST  GOES15 29.0
2012OCT14 090000  3.2 1000.9  49.0  3.1 2.9 2.8  0.2T/hour  ON  OFF  OFF  OFF -65.56 -52.56  UNIFRM   N/A   N/A    14.30  114.50  FCST  GOES15 29.0
2012OCT14 093000  3.2 1000.9  49.0  3.0 2.9 2.8  0.2T/hour  ON  OFF  OFF  OFF -69.86 -54.18  UNIFRM   N/A   N/A    14.34  114.54  FCST  GOES15 29.0
2012OCT14 100000  3.2 1000.9  49.0  3.0 3.2 3.2  NO LIMIT   ON  OFF  OFF  OFF -71.26 -56.59  IRRCDO   N/A   N/A    14.37  114.58  FCST  GOES15 28.9
2012OCT14 103000  3.2 1000.9  49.0  3.0 2.9 2.9  NO LIMIT   ON  OFF  OFF  OFF -69.86 -57.24  UNIFRM   N/A   N/A    14.41  114.62  FCST  GOES15 28.9
2012OCT14 110000  3.2 1000.9  49.0  3.0 2.9 2.9  NO LIMIT   ON  OFF  OFF  OFF -67.26 -58.40  UNIFRM   N/A   N/A    14.45  114.66  FCST  GOES15 28.9
2012OCT14 113000  3.2 1000.8  49.0  2.9 3.0 3.0  NO LIMIT   ON  OFF  OFF  OFF -65.16 -58.95  UNIFRM   N/A   N/A    14.49  114.69  FCST  GOES15 28.9
<records deleted from listing>
2012OCT14 203000  3.5  994.6  55.0  3.5 3.5 3.5  NO LIMIT  OFF  OFF  OFF  OFF -65.16 -66.42  UNIFRM   N/A   N/A    15.34  115.18  FCST  GOES15 29.0
2012OCT14 210000  3.5  994.6  55.0  3.5 3.4 3.4  NO LIMIT  OFF  OFF  OFF  OFF -64.36 -65.05  UNIFRM   N/A   N/A    15.40  115.20  FCST  GOES15 29.1
2012OCT14 213000  3.5  994.6  55.0  3.5 3.4 3.4  NO LIMIT  OFF  OFF  OFF  OFF -62.46 -64.99  UNIFRM   N/A   N/A    15.46  115.22  FCST  GOES15 29.1
2012OCT14 220000  3.5  994.5  55.0  3.4 3.3 3.3  NO LIMIT   ON  OFF  OFF  OFF -59.46 -64.81  UNIFRM   N/A   N/A    15.52  115.23  FCST  GOES15 29.1
2012OCT14 223000  3.5  994.5  55.0  3.4 3.3 3.3  NO LIMIT   ON  OFF  OFF  OFF -62.46 -65.18  UNIFRM   N/A   N/A    15.57  115.25  FCST  GOES15 29.1
2012OCT14 230000  3.5  994.5  55.0  3.4 3.3 3.3  NO LIMIT   ON  OFF  OFF  OFF -68.96 -65.29  UNIFRM   N/A   N/A    15.63  115.27  FCST  GOES15 29.2
2012OCT14 233000  3.5  994.4  55.0  3.3 3.3 3.3  NO LIMIT   ON  OFF  OFF  OFF -69.46 -64.41  UNIFRM   N/A   N/A    15.68  115.28  FCST  GOES15 29.2
2012OCT15 000000  3.5  993.4  55.0  3.5 3.5 3.3  MW Adjst   ON  OFF  OFF  OFF -68.06 -65.31  UNIFRM   N/A   N/A    15.73  115.29  FCST  GOES15 29.2 MWinit1=3.3/3.3/3.5
2012OCT15 003000  3.5  993.4  55.0  3.5 3.5 3.3  MW Adjst   ON  OFF  OFF  OFF -65.96 -65.53  UNIFRM   N/A   N/A    15.79  115.31  FCST  GOES15 29.2 MWinit1=3.3/3.3/3.5
2012OCT15 010000  3.6  992.1  57.0  3.6 3.6 3.4  MW Adjst   ON  OFF  OFF  OFF -61.66 -67.75  UNIFRM   N/A   N/A    15.84  115.32  FCST  GOES15 29.3 MWinit1=3.4/3.3/3.5
2012OCT15 013000  3.6  992.0  57.0  3.6 3.6 3.4  MW Adjst   ON  OFF  OFF  OFF -60.16 -69.73  UNIFRM   N/A   N/A    15.89  115.33  FCST  GOES15 29.3 MWinit1=3.4/3.3/3.5
2012OCT15 020000  3.7  990.7  59.0  3.7 3.7 3.5  MW Adjst   ON  OFF  OFF  OFF -71.26 -71.44  UNIFRM   N/A   N/A    15.95  115.35  FCST  GOES15 29.3 MWinit1=3.5/3.3/3.5
2012OCT15 023000  3.7  990.8  59.0  3.7 3.7 3.7  MW Adjst   ON  OFF  OFF  OFF -80.56 -75.44  UNIFRM   N/A   N/A    15.72  115.30  FCST  GOES15 29.2 MWinit1=3.7/3.4/3.5
2012OCT15 030000  3.8  989.4  61.0  3.8 3.8 3.7  MW Adjst   ON  OFF  OFF  OFF -78.26 -76.49  UNIFRM   N/A   N/A    15.80  115.30  FCST  GOES15 29.2 MWinit1=3.7/3.4/3.5
2012OCT15 033000  3.8  989.4  61.0  3.8 3.8 3.7  MW Adjst  OFF  OFF  OFF  OFF -73.66 -75.53  UNIFRM   N/A   N/A    15.88  115.30  FCST  GOES15 29.3 MWinit1=3.7/3.5/3.5
2012OCT15 040000  3.9  988.0  63.0  3.9 3.9 3.6  MW Adjst  OFF  OFF  OFF  OFF -66.86 -73.71  UNIFRM   N/A   13.9   15.96  115.30  FCST  GOES15 29.4 MWinit1=3.6/3.6/3.6
2012OCT15 043000  4.0  986.6  65.0  4.0 4.0 3.6  MW Adjst  OFF  OFF  OFF  OFF -63.16 -71.29  EMBC     N/A   13.9   16.03  115.30  FCST  GOES15 29.4 MWinit1=3.6/3.6/3.6
2012OCT15 050000  4.0  986.6  65.0  4.0 4.0 3.5  MW Adjst  OFF  OFF  OFF  OFF -60.86 -69.13  UNIFRM   N/A   13.9   16.11  115.29  FCST  GOES15 29.5 MWinit1=3.5/3.6/3.6
2012OCT15 053000  4.1  984.9  67.4  4.1 4.1 3.5  MW Adjst  OFF  OFF  OFF  OFF -59.76 -67.72  UNIFRM   N/A   13.9   16.18  115.29  FCST  GOES15 29.5 MWinit1=3.5/3.6/3.6
2012OCT15 060000  4.1  984.9  67.4  4.1 4.1 3.4  MW Adjst   ON  OFF  OFF  OFF -58.36 -66.82  UNIFRM   N/A   13.9   16.26  115.29  FCST  GOES15 29.6 MWinit1=3.4/3.5/3.6
2012OCT15 063000  4.2  983.2  69.8  4.2 4.2 3.4  MW Adjst   ON  OFF  OFF  OFF -56.66 -66.66  EMBC     N/A   13.9   16.34  115.29  FCST  GOES15 29.6 MWinit1=3.4/3.5/3.6
2012OCT15 070000  4.3  981.5  72.2  4.3 4.3 3.4  MW Adjst   ON  OFF  OFF  OFF -58.36 -66.91  UNIFRM   N/A   13.9   16.41  115.28  FCST  GOES15 29.7 MWinit1=3.4/3.4/3.6
2012OCT15 073000  4.3  981.4  72.2  4.3 4.3 3.3  MW Adjst   ON  OFF  OFF  OFF -56.66 -66.00  UNIFRM   N/A   13.9   16.49  115.28  FCST  GOES15 29.8 MWinit1=3.3/3.4/3.6
2012OCT15 080000  4.4  979.7  74.6  4.4 4.4 3.3  MW Adjst   ON  OFF  OFF  OFF -48.16 -64.59  EMBC     N/A   13.9   16.56  115.27  FCST  GOES15 29.8 MWinit1=3.3/3.3/3.6
2012OCT15 083000  4.5  978.2  77.0  4.5 4.5 3.6  MW Adjst   ON  OFF  OFF  OFF -69.86 -76.28  UNIFRM   N/A   13.9   16.11  114.92  FCST  GOES15 29.8 MWinit1=3.6/3.4/3.6
2012OCT15 090000  4.5  978.1  77.0  4.5 4.5 3.6  MW Adjst   ON  OFF  OFF  OFF -68.96 -75.06  UNIFRM   N/A   13.9   16.20  114.90  FCST  GOES15 29.9 MWinit1=3.6/3.4/3.6
2012OCT15 093000  4.6  976.2  79.6  4.6 4.6 3.6  MW Adjst   ON  OFF  OFF  OFF -68.06 -74.40  UNIFRM   N/A   13.9   16.29  114.89  FCST  GOES15 30.0 MWinit1=3.6/3.4/3.6
2012OCT15 100000  4.6  976.2  79.6  4.6 4.6 3.7  MW Adjst   ON  OFF  OFF  OFF -61.26 -74.08  EMBC     N/A   13.9   16.39  114.87  FCST  GOES15 30.0 MWinit1=3.7/3.5/3.6
2012OCT15 103000  4.7  974.2  82.2  4.7 4.7 3.7  MW Adjst   ON  OFF  OFF  OFF -64.76 -75.64  EMBC     N/A   13.9   16.48  114.86  FCST  GOES15 30.1 MWinit1=3.7/3.5/3.6
2012OCT15 110000  4.8  972.2  84.8  4.8 4.8 3.7  MW Adjst  OFF  OFF  OFF  OFF -56.66 -77.94  EMBC     N/A   13.9   16.73  114.68  SPRL  GOES15 30.4 MWinit1=3.7/3.6/3.6
2012OCT15 113000  4.8  972.2  84.8  4.8 4.8 3.7  MW Adjst  OFF  OFF  OFF  OFF -59.06 -78.24  EMBC     N/A   13.9   16.73  114.77  SPRL  GOES15 30.4 MWinit1=3.7/3.6/3.6
2012OCT15 120000  4.9  971.1  87.4  4.9 4.9 3.8  MW ON     OFF  OFF  OFF  OFF -59.06 -78.69  EMBC     N/A   57.8   16.83  114.66  SPRL  GOES15 30.5 MWinit2=4.3/4.3/4.3
2012OCT15 123000  4.9  971.1  87.4  4.9 4.9 3.8  MW ON     OFF  OFF  OFF  OFF -55.96 -78.14  EMBC     N/A   57.8   16.93  114.64  SPRL  GOES15 30.6 MWinit2=4.3/4.3/4.3
2012OCT15 130000  5.0  969.1  90.0  5.0 5.0 3.8  MW ON     OFF  OFF  OFF  OFF -57.66 -76.63  UNIFRM   N/A   57.8   17.03  114.73  SPRL  GOES15 30.6 MWinit2=4.3/4.3/4.3
2012OCT15 133000  5.0  969.1  90.0  5.0 5.0 3.8  MW ON     OFF  OFF  OFF  OFF -65.56 -76.70  UNIFRM   N/A   77.3   17.03  114.61  SPRL  GOES15 30.7
2012OCT15 140000  5.0  969.0  90.0  5.0 5.0 3.8  MW ON     OFF  OFF  OFF  OFF -70.36 -75.65  UNIFRM   N/A   77.3   17.13  114.59  SPRL  GOES15 30.8
2012OCT15 143000  5.0  969.0  90.0  5.0 5.0 4.2  MW ON     OFF  OFF  OFF  OFF -65.56 -74.68  EMBC     N/A   77.3   17.16  114.56  SPRL  GOES15 30.8
2012OCT15 150000  5.0  969.0  90.0  5.0 5.0 6.3  MW ON     OFF  OFF  OFF  OFF -22.98 -74.09  EYE/P  -99 IR  77.3   17.25  114.54  SPRL  GOES15 30.9
2012OCT15 153000  5.0  968.9  90.0  5.0 5.0 6.2  MW ON     OFF  OFF  OFF  OFF -20.18 -72.93  EYE/P  -99 IR  77.3   17.44  114.52  SPRL  GOES15 31.1
2012OCT15 160000  5.0  968.9  90.0  5.0 5.5 6.1  MW AdjEnd OFF  OFF  OFF  OFF -27.46 -72.58  EYE    -99 IR  77.3   17.43  114.40  SPRL  GOES15 31.2
2012OCT15 163000  5.2  965.1  94.8  5.2 6.1 6.1  NO LIMIT  OFF  OFF  OFF  OFF -12.56 -70.47  EYE    -99 IR  77.3   17.63  114.48  SPRL  GOES15 31.3
2012OCT15 170000  5.3  963.1  97.2  5.3 5.9 5.9  NO LIMIT  OFF  OFF  OFF  OFF -18.26 -68.75  EYE    -99 IR  77.3   17.72  114.56  COMBO GOES15 31.3
2012OCT15 173000  5.5  959.3 102.0  5.5 6.2 6.2  NO LIMIT  OFF  OFF  OFF  OFF   6.74 -68.19  EYE     19 IR  77.3   17.72  114.53  COMBO GOES15 31.3
2012OCT15 180000  5.7  955.0 107.2  5.7 6.3 6.3  NO LIMIT  OFF  OFF  OFF  OFF   7.94 -68.28  EYE     21 IR  77.3   17.82  114.40  COMBO GOES15 31.5
2012OCT15 183000  5.8  952.8 109.8  5.8 6.2 6.2  NO LIMIT  OFF  OFF  OFF  OFF   8.84 -67.74  EYE     23 IR  77.3   17.91  114.38  COMBO GOES15 31.5
2012OCT15 190000  6.0  948.4 115.0  6.0 6.3 6.3  NO LIMIT  OFF  OFF  OFF  OFF   8.24 -68.05  EYE     25 IR  77.3   18.01  114.25  COMBO GOES15 31.7
2012OCT15 193000  6.1  946.3 117.4  6.1 6.3 6.3  NO LIMIT  OFF  OFF  OFF  OFF   7.94 -67.90  EYE     23 IR  77.3   18.12  114.22  COMBO GOES15 31.8
2012OCT15 200000  6.1  946.1 117.4  6.1 6.1 6.1  NO LIMIT  OFF  OFF  OFF  OFF   2.64 -66.89  EYE     25 IR  77.3   18.42  114.19  COMBO GOES15 32.1
2012OCT15 203000  6.2  944.1 119.8  6.2 6.0 6.0  NO LIMIT  OFF  OFF  OFF  OFF  -6.26 -67.32  EYE     25 IR  77.3   18.35  114.18  COMBO GOES15 32.0
2012OCT15 210000  6.2  944.0 119.8  6.1 6.0 6.0  NO LIMIT   ON  OFF  OFF  OFF  -7.56 -66.42  EYE     24 IR  77.3   18.45  114.15  COMBO GOES15 32.1
2012OCT15 213000  6.2  944.0 119.8  6.1 6.0 6.0  NO LIMIT   ON  OFF  OFF  OFF   1.14 -65.52  EYE     19 IR  77.3   18.55  114.00  COMBO GOES15 32.3
2012OCT15 220000  6.2  943.9 119.8  6.0 5.9 5.9  NO LIMIT   ON  OFF  OFF  OFF   0.04 -64.97  EYE     23 IR  77.3   18.75  113.97  COMBO GOES15 32.5
2012OCT15 223000  6.2  943.9 119.8  6.0 5.7 5.7  NO LIMIT   ON  OFF  OFF  OFF  -7.56 -64.05  EYE     18 IR  77.3   18.85  113.93  COMBO GOES15 32.6
2012OCT15 230000  6.2  943.8 119.8  5.8 5.5 5.5  NO LIMIT   ON  FLG  OFF  OFF -14.26 -62.77  EYE     23 IR  77.3   18.96  113.89  COMBO GOES15 32.7
2012OCT15 233000  6.2  943.7 119.8  5.7 5.4 5.4  NO LIMIT   ON  FLG  OFF  OFF -14.86 -61.39  EYE     21 IR  49.1   19.16  113.85  COMBO GOES15 32.9
2012OCT16 000000  6.2  943.7 119.8  5.6 5.3 5.3  NO LIMIT   ON  FLG  OFF  OFF -15.36 -60.46  EYE     20 IR  49.1   19.26  113.81  COMBO GOES15 33.0
<records deleted from listing
2012OCT16 110000  5.7  951.7 107.2  5.5 5.4 5.4  NO LIMIT   ON  OFF  OFF  OFF -47.06 -67.90  EYE    -99 IR  47.3   22.65  112.18  SPRL  GOES15 36.9
2012OCT16 113000  5.7  951.6 107.2  5.4 4.8 4.6  0.7T/6hr   ON  OFF  OFF  OFF -65.96 -67.77  UNIFRM   N/A   47.3   22.77  112.27  SPRL  GOES15 36.9
2012OCT16 120000  5.7  951.6 107.2  5.2 4.8 4.6  0.7T/6hr   ON  FLG  OFF  OFF -70.36 -70.13  UNIFRM   N/A   47.3   22.88  112.25  SPRL  GOES15 37.0
2012OCT16 123000  5.7  951.2 107.2  5.1 5.0 4.4  0.7T/6hr   ON  FLG  OFF  OFF -65.16 -65.79  UNIFRM   N/A   47.3   23.57  112.12  FCST  GOES15 37.6
2012OCT16 130000  5.6  953.3 104.6  5.0 4.9 4.3  0.7T/6hr   ON  FLG  OFF  OFF -67.26 -63.35  UNIFRM   N/A    5.8   23.80  112.07  FCST  GOES15 37.9
2012OCT16 133000  5.6  953.1 104.6  5.0 4.9 4.2  0.7T/6hr   ON  FLG  OFF  OFF -71.66 -61.66  UNIFRM   N/A    5.8   24.02  112.02  FCST  GOES15 38.1
2012OCT16 140000  5.5  955.4 102.0  4.9 4.8 4.6  0.7T/6hr   ON  FLG  OFF  OFF -71.66 -70.12  UNIFRM   N/A    5.8   23.79  112.03  SPRL  GOES15 37.9
2012OCT16 143000  5.5  955.3 102.0  4.8 4.8 4.6  0.7T/6hr   ON  FLG  OFF  OFF -67.66 -70.29  UNIFRM   N/A    5.8   23.91  111.94  SPRL  GOES15 38.0
2012OCT16 150000  5.5  955.2 102.0  4.8 4.8 4.6  0.7T/6hr   ON  FLG  OFF  OFF -69.46 -69.50  UNIFRM   N/A    5.8   24.15  112.04  SPRL  GOES15 38.2
2012OCT16 153000  5.5  955.2 102.0  4.8 4.8 4.6  0.7T/6hr   ON  FLG  OFF  OFF -68.06 -68.93  UNIFRM   N/A    5.8   24.19  112.02  SPRL  GOES15 38.2
2012OCT16 160000  5.5  955.2 102.0  4.8 4.8 4.4  0.7T/6hr   ON  OFF  OFF  OFF -67.26 -66.19  UNIFRM   N/A    5.8   24.13  111.90  SPRL  GOES15 38.2
2012OCT16 163000  5.5  955.2 102.0  4.8 4.8 4.3  0.7T/6hr   ON  OFF  OFF  OFF -67.26 -62.92  UNIFRM   N/A    5.8   24.16  111.88  SPRL  GOES15 38.3
2012OCT16 170000  5.5  955.1 102.0  4.8 4.8 4.3  0.7T/6hr   ON  OFF  OFF  OFF -60.16 -62.28  UNIFRM   N/A    5.8   24.39  111.64  SPRL  GOES15 38.6
2012OCT16 173000  0.0    0.0   0.0  0.0 0.0 0.0            N/A  N/A  OFF  OFF  99.50  99.50  LAND     N/A   N/A    24.62  111.62  SPRL  GOES15 38.8
2012OCT16 180000  0.0    0.0   0.0  0.0 0.0 0.0            N/A  N/A  OFF  OFF  99.50  99.50  LAND     N/A   N/A    24.94  111.49  SPRL  GOES15 39.2
2012OCT16 183000  0.0    0.0   0.0  0.0 0.0 0.0            N/A  N/A  OFF  OFF  99.50  99.50  LAND     N/A   N/A    25.06  111.47  SPRL  GOES15 39.3
2012OCT16 190000  0.0    0.0   0.0  0.0 0.0 0.0            N/A  N/A  OFF  OFF  99.50  99.50  LAND     N/A   N/A    25.08  111.33  SPRL  GOES15 39.4
2012OCT16 193000  0.0    0.0   0.0  0.0 0.0 0.0            N/A  N/A  OFF  OFF  99.50  99.50  LAND     N/A   N/A    24.94  112.03  FCST  GOES15 38.8
2012OCT16 200000  0.0    0.0   0.0  0.0 0.0 0.0            N/A  N/A  OFF  OFF  99.50  99.50  LAND     N/A   N/A    25.05  112.01  FCST  GOES15 38.9
Utilizing history file /home/adt/adt91/scripts/history/16E.ODT
Successfully completed listing
```

The text output displays time, date, all intensity values (CI# with corresponding adjusted MSLP and wind values, Final T#s, and the Adjusted and Initial/Unadjusted Raw T# values), T#/CI# constraint and weakening rules, eye and cloud region temperatures, scene type, estimated radius of maximum wind value, MW eye score values, storm position, and storm center fix method (manual or automated technique). Any comments that have been entered will be displayed at the end of each history file entry.

If an external ASCII output file is desired, the ADT keyword command “OUTPUT=FILE <filename>“ is used. The directory location where the output text file is written is defined with the ADT environment argument ODTOUTPUT. For example, an output file defined as “listing.txt” will produce the following output message:

```
History file listing written to ASCII file /home/adt/output/listing.txt
```

b.) ATCF Format Listing

Any or all records a history file can be displayed in ATCF format using the ATCF keyword in conjunction with the LIST parameter. The output will be displayed in the text output window unless specifically requested to be stored in an output file using the OUTPUT keyword. A sample ATCF format file is displayed below:

```
===== ADT-Version 9.1 =====

AL, 08, 199909081515,  20, DVTO,          I,  , 1581N,  5006W,      , 3,  45, 2, 1000, 2, DVRK,   ,    ,    ,    ,    ,   , , , , ,
,   ,   , ,   NHC, AUT,    I, 30, 2, 30,   6, T, 30, -158, -276, SHER,   ,  GOES8, T,
AL, 08, 199909081615,  20, DVTO,          I,  , 1585N,  5027W,      , 3,  45, 2, 1000, 2, DVRK,   ,    ,    ,    ,    ,   , , , , ,
,   ,   , ,   NHC, AUT,    I, 30, 2, 30,   6, T, 31,  -61, -288, SHER, R8,  GOES8, T,
AL, 08, 199909081715,  20, DVTO,          I,  , 1590N,  5050W,      , 2,  45, 2, 1000, 2, DVRK,   ,    ,    ,    ,    ,   , , , , ,
,   ,   , ,   NHC, AUT,    I, 30, 2, 30,   6, T, 30,  -55, -338, ICDO, R8,  GOES8, T,
AL, 08, 199909081815,  20, DVTO,          I,  , 1596N,  5072W,      , 2,  45, 2, 1000, 2, DVRK,   ,    ,    ,    ,    ,   , , , , ,
,   ,   , ,   NHC, AUT,    I, 30, 2, 29,   6, T, 29, -199, -365, ICDO, R8,  GOES8, T,
AL, 08, 199909081915,  20, DVTO,          I,  , 1602N,  5095W,      , 3,  45, 2, 1000, 2, DVRK,   ,    ,    ,    ,    ,   , , , , ,
,   ,   , ,   NHC, AUT,    I, 30, 2, 29,   6, T, 30, -415, -340, CBND,   ,  GOES8, T,
AL, 08, 199909082015,  20, DVTO,          I,  , 1606N,  5118W,      , 2,  45, 2, 1000, 2, DVRK,   ,    ,    ,    ,    ,   , , , , ,
,   ,   , ,   NHC, AUT,    I, 30, 2, 29,   6, T, 29, -293, -354, ICDO, R8,  GOES8, T,
AL, 08, 199909082115,  20, DVTO,          I,  , 1662N,  5175W,      , 3,  45, 2, 1000, 2, DVRK,   ,    ,    ,    ,    ,   , , , , ,
,   ,   , ,   NHC, AUT,    I, 30, 2, 29,   6, T, 30, -349, -451, CBND, R8,  GOES8, T,
<records deleted from listing>
AL, 08, 199909101445,  20, DVTO,          I,  , 1956N,  5963W,      , 2,  77, 2,  975, 2, DVRK,   ,    ,    ,    ,    ,   , , , , ,
,   ,   , ,   NHC, AUT,    I, 45, 2, 45,   6, T, 45, -651, -685,  CDO,   ,  GOES8, T,
AL, 08, 199909101545,  20, DVTO,          I,  , 1950N,  5947W,      , 2,  77, 2,  975, 2, DVRK,   ,    ,    ,    ,    ,   , , , , ,
,   ,   , ,   NHC, AUT,    I, 45, 2, 45,   6, T, 45, -601, -648, EMBC,   ,  GOES8, T,
AL, 08, 199909101645,  20, DVTO,          I,  , 1965N,  6004W,      , 2,  77, 2,  975, 2, DVRK,   ,    ,    ,    ,    ,   , , , , ,
,   ,   , ,   NHC, AUT,    I, 45, 2, 45,   6, T, 45, -655, -646,  CDO,   ,  GOES8, T,
AL, 08, 199909101745,  20, DVTO,          I,  , 1993N,  5988W,      , 2,  77, 2,  976, 2, DVRK,   ,    ,    ,    ,    ,   , , , , ,
,   ,   , ,   NHC, AUT,    I, 45, 2, 44,   6, T, 45, -664, -656,  CDO,   ,  GOES8, T,
AL, 08, 199909101815,  20, DVTO,          I,  , 1986N,  5984W,      , 2,  77, 2,  975, 2, DVRK,   ,    ,    ,    ,    ,   , , , , ,
,   ,   , ,   NHC, AUT,    I, 45, 2, 45,   6, T, 46, -612, -658, EMBC,   ,  GOES8, T,
<records deleted from listing>
AL, 08, 199909131015,  20, DVTO,          I,  , 2400N,  7105W,      , 1, 127, 1,  935, 1, DVRK,   ,    ,    ,    ,    ,   , , , , ,
,   ,   , ,   NHC, AUT,    I, 65, 1, 65,   6, T, 65,  194, -704,  EYE,   ,  GOES8, T,
AL, 08, 199909131115,  20, DVTO,          I,  , 2404N,  7127W,      , 1, 127, 1,  935, 1, DVRK,   ,    ,    ,    ,    ,   , , , , ,
,   ,   , ,   NHC, AUT,    I, 65, 1, 64,   6, T, 64,  191, -698,  EYE,   ,  GOES8, T,
AL, 08, 199909131215,  20, DVTO,          I,  , 2407N,  7151W,      , 1, 127, 1,  935, 1, DVRK,   ,    ,    ,    ,    ,   , , , , ,
,   ,   , ,   NHC, AUT,    I, 65, 1, 64,   6, T, 63,  194, -683,  EYE, R9,  GOES8, T,
AL, 08, 199909131315,  20, DVTO,          I,  , 2412N,  7173W,      , 1, 127, 1,  935, 1, DVRK,   ,    ,    ,    ,    ,   , , , , ,
,   ,   , ,   NHC, AUT,    I, 65, 1, 63,   6, T, 61,  191, -658,  EYE, R9,  GOES8, T,
AL, 08, 199909131415,  20, DVTO,          I,  , 2417N,  7194W,      , 1, 127, 1,  935, 1, DVRK,   ,    ,    ,    ,    ,   , , , , ,
,   ,   , ,   NHC, AUT,    I, 65, 1, 62,   6, T, 61,  187, -654,  EYE, R9,  GOES8, T,
<records deleted from listing>
AL, 08, 199909152245,  20, DVTO,          I,  , 3179N,  7841W,      , 1, 109, 1,  960, 1, DVRK,   ,    ,    ,    ,    ,   , , , , ,
,   ,   , ,   NHC, AUT,    I, 58, 1, 54,   6, T, 56,   28, -607,  EYE, R9,  GOES8, T,
AL, 08, 199909152345,  20, DVTO,          I,  , 3209N,  7837W,      , 1, 109, 1,  960, 1, DVRK,   ,    ,    ,    ,    ,   , , , , ,
,   ,   , ,   NHC, AUT,    I, 58, 1, 54,   6, T, 56,   20, -602,  EYE, R9,  GOES8, T,
AL, 08, 199909160015,  20, DVTO,          I,  , 3234N,  7833W,      , 1, 109, 1,  960, 1, DVRK,   ,    ,    ,    ,    ,   , , , , ,
,   ,   , ,   NHC, AUT,    I, 58, 1, 53,   6, T, 49,  -77, -608,  EYE, 89,  GOES8, T,
AL, 08, 199909160145,  20, DVTO,          I,  , 3279N,  7826W,      , 1, 109, 1,  961, 1, DVRK,   ,    ,    ,    ,    ,   , , , , ,
,   ,   , ,   NHC, AUT,    I, 58, 1, 51,   6, T, 48,  -72, -602,  EYE, R9,  GOES8, T,
Utilizing history file /home/adt/output/FLOYD.ODT
Successfully completed listing
```

For more information on the ATCF format refer to Section 4D8.

2.) Graphical Output

A time series graph of intensity estimates and environmental temperature values stored within history files can be displayed within the McIDAS image/graphics window. **This is only available when the ADT is compiled in McIDAS mode (see Section 3).** Graphic capabilities are controlled using the ADT parameter PLOT along with the keywords COLOR, DOMAIN, CKZ, and DATE. WIND and TEM can also be used in conjunction with the PLOT parameter to plot the intensity estimates in terms of wind speed values or plot the various ADT temperature values over time, respectively

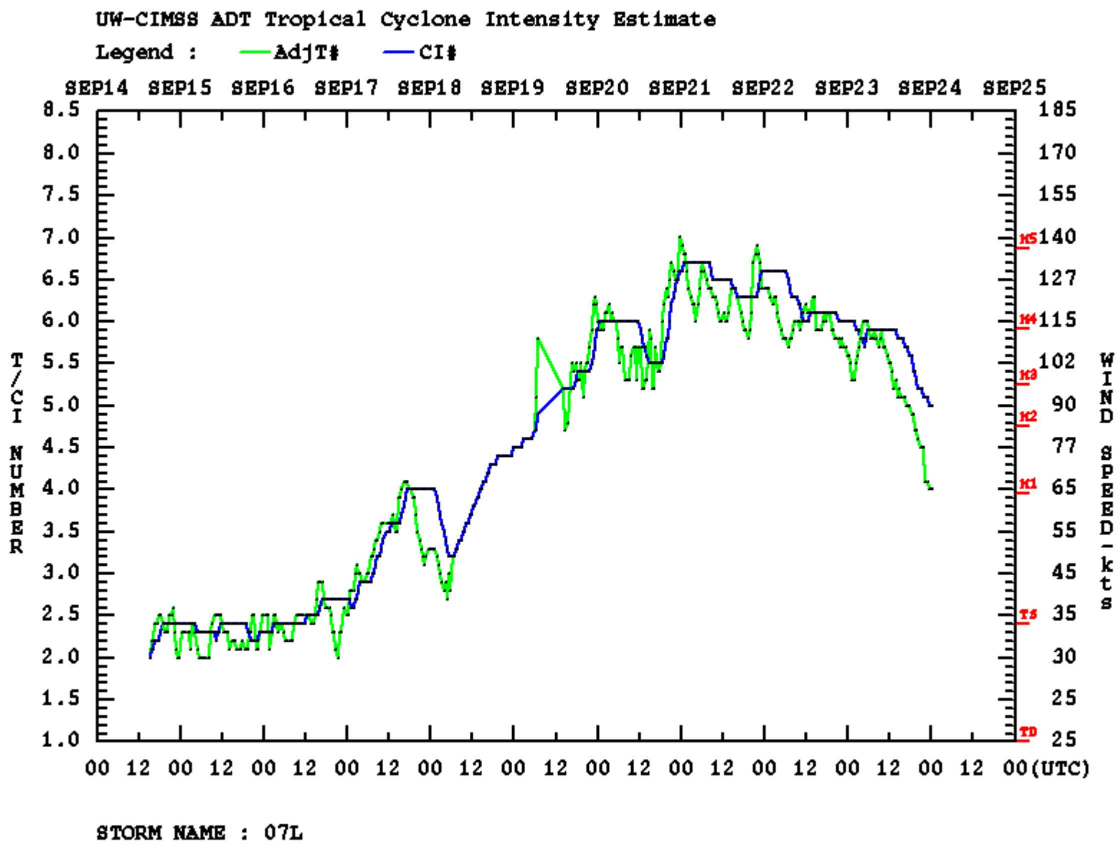

Figure 1: Example ADT graphical time-series output of a history file.

In Figure 1, the CI#, and Adjusted Raw T# (AdjT#) values are displayed. Any combination of the intensity estimate values can be plotted using the COLOR keyword (Section 4A1).

The intensity estimate values are plotted along the ordinate; CI#/T# values along the left hand side and corresponding pressure/wind values along the right side. Time is plotted along the abscissa, with Julian date and time (UTC) displayed at the bottom and the corresponding calendar day (month and day) plotted along the top of the graph. Any portion of the history file can be plotted using the DATE keyword. The various environmental temperature values calculated and used by the ADT in the intensity estimate calculations can also be graphed using the TEM parameter.

F.) ADT and ARCHER Satellite Information

The ADT and ARCHER utilize various channels from several different and currently operational (or soon to be operational) geostationary satellites. The ADT uses the Infrared "Clean Window" channel (approximate 10.7μm) for the ADT intensity analysis, as listed in Table 1.

Satellite	Channel	Central Wavelength	Description
GOES-16/17/18 ABI	13	10.3 μm	Infrared (IR) "Clean" Longwave Window
Himawari-8/9 AHI	13	10.4 μm	
Meteosat-8/9/10/11 SEVERI	9	10.8 μm	
Meteosat-12/13/14/15 FCI	14	10.5 μm	

Table 1: Current and near-future geostationary satellite channels used by the ADT algorithm to estimate the TC intensity.

The ARCHER automated storm positioning methodology uses a combination of MW imagery (approximately 89GHz channel) as well as three channels of geostationary imagery, the IR "Clean Window" Infrared channel, the 3.9μm Shortwave Infrared channel, and the "Red" Visible channel (approximately 0.64μm) as listed in Table 2.

Satellite	Channel	Central Wavelength	Description
GOES-16/17/18 ABI	13	10.3 μm	Infrared (IR) "Clean" Longwave Window
	7	3.9 μm	Shortwave Window Infrared
	2	0.64 μm	Visible "Red" Channel
Himawari-8/9 AHI	13	10.4 μm	Infrared (IR) "Clean" Longwave Window
	7	3.9 μm	Shortwave Window Infrared
	3	0.64 μm	Visible "Red" Channel
Meteosat-8/9/10/11 SEVERI	9	10.8 μm	Infrared (IR) "Clean" Longwave Window
	5	3.9 μm	Shortwave Window Infrared
	1	0.80 μm	Visible "Red" Channel
Meteosat-12/13/14/15 FCI	14	10.5 μm	Infrared (IR) "Clean" Longwave Window
	9	3.8 μm	Shortwave Window Infrared
	3	0.64 μm	Visible "Red" Channel

Table 2: Current and near-future geostationary satellite channels used by the ARCHER algorithm to determine the current TC center position.

5.) Background Information

A.) Land Flag

TC land interaction will be determined utilizing the high-resolution digital elevation map ***digilev_hires_le.map*** provided in the ADT package. The file supplied with the ADT package uses an 8-km surface elevation map, adopted from the GEOCAT library, which was originally derived from the USGS GTOPO30 dataset available on the USGS website at: http://edcdaac.usgs.gov/gtopo30/gtopo30.html.

To determine if a storm is over land, the topography flag corresponding to the storm location is examined. If the land/ocean flag indicates the storm is over land, no intensity estimate will be produced unless specifically requested by the user using the LAND keyword. The history file will still include an entry for any intensity estimate attempted while over land. Typically, the automated ADT will continue to attempt intensity estimates while the storm is over land until either the official TCFC forecasts are discontinued or the TC reemerges over the open ocean again and has not dissipated while over the land surface. The date and time(s), latitude, longitude, land flag, internal ADT satellite ID, and automated centering method values will contain their assigned values, however the values for the intensity estimates and the remaining parameters will be assigned a "missing value". All values will contain zero for their missing values except the four temperature values (99.50), the radius of maximum wind value (-99.5), and microwave eye score value (-99.5). Calculation of both Final T# values and the CI# value will exclude all "over land" entries once the storm resumes movement over open water (non-land grid points).

B.) Scene Classification

The original "decision tree" methodology of scene type determination patterned after the subjective Dvorak Technique has been replaced with a "scene score" determination scheme. This methodology helps alleviate the occasional rapid and unrealistic scene type variability in the ADT output between consecutive image analyses by replacing the "branches" in the decision tree methodology with natural threshold divisions (scores).

The scene score is a sum of selected environmental parameters measured from the satellite imagery for both the eye (when an eye is present, 0-24 km from the determined center position) and cloud region (24-136km from the center position) of the TC. These scores are used to objectively determine the storm scene type. Each parameter in the scene score derivation was originally a "branch" in the initial decision-tree methodology and is weighted by an empirically-determined value, shown in the equations listed below, chosen to closely mirror the influence of the parameter in the original determination methodology.

The eye region scene score is derived with the following equation:

Eye score = $FFT_{Eye} + BD_{Eye} + PrevEye + \Delta T_{Eye\text{-}Cloud} + Adj_{T\text{-}12hr}$

FFT_{Eye} : Number of harmonics in eye region Fast Fourier Transform
1.0-((EyeHarmonicValue – 2)*0.1)
BD_{Eye} : BD-enhancement category of eye region temperature
-1.0*(EyeBDCat*0.5)
PrevEye : Adjustment for previous record eye scene
+0.25
$\Delta T_{Eye\text{-}Cloud}$: Difference between eye and cloud region BD-enh. categories
(0.25*(CloudBDCat-EyeBDCat))+
(0.50*(CloudCWBDCat-EyeBDCat)
$Adj_{T\text{-}12hr}$: Adjustment for 12-hour previous record T# strength
MAX(-1.0,T#Value$_{T\text{-}12hrs}$ – 4.5)

The cloud region scene score is derived with the following equation:

Cloud score = $BD_{CloudCW} + BD_{Cloud} + FFT_{Cloud} + PrevScene + Adj_{T\text{-}12hr}$

$BD_{CloudCW}$: BD-enh. category of "coldest-warmest" cloud region temp.
CloudCWBDCat*0.25
BD_{Cloud} : BD-enhancement category of eye region temperature
CloudBDCat*0.25
FFT_{Cloud} : Adj. based on harmonics in cloud region Fast Fourier Trans.
If(CloudHarmonicValue<=2)value=MIN(1.5,$BD_{CloudCW}$*0.25)
PrevScene : Adjustment for previous record cloud scene
-0.50 if curved band or shear scene
$Adj_{T\text{-}12hr}$: Adjustment for 12-hour previous record T# strength
MIN(1.0,T#Value$_{T\text{-}12hrs}$ – 2.5)

More specific definitions and measurement details of utilized temperature categories and values, such as the "coldest-warmest" cloud region temperature value and BD enhancement category, are discussed here and in the following sections of this document.

- EyeHarmonicValue: Count of the number of times the harmonic values in the Fast Fourier Transform analysis increases over the previous value. Each harmonic value corresponds to a single cosine wave, at different frequencies, used to approximate the temperature histogram for the image region being investigated. More changes in the values indicate more harmonics and a less uniform temperature scene in the eye region.
- CloudHarmonicValue: Same as EyeHarmonicValue, but with cloud region.
- EyeBDCat: Gray scale category within the BD-curve enhancement of the eye region temperature value. The BD-curve enhancement is shown in Figure 4, with Table 3 listing the temperature breakdown values for each gray scale range.
- CloudBDCat: Same as EyeBDCat, but with cloud region temperature value.

- CloudCWBDCat: Same as EyeBDCat, but with cloud region "coldest warmest" temperature value.
- T#Value$_{T\text{-}12hrs}$: Final T# value at time 12 hours previous of current time.

The Fast Fourier Transform (FFT) analysis is a well-established and documented mathematical function to determine the variability of a "signal" over its range of values. In this case, the signal is the temperature histogram over a set temperature range. The FFT attempts to approximate this signal using a combination of a number of cosine waves with different frequency. A histogram with containing a large number of values in a small number of bins can be estimated with a low frequency cosine wave, while more chaotic histograms with more temperature value bins containing data can be approximated by the combination of several cosine waves at different frequencies.

Additional environmental variables are used in several specific checks to further refine eye and cloud scene types after the individual scene score values have been derived, such as the cloud symmetry value (discussed in Section 5H) to help determine an 'Irregular CDO' scene, or eye radius size to define a' Large Eye' scene.

The three/five eye/cloud region scene types are described below:

Eye Region Scene Type	Description
EYE	Any eye type (clear, ragged, and obscured)
PINHOLE	Very small eye/pronounced warm spot
LARGE	Clear, well-defined eye with radius >= 38 km

Cloud Region Scene Type	Description
UNIFORM CDO	Overcast cloud region with uniform temperature structure
EMBEDDED CENTER	Arc of convection within central overcast cloud region
IRREGULAR CDO	Cloud region over storm center, but large shift in coverage
CURVED BAND	Curved cloud region surrounding circulation center
SHEAR	Displaced convection and exposed circulation center

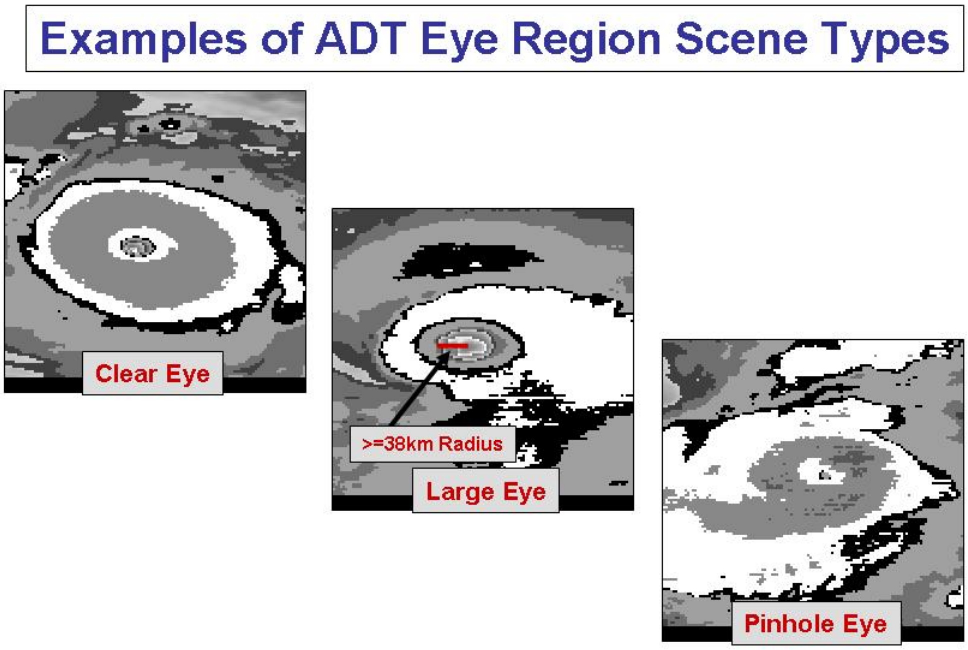

Figure 3: Examples of three ADT Eye Region scene types.

Examples of the three eye scene types are shown in Figure 3. Eye size is derived by measuring the distance across the eye between BD-curve "Dark Gray" temperature range edges (Figure 4). Table 3 lists the temperature ranges and the corresponding "gray scale" color values. Distances are measured at 90° angles outward from the auto-selected center location and are averaged to give an approximate eye size.

Temperature Range	Gray Scale Category/Comment
> +9°C	No enhancement – Low clouds
+9°C to -30°C	Off White – Cirrus Outflow Pattern
-30°C to -42°C	Dark Gray
-42°C to -54°C	Medium Gray
-54°C to -64°C	Light Gray
-64°C to -70°C	Black
-70°C to -76°C	White
-76°C to -80°C	Top Medium Gray
< -80°C	Top Dark Gray

Table 3: BD-curve enhancement temperature and corresponding gray scale values.

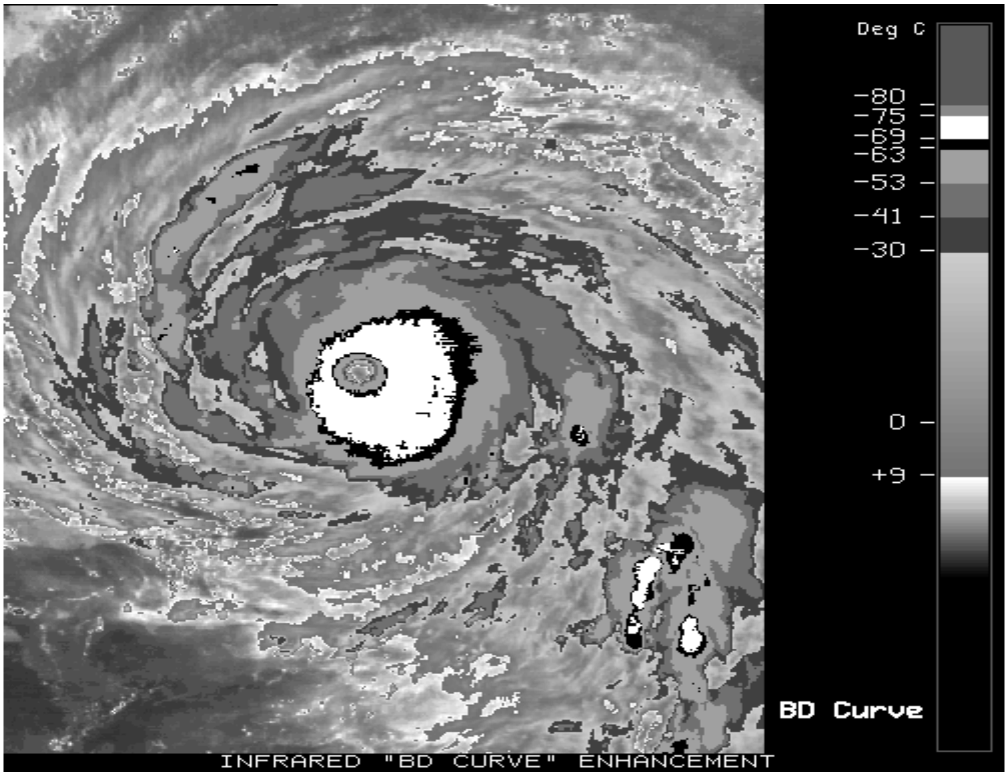

Figure 4: BD-curve Enhancement displayed on a longwave IR window channel image.

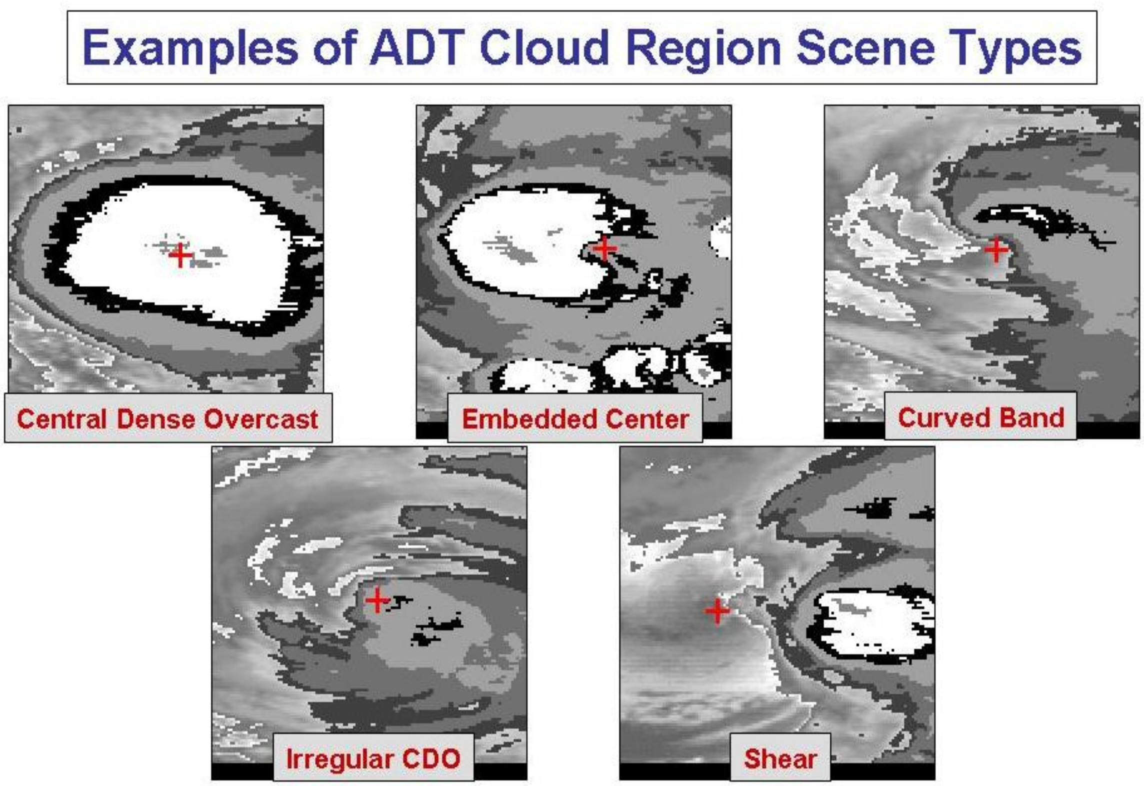

Figure 5: Examples of the five ADT Cloud Region scene types.

Examples of the five cloud region scene types are shown in Figure 5. If the cloud scene is determined to be a "Curved Band" type scene, a 10° Log Spiral analysis will be performed to determine the curvature extent of the convective cloud region around the selected center position (described in greater detail in Section 5H2). The amount of curvature depends on the BD-Curve Gray Scale (Table 3) being used. The algorithm will first target the "Light Gray" gray scale range to define the convective region of the curved band area. If this temperature region is devoid of significant activity or completely surrounds the selected storm center position in this gray scale range, analysis of warmer/colder ranges BD-curve temperature levels will be performed. Once a Curved Band gray scale and curvature amount at the provided storm center location is determined, an additional search will be performed to look for another possible storm center location that yields a greater amount of curvature in the cloud region, and thus a higher intensity estimate. This maximum curvature search value is supplied only as a reference to the ADT user and is not utilized in any way by the ADT algorithm or stored in the history file for future use/reference. It is supplied at the request of ADT users to help assess the accuracy of the curved band intensity calculation and to aid TCFC forecasters in the TC storm center determination process for possible storm center location adjustment. The location and associated amount of maximum cloud curvature can vary greatly from image to image, so interpretation of its value is left to the user to assess.

Once the scene type has been determined the intensity estimate for the derived scene type will be calculated using various environmental values such as the eye and surrounding cloud top temperatures, convective symmetry, eye and cloud region sizes, and other measured or derived values stored in the history file using various methods described in the following sections.

C.) Eye and Surrounding Cloud Region Temperature Determination

Proper determination of the storm center is paramount for an accurate storm intensity estimate since the eye and cloud region temperature value calculations are heavily dependent on this location.

Determination of the eye region temperature is straightforward. This temperature is assigned the value of the warmest pixel within a 24 km radius from the user or automated storm center location. Since an incorrect eye temperature can lead to an incorrect intensity estimate, proper selection of the storm center location is essential.

Calculations of the two surrounding cloud region temperature values are a bit more complicated than for the eye temperature. The first cloud region temperature value computed is centered at the storm center location and lies between 24 and 136 km from the center location. Individual analysis rings are selected, and are dependent upon the resolution of the satellite imagery. Thus for a 4 km resolution infrared image, there will be (136 - 24)/4 = 28 rings. On each ring the warmest temperature will be found. The coldest of these values will be used as the cloud top temperature value. This value is referred to as the "coldest-warmest" temperature, and it is used only in the determination process for the cloud region scene type. The ring number (CWRN) distance (in km from the storm center location) on which the "coldest-warmest" temperature value is located is used in the determination of the "mean" cloud region temperature discussed below. For more information about this value, see Velden et al. (1998) and Zehr (1989).

The second cloud region temperature computed is the "mean" cloud region temperature value, and is the actual value that is assigned as the cloud region temperature. First, an annulus region is determined around the storm center location. The annulus will be a total of 80 km wide and is centered on the CWRN distance explained above. The minimum inner/maximum outer radius of the annulus will be the CWRN distance minus/plus 40 km. The minimum inner radius cannot be less than 24 km from the storm center location, but there is no maximum limit on the outer radius distance. For example, if the CWRN distance is 48 km, the inner distance will be a minimum of 24 km (not 8 km), and the outer distance will be 104km. Once the annulus is defined, it is divided into 24 arc regions (15° each) and the average temperature of each arc is calculated. The average of the 24 average arc temperature values is computed and assigned to the "mean" cloud region temperature value.

The "coldest-warmest" temperature value was replaced with the "mean" temperature value after close examination of both values, and their respective Raw T# intensity values, in relation to aircraft reconnaissance intensity measurements. The "coldest-warmest" temperature value varied significantly more than the "mean" values, and their corresponding intensity estimates. The intensity estimate values computed using the coldest-warmest temperature values were found to be inferior to the intensity estimates using the mean temperature values, thus the change was implemented. The CloudCW value is still utilized within the ADT scene selection process as described above, so the calculation of the value still remains within the ADT algorithm and the derived parameters are saved in the ADT history files.

D.) Time Averaging Scheme

Time-averaging of ADT intensity outputs is employed to smooth the "noise" inherent in individual estimates, which as mentioned above can result from objectively changing scene types and crossing value thresholds in consecutive analysis times. The time-averaging scheme uses the current Raw T# and all available Raw T# values obtained within the last 3 hours. The time-average is a straight non-weighted mean of these estimates. The 3-hr time window for the averaging is based on empirical analysis noted above, and user preference input. The ADT Final T# at any current analysis time reflects this time-averaged value.

E.) Weakening Flag (Dvorak EIR Rule 9)

The ADT Weakening Flag is modeled after the STD EIR Rule 9 (Dvorak, 1984), but also utilizes a modification to the original STD EIR Rule 9 that is applied at some operational TC forecasting centers. The "original" STD ERI Rule 9 rule is used in the determination of the CI# after a storm has reached its maximum intensity and is weakening during the dissipation stage of the TC lifecycle (e.g. extra-tropical transition, moving over cold waters, interacting with severe atmospheric shear, etc). The EIR Rule 9 will hold the CI# at values 0.5 to 1.0 higher in value than the current Final T# (Raw T# after adjustments and time-averaging). Subjective application of this rule (e.g. how and when to apply it) varies between forecasters and is the focal point of much debate. The value of 1.0 is utilized in the ADT since it provides the most statistically accurate estimates of storm intensity when compared with actual reconnaissance observations.

The “modified” Weakening Flag rule logic affects the calculation of the CI# during the formation/strengthening stage of the storm prior to maximum TC intensity (where the ”original” Rule 9 rule will be invoked) as follows: “Always hold the CI# to the highest Final T# over the last 6/12 hours, but never greater than 1.0, in all cases”. This rule will hold the ADT CI# equal to the highest Final T# obtained during the previous 12 hours in all ocean basins EXCEPT in the East Pacific where it will be held to the highest value over the past 6 hours. For example, if the Final T# value had previously obtained a value of 5.2 in an Atlantic storm, but now is decreasing, the CI# value will be held at 5.2 for up to 12 hours or until the Final T# falls below 4.2. This rule is dis-invoked if the TC re-strengthens to the held CI# and greater intensity values.

F.) Constraint Limits (Dvorak EIR Rule 8)

The ADT limits the magnitude of intensity change between estimates based on a modification to the SDT EIR Rule 8 which constrains the rate of increase or decrease of the Raw T# intensity estimate (value initially determined by the scene type and/or regression analyses, and before any rules or adjustments are applied) based upon specified rates of change over designated time periods. The rate of change checks are performed against the Final T# (after rule adjustments and time averaging described later) values stored in the history file for times prior to the current analysis time. The rate of change allowance is dependent upon the current intensity of the storm, as defined in the Dvorak EIR technique (Dvorak 1984). The Final T# value of the record immediately prior to the current analysis time is used as the current intensity estimate. When the intensity of the storm is less than T4.0, the current Raw T# rate of change cannot exceed ±0.5 T# over 6 hours. If greater or equal to T4.0, the rate of change of the Raw T# value cannot exceed the following rates: 1.0 over 6 hours, 1.5 over 12 hours, 2.0 over 18 hours, and/or 2.5 over 24 hours.

The ADT also employs a modified version of this rule based upon the current scene type analyzed: The allowable rate of change is reduced by 0.5 during most non-Eye scene types (Curved Band, CDO, Embedded Center), so that the amount of change is limited to 0.5/1.0/1.5/2.0 T# over 6/12/18/24 hours. For Eye scenes the amount of allowed change is increased by 0.5 to 1.5/2.0/2.5/3.0 T# over 6/12/18/24 hours. The latter modification allows the Final T#/CI# to increase at a quick enough and realistic rate during “rapid intensification” events. For Shear scenes, the rate of change rule is unmodified from the original SDT EIR Rule 8.

If one of the criteria is exceeded, the Adjusted Raw T# (value after all rules/adjustments, but before time-averaging) will be assigned the maximum/minimum value allowed by the above criteria, and will be used in the determination of the corresponding Final T# and CI# values. Note: The unadjusted Raw T# value, before any adjustments have been made, is always stored in the history file for reference.

As a final “gross error check” for the Raw T# values derived by the ADT, a supplementary Rule 8 rule has been added to the constraint limits listed above. This additional rule will limit the growth of the Raw T# value by 0.5 over 1 hour. Implementation of this rule was found to be necessary due to the inherent variability of the ADT during “scene type transitions”, especially between eye and non-eye cases. Due to the completely objective nature of the scene determination scheme, and the discrete threshold values that are used to define the different scene types, changes between scene types can result in unrealistic jumps in Raw T# values from one intensity estimate to another. The addition of this rule produces estimates that are reasonable when these types of scene changes occur, but will not allow the Raw T# values to change at a rate greater than observed in nature.

Implementation of this modified rule has allowed for the Final T# calculation to be changed from a time-weighted 6-hour average to a 3-hour average (discussed in the next section). By utilizing the 3-hour scheme, the admissible rate of change of the Final T# value is greater than with the 6-hour scheme, making for more allowable rapid increases in intensity over short time periods that can be associated with storms undergoing rapid intensity changes.

G.) Rapid Weakening Flag

It is commonly observed that TCs can dissipate at a very rapid rate as they move over colder waters. However, the Dvorak Technique Rule 8 and Rule 9 constrain the rate of dissipation and it is believed that these rules do not allow for the rapid dissipation rates commonly observed in the East Pacific and periodically in other regions.

In order to alleviate this limitation, the Dvorak EIR Weakening Rule 9 has been modified to allow the CI# intensity estimate to reflect this commonly observed phenomenon. The ADT Rapid Weakening Flag relaxes the application of the original Rule 9 intensity adjustment to the Final T# when determining the CI#. Normally, up to 1.0 T# is added to the current Final T# value to come up with the CI#. In cases where rapid weakening is determined, the additive value can be modified to only 0.5.

To be identified as a possible rapid weakening event, the Adjusted Raw T# values over the previous six hours are evaluated. If the slope of the Adjusted Raw T# values is less than -1.5/24 hours in the East Pacific or -2.0/24 hours outside of the East Pacific, the weakening flag is tripped. If the slope during the subsequent six-hour period does not increase above the weakening threshold, the rapid weakening flag is turned on and the CI# additive constant is adjusted from 1.0 to 0.5. The rapid weakening flag is held on until the slope of the Adjusted T# values over six hours becomes greater than -1.0/24 hours in the East Pacific or -1.5/24 hours in the non-East Pacific basins. If this condition is exceeded for a continuous period of six hours, the rapid weakening flag is then turned off and the additive value returns to 1.0.

H.) Intensity Estimate Derivation Methods

As discussed in the Algorithm Overview in Section 1, the ADT is originally based upon the operationally-utilized Subjective Dvorak Enhanced Infrared 'EIR' Technique (SDT). Several deviations from the original SDT have been included into the ADT in order to improve upon the initial implementation of logic from the SDT into the ADT. The primary advancement involves the utilization of linear regression equations relating various cloud parameters to TC intensity. These equations were implemented for all eye scenes and several of the cloud scenes. The remaining scene types not utilizing regression-based methods have also been improved to better correlate their specific cloud parameter measurements to TC intensity.

1.) Regression-based Intensity Estimates

As mentioned previously, a regression-based analysis scheme was implemented in order to better correlate ADT eye and cloud region temperature measurement values with observed intensity. Measured values such as maximum eye region and minimum cloud region temperatures have been used historically in the SDT and early versions of the ADT to estimate TC intensity in all eye scene types as well as the CDO (and Irregular CDO) and Embedded Center cloud scene types. These parameters worked well in most cases, but additional methods were explored to better assess the TC intensity. Using linear regression analysis, additional parameters were found to aid significantly in the process of estimating TC intensity using infrared window imagery. A schematic representation of the regression-based parameters used in the ADT is provided in Figure 6.

The cloud symmetry value measures the temperature difference between opposing sides of the storm to assess the structure of the convection surrounding the eyewall region of the TC. Storms possessing a more symmetric convective structure (smaller temperature differences between opposing sections of the storm eyewall cloud region) are typically more intense than storms with asymmetric convection. This parameter is actually indirectly included in the SDT EIR technique via measurements of the width of the various BD-enhancement gray shades surrounding the storm center position as well in the "climatological" pattern-T# comparison diagrams. The cloud symmetry value is obtained by determining the average cloud top temperature value within the 24 sectors defined earlier (15-degree arcs, 80-km wide annulus from storm center with distance from eye pre-determined by warmest-coldest ring value). Opposing sector values (180-degree rotation) are differenced and summed around the storm center. These twelve values are then averaged to determine the final cloud symmetry value.

Another important parameter is the size of the central dense overcast, or CDO scene type, region in a non-eye situation. This parameter mimics the SDT which also makes use of a CDO size parameter to help assess the current strength of the storm. The impact of this value itself is not large, but it was found to be a significant contributor to estimating intensity in these situations when combined with the other parameters. The value is derived by simply averaging the radial measurements of the storm CDO along four axes centered on the storm center position. The CDO edge is defined as the boundary between the Light

Gray and Medium Gray shades in the BD-enhancement shown in Figure 4 and listed in Table 3.

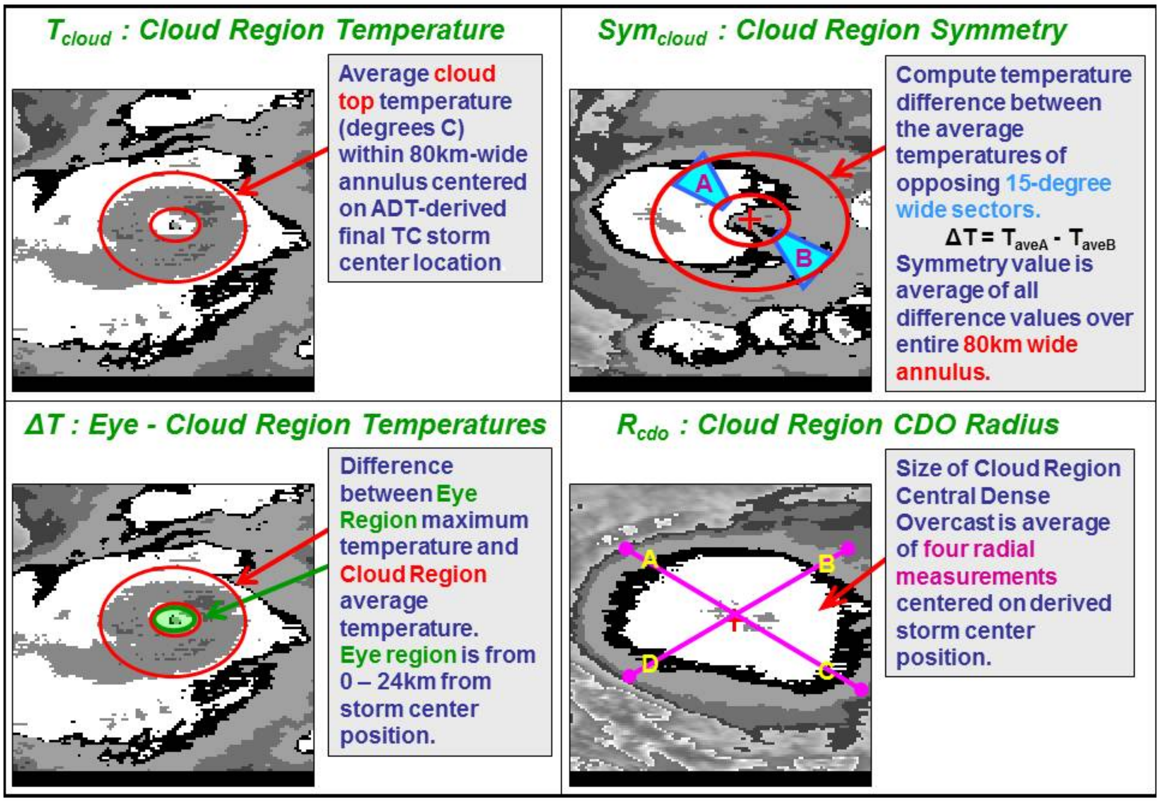

Figure 6: Schematic representation of the four regression equation parameters.

Two separate sets of regression equations are used in the ADT; one set for the eye scene types and one set for the cloud scene types. The equations yield intensity estimates in terms of T# values which can be converted to MSLP or Maximum Wind Speed (as discussed in Sections 5I and 5P). For Eye Scenes, three sets equations are used; one for the North Atlantic and North East/Central Pacific, one for the North West Pacific, and one for “Other”. For Cloud Scenes, only two sets of regression equations are used; one for the North Atlantic and East/Central Pacific and one for all other basins (North West Pacific and Other basins are the same). These equations are listed in Table 4.

Region	Intensity
Eye scenes	
Atlantic	Intensity = $1.10 - 0.070*T_{cloud} + 0.011*\Delta T - 0.015*Sym_{cloud}$
West Pacific	Intensity = $2.65 - 0.030*T_{cloud} + 0.015*\Delta T - 0.015*Sym_{cloud}$
Cloud/CDO Scenes	
Atlantic	Intensity = $2.60 - 0.020*T_{cloud} + 0.002*R_{cdo} - 0.030*Sym_{cloud}$
West Pacific	Intensity = $3.00 - 0.010*T_{cloud} + 0.001*R_{cdo} - 0.015*Sym_{cloud}$
T_{cloud}	Cloud region average temperature (degree
ΔT	Eye (max) – cloud (ave) region temperatures (degree C)
Sym_{cloud}	Cloud region temperature symmetry (degree C)
R_{cdo}	Cloud region CDO size (km)

Table 4: Base regression equations for the Eye and Cloud/CDO scene types.

In actuality, the base number (y-intercept: 1.1 or 2.6 in the Atlantic eye/cloud equations, for example) and the T_{cloud} parameters have been replaced with modified values in the ADT to try to provide an approximation to a nonlinear relationship between the T_{cloud} and derived intensity values. Three arrays containing T# values at the specific temperature breakpoint values in Table 3 are used to modify the regression equations for the T_{cloud} and base value parameters as shown in Tables 5 and 6.

The "original" row value is what the equation would have provided at the T_{cloud} temperature value, with the "Adjusted" row displaying what the value was changed to for both the Atlantic and West Pacific equations. The Atlantic equations are used in the North Atlantic and East/Central Pacific east of the International Dateline.

The West Pacific equations are used in the northwest Pacific west of the International Dateline. The "Other" equations are used in the Indian Ocean and Southern Hemisphere ocean basins and use the West Pacific regression equations for both the Eye and Cloud/CDO scene types.

The original West Pacific equations were developed on a much older, smaller, and lower satellite spatial and temporal resolution dataset, from the early/mid-1980s, when in-situ aircraft reconnaissance validation was available. As can be seen, the regression equations are much flatter than the corresponding Atlantic equations and were adjusted using more current validation using Best Track intensity estimates. These adjustments led to higher-intensity estimate values in the colder cloud region temperature ranges, for example, especially for the eye regression equations.

Temperature	Atlantic-Orig	WPacific - Orig	Atlantic - Adj	WPacific - Adj	Other – Adj
+30°C	-1.00	1.80	1.00	1.50	150
+9°C	0.47	2.43	2.00	2.25	2.25.
-30°C	3.20	3.60	3.25	3.30	3.30
-42°C	4.04	3.96	4.00	3.85	3.85
-54°C	4.88	4.32	4.75	4.50	4.50
-64°C	5.58	4.62	5.25	4.75	4.75
-70°C	6.00	4.80	5.75	5.15	5.15
-74°C	6.42	4.98	6.55	5.65	5.50
-80°C	6.70	5.10	7.35	6.30	6.00
-84°C	6.98	5.22	7.85	6.55	6.25
-100°C	8.10	5.70	8.10	7.05	6.75

Table 5: The original regression (Orig) and current adjusted (Adj) T_{cloud} eye scene regression parameter values for the Atlantic, West Pacific, and Other equations.

Temperature	Atlantic - Orig	WPacific - Orig	Atlantic - Adj	WPacific - Adj	Other - Adj
30°C	2.00	2.70	2.00	2.05	2.05
+9°C	2.42	2.91	2.40	2.40	2.40
-30°C	3.20	3.30	3.25	3.00	3.00
-42°C	3.44	3.42	3.50	3.20	3.20
-54°C	3.68	3.54	3.75	3.40	3.40
-64°C	3.88	3.64	4.00	3.55	3.55
-70°C	4.00	3.70	4.10	3.65	3.65
-74°C	4.08	3.74	4.20	3.75	3.75
-80°C	4.20	3.80	4.30	3.80	3.80
-84°C	4.38	3.84	4.40	3.90	3.90
-100°C	4.60	4.00	4.70	4.10	4.10

Table 6: The original regression (Orig) and current adjusted (Adj) T_{cloud} Cloud/CDO scene regression parameter values for the Atlantic, West Pacific, and Other equations.

Significant correlation improvements between ADT intensity estimates and aircraft reconnaissance intensity observations were realized with the implementation of the original regression equations over the previous intensity estimation techniques. The cloud scene correlations improved from 0.28 to 0.50, while the Eye scenes improved from 0.62 to 0.70 with the implementation of the original equations.

The improvement in the cloud scene correlation is most significant since the CDO scene type still remains the most troublesome area within the ADT algorithm and one that continues to merit research attention. Some of the newest eye scene adjustments were derived during a study in which the ADT was used to objectively determine the strongest tropical cyclones during the satellite era (Velden et al., 2017).

2.) Non-regression-based Intensity Estimates

The remaining cloud scene types that do not utilize a regression-based intensity estimation scheme are the Curved Band and Shear scenes. Intensity estimates for these two scenes rely on techniques based on the original SDT. The Shear scene type measures the distance between the determined storm center position (usually the interpolated forecast position) and the leading edge of the main convective region defined as the minimum distance to the "Dark Gray" BD-curve Gray Scale temperature range (Table 3). The value of this distance is then related to intensity; the greater the distance the weaker the storm intensity. A distance of 140km or greater will correspond to a T# intensity of 1.5, with an increase in intensity of 0.5 for every 30km distance reduction (except for the following two exceptions; 1.) At 80km, the intensity is 2.25; and 2.).Between 0 and 35km, the T# intensity is at its maximum value of 3.5). Subsequent modifications have improved the identification of the edge of the main cloud region, leading to superior intensity results for this scene type.

The Curved Band scene type utilizes a methodology similar to the one used in the automated storm center determination scheme described in Section 5J2. This technique utilizes a 10-degree log spiral to measure the amount of convection and determines the amount of curvature, in terms of 15° segments, in the cloud region surrounding the storm center. The technique to compute the curvature measures the cloud top temperature at each point on the log spiral in 15° steps along the spiral. The measured temperature must be colder than the specific threshold temperature value being checked to be classified as convective cloud. The specific threshold temperature values correspond to the maximum temperature values within each gray scale temperature range listed in Table 3. The gray scale ranges between the Dark Gray and White enhancement ranges, inclusive are utilized in this process. Each point on the log spiral arc are checked at 15° increments, with a count of "consecutive cloud segments" retained to find the maximum number of consecutive segments in each gray scale range, if available. Consecutive cloud segments are counted on this arc to determine the amount of curvature (24 segments would correspond to 360-degrees of curvature).

The Light Gray temperature range is checked first, with warmer ranges checked if the number of consecutive segments does not exceed seven segments. If a gray range is not found in these three ranges, the scene type is assumed to be a shear scene. If the Light Gray region is found to possess more than 25 consecutive segments, the routine will then check the curvature of the Black and White temperature ranges. If each number of consecutive segments in the Black and White ranges are also greater than 25, the scene type will be assigned a CDO/Embedded Center scene type, otherwise the scene will be assigned a Curved Band scene type. The amount of curvature is then related to a T# intensity value based upon the original Dvorak Technique (with an additional adjustment provided for curved bands measure from the Black and White temperature ranges). For less than 20% curvature the T# intensity will be equal to 1.5. Between 20% and 40% curvature, the T# range will increase from 1.5 to 2.5. Above 40% curvature the T# intensity will increase by 0.5, starting at 2.5 for 40% to 4.0 for 100% (and up to 4.5 for 120% curvature). T# values are interpolated to the nearest 0.1 increment between the curvature threshold values listed.

The storm center utilized for the Curved Band scene is primarily the interpolated official forecast since the storm strength is typically too low for the auto-centering techniques to be used. The 10-degree log spiral is rotated in 10-degree increments around the storm center to find the maximum cloud curvature amount at the selected center position. A search for the storm center position that yields the highest value is also conducted and output to the user for reference if it does not correspond to the original, interpolated forecast position.

I.) Dvorak T# to MSLP Conversion Relationship Auto Determination

The ADT intensity estimates are derived in terms of T# and CI#, which are a holdover from the SDT, where higher values correspond to stronger, more intense tropical cyclones. The T# is short for "Tropical Number", and is defined in the SDT in relation to storm strength categories of mean sea level pressure (MSLP) and maximum sustained surface wind speeds (Dvorak 1984). The T# represents the "current" intensity of the storm. There are three T# values derived by the ADT; the Raw T#, the Adjusted Raw T#, and the Final T# values. These are explained in Section 5F.

The Current Intensity (CI#) is derived from the ADT Final T# value after a final set of time-based intensity constraint rules/adjustments are applied after the storm has stopped (temporarily?) strengthening, and represents the final intensity estimate output by the ADT. The three T# and CI# values can differ depending on the current intensity status of the storm and how it has changed over a given period of time (the constraint rules can vary over different time periods), but each value provides information about the current storm status and evolution.

The empirically-derived relationship between the CI# and storm intensity categories is given in Table 7 for the Atlantic TC basin (after Dvorak, 1984) and Northwest Pacific basin (Shewchuck and Weir, 1980). Thus, proper identification of the correct relationship to use is essential for conversion of the CI# to intensity. The ADT can automatically determine the conversion method "basin" based upon the longitude value of the selected storm center location. A storm west of the international dateline (180° E/W) and east of the Prime Meridian (0° E/W) is designated as a Northwest Pacific storm (regardless of N/S hemisphere), with all other storms designated as Atlantic basin (in consultation with users).

It should be noted that for T#/CI# values greater than 8.0 or less than 2.0 in Table 7, the MSLP estimates were not provided by the original Dvorak study, and are thus extrapolated in the ADT by using MSLP gradients from preceding/following categories in the conversion table. These values include those found between 1.0 and 2.0 and between 8.0 and 8.5.

Classification (approx)	**CI# Value**	**Wind Speed (kts)**	**Atlantic MSLP (hPa)**	**West Pacific MSLP (hPa)**
	1.0	*25.0*	*1014.0*	*1005.0*
	1.5	*25.0*	*1012.0*	*1003.0*
	2.0	30.0	1009.0	1000.0
Tropical Storm	2.5	35.0	1005.0	997.0
	3.0	45.0	1000.0	991.0
	3.5	55.0	994.0	984.0
Hurricane – Cat 1	4.0	65.0	987.0	976.0
	4.5	77.0	979.0	966.0
Hurricane – Cat. 2	4.7	82.2	975.4	961.2
	5.0	90.0	970.0	954.0
Hurricane – Cat 3	5.2	94.8	966.0	948.8
	5.5	102.0	960.0	941.0
Hurricane – Cat 4	6.0	115.0	948.0	927.0
	6.5	127.0	935.0	914.0
Hurricane – Cat 5	6.8	134.8	926.6	904.4
	7.0	140.0	921.0	898.0
	7.5	155.0	906.0	879.0
	8.0	170.0	890.0	858.0
	8.5	*185.0*	*873.0*	*835.0*

Table 7: Relationships between ADT-derived CI# values and TC maximum sustained surface wind speed and mean sea level pressure (MSLP) values for Atlantic basin storms.

J.) Automatic Storm Center Determination Methodologies

The ADT automated storm center location algorithm approximates TC position using three methods: polynomial interpolation of TCFC forecasts, linear extrapolation of the history file positions, or with an advanced but older "pre-ARCHER" dual methodology examining the TC cloud top spiral features and circular feature (ring) search discussed in (Wimmers and Velden, 2004).

The ARCHER methodology (Wimmers and Velden, 2016) (Section 6) has been included with Version 9.1 due to its increased accuracy and performance. It is suggested that the ARCHER methodology should be used if at all possible, however if it proves too difficult to implement the ARCHER software package, the original pre-ARCHER methodology can still be utilized with great confidence. The pre-ARCHER method will still be performed in "non-McIDAS" mode when reading netCDF files using the NOAA, GENERIC, or McIDAS type options within the netCDF keyword. HURSAT files will utilize the included storm center position latitude and longitude values contained within the files and will not perform the pre-ARCHER method to determine a better storm center position since the HURSAT files already provide the ARCHER position.

K.) Forecast File Usage

As a first guess, the forecast positions from TCFC forecast, with its file name and directory location passed to the ADT algorithm via algorithm inputs (command line, GUI values, or environmental variables, depending on the implantation of the algorithm), are read within the ADT algorithm to obtain the current position using a polynomial interpolation routine. This interpolation routine uses three forecast positions (current, 12 hour, and 24 hour positions) defined in the forecast file to interpolate the current position defined by the time of the image being examined. If the image time falls within the time period defined within the forecast file positions/times, a valid interpolated forecast position will be used within the algorithm, otherwise an extrapolation of the previous history file positions will be used.

The ADT algorithm will typically be utilized from the time of the first TCFC forecast is provided for the storm in question until the storm dissipates over land, becomes extratropical, or weakens to below tropical depression status, resulting in the TCFC to issue a final forecast for the storm being analyzed. The ADT can be terminated at any point after the final forecast is issued. An upper limit of 24 hours beyond the "initial" time in the final forecast is typically used to end the ADT processing. The five types of acceptable input file formats are:

- ATCF Forecast Record file (f-deck)
- ATCF Best Track file (b-deck)
- NHC/CPHC Discussion/Warning files
  (WMO headers: "WTNT4? KNHC" or "WTPZ4? KNHC" or "WTPA4?" PHFO)
- JTWC Tropical Cyclone Warning files
  (WMO header: "WTPN3? PGTW")
- Other Regional Specialized Meteorological Center (RSMC) Formats
  - ICAO format files from:
    - RSMC Nadi (Fiji): FKPS01-02 NFFN
    - RSMC New Delhi (India): FKIN20 VIDP
    - RSMC Tokyo (Japan): FKPQ30-34 RJTD
  - Tropical Cyclone Warning Centers (TCFC) Technical Bulletins: Australia
    - TCWC Perth: AXAU01-02 APRF
    - TCWC Darwin: AXAU01-02 ADRM
    - TCWC Brisbane: AXAU21 ABRF
  - RSMC La Reunion, MeteoFrance Warning files
    (WMO header: WTIO30 FMEE)
- Generic Entry file

Below are forecast file examples for various formats allowed with the ADT algorithm.

<u>ATCF Forecast Record Format</u>

ATCF Forecast Record files are provided for storms analyzed by NHC, CPHC, and JTWC. The forecast file will contain the initial position at time 0 and forecast positions at 3, 12, 24, 36, 48, 72, 96, and 120 hours from the initial time. For forecast periods where the forecast intensity is 50 knots or above, a duplicate record will be provided to show wind radii information specific to that intensity value. A third record will also be added for storms with forecast intensities above 64 knots. The first record will only be read for any redundant time periods by the ADT forecast interpolation routine. In the example below there are two or three records for each time period corresponding to the 34, 50, and 64 knot wind critical radii entries (not for the 96 and 120 hour forecasts, however).

The naming convention for these files is “fXXSSYYYY.dat”, where XX is the basin (“al” for Atlantic, “ep” for East Pacific, “cp” for central pacific, “wp” for West Pacific, “io” for Indian Ocean, and “sh” for Southern Hemisphere storms.

```
AL, 13, 2002092400, 03, OFCL,   0, 127N,  620W,  50, 1006, TS,  34, AAA,    0,    0,    0,    0,    0,    0,   0,  60,
0,    ,   0, BRJ, 275,  16,
AL, 13, 2002092400, 03, OFCL,   3, 127N,  627W,  50, 1006, TS,  34, NEQ,   90,   30,   50,   90,    0,    0,   0,  60,
0,    ,   0, BRJ, 275,  15,          ,   , 12, NEQ, 100,   0,  50, 100,
AL, 13, 2002092400, 03, OFCL,   3, 127N,  627W,  50, 1006, TS,  50, NEQ,   20,    0,    0,   20,    0,    0,   0,  60,
0,    ,   0, BRJ, 275,  15,          ,   , 12, NEQ, 100,   0,  50, 100,
AL, 13, 2002092400, 03, OFCL,  12, 138N,  648W,  55, 1006, TS,  34, NEQ,  100,   30,   50,  100,    0,    0,   0,  65,
0,    ,   0, BRJ, 300,  15,
AL, 13, 2002092400, 03, OFCL,  12, 138N,  648W,  55, 1006, TS,  50, NEQ,   20,    0,    0,   20,    0,    0,   0,  65,
0,    ,   0, BRJ, 300,  15,
AL, 13, 2002092400, 03, OFCL,  24, 150N,  671W,  60, 1006, TS,  34, NEQ,  100,   50,   50,  100,    0,    0,   0,  75,
0,    ,   0, BRJ, 300,  13,
AL, 13, 2002092400, 03, OFCL,  24, 150N,  671W,  60, 1006, TS,  50, NEQ,   30,   20,   20,   30,    0,    0,   0,  75,
0,    ,   0, BRJ, 300,  13,
AL, 13, 2002092400, 03, OFCL,  36, 161N,  690W,  70, 1006, TS,  34, NEQ,  100,   60,   60,  100,    0,    0,   0,  85,
0,    ,   0, BRJ, 300,  11,
AL, 13, 2002092400, 03, OFCL,  36, 161N,  690W,  70, 1006, TS,  50, NEQ,   50,   30,   30,   50,    0,    0,   0,  85,
0,    ,   0, BRJ, 300,  11,
AL, 13, 2002092400, 03, OFCL,  36, 161N,  690W,  70, 1006, TS,  64, NEQ,   30,   20,   20,   30,    0,    0,   0,  85,
0,    ,   0, BRJ, 300,  11,
AL, 13, 2002092400, 03, OFCL,  48, 170N,  705W,  75, 1006, TS,  34, NEQ,  120,   80,   80,  120,    0,    0,   0,  90,
0,    ,   0, BRJ, 300,   8,
AL, 13, 2002092400, 03, OFCL,  48, 170N,  705W,  75, 1006, TS,  50, NEQ,   50,   30,   30,   50,    0,    0,   0,  90,
0,    ,   0, BRJ, 300,   8,
AL, 13, 2002092400, 03, OFCL,  72, 190N,  730W,  70, 1006, TS,  34, NEQ,  100,   60,   60,  100,    0,    0,   0,  85,
0,    ,   0, BRJ, 310,   8,
AL, 13, 2002092400, 03, OFCL,  72, 190N,  730W,  70, 1006, TS,  50, NEQ,   50,   30,   30,   50,    0,    0,   0,  85,
0,    ,   0, BRJ, 310,   8,
AL, 13, 2002092400, 03, OFCL,  96, 225N,  750W,  80, 1006, TS,  34, AAA,    0,    0,    0,    0,    0,    0,   0, 100,
0,    ,   0, BRJ, 330,  10,
AL, 13, 2002092400, 03, OFCL, 120, 260N,  770W,  90, 1006, TS,  34, AAA,    0,    0,    0,    0,    0,    0,   0, 110,
0,    ,   0, BRJ, 335,  10,
```

NHC Discussion Format

These files can be obtained easily from various internet sources. The WMO header will change for each active storm (up to five active storms at a time) and each basin covered by the NHC and/or CPHC (Atlantic, East and Central Pacific).

```
WTNT42 KNHC 281454                                         2005240 1454
TCDAT2
HURRICANE KATRINA DISCUSSION NUMBER  23
NWS TPC/NATIONAL HURRICANE CENTER MIAMI FL
11 AM EDT SUN AUG 28 2005
THE AIR FORCE HURRICANE HUNTERS JUST MEASURED A 166 KT FLIGHT LEVEL
WIND IN THE NORTHEAST EYEWALL...WHICH REQUIRES AN ADDITIONAL UPWARD
ADJUSTMENT OF THE CURRENT INTENSITY TO 150 KT.  A DROP IN THE EYE
GAVE A CENTRAL PRESSURE OF 907 MB.  KATRINA IS COMPARABLE IN
INTENSITY TO HURRICANE CAMILLE OF 1969...ONLY LARGER.  GPS
DROPSONDE DATA FROM THE NOAA G-IV MISSION EARLIER TODAY SHOWED
KATRINA'S INTENSE CYCLONIC CIRCULATION EXTENDING THROUGH THE 200 MB
LEVEL...WITH THE FLOW SPIRALING ANTICYLONICALLY OUTWARD IN A
WELL-DEVELOPED UPPER-LEVEL OUTFLOW PATTERN BEYOND A COUPLE HUNDRED
N MI FROM THE CENTER.  FLUCTUATIONS IN STRENGTH...DUE TO INTERNAL
```

```
STRUCTURAL CHANGES...ARE LIKELY PRIOR TO LANDFALL.  HURRICANES
RARELY SUSTAIN SUCH EXTREME WINDS FOR MUCH TIME.  HOWEVER WE SEE
NO OBVIOUS LARGE-SCALE EFFECTS TO CAUSE A SUBSTANTIAL WEAKENING THE
SYSTEM...AND IT IS EXPECTED THAT THE HURRICANE WILL BE OF CATEGORY
4 OR 5 INTENSITY WHEN IT REACHES THE COAST.

THERE IS NO CHANGE TO THE TRACK FORECAST.  KATRINA SHOULD GRADUALLY
TURN TOWARD THE NORTH...INTO A WEAKNESS IN THE SUBTROPICAL RIDGE
ASSOCIATED WITH A LARGE MID-LATITUDE CYCLONE OVER THE NORTHERN
UNITED STATES AND SOUTHERN CANADA.  THE OFFICIAL FORECAST TRACK IS
ABOUT IN THE MIDDLE OF THE DYNAMICAL GUIDANCE MODELS...WHICH ARE
RATHER TIGHTLY CLUSTERED.  RECALLING THAT THE AVERAGE NHC 24-HOUR
TRACK FORECAST ERROR IS ABOUT 80 N MI...THE ACTUAL LANDFALL POINT
COULD STILL BE ANYWHERE FROM SOUTHEASTERN LOUISIANA TO THE
MISSISSIPPI COAST.  ALSO...WE MUST CONTINUE TO STRESS THAT THE
HURRICANE IS NOT JUST A POINT ON THE MAP...BECAUSE DESTRUCTIVE
WINDS...TORRENTIAL RAINS...STORM SURGE...AND DANGEROUS WAVES EXTEND
WELL AWAY FROM THE EYE.  IT IS IMPOSSIBLE TO SPECIFY WHICH COUNTY
OR PARISH WILL EXPERIENCE THE WORST WEATHER.

THIS ADVISORY SHOWS AN ADDITIONAL EXPANSION OF THE WIND FIELD OVER
THE EASTERN SEMICIRCLE BASED ON AIRCRAFT AND SURFACE OBSERVATIONS.
HURRICANE FORCE WINDS ARE FORECAST TO SPREAD AT LEAST 150 N MI
INLAND ALONG THE PATH OF KATRINA.  CONSULT INLAND WARNINGS ISSUED
BY NATIONAL WEATHER SERVICE FORECAST OFFICES.

FORECASTER PASCH


FORECAST POSITIONS AND MAX WINDS

INITIAL      28/1500Z 26.0N  88.1W   150 KT
 12HR VT     29/0000Z 27.2N  88.9W   145 KT
 24HR VT     29/1200Z 29.1N  89.6W   140 KT
 36HR VT     30/0000Z 31.4N  89.5W    85 KT...INLAND
 48HR VT     30/1200Z 34.5N  88.5W    45 KT...INLAND
 72HR VT     31/1200Z 40.0N  84.0W    30 KT...INLAND
 96HR VT     01/1200Z 45.0N  77.0W    25 KT...EXTRATROPICAL
120HR VT     02/1200Z 52.0N  69.0W    25 KT...EXTRATROPICAL
```

JTWC Tropical Cyclone Warning Format

As with NHC Discussions, these forecasts can be readily obtained from the internet, and will have a separate WMO header for each storm and each basin covered by the Joint Typhoon Warning Center.

```
WTPN32 PGTW 291500                                          2004242 1417
MSGID/GENADMIN/NAVPACMETOCCEN PEARL HARBOR HI/JTWC//
SUBJ/TROPICAL CYCLONE WARNING//
RMKS/
1. TYPHOON 19W (CHABA) WARNING NR 044
   02 ACTIVE TROPICAL CYCLONES IN NORTHWESTPAC
   MAX SUSTAINED WINDS BASED ON ONE-MINUTE AVERAGE
    ---
   WARNING POSITION:
   291200Z4 --- NEAR 29.4N5 130.0E4
     MOVEMENT PAST SIX HOURS - 325 DEGREES AT 07 KTS
     POSITION ACCURATE TO WITHIN 040 NM
     POSITION BASED ON CENTER LOCATED BY A COMBINATION OF
     SATELLITE AND RADAR
   PRESENT WIND DISTRIBUTION:
   MAX SUSTAINED WINDS - 095 KT, GUSTS 115 KT
   RADIUS OF 064 KT WINDS - 050 NM NORTHEAST QUADRANT
                            050 NM SOUTHEAST QUADRANT
                            050 NM SOUTHWEST QUADRANT
                            050 NM NORTHWEST QUADRANT
   RADIUS OF 050 KT WINDS - 080 NM NORTHEAST QUADRANT
                            080 NM SOUTHEAST QUADRANT
                            080 NM SOUTHWEST QUADRANT
                            080 NM NORTHWEST QUADRANT
   RADIUS OF 034 KT WINDS - 200 NM NORTHEAST QUADRANT
```

```
                              OVER WATER
                       180 NM SOUTHEAST QUADRANT
                       180 NM SOUTHWEST QUADRANT
                       180 NM NORTHWEST QUADRANT
   REPEAT POSIT: 29.4N5 130.0E4
    ---
   FORECASTS:
   12 HRS, VALID AT:
   300000Z3 --- 31.6N0 130.3E7
   MAX SUSTAINED WINDS - 080 KT, GUSTS 100 KT
   RADIUS OF 064 KT WINDS - 050 NM OVER WATER
   RADIUS OF 050 KT WINDS - 080 NM OVER WATER
   RADIUS OF 034 KT WINDS - 200 NM NORTHEAST QUADRANT
                              OVER WATER
                       180 NM SOUTHEAST QUADRANT
                              OVER WATER
                       180 NM SOUTHWEST QUADRANT
                       170 NM NORTHWEST QUADRANT
                              OVER WATER
   VECTOR TO 24 HR POSIT: 030 DEG/ 19 KTS
    ---
   24 HRS, VALID AT:
   301200Z6 --- 34.9N6 132.7E3
   MAX SUSTAINED WINDS - 060 KT, GUSTS 075 KT
   RADIUS OF 050 KT WINDS - 070 NM OVER WATER
   RADIUS OF 034 KT WINDS - 180 NM NORTHEAST QUADRANT
                              OVER WATER
                       170 NM SOUTHEAST QUADRANT
                              OVER WATER
                       170 NM SOUTHWEST QUADRANT
                              OVER WATER
                       160 NM NORTHWEST QUADRANT
   VECTOR TO 36 HR POSIT: 040 DEG/ 30 KTS
    ---
   36 HRS, VALID AT:
   310000Z4 --- 39.5N7 137.4E5
   MAX SUSTAINED WINDS - 045 KT, GUSTS 055 KT
   BECOMING EXTRATROPICAL
   RADIUS OF 034 KT WINDS - 170 NM NORTHEAST QUADRANT
                              OVER WATER
                       130 NM SOUTHEAST QUADRANT
                              OVER WATER
                       160 NM SOUTHWEST QUADRANT
                       130 NM NORTHWEST QUADRANT
   VECTOR TO 48 HR POSIT: 035 DEG/ 34 KTS
    ---
   EXTENDED OUTLOOK:
   48 HRS, VALID AT:
   311200Z7 --- 44.9N7 142.8E5
   MAX SUSTAINED WINDS - 035 KT, GUSTS 045 KT
   EXTRATROPICAL
    ---
REMARKS:
291500Z7 POSITION NEAR 30.0N3 130.1E5.
TYPHOON (TY) 19W (CHABA), LOCATED APPROXIMATELY 215 NM SOUTH
OF SASEBO, JAPAN, HAS TRACKED NORTHWESTWARD AT 07 KNOTS OVER
THE PAST 06 HOURS. THE WARNING POSITION IS BASED ON 291130Z6
ENHANCED INFRARED SATELLITE IMAGERY. THE WARNING INTENSITY
IS BASED ON SATELLITE CURRENT INTENSITY ESTIMATES OF 90 AND
102 KNOTS. NEXT WARNINGS AT 292100Z4, 300300Z6, 300900Z2 AND
301500Z9. REFER TO TYPHOON 22W (SONGDA) WARNINGS (WTPN33 PGTW)
FOR SIX-HOURLY UPDATES.//
```

RSMC Formats

The WMO RSMC sites produce forecast products in several formats for an individual storm. The ADT algorithm can read most of these formats; however, subtle differences between site formats may lead to errors. If one forecast format fails, another format may be available from the RSMC providing the forecast. The formats listed below are the suggested forecast product formats to use for the different RSMC sites.

ICAO Format: Unfortunately the ICAO format is not uniform across all RSMC forecast centers. The ADT, however, attempts to account for the current differences and should successfully read all ICAO format forecasts unless they change.

```
FKPS01 NFFN 060300                                              2008037 0307
TC ADVISORY
DTG:           20080206/0300Z
TCAC:          DARWIN
TC:            GENE
NR:            35
PSN:           S2854 W17748
MOV:           ESE 15KT
C:             972HPA
MAX WIND:      65KT
FCST PSN +12HR: 11/1200 S3042 W17418
FCST MAX WIND +12HR: 55KT
FCST PSN +18HR: 12/0000 S3118 W17230
FCST MAX WIND +18HR: 50KT
FCST PSN +24HR: 12/1200 S3200 W17030
FCST MAX WIND +24HR: 45KT
NXT MSG:       20080206/0800Z
WXTLIST: done
```

Australian AXAU Format: This warning format is produced by the Australian TCWCs and is utilized over the ICAO format due to the inclusion of the Identifier tag in the forecast body, allowing for greater ease in automated processing for obtaining and parsing the product information.

```
AXAU01 APRF 260705
IDW27600
TROPICAL CYCLONE TECHNICAL BULLETIN: AUSTRALIA - WESTERN REGION
Issued by PERTH TROPICAL CYCLONE WARNING CENTRE
at: 0704 UTC 26/01/2009
Name: Tropical Cyclone Dominic
Identifier: 12U
Data At: 0600 UTC
Latitude: 20.1S
Longitude: 115.6E
Location Accuracy: within 25 nm [46 km]
Movement Towards: south southwest [207 deg]
Speed of Movement: 8 knots [15 km/h]
Maximum 10-Minute Wind: 45 knots [85 km/h]
Maximum 3-Second Wind Gust: 65 knots [120 km/h]
Central Pressure: 987 hPa
Radius of 34-knot winds NE quadrant: 60 nm [110 km]
Radius of 34-knot winds SE quadrant: 60 nm [110 km]
Radius of 34-knot winds SW quadrant: 60 nm [110 km]
Radius of 34-knot winds NW quadrant: 60 nm [110 km]
Radius of 48-knot winds NE quadrant:
Radius of 48-knot winds SE quadrant:
Radius of 48-knot winds SW quadrant:
Radius of 48-knot winds NW quadrant:
Radius of 64-knot winds:
Radius of Maximum Winds:
Dvorak Intensity Code: T3.0/3.0/D1.0/24HRS
Pressure of outermost isobar: 1002 hPa
Radius of outermost closed isobar: 75 nm [140 km]
Storm Depth: Deep
FORECAST DATA
Date/Time   : Location    : Loc. Accuracy: Max Wind   : Central Pressure
[UTC]       : degrees     :      nm  [km]: knots[km/h]: hPa
+12: 26/1800: 21.4S 115.3E:     055 [100]:  050  [095]:  982
+24: 27/0600: 22.8S 115.6E:     085 [155]:  030  [055]:  996
+36: 27/1800: 24.2S 116.4E:     120 [220]:  025  [045]:  999
+48: 28/0600: 25.4S 117.6E:     160 [295]:  025  [045]:  998
+60: 28/1800: 26.7S 118.6E:     210 [390]:  020  [035]: 1000
+72: 29/0600: 28.2S 119.7E:     250 [465]:  020  [035]: 1000
```

```
REMARKS:
TC Dominic was named at 03Z.
```

WTIO30 FMEE Format: This format is primarily used from the MeteoFrance site at La Reunion Island in the Southern Indian Ocean.

```
WTIO30 FMEE 071800                                             2008038 1802

RSMC / TROPICAL CYCLONE CENTRE / LA REUNION
TROPICAL CYCLONE FORECAST WARNING (SOUTH-WEST INDIAN OCEAN)
0.A WARNING NUMBER                  : 15/10/20072008
1.A VERY INTENSE TROPICAL CYCLONE 10  (HONDO)
2.A POSITION 2008/02/05 AT 1800 UTC :
15.0S / 82.9E
(FIFTEEN DECIMAL ZERO DEGREES SOUTH AND EIGHTY TWO DECIMAL NINE DEGREES
EAST)
3.A DVORAK ANALYSIS                 : 6.5/7.0 /D  1.0/18 H
4.A CENTRAL PRESSURE                : 906 HPA
5.A MAX AVERAGE WIND SPEED (10 MN) : 120 KT
6.A EXTENSION OF WINDS BY QUADRANTS (KM):
30 KT       NE: 160   SE: 160   SO: 260   NO: 200
50 KT       NE: 060   SE: 040   SO: 080   NO: 080
7.A FIRST CLOSED ISOBARE (PRESSURE / AVERAGE DIAM): 1004 HPA / 800 KM
8.A VERTICAL EXTENSION OF CYCLONE CIRCULATION: DEEP
1.B FORECASTS:
12H: 2008/02/06 06 UTC: 15.3S/83.3E, MAX WIND=110KT, INTENSE TROP. CYCL..
24H: 2008/02/06 18 UTC: 15.6S/83.7E, MAX WIND=100KT, INTENSE TROP. CYCL..
36H: 2008/02/07 06 UTC: 16.4S/84.6E, MAX WIND=090KT, INTENSE TROP. CYCL..
48H: 2008/02/07 18 UTC: 17.6S/85.5E, MAX WIND=080KT, TROPICAL CYCLONE.
60H: 2008/02/08 06 UTC: 18.9S/86.2E, MAX WIND=060KT, SEVERE TROP. STORM.
72H: 2008/02/08 18 UTC: 20.1S/86.4E, MAX WIND=050KT, SEVERE TROP. STORM.
2.B OTHER INFORMATIONS:
T=6.5+, CI=7.0
HONDO SHOWS AN ANNULAR PATTERN (YET SLIGHTLY ERODED IN THE SOUTHEASTERN
PART) . THE ENVIRONMENT IS FAVORABLE ; LOW LEVELS INFLOWS ARE WELL
ESTABLISHED, WINDSHEAR IS WEAK AND UPPER LEVEL DIVERGENCE RATHER GOOD.
HOWEVER THE SYSTEM HAS A RATHER SMALL SIZE (CF MICROWAVE IMAGERY) AND
SHOULD THEN QUICKLY
REACT TO MODIFICATIONS IN THE ENVIRONMENTAL CONDITIONS.
HONDO IS LOCATED BETWEEN TWO COMPETING STEERING FLOWS; SUBTROPICAL HIGH
PRESSURES IN THE SOUTHWEST AND EQUATORIAL UPPER LEVEL RIDGE THAT REMAINS
THE DOMINANT STEERING FLOW. HONDO IS THEN EXPECTED TO KEEP ON TRACKING
SLOWLY SOUTHEASTWARDS, THEN QUICKER BEYOND 36 HOURS TOWARDS A WEAKNESS IN
 THE SUBTRO
PICAL RIDGE IN THE SOUTHEAST.
WEAKENING IS EXPECTED TO BE STRONGER BEYOND 48 TO 60 HOURS ON COOLER SEA
SURFACE TEMPERATURES.
```

ATCF “B-deck” Best Track Format

The ATCF Best Track format is very similar to the Forecast Record format above except the records are for prior positions instead of forecast positions. As with the Forecast Record files, the first record will only be read for any redundant time periods. In the example below (and above) there are two or three records for each time period corresponding to the 34, 50, and 64 knot wind critical radii entries. ATCF Best Tracks will be extrapolated if used in real-time since the current image date/time being used for the analysis will most likely be after the last entry in the Best Track file (which are typically only updated every six hours). Best Track files are best to use in historical post-processing of ADT storm intensity estimates.

The naming convention for these files is "bXXSSYYYY.dat", where XX is the basin ("al" for Atlantic, "ep" for East Pacific, "cp" for central pacific, "wp" for West Pacific, "io" for Indian Ocean, and "sh" for Southern Hemisphere storms.

```
AL, 12, 2005082318,   , BEST,   0, 231N,  751W,  30, 1008, TD,   0,    ,    0,    0,
0,    0, 1012,  150,  30,  40,   0,   L,   0,    ,   0,   0,     TWELVE, D,
AL, 12, 2005082400,   , BEST,   0, 234N,  757W,  30, 1007, TD,   0,    ,    0,    0,
0,    0, 1011,  150,  40,  40,   0,   L,   0,    ,   0,   0,     TWELVE, D,
AL, 12, 2005082406,   , BEST,   0, 238N,  762W,  30, 1007, TD,   0,    ,    0,    0,
0,    0, 1012,  150,  40,  40,   0,   L,   0,    ,   0,   0,     TWELVE, D,
AL, 12, 2005082412,   , BEST,   0, 245N,  765W,  35, 1006, TS,  34, NEQ,   60,   60,
0,    0, 1012,  150,  55,  45,   0,   L,   0,    ,   0,   0,    KATRINA, D,
AL, 12, 2005082418,   , BEST,   0, 254N,  769W,  40, 1003, TS,  34, NEQ,   60,   60,
0,    0, 1012,  130,  55,  50,   0,   L,   0,    ,   0,   0,    KATRINA, D,
AL, 12, 2005082500,   , BEST,   0, 260N,  777W,  45, 1000, TS,  34, NEQ,   60,   60,
0,    0, 1012,  130,  55,  50,   0,   L,   0,    ,   0,   0,    KATRINA, D,
<record deleted from listing>
AL, 12, 2005082806,   , BEST,   0, 252N,  867W, 125,  930, HU,  50, NEQ,  100,  100,
75,  100, 1008,  300,  25, 155,   0,   L,   0,    ,   0,   0,    KATRINA, D,
AL, 12, 2005082806,   , BEST,   0, 252N,  867W, 125,  930, HU,  64, NEQ,   75,   75,
50,   75, 1008,  300,  25, 155,   0,   L,   0,    ,   0,   0,    KATRINA, D,
AL, 12, 2005082812,   , BEST,   0, 257N,  877W, 145,  909, HU,  34, NEQ,  180,  180,
125,  140, 1008,  300,  20, 170,   0,   L,   0,    ,   0,   0,    KATRINA, D,
AL, 12, 2005082812,   , BEST,   0, 257N,  877W, 145,  909, HU,  50, NEQ,  120,  120,
75,  100, 1008,  300,  20, 170,   0,   L,   0,    ,   0,   0,    KATRINA, D,
AL, 12, 2005082812,   , BEST,   0, 257N,  877W, 145,  909, HU,  64, NEQ,   90,   90,
50,   75, 1008,  300,  20, 170,   0,   L,   0,    ,   0,   0,    KATRINA, D,
AL, 12, 2005082818,   , BEST,   0, 263N,  886W, 150,  902, HU,  34, NEQ,  200,  180,
125,  180, 1006,  300,  20, 185,   0,   L,   0,    ,   0,   0,    KATRINA, D,
AL, 12, 2005082818,   , BEST,   0, 263N,  886W, 150,  902, HU,  50, NEQ,  120,  120,
75,  120, 1006,  300,  20, 185,   0,   L,   0,    ,   0,   0,    KATRINA, D,
AL, 12, 2005082818,   , BEST,   0, 263N,  886W, 150,  902, HU,  64, NEQ,   90,   90,
50,   90, 1006,  300,  20, 185,   0,   L,   0,    ,   0,   0,    KATRINA, D,
AL, 12, 2005082900,   , BEST,   0, 272N,  892W, 140,  905, HU,  34, NEQ,  200,  200,
150,  180, 1006,  350,  20, 170,   0,   L,   0,    ,   0,   0,    KATRINA, D,
AL, 12, 2005082900,   , BEST,   0, 272N,  892W, 140,  905, HU,  50, NEQ,  120,  120,
75,  100, 1006,  350,  20, 170,   0,   L,   0,    ,   0,   0,    KATRINA, D,
AL, 12, 2005082900,   , BEST,   0, 272N,  892W, 140,  905, HU,  64, NEQ,   90,   90,
60,   80, 1006,  350,  20, 170,   0,   L,   0,    ,   0,   0,    KATRINA, D,
<records deleted from listing>
AL, 12, 2005083000,   , BEST,   0, 326N,  891W,  50,  961, TS,  34, NEQ,   75,   90,
90,   50, 1005,  300,  30,  65,   0,   L,   0,    ,   0,   0,    KATRINA, D,
AL, 12, 2005083000,   , BEST,   0, 326N,  891W,  50,  961, TS,  50, NEQ,   50,   60,
0,    0, 1005,  300,  30,  65,   0,   L,   0,    ,   0,   0,    KATRINA, D,
AL, 12, 2005083006,   , BEST,   0, 341N,  886W,  40,  978, TS,  34, NEQ,   75,   90,
75,   50, 1005,  300,  30,  55,   0,   L,   0,    ,   0,   0,    KATRINA, D,
AL, 12, 2005083012,   , BEST,   0, 356N,  880W,  30,  985, TD,   0,    ,    0,    0,
0,    0, 1005,  300,  30,  40,   0,   L,   0,    ,   0,   0,    KATRINA, D,
AL, 12, 2005083018,   , BEST,   0, 370N,  870W,  30,  990, TD,   0,    ,    0,    0,
0,    0,
AL, 12, 2005083100,   , BEST,   0, 386N,  853W,  30,  994, EX,   0,    ,    0,    0,
0,    0,
AL, 12, 2005083106,   , BEST,   0, 401N,  829W,  25,  996, EX,   0,    ,    0,    0,
0,    0,
```

Generic Format

Each line in the Generic Entry file contains either the initial/current position of the storm or a forecast position at 12-hours or 24-hours, and are formatted as follows:

dd mm yyyy tttt aa.a bbb.b

parameter	value	format
dd	date	two digit integer
mm	month	two digit integer

yyyy	year	four digit integer
tttt	UTC time	HHMM format : HH-hour MM-minute
aa.a	latitude	floating point (+/- : north/south)
bbb.b	longitude	floating point (+/- : west/east)

An example file for Floyd using the 12 September 1999/03:00UTC forecast product :

```
12 09 1999 0300 22.7 64.5
12 09 1999 1200 22.9 66.0
13 09 1999 0000 23.2 68.3
```

The first line contains the "initial" position, with the second and third lines containing the 12-hour and 24-hour forecast positions. Use of a forecast file older than 24 hours will result in a failure with the auto-positioning routine.

L.) Maximum Curved Band Location Search

If a Curved Band scene type has been determined automatically, or was selected manually during a scene override, an additional search will be performed to locate a storm center position possessing a greater cloud curvature measurement than obtained at the original selected storm center location. The search will examine the same BD-curve temperature range as obtained with the automatic scene type determination scheme. A 2° latitude/longitude box, centered at the originally selected storm center location, will be examined at a 0.2° spacing between search points. At each search point, the 10° Log Spiral will be examined to determine the maximum arc length of the BD-curve temperature range being targeted. The spiral will then be rotated 15° and the measurement is performed again. Once the spiral has been rotated 360°, the spiral is moved to the next search point and the process is repeated. The search point possessing the maximum arc length measurement will then be shown in the intensity analysis output.

This feature was incorporated, in response to user feedback, due to the high degree of subjectivity inherent to the curved band analysis technique. It was added to provide an objectively determined location with the greatest curvature; however, this location may or may not be the best location and should only be used as a suggestion.

M.) Latitude Bias Adjustment

If the Courtney/Knaff/Zehr pressure/wind relationship is not utilized by the ADT (Section 5O), the MSLP value output by the ADT will include an adjustment based on the latitude of the storm, designed to eliminate a bias noted by Kossin and Velden (2003) in the ADT-derived MSLP values and underlying Dvorak Technique. The equation used for this adjustment is:

$$CI\#_{adj} = CI\#_{orig} + (7.325 - (0.302)*ABS(latitude)))$$

This equation requires the $CI\#_{orig}$ value to be entered in units of pressure (hPa). Since the ADT produces estimates in terms of T# values, the $CI\#_{orig}$ value must be converted to millibars before the adjustment equation is applied. The pressure adjustment value is stored in a history file.

The MSLP bias adjustment is only applied to scene types that utilize eye and cloud temperature values to determine the strength of the storm since the bias is related to corresponding temperatures associated with a higher/lower tropopause height. In order for the adjustment to be turned “on”, six hours of continuous “EIR-type” scenes must be present. These types of scenes are CDO, Embedded Center, and Eye scenes, while non-EIR scenes include Shear, Curved Band, and Irregular CDO. Once the scene criterion is met, the bias adjustment is blended into use over the next six hours using a time-weighted multiplication factor, ranging from 0.0 at the initial time to 1.0 at the six hour time period, with the determined latitude bias adjustment value.

For more specific information about the latitude bias adjustment, please refer to the following online document (Kossin and Velden, 2003) at:

http://www.ssec.wisc.edu/~kossin/articles/kossin_velden_MWR.pdf

N.) Estimate of Radius of Maximum Wind (RMW)

The ADT invokes a subroutine after each intensity estimate to approximate the radius of maximum wind (RMW). This subroutine calculates the RMW using a regression equation derived from historical comparisons between IR imagery cloud top temperature fields and collocated in-situ reconnaissance aircraft radius of maximum wind measurements. If the derived ADT cloud region temperature (described in Section 5C) is colder than –50°C, the distance from the storm center to the -45°C cloud top temperature isotherm is measured in four directions and averaged to produce a final distance measurement. The RMW location (in kilometers from the storm center position) is then determined from this distance using the equation:

$$RMW = 2.8068 + (0.8361*dist)$$

If the ADT derived cloud top temperature value is warmer than -50°C, the distance to the isotherm defined by the equation (ERT + 2.0*CRT)/3.0, where ERT is the eye (center) temperature and CRT is the cloud region temperature, is used in the above equation to determine the RMW value.

O.) Passive Microwave (PMW) Eye Score

Information on the PMW image processing procedure can be found in Section 6B. That section outlines the procedure used/suggested to obtain, pre-process, and utilize PMW imagery data directly within the ADT. This current section discusses how the derived eye score value is utilized within the ADT intensity derivation process.

In order to try and alleviate a long standing issue with obtaining accurate intensity estimates with the ADT during Central Dense Overcast (CDO) scene types, an “eye score” value is either passed into or derived within the ADT to help obtain a more accurate intensity estimate than can be obtained with the IRW imagery alone.

Utilization of the PMW eye score value will only be allowed prior to three consecutive, automated "eye" scene type determinations by the ADT algorithm. Once three consecutive eye scene types have been found using the IR imagery alone, the PMW "eye score" information will be ignored no matter what its value may be.

Before the three eye scenes are found, the PMW eye score value will be used to determine the intensity of the storm at the time of the PMW eye score value (it will actually be assigned to the time record in the existing storm history file that exists immediately after the date/time of the PMW eye score record). There are two threshold eye score values that are utilized in the PMW eye score routine, each corresponding to a different T# intensity value to be assigned in the ADT algorithm for the intensity. If the eye score value is equal to or greater than 20.0, but less than 60.0, the ADT will reassign the Raw T# intensity score of the existing record in the ADT history file to be 4.3. If the eye score value is greater than or equal to 60.0, the Raw T# value for this record will be assigned to a 5.0. If no records exist in the ADT history file after the PMW eye score record time, the intensity estimate for the current IR image being analyzed will be modified to one of these two values.

In order to try and alleviate an artificial "jump" in the ADT history file records once the PMW eye score value exceeds one of the threshold values, all of the CI# values, as well as the adjusted Raw T# and Final T# values, in each record up to 12 hours prior to the PMW eye score record time will be adjusted linearly to a value between the "current" PMW eye score intensity value and the CI# value of the 12-hour previous record. The history file records will be physically changed within the history file, but the "historical" values (obtained prior to the application of the PMW eye score adjustment) will be kept in the history file comment section for each record.

For example, if the PMW eye score value of 26.2 occurred at 20:56UTC, the following record in the history file (most likely at 21:15UTC) will have its Adjusted Raw T#, Final T#, and CI# values all changed to 4.3. Looking back 12 hours from the 21:15UTC record shows the 9:15UTC record with an intensity value (CI#) of 3.4. Thus, all records between 9:15 and 21:15 will have their Adjusted Raw T#, Final T#, and CI# values changed to the corresponding linear interpretation value between 3.4 and 4.3 (depending on the time between the two end times). The original values will be stored for each of these times in their corresponding comment section in the history file.

The same adjustment 12-hour previous record adjustment will be applied if the PMW eye score values change from the first threshold range (between 20.0 and 59.9) to the second (60.0 and above). For example, if the MW eye score exceeds 60.0 at 14:45UTC, all records back to 2:45UTC will be linearly adjusted between the 5.0 value at 14:45 and the CI# value at 2:45UTC.

The PMW eye score adjustment will continue to be applied as long as two conditions are not met. The first, as mentioned previously, occurs when three consecutive (assuming 30-minute resolution imagery is being used), automatically determined scene types are determined from the IR imagery to be "eye" scene types. The second occurs when the PMW eye score value drops below the 20.0 threshold value for more than 12 hours. Once either of these situations occurs, the PMW eye score adjustment process will be terminated. If the first situation occurs, the PMW eye score adjustment can never be applied during the remainder of the storm's lifecycle. If the second situation occurs, the PMW adjustment can once again be applied if a PMW eye score value once again exceeds a threshold value.

During the application of the PMW eye score adjustment, the Rule 8 flag value in each history file record will be modified to store a descriptive value for each situation during the PMW eye score adjustment period. These values will be displayed in the History File Listing described in Section 4E1a. The value will be "MW ON" when the eye score values are 20.0 and above, "MW Adj." for the 12-hour period prior to the first eye score values exceeding 20.0, and "MW Off" for either of the two conditions where the eye score adjustment is turned off described above. The records modified during the initial 12-hour adjustment periods (either with the first eye score value above 20.0 or with the transition between the 20.0 and 60.0 values) will all have their comment section appended with the information "MWinit=A.A/B.B/C.C", where A.A, B.B, and C.C are the initial Adjusted Raw T#, Final T#, and CI# values, respectively (prior to the MW adjustment).

The application of any ongoing MW eye score adjustment will be suspended if a "non-EIR" scene type (either Shear or Curved Band) is encountered. If three (assuming 30-minute imagery resolution) consecutive non-EIR scene types are encountered, the application of the MW eye score adjustment will also be terminated and the Rule 8 History File Listing value will become "MW Off". In addition, if the storm moves over a land surface for more than six hours, any ongoing MW eye score adjustment process will be terminated. Finally, if the MW eye score being used has not updated for eight hours, the PMW eye score adjustment will turn off.

Once the PMW eye score adjustment has been utilized and subsequently turned off because three consecutive eye scenes have been found, the utilization of another eye score adjustment is disallowed unless the storm CI# intensity falls below 4.0. If the CI# falls below 4.0 the utilization of any subsequent eye score values (and related adjustments to the various intensity values) is once again allowed.

As noted previously in Section 4A1, it is NOT RECOMMENDED to edit the ADT History file when utilizing PMW information. Adding/Modifying/Deleting records with the EDIT parameter may incorrectly modify the contents of the PMW data being stored in the history file.

P.) Courtney/Knaff/Zehr Wind-Pressure Relationship

An additional relationship between the TC wind and MSLP values has been implemented into the ADT using the methodology outlined in Knaff and Zehr, 2007 and Courtney and Knaff, 2009. This technique utilizes several environmental TC parameters to convert the T# value obtained by the ADT to wind speed (using the relationship shown in Table 7) and then to an estimate of MSLP, and is far too complex to describe in detail in this document.

The environmental parameters needed by the ADT to calculate the MSLP estimate are the environmental MSLP and the gale radius (the 34 knot wind radius) of the TC being examined. The environmental MSLP value can be obtained by determining the outermost closed isobar and adding 2 hPa, while the gale radius can be derived by averaging all available quadrant 34 knot wind radii estimate values. If the 34 knot wind radii values are not available, a proxy value can be derived using the radius of last closed isobar (ROCI) value multiplied by -1. The negative value indicates to the ADT that the proxy for the 34knot radius needs to be derived using the following equation:

$$R34_{proxy} = (0.354 * ROCI) + 13.3$$

Each of these values are obtained from the ATCF Best Track/Objective Aid/Wind Radii format files using the observational comprehensive archive (CARQ) record values. The ATCF homepage is provided in Section 4D8. The environmental MSLP/last closed isobar value is the "RADP" value, while the 34 knot radii values (value of 34 in the RAD column) will be stored in the RAD1 through RAD4 values. The ROCI value is stored in the ROUTER value.

Q.) Subtropical Analysis

The subtropical (ST) analysis scheme is employed within the ADT algorithm using the SUBTROP keyword. It is used when the storm being analyzed is designated as a subtropical system by the tropical cyclone forecast center issuing the forecasts/warnings on the storm. Forecast centers like NHC, CPHC and JTWC will utilize special designators in their real-time ATCF Best Track files in the TC development common field, which is a two letter ID designating the current level of storm intensity. The designators are "SD" and "SS" for subtropical depression and subtropical storm, respectively.

The example script file getSTfiles.scr in the ADT91/scripts directory will search for either of these designators in the current Best Track file for the storm being analyzed. If found, the ADT will utilize the subtropical analysis scheme to derive the intensity estimate.

When the ST adjustment utilizes the Curved Band and Irregular CDO scene types to determine the intensity of the storm. The Shear scene type is not allowed/utilized. A modification to the existing Curved Band analysis scheme is employed during the ST analysis scheme. The Curved Band analysis scheme will begin with a new, warmer, cloud top brightness temperature range, from -10 to -30C, instead of starting at the normal "Dark Gray" temperature range (-30 to -42C). This new range increases the spatial size and coherency of the curved band scene being examined, and is highlighted in blue in the examples below in Figure 7.

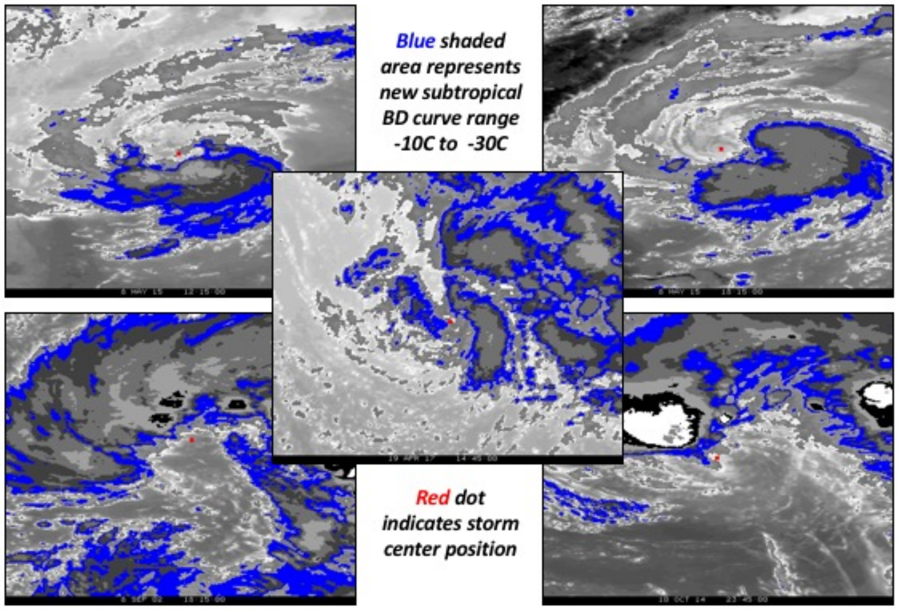

Figure 7: Examples of new ST Curved Band cloud top temperature range in IR imagery.

A final 5 knot bias adjustment is applied to the Curved Band or Irregular CDO derived estimates to result in the final ST intensity analysis.

R.) Extratropical Adjustment

The ADT Extratropical (ET) adjustment was developed by Clark Evans of the University of Wisconsin-Milwaukee. The adjustment is a simple regression based adjustment that is basin-specific. The adjustments are based on wind speed, with the adjustment applied to the current ADT CI# value (converted to wind speed using the Dvorak CI# to wind speed conversion discussed in Section 5I).

WCI = Wind speed converted from current CI# (units = knots)

Atlantic/East Pacific : Wind_Correction = -0.57*WCI + 30.0kts
Other Basins : Wind_Correction = -0.70*WCI + 30.0kts

Final CI# after adjustment = (WCI + Wind_Correction) converted back to CI#

In order to use the ET adjustment, the following criteria must be met. The current and 6-hour previous beta parameter value from the FSU Cyclone Phase Space product must both be greater than 10.0 and the current storm latitude must be greater than the absolute value of 20.0. This check is performed in the example script file checkETfile.scr (provided in the ADTV91/scripts directory). A storm-specific control file will be created (ADTV91/scripts/ETfiles/activeET.<stormID>) containing the current ET flag (ON/OFF) and the two beta parameter values.

If the criteria above have been met the ET flag value will switch in the file from OFF to ON to indicate the the ET adjustment can be applied. The flag will remain ON for the remainder of the storm life cycle even if the storm moves equatorward of 20N/S or the beta value(s) fall below 10.0.

The ET flag value and the latest beta value will be passed into the ADT via the ET command line keyword (see Section 4A). Within the ADT algorithm, a few additional checks will be performed to control the application of the ET adjustment if the flag is ON in the control file. First, the indication of a possible ET situation must be greater than 24 hours from a PMW adjustment. An additional check of the current storm location latitude value must have the storm poleward of 20N or 15S. The current input beta value must also be greater than or equal to 10.0. Finally, the percent of shear scenes within the previous 12 hours (stored in the history file) must be greater than or equal to 50%. If all of these criteria are met within the algorithm, the ET adjustment will be applied and the ET flag in the history file will be set to 1 (0 equals ET adjustment is not utilized). The ET adjustment will then be applied for the remainder of the storm life cycle.

As with the PMW adjustment, at the first ADT analysis where the ET adjustment is to be applied (turned ON), the CI# values for the records within the previous 12-hours will be modified to linear interpolate between the current ET adjusted CI# value and the CI# value of the record 12-hours previous to the current record. This will blend in the ET adjustment and avoid unnatural jumps in the CI# value at the time the ET adjustment is applied.

The ADTV9.1 running at CIMSS in real-time is utilizing the FSU Cyclone Phase Space to obtain the beta parameter value. Information about the FSU Cyclone Phase Space information can be accessed at the following site: http://moe.met.fsu.edu/cyclonephase Currently the FSU phase space information utilized by the ADT routines is provided in real-time from NOAA/NESDIS at:
https://ftp.ncep.noaa.gov/data/nccf/com/ens_tracker/prod/gfs.<date>/<hour>/tctrack
(use the "avnop" files; where <date> is in format yyyymmdd and <hour> is 00, 06,12, 18).

S.) 2-Dimensional Surface Wind Field Estimates

The 2-dimentional surface wind field estimates are derived from a routine developed by John Knaff at NOAA/NESDIS/RAMMB. The routine will output wind radii (in nautical miles) at the standard wind speed thresholds of 34 knots, 50 knots, and 64 knots. These radii are produced for four storm quadrants; northeast, southeast, southwest, and northwest. Details on how the technique works can be found in Knaff et al., 2016.

The routine will utilize the current ADT estimated wind speed intensity (derived from the current CI# value converted to wind speed using the Dvorak CI#/wind speed conversion) and the the current storm motion vector information (speed, in knots, and direction) derived from either the input forecast or best track position. The routine also requires an estimate of RMW (in nautical miles), either derived from the ADT analysis or a climatological value of RMW. It will interrogate the input IR image to estimate the three different wind speed radii values in the four quadrants.

To generate the surface wind field radii estimates, use the 2DWIND keyword described in Section 4A. The wind radii will be output in the ADT intensity bulletin output and can also be output to a text file if defined in the keyword command. The output file will be placed in the directory specified by the ODTOUTPUT environmental parameter. This listing will include the date and time of the image being analyzed, the storm motion vector information, the current storm position, and the wind radii for the three speed thresholds in each of the four quadrants.

6.) Python-based ARCHER Package

The ARCHER package is available and maintained by Tony Wimmers at the following website: https://github.com/ajwimmers/archer. This package contains primarily the ARCHER storm center determination software package, written in python. It also contains a primitive PMW eye score derivation program. It is encouraged that this package is used by ADT users in order to upgrade the storm center determination scheme to the most current version of the code available by Tony. The internal PMW eye score algorithm has been removed from the ADT package in Version9.1 so determination of this value using the ARCHER package is necessary to providing this value to the ADT.

A.) ARCHER

The ARCHER storm center determination algorithm utilized in the ADT is fully described in Wimmers and Velden, 2016, so how the algorithm works will not be described here. Portions of the ARCHER algorithm are very similar to the original ADT "pre-ARCHER" storm center determination scheme described in Section 5J. ARCHER utilizes several different types of multispectral satellite imagery, including geostationary IR, shortwave IR, and visible images as well as passive microwave imagery, including 37GHz and 85-89GHz imager channels as well as scatterometer winds. The ADT ARCHER does not utilize scatterometer or 37GHz imagery data.

The ARCHER algorithm still performs the ring fitting and spiral centering analysis as with the original version, as well as creating a combination field that includes a distance penalty function field based on the distance from the initial first guess position (interpolated forecast, most likely), however it also includes new analysis information that the original version does not, including eyewall radius, storm position certainty radii (50% and 95% values), eye probability, and position confidence score values.

The ARCHER is run PRIOR TO the ADT intensity estimate derivations (recommended every 30 minutes). This differs from the operation of the ARCHER routine described in Wimmers and Velden, 2016, which runs every 3 hours. This will assure the ADT ARCHER position will as up to date as it can be when utilized by the ADT algorithm.

The README file within the ADTV91/ARCHER/scripts directory outlines the programs, scripts, and output files used during the ARCHER analysis process. Three geostationary channels should be examined (IR, Near (or shortwave) IR, and visible when available) for each ARCHER analysis, along with any new 85-89GHz PMW imagery that may be available. The ADT ARCHER programs provided (archer_adt_geo.py and archer_adt_mw.py) are derived from the demo.py file provided in the Wimmer's ARCHER python code package and have been modified to read either netCDF files (for geostationary files) or ASCII text files (for PMW files). These programs can be further modified for use with specific user's local input, as needed.

As a guide, the ADT geostationary files currently read netCDF files with the following variable and attribute names (following the format used when converting a McIDAS AREA file to netCDF format within McIDAS-X):

imageDate	: Image Date in YYYYDDD format (YYYY=year, DDD=day number)
imageTime	: Image Time in HHMMSS format (HH=hour, MM=minutes, SS=seconds)
bands	: Satellite Channel Number
lat	: Array of Latitude values in (y,x) format (+/- = North/South)
lon	: Array of Longitude values in (y,x) format (+/- = East/West)
data	: Array of Brightness Temperature values in (y,x) format (degrees K)
sensorID	: McIDAS sensor number, if available
- attributes	
Satellite Sensor	: Character representation of satellite name (e.g. "GOES-17","Himawari-9, etc.).

The archer_adt_geo.py requires input of the initial forecast position and wind speed value along with the longitude of the nadir position of the satellite and the channel being used (IR, SWIR, Vis). The archer_adt_mw.py does not require any input information since the needed values are obtained from the input ASCII text file.

The output generated for each image will include detailed information regarding the ARCHER analysis, including storm center position estimates from the three methods used in the ARCHER analysis (spiral center, ring analysis, and combination field) as well as other pieces of information as described above. The alpha "confidence" scores generated for each available image analysis are then compared. The analysis with the highest alpha score is then designated the "best" position. This value, along with the corresponding latitude and longitude position, can then be passed into the ADT to designate the ARCHER position. This analysis information is also added to a file that the ADT can also use in the ADT intensity estimation process. It should be noted that the PMW alpha scores are reduced over time, which is dependent upon the amount of time between the current analysis time and the PMW overpass time. Below is an example output for the ARCHER IR and ARCHER MW (SSMIS-F16) analysis:

<u>Geostationary IR</u>

```
Computing center-fix on full image...
Regridding data to equal lon/lat aspect ratio ...
Calculating spiral center ...
Calculating ring center ...
sensor_type =  IR
Radius (deg) = 0.50 0.45 0.40 0.35 0.30 0.25 0.20 0.15 0.10 0.05
fdeck output:
BB, NN, 2301251600,  70, INFR,         C,  , 1960S,  4301E,      ,
1,    ,  ,    ,  ,     ,    ,     ,     ,     ,     ,     ,  ,  ,  ,  ,  ,
,    ,  ,  CIMS,
AUT,    ,            ,            ,    ,     ,                      i,
irad=0.25 | r50=0.13 | r95=0.38 | ep=100 | src=ARCH
20230125 160000   METEOSAT9      IR  -19.65   42.90 102.0   -
19.60   43.01    0.13   0.38   0.25   1.15  12.61  100.0
```

<u>MW SSMIS-F16</u>

```
SSMI image
Total points masked for coastal boundaries: 814
Computing center-fix on whole image...
Regridding data to equal lon/lat aspect ratio ...
Calculating spiral center ...
Calculating ring center ...
sensor_type =  89GHz
Radius (deg) = 2.50 2.45 2.40 2.35 2.30 2.25 2.20 2.15 2.10 2.05 2.00 1.95 1.90
1.85 1.80 1.75 1.70 1.65 1.60 1.55 1.50 1.45 1.40 1.35 1.30 1.25 1.20 1.15 1.10
```

```
1.05 1.00 0.95 0.90 0.85 0.80 0.75 0.70 0.65 0.60 0.55 0.50 0.45 0.40 0.35 0.30
0.25 0.20 0.15 0.10 0.05
fdeck output:
BB, NN, 2301251500,  70, SSMI,          C,  , 1965S,  4291E,      ,
1,    ,  ,     ,  ,     ,    ,      ,      ,      ,      ,     ,  ,  ,  ,  ,  ,
,    ,  ,  CIMS,
AUT,    ,              ,              ,    ,     ,                        m,
irad=0.40 | r50=0.12 | r95=0.33 | ep= 82 | src=ARCH
{'sensor': '89GHz', 'lon_mx': array([[58.28479015, 58.2089591 , 58.12636476,
..., 38.9462342 ,
<lines deleted>
       [276.67, 277.31, 277.41, ..., 233.93, 244.84, 274.74]]), 'time':
1674658833, 'op_lon': 42.8, 'op_lat': -19.9, 'op_vmax': 70.0, 'ring_weight':
0.0694}
20230125 150033    SSMISF16    89GHz  -19.90   42.80  70.0   -
19.65   42.91    0.12   0.33   0.40   3.45  14.42   81.8
```

Various example scripts within the ADTV91/ARCHER/scripts directory are provided to demonstrate how the ARCHER analysis is performed and how the output analysis parameters for each run are extracted and combined for determination of the best position. Various output text and graphical files are placed in subdirectories within ADTV91/ARCHER/scripts. The ODTARCHER environmental variable in the adtenv file should be set to this directory for use in the ADT algorithm. The ADT will then use either the final "best" alpha score and position derived from the most current ARCHER analysis or the file ARCHER_listing.<stormID>.best.txt which is appended with the "best" ARCHER analysis alpha score and other important information (see ARCHER keyword in Section 4A1).

The output information written to the "best" file contains the following information for each complete ARCHER analysis (the **BOLD** lines at the end of the examples above):

date time sat chan latf lonf vmaxf lat lon rad50 rad95 radeye conf alpha probeye conf

date - date in yyyymmdd format
time - time in HHMMSS format
sat - satellite source (geostationary or MW sensor satellite name)
chan - satellite channel/source (IR/NearIR/Visible/89GHz)
latf - forecast latitude (N/S +/-)
lonf - forecast longitude (E/W +/-)
vmaxf - forecast max wind speed value (kts)
lat - ARCHER latitude
lon - ARCHER longitude (interpolated to geostationary time for MW sensor)
rad50 - radius of circle of 50% certainty of ARCHER position (degrees)
rad95 - radius of circle of 50% certainty of ARCHER position (degrees)
redeye - radius of eye diameter (degrees)
conf - confidence score
alpha - alpha score (adjusted for MW sensors from time of original overpass time)
probeye- probability (%) that an eye exists in image (only for IR and 85-89GHz imagery)
conf - confidence score

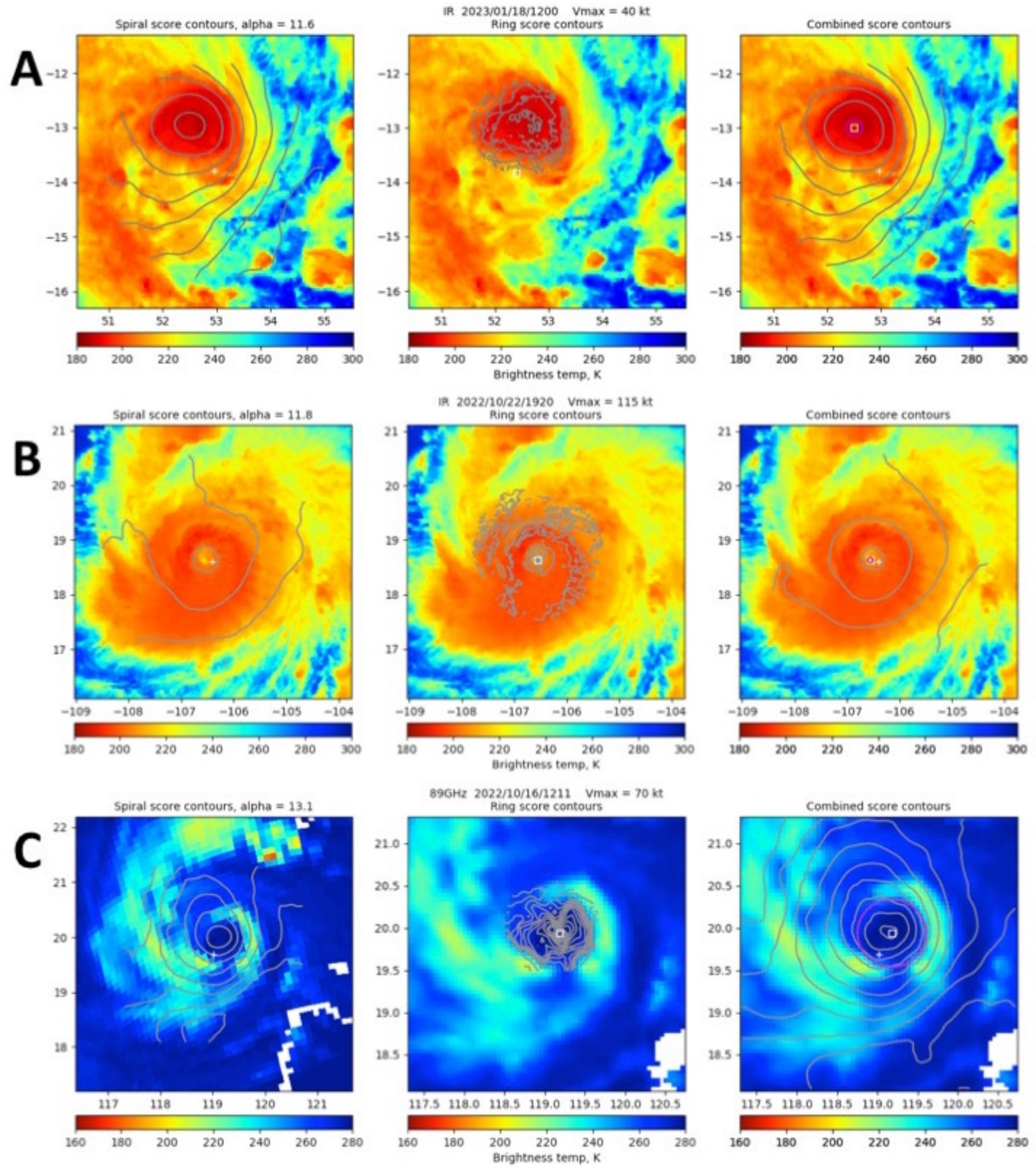

Figure 8: ARCHER analysis graphical output displays for two IR images (A and B) and a MW image (C). Forecast first guess position is indicated by "+" sign, with final ARCHER location indicated by a box along with magenta circle indicating eye radius.

The contents of the "best" file can be displayed along with the graphical output derived by the ARCHER derivation package. This graphical output file will display the analysis of the spiral, ring, and combined analysis along with the initial forecast "first guess" position and the final position and "eye size" ring. Figure 8 demonstrates sample output graphical analysis displays for two IR images (A and B) and one PMW 89GHz image (C). The output ARCHER analysis graphical display image will be written, in the ARCHER/imgs directory, to the files archer_adt_geo.png or archer_adt_mw.png for the geostationary or MW analysis, respectively.

It must be noted that the ADT software package includes some modified versions of code from the base ARCHER python package that optimize the package for the ADT, such as specifically formatted input satellite files and output text information. These are described in the README file included in the ADTV91/ARCHER directory.

B.) PMW Eye Score

The PMW eye score analysis is very similar to the ARCHER analysis outlined above. The python program is named archer_adt_MWeyescore.py and was modified from the original Wimmer's ARCHER python program demo_inten_score.py to utilize the same ASCII text input files used with the ARCHER MW analysis program archer_adt_mw.py.

The raw PMW files are converted from their native format to an ASCII text file that contains the coordinates of each pixel along with the brightness temperature values. The header line of the file contains other information for the processing of the PMW data. The PMW data will follow the header line.

-- Header
  Latitude, Longitude, Maximum Wind Speed, Date (YYMMDD format), Time (HHMMSS format), Number of Columns (Y-direction), Number of Rows (X-direction), Satellite ID, Orbit ID

-- Data
  Column Number (Y), Row Number (X), Latitude, Longitude, Temperature (vertical polarization, deg K), Temperature (horizontal polarization, deg K)
    Where:
    - Latitude: given in +/- Northern/Southern Hemisphere
    - Longitude: given in +/- Western/Eastern Hemisphere (McIDAS format)
    - Maximum Wind Speed: in knots (obtained from current TCFC forecast product)
    - Satellite ID: TRMM, SSMI(15-18), or AMSR (not available)
    - Orbit ID: Taken from HDF file name

A file will have the following format:

Storm_Latitude Storm_Longitude Storm_Vmax Overpass_Date Overpass_Time Num_Rows Num_Cols Overpass_Satellite Overpass_ID
Y X Latitude Longitude Bt_Vertical Bt_Horizontal
Y X+1 Latitude Longitude Bt_Vertical Bt_Horizontal
Y X+2 Latitude Longitude Bt_Vertical Bt_Horizontal
(etc.)

The output of the ADT PMW Eye Score determination program includes many lines of intermediate array listings and analysis parameters, however the final line contains the final output of the analysis that can be passed into the ADT via the MW keyword (Section 4A1). The final line includes the following:

<date> <time> <sat> <chan> <fcst lat> <fcst lon> <fcst Vmax> <lat> <lon> <hotspot> <weakT> <diffT> <compl> <sfcDia> <score>

date - date in yyyymmdd format
time - time in HHMMSS format

sat - satellite source (geostationary or MW sensor satellite name)
chan - satellite channel/source (IR/NearIR/Visible/89GHz)
fcst lat - forecast latitude (N/S +/-)
fcst lon - forecast longitude (E/W +/-)
lat - ARCHER analysis latitude
lon - ARCHER analysis longitude
hotspot - warmest eye temperature pixel (deg K)
weakT - warmest pixel on eye wall (deg K)
diffT - difference between hotspot and weakLink values (deg K)
compl - "completeness" of ring (eyewall inner boundary); value is greater value between
either a) % pixels on ring colder than hotspot by 20 degK
or b) % pixels on ring colder than 232K and colder than hotspot by 10 degK
sfcDia - diameter of eyewall inner boundary at surface (MW eyewall edge diameter - 10km)
score - final PMW eye score

Below is an example of the output provided by the MW Eye Score analysis for the same SSMIS-F16 image examined in the ARCHER analysis above:

```
SSMI image
Total points masked for coastal boundaries: 814
Computing center-fix on whole image...
Regridding data to equal lon/lat aspect ratio ...
Calculating spiral center ...
Calculating ring center ...
sensor_type =  89GHz
Radius (deg) = 2.50 2.45 2.40 2.35 2.30 2.25 2.20 2.15 2.10 2.05 2.00 1.95 1.90
1.85 1.80 1.75 1.70 1.65 1.60 1.55 1.50 1.45 1.40 1.35 1.30 1.25 1.20 1.15 1.10
1.05 1.00 0.95 0.90 0.85 0.80 0.75 0.70 0.65 0.60 0.55 0.50 0.45 0.40 0.35 0.30
0.25 0.20 0.15 0.10 0.05
fdeck output:
BB, NN, 2301251500,  70, SSMI,          C,  , 1965S,  4291E,      ,
1,    ,  ,     ,  ,     ,    ,     ,     ,     ,     ,     ,  ,  ,  ,  ,  ,
,    ,  ,  CIMS,
AUT,    ,             ,           ,   ,    ,                        m,
irad=0.40 | r50=0.12 | r95=0.33 | ep= 82 | src=ARCH
{'sensor': '89GHz', 'lon_mx': array([[58.28479015, 58.2089591 , 58.12636476,
..., 38.9462342 ,
<lines deleted>
       [276.67, 277.31, 277.41, ..., 233.93, 244.84, 274.74]]), 'time':
1674658833, 'op_lon': 42.8, 'op_lat': -19.9, 'op_vmax': 70.0, 'ring_weight':
0.0694}
hotSpot=281.08
weakLink=276.10
diffScore=  4.98
completeness=  0.15
sfcDiamKM= 78.94
finalScore=  4.98
20230125 150033    SSMISF16    89GHz  -19.90   42.80  70.0   -
19.65   42.91    281.08   276.10     4.98    0.15   78.94    4.98
```

The “score” parameter can then be passed into the ADT using the MW keyword. It should be noted that the score value will be negative if the input forecast wind speed is less than 55 knots. This is done to reduce any false score values during weaker storm intensities. The use of the score value within the ADT is discussed in Section 5O.

An output file is also produced to the file MWeyescore_adt.png within the ARCHER/imgs directory. The analysis is the same as those produced with the ARCHER analysis for the MW plot (see Figure 8C).

Examples of how the ADT ARCHER and PMW Eye Score analysis can be presented to users on a webpage can be found within the individual ADT anlaysis storm pages at https://tropic.ssec.wisc.edu/real-time/adt, including the plots shown above.

7.) Non-McIDAS Environment Compilation and Utilization

If the ADT code is to be run in an environment where McIDAS is not installed, the ADT can be compiled completely free of the McIDAS core environment using a special keyword during the use of the "compileall" script file. If the ADT code had been compiled in McIDAS mode previously, it can be uninstalled using the following command:

compileall clean

This command will remove the naodt command, local object *.o files, library *.a files, and links to the library files in the lib directory.

To compile the ADT code in non-McIDAS fashion, use the following command:

compileall nonmcidas

This command will eliminate the symbolic link to the libmcidas.a library file within the compileall script. It will run the Makefile_noMC within the main ADT source "src" subdirectory and Makefile_cimss_noMC within the odtlib and odtappl subdirectories also. These makefiles call special versions of the odtappl/odtappl.c and odtlib/odtenv.c files that contain and control the operation of the ADT when not using McIDAS.

The resulting executable will not be able to be run in any sort of interactive mode as available with the McIDAS version of the code, but can still be run utilizing the same command line parameter/keyword structure. The resulting ADT executable will be called "naodt".

The user will be required to write any sort of data ingesting routines necessary to read the non-McIDAS format satellite imagery and pass it into the ADT application program odtappl/odtappl.noMC.c.

Three sample programs are provided in the odtnetcdf directory to read and pass the information to the top ADT application in the odtappl/odtappl.c program. One program (readnetcdf-hursat.c) will read HURSAT type netCDF files (NOAA files are formatted very similar), while the second program (readnetcdf-generic.c) will read a more generic type of file (currently utilized at the Central Weather Bureau in Taiwan). A third version will read netCDF files which were created within McIDAS directly from McIDAS AREA format image files. DO NOT RELY ON THESE PROGRAMS TO READ YOUR LOCAL DATA! One of these programs may need to be modified to work with local user netCDF files correctly. It is up to the user to adapt or create a program to work within the non-McIDAS mode of the ADT.

It must be noted that when using the netCDF keyword in ADTV9.1 (see Section 4A1), there are four options for the "type" parameter; HURSAT, NOAA, McIDAS, and GENERIC. HURSAT and NOAA will use the readnetcdf-hursat.c program to read the netCDF file. McIDAS will use the readnetcdf-mcidas.c program, while GENERIC will use the readnetcdf-generic.c program. For the HURSAT option, the storm position provided in the netCDF file with the CentLat and CentLon variables will be used as the final storm position unless the ARCHER keyword is utilized. With the NOAA, McIDAS, and GENERIC type parameter, the final location will be determined using the original "pre-ARCHER" methodology or the interpolation of the input position (e.g. forecast interpolation) if the ARCHER position is not utilized.

For more specific information on HURSAT data, please visit the HURSAT webpage at: https://www.ncdc.noaa.gov/hursat/

When compiling the ADT in "nonmcidas" mode, the user must define the location of the netCDF directory in the compileall script using the NETCDF variable. The directory location should be something like /home/user/netcdf and should contain a bin and lib directory where the netCDF executable and library files are located (and any other software/library packages utilized by netCDF, such as szip, udunits, zlib, HDF, and HDFview).

To run the ADT in non-McIDAS mode, the user must utilize the NETCDF keyword, as defined in Section 4A1. The ADT is run from the UNIX/LINUX command line using the naodt executable file in the ADTV91/src directory. Examples of executing the ADT in non-mcidas mode are provided below:

naodt AUTO X X KATRINA.ODT NETCDF=FILE Katrina.08.23.2005.1800.nc HURSAT

The ADT will run in "automated mode" using the final position provided by the HURSAT netCDF image file Katrina.08.23.2005.1800.nc. The output analysis being written to the history file KATRINA.ODT. ***Note that no forecast file and type parameters are defined when using the HURSAT file type.***

naodt AUTO ATCF NOAA/fwp102019.dat 10W_2019.ODT NETCDF=YES HS_H08_20190807_0800_B13_10W_TY.nc NOAA ARCHER=YES 20.5 21.30 -127.60 12.0

The ADT will run in "automated mode" using the interpolated storm location from the ATCF format file fwp102019.dat as the first guess position. The NOAA-format netCDF file HS_H08_20190807_0800_B13_10W_TY.nc is utilized. The ARCHER position located at 21.30N/127.60E (note this is in McIDAS longitude format, where the East Hemisphere is negative) is input using the ARCHER keyword, with a score value of 20.5 and a threshold value of 12.0. In this case, the ARCHER position will be used since the score is greater than the threshold value. If the score had been less than the threshold value, the first guess position would be used. If the ARCHER keyword was not used, the "pre-ARCHER" positioning methodology would be attempted to improve the first guess storm location.

The ADT parameter PLOT, which graphically displays the ADT history file, will not be available when compiling the ADT in non-McIDAS mode. An error message will result to remind the user of this restriction.

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