AODT – Advanced Objective Dvorak Technique
USERS' GUIDE
(McIDAS Version 6.2)

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Users' Guide

Table of Contents

1.) Description of the AODT Algorithm

The Advanced Objective Dvorak Technique (AODT) 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 AODT can be used to classify storm intensity beginning from storm formation through development and dissipation. Previous versions of the ODT could only classify intensities once the storm being examined reached hurricane strength or greater (T# 3.5 or approximately 994/984mb in the Atlantic/Western Pacific).

The AODT is patterned after the Subjective Dvorak Enhanced Infrared 'EIR' Technique (SD) (Dvorak, 1975, 1984) which made use of various pattern identification schemes and rules to determine tropical cyclone intensity. The AODT has been developed to closely mimic the SD methodology in terms of intensity determination protocol and the incorporation of various rules and analysis methods.

The AODT 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 AODT, 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, and the use of various SD rules governing the variability of the intensity estimate values. These changes have led to more stable and statistically sound estimates of intensity.

For greater detail about the development process and statistical accuracy obtained with the current and previous ODT/AODT algorithm , please refer to Velden et al. (1998) and Olander et. al. (2002).

2.) System Hardware and Software Requirements

The AODT 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 AODT was primarily developed utilizing McIDAS 7.6 on a Silicon Graphics, Inc. Indigo2 running the UNIX-based IRIX 6.4 operating system. The AODT has been tested and operated on additional UNIX operating systems, including HP and Sun platforms. Integration within LINUX systems has also been successfully performed. Use of the GCC C-compiler is recommended, but the local system C-compiler can be used if the Makefile files in the two navcal directories are modified correctly.

3.)   AODT Acquisition and Installation

The current version of the AODT algorithm can be obtained via the UW-CIMSS AODT web page, along with the Users' Guide. All files required for installation of the AODT are contained within a single compressed UNIX tar file. The AODT can be obtained from the following URL address :

http://cimss.ssec.wisc.edu/tropic/aodt/aodt.html

Once the AODT tar file has been downloaded, it can be uncompressed and unpacked using the following command :

gunzip AODT-v6.2.tar.gz
tar -xvf AODT-v6.2.tar

Once completed, an "aodt-v6.2" directory should contain all of the files necessary to compile and create the AODT executable. The contents of the aodt-v6.2 directory is :
- NOTES   : AODT notes and instructions
- odt.c odtauto.c odtdata.c odtfft.c odthistory.c odtintensity.c odtmcidas.c
  odtmcinput.c odtoutput.c odtscene.c odtsst.c : AODT C programs
- odt.h,odtsst.h   : AODT include files
- TOPOLRES   : Low resolution topography file
- aodt-compile   : AODT compile script
- aodtenv   : AODT environment argument setup file (Section 4.E)
- bin/   : directory containing binary files created during compilation
- history/   : directory containing output history files (suggested location)
- lib/   : directory containing library files
- navcal/   : directory containing navigation/calibration files and F2C files
- sst/   : directory containing current sea surface temperature files
- test/   : directory containing test script and data and sample forecast files

Prior to installation of the AODT, the current libmcidas.a library file must be located and linked to within the aodt-v6.2/lib directory. The AODT requires this file for all text and graphical output within the McIDAS user interface windows. This file should reside in the ~mcidas/lib directory. The actual linking is performed within the "aodt-compile" script using the variable MCLIB to define the location of the libmcidas.a file. The MCLIB variable should be modified to reflect the location of the file on the machine where the AODT is being installed. Note that 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 AODT algorithm can be compiled using the following syntax :

aodt-install <gcc/cc>
<gcc/cc>   - designates use of the system C-compiler (CC) or the GNU C compiler. GCC is recommended, but should be the same compiler used to compile the McIDAS code.

4.)   Using the AODT

The AODT 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 AODT algorithm is initiated via the McIDAS command line structure using a selection of keywords to control various functions of the AODT algorithm. All AODT keywords are defined in Section 4A1, with examples provided in Section 4A3.

A.)   Command Line Structure and Keywords

The AODT is initiated and controlled with the following command line structure :

AODT *<keywords>*

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

1.)   Description of Use

HISTORY=filename   (default=none)
> History file used for the AODT analysis. If no history file is specified, no history file will be created/appended. History file names can be up to twelve total characters in length, including the suffix ".ODT", which will be added to the end of all history file names. The directory where the history files are written to is defined with the ODTHISTORY environment argument. See Special Keyword Notes in Section 4A2 and Section 4B for additional information about the AODT history file.

LIST=YES/NO   (default=NO)
> List contents of history file within McIDAS text window. Can be used in conjunction with DATE, OUTPUT, and DOMAIN keywords. Pressure/wind units in terms of millibars/knots. AODT analysis will not be performed.

OUTPUT=SCREEN/FILE filename   (default=SCREEN)
> Direct LIST=YES keyword output to McIDAS text window or ASCII file *filename*. The default output filename is ODTDUMP.ASC. The directory where the FILE output is written is defined with the ODTOUTPUT environment argument (see Section 4C).

GRAPH=YES/NO/TEM   (default=NO)

Plot intensity estimates from history file to McIDAS image window. Can be used in conjunction with DATE, PLOT, DOMAIN, and WIND keywords. Pressure/wind units in terms of millibars/knots. TEM value plots eye region, cloud region, and "coldest-warmest" cloud region temperatures, respectively. Temperature units in terms of degrees Celsius/Fahrenheit. AODT analysis will not be performed.

PLOT=c1 c2 c3 c4 c5 c6 c7 c8 c9   (defaults=1 2 0 0 0 6 0 1 7; 0 to not display)

Defines graphic color level values for CI#, Adjusted MSLP, Final T# (6-hr time-weighted), Final T# (3-hr average), Raw T#, 12-hour Average TIE Model value, Current TIE Model value, graphics boundaries, and graphics wording, respectively. If TEM keyword is used with GRAPH keyword, the color levels will be for the eye region temperature, cloud region temperature, and "coldest-warmest" cloud region temperature, respectively (the other four values will not be used). Color values can be modified using the McIDAS command GU. Graphics color level value of zero (0) will suppress plotting of desired intensity estimate value. Used in conjunction with GRAPH keyword.

DELETE=YES/NO   (default=NO)

Allows for manual deletion of history file records. Must be used in conjunction with DATE keyword to define date/time limits to remove. Any records existing in history file after deletion of unwanted records will be updated as necessary (Final T# and CI values will be recalculated). See DATE keyword for default values associated with DELETE keyword. AODT analysis will not be performed.

DATE=date1 time1 date2 time2   (default=see below)

Defines range of dates and times for LIST, GRAPH, and DELETE keywords. Format for date and time values are the same as those given within the text listing (LIST=YES option) :

date format   : YearMonDy (e.g. 1998OCT17)
time format   : HHMMSS (e.g. 131500)
Default values :

GRAPH and LIST	: date1/time1 : first record	
	date2/time2 : last record	
DELETE	: date1/time1 : no default, must specify	
	date2/time2 : date1/time1	

WIND=YES/NO   (default=NO)

Intensity units given in terms of maximum wind speed (knots) instead of mean sea level pressure. Used in conjunction with GRAPH keyword to plot intensity estimates in terms of wind speed. Speed and pressure values are related to CI number values using empirical relationships defined in Dvorak (1984) and (Shewchuck and Weir, 1980).

DOMAIN=ATL/PAC   (default=auto determination)

Define oceanic domain which tropical cyclone resides. ATL should be used for storms within North Atlantic basin, while PAC should be used for storms within Western Pacific basin. If oceanic basin is not explicitly defined with this keyword, a basin will selected automatically (see Section 5G). Domain selection will affect Raw T# intensity estimate determination and corresponding CI number pressure value (empirical CI number/pressure relationship). Can be used with LIST and GRAPH keywords or with AODT analysis.

AUTO=YES/NO type filename atcftype (defaults=NO 0 AUTOFIX OFCL)

Allow for completely automated operation of AODT, utilizing NHC/JTWC forecasts and Laplacian Analysis to objectively determine storm center position. ***Cannot be used with OVER keyword***.

type = 0   : ATCF Tropical Cyclone Forecast Record files.
type = 1   : TPC WTNT4? (North Atlantic) or WTPZ3? (East Pacific) storm
                       specific DISCUSSION files.
type = 2   : JTWC WTPN3? (Western North Pacific) TROPICAL
                       CYCLONE WARNING file.
type = 3   : Generic format (see Section 5H for format/example)
filename   : Name of input file. The directory where the input files is
                       located is defined with the ODTAUTO environment argument.
atcftype   : ATCF objective technique acronym (default is official forecast)

OVER=YES/NO   (default=NO)

Allow user to manually override AODT scene identification. ***Cannot be used with AUTO keyword***. See Section 4D5 for more information.

IC=value   (default=1.0)

Allow user to override the initial Raw T# intensity classification value, as defined in the Subjective Dvorak Rules. The initial Raw T# classification value will be set to 1.0 unless explicitly defined by the user as another value. This keyword should only be used when analysis of a tropical cyclone is initiated at a time later than initial formation (storm has a Raw T# value greater than 1.0). If value is set to 0.0, this function will be turned off for the analysis, allowing for the AODT derived value to be displayed as the Raw T#.

REMOTE=YES/NO localserver localarea (default=NO ODTLSERVE ODTLDATA)

Utilize a remotely displayed/stored McIDAS image for AODT analysis. Subset of data image will be copied to the local server as defined by the *localserver* and *localarea* UNIX environment arguments. See Section 4C for more information.

localserver   : ADDE dataset name (group/descriptor format or alias name). The default is the environment argument ODTLSERVE.

localarea   : ADDE dataset position (within local group/descriptor). The default value is the environment argument ODTLDATA.

LAND=YES/NO   (default=YES)

Apply AODT land interaction rule.   See Section 4D5 and 5A for more information.

SST=filename   (default=SST.DAT)

Name of file containing SST information for TIE Model. Directory where SST file is located is defined using ODTSST environmental variable. See Section 5K for more information.

SEARCH=YES/NO   (default=YES)

Perform search for maximum curved band location if Curved Band scene type was automatically determined or manually selected. See Section 5J for more information.

2.)   Special Keyword Notes

If no history file is provided, the AODT intensity bulletin and runtime output (see Section 4D) will be abbreviated, providing the user with only the intensity estimate value at the current time. No analysis flag values will be listed, and no history file will be created or modified.

If the GRAPH, LIST, or DELETE keywords are used, an AODT intensity analysis will not performed. These functions are used to only investigate and modify the contents of the history file.

The AUTO and OVER keywords cannot be used in the command line at the same time. No user interaction is allowed during the automated operation of the AODT. If these keywords are used in the same command line entry, the override capability will be disabled, and an error message will alert the user of this fact.

3.)   Examples

AODT

Perform abbreviated AODT 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.

AODT HISTORY=OPAL.ODT

Perform AODT 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.

AODT HISTORY=OPAL.ODT IC=2.5

Perform AODT 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.

AODT HISTORY=OPAL.ODT OVER=YES

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

AODT HISTORY=OPAL.ODT GRAPH=YES PLOT=3 4 0 1 2

Display graph of contents of history file OPAL.ODT in current graphic image using color level 3, 4, 1, and 2 for the CI, Final T# (6-hr average), Raw T#, and TIE model estimate plots, respectively. The Final T# (3-hr average) values will not be displayed. Graph boundary and wording will utilize the default values. No intensity analysis is performed.

AODT HISTORY=OPAL.ODT LIST=YES

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

AODT HISTORY=OPAL.ODT LIST=YES OUTPUT=FILE OPAL.TXT

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

AODT HISTORY=OPAL DELETE=YES DATE=1995OCT03 151500

Delete only the 1995OCT03/151500UTC 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.

AODT HISTORY=OPAL DELETE=YES DATE=1995OCT03 151500 1995OCT03 191500

Delete all records between 1995OCT03/151500UTC and 1995OCT03/191500 UTC 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.

AODT HISTORY=OPAL LIST=YES DATE=1995OCT03 1500

List all records between 1995OCT03/001500UTC and the end of the history file OPAL.ODT. No intensity analysis is performed.

AODT HISTORY=OPAL LIST=YES DATE=X X 1995OCT03 31500

List all records between the beginning of the history file OPAL.ODT and 1995OCT03/31500UTC. No intensity analysis is performed.

AODT HISTORY=OPAL.ODT AUTO=YES 2 wp2698.txt

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

AODT HISTORY=OPAL.ODT REMOTE=YES

Perform AODT analysis on the remotely stored image currently displayed in the McIDAS image display window. A subset of the displayed image will be copied to the local server on the user's machine in a location defined using the environment arguments ODTLSERVER and ODTLDATA. See Sections 4C and 4D6 for more details.

B.)   History File

        The AODT history file is an ASCII format file containing AODT intensity estimates, locations, and other specific information for each previous image analysis. The AODT algorithm utilizes records in the history file for the determination of the two Final T# values as well as in the determination of various rules utilized within the intensity estimate routines.

        Due to McIDAS constraints, with origins dating back to DOS-based McIDAS operation, history file names are limited to 12 characters. AODT history files will have the suffix ".ODT" appended to the file name if it does not exist in the command line entry. File names over eight characters in length will be truncated and appended with the ".ODT" suffix. For example, the history file named JOSEPHINE will result in a history file named JOSEPHIN.ODT, while the file name OPAL.ODT will be left as OPAL.ODT (an additional .ODT will not be appended). The directory location for the history file is defined using the ODTHISTORY environment argument.

        Each individual analysis stored in a history file contains the following 32 records :

Value 1   : date (YYYYMMDD format : YYYY=year, MM=month, DD=day)
Value 2   : time (hhmmss format)
Value 3   : raw T# value
Value 4   : final T# value (6-hour time-weighted average)
Value 5   : final T# value (3-hour average)
Value 6   : final CI# value
Value 7   : eye region temperature (°C)
Value 8   : mean cloud region temperature (°C) – movable annulus
Value 9   : mean cloud region temperature (°C) – set region (old method)
Value 10   : "coldest-warmest" cloud region temperature (°C)
Value 11   : storm center latitude (+/- = North/South Hemisphere)
Value 12   : storm center longitude (+/- = West/East Hemisphere)
Value 13   : eye diameter or shear distance (in km)
Value 14   : eye region temperature standard deviation value
Value 15   : cloud region symmetry value
Value 16   : eye region scene type (original value)
Value 17   : cloud region scene type (original value)
Value 18   : eye region scene type (user override value)
Value 19   : cloud region scene type (user override value)
Value 20   : Dvorak Weakening flag
Value 21   : Dvorak Rule 8 flag
Value 22   : land/ocean flag
Value 23   : eye region FFT value
Value 24   : cloud region FFT value
Value 25   : curved band analysis – BD curve gray scale value
Value 26   : curved band analysis – convection curvature amount (out of 25)
Value 27   : distance from center to "coldest-warmest" temperature value
Value 28   : automated center determination flag
Value 29   : MSLP pressure value using latitude bias adjustment
Value 30   : TIE model current pressure value – if SST value available
Value 31   : TIE model 12-hour averaged pressure value – if SST value available
Value 32   : sea surface temperature value (°C) – 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 AODT command line entry with select keywords, such as DELETE and DATE, in order to assure correct modification to the remaining history file entries.

C.)   UNIX Environment Arguments

In order to provide more control regarding various AODT input/output file and directory definitions, the AODT utilizes UNIX environment arguments to define specific variables used within the AODT algorithm. This provides the user greater ability to personalize the AODT to the local machine on which it is operating.

Seven environment arguments are defined within the aodtenv file :

Variable	Description
ODTTOPO	Directory where TOPOHRES topography file is located
ODTHISTORY	Directory where AODT history files are stored
ODTAUTO	Directory for forecast files for AODT auto mode
ODTOUTPUT	Directory for LIST output
ODTSST	Directory for the external SST input file
ODTLSERVER	Name of local ADDE server dataset name
ODTLAREA	ID number of local ADDE server dataset position

ODTTOPO, ODTHISTORY, ODTAUTO, ODTOUTPUT, and ODTSST are directory names. The default value for the base directory for these variables is defined using the $ODTHOME environmental variable, which is defined on line one of the aodtenv file. If any of these variable names are not defined in the aodtenv file explicitly, the value will default to the $HOME environment variable value.

The ODTLSERVER and ODTLAREA variables will copy a remotely stored image to the local server using the standard McIDAS ADDE dataset name and position identification scheme. ODTLSERVER is the dataset name, in either *group/descriptor* format or an ADDE alias name (using AKA), with ODTLAREA being the *position* variable. Please refer to the McIDAS Users' Guide for details on specific McIDAS ADDE server definitions and topics.

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

. aodtenv

Once entered in the UNIX environment, any McIDAS session initiated will utilize the seven AODT environment arguments. The UNIX "env" command can be used to verify the values assigned to each of the variables.

D.)   Algorithm Output

During AODT 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 AODT Analysis

Full AODT analysis of an image requires the use of a history file and may use various combinations of specific keywords. Below is sample output obtained during analysis of an image for Hurricane Floyd :

```
Utilizing history file /home/odt/aodt-v6.2/history/FLOYD.ODT
Performing full AODT analysis
Utilizing image data file /home/odt/mcidas/data/AREA2010
Using USER-SELECTED center position : LAT: 22.99 LON:  66.21
SST value of 18.6C at cursor location
Ocean basin automatically selected as ATLANTIC
Warmest pixel temperature of  -0.1C at LAT:  23.99 LON:  66.21
ADDED RECORD TO END OF HISTORY FILE
WROTE 66 RECORDS TO HISTORY FILE /home/odt/aodt-v6.2/history/FLOYD.ODT
**************************************************

                  UW - CIMSS
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              AODT – Version 6.2
        Tropical Cyclone Intensity Algorithm


            ----- Current Analysis -----
   Date :  12 SEP 1999     Time :  124500 UTC
    Lat :   22:59:26 N      Lon :  66:12:49 W


             CI# /Pressure/ Vmax
             6.5 / 934.8mb/127.0kt


     Latitude bias adjustment to MSLP :   -0.2mb


        6hr-Avg T#      3hr-Avg T#       Raw T#
           6.3             6.4             6.5


 Eye Temp :  -0.1C       Cloud Region Temp : -70.2C
 Scene Type : CLEAR EYE
 Ocean Basin : ATLANTIC
 Flags :    Rule 8 : NO LIMIT   Weakening : OFF

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                  UW - CIMSS
     TROPICAL CYCLONE INTENSITY ESTIMATE MODEL
           TIE MODEL – Version 0.0A Beta

           Sea Surface Temperature=18.6C
      Current Pressure/Vmax : 920.0mb/140.4kt
      12hr-Avg Pressure/Vmax : 923.8mb/137.4kt

**************************************************
Successfully completed AODT analysis
```

The first section of the AODT output include 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 history file utilized will be displayed first, and thus a full AODT analysis will be performed on the image. This will be indicated by the following message :

```
Performing full AODT analysis
```

The path and file name of the current image file being analyzed will be listed next. In this example the locally stored image file is named AREA2010. 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 4D6.

The location of the storm center selected for the current intensity analysis will then be shown. The example above used a manually selected storm center location, indicated by the USER-SELECTED message containing the storm center coordinates. A discussion of an automatically selected storm center location will be provided in section 4D4. The ocean basin in which the storm is located will be displayed next. This value will either be ATLANTIC or PACIFIC, indicating the MSLP-T# relationship used for the output pressure value in the intensity bulletin and history file listing. The basin will automatically be determined unless manually overridden using the BASIN keyword. See Section 5G for more information on the ocean basin determination.

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, and was indicated by the message :

```
Added record to end of history file
```

The above message will appear most frequently since the AODT will usually be executed utilizing the latest available image for the storm being investigated. 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 :

```
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>
```

 or

```
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>
```

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

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 Raw T#, Final T# (6-hour time-weighted average), Final T# (3-hour average), and CI#. The "Raw T#" value represents the current intensity of the storm. The "6hr-Avg T#" value is the 6-hour time-weighted averaged intensity of the storm. The time averaging scheme is explained in greater detail in Section 5D. The "3hr-Avg T#" value is the average of the current and previous three hour analyses values. Finally, the "CI#" value represents the 6-hour time-weighted averaged value after various subjective Dvorak EIR rules governing its variability, Rule 8 and Rule 9 have been applied. For more details on these rules, see Section 5F. Adjacent to the "CI#" value are the corresponding estimated mean sea level pressure (MSLP) and maximum wind (Vmax) values. These values are based upon specific relationships between T# and MSLP for different oceanic basins (see Section 5G)

The MSLP value displayed for the derived CI# intensity estimate has 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. The amount of the adjustment is listed under the CI#/MSLP/Vmax information in the intensity estimate bulletin. A positive/negative adjustment will increase/decrease the MSLP value obtained from the specific CI#/MSLP relationship for the scene being investigated. Please see Section 5L for more information on this adjustment.

The next section of the intensity estimate bulletin contains information about the scene being analyzed and various rule flag values affecting the current intensity estimate calculation. First, the eye and surrounding cloud region temperature values, described in Section 5C, are provided first. Beneath the eye temperature, the objectively determined scene type is listed. This classification can be manually defined by the user, if desired, using the OVER manual override keyword. Objective scene type determination is described in Section 5B. Next, the current oceanic basin is provided, and will be automatically determined unless explicitly defined by the user with the DOMAIN keyword, and is described in Section 5G. Finally, two Dvorak EIR Rule flag values are displayed. These flags, described in Sections 5E and 5F, notify the user whether these rules, which govern the determination of the Final T# and CI# values, have been applied during the current intensity estimation analysis.

The final section of the intensity estimate bulletin is the experimental Tropical Cyclone Intensity Estimate (TIE) Model output. This estimate will appear if a valid sea surface temperature (SST) can be obtained from an external data file at the cursor position. The format of this SST file is described in Section 5K. Additional information about the TIE Model is presented in the separate TIE Model Users' Guide, available on the AODT homepage.

2.) Abbreviated AODT Analysis

If a history file is not specified on the command line when utilizing the AODT, 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 :

```
Performing abbreviated AODT analysis
Utilizing image data file /home/odt/mcidas/data/AREA2010
Using USER-SELECTED center position : LAT: 22.99 LON:  66.21
SST value of 18.6C at cursor location
Ocean basin automatically selected as ATLANTIC
Warmest pixel temperature of  -0.1C at LAT:  23.99 LON:  66.21

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          ADVANCED OBJECTIVE DVORAK TECHNIQUE
                AODT - Version 6.2
          Tropical Cyclone Intensity Algorithm

              ----- Current Analysis -----
      Date :  12 SEP 1999     Time :  124500 UTC
       Lat :   22:59:26 N      Lon :  66:12:49 W

              CI# /Pressure/ Vmax
              6.5 / 934.8mb/127.0kt

      Latitude bias adjustment to MSLP :  -0.2mb

 Eye Temp :  -0.1C        Cloud Region Temp : -70.2C
 Scene Type : CLEAR EYE
 Ocean Basin : ATLANTIC

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                   UW-CIMSS
      TROPICAL CYCLONE INTENSITY ESTIMATE MODEL
            TIE MODEL - Version 0.0A Beta

          Sea Surface Temperature=18.6C
       Current Pressure/Vmax : 920.0mb/140.4kt
      12hr-Avg Pressure/Vmax : 923.8mb/137.4kt

****************************************************
Successfully completed AODT 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 :

```
Tropical cyclone is over land

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

                    UW - CIMSS
         ADVANCED OBJECTIVE DVORAK TECHNIQUE
               AODT - Version 6.2
         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 AODT ANALYSIS AVAILABLE

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

4.)   Automated Storm Center Determination

       The AODT algorithm can be run in a completely automated mode, utilizing interpolated tropical cyclone forecasts and a Laplacian-based storm center determination routine to obtain a completely objective storm intensity estimate. See Section 5H for specific information on the formats allowed for the input forecast files.

       The automated storm center location is determined using one of three techniques; polynomial interpolation of a forecast, Laplacian analysis of the current image, or linear extrapolation of previous history file positions. 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 or JTWC forecast 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 either the interpolation or extrapolation methods are successful, a Laplacian analysis of the cloud top temperature field, within 75km of the interpolated/extrapolated "first guess" position, will be performed. This analysis scheme will search for large gradients in the cloud top temperature values concentrated in small regions (e.g. eye regions).

       Confidence factors (CF) are determined for each of the three storm position methods. The CF for the extrapolated position is a constant value, while the CF for the interpolated forecast position based upon the difference between the current image time

14

and the time of the initial forecast position. The CF for the Laplacian analysis position is calculated based upon the number and scatter of the two sets of points that have exceeded two threshold values in the Laplacian analysis of the cloud top temperature gradient field. The method that produces the highest CF value is used as the storm center position. Typically, the Laplacian analysis technique will be used for storms with an "eye region", while the interpolated forecast position will be used in the large majority of other cases.

In the following examples, a TPC/NHC forecast was used in the polynomial interpolation scheme. The data points used in the polynomial interpolation scheme are displayed prior to the interpolated position. The Laplacian analysis is then performed using the interpolated position as the center point of the analysis region. Since an eye region was found, the Laplacian analysis position was used.

```
Accessing forecast file /home/aodt-v6.2/forecasts/storm01-15.txt
CURRENT ANALYSIS TIME : 01/OCT/2000   0715UTC
          DATE        TIME       LAT        LON
T0  01/OCT/2000   0300UTC     18.10      87.10
T1  02/OCT/2000   1200UTC     18.30      87.40
T2  02/OCT/2000   0000UTC     19.00      87.50
FORECAST INTERPOLATION successful -- LAT: 18.16 LON:  87.27
Will utilize LAPLACIAN ANALYSIS position -- LAT: 17.96 LON:  87.28
```

If the polynomial interpolation scheme fails, and the linear extrapolation of the previous 12 hour storm center locations, stored within the history file, is used as the first guess for the Laplacian analysis.

```
Accessing forecast file /home/aodt-v6.2/forecasts/storm01-15.txt
Error accessing forecast file /home/aodt-v6.2/forecasts/storm01-15.txt
FORECAST INTERPOLATION failed
LINERAR EXTRAPOLATION successful – LAT: 18.09 LON:  87.22
Will utilize LAPLACIAN ANALYSIS position – LAT: 17.96 LON:  87.28
```

If both the polynomial interpolation and linear extrapolation schemes fail, the Laplacian analysis will not be performed and the AODT will quit and the user will be notified in the runtime message output section with the following message :

```
Error with autopositioning
Exiting AODT
```

As mentioned previously, the automated center determination scheme cannot be used in conjunction with the manual override capability (see next section). 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.)   User Override Function

The user override function allows the user to modify the automatically determined scene type classification prior to the AODT storm intensity estimate calculation. This is 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 :

```
AODT has classified the EYE SCENE as CLEAR
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 :

```
AODT has classified the EYE SCENE as RAGGED
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 OBSCURED
  <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 AODT 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.

6.)   Remote Server Data Access

The AODT has the ability to utilize remotely stored and displayed McIDAS imagery. The AODT will assume the data is stored locally unless the keyword REMOTE is used. The REMOTE keyword utilizes two AODT environment arguments to describe the name and location of the data file being examined. These variables can be defined in the aodtenv file (see Section 4C) or with two REMOTE keyword entries (see Section 4A1).

If a remotely stored McIDAS image is investigated by the AODT, a subsection of the image displayed within the McIDAS image display window will be copied to the local machine. The McIDAS server dataset and position variables, defined with the ODTLSERVER and ODTLAREA AODT environment arguments, will be used to define the location and name where the image will be copied. The variable ODTLSERVER defines the ADDE *group/descriptor* name (or alias name) while ODTLDATA defines the *position* number within the *group/descriptor*. The size of the image copied will be 480x640 pixels and will be centered at the user-selected storm center position. An example output text message when using the REMOTE keyword follows :

```
DOWNLOADING REMOTE IMAGE EAST/NH.5 TO LOCAL IMAGE LOCAL/IMAGES.7777
  WITHIN LOCAL DIRECTORY AT /home/aodt-v6.2/mcidas/data/AREA7777
Utilizing image data file /home/aodt-v6.2/mcidas/data/AREA7777
```

In the example above, the AODT 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 of "LOCAL/IMAGES" into position 7777. The local ADDE image in this example was located in the /home/aodt-v6.2/mcidas/data directory in the file AREA7777. The AODT algorithm then utilized this locally stored image in the derivation of the intensity estimate for the storm image being examined.

E.)   History File Output

1.)   Text Output

An abbreviated listing of the history file contents can be displayed within the McIDAS text display window or written to an output file using the LIST, DATE, and OUTPUT keywords. An example of a text window listing is provided below for Hurricane Keith:

```
Utilizing history file /home/tlo/aodt-v6.2/history/KEITH.ODT
                ------Intensity-------  ----Tno----  --TIE Model-- -Temperature- Scene  Wkng Rule8      Storm Location
       Date     Time  CI  MSLP /Adjst/Vmax   6hr 3hr Raw   12hr    Raw    Eye   Cloud  Type   Flag Flag        Lat    Lon
2000SEP28 214500  1.5 1016.5/ +4.5/ 25.0  1.5 1.5 1.5  -99.9   -99.9 -17.76 -43.09 CRVBND OFF  No Limit   16.09  83.09
2000SEP28 224500  1.7 1015.2/ +4.4/ 27.0  1.7 1.7 2.0  -99.9   -99.9  -0.76 -40.44 SHEAR  OFF  0.5/6hr    16.21  83.21
2000SEP28 234500  1.8 1014.5/ +4.3/ 28.0  1.8 1.8 2.0  -99.9   -99.9  -4.56 -35.06 CRVBND OFF  0.5/6hr    16.29  83.41
2000SEP29   4500  1.9 1014.0/ +4.4/ 29.0  1.9 1.8 2.0  -99.9   -99.9  -8.26 -31.71 SHEAR  OFF  0.5/6hr    16.28  83.30
2000SEP29  14500  1.9 1014.0/ +4.4/ 29.0  1.9 2.0 2.0  -99.9   -99.9  -4.56 -35.15 CRVBND OFF  0.5/6hr    16.21  83.30
2000SEP29  24500  1.9 1014.0/ +4.4/ 29.0  1.9 2.0 2.0  -99.9   -99.9 -13.96 -37.10 CRVBND OFF  0.5/6hr    16.21  83.21
2000SEP29  74500  2.3 1010.8/ +4.2/ 33.0  2.3 2.4 2.4  -99.9   -99.9  13.84 -43.41 CRVBND OFF  0.5/6hr    16.48  83.71
2000SEP29  84500  2.3 1010.7/ +4.1/ 33.0  2.3 2.4 2.4  -99.9   -99.9   0.44 -40.25 CRVBND OFF  0.5/6hr    16.60  83.80
2000SEP29  94500  2.5 1009.1/ +4.1/ 35.0  2.5 2.5 2.8  -99.9   -99.9  -7.46 -40.08 CRVBND OFF  0.5/6hr    16.60  83.80
2000SEP29 104500  2.5 1009.0/ +4.0/ 35.0  2.4 2.4 2.2  -99.9   -99.9   2.34 -40.88 CRVBND ON   No Limit   16.72  83.81
2000SEP29 114500  2.5 1008.9/ +3.9/ 35.0  2.5 2.5 2.8  -99.9   -99.9   3.84 -33.58 SHEAR  OFF  0.5/6hr    16.79  83.90
2000SEP29 124500  2.6 1007.8/ +3.8/ 37.0  2.6 2.6 2.8  -99.9   -99.9   5.54 -42.03 SHEAR  OFF  0.5/6hr    16.91  83.99
2000SEP29 134500  2.6 1007.7/ +3.7/ 37.0  2.6 2.7 2.8  -99.9   -99.9   1.14 -38.10 SHEAR  OFF  0.5/6hr    16.99  84.20
2000SEP29 144500  2.7 1006.6/ +3.6/ 39.0  2.7 2.7 2.8  -99.9   -99.9   7.14 -31.58 SHEAR  OFF  0.5/6hr    17.11  84.40
2000SEP29 154500  2.8 1005.5/ +3.5/ 41.0  2.8 2.8 3.0  -99.9   -99.9   4.04 -43.68 SHEAR  OFF  0.5/6hr    17.19  84.50
2000SEP29 164500  2.8 1005.4/ +3.4/ 41.0  2.8 2.8 2.9  -99.9   -99.9   5.04 -44.12 SHEAR  OFF  0.5/6hr    17.31  84.59
2000SEP29 174500  2.8 1005.4/ +3.4/ 41.0  2.8 2.8 2.7  -99.9   -99.9  -9.36 -44.66 CRVBND OFF  No Limit   17.38  84.69
2000SEP29 184500  2.8 1005.3/ +3.3/ 41.0  2.8 2.9 3.0  -99.9   -99.9 -13.26 -45.28 CRVBND OFF  No Limit   17.50  84.81
2000SEP29 194500  2.9 1004.2/ +3.2/ 43.0  2.9 2.9 3.1  -99.9   -99.9 -41.06 -49.76 CRVBND OFF  0.5/6hr    17.58  84.90
2000SEP29 204500  3.0 1003.1/ +3.1/ 45.0  3.0 3.0 3.2  -99.9   -99.9 -62.06 -53.11 CRVBND OFF  0.5/6hr    17.70  85.00
2000SEP29 214500  3.1 1001.9/ +3.1/ 47.0  3.1 3.1 3.3  -99.9   -99.9 -65.56 -58.39 UNIFRM OFF  0.5/6hr    17.70  85.00
2000SEP29 224500  3.1 1001.8/ +3.0/ 47.0  3.1 3.2 3.3  -99.9   -99.9 -63.96 -57.87 UNIFRM OFF  0.5/6hr    17.82  85.01
2000SEP29 234500  3.2 1000.5/ +2.9/ 49.0  3.2 3.2 3.3  -99.9   -99.9 -58.36 -56.51 UNIFRM OFF  0.5/6hr    17.90  84.99
2000SEP30   4500  3.2 1000.5/ +2.9/ 49.0  3.2 3.2 3.3  -99.9   -99.9 -41.06 -52.82 CRVBND OFF  0.5/6hr    17.90  85.19
2000SEP30  14500  3.3  999.4/ +3.0/ 51.0  3.3 3.3 3.4  -99.9   -99.9 -40.56 -55.05 CRVBND OFF  No Limit   17.78  85.41
2000SEP30  24500  3.3  999.4/ +3.0/ 51.0  3.3 3.4 3.5  -99.9   -99.9 -42.16 -60.46 CRVBND OFF  No Limit   17.78  85.50
2000SEP30  64500  3.6  995.6/ +3.0/ 57.0  3.6 3.7 3.7  -99.9   -99.9 -73.66 -70.31 UNIFRM OFF  0.5/6hr    17.79  85.99
2000SEP30  74500  3.7  994.1/ +2.9/ 59.0  3.7 3.7 3.8  -99.9   -99.9 -69.86 -69.71 UNIFRM OFF  0.5/6hr    17.91  86.11
2000SEP30  84500  3.7  994.1/ +2.9/ 59.0  3.7 3.7 3.8  -99.9   -99.9 -68.16 -70.70 EMBC   OFF  0.5/6hr    17.91  86.20
2000SEP30  94500  3.8  992.7/ +2.9/ 61.0  3.8 3.8 4.1  -99.9   -99.9 -63.26 -74.06 EMBC   OFF  0.5/6hr    17.91  86.40
2000SEP30 104500  3.9  991.3/ +2.9/ 63.0  3.9 3.9 4.1  -99.9   -99.9 -62.06 -72.94 EMBC   OFF  0.5/6hr    17.91  86.49
2000SEP30 114500  4.0  989.9/ +2.9/ 65.0  4.0 4.0 4.1  -99.9   -99.9 -59.16 -71.85 EMBC   OFF  0.5/6hr    17.87  86.60
2000SEP30 124500  4.1  988.2/ +2.8/ 67.4  4.1 4.2 4.6  -99.9   -99.9 -48.46 -70.71 EYE/OB OFF  1.0/6hr    18.07  86.69
2000SEP30 134500  4.3  985.1/ +2.8/ 72.2  4.3 4.4 4.7  -99.9   -99.9 -49.36 -73.32 EYE/OB OFF  1.0/6hr    17.87  86.63
2000SEP30 144500  4.5  982.0/ +3.0/ 77.0  4.5 4.5 4.7  -99.9   -99.9 -55.36 -72.88 UNIFRM OFF  No Limit   17.76  86.84
2000SEP30 154500  4.5  982.0/ +3.0/ 77.0  4.5 4.6 4.7  -99.9   -99.9 -61.66 -73.23 UNIFRM OFF  No Limit   17.84  86.76
2000SEP30 164500  4.6  980.2/ +3.0/ 79.6  4.6 4.6 4.6  -99.9   -99.9 -66.06 -71.87 UNIFRM OFF  No Limit   17.80  86.80
2000SEP30 174500  4.7  978.4/ +3.0/ 82.2  4.7 4.7 4.5  -99.9   -99.9 -47.06 -71.93 EYE/OB OFF  1.0/6hr    17.76  86.81
2000SEP30 184500  4.8  976.5/ +2.9/ 84.8  4.8 4.8 5.1  -99.9   -99.9 -29.16 -71.15 EYE/C  OFF  1.0/6hr    17.96  86.81
2000SEP30 194500  5.0  972.8/ +2.8/ 90.0  5.0 5.0 5.3  -99.9   -99.9 -29.16 -68.55 EYE/C  OFF  1.0/6hr    18.00  86.91
2000SEP30 204500  5.1  970.9/ +2.9/ 92.4  5.1 5.2 5.5  -99.9   -99.9 -12.06 -71.18 EYE/C  OFF  1.0/6hr    17.96  86.95
2000SEP30 214500  5.3  966.8/ +2.8/ 97.2  5.3 5.3 5.5  -99.9   -99.9   5.84 -72.59 EYE/C  OFF  1.0/6hr    18.00  86.86
2000SEP30 224500  5.4  964.8/ +2.8/ 99.6  5.4 5.4 5.6  -99.9   -99.9  13.44 -72.35 EYE/C  OFF  1.0/6hr    18.00  86.95
2000SEP30 234500  5.5  962.8/ +2.8/102.0  5.5 5.5 5.7  -99.9   -99.9  15.24 -73.38 EYE/C  OFF  1.0/6hr    18.04  86.93
2000OCT01   4500  5.6  960.4/ +2.8/104.6  5.6 5.6 5.8  -99.9   -99.9  16.14 -74.37 EYE/C  OFF  1.0/6hr    18.08  86.96
2000OCT01  14500  5.7  958.0/ +2.8/107.2  5.7 5.7 6.0  -99.9   -99.9  15.34 -75.89 EYE/C  OFF  1.0/6hr    18.04  87.07
2000OCT01  24500  5.8  955.6/ +2.8/109.8  5.8 5.9 6.1  -99.9   -99.9  17.14 -75.73 EYE/C  OFF  1.0/6hr    18.08  87.16
2000OCT01  64500  6.4  940.4/ +2.8/124.6  6.4 6.6 6.6  -99.9   -99.9  15.34 -74.34 EYE/C  OFF  1.0/6hr    18.00  87.20
2000OCT01  74500  6.5  937.8/ +2.8/127.0  6.5 6.5 6.5  -99.9   -99.9   9.24 -73.29 EYE/C  OFF  1.5/12hr   18.00  87.31
2000OCT01  84500  6.5  937.8/ +2.8/127.0  6.5 6.5 6.5  -99.9   -99.9  13.84 -71.72 EYE/C  OFF  2.0/18hr   18.04  87.25
2000OCT01  94500  6.5  937.8/ +2.8/127.0  6.5 6.5 6.5  -99.9   -99.9  14.64 -71.70 EYE/C  OFF  2.0/18hr   18.04  87.34
2000OCT01 104500  6.5  937.7/ +2.7/127.0  6.4 6.4 6.4  -99.9   -99.9  17.84 -70.23 EYE/C  ON   2.5/24hr   18.12  87.39
2000OCT01 114500  6.5  937.8/ +2.8/127.0  6.4 6.4 6.5  -99.9   -99.9  15.54 -70.21 EYE/C  ON   No Limit   18.04  87.48
2000OCT01 124500  6.5  937.8/ +2.8/127.0  6.4 6.4 6.4  -99.9   -99.9  19.04 -69.33 EYE/C  ON   No Limit   18.00  87.54
2000OCT01 134500  6.5  937.8/ +2.8/127.0  6.4 6.4 6.3  -99.9   -99.9  16.44 -68.77 EYE/C  ON   No Limit   18.00  87.59
2000OCT01 144500  6.5  937.9/ +2.9/127.0  6.3 6.3 6.3  -99.9   -99.9  16.44 -67.86 EYE/C  ON   No Limit   17.93  87.67
2000OCT01 154500  6.5  937.9/ +2.9/127.0  6.2 6.2 6.1  -99.9   -99.9  13.24 -65.99 EYE/C  ON   No Limit   17.93  87.72
2000OCT01 164500  6.5  937.9/ +2.9/127.0  6.1 6.1 6.0  -99.9   -99.9   5.34 -64.95 EYE/C  ON   No Limit   17.89  87.71
2000OCT01 174500  6.5  937.9/ +2.9/127.0  6.0 6.0 5.8  -99.9   -99.9   7.94 -63.00 EYE/C  ON   No Limit   17.89  87.76
2000OCT01 184500  6.5  937.9/ +2.9/127.0  5.8 5.8 5.6  -99.9   -99.9   3.04 -60.81 EYE/C  ON   No Limit   17.89  87.83
2000OCT01 194500  6.5  938.0/ +3.0/127.0  5.7 5.7 5.4  -99.9   -99.9 -17.56 -58.61 EYE/C  ON   1.0/6hr    17.81  87.89
2000OCT01 204500  6.5  938.0/ +3.0/127.0  5.5 5.5 5.3  -99.9   -99.9 -18.66 -54.22 EYE/C  ON   1.0/6hr    17.85  87.85
2000OCT01 214500  6.4  940.6/ +3.0/124.6  5.4 5.3 5.2  -99.9   -99.9 -37.56 -52.83 IRRCDO ON   1.0/6hr    17.81  87.89
2000OCT01 224500  6.2  945.9/ +3.1/119.8  5.2 5.2 5.1  -99.9   -99.9 -48.46 -52.14 IRRCDO ON   1.0/6hr    17.73  87.90
2000OCT01 234500  6.1  948.4/ +3.0/117.4  5.1 5.1 5.0  -99.9   -99.9 -57.36 -51.97 IRRCDO ON   1.0/6hr    17.81  87.91
2000OCT02   4500  0.0    0.0/ +0.0/  0.0  0.0 0.0 0.0  -99.9   -99.9  99.99  99.99 LAND   OFF  N/A        17.81  88.00
<records deleted from listing>
2000OCT02  84500  0.0    0.0/ +0.0/  0.0  0.0 0.0 0.0  -99.9   -99.9  99.99  99.99 LAND   OFF  N/A        17.70  88.10
2000OCT02  94500  5.5  963.1/ +3.1/102.0  4.5 4.5 4.5  -99.9   -99.9 -72.16 -68.19 UNIFRM ON   No Limit   17.69  87.99
2000OCT02 104500  5.5  963.1/ +3.1/102.0  4.5 4.5 4.5  -99.9   -99.9 -72.66 -64.41 UNIFRM ON   No Limit   17.69  87.99
2000OCT02 114500  5.5  963.1/ +3.1/102.0  4.5 4.5 4.5  -99.9   -99.9 -75.66 -59.65 UNIFRM ON   No Limit   17.69  87.90
2000OCT02 124500  5.5  963.1/ +3.1/102.0  4.5 4.5 4.5  -99.9   -99.9 -73.16 -55.65 UNIFRM ON   No Limit   17.69  87.90
2000OCT02 134500  0.0    0.0/ +0.0/  0.0  0.0 0.0 0.0  -99.9   -99.9  99.99  99.99 LAND   OFF  N/A        17.62  88.01
<records deleted from listing>
2000OCT04  24500  0.0    0.0/ +0.0/  0.0  0.0 0.0 0.0  -99.9   -99.9  99.99  99.99 LAND   OFF  N/A        19.40  90.79
2000OCT04  64500  3.4  996.4/ +1.2/ 53.0  3.4 3.4 3.4  -99.9   -99.9   1.74 -40.08 SHEAR  ON   No Limit   19.81  91.60
2000OCT04  84500  3.4  996.4/ +1.2/ 53.0  3.1 3.2 3.0  -99.9   -99.9 -50.26 -40.23 CRVBND ON   No Limit   19.82  92.00
<records deleted from listing>
2000OCT04 204500  3.2  998.0/ +0.4/ 49.0  3.1 3.1 3.0  -99.9   -99.9 -72.66 -59.11 IRRCDO ON   No Limit   20.70  94.00
2000OCT04 214500  3.2  998.0/ +0.4/ 49.0  3.2 3.2 3.3  -99.9   -99.9 -78.36 -69.24 UNIFRM OFF  0.5/6hr    20.70  94.10
2000OCT04 224500  3.2  998.1/ +0.5/ 49.0  3.2 3.2 3.4  -99.9   -99.9 -80.56 -80.56 UNIFRM OFF  0.5/6hr    20.59  94.30
2000OCT04 234500  3.3  996.9/ +0.5/ 51.0  3.3 3.2 3.5  -99.9   -99.9 -78.36 -81.65 UNIFRM OFF  0.5/6hr    20.59  94.49
2000OCT05   4500  3.4  995.6/ +0.4/ 53.0  3.4 3.4 3.6  -99.9   -99.9 -80.06 -81.48 UNIFRM OFF  0.5/6hr    20.72  94.71
2000OCT05  14500  3.5  994.3/ +0.3/ 55.0  3.5 3.5 3.7  -99.9   -99.9 -78.86 -79.15 UNIFRM OFF  0.5/6hr    20.80  94.89
2000OCT05  24500  3.5  994.3/ +0.3/ 55.0  3.5 3.6 3.6  -99.9   -99.9 -72.16 -75.20 UNIFRM OFF  0.5/6hr    20.89  95.20
2000OCT05  64500  3.8  989.8/ -0.0/ 61.0  3.8 3.9 3.9  -99.9   -99.9 -69.86 -69.51 UNIFRM OFF  0.5/6hr    21.20  96.10
2000OCT05  74500  3.9  988.3/ -0.1/ 63.0  3.9 3.9 4.0  -99.9   -99.9 -65.16 -68.56 EMBC   OFF  0.5/6hr    21.28  96.29
2000OCT05  84500  3.9  988.1/ -0.3/ 63.0  3.9 3.9 4.0  -99.9   -99.9 -55.96 -67.90 EMBC   OFF  0.5/6hr    21.49  96.50
2000OCT05  94500  3.9  988.0/ -0.4/ 63.0  3.8 3.8 3.5  -99.9   -99.9 -41.36 -66.14 CRVBND ON   No Limit   21.62  96.60
2000OCT05 104500  3.9  988.0/ -0.5/ 63.0  3.8 3.8 3.9  -99.9   -99.9 -41.36 -64.63 CRVBND ON   No Limit   21.70  96.69
2000OCT05 111500  3.9  987.9/ -0.5/ 63.0  3.8 3.8 3.9  -99.9   -99.9 -33.86 -62.68 CRVBND ON   No Limit   21.78  96.78
2000OCT05 121500  3.9  987.8/ -0.6/ 63.0  3.7 3.7 3.5  -99.9   -99.9 -50.56 -60.28 CRVBND ON   No Limit   21.87  96.87
2000OCT05 131500  3.9  987.7/ -0.7/ 63.0  3.6 3.6 3.4  -99.9   -99.9 -17.76 -50.55 CRVBND ON   0.5/6hr    22.00  97.25
2000OCT05 141500  3.9  987.5/ -0.9/ 63.0  3.5 3.5 3.4  -99.9   -99.9 -27.66 -49.29 CRVBND ON   0.5/6hr    22.17  97.39
2000OCT05 151500  3.9  987.3/ -1.1/ 63.0  3.4 3.4 3.3  -99.9   -99.9 -22.86 -47.28 CRVBND ON   0.5/6hr    22.42  97.39
2000OCT05 161500  3.9  987.2/ -1.2/ 63.0  3.6 3.5 4.2  -99.9   -99.9 -74.16 -48.03 UNIFRM ON   No Limit   22.51  97.61
2000OCT05 171500  3.9  987.2/ -1.2/ 63.0  3.8 3.8 4.3  -99.9   -99.9 -69.86 -53.02 UNIFRM ON   0.5/6hr    22.60  97.86
Successfully completed listing
```

The text output displays time, date, intensities (CI# with corresponding pressure/wind value, Final T#s (both 6 and 3 hour averaged values), and Raw T#), eye and cloud region temperatures, scene type, and the Dvorak Rule 9 and Rule 8 flag values. If the storm center is located over a land feature at the time listed, "LAND" will be listed prior for the scene type. The storm location is listed in the final two columns.

If an external ASCII output file is desired, the AODT keyword command "OUTPUT=FILE <filename>" is used. The directory location where the output text file is written is defined with the AODT environment argument ODTOUTPUT. For example, an output file defined as "floyd-dat.out" will produce the following sample text output message :

```
History file listing written to ASCII file /home/aodt-v6.2/output/floyd-dat.out
```

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. Graphic capabilities are controlled using the AODT keywords GRAPH, PLOT, and DATE. Below is an example for intensity estimates during Hurricane Keith:
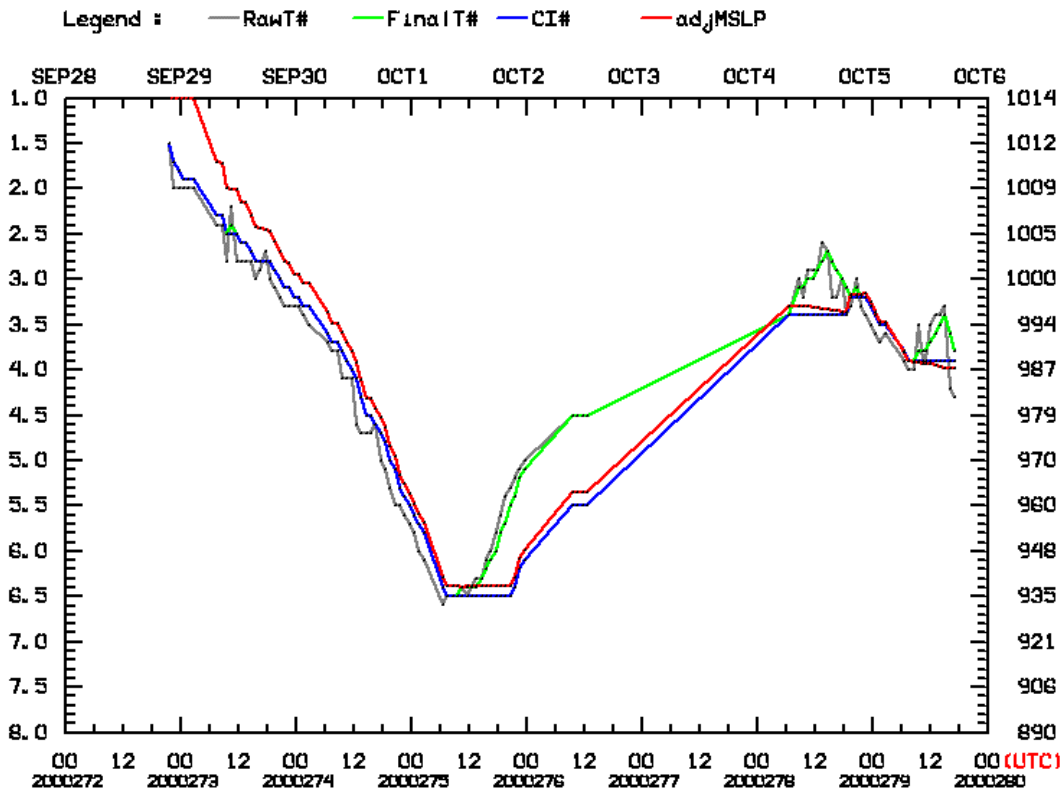
In the example above, the CI#, 6-hour time-weighted average Final T# (T#6hr), Raw T# (T#raw), and latitude bias-adjusted MSLP values are all displayed, but the TIE Model estimates are not displayed (SST values not available for this example). Any combination of the five values can be plotted using the PLOT keyword. The TIE Model intensity estimates for Keith are provided in the TIE Model Users' Guide.

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 complete history file name is displayed in the bottom-left hand corner of the graph, with a legend of the displayed variables presented along the top of the graphics window. The various environmental temperature values calculated and used by the AODT in the intensity estimate calculations can also be graphed.

5.)   Background Information

A.)   Land Flag

Tropical cyclone land interaction is determined utilizing the low-resolution topography map TOPOLRES provided. The resolution of the map file is 1.0° X 1.0° latitude/longitude. If the storm center is positioned over a grid box with an average height greater than sea level (and more than 50% covered by land), the land flag will be triggered. If the land flag is triggered, 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. The latitude, longitude, and land flag parameters will contain their assigned values, however the values for the intensity estimates and the remaining parameters will be assigned a "missing value" (mostly 0's). 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

Objective scene identification is performed using Fast Fourier Transform (FFT) analysis, 10° log spiral analysis, and/or other statistical analysis techniques. Scene classifications are performed separately for the eye (0-24km from storm center) and surround cloud (24-136km) regions. Determinations of certain scene types are dependent upon past intensity estimates stored in the history file of a particular storm, closely mirroring the thresholds defined in the subjective Dvorak EIR technique. The six eye region scene types and five cloud region scene types are described below :

Eye Region

Scene Type	Description
CLEAR	Clear, well-defined eye
PINHOLE	Very small eye/pronounced warm spot
LARGE CLEAR	Clear, well-defined eye greater than 40 km diameter
LARGE RAGGED	Ill-defined eye region greater than 40 km diameter
RAGGED	Ill-defined (cloudy or oblong) eye region
OBSCURED	Very cloudy/cloud covered warm region
NONE	No eye

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

Eye scene types are derived by examining the eye region FFT harmonics, variability of temperature values in the eye region, and "BD enhancement curve" categorical differences between the eye and surrounding cloud region temperature values. Eye size is derived by measuring the distance across the eye between BD-curve "Dark Gray" temperature range edges. Distances are measured at 90° angles outward from the user or auto-selected storm center location, and are averaged to give an approximate eye size.

Cloud region scene types are determined by examination of the entire cloud region FFT harmonics, the average difference between opposing 15° arc average temperatures (convective symmetry value), and by differencing the average and "coldest-warmest" cloud region temperature values. If the cloud scene is thought 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. The algorithm will first target the BD-curve "Light Gray" temperature range to define the convective region of the curved band area. If this temperature region is devoid of significant activity/completely surrounds the selected storm center position, analysis of warmer/colder ranges BD-curve temperature levels will be performed. If the scene is determined to be a "Shear" scene, the distance between the center position and the closest BD-curve "Dark Gray" temperature range pixel will be determined.

Once the scene type has been automatically or manually determined, the value used in conjunction with eye and surrounding cloud top temperatures, oceanic basin type, and other history file information to calculate the intensity estimate for the image being investigated.

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. It is assigned the temperature value the warmest pixel within a 24 km radius from the user or automated storm center location. An incorrect eye temperature value can obviously lead to an incorrect intensity estimate, since a relatively small area is examined to obtain this value.

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 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 qualitatively and qualitatively to the intensity estimates using the mean temperature values, thus the change was implemented.

D.)   Time Averaging Scheme

The Final T# (6-hour average) value is calculated using a linear-weighted time averaging scheme, which places greater weight on the current intensity estimate value and less weight upon each preceding intensity estimate. The time averaging scheme uses the current Raw T# value and all available Raw T# values obtained within the last 6 hours. The current value is given a weight of 6.0, with all other values given weights directly proportional to their time difference from the current analysis time.

Determination of the time-weighted Final T# value previously utilized a 12-hour time period, but it was found that by changing the analysis period to 6 hours coupled with the use of the Dvorak EIR Rule 8 (see Section 5F) provided a statistically superior intensity estimate. In addition, utilizing a 6-hour time averaging period eliminates the need for the Rapid Deepening flag and corresponding time-averaging period change (from 12 hours to 3 hours). The rapid deepening flag had been a documented source of error in the analysis of some tropical cyclones where it had been (incorrectly?) triggered. See section 5F for additional discussion on this topic.

E.)   Dvorak EIR Rule 9/Weakening Rule

          The Dvorak EIR Rule 9/Weakening Rule (Dvorak, 1984) is used in the
determination of the CI# after a storm has reached its maximum intensity and is
weakening. This rule holds the CI# values 0.5 to 1.0 T# higher in value than the current
Final T#. Subjective application of this rule (e.g. how and when to apply it) varies from
forecaster to forecaster and is the focal point of much debate. The value of 1.0 is utilized
in the AODT algorithm since it provides the most statistically accurate estimates of storm
intensity when compared with reconnaissance pressure measurements.

          In the AODT algorithm, application of this rule is performed when the storm has
undergone a "significant strengthening event". This event is identified by computing a
least squares fit to the current and all Final T# values during the past 24. If the slope of
this fit is greater than or equal to 1.0 (increasing 1.0 T# in the last 24 hours), a significant
strengthening event is said to be occurring. Once the Final T# (6-hour average) begins to
decrease, the Rule 9 guidelines are applied to calculate the CI#.

          An additional criteria check can modify the Rule 9 "additive" constant of 1.0 if
the storm CI# values becomes "constant" (does not vary by more than 0.5) for a
continuous 24-hour period. If this condition is met, the additive value will be reduced to
0.5 while the storm maintains its steady state condition. Once this steady-state condition
is exceeded, the additive constant will return to the maximum value of 1.0.

          An additional rule within the AODT affects the calculation of the Final T# and
CI# prior to weakening after a "significant strengthening event" (e.g. during the
formation stages). This rule is as follows: "Always hold the CI# to the highest Final T#
in the last 12 hours (but never greater than 1.0 for the CI#) in all cases". This rule will
hold the CI# equal to the highest Final T# (6-hour averaged) obtained during the previous
12 hours. For example, if the Final T# value increased to 5.2 then decreases in intensity,
the CI# value will be held at 5.2 for 12 hours unless the T# exceeds 5.2 during that time
period. If this rule is invoked, the intensity estimate bulletin (Section 4D1) will display
"WEAK" next to the Rule 9 indicator on the "Flags" line (as opposed to "ON" when the
Dvorak EIR Rule 9, discussed above, is being applied).

F.)   Dvorak EIR Rule 8

          The Dvorak EIR Rule 8 constrains the rate of increase or decrease of the Raw T#
intensity estimate value based upon specified rates of change over specific time periods.
The rate of change comparisons are performed against the Final T# (6-hour average)
values stored in the history file at various times prior to the current analysis time, with the
rate of change constraints being dependent upon the "current" intensity of the storm, as
defined in the Dvorak EIR technique. The Final T# (6-hour average) value of the record
immediately prior to the current analysis time is used as a proxy for the "current"
intensity estimate. When "current" intensity of the storm is less than 4.0, the current Raw

T# rate of change cannot exceed ±0.5 T# over 6 hours. If the "current" intensity estimate value is greater or equal to 4.0, 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. If one of the criteria is/are exceeded, the Raw T# will be assigned the maximum/minimum value that does not exceed the criteria in question.

Implementation of this rule has allowed for a modification of the time-weighted Final T# calculation from 12 hours to 6 hours, with the 6-hour weighted average proving to be slightly more accurate statistically than the previous 12-hour methodology. By utilizing the 6-hour scheme, the rate of change of the time-weighted Final T# value is typically more than with the 12-hour scheme, allowing for greater rapid increases in intensity over time than previously found. Introduction of the Dvorak EIR Rule 8 limits this growth realistically, and has allowed for the rapid flag determination scheme to be removed from the AODT. The rapid flag was found to work in certain cases, but often led to significant overestimates of intensity in other cases, due to the time-weighted averaging scheme changing from 12 hours to 3 hours. The integration of the Dvorak EIR Rule 8 in conjunction with the new 6-hour time-weighted average Final T# scheme has resulted in more realistic intensity estimates and changes over time.

G.)   Oceanic Domain Auto Determination

The AODT intensity estimates are dependent upon the ocean basin in which the storm being examined is located. This is a result of using separate empirical relationships between CI# and minimum sea level pressure (MSLP) for the North Atlantic (Dvorak, 1984) and Northwest Pacific (Shewchuck and Weir, 1980) basins. Also, a different Raw T# may result for a particular eye and cloud region temperature pair, depending upon which basin is designated.

Previous versions of the ODT relied on the user to manually designate the ocean basin using the DOMAIN keyword. The AODT can automatically determine the ocean 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 (longitude-wise) designated as Atlantic. The user can override this determination process with the DOMAIN keyword, if desired.

The division point in the Pacific Ocean was chosen to match the "areas of responsibility" for the Joint Typhoon Warning Center and Central Pacific Hurricane Center. Use of either CI#/pressure relationship in the Eastern Pacific Ocean is a topic for debate, but no specific rules defining the use of one of the relationships for this or other regions, such as Indian Ocean or Southern Pacific Ocean, have been documented, so it is left to the user to decide which is the proper relationship in these regions.

H.)   Automatic Storm Center Determination

The automated storm center location algorithm approximates tropical storm position using four methods : polynomial interpolation of NHC/JTWC forecasts, warmest pixel search, Laplacian Analysis of the cloud region temperature values, and linear extrapolation of the history file positions.

As a first guess, the forecast positions from NHC or JTWC are used in conjunction with previous storm locations in the polynomial interpolation routine. This routine interpolates the position at the time desired using three forecast positions (current, 12 hour, and 24 hour positions). The four types of input file formats are :

-   ATCF Forecast Record file ("OFCL" forecast is default)
-   NHC Tropical Storm/Hurricane Discussion files (WTNT4? or WTPZ4?)
-   JTWC Tropical Cyclone Warning files (WTPN3?)
-   Generic Entry file (see below for format)

If the forecast interpolation fails, a linear extrapolation of storm positions for the previous 12 hours (stored in the history file) is attempted. Once a valid interpolated forecast or extrapolated history file position is obtained, the Final T# intensity estimate of the record immediately preceding the current analysis time in the history file found. If this value is less than 4.5, the interpolated/extrapolated point is used as the final automated storm position. However, if this value is greater or equal to 4.5, a more thorough analysis of the image is conducted to determine a better storm center location.

The analysis begins by searching for the warmest satellite image pixel within 75km of the forecast interpolated/history file extrapolated point. A Laplacian Analysis is then performed over a 75km radius analysis region, which identifies temperature gradients exceeding various threshold values. The gradient threshold fields are then statistically analyzed, with an empirically defined "confidence factor" derived based upon the scatter and cohesiveness of the gradient points for each of the thresholds.

If this confidence factor is greater than an empirically defined threshold "A", a well-defined and spatially confined cloud feature with strong temperature gradients has been located (e.g. an eye). The average position of the Laplacian Analysis gradient threshold field points determined for the storm center location in this case.

If the confidence factor is below "A", but above "B", a less well-defined feature has been located, but still is relatively concentrated spatially (e.g. a warm spot/forming eye feature). The location of the warm spot is provided as the storm center location if this location is within 40km of the initial interpolated/extrapolated position and is significantly warmer than the cloud top temperature at the interpolated/extrapolated position.

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.

I.)   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-curved 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, due to limitations inherent to the technique. The storm center location produced by this method should be used as a suggestion, and should be examined closely to determine its applicability to the current scene analysis over the original storm center location.

J.) **Sea Surface Temperature Information**

The sea surface temperature (SST) information is used in conjunction with various parameters in the AODT history file in the determination of the TIE Model intensity estimate for the current scene being analyzed. Details on the usage of the SST values and the derivation of the TIE-Model intensity estimates are discussed in the TIE Model User's Guide, obtained at the following website:
> http://cimss.ssec.wisc.edu/tropic/aodt

The SST data used for the TIE Model intensity estimate within the AODT package can be obtained from various FTP sites listed on the following website :
> http://polar.wwb.noaa.gov/sst/

The SST files obtained from the above website are real-time, global, one-degree resolution GRIB format files (RTG_SST) distributed by the National Centers for Environmental Prediction/Marine Modeling and Analysis Branch (NCEP/MMAB). Significant detail on the derivation process for the RTG_SST files can also be found at the above website.

Once obtained, the SST files should be placed in the directory defined in the "aodtenv" file with the ODTSST environmental variable. The name of the file to be used is obtained by the AODT algorithm using the SST keyword, as described in Section 4A1. If the SST file is available, the TIE Model intensity estimate will be appended to the end of the AODT intensity estimate bulletin. An example of this is shown in Section 4D1.

K.) **Latitude Bias Adjustment**

The MSLP value displayed in the AODT intensity estimate bulletin is adjusted using a linear regression-based adjustment equation. This equation is designed to eliminate a pronounced intensity estimate bias noted in the derived CI# value of the AODT and underlying Dvorak Technique. The equation used for this adjustment is as follows :

$$CI\#_{adj} = CI\#_{orig} - (-18.78027 + (0.8863751*ABS(latitude)))$$

This equation requires the $CI\#_{orig}$ value to be entered in units of pressure (millibars). Since the AODT produces estimates in terms of T# values, the $CI\#_{orig}$ value must be converted to millibars before the adjustment equation is applied. This pressure value is stored in a history file in value 29.

For more specific information about the derivation and reasoning behind this 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

6.)   Acknowledgments

7.)   References

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