The UW-CIMSS
Advanced Dvorak Technique (ADT) :
An Automated IR Method to Estimate Tropical Cyclone Intensity

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Motivation

The ADT was developed to provide tropical cyclone (TC) forecasters with a purely objective tool to estimate TC intensity using geostationary satellite imagery in regions where aircraft reconnaissance and other data are not available.

The ADT is based upon the Dvorak Technique (DT), a "decision tree" methodology, which primarily relies upon human interpretation of cloud patterns in satellite imagery to derive TC intensity. The major drawbacks of the DT are its inherent subjectivity and time required to master its regional subtleties.

The ADT represents an attempt to advance beyond the limits of the DT while still retaining its basic philosophy. The ultimate goal is to provide an objective tool that yields reliable TC intensity and structure information to help improve forecasts.

Background
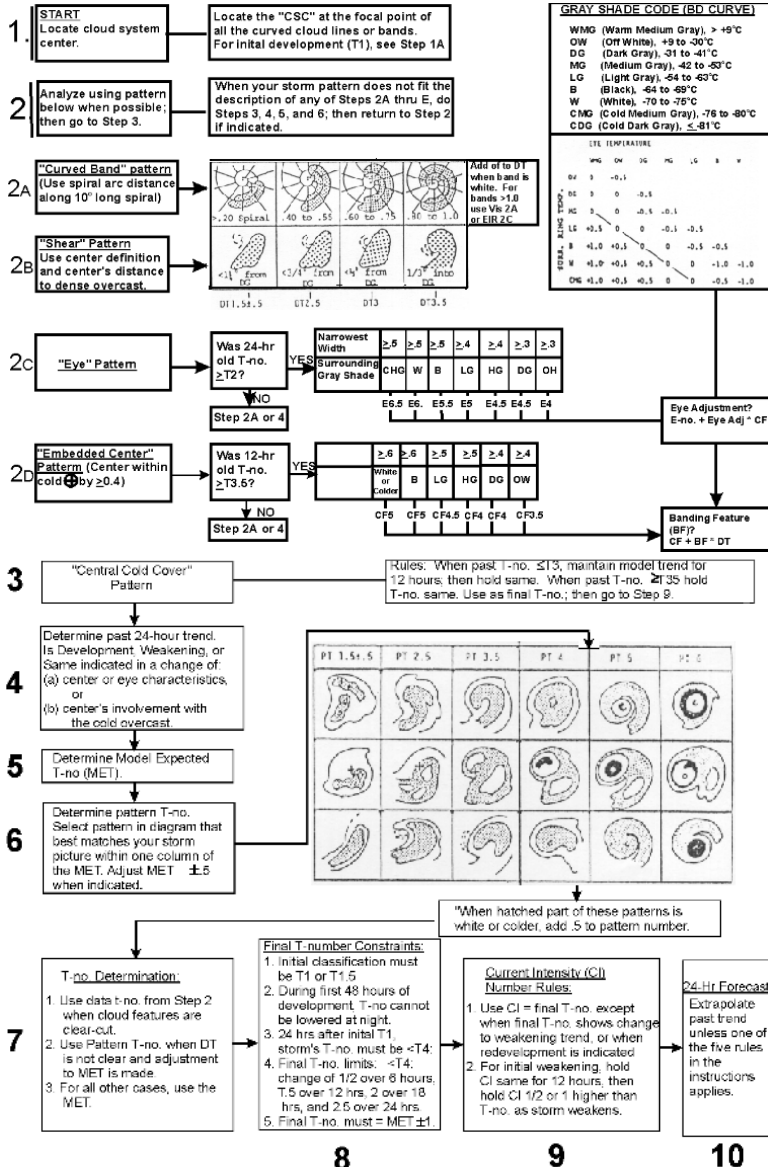
The original/subjective DT is a "top-down" flow chart methodology which guides the TC analyst to an estimated storm intensity through a series of steps focusing on:

- The current storm presentation ("scene type") in the satellite image

- Recent storm history (and model "expected" current intensity)

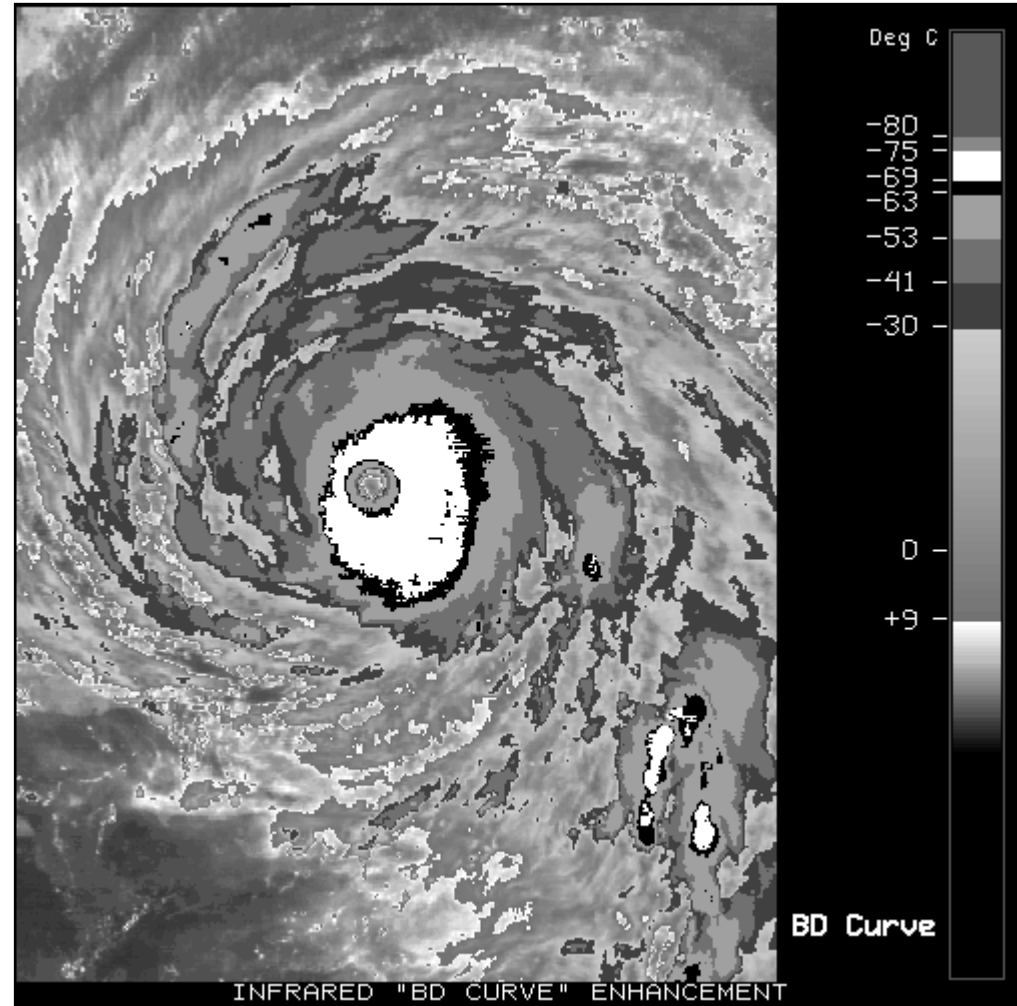- Various constraints regarding the allowable strengthening/weakening rates.

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This enhancement is known as the "Dvorak Hurricane IR Curve for Tropical Cyclone Classification" and is applied to infrared (11μm) imagery. Each different black/ white/gray shade corresponds to a specific cloud-top temperature range and represents different intensity classifications in the Subjective Dvorak Intensity Classification Technique.
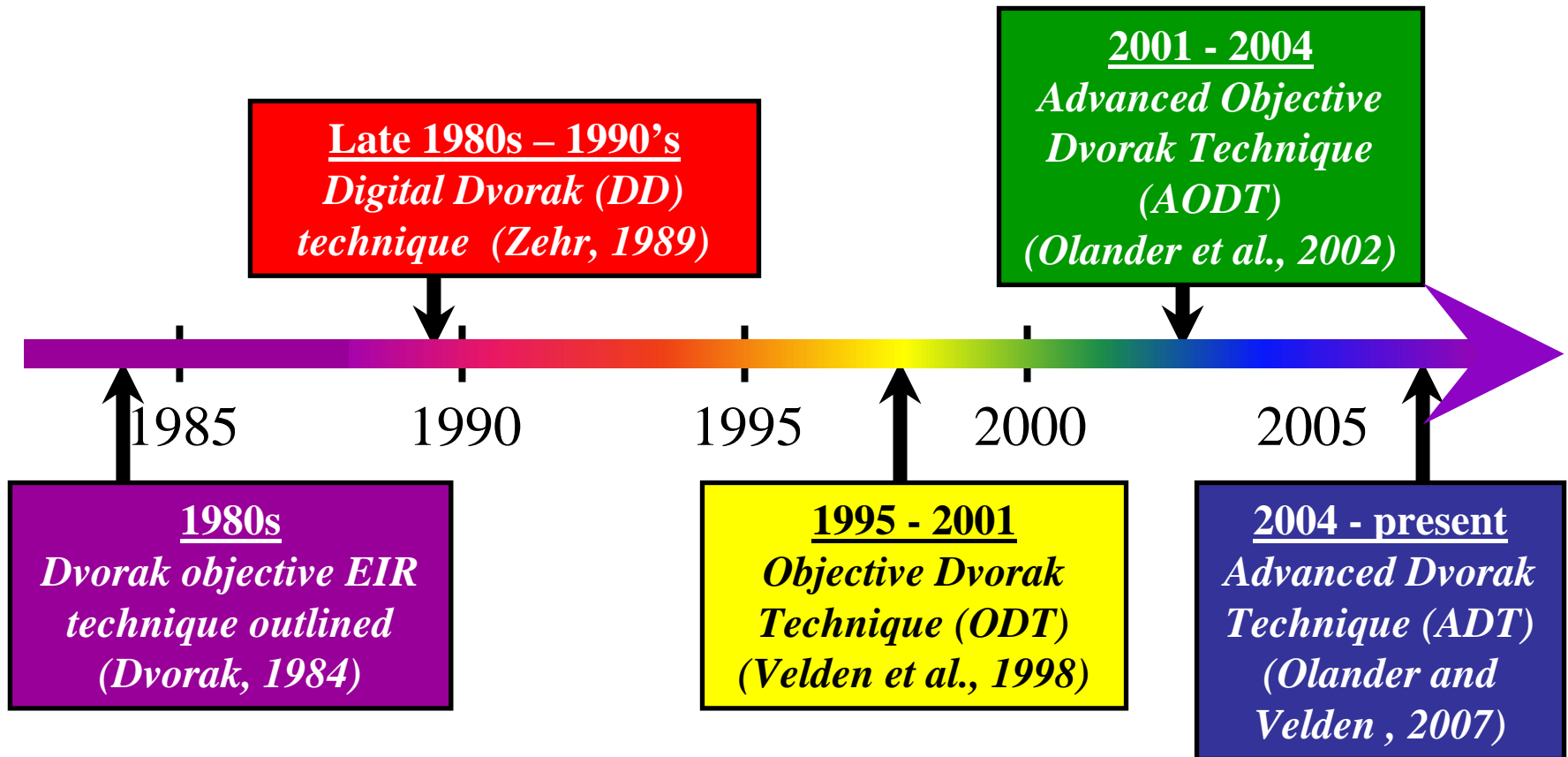*(NOAA Technical Report NESDIS 11, 1984)*

The ADT utilizes this "BD Curve" but has modified the relationships between the cloud-top temperatures and TC intensity using statistical regression analysis and additional/new cloud characteristic parameters.

INFRARED "BD CURVE" ENHANCEMENT

ADT Development Timeline

Late 1980s – 1990's
Digital Dvorak (DD) technique (Zehr, 1989)

2001 - 2004
Advanced Objective Dvorak Technique (AODT)
(Olander et al., 2002)

1985   1990   1995   2000   2005

1980s
Dvorak objective EIR technique outlined (Dvorak, 1984)

1995 - 2001
Objective Dvorak Technique (ODT)
(Velden et al., 1998)

2004 - present
Advanced Dvorak Technique (ADT) (Olander and Velden , 2007)

ADT Information

◦ **The ADT utilizes imagery from the longwave infrared window channel** (~11μm) from most of the current, operational geostationary satellites available. The algorithm is constantly updated to utilize any new satellites as they come online, and the data is made available. In addition, a current NESDIS/CIMSS/CIRA study is underway using simulated data to determine the potential impact of the upcoming GOES-R Advanced Baseline Imager (ABI) imagery on the ADT algorithm.

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ADT Information

○ The ADT retains many of the qualities of the original Dvorak Technique, such as scene type determination and various intensity time constraints.

○ A completely automated and objective TC storm center determination scheme has been implemented to remove all subjectivity from the ADT analysis. However, an ADT user has the option to modify/over-ride the objectively-chosen location, or scene type determination (e.g. 'pinhole' eyes are difficult).

○ The ADT code can be installed within a McIDAS environment *(now a core McIDAS routine)* or integrated within a separate satellite analysis platform (e.g., a version now operates in the NWS N-AWIPS system).
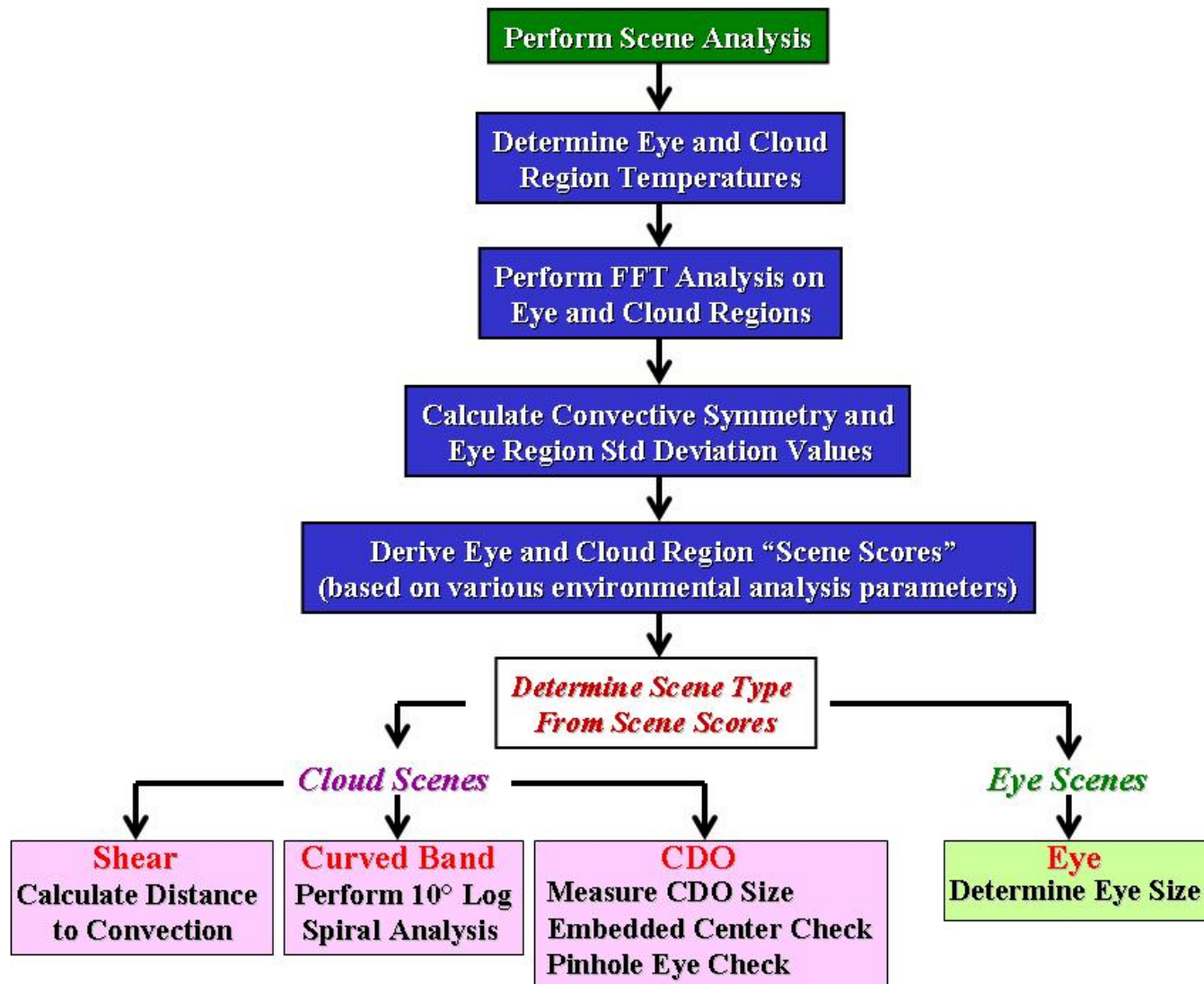
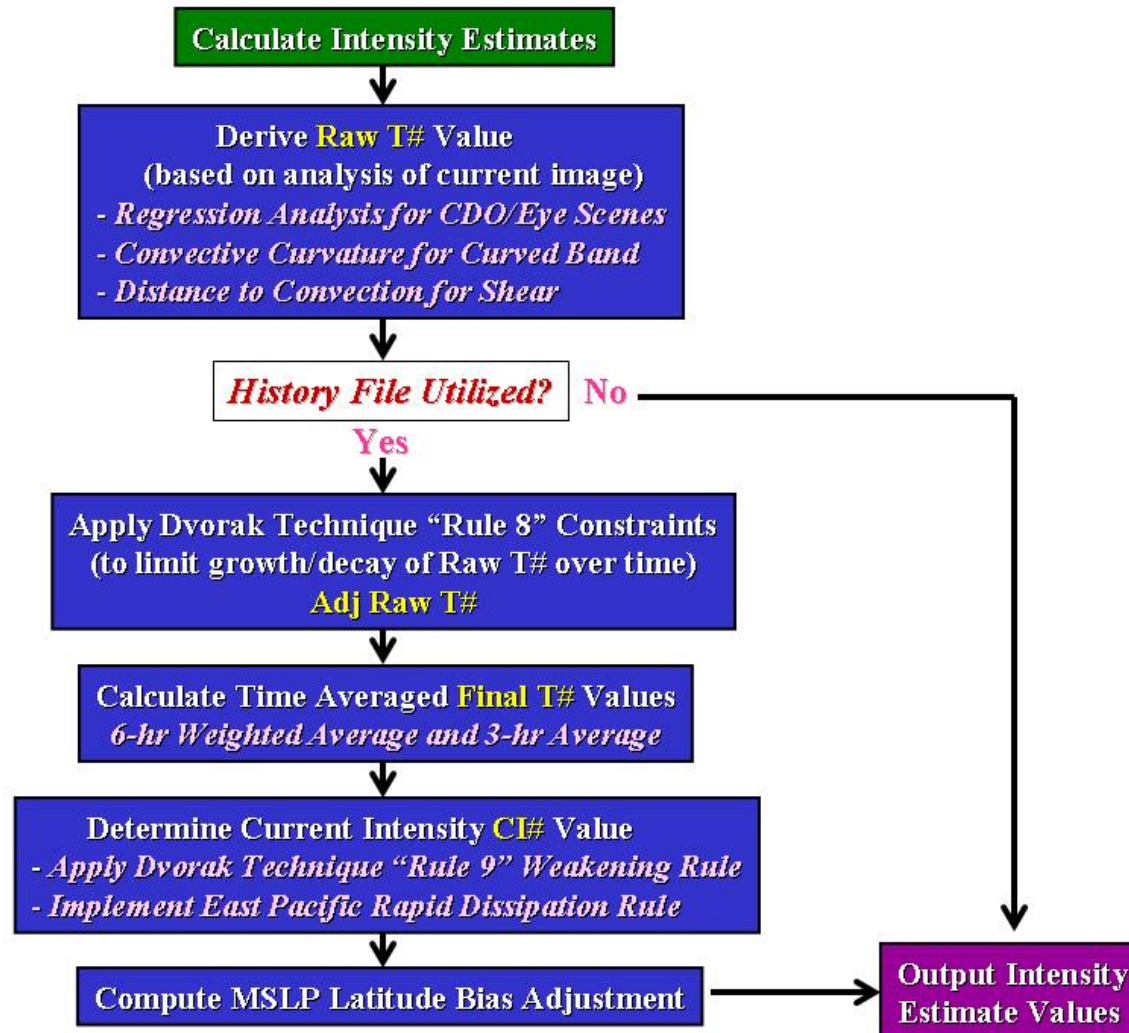# The **A**dvanced **D**vorak **T**echnique

ADT Flowchart - Overview

The **A**dvanced **D**vorak **T**echnique
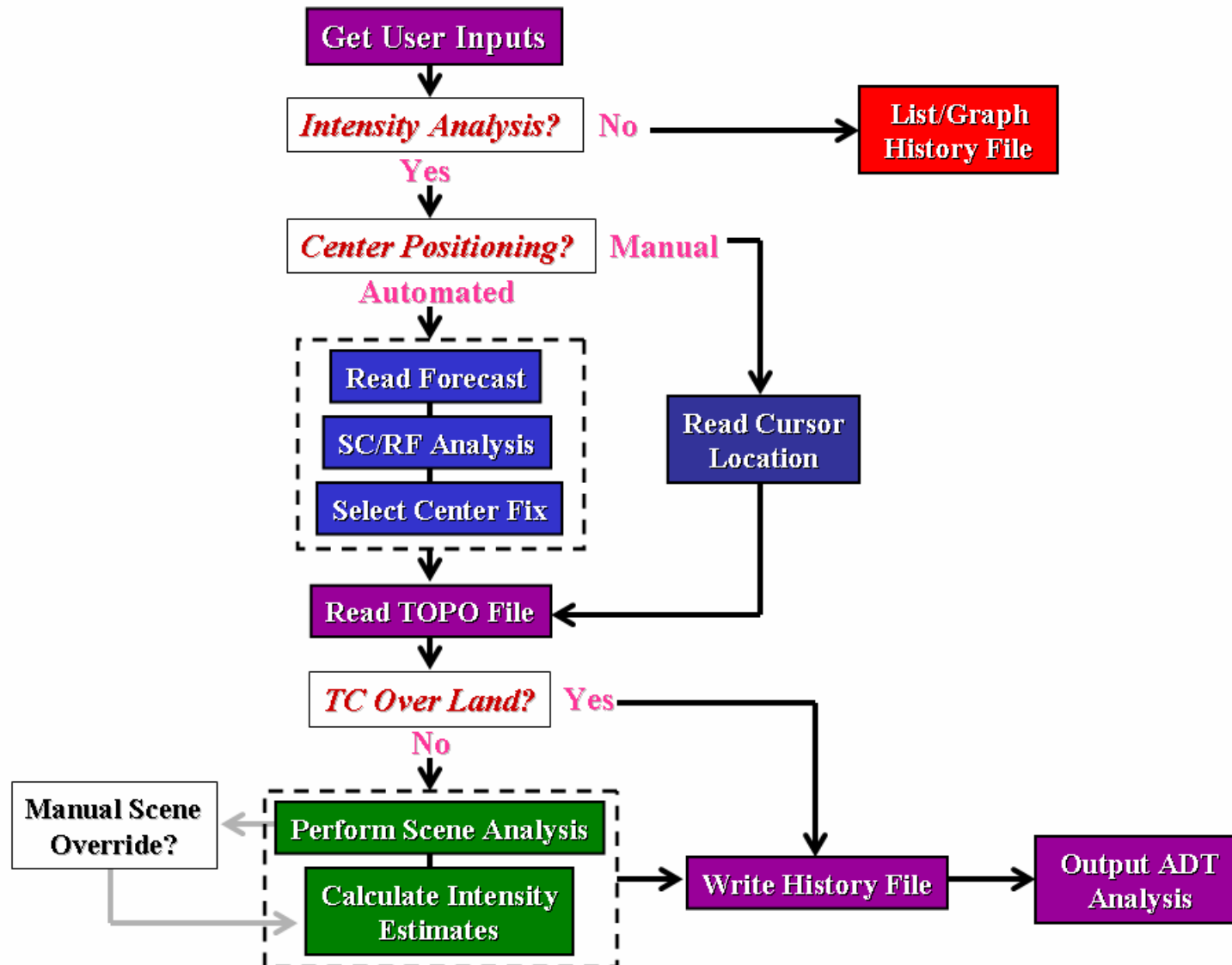
ADT Flowchart – Scene Type Determination

The Advanced Dvorak Technique

ADT Flowchart – Intensity Estimation

Validation

Homogeneous comparison between ADT and Operational Forecast Center (OFC) DT estimates of TC Central MSL Pressure (in hPa)
Ground Truth: Coincident aircraft reconnaissance reports
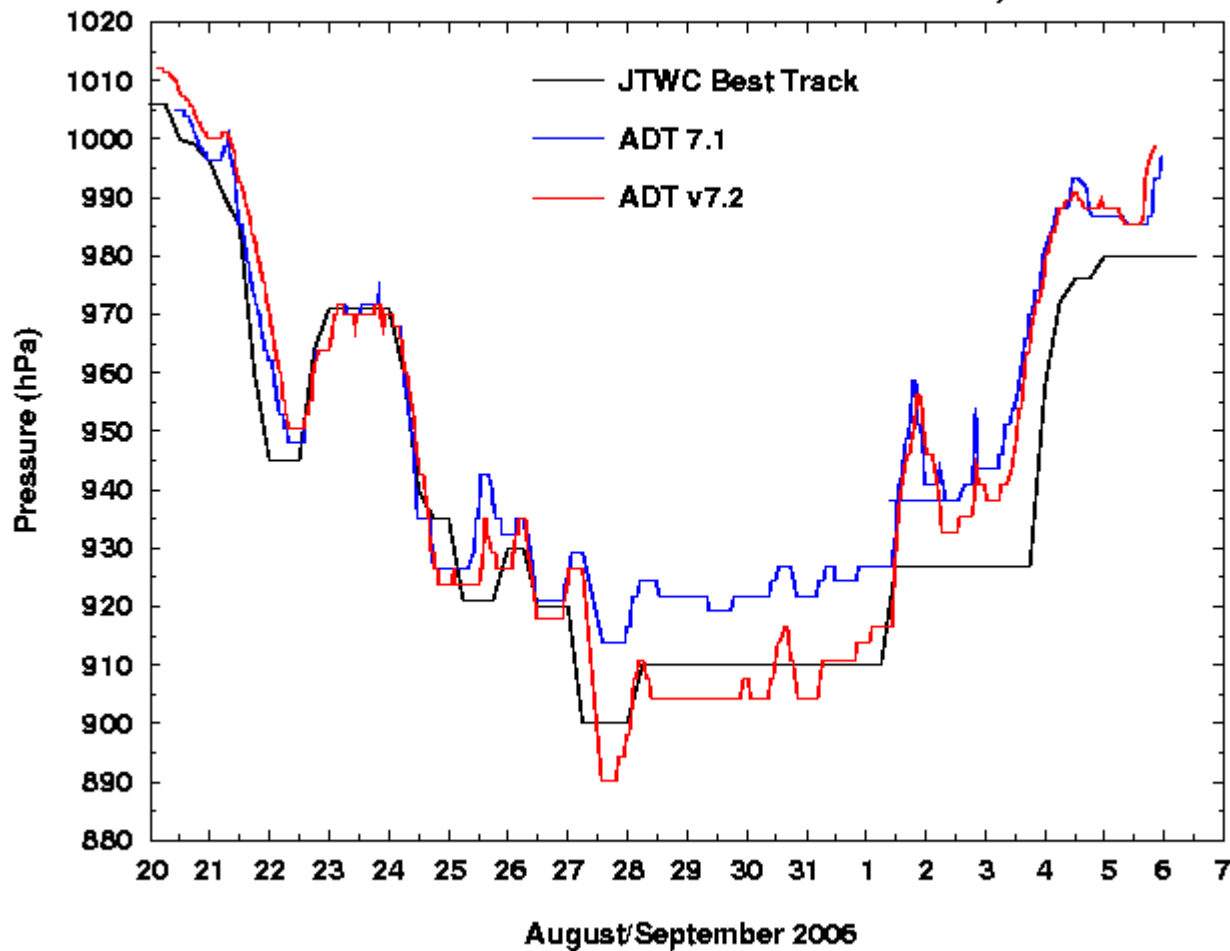
Atlantic TCs -- 2006

	Bias	RMSE	Ave	#matches
ADT	-2.77	8.21	6.10	190
OFC	-3.16	9.01	6.54	190

(Negative bias = ADT over-estimate)

Hurricane Ioke/Super Typhoon 01C

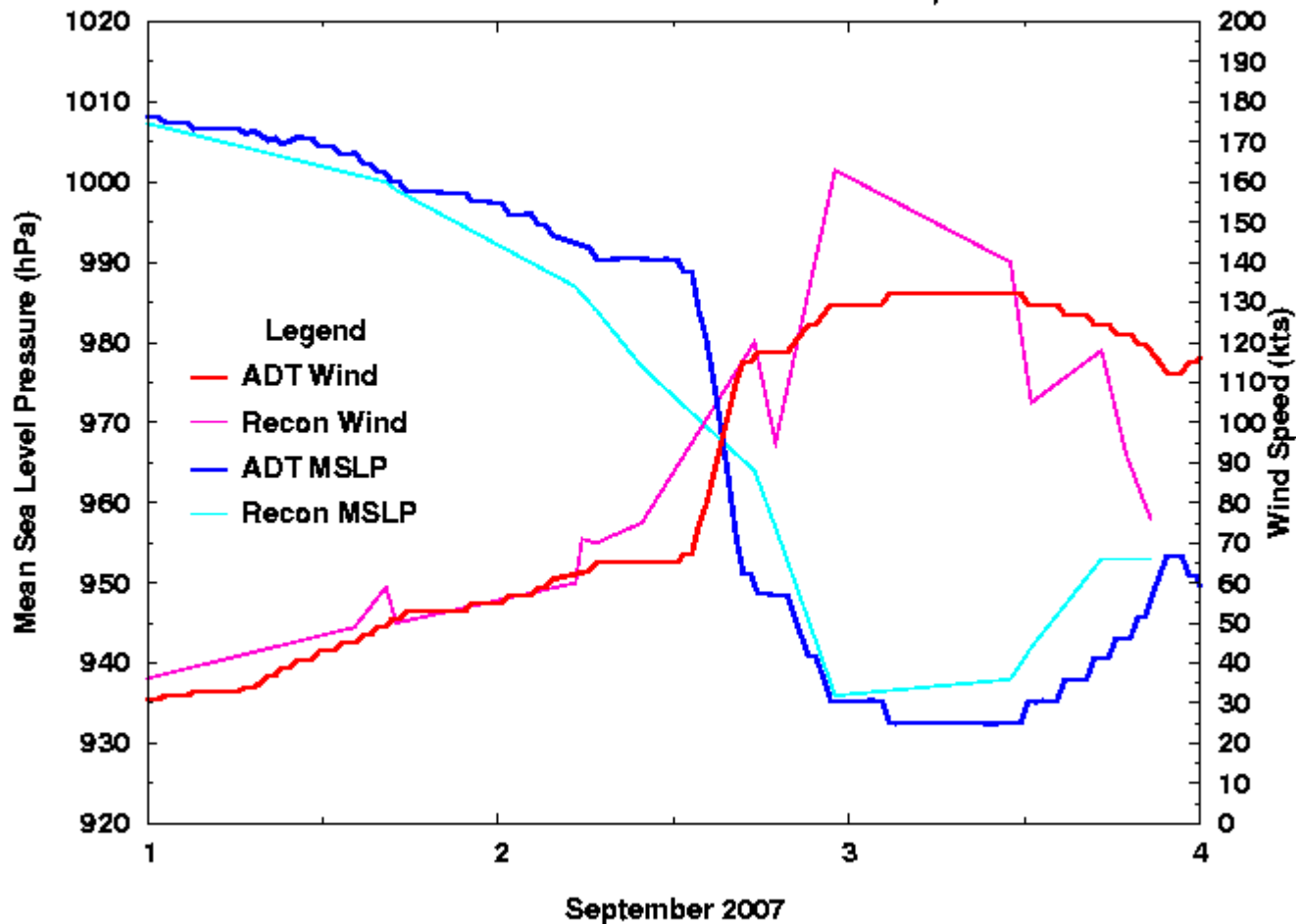ADT v7.1 and v7.2 versus JTWC Best Track MSLP intensity estimates

Hurricane Felix

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Future Directions

➤ **Continue improving scene identification scheme**
  ◦ *Utilize auto-centering techniques in (pinhole) eye identification*

➤ **Explore regression analysis for other scene types**
  ◦ *Target shear and curved band scenes*

➤ **Examine methods to improve intensity estimates**
  ◦ *Multi-channel methods such as WV/IR difference (see poster)*
  ◦ *Possible microwave imager "Dvorak-type" analysis*
  ◦ *Explore TC stage breakdowns (formation, mature, dissipation)*

➤ **Continue ADT integration within UW–CIMSS Satellite Consensus (SATCON) TC Intensity Algorithm** (see poster)

Current ADT User Sites

Operational Usage
○ *NOAA/Tropical Prediction Center*
○ *NOAA/Satellite Analysis Branch*
○ *NOAA/Central Pacific Hurricane Center*
○ *Joint Typhoon Warning Center*
○ *Australian Bureau of Meteorology*
      (Melbourne and Perth Regional Offices)

Experimental or Research Usage
○ *Japan Meteorological Agency*
○ *Shanghai Typhoon Institute of China*
○ *National Typhoon and Marine Forecast Center – China Met. Adm.*
○ *The Meteorologist Department – Thailand*
○ *Cooperative Institute for Meteorological Satellite Studies*

The **A**dvanced **D**vorak **T**echnique

References

http://cimss.ssec.wisc.edu/tropic2

The Advanced Dvorak Technique: Continued Development of an Objective Scheme to Estimate Tropical Cyclone Intensity Using Geostationary Infrared Satellite Imagery,
Olander and Velden, *Wea. Forecasting*, April 2007.

The Dvorak Tropical Cyclone Intensity Estimation Technique: A Satellite-Based Method that Has Endured for over 30 Years,
Velden et. al., *Bull. Amer. Met. Soc.,* September 2006, 1195-1210.