From: Govan, Tekia
Sent: Monday, June 20, 2011 1:41 PM
To: STPCOL
Subject: FW: ADCIRC Presentation - August 31, 2010 Audit in Bay City (Part 1 of 3)
Attachments: STP - ADCIRC - August 31, 2010, Audit Presentation (1 of 3).pdf

Tekia V. Govan, Project Manager
U.S. Nuclear Regulatory Commission
Office of New Reactors
MS T-6-D48
Washington DC 20555-0001
301-415-6197
Tekia.Govan@nrc.gov

From: Bense, Richard [mailto:rhbense@STPEGS.COM]
Sent: Monday, June 20, 2011 12:07 PM
To: Govan, Tekia
Subject: ADCIRC Presentation - August 31, 2010 Audit in Bay City (Part 1 of 3)

Tekia,

Attached is Part 1 of 3 of the slides for the STP 3 & 4 presentation during the August 31, 2010 audit regarding use of the Advanced Circulation (ADCIRC) model to predict the probable maximum storm surge (PMSS). This presentation was developed and presented by Dr. James R. (Bob) Bailey, Ph.D., P.E., of Exponent Corporation.

Dick Bense
Licensing Engineer, STP 3 & 4
RHBense@STPEGS.Com
RHBense@MSN.Com

(361) 972 4802 (Bay City Office)
(215) 353-8857 (mobile)
(215) 362-2552 (home office)

Hearing Identifier: SouthTexas34Public_EX
Email Number: 2882

Mail Envelope Properties (F5A4366DF596BF458646C9D433EA37D793E04DDD36)

Subject: FW: ADCIRC Presentation - August 31, 2010 Audit in Bay City (Part 1 of 3)
Sent Date: 6/20/2011 1:40:38 PM
Received Date: 6/20/2011 1:40:39 PM
From: Govan, Tekia

Created By: Tekia.Govan@nrc.gov

Recipients:
"STPCOL" <STP.COL@nrc.gov>
Tracking Status: None

Post Office: HQCLSTR01.nrc.gov

Files	**Size**	**Date & Time**
MESSAGE	972	6/20/2011 1:40:39 PM
STP - ADCIRC - August 31, 2010, Audit Presentation (1 of 3).pdf	1219844	

Options
Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received:

FSAR 2.4.5, "Probable Maximum Surge and Seiche Flooding"

NRC Audit
South Texas Project
August 31, 2010

James R. (Bob) Bailey, Ph.D., P.E.

NRC Audit Plan: Item 1

- Provide a detailed description of the ADCIRC model including details of the Holland B model (or SWAN model) to generate hurricane wind distributions at the offshore.
- Provide a comparison of the wind models used in ADCIRC and SLOSH models.
- Provide a comparison of wind stresses produced by ADCIRC and SLOSH.

ADCIRC Model - Description

A 2D/3D hydrodynamic model (configured for this project in 2D) that simulates water level and current over an unstructured gridded domain. It is used to model:

- Tidal, wind, and wave driven circulation in coastal waters,
- Forecasts of hurricane storm surge and flooding,
- Transport and morphology of inlet sediments, and
- Disposal of dredging materials.

ADCIRC Wind Model

An asymmetric model based on Holland (1980):

$$p(r) = p_o + \Delta p \times \exp\text{-}\left(\frac{RMW}{r}\right)^{B}$$

Where: $p(r)$ = surface pressure a distance r from the storm center

p_o = central pressure

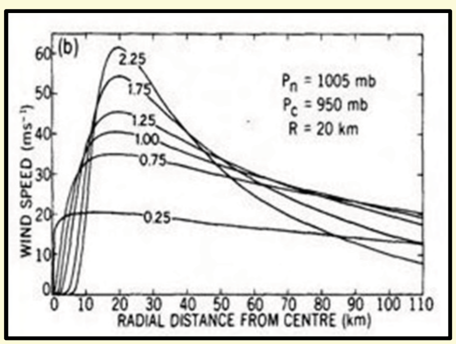
p_b = peripheral or background pressure

Δp = difference between central and background pressures

RMW = radius to maximum winds

r = distance from the storm center

B = pressure profile parameter (calculated)



ADCIRC Wind Model

The gradient wind V_G is a function of [$p(r)$, ρ, f] and V_G is a maximum value at *RMW*, hence:

$$V_{G\max} = \sqrt{\frac{B \times \Delta p}{e \times \rho}}$$

Where:

- V_G = gradient wind
- B = pressure profile parameter
- Δp = difference between central and background pressures
- e = base of natural logarithms
- ρ = density of air
- f = Coriolis parameter

ADCIRC Wind Model

The maximum gradient wind V_{Gmax} is calculated using the **maximum hurricane wind speed**, $V_{max@10m}$:

$$V_{Gmax} = c \times V_{max@10m}$$

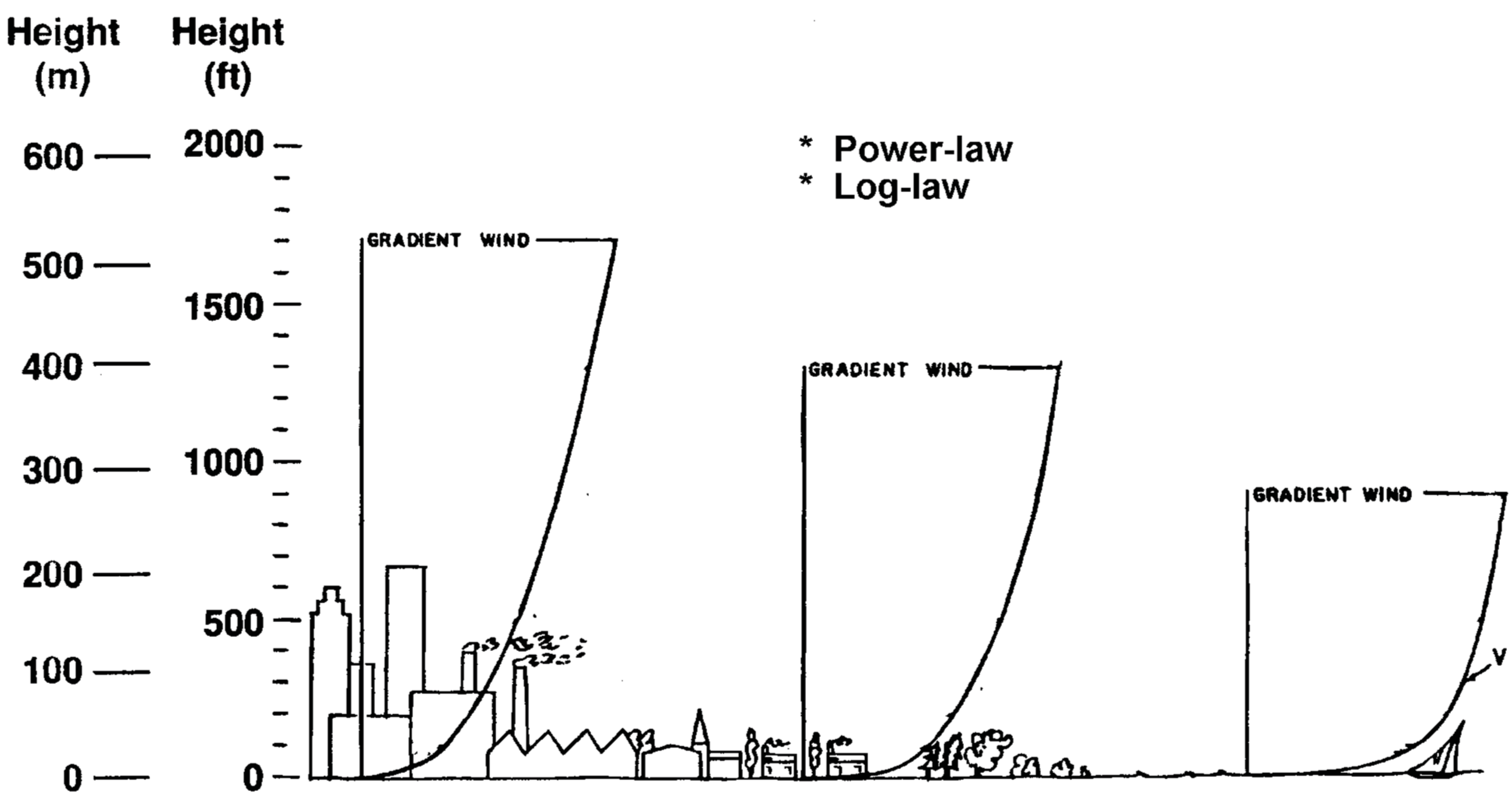
Where: V_{Gmax} = maximum gradient wind

c = surface profile constant

…enabling calculation of the Pressure Profile Parameter B:

$$B = \left[(V_{Gmax})^2 \times e \times \rho \right] / \Delta p$$

ADCIRC Wind Model

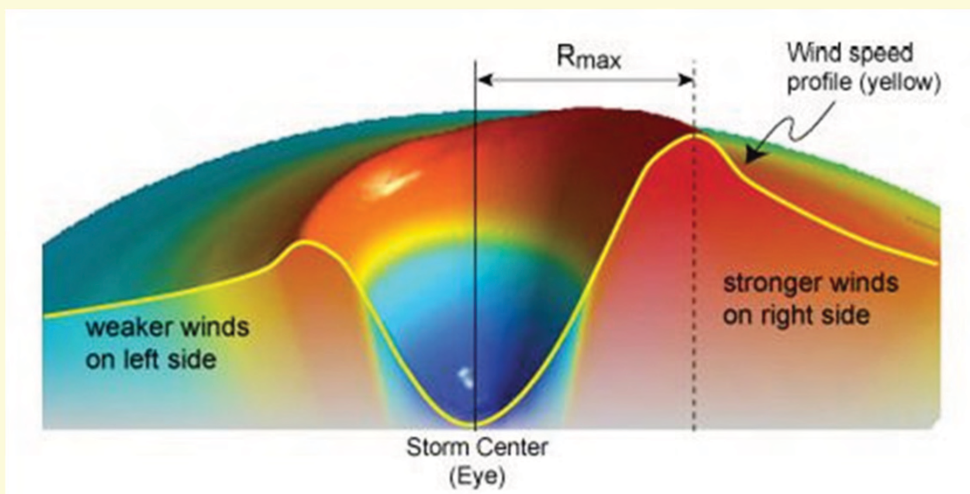


* Power-law
* Log-law

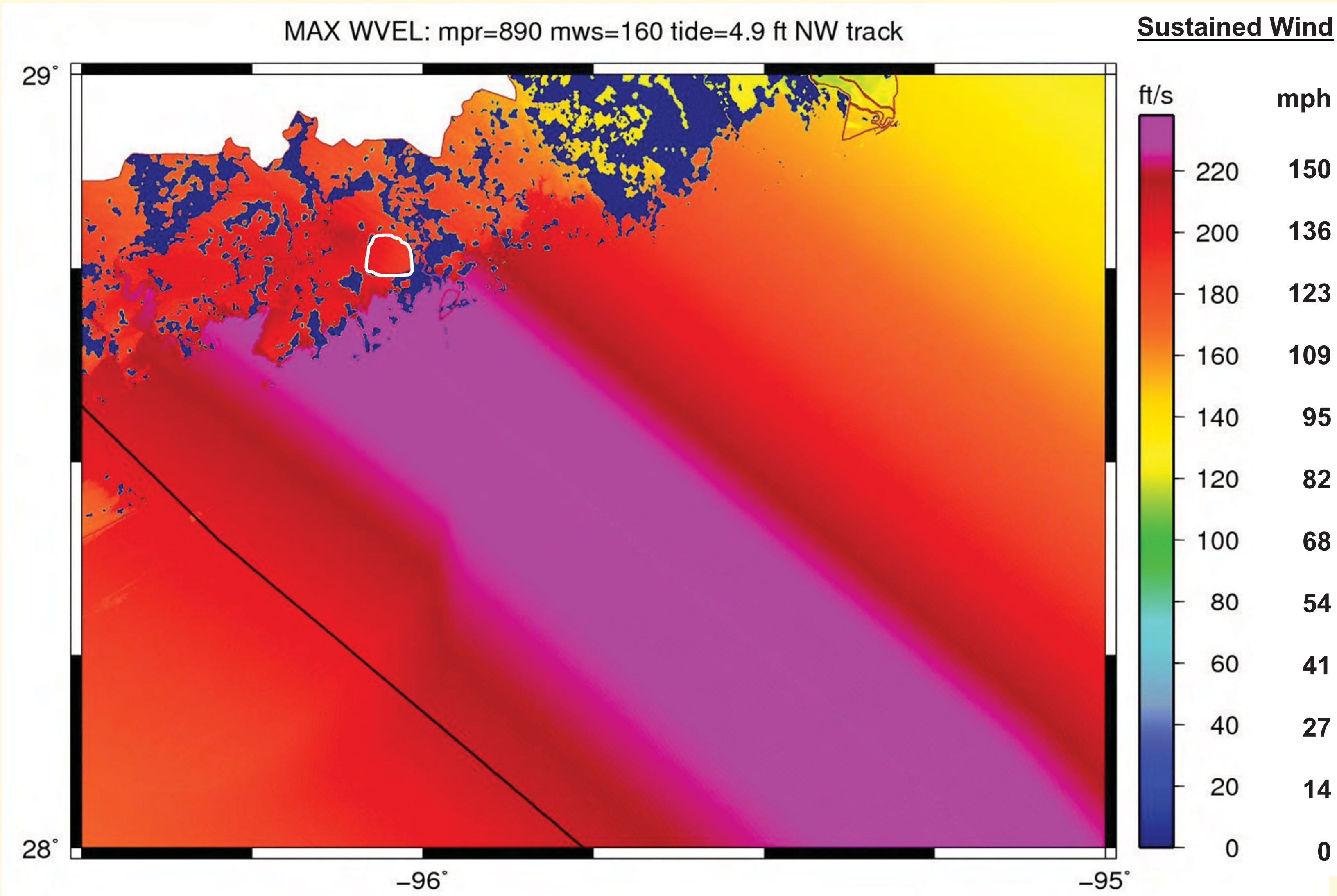
ADCIRC Wind Model

The wind field is adjusted to account for asymmetry associated with the forward movement, V_t, of the storm based on Mattocks et al (2006):

$$B = \frac{\left(c \times (V_{max@10m} - V_t)\right)^2 \times e \times \rho}{\Delta p}$$



ADCIRC Results - Wind



SLOSH Model - Description

- Designed as an operational tool for Emergency Managers.
- Computes storm surge heights from tropical cyclones using pressure, size, forward speed, and track data to create a model of the wind field.
- Consists of a set of equations derived from the Newtonian equations of motion (shallow water equations) and the continuity equation applied to a rotating fluid with a free surface.

SLOSH Wind Model

A circularly-symmetric profile based on Jelesnianski and Taylor (1973):

$$V(r) = V_R \times \left(\frac{2 \times R \times r}{R^2 \times r^2} \right)$$

Where: $V(r)$ = wind speed a distance *r* from the storm center

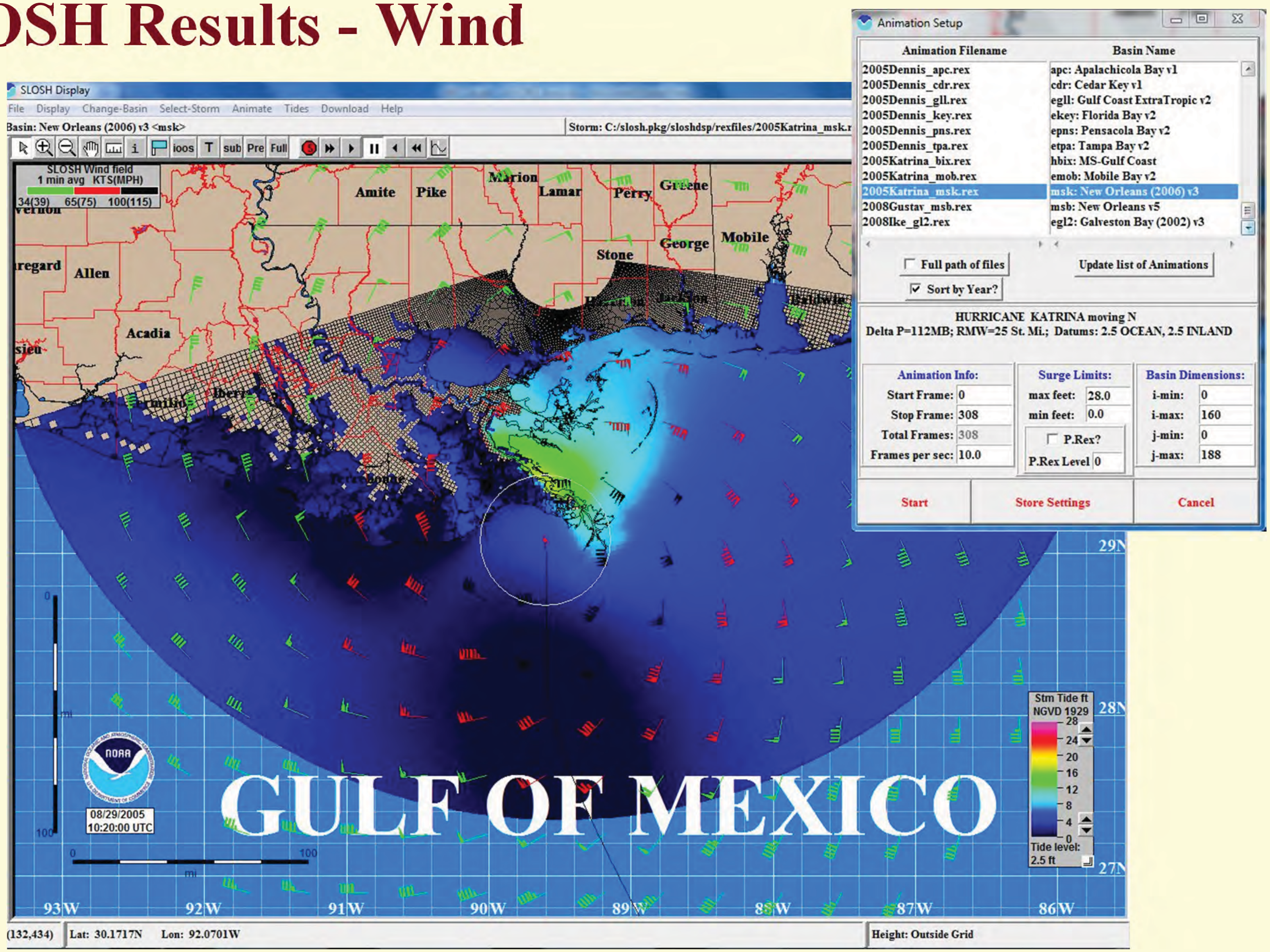
V_R = maximum hurricane wind speed

R = radius to maximum winds

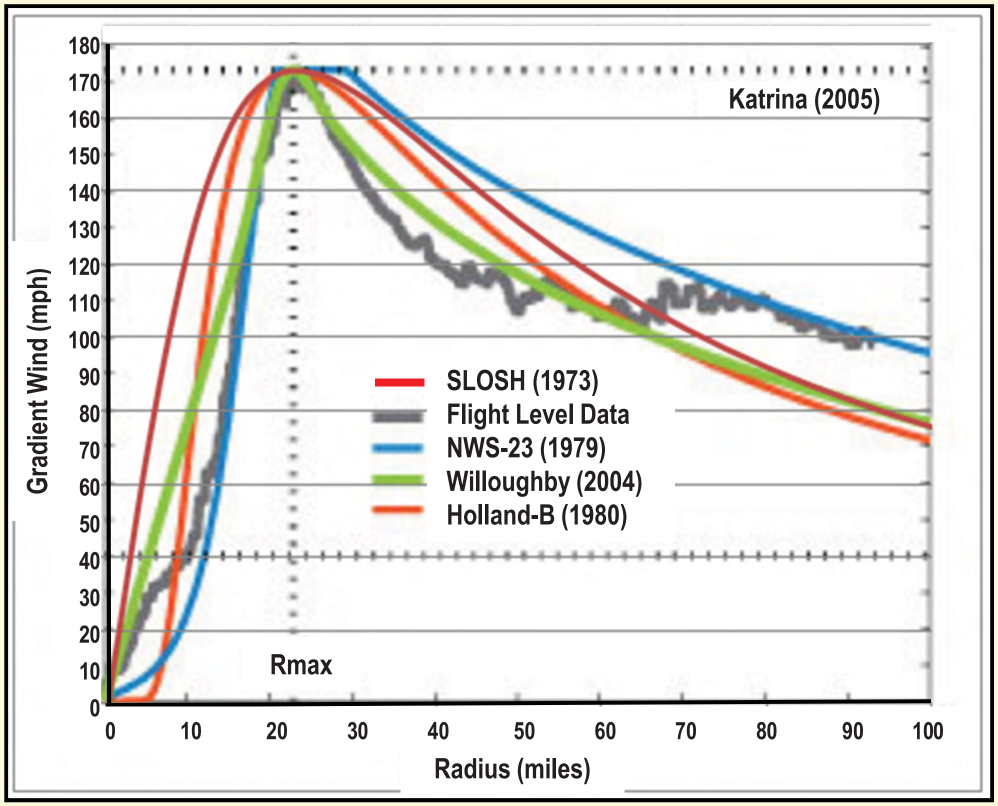
r = distance from the storm center

However, V_R is not a direct input, but is approximated based on an iterative process using Δp.

SLOSH Results - Wind



Wind Model Comparison



Source: *Wind Profiles in Parametric Hurricane Models*, Dr. Ioana Dima and Dr. Melicie Desflots, AIR Worldwide, July 2010.

Wind Model Comparison

ADCIRC

- Dynamic atmospheric model.
- Requires five input parameters:
  - Central Pressure, p_o
  - Background Pressure, p_b
  - Radius of Maximum Winds, RMW
  - Maximum Wind Speed, $V_{max\ @10m}$
  - Forward Velocity, V_f
- Multiple number of dynamic surface friction coefficients.

SLOSH

- Simplified parametric model.
- Requires three input parameters:
  - Central Pressure, p_o
  - Background Pressure, p_b
  - Radius of Maximum Winds, RMW
- Limited number of static surface friction coefficients.

ADCIRC and SLOSH – Wind Stresses

Both models calculate surface stress at the air-water boundary layer in a similar manner:

$$\sigma(r) = k_1 \times C_d \times \left(V_{max@10m}\right)^2$$

Where: $\sigma(r)$ = surface stress at a distance r from storm center

k_1 = relative fluid density

C_d = surface drag coefficient

$V_{max@10m}$ = hurricane wind speed at a distance r from storm center