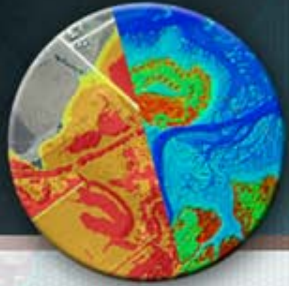


FEMA R-2

Coastal Flood Study

April 5, 2011 Technical Briefing

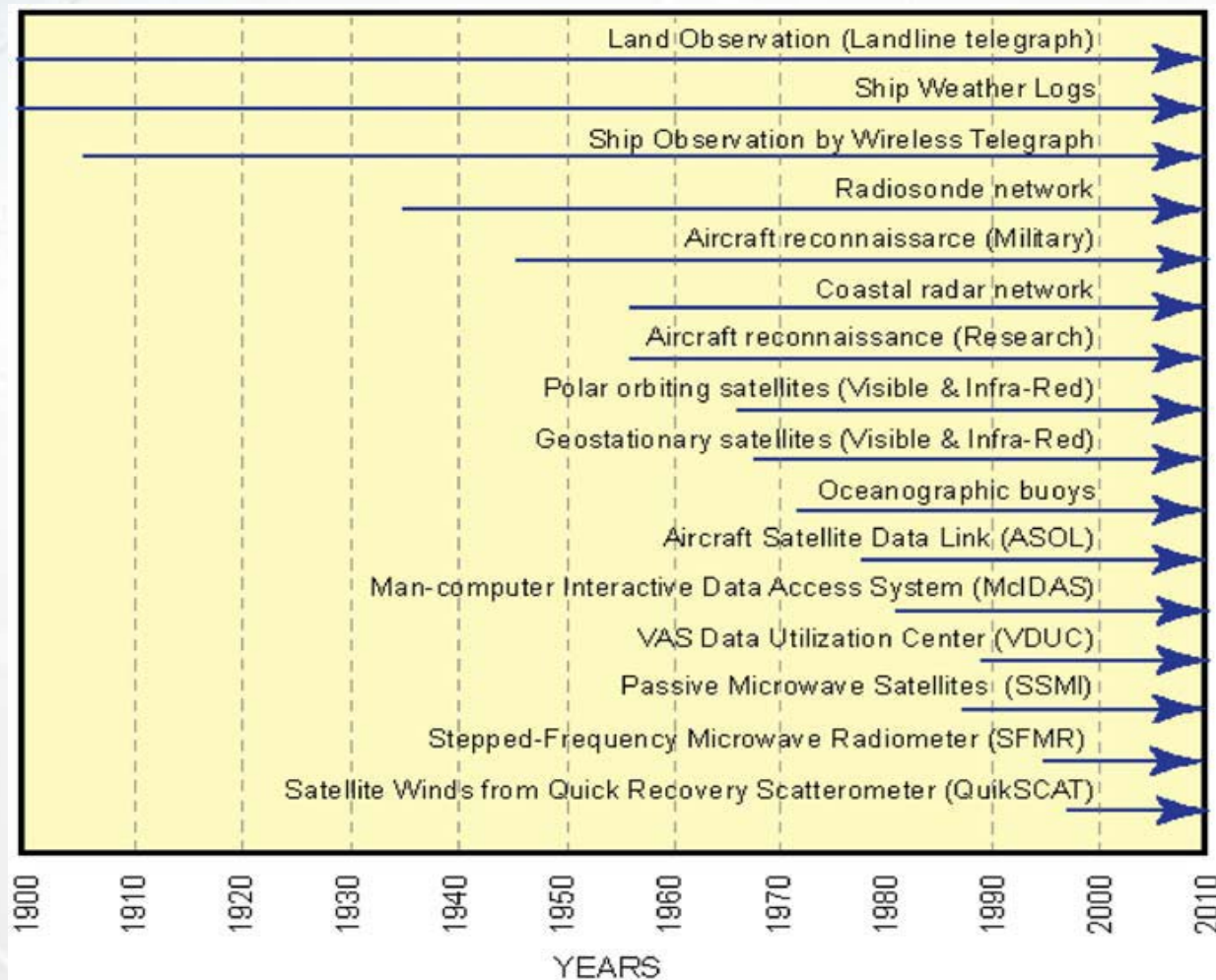
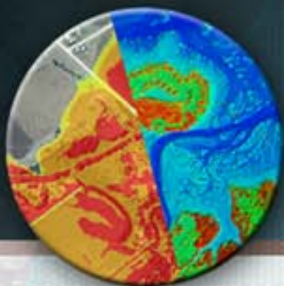
Characterize Study Area
Storm Climate Meteorology
(Hurricanes & Nor'easters)



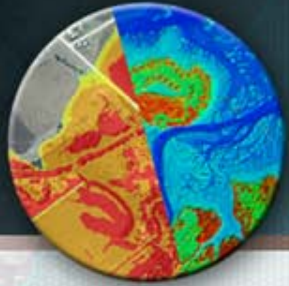
Objectives

- Adequately & correctly characterize the present storm climate (assume to continue into the future)
- Selected a storm set for model verification
- Seek to minimize the number of hurricane parameters to make storm surge calculations with the AdCIRC model practical

Developments in Hurricane Measurements

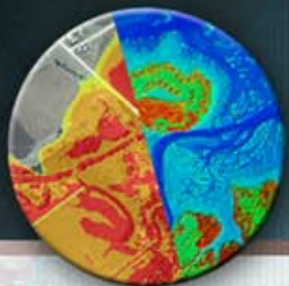


Source: Levinson, Vickery & Resio, 2010



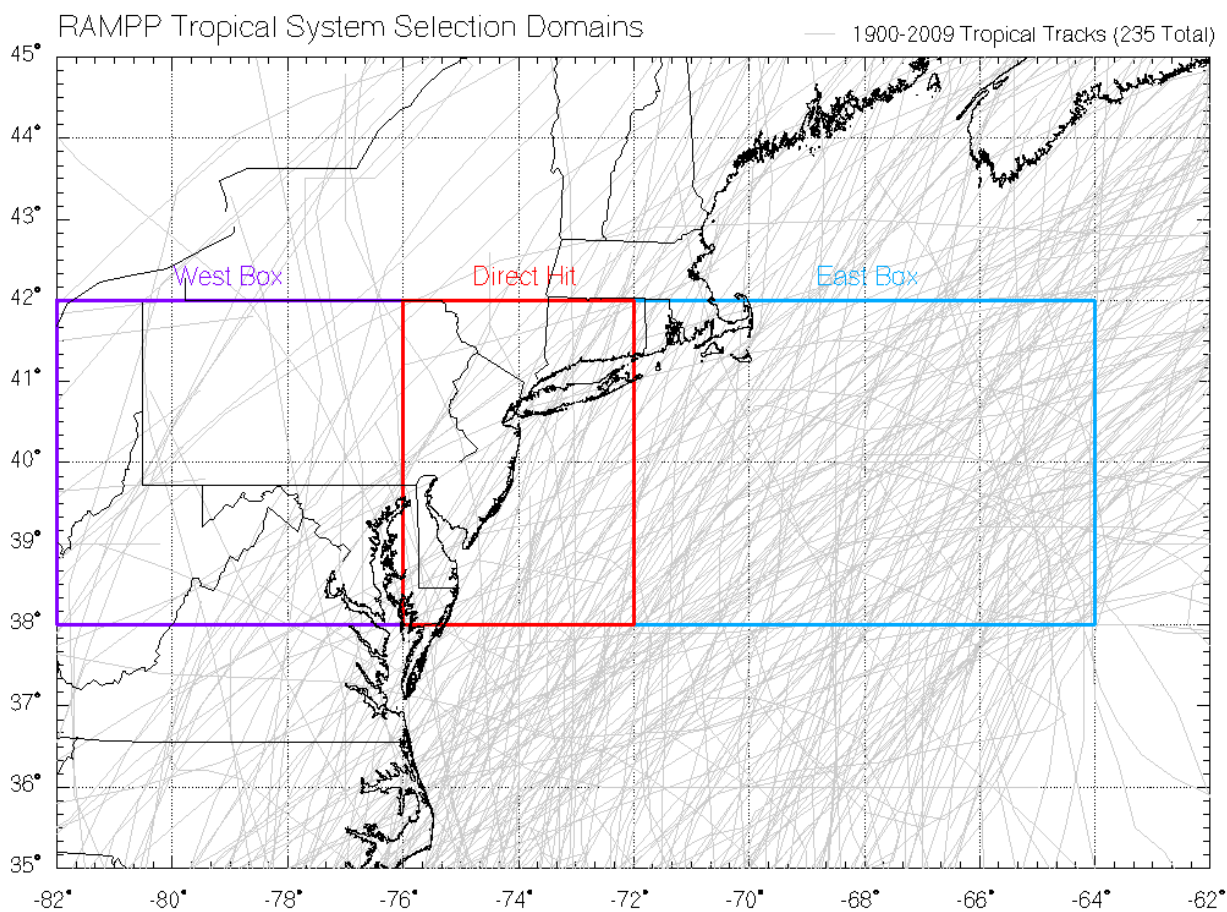
Period of Record

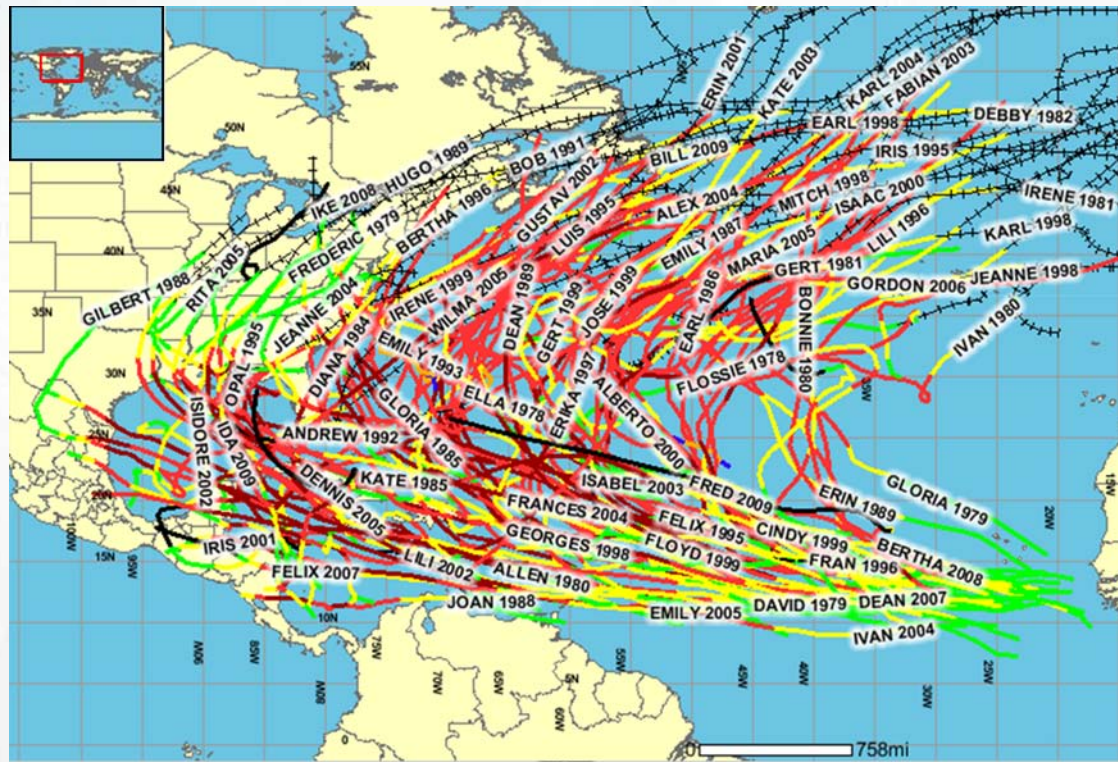
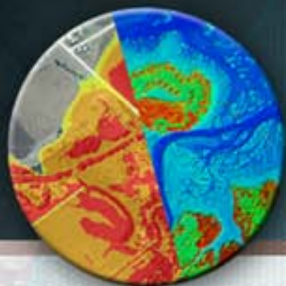
- 1851: Limit of Hurdat
 - 1900: Former FEMA Data Limit
 - 1940s: Offshore Aircraft Observations
 - 1960s: Satellites and Data Buoys
 - 1990s: Doppler Radar
 - 2009: Limit Of Study Data
- Tropical
 - ✓ Characterization: => 1933-2009
 - ✓ JMP-Development: Delta P => 1938-2009, all else => 1948-2009
 - Extra-tropical
 - ✓ 1950 -2009



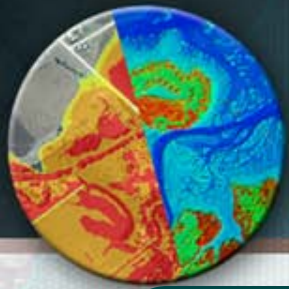
Joint Probability Method (JPM)

Define a Capture Zone

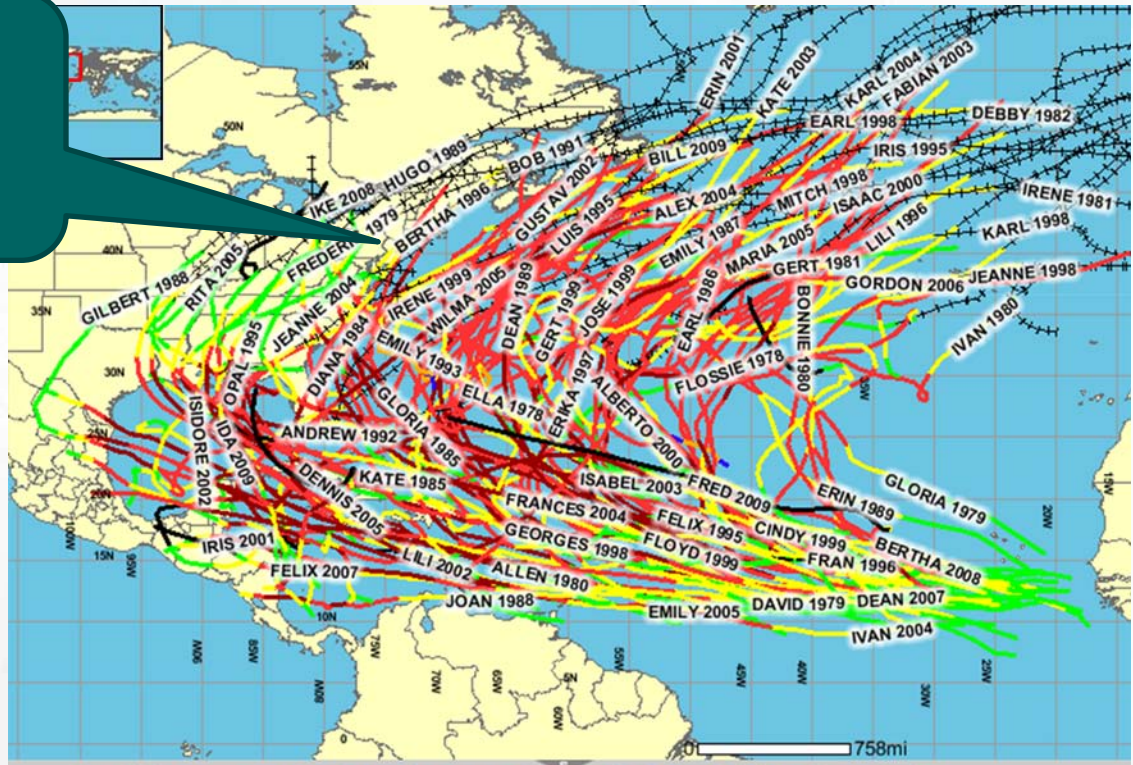




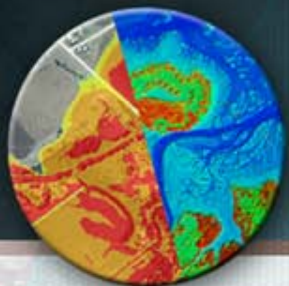
In this example hurricanes from 1978 -2009 Cat 2 -5



Dominant
Coast
Parallel
Tracks

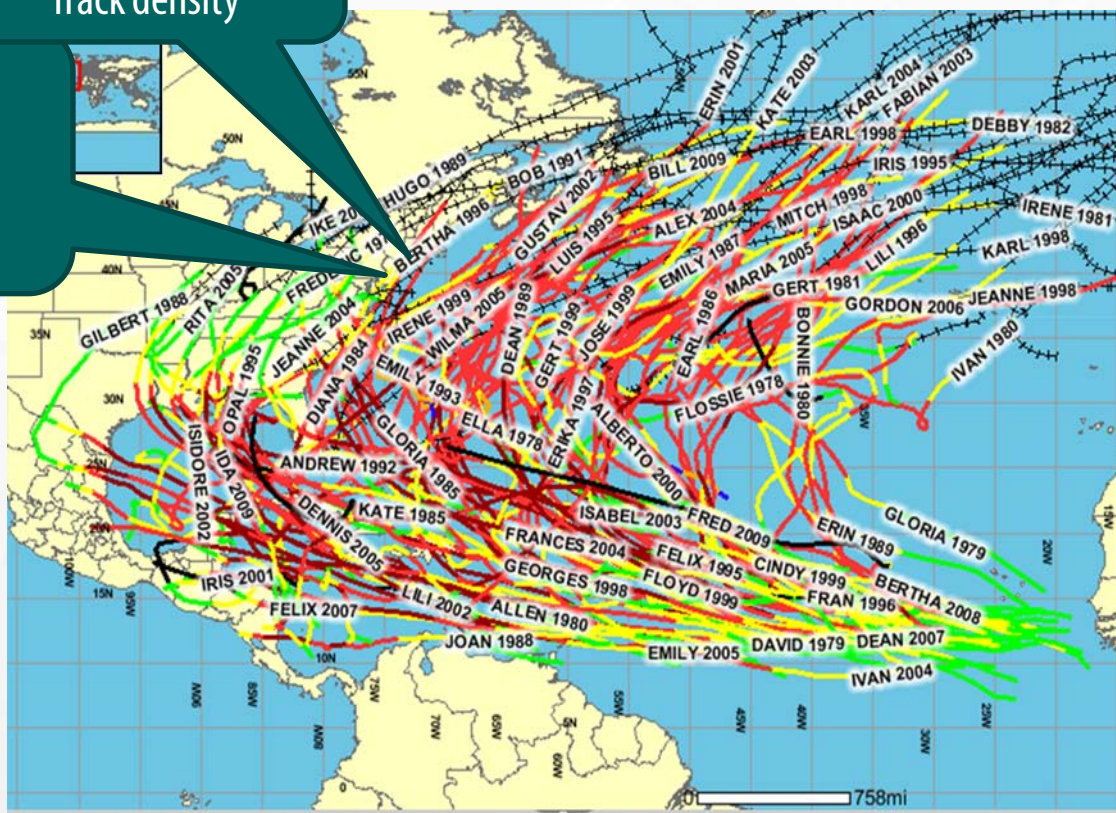


In this example hurricanes from 1978 -2009 Cat 2 -5

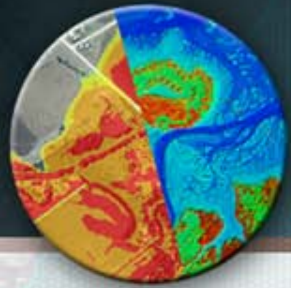


Note the "Blue Hole" in the Track density

Dominant Coast Parallel Tracks

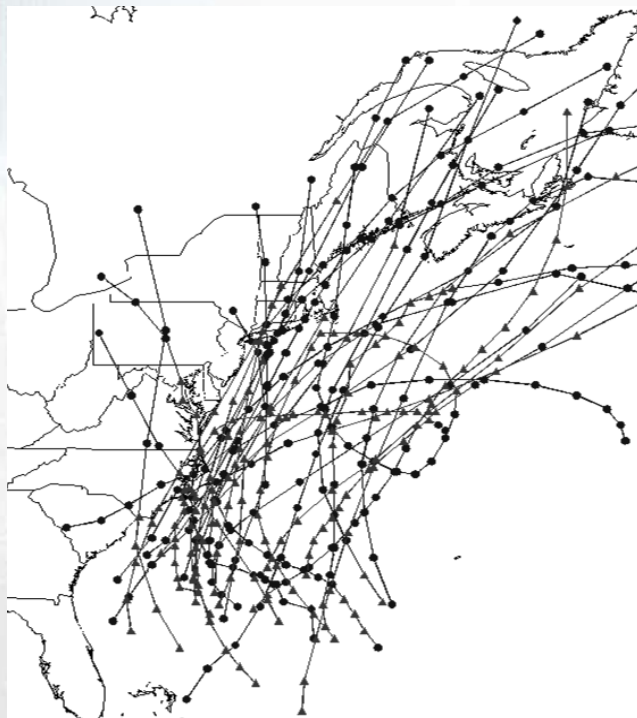


In this example hurricanes from 1978 -2009 Cat 2 -5



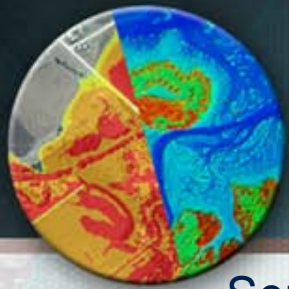
Storm Selection for Synoptic Climatology

Thirty storms selected for synoptic climatology



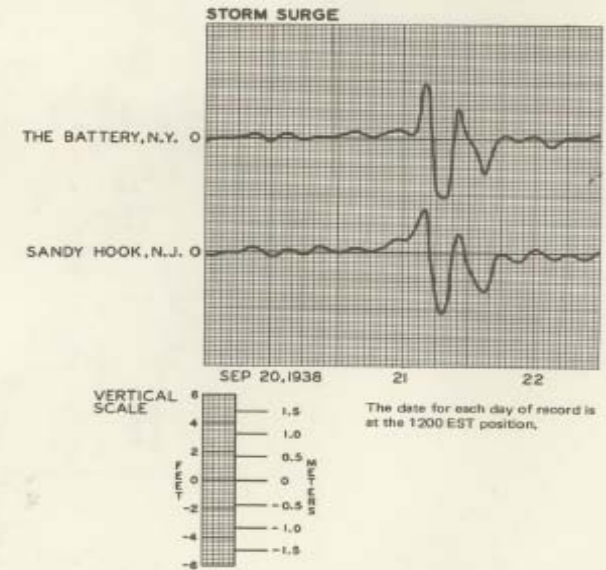
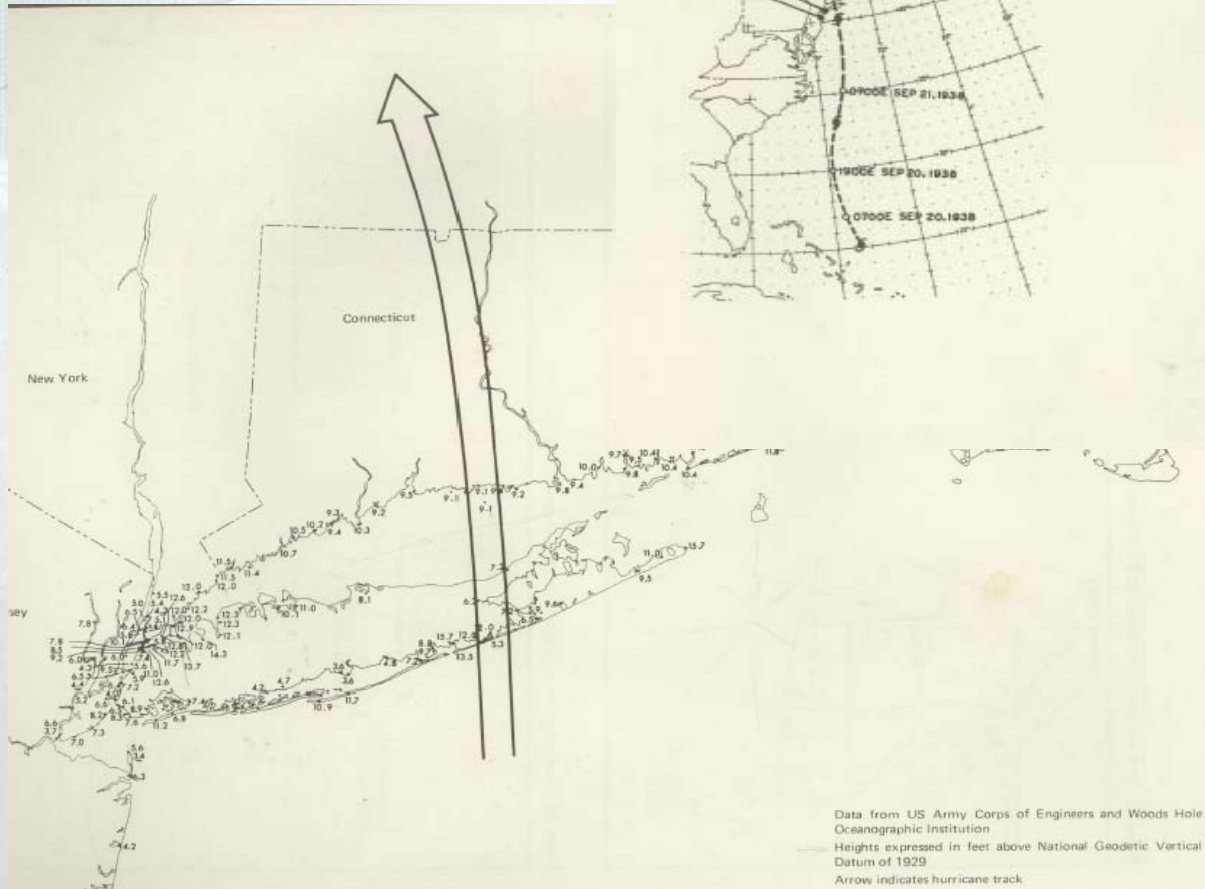
1938_04NOTNAMED*	1972_02AGNES
1944_07NOTNAMED*	1976_03BELLE
1948_03NOTNAMED	1978_06ELLA
1952_03BAKER	1985_07GLORIA*
1953_02BARBARA	1990_02BERTHA
1953_04CAROL	1991_02BOB
1954_03CAROL	1993_05EMILY
1954_05EDNA	1996_05EDOUARD
1954_09HAZEL	1996_08 HORTENSE
1955_02CONNIE	1999_06FLOYD
1958_04DAISY	2002_08GUSTAV
1960_05DONNA*	2003_09ISABEL
1961_05ESTHER	2004_01ALEX
1967_04DORIA	2007_16NOEL
1969_07GERDA	2009_03BILL

* Used as “AdCIRC/UNSWAN Verification Storm “



Tropical Validation Storms

September 1938
Hurricane

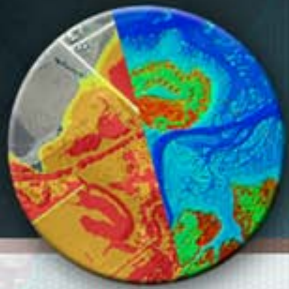


Landfall 941mb

Measured surges at
Battery NY and Sandy
Hook, NJ 3-4 feet

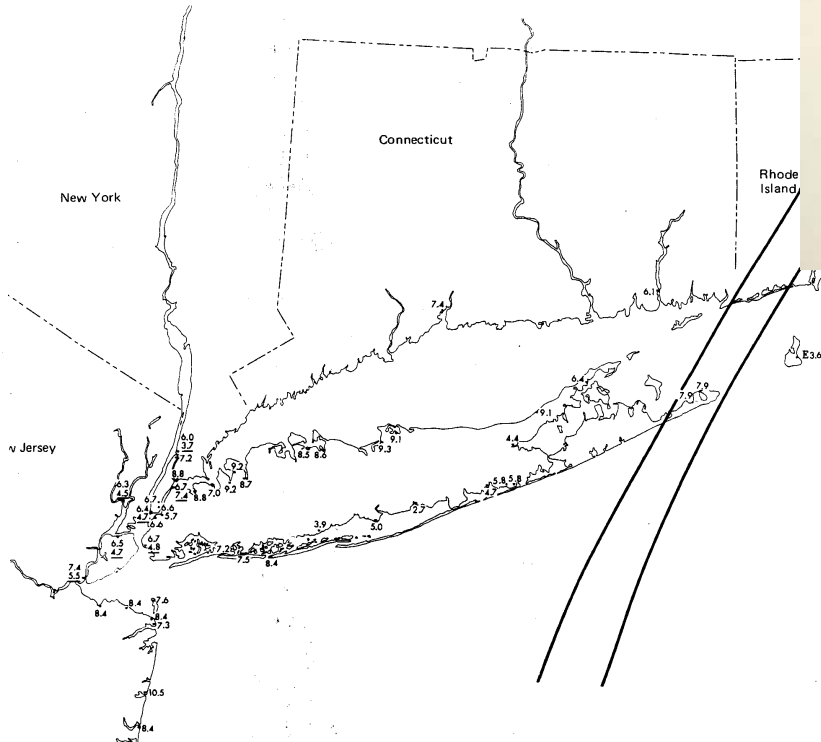
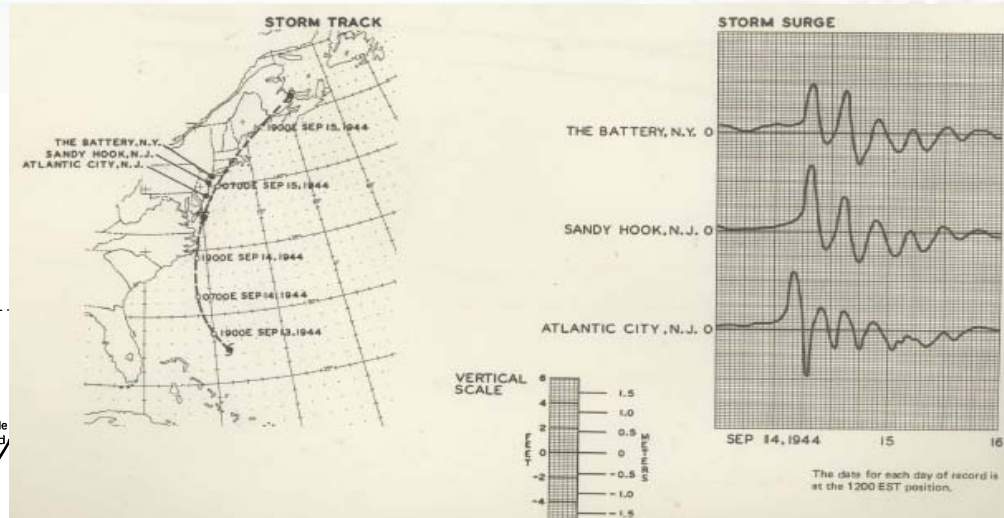
Estimated high water
marks up to 15.7 feet

Figures from MESA New York Bight Atlas Monograph 6



Tropical Validation Storms

September 1944 Hurricane

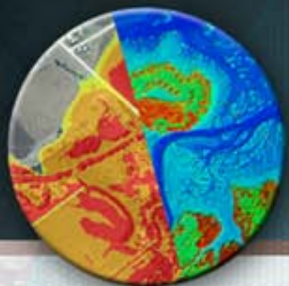


Heights expressed in feet above National Geodetic Vertical Datum of 1929; underlined values are peak storm surges
Arrow indicates hurricane track

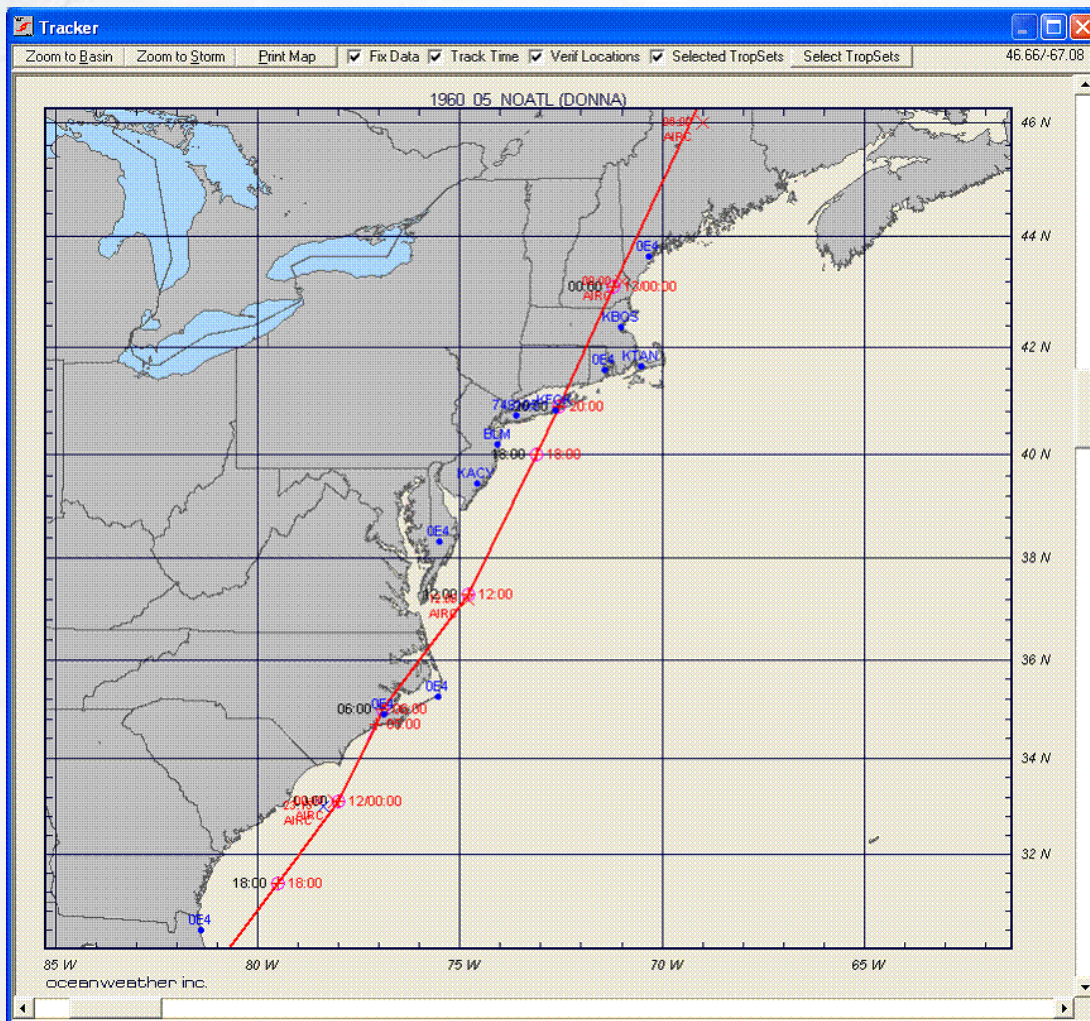
Landfall 963mb

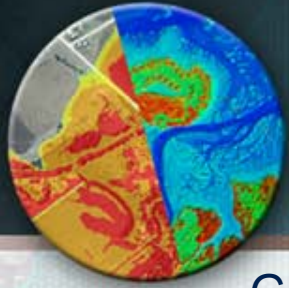
Measured surges at Battery NY, Sandy Hook, NJ, Atlantic City, NJ 4-5 feet

Estimated high waters up to 10.5 feet in study area



HURRICANE DONNA 1960

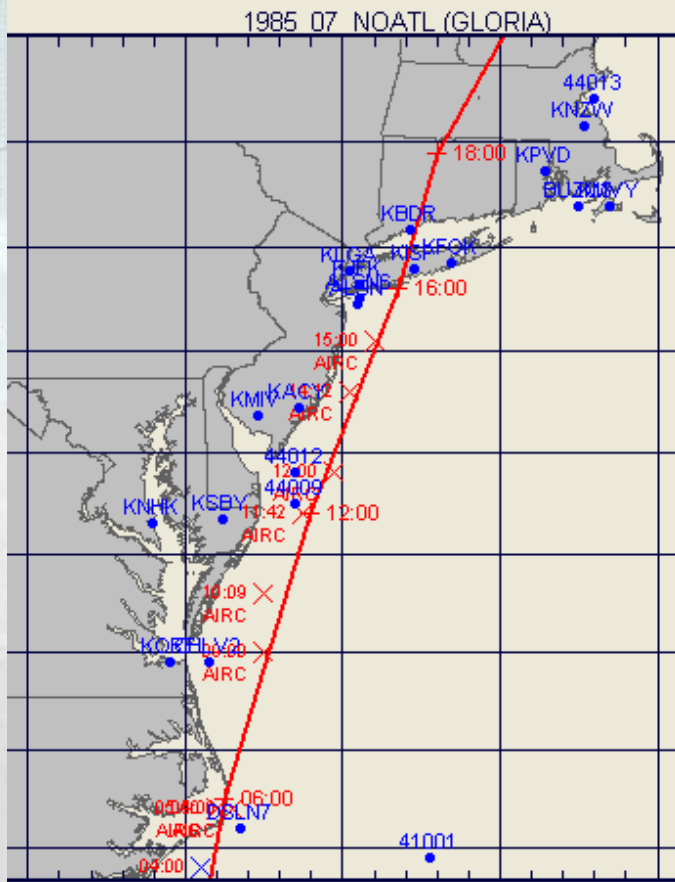




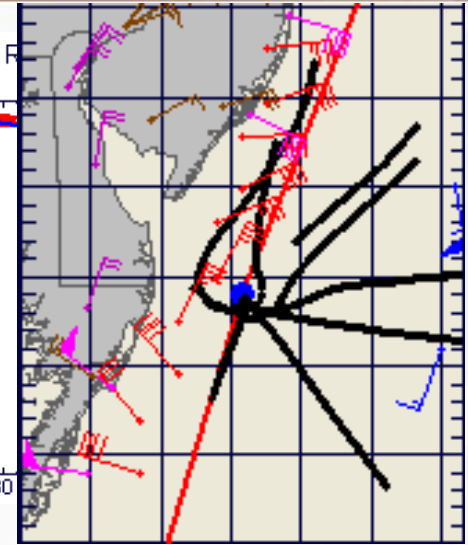
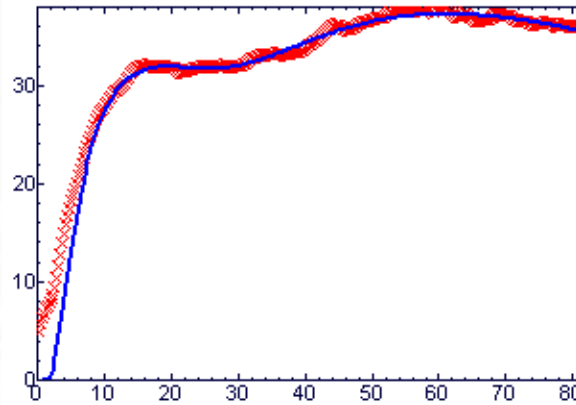
Tropical Validation Storms

Gloria 1985

1985 07 NOATL (GLORIA)



Flight Level Tangential Wind (m/s) vs R

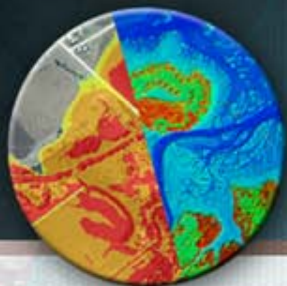


Landfall 957mb

High resolution aircraft reconnaissance for parameter fitting, NDBC Buoys for wave validation

Digital water level measurements at numerous stations

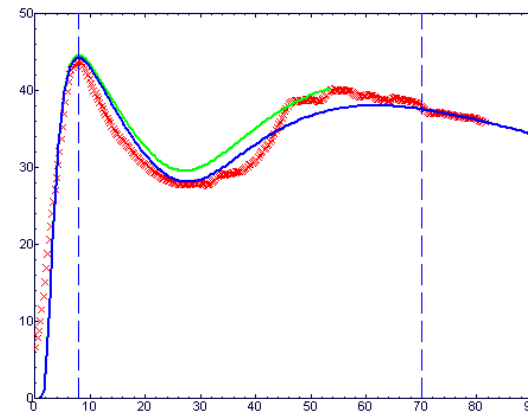
Battery, NY 7.0 feet, Most reports 4-7 feet



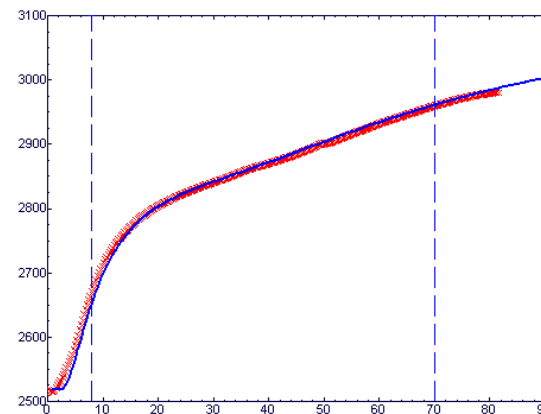
Present Methodology

- *Apply double exponential pressure profile as implemented in TropPBL*
- *Expand cost function to allow sea level pressure measurements as well as flight level tangential wind and height*
- *Apply to azimuthally averaged data rather than individual recon legs*
- *Display available fit information in work station to allow storm analysis which tracks the parameter set throughout the storm life cycle*

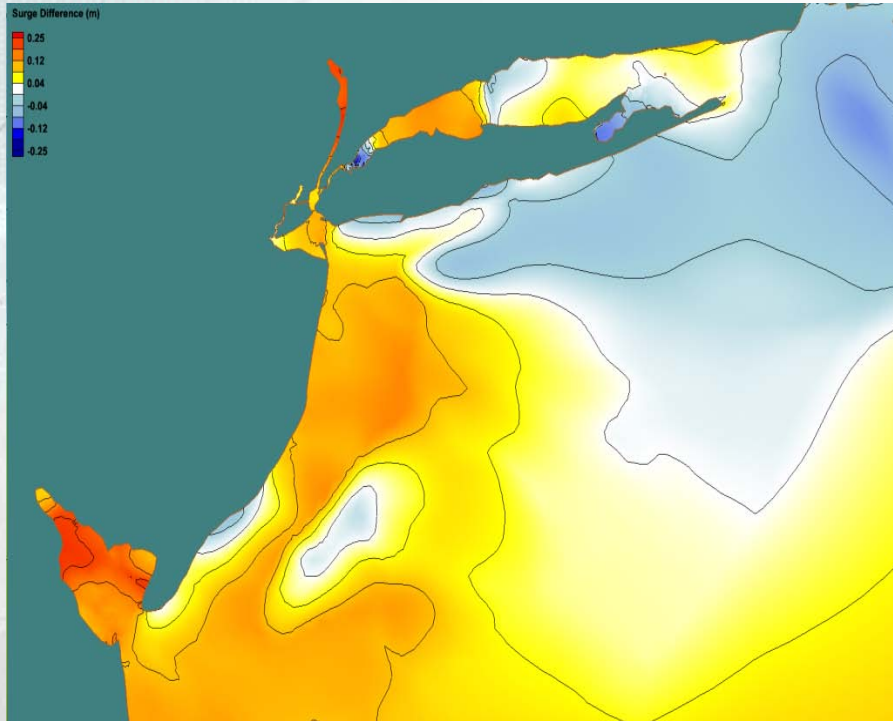
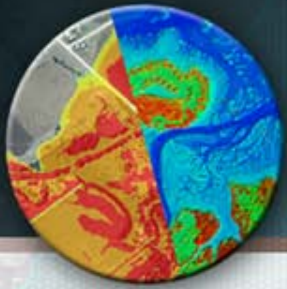
Flight Level Tangential Wind (m/s) vs Radius (Nmi)



Flight Level Height (m) vs Radius (Nmi)

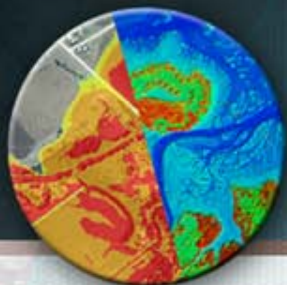


Tropical Synoptic Climatology: Doubles as Singles



Difference in ADCIRC Surges (Single-Double) for Gloria 1985

Observation Station	Max Surge Elevation (m)		Diff. (m) [S-D]	Diff. (%) [(S-D)/S]
	Single Exp Field	Double Exp Field		
Brandywine Shoal Light/DE Bay	1.768	1.660	0.108	6.1
Atlantic City NJ	2.085	2.102	-0.017	-0.8
Seaside Heights NJ	1.798	1.714	0.084	4.7
Sandy Hook/Queens Co	2.059	2.059	0.000	0.0
Jones Beach NY	2.202	2.227	-0.025	-1.1
Fire Island NY	2.716	2.747	-0.031	-1.1
Westhampton NY	1.693	1.718	-0.025	-1.5
Southampton NY	1.398	1.449	-0.051	-3.6
Amagansett NY	1.155	1.155	0.000	0.0
Battery-NY	2.123	2.072	0.051	2.4
LIS – Willets Pt	1.591	1.698	-0.107	-6.7
LIS – Westchester Co	1.407	1.329	0.078	5.5
LIS – Stamford	1.292	1.186	0.106	8.2
LIS – Bridgeport	1.139	1.153	-0.014	-1.2
LIS – New Haven	1.648	1.619	0.029	1.8
LIS – Gardiners	1.436	1.427	0.009	0.6



Winter Storms: Storm Selection

9 station locations at exposed locations with long-term near-continuous measurements

Time range selected: 1950-2009 (constrained by amount of insitu wind data pre-1950 for later analysis)



Station ID	Lat	Long	Record Began (YMD)	Record Ended (YMD)	Station Location
8638863	36.966	-76.113	19750126	20091130	Chesapeake Bay Bridge, VA
8461490	41.36	-72.09	19380601	20091130	New London, CT
8510560	41.05	-71.96	19590101	20091130	Montauk, NY
8516990	40.79	-73.78	19570101	20001130	Willets Point, NY
8518750	40.70	-74.01	19580501	20091130	The Battery, NY
8536110	38.968	-74.96	19651101	20091130	Cape May, NJ
8531680	40.47	-74.01	19100101	20091130	Sandy Hook, NJ
8534720	39.35	-74.42	19110801	20091130	Atlantic City, NJ
8557380	38.782	-75.12	19570101	20091130	Lewes, DE

Winter Storms: Storm Analysis

All available wind measurements are adjusted for height, stability and exposure to a common 10-meter neutral wind speed

A man-intensive process where wind speeds (isotachs) and wind directions (streamlines) are hand-drawn to best represent the available observations while preserving the primary meteorological principles of storm development and continuity

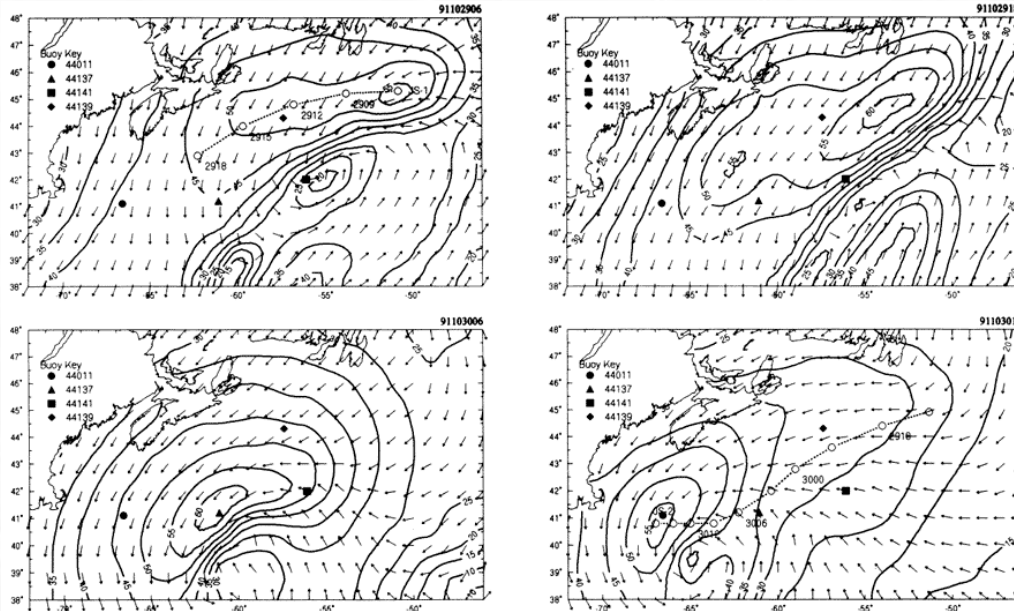
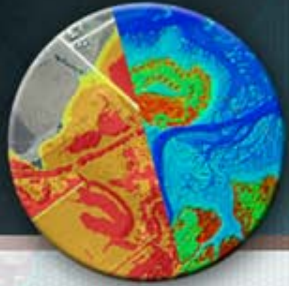


FIG. 5. Twelve-hour (a)–(d) surface wind field analyses in the immediate vicinity of the Halloween storm, showing evolution of major circulation features including jet streaks between 0600 UTC 29 October and 1800 UTC 30 October.

From Cardone, V. J., R. E. Jensen, D. T. Resio, V. R. Swail and A. T. Cox. **Evaluation of contemporary ocean wave models in rare extreme events: Halloween storm of October, 1991; Storm of the century of March, 1993.** *J. of Atmos. And Ocean. Tech.*, 13, 198-230.



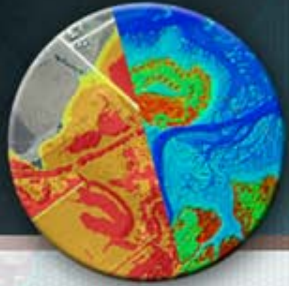
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8557380	38.782	-75.12	19570101	20091130	Lewes, DE



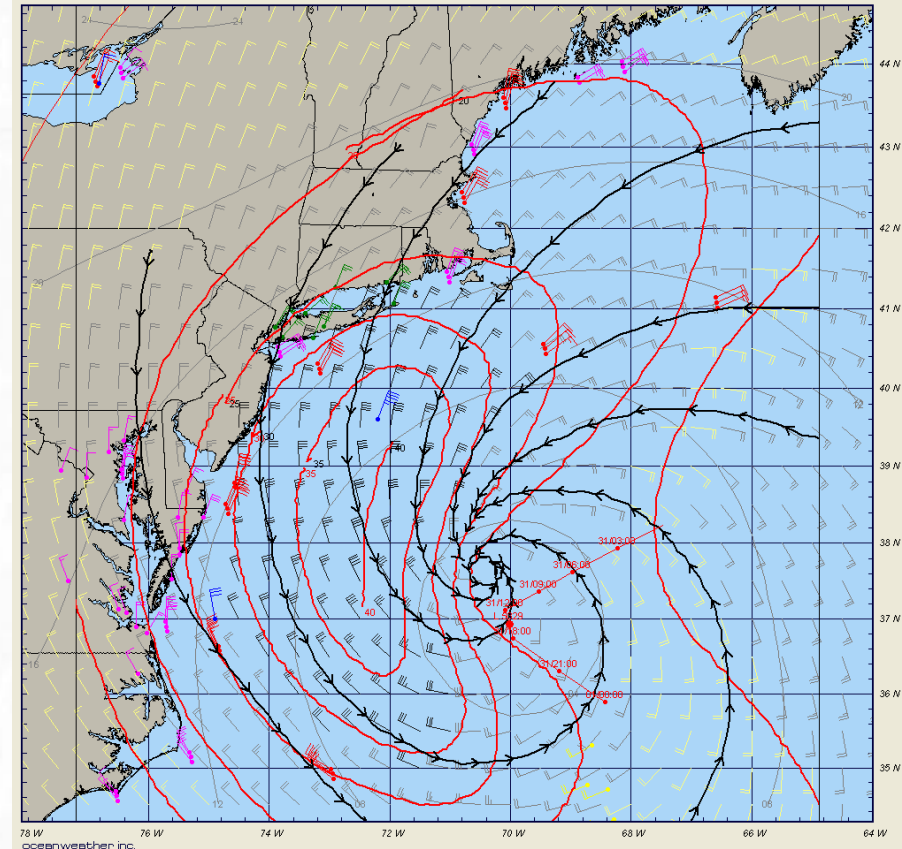
Winter Storm Wind and Pressure Forcing

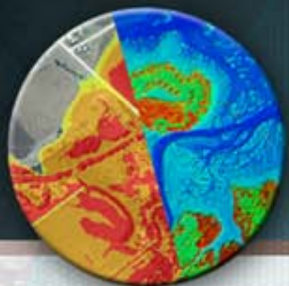
Winter Storms (aka extra-tropical storms, nor'easters)

Methodology of storm selection and analysis follows that of the Region III study

Storm selection based on measured surge response at NOS stations

Storm analysis consists of kinematic analysis of wind features to track the time-space evolution of the major wind maxima imbedded within the storm





Winter Storms: Storm Analysis

Storm Dates (CYMD)

19501125	19921211*
19610413	19930314
19620306	19940303
19640112	19941224
19660123	19950204
19681112	19951115
19701217	19960108
19710208	19961020
19711125	19961206
19720219	19980128
19741202	19980205
19790125	20051025
19840329*	20070416
19870123	20080512
19911031*	20091113

* Used as AdCIRC/UNSWAN Verification Storm



Questions & Discussion