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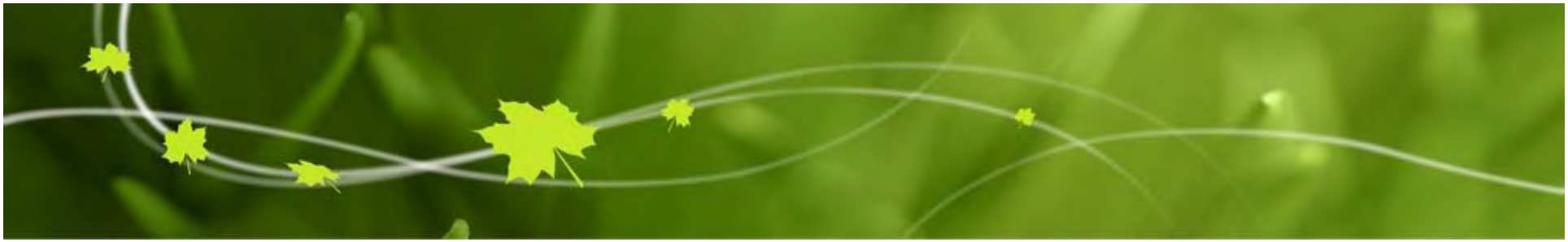


2013 Hurricane Briefing

Institute for Catastrophic Loss Reduction

Bob Robichaud
Warning Preparedness Meteorologist
Canadian Hurricane Centre
Environment Canada
June 14th, 2013

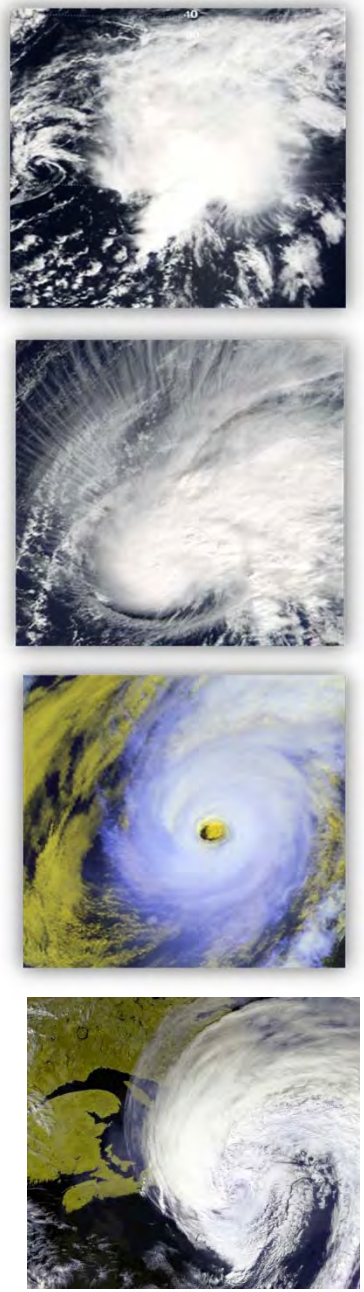
Contents

- Tropical Cyclones 101: Lifecycle, climatology and associated hazards
- Summary of the 2012 Hurricane Season
- Operational Response to Approaching Storms: Forecasting and Communications
- Outlook for the 2013 Hurricane Season

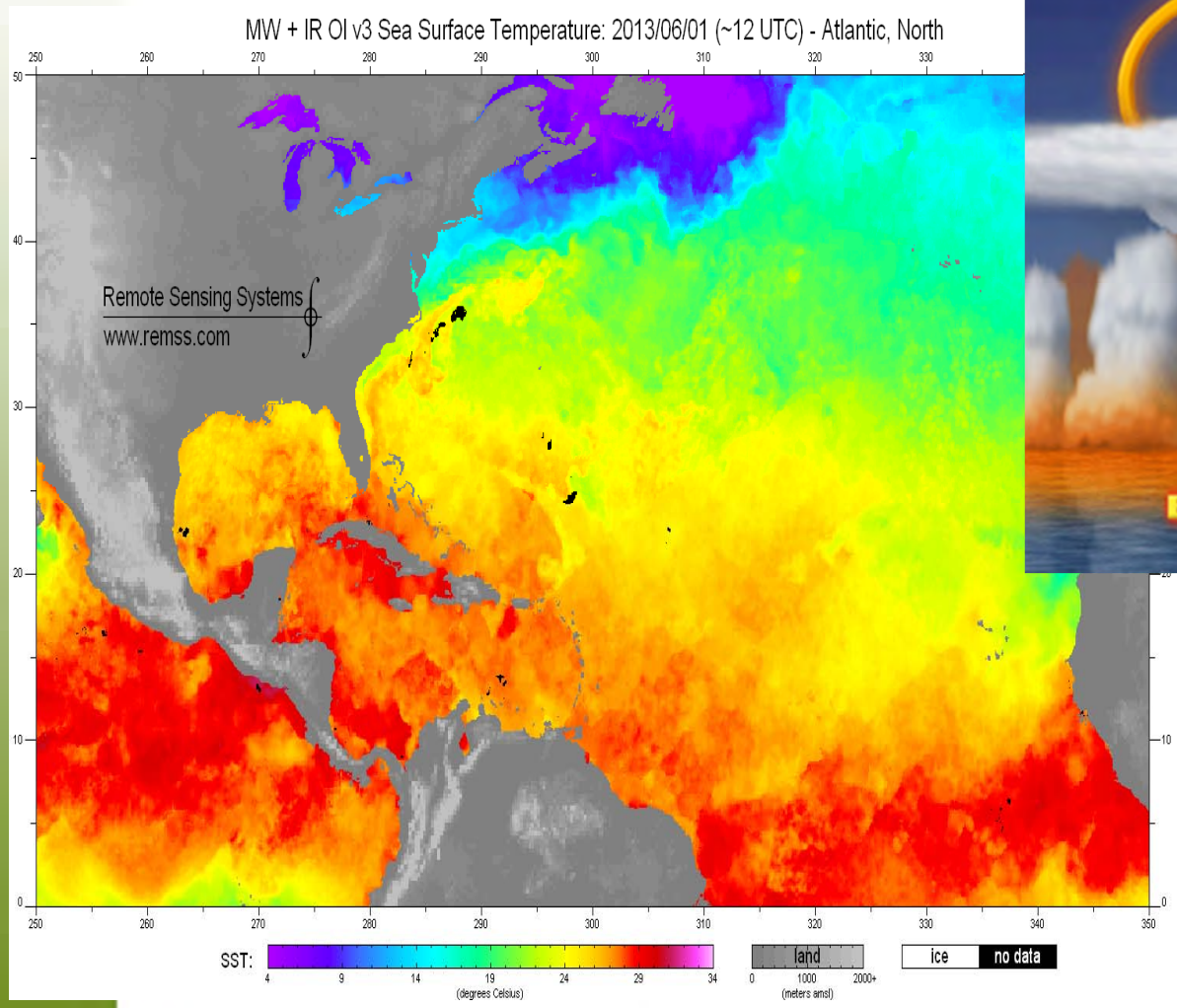
What is a Tropical Cyclone?

- A relatively large and long-lasting low pressure system
  - Can be dozens to hundreds of km wide and last for days
- No fronts attached (unlike a winter storm)
- Forms over tropical or subtropical oceans
- Produces organized thunderstorm activity
- Has a closed surface wind circulation around a well-defined center

- Classified by maximum sustained surface wind speed
  - Tropical depression: < 63 km/h
  - Tropical storm: 63 - 117 km/h
  - Hurricane: 118 km/h or greater
    - Major hurricane: 178 km/h or greater
- Often storms will transform into a system that looks more like a winter storm

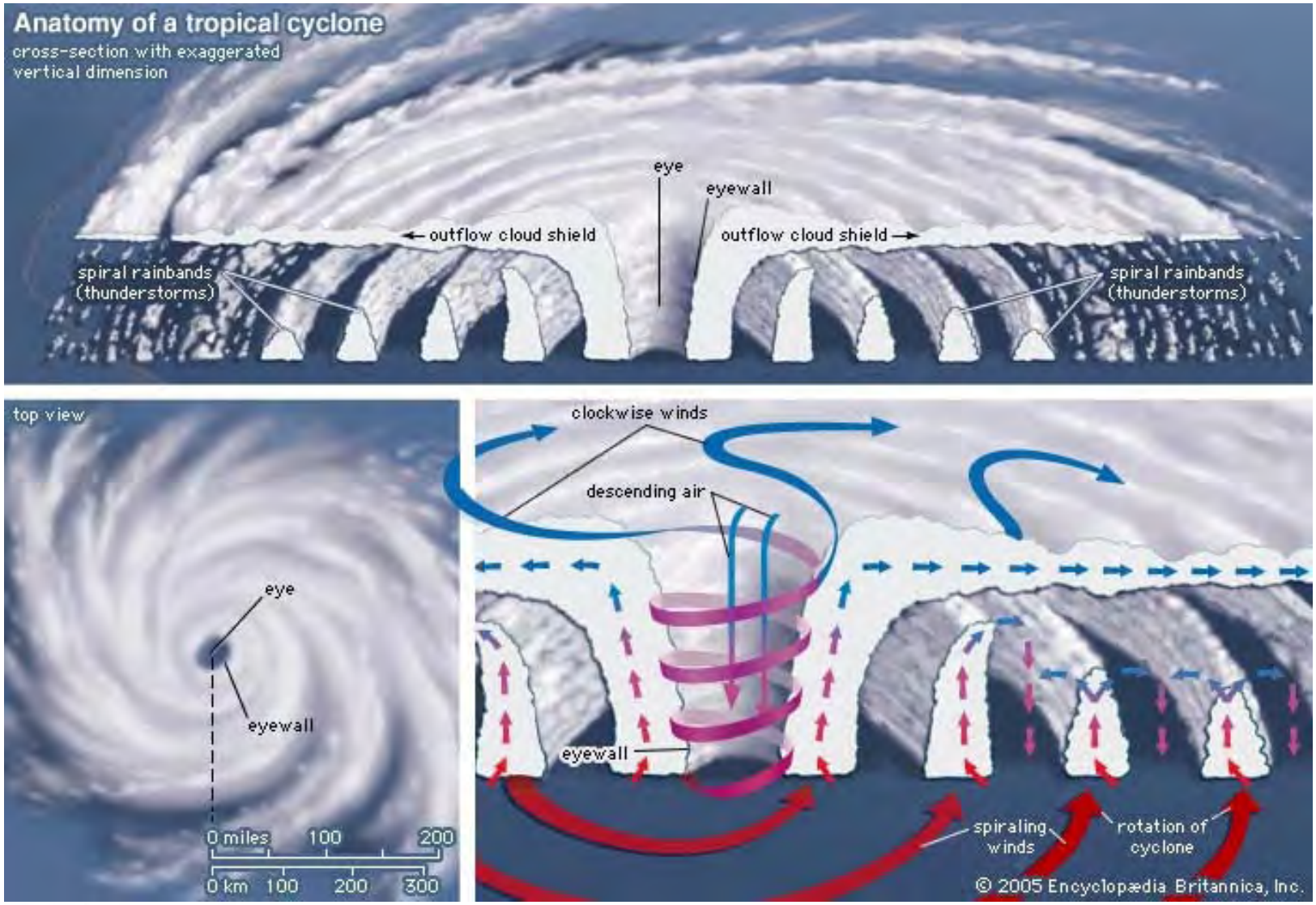


Why do they form?



- Tropical Cyclones form due to excess heat stored in the ocean
- Nature redistributes this heat into the atmosphere through hurricanes

What do they look like?



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In the Eye of the Storm

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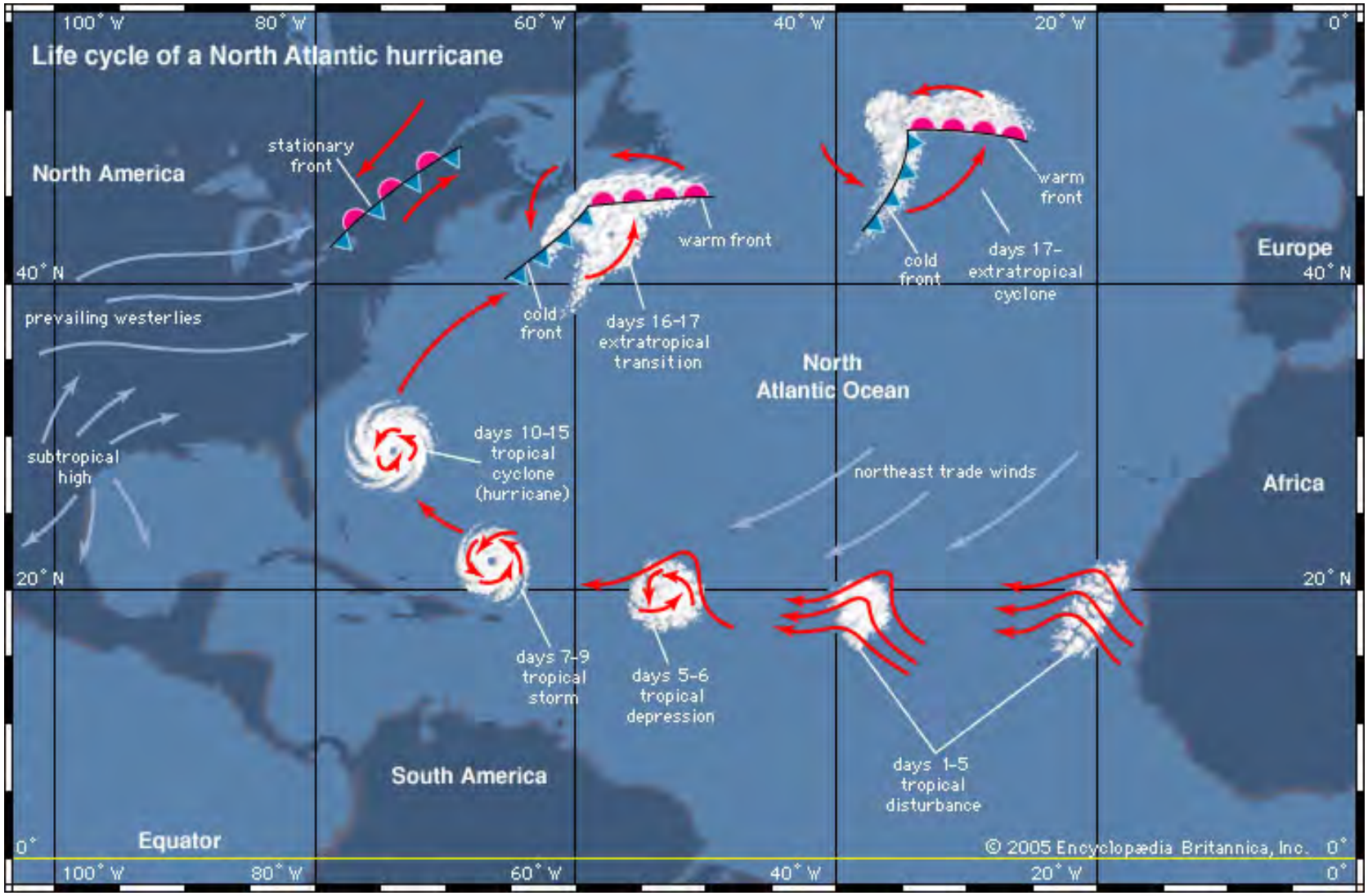
Typical life cycle of a hurricane



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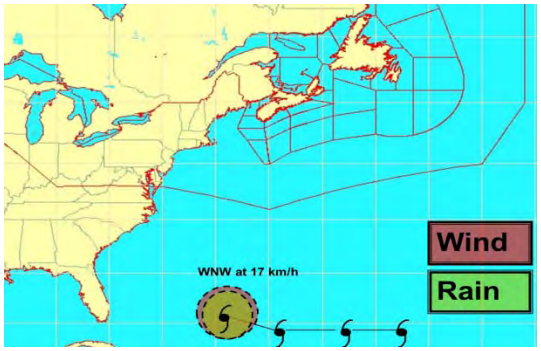
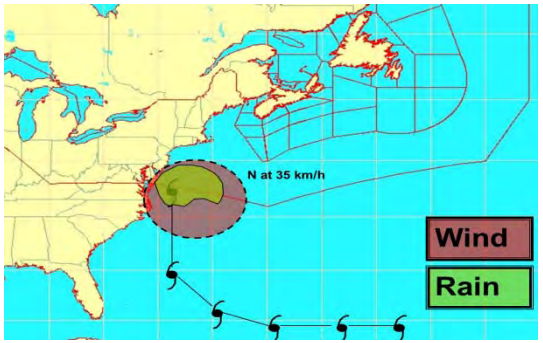
How do they behave when they approach Canada?

- Weaken as they get cut off from the warm water source (either over land or over colder water)
- Merge with or become absorbed by a larger weather system and then weaken
- They can become "**Post-Tropical"** and sometimes re-intensify

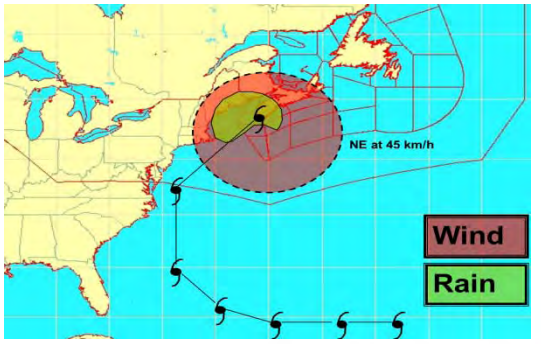
Purely Tropical
- Slow-moving
- Symmetrical wind and rain patterns



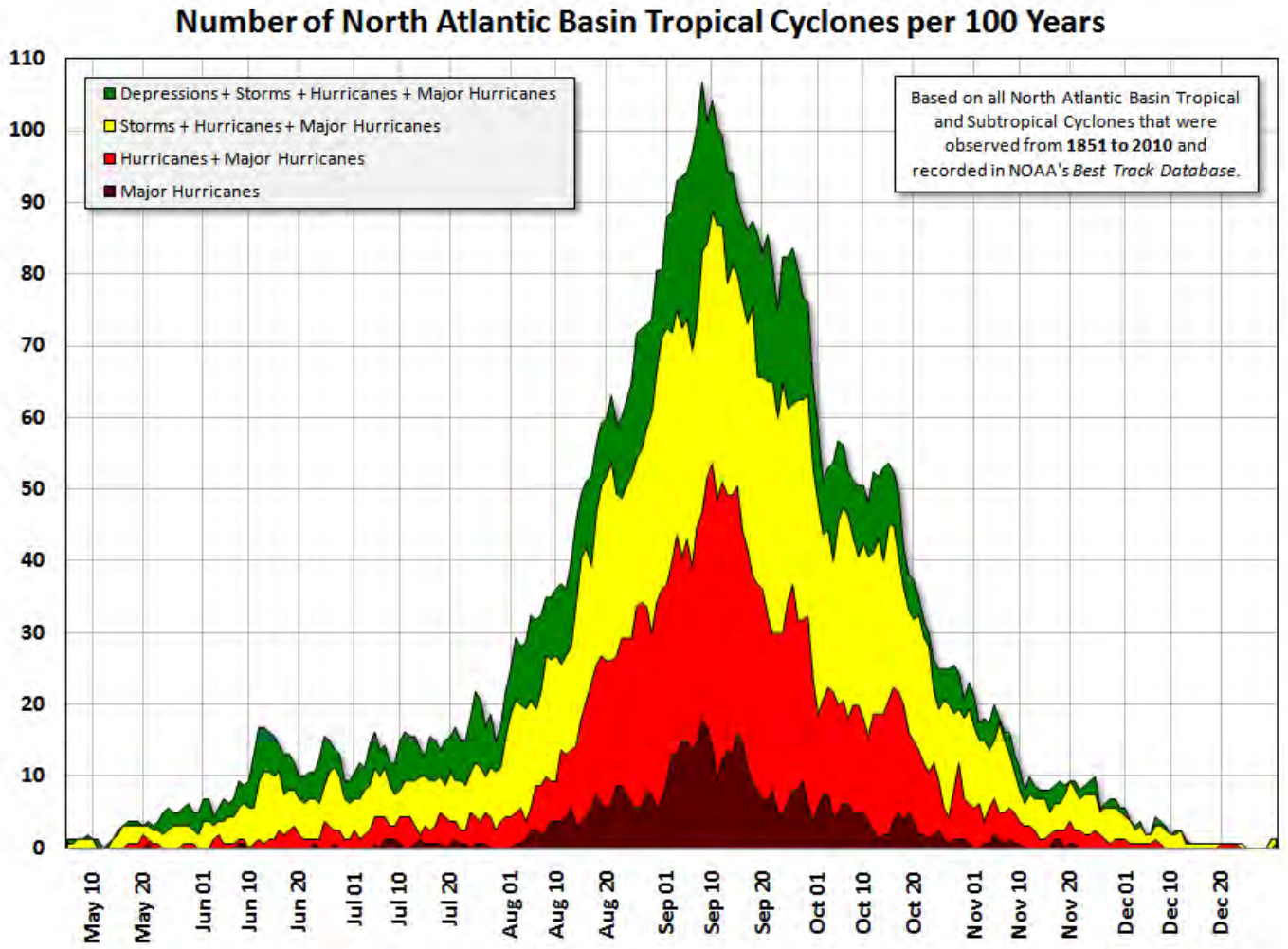
Transition to PT
- Speeding up
- Rain shifting to the left of track
- Wind covers larger area



Post-Tropical
- Fast-moving
- Asymmetrical wind and rain patterns



Tropical Cyclone Climatology



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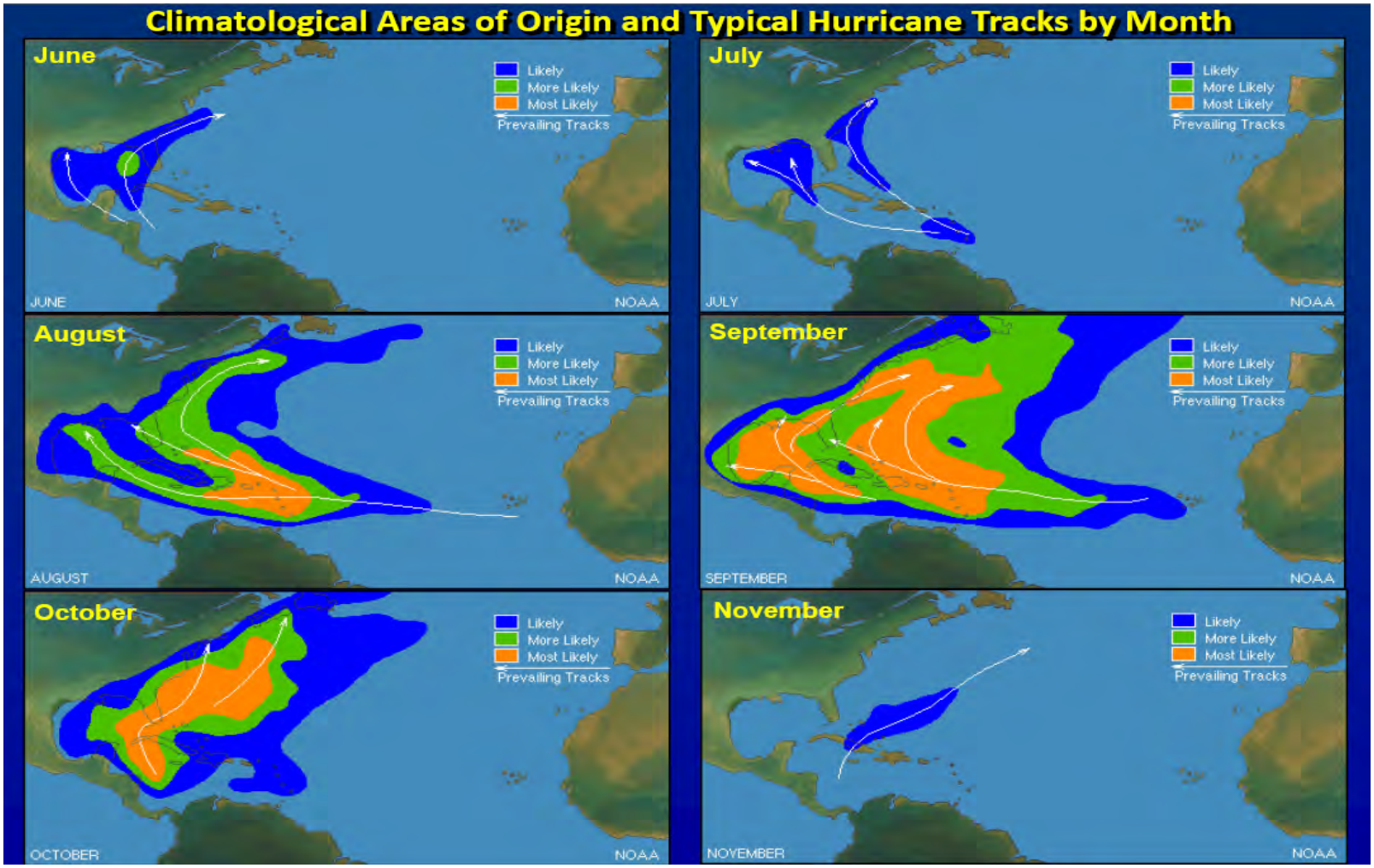
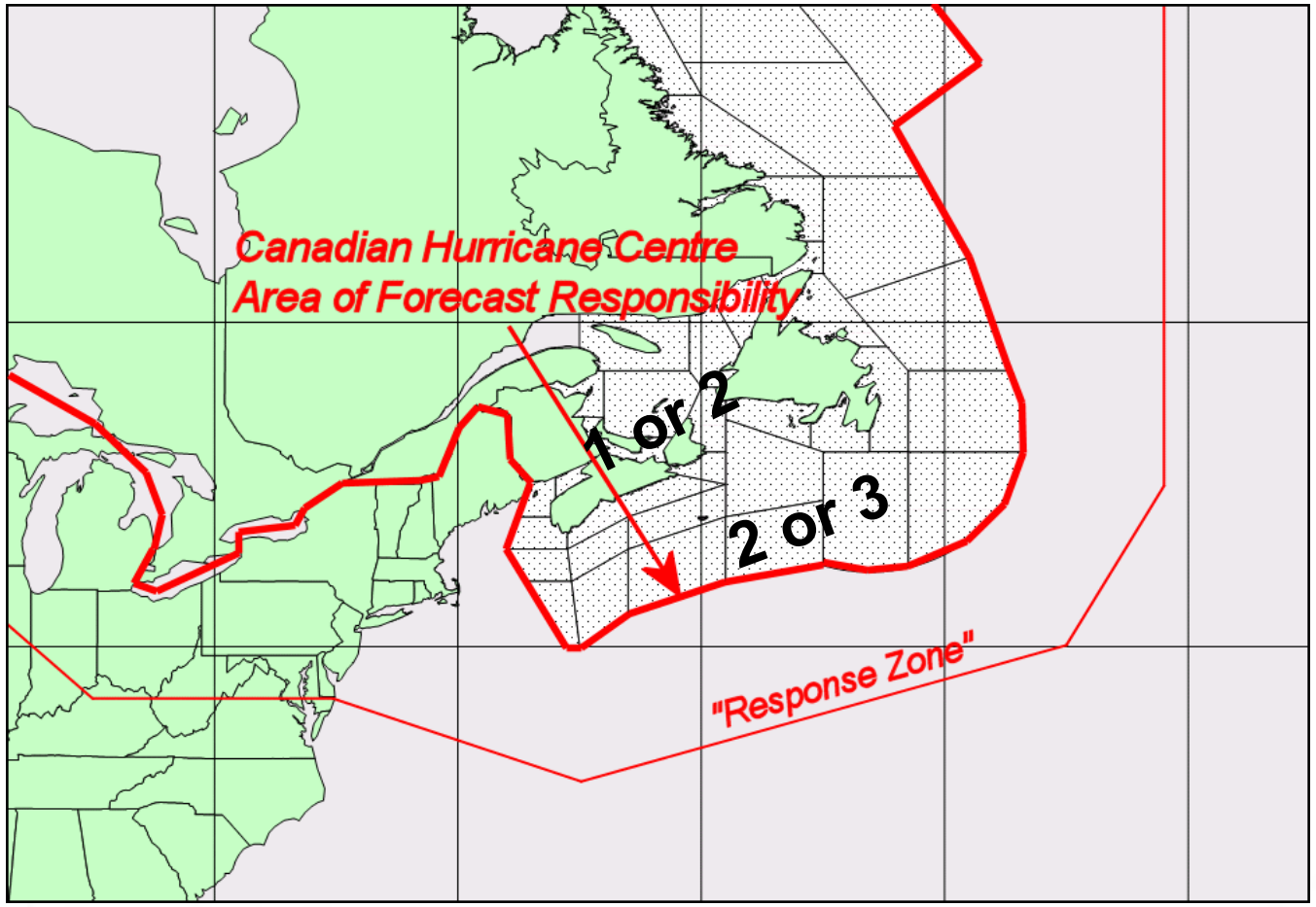
Areas of Origin and Typical Hurricane Tracks by Month



Canadian Hurricane Centre Response Zone

On average, 1 or 2 storms directly affect Canadian land regions each year. Another 2 or 3 typically threaten our offshore waters.



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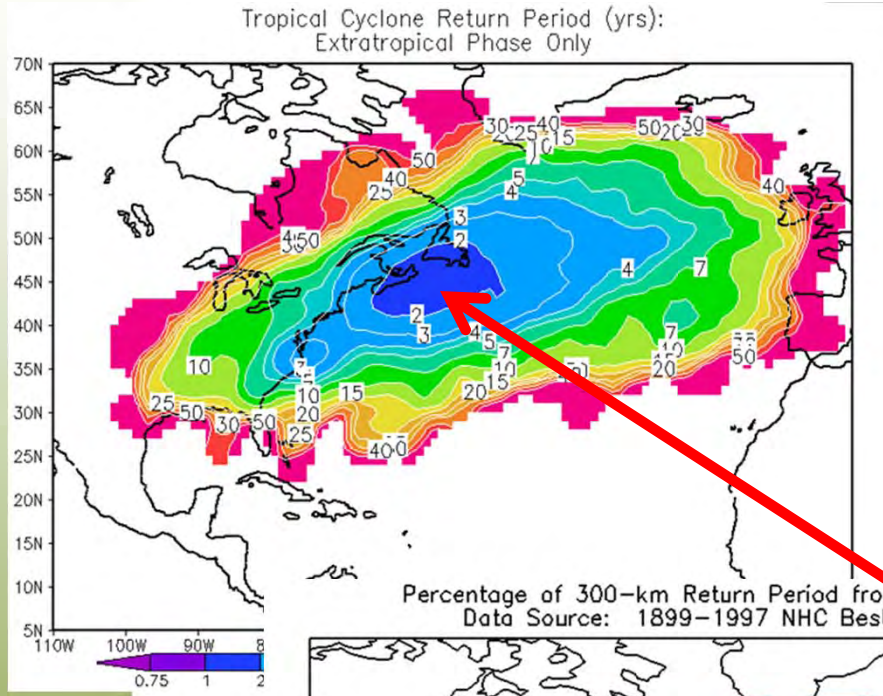
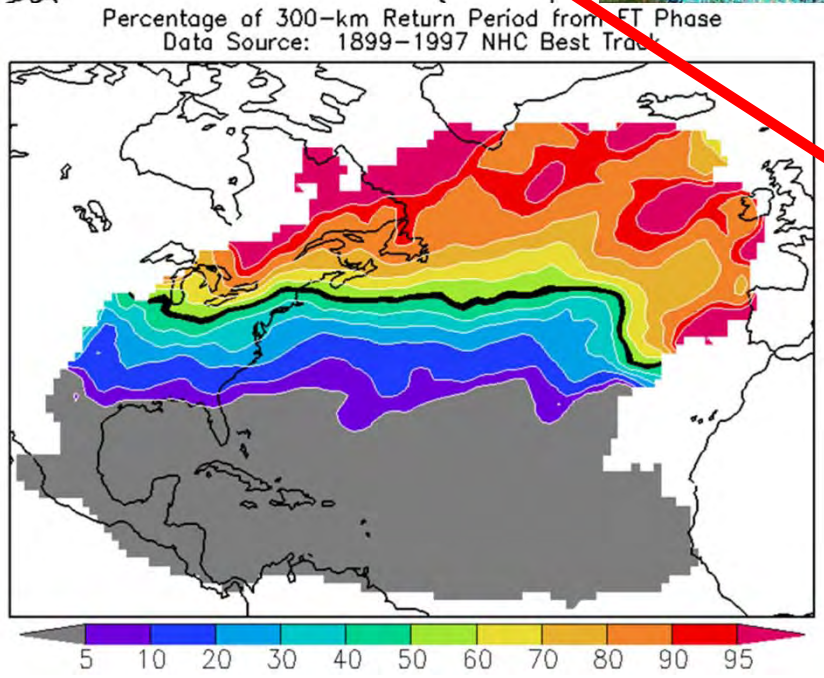
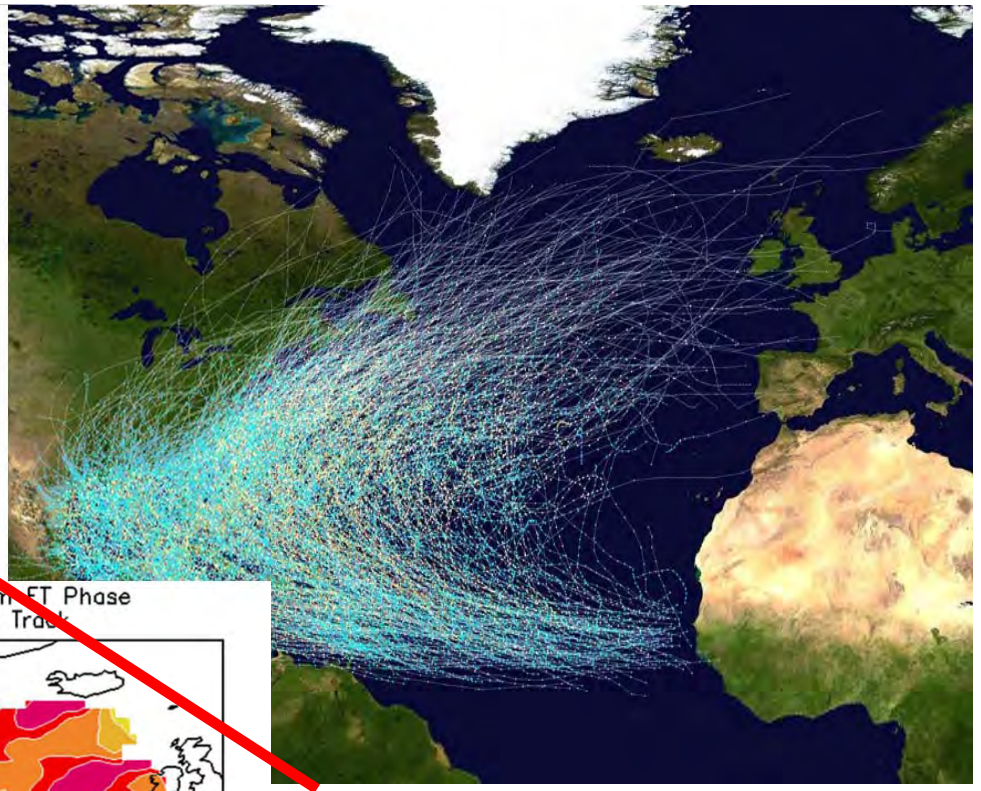
Tropical Cyclones in Canada







This is where we are most likely to see a post-tropical storm!

Canada

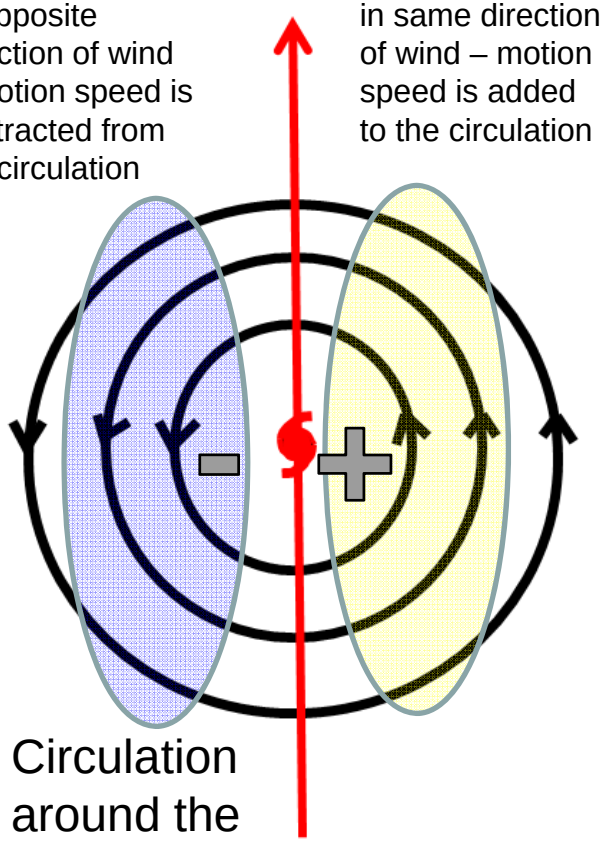
Tropical Cyclone Hazards

Wind

Storm direction and speed

Storm movement in opposite direction of wind – motion speed is subtracted from the circulation

Storm movement in same direction of wind – motion speed is added to the circulation



Circulation around the centre

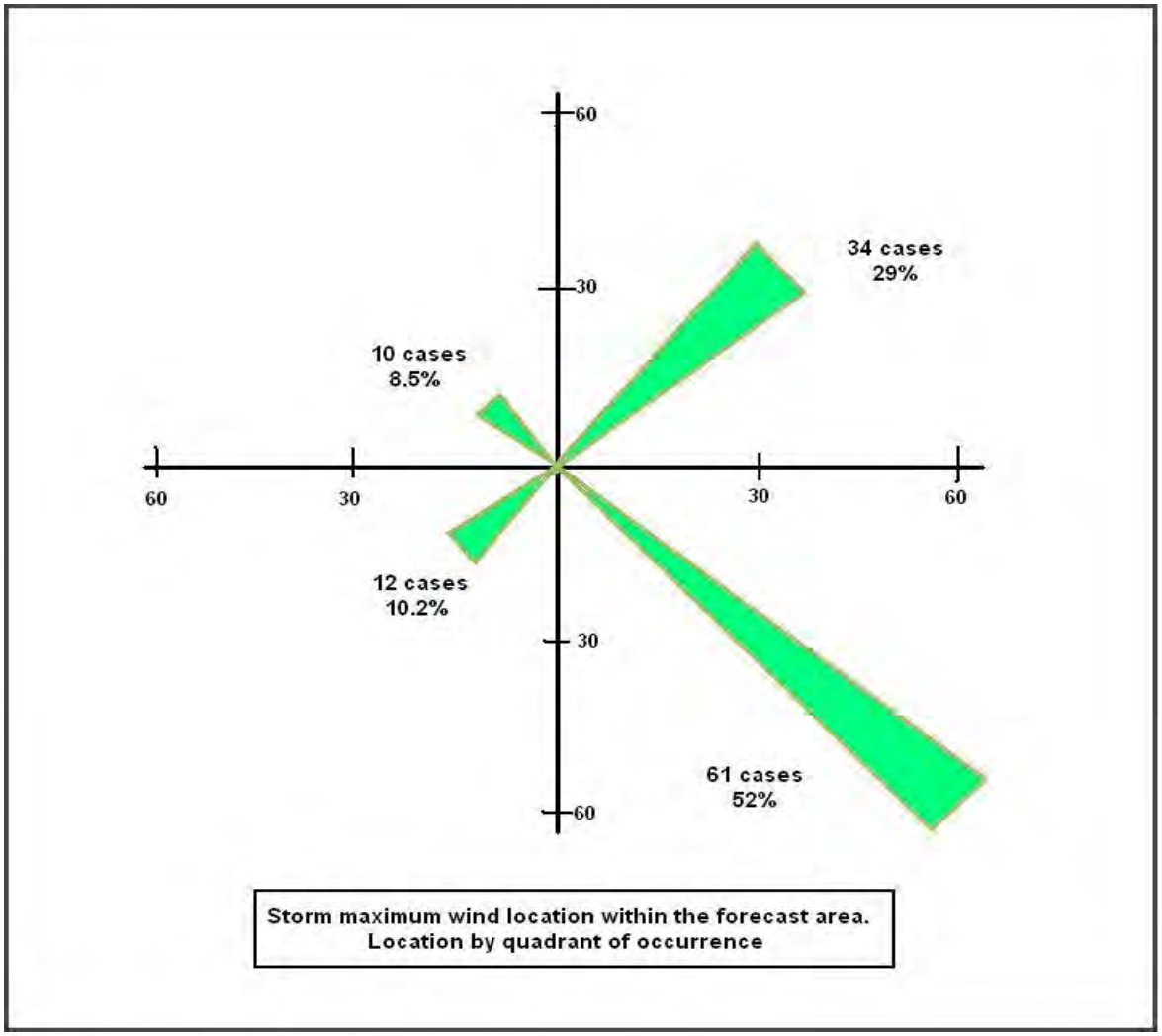
Saffir-Simpson Scale for Hurricanes		
Category	Wind Speed (km/h)	Description
1	119 - 153	Very dangerous winds will produce some damage
2	154 - 177	Extremely dangerous winds will cause extensive damage
3	178 - 208	Devastating damage will occur
4	211 - 249	Catastrophic damage will occur
5	>249	Catastrophic damage will occur

Example 1: Hurricane
Storm winds are blowing at 150 km/h
Storm Speed is 10 km/h
Wind on the right: 160 km/h
Wind on the left: 140 km/h

Example 2: Post-Tropical Storm
Storm winds are blowing at 115 km/h
Storm Speed is 50 km/h
Wind on the right: 165 km/h
Wind on the left: 65 km/h

Tropical Cyclone Hazards

Wind

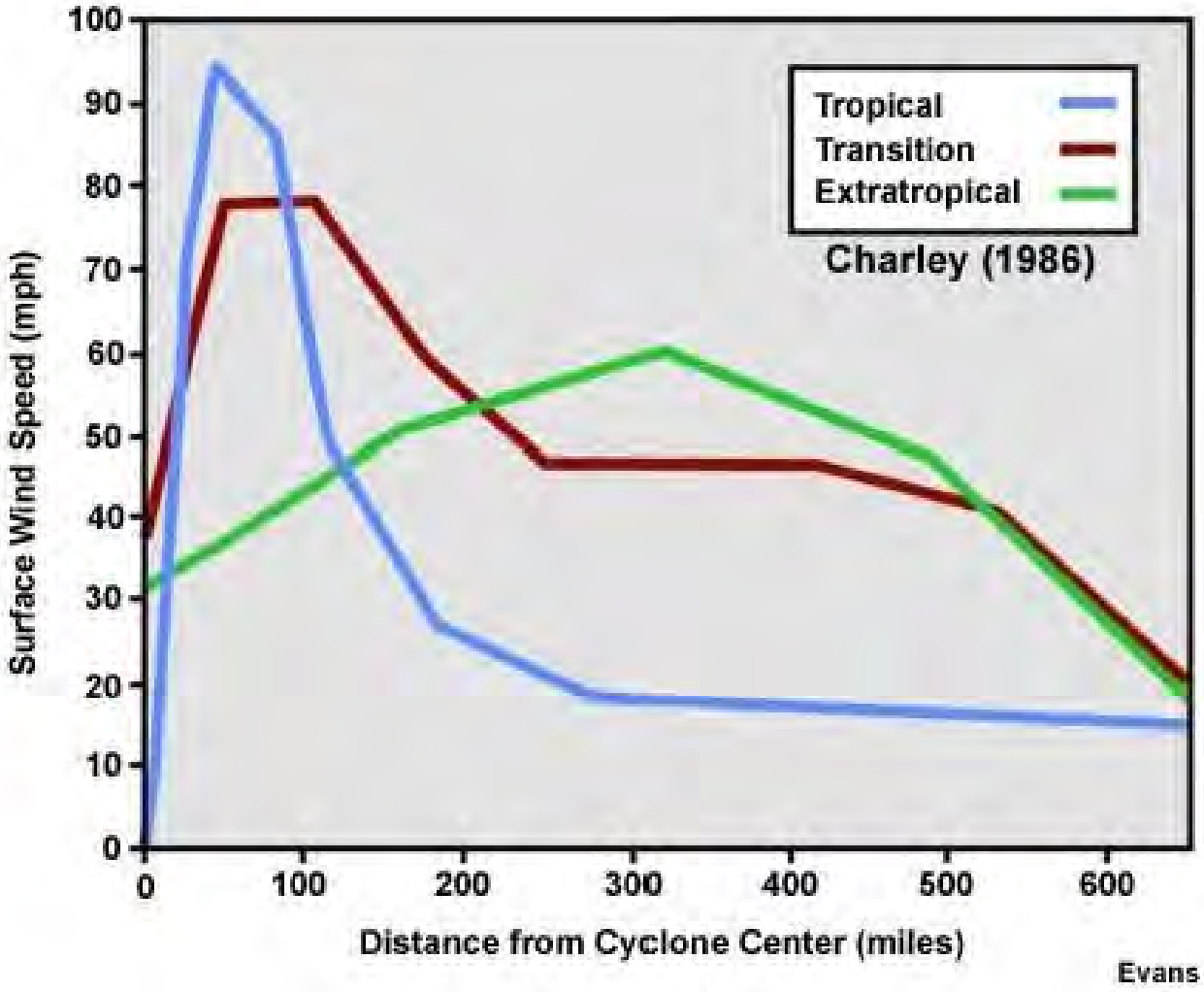


Storm maximum wind location for storms entering the CHC Response Zone.

(Location by quadrant of occurrence)

Tropical Cyclone Hazards

Wind



Evolution of the location of maximum winds relative to the storm center during extra-tropical transition.

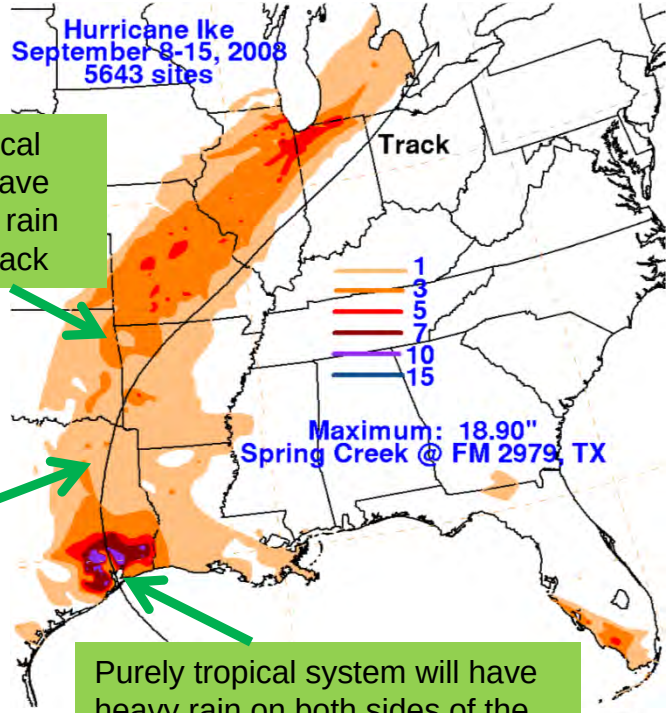
Tropical Cyclone Hazards

Rain

Tropical systems by their very nature produce extreme rainfall rates. Rainfall rates can reach 20-50 mm per hour

Factors affecting rainfall amounts and distribution in tropical cyclones

1. **Size** (bigger storm = more rain)
2. **Motion** (slower storm = more rain)
3. **Rain rate** (higher rain rate = more rain)
4. **Duration** (longer duration = more rain)
5. **Stage of ET Transition**



A post-tropical storm will have most of the rain left of the track

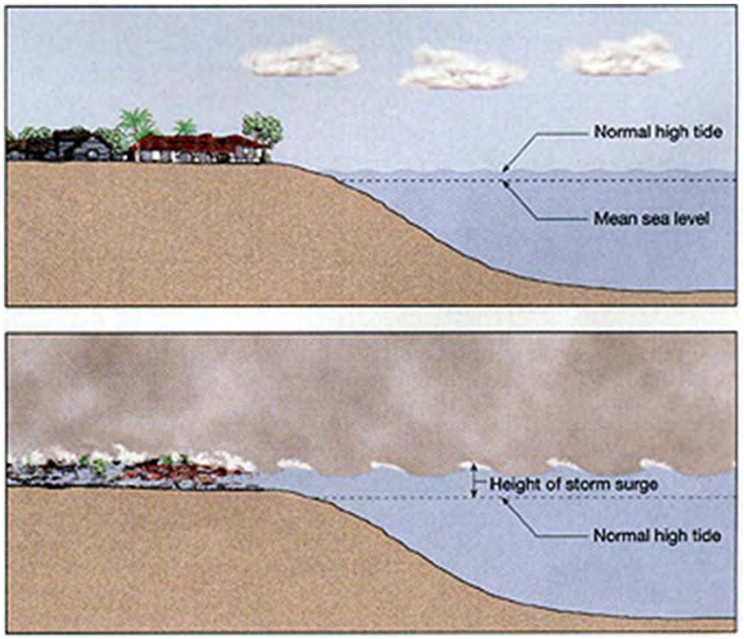
Rain in extratropical transition will begin to shift to the left although still have rain on both side

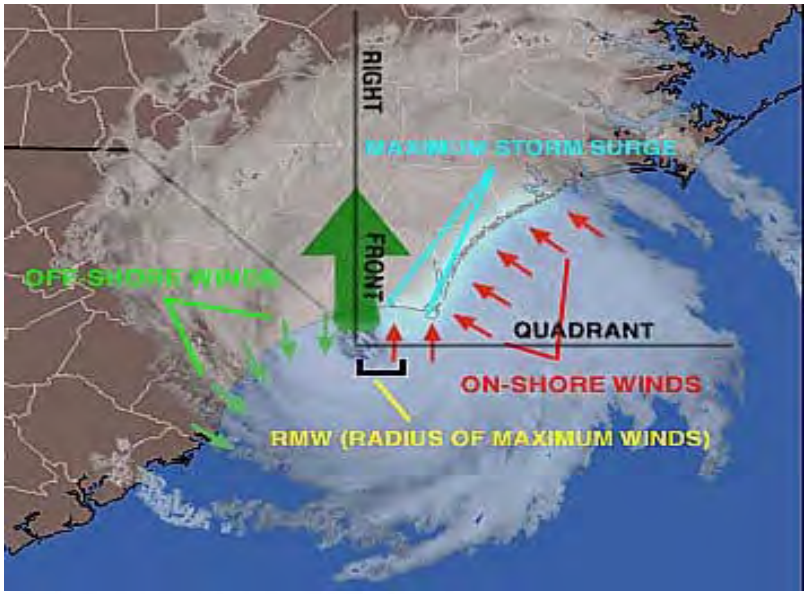
Purely tropical system will have heavy rain on both sides of the track

Tropical Cyclone Hazards

Storm Surge

- Abnormal rise in water generated by a storm, over and above the astronomical tide
- Caused primarily by force of wind blowing across water surface
- Contribution by low pressure within center of storm is minimal





Some Factors Affecting Storm Surge:

- Wind speed
- Direction of the storm
- Size of the storm
- Coastal bathymetry

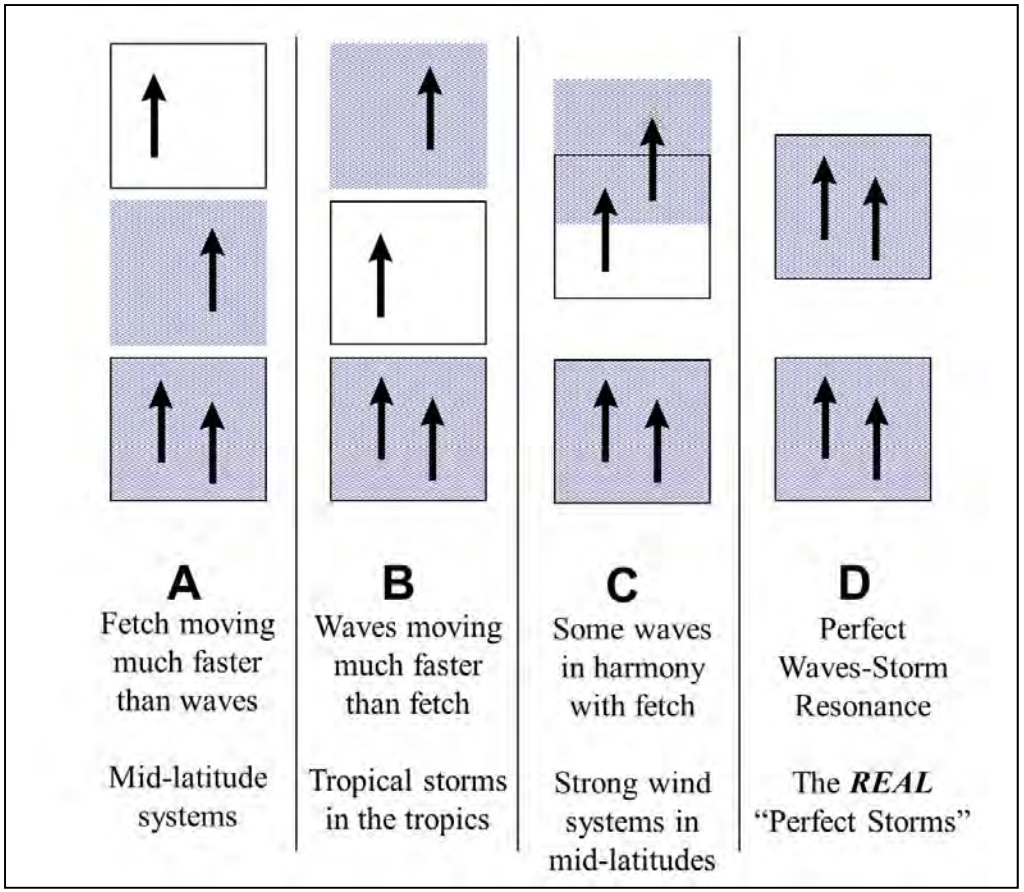
Tropical Cyclone Hazards

Storm Surge

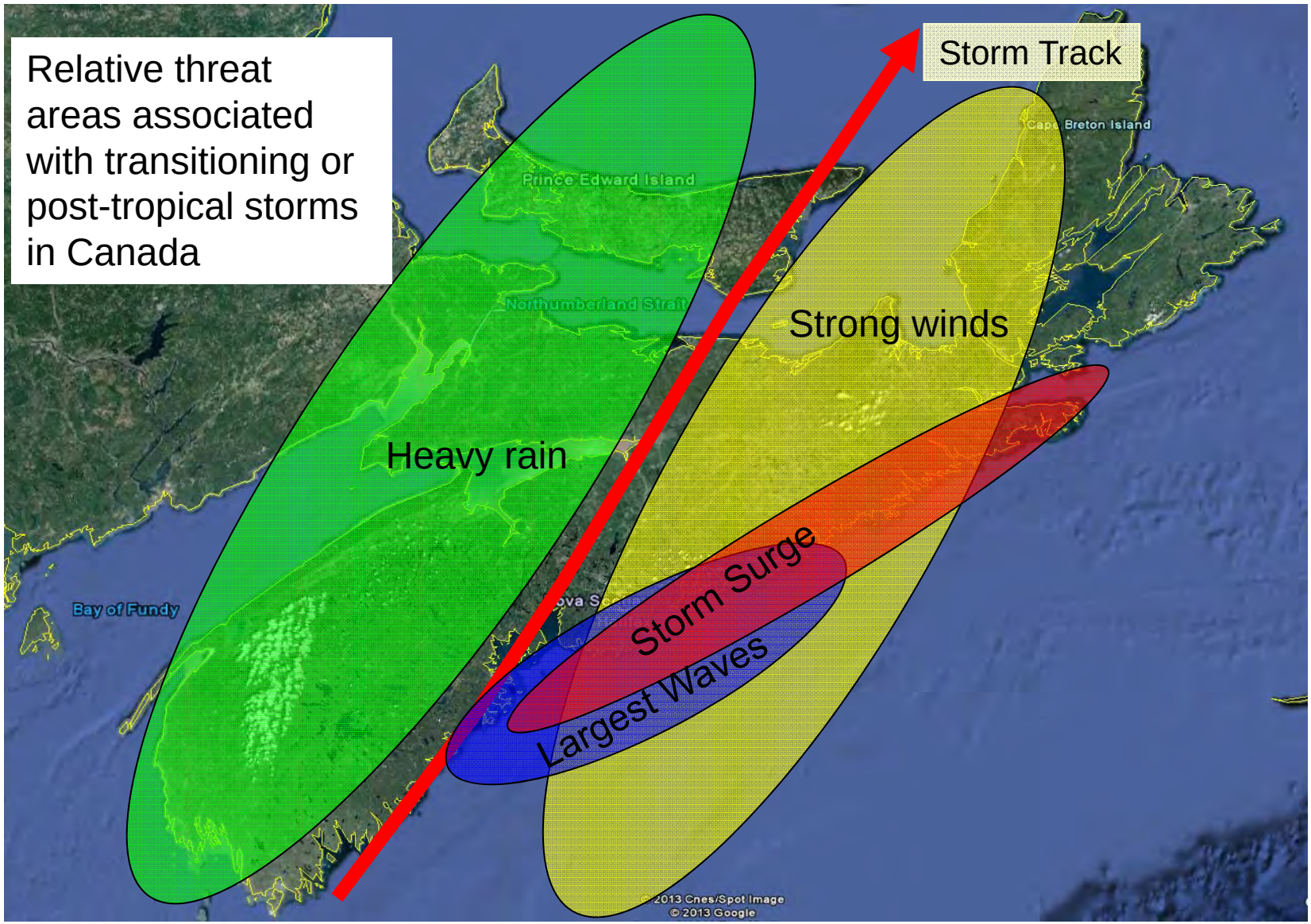
Tropical Cyclone Hazards

Damaging Waves

- On occasion a particular phenomenon can give rise to extreme wave heights
- Meteorologists at the (CHC) have investigated the problem of waves that are “trapped” within a weather system
- Waves move in harmony with a storm, allowing waves to build to enormous heights
- This threat is most significant along the Atlantic coast
- Large waves and ponding surf can also be a threat in the Gulf of St Lawrence



Typical Threat Areas



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Hurricane Season 2012 in Review

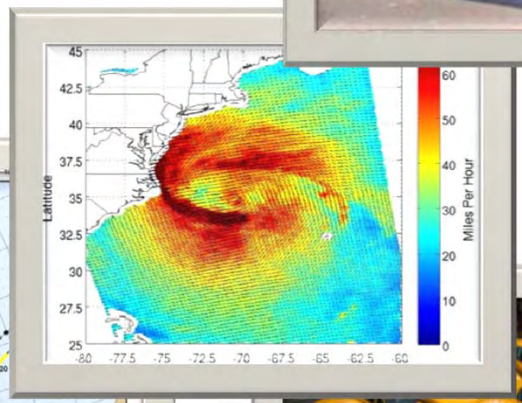
Summary:

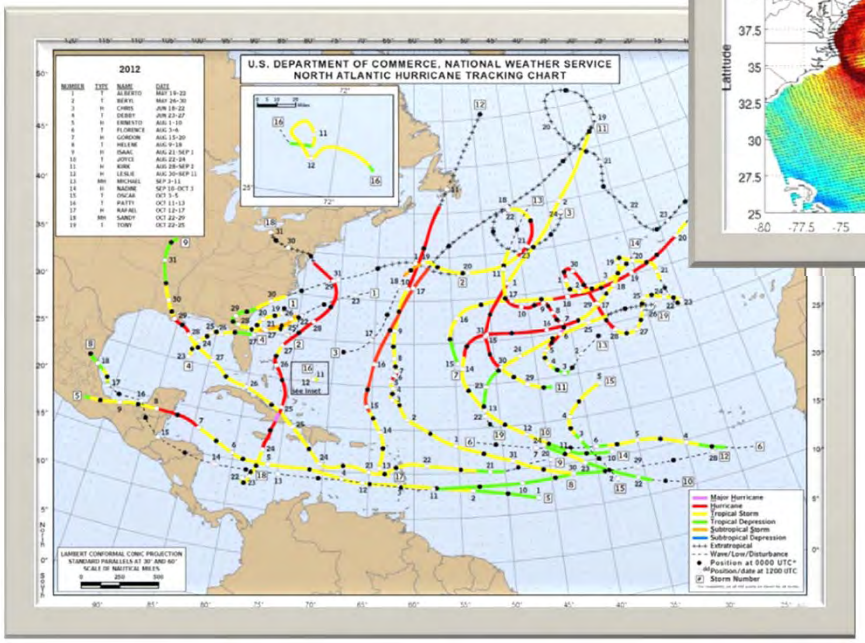
19 Named Storms

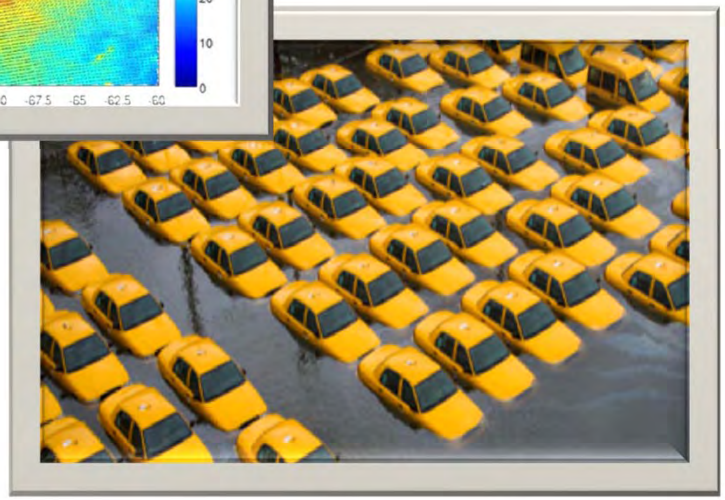
10 Hurricanes

2 Major hurricanes

Canadian Hurricane Centre







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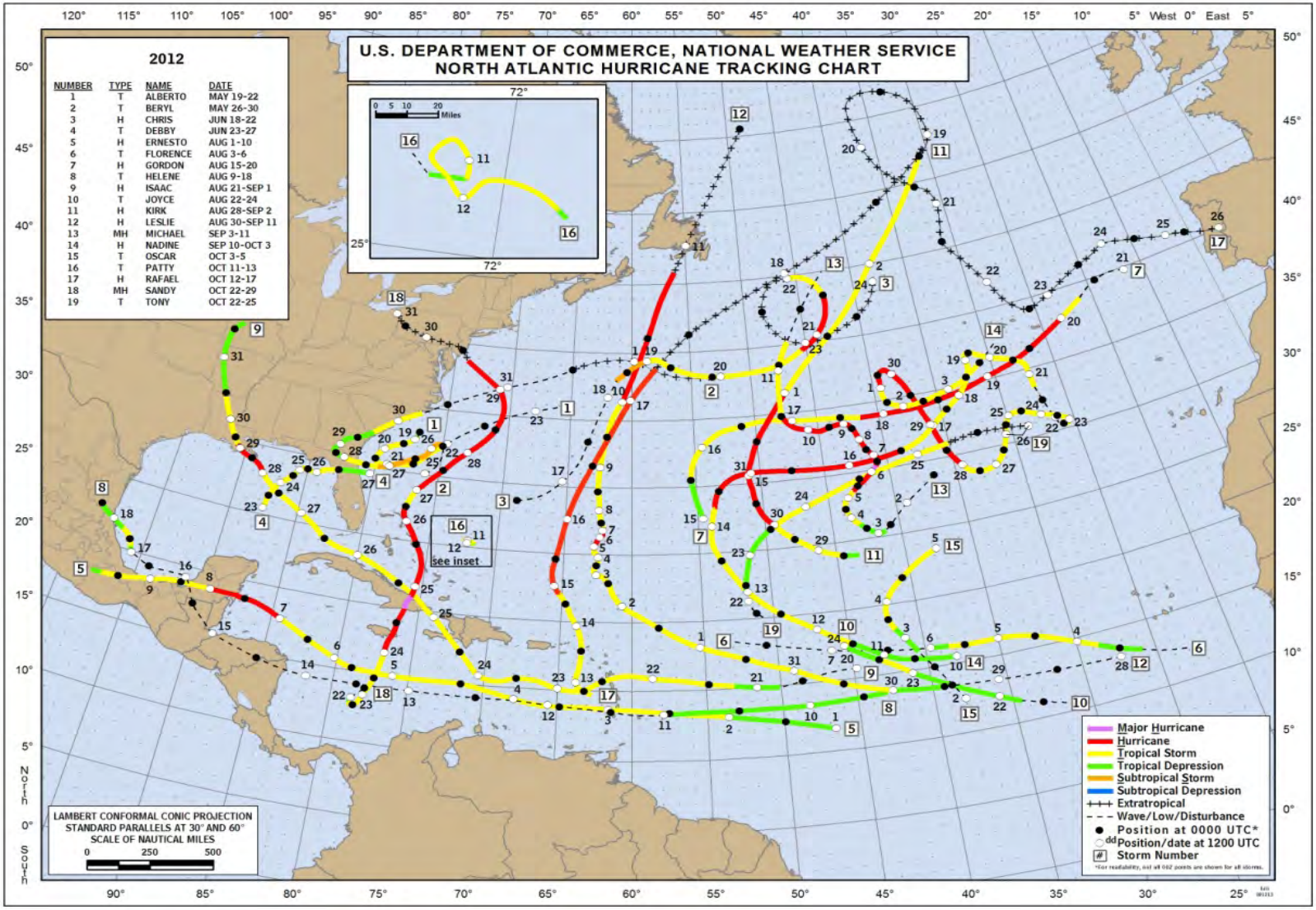
2012 Season in Review

2012 Forecast	Named Storms	Hurricanes	Cat. 3-5 Hurricanes
National Oceanographic and Atmospheric Administration (NOAA)	9-15	4-8	1-3
Actual	**19**	**10**	**2**

- 6 storms entered CHC response zone
- 3 storms affecting land in Canada

2012 Season in Review



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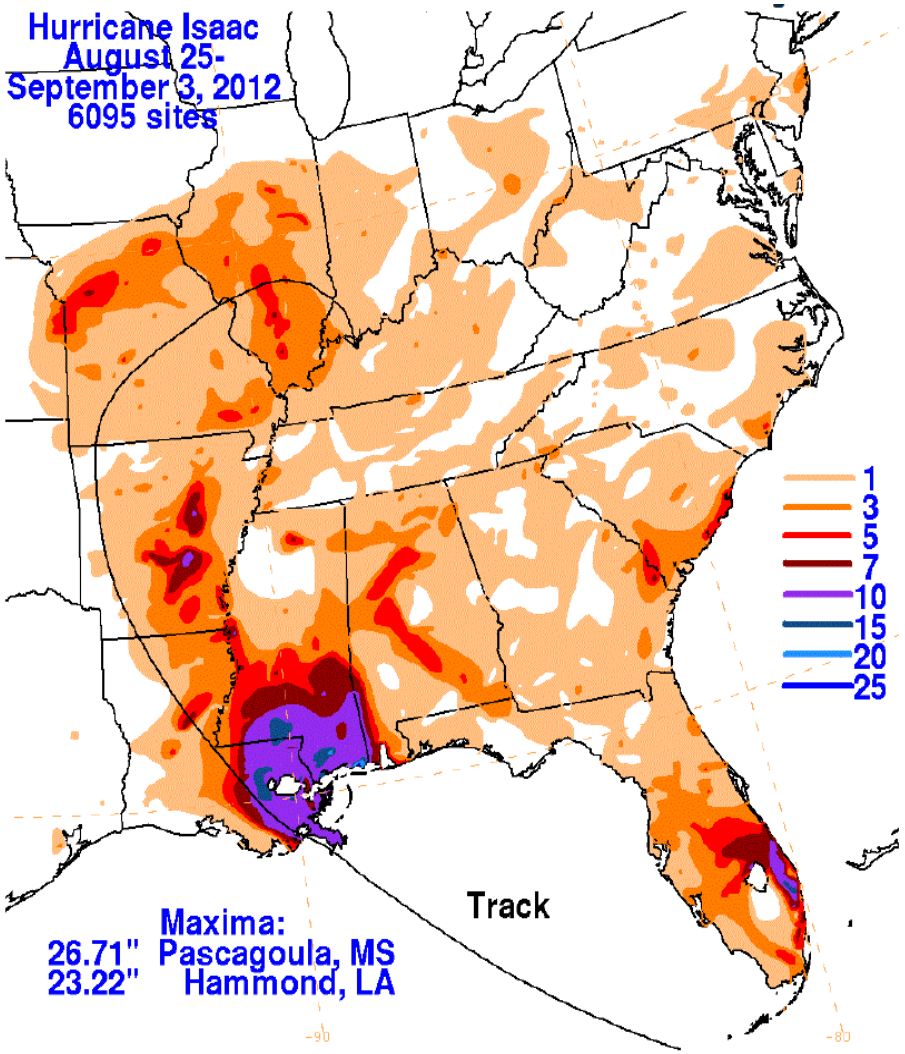
2012 Season in Review

2012 Hurricane Season in 4.5 minutes

http://www.youtube.com/watch?feature=player_embedded&v=dmLYjs0kwnc

2012 Season in Review – Hurricane Isaac



- Became Category 1 hurricane just before landfall
- Storm then became almost stationary over Louisiana producing extreme, record rainfall
- Total of 34 fatalities
- $2.35 Billion in damages
- The perception of many residents was that the threat was minimal because it was “only a Category 1” storm

2012 Season in Review – Hurricane Isaac

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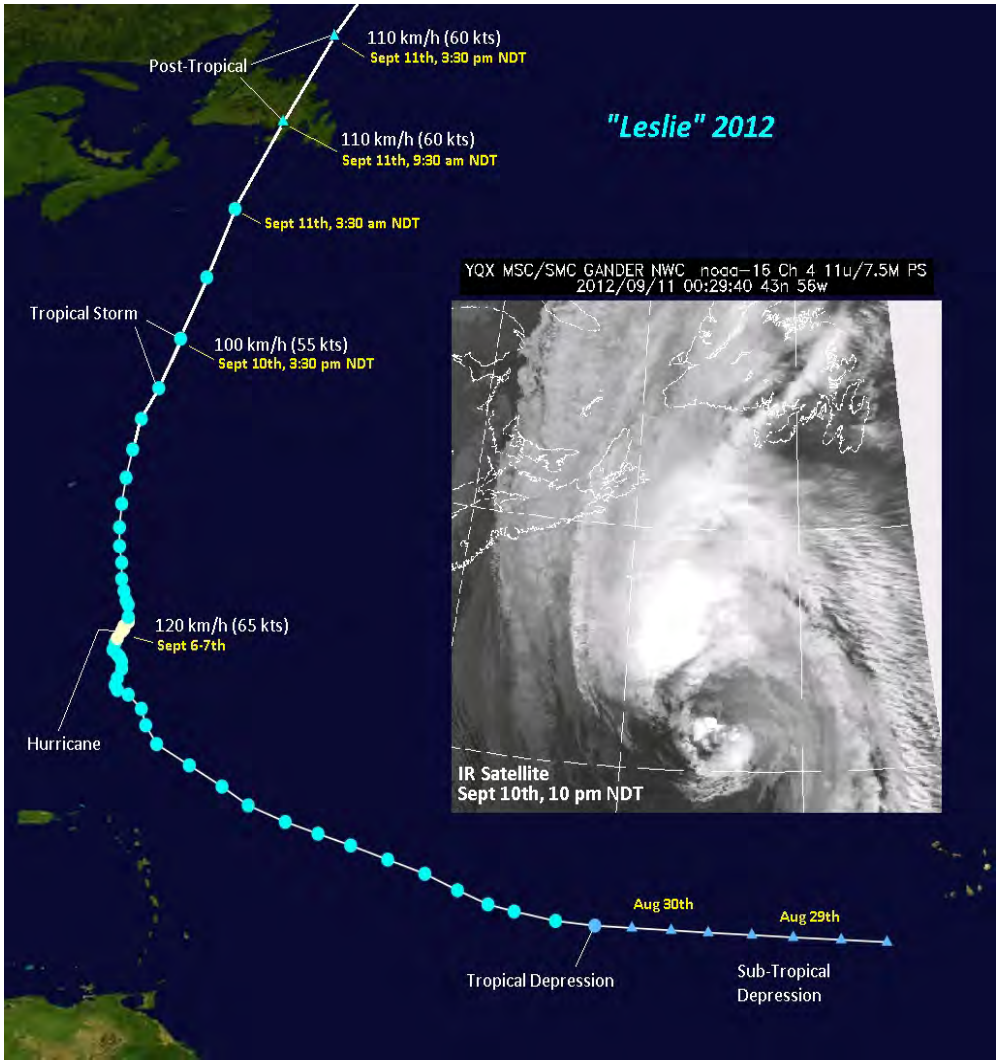
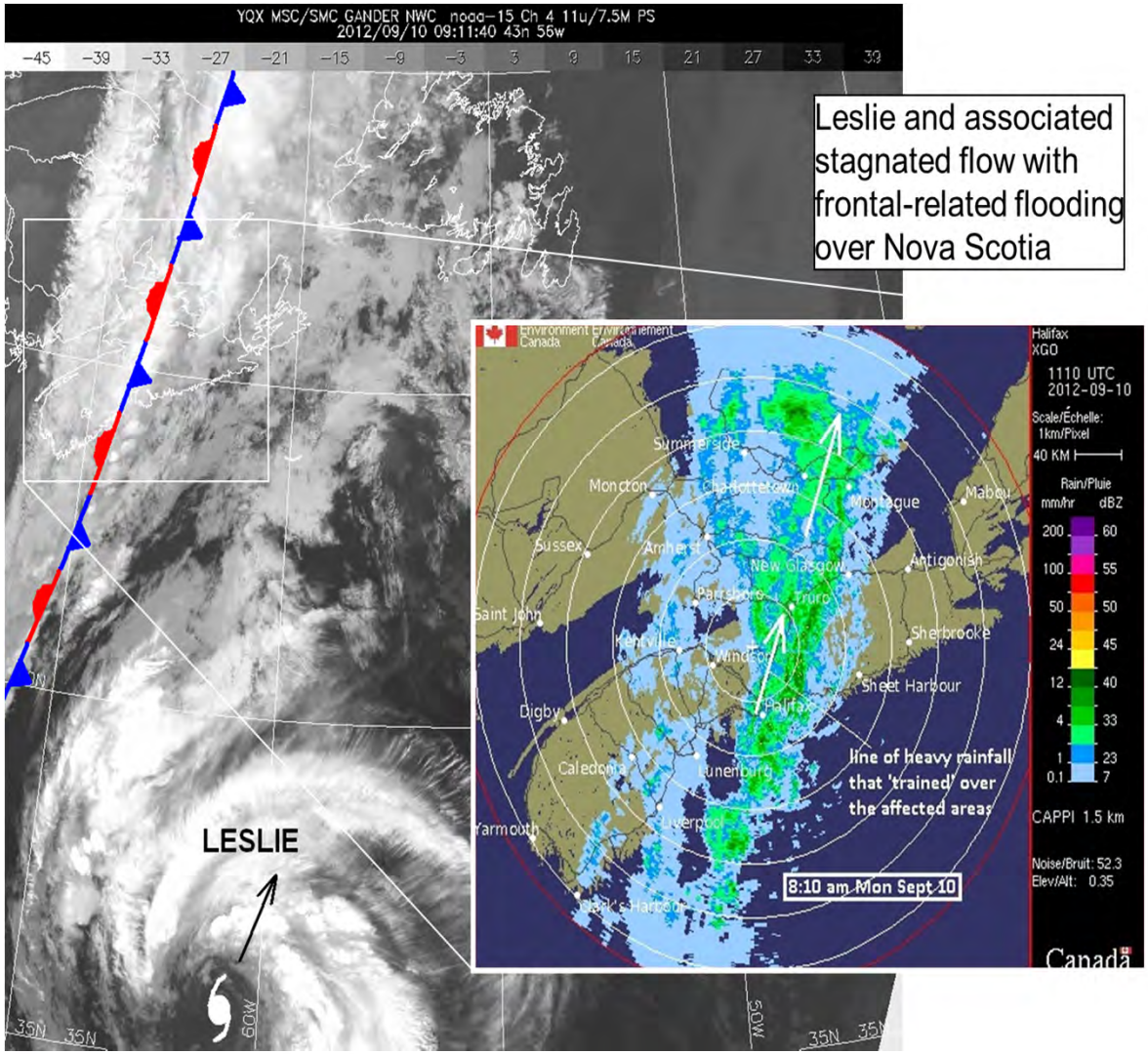
2012 Season in Review – Hurricane Leslie



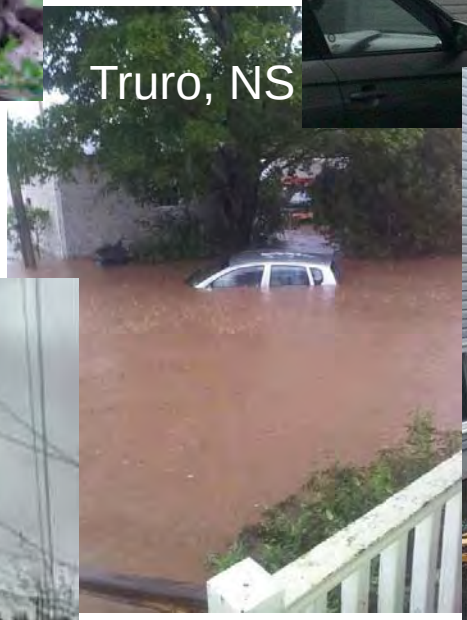
- Leslie formed in early September
- Spent a prolonged period of time moving very slowly northward
- Leslie finally began to approach Atlantic Canada on September 9th
- On September 11th, the storm tracked into eastern Newfoundland as a hurricane-force Post-Tropical Storm

2012 Season in Review – Hurricane Leslie

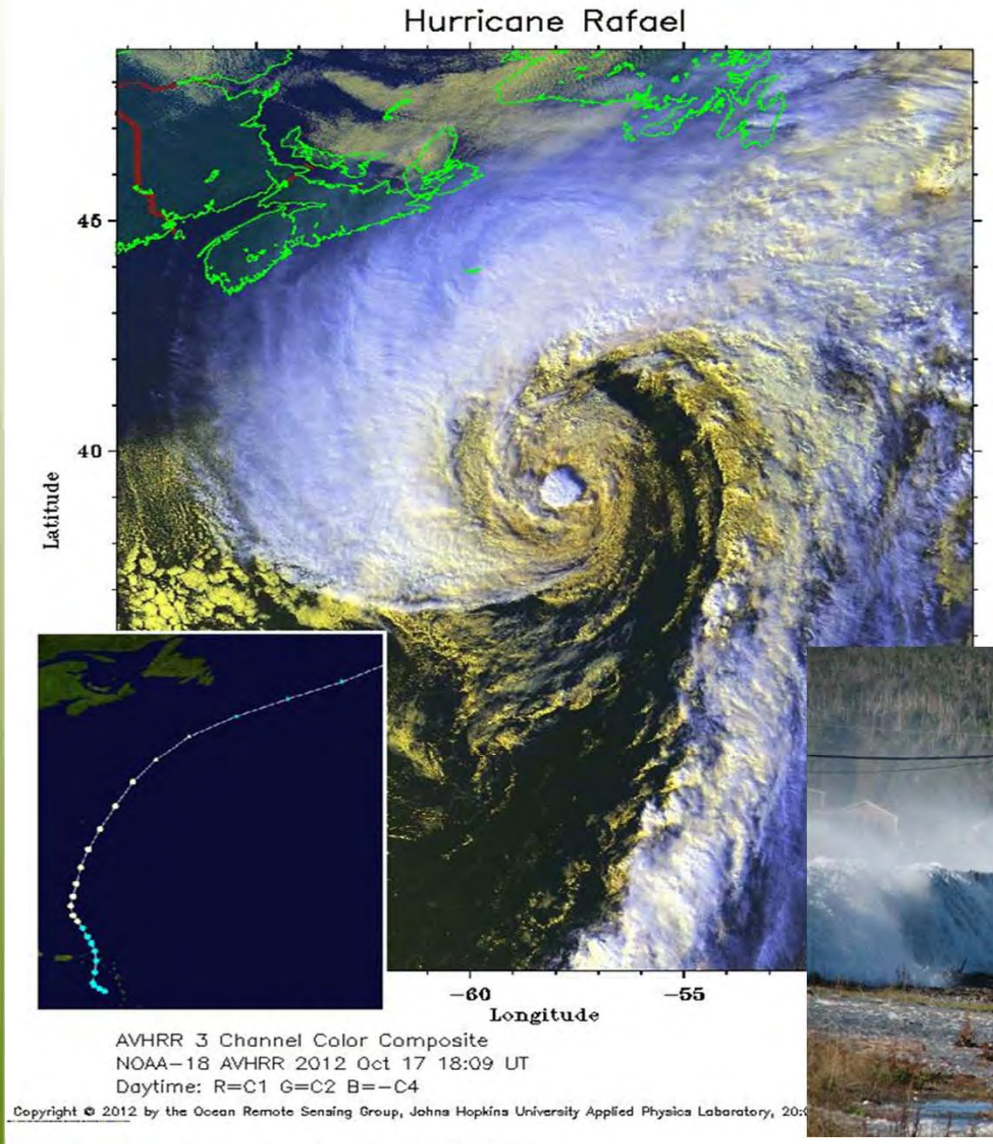


- Also a front stalled over Nova Scotia as it approached Leslie.
- Moisture converging along the front streamed across central Nova Scotia

2012 Season in Review – Hurricane Leslie



2012 Season in Review – Hurricane Rafael



- No significant impact over land other than large swell and rapid water level fluctuations

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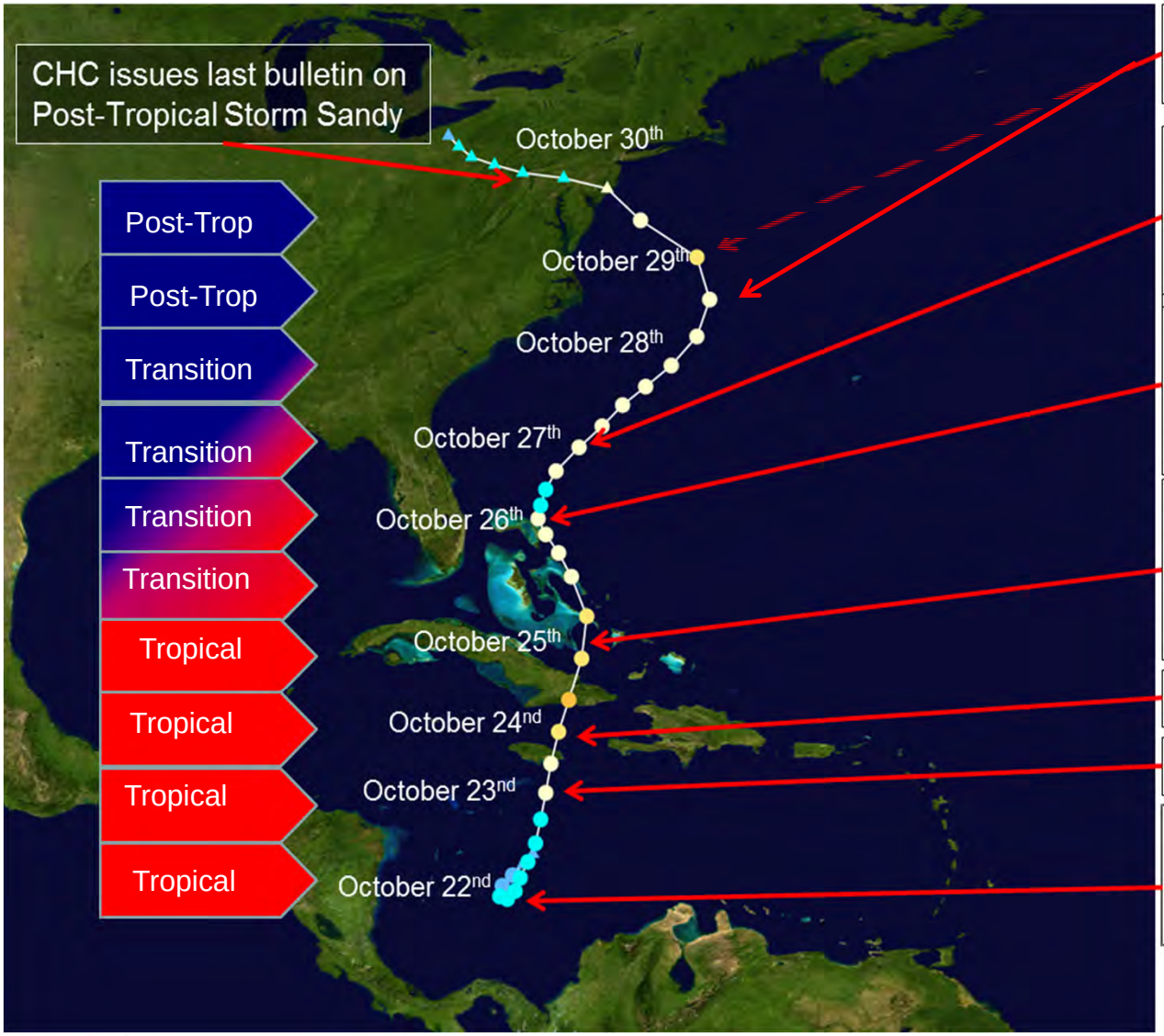
2012 Season in Review – Hurricane Sandy



First warnings issued in Canada for Sandy

CHC begins regular 6-hourly bulletins and regional special weather statements are issued

First formal emergency management briefing and first media technical briefing

- First public bulletin from CHC
- First Internal coordination conference call

First media interview

Internal messaging began

Initial discussions with emergency management officials

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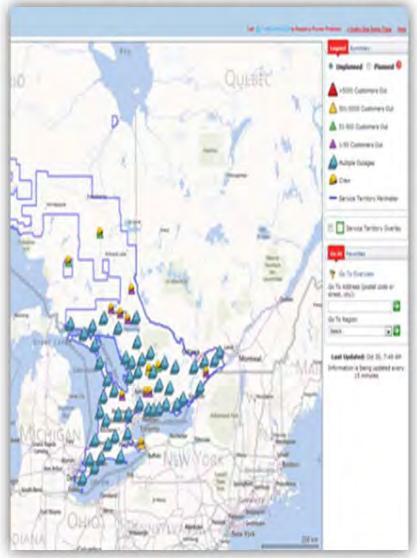
2012 Season in Review – Hurricane Sandy

- Wind warnings were posted for many areas of southern Canada specifically in Ontario and along the St. Lawrence River in Quebec
- Sandy's circulation while in the Post-Tropical phase exceeded 1600 km, extending from the U.S South to Atlantic Canada and as far west as Wisconsin
- Major to record storm surge with catastrophic damage along large portions of the New Jersey, New York, Connecticut, Rhode Island and Massachusetts coasts
- 147 direct fatalities from the Caribbean up to Canada
- Over $74 billion property damage
- Nearly 9 million homes lost power – some outages lasted weeks
- Recovery is STILL ongoing!

Environment Canada Warnings

Southern Ontario Power Outages



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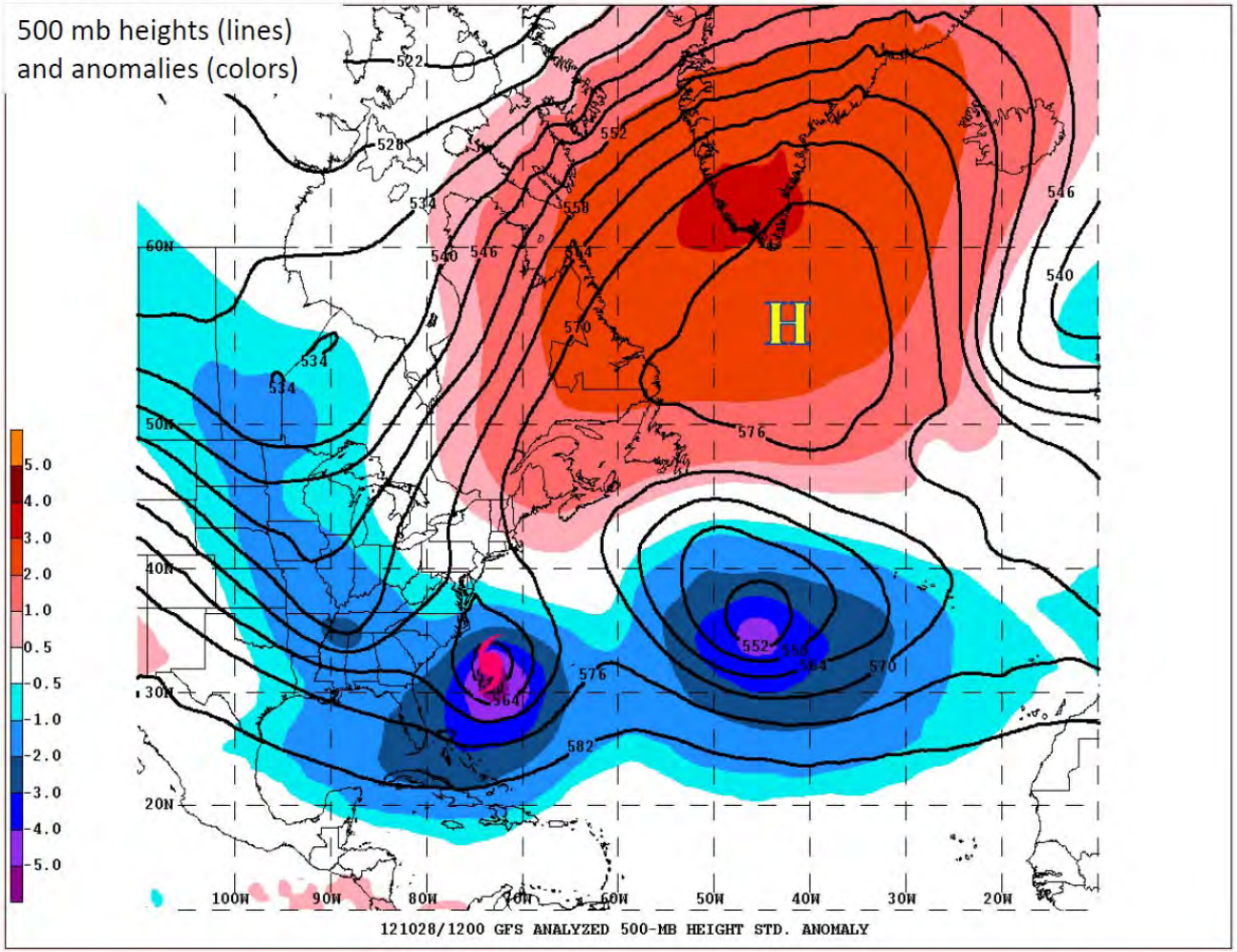
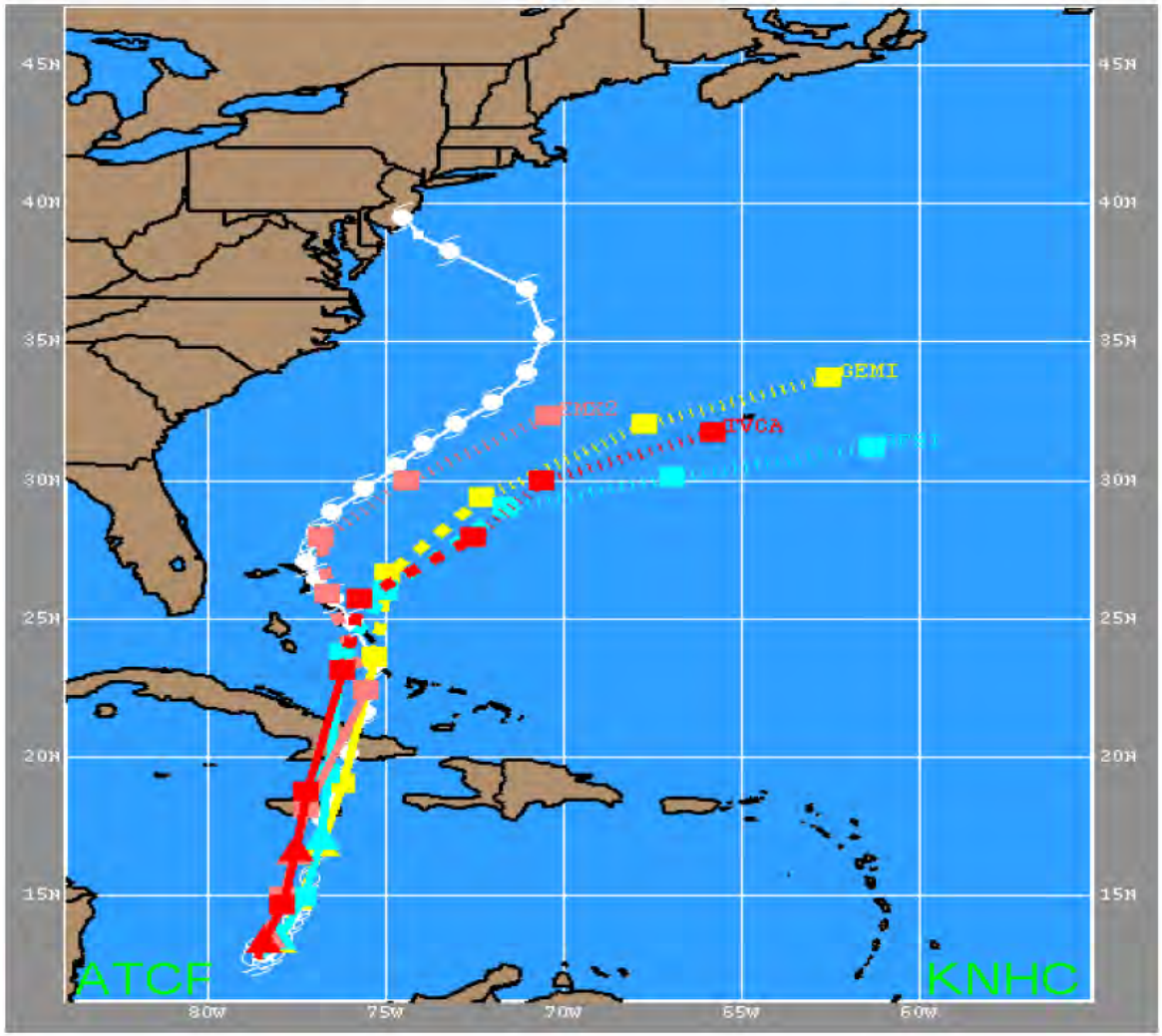
Patterns affecting Sandy's track



Strong area of high pressure over the North Atlantic essentially created a blocking pattern preventing Sandy from following a more conventional track

Sandy's Track

Model Guidance for Sandy– 7 days before landfall



ECMWF

GFS

GFS Ensemble

Consensus

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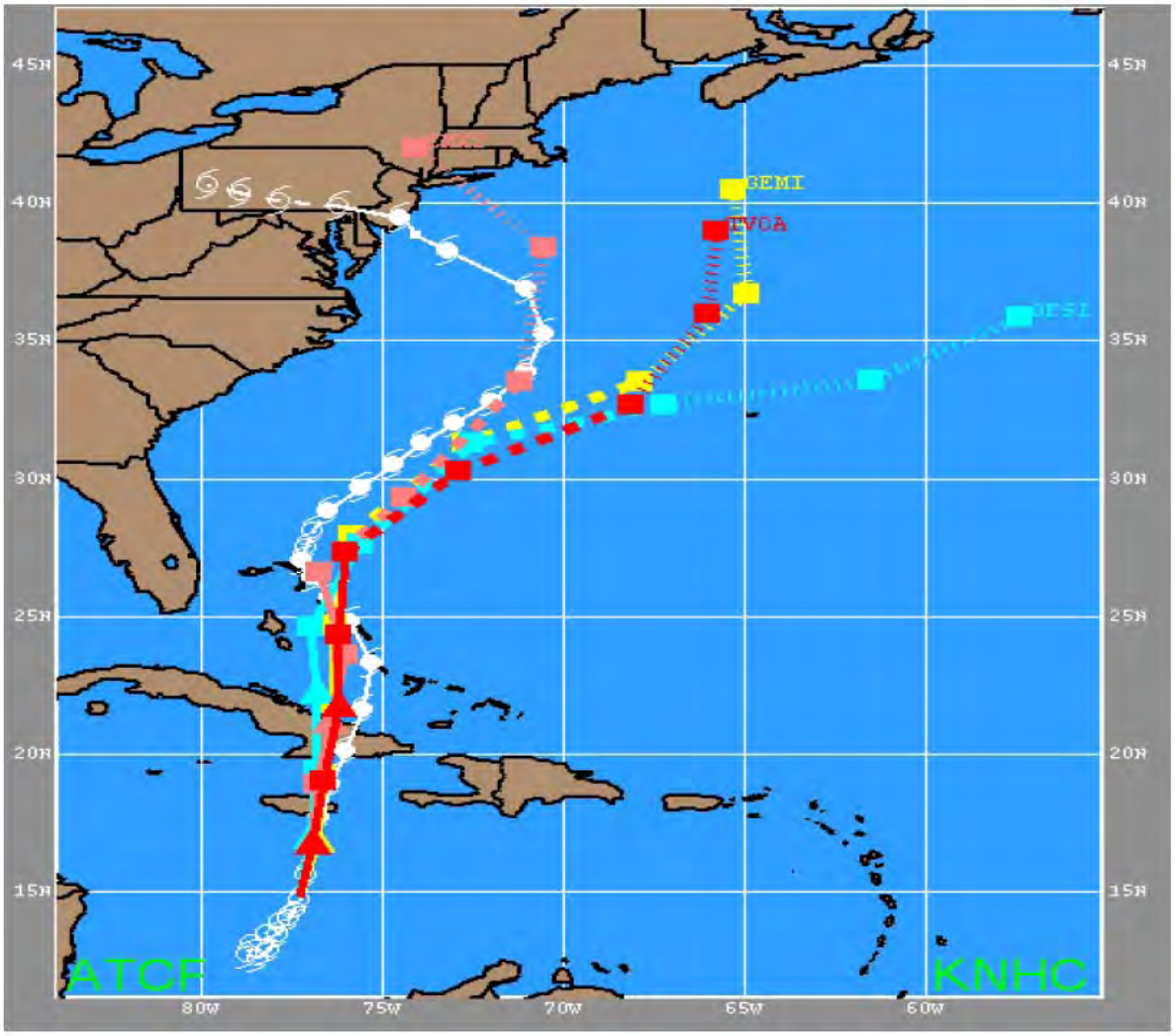
Sandy's Track

Model Guidance for Sandy– 6 days before landfall



ECMWF

GFS

GFS Ensemble

Consensus

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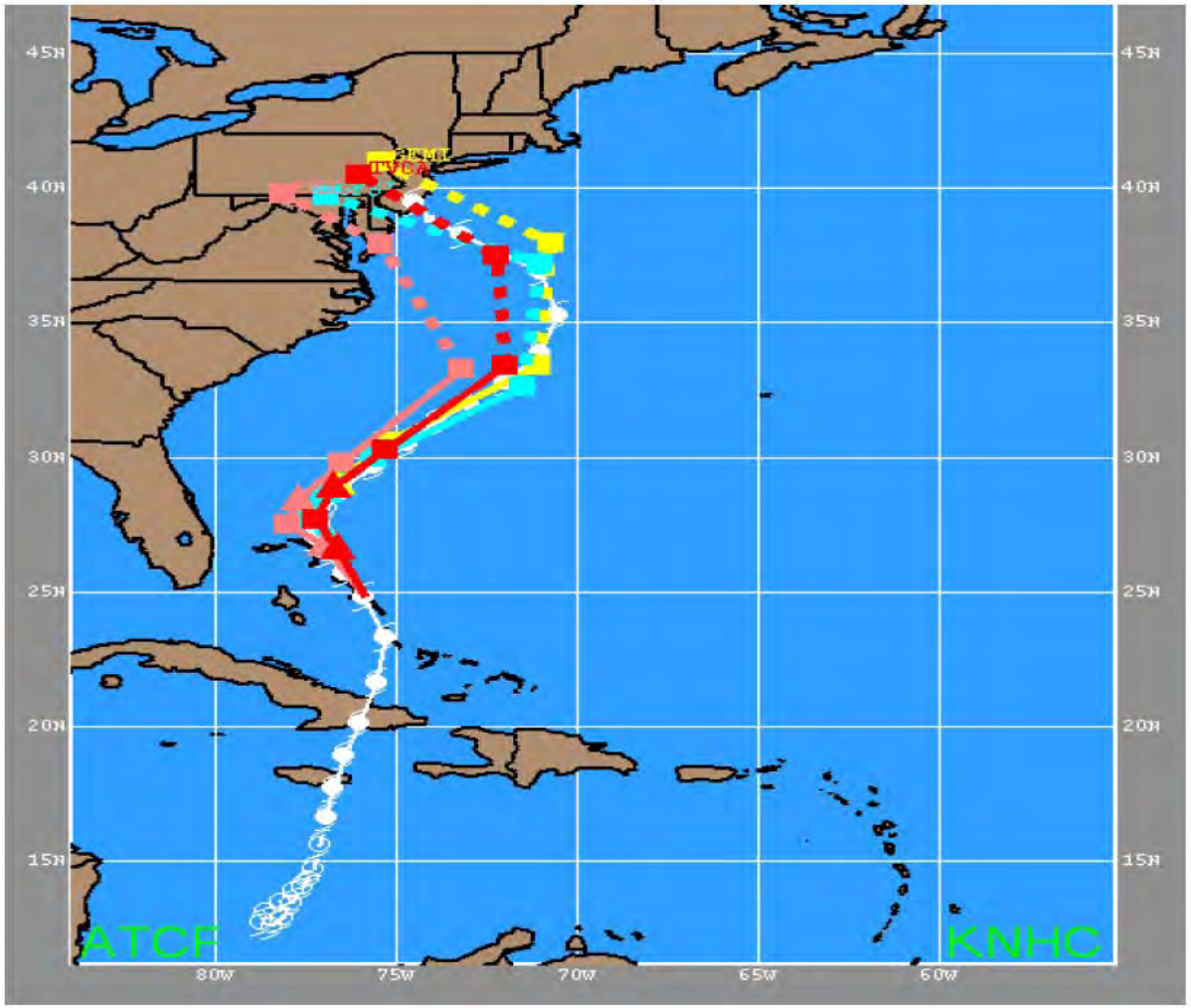
Sandy's Track

Model Guidance for Sandy– 4 days before landfall



ECMWF

GFS

GFS Ensemble

Consensus

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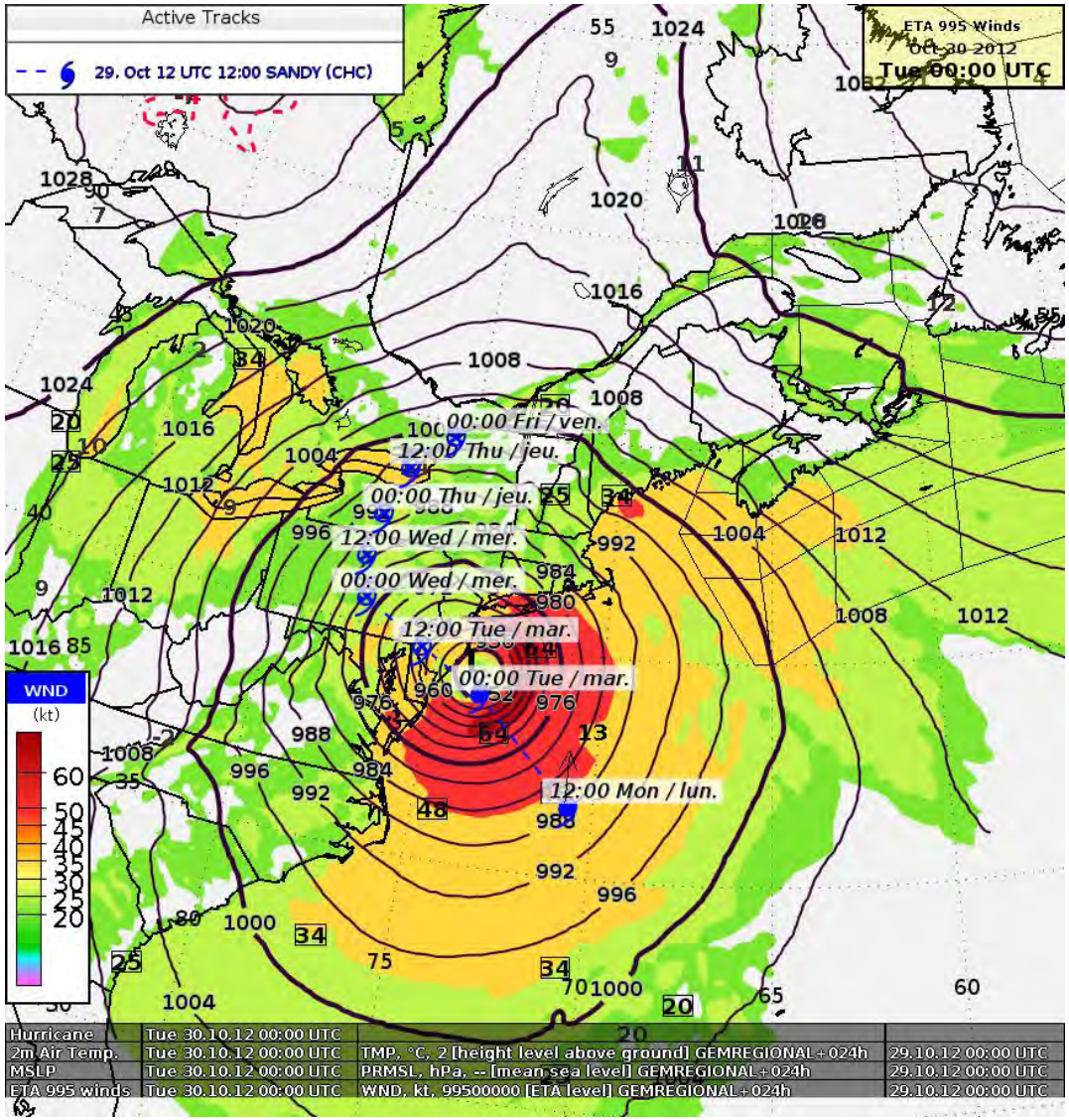
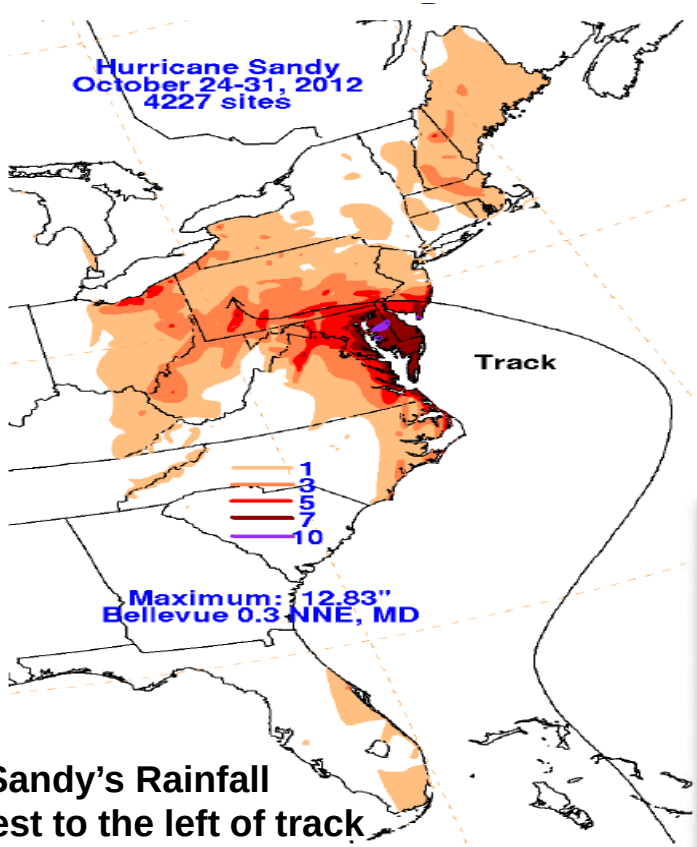
Sandy's Landfall

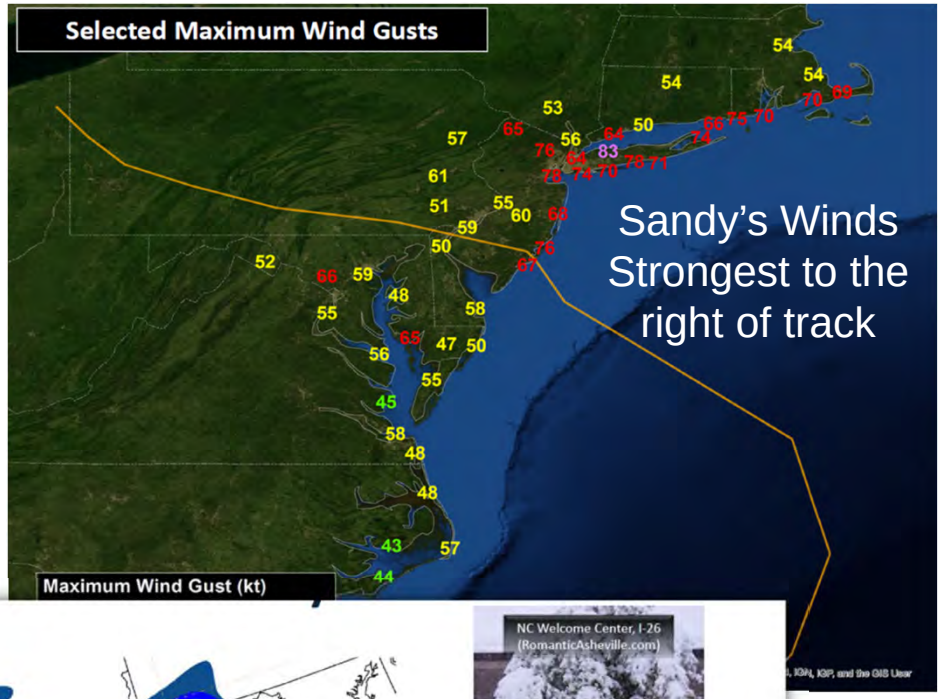


Sandy made landfall as a post-tropical cyclone near Brigantine, New Jersey

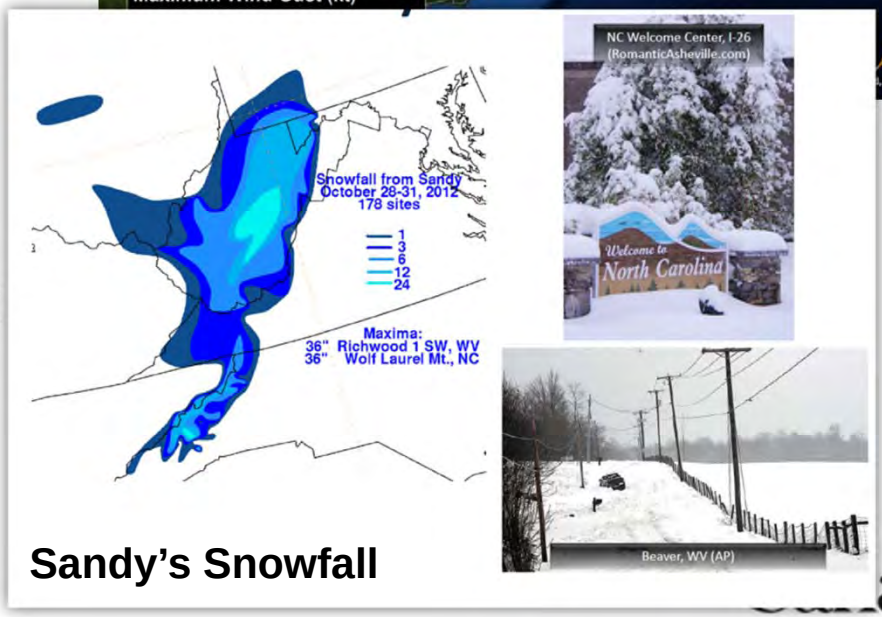
Sandy's Extreme Weather



Sandy's Rainfall
Heaviest to the left of track



Sandy's Winds
Strongest to the
right of track



Sandy's Snowfall

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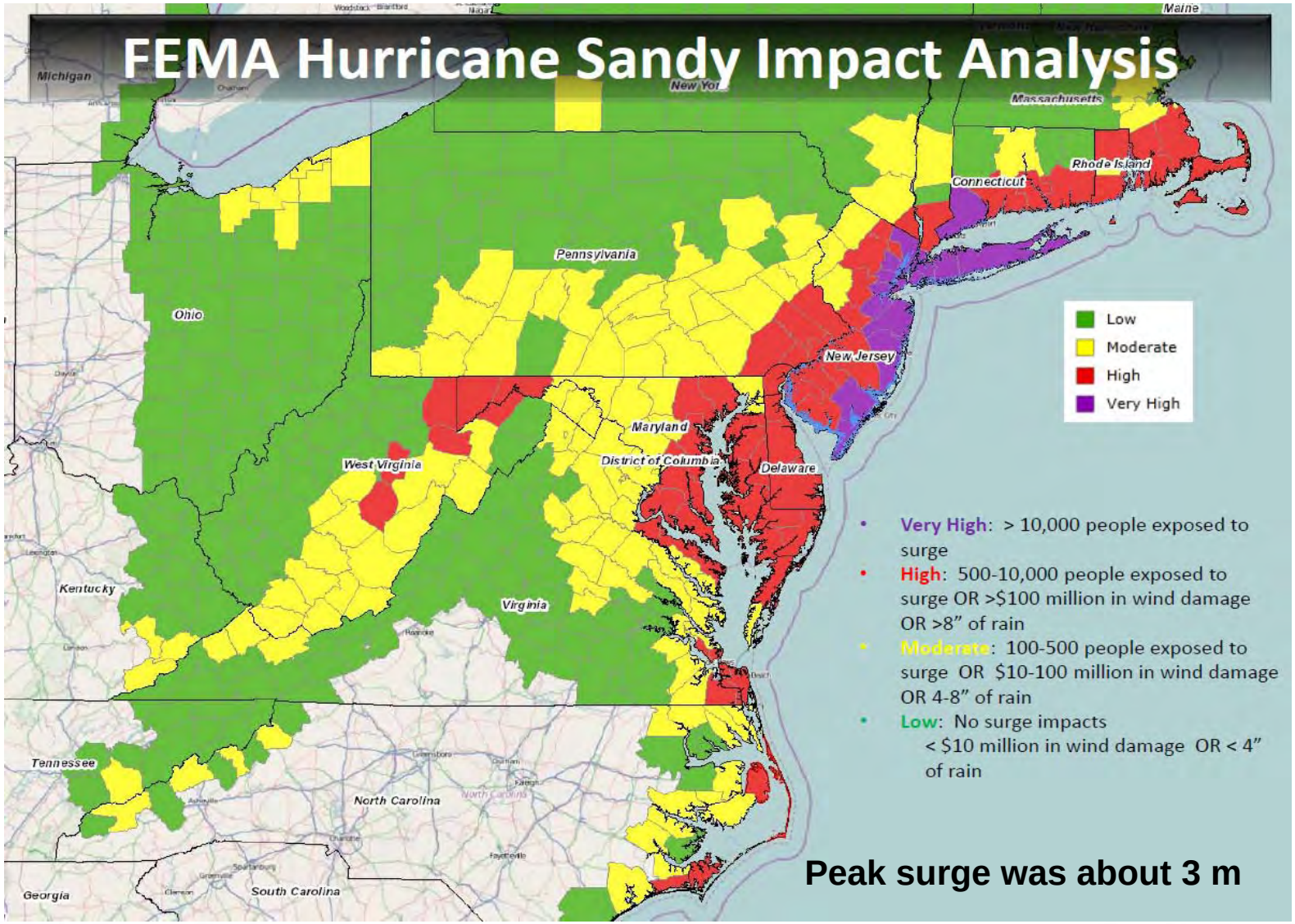
Sandy's Impacts



2012 Season in Review – Hurricane Sandy

New York's Costliest Disasters to Date
(FEMA Public Assistance Costs)

Sandy's Impacts


PATH station, Hoboken, NJ
AFP PHOTO / The Port Authority of New York & New Jersey


Harvey Cedars, Long Beach Island, New Jersey
(AP Photo/The Philadelphia Inquirer, Clem Murray)


Atlantic City, NJ (Tom Mihalek/Reuters)


Union Beach, NJ (blog, Spleeness)

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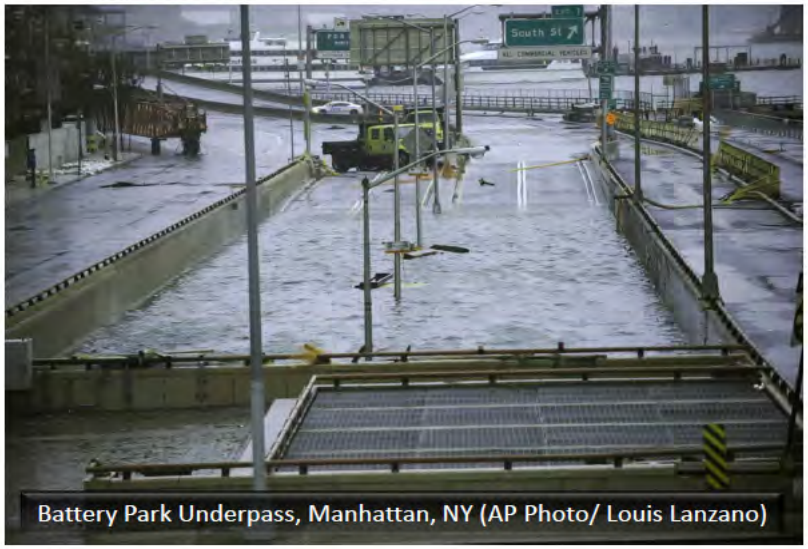
Sandy's Impacts


Dumbo, Brooklyn, NY (AP Photo/Bebeto Matthews)


Bellport, NY (Lucas Jackson/Reuters)



Battery Park Underpass, Manhattan, NY (AP Photo/ Louis Lanzano)


Lindenhurst, NY (AP Photo/Jason DeCrow)

Sandy's Impacts


East Haven, CT (AP Photo/Jessica Hill)


Stratford, CT (Ned Gerard)


South Kingstown, RI (AP Photo/Steven Senne)


Scituate, MA (David L Ryan/Boston Globe)

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Sandy's Impacts

Sandy's Impacts in Canada

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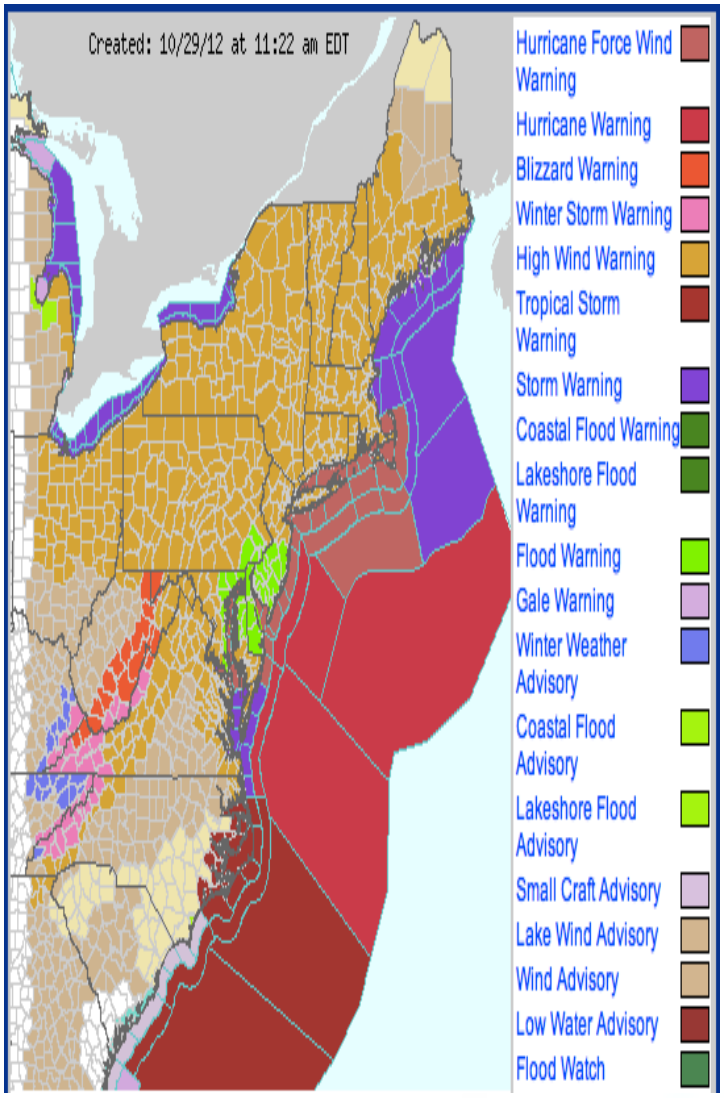
Warning Challenges

- Weather a storm is Tropical or Post Tropical has major operational implications
- Operational handling of cyclone types requires a ‘yes or no’ response - tropical cyclone (TC) warnings or non-tropical wind warnings
- It also has major insurance implications in the U.S.
- NHC (Miami) procedures prevented them from issuing tropical warnings for post-tropical storms
- Their procedures have been changed this year and are now aligned with those at the Canadian Hurricane Center



2012 Season in Review – Hurricane Sandy

Why Post-Tropical Storm Sandy is Important for Eastern Canada

- The main factor affecting intensity at landfall was no longer the warm water temperature but rather the horizontal air temperature difference
- This means that a storm like Sandy could just as easily track up towards Atlantic Canada as it did into New Jersey
- This would represent a worst-case scenario of sorts for eastern Canada:
  - **Late season hurricane becoming post-tropical south of Atlantic Canada**
  - **Cold front or trough of low pressure to the west**
  - **Re-intensification as a Post-Tropical Storm and the storm increasing in size**

2012 Season in Review – Hurricane Sandy

Other interesting facts about Sandy

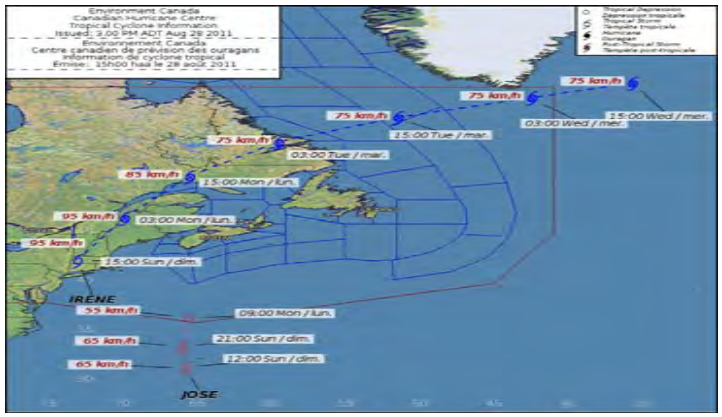
- Sandy was an unprecedented storm for the Canadian Hurricane Centre from a communications standpoint
- NY 911 Call Centre received 20,000 calls per hour at the peak
- Residents had difficulty getting through an resorted to social media – 911 Call Centre had people taking “Twitter Emergency Calls”
- Hurricane Sandy dumped 11billion gallons of raw sewage in eastern US waterways
- Waves generated by Sandy hitting each other and the shore rattled the seafloor and much of the United States - shaking was detected by seismometers across the country

Operational Response to Hurricanes

Forecast/Business Cycle at the CHC	
Time (HR:MM) (Eastern time)	**Event or Task**
8:00 am	• Issue CHC Hurricane Information Statement, Technical Bulletin and the forecast track map • Update any Tropical Warnings
8:15 am	• Emergency Management Briefings (if necessary)
9:00 am	• Federal GOC Briefing (if necessary)
10:00 am	• Internal coordination call
11:00 pm	• Transmit intermediate bulletin (if necessary) • Prepare material for media briefing • Review NHC updated advisory • Review new model guidance
12:00 pm	• Media technical media briefing
1:00 pm	• Blackout period for the media • Intermediate consultation with emergency managers
2:00 pm	• New cycle begins

Operational Response to Hurricanes

CHC Website



www.hurricanes.ca

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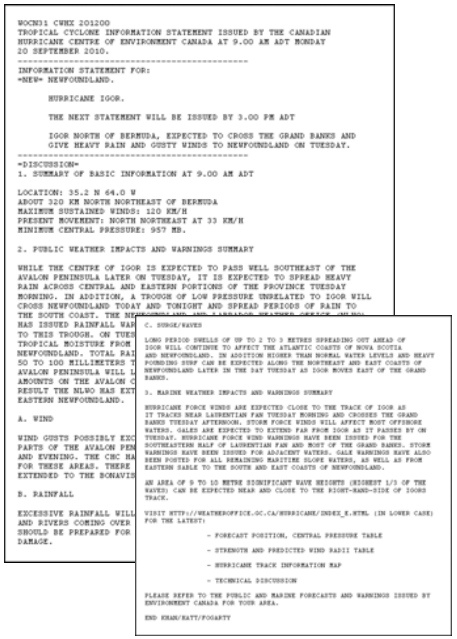
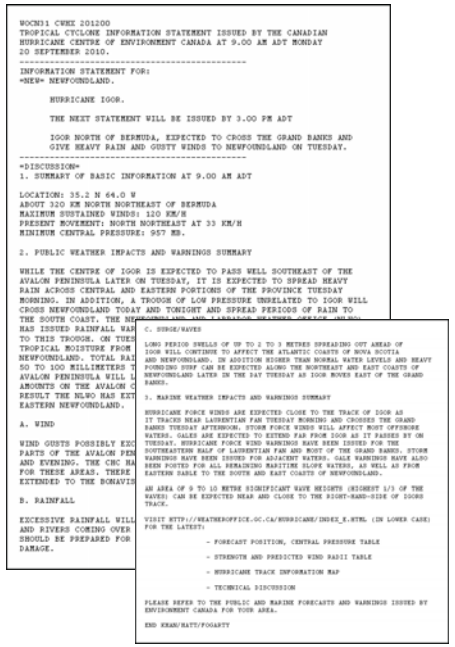




Public Bulletin

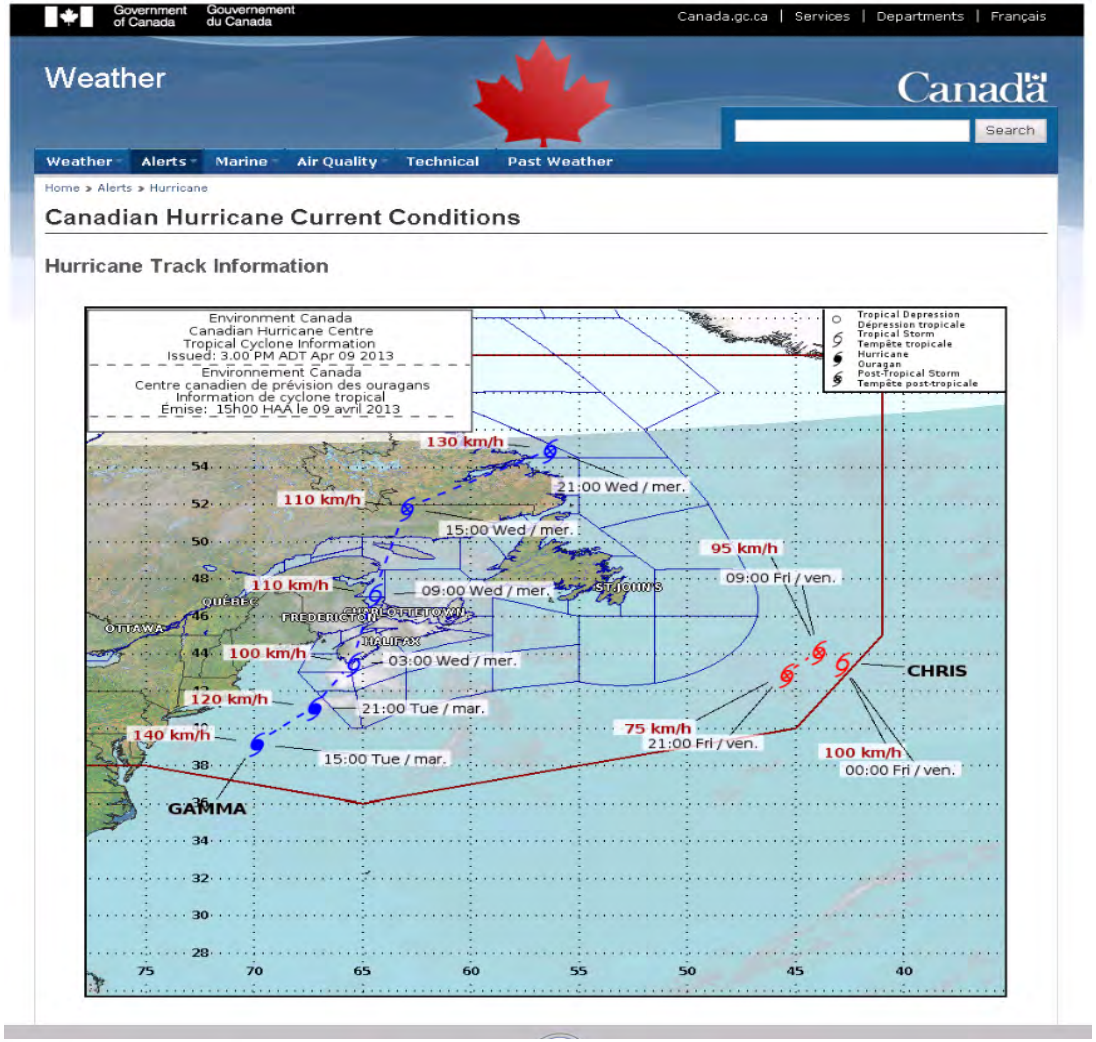
- Non technical language
- Intended for the public

Technical Bulletin

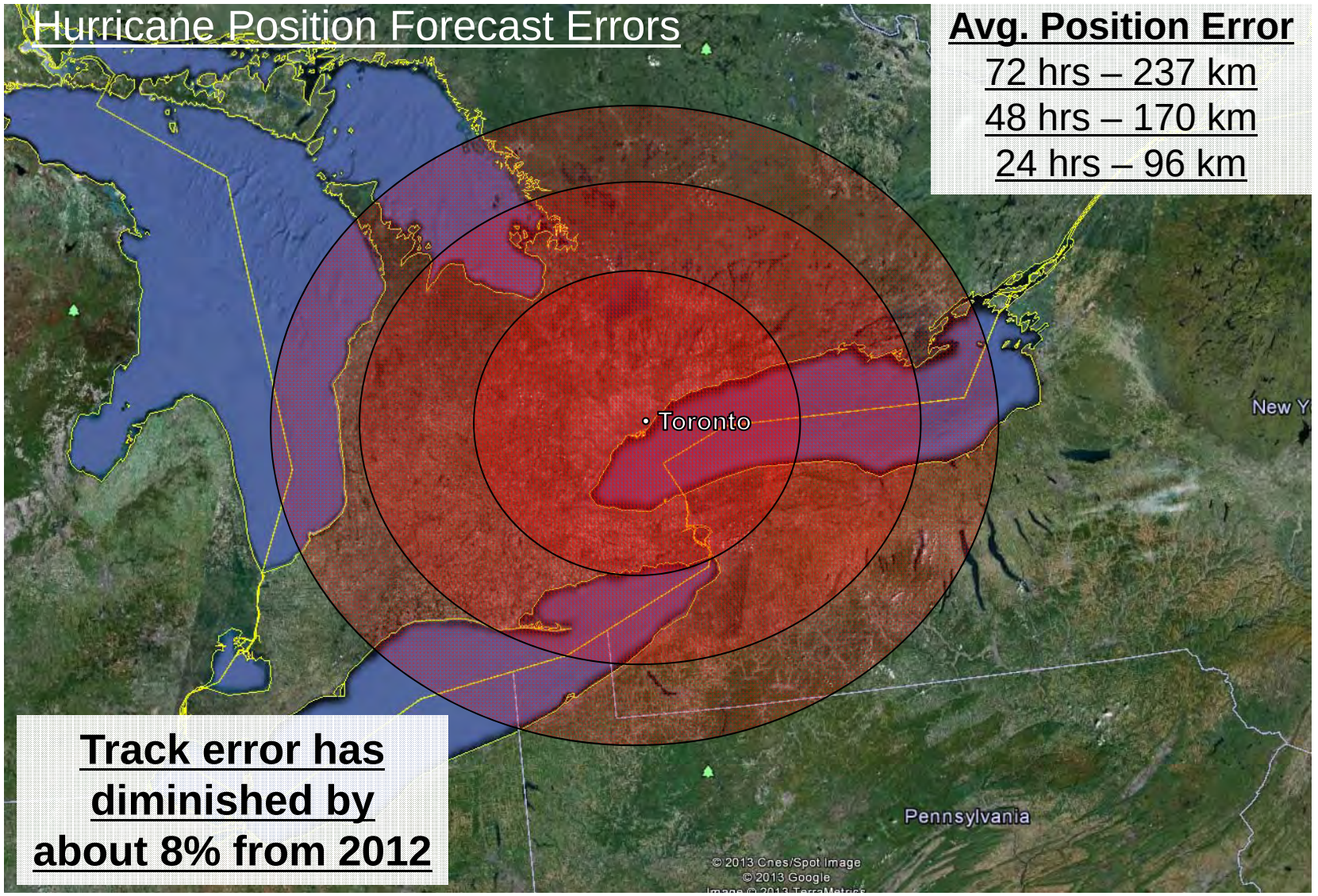
- More technical details
- Intended for other weather centres

Canada

Operational Response to Hurricanes



Operational Response to Hurricanes



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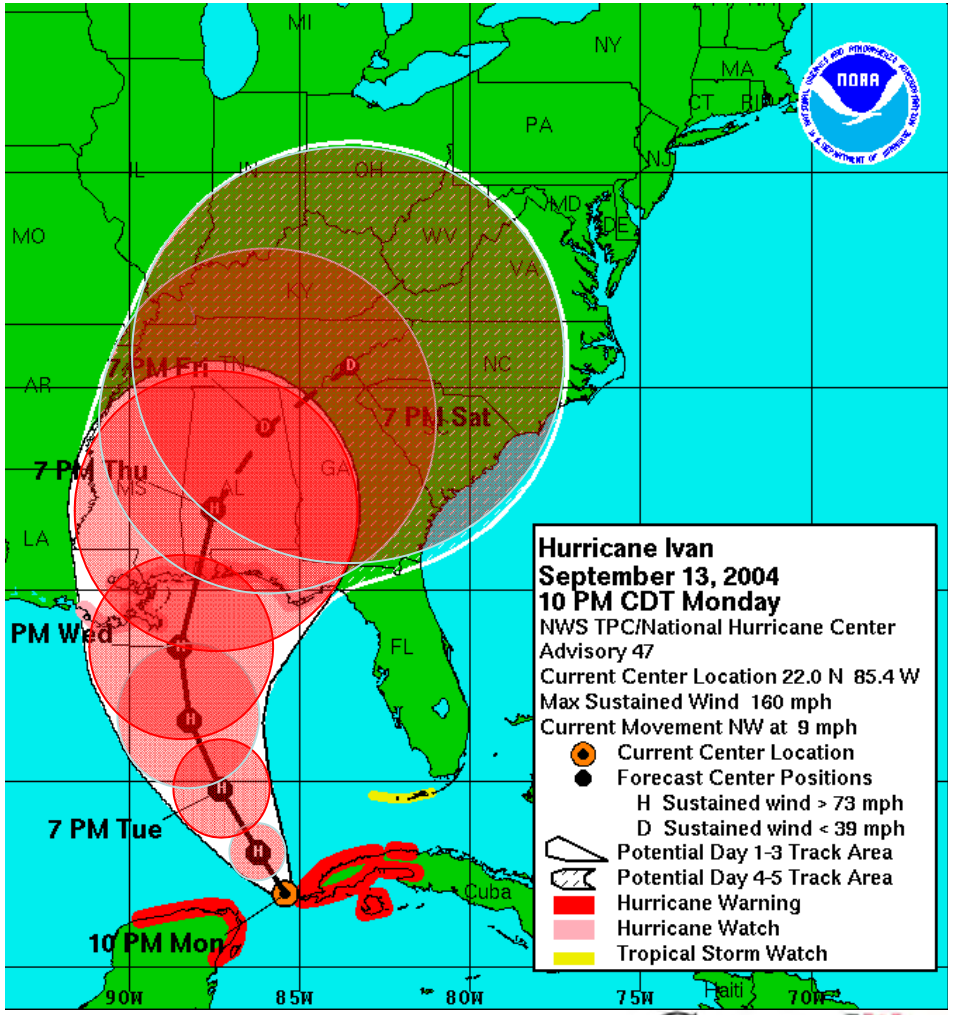
Operational Response to Hurricanes

Common Misconception – Track Forecast

- Represents the probable track of the *center* of the tropical cyclone
- Track error cone is formed by connecting circles centered on each forecast point (at 12, 24, 36 h, etc.)
- Size of the circles are determined so that the actual storm position at a certain time will be within the corresponding circle 67% of the time



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Operational Response to Hurricanes

Seasonal Media Briefing

- CHC holds pre-seasonal briefings timed with the release of the NOAA Hurricane Season Forecast
- Used primarily to explain what the NOAA numbers mean for Canada and to promote preparedness
- Emergency management officials typically invited to speak to enhance the preparedness messages

Storm Specific Media Briefings

- Generally held for higher impact storms
- Start 3-4 days prior to storm's arrival
- In-person briefing to explain what the storm is doing and what is expected
- Typically held in the afternoon

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Operational Response to Hurricanes

Emergency Management Seasonal Briefing

- Cover the basics of tropical cyclones and how they affect Canada, review of previous year and outlook for the current year
- Review of the established operational practices used during actual storms
- Typically held around the start of the season
- Occasionally we will deliver a full-day or ½-day training session

Emergency Management Storm Briefing

- Briefing held by the CHC for provincial EMO and PS representatives
- Key step in the coordinated approach to getting the latest information on the storm to key emergency management officials
- These briefings are held using WebEx

Operational Response to Hurricanes

Emergency Management Briefings

1. General update on the storm with potential impacts
2. Briefing usually 15 minutes plus time for questions and discussion
3. Total time 30-45 minutes
4. WPMs also take in the briefing

Canadian Hurricane Centre

Morning Briefing (0915 AT)

(Robichaud/Fogarty)

WebEx

Held at the request of any EM agency OR when CHC deems appropriate

Government Operations Centre Ottawa

Nova Scotia EMO & PSC

Newfoundland and Labrador FES & PSC

Prince Edward Island Office of Public Safety & PSC

New Brunswick EMO & PSC

Other affected Provinces

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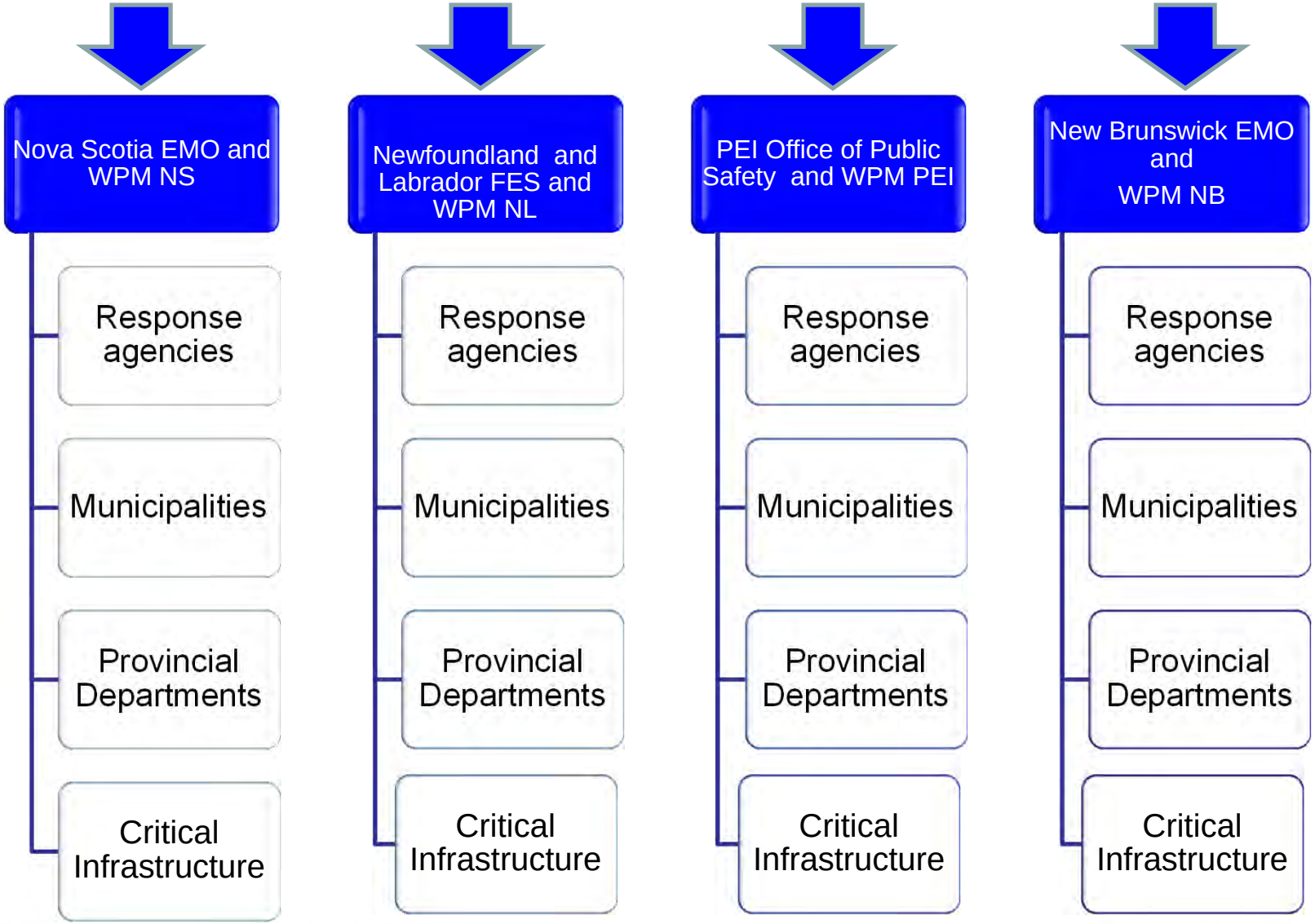
Operational Response to Hurricanes

Provincial Emergency Management Briefings



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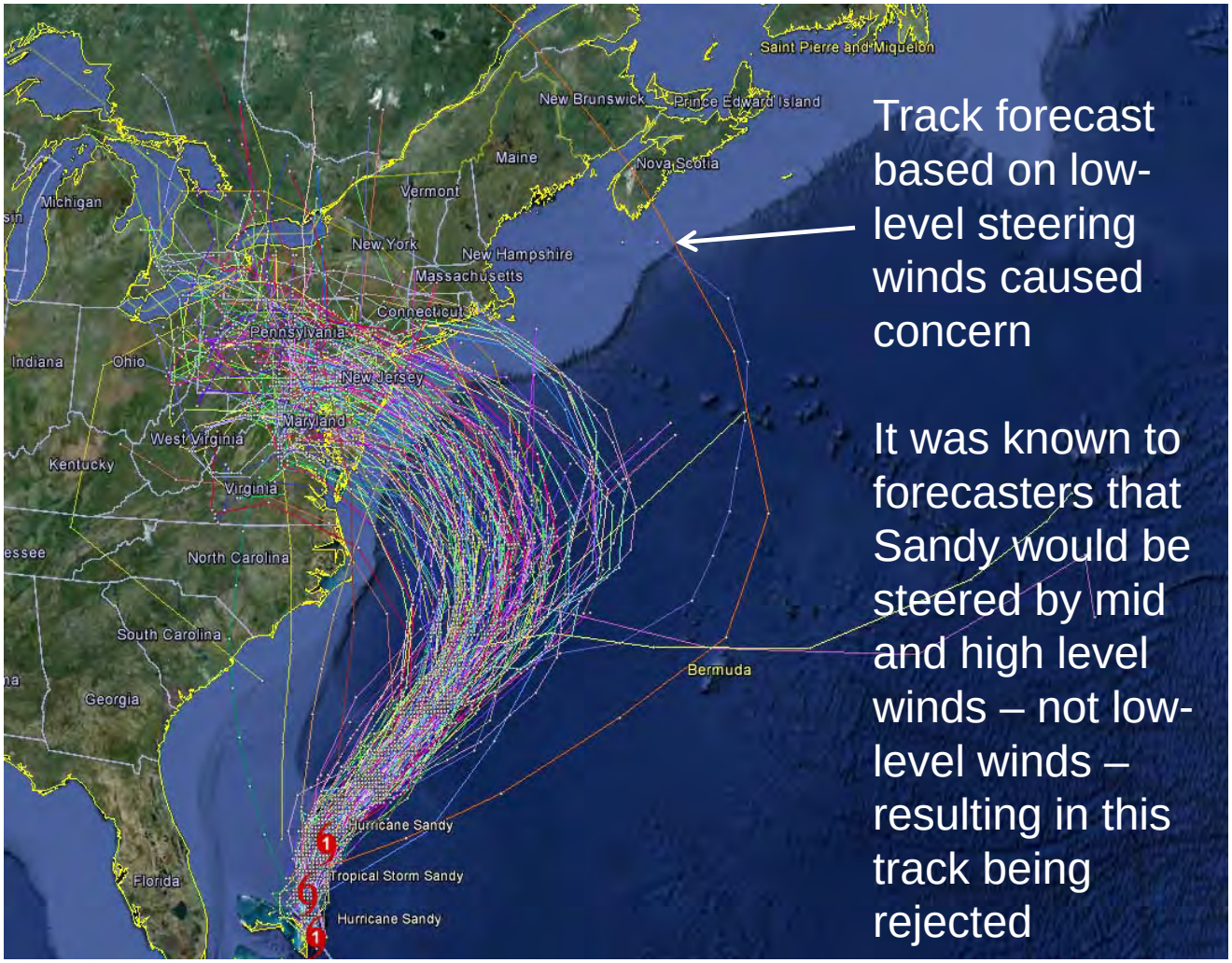
Operational Response to Hurricanes

Use caution when interpreting model track forecasts!

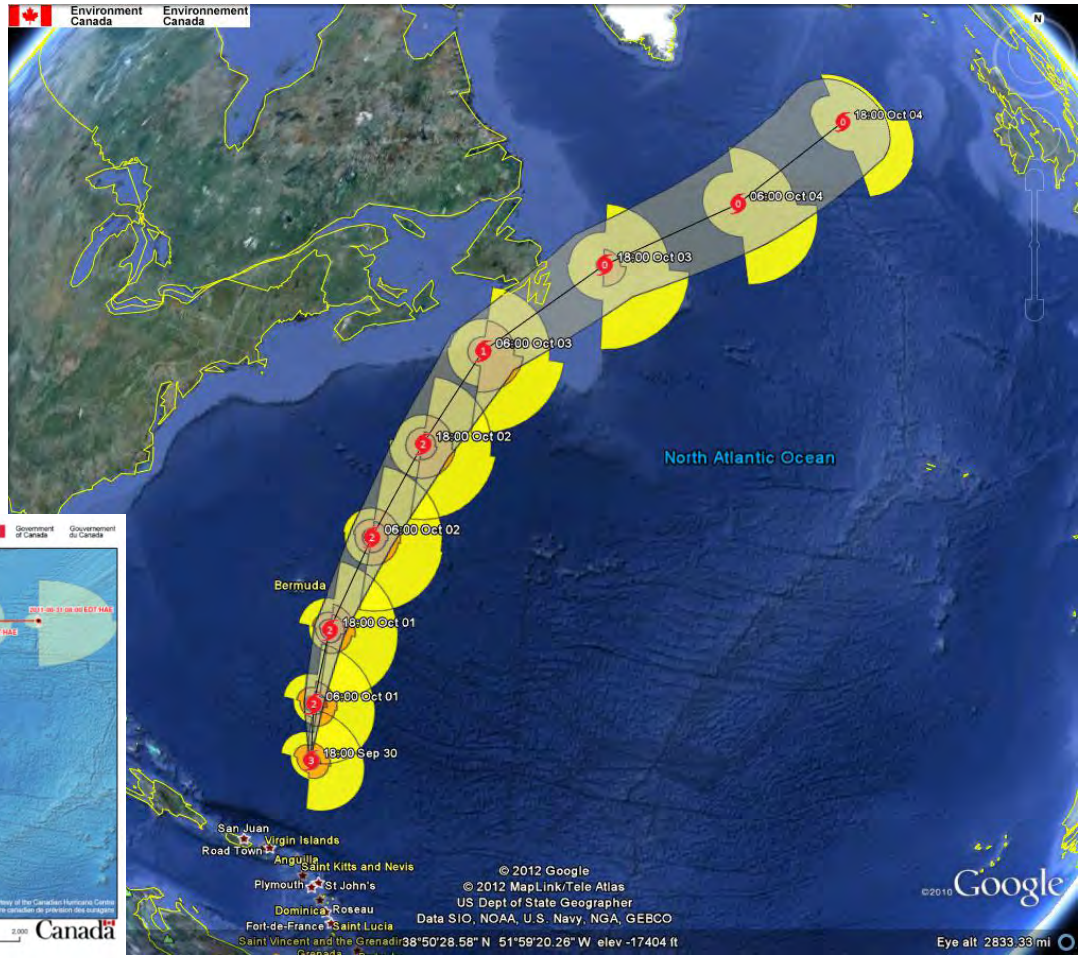


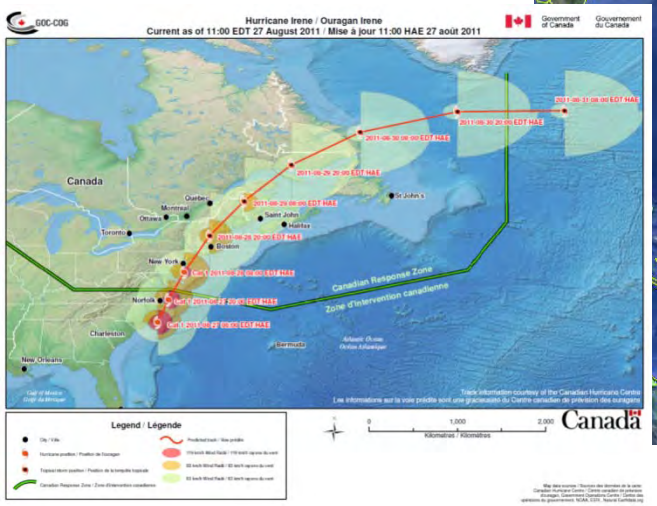
- About 35 different track models
- Some of these models will provide more than one possibility
- Some models simply do not apply under certain situations

Operational Response to Hurricanes

New and Upcoming Tools

- Shape files are produced by the Canadian Hurricane Centre to be ingested into GIS applications
- Can also be viewed using Google Earth





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Operational Response to Hurricanes

Social Media

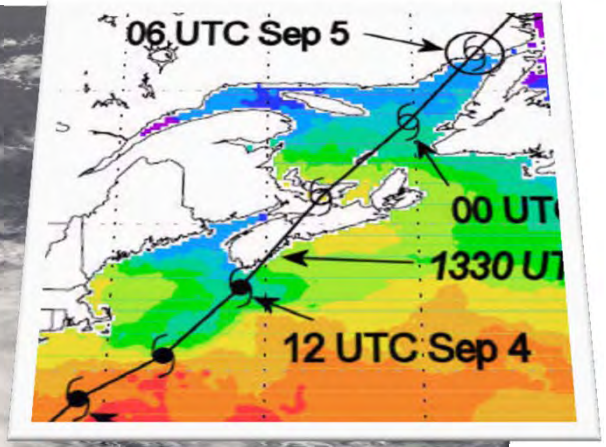
- Using Twitter more this year to point to updates in the hurricane status
- Experimenting with YouTube to post short updates on active storms approaching Canada

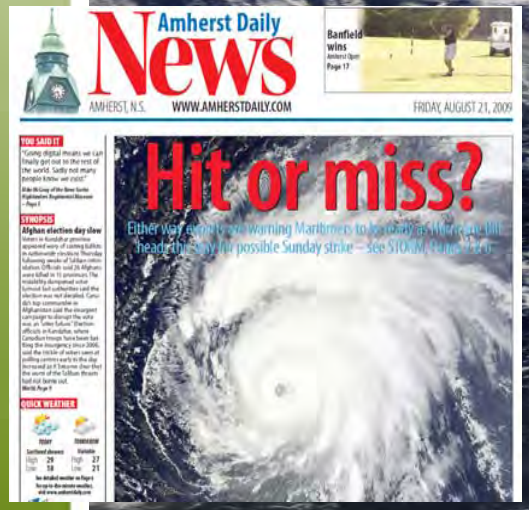
@environmentca

Canadian Hurricane Centre

2013 Seasonal Hurricane Forecast

Canadian Hurricane Centre





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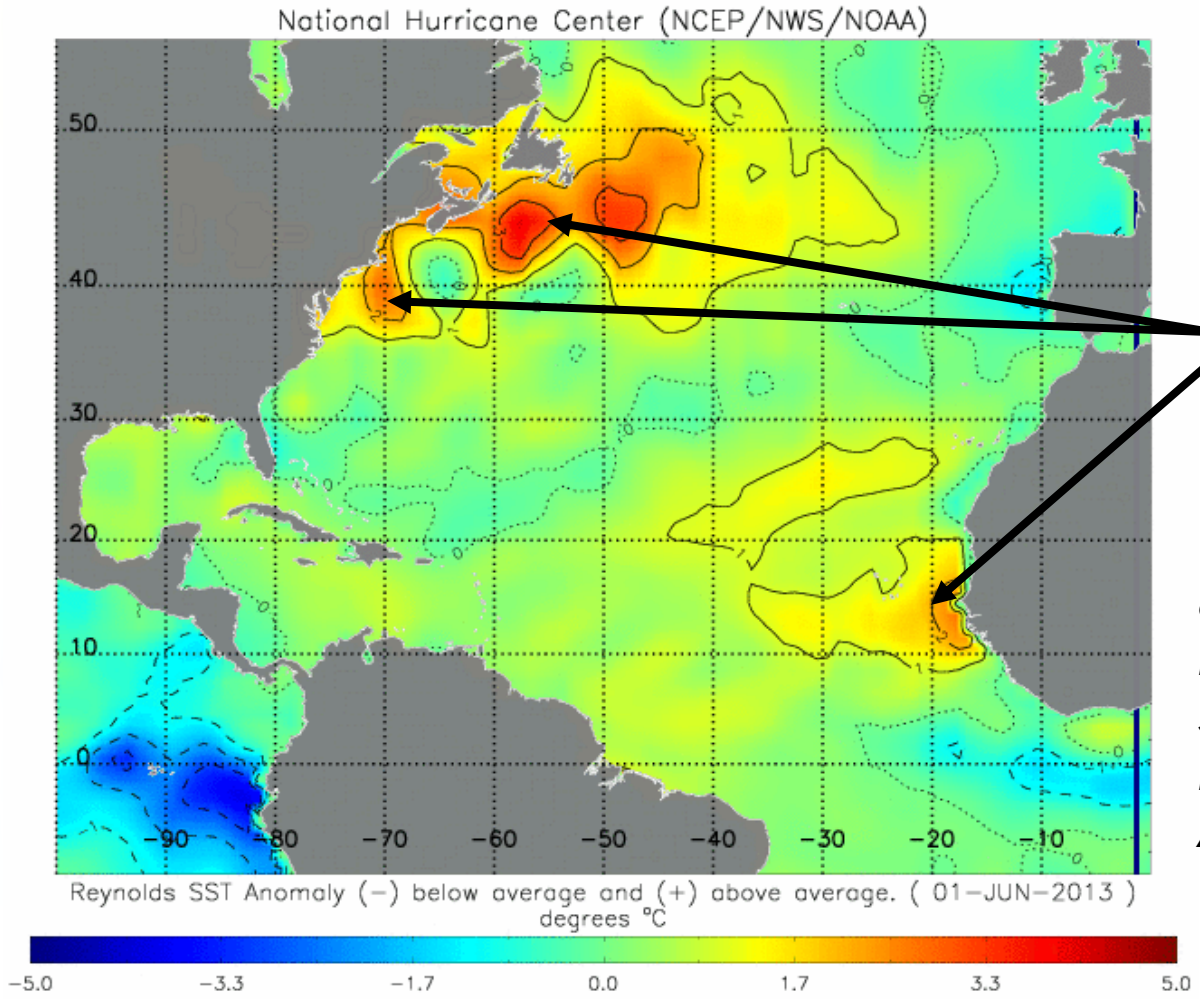
2013 Atlantic Hurricane Forecast

	Named Storms	Hurricanes Category 1 to 5	Major Hurricanes Category 3-5
National Oceanic and Atmospheric Administration (US)	**13-20**	**7-11**	**3-6**
1981-2010 Average	**12**	**6**	**3**
1961-2010 Average	**11**	**6**	**2 or 3**

Latest Sea Surface Temperature Patterns



Warmer than normal sea surface temperature

Water temperatures are higher than normal in the main storm formation region of the tropical Atlantic Ocean.

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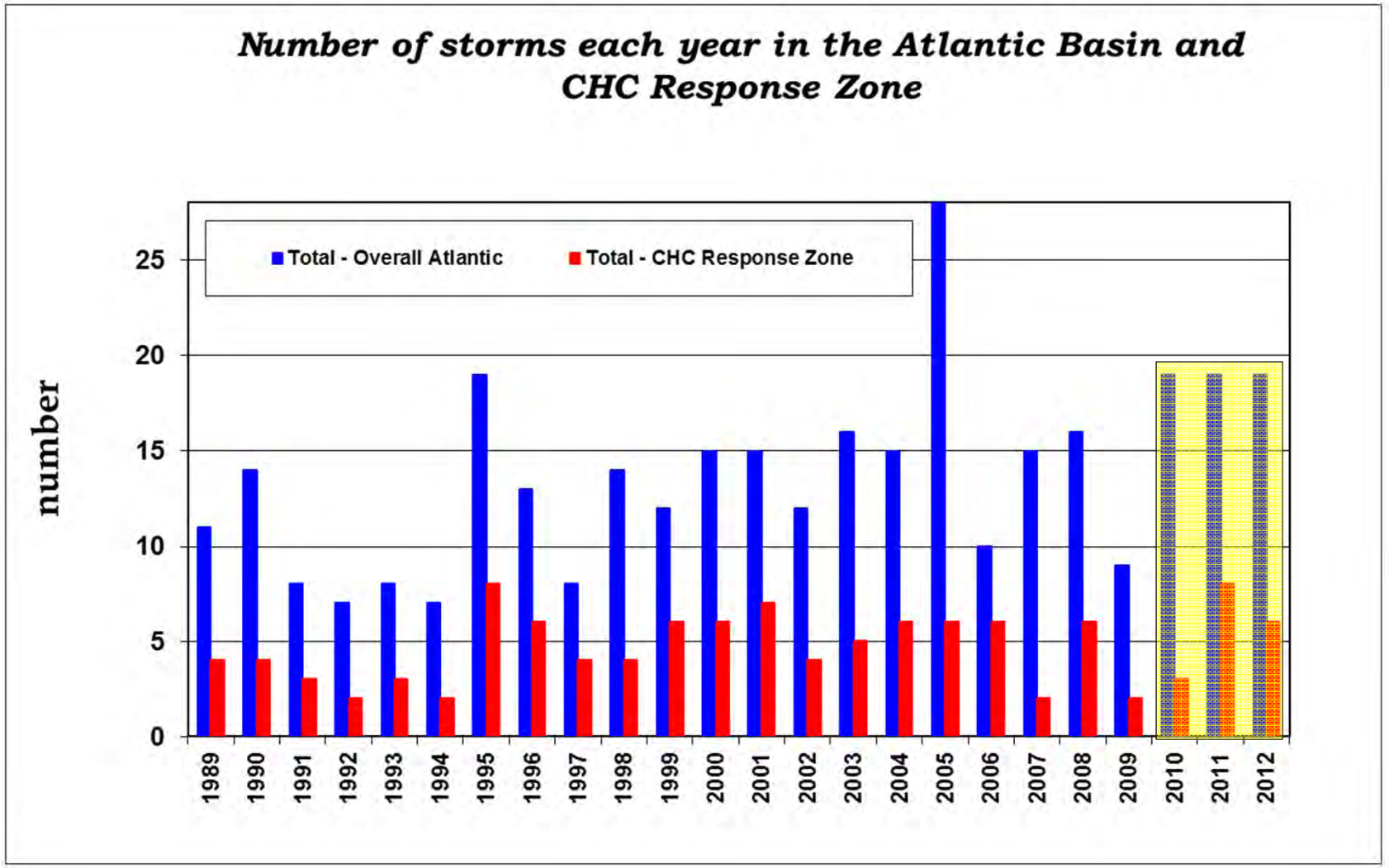
Number of Storms per Year



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List of Atlantic Storm Names

2013	2014	2015	2016	2017	2018
Andrea	Arthur	Ana	Alex	Arlene	Alberto
Barry	Bertha	Bill	Bonnie	Bret	Beryl
Chantal	Cristobal	Claudette	Colin	Cindy	Chris
Dorian	Dolly	Danny	Danielle	Don	Debby
Erin	Edouard	Erika	Earl	Emily	Ernesto
Fernand	Fay	Fred	Fiona	Franklin	Florence
Gabrielle	Gonzalo	Grace	Gaston	Gert	Gordon
Humberto	Hanna	Henri	Hermine	Harvey	Helene
Ingrid	Isaias	Ida	Ian	Irma	Isaac
Jerry	Josephine	Joaquin	Julia	Jose	Joyce
Karen	Kyle	Kate	Karl	Katia	Kirk
Lorenzo	Laura	Larry	Lisa	Lee	Leslie
Melissa	Marco	Mindy	Matthew	Maria	Michael
Nestor	Nana	Nicholas	Nicole	Nate	Nadine
Olga	Omar	Odette	Otto	Ophelia	Oscar
Pablo	Paulette	Peter	Paula	Philippe	Patty
Rebekah	Rene	Rose	Richard	Rina	Rafael
Sebastien	Sally	Sam	Shary	Sean	Sara*
Tanya	Teddy	Teresa	Tobias	Tammy	Tony
Van	Vicky	Victor	Virginie	Vince	Valerie
Wendy	Wilfred	Wanda	Walter	Whitney	William

*** Sandy was replaced with Sara**

BE CAREFUL WHAT YOU EXERCISE!

The Palm Beach Post
BREAKING NEWS STARTS HERE
80° West Palm Beach, H: 81° L: 75°
Interactive Radar | Weather App
JOBS AUTOS REA
HOME NEWS WEATHER SPORTS BUSINESS OBITUARIES OPINION LIVING E

EYE ON THE STORM

« Hurricane Irene name retired

Florida Hurricane Conference is this week »

Hurricane slams GOP Convention! Just a drill.

by Eliot Kleinberg
Posted 10:20 a.m. Friday, May 11, 2012

Every year, Florida runs a statewide hurricane exercise. Organizers like to generate the most challenging scenario they can conjure up.

For this year's version, set for May 21-24, they went all out: a hurricane striking the Tampa area during the Republican National Convention.

The fictitious Hurricane Gispert is named for retired Hillsborough County Emergency Manager Larry Gispert.

The convention isn't until Aug. 27-30. But anyone who lives in Florida knows that's near the height of hurricane season.

The gallows humor follows the old saw that you laugh at what fears you most. Tampa Bay – densely populated and low-lying, with not enough evacuation routes – is second only to New Orleans among urban areas in the potential for hurricane calamity.

The last major storm to hit was a Category 4 in 1921; it made landfall the tip of the Pinellas peninsula, bringing its powerful right quadrant right into downtown. The surge inundated the low-lying metro area for miles. And, of course that region has many, many, more people than it did in 1921.

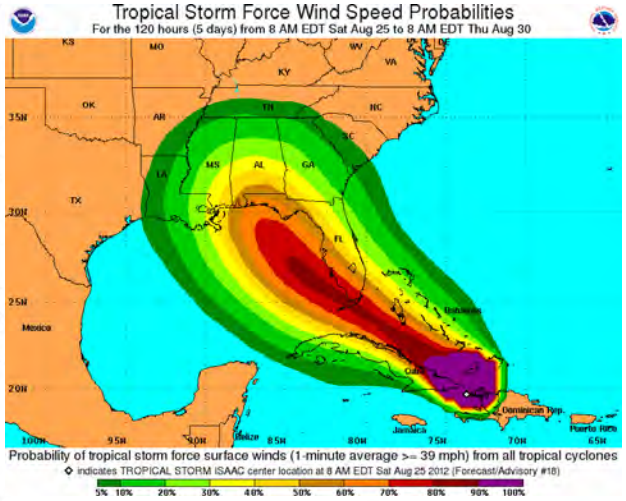
"Unfortunately there is nothing funny about the possibility of a hurricane ever hitting Florida," Florida GOP press secretary Kristen McDonald said. "The Republican Party Of Florida hopes we continue to be blessed and do not see one in our state this year. If we do, we are certainly grateful that state and local officials care enough to be prepared for all of the possible effects of such a storm."

The up side of all of this is that Florida has gone six years (Wilma, 2005) without being hit by a hurricane. But of course it's been said many times that the odds at any moment are 50-50.

Emergency management officials conducted and exercise involving Hurricane "Gispert"

Strong hurricane about to make landfall on Tampa in the middle of the republican convention with 70,000 new visitors in the storm's path.

BE CAREFUL WHAT YOU EXERCISE!



On August 27th strengthening Tropical Storm Isaac tracked just west of Tampa producing strong winds and heavy rain

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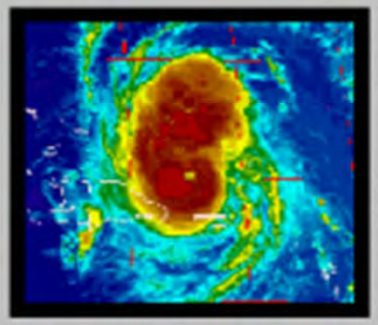
BE CAREFUL WHAT YOU EXERCISE!

Netscape: SET DRILL: Hurricane Sandy

File Edit View Go Bookmarks Options Directory Window Help

THIS IS ONLY A DRILL



HURRICANE SANDY
Welcome to the 1997 American Radio Relay League Simulated Emergency Test (SET) in Westchester County, NY

Hurricane Sandy is a fictitious hurricane based on a real one: the Hurricane of 1938. The following National Weather Service advisories and storm tracks are based on data from that storm and are being used as stimuli for an Amateur Radio emergency communications drill. They were produced at a training seminar at the National Hurricane Center in Miami, FL. The image to the left is from the NHC web page and is of Hurricane Bertha.

Thu 10/02/97	5:00 p.m. (2100Z)	Bulletin	Discussion	Forecast	Probabilities	Map
Thu 10/02/97	11:00 p.m. (0300Z)	Bulletin	Discussion	Forecast	Probabilities	
Fri 10/03/97	5:00 a.m. (0900Z)	Bulletin	Discussion	Forecast	Probabilities	

THIS IS ONLY A DRILL

….it only takes one storm!
Are you prepared?

Hurricane Juan Retrospective

Before

- No tropical type watches or warnings
- CHC handled media requests as they came in
- There was no formal response to the seasonal tropical outlook
- Media would come into the operational area to conduct interviews and take B-roll
- Two landfalling hurricanes in Nova Scotia in the ten years prior to Juan
- CHC used to be on the 19th floor of Queen Square in Dartmouth
- Canada had never requested a tropical cyclone name be retired
- Typical forecast track errors for 72, 48 and 24 hours were 140 nm, 115 nm and 72 nm respectively
- No emergency management-specific hurricane training was available
- Any emergency management-specific hurricane briefings were strictly on an ad-hoc basis

After

- CHC now has the ability to issue tropical-type watches and warnings
- CHC now holds media technical briefings during the larger events
- The CHC now coordinates a formal response to the seasonal forecast by holding a media technical briefing and engaging emergency management partners
- MSC now has a media room designed for these types of interviews and other media related activities
- Two landfalling hurricanes in Nova Scotia in the ten years after Juan
- CHC is now on the 3rd floor
- Two tropical cyclone names have been retired at Canada's request: Juan and Igor
- Typical forecast track error for 72, 48 and 24 hours are now 128 nm, 92 nm and 52 nm respectively
- Weather related training is now available to emergency management agencies which includes extensive hurricane related info
- The CHC now coordinates and hosts emergency management hurricane briefings at the beginning of the season and during real-time events. During severe events a trained MSC meteorologist may relocated to an EOC for direct support (e.g. Kyle, Earl)

Thank you!

Bob Robichaud

Warning Preparedness Meteorologist

Canadian Hurricane Centre

Dartmouth, NS

Tel: **902-244-7214**

Email: **Bob.Robichaud@ec.gc.ca**