



# **Canadian Hurricane Centre** ***Reflections***

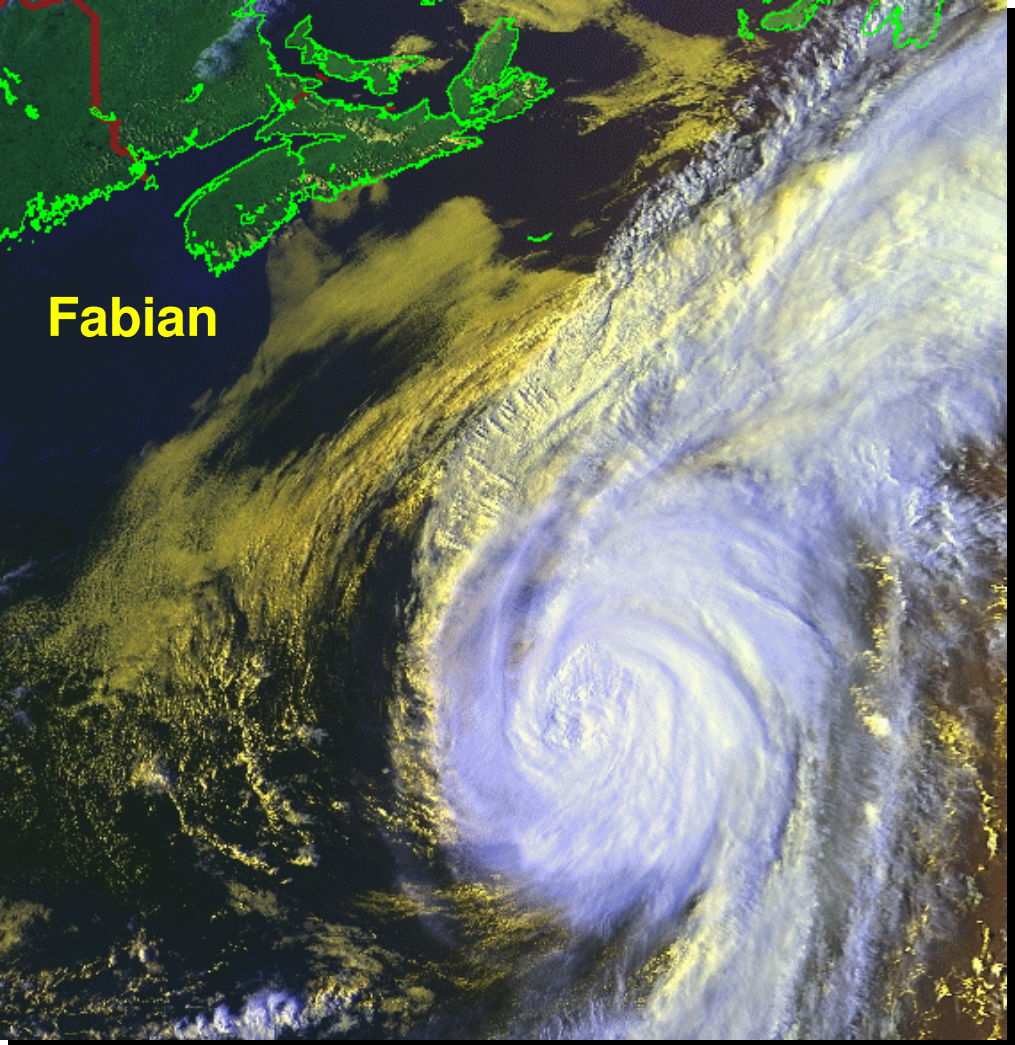
***Peter Bowyer***

Two Decades  
of Lessons Learned

The *EVIL* Wind ... Accounts for 30% of Global Insurance Losses



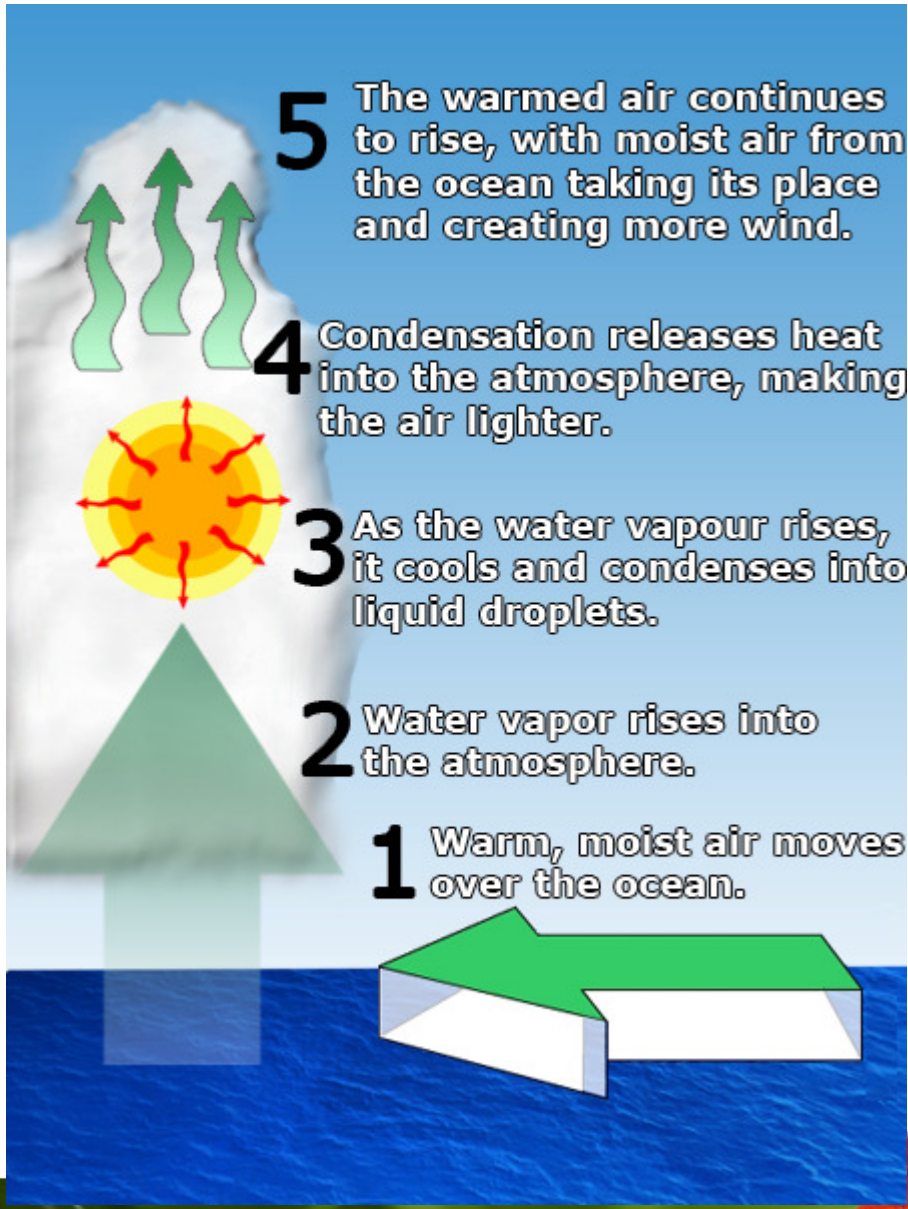
Canadian  
Hurricane  
Centre



## Atmospheric heat engines



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Hurricane  
Centre



Serving a useful purpose

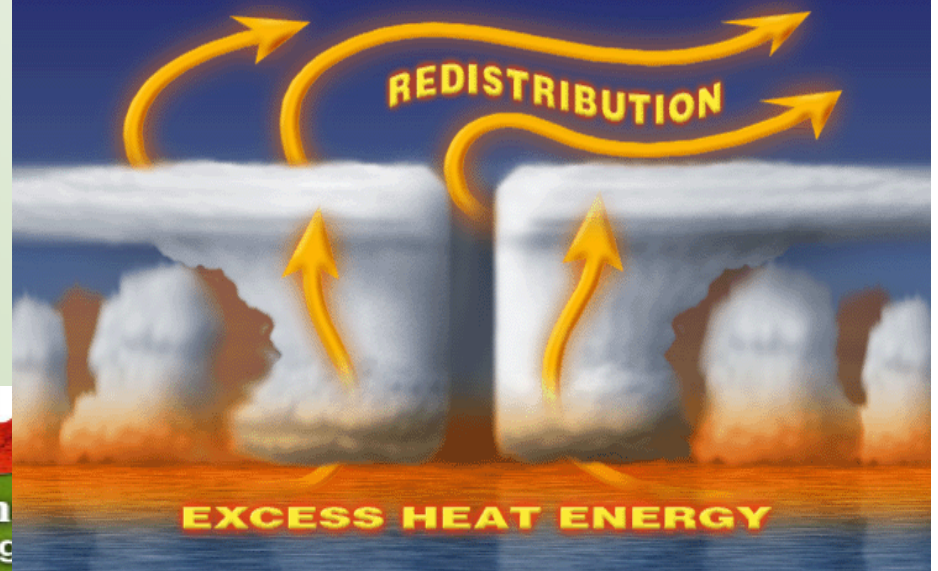


Canadian  
Hurricane  
Centre

# A HURRICANE'S PURPOSE

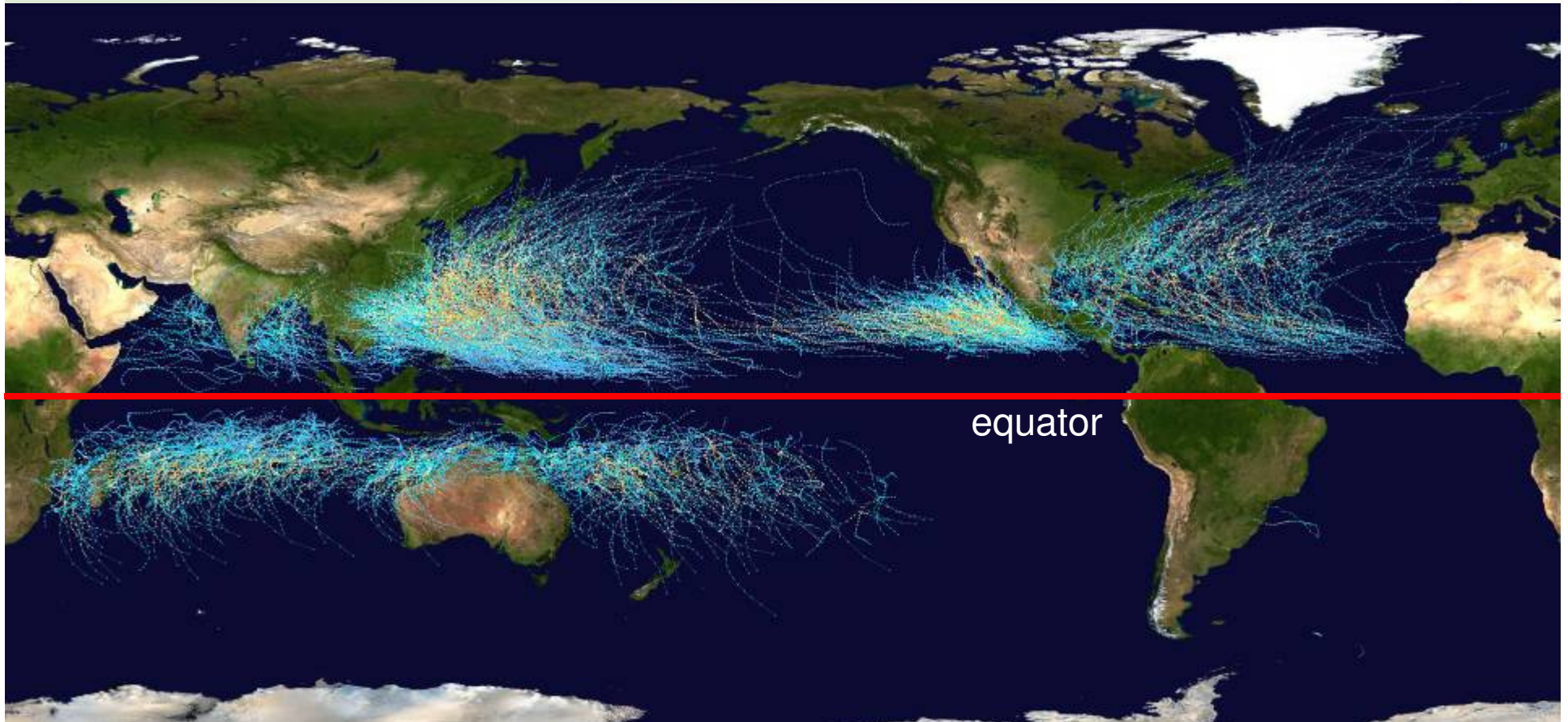


# THE PURPOSE OF A HURRICANE





Global average ~80-90 per year



**To get a tropical cyclone started ...**

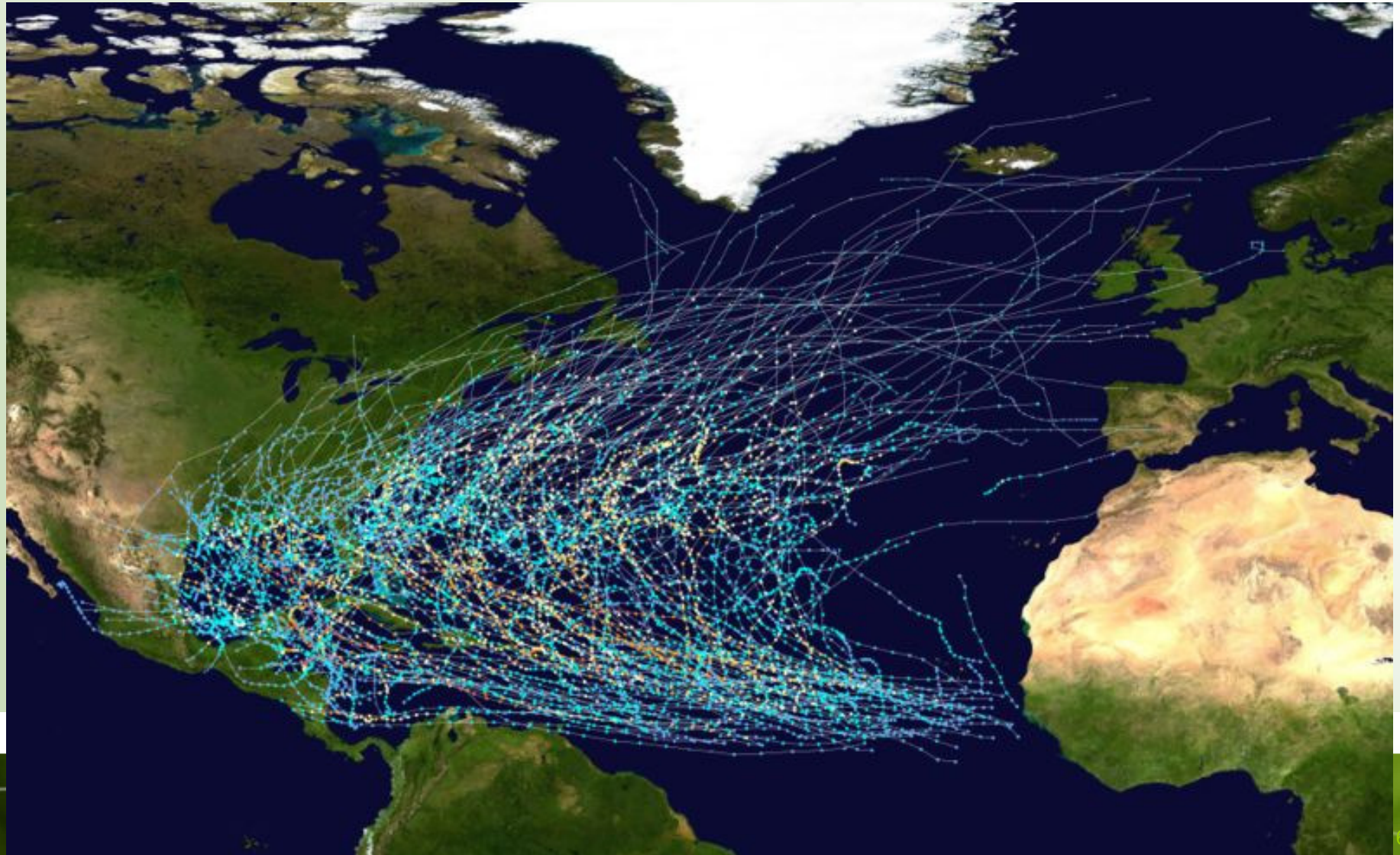
1. Greater than 500 km away from equator
2. Hot, moist, unstable atmosphere
3. Water temperatures usually  $>26^{\circ}$
4. Converging winds near surface
5. High pressure "chimney" in upper atmosphere

Closer to home

1985-2005



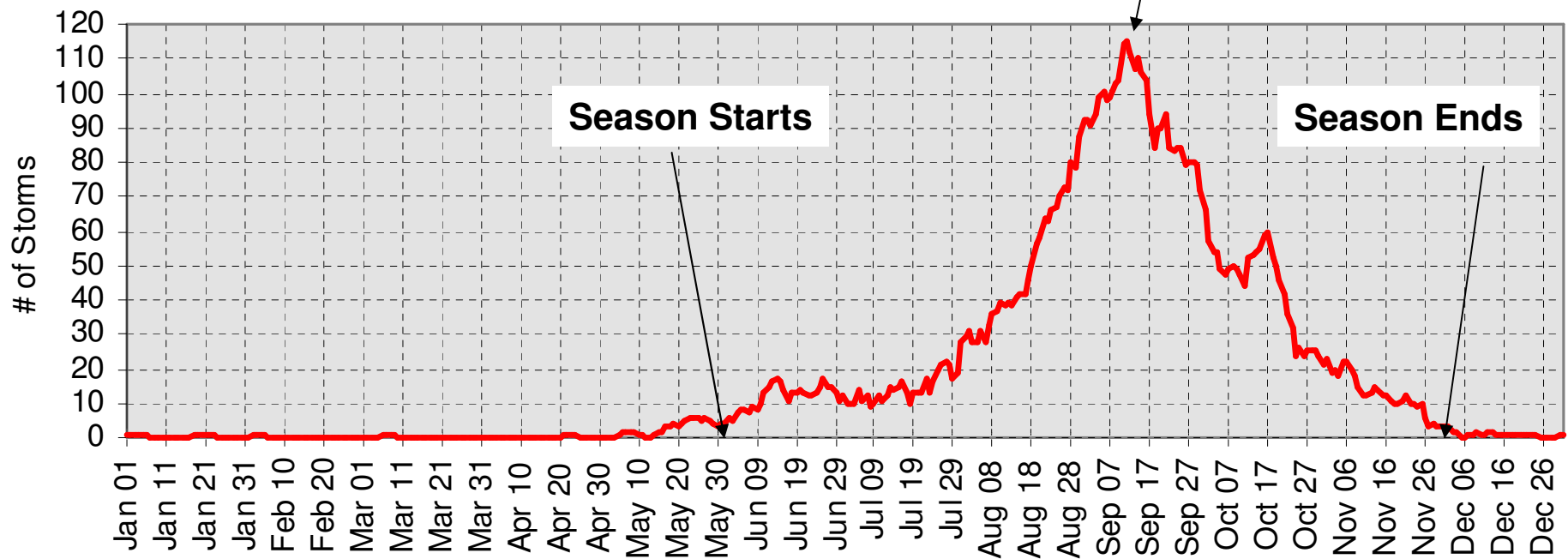
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# When and when not



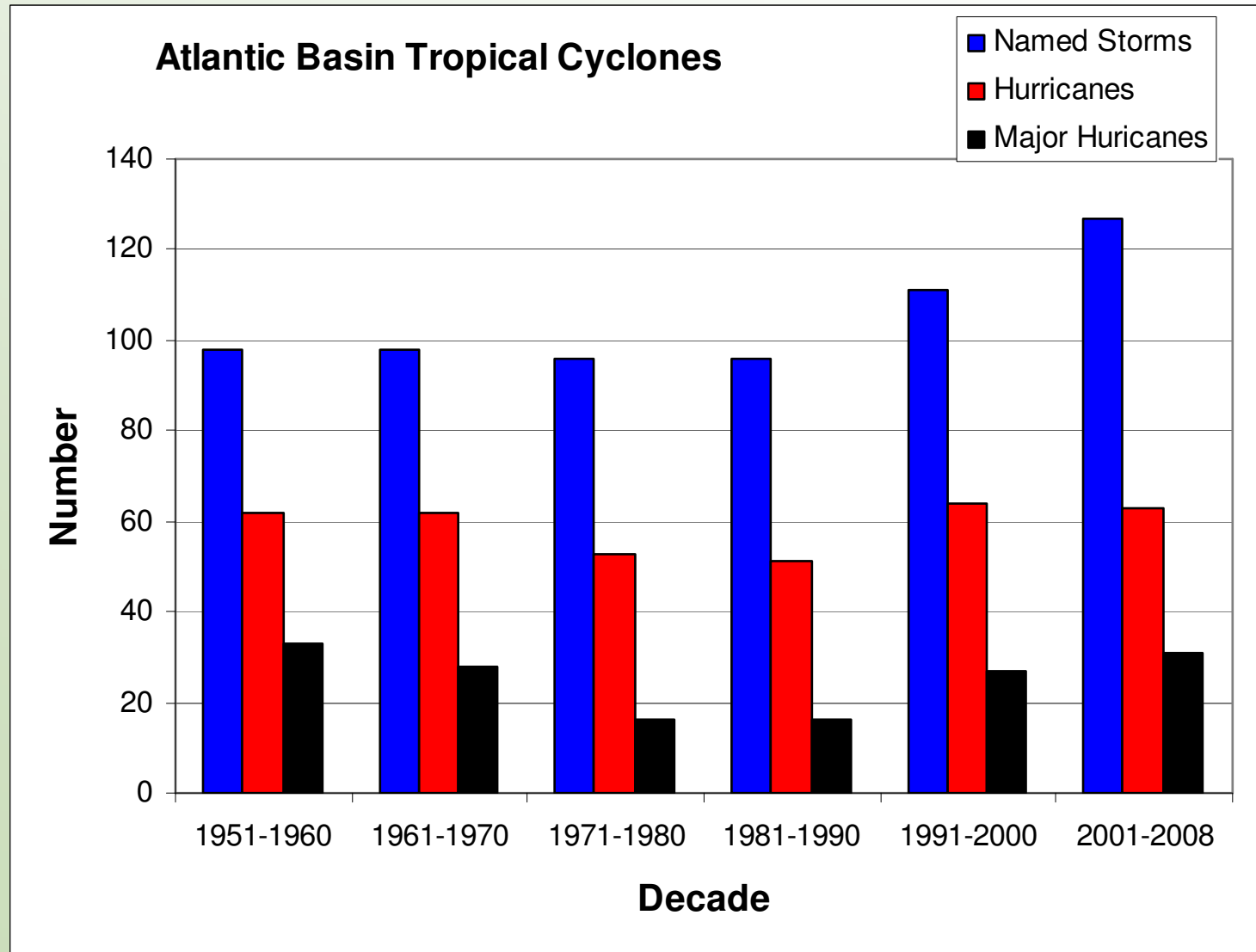
Tropical Storm Frequency by Day - North Atlantic Basin 1901 to 2000  
(115 individual storms have been reported on Sep 11 between 1901 and 2000)



## Trends out there?



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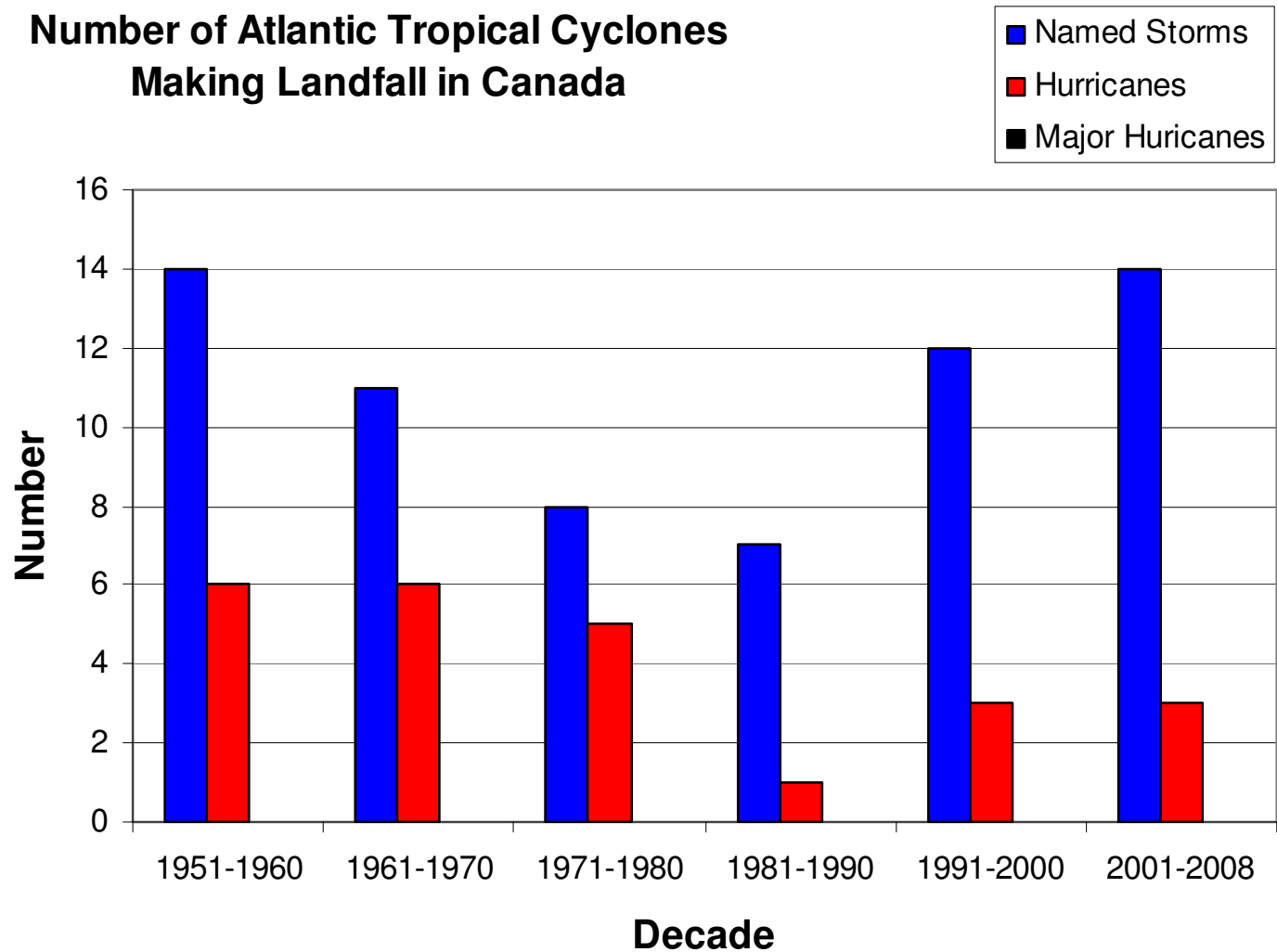


.... or at home?



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Centre


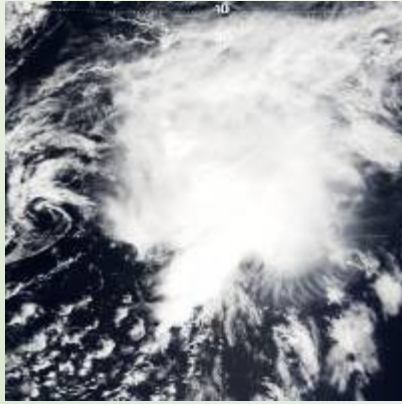
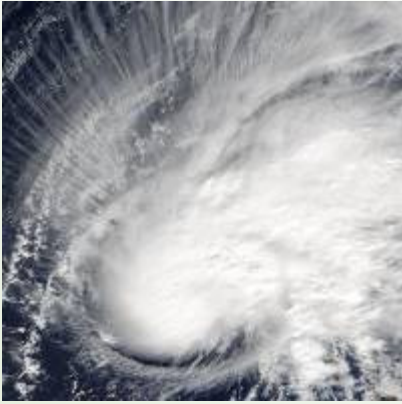


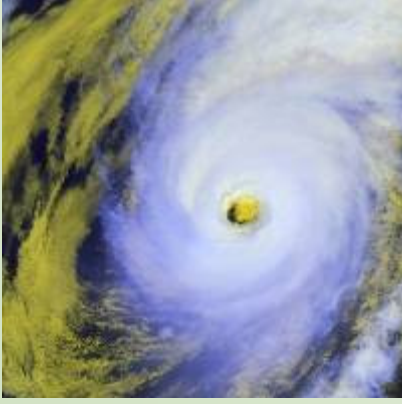


### Number of Atlantic Tropical Cyclones Making Landfall in Canada



# Stages of development



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	<b>NUMBERED</b>	<b>NAMED</b> →	
Tropical Disturbance Wind < 37 km/h	Tropical Depression Wind 37+ km/h	Tropical Storm Wind 63+ km/h	Hurricane – Cat. 1 Wind 119+ km/h
			
			
Wind 154+ km/h Hurricane – Cat. 2	Wind 178+ km/h Hurricane – Cat. 3	Wind 211+ km/h Hurricane – Cat. 4	Wind > 251 km/h Hurricane – Cat. 5



**Environment Canada**  
www.ec.gc.ca

# The "FUN" side of hurricanes



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<u>2009</u>	<u>2010</u>	<u>2011</u>	<u>2012</u>	<u>2013</u>	<u>2014</u>
Ana	Alex	Arlene	Alberto	Andrea	Arthur
Bill	Bonnie	Bret	Beryl	Barry	Bertha
Claudette	Colin	Cindy	Chris	Chantal	Cristobal
Danny	Danielle	Don	Debby	Dorian	Dolly
Erika	Earl	Emily	Ernesto	Erin	Edouard
Fred	Fiona	Franklin	Florence	Fernand	Fay
Grace	Gaston	Gert	Gordon	Gabrielle	Gonzalo
Henri	Hermine	Harvey	Helene	Humberto	Hanna
Ida	Igor	Irene	Isaac	Ingrid	Isaias
Joaquin	Julia	Jose	Joyce	Jerry	Josephine
Kate	Karl	Katia	Kirk	Karen	Kyle
Larry	Lisa	Lee	Leslie	Lorenzo	Laura
Mindy	Matthew	Maria	Michael	Melissa	Marco
Nicholas	Nicole	Nate	Nadine	Nestor	Nana
Odette	Otto	Ophelia	Oscar	Olga	Omar
Peter	Paula	Philippe	Patty	Pablo	Paulette
Rose	Richard	Rina	Rafael	Rebekah	Rene
Sam	Shary	Sean	Sandy	Sebastien	Sally
Teresa	Tomas	Tammy	Tony	Tanya	Teddy
Victor	Virginie	Vince	Valerie	Van	Vicky
Wanda	Walter	Whitney	William	Wendy	Wilfred

**Retired in  
April 2009**

~~Gustav~~

~~Ike~~

~~Paloma~~



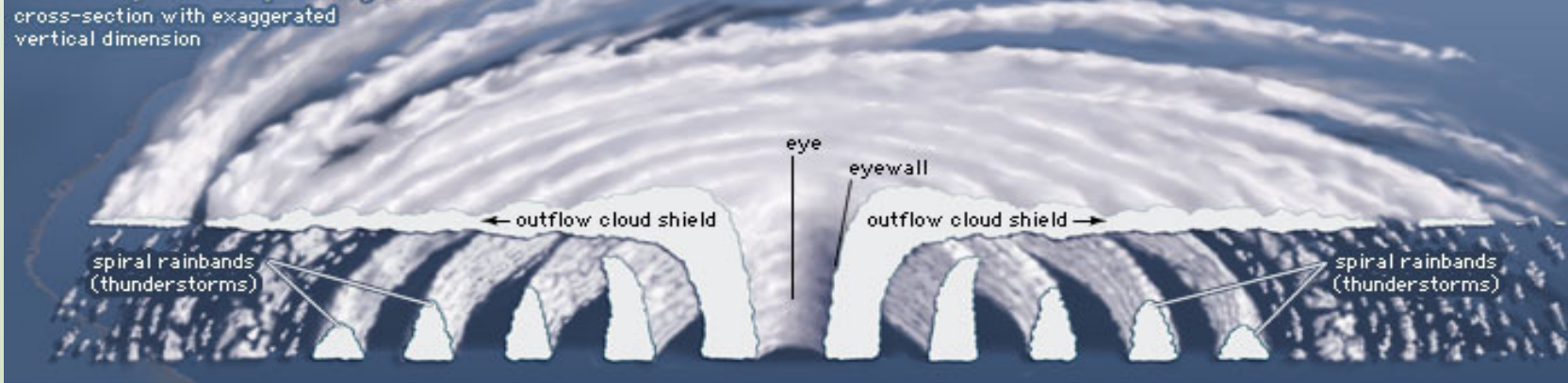
# A complex elegance



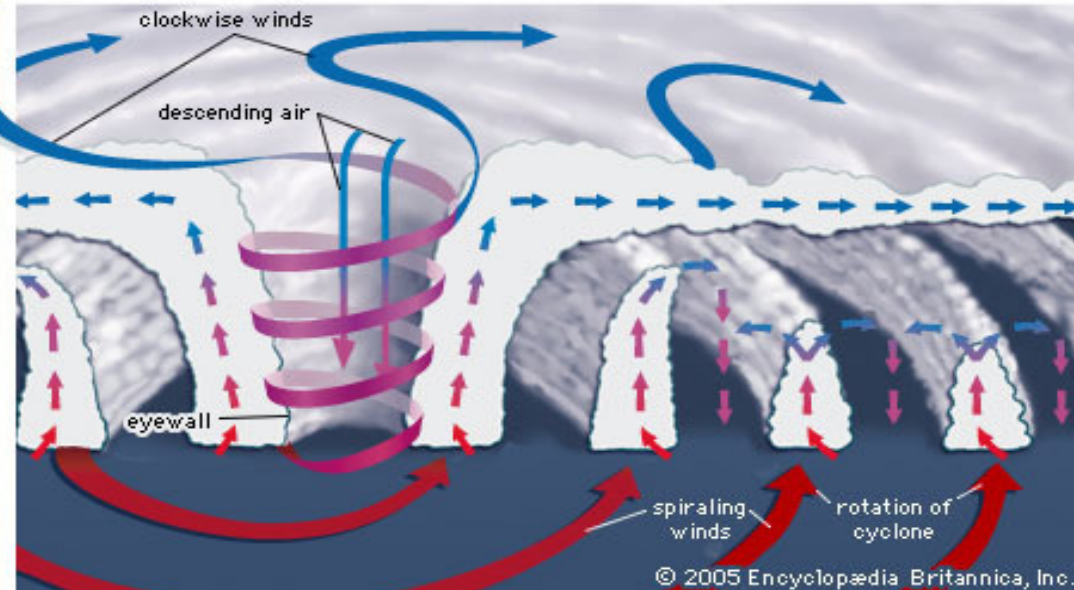
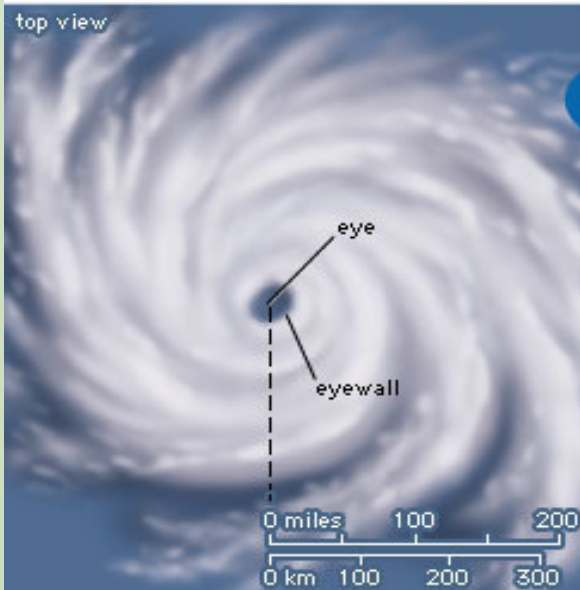
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Centre

## Anatomy of a tropical cyclone

cross-section with exaggerated vertical dimension



top view



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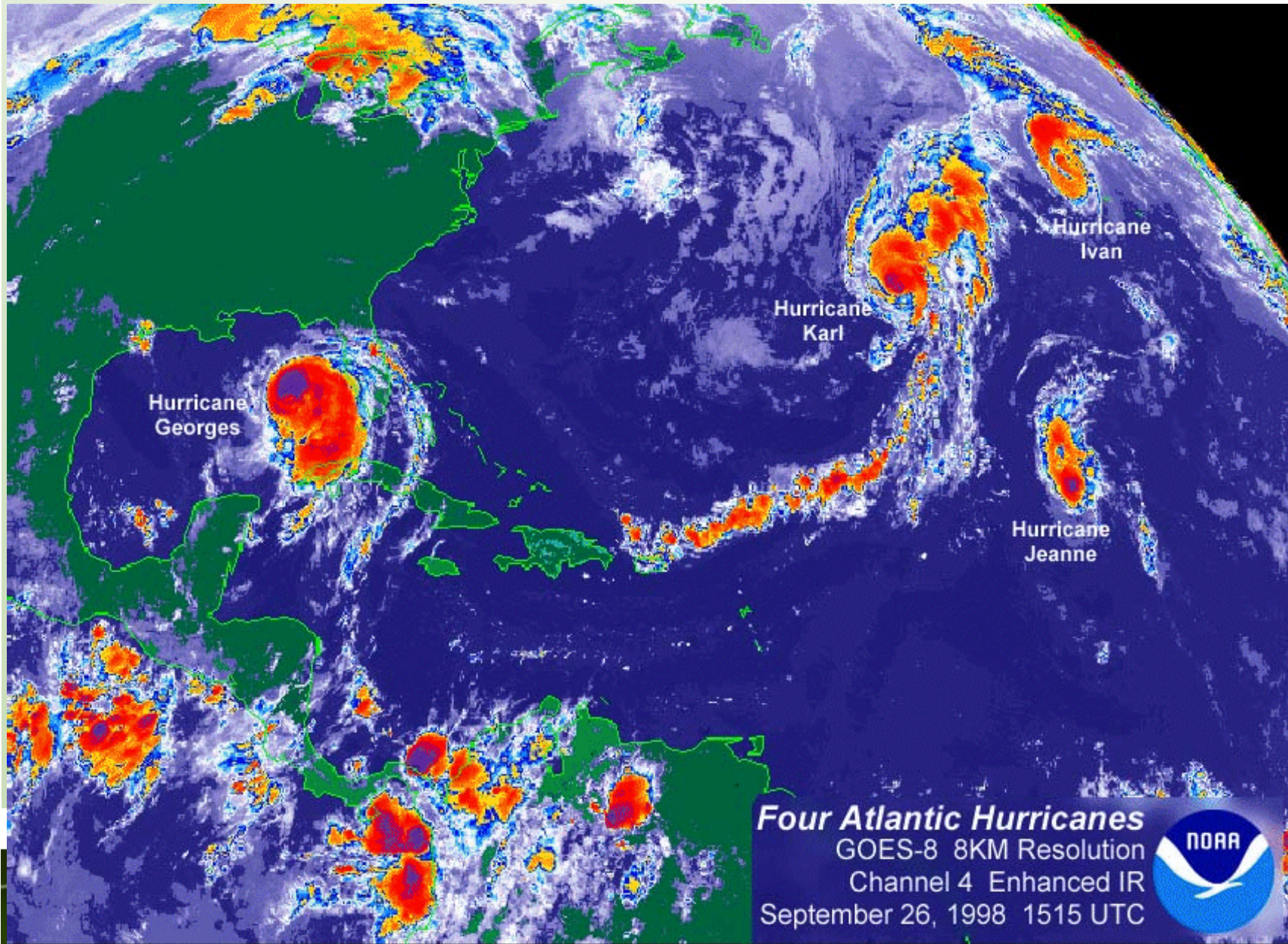


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All different shapes and sizes



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A classic mistake ... size doesn't matter



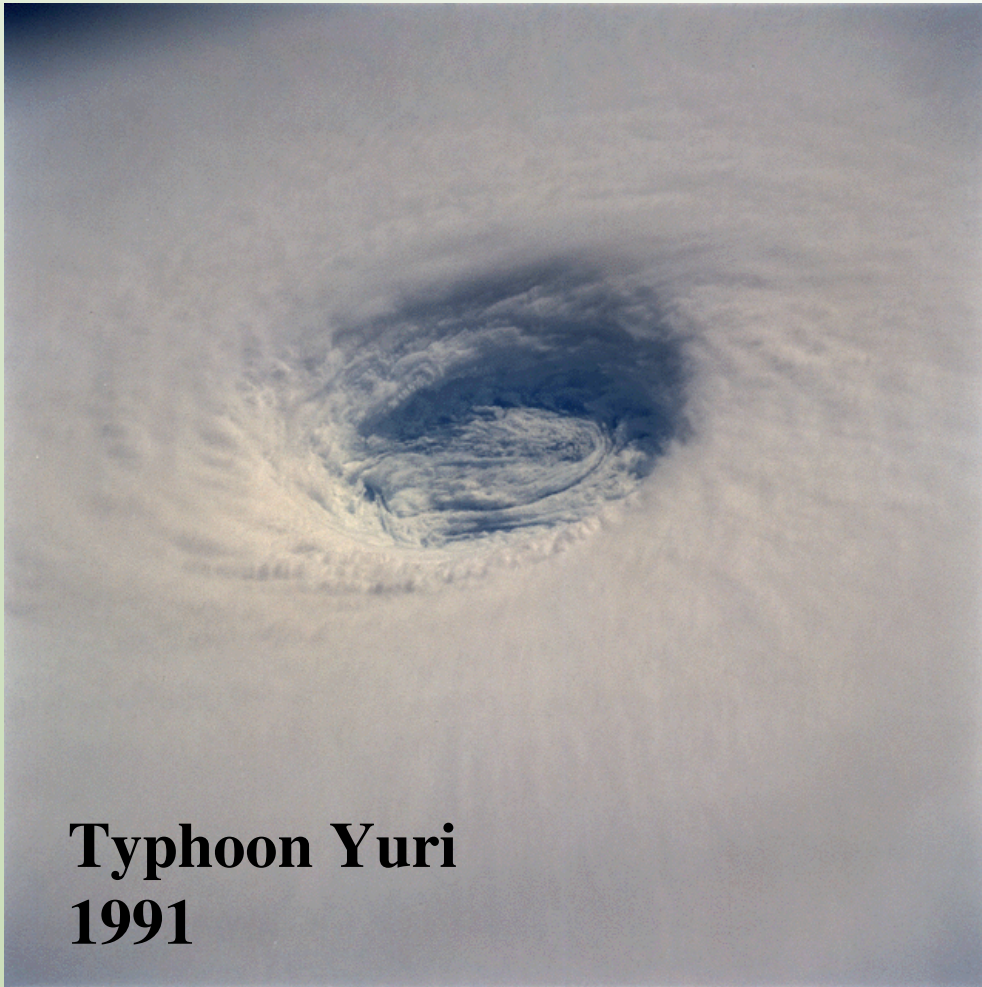
Canadian  
Hurricane



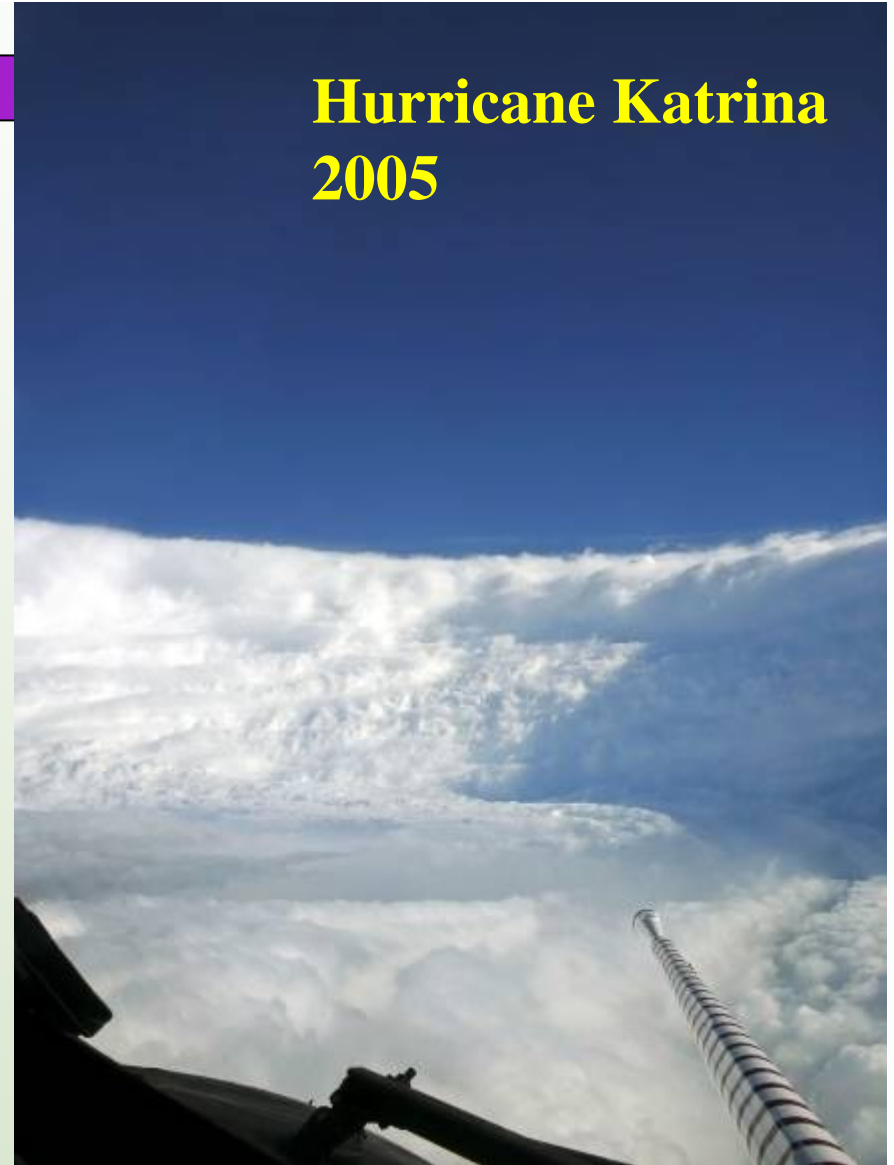
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The “stadium” effect

**Hurricane Katrina  
2005**



**Typhoon Yuri  
1991**



## The engine keeps going until ...

1. It loses its source of heat and moisture
2. It encounters vertical wind shear
3. Dry, cool air gets imported into the storm
4. The “chimney” is replaced by an upper atmospheric “low”





From frisbees to drains ....

TROPICS

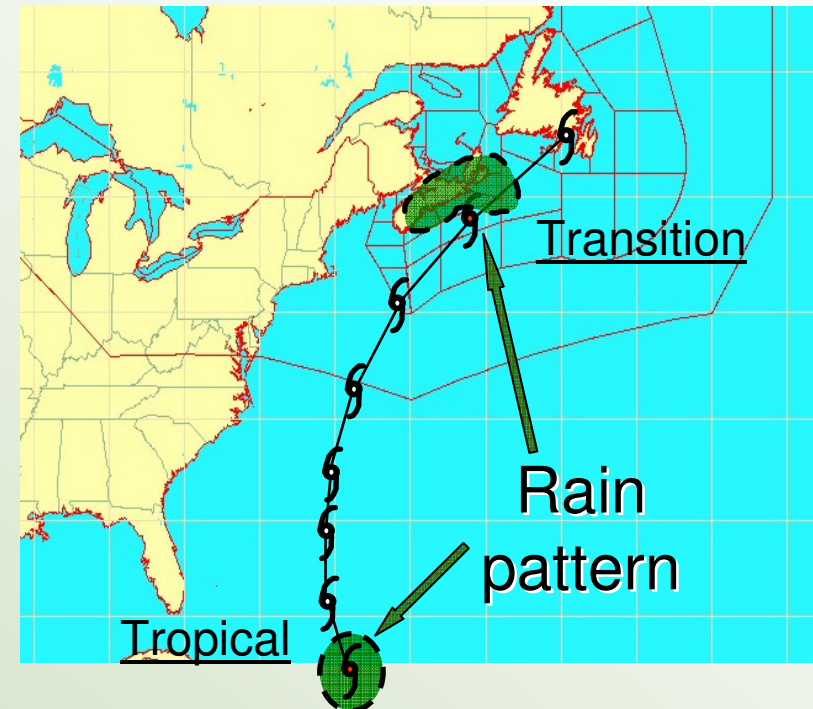
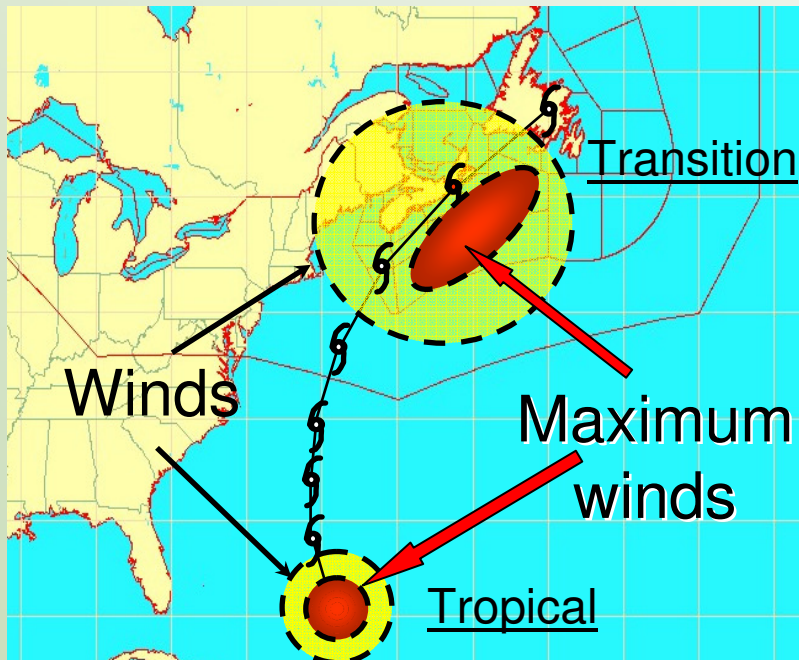
MID-LATITUDES



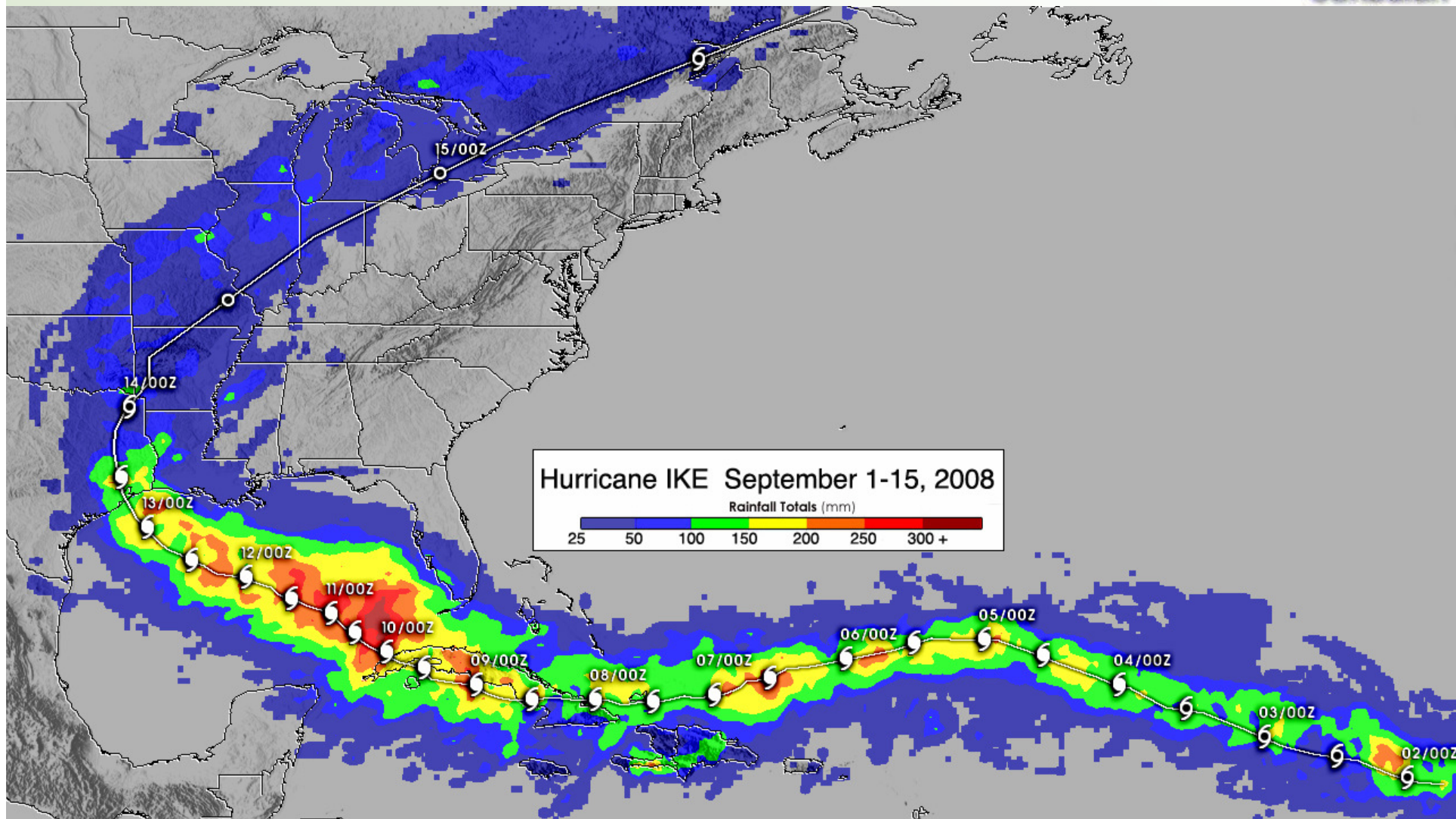
A different beast behaves differently

Wind Pattern

Rain Pattern



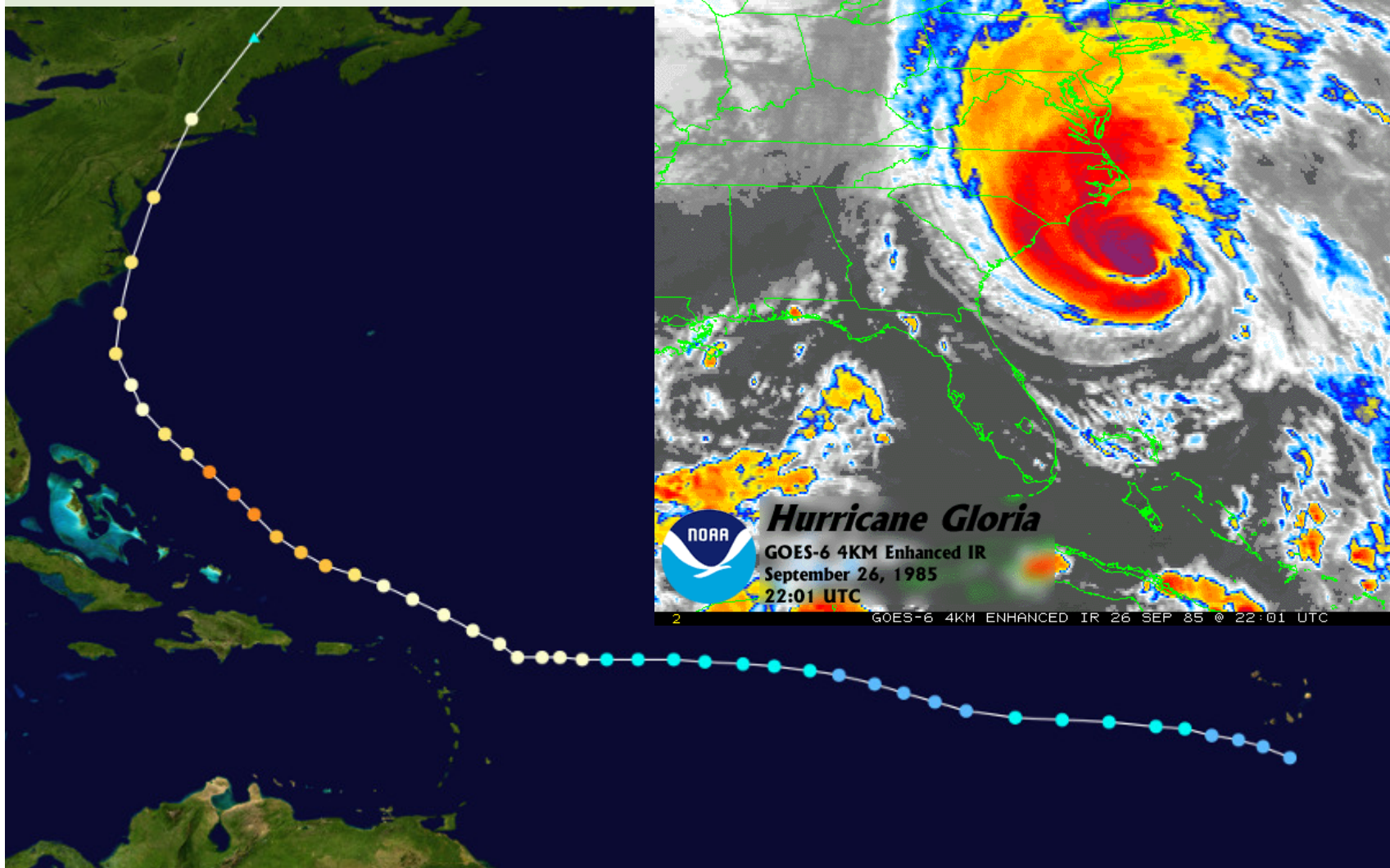
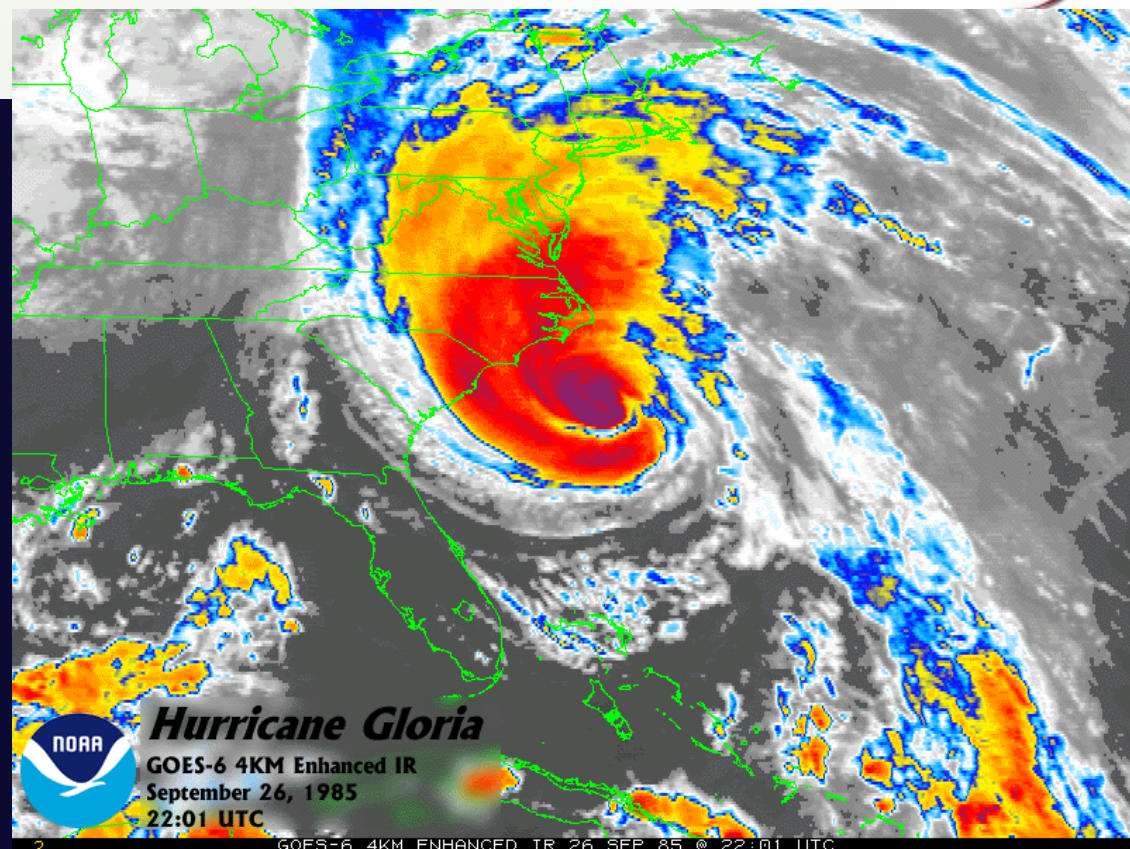
# Ike's visit to Canada in 2008



# “Storm of the Century”



1985



A new Canadian perspective on a global hazard



1987

# Canadian Hurricane Centre



## Kindred spirits who deserve to be in the game

1988



### Intense Rainfalls

Hazel '54, PT Harvey '99, PT-Gabrielle '01, Frances '04, Chantal '07, Cristobal & Hanna '08

### Winds of hurricane force in Summer/Fall

Hortense '96 > 120 km/h, Gustav '02 > 120km/h,  
Juan '03 > 150 km/h, Florence '06 > 130 km/h,  
Noel '07 > 140 km/h

### Extreme Wave Heights

Oct. '91~30m, Luis '95~30m, Danielle '98~27m,  
Noel '07~26m

### Damaging Storm surges

Saxby Gale (1869) > 2.0m, Unnamed '00 ~1.6m,  
Juan '03 ~2.0 m



# A great American re-awakening

1989

HUGO



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Hurricane  
Centre

The Atlantic House  
Restaurant and beach



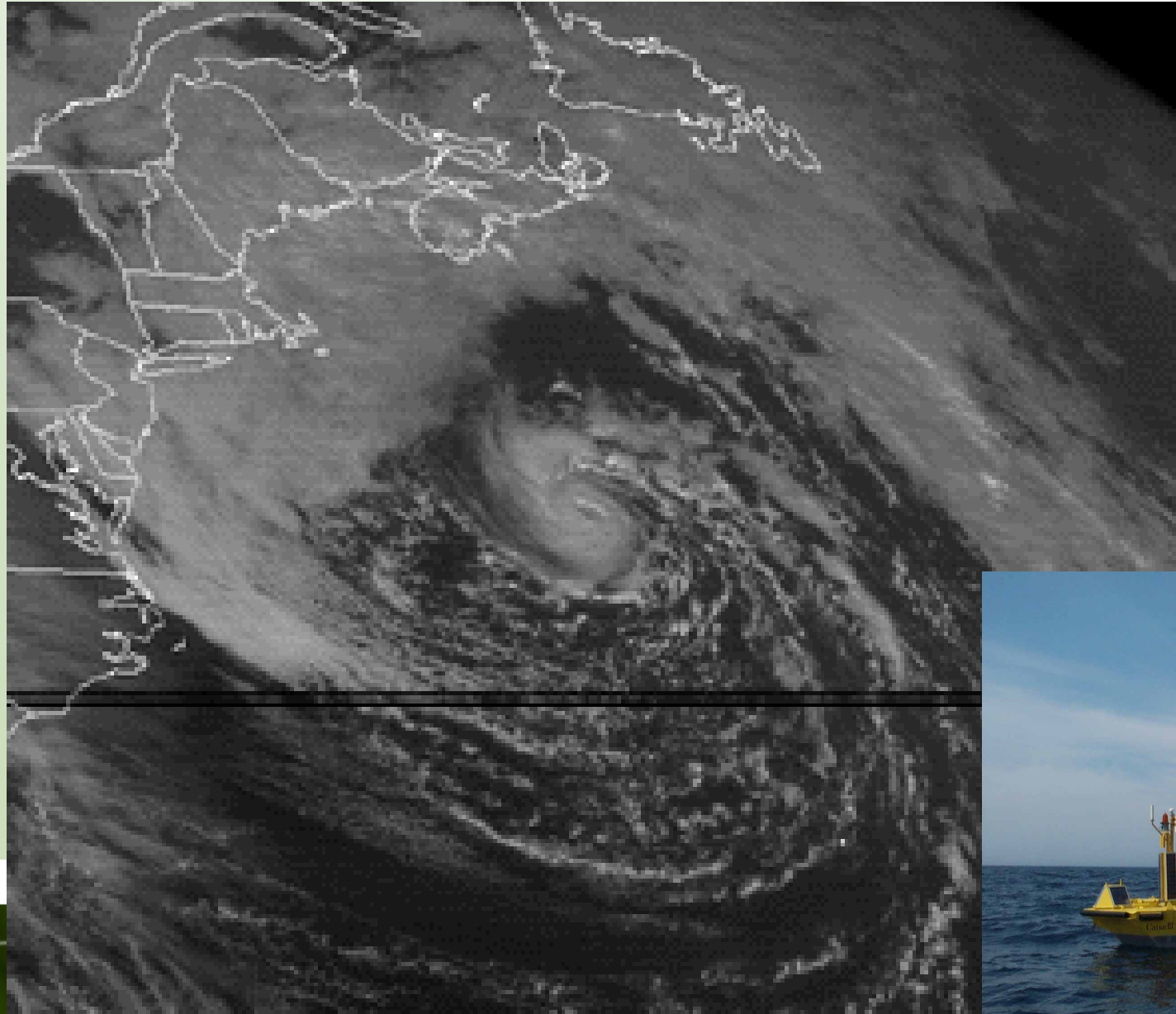
1<sup>st</sup> US major hurricane making landfall on the southeast coast in a generation (since Donna 1960). Cat. 4 at landfall.

# A Perfect Hallowe'en Scare

1991



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Centre





**It only takes one to make it a bad hurricane year**



**Canadian  
Hurricane  
Centre**

1992



\$25 billion  
Costliest US natural disaster  
Only 3<sup>rd</sup> landfalling Cat.5 hurricanes



7 named storms  
4 hurricanes  
1 major hurricane

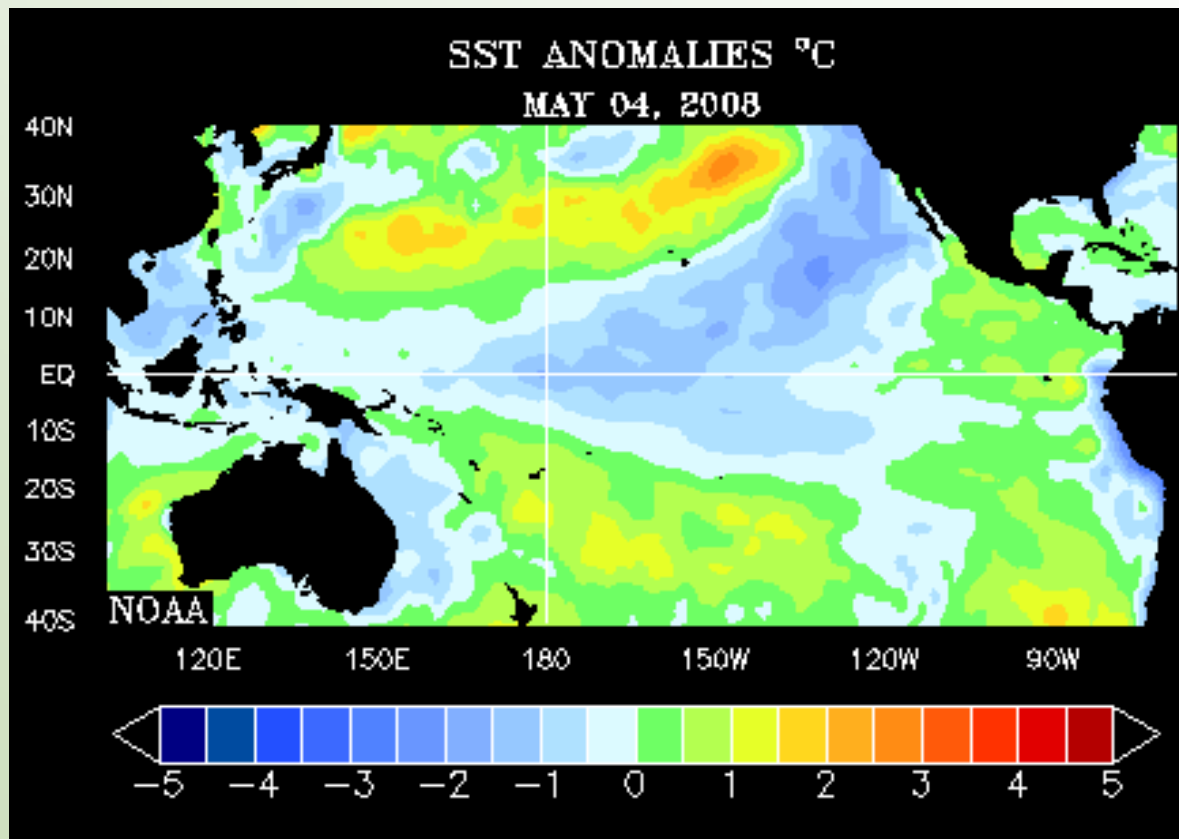
Average Since 1995  
15 named storms  
8 hurricanes  
4 major hurricane



## Speaking of ENSO ....



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Centre



**El Niño inhibits the production of Atlantic hurricanes by shifting the long-wave trough to bring increased shear over the tropical Atlantic.**

**El Niño-Southern Oscillation (ENSO; commonly referred to as simply El Niño) is a global coupled ocean-atmosphere phenomenon. The Pacific ocean signatures, El Niño and La Niña are important temperature fluctuations in surface waters of the tropical Eastern Pacific.**



Environment Canada  
[www.ec.gc.ca](http://www.ec.gc.ca)

# The Mother Ship

1993



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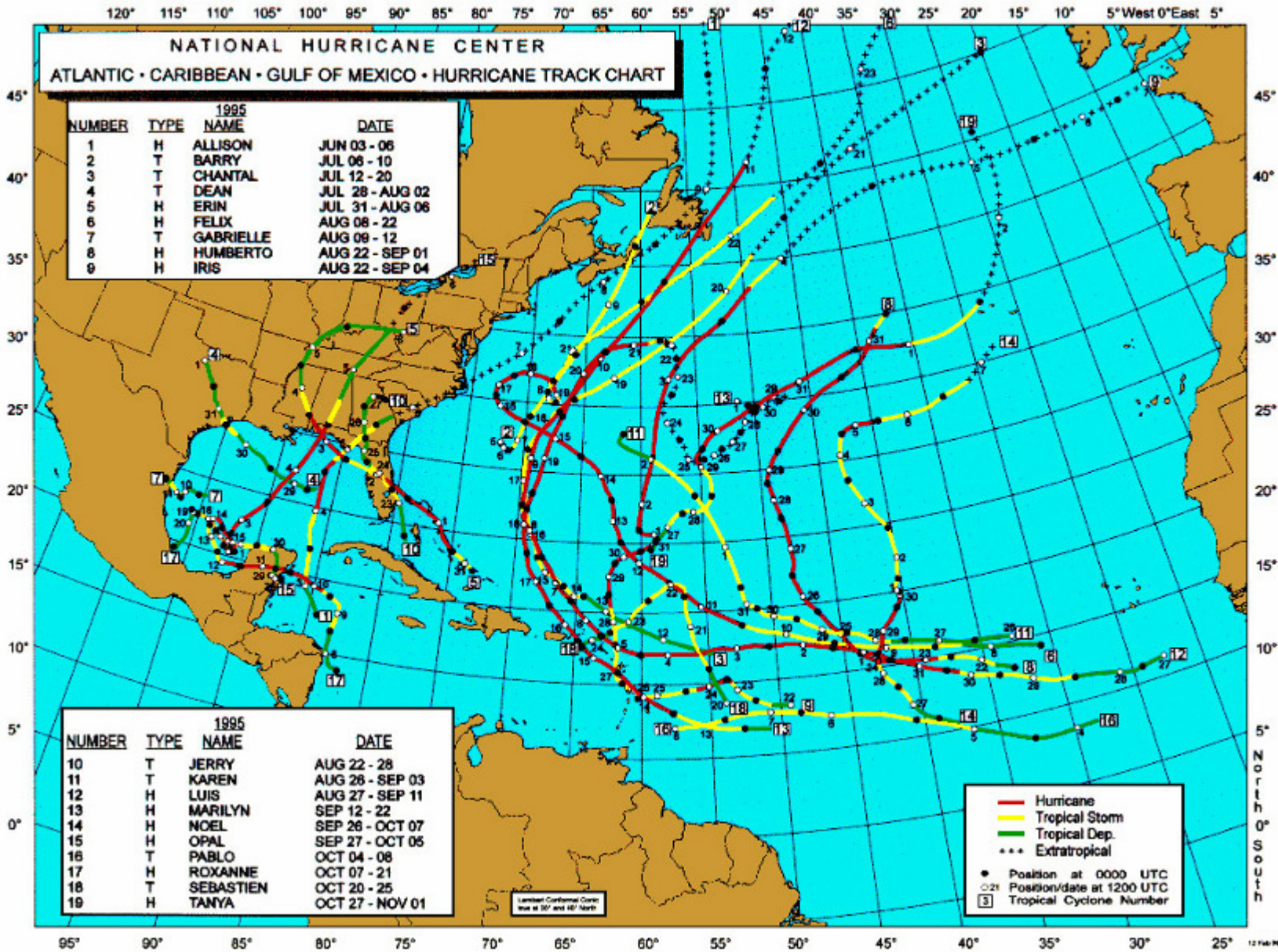


# The new era

1995



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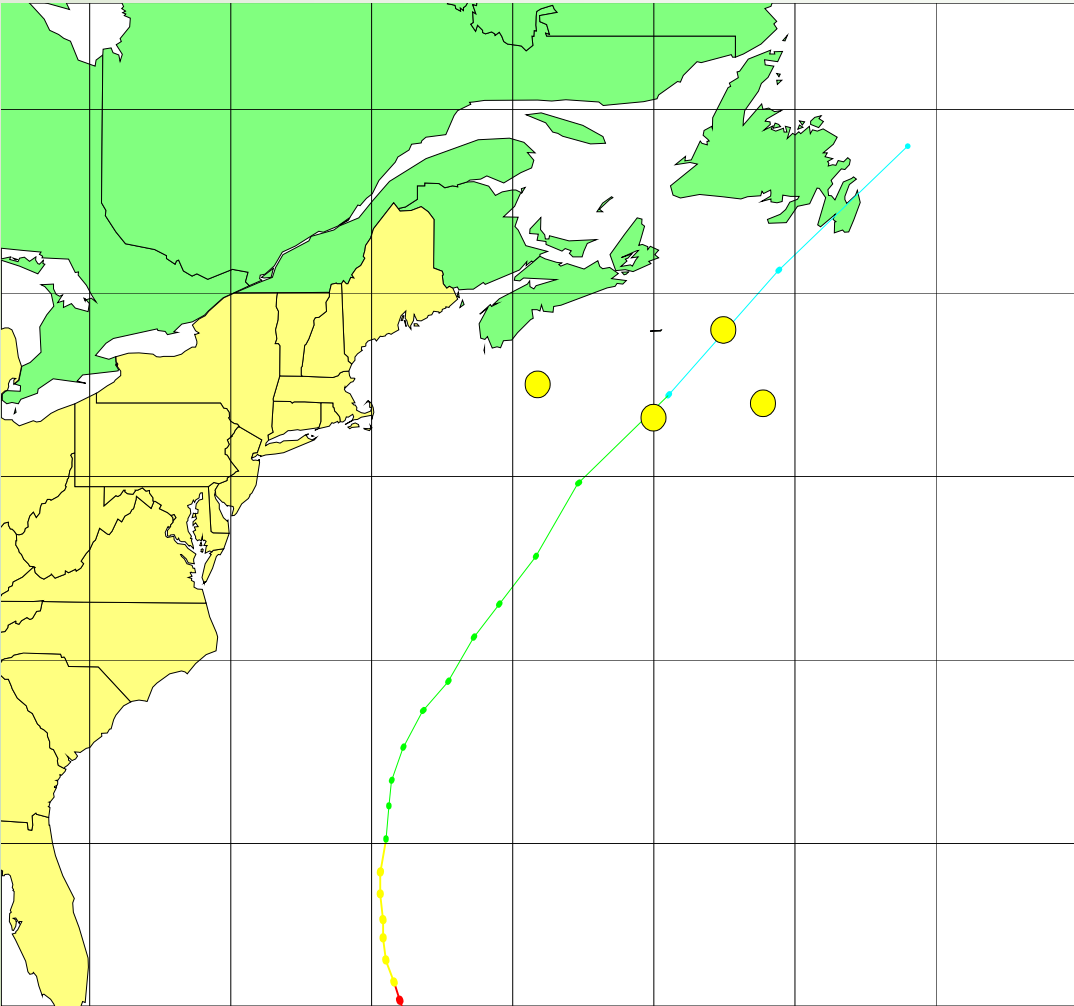


# Luis, the Queen and the Buoys

1995



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Hurricane  
Centre

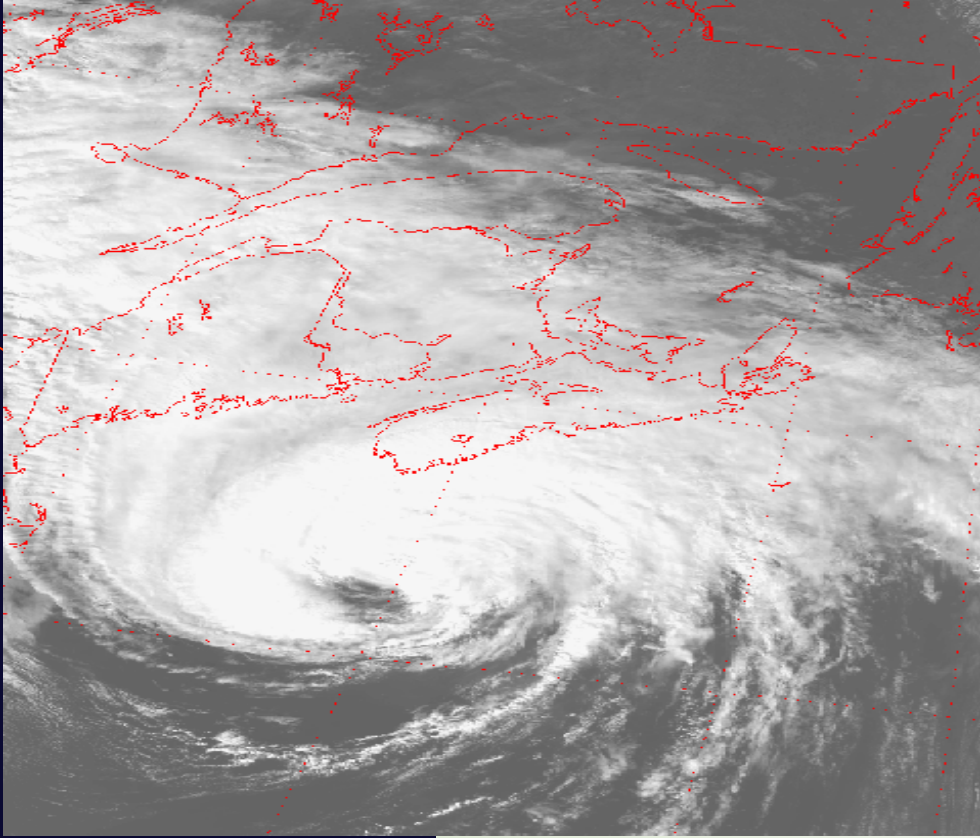
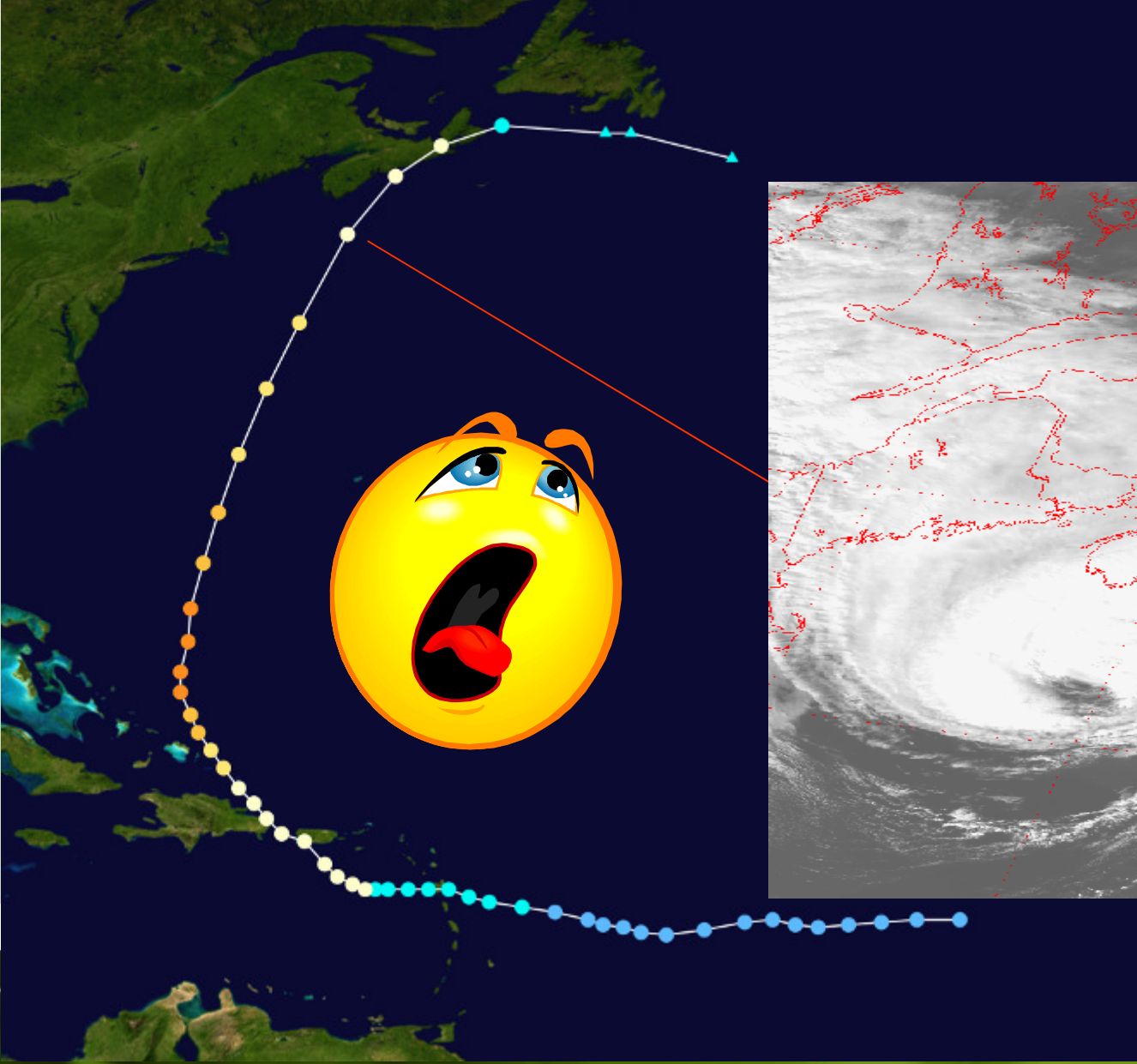


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# The "Ho-Hum" Hurricane

1996

HORTENSE

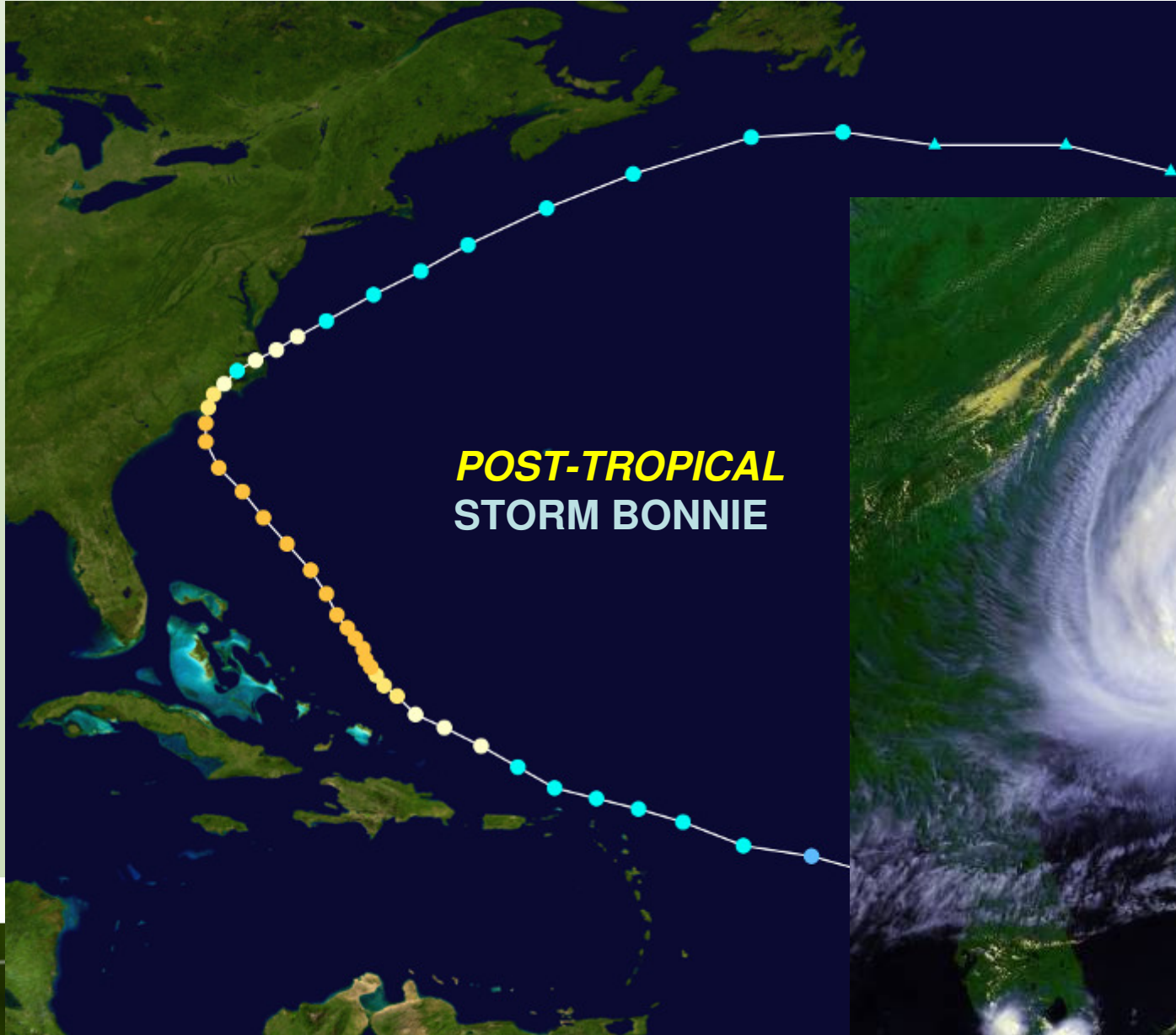


# A new naming convention

1998



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Hurricane  
Centre

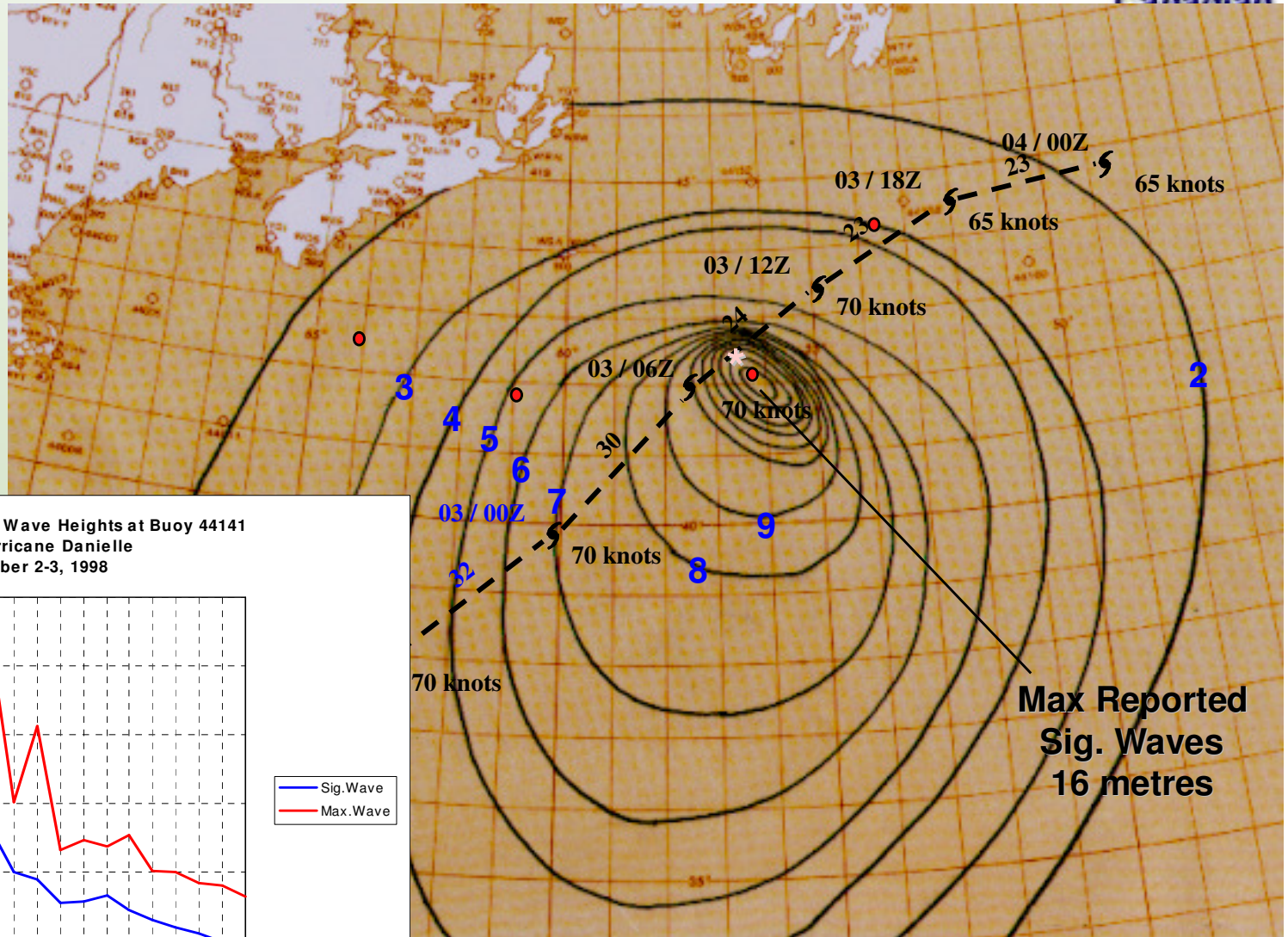


No saving graces up here ....

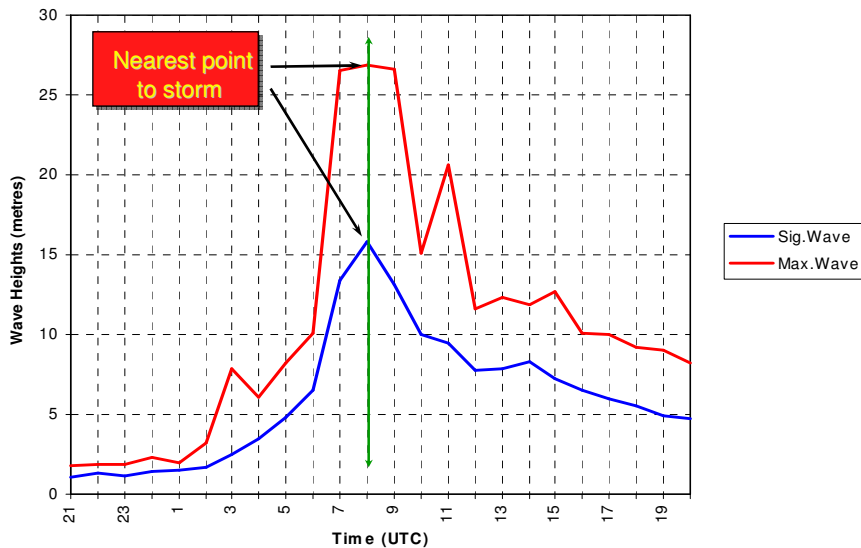


1998

DANIELLE



Significant & Maximum Wave Heights at Buoy 44141 During Hurricane Danielle September 2-3, 1998

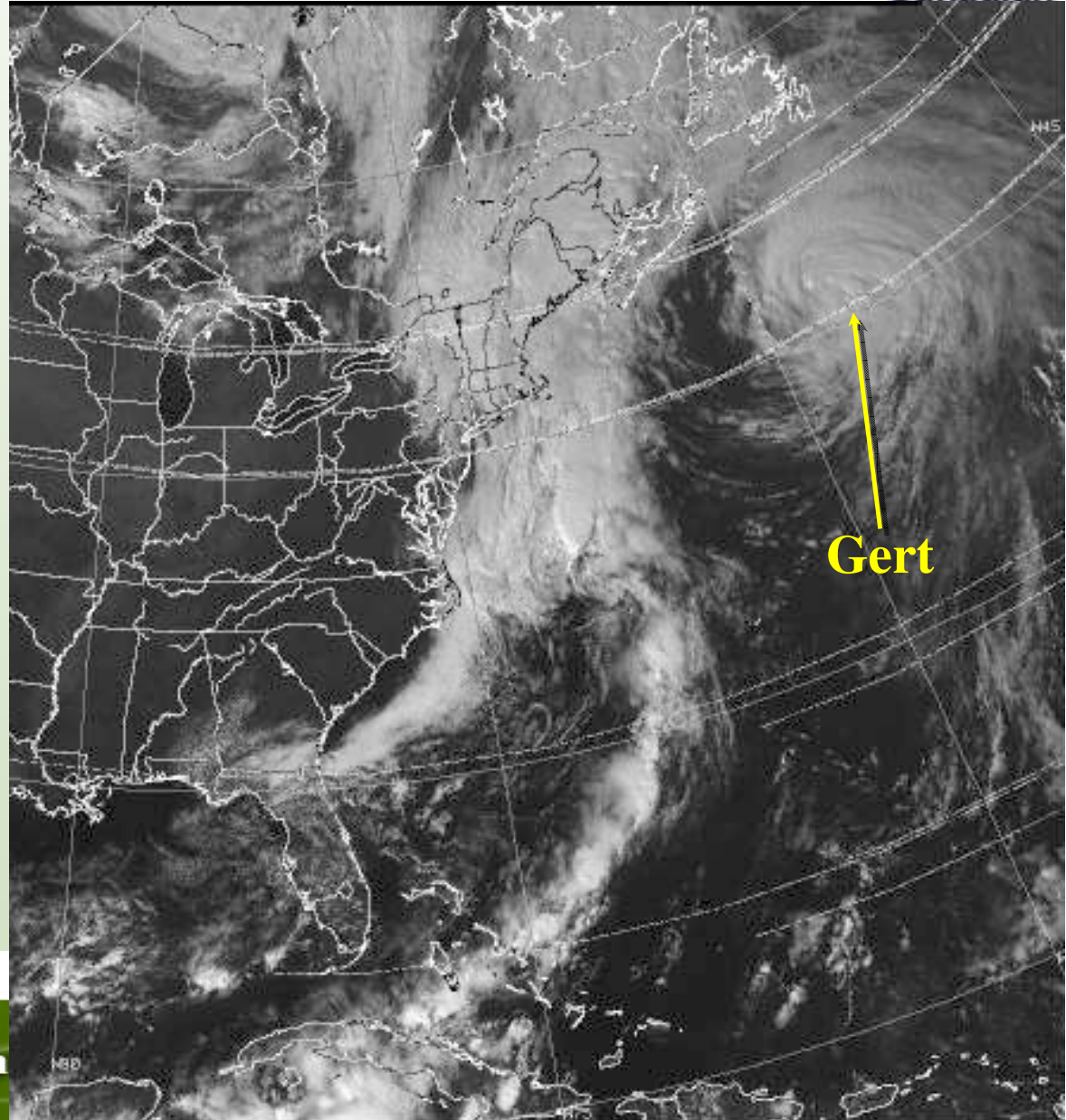




# The Great Decoy

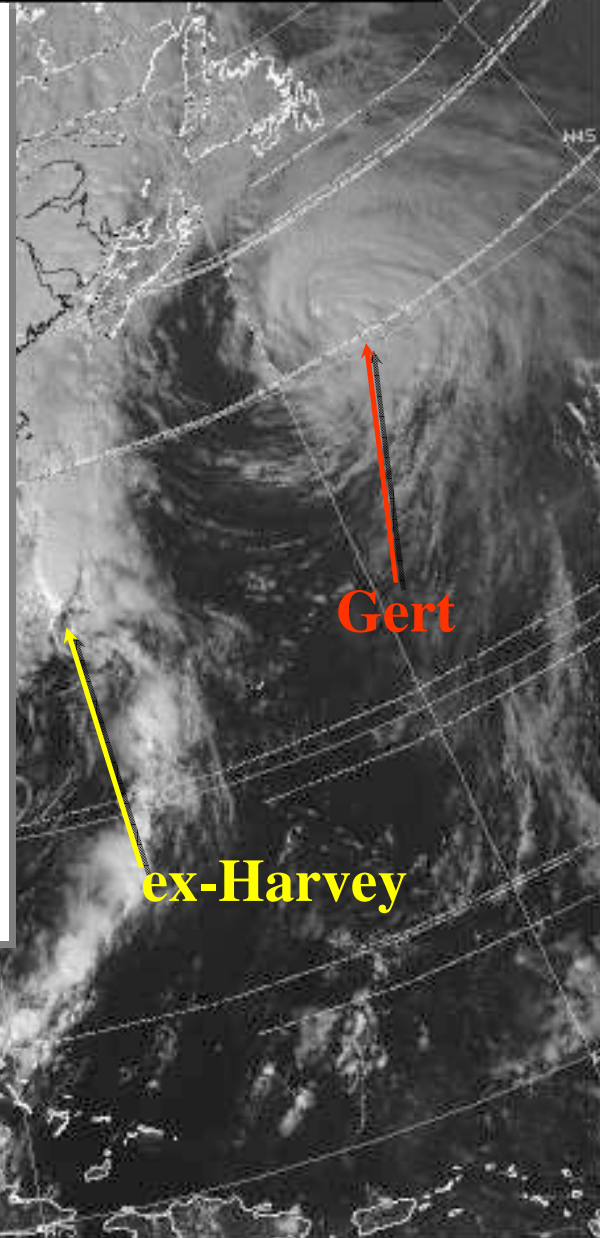
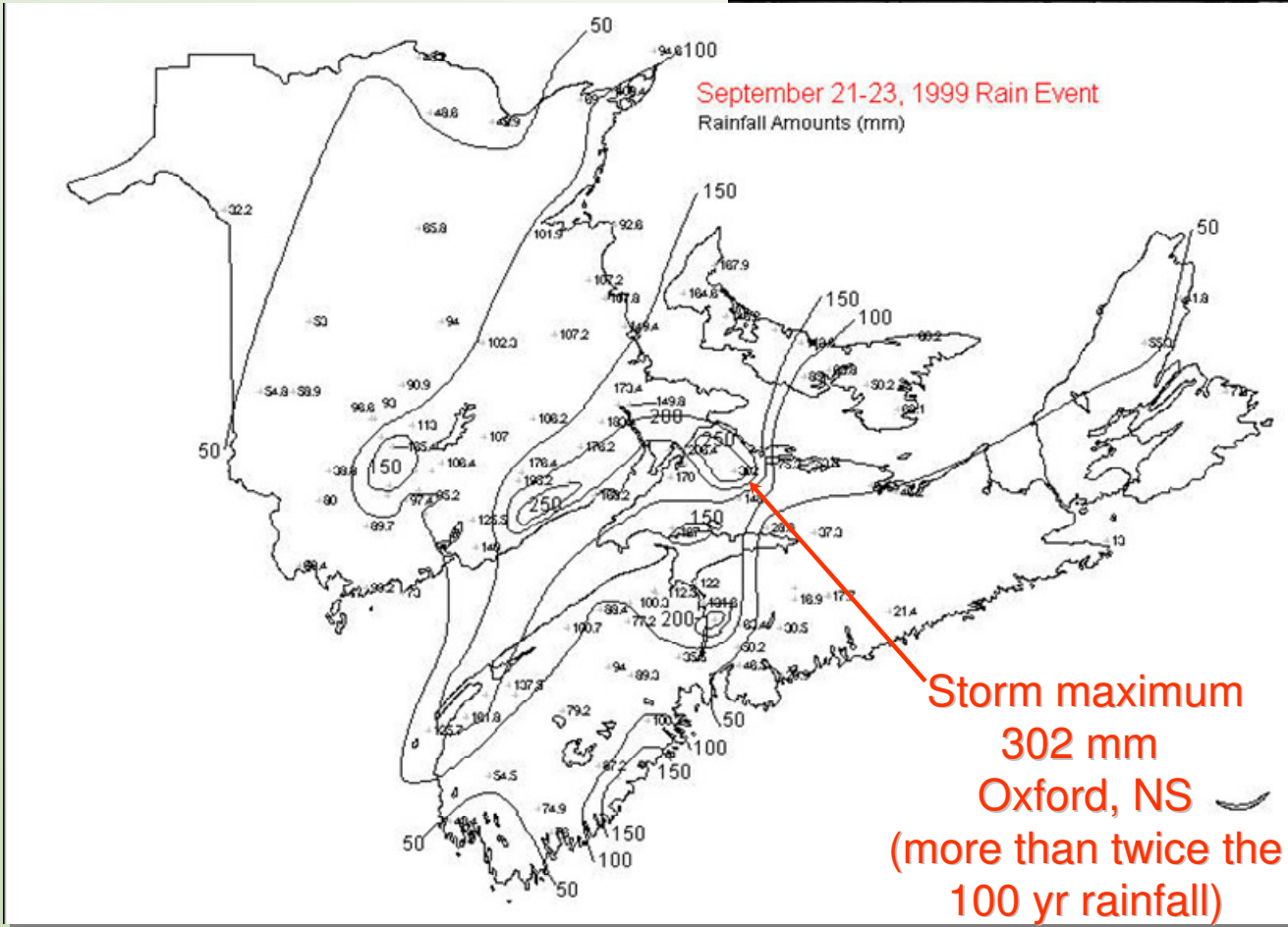


1999



# Wet Blueberries

1999



# Wet Blueberries

1999



Canadian  
Centre for  
Environmental Health



Courtesy Jane Smith

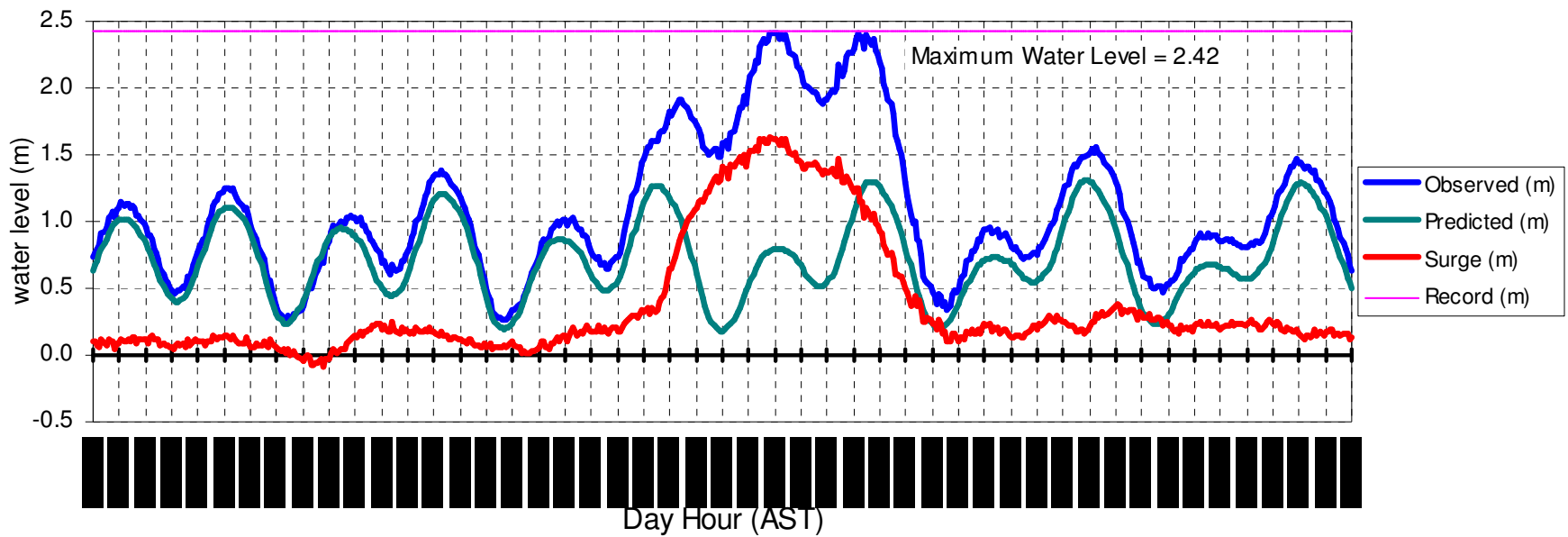
Environment Canada  
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# They dodged a bullet

2000



Escuminac Storm Surge - Oct 29, 2000 - (Nov 21, 1988 Record = 2.43 m)



An ocean surprise

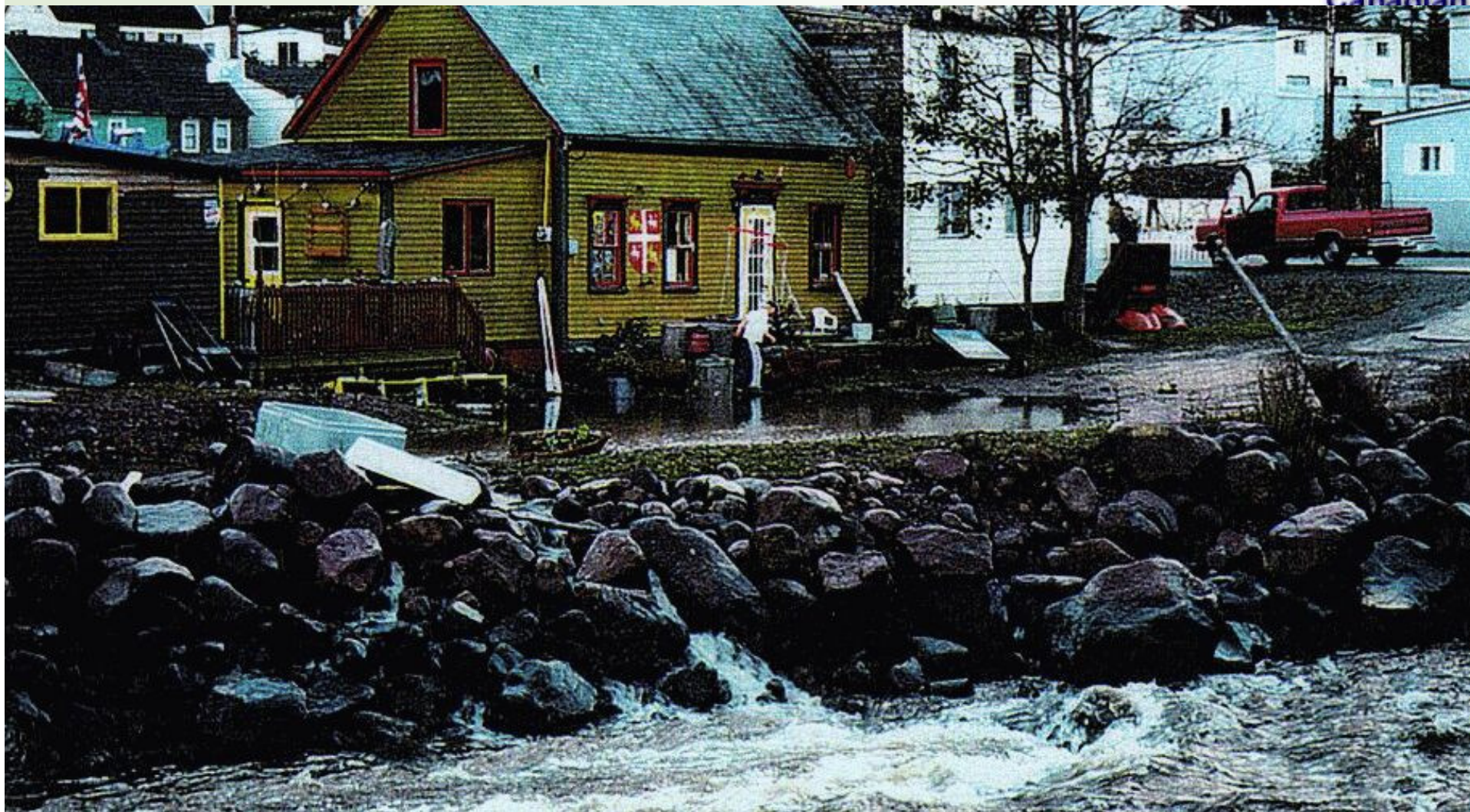








Canadian



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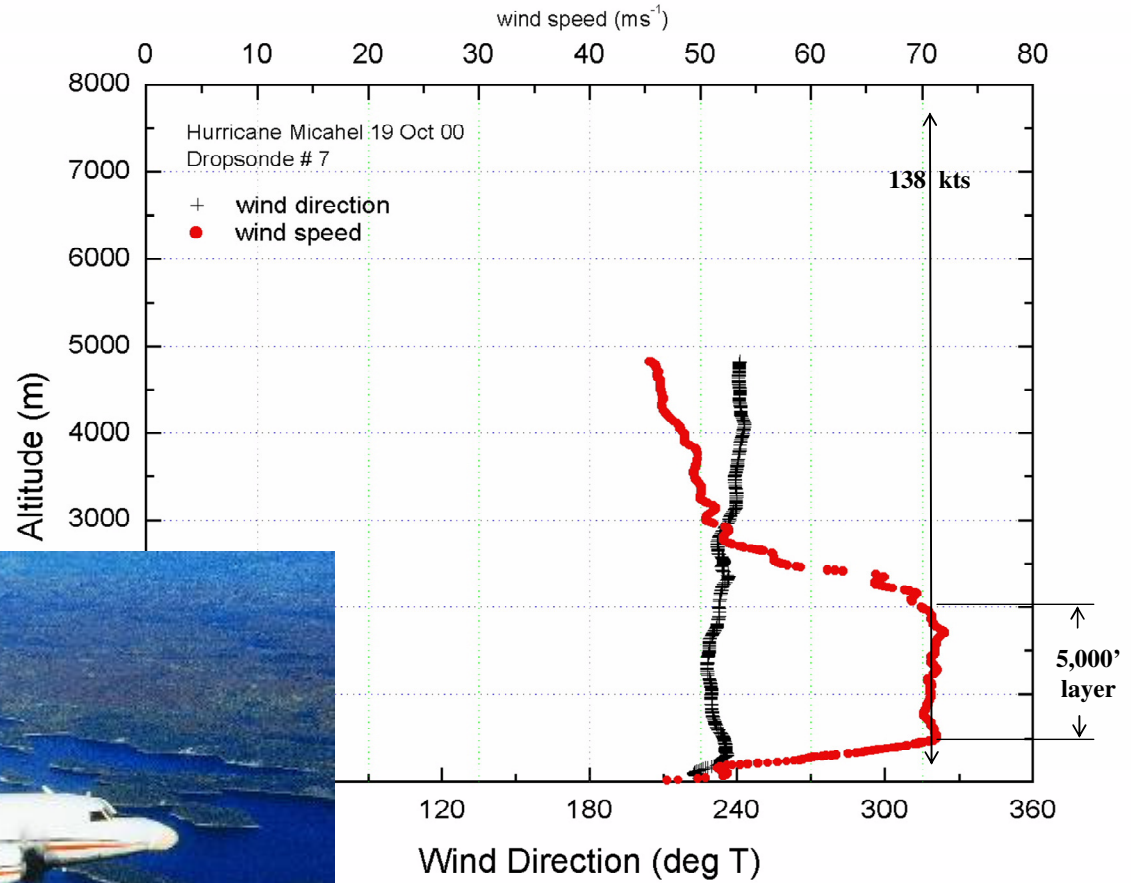
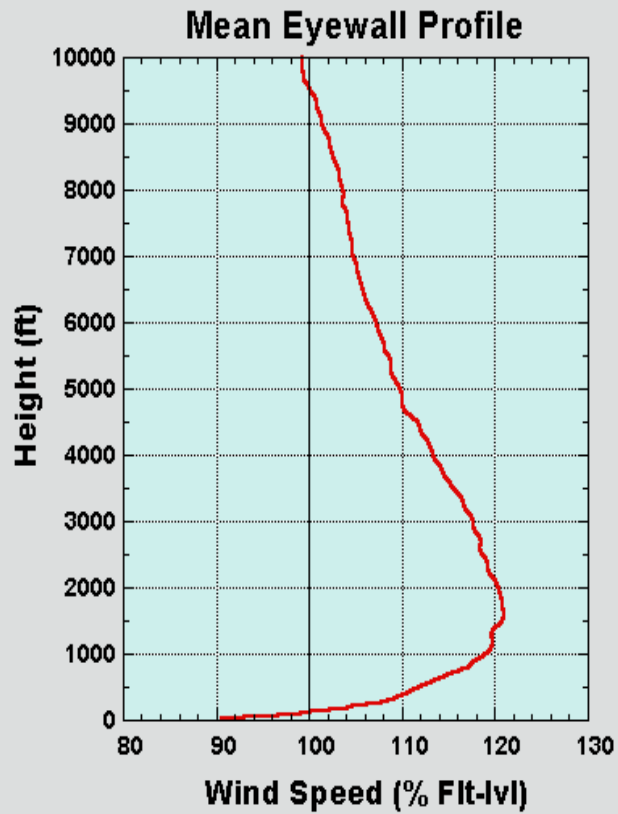
# Canadian hurricane flights ... another new era



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Hurricane  
Centre

2000

MICHAEL



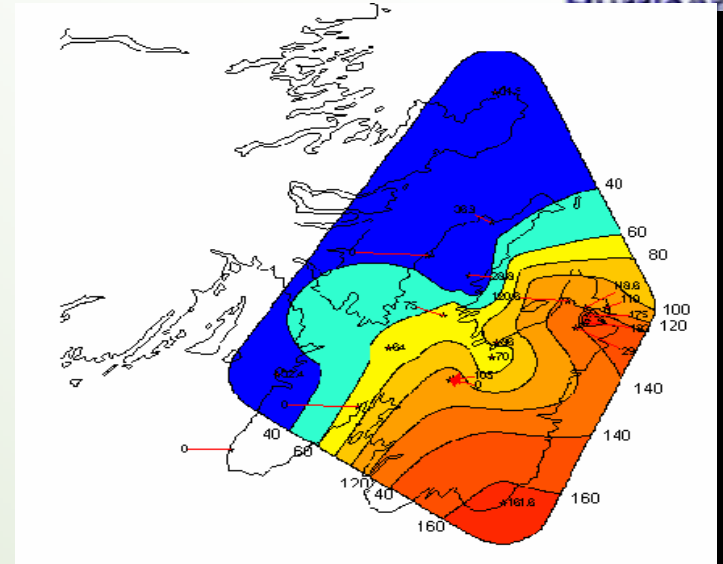
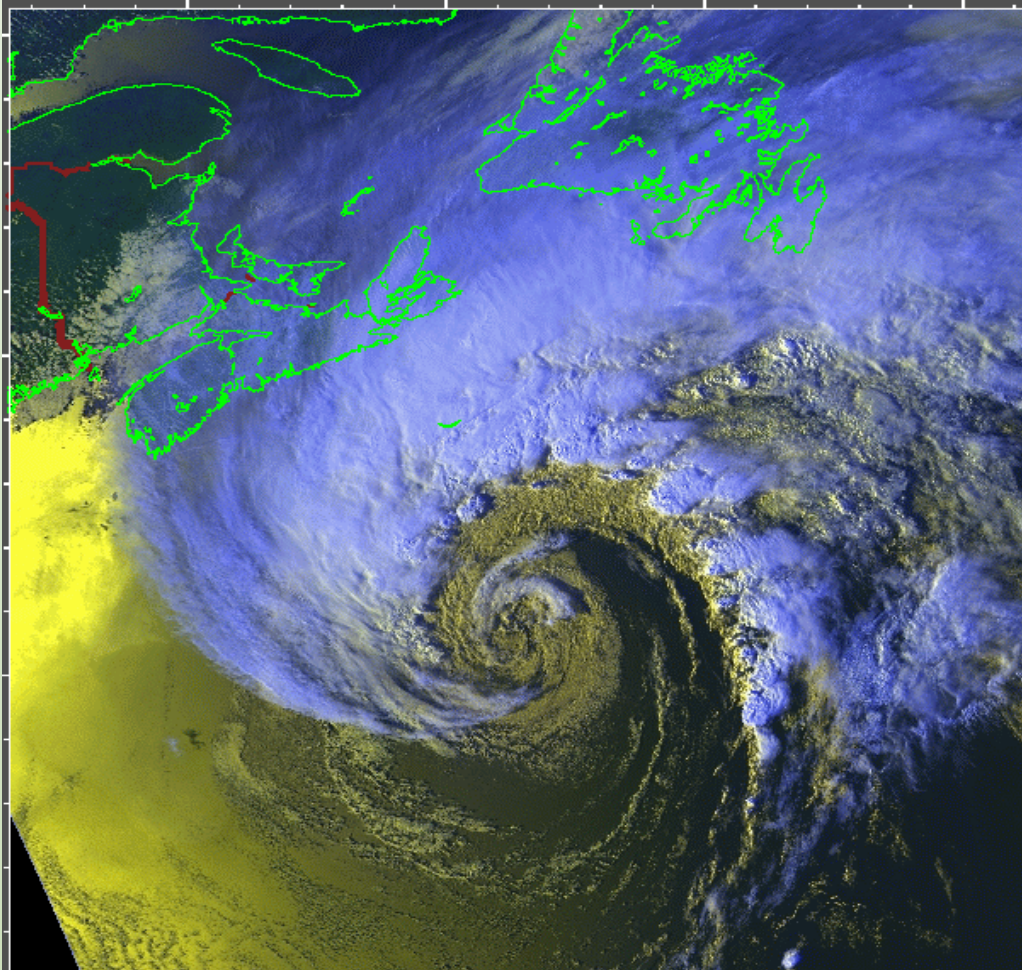
# St. John's' "storm of the century"



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Hurricane  
Centre

2001

## GABRIELLE



*“Worst storm in 100 years.”*

Mayor, St. John's

Environn  
www



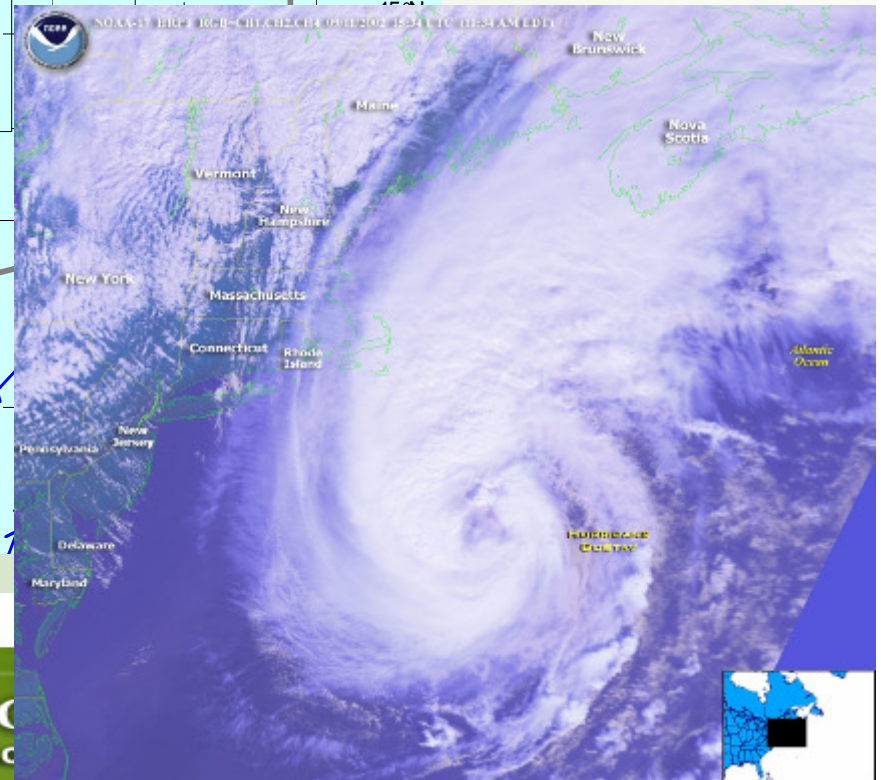
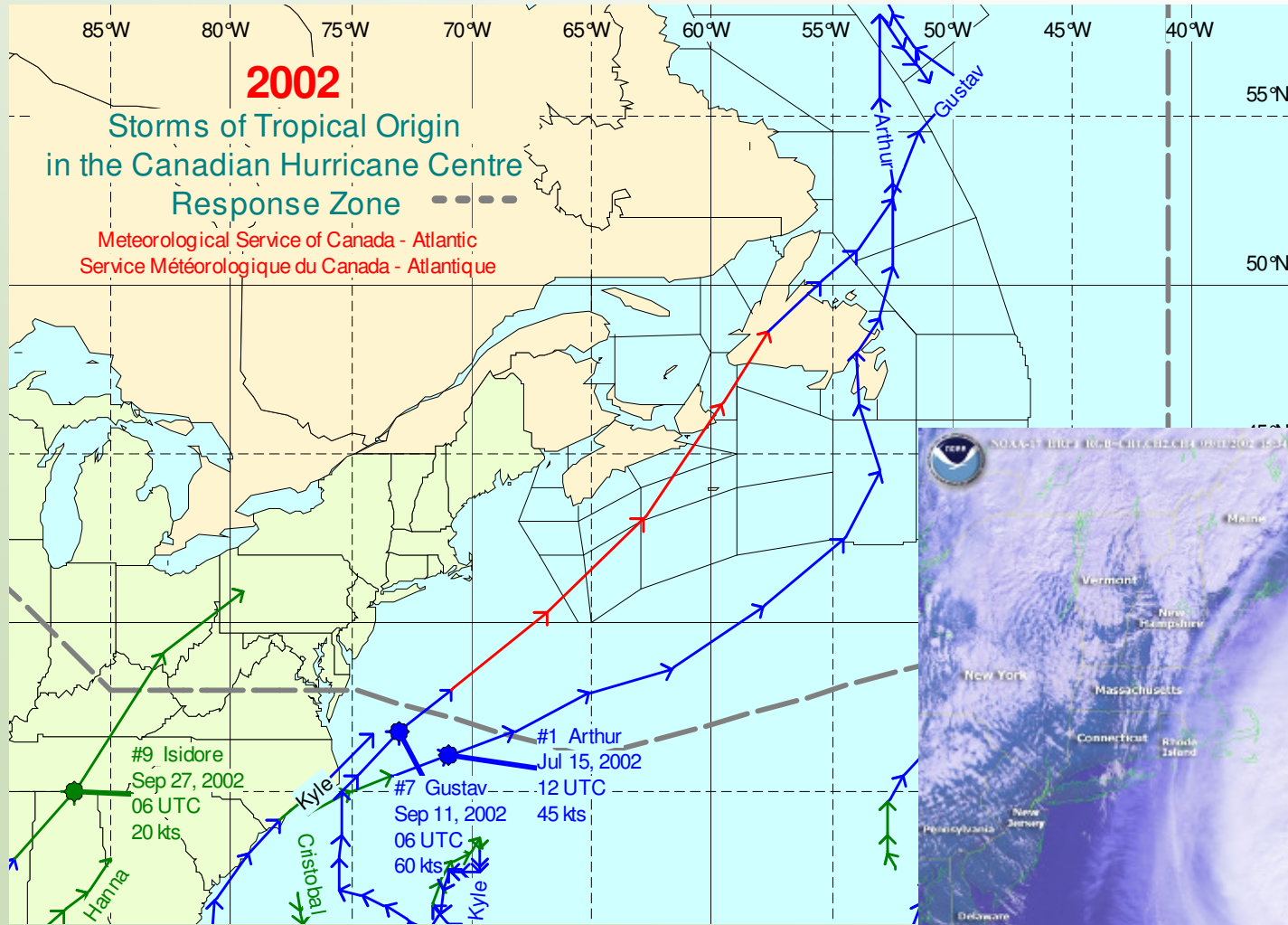
BOTTOM OF STADIUM PARKING LOT

# Hurricane Whatizname



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Centre**

2002



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