2016 Hurricane Briefing for the Institute for Catastrophic Loss Reduction

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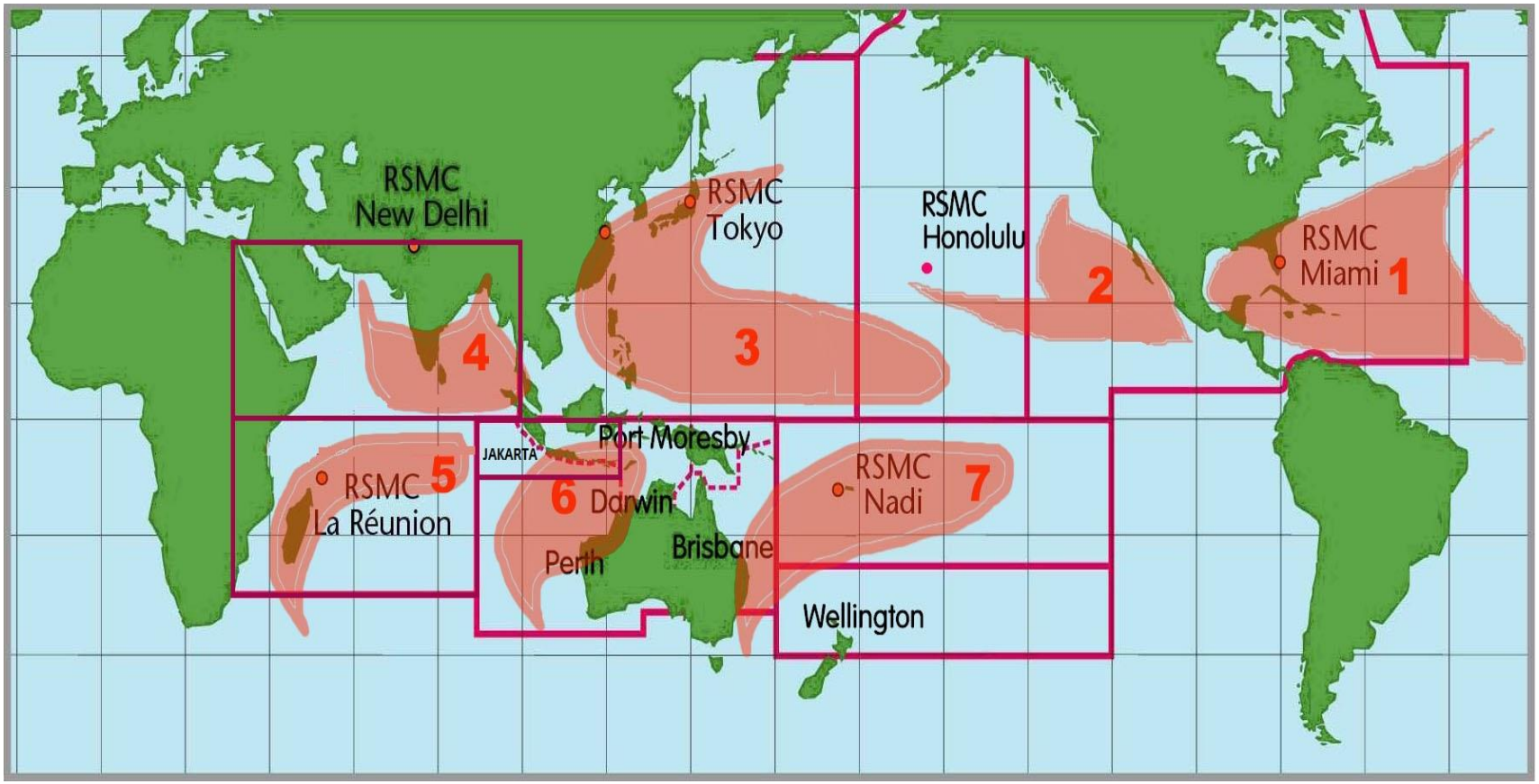
Contents

- The 5 Ws of Tropical Cyclones
- Tropical Cyclone Hazards
- Review of the 2015 Hurricane Season
- Outlook for the 2016 Hurricane Season
- Operational Response to Approaching Storms: Forecasting and Communications

Who…

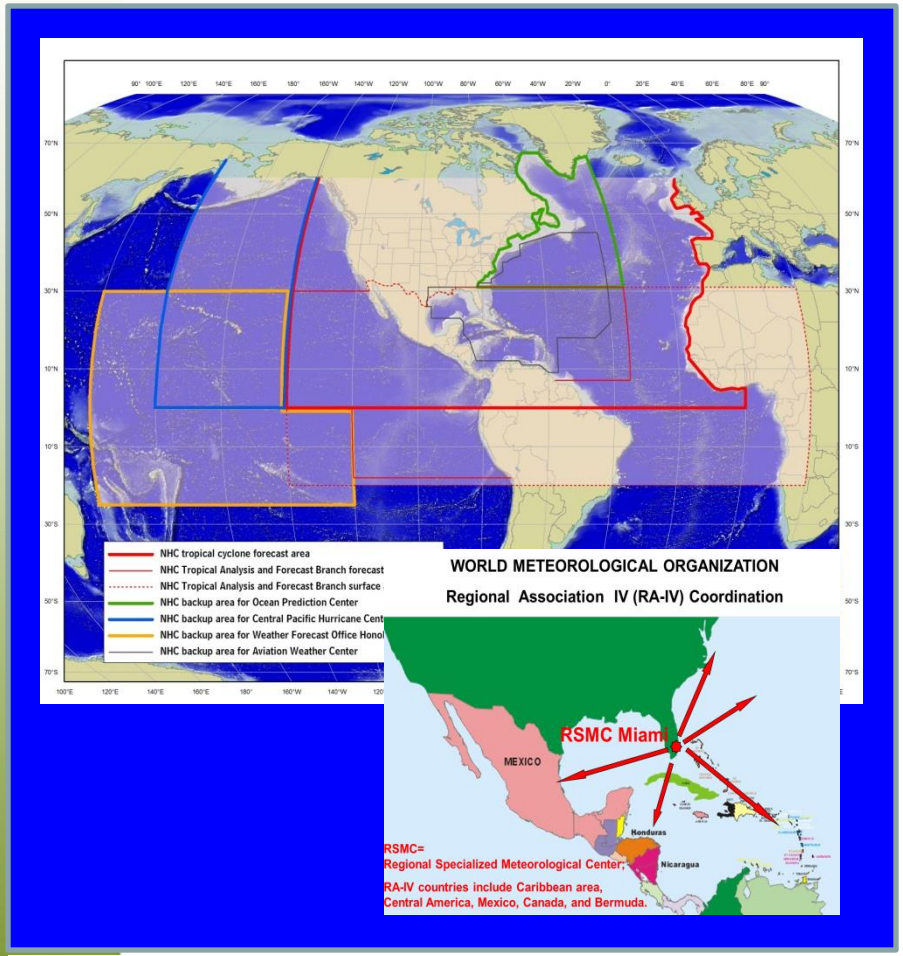
…issues forecasts for tropical cyclones?

Who issues forecasts for Tropical Cyclones?

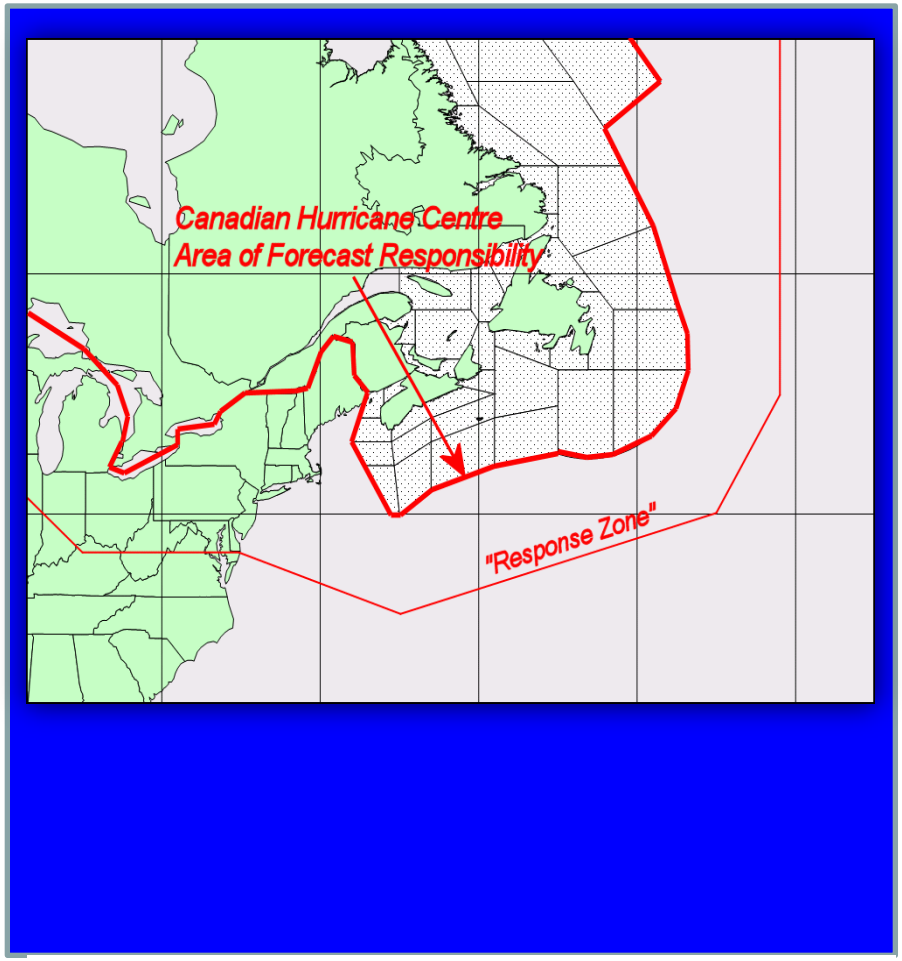


- NHC is one of 7 RSMCs that produce and coordinate tropical cyclone forecasts for various ocean basins.
- NHC is responsible for both the Atlantic and eastern North Pacific Ocean basins.

Who issues forecasts for Tropical Cyclones?



NHC is the Regional Specialized Meteorological Center (RSMC) for the WMO RA-IV



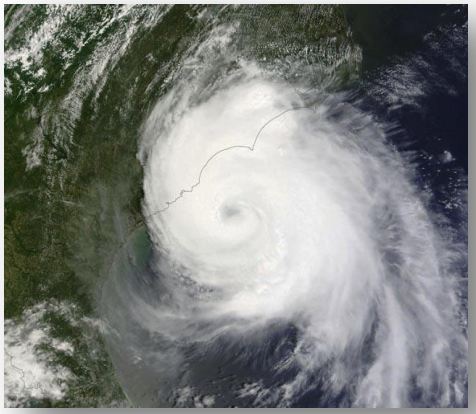
CHC provides Canadians with meteorological information on hurricanes, tropical storms and post-tropical storms

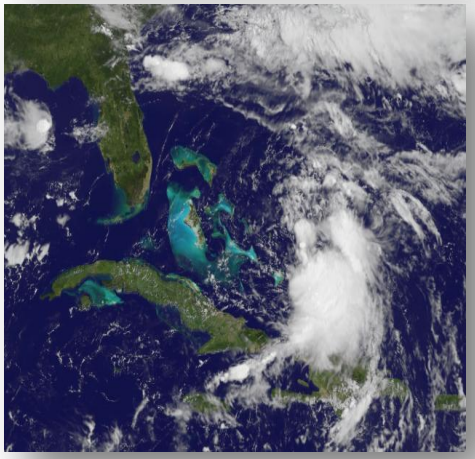
What…

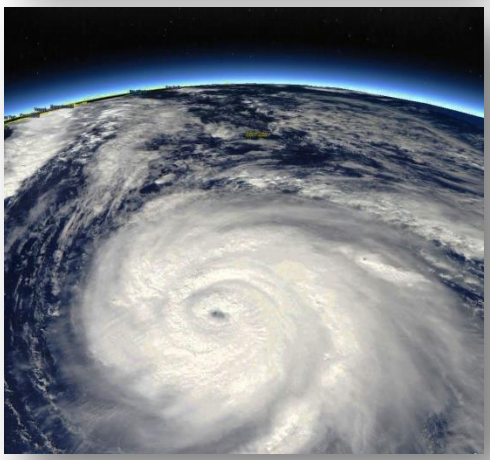
…are tropical cyclones?

Tropical Cyclones

- Tropical cyclones are relatively large and long-lasting low pressure systems that form over warm water
- Tropical cyclones must have a closed surface wind circulation around a well-defined center
- They are classified by maximum sustained surface wind speed



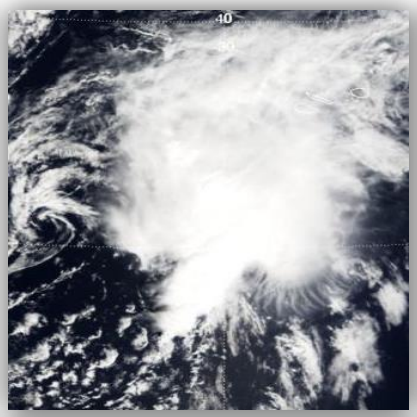




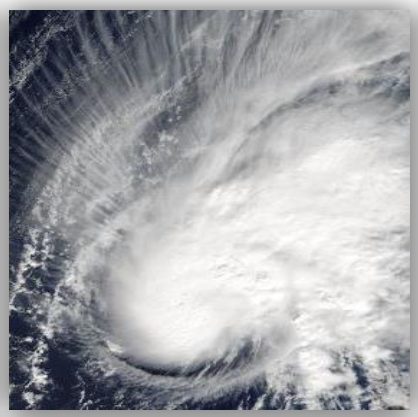
Tropical Cyclone Classification

Tropical Disturbance
Wind < 37 km/h (23 mph)

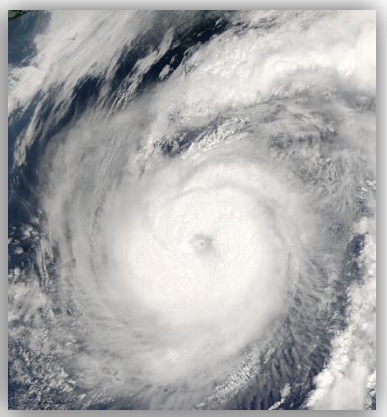
Tropical Depression
Wind 37+ km/h (23 mph)

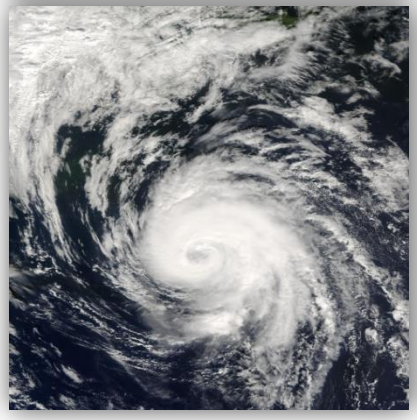


Tropical Storm
Wind 63+ km/h (39 mph)

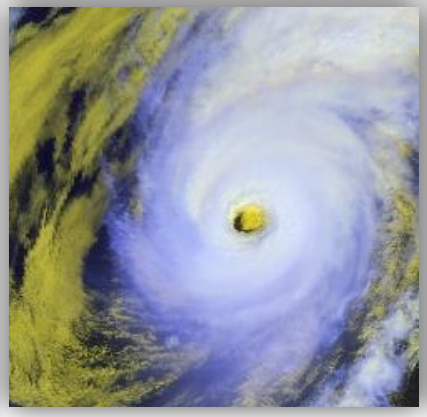


Hurricane – Cat. 1
Wind 118+ km/h (74 mph)



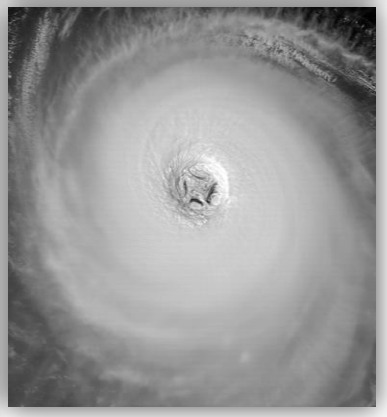


Wind 154+ km/h (96 mph)
Hurricane – Cat. 2



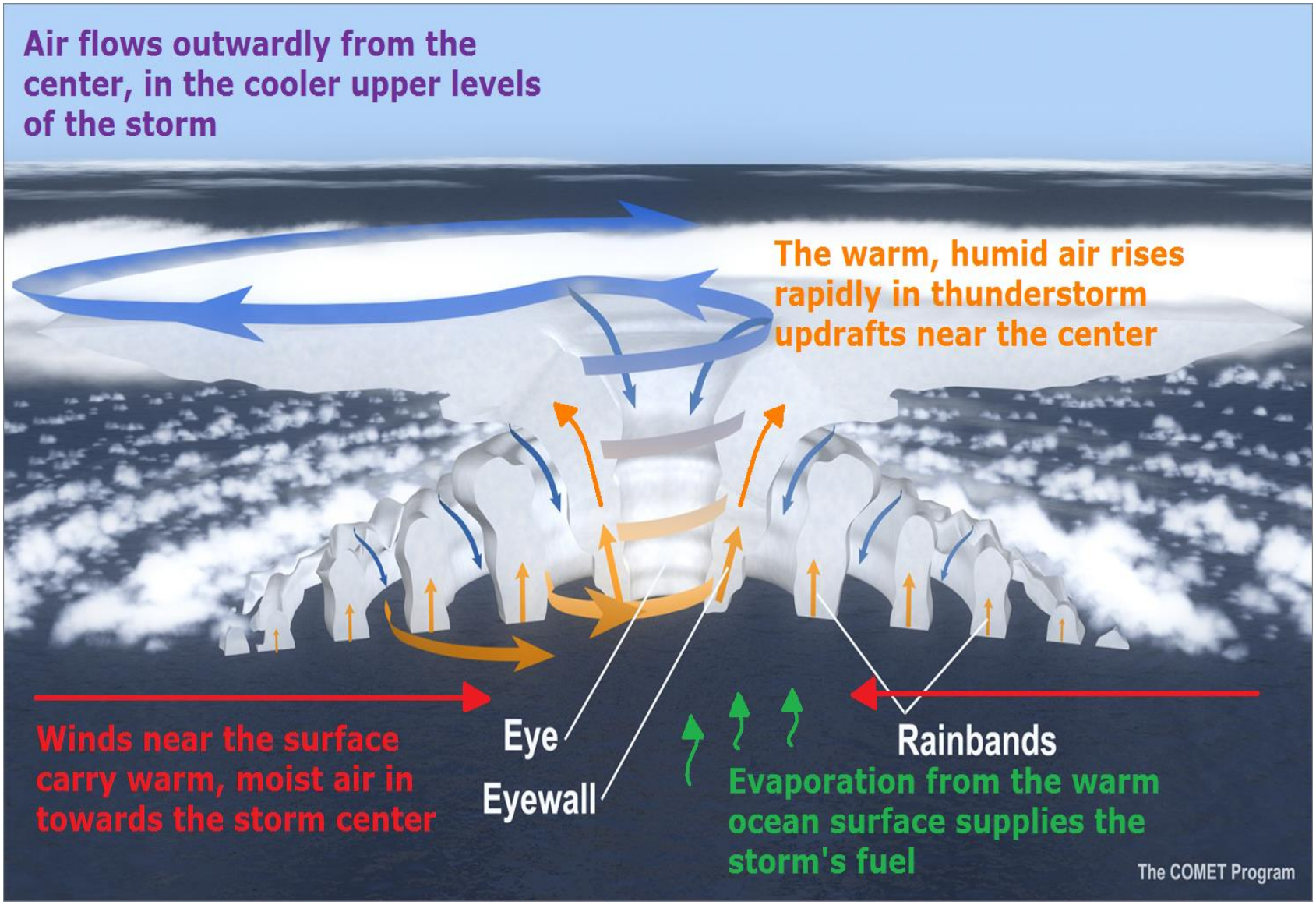
Wind 178+ km/h (111 mph)
Hurricane – Cat. 3
Major Hurricane

Wind 211+ km/h (131 mph)
Hurricane – Cat. 4
Major Hurricane



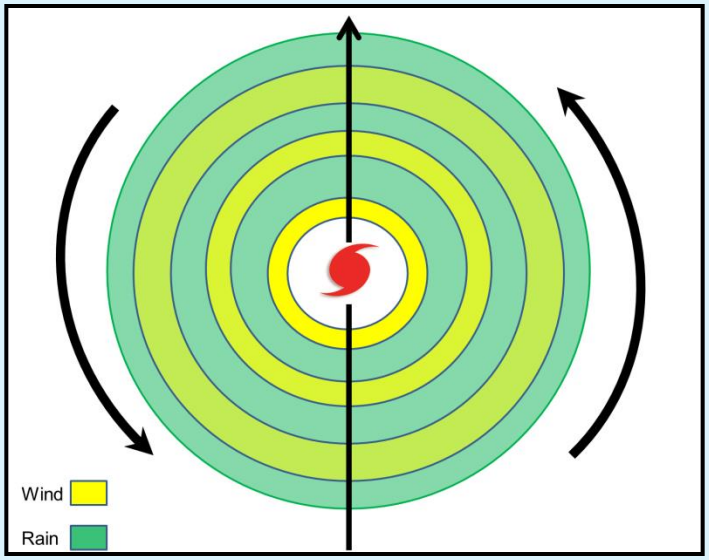
Wind > 251 km/h (156 mph)
Hurricane – Cat. 5
Major Hurricane

Tropical Cyclones – Nature's Heat Engine



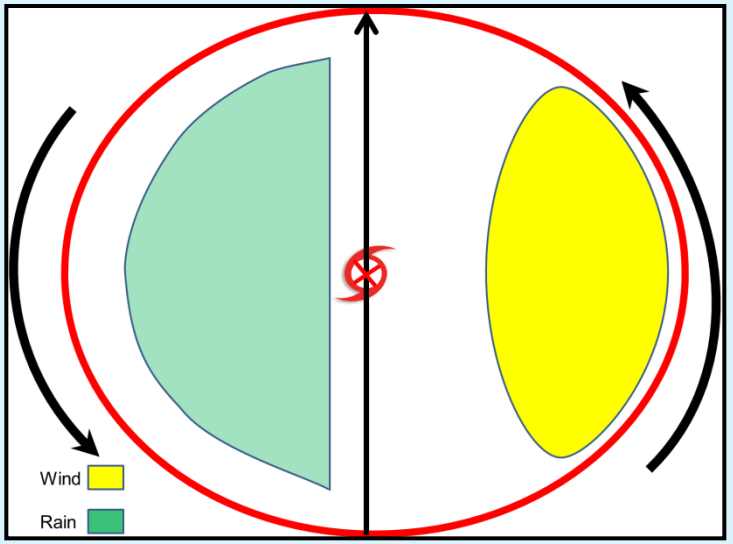
Tropical vs. Post-Tropical

Tropical



- Stronger winds for a series of concentric bands around the centre of the storm
- Strongest winds are found in the band closest to the centre – this is called the eyewall
- Rain is heavy and fairly symmetric around the centre of the storm

Post-Tropical

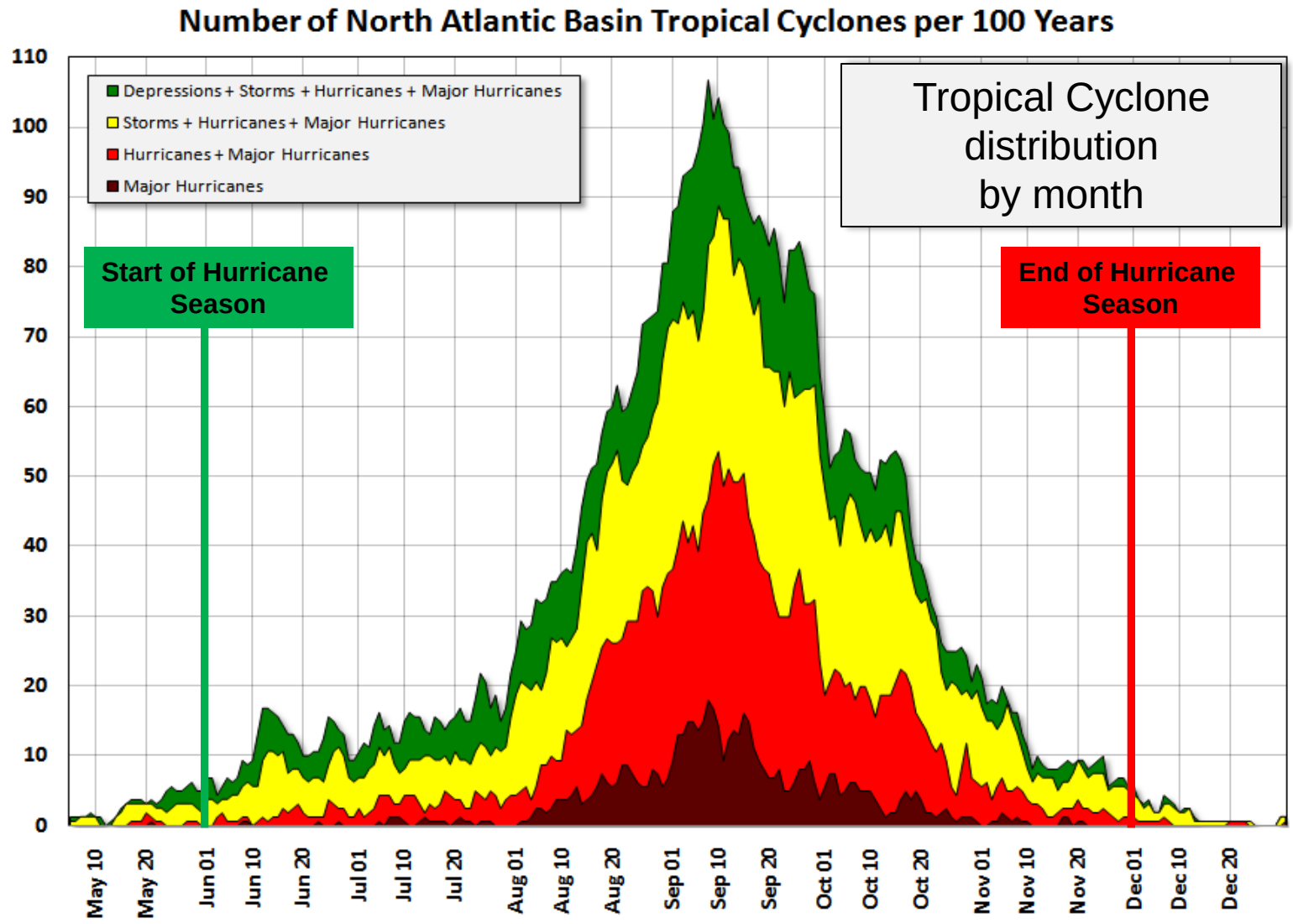


- Size of the storm increases
- Strongest winds usually found on the right side of the storm's track and some distance away from the centre
- Heaviest rain usually found on the left side of the storm's track

When…

…do tropical cyclones form?

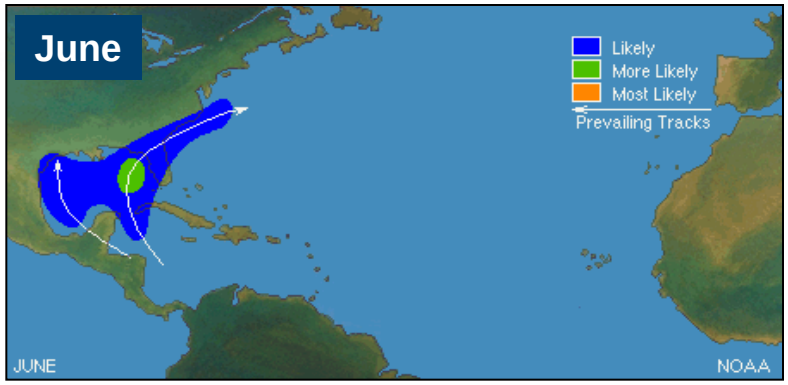
Tropical Cyclone Climatology

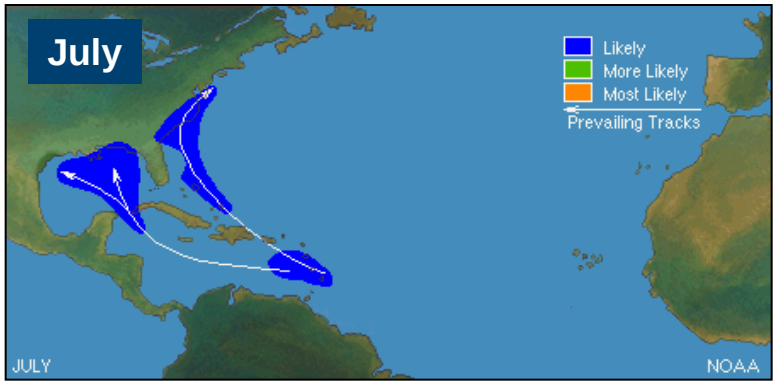


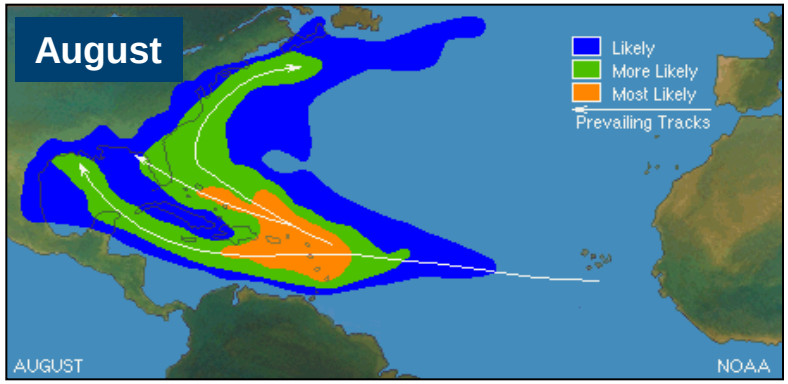
Where…

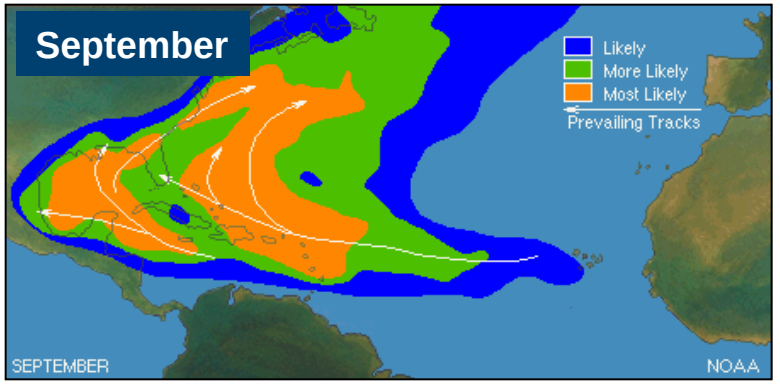
…do tropical cyclones form?

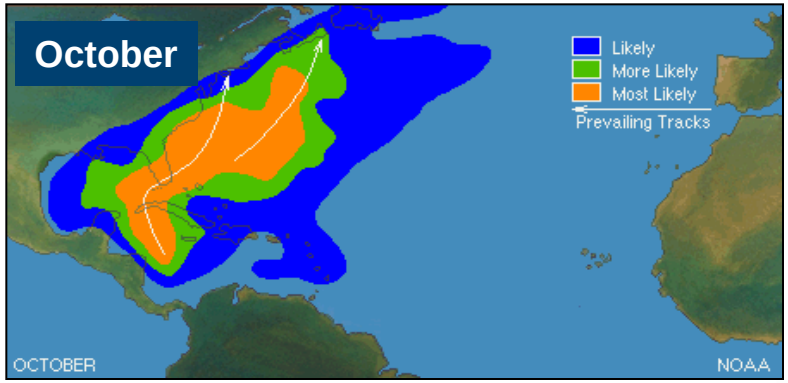
Climatological Areas of Origin of Tropical Cyclones

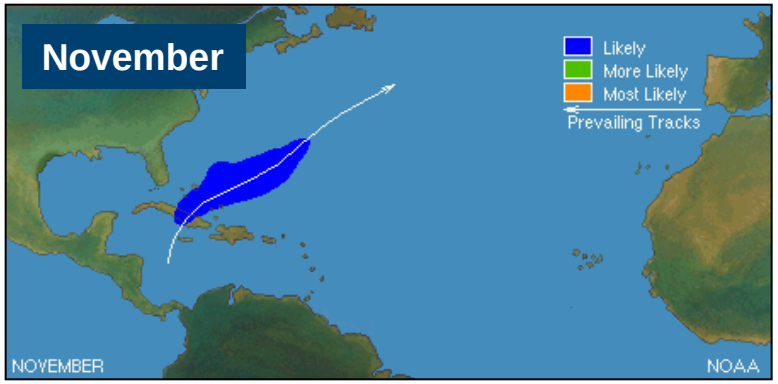












Why…

…do tropical cyclones form?

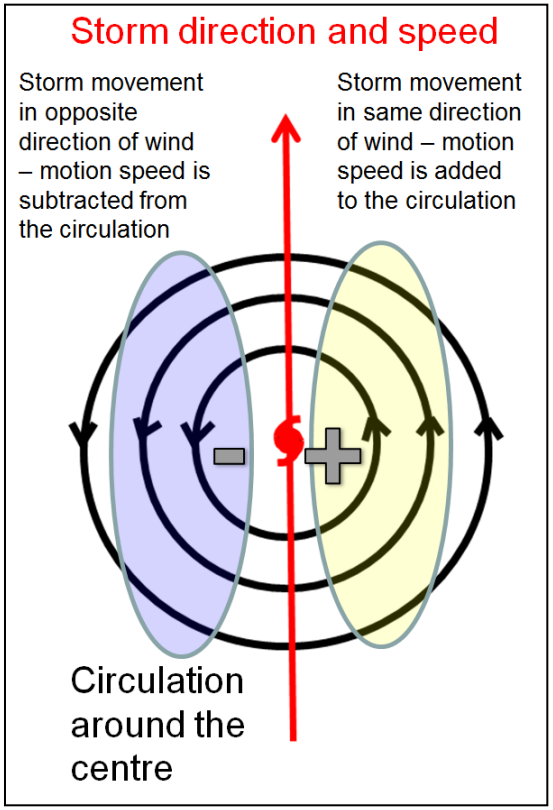
Why do they form?

- Tropical Cyclones form due to a build-up of heat energy in the ocean
- The purpose of a Tropical cyclone is to regulate the planet's temperature

Tropical Cyclone Hazards

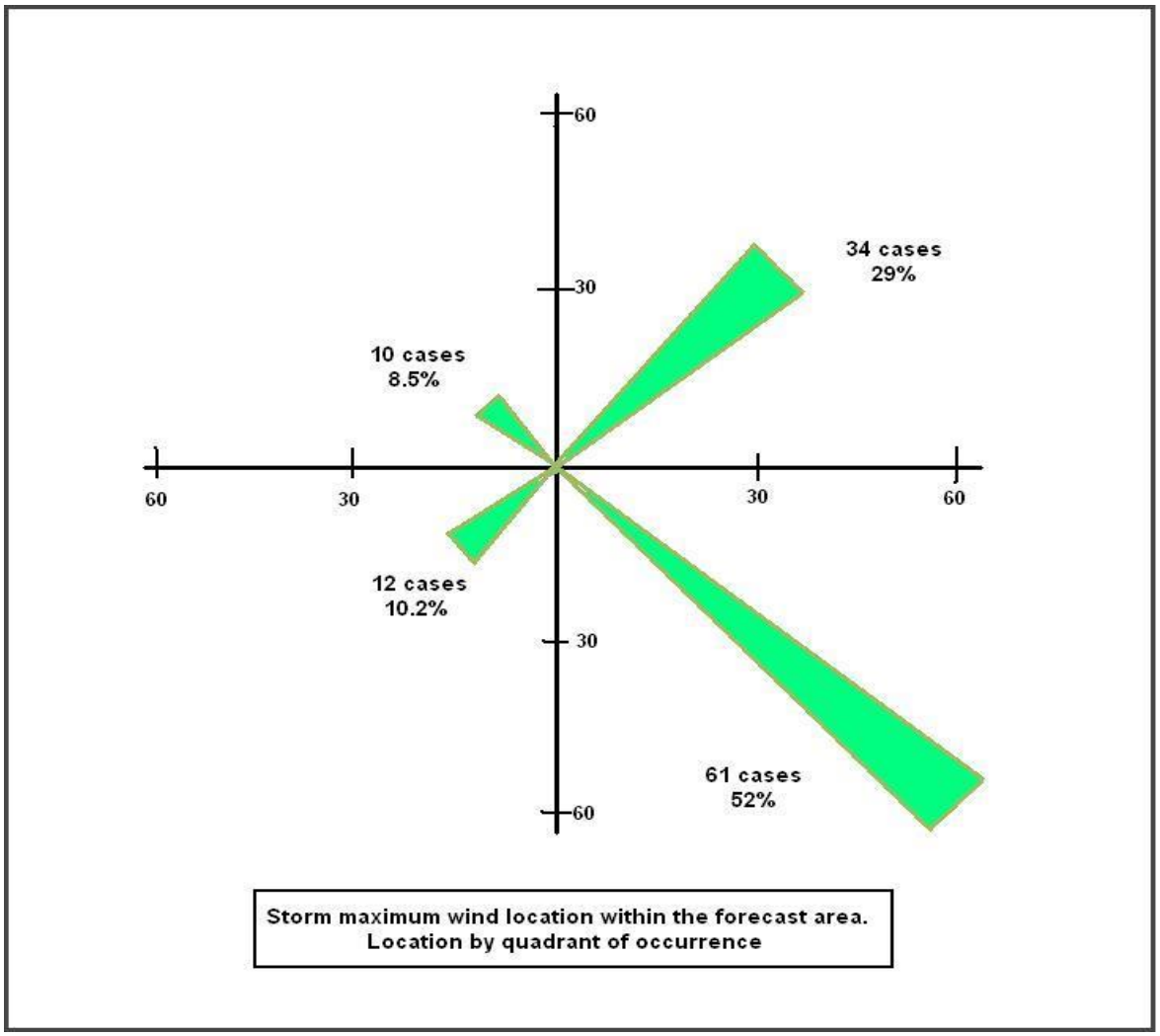
Tropical Cyclone Hazards - Wind

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



- Winds are strong on both sides of a hurricane
- When a storm becomes post-tropical:
  - Storm size increases
  - Speed of the storm increases
  - Difference in wind speed between right and left side of the track increases
- Sometimes a post-tropical storm can interact with a trough and produce strong winds on both side

Tropical Cyclone Hazards - Wind



Storm maximum wind location within the forecast area.
Location by quadrant of occurrence

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

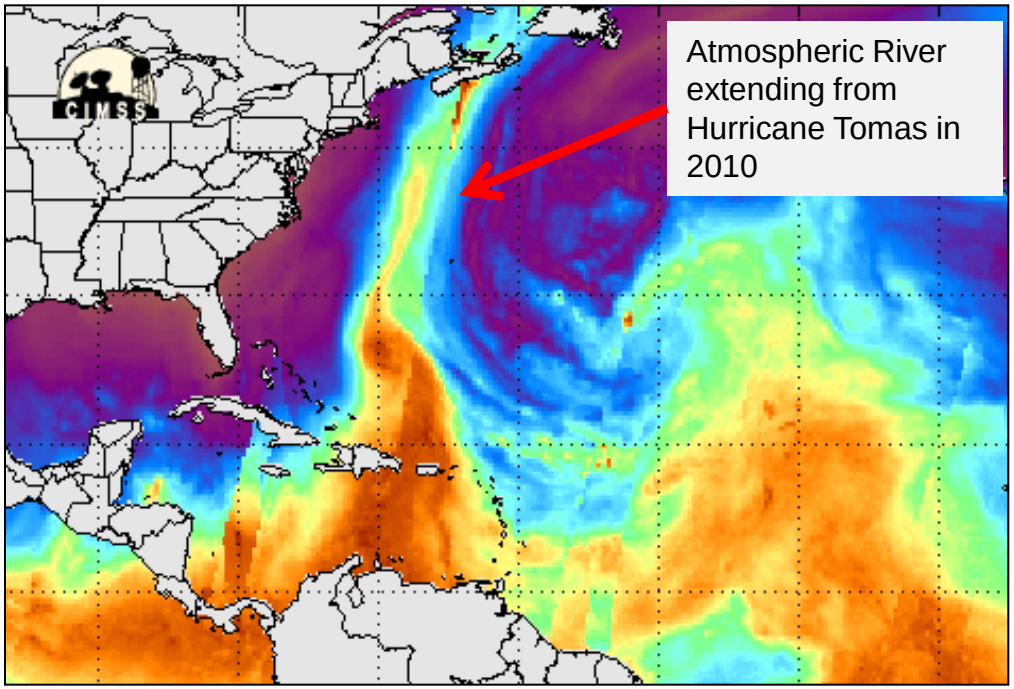
(Location by quadrant of occurrence)

Tropical Cyclone Hazards - Rain

- Tropical systems by their very nature produce extreme rainfall rates (rates can reach 20-50 mm per hour)
- As tropical cyclones become post-tropical the heaviest rain migrates to the left side of the storm track
- Sometimes narrow bands of concentrated moisture originating from the tropics can cause extreme rainfall
- These “Atmospheric Rivers” can extent 1000s of km from a tropical cyclone and cause significant flooding even though the actual storm is far away

Factors affecting rainfall amounts and distribution in tropical cyclones

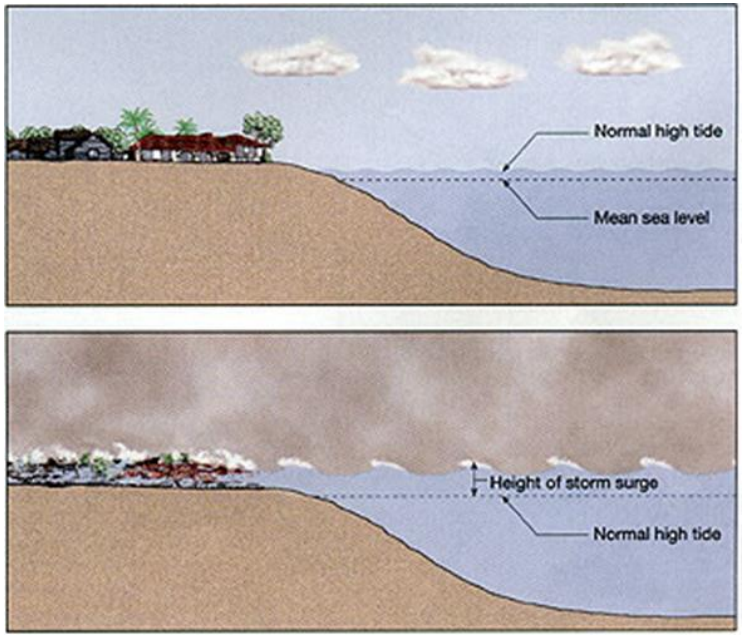
1. **Size** (bigger storm = more rain)
2. **Motion** (slower storm = more rain)
3. **Rain rate** (higher rain rate = more rain)
4. **Duration** (longer duration = more rain)
5. **Stage of transition to post-tropical**

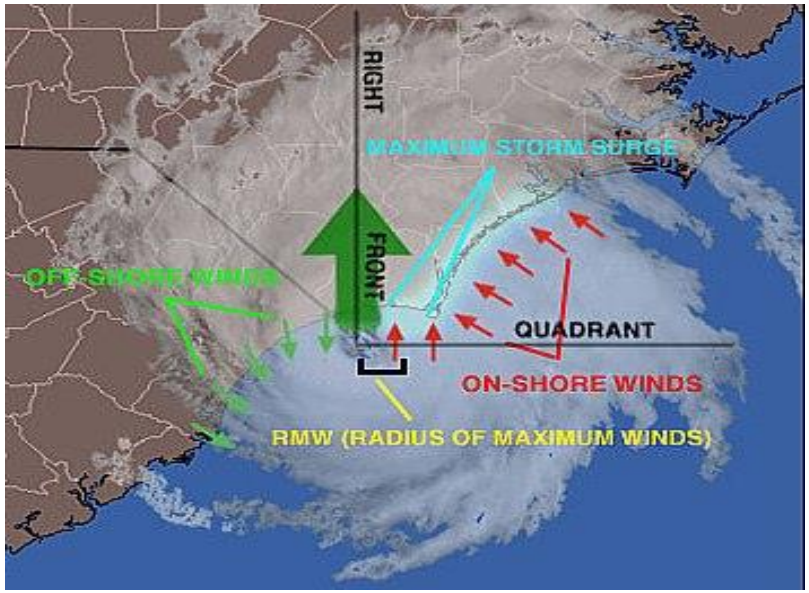


Tropical Cyclone Hazards – Storm Surge

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 - Waves

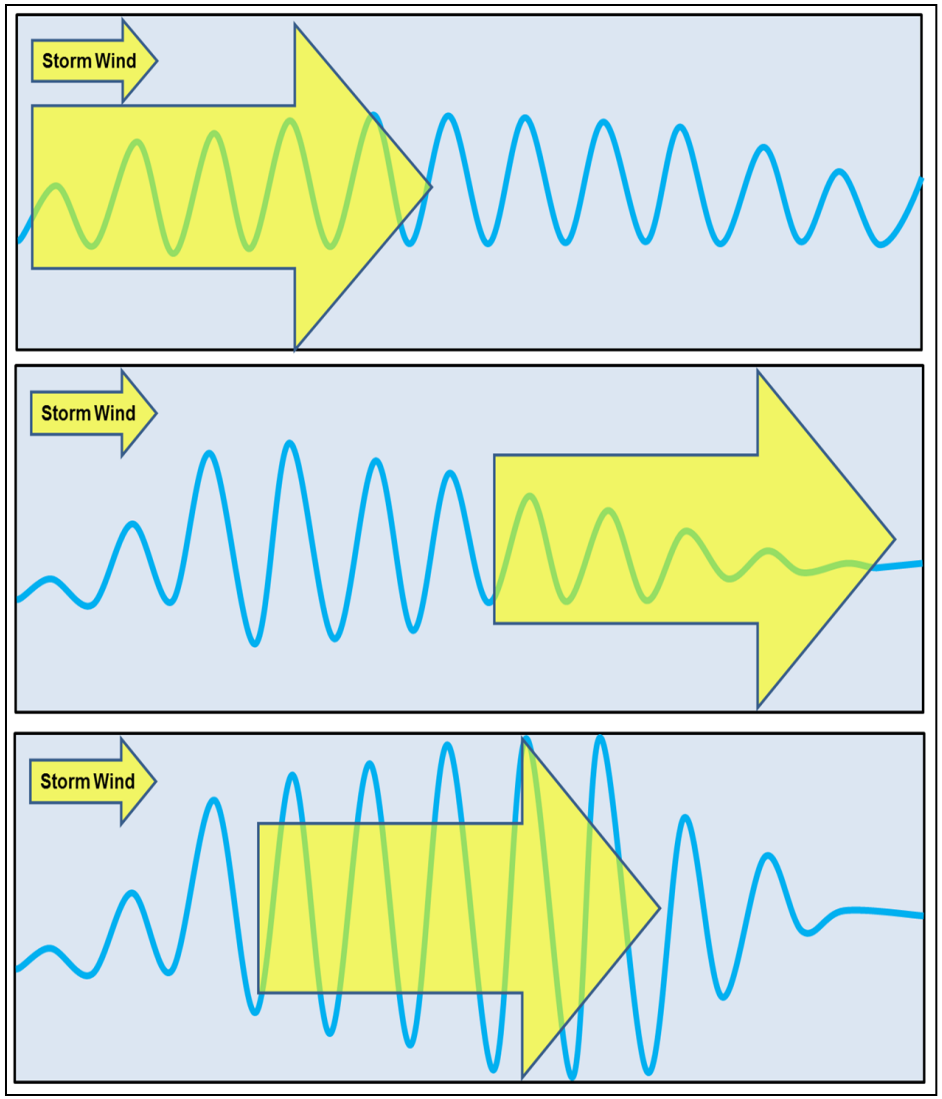
Damaging Waves

- On occasion a particular phenomenon can give rise to extreme wave heights
- Waves move in harmony with a storm, allowing waves to build to enormous heights
- This threat is most significant along the Atlantic coast

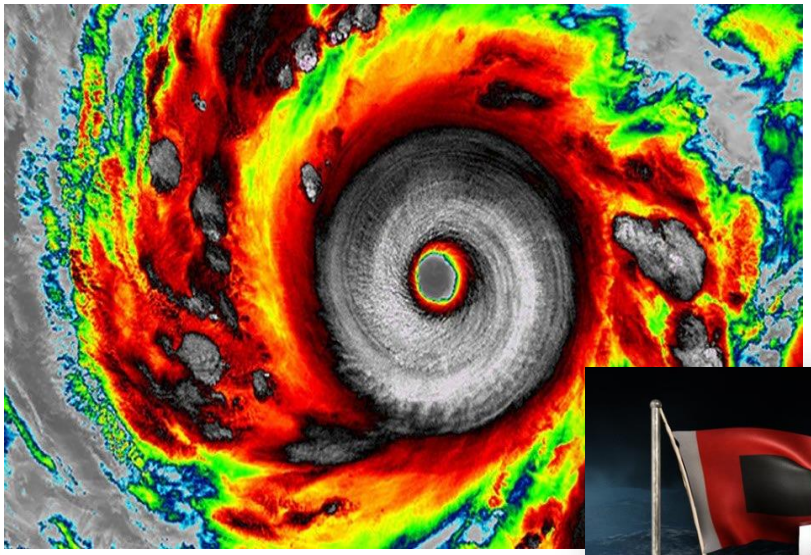
Hurricane: Slow-moving storm, waves move out ahead of storm

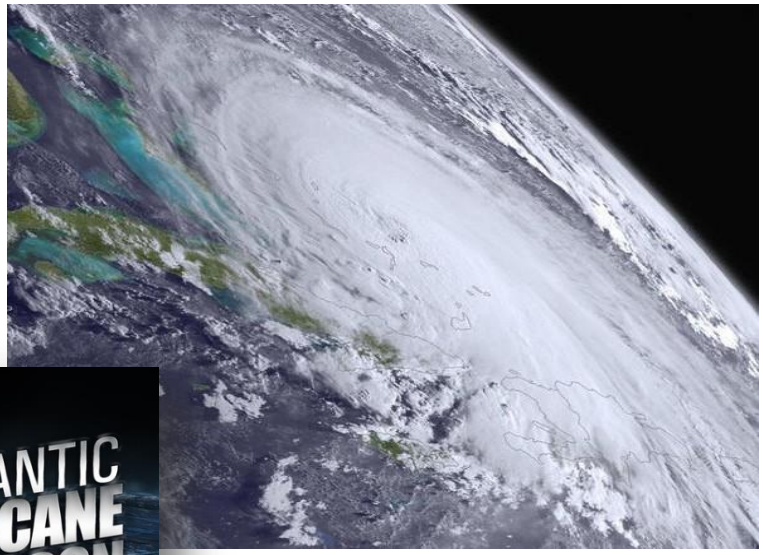
Winter storm: Fast-moving storm, large waves lag behind the storm

Post-tropical storm: Accelerating storm, waves/storm in sync, waves build to extreme heights



Hurricane Season 2015 in Review





Canadian Hurricane Centre

Canadian Hurricane Centre

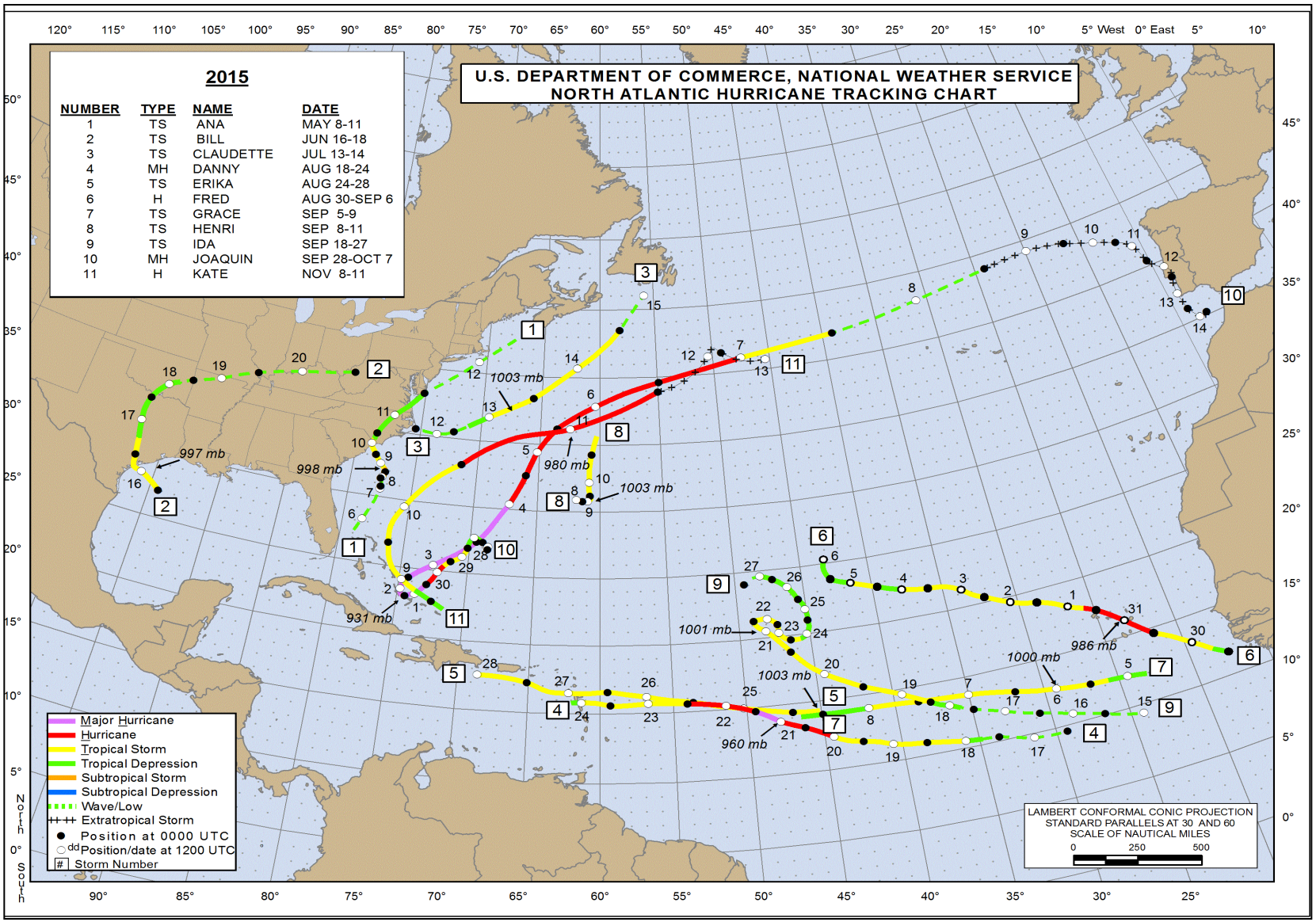
Environment and Climate Change Canada | Environnement et Changement climatique Canada

Canada

What happened last year?

	Named Storms	Hurricanes Category 1 to 5	Major Hurricanes Category 3-5
National Oceanic and Atmospheric Administration (US)	**6-11**	**3-6**	**0-2**
Actual storms in 2015	**11**	**4**	**2**
1981-2010 Average	**12**	**6**	**2 or 3**

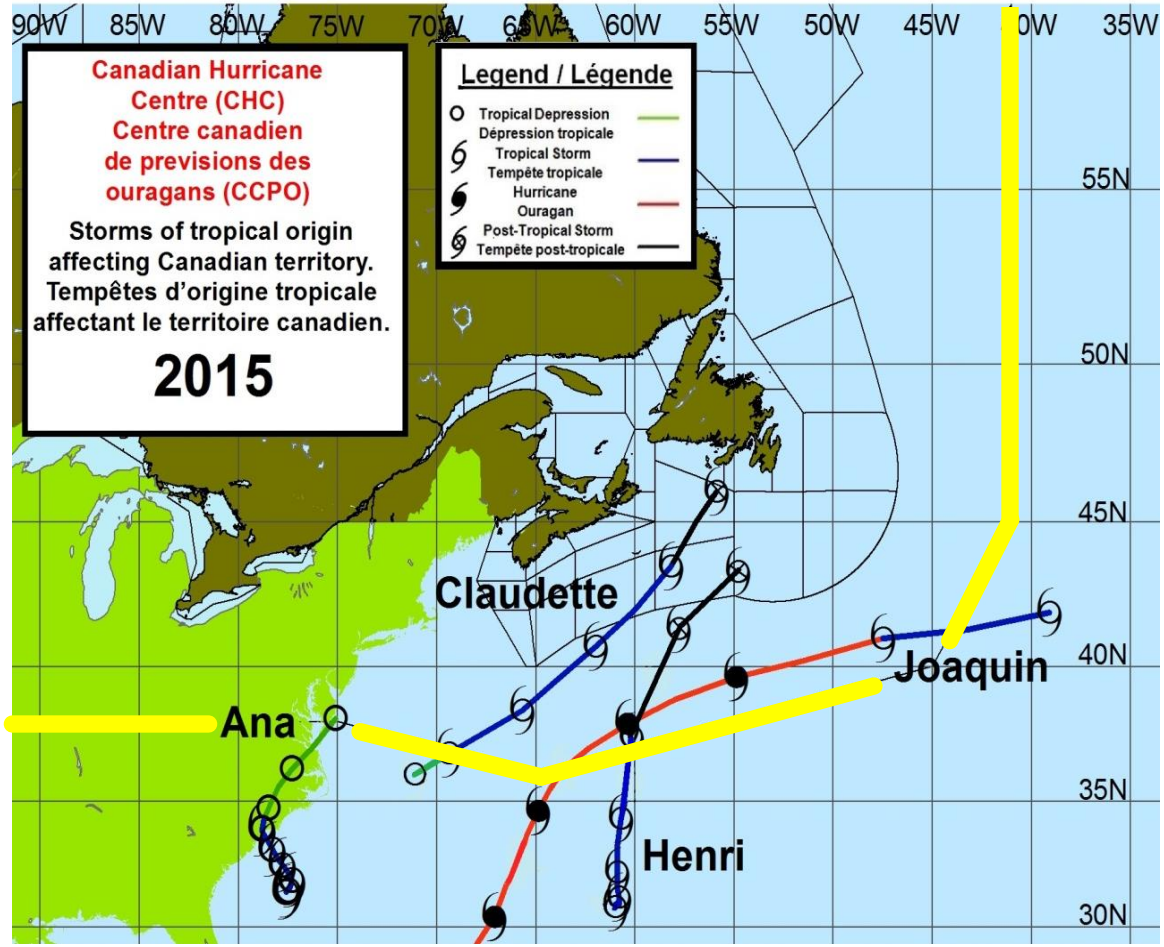
2015 Season in Review



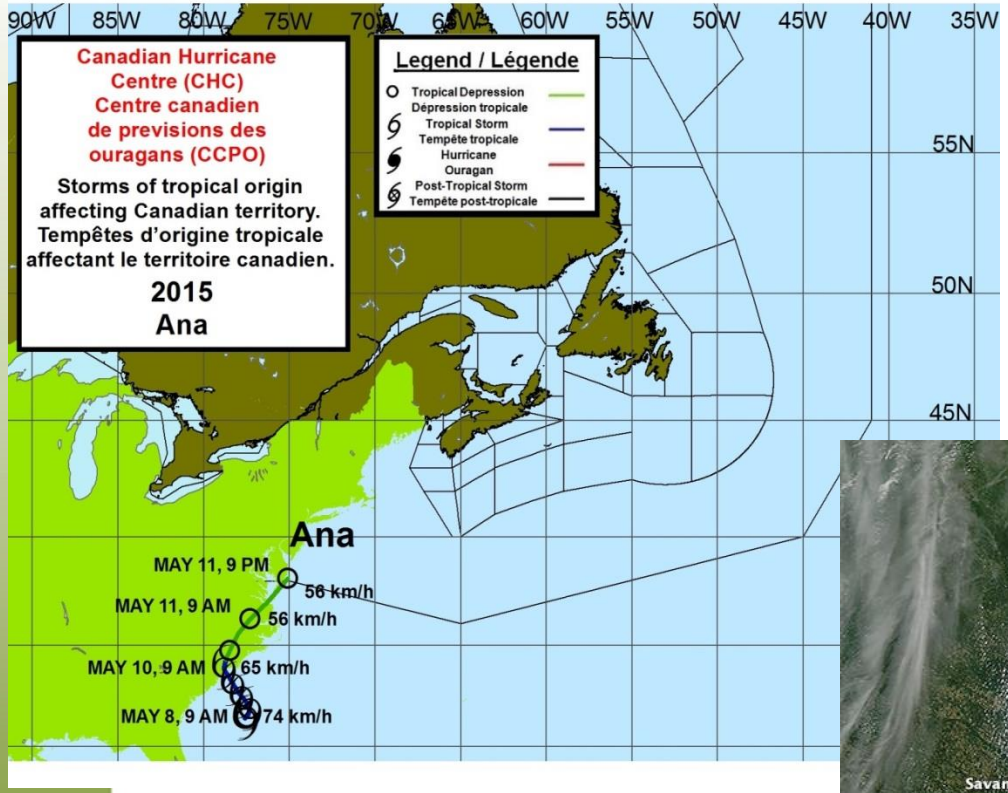
2015 Season in Review

2015 season activity:

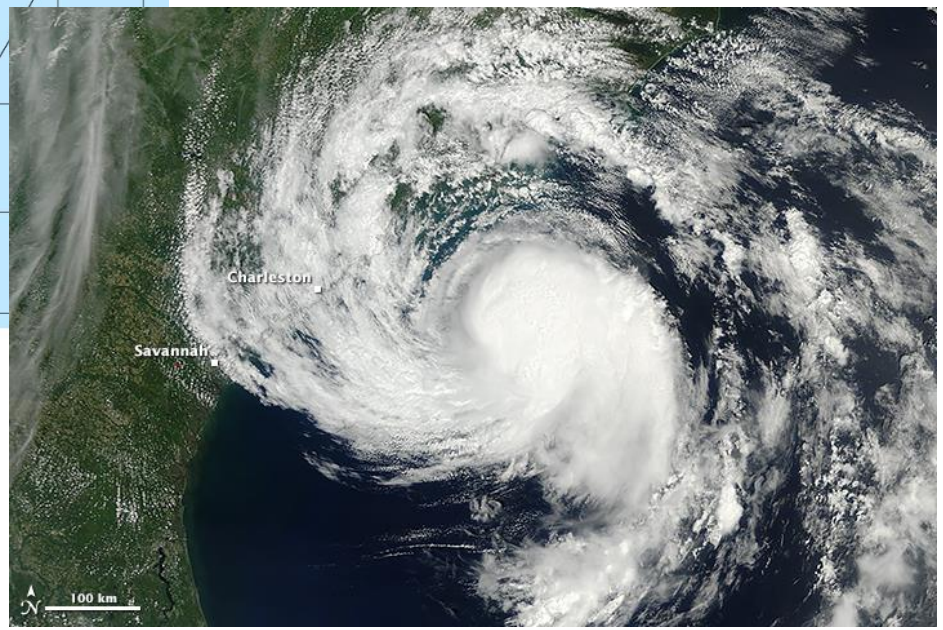
- **4 storms entered CHC response zone**
- **Average is also about 4**



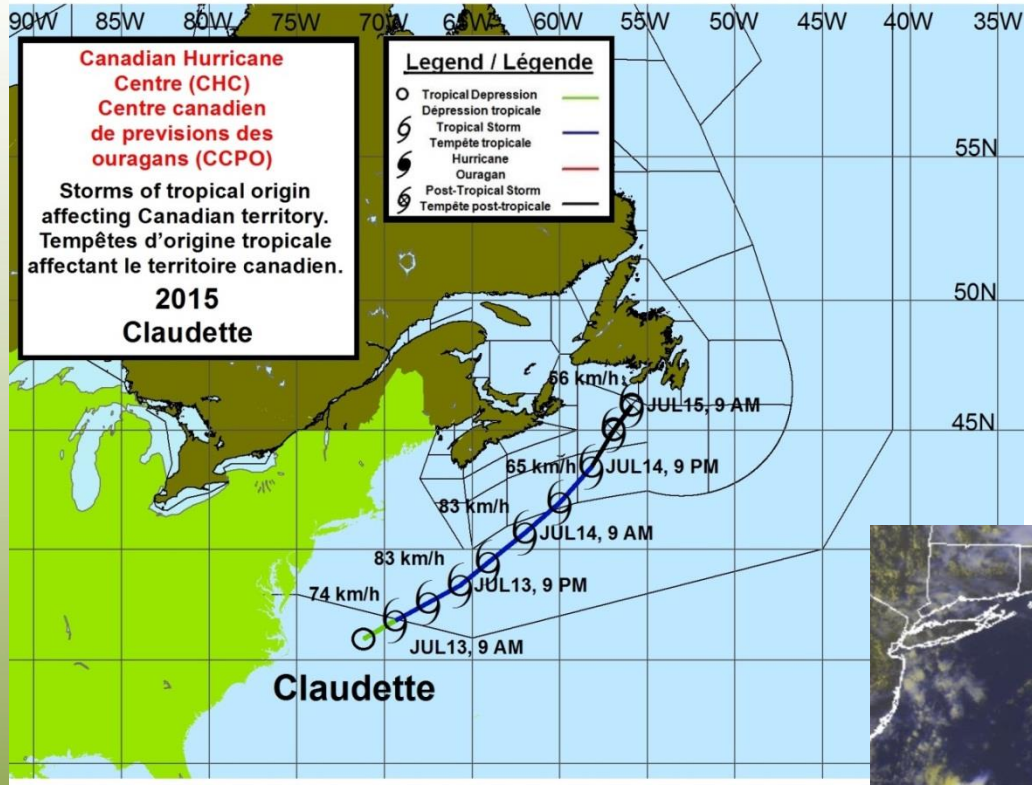
2015 Season in Review – Ana



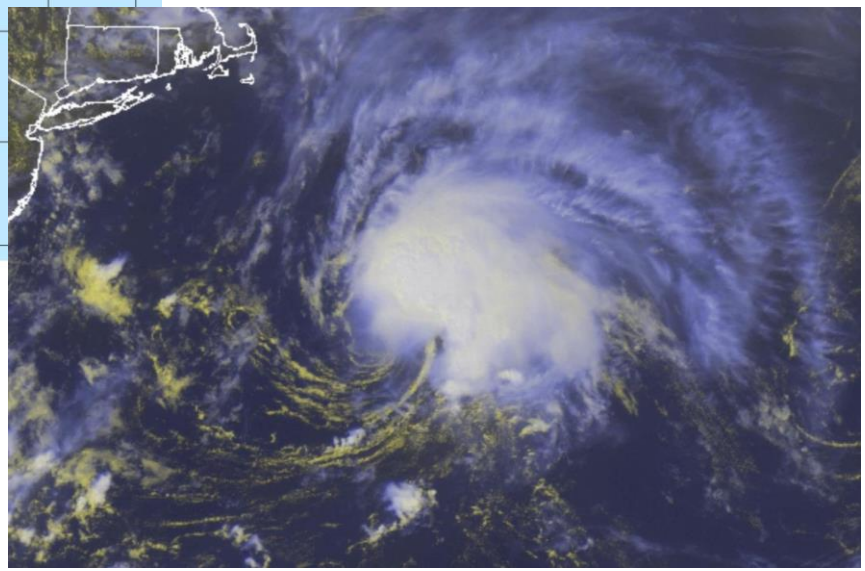
- Formed in early May and became a tropical storm
- Presented some forecasting challenges but no impacts on Canada



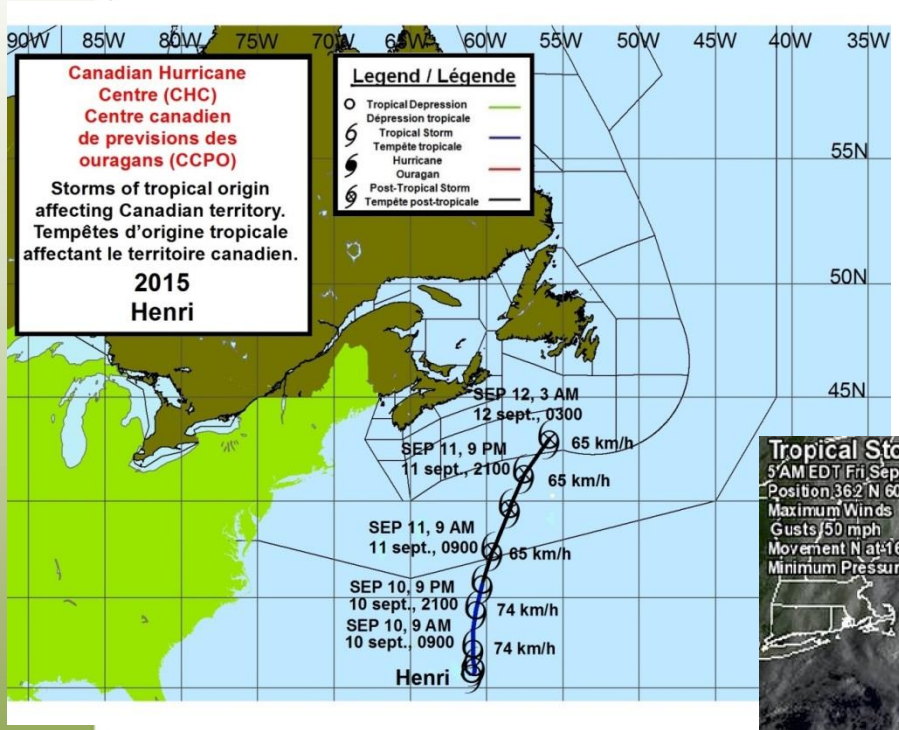
2015 Season in Review – Claudette



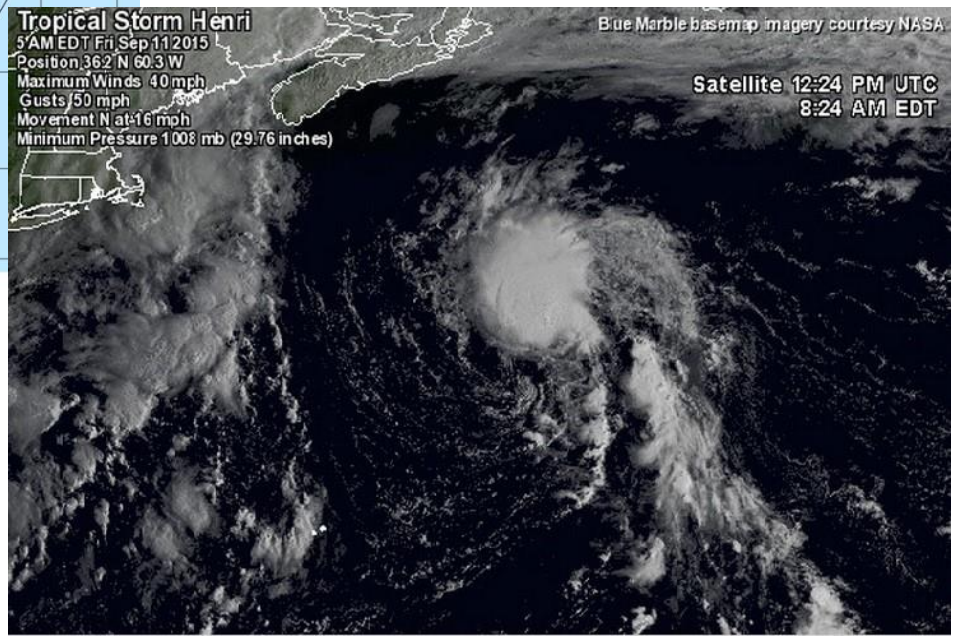
- Formed off the coast of SC on July 12th then became a tropical storm
- Moved northeastward over the next few days
- Produced locally heavy showers in Newfoundland and Labrador but otherwise little impact



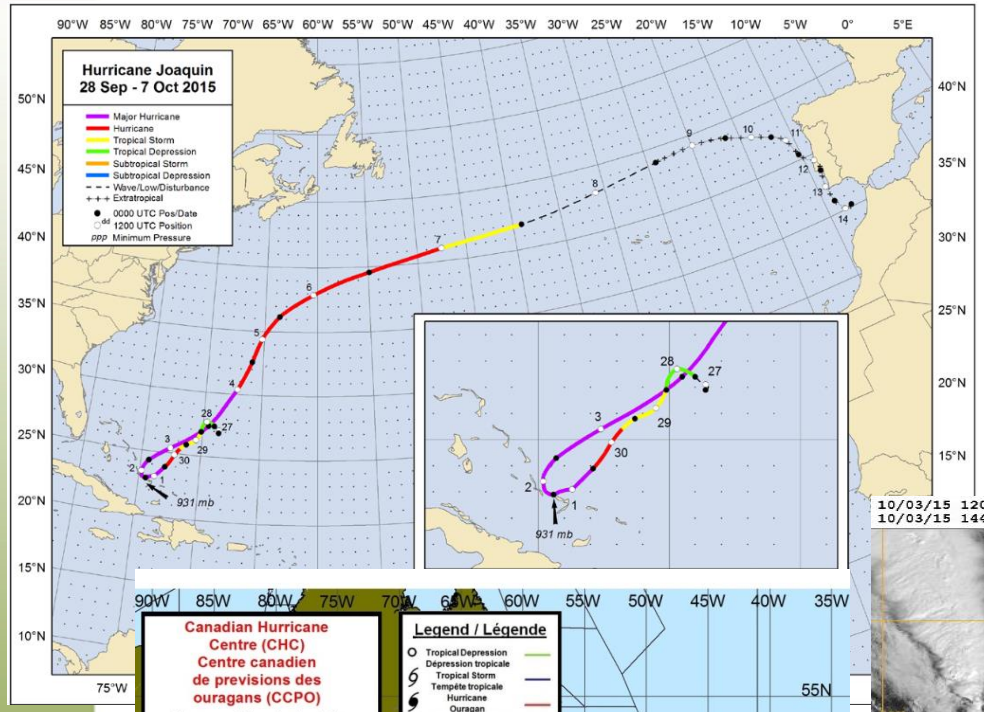
2015 Season in Review – Henri

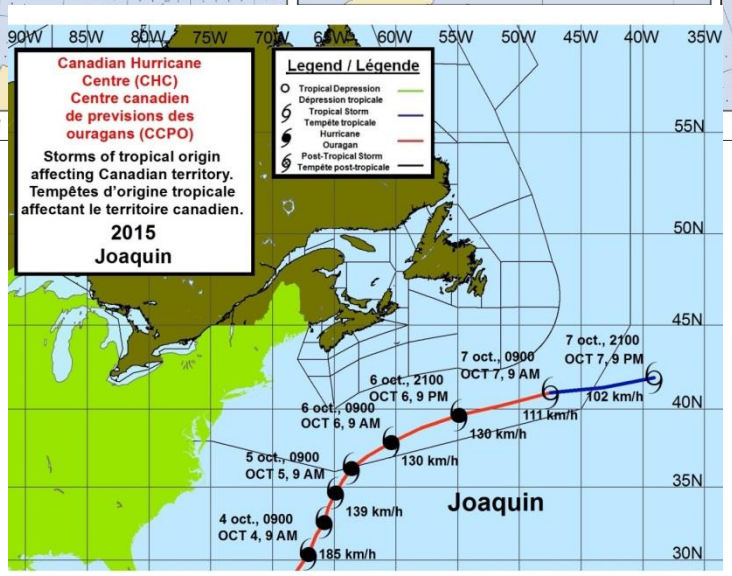


- Became a tropical storm September 8th over the open ocean
- Maximum winds reached 90 km/h followed by rapid weakening
- No significant impacts in Canada

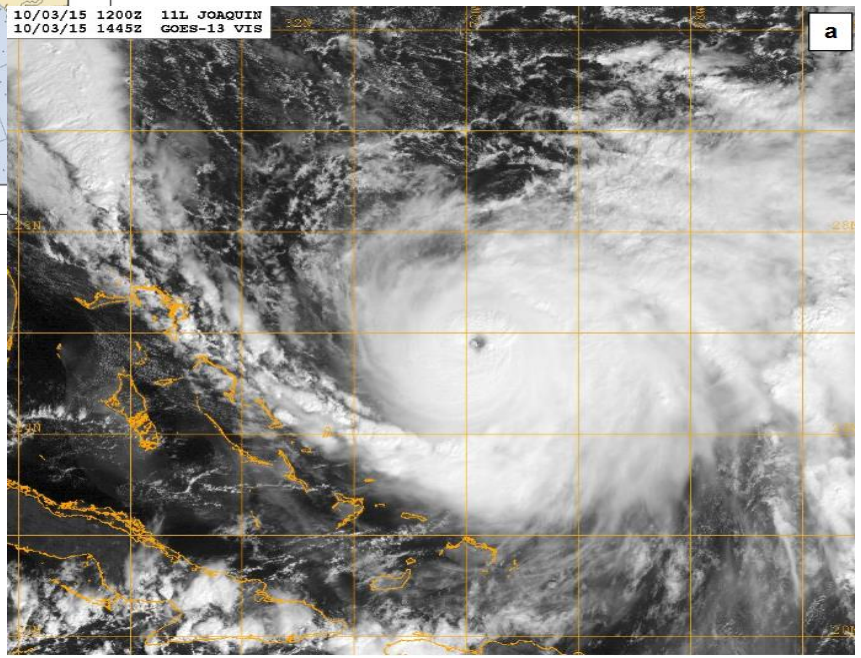


2015 Season in Review – Joaquin





- Became a tropical storm September 28th
- Reached hurricane September 30th and went from Cat 1 to Cat 3 in 12 hours
- Some swell reached NS and NL but no significant impacts



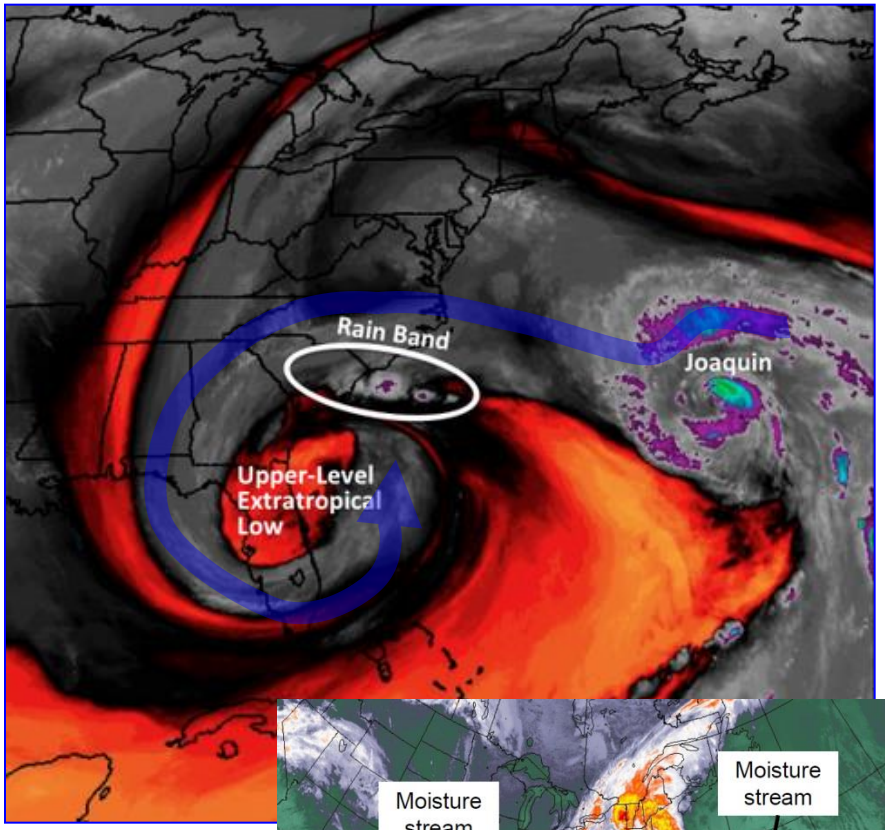
Hurricane Joaquin – Indirect impacts

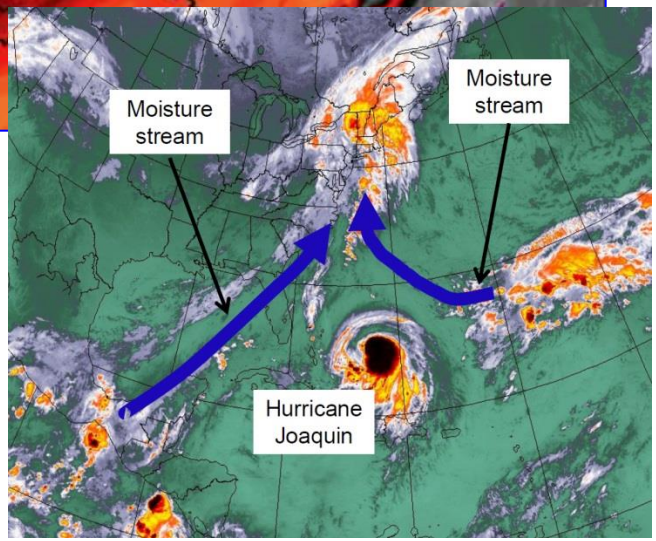
- Well after the threat of Joaquin making landfall in the U.S. or Canada had passed, a stalled weather system over the Southeast U.S. entrained some moisture from Joaquin

- This second system was also associated with the one that resulted in 200+ mm of rain in New Brunswick on October 1st

- The combination of these two events resulted in a very heavy rainfall over the Southeast

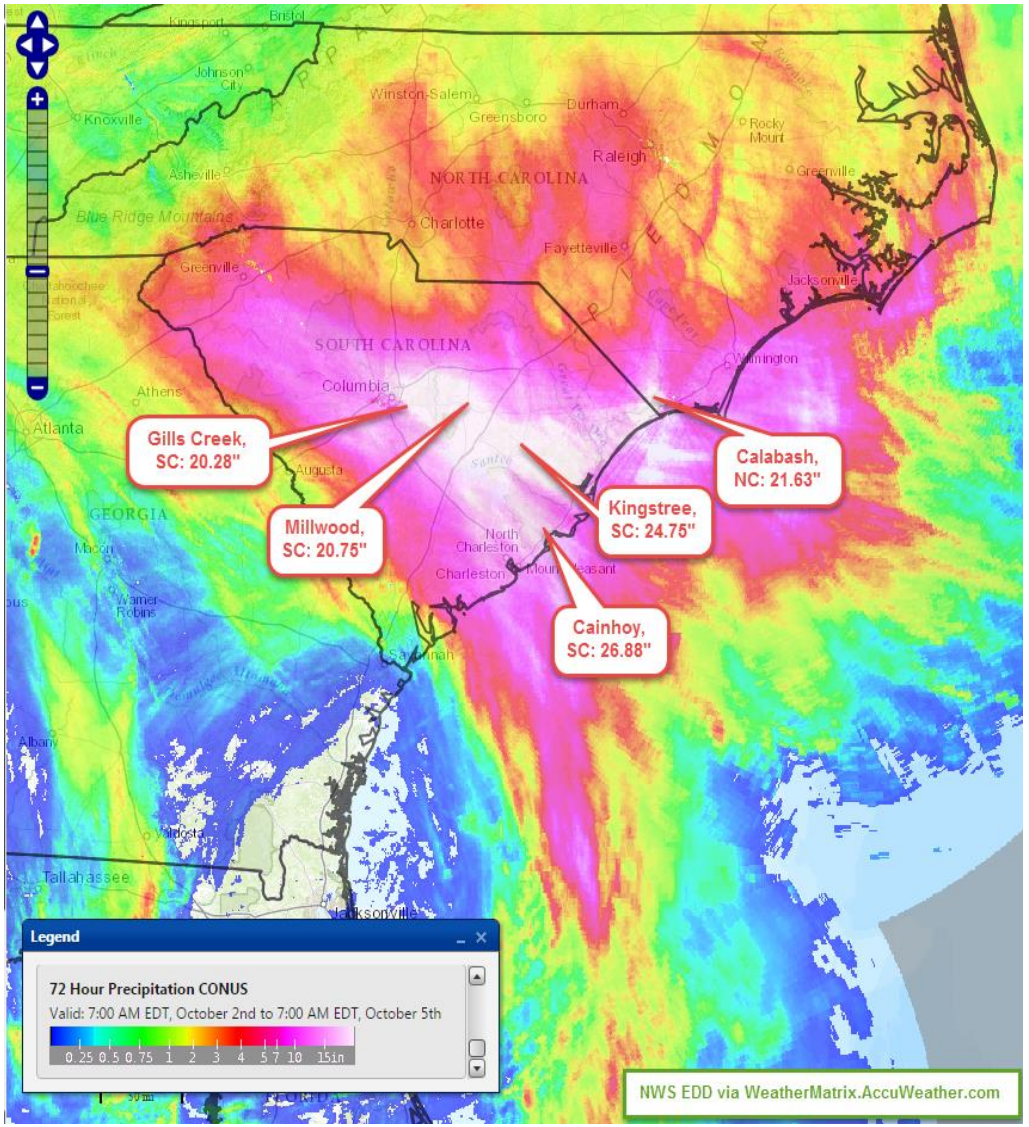
- South Carolina was particularly hard-hit as what occurred there has been characterized as a 1 in 1000 year rainfall event





Hurricane Joaquin – Indirect Impacts

- Peak rainfall amounts recorded were 722 mm near Charleston SC
- Equivalent of 11 trillion gallons of water fell on Charleston in 3 days
- Record flooding event for South Carolina
- State EOC was activated from October 1st to October 23rd

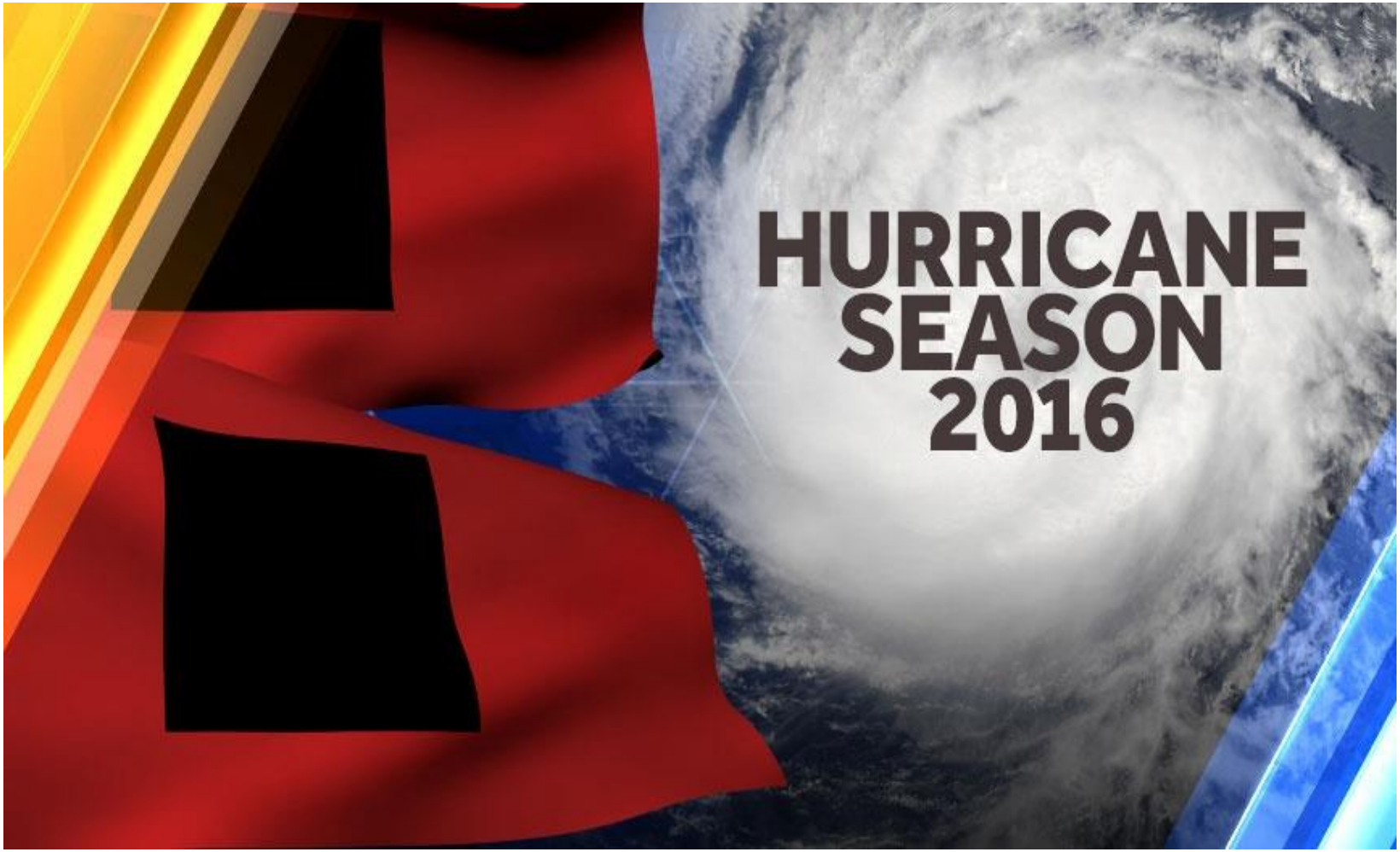


Hurricane Joaquin – Indirect Impacts

- Storm related fatalities: 19
- Displaced citizens: Over 20,000
- Shelters: 32
- Emergency meals served: 2.7M
- People without water: 40,000
- Collisions during the event: 3,521
- Dam failures: 36
- Roads and bridges closed: 500+
- Water rescues: Over 1,500
- Calls taken by the Public Information phone System: 12,900+

2016 Hurricane Season Outlook

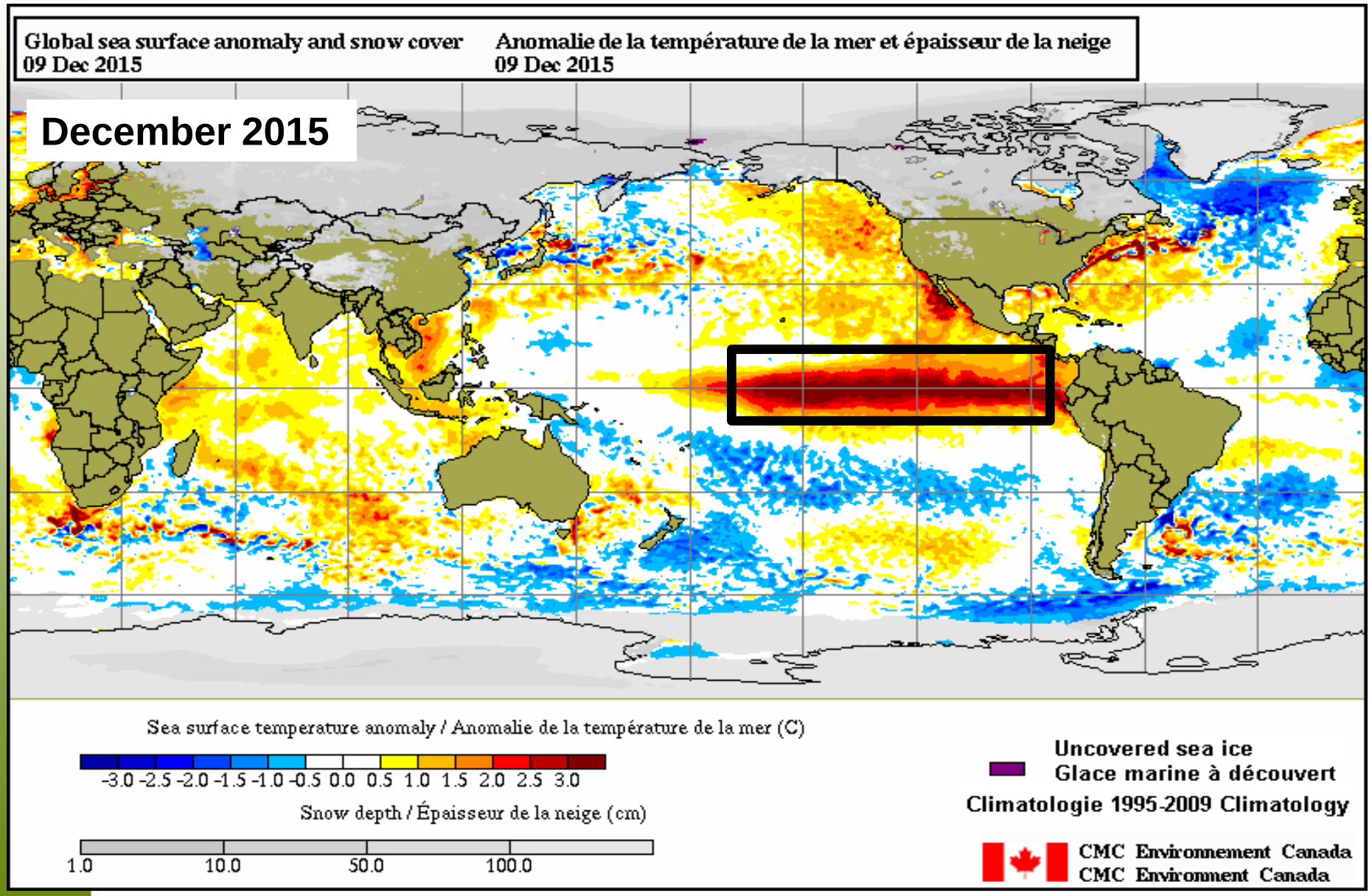
Canadian Hurricane Centre



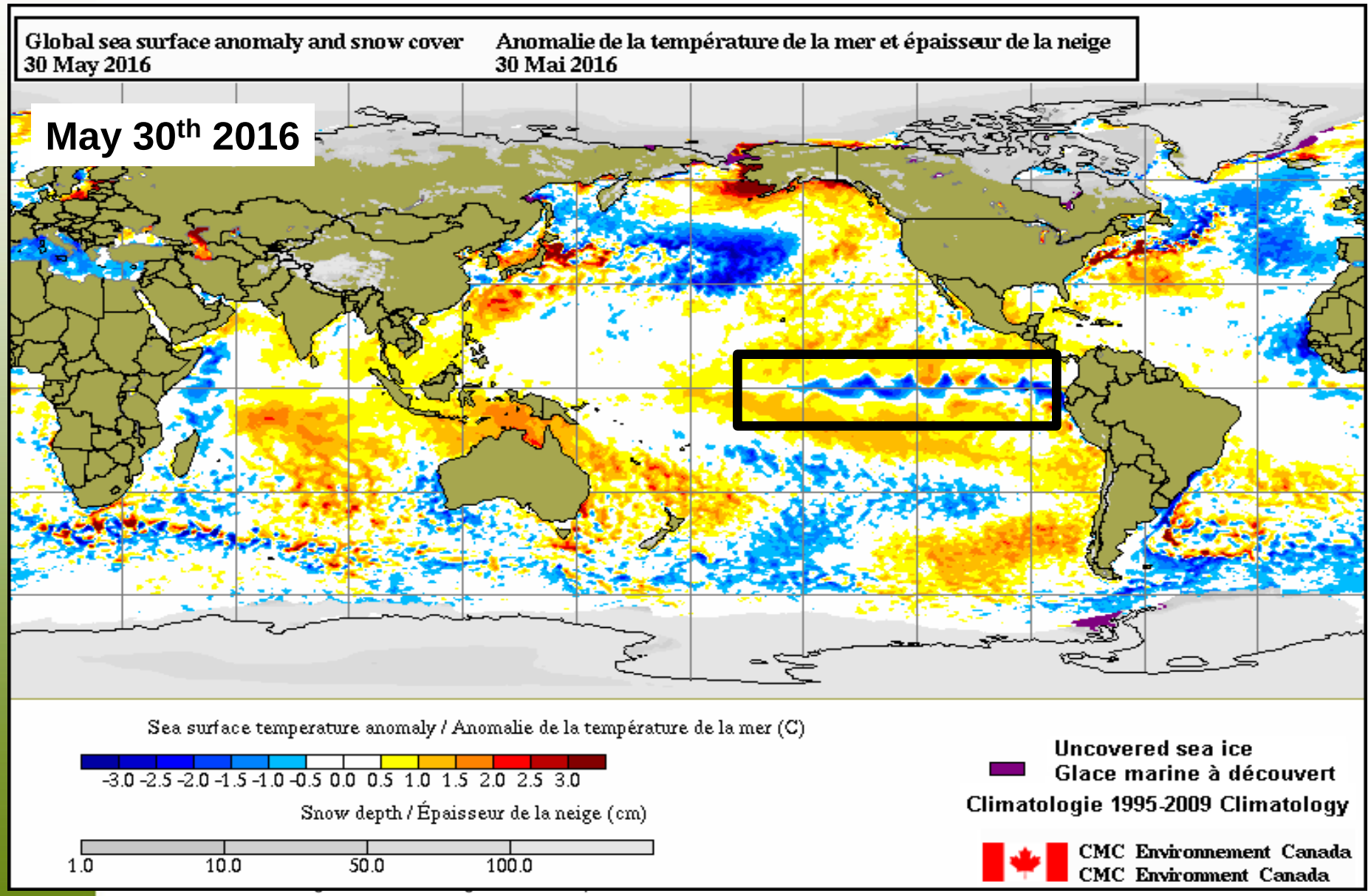
2016 Hurricane Season Outlook

	Named Storms	Hurricanes Category 1 to 5	Major Hurricanes Category 3-5
National Oceanic and Atmospheric Administration (US)	**10-16**	**4-8**	**1-4**
1981-2010 Average	**12**	**6**	**2 or 3**
1961-2010 Average	**11**	**6**	**2**

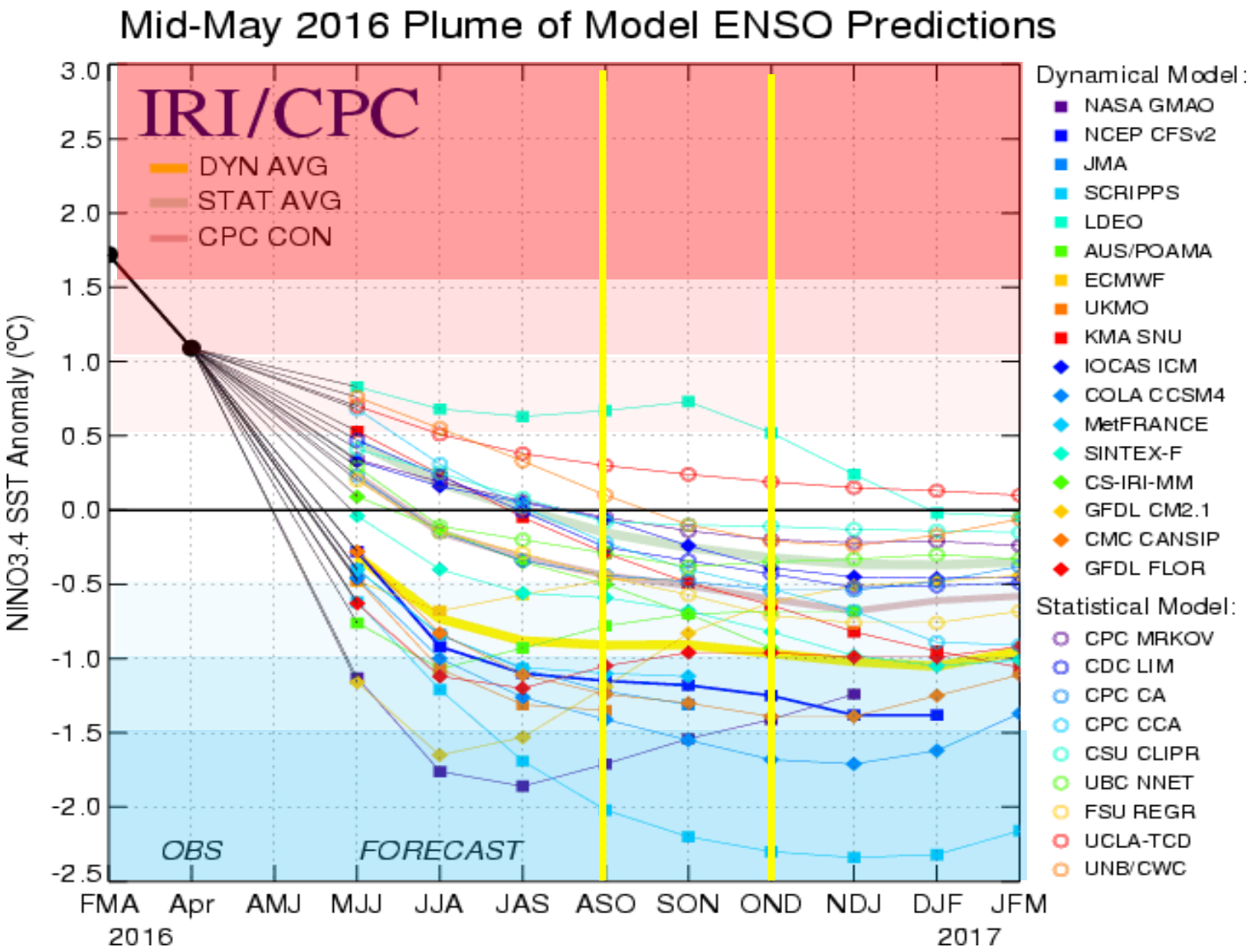
Factors Affecting the 2016 Hurricane Season



Factors Affecting the 2016 Hurricane Season



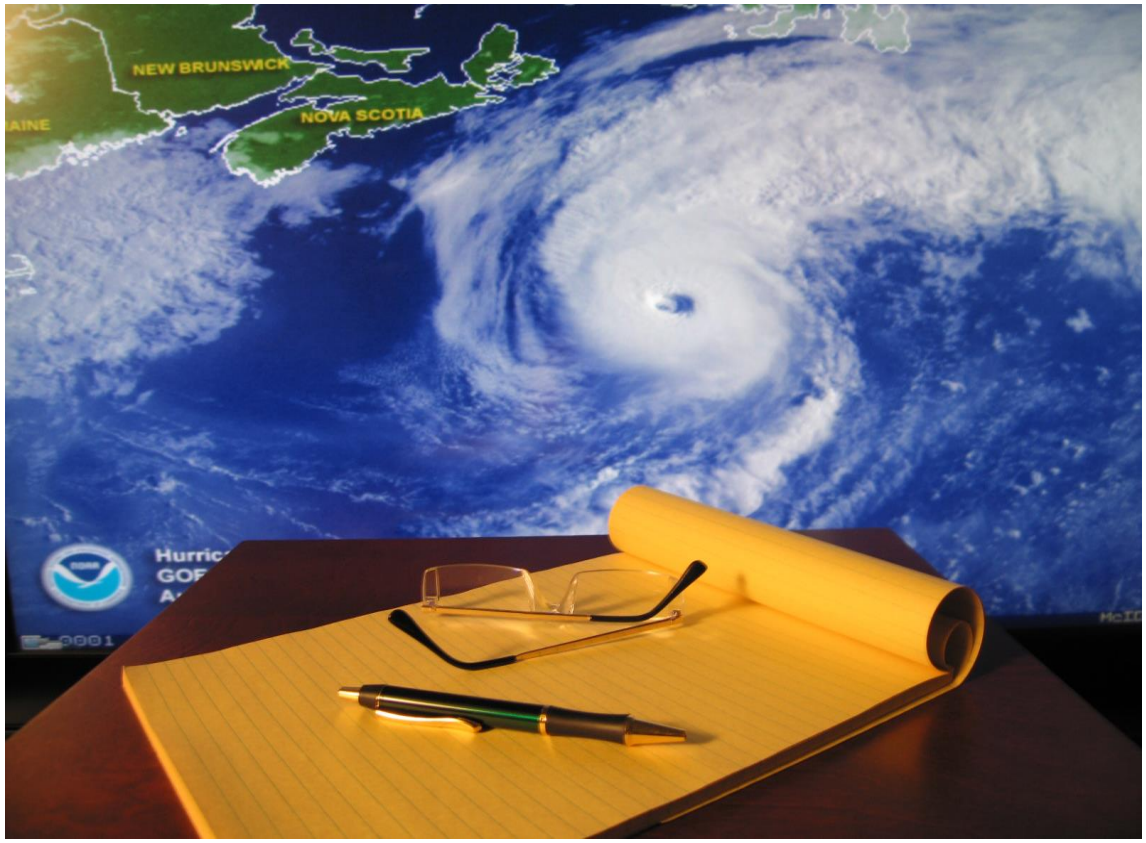
El Niño forecast through hurricane season



List of Atlantic Storm Names

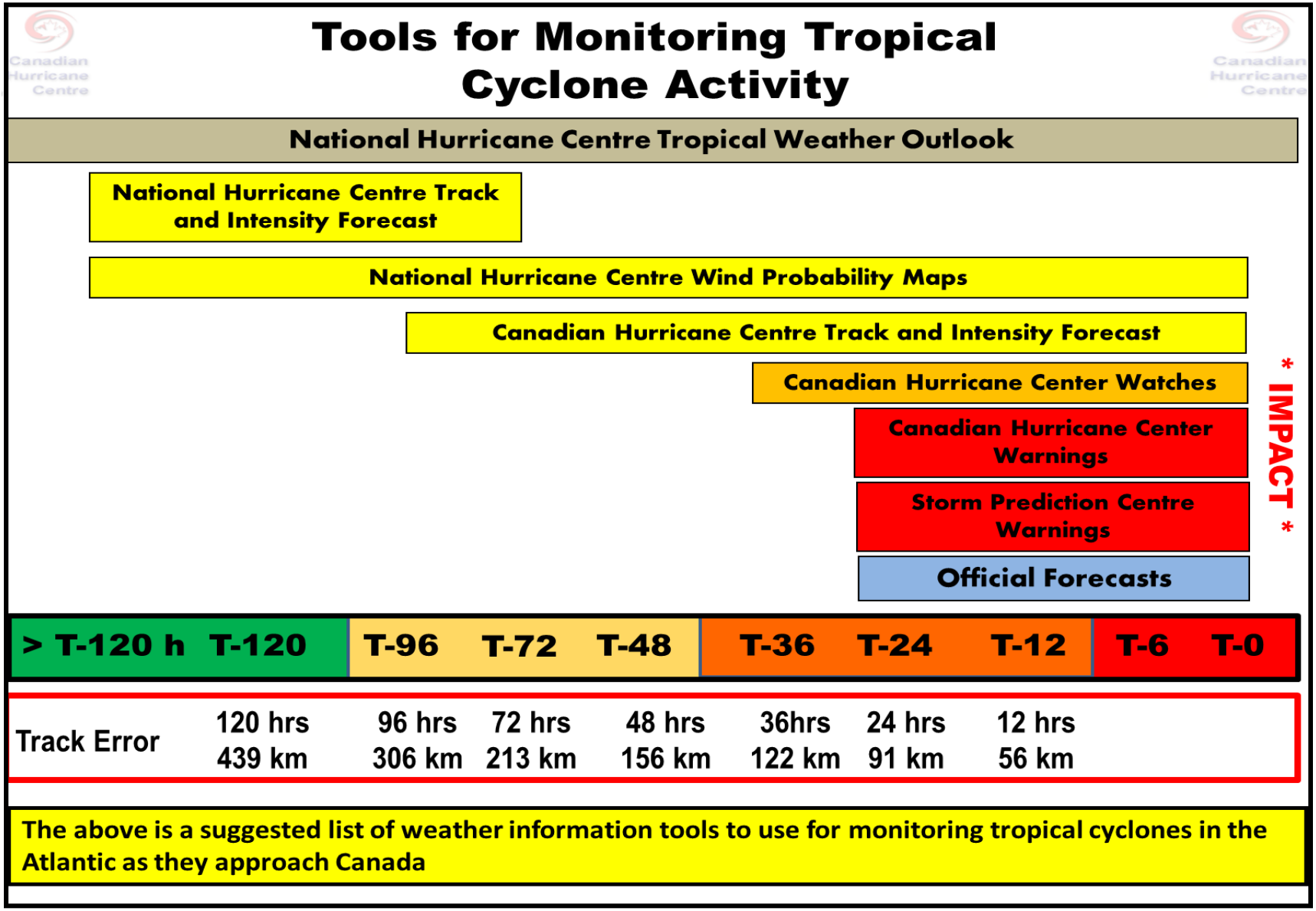
2016	2017	2018	2019	2020	2021
Alex	Arlene	Alberto	Andrea	Arthur	Ana
Bonnie	Bret	Beryl	Barry	Bertha	Bill
Colin	Cindy	Chris	Chantal	Cristobal	Claudette
Danielle	Don	Debby	Dorian	Dolly	Danny
Earl	Emily	Ernesto	Erin	Edouard	Elsa
Fiona	Franklin	Florence	Fernand	Fay	Fred
Gaston	Gert	Gordon	Gabrielle	Gonzalo	Grace
Hermine	Harvey	Helene	Humberto	Hanna	Henri
Ian	Irma	Isaac	Imelda	Isaias	Ida
Julia	Jose	Joyce	Jerry	Josephine	Julian
Karl	Katia	Kirk	Karen	Kyle	Kate
Lisa	Lee	Leslie	Lorenzo	Laura	Larry
Matthew	Maria	Michael	Melissa	Marco	Mindy
Nicole	Nate	Nadine	Nestor	Nana	Nicholas
Otto	Ophelia	Oscar	Olga	Omar	Odette
Paula	Philippe	Patty	Pablo	Paulette	Peter
Richard	Rina	Rafael	Rebekah	Rene	Rose
Shary	Sean	Sara	Sebastien	Sally	Sam
Tobias	Tammy	Tony	Tanya	Teddy	Teresa
Virginie	Vince	Valerie	Van	Vicky	Victor
Walter	Whitney	William	Wendy	Wilfred	Wanda

Canadian Hurricane Centre



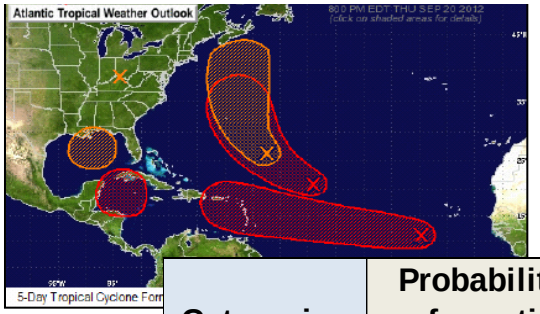
Hurricane Readiness and Operational Response to Hurricanes

Hurricane Weather Products



Hurricane Weather Products

5-day GTWO Operational in 2015



Categories	Probability of formation
Low	< 40%
Medium	40-60%
High	>60%

Monitoring Storm Formation Potential

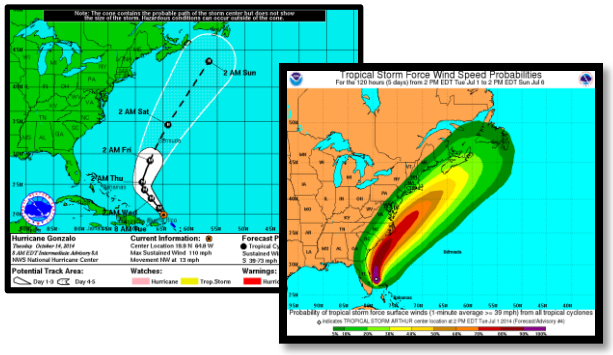
A good tool to check overall tropical activity is the Tropical Weather Outlook issued by the NHC

www.nhc.noaa.gov/gtwo_atl.shtml

Monitoring Individual Storms

Details on storms that are not an imminent threat to Canada can be found on the National Hurricane Centre Website:

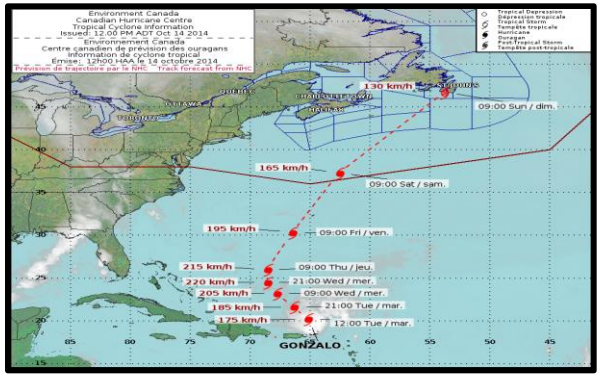
www.nhc.noaa.gov



Monitoring Individual Storms

Details on storms are expected to have an impact in Canada can be found on the Canadian Hurricane Centre Website:

www.hurricanes.ca



Environment and Climate Change Canada | Environnement et Changement climatique Canada

Hurricane Weather Products – 36 hrs or less

Watches and Warnings

- Once the storm is close enough and forecast confidence is higher watches and warnings are issued in addition to the information bulletins

Tropical Storm: winds 70 km/h to 118 km/h

Hurricane: winds 119 km/h or more

A Watch lets you know conditions are favourable for the hazard to occur within 36 hours

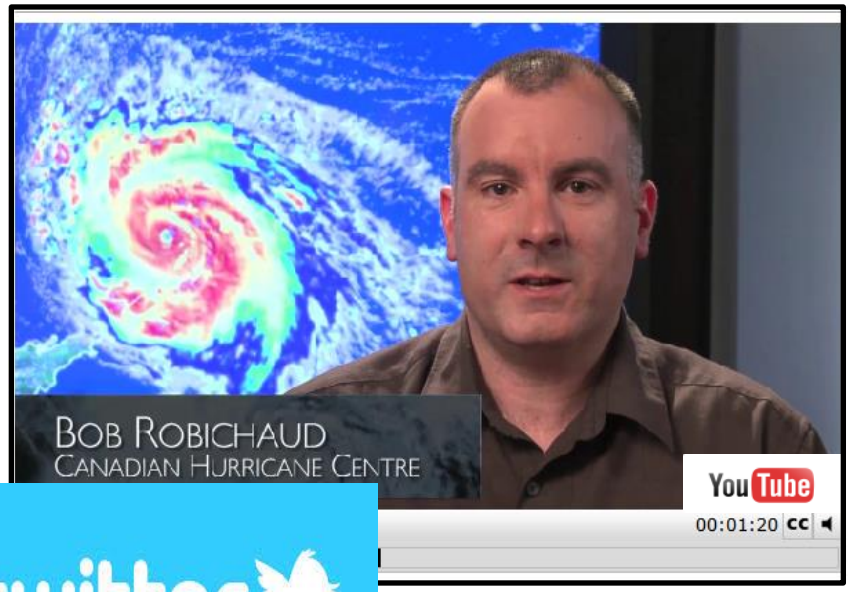
A Warning requires immediate action as the hazard is occurring or is likely to occur within 24 hours

Note: It is recommended that all storm preparation activities be complete prior to the arrival of Tropical Storm Force winds

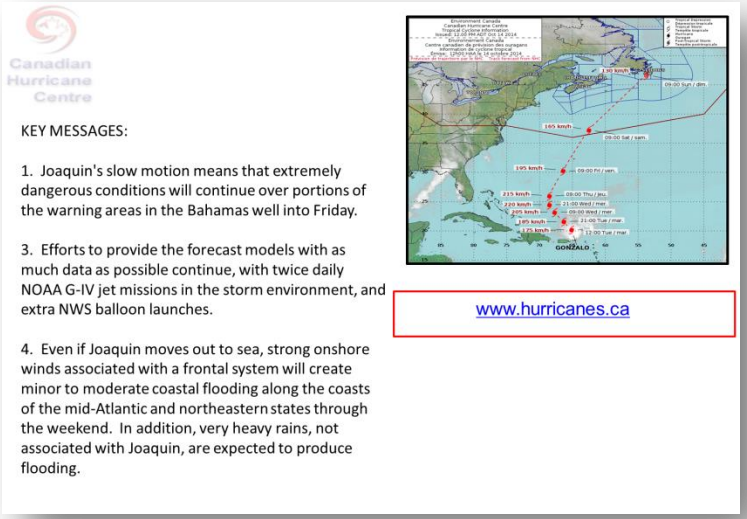
Operational Response to Hurricanes

Key Messages

- The CHC will continue to try and increase our activity on social media
- A TweetChat is being planned for some time during the hurricane season
- The CHC is also planning on adopting the “key messages” approach in the bulletins
- Key messages can easily adapted for social media



twitter
@environmentca



Hurricane Season 2016 Outlook

- The numbers of tropical storms and hurricanes are expected to be near or slightly above normal

- One of the key weather patterns that reduces hurricane activity in the Atlantic, El Nino, is not expected to be a factor this year

- There are some theories that would suggest more of the 2016 hurricane season storms will develop in the Caribbean or western Atlantic rather than off the coast of Africa

- If this season is near normal, it would be the 4th year in a row with near average or below average

….it only takes <u>one</u> storm to make it a bad year!