FINAL

# Hurricane Season Outlook 2016

Submitted to:

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**Department of Environment and Conservation**

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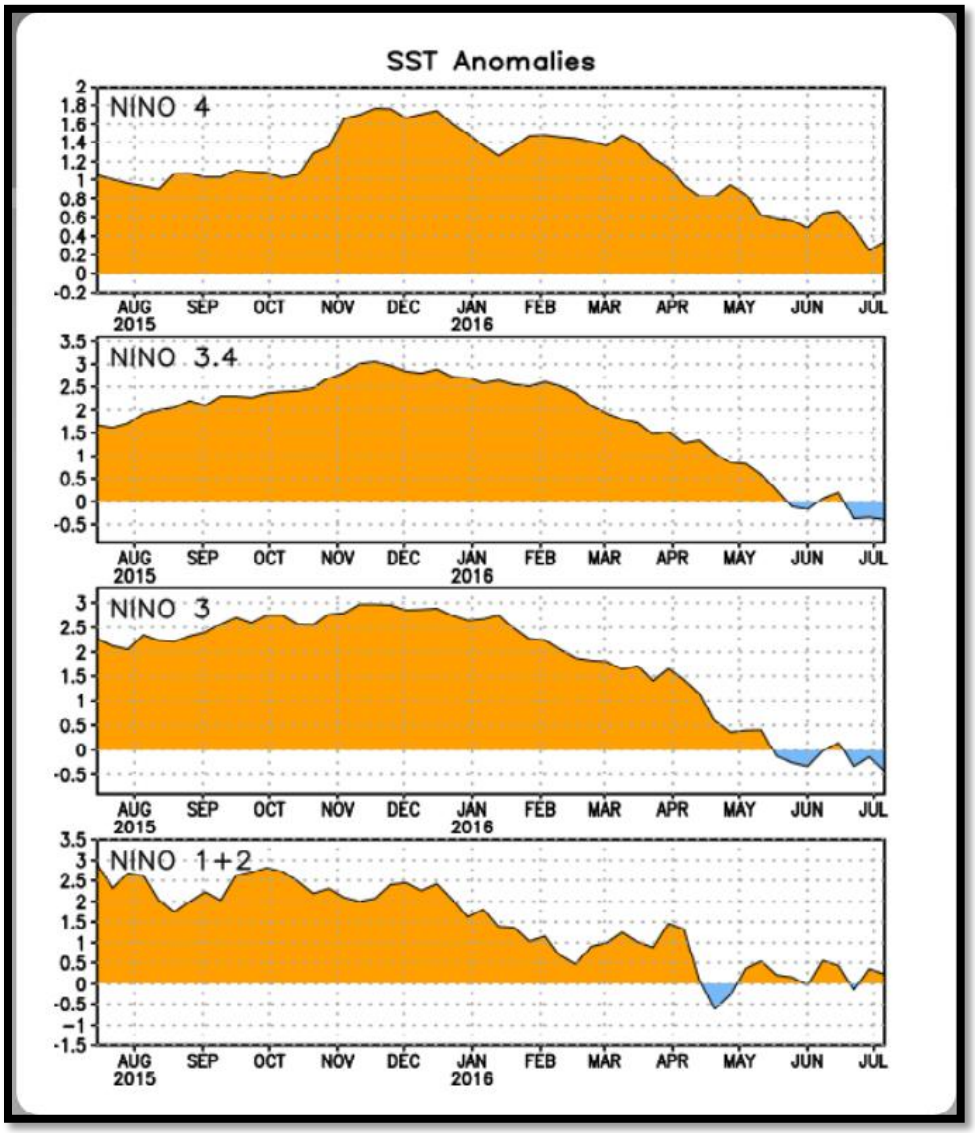
## 1.0 2016 ATLANTIC HURRICANE SEASON OUTLOOK

The National Hurricane Center's 2016 Atlantic Hurricane Season Outlook (27 May, 2016) favors a near-normal Hurricane Season with a 70% likelihood of: 10-16 Named Storms (including Alex in January); 4-8 Hurricanes (including Alex in January), and 1-4 Major Hurricanes. Concurrently, the Dept. of Atmospheric Science at the Colorado State University (CSU) is calling for near-normal season (updated 1 July, 2016) with 11 Named Storms, 5 Hurricanes, and 2 Major Hurricanes. Major Hurricanes are defined as those reaching Category 3 or greater with winds of or exceeding 178 km/h. These estimates pertain to the formation of such tropical systems over the Atlantic Ocean and do not imply subsequent track or landfall. Track and landfall predictions depend on the concurrent state of the atmosphere and cannot be assessed reliably more than 7-10 days in advance.

This outlook is based on predictions of the main climate factors know to influence seasonal Atlantic hurricane activity and regional and global model predictions of atmospheric and oceanic conditions. The Atlantic Multi-decadal Oscillation (AMO) is considered a main climate factor that influences the Atlantic hurricane season as it sets the way to other climate phenomena such al El Nino or La Nina. The AMO is defined from sea-surface temperature (SST) patterns in the North Atlantic.

After one of the strongest El Niño seasons, current sea-surface temperatures (SSTs) are near or below average in the east-central and eastern equatorial Pacific Ocean which is reflected as a neutral state. Figure 1 shows the SST of the four Niño Regions.



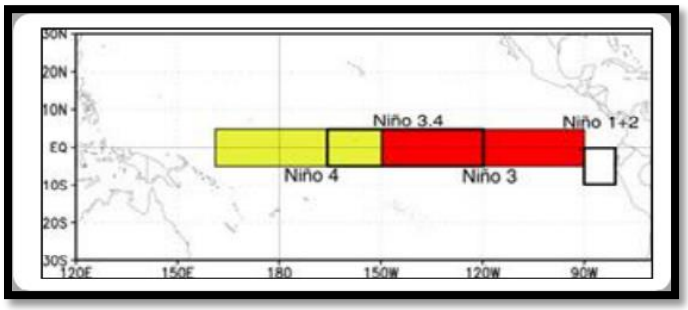




**Figure 1.** SST Anomaly in the Niño regions.

El Niño Oscillation (ENSO) is a measure of the anomaly in sea surface temperatures (SSTs) and winds over the tropical eastern Pacific Ocean. ENSO greatly affects the activity of the hurricane season by developing areas of above normal SSTs which could play a major role in suppressing the fueling for tropical storms. Current ENSO conditions indicate a neutral phase with the latest forecast (updated 21 July, 2016) indicating a slightly above 50% chance of La Niña developing later this fall or winter. If either neutral ENSO persists or weak La Niña conditions prevail through the end of the hurricane season, low vertical wind shear conditions would be present and thus be more conducive for hurricane formation. High vertical wind shear would work against the development of tropical storms and hurricanes in the Caribbean and potentially also in the Main Development Regions (MDR), moreso than in the past two years.

**Note: The horizontal axis in the below graph represents the time period starting July-August-September (JAS) of 2016 and ending March-April-May (MAM) of 2017.**

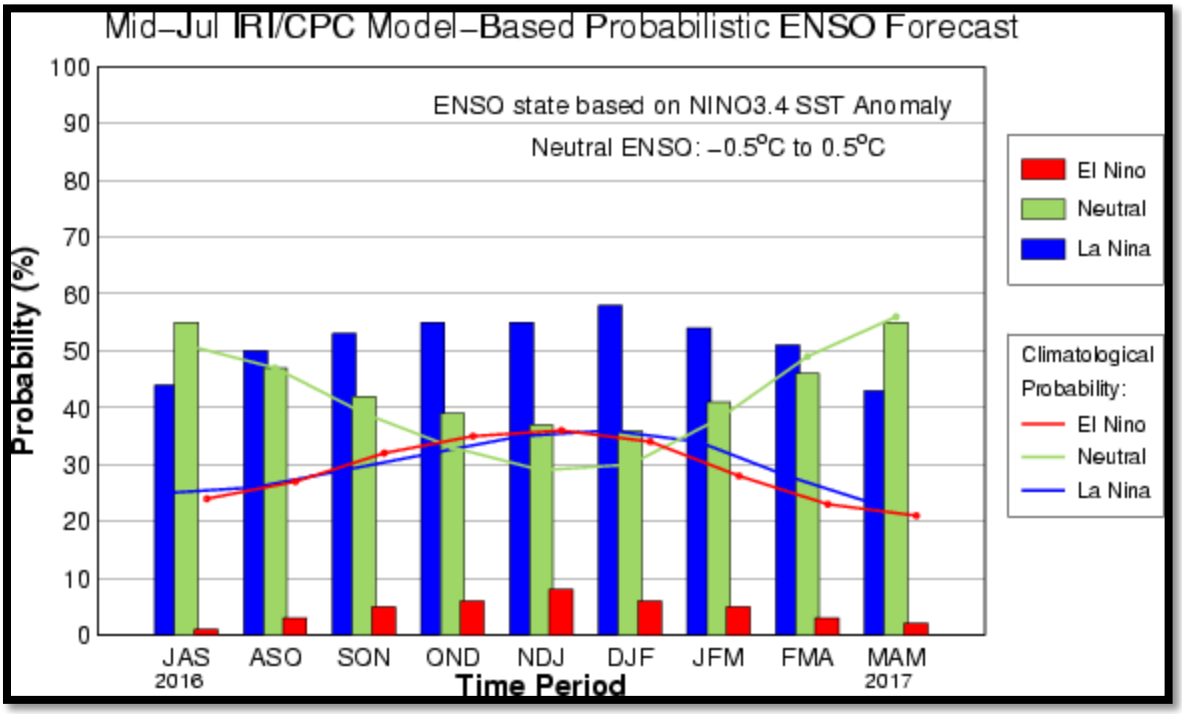



**Figure 2.** Probabilistic ENSO Forecast by the International Research Institute for Climate and Society.

The representation of the negative phase of the AMO seen in Figure 3 (slightly above normal SST in the tropical Atlantic basin with colder than normal SST in far North Atlantic basin) and the anomalous

reduction in vertical wind shear across the Caribbean (not shown) are key characteristics of a neutral ENSO to weak La Niña conditions.

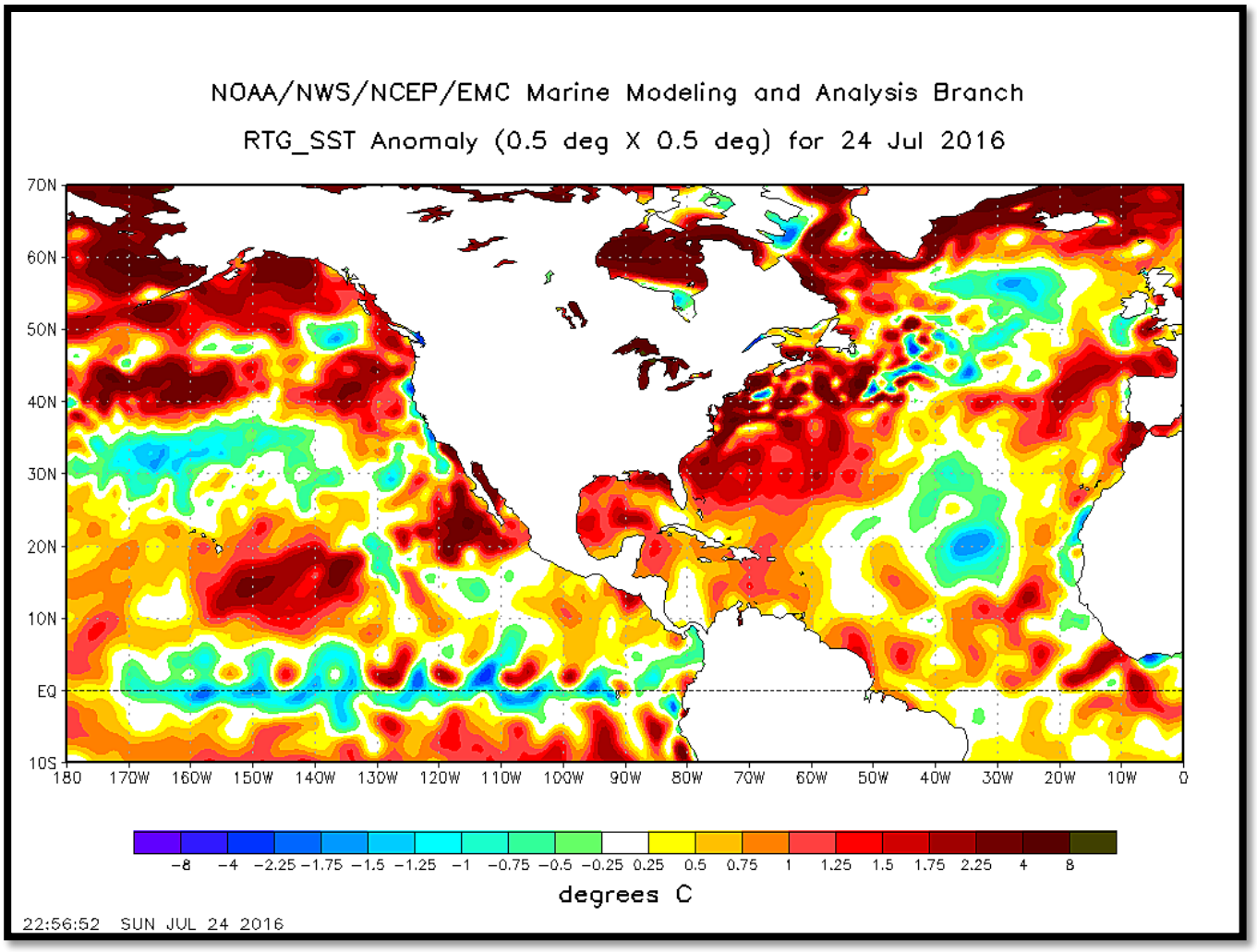



**Figure 3.**Atlantic basin SST anomalies (update: late June 2016).

Although the strength of the hurricane season does not solely depend on the ENSO conditions, more conducive atmospheric conditions within the MDR are likely during La Niña, thus making it favor a more active hurricane season. Such conditions are weaker vertical wind shear due to weaker upper-level westerly winds, weaker sinking motion, and increases in the atmospheric instability due to the warmer than normal water temperatures.

The summary of the current season shows the formation of one Hurricane (Alex) and three tropical storms (Bonnie, Colin, and Danielle). Alex was formed in January, Bonnie formed late May to early June, Colin formed immediately after Bonnie, and Danielle formed during the third week of June. Figure 4 below shows the track of the above mentioned weather systems.

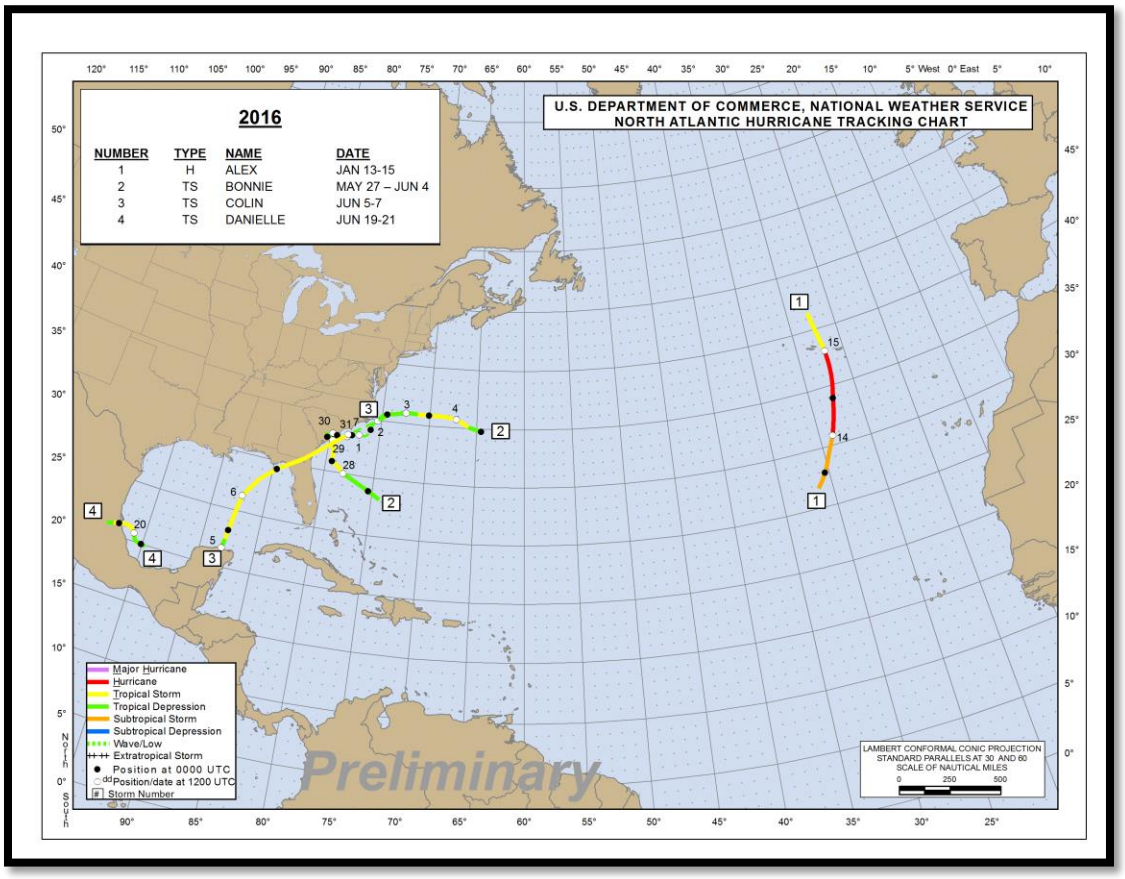



**Figure 4.** Atlantic basin hurricane tracking charts of the current season (2016).

## 2.0 HISTORICAL AND ANALOG YEARS OF THE HURRICANE SEASONS

Based on Environment Canada and Climate Change (ECCC) records, Newfoundland experiences more tropical storms than Labrador. Figure 4(a-b) shows the frequency of tropical storms by year for both locations between 1901 and 2000.

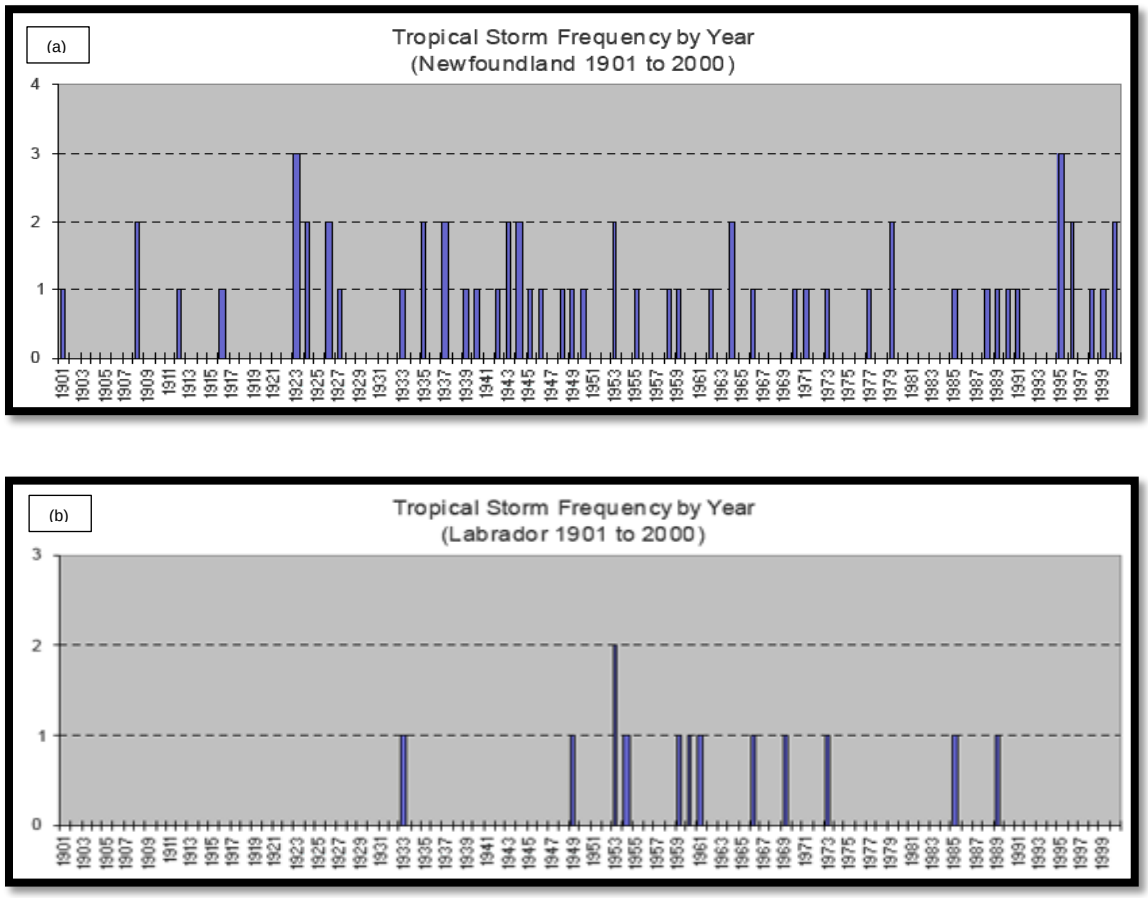



**Figure 5.** Tropical storm frequency by year for Newfoundland (a) and Labrador (b) between 1901 and 2000.

The same records reveal the month of September as the month with the highest number of tropical storm frequency for both Newfoundland and Labrador. The frequency of Newfoundland tropical storms remains active in October before subsiding in November, with zero tropical storms likely in October and November in Labrador as seen in figure 5 (a-b).

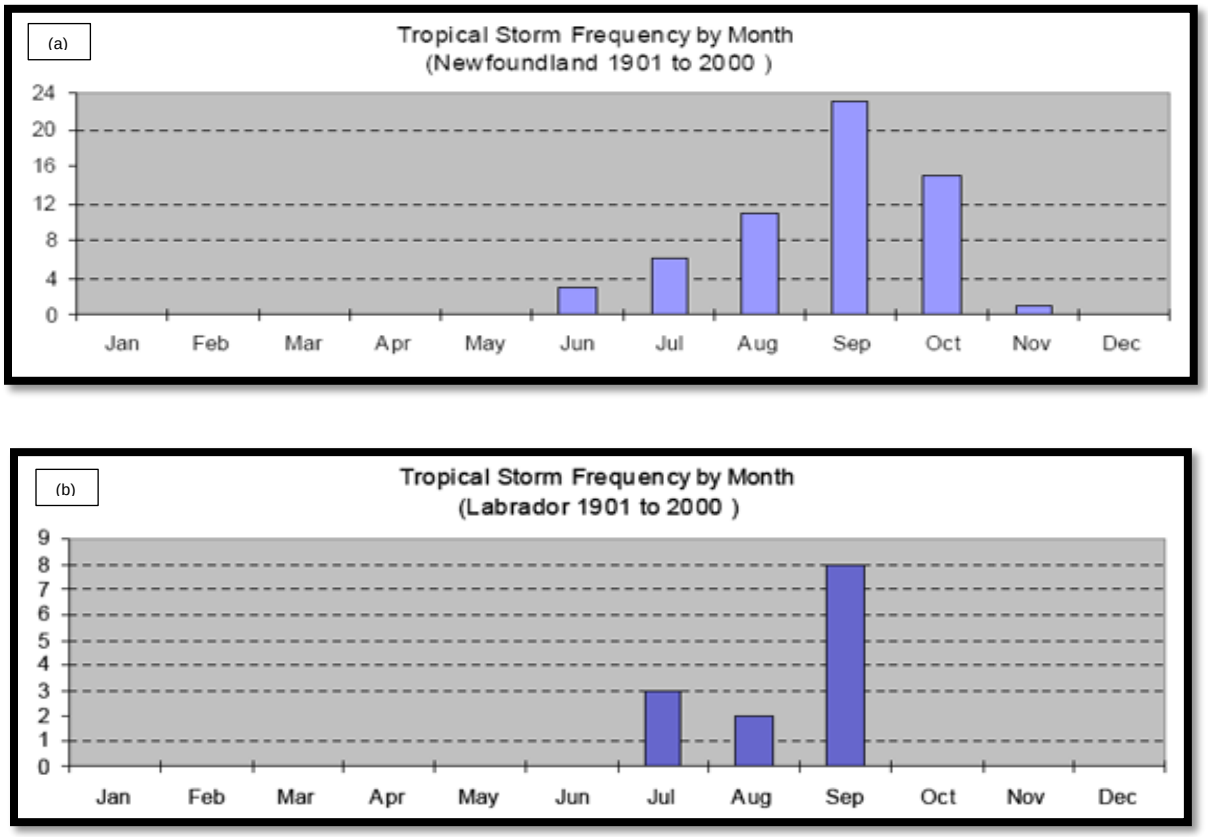



**Figure 6.** Tropical storm frequency by month for Newfoundland (a) and Labrador (b) between 1901 and 2000.

Given the current teleconnections, 1970, 1983, 1998, and 2007 are considered the best analog years for this hurricane season. Analog years depict similar SST patterns and conditions in addition to similar teleconnection phases such as Arctic Oscillation (AO), North Atlantic Oscillation (NAO), Madden-Julian Oscillation (MJO), and Pacific North America Oscillation (PNA). AO is a climate pattern that characterizes the cyclonic wind circulation around the Arctic, NAO is the pressure difference at sea level between the Islandic low and the Azores high, MJO is the intraseasonal variability of the atmosphere in the tropics, and PNA is geopotential height anomalies observed over the western and eastern united States. Such indices govern the global atmospheric pattern and thus affect the activity of the hurricane season. Below is a tabular description of storms that affected Newfoundland and Labrador during the designated analog years.

**Table 2-1: 1970 Season**

| | |
|---|---|
| **None** | No tropical storms or hurricanes entered the Canadian hurricane Center's (CHC) response zone. Storm number 9 in figure 6 below had no name when it entered the CHC. |

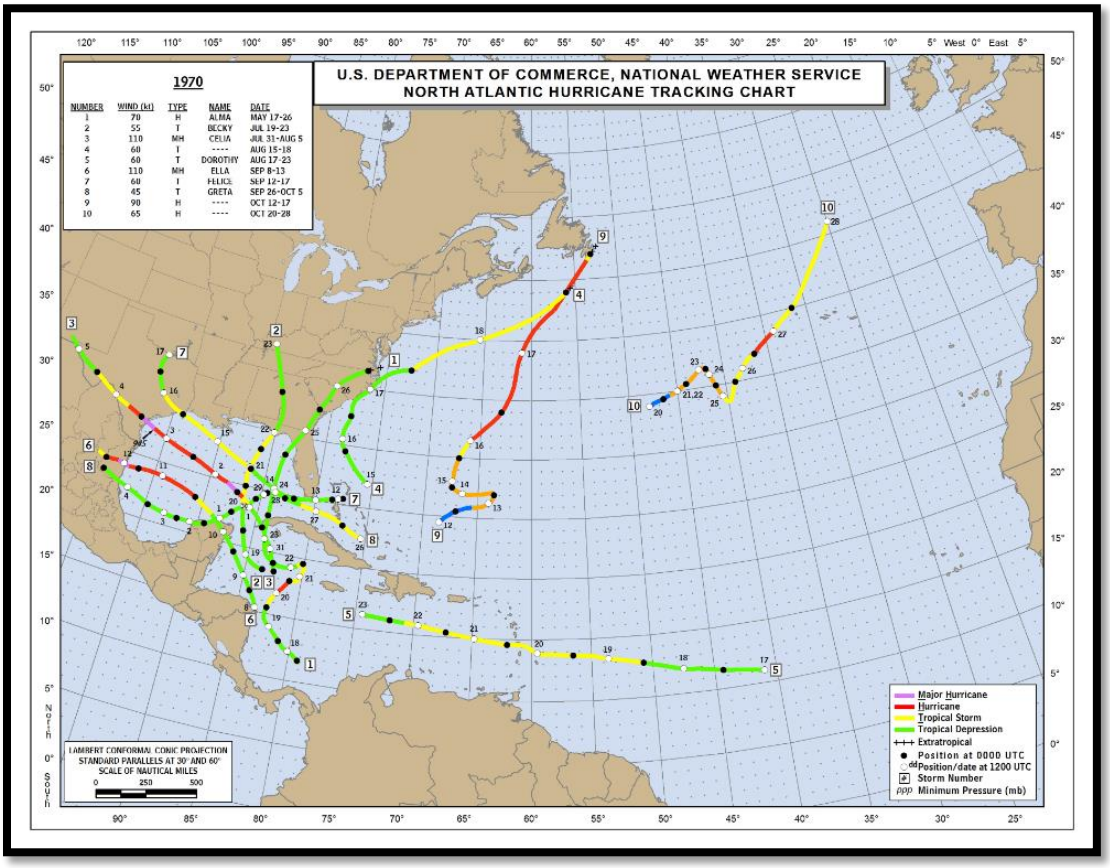



**Figure 7.** Atlantic basin hurricane tracking chart 1970.

**Table 2-2: 1983 Season**

| | |
|---|---|
| **None** | No tropical storms or hurricanes entered the Canadian hurricane Center's (CHC) response zone. |

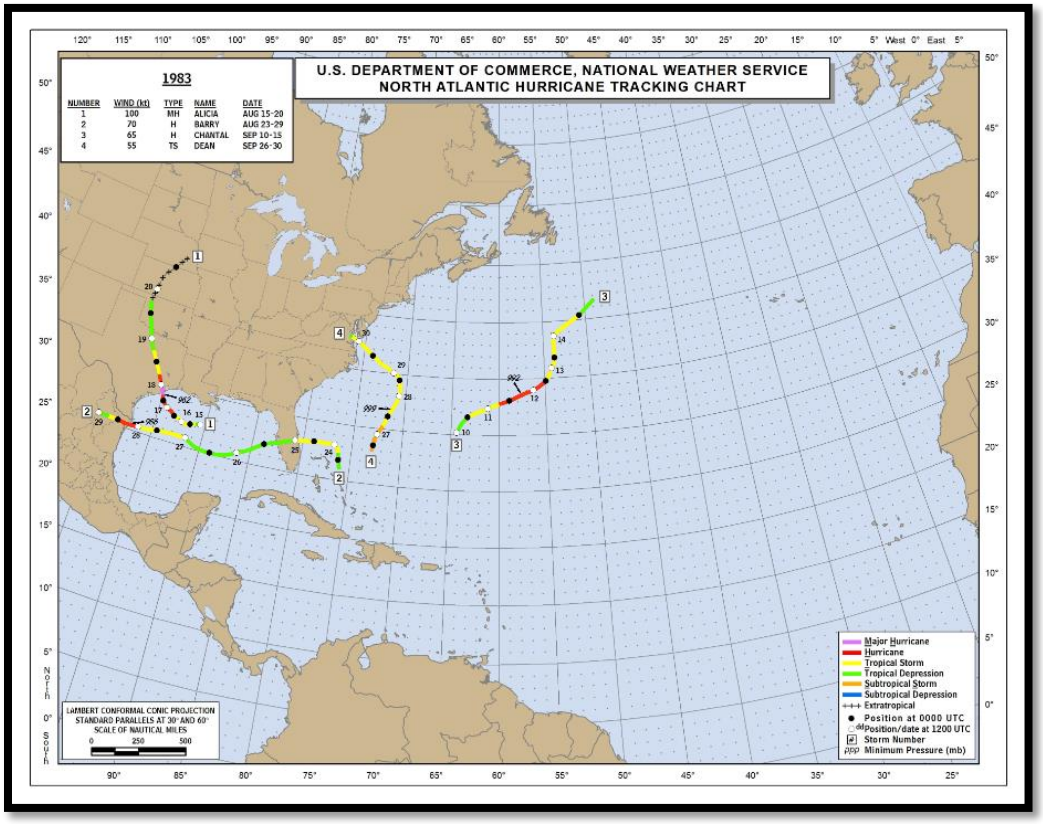



**Figure 8.** Atlantic basin hurricane tracking chart 1983.

**Table 2-3: 1998 Season**

| | |
|---|---|
| **Hurricane Bonnie** | As Bonnie passed south of Newfoundland, its minimum central pressure had risen to about 995 hPa. The effects on land were minimal as most of the precipitation and strong winds remained just off the southeast coast of the Avalon Peninsula. Offshore, a maximum wind speed of 74 km/h with a gust to 100 km/h was recorded at the Southwestern Grand Banks buoy. The maximum significant wave height from the same buoy was 14.4 m |
| **Hurricane Danielle** | As Danielle passed south of Newfoundland, a maximum offshore wind speed of 85 km/h with a gust to 115 km/h was recorded at the Southwest Grand Banks buoy. Also, a maximum wind speed of 93 km/h was reported at the Hibernia drilling site located about 167 km north of the storm's track. |

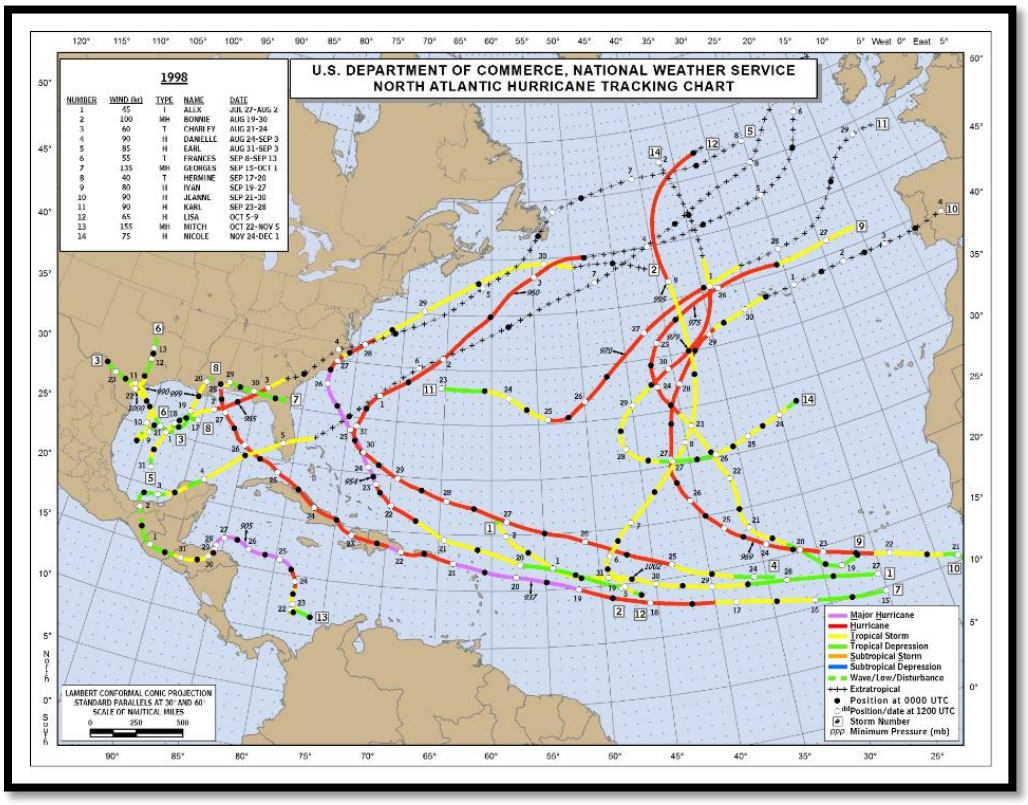



**Figure 9.** Atlantic basin hurricane tracking chart 1998.

**Table 2-4: 2007 Season**

| | |
|---|---|
| **Hurricane Chantal** | Intense flooding rains were confined to the Avalon and Burin peninsulas where more than 100 mm fell mostly between midnight and midday on August 1. Maximum reported rainfalls were 200.4 mm at Argentia and 189.9 mm at Whitbourne. The heaviest reported one-hour rainfalls were 43 mm at St. John's West and 49 mm in Mount Pearl between 6:30 and 7:30 a.m. on August 1. Numerous rainfall records were broken. There were several reports of significant bridge and road washouts during the morning of August 1 and thousands of homes were impacted by flooding. Ten separate communities became isolated by the flooding and declared a state of emergency |
| **Hurricane Noel** | In Labrador the precipitation came in the form of 152.5 cm of snow while in the higher grounds of the Gaspé Peninsula of Quebec there were unconfirmed reports of 30–60 cm of snow. Significant damage–mostly from huge and powerful waves–was sustained to coastal infrastructure such as docks and breakwaters, while there were also road washouts as well as some inland damage from downed trees and power lines, and damage to roofing and siding material on homes. One fatality was linked to the storm when a boat capsized following the storm |

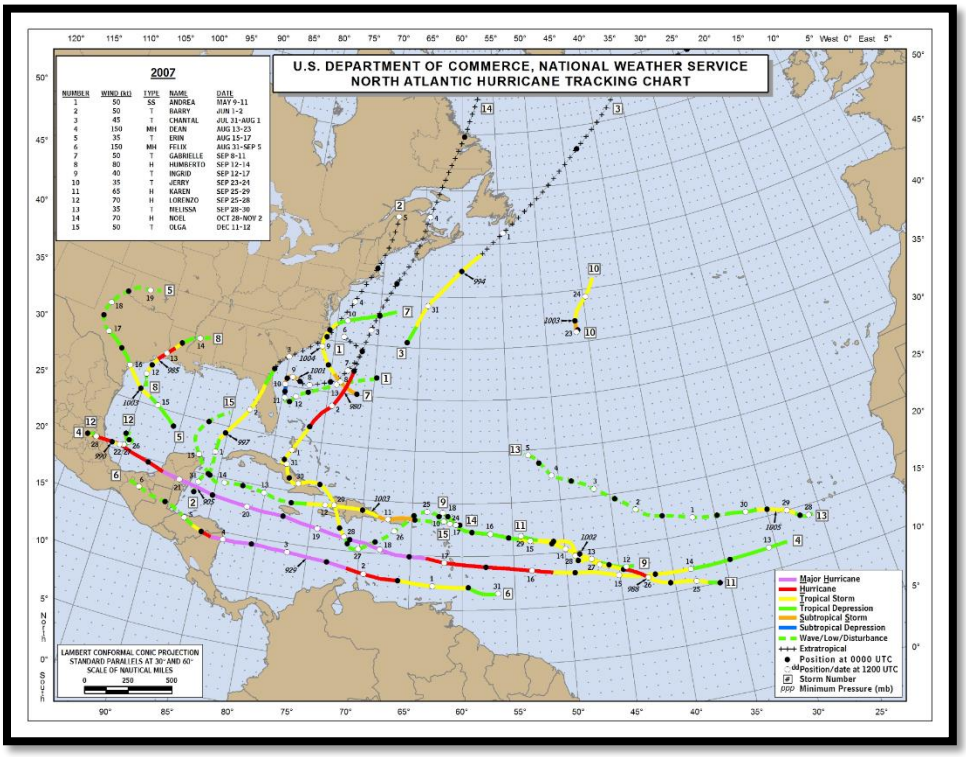



**Figure 10.** Atlantic basin hurricane tracking chart 2007.

## 3.0 AVERAGE NEWFOUNDLAND AND LABRADOR HURRICANE SEASON

The Canadian Hurricane Centre's (CHC) records are updated through 2014. The thirty years records (1983-2014) show 44 tropical/post-tropical cyclones in the Atlantic Ocean have made landfall in or have passed within 100 km of Newfoundland and Labrador. This represents 11% of all tropical/post-tropical cyclones that have formed in the Atlantic Ocean for this period.

For Labrador, hurricane activity is limited by the fact that a hurricane must traverse land or cross over cold ocean water to reach Labrador. As hurricanes move north and pass over the colder waters of the Labrador Current, it dramatically decreases the energy available to fuel the storm. In addition, hurricanes have typically lost strength by the time they reach Labrador because they have made landfall by that point, cutting off the source of warm, moist air that was encouraging storm development.

## 4.0 2016 NEWFOUNDLAND AND LABRADOR HURRICANE SEASON OUTLOOK

Given the current oceanic and atmospheric conditions in addition to the concurring forecasts of NOAA and CSU discussed earlier, there is a potential of 1 to 3 tropical/extratropical cyclones to affect Newfoundland and Labrador through the rest of this season with the highest impact expected to be along southern Newfoundland and Labrador as shown in figure 11. Historically, September shows the highest impact month for Newfoundland and Labrador with the threat likely to remain through October for the island of Newfoundland. Although the current normal to below normal SST area south and east of island of Newfoundland is likely to curb further intensification of cyclones tracking through that area, if not reducing their intensity, weather systems transitioning from being tropical in origin into a strong area of low pressure are likely to produce periods of heavy rainfall and strong sustained winds that can cause significant damage.

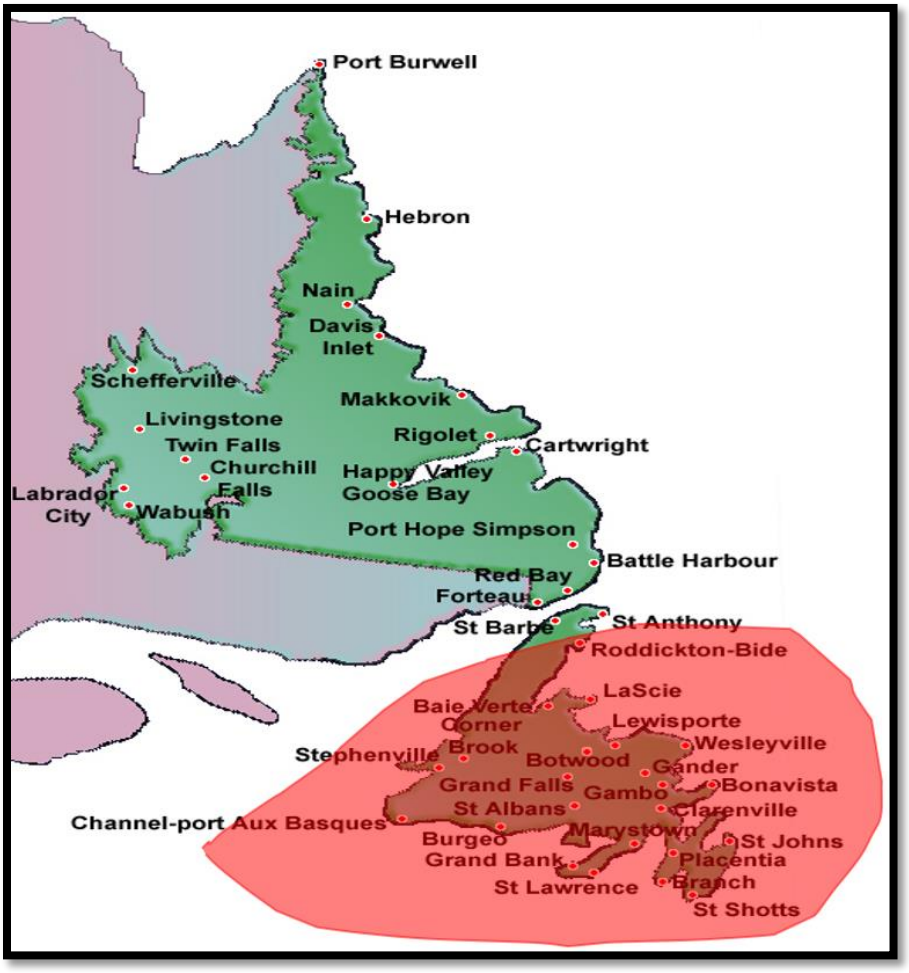


**Figure 11.** Tropical/extratropical cyclones track high impact risk map for NL and Labrador (Water Resources Management Division Department of Environment and Conservation) 2016 Hurricane season.

## 5.0 CLOSURE

We trust that this report meets your needs. Please do not hesitate to contact the undersigned if you have any questions or comments regarding the hurricane season outlook.

Yours sincerely,

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