NL WATER RESOURCES MANAGEMENT DIVISION

NEWFOUNDLAND AND LABRADOR HURRICANE SEASON OUTLOOK 2023

WEATHER & CLIMATE

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CONFIDENTIAL

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1 ATLANTIC HURRICANE SEASON OUTLOOK 2023

The Atlantic Hurricane Season runs from June 1st to November 30th, although storms can and do form outside of the designated season. The peak of the hurricane season for the basin and for Newfoundland and Labrador is early to mid-September. The hurricane season can be a trying time for many peoples in the Caribbean, central America, the US, and Atlantic Canada, with major costs to life and property at stake. While the greatest impacts of the hurricane season tend to be felt in the tropical and subtropics, Atlantic Canada is no stranger to significant impacts. We've seen the difficulties with Fiona (2022), Dorian (2019), Larry (2021), and Igor (2010).

There are numerous sources of weather data are used in this hurricane outlook. The major sources are based on the prediction of the El Niño-Southern Oscillation (ENSO) condition, Sea Surface Temperatures (SSTs), model prediction, and weather patterns. Models also have limited long-range skill in predicting SSTs, vertical wind shear, moisture availability, stability, and predicting weather patterns in the coming months. The seasonal weather pattern prediction is an outlook of an overall season, but we cannot fully convey the daily and weekly changes in the pattern. The short-term variability in the weather pattern plays a major role in the development, intensification, and tracking of tropical storms and hurricanes. Furthermore, the intensity and duration of the predicted tropical storms and hurricanes can occur under different combinations of climatic signals, which amplifies the uncertainty of such predictions.

Several agencies issue an Atlantic hurricane season outlook, including the National Oceanic and Atmospheric Administration (NOAA) [1] Colorado State University (CSU) [2], and Tropical Storm Risk (TSR) [3]. An unnamed subtropical storm formed in mid-January, and this will need to be considered for tabulating storm numbers for 2023 and the predictions for the coming season. NOAA's 2023 Atlantic Hurricane Seasonal Outlook predicts a near-normal season (40%), followed by a 30% chance of above-normal season and a 30% chance of a below-normal season. Colorado State and Tropical Storm Risk also forecast Accumulated Cyclone Energy (ACE) which is an aggregate measure of storm intensity, duration, and number. ACE biases toward long-lasting intense hurricanes rather than weak tropical storms because long-lasting intense hurricanes are more likely to cause destruction. Colorado State is predicting a seasonal ACE 19% below the 1991-2020 average. Meanwhile, Tropical Storm Risk (TSR) predicts the 2023 Atlantic hurricane season to be 20% below the long-term (1950-2022) normal and 31% below the 30-year (1991-2020) normal in terms of ACE. Table 1 below summarizes the predictions from each source. The CSU forecast team also forecasts the probability of a named storm impact for Newfoundland and Labrador at 27%, with a 16% probability of a hurricane impact. These are both near-normal. An impact is defined as a storm centre passing within 80 km of the province.

Table 1. Atlantic Basin 2023 hurricane forecast by NOAA, CSU, and TSR

	NOAA	CSU	TSR
Named Storms	12-17[1]	13[2]	12[3]
Hurricanes	5-9	6	6
Major Hurricanes	1-4	2	2

[1] NOAA's Outlook was issued May 25th

[2] CSU's forecast was issued April 13th

[3] Tropical Storm Risk's forecast was issued April 6th

The El Niño-Southern Oscillation (ENSO) is an irregular periodic variation in winds and sea surface temperatures of the tropical eastern Pacific Ocean. It is the leading predictor for seasonal forecasts as it is reasonably forecastable on the time scale of months and has a large effect on global atmospheric circulation. The phase of the ENSO is typically defined by the persistence of warm SST anomalies (>0.5 °C) for 5 consecutive 3-month periods in the Niño 3.4 region (Fig. 1), while the opposite is true for La Niña. The neutral phase is defined when the Niño 3.4 region is within ±0.5 °C for 5 consecutive 3-month periods.

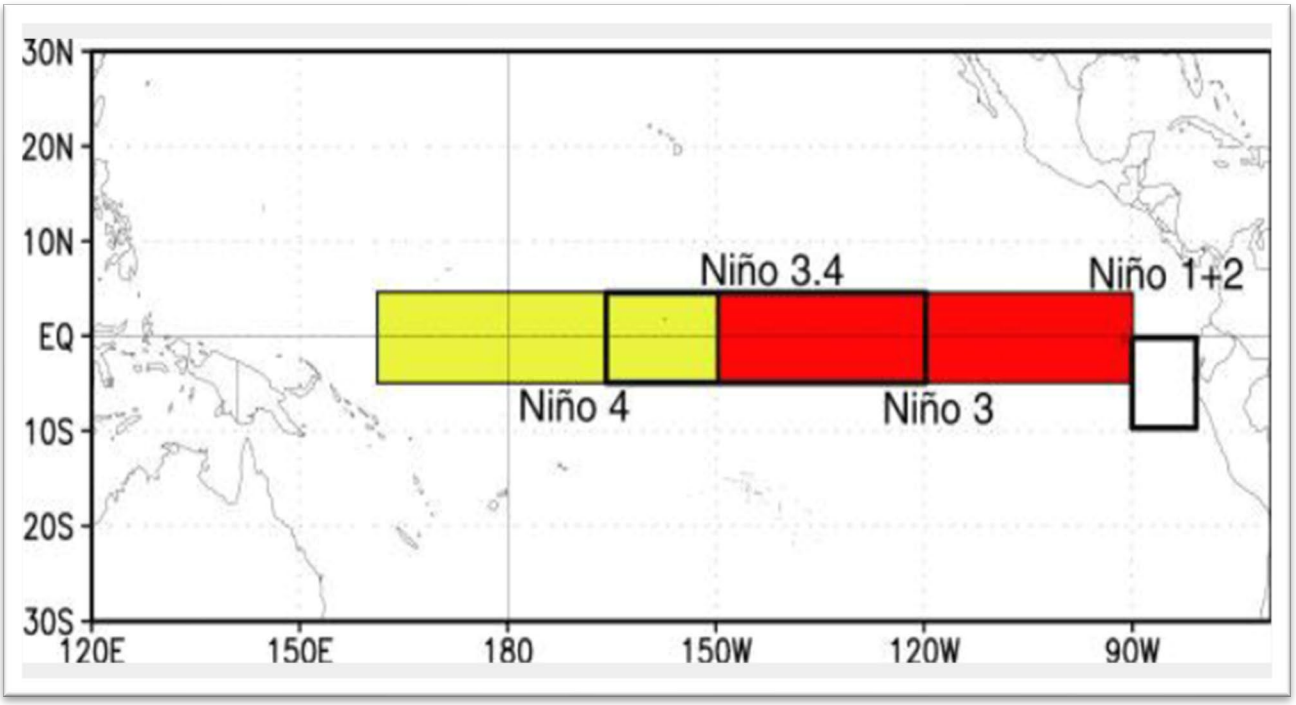

Figure 1 Niño Regions.

The La Niña phase is climatologically associated with weaker vertical wind shear, weaker trade winds, and increased atmospheric instability across the Atlantic basin, which in turn helps the overall organizational structure of any tropical storm. Meanwhile, the El Niño phase suppresses storm organization due to stronger wind shear, stronger trade winds, and greater atmospheric stability across the Atlantic basin. It is also worth noting that both ENSO phases have opposite effects on the East Pacific and Atlantic basins.

Figure 2 shows the probabilistic ENSO forecast based on the Niño 3.4 SST anomaly. The figure shows that El Niño conditions are highly likely to develop this summer and persist into the coming winter, with an 88% risk at the peak of hurricane season (ASO) per the dynamical and statistical forecasts. There is a near 0% risk of La Niña and a 12% chance of a neutral ENSO conditions.

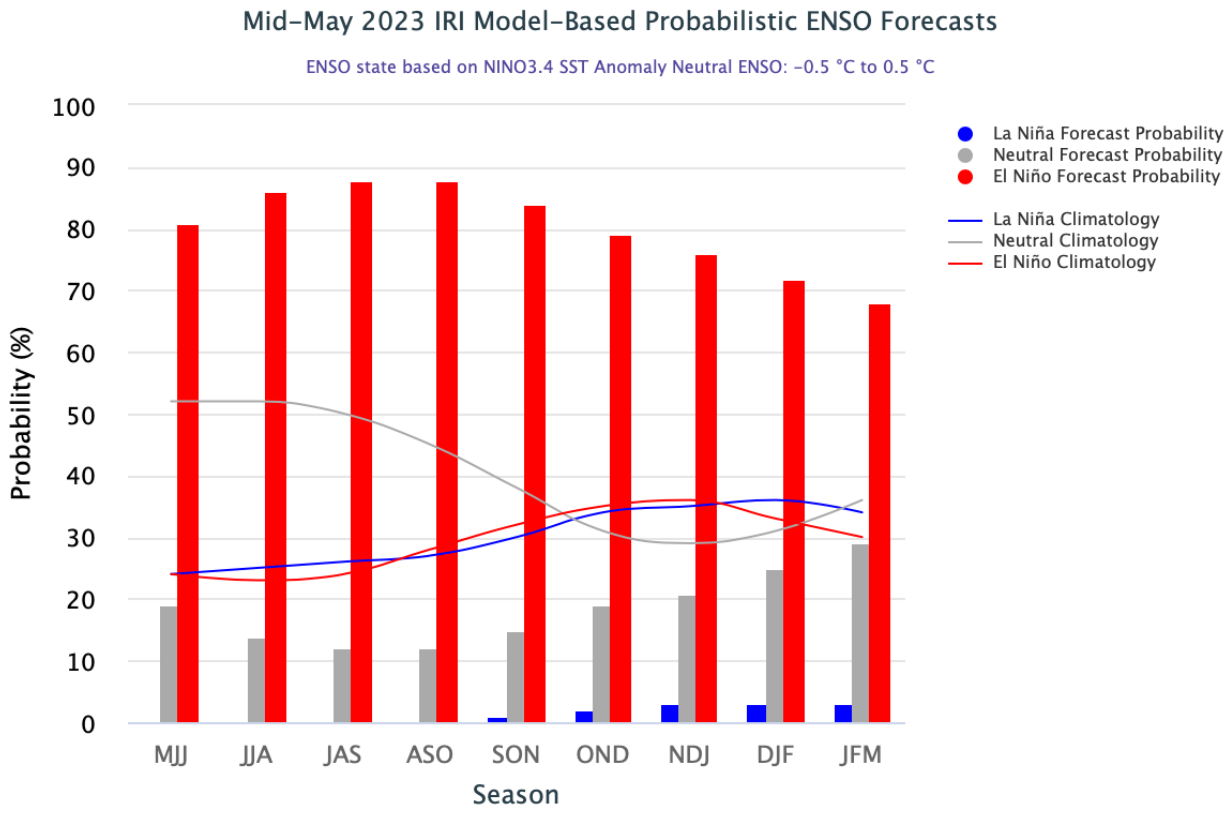

Figure 2 ENSO Probability Forecast (IRI/CPC) [4]

Hurricane season predictions consider the various and complex interactions of variables such as the ENSO and Atlantic Multidecadal Oscillation (AMO), mid-level moisture, and NW Atlantic sea level pressure and upper air patterns. The AMO is an index that measures the decadal SST variability in the Atlantic basin. Positive AMO years generally have warmer than normal SSTs in the tropical Atlantic and below normal SSTs in the subtropical Atlantic. The opposite is true for negative AMO years. The current positive phase of the AMO (Fig. 3), which we've been in since about 1995, is conducive to lower surface pressure, moist atmospheric mid-levels over the tropical Atlantic, and, likewise, more hurricane activity.

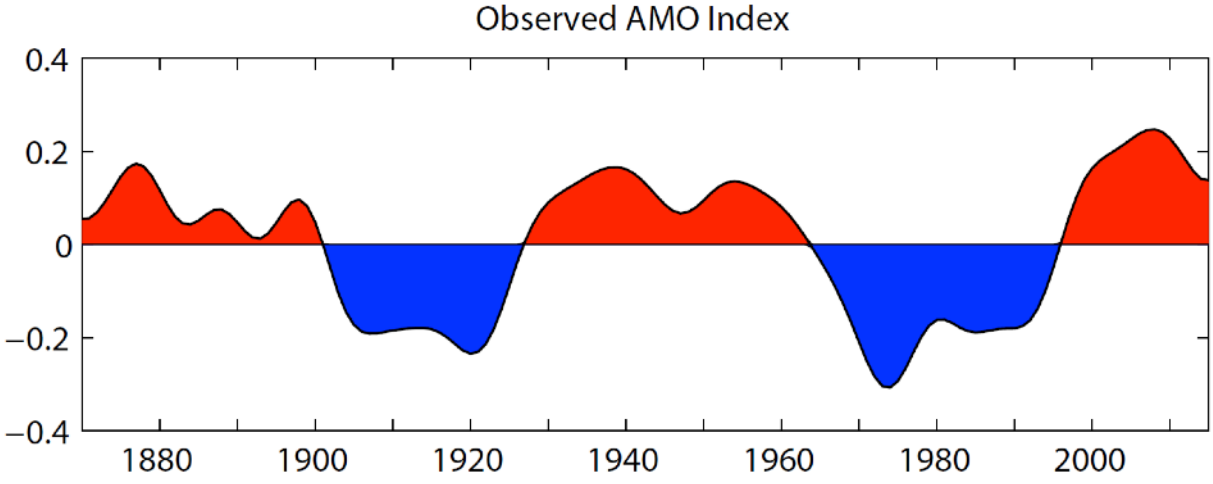

Figure 3 Smoothed AMO Index [1870-2021 (NCAR) [5]

The latest SST observation (Figure 4) shows very warm water relative to normal in the tropical Atlantic, in the Main Development Region (MDR), 10-20 °N, and 20-60 °W (right red box). Warmer than normal water in the MDR and, likewise, a positive Atlantic Multidecadal Oscillation is associated with a more active than normal Atlantic Hurricane Season. This conducive element is expected to be in direct contrast to the already present warmer than normal water in the equatorial Pacific and the developing El Niño. Due to these opposing elements, there is more than typical uncertainty for the coming season.

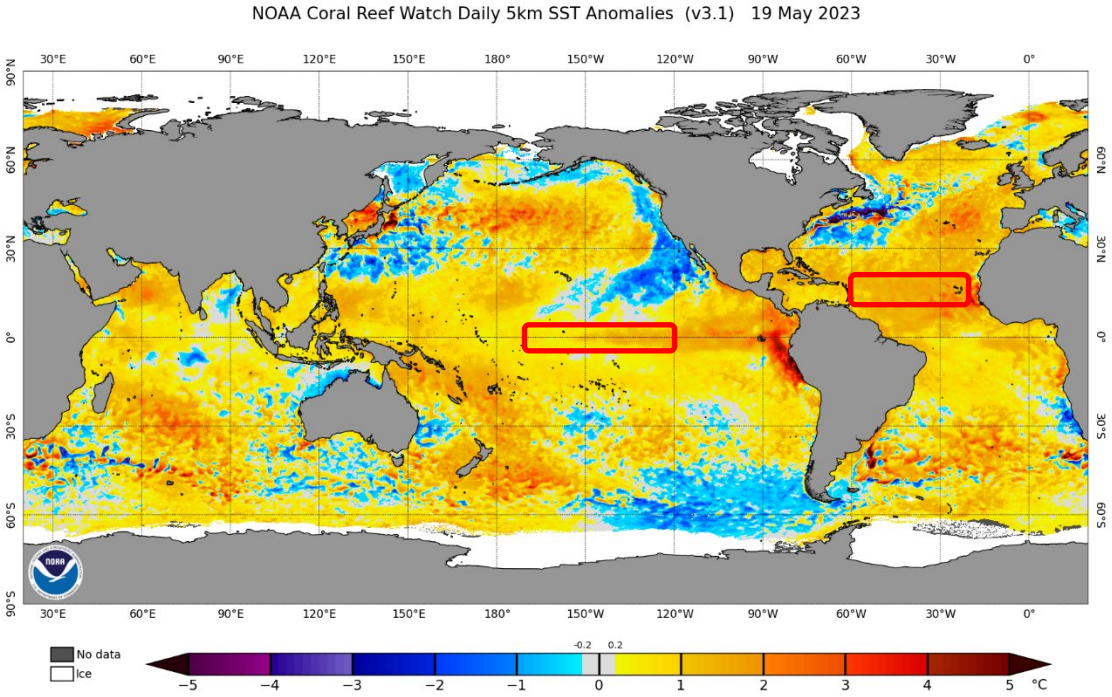

Figure 4 Global SST Anomaly on May 19th The right red box shows the warm MDR region in the Atlantic Ocean and the left red box the warming Niño 3.4 region in the Pacific (NOAA) [6]

The WSP Seasonal Outlook Team is anticipating a near normal Atlantic Hurricane Season. The strong signal for El Niño, with many models showing moderate strength, should impart strong wind shear across the Caribbean, especially in the later portion of the season. Given the very warm Atlantic Ocean, it is likely still that tropical waves which find a favorable area of development outside of the areas of wind shear and dry air could become intense. Due to our analogs, and the general area of the wind shear that El Niño likely imparts, it seems reasonable to expect the more intense storms are likely to be over the central Atlantic Ocean and not as likely in the Caribbean or the Gulf of Mexico. This is also supported by the seasonal model guidance, like the ECMWF, which shows less than normal precipitation during peak hurricane season across the Caribbean and the central Gulf of Mexico, but above normal precipitation and lower than normal sea level pressure in the central North Atlantic.

2 HISTORICAL NEWFOUNDLAND AND LABRADOR HURRICANE SEASONS

The archive records from the National Hurricane Center HURDAT2 and NOAA's IBTrACS data sets show Newfoundland being impacted by more than double the tropical storms, hurricanes, and extratropical remnants than Labrador, as seen in Figure 5. This year's report used a further expanded historical data set that better accounts for extratropical remnants and storms which didn't make landfall but tracked close enough to the province to make an impact. These storms do not have to retain much of their prior strength to bring high levels of atmospheric moisture, rainfall, and likewise flooding to our region.

Even so, this larger database did not cover all floods directly or indirectly related to tropical systems. Two floods of record, one from Post-Tropical Earl (2022) in eastern Newfoundland (Fig. 7) and another from the moisture from Hurricane Matthew (2016) in western and central Newfoundland, are not included in this database. Earl tracked too far from Newfoundland (270 km SSE of Cape Race). The surface low of Hurricane Matthew dissipated east of the North Carolina coast despite large amounts of atmospheric moisture flowing northward into a separate non-tropical system that developed over Atlantic Canada. The heavy rainfall and flooding led to traffic flow across the island being halted as flood waters split the road in the Terra Nova section of the Trans-Canada Highway.

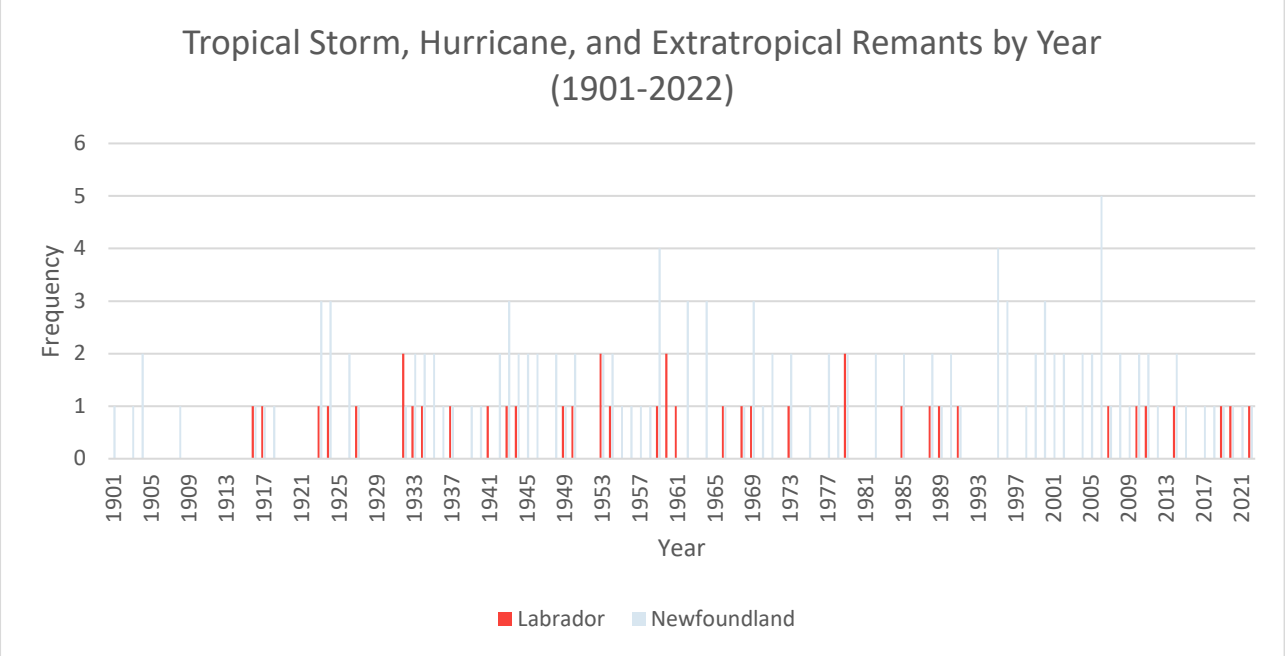

Figure 5 Tropical Cyclone and Extratropical Remnants by year for NL between 1901 and 2022 (NOAA) [7]

The same records revealed the month of September as the peak month for activity in the province storm, followed by October, and then August (Fig. 6).

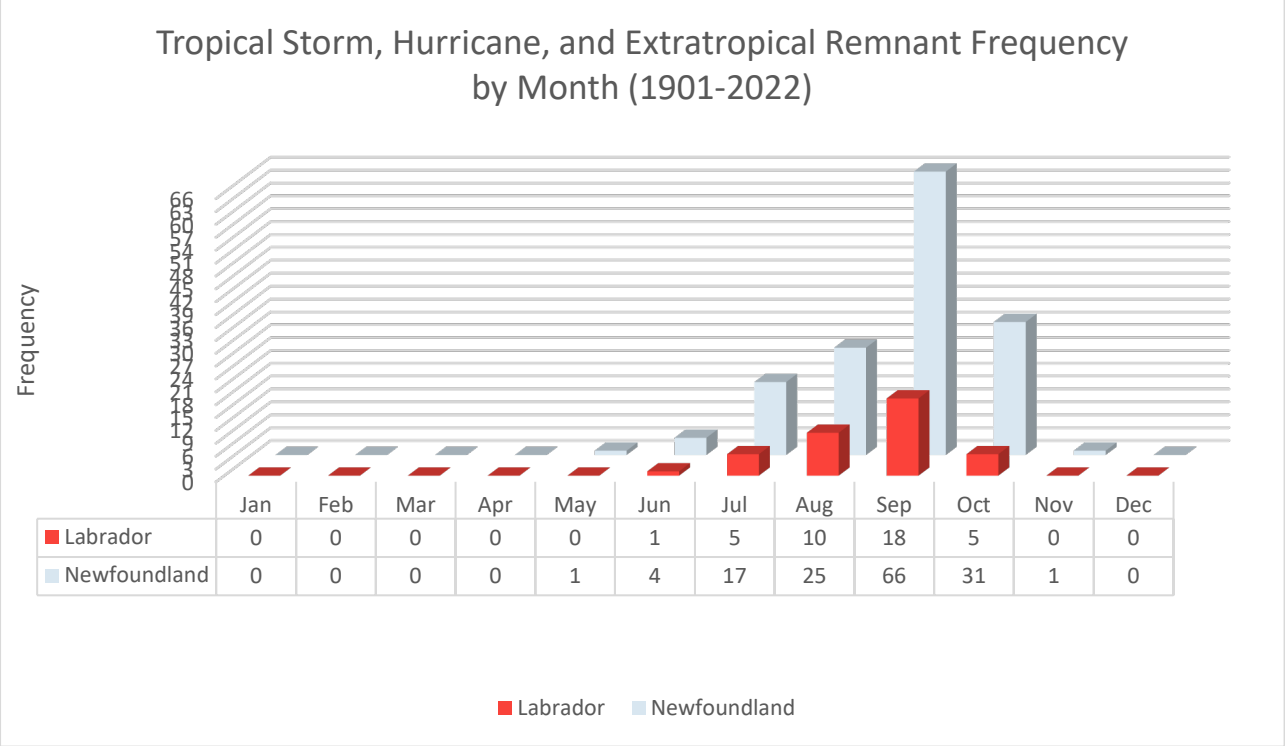

Figure 6 Tropical Cyclone and Extratropical Remnant Frequency by month for NL between 1901 and 2022 (NOAA) [7]

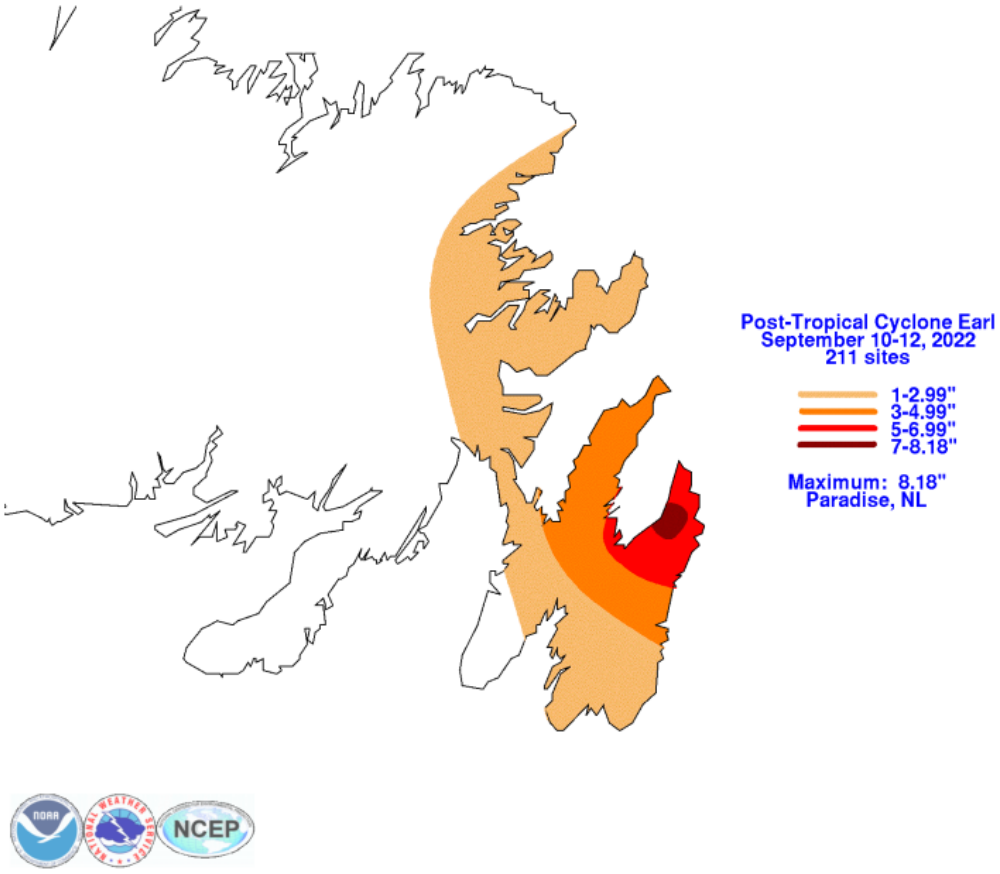

Figure 7 Rainfall Totals in Eastern Newfoundland from Earl (2022), 1 inch = 25.4 mm (NHC) [8]

Figure 8 shows the Florida State University (FSU) probabilistic tropical cyclones tracking over Newfoundland using 1886-2020 historical data. Storms that affect Newfoundland most regularly approach from the south-southwest and generally pass near or west of Bermuda before arriving on the Newfoundland Coast. Any storm this year that tracks through the blue and green colours on this chart will be further scrutinized by WSP forecasters to gauge potential future impacts to the province.

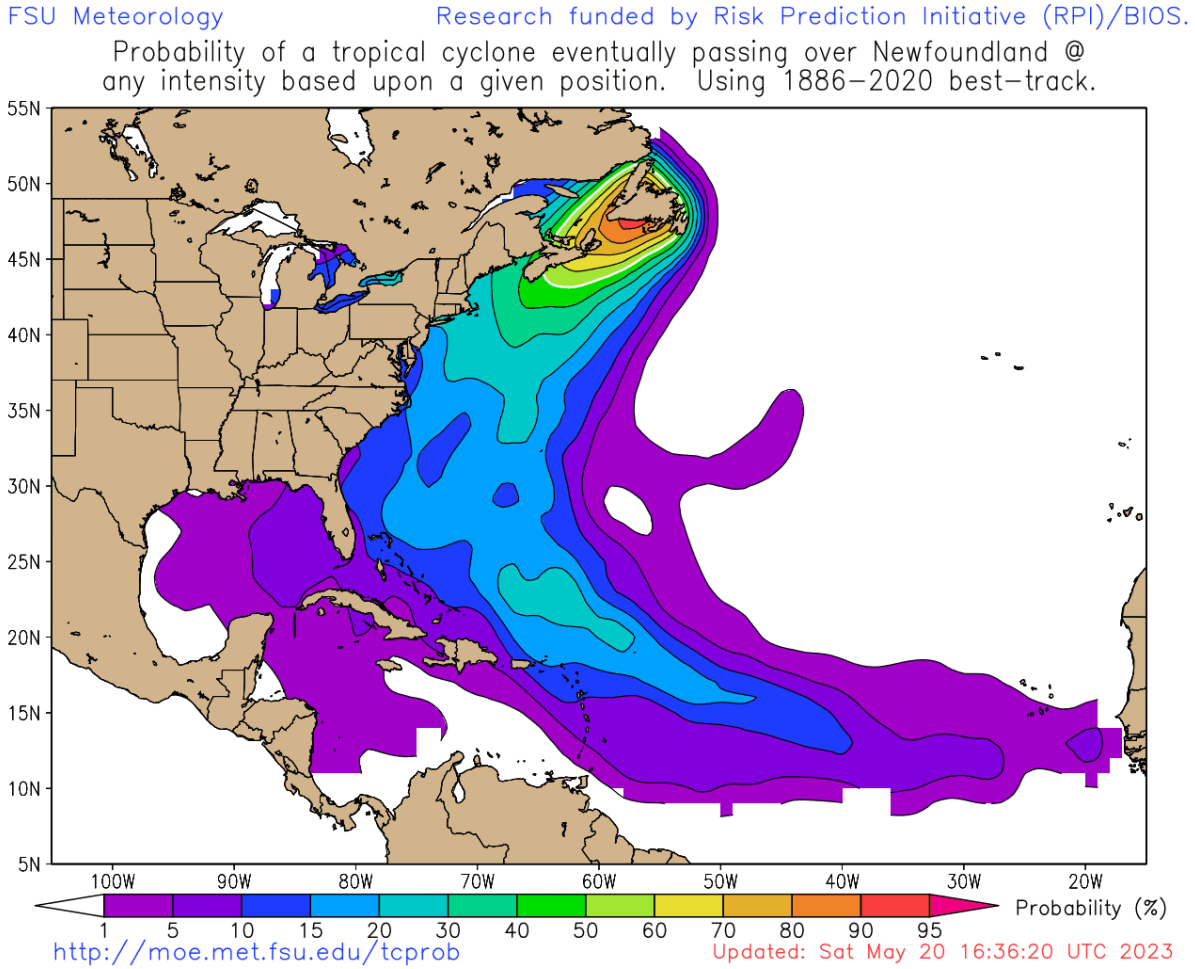

Figure 8 Newfoundland tropical cyclone probability using 1886-2020 best-track [9]

3 ANALOG YEARS AND HISTORICAL TRACKS

Given the projected ENSO conditions, the best analog years are 1951, 1953, 1963, 2006, and 2009. Due to inconsistent climatology prior to the advent of the satellite era in 1979 and new analysis techniques, it is likely that about 3.2 tropical storms per year were missed in the 1900-1965 era (Landsea 2007 [10]), so three of our analogs 1951, 1953, and 1963 must be adjusted to represent modern climatology. Figure 9 shows the upper air (500 hPa) geopotential height (m) composite anomaly based on 1991-2020 climatology for the period from June and through November for the combined analog years. Given the older years used in this composite is difficult to glean too much from the anomalies overall, but the lower than normal 500 hPa heights over Labrador and northern Newfoundland could serve to suppress recurving storms south of the province.

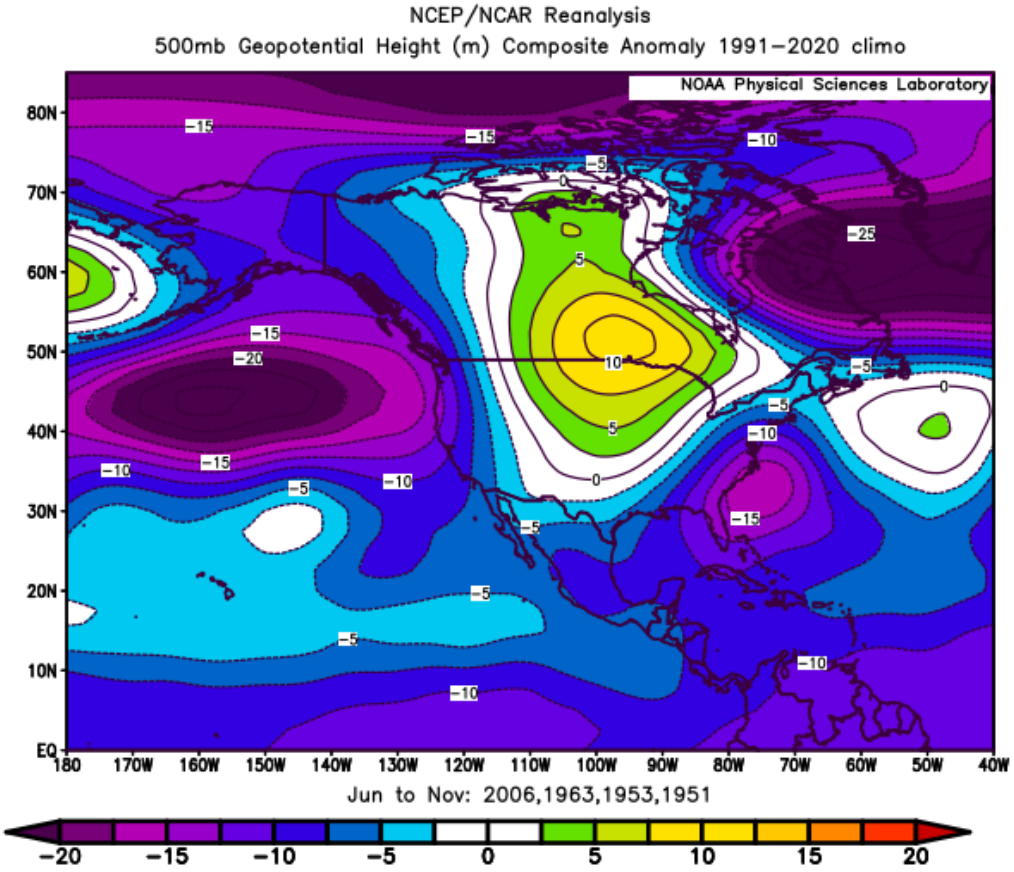

Figure 9 Upper air (500 hPa) Geopotential Heights (m) composite anomaly for June through November of the analog years (NOAA PSL) [11]

The hurricane track charts for the analog years are given in Figures 10 to 14. Generally, the analog years depict a near-normal hurricane season, with an adjusted range of 9 to 17 named storms, of which 3 to 7 became hurricanes, and of which 2 to 3 became major hurricanes.

No storms had a direct impact on Newfoundland and Labrador in 1951. Barbara (1953) affected western Newfoundland and Labrador and unnamed (1953) affected eastern Newfoundland. Carol and Barbara affected Labrador with minor rainfall. No storms had a direct impact in 1963. 2006 was a busy year for Newfoundland with 4 impacts from tropical cyclones or former tropical cyclones. Alberto, Florence, and Isaac affected eastern Newfoundland and Beryl affected western Newfoundland. Alberto dropped about 20 mm of rainfall in Gander and St. John's. Cape Race recorded about 40 mm of rainfall and gusted to 97 km/h during Isaac's passage. Post-Tropical Florence dropped 67 mm of rainfall in Salt

Pond Newfoundland and about 50 mm in St. John's. Segona Island recorded a wind gust of 150 km/h and there was an estimated wind gust of 102 km/h in St. John's. Beryl merged with another low over Newfoundland dropped nearly 50 mm of rainfall in Stephenville. Hurricane Bill (2009) brought 71 mm of rainfall to Gander, about 40 mm to St. John's and a wind gust to 131 km/h in Cape Race.

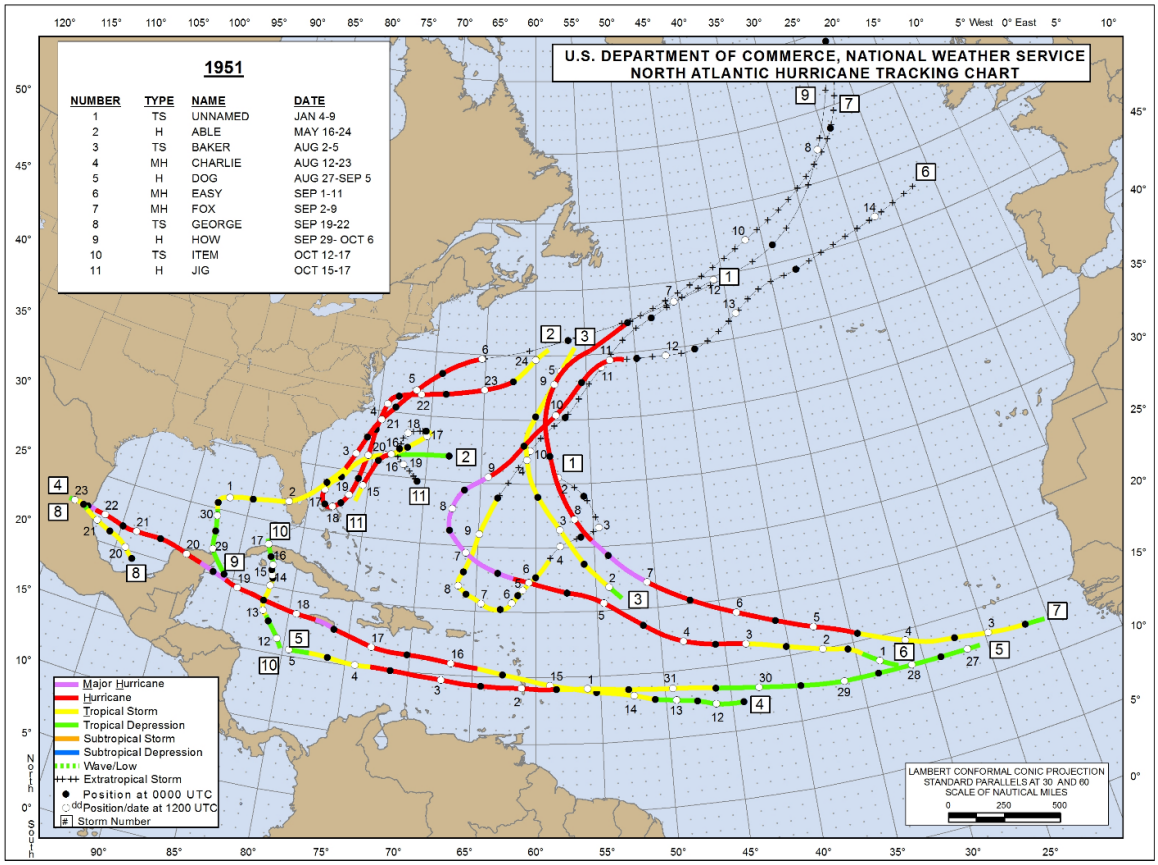

Figure 10 North Atlantic Hurricane Tracking Chart (1951) (NHC) [12]

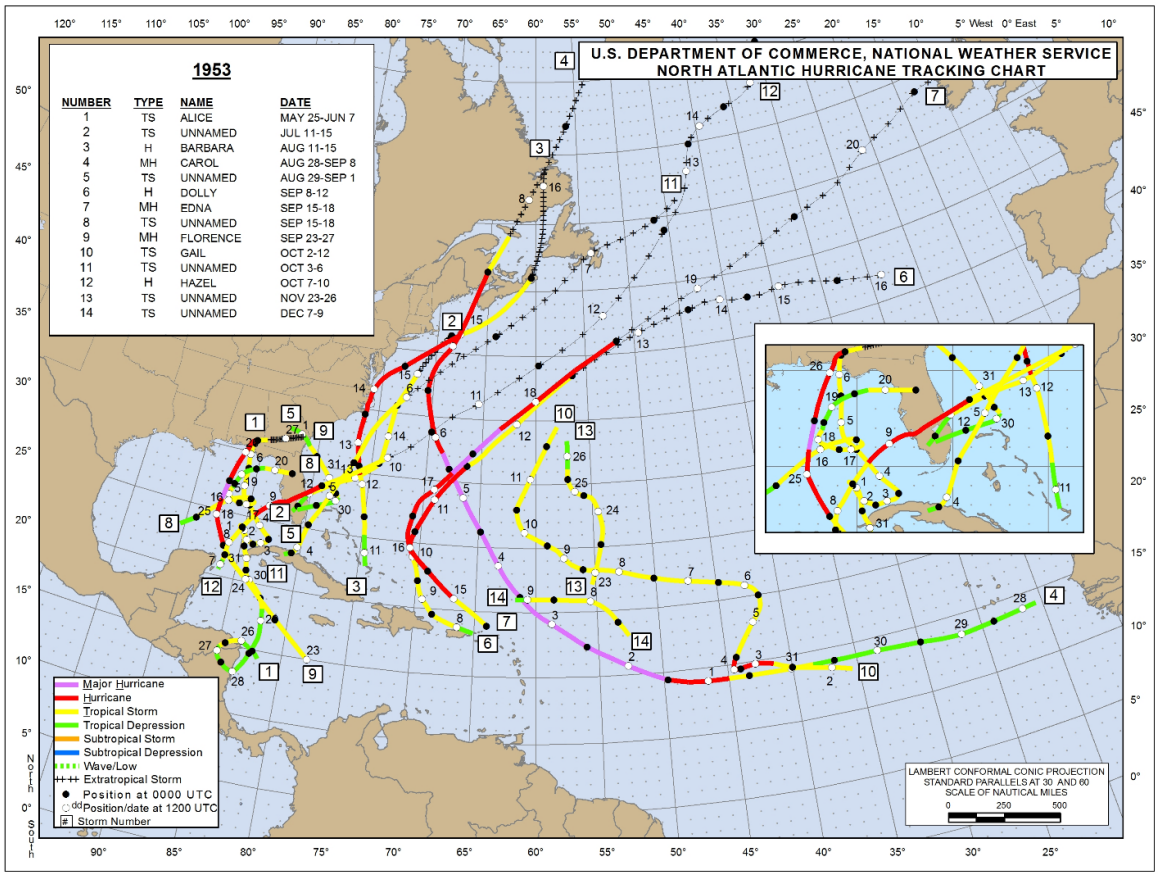

Figure 11 North Atlantic Hurricane Tracking Chart (1953) (NHC) [12]

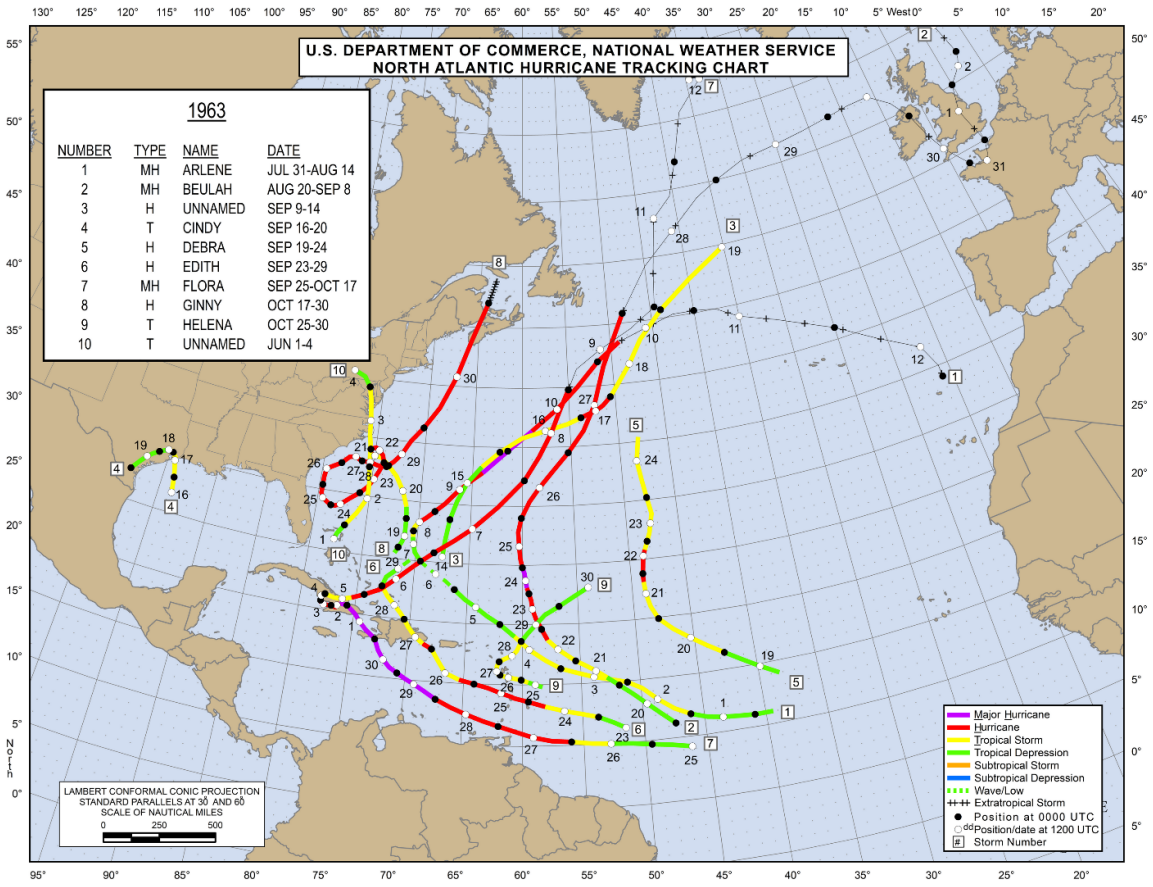

Figure 12 North Atlantic Hurricane Tracking Chart (1963) (NHC) [12]

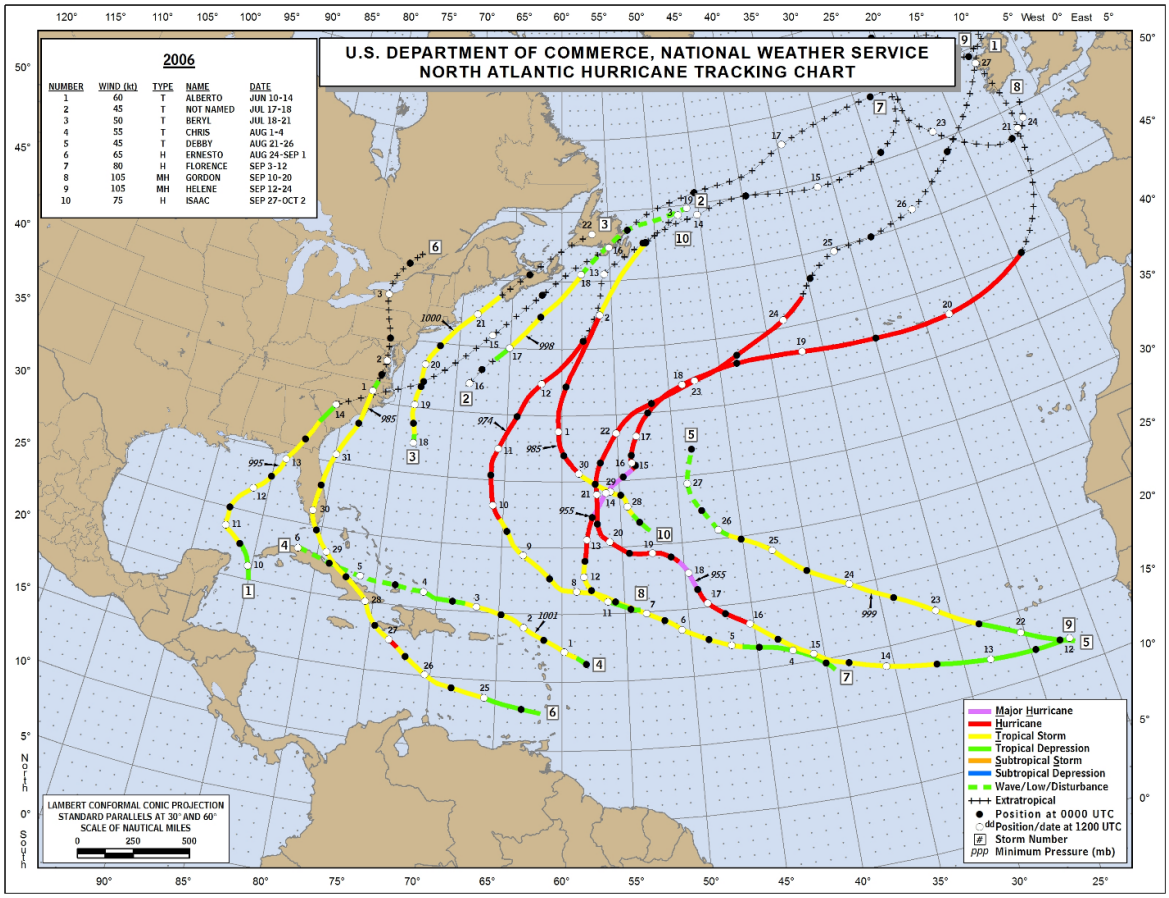

Figure 13 North Atlantic Hurricane Tracking Chart (2006) (NHC) [12]

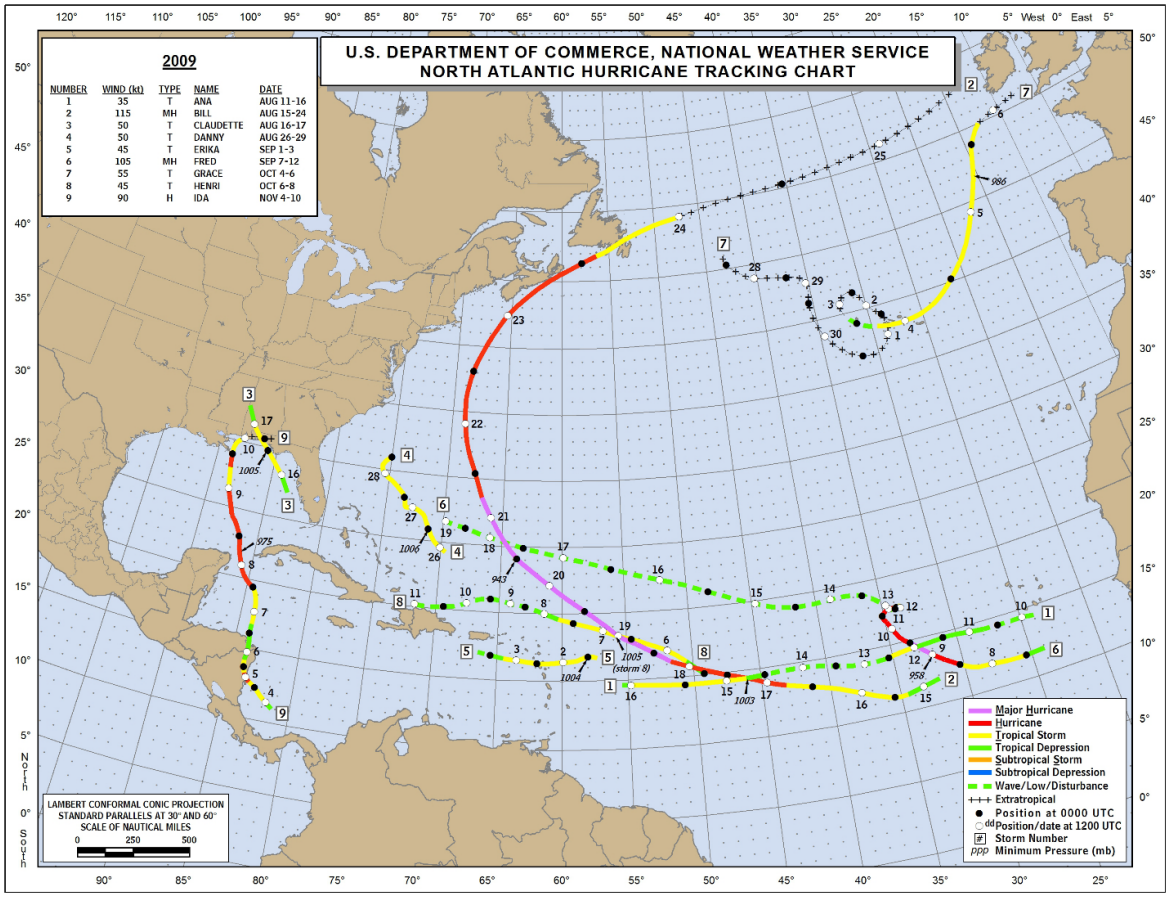

Figure 14 North Atlantic Hurricane Tracking Chart (2009) (NHC) [12]

4 NEWFOUNDLAND AND LABRADOR HURRICANE SEASON OUTLOOK 2023

WSP anticipates a near normal season for the province, with the greatest risk of tropical storms, hurricanes, and strong post-tropical storms across eastern Newfoundland, including St. John's (Fig. 15). These types of storms carry the associated risk of high wind gusts of more than 100 km/h, heavy rain of more than 100 mm with associated flooding, and storm surge flooding on exposed coastline near sea level. For areas in the lower risk zone in central and western Newfoundland and southeast Labrador, there is a much lower risk of very high wind gusts and storm surge, but there is a still a considerable risk of heavy rain and associated flooding as weak storms merge with other lows.

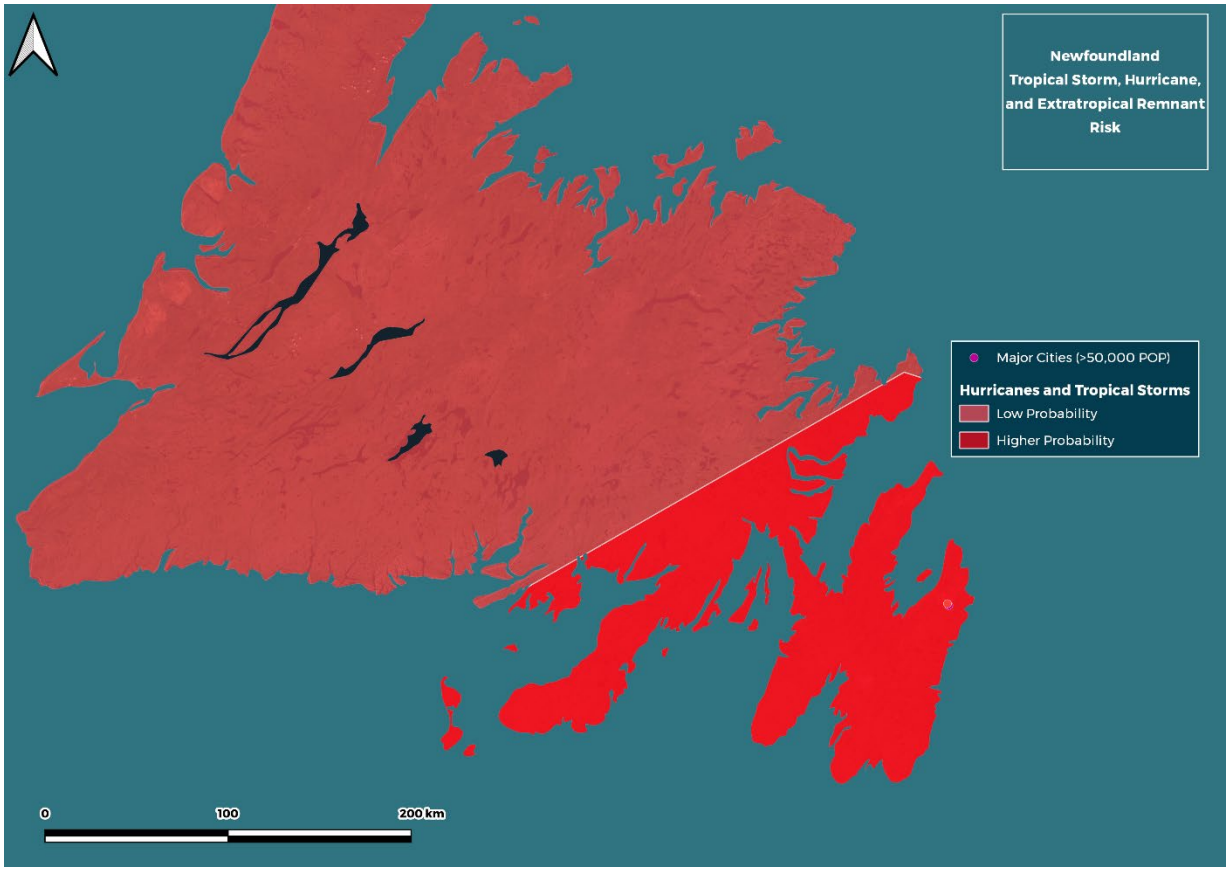

Figure 15 Newfoundland Hurricane Season Risk Map

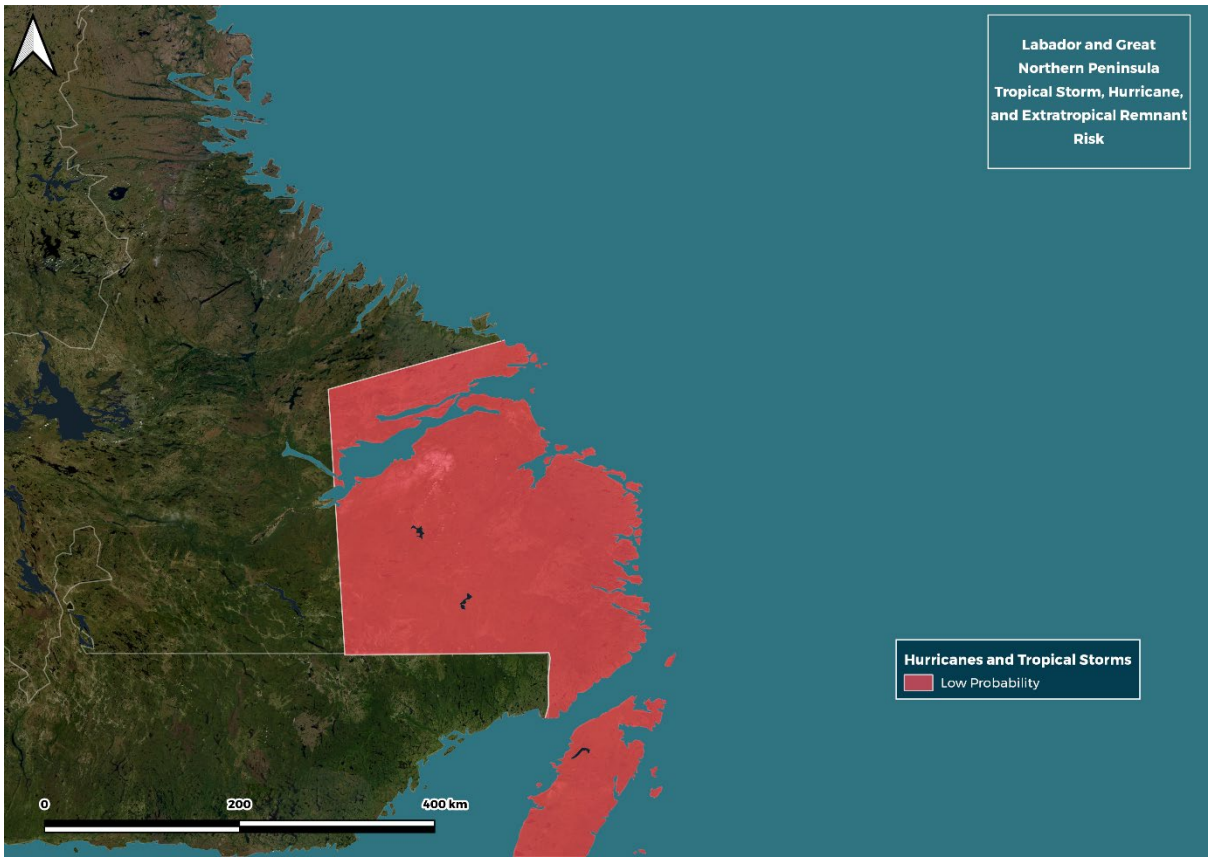

Figure 16 Labrador and Great Northern Peninsula Hurricane Season Risk Map

5 CLOSURE

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

Yours sincerely,

WSP E&I Canada Limited

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Meteorologist/Weather and Climate Consultant

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