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Seasonal Summary

Eastern Canada
Winter 2016-2017

By



Canadian Ice Service
Le service canadien des glaces

Summary for the East Coast

For a second consecutive ice season, the East Coast demonstrated a distinct regional separation of ice regimes. In winter 2016-2017, the Estuary and Gulf of St. Lawrence experienced lower than normal ice coverages whereas ice cover across the East Newfoundland Waters and the Southern Labrador Sea were near normal climatological extents. With respect to surface air temperature anomalies, two discrete periods were distinguishable across the East Coast. The first period commenced in early November 2016 and continued through January 2017, with surface air temperatures slightly above normal from Newfoundland and along the Labrador coast, while the Gulf experienced a noticeably warmer than normal start to the season. From February 2017 to the end of the spring, below normal surface air temperatures were established across the Estuary, northern Gulf, Newfoundland waters and along the Labrador coast. The timing of the onset of this cold anomaly was critical for ice development over the East Coast waters, as the late arrival of this phenomenon was fundamentally related to the differences in ice cover observed in the region.

Ice cover across the East Coast was driven by the timing of the observed temperature anomalies. A near normal start to the season in early December would not be sustained as a lack of ice in the Gulf of St. Lawrence was the notable trend for the region through late December and into late February. The lower than normal total accumulated ice coverage (TAC) in the Gulf of St. Lawrence and Estuary was likely a result of the initial warm phase that commenced in December followed by the cold anomaly developing shortly after the peak of the ice season for this region. Climatologically, the median ice coverage reaches a maximum in the first week of March in the Gulf then decays rapidly after this point. This late arrival of the colder than normal period led to a modest recovery in ice coverage in early March but the majority of the ice melted from the Gulf two to three weeks earlier than normal in early April. This rapid melt was related to the lack of substantial ice thickness as much of the ice in the region was one to two thickness categories below the expected climate normal.

The situation in the East Newfoundland waters and Labrador coast was different as the median ice cover typically grows towards its maximum through March, permitting the observed below normal air temperature anomaly to sustain continued ice growth in these areas. Near to slightly above normal ice concentrations were detected along the Labrador coast and in East Newfoundland waters from the start of the season in December and through mid-March, before beginning to exceed the climate median ice cover in late March and into the spring of 2017. The development of the colder than normal surface air temperature period in March led to the rapid expansion of ice over the preconditioned ocean waters. The unusual persistence of ice cover in East Newfoundland waters during the spring was aided by an anomalous sea level pressure pattern as well. The configuration of the anomalous high surface pressure over Labrador and the anomalous low surface pressure southeast of Newfoundland was notable for its persistent northeasterly flow over East

Newfoundland waters. This wind orientation favours onshore flow and the compression and compaction of sea ice along the shore, in the bays of northeast Newfoundland and westward into the Strait of Belle Isle. Ice trapped in this region survived significantly longer than climatologically expected and led to higher than normal TAC values in Newfoundland. Final clearing of ice proceeded first in the Strait of Belle Isle near mid-June 2017, followed by the south Labrador coast in the third week of the month. Sea ice along the northeast Newfoundland coast lasted the longest in the region due to the dense packing of the ice along the shore, and the last remnants of ice melted from the area by the end of June. The clearance of ice was up to two months slower than the median climatological values across southern Labrador and northeast Newfoundland waters.

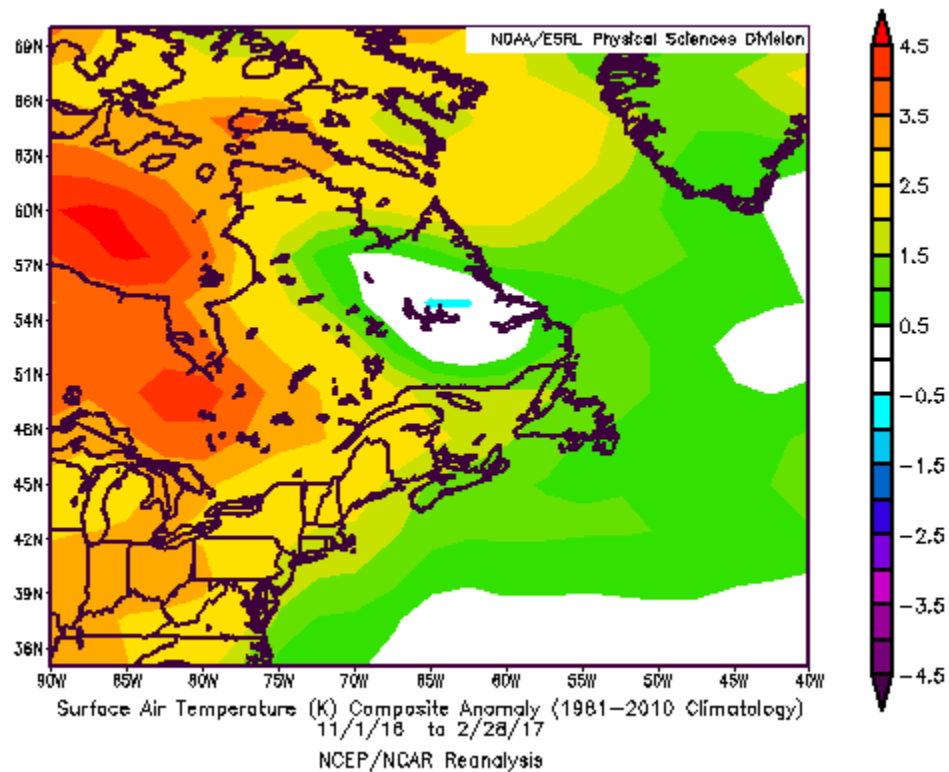


Figure 1: Surface Air Temperature Anomaly November 2016 to February 2017.

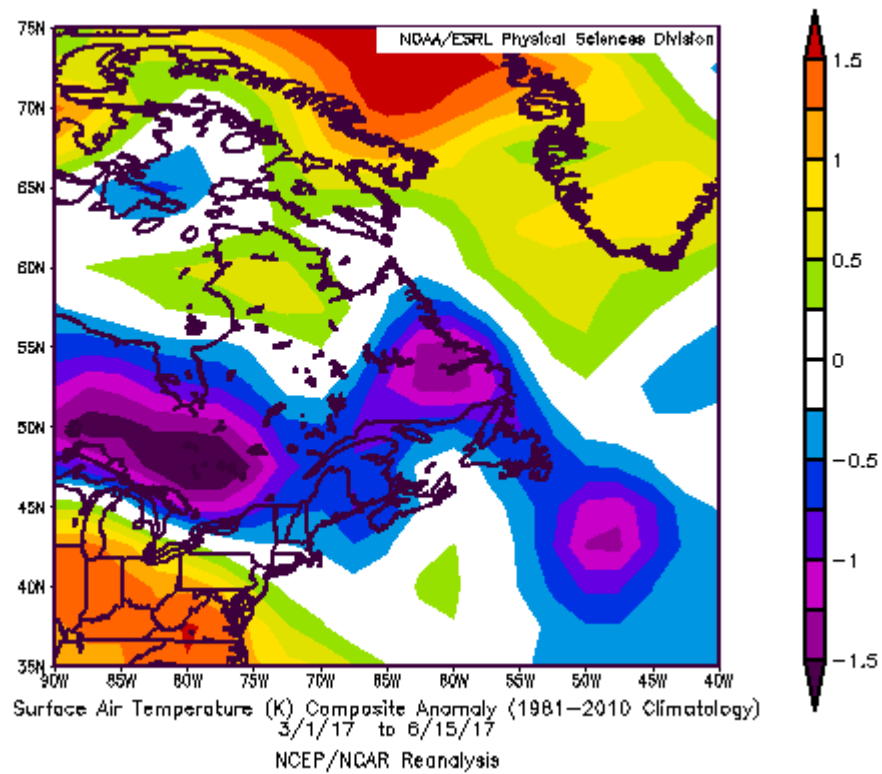


Figure 2: Surface Air Temperature Anomaly March 2017 to mid-June 2017.

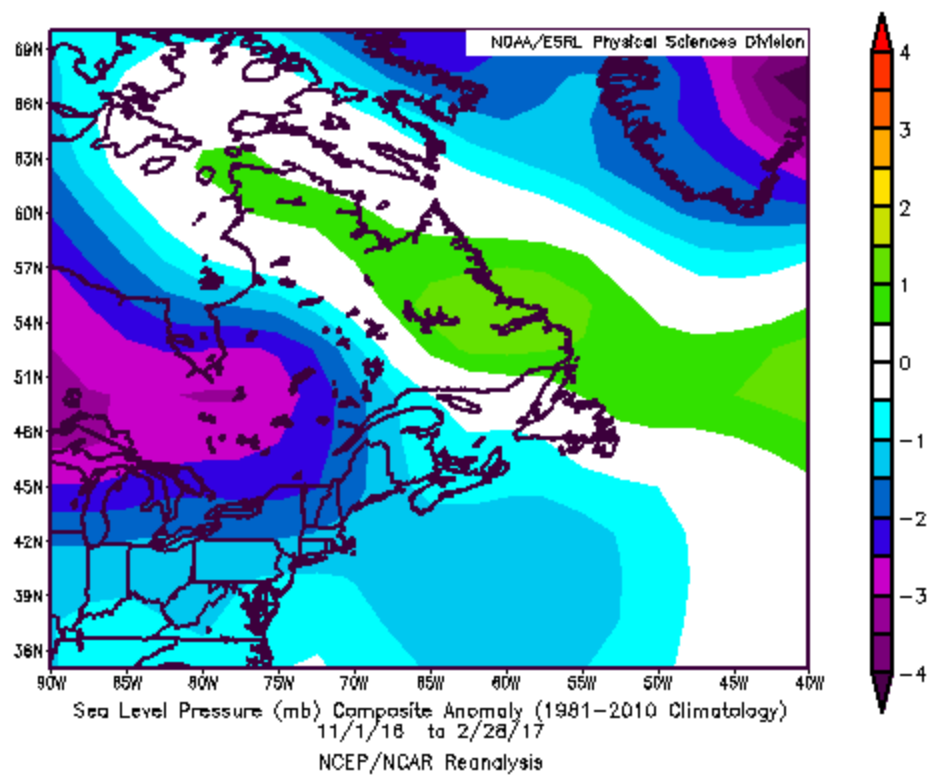


Figure 3: Sea Level Pressure Anomaly November 2016 to February 2017.

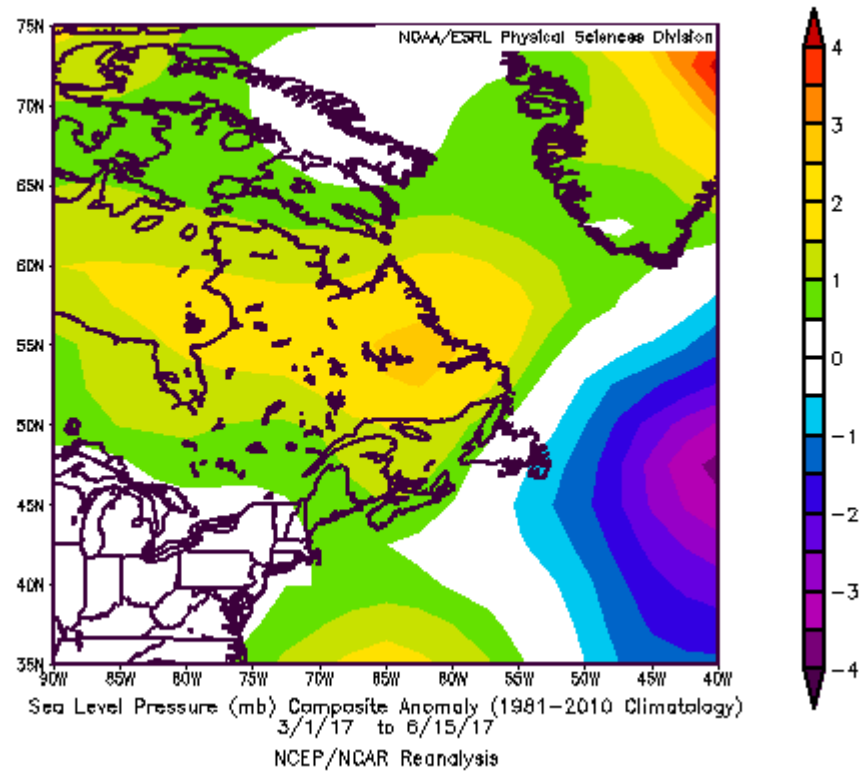


Figure 4: Sea Level Pressure Anomaly March 2017 to mid-June 2017.

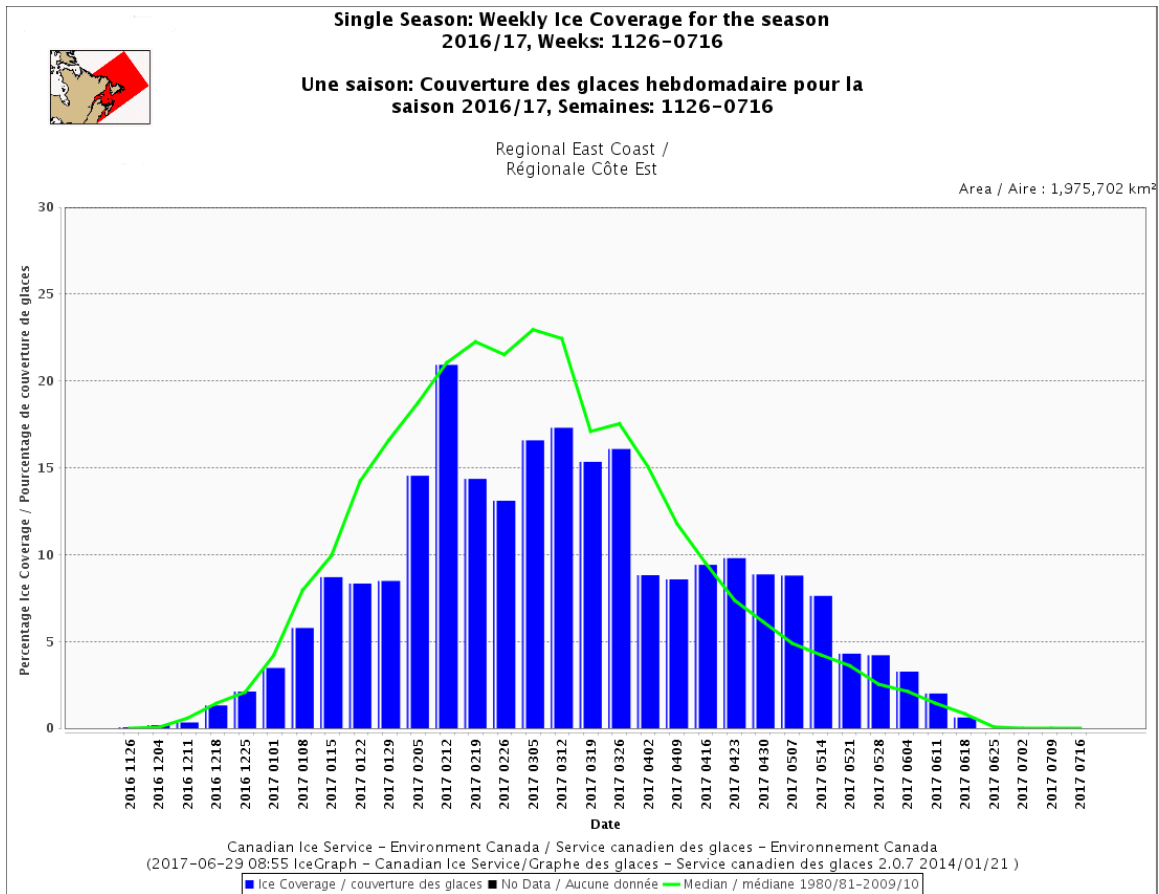


Figure 5: East Coast Weekly Ice Coverage for the 2016-17 winter season.

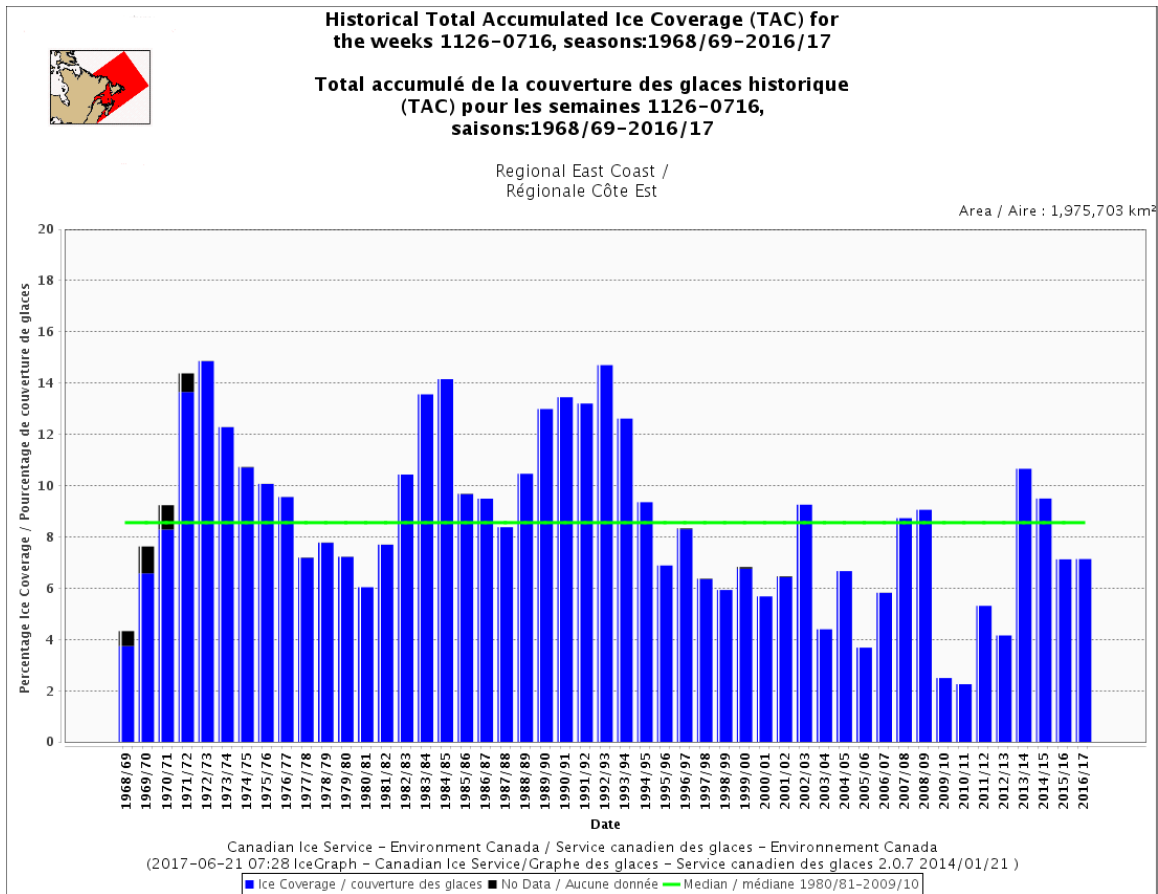


Figure 6: East Coast Historical Total Accumulated Ice Coverage by season, 1968-2017.

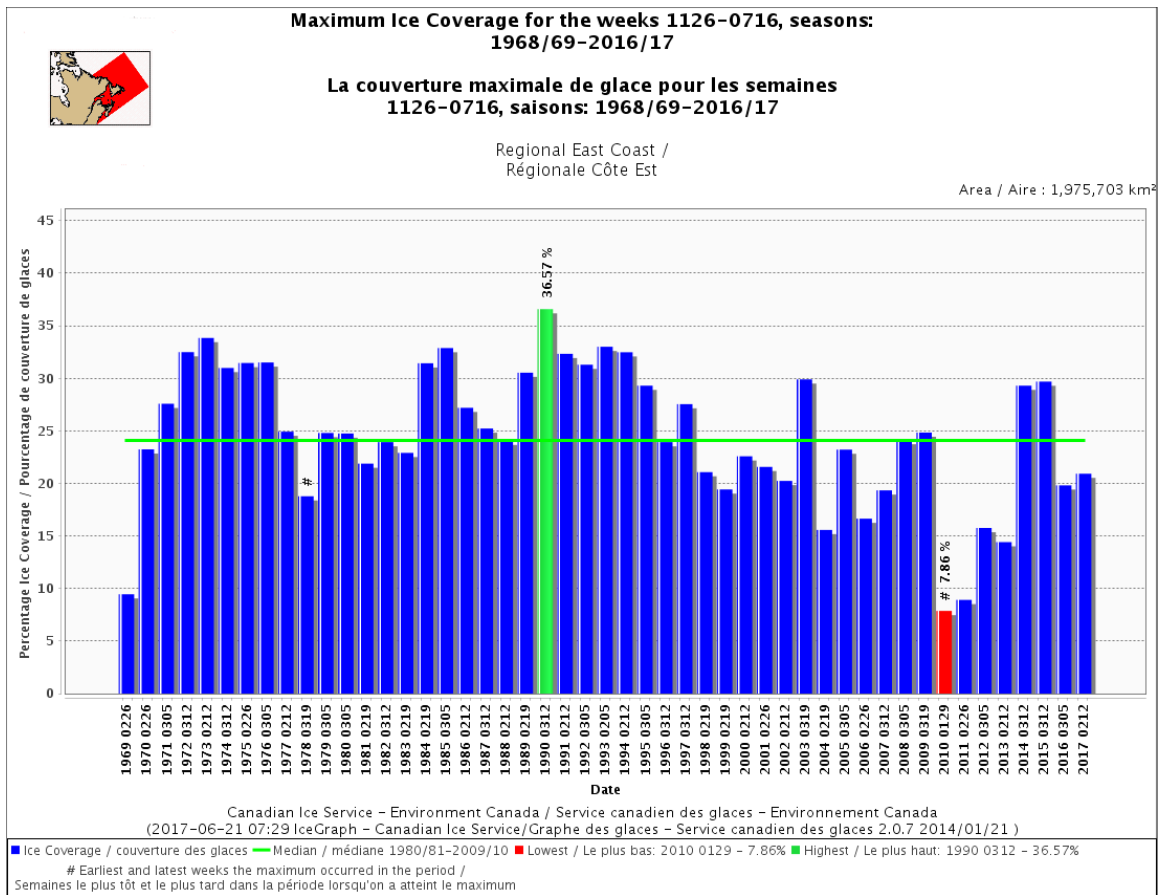


Figure 7: East Coast Historical Maximum Ice Coverage by season, 1968-2017.

Gulf of St Lawrence

2016-2017 Season temperatures and weather: November to June.

Surface air temperature anomalies from November 2016 to February 2017 were above normal with respect to the 1981 to 2010 climatology. The value of this positive anomaly ranged from 0.5 to 3.0°C for this period, with the strongest warm anomaly positioned over the Estuary. Anomalous low pressure over the Great Lakes accompanied by an anomalous ridge of high pressure over Labrador and Newfoundland maintained a generally southerly atmospheric flow over the Gulf, accounting for the warmer than normal temperatures.

In early March 2017 and through the spring, the sea level pressure anomaly exhibited a marked change. The anomaly low previously over the Great Lakes weakened and was displaced by a strengthening of the anomaly ridge centred over Labrador. The orientation of the anomalous high pressure pattern induced a northeasterly flow over the northern portion of the Gulf, whereas a

second anomalous ridge centered offshore of North Carolina permitted the development of a weak southwesterly flow over the southern half of the Gulf. These opposing flow regimes led to the northern section of the Gulf becoming up to 1.5°C colder than normal during this period, and the southern portion to exhibit near normal surface air temperatures.

December ice conditions:

A near normal start to the season in the second week of the month saw new sea ice appear in isolated bays and inlets along the New Brunswick coast and the north shore of Quebec. Ice growth was slow across the region and lagged below the climatological median for the remainder of the month. Limited ice expansion was observed with narrow bands of ice forming and being quickly destroyed along the shores. A delay of one week with respect to the climatological median was noted across the Gulf by the end of the month.

January ice conditions:

Ice development increased marginally in early January 2017 but still was underwhelming across the Gulf of St. Lawrence. TAC values were more than 50% below the median of 15.04% at mid-month, with predominantly new and grey ice and isolated areas of grey-white ice confined to shores of the estuary, southern Chaleur Bay, Northumberland Strait, the Magdalene Islands and in narrow bands along the north shore of Quebec. A decline in ice coverage was then noted across the basin at this point, as destruction was evident in Chaleur Bay and the estuary in particular. Before the end of the month, an incursion of grey and grey-white ice took place in the Strait of Belle Isle. This ice moved southeastward near Blanc Sablon and filled the entrance to the strait. Ice growth in general at the end of January was similar to that expected for the start of the month, a significant delay that was exhibited across the entire Gulf.

February ice conditions:

February was a month marked by a high degree of variability in terms of the ice cover in the Gulf of St. Lawrence. Ice cover tripled in the first week as it expanded to line the northern shore of Prince Edward Island, Chaleur Bay and the estuary west of Sept-Îles. TAC more than doubled again in the following week as new and grey ice covered the eastern half of the Gulf and extended up to 60 nautical miles from the north shore of Quebec. Predominantly grey-white ice was established in Northumberland Strait, Chaleur Bay, the Northeast Arm and over the southern section of the estuary. Ice thickness at this stage was one to two categories below normal due to the earlier delays discussed in January.

After this peak in ice coverage, the gains were lost rapidly in the following two weeks. Steady destruction of this fragile ice was observed in the central and northern Gulf near Anticosti Island and southwards towards the Magdalene

Islands. Continued destruction took place along the New Brunswick coast near Miramichi Bay, in eastern Chaleur Bay and over the northern portion of the estuary near Baie Comeau. Some thickening was analyzed as ice reached the thin first-year stage in sheltered sections of the Gulf, notably Northumberland Strait and in the Strait of Belle Isle, but overall concentrations were well below normal. Ice cover at the end of February across the entirety of the Gulf was one third of the median value according to the climatology.

March ice conditions:

March was notable for its shift towards higher TAC values in response to anomalous cold surface air temperatures. A doubling of ice cover took place in the first week as an expansion period saw new and grey ice return to the eastern and northern halves of the Gulf and the first traces of ice began to invade Cabot Strait. Thin first-year ice flowed eastward out of Northumberland Strait and along the Cape Breton coast and was compressed along the southern shore of Chaleur Bay. This marked the peak of the ice season in terms of TAC for the Gulf of St. Lawrence at 37.49% coverage, short of the median peak of 41.82% according to the climatological statistics.

The decline phase of the ice season followed this maximum as average surface air temperatures began to warm with the arrival of spring. Destruction was most rapid over the northern section of the Gulf as the western half of the estuary was predominantly open water by the fourth week of March. Ice north of Anticosti Island and over the central Gulf was reduced substantially near the end of the month and little remained in the estuary. Areas of thicker thin first-year ice were left in eastern Chaleur Bay and western Northumberland Strait and along the northwestern coast of Cape Breton Island. A section of the Gulf from Anticosti Island to the Strait of Belle Isle resisted this destruction pattern as elevated concentrations of thin first-year ice were observed from Harrington Harbour and eastward in this pack ice. Overall, the extent of first-year ice in the Gulf was well below seasonal normals.

April - May - June ice conditions:

Through this period, ice in the central and eastern Gulf quickly disappeared to the point that the only remaining sea ice was confined to isolated bays and inlets along the New Brunswick coast near mid-April, a near normal conclusion to the ice season in these areas. The Northeast Arm defied the pattern of destruction found elsewhere in the Gulf as ice continued to flow southeastward into the region well into June 2017. Ice in this area reached the medium first-year stage in early April and a trace of old ice was analyzed in the pack ice near Blanc Sablon. This ice receded through late April and into May, finally diminishing to the vicinity of Blanc Sablon in the third week of May.

The season was not quite at its conclusion though, as ice was driven westward through the Strait of Belle Isle into the Northeast Arm again near the

end of May. Predominantly thick first-year ice with a trace of old ice blocked the eastern portion of the passage and extended along the northern shore of Quebec to Harrington Harbour. This sea ice remained in place through the first week of June before increased warmth led to the gradually melting of this pack ice. The last strips and patches of sea ice melted from the Northeast Arm during the third week of June, bringing the ice season to a close approximately one and a half months later than usual.

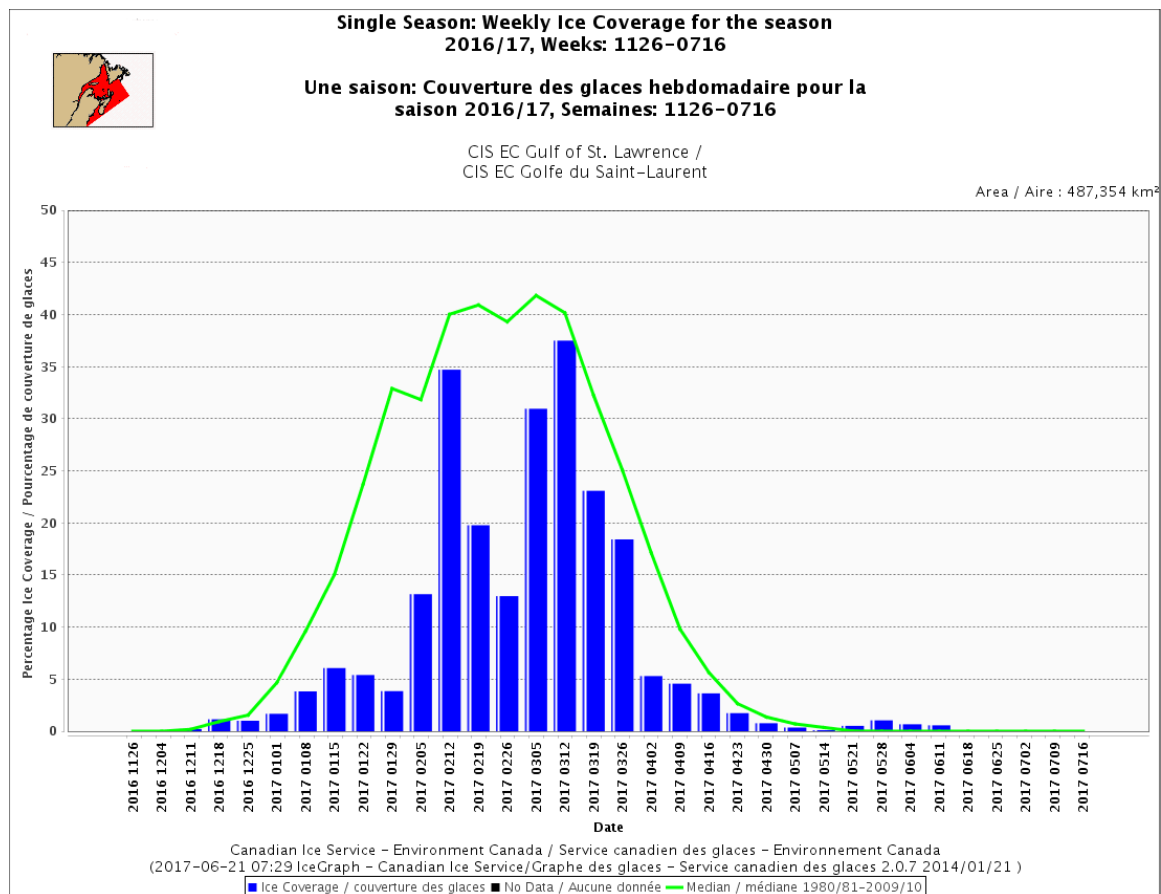


Figure 8: Weekly Ice Coverage for the 2016-2017 season in the Gulf of St. Lawrence.

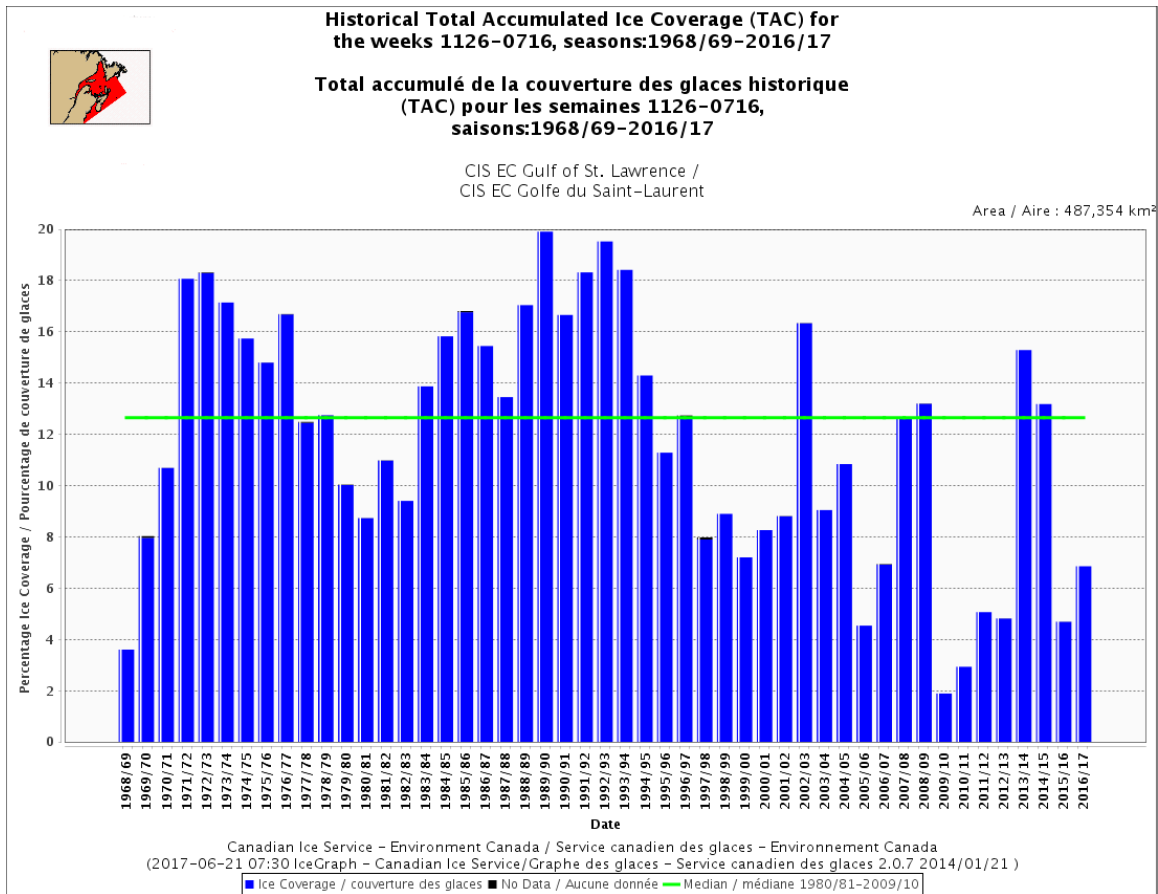


Figure 9: Historical Total Accumulated Ice Coverage for the Gulf of St. Lawrence by season, 1968-2017.

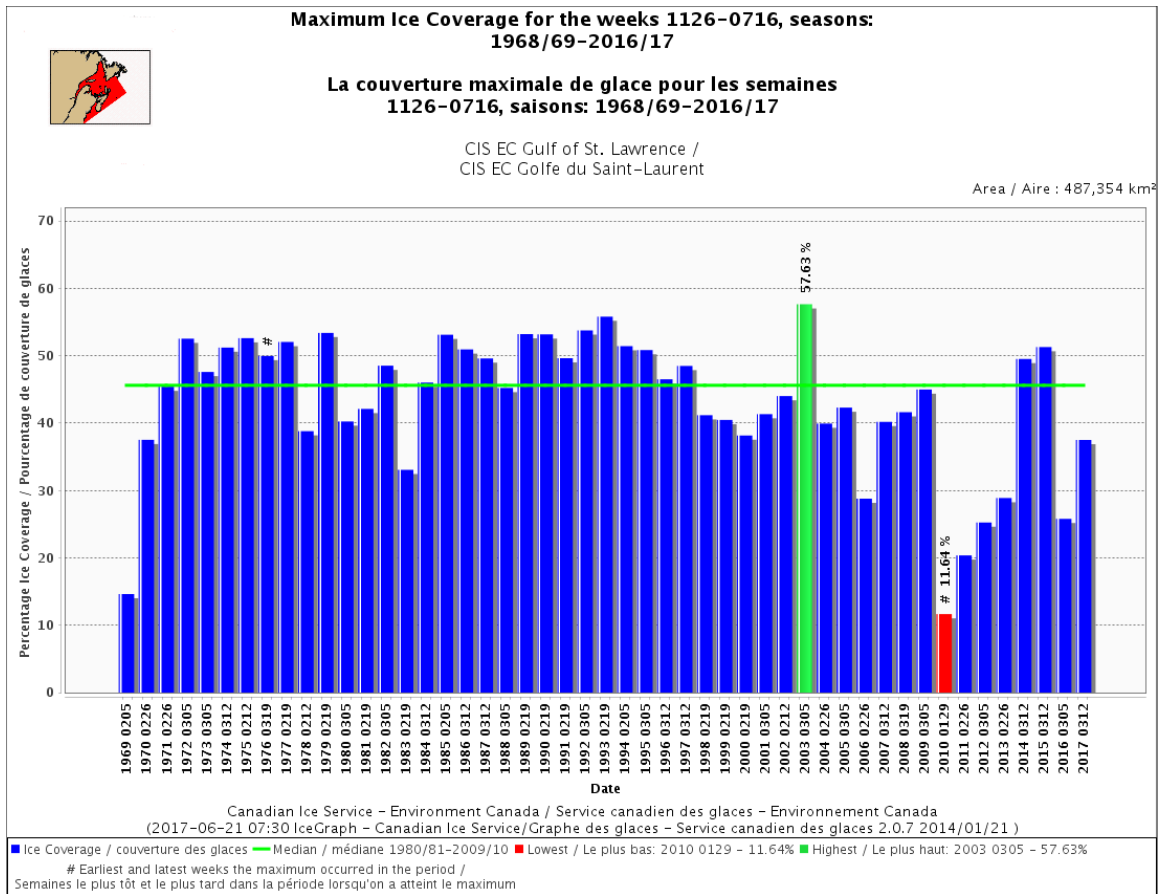


Figure 10: Maximum Ice Coverage in the Gulf of St. Lawrence by season, 1968-2017.

Newfoundland and Labrador Waters

2016-2017 Season temperatures and Weather: November to mid-June

Along the Labrador Coast and over East Newfoundland waters the surface air temperatures were up to 1.5°C above the climate mean for the period from November 2016 to February 2017. The weak anomalous ridging over Labrador was collocated with the temperature anomaly during this period.

A significant shift in the air temperature regime took place in March and persisted through June 2017. The high pressure anomaly built steadily over central Labrador as a pool of cold air settled over the area. This broad, cold air mass led to the establishment of a surface air temperature anomaly of up to -1.5°C for the region. Northeasterly flow along the eastern side of the anomalous ridge also pushed sea ice southwestward and led to the unusual presence of sea ice along the northeastern Newfoundland coast late in the season.

November ice conditions:

The first ice of the season formed over the western section of Lake Melville in the last week of November. Isolated areas of new sea ice also developed at the end of the month near Cartwright, but otherwise the Labrador and Newfoundland waters remained free of ice in general.

December ice conditions:

In the first week of December the entirety of Lake Melville became covered with ice. The western section of the lake was consolidated with grey-white ice and the remainder was a mixture of grey and grey-white ice. Further south, new ice was detected in isolated bays and inlets along the northeast Newfoundland coast. By mid-month, a narrow band of new and grey ice extended along the northern Labrador coast and southward to Cartwright. This coastal ice widened to approximately 40 to 60 nautical miles by the end of the month, and reached the Strait of Belle Isle. Grey-white ice was predominant in this pack ice and Lake Melville was consolidated with thin first-year ice. Sea ice expansion was well within the normal range at this point for the region.

January ice conditions:

The first notable development of sea ice in Newfoundland waters occurred shortly before mid-January, with predominantly grey and grey-white ice analyzed near St. Anthony and the Grey Islands. The ice edge had expanded considerably along the southern Labrador coast, extending up to 150 nautical miles from shore. The first significant amounts of first-year ice in the pack were detected in Groswater Bay at this time as well.

In the fourth week of the month, grey and grey-white ice approached Notre Dame Bay from the north and reached White Bay, and thin first-year ice was present near Battle Harbour. A trace of old ice drifted southward amongst the pack ice and the southern limit of this trace was near 54°N. The pack ice was spread over a distance of up to 180 nautical miles from the coast along the southern Labrador coast and the Northern Peninsula, again representing a near normal distribution of ice with respect to the climatology.

February - March – April ice conditions:

Sea ice expansion continued in early February across the region, with the southern Labrador Sea attaining its maximum coverage (25.05%) by the second week of the month. This peak was near the usual median peak value of 24.32% recorded for the sea. Sea ice was over 160 nautical miles in width along the southern Labrador Coast at this point, a slight drop from the January high. Elsewhere in Newfoundland waters, grey-white and thin first-year ice was

encroaching on Bonavista Bay and extended approximately 100 nautical miles east of Bonavista, while medium first-year ice was now drifting southward east of St. Anthony. A steep decline in ice cover over the Southern Labrador Sea was observed in the second half of February due to strong northeasterly winds in the region. These winds destroyed, compressed and mechanically thickened the ice along the coast and reduced the ice extent to within 90 nautical miles of the shore. The East Newfoundland waters were also impacted by this event as ice concentrations dropped substantially as a result and the trace of old ice was transported significantly further south, now nearing 50°N.

Early March heralded a return to an ice expansion phase for the Newfoundland sector, as anomalously cold surface air temperatures and northeasterly winds permitted the sea ice to push southward to 48°N approximately 160 nautical miles offshore. The Southern Labrador Sea was experiencing a contraction phase by contrast, with intensely strong northeast winds compressing the sea ice to within 20 nautical miles of the coast south of Cartwright. By mid-March the trace of old ice embedded in the medium first-year ice was south of 49°N and the advancing ice cover in this region reached its seasonal peak by the end of the month. This maximum coverage was measured at 10.6% of the area, corresponding well to the median peak of 10.69%.

According to the climatological statistics, April normally marks the beginning of significant declines in sea ice cover for the Labrador and Newfoundland waters. The 2017 spring defied this convention, with TAC values increasing through the month. Continued below normal temperatures and northeast winds across the East Coast supported the development of sea ice during a period of expected losses. At the beginning of the month of April, thick and medium sea ice with a trace of old ice was pushed southeastward into the bays of northern and eastern Newfoundland. A highly unusual presence of ice was noted south of the Avalon Peninsula, reaching 46°N due to the southwestward drift. Extremely compressed and deformed ice was packed into White, Notre Dame and Bonavista Bays, leading to substantial mechanical thickening of the pack ice. The ice edge retreated rapidly to within 90 nautical miles of the Northern Peninsula but in remained elevated concentrations. At mid-month the compressed ice in White Bay became a consolidated mixture of thick and medium first-year ice and the ice edge along the southern Labrador coast had expanded to 160 nautical miles from shore. Sea ice near the Avalon Peninsula was unusual in its presence at this point, particularly the ice along the southern sections of the peninsula. Ice had retreated slightly near the end of the month with the sea ice south of the Avalon Peninsula melting but otherwise the situation remained stable from mid-month.

May to mid-June ice conditions:

Through mid-May, ice concentrations and extents were elevated well above the seasonal normal across the region, with nearly five times the amount of ice present in East Newfoundland waters compared to the climate median.

Increased seasonal warmth and southerly winds over Newfoundland and Labrador ushered in significant ice destruction in the second half of May, as ice was generally limited to within 60 nautical miles of the coast by month end. Groswater Bay became predominantly bergy water and Lake Melville showed signs of breakup in the extreme western section near the midpoint of the month. Predominantly thick first-year ice with a trace of old ice composed the majority of this pack ice due to the extreme compression of the sea ice and a substantial quantity of ice drifted westward through the Strait of Belle Isle into the Northeast Arm of the Gulf of St. Lawrence. Lake Melville was unconsolidated by the fourth week of May and began to clear before the end of the month.

By the end of the first week of June, sea ice had melted completely from the vicinity of the Avalon Peninsula. Thick first-year ice with some old ice was densely packed along the northeast Newfoundland coast from Fogo Island and westward to White Bay, as well as near St. Anthony. A narrow band of ice remained from Groswater Bay and southward to the Strait of Belle Isle, composed mainly of thick first-year ice and small quantities of old ice. This band of ice cleared in the third week of June, leaving only sea ice in Notre Dame Bay and Bonavista Bay. This remaining ice cleared near the end of June 2017, thus concluding the season on the East Coast. Ice clearing was over three months slower than the median climatology for Bonavista Bay, and nearly two months slower elsewhere.

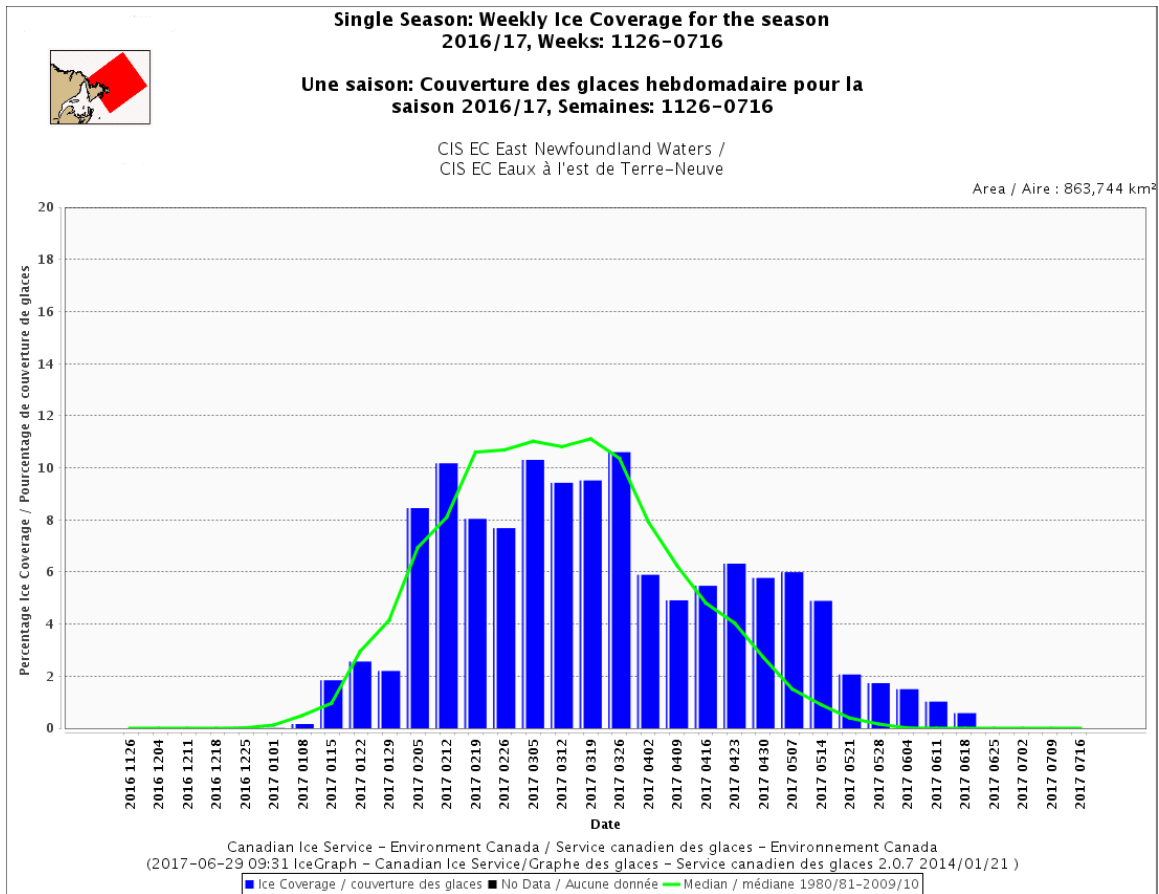


Figure 11: Weekly Ice Coverage for the 2016-2017 season in East Newfoundland Waters.

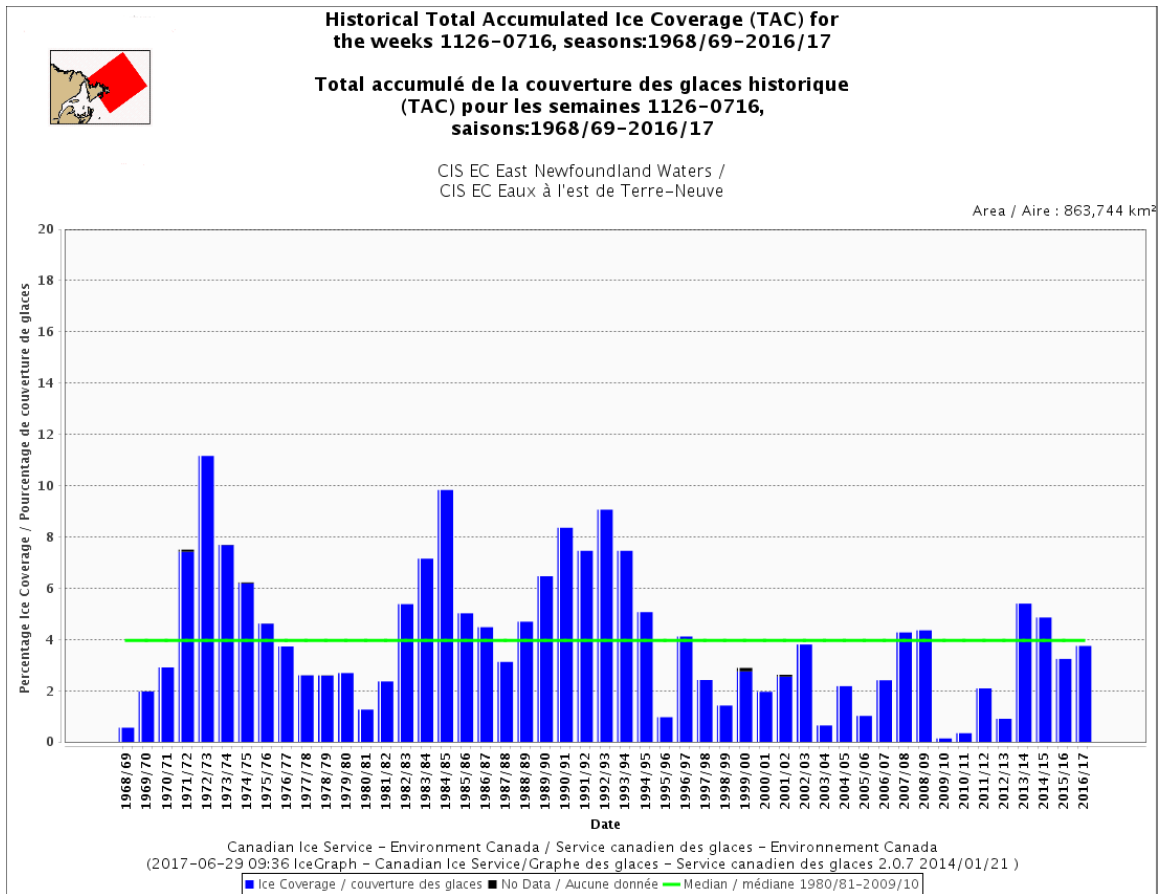


Figure 12: Historical Total Accumulated Ice Coverage for the 2016-2017 winter season in East Newfoundland Waters.

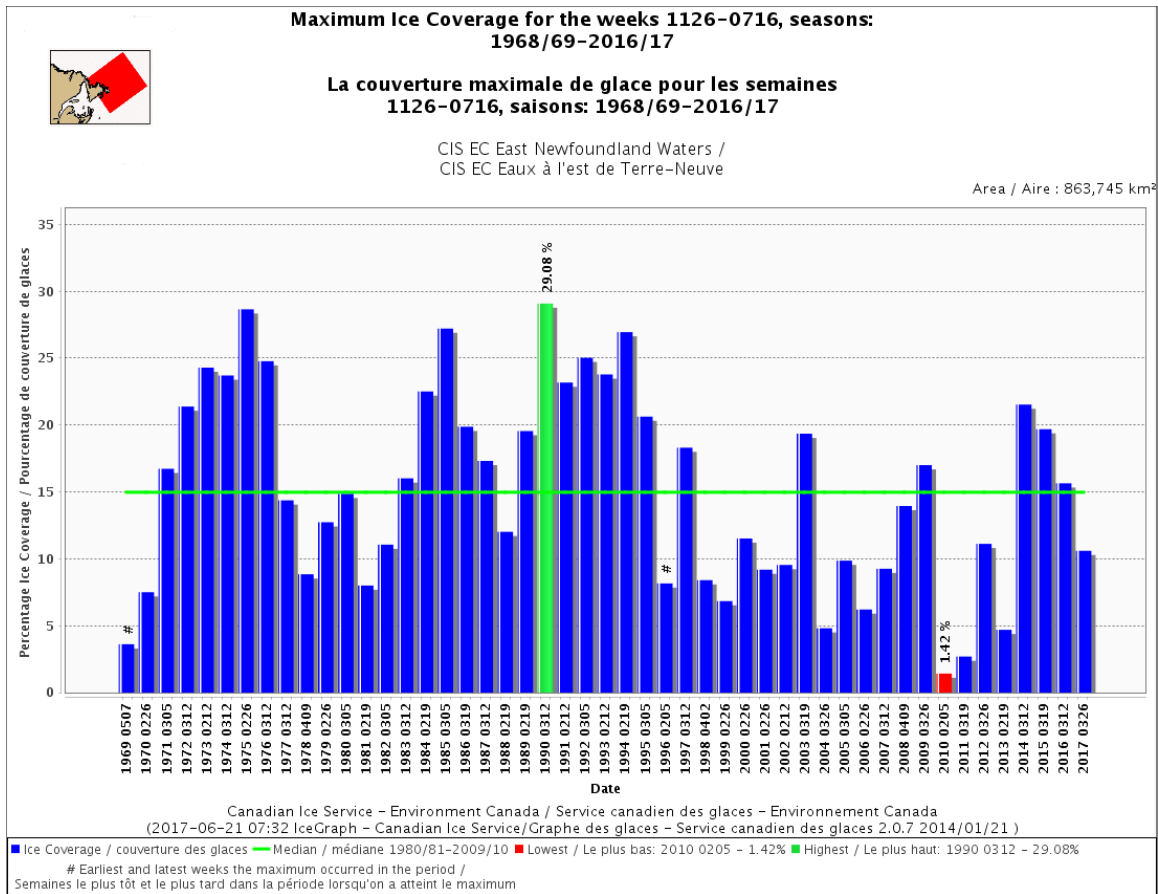


Figure 13: Maximum Ice Coverage in East Newfoundland Waters by season, 1968-2017.

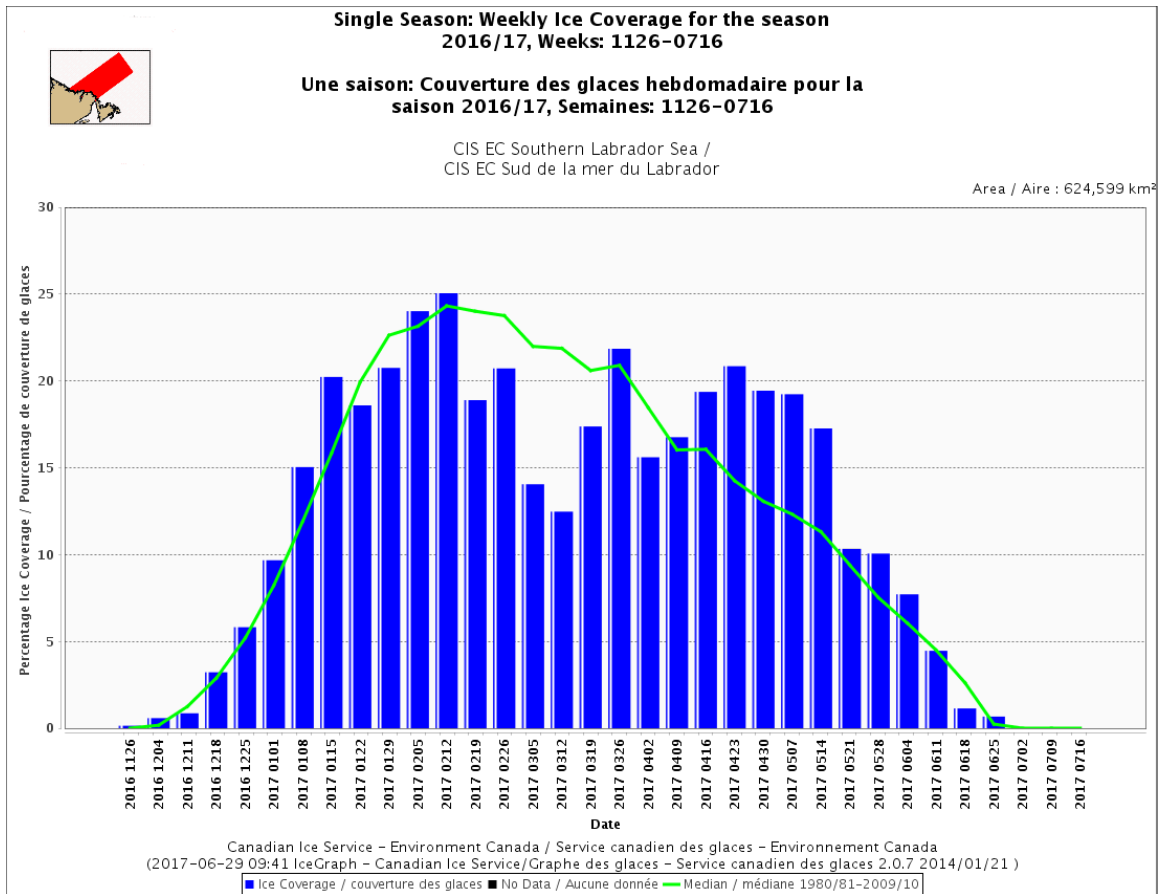


Figure 14: Weekly Ice Coverage for the 2016-2017 season for the Southern Labrador Coast.

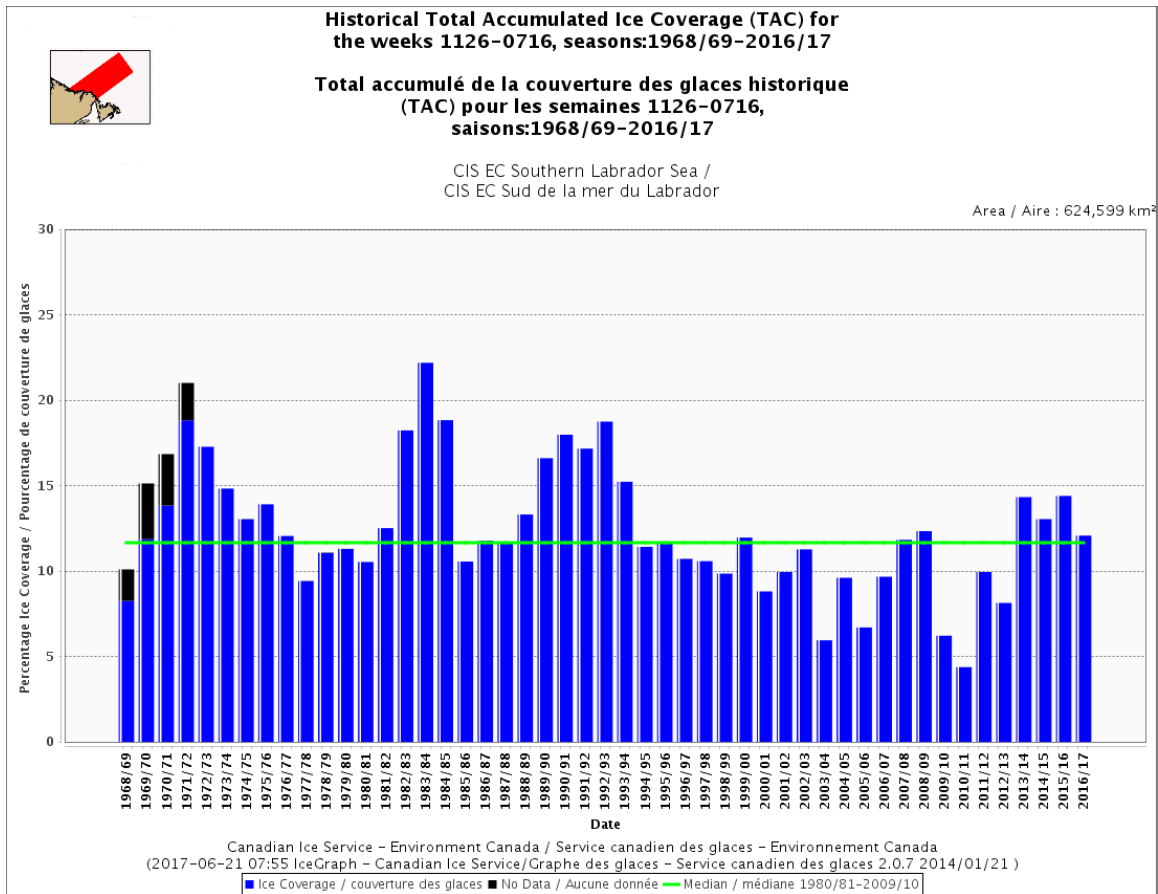


Figure 15: Historical Total Accumulated Ice Coverage along the Southern Labrador Coast by season, 1968-2017.

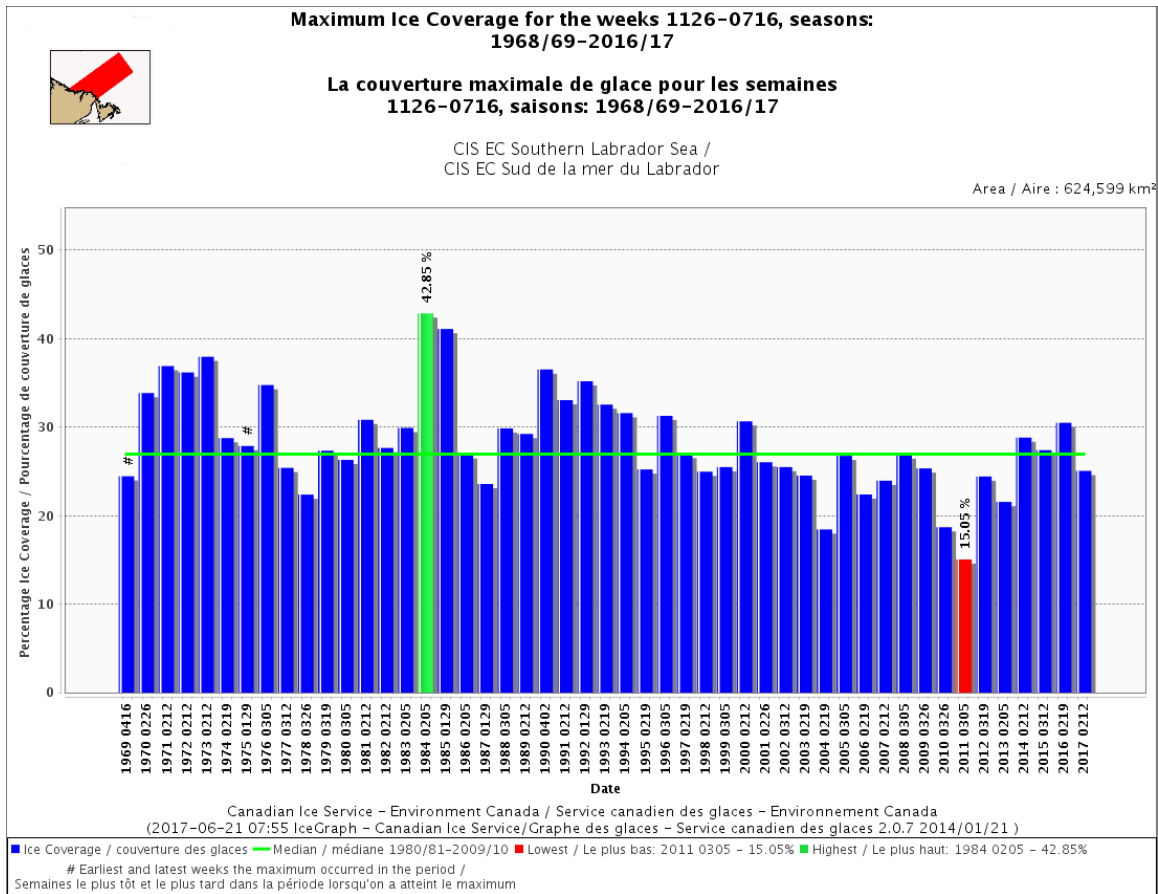


Figure 16: Maximum Ice Coverage in the Southern Labrador Sea by season, 1968-2017.

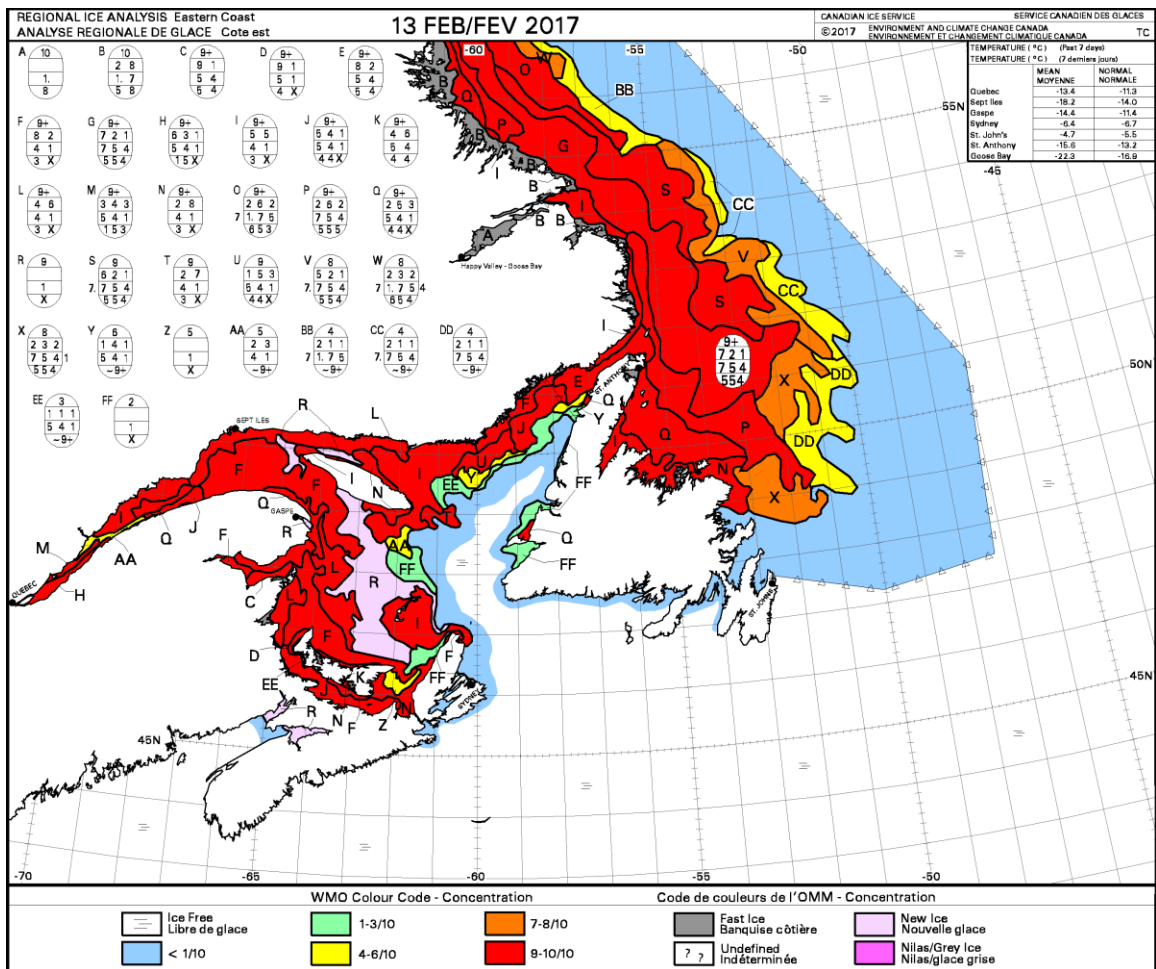


Figure 17: Maximum ice coverage on the East Coast during the 2016-17 season.