Support for Winter Tourism Climate Change Adaptation
Newfoundland and Labrador Tourism

Zone
2

Natural Resources Canada | Ressources naturelles Canada
Canada
Newfoundland & Labrador
Funded by the Department of Environment and Climate Change

Background

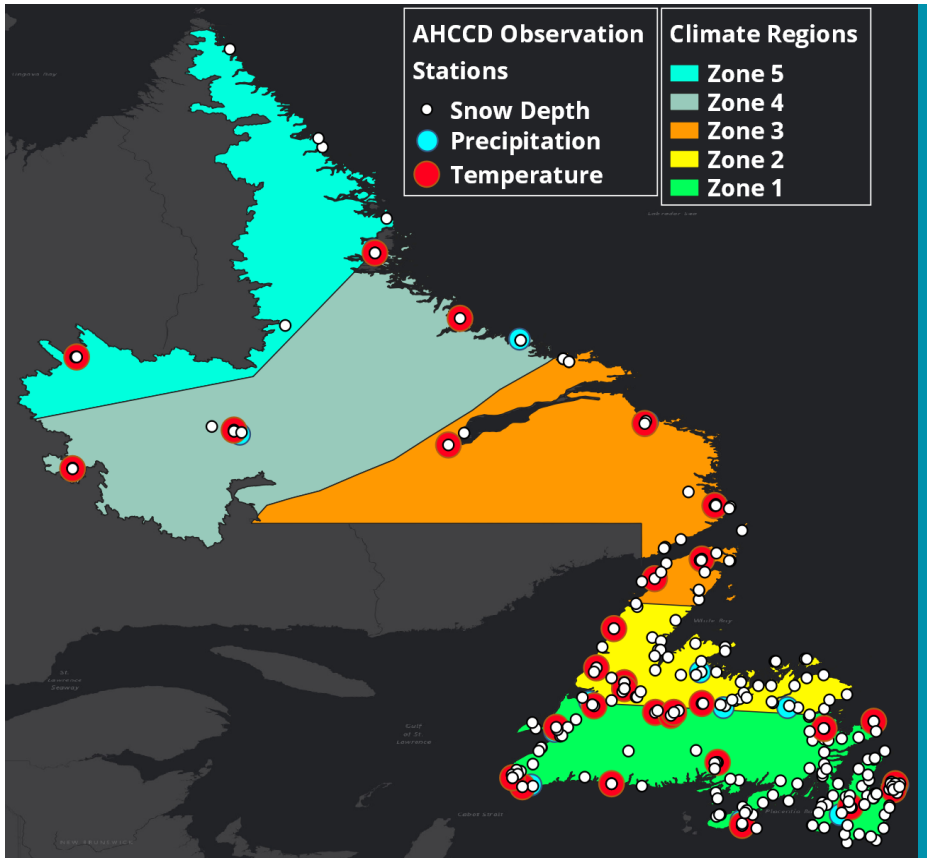
Zone 2

Climate change will impact the Winter Tourism Industry across Newfoundland and Labrador. Operators are encouraged to adopt a proactive approach to mitigate the impacts of climate change.

This study presents climate change projections for key climate indices derived from temperature, precipitation, and snow depth across the province. Through consultation with local operators, the climate parameters were selected as key operating indicators for the industry.

Potential impacts to key operating factors as a result of climate change are presented. Understanding the impacts of climate change will allow the industry and local operators to prepare and adapt to future conditions, unlocking new and innovative ways to successfully operate during the winter season.

Climate Zones



Climate in Newfoundland and Labrador is highly variable based on location. This is due to the size, latitudinal range, proximity to the coast, and varying coastal influences. As a result, climate change is expected to impact regions across the province differently, such as different rates of warming and changes in precipitation types and frequency varying throughout the province. To gain more granularity over this vast region, representative climate zones are used in this study. However, climate can vary at scales much smaller than the selected climate zones, and as such, spatial patterns are presented through maps and appropriate caveats are provided on the interpretation of the calculated climate indices.

Data Sources, Time Horizons, and Seasons

Historical Data Sources

- Adjusted and Homogenized Canadian Climate Data (AHCCD).
- Canadian Historical Daily Snow Depth Database (Brown et al. 2021).
- Historical Time Period: 1981-2010.

Projection Data Source

- Canadian Regional Climate Model (CanRCM4) – Large Ensemble (50 model runs).
- Projected Time Periods: 2030s (2021-2050) and 2050s (2041-2070).

Interpretation of Graphs and Data

Historical Data

- Climate indices from observation stations are averaged across each climate zone and across the historical period to obtain the average historical value per zone.
- Spatial patterns in historical data for selected key indices are presented using maps.
- Average historical values are presented in the form of text, as boxplots showing variability over time or as other plots (e.g., bar plots, line plots).

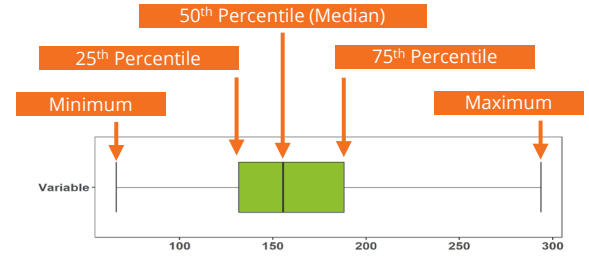
Projections Data

- Climate indices calculated from all climate model run are averaged across each zone and across each projected time horizon to obtain the average projected value per zone.
- Most projection data is shown as boxplots, representing the range of projections across the models.
- Where the range of models is not presented, the projected value always refers to the Median of the model range.

Maps

- In order to present the spatial patterns and highlight climate variability within each climate zone, a few key climate indices are presented in the form of maps.
- The map legend shows a range in the form of (exclusive, inclusive] values.

How to Read a Boxplot

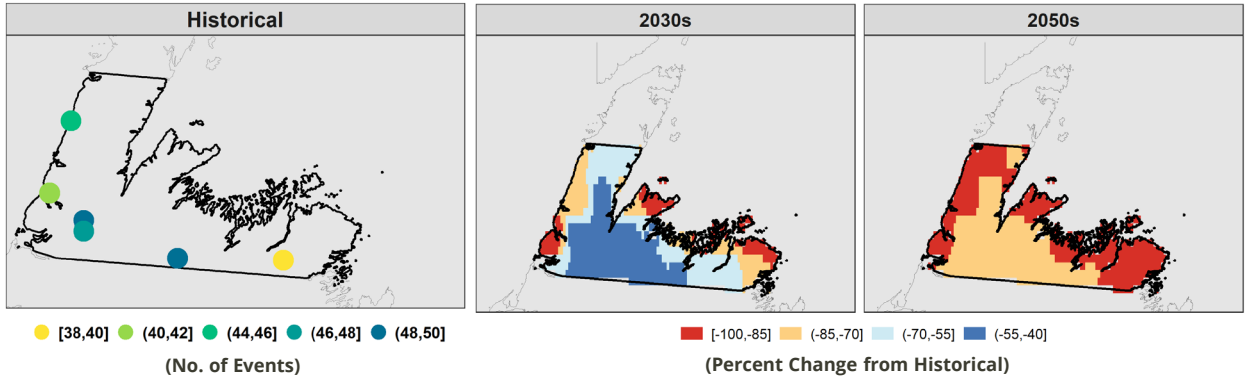


The projected numbers are representative of the regional average conditions (across time, locations, and models). Climate change at the local scale will be more variable, and more extreme values (both high and low) should be expected, irrespective of the average conditions.

Climate Change Across Newfoundland and Labrador

Zone 2

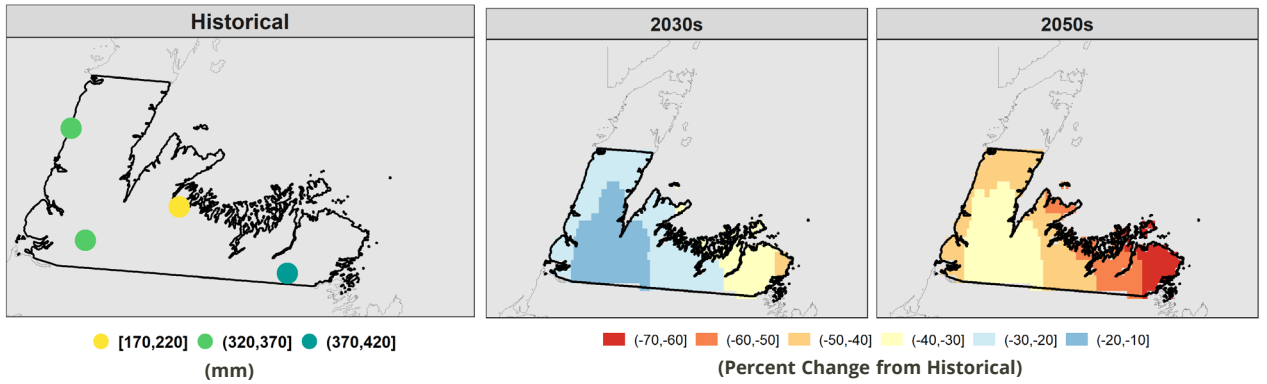
Winter Deep Freeze Events (Daily Minimum Temperature < -10°C)



All locations in this zone experience at least nearly 40 deep freeze events. The lack of a dense observation station network makes it challenging to identify spatial patterns in historical data.

Deep freeze events are projected to decrease at a faster rate along the eastern and western coastal areas. By 2050s, deep freeze events are projected to rarely occur in these areas, while regions in central Newfoundland will continue to experience deep freeze events in the Winter.

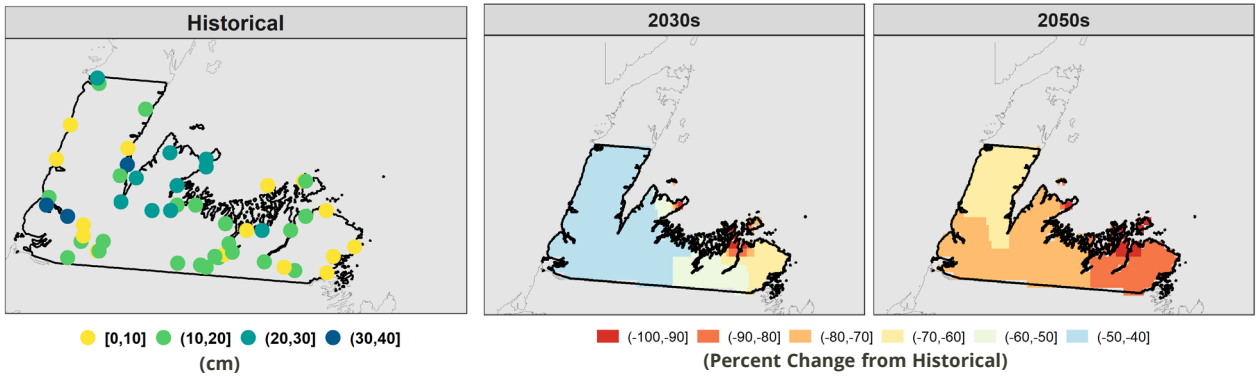
Total Winter Snowfall



Snowfall in winter varies by a relatively high magnitude amongst the locations in this zone, ranging from under 220 mm to over 370 mm, averaged over the historical period.

Projections show that snowfall will reduce the most around the eastern coast along the Atlantic Ocean, while snowfall in central Newfoundland will decrease relatively less. Note that the average total winter amounts do not reflect extreme events such as snow-storms/blizzards which could still bring heavy snowfall events to regions with large projected reduction in total snowfall.

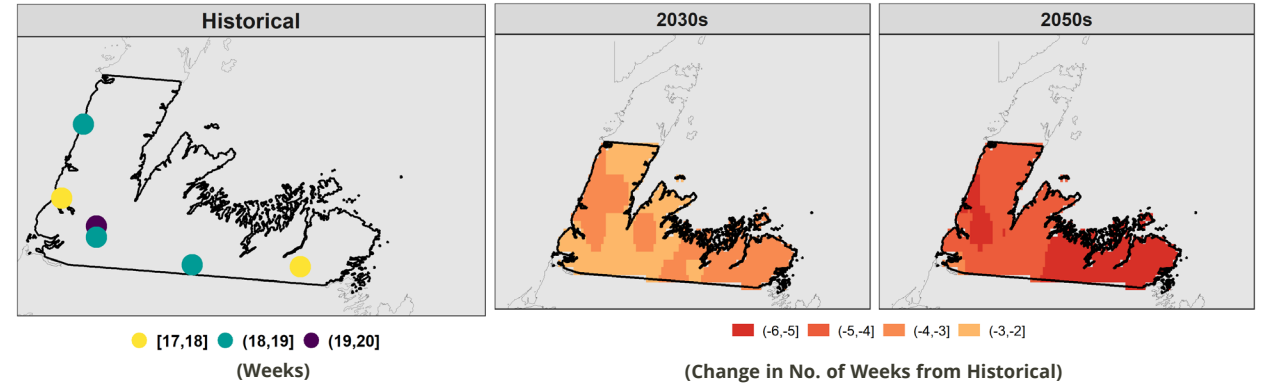
Winter Average Snow Depth



Historically, the average snow depth ranges from under 10 cm to over 30 cm in this zone. Highest average snow depth are found at two locations near the Gros Morne National Park.

Projections show that average snow depth will reduce in the future, following similar spatial patterns to winter snowfall. The average snow depth will reduce sooner, and with a higher magnitude at areas near Bonavista and Twillingate.

Snowmaking Season Length (Weeks from First to Last 3 consecutive days with nighttime temperature < -5°C)



The length of snowmaking season varies up to 3 weeks from the shortest season of just over 17 weeks, to the longest at just under 20 weeks between the locations.

Snowmaking season is projected to reduce in both time periods. The reduction in the season length will be limited to under 4 weeks for most areas in 2030s. In the 2050s, the season will further reduce by around 2 weeks throughout the zone.

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Changes in Winter and Spring Temperatures

Zone 2

Shifts in seasonality are expected with climate change.

Increasing temperatures will lead to fewer deep freeze events and more frequent snow melt events. This may impact snowpack conditions and worsen trail conditions.

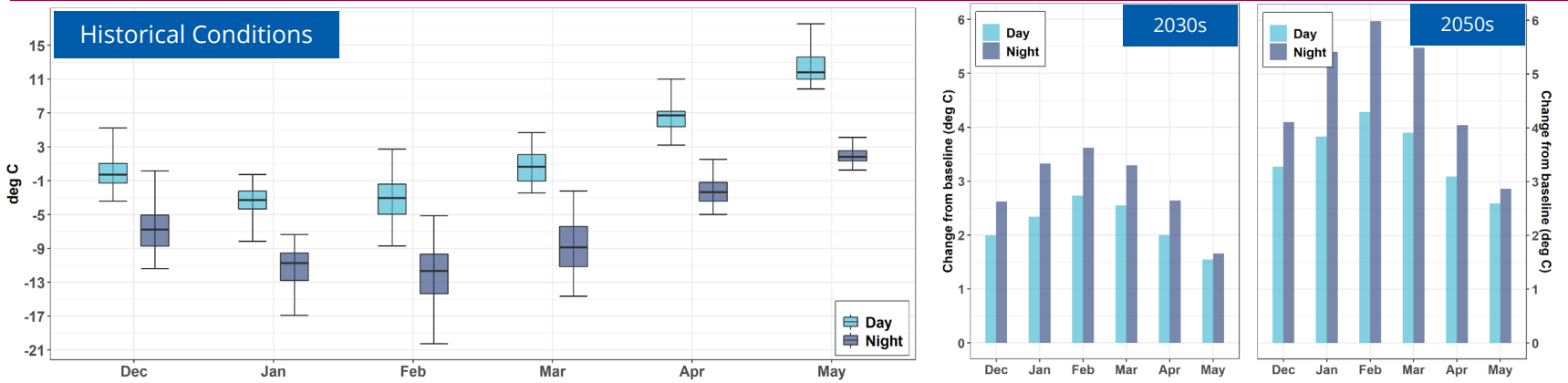
Potential Impacts to Snowpack Conditions from Increasing Temperatures:

- Increased pooling of water on trails and recreation areas.
- Slushy or icy conditions on trails and recreation areas.
- Thinner snowpacks.
- More frequent melting episodes.
- Decreased snowpack accumulation and retention.
- Increased snowpack density.

Potential Operational Impacts of Increasing Temperatures

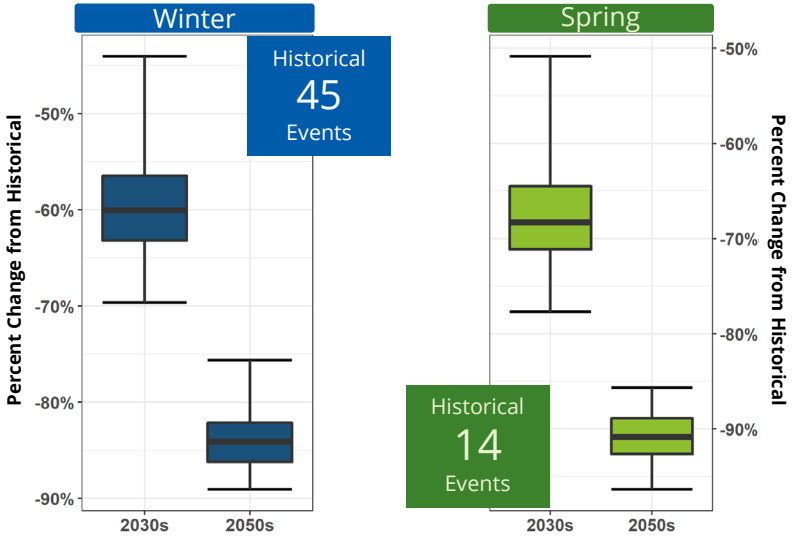
- Increased frequency of temporary closures.
- Increased need for snow making and/or stored snow for maintenance and grooming.

Changes in Average Daytime and Nighttime Temperatures



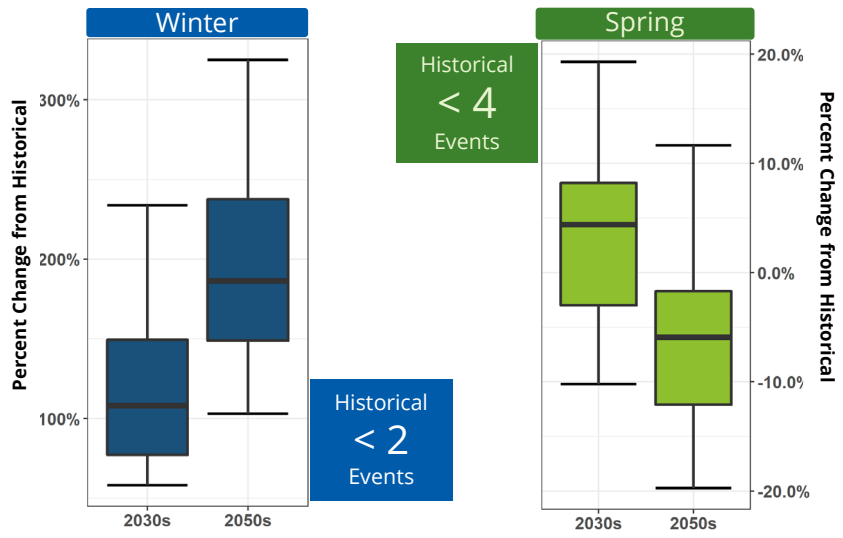
Projections show an average increase of approximately +2°C and +3.5°C (from historical) in average Winter daytime temperatures by 2030s and 2050s, averaged over the zone. Nighttime temperatures in Winter are projected to increase by a higher magnitude than daytime. The highest relative increase in nighttime temperature is expected to occur from January – March and is projected to be greater than +5°C (from historical) in the 2050s.

Deep Freeze Events (Nighttime Temperature < -10°C)



Projections indicate a decrease in the number of deep freeze events averaged over the zone. The projected decrease is about 10% higher in Spring than Winter. The range of projections is larger in the 2030s, extending from -45% to -70% reduction in Winter.

Melting Episodes (3 consecutive days with Daily Average Temp. > 0°C)



Winter melt episodes are projected to increase due to rising temperatures. In Spring, projections show very little changes on average driven primarily by a shorter snowpack duration during this season.

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Changes in Winter Precipitation (Rain and Snow)

Zone 2

Winter recreation operations typically **close** during days with more than **10mm of rain**.

Increased closures are expected due to **increasing frequency and intensity** of rain events.

Winter Rain events impact trail conditions, recreation area conditions, snowpack and melt conditions, runoff regimes, and operations.

Dangerous **icy conditions** can be caused by freezing rain events resulting in increased **Health and Safety concerns.**

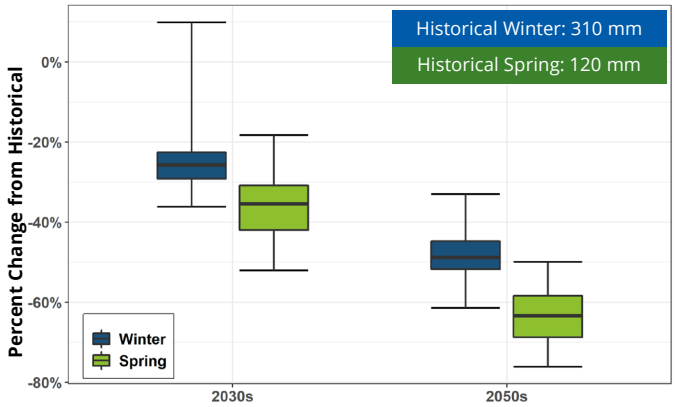
Operational impacts

- Increased frequency and extent of maintenance and grooming requirements.
- Increased frequency and extent of temporary closure of trails and recreation areas.

- Potentially **increased flood conditions** and pooling of water on trails and recreation areas.
- **Increased melting**, thinner snowpack, and **decreased snow retention.**
- Increased frequency of **wet/ slushy or icy conditions** expected following rain events.

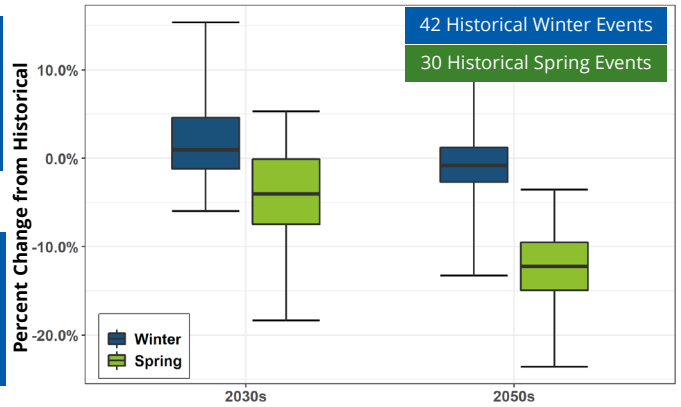
Average rainfall and snowfall totals presented here provide an understanding of the overall climatic conditions regarding precipitation in the future.

However, the averages do not represent occurrence of extreme events which occur at relatively smaller scales. Moreover, climate change is expected to cause an increase in the overall storm activity, which will also affect extreme precipitation.



Total precipitation conditions favorable to freezing rain

Precipitation > 20mm followed by freezing conditions



Model results project an overall decrease in events that lead to icy conditions. The occurrence of days with precipitation (>10mm) during conditions favorable to freezing rain is projected to decrease in all cases. However, some models indicate an increase in heavy precipitation events followed by freezing conditions in Winter which may cause more icy conditions on the ground.

Some studies have indicated an increase in the frequency of freezing rain could be expected, due to the north/north-east movement of the zero-degree isotherm.

Total Winter Rain and Snow

Historical Rain
80 mm

65% more in 2030s

107% more in 2050s

Historical Snowfall
350 mm

35% less in 2030s

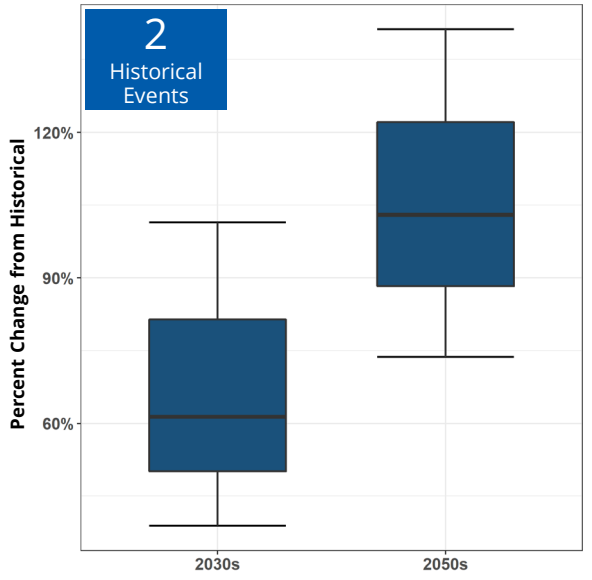
43% less in 2050s

Rising temperatures in winter will cause more precipitation to fall as rain instead of snow, leading to higher winter rainfall totals and lower winter snowfall total in the future.

Similarly, winter rain events (Rainfall > 10mm) are also projected to increase in the future, although the range of projections is relatively large.

Studies have shown that warmer air can carry more moisture than cooler air.

Winter Rain Events



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Snowfall, Snow Depth and Snowfall Timing

Zone 2

Changes in Winter Snow Depth

Historical Average
15 cm

- 48% Decrease in 2030s
- 73% Decrease in 2050s

Historical Maximum
25 cm

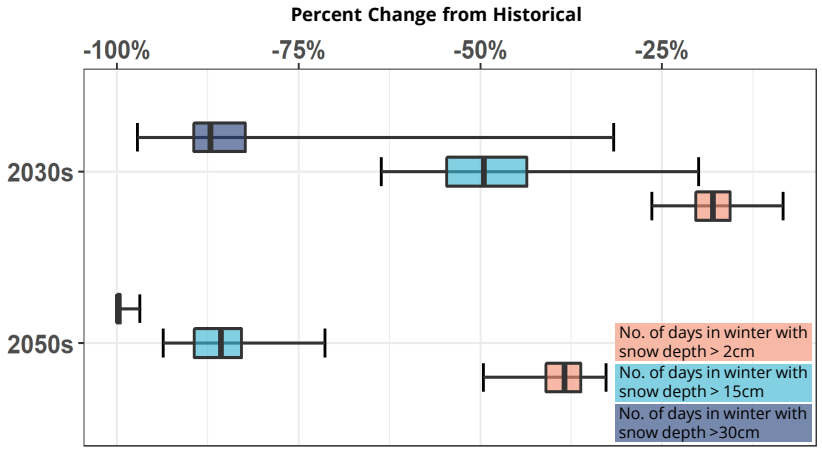
- 34% Decrease in 2030s
- 56% Decrease In 2050s

- Average and maximum snow depths are projected to decrease significantly over time.
- The largest impacts on snow depth will be seen along the coast, adjoining the Atlantic ocean while bigger impacts in central Newfoundland will be observed relatively later in the 21st century.

- Winter sport and recreation activities require different minimum snow depths.
- Activities requiring larger snow depths (e.g., 30 cm) are expected to experience greater reduction in operable days than those which require shallower snow depths.
- Thinner snowpacks indicate increased snowmaking capacity required to achieve operability.

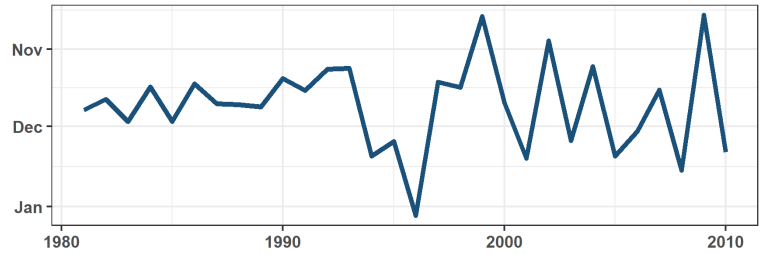
Historical Conditions

No. of days in winter with snow depth > 2cm	21
No. of days in winter with snow depth > 15cm	12
No. of days in winter with snow depth > 30cm	10



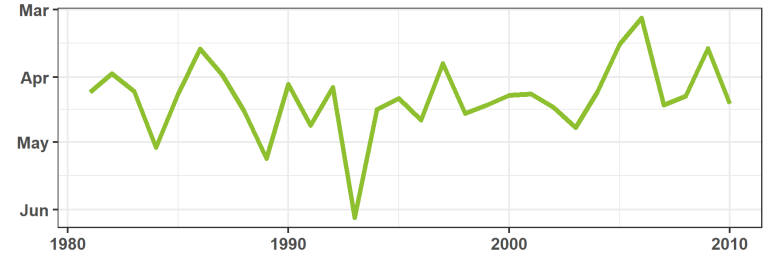
- The number of days with greater snow depths (e.g., 30cm) occur **much less frequently** than shallower snow depths (e.g., 2cm).
- By 2050s, projections show that a large reduction in the occurrence of deeper snowpacks, while shallower snowpacks will likely exist more frequently.

Snowfall Timing



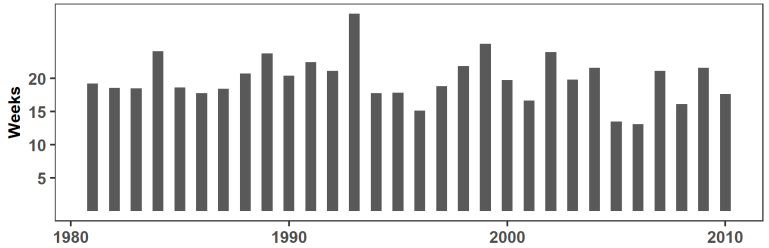
First Snowfall

2030s	2050s
12 Days Later	24 Days Later



Last Snowfall

2030s	2050s
11 Days Early	22 Days Early



Snowfall Duration

2030s	2050s
> 3 Weeks Shorter	> 6 Weeks Shorter

- On an average, the timing of the first snowfall is projected to shift from the end of November to the end of December by the 2050s.
- On an average, the timing of the last snowfall is projected to shift from the beginning of April to the beginning of March by the 2050s.
- On an average, the duration from first to last day of snowfall is projected to reduce by over 3 weeks by 2030s, and by over 6 weeks by 2050s, as compared to the historical period.

- **Operational Impacts:** Decreased operating length for winter recreation and snow sports, leading to a potential loss of revenue and higher cost of upkeep and maintenance in order to sustain winter activities for longer periods.

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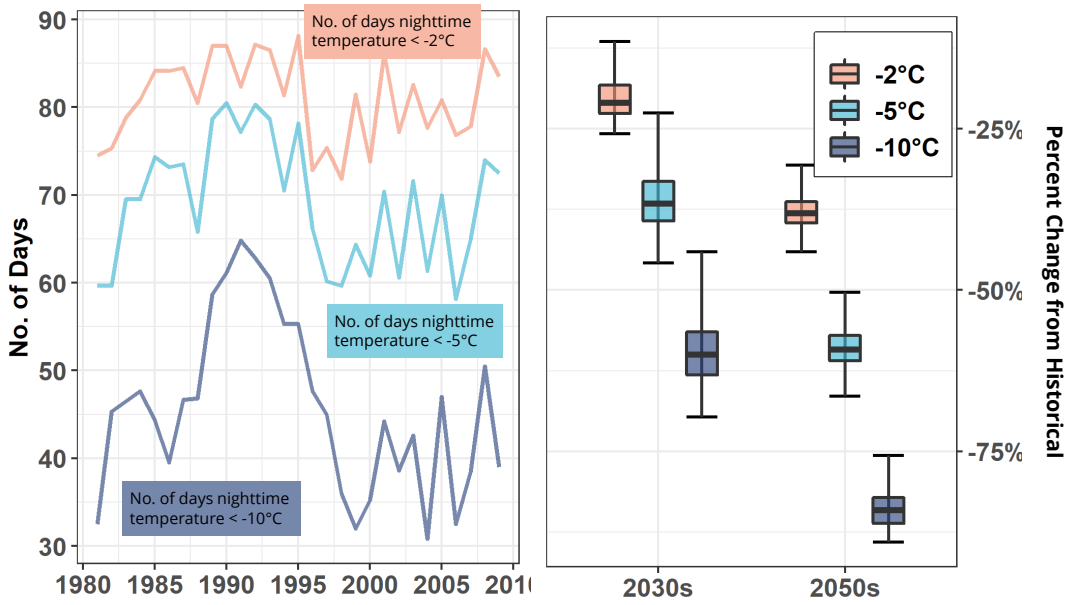
Changes in snow-making conditions

Zone 2

Number of Days Temperatures below -2°C, -5 °C, and -10 °C



- Historical data shows generally decreasing trends since 1990s.
- The number of days below minimum snowmaking temperatures are projected to decrease significantly over time. Frequency of nighttime temperatures above -2°C is projected to decrease at a slower rate than the frequency of nighttime temperatures above -10°C.
- Days with temperatures below -5 °C are projected to decrease approximately 35% by the 2030s and 60% by the 2050s.

Colder temperatures will be experienced on a **significantly less frequent** basis throughout the season.

Snowmaking operations requiring lower operating temperatures will be **more impacted** by climate change than those with higher operating temperatures.

Snowmaking equipment with lower operating temperatures will be able to produce snow on a less frequent and less reliable basis compared to equipment able to operate at higher temperatures.

Timing of Snowmaking Season

Typically, snowmaking equipment requires at least 3 consecutive days below the minimum operating temperature to begin producing snow.

The start of the snowmaking season depends on the minimum operable temperature of the snowmaking equipment.

Humidity

Negligible changes in average winter humidity are projected.

Important for determining good snow-making conditions.

Start of Season

Historical	2030s	2050s	Minimum Operating Temperature
Nov. 09	16 days later	26 days later	-2°C
Dec. 01	18 days later	27 days later	-5°C
Dec. 21	21 days later	31 days later	-10°C

End of Season

2050s	2030s	Historical
23 days early	13 days early	Apr. 27
30 days early	16 days early	Apr. 09
27 days early	17 days early	Mar. 19

Climate Change
=
Season Shifts
+
Shorter Winters & Earlier Springs

The onset of colder temperatures is expected to occur later in the season, thus impacting the start of the snowmaking season and achievable opening dates.

- Snowmaking operations are expected to **shut down earlier** in the year due to the earlier onset of warmer temperatures.
- Snow making equipment able to operate at higher temperatures will experience a **longer operable season** than those which require lower temperatures.
- Higher operating thresholds may allow for an **extended operating season** due to snow availability.

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