Climate 2085: Climate Change Impact Assessment of Western Canadian Ski Resorts

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Introduction

Scientists believe future climate change will have significant impact on a number of socio-economic activities. Winter skiing and snowboarding are at a severe risk and the impacts of climate change are being observed today, with major reductions in the length of the winter season. Over the last 15 years climate research into the impacts on ski resorts and other winter sport activities has increased substantially. Winter skiing and snowboarding stakeholders have become active lobbyists against climate change and ski resorts are taking major steps towards adaptation and a more sustainable future. Our goal is to model the changes in ski season length under the RCP8.5 emission scenario for selected ski resorts in Western Canada. Previous studies have been conducted using precipitation as the climate variable defining the ski season length under a changing climate [1]. Our technique uses temperature to model future changes in season length.

Objectives

The purpose of our research is to determine the impact of future climate change on the length of ski season for selected ski resorts in Western Canada. This research uses climate databases ClimateBC and ClimateNA to produce high quality historical data and future predicted data from 15 global climate models (GCMs) [2]. Using polynomial regression we model the length of ski season at ski resort mid-elevation for the normal period 1981-2010 and the RCP8.5 emission scenario in 2085.

Table 1. List of ski resorts in Western Canada study area (* - proposed ski resort).

1 - Apex	2 - Big White	3 - Cypress	4 - Fernie	5 - Garibaldi*
6 - Lake Louise	7 - Marmot Basin	8 - Mt Norquay	9 - Nakiska	10 - Panorama
11 - Red Mountain	12 - Revelstoke	13 - Sasquatch	14 - Silver Star	15 - Sun Peaks
16 - Sunshine	17 - Whistler	18 - Whitewater		

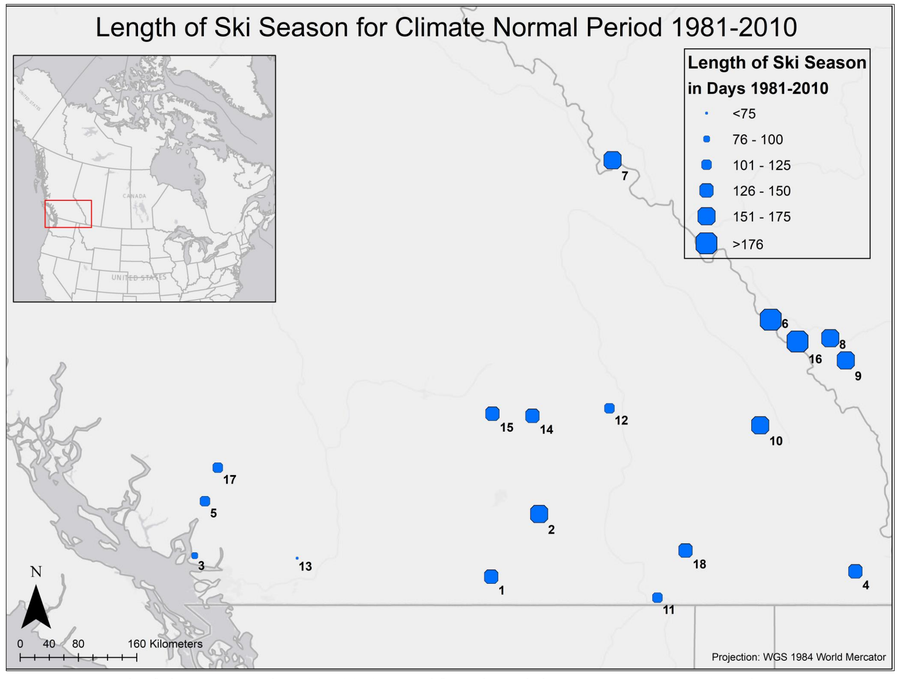

Figure 2. Length of ski season under 1981-2010 period for selected ski resorts in Western Canada.

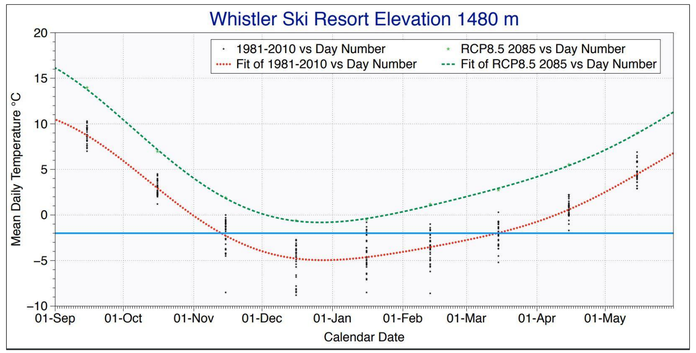

Figure 1. Polynomial regression best fit lines for the 1981-2010 period and RCP8.5 for the year 2085: Whistler Ski Resort (mid-elevation). This analysis shows a ski season reduction of 100% determined by the -2°C threshold, 121 days (1981-2010) to 0 days (RCP8.5).

Methods and Results

1) From ClimateBC and ClimateNA, monthly mean temperature data was generated for individual years between 1981-2010.
2) ClimateBC and ClimateNA were also used to produce monthly mean temperature data for the year 2085 under RCP8.5, averaged for 15 GCMs.
3) A polynomial regression was used to create daily mean temperature curves from the monthly data for 1981-2010 and RCP8.5 2085.
4) Season length was determined using a -2°C threshold, the temperature required for artificial snowmaking (see Figure 1).
5) Calculated 1981-2010 season length is displayed in Figure 2. Figure 3 compares season length for 1981-2010 and 2085 under RCP8.5. Figure 4 shows the percent reduction in ski season length by 2085 under RCP8.5.

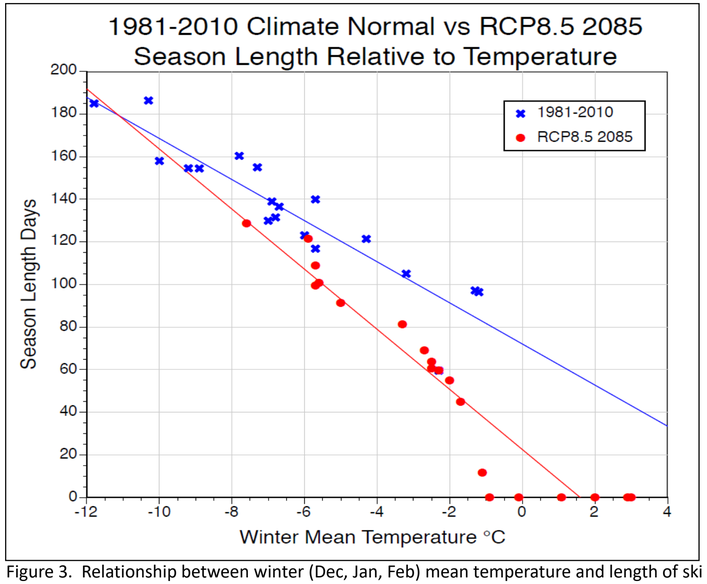

Figure 3. Relationship between winter (Dec, Jan, Feb) mean temperature and length of ski season for the 1981-2010 climate normal (R^2 - 0.8444) and RCP8.5 2085 (R^2 - 0.8998)

Discussion and Conclusion

There is considerable differences in the length of the ski season for the resorts studied for the period 1981-2010 (Figure 2). These differences are related to the coldness of the winter season. Coastal resorts have the mildest winters. Winter gets colder as one moves into the continental interior.

Strong correlation exists between winter mean temperature and ski season length. Warmer winter mean temperatures cause a decrease in ski season length (Figure 3). All resorts show a reduction in season length by 2085 under warmer winter mean temperatures caused by anthropogenic climate change. According to regression analysis a 1°C increase in winter mean temperature results in an average decrease in ski season length of 10 days for 1981-2010. Under RCP8.5 2085 this increases to 15 days per 1°C decrease in winter mean temperature. Ski resort winter mean temperatures range from -12°C to -1°C for 1981-2010 and range from -8°C to +3°C for RCP8.5 2085 with 4 resorts having a winter mean temperature above freezing (0°C).

Six of the 19 ski resorts studied in Western Canada completely lose their season (Figure 4) in 2085 under RCP8.5. These resorts were generally more coastal with milder winters and relatively short ski season in 1981-2010. Smallest reduction in ski season length occurred at resorts furthest from the coast. For example, Lake Louise Ski Resort saw its ski season length decrease from 185 days to 128 days (31% reduction).

The results presented here represent a subset of a larger project involving 150+ ski resorts in Western North America. Primary stakeholders in the ski industry can use this information to adopt adaptation strategies and lobby for mitigation efforts.

References:
1 - Wobus, C., Small, E. E., Hosterman, H., Mills, D., Stein, J., Rissing, M., ... Martinich, J. (2017). Projected climate change impacts on skiing and snowmobiling: A case study of the United States. *Global Environmental Change*, 45, 1-14.
2- Wang, T., Hamann, A., Spittlehouse, D., & Carroll, C. (2016). Locally downscaled and spatially customizable climate data for historical and future periods for North America. *PLoS ONE*, 11, 1–18.

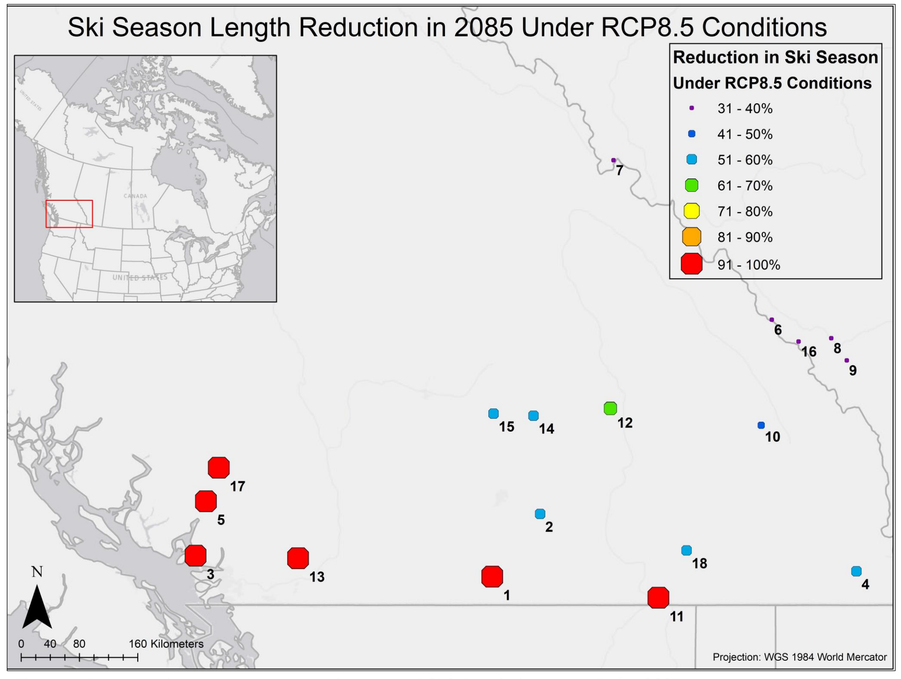

Figure 4. Percent ski season length reduction under RCP8.5 emission scenario for 2085.