ClimateBC: A Computer Program to Generate High-resolution Climate Data for British Columbia

submitted by Tongli Wang

Introduction

With increasing concern about climate change, climate data have become essential for ecological research and forest genetic resource management. Due to the limited number of weather stations available, climate data for a site of interest must be estimated based on data from weather stations nearby, a process called interpolation. Widely used interpolated climate data for British Columbia are PRISM 1961–1990 climate normals (Daly et al. 2002). Climate normals represent a long-term (30-year) average of climate data. This PRISM climate normal dataset has been generated for mean monthly maximum and minimum temperatures and monthly precipitation at a resolution of about 4 × 4 km (Daly et al. 2002).

As shown in Figure 1A, this resolution is not high enough for practical applications in mountainous regions. For temperature variables in particular, predicted values can be several degrees different from observed ones due to elevational differences (up to 1200 m in BC) within a 4 × 4 km PRISM tile. In addition, there is a need for additional variables such as dryness, growing degree days, frost-free period, etc. The ClimateBC software has been developed as a one-stop solution to: 1) downscale the PRISM data; 2) estimate additional climate variables; and 3) integrate historical climate data as well as future predictions by global circulation model. Interpolated climate variables using ClimateBC were substantially improved over the original PRISM data in terms of both spatial resolution (Figure 1) and prediction precision (15–30% for temperatures and 14% for precipitation) (Wang et al. 2006; Hamann and Wang 2005).

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The ClimateBC Software

ClimateBC is based on the PRISM 1961–1990 normal data covering British Columbia, the Yukon, the Alaska Panhandle, and western Alberta and parts of the Northwest Territories, Washington, Idaho, and Montana (Figure 2). Methodologies that downscale PRISM data and calculate many derived variables are described by Wang et al. 2006 and Hamann and Wang 2005.

The current (June 2006) and tested version of ClimateBC is version 2, which generates scale-free seamless climate data for annual, seasonal, and monthly temperature and precipitation variables. It also estimates 11 more complex, but biologically relevant climate variables, such as frost-free period, and various growing degree days. Some major global circulation models (GCM) have also been integrated for predicting climates in the 2020s, 2050s and 2080s. A more complete version (version 3), which includes predictions by many more general circulation

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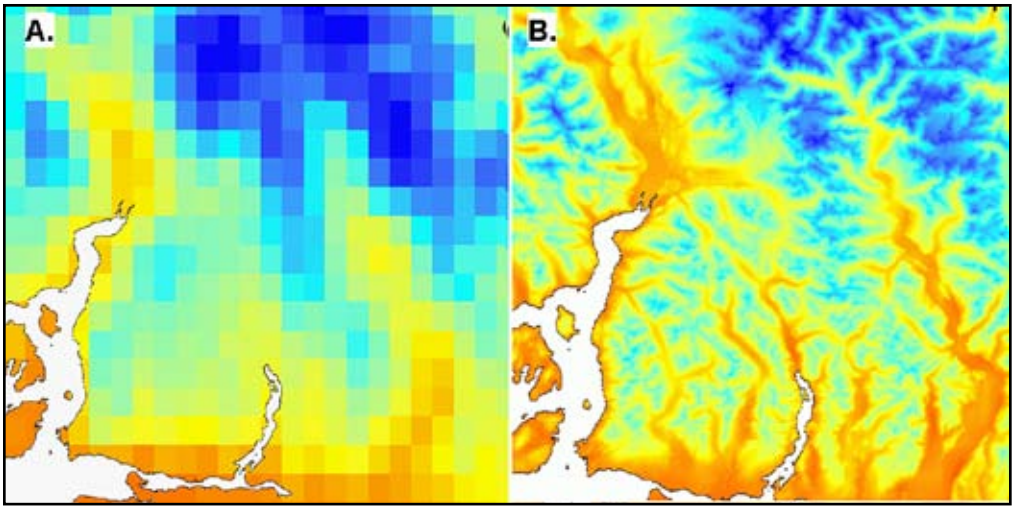

Figure 1. Maps of mean annual temperature predicted by A) PRISM, and B) ClimateBC v2.3 for the area north of Vancouver area at a resolution of 100 × 100 m. Source: Wang et al. 2006.

With the climate data generated by ClimateBC, high-resolution climate maps can be produced for current and future periods.

Figure 2. The areas covered by ClimateBC.

models and emission scenarios as well as historical climate data, is currently in the beta testing stage. A web version of ClimateBC has also been developed. The functionality of the web version is equivalent to ClimateBC v2, except for the ability to process multiple locations at a time. All versions can be accessed at the Centre for Forest Gene Conservation web site at http://genetics.forestry.ubc.ca/cfgc/climate-models.html.

As shown in Figure 3, the user can input latitude, longitude, and elevation (optional) to generate up to 75 monthly, seasonal, and annual climate variables. The multi-location processing function can be used to process spreadsheets of coordinates.

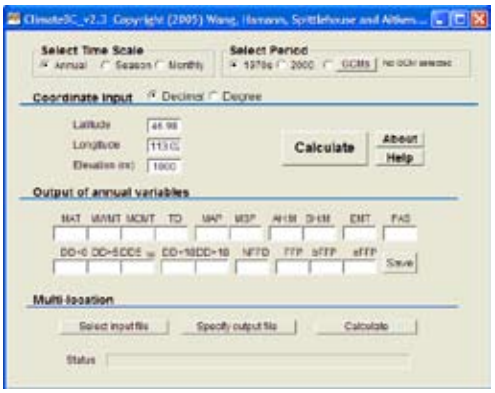

Figure 3. The interface of ClimateBC v2.

Applications

With the climate data generated by ClimateBC, high-resolution climate maps can be produced for current and future periods. The maps of mean annual temperature (MAT) for BC are shown in Figure 4 for the reference period (1970s) and future periods (2020s and 2050s). ClimateBC makes much ecological research possible. For example, the modeling of Biogeoclimatic Ecological Classification (BEC) with climate variables (Hamann and Wang 2006) requires high-resolution climate data for accurate modeling (Figure 5). Similarly, the use of ClimateBC is also critical for modeling seed planning units (SPUs) in order to decide where to deploy species and genotypes so that they can thrive under current and potential future scenarios. Further examples for applications are provenance testing, where genetic variation can now be analyzed as a function of multiple climate variables (Wang et al. 2006). The software and data has also been used for better understanding of ecological interactions between hosts and diseases (Woods et al. 2005).

Acknowledgements

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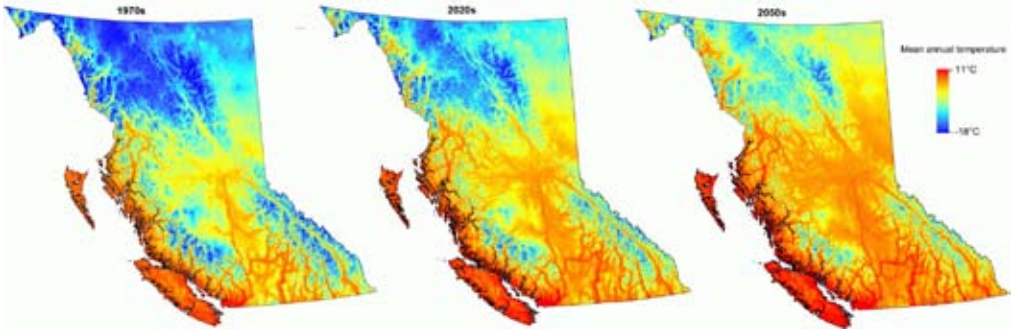

Figure 4. High-resolution maps of mean annual temperature (MAT) for BC for the periods of the 1970s (1961–1990, the reference period), 2020s (2011–2040), and the 2050s (2041–70).

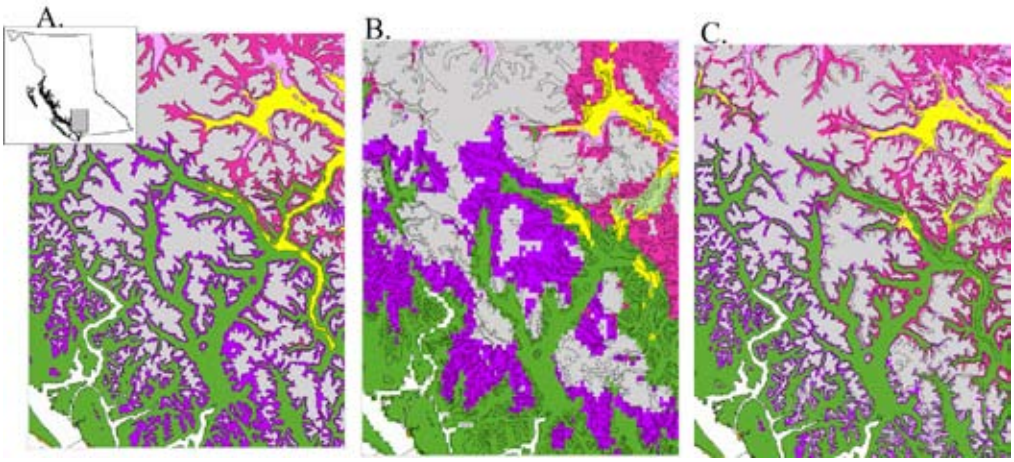

Figure 5. Modeling of BEC zones using ClimateBC vs. Prism data A) observed, B) modeled using PRISM data, and C) modeled using ClimateBC. Source: Hamann and Wang (2005).