Introduction

The need for future projections of extremes is growing, particularly as users planning to adapt to climate change continue to experience record-breaking events (Figure 1). Decision-making demands that such projections possess high spatial resolution. Downscaling has been carried out for Canada by the Pacific Climate Impacts Consortium for the newest Global Climate Model (GCM) and Regional Climate Model (RCM) projections. However, previous work has shown that downscaled projections over Western North America compared with other gridded methods suffered from a “downscaling bias”, where RCMs overestimated precipitation over topographically complex terrain. Certain stretches of British Columbia highway have experienced extreme precipitation resulting in substantial damage and have prompted the Ministry of Transportation and Infrastructure to consider a 100-year flood event for structure design.

Method selection

We compared the performance of eight statistical downscaling methods (Bürger et al. 2013; Cannon et al., in prep.) by training on reanalysis and validating against historical observations, as well as using RCM emulation (Figure 2). We considered metrics of three types: (i) daily sequencing of events, (ii) similarity of distribution of values, and (iii) spatial variability.

Consequently, we modified BCCA, which is a gridded statistical downscaling method that bias-corrects daily climate model output via quantile mapping using observations that are aggregated to the model scale. This is similar to the widely used RCM method, however BCCA uses a linear combination of historical analogues for daily large-scale anomalies to preserve spatial variability. Finally, our modified version, BCCAQ, includes a post-processing quantile mapping step at high resolution. This gives the method superior performance over North America compared with other gridded methods.

Downscaling

Statistical downscaling with BCCAQ was carried out on all NARC-CAP RCMs and the selected subset of CMIPS GCMs following RCP2.6, 4.5, and 8.5. We produced downscaled scenarios over Canada at a daily time resolution and 300 arc second (~10 km) spatial resolution for 1951-2100. The ANUSPLIN gridded daily observations produced by Natural Resources Canada (McKenney et al. 2011) were used to train the statistical downscaling.

Applications

The dataset has been used to provide climate information for adaptation. Certain stretches of British Columbia highway have experienced extreme precipitation events resulting in substantial damage and have prompted the Ministry of Transportation and Infrastructure to consider a 100-year flood event for structure design. The BC Ministry of Transportation and Infrastructure considered three case studies, including Bella Coola (Figure 1). Table 2 shows estimated risk to infrastructure components based on projected climate change. Projected changes in extremes (Figure 5) tend to be relatively larger than seasonal (Figure 6) and annual precipitation change itself (Table 3).

Table 3: Summary of infrastructure risk to various climate events for Bella Coola following the Public Infrastructure Engineering Vulnerability Committee (PIEVC) risk assessment protocol of Engineers Canada. Low risk, less than 12, indicates no immediate action is necessary. Medium risk, 12-36, is shaded yellow and suggests that action or more in-depth engineering analysis may be required. High risk, greater than 36, indicates that immediate action is needed. Numerical values are assigned using expert opinion in a workshop setting to estimate vulnerability to projected climate change.