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Combining outputs from the North American Regional Climate Change Assessment Program by using a Bayesian hierarchical model

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Abstract

We investigate the 20-year-average boreal winter temperatures generated by an ensemble of six regional climate models (RCMs) in phase I of the North American Regional Climate Change Assessment Program. We use the long-run average (20-year integration) to smooth out variability and to capture the climate properties from the RCM outputs. We find that, although the RCMs capture the large-scale climate variation from coast to coast and from south to north similarly, their outputs can differ substantially in some regions. We propose a Bayesian hierarchical model to synthesize information from the ensemble of RCMs, and we construct a consensus climate signal with each RCM contributing to the consensus according to its own variability parameter. The Bayesian methodology enables us to make posterior inference on all the unknowns, including the large-scale fixed effects and the small-scale random effects in the consensus climate signal and in each RCM. The joint distributions of the consensus climate and the outputs from the RCMs are also investigated through posterior means, posterior variances and posterior spatial quantiles. We use a spatial random-effects model in the Bayesian hierarchical model and, consequently, we can deal with the large data sets of fine resolution outputs from all the RCMs. Additionally, our model allows a flexible spatial covariance structure without assuming stationarity or isotropy.
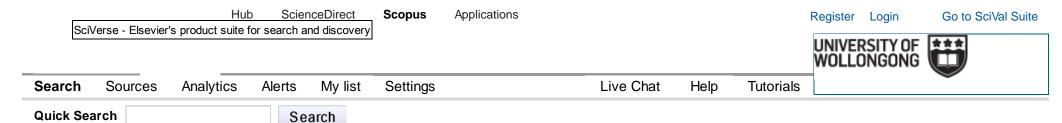
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climate, change, assessment, program, regional, bayesian, combining, hierarchical, outputs, model, american, north

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Abstract

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We investigate the 20-year-average boreal winter temperatures generated by an ensemble of six regional climate models (RCMs) in phase I of the North American Regional Climate Change Assessment Program. We use the long-run average (20-year integration) to smooth out variability and to capture the climate properties from the RCM outputs. We find that, although the RCMs capture the large-scale climate variation from coast to coast and from south to north similarly, their outputs can differ substantially in some regions. We propose a Bayesian hierarchical model to synthesize information from the ensemble of RCMs, and we construct a consensus climate signal with each RCM contributing to the consensus according to its own variability parameter. The Bayesian methodology enables us to make posterior inference on all the unknowns, including the large-scale fixed effects and the small-scale random effects in the consensus climate signal and in each RCM. The joint distributions of the consensus climate and the outputs from the

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Author keywords

Downscaling; North American Regional Climate Change Assessment Program; Posterior distribution; Regional climate model; Spatial random-effects model

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