

Intercomparison of Downscaling Methods

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Dynamical downscaling of local climate from coupled atmosphere-ocean model (AOGCM) output can be carried out using high or variable resolution global atmospheric models (HiGCMs) or nested atmospheric regional climate models (RCMs). An alternative approach is statistical downscaling (SDS) involving use of relationships calibrated from observations to infer local predictand variables from large scale predictor variables simulated by the AOGCM. Examples also exist of a mixed statistical-dynamical approach.

Whilst the HiGCM, RCM and SDS methods have been extensively investigated in isolation there have been only a few comparative studies, focusing on the relative performance of the RCM and SDS techniques. The two methods are found to perform with similar skill in predicting present climate but produce significant differences in predictions of future changes. Investigation of the causes of these differences reveals strengths and weaknesses in either technique and can identify areas where future research should be targeted. For example climate models often fail to reproduce correctly observed inter-variable correlations used to calibrate SDS relationships, while SDS techniques may exclude predictor variables which play an important role in climate change feedbacks but are excluded from the SDS equations because they are weak predictors of natural variability.

There is a need to firm up and extend these conclusions by setting up formal coordinated comparisons of the different downscaling methods. Such comparisons would ideally be carried out over a number of regions encompassing all major global climatic regimes and using a common observing period and experimental design. This would allow improved understanding and quantification of the uncertainties inherent in the downscaling process.

Many of the traditional arguments supporting the use of SDS (cheapness, simplicity, exclusion of predictor variables not reliably simulated in AOGCMs) are susceptible to a number of emerging developments:

- a wide range of predictors must be included to match HiGCM or RCM performance
- consistent multi-variable daily time series are needed for impacts assessments – these are difficult to supply via SDS unless complex multi-stage methodologies are used
- HiGCM or RCM results will become more widely available due to easier and cheaper access to fast computers.

Nevertheless there is likely to remain a role for SDS for the foreseeable future because exclusive reliance on dynamical methods is unlikely to cover all applications. In many cases it may be appropriate to use an ensemble of alternative methods applied in parallel (to provide uncertainty ranges) or an ensemble of methods applied in series (e.g. AOGCM provides SSTs for a 100km HiGCM whose circulation drives 25km RCM whose grid box output is downscaled to point locations using SDS).