

Use of GCMs in Regional Climate Studies

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This presentation reviews the use of output of global climate models in regional studies of climate variability, climate change and climate change impact assessment, without the application of any additional downscaling techniques. This presentation reviews such applications, focusing mainly on climate change studies, and an assessment of strengths and weaknesses of the approach is made. Selected examples will be used to illustrate the points made.

The application of GCM output in regional studies has the advantage that the simulated climate is internally physically consistent (according to the physics represented in the model). In particular, simulated climate of a given region is consistent with that simulated for all other regions – a desirable property in general, but also valuable when regional climate is to be analyzed and compared across a number of regions. This consistency is not always preserved when downscaling techniques are applied. Another advantage of the approach is one of simplicity. For many applications the necessary model data will be readily obtainable from existing model runs and no application-specific modeling is required. Another important practical advantage of using GCM output in climate change analysis is the ability to explore regional uncertainty associated with systematic differences between GCMs. Representation of this uncertainty is not precluded by the use of downscaling techniques, but in such applications practicalities usually limit it.

However, there are disadvantages in using GCM data in regional studies. GCMs show some simulation biases at continental and broader scales and more significant biases at regional (sub-continental) and finer scales. Climate features of a spatial scale of less than 200-300 km (gridscale in typical GCMs) cannot be represented at all (and physical processes that operate at such a scale will be poorly or not represented). In addition, many features of short time scale climatic variability, such as occurrence of extreme rainfall events and some extreme weather systems such as tropical cyclones cannot be adequately represented at the spatial resolution of a GCM. However, many applications demand realistic simulated climate information at very fine spatial scales. For example, it is very common in climate change impact applications to require the equivalent of point (station-based) climate data. Current climate simulation biases and inadequate resolution of GCM simulations are often avoided by simply applying interpolated climate changes or anomalies obtained from a GCM to fine resolution observed climate data. This may often not be appropriate.

These advantages and disadvantages will weigh-up differently depending on the region, variables of interest and the objectives of the study. In areas where

climate is strongly topographically controlled, and the topography cannot be represented at the GCM resolution, use of GCM output without downscaling is unlikely to be acceptable. However, in some other cases (such as where topographical effects are less important but model to model uncertainty large) use of GCM data in regional studies may be quite appropriate. Such differences also mean that it is difficult to define a standard spatial scale at which it is appropriate to evaluate GCMs.