Abstract

General circulation models (GCMs) are considered to provide the greatest potential for scenario construction for enhanced greenhouse effect impact studies, but the current generation typically have a spatial resolution of about 300 kilometres. Thus there is a need to downscale from this relatively coarse scale to the finer scale required for impact assessments. In this thesis, the potential of the circulation-based approach to downscaling (one of the most promising empirical approaches) is explored in depth.

This approach is developed and tested in a highly seasonal Mediterranean regime. Three study areas, providing a transect across the Mediterranean Basin, are used: the Guadalentin in southeast Spain, the Agri in central Italy and the Greek island of Lesvos.

An automated method based on Lamb Weather Types is used to classify the circulation on a daily basis using gridded sea level pressure data from the observations and from two versions of the UK Hadley Centre GCM (UKTR and HadCM2SUL). It is shown that the circulation-typing scheme is discriminating in terms of the rainfall characteristics underlying each type. This, together with the finding that each type has a characteristic underlying synoptic pattern, indicates that the scheme provides a suitable basis for downscaling. A stochastic weather generator in which rainfall is dependent on the circulation type of each day and on the wet/dry status of the previous day is developed and used to construct daily rainfall scenarios for 1970-1979, 2030-2039 and 2090-2099.

The final rainfall scenarios are considered more plausible than the raw GCM changes. The method is, however, affected by a number of problems which are common to all empirical, and many numerical model-based, downscaling approaches (i.e. stationarity, overdispersion, data availability and the reliability of GCMs). A number of ways in which the method could be further refined and developed to reduce these problems are proposed.

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