Issues in downscaling for climate change studies

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Applications have been driven in large measure by the need to examine the effects of climate change on the regional scale and to improve forecasts of extreme weather. It is clear that we would like to maintain the “climate signal” based on a GCM such as CCSM and then drive the regional and smaller scale climate through a regional scale model such as WRF to examine the impacts, in particular the transient and diagnostic features, on climate at finer resolution than in the GCM. In the atmosphere, there is a balance between forcing by large scale features and regional scale circulations. The challenge in downscaling applications is to achieve this balance by allowing the finer scale model to capture the local response to large scale climate forcing without having regional scale features dominated by patterns at one scale or the other. In analysis of results, most effort has been placed on individual variables such as surface temperature, pressure or relative humidity but climate is characterized by interactions among these variables which can be dramatic. For example, small changes in temperature fields can be associated with large changes in moisture variables.

One common way to analyze the results of the model outputs at different resolutions is to compare and analyze basic parameters such as temperature, winds, and precipitation. While this can give a good idea on the consistencies, spatial and temporal similarities or differences between such basic parameters, it will not give a comprehensive picture of the transitions at modeled different horizontal resolution. We introduce here a more comprehensive approach using the air mass concept where synoptic scale circulation at a given location is classified based on air mass types depending on the prevailing meteorological conditions. In this paper we provide analysis of the possible effects on characterizing air masses for WRF model resolutions ranging from 108 km to 36 km to 12 km.