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Diagnosis of the North American monsoon and its teleconnections in current and future climates as simulated by multiple GCMs

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The North American monsoon is manifested by a sharp precipitation increase over northwestern Mexico and the southwestern United States beginning in late June to early July. Heating from organized deep convection over this region produces a teleconnection pattern that strongly affects summer precipitation over much of the remainder of North America, such that observed precipitation over the monsoon core region is out-of-phase with precipitation over the central U.S. and in-phase with precipitation over the eastern U.S. and Canada. We evaluate the ability of current state-of-the-art general circulation models (GCMs) to depict the North American monsoon and its influence on continental-scale precipitation and circulation by analyzing results from GCMs that have supplied output in support of the IPCC Fourth Assessment Report (AR4). We evaluate the ability of these GCMs to depict the North American monsoon system in the current climate and diagnose projected changes in the monsoon through the end of the 21st century.

The current climate is taken as the period 1961-1990 in "Climate of the 20th century" runs submitted for the AR4 archive. To date, analysis of current climate has been completed for all models presently available (GFDL CM2.0, CNRM, MRI CGCM, NCAR PCM and CCSM, MIROC high- and medium-resolution, and three versions of the GISS model). Where multiple runs of a given model and scenario are available we analyze each of the individual realizations as well as the ensemble mean. All models produce the main signal of the North American monsoon, i.e., an increase in precipitation over northwestern Mexico from June to July. Their ability to reproduce the observed teleconnections of the monsoon (namely, the decrease in precipitation over the central U.S. around and following monsoon onset) is more variable,

with some models producing a realistic teleconnection pattern, some producing overly strong and extensive teleconnections, and others producing almost no teleconnections in the precipitation field. The most realistic results are produced by the MIROC high-resolution (T106L56) model, which creates a continental-scale pattern of precipitation change that is remarkably similar to the North American monsoon in climatologies of July-minus-June IR satellite imagery. The medium-resolution (T42L20) version of the same model does not produce such realistic results. This difference between the two MIROC implementations suggests that the realism of the high-resolution MIROC likely is attributable to resolution rather than some other aspect of the model.

Changes to the North American monsoon in future climate are assessed by comparing the periods 2041-2070 and 2071-2100 to the 1961-1990 "Climate of the 20th Century" results in all models that have submitted output for the SRES A2 scenario. Results to date suggest a moderate tendency for the monsoon to produce greater precipitation in the northwest Mexico core region, and to produce strengthened teleconnections across North America. These changes are not, however, consistent among the models, nor in some cases from run to run within an ensemble. The AR4 archive is currently in progress and the present analysis is continually updated as more model output becomes available.