Detection, attribution and prediction of decadal-scale rainfall changes over South America using a high-resolution global climate model

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A critical challenge in climate science is developing the capability to predict rainfall changes over the coming decades, particularly on regional spatial scales. Such predictions and projections are of vital societal interest across many different sectors. We present results from a suite of simulations with a newly developed high-resolution global climate model (GFDL CM2.5). This new model produces a remarkably accurate simulation of precipitation over South America, and is an important new tool for assessing past change and predicting future change. The global model has horizontal resolution of 50 Km in the atmosphere and 8-27 Km in the ocean, thereby permitting simulation of small-scale climatic features with considerably reduced bias relative to previous generation models. We first demonstrate the ability of the model to accurately simulate the mean climate over South America. We also show that a version of this model is used as a very successful seasonal prediction mo del. We then present results from suites of simulations over the 20th and 21st centuries driven by estimates of changing radiative forcing. We show that the model reproduces quite faithfully the changes in regional scale summer precipitation over southern South America, including parts of Argentina, Chile, Uruguay and Paraguay. We show that the tendency for increased summer rainfall over parts of northern Argentina and adjacent regions, as well as the drying in southwestern Argentina and Chile, is captured by the model, and is largely a response to human-induced radiative forcing changes. The model simulations reproduce the observed change over the last several decades quite well when forced with anthropogenic radiative forcing changes. However, when only natural forcings are used, such as volcanic aerosols and solar irradiance changes, the pattern of recent change does not appear in the model, thereby providing evidence for a human influence on recent precipitation changes in South America. We then use this model to make projections of regional rainfall changes over the 21st century. Our model projections suggest that the trend observed over the last decades will continue and amplify throughout the 21st century. If correct, these simulations provide important guidance for adaptation planning in the 21st century.