Evaluation of climate models for the Mid- and Upper-Atlantic Region of the United States

Raymond Najjar, Steve Graham, Steve Crawford and Steve Greybush
Pennsylvania State University

Introduction

Because the effects of climate change are felt locally it is important to know the accuracy of climate models at local scales. The Consortium for Atlantic Regional Assessment (CARA) is making climate projections for the Mid- and Upper-Atlantic Region available to stakeholders through the internet. Here we present an evaluation of those climate models.

Figure 1

Models and observations

We evaluate seven models run under two greenhouse gas emissions scenarios (A2 and B2, which correspond to CO2 levels of about 800 and 600 ppm, respectively) from IPCC Third Assessment Report. Model output we are analyze is monthly temperature and precipitation from 1900 to 2100. The data were made available on the grid shown in Figure 1. We then spatially smoothed the output and fit a two-dimensional surface to it using splines. Output was then available on a 1/8^{o} grid for comparison to the observations. We also corrected for model elevation errors, using a mean lapse rate of x.

Observations of temperature and precipitation are from the Historical Climate Network. There are approximately 200 HCN stations in the MUAR.

Temperature: long-term mean and seasonal range

The simulated mean temperature (with altitude correction) at the HCN stations for 1971-2000 varies from 8.0 to 12.2 deg C among the models, with a model mean of 9.75 deg C, which is 0.12 deg C higher than observed (Figure 2). The RMS errors in mean temperature over this period vary from 0.7 to 2.6 deg C among the models, with a model mean of 1.4 deg C (not shown). The altitude correction decreased the RMS error, on average, by 0.3 deg C.

Model seasonality in temperature was evaluated using the difference between the summer (June-August) and the winter (December-February), as shown in Figure 2. This seasonal difference varied from 22.0 to 32.6 deg C among the models, with a model mean of 26.0 deg C, 3.2 deg C (14%) larger than observed.

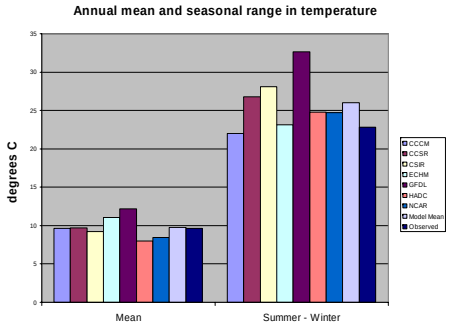

Figure 2

Precipitation: long-term mean and seasonal variation

The simulated mean precipitation at the HCN stations for 1971-2000 varies from 2.7 to 3.4 mm d^{-1} among the models, with a model mean of 3.0 mm d^{-1}, which is equal to the observed. The RMS errors in mean precipitation over this period vary from 0.35 to 0.55 mm d^{-1} among the models, with a model mean of 0.40 mm d^{-1}.

There is a weak annual cycle in observed precipitation, with summer highest and winter lowest (Figure 3). Precipitation in summer is 0.71 mm d^{-1} (28%) higher than that in winter. The summer-winter difference is predicted well by the model mean (0.79 mm d^{-1}), but the phasing of precipitation is generally ahead of the observations, with four of the models putting highest precipitation in spring and five putting lowest precipitation in fall. The model mean spring precipitation is 49% higher than the model mean fall precipitation, whereas the observations show very little difference between these seasons (2%).

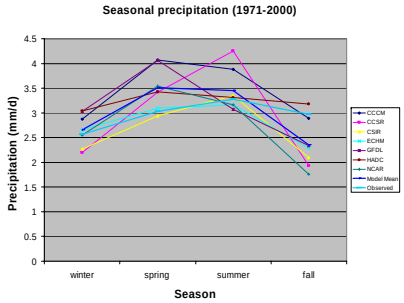

Figure 3

Temperature change

The temperature change from the 1911-1940 period to the 1971-2000 period varied among the models from –0.10 to 0.72 deg C, with a model mean of 0.42 deg C, 35% higher than observed. The difference between the model mean and the observed is found in the summer and fall, where the model warming is 0.44 and 0.27 deg C greater than observed, respectively (Figure 4).

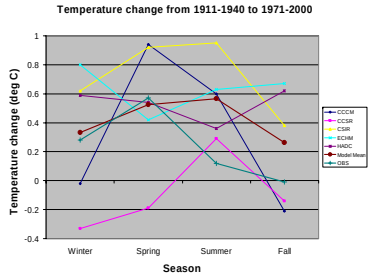

Figure 4

Summary

Overall, the climate models are able to capture the long-term means in temperature and precipitation. The seasonal range is somewhat overestimated for both parameters. The models tend to predict too much warming over the 20th century, and the projected warming for the region may be an overestimate.