Supporting Online Material

"Detection of a human influence on North American climate", D. J. Karoly et al. (2003)

Materials and Methods

Description of the climate models

GFDL R30 is a spectral atmospheric model with rhomboidal truncation at wavenumber 30 equivalent to 3.75° longitude × 2.2° latitude (96 × 80) with 14 levels in the vertical. The atmospheric model is coupled to an 18 level gridpoint (192 × 80) ocean model where two ocean grid boxes underlie each atmospheric grid box exactly. Both models are described by Delworth et al. (*S1*) and Dixon et al. (*S2*).

HadCM2 and HadCM3 use the same atmospheric horizontal resolution, 3.75° × 2.5° (96 × 72) finite difference model (T42/R30 equivalent) with 19 levels in the atmosphere and 20 levels in the ocean (*S3, S4*). For HadCM2, the ocean horizontal grid lies exactly under that of the atmospheric model. The ocean component of HadCM3 uses much higher resolution (1.25° × 1.25°) with six ocean grid boxes for every atmospheric grid box. In the context of results shown here, the main difference between the two models is that HadCM3 includes improved representations of physical processes in the atmosphere and the ocean (*S5*). For example, HadCM3 employs a radiation scheme that explicitly represents the radiative effects of minor greenhouse gases as well as CO_2, water vapor and ozone (*S6*), as well as a simple parametrization of background aerosol (*S7*).

ECHAM4/OPYC3 is an atmospheric T42 spectral model equivalent to 2.8° longitude × 2.8° latitude (128 × 64) with 19 vertical layers. The ocean model OPYC3 uses isopycnals as the vertical coordinate system. As with HadCM3, ECHAM4 also explicitly represents the effects of a range of greenhouse gases and includes an explicit treatment for the radiative effects of aerosols. A description of the coupled model can be found in Roeckner et al. (*S8*).

PCM is the NCAR Parallel Climate Model. It makes use of the NCAR Community Climate Model (CCM3) T42 (2.8° × 2.8°) atmospheric model and Land Surface Model (LSM). The ocean component uses the Los Alamos National Laboratory Parallel Ocean Program (POP) model, which has 2/3° average horizontal grid spacing (with increased resolution near the equator and North Pole) and 32 vertical levels. A description of the PCM can be found in Washington et al. (*S9*).

Estimating uncertainty due to internal climate variability

Long control simulations from the climate models provide us with probably the best statistics to estimate the uncertainty associated with internal climate variability. Frequency distributions of decadal standard deviations (from a 100 year sample), 50-year trends and 100-year trends were calculated from 50% overlapping 50-year or 100-year samples from the control runs. These distributions were used to estimate the 5-95% confidence interval for each parameter from each model.

The assessment of decadal variability in the model simulations in Figure 1 indicates that the models simulate the internal variability of the observed climate reasonably well on the time and space scales considered in this study. Based on this assessment, we use the model control runs to estimate the uncertainty in the observations due to internal climate variability. The uncertainty estimates from three models, ECHAM4, HadCM2 and PCM, are combined and weighted by the length of their control runs to give the uncertainty estimate for the observations. These were the only models with DTR data available. The results are not sensitive to whether one, two, or three models are used to estimate the observational uncertainty, as no single model has the largest variability across all the different indices.

The uncertainty of the simulated ensemble-mean response to imposed forcing for each model was estimated using the standard deviation of the 50-year and 100-year trends from the respective model's control run. This standard deviation was reduced by dividing by the square root of the number of members in the ensemble to estimate the standard deviation of the ensemble mean trend due to internal variability.

As only 240 years of ECHAM4 control run output were available, this simulation was not considered to be long enough to estimate the uncertainty of 100-year trends or the decadal standard deviation from a 100-year sample.

References

S1. T.L. Delworth *et al*., *Climate Dyn.*, **19**, 555 (2002).

S2. K. W. Dixon *et al*., *Global Planet. Change*, **37**, 81 (2003).

S3. T.C. Johns, "A description of the Second Hadley Centre Coupled Model (HadCM2)" (Climate Research Technical Note 71, Hadley Centre, United Kingdom Meteorological Office, Bracknell, UK, 1996).

S4. T.C. Johns *et al*., *Climate Dyn,* **13**, 103 (1997).

S5. C. Gordon *et al*., *Climate Dyn.,* **16**, 147 (2000).

S6. J.M. Edwards, A. Slingo, *Quart. J. Roy. Meteor. Soc.,* **122,** 689 (1996).

S7. S. Cusack, A. Slingo, J.M. Edwards, M. Wild, *Quart. J. Roy. Meteor. Soc.,* **124**, 2517 (1998).

S8. E. Roeckner, J.M. Oberhuber, A. Bacher, M. Christoph, I. Kirchner. *Climate Dyn*., **12**, 737 (1996).

S9. W.M. Washington *et al., Climate Dyn.*, **16**, 755 (2000).