How Well do Coupled Models Simulate Present-day Mean Climate?
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1. Motivation
Recently various modeling groups around the world produced climate change experiments in support of the 4th IPCC assessment report. The question addressed in this study is how the latest model improvements and the full range of external forcings considered in these simulations affect the ability of such models to match the observations of present-day climate. The answer to this question is important to give credible estimates of future climate change.

2. Methodology
We calculate mean climatologies (1979-1999) of various fields to verify model output against observations. We determine the model performance by calculating for each model and field a normalized mean-square error $E^2$ defined by

$$E^2 = \frac{1}{N} \sum_{i=1}^{N} \left( \frac{b_i - a_i}{\sigma_{a_i}} \right)^2,$$

where $\sigma_{a_i}$ is the interannual standard deviation at grid point $i$ derived from observations, and $b_i$ are appropriate weights. For the comparison we renormalize $E^2$ with the average $E^2$ over all models:

$$I^2_{nm} = \frac{E^2_n}{E^2_{\text{overall}}},$$

1: better than average
+1: worse than average

3. Zonal Mean Zonal Wind: IPCC-AR4
a. Individual models verified against ERA-40
b. Ranking based on $I^2$

4. IPCC-AR4 (20C3M): 35 Variables

5. Three Model Generations: 15 Variables

6. Performance of the Ensemble Mean
a. Performance of Increasing Number of Models

7. Errors by Model Generation
• Systematic $\frac{b_i - a_i}{\sigma_{a_i}} = \bar{b}_i - \bar{a}_i$
• Absolute $|b_i - a_i|$

8. Spatial Correlations of Error Patterns

9. Overall

10. By variable

11. Breakdown by variable (overall best, best by variable)

12. Mean Correlations Over All Models

13. Precipitation

14. SST

15. Extreme outlier

16. Sea surface temperature $t_{os}$ (K)

17. Sea ice fraction, spatial variance sic (%)