The slowdown in global temperature trends: No systematic error in climate models

Observations suggest a slowdown in global surface temperature trends since 1998, whereas most climate models simulate continued warming. Some have speculated that this difference occurs because climate models respond too sensitively to greenhouse-gas increases, and thus overestimate climate change. A study just published by the Max Planck Institute for Meteorology, Germany (MPI-M) and the University of Leeds gives a clear answer: There is no evidence for systematic model error and the observed discrepancy is mostly due to chance.

Writing in Nature, Professor Jochem Marotzke, from MPI-M, and his colleague, Professor Piers Forster from the University of Leeds, determine for the first time to what extent the simulated global temperature trends of the past depend on physical causes.

The authors proceed in two steps. First, they compare simulated and observed 15-year trends over the entire period from 1900 to 2012 (Figure 1). This provides the context for analysis of the more recent period. Figure 1 compares observations with all 114 available simulations. A start year of 1900 means that the trend is computed over the period from 1900 to 1914, a start year of 1901 that the trend is computed over the period 1901 to 1915, and so on. For each start year the colour shading indicates how frequently a particular trend size appears in the ensemble of simulations. Compared with the simulations, the observed trends are distributed in no discernibly preferred way and occur sometimes at the upper end of the ensemble and sometimes at the lower end of the ensemble. The simulated trends are thus broadly consistent with the observations.

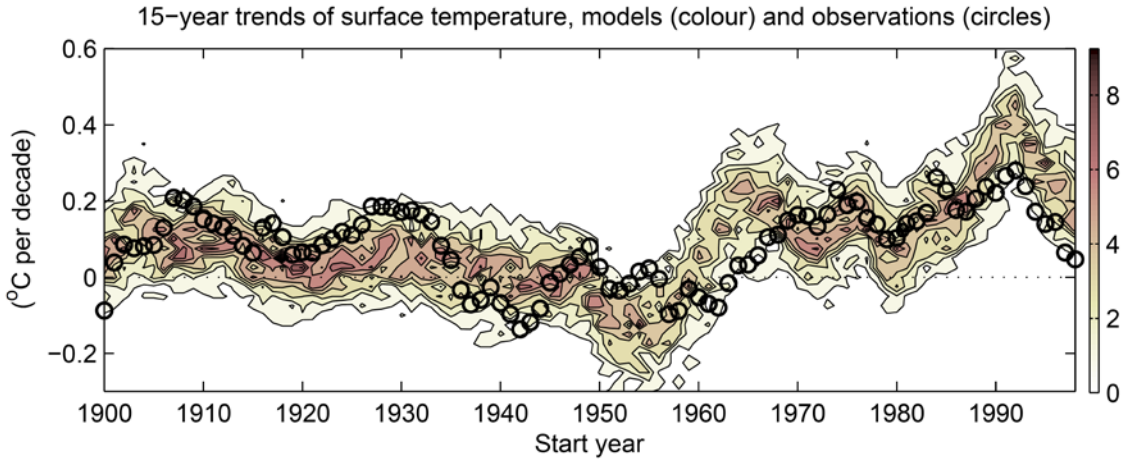

Figure 1: Simulated and observed 15-year trends of globally averaged surface temperature since 1900. The colour shading indicates how frequently a particular simulated temperature trend occurs as a function of the start year, based on the available 114 simulations. The trends are sorted in classes of 0.025 °C per decade. The circles mark the observed temperature trends.

In a second step, the authors investigate the causes of the spread in the simulations. To this end, they isolate with the help of a statistical approach the contributions of individual processes. Physical considerations suggest that the spread in temperature trends should depend on the trends in radiative forcing, on the sensitivity of climate in the individual models, and on the efficiency of oceanic heat uptake in the individual models. If too high model sensitivity were responsible for the too large temperature trend of the past 15 years, the models with a high sensitivity should systematically show a larger temperature trend than the models with a lower sensitivity.

For all 15-year trends in surface temperature since 1900, physical deterministic effects contribute much less to ensemble spread than does spontaneous variability (Figure 2b,c). This confirms that random spontaneous climate variability dominates the differences between individual simulations as well as the differences between observations and simulations.

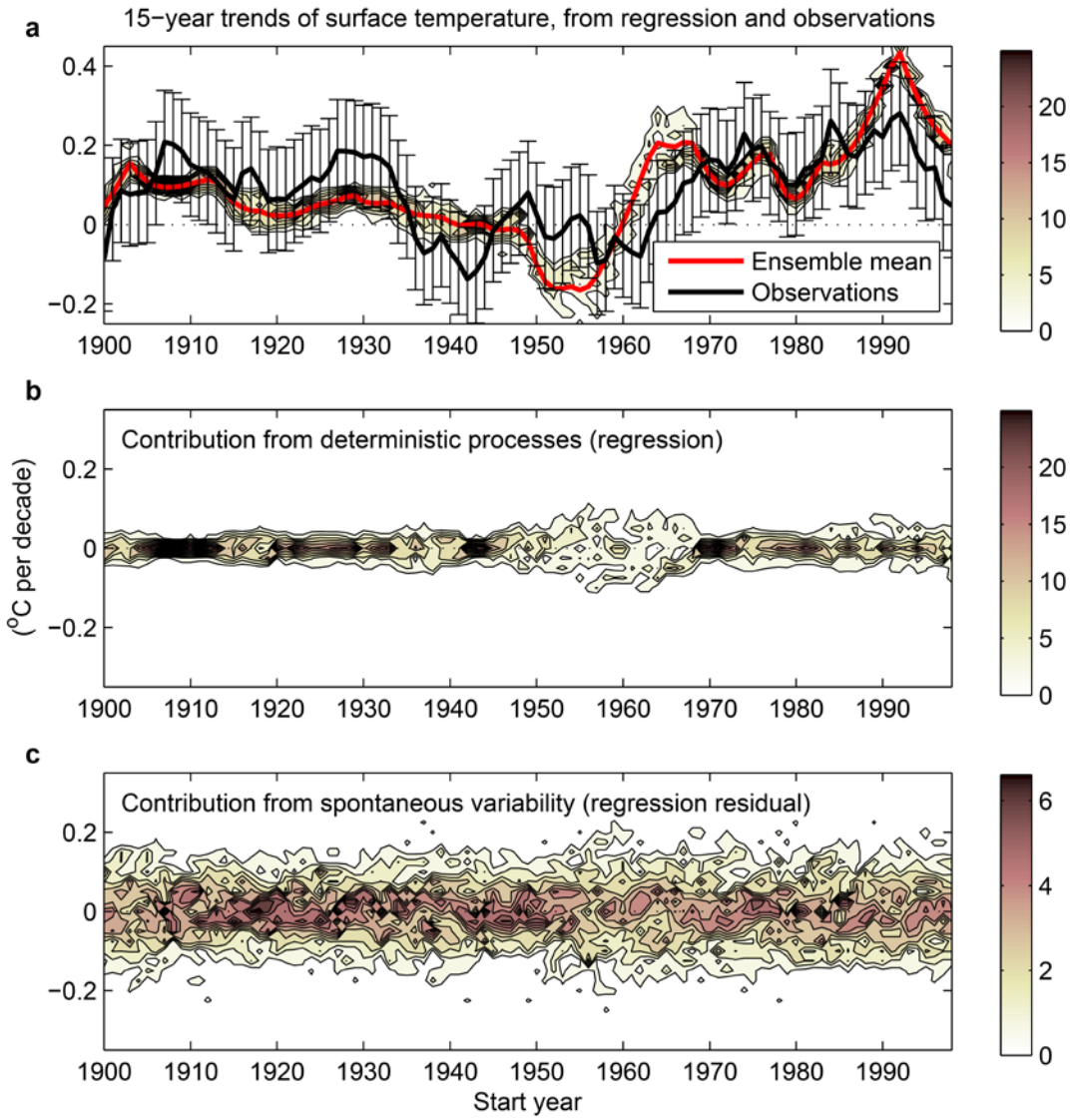

Figure 2: Regression-based and observed 15-year trends of globally averaged surface temperature since 1900. The colour shading indicates how frequently a particular simulated temperature trend occurs as a function of the start year, based on the 75 simulations for which forcing information is available. (a) Sum of regression-based trends (from Figure 2b) and ensemble mean (in red). The black curve indicates the observed trends; the whiskers show the uncertainty that arises from spontaneous variability (from a time-average of Figure 2c). (b) Regression-based trends. (c) Regression residual as a measure of spontaneous climate variability. All trends in (a) to (c) are sorted in classes of 0.025 °C per decade.

In summary, for the globally averaged surface temperature over the entire period from 1900 to 2012, the simulated 15-year trends show no systematic deviation from the observations. The differences between simulated and observed trends are dominated by spontaneous climate variability. In particular, the sensitivity of climate in the models plays no role in the difference between simulations and observations. This latter fact occurs although sensitivity varies across models by a factor of three. The claim that climate models systematically overestimate the warming caused by increasing greenhouse-gas concentrations is likely unfounded.

Original publication:

Marotzke, J., and P.M. Forster, 2015: Forcing, feedback, and internal variability in global temperature trends. *Nature*, DOI 10.1038/nature14117