CC-15

# Policy Implications of Climate Models on the Verge of Failure


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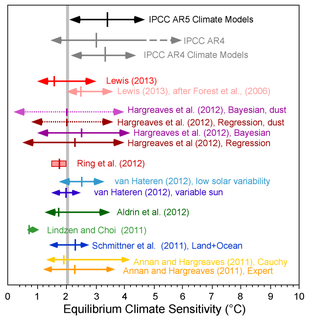
## INTRODUCTION

Assessing the consistency between real-world observations and climate model projections is a challenging problem but one that is essential prior to making policy decisions which depend largely on such projections. National and international assessments often mischaracterize the level of consistency between observations and projections. Unfortunately, policymakers are often unaware of this situation, which leaves them vulnerable to developing policies that are ineffective at best and dangerous at worst.

Here, we find that at the global scale, climate models are on the verge of failing to adequately capture observed changes in the average temperature over the past 10 to 30 years—the period of the greatest human influence on the atmosphere. At the regional scale, specifically across the United States, climate models largely fail to replicate known precipitation changes both in sign as well as magnitude.

On the first count, the near inability of climate model projections to contain the observed global temperature trends, it is likely that the climate model overestimation of the earth's equilibrium climate sensitivity—an overestimation which averages about 40 percent—is playing a large role in the models' gross exaggeration of the current rate of temperature rise (which, for example, has been virtually zero during the past 16 years). On the second count, the general inability of general circulation models to even get the sign of the observed precipitation changes across the U.S. correct, much less the magnitude, likely stems from the complexities of the climate system on spatial and temporal scales that lie far beneath those of current generation GCMs.

## EQUILIBRIUM CLIMATE SENSITIVITY




Climate sensitivity estimates from new research published since 2010 (colored, compared with the range given in the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) (gray) and the IPCC Fifth Assessment Report (AR5; black). The arrows indicate the 5 to 95% confidence bounds for each estimate along with the best estimate (median of each probability density function; or the mean of multiple estimates; colored vertical line). Ring et al. (2012) present four estimates of the climate sensitivity and the red box encompasses those estimates. The right-hand side of the IPCC AR4 range is dotted to indicate that the IPCC does not actually state the value for the upper 95% confidence bound of their estimate and the left-hand arrow only extends to the 10% lower bound as the 5% lower bound is not given. The light grey vertical bar is the mean of the 14 best estimates from the new findings. The mean climate sensitivity (3.4°C) of the climate models used in the IPCC AR5 is 13 percent greater than the IPCC's "best estimate" of 3.0°C and 70% greater than the mean of recent estimates (2.0°C).


**References:**

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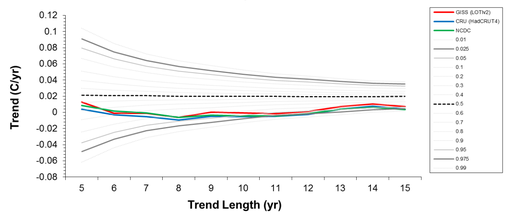
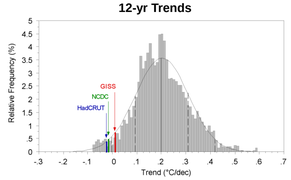
## GLOBAL TEMPERATURE

### Surface Air Temperature Trends

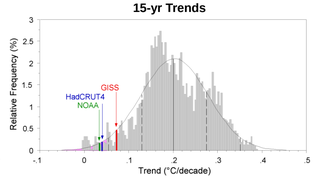



Current (ending in December 2012) trends in three observed global surface temperature records of length 5 to 15 years (colored lines) set against the probability (gray lines) derived from the complete collection of climate model runs used in the IPCC Fourth Assessment Report under the SRES A1B emissions scenario.

### 12-yr Trends

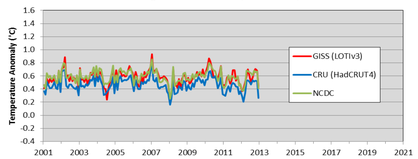



### 15-yr Trends



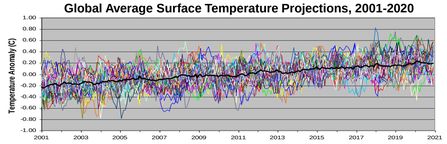

Distribution of 12-yr temperature trends (left) and 15-yr temperature trends (right) projected by climate models during the first two decades of the 21st century (gray). The mean (vertical black line) and 1 and 2 standard deviations (vertical dashed lines) of the distributions are also indicated. The observed 12-yr temperature trend from 2001-2012 (left) and 15-yr temperature trends from 1998-2012 (right) are indicated by the colored bars.

### Global Average Surface Temperatures, 2001-2012




Observed surface temperature changes from 2001-2012 from the three primary surface temperature compilations.

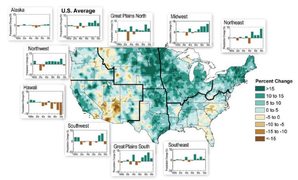
### Global Average Surface Temperature Projections, 2001-2020




Projected surface temperature changes from 2001-2020 from 51 climate model simulations under the SRES A1B emissions scenario.

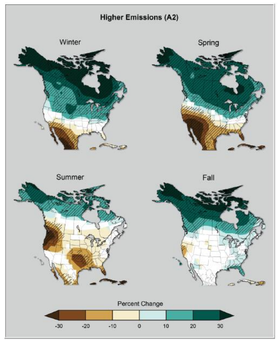
## U. S. PRECIPITATION

### Observed U.S. Precipitation Change




The colors on the map show annual total precipitation changes (percent) for 1991-2011 compared to the 1901-1960 average, and show wetter conditions in most areas. The bars on the graphs show average precipitation differences by decade (relative to the 1901-1960 average) for each region. The far right bar is for 2001-2011. (Figure source: Draft National Assessment Report)

### Projected U.S. Precipitation Change




Projected percent change in seasonal precipitation for 2070-2099 (compared to the period 1901-1960) under an emissions scenario that assumes continued increases in emissions (A2). Teal indicates precipitation increases, and brown, decreases. Hatched areas indicate confidence that the projected changes are large and are consistently wetter or drier. White areas indicate confidence that the changes are small. (Figure source: Draft National Assessment Report)

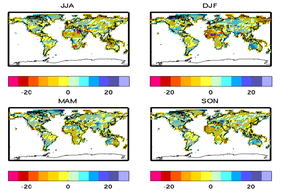
### Number of Years Before Predicted Changes Are Greater Than Natural Variability

| State | DJF | MAM | JJA | SON |
|---|---|---|---|---|
| AL | n/a | 211 | 444 | Achieved |
| AZ | 1109 | 221 | n/a | n/a |
| AR | n/a | 1146 | 127 | n/a |
| CA | n/a | 332 | 2111 | 467 |
| CO | 417 | 229 | | n/a |
| CT | 183 | n/a | n/a | n/a |
| DE | 275 | n/a | n/a | n/a |
| FL | n/a | 145 | 139 | 265 |
| GA | n/a | Achieved | n/a | Achieved |
| ID | 285 | Achieved | 380 | n/a |
| IL | 76 | 76 | n/a | n/a |
| IN | 258 | 76 | n/a | n/a |
| IA | 197 | Achieved | n/a | n/a |
| KS | Achieved | n/a | 1017 | n/a |
| KY | 695 | n/a | n/a | n/a |
| LA | n/a | 168 | 230 | n/a |
| ME | 140 | 80 | n/a | n/a |
| MD | 259 | n/a | n/a | n/a |
| MA | 85 | n/a | n/a | n/a |
| MI | 94 | 97 | 263 | Achieved |
| MN | 151 | 88 | n/a | n/a |
| MS | n/a | 391 | n/a | n/a |
| MO | n/a | n/a | 306 | n/a |
| MT | 473 | 15 | 833 | n/a |
| NE | 463 | n/a | n/a | n/a |
| NV | n/a | 419 | 370 | n/a |
| NH | 97 | 41 | n/a | n/a |
| NJ | 221 | n/a | n/a | n/a |
| NM | 1660 | 246 | n/a | n/a |
| NY | 112 | 120 | n/a | n/a |
| NC | n/a | n/a | n/a | n/a |
| ND | 122 | 99 | n/a | n/a |
| OH | 266 | 121 | n/a | n/a |
| OK | n/a | 629 | 313 | n/a |
| OR | 444 | n/a | 249 | n/a |
| PA | 154 | 182 | n/a | n/a |
| RI | 131 | n/a | n/a | n/a |
| SC | n/a | n/a | n/a | n/a |
| SD | 207 | Achieved | n/a | n/a |
| TN | n/a | n/a | n/a | n/a |
| TX | 1217 | 206 | n/a | n/a |
| UT | n/a | 450 | n/a | n/a |
| VT | 45 | 58 | n/a | n/a |
| VA | 319 | n/a | n/a | n/a |
| WA | 356 | Achieved | 200 | n/a |
| WV | 330 | n/a | n/a | n/a |
| WI | 144 | 85 | n/a | n/a |
| WY | 249 | n/a | n/a | n/a |
| **AVG** | **340** | **228** | **520** | **366** |

TABLE: Years until projected change (in map on left) exceeds one standard deviation (calculated using the 1896-2011 data) from the 1991-2011 average value (calculated using McRoberts and Nielsen-Gammon, 2011). Blue indicates projected increases, red indicates projected decreases. A "n/a" indicates that no consistent projection was made, "achieved" means that the projected change has already been exceeded (that is, the change from 1901-1960 to 1991-2011 was larger than the climate model projected change from 1901-1960 to 2070-2099). Highlighted values indicate two centuries or more.

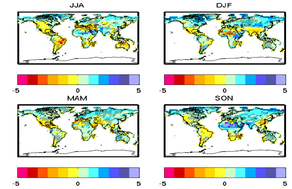
## U. S. PRECIPITATION

### Observations, 1951 - 2005




Percentage change in precipitation per decade for 1951-2005 for DJF, MAM, JJA and SON. Hatched grid-boxes show where the sign of the change is consistent across all observation datasets with data available for that grid-box. (Source: Polson, D., et al., 2013. Causes of Robust Seasonal Land Precipitation Changes. *Journal of Climate*, doi:10.1175/JCLI-D-12-00474.1, in press.)

### Models, 1951 - 2005




Percentage change in precipitation per decade for the ALL forced multi-model mean for 1951- 2005 for DJF, MAM, JJA and SON. Hatched grid-boxes show where the sign of the change is consistent across all four observation datasets and the multi-model mean. Note the smaller scale of change patterns as multi-model mean changes show a much reduced influence of internal climate variability. (Source: Polson et al., 2013)

## CONCLUSIONS

It is impossible to present reliable future projections from a collection of climate models which generally cannot simulate observed change. As a consequence, we recommend that unless/until the collection of climate models can be demonstrated to accurately capture observed characteristics of known climate changes, policymakers should avoid basing any decisions upon projections made from them. Further, those policies which have already be established using projections from these climate models should be revisited.

Assessments which suffer from the inclusion of unreliable climate model projections include those produced by the Intergovernmental Panel on Climate Change and the U.S. Global Climate Change Research Program (including the draft of their most recent National Climate Assessment). Policies which are based upon such assessments include those established by the U.S. Environmental Protection Agency pertaining to the regulation of greenhouse gas emissions under the Clean Air Act.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