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Is the global mean temperature trend too low?

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The global mean temperature trend may be biased due to similar technological and economical developments world wide. As far as we know there are no estimates for the remaining uncertainty in the global mean trend after homogenization. In this study we want to present a considerable number of recent results that suggest that the global mean temperature trend might be somewhat steeper as generally thought.

In the Global Historical Climate Network version 3 (GHCNv3) the global land surface temperature is estimated to have increased by about 0.8°C between 1880 and 2012. In the raw temperature record, the increase is 0.6°C; the 0.2°C difference is due to homogenization adjustments. Given that homogenization can only reduce biases, this 0.2°C stems from a partial correction of bias errors and it seems likely that the real non-climatic trend bias will be larger. Especially in regions with sparser networks, homogenization will not be able to improve the trend much. Thus if the trend bias in these regions is similar to the bias for more dense networks (industrialized countries), one would expect the real bias to be larger.

Regional datasets can be better homogenized as global ones, the main reason being that global datasets do not contain all stations known to the weather services. Furthermore, global datasets use automatic homogenization methods and have less or no metadata. Thus while regional data can be biased themself, comparing them with global datasets can provide some indication on biases. For example, the mean annual temperature increase since 1890 in the Alps is 1.1 K, which is twice as much as the 0.55 K in the respective grid boxes of the global dataset of the Climatic Research Unit (CRU).

Papers by McKitrick and Michaels suggest that the temperature trend in prosperous regions is stronger. (However, they did not take spatial dependencies into account. Thus while the relationship exists, it is not statistically significant.) They attribute the relationship to increases in urbanization. It could also be that these datasets have a stronger trend because they are better homogenized, especially due to higher station densities in wealthy countries.

The most direct way to study biases in the temperature records is by making parallel measurements with historical measurement set-ups. Several recent parallel data studies suggest larger biases. Furthermore, the influence of many historical transitions, especially the ones that could cause an artificial smaller trend, have not been studied in detail yet. We urgently need to study improvements of exposure (especially in the (sub-)tropics), relocations to airports, and relocations to suburbs of stations that started in the cities, for example.

If the temperature trend were actually larger it would reduce discrepancies between studies for a number of problems in climatology. For example, the estimates of transient climate sensitivity using instrumental data are lower as the one using climate models, volcanic eruptions or paleo data. Physical models of ice sheets, using instrumental temperature data, predict less sea level rise as semi-empirical models. Climate models assume quite high increases in aerosol loading since pre-industrial times. If the temperature increase were larger, lower aerosols concentrations could be used, which some see as more realistic.

Concluding, at the moment there is no strong evidence yet that the temperature trend is underestimated. However, we do have a considerable amount of circumstantial evidence that suggests that there is a small, but climatologically important bias that we should study with urgency.