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## Identifying exposure biases in early instrumental data

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Long observational records of land surface air temperature are vital to our understanding of climate variability and change, as well as for testing predictions of climatic trends. However, of the relatively few long observational records which exist, many contain inhomogeneities or biases resulting from changing instrumentation, station location/surroundings and/or observing practises. One of the most significant issues is the exposure bias. Prior to the widespread adoption of louvered Stevenson-type screens in the late-19<sup>th</sup> century, various (often insufficient) approaches were used to shield thermometers. Each approach exposed the thermometer to differing levels of solar radiation, thus introducing inhomogeneities into individual station records and biases across regions, if similar approaches were used. Poorly shielded thermometers, for example, tended to read higher during the summer half year than those in Stevenson-type screens. Despite a number of studies documenting the presence of the exposure bias in early instrumental data, relatively few corrections have been applied or incorporated into global temperature datasets. This is largely due to the pervasive nature of the bias and a lack of observational metadata impeding bias identification or estimation of the appropriate correction.

In this work we explore a range of datasets to identify the potential for exposure bias in early instrumental data. We analyse historical data, corrections applied to homogenized datasets, as well as the small number of parallel measurements from differentially-shielded thermometers, in order to better define the characteristics of the exposure bias. These characteristics are then used to identify potential instances of exposure bias in early instrumental temperature records. We consider differences in seasonal anomalies, which is a key feature of many exposure biases, as well as their geographical variation (focussing mostly, but not solely, on Europe). We analyse how these behave at stations where it is known that exposure bias has already been adjusted for (though perhaps not completely) versus those that have not been. We also make comparisons with proxy reconstructions of temperature as an independent reference that is not susceptible to the same biases as the early instrumental data.

This work forms part of the NERC-funded GloSAT project which is developing a global surface air temperature dataset starting in 1781. The ultimate aim of the work reported here is to refine the error associated with these biases, in order to improve the representation of the exposure bias in error models used for gridded instrumental temperature datasets.