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Improving the estimation of historical marine surface temperature changes

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Global Surface Temperature (GST) is one of the main indicators of climate change and Sea Surface Temperature (SST) forms its marine component. Historical SST observations extend back more than 150 years and are used for monitoring climate change and variability over the oceans, for validation of climate models and to provide boundary conditions for atmospheric models.

SST observations from ships form our longest instrumental record of surface marine temperature change, but over the years different methods of measuring SST have been used, each of which potentially has different biases. Changes in technology and observational practice can be rapid and undocumented: generally, it is assumed that almost all SST data collected before the 1940s were derived from bucket samples although the measurement practice is almost never known in detail. Especially prior to the 1940s where buckets measurements prevailed, SST biases are expected to be large, namely comparable to the climatic increase in the GST over the past two centuries.

Currently, SST datasets use bias models representing only large-scale effects, based on 5° area average monthly climatological environmental conditions or on large-scale variations in air-sea temperature difference, which is also uncertain. There are major differences between the bias adjustment fields used to date, which limits our confidence in global and regional estimates of historical SST as well as in long term trends, which are expected to be controlled by uncertainty in systematic biases.

The main barrier to finer-scale adjustments of SST is that information about measurement methods and ambient environmental conditions is usually insufficient. As a result, many reports cannot be confidently assigned to a particular vessel and hence, cautiously, to the same measurement methodology. Here we present a new approach to the quantification of SST biases that can be applied on a ship-by-ship basis. These ship dependent adjustments are expected to account for the instrumental and environmental conditions particular to each platform and to enable the detection of biases directly from the data, avoiding untested a priori assumptions. In this context, laboratory experiments to study the temperature evolution of water samples in SST buckets have also been designed and the results compared to existing models. Future work will be directed towards the application of this approach into the whole observational record and to the review of the resulting SST analysis.