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Improving the global SST record: estimates of biases from engine room intake SST using high quality satellite data

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Sea Surface Temperature (SST) is the marine component of the global surface temperature record, a primary metric of climate change. SST observations from ships form one of the longest instrumental records of surface marine climate. However, over the years several different methods of measuring SST have been used, each with different bias characteristics. The estimation of systematic biases in the SST record is critical for climatic decadal predictions, and uncertainties in long-term trends are expected to be dominated by uncertainties in biases introduced by changes of instrumentation and measurement practices.

Although the largest systematic errors in SST observations relate to the period before about 1940, where SST measurements were mostly made using buckets, there are also issues with modern data, in particular when the SST reported is the temperature of the engine-room cooling water intake (ERI). Physical models for biases in ERI SSTs have not been developed as the details of the individual setup on each ship are extremely important, and almost always unknown.

Existing studies estimate that the typical ERI biases are around 0.2˚C and most estimates of the mean bias fall between 0.1˚C and 0.3˚C, but there is some evidence of much larger differences. However, these analyses provide only broad estimates, being based only on subsamples of the data and ignoring ship-by-ship differences.

Here we take advantage of a new, high spatial resolution, gap-filled, daily SST for the period 1992-2010 from the European Space Agency Climate Change Initiative (ESA CCI) for SST dataset version 1.1. In this study, we use a Bayesian statistical model to characterise the uncertainty in reports of ERI SST for individual ships using the ESA CCI SST as a reference. A Bayesian spatial analysis is used to model the differences of the observed SST from the ESA CCI SST for each ship as a constant offset plus a function of the climatological SST. This was found to be an important term for some ships. By explicitly modelling the correlation present in the data, this method allows us to better estimate the seasonal mean bias and the related uncertainty for each ship, down weighting observations taken at the same site as well as whole regions which where found artificially warm or cold relative to other areas sampled by the ship.

Future work will extend this method to ship measurements made with buckets, allowing in the ESA CCI period a full characterisation of the SST ship biases and their uncertainty and leading to a better estimate of the SST trend. We will also use the results from this well-characterised period to understand how to extend the analysis back in time to periods where such high quality reference SST is not available.