Testing the HadISST2 Analysis in an Ideal World

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INTRODUCTION

The Met Office Hadley Centre sea ice and SST analysis version 1, HadISST1 (Rayner et al, 2003), is a globally-complete monthly analysis of SST and sea ice concentration since 1870 with near-real time updates and has been widely used in various climate applications, including ERA40. The next generation of the data set, HadISST2, is currently being developed. This will incorporate many new observations of SST and sea ice and will extend back to 1850. We are developing an analysis system which is intended to be flexible enough to produce HadISST2 on different spatial and temporal resolutions, to suit different applications. As was done for HadISST1, we will use a reduced space approach for the analysis, using Empirical Orthogonal Functions (EOFS) of anomalies to reconstruct the complete fields. HadISST2 will also include comprehensive estimates of uncertainty.

IDEAL WORLD TEST FRAMEWORK

We are able to test our reconstructions and estimates of uncertainty in an "ideal world" framework (cf the pseudo proxy approach of von Storch et al. 2004) using simulations from the HadGEM1 coupled climate model (Johns et al, 2006). We withhold data according to historical patterns of observations and add noise to mimic observational uncertainties. We then use Reduced Space Optimal Interpolation (RSOI) to produce reconstructions of the complete fields and compare these to the original, perfect model fields. By progressively making our tests more realistic (and deviating from the theoretical assumptions), we will be able to isolate the impact of each change on the verisimilitude of our reconstruction.

RSOI CAN HANDLE CORRELATED ERRORS

One common simplifying assumption of optimal interpolation procedures and SST analyses in general (e.g. Kaplan et al. 1997, Smith and Reynolds 2004, Rayner et al. 2003, Rayner et al. 2006) is that observational uncertainties are uncorrelated between data points. However, many observational uncertainties are correlated. Here we test the effect on the analysis errors of (i) making this assumption where it is not justified and (ii) adapting the system to allow correlated observational errors. We use simple, unrealistic error structures here to illustrate the effects, so the size of the uncertainty in tropical average SST given in the figures is not representative of reality. Figure 1 illustrates the veracity of the analysis uncertainty when input errors are uncorrelated by comparison of the reconstruction with the original model data. Figure 2 shows that the analysis uncertainty is an underestimate of the true uncertainty when the observational errors are assumed to be uncorrelated, but are actually correlated. Figure 3 illustrates that the analysis uncertainty is correctly estimated when the correlation in the observational errors is acknowledged. Note that when the errors are correlated, the actual uncertainties are greater.

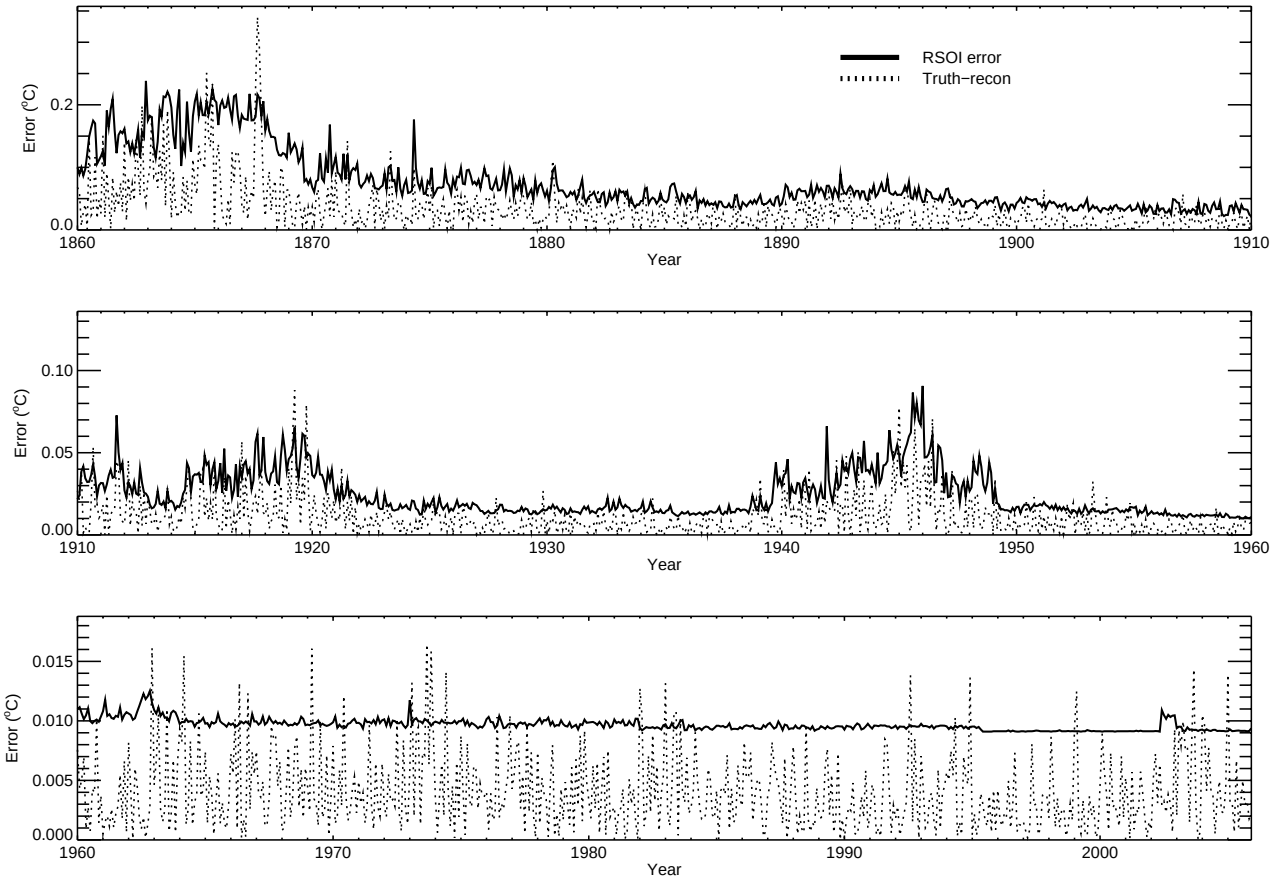

Figure 1 Errors in reconstructed tropical (30˚S-30˚N) SST if grid box uncertainties are uncorrelated. The solid line shows the estimated 2-sigma uncertainty on the reconstruction. The dashed line shows the difference between the reconstruction and the original model data.

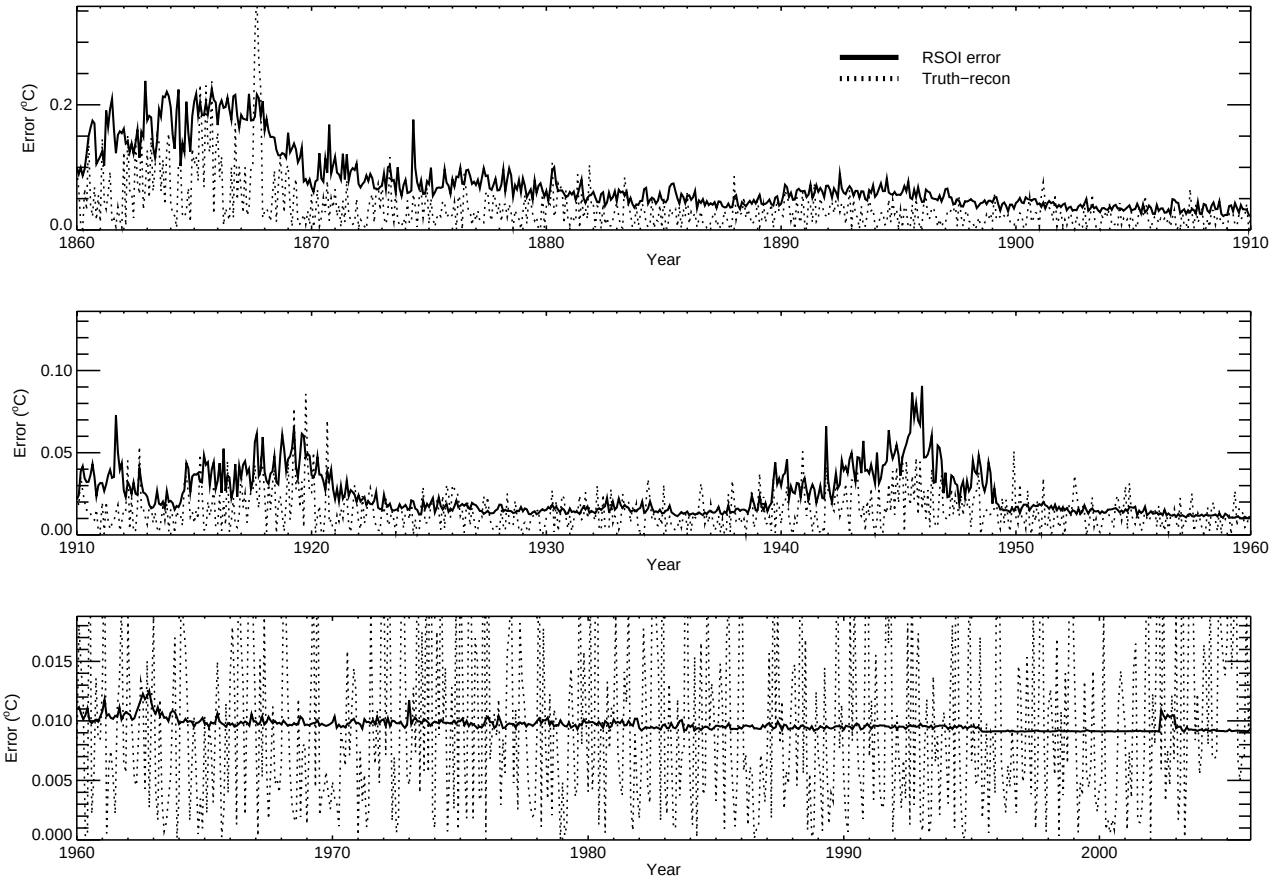

Figure 2 Errors in reconstructed tropical (30˚S-30˚N) SST if grid box uncertainties are correlated, but assumed uncorrelated. The solid line shows the estimated 2-sigma uncertainty on the reconstruction. The dashed line shows the difference between the reconstruction and the original model data.

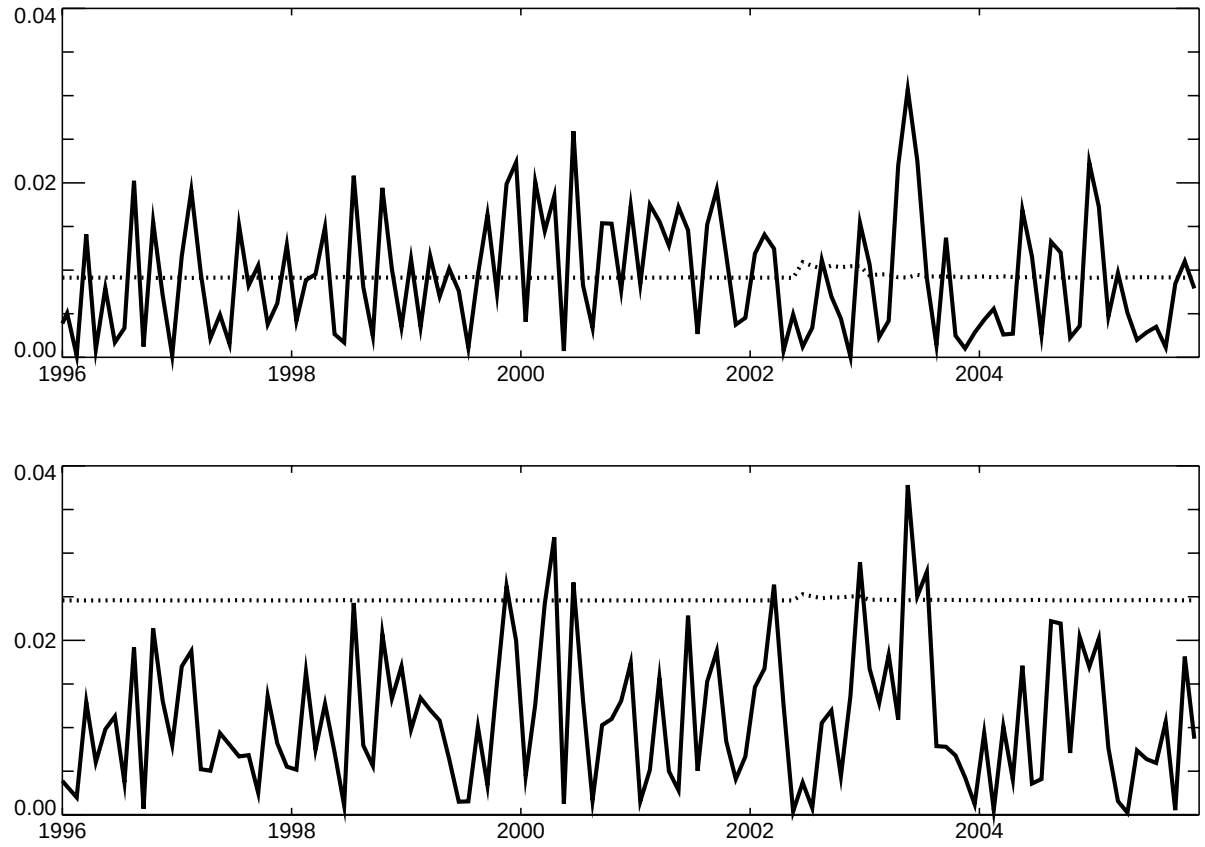

Figure 3 Errors in reconstructed tropical (30˚S-30˚N) SST if grid box uncertainties are correlated and assumed to be uncorrelated (top) and correlated (bottom). The solid lines are the difference between the reconstruction and the truth. The dotted lines are the uncertainty estimates.

BIASES HAVE NO EFFECT

The observational SST data base comprises data taken from many different platforms e.g. ships, drifting buoys and radiometers mounted on satellites. Each of these platforms produces data which is different in some way from that of another, causing relative biases. The relative dominance of each of these platforms changes with time, sometimes slowly and sometimes suddenly, resulting in slowly- or suddenly-varying biases. Some of the biases are currently corrected for (Folland and Parker 1995, Rayner et al. 2006) and we are in the process of developing corrections for others. New or previously undetected biases are likely to arise in the future. We tested the effect of uncorrected biases on our reconstruction by creating a set of partially biased test data (mimicking biases in bucket-collected SST) using this to generate EOFs, and producing a reconstruction with these EOFs, but applied to unbiased "observational" data. We found no effect on the reconstruction that we could attribute to the biased EOFs, giving us confidence that periods containing uncorrected or undetected biases are not likely to adversely affect periods without such biases.

RSOI CAN HANDLE UNDER-SAMPLED REGIONS

The Southern Ocean is very sparsely sampled and provides a tough test of the RSOI method (Figure 4). Here, EOFs were generated from full, perfect data, so the test is not fully realistic. However, it does demonstrate that data in other oceans can be used to reconstruct data voids, when we know the large-scale covariances.

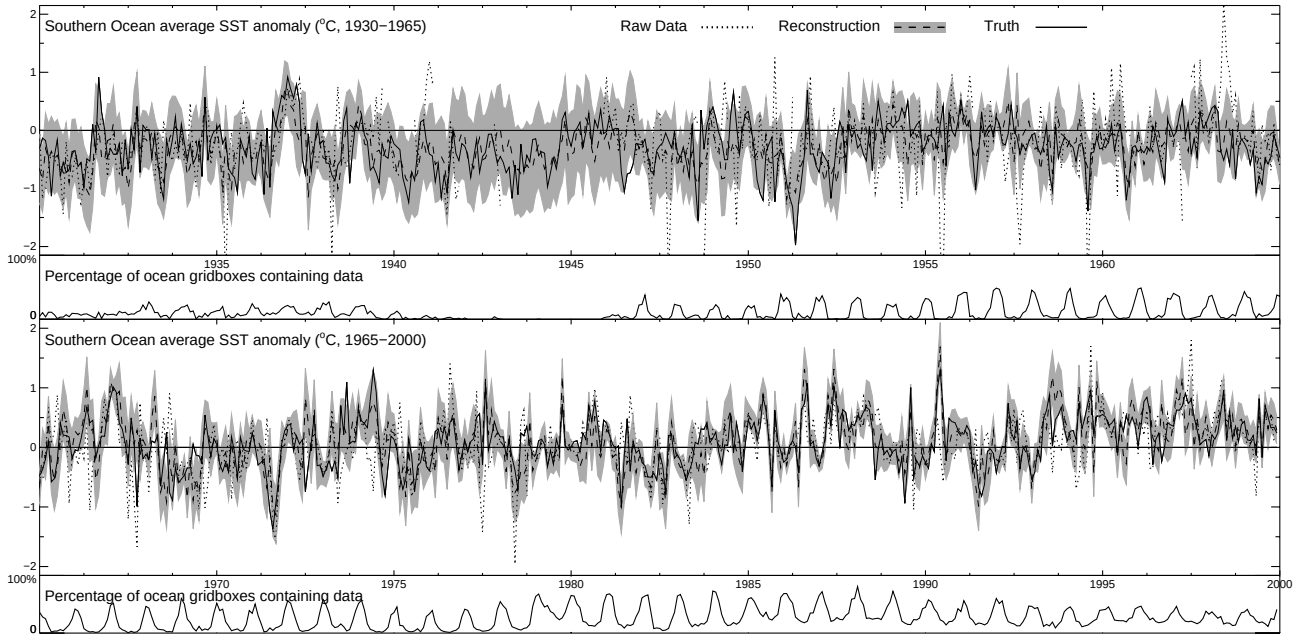

Figure 4 Comparison between monthly Southern Ocean average SST anomaly from reconstruction, sub-sampled data and full data set. Also shown is the percentage of ocean grid boxes containing data in each month.

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