ESA Climate Change Initiative Phase-II Sea Surface Temperature

www.esa-sst-cci.org

Exploiting passive microwave observations of sea surface temperature within the climate record (SST CCI)

Kevin Pearson and Chris Merchant (presenting)

Key points:

Passive microwave radiometer (AMSR2) used to derive SST, ultimate objective being to blend with infra-red based climate data record.

Using optimal estimation, but need to account for very significant calibration and forward model biases, so “bias aware” optimal estimation framework has been developed.

Bias-aware OE copes with systematic effect in radiance, wind speed and time, yielding retrieval accuracy with mean bias 0.14 K and median absolute deviation 0.29 K.

1. Background

Compared to infra-red measurements, passive microwave (PMW) observations of SST have poorer radiometric accuracy and spatial resolution, but a strong advantage of being able to make measurements through cloud, enabling greater coverage of SST and access to persistently cloudy regions. We have been investigating the use of PMW data as part of the ESA Climate Change Initiative Phase II for Sea Surface Temperature using AMSR2 data.

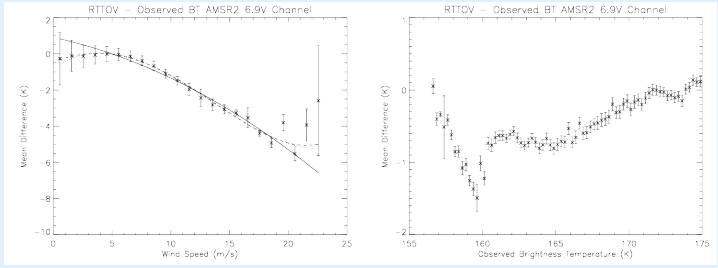
Optimal estimation (OE) enables the ‘best’ use to be made of information contained in a set of measurements when retrieving geophysical variables.

OE is susceptible, however, to systematic errors in the retrieval due to biases that are unaccounted for in the forward model. These might be, for example, poor calibration in the observations or a misrepresentation of physical processes in the radiative transfer calculation.

A “bias-aware” formulation of OE has been developed that makes use of a Kalman-filter approach to determine these systematic effects alongside the retrieval of the geophysical variables.

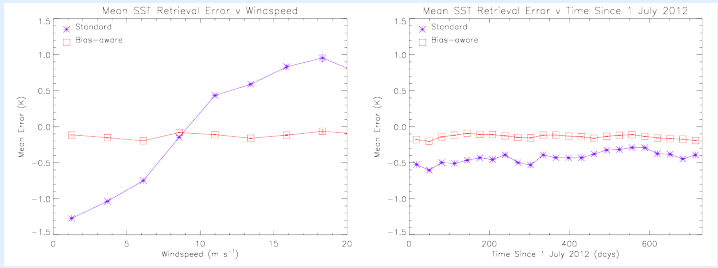
2. Application to AMSR2 Retrievals

Applying the standard OE method to AMSR2 data matched to the time and location of *in situ* buoy measurements of SST showed such systematic effects. The figure below shows the difference between observed and simulated brightness temperatures in the 6.9V channel plotted against the observed brightness temperature and the wind speed for a sample of approximately 10^6 matches.

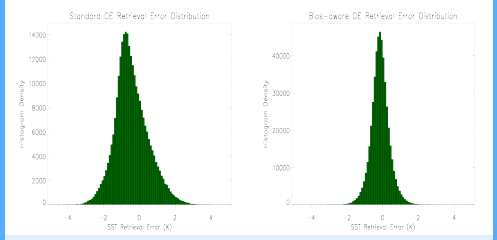


Difference between simulated and observed brightness temperatures as a function of wind speed (left) and observed brightness temperature (right). N=2,3 and 4 polynomial fits are shown for the wind-speed effect. The simulations used RTTOV 11.3 with FASTEM 6 emissivity module.

The figures below show the results of standard and bias-aware OE applied to the matched AMSR2-*in situ* dataset. The bias-aware scheme was formulated to allow for an arbitrary brightness-temperature-dependent effect, a quartic wind-speed dependence and a linear time trend. It shows a large reduction in the SST retrieval bias.



Mean SST retrieval error plotted vs wind speed and time for both standard OE (adversely affected by biases, blue) and for bias-aware OE methods (parameters compensating for bias are retrieved along with geophysical variables, red).



3. Error Histograms

SST retrieval error distributions for the standard OE scheme (left) and bias-aware scheme (right).

The overall effect of the bias-aware scheme is to reduce both the bias and spread in the retrieval error. The above figures show the error distribution for the two retrieval schemes. The bias-aware scheme resulted in a mean bias of 0.14K and median absolute deviation of 0.29K. The residual bias reflects a systematic difference between the *a priori* SST values taken from an NWP source and the *in situ* values. The median absolute deviation is comparable to those of other widely-used AMSR2-derived SSTs.

4. Conclusions and next steps

- Bias-aware OE method enables the systematic estimation of retrieval biases within the retrieval framework.
- PMW SST validation results obtained have a standard deviation that is useful in the context of the SST climate data record (CDR), and global bias approaching the <0.1 K level required for use with IR data in CDR.
- Will need to account for the geophysical difference between skin and sub-skin SST when using PMW and IR data together.
- Once achieved, use of PMW in the SST CDR will benefit the analysis of SST fields in persistently cloudy areas significantly, including high latitudes.