An Accuracy Assessment of AATSR LST Data using Empirical and Theoretical Methods

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ABSTRACT

The Advanced Along-Track Scanning Radiometer (AATSR), onboard ESA's Envisat Satellite, is a precision radiometer that provides data from which global observations of land surface temperature (LST) can be derived. These LST data are retrieved using a nadir-only split window algorithm, with a target accuracy of 2.5 K during the day and 1.0 K at night. The algorithm will also be applied operationally to data recorded by the AATSR's predecessors, ATSR-1 (ERS-1) and ATSR-2 (ERS-2), leading to a > 15-year record of global LST data.

We present the results of comparisons between operational AATSR LST retrievals and collocated in situ LST data that have been recorded continuously over two test sites. The exercise provides an excellent opportunity to assess the long-term accuracy of the satellite LST data. The accuracy of the product is also assessed through radiative transfer simulations of bias over a number of test sites. Both the empirical and theoretical results demonstrate that, although the AATSR LSTs are achieving good accuracies on most occasions, the retrievals are seasonally biased. We attribute the seasonal bias to the algorithm's sensitivity to the atmosphere and surface conditions.

1) EMPIRICAL RESULTS

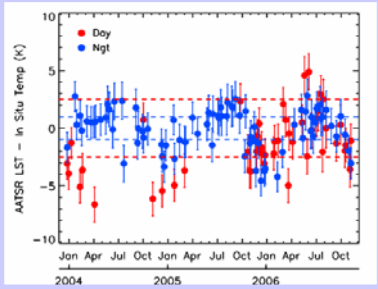

Figure 1: Comparison between cloud-free AATSR and in situ LSTs at the ARM-Oklahoma site (-097.500, 36.600)

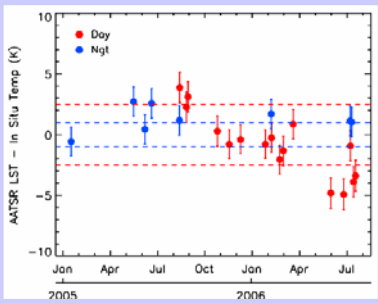

Figure 2: Comparison between cloud-free AATSR and in situ LSTs at the Cardington site (-000.425, 52.100)

Figures 1 and 2 show the variation in apparent cloud-free AATSR LST bias (AATSR minus in situ LST) with time for two test sites. In both cases, the in situ data have been derived from at-surface radiometric observations made in the infrared. These data have been corrected for emissivity effects to estimate the kinetic LST at the site.

In general, the AATSR LSTs are warmer than the in situ data in the summer and colder in the winter. This is particularly apparent for the night time Oklahoma data (Figure 1, blue data points).

Correlation of the (AATSR minus in situ) LST bias with in situ LST and water vapour observations suggests that the AATSR LST bias becomes increasingly warm at warmer LSTs and higher water vapour loading (Figures 3a and b).

Site	N Data		Bias ± StDev (K)	
	Day	Ngt	Day	Night
Oklahoma	47	81	-1.4 ± 2.6	-0.1 ± 1.8
Cardington	16	8	-0.8 ± 2.6	1.3 ± 1.1

Table 1: Statistics for AATSR minus in situ LST comparison.

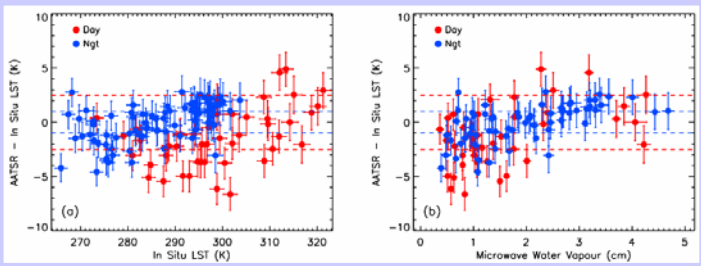

Figure 3: Variation in AATSR minus in situ LST bias at the Oklahoma test site vs (a) in situ LST and (b) in situ total column water vapour derived from in situ microwave observations.

2) MODEL RESULTS

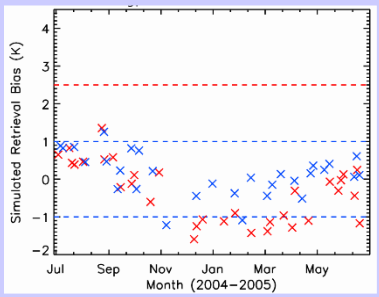

Figure 4: Simulated AATSR LST bias over ARM-Oklahoma site (-097.500, 36.600)

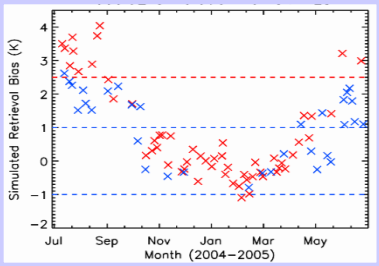

Figure 5: Simulated AATSR LST bias over test site at 047.500, 55.000.

Figures 4 and 5 show examples of the simulated AATSR LST bias over two test sites. The data points correspond to real cloud-free AATSR overpasses over one year.

The bias has been simulated using a radiative transfer model (Oxford Reference Forward Model) and the operational AATSR LST algorithm. The atmospheric and surface conditions used in the model were derived from European Centre for Medium Range Weather Forecasts (ECMWF) data.

These results are typical of nearly all the 13 locations tested in this study. The results are quite consistent with the in situ comparison results, where the AATSR retrievals are warm during the summer and cold in winter.

The magnitude of the bias varies strongly with geographical location and the LST retrieval coefficients (which depend on land surface type and vegetation fraction).

Figure 6 shows the tropospheric profiles for the 2005 matchups for the Oklahoma test site, which demonstrates that the AATSR LST bias is higher for high water vapour loading and atmospheric temperature.

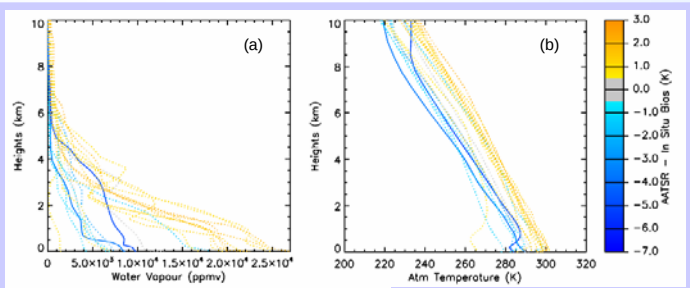

Figure 6: ECMWF atmospheric profiles for Jan – August 2005 matchups shown in Figure 1 (Oklahoma test site), for (a) water vapour and (b) atmospheric temperature.

3) CONCLUSIONS

- In general, AATSR LSTs show reasonable agreement with collocated in situ LSTs. The agreement is significantly better at night, which can probably be attributed to higher LST anisotropy during the day (in situ LSTs are less representative over the area of the satellite pixel).
- The apparent accuracy is within or close to the target accuracy of the AATSR LST retrieval scheme.
- A seasonal bias in the AATSR LSTs is evident in both the simulation and in situ comparison results, where AATSR is warmer in the summer and colder in the winter.
- We attribute this seasonal bias to the algorithm's sensitivity to atmospheric variability (water vapour, temperature) and possibly LST.

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