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AN ALGORITHM FOR THE ESTIMATION OF BOUNDS ON THE EMISSIVITY AND TEMPERATURES FROM THERMAL MULTISPECTRAL AIRBORNE REMOTELY SENSED DATA

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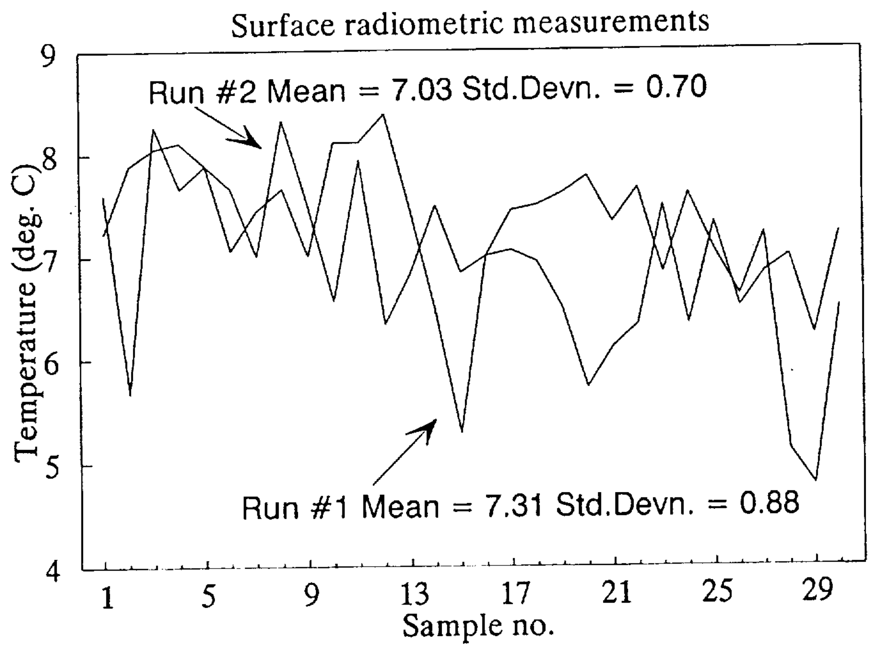
The effective flux incident upon the detectors of a thermal sensor, after it has been corrected for atmospheric effects, is a function of a non-linear combination of the emissivity of the target for that channel and the temperature of the target. The sensor system cannot separate the contribution from the emissivity and the temperature that constitute the flux value.

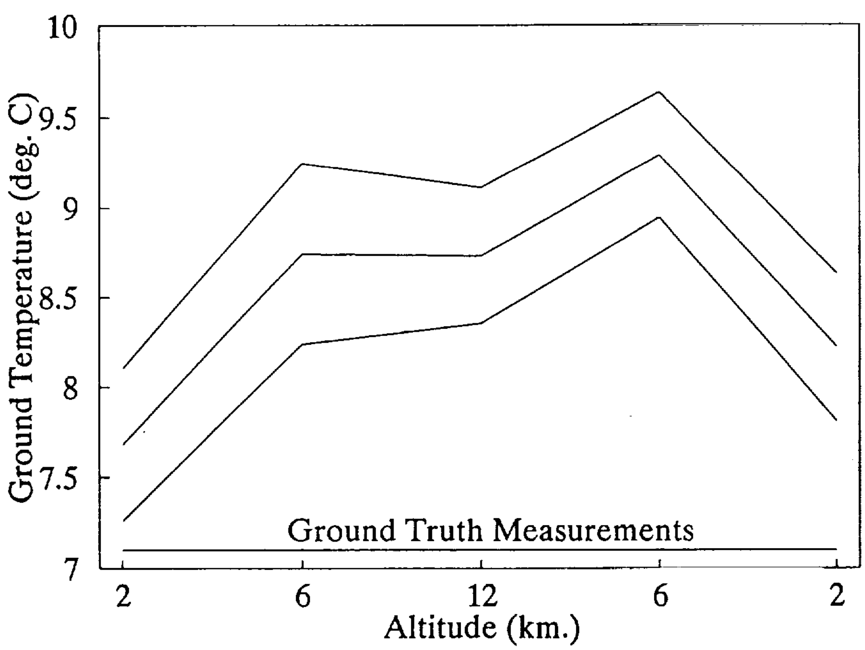
In this paper, we describe a method that estimates the bounds on these temperatures and emissivities from thermal data. This method is then tested with remotely sensed data obtained from NASA's Thermal Infrared Multispectral Scanner (TIMS) - a 6 channel thermal sensor. Since this is an under-determined set of equations i.e there are 7 unknowns (6 emissivities and 1 temperature) and 6 equations (corresponding to the 6 channel fluxes), there exist theoretically an infinite combination of values of emissivities and temperature that can satisfy these equations. Using some realistic bounds on the emissivities , bounds on the temperature are calculated. These bounds on the temperature are refined to estimate a tighter bound on the emissivity of the source. An error analysis is also carried out to quantitatively determine the extent of uncertainty introduced in the estimate of these parameters. This method is useful only when a realistic set of bounds can be obtained for the emissivities of the data. In the case of water the lower and upper bounds were set at 0.97 and 1.00 respectively.

Five flights were flown in succession at altitudes of 2 km (low), 6 km (mid), 12 km (high), and then back again at 6 km and 2 km. The area selected was the Ross Barnett reservoir near Jackson, Mississippi. The mission was flown during the predawn hours of Feb. 1, 1992. Radiosonde data was collected for that duration to profile the characteristics of the atmosphere. Ground truth temperatures using thermometers and radiometers were also obtained over an area of the reservoir. The results of two independent runs of the radiometer data averaged 7.03±.70 for the first run and 7.31±.88 for the second run.

The results of the algorithm yield a temperature of 7.68 for the low altitude data to 8.73 for the high altitude data.



Distribution of reservoir surface temperature 5AM 2/1/92



Variation of Ground Temperature with altitude.

Average of brightness temperature in all channels.

Flt.Ln.	Mean	Sigma	Mean-sigma	Mean+Sigma
1	6.51	0.306	6.204	6.816
2	7.45	0.278	7.172	7.728
3	7.86	0.234	7.626	8.094
4	8.38	0.282	8.098	8.662
5	7.39	0.321	7.069	7.711

Groung temperature using the bounds algorithm.

Flt. Ln.	Mean	Sigma	Mean-sigma	Mean+Sigma
1	7.68	0.422	7.258	8.102
2	8.74	0.504	8.236	9.244
3	8.73	0.380	8.350	9.110
4	9.29	0.348	8.942	9.638
5	8.22	0.410	7.811	8.630