August 21, 1995

To: Bruce Guenther
Harry Montgomery

From: Daniel Knowles Jr.

Subject: MODIS 1995 ATBD Thermal Calibration "Hybrid" Approach (Traditional vs Universal Curve)

The "universal curve" IR calibration approach (aka master curve) was cleverly devised (but not so cleverly named) by Tom Pagano to calibrate an instrument where little pre-launch data is available. This "universal curve" approach was so named because it takes into account the total focal plane voltage. There is no assumption that this curve remains invariant except for its associated nonlinear term. Since the linear term and offset are adjusted every scan, "universal curve" is a somewhat poor choice of words for this approach and riles up all sorts unwarranted grimaces.

The key difference between the "universal curve" approach and the traditional approach is how the nonlinearity is defined and tracked on orbit.

For the case of the "universal curve" approach: the total focal plane voltage is related to detector incident power whereby the nonlinear term is theoretically independent of the optical background. Optical background is accounted for from the total focal plane voltage of the space view signal.

For the case of the traditional approach: the at-aperture irradiance is related to the difference between the OBC blackbody signal and the space view signal whereby the nonlinear term is dependent on the optical background. Optical background is accounted for from the optics thermistors and the appropriate value of the nonlinear term is then used.

With some modifications pertaining to the scan mirror angular variations, noise reduction techniques, and definition of detector background power, I have revamped Tom's "universal curve" approach to better account for on-orbit changes.

Since SBRC has failed to prove the "universal curve" approach due to lack of useful data from the thermal vacuum tests, GSFC deems it desirable to increase the pre-launch data set so that the traditional approach can be used.

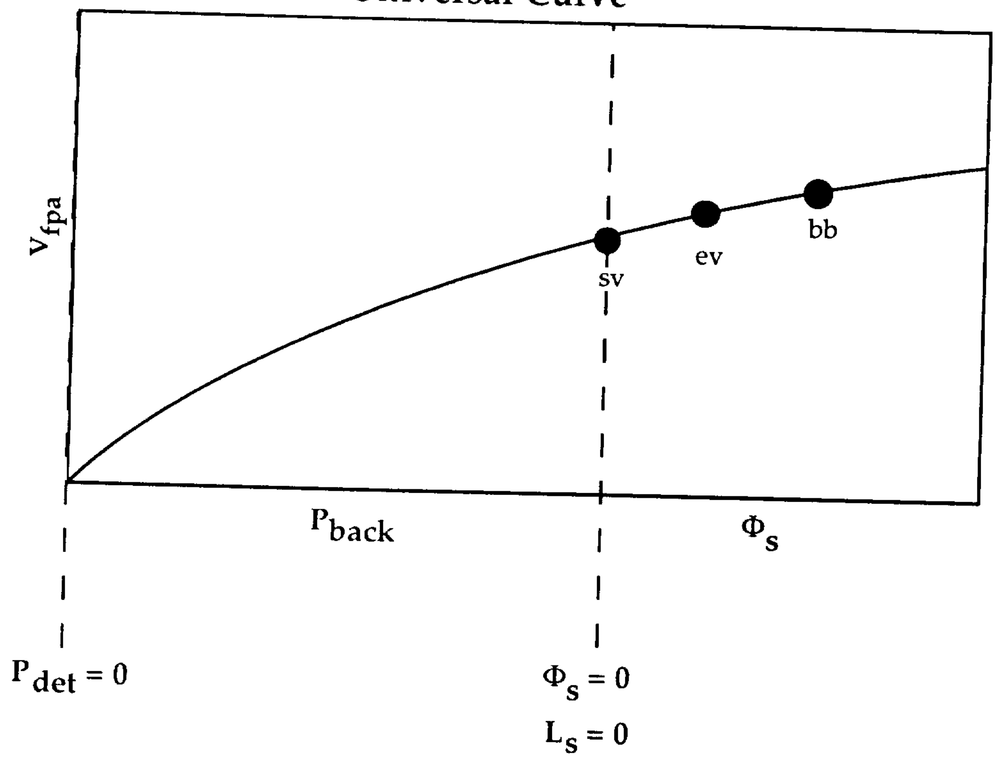
With this increase in pre-launch data at multiple instrument temperatures, a hybrid approach becomes possible. This approach, which is the current approach, is primarily based on the revamped "universal curve", but with the nonlinear term determined as a function of optics temperatures. The key advantage to this hybrid over the two aforementioned approaches is that it utilizes both the space view voltage and the optics temperatures to account for the optical background.

Attached are two representative drawings of the calibration curves pertinent to this memo. It can be noted that the coordinate system is the primary difference between the two methods. The traditional approach locks its origin on the space view. Now look at the universal curve and think of a coordinate system centered at the sv point. As the optical background cools this superimposed coordinate system will shift to the left (down the curve); as the optical background becomes warmer, this superimposed system will shift to the right. This movement of the coordinate system causes the dependence of the traditional nonlinear term on optical background. P_{back} on the universal curve is the extrapolated optical background power term which is solved for every scan. The universal coordinate system is assumed not to move and therefore has a fixed nonlinear term. On the other hand, the hybrid coordinate system is essentially identical to the universal curve coordinate system except that the nonlinear term is allowed to vary with optical thermistor measurements. Pback of the hybrid approach will be different from Pback of the universal approach because the nonlinear term is allowed to vary for the hybrid approach. The nonlinear term is fixed for the universal approach.

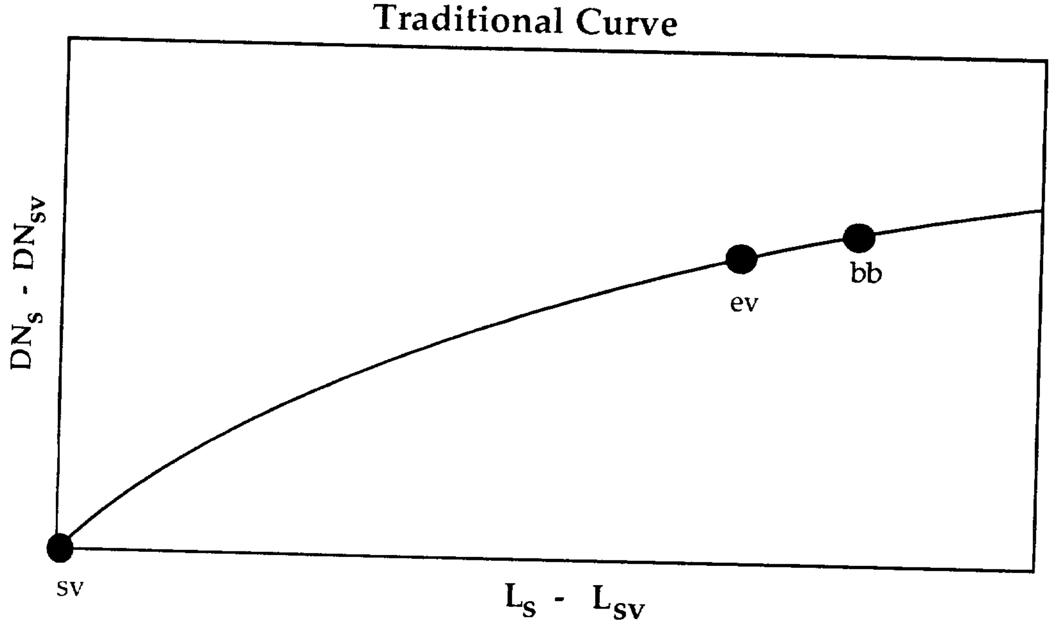
Attached is also an instrument test grid with my suggested check marks. Ideally we would want a four by four grid or better, but we may get less than a three by three which force a game of tic tac toe. The traditional nonlinear term is measured for each check mark. The "universal curve" nonlinear term is measured for every patch temperature but is considered invariant for every instrument (optics) temperature. The hybrid nonlinear term is measured for each check mark. The suggested check marks include all nominal values plus an additional cold value for maximum nonlinearity measurements.

Although the science and analysis required for both the hybrid and the traditional approaches is extensive, the code in the final Level 1B software is relatively short and similar for the two approaches. Since the input parameters of the traditional approach is a subset of the input parameters of the hybrid approach and the actual change in the code would be somewhat trivial to convert to the traditional approach, I suggest that we code the current hybrid approach, which has already been reviewed by Geir Kvaran and Marghi Hopkins. With the current maturity of the science, analysis, and code of the hybrid approach, I feel that we should use this approach for the upcoming version of the ATBD.

Universal Curve



Traditional Curve



Test Conditions for Determining Nonlinear Coefficient

Instrument Temperature

Patch Temperature		Low	Nom	Hi
	Low	✓	✓	
	Nom	✓	✓	✓
	Hi		✓	

Traditional vs Universal algorithm argument is based on this incomplete 3 X 3 grid

Historically a 4 X 4 grid has been used (AVHRR)

** Check marks denote possible higher priority tests