APPENDIX K: CONVERSION OF BLACKBODY TEMPERATURES TO AVHRR RADIANCES

The radiance N sensed in a particular channel from a blackbody at temperature T is the weighted mean of the Planck function over the spectral response function of the channel:

$$N(T) = \frac{\int_{\upsilon_1}^{\upsilon_2} B(\upsilon,T)\Phi(\upsilon)d\upsilon}{\int_{\upsilon_1}^{\upsilon_2} \Phi(\upsilon)d\upsilon} \qquad \text{(K-1)}$$

where ν; is the wavenumber (cm^{-1}), Φ is the spectral response function, and ν_1 and ν_2 are its lower and upper limits, respectively. The Planck function B(ν,T) is given by,

$$B(\upsilon,T) = \frac{c_1\upsilon^3}{e^{(\frac{c_2\upsilon^3}{T})} - 1} \qquad \text{(K-2)}$$

constants c_1 and c_2 are $1.191042869 \times 10^{-5}$ mW/(m^2-sr-cm^{-4}) and 1.4387770 K-cm, respectively. (The use of these constants was recommended by the Committee on Data for Science and Technology (CODATA) of ICSU in 2010. However, NESDIS may still be using the constants that were formally adopted early in 2002 from the CODATA put forth in 1998.

For the AVHRR, Equation 2 is evaluated numerically by,

$$N(T) = \frac{\sum_{i=1}^{n} B(\upsilon,T)\Phi(\upsilon_i)\Delta\upsilon}{\sum_{i=1}^{n} \Phi(\upsilon_i)\Lambda\upsilon} \qquad \text{(K-3)}$$

For all NOAA satellites, NESDIS has used Equation 3 to generate look-up tables relating blackbody temperature to AVHRR radiance. For each thermal channel, there is one table which specifies the radiance at every tenth of a degree Kelvin for temperatures in the 180K to 340K range. These tables, containing 1701 (temperature, radiance) pairs for each channel, are the standards. For convenience and data compression purposes, NESDIS now provides users of NOAA-15 (and later satellites in that series) AVHRR thermal channel data with a much simpler equation that approximates the values in a look-up table very accurately. This is the two-step equation found in Section 7.1.2 of the main text for converting blackbody temperature to AVHRR radiance and vice-versa. The RMS difference between the approximate value from the Section 7.1.2 equation and the look-up table value is generally less than 0.01K, when expressed in units of equivalent blackbody temperature.