THE EFFECT OF EXTRATERRESTERIAL SOLAR MODEL AND SPECTRAL DIFFERENCES ON CROSS CALIBRATION

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Abstract: Remotely sensed data is being used to monitor global change, and many applications require multiple sensors to achieve a desired temporal sampling of radiance or top-of-atmosphere reflectance (ToA reflectance). Use of multiple sensors requires conversion from image digital numbers (DN) to physical units of at-sensor spectral radiance (W m^{-2} sr^{-1} um^{-1}) or ToA reflectance. Furthermore, a spectral band adjustment factor (SBAF) must be used in the process to account for differences in the spectral bandpasses of the two sensors. There are two steps to convert satellite DNs to ToA reflectance: first, conversion of DNs to radiance values using the bias and gain values which are specifically given by satellite provider. Secondly the radiance data is converted to ToA reflectance, this requires a spectral band specific exoatmospheric solar irradiance ($ESUN_\lambda$) value which is normally derived from a selected extraterrestrial solar model convolved with the relative spectral response (RSR) of each sensor and is normally provided by the satellite provider.

The two common extraterrestrial solar models used to derive satellite specific $ESUN_\lambda$ are World Radiation Center (WRC) from a series of solar measurements (Wherli, 1985) and Thuillier's model which was recommended by Committee on Earth Observation Satellites (CEOS). The paper will demonstrate the effect of these two extraterrestrial solar models as used to derive $ESUN_\lambda$ values, and the impacts of these different calculation methods. The paper will present the results of an inter-comparison of Landsat 5 TM with Thaichote based on ToA reflectance over the Libya 4 Pseudo Invariant Calibration Site using derived $ESUN_\lambda$ values based on the two extraterrestrial solar models.

Due to filter design and manufacturing differences, the RSR of individual bands can vary dramatically between sensors. The paper will evaluate the effect of these RSR differences between satellites as it relates to cross comparison, and the impact it has on cross calibration uncertainties. An SBAF will be derived to account for these differences. This SBAF will then be used to convert the imagery to a common spectral basis.

Initial study reveals that using different extraterrestrial solar models to derive $ESUN_\lambda$ values gives differences from 1.5-7% for the Blue, Green, and Red bands and up to 8% for NIR band. The impacts of different $ESUN_\lambda$ calculation methods can impact the ToA reflectance values of 0.5%-0.14% for the Blue, Green, and Red bands and up to 8% for NIR band.

Keyword : extraterrestrial solar models, cross calibration, $ESUN_\lambda$, ToA reflectance, PICS