"Evaluation of Automated Radiative Transfer Modelling in an Operational Environment on Poorly Calibrated Medium Resolution Satellite Imagery"

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Spectral accuracy of multispectral satellite imagery is crucial for many remote sensing applications. This is especially relevant when dealing with data sets covering large areas with multiple scenes or for multitemporal monitoring or change detection approaches. It further gains relevance for automated image analysis dependent on spectral consistency.

Landsat TM has provided a continuous stream of data over several decades at a moderate resolution suitable to extract land based information. Landsat 5 TM being in orbit for almost 25 years, far exceeding design expectations has degraded significantly in its spectral properties. Although new methods for the determination of calibration parameters have been published several years ago (Chander & Markham 2003), these have not been implemented in low end product generation systems used by ground receiving stations in the third world. Resulting imagery from such systems is thus unsuitable as input for standard atmospheric correction processing chains. This is particularly tragic as it is the poorer countries that can reap the highest benefit from TM imagery, and most data resides at local ground receiving stations and therefore can not be processed and ordered trough the USGS.

The authors investigate, to what extent sensor degradation can be described over time using pseudo invariant features (PIFs) extracted from already pre-processed imagery produced by a low end product generation system. Inferred gain and bias values are compared to those derived by (Chander & Markham 2003) who assessed time dependent sensor degradation using imagery processed with state of the art level 1 processing systems.

In the experimental design, PIFs are identified and variance of at-satellite reflectance quantified with a time series of well calibrated Landsat 7 ETM+ imagery (Huang et al. 2001). Variance reduction is investigated with an automatic rule based atmospheric correction method and manual correction method using Atcor 3 (Richter 2004) for both instances. Mean reflectance values per selected PIFs are converted to radiance values taking imaging conditions (solar incidence angle and earth sun distance) into account for each Landsat 5 TM scene available for the time series. Regressing Landsat 5 TM DN values against the PIF radiance values produces new gain and bias values. With the time series of these new gain and bias values a time dependant degradation factor ands its accuracy is calculated and can now be applied to any Landsat 5 TM image produced by inferior product generation systems. Results are compared to those of Moran et al. 2001.

The relevance of these new calibration parameters is finally proven by undertaking radiative transfer modelling using Atcor 3, correcting imagery with old and new calibration parameters manually and with an automated rule based procedure. With the current methodology it is proven that the correct calibration parameters need to be applied in order to do any kind of quantitative image analysis, comparing values of basic vegetation indices and a tasselled cap transformation (Huang et al. 2002).

Additionally, for the radiometric correction of recent multi-spectral imagery from a range of sensors, a correction method using simultaneous MODIS acquisitions is demonstrated adapted from Hu et al. 2001. The outcomes of this research is used to validate automated radiometric correction processing chains (comparable to those of Arino et al. 2004) at the Satellite Applications Centre of the CSIR in South Africa.

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