A SYSTEMATIC APPROACH FOR OPTIMIZING SPECTRAL AND SPATIAL MATCHING BETWEEN INDEPENDENT DATASETS. Y. H. Daydou[1], P. C. Pinet[1], S. Chevrel[1], S. Le Mouélic[2], [1] UMR5562 (GRGS, Observatoire de Midi-Pyrénées, Toulouse, France, Yves.Daydou@cnes.fr), [2] BRGM (Luminy, Marseille, France).

Introduction: In the field of Earth observation and planetary exploration, a number of spacecrafts have been equipped in the last years with various multispectral and/or hyperspectral optical instruments spanning the ultraviolet-visible-near-infrared spectral domain. In this context, a long-standing and recurrent problem in the field of planetary remote sensing lies in the combined use of independent datasets, with the frequent case of one dataset being taken as a reference. We propose a general methodology which provides both an optimized matching and also an associated estimate of its spatial and spectral stability and uncertainty. This algorithm can be applied indifferently to either 1) assess the quality of the photometric calibration already performed, establish its uniqueness and determine whether it is optimal or not; or 2) carry out the "calibration", at the level of quality of the reference dataset. Our method is presented here (see also [1]) with an example of calibration of a Clementine multiband mosaic of the Aristarchus plateau on the Moon, using Earth-based telescopic visible-infrared spectra as references.

Inputs: The process considers as inputs: 1) a multiband imaging dataset, reduced from instrumental corrections and 2) a reference spot spectroscopic dataset, photometrically homogeneous with the imaging dataset and for which we know the spots pointing and positioning accuracies and the a priori spot sizes.

Process: The process finds the acceptable set of solutions among all the possible spatial combinations of spot spectra (positions and sizes) to meet required threshold conditions between regressed multiband imaging data and reference spot spectra. If available, independent control spectra can be used to select the best solution among the previous acceptable solutions provided an acceptable level of photometric homogeneity with the reference dataset.

Outputs: Under the assumption of linearity, the procedure gives the optimized gains and offsets to be applied, on each band, to the images, to match the reference spot spectra and to obtain a multiband imaging data calibrated in absolute reflectance, with an evaluation of the performance of this calibration. It delivers at the same time the a posteriori set of optimized matching for the spot positioning and size of the reference spectra. If we consider the set of acceptable solutions, the dispersion of the gains and offsets and of the distribution in size and positioning for each spot is used as an indicator of the reliability of the proposed solution.

Application: A Clementine multiband UVVIS and near-infrared mosaic, instrumentally corrected, has been produced by [2] for the Aristarchus Plateau on the Moon[3]. We used 4 reference earth-based telescopic spectra from [4] to calibrate in absolute reflectance this 9 channel mosaic. Figure 1 represents the a priori spot positions and sizes for the 4 telescopic spectra on the Aristarchus mosaic, and their allowed exploration window (detailed in figure 2). After processing, we obtained an optimized solution of gains and offsets to be applied, with the corresponding a posteriori positions and sizes for the 4 reference spectra (figure 3). In terms of reflectance, for each channel, the root mean square residuals are better than 0.01 between the reference spectra from [4] and the optimized calibration found (figure 4).

Conclusion: The algorithm represents an improvement over existing procedures in standard spectra and image processing software. The algorithm is applied preferentially for optimizing gain and offset determinations or for photometric intercalibration purposes between independent datasets. More generally the photometric calibration of spaceborne instruments remains a delicate technical task of utmost importance in terms of scientific return, and benefits from indirect calibration approaches relying on systematic intercalibration tools. Today, the new methodologies implemented for the purpose of deriving the optical properties of planetary surface regoliths imply the use of very homogeneous and photometrically well-calibrated absolute reflectance datasets [5,6,7]. In the coming years, given the improvement of the spatial and spectral resolutions of the instruments to be flown on upcoming planetary missions (e.g. Mars-Express, Smart-1, Selene, Mars Explorer Rover 2003, Mars Reconnaissance Orbiter 2005, …), this kind of algorithm will be quite useful, particularly for systematic intercalibration purposes between independent instruments to be used in synergy, either in a real time operational viewpoint or in an integrated scientific perspective.

References: [1] Daydou Y.H. et al. (2003) submitted *Planetary and Space Science*. [2] Le Mouélic S. et al. (1999) *JGR, 104, E2*, 3833-3843. [3] Pinet P.C. et al. (1999) *LPS XXX*, Abstract #1555. [4] Lucey P.G. et al. (1986) *JGR, 82*, D344-D354. [5] Pieters et al. (2002) *Icarus, 155*, 285-298. [6] Shkuratov et al. (2002) in press *Solar System Research*. [7] Shkuratov et al. (2003) submitted *JGR*.

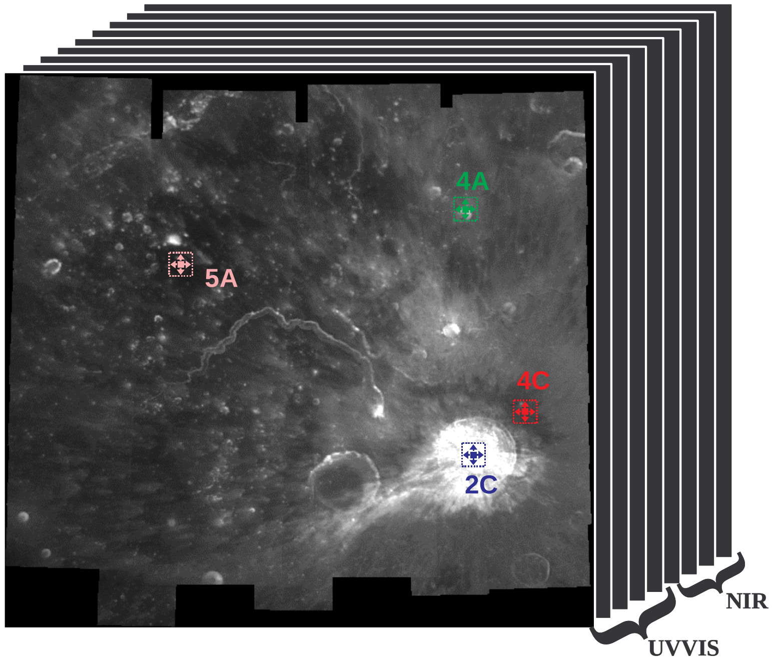

Figure 1: Clementine mosaic of the Aristarchus plateau, on the Moon. The a priori spot positions and sizes are represented with colored squares. The dotted squares are the exploration windows for the 4 calibration spots (2C, 5A, 4A and 4C). Denomination of the spots is taken from [4]

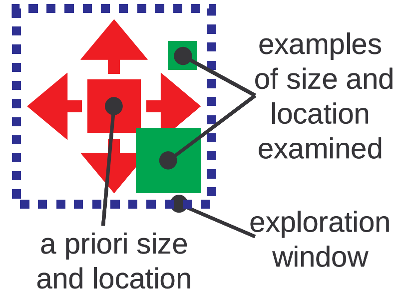

Figure 2: Detail of a spot exploration window. Rectangle in the center represents the a priori spot size and location. Along with the degrees of freedom for the spot, all the possibilities of location and size, inside the possible exploration window, are examined.

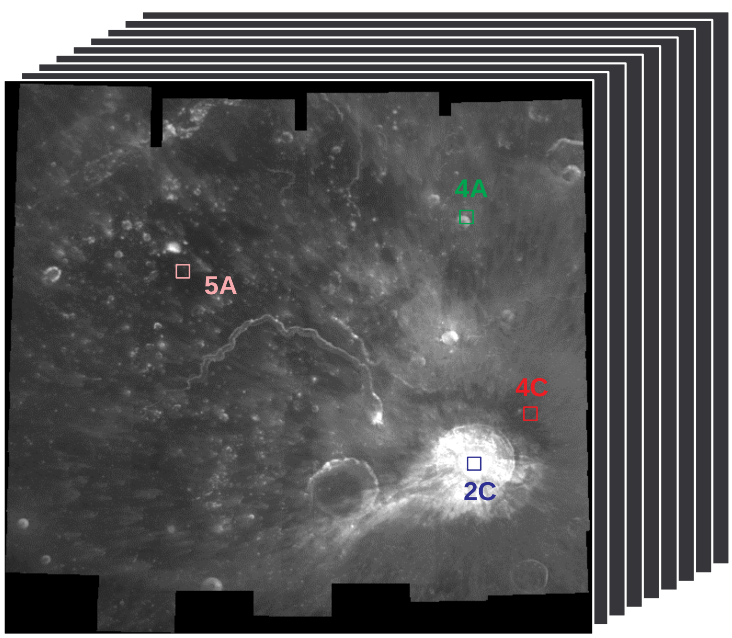

Figure 3 : Resulting spot positions and sizes leading to the optimized linear calibration.

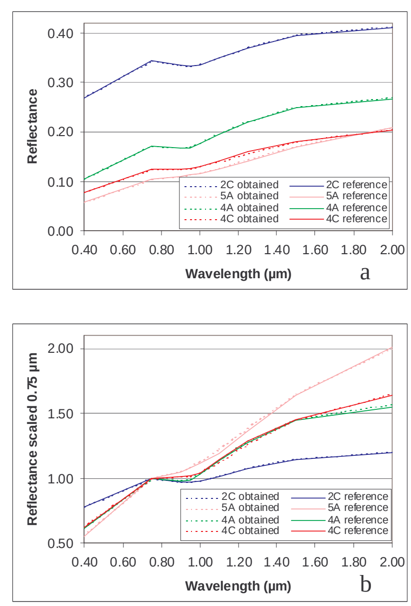

Figure 4: Resulting spectra from the optimized solution shown in figure 3, compared with the reference spectra from [4]. a: calibration spectra in reflectance. b: calibration spectra scaled at 0.75 µm.