PLEIADES: towards a new radiometric model of the Moon?

Sophie Lachérade – CNES

In the field of Earth observation, radiometric quality of the data is often a crucial point that requires the development of more and more precise calibration methods in order to characterize the instruments once they are in orbit. The precisions reached from observations of calibration sites on Earth (African deserts, Antarctica, clouds, instrumented sites) are about 2-3% for most of the spectral bands in the visible and the near infrared spectra. However, it is very difficult to further improve this precision down to 1% because each method has its own limitations, generally due to atmospheric disturbances. In this context, the Moon seems to be an ideal calibration site: there is no atmosphere and its surface properties – thus its optical properties - are perfectly stable. The only limits of this extraterrestrial site are geometrical (but with radiometric consequences!): the visible side of the Moon varies every day (lunar phase corresponding to the Earth-Moon-Sun angle). Moreover, for a given phase, lunar librations cause slightly different parts of its surface to be observable at different moments.

The ROLO model (Robotic Lunar Observatory), developed by USGS (United States Geological Survey), is a radiometric model of the lunar reflectance integrated on the complete apparent disk, taking into account the effects of lunar phase and libration. This model is internationally accepted and used by every space agency for the calibration of satellites which are able to aim at the Moon.

In the framework of the PLEIADES 1A and PLEIADES 1B in-flight calibration, studies took place in order to determine the calibration precision that could be reached from the acquisitions realized during different lunar phases. Indeed, PLEIADES satellites being very agile systems, it was possible to acquire images of the Moon during every orbit of the both satellites, during several lunar cycles, thus generating a unique data set of the Moon at very high spatial resolution (380 m). The POLO data set (Pléiades Orbital Lunar Observations) was born: over 1000 images of the Moon acquired over 6 months for viewing angles varying from -115° to +115° (0° corresponding to the full Moon, 180°, to the new Moon).

The analysis of this very high spatial resolution lunar data set makes it conspicuous that there are several insufficiencies in the way the ROLO model handles the influence of the lunar phase. This is a problem for satellites or systems that cannot acquire the Moon every month (in fact every 28 days), with a nearly identical lunar phase. It is the case, for example, of the geostationary satellites and satellites on lower orbit, which are less agile than PLEIADES or have other system constrains. The short term objective is now to use this POLO data set to improve the ROLO lunar model. This new model should then be available to the international community through our participation to the GSICS (Global Space-based Inter-Calibration System).