Technical Memorandum

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Subject: **ABI Lunar Trending Image Collection Requirements in the Operational Period**

Date: 05/01/2018 Rev: Rev 2.0

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This technical memo lists the set of lunar trending requirements for the GOES-16 ABI operational period, which can be summarized as followed:

Scan pattern: (1) the unclipped Moon can be scanned with either MESO1 or MESO2; and (2) the Moon should be located near the center of the MESO swath at the north-south direction for all the ABI bands.

Location: (1) the Moon should appear within the ABI field of regard (FOR); (2) the center of the Moon should be at least 0.013 radians away from the Earth limb for all the ABI bands; and (3) the edge of the Moon should be at least 0.002 radians away from the MESO frame boundary at the east-west direction.

Frequency per month: 2-4 trending events per lunar phase.

Phase Angle Range: (1) the highest priority two lunar trending events shall have the smallest absolute phase angle as possible between Earth and Moon, but not less than 5.0 degrees. These two trending events shall be on opposite sides of the Earth. (2). The other two lunar trending events with relatively lower priority shall have an absolute phase angle as close as possible to 60 degrees between Earth and Moon, but not more than 90.0 degrees. These two trending events shall also be on opposite sides of the Earth.

Descriptions of the Requirements

The Moon, due to its many unique physical properties from the Earth, is of great value for the on-orbit satellite instrument calibration and validation. The extremely stable surface reflectance with no intervening atmosphere, for example, makes it an excellent on-orbit radiometric calibration reference and an effective solar diffuser to the GOES ABI solar reflective bands. During the GOES-16 ABI post-launch testing (PLT) and post-launch product testing (PLPT) period, a series of special scans were successfully conducted to collect the lunar images to validate and examine the ABI instrument in-orbit performance, including 1) lunar chasing events for the validation of spatial response uniformity for the visible and near infrared (VNIR) bands, 2) lunar north-south scans (NSS) to examine the out-of-field (OOF) response, blooming effect and response uniformity for each detector at all the bands, and 3) lunar trending events for the trending

of the solar calibration variation. While the lunar chasing and NSS events are normally conducted only during the ABI PLT/PLPT periods, the lunar trending data collection will be continuing through the satellite instrument mission life.

However, as the lunar surface is not uniform, using the Moon as the radiometric calibration reference requires an accurate physical model to predict the energy reflected from the non-Lambertian lunar surface. Currently, the most popular lunar model is the U.S. Geological Survey Robotic Lunar Observatory (ROLO) model which was developed based on the lunar irradiance measured when the Moon appeared between the 1st and 3rd quarters, excluding the specular reflectance phase angle range of [-5°, 5°] [1]. The ROLO model was later implemented within the Global Satellite Inter-Calibration System (GSICS) community (NOAA is one of co-founders of GSICS) and named as GIRO (Gsics Implementation of the ROlo) model. To use ROLO/GIRO model as the radiometric calibration reference, all the ABI lunar trending images should have absolute phase angle in between [5°, 90°].

The ROLO/GIRO model is well known for the high relative calibration accuracy at a small range of lunar phase angles [2][3]. Recent studies showed that its relative calibration accuracy is very stable at the short-wavelength solar reflective channels (e.g. ABI B01 at 0.47μm, B02 at 0.65μm and B03 at 0.85μm) with bright moons. The residual of the calibration accuracy at the short-wavelength channels increases significantly when the absolute phase angle is beyond of 35°-50° [4][5]. Since the ABI lunar appearance prediction model showed that the Moon can appear within the space of the ABI Field of Regard (FOR) at both sides to the Earth at least once a month for the absolute phase angle less than 60°[6], it is therefore desirable to have at least one trending event with the absolute lunar phase angle less than 60° for each month. The smallest available absolute phase angle is preferred for this tending event.

To compensate for the possible residual of the ABI scan mirror spatial uniformity correction, the Moon should be scanned within the FOR space at both sides to the Earth. Therefore, at least two trending events, one at each side to the Earth, should be scanned per month.

In addition to the phase angle dependent relative calibration accuracy, the ROLO/GIRO model is also reported to have relatively large uncertainty in the absolute calibration accuracy, and certain residual of libration correction as well. To overcome these issues, an alternative method is currently undergoing at NOAA/NESDIS/STAR to develop a new lunar calibration model. NOAA/NESDIS/STAR, in collaboration with Japan Meteorological Agency (JMA), is leading the effort to develop a lunar model based on the radiance observations over the selected uniform lunar targets [7][8]. In order to be applicable to all the GOES ABI and ABI-like instruments, the ABI lunar images used for the model development should cover a large range of viewing/illumination conditions. Two additional lunar trending events per month are thus required for this purpose. The absolute phase angles for these two additional trending events should also **be between 5° and 90°, with close to 60° preferred**; and the viewing/illumination conditions should be as much different from the first selected two trending events as possible. The two additional lunar trending events, which are away from the time for the first selected events, can also help to reduce the risk of trending event cancellation due to the critical weather days. Therefore, if possible, the four trending events should cover as much large difference in the phase angle range as possible.

The unclipped Moon is scanned with one of the ABI MESO swaths. It is located near the center of the swath at the north-south direction. To avoid of the impact of the Earth atmosphere, the center of the Moon should be at least 0.013 radians away from the Earth limb at all the ABI bands. The Moon should be within the ABI FOR and at least 0.002 radians away from the MESO frame boundary at the east-west direction, for the straylight and crosstalk analyses [9][10].

References:

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