An Analysis of Illumination and Communication Conditions near Lunar South Pole based on Kaguya data

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ABSTRACT

This paper presents the analyses of the illumination and communication conditions at the Lunar South Pole, based on terrain models derived from the Kaguya Laser Altimeter, and discusses the implications for the landing site selection and system design with particular reference to the European Space Agency's Lunar Lander mission and its development through upcoming Phase B1 activities.

Previous studies indicated that a number of sites near the Moon's South Pole can experience very favourable illumination conditions, in terms of long accumulated illumination and short periods of darkness, however the data used in these past analyses had a relatively course resolution and was incomplete. In order to better characterise the illumination conditions of certain specific sites, as well as the extent of such areas, detailed analyses were performed using Kaguya terrain data, which has a horizontal resolution of ~200 m and a vertical resolution of 4 m (spatially correlated).

The tool developed for this analysis computes the local horizon for each point of interest and then the illumination conditions over a year, evaluating whether the Sun is obstructed by the terrain for each time step. The Sun access history for each point is then processed in order to extract the duration of the longest period of quasi continuous illumination, i.e. the duration of the illumination period interrupted by short periods of darkness. The illumination period duration is exported in the form of maps, which allow the assessment of the extent of the areas.

Several locations were found which possess positive illumination conditions on the order of 6-8 months, taking into account short darkness periods of ~60hours. However the physical size of these areas was found to be significantly restricted, on the order of only a few hundred metres up to 1km, imposing stringent requirements on the end-to-end absolute landing precision performance.

Direct communication conditions with the Earth were also evaluated for the identified sites, finding that at least 14 days of Earth visibility are available. This should be taken into account in the design of the operations and in the evaluation of the actual start and end of the mission opportunity.

The methodology implemented here represents a foundation for future analyses which will include more detailed modelling, further validation of the tools and potentially the use of more accurate data from the Lunar Reconnaissance Orbiter (LRO).