MISSION PLANNING FOR A LUNAR POLAR MISSION: ISPACE'S POLAR ICE EXPLORER. A. Calzada Diaz[1], D. Bolan[1] and M. Puntar[1], [1]ispace Europe, Rue de l'Industrie 5 1811, Luxembourg (a-calzada@ispace-inc.com)

Introduction: The Polar Ice Explorer mission is an ispace mission with the goal of determining the local distribution, abundance and form in which hydrogen is contained in the polar regolith of the Moon. A detailed analysis of regions of interest is being performed by ispace Europe in order to select the most scientifically interesting and safe landing site.

The Polar Ice Explorer consists in a small-size (< 6 kg) rover based off the innovative SORATO design, this rover is the lightest flight-qualified planetary rover up to date. The rover will carry a suite of instruments to detect, map and characterize H distribution within the first meter of the regolith. It will be delivered to the lunar surface by ispace's lander. This lander is currently under development with a first launched scheduled for 2021.

We are also developing a user-friendly data processing pipeline for automating portions of the landing site analysis and selection process. With these we've been able to significantly reduce the time required to produce evaluations of regions and of specific sites within those regions.

In this work, we present the Mission Planning Tools that are being developed by ispace Europe and used to characterize a region with the potential of harboring hydrogen in form of water ice deposits to determine if they are suitable and safe for a surface exploration mission such as the Polar Ice Explorer.

Mission Planning Toolkit: As the frequency of lunar missions is projected to increase rapidly, there is a strong incentive to streamline the site selection and mission planning process to allow faster iteration. We are developing a series of user-friendly tools to aid in collecting data and producing basemaps to use in GIS software for further analysis. These tools are accessed through a web application and data pipelines are run in the cloud, obviating the need for local setup. The data we will deliver include raw remote sensing data, generated DTMs, and high resolution maps of illumination, visibility, roughness, and hazard density. Using this data processing pipeline internally we were able to complete initial evaluations of new sites much faster than was possible with other existing tools.

Polar Ice Explorer Mission Planning: The selection of an area of interest for the Polar Ice Explorer was made after a literature review on the detection on lunar water from orbit and stability of lunar ice (eg. [1,2]). Potential RoIs in the farside polar regions were dismissed as they cannot maintain direct communication link to the Earth.

An area close to the Amundsen crater was selected as the first region of interest to be addressed as a potential landing site for the Polar Ice Explorer (Figure 1 and 2). This area was identified by [1,2] as an area that could contain stable water ice within the first meter of the lunar regolith.

The landing constraints for the Polar Ice Explorer are established to ensure a successful landing and to optimize rover surface operations during the mission. The region of interest is a broad area (~ 20 km x 15 km) where an initial study suggested that scientific constraints are met.

The first constraint is imposed by the exploration objectives of the mission to land in an area where there is presence of hydrogen within the first 50 cm of the regolith from the surface.

A safe landing requires a relatively obstacle-free and plain surface. For the successful landing and operations of the Polar Ice Explorer, a set surface hazards such as slopes over 15º, crater, and boulder abundances were established.

In order to delimit the exploration area of the Polar Ice Explorer, we used Diviner data [2] to restrict the stability of the water ice within the region and LROC NAC images to identify potential surficial hazards (Figure 3).

The Polar Ice Explorer is a solar-powered rover that requires permanent illumination. Also, the lander will transmit the data directly to the Earth so constant Earth visibility for the entire duration of the mission is mandatory. We have also performed analyses on the illumination and Earth visibility conditions of the area for the potential launch year of 2023 (Figure 4).

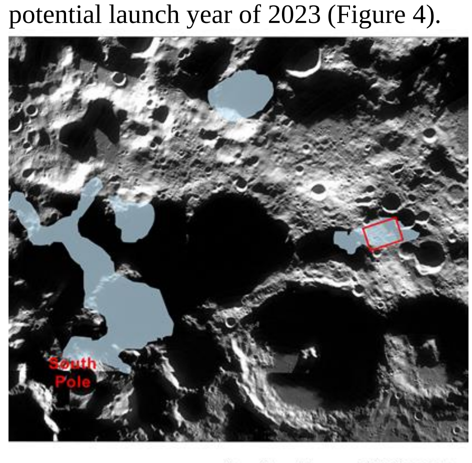

Figure 1 Location of the Region of Interest for the Polar Ice Explorer (red square) over LROC WAC mosaic (ASU-NASA). The blue areas are the areas of permafrost identified by Mitrofanov et al. 2012.

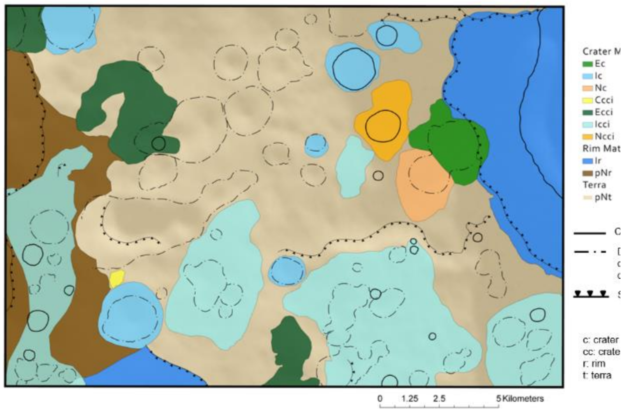

Figure 2 Geological map of the area of interest. Relative ages were assigned using [3].

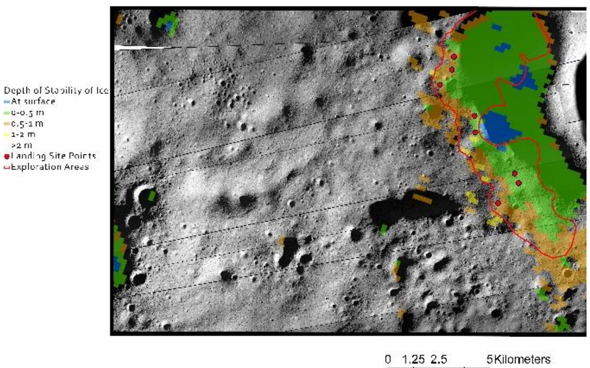

Figure 3 Exploration Area delimited by a red line. Shown in color are the depths for water ice stability by [2]. Red points indicates potential areas for landing. Basemap is a mosaic of LROC NAC images (ASU-NASA).

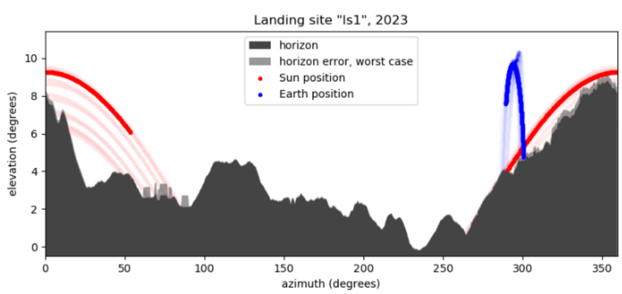

Figure 4 Example of one output from the illumination and visibility tool. The gray fill represents the horizon and the translucent gray represents the worst case error in the DEM used for calculation, which is correlated to the distance to the horizon. The red line represents the position of the Sun and the blue line indicates the position of the Earth. Both are highlighted for the duration of the longest mission window.

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References:

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[2] Paige D. A., et al. (2010) Science 330.6003, 479-482.
[3] Wilhelms D. E. USGS Professional Paper 1348