FRAMEWORK FOR COORDINATED EFFORTS IN THE EXPLORATION OF VOLATILES IN THE SOUTH POLAR REGION OF THE MOON. M. Lemelin$^{1,2}$, S. Li$^3$, E. Mazarico$^4$, M. Siegler$^{2,5}$, D. A. Kring$^{2,6}$, 1 Département de Géomatique appliquée, Université de Sherbrooke, Sherbrooke, QC, Canada, JIK 2R1, Myriam.Lemelin@USherbrooke.ca, 2 NASA Solar System Exploration Research Virtual Institute, 3 Hawaii Institute of Geophysics and Planetology, University of Hawaii at Manoa, Honolulu HI USA, 4 NASA Goddard Space Center, Greenbelt MD USA, 5 Planetary Science Institute, 6 Center for Lunar Science and Exploration, Lunar and Planetary Institute, Universities Space Research Association, Houston TX USA.

Introduction: The robotic exploration of the lunar south polar region and the ground truthing of polar volatiles is one of the next steps of NASA’s Artemis program, which aims to return humans to the Moon by 2024 with the support of other space agencies and private companies. The cadence of static spacecraft and rovers landing on the lunar surface may be as high as two per year in the near future.

While several remote sensing measurements made since the 1990s have implied the presence of water ice in the lunar south polar region, it is only in 2018 that the first unambiguous regional (yet spatially resolved) detection of surficial water ice was achieved using the Moon Mineralogy Mapper (M3) data [1]. It revealed that surficial water ice is present in many permanently shaded regions (PSRs).

Here we use these recent M3 measurements, along with several other remote sensing datasets, to identify the most promising south polar sites to ground truth polar volatiles and provide a framework for coordinated efforts in the exploration of volatiles in the lunar south polar region.

Materials and method: We first characterize 169 water ice-bearing PSRs using Lunar Prospector hydrogen abundances [2], slopes derived from LOLA topography data [3], DIVINER temperatures [4], illumination conditions derived from LOLA [5], and the modeled depths of stability of H$_2$O and CO [6]. We then identify nearby potential landing sites and characterize the mobility required between landing sites and water ice-bearing PSRs. We use the derived characteristics of the water ice-bearing PSRs to determine which PSRs should be preferentially explored given different mission goals such as (1) sampling the highest concentration of volatiles, (2) characterizing the lateral or (3) vertical distribution of volatiles, or (4) gaining the fastest access to a known water ice-bearing site.

Results: We identified 36 water ice-bearing PSRs that show the greatest promise of answering these mission goals, allowing many missions to be undertaken. Eleven of these PSRs can address more than one mission goal and are, thus, considered to be high priority targets for future exploration. These PSRs are: Shoemaker, Faustini, Cabeus 1, Malapert, Nobile 2, Sverdrup 1, Wiechert J, Haworth, and unnamed PSRs 57, 120, and 89 (Fig. 1). Although the absolute model age for the largest of these PSRs has been estimated to be between 3.20 and 4.18 [7], we anticipate the volatiles detected from orbit were deposited after the last major impact event to blanket these sites.

We also investigate potential traverses to three of these PSRs in short- (20-50 km), medium- (~100 km), and long-distance missions (~300 km), reflecting different rover and instrument capabilities. The 20-km mission is, for example, compatible with the NASA VIPER rover.

Conclusion: The variety of water ice-bearing PSRs we characterized can be used to help direct missions with specific goals and/or capabilities to the best site, or conversely the results can help design missions targeting a specific location of interest. These sites and their characteristics illustrate the trades available between different mission scenarios.