Implementing a Coordinated International Lunar Resource Evaluation Campaign. C. R. Neal[1], [1]Dept. of Civil & Env. Eng. & Earth Sciences, University of Notre Dame, Notre Dame, IN 46556, U.S.A. [cneal@nd.edu].

Introduction: The Findings & Recommendations from LSSW-17 [1] highlighted the need for understanding if lunar resources are reserves and the types of data needed to do that. Much of these new data types [2] would need to be taken via surface mobile assets. Based upon current orbital data, the 10 most promising sites for polar volatiles cover an area >6,000 km^2 [3]. LSSW-17 also recommended that coordination of evaluating polar volatile resources should be international in scope and led by NASA (given the area covered by the current top 10 best targets [3]), and outlined what should be implemented in such a coordinated campaign:

1. Coordinating data gathering efforts from current & funded missions that are focused on lunar resources;
2. Defining the data types and fidelity needed to derive useful products for future missions;
3. Developing lunar resource standards & evaluation metrics;
4. Inclusion of partners in this effort;
5. Defining a data policy (or data policies);
6. Leveraging private industry where possible;
7. Developing a list of high priority targets using existing orbital datasets to focus surface exploration
8. Developing mission concepts that could be conducted from orbit (neutron spectrometry, radar, IR reflectance) at better resolution than current datasets.

Beginning the Coordination (#1 above): Table 1 represents the ongoing and scheduled missions that will visit the Moon to fully or partially focus on exploring polar volatiles. These missions involve orbiters, landers, and rovers from a number of different countries and commercial companies. Coordinating these missions does not mean control over each mission, but agreeing on data fidelity, defining a common data policy, and developing standards so the datasets from various missions can be directly compared and overlain (#2, #3, and #5 above). This also includes using the same agreed upon coordinate system for seamless integration of datasets (#3). This allows development of data products that enable better location of surface assets. High priority targets for these missions (#7) begin with those already defined [3]. Developing international collaborations between countries in Table 1 also represents an opportunity for diplomacy in a time that desperately needs it.

Expanding the Coordination: Coordinating the ongoing and scheduled missions will lay the foundation for more targeted missions. For example, the current neutron datasets from Lunar Prospector (15-45 km^2/pixel) and LRO (~10 km^2/pixel) require refinement. The cubesat mission LunaH Map will give neutron data at ≤15 km^2/pixel [4], but orbital concepts are available to obtain neutron data with 200 ppm H detection at 5 km^2/pixel at both poles [5]. Such a mission could be an important addition to the list in Table 1 and implement #8 of the LLSW-17 recommendation [1].

Missions to Explore the Poles of the Moon			
Mission	**Country/Agency**	**Launch Date**	**Type**
Lunar Reconnaissance Orbiter (LRO)	U.S.A./NASA	Ongong	Polar Orbiter
Korean Pathfinder Lunar Orbiter (KPLO)	Korea/KARI	Ongong	Polar Orbiter (Image Polar PSRs)
LunaH Map	U.S.A./NASA	2022 (Artemis 1)	Polar Orbiter (Polar H Mapping)
Lunar Ice Cube	U.S.A./NASA	2022 (Artemis 1)	Polar Orbiter (map water/volatiles)
Lunar Flashlight	U.S.A./NASA	2023	Polar Orbiter (South Pole Volatiles)
Lunar TrailBlazer	U.S.A./NASA	2023	Polar Orbiter (high-resolution mapping)
Luna 25	Russia/Roscosmos	2023?	Lander (South Pole)
Polar Resources Ice Mining Experiment-1 (PRIME-1)	U.S.A./NASA	2023	Nova-C Lander (South Pole)
Volatiles Investigating Polar Exploration Rover (VIPER)	U.S.A./NASA	2024	Lander-Rover (Nobile Region, South Pole)
Chang'E-7	China/CNSA	2024	Lander (South Pole)
Luna 26	Russia-China	2024?	Polar Orbiter
Lunar Polar Exploration Mission (LUPEX)	Japan-India	2025	Lander-Rover (South Pole)
Artemis 3	U.S.A./NASA	2025	Crewed Landing (South Pole)
Package for Resource Observation and in-Situ Prospecting for Exploration, Commercial exploitation and Transportation (PROSPECT)	ESA	2025	TBD Lander (South Pole)

Commercial Missions			
Mission	**Company**	**Launch Date**	**Type**
XL-1	Masten	2023	Lander (South Pole - Haworth Crater)
Nova-C	Intuitive Machines	2023	Lander (South Pole - Shackleton connecting ridge)
TBD	TBD	2025	Lander (South Pole)

Table 1: Ongoing and scheduled missions to explore the Moon's polar regions.

Coordinating Surface Exploration: Once surface locations are specified, the collaboration and cooperation developed by coordinating the current missions can develop the surface campaign to obtain the required data [5]. Coordination of surface missions can implement #4 & #6 from LSSW-17 [1], highlight areas for pilot plant locations, and deliver important scientific analyses and potential sample return demonstrating this campaign will inform multiple stakeholders.

Conclusion: Coordinating an international lunar resource evaluation campaign will not be easy. However, implementation could begin with the missions in Table 1, thus building the foundation for detailed surface missions to multiple locations to inform science, exploration and commercial stakeholders.

References: [1] LSSW 17 Final Report (2022) https://www.hou.usra.edu/meetings/lunarsurface17/pdf/LSSW-17-Findings-Recommendations.pdf [2] Neal et al. (2022) *LSSW 17*, abs.#5025. [3] Brown et al. (2022) *Icarus 377*, 114874. [4] Hardgrove et al. (2020) IEEE *Age Syst. Mag. March* 54-69. [5] Lawrence et al. (2015) *Acta Astro., 115,* 452-462,