Characterizing Lunar Polar Volatiles at the Working Scale: Going from Exploration Goals to Mission Requirements

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The mission must sufficiently characterize an area to evaluate the resource need or physical processes

- Terrestrial mining companies have worked this problem for many years, developing “Mineral Models” for production evaluation
- Unfortunately the “Mineral Model” for lunar water is very uncertain, however many of the same techniques can be applied

To characterize an areas’ water content for ISRU requires making spatially distributed point measurements

- Have built several Monte Carlo models and applied instrument models to simulate observations
- Applied various interpolation techniques to estimate total water from simulated instrument measurements

Making the number of measurements required for accurate characterization can only be done with surface mobility that can span scales of 10s to 100s of meters
Simulations can put real numbers on how much prospecting and subsurface analysis is needed to meet measurement goals

- Example of simulations with random mixes of water
- Random concentrations and distributions (lateral and vertical) modeled and neutron observations modeled along arbitrary traverse

Water Column Concentration

Water Column Integrated Mass (kg) With Example Traverse
Spatial Weighted Modeling with Neutron Spectrometer Model

Interpolated total water from traverse measurements
- Used predicted water along traverse based on neutron measurements
- Performed a Kiging (Gaussian process regression) interpolation across entire area
- Errors within/near the traverse area are typically <20%
- The error is a strong function of the number of unique sites sampled (the traverse path)
Interpolated total water from traverse measurements

- The error is a strong function of the number of unique sites sampled (the traverse path)
- Can estimate the total uncertainty in the total water estimated across model area (about 4300 m²)

What one might expect for 10 static landers

To characterize the total water in an area with an uncertainty of <50% must sample with a density of >15%

Additionally lateral/vertical physical scales show “ranges” (distinct changes in scale structure) at scales between 10s and 100s of meters

See poster for more details!
Thank You!