

Regions of interest identified by
the Lunar Exploration Analysis Group (LEAG)
Volatiles Specific Action Team (VSAT)

based on the Final Report 12/31/14

http://www.lpi.usra.edu/leag/reports/vsat_report_123114x.pdf

presented to

the International Space Exploration Coordination Group (ISECG)
Lunar Polar Volatiles Virtual Workshops
Where to Explore, and How

January 20th, 2016

Myriam Lemelin, on behalf of the LEAG VSAT team

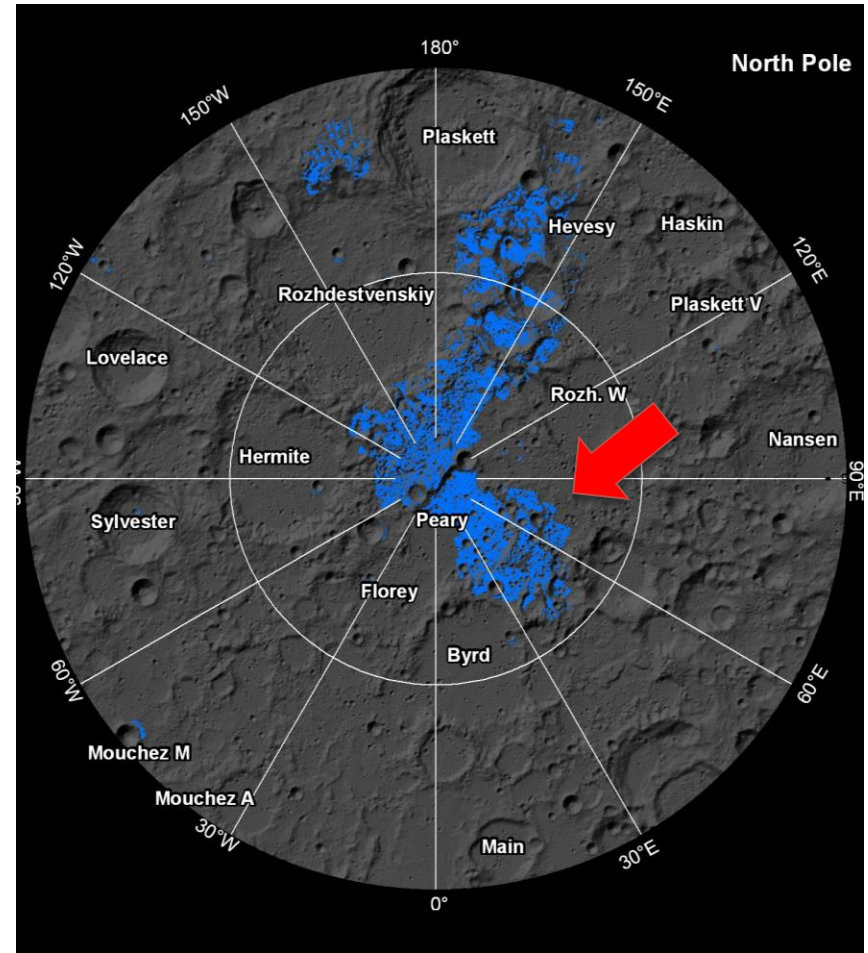
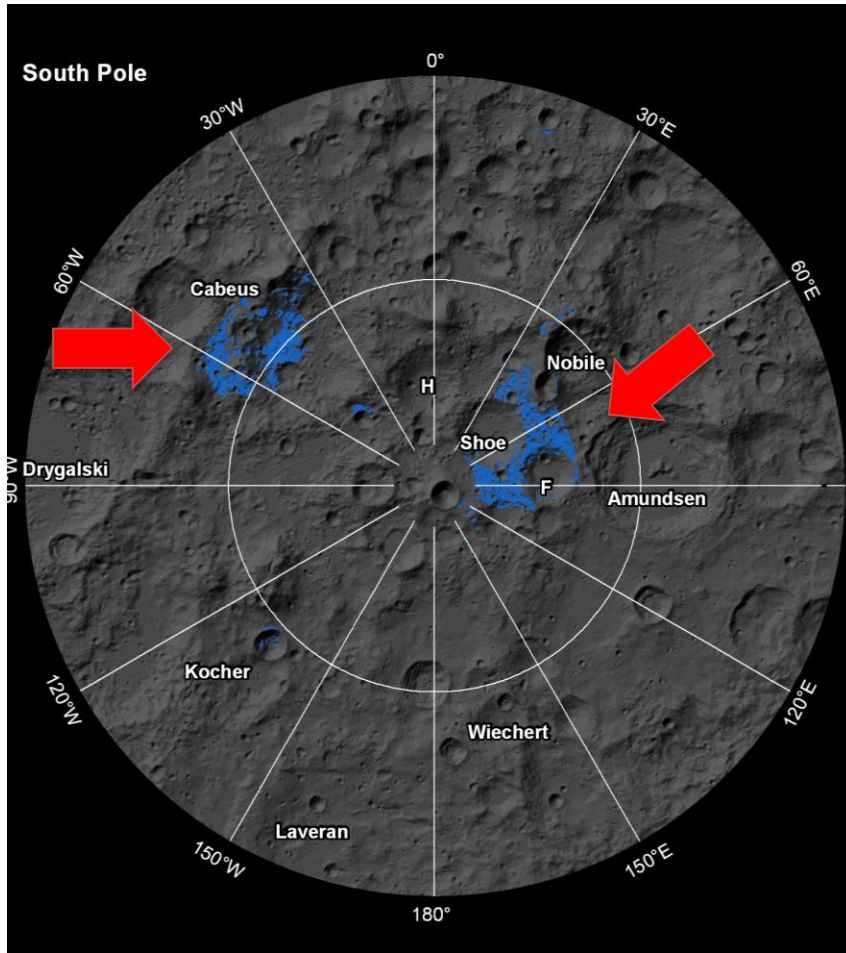
Motivation and Execution

- Upon NASA's Human Exploration and Operations Mission Directorate (HEOMD) request, the Lunar Exploration Analysis Group (LEAG) established the Lunar Polar Volatiles Specific Action Team (VSAT) to:
 - select and prioritize regions of interest with the potential of accessible volatiles that may support a synergistic approach of multiple missions
- Two approaches were used to reveal widespread regions of interest:
 1. Multi-parameter analysis
 - optimized a number of volatile relevant and environmental parameters: hydrogen abundance, temperature, slope, proximity to permanently shaded regions (PSRs) and Earth visibility
 2. Similarity to LCROSS site
 - based on hydrogen abundance and average annual temperature
- These were supplemented by examining
 - Proximity to permanently shaded regions (PSRs)
 - Direct to Earth visibility
 - Illumination based on total lighting over a lunar diurnal cycle

Multi-parameter analysis

	Dataset	Resolution	Threshold	Reason
Criteria	Hydrogen abundances (Lunar Prospector)	0.5 ppd (15 km/pix)	>150 ppm	Contains volatiles
	Average annual temperature (DIVINER)	240 m/pix	< 110 K	Preserves subsurface ice for geologic time
	Slope (LOLA)	20 m/pix	< 10°	Navigable by current rovers
	PSRs (LOLA)	240 m/pix	outside	Lighting available
Complement	<i>Proximity to PSRs</i>	-	< 1 km	<i>Allow small rover access</i>
	<i>Direct to Earth visibility</i>	500 m/pix	-	<i>Line of sight communication</i>
	<i>Illumination</i>	500 m/pix	-	

Multi-parameter analysis

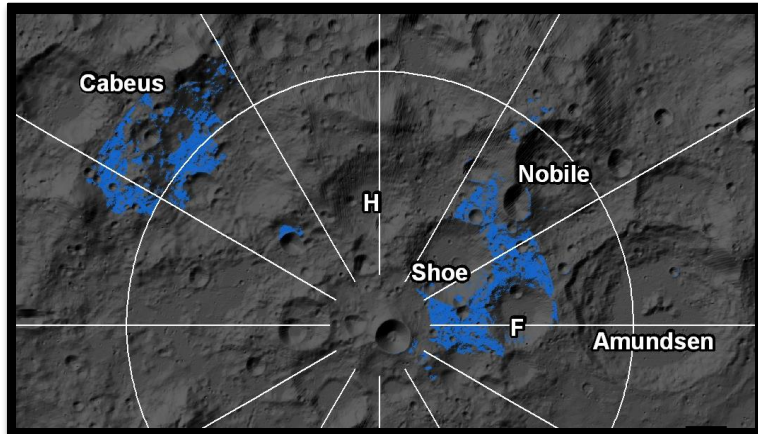


ROI 1: Cabeus vicinity
ROI 2: Shoemaker/Nobile vicinities

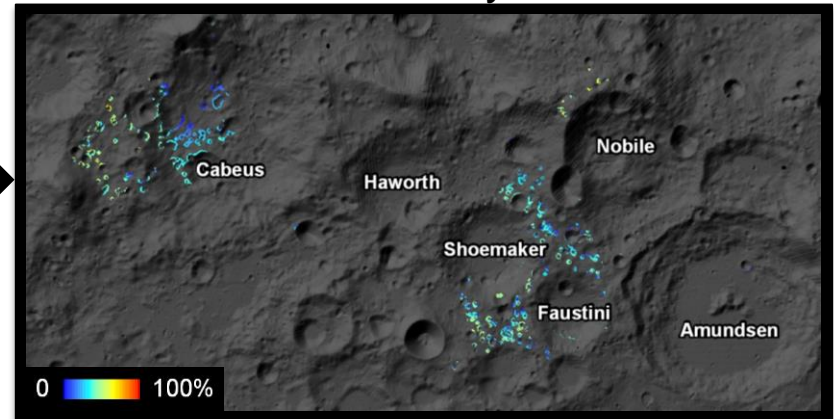
ROI 3: Peary vicinity
Substantial area of farside also meet general criteria

Multi-parameter analysis: adding more constraints

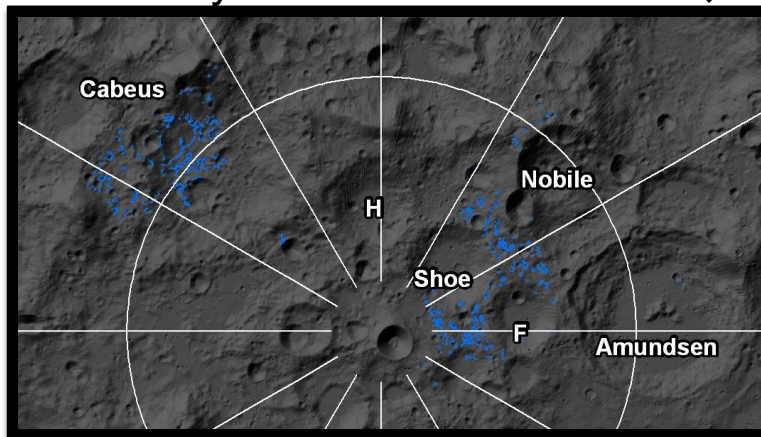
South Polar ROIs



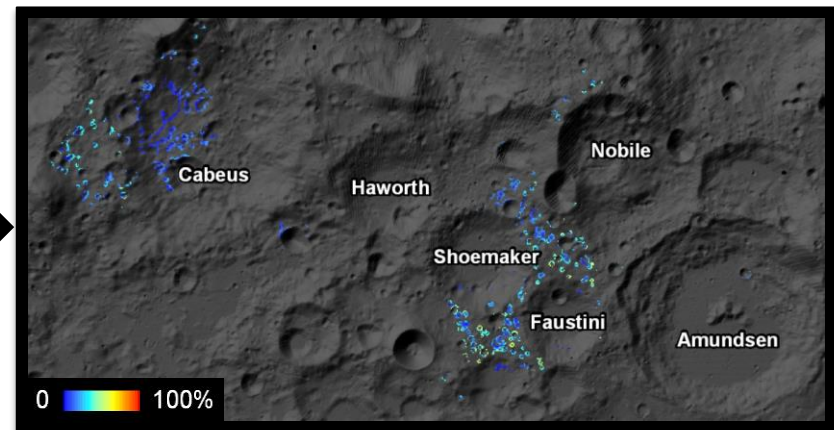
Direct to Earth visibility



Proximity to PSR < 1 km



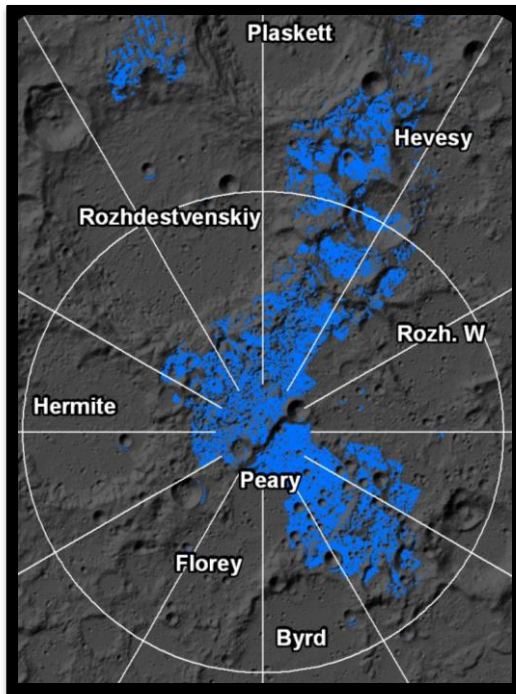
Illumination



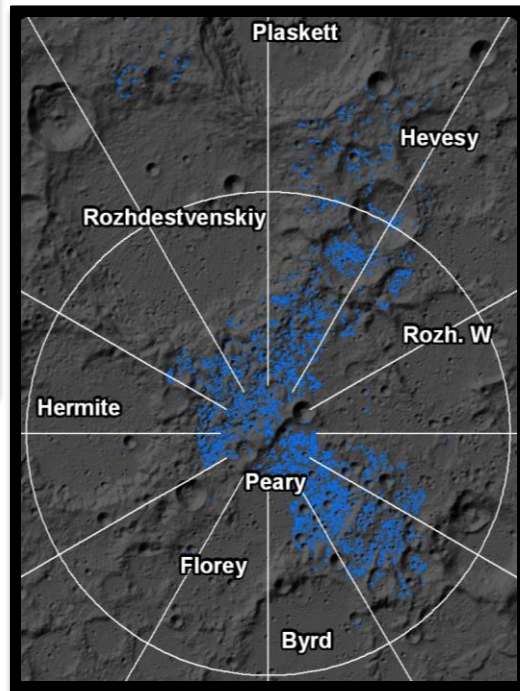
Illumination is generally low
Restricted regions have ~50% available lighting

Multi-parameter analysis: adding more constraints

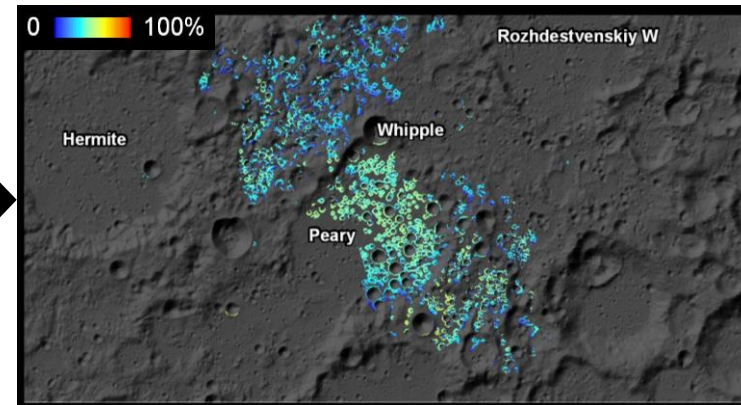
North Polar ROI



Proximity to PSR < 1 km

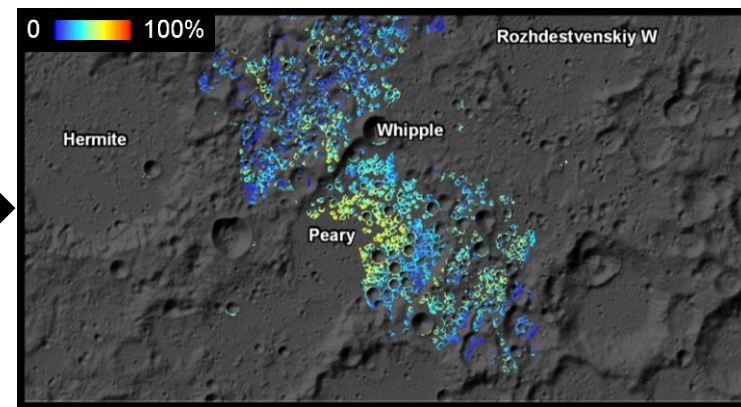


Direct to Earth visibility



No Earth visibility on the farside

Illumination



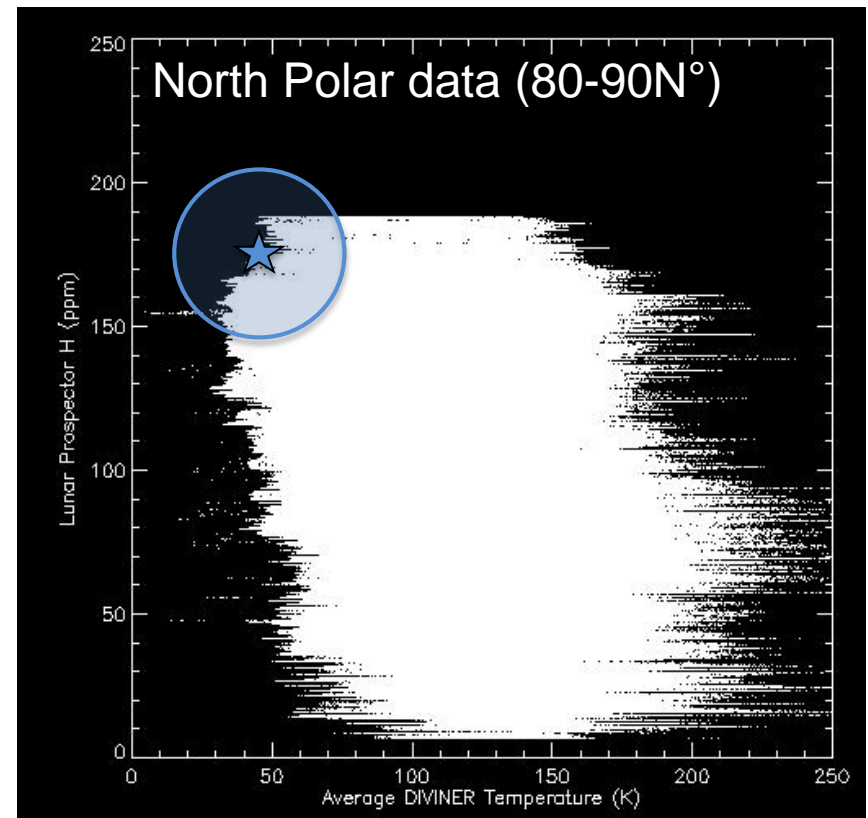
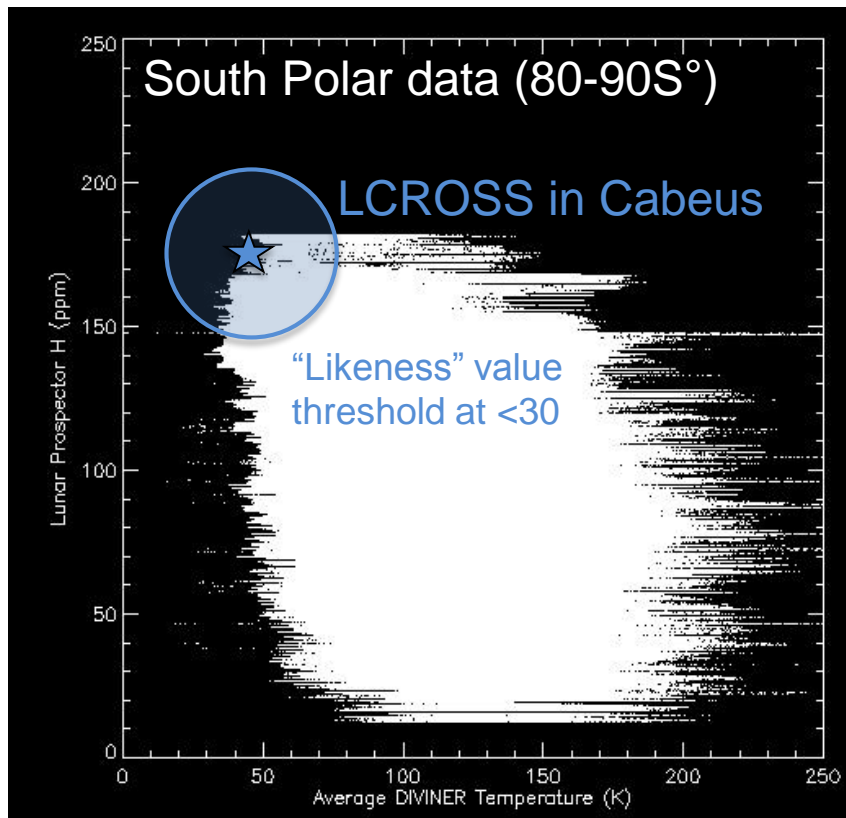
Illumination in the Peary region is more favorable than the south polar site, or the farside north polar sites

Similarity to LCROSS site

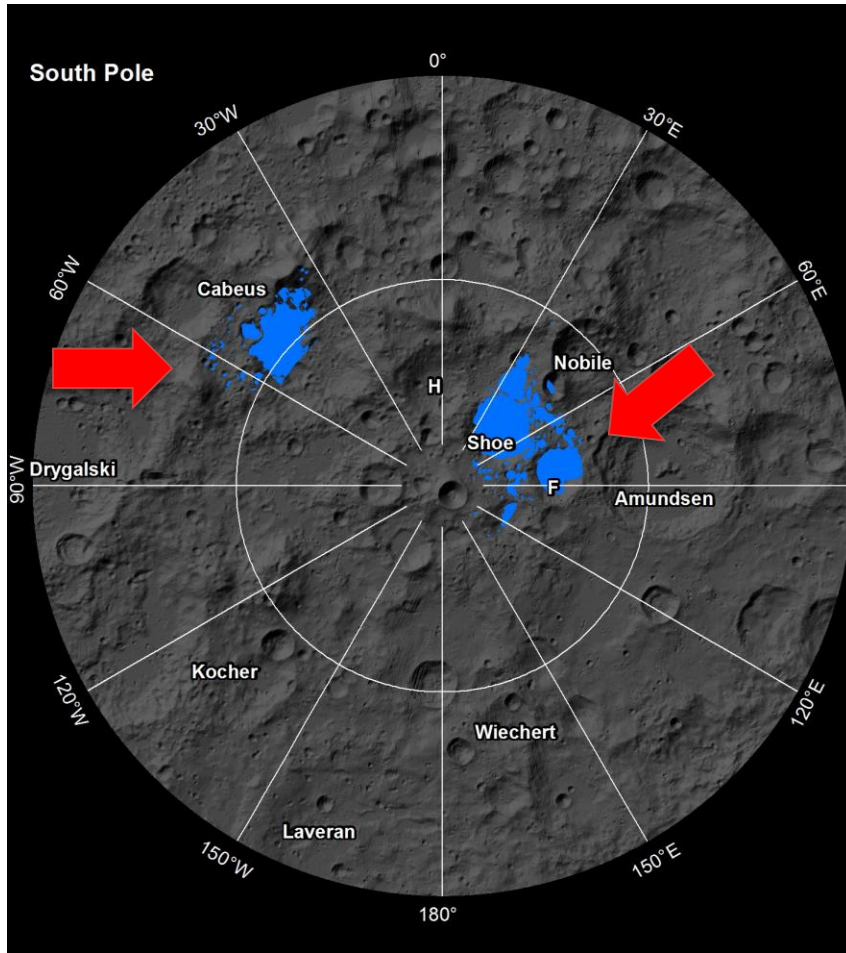
Criterion

- Regions similar to LCROSS Cabeus site in terms of hydrogen and average annual temperature

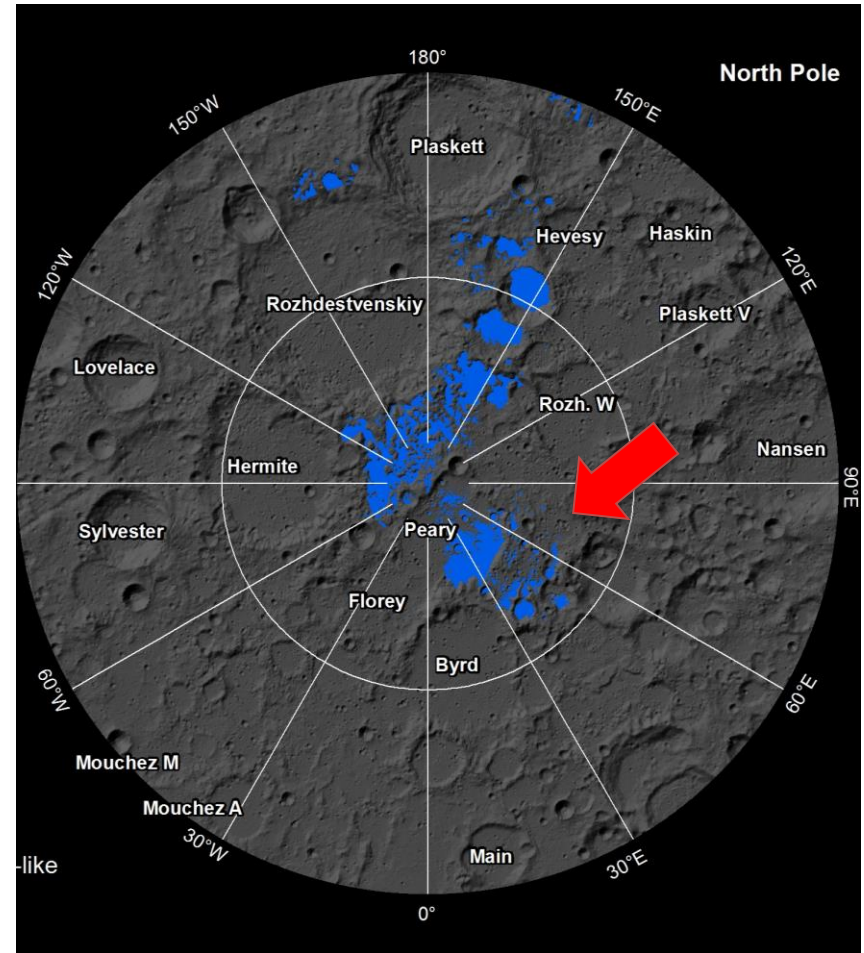
$$\text{"Likeness"} = \sqrt{(H - H_{\text{Cabeus}})^2 + (T - T_{\text{Cabeus}})^2}$$



Similarity to LCROSS site



ROI 1: Cabeus vicinity
ROI 2: Shoemaker/Nobile vicinities



ROI 3: Peary vicinity
North rim of Hermite vicinities and farside also

Summary

At both poles there are regions that are generally suitable for a common landing:

ROI 1: Cabeus vicinity (South Pole)

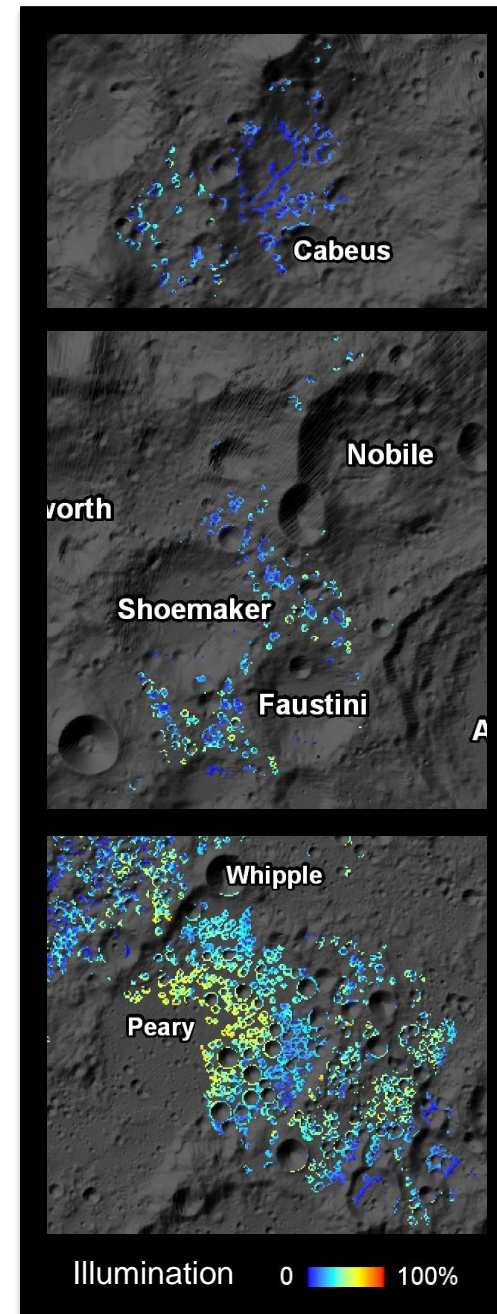
ROI 2: Shoemaker/Nobile vicinities (South Pole)

ROI 3: Peary vicinity (North Pole)

These are:

- Volatile rich ($H > 150$ ppm)
- Can maintain subsurface ice (average annual temp $< 110K$)
- Modest slopes ($< 10^\circ$)
- Adjacent to locations similar to the LCROSS impact site in terms of hydrogen and temperature
- Availability of PSR < 1 km from lit areas

When including Earth visibility and lighting, the north polar Peary vicinity is slightly favored owing to somewhat more persistent lighting, with the Cabeus vicinity showing the least persistent lighting.



Data source:

Average annual Temperature: Diviner, 240m/pix
Paige personal comm.

Hydrogen: Lunar Prospector, 0.5deg/pix

http://pds-geosciences.wustl.edu/missions/lunarp/reduced_special.html

Slope: derived from LOLA DEM, 20m/pix from

http://imbrium.mit.edu/BROWSE/LOLA_GDR/North_pole.html

http://imbrium.mit.edu/BROWSE/LOLA_GDR/South_pole.html

Illumination conditions: model, 500m/pix
Cahill and McGovern personal comm.