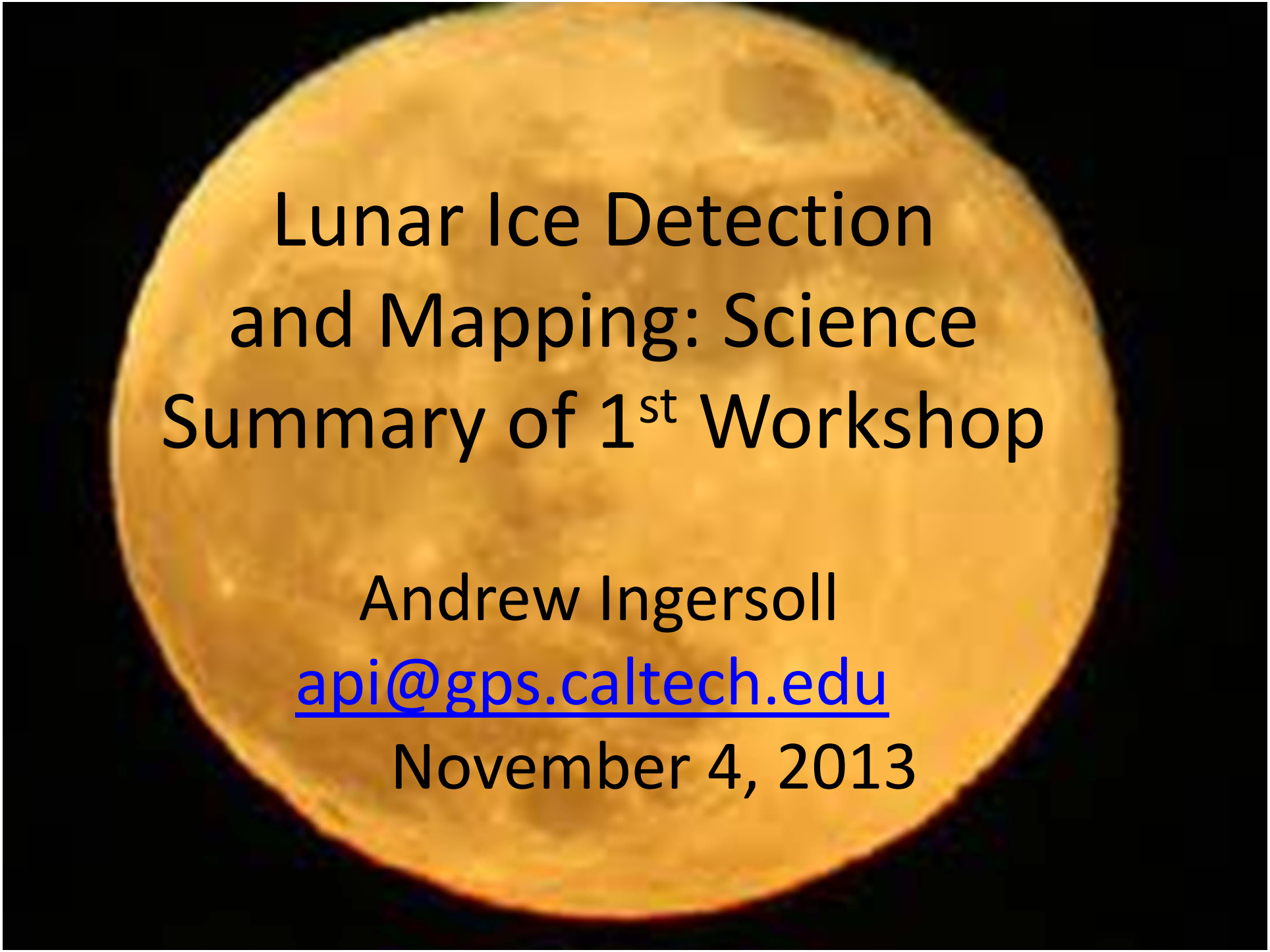

Lunar Ice Detection and Mapping: Science Summary of 1st Workshop

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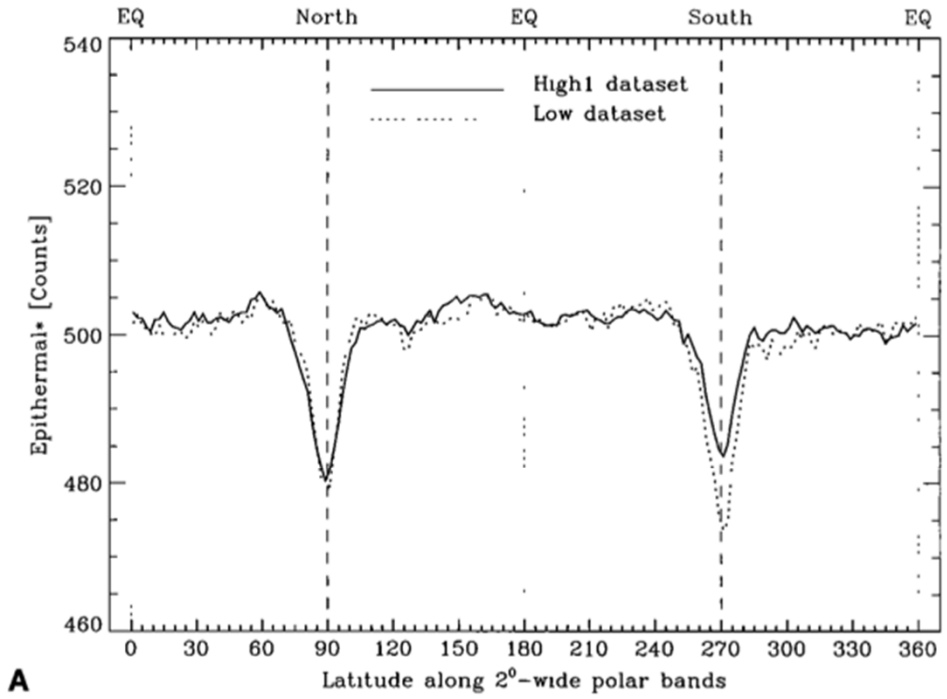
Feldman et al. (2000)
~2 x 10^{15} g ice at lunar poles

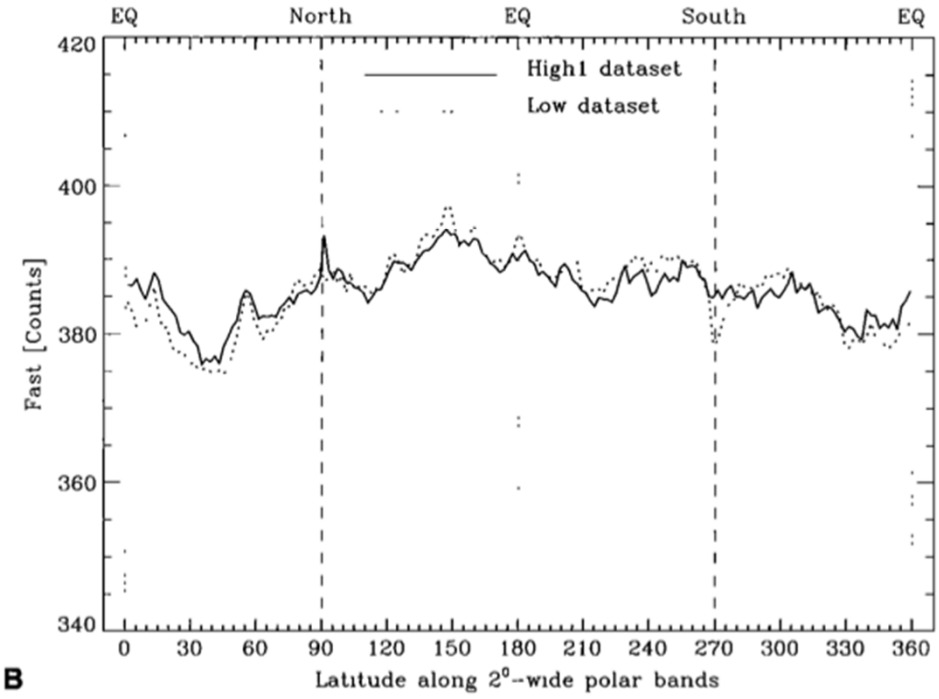
A. Epithermal neutrons
B. Fast neutrons

Low counting rates indicate absorption by hydrogen. Fast neutrons are more sensitive to elements beside H.

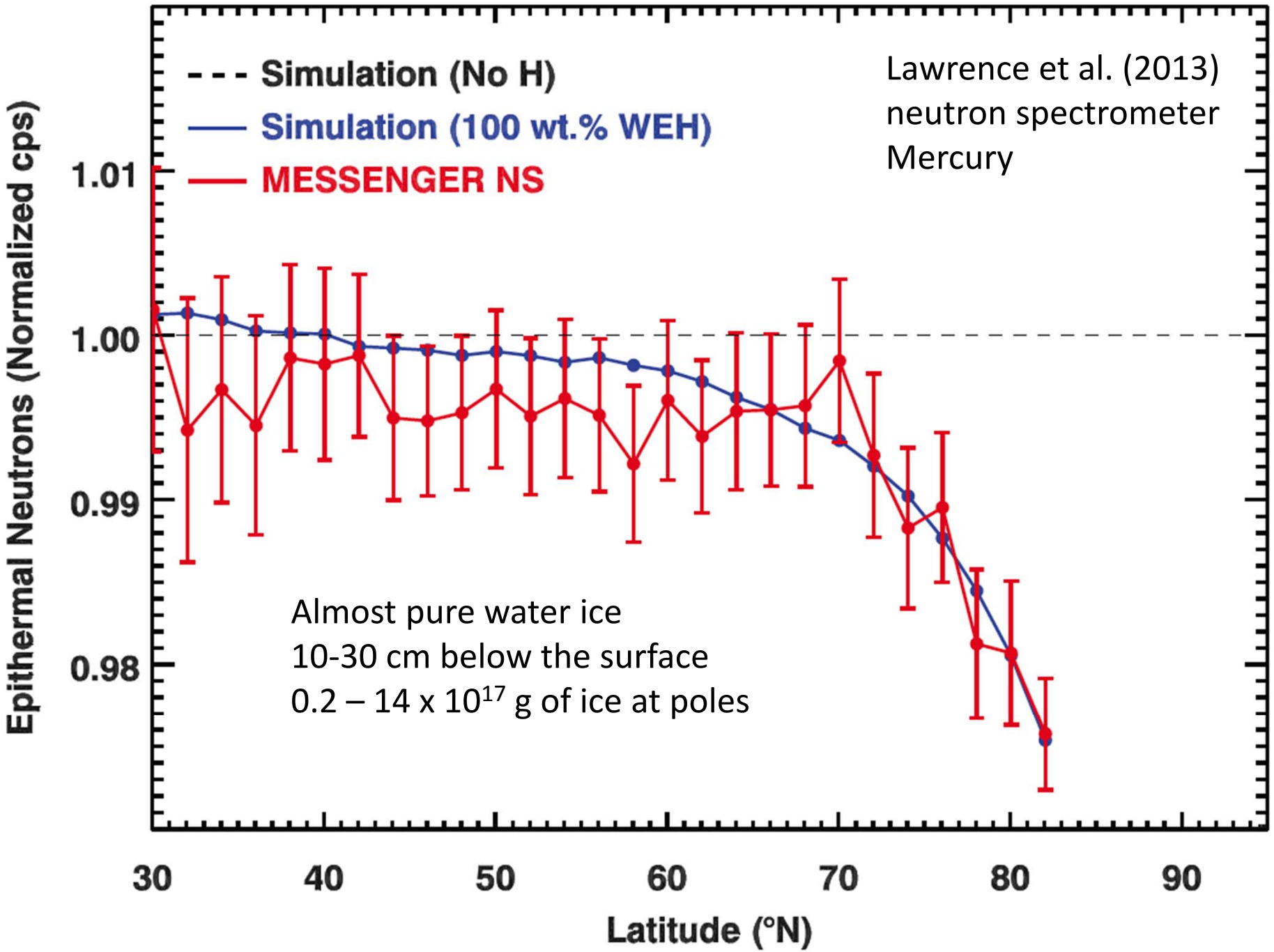
The polar deposits are estimated to be 1.5 ±0.8% by mass of water ice. Any deposits of pure water ice must be at least 1 m below the surface.



A



B


Simulation (No H)
Simulation (100 wt.% WEH)
MESSENGER NS
Lawrence et al. (2013)
neutron spectrometer
Mercury
Almost pure water ice
10-30 cm below the surface
0.2 – 14 x 10^17 g of ice at poles
Epithermal Neutrons (Normalized cps)
1.01
1.00
0.99
0.98
30
40
50
60
70
80
90
Latitude (°N)

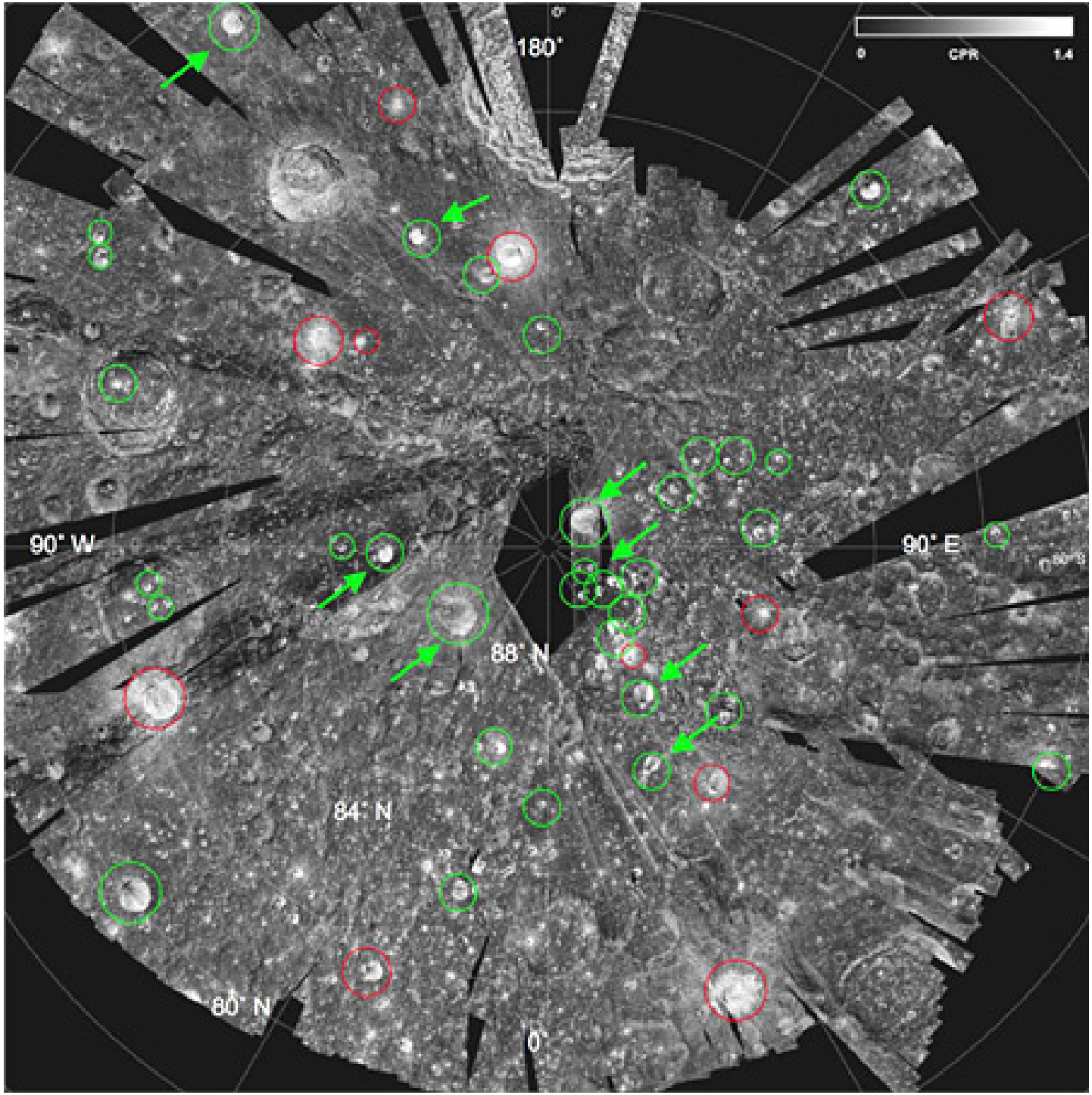
Spudis et al. (2010) Mini-SAR

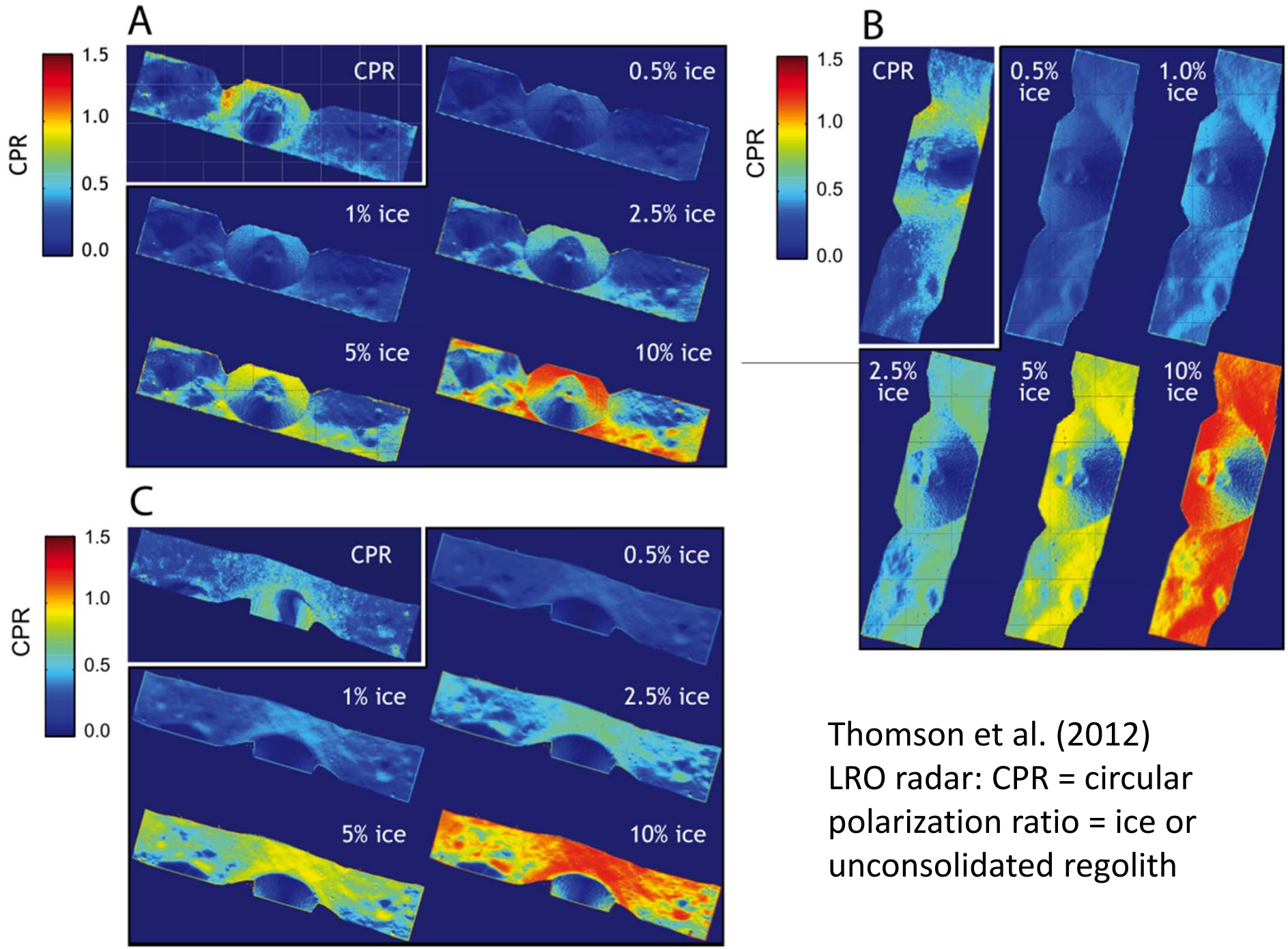
Lunar north pole

CPR = circular polarization ratio

Green = shadowed craters = ice?

Red = fresh craters with high CPR = regolith?

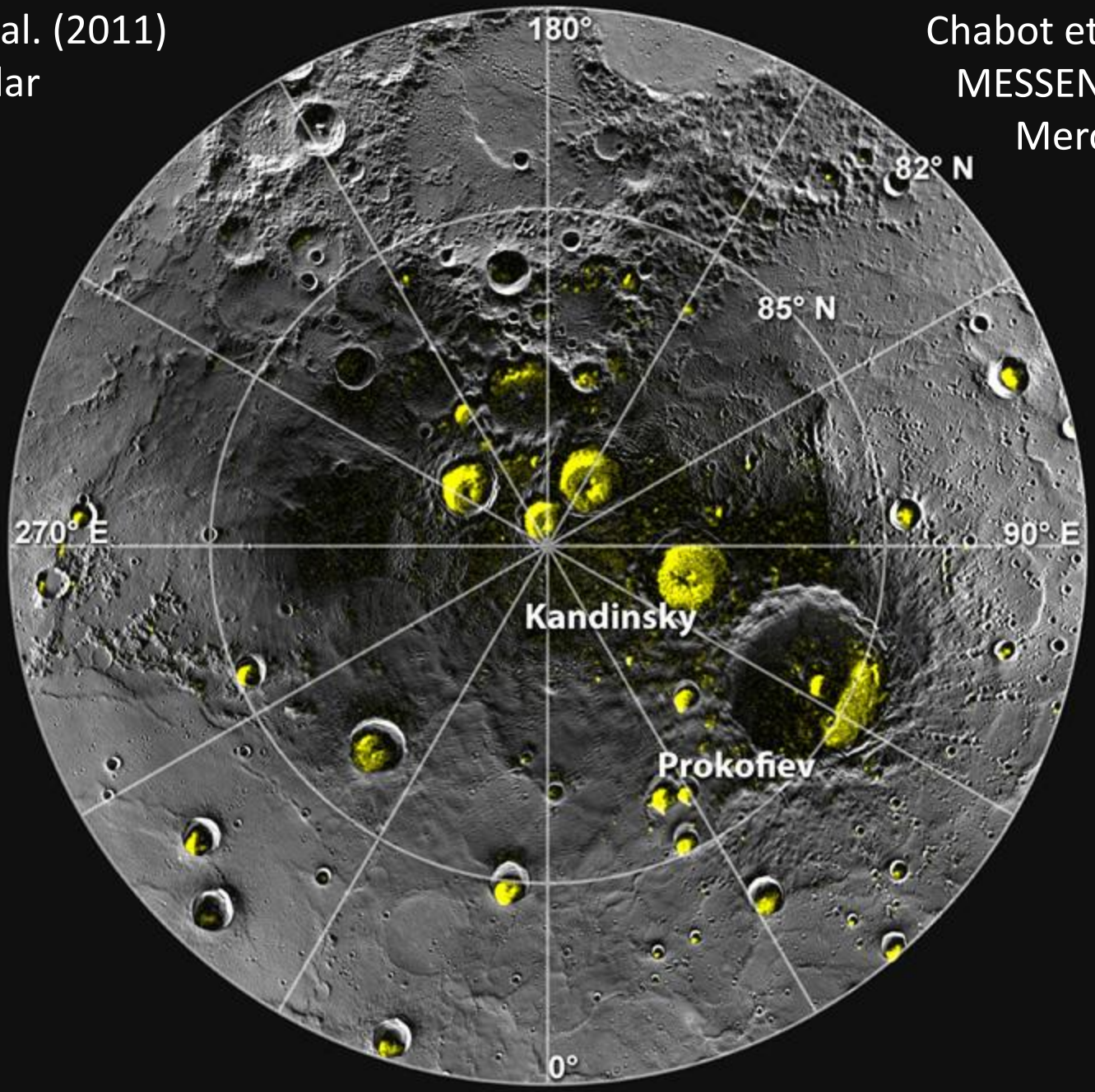


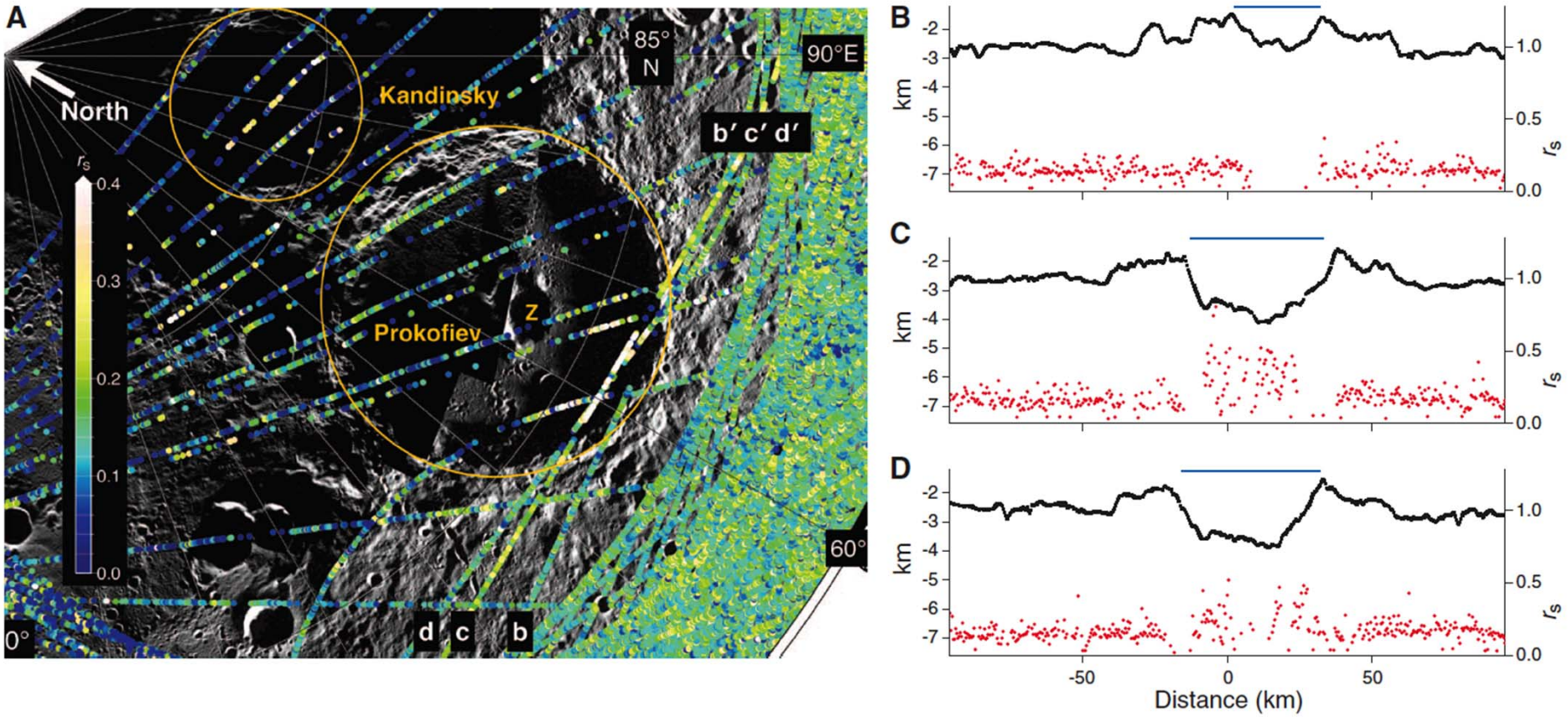


Thomson et al. (2012)
LRO radar: CPR = circular polarization ratio = ice or unconsolidated regolith

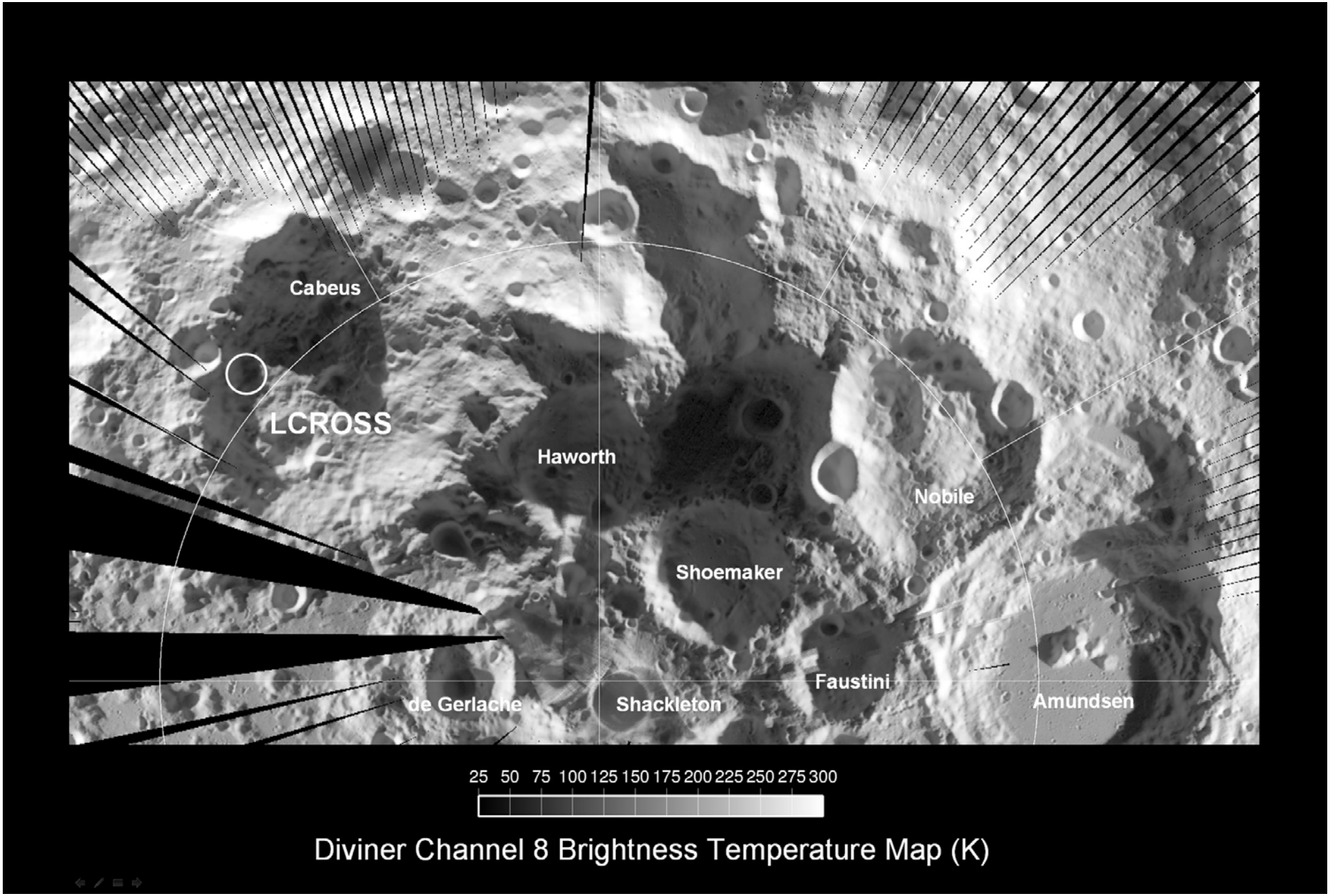
Harmon et al. (2011)
Arecibo radar
(yellow)

Chabot et al. (2013)
MESSENGER images
Mercury





Neumann et al. (2013) reflectivity from MESSINGER laser altimeter



Paige et al. (2010) Lunar Diviner. White circle is at 85° S

Colaprete et al. (2010): Moon. LCROSS ejecta plume

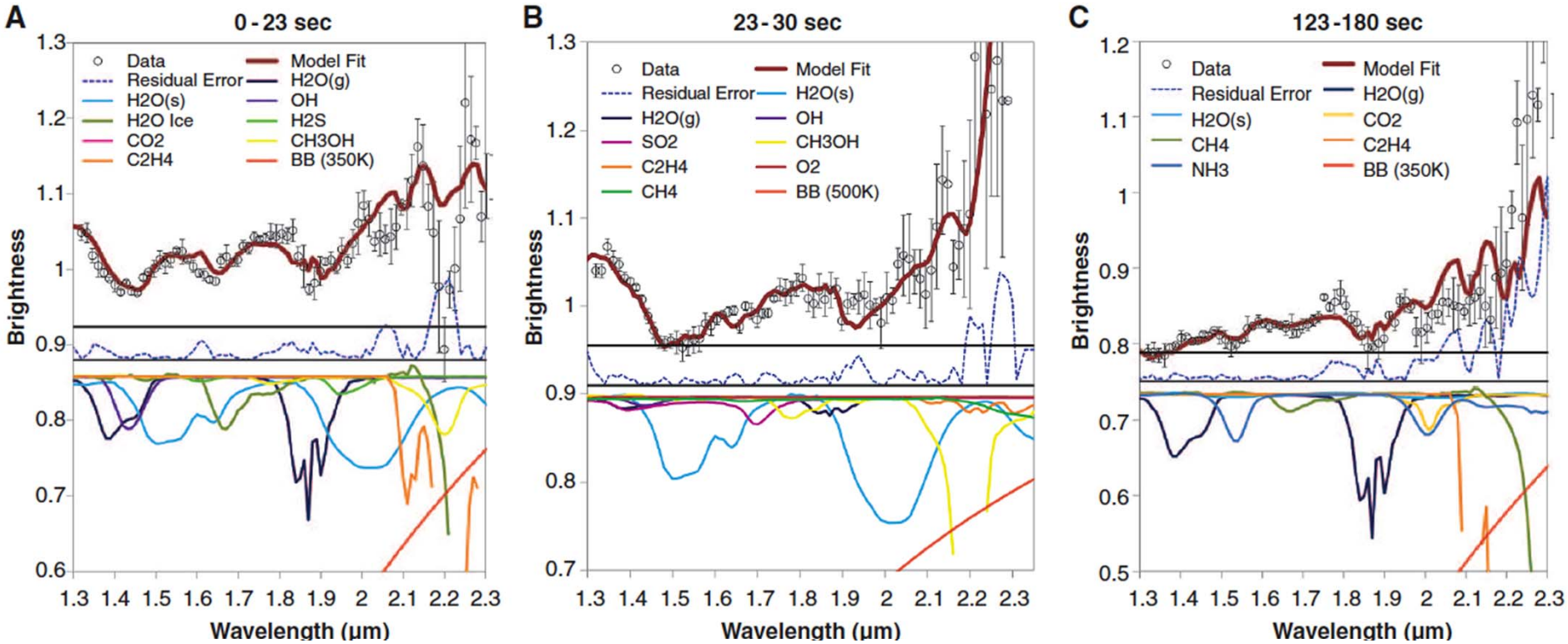
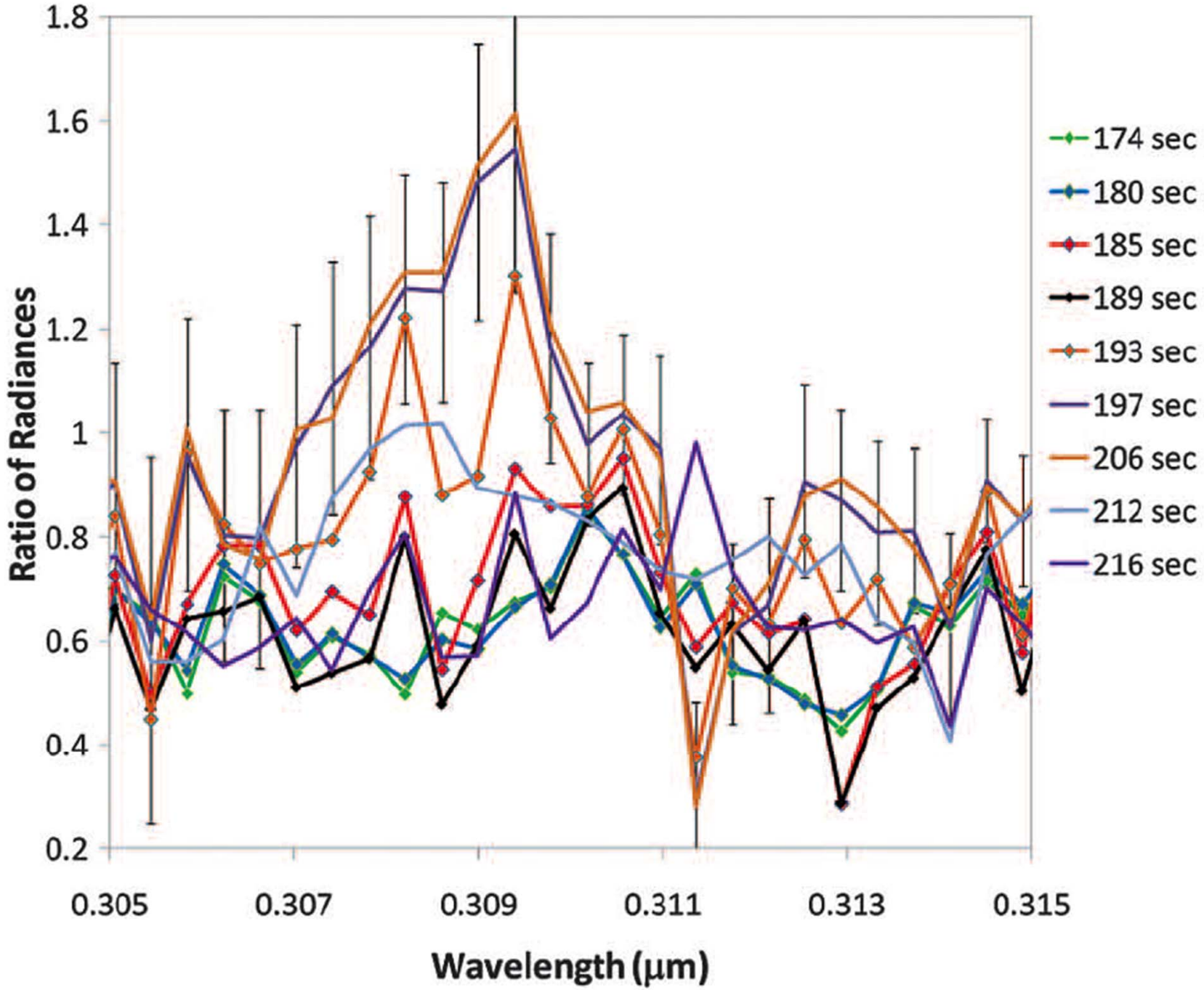


Table 1. Summary of the total water vapor and ice and ejecta dust in the NIR instrument FOV. Values shown are the average value across the averaging period, and errors are 1 SD.

	Water mass (kg)			
Time (s)	Gas	Ice	Dust mass (kg)	Total water %
0–23	82.4 ± 25	58.5 ± 8.2	3148 ± 787	4.5 ± 1.4
23–30	24.5 ± 8.1	131 ± 8.3	2434 ± 609	6.4 ± 1.7
123–180	52.5 ± 2.6	15.8 ± 2.2	942.5 ± 236	7.2 ± 1.9
Average	53 ± 15	68 ± 10	2175 ± 544	5.6 ± 2.9


1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
Ratio of Radiances
0.305
0.307
0.309
0.311
0.313
0.315
Wavelength (μm)
174 sec
180 sec
185 sec
189 sec
193 sec
197 sec
206 sec
212 sec
216 sec

Solar wind particle flux
3×10^{8} cm^{-2} s^{-1} .

Assume it impacts the lunar disk for 3.5 b.y. and produces one H_2O for every 2 particles (100% efficiency, no losses).

Total mass = 4.7×10^{19} g.

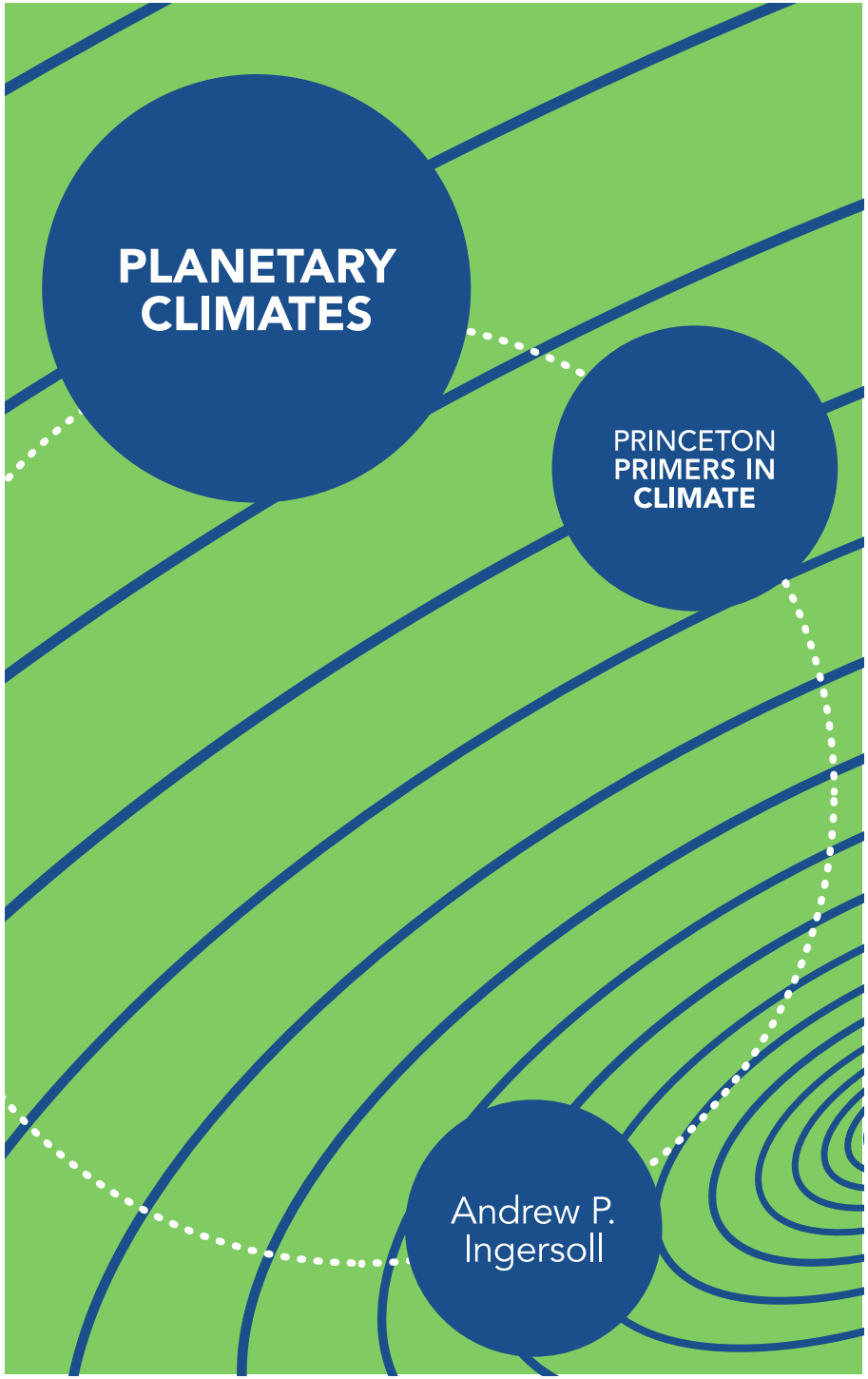
100 x (asteroids + comets)
100 x Mercury ice deposits
10,000 x Lunar ice deposits

Lunar Ice: Questions

- Why does Moon have less ice than Mercury?
- Was ice lost during a high-obliquity period?
- Are there fewer impacting bodies at Moon?
- Is ice buried under a thick layer of regolith?
- Is the ice intimately mixed with the regolith?
- Is ice scattered in micro-shadowed areas?
- What is relative abundance of OH and H_2O?

Lunar Ice: Strategies

- Focus on a single place or global distribution?
- Importance of a clean impact, e.g., metal ball?
- Can we view impact plume from Earth?
- Feasibility of multiple impacts – cluster bombs?
- Ultra-small orbiters at ultra-low altitude?
- Seeing in the dark – starlight, lasers, spectra?
- Landers and rovers – feasibility and cost issues?
- Flagship or low-cost: What is the best strategy?
- Relation to other potential missions?


PLANETARY CLIMATES
PRINCETON PRIMERS IN CLIMATE
Andrew P. Ingersoll

Lunar Volatiles: Principles.1

- KISS: Look beyond the soon-to-be-funded missions of NASA and other agencies.
- Leon Alkalai: Develop a scientific vision; if it is worthy, the missions will follow. Do not be constrained by cost at the outset.
- Meanwhile, NASA HEO Directorate has a rover mission, RESOLVE, scheduled for launch in 2016 and targeted for the polar regions

Lunar Volatiles: Principles.2

- Finding macroscopic ice has been the focus of this workshop. Is this sufficiently scientific and visionary? Should we include resource utilization as one of our objectives?

Lunar Volatiles: Principles.3

- Finding macroscopic ice has been the focus of this workshop. Is this sufficiently scientific and visionary? Should we include resource utilization as one of our objectives?
- Example of something scientific and visionary
- “Understand the origin and evolution of water in the inner solar system”
- Our job is to identify the next step and take it