Focusing on the Water Ice Crystallization from Surface Thermal Flux in Lunar Permanently Shadowed Craters using LRO Diviner

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Introduction

- There are currently uncertainties regarding the thermal stability and surface thermal flux of these Permanently Shadowed Craters (PSRs), particularly on a seasonal scale.
- In this (preliminary) work, we measure the day and night-time bolometric temperatures from Diviner over seven years (2009-2016) of a specific season. We can calculate the surface thermal flux within a crater to either verify or redefine the PSR volatile ice stability.

Methods

- Once the Diviner bolometric temperature are recorded across an impact crater, the average difference in day/night temperatures (ΔT) within a specific season are used to determine the heat transfer Q (in units of W): **$Q = kA(\Delta T)/d$**
- Where k is the thermal conductivity (used as 0.0093 (W m-1 K-1), A is the area of the crater, and d is a uniform thickness (in this study, we used 0.02 m). Q is then be used to determine the surface thermal flux as: **$Q_{IR} = Q/A$**

Future Work

- Knowing the different water ice crystallization regimes gives us insight to the thermal stability of the PSRs
- Expand this work to other times of the sidereal year.
- Thus, the thermal modeling used from this work could help define the amorphous or crystalline state of water ice at PSRs.

Acknowledgments

We gratefully acknowledge the NASA LRO mission and the Diviner Operations and Science Teams for the collecting of this data for continued research.

Results

Wiechert J (85.1°S, 182.8°E)

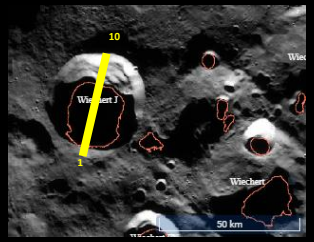

Fig 1: Wiechert J crater from LROC QuickMap. Outlines indicate PSR boundaries. Line indicates traverse site #s (x-axis in charts).

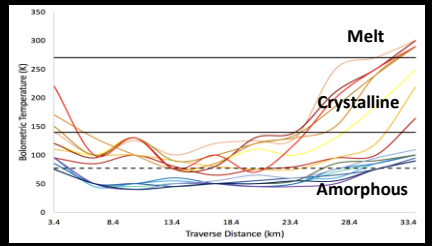

Fig 2: Diviner bolometric temperature (red = day-time, blue = night-time) over multiple years. Water ice crystallization stages labeled. Note **Traverses 2-7** mostly within **amorphous ice** (with possible density changes—dotted line)

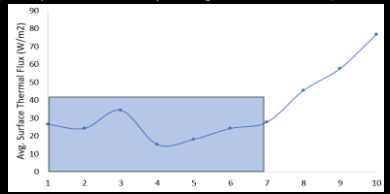

Fig 3: Calculated average thermal flux. Blue box indicates PSR boundary from QuickMap. Note that wide range of thermal flux (**ΔQ_{IR} > 15 W**) could be due to possible density changes of the amorphous/crystalline properties.

Amundsen (84.4°S, 88.2°E)

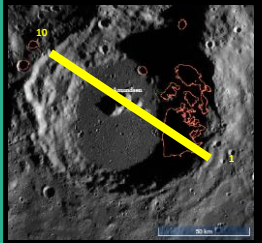

Fig 4: Amundsen crater from LROC QuickMap. Outlines indicate PSR boundaries. Line indicates traverse.

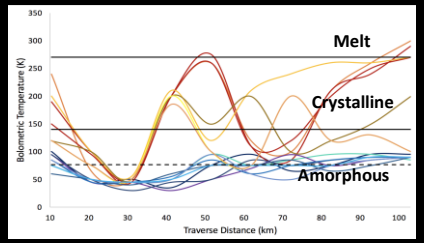

Fig 5: Diviner bolometric temperature over multiple years. Water ice crystallization stages labeled. Note **Traverse 2-3** mostly within **lower-density amorphous** ice

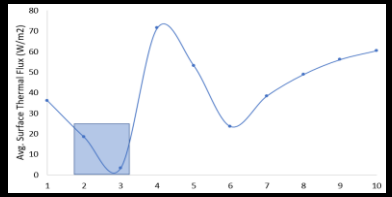

Fig 6: Calculated average thermal flux. Blue box highlights QuickMap PSR boundary. Note lower thermal flux than Wiechert J (**ΔQ_{IR} < 15 W**), which could be due to possible lower amorphous ice density.

Braude (81.8°S, 158.8°E)

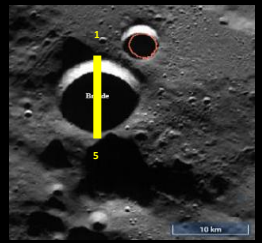

Fig 7: Braude crater from LROC QuickMap. Line indicates traverse.
Note: no current PSR ice observation

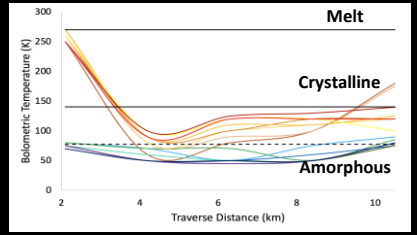

Fig 8: Diviner bolometric temperature over multiple years. Water ice crystallization stages labeled. Note **Traverse 2-4** mostly within **amorphous ice** (with possible density changes—dotted line)

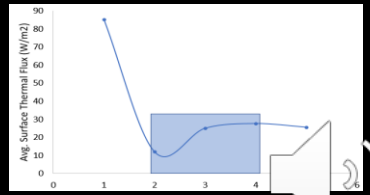

Fig 9: Calculated average thermal flux. Blue box indicates *possible* PSR locations. Note similar thermal flux than Wiechert J (**ΔQ_{IR} > 15 W**), which could be due to density changes within the amorphous ice range.