Pushing the boundaries of lunar ice: the effects of vertical volatile transport in seasonally shadowed regions

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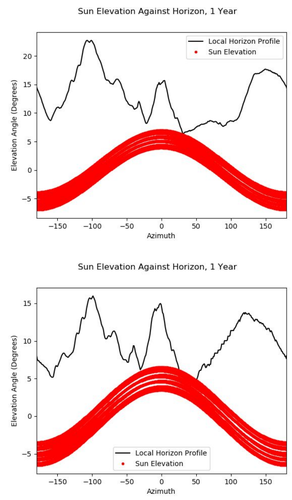
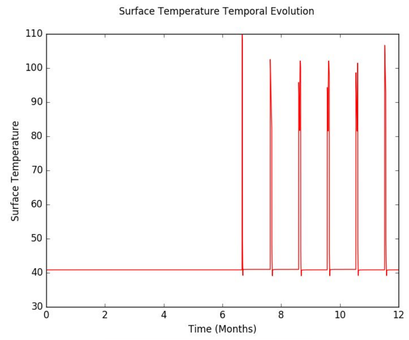
Surface Temperature

- Using LOLA maps to create horizon profiles (right), I find the solar radiation delivered to the surface and converted into surface temperature over the course of a lunar year (below)
- Cabeus pilot study using SSR (lower right)
- Additionally, test using Cabeus SSR with increased temperatures due to solar radiation
- Selected craters: Cabeus, Amundson, Shoemaker, Haworth, Faustini, Idel'son L, Hale Q





Vertical Temperature Profile

- Allow surface temperature changes to propagate through a vertical temperature profile (lower right)
- Density, thermal conductivity, heat capacity change with depth and temperature
- Small time steps (26 seconds) needed due to connection between heat capacity and temperature
- Surface temperature changes take minutes to propagate down 10 cm below the surface, causing a temporal lag in escaping ice
- If such a temporal lag could be observed, it could constrain the vertical mixing rate of ice in SSRs

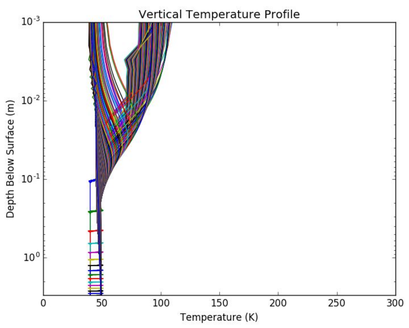
Modeling Vertical Transport Within Seasonally Shadowed Regions (SSRs)

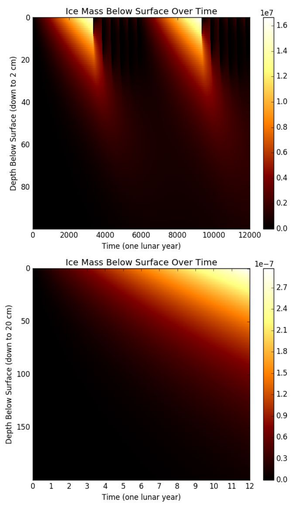
- **Can we use the vertical ice profiles within PSRs to access the geological history of water delivery to the Earth-Moon system?**

- Model vertical ice profiles due to solar wind implanted water ice
- Deviations from this profile in measured vertical ice profiles may indicate additional processes or disruptions in the solar wind implantation process
- But...we need to know the vertical mixing rate of water ice in shadowed regions

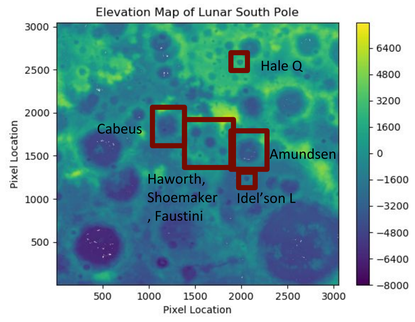
- Like PSRs, SSRs sequester ice beneath their surfaces, but regular sunrises disrupt that process
- We can use these disruptions to measure the vertical migration rate of water ice in shadowed regions

- We are specifically looking for SSRs on the boundary of having stable ice, depending on the vertical mixing rate
- A detection or non-detection of ice in these boundary case SSRs would constrain the vertical mixing rate in shadowed regions

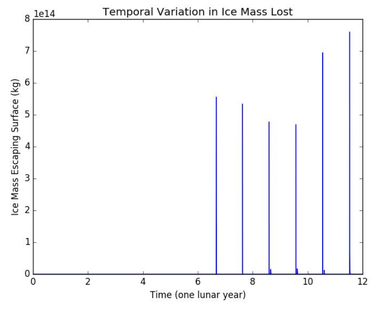




Global Lunar Water Cycle



- 1D Global water migration model that tracks water delivered to the surface by the solar wind implantation method
- Track water ice ballistically hopping in terms of water ice mass landing on the lunar surface in each latitude bin
- Track outgoing water mass from SSRs using residence times that depend on local temperature



Vertical Ice Profile

- Ice deposited at the surface migrates downwards
- Residence time depends on local temperature (vertical temperature profile)
- Ice may migrate downwards far enough that it stays cool enough to remain stable over geological time scales
- Cabeus pilot study, lower left
- Cabeus pilot with increased heat, upper left - some ice remains after surface ice escapes
- Looking for boundary case SSRs where ice MAY be present at a stable depth, depending on the vertical mixing rate
- A detection or non-detection of ice in such boundary case SSRs would constrain the vertical mixing rate of ice in shadowed regions