How do surface shadowing and solar insolation influence seasonal CO₂ gas jet activity and araneiform formation?

Introduction

- Every winter, a translucent slab of CO₂ ice forms at the poles of Mars.
- During spring, solar energy penetrates this slab and sublimates CO₂ from the base, creating a high-pressure gas which erupts through weak spots in the ice.
- Repeated eruptions erode the underlying substrate, producing the so-called araneiform terrain (colloquially called martian “spiders”).

Our aim is to investigate how topography, solar energy input, and time-dependent shadowing influence the distribution of the activity that leads to araneiform formation. Using high-resolution digital terrains models (DTMs) produced from HiRISE stereo images with precise SPICE calculations of the Sun’s position in the local sky, we created integrated flux plots and solar insolation maps for regions of interest at the southern Martian pole.

Changing Surface Angles

- Inclination of the surface influences solar energy input and intensity
- Azimuth direction of the inclined surface also plays a large role in solar energy input and intensity

Solar Insolation Maps

- Solar insolation (resolution of 2m/pixel) based on real-life topography.
- SPICE calculations were used to determine the sun’s location in the local sky for each region of interest.

Integrated Flux at Regions of Interest

- Solar flux was integrated over a period of one day at Inca City and Manhattan
- Using high-resolution DTMs produced from HiRISE with precise SPICE calculations of the Sun’s position, we created integrated flux plots and solar insolation maps for regions of interest.

Conclusions and Future Work

- Using high-resolution DTMs produced from HiRISE with precise SPICE calculations of the Sun’s position, we developed tools to produce solar insolation maps for areas of interest around the martian south pole.
- These insolation maps account for local surface angles (slope and aspect) as well as time-dependent shadowing due to topographical features.
- Future work: Correlate the amount of energy that a feature receives over martian hours, days, or a complete season to the CO₂ jet activity nearby.
- Our goal is to compare insolation maps with the spatial distribution of araneiforms to determine if current insolation is correlated with density of araneiform terrains in different regions of interest.

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References