Planet Four: CO$_2$ jets formed by basal sublimation in Mars’ southern polar regions

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Mars southern seasonal polar CO$_2$ ice cap

Atmospheric CO$_2$ condenses $\rightarrow$ basal sublimation of the polar ice cap $\rightarrow$ gas jet erupts $\rightarrow$ deposits fans and blotches

Directed shape
Influenced by local winds and eruption physics

Elliptical shape
Influenced by eruption physics
The blotches:
- Number
- Time history
- Area
- Eccentricity

Help us understand:
- sublimation and eruption process
- spring winds

Quantify the relationship between the timing of seasonal activity to global dust storm

Describe the physical appearance of the blotches in the most precise way so those descriptions can be used by models

Artist Ron Millers’ concept showing CO$_2$ jets erupting from Martian geysers, published by NASA
Questions we want to answer:

• Hypothesis: deposits interact with ice
  Do blotches look different over time?
• Hypothesis: differences in CO$_2$ ice layer quality affect jet eruption physics
  Do blotches look different at the same time in different locations?
Mars Reconnaissance Orbiter’s (MRO) High Resolution Imaging Science Experiment (HiRISE) camera

Data taken in southern spring during Mars Years 29 and 30 (2008-2009/2010-2011)
Planet Four catalog

• Online citizen science project
• Systematic mapping of shapes and sizes of blotches

Planet Four catalog

• Each HiRISE image (obsid: ESP_020146_0950) is divided into sub-images called “tiles”

• Each tile_id contains many blotches
Map overview of the regions of interest in south polar region for the seasonal monitoring campaign of HiRISE.

- Ithaca
- Portsmouth
- Manhattan
- Oswego
- Starburst
- Giza
- Inca City
- Potsdam
- Buenos Aires
- Macclesfield
Measured parameters

- Solar longitude (Ls) – Martian year divided into 360°. Southern spring starts at 180°

- Area = \( \pi \times \text{radius}_1 \times \text{radius}_2 \)

- Eccentricity = \( \sqrt{1 - \frac{\text{radius}_2^2}{\text{radius}_1^2}} \)

- Map scale (MS) – sampling size varies from HiRISE data
Ithaca: median area vs. $L_s$ for Mars years 29 and 30

- Blue dots: MY29, n>100
- Orange dots: MY30, n>100

Histograms showing the distribution of areas for different $L_s$ values:
- ESP_020146_0950, $L_s=180, MS=1.0$
- ESP_011931_0945, $L_s=207, MS=0.5$
- ESP_012076_0945, $L_s=214, MS=0.25$

ROI: Ithaca

Images of Ithaca with different views and annotations:
Ithaca: eccentricity median vs. $L_s$ for Mars years 29 and 30

- Blue dots: MY29, $n > 100$
- Orange dots: MY30, $n > 100$

![Graph showing eccentricity median vs. $L_s$ for Mars years 29 and 30](image)

![Histograms](image)
ROI: Portsmouth
Median areas over time

Starburst: median area vs. Ls for Mars years 29 and 30

Giza: median area vs. Ls for Mars years 29 and 30

Inca City: median area vs. Ls for Mars years 29 and 30

Oswego Edge: median area vs. Ls for Mars years 29 and 30

Potsdam: median area vs. Ls for Mars years 29 and 30

Buenos Aires: median area vs. Ls for Mars years 29 and 30

Macclesfield: median area vs. Ls for Mars years 29 and 30

Manhattan Classic: median area vs. Ls for Mars years 29 and 30
Conclusions

- Hypothesis: differences in CO$_2$ ice layer quality affect jet eruption physics
  - Trend comparable in many regions $\rightarrow$ 
  - quality of ice similar

- Hypothesis: deposits interact with ice
  - Size of blotches vary $\rightarrow$ interactions of deposits with ice

- Most plots show similar trends for both Mars years 29 and 30 $\rightarrow$ spring sublimation is a constant, yearly-repeating process

- Most plots show both similarities but also clear, distinctive trends for different regions $\rightarrow$ region of interest affects the number, area, and eccentricity of blotches that form

- Inclusion of wind ground transport $\rightarrow$ wind might also affect blotches, data showed more complexity than expected