Investigation of Progression and Distribution of Cryptic Spots in the Richardson Crater

Upper Darby High School, Period 6

Introduction

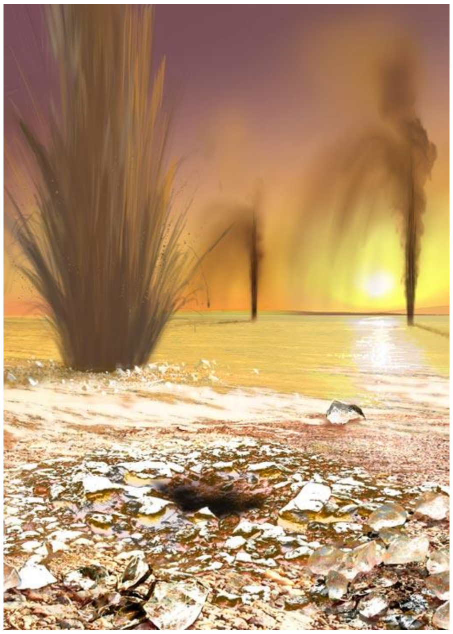
As we begin to gain a greater understanding of Mars, we begin to uncover more mysteries. One of these such anomalies is the cryptic region within Richardson Crater. At first glance, this crater does not appear to be very exceptional in any way; however, as we obtain more detailed images we can see a phenomenon that we have not encountered anywhere else in the universe. Seasonally, we can observe dark spots along the dunes of the crater. These spots are the foundation of our research. The purpose of our investigation is to determine the following:

A. the progression of these spots during the local Martian spring,
B. the relative location of the spots from year to year, and
C. the location of the spots relative to the surface elevation between the dunes to determine if they form at a high or low edge of a slope.

Background

(**http://spacespin.org/article.php/71229-mro-mars-cryptic-terrain**)

The cryptic region where these "dalmatian" spots appear is located near the Martian South Pole, in an area that is covered by the seasonal ice cap.


(http://en.wikipedia.org/wiki/File:Geysers_on_Mars.jpg)

It is believed that these dark spots are created by geysers erupting due to the seasonal sublimation of the CO_2 ice. Every spring, due to the transparent nature of the ice, the Sun's rays penetrate through the ice and heat the ground below. The ground then begins to sublimate the ice from below, creating pockets of CO_2 gas. These pockets join by "spider" streams until enough pressure builds up and creates geysers, carrying dust with the CO_2. The CO_2 disappears into the Martian atmosphere and leaves dark "dalmatian" spots behind.

Methods

We used the HiRise stamps and MOLA colorized elevation over THEMIS IR to gather data about the cryptic features of the Richardson Crater, located in the seasonal ice caps of the South Pole.

A. Progression of spots in Mars Year 28

We used HiRise stamps from solar longitudes 160.163 to 283.398 in order to obtain qualitative data about the progression of spots throughout Mars Year 28. We counted the number of spots on HiRise images for solar longitudes from 160.163 to 210.573 using the crater counting layer. We also measured the area of each stamp using the custom shape layer.

B. Comparison of Mars Years 28 and 31

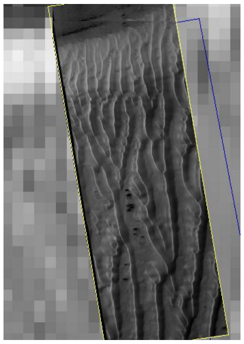
We rendered HiRise stamps from Mars Year 28 and Mars Year 31 from similar solar longitudes so we could see the spots at the same time of year during different years. HiRise stamps PSP_002186_1080_RED from 2007 (Mars year 28) imaged during solar longitude 166.204 and ESP_028611_1080_RED from 2012 (Mars year 31) imaged during solar longitude 165.232 were obtained to gain qualitative data concerning the location of the recurring spots from year to year. We added a crater counting layer to circle the spots on the image from Mars Year 28 and used another layer to display the stamp from Mars Year 31, to compare the regions in which the spots formed.

C. Elevation

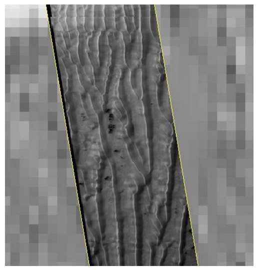
We rendered a Hi Rise stamp and used the MOLA Colorized Elevation over THEMIS IR map. A profile line was drawn to determine the slope between dunes. We then analyzed the location of the spots to determine if they are at a high or low point of the slope.

DATA

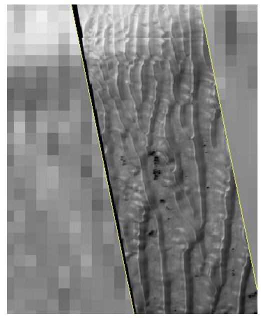
A: Progression of Spots in Mars Year 28 Images



ID: PSP_002041_107_RED
Solar Longitude:(160.163)



PSP_002186_1080_RED
(166.204)



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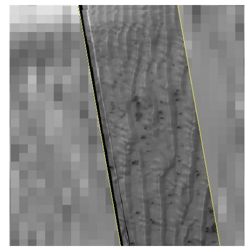
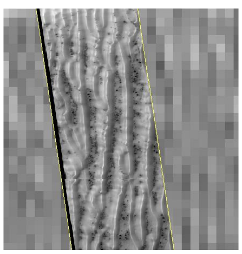
(168.993)



PSP_002397_1080_RED
(175.208)



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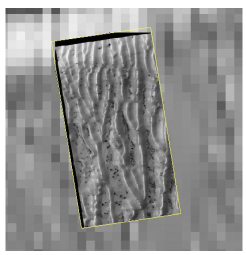
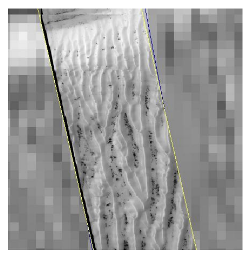
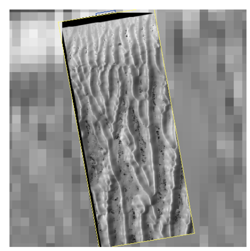
Solar Longitude:(181.545)



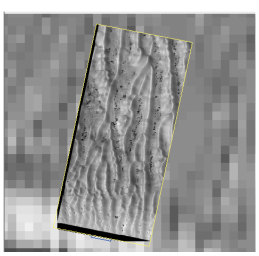
ESP_011640_1080_RED
(194.229)



PSP_002885_1080_RED
(197.001)



PSP_003175_1080_RED
(210.573)



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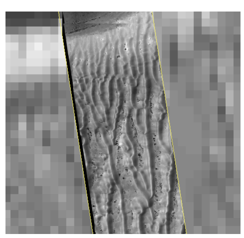
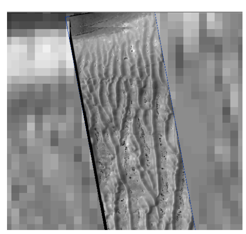
Solar Longitude:(213.174)



PSP_003320_1080_RED
(217.498)



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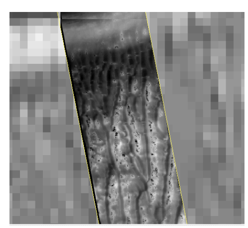
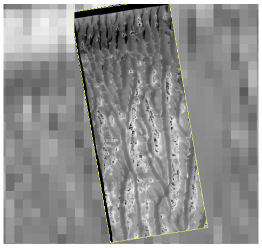
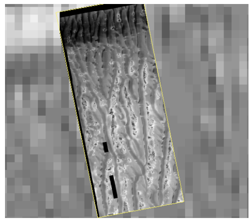
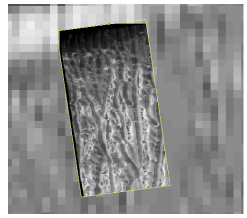
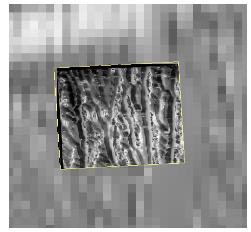
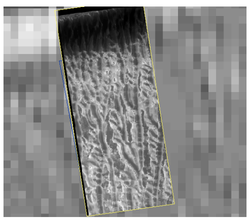
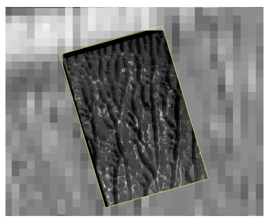
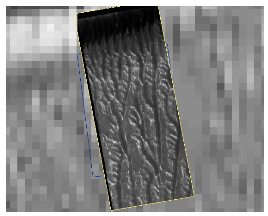
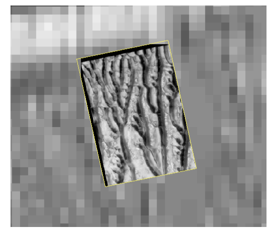
(220.678)



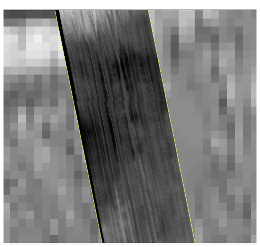
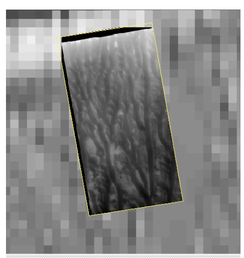
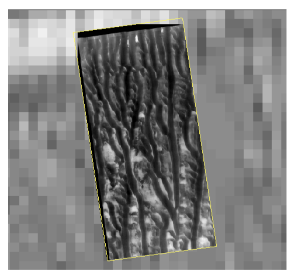
PSP_00359_71080_RED
(230.942)

ID: PSP_003742_1080_RED PSP_003808_1080_RED PSP_003887_1080_RED PSP_003900_1080_RED
Solar Longitudes: (238.061) (241.314) (245.215) (245.857)

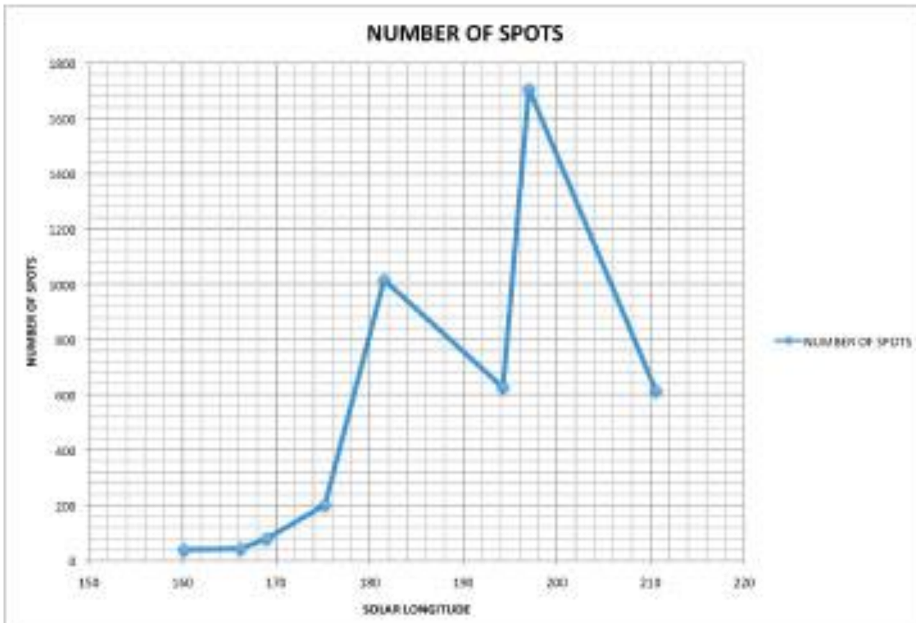
   

ID: PSP_003953_1080_RED PSP_004006_1080_RED PSP_004032_1080_RED PSP_004230_1080_RED
Solar Longitudes:(248.478) (251.009) (252.385) (262.165)

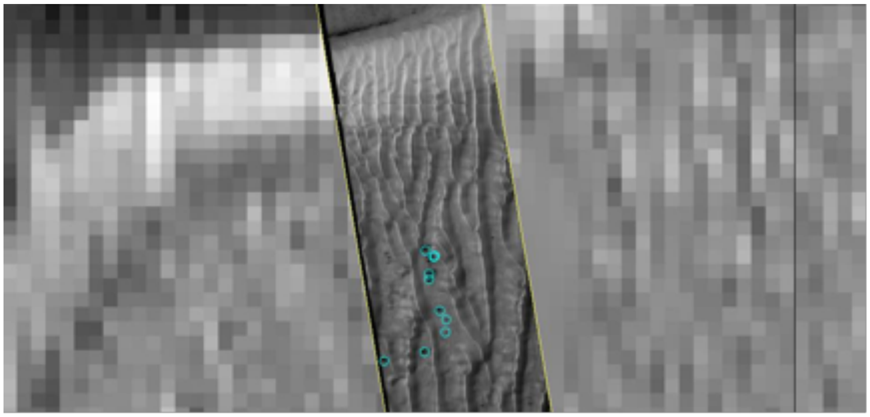
ID: PSP_004375_1080_RED PSP_004520_1080_RED PSP_004665_1080_RED
Solar Longitudes: (269.295) (276.379) (283.398)

SOLAR LONGITUDE	NUMBER OF SPOTS	AREA(km^2)	SPOTS PER km^2
160.163	39	98.057	0.397727852
166.204	43	79.313	0.542155763
168.993	79	76.402	1.034004345
175.208	201	94.741	2.121573553
181.545	1015	126.024	8.054021456
194.229	626	48.593	12.88251394
197.001	1705	74.650	22.83991962
210.573	614	60.683	10.11815500

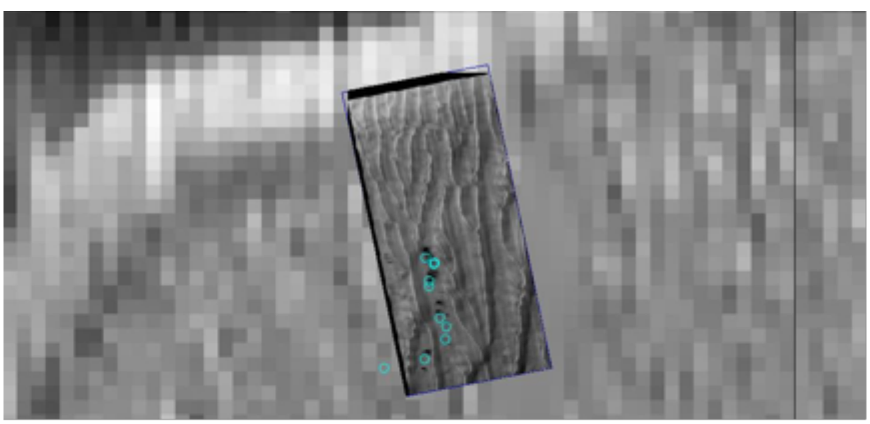


Data continued

B. Comparison of Mars Years 28 and 31



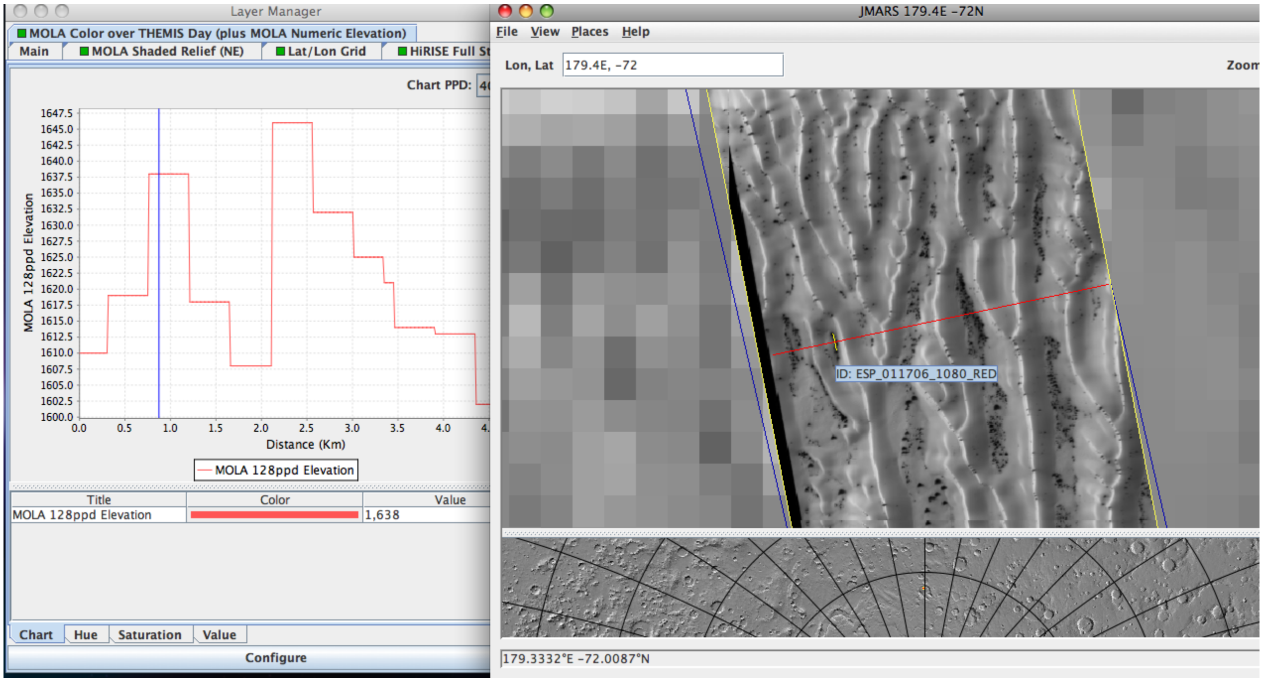
2007 Image ID#: PSP_002186_1080_RED
Mars Year 28, Solar Longitude: 166.204



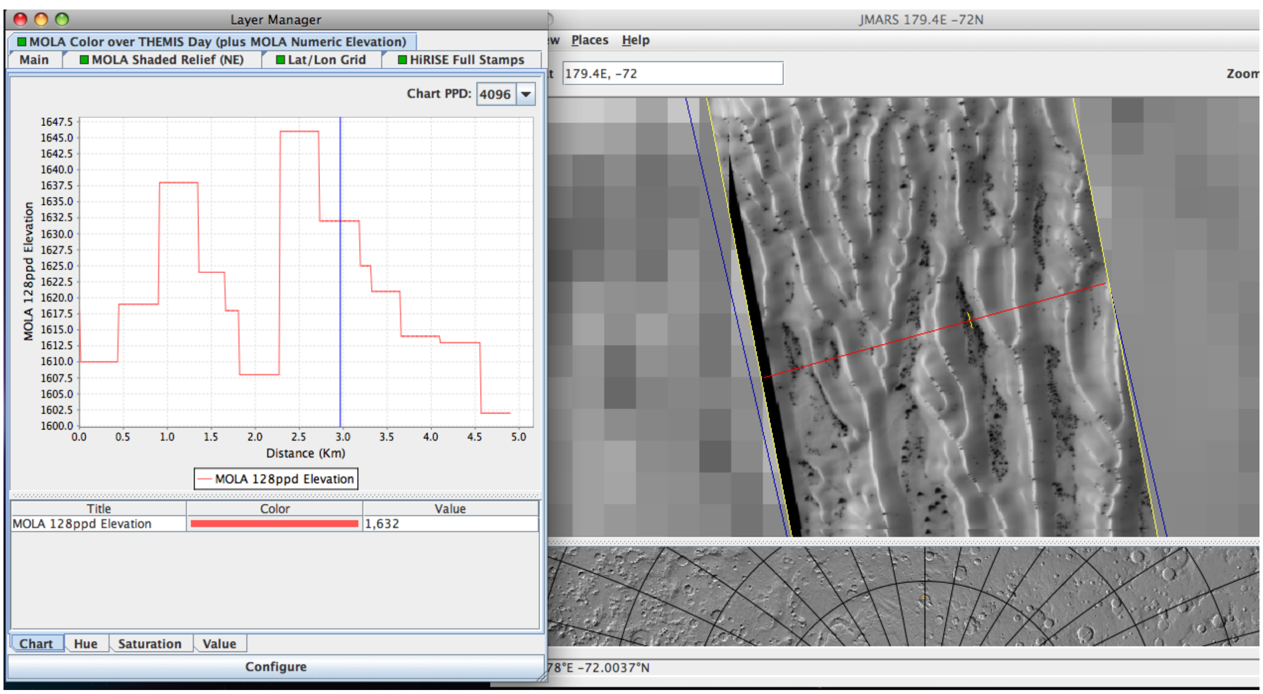
2012 Image ID#: ESP_028611_1080_RED
Mars Year 31, Solar Longitude:165.232

Data

C. Elevation



The spots marked by the yellow line are between a dune with an elevation of 1619 m to the left and a dune with an elevation of 1638 m to the right. The ground between the dunes is sloped uphill from left to right. The spots form to the right, which is uphill.

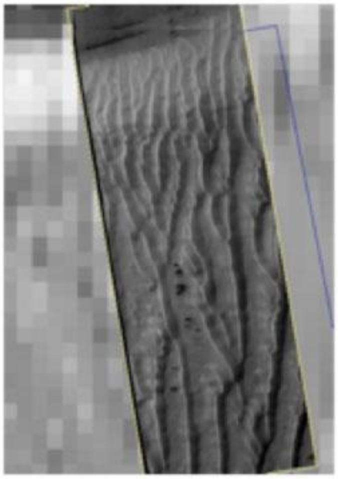


The spots marked by the yellow line are between a dune with an elevation of 1648bm to the left and a dune with an elevation of 1625 m to the right. The ground between the dunes is sloped downhill from left to right. The spots form to the right, which is downhill.

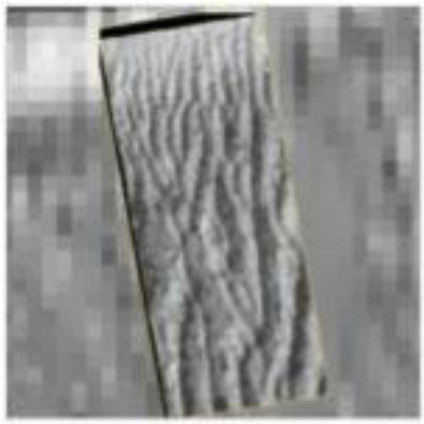
Discussion

A. Progression of spots in Mars Year 28

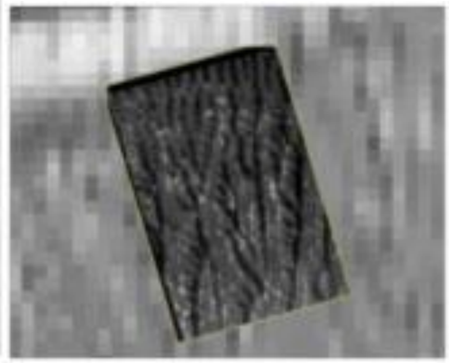
We collected a series of HiRise images of solar longitudes from 160.163 to 283.398.



Solar Longitude 160.163
Spots first appear.

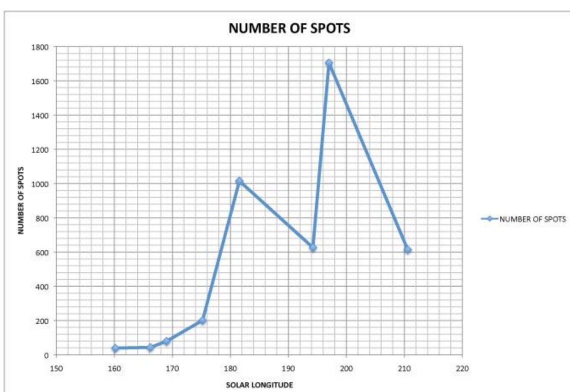


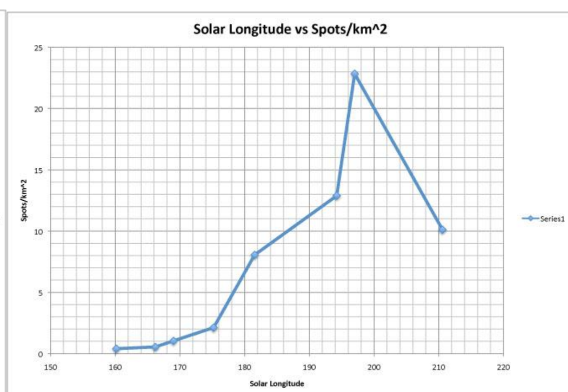
Solar Longitude 210.573
Spots begin to join together.



Solar Longitude 251.009
Spots disappear as ice melts.

Our images show the first sign of spots at solar longitude 160.163. At solar longitude 210.573 some spots are so close together that they join together to form larger spots. From solar longitude 245.215 to solar longitude 248.478, the ice began to sublimate causing the spots to disappear. At solar longitude 251.009, the ice is completely sublimated and there are no spots left behind.



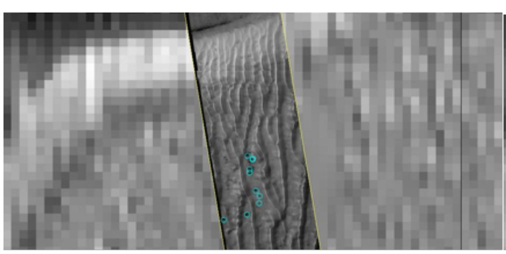


In Part A of the data section, we created two graphs. The first graph is the relation between the solar longitude and the number of spots that we counted, using the crater counter in the JMARS application. The second graph is the relation between the solar longitude and the spots per area. In Graph 1, we can see the shape of an exponential graph becoming distinct, however there is a dip at solar longitude 194.229, which causes a linear change and then the graph rebounds and dips again at solar longitude 210.573. We can see that Graph 1 has a significant dip, which is caused by the stamp having less area than the rest of the stamps that we measured for this research. The rebound is caused by the stamp being bigger, and the ability to see the spots clearly. The second dip has a steeper slope, which is caused by the spots forming into one big spot. The solar longitude stamp at 197.001 has more spots because we can count the separate spots. However, for the solar longitude stamp at 210.573, these spots join together and we count them as one big spot, since we are unable to tell whether this spot is actually a big spot or multiple spots merge together. This joining together of the spots led to inaccuracies or misinterpretations in our data, which can be seen by the dip in the graph. For this reason, we did not count any spots after solar longitude 210.573.

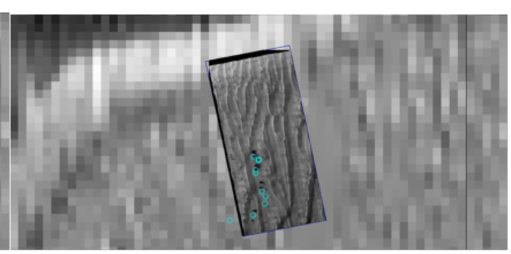
In Graph 2 of Part A, we can see the similarities in the shape of the graphs. It begins as the shape of an exponential graph, and continues to include linear changes. This is similar to Graph 1. However, unlike in Graph 1, there is not a dip at solar longitude 194.229, but instead the increase trend continues. This is because of the lower area of this stamp. There is a dip at solar longitude 210.573 like in Graph 1. Also like in Graph 1, the reason for this inaccuracy is because groups of spots merged into a single, larger spot.

B. Comparison of Mars Years 28 and 31

In part B of the data section, two HiRise images were compared to determine if the spots form in the same region each year. The first image was taken in Mars Year 28 and the second image was taken in Mars Year 31. The two images were compared by adding a crater counting layer to identify the spots visible on the stamp taken in Mars Year 28. The layer showing the stamp from Mars Year 31 was then added to determine whether or not the spots from both stamps aligned with each other.



Mars Year 28

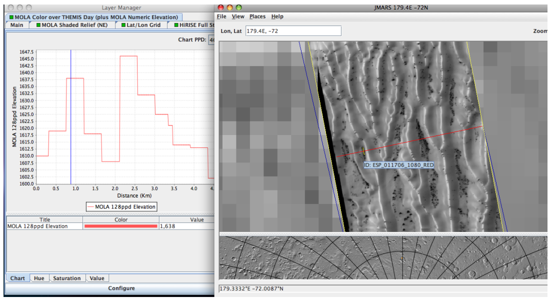


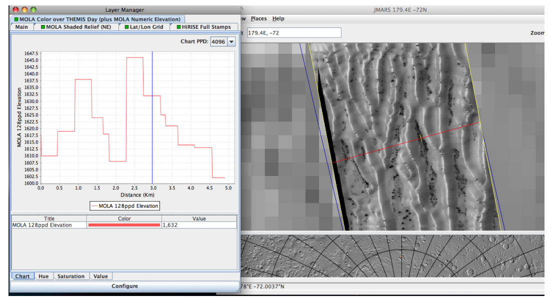
Mars Year 31

After careful analysis, one would conclude that the spots occur in the same region from year to year. A source of error could be the focus on a marginal area of the crater that the spots are located at instead of using images from various parts of the crater to obtain more accurate data.

C. Elevation

In part C we were attempting to identify a correlation between relative elevation and formation of the spots.





However, after collecting data from JMARS we found formations of the spots going both uphill (as show in the image above to the left) and downhill (as shown in the figure above to the right). Therefore, we are unable to conclude that elevation has any effect on where the spots form.

Error in collecting data could have occurred because the images and elevations were pixelated.

Conclusion

We conducted our research to determine the following information about the spots on the Richardson Crater:

A. the progression of these spots during the local Martian spring,

B. the relative location of the spots from year to year, and

C. the location of the spots relative to the surface elevation between the dunes to determine if they form at a high or low edge of a slope.

In examining the progression of the spots, we found that there was an increase in spots up to a certain solar longitude, 194.229, and then the spots begin to merge together at longitude 210.573 and then disappear as the ice sublimates. The ice is totally sublimated by solar longitude 251.009, so that all of the spots are gone by that time.

Based on the data from the HiRise stamps from 2007 and 2012, we concluded that the spots located in cryptic regions occur in the same place from year to year.

With our collected data, we were unable to determine any correlation between the formation of the spots and elevation of the dunes because we observed spots forming in an ascending and descending manner.

Our work could be expanded if we were to obtain additional information, such as more detailed HiRise images from a broader range of places over a longer period of time. Perhaps with this we could form a more solid hypothesis about why these spots form in the first place. But for now we would like to thank our sponsor, Roseann Burns and the MSIP program for giving us this opportunity to research such an important scientific matter.

References

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