Tracking Jupiter's Great Red Spot

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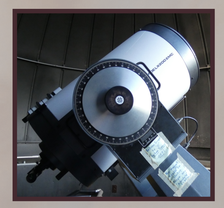
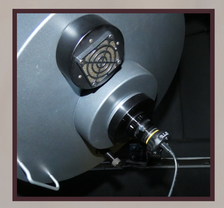
Introduction

- Jupiter's gaseous atmosphere causes differential rotation where the bands and zones rotate at different speeds along the latitudes
- The Great Red Spot (GRS) is a large storm lasting for centuries that is an easily identifiable feature on Jupiter
- It is estimated the GRS speed is 11.5 km/s around Jupiter's 22° south latitude

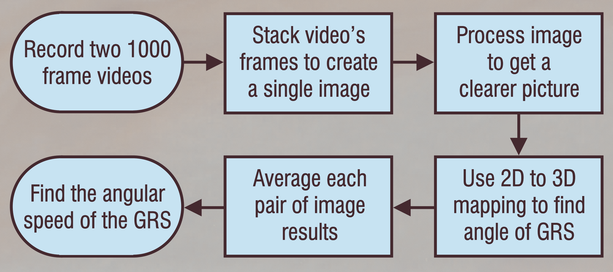
Equipment





The telescope and Neximage webcam at the W. M. Keck Observatory at PLU

Strategy



Benefits of Image Processing

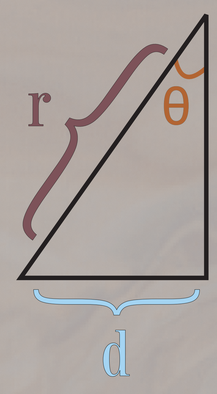
ABSTRACT

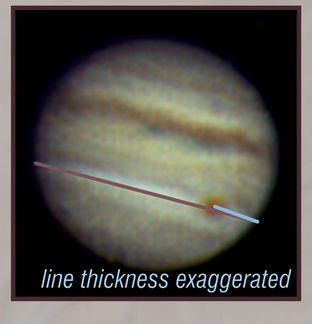
Jupiter's atmosphere is subject to differential rotation in which the bands and zones of the planet rotate at different speeds. The Great Red Spot (GRS) is located 22° south of Jupiter's equator and has a drift velocity which changes its rotational period monthly. We use feature tracking and 2D to 3D mapping techniques to observationally determine the rotation of the GRS and compare it to the expected rotation rate of 11.5 km/s determined by observations of the magnetosphere. Through our analysis we observe the movement of the GRS over multiple nights and construct an average speed based on this data. We determine the average speed of the GRS to be around 10.97 km/s, a 4.60% difference from the expected value.

2D to 3D Mapping

- Measure the diameter of the GRS's circular trajectory (purple) to get the radius (r)
- Measure the distance from the side of Jupiter to the center of the GRS (blue)
- Calculate distance from GRS to center of trajectory (d)
- Find angular displacement

$$\theta = \arcsin(d/r)$$

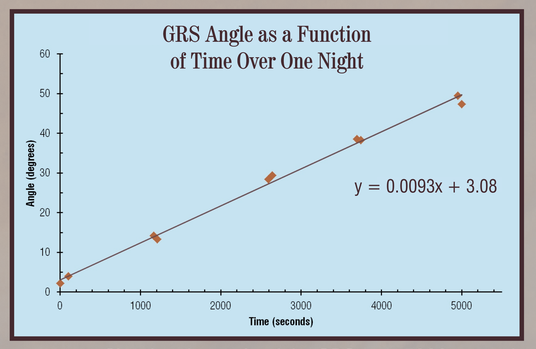




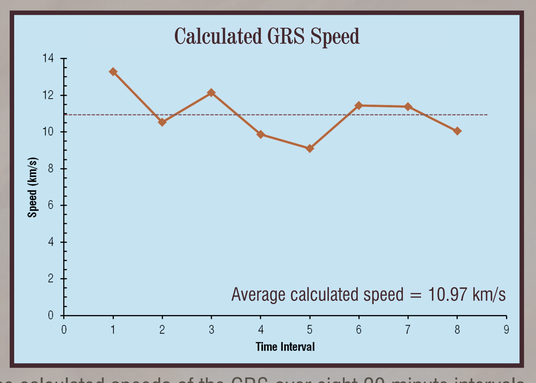
It is important that the entire GRS is in view and it is not being warped by the edges of Jupiter

Results

- Calculated an average speed of 10.97 km/s, only 4.60% off from the expected 11.5 km/s



Charting the angle of the GRS over 5000 seconds



The calculated speeds of the GRS over eight 20 minute intervals

Improvements

- Define an angular range where the effects of warping from Jupiter's curve are negligible
- Collect more videos over shorter time intervals to gather more data to compare and factor into average speed
- Study image processing and stacking techniques to more clearly define the GRS in images

Acknowledgments

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Background image by NASA