Iris CubeSat:

Method for Determining Atomic Oxygen Interaction

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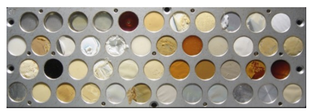
Introduction

Atomic Oxygen (AO) effects the optical properties of materials in space. Missions like OSIRIS-Rex are bringing asteroid samples back to Earth from space; these samples are going to change once they reach our atmosphere due to AO.

OSIRIS-Rex [1]

Example of erosion on materials from MISSE-2 Satellite [2]:

Pre-Flight Samples



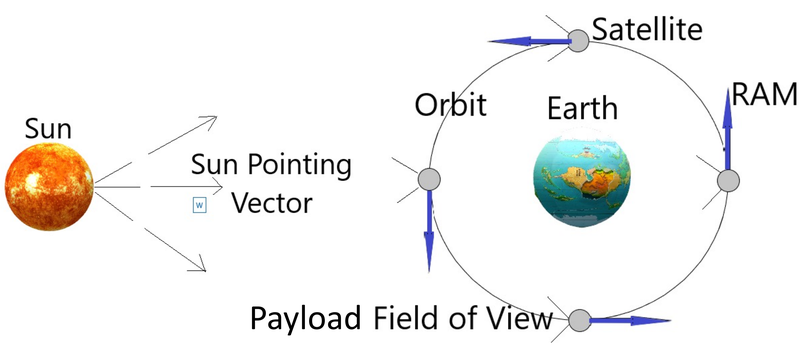
Post-Flight Sample

STARLab wants to understand the extend of AO exposure to predict the expected optical changes

Objective

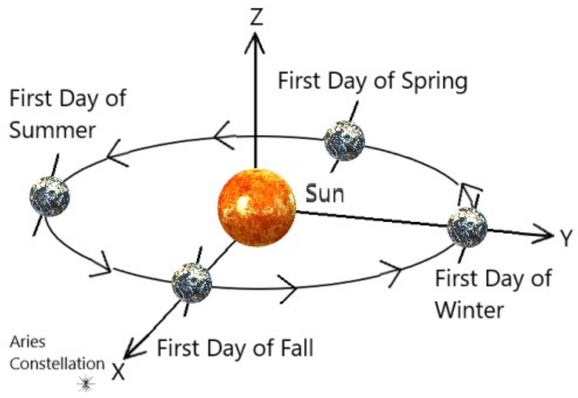
1. Determine the angle between the direction of motion (RAM) and the payload samples (always facing the Sun).
2. Determine the amount of expected AO.

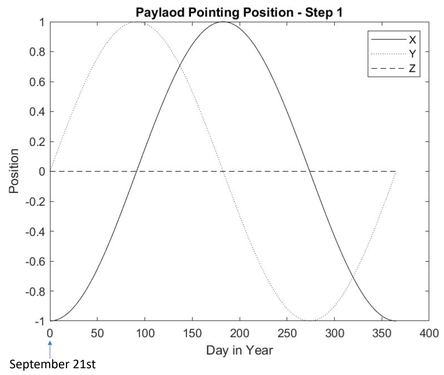
Approach



1. Determine Sun vector, with no Earth tilt.
2. Determine Sun vector with Earth tilt included.
3. Include orbital orientation.
4. Determine AO flux on payload samples.

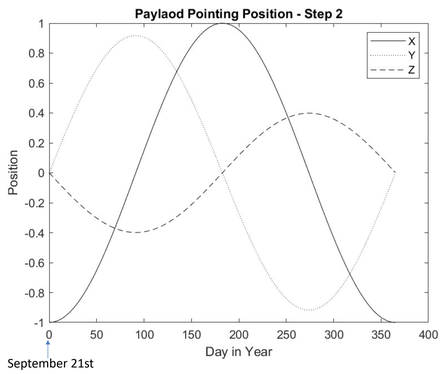
Results





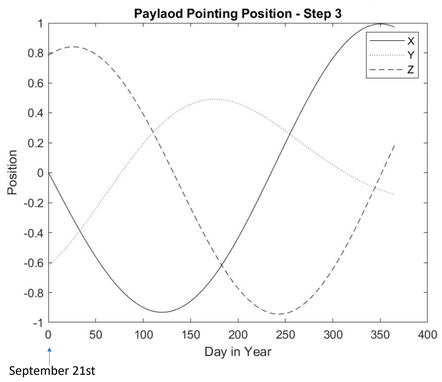
Step 1 Assumptions:

- The Sun is a fixed point.
- Circular Earth orbit.



Step 2 Assumptions:

- The Earth's tilt is 23.5^o.

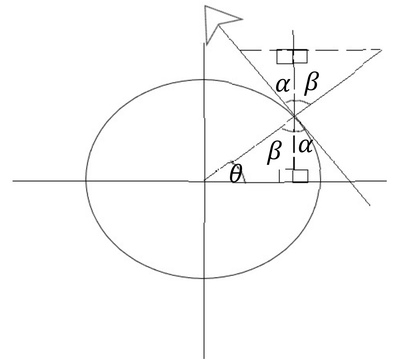


Step 3 Assumptions:

- The satellite's orbital plane precesses due to the oblateness of the Earth.
- Orbital inclination: 51.6^o.
- Altitude: 400 km.

$$\vec{R} = \begin{bmatrix} -\sin\theta \\ \cos\theta \end{bmatrix} \text{ (RAM)}$$

Step 4:
23.3%
AO flux



Angle Identities:

$\beta = 90 - \theta$

$\alpha = \theta$

Conclusion

The previous analysis used classical orbital mechanics to predict atomic oxygen exposure to the Iris payload.

While AO may pose a problem, it is only present less than a quarter of the year. With this information, colleagues at the University of Winnipeg, can now predict the optical changes caused by AO.

Software

MATLAB®

Acknowledgments

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References

[1] D. S. Lauretta, "OSIRIS-Rex Asteroid Sample-Return Mission," *Handbook of Cosmic Hazards and Planetary Defense*, pp. 1–21, 2014.

[2] De Groh, Kim K., et al. "MISSE 2 PEACE polymers atomic oxygen erosion experiment on the international space station." High Performance Polymers 20.4-5 (2008): 388-409.