

## Design and Optimization of Steering Laws for Geocentric Solar Sailing

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**Publication date**

2021

**Document Version**

Final published version

**Citation (APA)**

Wilkie, W. K., Cook, S. M., Carzana, L., Heiligers, M. J., & Heaton, A. F. (2021). *Design and Optimization of Steering Laws for Geocentric Solar Sailing*. 35th Annual Small Satellite Conference.

**Important note**

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# Design and Optimization of Steering Laws for Geocentric Solar Sailing

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**35<sup>th</sup> Annual Small Satellite Conference**  
August 7-21, 2021



National Aeronautics and  
Space Administration



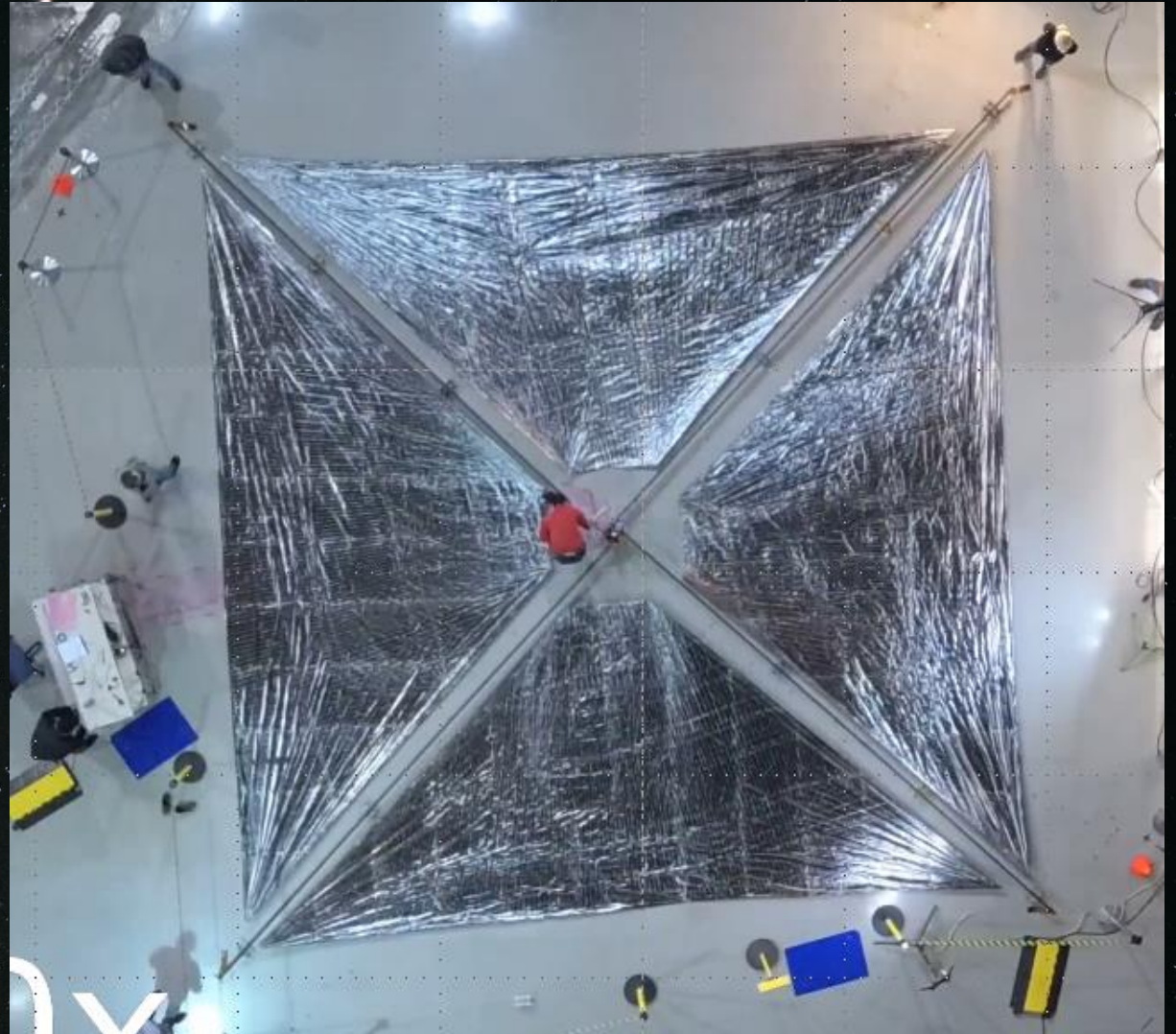


# ACS3: Advanced Composite Solar Sail System

The upcoming NASA Advanced Composite Solar Sail System (ACS3) will be the first spaceflight application of NASA's newest smallsat deployable composite boom technology, and NASA's first practical solar sail.

The 12U ACS3 satellite will deploy an 80 m<sup>2</sup> solar sail from a 715 km Sun-synchronous or mid-inclination circular orbit using its deployable composite booms. Total mass of the ACS3 sailcraft is approximately 16 kg. ACS3's solar radiation pressure characteristic acceleration is 0.05 mm/s<sup>2</sup>.

As the ACS3 solar sail will fly in a low Earth orbit, its trajectory will be highly affected by different perturbations typical of the near-Earth environment. Disturbances such as **aerodynamic drag** and **eclipsing** can be of the same order or greater than forces caused by solar radiation pressure and pose substantial challenges to the control and operation of solar sailing spacecraft in low Earth orbits.





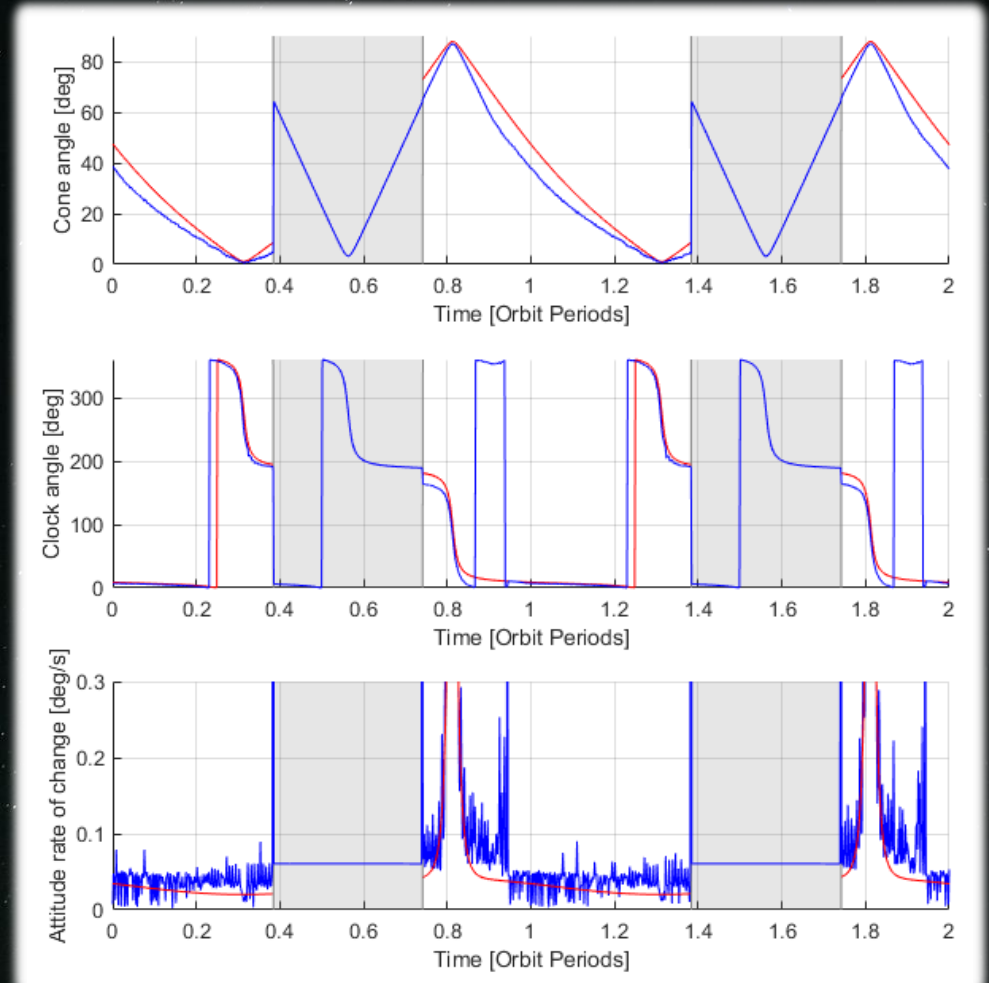
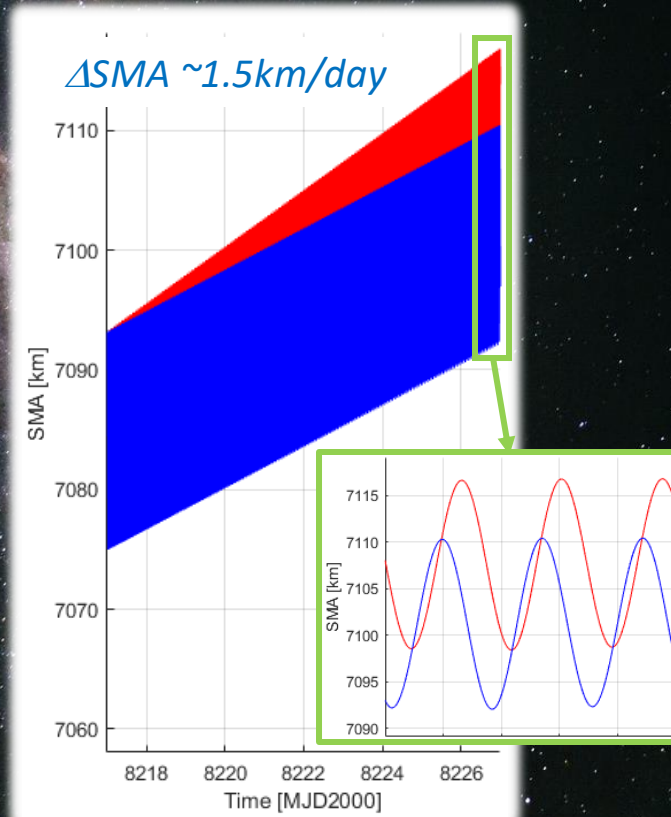
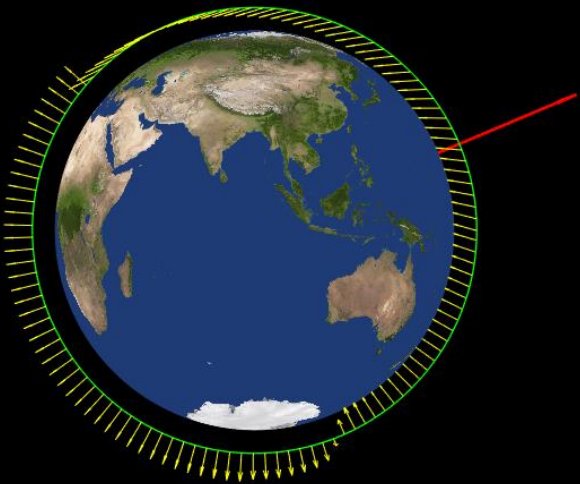
# ACS3 Trajectory Design: Orbit Raising

Ideal reflection sail model with characteristic acceleration of  $0.05 \text{ mm/s}^2$   
Dynamical model with SRP and  $J_2$  acceleration, **with** and **without** aerodynamics, 715 km-altitude Sun-synchronous noon-midnight circular orbit.

Simulation start date: July 1, 2022

Initial SMA: 7093.160 km

Steering law: orbit raising





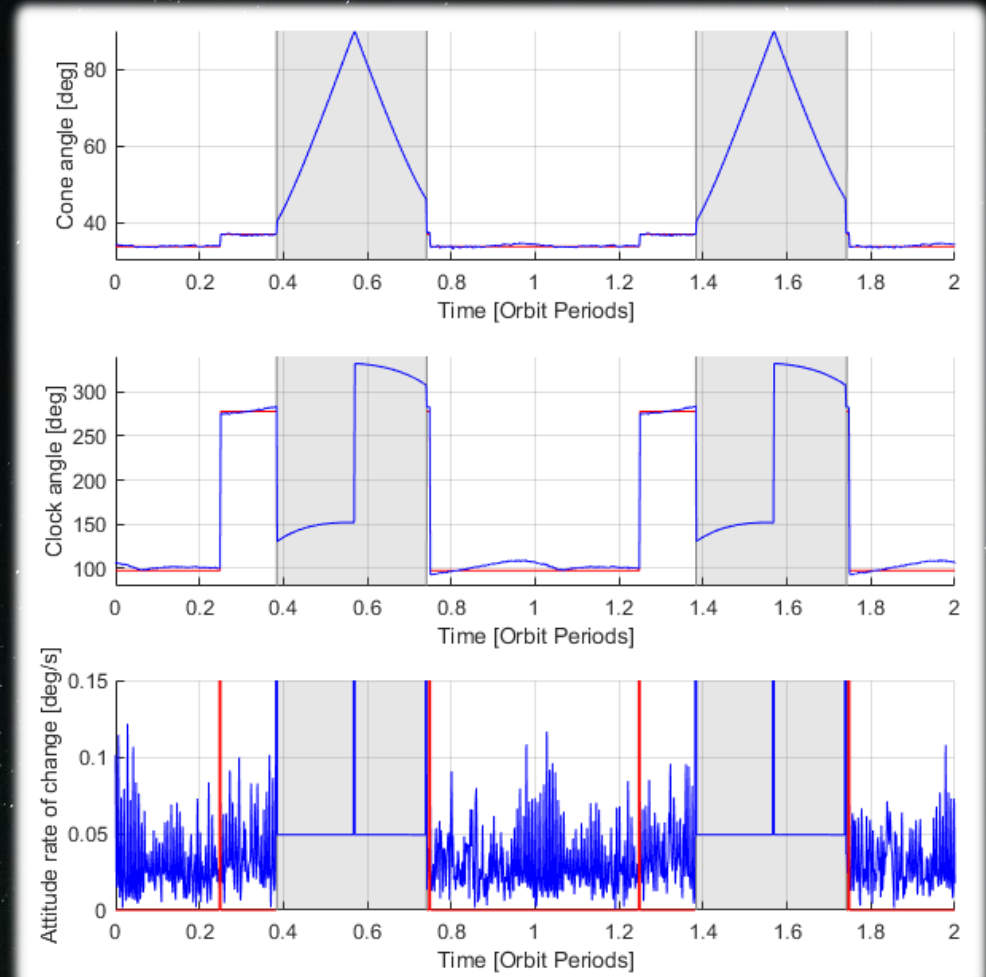
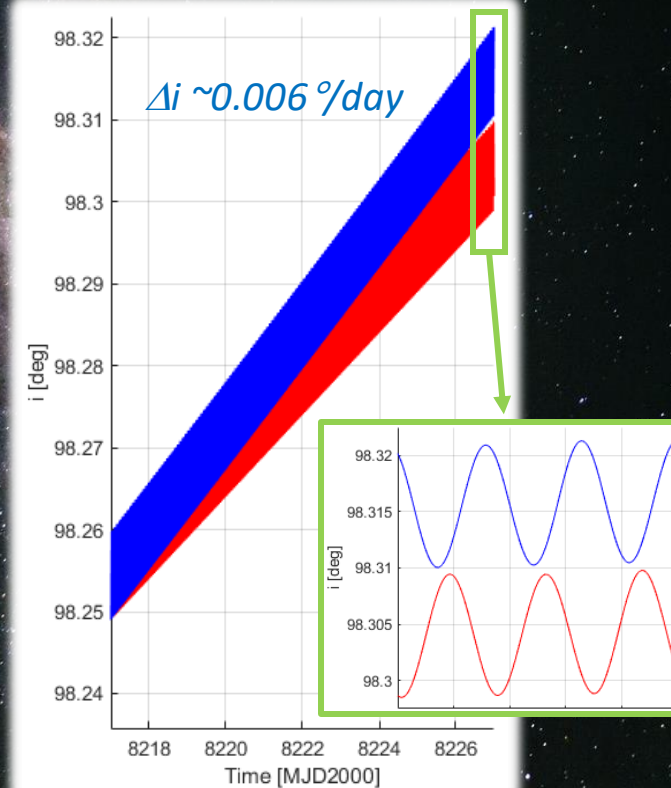
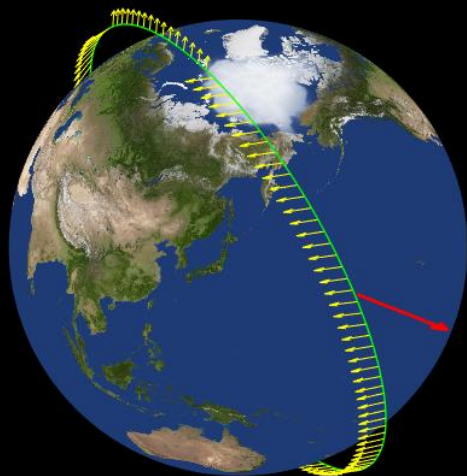
# ACS3 Trajectory Design: Inclination Change

Ideal reflection sail model with characteristic acceleration of  $0.05 \text{ mm/s}^2$   
Dynamical model with SRP and  $J_2$  acceleration, **with** and **without** aerodynamics, 715 km-altitude Sun-synchronous noon-midnight circular orbit.

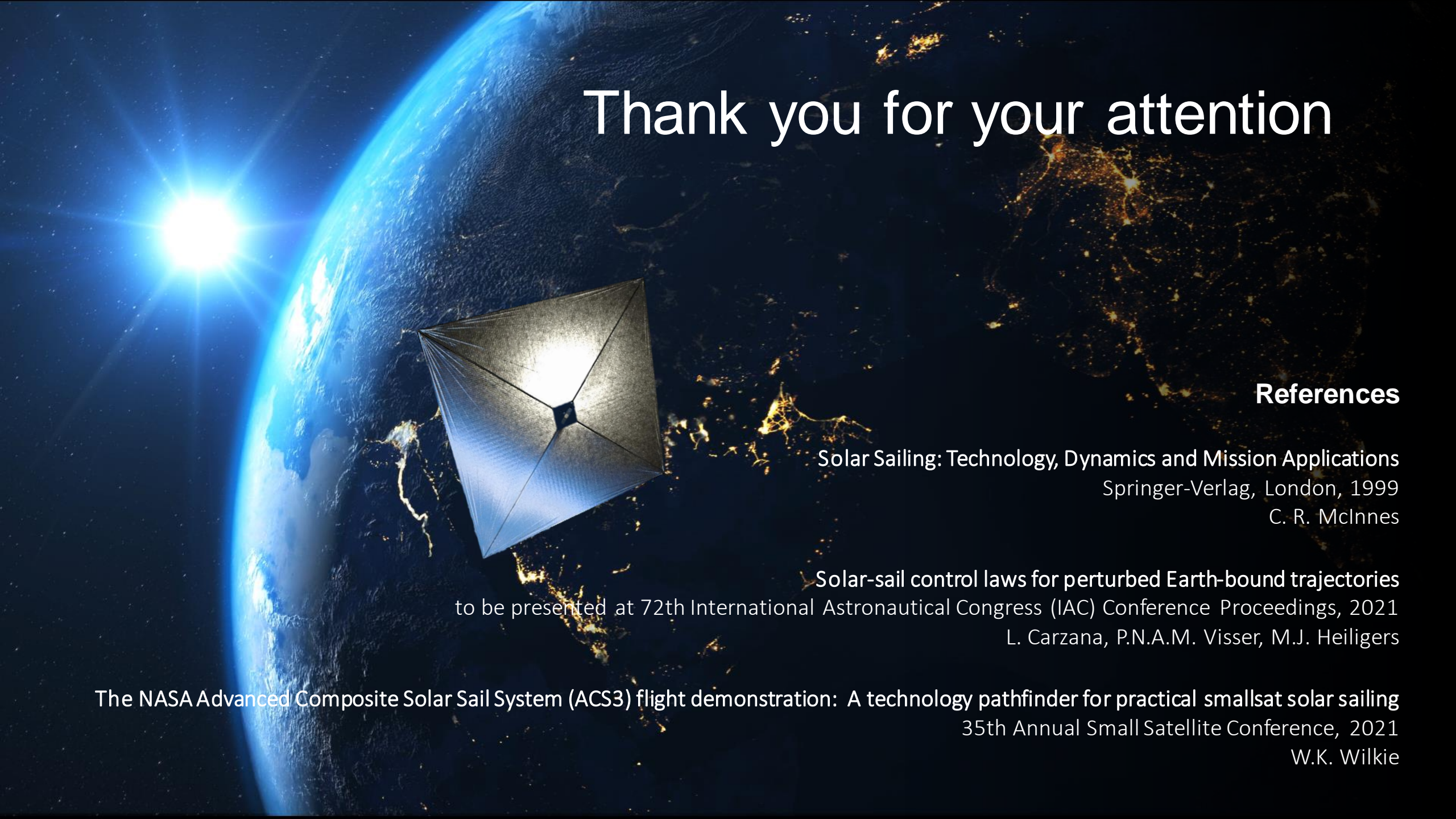
Simulation start date: July 1, 2022

Initial inclination: 98.249 deg

Steering law: inclination change





The background of the slide is a composite image. On the left, a bright sun with a lens flare effect is visible. In the center, the Earth's blue and white horizon curves across the frame. In the foreground, a solar sail spacecraft is shown, consisting of a central hub and four triangular sails that form a square-like shape. The sail is illuminated from the sun, creating a bright spot on its surface. The rest of the background is a dark space filled with faint, glowing orange and yellow patterns, possibly representing a star field or a nebula.

# Thank you for your attention

## References

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L. Carzana, P.N.A.M. Visser, M.J. Heiligers

The NASA Advanced Composite Solar Sail System (ACS3) flight demonstration: A technology pathfinder for practical smallsat solar sailing  
35th Annual Small Satellite Conference, 2021  
W.K. Wilkie