Design and Optimization of Steering Laws for Geocentric Solar Sailing

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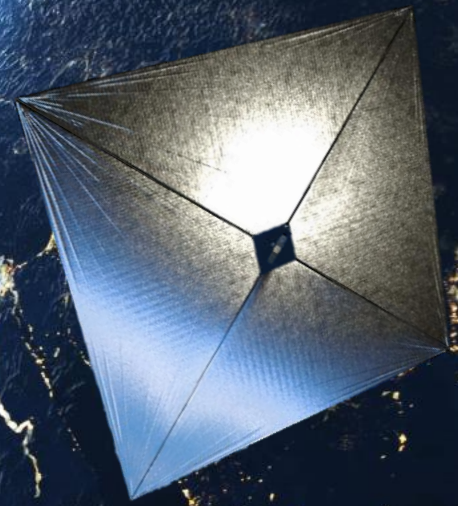
Design and Optimization of Steering Laws for Geocentric Solar Sailing



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TU Delft

National Aeronautics and Space Administration

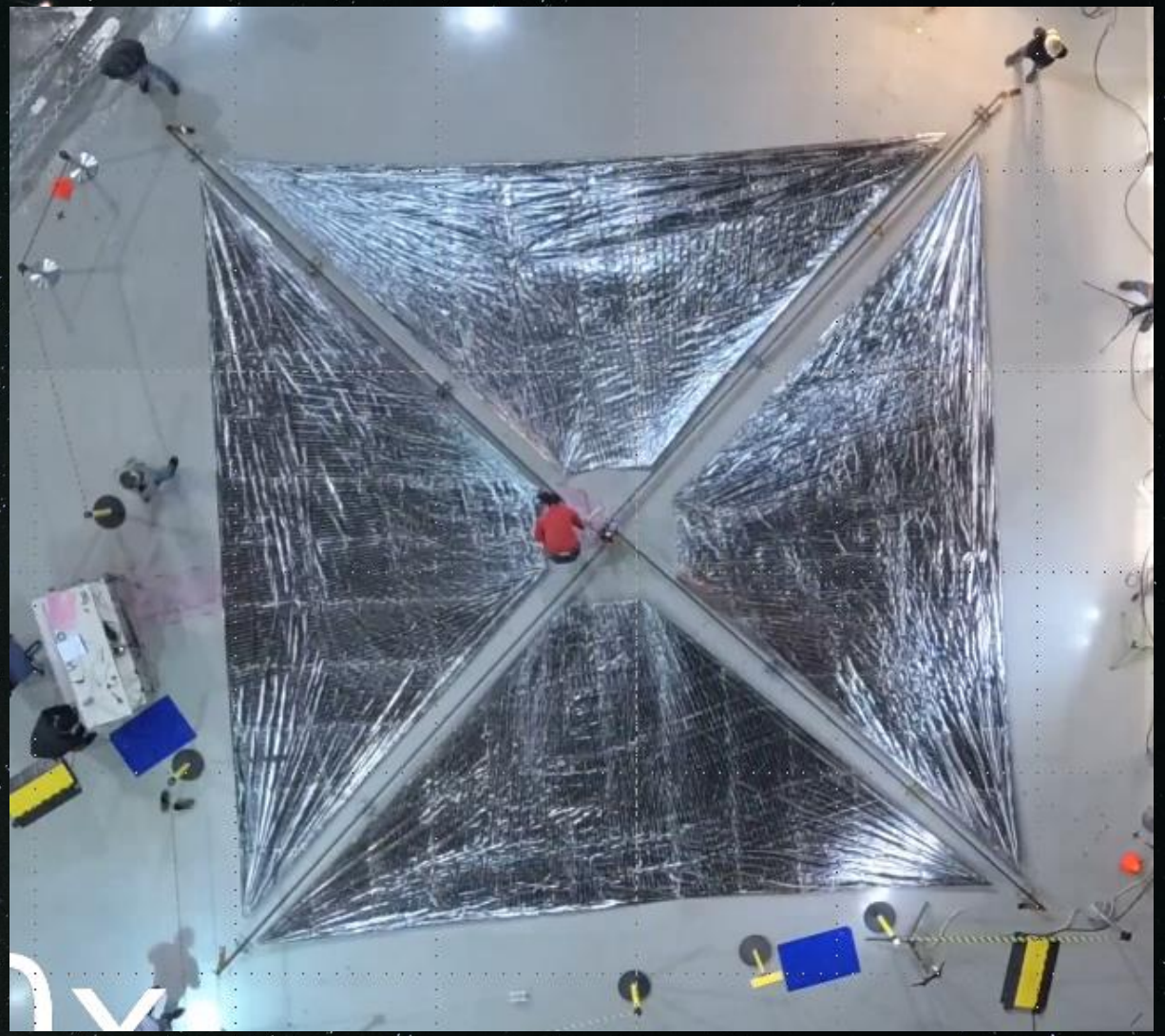
small SATELLITE

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^2 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^2.

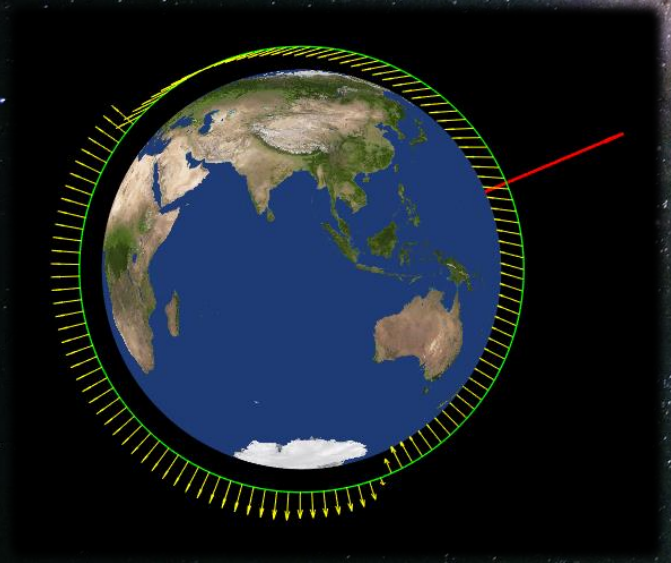
As the ACS3 solar sail will fly in a low Earth orbit, its trajectory will be highly affected by different perturbations typical of the near-Earth environment. Disturbances such as **aerodynamic drag** and **eclipsing** can be of the same order or greater than forces caused by solar radiation pressure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

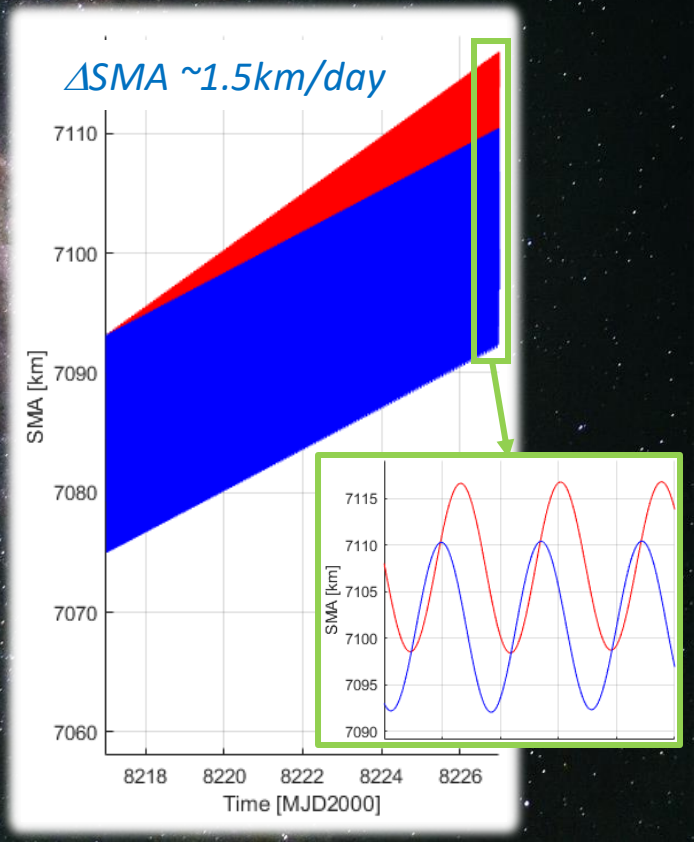


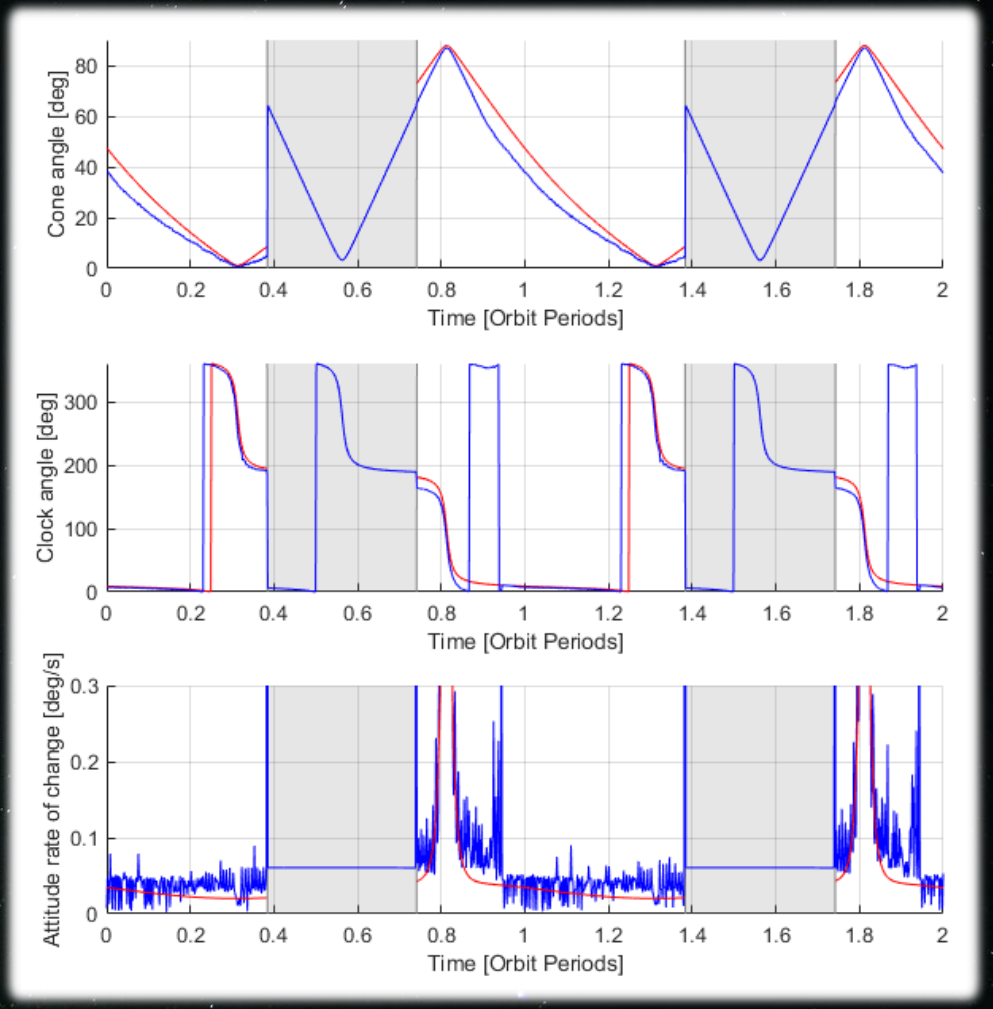
ACS3 Trajectory Design: Orbit Raising

Ideal reflection sail model with characteristic acceleration of 0.05 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



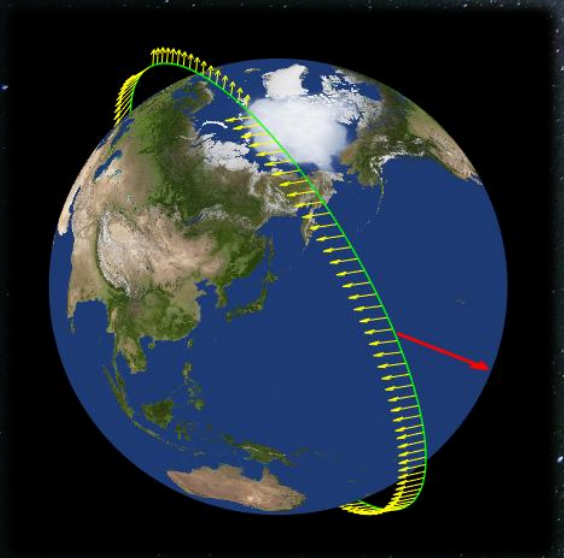


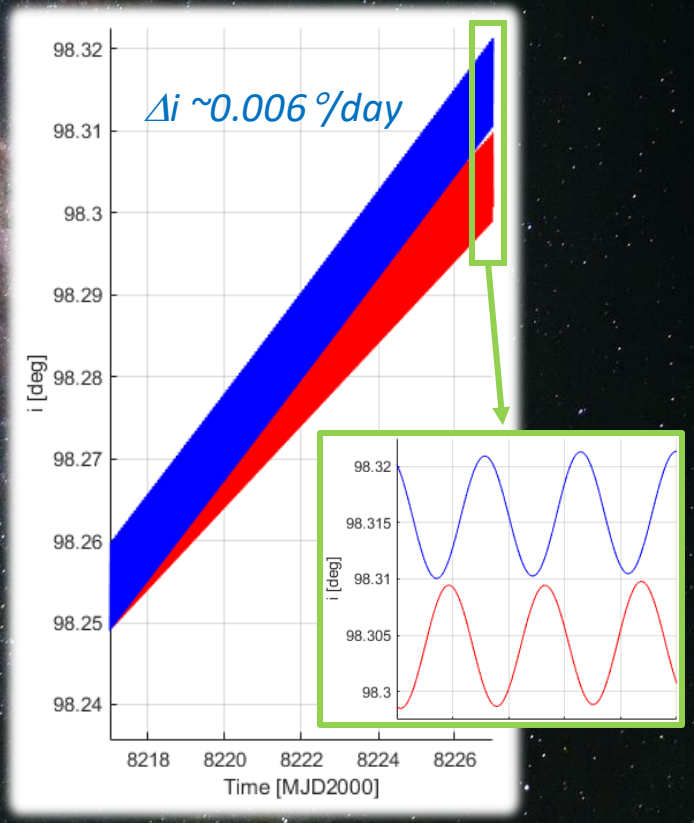


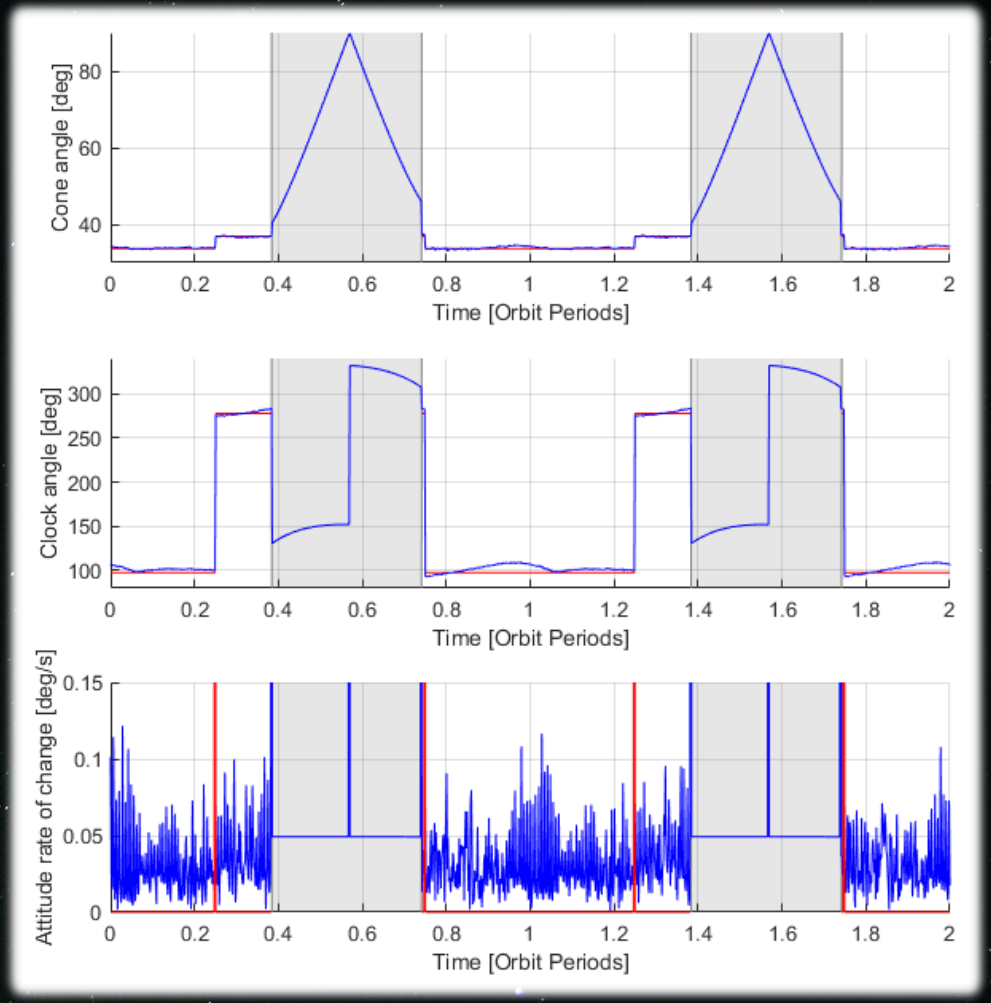
ACS3 Trajectory Design: Inclination Change

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

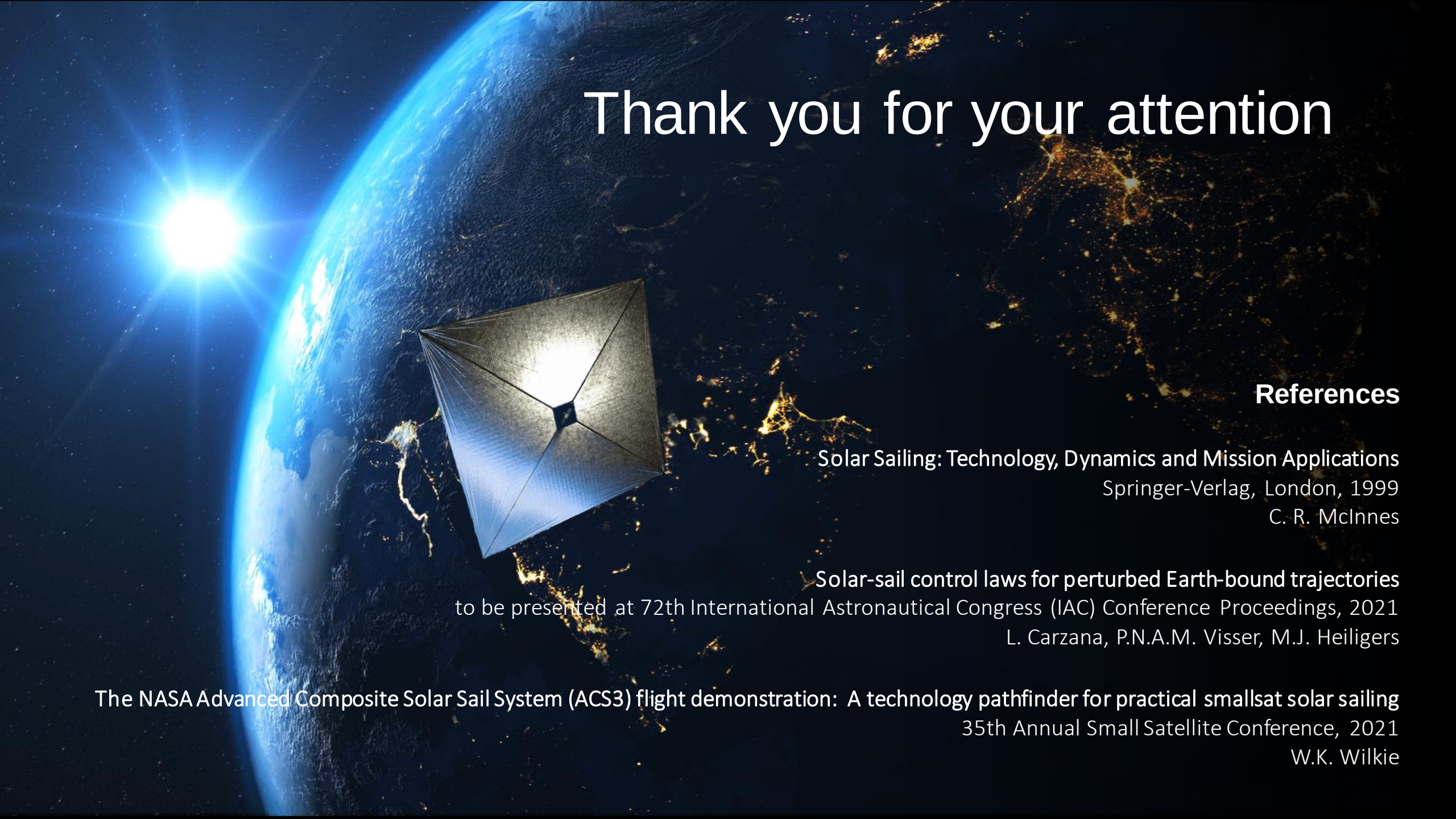
Simulation start date: July 1, 2022
Initial inclination: 98.249 deg
Steering law: inclination change







Thank you for your attention



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