Optimization of Solar Array Positioning Actuators for Small Satellites

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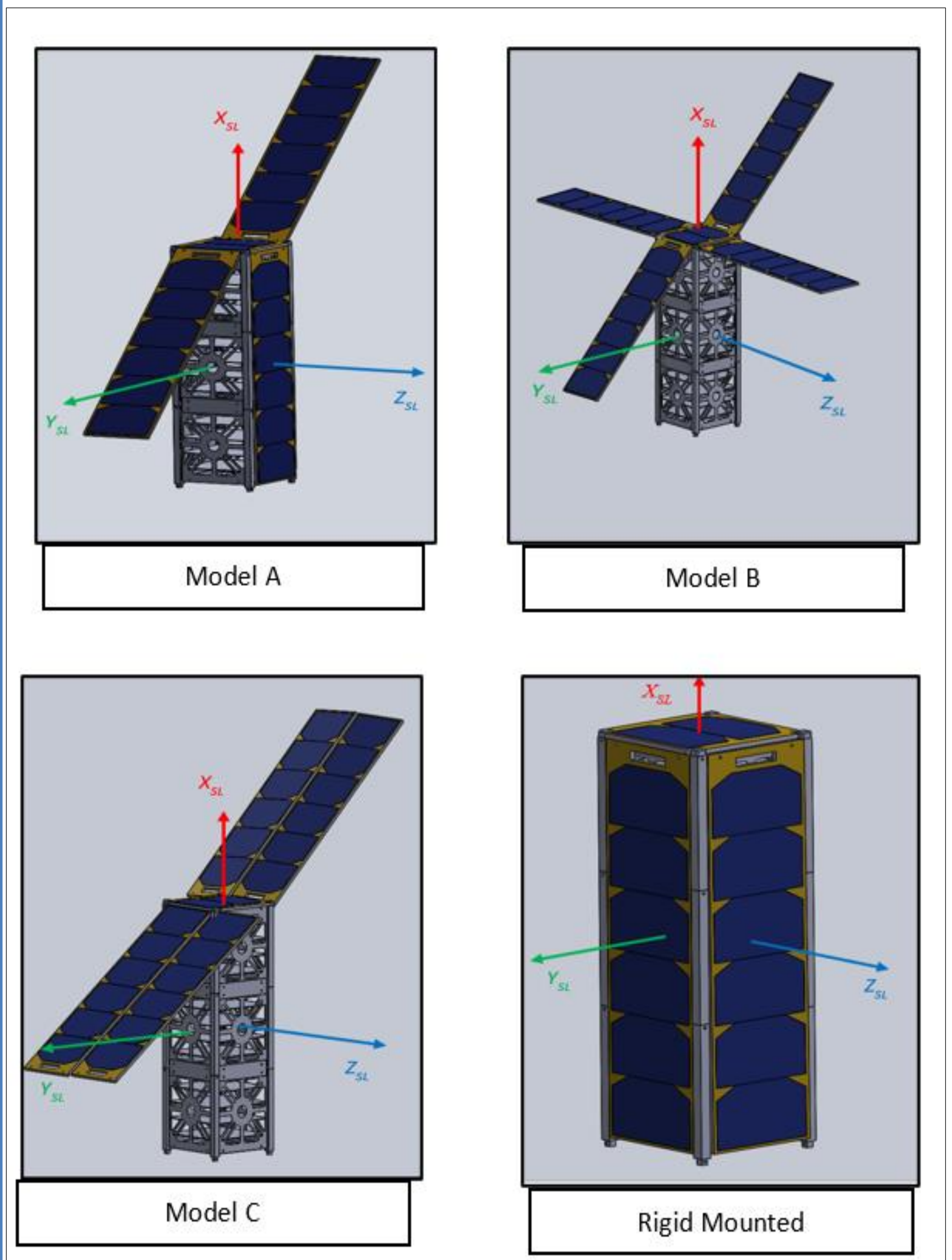
Objective: The goal of this research is to maximize the energy per weight ratio of solar array designs for a 3U CubeSat. The solar array configurations investigated include rigidly mounted to the CubeSat sides, and deployed with zero, one and two degree of freedom, active positioning actuation schemes. Numerical models are created for multiple variations of geo-synchronous and sun-synchronous orbits, which are common for CubeSat missions. The results for orbit parameters and energy acquisition for rigid-mounted solar arrays are validated with commercially available orbital mechanics software (STK). The various solar cell designs are evaluated based on their energy acquisition potential and actuation complexity and weight of design.

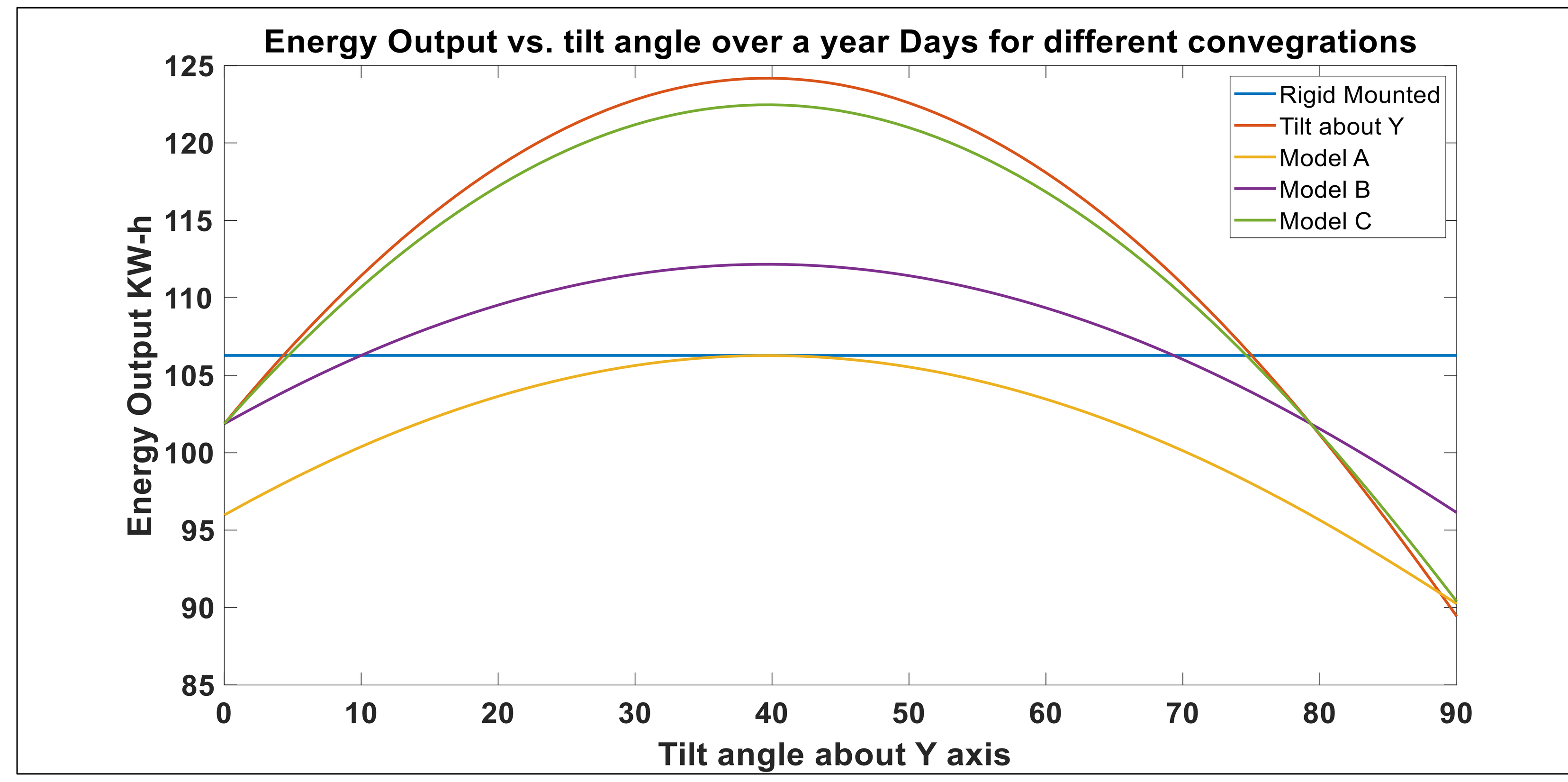
Introduction:

CubeSats are standard and modularized satellites that have gained widespread implementation among the scientific research community due to their low cost of manufacture and launch. The only source of energy for CubeSat missions are from solar arrays, which are coupled to rechargeable batteries that provide power during the shaded portion of orbit.

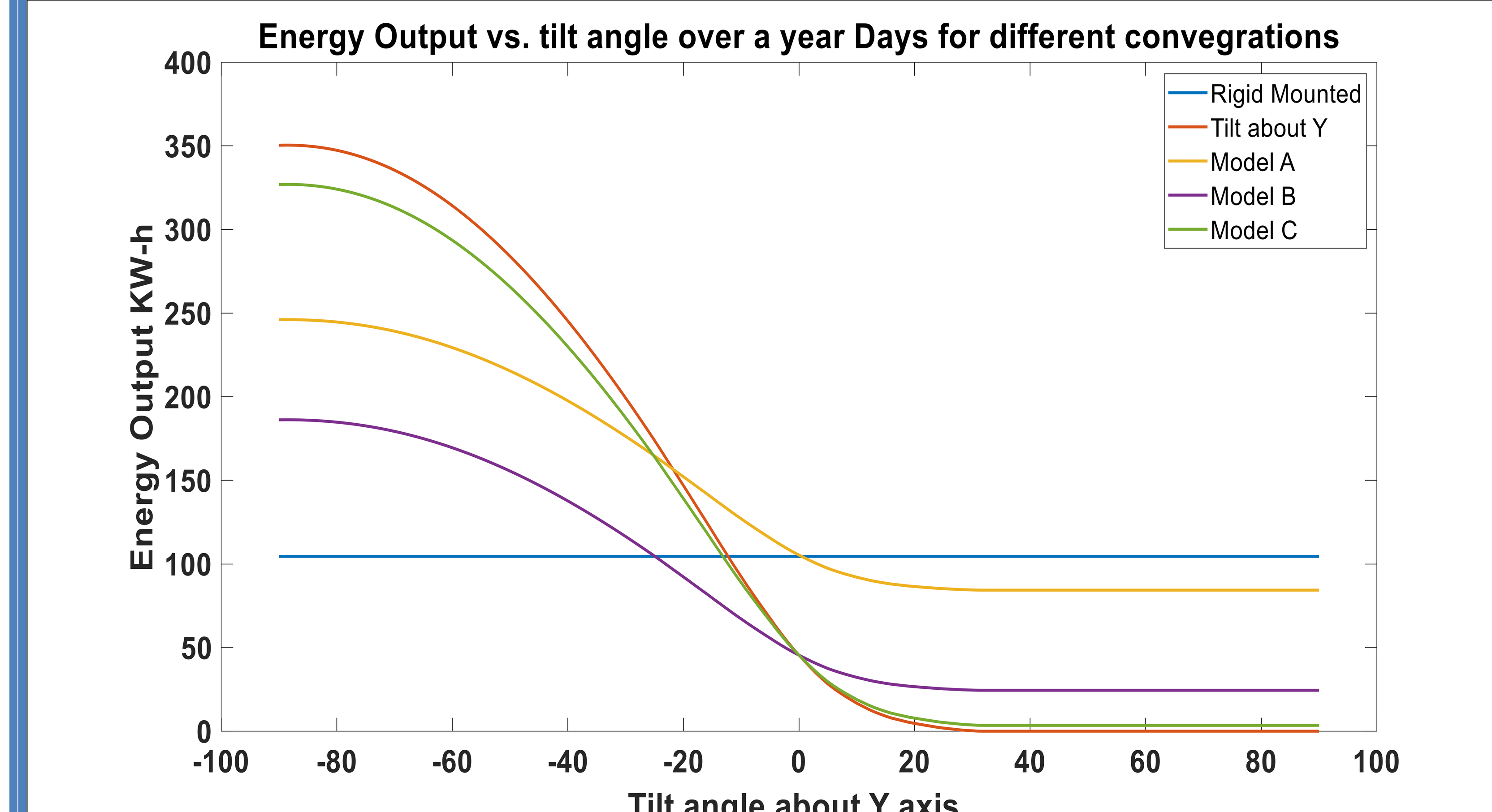
1. Rigid and Zero DOF:



a) Geosynchronous orbits

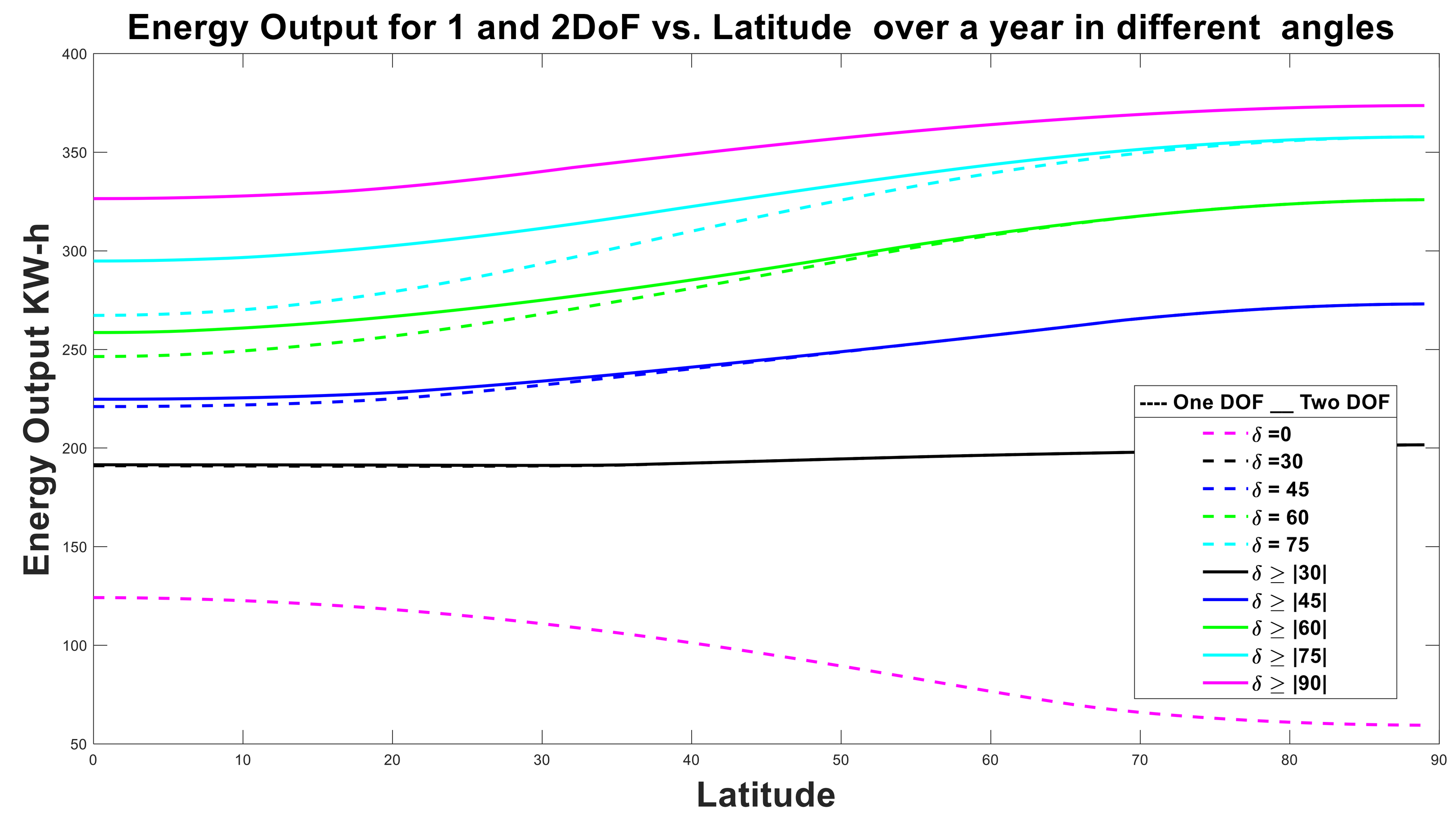


b) Sunsynchronous orbit:

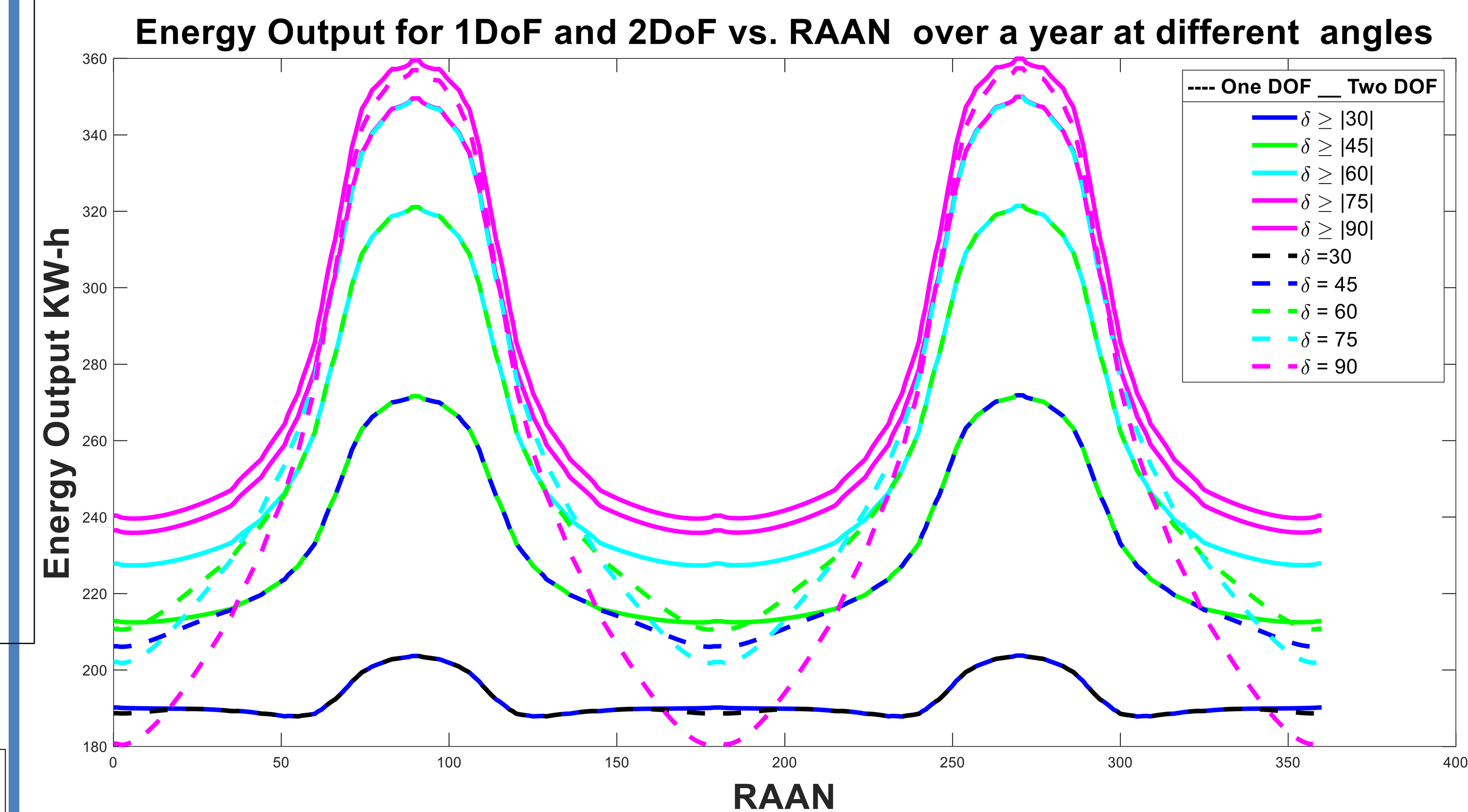


2. One and Two DOF:

a) Geosynchronous orbit:

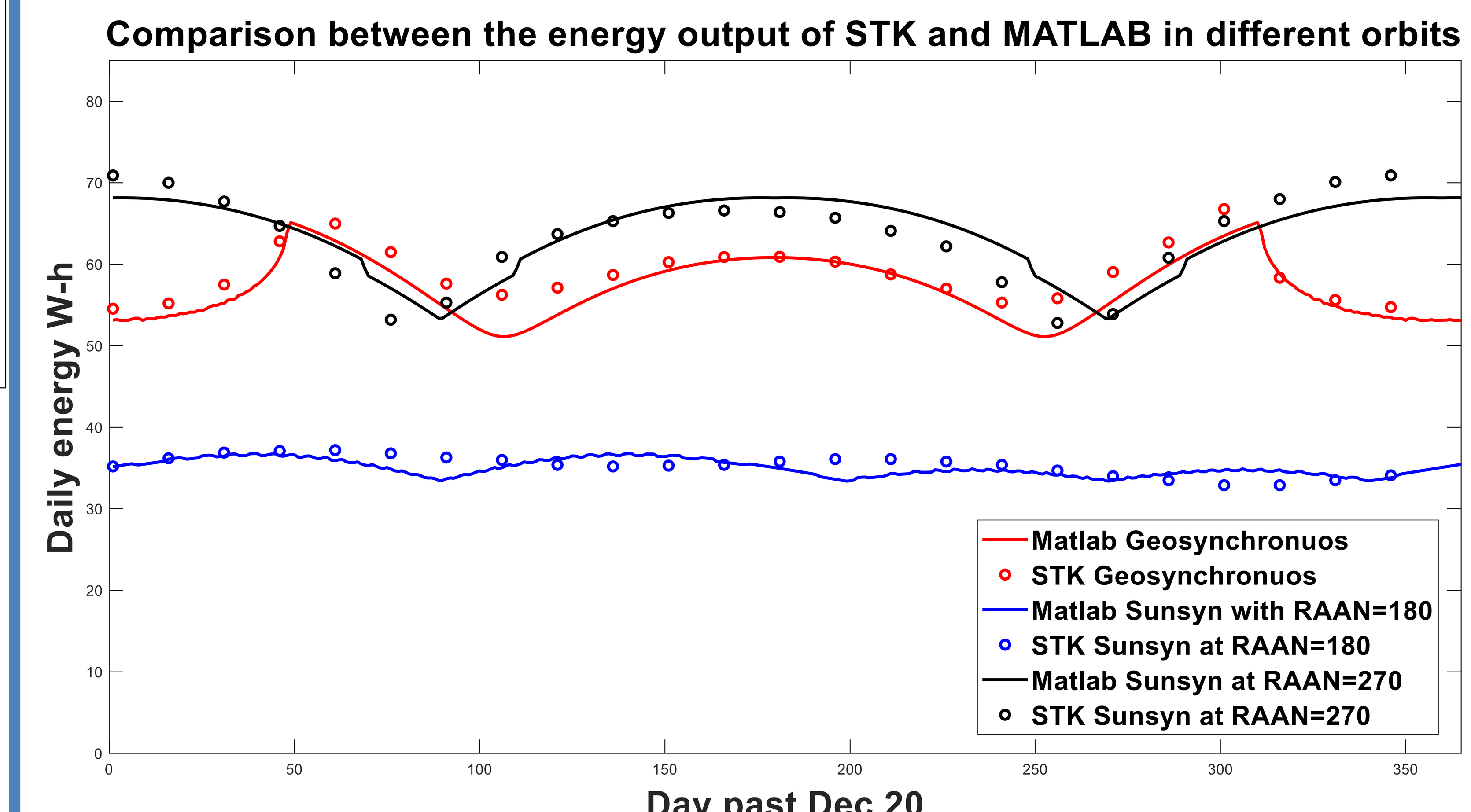


b) Sunsynchronous orbit:



Validation the results:

Results from Geosynchronous and Sunsynchronous orbits of 1U CubeSat with rigid mounted solar arrays were confirmed with commercial orbit software (STK).



Conclusions:

- In Geosynchronous orbit, a zero DOF design produces the same energy as an actuated design.
- In the Sunsynchronuons orbit, one and two DOF designs produce nearly the same energy. Thus, one DOF is the more efficient solution.