AOCS for future multi-satellite geodesy missions

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Relativistic Modelling
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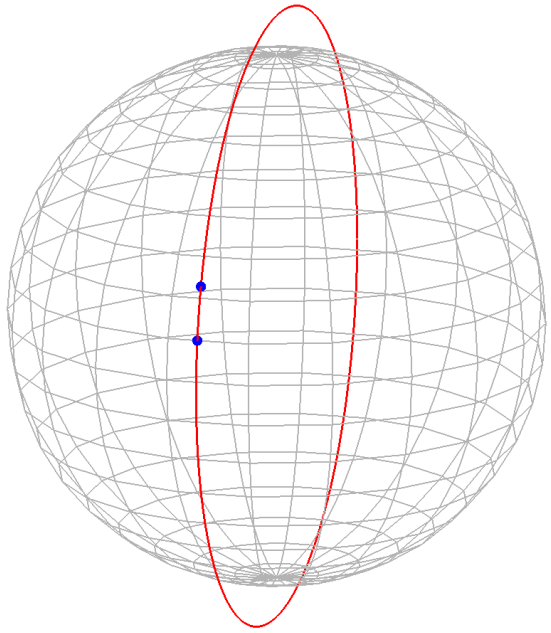
Outline

- Striping with GRACE data in gravity field recovery
- Pendulum orbits reduce striping
- Formation and Clusters for reduced AOCS requirements
- Simulating satellite formations
- Challenges with formations and gravity field recovery

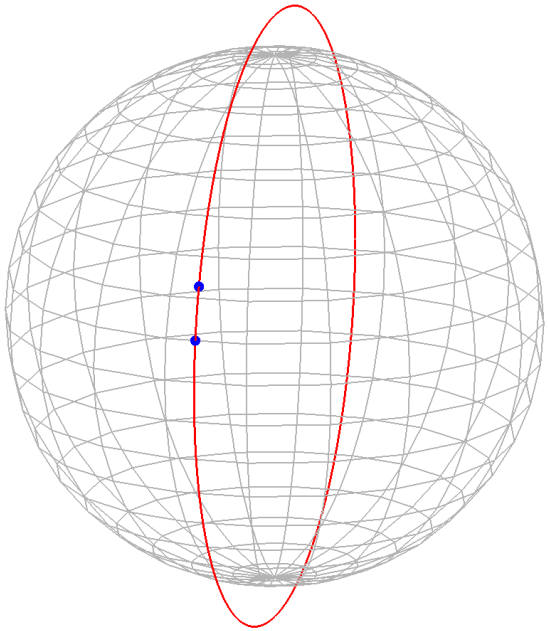
The Problem with GRACE like Missions

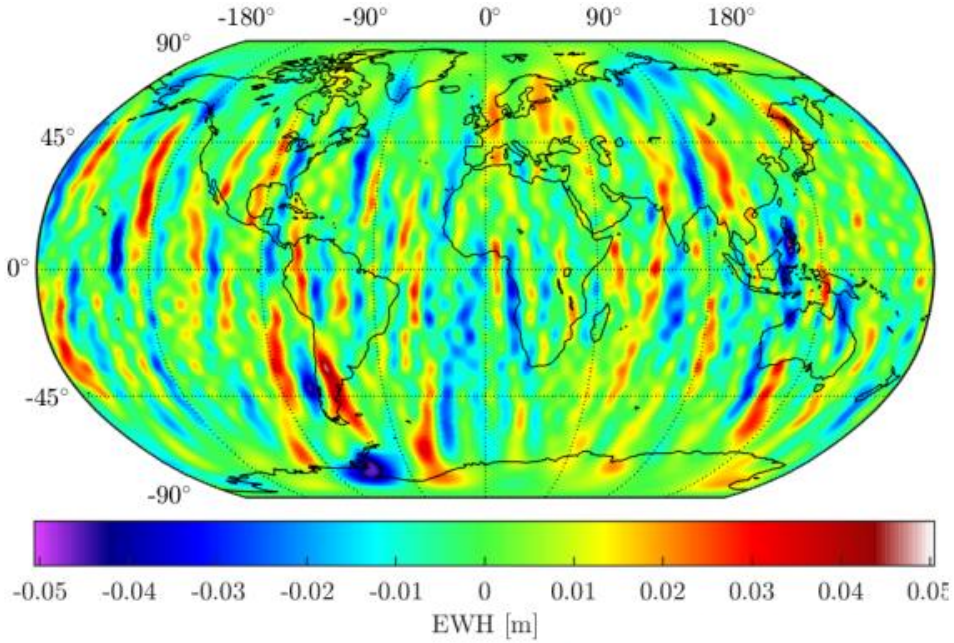
- GRACE like mission trajectory



The Problem with GRACE like Missions

- GRACE measurement sensitivity is directional

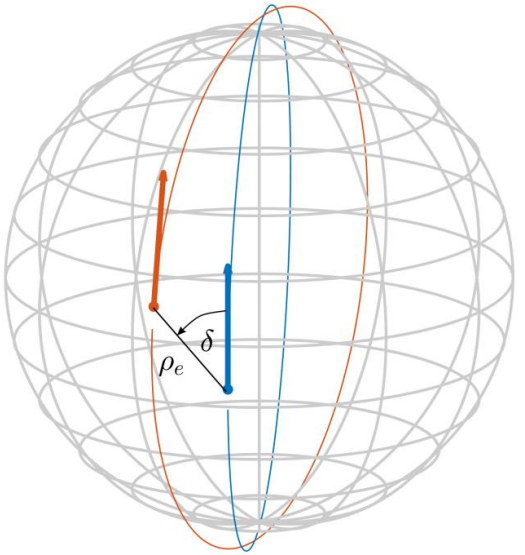




[Presentation EGU21-12257, Florian Wöske]

Pendulum Orbits - A Solution to the “GRACE Problem”

- Add additional measurement direction



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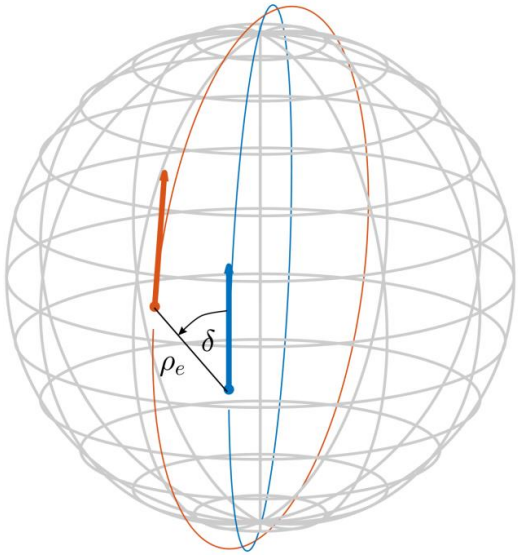
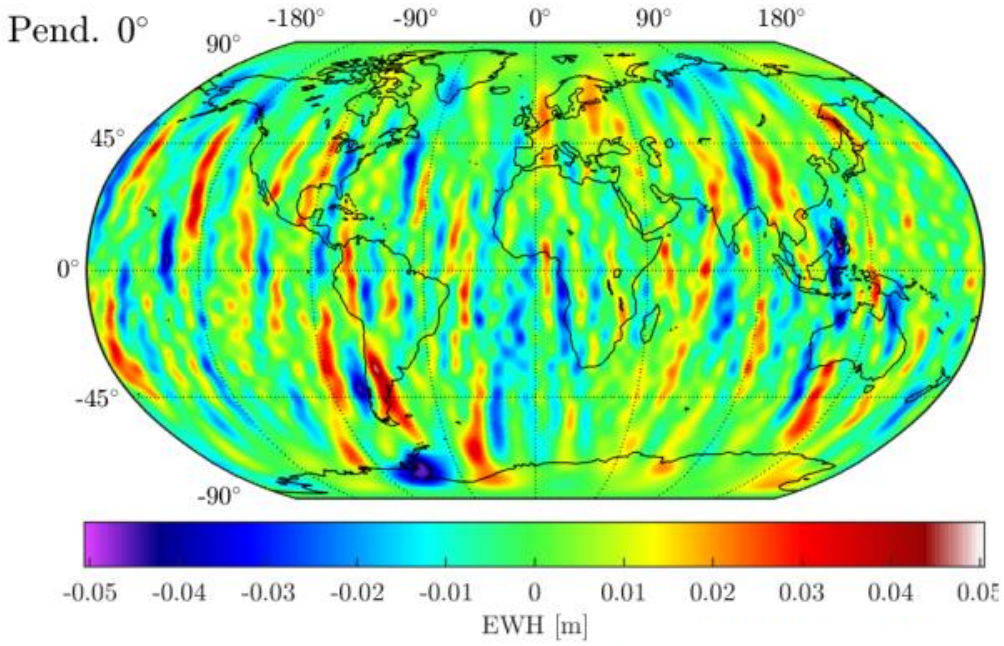
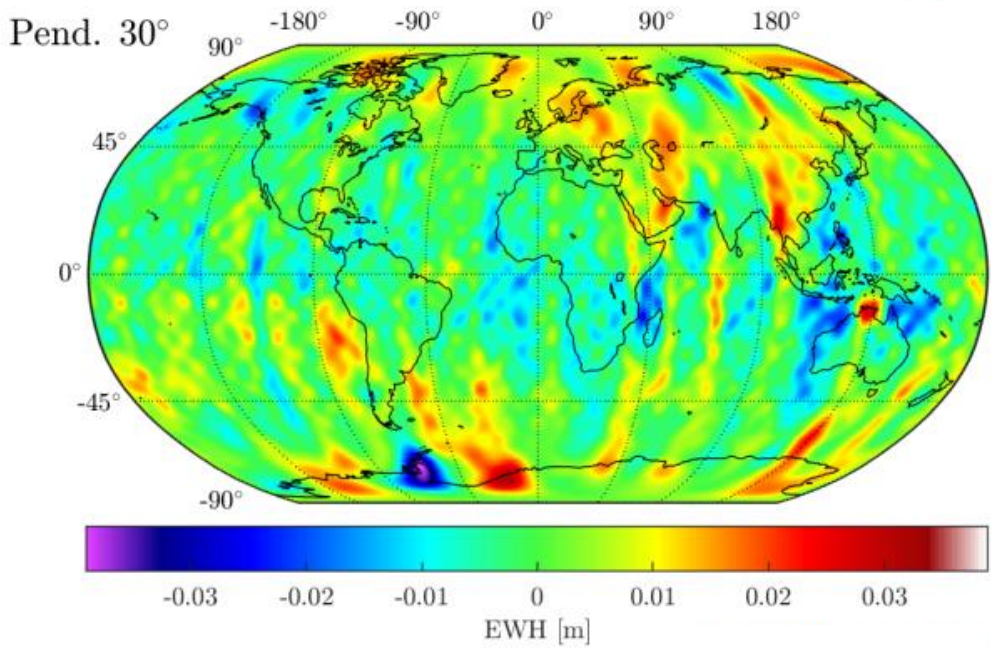


- Add additional measurement direction
  - Pendulum orbit would introduce another measurement direction



GRACE like



Pendulum Orbit

[Presentation EGU21-12257, Florian Wöske]

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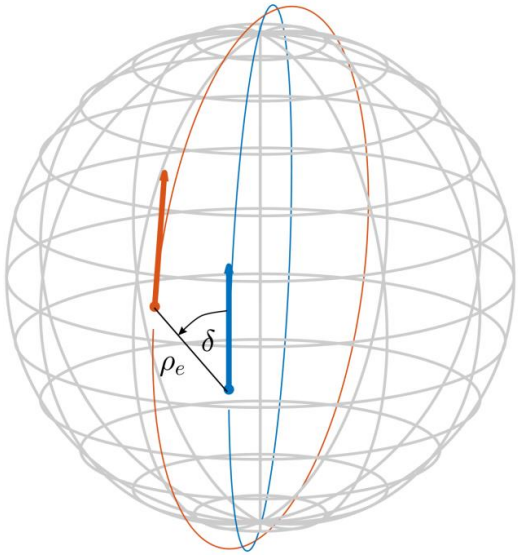
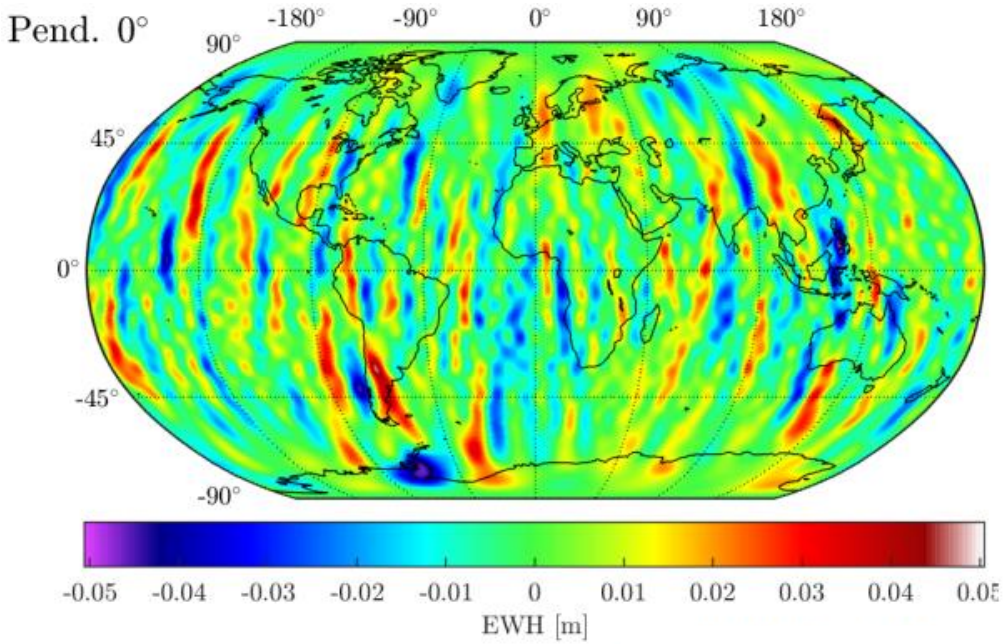


- Add additional measurement direction
  - Pendulum orbit would introduce another measurement direction
  - Pendulum orbits have high requirements on AOCS



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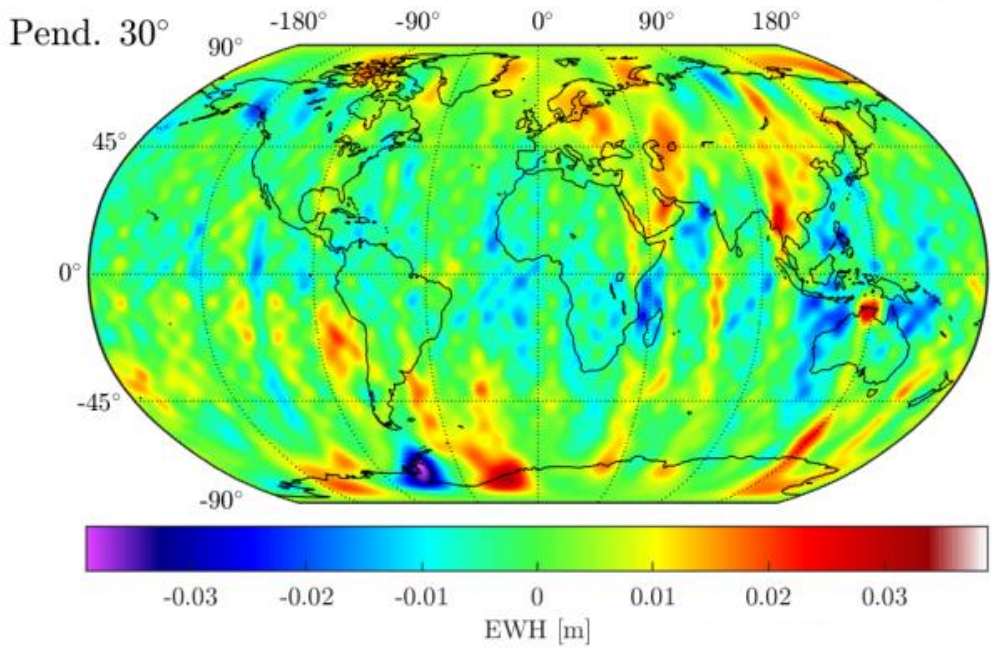

Pendulum Orbit

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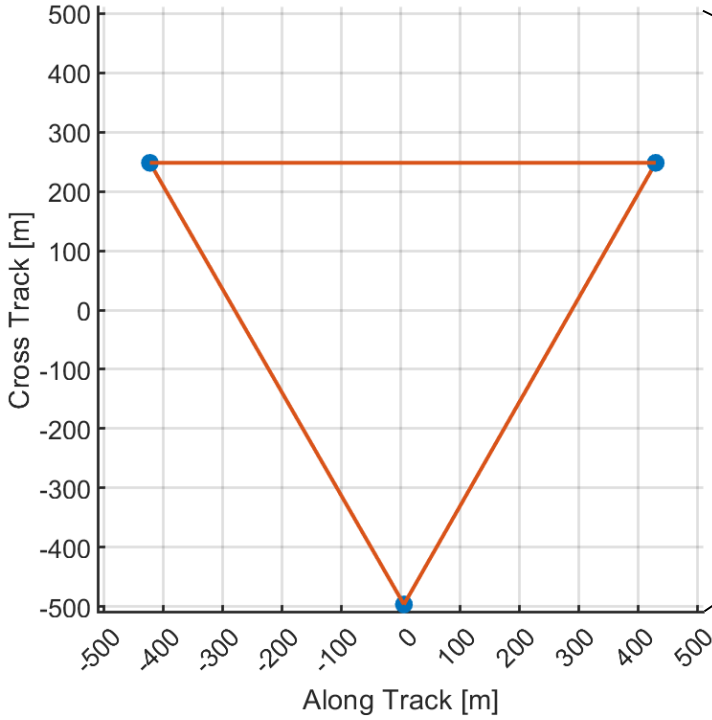
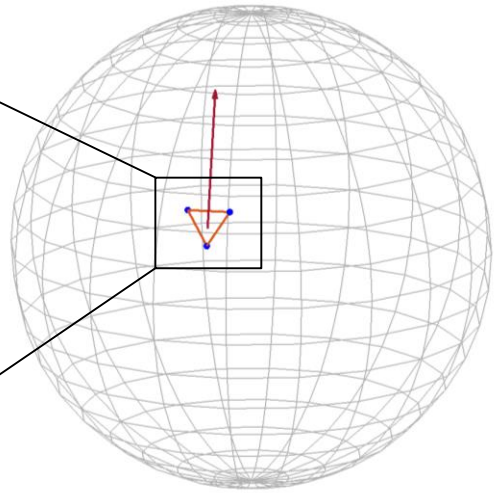
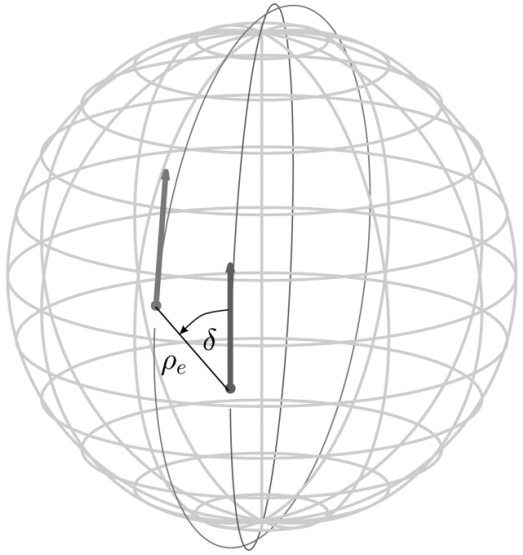
Cluster/Formation flying

- Add additional measurement direction with a triangle formation





AOCS Requirements ⬇



AOCS Requirements ⬆

Constraints for Cluster/Formation *free* flying

Hill's equations[1]:

$$x = \rho \sin(\omega t + \theta) + a$$

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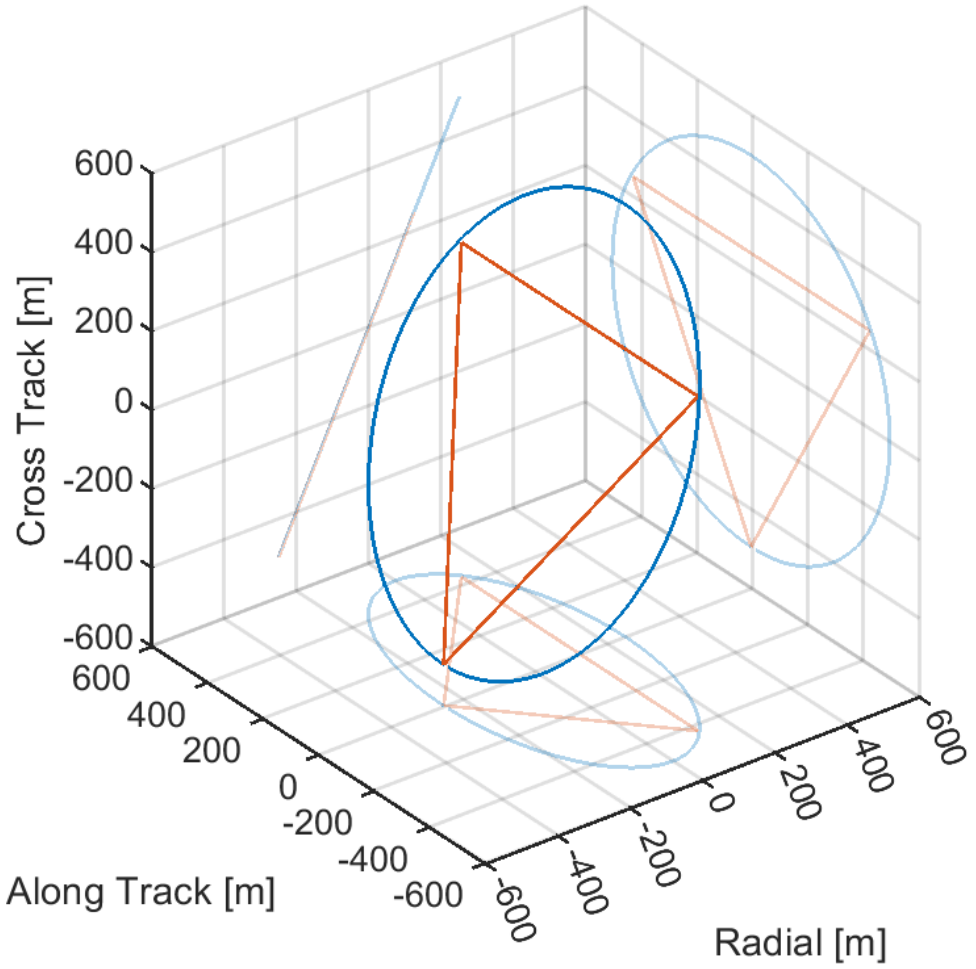

1 [Hsi-Han Yeh and A. Sparks, "Geometry and control of satellite formations," *Proceedings of the 2000 American Control Conference. ACC (IEEE Cat. No.00CH36334)*, 2000, pp. 384-388 vol.1, doi: 10.1109/ACC.2000.878926.]

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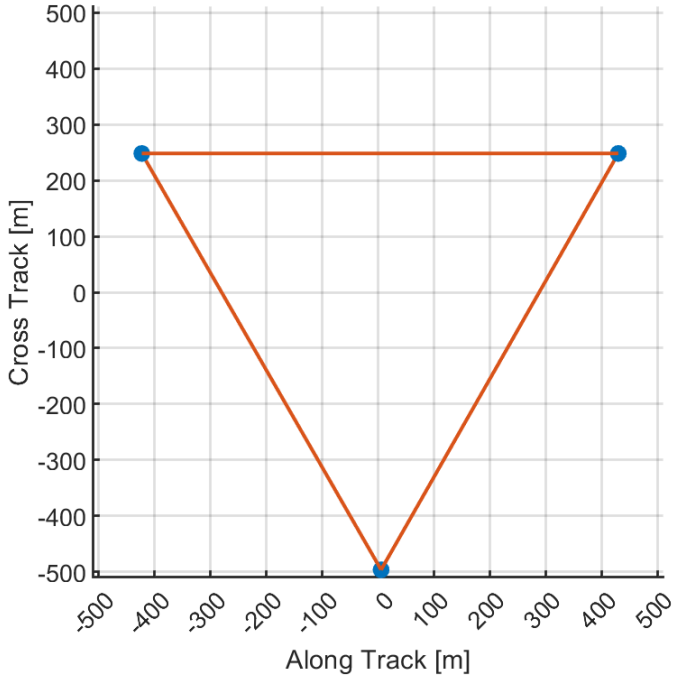

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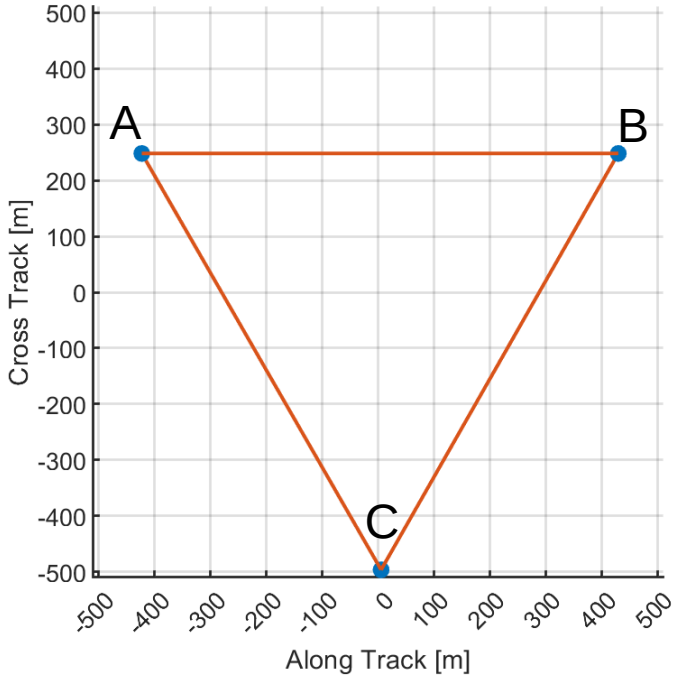
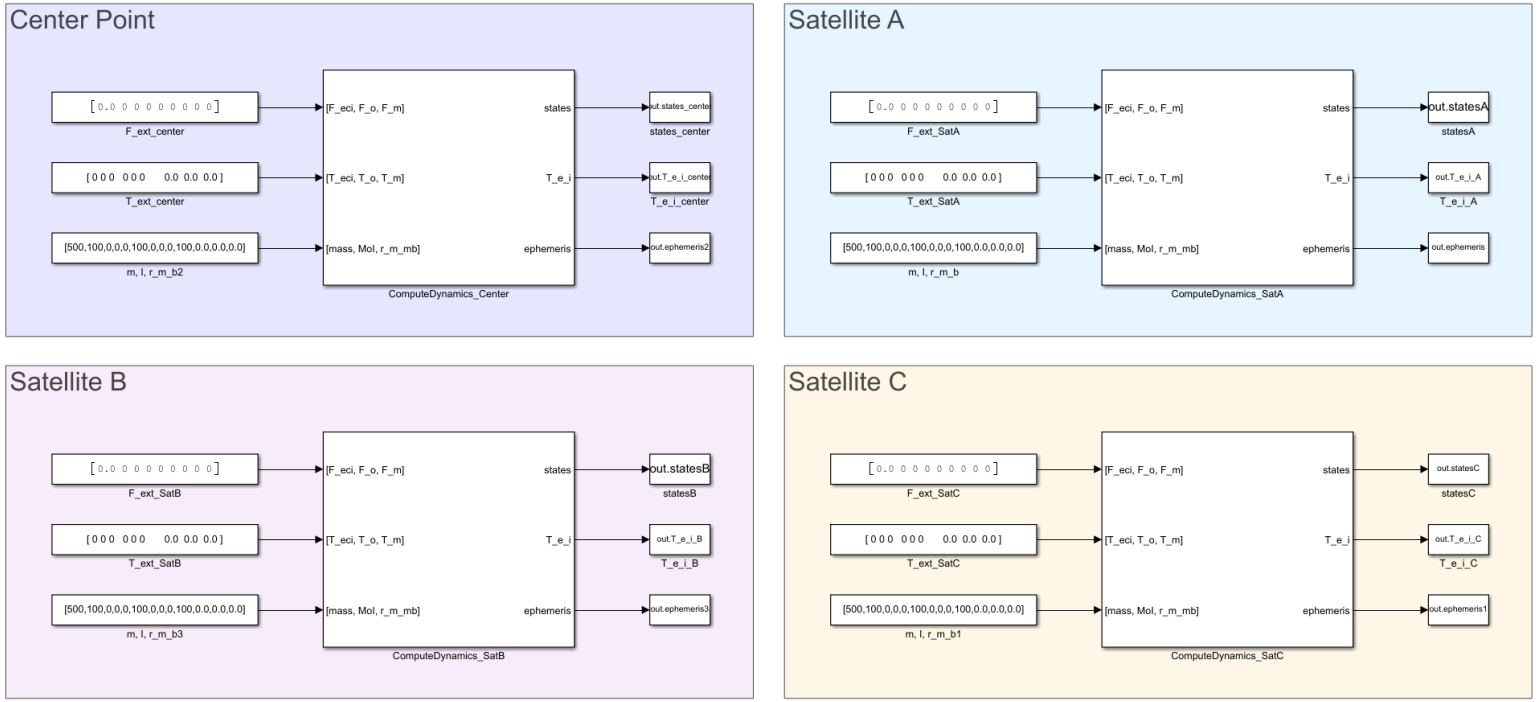


Simulink XHPS Simulation Setup



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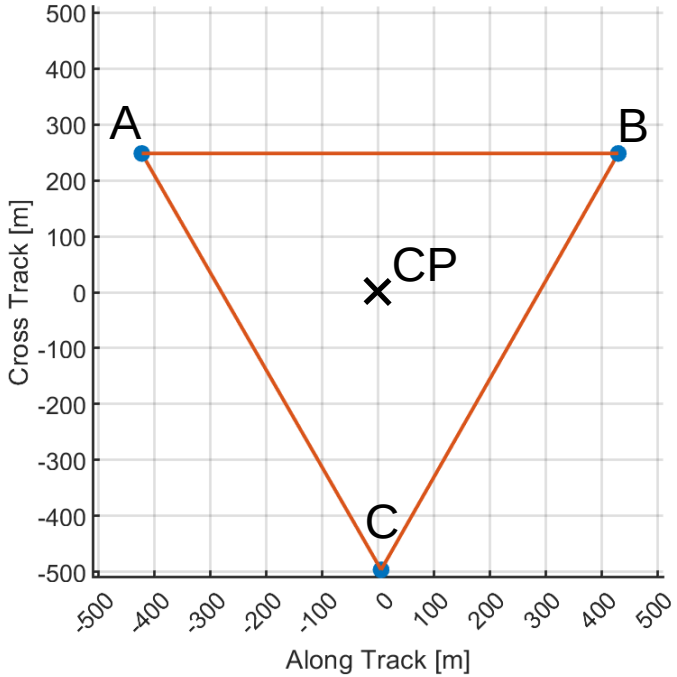

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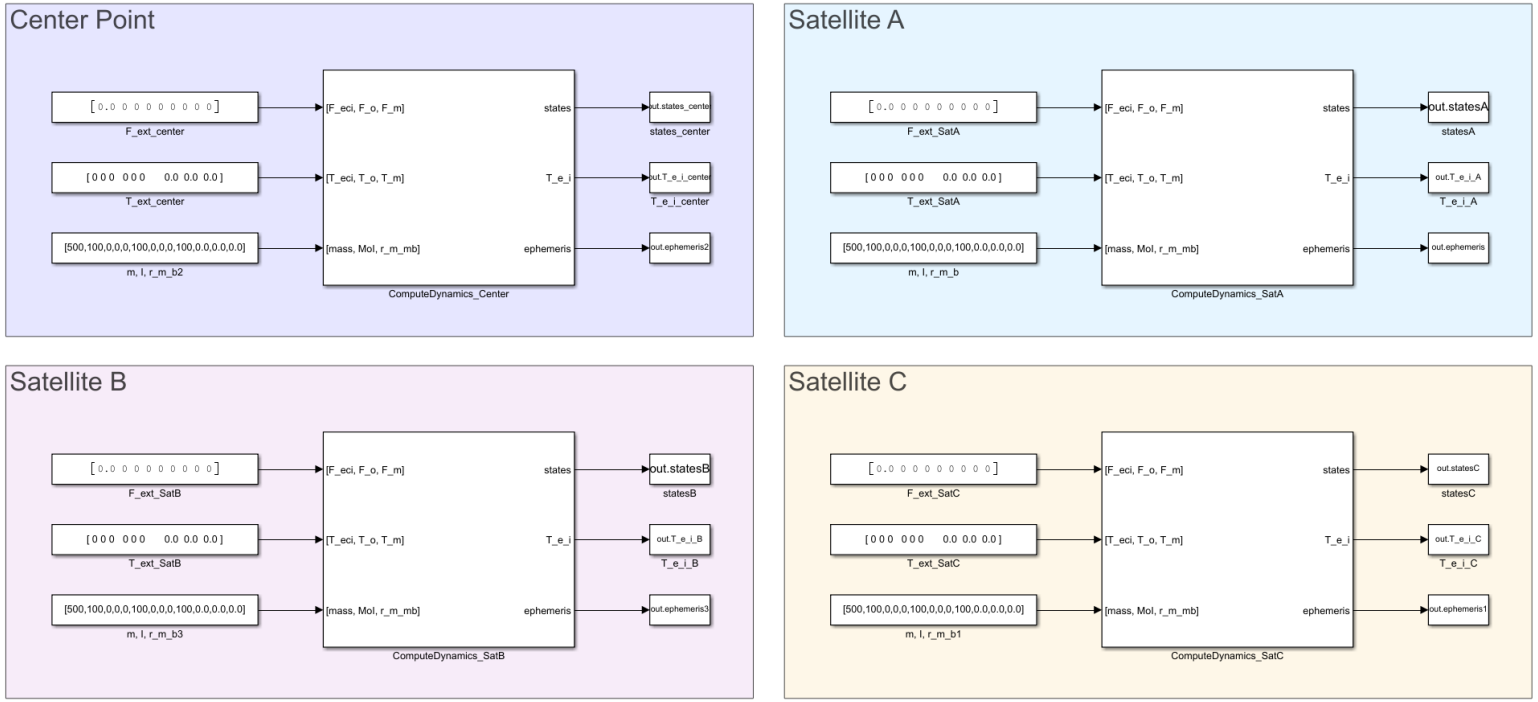

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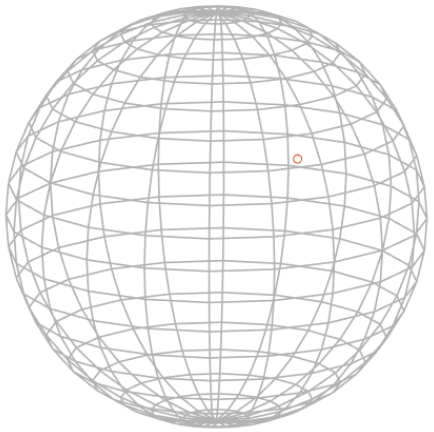
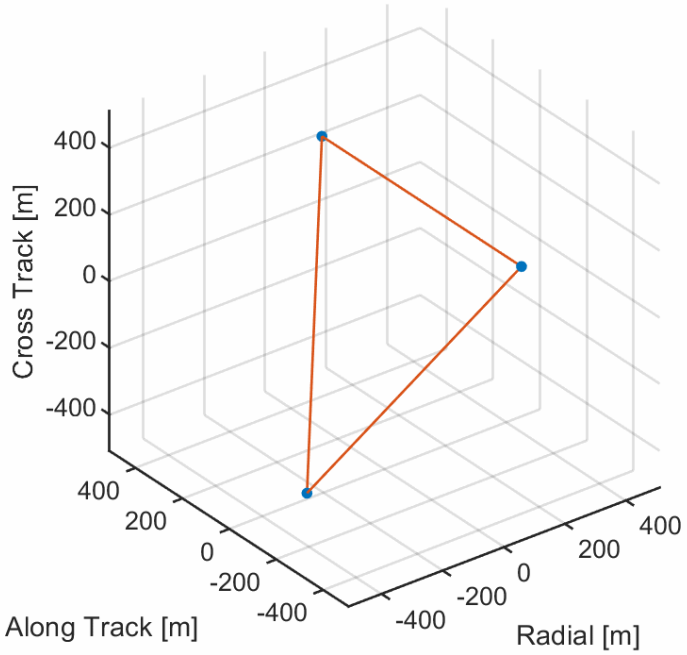
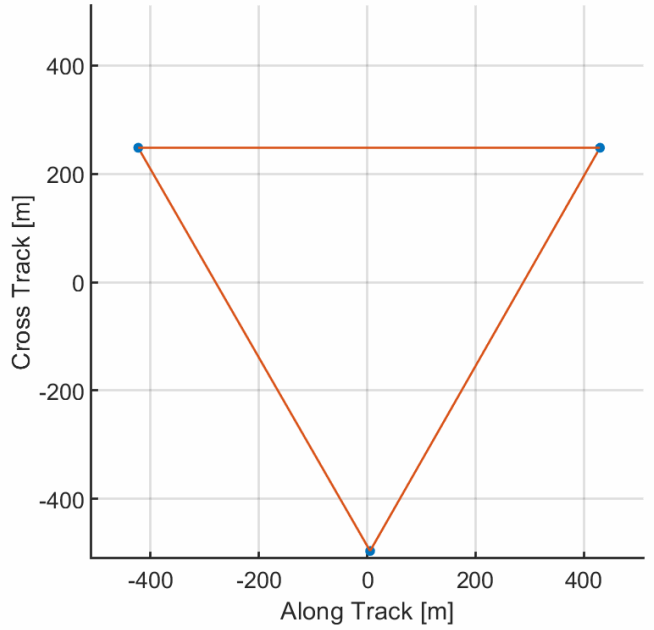
Undisturbed flying Clusters/Formations

- Free fly orbits for a triangular formation





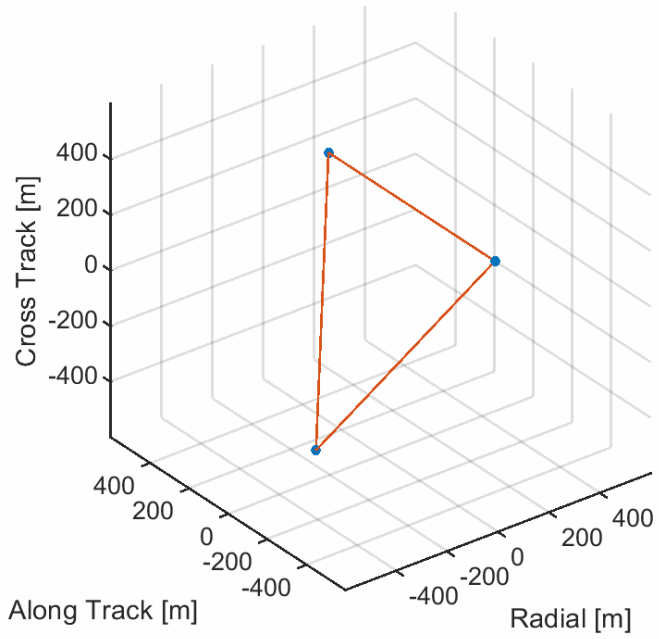
Center Point Frame

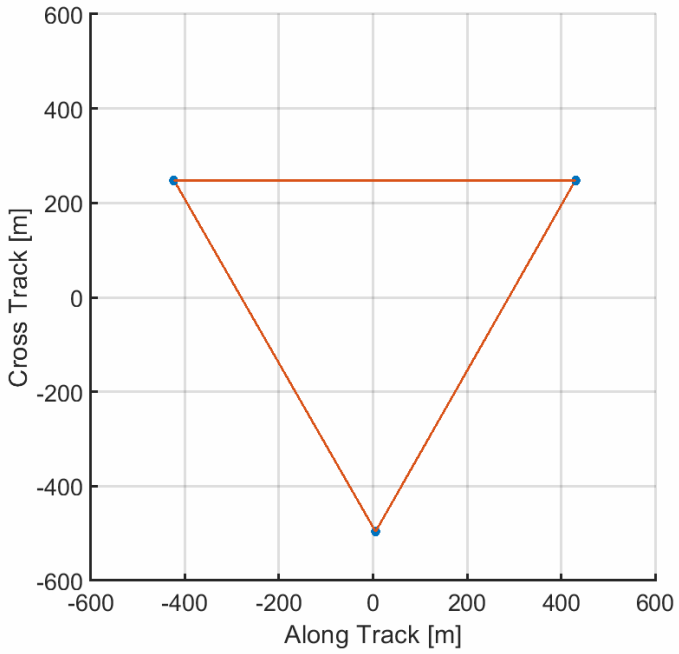


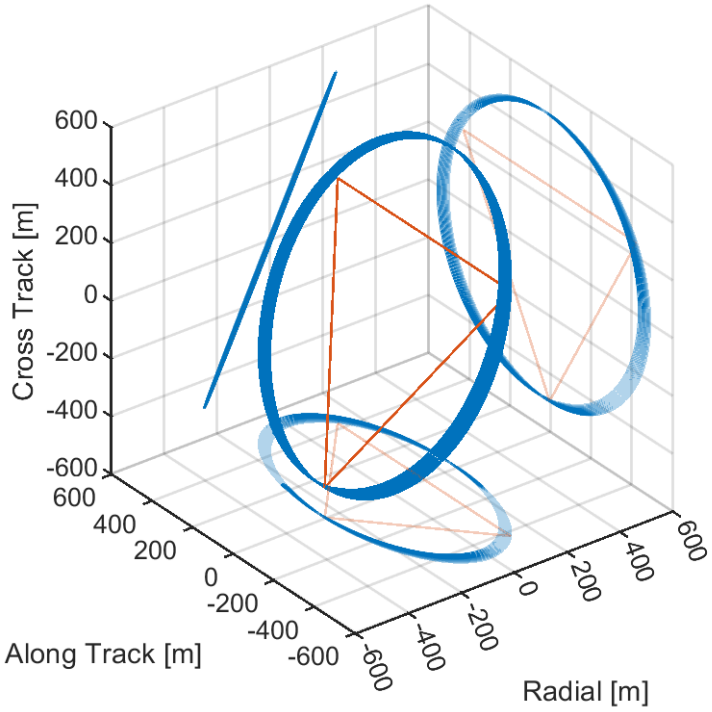
Projected circular formation

Disturbed flying Clusters/Formations

- Formation will break up when disturbed by a non-spherical gravitational field







Possible AOCS Solutions for NGGM & Future Work

Formation maintenance

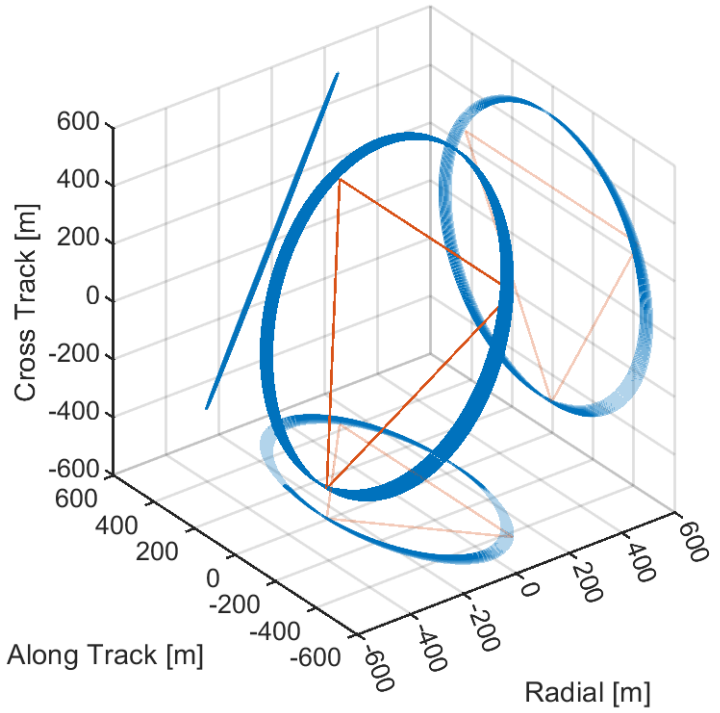
- Continuous error correction
- Error threshold correction

Energy consumption vs Measurement accuracy

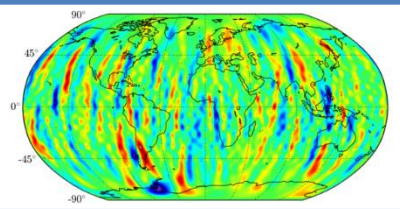
- How does the formation maintenance influence the measurement?

Challanges

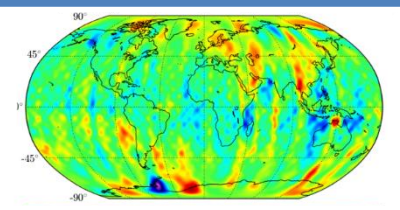
- Distance measurement between satellites
- Angles inside triangle formation
- Satellite form (Cube-Sats)



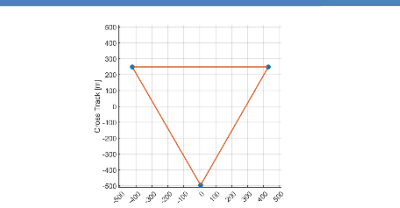
Summary



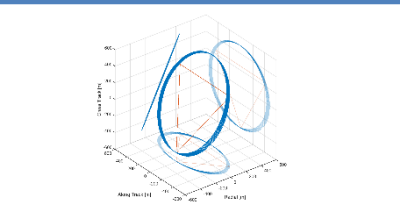
GRACE like missions sensitivity is directional, which yields to striping in the gravity field recovery



Introducing another measurement direction reduces the striping



Formations introduce multiple measuring directions and have low AOCS requirements



AOCS is required to avoid break up of formation

Thank you for your attention

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