

Improving the consistency of aerodynamic models and thermospheric density and wind data (PP)

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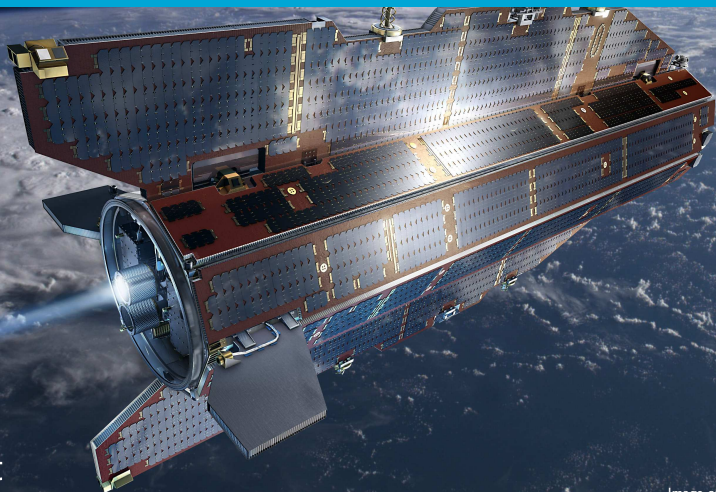
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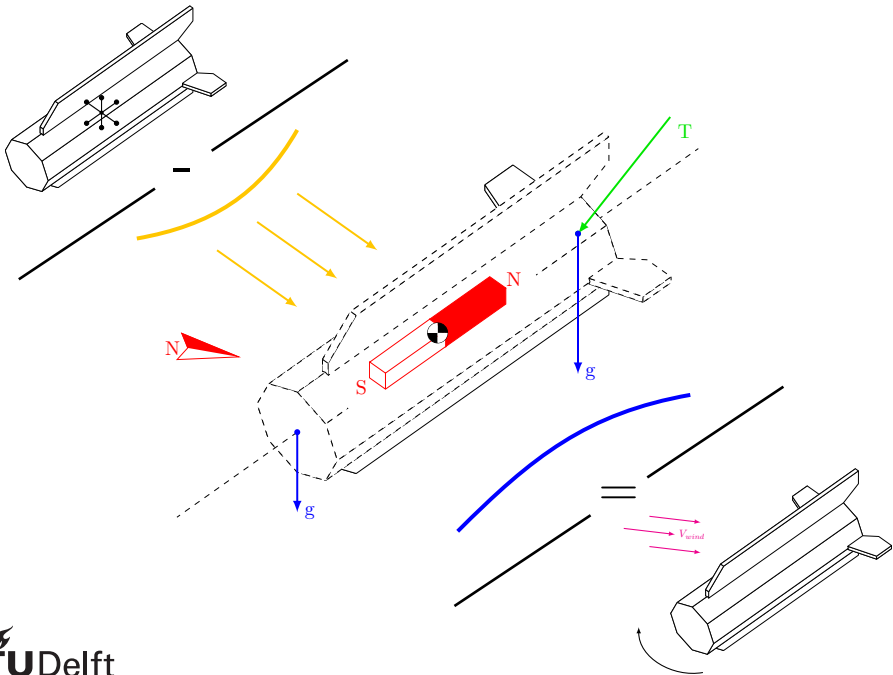
Thermospheric wind measurements from GOCE angular accelerations

T. Visser; Delft University of Technology

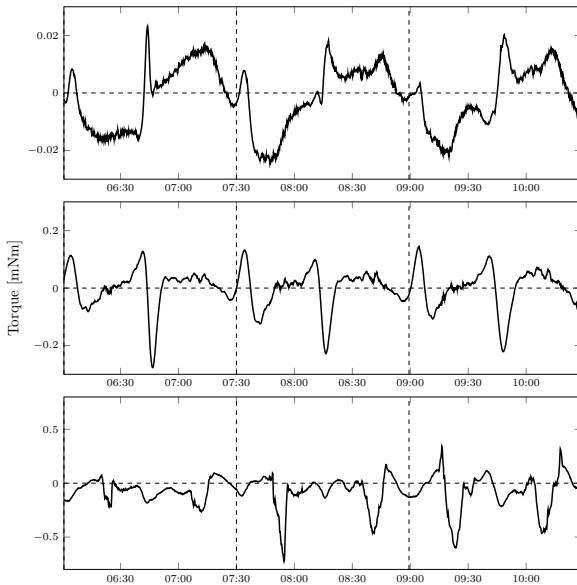
SPP1788 DynamicEarth Winter School, Kühlungsborn, Germany

29 January 2018



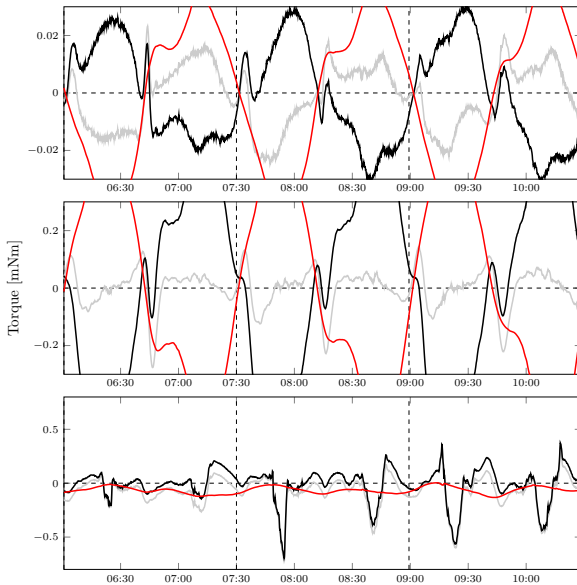


Measured torque



Measured torque

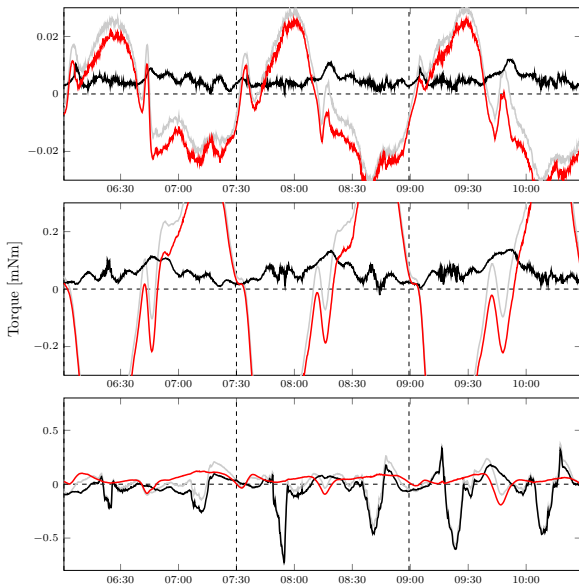
- Magnetic



Measured torque

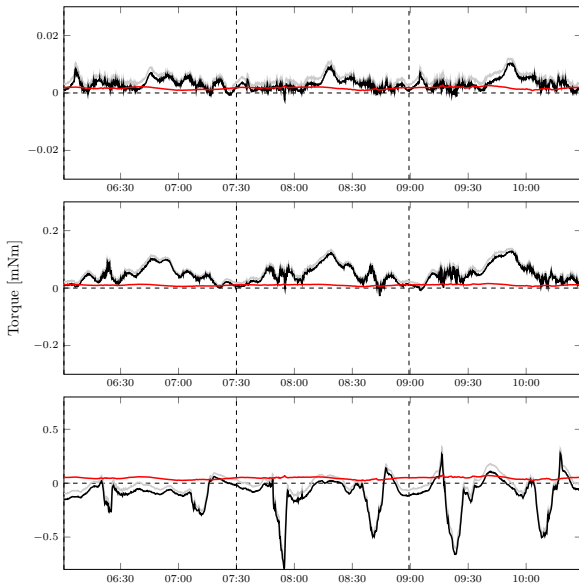
- Magnetic

- Control



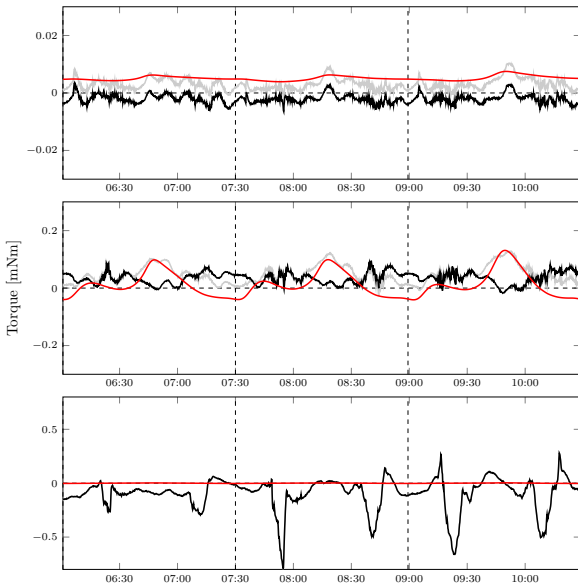
Measured torque

- Magnetic
- Control
- Thruster



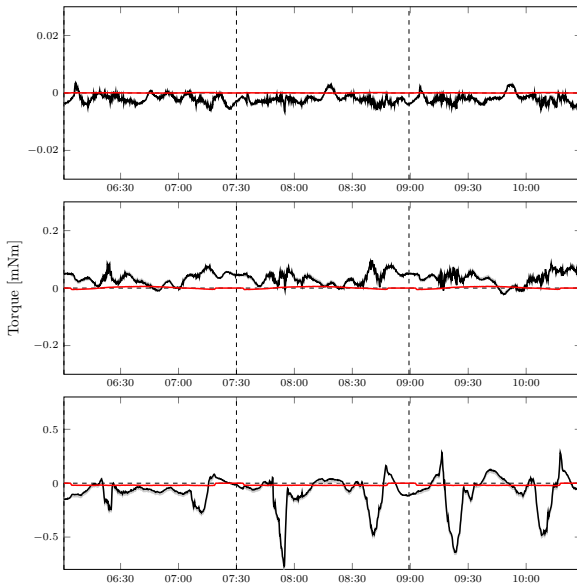
Measured torque

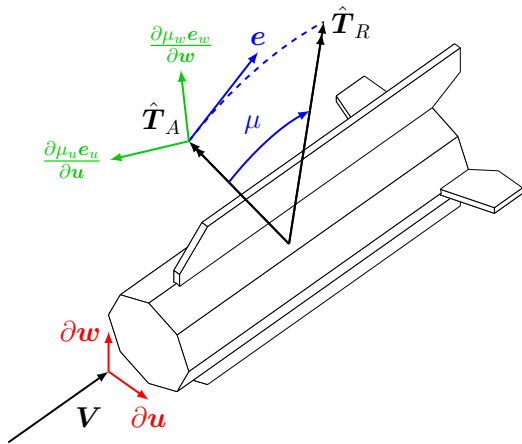
- Magnetic
- Control
- Thruster
- Gravity



Measured torque

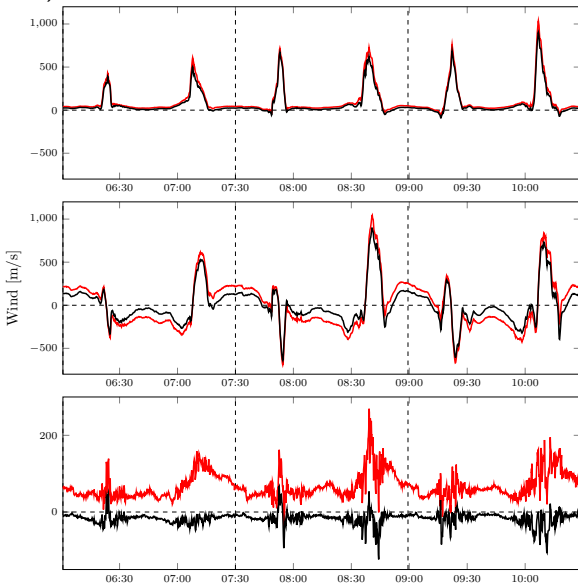
- Magnetic
- Control
- Thruster
- Gravity
- Solar radiation





Wind (North-East-Down)

- From forces
- From torques

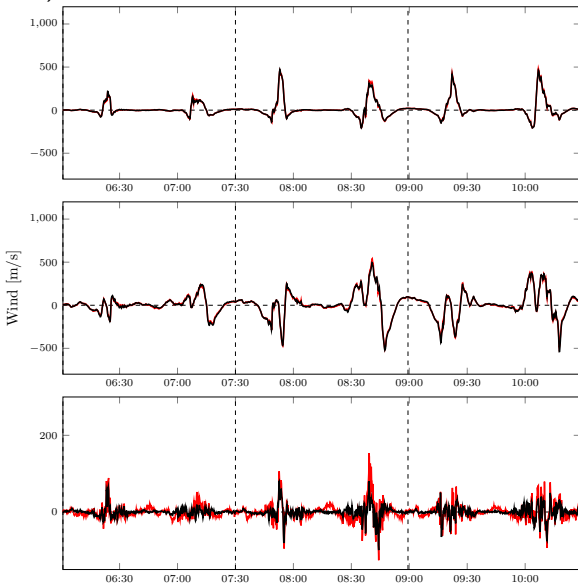


Wind (North-East-Down)

- From forces

- From torques

Filtered ($f \geq 3f_{orbit}$)





Improving the consistency of aerodynamic models and thermospheric density and wind data

Geometry and aerodynamic model improvement for thermospheric densities

Günther March
Ph.D. Candidate at TU Delft
g.march@tudelft.nl

Current panel models

Swarm Astrium Macro Model

PANEL	0	1	1	1000101	0.0	0.0	1.0
PANEL	0	1	2	1000101	1.540		
PANEL	0	1	3	1000101	0.03	0.0	0.01
PANEL	0	1	4	1000101	0.79	0.0	0.31
PANEL	0	1	5	1000101	0.68		
PANEL	0	2	1	1000101	-0.19766	0.0	0.98027
PANEL	0	2	2	1000101	1.400		
PANEL	0	2	3	1000101	0.06	0.0	0.02
PANEL	0	2	4	1000101	0.17	0.0	0.20
PANEL	0	2	5	1000101	0.78		

... for a total of (only) 15 panels

Current panel models

Swarm Astrium Macro Model

PANEL	0	1	1	1000101	0.0	0.0	1.0
PANEL	0	1	2	1000101	1.540		
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Current panel models

Swarm Astrium Macro Model

Normal vector components

PANEL	0	1	1	1000101	0.0	0.0	1.0
PANEL	0	1	2	1000101	1.540		
PANEL	0	1	3	1000101	0.03	0.0	0.01
PANEL	0	1	4	1000101	0.79	0.0	0.31
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PANEL	0	2	5	1000101	0.78		

... for a total of (only) 15 panels

Current panel models

Swarm Astrium Macro Model

Normal vector components

PANEL	0	1	1	1000101		0.0	0.0	1.0
PANEL	0	1	2	1000101	<u>Area</u>	1.540		
PANEL	0	1	3	1000101		0.03	0.0	0.01
PANEL	0	1	4	1000101		0.79	0.0	0.31
PANEL	0	1	5	1000101		0.68		
PANEL	0	2	1	1000101		-0.19766	0.0	0.98027
PANEL	0	2	2	1000101		1.400		
PANEL	0	2	3	1000101		0.06	0.0	0.02
PANEL	0	2	4	1000101		0.17	0.0	0.20
PANEL	0	2	5	1000101		0.78		

... for a total of (only) 15 panels

Current panel models

Swarm Astrium Macro Model

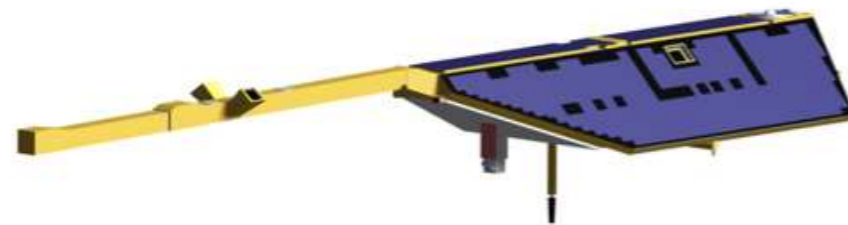
				<u>Normal vector components</u>			
PANEL	0	1	1	1000101	0.0	0.0	1.0
PANEL	0	1	2	1000101	<u>1.540</u>		
PANEL	0	1	3	1000101	0.03	0.0	0.01
PANEL	0	1	4	1000101	0.79	0.0	0.31
PANEL	0	1	5	1000101	0.68		
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PANEL	0	2	2	1000101	1.400		
PANEL	0	2	3	1000101	0.06	0.0	0.02
PANEL	0	2	4	1000101	0.17	0.0	0.20
PANEL	0	2	5	1000101	0.78		

Area

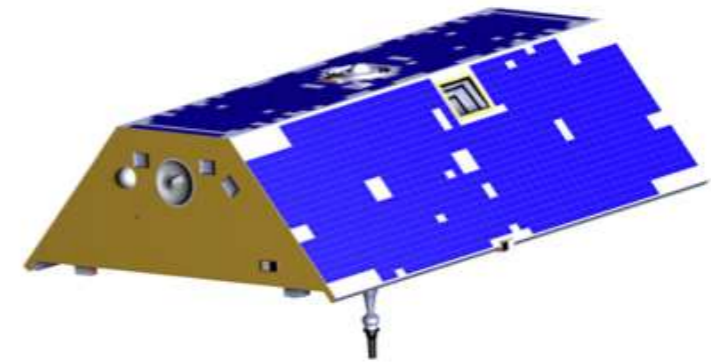
Optical
properties

... for a total of (only) 15 panels

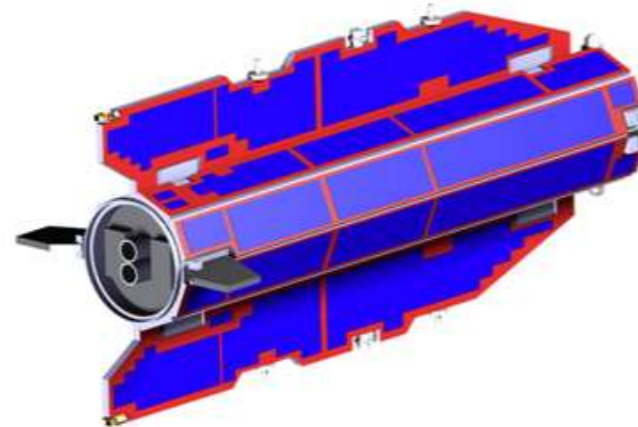
Improved geometry & aerodynamic model



CHAMP



GRACE



GOCE



Swarm

Computational method for Rarefied flows

SPARTA DSMC Simulator

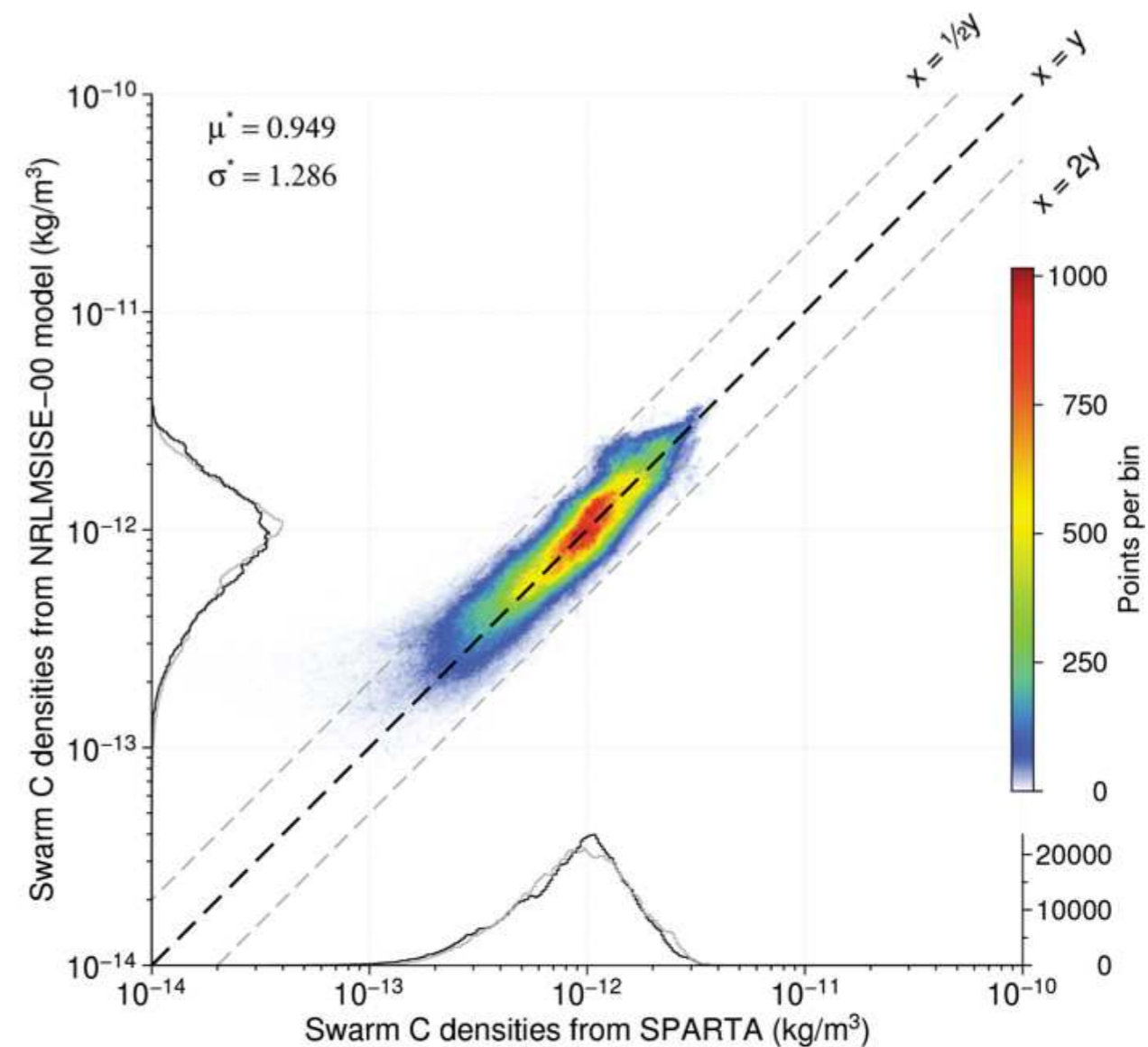
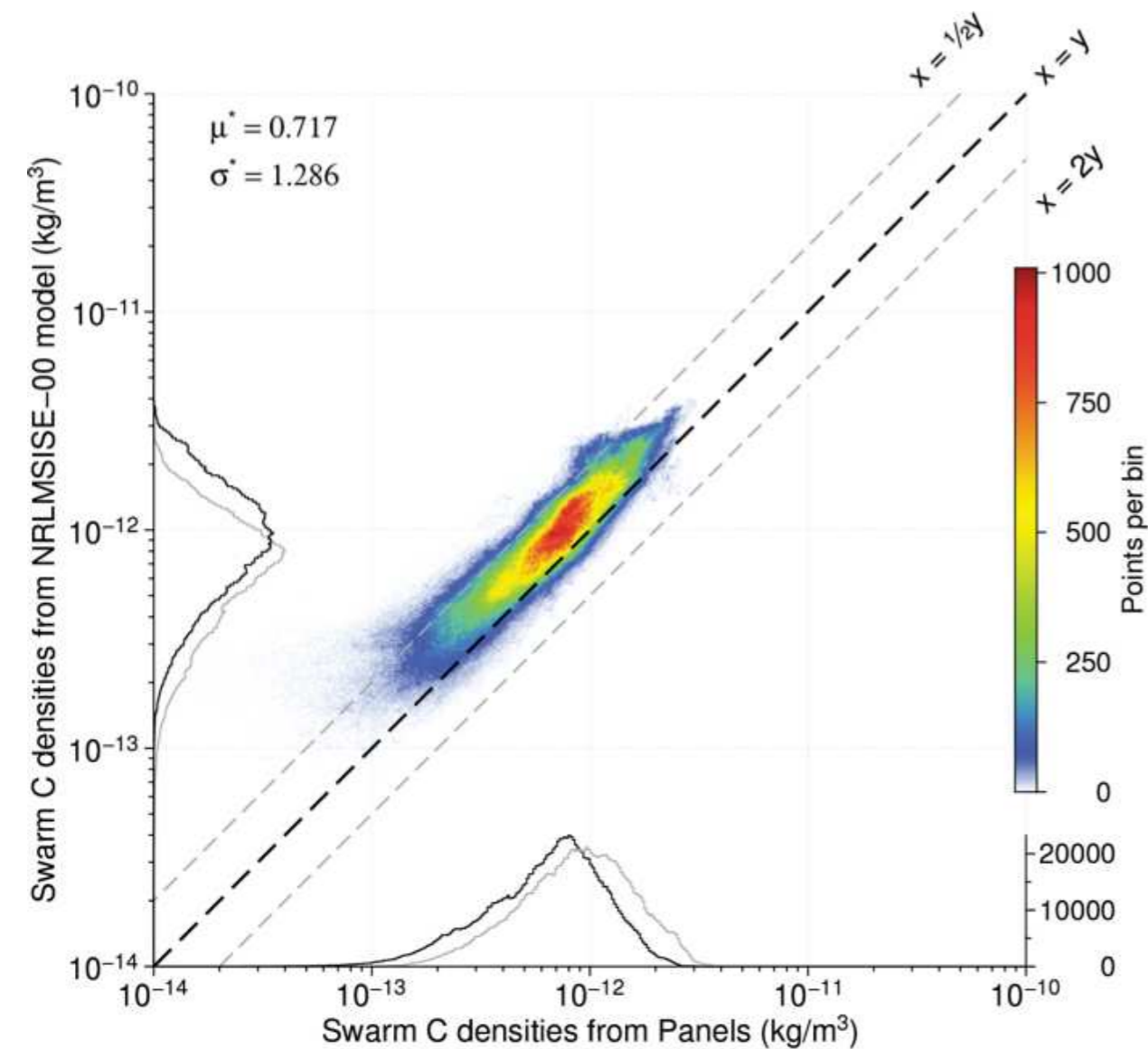
Stochastic **PA**rallel **R**arefied-gas **T**ime-accurate **A**nalyzer

<http://sparta.sandia.gov>

Statistical comparison

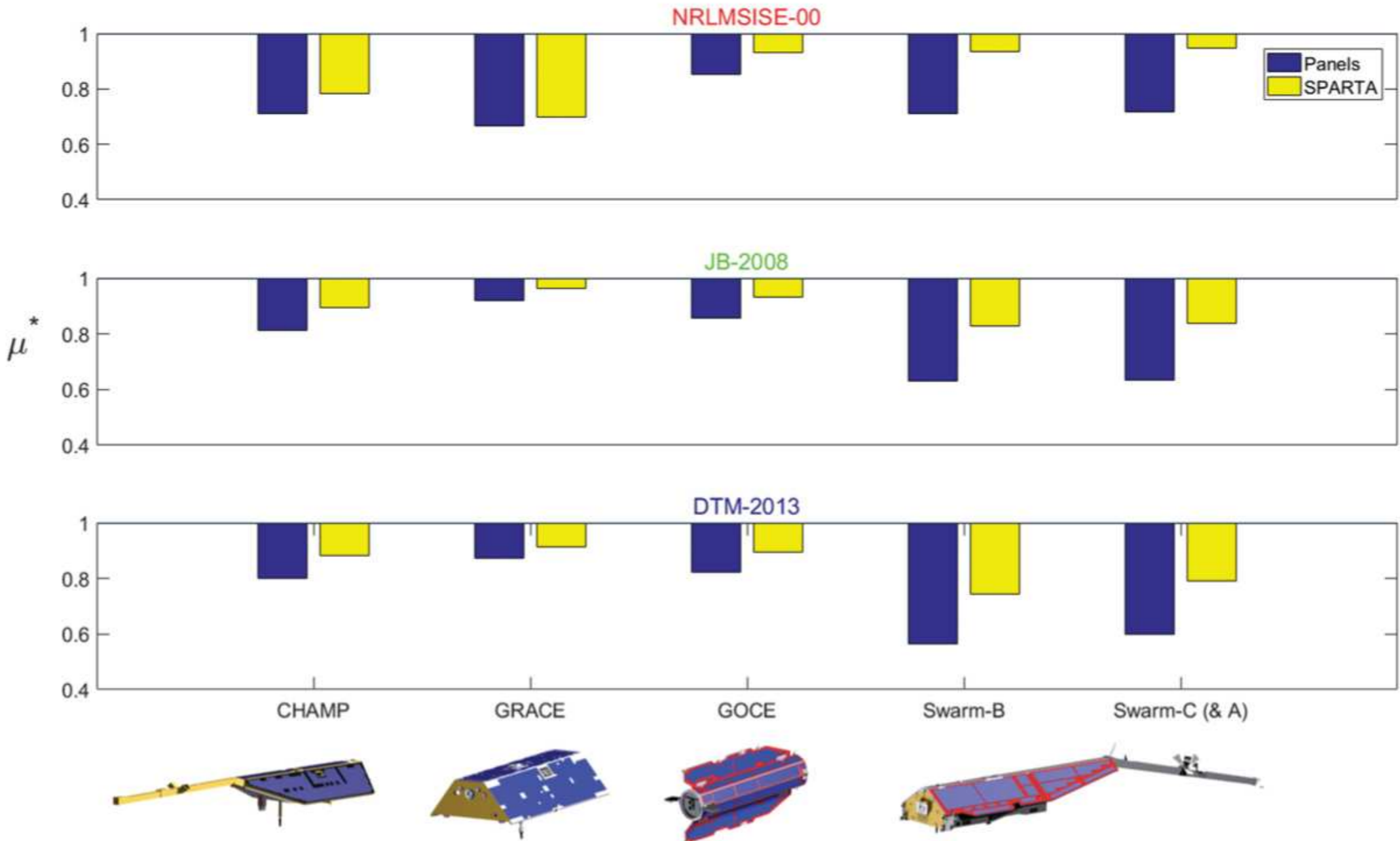
Swarm C density data for the period 19/07/2014 - 30/09/2016 with equivalent **NRLMSISE-00** model output.

Panels method densities (left) are compared with SPARTA results (right).



Consistency with other satellites

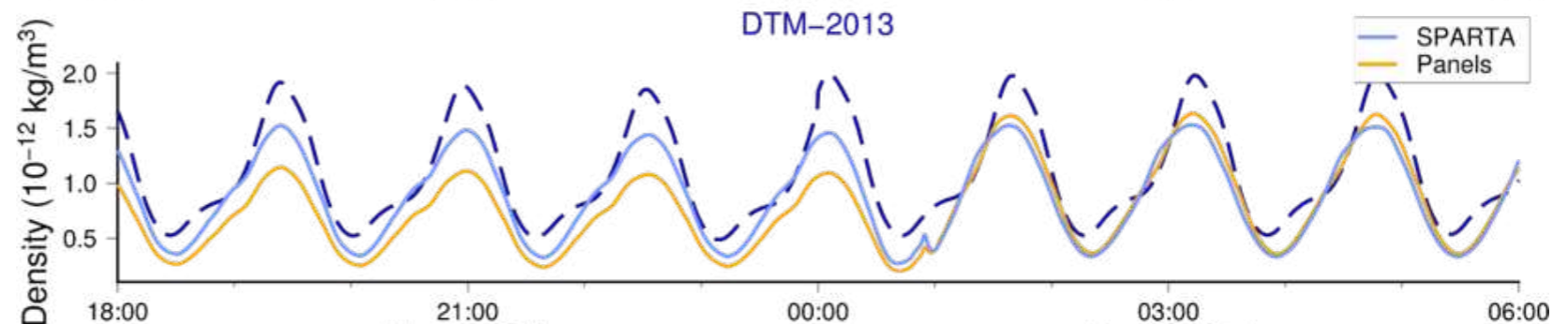
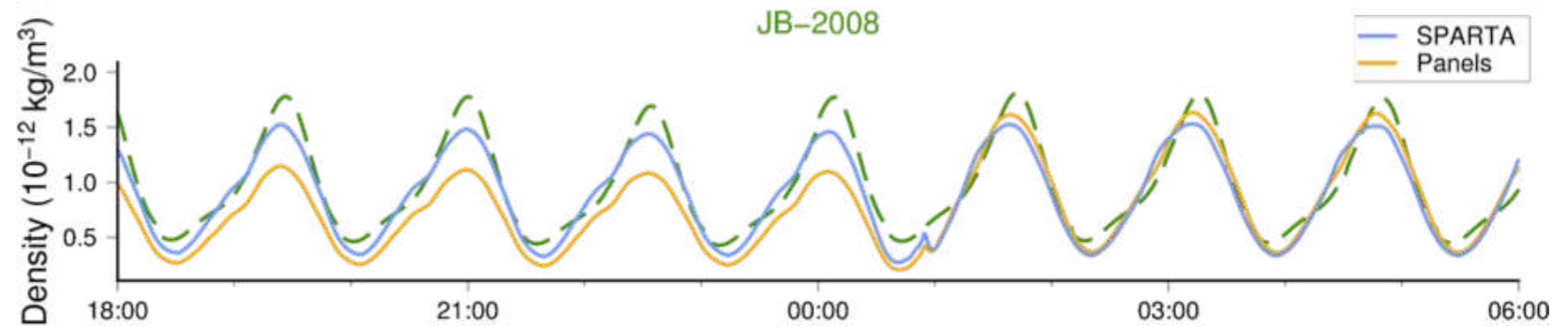
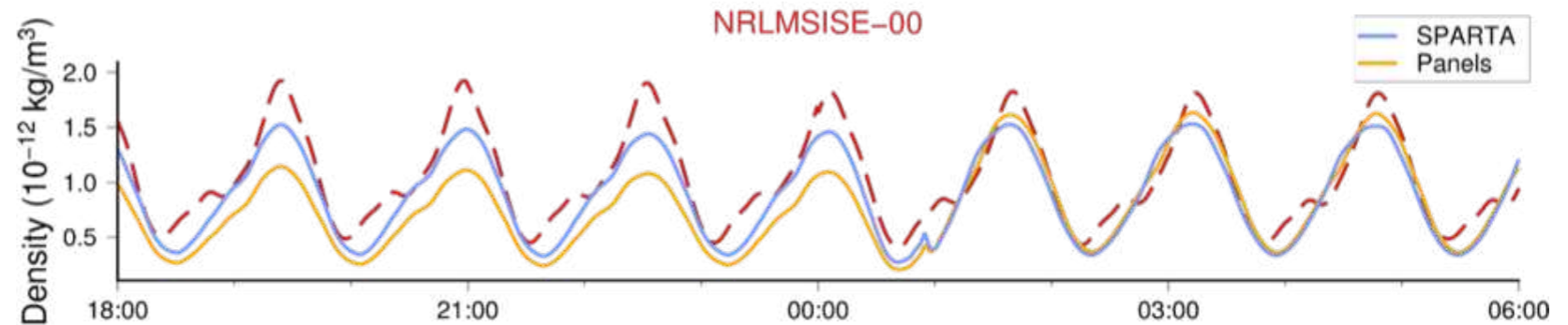
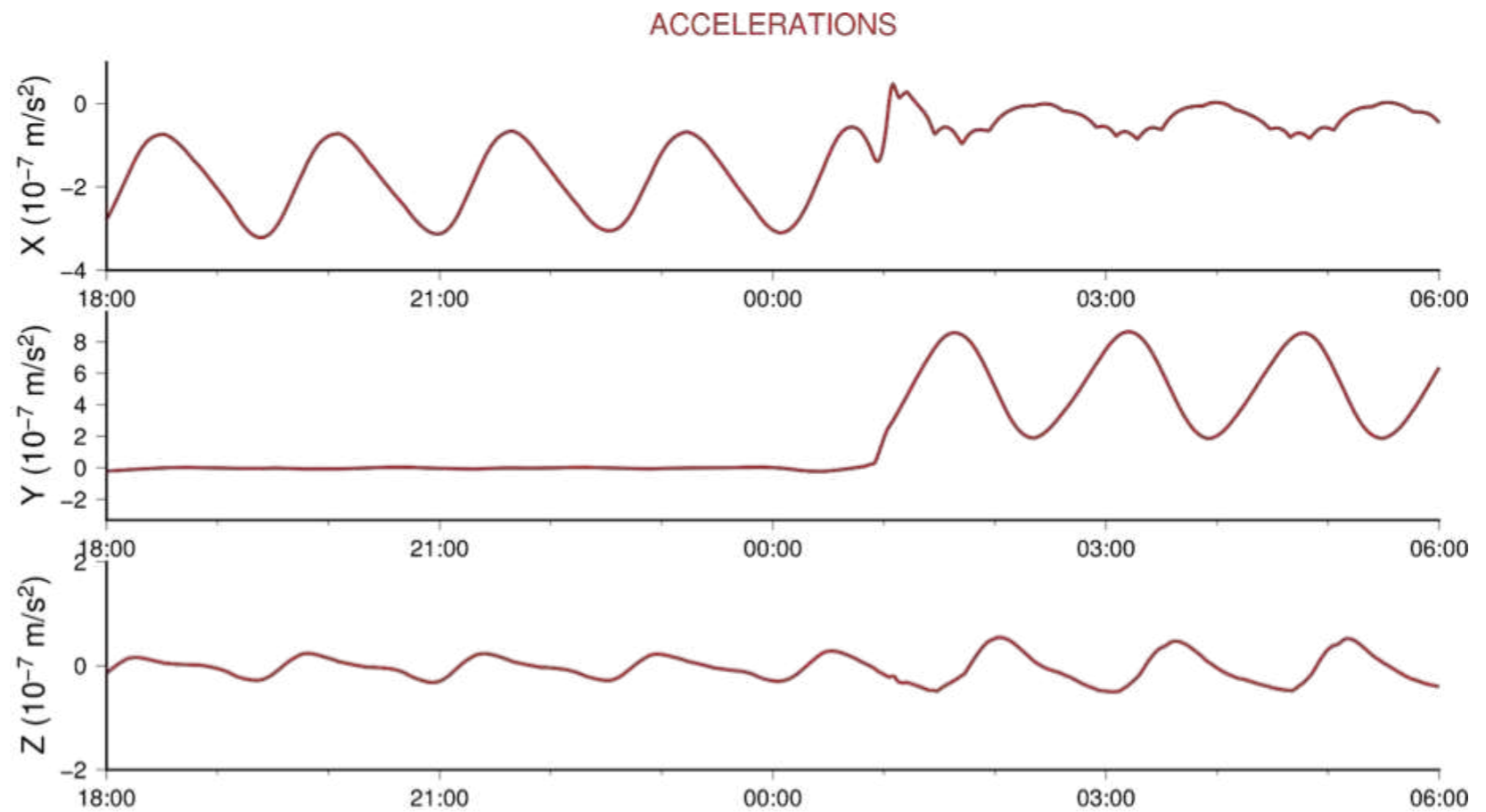
New densities turned out to be higher reaching a mean **+11%** for CHAMP, **+5%** for GRACE, **+9%** for GOCE and **+32%** for Swarm.



Attitude manoeuvre Comparison

(90° Yaw man.)
13/05/2014

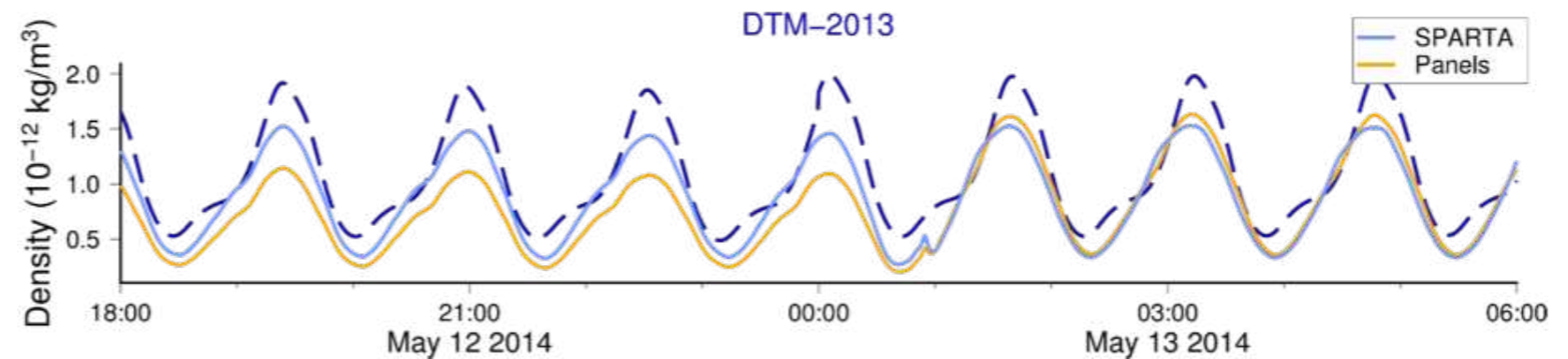
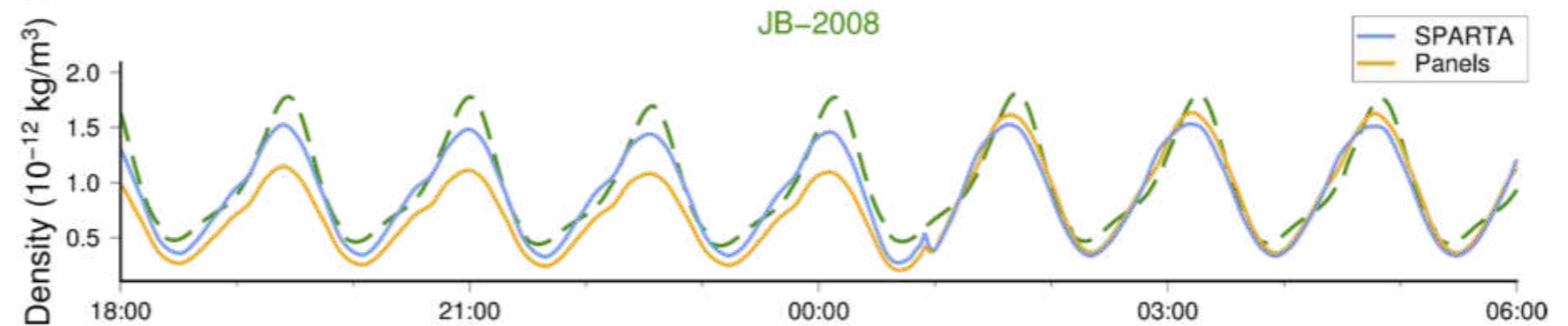
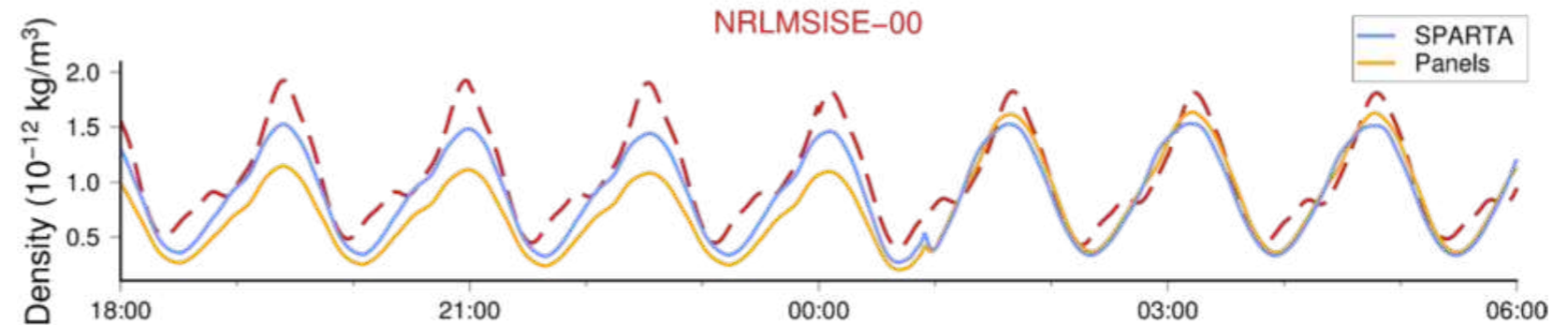
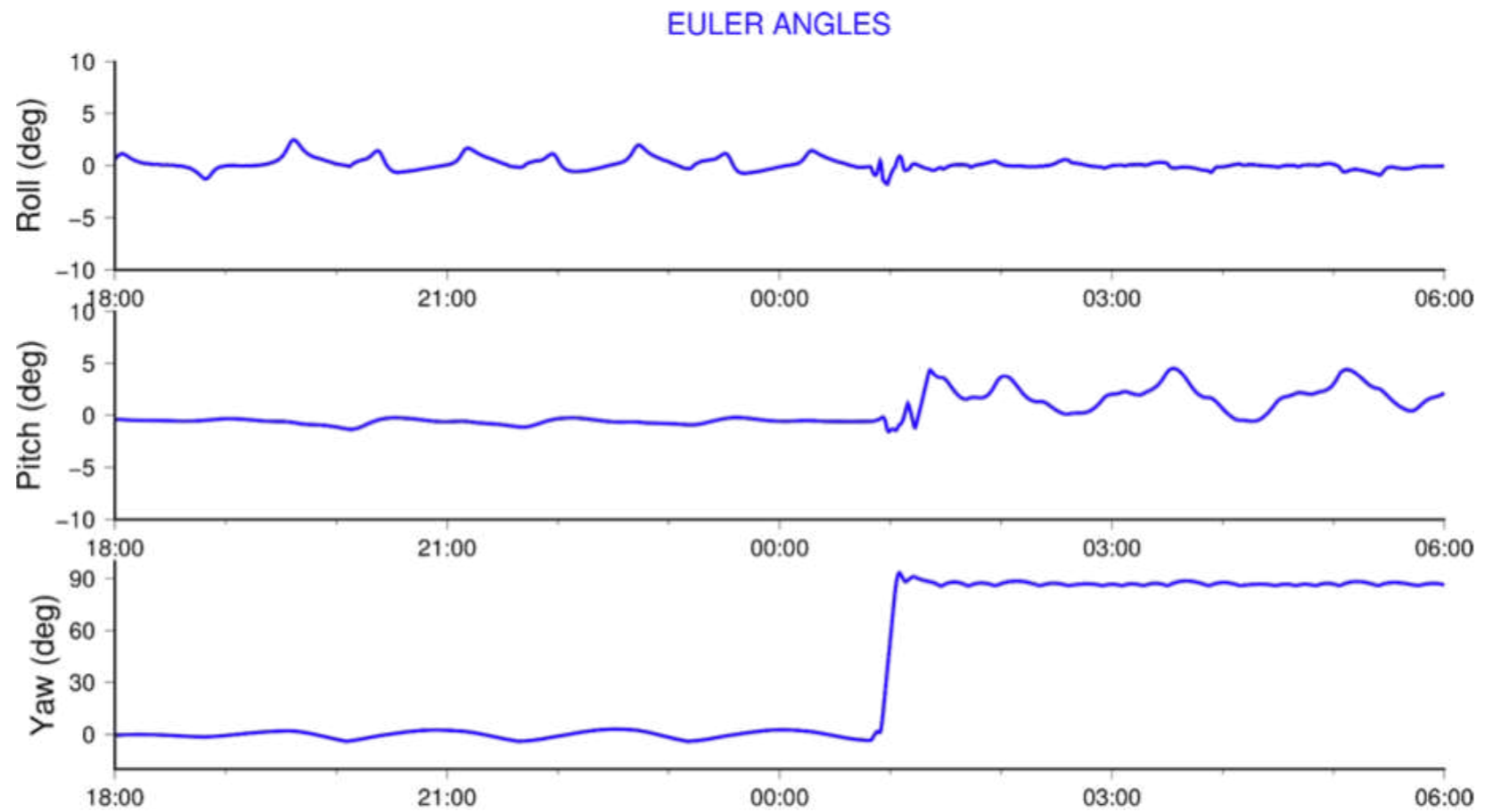
X-Y-Z Accelerations
&
Density comparison with 3
atmospheric models



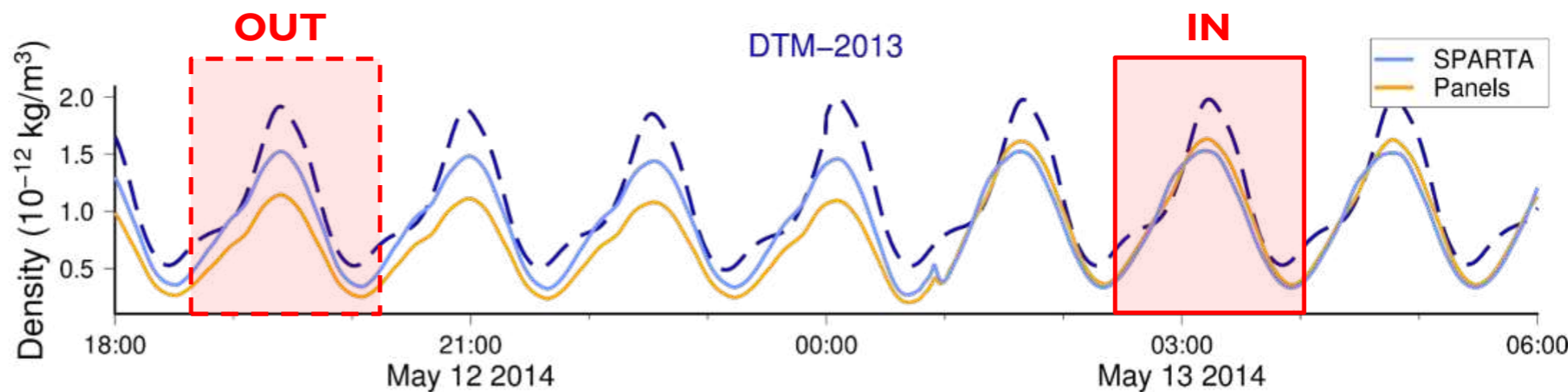
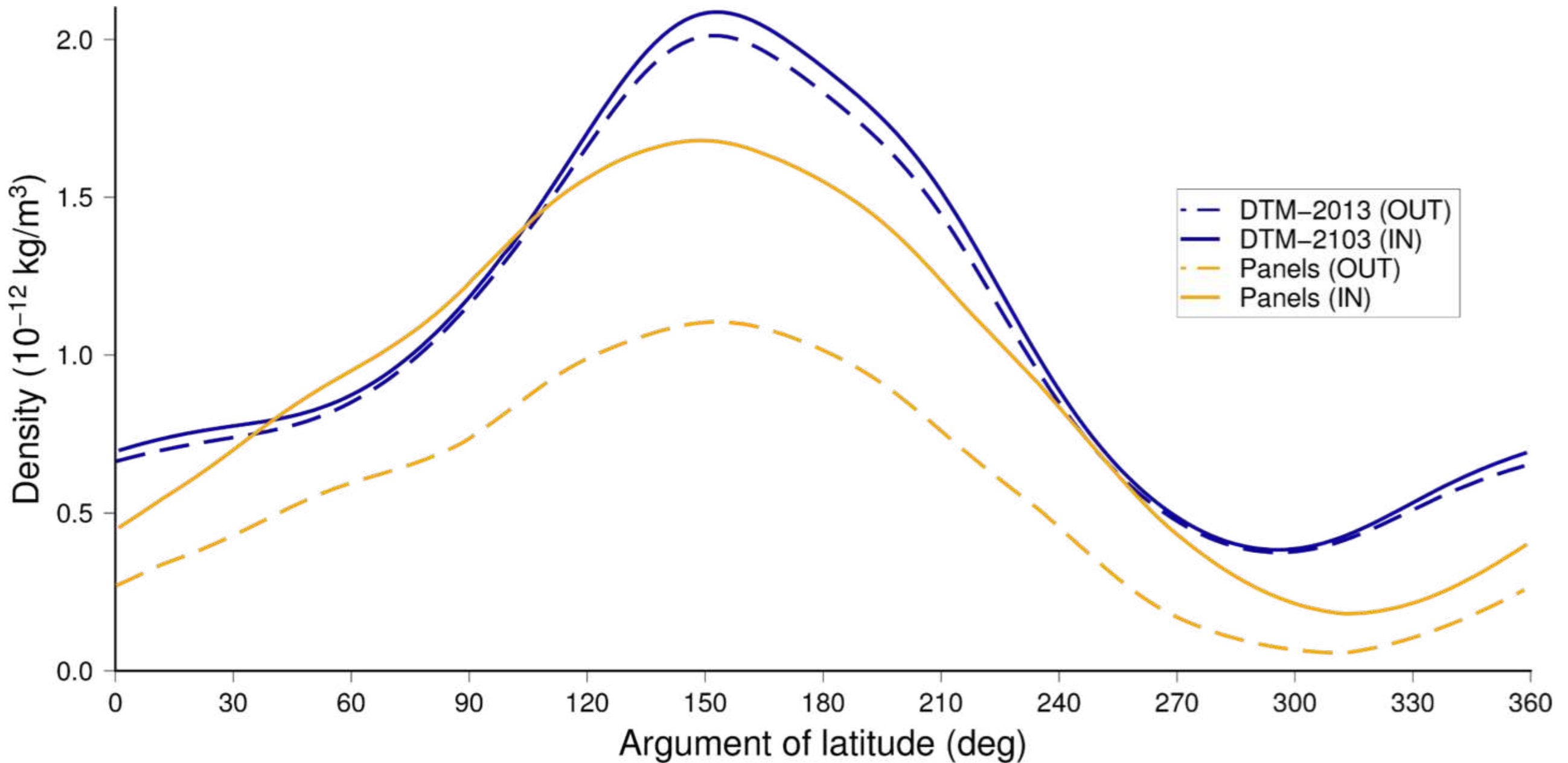
Attitude manoeuvre Comparison

(90° Yaw man.)
13/05/2014

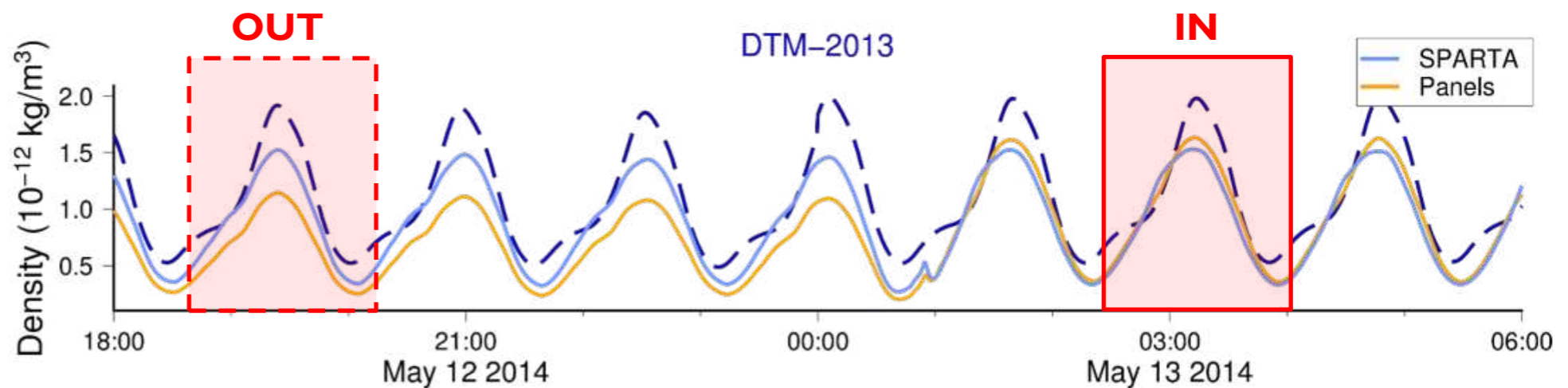
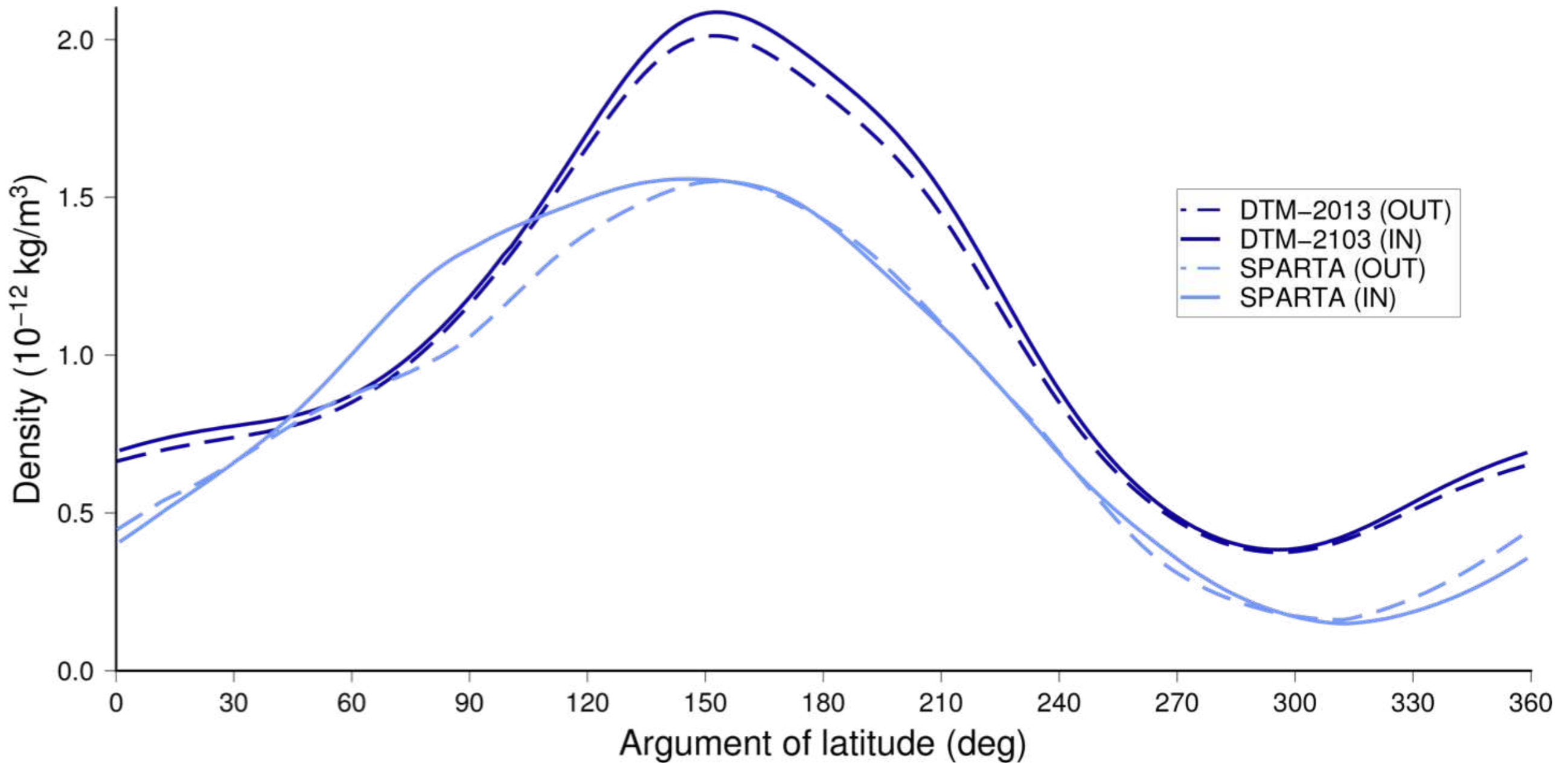
Euler Angles
&
Density comparison with 3
atmospheric models



Attitude manoeuvre comparison (90° Yaw)



Attitude manoeuvre comparison (90° Yaw)

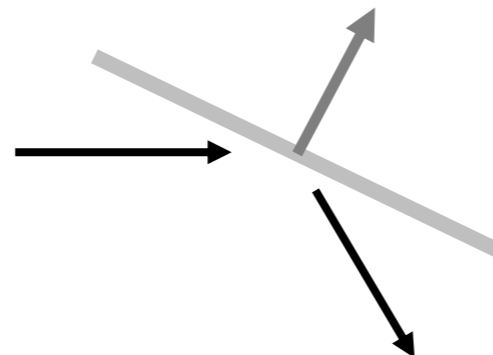


Summary & Outlook

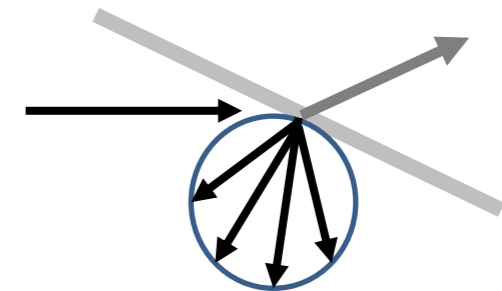
SPARTA data set is currently adopted for L2 DNS-POD product

Gas-Surface Interactions

Specular reflection



Diffuse reflection



Solar radiation pressure modelling