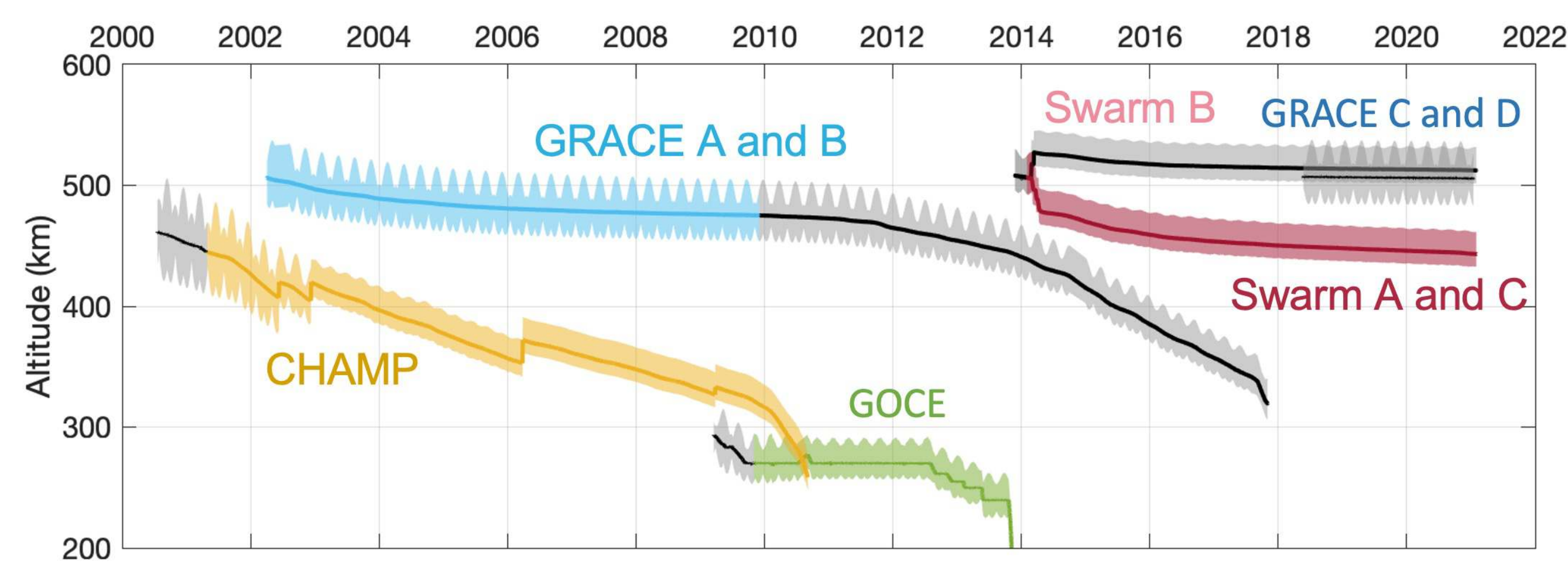


TOLEOS – Thermosphere Observations from Low-Earth Orbiting Satellites

<http://thermosphere.tudelft.nl>

The objective of the TOLEOS project is to process the CHAMP, GRACE, and GRACE-FO accelerometer measurements with improved processing standards to obtain thermosphere density and crosswind data products. These new data products will cover the entirety of the accelerometer missions and complement the existing ESA databases for Swarm and GOCE. The improvements in the processing focus on the radiation pressure modelling, which is expected to have a significant effect on the density and crosswind data, in particular at altitudes above 450 km during solar minimum conditions. Substantial validation activities are performed since the project's start in June 2021 and will continue until the end of the project in July 2022.

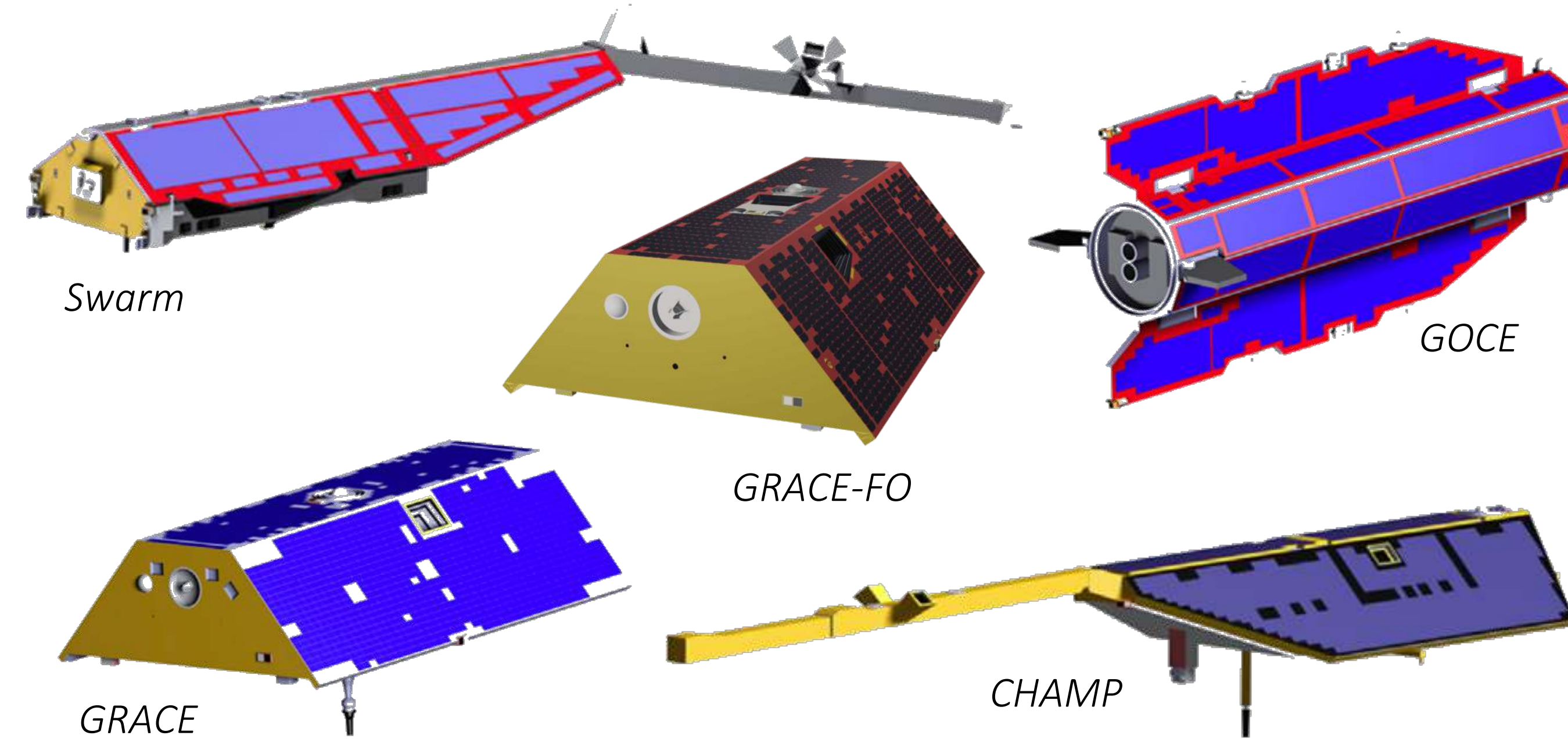
Thermosphere data availability



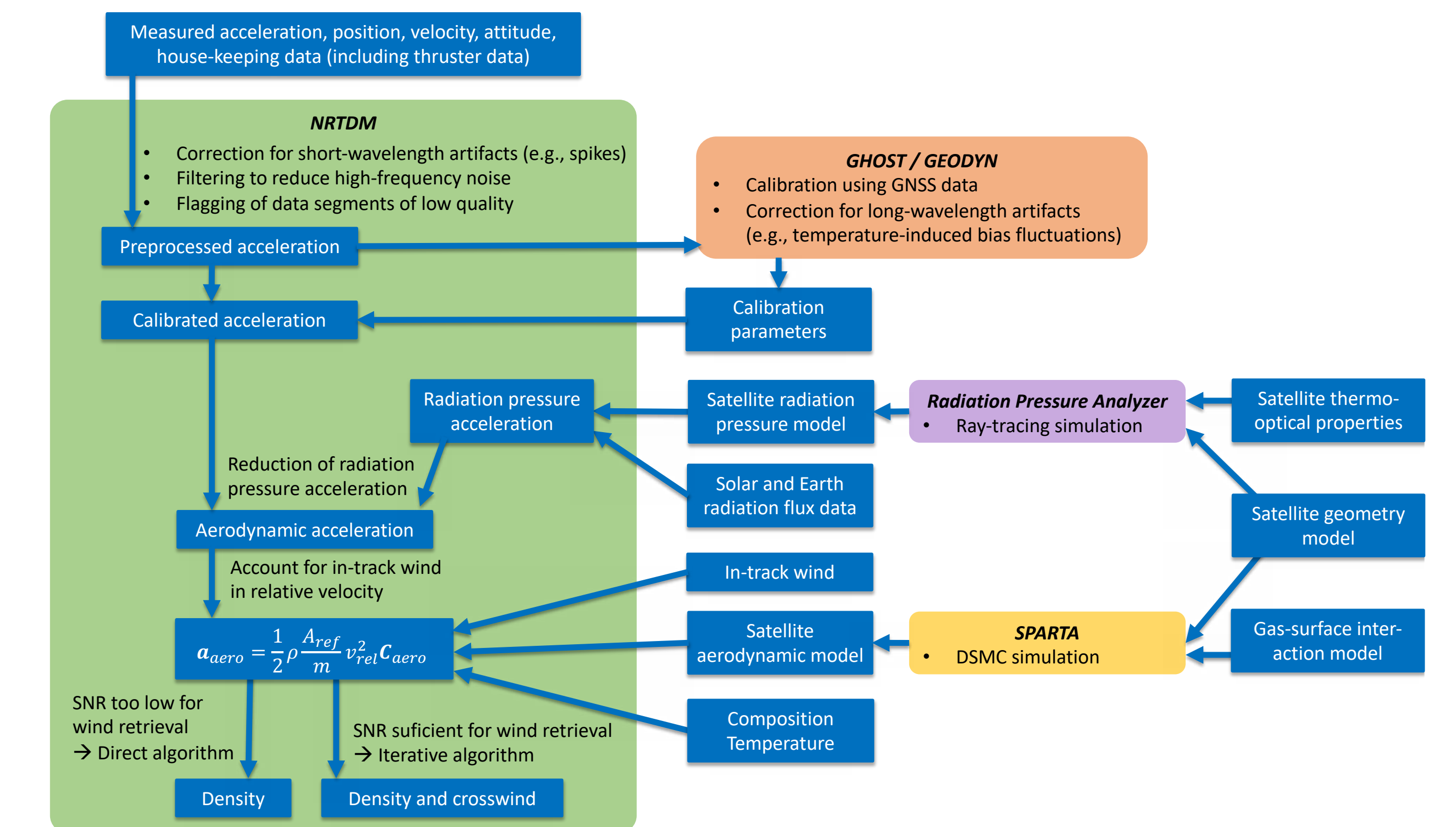
Colors indicate the parts of the mission for which thermosphere observations are presently available, while gray indicates parts that have not yet been processed. By the end of the TOLEOS project, all gray areas for CHAMP, GRACE, and GRACE-FO will be processed, whereas the colored parts will be reprocessed with improved accelerometer calibration and processing standards.

High-fidelity satellite geometry models

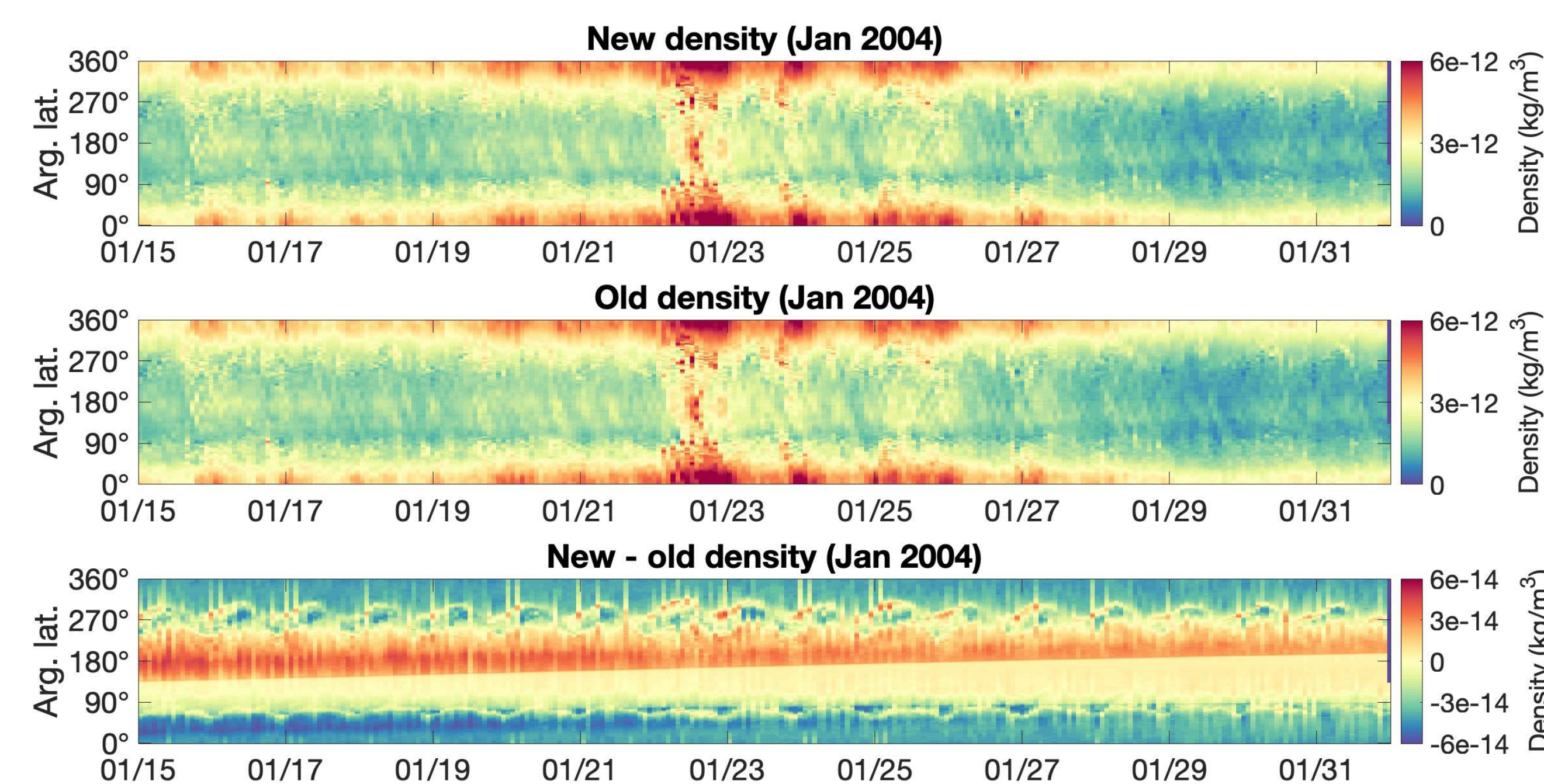
Highly detailed models of the satellite geometry are essential for accurate aerodynamic and radiation pressure modelling. The GRACE-FO geometry model was specifically created for the TOLEOS project.



From accelerometer data to thermosphere observations

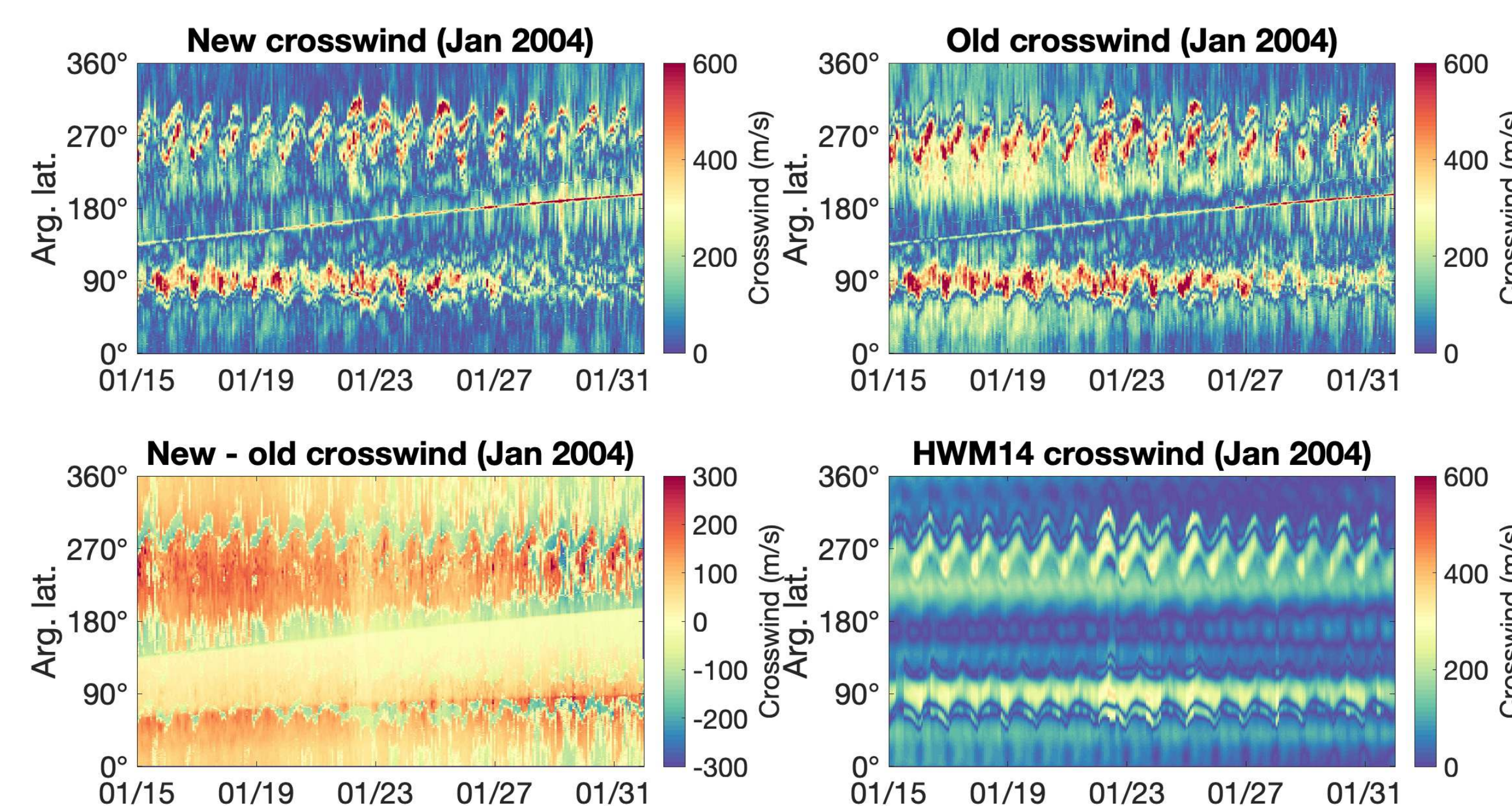


Effect on CHAMP density observations



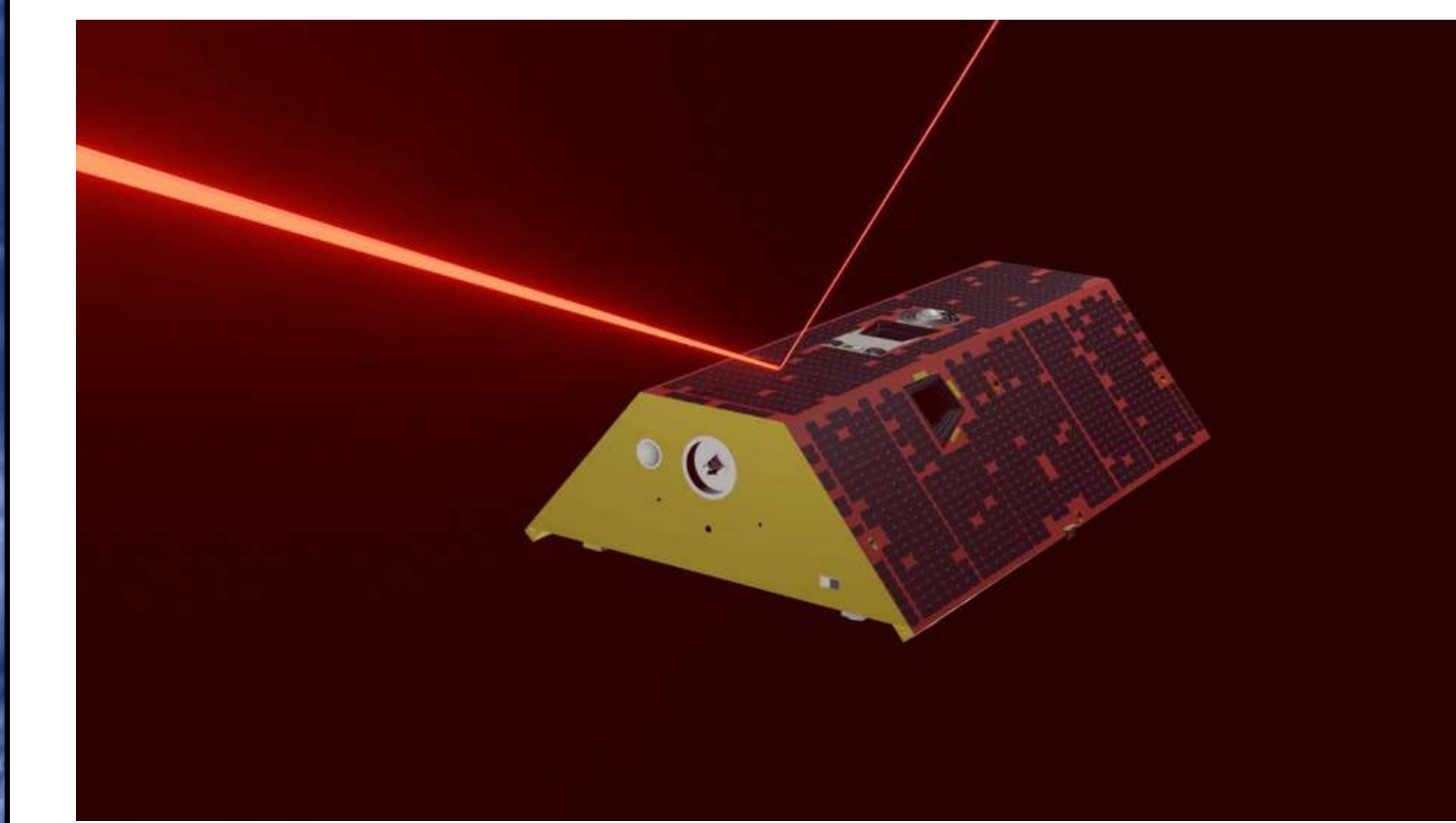
A first assessment of the effect of the upgraded radiation pressure model on CHAMP density observations in January 2004. The difference between old and new density observations is on the order of 2%. Since CHAMP was orbiting at 400 km altitude in active solar conditions, we may expect a much larger effect for GRACE during the 2008/2009 solar minimum and GRACE-FO in the present solar minimum.

Effect on CHAMP crosswind observations



A first assessment of the effect of the upgraded radiation pressure model on CHAMP crosswind observations in January 2004. The difference between old and new density observations is on the order of 200 m/s. The new crosswind observations tend to be much smaller at non-polar latitudes and show larger peak wind speeds within the auroral region.

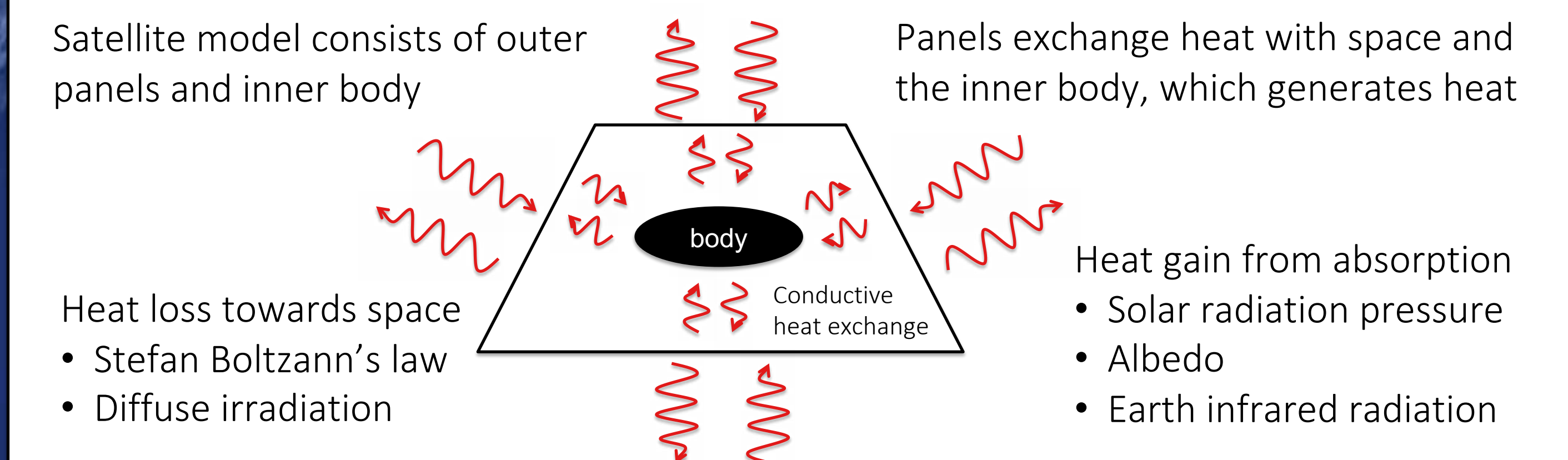
Radiation pressure modelling – ray tracing



Radiation pressure from incoming radiation is simulated by tracing millions of test rays from every direction using the high-fidelity geometry models

- More accurate than panel models
- Shadowing effects
- Multiple reflections

Radiation pressure modelling – new thermal model



The TOLEOS project is funded by



Christian Siemes, Claudia Borries, Sean Bruinsma, Isabel Fernandez-Gomez, Natalia Hładczuk, Timothy Kodikara, Jose van den IJssel, Kristin Vielberg, Pieter Visser

The TOLEOS project is a collaboration of

