Implementation and assessment of a new blended whole atmosphere model in re-entry services for space surveillance & tracking operations as part of SWAMI H2020 project

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Space Weather Atmosphere Models and Indexes

H2020 European Union research activity

From January 2018 to March 2021

Objectives:

- To provide an improved and comprehensive representation of the neutral atmosphere from the surface to 1500 km altitude by developing the new whole atmosphere model (MOWA)
- MOWA is based on a coupling between existing models that represent different parts of the near-Earth space environment
- New high-cadence geomagnetic indices (Hp) will be developed and used to drive the model, enabling accurate phasing of storm events

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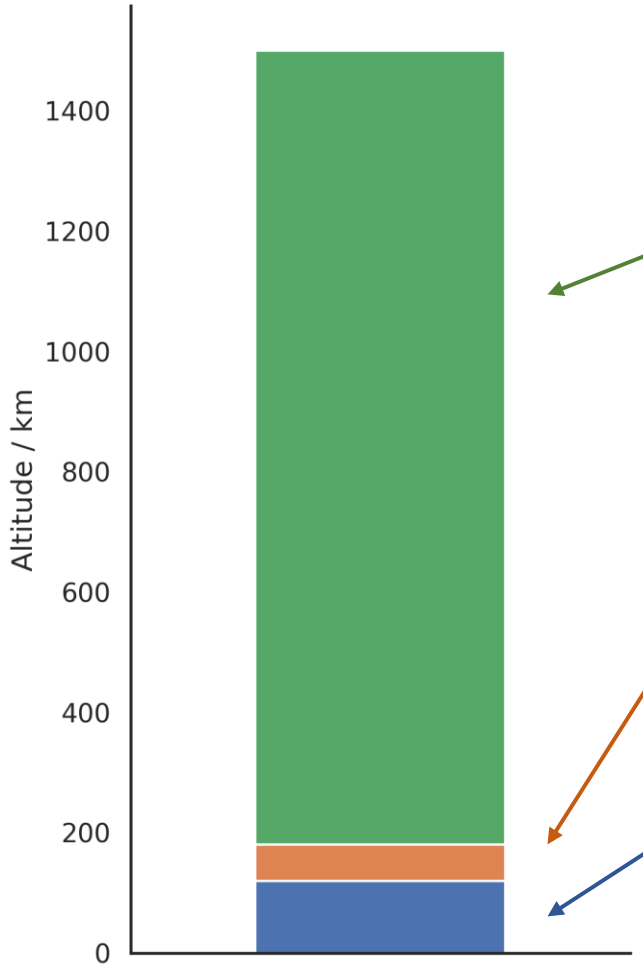
MOWA: Model of the Whole Atmosphere



DTM2020: Drag Temperature Model (CNES)

Transition

UM: Unified Model (MetOffice)

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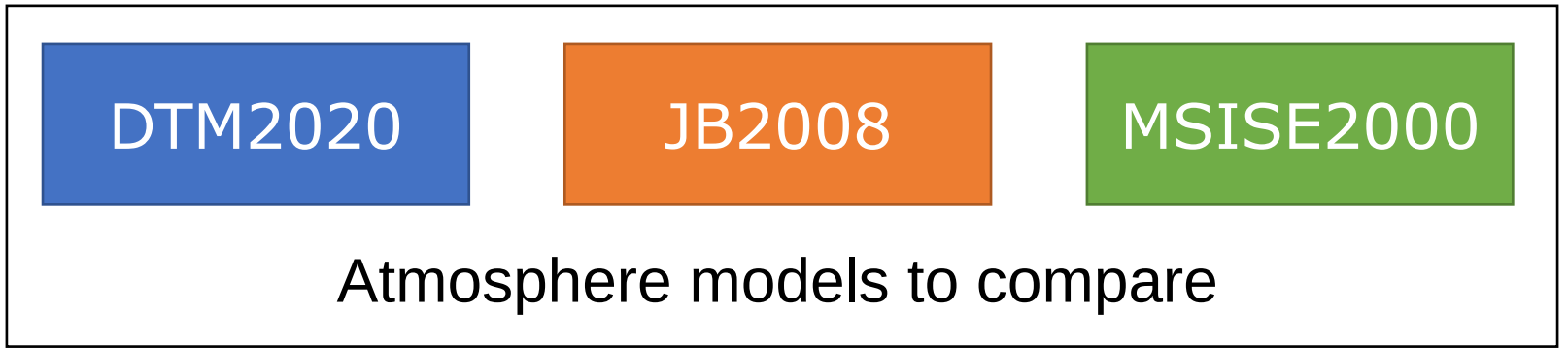
Evaluation of DTM2020



1. Integrate the DTM2020 into a numerical propagator
2. Use a couple of test cases to compare these models against precise reference ephemeris
3. Do large-scale comparison against TLE data points

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Comparison vs SP reference data

Name	NORAD	COSPAR	Epoch	Mass [kg]	Area [m2]	Perigee alt. [km]	Apogee alt. [km]
GRACE-FO-1/2	43476	2018-047A	2019-09-17	600	1.89	491	499
STSAT-2C	39068	2013-003A		100	0.92	263	527
Swarm-B	39451	2013-067A		473	2.65	498	516
Starlette	7646	1975-010A		47	0.05	798	1109
CryoSat-2	36508	2010-013A		720	5.69	704	736

Mass and area from DISCOS

DTM2020

JB2008

MSISE2000

Atmosphere models to compare

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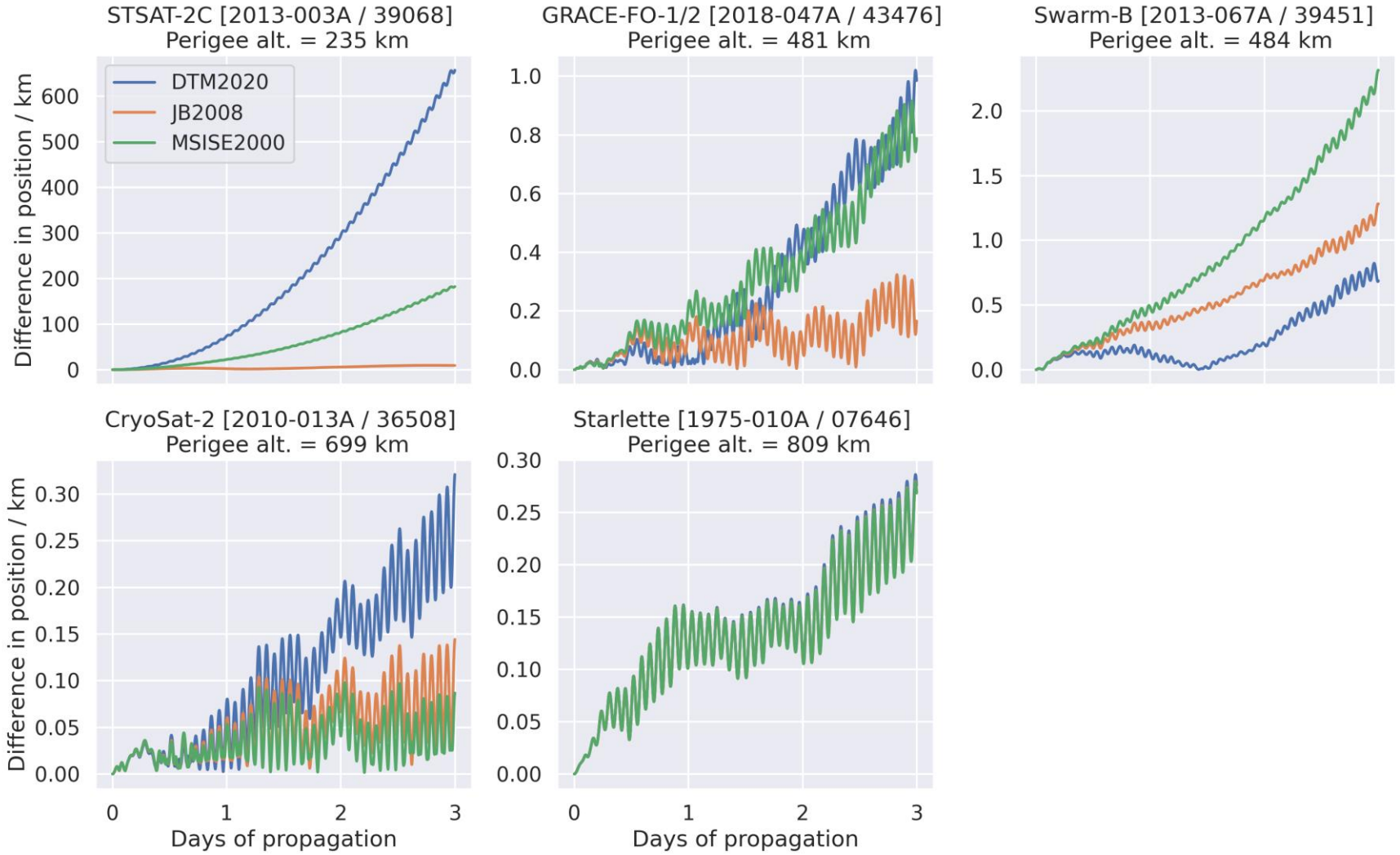
Comparison vs SP reference data



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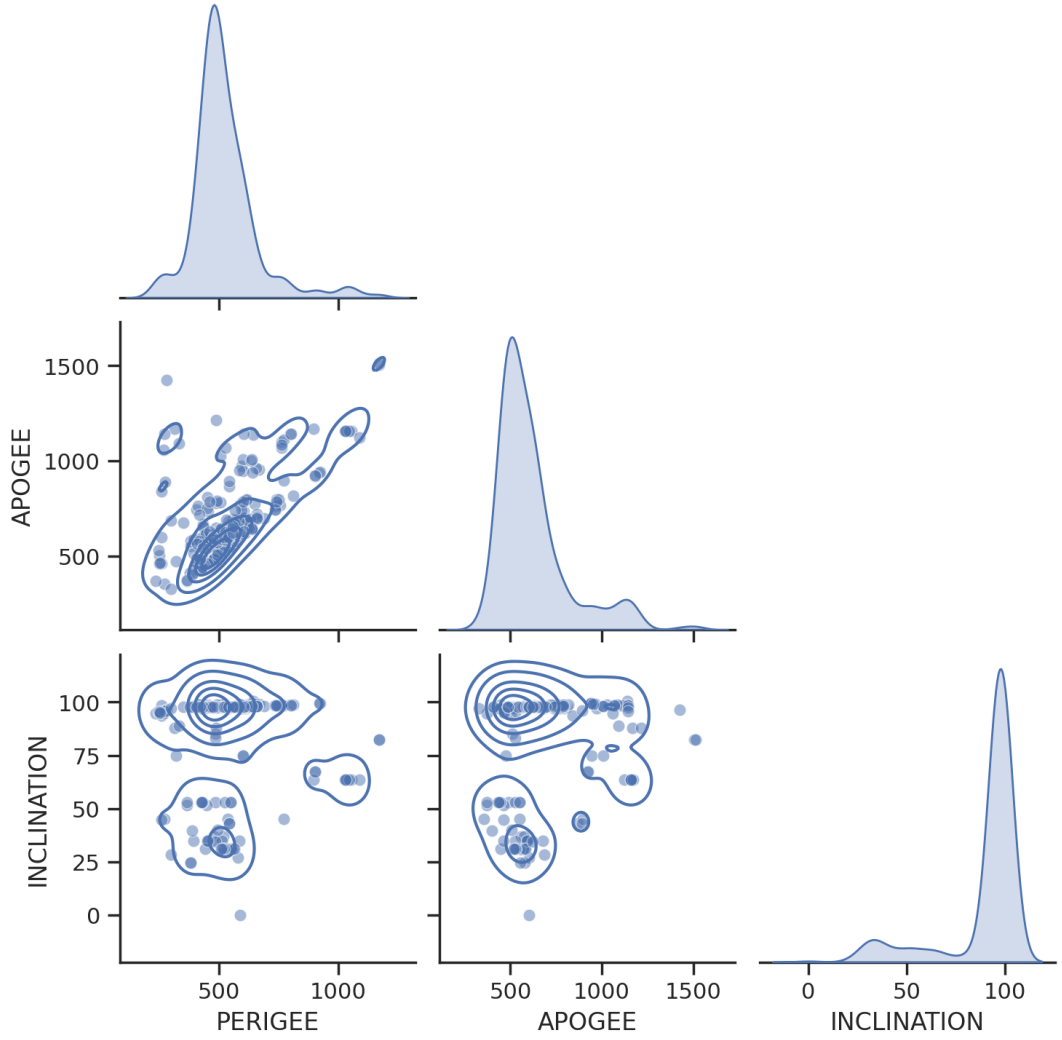
Comparison against TLE catalogue: dataset

Space Track

- Perigee alt. ≥ 200 km
- Perigee alt. ≤ 1500 km
- Launched between 2016 and 2019
- Non-manoeuvrable

~400
LEO objects



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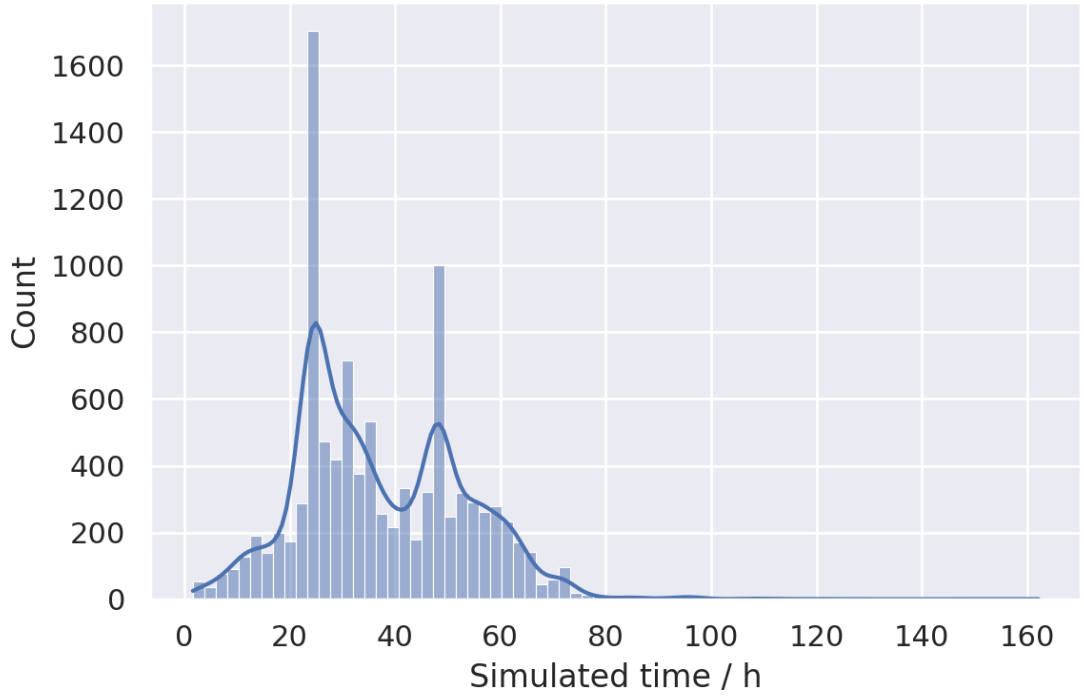
Comparison against TLE catalogue: dataset

- 394 objects
- 6 epochs
  - January 2016
  - October 2016
  - July 2017
  - April 2018
  - January 2019
  - October 2019
- 3 atmosphere models: DTM2020, JB2008, MSISE2000
- Paired subsequent TLEs between epoch and 10 days after

Almost 38.000 simulations



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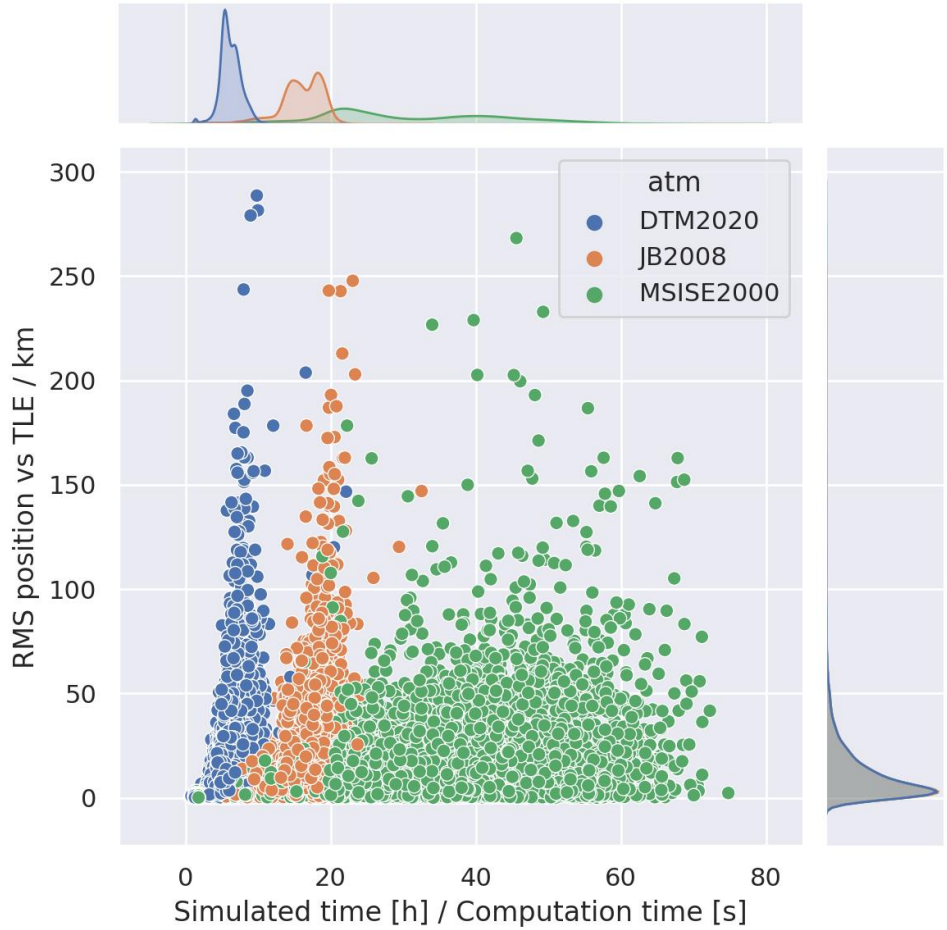
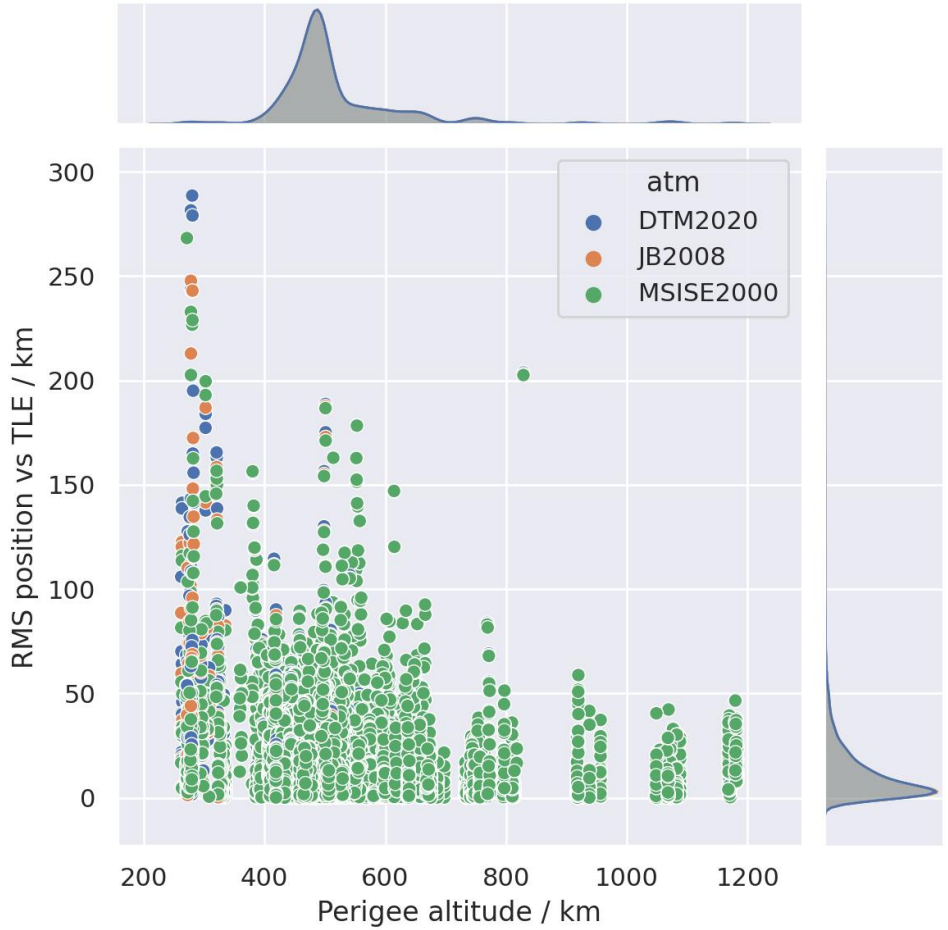
Comparison against TLE catalogue: results



(The higher the better)



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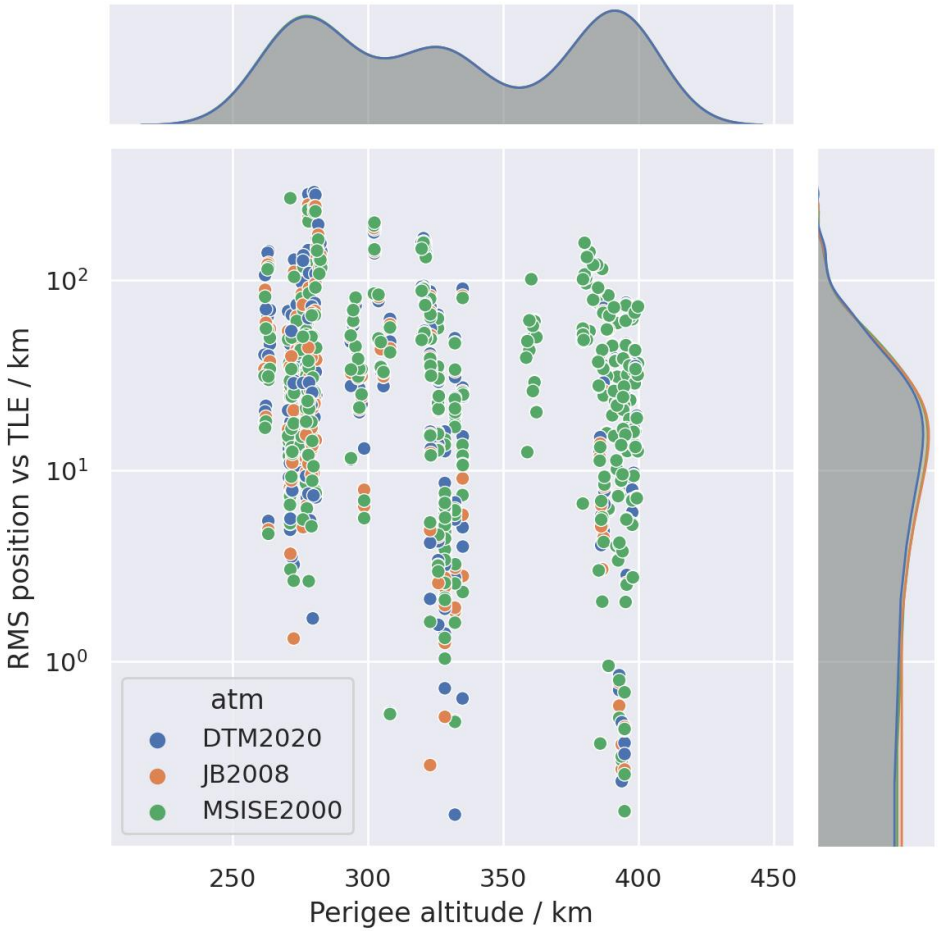
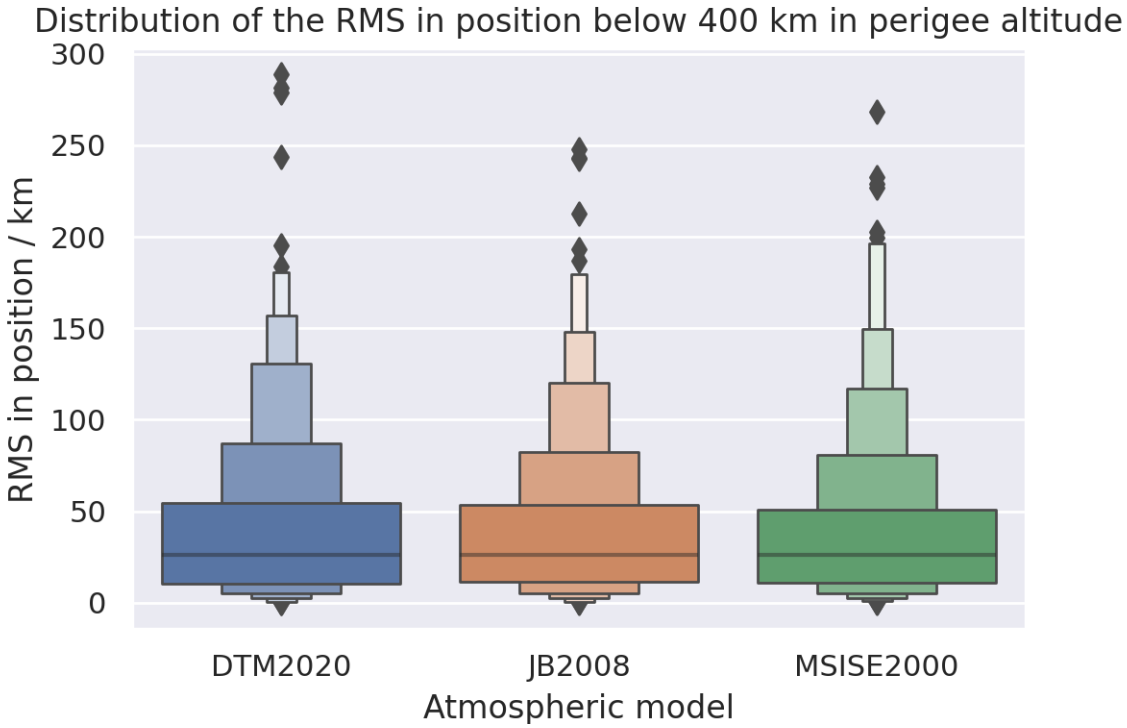
Comparison against TLE catalogue: results





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Some remarks & Future work

- At this time, DTM2020 does not seem to do better, although TLE data is not very good in this altitude range
- DTM2020 seems to be more expensive computationally
- The difference between models appear in the VLEO region

- ❑ Use SP instead of TLE for bulk assessment. TLEs have lower precision
- ❑ Integrate the new blended MCM model when it is ready
- ❑ SWAMI final model will also provide density uncertainty → Useful for re-entry analysis
- ❑ Use measured propagation and re-entry data points to evaluate effectively the new model

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