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Evaluation of the tropospheric correction modelling with GPT2/VMF1

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1. Tropospheric correction modelling

Due to the refractive index of the Earth's atmosphere, microwave signals suffer from tropospheric propagation delays. The total tropospheric delay correction, TTC, in direction of a particular satellite can be divided into a hydrostatic and a wet component in such a way that :

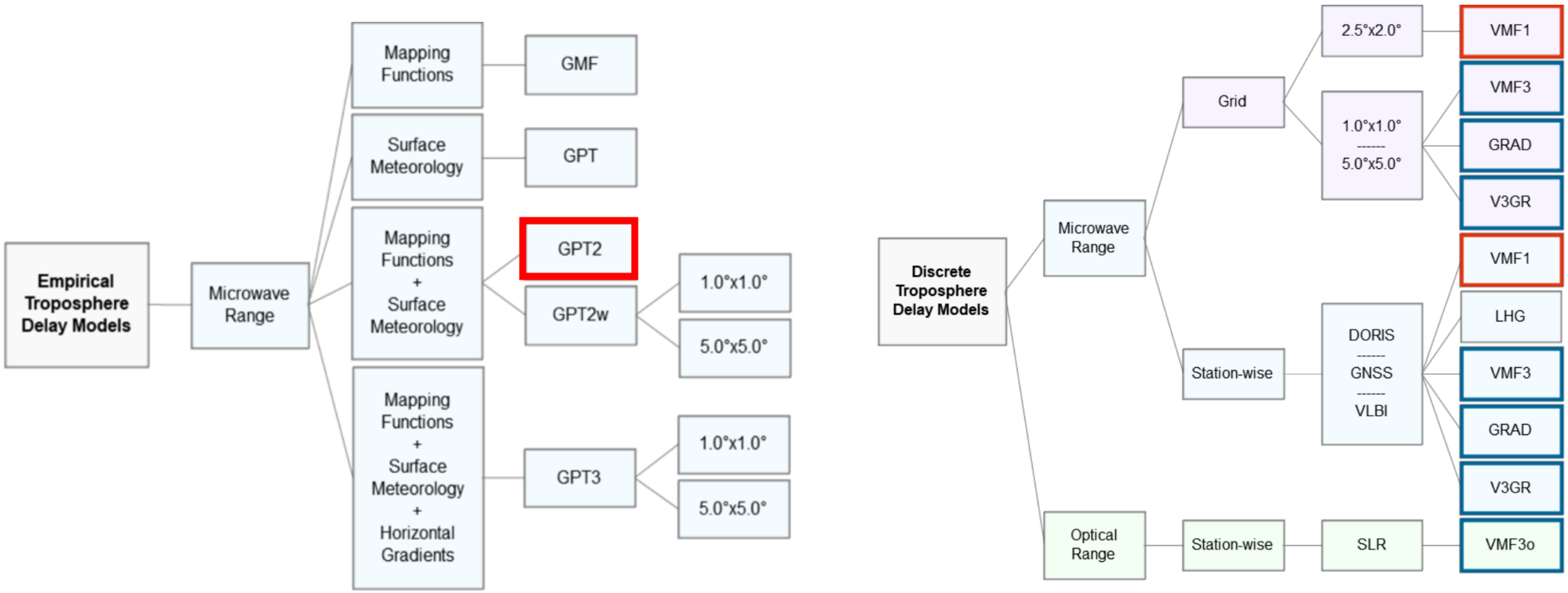
$$TTC = THC + TWC = MFH \cdot ZHD + MFW \cdot ZWD$$

where :

- ZHD is the Zenith Hydrostatic Delay in meters.
- ZWD is the Zenith Wet Delay in meters.
- MFH and MFW are the hydrostatic and wet Mapping Functions to scale the corresponding delays to the actual satellite elevation angle.

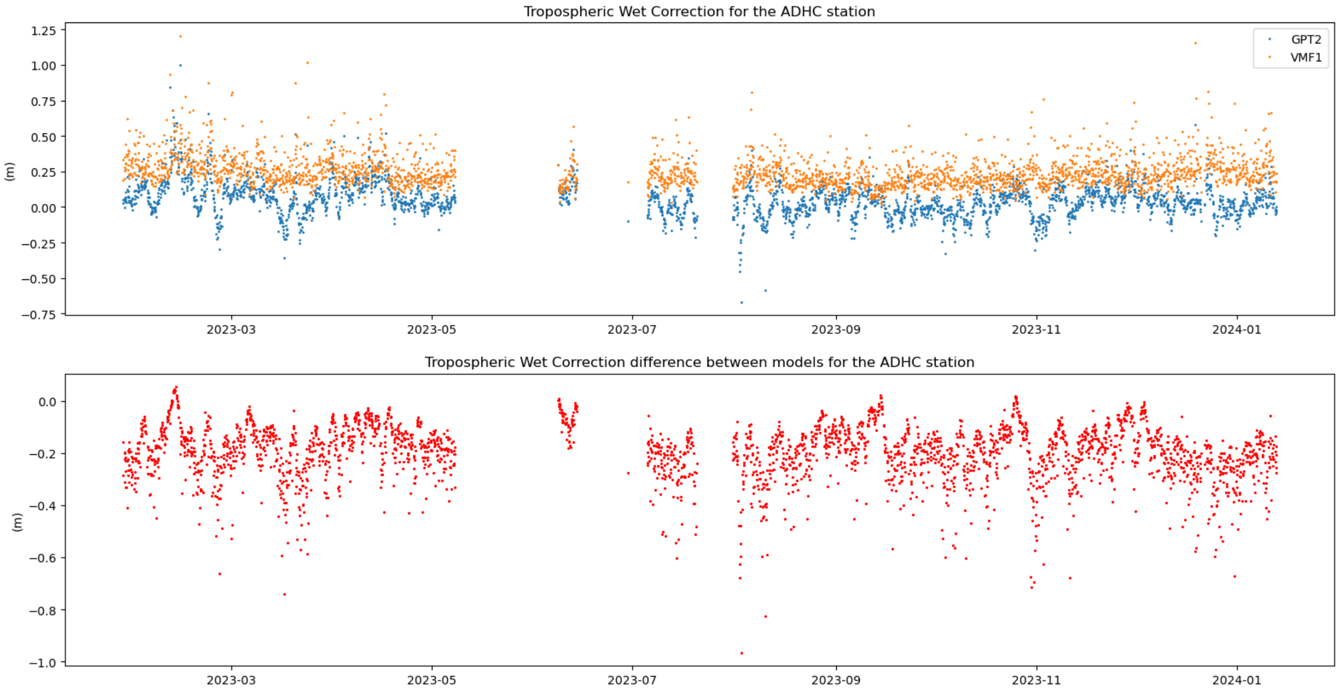
The hydrostatic delay component accounts for roughly 90% of the total delay and it can be accurately computed based on a priori reliable surface pressure data. However, there is no simple method to estimate an accurate a priori value for the wet delay. So, in most precise applications the wet delay must usually be estimated.

2. GPT2 vs. VMF1



Both models have dedicated routines with different approaches for the calculation of the Mapping Functions and Delays. See https://vmf.geo.tuwien.ac.at/

2. GPT2 vs. VMF1 for the Wet component



The wet component is not modelled but estimated with the other geodetic parameters.

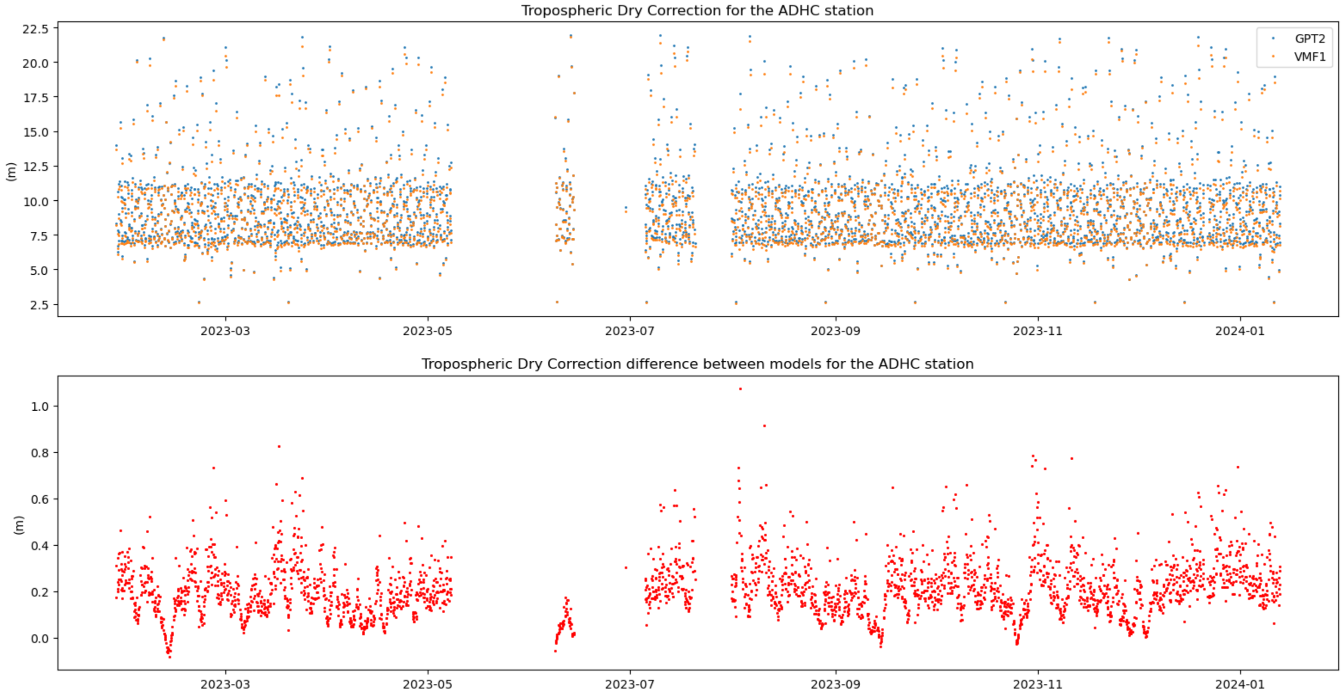
The wet delay correction given by the two models is shown on the upper left-hand side plot. Each point represents the mean correction of each passage between the station and the satellite*.

We can see that :

- VMF1 estimates for the wet component are bigger and less scattered.
- Differences between the two models are in the cm-level.

(*) DORIS data from Sentinel-3A and Terre-Adelie, 2023

2. GPT2 vs. VMF1 for the Hydrostatic component



The hydrostatic delay correction given by the two models is shown on the upper left-hand side plot.

We can see that :

- The hydrostatic correction order of magnitude is 2x as big as the wet correction.
- Differences between the two models are in the cm-level.

(*) DORIS data from Sentinel-3A and Terre-Adelie, 2023

2. GPT2 vs. VMF1 for the Total Correction (Hydrostatic + Wet)

The total tropospheric correction given by the two models is shown on the upper left-hand side plot.

We can see that :

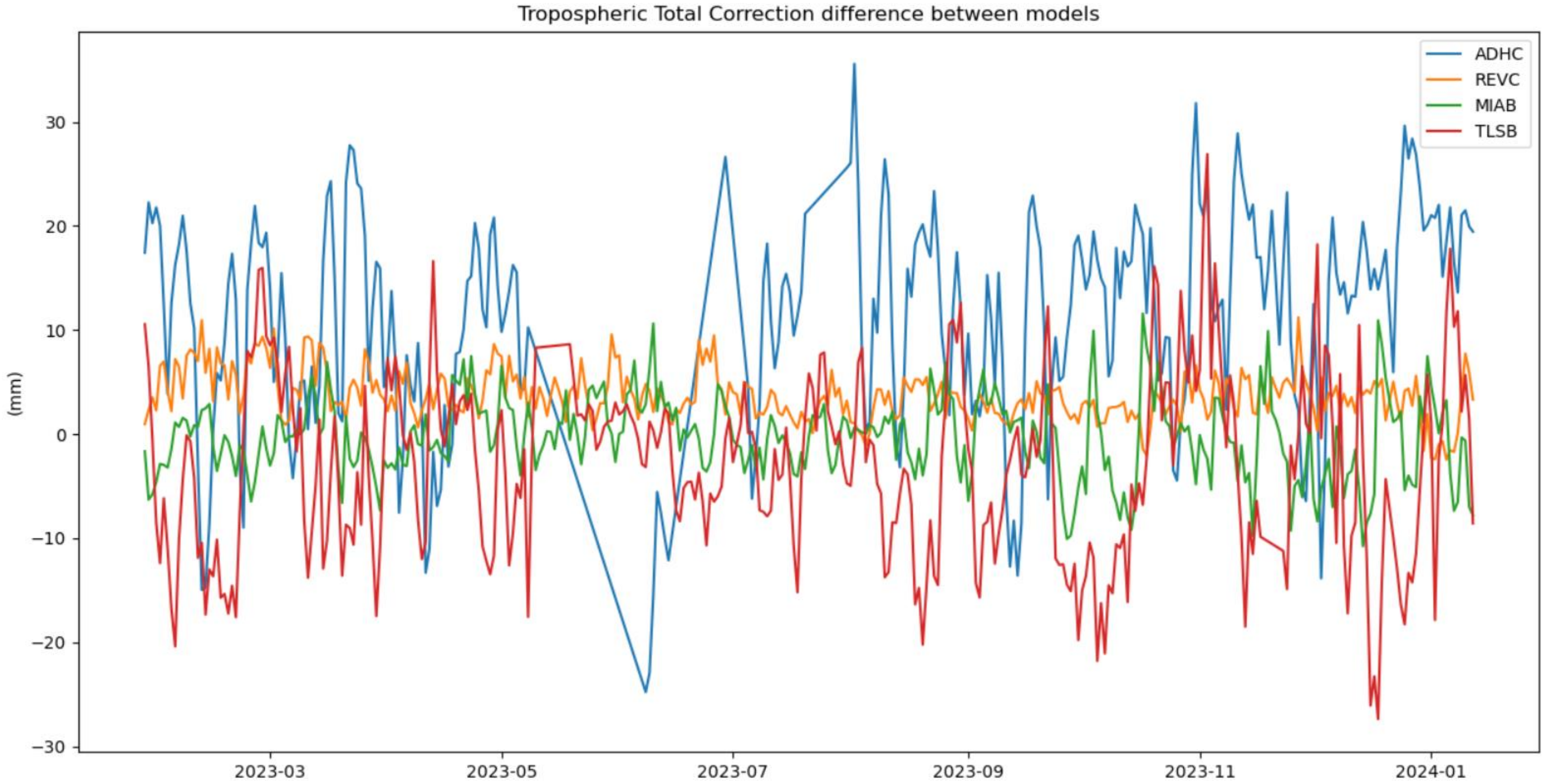
- Differences between the two models are in the mm-level.
- What is the difference between models for other stations?
- How much will this difference impact the position of the station?

(*) DORIS data from Sentinel-3A and Terre-Adelie, 2023

2. GPT2 vs. VMF1 on four different IDS stations

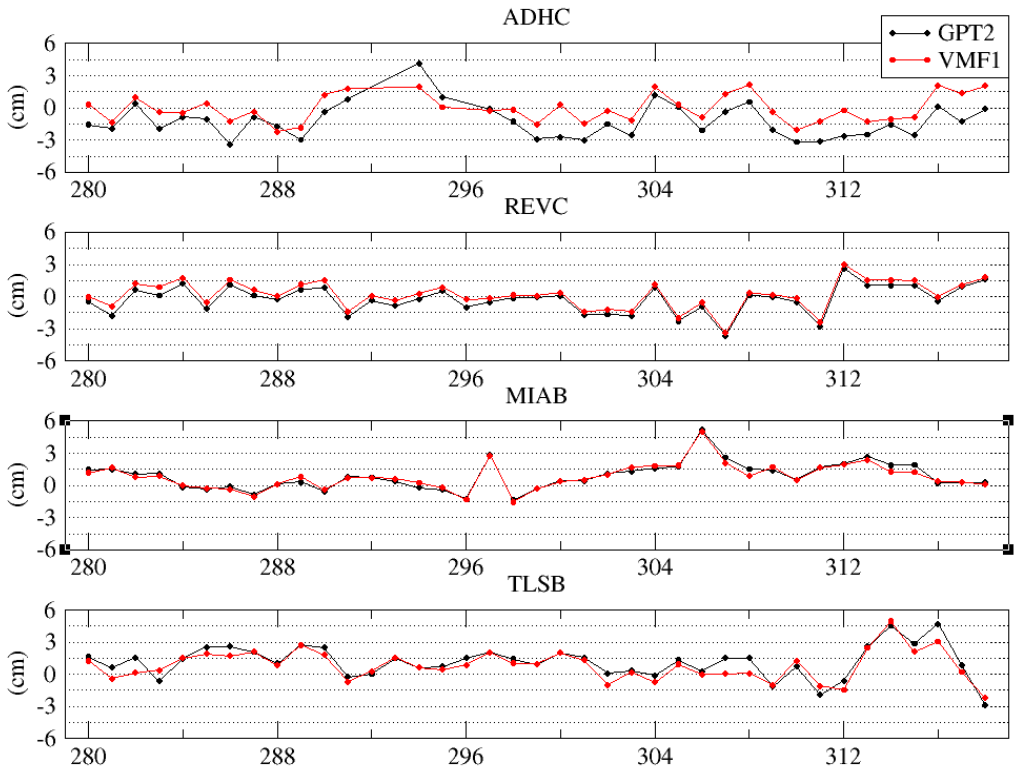
Tropospheric corrections will ultimately depend on the station site. That's why four different stations (ADHC, REVC, MIAB, TLSB) have been chosen to asses their corrections and subsequently, quantify the impact on their position.

2. GPT2 vs. VMF1 on four different IDS stations



3. Impact on station coordinates

Difference in the Up coordinate wrt. ITRF2020

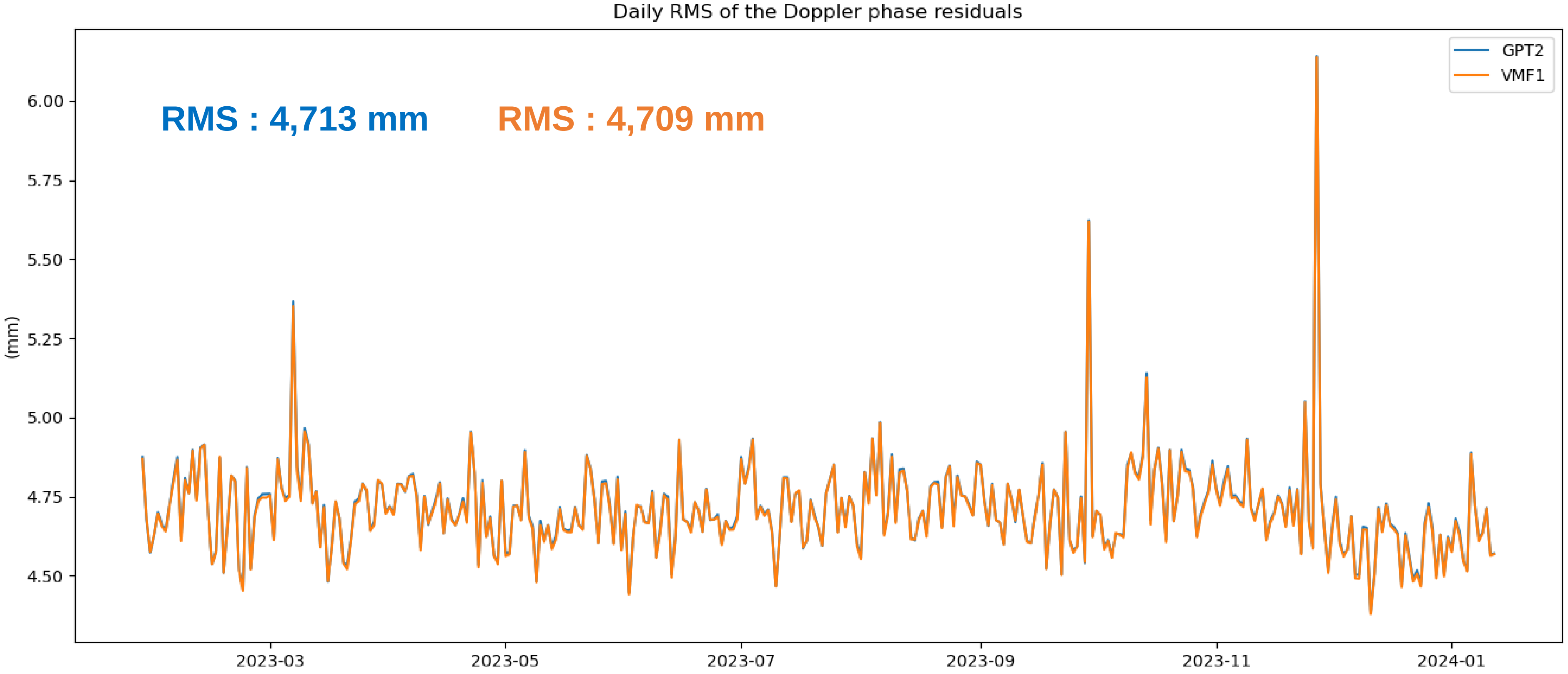


Sentinel-3A cycles

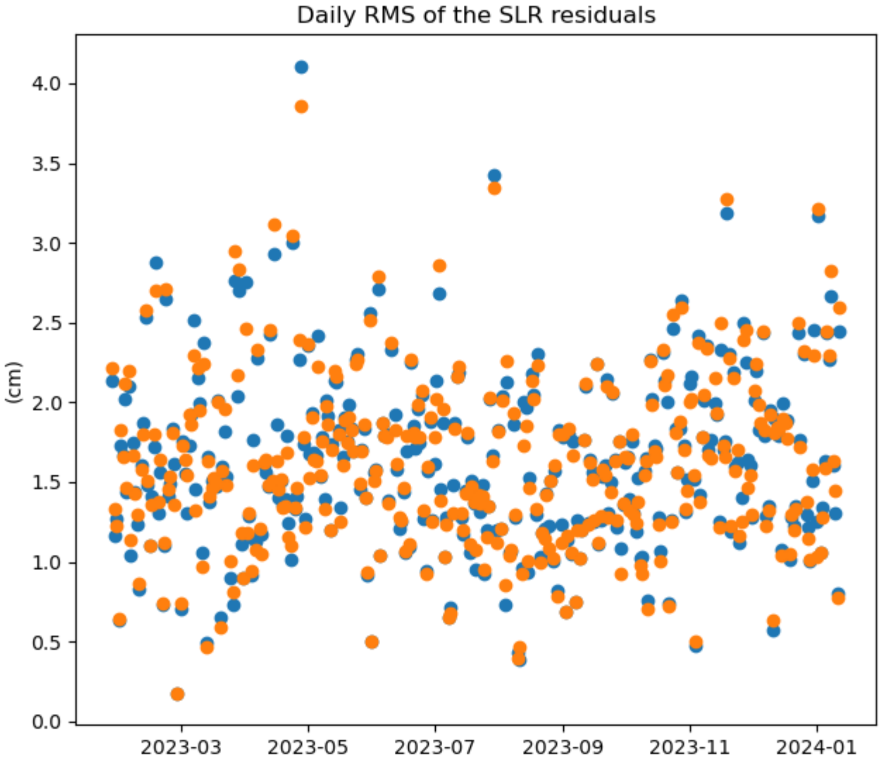
Station	GPT2	VMF1
ADHC	2,006 ± 1,615 (cm)	1,282 ± 1,298 (cm)
REVC	1,293 ± 1,286 (cm)	1,290 ± 1,295 (cm)
MIAB	1,523 ± 1,267 (cm)	1,447 ± 1,206 (cm)
TLSB	1,886 ± 1,513 (cm)	1,608 ± 1,395 (cm)

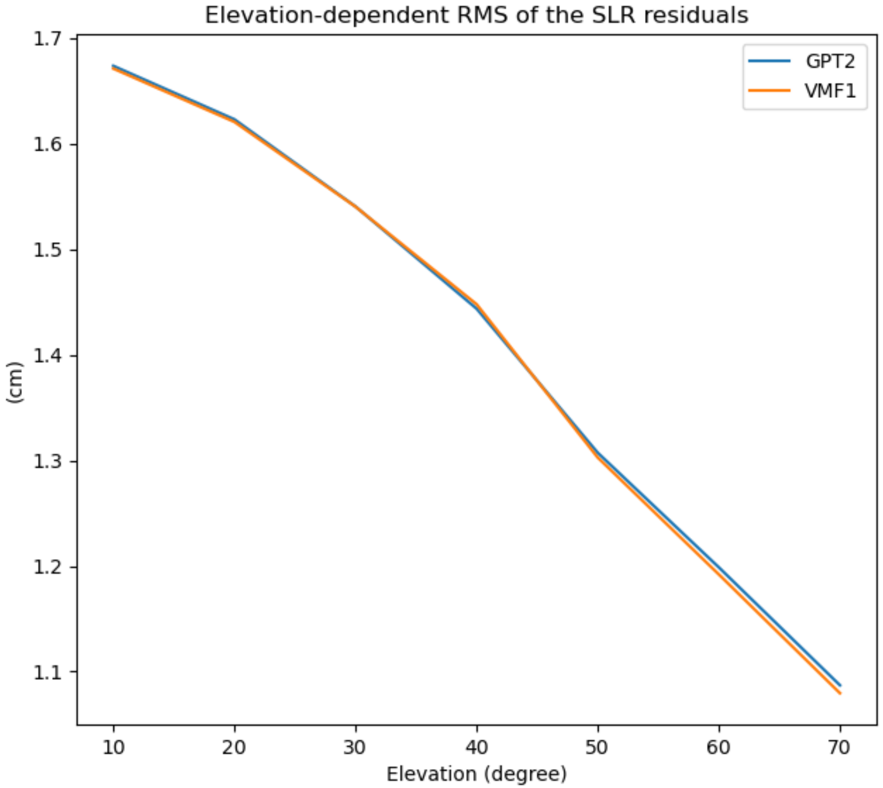
(*) DORIS data from Sentinel-3A, 2023

4. Impact on Sentinel-3A DORIS measurement residuals



4. Impact on Sentinel-3A DORIS orbits





RMS : 1,619 cm **RMS : 1,615 cm**

5. Conclusions and perspectives

Conclusions :

- Up to cm-level differences in TTC between the two models GPT2 and VMF1 depending on the location of the station.
- Clear improvement for some stations, specially those with changeable weather conditions.
- Same measurement residuals and orbits.

Perspectives :

- Use the ZWD given by the VMF1 model. How does it compare against the ZWD estimation?
- Use VMF3 and Adaptive Mapping Functions (AMF).
- PPP processing by the CA CNES/CLS for the IDS.