EFFECT OF THE SECOND ORDER IONOSPHERIC DELAY ON PRECISE ORBIT DETERMINATION OF DORIS SATELLITES AND ON THE CNES/CLS IDS ANALYSIS CENTER SOLUTION

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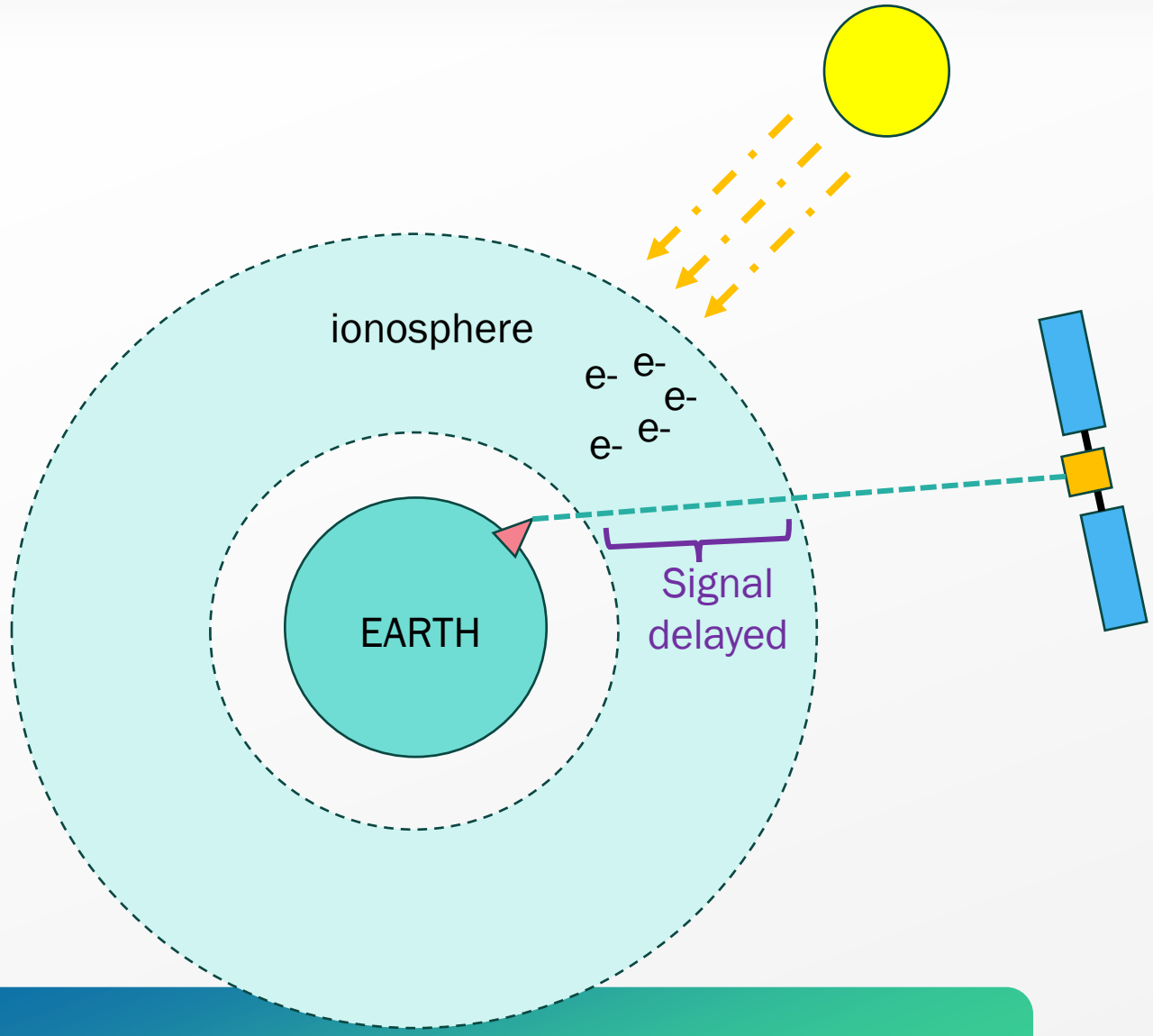
Contents

- Overview & implementation
- Impact on precise orbit determination
- Impact on station’s position solution

2nd Order Ionospheric correction overview



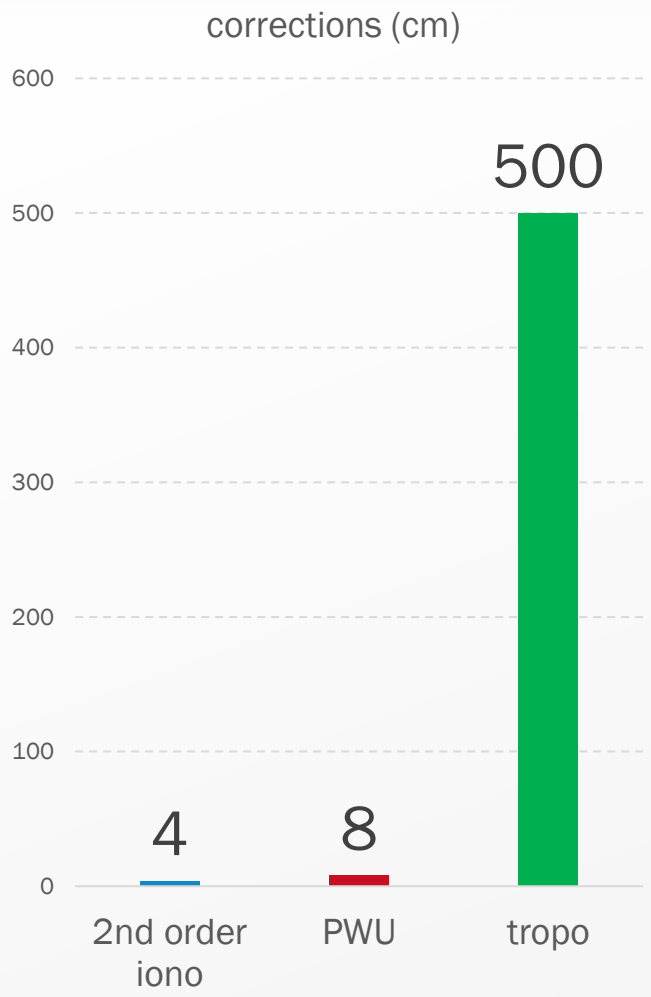
- Ionosphere : upper layer of the atmosphere (60-800km), ionized by solar radiation
- Signal delayed through ionosphere by the charged particles
- First order ionospheric delay: +10 meters
- First order is removed by using iono-free combination
- Second order remained

2nd Order Ionospheric correction overview

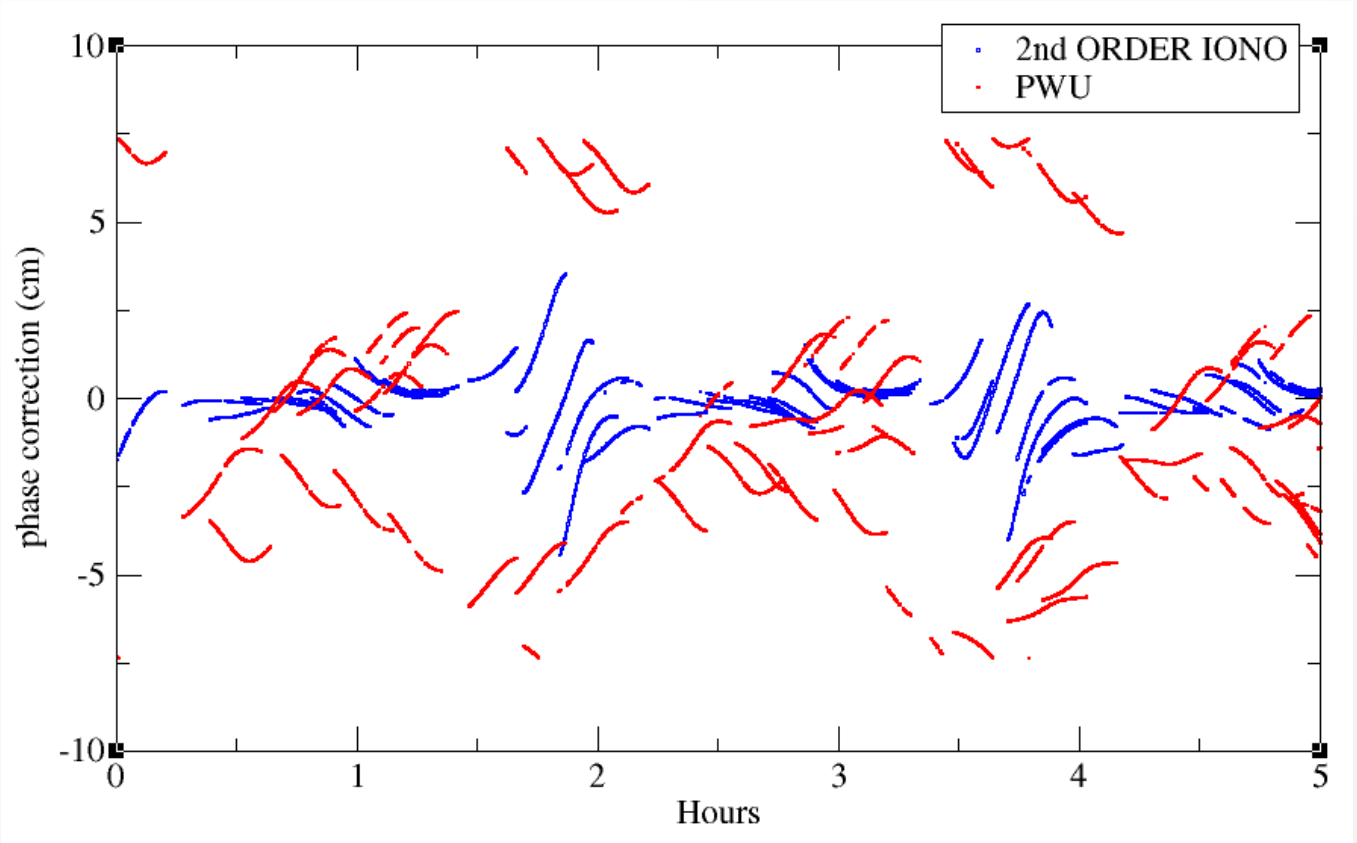
$$\Delta I^{(2)} \equiv f(\omega, B, STEC)$$

- W : frequency (DORIS: 400MHz and 2000MHz)
- B : magnetic field
- STEC: Slant Total Electron Content = amount of free electron on the path of the signal

2nd Order Ionospheric correction overview



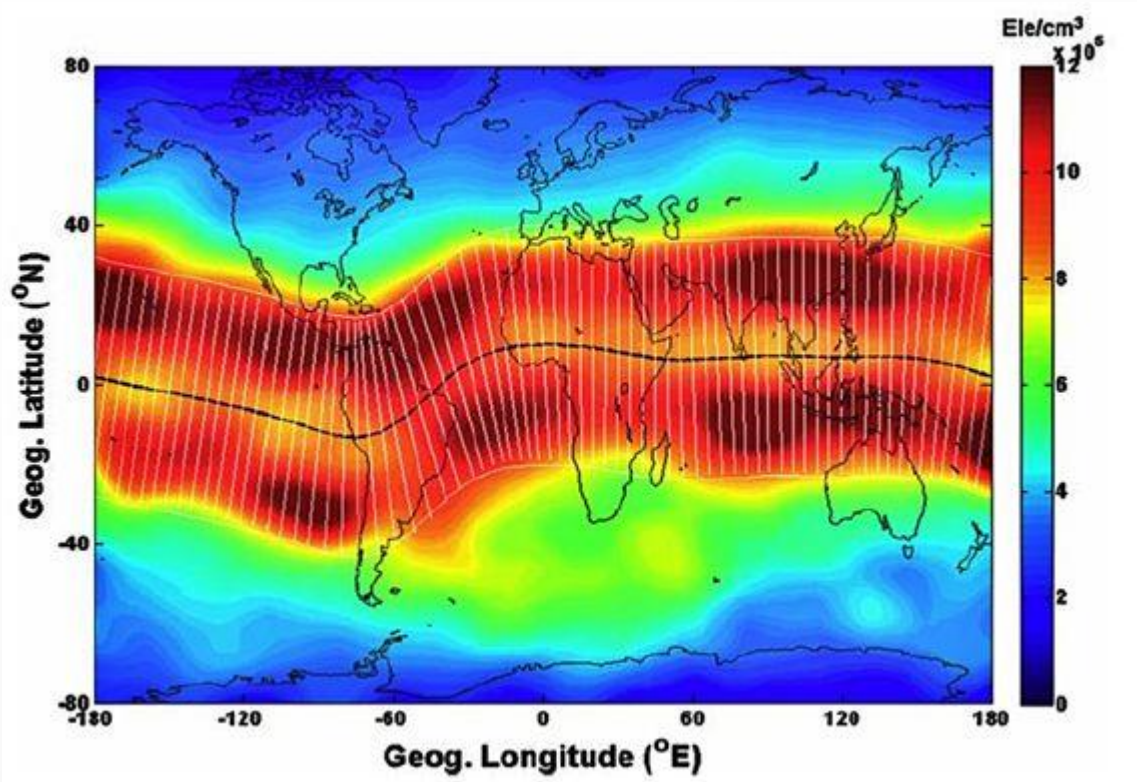
2nd order ionospheric iono-free phase corrections : <4cm

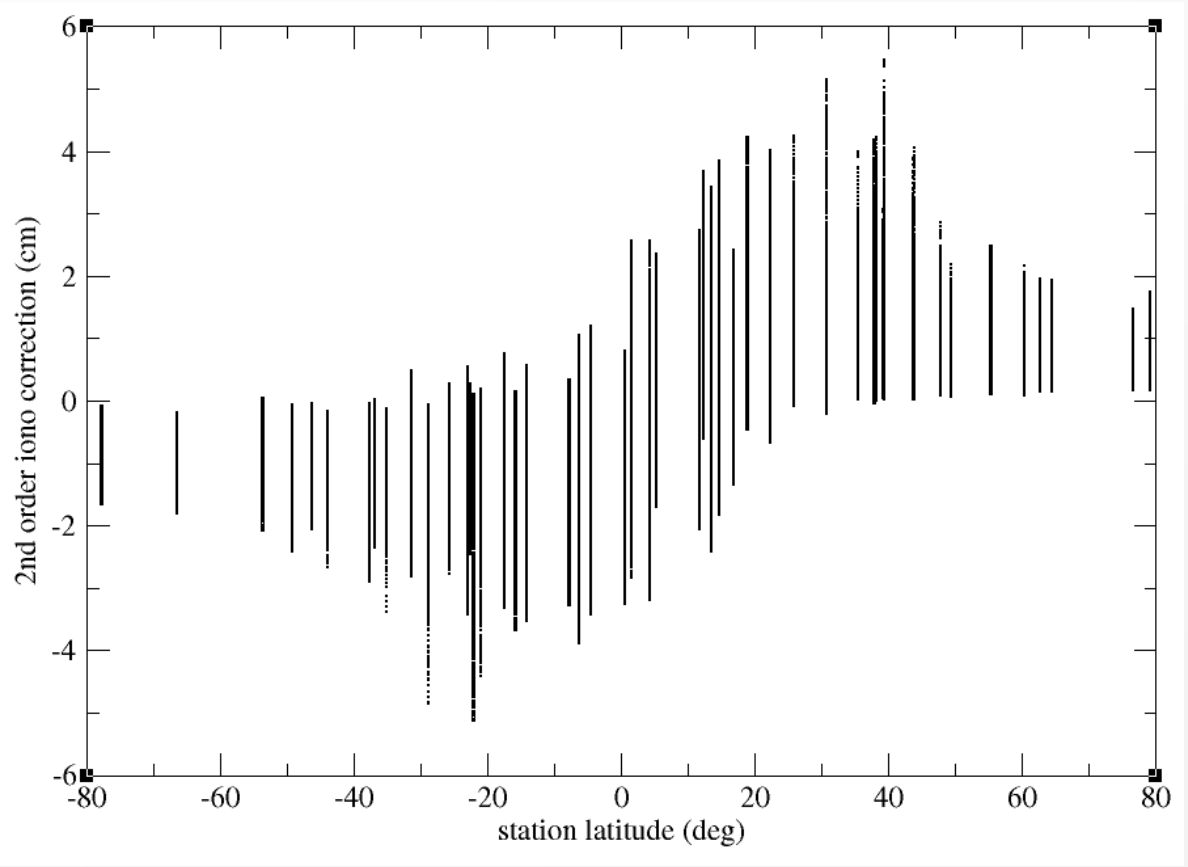


2nd order ionospheric correction is more important at the beginning or the end of a pass

2nd Order Ionospheric correction : station latitude dependency

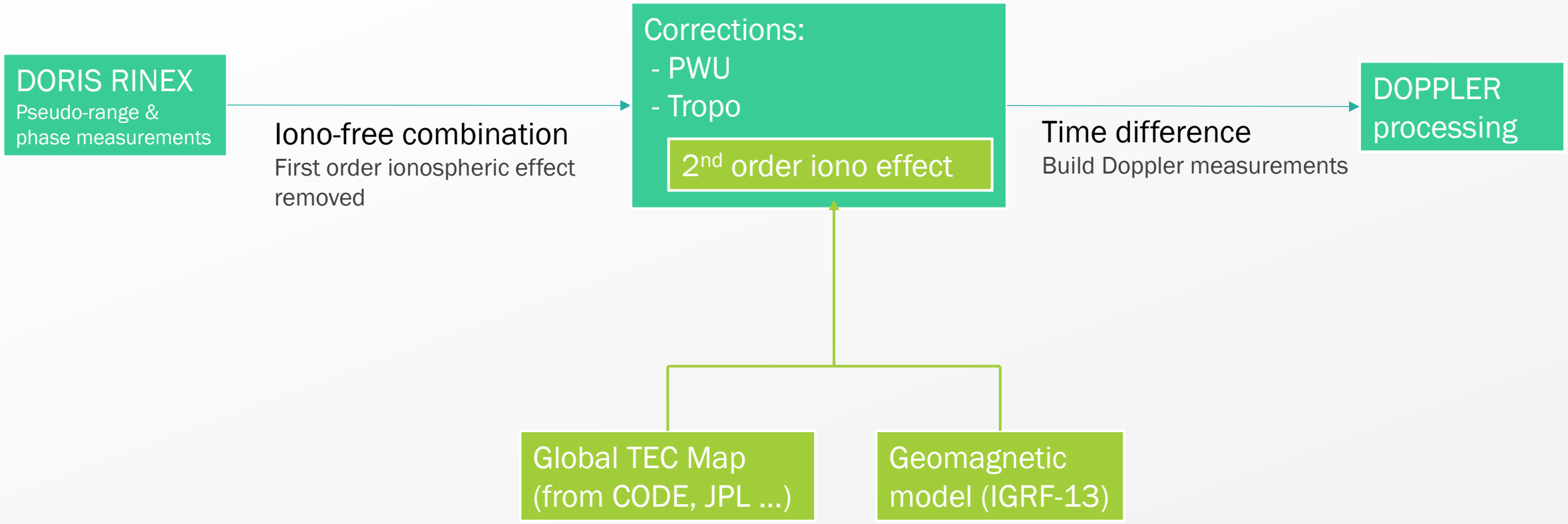
distribution of the mean electron density in the ionosphere





Affect majoritary stations near tropics

Implementation in our processing software GINS



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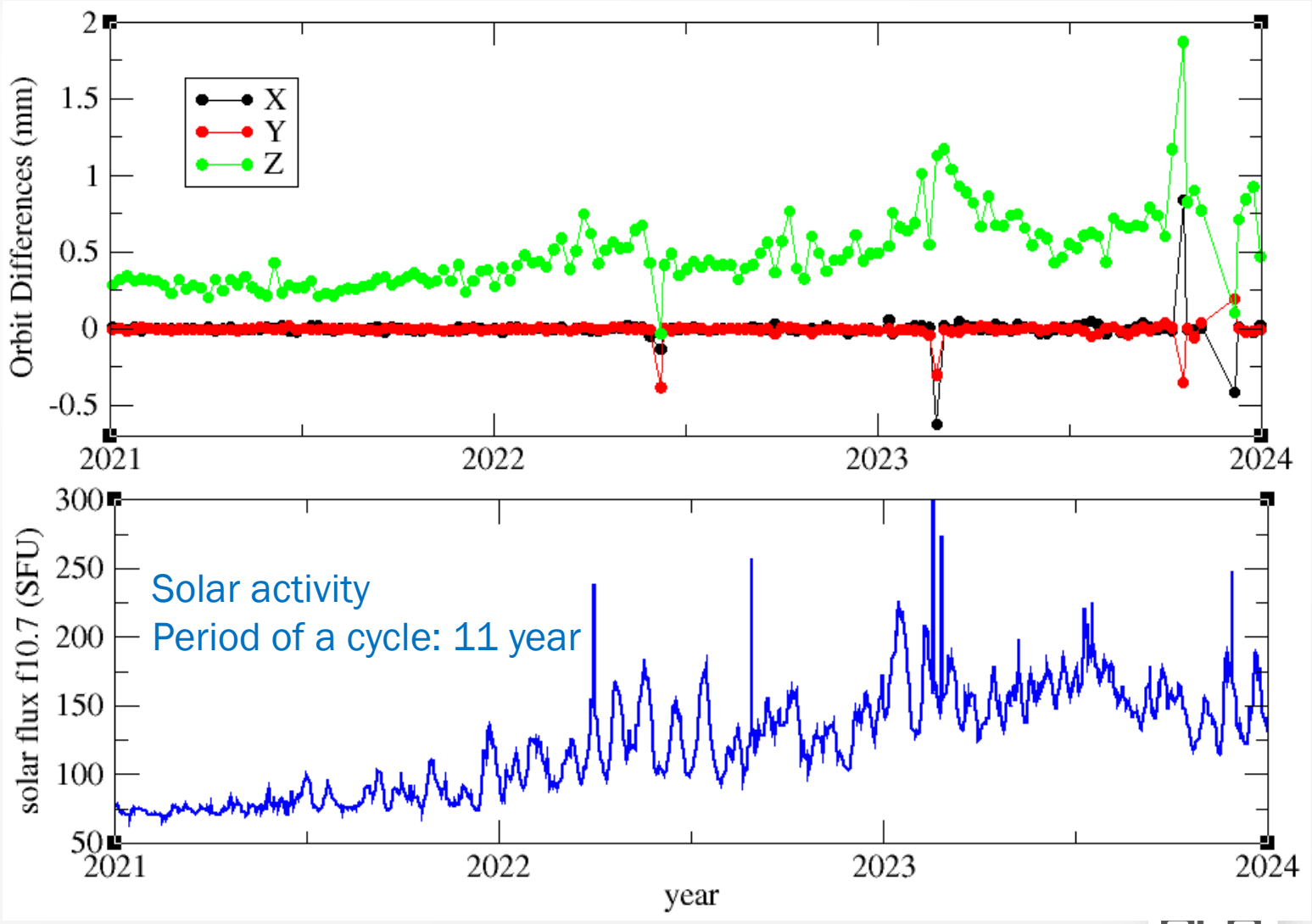
S3A : orbit comparison , XYZ terrestrial frame

Orbit differences (without versus with 2nd order ionosperic correction) in XYZ terrestrial frame

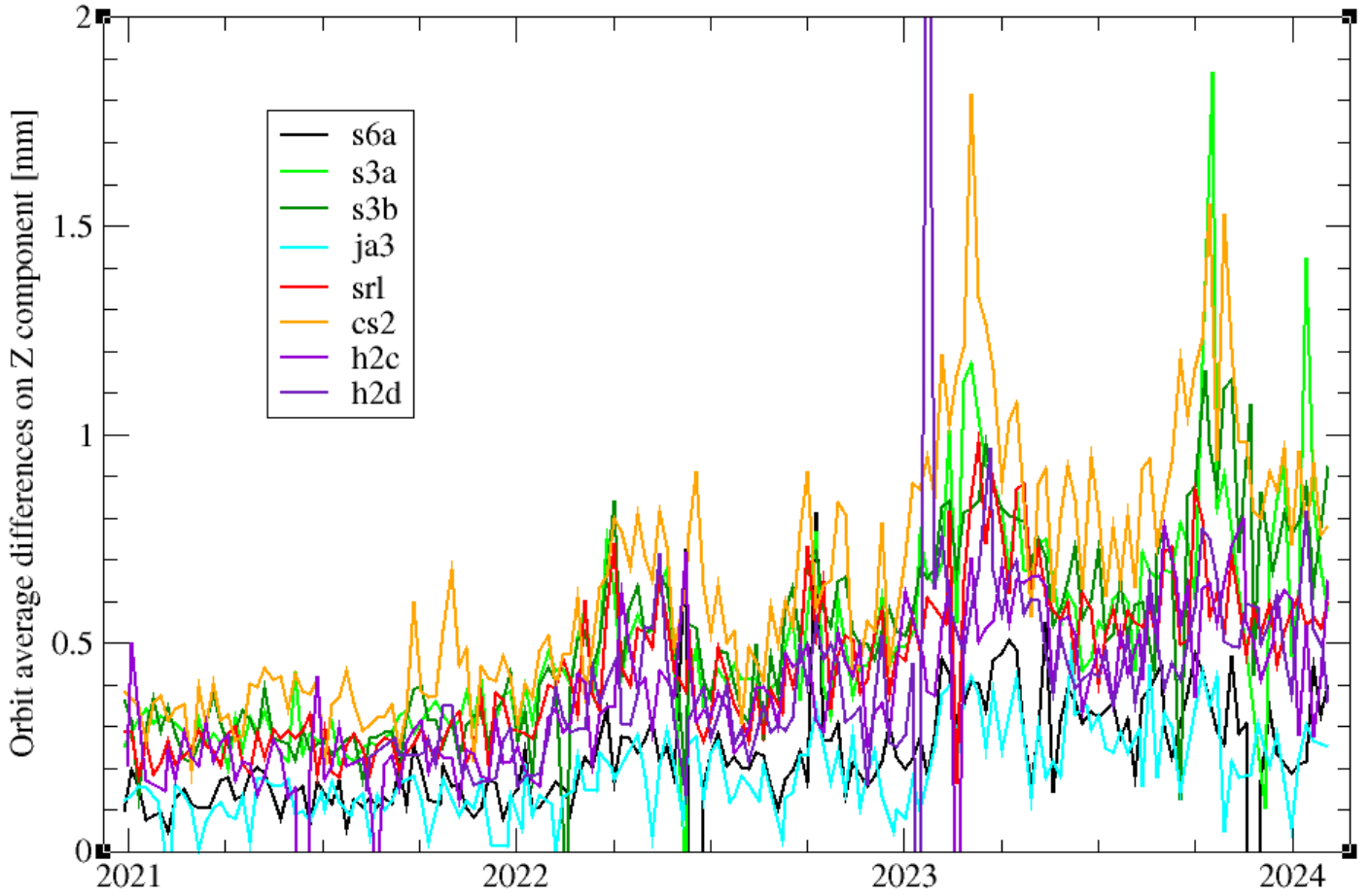
- Sub-millimetric offset in Z component
- Correlated with the solar activity



orbit comparison for all satellites on Z component

Satellite	Altitude (km)
S6A	1336
JA3	1336
HY2D	971
HY2C	957
S3A&S3B	814
SRL	800
CS2	717

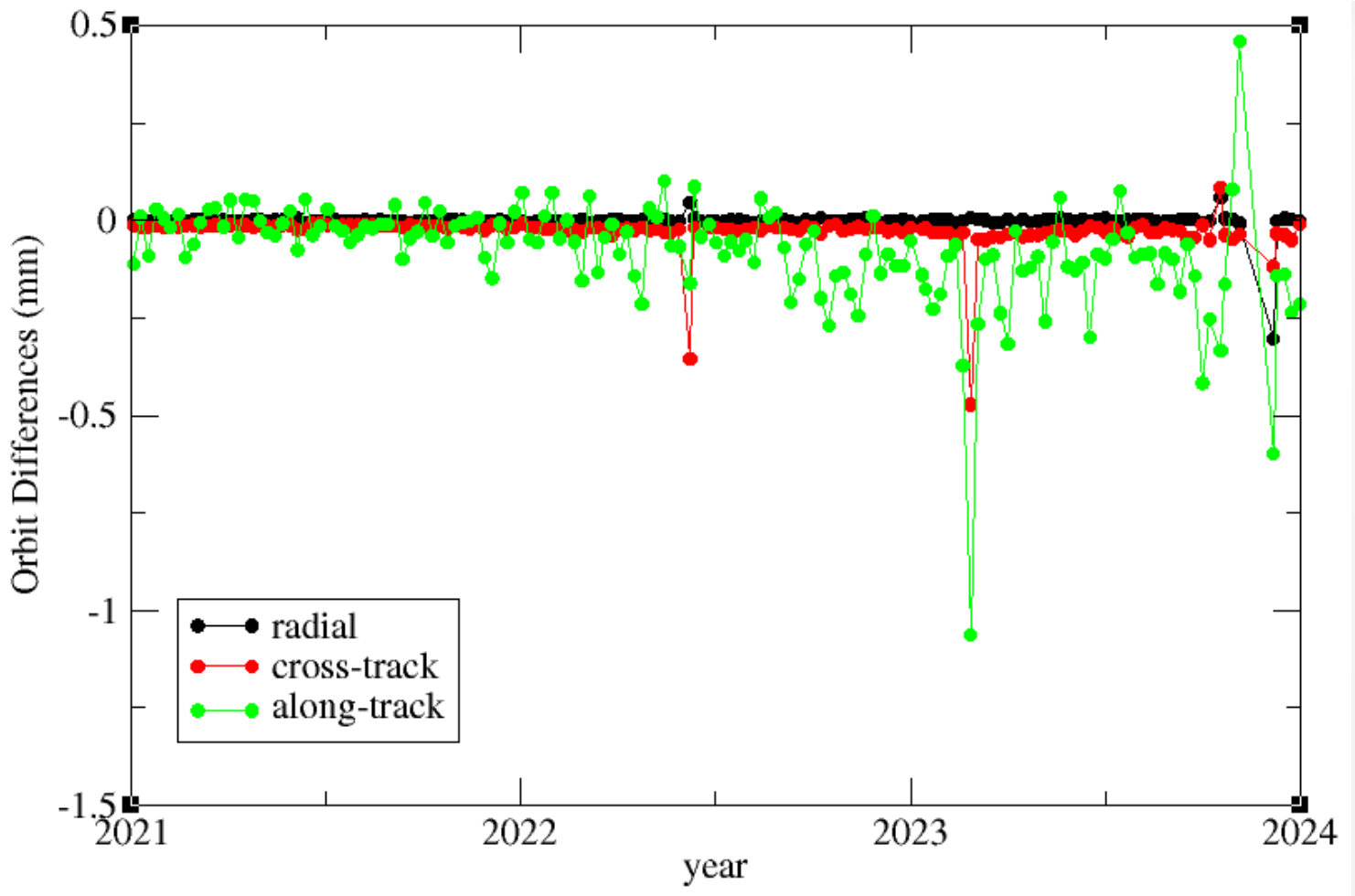
Z offset increase



S3A : orbit comparison , Radial-Tangential-Normal frame

Orbit differences (without versus with 2nd order ionosperic correction) in RTN frame

- No impact on the radial component, goor for altimetry purpose



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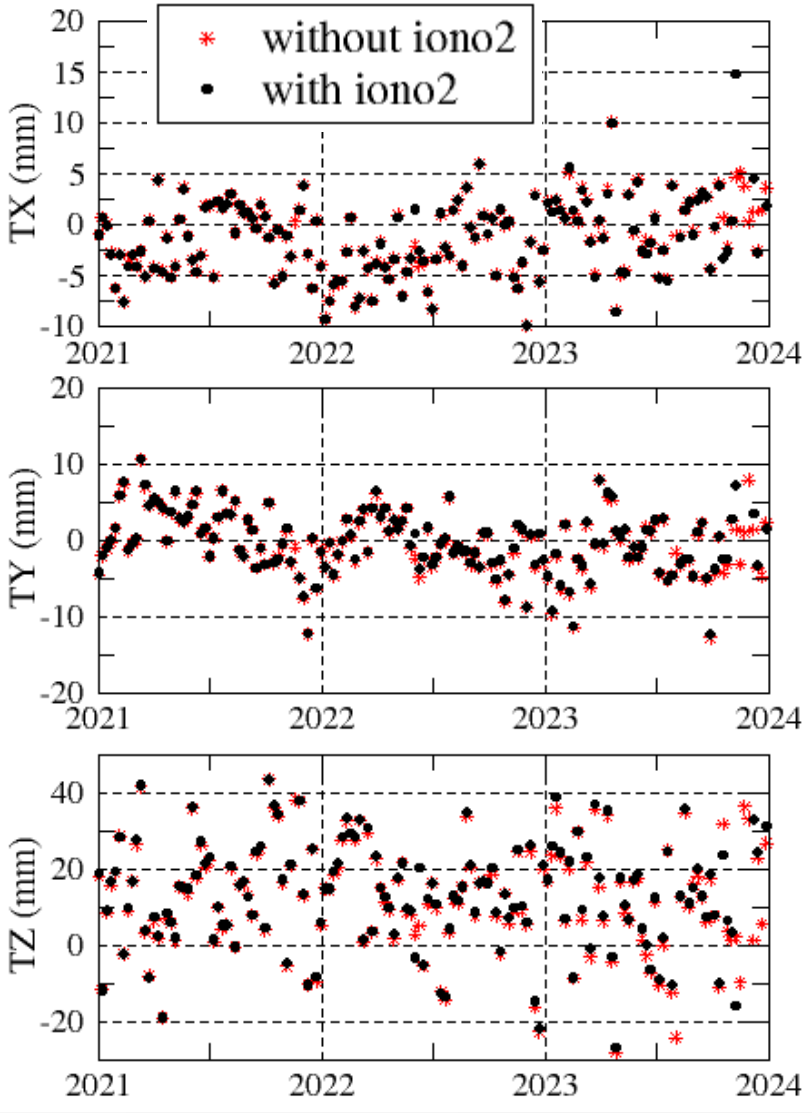
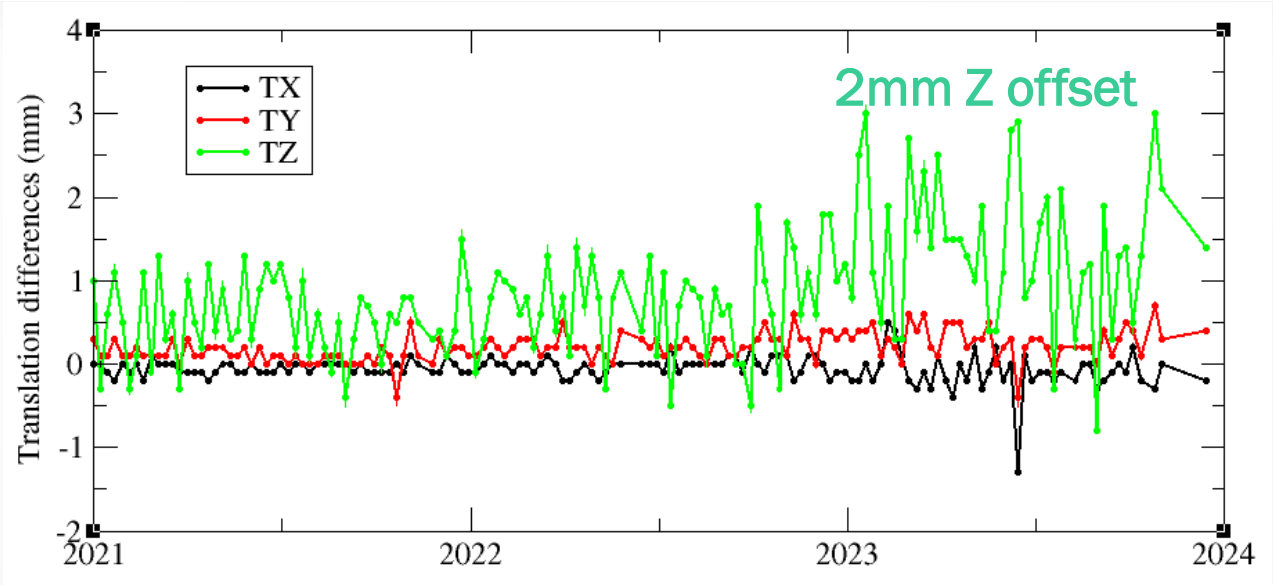
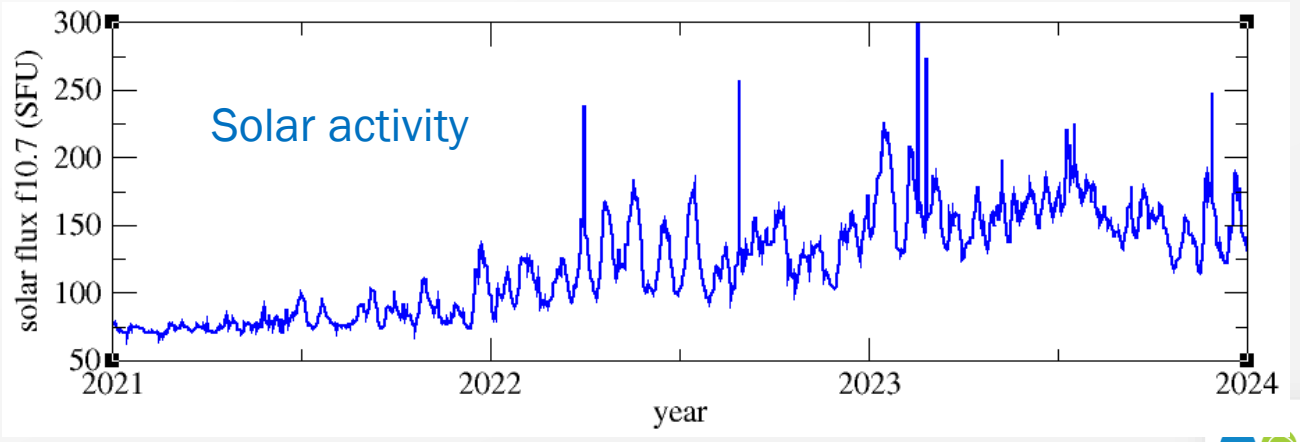
S3A: station position solution comparison

S3A altitude: 814km



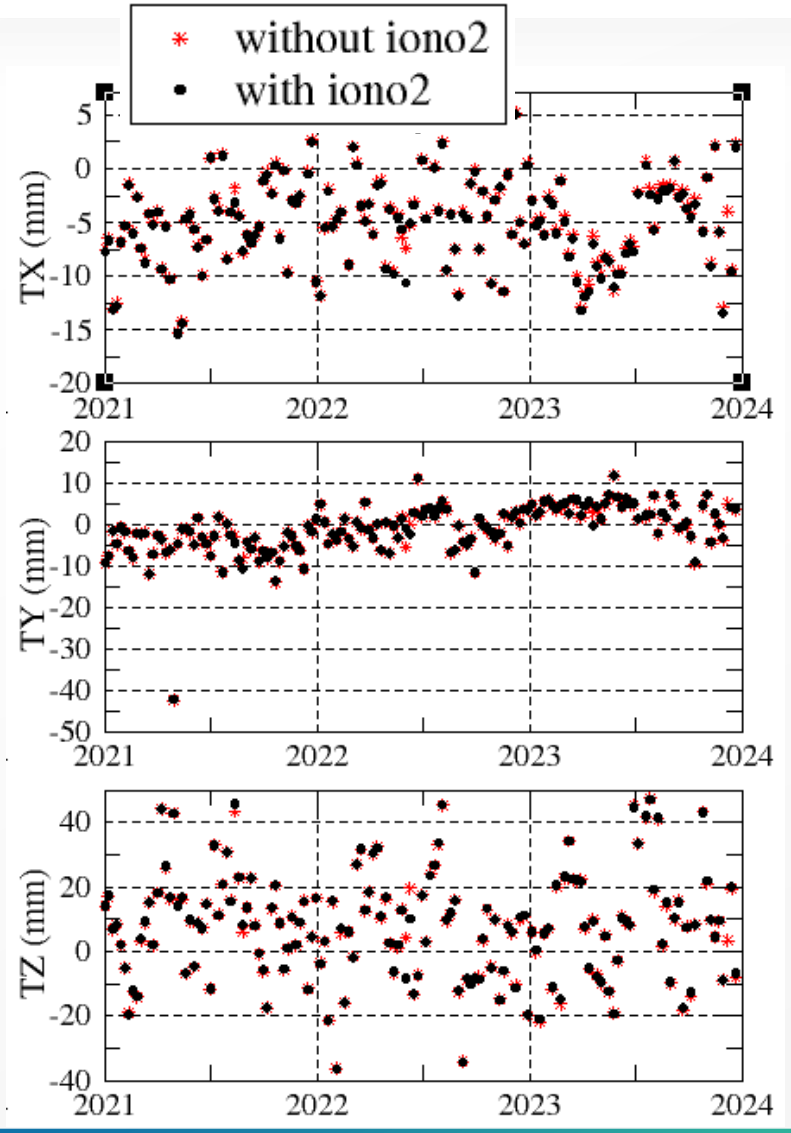


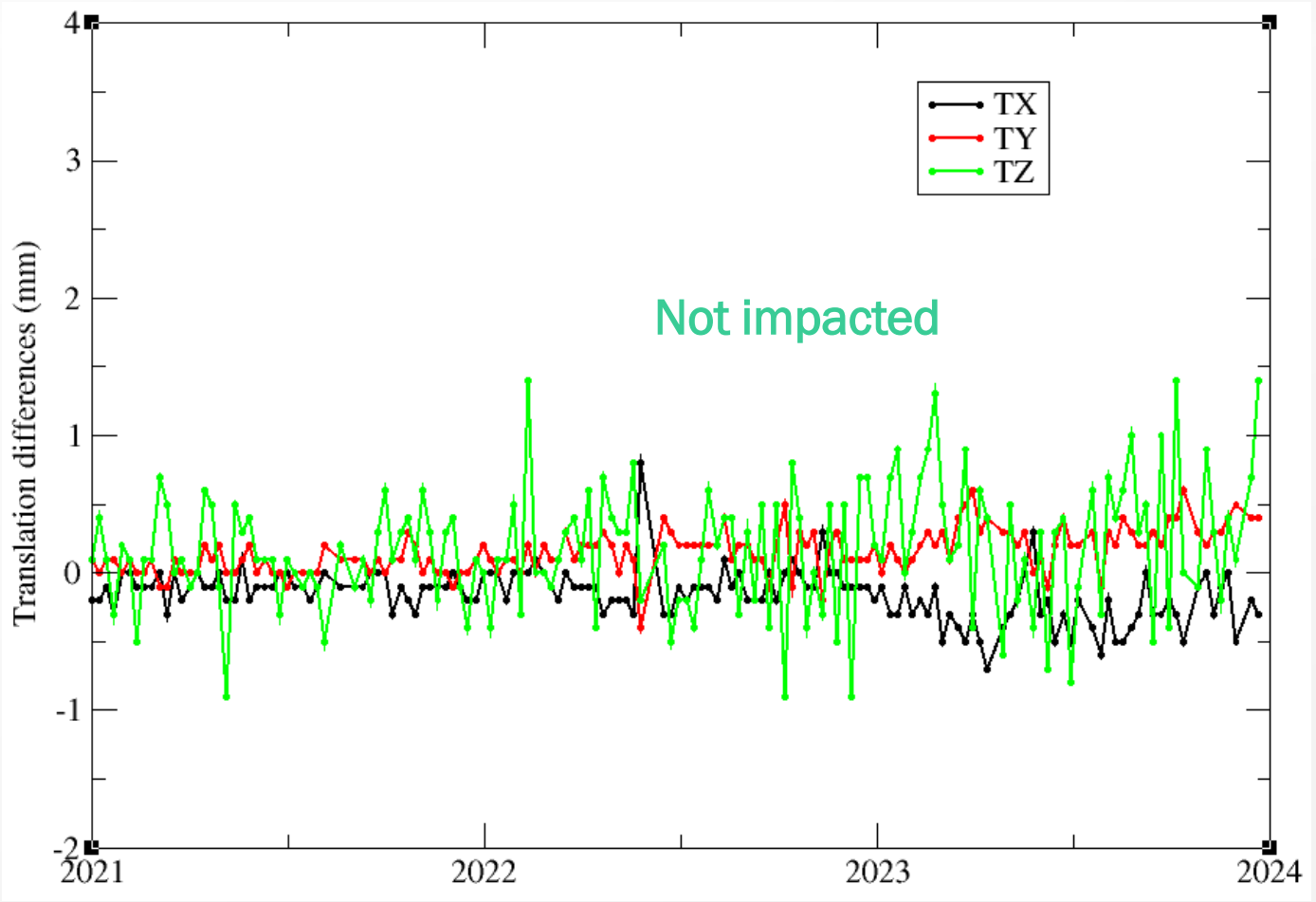


Versus DPOD2020

S6A: station position solution comparison

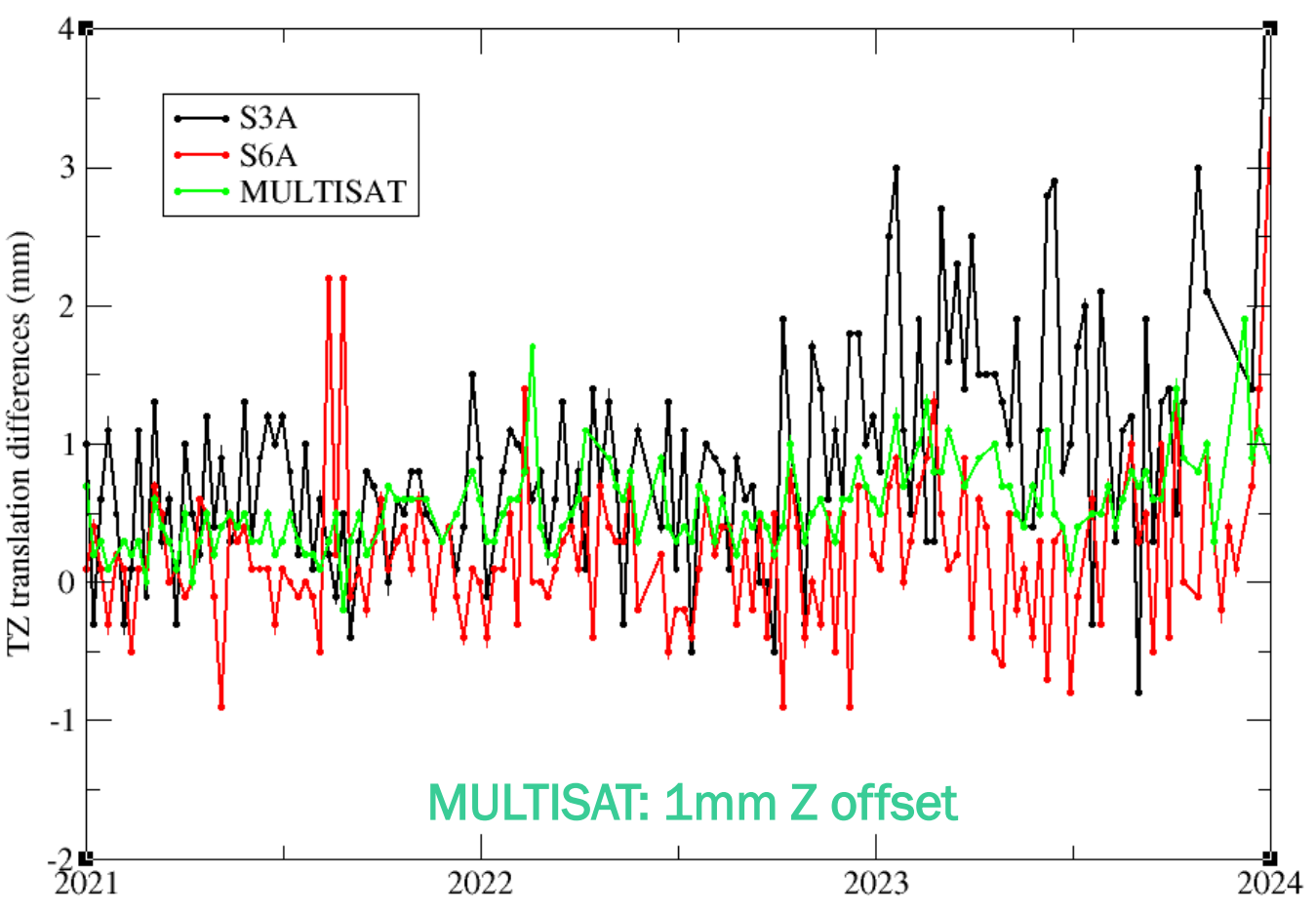
S6A altitude: 1336km





MULTISAT: station position solution comparison

S6A, JA3, S3A, S3B, SRL, CS2, HY2C, HY2D



Conclusion

- 2nd order ionospheric effect depends on:
  - Latitude (stations close to the equator are more impacted)
  - only affects the Z component.

- It impacts precise orbit determination :
  - 1mm Z offset for low altitude satellites (S3A, CS2 …)
  - < 0,5mm Z offset for higher altitude satellites (S6A, Jason3)
  - No impact on radial component for all satellites

- It impacts on station's position solution :
  - 2 mm Z translation for low altitude mono-satellite solution (S3A, CS2 …)
  - Almost no effect for higher altitude mono-satellite solution (S6A, Jaons3)
  - 1 mm Z translation for multi-satellite solution

Thank you for your attention