

# Precise orbit and reference frame determination using multiple altimetry satellite missions with DORIS technique

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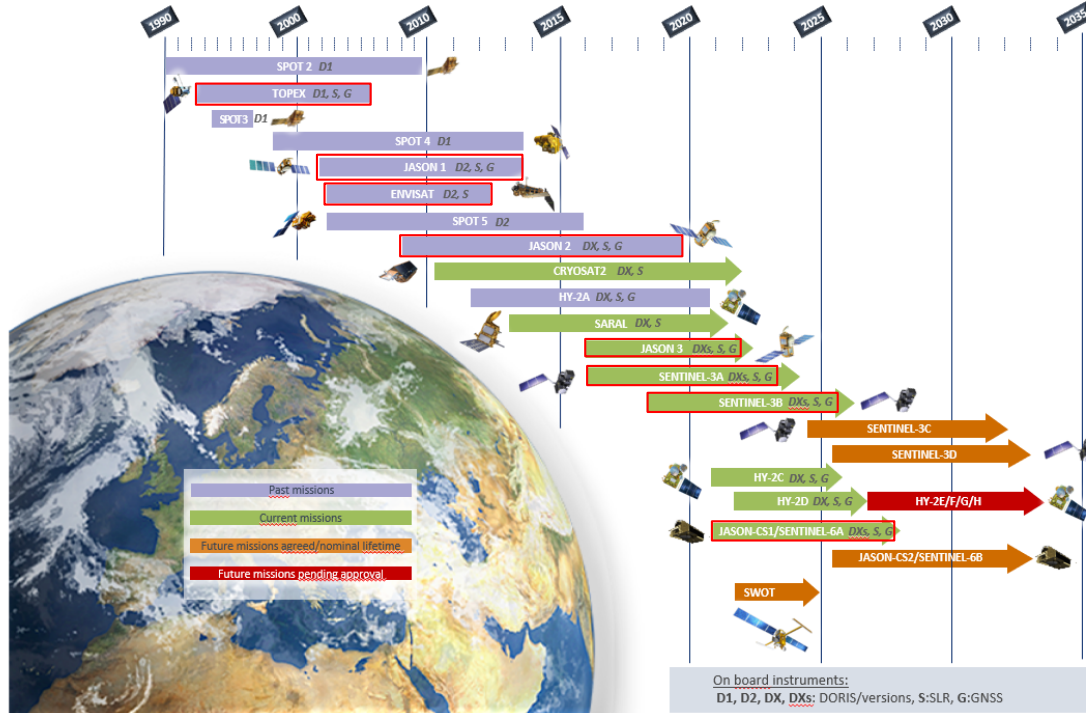
# Outline

- 1) Motivation
- 2) Missions
- 3) Precise Orbit Determination
- 4) Estimation of station positions and Earth Rotation Parameters
- 5) Summary

# 1.1 Motivation

- Future GFZ contribution to the DORIS Part of International Terrestrial Reference Frame (ITRF)
- In this Study: Analysis of the latest orbit products generated with EPOS-OC using the DORIS techniques

# 2 Missions



- Topex
- Jason-1
- Envisat
- Jason-2
- Jason-3
- Sentinel-3A
- Sentinel-3B
- Sentinel-6A

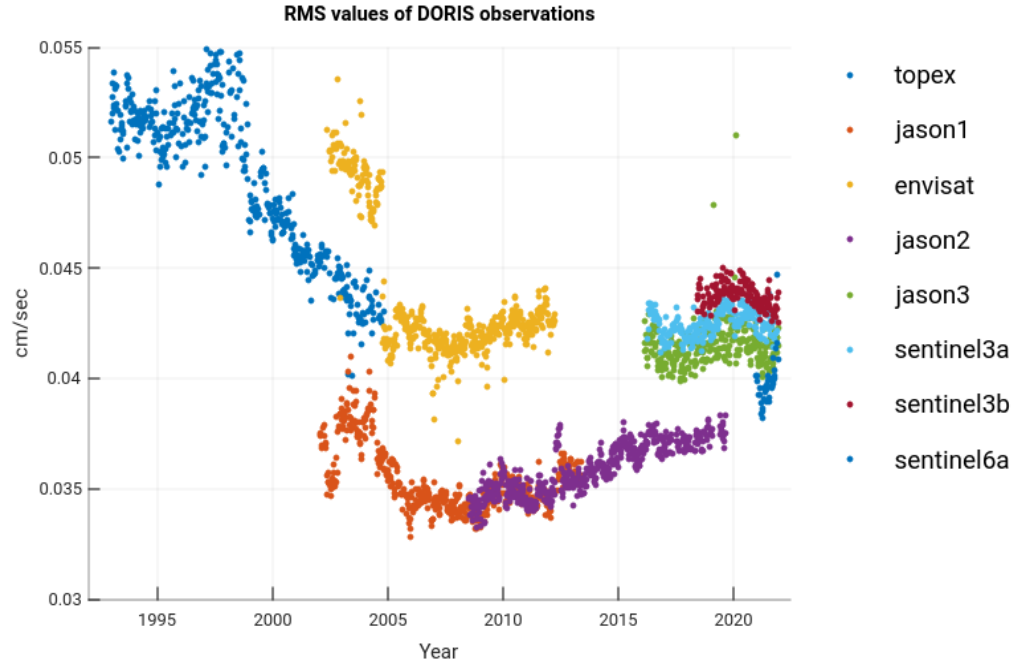
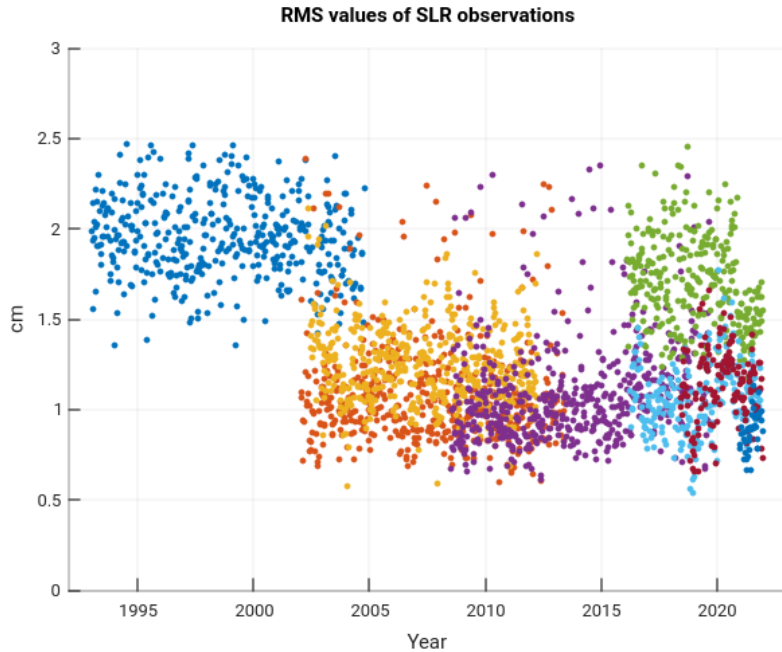
**Time Span:**  
1993-2021

(Courtesy IDS, 2022)

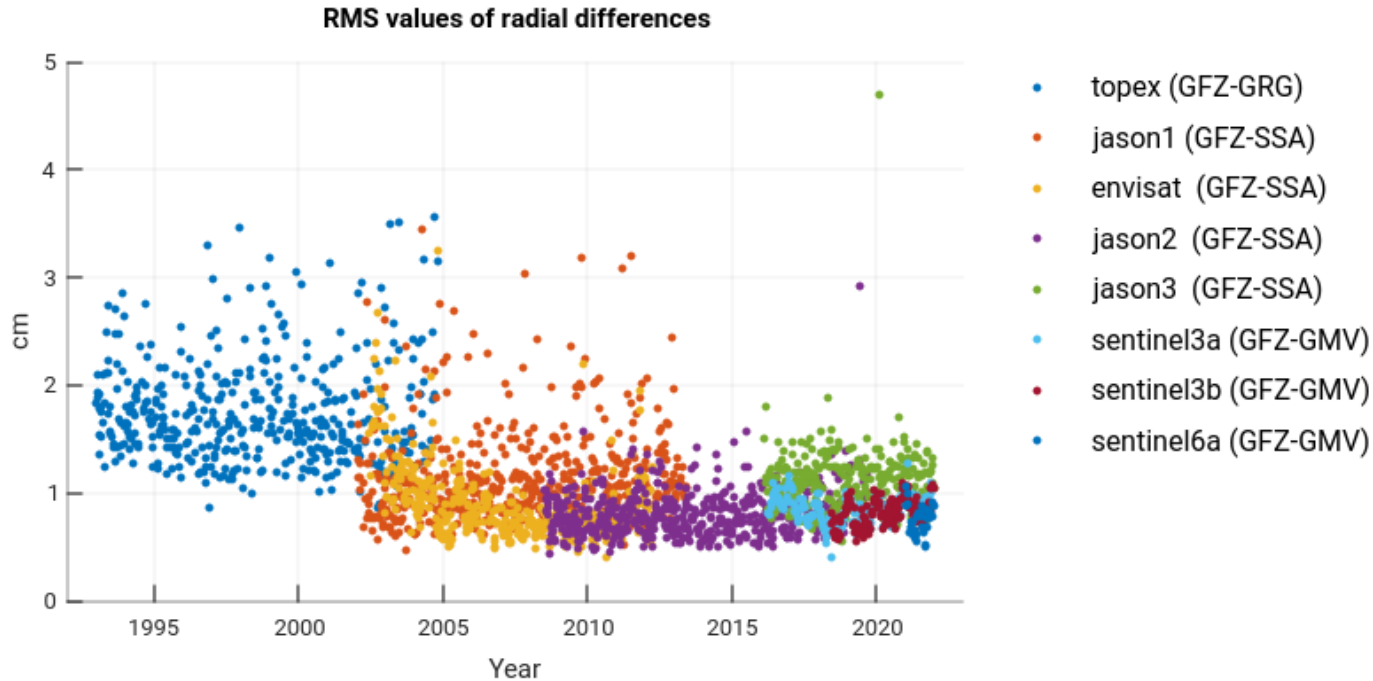
# 3 Precise Orbit Determination

- Analyse time span: 1993-2021
- Arc length: 7 days according to GPS weeks
- Approach:
  - Combined (SLR+DORIS)
  - DORIS only

# 3.1 Orbit Quality



# 3.2 Orbit comparison



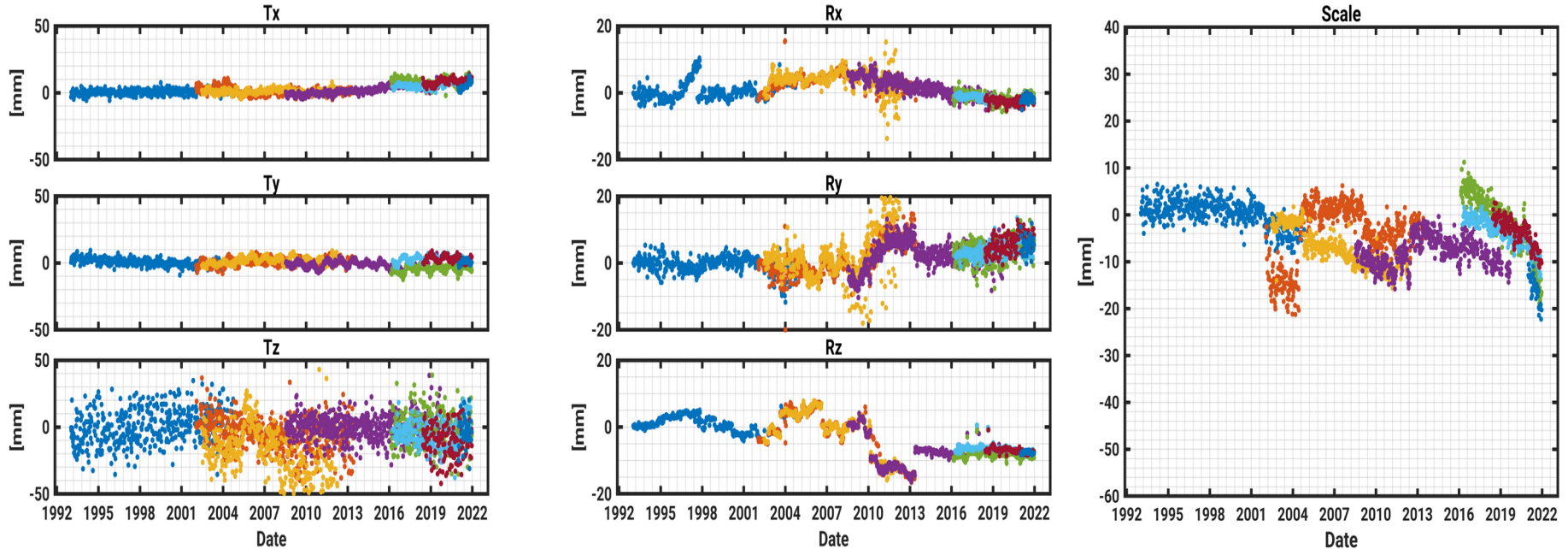
# 4 Estimation of station positions and Earth Rotation Parameters

- Solution strategy:
  - Converge orbits
  - Set stations coordinates and Earth Rotation Parameters (ERP) free and compute normal equation matrices (NEQ) per arc and per satellite
  - Set additional ERP constrains
  - Solve NEQs for station positions and ERPs with iterative No-Net Rotation constrains (NNR, 1mm)

=> Single and Combined Solution of local weekly TRFs

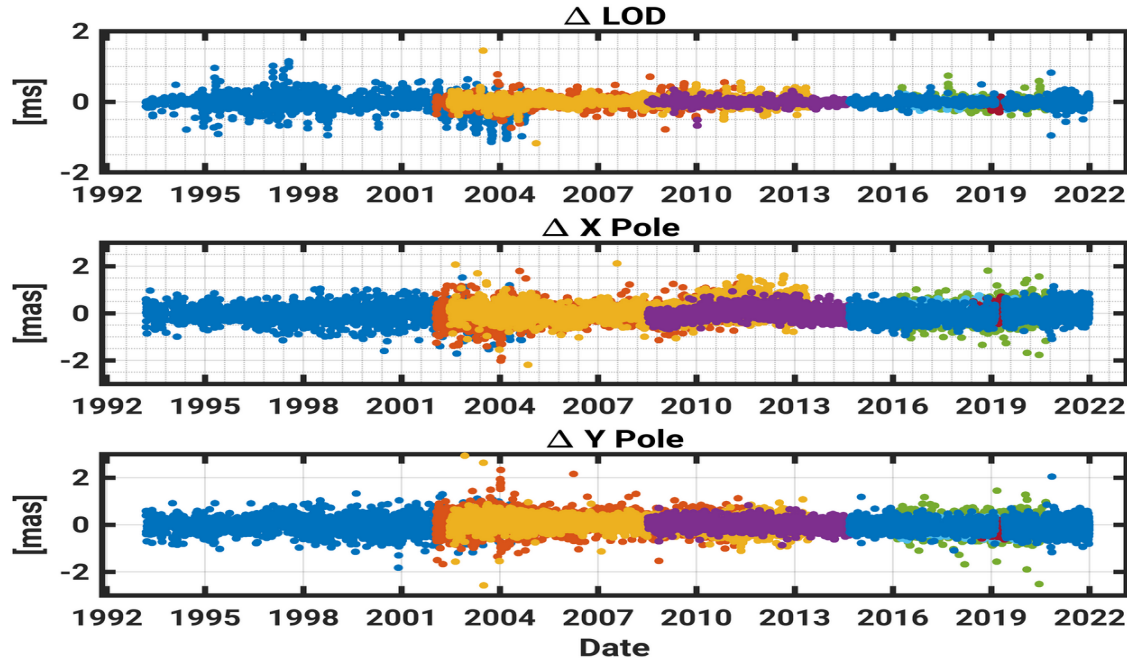


# 4.1 Single Solution (1)



Topex Jason1 Envisat Jason2 Jason3 Sentinel3A Sentinel3B Sentinel6A

# 4.1 Single Solution (2)



Topex

Jason1

Envisat

Jason2

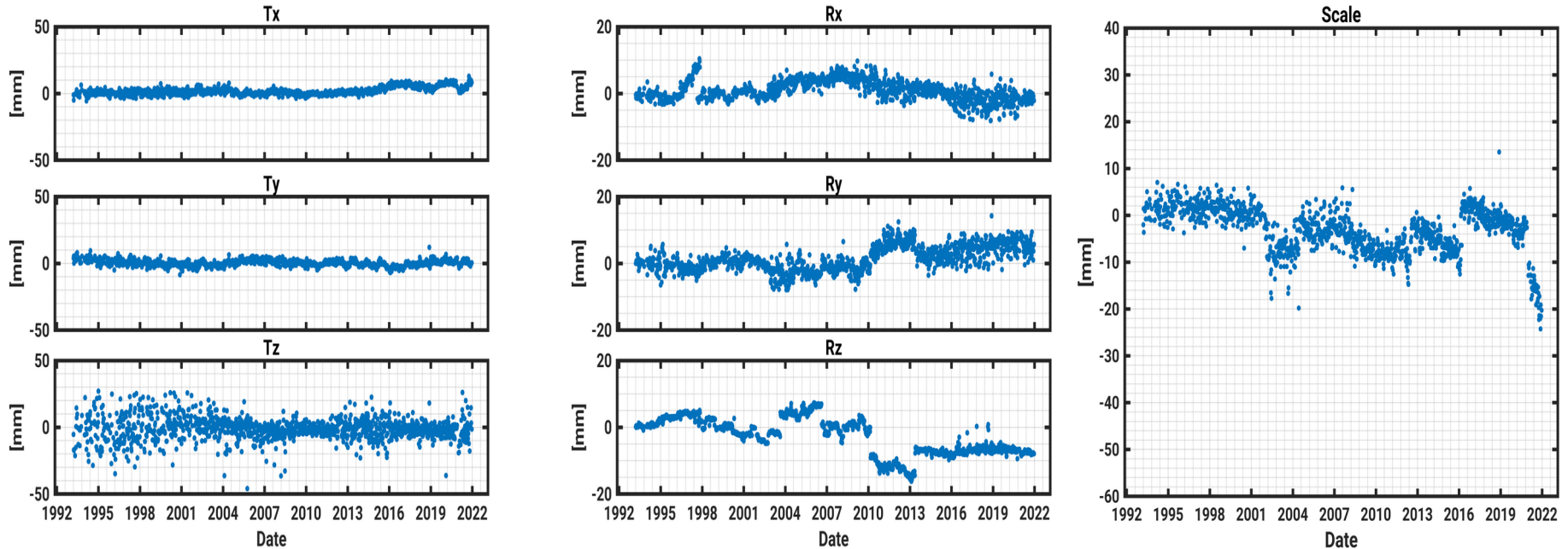
Jason3

Sentinel3A

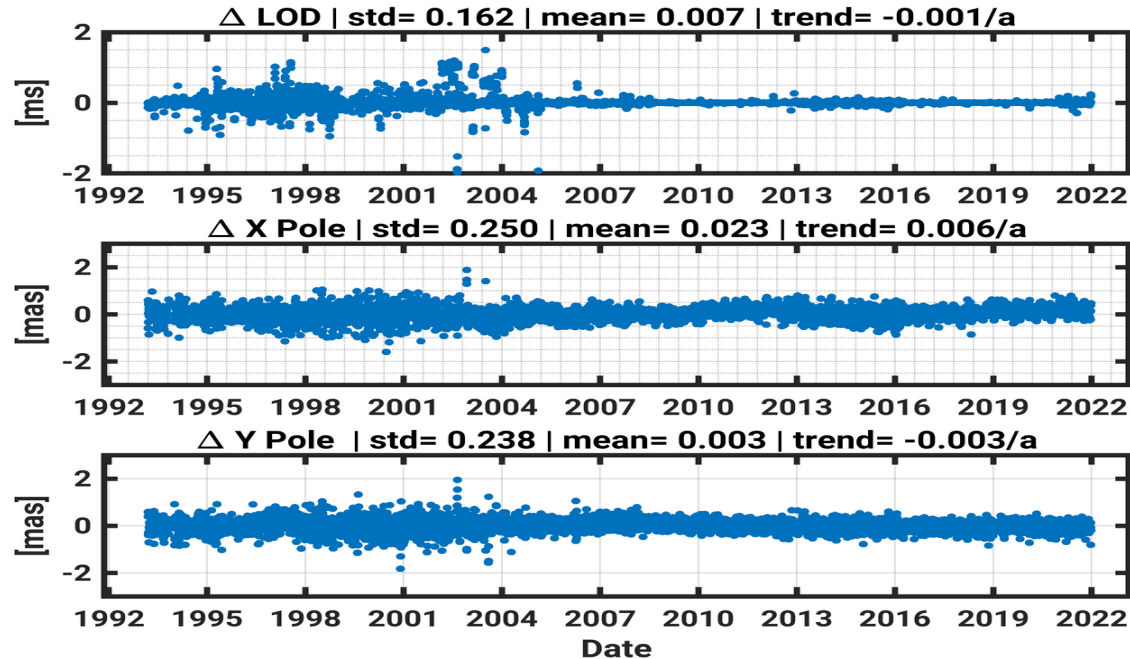
Sentinel3B

Sentinel6A

# 4.2 Combined Solution (1)



## 4.2 Combined Solution (2)

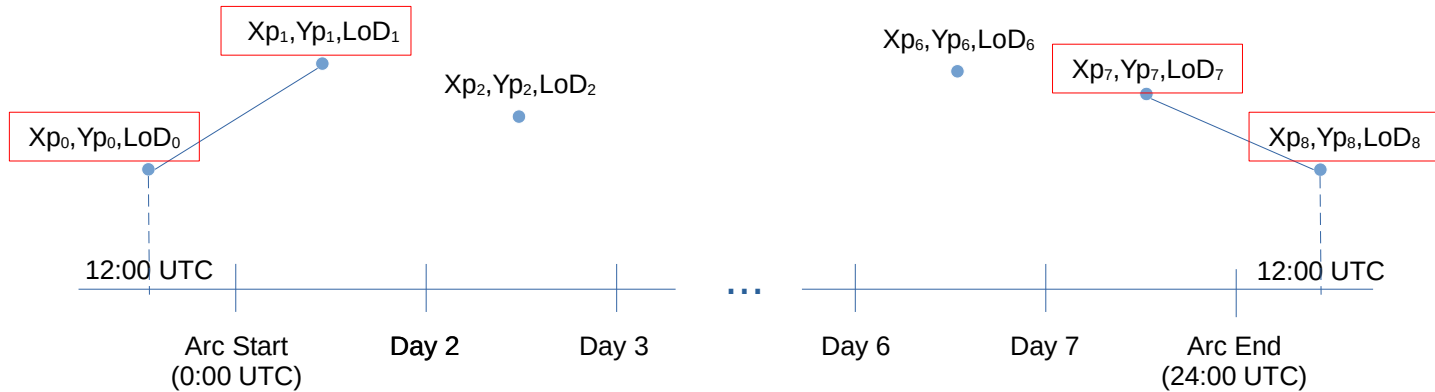


# 5 Conclusion & Outlook

- Combined solution shows higher quality results for ERPs compared to single solution
- Jumps in scale and rotation due single satellite events
- Higher drift in scale by Sentinel Missions starting from 2021
- Further tests and improvements ongoing
- Implementation of Saral and Cryosat2 is on the way

# Estimation of stations positions and Earth Orientation Parameters

- Additional ERP constrains:



$X, Y_{p1} - X, Y$  *constrained to*  $X, Y_{p1,apriori} - X, Y_{p0,apriori}$   
 $X, Y_{p8} - X, Y_{p7}$  *constrained to*  $X, Y_{p8,apriori} - X, Y_{p7,apriori}$

$LoD_0$  *constrained to* apriori  
 $LoD_8$  *constrained to* apriori

# Precise Orbit Determination

- Models and standards
  - Earth Gravity Field: GOCO06s 120x120 (static+time variable)
  - Ocean tides: FES2014 100x100
  - Non-tidal atmospheric mass variations: AOD1B RL06 180x180
  - Albedo Modell: Heurtel
  - Atmospheric density: MSISE-90
  - Reference frame: DPOD 2014 v5.5, SLRF 2014
  - Troposphere model: VMF1 (DORIS), Mendes-Pavlis (SLR)

# Precise Orbit Determination

- Parametrization used in POD
  - Arc length 7 days according to GPS weeks
  - Atmospheric drag scaling factor: 1 global factor per arc
  - Empirical acceleration: 1 cos, sin per 48h in transversal and normal direction
  - Solar radiation: 1 scaling factor per day
  - Frequency bias: 1 per station and pass
  - Range-bias: 1 global bias
  - Time-bias: 1 global bias
  - Troposphere bias: 1 per station and pass