GNSS PPP Service Enhancements in 2024

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Hydro 2024 Warnemünde, Germany

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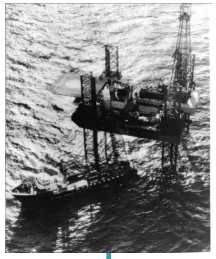
Fugro positioning service evolution

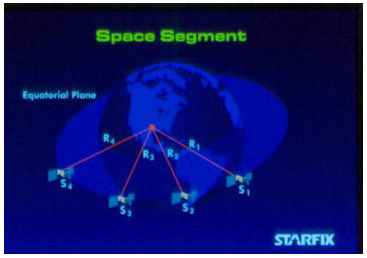
Transit system first used



1974

1984

Starfix positioning system

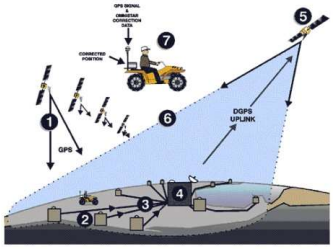


High frequency DGPS L1 service

1986

1996

Omnistar Satellite based code L1 VBS



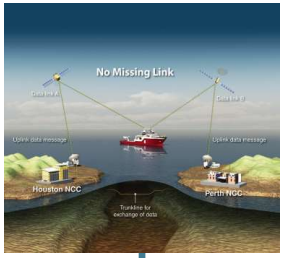
HP dual-frequency DGPS service

2001

2006

XP PPP service

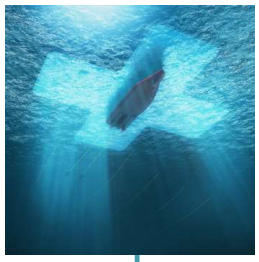
G2 GPS & GLONASS PPP service



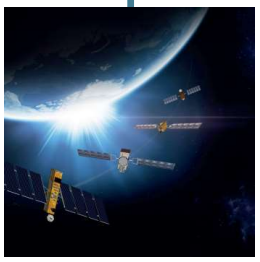
2009

Fugro positioning service evolution

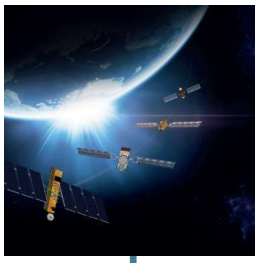
2015 — G2+ ambiguity-fixed PPP Service



2015 — Added BeiDou into G4 service



2016 — Added Galileo into G4 service



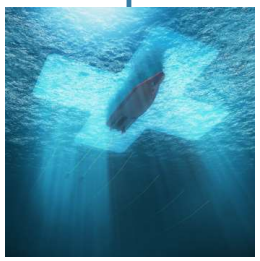
2021 — SpaceStar LEO PPP

2022 — AtomiChron timing service

2023 — Independent Orbit+Clock GPS+GIO+Galileo

XP3

2023 — G4 ambiguity fixing



2024 — 3 Frequency fast convergence

2024 — Satguard NMA Spoofing Protection

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Fugro Satellite Positioning
- thousand active users globally

Research vessels

Hydrographic Survey vessels

Dredging vessels

Cable Lay vessels

Windfarm installation/support vessels

Navy / Coast guard vessels

Fishing / Fish farming vessels

USVs

Marinestar Compatible Receivers(1/3)

Trimble

MPS566

SPS855

MPS865 (MB2)

R750

BX992 (BD992)

Applanix POSMV

KONGSBERG

Seapath Series using a
3610 or 3710 demodulator

FUGRO

Marinestar Compatible Receivers(2/3)

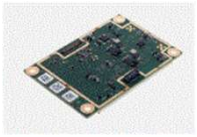
septentrio

AsteRx-u3 Marine

AsteRx-m3 OEM

AsteRx-u-fg

AsteRx4-Fg OEM



SBG SYSTEMS

Navsight Ekinox Marine

Apogee-D

Ekinox-D

Ping DSP
A NORBIT Company

3DSS-iDX Sonar

MGBTECH

UKKO2

FUGRO

New Marinestar Integrated products in 2024

R2SONIC
OUR VISION IS SOUND™

Norbit Winghead

aae technologies
MiniPod 200 series

Teledyne Intrepid

JAVAD

SIGMA

FUGRO

Changes in the GNSS Satellite Constellation in 2024

GPS 31

Next Launch Jan 2025

2025 from 31->32 SV

~~G1~~

Galileo 24

2 Launch in 2024

6! Launches in 2025

~~E1~~

BeiDou 35

4 Launches in 2024

~~C46~~

Glonass 20

1 Launch Dec? 2024?

~~R6,R10, R13,R23,R25~~

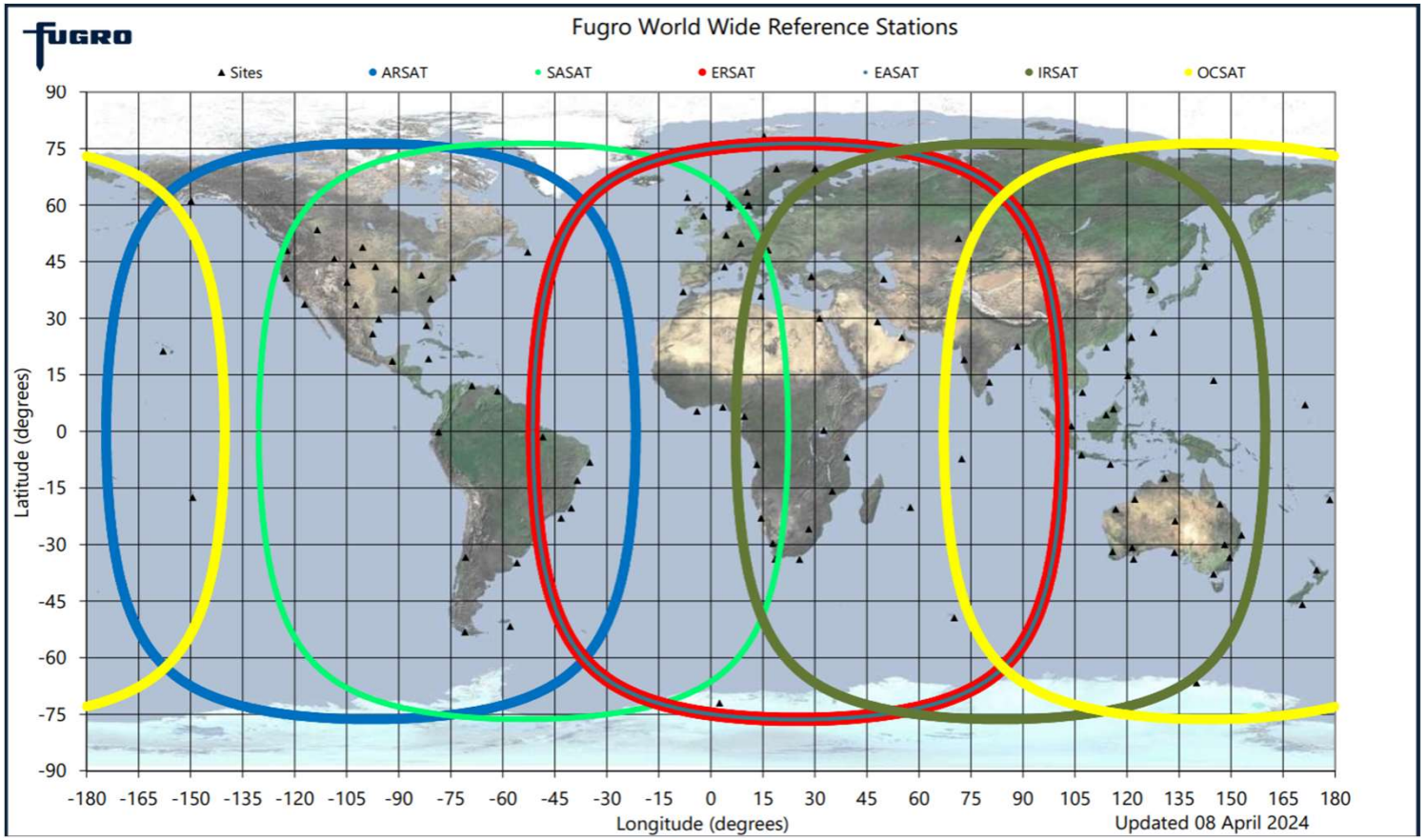
https://www.youtube.com/watch?v=60-xdbqXUoA

NextG4: Fugro infrastructure

100+ reference stations

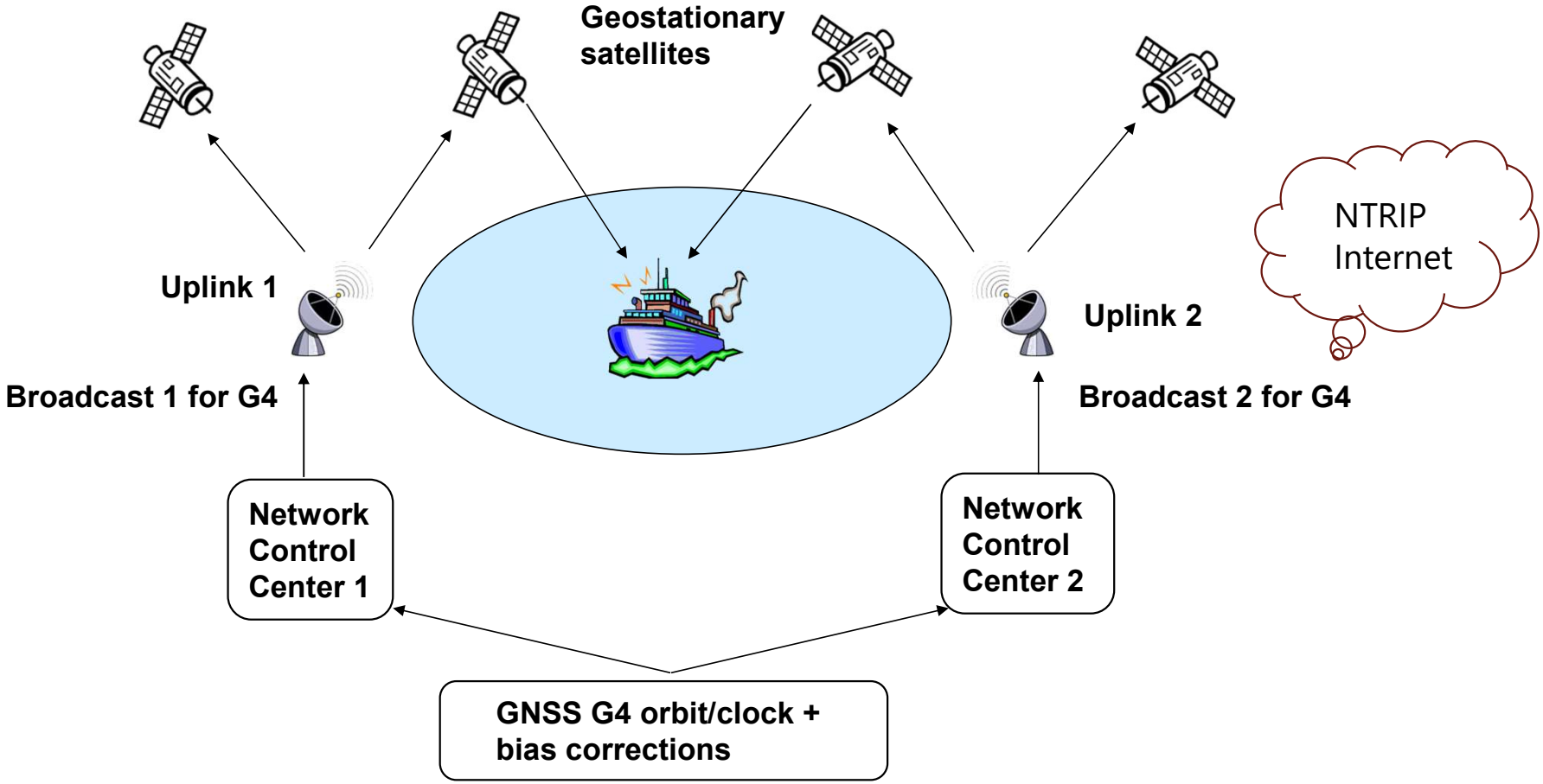
6 global L-band GEO broadcast satellite beams

2 fully redundant Network Control Centers (NCCs)



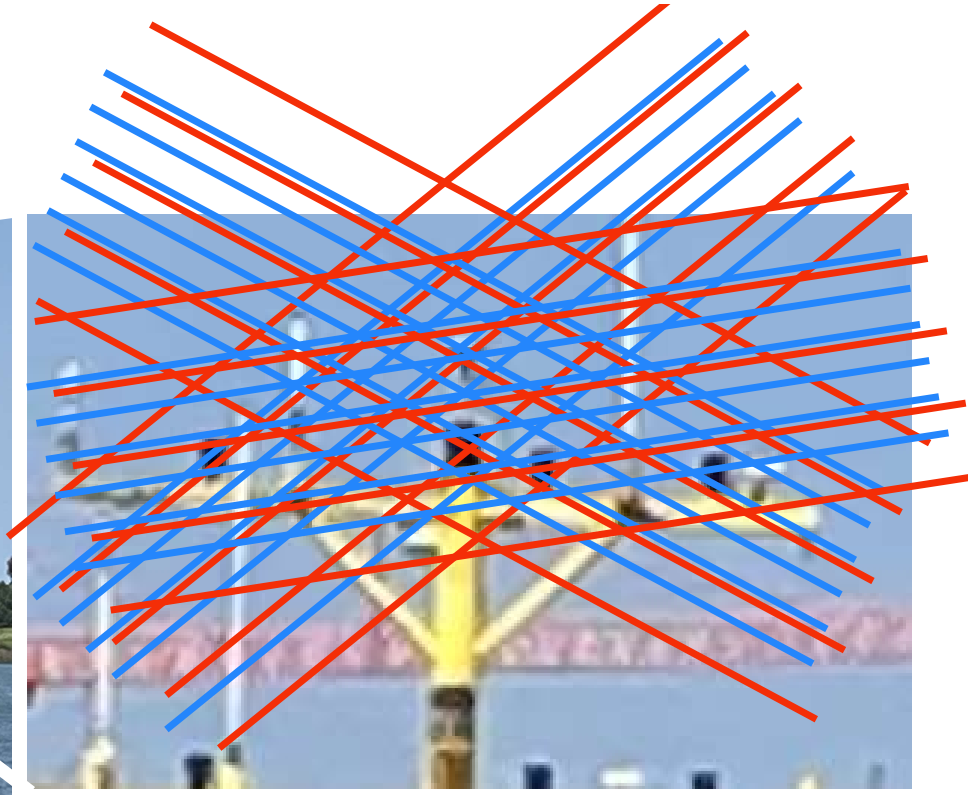
https://fsp.support/marinestar/

Fugro Satellite Positioning infrastructure



https://www.fugro.com/expertise/other-expertise/marinestar#benefits

Fixing the correct wavelengths



~40-50 Satellites

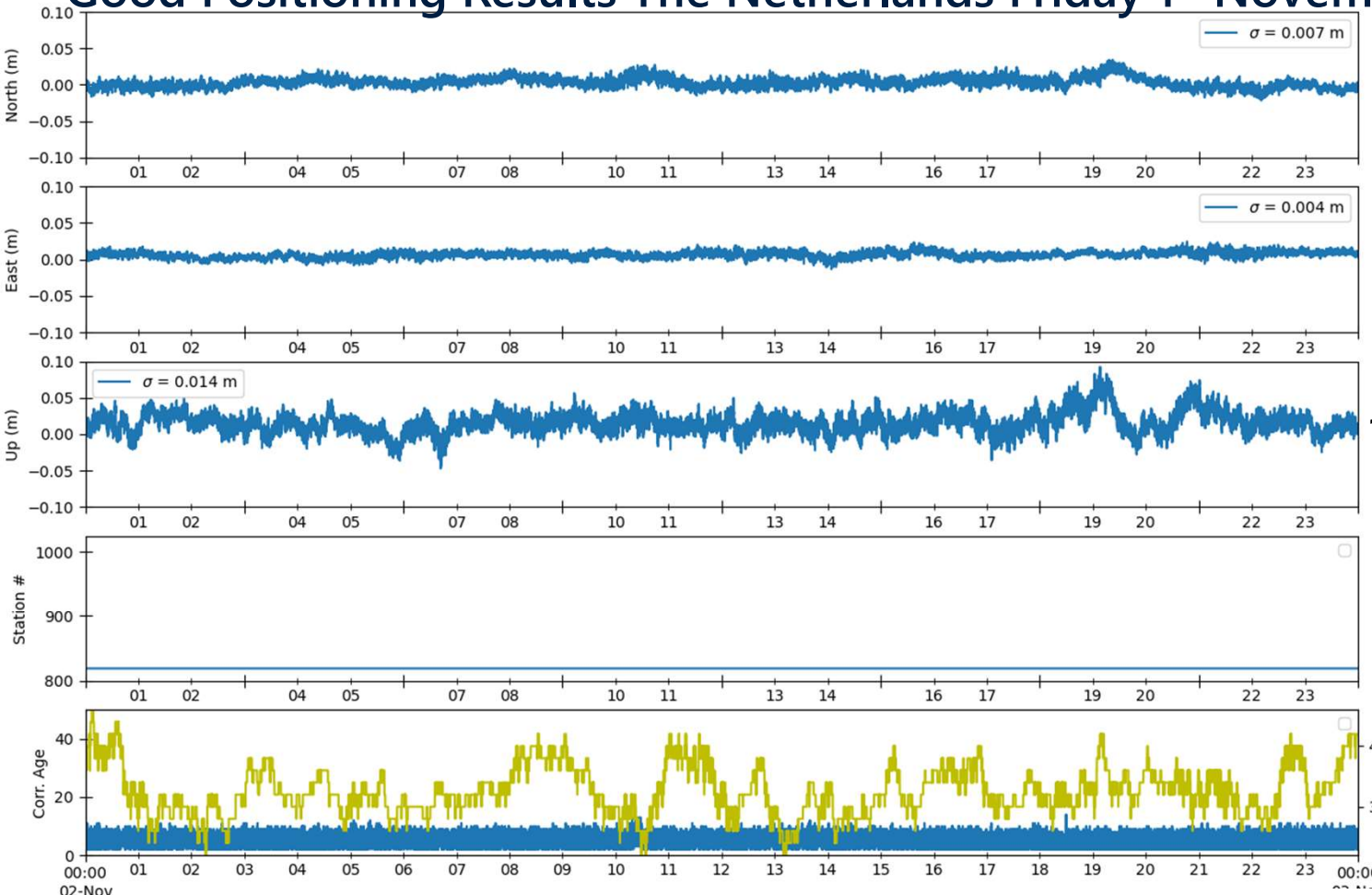
3 Frequencies. Wavelength ~10, ~20, ~80 cm range

3 Constellations. (Glonass not fixed)

Computational challenge. Lambda method

ND28
2024 11 01

Good Positioning Results The Netherlands Friday 1 –November-2024



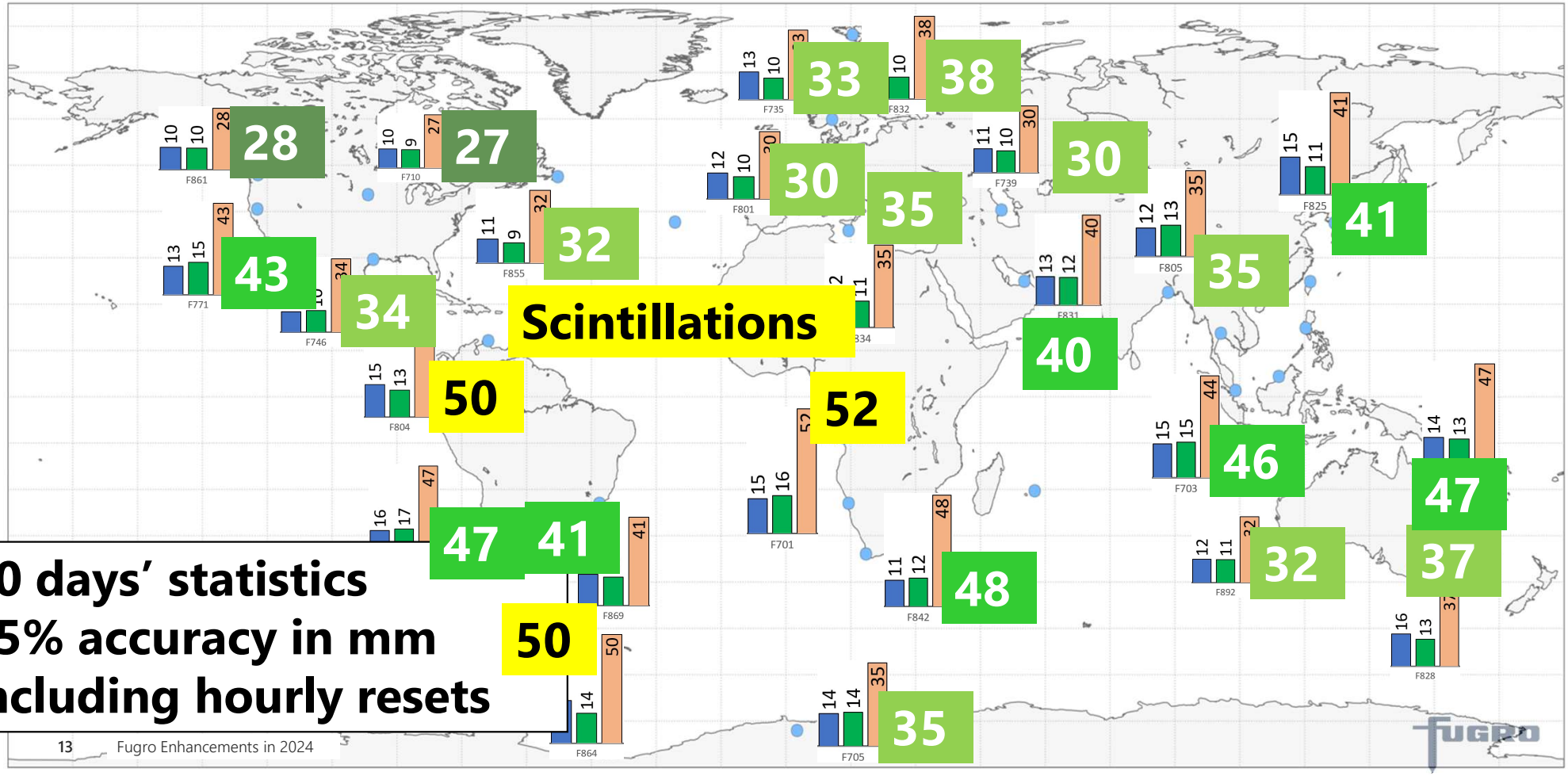
7 MM Std

4 MM Std

14 MM Std

30-40 Satellites

Positioning accuracy results triple frequency Spring 2024

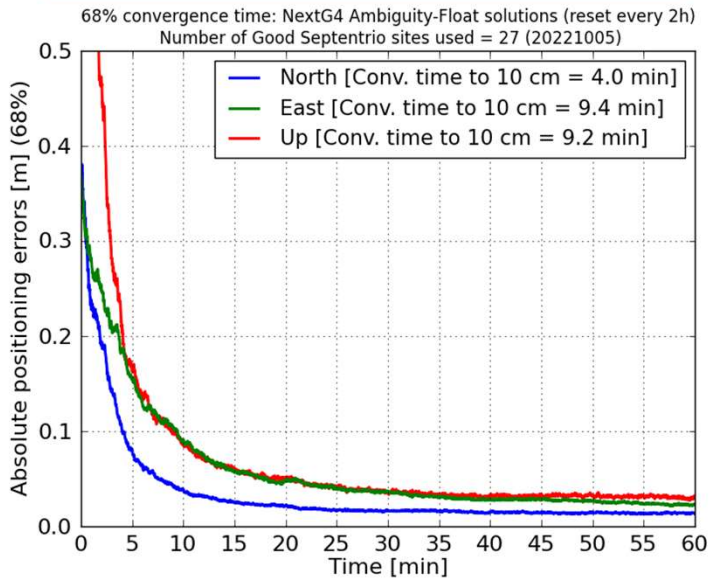


10 days' statistics
95% accuracy in mm
including hourly resets

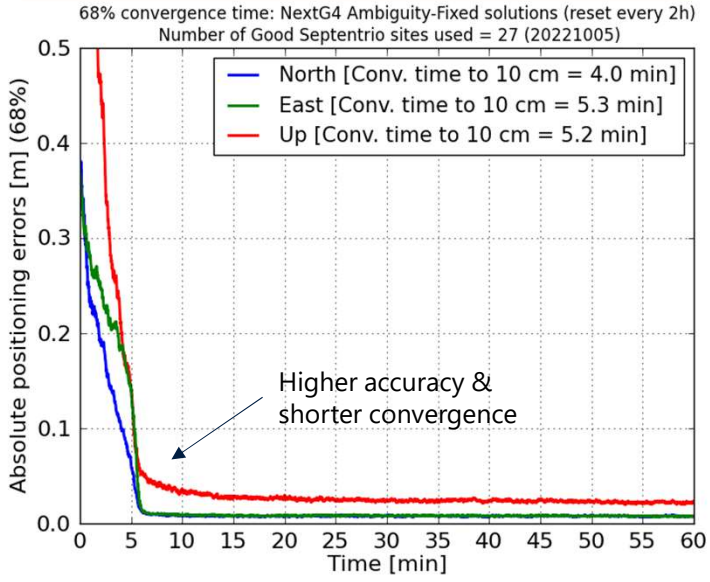
Positioning results 68% dual frequency

Convergence time statistics, results are obtained with Fugro PolaRx5 stations' data

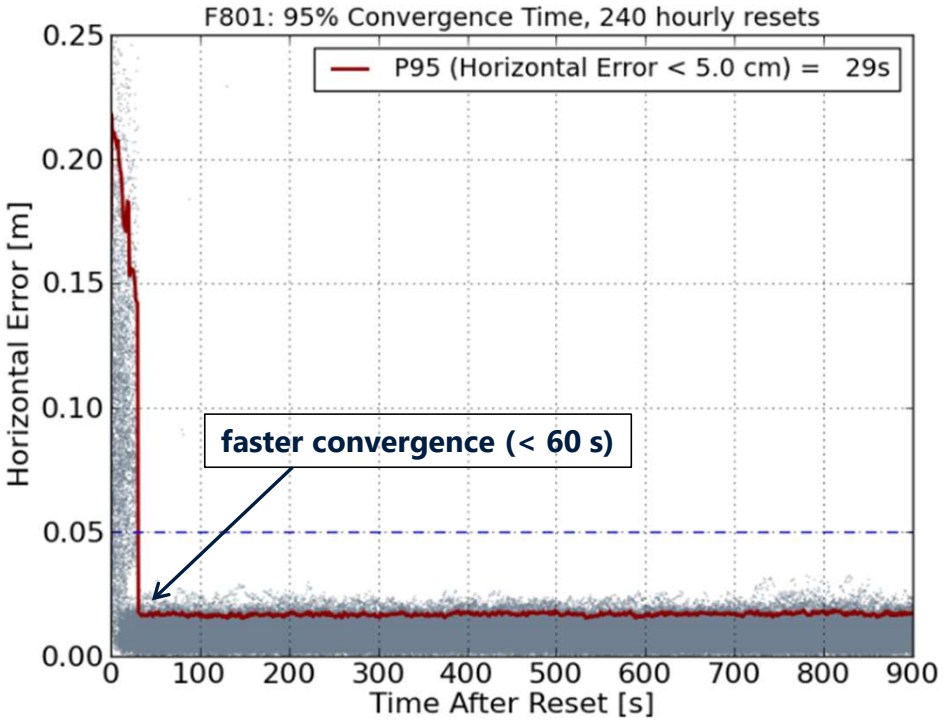
G4 (no ambiguity fixing)

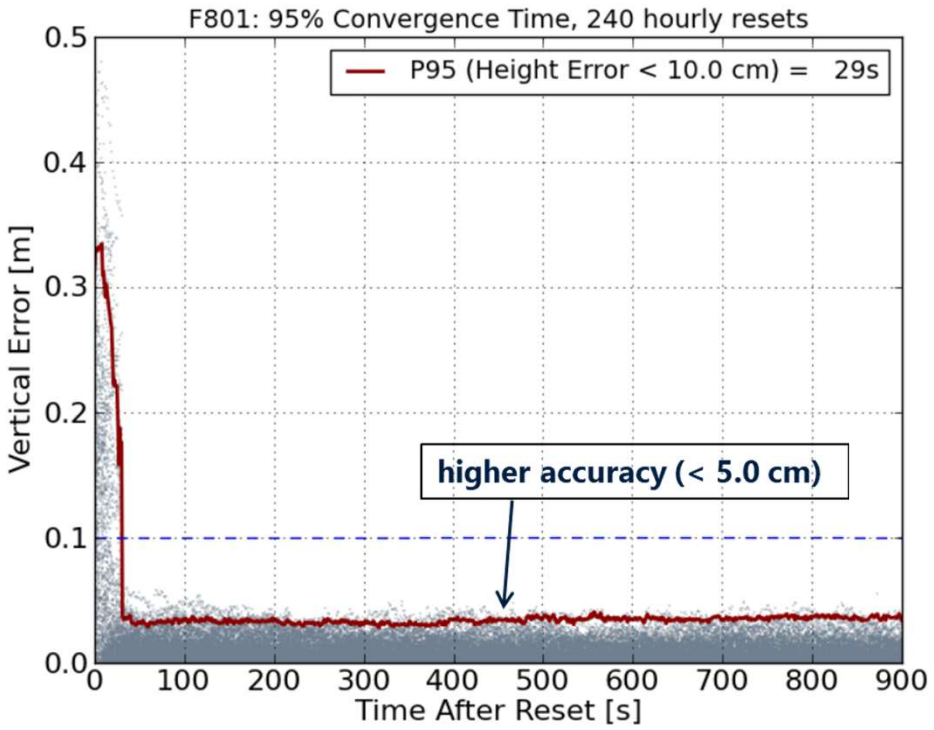


G4: GPS/GAL/BDS ambiguity fixing



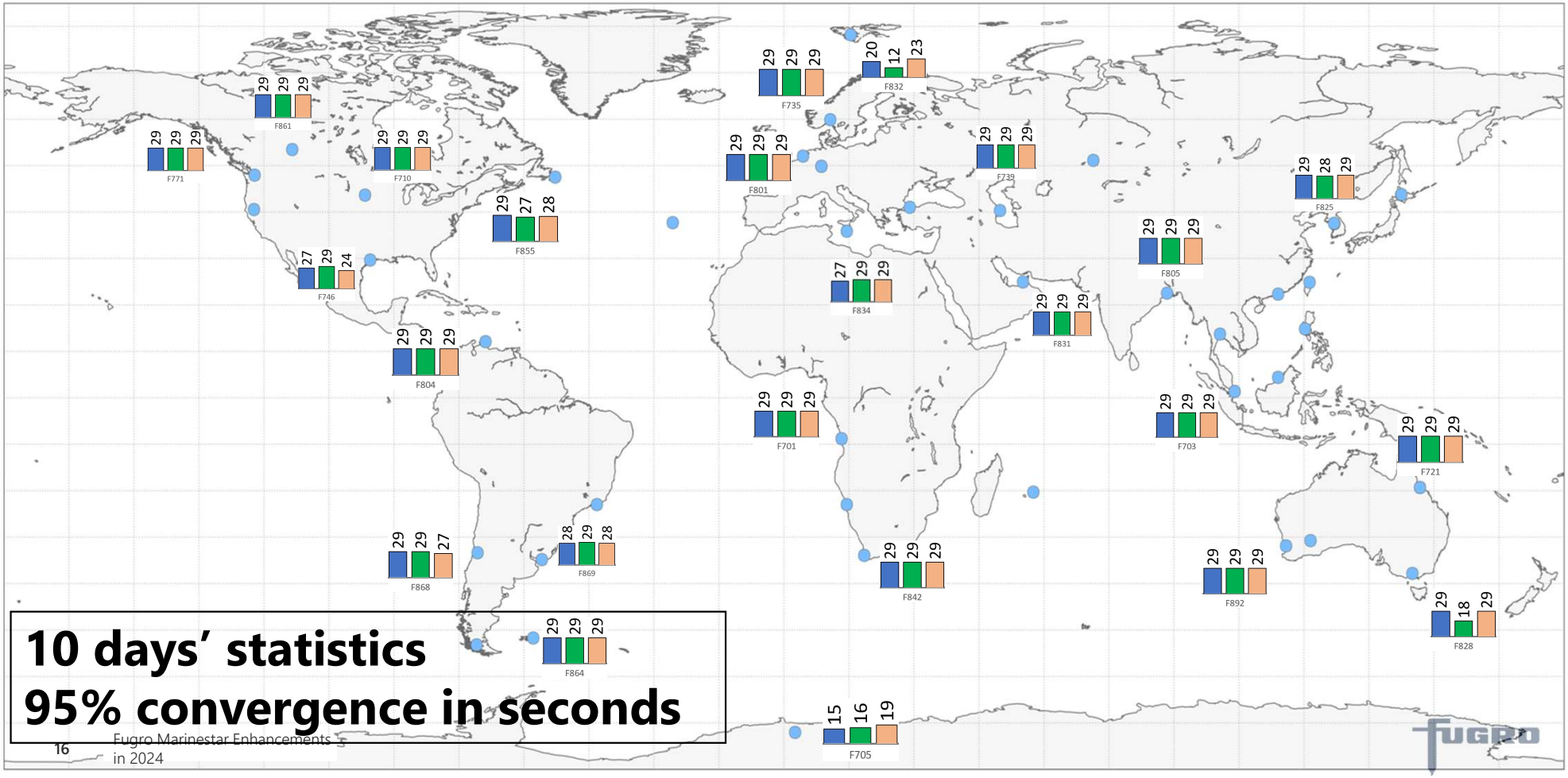
Positioning results triple frequency 95% Horizontal and Height





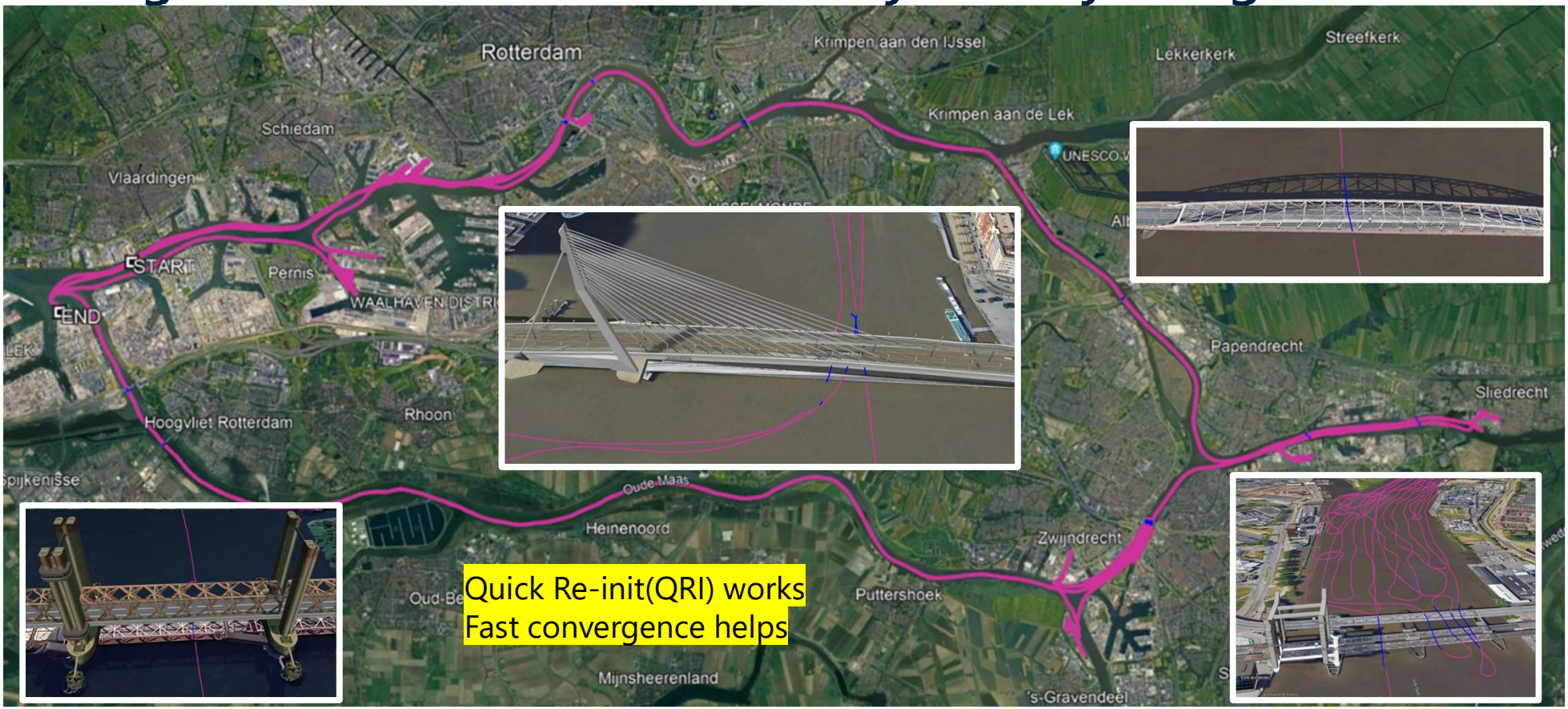
10 days' statistics

Positioning convergence results tripe frequency in 29 Seconds.

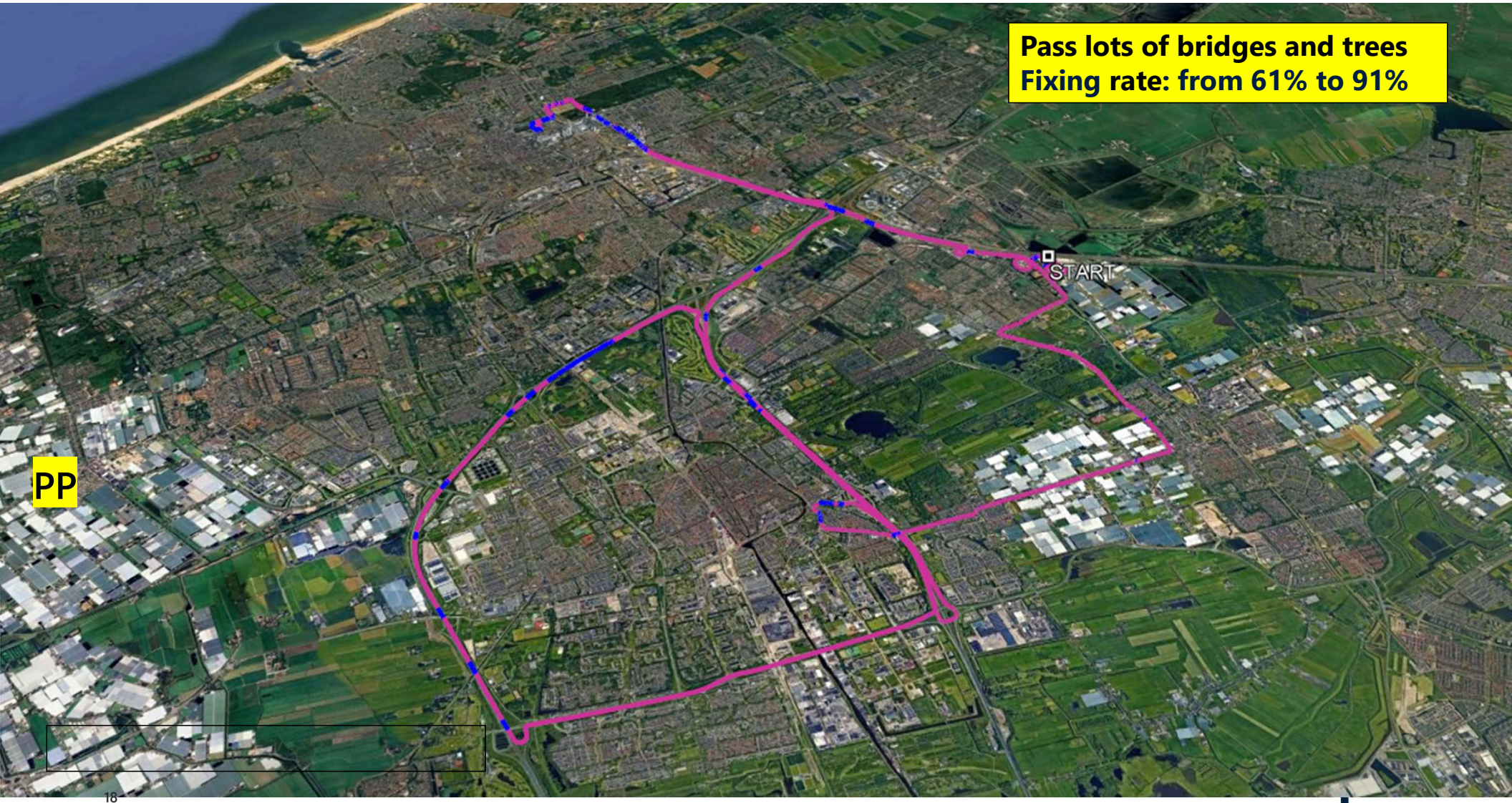


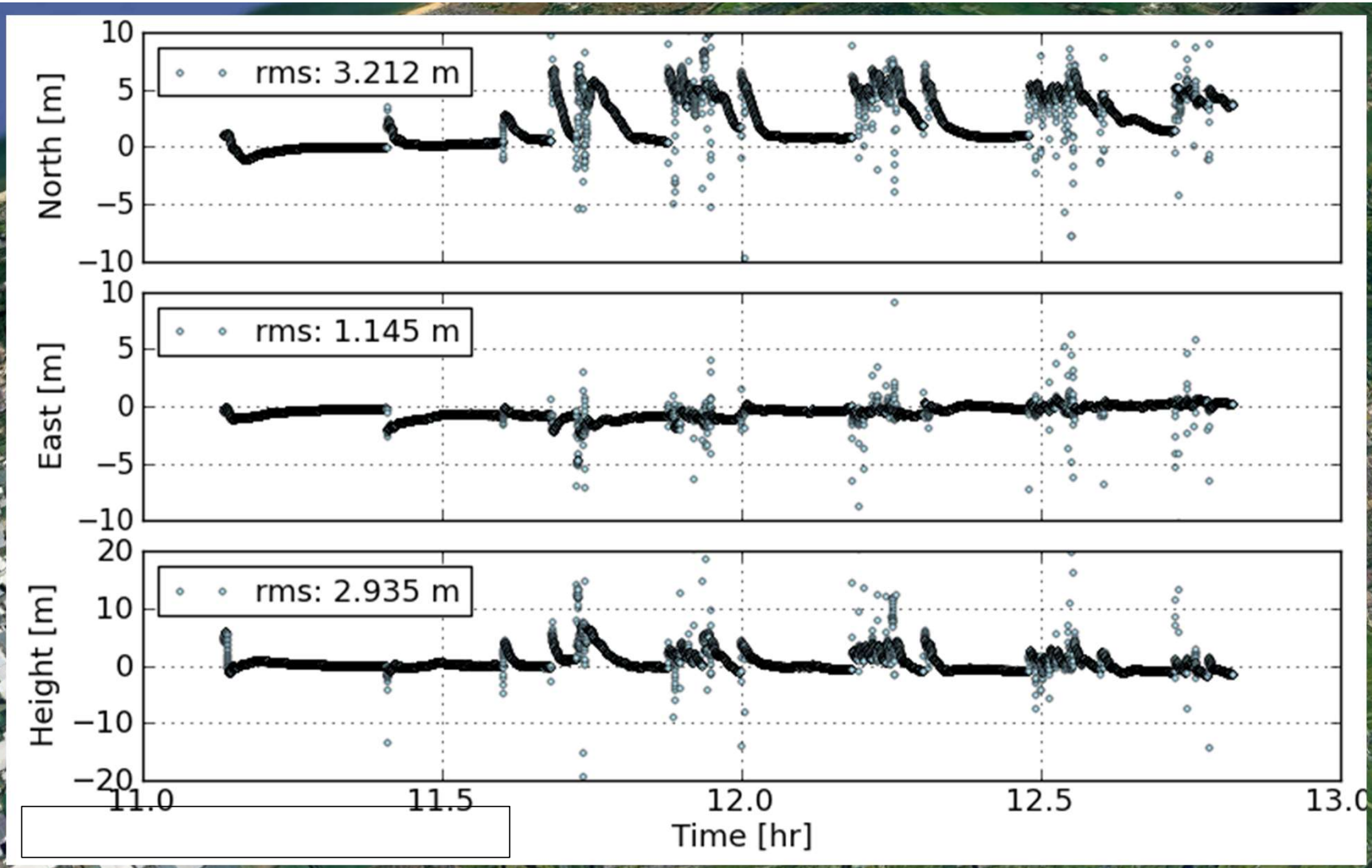
10 days' statistics
95% convergence in seconds

Sailing Harbour of Rotterdam 2 days. Many bridges

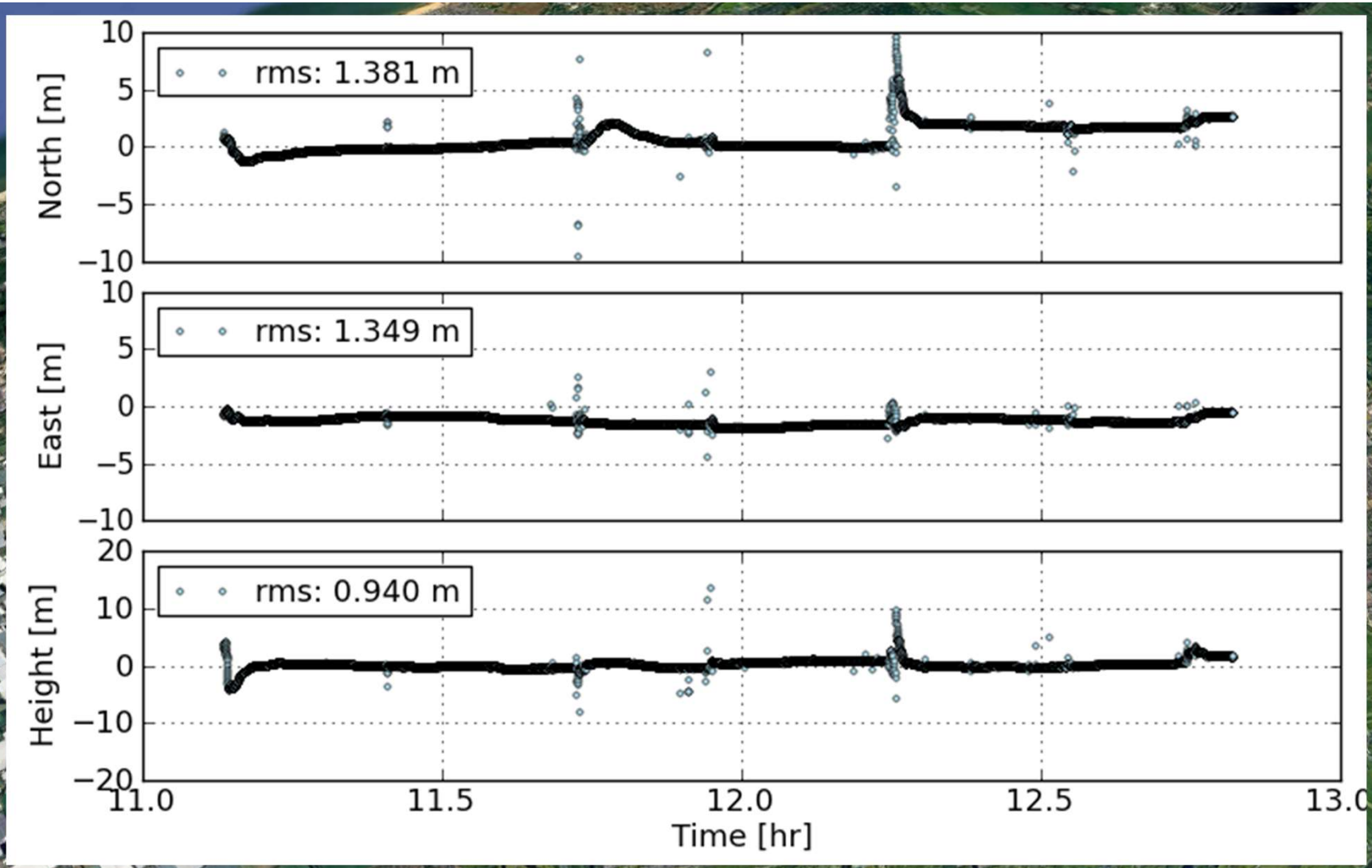


Thanks to support Willem Snoek, Harbour of Rotterdam

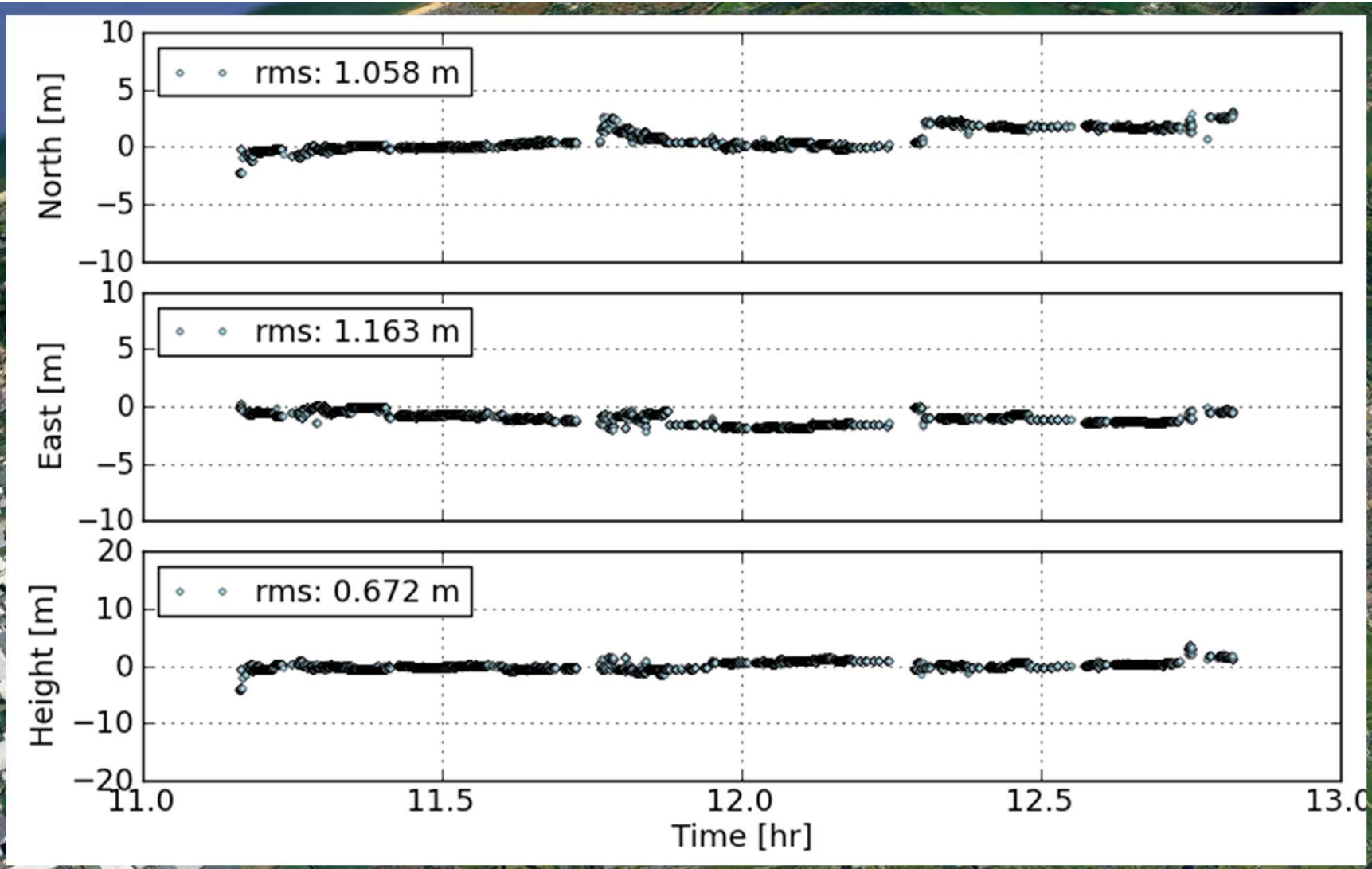

Pass lots of bridges and trees
Fixing rate: from 61% to 91%
START
PP



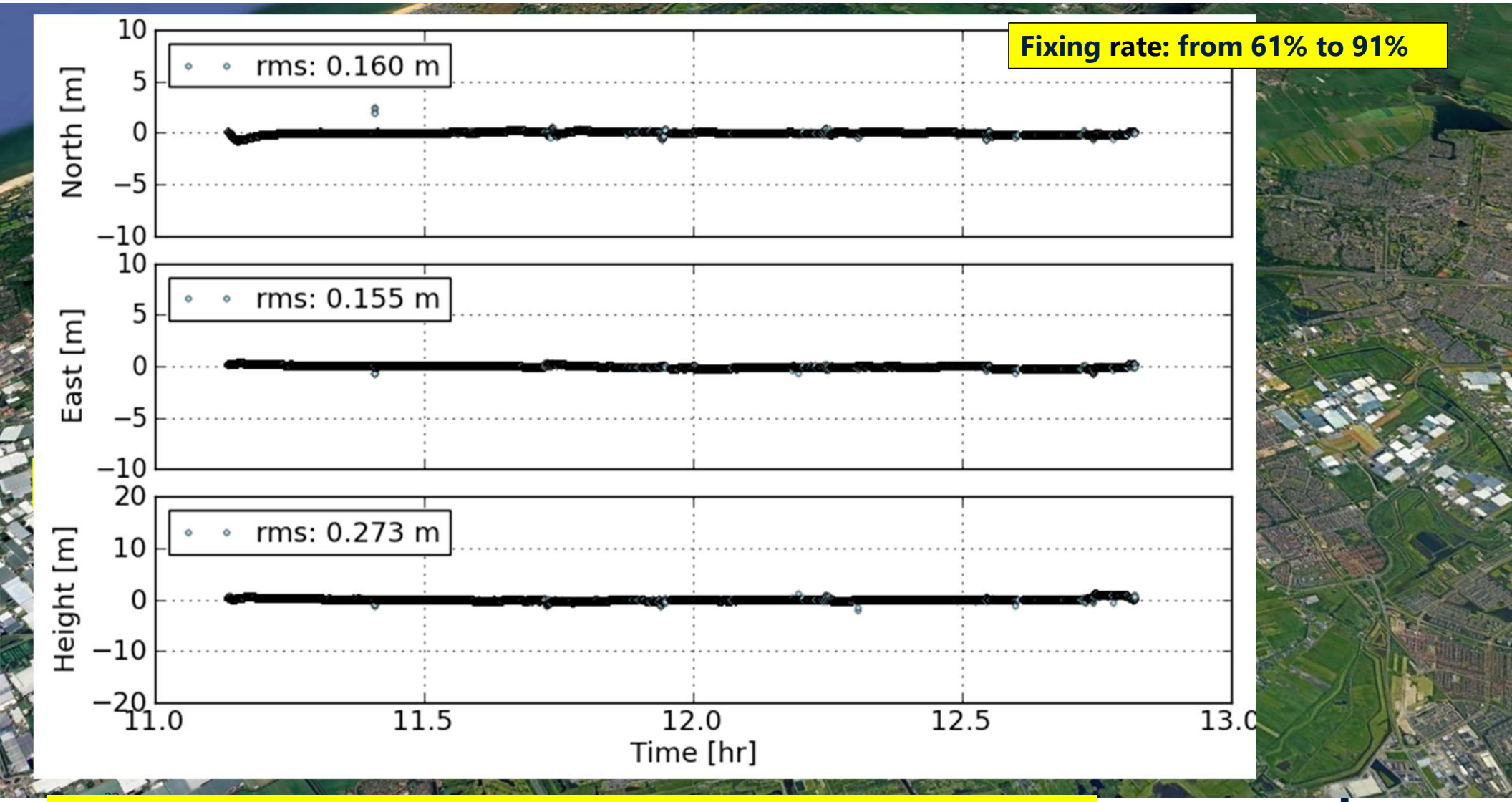
Standard PPP for 4 Constellations



PPP+Quick Reinit

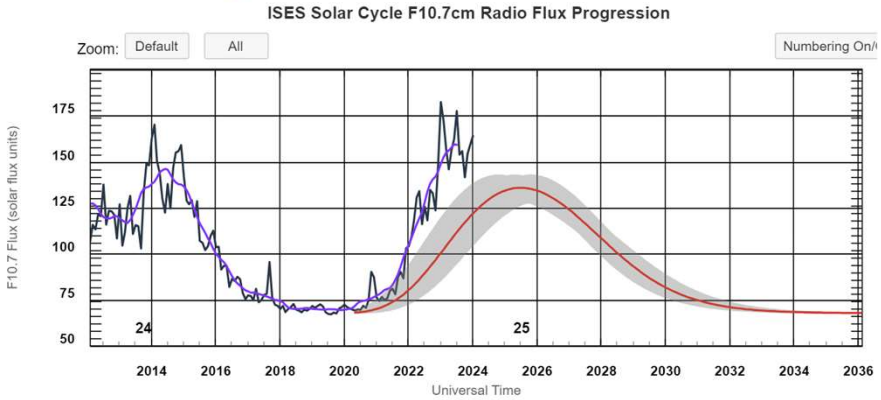


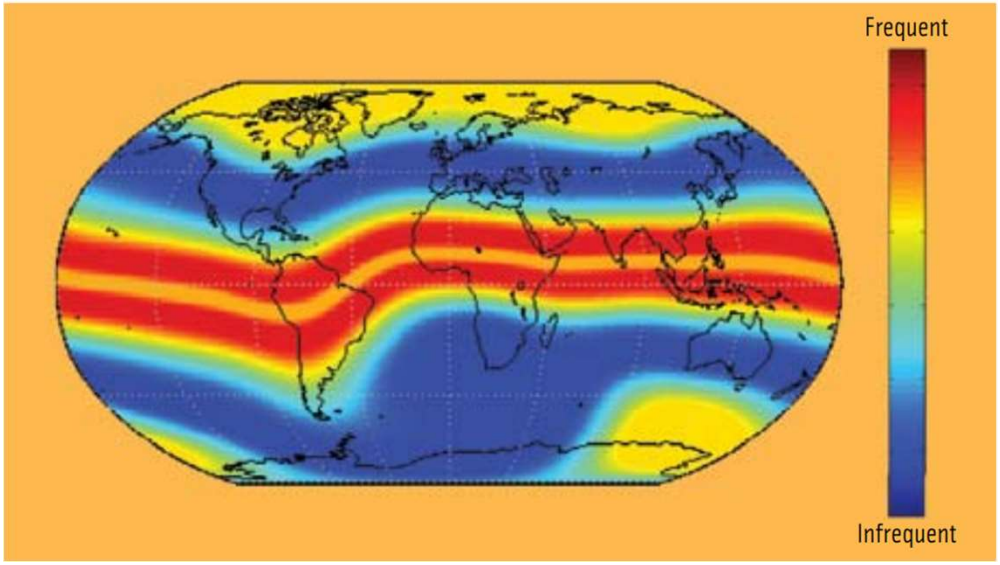
G4+ and Quick Reinit



Triple Frequency+ Quick Reinit+Use of Ionosperic corrections

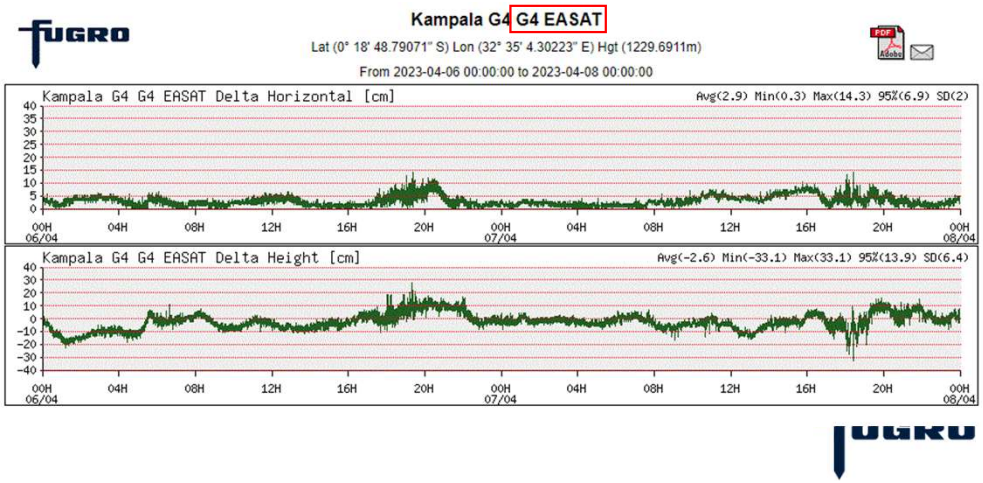
Solar cycle 25





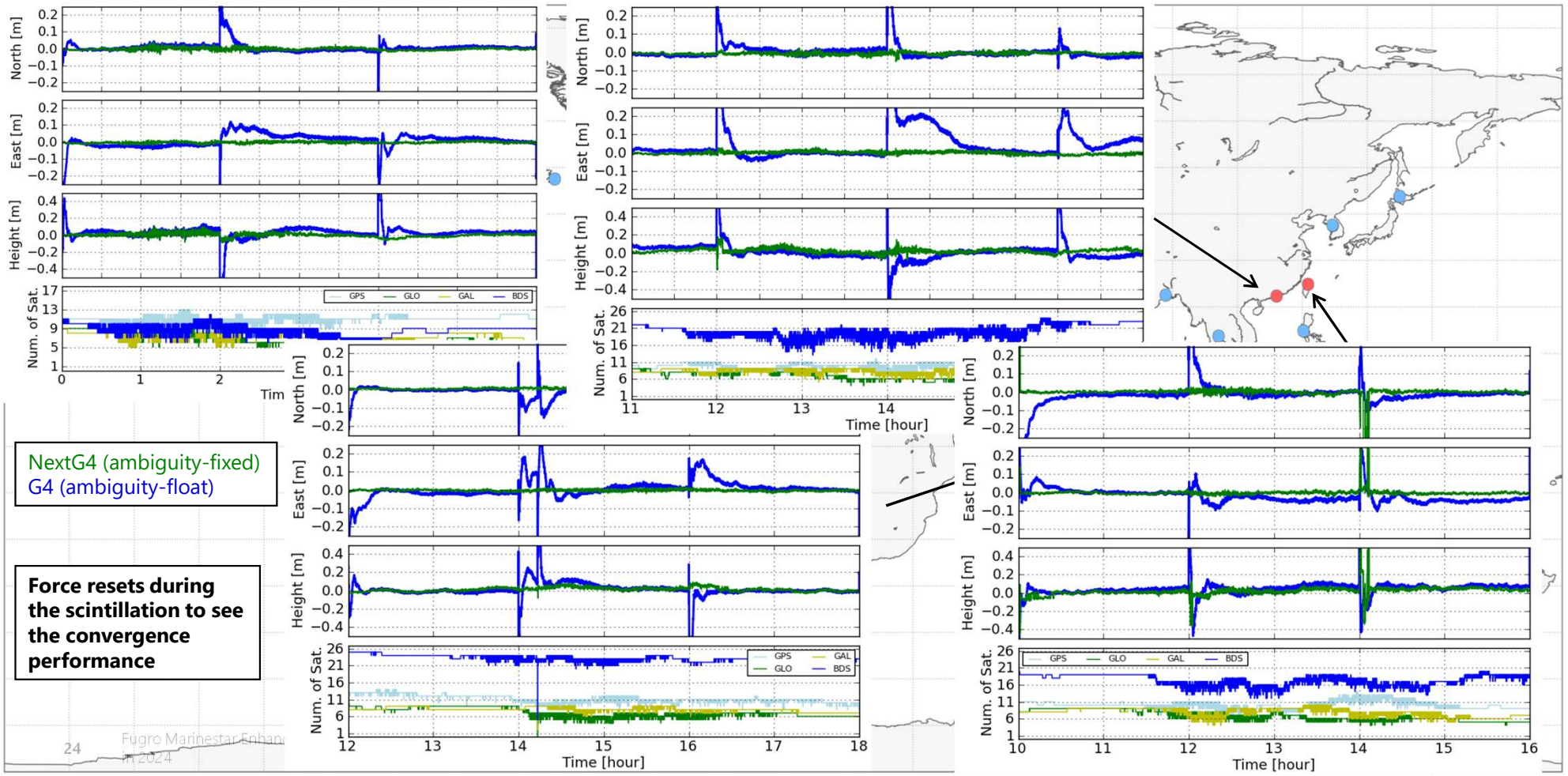
- Solar cycle 25 expecting to peak 2024-2025
- Affects predominately equatorial less in polar regions

- To mitigate the effects of solar activity:
  1. Use G4 with BeiDou3 (Up to C37 for Ax4, C46 For U3)
  2. Use 5 degrees elevation mask.
  3. Use receivers that can receive multiple L-band satellites simultaneously
  4. Use NTRIP for back-up corrections

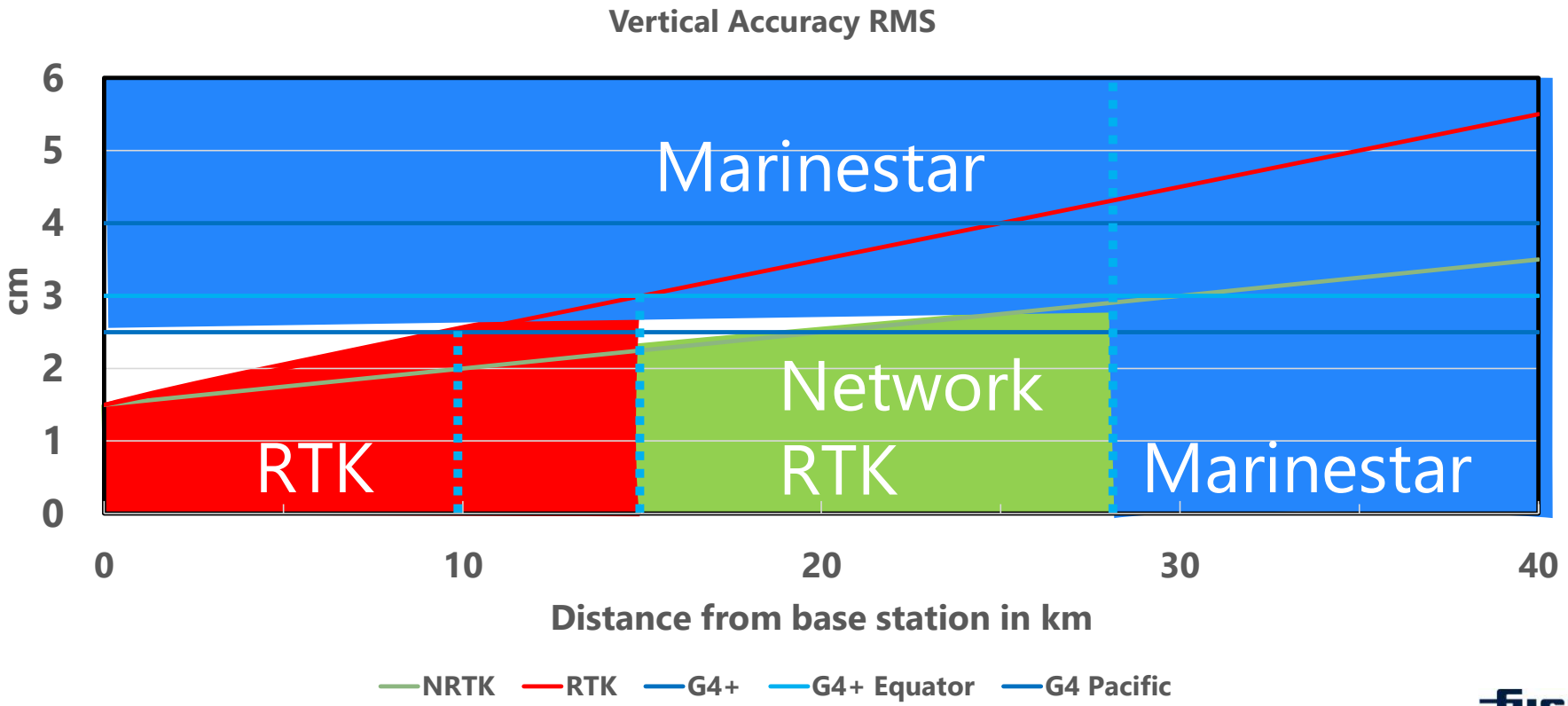


See more: https://fsp.support/pl/12321850

Positioning results in scintillation



RTK versus Marinestar Height



See:https://fsp.support/pl/24042300 RTK NRTK Specifications from AsteRx-U3

Satguard NMA

Spoofing
- Change orbits
- Pseudo Range.

Navigation Message Authentication
GPS, Galileo, BeiDou, Glonass, Corr.
Compare Checksum with
received Orbit.

Modes:
Strict: Only use Authenticated SV.
Relaxed: Start Position if no NMA.
Flag: Report Status in Display/Nmea

See: https://www.youtube.com/watch?v=AFSuTGncjI0

FUGRO OCEANSTAR®

Conclusions and outlook

- New manufacturers are added in 2024.
- Both multi-frequency and multi-constellation play crucial role in fast convergence.
- Convergence time has been reduced from approximately 12 min to just 3 min with accuracy improving to 2.5 cm horizontally and 5.0 cm vertically in good environment.
- BeiDou significantly contributes to the reduction of scintillation effect.
- XP3 independent Orbit and Clock Galileo has been added.
- Navigation Message Authentication helps against spoofing.

- Fugro is further improving the service performance in challenge observation environments for broader applications.

Unlocking **Insights**
from **Geo-data**