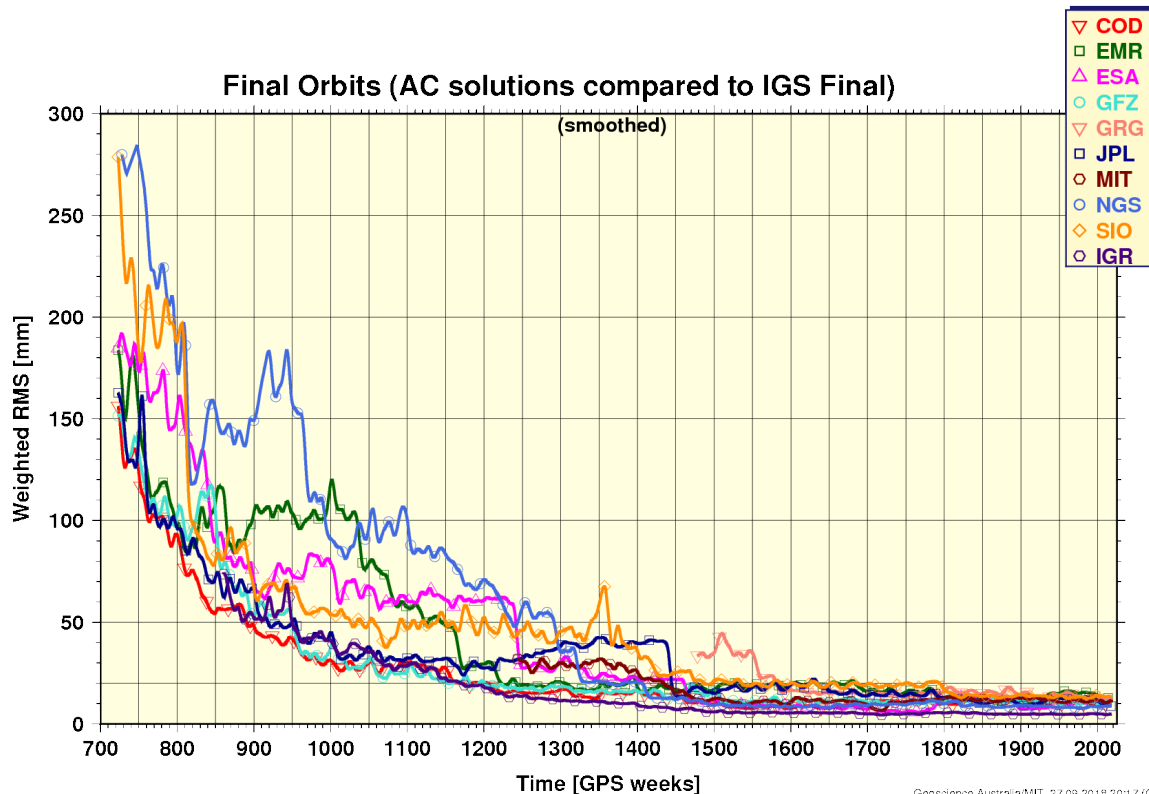


# Presentation of Public ESA Multi-GNSS Products

Volker Mayer, T. Springer, E. Schönemann, W. Enderle

17/10/2018

- Located at ESOC in Darmstadt
- Providing high precision GNSS orbit and clock products since 1992:
  - IGS (GPS+GLONASS)
  - GRAS GSN
  - GGSP/OVF (+Galileo)
  - Sentinel
  - etc.

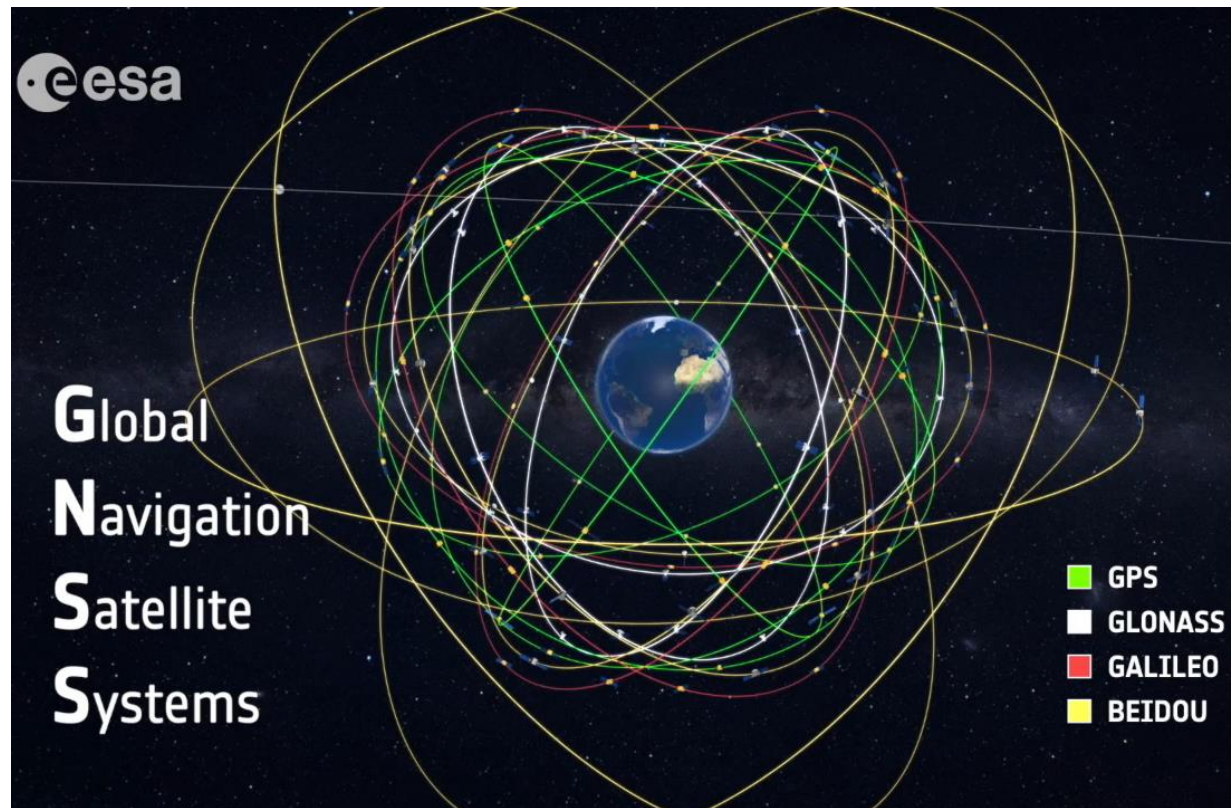


Geoscience Australia/MIT, 27.09.2018 20:17 (GMT)

# Multi-GNSS

- All projects push to exploit advantages of Multi-GNSS

	In Operation	In Orbit
GPS	31	32
GLO	24	25
GAL	17	26
BEI	16	35
QZS	4	4
<b>Total</b>	<b>93</b>	<b>122</b>



# Multi-GNSS Efforts at ESOC



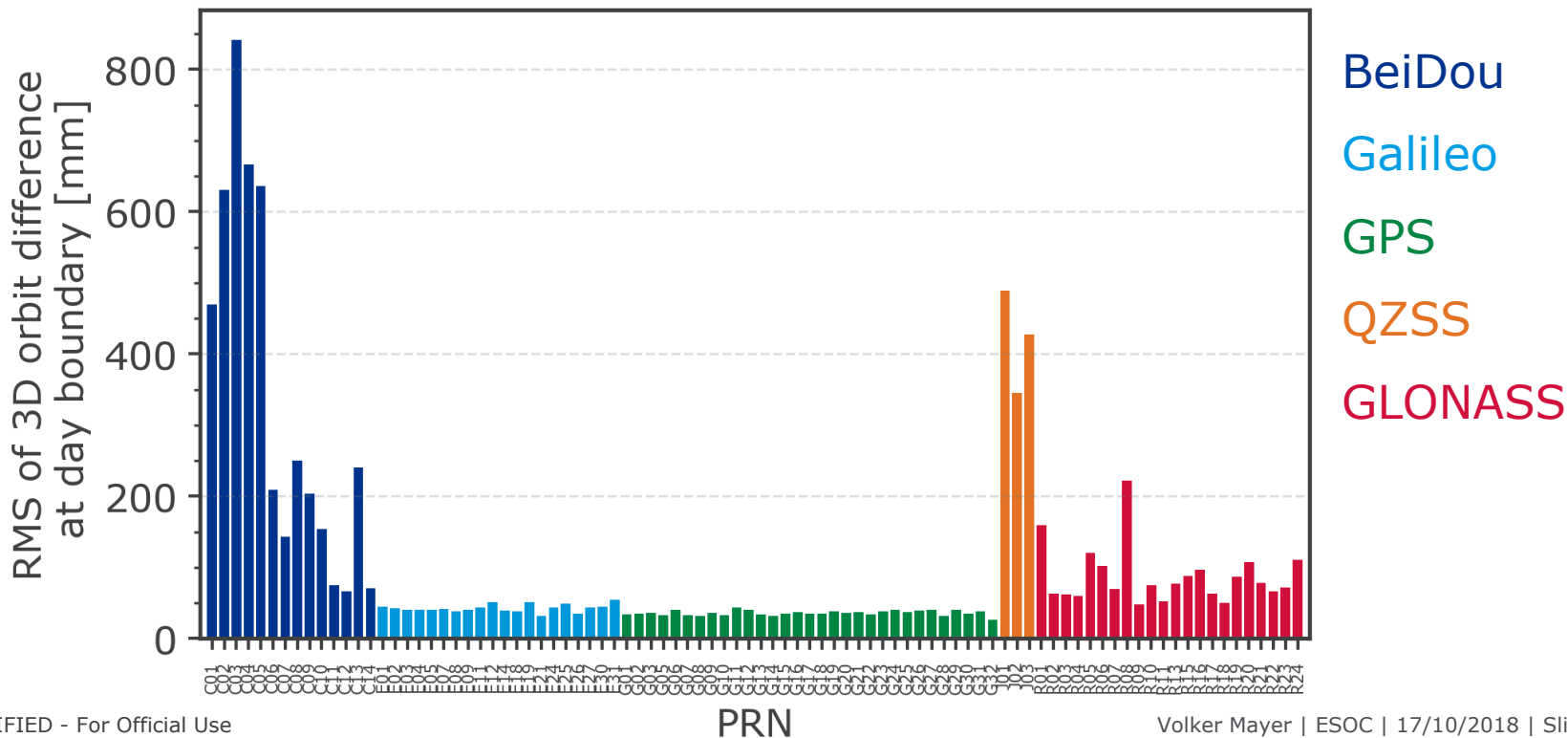
- Daily processing routine of multi-GNSS, based on IGS routine
  - Minimal-constraint 24 hours network-solution of all operational GNSS satellites
  - Started in 2005 as experiment to study characteristics of the new constellations
- Centre-piece of ongoing development work at ESOC:
  - Orbit & Clock modelling
  - Cycle Ambiguity resolution
  - Differential Code/Carrier Biases
  - L-Band signal combinations (all available signals)
  - ESA Earth Orientation Parameters (based on GNSS, VLBI, SLR and DORIS)
  - POD of Formation Flying and Constellations
  - GNSS Space Service Volume



# Day-boundary orbit differences (worst case)



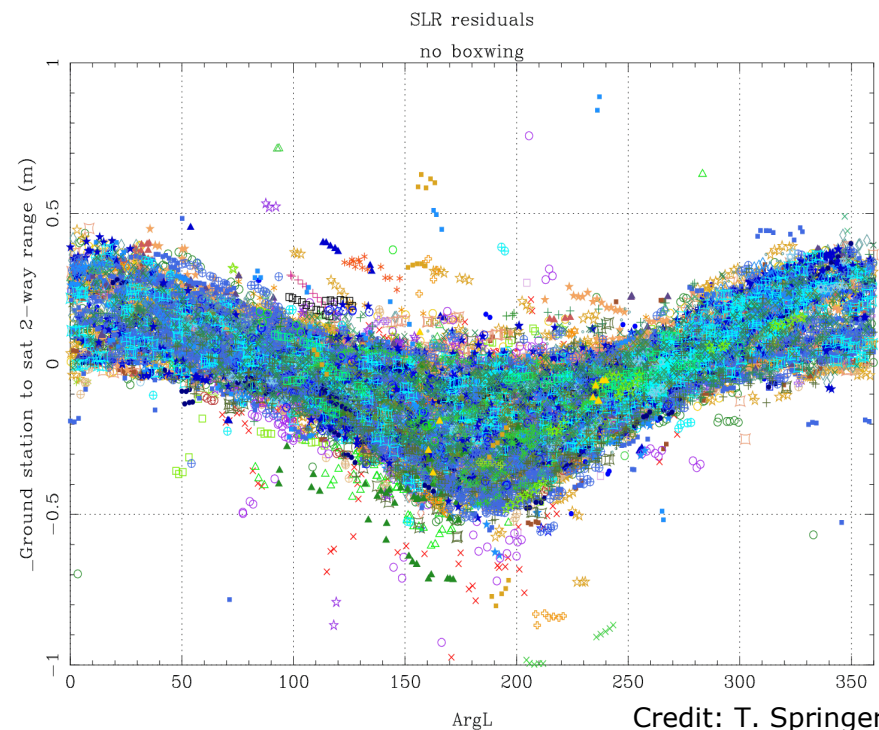
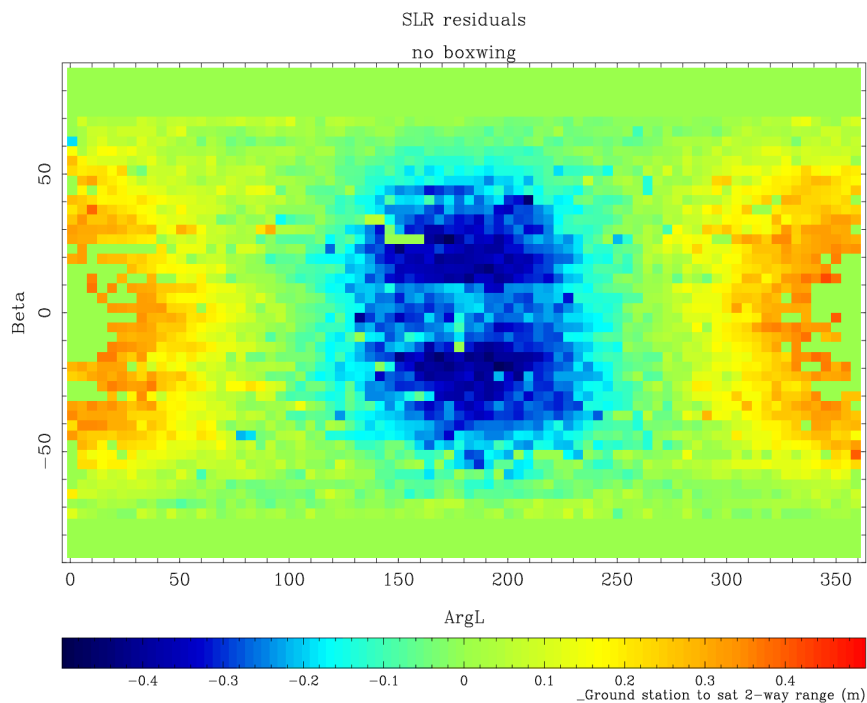
ESOC MGNSS Products  
01.2018 - 06.2018





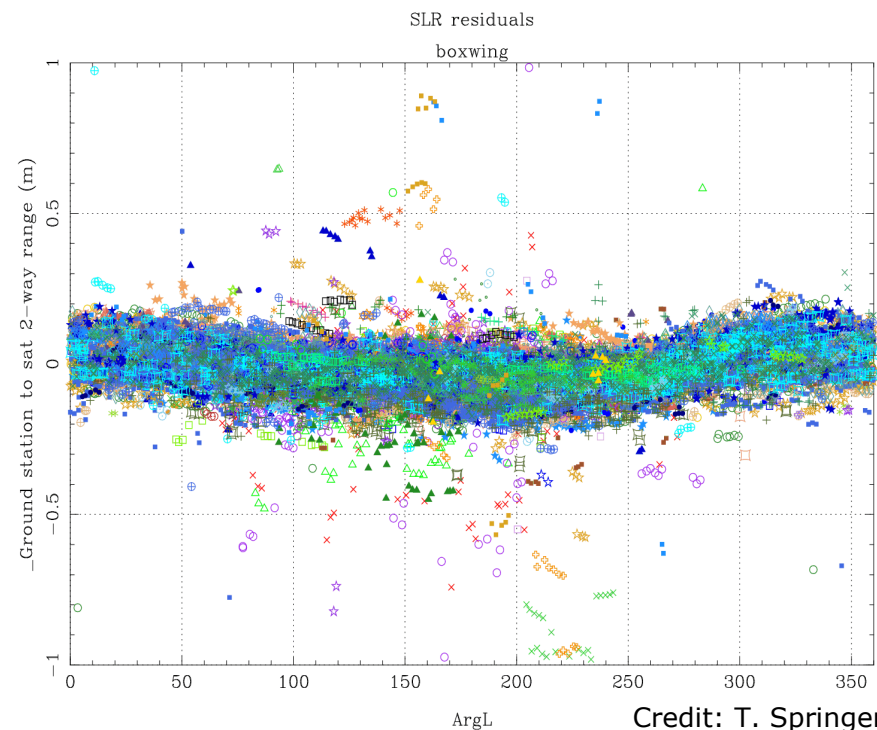
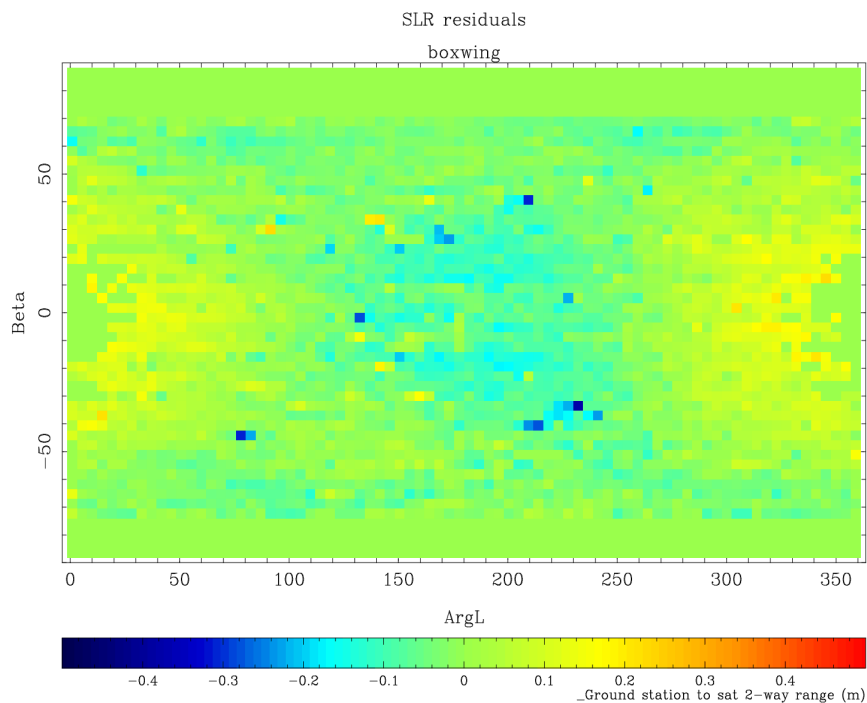
# GALILEO Radiation Pressure Modelling

## SLR Residuals with only ECOM (empirical model)



# GALILEO Radiation Pressure Modelling

## SLR Residuals with Box-Wing model (physical model)

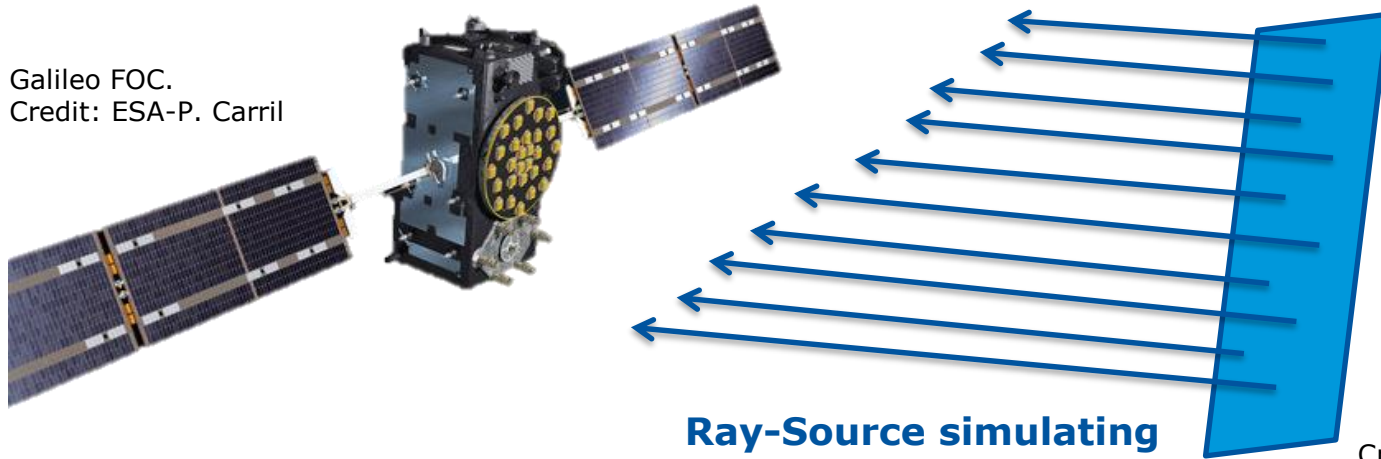


# Next Generation Radiation Pressure Model

## ARPA (Aerodynamics and Radiation Pressure Analysis)

- **In Testing:**
  - Replacement of Box-Wing model by **Raytracing** Procedure
  - Detailed information about satellite geometry and surface properties allows improved modelling of **Radiation Pressure** and **Air Drag** (LEO)

Galileo FOC.  
Credit: ESA-P. Carril



**Ray-Source simulating  
the Sun or the Earth**

Credit: F. Gini

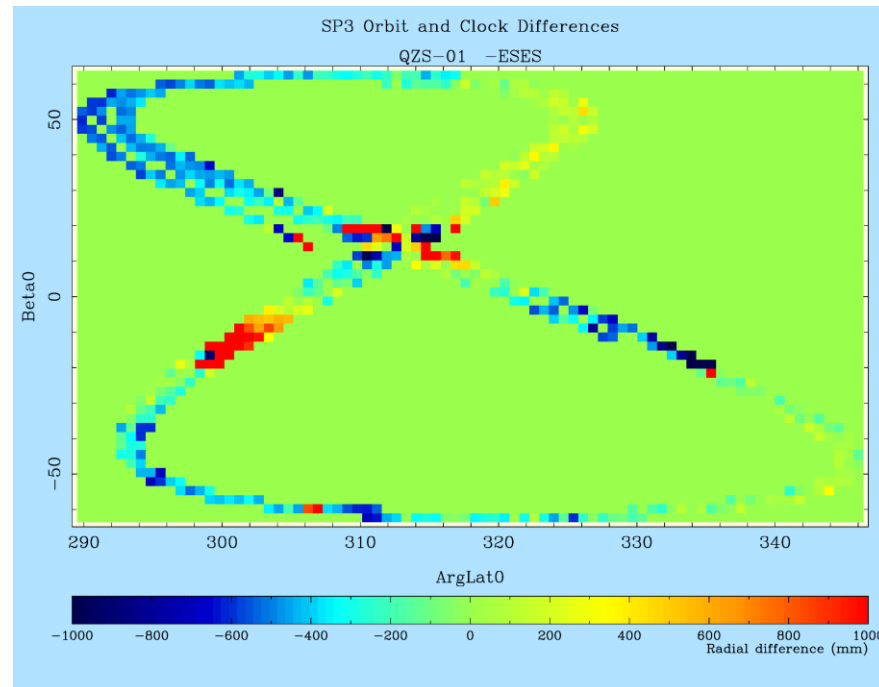
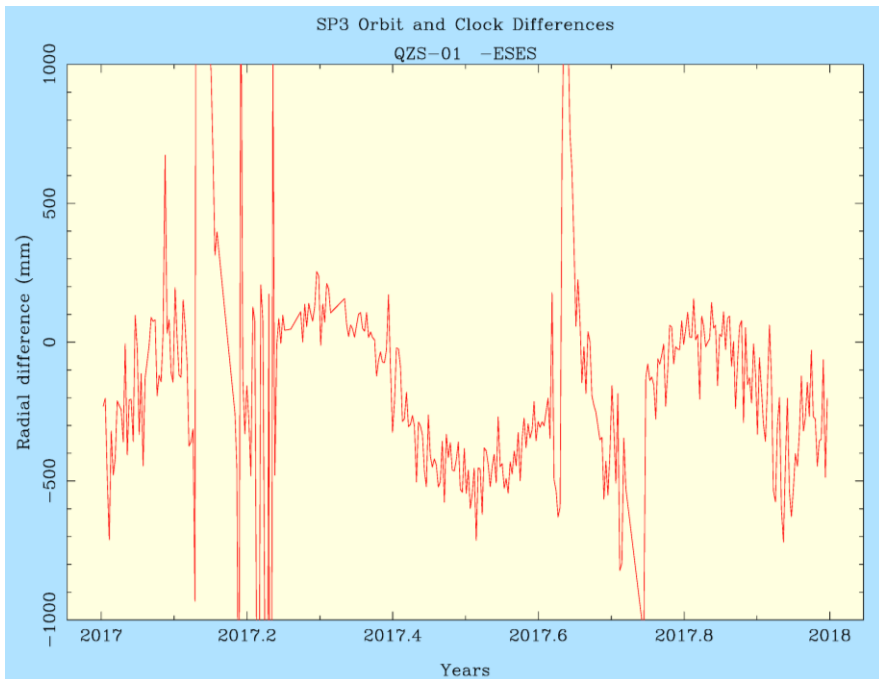


# QZSS – Cooperation with JAXA



- **Ongoing** bilateral project to improve QZSS products of JAXA and ESOC

## Day boundary differences of ESOC products



# Latest improvements

## Zero-Mean Reference Clock

- New logic to overcome clock datum defect:

### Old:

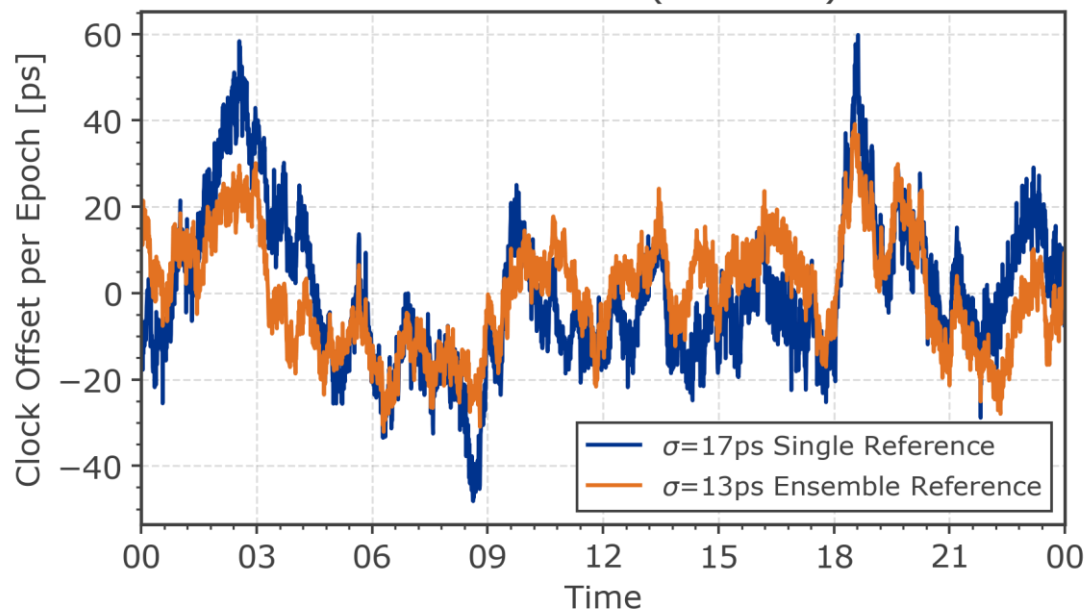
Fix **Station clock** with best linear fit as Reference clock

### New:

## Ensemble Clock

Zero-mean constraint on the stations with best linear fit to reduce systematics

ESOC MGNSS Finals 04.10.2018  
ESOC Station (H-Maser)



- Final products with 13 – 6 days delay

Products	Format	Ext.	Interval	Period
Ephemeris	SP3	.sp3	300 s	24 h
Clocks	CLK RINEX	.clk	30 s	24 h
Inter-System Bias	SINEX	.bias	24 h	24 h
Earth Rotation Parameter	ASCII	.erp	24 h	24 h
Summary file	ASCII	.sum		168 h

- Available at:
  - <http://navigation-office.esa.int>
  - (soon) GNSS Science Support Centre <https://gssc.esa.int>

# Application of MGNSS solution at ESOC

- Test environment and template for future projects
- Performance Monitoring for:
  - **ESA's GNSS Observation Network (EGON)**
  - UTC(ESA)
  - Reference solution for external projects
- Galileo Predictions for the ILRS
- IGS-IGMA Pilot Project (International GNSS Monitoring and Assessment)

