

# GPS-only or multi-GNSS?

R. Dach, T. Springer, A. Sibthorpe

based on contributions from the satellite geodesy research group at AIUB

*Chairs of the session on Orbit Modelling*

IGS AC Workshop  
15–17. April 2019, Potsdam, Germany

# Overview

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Why not?

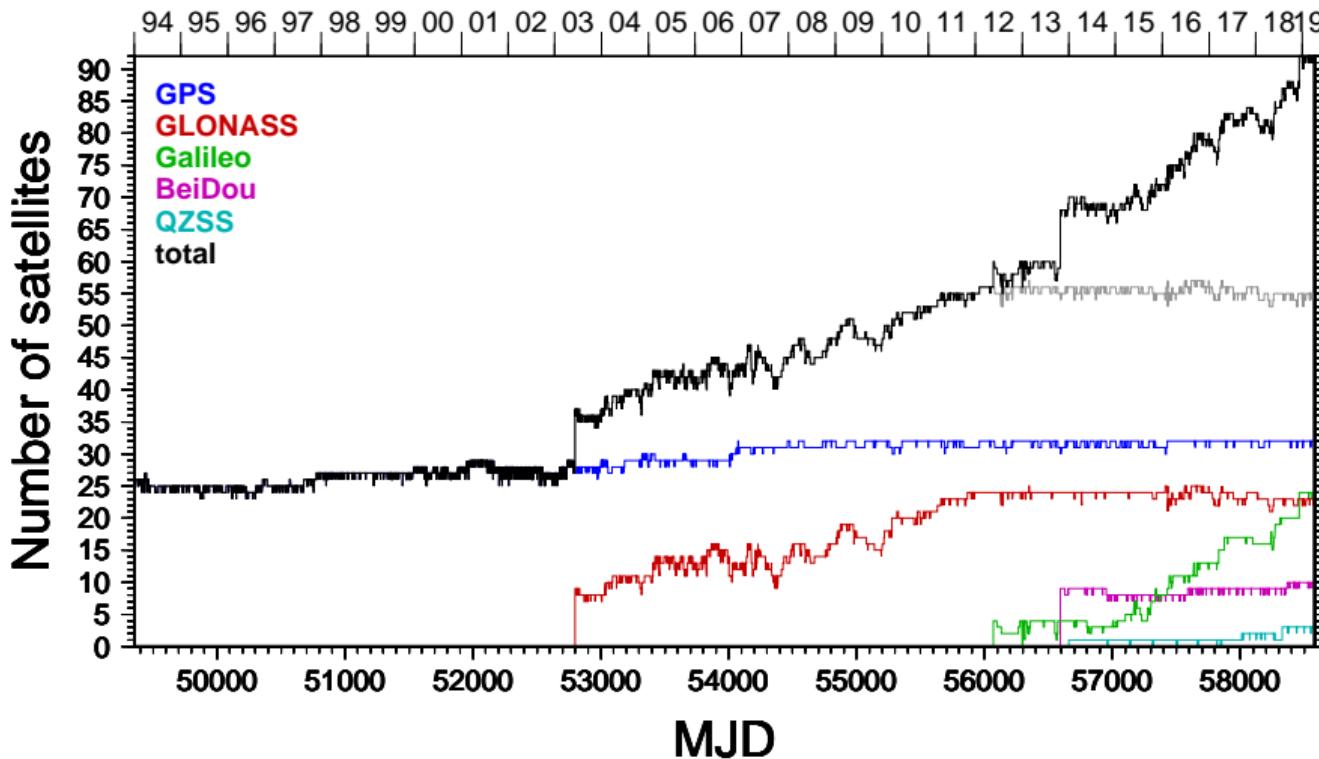
GNSS and their characteristics

Related papers

# IGS = International GNSS Service

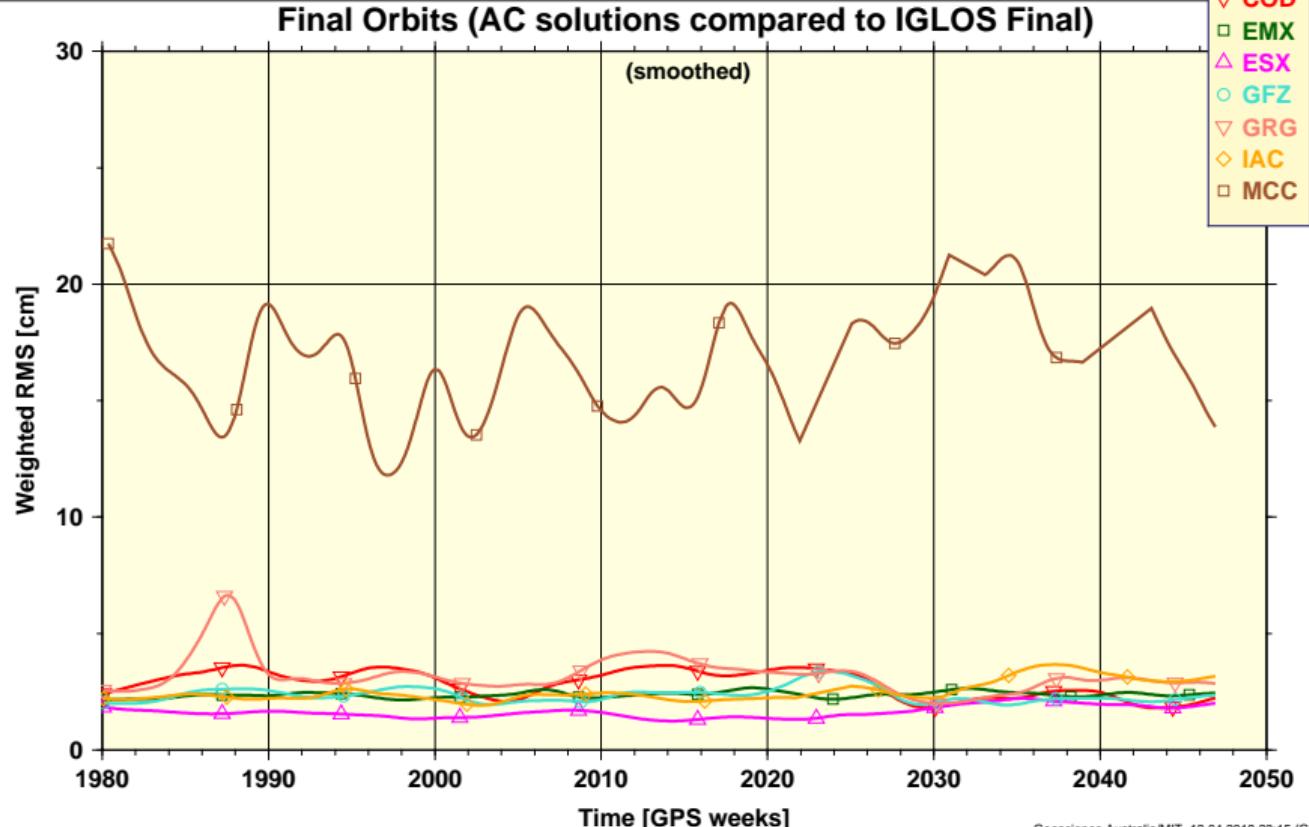
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# IGS = International GNSS Service



Number of satellites provided by CODE in its final/MGEX orbit

# GLONASS solutions are available



# Galileo solutions are available

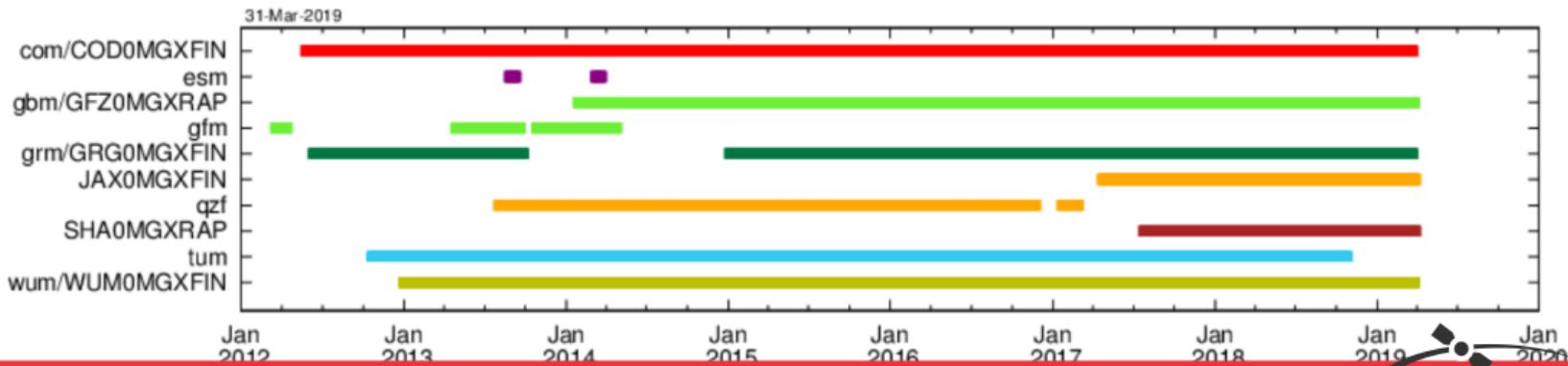
## MGEX Product Analysis



This website is updated on a weekly basis, last update: 2019-MAR-31 21:57:01

AC ID	AC full name	Latest file
COD	Center for Orbit Determination in Europe (CODE)	COD0MGXFIN_20190820000_01D_05M_ORB.SP3
GFZ	Deutsches GeoForschungsZentrum Potsdam (GFZ)	GFZ0MGXRAP_20190860000_01D_05M_ORB.SP3
GRG	CNES/CLS	GRG0MGXFIN_20190820000_01D_15M_ORB.SP3
JAX	Japan Aerospace Exploration Agency (JAXA)	JAX0MGXFIN_20190880000_01D_05M_ORB.SP3
SHA	Shanghai Observatory (SHAO)	SHA0MGXRAP_20190880000_01D_15M_ORB.SP3
tum	Technische Universität München (TUM)	tum20245.sp3
WUM	Wuhan University	WUM0MGXFIN_20190860000_01D_15M_ORB.SP3

## Product availability



# ACs that are including more than just GPS:

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GLONASS:

final: CODE, NRCan, ESA, GFZ, GRGS

last repro: CODE, ESA, GRGS

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---

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last repro: CODE, ESA, GRGS

Galileo:

currently in MGEX: CODE, GFZ, GRGS, Wuhan

outside MGEX: ESA?

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---

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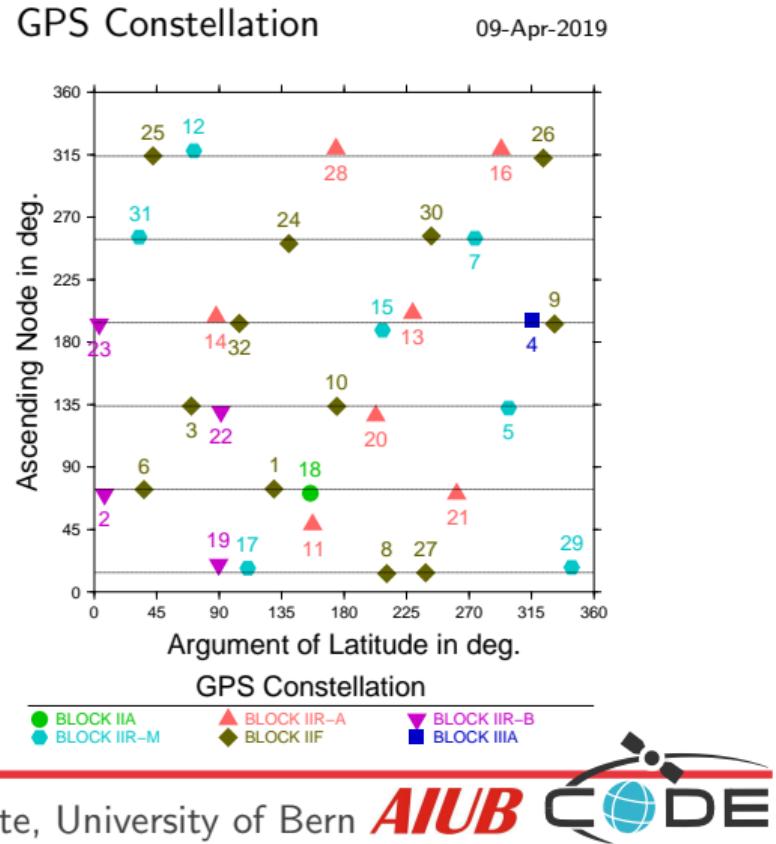
Galileo:

currently in MGEX: CODE, GFZ, GRGS, Wuhan  
outside MGEX: ESA?

I assume that none of the ACs want to do less than in the previous repro.

## GPS Constellation

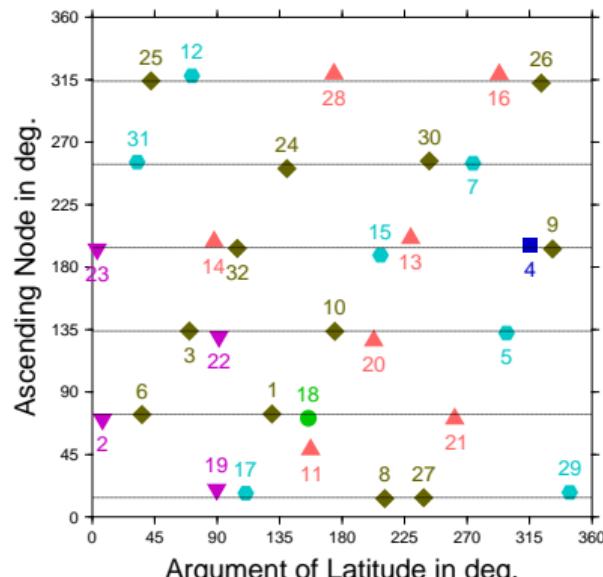
- Revolution period  $11^{\text{h}} 58^{\text{m}}$   
(same constellation after 2 revolutions within 1 sidereal day)
  - Repetition rates:  
same geometry: 1 sidereal day  
same constellation: 1 sidereal day



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- Repetition rates:  
same geometry: 1 sidereal day  
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- Signals:  
Code: C1,  
P1, P2,  
Phase: L1, L2

GPS Constellation 09-Apr-2019



GPS Constellation

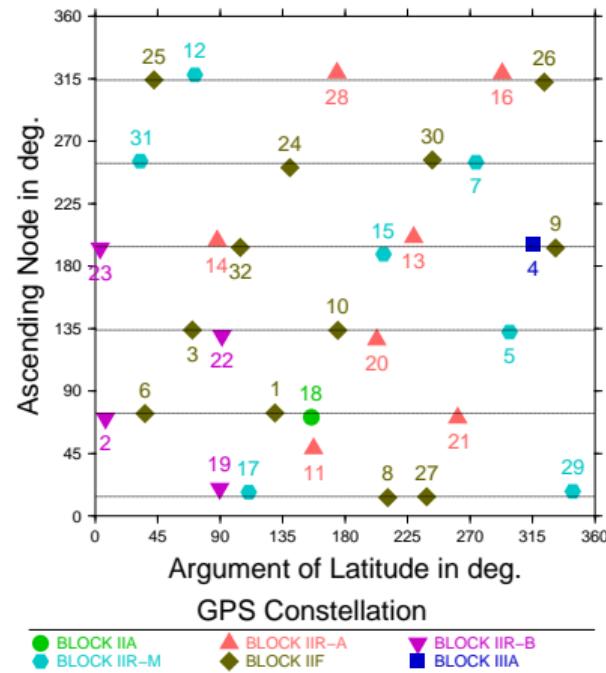
● BLOCK IIA    ▲ BLOCK IIR-A    ▼ BLOCK IIR-B  
● BLOCK IIR-M    ◆ BLOCK IIF    ■ BLOCK IIIA



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(same constellation after 2 revolutions within 1 sidereal day)
- Repetition rates:  
same geometry: 1 sidereal day  
same constellation: 1 sidereal day
- Signals:  
Code: C1, C2 (since IIR-M),  
P1, P2,  
Phase: L1, L2 (L2C!!)

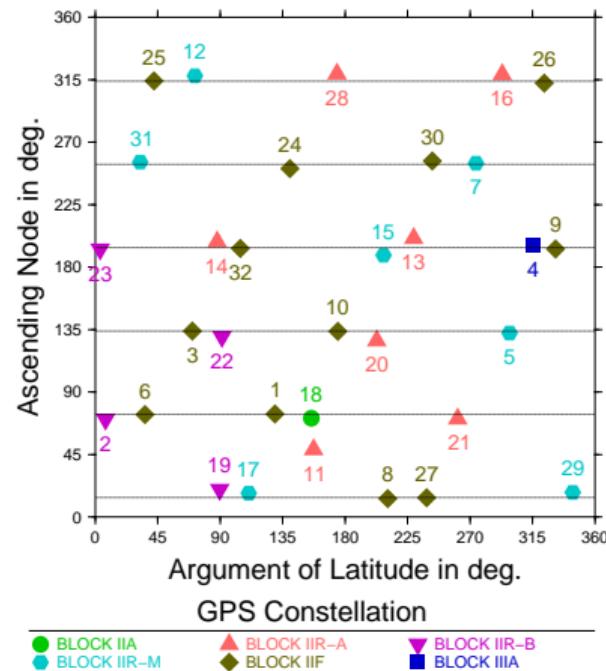
GPS Constellation 09-Apr-2019



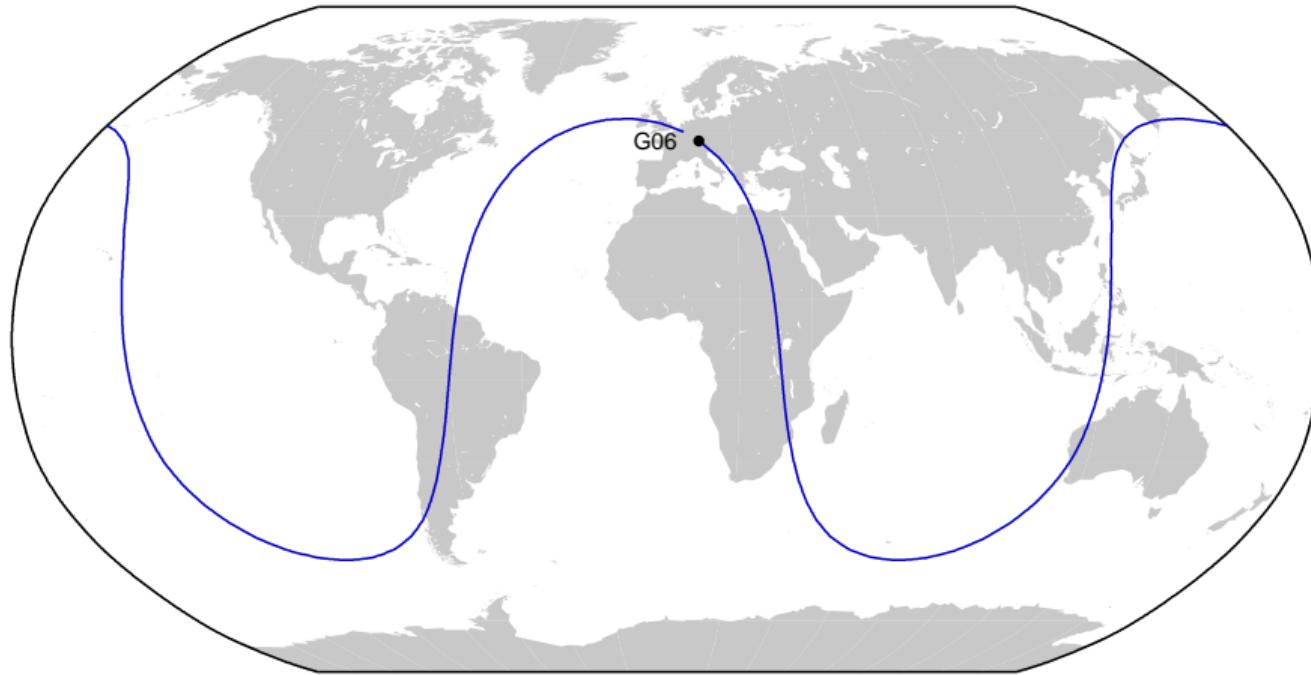
# GPS Constellation

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same geometry: 1 sidereal day  
same constellation: 1 sidereal day
- Signals:  
Code: C1, C2 (since IIR-M),  
P1, P2, C5 (since IIF)  
Phase: L1, L2 (L2C!!), L5

GPS Constellation 09-Apr-2019

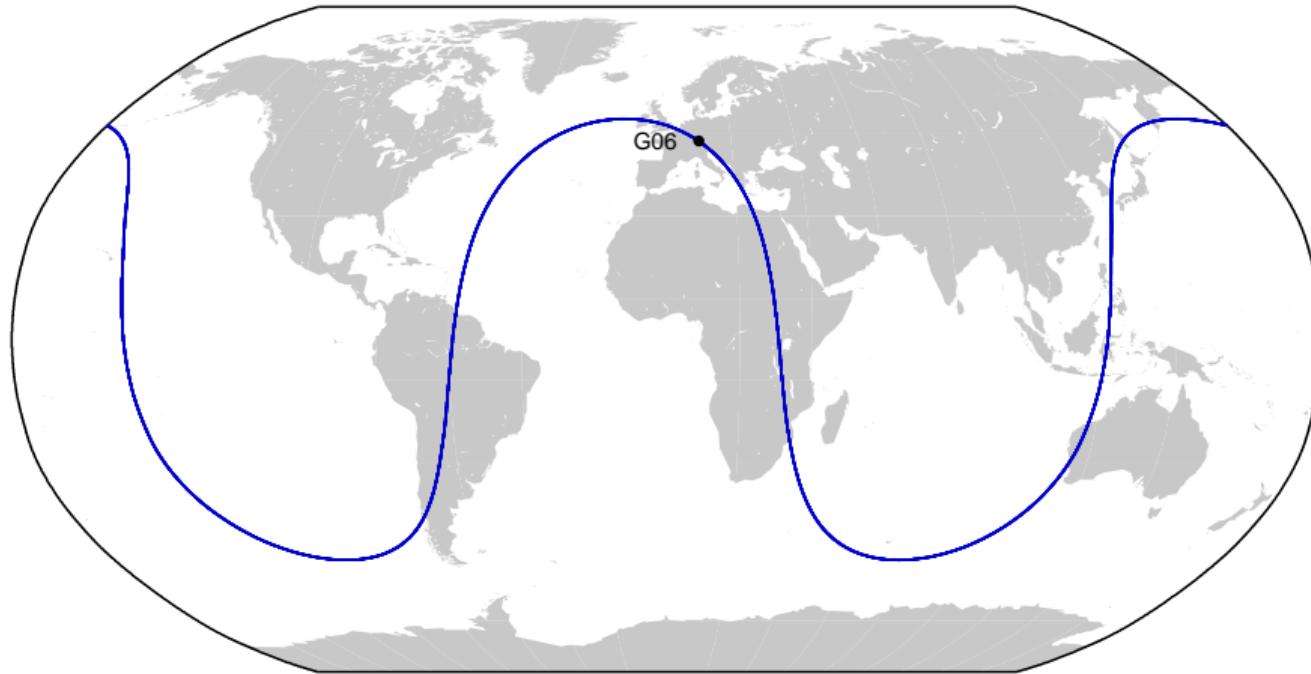


# GPS Constellation



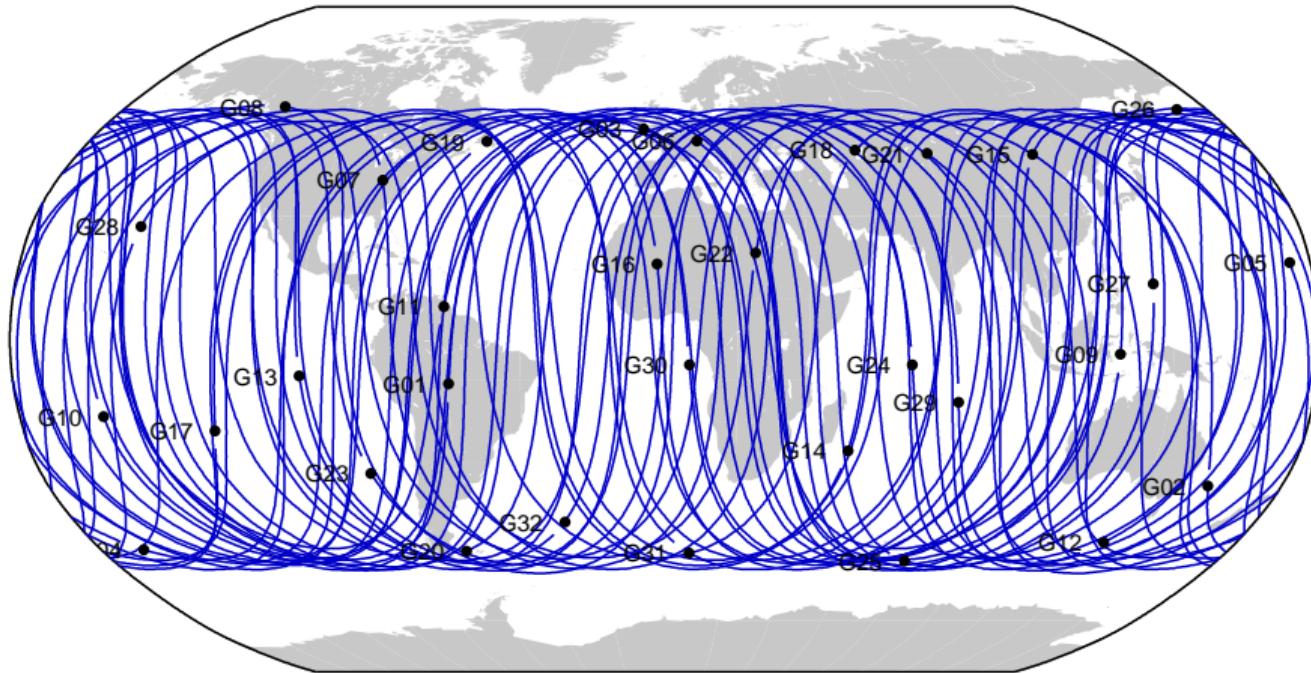
G06 for 1 day (09-May-2012)

# GPS Constellation



G06 for 10 days (from 09-May-2012 to 18-May-2012)

# GPS Constellation

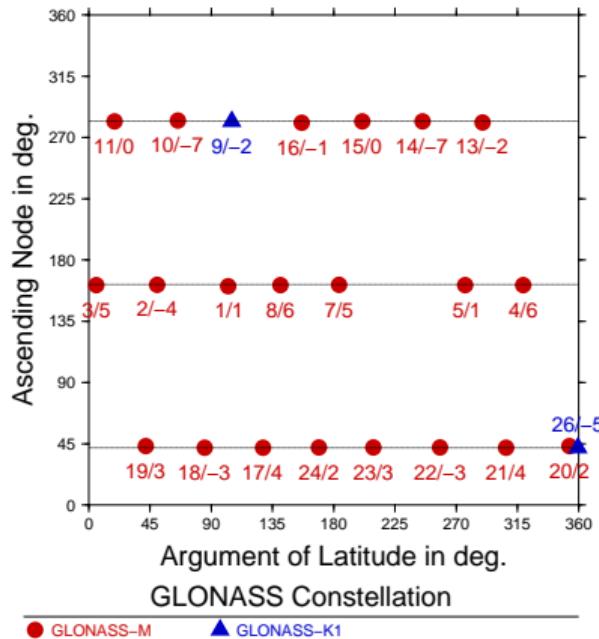


All GPS-satellites for 1 day (09-May-2012)

# GLONASS Constellation

- Revolution period  $11^{\text{h}} 16^{\text{m}}$   
(same constellation after 17 revolutions within 8 sidereal days)
- Repetition rates:
  - same geometry:
    - same plane: 1 sidereal day
    - next plane:  $\frac{1}{3}$  sidereal day
  - same constellation: 8 sidereal days

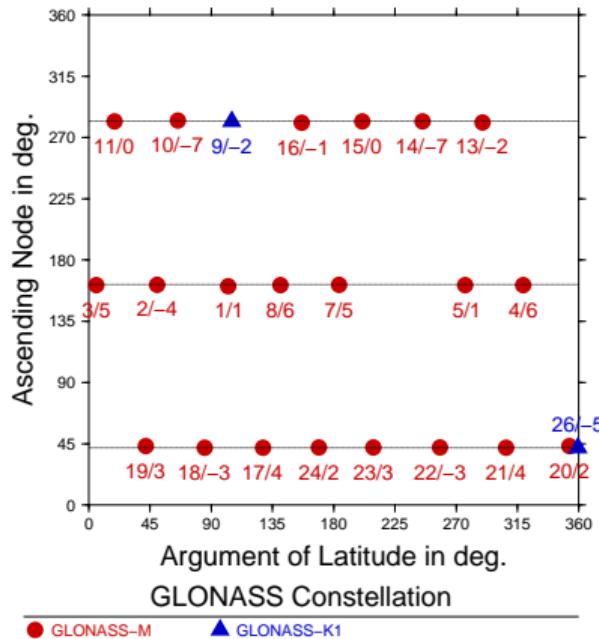
GLONASS Constellation 09-Apr-2019



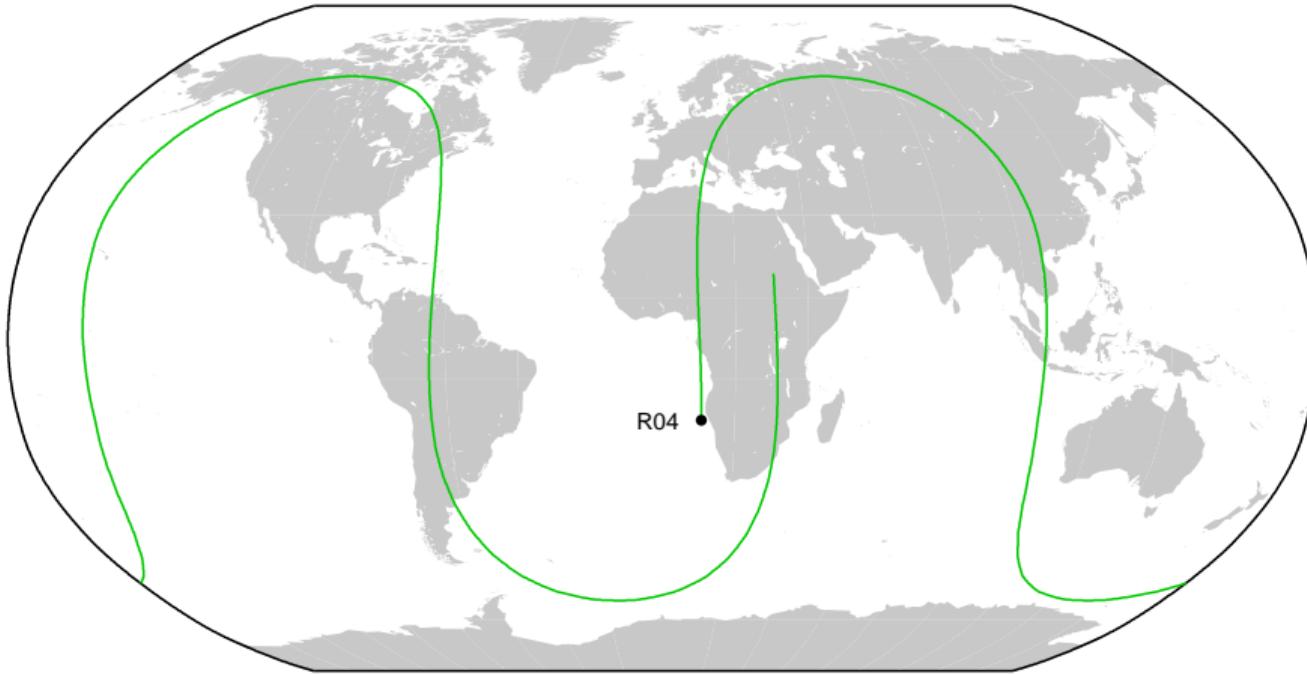
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GLONASS Constellation 09-Apr-2019

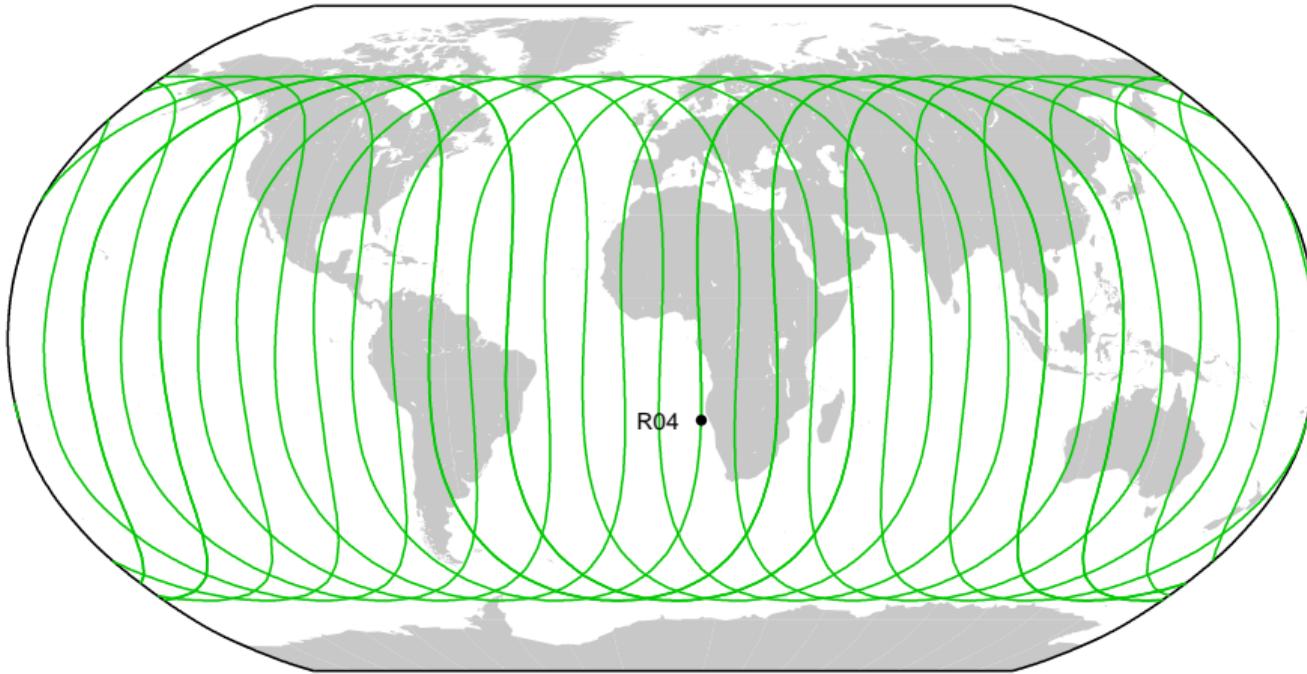


# GLONASS Constellation



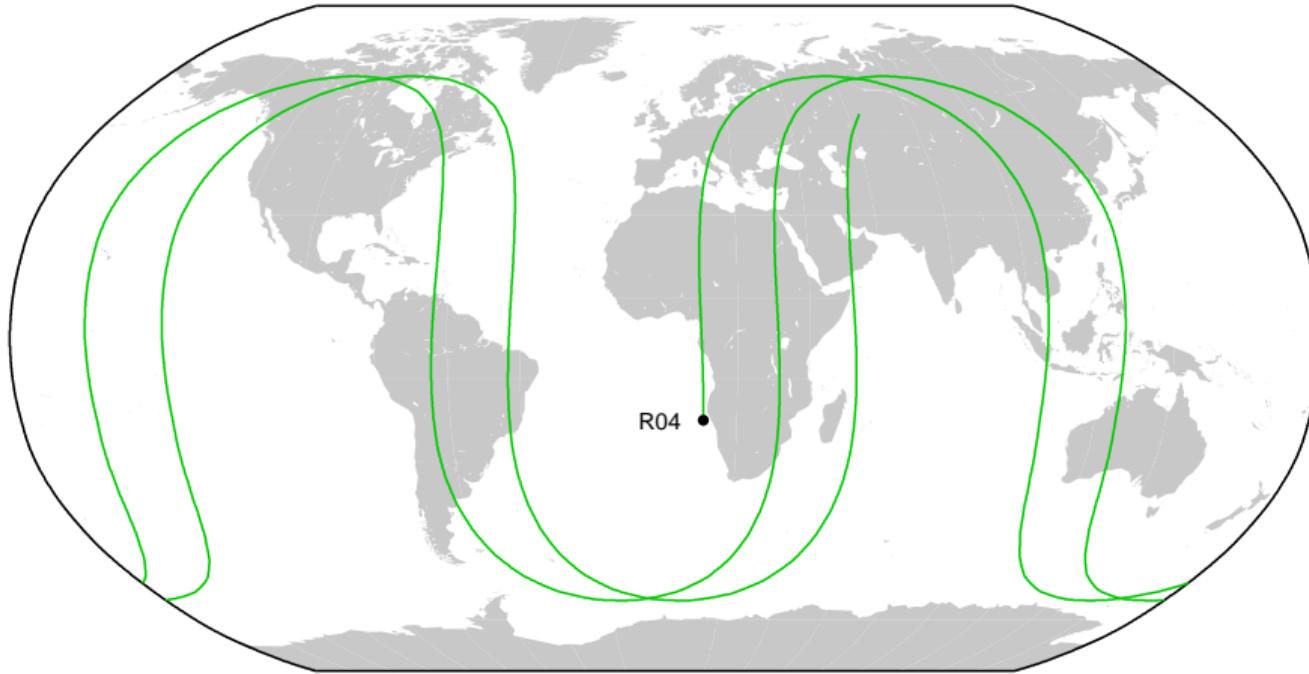
R04 for 1 day (09-May-2012)

# GLONASS Constellation



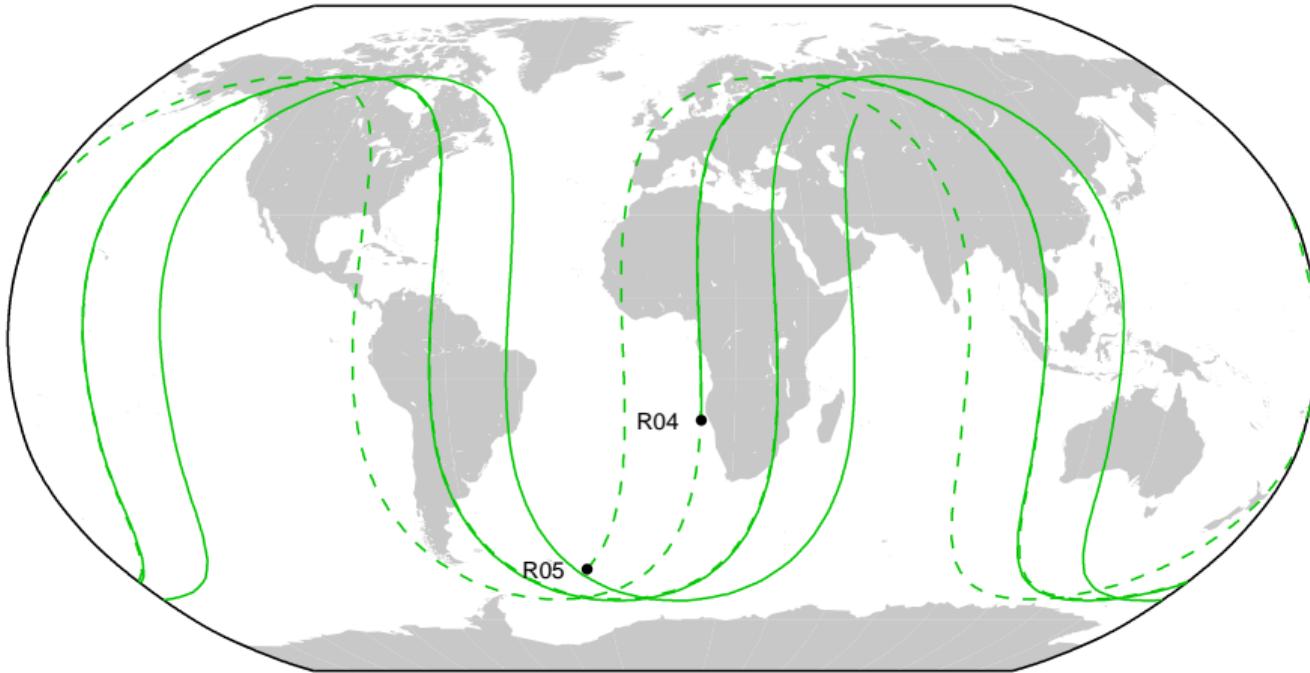
R04 for 10 days (from 09-May-2012 to 18-May-2012)

# GLONASS Constellation



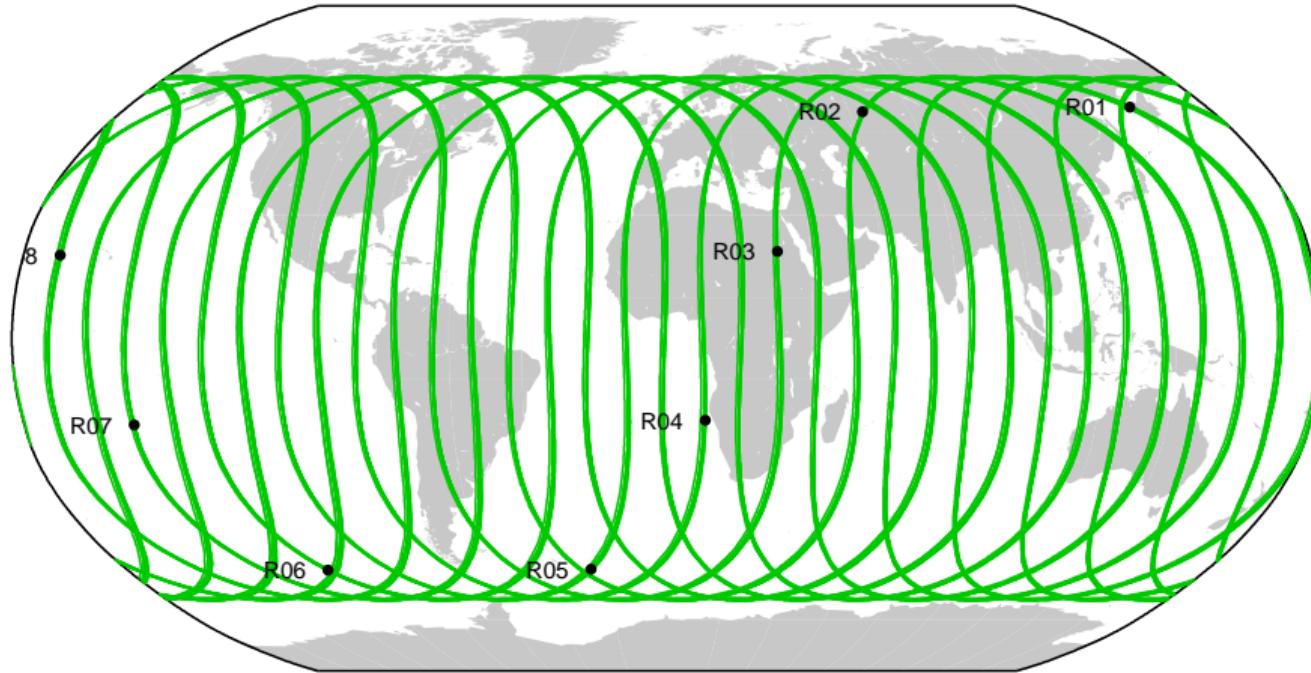
R04 for 2 days (from 09-May-2012 to 10-May-2012)

# GLONASS Constellation



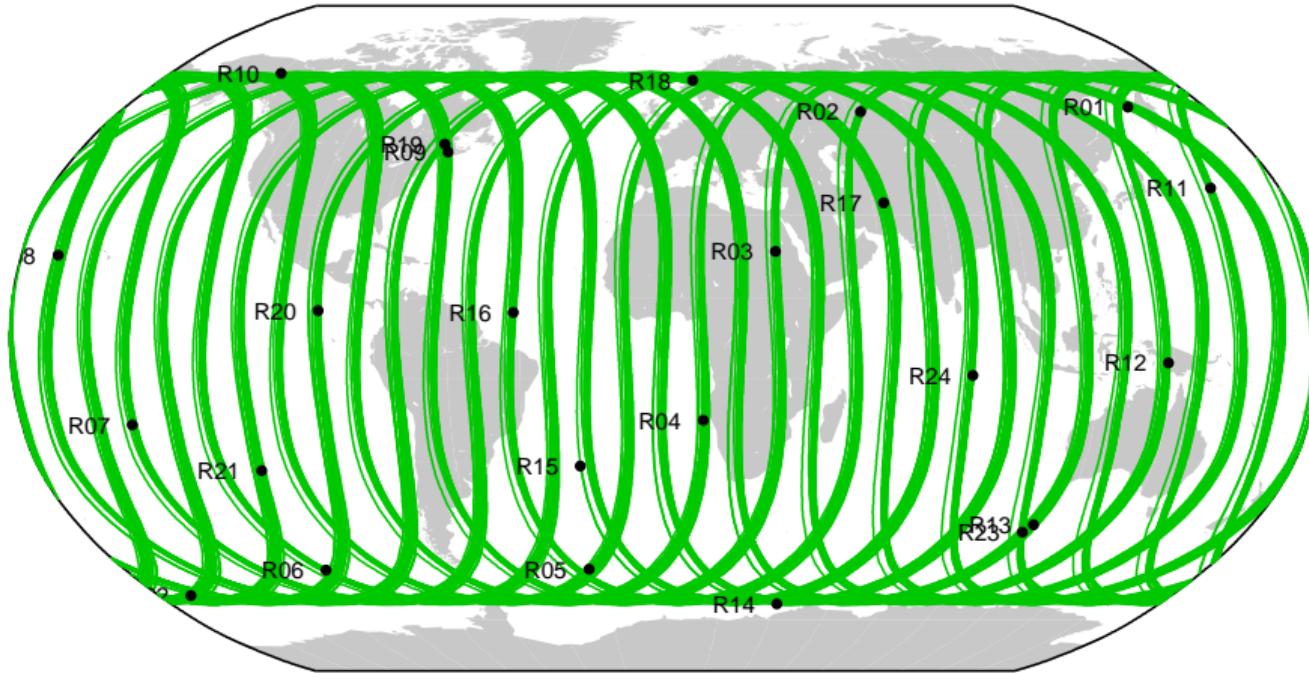
R04 and R05 for 2 days (from 09-May-2012 to 10-May-2012)

# GLONASS Constellation



R01 to R08 for 10 days (from 09-May-2012 to 18-May-2012)

# GLONASS Constellation

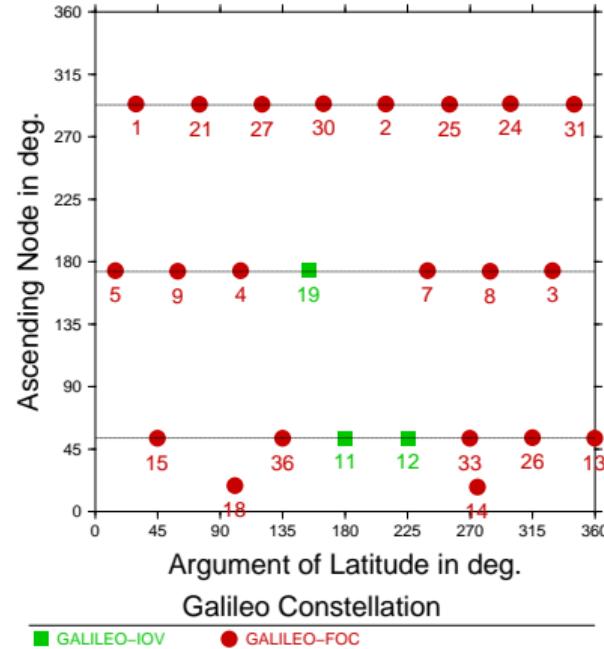


All GLONASS satellites for 10 days (from 09-May-2012 to 18-May-2012)

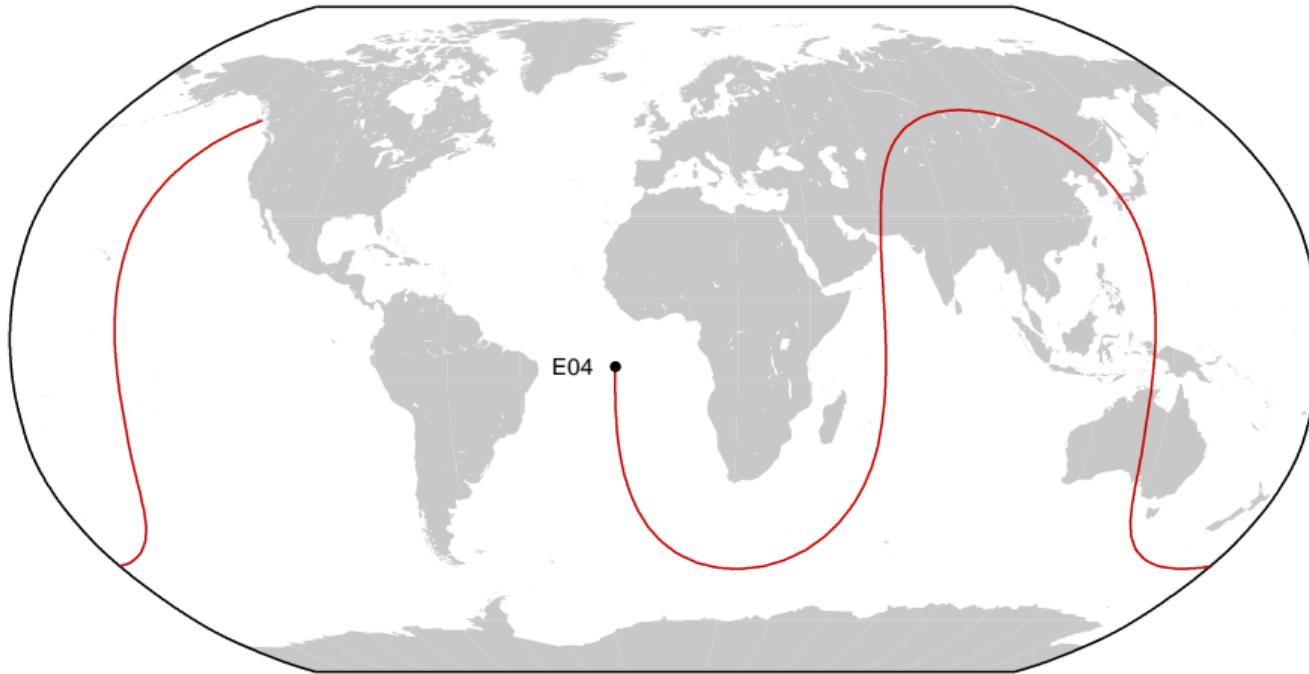
# Galileo Constellation

- Revolution period  $13^{\text{h}}\ 45^{\text{m}}$   
(same constellation after 17 revolutions within 10 sidereal days)
- Repetition rates:  
same geometry/constellation:  
10 sidereal days

Galileo Constellation 19-Apr-2019

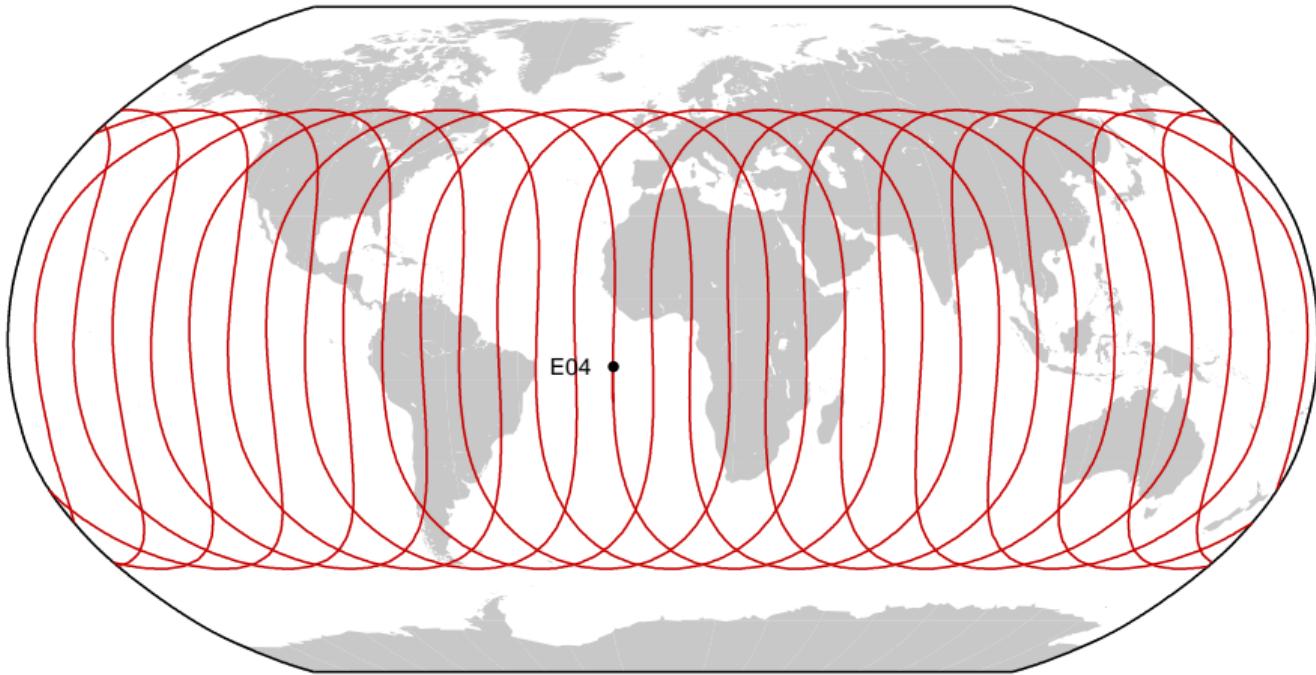


# Galileo Constellation



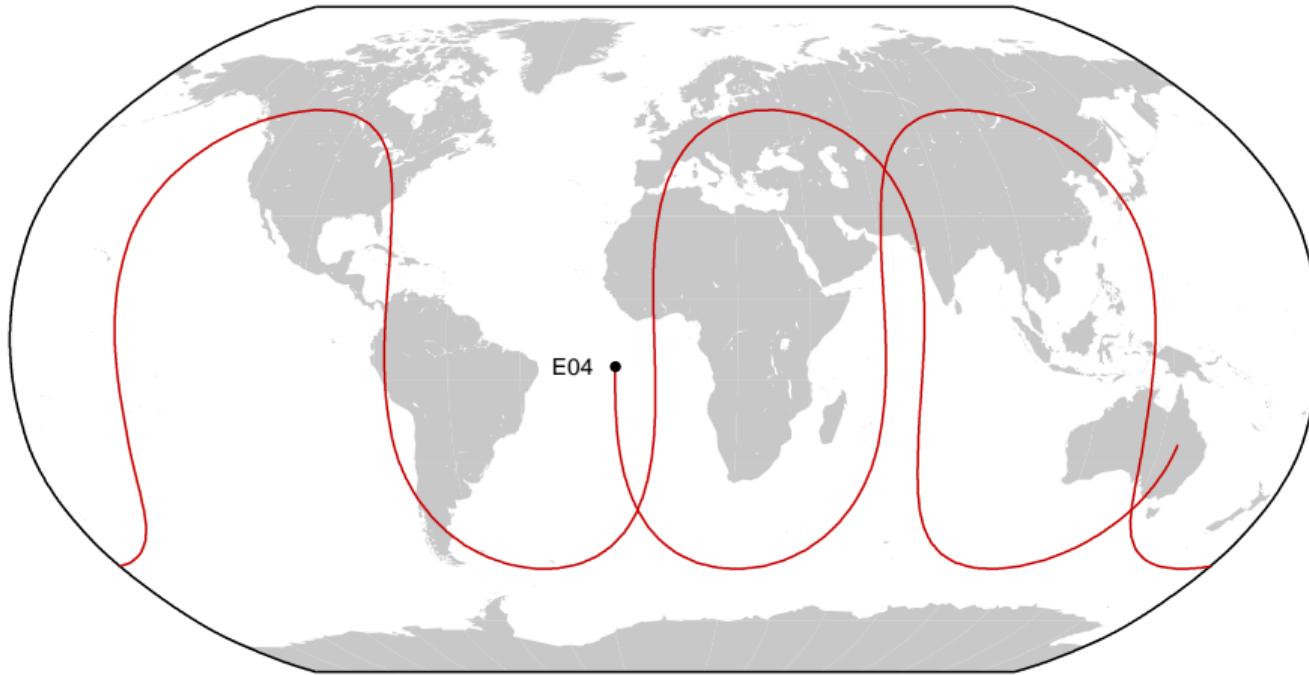
Fictive E04 for one day

# Galileo Constellation



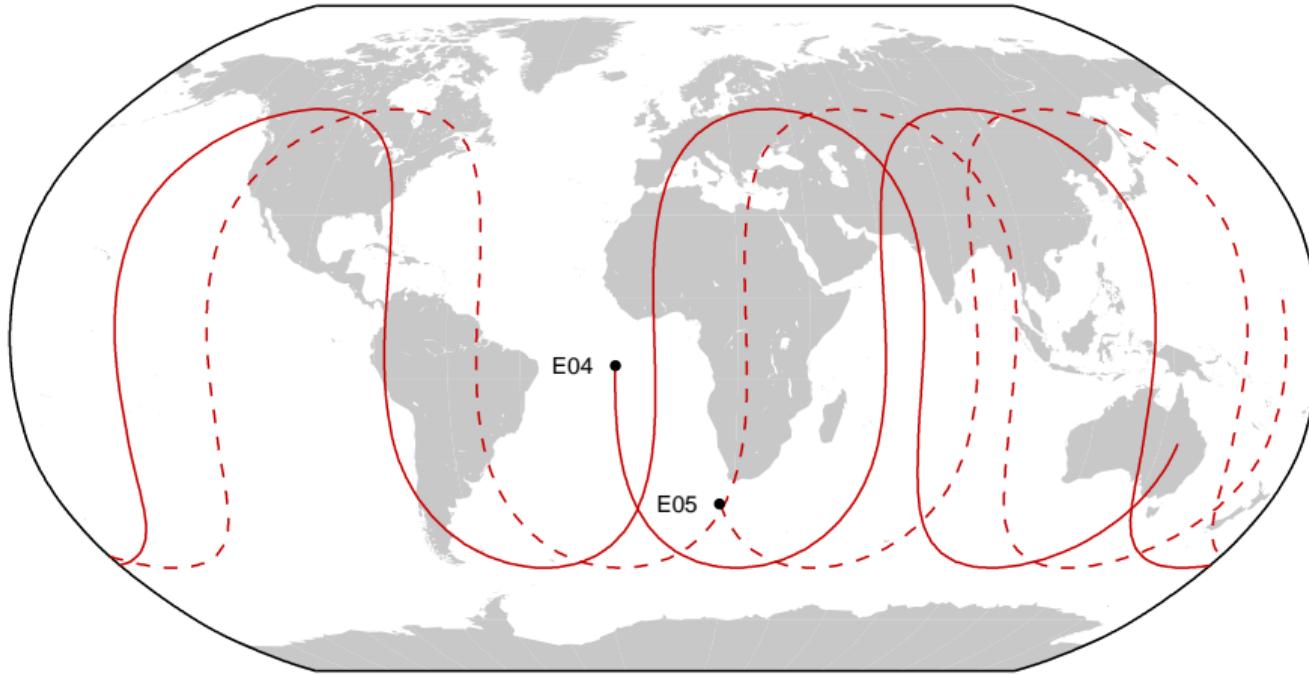
Fictive E04 for 10 days

# Galileo Constellation



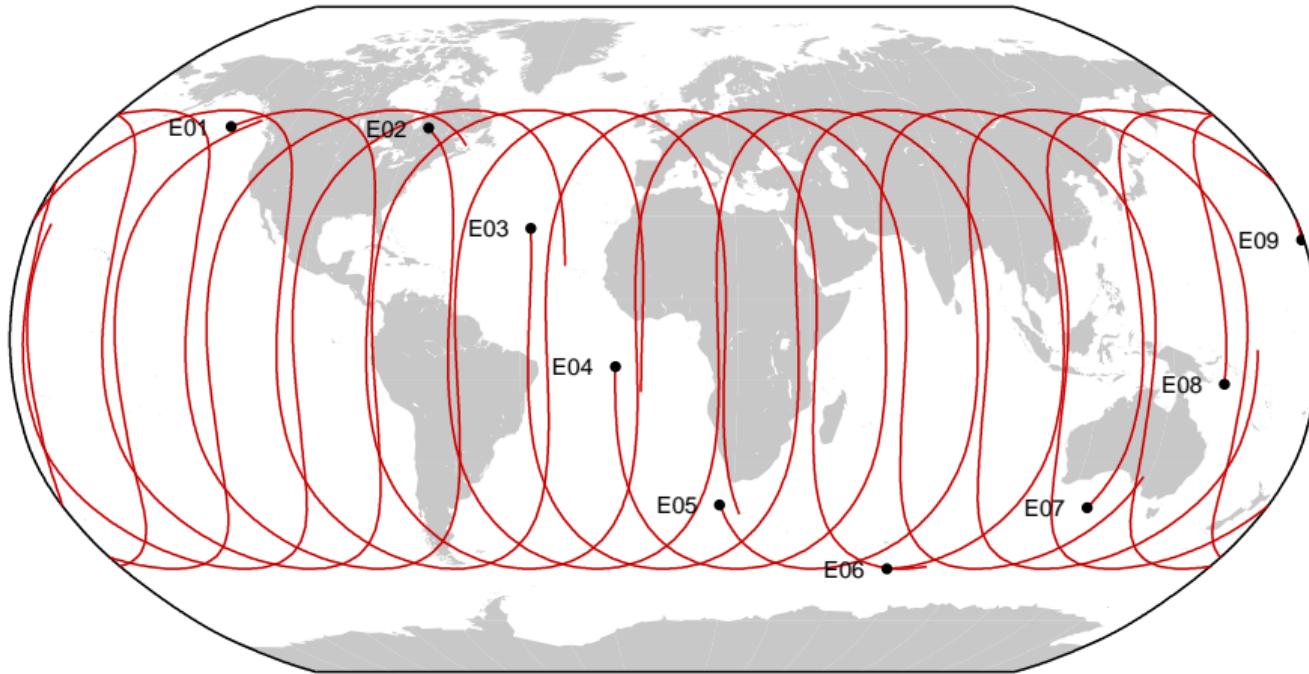
Fictive E04 for two days

# Galileo Constellation



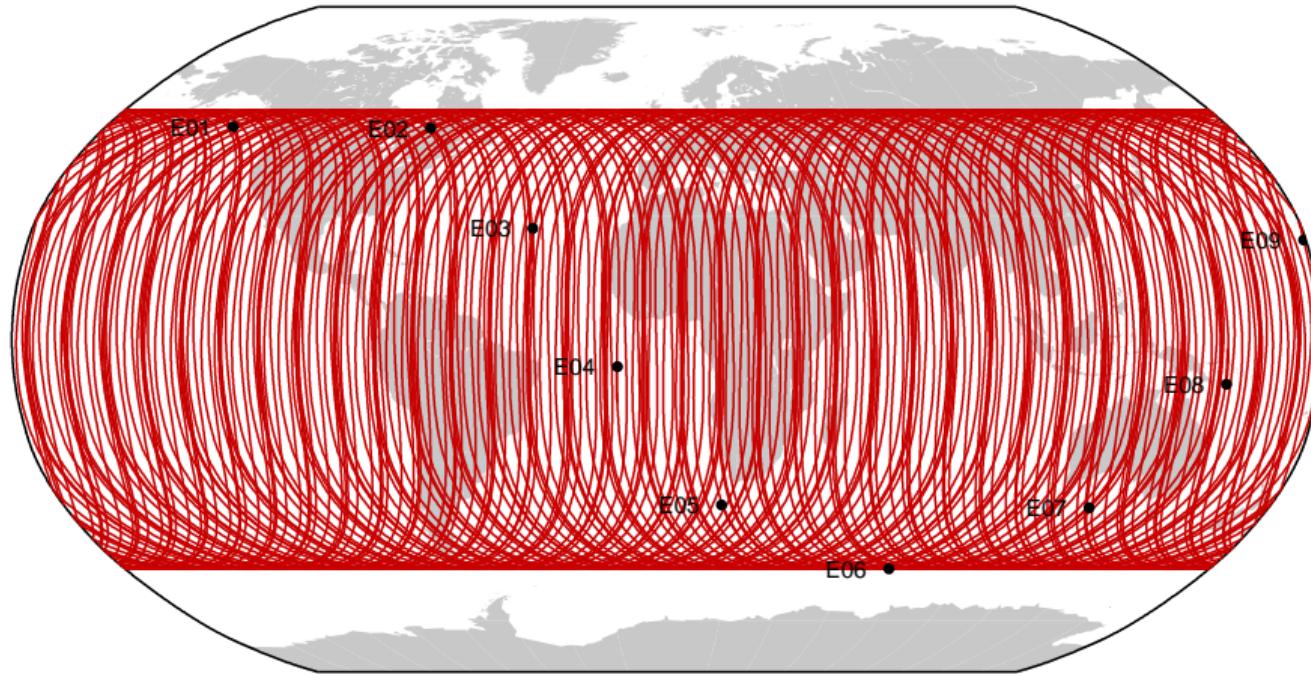
Fictive E04 and E05 for two days

# Galileo Constellation



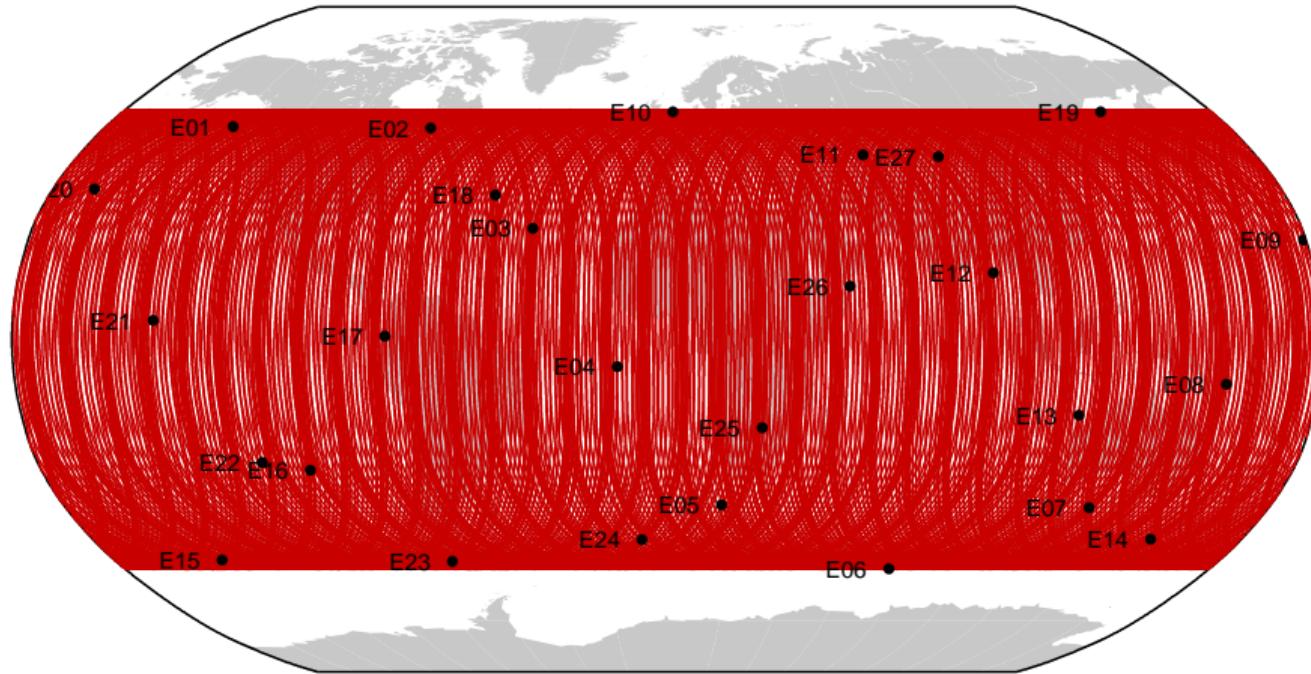
Fictive E01 to E09 for two days

# Galileo Constellation



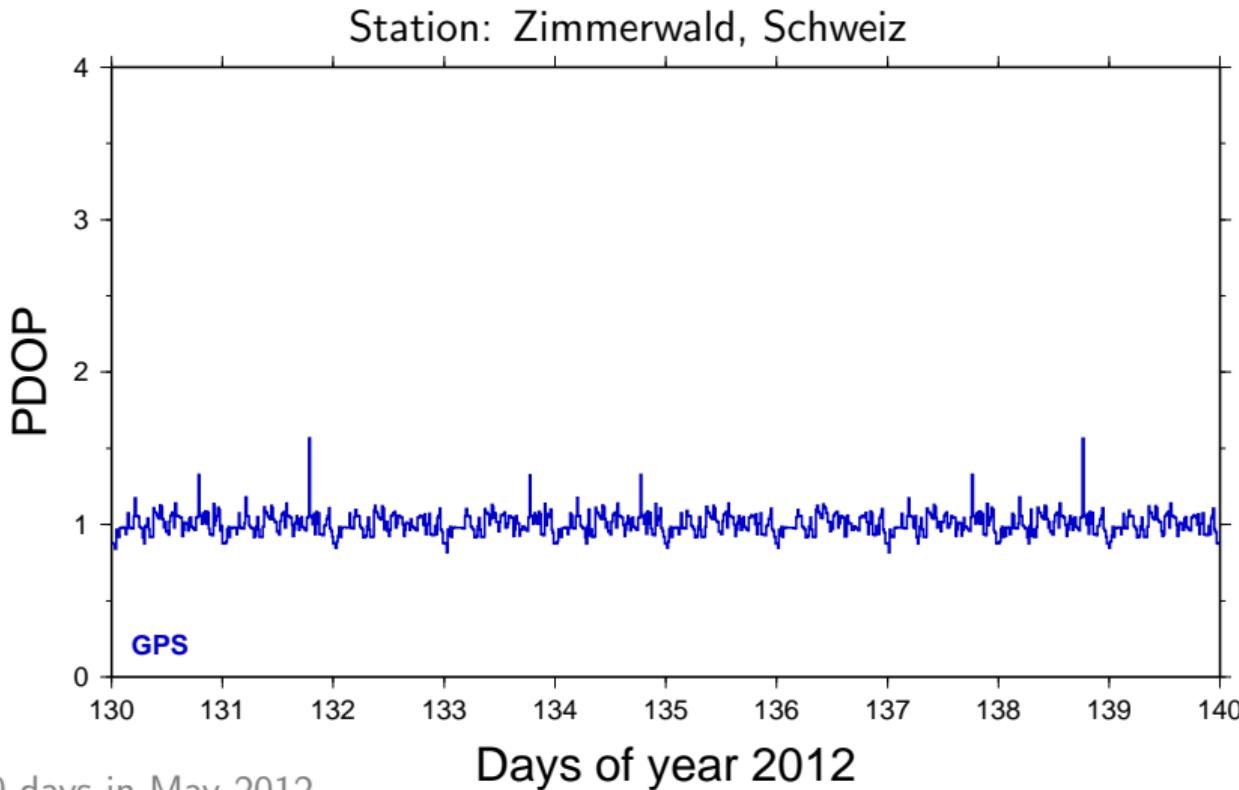
Fictive E01 to E09 for 10 days

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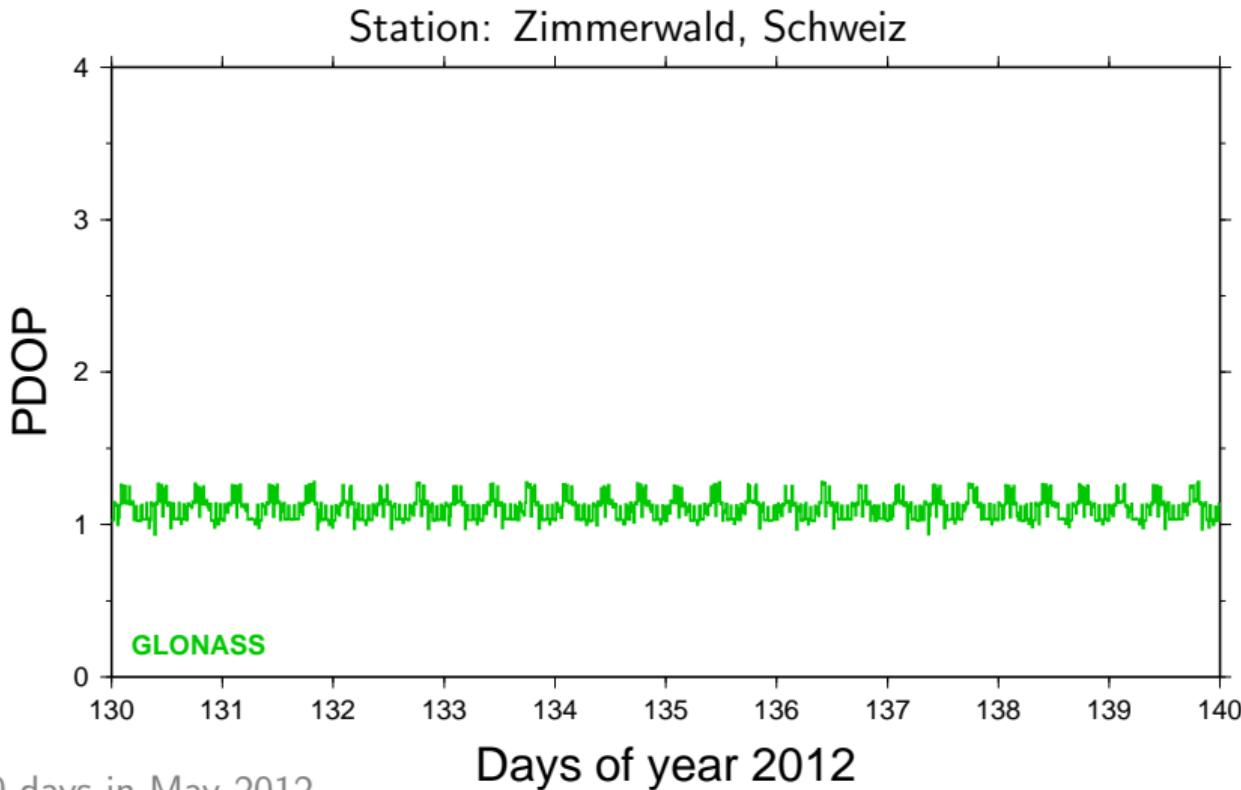


Fictive Galileo constellation for 10 days

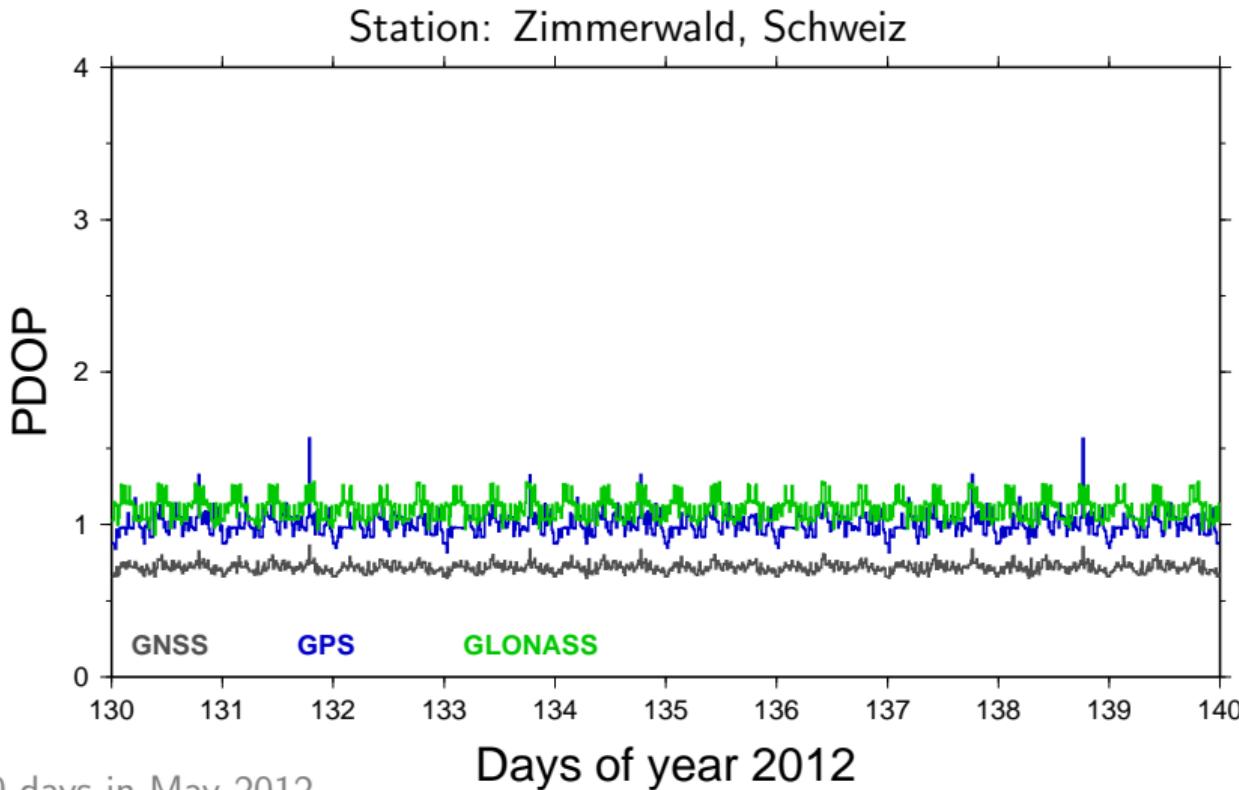
# Compare PDOP-Characteristics of the GNSS



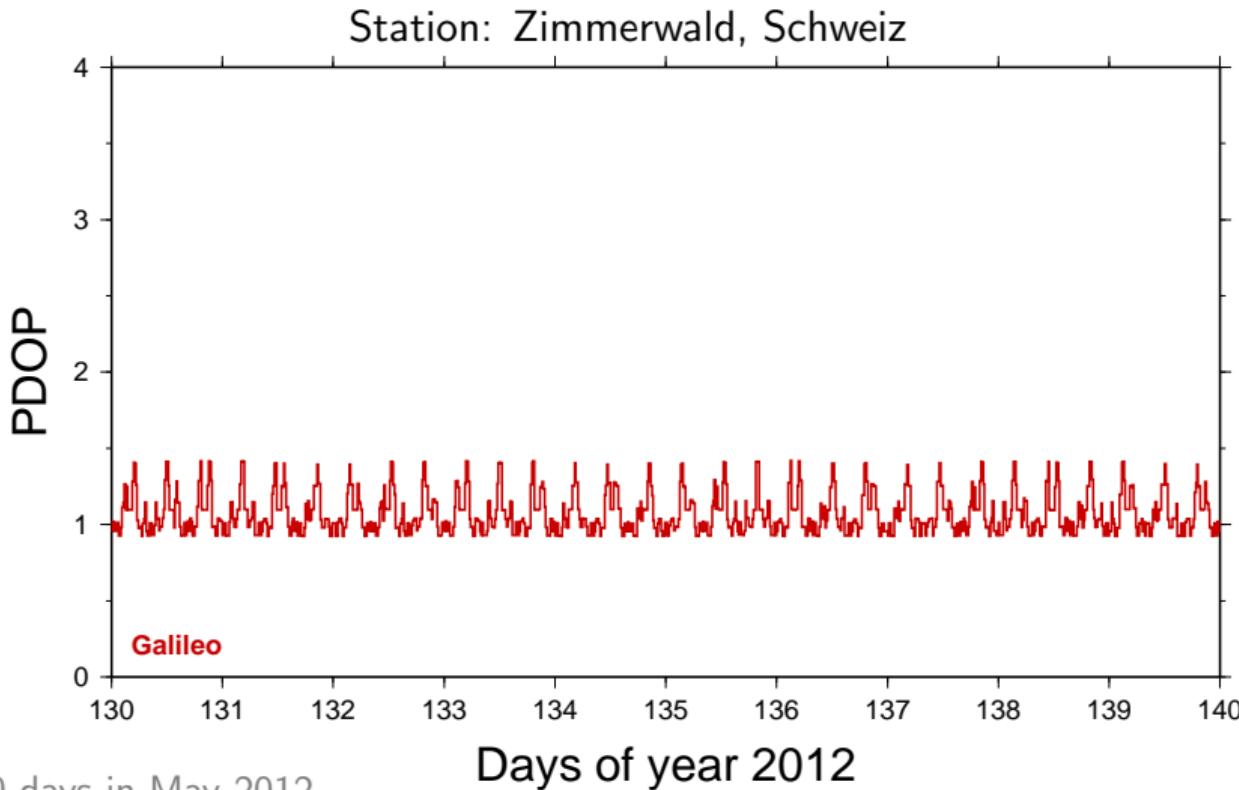
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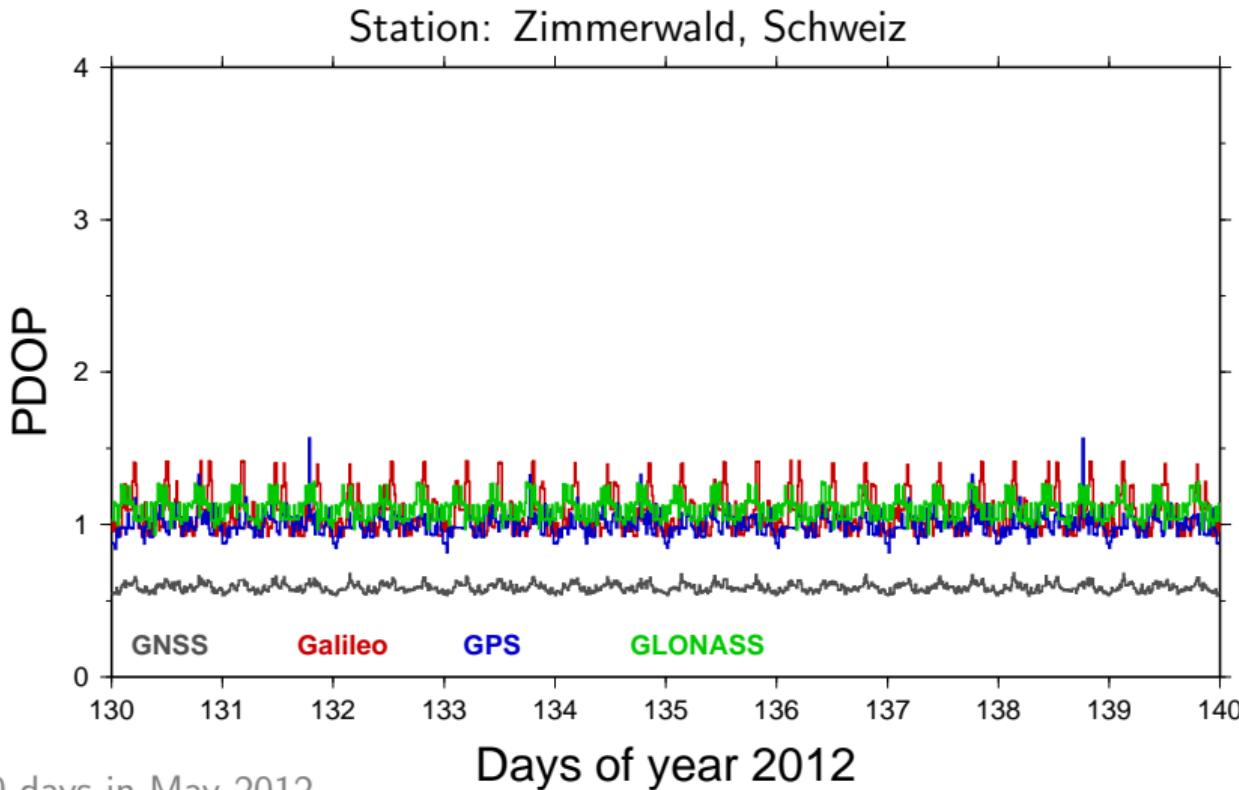
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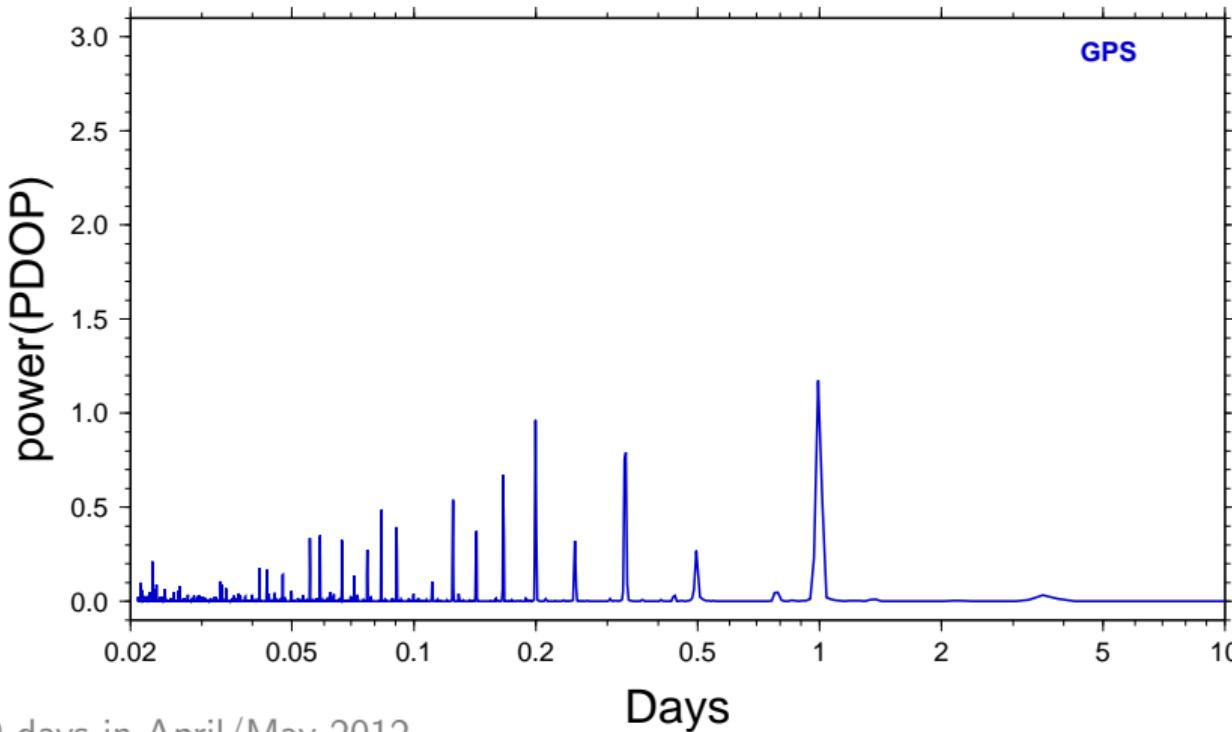


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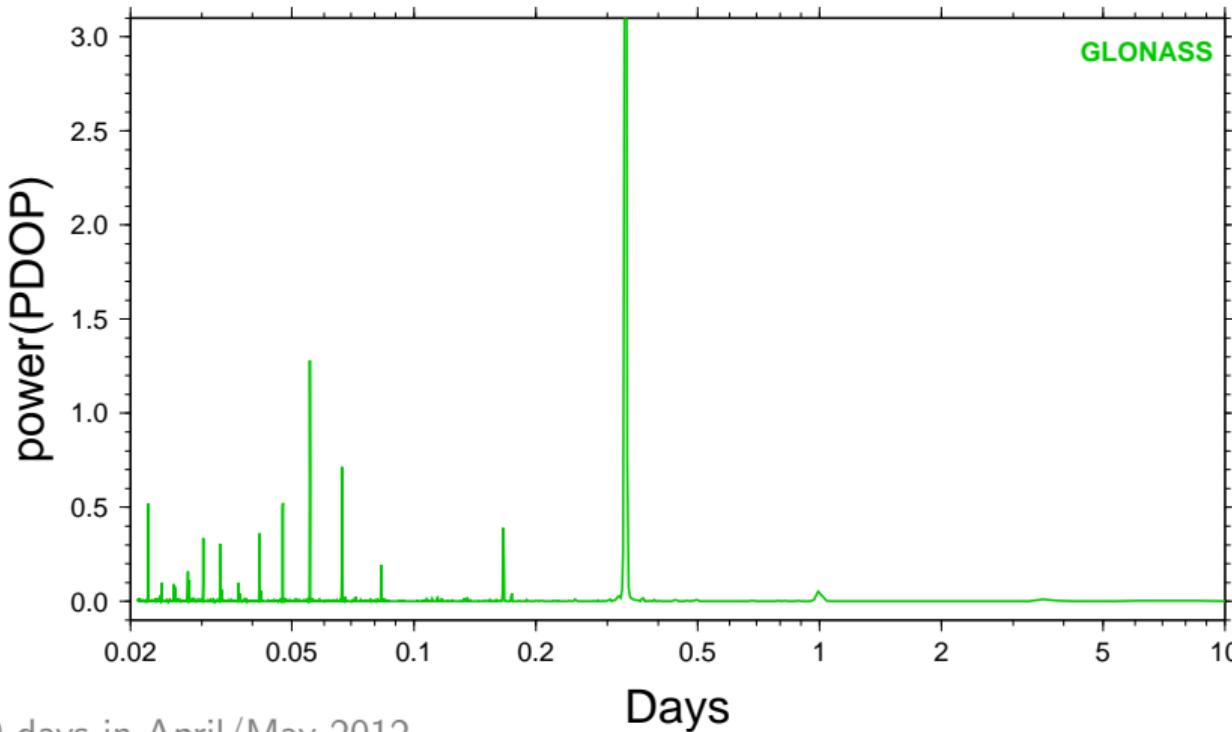
Station: Zimmerwald, Schweiz



based on 60 days in April/May 2012

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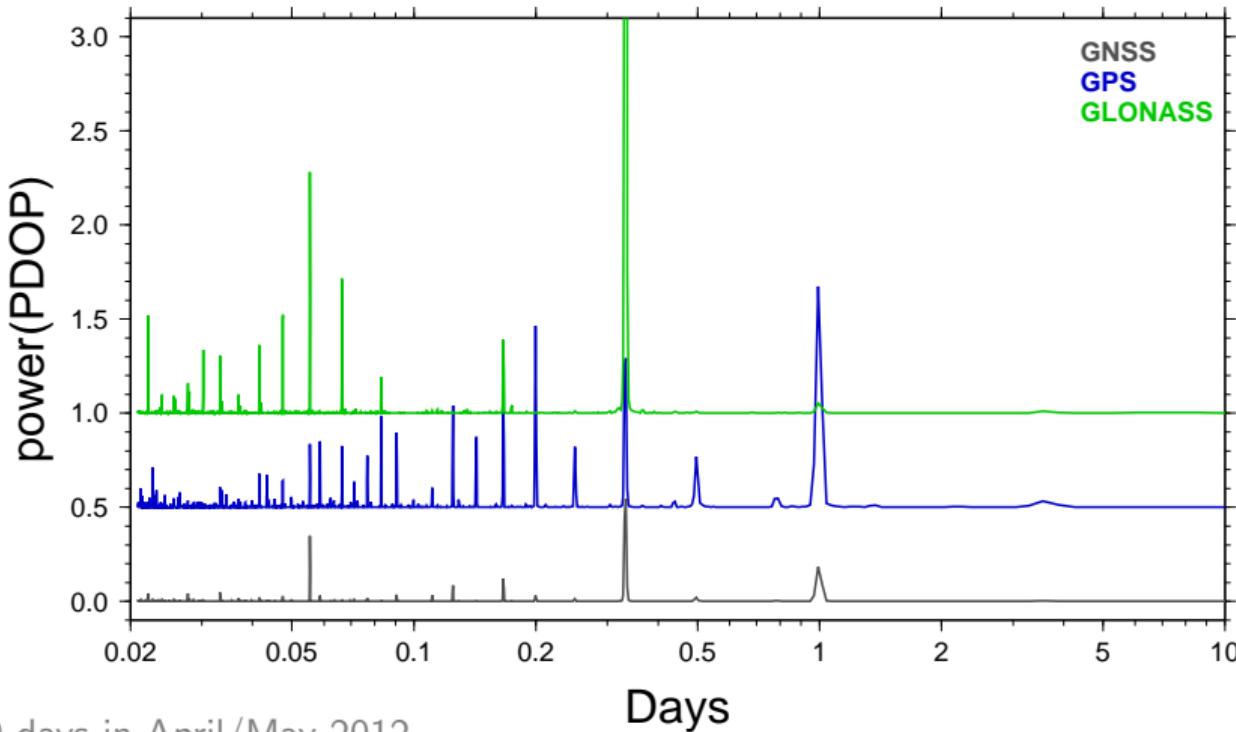
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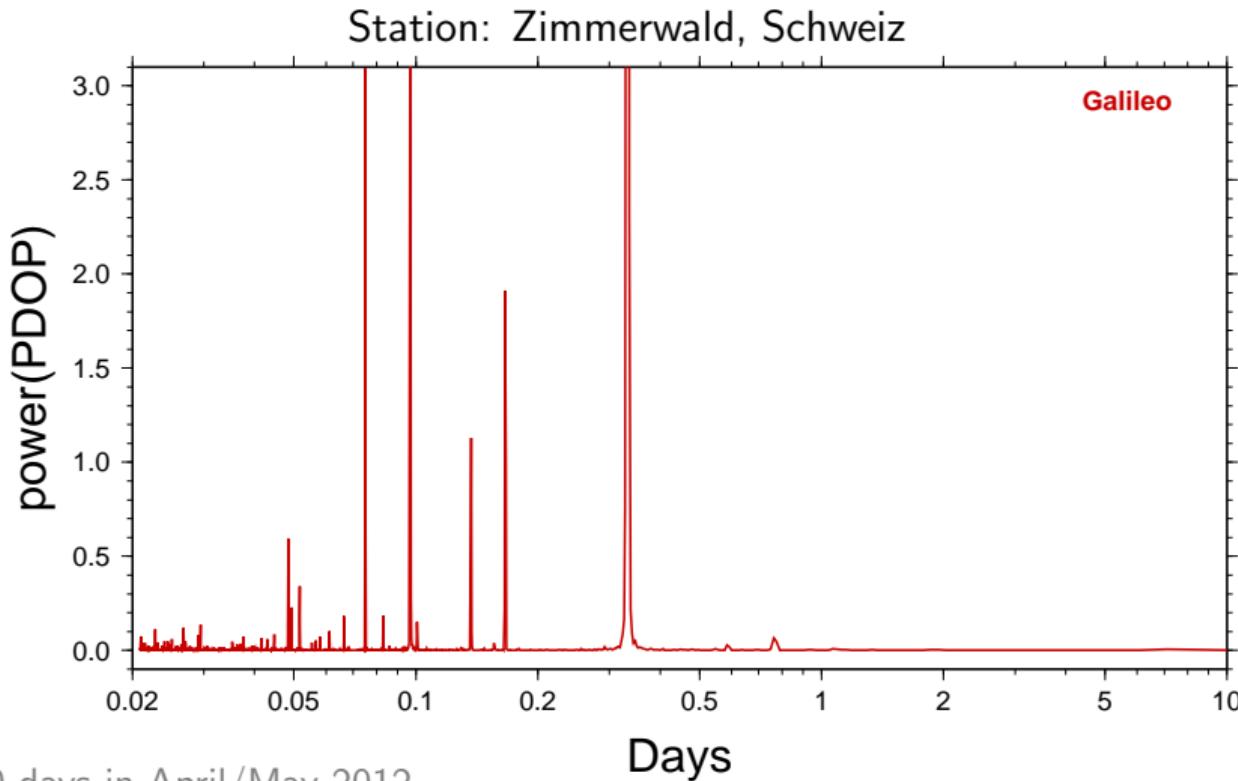
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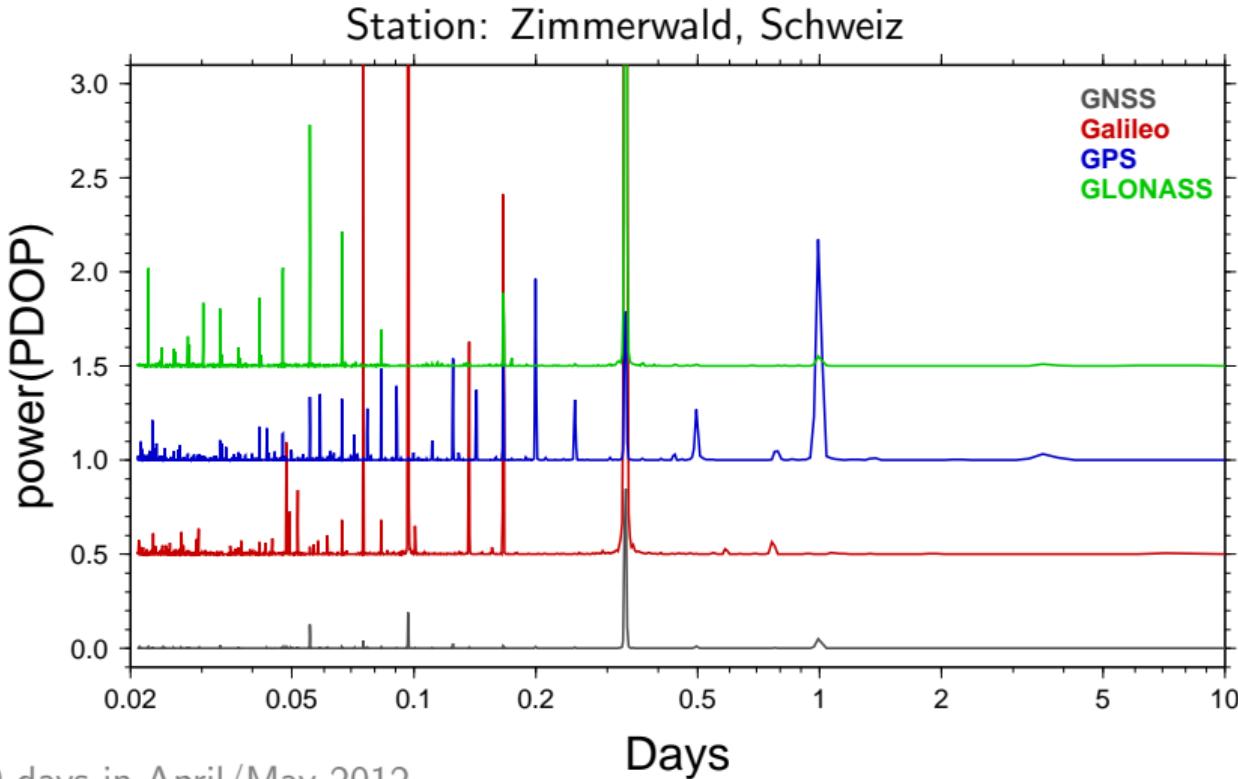


based on 60 days in April/May 2012

# Compare PDOP-Characteristics of the GNSS



# Compare PDOP-Characteristics of the GNSS



# Related papers

## Homogeneous reprocessing of GPS, GLONASS and SLR observations

### Authors

### Authors and affiliations

Mathias Fritsche  , Krzysztof Sośnica, Carlos Javier Rodríguez-Solano, Peter Steigenberger, Kan Wang, Reinhard Dietrich, Rolf Dach, Urs Hugentobler, Markus Rothacher

Original Article

First Online: 25 March 2014



1.1k



28

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Citations

# Related papers

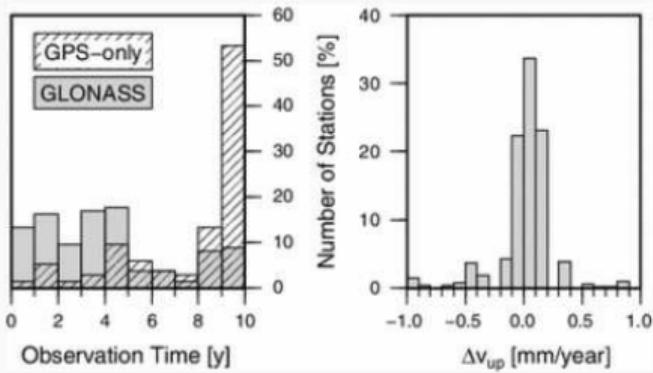


Fig. 3

Contribution of GLONASS to a combined GNSS processing (2002–2011, 135 GPS+GLONASS sites). *Left* comparison of system-specific observation time. *Right* differences in vertical station velocities computed from a GPS-only and a GPS+GLONASS terrestrial reference frame solution

# Related papers

[Journal of Geodesy](#)

January 2018, Volume 92, [Issue 1](#), pp 93–104 | [Cite as](#)

## Dependency of geodynamic parameters on the GNSS constellation

Authors

Authors and affiliations

Stefano Scaramuzza  , Rolf Dach, Gerhard Beutler, Daniel Arnold, Andreja Sušnik, Adrian Jäggi

Original Article

First Online: 19 July 2017



536

Downloads

# Related papers

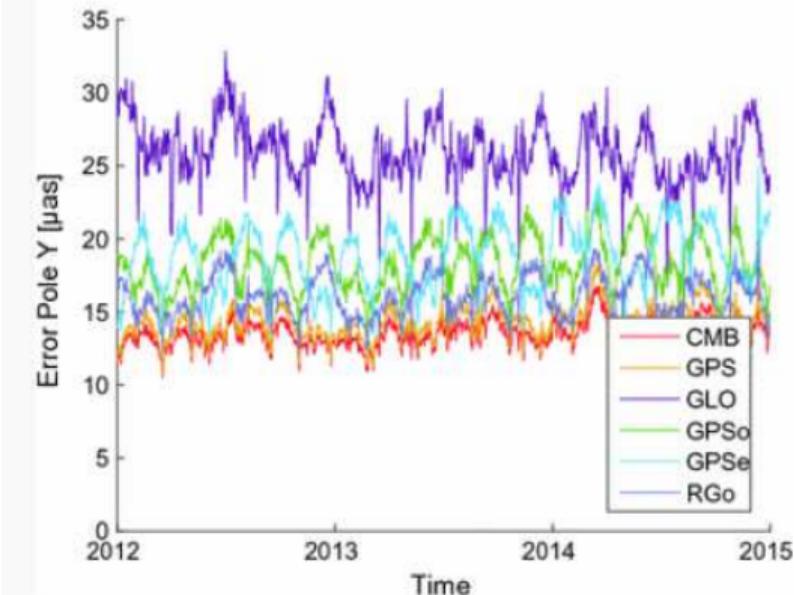
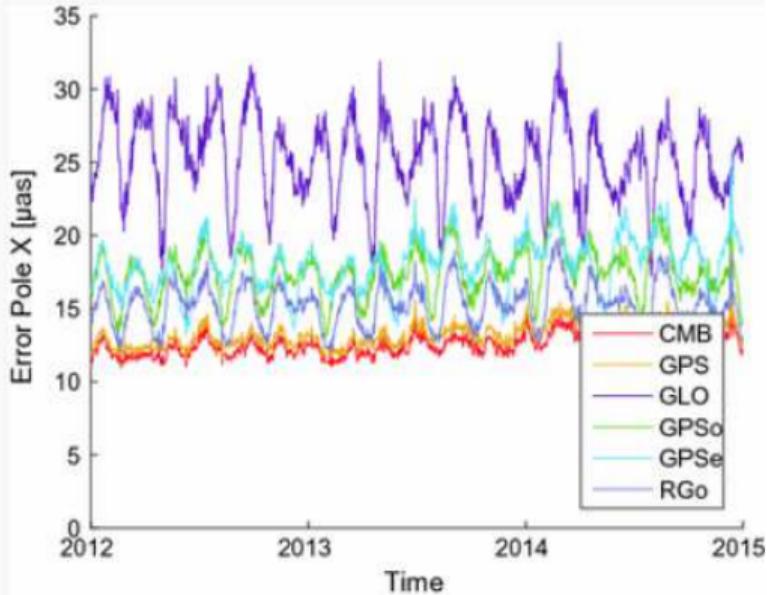


Fig. 12

Formal errors of the pole  $y$ -coordinate from GPS, GLONASS and the combined solution (top) and from GPS, GPSo and GPSe (bottom)

# Three completed GNSS: GPS, GLONASS and Galileo

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- GPS-only with daily processing hides potential problems showing up with the system repetitions rate
- adding another system reduces the spectral characteristics of other systems
- orbits (and satellite clock corrections) for all included systems are made consistently available
- whether Galileo is included or not depends on the decision with respect to the receiver antenna calibration

# Non-IGS reprocessing at AIUB

---

## GNSS Reprocessing in 2015:

### Product availability:

	GPS	GLONASS
GNSS satellite orbits:	since 1994	since 2002
GNSS satellite clock corrections:		
sampling 30 s:	since 2000	since 2008
sampling 5 s:	since 2003	since 2010

Will serve as basis for repro3 – we do not plan to provide less.

# Non-IGS reprocessing at AIUB

---

## GNSS Reprocessing in 2015:

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	GPS	GLONASS	Galileo
GNSS satellite orbits:	since 1994	since 2002	since 2012(?)
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sampling 30 s:	since 2000	since 2008	since 201?
sampling 5 s:	since 2003	since 2010	???

Will serve as basis for repro3 – we do not plan to provide less.

# Plans at JPL

---

## GNSS Reprocessing for ITRF2014:

### Product availability:

GNSS satellite orbits:

GPS

since 1995/1992

GNSS satellite clock corrections:

sampling 300 s:

from the beginning

sampling 30 s:

since 2000

JPL just started to trace into the multi-GNSS world. To cause no delays and potential degradations for repro3, it is planned as GPS-only.

# Plans at ESA

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**GNSS Reprocessing for ITRF2014 is used as the basis:**

## Product availability:

	GPS	GLONASS	Galileo
GNSS satellite orbits:	since 1995	since 2009	???
GNSS satellite clock corrections:			
sampling 300 s:	since 1995	since 2009	???
sampling 30 s:	since 1995	since 2009	???

Will serve as basis for repro3; no decision about Galileo so far.

# Conclusions for repro3

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# Conclusions for repro3

---

- ACs should be encouraged to process multi-GNSS as far as they are capable.
- Assuming that the combination software developed at GFZ progresses until end of 2020 even a combination might be feasible.
- There is the potential of a contribution to the TRF-scale from GNSS for the first time when including Galileo!
- Scientific solutions to assess the GNSS-specific characteristics should be collected (optional and outside from the repro3-schedule regarding the processing load and to make clear what is the official product from the AC).