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

Why not?

GNSS and their characteristics

Related papers
IGS = International GNSS Service
Number of satellites provided by CODE in its final/MGEX orbit
GLONASS solutions are available
Galileo solutions are available

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

<table>
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<tr>
<th>AC ID</th>
<th>AC full name</th>
<th>Latest file</th>
</tr>
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<tr>
<td>COD</td>
<td>Center for Orbit Determination in Europe (CODE)</td>
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<td>Deutsches GeoForschungsZentrum Potsdam (GFZ)</td>
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Product availability

http://mgex.igs.org/analysis/index.php
ACs that are including more than just GPS:

GLONASS:
final: CODE, NRCan, ESA, GFZ, GRGS
last repro: CODE, ESA, GRGS
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Galileo:
currently in MGEX: CODE, GFZ, GRGS, Wuhan
outside MGEX: ESA?
ACs that are including more than just GPS:

GLONASS:
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last repro: CODE, ESA, GRGS

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.
• Revolution period $11^h\, 58^m$
  (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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• Signals:
  Code: C1, P1, P2,
  Phase: L1, L2
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  - same geometry: 1 sidereal day
  - same constellation: 1 sidereal day

• Signals:
  - Code: C1, C2 (since IIR–M), P1, P2
  - Phase: L1, L2 (L2C!!)
- Revolution period $11^h 58^m$ (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, C5 (since IIF)
  - Phase: L1, L2 (L2C!!), L5
GPS Constellation

G06 for 10 days (from 09-May-2012 to 18-May-2012)
All GPS-satellites for 1 day (09-May-2012)
• Revolution period $11^h 16^m$
  (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

- Revolution period 11$^h$ 16$^m$
  (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
- Signals:
  Code: C1, C2, P1, P2
  Phase: L1, L2

GLONASS Constellation 09-Apr-2019

- Ascending Node in deg.
- Argument of Latitude in deg.

- GLONASS-M
- GLONASS-K1
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)
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)
• Revolution period $13^h 45^m$ (same constellation after 17 revolutions within 10 sidereal days)

• Repetition rates:
  same geometry/constellation: 10 sidereal days
Galileo Constellation

Fictive E04 for one day
Fictive E04 for 10 days
Galileo Constellation

Fictive E04 for two days
Galileo Constellation

Fictive E04 and E05 for two days
Fictive E01 to E09 for two days
Galileo Constellation

Fictive E01 to E09 for 10 days
Galileo Constellation

Fictive Galileo constellation for 10 days
Compare PDOP Characteristics of the GNSS

Station: Zimmerwald, Schweiz

Days of year 2012

GPS

based on 10 days in May 2012
Compare PDOP Characteristics of the GNSS

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Days of year 2012

PDOP

GLONASS

based on 10 days in May 2012
Compare PDOP Characteristics of the GNSS

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Days of year 2012

PDOP

GNSS  GPS  GLONASS

based on 10 days in May 2012
Compare PDOP-Characteristics of the GNSS

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Days of year 2012

PDOP

Galileo

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GNSS

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GPS

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![Graph showing PDOP characteristics over 60 days in April/May 2012](image)

Based on 60 days in April/May 2012
Compare PDOP Characteristics of the GNSS

Station: Zimmerwald, Schweiz

Power(PDOP) vs Days

Based on 60 days in April/May 2012
Compare PDOP-Characteristics of the GNSS

Station: Zimmerwald, Schweiz

power(PDOP) based on 60 days in April/May 2012

GNSS
GPS
GLONASS

Days
Compare PDOP-Characteristics of the GNSS

Station: Zimmerwald, Schweiz

Galileo

based on 60 days in April/May 2012
Compare PDOP-Characteristics of the GNSS

Station: Zimmerwald, Schweiz

- GNSS
- Galileo
- GPS
- GLONASS

Based on 60 days in April/May 2012
Related papers

Homogeneous reprocessing of GPS, GLONASS and SLR observations

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

Authors and affiliations

Original Article
First Online: 25 March 2014

Downloads 28
1.1k Citations
Fig. 3

Dependency of geodynamic parameters on the GNSS constellation

Authors

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

Original Article

First Online: 19 July 2017

Downloads: 536
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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CODE contribution will be a multi-GNSS solution because

- our operational solution currently consists of GPS and GLONASS
Three completed GNSS: GPS, GLONASS and Galileo

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- adding another system reduces the spectral characteristics of other systems
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- our operational solution currently consists of GPS and GLONASS
- 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
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:

<table>
<thead>
<tr>
<th>GNSS satellite orbits:</th>
<th>GPS</th>
<th>GLONASS</th>
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<tr>
<td></td>
<td>since 1994</td>
<td>since 2002</td>
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<th>GNSS satellite clock corrections:</th>
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<tr>
<td>sampling 30 s:</td>
<td>since 2000</td>
<td>since 2008</td>
</tr>
<tr>
<td>sampling 5 s:</td>
<td>since 2003</td>
<td>since 2010</td>
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Will serve as basis for repro3 – we do not plan to provide less.
Non-IGS reprocessing at AIUB

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<td>since 2002</td>
<td>since 2012(?)</td>
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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** 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

GNSS Reprocessing for ITRF2014 is used as the basis:

## Product availability:

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Will serve as basis for repro3; no decision about Galileo so far.
Conclusions for repro3
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- ACs should be encouraged to process multi-GNSS as far as they are capable.
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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 characterisitics 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).