‘Galileo ready’ @NSGI

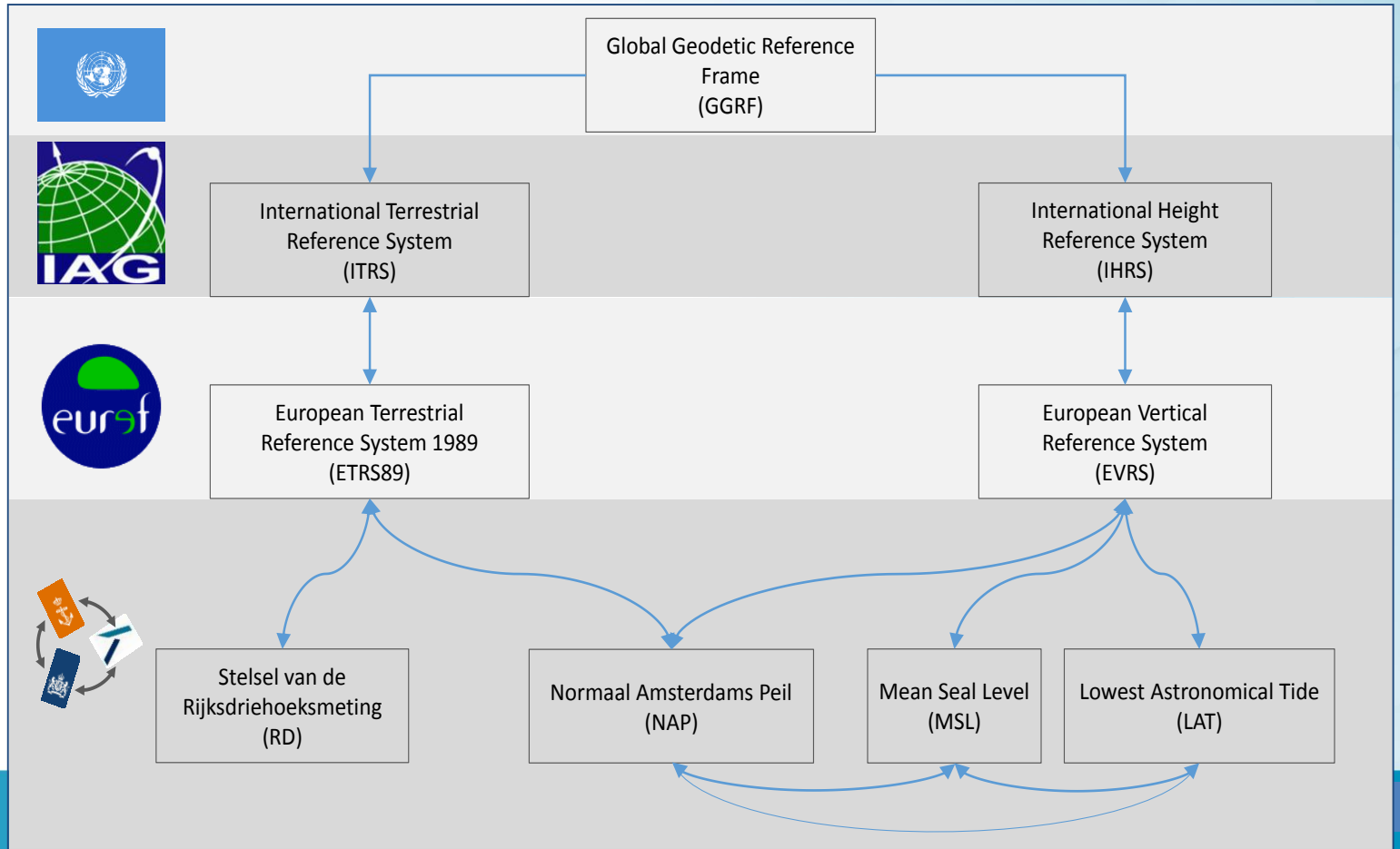
Lennard Huisman
Senior Coordinator

Nederlandse Samenwerking voor Geodetische Infrastructuur (NSGI)
Netherlands Partnership for Geodetic Infrastructure

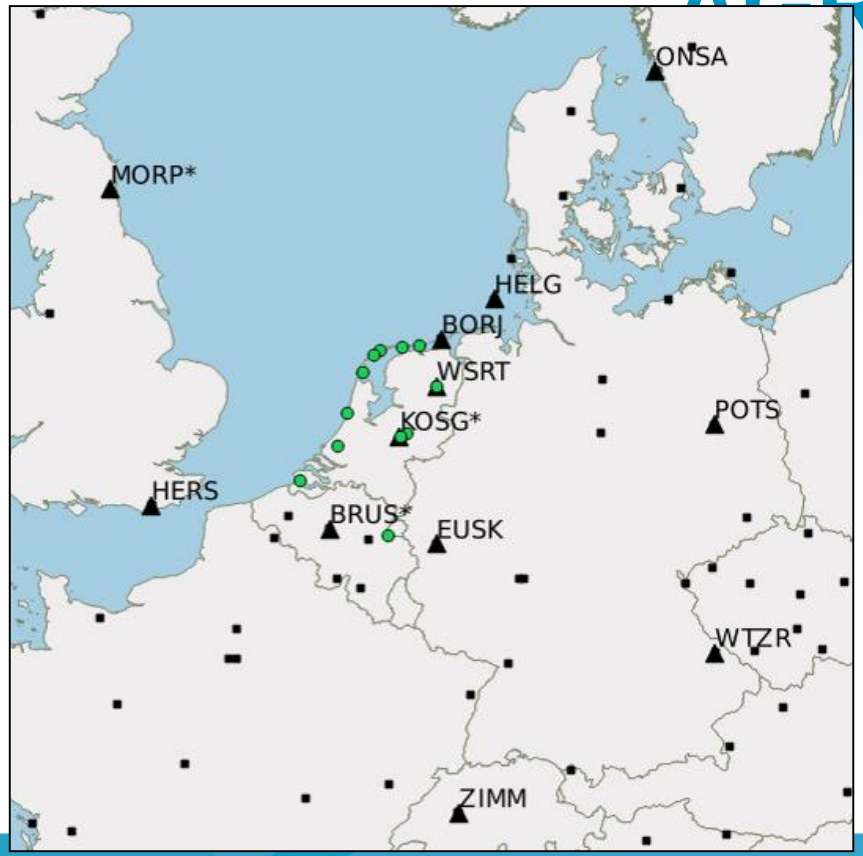
Outline

- **National reference frame for GNSS services**
- RTK and DGNSS services
- Galileo readiness

NSGI


Global Geodetic Reference Frame (GGRF)
International Terrestrial Reference System (ITRS)
International Height Reference System (IHRS)
European Terrestrial Reference System 1989 (ETRS89)
European Vertical Reference System (EVRS)
Stelsel van de Rijksdriehoeksmeting (RD)
Normaal Amsterdams Peil (NAP)
Mean Seal Level (MSL)
Lowest Astronomical Tide (LAT)

Realization of ETRS89 by GNSS: AGRS.NL



Outline

- National reference frame for GNSS services
- **RTK and DGNSS services**
- Galileo readiness

RTK and DGNSS services

- GNSS-service providers
  - 6 national providers
  - Local providers
- NSGI ensures common reference frame by ‘certification’ (= coordinate computation) of GNSS reference stations

Certification of GNSS reference stations

RDNAP

kadaster

Certificaat van Goedkeuring

Uitgereikt aan:

06-GPS B.V.
Kubus 11, 3364 DG, Sliedrecht

De Dienst voor het kadaster en de openbare registers (Kadaster) en de DID van Rijkswaterstaat (voorheen AGI), als beheerders van de geometrische infrastructuur van Nederland samenwerkend onder de naam RDNAP, verklaren dat het referentiestation

Lottum

van bovengenoemde leverancier beoordeeld en in overeenstemming bevonden werd met de eisen die door Kadaster en DID zijn vastgesteld.
Het bovengenoemde referentiestation past hiermee binnen de geometrische infrastructuur van Nederland.

De coördinaten van het **"Antenne Referentie Punt" (ARP)** van het bovengenoemde station zijn met gegevens van **19 maart t/m 26 maart 2015, in combinatie met de absolute antenne kalibratie file "762-11302.atx"** vastgesteld op:

European Terrestrial Reference System, ETRS89

X	*3959776,531 m*	*noorderbreedte*	*51°*	*27'*	*23,67432"*
Y	*424607,180 m*	*oosterlengte*	*6°*	*07'*	*13,60081"*
Z	*4965414,339 m*	*ellipsoïdische hoogte*			*77,761 m*

Stelsel van de Rijksdriehoeksmeting (RD) en hoogte H_{NAP} volgens het Normaal Amsterdams Peil (NAP) berekend uit ETRS89 met de transformatie RDNAPTRANS™2008.

X_{RD}	*205962,080 m*
Y_{RD}	*385534,129 m*
H_{NAP}	*33,279 m*

Behoudens de voortdurende, ongewijzigde en bevredigende werking van het referentiestation en gebruikmakend van bovenstaande coördinaten is dit certificaat geldig vanaf **26 maart 2015** tot en met **26 maart 2016**.

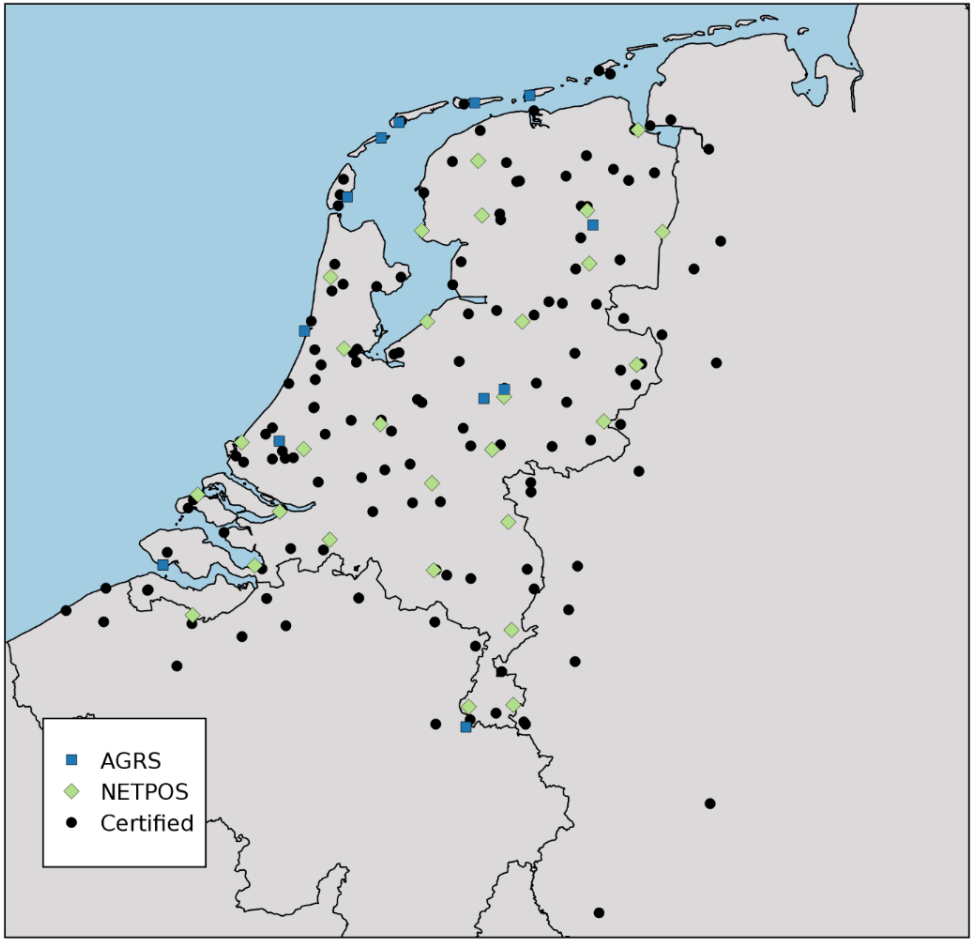
Datum: **20 april 2015**

Voor Kadaster en DID

Ing. S.H. Oosterhof

Certificaat nummer: **368-26032015**

011009



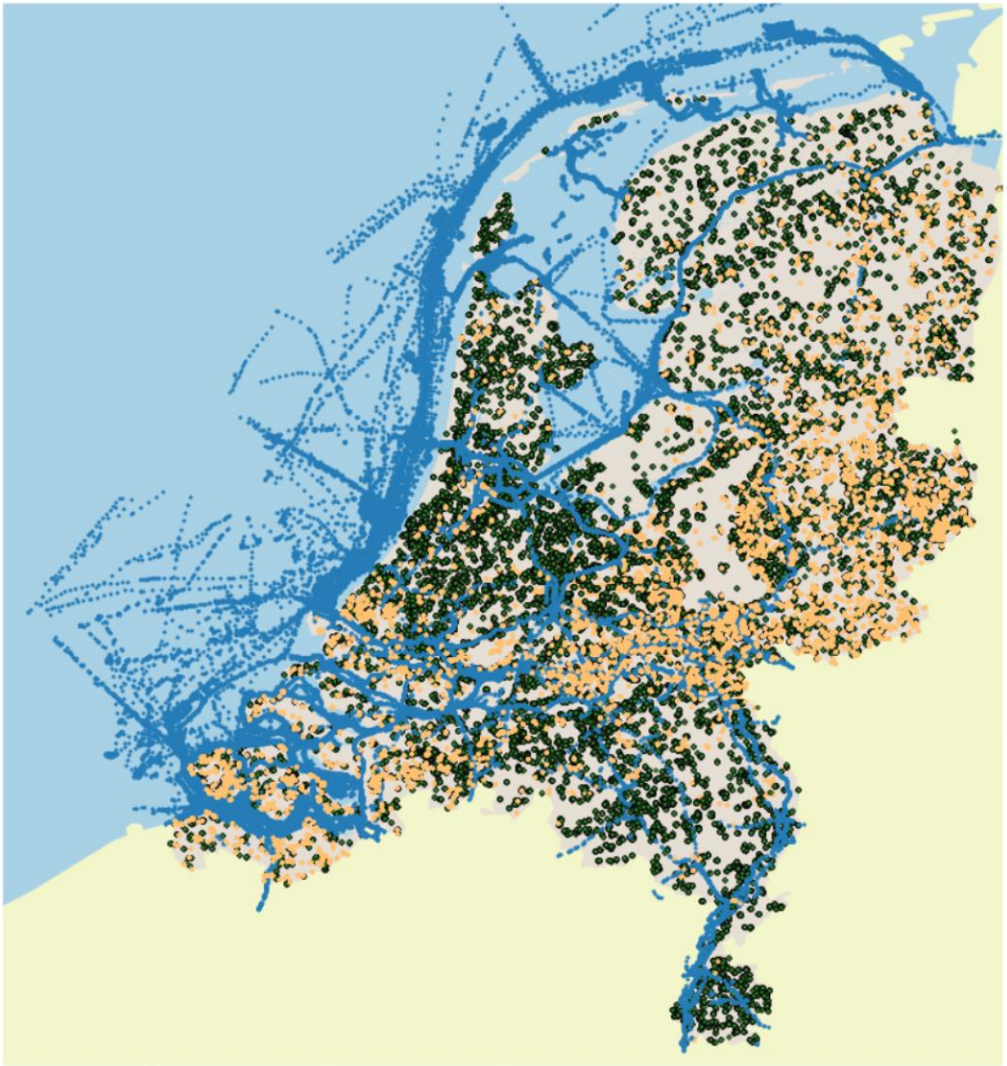
NETPOS

- National correction service for:
  - Kadaster*
    - Surveying
  - Rijkswaterstaat*
    - Surveying
    - IALA/AIS
  - Research, Education and Innovation

*) and their contractors

NETPOS RTK usage 2017

- Black: Kadaster
- Blue: Rijkswaterstaat
- Orange: Other (Contractors / Education and research)



Outline

- National reference frame for GNSS services
- RTK and DGNSS services
- **Galileo readiness**
  - Single baseline experiment
  - Zero baseline calibration site

Galileo Ready?

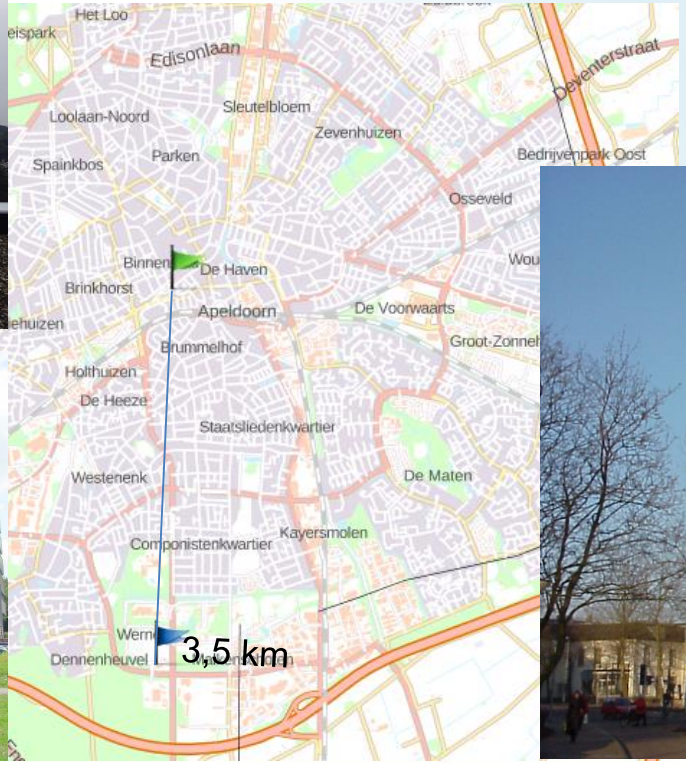
- All GNSS reference stations operated by NSGI capable of tracking Galileo (E1, E5a, E5b, AltBOC)
- NETPOS:
  - Network software available with Galileo support
  - Kadaster users equipped with Galileo ready RTK rovers
  - RWS vessels to be equipped 2019-2020

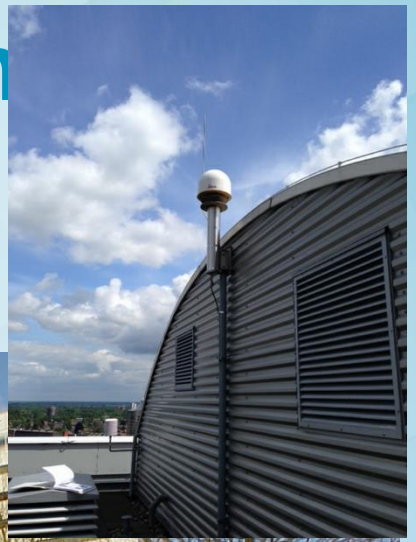
Legenda
Merk ontvanger
Septentrio
Trimble
Leica
AMEL
SCHI
TERS
VLIE
DZYL
LWRD
TXE2
JOUR
ASS2
WSRA
TAPL
STAV
HOOG
WARM
LELY
ZWO2
IJMU
AMST
OLDE
APEL
KOS1
ADR2
EBRG
UTR2
EPL1
HHOL
DLF1
RDAM
ARNH
LITH
SDYK
WIL2
BOXM
BRD2
VLIS
RIL2
EHVN
SASG
ROE2
MSTR
KERK
EIJS

Galileo experiment Apeldoorn

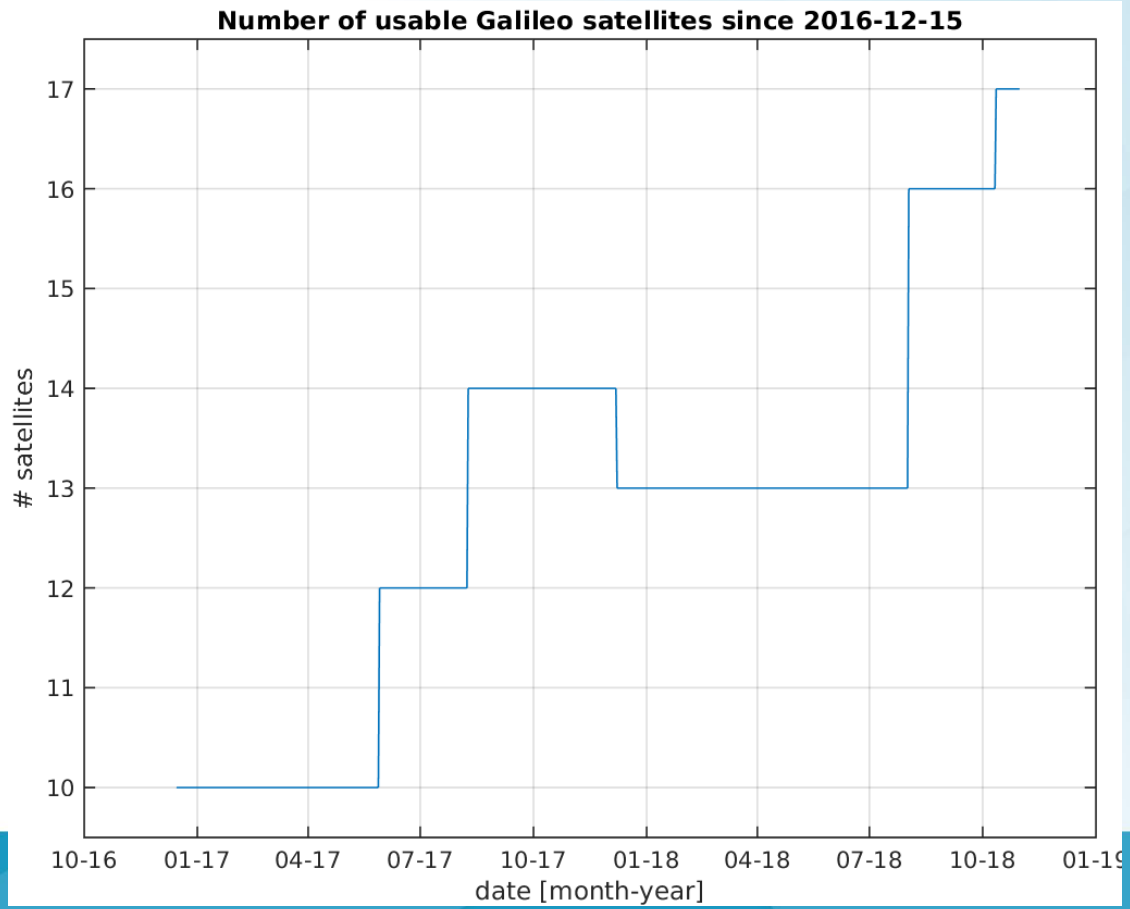
- Motivation
  - Test Galileo readiness hardware
  - *Is it possible to do Galileo only RTK?*
- Methodology
  - Single baseline (3.5 km, identical receivers)
  - RTKLIB library
  - PPK as if RTK with instantaneous ambiguity resolution
  - 1 Hz data, processing restarted every 15 minutes
- Parameters
  - Availability
  - Repeatability
  - Acccuracy

Galileo experiment Apeldoorn

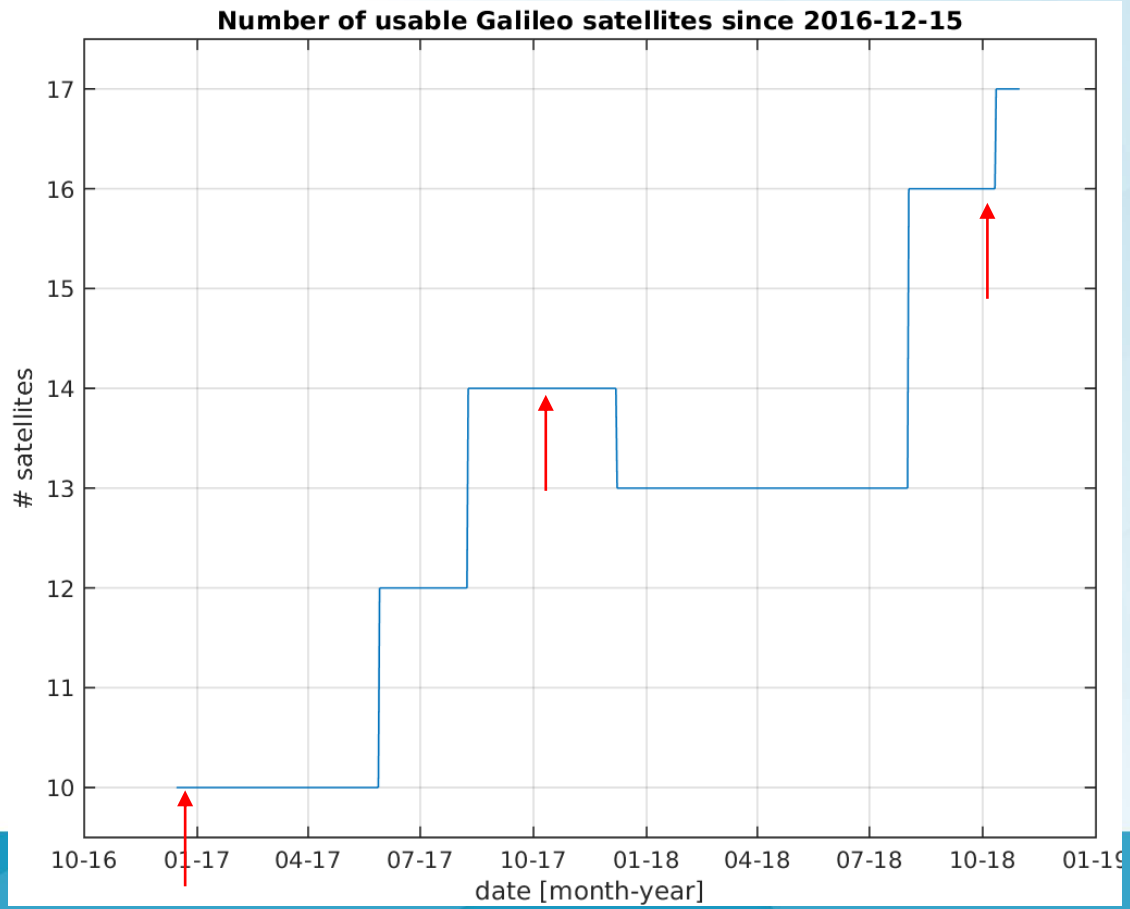


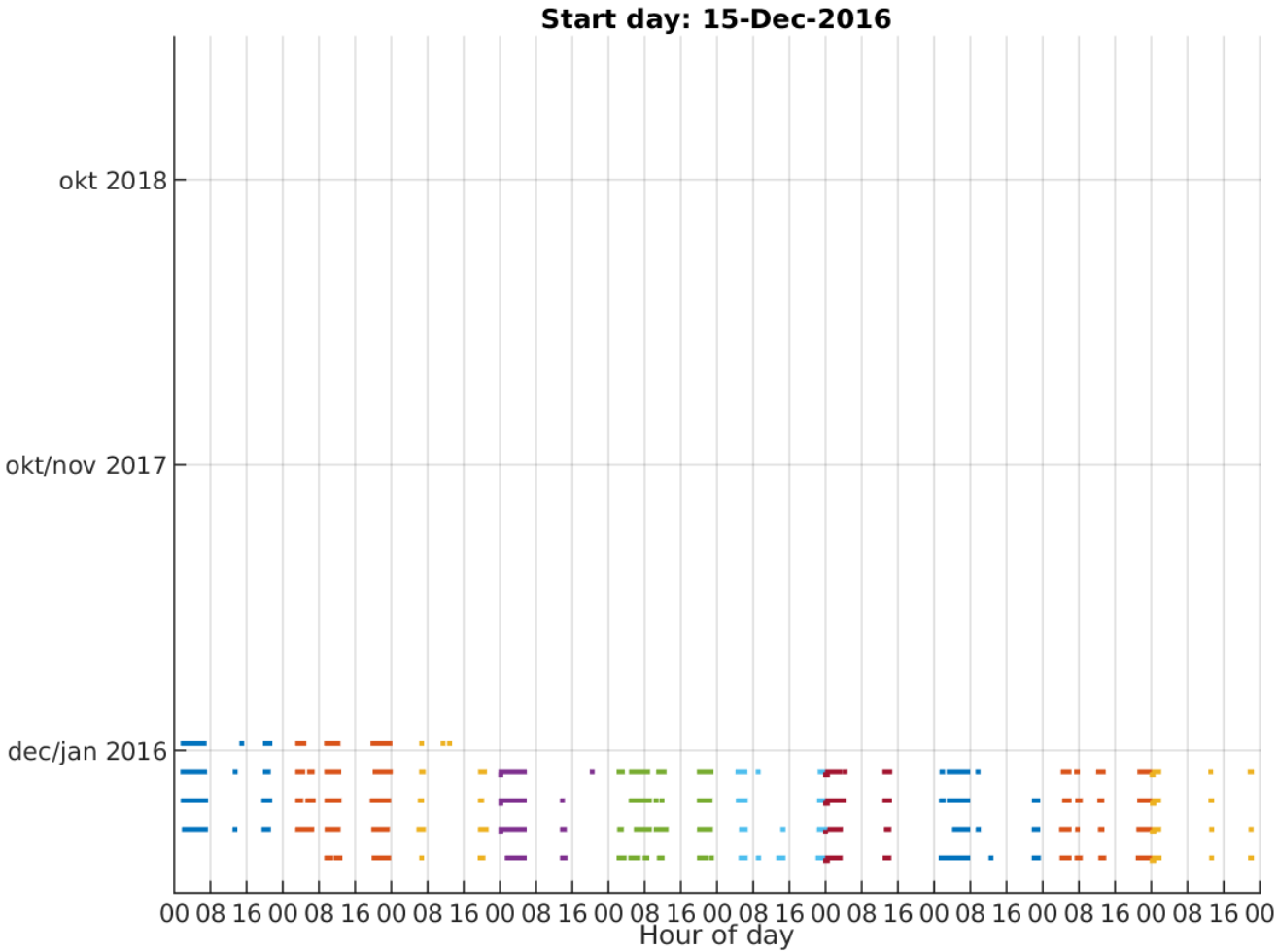


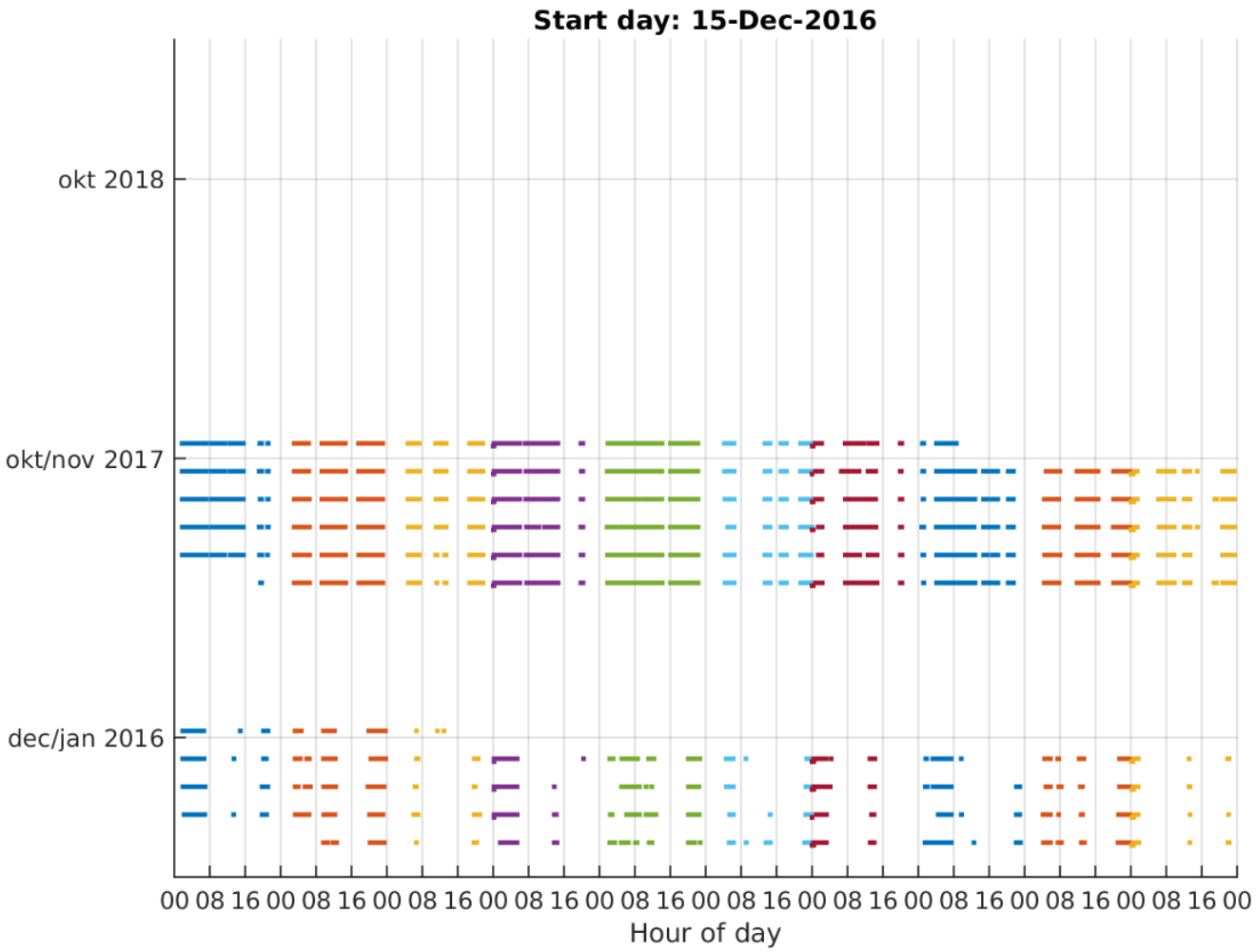
Availability of Galileo satellites



Availability of Galileo satellites




Start day: 15-Dec-2016
okt 2018
okt/nov 2017
dec/jan 2016
00 08 16 00 08 16 00 08 16 00 08 16 00 08 16 00 08 16 00 08 16 00 08 16 00 08 16 00 08 16 00
Hour of day


Start day: 15-Dec-2016
okt 2018
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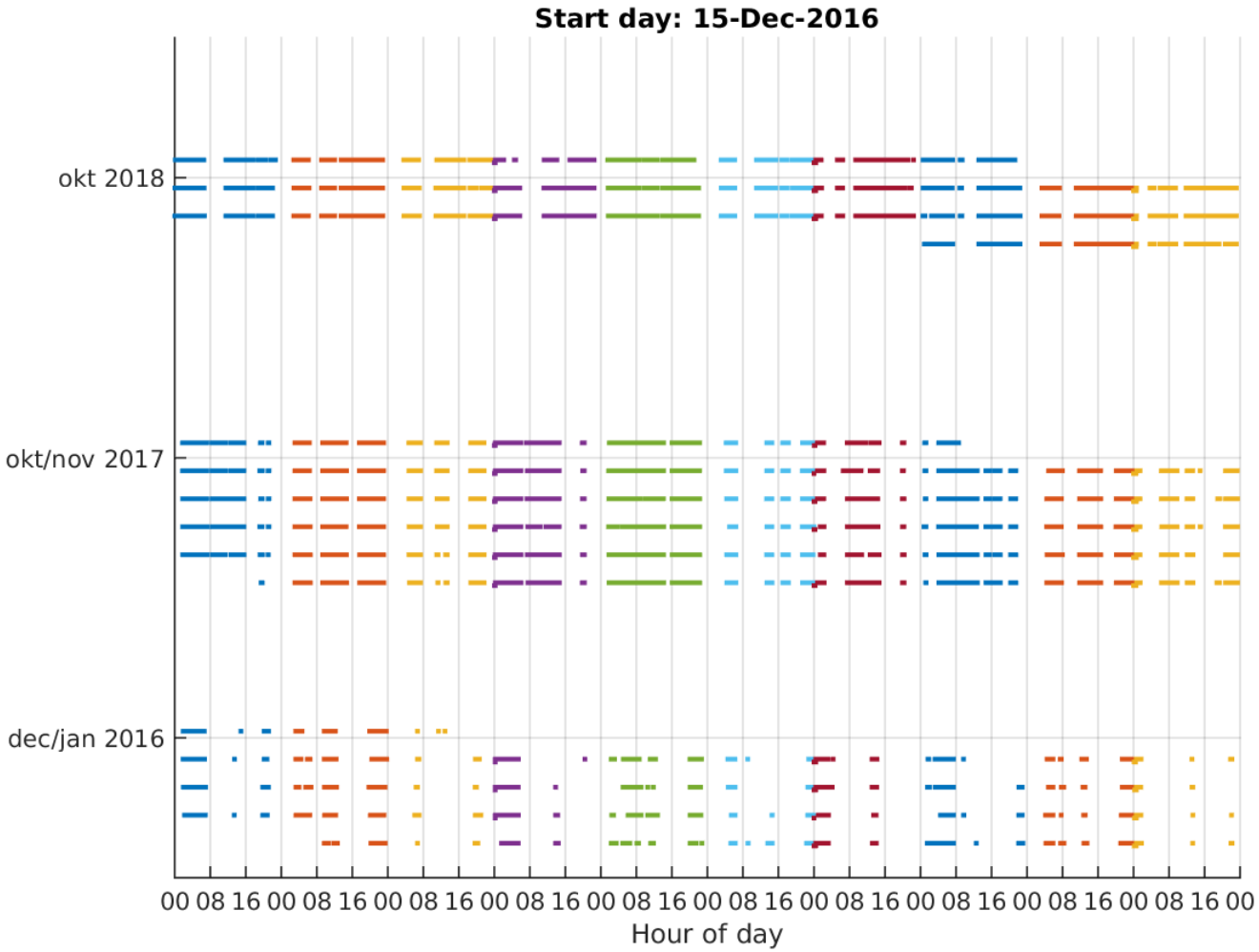
Hour of day


Start day: 15-Dec-2016
okt 2018
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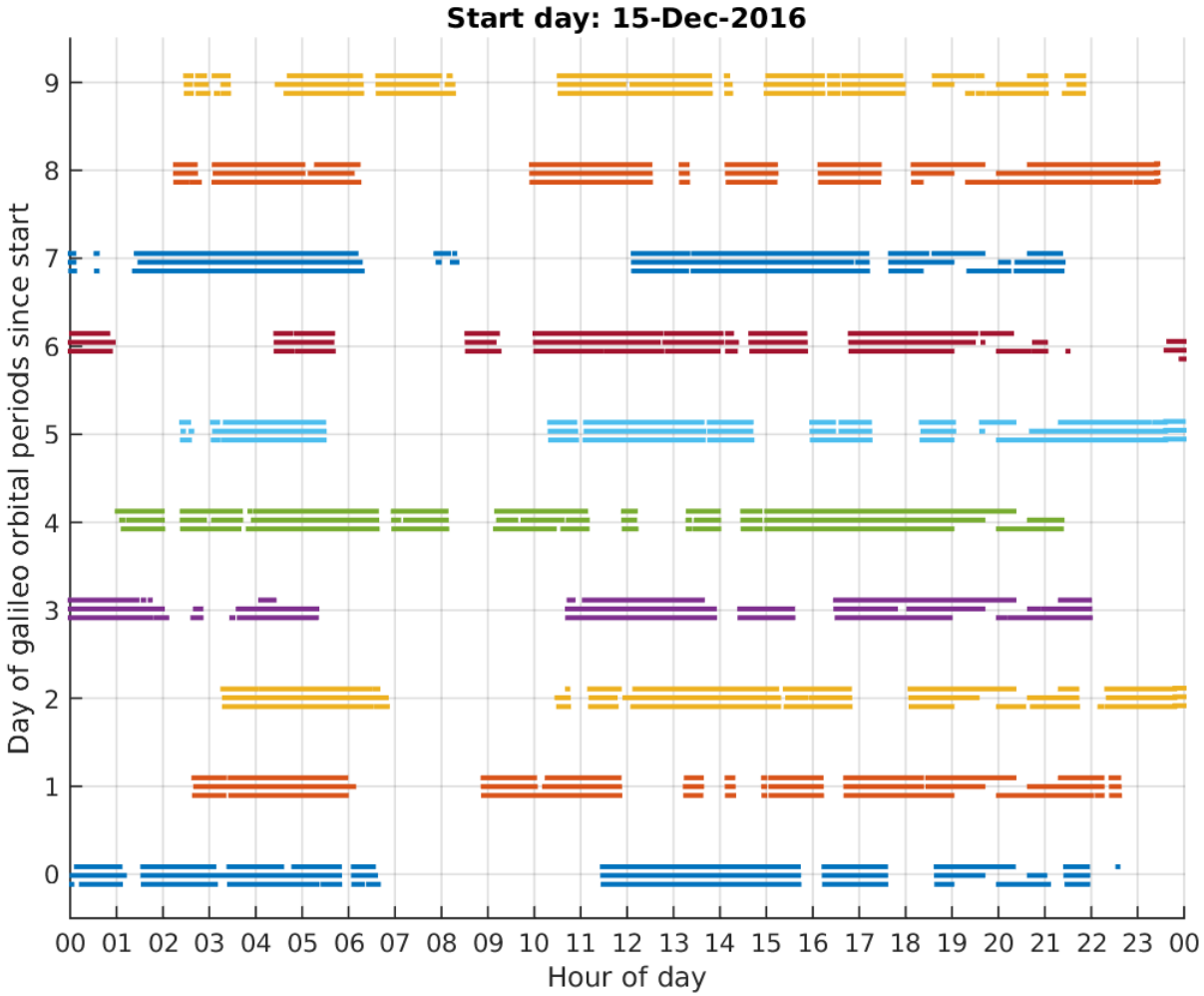
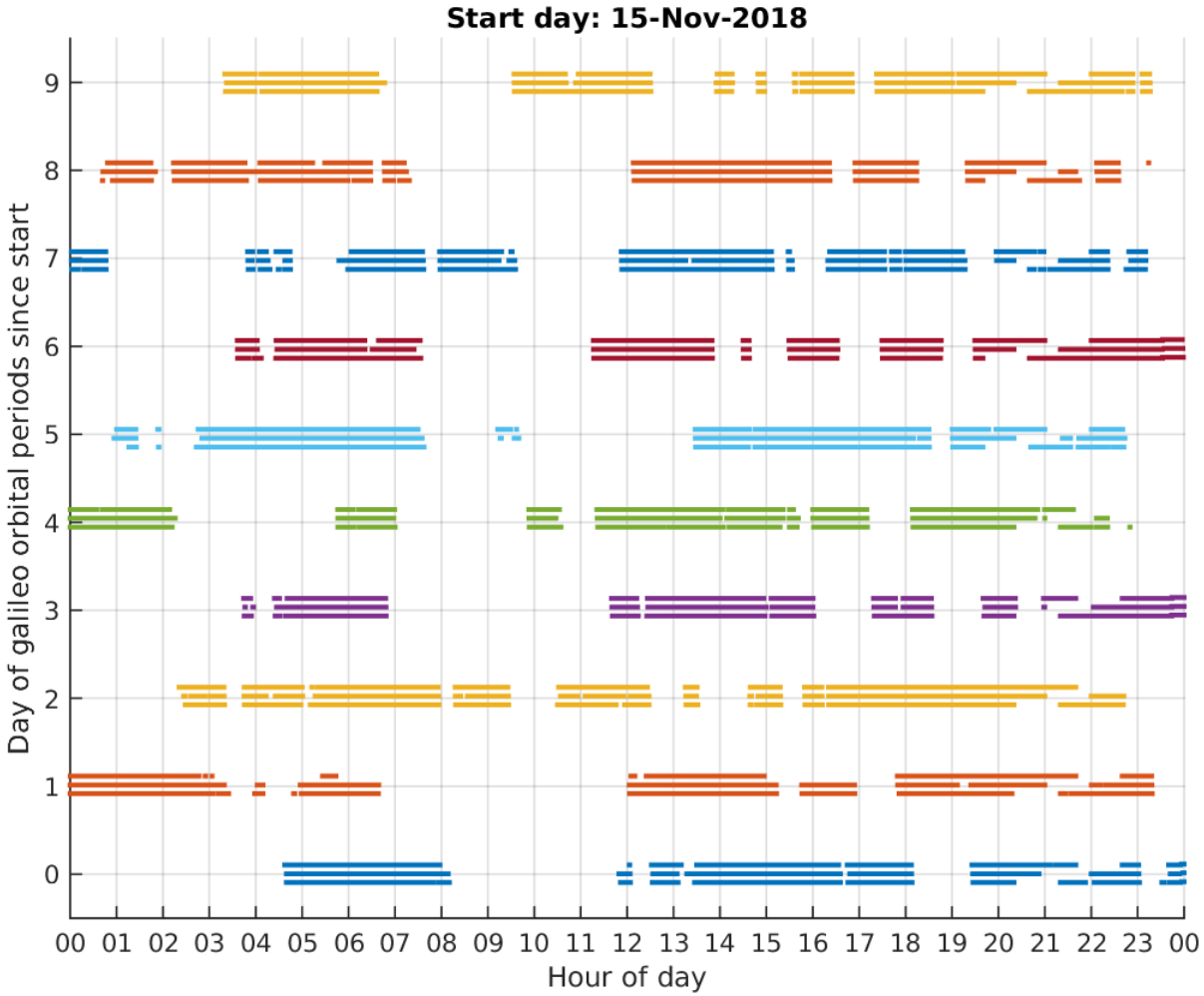
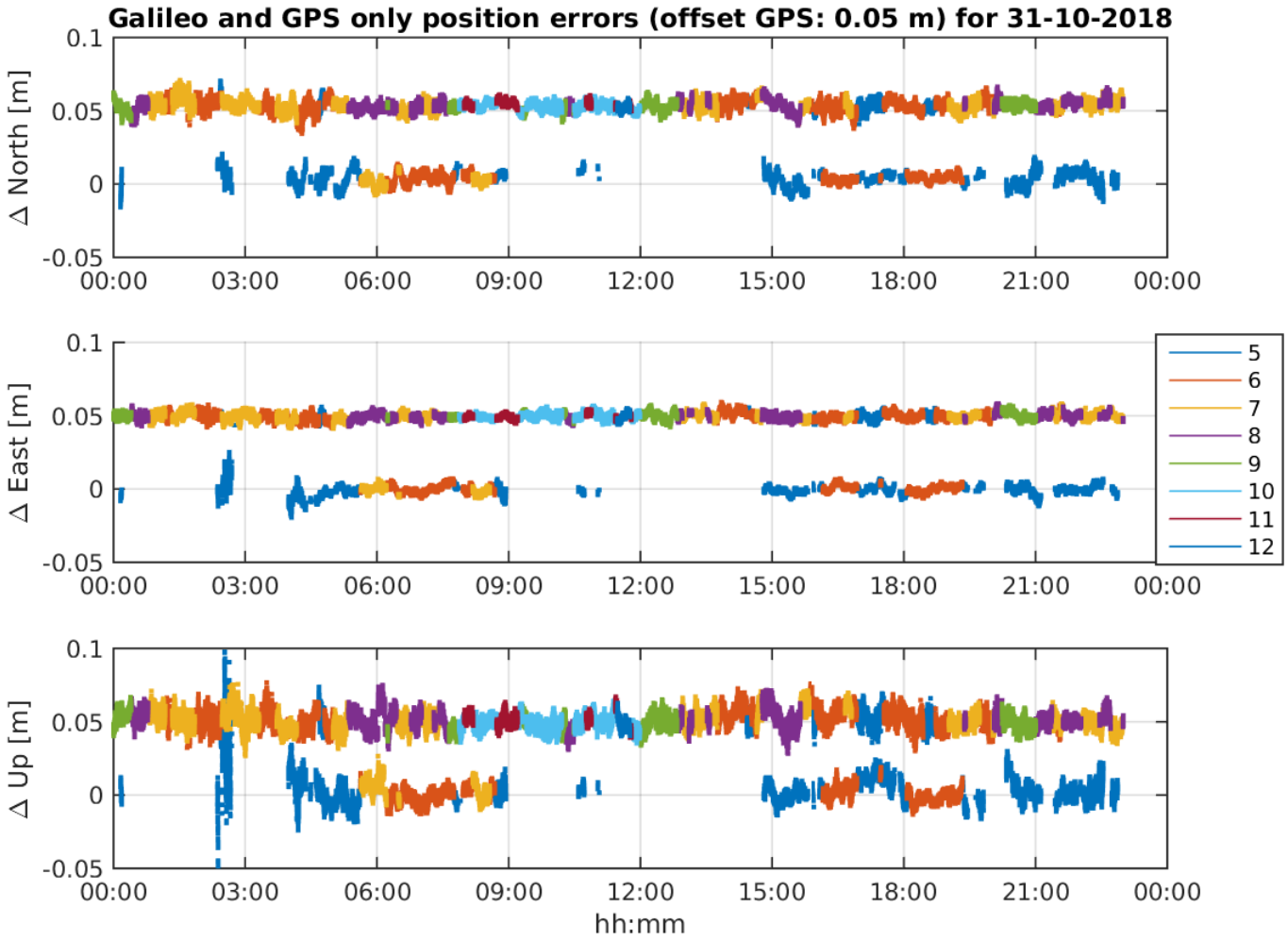
Hour of day


Start day: 15-Dec-2016
Day of galileo orbital periods since start
0
1
2
3
4
5
6
7
8
9
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 00
Hour of day

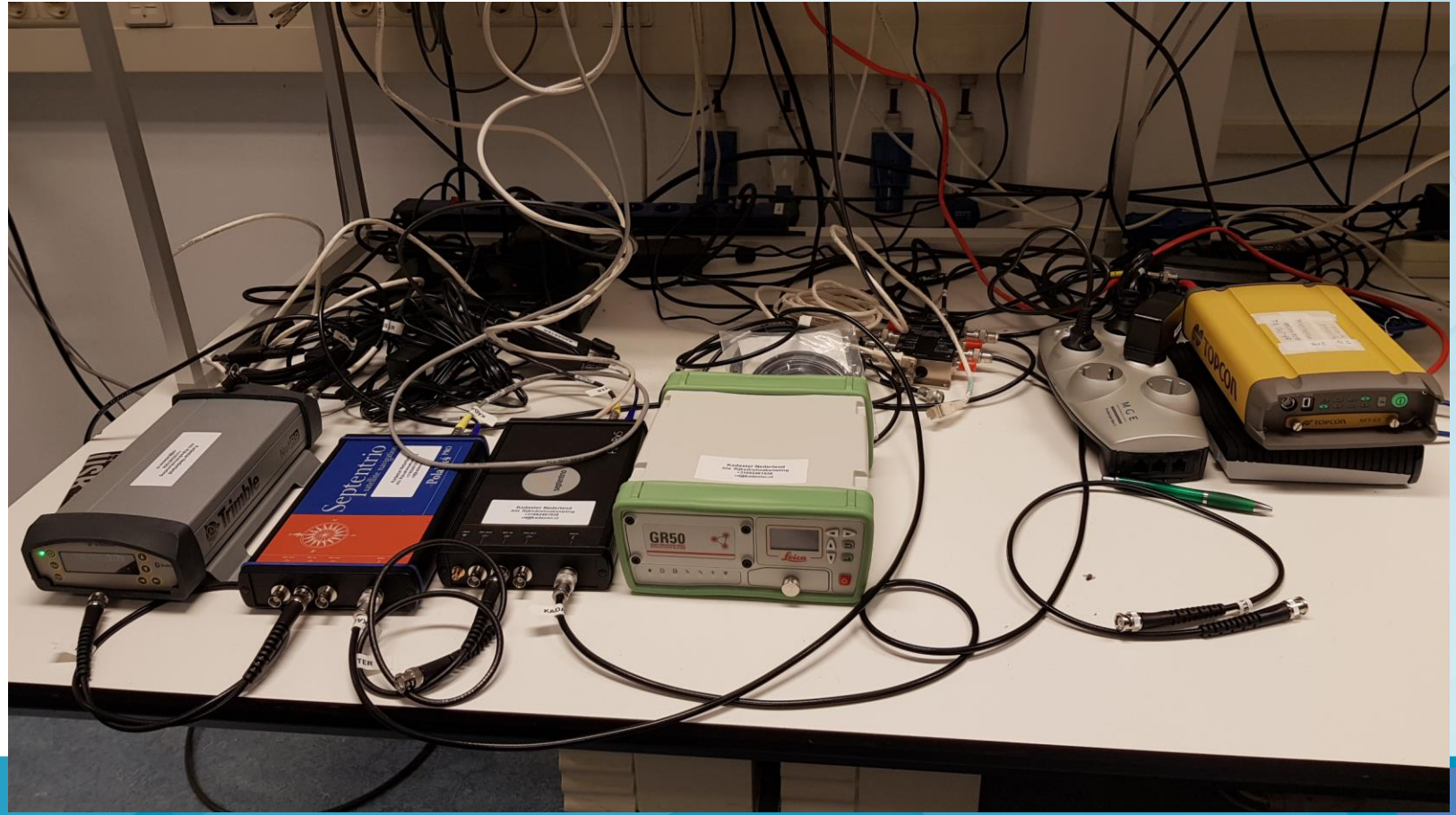

Start day: 15-Nov-2018
Day of galileo orbital periods since start
0
1
2
3
4
5
6
7
8
9
00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 00
Hour of day


Galileo and GPS only position errors (offset GPS: 0.05 m) for 31-10-2018
Δ North [m]
Δ East [m]
Δ Up [m]
0.1
0.05
0
-0.05
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
hh:mm
5
6
7
8
9
10
11
12

Zero baseline calibration site

- Motivation
  - Biases between receivers / frequencies / systems / signals
  - Become relevant in mixed receiver networks
- Set-up
  - Zero-baseline
  - External cesium frequency
- Data availability real time through TU Delft ntripcaster:
  - RTCM-MSM
  - Propietary

Zero baseline calibration site



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Continuously Operating Reference Stations

1st order

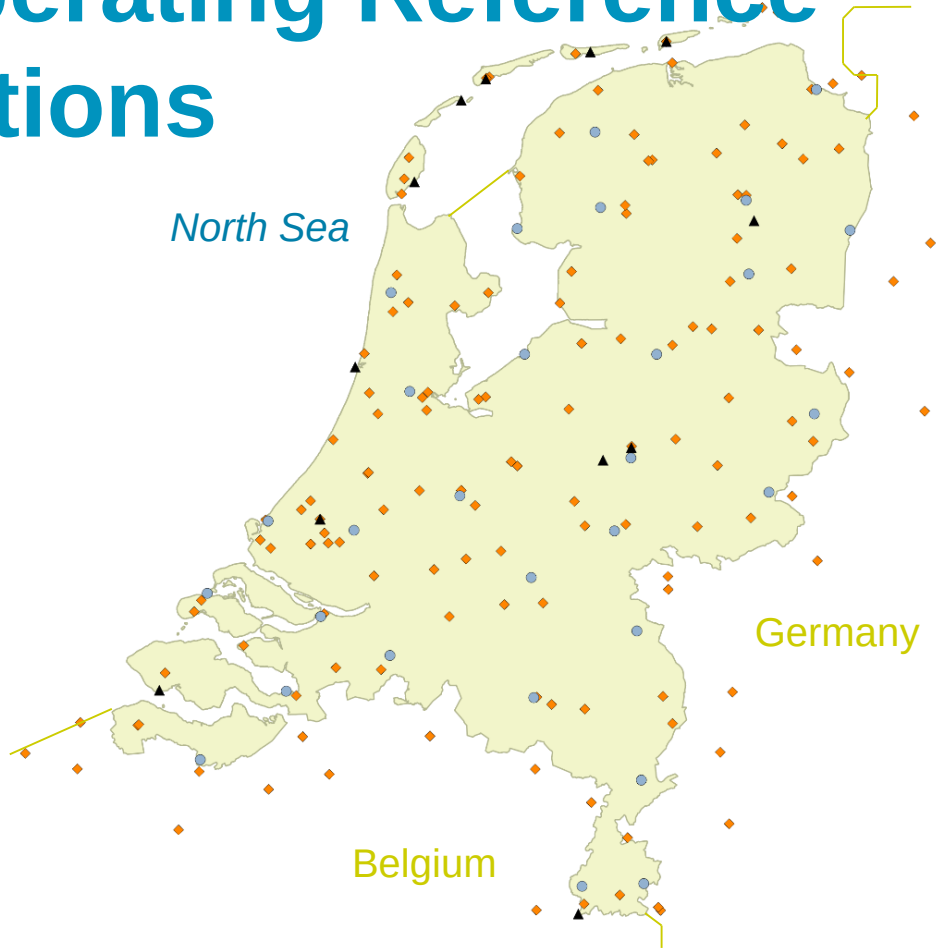
▲ AGRS.NL

2nd order

● NETPOS

◆ Certified other parties

- networks
- single stations



Passive reference points

- GNSS Footprint (backup)
- Levelling benchmarks (only 1st order shown!)
- Absolute gravimetry

No maintenance:

- x Triangulation points
- x GNSS Kernnet
- x Relative gravimetry