Nav-5.1

Strapdown Inertial Navigation System based on FOG sensors for aerial applications

System overview

October 2014

1. Introduction

Nav-5.1 is strapdown inertial navigation system based on modern IMU built on FOG sensors. System includes embedded dual system (GLONASS/GPS) GNSS receiver and barometric altimeter. The navigation system provides continuous determination and output of position coordinates, motion parameters and attitude angles. Per customer choice any multi-system GNSS receiver can be used.

To enhance accuracy characteristics in autonomous inertial mode the system can acquire data from air data system (ADS sensor).

2. Technical characteristics

2.1. System architecture

Nav-5.1 navigation system consists of:

- Navigation system unit (incorporates an IMU with 3 FOG sensors, 3 quartz accelerometers, barometric altimeter and GNSS receiver)
- GNSS receiver antenna
- Commutation cables

Figure 1. Nav-5.1 navigation system

2.2. Specification

Table 1

Navigation system unit	
Size	224×176×135 mm (8.82” x 6.93” x 5.31”)
Weight	7 kg (15.43 lbs)
Electrical	
Input voltage	9..36 VDC
Power	30 W (max)
Data output	
Interface	RS-232 (2 ports), RS-422 (2 ports)
Output data rate	100 Hz
Data format	binary
Cold start (including alignment with GNSS)	10 min
Operating ranges	
Angular rate	±150 °/s
Acceleration	±10g
Altitude	up to 20000 m
Pitch	±90°
Roll	±180°
Heading	0..360°
Latitude	±90°
Longitude	±180°

3. Accuracy[1]

Table 2

	INS+GNSS mode	INS + ADS mode
Horizontal coordinates	6 m	1 n.m. per 1 hour (CEP)
Ground speed	0.08 m/s	0.8 m/s
Vertical speed	0.1 m/s	0.15 m/s
Attitude (roll, pitch)		
dynamic accuracy	0.03°	0.04°
Heading		
dynamic accuracy	0.08°	0.1° (per 1 hour)
Altitude	2 m	4 m

All data is 1σ

[1] Accuracy data subject to change without notice.

4. Testing

Flight test of Nav-5.1 navigation system was carried out on Mi-8 MTV helicopter. Total flight time is 24 flight hours. During the test flights, the navigation system functioned in the following modes:

1) 10-15 minutes initialization based on GNSS data, then GNSS receiver was turned off and Nav-5.1functioned in autonomous mode within 1 hour. Autonomous mode assumes ADS sensor is connected and INS + ADS operating mode is implemented.
2) Autonomous operation when GNSS is not used at all. Autonomous horizontal and azimuth alignment and then 1.3-1.4 hours of navigation. Autonomous mode assumes ADS sensor is connected INS + ADS operating mode is implemented.
3) 10-15 minutes initialization based on GNSS data, then autonomous navigation within more than 1 hour (GNSS receiver is turned off). Autonomous navigation assumes ADS sensor is connected INS + ADS operating mode is implemented.

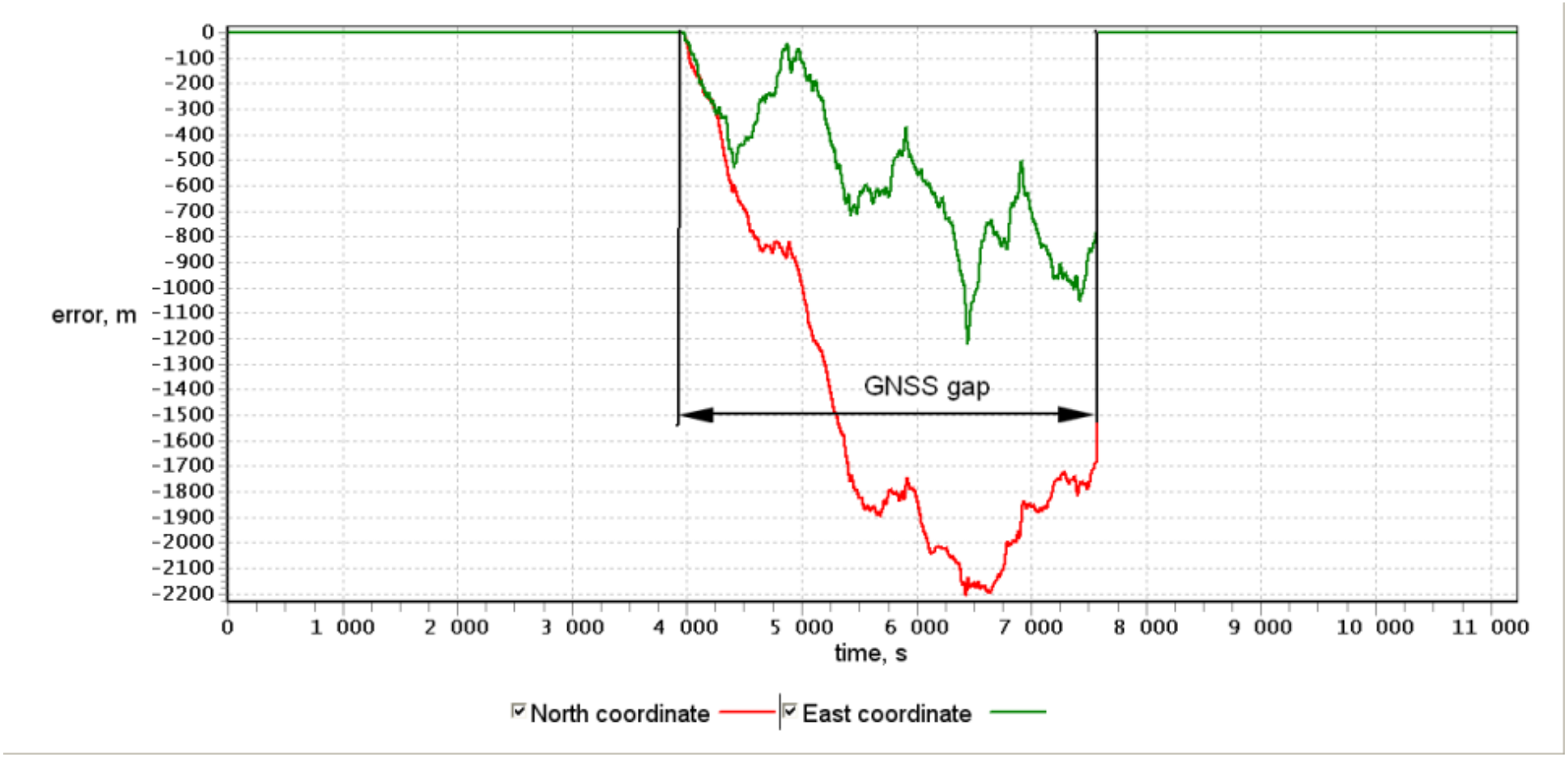

Figure 2. Position errors after GNSS-aided alignment (1 hour GNSS gap)

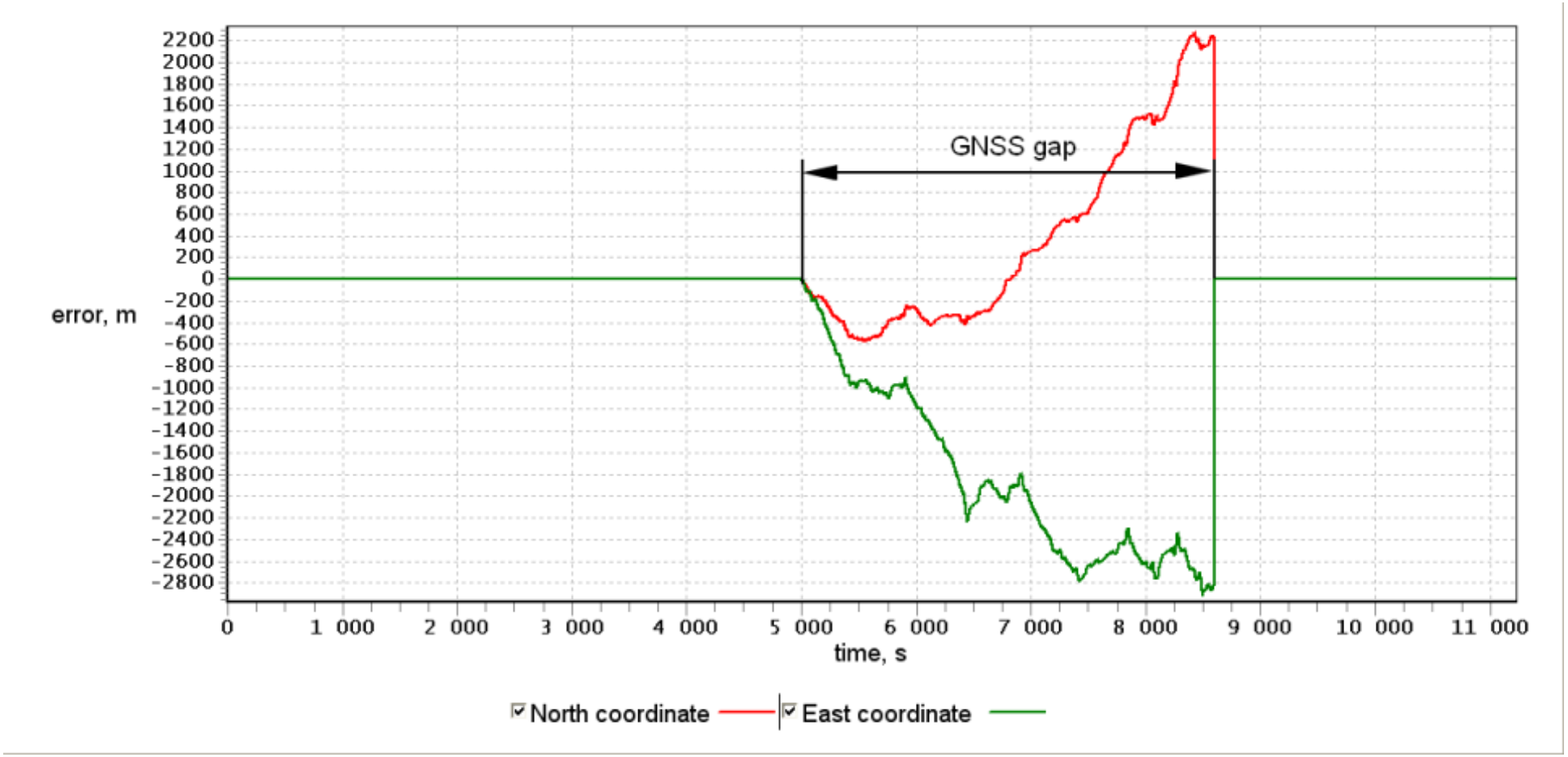

Figure 3. Position errors after GNSS-aided alignment (1 hour GNSS gap)

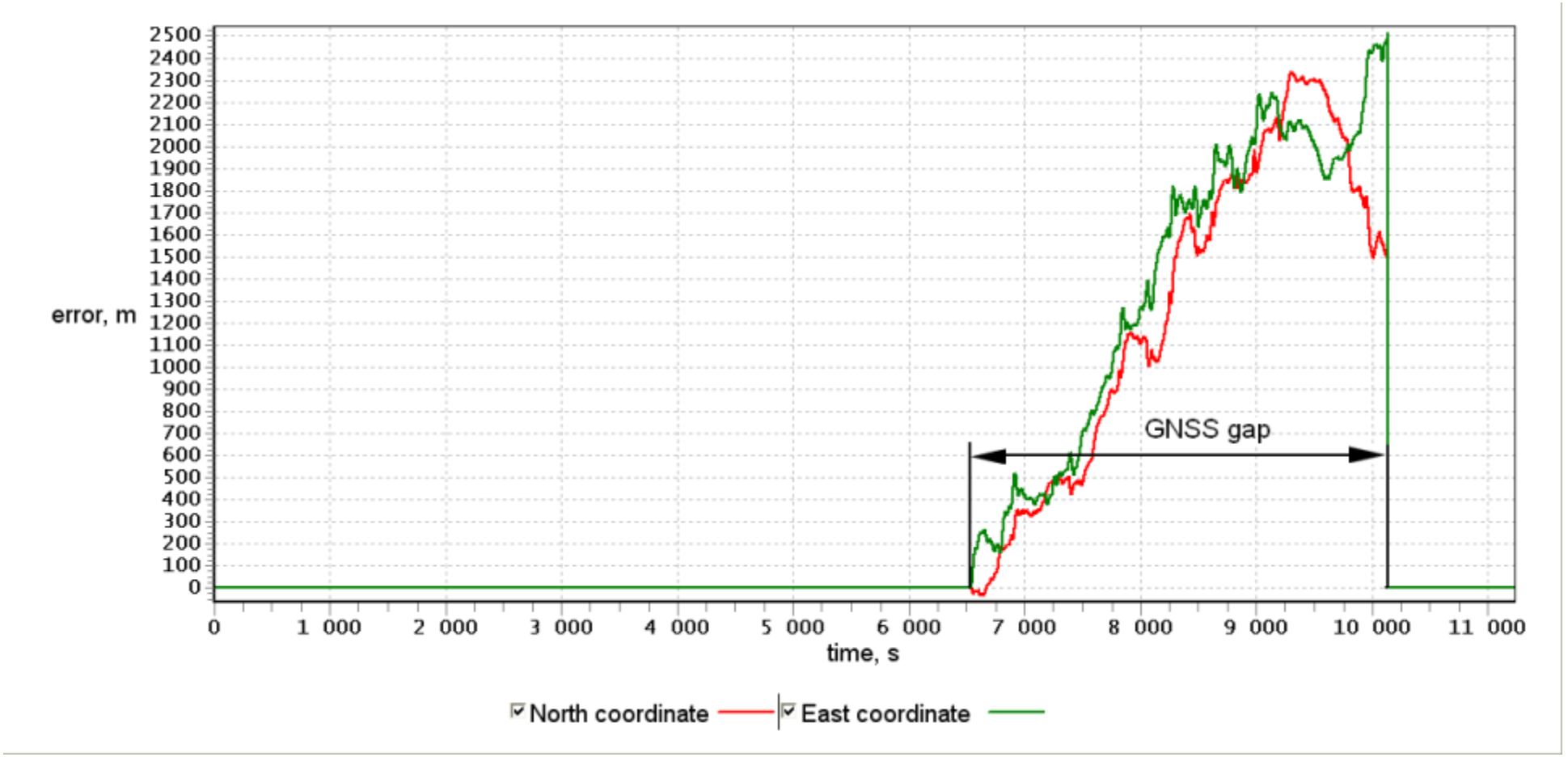

Figure 4. Position errors after GNSS-aided alignment (1 hour GNSS gap)

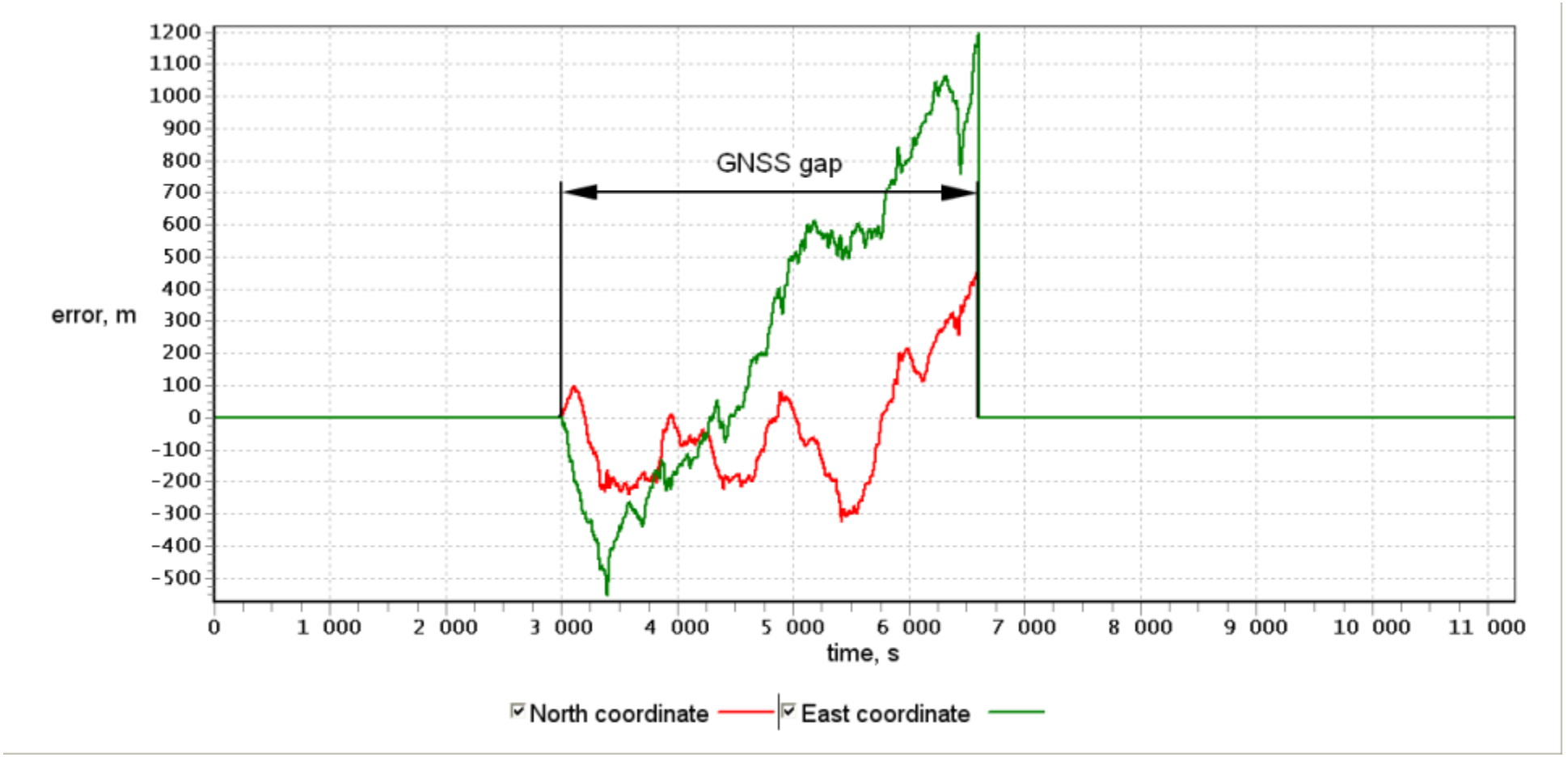

Figure 5. Position errors after GNSS-aided alignment (1 hour GNSS gap)

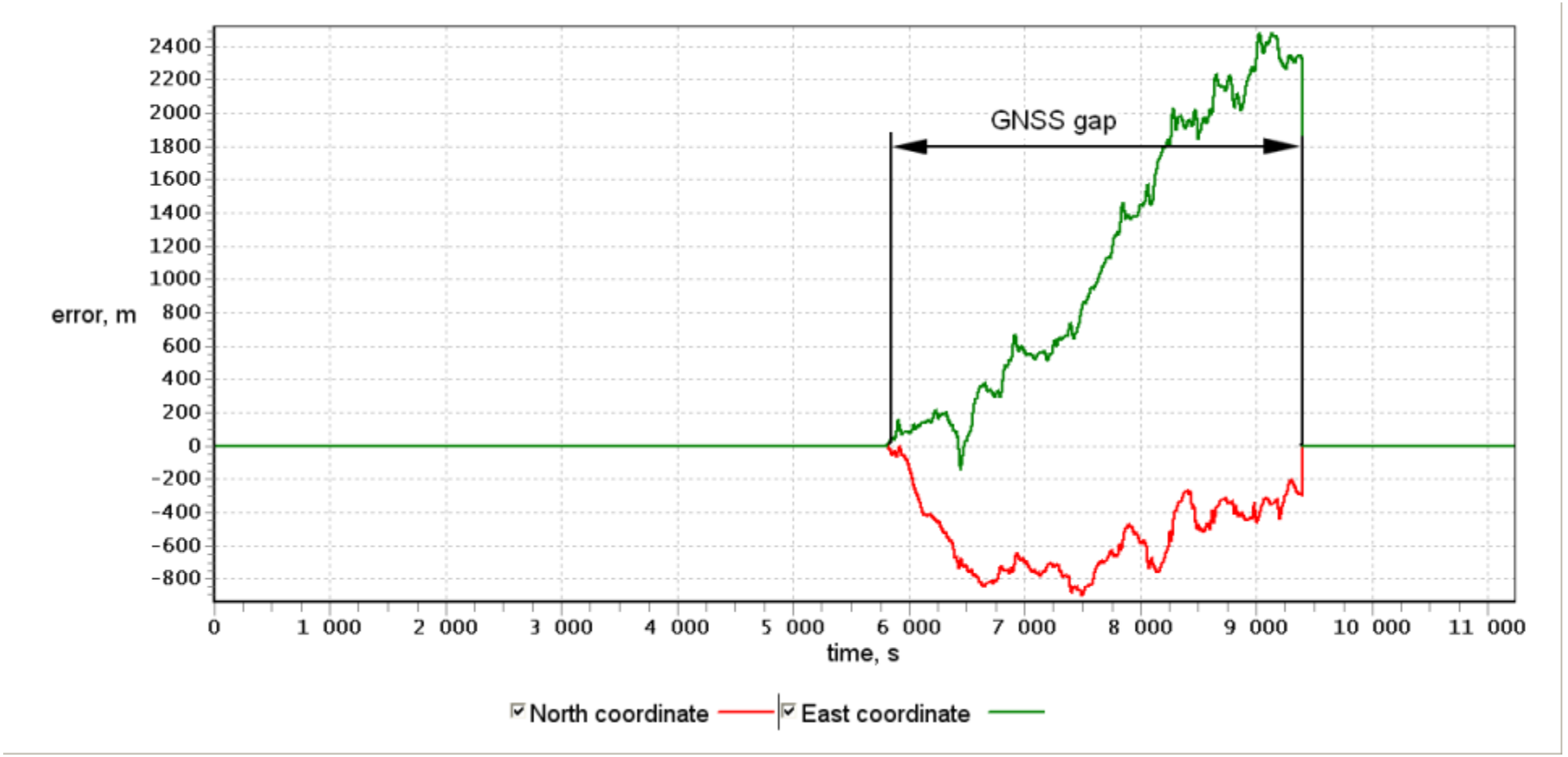

Figure 6. Position errors after GNSS-aided alignment (1 hour GNSS gap)

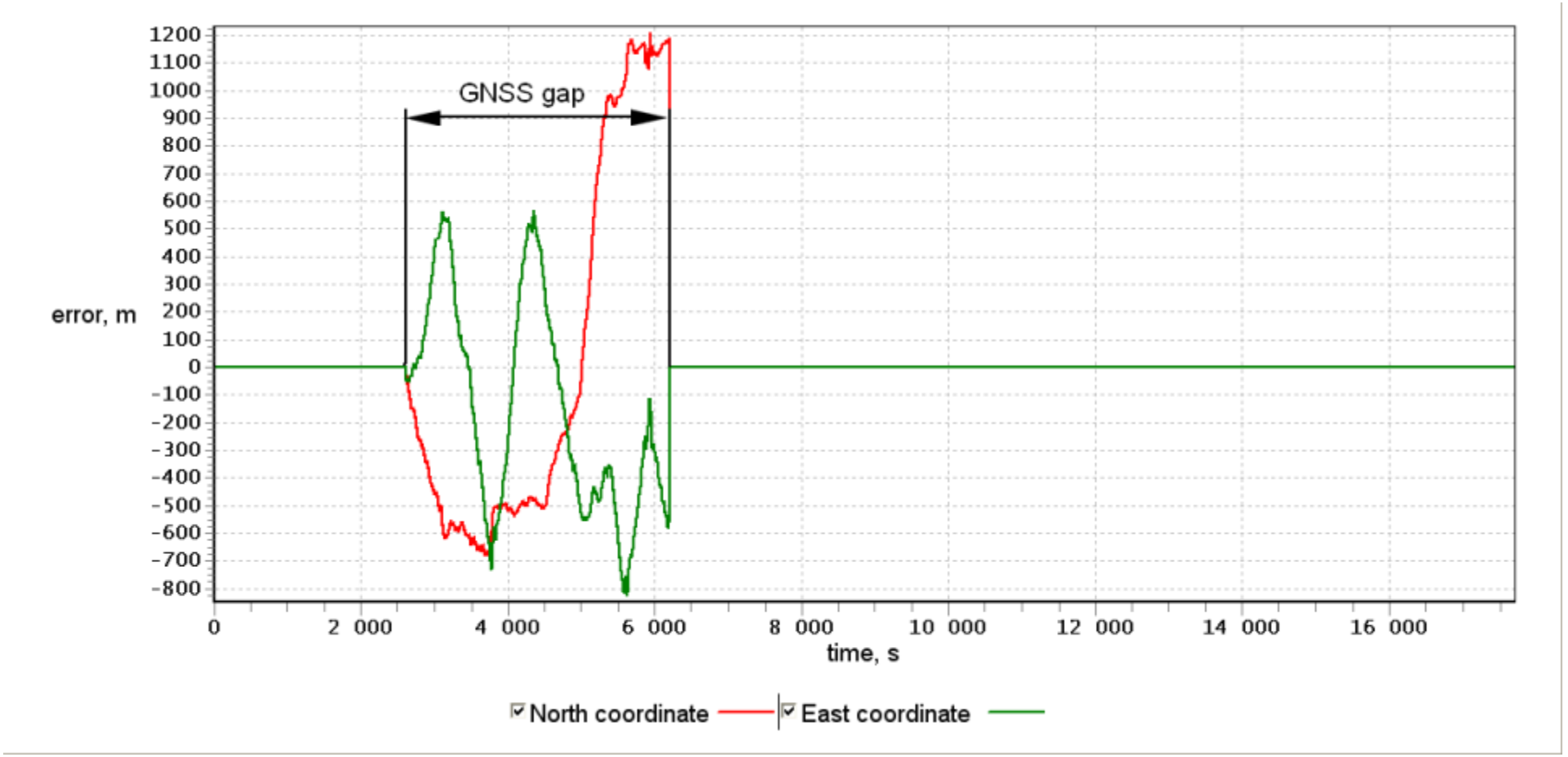

Figure 7. Position errors after GNSS-aided alignment (1 hour GNSS gap)

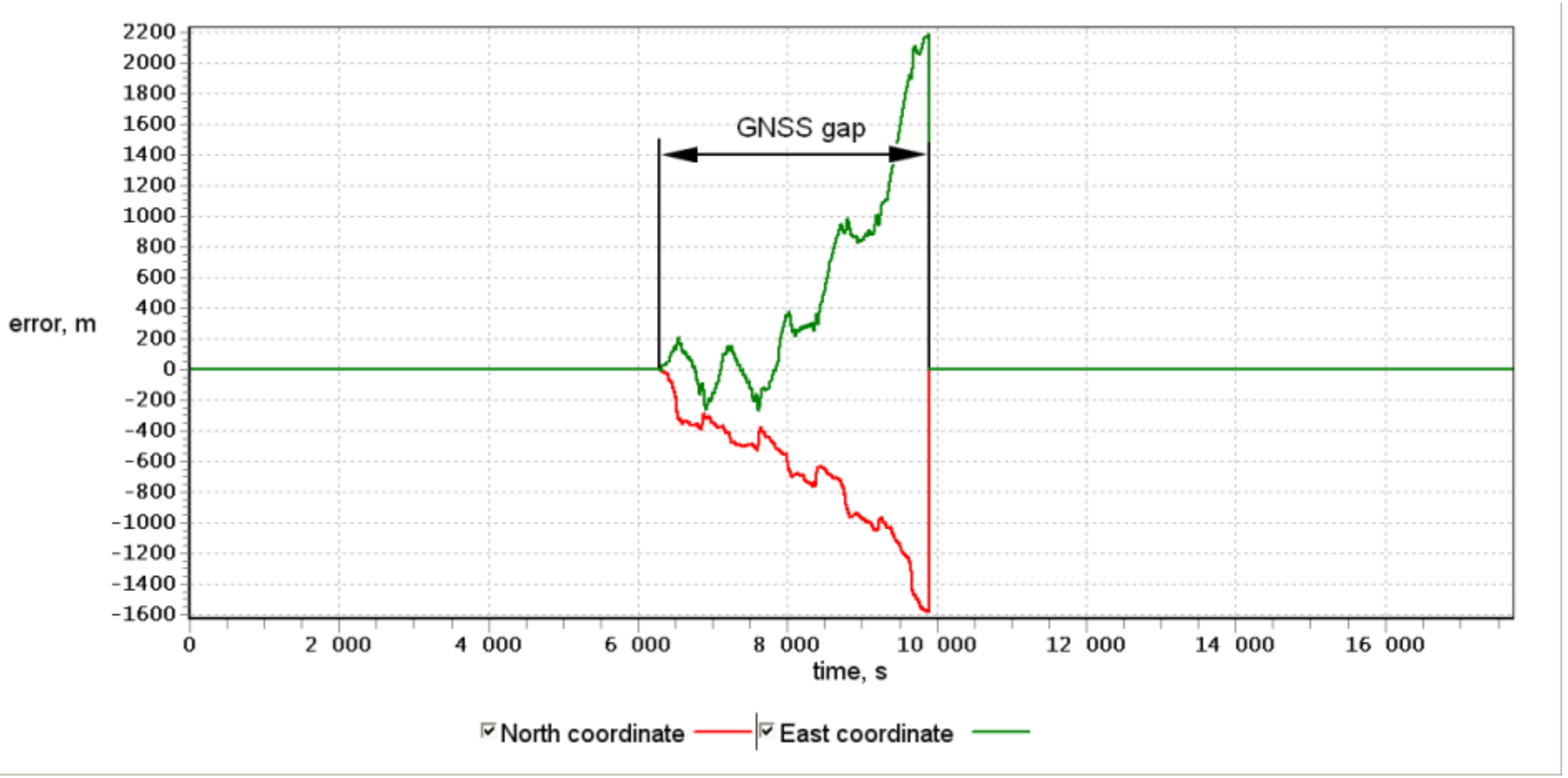

Figure 8. Position errors after GNSS-aided alignment (1 hour GNSS gap)

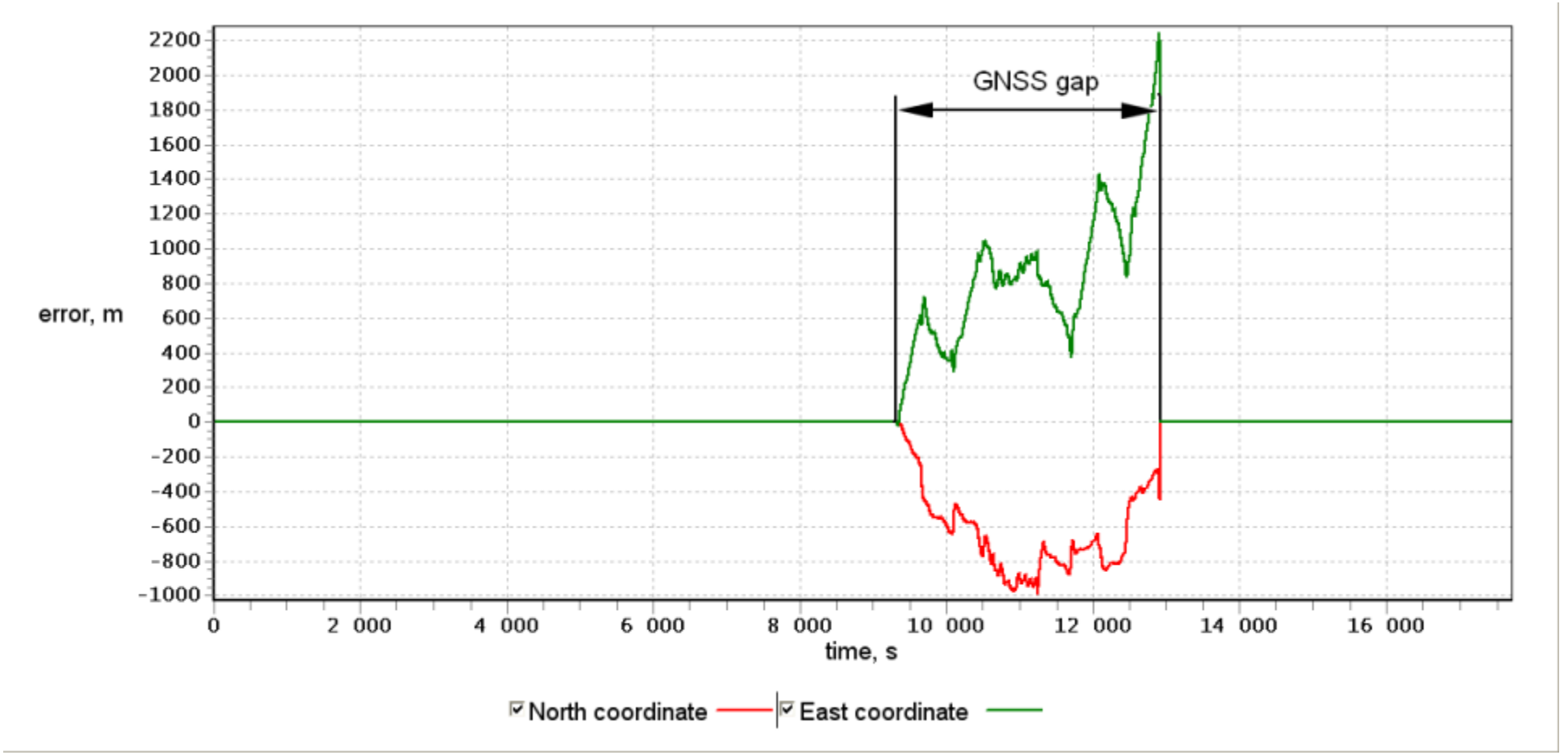

Figure 9. Position errors after GNSS-aided alignment (1 hour GNSS gap)

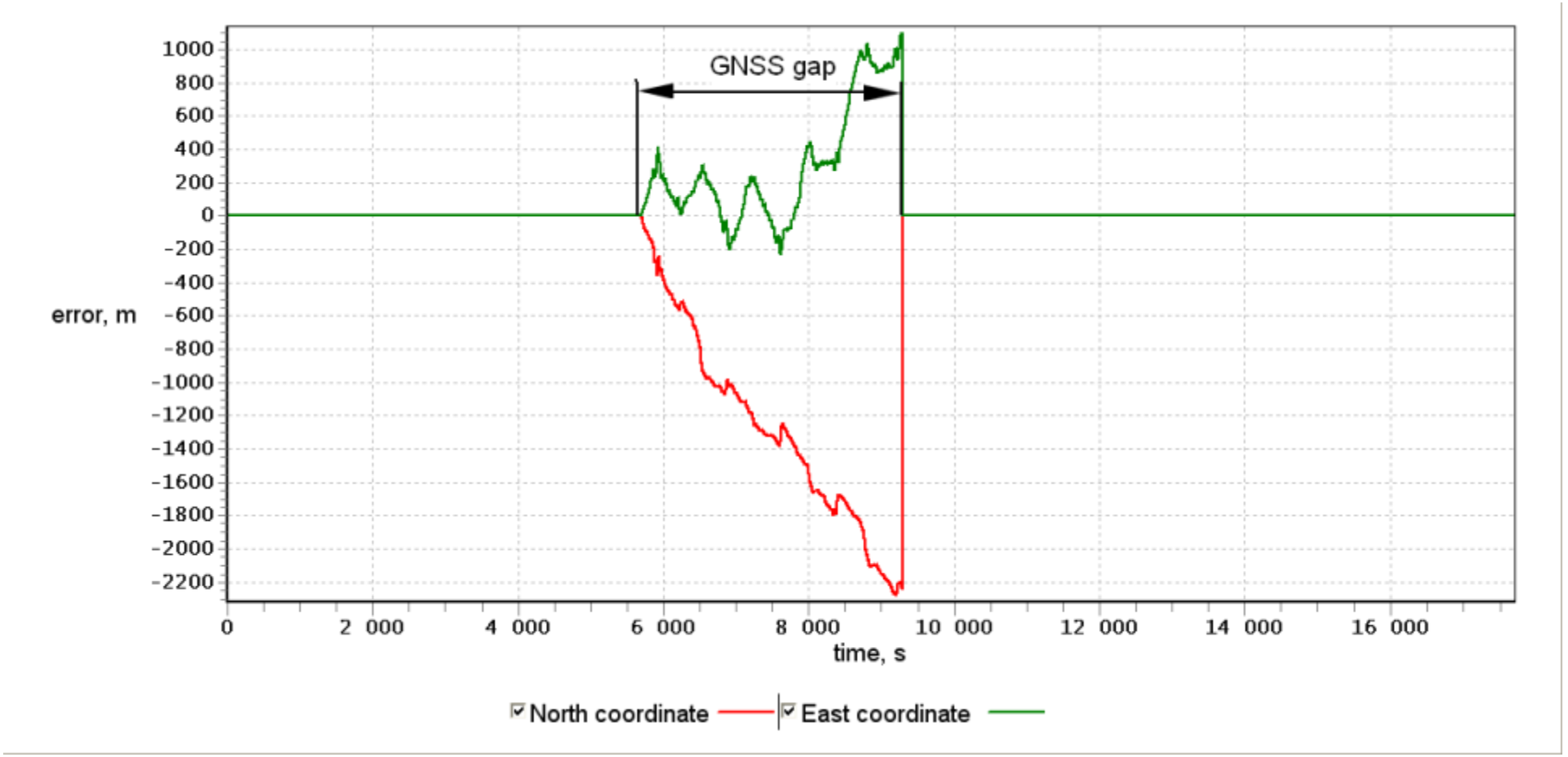

Figure 10. Position errors after GNSS-aided alignment (1 hour GNSS gap)

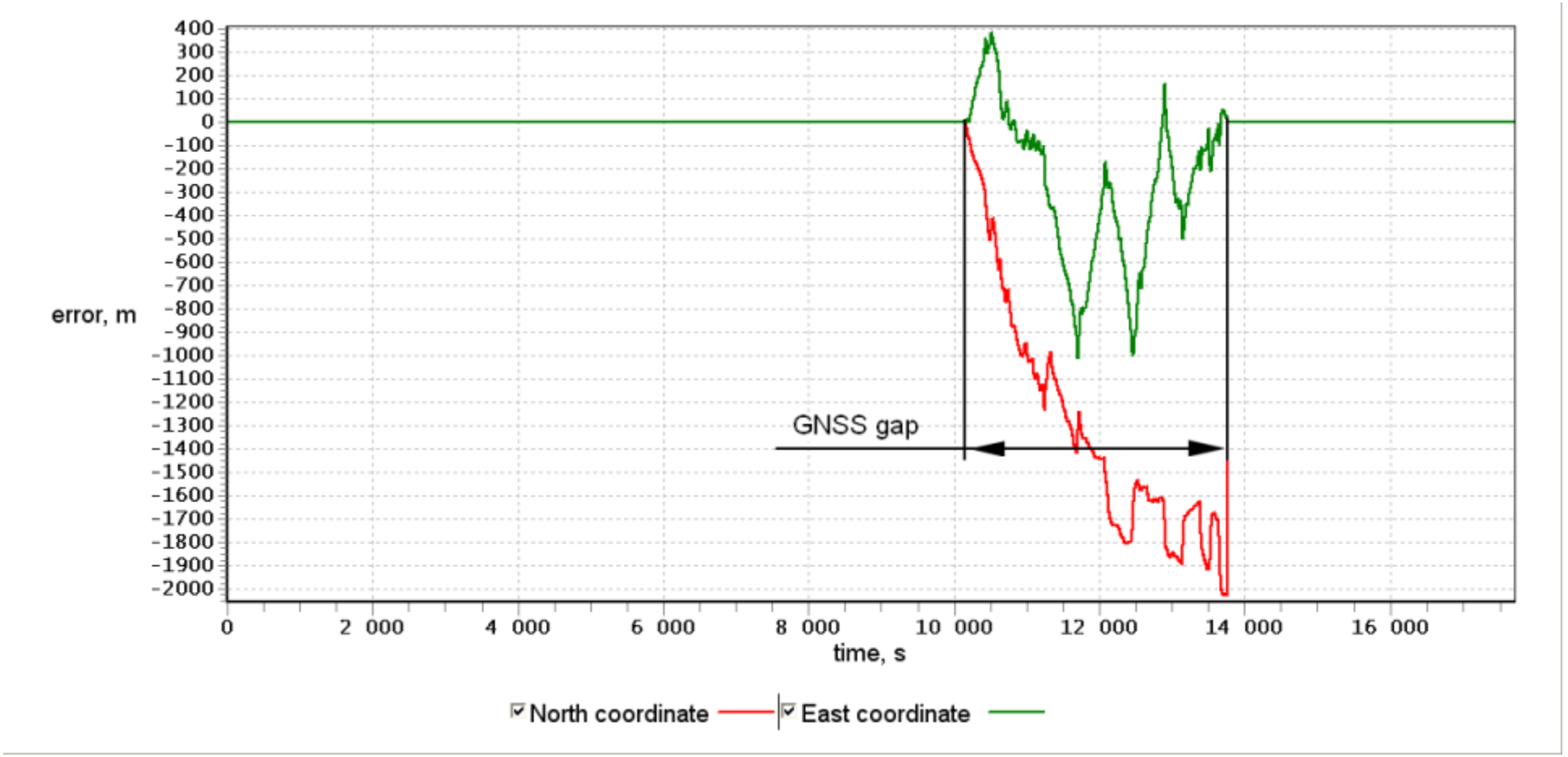

Figure 11. Position errors after GNSS-aided alignment (1 hour GNSS gap)

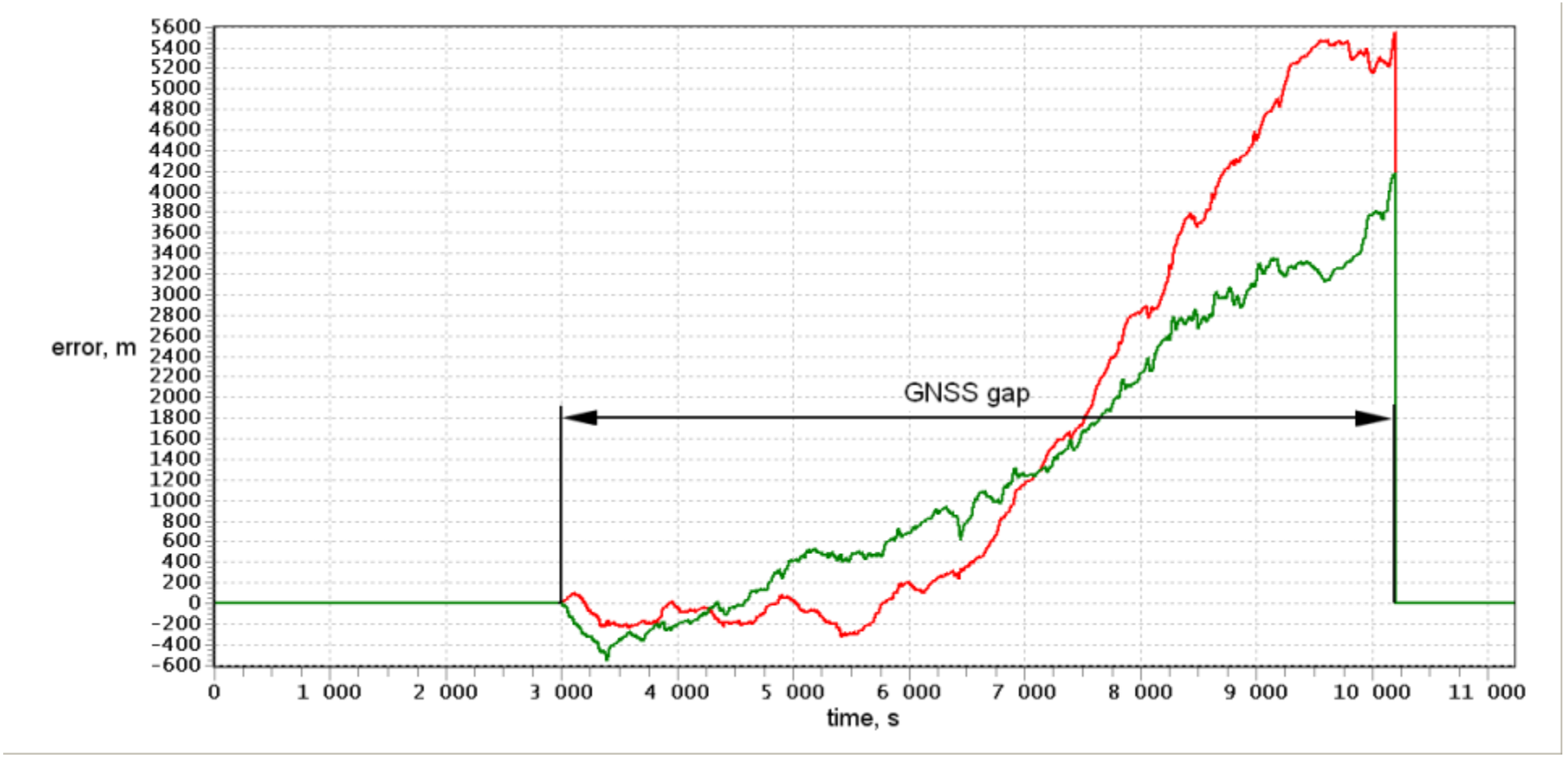

Figure 12. Position errors after GNSS-aided alignment (2 hour GNSS gap)

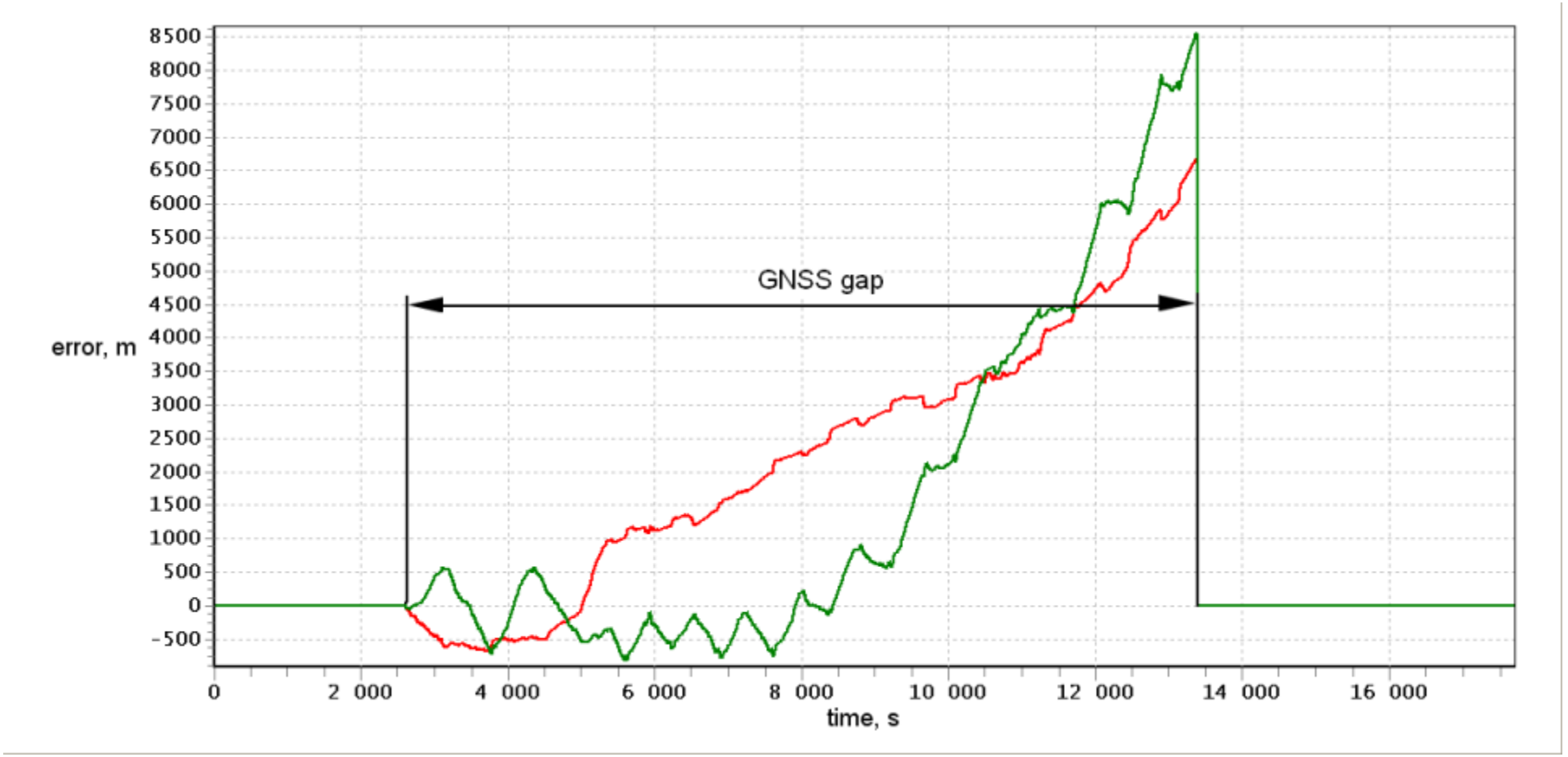

Figure 13. Position errors after GNSS-aided alignment (2 hour GNSS gap)

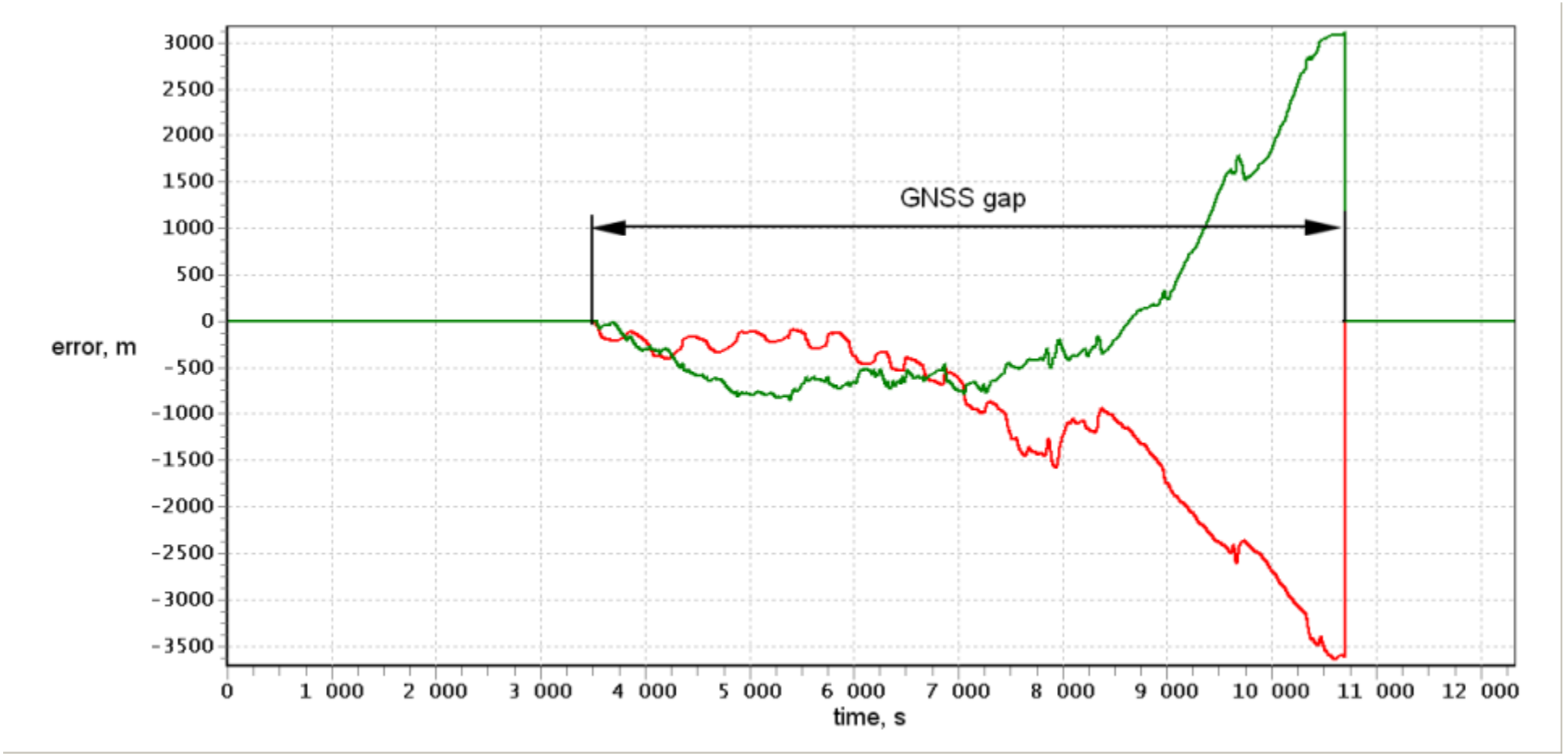

Figure 14. Position errors after GNSS-aided alignment (2 hour GNSS gap)