

Interoperability of GLONASS observations for RTK positioning applications

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1 Introduction

State of the art geodetic satellite receivers are capable of tracking GPS and GLONASS satellites and use data from both systems to determine a combined position solution. Contrary to GPS, GLONASS uses Frequency Division Multiple Access (FDMA) to uniquely identify satellites. Therefore, each satellite in view broadcasts signals on slightly different frequencies, which introduces code and carrier phase inter-frequency biases on the receiver.

In modern GLONASS receivers, the magnitude of the differential inter-frequency biases for a homogeneous pair of receivers is usually less than the measurement noise and therefore not significant for RTK positioning. However, when mixing receivers of different manufacturers, the code and phase measurements may be affected by significant inter-frequency biases. In this case, the presence of differential inter-frequency biases limits interoperability.

In this paper the interoperability of GLONASS observations is examined. It is demonstrated how state of the art receivers have to handle inter-frequency when receivers from different manufacturers are combined in order to obtain the best rover position.

2 GLONASS

2.1 History

The first satellite of the Russian Global'naya Navigatsionnaya Sputnikovaya Sistema (GLONASS) was launched in 1982 only four years after the first GPS satellite was put into orbit. Both navigation systems have a nominal constellation of 24 satellites. Today, GPS is exceeding the nominal constellation by having 31 active satellites in space (08.12.2008, US Naval Observatory). On the contrary, GLONASS never reached the nominal constellation. The main reasons were funding limitations and the short lifetime of the satellites. This trend changed in the last years. In 2006 \$200 million were allocated to GLONASS which was increased to \$418 million in 2007. In September 2008 Prime Minister Putin signed a directive for additional \$2.6 billion to develop GLONASS (GPS Daily, 2008). As a direct consequence of the restored funding the number of satellite launches per year has doubled. Since 2007 six instead of three satellites are put into orbit each year.

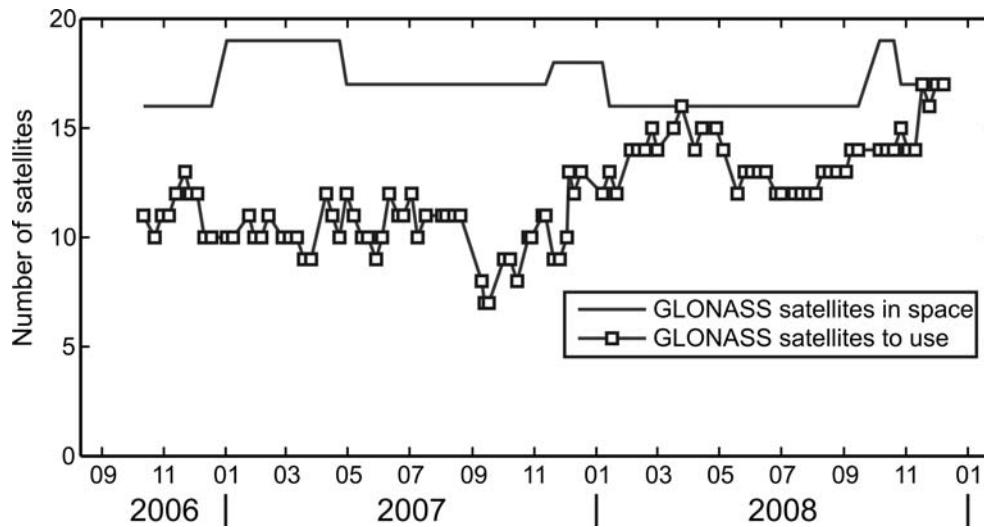


Fig. 1: Number of GLONASS satellites in space and number of active satellites (data derived from daily reports of GLONASS Information Analytical Center, 2006-2008)

Figure 1 shows the number of GLONASS satellites in space and the number of useable satellites for the last two years. Although the number of satellites in space was constantly between 16 and 19 no more than 12 satellites could be used until December 2007. Only recently the number of useable satellites matched the number of satellites in space. Currently (09.12.2008) all 17 satellites in space can be used.

2.2 Carrier frequencies

Today, GPS and GLONASS satellites transmit signals in two frequency bands L1 and L2. In order to uniquely identify a satellite both systems use different strategies. GPS is based on Code Division Multiple Access (CDMA), where every GPS satellite is transmitting a different code modulated on the same carrier frequency. GLONASS uses Frequency Division Multiple Access (FDMA). Therefore, every GLONASS satellite transmits the same code but modulated on a different carrier frequency. The carrier frequency of an individual GLONASS satellite can be calculated by adding an offset to the defined base frequency, see table 1.

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