Geodetic data analysis of VGOS experiments

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Abstract

Very Long Baseline Interferometry (VLBI) serves as one of the common geodetic methods to define the global reference frames and monitor Earth’s orientation variations. The technical upgrade of the VLBI method known as the VLBI Global Observing System (VGOS) includes a critical re-design of the observed frequencies from the dual band mode (S and X band, i.e. 2 GHz and 8 GHz) to observations in a broadband (2 - 14 GHz). Since 2019 the first VGOS experiments are available for the geodetic analysis in free access at the International VLBI service for Geodesy and Astrometry (IVS). Also regional-only subnetworks such as European VLBI stations have succeeded already in VGOS mode. Based on these brand-new observations we review the current geodetic data analysis workflow to build a bridge between geodetic observed delays derived from different bands.

1 Introduction

Very Long Baseline Interferometry (VLBI) is the widely used radio observation method to measure the time delays of arriving wave front from the extremely remote radio sources (i.e. quasars) simultaneously at the stations separated by thousands of kilometers. The obtained time delays are correlated at each observation moments to define the standard geodetic parameters: global reference frames and Earth’s orientation variations. Among the other geodetic methods, the geodetic VLBI analysis allows the evaluation of all set of variables: the station positions, source positions and Earth rotation variations as independent parameters. In the last 30 years the VLBI observations have grown into one of the major contributions into the primary geodetic products such as International Terrestrial Reference Frame and Earth Orientation Parameters. The geodetic products improvement is associated closely with technical development. At this moment when the broadband observations are mastered, we can deal with an adjustment of the geodetic analysis. In the beginning, we consider the broadband delays split in 4 single bands in comparison with dual bands (S and X bands) used in the geodetic analysis before, as well as group delays already collapsed in a single band combination. Next, session-wise geodetic parameters such as clock polynomials, zenith wet delays and gradients are reviewed.

2 VGOS experiments

The next generation of the VLBI observations are similar to usual VLBI sessions: VGOS are organized as sessions
of a limited duration repeated 2-3 times per month on a
defined network [1]. 22 VGOS experiments were released
in 2019 at the IVS website. A maximum 8 stations
supplied with broadband receivers participated:
GGAO12M, ISHIOKA, KOKKE12M, ONSA13NE,
ONSA13SW, RAEGYEB, WESTFORD, WETTZ13S.
The processed broadband delays calculated by the MIT
Haystack correlator are set to 6 GHz band which is the
closest band to the X band used in geodetic analysis
before. Their experiment duration lasts 24 hours which is
most common length of VLBI sessions. On a local
European Network 3-12 experiments of 6 hours duration
were observed in 2018 – 2019. These experiments include
RAEGYEB in Spain, Onsala Twin Telescopes and
broadband twin antenna at Wettzell Observatory in
Germany. Broadband observations for this network were
correlated in Bonn independently.

3 Geodetic Analysis

In dual band approach the linear combination of S and X
bands was used to correct observations for ionospheric
distortions. The stochastic parameters are evaluated by
means the various methods of the least squares adjustment
based on the X band observations only. The broadband
VGOS observations are processed preliminary using
minimal parameter number to validate the obtained
delays. At this step we consider both global and local
VGOS experiments are eligible for this analysis. And
mainly we pay attention to the sessions-wise geodetic
parameters which represent reasonable variations. Also,
we discuss an efficiency of an assessment of station
positions, source coordinates and Earth Orientation
Parameters (EOP).

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5 References

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