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Geodetic data analysis of VGOS experiments

Walter Alef[1], Yngvild L. Andalsvik[2], James M. Anderson[3],[4], Simone Bernhart[5], Johannes Böhm[6], Johannes Boumann[7], Yoon Kyung Choi[5], Francisco Colomer[8], Gerald Engelhardt[7], Claudia Flohrer[7], Anastasiia Girdiuk[7], Javier Gonzalez[9], Jakob Franz Gruber[6], Rüdiger Haas[10], Roger Hammargren[10], Martin Hohlneicher[7], Frederic Jaron[1], Okky S. Jenie[3],[4], Niko Kareinen[11], Laila Løvhøiden[2], Elena Martinez[9], Iván Marti-Vidal[12], Alexey Melnikov[13], Arno Mueskens[1], Alexander Neidhardt[14], Axel Nothnagel[6], Leonid Petrov[15],Christian Plötz[7], Helge Rottmann[1], Tuomas Savolainen[16], Matthias Schartner[6], Harald Schuh[4], [3], Torben Schueler[7], Des Small[8], Arpad Szomoru[8], Daniela Thaller[7], Dieter Ullrich[7], Eskil Varenius[10],[17], Harro Verkouter[8], Pablo de Vicente[9], Jan Wagner[1], Minghui Xu[16] and Nataliya Zubko[11]

(1) Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, 53121 Bonn, Germany
(2) Norwegian Mapping Authority, Global Geodesy, Kartverksveien 21, 3511 Hoenefoss, Norway
(3) Technische Universität Berlin, Straße des 17. Juni 135, 10623 Berlin, Germany
(4) GFZ German Research Centre for Geosciences, Department 1: Geodesy, Telegrafenberg, 14473 Potsdam, Germany
(5) Reichert GmbH, Hittorfstr. 26, 53129 Bonn, Germany
(6) TU Wien, Wiedner Hauptstraße 8, 1040 Wien, Austria
(7) The Federal Agency for Cartography and Geodesy (BKG), Frankfurt am Main, 60598, http://www.bkg.bund.de
(8) Joint Institute for VLBI ERIC, Oude Hoogeveensedijk 4, 7991 PD Dwingeloo, Netherlands
(9) National Geographical Institute, Observatorio de Yebes, Cerro de la Palera S/N, 19141 Yebes, Spain
(10) Department of Space, Earth and Environment, Chalmers University of Technology, Onsala Space Observatory, 439 92 Onsala, Sweden
(11) Finnish Geospatial Research Institute, National Land Survey of Finland, Opastinsilta 12, Helsinki, 00520, Finland
(12) University of Valencia, Astronomy and Astrophysics, Dr. Moliner, 50, 46100 Burjassot, Spain
(13) Institute of Applied Astronomy of the Russian Academy of Sciences, Kutuzov embankment, 10, St Petersburg, Russia
(14) Technical University of Munich, Forschungseinrichtung Satellitengeodäsie, Arcisstrasse 21, 80333 Muenchen, Germany
(15) NASA Goddard Space Flight Center
(16) Aalto University Department of Electronics and Nanoengineering, PL 15500, FI-00076 Aalto, Finland
(17) Jodrell Bank Centre for Astrophysics, The University of Manchester, Oxford Rd, Manchester M13 9PL, UK

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, KOKEE12M, 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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