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PREFACE

Preface to the special issue on CONT17

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This special issue of the Journal of Geodesy gathers together many scientific papers related to CONT17, a campaign of continuous Very Long Baseline Interferometry (VLBI) sessions lasting for 15 days from November 28 to December 12, 2017. The topics covered span a broad range and include articles on organization and planning of CONT17 (Behrend 2020), hardware used in CONT17 (Sekido 2021), geophysical signals observed in the CONT17 data, CONT17 as a measure of the accuracy of VLBI (MacMillan 2022), the comparison of VLBI results with that of other techniques and other issues.

CONT17 is the latest of a series of continuous campaigns organized by the International VLBI Service for Astrometry and Geodesy (IVS). These campaigns occur roughly every three years, and the earlier IVS campaigns were CONT02, CONT05, CONT08, CONT11, and CONT14. The CONT campaigns predate the IVS, which was founded in 1999. The first CONTs—CONT95 and CONT98—were coordinated by the VLBI group at NASA GSFC and involved contributions from institutions from around the world. The common thread of all CONTs is to demonstrate the state-of-the-art of geodetic VLBI at the epoch of the campaign and to provide a high-quality data set for scientific analysis.

The J. of Geodesy published a previous special issue on CONT08. This issue summarized findings on troposphere mapping functions (Heinkelmann 2011), (Teke 2011), precession and measurement of UT1 with VLBI (Nilsson 2011), comparison of VLBI derived EOP and atmospheric AAM (Schindelegger 2011), (Gambis 2011), and comparison of VLBI and GNSS derived TEC (Dettmering 2011).

At the current time, the IVS schedules about four 24-h observing sessions per week and the networks vary from session to session. Stations are known to have unmodeled seasonal and secular motion of a few mm in the horizontal directions and up to ten mm in the vertical (MacMillan 2000; Ding 2005). One expects this motion to be reduced over a short period of time. Furthermore (apart from equipment failures), the CONT networks remain the same over the entire two-week period so one does not have to worry about discontinuities introduced by changing networks. Hence, the CONT campaigns provide a continuous, homogeneous, high-quality data that can be used for scientific analysis in areas such as Earth Orientation Parameters (EOP), reference frame stability, atmospheric modeling, and others.

Frequently, the CONT campaigns serve as preview of routine operations a few years later. For example, the earlier CONTs focused on what were, at the time, large networks of seven or eight stations (so called ‘golden-global’ networks). It is now routine to observe with 14 stations, and observations with 20 or more stations are not uncommon. The earlier CONTs also showcased new VLBI techniques, such as increasing the frequency bandwidth or increasing the number of bits recorded. Both of these increase the precision of the VLBI observable and have since become part of routine VLBI observations.

CONT17 was unique in that we had three independent VLBI observing networks (Behrend 2020): two legacy S/X networks of 14 stations each that observed for 15 days, and a VLBI Global Observing System (VGOS) network of six stations that observed continuously for five days. This allows us to compare results across networks (Kwak 2022). This ambitious experiment stressed all aspects of the IVS—stations, operation centers, coordinating center, analysis center, and the correlators—and involved substantial planning and coordination. In addition to successfully observing CONT17, the IVS also needed to continue to produce operational products in a timely fashion.

The presence of three independent networks means that we can compare results between the networks to see how well they agree. Raut (2022) compared the measurement of UT1-UTC between the three CONT networks and also included the 1-h IVS Intensive series during this time. MacMillan (2022) did the same sort of analysis for all 3 components of EOP. This gives us an estimate of the intrinsic accuracy of VLBI or precision. Diamantidis (2021) and MacMillan

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(2022) compared the polar motion estimates from VLBI and GNSS to give an another measure of accuracy. This comparison also extends to other products such as station position or atmosphere zenith delay (Kitpracha 2022). The continuous nature of the observing means that we can study variations in signals with periods of a few days, something that is difficult or impossible to carry out with normal VLBI observing. For example, we can compare atmospheric angular momentum (AAM) data with the EOP estimates obtained during the CONT period.

CONT17 was the first demonstration of VGOS observing for an extended time period. Compared to the legacy S/X networks, the VGOS network was small—6 stations compared to 14. The S/X networks were designed to have global coverage. In contrast, all of the VGOS stations were in the northern hemisphere and occupied the relative narrow latitude range between 22.16°N (Kokee Park, Hawaii) and 49.15°N (Wettzell, German). In spite of these limitations, the UT1 estimates from the VGOS network were comparable in precision to the much larger S/X networks (MacMillan 2022). A VGOS network comparable in size to the CONT17 S/X networks should thus provide much more precise geodetic estimates than those from the corresponding S/X network, a hypothesis that the unrelenting rollout of the VGOS network will soon enable testing.

The CONT campaigns also serve as arenas to test new analysis strategies. For example, a known problem in VLBI is the issue of source-structure. This becomes more important in VGOS observing because of the higher precision of the delay observable—a few picoseconds (ps) compared to the more typical 30 ps in S/X observing (Xu 2021). Over long periods of time, the source image changes, which means that the effects of source structure also change. However, over periods of a few days, such as the CONT campaigns, it may be reasonable to assume that the source remains approximately stable. In this approximation, source structure effects depend only on the observing network, the source image, and the Greenwich Sidereal time (GST) of the observation. Hence, CONT17 with its homogeneous network and continuous observing provides an ideal test-bed for studying different ways of removing source structure (Xu 2021).

To conclude, we want to thank all of the individuals and institutions who helped make CONT17 a success:

- The IVS Coordinating Center which coordinated the entire effort and wrote the schedules.
- The station personnel who operated the stations around the clock for 15 consecutive days.
- The Washington correlator which took over the processing of the regular IVS sessions from November 2017 to April 2018 so there was no interruption in the regular IVS EOP data products.
- The Astro/Geo Correlator at MPIfR Bonn, Germany, and the National Radio Astronomy Observatory in Socorro, USA, which correlated the two legacy S/X networks in CONT17.
- The MIT Haystack Observatory correlator that correlated the VGOS network.
- The IVS Data Centers at BKG, Paris Observatory, and NASA GSFC that made the data products available.
- The many scientists at the IVS Analysis Centers who analyzed the data and provided new insights into the accuracy of VLBI.

CONT17 is an example of the cooperative nature of VLBI at its very best.

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