EFFECT OF VLBI INTENSIVE SESSIONS ON DAILY AND SUB-DAILY ERP DETERMINED FROM CONT17 IVS DATA

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ABSTRACT. This work deals with validating the established approach of analyzing VLBI intensive sessions to determine dUT1. VLBI sessions from the CONT17 campaign are chosen as they provide continuous VLBI observations over two weeks (28th Nov - 12th Dec 2017) of the currently highest quality. For the standard 24-hour sessions in this campaign, two different legacy networks were involved, the legacy-1 network, which was entirely based on IVS network stations with global distribution, and legacy-2 network involving VLBA and a few IVS network stations for the global extension. In addition to these 24-hour sessions, two different IVS and one Russian intensive sessions were observed every day during CONT17. The dUT1 determined from the intensive sessions are compared with daily and hourly dUT1 from 24-hour sessions during this 15-day time-frame. The results show that the dUT1 determined from intensive sessions do not show good agreement with daily dUT1 from 24-hour sessions; however, it shows better agreement with hourly dUT1.

1. INTRODUCTION

Very long baseline interferometry (VLBI) is a microwave-based space geodetic technique that measures the difference in arrival time of signals from extra-galactic radio source (e.g., the Quasars) received simultaneously at two or more radio telescopes. VLBI is one of the high precision space geodetic techniques which can provide the full set of the Earth orientation parameters (EOP). The EOP represent the link between the Terrestrial reference frame (TRF) and the Celestial reference frame (CRF). The EOP consist of five angles, namely x_p and y_p the pole coordinates describing the polar motion, UT1−UTC correcting the phase of the rotation angle Ω UT1(Ω is the nominal Earth angular velocity), and celestial pole offsets (CPO) (dX,dY).
The International VLBI Service for Geodesy and Astrometry (IVS) normally conducts two types of VLBI network sessions, 24-hour sessions, which are carried out about three days per week, and the hour-long one-baseline intensives which are carried out daily. The intensives are used to determine UT1-UTC on a daily basis, whereas the 24-hour sessions give the complete set of EOP several times per week. The so-called dUT1 value is determined from the one-hour intensive VLBI daily session carried out on one baseline. During the analysis of intensive session, parameters like dUT1, single clock offset, and zenith wet delay are estimated whereas other parameters such as polar motion (PM), celestial pole offsets (CPO), station and source coordinates and tropospheric gradients are fixed to their a priori values respectively. Such kind of parameterization is chosen as there are not enough observations per parameter. Besides, the station coordinates cannot be estimated as one baseline is insufficient to fix the degree of freedom of the terrestrial basis. As intensive sessions contain observations during one hour, they give rise to correlations between CPO and terrestrial pole coordinates. The dUT1, which is estimated from this approach, may contain inaccuracies.

Whereas analyzing 24-hour VLBI sessions, the parameters which were fixed to their respective a priori values in the approach mentioned above, are estimated in this approach. This is possible as the 24-hour sessions contain multiple baselines and enough observations per parameter.
This can be validated by comparing dUT1 values derived from intensive sessions and 24-hour VLBI sessions considering their different observation intervals through sub-daily parameterization. This gives an idea of how different parameterization can affect dUT1 determination. For this work, we chose the continuous VLBI campaign CONT17. Such campaign, that take place every three years intend to have continuous VLBI observations over two weeks. The CONT17 campain differed from the previous ones, as the observations were carried out by three independent networks: two legacy networks observed at S/X band, one VGOS network performed broadband observing. During these 15 days, 24-hour sessions took place daily, along with two intensive sessions.

2. CONT17 campaign

The campaign began on Tuesday, 28th November 2017, at 00:00:00 UT, and it concluded on Tuesday, 12th December 2017, at 23:59:59 UT. The geographical positions of the stations that participate in this CONT17 campaign can be seen in Figure **??**.
The number of observations during the CONT17 period are shown in Figure **??**. The observations in a single session in the legacy-1 network are around 10,000, and legacy-2 has around 15,000 observations. Besides, we have 5 VGOS sessions from 4th December to 8th December, and every session has around 3000 - 4000 observations. The Badary-Zelenchk (Russian) intensives have approximately 25 observations in a single session, and the Kokee-Wettzell (IVS) intensives have around 18 observations except for four days where it has approximately 30 observations.

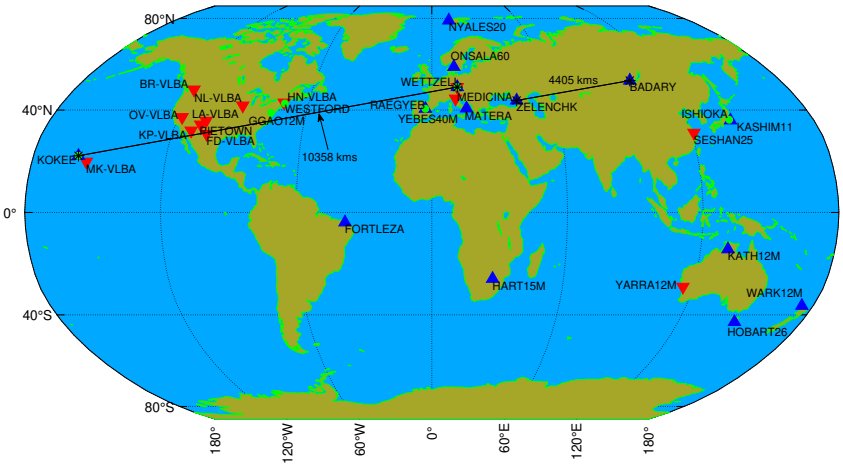

Figure 1: Geographical representation of the stations of the various network. Legacy (S/X) stations in VLBA network (marked as the red triangle), IVS network (marked as the blue triangle); VGOS stations are represented by a Green circle; stations which participate in intensives are indicated by a black cross and their baselines are represented by a black solid line.

3. METHODOLOGY

We will validate the credibility of the two methods, which estimate dUT1 from intensive and 24-hour sessions, respectively. The dUT1 is estimated using VieVs@GFZ software The dUT1 estimated from intensive sessions are compared with daily dUT1 and hourly dUT1 values derived

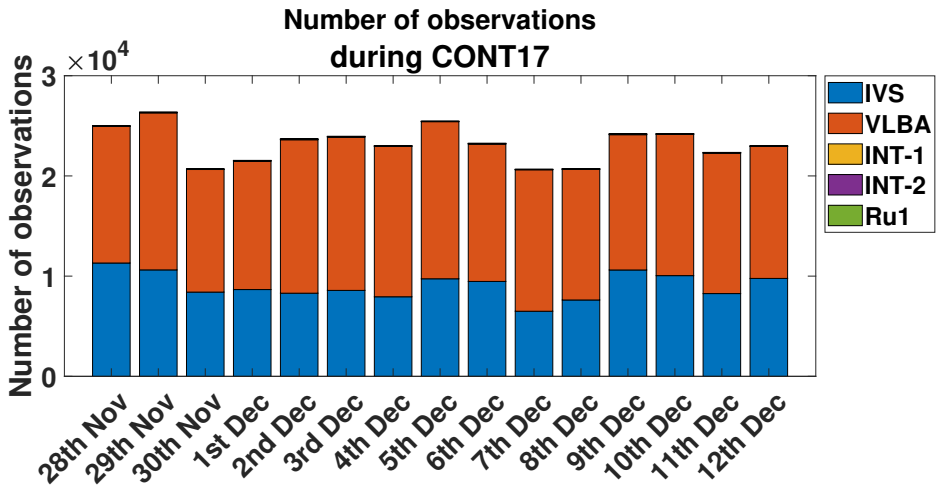

Figure 2: Number of VLBI observations during CONT17 campaign. (observations from VGOS are not included)

from 24-hour sessions, respectively.

4. RESULTS

The Figure **??** shows a comparison of dUT1 estimated from two intensive baselines, i.e., Kokee-Wettzell (IVS), and Badary-Zelenchk (Russian) during the 15 days. We can observe that dUT1 estimated from Russian intensives have higher formal errors as compared to IVS intensives. The main reason for this is due to the different baseline length, and dUT1 is sensitive to a more extended east-west baseline. Since Russian intensive (4405 km) has a shorter baseline than IVS intensive (10358 km), resulting in higher formal errors in dUT1. Now, the dUT1 from the intensives are

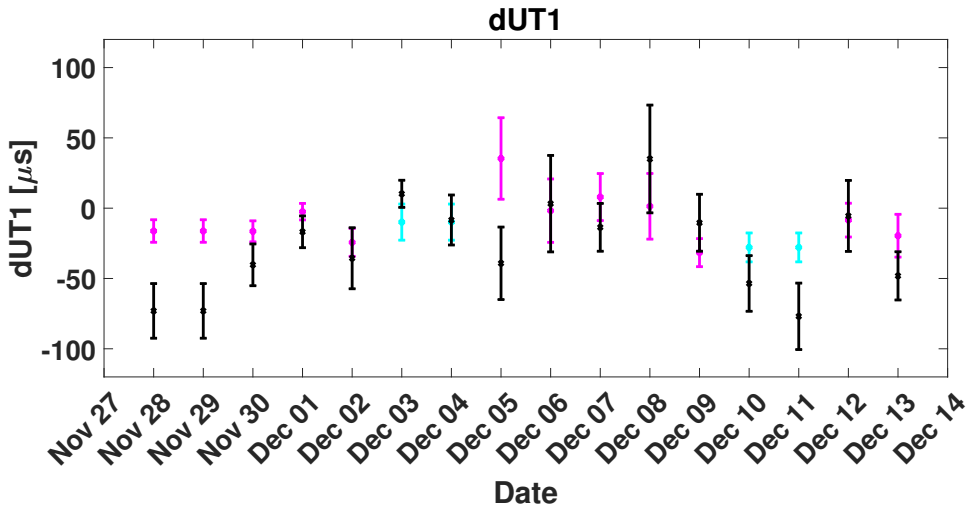

Figure 3: dUT1 from IVS and Russian intensives sessions; Magenta, cyan and black points represents dUT1 from IVS(INT-1), IVS(INT-2), and Russian intensives respectively.

plotted against daily dUT1 values from 24-hour sessions in the Figure **??**. It can be observed that the dUT1 values from intensives do not show good agreement with daily dUT1 values from 24-hour sessions. The reason can be explained as most parameters are not estimated, i.e., fixed to a priori

values when estimating dUT1 from intensives. The inaccuracies present in the a priori values of fixed parameters, it will propagate in dUT1 determination.
As can be seen in Figure **??**, the dUT1 estimated from the intensives are plotted against hourly dUT1 estimated from 24-hour sessions. Even in this case, the dUT1 from intensives does not show a good agreement with dUT1 from 24-hour sessions. For further investigation, the root mean square of the difference between dUT1 from intensives and 24-hour session were taken. It was found that dUT1 from intensives (IVS and Russian) show slightly better agreement (7 percent) with hourly dUT1 than daily dUT1 from the 24-hour sessions. This can be because the sub-daily variations are accounted in hourly dUT1 values from the 24-hour sessions.

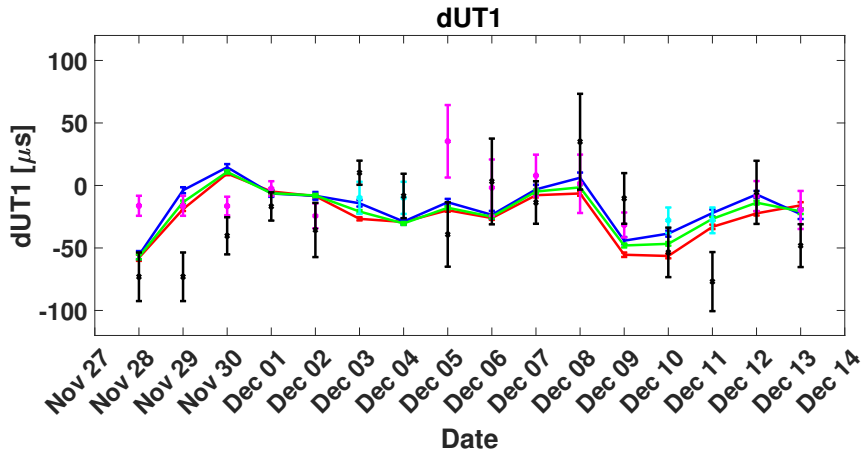

Figure 4: dUT1 from intensives and 24-hour sessions (daily). Blue, red and green lines represent daily dUT1 derived from IVS, VLBA and combined network respectively. Magenta, cyan and black points represent dUT1 from IVS(INT-1), IVS(INT-2), and Russian intensives respectively.

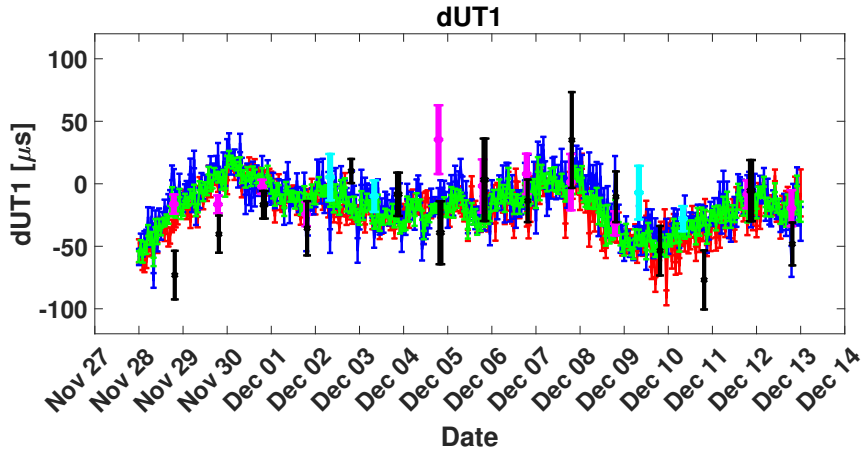

Figure 5: dUT1 from intensives and 24-hour sessions (hourly); Blue, red and green line represents hourly dUT1 derived from IVS, VLBA and combined network respectively. Magenta, cyan and black points represents dUT1 from IVS(INT-1), IVS(INT-2), and Russian intensives respectively.

5. CONCLUSIONS

The dUT1 values derived from intensives and 24-hour sessions show differences that can exceed the formal errors. The dUT1 obtained from intensive sessions show approximately 7 percent better agreement with hourly dUT1 of the CONT17 campain as compared to daily dUT1 from 24-hour sessions.

6. REFERENCES

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