Assessment of the First Use of the Uniform Sky Strategy in Scheduling the Operational IVS-INT01 Sessions

Karen Baver[1], John Gipson[1], Kerry Kingham[2], Merri Sue Carter[3]

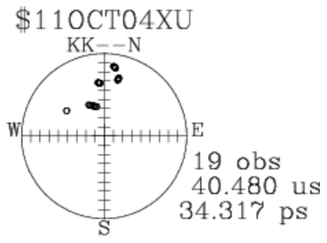
[1] NVI, Inc./NASA Goddard Space Flight Center, Greenbelt, MD, USA , [2]The United States Naval Observatory (USNO), Washington, DC, USA,
[3] The United States Naval Observatory (USNO) Flagstaff Station, Flagstaff, AZ, USA

Background

Goal: Improving the accuracy and the precision of the UT1 estimates in IVS-INT01 Intensive schedules.

Problem: Better sky coverage is empirically linked to better UT1 estimate precision and accuracy. But the original, standard ("STN") scheduling strategy uses only the strongest sources, and because strong sources are unevenly distributed, there are only a few sources available at some times of the year, resulting in bad sky coverage. The worst source availability occurs in October, but other times of the year could also use improvement.

Solution: The USS (Uniform Sky Strategy), which uses all sources that are mutually visible at the regular IVS-INT01 stations, Kokee and Wettzell. But source strength and the number of observations are believed to also play a role in the UT1 formal errors, creating trade-offs needing testing and study.

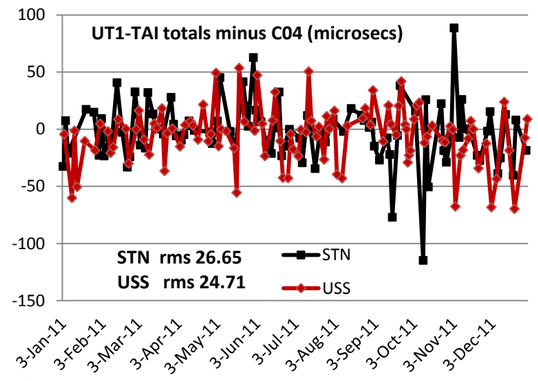


Worst STN: sky coverage and UT1 formal error in μs

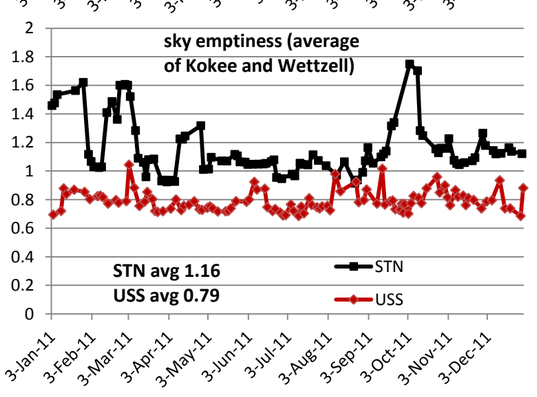
USS factors that favor UT1	USS factors that work against UT1
More sources	Weaker sources
Better sky coverage	Fewer observations

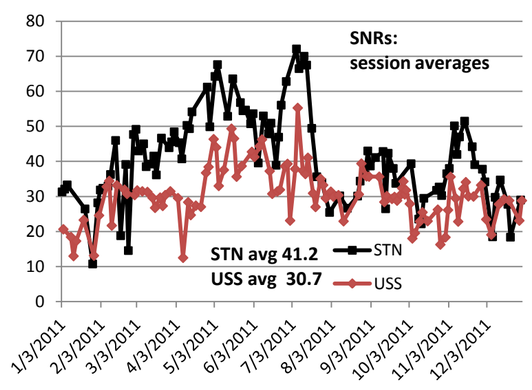
Timeline for testing the USS
July 2009 – June 2010: the GSFC Analysis Center uses R&Ds to test the USS.
July 2010 – August 2010: the NEOS Operation Center begins to alternate the STN and the USS strategies in operational IVS-INT01s for comparison.
September 2010 – November 2010: Due to repairs, the Wettzell station is replaced by alternate stations.
December 2010:to present: resumption of the scheduling of alternating STN and USS Kokee – Wettzell IVS-INT01 sessions.

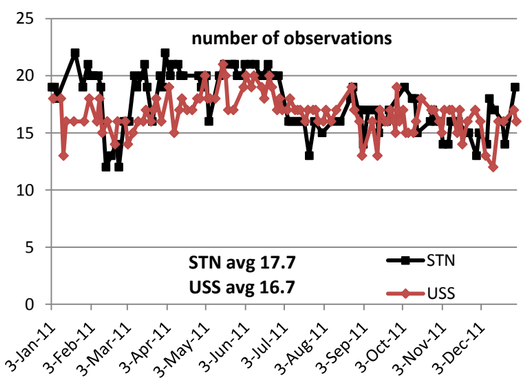
2011 Sessions: Accuracy & Results

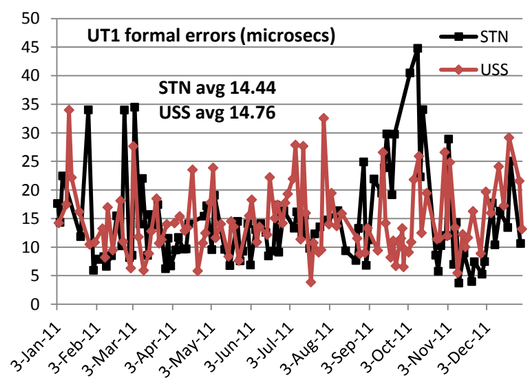


The USS UT1-TAI totals are a better match to C04. In addition, USNO has verified that the USS values are acceptable through their operational combination solutions.



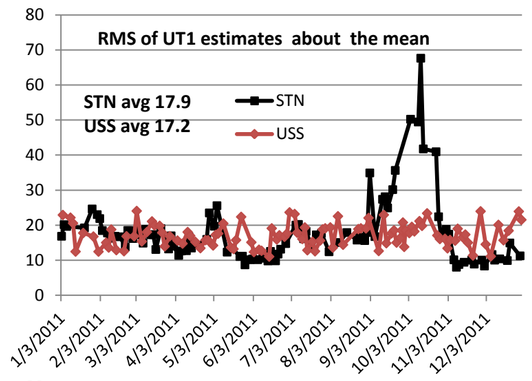


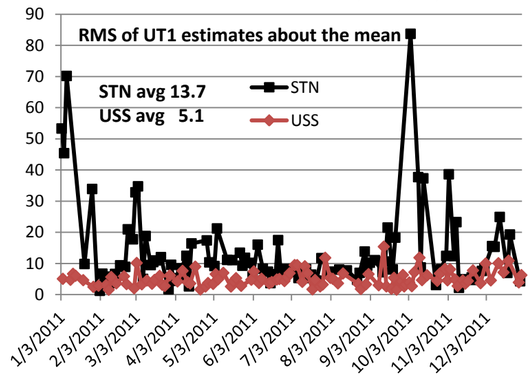




The middle left plot indirectly shows sky coverage by showing sky emptiness (the results of sampling the sky and summing the distances to the nearest observation; a smaller sum means less emptiness, or more coverage). The USS has better sky coverage, but it has slightly worse average UT1 formal errors. The October formal errors are greatly improved, but some other times could still use improvement. As expected, the USS has lower average SNRs and a lower average number of observations, both of which contribute to the higher UT1 formal errors. Other factors currently under investigation may contribute as well.

Robustness Tests

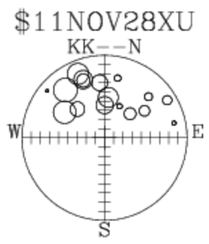


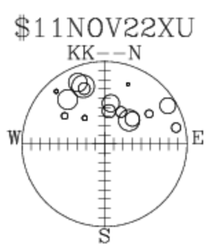


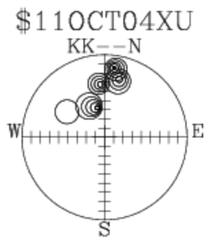
Test 1: Effect of noise on UT1 estimates.
Method: Run every 2011 session 100 times adding random noise.
Conclusion: The USS provides better protection from noise overall, and especially in October, the time when the STN provides few sources.

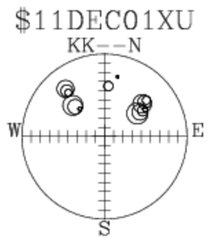
Test 2: Effect of source loss on UT1 estimates.
Method: For every 2011 session, remove every source, one at a time.
Conclusion: The USS provides much better protection against source loss than the STN**.**

Spatial vs. Temporal Coverage









The four plots at left show spatial and temporal coverage in four sessions. The circles show observation positions on an AZ-EL plot at Kokee, and the sequence of observations is shown by circles of increasing size.

Top two plots (USS): The USS gives more consistent spatial sky coverage throughout the year. But temporal coverage is a consideration in this strategy. The USS observes many sources, generally only once; depending on the order, the USS may favor one part of the sky, then leave it for another part, providing uneven sampling over time (plot 1). Even sampling also occurs (plot 2), but only by chance.

Bottom two plots (STN): The STN strategy is not temporally dependent; it uses few sources, so the schedule cycles through all sources repeatedly. The STN's coverage is spatially dependent. The few sources may be badly placed (plot 3) or well-placed (plot 4) depending on the time of the year.

Effects: Visual examination of temporal plots suggests that temporal coverage is a factor in test 1 (the effect of random noise) shown in the previous section. Plots 1 and 2 loosely correspond to variations in the USS values shown in test 1 (although low numbers of observations are also a factor). Test 1 suggests that for noise protection, spatial coverage is essential, with temporal coverage enhancing it. Plots 1 and 2 have good spatial coverage and good protection with small variations that seem related to temporal coverage. Plot 4 (representative of December) has spatial and temporal coverage at what appear to be key positions, and the best protection; this seems to be the ideal schedule for noise protection. Plot 3 (representative of October) has good temporal coverage, but it lacks spatial coverage and has bad protection. Test 1 suggests that both spatial and temporal coverage should be considered in scheduling.

Conclusions

- The USS is preferable to the STN, because it provides better protection against noise and source loss and because it improves the October UT1 formal errors. But other times still need smaller UT1 formal errors.
- Temporal coverage seems to be a factor in protecting against noise and should be investigated further and taken into account in scheduling.
- Sked should also be used to improve source strength in schedules. We have identified parameters that should make it possible to do this.
- The USS is a good first step to improving the IVS-INT01 schedules, and it should be retained but also further refined.

7th IVS General Meeting "Launching the Next-Generation IVS Network"
Madrid, Spain, 4–9 March 2012

Contact author: ***Karen Baver***
NVI, Inc./NASA GSFC, Code 698.2
Greenbelt, MD 20771, USA
karen.d.baver@nasa.gov
+1-301-614-6160