

The IGS Campaign to Measure Position Corrections for Uncalibrated IGS Radome Stations

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Abstract

The IGS, through the Infrastructure Committee, the Analysis Center Coordinator, the Antenna Working Group, the Reference Frame Working Group and the Central Bureau have organized a campaign to measure the unknown bias in the estimated position for collocated stations due to uncalibrated radomes over the GNSS antenna. The proposed approach of removing the uncalibrated radome for a significant number of weeks and then putting the radome back on in the exact same position, have been agreed by a number of relevant Station Operators. This poster presents the campaign approach, the participating stations and some initial results.

Affected Stations

Covering a GNSS antenna with a radome whose phase center variations (PCVs) have not been calibrated will usually cause an unknown bias in the estimated position for that station. This bias is equivalent to a local tie error for those IGS stations collocated with other techniques and is thus a serious concern for ITRF, which aims for tie accuracies at the 1 to 2 mm level. Radome effects can often be much larger, up to several cm. Therefore these uncalibrated radomes prevent an accurate connection between collocated space geodetic instruments and weaken the ITRF.

Absolute tie discrepancies from ITRF2008 reach up to 32 mm in North, 16 mm in East, and 99 mm in Up, although technique and tie survey errors also contribute to these. Every effort is needed at this time to reduce the uncalibrated radome effect.

This proposal considers only those un-calibrated radomes at stations that are collocated with SLR or VLBI observatories. Non-collocated stations and those near DORIS stations are NOT considered here. However, operators are strongly urged to please arrange to calibrate the un-calibrated equipment or replace it as soon as possible (please coordinate with the IGS Central Bureau and Infrastructure Committee).

Since uncalibrated radomes prevent an accurate connection between collocated space geodetic instruments and weaken the ITRF. The IGS is strongly considering to stop publishing results for the affected stations that do not respond to this solicitation with specific arrangements to resolve this issue promptly.

Proposal

All Station Operators of the stations listed in the map below, have been asked to reply with one of the following designations for each of their stations (in order of decreasing preference):

- 1. Calibration planned.** Un-calibrated equipment of exact same type will be calibrated for the absolute PCVs. Please provide details of the arrangements being made and when calibration results are expected.
- 2. Radome can be removed and reinstalled.** Please schedule a period to remove the un-calibrated radome for a period of 8 weeks to make an empirical measurement of the radome bias offset effect. See details below.
- 3. Radome cannot be reinstalled if removed.** Please provide details. In this case, we ask that operators arrange to install calibrated replacement equipment at the earliest opportunity. BUT BEFORE DOING SO, please arrange to remove the radome for an 8-week period just before the new equipment is installed in order to determine the empirical radome offset to correct the historic time series.
- 4. Radome cannot be removed without destroying entire antenna assembly.** Please provide details. In this case, we ask that operators arrange to install calibrated replacement equipment at the earliest opportunity. For these stations the historic time series will never be reliable for local ties between techniques.

So far Station Operators have agreed only with **Option 2** as most assemblies are not subject to calibration either with a field robot or in a chamber.

Station Participation so far

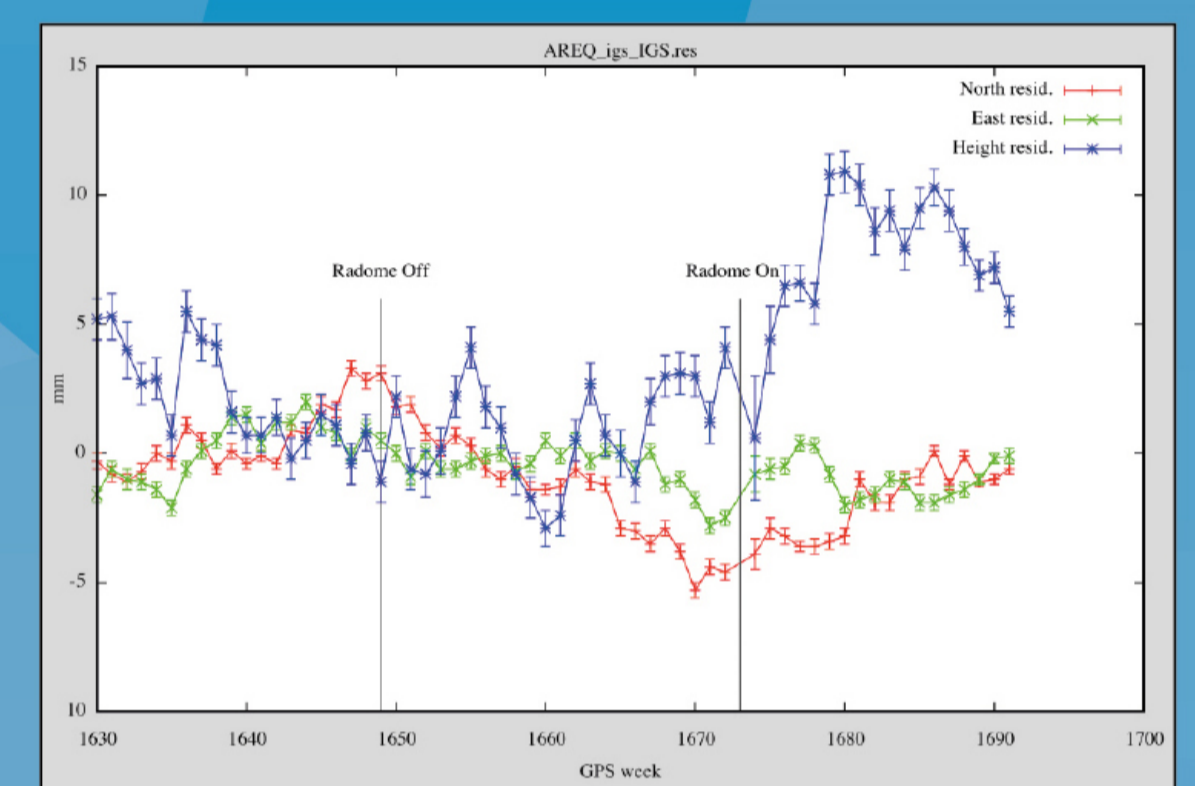
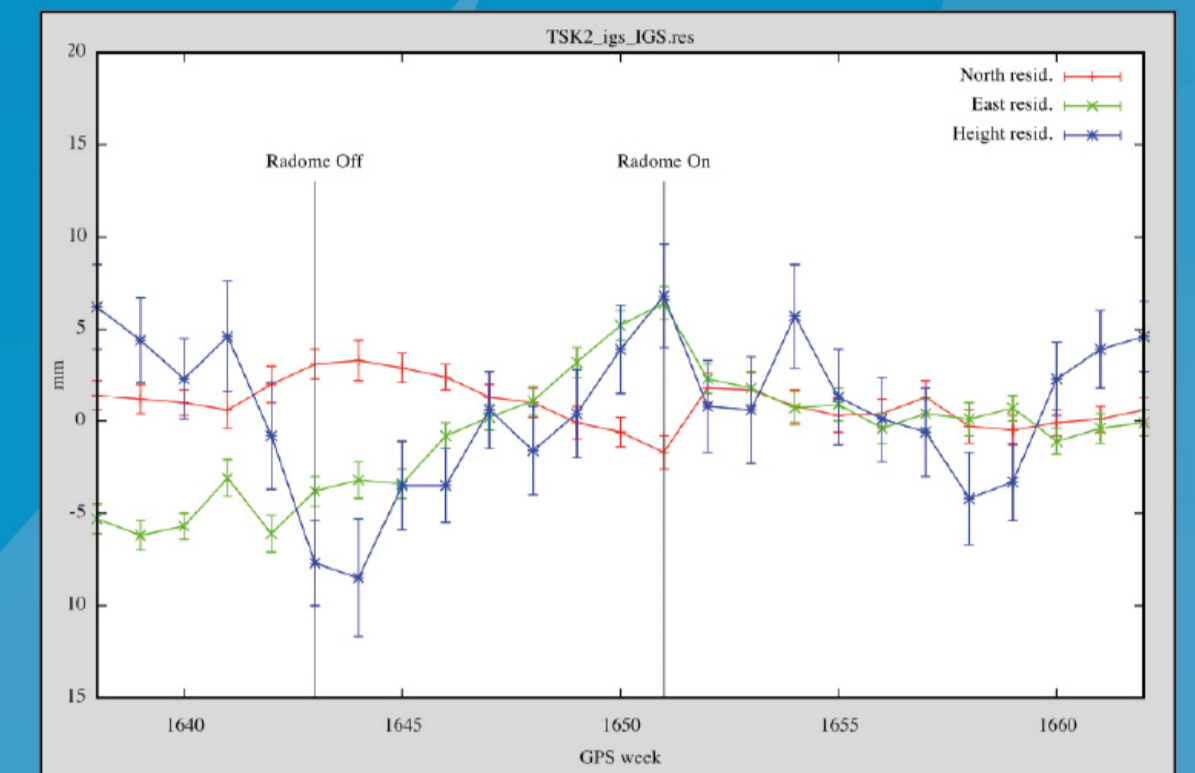
Station	Radome Removal	Re-Installation
CRO1	01-Apr-2011	24-Jun-2011
TSKB	01-Jul-2011	30-Aug-2011
TSK2	01-Jul-2011	30-Aug-2011
AREQ	19-Aug-2011	03-Feb-2012
FAIR	28-Apr-2012	Not yet
YAR2	28-Apr-2012	Not yet
GODE	06-Jul-2012	Not yet

Radome-Off Test Candidate Stations

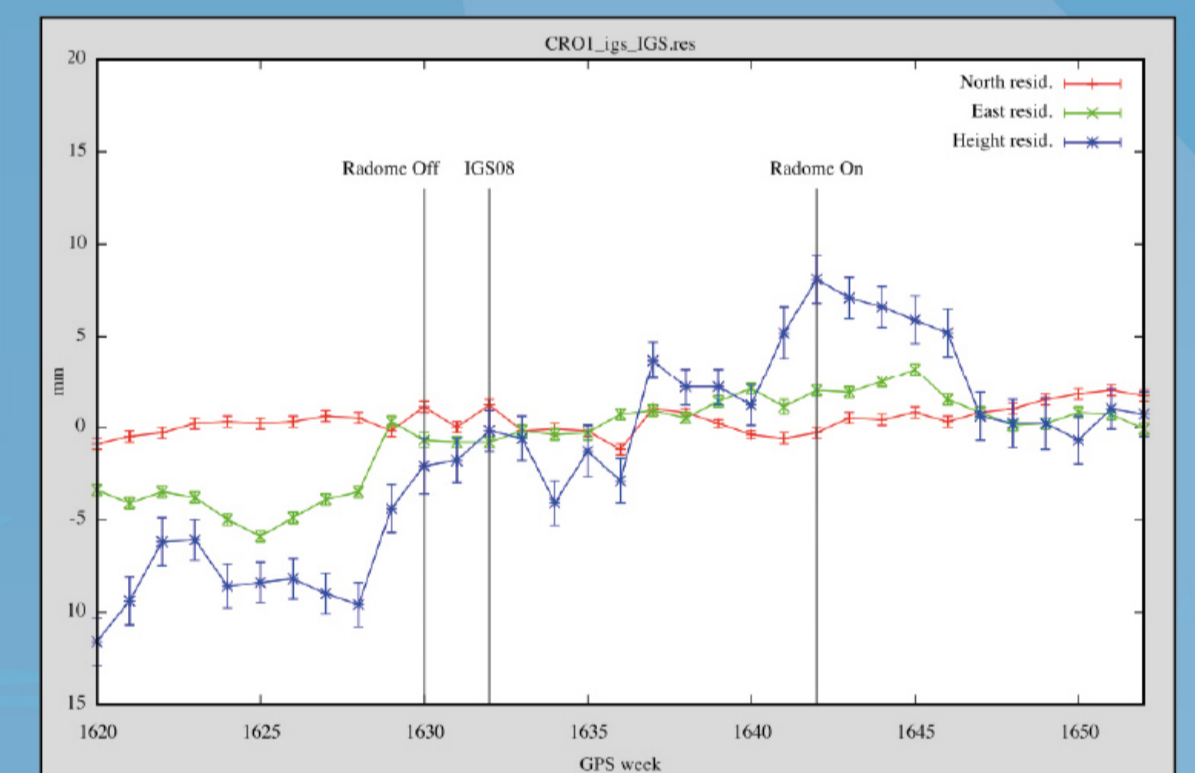


Results

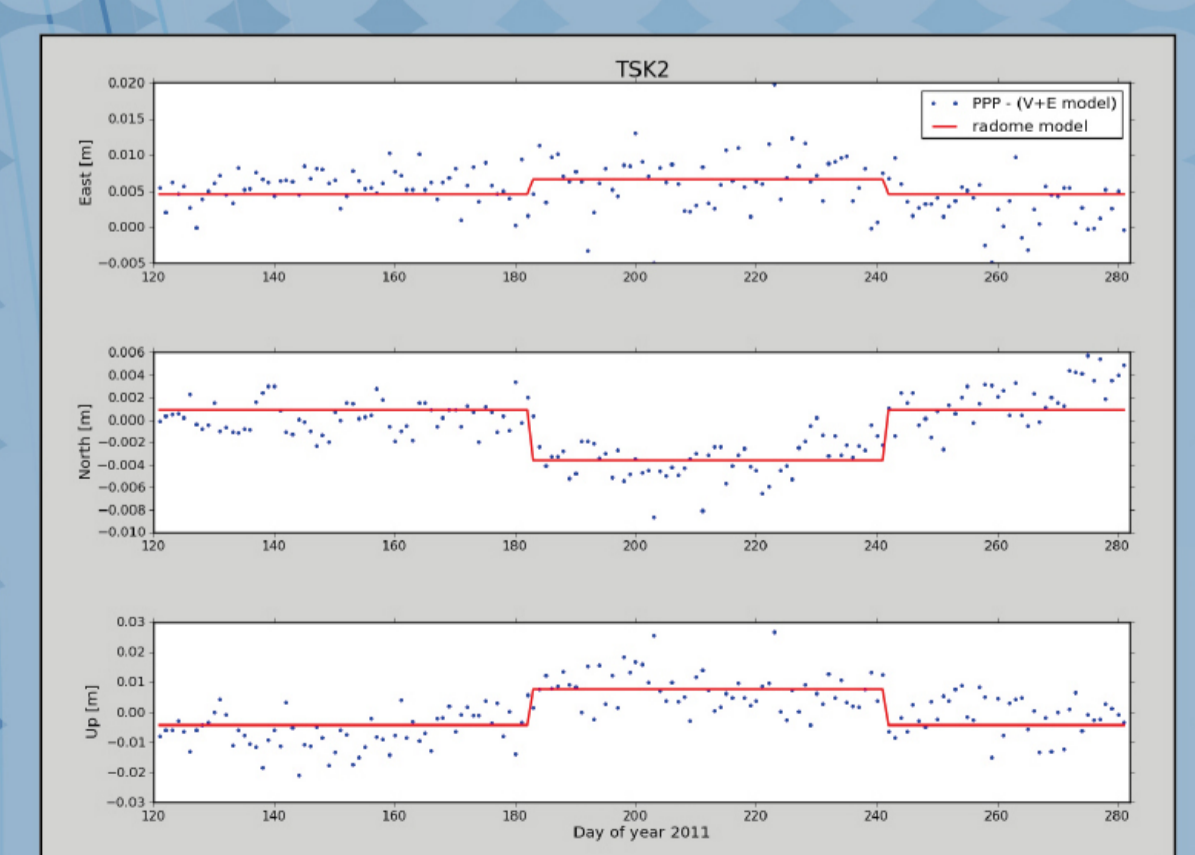
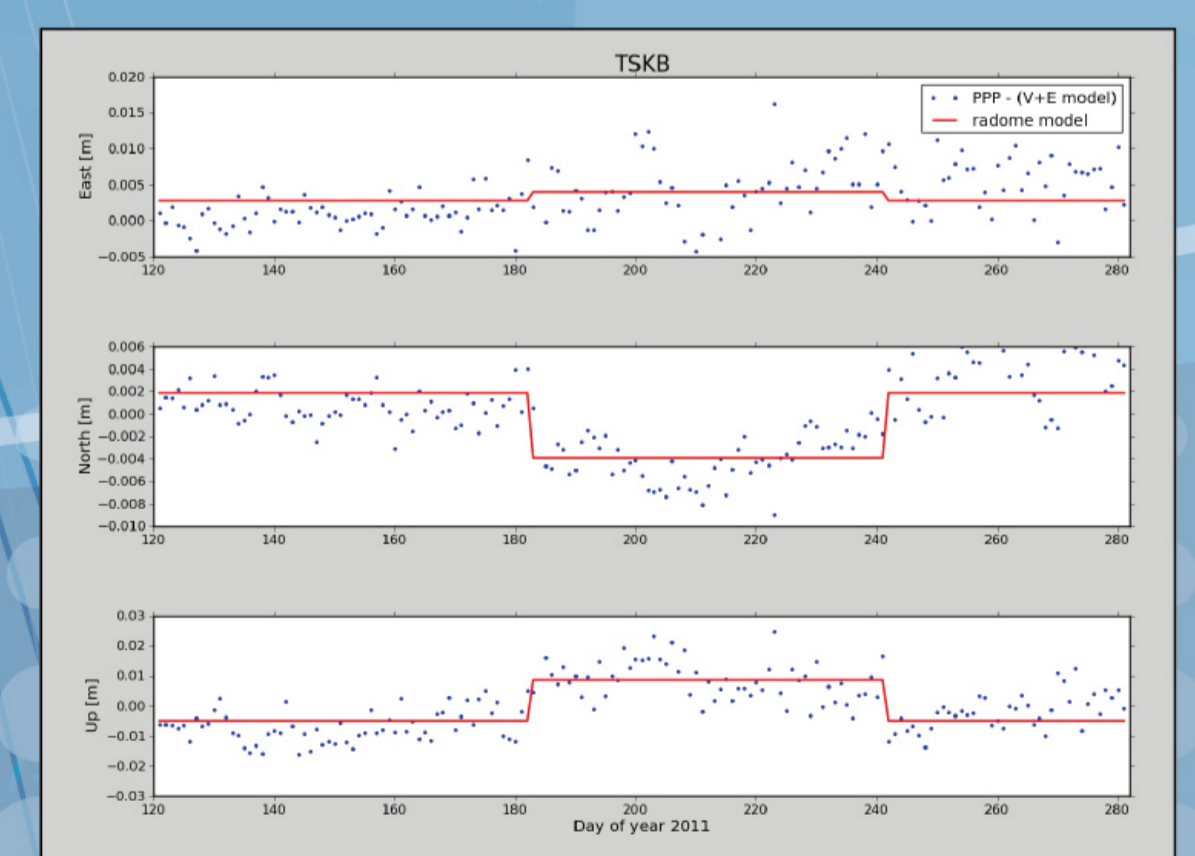
SINEX weekly position residuals between the combined solution and the IGS long-term accumulated frame solution that is used as reference solution could possibly help to estimate the radome offset. Initial residual analysis does not show a clear signal in most stations, as can be seen in the plots below from the residuals of the SINEX combination process.



Unfortunately station CRO1 was not properly handled in this activity as the Radome removal took place just before the introduction of the IGS08 reference frame and so it is very difficult to differentiate now the radome offset from the reference frame update! In any case it appears that there is no North effect as a result of the uncalibrated radome.



PPP detailed analysis of station position have been conducted with Bernese and Gipsy independently and it is still under study. Certain loading effects and corrections need to be properly accounted for still, and more solutions will be considered in due time. Preliminary analysis shows that for some stations some effect of removing the radome is noticeable as seen in the Figures below for TSKB and TSK2.



Additional PPP solutions from packages such as NAPEOS (ESA) will be analyzed, plus position changes in local short-baseline solutions can also be analyzed. All the remaining work will be coordinated by the Reference Frame Working Group.

Procedure

The participating stations are well suited for the proposed empirical offset calibration (**Option 2**, above), which can provide a correction for the local tie vector to other techniques, similar to what was done at Fortaleza, Brazil: <http://acc.igs.org/misc/brft-gpssoln07.pdf> the following procedure has been recommended:

- 1. Scheduling.** Each station will schedule an 8-week period, or more, during which the uncalibrated radome will be removed. Users will be notified of plans via IGS Station Mail and site logs should be updated accordingly.
- 2. Radome Removal.** The uncalibrated radome should be removed late in the week before the radome-free period begins, preferably Saturday or Friday, since IGS analyzes data for each Sunday-Saturday period.
- 3. Radome-Free period.** Normal operations for the station with no radome in place will continue for 8 weeks, or more, to allow an accurate determination of the position shift. The stations will continue to be included in the Analysis Center position estimation (SINEX solutions), and the Reference Frame WG is fully aware that discontinuities may have to be included as needed in the position time series of the stations.
- 4. Radome re-installation.** The radome should be re-installed at the beginning of a week, Sunday or later. The re-installation shall be announced via IGS Station Mail and site logs should be updated accordingly.
- 5. Analysis.** The estimated station position before and after the radome removal are to be compared to the estimated position during the period of no radome to determine the offset effect of the radome. It is important to use global network

solutions with dual-frequency data in order to be fully sensitive to the same biases as normal IGS solutions. Other solution types will also be encouraged such as PPP and local short-baseline networks. In the latter parallel GNSS stations can be used for comparison purposes. PPP position estimation solutions can also be used for the affected stations to provide extra inputs to the Reference Frame WG to estimate the best possible radome offset effects.

Conclusions

There are a number of critical stations for ITRF maintenance that are collocated with other reference Frame techniques (VLBI, SLR) which suffer from bad inter-technique tie quality. The ITRF aims for tie accuracies of a few millimeters and uncalibrated radomes can have much larger effects. To quantify the uncalibrated effect this experiment has been devised by the IGS Infrastructure Committee, Reference Frame WG, Antenna WG, Analysis Center Coordinator and the Central Bureau.

This IGS Radome-off experimental campaign will continue during 2012. It is shown that it is possible to observe the effect of the uncalibrated radome but it is not yet possible to conclude that the observed uncalibrated radome effects are completely responsible for the tie inconsistencies observed in ITRF2008. In any case this is as expected and this effort intends to minimize the effect of the uncalibrated radome so that other effects from techniques and tie survey errors can be better isolated. More investigations will take place in the context of this study to evaluate whether the derived corrections can be applied to the historical time series of these stations to improve the ITRF generation.