Position Corrections due to Uncalibrated GNSS Antenna Radomes at IGS Co-located Geodetic Observing Stations

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Abstract
The International GNSS Service (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 from 2011 to 2013 to analyze the unknown bias in the position time series of the co-located radomes due to uncalibrated radomes over the IGS antenna. Co-located stations have more than one geodetic technique present (VLBI, SLR, etc.) and they are a critical element for the realization of the ITRF. The use of uncalibrated radomes over the IGS antennas at these important sites is often a matter of techniques do not have the expected accuracy, and therefore a campaign to analyze different radome effects was planned and executed at many of the affected IGS stations.

The proposed approach is an expedient way to mitigate empirically an unwanted situation with these uncalibrated radomes in the weekly IGS station network so as to try to reverse the historic position time series of these stations for the most ITRF realization. The process has involved removing the uncalibrated radome for a significant number of weeks and then putting the radome back on in the exact same position. The investigation proceeds with dedicated PPP analyses from different sources plus a detailed analysis of the weekly IGS station position combinations. This paper presents one of the campaigns approaches, the participating stations and the results.

Stations Affected
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 bias error for those IGS stations co-located with other techniques and is a serious concern for VLBI, which allows for accuracies at the 1 to 2 mm level. Radome effects can often be much larger, up to several cm. Therefore these uncalibrated radomes present an accurate connection between co-located space geodetic instruments and weaken the ITRF.

Radome full is removed in the first step. The next two steps remove the radome. The radome removal follows after the radome is removed. Please provide details in text only. The radome removal steps are not fully sensitive to the same biases as normal IGS solutions. For the radome removal steps are not fully sensitive to the same biases as normal IGS solutions. For the radome removal steps are not fully sensitive to the same biases as normal IGS solutions.

The radome should be removed late in the week before the radome-free observations start. Please provide details in text only. The radome removal steps are not fully sensitive to the same biases as normal IGS solutions. For the radome removal steps are not fully sensitive to the same biases as normal IGS solutions.

Proposed
The station positions before and after the radome removal have been estimated using different programs and have been compared with the International GNSS Service (IGS) solutions. This analysis so far the following have been considered and the results in this analysis are mentioned below:

1. The weekly daily IGS Analysis Center combined coordinates
   2. JPL’s daily position time series
   3. Daily “Network PPP” with ambiguities fixed from JPL’s (IGS/ESAC/Concepts CERN GMS software)
   4. Daily single-station PPP solutions from Bernese
   5. Daily single-station PPP solutions from Bernese

The station positions and velocity are plotted as follows:

Results
Two stations have been added to the experiment in late 2013 (SHAO and KSMV, see table below). As can be seen below, some of the effects are quite significant. To estimate the jump in station coordinate components due to the removal of the radome, the following measurements were taken:

- Inconclusive (low frequency noise)
- Inconclusive (post-seismic relaxation)
- Inconclusive (low frequency noise)
- Estimated jumps not reliable.
- A 3rd jump due to another radome manipulation follows the radome removal.
- Not significant

The orange lines indicate known time series discontinuities. On the left the long term time series (blue dots) are extracted in most cases from the global solutions analysed up to this point. Even when complex correction models are applied to the data, jumps are quite small and when calibration results are expected. If duplicate stations that do not have a radome effect are present in the analysis, the results in this analysis are mentioned below.

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Conclusions
There are many critical IGS stations co-located with other geodetic techniques which suffer from discrepancies between space geodetic techniques and local geodetic techniques. In addition, the radome introduces significant bias to the results. Unfortunately the effect of the uncalibrated radomes cannot be corrected in a straightforward manner. To improve the ITRF, it is clear from the estimated jumps presented in the table above that it is possible to correct the historic time series and the estimation of the jump is not as significant as the “radome induced jumps” at the majority of the sites with uncalibrated equipment. It is clear from the estimated jumps presented in the table above that it is possible to correct the historic time series and the estimation of the jump is not as significant as the “radome induced jumps” at the majority of the sites with uncalibrated equipment.