INVESTIGATION OF PHASE CENTRE VARIATION OF THE GNSS ANTENNAE USING PORTABLE KINEMATIC TILTING DEVICE

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Phase centre changes due to the different height of antenna mount

• The Institute of Geodesy and Cartography, Warsaw, Poland has been involved in GPS antenna phase centre investigations since nineties of last century. In order to calibrate a variety of geodetic antennae and mounts, the field tests on short baselines in the Geodetic-Geophysical Borowa Gora Observatory have been conducted and elaborated. The results are summarized in the presentation.

From Jim Rey publication



The effect of multipath and scattering





Reflecting surface

Two experiments were performed in Borowa Gora Observatory. In summer 2006 the choke ring antenna was placed on a tribrach above the large concrete pillar. The elevation of the antenna reference point was changed from 0 up to 78 cm. (left fig) Winter observations were based upon combinations of different weather conditions (centre and right)



Two extremes, in those experiments, are the use of wooden tripod (without any scattering or reflecting surfaces), and a metal plate on the top of the pillar, applied at some permanent stations. There was no significant or systematic trend of "apparent" height vs. antenna elevation above the tripod. The phase centre changes vs. antenna elevation over metal plate are shown in Fig. (right). Variation of the antenna elevation in this case gives a distinguishable and stable effect very similar for both frequences and their combinations.



An other experiment was performed in summer with antenna placed near the ground. The graph below shows the phase centre changes (L1 and L2) vs. antenna elevation.



In situ antenna calibration tilting device

- A simple and portable prototype of the device for antenna calibration was constructed in the Institute of Geodesy and Cartography, Warsaw. In this kinematic instrument the antenna is mounted on the rocking lever.
- Using the antenna-tilting device it is possible to determine the mean phase centre offset as well as the PCV in a real multipath and scattering situation.
- Differences arise due to continuous angular movement (tilting) of antenna contrary to the discrete tilting of robot carrying antenna.
- The simple filtering procedures for extraction of measured by means of a special sensor.
- Phase centre offset is being measured with the use of a reference site, whose antenna does not need a precise or absolute calibration. On the other hand, PCV may be measured in single site mode with usage of satellite-satellite carrier differences.





 $\Box D_{ph} = X (\cos(AZ) \cos(EL) \sin(\Box) + \sin(EL) \cos(\Box))$





PCV vs. apparent angle "antennasatellite" and the scheme of transformation of modulation of angle onto modulation of distance "satelliteantenna" Results of measurements of PCV modulation for three satellites in 10minute session on the background of model of PCV of choke ring antenna PCV vs. zenith angle drawing up on the basis of five 10-minute sessions (coloured points and lines). A green line shows the model for the choke ring antenna (according to EPN data)



Conclusions and future works

- the uncertainty of the measured height of site due to the scattering of an electromagnetic wave on the top of the pillar may be from one to several millimeters;
- the effect of scattering on the top of the concrete pillar is unstable and depends on humidity at the pillar basement;
- scattering on the metal surface, found under antenna at some permanent stations, gives regular and stable in-time change of the measured height of site up to 5 millimeters;
- the most stable results were obtained in the absence of disseminating surfaces near the antenna, namely the installation of antenna on a standard wooden geodetic tripod at height of approximately 1.5 m above a grass covered ground;
- the measurements executed with the antenna located on the elevation from several centimeters up to half of meter above a soil, have yielded the most unstable results with variations of the measured height at a level up to 2 cm;
- investigation of antennae in real conditions of installation, that is, "in situ", should be carried out. This would allow for testing the stability of scattering of satellite signals and multipath and, in case of stable conditions, there could be a calibration conducted "in situ".
- The development of the kinematic tilting device should be continue and a final method of calibration ,,in situ" should be elaborated.