Datum Issue in Deformation Monitoring Using GPS

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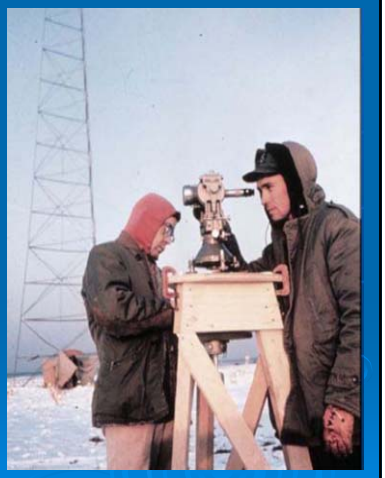
Before GPS

- field works were heavy tasks,
- intervisibility between the site points was a crucial necessity,
- measurements (directions, distances and etc.) needed to be reduced onto a pre-defined reference surface,
- Large scale geodetic network were not possible, and
- Designing a three dimensional network was too difficult.



Before GPS

However,

- Data processing related to the geodetic networks was completely inside the geodetic expertise. Therefore, every practitioner of geodesy having average programming skill was able to develop their own software for the adjustment of the geodetic networks.

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After GPS

All the inadequacies and difficulties of the conventional methods have been surmounted through the GPS technology.

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After GPS

Despite its advantages, the GPS evaluation procedure for the geodetic applications is not an easily manageable process. To develop a personal software including the entire steps of GPS processing, one must have scientific knowledge on different topics of fundamental and engineering sciences as well as advanced programming skills. For that reason, the most practical way for the surveyors is to use commercial software provided by the GPS equipment manufacturers or academic ones developed by some university research teams.

Evolution in Surveyor profile

- This development in surveying technology has led to a fundamental evaluation in the geodetic practitioner profile. The new generation prefers learning how to use ready packet programs rather than learning theoretical terms, while the former ones had to know theory to make their own programs.

Datum enigma of GPS

- As a result, Datum of GPS has been a big enigma for most surveyors especially in deformation monitoring.
- The main reason of it is that some academic software need Earth Orientation Parameters (EOP), polar motion and UT1-UTC parameters, but the most of the commercial software don not need them. The most surveyors have no idea why some software apply to these parameters, or some software do not.

Answer of the question

The answer of this question lay under the datum to which GPS has been referenced:

- The broadcast ephemeredes of GPS satellites referenced to ITRF96 at actual epoch.
- The precise ephemeredes are always referenced to the latest ITRF version at actual epoch;
- The reference epochs are 1998.0 for ITRF96 and 2000.0 for ITRF05 (Gurtner, 1993; Bock, 2004, URL1).

At this point, the reference system represented by ITRF has a key role to respond the questions above.

Definition of ITRF

- ITRF is the realization of the crust fixed CTRS taking into account the plate tectonics as well as the polar motion.
- The polar motion is removed by two parameters (xp, yp).
- As opposed, plate motions are too complex. In that case, the solution is to define a reference frame by means of a consistent coordinate set and velocities, in which all tidal effects are removed, of global tracking stations at a certain epoch.

Definition of ITRF

- Depending on advances in defining the very complex nature of plate motions and in data processing and computational techniques, IERS updates the ITRF solutions. These solutions are represented by the short notation ITRFyy where "yy" is the last two digits of the solution year.

GPS-defined coordinates

According to the definition, the GPS-determined coordinates

- do not need to be corrected due to the polar motion,
- are free from all the tidal effects, and
- are at actual epoch of the crust.

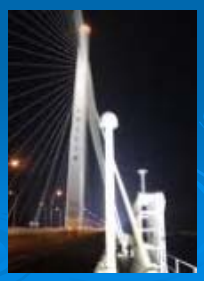
Deformation monitoring by GPS

- Coordinates at actual epoch are invaluable for deformation monitoring because the network determinations in different observation periods can directly be compared with each other to produce deformations, with no need of any correction due to polar motion, UT1-UTC and tidal effects.

Be careful!

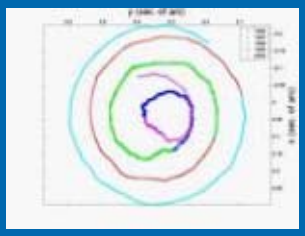
However, a surveyor must be careful about

- observations carried out in different days must be combined at a common epoch,
- ITRF solution might be changed between the observation periods.



Why some software need EOP?

The only reason is that some software transform satellite orbits into inertial space, i.e. Conventional Celestial Reference System (CCRS), and performs orbit interpolations for proper epochs in this reference system using dynamic models.



Conclusion

- Deformation monitoring by GPS is not a big deal when become aware of its datum.
- There are many practitioners from other disciplines having good command of GPS software for the geodetic applications. A surveyor's advantage to them is to know GPS's tricks. Datum is one of the most important tricks.

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Thank you very much for your interest!

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