Precision of GPS Point Positioning -part11-Environmental Remote Sensing by GPS for Atmospheric Pollution

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http://home.att.ne.jp/iota/bluedoor2001/index33.html

The GPS (Global Positioning System) point positioning by single frequency is used primarily for navigation, and has error range within 10m after elimination of SA (Selective availability), but is incomparable with mm range accuracy of relative positioning by double frequencies for the GPS surveying. However, it has been clear from the former result of this series of studies that it is possible to transform geodetic noises to signals for the Earth atmosphere in the same logic as GPS meteorology.

The previous studies of GPS point positioning in Odawara-city, Kanagawa Prefecture, from December 2002 to September 2005 have suggested that GPS data have 1 day cycle, 1 month cycle and seasonal variation, which caused atmospheric refraction. Another factor for the variation is assumed the effect of geomagnetism.

Especially, the possibility to use GPS as environmental remote sensing was suggested in the poster session of the conference last year on the basis of observation of geographical distribution of correlation among air pollution, geomagnetism and GPS data.

This part is on the availability of GPS as remote sensing on the basis of correlation among GPS data, air pollutants concentration and troposphere refraction due to atmospheric tide (tidal and centrifugal force) and atmospheric expansion by solar radiation as well as geomagnetism.

The method is as follows:

A GARMIN GPS II and ProAtras2000 were used as a GPS receiver and a data logger, respectively. The web-pages of SORAMAME-KUN of NIES were cited as air pollution data.

Not continuous time series (N=30) of GPS positioning data were correlated with atmospheric factors as 1.Tidal force and centrifugal force, 2.Solar energy radiated on ground, 3.Geomagnetism, and the running averages of air pollutants concentration were taken in the corresponding period (N=30). These series of running correlations and running averages were correlated again. As a result, one correlation coefficient was fixed on each observation point for air pollution. In the geographical distribution map of these correlations, taking running averages within about 40km distance can transform not continuous plot data to continuous plane data.

Consequently, two-dimensional correlation maps of [GPS: Atmospheric factors: Air pollution] visualize geographical distributions of air pollutants which are effectively influencing to GPS electromagnetic wave. The characteristics are as follows:

1.In methodology, they indicate time averages, not instantaneous values.

2.Since electromagnetic wave from satellites of lower altitude is influenced more intensively, there may be high correlation even at further points of one hundred to several hundred km distance, and inversely there may be only lower correlation at very near points.

3.In GPS meteorology, which measure precipitable water vapor, vertical delay is discussed, but here mainly a horizontal error. However, a final error after calculation process occurs even in height.

4.Several air pollutant concentrations have correlation with GPS data simultaneously.

5.The ground-based observation data of air pollution are useful without correction. The air pollution data of high altitude may have different correlation.

Hereafter, this GPS remote sensing may succeed to a variety of applications as follows:

1.Visualization of dynamics or flow of air pollutant gases

2.Estimation of column density of atmospheric components

3.Correction of GPS positioning data