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An approach for determining the orthometric height using GPS signals and the preliminary experimental results

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Theoretically, given the frequency shift of an electromagnetic wave signal between two points P and Q which are located on ground, one could determine the orthometric height difference between these two points based on the gravity frequency shift equation. Further, the orthometric height difference between points P and Q could be determined by using the GPS signals (Shen et al. 1993, 2008). Signals with frequency f are emitted by the GPS satellite, and two receivers at P and Q receive simultaneously the signals with the frequencies f_P and f_Q, respectively. Then, one could determine the signal's frequency shift between P and Q due to the geopotential difference, which is just the same as the frequency shift of a signal propagating from P directly to Q. This is referred to as the GPS approach. In practice, the accuracy in determining the orthometric height difference between two points by GPS approach depends on the stability of the time-keeping system, which is realized by atomic clocks. At present, the stability of the time-keeping system has achieved 6×10^{-16}. With the quick development of time and frequency science, the stability of the time-keeping system might achieve 10^{-18} in few years. In the present paper, we use the GPS Doppler observations (D1 and D2 in RENIX files) at several stations, and calculate the frequency shifts among different stations. Then, based on the gravity frequency shift equation we determine the geopotential difference and the orthometric height difference between every pair of these stations. Preliminary results show that the accuracy in the height determination is about 100 m, which is due to the fact that the stabilities of the time-keeping systems combined with the observations are around $10^{-13} \sim 10^{-14}$. One byproduct of our study is that our results support the general relativity theory: there exists the relativistic gravity frequency shift effect. Further investigations are in process to determine the orthometric height with successive accuracy, based on the GPS approach. This study is supported by National 863 Project of China (Grant No.: 2006AA12Z211)