Geophysical Research Abstracts, Vol. 9, 08768, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-08768

Directional statistics and its application in the hypothesis testing of GPS integer ambiguity resolution

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High precision relative global positioning system (GPS) positioning is based on the very precise carrier phase measurements, where the resolution of the phase ambiguity is a crucial problem. When the integer ambiguity is correctly determined the positioning results with millimeter accuracy can be achieved. This topic has therefore been a rich source of GPS research over the last decade and there are many different approaches that have been proposed for carrier phase ambiguity fixing, which consists of two distinct parts: (i) the ambiguity estimation problem and (ii) the ambiguity validation problem. In order to valid the estimations of the carrier phase ambiguities, hypothesis testing has to be applied, which are usually based on the statistical properties of these integer estimations. Unfortunately, the classical testing theory (such as, Chi-squared test and F-test) can not apply to the integer GPS model since the integer estimators are not Gauss normally distributed anymore. Ever since von Mises (1918) introduced the von Mises normal distribution on the circle, its importance has not been recognized by the data analysts. In practice, this fact is often ignored, for example, the statistical property of the fractional parts of the float solution of carrier phase ambiguities with respect to their fixed solution (integer values) are regards as Gauss-Laplace normal distribution. Actually von Mises developed the normal distribution for the circular (directional, angular) random variable by the investigation of the distribution of the fractional parts of the atomic weights, which is just appropriate to fractional parts of GPS carrier phase ambiguity float solution. Here the statistical property of the fractional parts of phase ambiguity float solution is analyzed through the Test of Uniformity, Test of Goodness-of Fit and Tests on von Mises distributions based on the solution of double difference GPS phase observations. Under the von Mises normal

distribution property of the float solution the proper search criterion applied in resolving the integer ambiguities and further on proper hypothesis tests on it are discussed and proposed.