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IONOSPHERIC EFFECTS ON GPS SIGNAL IN LOW-LATITUDE REGION: A CASE STUDY REVIEW OF SOUTH EAST ASIA AND AFRICA

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ABSTRACT

The ionosphere is a significant source of errors affecting L-Band (1-2 GHz) signal propagation using Global Position System (GPS). The propagated GPS signals that passes through the Earth's atmosphere where affected by ionosphere and troposphere irregularities and caused the signal propagation delay. However, the velocity of signals that propagate within the atmosphere deviates from vacuum line of sight (LOS), while the refractivity of ionosphere and troposphere influence the signal propagation delay causing atmospheric effects due to high electrons density. Both affect the signal in different ways due to their particular refractive properties. The review focuses of some of the previous research studies conducted on empirical modeling of the ionospheric effect in low latitude region. The tabulated findings of such models presented in this article.

Keywords: *Low-latitude, ionospheric effect, GPS, TEC, SNR*

1. INTRODUCTION

The launching of 24 NAVISTAR satellites was completed by U.S Air force on 26th June 1993 and the network of these satellites is called Global Positioning System (GPS). These NAVSTAR satellites were designed by Rockwell International. Initially, the operation started in 8th December 1993, but full functioning commenced on 27th April 1995[1]. The orbits inclined at about 55^{o} to the equatorial plane and is located approximately 20,183 km above the earth's surface[1], [2]. The network of these satellites provides continuous 24 hours coverage to all parts of the globe. GPS has been under development, operated, and maintained by the U. S. Department of Defense (DoD). Because of its uniqueness and its potential applications, particularly related to mobile users, the NAVSTAR GPS deserves particular attention especially the ionospheric nature that cause signal fading. The signals could be intersperse with interfering signals. However, GPS link is more likely to be susceptible to limiting conditions. Such as rain attenuation, multipath fading, shadowing effect, Doppler shift, interference and ionosphere scintillation [4]–[6]. In this research review, only ionospheric effect for open space signals will be considered.

GPS provides special coded satellite signals that will be processed by GPS receivers and enabling them to compute position, speed and time. The Precise Point Positioning (PPP) for GPS tasks using four mobile satellite signals to compute positions in three dimensions in the receiver clock. GPS provides accurate locations, time information at a particular precise position at all different weather around the world [7]–[9].

Using the GPS dual frequencies receiver system to eliminate ionospheric delays provides a useful tool for measuring the ionospheric total electron content (TEC). Atmosphere becomes an important medium for the GPS signal communication path, but ionospheric effect degrades the signal as a result of fading effect and presence of much electrons contents. These electrons densities will cause the scintillation effect [10]–[12].

This literature studies will focus on the past and present ionospheric studies conducted in the low-latitude regions, given much emphasis on some part of South-East Asia and Africa regions.

2. IONOSPHERIC EFFECT

GPS signals that transmit from the satellite at a distance of 20,183 km, passes through a vacuum until they reach

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