UNIVERSITI TEKNOLOGI MARA

EMPIRICAL CHARACTERIZATION OF EQUATORIAL GEOMAGNETICALLY INDUCED CURRENTS (GICs) DUE TO SPACE ELECTROMAGNETIC PERTURBATIONS

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of the requirements for the degree of
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(Radio Frequency (RF) and Electromagnetic)

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CONFIRMATION BY PANEL OF EXAMINERS

I certify that a Panel of Examiners has met on 1st June 2018 to conduct the final examination of Farah Adilah binti Mohd. Kasran in her **Doctor of Philosophy** thesis entitled "Empirical Characterization of Equatorial Geomagnetically Induced Currents (GICs) due to Space Electromagnetic Perturbations" in accordance with Universiti Teknologi MARA Act 1976 (Akta 173). The Panel of Examiner recommends that the student be awarded the relevant degree. The Panel of Examiners was as follows:

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I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

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ABSTRACT

Geomagnetically induced currents (GICs) is the ground end effect manifested by the space electromagnetic perturbations. It is potentially harmful to the ground surface infrastructures and most of the attention has been focused on the power network failures. Previous report has revealed that the strong space electromagnetic perturbations in March 1989 has led to the power network failure driven by GIC in Canada, leaving the people in black out for 12 hours. Typically, GIC is a special concern in high latitude region during a strong geomagnetic storm since its effects are the most intense and most frequent in this region, whereas in low latitude region, especially in equatorial region, less GIC investigation has been conducted due to the lack of awareness. However, the destructive of transformer of low latitude region in 2002, has provided the evidence that the space electromagnetic effect in this region shouldn't be neglected. Here, in order to address the gap, the study intends: 1) to characterize the ground magnetic variations and the time derivative of magnetic field, *dB/dt* in function to different latitudes associated with the space weather events, 2) to identify the Earth's current systems that influence the ground induced current in equatorial regions, and 3) to produce an empirical characterization of equatorial time derivative of magnetic field *dB/dt* as GIC indicator. Firstly, the analysis on the highest value of *dB/dt* has been performed during the most severe geomagnetic storms from 2000 until 2015 in equatorial stations. Results show that higher number of strong *dB/dt* value in this region occurred during initial geomagnetic storm phase with 62% compared to other geomagnetic storm phases. The results also deduced that higher number of strong equatorial *dB/dt* happened during local noon and it has a strong correlation with the solar wind dynamic pressure, P_{dyn}. By taking those parameters into consideration, the study on the equatorial *dB/dt* was then focused on the specific space event, which is so-called storm commencement (SC) event. The current discrimination has been performed in order to identify the dominant current (i.e. magnetospheric or ionospheric current) that led to intense GIC value during the SC events from 2008 until 2015 at three equatorial stations in American, African and Asian sectors. After performing the correlation coefficient analysis, the obtained results suggest three main findings which are 1) the ionospheric current is dominant in American region with r=0.96, 2) the magnetospheric current is higher than the ionospheric current in African region with r=0.87 and 3) the *dB/dt* value in Asian station is highly controlled by global magnetic index, SYMH with r=0.9. These different characteristics are influenced by the different strength of Cowling conductivity at each sector, which acts as the ionospheric current intensification, along the dayside dip equator or known as equatorial electrojet (EEJ). The amplification of EEJ current is clearly observed in American and African sectors since the stations located near to dip equator. However, for the Asian sector where the station is apart from 0^{o}, less ionospheric current, intensified by the Cowling effect. Thus, the GIC activity at this station was considerably depending on the global effect of geomagnetic activity. In overall, the GIC activity in equatorial could be categorized into two 1) for the stations located within the dip equator, the GIC value is highly controlled by the local current systems, and 2) for the equatorial station that located far away from 0^{o}, the GIC value is greatly influenced by the global magnetic index.

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