Geomagnetic Indices and The Ring Current

Introduction

Since the Space Age, the study of the near Earth space environment has become of great importance due to the advent of electrical systems, radio communications, and satellites which are directly affected by the state of the space environment around the Earth. The study of the ‘weather’ of this space environment comes in many shapes and forms but has mostly centered around the analysis and prediction of disturbances in the environment. These disturbances have been dubbed ‘geomagnetic storms’, and their effects can range from inconsequential to, in the most severe cases, society altering. Several features of this space environment create changes at the ground level as they vary which can be measured and assigned values. In this poster we focus on three such values (or indices): K$_p$, F$_{10.7}$, and Sym-H/Dst. The Sym-H/Dst index is of particular interest as it relates to one of the more prominent subsystems of the Earth’s geospace environment, namely the ring current.

K$_p$ Index

The first index of importance is the K$_p$ index, which has been shown to have correlations with many different systems of the geospace environment (Matzka 2021). Several parameters of the ionospheric system correlate well with the Kp index, including ions flowing out of the ionosphere, thermospheric densities, and height integrated ionospheric conductance. But what is the K$_p$ index? The K$_p$ index is created from a network of 13 magnetic observatories.

F$_{10.7}$ Index

F$_{10.7}$ is a measure of the global activity on the surface of the Sun which is facing the Earth. It can be used to determine how active the surface of the Sun is, which will in turn affect Earth’s geospace environment. 10.7 cm emissions can also be absorbed in the Earth’s ionosphere, which can lead to heating and variability of scale heights of certain regions of the atmospheric system.

Sym-H/Dst and The Ring Current

The third, but certainly not least, important geomagnetic index we highlight is the Sym-H/Dst index. We say Sym-H/Dst due to the highly related nature of these two indices. However, these values are calculated separately by different groups. Sym-H/Dst shares many characteristics with the K$_p$ index in terms of indicating an active geomagnetic environment. However, it is also able to quantify the state of an important subsystem in the Earth’s near-space environment. This subsystem is the Earth’s Ring Current, and has been and continues to be the subject of rigorous investigations. The structure of dips in Sym-H/Dst can also be used to determine what type of activity initiates geomagnetic storms. The ring current is fascinating from a fundamental physics standpoint, as well. The pioneering work of (Vasyliunas, 1968) showed a new branch of thermodynamics which was previously unknown. However, most observations of this new thermodynamic regime have been limited to short timespans. The proximity of the ring current to Earth and the advanced understandings of the Earth’s system makes the ring current an ideal experimental environment to investigate this new regime, and to determine how it can affect populations of larger particles, such as hydrogen, helium, and oxygen.

Acknowledgements: The author would like to thank NJIT-CSTR for providing travel support for this presentation.