

[Applicant's Name]

[Mentor's Name]

Project Title: Use of Global Positioning System (GPS) Satellites to Study Disturbances in the Earth's Low Latitude Ionosphere

Project Proposal: This project is designed to study the behavior of the Earth's upper atmosphere, the ionosphere, through the use of GPS data and all-sky imagers. The ultimate goal of the project is to determine how irregularities in the ionosphere, occur, last, and decay.

GPS determines positions on Earth based on radio signals sent from satellites to ground-based stations. As the radio signal passes through the ionosphere, the signal is slowed due to the electrons in the ionosphere. GPS must account for this delay in calculating distances, and so it measures the conditions of the ionosphere and subtracts out the delay. The ionospheric data is then placed into on-line databases by the International GPS Service for Geodynamics so scientists can use the data. Although the data obtained by the GPS satellites has limitations, it is still very useful to scientists since it provides a continuous stream of data from over 200 stations worldwide. (Mendilla et al., 2000) The sheer volume of data makes it very useful, and the continuity of the data makes it possible to monitor an ionospheric disturbance throughout its entirety. The two all-sky imagers used on this project are located in Puerto Rico and Argentina. They are used to photograph the disturbances in the sky throughout the night.

I will access the on-line GPS datasets. Using existing computer programs, I will analyze data sets from a specific sub-set of stations that observe GPS satellite radio signals from sites within approximately 20 degrees latitude of the Earth's equator. This project will examine the behavior of the irregularities in the ionosphere during periods of high activity from the past. The results will be transformed into graphical representations to show how disturbances in the ionosphere, called space weather events, behave. The photographs from the all-sky imagers will also be used to verify the observations from the GPS data. In addition, the imagers will be used to find days with disturbances which can then be analyzed further with the GPS data.

The goal of this project is to find correlations in the data from the imagers and GPS. By relating the different events seen by the imager to specific behaviors of the GPS data, a better idea of what these events entail can be gained. Understanding the physical mechanisms of how these disturbances are generated, can lead to predicting such events in the future.

This project is a blend of basic research on how ionized gases, called plasmas, behave and how such research relates to the practical concerns and needs of a highly technological society. Knowledge about the ionosphere acquired through this project will help determine how the ionosphere is formed, and how it relates to the general space environment. Disturbances in the ionosphere can cause severe disruptions of radio communications, navigation, and positioning systems used by civilian agencies (FAA tracking of airplanes) and Defense Department needs for reliable radio communications in countries at low latitudes. Space weather events can cause a large accumulation of charge within the atmosphere making power grids very vulnerable to failures due to overloads that in turn cause power outages, blackouts. By understanding the mechanisms behind such space weather events, they could be predicted, allowing for preparation and protection of sensitive equipment.

I will analyze particular days of high disturbances, "case studies" when the Sun's activity was high and disruptions would be expected to occur. I will also work on the computer program I have written to make it more useful and more robust so that it can provide better analysis of the

data. I will also compare the GPS data for the case studies to the imager photos to try to find correlations. I will then determine if each event is a unique type, or if there are common elements to the effects observed. Whether the event is unique or has commonalities with other events will help to determine the cause and behavior of such events. If the events have similarities, then their specific behaviors can be extended to other space weather events and their behaviors, possibly leading to the prediction of future events.

Bibliography:

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