MSc Proposal in Space Physics
Supervisor: Dr Daniel Moeketsi
Co-supervisor: Dr Joseph Omojola

Title:

1. A Comparative Analysis of Geospace Response to Severe Geomagnetic Storms (2003-2024)
2. From Solar Cycle 23 to 25: Investigating the Geospace Response to Major Geomagnetic Storms

Aim:

The study aims to understand the interconnectedness of the magnetosphere, ionosphere, and thermosphere during these significant geomagnetic storms. The results will offer insights into the Earth's response to solar activity events and severe geomagnetic storms.

Summary:
This research proposal outlines a study comparing the Earth's geospace reaction to intense geomagnetic storms between 2003 and 2024, encompassing solar cycles 23 and 25. The investigation will analyse the ionosphere's total electron content (TEC), thermospheric circulation patterns, GNSS signal behaviour, and magnetospheric responses during storm events with magnitudes exceeding -300nT.

Highlights:

Comparison of the geospace response to severe geomagnetic storms (> 300nT) from 2003 to date spanning the waning period of solar cycle 23 to the waxing phase of solar cycle 25.

2003/11/20 ---------- Nov. -422nT
2003/10/30 --------- Oct. -383nT
2004/11/08 --------- Nov. -374nT
2024/05/11 --------- May -412nT
2024/10/11 --------- Oct. -335nT

Geophysical parameters to be studied:

Ionosphere TEC response: Total Electron Content (TEC) measures the total number of electrons in a column of the ionosphere. Analysis of TEC response during geomagnetic storms can reveal how these storms affect the density and distribution of electrons in the ionosphere.

Thermosphere circulations: The thermosphere is the layer of the atmosphere above the mesosphere. Geomagnetic storms can cause changes in the circulation patterns of the thermosphere, which can affect the density and temperature of this layer. Examining these changes can help scientists understand the impact of storms on the upper atmosphere.

GNSS signal response: The Global Navigation Satellite System (GNSS) relies on signals from satellites to provide positioning and navigation information. Geomagnetic storms can disrupt these signals, causing errors in GNSS measurements. Analysing GNSS signal response can help assess the impact of storms on navigation and communication systems.

Magnetospheric response: The magnetosphere is the region of space surrounding the Earth that is dominated by the Earth's magnetic field. Geomagnetic storms cause significant changes in the magnetosphere, such as compressions and expansions. Studying the magnetospheric response can provide insights into the dynamics of this region during storm events.

Magnetosphere-ionosphere-thermosphere coupling: This refers to the complex interactions between the magnetosphere, ionosphere, and thermosphere. Geomagnetic storms can disrupt this coupling, leading to changes in the energy and momentum transfer between these regions.

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Study areas:
IGS Stations within Latitude ±40º and Longitude ±40º in the figure below.

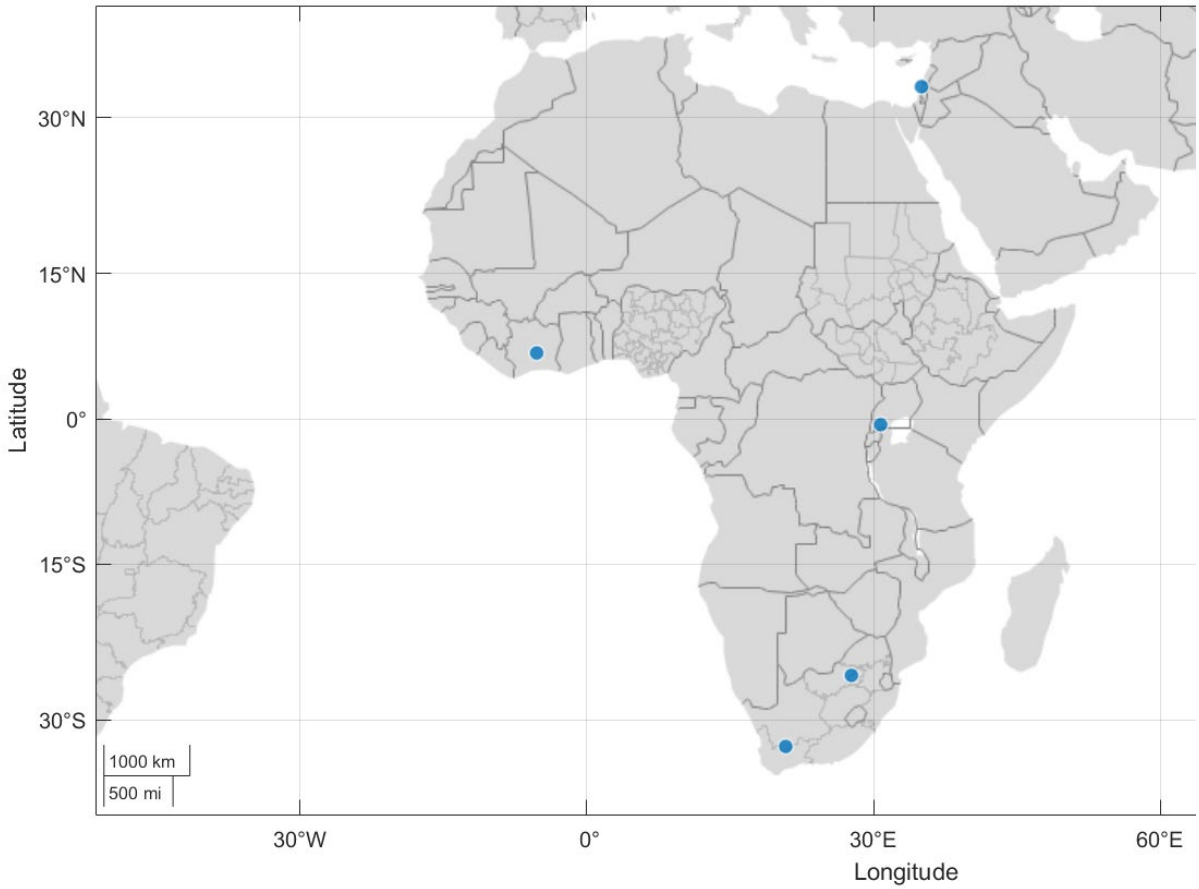

Figure 1: African sector of the world map.