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TOWARDS A SPACE WEATHER MONITORING AND FORECASTING CENTER IN KENYA: A STRATEGIC APPROACH FOR EARLY WARNING AND RESILIENCE

Abstract

Space weather poses significant threats to technological infrastructure worldwide, yet its impacts are regionally unique. Kenya, positioned near the geomagnetic equator, experiences intense ionospheric disturbances due to the Equatorial Ionization Anomaly (EIA), directly affecting GNSS-based navigation, HF communication, and power grid stability. Despite these vulnerabilities, space weather monitoring in Kenya remains fragmented, with no centralized forecasting and early warning system. This paper presents a case for establishing a Kenyan Space Weather Monitoring and Forecasting Center, leveraging existing instrumentation, real-time data analytics, and predictive modeling to enhance national and regional preparedness. By integrating multi-instrument observations from GNSS receivers, ionosondes, and magnetometers, the study assesses space weather disturbances and their impact on critical infrastructure. Real-time variations in GNSS positioning errors, HF signal tracking, ionospheric electron content, and signal scintillation are analyzed to determine optimal communication windows and navigation reliability. An AI-driven predictive model, trained on historical data, enhances early warning capabilities. Beyond scientific advancements, this initiative aligns with global efforts to strengthen emerging space ecosystems. The feasibility of a national space weather center is evaluated through stakeholder analysis and infrastructure mapping, fostering collaboration between Kenyan research institutions, regional space agencies, and international partners. Public-private partnerships with aerospace companies, startups, and nations will be crucial in building a sustainable space weather infrastructure, facilitating technology transfer, capacity building, and the deployment of advanced instrumentation. Preliminary findings reveal frequent evening scintillation and peak electron content during the day, leading to GNSS positioning errors beyond standard tolerances, particularly during geomagnetic storms. HF communication tracking indicates signal degradation and blackout periods correlated with ionospheric disturbances, solar X-ray flux, and energetic particles, highlighting risks for aviation and emergency response. Ionosonde data confirms significant F-layer height variations, reinforcing the need for localized forecasting models rather than reliance on global indices. The AI-driven model has successfully predicted these variations, identifying optimal HF communication windows, periods of minimal scintillation, and navigation errors, further demonstrating its potential for real-time forecasting. Establishing a Space Weather Monitoring and Forecasting Center in Kenya would be a transformative step, enhancing Africa's role in global space weather research and fostering integration into international monitoring networks. Building on the insights from preliminary findings, Kenya can position itself as a hub for real-time space weather monitoring and prediction by forging strategic collaborations with space agencies, industry leaders, and startups for instrumentation deployment, further strengthening its role in the growing space ecosystem.