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Publication date:
2016

Document Version
Peer reviewed version

Citation (APA):
Forte, B., Da Dalt, F., Panicciari, T., Jayawardena, T. T. P., Mitchell, C., Wilhelm, N., ... Jackson, D. (2016). Algorithms for the mitigation of space weather threats at low latitudes, contributing to the extension of EGNOS over Africa. Abstract from 2016 Beacon Satellite Symposium , Trieste, Italy.

Algorithms for the mitigation of space weather threats at low latitudes, contributing to the extension of EGNOS over Africa

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ABSTRACT

GNSS is already a technology that pervades modern lifestyles and over the last decade has become integral to many of our transport systems. One of the major barriers to the development of GNSS for safety-critical services such as aviation comes from the unknown threats from Space Weather.

In order to overcome the intrinsic limitation posed by space weather, regional systems called Satellite Based Augmentation Systems (SBAS) have been developed. The European region has a system called EGNOS. The idea behind these systems is to ensure that integrity information is provided to the GNSS user. Part of the function of an SBAS system is to map

the ionised regions of the upper atmosphere (the ionosphere) to enable specialist aviation GNSS receivers to make corrections for the ionospheric delay and hence to achieve a more accurate position. This is very important but more critical still is the capability to know how accurate a position is at a given time and this is also an important function of SBAS. However, the SBAS systems still have significant limitations that prevent the extension of the EGNOS system into new geographical regions and this project addresses these limitations.

Within the framework of A EC-funded project, algorithms to mitigate against space weather vulnerabilities (i.e. ionisation gradients and scintillation) at both receiver and system level are investigated and prepared.

From the point of view of ionization gradients, worst-case scenarios characterized through diverse datasets were prepared and used to simulate EGNOS performance at low latitudes in Africa. Furthermore, alternative methods to calculate grid corrections and errors were investigated and evaluated against the state of the art (Figure 1).

From the point of view of scintillation, two dedicated GISMO monitoring stations were installed in San Pedro and Brazzaville with the purpose to assess the impact of scintillation on EGNOS availability maps as well as on the performance of the receiver in the presence of scintillation (Figure 2). Algorithms capable of minimizing the impact of scintillation at both receiver and system level were investigated.

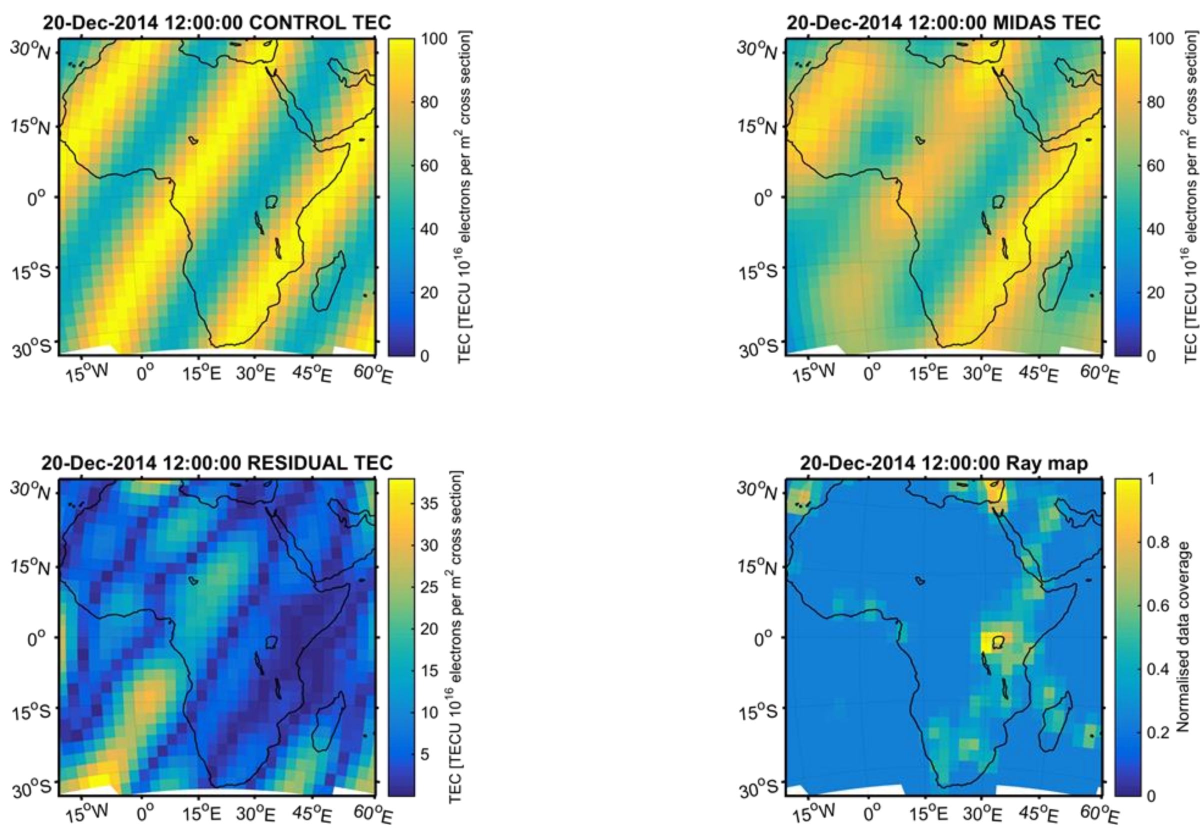

Figure 1: Simulation of ionization gradients by using MIDAS [1].

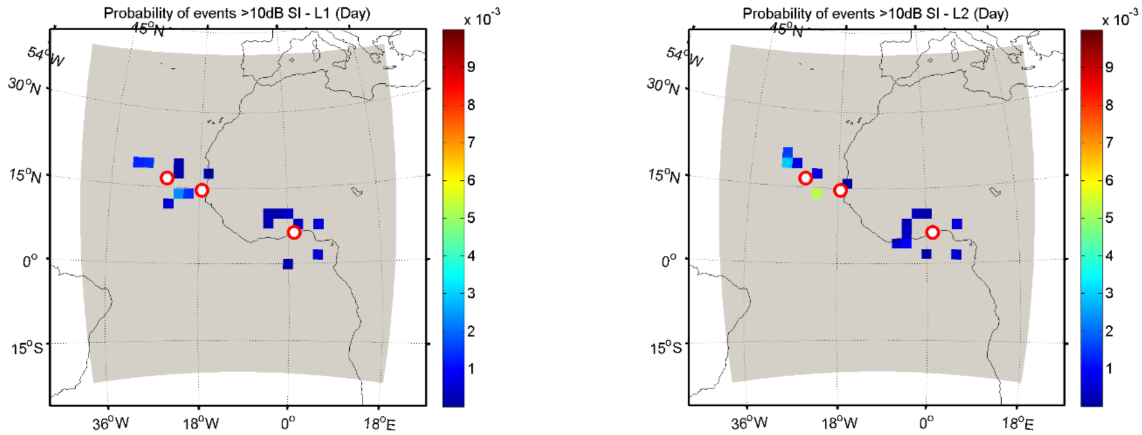

Figure 2: Occurrence of fades deeper than 10 dB at L1 and L2 simultaneously at stations at Cape Verde, Dakar, and Lome, following [2].

Recent developments in the framework of the aforementioned activities will be illustrated and discussed.

Key words: SBAS, TEC maps, Scintillation.

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Acknowledgements: The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement n° [607081].