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Scintillations and TEC gradients from Europe to Africa: a picture by the MISW project

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MISW (Mitigation of space weather threats to GNSS services) is an EU/FP7 project with the purpose of tackling the research challenges associated with Space Weather effects on GNSS (Global Navigation Satellite System). In particular, the objective of MISW is to develop suitable algorithms capable of enabling Satellite Based Augmentation Systems (e.g. EGNOS) in the low-latitude African sector. For this purpose, MISW has created a detailed picture of extreme space weather events that occurred in the past and in the current solar cycle. Despite its weakness, the current solar cycle exhibited two superstorms that happened during the descending phase, in March and in June 2015. The latter has been studied in detail through a careful analysis of GNSS data acquired by TEC (Total Electron Content) and scintillation monitors and by IGS and regional geodetic networks located in Europe and in Africa. The investigation enabled creating the actual scenarios of TEC gradients and scintillation that occurred over a wide latitudinal extent between 21 and 30 June 2015. The investigation is based on calibrated TEC from different receivers, aiming at the estimation of east-west and north-south TEC gradients and on the integration of calibrated TEC and TEC gradients with the scintillation data. The impact of the storm on GNSS performance has also been investigated in terms of losses of lock.

The results of this study highlight the importance of assessing the latitudinal and the longitudinal TEC gradients as crucial information to identify to what extent different ionospheric sectors are severely affected by scintillation. On the other hand, this study also shows evidences of how TEC gradients are not always responsible for the observed scintillation.

Finally, the outcomes of the study demonstrate the complex relation between scintillation, TEC gradients and losses of GNSS satellites lock.