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Adaptive Phase Detrending for GNSS Scintillation Detection: A Case Study Over Antarctica

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We investigate the reliability of the widely used phase scintillation index determined by receiving Global Navigation Satellite System (GNSS) signals at ground in the high latitudes. To the scope, we leverage on a recently introduced detrending scheme based on the signal decomposition provided by the Fast Iterative Filtering (FIF) technique [1]. This detrending scheme enables a fine tuning of the cutoff frequency for phase detrending used in the phase scintillation index definition, mainly aimed, at its best, at disentangling diffraction and refraction effects and decoupling the index values from the plasma drift velocity [2]. This in view of providing an index that accounts only for the most disruptive effects on the phase of GNSS signals, i.e., those due to the stochastic effects triggered by small-scale irregularities. By analyzing GPS and Galileo data taken by a GNSS Ionospheric Scintillation Monitor Receiver (ISMR) in Concordia Station (Antarctica) during the September 2017 storm, we implemented a FIF-based detrending algorithm. This algorithm relies on the comparison of the FIF-derived spectra of the GNSS raw phases of L1/L2 (GPS) and E1/E5a (Galileo), and of the corresponding Ionospheric Free Linear Combination [2]. We report how this detrending scheme allows: (i) a fine frequency identification for Fresnel's frequency identification on phase spectra and (ii) the derivation of adaptive cutoff frequencies, whose value changes minute-by-minute [3]. This allows better accounting for diffractive effects in phase scintillation index calculation and shows the limitations on the use of such index, being still widely used in the community, both to characterize the features of ionospheric irregularities and to adopt mitigation solutions.

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