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GNSS Astronomy: a new field of synergestic research facilitated by the response of the Earth's ionosphere to solar flares and stellar superflares

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A new method to detect very small solar flares and EUV flux sub-flare variations is presented. Such method consists in using the SOLERAdrift-search technique to detect the associated ionospheric footprint ([1]) from thousands of simultaneous worldwide GNSS measurements. By extending the detection from C-class to extremely weak B-class solar flares and sub-flare flux variations, it is then possible to increase the sensitivity by more than one order of magnitude with respect to previous works [3], (see a typical example of B and sub-flare detection in Figure 1).

(EX)SOLERAdrift-search has estimated the probable GNSS detection of the ionosphere footprint for the first naked-eye detected superflare of Proxima Cen, during day 78, 2016, previously reported in [2]. This result, among other astronomical events recently studied, paves the way for focusing the enhanced GNSS Ionosphere Astronomical Sensor (GIAS) towards other EUV- (also X-ray and γ-ray bands) detectable extrasolar phenomena.

References

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[3] Singh, T., Hernández-Pajares, M., Monte, E., Garcia-Rigo, A., & Olivares-Pulido, G. (2015). GPS as a solar observational instrument: Real-time estimation of EUV photons flux rate during strong, medium, and weak solar flares. *Journal of Geophysical Research: Space Physics*, 120(12), (2015): 10-840.

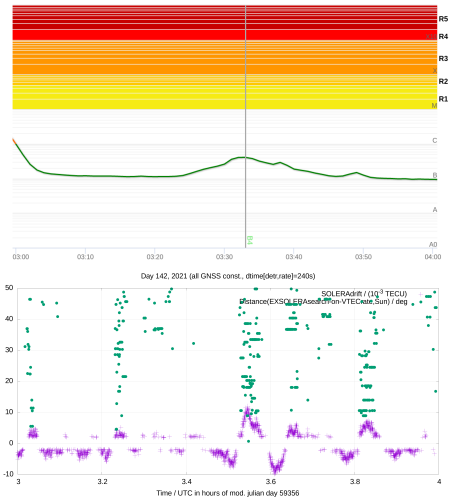

Figure 1. Time evolution, since 03h to 04h UTC on day 142 of 2021 of: (1) the directly (GOES) measured solar flux in X-ray band (top plot), and (2) the indirectly (ionospheric footprint with GNSS) EUV-flux sensitive SOLERAdrift index and the SOLERAdrift-search distance to the Sun in degrees (dark-violet and green points in bottom plot).