URSI GASS 2021, Rome, Italy, 28 August - 4 September 2021

Joint use of in-situ electron density, ionosonde parameters and whistler signals to validate IRI profiles

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The satellites of the Swarm ESA mission measure the intensity of the Earth magnetic field using the Absolute Scalar Magnetometer (ASM) [1]. Nominal acquisition is at 1 Hz, but specific burst session can be operated at 250 Hz. After some test sessions in 2014 and 2018, from the second half of 2019 regular 1-week burst sessions are operated alternatively on Swarm A and B, depending on their orbital local time. These are the only times when the Swarm satellites can detect natural signals occurring at a frequency higher than 25 Hz. These include whistlers in the Extremely Low Frequency (ELF). Specific automatic detection algorithms have been developed and applied to characterise them. From their dispersion it is possible to obtain the timing of the lightning strikes from which they originated. We used data from the World ELF Radiolocation Array (WERA) [2] to locate and characterise them, because it measures on ground the magnetic field in the same frequency band.

We also analysed ionosonde data, when available in a radius up to 600 km from the detection point within 15 minutes (or less, when available) of the whistler occurrence, in order to obtain the background ionospheric conditions of propagation, including also the additional in-situ measurements of electron density by Swarm's Langmuir probes. The comparison of the whistler dispersion with the one computed by ray-tracing simulations based on IRI model [3] constitute a new model validation approach. The use of IRTAM update of the main ionospheric profiles parameters was also evaluated to extend the validation towards areas not covered with ionosondes.

The whistlers in ELF band can be used as additional experimental data useful to monitor the ionosphere below the orbital altitudes and for the IRI model validation, especially over the low latitude regions where there is a lack of ground stations. This kind of study could be extended to other satellite missions, like the future NanoMagSat, that will enable continuous ELF observations.

References

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