The dominant scales of solar wind-ionosphere coupling revealed using the Fast Iterative Filtering

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The present study focuses on finding the scale-specific relations and their time lags between the solar wind driver and ionospheric plasma density irregularities detected using the ground-based GNSS receivers. Similar results are sought with the ionospheric plasma density measured in-situ at all latitudes in the Earth's ionosphere by Langmuir probes onboard the European Space Agency's Swarm satellites.

The advantage of the study is the extensive statistical analysis of the decomposed signal components using novel Fast Iterative Filtering (FIF) [1] and Multivariate FIF (MvFIF) [2] techniques, respectively. This provides the significance of potential couplings separately for specific frequency scales.

Verification is provided using the same technique for the idealized ionospheric disturbances being only initiated by the solar EUV/X-ray fluxes. This verification dataset has the advantage of zero non-ionospheric (propagation/coupling) time lags. For a more realistic distinction between the predominant initiation by the solar wind variations or the solar flare-related fluxes, there are used specific cases with the significant forcing provided by only one of those. The scales in the solar wind are treated using the original spacecraft data, only applying lag equal to propagation time to the Earth's magnetopause.

The FIF analysis employed this way therefore shows the details of the scale sizes on which coupling occurs for specific forcing, with its inherent time lags. The resolved coupling characteristics are validated using the means of traditional spectral analysis as they are supposed to be further applied in the Generalised Linear Modelling. This study is thus expected to provide inputs into models of ionospheric plasma variability being developed within the scope of the ESA funded, 4D-Ionosphere – Swarm VIP project.

References

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