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Real-time detection and characterisation of solar flares from ground-based VLF data

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Solar flares are fast increases in the X-ray flux. When they reach Earth, these energetic radiations ionize the atmosphere, increasing thus the electron density down to the lowest D-region of the ionosphere (60km). This, in turn, causes a greater absorption of the HF waves, which are frequency bands used by several actors like civil aviation and emergency services. Real-time detection of solar flares is thus needed to mitigate radio communications.

To study the D-region, we use Very Low Frequency waves, which propagate in the Earth-ionosphere waveguide. The rise in electron density during solar flares induces a change in the conductivity of the waveguide upper limit, which impacts the propagating waves. Ground-based VLF instruments are thus very efficient in detecting solar flares and enable continuous surveys of remote regions (such as oceans).

We present here a system for detecting and characterizing solar flares, based on the real-time analysis of VLF waves and an incremental algorithm based on the automated detection of the slope changes in the data (Guralnik & Srivastava, 1999). As a result, 85 % of the moderate and strong flares (M to X) are detected within 2.6 min (in average) after their start, forming the first step of a real-time alert system.

Astrophysics Field

Space weather, Ionosphere, Solar flares

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