Radio imaging and spectroscopy tools for space weather applications

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Electromagnetic radiation from the Sun as well as energetic particles associated with flares or CMEs can affect the terrestrial environment (e.g. radio black outs, radiation damage) on short timescales (8 minutes to a few hours). The solar wind and its perturbations (shocks, coronal mass ejections) affect the Earth's environment on a longer time scale (2 to 4 days). The continuous survey of the sun and of its activity in view of space weather applications is nowadays in a phase of full development. Radio emissions below 1000 MHz are among the first signatures of space-weather relevant disturbances originating from the solar atmosphere. Radio emissions associated with flares, shocks and CMEs are produced by energetic electrons either through various plasma mechanisms (narrow band emissions observed in particular below 1000 MHz) or by gyrosynchrotron emissions (large broadband continuum emission observed predominantly above 1000 GHz). For plasma mechanisms, (which are the primary emission processes at frequencies below 1000 MHz), the emitting frequency is related to the plasma frequency or its double (harmonic) and therefore decreases with height in the solar corona. Measuring radio emissions at different frequencies (either with spectroscopy or through imaging) thus allows to probe phenomena at different heights of the solar atmosphere as well as to follow the propagation of disturbances from e.g. the low corona to the interplanetary medium. In addition, some specific radio emissions (long duration radio continua called type IV) can be used as tracers of the development in the low corona of CMEs, well before they are detectable in the field of view of coronographs. In the case of a large flare, the lack of radio emissions at metric wavelengths can also be used as an indication that there is no potential escape of energetic particles from the flare site. This is an important factor which could be used to predict in advance that there will be no major solar particle events in association with a specific flare.

I shall present in this talk an overview of the ensemble of solar dedicated ground-based radio observations hosted at the Nançay radio observatory (Observatoire de Paris). It consists of : an imager of the corona and of its activity at several frequencies in the 150-450 MHz range (Nançay Radioheliograph or NRH), unique in the world;, and of two spectrographs, the (Nançay Decameter Array (; NDA) in the ;20-70 MHz range) and ORFEES (140-1000 MHz-130 MHz). The combination of these observations allows to diagnose the characteristics of the transient phenomena which take place in the corona on a wide range of coronal heights, namely from 0.1 solar radii above the photosphere to the high corona. These are key regions for the understanding of the origin and propagation of coronal mass ejections, shock waves and electron acceleration in flares and propagation to the interplanetary medium. I shall discuss the possible use of these observations for space weather applications.