EGU21-15048
https://doi.org/10.5194/egusphere-egu21-15048
EGU General Assembly 2021

Observing the Sun with LOFAR: an overview of the telescope capabilities and the recent results from the PSP groud base support campaign.

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Understanding and modelling the complex state of the Sun-solar wind-heliosphere system, requires a comprehensive set of multiwavelength observations. LOFAR has unique capabilities in the radio domain. Some examples of these include: a) the ability to take high-resolution solar dynamic spectra and radio images of the Sun; b) observing the scintillation (interplanetary scintillation - IPS) of distant, compact, astronomical radio sources to determine the density, velocity and turbulence structure of the solar wind; and c) the use of Faraday rotation as a tool to probe the interplanetary magnetic-field strength and direction. However, to better understand and predict how the Sun, its atmosphere, and more in general the Heliosphere works and impacts Earth, the combination of in-situ spacecraft measurements and ground-based remote-sensing observations of coronal and heliospheric plasma parameters is extremely useful. Ground-based observations can be used to infer a global picture of the inner heliosphere, providing the essential context into which in-situ measurements from spacecraft can be placed. Conversely, remote-sensing observations usually contain information from extended lines of sight, with some deconvolution and modelling necessary to build up a three-dimensional (3-D) picture. Precise spacecraft measurements, when calibrated, can provide ground truth to constrain these models. The PSP mission is observing the solar corona and near-Sun interplanetary space. It has a highly-elliptical orbit taking the spacecraft as close as nearly 36 sola radii from the Sun centre on its first perihelion passage, and subsequent passages ultimately reaching as close as 9.8 solar radii. Four instruments are on the spacecraft's payload: FIELDS measuring the radio emission, electric and magnetic fields, Poynting flux, and plasma waves as well as the electron density and temperature; ISOIS measuring energetic electrons, protons, and heavy ions in the energy range 10 keV-100 MeV; SWEAP measuring the density, temperature, and flow speed of electrons, protons, and alphas in the solar wind; and finally, WISPR imaging coronal streamers, coronal mass ejections (CMEs), their associated shocks, and other solar wind structures in the corona and near-Sun interplanetary space, and provide context for the other three in-situ instruments. In this talk, the different observing modes of LOFAR and several results of the joint LOFAR/PSP campaign will be presented, including fine structures of radio bursts, localization and kinematics of propagating radio sources in the heliosphere, and the challenges and plans for future observing campaigns including PSP and Solar Orbiter.