# Solar Radar

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The prospects of probing the solar corona, solar prominences, and coronal mass ejections (CMEs) from the ground using a large radar will be examined. Solar radar would utilize direct reflection (i.e. soundings) from the solar plasma supplemented by coherent scatter from Langmuir waves in coronal arcs and CMEs. Active sounding could provide unambiguous information about the range, bearing, and speed of the targets. Such information would be crucial for initial-value and assimilative space-weather models providing operational space-weather forecasts.

Challenges posed by solar-radar are significant but manageable, and many of the design choices are clearcut. For solar studies, the radar wavelength must be longer than the plasma Debye length. This places a premium on low radar frequencies which overrides the penalty of increased sky and solar noise. However, the radar frequency should not fall below the maximum usable frequency (MUF) since that would invite radar clutter from sky waves. The ideal frequency is therefore between 40--50 MHz. The most important parameter is the transmitter power-aperture product which limits the flux that can be delivered to the Sun. To optimize this flux, the antenna for transmission should be a steerable aperture or filled array with about a 1-degree half-power beamwidth. Steerability is required to keep the radar beam trained on the Sun, facilitating long incoherent integration times. The receive array meanwhile must be large enough that most of the noise it receives comes from the solar disk itself and not from the galactic background. However, we must consider that the main source of noise will be type III radio bursts. The noise temperature at VHF frequencies from solar radio bursts can be several orders of magnitude greater than that of the quiet sun, and system performance will depend on discriminating solar echoes from radio bursts. Adaptive beamforming will ultimately be critical for operational solar-radar space-weather applications. It is in this way that a large, modular receiving arrays become important.

All things considered, a facility comparable in size and power to the existing NSF Geospace Facilities but operating in the VHF band and possessing spaced-receiver capabilities should be able to detect solar echoes. Several attempts have been made already to detect solar echoes. The historical record is mixed, and the plausibility of the concept remains somewhat ambiguous. Recent and ongoing attempts to receive solar echoes at The Jicamarca Radio Observatory near Lima,

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Peru, will be discussed.

Keywords: space weather, radar, solar corona

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