



A Low-band VHF Radar for Geospace, Cislunar, Planetary, Solar, and Astronomical Research

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The construction of a low-band HF/VHF (20-80 MHz) deep space radar observatory, for research spanning the neutral atmosphere, the ionosphere and magnetosphere, meteors and hypersonic vehicles, cislunar objects, asteroids, planets, the solar corona, and radio astronomy, has been a decades-long dream of space scientists. Over the years our awareness of what might be gained has increased, and the techniques that can be used have dramatically improved, making this an opportune time for the design and construction of a modern deep space radar observatory:

– High-sensitivity high-resolution vector measurements of coherent and incoherent scatter from the neutral atmosphere and ionosphere would change the nature of what can be observed.

– A MIMO VHF system would be a powerful tool for the study of meteors both for science goals and as a proxy for the development of techniques for tracking hypersonic vehicles.

– Advanced VHF radar can warn of potential asteroid earth impact, perform deep subsurface studies of asteroids, moons, and planets, and aid in the development of methods for tracking cislunar objects.

– Solar radar observations require low VHF frequencies. Some observations were done in the past, but the technology and supporting measurements were limited.

– High sensitivity will provide important low-frequency radio astronomical capabilities, including detection of magnetized extra-solar planets, whose magnetic fields, as shields against cosmic rays, could be a prerequisite for life.

High continuous power, multiple receiving sites for 3-D velocity measurements and radar imaging, multiple transmitting sites for MIMO operation, frequency agility for observations at multiple scale lengths, and wide bandwidth for high range resolution, will open a powerful new solar, sun-earth, planetary, space weather, and astronomical research and monitoring capability, as well as a testbed for detection and tracking of hypersonic and cislunar vehicles.

Atmospheric and space weather monitoring and prediction are critical for communication, navigation, power distribution, and for both manned and unmanned aircraft and spacecraft. The relatively long wavelengths of the low VHF band will lead to new discoveries in asteroid and planetary science. Solar radar will be a game changer for solar physics research and space weather prediction and monitoring, opening up a new window on the sun and providing early warning of earth-directed coronal mass ejections.