Seeing Red …

In recognition of February's successful landing and deployment of the Perseverance rover on Mars, as well as reception of signals from NASA's Mars Reconnaissance Orbiter by a ham last fall (Scott Tilley, VE7TIL/VA7LF), we thought it would be appropriate this month to reprise the prophetic article by Professor Emil Heisseluft 27 years ago, in April 1994, titled "Ionospheric Propagation Possible on Mars."

And yes, ionospheric propagation on Mars *is* possible, at frequencies between 4.5 and 450 MHz, covering distances of up to 580 miles (see *Figure 1*), according to NASA's 2002 publication, "Radio Wave Propagation Handbook for Communication on and Around Mars" <https://tinyurl.com/cakk47bn>. Of particular interest is Section 2, "Martian Ionosphere and Its Effects on Propagation (Plasma and Magnetic Field)" <https://tinyurl.com/4sc8lbvr>. Note that Professor Heisseluft's *CQ* article preceded NASA's by eight years!

The Perseverance rover's first full-color look at the surface of Mars. (NASA/JPL-CalTech photo)

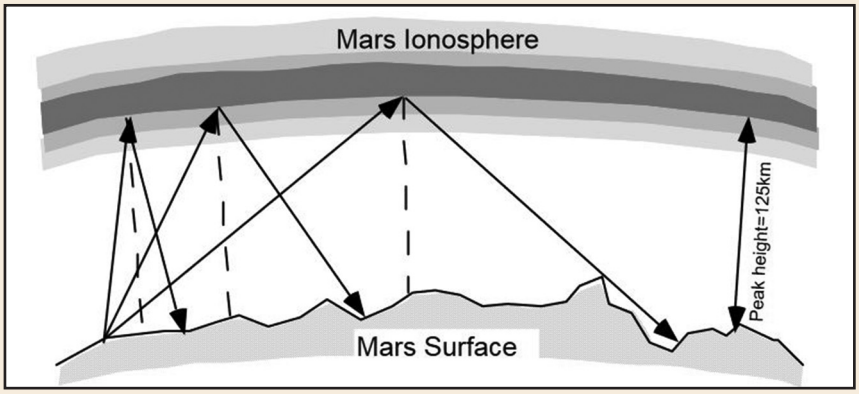

Figure 1. Communication possibilities on the dayside of Mars (NASA image from "Radio Wave Propagation Handbook for Communication on and Around Mars," 2002)

International organizations to mount major amateur HF experiment by end of decade.

Ionospheric Propagation Possible On Mars

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I haven't heard from Professor Heisseluft since late in 1984, when he forwarded his manuscript for "Amateur Radio's New Frontier: The Bands Below 30 kHz." Imagine my surprise, then, when the good professor's manuscript for this exciting article appeared on my desk! Not only does the professor discuss the exciting possibility of HF propagation on Mars, but he also reveals a hush-hush public relations project jointly sponsored by the United Nations and the World Meteorological Organization that could result in amateur radio communications on the Red Planet by the year 2000. —K2EEK

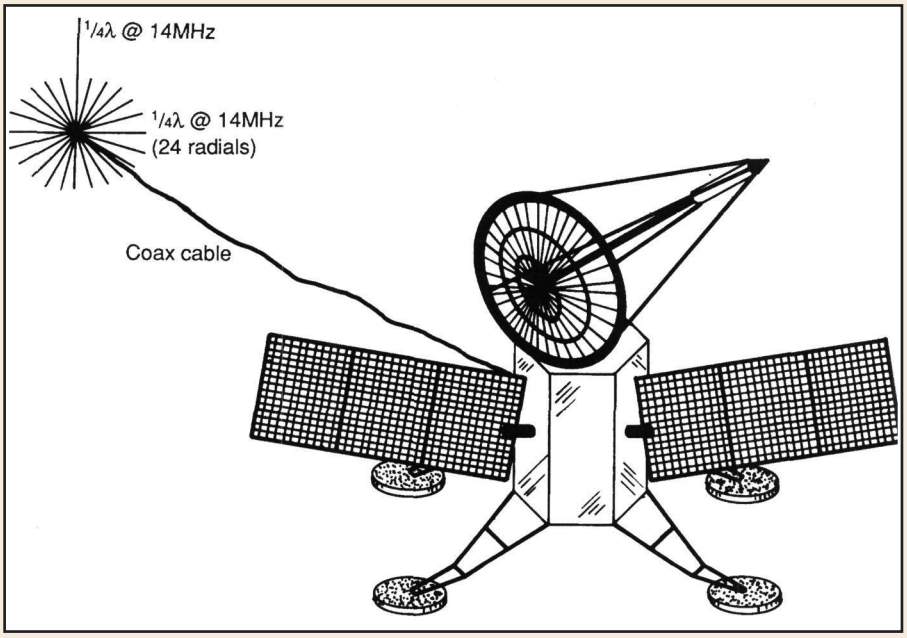
Talk of a mission to Mars has for years occupied layman and scientist alike. Today the planet is a primary target of numerous planetary exploration programs. One proposal now being considered in the United States, for example, is a mission called the Mars Environmental Survey (MESUR). This project calls for establishing 16 unmanned scientific stations on the planet's surface which will be used to collect meteorological and other data (see references 1 and 2). A similar concept set forth by the European Space Agency is embodied in a mission called MARSNET, and it would employ three surface stations for the same purpose. Both

MESUR and MARSNET are scheduled for implementation by the year 2000.

With the discovery some years ago of an ionosphere on Mars similar to the ionosphere on Earth, both the United Nations (UN) and the World Meteorological Organization (WMO), in cooperation with NASA and the European Space Agency, are now developing a plan to facilitate HF communications on Mars by Earth-bound amateurs. The plan, which is now very hush-hush, will work as follows.

First, both the UN and the WMO will issue a limited number of amateur radio licenses to Earth-bound amateurs. The assignments will be done by lottery, and winners will be assigned either a 4U4AAA-4U4ZZZ callsign (UN affiliated) or a C74AAA-C74ZZZ callsign (WMO affiliated). An amateur may hold only one call. These calls will be stored digitally in the memories of two MESUR stations which will be equipped with low-power HF transmitters. At random times over the Martian solar day (which interestingly is only 40 minutes longer than a solar day on Earth), callsigns will be selected from the memories of both stations, and an attempt will be made to communicate using packet techniques. If the exchange is successful, a Worked All Mars certificate will be issued to the two amateurs whose callsigns were used. All of the organizations involved would probably agree that this is nothing more than a public relations ploy. However, the goodwill and publicity that will be generated cannot help but draw the public's attention to, and support for, all space programs.

Let's look in more detail at the various aspects of this exciting project.



Artist's conception of the United Nations' MESUR Station at Olympus Mons. The 14 MHz, 1/4-wavelength vertical antenna is hydraulically erected, while the 24 radials are explosively ejected from tubes at the base. This HF antenna system is designed to be 90% efficient, with a take-off angle of 10° relative to the horizontal.

Ionospheric Propagation On Mars

As early as the 1970s, a number of researchers (see refs. 3 and 4) reported peak Martian daytime electron densities of 1×10^5 cm^{-3} at a height of 130-140 km. It should be noted that the data used were acquired just before, or during, a minimum in the sunspot cycle. Additional studies in the late 1980s (refs. 5 and 6) supported the existence of a Martian ionosphere. Importantly, the peak electron densities and altitudes noted above compare favorably with those of the Earth's E-layer during periods of low solar activity (peak electron densities of 2×10^5 cm^{-3} at heights of 120-140 km), and so we would, to a first approximation, expect Martian HF propagation to closely resemble that observed using our planet's E-layer. Specifically, the ionosphere of Mars ionosphere should support one-hop propagation to distances of 2000 km. Looked at another way, given that Mars has a radius roughly equal to half that ofthe Earth (3393 km vs. 6380 km), a onehop, 2000 km path on Mars is, relatively speaking, equivalent to a one-hop, 4000 km F2-layer ionospheric path on Earth! Finally, because Mars does not have a strong magnetic field, ionospheric storms on this planet will be considerably milder than on Earth. Aurora, too, will not present a problem. And best of all, on Mars interference from other amateurs will be nonexistent.

The Mars Environmental Survey (MESUR)

As presently envisioned by its creators, MESUR will be comprised of 16 stations and several micro-rovers, all of which will be distributed over the Martian surface (see ref. 2). The network formed by these stations may employ relay satellites to transmit the data collected back to Earth from specific sites within the network, though direct transmission to Earth from each site is also a possibility. The 16 sites proposed for MESUR are shown in Table 1 (from ref. 2).

The two sites proposed for the amateur communications "contest" are Olympus Mons (Site 4) and Gusev Crater (Site 12). The distance between them is 3625 km; as such, a two-hop ionospheric path will be required for the two stations to communicate. The frequency of operation will be around 14 MHz. To achieve the low take-off angle required for effective communications, a one-half wavelength, base-loaded vertical antenna with 24 quarter-wavelength radials will be erected at each site. Transmitter output power will be 5 watts, though lesser power levels are under consideration to minimize battery drain and recharge time.

Amateur Proxy Licenses

Needless to say, it is expected that amateurs worldwide will want to participate in this "contest." Accordingly, both the UN and the WMO are now making plans to begin issuing licenses by lottery in 1997. Though the details are still sketchy, usually reliable sources in Washington, DC have told me that amateurs will be able to apply for licenses to both organizations beginning April 1st of that year. Forms will be made available through all national radio clubs or directly by mail, and the only requirement for a Mars license is that the applicant have a valid license that permits operation in the HF bands (a copy of the license must accompany each application). The "window" during which applications may be submitted will run from April 1st through July 1st of 1997. Applications can be made both to the United Nations and to the World Meteorological Organization.

Once applications have been received and validated, each will be assigned a number. The lottery to select the winning licensees will then be held on April 1, 1998. Winners in the United Nations' lottery will be assigned one of 17,576 three-letter-suffix callsigns from the block 4U4AAA-4U4ZZZ. Similarly, winners in the World Meteorological Organization's lottery will be assigned one of 17,576 possible calls from the block C74AAA-C74ZZZ. Those amateurs who are lucky

No.	Site	Latitude	Longitude
1	Valles Marineris	-6.0	58.0
2	Valles Marineris	-5.0	54.0
3	Chryse Plan, VL-1	23.0	48.0
4	Olympus Mons	13.0	130.0
5	Valles Marineris	-2.0	54.0
6	Hadriaca Patera	-32.0	268.0
7	NW Hellas	-40.0	310.0
8	Argyre Planitia	-37.0	44.0
9	South Pole	-86.0	315.0
10	Sirenum Terra	-45.0	185.0
11	Northern Plains	60.0	50.0
12	Gusev Crater	-15.0	185.0
13	Syrtis Major	5.0	295.0
14	North Arabia	38.0	309.0
15	North Pole	82.0	55.0
16	Chasma Borealis	-66.0	66.0

Table I- MESUR sites proposed by McNamee (see ref. 2).

enough to have their numbers drawn in both lotteries will be assigned either a UN or a WMO callsign. Multi-color, commemorative licenses suitable for framing will be issued and mailed to each winner.

The Contest On Mars

Upon completion of the drawing, the callsigns will be stored in memory devices that will be embedded in the MESUR control systems for the two transmitter sites. Then, upon landing and deployment of the equipment and antennas at each site, operations will commence. On a time-available basis throughout the Martian day, a callsign will be selected at random from the memory of the UN station (Olympus Mons), and a packet containing the callsign and the time of day will be sent up to three times to the WMO station (Gusev Crater). Once the transmission is received without error, the WMO station will transmit a packet containing a randomly selected WMO callsign and the time of day up to three times. If the transmissions are received without error by both stations, a “contact” will have occurred. This information will be relayed back to Earth as part of the MESUR network's data stream to NASA ground control, and the two amateurs holding the callsigns exchanged will each be mailed a beautiful Worked All Mars certificate.

Summary

The United Nations and World Meteorological Organization are now working with NASA and the European Space Agency to equip two sites on Mars with equipment suitable for HF communications. The two sites should be occupied by the year 2000, about three years into the next sunspot cycle. Using embedded callsigns assigned to licensees on Earth that will be selected at random, up to three attempts will be made to complete a packetized exchange. If successful, the Earth-bound amateurs to whom these callsigns have been assigned will receive a Worked All Mars certificate, attesting to the achievement.

Watch the pages of January 1997 CQ for a copy of the license application form and instructions on how to apply for your Martian HF license!

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