2690-2700 MHz

1. Band Introduction

The 2690-2700 MHz band is a shared band allocated to the Federal Government for the radio astronomy, earth exploration-satellite (passive), and space research (passive) services on a primary basis. There are no transmissions permitted in this receive-only scientific band.

2. Allocations

2a. Allocation Table

The frequency allocation table shown below is extracted from the Manual of Regulations & Procedures for Federal Radio Frequency Management, Chapter 4 – Allocations, Allotments and Plans.

Table of Frequency Allocations

United States Table

<table>
<tr><th>Federal Table</th><th>Non-Federal Table</th><th>FCC Rule Part(s)</th></tr>
<tr><td colspan="2">2690-2700
EARTH EXPLORATION-SATELLITE (passive)
RADIO ASTRONOMY US74
SPACE RESEARCH (passive)

US246</td><td></td></tr>
</table>

2b. Additional Allocation Table Information

US74 In the bands 25.55-25.67, 73.0-74.6, 406.1-410.0, 608-614, 1400-1427 (see US368), 1660.5-1670.0, 2690-2700, and 4990-5000 MHz, and in the bands 10.68-10.7, 15.35-15.4, 23.6-24.0, 31.3-31.5, 86-92, 100-102, 109.5-111.8, 114.25-116, 148.5-151.5, 164-167, 200-209, and 250-252 GHz, the radio astronomy service shall be protected from unwanted emissions only to the extent that such radiation exceeds the level which would be present if the offending station were operating in compliance with the technical standards or criteria applicable to the service in which it operates. Radio astronomy observations in these bands are performed at the locations listed in US311.

US246 No station shall be authorized to transmit in the following bands:

73-74.6 MHz,
608-614 MHz, except for medical telemetry equipment,[1]
1400-1427 MHz,
1660.5-1668.4 MHz,
2690-2700 MHz,
4990-5000 MHz,
10.68-10.7 GHz,
15.35-15.4 GHz,
23.6-24 GHz,
31.3-31.8 GHz,
50.2-50.4 GHz,
52.6-54.25 GHz,
86-92 GHz,
100-102 GHz,
109.5-111.8 GHz,
114.25-116 GHz,
148.5-151.5 GHz,
164-167 GHz,
182-185 GHz,
190-191.8 GHz,
200-209 GHz,
226-231.5 GHz,
250-252 GHz.

1 Medical telemetry equipment shall not cause harmful interference to radio astronomy operations in the band 608-614 MHz and shall be coordinated under the requirements found in 47 CFR. 95.1119.

3. Federal Agency Use:

3a. Federal Agency Frequency Assignments Table:

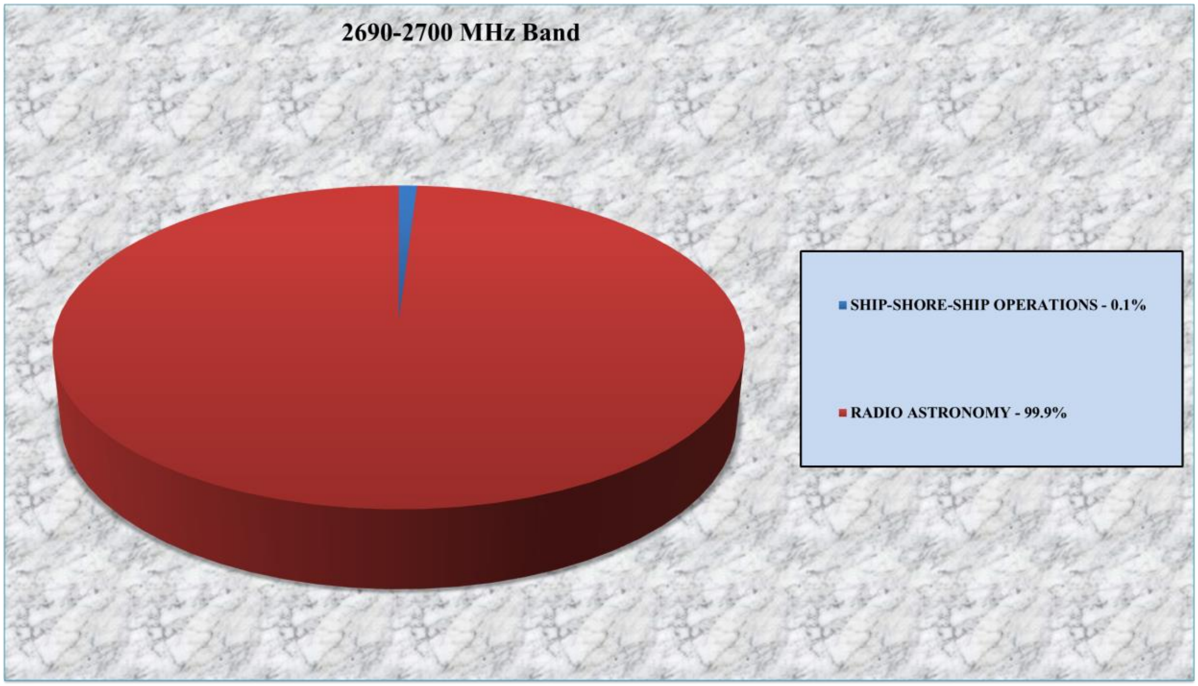
The following table identifies the frequency band, types of allocations, types of applications, and the number of frequency assignments by agency.

Federal Frequency Assignment Table

2690-2700 MHz Band					
SHARED BAND					
	EARTH EXPLORATION-SATELLITE (passive)				
	RADIO ASTRONOMY				
	SPACE RESEARCH (passive)				
	TYPE OF APPLICATION				
	RADIO ASTRONOMY	SHIP-SHORE-SHIP OPERATIONS			TOTAL
AF	2				2
N		1			1
NASA	1				1
NSF	1				1
TOTAL	4	1			5
The number of actual systems, or number of equipments, may exceed and sometimes far exceed, the number of frequency assignments in a band. Also, a frequency assignment may represent, a local, state, regional, or nationwide authorization. Therefore, care must be taken in evaluating bands strictly on the basis of assignment counts or percentages of assignments.					

Passive use does not require an authorization. Therefore, assignment counts in passive bands may not represent accurately the use.

3b. Percentage of Frequency Assignments Chart



4. Frequency Band Analysis By Application

4a. Radio Astronomy Service

Radio astronomy is defined as astronomy based on the reception of radio waves of cosmic origin.[1] The service is unique in that it involves only passive systems. Since the signals received emanate from natural sources, radio astronomers have no control over the power, the frequency, or other characteristics of the emissions. The spectrum used is based on physical phenomena rather than expected growth, as is the case for most other radio services. Using terrestrial radio telescopes, radio astronomers can observe cosmic phenomena at frequencies ranging from 15 MHz to over 800 GHz. To meet the needs of radio astronomy, frequencies at regular intervals across this range must be protected from interference in the vicinity of the radio astronomy observatories. The basic plan of spectrum management for radio astronomy is to protect small bands across the range for continuum observations, while choosing those bands so they contain the spectral lines of greatest scientific interest.[2] Radio astronomy has contributed much to the science of

[1]. NTIA Manual §6.1.1 at 6-12.

[2]. The preferred frequency bands for continuum and spectral line observations are specified in International Telecommunication Union-Radiocommunication Sector Recommendation RA.314-10.

astronomy and has produced numerous technical innovations that have benefitted radiocommunications and humankind in general. It has provided information on the atmospheric absorption of radio waves, important in the area of telecommunications and communications technology.[3]

Many extragalactic radio sources show a "break" in their non-thermal spectrum in the region between 1 to 3 GHz. Continuum measurements in the 2690-2700 MHz band are essential to accurately define the spectral characteristics from these radio sources. These measurements can provide information on the physical parameters of the radiating source such as density and temperature which are essential to understanding the physical processes that produced the radiation. The 2690-2700 MHz band is an ideal band for continuum measurements because the galactic background radiation is low, which allows radio astronomy receivers to be designed to detect weaker signals levels.

Federal and university radio astronomy research activities are interrelated and complementary. A list of the radio astronomy facilities that perform observations in the 2690-2700 MHz band are provided in Table 1.

Facility	Latitude	Longitude
Allen Telescope Array	40-49-04 N	121-28-24 W
Arecibo, PR	18-20-38 N	66-45-09 W
Socorro, NM	34-04-43 N	107-37-04 W
Green Bank, WV	38-25-59 N	79-50-23 W
Pie Town, NM	34-18-00 N	108-07-00 W
Kitt Peak, AZ	31-57-00 N	111-37-00 W
Los Alamos, NM	35-47-00 N	106-15-00 W
Fort Davis, TX	30-38-00 N	103-57-00 W
North Liberty, IA	41-46-00 N	91-34-00 W
Brewster, WA	48-08-00 N	119-41-00 W
Owens Valley, CA	37-14-00 N	118-17-00 W
Saint Croix, VI	17-46-00 N	64-35-00 W
Mauna Kea, HI	19-49-00 N	155-28-00 W
Hancock, NH	42-56-00 N	71-59-00 W
Very Large Array	34-04-44 N	107-37-04 W
Westford VLBI Station	42-36-47 N	71-29-38 W

Table 1.

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[3]. An overview of applications of astronomical techniques and devices that benefit the public is contained in National Telecommunications and Information Administration, NTIA Report 99-35, *Radio Astronomy Spectrum Planning Options* (April 1998) at Appendix B.

Radio astronomers employ radio telescopes, highly sensitive receivers with large, high-gain antennas, to detect the weak signals from space. Because the desired signals are so weak and the receivers are so sensitive, radio telescopes are highly susceptible to interference.[4] A typical radio astronomy telescope receives only about one-trillionth of a watt even from the strongest cosmic source. Radio astronomers can only control the electromagnetic signal environment at the receiver and this creates a potential incompatibility with other spectrum users. Radio observatories are usually built in remote locations with surrounding terrain that provides natural shielding from interference sources. Nonetheless, effective spectrum management is critical to protect the radio telescopes from harmful interference. Sources of potential interference are spurious, harmonic, and adjacent band emissions from satellite and airborne transmitters, and aggregate interference from licensed and unlicensed ground-based transmitters.

Spectrum contours for the facilities shown in Table 1 can be computed based on the maximum permissible interference level necessary to protect radio astronomy service receivers. The maximum permissible interference level necessary to protect a radio astronomy service receiver is specified in an International Telecommunication Union recommendation.[5] The spectrum contours are computed using a 0 dBi gain for the radio astronomy receive antenna[6]; a maximum allowable equivalent isotropically radiated power level of 10 dBW/MHz for a ground-based transmitter; and a terrain dependent propagation model.[7] The statistical and environmental parameters used with the terrain profile in calculating the propagation loss are shown in Table 2.

Parameter	Value
Refractivity	301 N-units
Conductivity	0.005 S/M
Permittivity	15
Humidity	10
Reliability	50 percent
Confidence	50 percent
Radio Climate	Continental Temperate

4. The receivers used by radio astronomers can detect signals that are typically 60 dB below thermal noise, whereas the signal levels for normal radiocommunication systems are typically 20 dB above thermal noise.

5. Recommendation ITU-R RA.769-1, *Protection Criteria Used For Radioastronomical Measurements* (1995).

6. Recommendation ITU-R RA.1031-1, *Protection of the Radioastronomy Service in Frequency Bands Shared with Other Services*.

7. The propagation loss for the spectrum contours are computed using the Irregular Terrain Model in the point-to-point mode and three second U.S. Geological Survey topographic data. A detailed description of the Irregular Terrain Model is available at http://flattop.its.bldrdoc.gov/itm.html.

Antenna Polarization	Vertical
Transmit Antenna Height	3 meters
Receive Antenna Height	Extracted from Terrain Database

Table 2.

The radio astronomy facility latitude and longitude in Table 1 represents the center point for the contour.

The spectrum contours for the radio astronomy facilities performing observations in the 2690-2700 MHz band are shown in Figures 1 through 9.

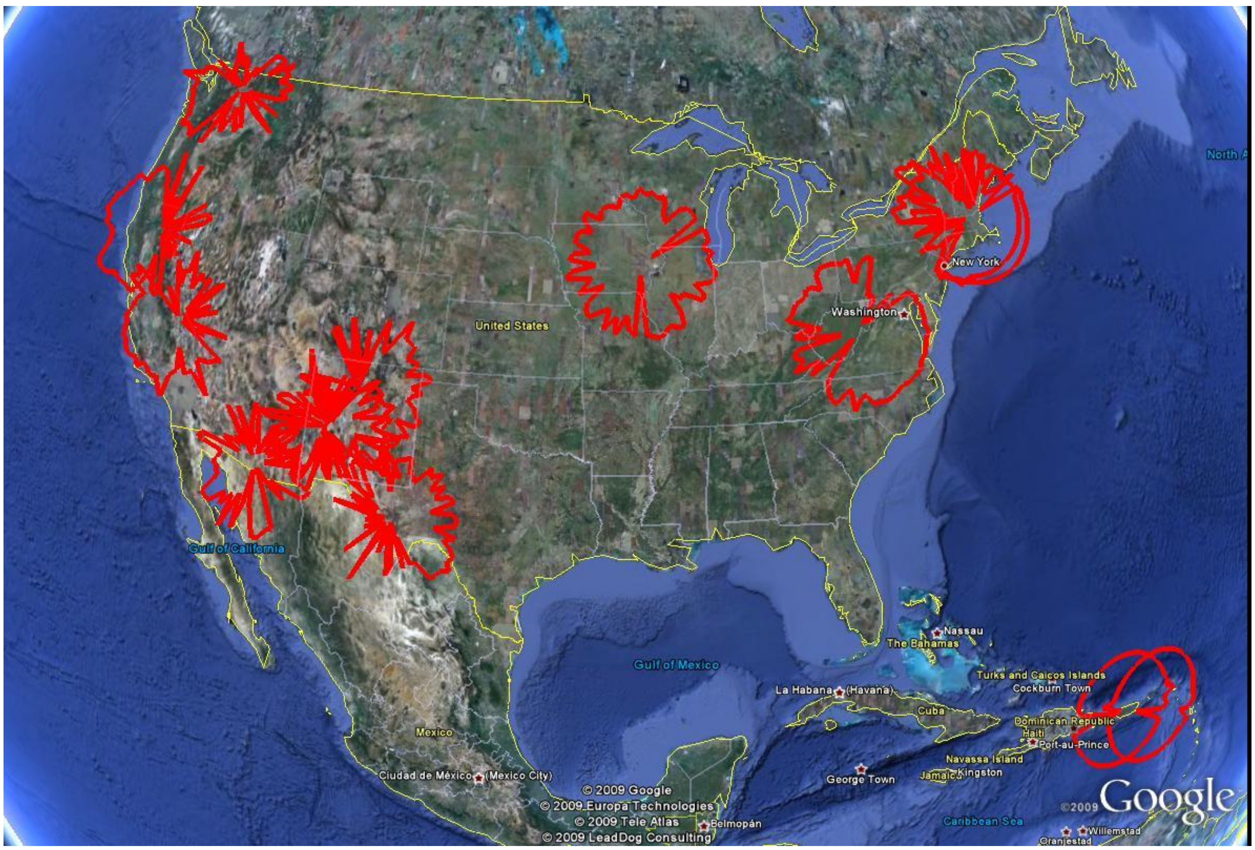

Figure 1.

2690-2700 MHz Radio Astronomy Spectrum Contours
in the
Continental United States

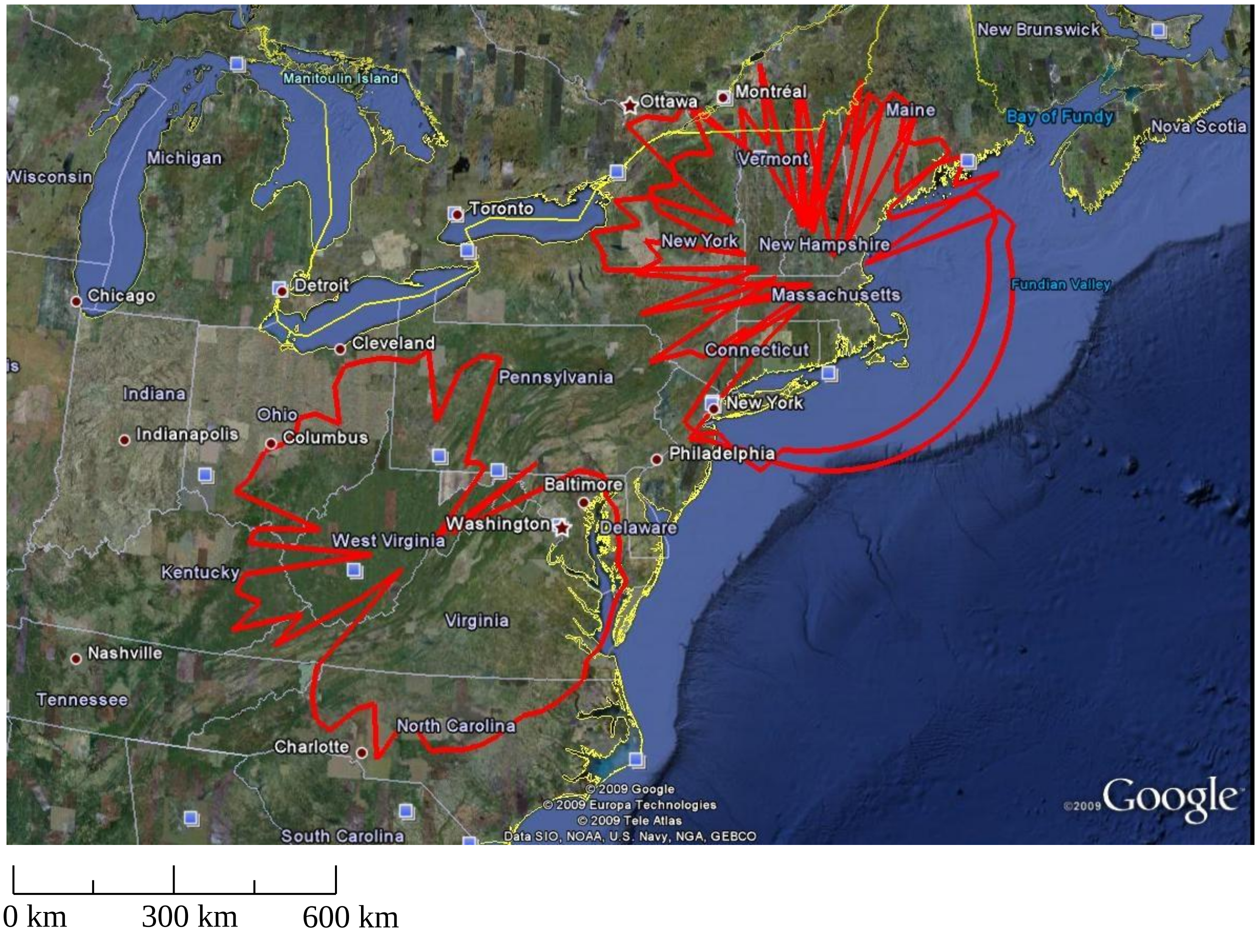

Figure 2.

Hancock, NH, Green Bank, WV and Westford VLBI Station
2690-2700 MHz
Radio Astronomy Spectrum Contours

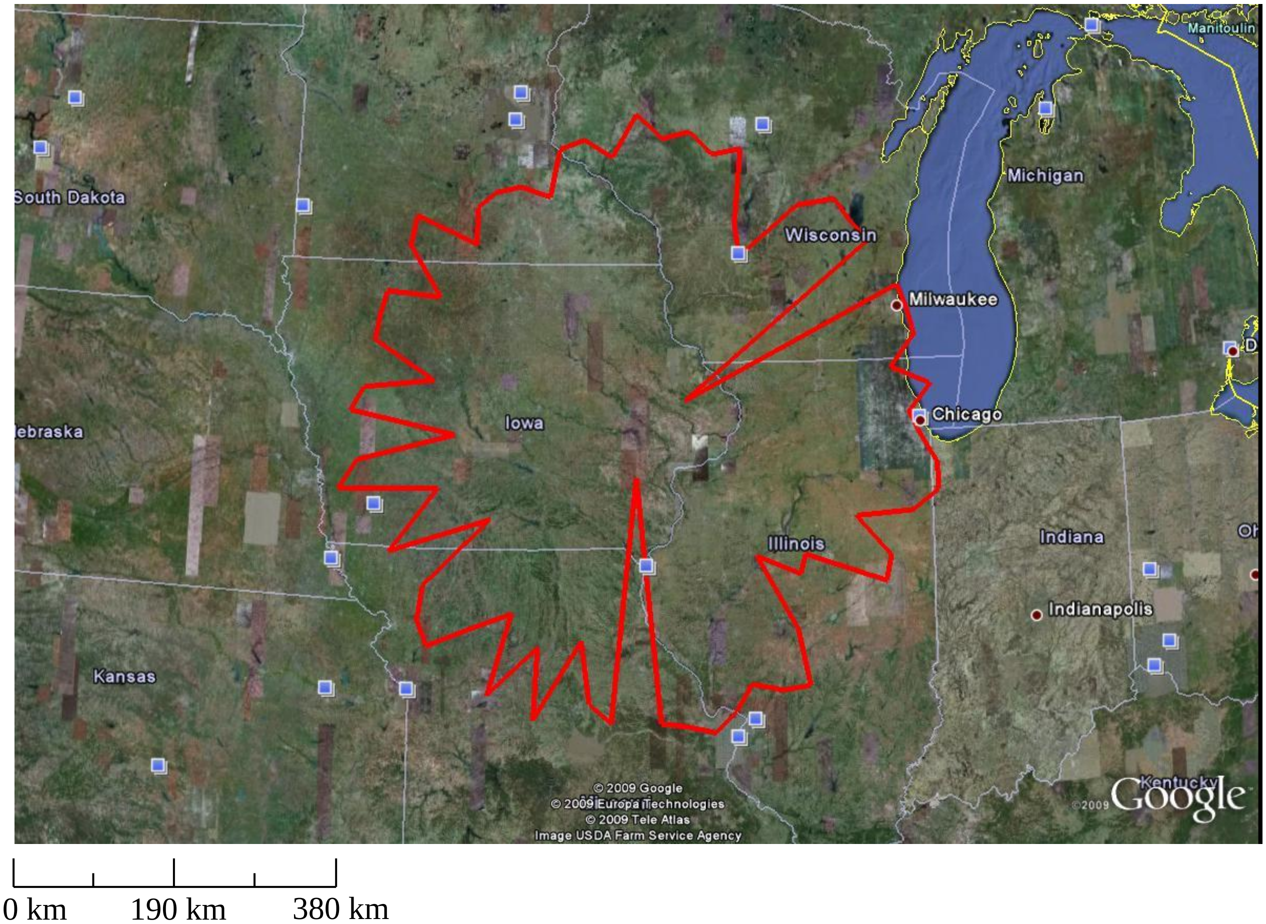

Figure 3.

North Liberty, IA
2690-2700 MHz
Radio Astronomy Spectrum Contours

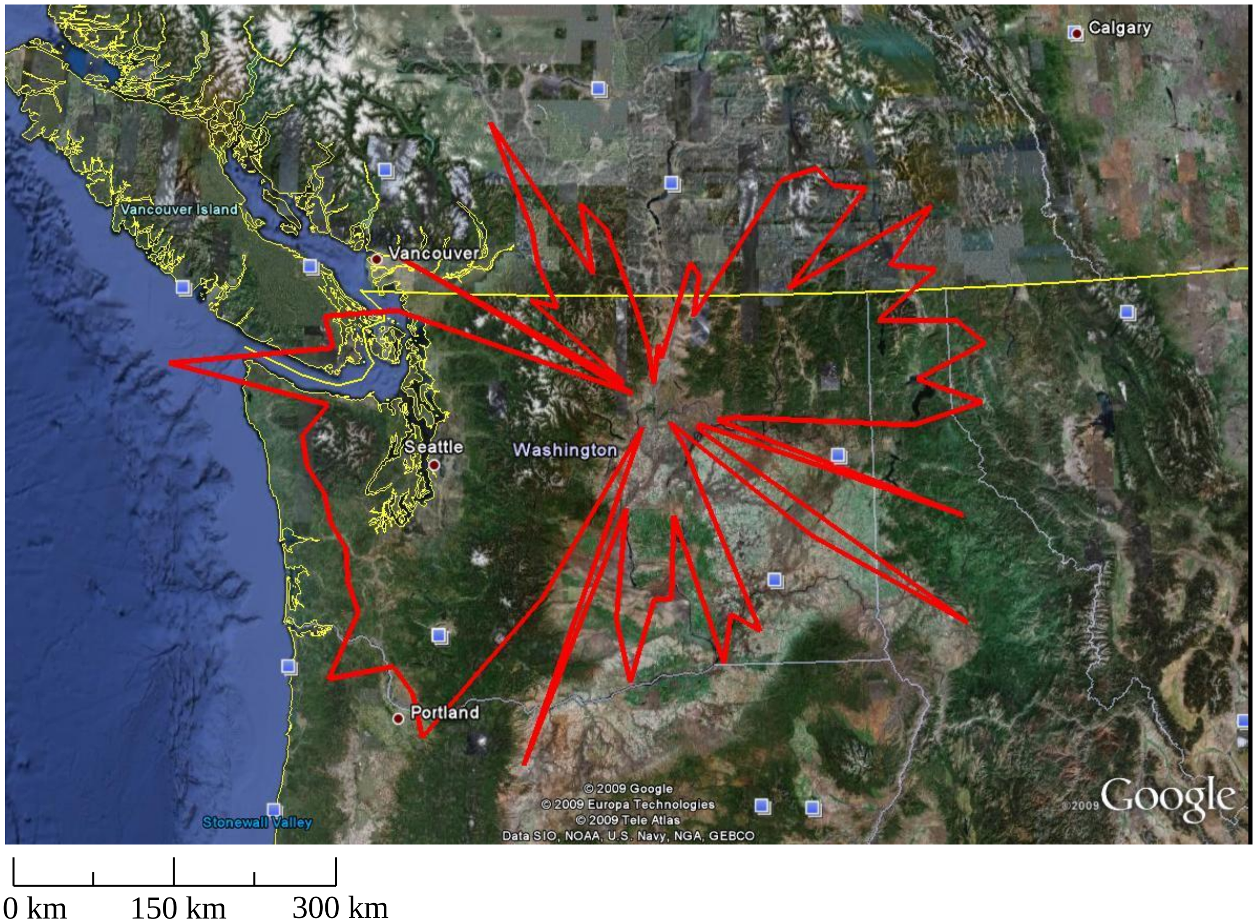

Figure 4.

Brewster, WA
2690-2700 MHz
Radio Astronomy Spectrum Contours

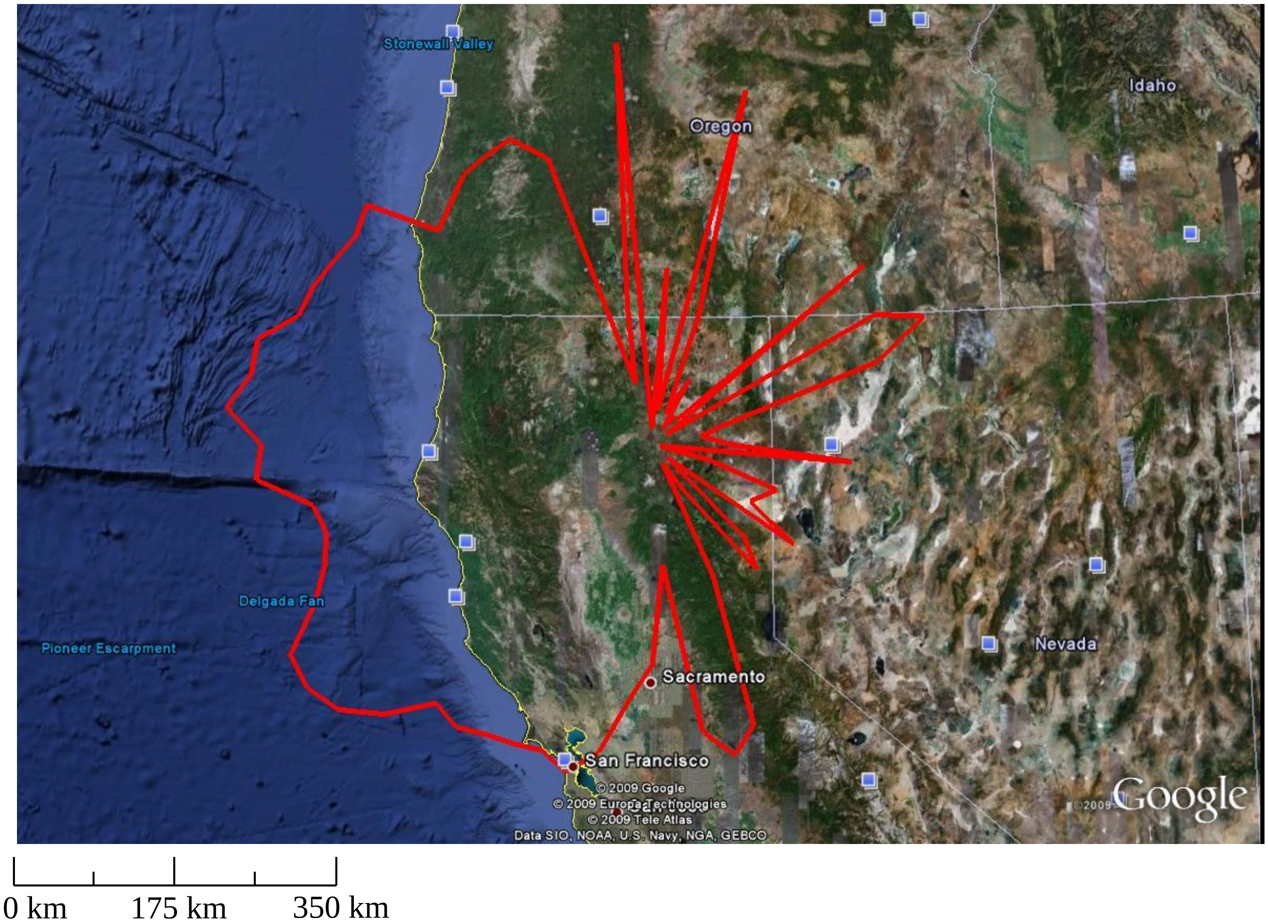

Figure 5.

Allen Telescope Array, CA
2690-2700 MHz
Radio Astronomy Spectrum Contours

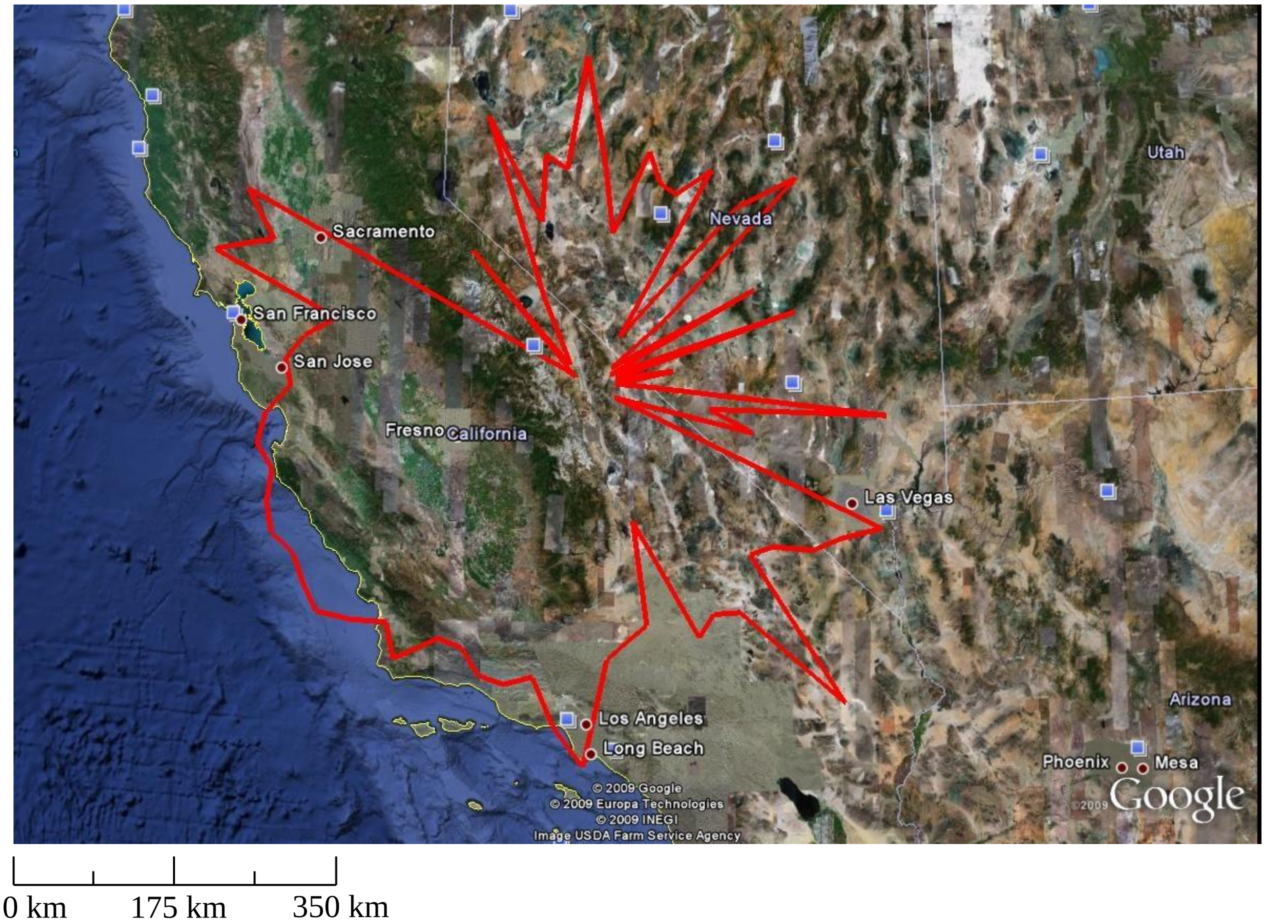

Figure 6.

Owens Valley, CA
2690-2700 MHz
Radio Astronomy Spectrum Contours

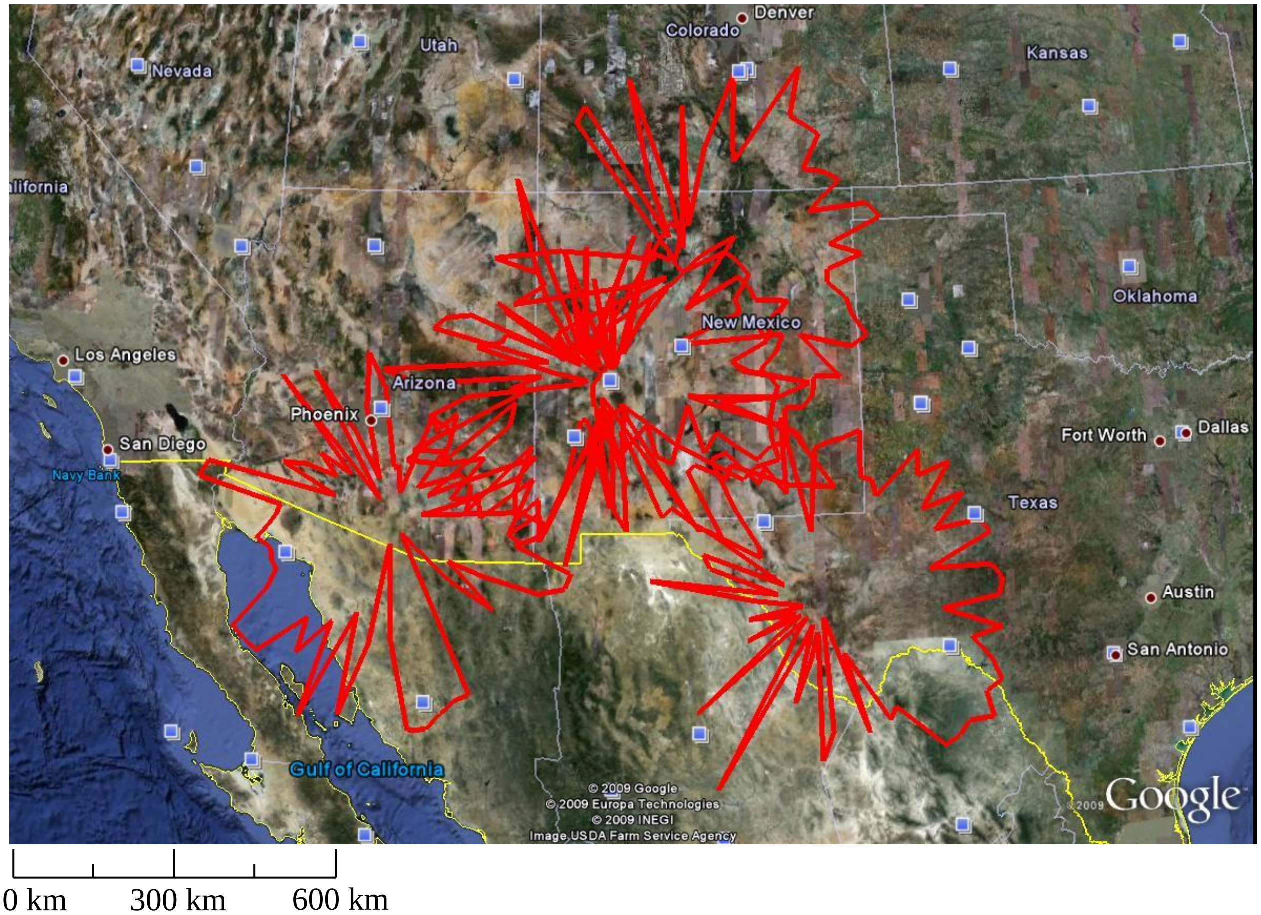

Figure 7.

Kitt Peak, AZ, Socorro, NM, Pie Town, NM, Los Alamos, NM Fort Davis, TX and Very Large Array, NM
2690-2700 MHz
Radio Astronomy Spectrum Contours

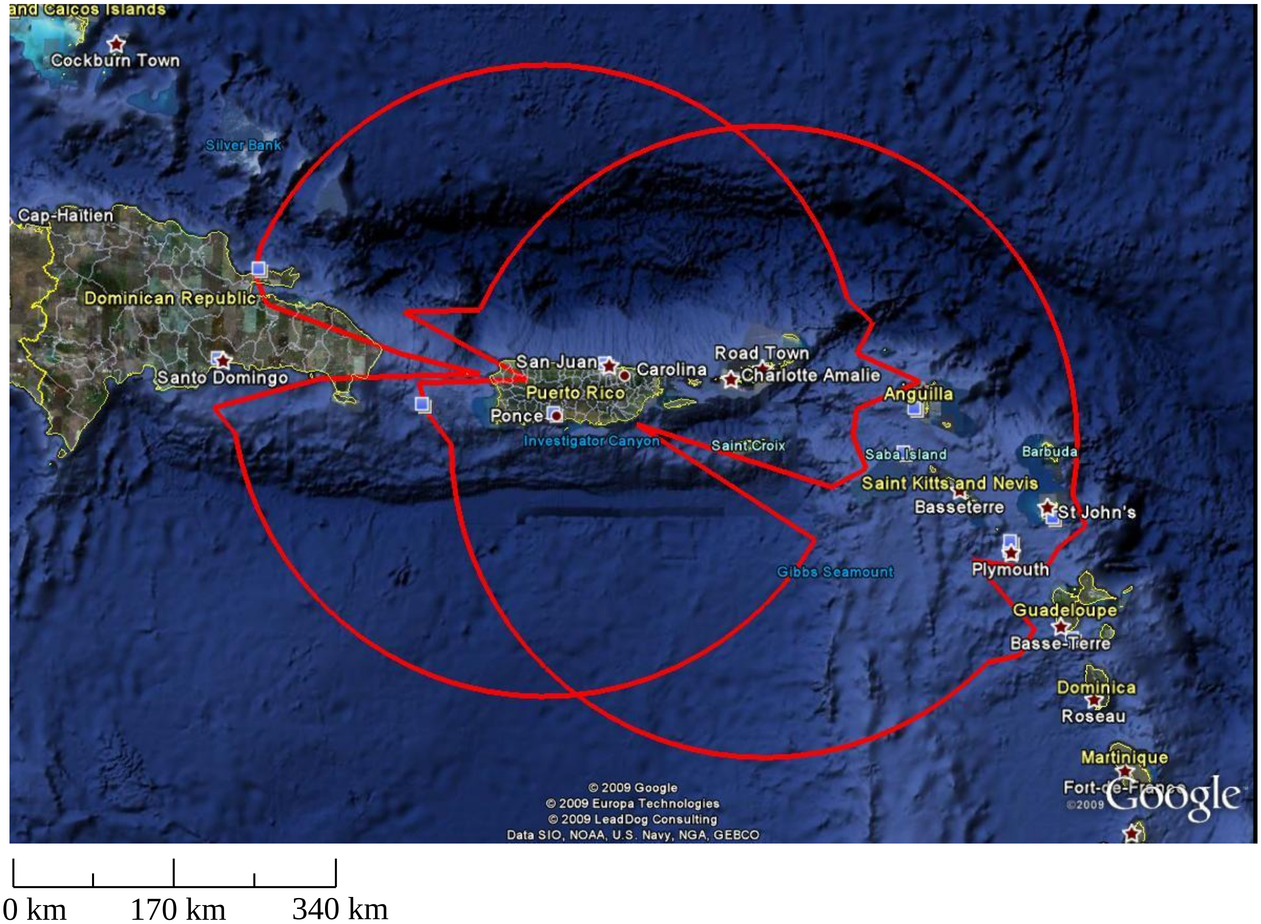

Figure 8.

Arecibo, PR and Saint Croix, VI
2690-2700 MHz
Radio Astronomy Spectrum Contours

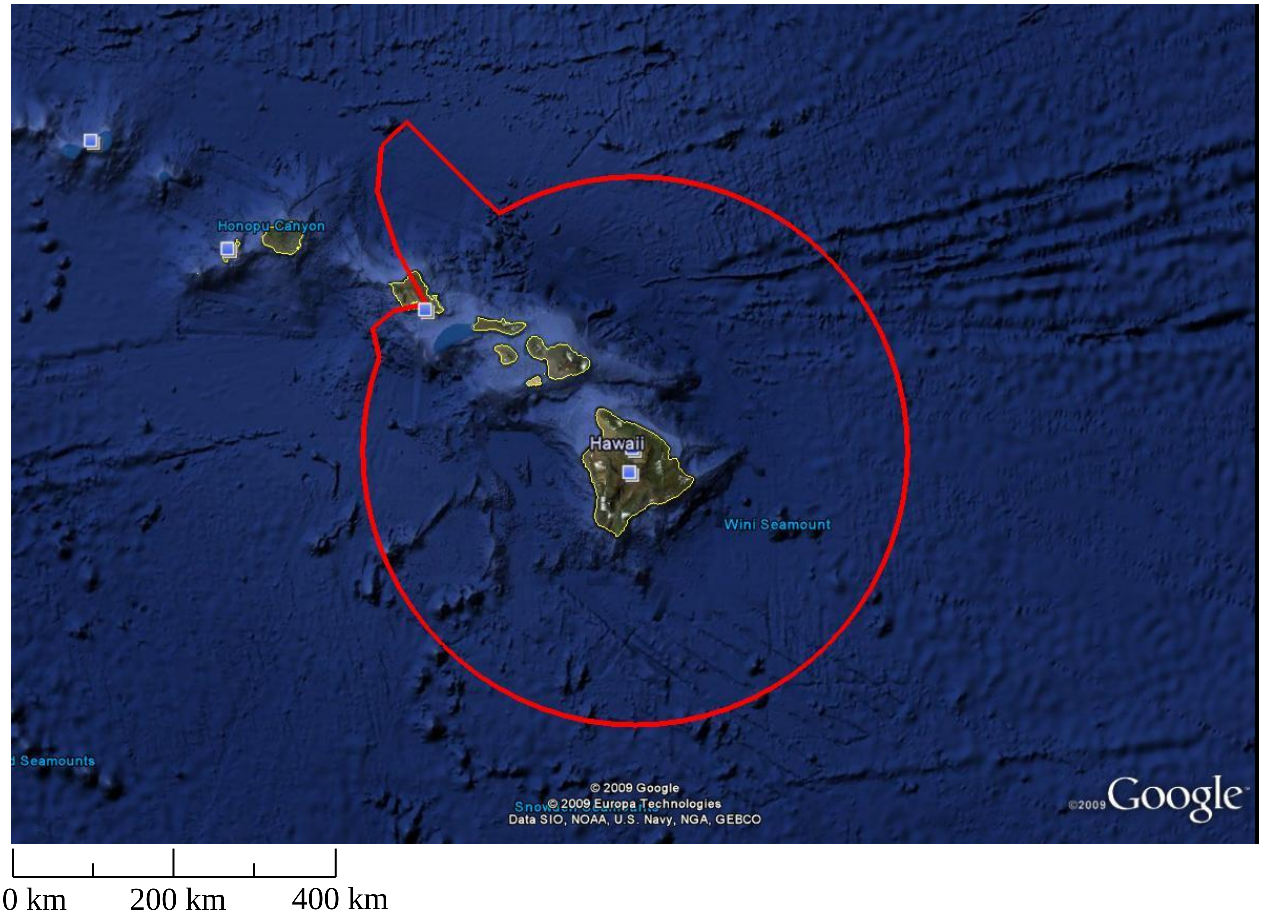

Figure 9.

Mauna Kea, HI
2690-2700 MHz
Radio Astronomy Spectrum Contours

4b. Earth Exploration-Satellite (Passive) Service

The Federal Government does not have any ongoing missions that are performing passive sensing measurements in the 2690-2700 MHz band.

4c. Space Research (Passive) Service

The Federal Government is not using the 2690-2700 MHz band for space research (passive) operations at this time.

5. Planned Use

The radio astronomy observations performed in this band are expected to continue indefinitely. There are currently no plans to use this band for Earth exploration-satellite (passive) or space research (passive) operations at this time.