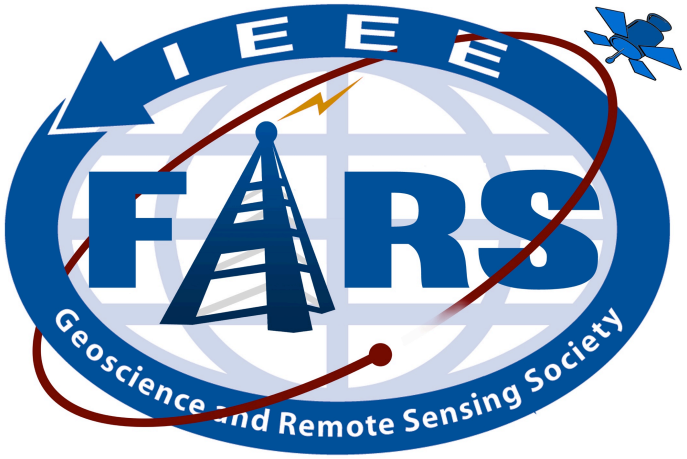
Frequency Allocations in Remote Sensing Technical Committee (FARS TC)

Annual Meeting

July 11, 2016



Sidharth Misra
Paolo de Matthaeis

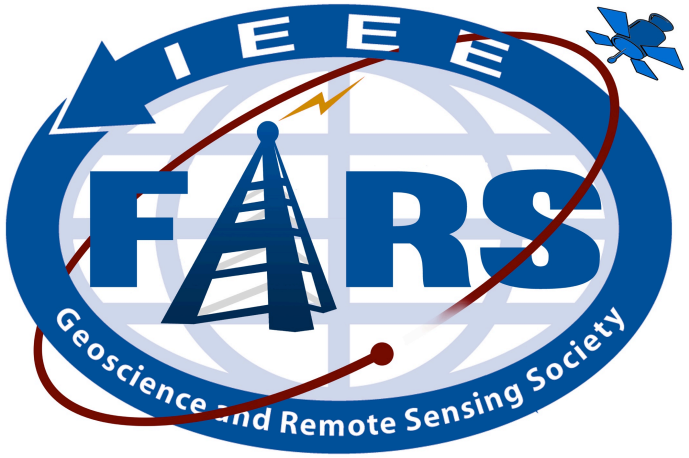
IEEE

Overview

- **Introduction:**
  - Last year's activities
  - RFI Workshop
  - FCC filing
  - Meetings attended
  - SFCG-36 report
  - RFI reporting tool development status
- **Presentation by NASA Spectrum Manager *Tom Von Deak***

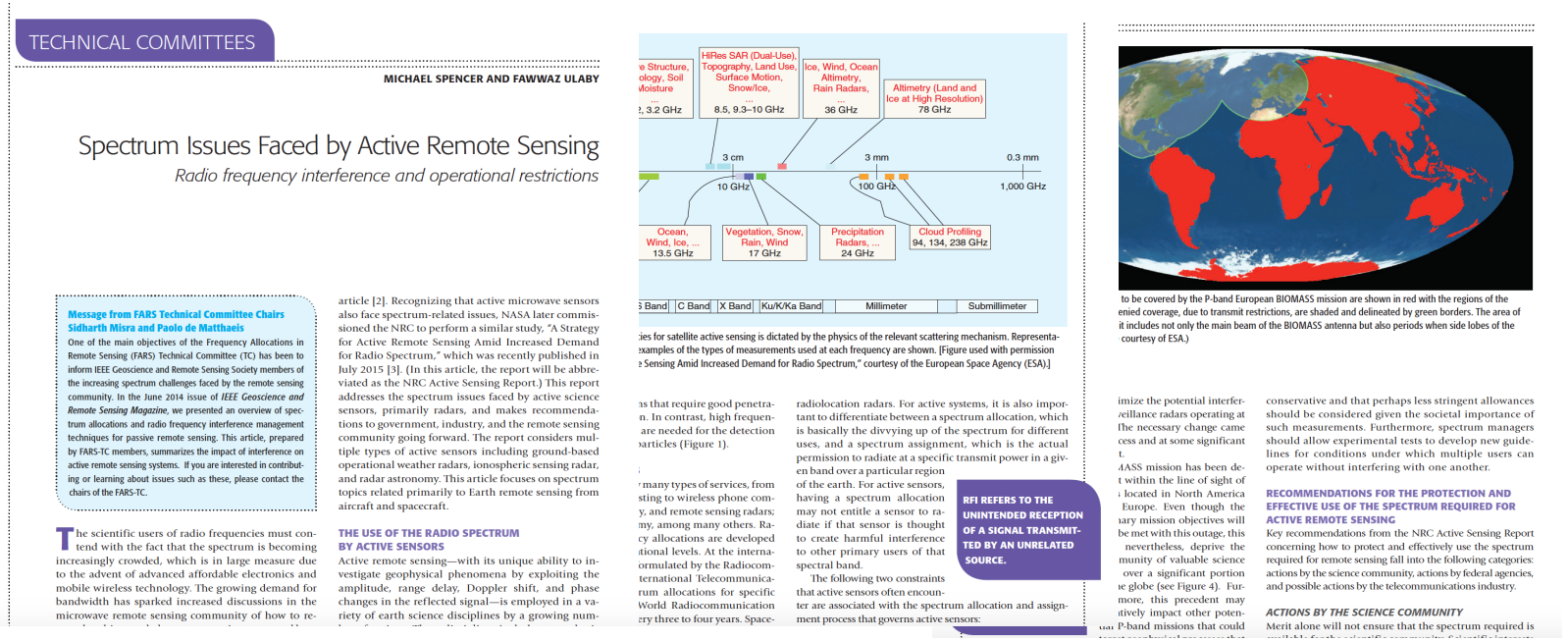
FARS-TC Mission

To interface between the GRSS membership and the frequency regulatory process, this includes educating the membership of current frequency management issues, processes and influencing regulatory efforts by organizing a GRSS response. We coordinate GRSS technical recommendations and responses to regulatory organizations. We track current and future user spectrum requirements, investigate potential interference issues and promote the development of interference mitigation techniques.



Geoscience and Remote Sensing Magazine Article Based on National Academy of Science Active Study

- **GRSM article published in the April 2016 issue**
  - **Intentional contrast with last year's FARS-TC article**
    - » **July 2015 issue – on the needs and challenges faced by Passive sensing**
    - » **April 2016 issue – on the matters affecting Active sensing**
  - **Authors – FARS-TC members**
    - » **Dr. Mike Spencer, JPL, California Institute of Technology**
    - » **Prof. Fawaz Ulaby, University of Michigan**



TECHNICAL COMMITTEES

MICHAEL SPENCER AND FAWWAZ ULABY

Spectrum Issues Faced by Active Remote Sensing

Radio frequency interference and operational restrictions

Message from FARS Technical Committee Chairs Sidharth Misra and Paolo de Matthaeis

One of the main objectives of the Frequency Allocations in Remote Sensing (FARS) Technical Committee (TC) has been to inform IEEE Geoscience and Remote Sensing Society members of the increasing spectrum challenges faced by the remote sensing community. In the June 2014 issue of *IEEE Geoscience and Remote Sensing Magazine*, we presented an overview of spectrum allocations and radio frequency interference management techniques for passive remote sensing. This article, prepared by FARS-TC members, summarizes the impact of interference on active remote sensing systems. If you are interested in contributing or learning about issues such as these, please contact the chairs of the FARS-TC.

The scientific users of radio frequencies must contend with the fact that the spectrum is becoming increasingly crowded, which is in large measure due to the advent of advanced affordable electronics and mobile wireless technology. The growing demand for bandwidth has sparked increased discussions in the microwave remote sensing community of how to re-

article [2]. Recognizing that active microwave sensors also face spectrum-related issues, NASA later commissioned the NRC to perform a similar study, "A Strategy for Active Remote Sensing Amid Increased Demand for Radio Spectrum," which was recently published in July 2015 [3]. (In this article, the report will be abbreviated as the NRC Active Sensing Report.) This report addresses the spectrum issues faced by active science sensors, primarily radars, and makes recommendations to government, industry, and the remote sensing community going forward. The report considers multiple types of active sensors including ground-based operational weather radars, ionospheric sensing radar, and radar astronomy. This article focuses on spectrum topics related primarily to Earth remote sensing from aircraft and spacecraft.

THE USE OF THE RADIO SPECTRUM BY ACTIVE SENSORS

Active remote sensing—with its unique ability to investigate geophysical phenomena by exploiting the amplitude, range delay, Doppler shift, and phase changes in the reflected signal—is employed in a variety of earth science disciplines by a growing num-

ies for satellite active sensing is dictated by the physics of the relevant scattering mechanism. Representaxamples of the types of measurements used at each frequency are shown. [Figure used with permission e Sensing Amid Increased Demand for Radio Spectrum," courtesy of the European Space Agency (ESA).]

to be covered by the P-band European BIOMASS mission are shown in red with the regions of the enied coverage, due to transmit restrictions, are shaded and delineated by green borders. The area of it includes not only the main beam of the BIOMASS antenna but also periods when side lobes of the courtesy of ESA.)

ns that require good penetra- n. In contrast, high frequen- are needed for the detection articles (Figure 1).

many types of services, from sting to wireless phone com- y, and remote sensing radars; my, among many others. Ra- cy allocations are developed tional levels. At the interna- ormulated by the Radiocom- ternational Telecommunica- rum allocations for specific World Radiocommunication ery three to four years. Space-

radiolocation radars. For active systems, it is also important to differentiate between a spectrum allocation, which is basically the divvying up of the spectrum for different uses, and a spectrum assignment, which is the actual permission to radiate at a specific transmit power in a given band over a particular region of the earth. For active sensors, having a spectrum allocation may not entitle a sensor to radiate if that sensor is thought to create harmful interference to other primary users of that spectral band.

RFI REFERS TO THE UNINTENDED RECEPTION OF A SIGNAL TRANSMITTED BY AN UNRELATED SOURCE.

The following two constraints that active sensors often encounter are associated with the spectrum allocation and assignment process that governs active sensors:

imize the potential interfer- veillance radars operating at The necessary change came cess and at some significant t. MASS mission has been de- t within the line of sight of located in North America Europe. Even though the ary mission objectives will be met with this outage, this nevertheless, deprive the munity of valuable science over a significant portion e globe (see Figure 4). Furmore, this precedent may tively impact other potenP-band missions that could

conservative and that perhaps less stringent allowances should be considered given the societal importance of such measurements. Furthermore, spectrum managers should allow experimental tests to develop new guidelines for conditions under which multiple users can operate without interfering with one another.

RECOMMENDATIONS FOR THE PROTECTION AND EFFECTIVE USE OF THE SPECTRUM REQUIRED FOR ACTIVE REMOTE SENSING

Key recommendations from the NRC Active Sensing Report concerning how to protect and effectively use the spectrum required for remote sensing fall into the following categories: actions by the science community, actions by federal agencies, and possible actions by the telecommunications industry.

ACTIONS BY THE SCIENCE COMMUNITY

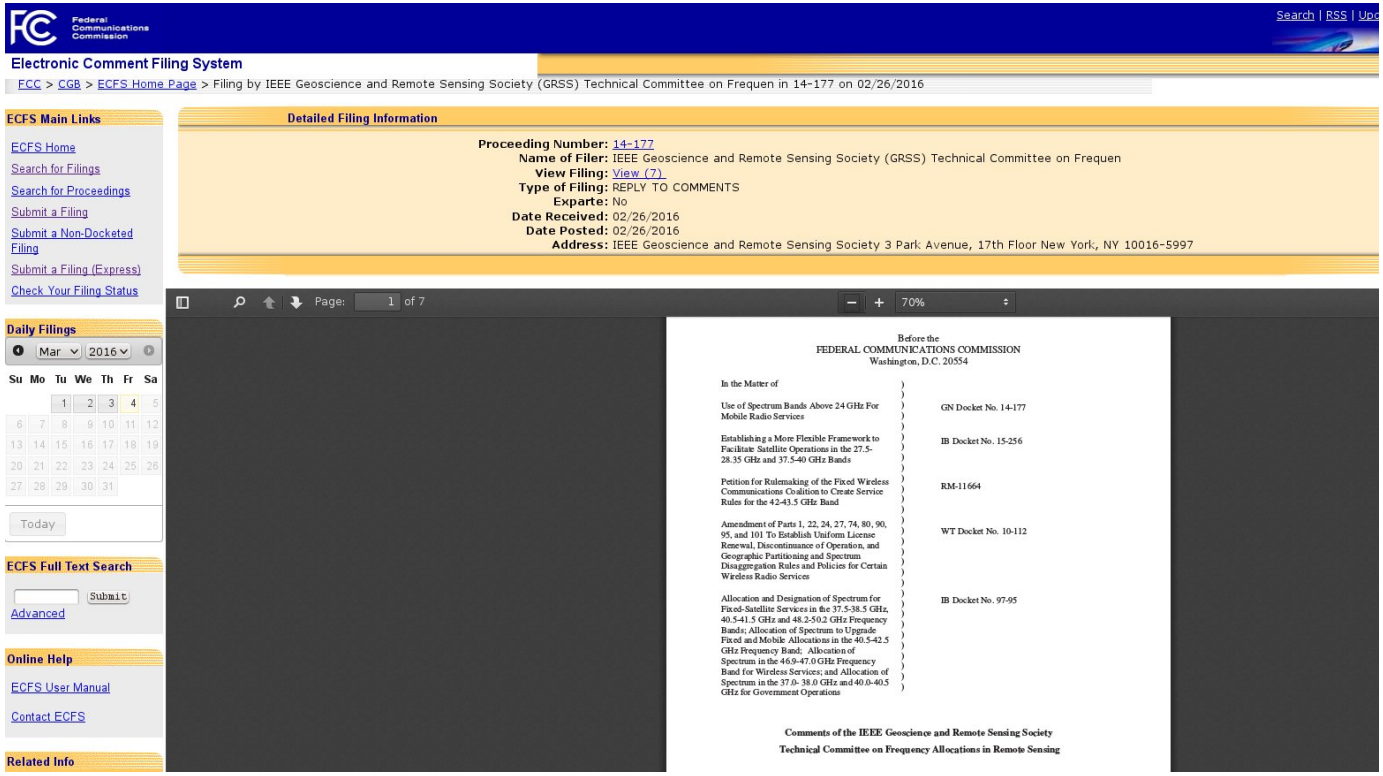
Merit alone will not ensure that the spectrum required is

RFI 2016 Workshop

- Paolo de Matthaeis has taken a lead role in this conference as Technical general co-chair guiding this traditionally radio astronomy oriented workshop toward more Earth remote sensing content
- Workshop will take place in Socorro (New Mexico, USA) on October 17-22, 2016
- Workshop will discuss RFI impacting radio astronomy, passive and active remote sensing
- Scientific Organizing Committee includes other FARS-TC members:
  - Prof. Joel Johnson
  - Dr. David Le Vine
  - Dr. Sidharth Misra
  - Dr. Elena Daganzo-Eusebio
- ~ 120 attendees expected
- MoU took some time – getting finalized last month

Response to FCC Notice of Proposed Rule Making

- **FARS-TC has submitted a filing in response to US Federal Communication Commission (FCC) Notice of Proposed Rule Making (NPRM)**
  - **Collaborative effort between various FARS members**
  - **FARS posted the filing in response to FCC inquiring about:**
    - **The need for special protection for EESS passive services below 37 GHz**
    - **Revisiting rules prohibiting WiGig deployment on-board aircraft between 57 and 64 GHz**
  - **Both rulings would have a potentially disastrous impact on GRSS members working with AMSU, ATMS, GPM, WindSat, etc.**



Other Recent Activities

- **Space Frequency Coordination Group meeting (SFCG-36), Mainz, Germany, June 2016**
  - Co-chair Paolo de Matthaeis attended the meeting in June 2016 representing FARS
  - He will present a brief report at this FARS-TC annual meeting
  - Continued co-operation is expected to represent spectrum interests of the GRSS community
- **Committee on Radio Frequencies (CORF) spring meeting, Washington DC, May 2016**
  - FARS-TC is redeveloping its working relationship with CORF
  - FARS-TC has been present at CORF meetings for the past three years
  - Some FARS-TC members also sit on CORF
    - David LeVine, Todd Gaier, Jasmeet Judge (chair), William Blackwell, Paul Siqueira, David Lang
  - CORF helped with recent FCC filing
    - CORF did show interest to use FARS-TC as a conduit to push agenda items they cannot, due to certain regulations (e.g., "Ex-parte" responses)

GRSS/FARS-TC
Strategic Objectives

- **Crowd-Sourcing**
  - RFI reporting tool
- **Education**
  - FARS-TC is considering Prof. Sandra Cruz-Pol to produce an online tutorial
    - She is a former NSF Program manager for EARS
- **Globalization**
  - FARS-TC involvement from under-represented countries is still weak
  - Surprisingly China is "under-represented" in FARS though one of the worst offenders with respect to spectrum interference (this IGARSS might help)
- **Industry**
  - FARS-TC has very strong space-agency and industry interaction

SFCG-36 Report: Introduction

- **The Space Frequency Coordination Group (SFCG)**

  - **is concerned with the effective use and management of those radio frequency bands that are allocated by the Radio Regulations of the ITU to the Space Research, Space Operations, Earth Exploration Satellite, and Meteorological Satellite services, and with feeder links and data relay satellites operated in connection with these services, and with satellite-borne radio astronomy (including radar astronomy);**

  - **offers the opportunity for international informal agreement among participating space agencies concerning assignment of specific frequencies, and related technical issues besides the formal framework of the Radio Regulations.**

- **The principal result of SFCG meetings is the adoption of resolutions and recommendations which express technical and administrative agreements. These agreements may be used by space agencies to make best use of allocated bands and to avoid interference.**

SFCG-36 Report: Main Results and Discussions

• Passive Sensors

➢ ITU-R Recommendation and Template for RFI Reporting for Sensors updates to the ongoing work of developing an ITU-R Recommendation which will provide a common set of parameters for reporting RFI to EESS passive sensors

➢ IEEE Geoscience and Remote Sensing Society presented improvements to its Database and Reporting Tool for Frequency Allocations for Microwave Remote Sensing and Observed Radio Frequency Interference (RFI). IEEE GRSS was invited to present a status of the further evolution of the tool and database at the next meeting of the SFCG.

➢ Report of RFI received by the AltiKa 24 GHz Radiometer over South Africa.

• Active Sensors

➢ NI-SAR RFI to ARNS/RLS and RNSS Systems in 1215-1300 MHz Band: dynamic analyses with preliminary results for one EESS (active) system, the L-band SAR, and included some statistics of observed RFI into terrestrial radars and RNSS receivers over North America, S-band SAR not discussed.

➢ Interference potential between Radiolocation and EESS (active) at 35.5–36 GHz: analysis of the worst case interference levels from mainlobe-to-mainlobe antenna coupling into receivers of spaceborne active sensor in the EESS (active) from radars inthe radiolocation service (RLS) in the 35.5-36 GHz band allocated to both EESS (active) and RLS.

➢ Interference potential from RLAN into EESS (Active) at 5 GHz sharing studies between 5 GHz RLAN and Sentinel-3 Altimeter sensor (SRAL) and EPS-SG Scatterometer sensor (SCA): under all scenarios, RLAN deployment in the 5 GHz range would create large interference to an altimeter such as SRAL on board the Sentinel-3 satellites (up to 26.6 dB), and a scatterometer such as SCA sensor on board the EPS-SG satellites (up to 20.9 dB)

• Other

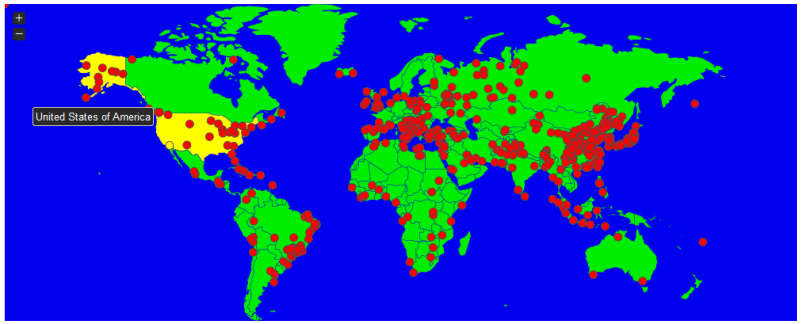
➢ World Meteorological Organization (WMO) online “Observing Systems Capability Analysis and Review Tool” (OSCAR): overview on improvements to the database (current version at http://www.wmo-sat.info/oscar/).

FARS Interference Database

GRSS / FARS-TC database for RFI and spectrum use

- Graphic User Interface (GUI) has been improved
- Functionality has been extended
- More input from CORF received
- More instruments have been added
- Efforts still ongoing to have space agencies cooperate to populate tool (to facilitate automatic extraction of inforation
- Currently shows EESS-only primary/secondary bands
- Neighboring allocation to EESS also displayed
- Standard RFI report card generated and modeled after current spectrum interference reporting forms

Database of Frequency Allocations for Microwave Remote Sensing and Observed Radio Frequency Interference (RFI)



Display Selection:

Display by Country: United States of America

Display a Frequency Range: From: 0 MHz To: 15617 MHz

Frequency Allocations | Interferers

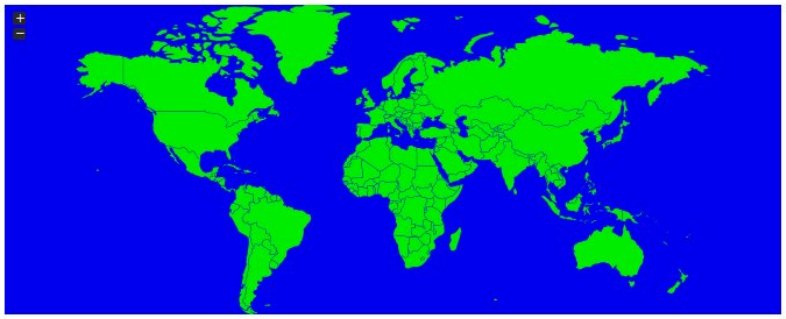
United States of America:
Show 10 entries

Search: Copy CSV Excel PDF Print

Freq Lower (MHz)	Freq Upper (MHz)	Lat	Long	Primary Use	Dates	Observing Instrument	Suspected Source	Comments
1386.5	1440.5	25.99	-80.36	EARTH EXPLORATION-SATELLITE (passive), RADIO ASTRONOMY, SPACE RESEARCH (passive)	2014-07-01T00:00:00 TO 2014-09-30T23:59:59	SMOS	unknown	none
1386.5	1440.5	43.11	-76.18	EARTH EXPLORATION-SATELLITE (passive), RADIO ASTRONOMY, SPACE RESEARCH (passive)	2013-02-01T00:00:00 TO 2013-02-20T23:59:59	Aquarius	unknown	none

FARS-TC Database: GUI

Database of Frequency Allocations for Microwave Remote Sensing and Observed Radio Frequency Interference (RFI)



Display Selection:

Display by Country: China

Display a Frequency Range: From: 0 MHz To: 250000 MHz

Allocations for China

Frequency Allocations | Interferers

China:

Show 10 entries Search: Copy CSV Excel PDF Print

Min (MHz)	Max (MHz)	Primary Use	Secondary Use
0.009	0.014	RADIONAVIGATION	
0.014	0.01995	FIXED, MARITIME MOBILE	
0.01995	0.02005	STANDARD FREQUENCY AND TIME SIGNAL (20 kHz)	
0.02005	0.07	FIXED, MARITIME MOBILE	
0.07	0.072	RADIONAVIGATION	Fixed, Maritime mobile
0.072	0.084	FIXED, MARITIME MOBILE, RADIONAVIGATION	
0.084	0.086	RADIONAVIGATION	Fixed, Maritime mobile
0.086	0.09	FIXED, MARITIME MOBILE, RADIONAVIGATION	
0.09	0.11	RADIONAVIGATION	Fixed
0.11	0.112	FIXED, MARITIME MOBILE, RADIONAVIGATION	

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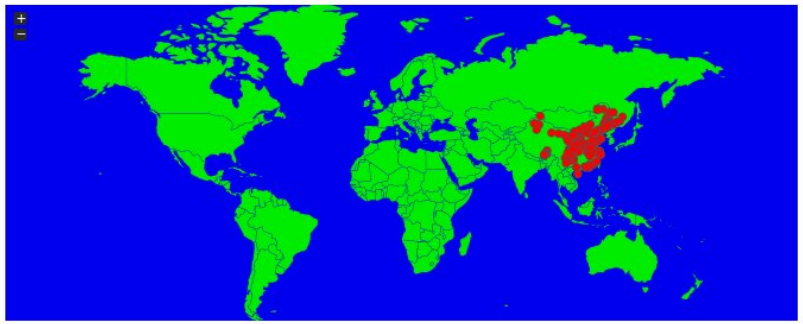
Database of Frequency Allocations for Microwave Remote Sensing and Observed Radio Frequency Interference (RFI)



Display Selection:

Display by Country: China

Display a Frequency Range: From: 0 MHz To: 250000 MHz

Interferers for China

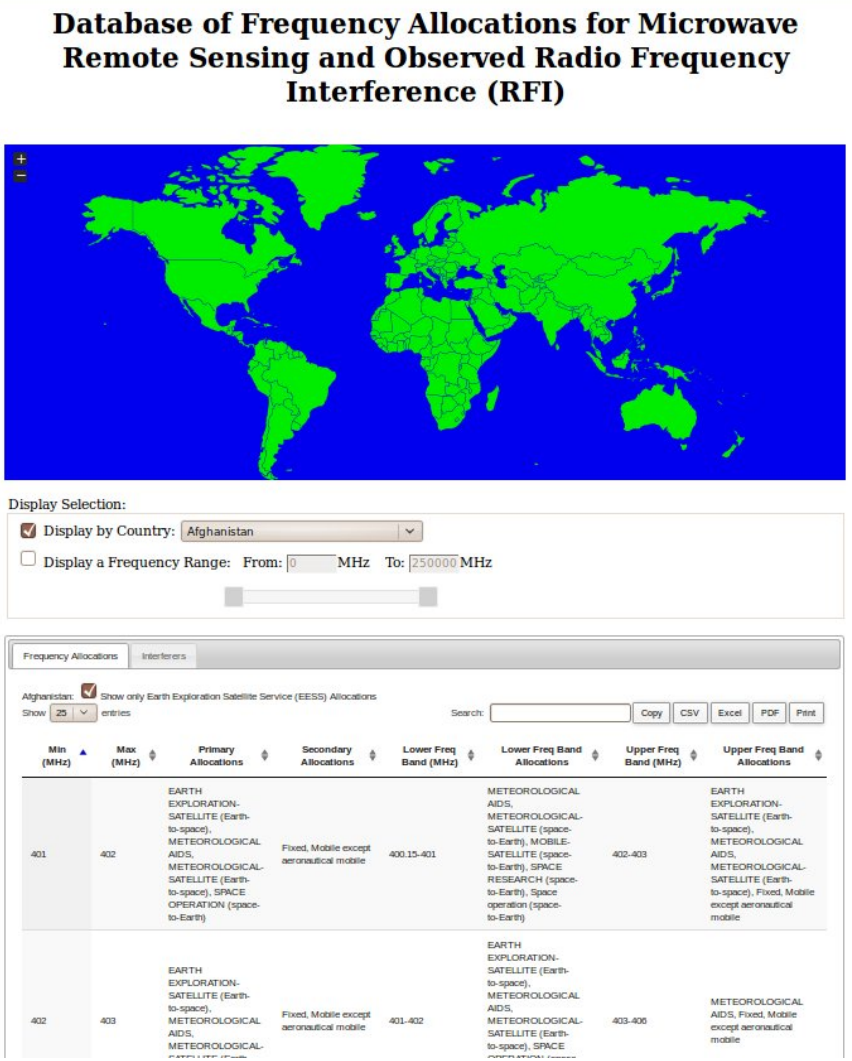
Frequency Allocations | Interferers

China:

Show 10 entries Search: Copy CSV Excel PDF Print

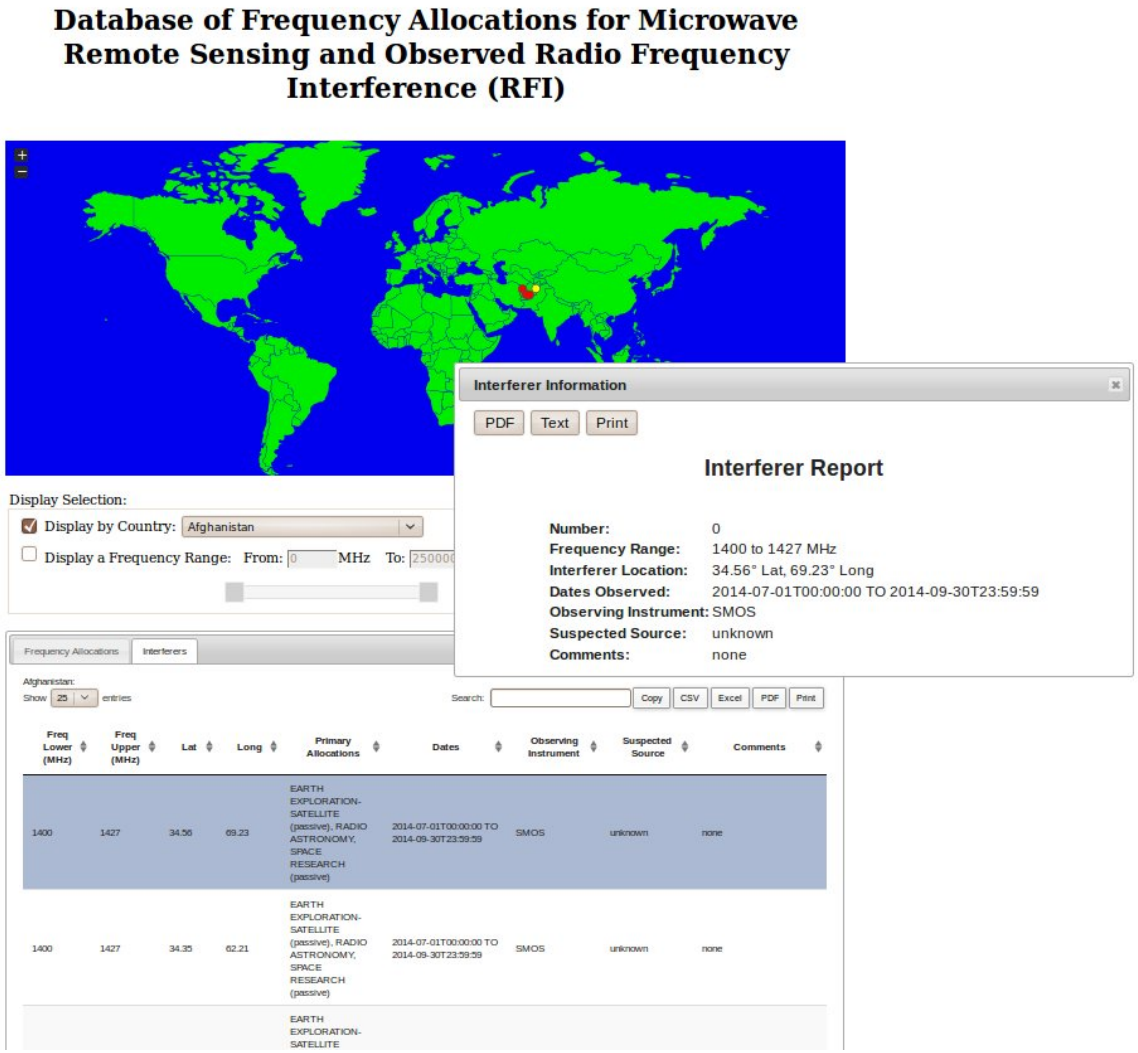
Freq Lower (MHz)	Freq Upper (MHz)	Lat	Long	Primary Use	Dates	Observing Instrument	Suspected Source	Comments
1386.5	1440.5	43.83	125.3	EARTH EXPLORATION-SATELLITE (passive), RADIO ASTRONOMY, SPACE RESEARCH (passive)	2014-07-01T00:00:00 TO 2014-09-30T23:59:59	SMOS	unknown	none
1386.5	1440.5	43.91	126.5	EARTH EXPLORATION-SATELLITE (passive), RADIO ASTRONOMY, SPACE RESEARCH (passive)	2014-07-01T00:00:00 TO 2014-09-30T23:59:59	SMOS	unknown	none

FARS-TC Database: GUI



Can also display only the EESS allocations, with the allocations of adjacent bands, both upper and lower.

FARS-TC Database: GUI



For each observation, a report can be generated and saved or printed

RFI Observations: Data Sources

- Currently, lists of observations are obtained from individual people involved with particular instruments
- Future goal is to use custom-built codes to extract the information and insert it into the database
- Ideally each satellite mission could publish their interferer data
- Then the data can be copied into the RFI database using standard tools, and updated automatically