



Geoscience and Remote Sensing Society

Frequency Allocations in Remote Sensing Technical Committee (FARS TC) Annual Meeting

July 11, 2016



Sidharth Misra
Paolo de Matthaeis





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

Message from FARS Technical Committee Chairs

Sidharth Misra and Paolo de Matthea

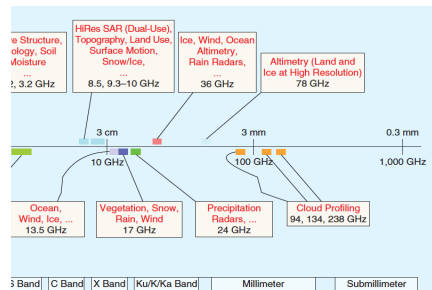
One of the main objectives of the Frequency Allocations in Remote Sensing (FARS) Technical Committee (TC) has been to inform IEEE Geoscience and Remote Sensing Society members of the increasing spectrum challenges faced by the remote sensing community. In the June 2014 issue of *IEEE Geoscience and Remote 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-

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-

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.



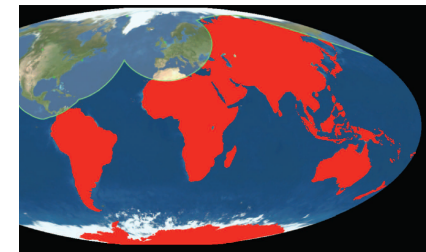
ies for satellite active sensing is dictated by the physics of the relevant scattering mechanism. Representative examples of the types of measurements used at each frequency are shown. [Figure used with permission of "Sensing Amid Increased Demand for Radio Spectrum," courtesy of the European Space Agency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

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

many types of services, from streaming to wireless phone company, and remote sensing radars; my, among many others. Racy allocations are developed at international levels. At the international level, the Radiocommunication Conference for the World Radiocommunication Conference every 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.

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



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.)

imize the potential interference radars operating at the necessary change came across and at some significant cost.

AASS mission has been detected within the line of sight of a radar located in North America. Europe. Even though the primary mission objectives will be met with this outage, this nevertheless, deprive the community of valuable science over a significant portion of the globe (see Figure 4). Furthermore, this precedent may indirectly impact other potential radar 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

RFI 2016

Coexisting with Radio Frequency Interference

Hosted by the
National Radio Astronomy Observatory (NRAO)
in Socorro, New Mexico, USA
October 17-20, 2016

Sponsored by

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Coexisting with Radio Frequency Interference

October 17-20, 2016
Socorro, New Mexico, USA





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.

FCC Federal Communications Commission

Electronic Comment Filing System

FCC > CGB > ECFS Home Page > Filing by IEEE Geoscience and Remote Sensing Society (GRSS) Technical Committee on Frequen in 14-177 on 02/26/2016

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Detailed Filing Information

Proceeding Number: **14-177**
Name of Filer: IEEE Geoscience and Remote Sensing Society (GRSS) Technical Committee on Frequen
View Filing: [view \(7\)](#)
Type of Filing: REPLY TO COMMENTS
Exparte: No
Date Received: 02/26/2016
Date Posted: 02/26/2016
Address: IEEE Geoscience and Remote Sensing Society 3 Park Avenue, 17th Floor New York, NY 10016-5997

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Related Info

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

| | |
|--|------------------------|
| In the Matter of |) |
| Use of Spectrum Bands Above 24 GHz For Mobile Radio Services |) GN Docket No. 14-177 |
| Establishing a More Flexible Framework to Facilitate Satellite Operations in the 27.5-28.35 GHz and 37.5-40 GHz Bands |) IB Docket No. 15-256 |
| Petition for Rulemaking of the Fixed Wireless Communications Coalition to Create Service Rules for the 42-43.5 GHz Band |) RM-11664 |
| Amendment of Parts 1, 22, 24, 27, 74, 80, 90, 95, and 101 To Establish Uniform License Renewal, Discontinuance of Operation, and Geographic Partitioning and Spectrum Disaggregation Rules and Policies for Certain Wireless Radio Services |) WT Docket No. 10-112 |
| Allocation and Designation of Spectrum for Fixed-Satellite Services in the 37.5-38.5 GHz, 40.5-41.5 GHz and 48.2-50.2 GHz Frequency Bands; Allocation of Spectrum to Upgrade Fixed and Mobile Allocations in the 40.5-42.5 GHz Frequency Band; Allocation of Spectrum in the 46.0-47.0 GHz Frequency Band for Wireless Services; and Allocation of Spectrum in the 37.0-38.0 GHz and 40.0-40.5 GHz for Government Operations |) IB Docket No. 97-95 |

Comments of the IEEE Geoscience and Remote Sensing Society
Technical Committee on Frequency Allocations in Remote Sensing





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 in the 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/>).



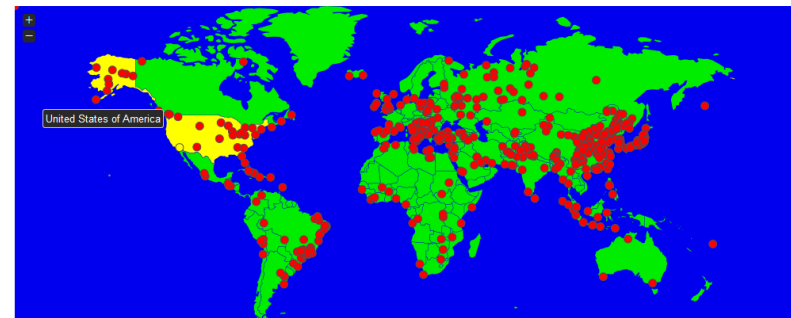


FARS Interference Database

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 information)
- 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: 156176 MHz

Frequency Allocations Interferers

United States of America:
Show 10 entries

Search:

| 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 |

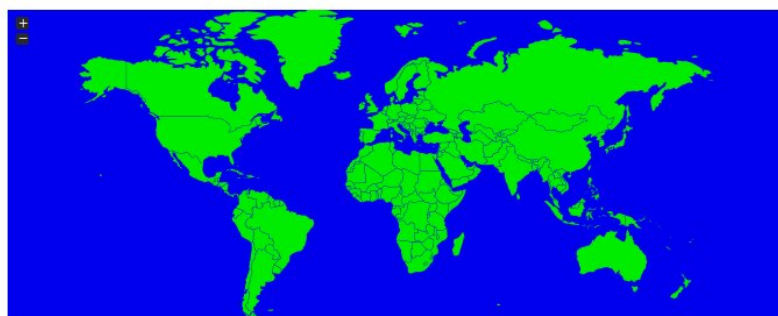




FARS-TC Database: GUI

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

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 | 0.0195 | FIXED, MARITIME MOBILE | |
| 0.0195 | 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 | |

Showing 1 to 10 of 487 entries

Previous

1

2

3

4

5

...

49

Next

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

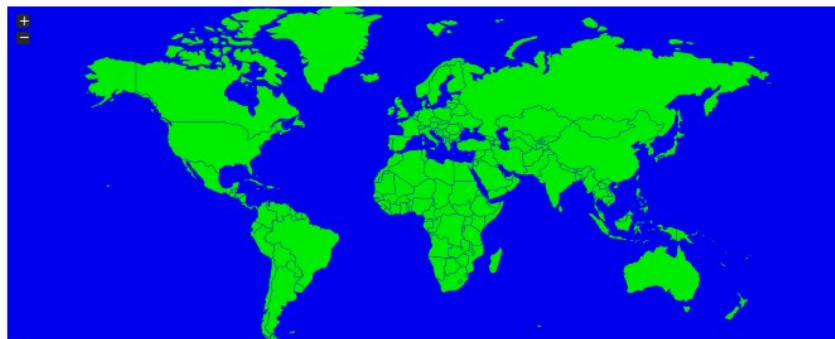
Print

| 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

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



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

Display Selection:

☒ Display by Country: Afghanistan

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

Frequency Allocations Interferers

Alghanistan ☒ Show only Earth Exploration Satellite Service (EESS) Allocations

Show 25 entries Search: Copy CSV Excel PDF Print

| Min (MHz) | Max (MHz) | Primary Allocations | Secondary Allocations | Lower Freq Band (MHz) | Lower Freq Band Allocations | Upper Freq Band (MHz) | Upper Freq Band Allocations |
|-----------|-----------|--|--|-----------------------|--|-----------------------|--|
| 401 | 402 | EARTH EXPLORATION-SATELLITE (Earth-to-space), METEOROLOGICAL AIDS, METEOROLOGICAL-SATELLITE (Earth-to-space), SPACE OPERATION (space-to-Earth) | Fixed, Mobile except aeronautical mobile | 400-15-401 | METEOROLOGICAL AIDS, METEOROLOGICAL-SATELLITE (space-to-Earth), MOBILE-SATELLITE (space-to-Earth), SPACE RESEARCH (space-to-Earth), Space operation (space-to-Earth) | 402-403 | EARTH EXPLORATION-SATELLITE (Earth-to-space), METEOROLOGICAL AIDS, METEOROLOGICAL-SATELLITE (Earth-to-space), Fixed, Mobile except aeronautical mobile |
| 402 | 403 | EARTH EXPLORATION-SATELLITE (Earth-to-space), METEOROLOGICAL AIDS, METEOROLOGICAL-SATELLITE (Earth-to-space) | Fixed, Mobile except aeronautical mobile | 401-402 | EARTH EXPLORATION-SATELLITE (Earth-to-space), METEOROLOGICAL AIDS, METEOROLOGICAL-SATELLITE (Earth-to-space), SPACE OPERATION (space-to-Earth) | 403-406 | METEOROLOGICAL AIDS, Fixed, Mobile except aeronautical mobile |



FARS-TC Database: GUI

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

The screenshot displays the FARS-TC Database GUI. At the top left is a world map with a red dot indicating a location in Afghanistan. Below the map, the 'Display Selection' section includes a checked box for 'Display by Country: Afghanistan' and an unchecked box for 'Display a Frequency Range: From: 0 MHz To: 250000'. Below this, there are tabs for 'Frequency Allocations' and 'Interferers'. The 'Interferers' tab is active, showing a table of interferer data. A pop-up window titled 'Interferer Information' is overlaid on the table, displaying details for a specific interferer.

Interferer Information

PDF Text Print

Interferer Report

Number: 0
Frequency Range: 1400 to 1427 MHz
Interferer Location: 34.56° Lat, 69.23° Long
Dates Observed: 2014-07-01T00:00:00 TO 2014-09-30T23:59:59
Observing Instrument: SMOS
Suspected Source: unknown
Comments: none

Frequency Allocations Interferers

Afghanistan: Show 25 entries Search: Copy CSV Excel PDF Print

| Freq Lower (MHz) | Freq Upper (MHz) | Lat | Long | Primary Allocations | Dates | Observing Instrument | Suspected Source | Comments |
|------------------|------------------|-------|-------|--|--|----------------------|------------------|----------|
| 1400 | 1427 | 34.56 | 69.23 | EARTH EXPLORATION-SATELLITE (passive), RADIO ASTRONOMY, SPACE RESEARCH (passive) | 2014-07-01T00:00:00 TO 2014-09-30T23:59:59 | SMOS | unknown | none |
| 1400 | 1427 | 34.35 | 62.21 | EARTH EXPLORATION-SATELLITE (passive), RADIO ASTRONOMY, SPACE RESEARCH (passive) | 2014-07-01T00:00:00 TO 2014-09-30T23:59:59 | SMOS | unknown | none |
| | | | | EARTH EXPLORATION-SATELLITE | | | | |

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

