

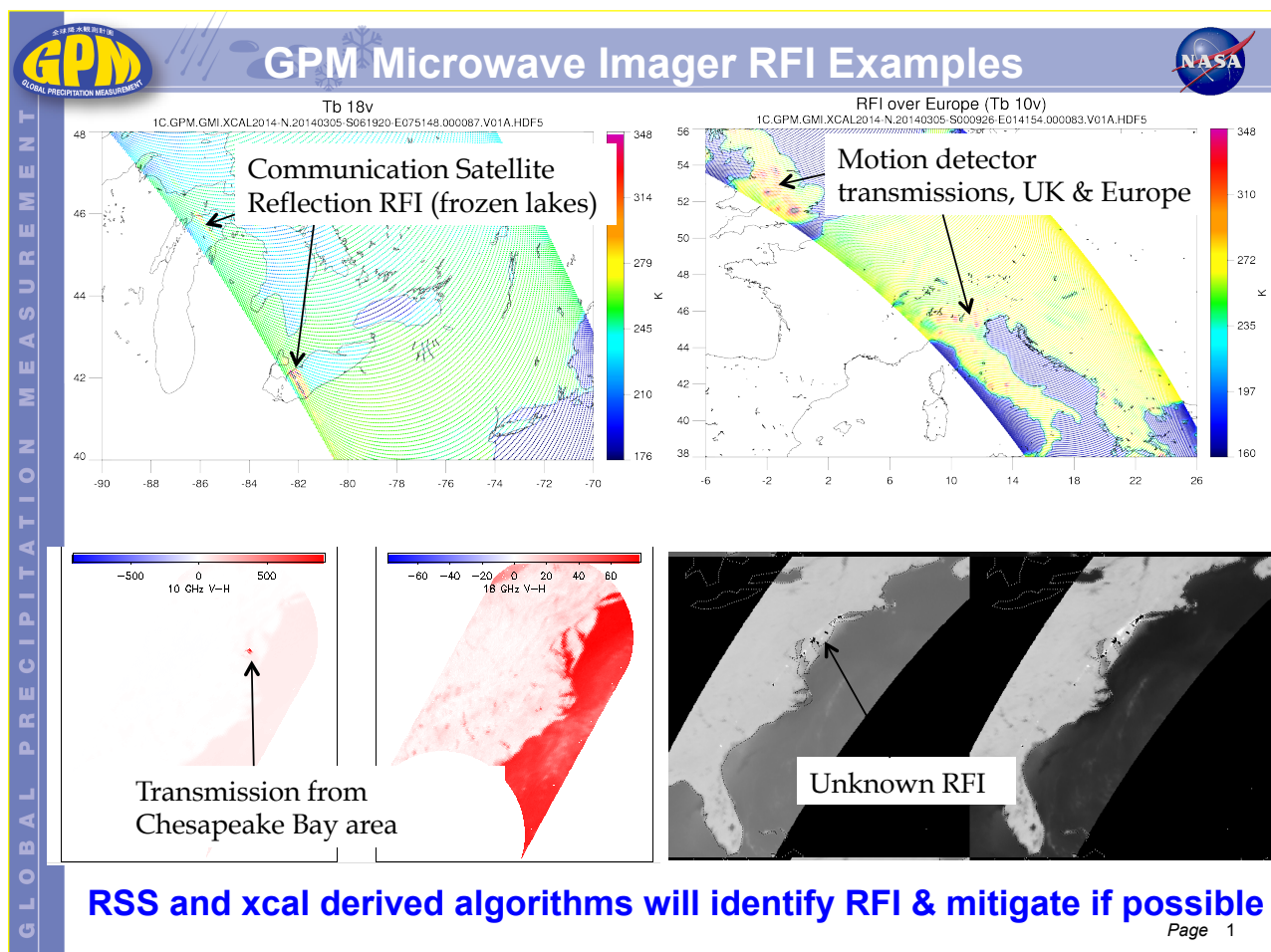
# IEEE-GRSS Frequency Allocations in Remote Sensing (FARS) Technical Committee

## Minutes of 2014 Annual Meeting

Québec City, Canada  
July 14th, 2014

The meeting is convened at 17:35 in room 2104 at the Québec City Convention Centre by FARS Technical Committee co-chairs Sidhart Misra and Paolo de Matthaeis. About 25 persons are in attendance through the meeting.

The discussion starts with an introductory slide (see figure below) by Gail Skofronik-Jackson, who briefly reports on RFI observed by the Global Precipitation Measurement (GPM) Microwave Imager (GMI) in its first few months of operation. The most interesting feature is the RFI observed at 18.70 GHz in March 2014 when the Great Lakes were frozen (in the upper left in the figure). The frozen surface is very reflective at this frequency and signals transmitted toward Earth by broadcast TV satellites are reflected by this surface. In the 10.65 GHz channel, RFI is visible over the United Kingdom and Europe, likely caused by motion detector transmissions (upper right image in the figure). This frequency band is relatively free of interference in the USA, however an unknown source is present in the Chesapeake Bay area, possibly a military radar operating outside its 9.3 GHz allowed band.



Sidhart Misra continues the meeting by presenting the agenda and giving a brief overview on:

- membership: roster almost unchanged, e-mail address list updated
- meeting attended by FATS TC co-chairs:
  - Active Use of the Spectrum Committee meeting in Washington DC (Paolo de Matthaëis)
  - spectrum management school in Chile organized by IUCAF (Todd Gaier)
  - Committee on Radio Frequencies (CORF) in Washington DC (Sidhart Misra and Paolo de Matthaëis)
  - Space Frequency Coordination Group (SFCG-34) in Boulder (Sidhart Misra and Paolo de Matthaëis):  
resolution increasing role of observers
- website update (add more material from past meeting), suggestions for members appreciated
- FARS article published in June issue of GRSM, printed copies available, and material from NAS

A presentation on the National Research Council (NRC) Active Sensing Use of the Spectrum study follows. The study committee is chaired by Fawwaz Ulaby, and Al Gasiewski, as a committee member, provides an overview of the committee, its tasks and the study.

The committee study has now been entitled “Active Sensing Use Under 340 GHz: Sharing and Interference”. In 2010, a Presidential Memorandum directed the US National Telecommunications and Information Administration (NTIA) to collaborate with the US Federal Communications Commission (FCC) to make available a total of 500 MHz of spectrum for mobile and fixed wireless broadband use by 2020. In order to support this presidential initiative for Spectrum Management for the 21<sup>st</sup> Century, an evaluation of current and future needs of scientific users of the spectrum has been necessary. A survey of the passive uses of the spectrum by the NRC produced a 2010 report, “Spectrum Management for Science in the 21<sup>st</sup> Century”. This report raised awareness about the negative consequences of interference on the scientific community and had a significant impact on the Administration and Congress policies. It led to discuss new ways of thinking about spectrum allocation between government and industry. A proposed \$10m actual survey of the spectrum use in the US (as opposed to what is theoretically perceived to be used) was never performed, however the National Science Foundation (NSF) created the Enhancing Access to the Radio Spectrum (EARS) program, and later NASA and NRC formed the committee to study the active use of the spectrum in an similar way as it had been done for the passive use.

The statement of tasks of the committee is as follows:

1. Describe the science that is currently being conducted using the radio spectrum for transmission and measurement of these active signals and identify the spectrum requirements necessary to conduct this research;
2. Identify the anticipated future spectrum requirements necessary to continue to conduct and expand this research for the next 10-20 years, taking into account trends in overall active use of the spectrum;
3. Discuss the value to the nation of accommodating the active scientific use of the spectrum, recognizing the need to balance the needs of multiple communities;
4. Assess the active science communities' current and anticipated future access to the spectrum required for research;
5. Recommend strategies to accommodate the continued active use of the spectrum for scientific purposes in order to maintain the needed science capabilities identified

above.

In addition, the committee will not make recommendations on communications operations (i.e., transmission of data) that support the scientific uses of the spectrum described above. The committee should consider proven and potential unilateral and cooperative mitigation techniques in its analysis of access to spectrum, but will not make recommendations on the allocation of specific frequencies

Members include scientists in radar remote sensing of land, ocean, snow, ice, weather and ionosphere and also radar astronomers, private sector consultants and members of passive remote sensing committee. Instruments include all types of active sensors, such as SAR's, altimeters, scatterometers, precipitation radars and cloud profiler radars. Among these, SAR's are the ones suffering interference the most.

Frequencies range from P-band to 340 GHz for proposed radars, with most problems occurring between P- and C-band. Radar is considered both as a victim as well as a potential perpetrator. However, a very few cases where are documented where a spaceborne or airborne radars causes problems. Example of radar instruments affected by RFI presented at an international workshop 2013 at JPL include:

- AIRMOSS, a P-band airborne radar used for biomass and, to some extent, soil moisture, which picks up a lot of RFI around the USA, much of it narrow and some wideband as well; determining the exact causes is financially almost impossible due to the challenging task of identifying the offending signals on the ground, and also to the difficulty in defining a metric for interference, which is a lot more complicated with active than with passive sensing;
- Biomass, a future P-band ESA mission expecting a lot of RFI over US, Siberia, Europe. The request for cooperation with the US Defense was not recognized, so as a results Biomass will not be able to operate over the USA;
- JERS-1, L-band SAR, with example of RFI evolution over time, showing that the situation is worsening; the mitigation option currently available is signal notching. However, notching degrades range resolution and fidelity of the image as the sidelobe levels goes up., so it is not a fully satisfactory solution;
- Aquarius scatterometer;
- SMOS, with example of sudden increase in RFI over Japan when new wireless communication product was introduced

At C-band, the issue is that wireless systems spectrum use is moving into the band used in remote sensing, making more difficult to use band historically used for active systems. RadarSat-2 is an example.

The final study document is planned to be released around the end of 2014 and briefings will be scheduled in 2015 with agencies in Washington regarding the results. One likely conclusion of the study will be the need for a comprehensive survey of the spectrum use in the USA, using spectrum trucks from NTIAA operating through the USA and airborne surveys by radiometers.

In concluding his presentation, Al Gasiewski mentions that the Presidential Directive of freeing 500 MHz of bandwidth will be partially fulfilled by consolidating operations from three frequency bands currently used by radars into one by the year 2020, which will yield approximately 350 MHz.

Also noted is the need to expand the FARS-TC membership to include more representatives from the active remote sensing community.

Paolo de Matthaëis introduces the issues related to the proposed sharing of 5350-5470 MHz

band between telecommunication services RLAN (Radio Local Area Networks including Wi-Fi) and active Earth Exploration Satellite Service (EESS) systems. SAR sensors such as ESA's Sentinel-1 and Canada's RadarSat operate at this frequency and would be negatively affected. A Space Frequency Coordination Group (SFCG) study has shown that a single outdoor RLAN operating within the whole 5350-5470 MHz band is sufficient to exceed the EESS (active) protection criteria and that a RLAN deployment consistent with RLAN industry expectations would create harmful interference well above protection limits. However, based on published articles, RLAN supporters contend that mitigation techniques would eliminate the problem. Chris Ruf notes that an unfortunate consequence of developing mitigation algorithm is the perception that there is no more need to worry about RFI. The current strategy from the scientific community is to convince US regulators of the negative economic effect that would be caused by not being able to use data from Sentinel-1 and similar instruments. Input from the FARS TC is requested on this issue, both on the effectiveness of available RFI mitigation techniques and on the economic impact of remote sensing losing this band. Al Gasiewski will make more material on this topic available to the committee.

Sidhart Misra shows slides from Thomas van Deak on developing better procedures and metrics to define harmful interference. The document is attached at the end of these minutes. David Kunkee will put together material on this topic, which distributed at a later date.

Finally, Sidhart Misra solicits ideas for strategic initiatives, such as workshops, tutorials, or other activities that follow the society strategic plan, i.e., focus on membership expansion, membership services, globalization, education and engagement with industry. Proposals from the chairs are to create a RFI reporting tool on the FARS-TC website and the formation of subcommittees for studying particular issues. Al Gasiewski suggests that FARS create posters to be presented at conferences to engage other societies such as AGU, etc. In addition, Ed Kim proposes a slide presentation also for conference display. Submission of ideas will be welcome anytime, but those received before July 23 will have a better chance to be considered in the next year budget.

The meeting is adjourned at 18:45.

#### Action Items:

- Collect input for strategic initiatives
- Post additional past material on FARS TC website
- Follow up on proposing a definition of harmful interference
- Distribute material on C-band RLAN issue and collect input from technical committee members

Attachment: Thomas van Deak's slides on the review of Recommendation ITU-R RS.1166-4.



# Review of Recommendation ITU-R RS.1166-4 “Performance and interference criteria<sup>\*</sup> for active spaceborne sensors”

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# REC. ITU-R RS.1166-4



- **Rec. ITU-R RS.1166-4**
  - Protection levels for studies
- **Recommendation's revision**
  - Last revised in 1998
- **Key Issues**
  - Reflect state of the art in active sensing
  - Align protection criteria with analysis methods
  - Expand material to include sensor mechanics



# Evaluation Criteria



## Recommendation ITU-R RS.1166-4

### Performance and interference criteria for active spaceborne sensors

#### Recommends 2

that the interference and data availability criteria given in Table 2 be applied for instruments used for active sensing of the Earth's land, oceans and atmosphere.

TABLE 2

Sensor type	Interference criteria		Data availability criteria (%)	
	Performance degradation	$I/N$ (dB)	Systematic	Random
Synthetic aperture radar	10% degradation of standard deviation of pixel power	-6	99	95
Altimeter	4% degradation in height noise	-3	99	95
Scatterometer	8% degradation in measurement of normalized radar backscatter to deduce wind speeds	-5	99	95
Precipitation radar	7% increase in minimum rainfall rate	-10	N/A	99.8
Cloud profile radar	10% degradation in minimum cloud reflectivity	-10	99	95

#### NOTES:

- Altimeter, Scatterometer, and Precipitation Radar operate in the 13.25-13.75 GHz band. Synthetic aperture radar and cloud profile radar do not operate in this band.
- Systematic data availability is in regards to the data availability of a particular measurement area of interest.
- Random data availability is in regards to the overall data availability; that is, the availability over the repeat period of the sensor.
- Systematic data availability criteria doesn't apply to precipitation radar.



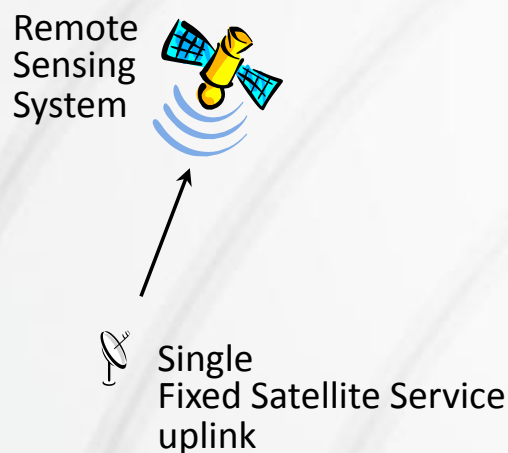


# Compatibility Analysis Methods

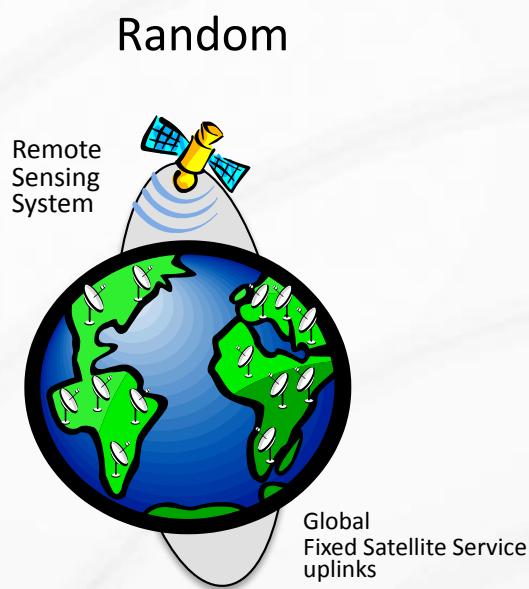


## Two basic types of analysis

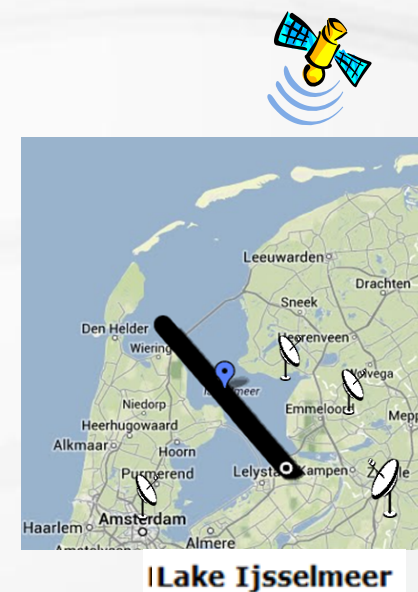
### Single entry



### Dynamic analysis



### Systematic







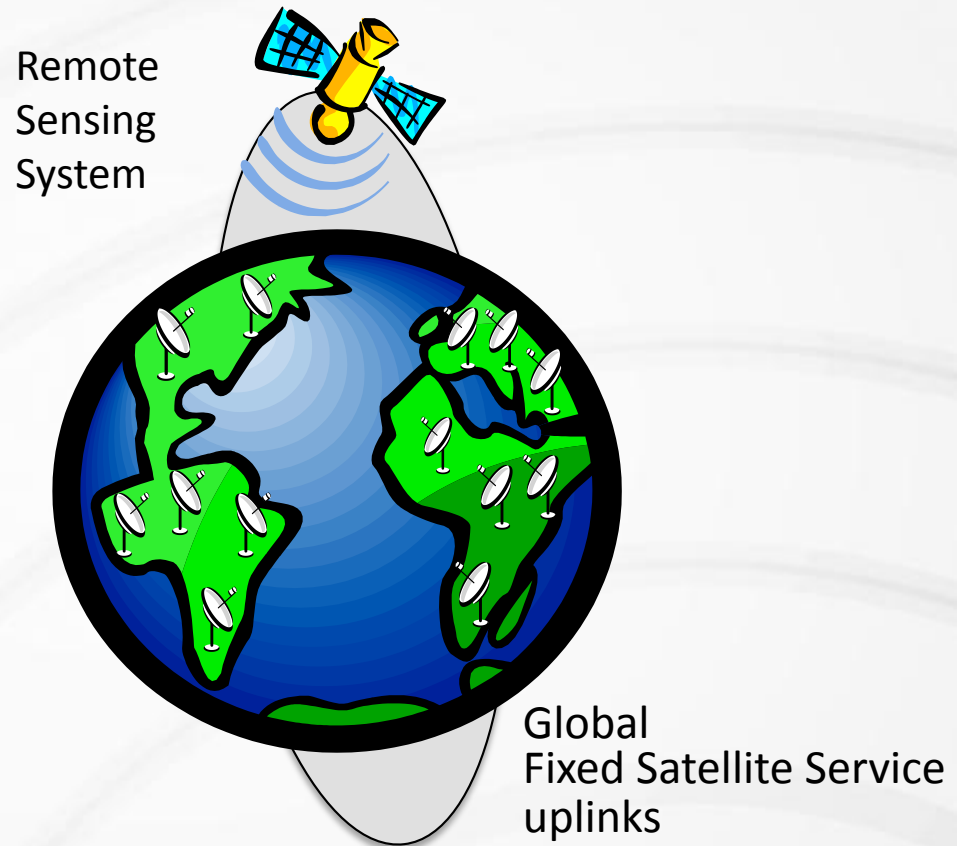
# Random Data Availability Criteria



***Global analysis simulated over the duration of the spaceborne sensor orbit repeat period.***

Analyses are typically performed to determine the percentage of time that the threshold level is exceeded.

A more realistic measure of interference impact may be to determine the percentage of measurement area where the threshold level is exceeded.





# Systematic Data Availability Criteria



*Analysis performed to determine interference impact to specific measurement areas.*

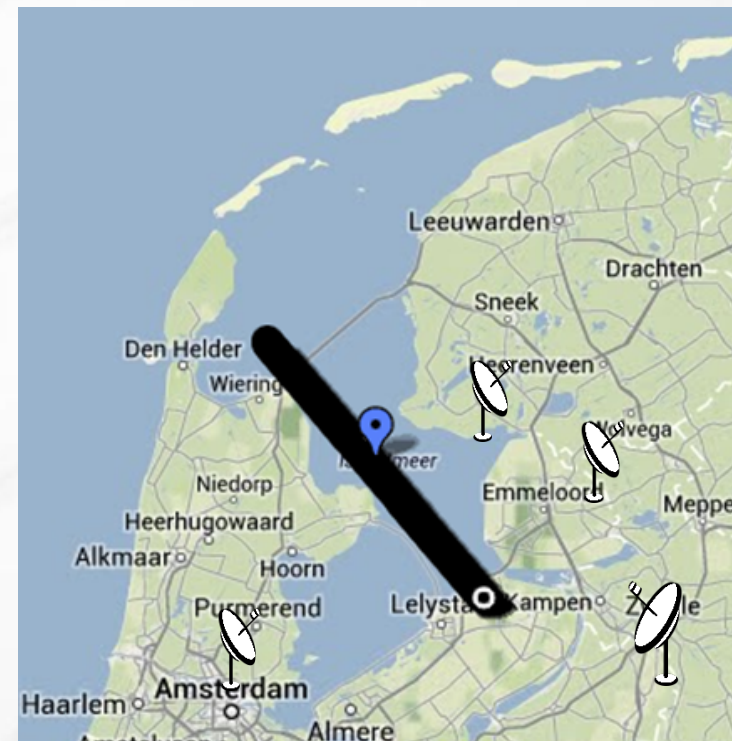
**JASON altimeter**

**USDA Global Lake and Reservoir Monitoring Program (83 sites)**

Swath measured once per orbit repeat period (10 days)

Average I/N per measurement set was used in determining if the protection threshold was exceeded.

This measurement area is comprised of 178 consecutive footprints. Height measurements can be derived from as few as 10 consecutive footprints.



Lake IJsselmeer



# Sensor Measurement Considerations



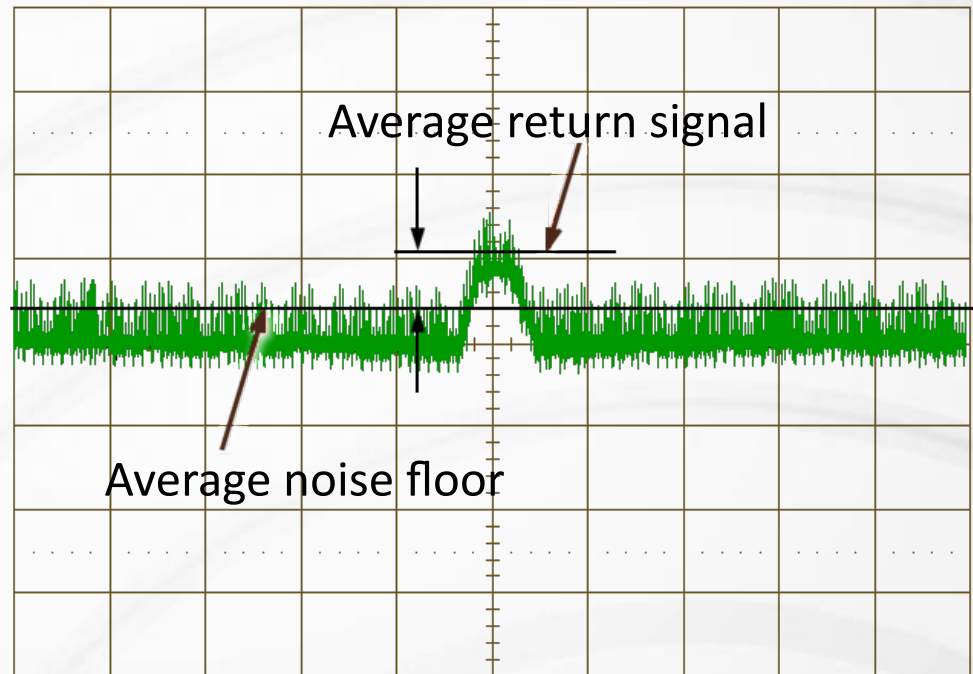
## Background noise processing on-board the spacecraft

It is known that current sensors measure the background noise as well as the return signal.

The mechanism for processing return signal and noise on-board the spacecraft is not well understood.

**Significant impact on the assessment of interference on sensor measurements????**

Detected radar pulse with background noise





# Sensor Measurement Considerations



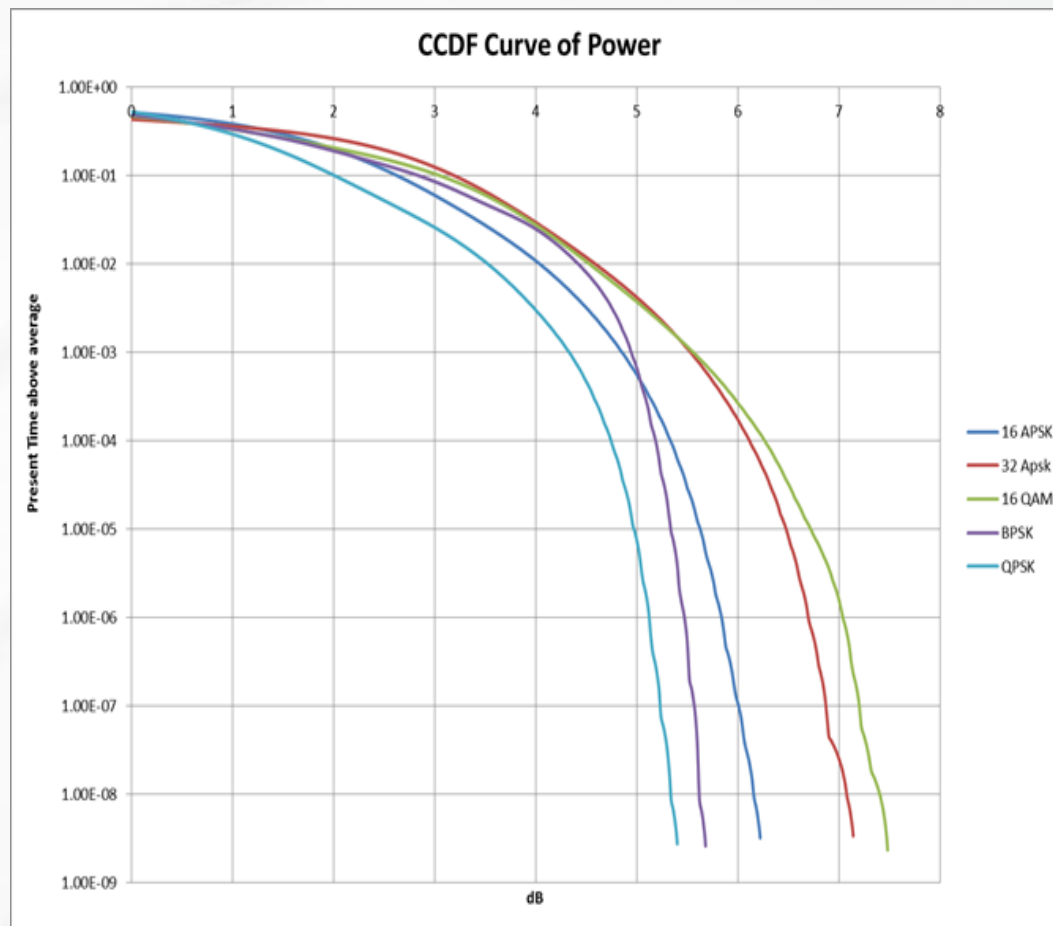
## Sensor sensitivity to peak emissions

Altimeters employ peak power detectors and therefore are sensitive to the peak emissions of interference.

Precipitation radar and scatterometers use average power detectors and therefore sensitive only to the average power of the interference source.

These results of measurements show that the peak power exceeds the average power by more than 7 dB.

The application of peak power to impact on measurement degradation is not straightforward.



**Statistical distribution of Power for common modulations**



# References



## Embedded documents

### Recommendation ITU-R RS.1166-4

RECOMMENDATION ITU-R RS.1166-4

**Performance and interference criteria\* for active spaceborne sensors**

(1995-1998-1999-2006-2009)

#### Scope

This Recommendation reflects the performance and interference criteria for spaceborne active sensors in the bands allocated to the EESS (active). The Annex presents the technical bases for development of performance and interference criteria for various types of spaceborne active sensors. The sensor type include altimeters, scatterometers, precipitation radars, synthetic aperture radars and cloud profile radars.

The ITU Radiocommunication Assembly,

#### considering

- that spaceborne active microwave remote sensing requires specific frequency ranges depending on the physical phenomena to be observed;
- that certain frequency bands have been allocated for spaceborne active microwave remote sensing;
- that these bands are also allocated to other radio services;
- that studies have established measurement sensitivity requirements;
- that performance requirements for active sensors can be stated in terms of precision of measurement of physical parameters and availability, measured at the satellite, assuming that degradation from other elements in the system will be small;
- that performance objectives for active spaceborne microwave sensors are a prerequisite for the establishment of the associated interference criteria;
- that interference criteria are needed to ensure that systems can be designed to achieve adequate performance in the presence of interference, assess compatibility with systems in other services and, if needed, to assist in developing sharing criteria;
- that Annex 1 presents the technical bases for performance and interference criteria based on representative active sensors,

\* Interference criteria do not imply automatically sharing criteria.

### U.S. Working Party 7C draft input

US Radiocommunication Sector			
FACT SHEET			
Study Group: USWP 7C		Document No: US 7C/[RS.1166]	
Reference: Recommendation ITU-R RS.1166-4		Date: 18-June-2014	
Document Title: Working Document towards the Revision of Recommendation ITU-R RS.1166-4 “Perf ormance and interference criteria* f or active spaceborne sensors			
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Purpose/Objective: Revise Recommendation ITU-R RS.1166			
<b>Abstract:</b> Recommendation ITU-R RS.1166 was last revised in 2009. Recommends 2 of that Recommendation provides for the Interference Criteria in terms of Performance degradation and I/N (dB). The I/N of the value provided in Recommends 2 corresponds to the performance degradation isted. The I/N (dB) provided in Recommends 2 applies to Gaussian and non-Gaussian interference as explained in the Annex of the Recommendation) however, it does not take into account pulsed nterference from emitters such as radar or FSS TDMA networks nor does it take into account the ransient impulses that occur from the use of higher order modulations used by some service pplications. While the I/N of these interference pulses and modulations with these transient mpulses may not exceed the threshold stated in Recommends 2, the pulses and impulses may cause a degradation to the performance of the EESS (active) sensors in exceedence of the performance riteria listed in Recommends 2. A preliminary examination of the impact of pulsed and impulsed nterference on the performance of EESS (active) sensors will be provided with the viewof revising Recommendation RS.1166 when the examination is complete.			
Fact Sheet Preparer:		Tom vonDeak, NASA	





# Summary



- Work has initiated on the revision of Recommendation ITU-R RS.1166-4
- The members of FARS are invited to contribute to this revision process.
- Bearing in mind that participation in the ITU-R meetings may be difficult, FARS members can contribute through
  - the U.S. WP 7C process
    - Telecons held about every two months
    - Not limited to U.S. nationals
  - Or the SFCG annual meetings