Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Recommendations Approved by the	)	
Advisory Committee for the 2007 World	)	IB Docket No. 04-286
Radiocommunication Conference	)	
	)	

To: Chief, International Bureau

COMMENTS OF THE
NATIONAL ACADEMY OF SCIENCES'
COMMITTEE ON RADIO FREQUENCIES

The National Academy of Sciences, through the National Research Council's Committee on Radio Frequencies (CORF, see Attachment), hereby submits its comments in response to the Federal Communications Commission's November 1, 2006, Public Notice in the above-captioned docket (DA 06-2262, hereinafter "*Notice*"). In these comments, CORF discusses the importance of the scientific observations performed only in the Earth Exploration Satellite Service (EESS) bands at issue in the *Notice* and the need to protect such observations. CORF also expresses general support for the use of mandatory out-of-band emission limits on active services to protect the adjacent and nearby EESS bands at issue herein.

I. The Importance of Remote Sensing Science, and the Spectrum Bands at Issue.

CORF has a substantial interest in this proceeding, as it represents the interests

of the passive scientific users of the radio spectrum, including users of the EESS bands. EESS observers measure weather and climate information on both a research and operational basis, and those measurements are extremely important, yet vulnerable to in-band and out-of-band interference.

The Commission has long recognized that Earth remote sensing is a critical and unique resource for monitoring the global atmospheric and surface state. Satellite-based microwave remote sensing represents the only practical method of obtaining uniform-quality atmospheric and surface data encompassing the most remote oceans as well as densely populated areas of Earth. EESS data have contributed substantially to the study of meteorology, atmospheric chemistry, oceanography, and global climate change. Currently, instruments operating in the EESS bands provide regular and reliable quantitative atmospheric, oceanic, and land measurements to support an extensive variety of scientific, commercial, and government (civil and military) data users. Major governmental users of the EESS data include the National Oceanic and Atmospheric Administration (NOAA), the National Science Foundation (NSF), the National Aeronautics and Space Administration (NASA), and the Department of Defense (DOD, especially the U.S. Navy). Applications of the data include weather forecasts for use in the energy industry,[1] and in military and civilian aviation and sailing;

[1] U.S. electricity providers save $166 million annually using 24-h temperature forecasts to improve the mix of generating units that are available to meet electricity demand. This example and the examples given in footnotes 2 and 3 are taken from *Economic Statistics for NOAA*, National Oceanic and Atmospheric Administration, Fifth Edition, April, 2006.

hurricane and severe storm warning and tracking,[2] tsunami prediction; flood monitoring; seasonal and interannual climate forecasts and monitoring; observation and prediction of El Niño effects on agricultural production;[3] studies of the ocean surface and internal structure; and monitoring of changes in vegetation cover, snow cover, water resources, and ozone holes, as well as many other critical areas.

Important research and observation are performed in each of the EESS bands at issue in WRC-07 Agenda Item 1.20:

> **1.40-1.427 GHz:** This band is used for measurements of salinity over oceans and soil moisture over land areas. It is the only EESS allocation that can be used for these measurements. Both salinity and soil moisture are key components of the global water cycle. Measurements of salinity, the concentration of dissolved salts in the ocean, help scientists link changes in global climate trends to large ocean currents. For example, forecasts of the El Niño/La Niña cycle should be improved with such measurements. El Niño in the Pacific Ocean can cause drastic changes in weather patterns throughout the United States, including impacts on hurricane activity in both the Pacific and the Atlantic Oceans.
>
> Soil moisture measurements link the land to the atmosphere to improve overall weather forecasting. Such measurements can improve daily forecasts for rain and predictions of costly floods and droughts. Knowledge of soil moisture enables forecasts of ground-level fog—an important safety concern in civilian and military aviation. This information is also used to determine the trafficability of terrain. Satellite remote sensing using this EESS allocation is the only feasible means of providing these data on a global basis. Interference in this band could significantly degrade the measurement accuracy of passive sensors operating in this critical band.

[2] NOAA's National Weather Service forecasts, warnings, and the associated emergency responses result in a $3 billion savings in a typical hurricane season. Two-thirds of this savings, $2 billion, is attributed to the reduction in hurricane-related deaths, and one-third of this savings, $1 billion, is attributed to a reduction in property-related damage because of preparedness actions.

[3] Benefits to U.S. agriculture by altering planting decisions have been estimated at $265 million to $300 million annually, throughout El Niño, normal, and La Niña years.

NASA will launch the Aquarius instrument in 2009 to make global maps of ocean salinity using this band.

23.6-24.0 GHz: This band is allocated to EESS because of the existence of a nearby water vapor absorption line, and observations in these bands are important for measurements of atmospheric humidity (total integrated water vapor). Water is one of the most important components of Earth's atmosphere and is essential for human existence. The global water cycle is a key component of Earth's climate system, and accurate predictions of the cycle are necessary for monitoring climate variability and change, weather forecasting, and ensuring sustainable development of water resources. Such data are critical in making predictions of regional drought or flooding.

Humidity in the atmosphere is measured using this band, with measurements made from both terrestrial and satellite-based instruments. The satellite-based instruments include the Advanced Microwave Scanning Radiometer for Earth Observing System (AMSR-E) and the Tropical Rainfall Measuring Mission (TRMM) Microwave Imager (TMI), both of which operate aboard NASA satellites. Other instruments observing in this band include WindSat, developed by the Naval Research Laboratory and the National Polar-Orbiting Operational Environmental Satellite System (NPOESS) Integrated Program Office for the U.S. Navy. The Advanced Microwave Sounding Unit-A (AMSU-A) makes observations in this band aboard four NOAA satellites, NOAA-15 through NOAA-18. Additionally, the Advanced Technology Microwave Sounder (ATMS) will operate aboard a NASA satellite and then will replace the AMSU aboard the NPOESS series of operational weather satellites.

In addition to making these measurements of water vapor in the atmosphere, another instrument observes in this band to perform a correction for a sea-surface altimeter that measures sea-surface height with centimeter accuracy, to detect variations including those associated with the El Niño/La Niña cycle. This instrument is the Jason Microwave Radiometer aboard a U.S. satellite known as the Jason-1 altimeter. Soon, the Ocean Surface Topography Mission (OSTM/Jason-2) will be launched to continue the mission of Jason-1. The Advanced Microwave Radiometer (AMR) on OSTM/Jason-2 will use this band.

31.3-31.5 GHz: The AMSU-A instrument aboard four NOAA satellites performs observations in this band, in conjunction with observations at 23.6-24.0 GHz, to map water in the atmosphere and clouds, snow cover

over land, and sea ice concentration. Collected over decades, these data provide important climate record information about water resources, including drinking water, irrigation, and flooding. Such data are critical for monitoring and predicting water resource needs in the United States. Data collection in this band will continue through the ATMS, which will operate aboard a NASA satellite and then will replace the AMSU aboard the NPOESS series of operational weather satellites.

50.2-50.4 and 52.6-54.25 GHz: These two bands are located at the lower end of the 60-GHz oxygen absorption complex of Earth's atmosphere. The primary use of these bands is to measure the air temperature and its variation with height in the lower part of the atmosphere. These are the only EESS allocations that provide this capability. Additionally, these bands are used to map snow cover, sea ice concentration, rain, and floods. The following instruments aboard NASA, NOAA, and DOD satellites make measurements in these bands: the AMSU-A, the Special Sensor Microwave/Temperature (SSM/T), and the Special Sensor Microwave Imager Sounder (SSMIS). Data collection in this band will continue through the ATMS, which will operate aboard a NASA satellite and then will replace the AMSU aboard the NPOESS series of operational weather satellites. Additionally, both NASA and NOAA have made significant investments in technology for the future to observe in these bands from geostationary orbit.

In sum, the bands at issue in the *Notice* are widely used by scientists to make observations that are important for monitoring the global atmospheric and surface state.

II. CORF Generally Supports the Proposed Use of Mandatory Out-of-Band Emission Limits to Protect These EESS Bands from Unwanted Emissions.

In order to allow remote-sensing scientists to perform important missions involving observations in the bands at issue in the *Notice*, it is critical that these observations be protected from interference, especially from unwanted emissions from active transmitters in adjacent or nearby bands. EESS bands such as these are particularly vulnerable to interference, and interference to observations in any of these

bands could significantly degrade the accuracy of the measurements made by the EESS passive sensors, which would significantly compromise the missions relying on such data.

It should be noted that remote-sensing scientists have little control over the frequencies at which they must observe in order to fulfill their research and operational missions—the specific frequencies of elements or molecules observed are established by the laws of physics and chemistry. Furthermore, these remote-sensing scientists observe transmissions as nothing more than extremely weak deviations in the noise floor that are measurable only by using wide bandwidths. For the EESS, harmful levels of interference are established in ITU-R RS.1029-2 and are as follows for the bands at issue herein:

1.40-1.427 GHz: –174 dBW/27 MHz @ 0.1%

23.6-24.0 GHz: –166 dBW/200 MHz @ 0.01%

31.3-31.5 GHz: –166 dBW/200 MHz @ 0.01%

50.2-50.4 GHz: –166 dBW/200 MHz @ 0.01%

52.6-54.25 GHz: –169 dBW/100 MHz @ 0.01%

The percentages listed are the allowable percentages of area or time for which the given interference levels may be exceeded, by either in-band or out-of-band emissions. EESS observations are made continuously (24 hours per day, 7 days per week), and for a typical location in the United States, an EESS sensor passes over that site

approximately 20 times per day. Such continuous, long-term observations are necessary to build data sets complete enough to examine minute but crucial details and explore long-term trends.

CORF is particularly concerned about interference to EESS bands that are adjacent to bands allocated to satellite Earth-to-space uplinks. EESS sensors installed on satellites are designed to look down at Earth. Satellite uplinks are the opposite: they are located on Earth and transmit directly up into space. Transmissions from such uplinks in bands adjacent to bands allocated to EESS can cause direct interference to EESS sensors, if the satellite uplinks are not regulated and/or are not operating properly.

CORF generally supports the use of mandatory out-of-band emission limits on active services to protect passive services in adjacent and nearby bands. Such limits not only impose protection requirements on active users, but they also educate both users and equipment manufacturers regarding the need to protect passive users in nearby bands. Mandatory out-of-band emission limits on active services appear at this time to be the most practical and effective method of protecting passive services in adjacent and nearby bands. Accordingly, CORF supports the recommendation for such mandatory limits in the U.S. proposal for WRC-07 Agenda Item 1.20.

III. Conclusion.

The critical science undertaken by the EESS remote sensing scientists cannot be performed without access to interference-free spectrum. Loss of such access constitutes a loss not only of important data for critical applications for numerous users,

but also of the scientific and cultural heritage of all people. Accordingly, CORF supports the recommendation, made in the U.S. proposal for WRC-07 Agenda Item 1.20, for mandatory out-of-band emission limits on active services to protect passive services in adjacent and nearby bands.

Respectfully submitted,

NATIONAL ACADEMY OF SCIENCES'
COMMITTEE ON RADIO FREQUENCIES

By:___/s/_____
E. William Colglazier
Executive Officer

Direct Correspondence to:

CORF
Keck Center of the National Academies
500 Fifth St., NW, MS W922
Washington, DC 20001
(202) 334-3520

December 6, 2006

Attachment

CORF Membership List:

Karen St. Germain, NOAA, *Chair*
David DeBoer, SETI Institute, *Vice Chair*
Steven Ellingson, Virginia Tech
David G. Long, Brigham Young University
James M. Moran, Harvard University
Jeffrey Piepmeier, NASA Goddard Space Flight Center
Melinda Piket-May, University of Colorado at Boulder
Steven C. Reising, Colorado State University
Daniel Smythe, Massachusetts Institute of Technology
Paul A. Vanden Bout, National Radio Astronomy Observatory
Lucy Ziurys, University of Arizona

Michael Davis, SETI Institute, *Consultant*
Paul Feldman, Fletcher, Heald, and Hildreth, *Consultant*
A. Richard Thompson, National Radio Astronomy Observatory, *Consultant*