Spectrum Management Activities of the U.S. National Research Council's Committee on Radio Frequencies

David B. Lang, U.S. National Research Council, The National Academies, 500 Fifth Street, NW, Keck 954, Washington, D.C., 20001, USA, Phone: 202-334-2395, Facsimile: 202-334-3575, dlang@nas.edu

Paul A. Vanden Bout, National Radio Astronomy Observatory, 520 Edgemont Road, Charlottesville, Virginia 22903, USA, Phone: 434-296-0231, Facsimile: 434-296-0385, pvandenb@nrao.edu

Jeffrey Piepmeier, NASA Goddard Space Flight Center, Code 555, Building 19, Room S6, Greenbelt, Maryland 20771, USA, Phone: 301-286-5597, Facsimile: 301-286-1750, jeff.piepmeier@gsfc.nasa.gov

1 Abstract

The U.S. National Research Council's Committee on Radio Frequencies will discuss the exciting scientific and technological developments in radio astronomy and Earth remote sensing and then describe CORF's role in protecting the passive, scientific use of spectrum. Involving the broad radio science and engineering community is critical to the committee's work, which bears directly upon radio astronomy and Earth science. As technology continues to progress and devices utilize wireless transmitters, it is essential for the active and passive users of the spectrum to communicate directly with one another to avoid potential conflicts in the future. Paul Vanden Bout-NRAO; Jeffrey Piepmeier-NASA-Goddard.

2 General Background

The Committee on Radio Frequencies (CORF) brings the prestige of the National Academy of Sciences (NAS) to the protection of the frequency interests of radio astronomers, remote-sensing researchers, and other scientific users of the radio spectrum. CORF's chief task is to coordinate the needs for radio-frequency allocations and protection from radio-frequency interference for U.S. scientific research. CORF brings together representatives from such fields as space science, radio astronomy, atmospheric science, oceanography, life science, and remote sensing. As an activity of the NAS, CORF provides independent, external advice.

3 Scientific Background

3.1 Radio Astronomy

Radio astronomy is a vitally important tool used by scientists to study our universe. It was through the use of radio astronomy that scientists discovered the first planets outside the solar system, circling a distant pulsar. Measurements of radio spectral line emission have identified and characterized the birth sites of stars in our own galaxy, and the complex distribution and evolution of galaxies in the universe. Radio astronomy measurements have discovered ripples in the cosmic microwave background, generated in the early universe, which later formed the stars and galaxies we know today. Observations of supernovas have allowed us to witness the creation and distribution of heavy elements essential to the formation of planets like Earth, and of life itself. Radioastronomical spectral line observations have enabled the study of interstellar chemistry and organic molecules in space that are likely pre-biotic in origin.

As passive users of the spectrum, radio astronomers have no control over the frequencies at which atoms and molecules radiate or over the character of the "transmitted" signal. These frequencies are set by the laws of nature. The emissions that radio astronomers measure are extremely weak--a typical radio telescope receives less than one-trillionth of a watt from even the strongest cosmic source, and as many as 7 orders of magnitude less (one tenth of one billionth of one billionth of a watt) from the weakest. Because radio astronomy receivers are designed to pick up such remarkably weak signals, such facilities are therefore particularly vulnerable to interference from in-band emissions, spurious and out-of-band emissions from licensed and unlicensed users of neighboring bands, and those that produce harmonic emissions that fall into the radio astronomy bands.

In addition to the gains in scientific knowledge that result from radio astronomy, such research spawns technological developments that are of direct and tangible benefit to the public. For example, radio astronomy techniques have contributed to advances in medical imaging, the understanding of plate tectonics and earthquakes, and wireless telephone geographic location technologies such as those used in connection with the U.S. Federal Communication Commission's (FCC) Emergency-911 requirements.

Continued development of new critical technologies from passive scientific observation of the spectrum depends on scientists having continued access to interference-free spectrum. More directly, the underlying science undertaken by the observers cannot be performed without access to interference-free spectrum. Loss of such access constitutes a loss for the scientific and cultural heritage of all people, and humanity, as well as for the practical applications from the information learned and the technologies developed.

3.2 Earth Remote Sensing

Earth remote sensing is a critical and unique resource for monitoring and measuring weather and climate information on both a research and an operational basis. 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. Remotely-sensed data have contributed substantially to the study of meteorology, atmospheric chemistry, oceanography, and global climate change. Currently, instruments operating in the remote sensing 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 remotely-sensed 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; military and civilian aviation and sailing; hurricane and severe storm warning and tracking; tsunami prediction; flood monitoring; seasonal and inter-annual climate forecasts and monitoring; observation and prediction of El Niño effects on agricultural production; 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. These measurements are extremely important, yet extremely vulnerable to in-band and out-of-band interference due to the extreme sensitivity needed to extract the needed information.

4 The Radio Environment

Demand for spectrum from commercial and other users has grown substantially over the past 20 years. The current generation of wireless electronics and communications applications has placed pressure on spectrum managers to open new areas of the spectrum for commercial use. Other technologies such as ultrawide-band (UWB) devices used by vehicular radars are also threatening access to bands which are needed to conduct scientific research.

Similarly, the frequency needs of the scientific and related engineering communities have become greater as radio research techniques and instruments have become more sophisticated and sensitive. For many researchers, CORF serves as a means for presenting their needs to federal regulatory agencies and for defending their frequency allocations from commercial competition. CORF represents the interests of nongovernment activities and scientists as well as those of federally supported scientists.

5 Activities of the Committee on Radio Frequencies to Protect the Passive, Scientific Use of the Spectrum

To protect these two especially important, and sensitive, passive science services, CORF monitors and responds to radio frequency interference and allocation issues as they arise and works closely with spectrum managers at the NSF, the frequency management office at NASA, and the office of radio frequency management at NOAA. CORF participates in filing comments before the FCC and the National Telecommunications and Information Administration (NTIA).

A major CORF activity is participation in public pleadings before the FCC and NTIA regarding allocation and assignment of radio frequencies and other regulatory matters. CORF also provides information on radio science frequency allocation matters to commercial radio users, who usually become aware of the committee through its FCC filings. CORF also participates in preparations for the World Radiocommunication Conferences through these channels.

To assist with these filings, CORF employs the services of Fletcher, Heald & Hildreth, a prominent national telecommunications law firm. These services include daily monitoring of the FCC releases for frequency assignment applications, which requires the skills of, and extensive publications available to, a law firm. The notices are examined for potential in-band, adjacent-band, and harmonic interference and other spectrum allocations that may cause problems for radio science and remote sensing. With the assistance of the legal counsel, CORF decides on action regarding FCC notices and prepares and submits comments when necessary.

Since radio emissions know no borders, CORF must stay apprised of spectrum policy developments and activities not only domestically but internationally. And, with many foreign nations increasing their interest in passive radio science, doing so has become critically important. To achieve global awareness, CORF maintains contact with the European Committee on Radio Astronomy Frequencies, the Inter-Union Commission on Frequency Allocations for Radio Astronomy and Space Science, the International Union for Radio Science, the International Astronomical Union, the Canadian radio-astronomy spectrum manager, Mexican radio astronomers and spectrum managers, and other foreign entities and personnel. CORF typically includes representatives from these groups in its spring meetings and has added North American, Central American, and European regional issues in radio-frequency protection to its meeting agendas. CORF also provides contact with other National Research Council boards, such as the Polar Research Board and Space Studies Board, and committees, including relevant U.S. national committees for international scientific unions, whose chairs or delegates may serve as ex-officio members on CORF. CORF works with the American Astronomical Society in communicating with the radio astronomy community and in soliciting input, and with the IEEE Frequency Allocations for Remote Sensing Committee in the same regard.

CORF was heavily involved in the finalization and publication of the "Handbook on Frequency Allocations and Spectrum Protection for Scientific Uses." This document provides radio astronomers, remote sensing scientists, agency spectrum managers, and relevant commercial interest with a compact, comprehensive guidebook of radio spectrum allocations and needs for the Radio Astronomy and Earth Exploration Satellite Services. The "Handbook" also provides nontechnical descriptions of the exciting scientific astronomical and Earth science research enabled by access to the spectrum. CORF plans to disseminate this document at a National Research Council exhibit at the URSI General Assembly in August 2008.

6 Conclusion and Final Justification

In general, one of CORF's main objectives is to educate the scientific community, the government, and the public concerning radio frequency interference. CORF members acquire significant experience on radio spectrum-management issues and on regulatory matters and find it very valuable to communicate their experiences to members of the passive and active communities. To help accomplish this goal, CORF members have made presentations at the National Radio Science Meetings of the International Union of Radio Science Commissions E (frequency management and interference) and J (radio astronomy), at American Astronomical Society meetings, American Geophysical Union meetings, and other professional society meetings. CORF is particularly interested in extending its message to a broader audience consisting of members of communities which may not be familiar with the operation and radio frequency interference sensitivity of the passive scientific services. For this reason, CORF requests time during the session.

Appendixes

A.1 Roster of the Committee on Radio Frequencies and Web Site Information

Membership
Paul A. Vanden Bout, Chair, National Radio Astronomy Observatory
Jeffrey Piepmeier, Vice Chair, NASA Goddard Space Flight Center
Ana P. Barros, Duke University

Douglas C.-J. Bock, University of California at Berkeley / Combined Array for Research in Millimeter-wave Astronomy
Steven W. Ellingson, Virginia Tech
David G. Long, Brigham Young University
Darren McKague, Ball Aerospace Corp.
James M. Moran, Harvard-Smithsonian Center for Astrophysics
Melinda Piket-May, University of Colorado at Boulder
Alan E.E. Rogers, Massachusetts Institute of Technology / Haystack Observatory
Steven C. Reising, Colorado State University
Lucy Ziurys, University of Arizona

Consultants
Paul Feldman, Esq., Fletcher, Heald and Hildreth
Michael Davis, retired
A. Richard Thompson, National Radio Astronomy Observatory

NRC Staff
Donald C. Shapero, Director, Board on Physics and Astronomy
David B. Lang, Associate Program Officer

The committee keeps a web page at http://www7.nationalacademies.org/corf/.