The National Academies of
SCIENCES • ENGINEERING • MEDICINE

Update on Activities of the US National Academies' Committee on Radio Frequencies (CORF)

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Spectrum management and policy

- The radio spectrum is shared between commercial, governmental, and scientific users (the latter both “passive” and “active”)
- Radio regulations are codified both internationally (by the International Telecommunication Union, ITU) and domestically (by the Federal Communications Commission, FCC, and the National Telecommunications and Information Administration, NTIA)
- There is an ever-increasing commercial demand for and usage of radio frequencies, driven in part by recent advances in telecommunications technologies
  - The 2021 FCC auction of 3.70–3.98 GHz raised $81.1 billion!
  - (By contrast, NOAA estimates $3 trillion of the US economy is weather-sensitive, and $35 billion in annual economic benefits from weather forecasting*)
- This increases the need for spectrum sharing and coordination
  - The passive use of the spectrum is under an ever-growing threat
  - It is hard to reverse regulations and recover spectrum when passive use is negatively impacted

Roles of CORF

- CORF represents interests of U.S. researchers using radio frequencies: both radio astronomers and Earth scientists
- CORF coordinates the views of U.S. scientists and acts as a channel to represent their interests
  - We recommend requirements and limits necessary to protect scientific use of the radio spectrum from interference
  - This is largely through filing comments in public proceedings of Federal Communications Commission (FCC)
- Comments are drafted by CORF and its legal counsel, then reviewed per standard Academy protocols and approved and signed by the National Academy President
- CORF also performs specific studies, maintains a Handbook and conducts various forms of outreach to scientists and industry
- CORF is funded by NSF and NASA

CORF membership

Committee members

Nathaniel Livesey, JPL (Chair) – EESS
Scott Paine, CfA (Vice Chair) – RAS
Nancy Baker, NRL – EESS
Laura Chomiuk, Michigan State – RAS
Dara Entekhabi, MIT – EESS
Phil Erickson, Haystack Observatory – EESS
Kelsey Johnson, U Virginia – RAS
Christopher Kidd, GSFC/UMD – EESS
Karen Masters, Haverford – RAS
Mahta Moghaddam, USC – EESS
Frank Schinzel, NRAO – RAS

Consultants

Darrel Emerson, Arizona, retired, RAS
Tomas Gergely, NSF, retired, RAS
Paul Feldman, Esq., Fletcher, Heald and Hildreth – Legal counsel

National Academies Staff

Colleen Hartman, Director, Space, Physics, and Aeronautics
Greg Mack, Senior Program Officer
Neeraj Gorkhaly, Linda Walker

Summary of CORF activity over last few years

2019 FCC filings

- NGSO ESIMs (10.7 GHz; 14.47–14.50 GHz; near 18.7 GHz)
- 6 GHz unlicensed devices
- Out of Band Emission (OOBE) limits for Satellites
- Geostationary to mobile Earth stations (10.7 GHz; near 18.7 GHz)
- Waiver to standard rules at at 70–80 GHz
- Airborne landing radars (92–95.5 GHz)
- US246 ("all emissions prohibited") protections on bands above 95 GHz
- Waivers for standard rules at 60–64 GHz

2020 FCC filings

- TV Channel 37
- 6 GHz unlicensed devices – revisit
- 70/80/90 GHz: Airborne internet
- 4.9 GHz: 7th filing on this topic

2021 FCC filings

- 23.6 GHz: Implications of international Mobile (i.e., 5G)
- 57 GHz: Approvals for short-range devices
- 4.9 GHz: 8th time round
- 70/80/90 GHz: Airborne internet revisit

2019: 92–95.5 GHz Airborne landing radars

- A company has proposed a new airborne landing radar, intended to operate only in bad weather conditions
- However, if it is installed on all aircraft, it is possible that it could be integrated into autopilot hardware/software and operate in all weather conditions in the future
- CORF reminded the FCC/industry that US regulatory footnote 161 requires coordination within 150 km of single dish mm-wave radio telescopes
  - There are 483 registered airports, airfields, heliports, etc. within 150 km of Haystack Observatory
- A question is how to address compatibility (and coordination!) when proposed use is probably OK, but one can reasonably assume that subsequent implementation will be more problematic
- Industry has reached out to individual astronomy facilities to iterate on their proposal
- The recent debacle over 5G vs. landing radar at the lower end of C-band (~4 GHz) may resurrect interest in this possibility from the aviation community

2020: 70/80/90 GHz for commercial aircraft

- In 2020, the FCC solicited comments on use of 70/80/90 GHz bands to provide internet to commercial aircraft via ground-to-air, air-to-ground, and air-to-air links
- CORF opposed use of the 80 GHz band (81–86 GHz) for downlinks and for aircraft-to-aircraft transmission
- CORF noted the need for guard bands to protect EESS from Out of Band Emissions (OOBE) at 86–92 GHz (an "All Emissions Prohibited" band)
- CORF also recommended updating OOBE limits to match those in ITU-R Resolution 750
- CORF further recommended an active tracking system be employed to null emissions in direction of orbiting EESS sensors

Concept for dynamic ground-to-air, air-to-ground, and air-to-air links.

2021: 23.6 GHz for 5G mobile phones

- In 2017 the FCC auctioned the band from 24.25–24.45 GHz for 5G use
- The associated OOBE limits were inconsistent with protecting 23.6–24.0 GHz EESS (column and near-surface water vapor) and RAS (NH_3) observations
- The FCC urged international confirmation of such limits, but WRC-19 adopted stricter limits (though not as strict as those advocated by, for example, WMO)
- In 2021, the FCC requested comments on US implementation of WRC-19 limits
- CORF responded with details on the importance of the 23.6–24.0 GHz band to Earth science and radio astronomy, urging that the WRC-19 limits be implemented as expediently as possible while arguing that they may still ultimately prove insufficient in some circumstances
- In an unusual move, the NTIA (that manages federal government spectrum usage) submitted a response on behalf of NASA and NOAA urging speedy implementation of the limits, with strong procedures for addressing violations

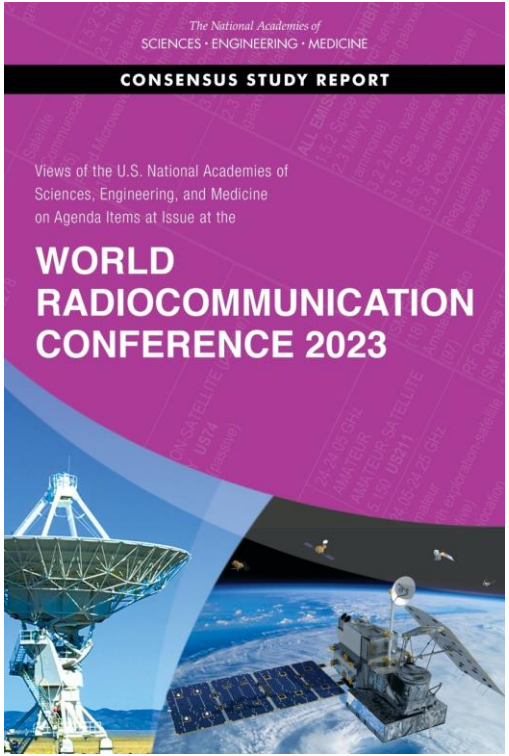
2021: Protection of EESS from 57–64 GHz active devices

- The 57–59.3 GHz (Oxygen) band is essential for temperature sounding
- The atmosphere shields spaceborne observations from ground-based emissions
- There has been increased use of this band for short-range active devices (unattended infants in cars, lawn mowers, building surveys)
- In 2021, the FCC released a notice outlining plans to loosen current limits for such devices (citing prior approvals on a case-by-case basis)
- The FCC noted no plans for increased airborne usage at this time (some limited airborne use has previously been approved)
- CORF filed comments stressing the importance of these bands and their extreme sensitivity to airborne emissions
- We further noted shortcomings in prior analyses from industry that underestimated absorption from aircraft windows
- Once again, NASA/NOAA/NTIA submitted their own filing

CORF members' involvement at the international level

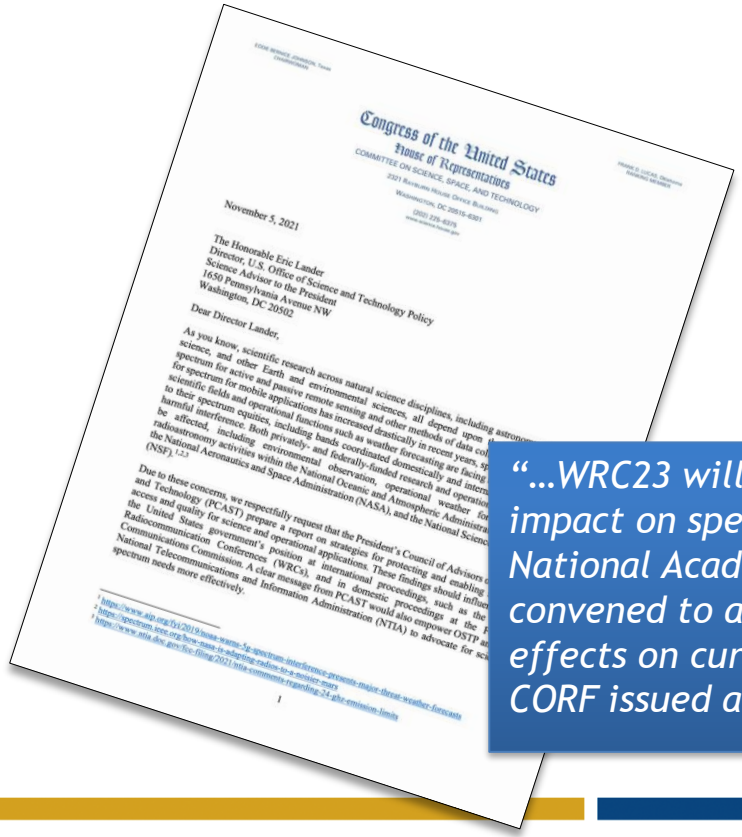
- CORF members participate in the US working party 7C (EESS) and 7D (RAS) meetings
  - CORF members also participate in US working party 3 (propagation)
  - We also participate in US working party 1A (spectrum management) as needs dictate
  - Note that participation is by CORF members as individuals, i.e., not wearing a "CORF hat"
- CORF members have also participated in the associated ITU meetings
  - Here our influence is limited, as all participants are part of the US delegation, so must follow agreed US positions
- We have noticed increased participation in 7C/7D by the communications industry, in some cases outnumbering EESS/RAS scientists/advocates (enabled in part by COVID-era remote meetings)
- In response, particularly for 7D/RAS we have encouraged the participation of more scientists in the US and ITU 7D meetings, including authoring new studies/reports
- This appears to be making a difference, but more participation, in both 7C and 7D, would probably help our collective cause

CORF activities: WRC-23 “Views” report



- This report represents input from US scientists regarding agenda items at the World Radiocommunication Conference 2023 (WRC-23), and preliminary items for the WRC-27 agenda
- Decisions at the WRCs lead to updates to international regulations under the ITU
- There are multiple agenda items with potentially significant impacts to RAS/EESS
- NASA and NSF (and FCC, NTIA, etc.) heavily involved
- More than 300 downloads from the National Academies Press since its June 2021 release
- Report briefed to NSF, NASA, and staffers from U.S. House of Representatives Science Committee

Follow up to WRC-23 “Views” report



Congress of the United States
House of Representatives
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

November 5, 2021

The Honorable Eric Lander
Director, U.S. Office of Science and Technology Policy
Science Advisor to the President
1650 Pennsylvania Avenue NW
Washington, DC 20502

Dear Director Lander,

As you know, scientific research across natural science disciplines, including astronomy, science, and other Earth and environmental sciences, all depend upon [illegible] spectrum for active and passive remote sensing and other methods of data co[illegible] for spectrum for mobile applications has increased dramatically in recent years, sp[illegible] scientific fields and operational functions such as weather forecasting are facing [illegible] to their spectrum equities, including bands coordinated domestically and internat[illegible] harmful interference. Both privately- and federally-funded research and operation[illegible] be affected, including environmental observation, operational weather fo[illegible] radioastronomy activities within the National Oceanic and Atmospheric Administra[illegible] the National Aeronautics and Space Administration (NASA), and the National Scienc[illegible] (NSF).[1,2,3]

Due to these concerns, we respectfully request that the President's Council of Advisors [illegible] and Technology (PCAST) prepare a report on strategies for protecting and enabling [illegible] access and quality for science and operational applications. These findings should influen[illegible] the United States government's position at international proceedings, such as the [illegible] Radiocommunication Conference (WRC-23), and in domestic proceedings at the F[illegible] Communications Commission. A clear message from PCAST would also empower OSTP a[illegible] National Telecommunications and Information Administration (NTIA) to advocate for sc[illegible] spectrum needs more effectively.

[1] https://www.aip.org/fyi/2019/noaa-warns-5g-spectrum-interference-presents-major-threat-weather-forecasts
[2] https://spectrum.ieee.org/how-noaa-is-adapting-radiosonde-to-a-noisier-space
[3] https://www.ntia.doc.gov/fcc-filing/2021/ntia-comments-regarding-24-ghz-emission-limits

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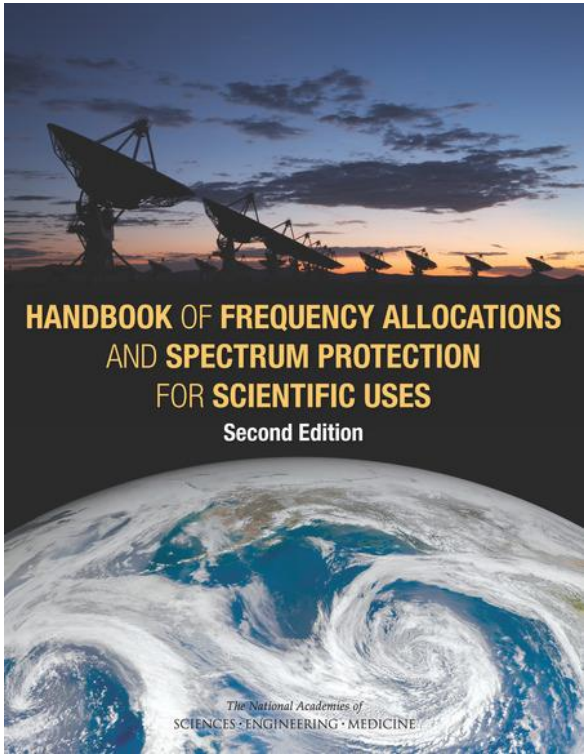
Letter from chair and ranking member of house science committee to Whitehouse Office of Science and Technology Policy

5 November 2021

“…WRC23 will consider specific Agenda items which have potential impact on spectrum used for radio astronomy and remote sensing. The National Academies Committee on Radio frequencies (CORF) has already convened to assess each agenda item and consider their potential effects on current and future radio frequency science applications. CORF issued a report on those items in late September…”

CORF activities: “CORF Handbook”



- Comprehensive resource for scientists, engineers, and spectrum managers
- Detailed information including a description of regulatory bodies, a discussion of the relevant scientific background, a list of science spectrum allocations in the United States, and an analysis of spectrum protection issues for RAS and EESS
- More than 4700 downloads from the National Academies Press

Future CORF activities

- Continue responding to FCC actions
- Engage more frequently with FCC Commissioners and Staff
- Educate Congressional staff and others regarding scientific use of the radio spectrum
- Engage in international spectrum management, particularly in regards to US facilities located abroad
- Continue to engage international scientists
  - Guest speakers at CORF meetings