On July 20, the House Committee on Science, Space and Technology held a hearing on "Spectrum Needs for Observations in Earth and Space Sciences." The Committee examined remote sensing applications in the 23.6 to 24.0 GHz band and the potential for harmful interference from operations in the adjacent 24.25 to 24.45 GHz band that was auctioned in 2019 for new 5G applications. They also considered "research and technology development needs to help anticipate, evaluate, and mitigate harmful interference with spectrum used for passive observation." The radio frequency bands at issue are used to support weather forecasting and monitoring, climate science, and astronomy. Witnesses included: Andrew Von Ah, Government Accountability Office (GAO); David Lubar, the Aerospace Corporation; Dr. Jordan Gerth, University of Wisconsin-Madison; Bill Mahoney, National Center for Atmospheric Research (NCAR); and Jennifer Manner, EchoStar Corporation / Hughes Network Systems LLC.

Von Ah noted that on July 19, GAO released its report entitled "Spectrum Management: Agencies Should Strengthen Collaborative Mechanisms and Processes to Address Potential Interference." During the U.S.'s preparation for the 2019 World Radiocommunication Conference, which updates global treaties and international regulations, the National Oceanic and Atmospheric Administration (NOAA), the National Aeronautics and Space Administration (NASA), the Federal Communications Commission (FCC), and the National Telecommunications and Information Administration (NTIA) were unable to agree on which studies and positions to present. "A key area of disagreement was how to protect instruments on weather satellites from interference from 5G wireless signals in the 24 GHz spectrum band. Consequently, the U.S. did not reach agreement on key technical contributions to submit to international technical meetings for the conference, creating challenges for the U.S.'s ability to present either a unified position or an agreed-upon technical basis for the conclusions the U.S. ultimately supported."

Van Ah's testimony addressed interagency collaboration, outdated guidance documents, internal procedures, and authority to initiate reviews about spectrum interference. He said: "[R]egulating and managing spectrum is a complex and challenging task. While mechanisms exist that facilitate collaboration between FCC and NTIA – the U.S. spectrum managers – and federal users like NOAA and NASA, gaps also exist. In this case, these gaps may have also contributed to hampering NOAA's and NASA's efforts to protect their satellite instruments from potential interference. In the future, these gaps could contribute to challenges in managing spectrum for other uses."

Lubar noted that the non-profit Aerospace Corporation was established by Congress in 1960 to provide independent technical advice to military, intelligence, and civil space programs. His spectrum experience includes two major environmental satellite programs for NOAA, one of which is the Joint Polar Satellite System (JPSS). "JPSS has a sounder instrument, specifically a microwave radiometer, which performs passive measurements worldwide in 22 passive frequency bands, including the 23.8 GHz spectrum. This sensor is essential to the timeliness and accuracy of weather predictions around the world. Because making passive measurements of subtle atmospheric conditions from space requires listening very carefully for natural phenomena against a background of human-created electromagnetic energy from our billions of radios, I have become very familiar with the International Telecommunications Union (ITU) study process and closely monitored the study reports and discussions through the ITU that resulted in the 24 GHz spectrum emission limits in 2019."

Lubar's testimony covered three main technical points: (1) the technology and signal sensitivities of smart phones and the passive scientific sensors crucial for weather forecasting are vastly different, and regulatory protections must consider the impact of noise interference on scientific instruments designed to detect small changes in the atmosphere; (2) the small atmospheric changes provide data on temperature, water vapor, and other values, and moderate levels of frequency contamination are the most damaging to weather prediction skills; and (3) there is no mitigation for frequency contamination, merely the identification and removal of contaminated data, meaning fewer data to inform weather forecasts.

Gerth noted that microwaves between 20 and 200GHz are the most valuable frequencies for weather forecasts. "Molecules such as oxygen and water vapor emit microwaves at unique frequencies, and those emissions help meteorologists identify and characterize weather systems and develop a vertical profile of temperature and humidity.... Microwaves…typically traverse through clouds without absorption and thus enabling meteorologists to examine the internal structure of storms in determining whether strengthening or weakening is likely." Satellites have been designed to sense microwaves for over 40 years. Next year, NOAA anticipates launching a new satellite in the JPPS with an Advanced Technology Microwave Sounder (ATMS), a passive sensor that listens to the atmosphere, including radio frequencies at 23.8 GHz. "23.8 GHz is sensitive to concentrations of water vapor near the ground and when used in combination with other frequencies can contribute to a vertical profile, or distribution, of humidity at various heights above the ground."

Gerth pointed out that 99% of the weather observation data input to numerical weather prediction models in supercomputers originates from satellites. “Improvements in numerical weather prediction performance over the past 20 years can be attributed to satellite observations, especially microwave sensing of water vapor, such as at 23.8 GHz and other frequencies. Today, approximately 15 to 30% of the assimilated observations are from passive microwave sensing.” Without a complete assessment of the atmosphere, weather forecasts will be less reliable and accurate over time, and would include a loss in lead warning time for storms. He said: “Terrestrial radio systems that emit 5G signals too closely to defined bands for weather sensing are a formidable threat to weather forecast and warning services because they are much louder than the atmosphere that satellites are trying to observe.”

Gerth recommended NOAA, NASA, and other agencies that operate satellites for environmental sensing do a routine audit of their use of spectrum and the value it provides in terms of contribution to numerical weather prediction skill. “This valuation should be conducted routinely because the speed of peer review is much slower than FCC proceedings. FCC proceedings have timelines of 60 to 90 days for comment while funding research for peer review related to a new proceeding is likely to take 18 to 24 months at a minimum. A new satellite currently takes 5 to 10 years to build and launch, and those program costs are in the billions per satellite. The estimated total cost of the JPSS program from 1995 through 2038 is $18.8 billion, so a loss of sensing capability that diminishes its intended mission has a real tangible cost for taxpayers even without considering the economic loss from the reduction in weather predictability.” He also added that weather forecast accuracy is not competing against the telecommunications industry, which is an essential partner in “delivering urgent weather messages to cell phones and establishing communications immediately after a disaster to assist in the response.” He emphasized the need to work together to deploy communications equipment outside the pre-existing frequency bands for Earth sensing.

Gerth said: “While the contentious circumstances surrounding 24 GHz were far from desirable, and 23.8 GHz sensing contributes useful water vapor information for weather forecasting that we may partially lose, the longest heritage of microwave sensing is between 50 and 60 GHz, where there are 13 ATMS bands. We should be especially careful of sharing arrangements in and around 50 to 60 GHz or the consequences for weather prediction may be more dire.”

Mahoney added that the U.S. economy is sensitive to weather, and that our economic output varies by about 3.4% of GDP, or $600B a year, due to weather variability. He said a nationwide survey published by the American Meteorological Society indicated that weather forecasts generated $41B in economic benefits to U.S. households. He noted that often, the same wavelengths that are valuable for passive remote sensing are also valuable for telecommunications because they can pass through weather, buildings, and other obstacles. He provided examples of frequency bands critical for Earth system sensing: 18.6 GHz for Sea Surface Wind Speed and Direction; Snow Coverage, Sea Ice, Precipitation; 23.8 GHz for Integrated Atmospheric Water Vapor; 36.5 GHz for Tropical Cyclone Monitoring; Sea Surface Wind Speed and Direction; and 50-60 GHz for Atmospheric Vertical Temperature Profile (multiple bands).

Mahoney said: “The significant progress that has been made in recent years in weather forecasting skill is largely attributable to these observing technologies and the use of Earth observations in weather prediction models, by forecasters, and the atmospheric science research community. To predict the weather accurately, the current state of the atmosphere must be known in detail across the globe from the surface of the Earth to the top of the atmosphere. In situ and remote sensing technologies are critical to the forecasting process. This is not an issue of academics or researchers losing access to a data set, this is about not having the necessary information to protect life and property. Weather data and forecasts are important for the public and are required for large segments of our Nation’s economy.”

Mahoney provided several examples of how the data and forecasts are used for agriculture, energy, emergency management, aviation, surface transportation, national security and defense. For water management, he said: “Daily to seasonal decisions are made for reservoir management, hydropower operations, river and stream flow rates for fish protection, recreation, to meet regulatory requirements, assess flooding potential, and predict water consumption.” And for wildfires, he added: “Weather information is used daily to determine the risk of wildfire ignition from lightning and human activities, fire rate of spread, intensity, air quality, and to manage ground based and airborne fire mitigation operations.”

Mahoney provided more information about how 5G wireless technology can contaminate Earth’s natural microwave emissions. “A total combined power in excess of 0.1 Watts from all terrestrial sources will contaminate the [microwave] measurements. 5G wireless technology encompasses a broad spectrum. It is projected that more than 50% of data transfer in 5G will take advantage of Wi-fi. Wi-fi signal strength (Pico Watt) is ten times stronger than the weakest signal detected by radar and satellite receivers. Therefore, radio frequency interference will significantly degrade or make the satellite and radar signals useless. Unwanted byproducts from a 5G signal that falls within the frequency range detected by the weather satellite would raise the noise floor or confuse the sensor. There is no method to separate the unwanted 5G signal from the desired natural signal, which simply measures the total power detected, meaning it would not be possible to know that the environmental data had been contaminated. Preliminary studies have indicated that the proliferation of terrestrial 5G systems using 24 GHz frequencies will make current and future data less accurate, or even unusable, unless 5G is rigorously implemented in a manner that protects the adjacent Earth Exploration Satellite Service spectrum."

Manner formerly served as Senior Counsel to FCC Commissioner Kathleen Abernathy with responsibility for wireless, international and new technology issues, and as the Co-Chair of NTIA's Commerce Spectrum Management Advisory Committee's Working Group, "charged with looking at the United States' current spectrum management approach and whether it is serving the entire stakeholder community or if it would benefit from reform." She recommended updating the 2003 NTIA-FCC memorandum of understanding to improve the spectrum management process. She noted that the need for spectrum planning has shifted as technology has improved, increasing the number of competing uses for the same bandwidth.

The FCC allocates spectrum according to "public interest" under its authorizing statute, which is consumer focused. Other agencies must consider "national interests" that take a broader view. Manner said: "Proceeds from recent FCC auctions demonstrate the economic value of spectrum for commercial broadband, but we must not lose sight of the value of space-based uses to the United States' strategic interests in climate science, national defense, or weather forecasting to protect lives and property. As members at this hearing are aware, many technological advancements have come from earlier investments in NASA and other science agencies, which have been applied broadly throughout our economy…. Auction proceeds cannot be our only measure of the value of spectrum to the United States' overall national interest. Spectrum for international satellite services is not auctioned, yet it serves critical national purposes, including delivering connectivity to rural users and rural Government facilities in underserved markets more economically than terrestrial options, and supporting users in times of emergency when the terrestrial network is not available. Yet, time and time again, the FCC has placed terrestrial use of this spectrum as of more importance than satellite using the public interest standard, even when it may conflict with the national interest in solving problems…. Deployment of the next generation of terrestrial broadband cannot be the only policy goal. Spectrum policy must balance the current and future requirements of our country, including remaining on the forefront of space sciences."