American Meteorological Society

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17 April 2023

National Telecommunications and Information Administration (NTIA)

1401 Constitution Avenue, NW

Washington, D.C. 20230

Re: NTIA-2023-0003 - Docket No. NTIA-230308-0068

Dear colleagues,

The American Meteorological Society (AMS) appreciates the opportunity to provide written comments on the National Spectrum Strategy. We appreciate the NTIA and broader Executive branch efforts to obtain public, government (including federal, state, local and tribal), academic, and private sector views on U.S. radio frequency spectrum allocation and its use.

The mission of AMS is to advance the atmospheric and related sciences, technologies, applications, and services for the benefit of society and does this through a diverse membership from across government, academia, and the private sector, including emergency managers and broadcast meteorologists. Furthermore, AMS serves as a focal point for those in allied fields that depend on weather, water and/or climate information such as agriculture, transportation, insurance, commodities, finance, emergency managers, space operations, maritime/fishing industries, water management, energy, utilities and more.

Throughout this document, we will refer to the diverse community of weather, water, and climate professionals from the public sector, private industry, and academic institutions as the weather-water-climate enterprise, or more simply, the "weather enterprise".

AMS values the radio frequency (RF) spectrum because of its vital importance to environmental sensing and its dedicated communication infrastructure. These spectrum-dependent technologies provide critical, time sensitive information essential for protecting life and safety, planning and executing the nation's businesses and commerce, and as essential support crucial to national defense missions.

A 2011 study estimated weather had a $485 billion or 3.4% annual effect on the nation's economy[1]. If that 3.4% is applied to the U.S. Bureau of Economic Analysis (BEA) 2022 GDP estimate of 26.14 trillion,[2] then weather had an annual effect of $889 billion on the nation's economy. (A more rigorous estimate using the appropriate discount rate, recent year dollars and public-benefit economics is beyond the scope of this submission.) That number will only increase in actual value and percentage with climate change impacts in the coming years.

Americans rely upon unrestricted access to unencumbered pristine spectrum for lifesaving forecasts and for understanding the hazards of a changing climate. Furthermore, policymakers must recognize

[1] Lazo et al. 2011: U.S. economic sensitivity to weather variability. *Bull. Amer. Meteor. Soc.*, 92, 709-720. DOI: https://doi.org/10.1175/2011BAMS2928.1.

[2] BEA News Release Gross Domestic Product, Fourth Quarter and Year 2022 (Third Estimate), GDP by Industry, and Corporate Profits, 23-12, https://www.bea.gov/news/2023/gross-domestic-product-fourth-quarter-and-year-2022-third-estimate-gdp-industry-and

that the radio spectrum is utilized for many applications besides telecommunications, and these uses serve important functions in support of the economy, national security, and public safety.

We have organized our response to the National Spectrum Strategy request for comment (RFC) to generally address each of the three pillars of the request and identify parenthetical references within the text to specific questions. The main points of the AMS response are noted below and will be detailed further under the response to each pillar from the RFC.

- Federal spectrum to support weather/water/climate predictions are critical to society. Though the spectrum is a federal allocation it is used extensively across the federal, public, private, non-profit, and academic sectors to support the life and safety needs of people across the nation and world. Spectrum use benefits multiple weather-sensitive segments of the economy, such as (but not limited to) aviation, land and sea transportation, energy exploration and production, agriculture, fishing, outdoor recreation, and professional sports.

- We encourage federal spectrum regulatory agencies to consider more active outreach to science communities, especially those reliant on Earth science spectrum allocations. Additional scientific evidence and insights would help to further inform spectrum allocation proceedings as conflicts have increased in intensity. An additional way to do this is to have more staff at NTIA and FCC with post-graduate science backgrounds.

- The Spectrum Pipeline Fund Act should be modified to allow for auction funding to be used to better understand adjoining band harmful interference in passive bands.

Pillar #1 – A Spectrum Pipeline to Ensure U.S. Leadership in Spectrum-Based Technologies

To create a reasonable and sustainable spectrum pipeline to drive economic growth, it is critical to capture the full utility and value of existing spectrum allocations. U.S. spectrum regulators should consider all users and uses of spectrum and their respective benefits to society. The weather enterprise has been frustrated by some regulatory proceedings over the past ten years that have indicated a-lack of understanding of our use of spectrum, the full utility and value of these allocations to economic prosperity, national security, and public safety, as well as the inherent vulnerability of these resources to harmful interference.

Question 1.6 under Pillar 1 in this RFC seems to be oriented toward responses from those who use spectrum for communications purposes, rather than oriented to optimize responses from all users of spectrum. Sharing with non-communications users means accommodating the performance parameters of diverse use cases. For example, performance requirements of certain types of passive microwave observations may inhibit certain sharing regimes, as both the frequency and time domain must be vacant for quality data. Certain types of active observations may have sharable qualities, but it is unlikely that the same performance metric used for communications systems would apply.

The spectrum resources relied upon by meteorologists, hydrologists, and other Earth scientists to produce forecasts are critical to operating numerous technologies. These include satellites and their instruments, wind profilers, radiosondes (weather balloons) and weather radars, as well as communication capabilities for dissemination of weather data and products, ranging from stream gauges to tidal buoys. The weather enterprise also benefits from protection of spectrum for other uses, such as radio navigation. Operational hydrometeorological agencies use GPS signals opportunistically to ingest information about the atmosphere, which helps calibrate other measurements and directly enhances forecast skill (known as GPS Radio Occultation).

Research and development are continual processes in the weather enterprise as the use of spectrum-dependent data expands into new forecasting capabilities and enhancements. New technologies with increasingly sensitive instruments will extract more information from current spectrum footprints and enhance environmental information for society. The time horizon for those developments vastly differs from that of the evolution of commercial spectrum use; some sensor development can take one or two decades before implementation. The amount of spectrum (Re: Question 1.2) is not necessarily the key performance parameter for our applications. Particularly for passive sensors, the performance of the system is strongly tied to the absence of contamination from anthropogenic radio emissions. Coverage for timely relay of in situ remote environmental data, especially in regions that may not be commercially viable for communications services, is another parameter important to the weather enterprise.

To operate these technologies that produce critical environmental data for forecasting, the weather enterprise is reliant on allocations of federal spectrum for active and passive remote sensing activities as well as communications. These spectrum allocations are diverse, and the locations of active and passive spectrum maximize the characteristics of spectrum that enable the most efficient measurements of natural phenomena. It is important to note that while these are federal allocations, the spectrum is extensively used and relied upon by numerous non-government stakeholders that make up the weather-water-climate enterprise.

We expect the weather enterprise's spectrum needs to continue for the long term (Question 1.1). The AMS remains committed to working with our partners in government, academia, and other industries to find reasonable and data-informed solutions to future spectrum allocations. Recognizing the increasing demand for spectrum across the economy, our community has been proactive in our contributions in the past few years. NOAA (and its federal, academic, private sector and state/local government stakeholders) agreed to give up more than 50 percent of its spectrum between 1670 and 1710 MHz to enable the AWS-3 auction that concluded in 2015, using spectrum auction revenues to fund the redeployment of radiosonde (weather balloon) communications technology to 400.15 - 406 MHz.

Spectrum proceedings in the U.S. have a global impact. We recommend ensuring that spectrum regulators coordinate not only with international bodies such as the International Telecommunications Union, but also the experts who design, build, operate, and harmonize Earth observations platforms, such as the National Academies of Science, Engineering, and Medicine (NASEM), Commission F of the Union Radio-Scientifique Internationale, and the United Nations' World Meteorological Organization. Consultation from remote sensing scientific experts such as the Institute of Electrical and Electronic Engineers (IEEE) Geoscience and Remote Sensing Society (GRSS) is also recommended.

In future proceedings on spectrum allocation, absent reliable information on the likely impacts to the weather-water-climate enterprise, we encourage the NTIA and FCC to exercise caution until the full impacts can be evaluated using the best available science and engineering. The proliferation of new mobile communications devices and architectures, coupled with the sensitivity of our systems to harmful interference, can cause irreversible harm without science-informed studies and protective measures.

The following are some examples of how active, passive and communications spectrum are used by the weather-water-climate enterprise and how each are important and complimentary to one another.

Spectrum for Passive sensing

The weather community operates a diverse network of passive sensors deployed in space, on aircraft, and on the ground. Forecasters rely on radiometric sensors on satellites that measure the weak thermal emissions of the atmosphere – essentially the vibration of water molecules and oxygen due to temperature – and what most communications engineers call fluctuations in the "thermal noise floor". By measuring these incredibly quiet emissions, we can obtain a 3-D map of temperature, pressure, and humidity worldwide, as well as several surface characteristics such as ocean-surface windspeed. These crucial variables are the backbone of supercomputer models that allow forecasters to predict weather and climate.

It is important to emphasize that these passive measurements are not communications signals and are orders of magnitude weaker than typical communications links. Passive instruments do not emit or transmit in passive bands, nor are they conventional receivers. They measure power, not detect and demodulate information content. Further, the properties of the atmosphere are defined by the laws of physics and chemistry and cannot be changed to optimize spectrum allocation. These measurements are especially vulnerable to harmful interference as even faint out-of-band emissions can, in aggregate, contaminate the thermal noise floor of the target channel.

The current operational radiometer on U.S. weather satellites, the Advanced Technology Microwave Sounder, or ATMS, hosted on NOAA's Joint Polar Satellite System (JPSS), senses atmospheric characteristics using passive absorption bands at 24 GHz, 31 GHz, 50 to 58 GHz, 88 GHz, and 183 GHz (also noted in attachment 1). With two JPSS satellites on orbit and two more to be launched by 2031, the sensors are expected to continue to operate through the 2030s. Future generations of environmental satellites will measure in these and in additional bands above 100 GHz. Early requirement efforts have already begun for the ATMS replacement, a next generation sensor that will operate through 2055. More channels are already proposed in additional passive frequency ranges. The world will continue to need passive sensing architectures to collect the data necessary to predict and forecast the weather.

DoD and NASA also have satellites that employ passive microwave sensors, as do other countries, many using similar spectral allocations to ATMS, and some target other phenomena with additional spectrum footprints (NOAA and DoD operational weather satellites detailed on the slide in attachment 1).

A single polar-orbiting weather satellite (such as those carrying a passive microwave sensor) observes the entire Earth, including the U.S., at least twice daily (once during the day and once at night), with a single satellite providing coverage of the poles every 100 minutes. As multiple polar-orbiting satellites are necessary to provide more frequent coverage for observing short-term changes in the weather, the satellites are staggered in orbit to achieve that. In addition to U.S. operational weather satellites, the U.S. relies on passive microwave observations collected with satellites operated by the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT), the Japan Aerospace Exploration Agency (JAXA) and the Korean Meteorological Agency (KMA), which are harmonized with U.S. assets to provide similar data. In addition, the U.S. relies on the NWP models developed by the European Centre for Medium Range Weather Forecasts (ECMWF), which also rely on similar passive microwave data sources, as well as passive observations from satellites operated by India and China.

Today, the U.S. seven-to-ten day weather forecasts are as accurate as three-to-five day forecasts were 20 years ago. Much of this increase in skill is directly attributable to enhanced satellite observations of the atmosphere from passive sensors. This improvement is a major scientific research and development success that has helped society in a significant way.

In developing the National Spectrum Strategy, we ask that before the U.S. government considers suggesting sharing with passive Earth sensing or operating in adjacent bands to carefully consider how microwave weather instruments work, the observations they collect, and the guard bands and emission limits necessary to ensure there is no contamination of observations with interfering terrestrial or aeronautical emissions. Maintaining and improving weather forecasts is critical as the impacts of climate change are beginning to be seen in more extreme weather events and passive information is critical to improving those forecasts.

Spectrum for Active sensing

The weather enterprise relies upon active sensors such as radars and wind profilers to observe various parameters of the Earth system. These radar sensors are deployed on satellites, ships, aircraft, and ground vehicles, as well as on permanent terrestrial installations, and serve various uses such as measuring sea level rise, studying cloud formation, and identifying oil spills. Perhaps the most well-known active sensors are the 159 NEXRAD doppler radars operated by the National Weather Service (NWS), Federal Aviation Administration (FAA), and DoD, which are critical for near-real-time observation and warning of severe weather, such as tornados, hail, and derechos. The spectrum footprint for these sensors is specific to the physical phenomena they are designed to observe. Active sensors are an area of significant research and advancement, and future technologies such as phased-array radars may have fundamentally different operational characteristics than existing infrastructure. Spectrum regulators should be mindful of both the current and future capabilities of these systems when developing a National Spectrum Strategy.

Spectrum for Communications and Data Dissemination

The weather-water-climate enterprise relies on spectrum allocations for important transmission of environmental data, especially in real time and in emergency situations where there may not be power or internet available, whether in a community facing hurricane landfall or the site of a western wildfire. Such communications spectrum is crucial for data relay from satellites, radiosondes (weather balloons), stream gauges, buoys, and wind profilers - all of which are important information for forecasting that benefits numerous sectors and industries. Key bands employed include C-, L- and X-bands.

The weather-water-climate enterprise relies on real-time data services from NOAA's Geostationary Operational Environmental Satellite (GOES) between 1675 and 1695 MHz for imagery and data necessary for critical early warning of severe weather, floods, and wildfires, as well as important information for marine transportation, aviation, agriculture and numerous other weather-dependent industries. For example, one only needs to look at GOES imagery of severe weather overlaid with the movement of commercial aircraft around the constantly changing atmospheric environment to understand that timely and accurate sensed weather data are essential to aviation.

For example, in the L-band between 1675 and 1695 MHz, hydrologists and meteorologists are reliant on real-time data services from NOAA's Geostationary Operational Environmental Satellite (GOES) to produce critical early warnings of severe weather, floods and wildfires, as well as important information for marine transportation, aviation, agriculture, dam operation, reservoir management, and numerous other weather/climate-dependent industries. These forecasts enable users across industries and affected communities to get timely and accurate information about critical weather hazards, ranging from hurricane track forecasts to flood warning. Consistent, reliable, and timely receipt of geostationary weather satellite data is a necessary element to delivering such important information to the U.S. public.

The hydrology and flood management community is specifically concerned with the delivery of real-time stream gage data and other crucial hydrologic and meteorological information that is transmitted near 1680 MHz and provides high flood risk communities throughout the U.S. and its territories with situational awareness and decision support during flood emergencies.[3] Ground receiving stations reliant on this real-time data are operated and funded by the U.S. Geological Survey (USGS), the U.S. Army Corps of Engineers, the U.S. Bureau of Reclamation, and many regional, state and local water resources and flood control agencies. Across the nation, federal and non-federal agencies work closely together in collecting, sharing, and analyzing this hydrologic data to reduce loss of life, injuries, property damage, school and business closures, and post-flood recovery costs. The sharing of these data at no cost among agencies and users is key. This is only possible due to the common spectrum and government communications system that allows aggregation of these hydrological sensor information into a single federal database. This technology is going to be particularly crucial this spring and summer in California and nearby states in managing snow melt following historic snowfalls due to coastal atmospheric river systems this past winter.

Reliable, accurate, and timely data is imperative for flood warnings, emergency management, operational hydrologic models, water supply management, reservoir operations, and recreation safety. Anything less than real-time information transmitted via the GOES and GOES-R satellites using this spectrum will threaten these important public safety activities.

[3] 18 Mar 2016 filing in RM-11681 Petition for Rulemaking to Allocate 1675-1680 MHz Band for Terrestrial Mobile Use. National Hydrologic Warning Council. https://www.fcc.gov/ecfs/document/60001510131/1

AMS is supportive of the analysis and recommendations within the "Spectrum Pipeline Reallocation 1675–1680 MHz Engineering Study (SPRES) Program Report"[4] released in 2022.[5] The SPRES report, a model assessment for identifying spectrum sharing risks with federal missions, indicates that satellite receivers operated by users of NOAA satellite data would likely incur radio frequency interference (RFI), in the presence of terrestrial downlinks, resulting in loss of data. The consequences of such interference would be harmful and costly.[6] Loss of critical information during a severe weather event would impede the ability of the NWS, DoD, and other federal, state, and local organizations to generate advance warnings, appropriately warn affected populations, and could result in significant property damage and loss of human life.[7] AMS believes the evidence provided in the SPRES report should signal a significant warning of the threat of sharing in this portion of the L-band. The FCC should vacate its efforts to proceed with final rulemaking in the 1675-1680 MHz radio spectrum.

Pillar #2 –Long-Term Spectrum Planning

Working together openly and transparently about spectrum allocation matters is a worthy goal but has not been the reality with recent contentious spectrum debates. As has been noted by the weather-water-climate enterprise in multiple filings to the FCC,[8] [9] open communications with telecommunications companies have been extremely challenging. While limited dialogues have

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[4] U.S. Department of Commerce. National Oceanic and Atmospheric Administration. National Environmental Satellite Data Information Service. Spectrum Pipeline Reallocation 1675–1680 MHz Engineering Study (SPRES) Program Report. Silver Spring, MD: NESDIS, October 2020. (Public release August 2022.) https://files.fcc.gov/ecfs/download/882cc388-9072-444a-bcda-2fa5cc25c458?orig=true&pk=cb77b2ec-1a58-dbc6-139b-ad192cfd5d9b.

[5] 13 Sept 2022 filing in WT Docket No. 19-116, Allocation Rules for the 1675-1680 MHz Band. AMS et al. https://www.fcc.gov/ecfs/document/1091338148923/1

[6] Ibid. p 2.

[7] Ibid. p 3.

[8] 26 July 2021 Reply Comment in ET Docket No. 21-186, Emission Limits in the 24.25-27.5 GHz Band. AMS et al. https://www.fcc.gov/ecfs/document/1072681501910/1

[9] 16 Dec 2016 Letter to Commerce Secretary Pritzker. AMS et al. https://www.ametsoc.org/index.cfm/ams/about-ams/ams-position-letters/joint-letter-to-secretary-of-commerce-pritzker-concerning-possible-sharing-of-satellite-spectrum/

occurred, the telecommunications industry, with its cadre of regulatory attorneys and the resources to engage extensively at both the domestic and international regulatory level, dominates within U.S. regulatory processes.

Scientific societies, and particularly individual scientists, have limited resources to follow and engage highly complex regulatory structures and policies. In addition, government members of scientific societies are limited in their ability to engage in federal regulatory activities as independent citizens. While U.S. spectrum regulators frequently call for public comments on proceedings of interest to the Earth science community, limited comments are filed due to lack of awareness, limited knowledge of regulatory process and RF spectrum policies. Most comments by scientific societies like AMS are assembled by volunteers, which is a significant contrast to those filed by telecommunications companies.

U.S. spectrum regulators need to do more to engage the full range of spectrum users in its proceedings and RFCs. The current processes and structures benefit those who have the most resources to influence the proceedings and have staff in the Washington, D.C. area to regularly engage with such regulators. The FCC should examine who most engages in their proceedings. Do those responses indicate an equitable process that has collected all feedback of potential merit and reached, if not involved, all stakeholders? Of note, there was only one scientific society represented among the speakers at the public sessions for the National Spectrum Strategy - AMS. Given that significant lack of input, what is NTIA doing to specifically engage more scientific stakeholders in this strategy process?

While we appreciate NTIA's sentiment to create a "long-term planning process in which affected stakeholders work together openly and transparently in an ongoing manner," there will need to be significant change to realize such a reality – and NTIA and FCC are encouraged to do more to rebuild trust with Earth science communities.

Recent discussions about meteorological use of passive spectrum near 24 GHz was controversial, highlighting the need for a more inclusive process, a fully informed record with both engineering and scientific evidence, and resources to efficiently and thoroughly conduct studies and testing related to spectrum proposals. For those to be a success, open and honest communications both within and outside government are required to satisfy the science, engineering, business, and legal components of our respective and at times divergent communities. Since FCC Auction 102 happened, the auction winners have not been forthcoming with our community to allow for any coordinated efforts as they test for the beginning of their deployment. FCC and NTIA should promote open communication and incentivize effective sharing of spectrum post auction and intervene to mitigate our valid concerns about harmful interference that will directly impact the accuracy of weather forecasts.

In 2010 the National Academies of Science published a report[10] on passive remote sensing that made specific recommendations on the need for RFI mitigating technology development and called on OSTP to develop a Permanent Representative Technology Advisory Body to identify technical and regulatory opportunities for improving spectrum sharing among all active and passive users, both government and non-government. This still needs to be done. There is a need for greater scientific leadership in government to more effectively integrate spectrum-related scientific research to inform the spectrum allocation process at the most senior level.

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[10] National Academies of Science Engineering and Medicine. Spectrum Management for Science in the 21st Century (2009) https://nap.nationalacademies.org/catalog/12800/spectrum-management-for-science-in-the-21st-century

There also needs to be additional scientific staff resources at both NTIA and FCC to enhance and ensure greater understanding of scientific uses of spectrum amongst regulators. We believe this was one of the major stumbling blocks that has led to past disputes. There are robust and highly respected scientific fellowship programs that place PhD level scientists into federal agencies, such as the American Association for the Advancement of Science (AAAS) science and technology policy fellows (STPF) program. Both the FCC and the NTIA need to engage in these programs and bring such scientific fellows on their staffs as soon as possible to both inform and implement the National Spectrum Strategy. This should also lead to the eventual appointment of Chief Science Officers at both agencies.

Pillar #3 – Unprecedented Spectrum Access and Management through Technology Development

The weather-water-climate enterprise has a long history of innovation and consistently improving weather and environmental forecasting through the development and implementation of new computing and observing technologies to improve models, which save lives and benefit the economy. But innovation takes time, effort, and resources. Science innovation is hindered when regulatory decisions are made without a fully informed science-based record and unjustified expectations that innovation will emerge when harmful interference occurs. Innovation cannot emerge without coordination, and given the past experience of the 24 GHz auction and U.S. delegation positions at WRC-19, it is too optimistic to expect innovation to emerge at the time of deployment. Science innovation requires thoughtful investments and effort over time. More studies are needed that involve coordination between all relevant parties to determine under real-world conditions whether sharing is at all feasible in areas adjacent to meteorological passive spectrum and other science-related and science-supporting allocations.

There is a critical need to invest in technologies and studies to be able to better characterize the nature and impact of interference on microwave observations and numerical weather prediction (NWP) that use microwave observations as an input. One way to do this is by conducting Observing System Experiments (OSEs) which evaluate the impact of observations on numerical model outputs.[11] For example, in an OSE, a NWP model could be configured to omit certain observations from passive microwave instruments. Omitting observations or eliminating a certain percentage of observations from near 23.8 GHz or decreasing the quality of the observational data with noise that increases the error, would provide some indication of the impact of harmful interference on past weather predictions. An OSE, known as a data denial experiment, that the ECMWF in Reading, UK, conducted plainly showed the impact of eliminating observations from polar orbiting satellites on the prediction of Hurricane Sandy because, without the polar satellite data, Sandy headed towards Europe, a stark contrast from the actual forecast – and outcome.[12]

It would be useful to the broader weather-water-climate enterprise for the National Weather Service to have an "on demand" OSE capability for operational NWP models such as the Global Forecast System (GFS). But such a capability is expensive in both computational and human resources. These types of studies could best value the current observations and therefore spectrum allocations for Earth system science, and significantly improve the timely responsiveness to rising spectrum issues. For example, with regular investments in supercomputing and scientists at NOAA, OSEs could be run if one or more passive channels are at risk of contamination, to determine if interference in one band limits or eliminates the application of passively sensed environmental observations for NWP.

[11] Zeng et al. "Use of Observing System Simulation Experiments in the United States." Bulletin of the American Meteorological Society. 2 Sep 2020. P E1427–E1438. https://journals.ametsoc.org/view/journals/bams/101/8/bamsD190155.xml#:~:text=An%20observing%20system%20simulation%20experiment,observational%20data%20are%20not%20available.
[12] Freedman, Andrew. "Sans Polar Satellites, Sandy Forecasts Would've Suffered." Climate Central. 12 Dec 2012. https://www.climatecentral.org/news/sans-polar-satellites-hurricane-sandy-forecasts-would-have-suffered-15347

In addition, more specialized instrumentation that accompanies passive microwave radiometers to observe the RF environment is another valuable capability in a future spectrum landscape that more heavily relies on sharing to meet all spectrum user needs.

These efforts take considerable resources by government science agencies and their stakeholders. Directing existing appropriations from science agencies to spectrum mitigations would diminish the ability of agencies to deliver scientific research and conduct operations central to their mission. To better understand and fully characterize the impact of contamination of passive microwave observations on weather forecasting, the Spectrum Pipeline Fund needs to be modified to fund certain complex key science technologies and applications to address the impact of spectrum sharing before further spectrum allocation decisions erode the ability to conduct atmospheric sensing. The technologies ("on demand" OSE supercomputer and RF detection technologies for passive instruments) have high potential to protect the most critical spectrum for hazard monitoring but also, potentially enable more unique, well informed, expedient, and less controversial sharing arrangements.

In conclusion, AMS appreciates the opportunity to comment on the National Spectrum Strategy and we look forward to the opportunity to engage further in this process in a future one-on-one session with NTIA to further speak to the points made in these comments.

Sincerely,

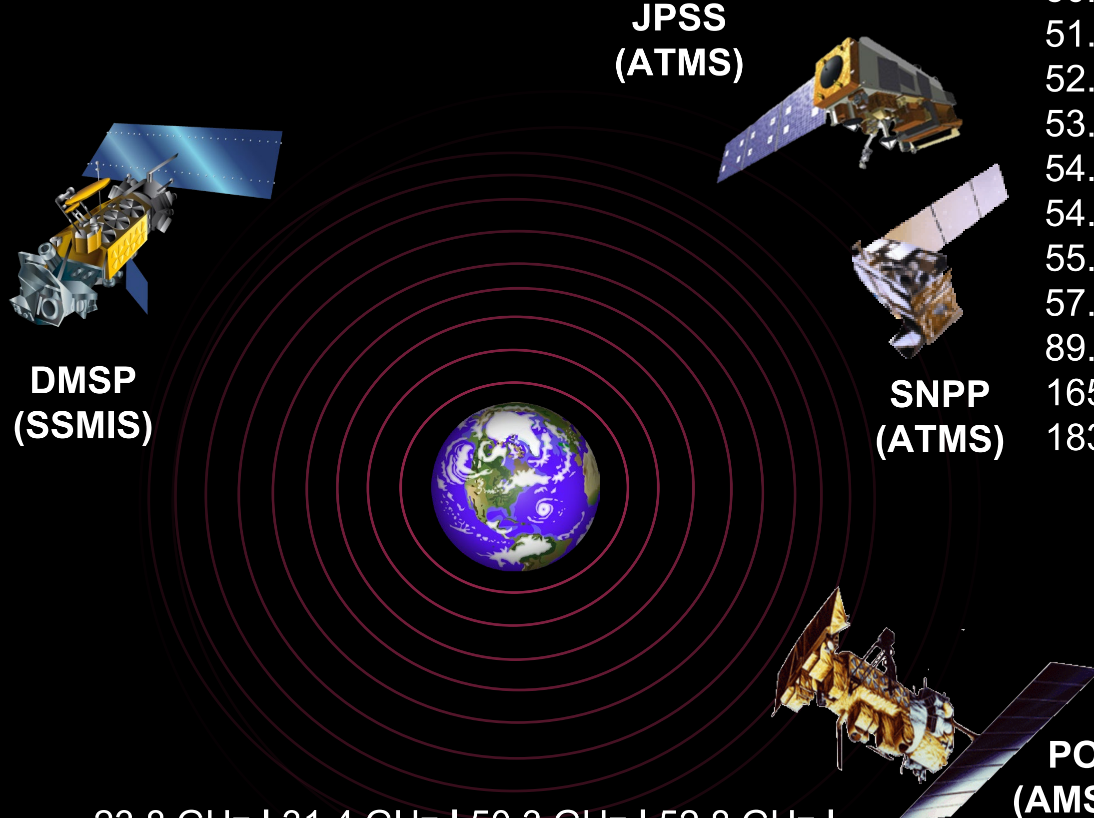
Stella Kafka, PhD

Executive Director & CEO

Attachment 1: Radiometers on U.S. Operational Environmental Satellites and Passive Spectrum Used

Radiometers on U.S. Operational Environmental Satellites

19.350 GHz
22.235 GHz
37 GHz
50.3 GHz
50.5 GHz
52.8 GHz
53.2 GHz
53.596 GHz
54.35 GHz
54.4 GHz
54.9 GHz
55.5 GHz
57.290 GHz
58.4 GHz
58.825 GHz
59.4 GHz
60.793 GHz
63.283 GHz
91.655 GHz
150 GHz
183.31 GHz



23.8 GHz
31.4 GHz
50.3 GHz
51.76 GHz
52.8 GHz
53.596 GHz
54.4 GHz
54.94 GHz
55.5 GHz
57.290 GHz
89.5 GHz
165.5 GHz
183.31 GHz

23.8 GHz | 31.4 GHz | 50.3 GHz | 52.8 GHz |
53.596 GHz | 54.4 GHz | 54.94 GHz | 55.5 GHz | 57.290 GHz |
89 GHz | 157 GHz | 183.31 GHz | 190.311 GHz