ATTACHMENT

NASA COMMENTS

National Aeronautics and Space Administration
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February 27, 2024

Reply to Attn of: Space Operations Mission Directorate

Mr. Charles Cooper
Associate Administrator
National Telecommunications and
Information Administration
U.S. Department of Commerce
14th and Constitution Avenue, NW
Washington, DC 20230

SUBJECT: NASA Review and Comments on the Federal Communications Commission Notice of Proposed Rulemaking to Modify Emissions Limits for the 24.25-24.45 GHz and 24.75-25.25 GHz Bands

The National Aeronautics and Space Administration (NASA) appreciates the opportunity to review the Federal Communications Commission (FCC) Notice of Proposed Rulemaking for Modifying Emissions Limits for the 24.25-24.45 GHz and 24.75-25.25 GHz Bands contained in FCC 23-114 (ET Docket No. 21-186) and provides the following comments. As discussions continue to establish additional spectrum access, policies, and procedures to meet the increasing demand to support commercial mobile telecommunications services in the United States, NASA values the FCC's measured and careful approach. This provides spectrum access to meet the commercial industry's requirement for access while protecting existing federal uses and providing avenues for continued collaboration.

NASA acknowledges supporting and promoting the commercial mobile telecommunications industry facilitates domestic economic growth and sustainment of United States global technological leadership. NASA notes such support requires the appropriate balance to meet the needs of the commercial industry with the needs of the federal agencies and their respective missions supporting space research, climate study, weather forecasting, management of the airspace, and national defense, amongst many others. In the case of this proceeding, a four-year intensive study cycle resulted in power limits for mobile broadband operations agreed globally upon at the 2019 International Telecommunication Union (ITU) World Radiocommunication Conference (WRC-19).

NASA supports direct implementation of the relevant outcomes from WRC-19, without modification, related to the protection of Earth Exploration-Satellite Service (passive) systems operating in the 23.6-24.0 GHz band. However, the NPRM also inquires about certain elements that were not considered during the WRC-19 study cycle and opens opportunities for additional study which may delay commercial access into the band. NASA identifies these elements below, as well as comments to the Proposed Rules from Appendix A.

- **Paragraph 18 (page 8) – Indoor Small-Cell Operations**
  Indoor small-cell operations (both base stations and user equipment) should not be exempt from the Resolution 750 limits. Although indoor operations may provide additional signal blockage (i.e.- attenuation) of those signals to NASA's Earth Exploration-Satellite Service (passive) sensors, this issue was not studied during WRC-19 to determine the potential impact from indoor small-cell operations to NASA missions. As demonstrated by the revision of the 5150-5250 MHz band Unlicensed National Information Infrastructure rules, indoor only use limitations remain extremely difficult to enforce. Without adequate technical study results, NASA experts consider that even a very small amount of hardware operating in this manner may pose impacts to NASA mission success.

- **Paragraph 24 (page 10) – Modified or Replaced Phase 1 Deployed Systems Required to Meet 2027 Emission Limits**
  NASA concurs with the two-phased approach for implementing the unwanted emission limits to provide immediate access for the commercial telecommunications industry while allowing adequate time for research and development of newer systems to meet the more stringent limits. However, as commercial deployment grows, the aggregation of unwanted emissions from both phase 1 and phase 2 deployments increase the risks of harmful interference to NASA's science capabilities.

  To reduce these risks, NASA recommends that systems deployed during phase 1 and those which are modified or replaced after September 1, 2027, conform to the stricter unwanted total radiated power (TRP) limitations. This includes any physical or electrical modifications to the systems. Maintenance personnel already visiting the site provides an opportunity for equipment to be replaced, reducing burden on the commercial licensees. This approach ensures that network providers cannot operate under the relaxed unwanted TRP limitations indefinitely.

- **Paragraph 25 (page 11) – Proposal to Permit Use of Conductive Power Measurements**
  NASA recognizes, in certain situations, TRP and conductive power measurements may be interchangeable methodologies to determine unwanted emissions, particularly for the protection of active communication systems. However, for Earth observations using Earth Exploration-Satellite Service (passive) sensors, TRP should be the only methodology used to measure unwanted emissions. Conductive power methodology should not be used as they do not provide an accurate depiction of the aggregate effects. These two approaches may produce very different quantitative limits for unwanted emissions in this situation. Furthermore, all domestic and international WRC-19 studies considered unwanted TRP. Considering an alternate approach to protect space-based passive sensors requires significant further technical analysis which would unnecessarily delay licensees' ability to begin deployments.

  All stakeholders clearly understand TRP for all system types ranging from those with a single transceiver and a single antenna to those with many transceivers and many antennas (e.g., Active Antenna Systems (AAS)). Conversely, conductive power limitations may introduce ambiguity in the case of complex systems as there have been significant debates on whether these limitations apply to the conducted power for the entire system (i.e., the sum of all elements) or solely for a single element. The debate in ITU-R Working Party 5D during the WRC-23 cycle on the correct application of Article 21.5 demonstrates this lack of consensus. Using TRP as the exclusive methodology for calculating unwanted emissions in this situation eliminates ambiguity regarding limit conformance.

- **Appendix A – Proposed Rules (page 19)**
  Regarding the proposed new footnote USxxx and revisions to Part 30 of the FCC Rules, NASA recommends the following editorials for clarity. First, USxxx should be modified to indicate that that the unwanted emission limitation(s) are determined based on system modification date, inclusive to the bringing-into-use date. Additionally, the before/on date should be explicitly provided to avoid any confusion on when or how to apply the limitations. Lastly, rather than replicating the new USxxx text into Section 30.203, it would be more efficient to simply state the unwanted TRP limitations in USxxx also apply to UMFUS licensees:

    - Clean version:

      (146) USxxx Stations operating in the mobile service in the bands 24.25-24.45 GHz or 24.75-27.5 GHz shall not exceed the following unwanted total radiated power (TRP) limitations in any 200 MHz of the band 23.6-24 GHz: if brought into use or modified before or on September 1, 2027, -33 dBW/200 MHz for base stations and -29 dBW/200 MHz for mobile stations; if brought into use or modified after September 1, 2027, -39 dBW/200 MHz for base stations and -35 dBW/200 MHz for mobile stations.
      …
      § 30.203 Emission Limits.
      (d) (1) In addition to the limits noted above, for licensees operating mobile equipment in the 24.25-24.45 GHz or 24.75-25.25 GHz bands, the unwanted total radiated power limitations in USxxx also apply.

    - In-line revision proposal version:

      (146) USxxx ~~In~~ Stations operating in the mobile service in the bands 24.25-24.45 GHz ~~and~~ or 24.75-27.5 GHz shall not exceed the following unwanted~~,~~ ~~the~~ total radiated power (TRP) ~~of emissions from stations in the mobile service~~ limitations in any 200 MHz of the band 23.6-24 GHz: if brought into use or modified before or on September 1, 2027, ~~shall not exceed~~ -33 dBW/200 MHz for base stations and -29 dBW/200 MHz for mobile stations;~~,~~ ~~and for stations~~if brought into use or modified after September 1, 2027, ~~TRP shall not exceed~~ -39 dBW/200 MHz for base stations and -35 dBW/200 MHz for mobile stations.
      …
      § 30.203 Emission Limits.
      (d) (1) In addition to the limits noted above, for licensees operating mobile equipment in the 24.25-24.45 GHz or 24.75-25.25 GHz bands, the unwanted total radiated power ~~of emissions in any 200~~limitations in USxxx also apply. ~~MHz of the 23.6-24.0 GHz band shall not exceed -33 dBW (for base stations) or -29 dBW (for mobile stations).~~
      ~~(2) For mobile equipment placed in service after September 1, 2027, the total radiated power of emissions in any 200 MHz of the 23.6-24.0 GHz band shall not exceed -39 dBW (for base stations) or -35 dBW (for mobile stations).~~

Once again, thank you for the opportunity to provide comment on this critical proceeding.

Lynna McGrath

Lynna H. McGrath
NASA

ATTACHMENT

NOAA COMMENTS

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ATTACHMENT

Comments on the Notice of Proposed Rulemaking

FCC 23-114

Released December 22, 2023

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Response to Questions in the Identified Paragraphs

1. THE COMMISSION SHOULD ALIGN ITS RULES WITH THE WRC-19 LIMITS ON EMISSIONS FROM ACTIVE OPERATIONS IN THE 24.25 – 25.25 GHZ BAND INTO PASSIVE SENSING IN THE 23.6 -24.0 GHZ BAND

Paragraph 10: National Oceanic and Atmospheric Administration (NOAA) agrees that the commission should adopt the Resolution 750 unwanted emissions limits adopted at 2019 World Radiocommunications Conference (WRC-19), to apply them to all mobile systems in the 24 GHz band, and to incorporate those limits into the commission's part 30 technical rules as well as codifying them in a new US footnote to the Table of Frequency Allocations (Allocation Table). While the WRC-19 OOBE limits were a delicate compromise and may be adequate, DOC believes that stricter limits would better protect Earth Exploration-Satellite Service (EESS) passive sensors in the 23.6-24.0 GHz band as potential harmful interference is highly dependent on mobile wireless deployment density. We find that the proposed rules may negatively impact NOAA's meteorological satellite mission operations if Phase 1 deployment density is meaningfully higher than expected. For that reason, we believe Phase 2 OOBE emission limits are preferable and we should accelerate adoption of Phase 2 limits.

2. THE COMMISSION REQUESTED INPUT TO QUANTIFY THE BENEFITS OF THESE LIMITS, FROM THOSE PARTIES THAT SUPPORT ADOPTING THE RESOLUTION 750 LIMITS

Paragraph 11: The NPRM asks, *"We ask parties that support adopting the Resolution 750 limits to quantify the benefits of these limits."*

To quantify the benefit of the out-of-band emission (OOBE) limits, one must understand what the measurements in the adjacent passive band (23.6 – 24.0 GHz) are used for, and how such data are gathered.

Use of 23.6 – 24.0 GHz Data

The National Weather Service (NWS) relies upon numerical weather prediction models (NWP) to develop computer simulations of the atmosphere. A global model, such as one might see on a television or internet weather forecast, covers the entire planet. The models use the information on current weather conditions as a starting point to solve complex mathematical equations on supercomputers to project the state of the atmosphere in the future.

NOAA's NWS uses these data from 23.6-24.0 GHz to infer the amount of cloud content in the observations so that other microwave channels may be screened for cloud content or for cloudy radiance assimilation.

Passive microwave observations from space provide information about atmospheric temperature, water vapor, cloud liquid water, ice water content, precipitation (rain and snowfall rate), ocean water salinity, ocean surface winds and soil moisture. The specific channel measured from 23.6 – 24.0 GHz is used in concert with other channels to measure total precipitable water (TPW) and contains data on cloud,

surface parameters and surface emissivity. (Precipitable water is the depth of water in a column of the atmosphere, from the surface to space, if all water in that column were precipitated as rain.) These data from the 23.6 – 24.0 GHz channel are used to acquire the atmospheric profile of water vapor.

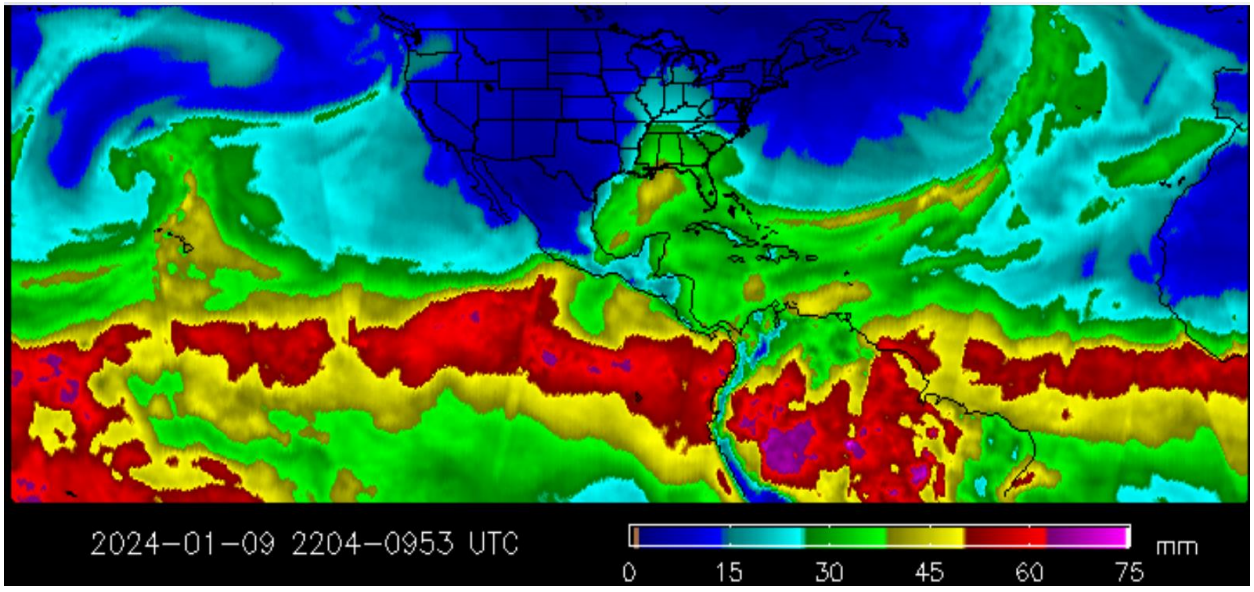

Figure 1: Blended Total Precipitable Water (TPW) Product

Forecast meteorologists use the TPW value and the other outputs from NWP, that utilize the 23.6 – 24.0 GHz measured data, to characterize where water vapor resides within the atmosphere and to help forecast heavy rain and flooding over the United States. Forecasts developed from these data are used to plan for extreme weather.

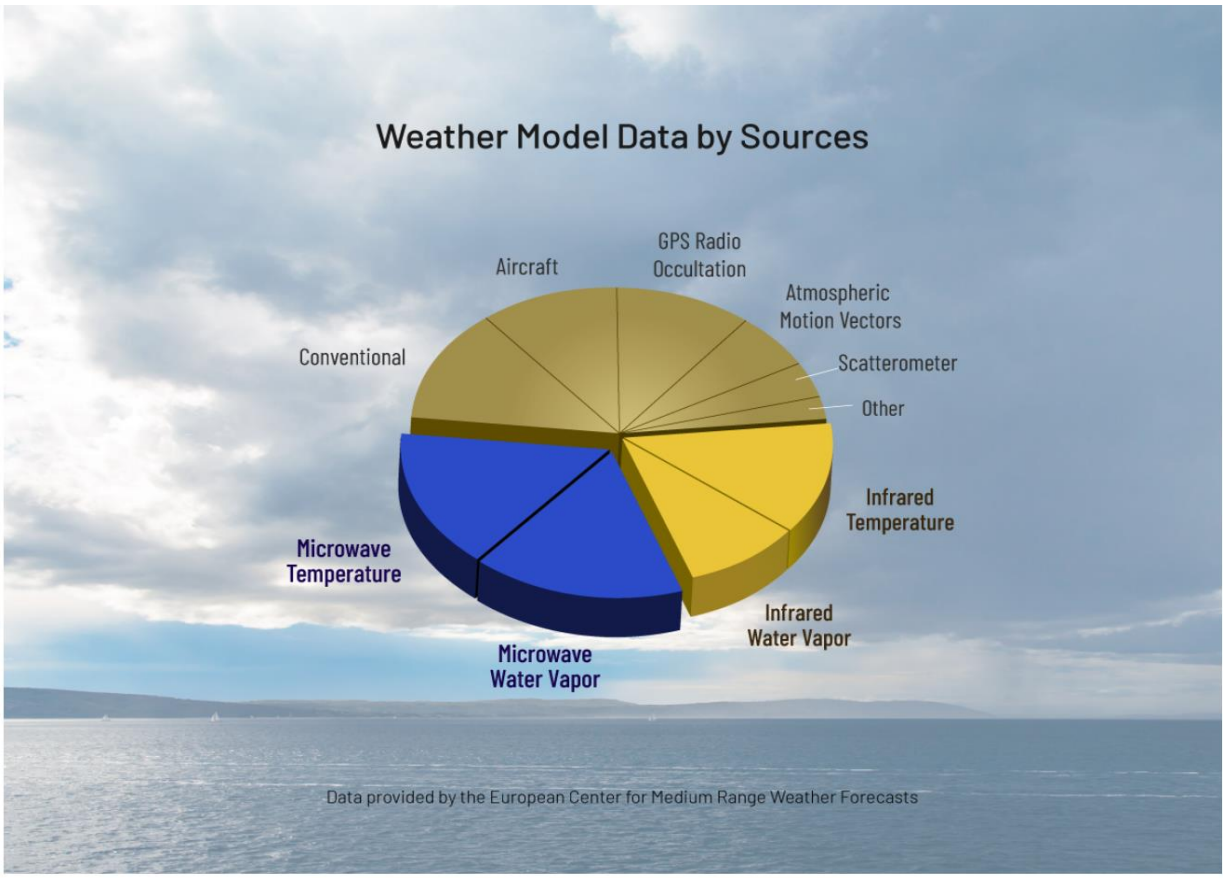

Figure 2: Passive Microwave Measurements are a Large Contributor to NWP Inputs [NOAA NESDIS][1]

One specific example using TPW would be the atmospheric river-induced heavy rains in January 2021 that unleashed damaging mudslides down California slopes, which had been stripped bare of vegetation by wildfires months earlier. Flowing mud and debris smashed into homes and washed a 150-foot section of Highway 1 into the Pacific Ocean.[2]

[1] https://www.nesdis.noaa.gov/our-satellites/currently-flying/joint-polar-satellite-system/advanced-technology-microwave-sounder-atms

[2] https://www.nesdis.noaa.gov/our-satellites/currently-flying/joint-polar-satellite-system/advanced-technology-microwave-sounder-atms

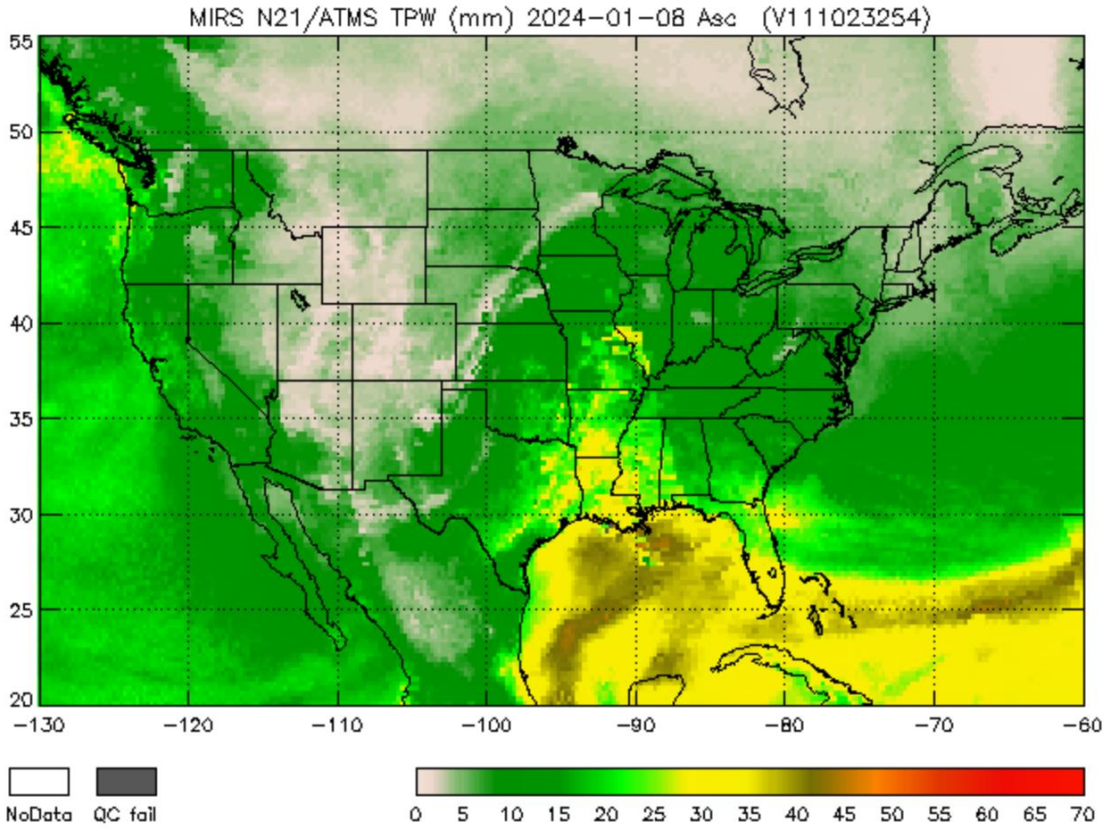

Figure 3: TPW Over the United States from NOAA 21 on 08 Jan 2024

A blend of measurements from multiple satellites, provide these data to NOAA from 23.6 – 24.0 GHz: NOAA satellites 19 & 20, NOAA/NASA's Suomi National Polar Partnership (S-NPP), Europe's MetOP-B and Sentinel-3, Japan's GCOM-W1, and NASA's Global Precipitation Mission (GPM) and AQUA[3]. NOAA either obtains these data from their own satellites or via data sharing agreements with partner nations to allow them to forecast over the United States. This international cooperation makes it even more important to minimize interference to the EESS sensors on a global basis.

Underserved and vulnerable communities may be adversely impacted by contamination of passive bands, leading to degraded forecasts or delayed / diminished warnings for severe weather. If input data that are assimilated into numerical weather prediction models, are impacted to the extent that the meteorological products suffer, and if high-density installations of base stations are assumed to be a more likely source of unwanted, out-of-band emissions, then this suggests terrestrial systems in the urban core or in proximity to outdoor open-air sports facilities could be areas of increased unwanted emissions. Forecast errors or inaccuracies might foster themselves in these regions, impacting data assimilation of more precise initial conditions for the models. Information "gaps" in the resultant models, could propagate this erroneous information to new locations in the next few days; thus, also exhibiting inaccuracies.

[3] The CORF comment posted June 25, 2021, during the 2021 FCC Public Notice proceeding (OET 21-186) contains a more complete list of satellites that make passive measurements in the 23.8 GHz Band.

Flooding or extensive snowfall could impact underserved and vulnerable communities. Storm surge induced flooding may disproportionately impact underserved and vulnerable communities. During Hurricane Katrina (August 2005, New Orleans), the media covered the disproportionate damage in the city's ninth ward. Quoting the National Hurricane Center's Tropical Cyclone Report for Hurricane Katrina[4], *"As the level of Lake Pontchartrain rose, several feet of water were pushed into communities along its northeastern shore in St. Tammany Parish from Slidell to Mandeville, Louisiana. High water mark data indicate the storm surge was 12 to 16 ft in those areas. The surge severely strained the levee system in the New Orleans area. The surge overtopped large sections of the levees east of New Orleans, in Orleans Parish and St. Bernard Parish. Overall, about 80% of the city of New Orleans flooded, to varying depths up to about 20 ft, within a day or so after landfall of the eye. These studies indicate that Katrina was responsible for a total of nearly 1400 combined direct and indirect fatalities. Presumably, most of the deaths in Louisiana were caused by the widespread storm surge induced flooding and its miserable aftermath in the New Orleans area."*

Climate change also exhibits disproportionate impact on underserved and vulnerable communities, because it contributes to the escalating frequency and severity of extreme weather events, as noted in numerous scientific studies and official reports. Amidst the escalating crisis, safeguarding critical weather forecasts and climate data gains heightened significance. The 23.6 – 24.0 GHz band is a vital component for passive microwave water vapor retrievals. And as we have described above, data from this band is used in concert with other passive-band derived datasets. These data play a pivotal role in ensuring the accuracy of precipitation forecasts and the timely prediction of flooding events, providing communities with the necessary tools to prepare for and respond to the impacts of extreme weather.

If the Commission fails to establish viable emission limits in this crucial passive band, it not only jeopardizes the accuracy of indispensable data but compounds the vulnerabilities of underserved communities already grappling with the severe consequences of climate change. The protection of the 23.6 – 24.0 GHz band (as well as others) is not merely a technical necessity; it is an ethical imperative to fortify the nation's resilience against climate-related changes and severe weather events and to safeguard vulnerable populations from exacerbated risks and unnecessary economic burdens.

Moreover, the EPA Social Vulnerability Report[5] emphasizes that the adverse effects of climate change are not distributed equally. Underserved communities, often lacking the financial resources and infrastructure necessary for effective preparedness and recovery, bear a disproportionate burden. Unnecessary evacuation orders resulting from compromised weather data due to unwanted emissions in the 23.6 – 24.0 GHz band add another layer of hardship to these already marginalized populations. Alternatively, failure to issue evacuation orders to the correctly affected population when it is truly necessary could lead to substantial loss of life and property.

Safeguarding passive frequency bands, such as 23.6 – 24.0 GHz, is not only about providing equitable access to digital technologies for underserved populations, or protecting accurate weather forecasts,

[4] Richard D. Knabb, Jamie R. Rhome and Daniel P. Brown, Tropical Cyclone Report, Hurricane Katrina, 23-30 August, 2005, NOAA National Hurricane Center, updated 4 January 2023.
https://www.nhc.noaa.gov/data/tcr/AL122005_Katrina.pdf

but also about addressing the broader issues of environmental justice. It is an essential step in mitigating the disproportionate impact of severe weather and climate change on vulnerable communities, ensuring that they are not further marginalized by avoidable economic burdens associated with unnecessary actions or evacuations.

Impact of OOBE to the 23.6-24.0 GHz Band

Presentations on the degradation of the 23.6 – 24.0 GHz channel due to out-of-band interference show examples such as the impact on estimation of TPW over land during Hurricane Harvey in August 2017.[5] Experiments conducted by NWS concluded that TPW measurements will be degraded by 14 to 51% in data not available due to Radio-Frequency Interference (RFI).

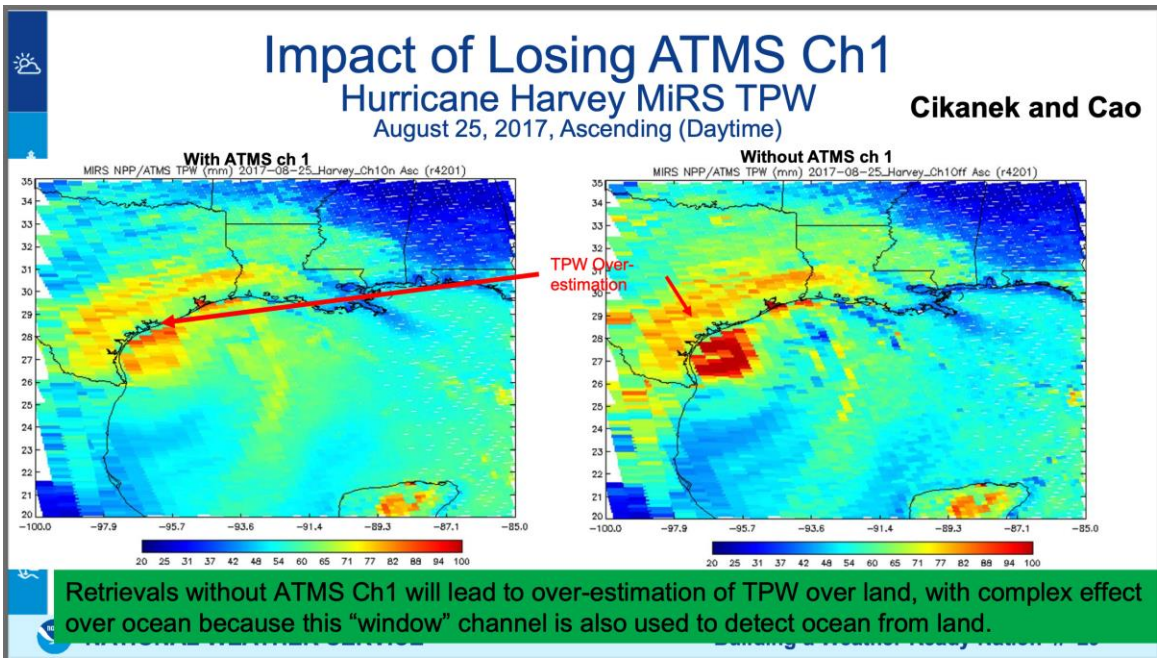

Figure 4: Removing 23.8 GHz Data due to Contamination Causes TPW to be overestimated

Benefit of Adopting OOBE Limits

Microwave instrument data from NOAA's Joint Polar Satellite System (JPSS) rely on measurements from 23.6 – 24.0 and 31.3 – 31.5 GHz to derive water content in the atmosphere to include prediction of precipitation and to achieve accuracy by adjusting for signal absorption due to humidity.

"Satellite measurements in the microwave bands play the key backbone role for the high quality of weather forecasts achieved in current [NWP] systems. A loss or degradation in the quality of the

[5] Collard, Andrew; Quanhua (Mark) Liu, Emily Liu, Daryl Kleist, "The Potential Impact of RFI on the Assimilation of Microwave Radiances at NCEP," Radio Frequency Interference Workshop, 2022, ECMWF. https://events.ecmwf.int/event/258/contributions/2885/attachments/1565/2804/RFI2022_Collard.pdf

forecasts which are necessary for a wide range of economic activities as well as the safety of modern societies. The areas affected by a loss or degradation of microwave observations include:

- Daily weather forecast
- Flood and storm damage warning and mitigation, public safety
- Severe storm forecasts (including tornados, hurricane), public safety
- Transport and logistics by road and rail, shipping and particularly aviation
- Energy, including the large and increasing renewable energy contribution
- Agriculture
- Tourism
- Public health, including air quality monitoring and forecasts
- Climate change monitoring
- Diverse business applications (including e.g. building [construction] industry
- Defense services and military operations, training and planning
- Providing early warning signs for famine over large areas
- Private households."[6]

How Such Data Are Gathered

Sounding measurements from microwave radiometers are the largest contributor to the NWP model data inputs. These radiometers are not radio receivers and protection criteria developed using communications engineering approaches would be woefully inadequate to protect these extremely sensitive instruments. "It detects weak power levels emitted from Earth or the atmosphere. These signals manifest themselves as variations of the noise floor. *Unwanted by-products from a 5G signal that falls within the frequency range detected by the weather satellite could raise the noise floor, masking the values of interest to the satellite or confusing the sensor.* There is no current method to separate the unwanted interfering signals from the desired natural signal. The microwave sensor, which measures the total power received, would not know the data had been contaminated by the operations of the 5G communications infrastructure."[7]

These natural emissions from which this vital information is derived are exceptionally weak and vulnerable to rather low levels of adjacent band interference, and therefore appropriate protection levels are necessary. Furthermore, data processing techniques do not exist to discern satellite observations containing non-natural signals except in extreme cases. The result is that uncertainty in the radio frequency environment results in a greater uncertainty in the quality of the observations collected, a lesser weight in the NWP models, and depending on the presence of other compensating observations, potentially a less constrained (less reliable) weather forecast.

[6] Final report, Radio-Frequency Interference (RFI) Workshop, 13-14 September 2018, "European Centre for Medium-Range Weather Forecasts," https://www.ecmwf.int/sites/default/files/elibrary/2019/19026-radio-frequency-interference-rfi-workshop-final-report.pdf

[7] David G. Lubar, David B. Kunkee, and Lina M. Cashin, and Susan Avery, The Aerospace Corporation: "Developing a Sustainable Spectrum Approach to Deliver 5G Services and Critical Weather Forecasts," January 2020. https://csps.aerospace.org/sites/default/files/2021-08/LubarKunkee_DevelopingSustSpectrum_20200109_web.pdf

Microwave sounder instruments used for space-based passive measurements feature moderately large coverage areas, scan types, and dwell durations that often encompass multiple cycles of operation in a wireless broadband system.

The footprint of the Cross Track-scanning instrument used on JPSS, when pointed straight down, has a diameter of approximately 50 miles. As each satellite in JPSS orbits, the microwave sensing instrument swath is approximately 1400 miles wide.

The instrument can measure the power of emissions within its footprint with a sensitivity of about 0.1 Kelvin. Considering a radiometer instrument that is measuring upwelling emission from the surface of the Earth over a nominal bandwidth of 200 MHz, this sensitivity is equivalent to identifying a change in power input to the instrument of $\sim k\Delta TB$ where $k = 1.38 \times 10^{-23}$ J/K, ΔT=0.1 K, and B is the radiometer bandwidth. Assuming a nominal radiometer bandwidth of 200 MHz, 0.1 K is then equivalently ~ 2.76×10^{-16} Watts or -125.6 dBm at the receiver input. This is a very low value when considering adjacent band compatibility. Note that this is an average value over the integration time, or equivalently the 'dwell' time (up to ~18 ms) that the radiometer performs its measurement. The variability of potentially interfering waveforms may need to be considered accordingly.

The most dangerous form of contamination of passive bands from OOBE would be insidious contamination, as seen in figure 5 below. Note the NEΔT value of 0.1 Kelvin on the right side of the chart.

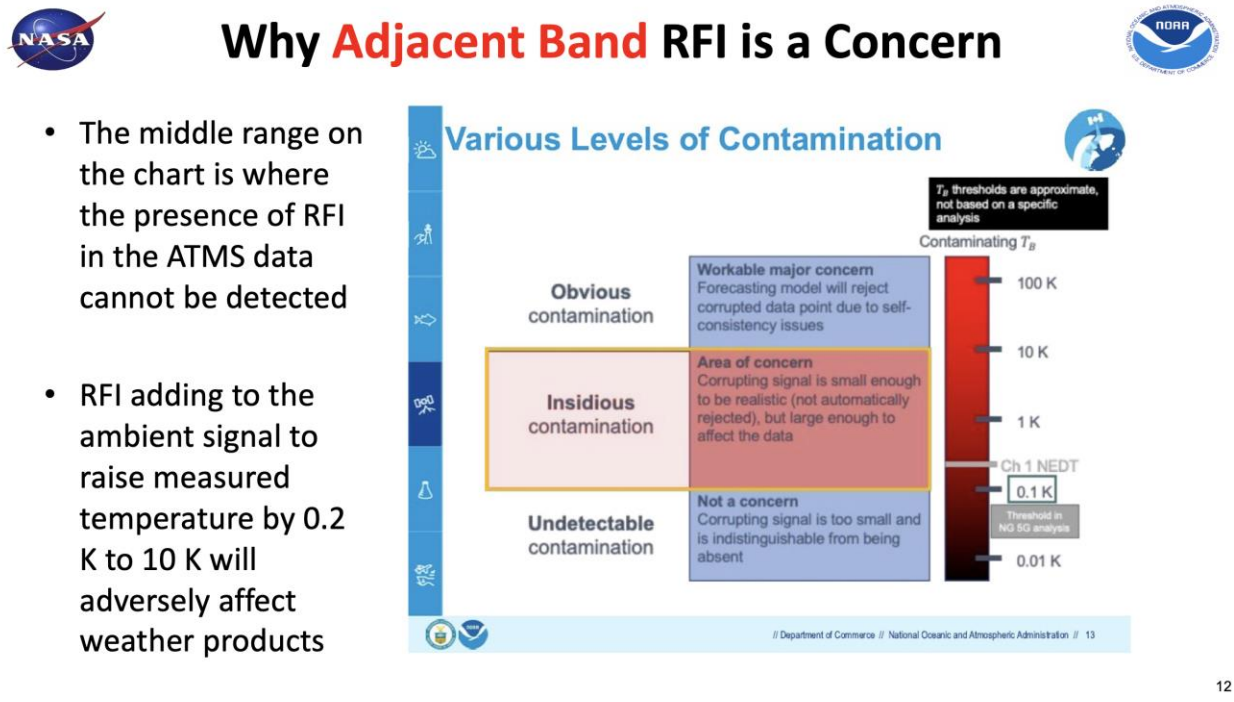

Figure 5: OOBE Raising the Ambient Signal by 0.2 to 10 Kelvin Will Adversely Affect Measurements

CORF argued in its 2021 filing that the Resolution 750 limits may not be adequate. Depending on how many broadband transmitters have upwelling emissions within the 75 km diameter footprint will

determine whether a given value is adequate. As seen in the figure below, the x-axis has transmitter density per square kilometers on a log scale; the y-axis is the exceedance threshold of undesired OOBE from adjacent band operations. The practical interference threshold is 0.1 x NEΔT.

Considerable analysis was undertaken by NASA and NOAA in 2019 and 2020 looking at a suitable protection level for the adjacent 23.6 – 24.0 GHz passive band. It is feasible that the most stringent limits (e.g., -39 dBW for base stations and -35 dBW for mobile) selected by WRC-19 might not prevent adjacent band contamination in all cases. However, the WRC-19 limits were a compromise, selected by the WRC for inclusion into the Radio Regulations, and those stringent limit values are what most countries are considering.

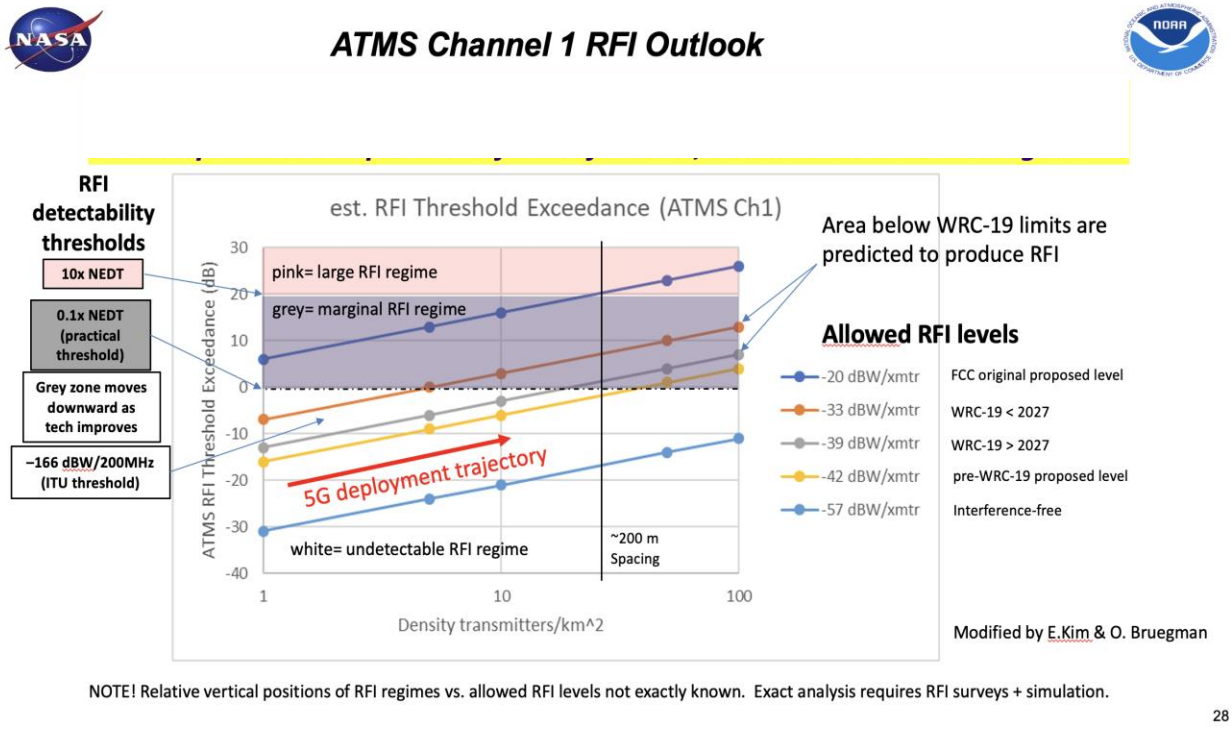

Figure 6: Passive Channel Exceedance in 23.6-24.0 GHz versus Various OOBE Limits

3. THE COMMISSION SHOULD URGE OR PROVIDE INCENTIVES FOR LICENSEES TO MEET THE MORE STRINGENT WRC-19 OOBE LEVELS BY 1 SEPTEMBER 2027 OR EVEN BEFORE 2027 – AND AS SOON AS REASONABLY POSSIBLE

Paragraph 19: The NPRM states, *"We propose to apply the new Resolution 750 unwanted emissions limits on the timeframes adopted at WRC-19…. We seek comment on this proposal."*

Paragraph 21: The NPRM states, *"We seek comment on the feasibility and appropriateness of accelerating the deadline for compliance with the Phase 2 standards."*

We see merit in the general idea of accelerating the deadline for compliance with the Phase 2 standards, as was done in the European Union (EU). The current perceived, slow rollout of high-density outdoor installations in the lower portion of the 24 GHz band means that there may be very limited impact to operators adopting the accelerated deadline for compliance with the Phase 2 Standards. It should be noted that the EU's more stringent limit of -39 dBm went into force on January 1, 2024. The ECC decision stated *"CEPT agreed on an earlier date of 1 January 2024 as transition from initial limits to the final limits, to avoid the risk of interference to EESS (passive) from large-scale MFCN deployments and to provide regulatory certainty and a clear signal to industry of the target to develop solutions.[8]"*

4. THE COMMISSION SHOULD CLARIFY THAT BASE STATION AND USER EQUIPMENT THAT HAS BEEN INSTALLED TO MEET THE -13 DBM/MHZ STANDARD SHOULD BE EITHER MODIFIED TO MEET THE FINAL STANDARD OR REMOVED AND REPLACED

Paragraph 4: The NPRM states, *"Among other things, the UMFUS rules specify that emissions outside of a licensee's assigned frequency block must be limited to -13 dBm/MHz. With respect to the passive systems operating in the 23.6 – 24.0 GHz band, the Commission noted that ongoing international studies included analyses to determine International Mobile Telecommunications (IMT) unwanted emissions limits necessary to protect passive sensors, and it acknowledged that the Commission's UMFUS rules might be revisited once these international studies had been completed."*

Any upwelling emission, such as reflections (from an IMT system) off local terrain, buildings or the ground, would exceed the NEΔT detection threshold of a space-based radiometer with even a single signal with the footprint of an instrument within a square kilometer. Note the dark blue line in Figure 6, representing UMFUS operations with a -20 dBW per 200 Mhz level (e.g., -13 dBm/MHz) falls completely within the gray and pink areas of the chart all which exceed the NEΔT detection threshold even at low density. Any systems that have already been installed with an OOBE level into the 23.6 – 24.0 GHz passive band of -13 dBm/MHz should be removed or their emission levels be reduced to the Resolution 750 values.

5. THE COMMISSION SHOULD PROHIBIT THE GRANT OF NEW EQUIPMENT CERTIFICATIONS THAT DO NOT MEET THE MORE STRINGENT RESOLUTION 750 VALUES AFTER MARCH 1, 2027

Paragraph 20: The NPRM discusses the Commission's equipment authorization program for RF devices. "*… we seek comment on whether we should prohibit the grant of new equipment certifications for, or the importation of, equipment not complying with the phase two unwanted emission limits at a date prior to September 1, 2027. For example, we could cease granting new equipment certifications or permitting*

[8] Electronic Communications Committee (ECC), European Conference of Postal and Telecommunications Administrations (CEPT), ECC Decision (18)06, "Harmonised technical conditions for Mobile/Fixed Communications Networks (MFCN) in the band 24.25 – 27.5 GHz, approved 06 July 2018, Amended 20 November 2020.

importation of equipment certified as complying with only the first phase limits after March 1, 2027—six months before the implementation of the second phase limits."

Paragraph 23: The NPRM states, *"NTIA urges, and AGU/AMS/NWA agrees, that base stations and user equipment modified or replaced after September 1, 2027, should comply with the post-2027 (e.g., -39 dBW) OOBE levels."*

These data that are used to derive values of natural phenomena within the volume of the atmosphere, are a unique natural resource. They cannot be replaced with other sources, and they are the reason that makes possible the forecast accuracy and duration seen in today's weather forecasts. There is no mitigation available for contaminated data due to OOBE; if/when it is possible to determine that such emissions have corrupted the data, it is required the corrupted measurement be discarded. The accuracy of data, as assimilated into numerical weather prediction models, can be adversely affected by insidious corruption of measured values, as well as discarding data which can be determined to be corrupted.

The spectrum bands used by microwave sounders are a unique natural resource that cannot be replaced with other sources. There is no mitigation for data that are corrupted by OOBE. We endorse implementing the -39 dBW limit to equipment deployed on and after September 1, 2027, and enforcing compliance for all RF devices after that date regardless of their installation date. Equipment that has been installed to meet previous limits, before the date where Resolution 750 final limits are required, should be modified to meet the final limits, or replaced by September 1, 2028.

A necessary aspect of spectrum sharing is the ability for all users to understand the current and future constraints on emissions. NOAA is particularly vulnerable to an uncertain emission environment because (1) NOAA satellites equipped with radiometers sensing passive microwaves have a physical inability to discriminate the source of emissions and (2) the global aspect of passive microwave sensing for weather forecasting requires a consistent sensing environment over a vast geographic area, if not global. For NOAA to tailor investments in future satellite missions, the ability to conduct weather sensing without risk of interference must be known. Otherwise, the weather-sensitive American public would lose twice: (1) in the degraded weather forecasting capability and (2) in the investment in instruments that are sensing in a band where non-atmospheric signals are detectable if variable emission thresholds are allowed for equipment that was excluded from new constraints. New NOAA satellite missions require three to over 10 years of rigorous planning and have programs with a cumulative cost of more than $10 billion. Changes to the design of instruments, particularly once they are partially or fully assembled, can incur significant costs in the tens to hundreds of millions of dollars.

We have not submitted an economic number associated with degradation of NWP model outputs to this proceeding. However, considering the extensive of use of forecasts, warnings and other meteorological products, impacts to every man, woman and child in the United States, to all major forms of transportation (especially aviation), to defense, tourism, marine activities (such as fishing and aquaculture) and to weather-sensitive industries such as but not limited to energy exploration and production, construction, agriculture and mining, that number would be extremely large and at

minimum, on par or exceeding the projected benefit of broadband wireless services in frequencies adjacent to passive bands.

6. ADDITIONAL RESPONSES AND COMMENTS BY PARAGRAPH OF THE NPRM

Paragraph 13: The NPRM states, *"we also seek comment on whether some changes to these limits may be appropriate to help strike the best balance and better serve the public interest in the United States while protecting EESS operations in the 23.6 – 24.0 GHz band."*

NOAA believes that stricter limits may better protect EESS passive sensors in the 23.6 – 24.0 GHz band.

Considerable analysis was undertaken by NASA and NOAA in 2019 and 2020 looking at a suitable protection level for the adjacent 23.6 – 24.0 GHz passive band. It is feasible that the most stringent limits (e.g., -39 dBW for base stations and -35 dBW for mobile) selected by WRC-19 might not prevent adjacent band contamination in all cases. However, the WRC-19 limits were a compromise, selected by the WRC for inclusion into the Radio Regulations, and those stringent limit values are what most countries are considering.

Paragraph 14: The NPRM states, *"We seek comment on CORF's proposal in the record. Parties supporting changes to the Resolution 750 unwanted emission limits should provide additional technical justification and explain why any stricter changes are necessary to protect EESS operations in the United States."*

NOAA aligns with CORF. CORF argued in its 2021 filing that the Resolution 750 limits may not be adequate. Depending on how many broadband transmitters have upwelling emissions within the 75 km diameter footprint will determine whether a given value is adequate. As seen in the figure 6 above, the x-axis has transmitter density per square kilometers on a log scale; the y-axis is the exceedance threshold of undesired OOBE from adjacent band operations. The practical interference threshold is 0.1 x NEΔT.

Paragraph 16: NOAA aligns with NTIA, CORF and IEEE that the Commission should apply the two-phased WRC-19 enhanced emissions limits to fixed deployments. We also do not see a technical justification for applying different emissions limits to IMT and non-IMT mobile systems.

Paragraph 18: The NPRM states, *"parties who support an exemption for indoor systems to include a technical justification for treating indoor small-cell systems differently".*

NOAA agrees with the need to examine the technical justification of exemptions for the indoor small cell systems. Any exemptions should be justified to determine true attenuation characteristics of the indoor deployments and no impact on passive EESS sensors.

Paragraph 25: The NPRM states, *" we propose to allow compliance with the unwanted emissions limits for the 23.6 – 24.0 GHz band to be demonstrated using TRP measurements, and we seek comment on whether to permit use of conductive power measurements as well."*

NOAA agrees to allow compliance with the unwanted emissions limits for the 23.6 – 24.0 GHz band to be demonstrated using TRP measurements only.

Paragraph 27: The NPRM states, *"Given the complexity of making TRP measurements, we seek comment on whether allowing equipment manufacturers to use conductive power or other measurement alternatives will result in the increased potential for harmful interference to occur to 23.6 – 24.0 GHz band passive sensors."*

NOAA agrees with NTIA, AGU/AMS/NWA, that only TRP measurements should be allowed, consistent with the rules adopted at WRC-19.

Furthermore as stated in the NPRM, Ericsson does not anticipate encountering any difficulties in performing TRP measurements on low signal levels in the 24.25 – 24.45 GHz and 24.75 – 25.25 GHz bands in a controlled chamber environment, such as anechoic chambers, where reliable and repeatable power measurements can be taken at discrete sets of points from all directions from the antenna.