



## News &amp; Highlights

## A Storm over Potential 5G Interference

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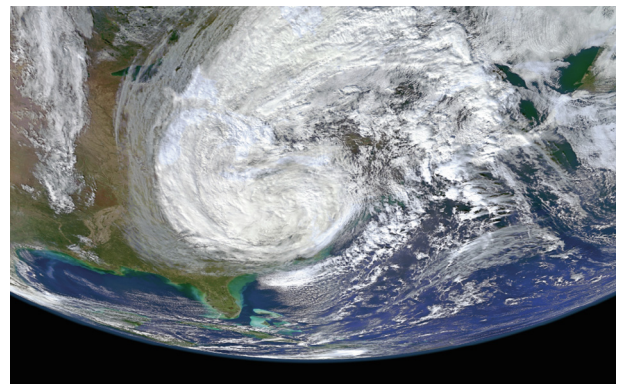
A bitter argument is taking place between the US government agency overseeing telecommunications and the country's agencies overseeing weather observations, seeming to pit faster cell phone service against accurate weather forecasts.

The US Federal Communications Commission (FCC), along with the country's wireless industry, is racing to deploy 5G technology, which promises to boost phone and internet speeds by about 100 times over current standards [1]. However, some scientists believe the technology could interfere with weather satellite measurements, potentially wiping out 40 years of progress in global weather forecasting capabilities. Such a setback could impede the world's ability to predict the paths of deadly hurricanes (Fig. 1) and other storms and reduce the amount of time available to evacuate people and secure buildings and other infrastructure.

On 14 March 2019, the FCC began auctioning off 2909 licenses in the 24 GHz frequency band to wireless carriers [2], despite the objections of scientists at the US National Aeronautics and Space Administration (NASA) and National Oceanic and Atmospheric Administration (NOAA). The 24 GHz-frequency band spectrums purchased for nearly \$2 billion USD by AT&T, T-Mobile, and other carriers range from 24.25–24.45 to 24.75–25.25 GHz [3]. Water vapor emits faint radiation at the nearby frequency of 23.8 GHz. NASA and NOAA scientists are concerned that Earth-observing satellites, such as NOAA's GOER-16, flying over areas of the United States with 5G wireless coverage will not be able to distinguish these faint signals because of interference from 5G transmissions in the adjacent 24 GHz frequency band.

In a letter dated 13 May 2019, US Senators Ron Wyden and Maria Cantwell wrote to FCC chairman Ajit Pai requesting the commission stop wireless companies from using the 24 GHz frequency band until a solution is found, and to temporarily halt additional planned auctions [4]. A few days later, on 16 May, the acting chief of NOAA Neil Jacobs testified in front of the US House Science Subcommittee on Environment. Jacobs told the committee that, based on the current 5G rollout plan, weather satellites would lose approximately 77% of the data they are currently collecting, reducing the power to forecast storms by as much as 30% [5]. "If you look back in time to see when our forecast skill was roughly 30% less than it is today, it's somewhere around 1980. This would result in the reduction of hurricane track forecasts' lead time by roughly two to three days," he said.

Jacobs added that even a 2% data loss could be large enough to violate the mission requirements of NOAA and NASA's planned



**Fig. 1.** US National Aeronautics and Space Administration (NASA) and National Oceanic and Atmospheric Administration (NOAA) scientists are concerned that the US FCC's plans for 5G technology will interfere with the ability of forecasters to accurately predict potentially impactful weather events, such as the landfall of Hurricane Sandy, shown here as it approaches the northeastern coast of the United States on 30 October 2012. Credit: NASA/NOAA/Goddard Space Flight Center/Suomi National Polar-Orbiting Partnership/Visible Infrared Imaging Radiometer Suite.

\$11 billion USD Joint Polar Satellite System, which will be used for weather forecasting as well as climate modeling and other applications [5]. Without critical water vapor data, Jacobs went on, the world's most accurate hurricane model would have predicted 2012's deadly Hurricane Sandy staying out at sea instead of abruptly curling westward and making landfall along the northeastern coast of the United States [6]. "If you can't make that prediction accurately," NASA administrator Jim Bridenstine told the US House Committee on Science, Space, and Technology earlier on 19 April 2019 [7], "then you end up not evacuating the right people and/or you evacuate people that don't need to evacuate, which is a problem."

Water vapor emits at only one frequency, meaning that forecasters have no other way to collect this information. However, the FCC can choose to either switch which regions of the spectrum it allocates to wireless companies or demand that carriers turn down the power emitted by 5G cellphone transmitters to avoid drowning out the sensitive weather satellite sensors. The FCC noise limit on the 24 GHz frequency band is currently  $-20$  dBW [8]. NOAA and NASA want the FCC limit to be closer to thresholds recommended by the European Commission—at  $-42$  dBW, 150 times

less noisy than the FCC limit—and the World Meteorological Organization (WMO), at  $-55$  dBW, 3000 times less noisy [8].

Requiring lower-power emissions in the 24 GHz spectrum could make the airwaves “unusable for 5G domestically,” Pai told the US Senate Committee on Commerce, Science, and Transportation on 12 May 2019 [9]. Pai went on to say that NOAA’s concern “ignores the fact that 5G will involve beamforming, essentially adaptive antenna arrays that will more precisely send 5G signals—sort of a rifle shot, if you will, instead of a shotgun blast of 5G spectrum.” Pai also told the Committee that there are already 40 000 microwave links operating in the frequency band just below 23.8 GHz, with no reported cases of interference with weather sensors.

“The FCC’s been doing this for a long time,” said Theodore Rappaport, director of NYU WIRELESS and professor of computer science and radiology at New York University in New York City, who agrees with FCC chairman Pai. “It regulates interference between satellites and mobile and fixed networks all the time.”

“My guess is some non-technical people have heard it might be an issue, but don’t understand the care and analysis that is done to properly regulate the radio spectrum,” Rappaport said. “You have to remember that mobile phones and base stations are operating at frequencies hundreds of megahertz away from those of any weather equipment and focusing their energy on the ground and the horizon; they’re not looking up into the sky where the weather satellites are.”

But beyond the current controversy, what the weather forecasters foresee on the horizon are potential additional headaches. The FCC plans to begin its next 5G auction, which will be the country’s largest ever, in December 2019. It will involve three more frequency bands near ones used to detect other meteorological phenomena: rain and snow (36–37 GHz), atmospheric temperature (50.2–50.4 GHz), and clouds and ice (80–90 GHz) [10].

Before that auction, though, regulators from around the world will gather at the World Radiocommunication Conference 2019 (WRC-19) organized by the International Telecommunications Union (ITU), a Geneva-based agency of the United Nations concerned with communications technologies, starting on 28 October 2019 in Sharm el-Sheikh, Egypt. Meeting participants are expected to work out international agreements for the frequencies that companies will be able to use for 5G transmissions, and what level of interference with Earth-observation frequencies will be acceptable [8].

Because Earth exploration-satellite service (EESS) sensors passively measure all emissions sources within a frequency band, including noise, “it is essential that the WRC-19 gets it right and adopts the level of interference protection that actually avoids

creating interference into the EESS passive sensors since interference detection and mitigation is not possible,” said Mario Maniewicz, director of the ITU Radiocommunication Bureau. According to the WRC-19 conference preparatory document [11], “Low levels of radio frequency interference cannot be discriminated from natural radiations and hence represent a very serious problem since degraded or incorrect data would be accepted as valid.”

How this argument gets resolved remains to be determined. However, because the United States is such a large communications market, the FCC position will likely hold considerable sway. Rappaport said he expects the ITU to adopt a spectral mask—the filter limiting emission noise—similar to the  $-20$  dBW level believed acceptable by at least some US experts. “I am confident that everything will continue to evolve, and the sky will not fall,” he said.

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