

January 13, 2025

**Via Electronic Filing**

Marlene H. Dortch, Secretary  
Federal Communications Commission  
45 L Street, N.E.  
Washington, D.C. 20554

**Re: ELS File No. 2145-EX-ST-2024**

**Supplemental Technical Submission**

Dear Ms. Dortch:

On November 14, 2024, AST & Science, LLC (“AST SpaceMobile”) requested Special Temporary Authority (“STA”) to conduct Supplemental Coverage from Space (“SCS”) service link testing using spectrum made available by our partner and mobile network operator, Verizon Communications Inc. (“Verizon”).<sup>1</sup>

In the instant submission AST SpaceMobile supplements the above-referenced application with the following exhibits:

**Exhibit A:** PFD contour plots that reaffirm AST SpaceMobile’s ability to direct energy away from international borders and demonstrate how AST SpaceMobile will protect Canadian and Mexican cross-border operations from interference.<sup>2</sup>

**Exhibit B:** A report providing in-depth technical analysis of radio frequency (RF) interference levels originating from an AST satellite orbiting at an altitude of 520 kilometers. The satellite provides coverage to four test areas in the United States: two near the Canadian border and two the near the Mexican border.

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<sup>1</sup> See ESL File No. 2145-EX-ST-2024, Attachment A to Legal Narrative (“Verizon License List”) (filed Nov. 14, 2024).

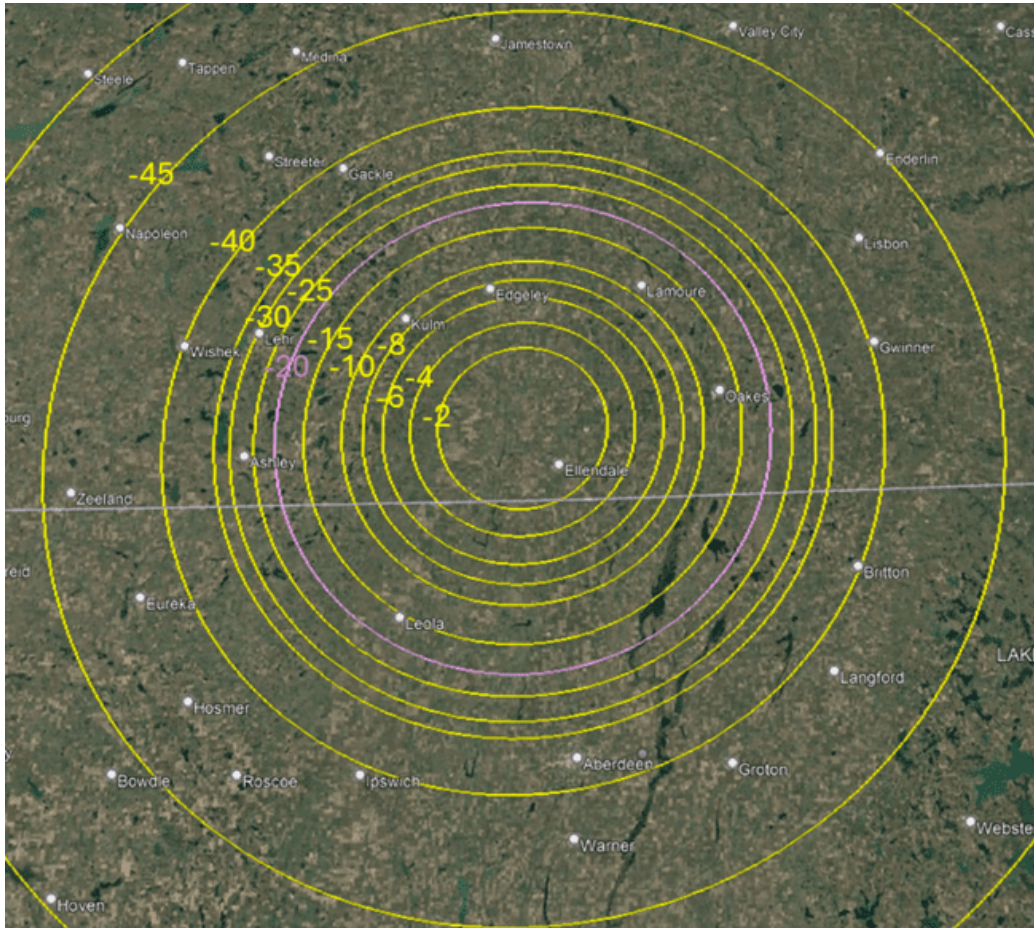
<sup>2</sup> At staff’s request, AST SpaceMobile modeled border areas near Buffalo, New York and Brownsville, Texas. AST SpaceMobile generated such contours for hypothetical operations at these locations only.

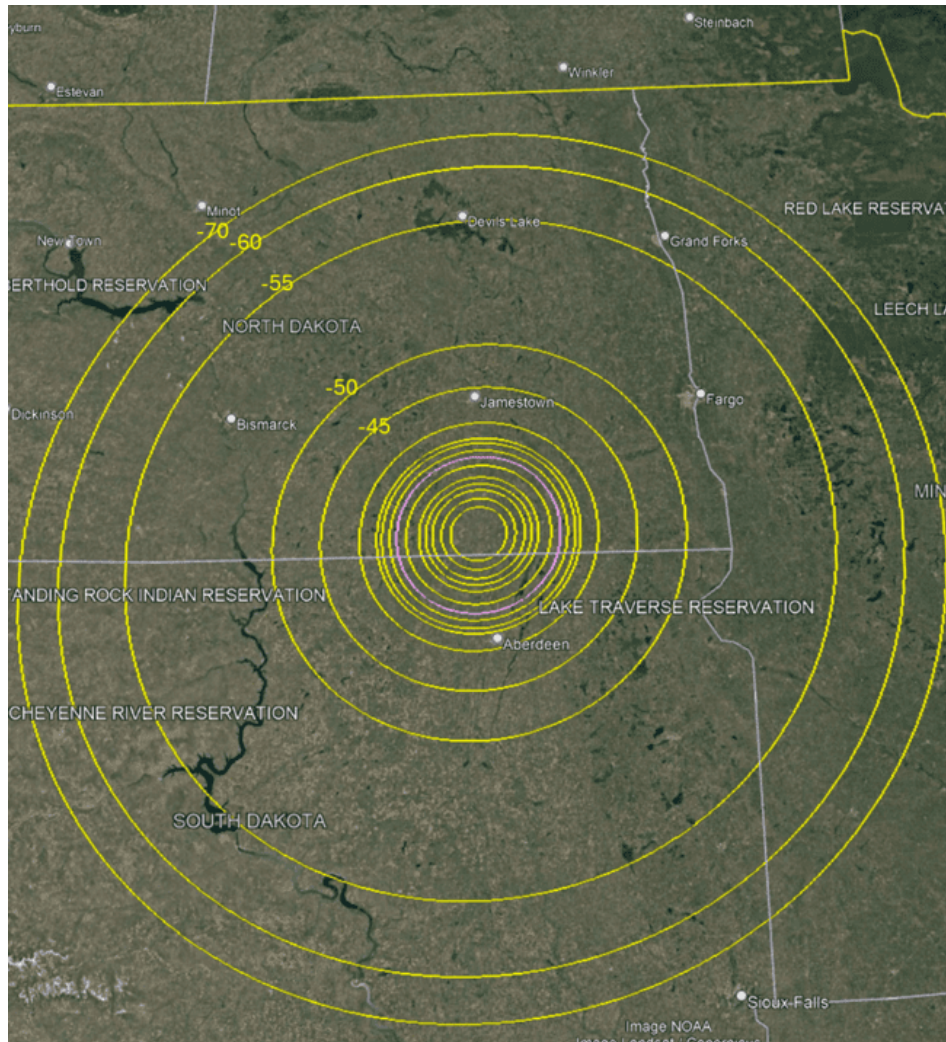
Please feel free to contact the undersigned with any questions.

Respectfully submitted,  
/s/  
Timothy Bransford  
Denise Wood  
*Counsel for AST SpaceMobile*

**Case 1-CAN-ND (Center Satellite):** PFD Contour Plot with dB roll off from Beam Center (nadir).

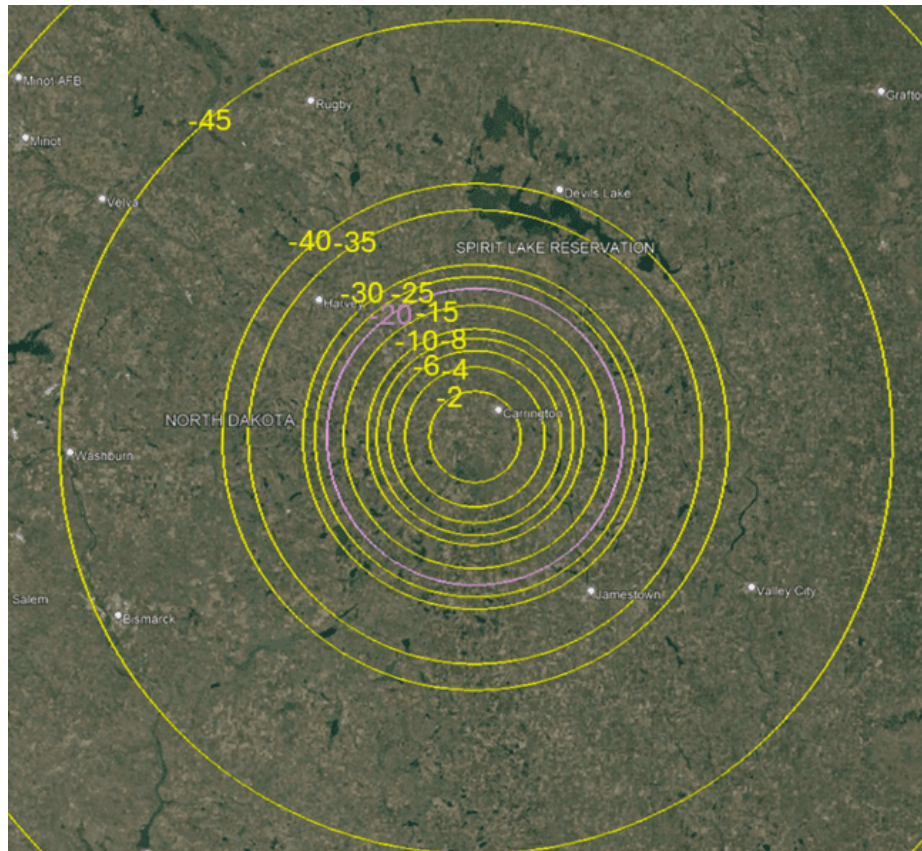
- The peak PFD at the center is  $-87.4 \text{ dBW/m}^2$
- The peak EIRP at the center is  $37.9 \text{ dBW}$

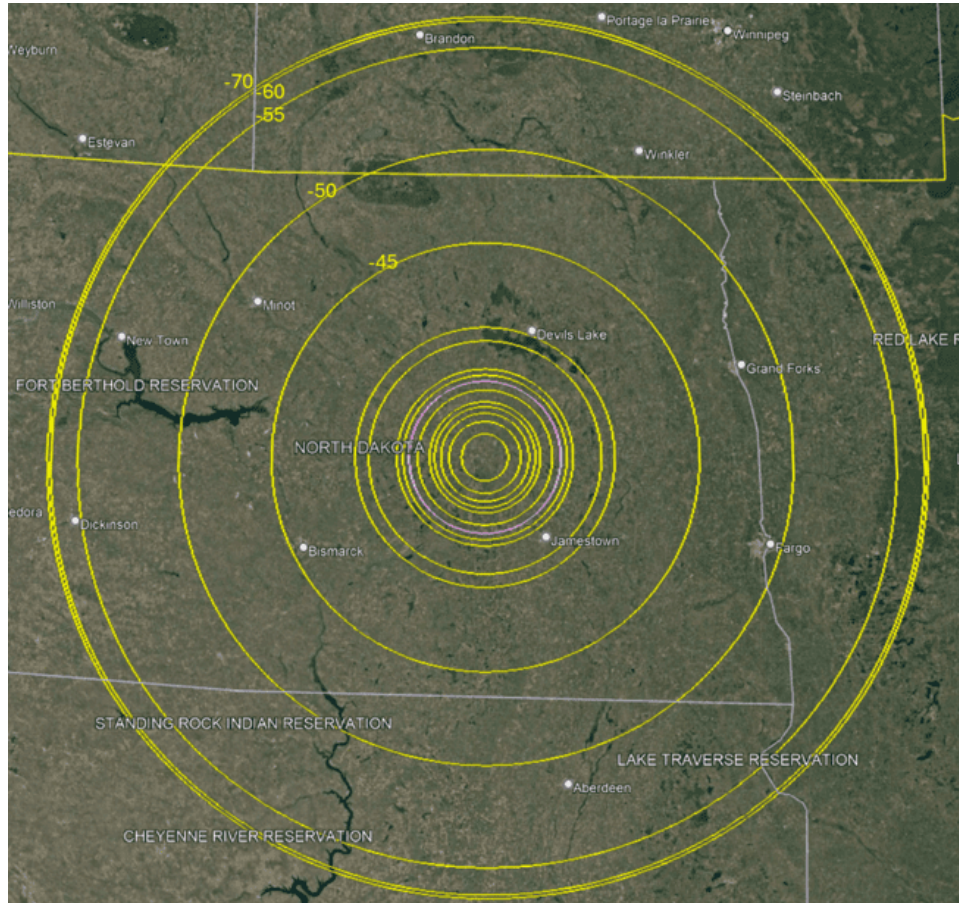




**Case 2-CAN-ND (Edge Satellite):** PFD Contour Plot with dB roll off from Beam Center (nadir).

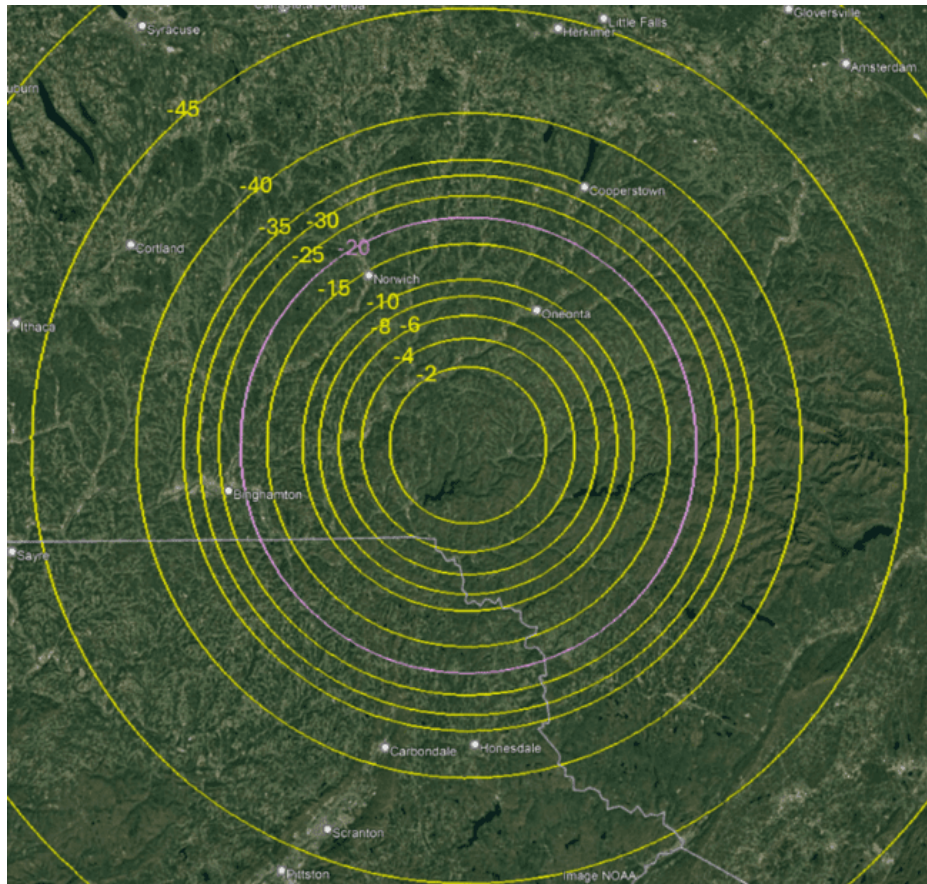
- The peak PFD at the center is  $-87.4 \text{ dBW/m}^2$
- The peak EIRP at the center is  $38.7 \text{ dBW}$

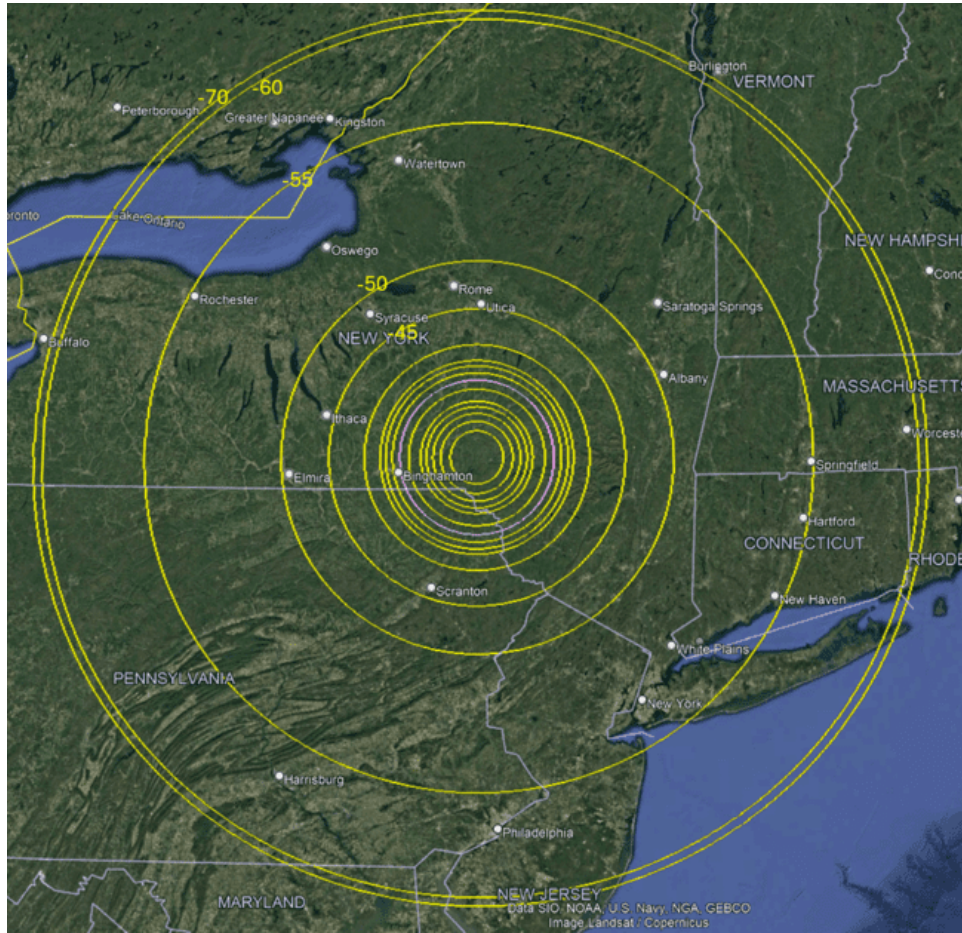




**Case 1-CAN-NY (Center Satellite):** PFD Contour Plot with dB roll off from Beam Center (nadir).

- The peak PFD at the center is  $-87.4 \text{ dBW/m}^2$
- The peak EIRP at the center is  $37.9 \text{ dBW}$

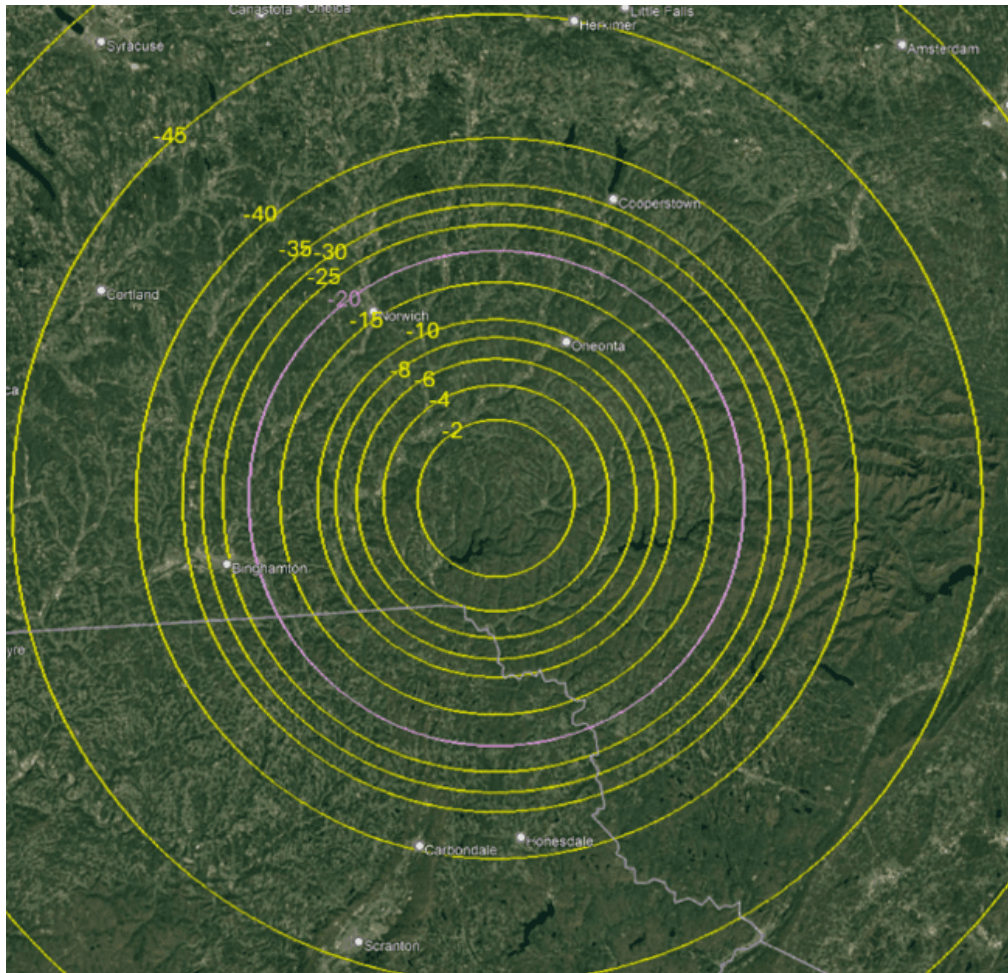


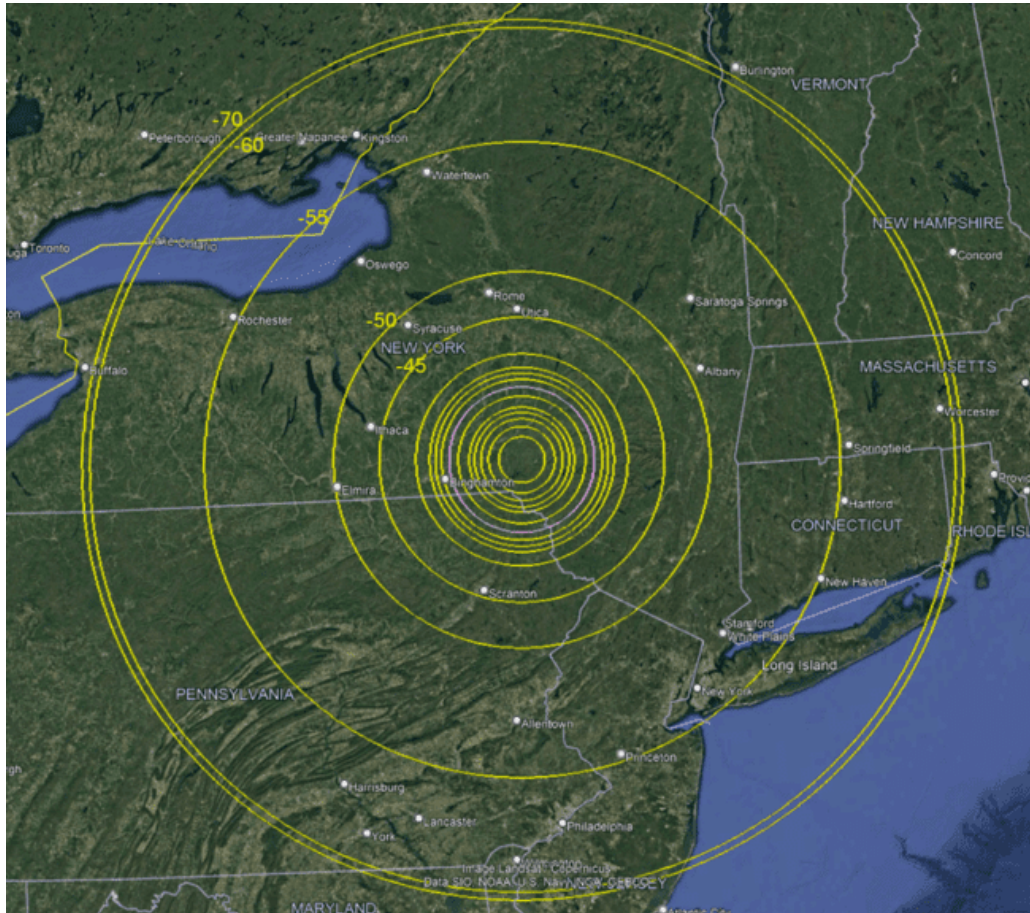




**Case 2-CAN-NY (Edge Satellite):** PFD Contour Plot with dB roll off from Beam Center (nadir).

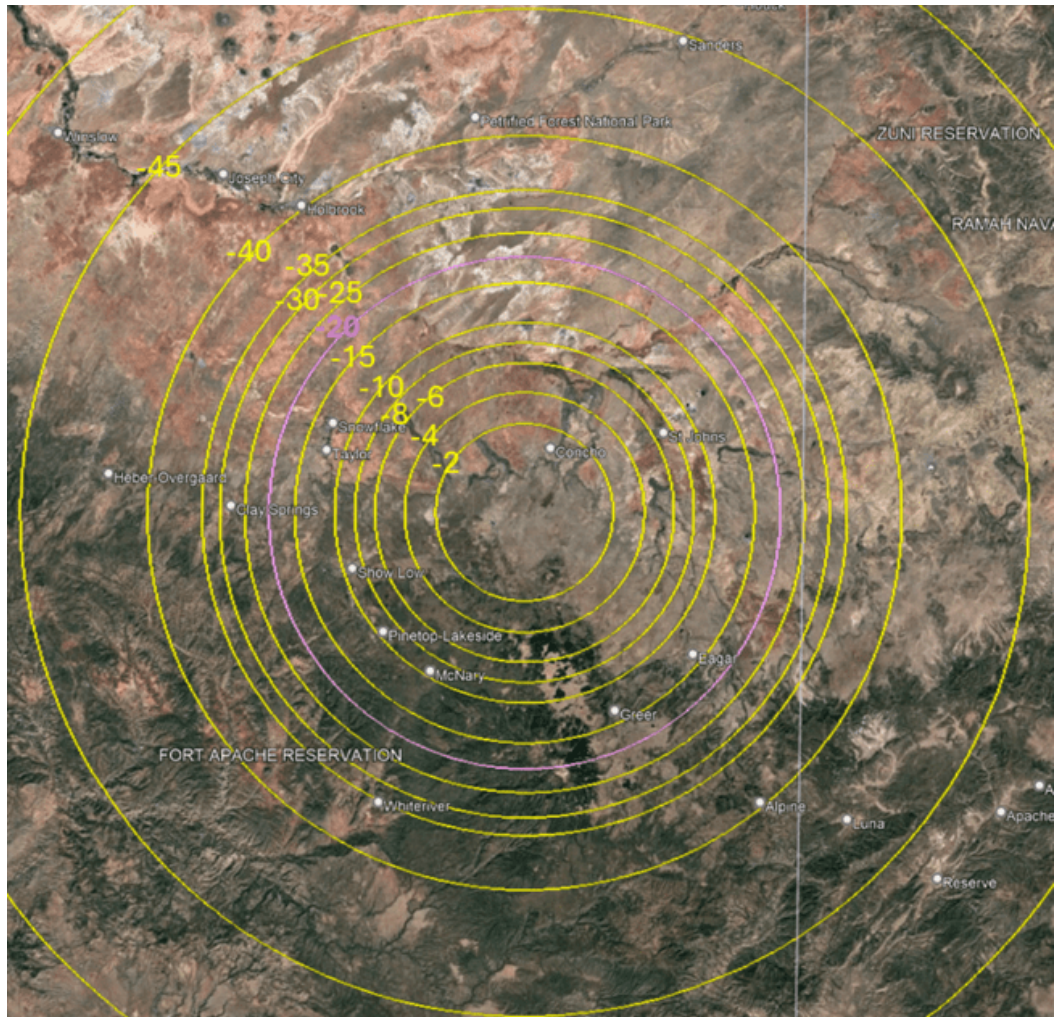
- The peak PFD at the center is  $-87.4 \text{ dBW/m}^2$
- The peak EIRP at the center is  $38.5 \text{ dBW}$

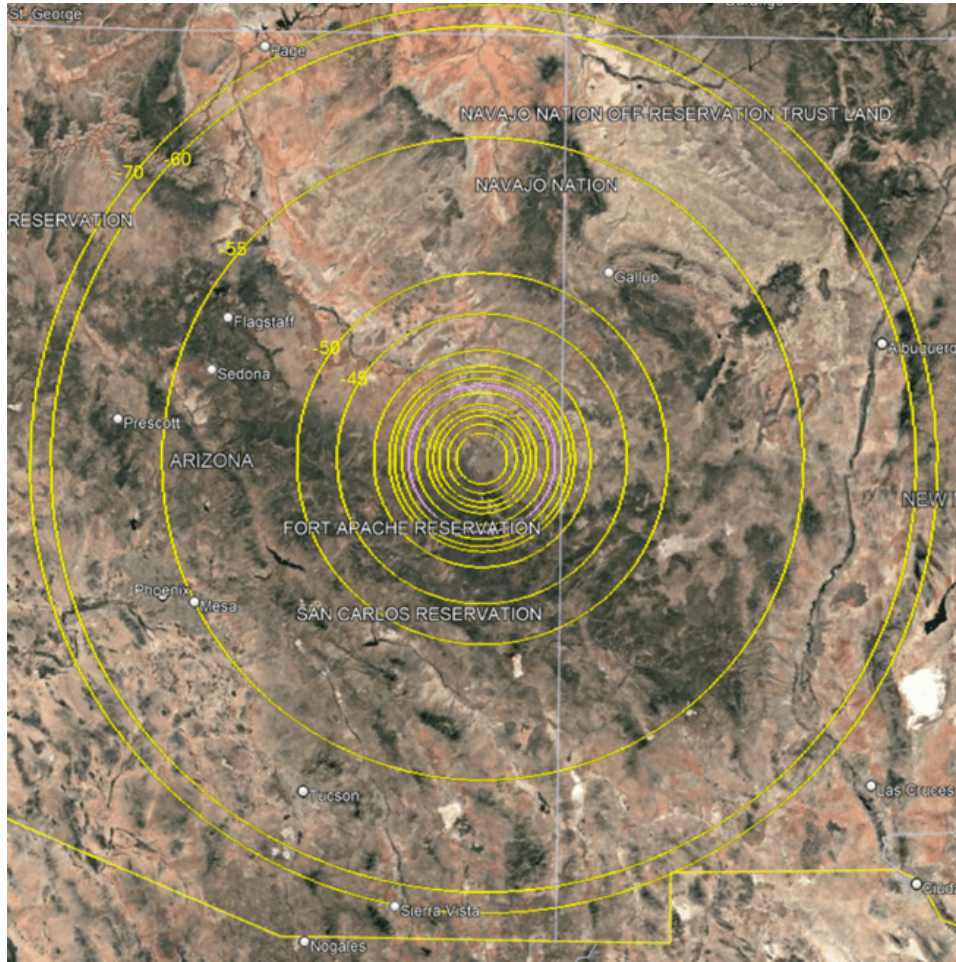




**Case 1-MEX-AZ (Center Satellite):** PFD Contour Plot with dB roll off from Beam Center (nadir).

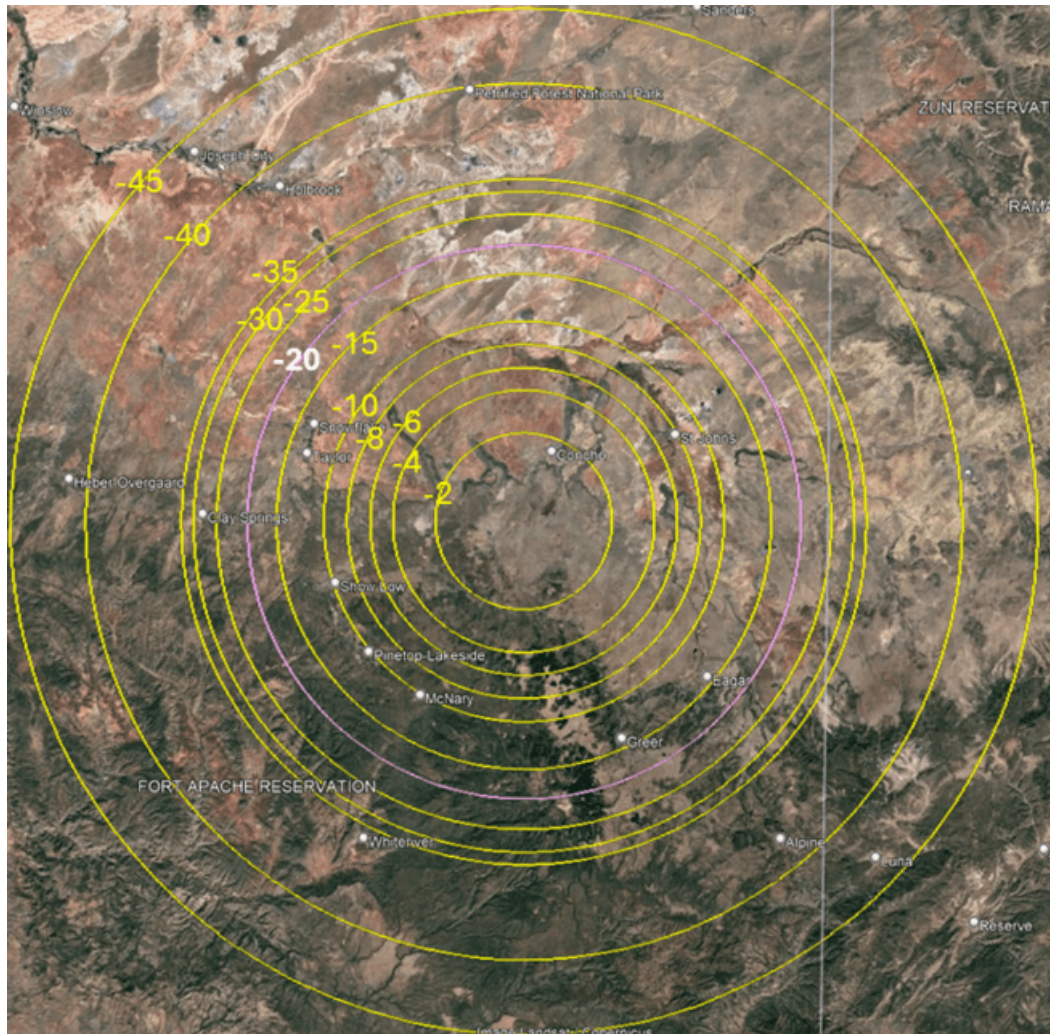
- The peak PFD at the center is  $-87.4 \text{ dBW/m}^2$
- The peak EIRP at the center is  $37.9 \text{ dBW}$

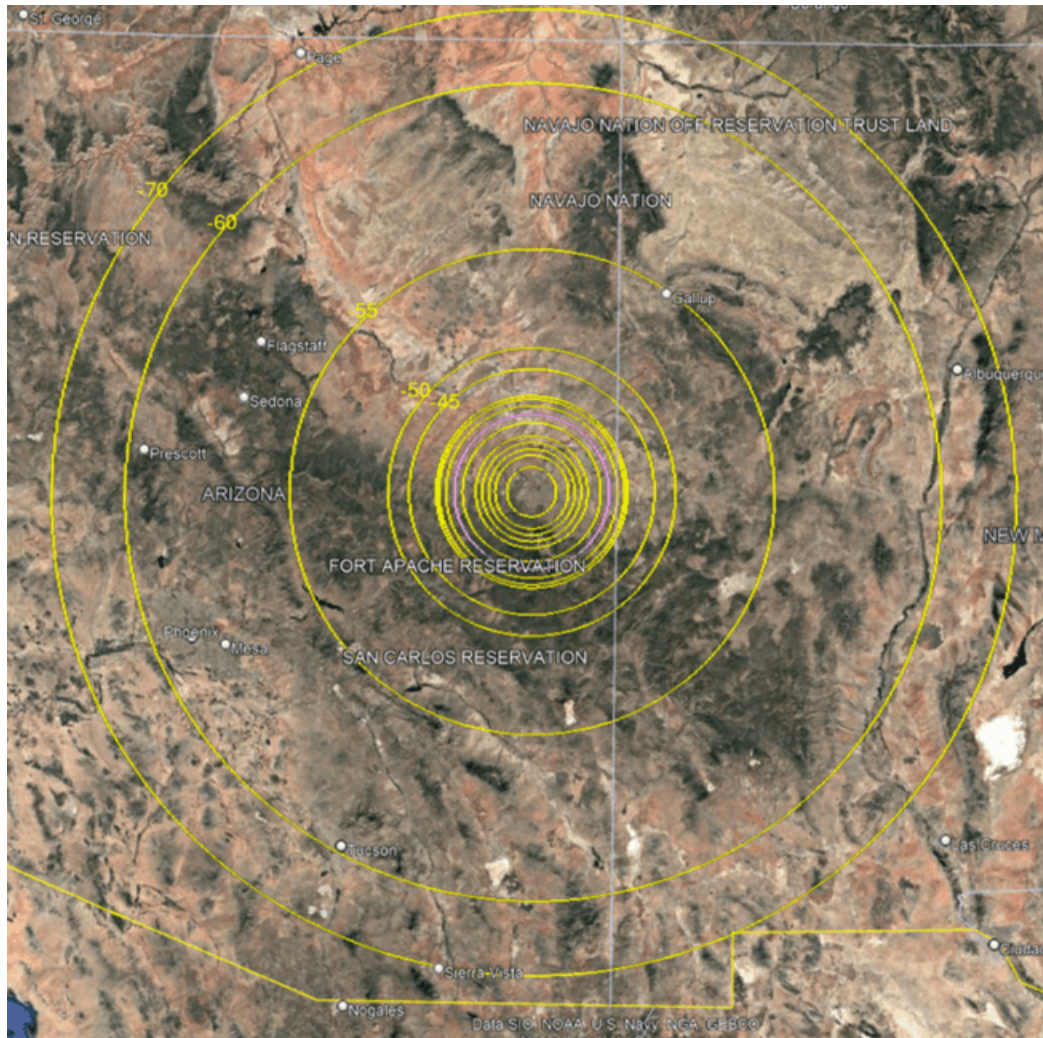




**Case 2-MEX-AZ (Edge Satellite):** PFD Contour Plot with dB roll off from Beam Center.

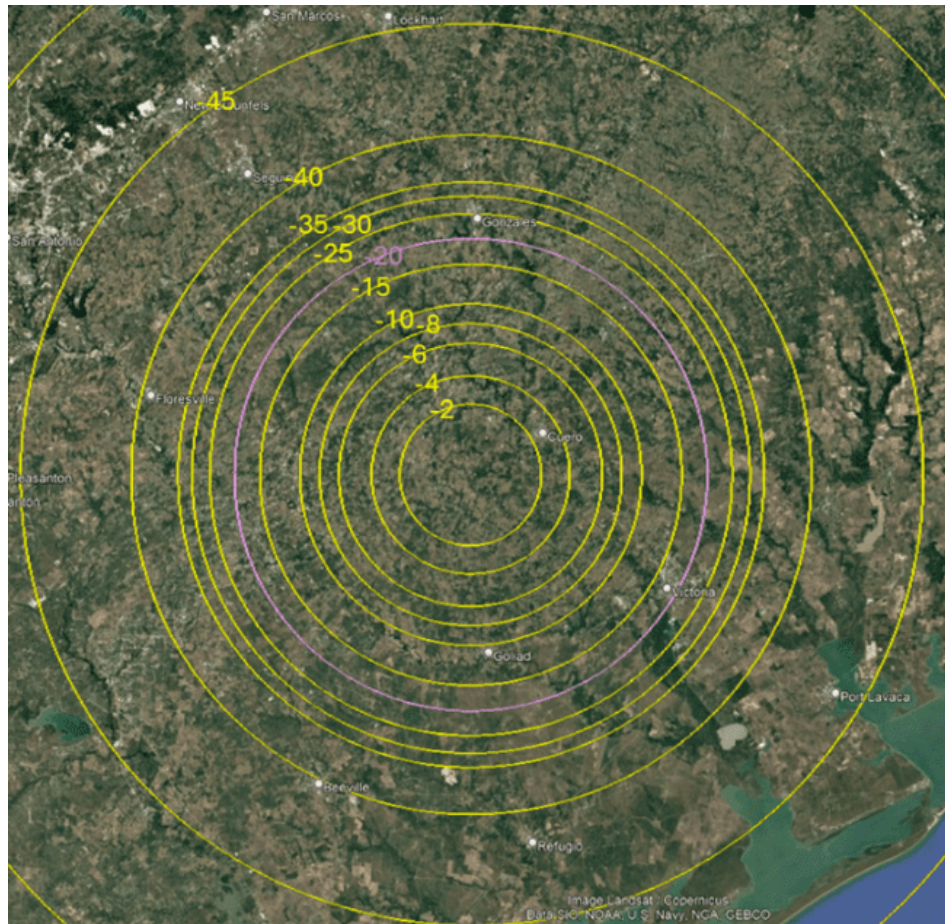
- The peak PFD at the center is  $-87.4 \text{ dBW/m}^2$
- The peak EIRP at the center is  $38.7 \text{ dBW}$

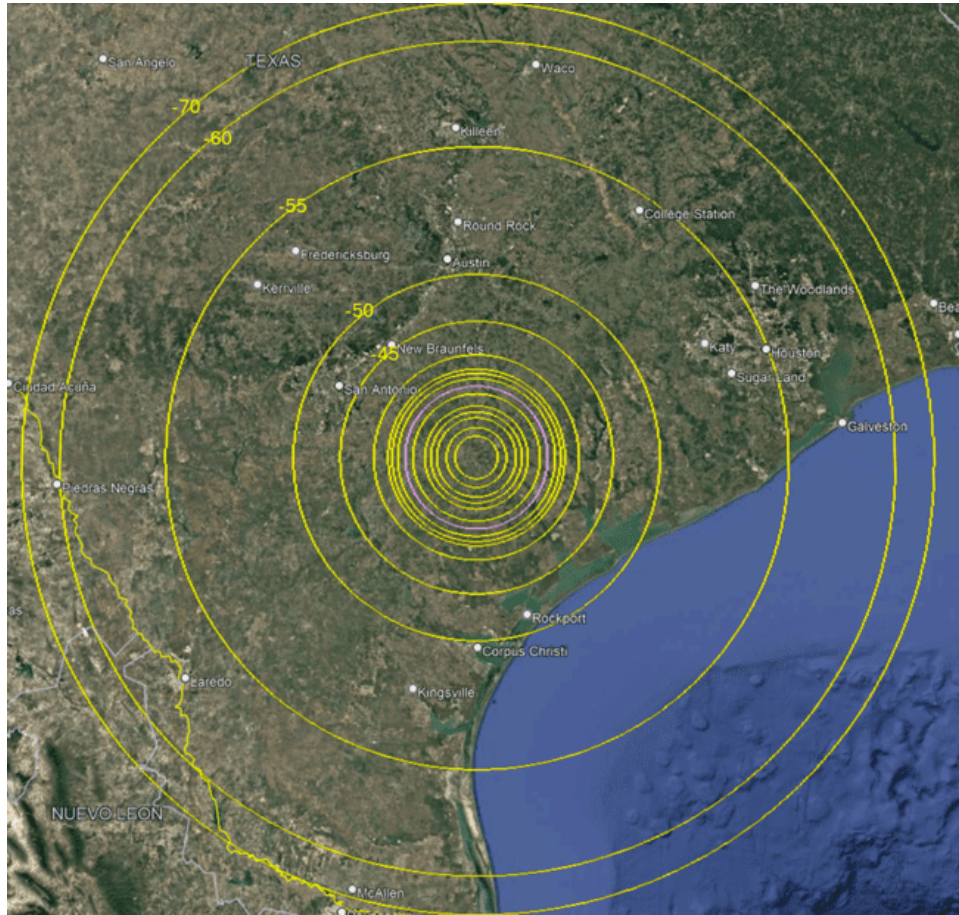




**Case 1-MEX-TX (Center Satellite):** PFD Contour Plot with dB roll off from Beam Center (nadir).

- The peak PFD at the center is  $-87.4 \text{ dBW/m}^2$
- The peak EIRP at the center is  $37.9 \text{ dBW}$

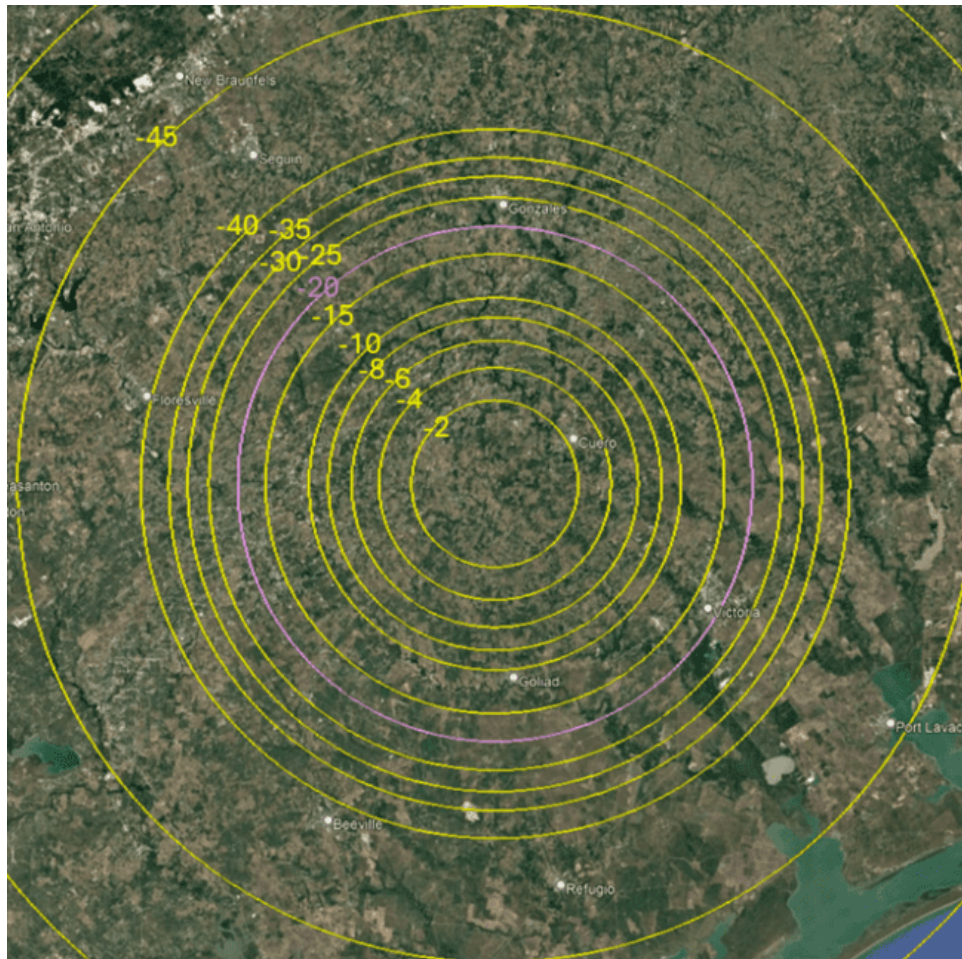


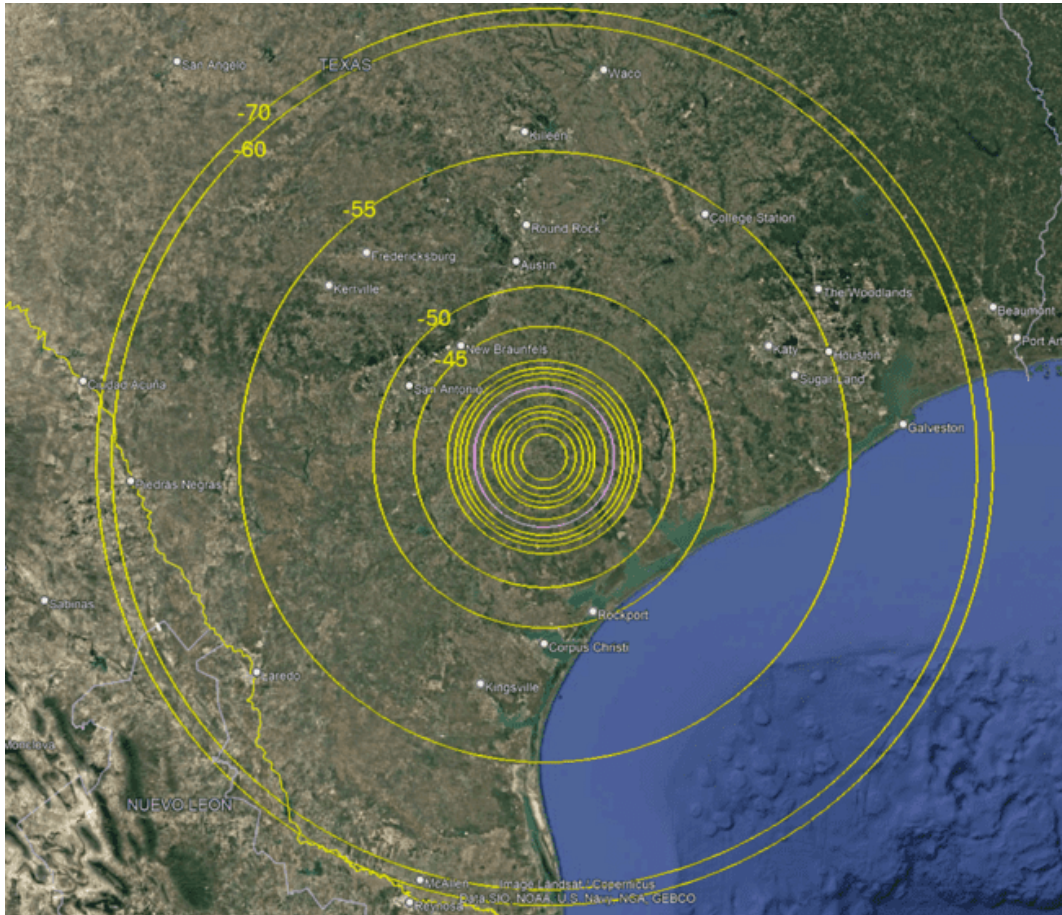




**Case 2-MEX-TX (Edge Satellite):** PFD Contour Plot with dB roll off from Beam Center (nadir).

- The peak PFD at the center is  $-87.4 \text{ dBW/m}^2$
- The peak EIRP at the center is  $38.5 \text{ dBW}$





## **Technical Analysis of RF Interference from an AST Satellite Covering Test Areas in the US at the Border with Canada and Mexico**

### **1. Introduction**

This report provides an in-depth technical analysis of radio frequency (RF) interference levels originating from an AST satellite orbiting at an altitude of 520 kilometers. The satellite provides coverage to four test areas in the United States: two near the Canadian border and two near the Mexican border. In all cases, the satellite provides coverage to 200 active beams. The primary aim of this analysis is to assess whether the satellite's emissions surpass the interference thresholds established by international regulations - 40 dB $\mu$ V/m in Canada and 37 dB $\mu$ V/m in Mexico - over a 5 MHz bandwidth. To achieve this, two distinct scenarios were simulated:

- the satellite positioned directly above the coverage area, and
- the satellite located at the outermost edge of the coverage zone, where the elevation angle from a point in the coverage area to the satellite is 40 degrees.

The analysis relies on simulated data based on key assumptions, including satellite RF power output, beam orientation, antenna radiation pattern, and the geographic propagation characteristics of the signal. The findings not only confirm compliance with international interference standards but also offer valuable insights into the behavior of emissions under various operating conditions, enhancing our understanding of RF propagation in different geographic contexts.

### **2. Methodology**

The evaluation was conducted by modeling the RF emissions of the AST satellite, incorporating realistic assumptions about power levels, beam patterns, and signal propagation over large distances. The analysis utilized the following key benchmarks:

- **Test Coverage Area:**
  - CAN-ND: a square area encompassing 200 beams centered at 46.21527°E, 98.71003°W (mostly over North and South Dakota) close to the Canadian border;
  - CAN-NY: a square area encompassing 200 beams centered at 42.15461°E, 75.082585°W (covering all of New York) close to the Canadian border;
  - MEX-AZ: a square area encompassing 200 beams centered at 34.360208°E, 109.648674°W (over Arizona and New Mexico) close to the Mexican border;
  - MEX-TX: a square area encompassing 200 beams centered at 29.15583°E, 97.453445°W (over Texas) close to the Mexican border.
  - For the CAN-ND and MEX-AZ test coverage areas, the 200 beams were chosen from the cells where Verizon and AT&T, or Verizon only have license to operate over Band 5 (869-894 MHz). These areas were selected since they are close to the Canadian and Mexican borders with the largest density of such cells to analyze the highest levels of interference. In addition, these areas are chosen with 1 cell away from the border. These cases represent the actual operation.
  - For the CAN-NY and MEX-TX test coverage areas, the 200 beams were selected in a different region using all adjacent cells (in a square) – regardless of the holders of the

corresponding terrestrial licenses. In addition, the cells next to the border are kept active. This would be the worst-case interference scenario, and operationally, the interference will be less since particularly for MEX-TX, many cells will be off.

- **Regulatory-constrained Area:**
  - Canada up to 500 km from the center of the test coverage area above
  - Mexico up to 500 km from the center of the test coverage area above
- **Interference Threshold:**
  - 40 dB $\mu$ V/m over 5 MHz in Canada
  - 37 dB $\mu$ V/m over 5 MHz in Mexico
- **EIRP:** Limited to a total of 50.5 dBW on a 5 MHz channel with beam-specific adjustments. This is the highest EIRP in the STA.

The actual AST beam power distribution algorithm was implemented where the satellite beam power is adjusted to achieve C/N of 20 dB in that beam, ensuring realistic simulations for two extreme satellite positions:

- **Case 1 - Satellite Centered Over Coverage Area:** The satellite is directly overhead, distributing power uniformly across the test zone.
- **Case 2 - Satellite at the Edge of Coverage Area:** The satellite is positioned toward the horizon, with beams pointing towards the border.

Terrain and atmospheric effects were assumed to be negligible, and propagation was modeled (as Free Space Path Loss) assuming open geographical features.

### 3. Assumptions

The analysis adhered to the following assumptions:

- Four test areas are modeled approximating a square containing 200 beams – two next to the Canadian and two next to the Mexican borders
- For two of the test cases, the cells adjacent to the Canadian and Mexican borders are shut off – modeling the actual operation.
- For the other two test cases, the cells adjacent to the Canadian and Mexican borders are kept on.
- The analysis was conducted up to 500 km from the center of the test areas.
- Acceptable RF power in Canada and Mexico was **40 dB $\mu$ V/m** and **37 dB $\mu$ V/m** over 5 MHz respectively.
- **Center Case Beam EIRP:**
  - Canadian Border CAN-ND: 37.9 to 39.9 dBW over 5 MHz bandwidth.
  - Canadian Border CAN-NY: 23.5 to 39.6 dBW over 5 MHz bandwidth.
  - Mexican Border MEX-AZ: 37.9 to 40.1 dBW over 5 MHz bandwidth.
  - Mexican Border MEX-TX: 23.9 to 39.9 dBW over 5 MHz bandwidth.
- **Edge Case Beam EIRP:**
  - Canadian Border CAN-ND: 37.9 to 41.3 dBW over 5 MHz bandwidth.
  - Canadian Border CAN-NY: 24.9 to 40.9 dBW over 5 MHz bandwidth.
  - Mexican Border MEX-AZ: 36.2 to 41.2 dBW over 5 MHz bandwidth.
  - Mexican Border MEX-TX: 24.5 to 40.6 dBW over 5 MHz bandwidth.

AST & Science, LLC  
Application File No. 2145-EX-ST-2024  
Supplemental Submission - Exhibit B

The simulation begins with the EIRP for each beam to meet 20 dB C/N. Aggregate interference exceedances are then identified and through an iterative process, EIRP in each beam is reduced or turned off until there are no aggregate interference exceedances.

#### 4. Results and Analysis

##### a. Canadian Border:

##### i. Case 1 CAN-ND and CAN-NY: Satellite Centered Over Coverage Area

The satellite's beams were centered directly above the test area, uniformly distributing RF power. The simulation modeled the RF field strength in Canada up to 500 km from the center of the test area. Key findings include:

- **Maximum Aggregate RF Field Strength:**
  - **CAN-ND: 24.6 dB $\mu$ V/m** (well below the 40 dB $\mu$ V/m threshold)
  - **CAN-NY: 37.0 dB $\mu$ V/m** (meeting the 40 dB $\mu$ V/m threshold)

The power distribution illustrated below in Figure 1 and Figure 2 demonstrates the gradual attenuation of signal strength as distance from the coverage center increases for CAN-ND and CAN-NY respectively. Having simulated out to 500 km from the center of the test area demonstrates that there are no interference exceedances for distances beyond 500 km.

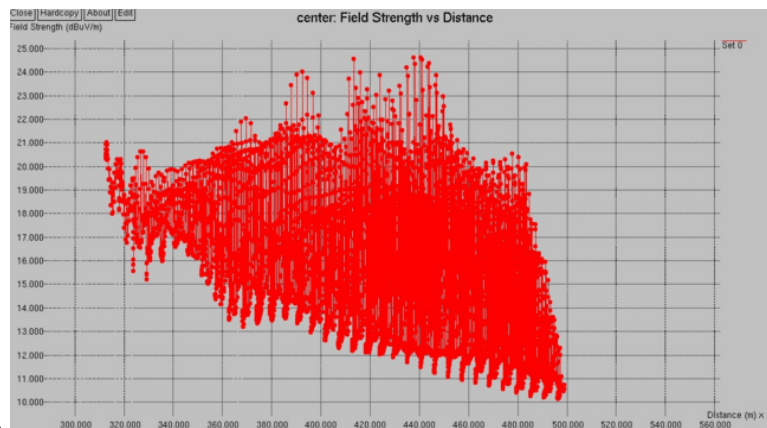


Figure 1- Field Strength vs. Distance for Centered Satellite Position (CAN-ND)

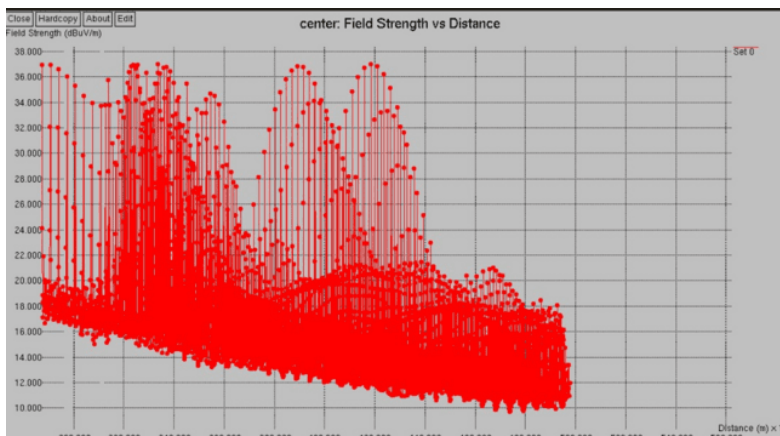


Figure 2 - Field Strength vs. Distance for Centered Satellite Position (CAN-NY)

A geographic visualization of the simulated scenario is shown in Figure 3. The colored area is in Canada up to 500 km from the center of the test area.

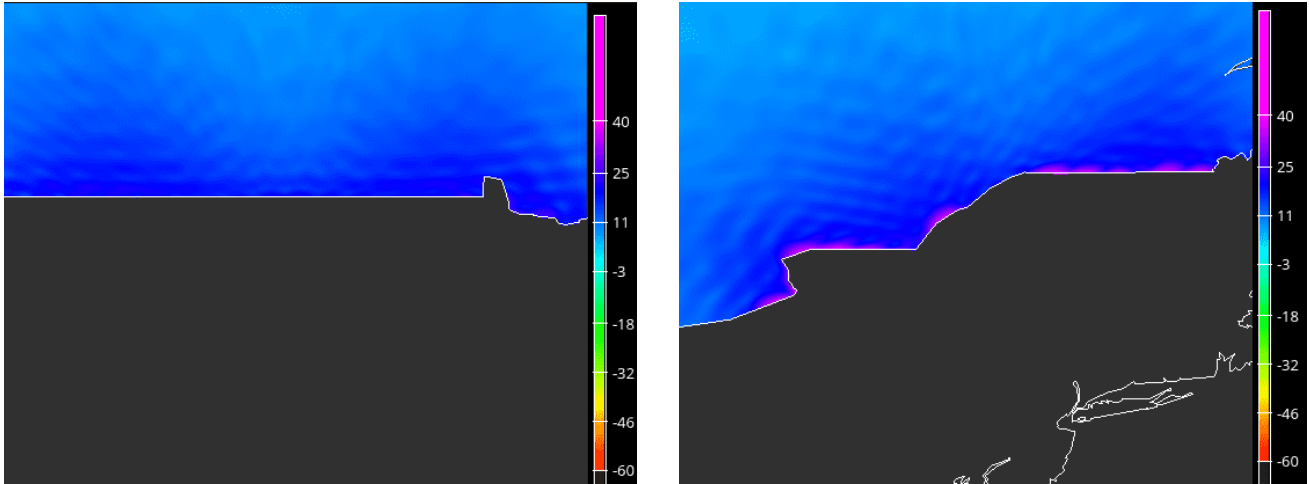


Figure 3 - Field Strength (dBµV/m) Distribution Across the Simulated Border Area for the Centered Satellite Position (Left: CAN-ND, Right: CAN-NY)

Figure 4 below shows the two test areas relative to the Canadian border.

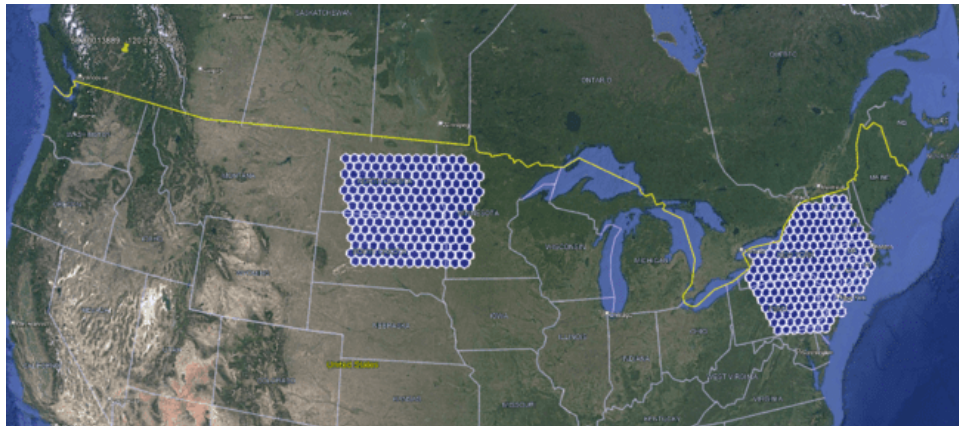


Figure 4 - Map of the two Test Areas Showing Distance to Actual Border (Left: CAN-ND; Right: CAN-NY)

For CAN-ND, the results showed that no reduction in beam EIRP (from what achieves 20 dB C/N in the coverage area) was needed to meet the aggregate interference limits. In fact, the emissions remain well below the acceptable interference limits.

For CAN-NY, as shown in Figure 5 below, the results showed that reduction in beam EIRP (from what achieves 20 dB C/N in the coverage area) was needed in the border beams to meet the aggregate interference limits. Eight of the beams (white cells in Figure 5) required an EIRP reduction of more than 15 dB (to achieve min C/N of 5 dB) and as such they were turned off. No EIRP reduction in EIRP was needed in the remaining (non-border) beams – consistent with the results for CAN-ND.

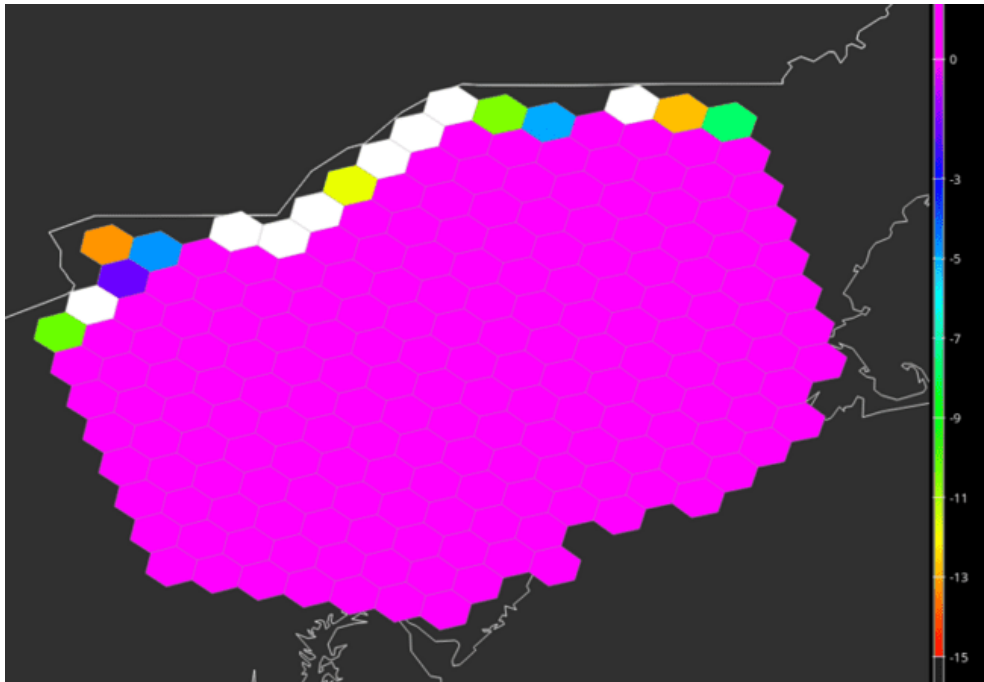


Figure 5 – Map of 200 beams in CAN-NY Test Area showing amount of EIRP reduction (in dB) required in each beam to meet the aggregate interference limits. White cells required more than max allowable EIRP reduction of 15 dB and hence they were shut off. (Case 1 CAN-NY)

Finally, for Case 1 CAN-ND and CAN-NY, the beam pattern (gain in dBi) over the center cell is illustrated below in Figure 6 on top of the cells laid down over the coverage area:

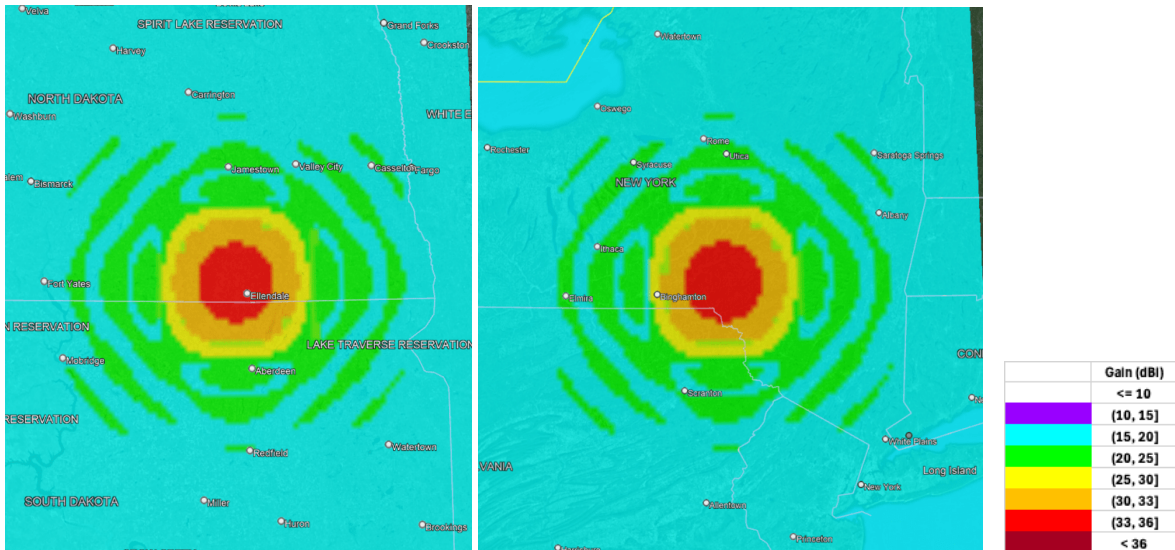


Figure 6 - Beam Pattern over the Center Cell of the Coverage Area (Centered Satellite Position) (Left: CAN-ND; Right: CAN-NY)



**ii. Case 2 CAN-ND and CAN-NY: Satellite at Edge of Coverage Area**

In this case, the satellite was repositioned at the extreme edge of the test zone, orienting its beams towards the simulated border. The simulation modeled the RF field strength in Canada up to 500 km from the center of the test area. Results showed:

- **Maximum Aggregate RF Field Strength:**
  - **CAN-ND: 34.4 dB $\mu$ V/m** (below the 40 dB $\mu$ V/m threshold)
  - **CAN-NY: 37.0 dB $\mu$ V/m** (below the 40 dB $\mu$ V/m threshold)

The power distribution in Figure 7 and Figure 8 demonstrates the effect of beam focusing over lower elevation angles, with higher emissions relative to the centered satellite position- for CAN-ND and CAN-NY respectively.

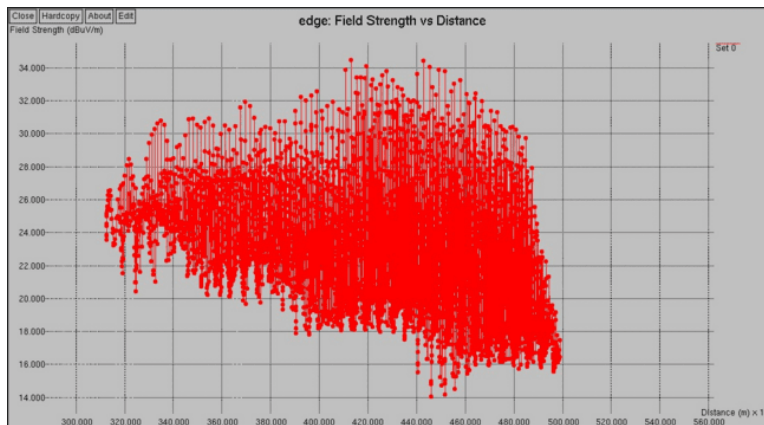


Figure 7 - Field Strength vs. Distance for Edge Satellite Position (CAN-ND)

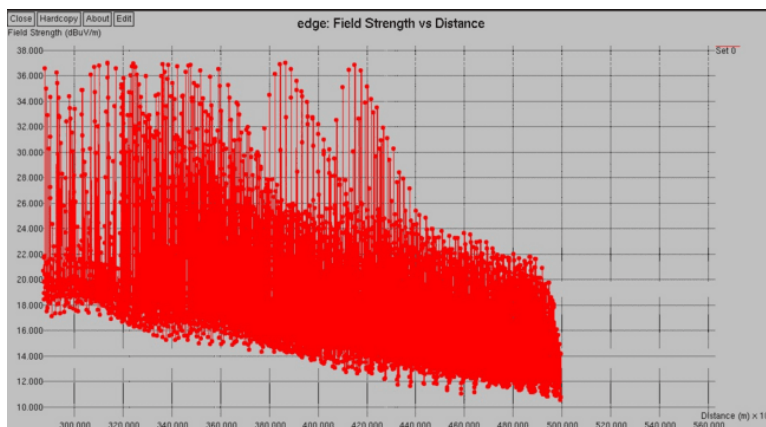


Figure 8 - Field Strength vs. Distance for Edge Satellite Position (CAN-NY)

A geographic illustration (Figure 9) highlights the RF propagation pattern under this scenario, showing power distribution extending towards the simulated border.

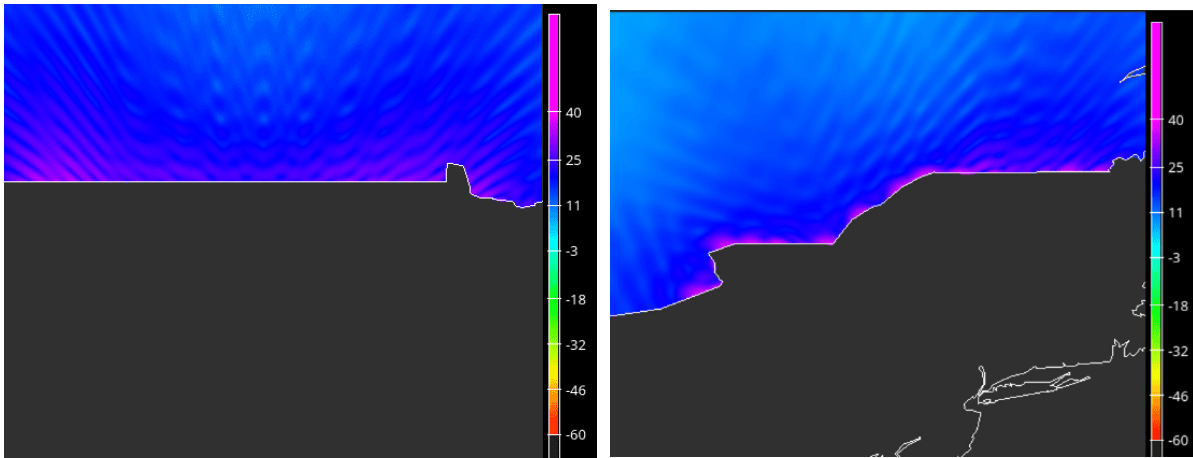


Figure 9 - Field Strength (dBμV/m) Distribution Across the Simulated Border for the Edge Satellite Position (Left: CAN-ND; Right: CAN-NY)

As in Case 1 CAN-ND, the results showed that no reduction in beam EIRP (from what achieves 20 dB C/N in the coverage area) was needed to meet the aggregate interference limits.

For Case 2 CAN-NY, as shown in Figure 10, the results showed that 5 beams needed to be turned off (white beams in Figure 10) and most of the remaining beams next to the border required an EIRP reduction. The remainder beams (not next to the border) did not require any EIRP reduction.

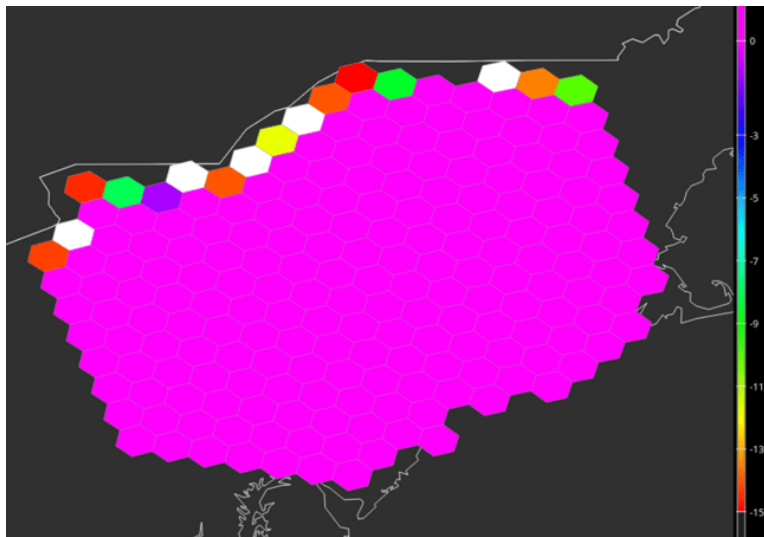


Figure 10 - Map of 200 beams in CAN-NY Test Area showing amount of EIRP reduction (in dB) required in each beam to meet the aggregate interference limits. White cells required more than max allowable EIRP reduction of 15 dB and hence they were shut off. (Case 2 CAN-NY)

Finally, for Case 2 CAN-ND and CAN-NY, the beam pattern (gain in dBi) over the center cell, calculated over the rectangular region ( $\pm 2.5^\circ$  longitude and  $\pm 2^\circ$  latitude) - is illustrated in Figure 11 below on top of the cells laid down over the coverage area:

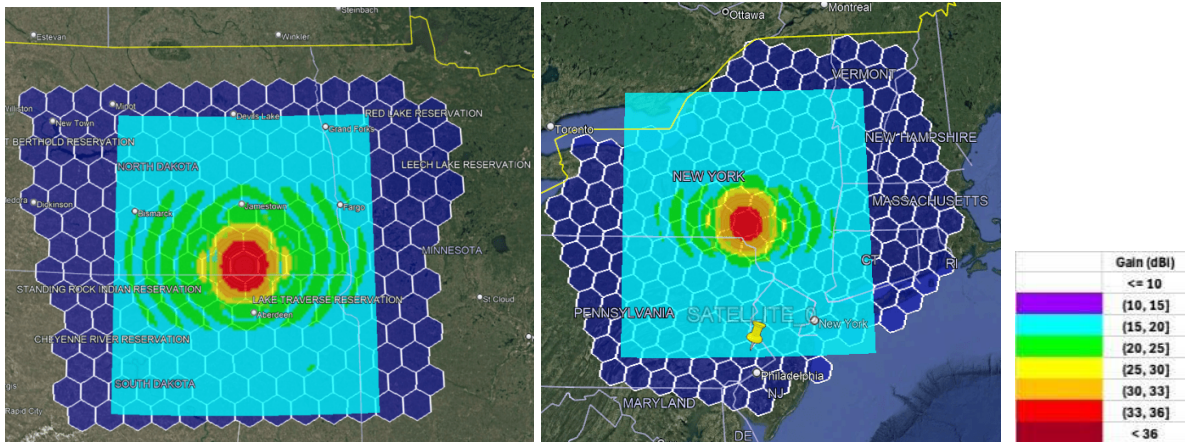


Figure 11 - Beam Pattern over the Center Cell of the Coverage Area (Edge Satellite Position) (Left: CAN-ND; Right: CAN-NY)

**b. Mexican Border:**

**i. Case 1- MEX-AZ and MEX-TX: Satellite Centered Over Coverage Area**

The satellite's beams were centered directly above the test area, uniformly distributing RF power. The simulation modeled the RF field strength in Mexico up to 500 km from the center of the test area. Key findings include:

- **Maximum Aggregate RF Field Strength:**
  - **MEX-AZ: 36.80 dB $\mu$ V/m** (below the 37 dB $\mu$ V/m threshold)
  - **MEX-TX: 36.98 dB $\mu$ V/m** (meeting the 37 dB $\mu$ V/m threshold)

The power distribution illustrated below in Figure 12 and Figure 13 – for MEX-AZ and MEX-TX respectively – demonstrates the gradual attenuation of signal strength as distance from the coverage center increases. Having simulated out to 500 km from the center of the test area demonstrates that there are no interference exceedances for distances beyond 500 km.

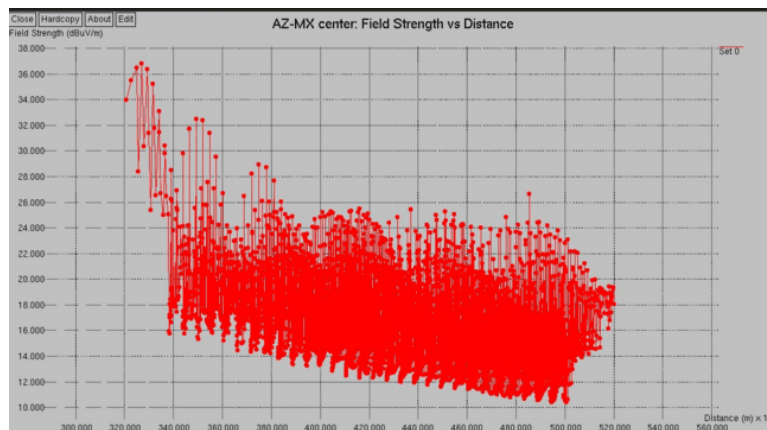


Figure 12 - Field Strength vs. Distance for Centered Satellite Position (MEX-AZ)

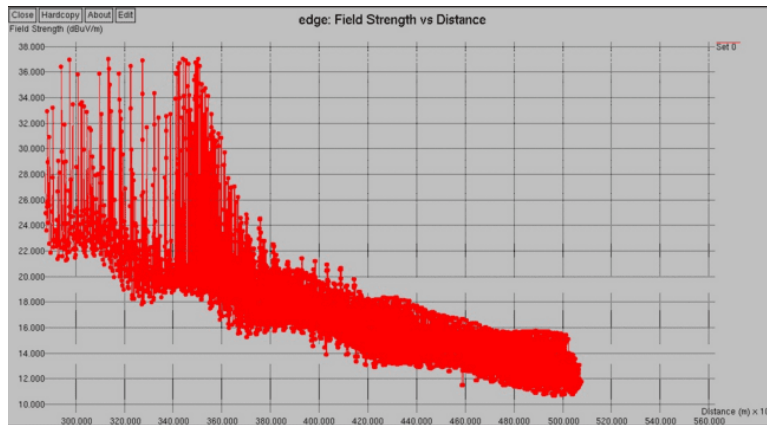


Figure 13 - Field Strength vs. Distance for Centered Satellite Position (MEX-TX)

A geographic visualization of the simulated scenario is shown in Figure 14. The colored area is in Canada up to 500 km from the center of the test area.

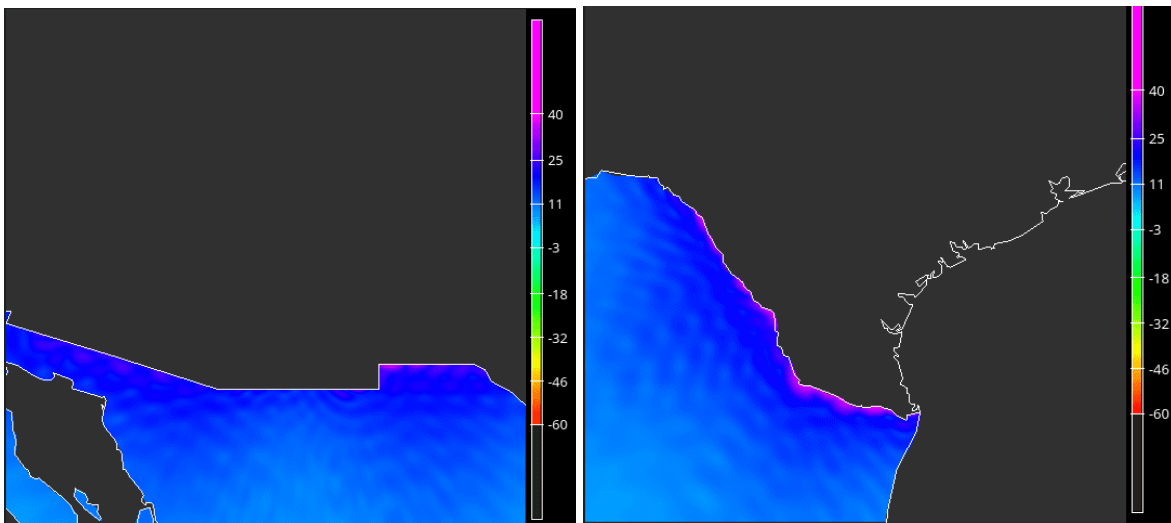


Figure 14 - Field Strength (dBuV/m) Distribution Across the Simulated Border Area for the Centered Satellite Position (Left: MEX-AZ; Right; MEX-TX)

Figure 15 below shows the two test areas relative to the Mexican border. The holes in the center north of the MEX-AZ test area corresponds to cells that are not licensed by Verizon or AT&T in Band 5.



Figure 15 - Map of the Two Test Areas Showing Distance to Actual Border (Left: MEX-AZ; Right: MEX-TX)

For Case 1 MEX-AZ, the results showed that no reduction in beam EIRP (from what achieves 20 dB C/N in the coverage area) was needed to meet the aggregate interference limits, except for one beam close to the Mexican border that required only 0.25 dB EIRP reduction.

For MEX-NY, as shown in Figure 16 below, the results showed that 8 beams needed to be turned off (white beams in Figure 16) and the remaining beams next to the border required an EIRP reduction. The remainder beams (not next to the border) did not require any EIRP reduction.

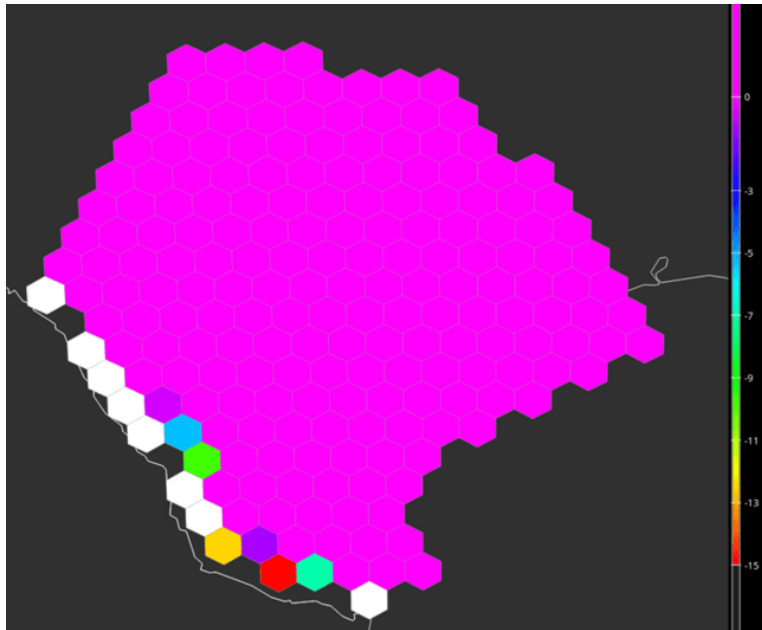


Figure 16 - Map of 200 beams in MEX-TX Test Area showing amount of EIRP reduction (in dB) required in each beam to meet the aggregate interference limits. White cells required more than max allowable EIRP reduction of 15 dB and hence they were shut off. (Case 1 – MEX-TX)

Finally, for Case 1 MEX-AZ and MEX-TX, the beam pattern (gain in dBi) over the center cell is illustrated below on top of the cells laid down over the coverage area:

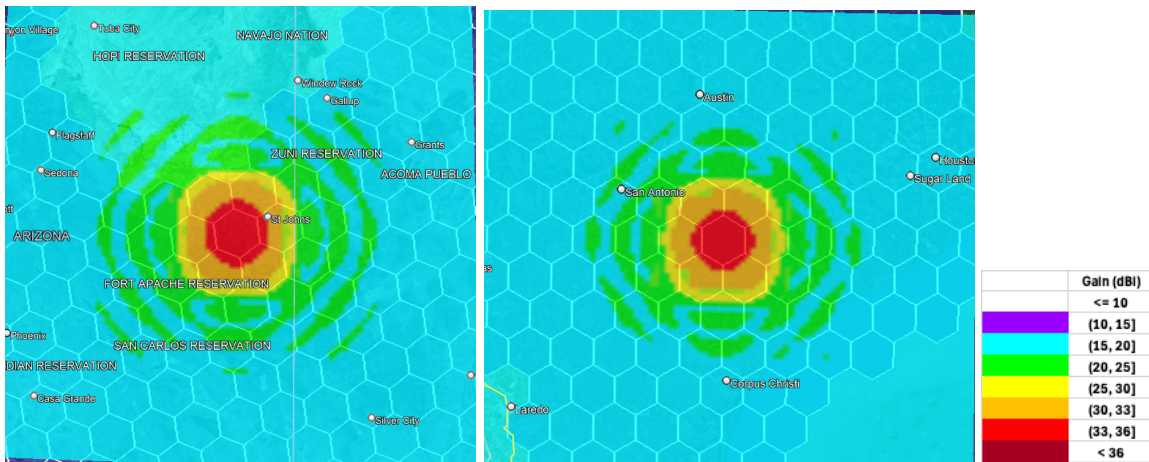


Figure 17 - Beam Pattern over the Center Cell of the Coverage Area (Centered Satellite Position) (Left: MEX-AZ; Right: MEX-TX)

**ii. Case 2 MEX-AZ and MEX-TX: Satellite at Edge of Coverage Area**

In this case, the satellite was repositioned at the extreme edge of the test zone, orienting its beams towards the simulated border. The simulation modeled the RF field strength in Mexico up to 500 km from the center of the test area. Results showed:

- **Maximum Aggregate RF Field Strength:**

- **MEX-AZ: 36.9 dB $\mu$ V/m** (meeting the 37 dB $\mu$ V/m threshold)
- **MEX-TX: 36.98 dB $\mu$ V/m** (meeting the 37 dB $\mu$ V/m threshold)

The power distribution in Figure 18 and Figure 19 – for MEX-AZ and MEX-TX respectively – demonstrates the effect of beam focusing over lower elevation angles, with slightly higher emissions relative to the centered satellite position.

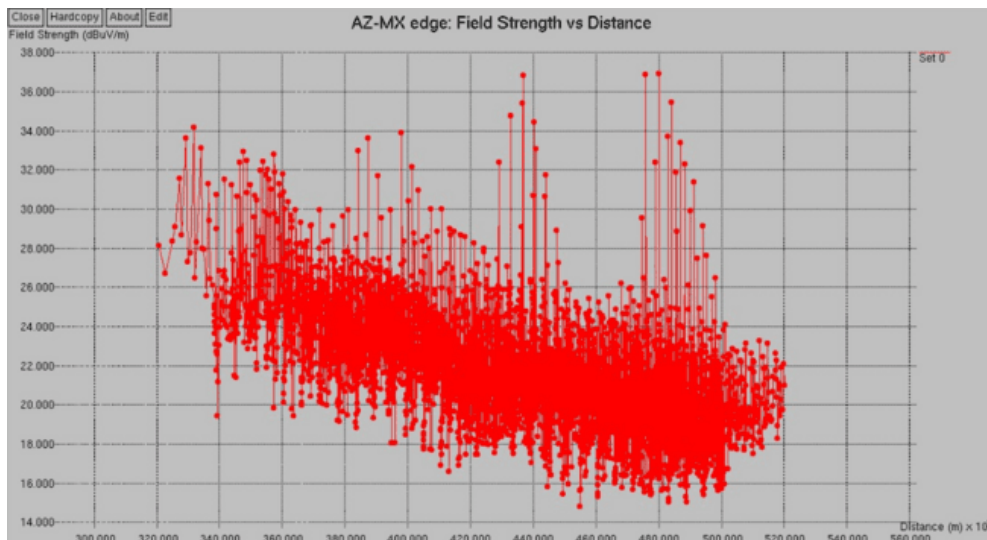


Figure 18 - Field Strength vs. Distance for Edge Satellite Position (MEX-AZ)

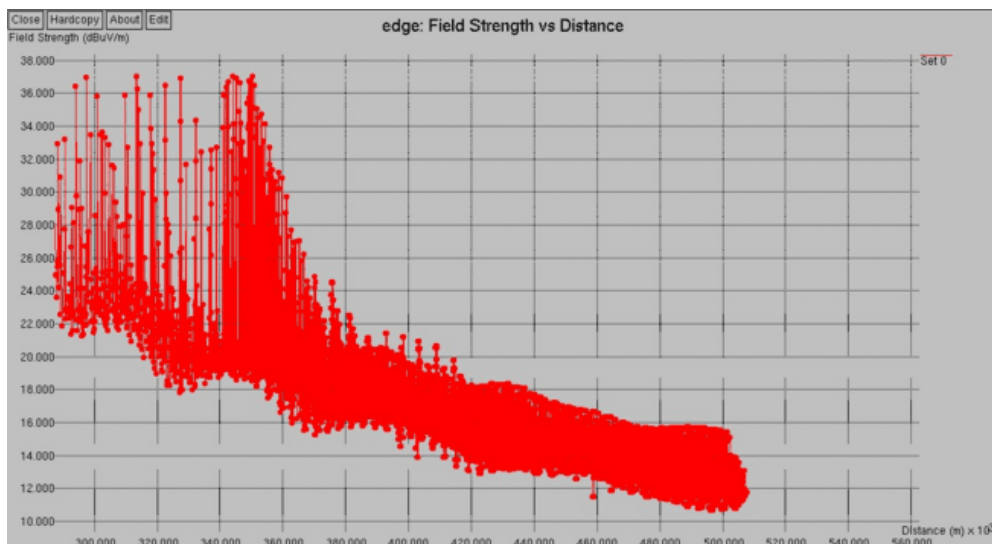


Figure 19 - Field Strength vs. Distance for Edge Satellite Position (MEX-TX)

A geographic illustration (Figure 20) highlights the RF propagation pattern under these scenarios, showing power distribution extending towards the simulated border.

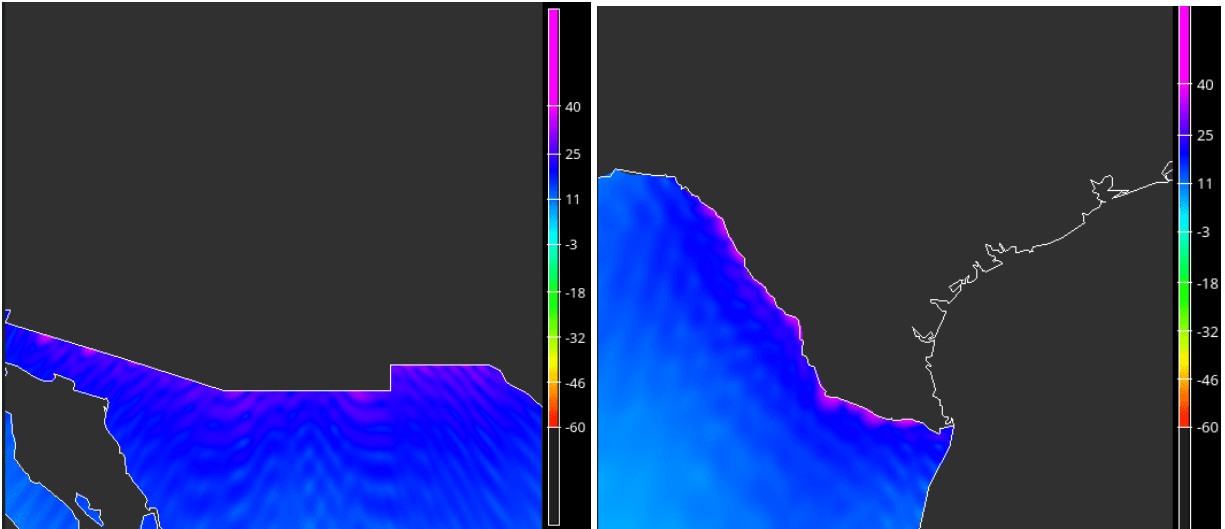


Figure 20 - Field Strength (dBμV/m) Distribution Across the Simulated Border for the Edge Satellite Position (Left: MEX-AZ; Right: MEX-TX)

For MEX-AZ, as shown in Figure 21 below, the results showed that no reduction in beam EIRP (from what achieves 20 dB C/N in the coverage area) was needed to meet the aggregate interference limits, except for two beams close to the Mexican border by only 1.75 and 5 dB.

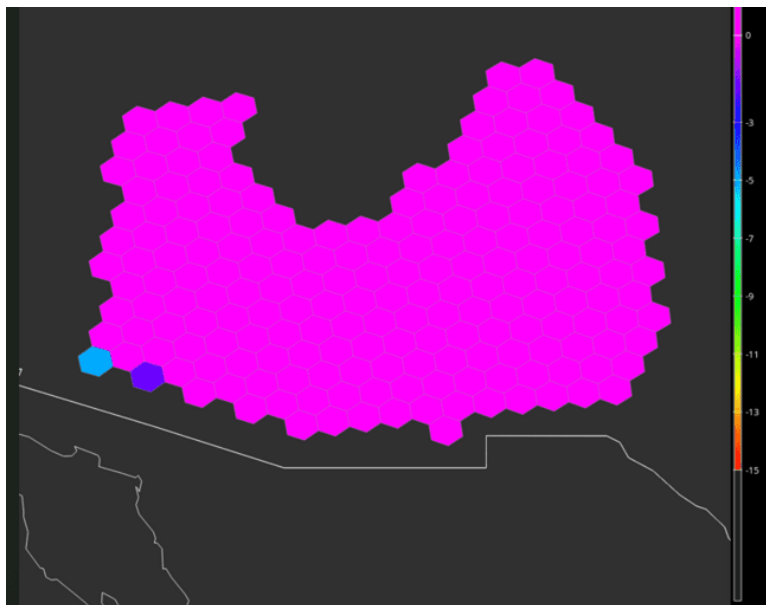


Figure 21 - Amount of EIRP reduction (in dB) required in each beam to meet the aggregate interference limit in Mexico (MEX-AZ)



For MEX-TX, as shown in Figure 22 below, the results showed that 8 beams needed to be turned off (white beams in Figure 22). The remaining beams next to the border and even some in the next row required an EIRP reduction. The remainder beams did not require any EIRP reduction.

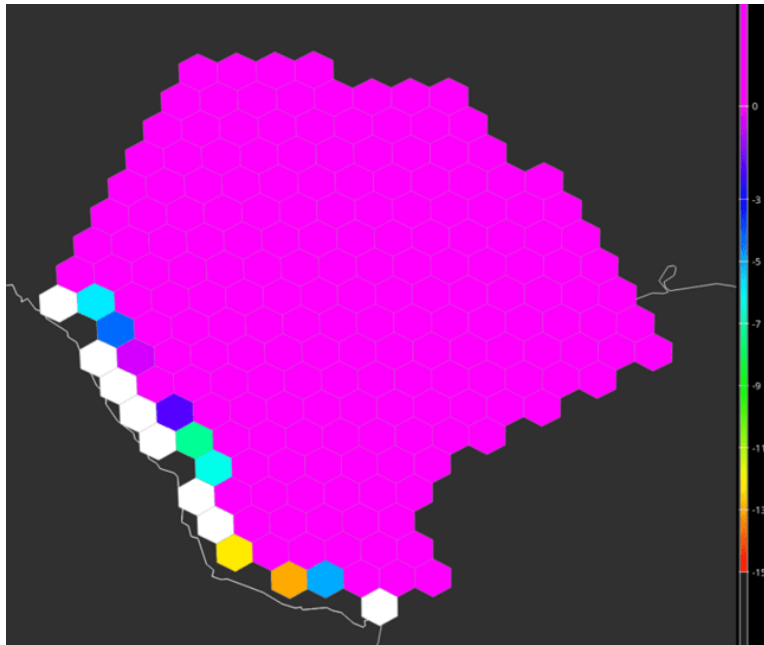


Figure 22 - Map of 200 beams in CAN-NY Test Area showing amount of EIRP reduction (in dB) required in each beam to meet the aggregate interference limits. White cells required more than max allowable EIRP reduction of 15 dB and hence they were shut off. (Case 2 MEX-TX)

Finally, for Case 2 MEX-AZ and MEX-TX, the beam pattern (gain in dBi) over the center cell, calculated over the rectangular region ( $\pm 2.5^\circ$  longitude and  $\pm 2^\circ$  latitude) - is illustrated below on top of the cells laid down over the coverage area:

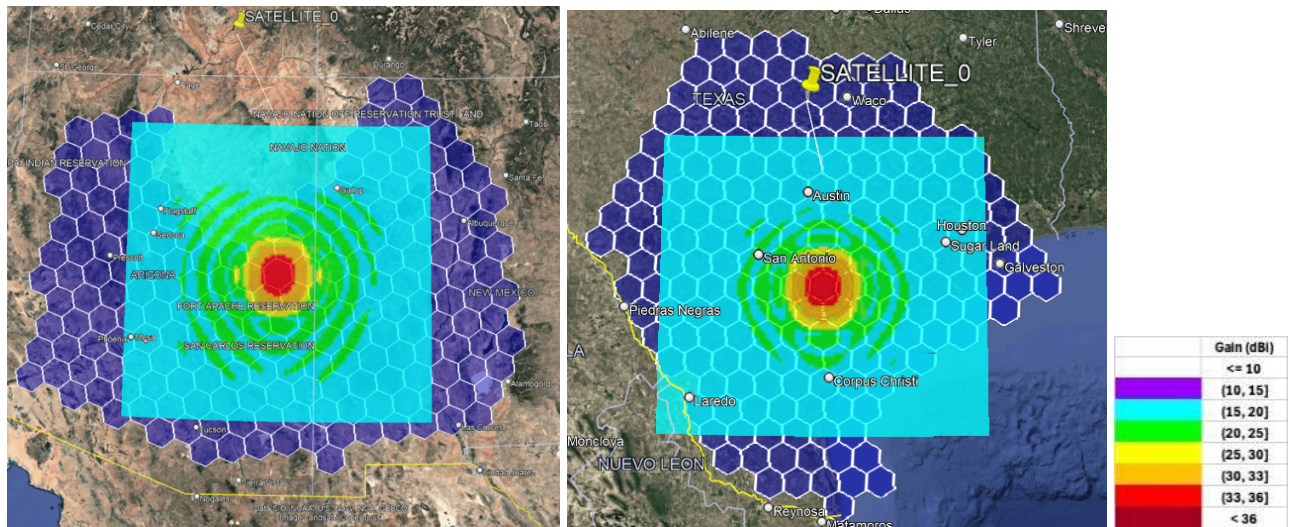


Figure 23 - Beam Pattern over the Center Cell of the Coverage Area (Edge Satellite Position) (Left: MEX-AZ; Right: MEX-TX)

## 5. Conclusion

The technical analysis confirms that RF emissions from the AST satellite covering test areas in the US close to the Canadian and Mexican borders comply with international interference thresholds. Specifically:

1. For **Case 1** (Centered Satellite), emissions measured at most **37.0 dB $\mu$ V/m** in Canada and **36.98 dB $\mu$ V/m** in Mexico - over the two test areas.
2. For **Case 2** (Edge Satellite), emissions measured at most **37.0 dB $\mu$ V/m** in Canada and **36.98 dB $\mu$ V/m** in Mexico – over the two test areas.

In both scenarios, the RF power levels remained below the **40 dB $\mu$ V/m threshold** in Canada and **37 dB $\mu$ V/m threshold** in Mexico. This analysis demonstrates that the AST satellite's beam shaping and radiated power are effectively managed to minimize interference. The findings ensure compliance with international standards while validating the system's operational capabilities for the test areas.