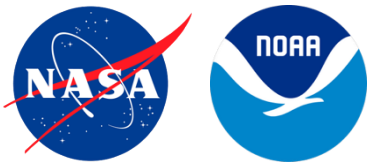


PRELIMINARY ASSESSMENT OF THE IMPACT ON THE V-BAND OXYGEN CHANNELS FROM SATELLITE COMMUNICATION UPLINKS

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EVERY WEEK THE NEWS HEADLINES ANNOUNCE A NEW COMMUNICATION CONSTELLATION

Starcloud's path to 88,000 computing satellites

Qianfan constellation deployment hits 200 satellites with Long March 8 and 6A launches

China launches test direct-to-device satellites for multiple projects

Loft Orbital expands into full-service constellation deals

China files ITU paperwork for megaconstellations totaling nearly 200,000 satellites

Amazon Leo passes 300 satellites with Atlas and Ariane launches

Orbital files plans for 100,000 orbital data centers

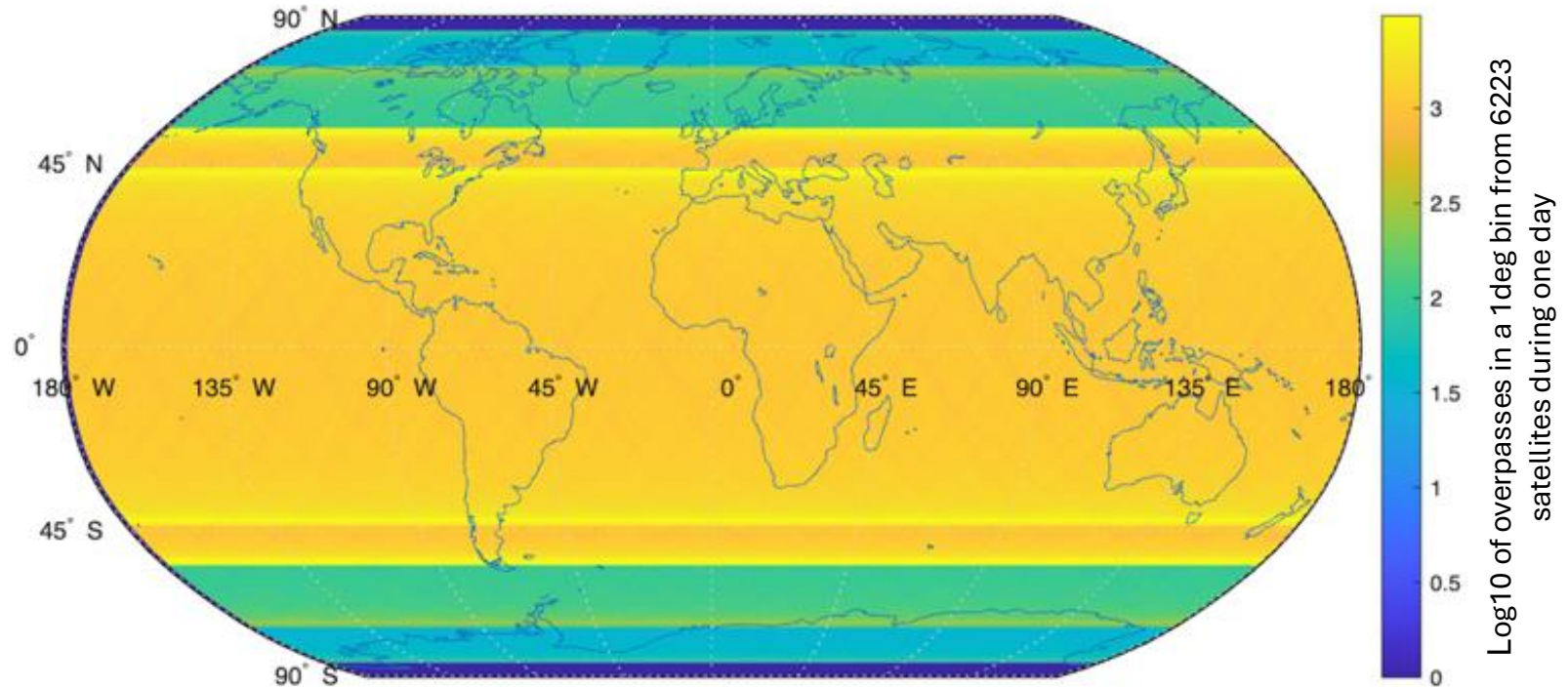
Cowboy files plans for up to 20,000 orbital data centers

FCC clears Logos to deploy more than 4,000 broadband satellites

SpaceX files plans for million-satellite orbital data center constellation

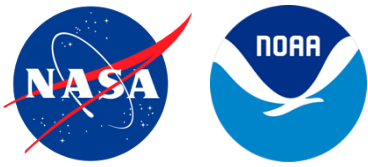
Open Cosmos advances broadband plans with spectrum once held by Rivada

THESE CONSTELLATIONS AFFECT REMOTE SENSING ASSETS



A satellite that is 'overhead' when seen from the ground is 'underfoot' when seen by a higher-orbit asset (like a EESS instrument)

EESS = Earth Exploration Satellite System



SHARING THE V-BAND SPECTRUM

FCC granted the windows from 47.2 to 50.2 and from 50.4 to 52.4 GHz for Satellite Communications (these are Unprotected Ranges of Spectrum), but they overlap ATMS Channel 4 and abuts Protected Ranges that are in use.

Absent mitigation measures, the current license grant specifications for the 47.2-52.4 GHz spectrum will certainly make ATMS channel 4 unusable (in-band interference) and it will most likely affect channels 3 and 5 (and possibly also channel 6 and above).

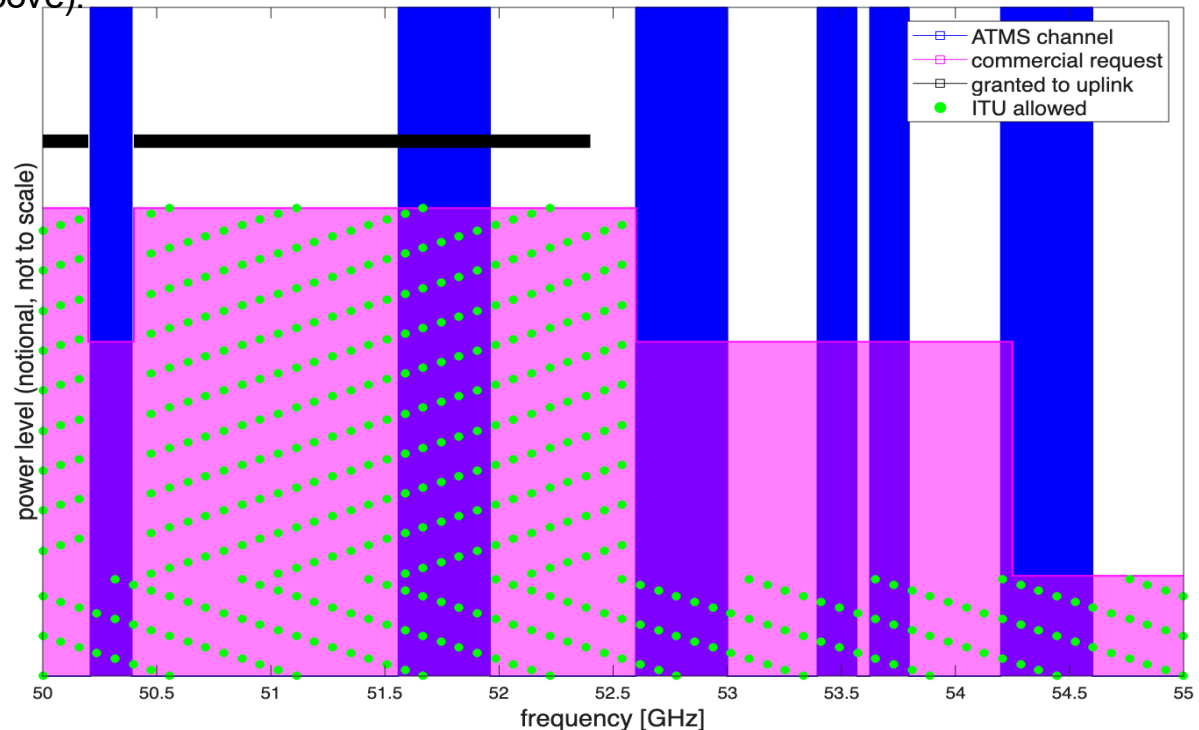
Expected consequences:

Losing channel 4 on ATMS should not impact the NWS NWP modeling.

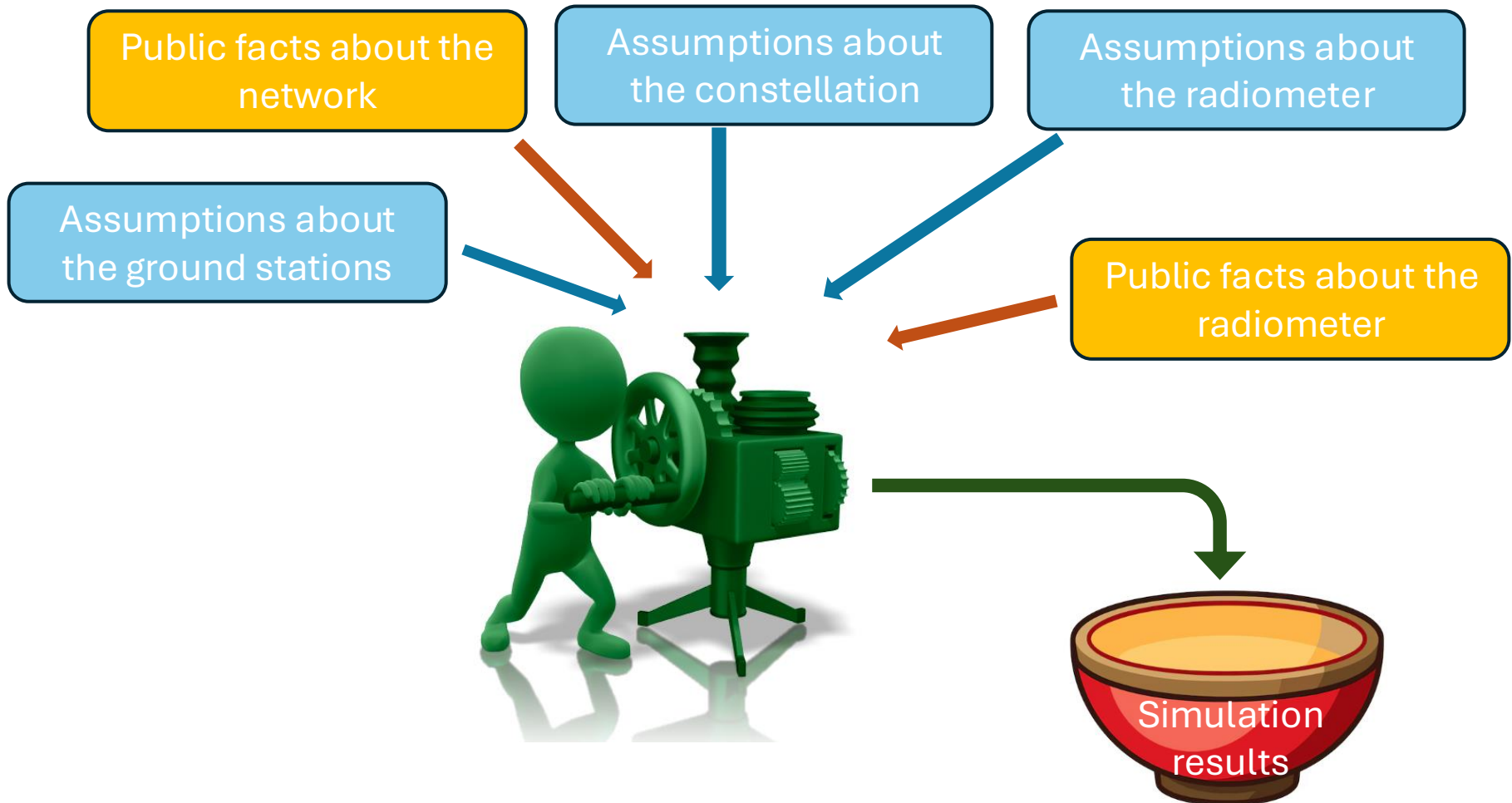
Data loss from other ATMS channels will impact NWP models, with the effect becoming more severe as the channel's frequency increases.

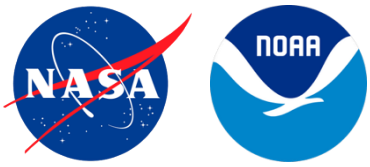
Unknown variables:

What is the cumulative affect of interference by the the ever-increasing number of transmitters globally and number of satellites in orbit



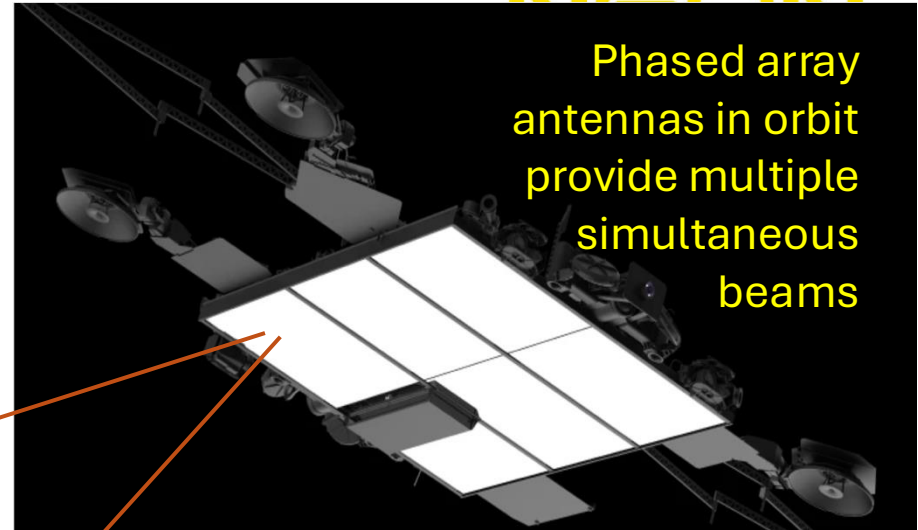
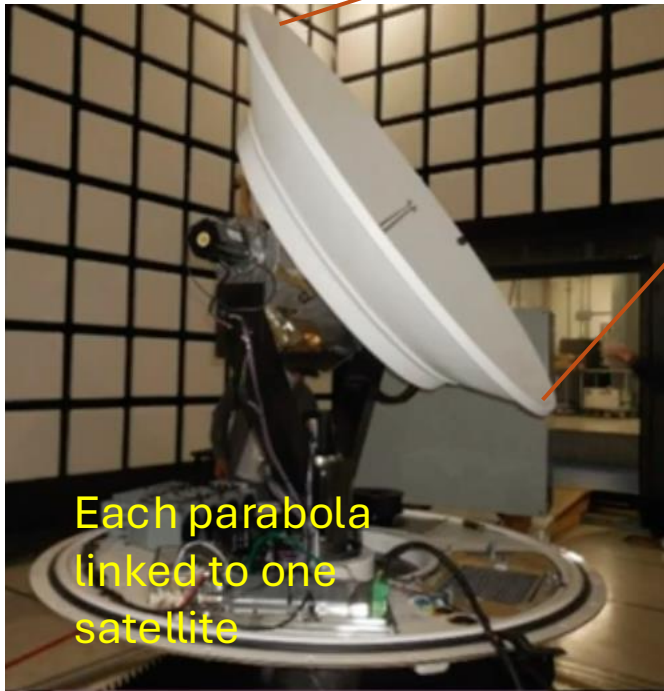
BUILD A MODEL AND RUN WITH IT





STARLINK NETWORK

From www.reddit.com/r/Starlink

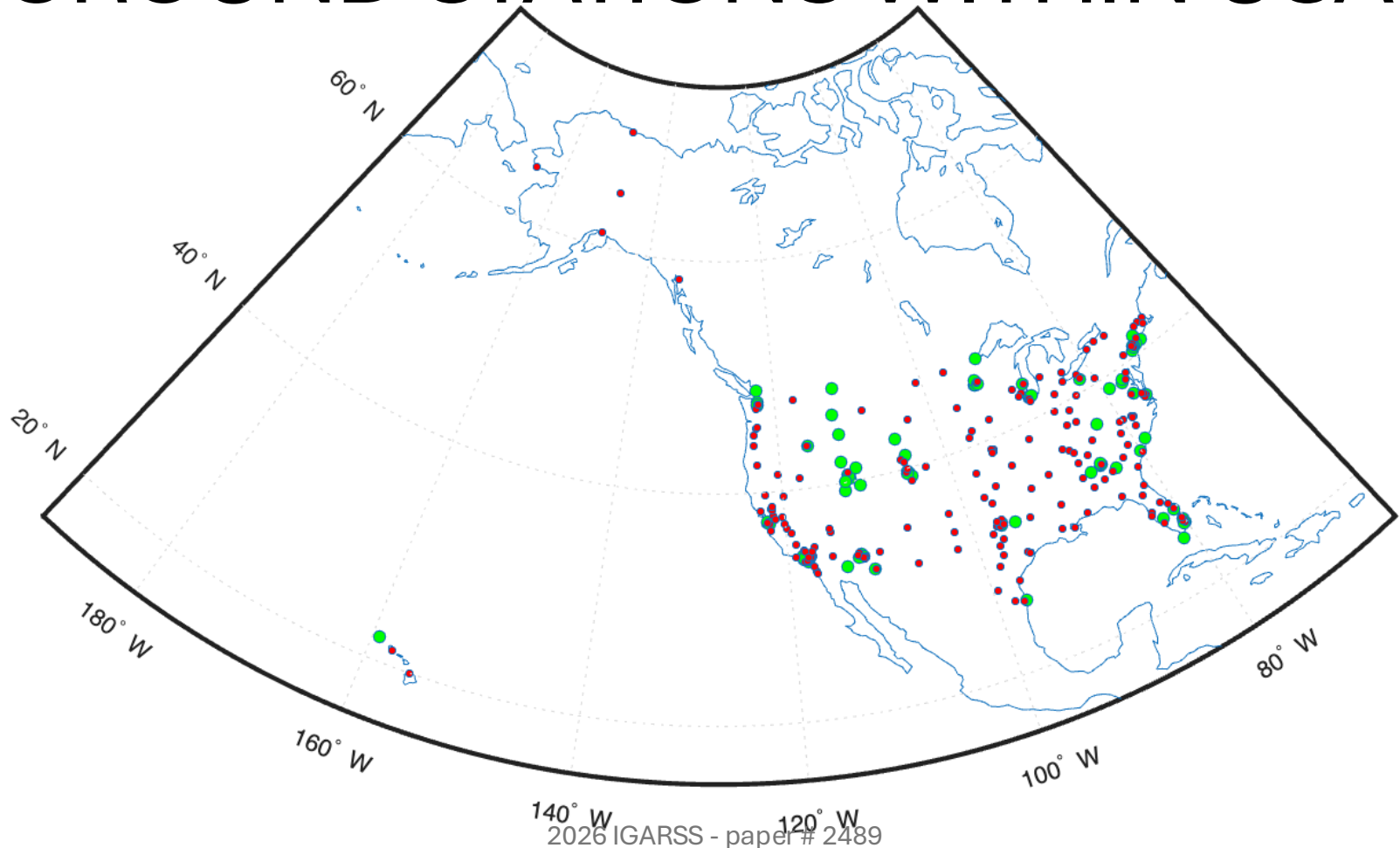


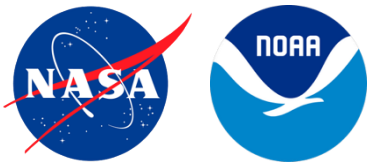
From starlink.com/technology

From Google Earth

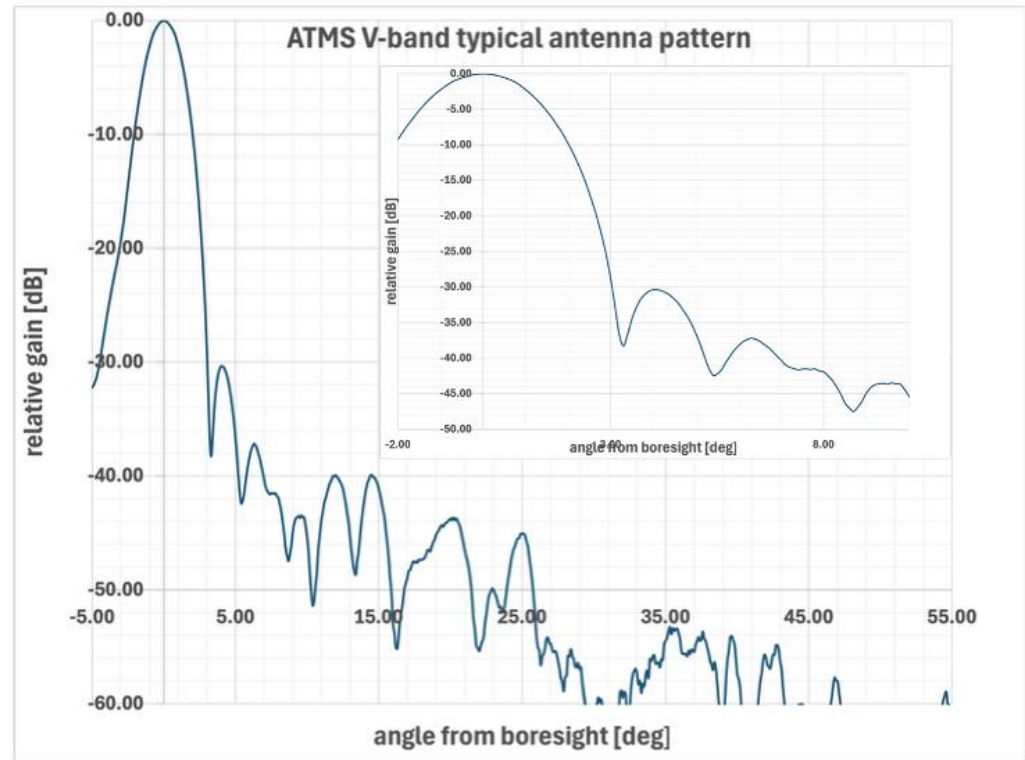
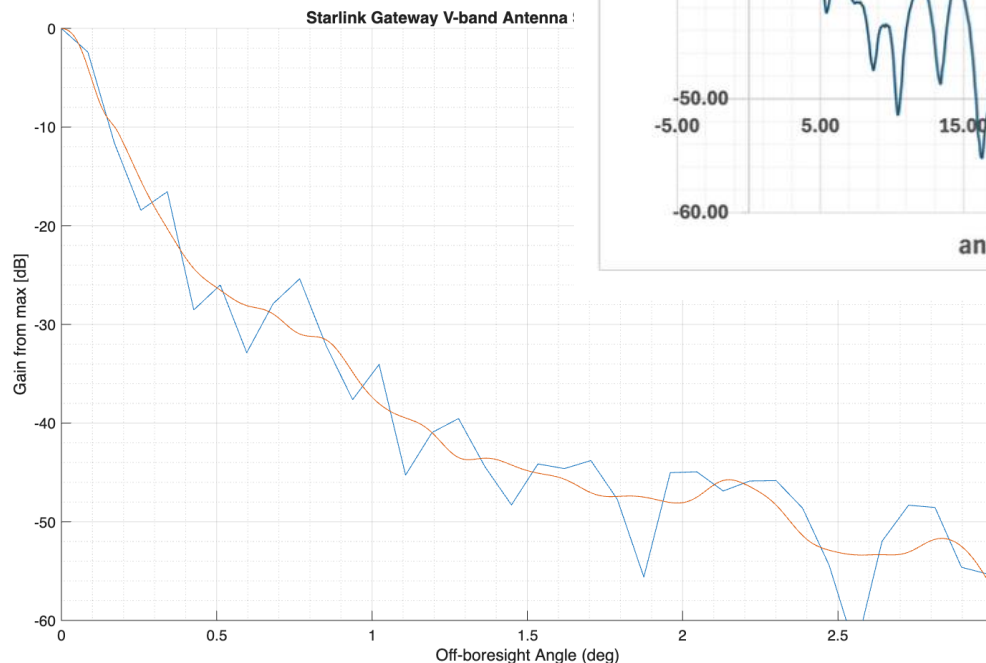


NOTIONAL DISTRIBUTION OF 300 GROUND STATIONS WITHIN USA

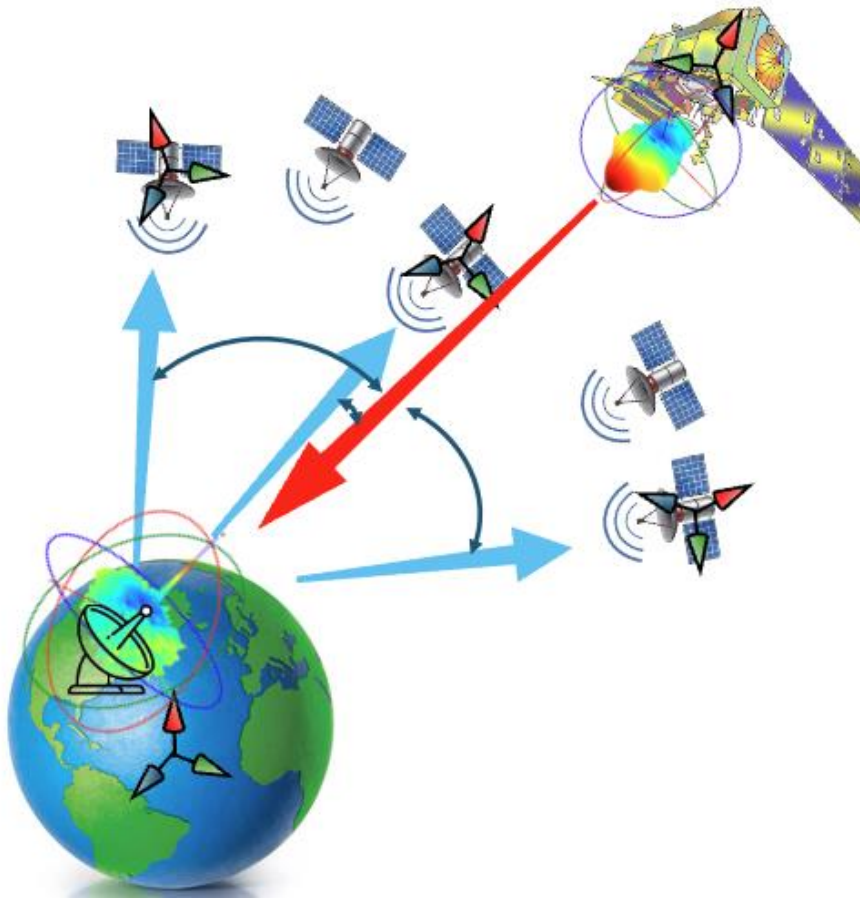




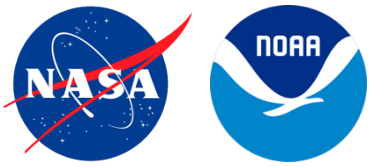
BEAMPATTERN IS THE
CONVOLUTION OF THE
TRANSMITTER (SOURCE)
ANTENNA AND THE
RECEIVER (VICTIM)
ANTENNA



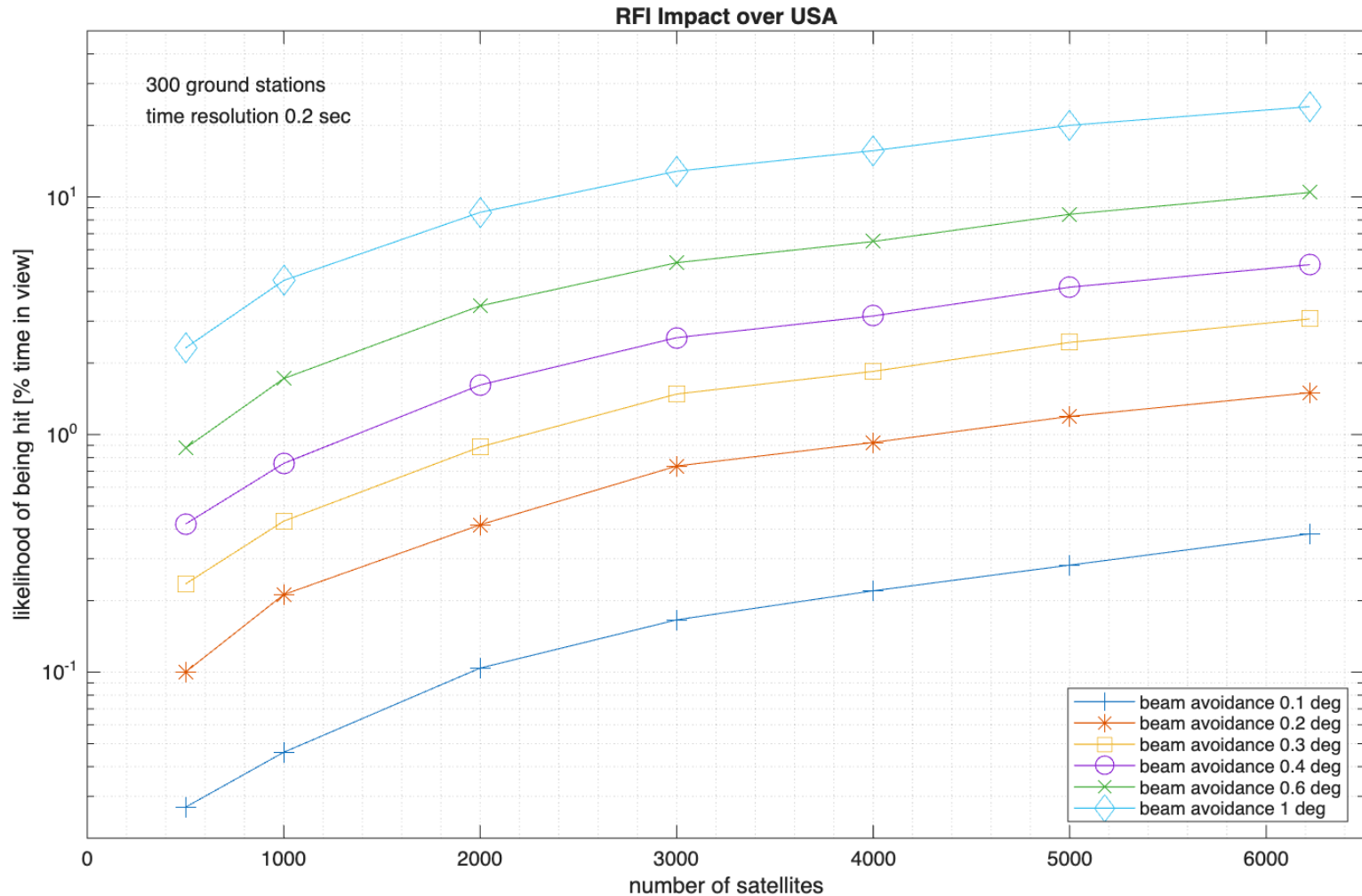
SIMULATION STEPS



- Select one representative victim EESS instrument/satellite combination
- Select a time resolution
- Find out when the victim EESS has LoS above the horizon as seen from a ground station.
- Find out which satellites have LoS above the horizon as seen from the ground station at those times.
- Calculate the angle between the LoS of each satellite and the LoS of the victim EESS.
- Calculate the antenna gain (attenuation) corresponding to that angle.
- Repeat for each ground station.

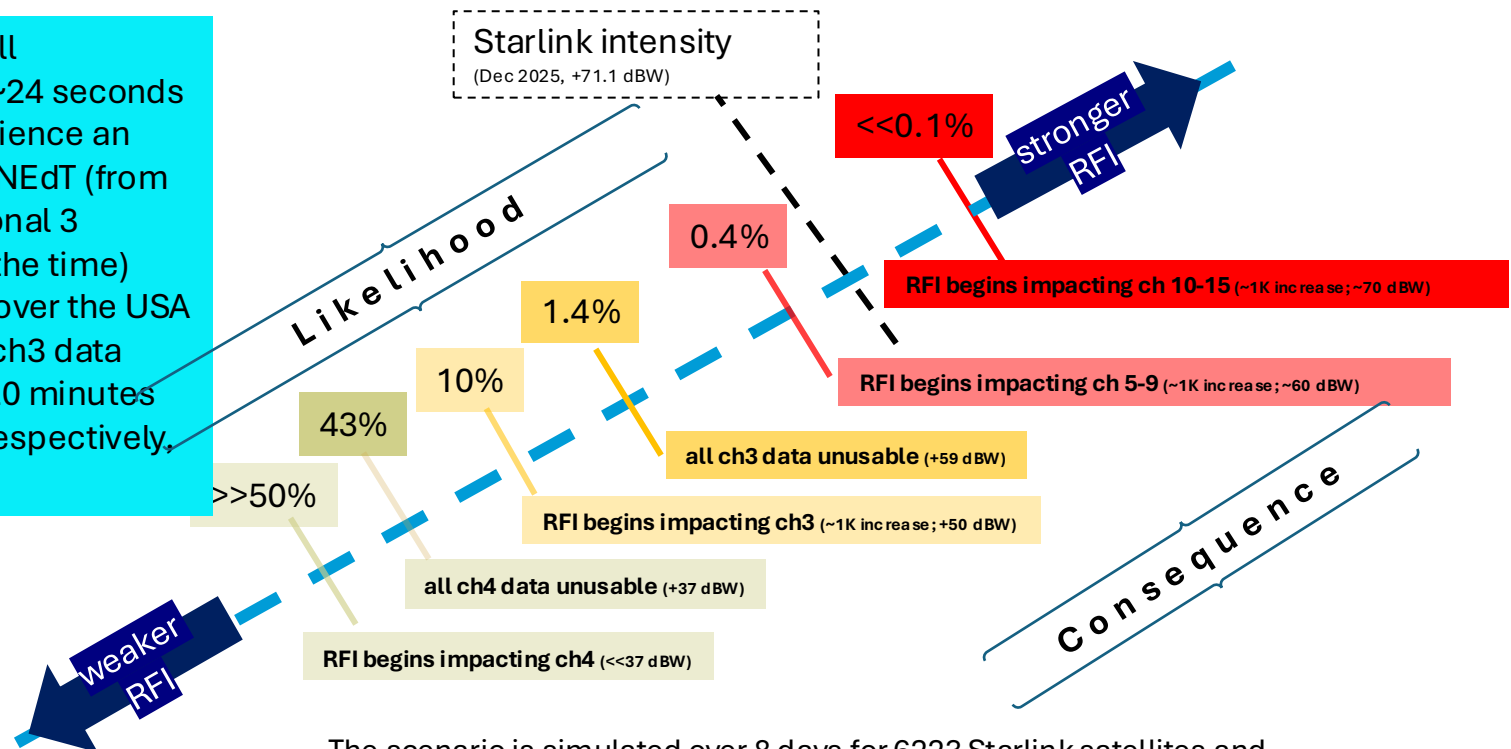


SIMULATION RESULTS

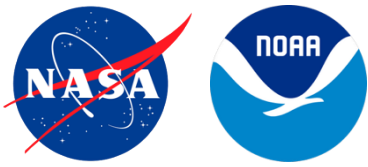


ATMS CONSEQUENCES VERSUS GATEWAY STATION INTENSITY

In one day ch3 will completely lose ~24 seconds of data and experience an increase of 1K in NEdT (from RFI) for an additional 3 minutes (10% of the time) while measuring over the USA . Worldwide the ch3 data loss becomes ~ 20 minutes and ~2.6 hours, respectively, per day.



The scenario is simulated over 8 days for 6223 Starlink satellites and 300 Gateway stations distributed in the USA (50 states and territorial waters). Each station has 40 beams and is connected 100% of the time to any in-view satellite.



CONCLUSIONS

- The license grant of the 50Ghz spectrum (a done deal) will impact ATMS
- A) ATMS Channel 4 will be the most impacted; B) adjacent channels will not remain untouched.
- A) Losing channel 4 on ATMS should not impact the NWS NWP modeling; loss of data from other ATMS channels will impact NWP models
- B) Loss of data on the other channels will depend on power and angle of incidence; the chance to damage ATMS due to excessive power levels (overheating) carries and infinitesimal chance to damage ATMS
- Unknown variable: the number transmitters globally and the number of satellites in orbit is bound to increase; we do not know if the combined effect will scale linearly, reach saturation, or enter a non-linear regime which would render any mitigation moot.



MITIGATION STEPS (FUTURE WORK)

Work with satcomm operators to limit the number of operational satellites

Work with satcomm operators to limit the number of transmitters

Work with satcomm operators to reduce the power output of the transmitters

Work with satcomm operators to program the transmitters to avoid illuminating EESS assets

Re-Engineer existing EESS assets : impossible for in-orbit instruments due obvious constraints and not advisable for ready-to-launch units due to cost and schedule implications

Develop software tools to detect corrupted data and remove them before they are ingested by the NWP

Design next-gen instruments to reduce vulnerability to this interference mechanism

Accelerate deployment of less-RFI-susceptible instruments to quickly populate backbone w/sounders that have RFI detection capability + less vulnerability than the present assets

Increase the number of flight units to capture multiple looks (expecting not all the looks will be contaminated)