Developments in TV Channel 37 (608-614 MHz) in the U.S.

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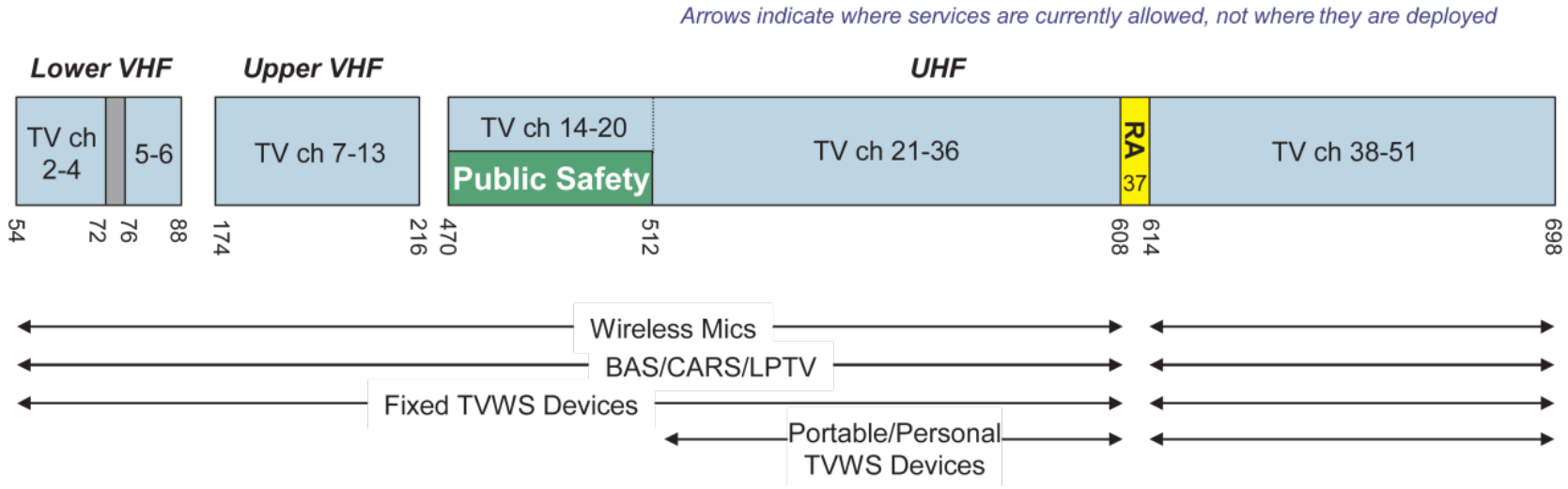
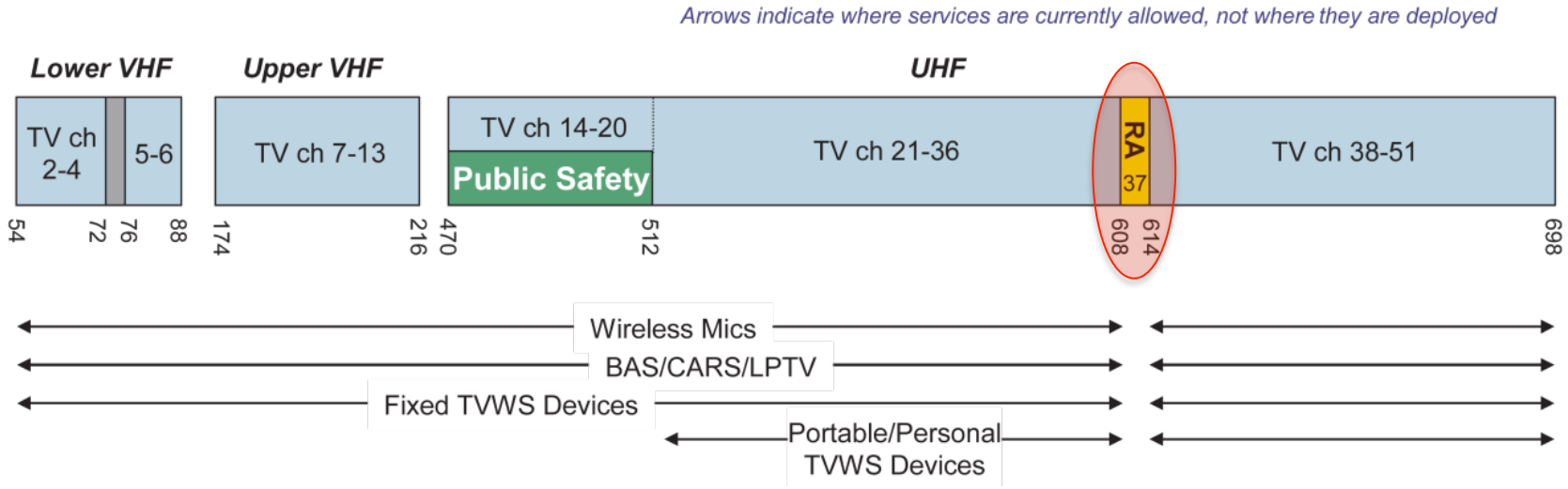
Current Environment

U.S. TV Band Today



- U.S. uses 6 MHz TV channel bandwidth
- Digital broadcast standard is ATSC
- All full-power TV stations have transitioned to digital
- Remaining low-power stations must transition by September 1, 2015

U.S. TV Channel 37 Today



- TV channel 37 (608-614 MHz) is allocated in the U.S. on a co-primary basis to the land mobile and radio astronomy services
  - Land mobile use is limited to the Wireless Medical Telemetry Service (WMTS)
  - WMTS must coordinate with RAS
- Internationally, 608-614 MHz is allocated to RAS in Region 2, and is noted in 5.149 in Regions 1 & 3
  - Corresponding TV channel number varies around the world due to difference in TV channel bandwidths

TV White Spaces

- FCC has authorized the use of locally-vacant TV channels (spectrum “white space”) for low-power unlicensed devices
- The technical parameters TV Band Devices (TVBDs) and the method by which TVBDs may access white spaces are carefully prescribed by the FCC
- Channel 37 is not available for TVBD use and additional criteria are in place to protect WMTS and RA

TV Band Devices (TVBDs)

- Fixed
  - Max 1 W power, 4 W EIRP
  - Geolocation (e.g. GPS) or professionally installed
  - Access TV white spaces database at least once per day
- Mode I Personal/Portable
  - 100 mW EIRP max; permanently-attached antenna
  - Retrieves channels from Fixed or Mode II device
- Mode II Personal/Portable
  - 100 mW EIRP max; permanently-attached antenna
  - Geolocation every 60 s; access database every 100 meters
- Additional power restrictions apply:
  - When operating on frequencies adjacent to in-use TV channels
  - For devices that use sensing only (must pass FCC tests)

Protection of Channel 37 from TVBDs

- No TVBD operation at all within 2.4 km of ATA, Arecibo, Green Bank, VLA, and VLBA
- No TVBDs permitted on the first channel on each side of channel 37 that is not occupied by a licensed service
  - Rule is actually in place to provide two channels in every location for wireless microphones, not for RA protection
- Lower out-of-band emission limits in channels 36-38 (602-620 MHz)
- Antenna height (AGL and HAAT) limits for fixed TVBDs

TVWS Database

- Fixed or Mode II personal/portable TVBDs must consult a database at least once each 24 hours (or when moved 100 m for Mode II devices) to determine which channels are available for TVBD use at their location
- Mode I personal/portable devices must receive a list of allowed channels through a Fixed or Mode II device
- Databases are kept by multiple commercial entities, and each must give exactly the same answer

TV Bands Database Contents

- Full-power TV broadcast stations
- Low Power & Class A TV stations
- Broadcast auxiliary point-to-point
- Land mobile radio systems on channels 14-20
- Offshore radiotelephone service (Gulf region)
- Cable/satellite head-end receive sites
- TV translator receive sites
- Fixed TVBDs
- Authorized wireless microphones
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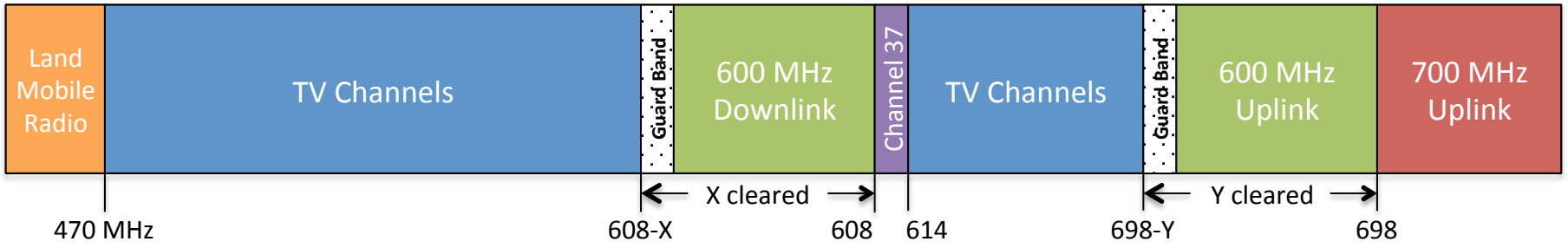
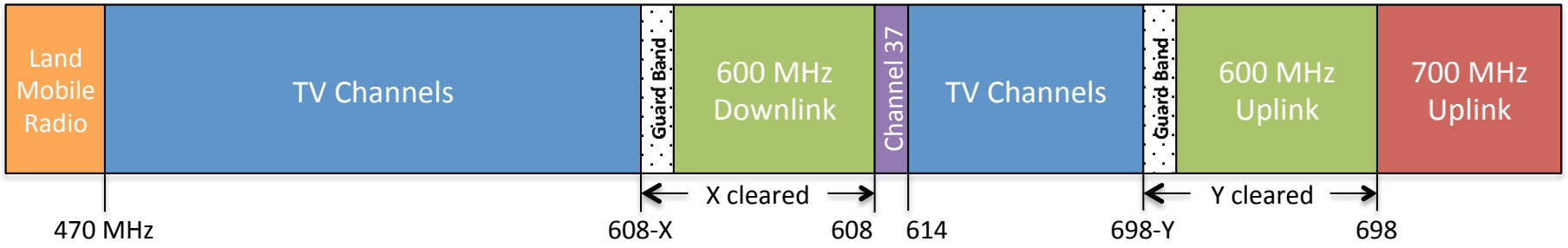
TV Band Developments

Incentive Auction



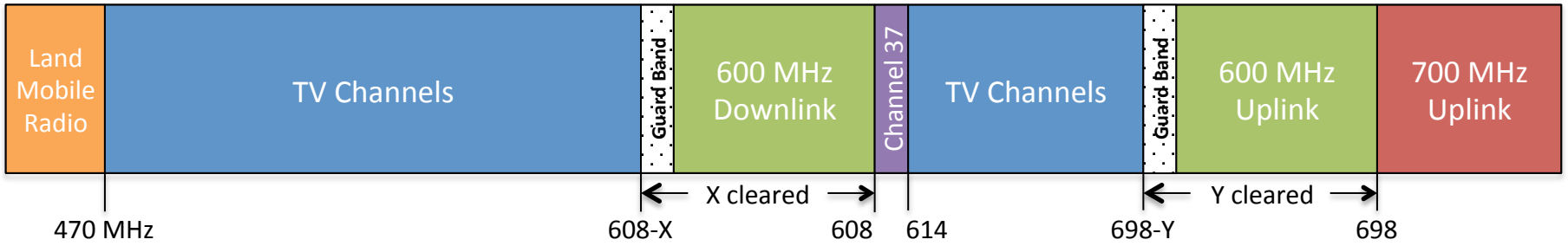
- Voluntary buy-back of broadcast TV spectrum rights
  - Broadcasters can bid to give up their license in exchange for money (reverse auction)
- Number of channels cleared in a given market will vary
  - "X" channels cleared for downlink, "Y" channels cleared for uplink
- Very complex auction, involving reverse auction, then new allotment calculations, followed by forward auction
  - First-ever such spectrum auction in the world
- Auction presently scheduled for mid-2015 timeframe

Refarming TV Spectrum



- Refarming proposals
  - Down from 51 (698 MHz) and 36 (608 MHz)
    - Lead proposal
  - Down from 51 and 32 (584 MHz)
    - Possible relocation of channel 37 to channel 33 (584-590 MHz)
  - Down from 51
    - If more than 84 MHz (14 channels) is cleared, channel 37 comes into play
  - In from 51 and 21 (470 MHz)

Incentive Auction & Channel 37



- Many possible dispositions of channel 37 after auction
  - Use remains the same (RA & WMTS)
    - Remains in 608-614 MHz
    - Moved to another frequency in the same general location
  - Use changes
    - Remains in 608-614, but unlicensed devices are allowed in
    - RA allocation is traded for a new allocation at a lower frequency (e.g., near 60 or 70 MHz) to support EOR and other low-frequency astronomy
    - RA allocation is lost altogether (not likely)
- In any event, spectrum environment will become more challenging than it is now due to presence of mobile broadband and increased density of TV channel packing

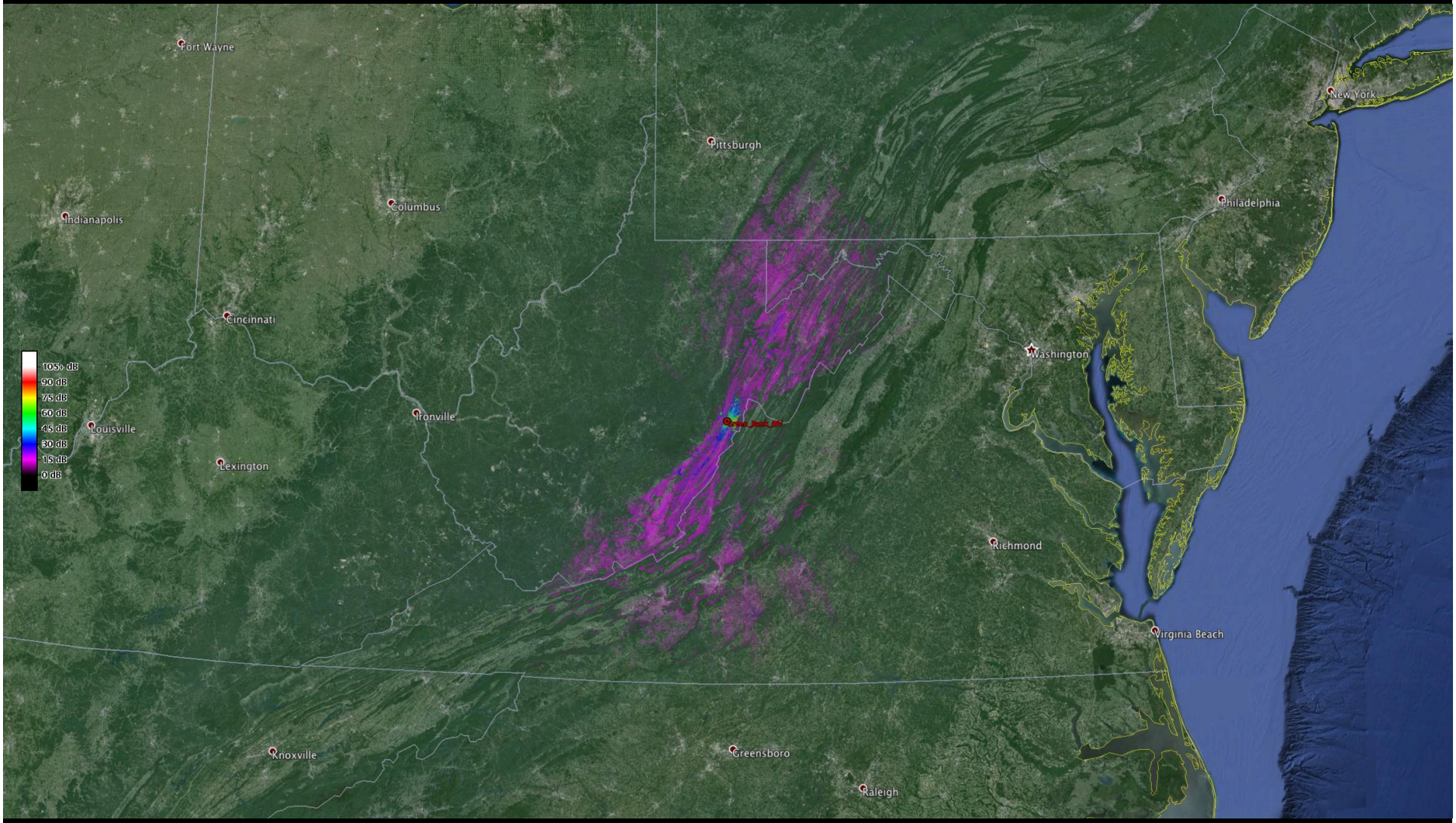
TVBDs in Channel 37

- If TVBDs are allowed in channel 37, the use of the band for RA would have to be coordinated to avoid interference
- Mitigation measures would likely be addressed in a Further Notice of Proposed Rulemaking issued by FCC
- One scenario is to integrate channel 37 RA utilization into TVWS database
- What would coordination distance be?

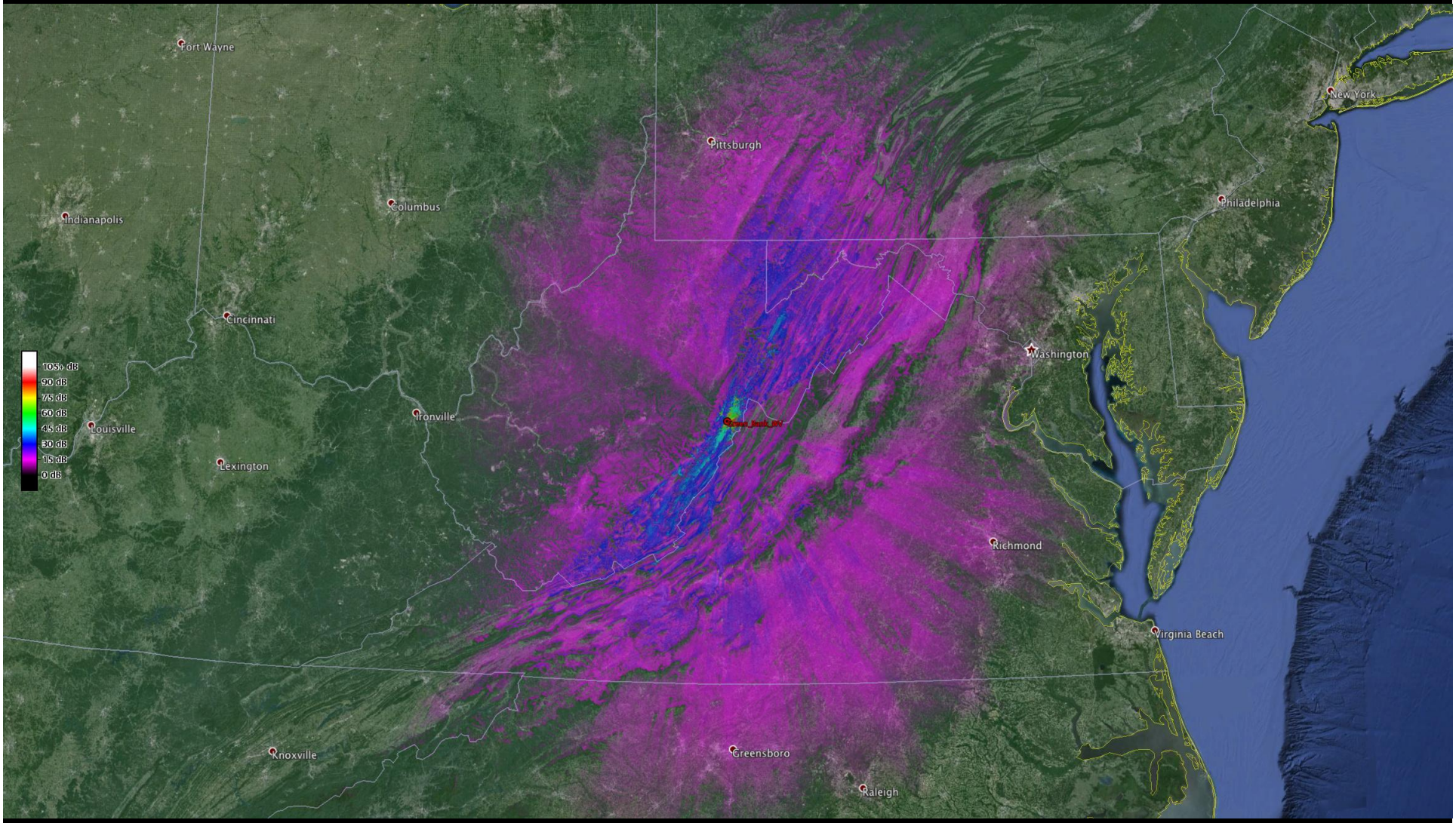
Modeling Overview

- Longley-Rice ITM point-to-point path loss
- Assuming “worst-case” 30m AGL outdoor TVBD emitter
  - 40 mW Portable Mode 1 TVBD
  - 100 mW Portable Mode 2 TVBD
  - 4 W Fixed TVBD
- Radio Astronomy sensitivity based on ITU-R RA.769-2
  - -172 dBm / 6 MHz for single dish
  - -131 dBm / 6 MHz for very long baseline interferometry
- Modeling 2% time exceeding Rec RA.769-2 (based on Rec RA.1513-1)
- Mapped TVBD power relative to RA.769-2 reference levels

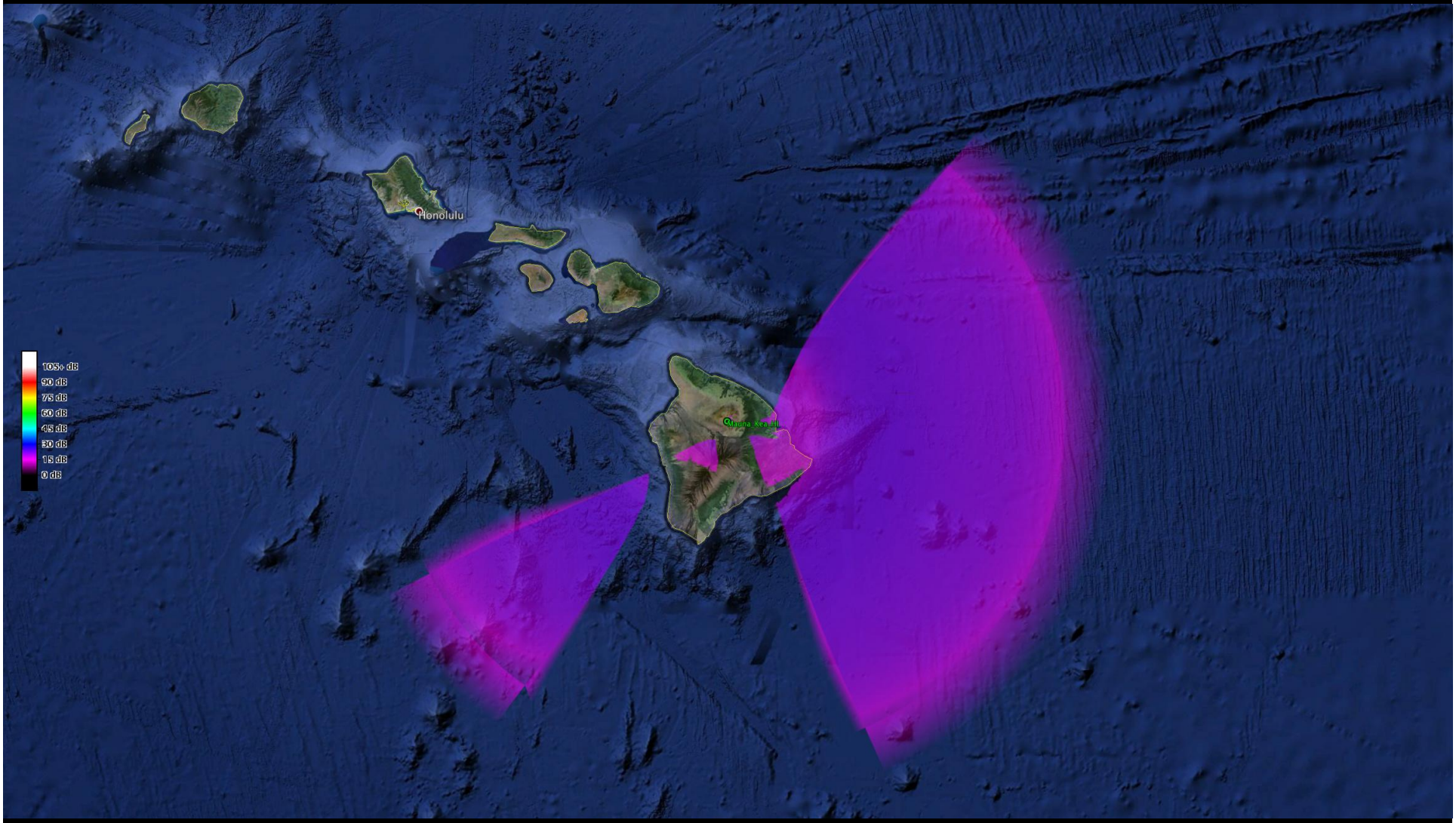
Green Bank, WV, single dish, 100 mW TVBD



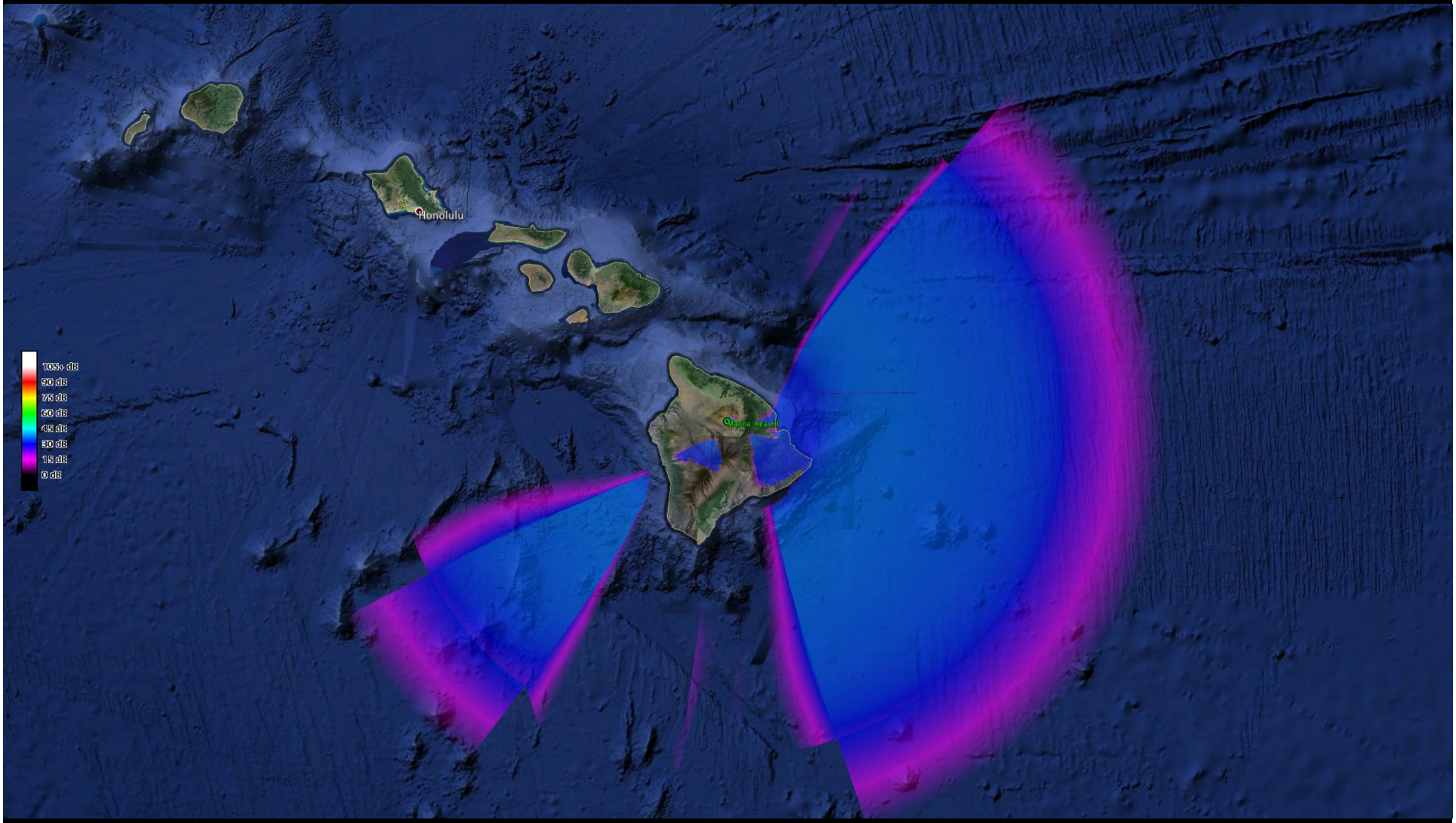
Green Bank, WV, single dish, 4 W TVBD



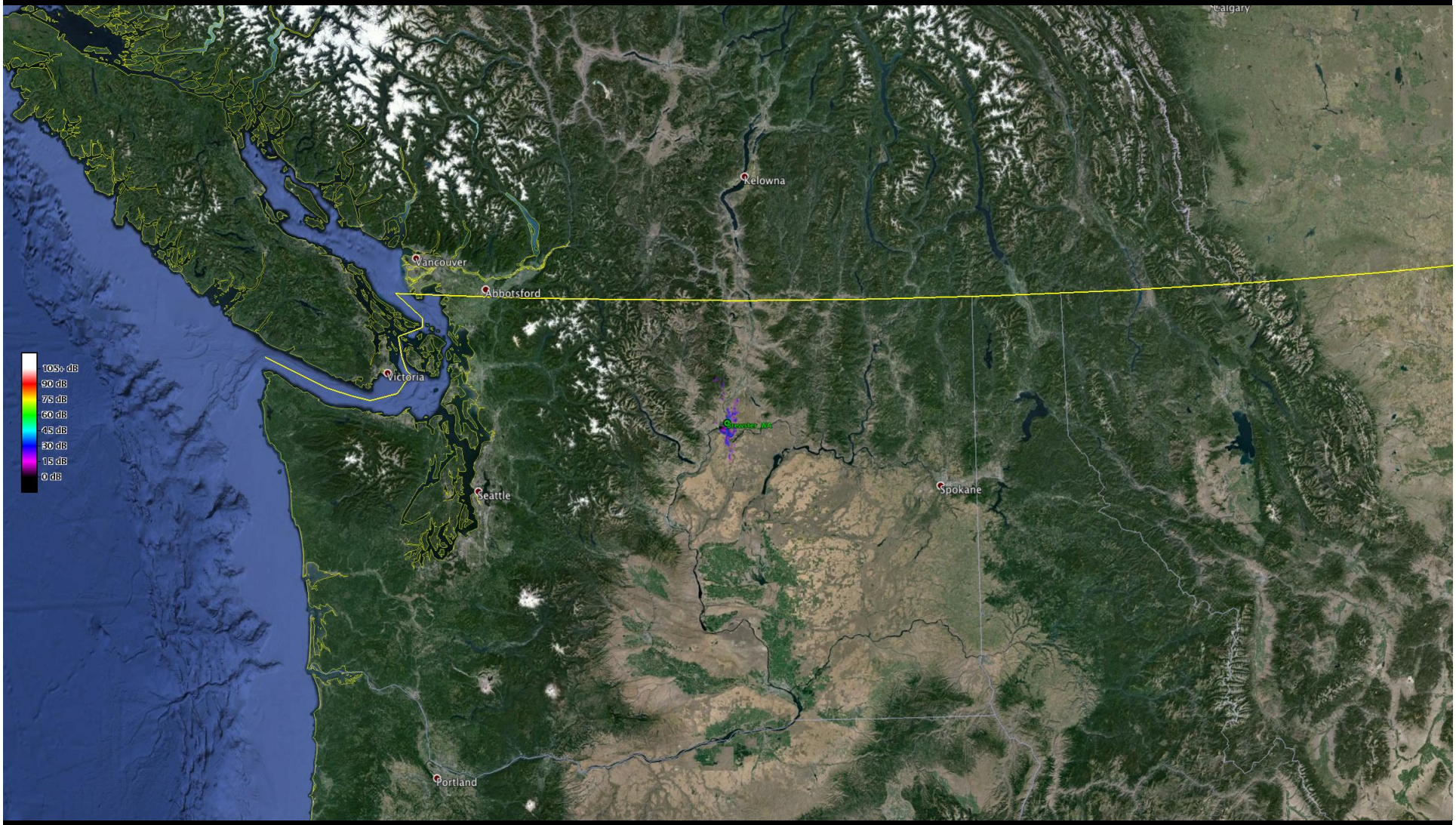
Mauna Kea, HI, VLBI, 100 mW TVBD



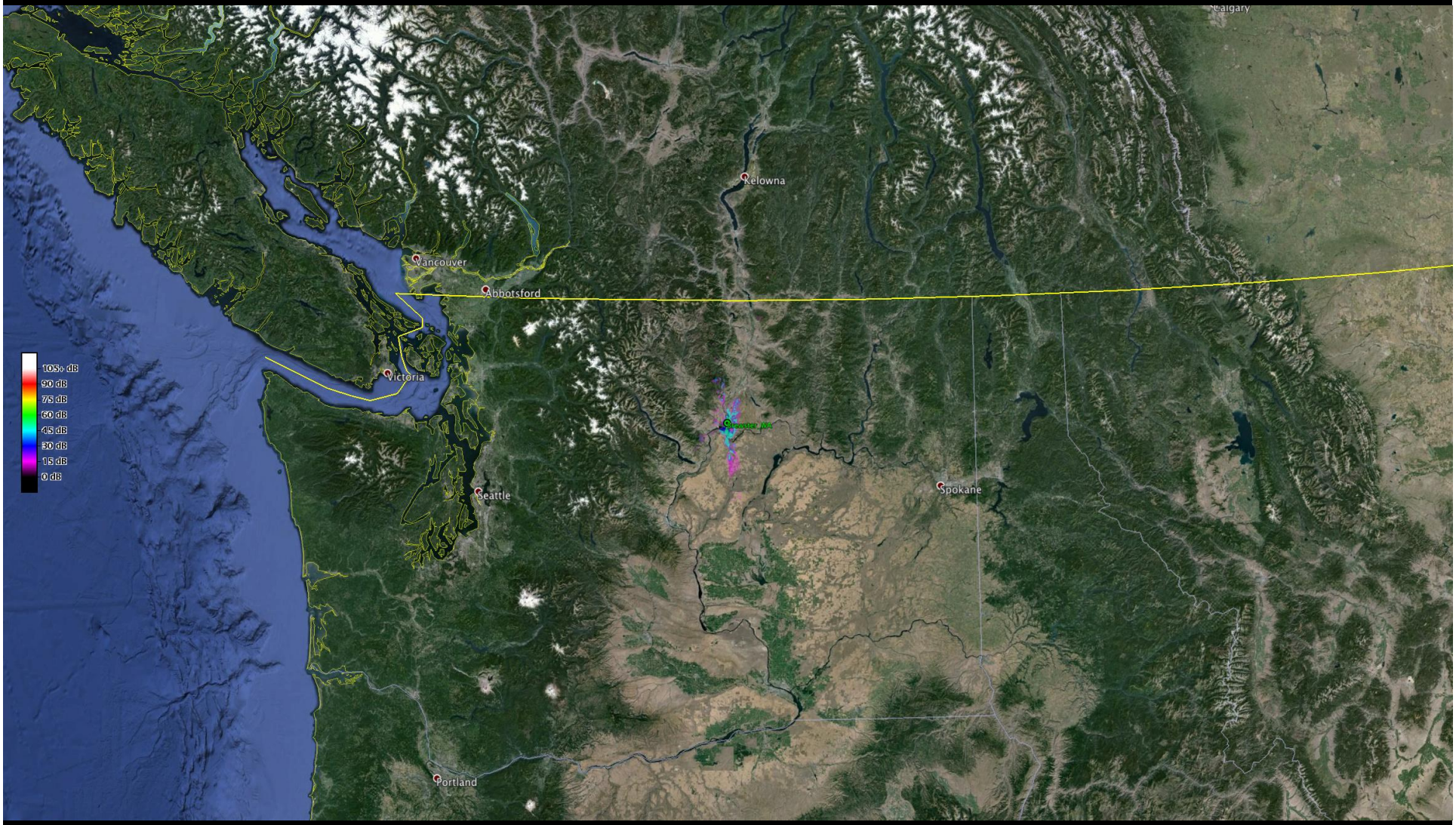
Mauna Kea, HI, VLBI, 4 W TVBD



Brewster, WA, VLBI, 100 mW TVBD



Brewster, WA, VLBI, 4 W TVBD



Modeling Summary

- Initial analysis
  - Assuming co-channel TVBD operations
  - Worst-case conditions (max power and height)
  - Assumes no automatic power control (required by rules)
- Coordination distances of a few tens to potentially ~200 km needed to protect RA observations from TVBD interference

Proposed Radio Astronomy Protection

- Compute protection contour using TVBD power relative to RA.796-2 reference levels with 2% time exceedance
  - 360 points at 1 degree azimuth intervals
  - Separate contour per TVBD power level (40 mW, 100 mW, and 4 W)
- Radio astronomy sites should register their time of use for protection. Channel becomes available to TVBD during times when there is no registered usage of radio astronomy sites
- Adjacent channel protections follow the in-channel protection timelines