Relocatable Over The Horizon Radar (ROTHR)

Forces Surveillance Support Center (FSSC)

Presented to:
Wind Turbine Radar Interference Mitigation Working Group (WTRIM) Webinar
29 JUN 2020

Overview

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- How ROTHR Works
- Operational Laydown
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- Wind Farm Mitigations
- Summary

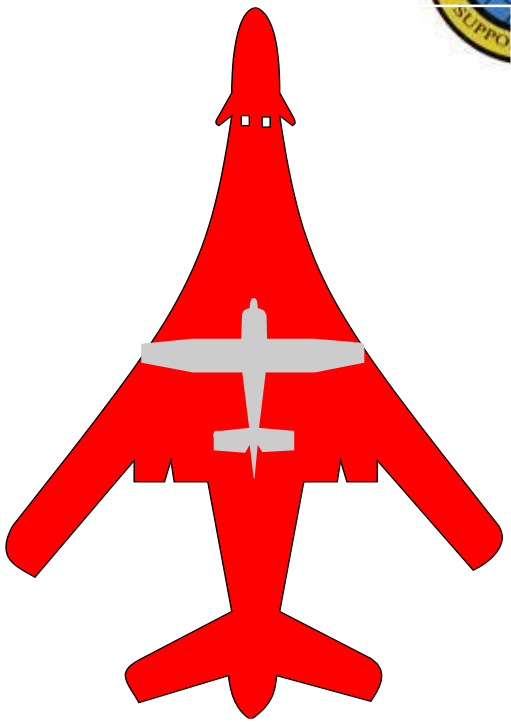
ROTHR Overview

Provide tactically significant wide-area air and sea surveillance track information to support US Southern Command's Counter-Illicit Drug Trafficking Mission

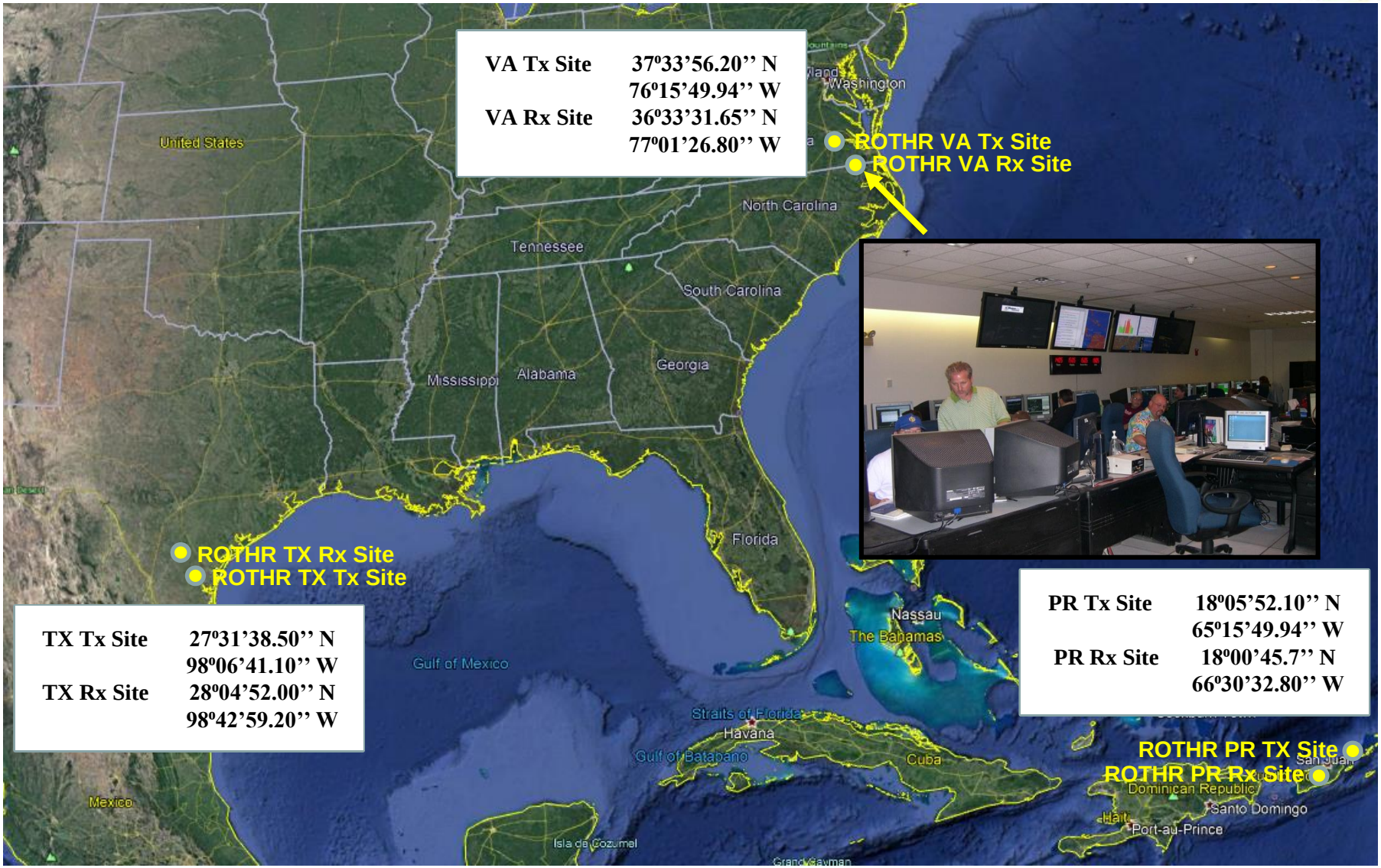
- ROTHR supports SOUTHCOM's drug interdiction mission as a detection and monitoring asset.
- Only wide area surveillance asset for SOUTHCOM:
  - Successes in detection and monitoring of air traffic have pushed traffickers to maritime/land methods.
  - Participated in 95% of all detected trafficking events.
  - Initial detection asset in 85% of all detected trafficking events.
  - Provided 85% of total tracking time of suspected trafficking events.
- Upcoming in-country agreements will double ROTHR detection and monitoring role.
- Desired performance improvement against maritime targets is dependent upon decreasing both the noise floor and spread doppler clutter.

ROTHR History

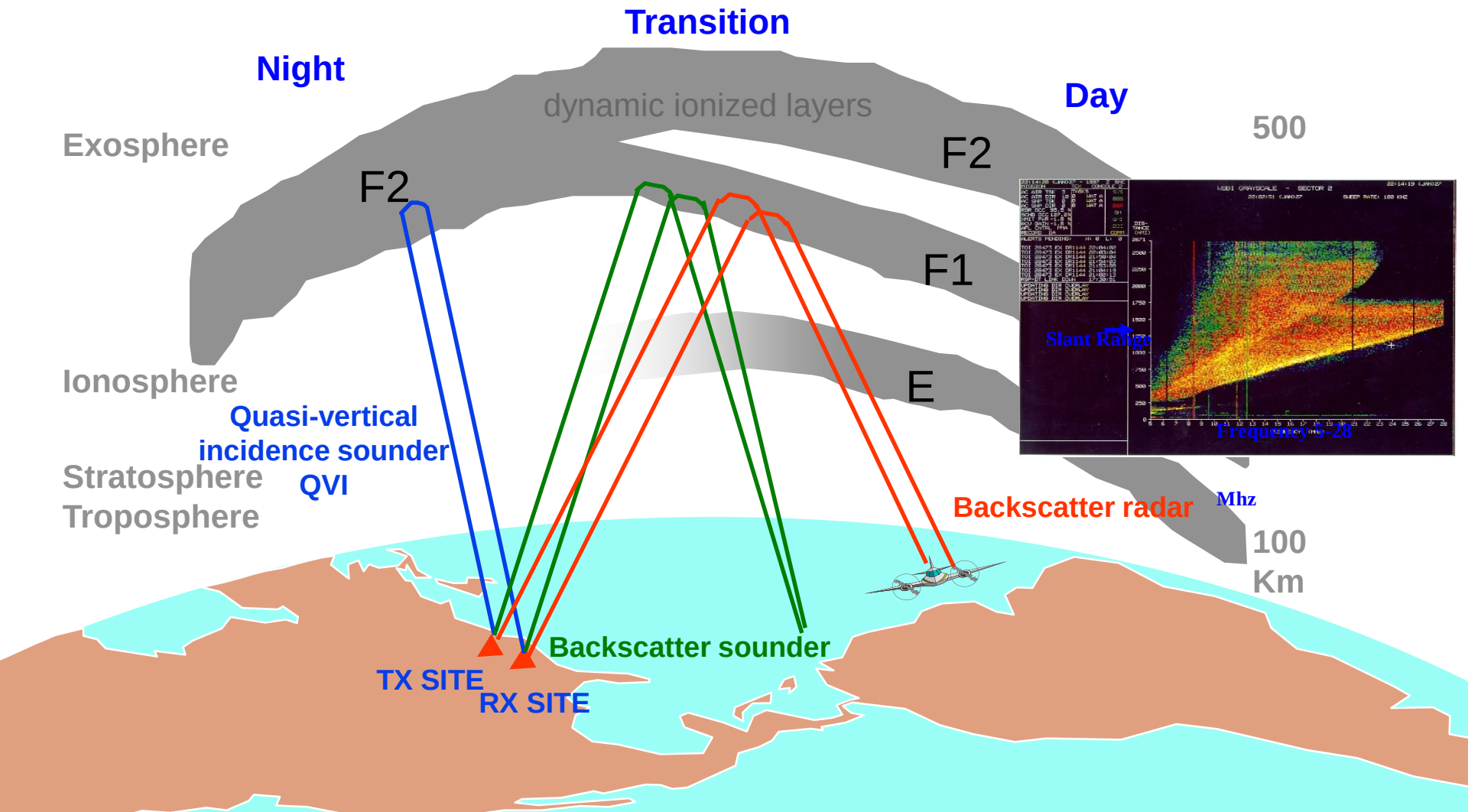
- **Original: Battle Force Defense**
  - 1980's Designed for early warning to carriers
  - 1989: Three production systems bought
  - 1992: USN terminates program with end of Cold War
- **Now: Counterdrug Support**
  - 1993: Mission changed, OSD funded for CD ops
  - 1993: VA begins CD operations
  - 1995: Texas begins CD operations
  - 2000: Puerto Rico begins CD operations
- **Future:** JIATF-S desires Detection/Tracking Capability for small "Go-Fast" Boats, and SPSS



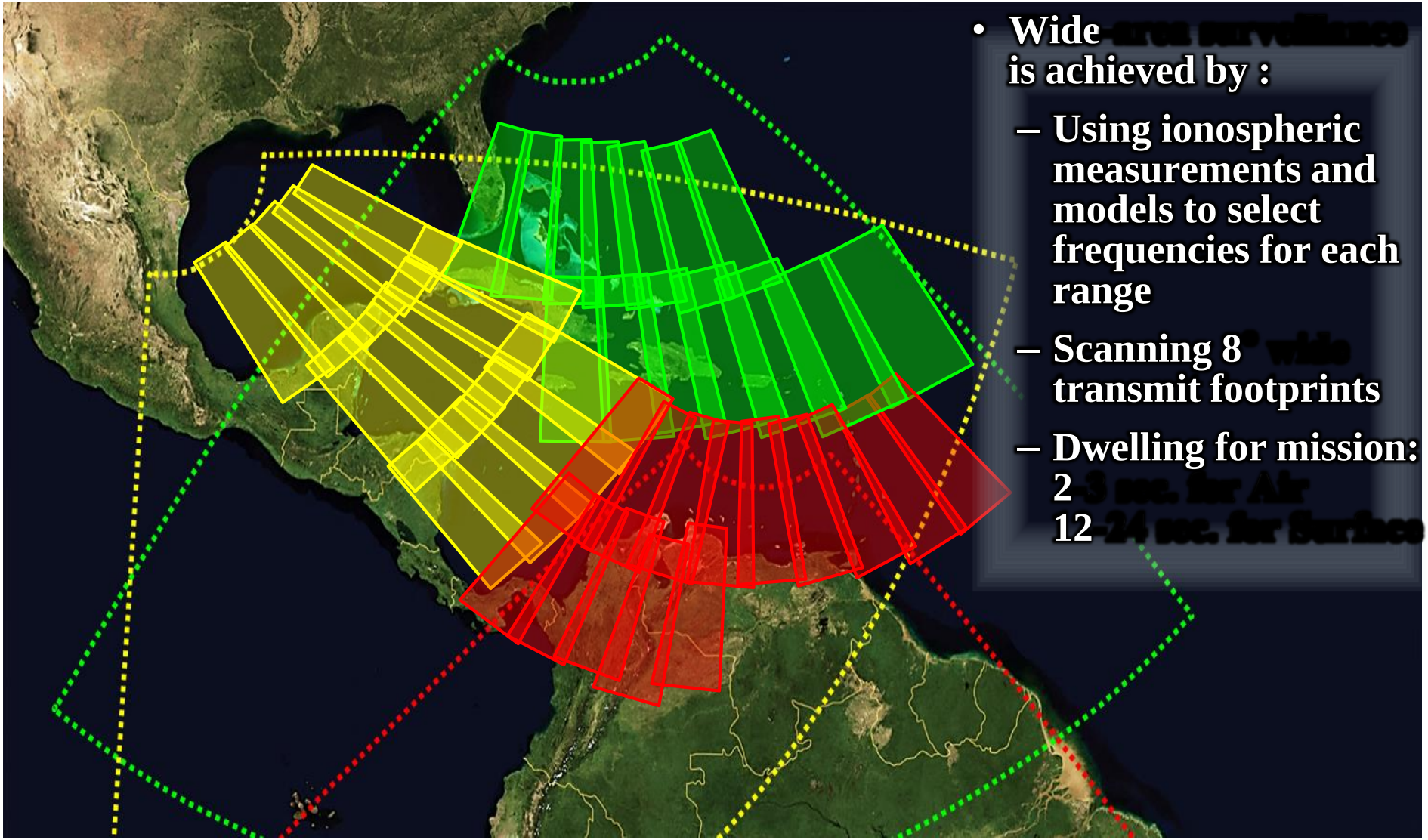
ROTHR Systems



How ROTHR Works



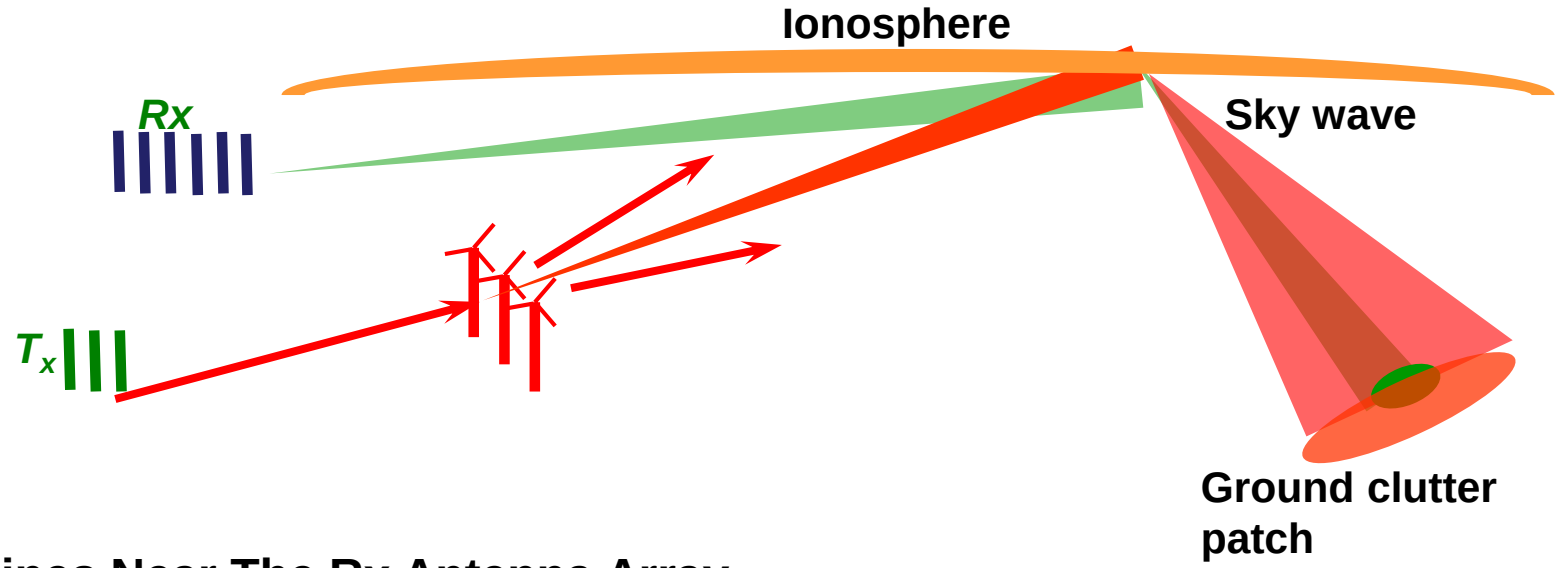
Operational Laydown



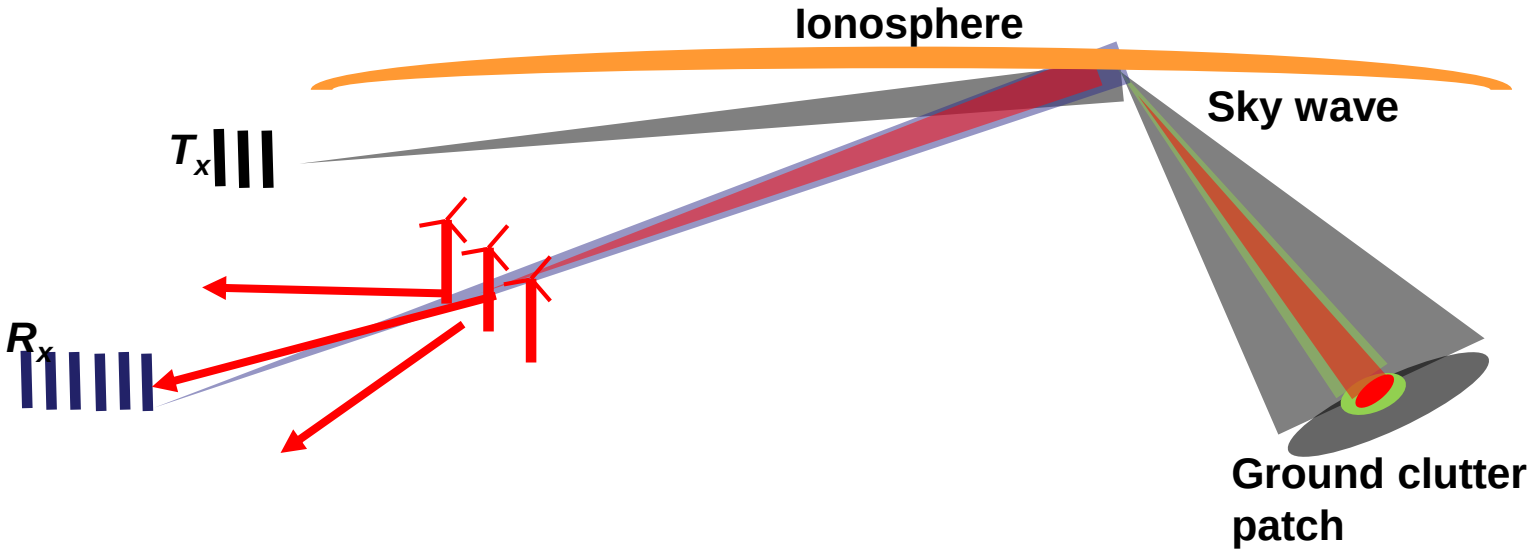
- Wide area surveillance is achieved by :
  - Using ionospheric measurements and models to select frequencies for each range
  - Scanning 8 wide transmit footprints
  - Dwelling for mission:
    2 3 sec. for Air
    12 24 sec. for Surface

Wind Farm Impacts on ROTHR

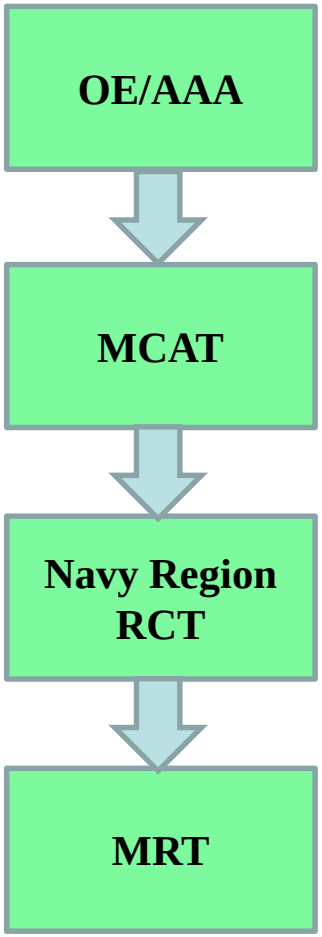
Turbines Near The Tx Antenna Array



Turbines Near The Rx Antenna Array



Wind Farm Modeling Process



Initial ROTHR involvement

Modeling Data

- If RCT/MRT discussions determine modeling is required, developer will be requested to provide turbine info:
  - Type of turbine planned, model name and number
  - Hub height
  - Blade length
  - Total height
  - Length and details of LPS
- Existing turbine data sets on file may be used

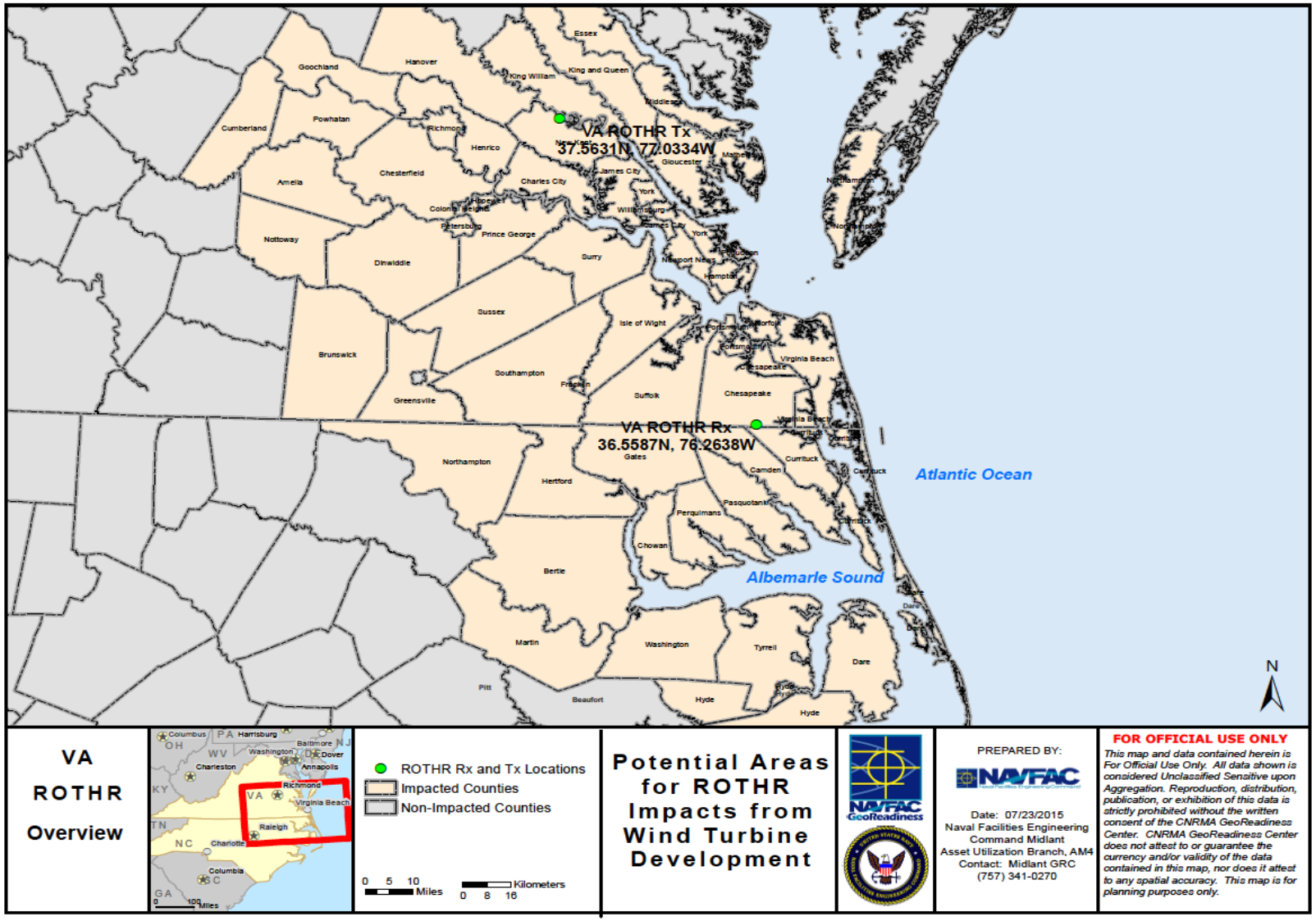
Wind Farm Modeling Process

- Modeling is a collaborative process with MIT LL and FSSC
- MIT LL conducted modeling with FSSC peer review of results
- Transitioning to FSSC modeling with MIT LL peer review of results
  - Graphical User Interface (GUI) capability transitioned to FSSC for VA Rx site modeling
  - Upcoming GUI capability transitioned to FSSC for five-wire modeling at all sites
  - Further GUI's to be completed
- FSSC primary interface with developers and RCT/MRT's
  - Robert Bush – WRSystems
  - rbush@wrsystems.com

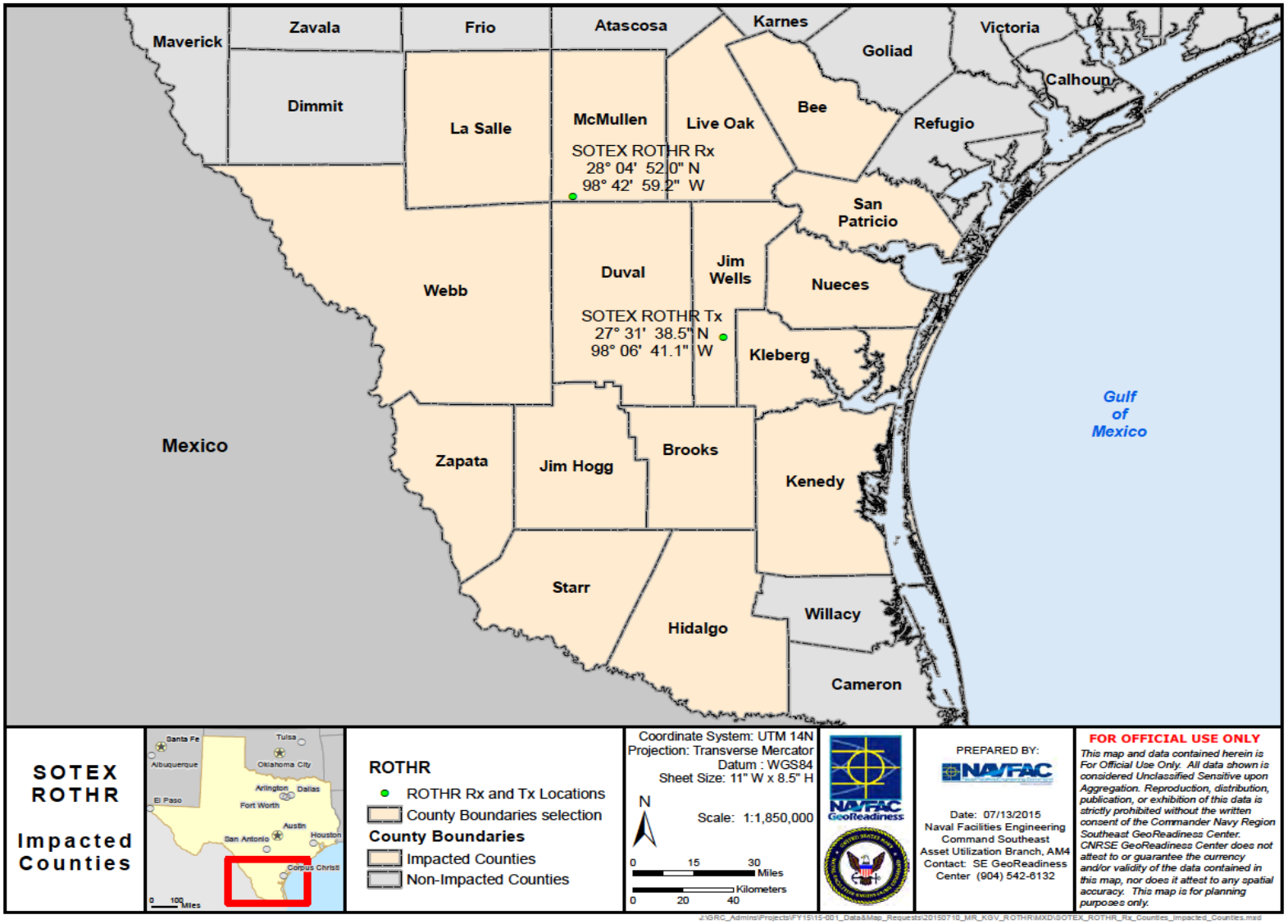
ROTHR Wind Farm Background

- Late 2010 - Wind Farms near ROTHR antennas proposed. Concerns raised over adverse impact on ROTHR operations.
- 2011 – 2013 – Initial studies completed on wind farm impacts
- 2014 – Initial predictive model completed by MIT LL
  - -70dB sub-clutter visibility in air mode operations for CD-sized targets concurred by all stakeholders
- Late 2014 – First ROTHR-related MOA signed with Avangrid
- 2014 – Present - FSSC and MIT/LL conducting Path Loss studies to verify portion of model associated with attenuation from turbine to ROTHR, and conducting post-construction testing.
- 2015 – Updated mapping on Navy Greenfleet website

NC Energy Wind Farms Counties of Concern Map



TX Energy Wind Farms Counties of Concern Map

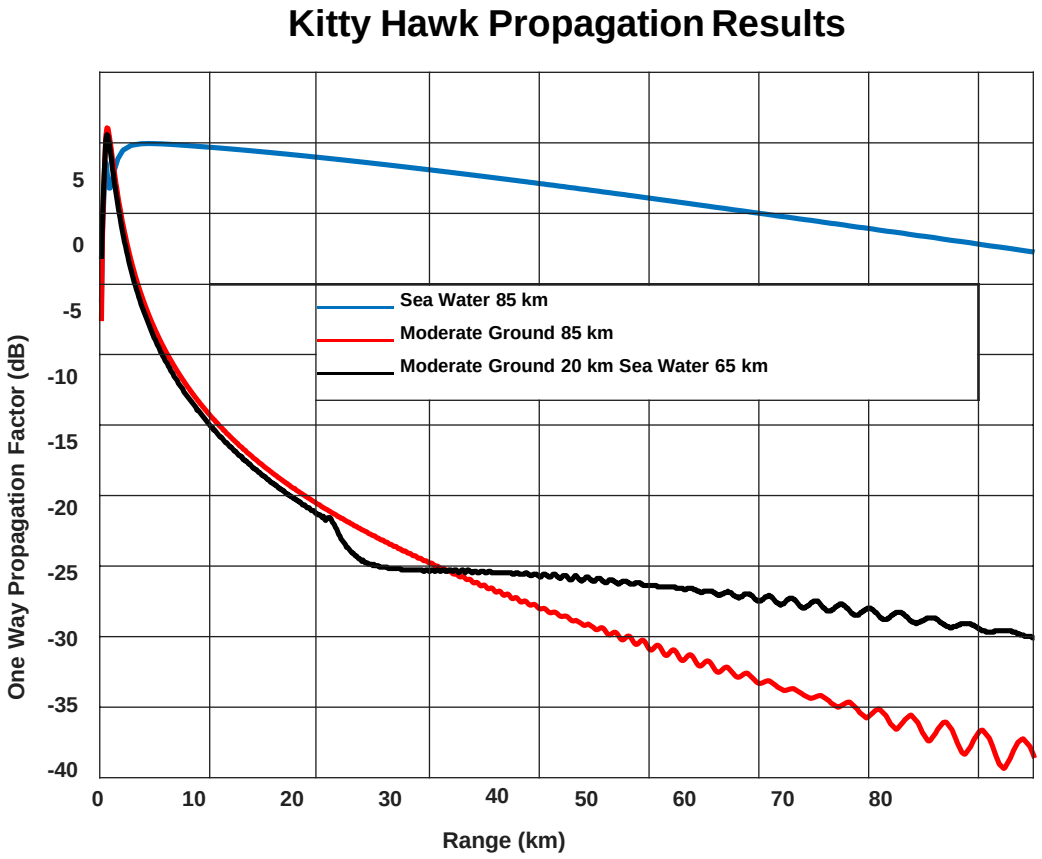


ROTHR Wind Farm Background

- Jan/Jul 2017 – Post-construction model validation testing
- 2014 – Present – A total of 47 land-based wind farms have been reviewed
  - Includes modeled, formal and informal reviews
  - Some others are currently being reviewed or modeled
- Aug 2015 – Awareness of offshore wind energy near ROTHR antennas. Concerns raised over adverse impact on ROTHR operations.
  - Concern raised to OPNAV N45
  - Identified need to conduct study due to differences with offshore wind farms

Offshore Wind Farm Concerns

- Propagation results are much different for land-based versus sea-based wind turbines
- The is an approximately 10dB difference in a mixed terrain path (land/sea) propagation factor versus and all land path at a turbine location 85km range for the Kitty Hawk lease area



Source: "Off-Shore Wind Turbine Interference Modeling"; J. Eisenman, MIT LL 11JUN2019

ROTHR Offshore Wind Farm Modeling

- JUNE 2019– MIT LL completed initial off-shore wind energy study
  - Kitty Hawk leased area modeled with notional 9.5MW turbine
  - NC/SC wind energy area modeled with GE Heliade-X 12MW turbine
  - Entire Kitty Hawk area modeled with “future” 15MW turbine
- JUNE 2019 – Offshore study results briefed to BOEM
- MAY 2020 – MIT LL begins evaluation of larger offshore turbines
  - Proposed turbine 2X the size used in initial study

Turbine	Hub Height (m)	Blade Length (m)
9.5 MW	110	87
GE 12MW Heliade-X	150	110
Future 15MW	169	128.5

- The notional 9.5MW turbine has a peak side lobe level ~ 2dB stronger than previous land-based turbines modeled
- The GE turbine has a peak side-lobe level ~7dB stronger than the 9.5MW turbine
- The future 15MW turbine has a peak side-lobe level ~2.5dB stronger than the GE turbine

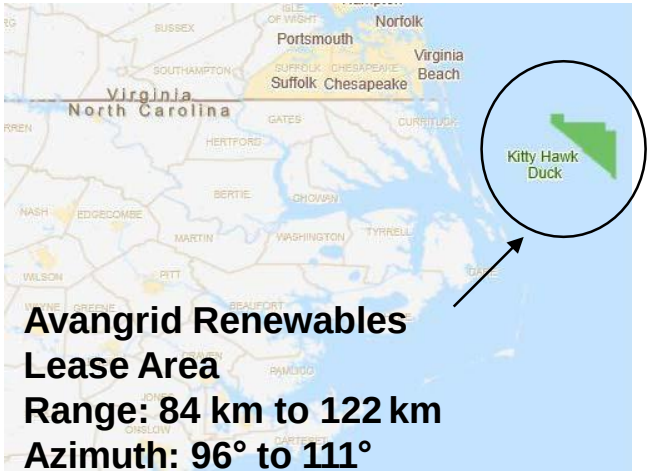
ROTHR Offshore Wind Farm Modeling
Off-Shore Wind Energy Areas (WEAs)

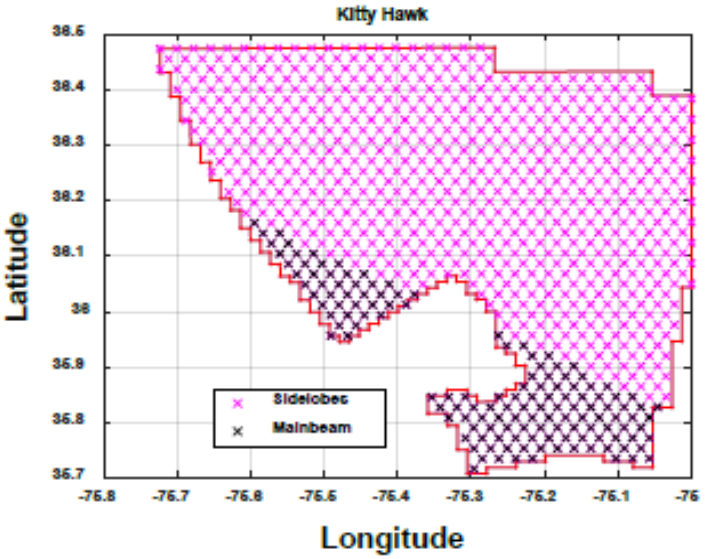
- **Wilmington:**
  - Land/Sea boundary for Wilmington-West does not occur till a range from ROTHR of 337 km
  - Closest turbine for Wilmington-West expected at a range of 357 km from ROTHR
  - Wilmington-East is further away at a range of 362 km
- **Kitty Hawk:**
  - Land/Sea boundary for Kitty Hawk is at a range of 20 km
  - The closest turbine expected at a range of about 85 km

Source: "Off-Shore Wind Turbine Interference Modeling"; J. Eisenman, MIT LL 11JUN2019

ROTHR Offshore Wind Farm Modeling Summary

- Analysis of offshore wind farms was completed by MIT LL
  - Wilmington/Grand Strand WEAs
  - Lease Sale OCS-A 0508
  - Additional leasing/development area in Kitty Hawk WEA
- Results of studies (based on current assumptions/information)
  - Wilmington East, Wilmington West, Grand Strand – Not expected to reduce the SCV
  - Current Avangrid Renewables lease for OCS-A 0508 – Not expected to reduce the SCV
  - Future development in Kitty Hawk WEA –-– Expect to mitigate potential for significant impact by avoiding siting turbines in the main beam as shown in dark cross-hatched area





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Wind Farm Mitigations

- Land-based wind farm mitigations primarily accomplished through
  - Change in proposed turbine type
  - Change in azimuth alignment
  - Change in spatial distribution
  - Reduction in turbine numbers
- Technology considerations
  - Segmented blade – not viable
  - Blade “tuning” – not viable
- Upgraded surface tracking capabilities may require increased SCV

- Offshore wind farm mitigations primarily accomplished through
  - Change in proposed turbine type
  - Change in azimuth alignment
  - Change in spatial distribution
  - Reduction in turbine numbers
- Offshore study efforts just beginning
  - Turbine sizes
  - Mixed propagation path
  - Limited predictive modeling to date
  - No post construction measurements to validate modeling for offshore

Summary

- Land-based wind farm process works well
- Informal or formal– Early in process is key.
- If you are planning a land-based wind farm in any of the counties, we would like to discuss. If you are planning an offshore wind farm in areas along the Atlantic Coast from VA to SC, or Gulf of Mexico, we would like to discuss.

- Offshore study efforts just beginning
  - Turbine sizes
  - Mixed propagation path
  - Limited predictive modeling to date
  - No post construction measurements to validate modeling for offshore
- Modeling process take time
  - Collaborative process with developers
  - Often an iterative process