EPA
United States
Environmental Protection
Agency

Updates to Air Quality Characterization for AirToxScreen

James Thurman

US EPA OAQPS/AQAD/AQMG

AirToxScreen Team

AQAD: Julia Black, Art Diem, **Caroline Farkas**, Alison Eyth, Alyssa Piliero, Sharon Phillips, Jeanette Reyes, Ron Ryan, Jason Smith, Doug Solomon, James Thurman

HEID: Dianna Francisco, Rod Truesdell, **Matt Woody**

PACS: Kristen Fillio

OTAQ: Chad Bailey, Ali Kamal

SPPD: Andrew Bouchard

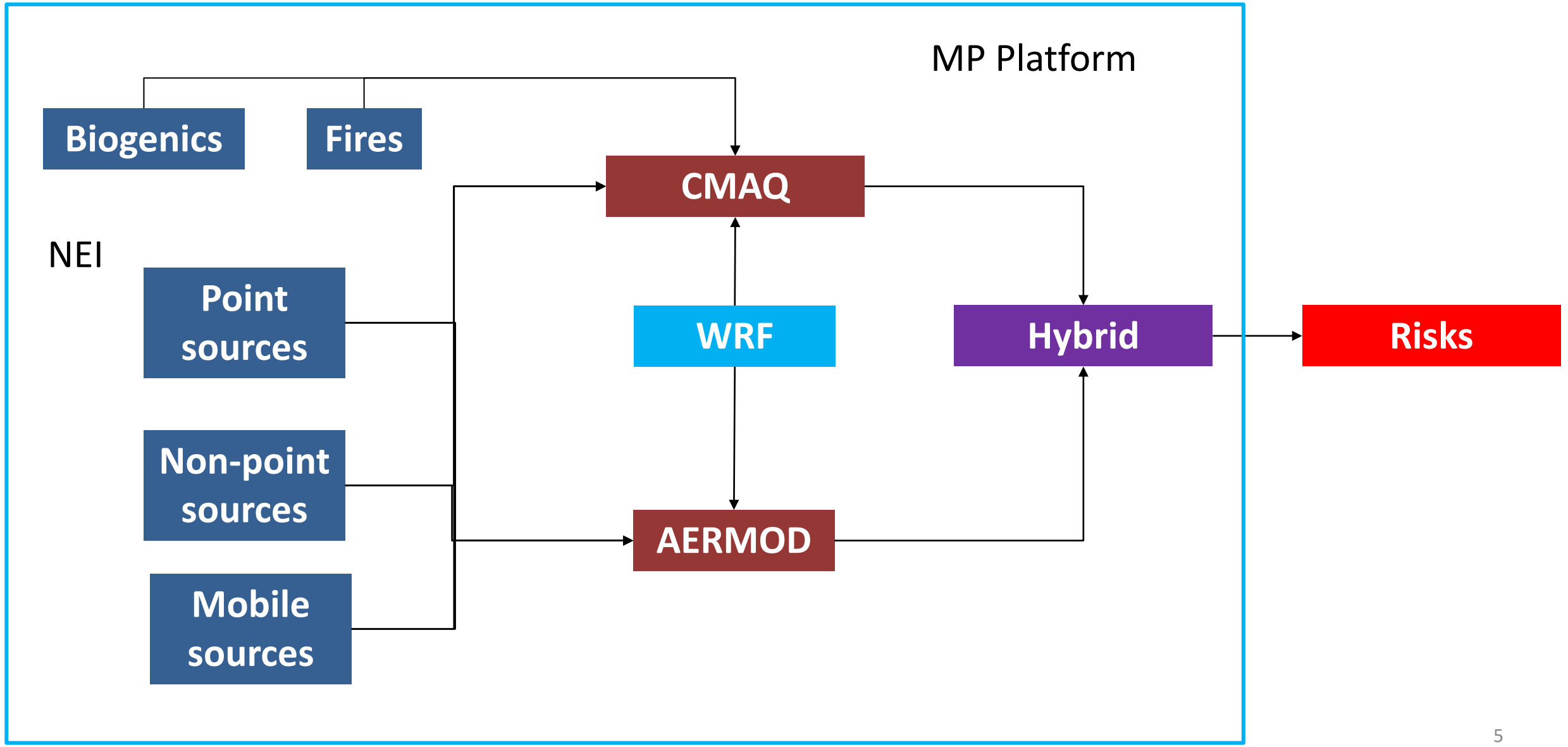
Background

- Beginning with 2017, AirToxScreen replaces NATA and will have an annual frequency vs triennial frequency
  - Results reported at census tract level
    - Modeling done at census block level and aggregated up to tract
  - 2017, 2018, 2019 released
- 2020 will be first AirToxScreen to report census block level results
  - Opportunity to revise the air quality characterization at census block level

AQ Characterization: Multi-pollutant Platform

- AQ characterization based on two air quality models
  - Community Scale Air Quality Model (CMAQ): photochemical model
  - AERMOD: EPA preferred near-field dispersion model
- Both air quality models use same emissions and meteorological data (WRF meteorological model)
- Results from both models combined with a hybrid approach to provide spatially representative average concentrations for each HAP
- The emissions, air quality models and hybrid approach comprise the multi-pollutant platform

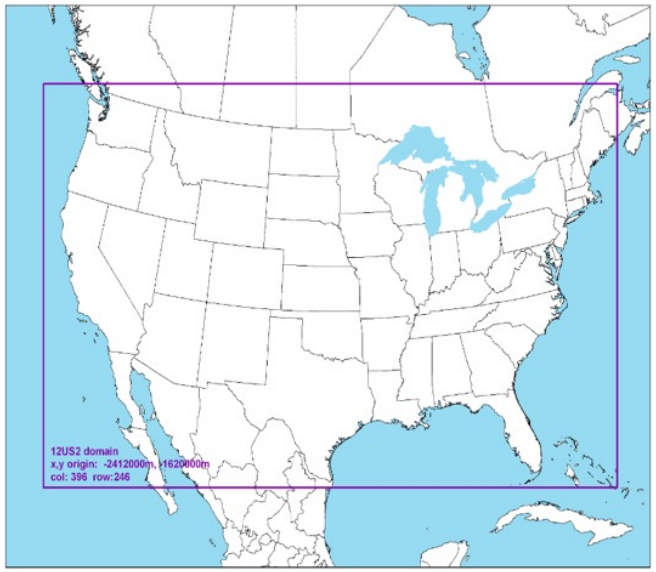
Multi-Pollutant Platform Framework



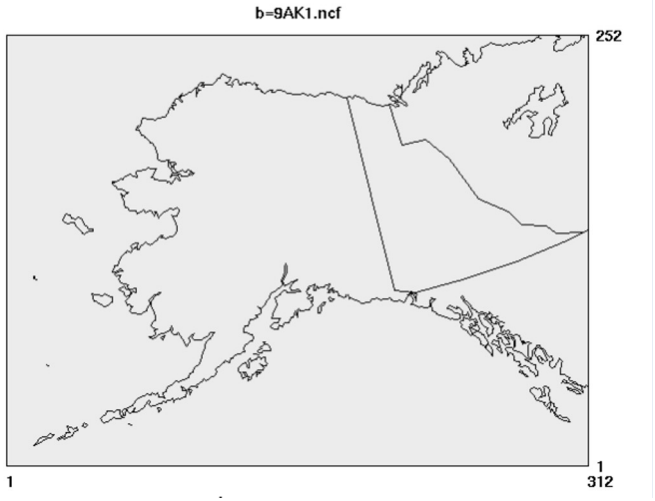
CMAQ Modeling

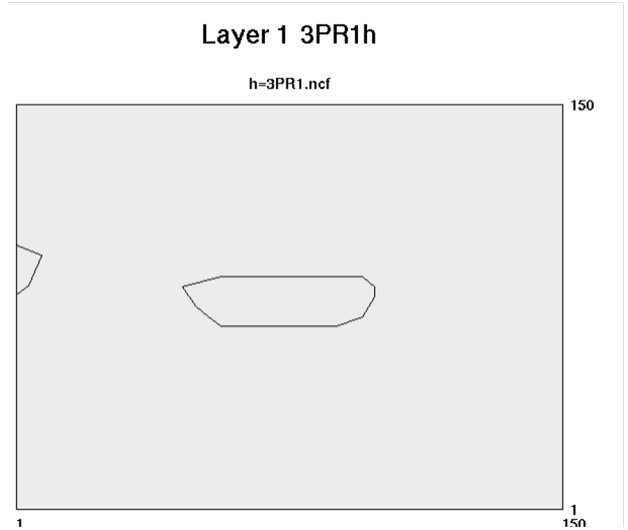
- CMAQ Multi-pollutant (v5.4)
  - 50+ HAPs based on NEI
  - All 50 states and PR/VI (4 domains)
    - CONUS: 12 km resolution
    - AK: 9 km resolution
    - HI & PR/VI: 3 km resolution
  - Three CMAQ runs per domain
    - Base: all emissions (anthropogenic, fires (prescribed and wild), biogenics)
    - No fires: (anthropogenic and biogenics)
    - No biogenics (anthropogenic and fires (prescribed and wild))
    - No fires and no biogenics needed for hybrid

CMAQ domains



Layer 1 9AK1b





Layer 1 3Hl1e

AERMOD Modeling (version 22112)

- 185 HAPs + diesel PM based on NEI
- All 50 states and PR/VI
- Various receptor types
- Source attribution (around 30 source groups)
- WRF data for meteorology
  - WRF resolution matches CMAQ resolution
  - Each source has its own unique meteorology
- AERMOD details in remaining slides

AirToxScreen Results by Source Group (and pollutant)

Onroad
Light duty gas on-network
Light duty diesel on-network
Refueling
Light duty gas off-network
Light duty diesel off-network
Heavy duty gas on-network
Heavy duty diesel on-network
Heavy duty gas off-network
Heavy duty diesel off-network
Heavy duty diesel hoteling

Point
Stationary point

Nonnroad
Recreational Including Pleasure Craft
Construction
Commercial Lawn & Garden
Residential Lawn & Garden
Agricultural Equipment
Commercial Equipment
All Other Nonroad Equipment
Commercial Marine Vessels – Ports (C1 and C2)
Commercial Marine Vessels – Ports (C3)
Commercial Marine Vessels – Underway
Locomotives
Airports (point)
Railyards (point)

Nonpoint Stationary
Oil and Gas
Residential Wood Combustion
Miscellaneous Nonindustrial
Commercial Cooking
Solvents and Coating
Storage and Transfer, Bulk Terminals, Gas Stage 1
Fuel Combustion except RWC
Industrial
Waste Disposal
Agricultural Livestock

CMAQ Only
Fires
Biogenics
Secondary formation (all sources)
Background

ATS sources/receptors: AERMOD

- AERMOD concentrations calculated for a variety of source types and receptors
  - Sources: gridded sources, point, airports, and ports
  - Receptors: block centroids, monitors, and gridded receptors
- HAP-specific AERMOD concentrations calculated during post-processing for block centroid, monitor, and gridded receptors
  - Directly modeled or interpolated from gridded receptors
- HAP specific AERMOD concentrations feed into hybrid equation with CMAQ predicted concentration estimates
- ATS output: Hybrid calculations provide cumulative, HAP-specific concentrations at census block centroids for risk calculations

EPA
United States
Environmental Protection
Agency

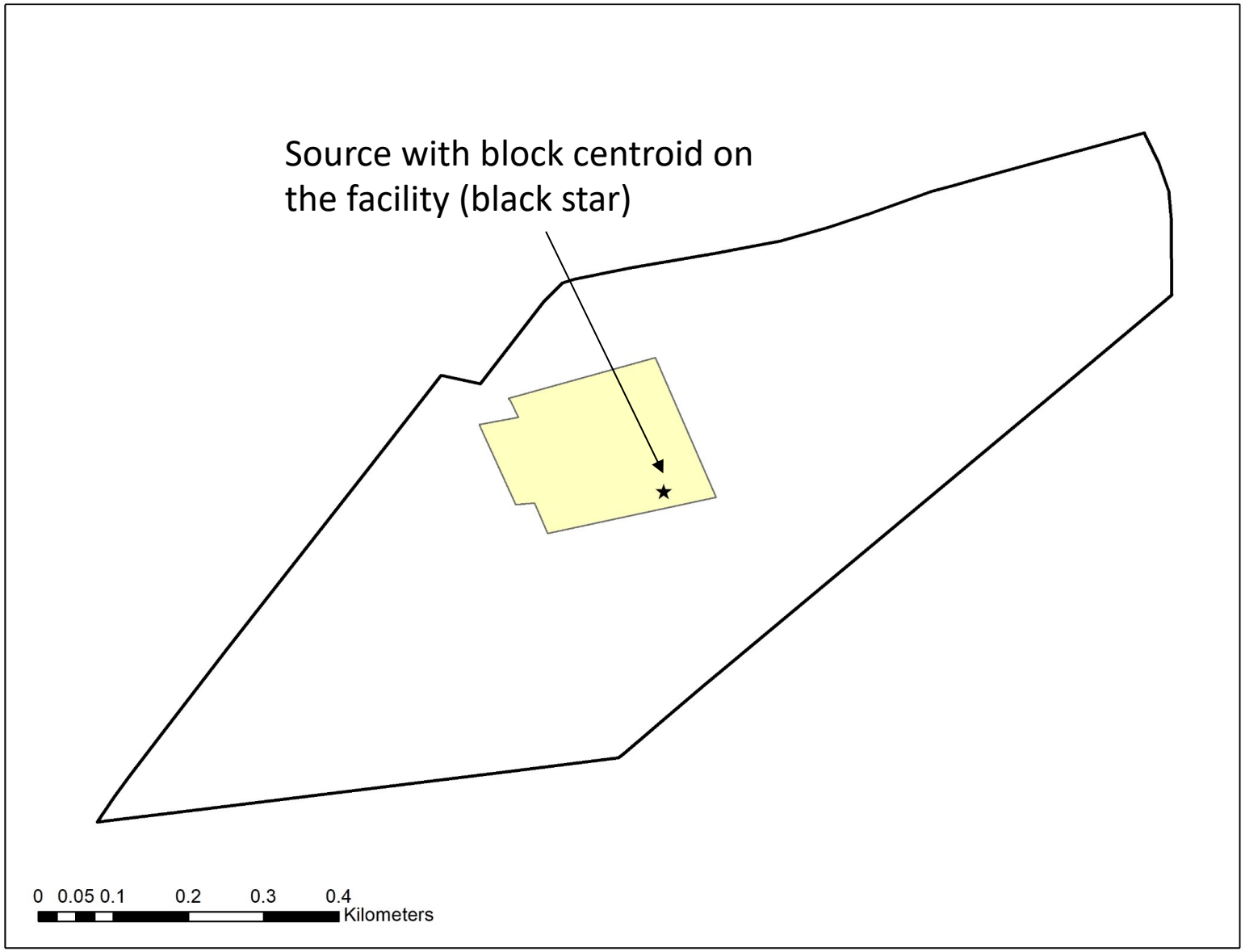
Receptor strategy for point, airports, and port sources

Air Quality Characterization Updates

- Purpose: To update our AirToxScreen (ATS) approach to air quality characterization (i.e., receptors) to meet EPA/OAQPS commitment to provide modeled concentrations and risk at census block level for 2020 ATS
- Focus: Describe changes in receptor approach for air quality characterization that will inform risk calculations
  - Block level receptors for point sources in AERMOD
  - Generating “hybrid” block level concentrations (cumulative, all sources)
- Outcome: New receptor approach for 2020 ATS that we expect will facilitate and improve our ability to report block level concentrations

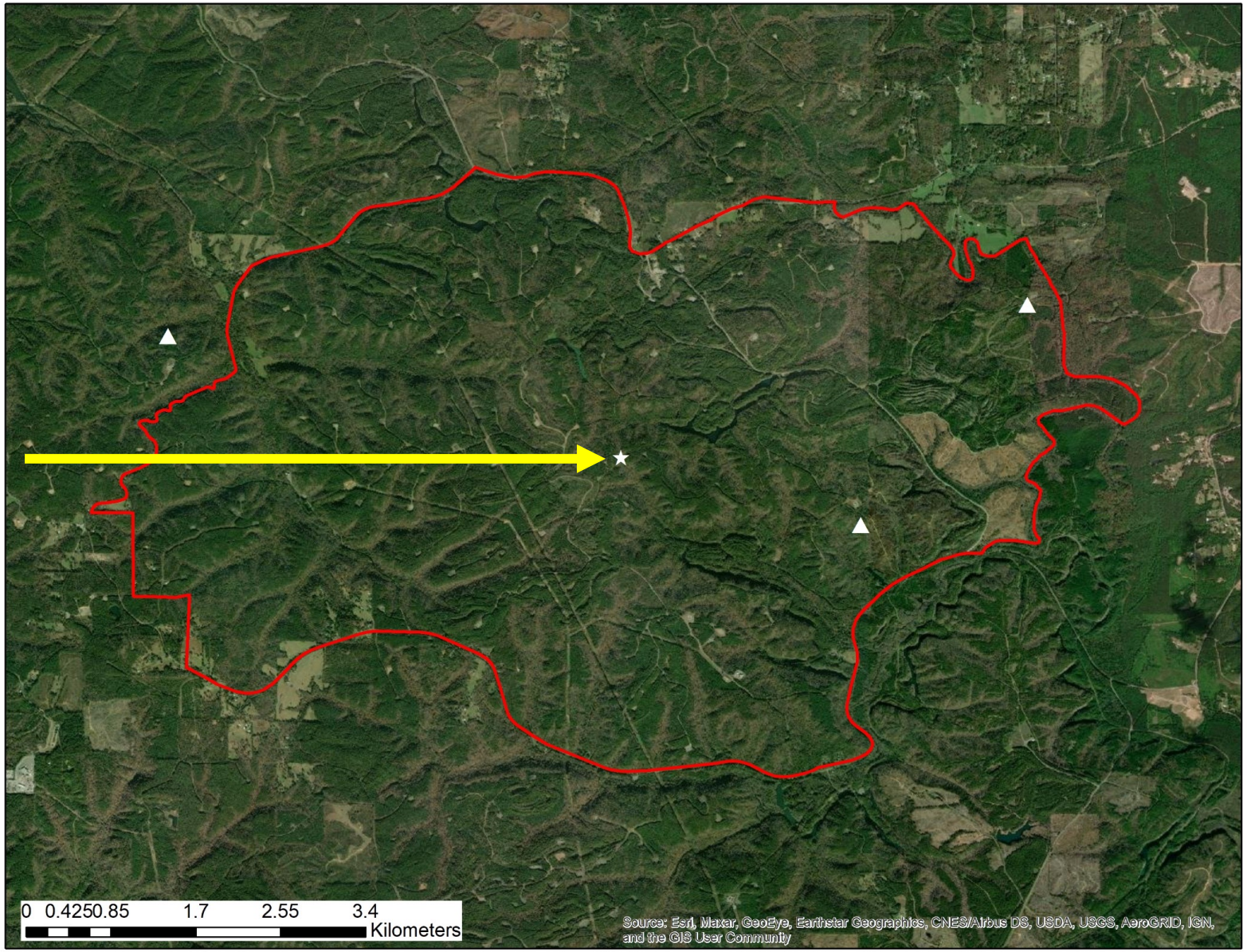
Current ATS approach: pre 2020

- Census blocks are building blocks of concentrations/risk in ATS
- Census block concentration represented by a single point, usually at the centroid
  - Both AERMOD and hybrid concentration outputs
- No accounting for “ambient air” near sources
- Considerations
  - Centroid receptor may be located in non-ambient air relative to a facility and therefore not representative of ambient conditions at fence line and beyond
  - Leads to overestimation of concentration for census block
  - In large blocks, centroid may be far from sources, leading to potential underestimation of concentrations for the block for those sources
  - Single receptor may not be representative of facility contributions due to heightened sensitivity to meteorology, e.g. wind direction impacts from facility to single receptors
    - Leads to over or underestimating concentrations that represent census block


Source with block centroid on the facility (black star)
0 0.05 0.1 0.2 0.3 0.4
Kilometers

Rural block with several point sources influencing the block

Current methodology: block concentration represented by block centroid or other single point

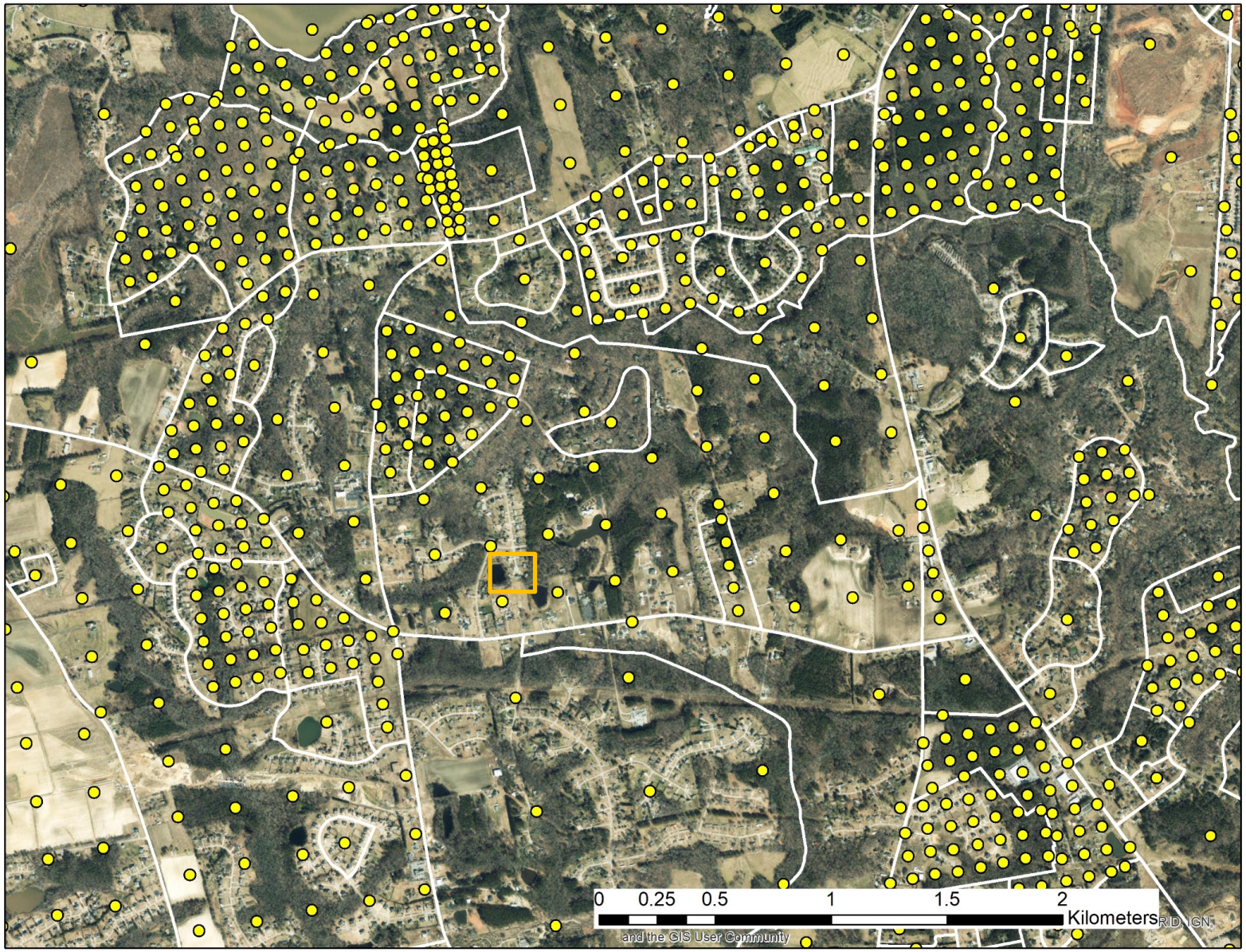


New Block Receptor Strategy for 2020 ATS

- For each census block, create a grid of receptors within the block
  - Resolution 25 m to 10 km depending on block size
  - Exception: blocks less than 500 x 500 m or less than 5 receptors at 25 m resolution will use the centroid to represent the block
  - Better characterizes air quality concentrations in larger census blocks
- Account for ambient air
  - If a receptor < 30 m (or other defined distance) from a source at a point facility, port, or airport then that receptor will not be deemed representative of ambient air
    - 30 m distance is default; working on facility specific distances
    - Receptor concentration will be ignored for the facility being modeled
    - Exception: If census block is represented by a single receptor, that receptor will be included for the facility
  - Bringing in fence-line/property boundary information
    - Within boundary, receptors ignored for facility with exception of census block centroid

Census blocks with centroids

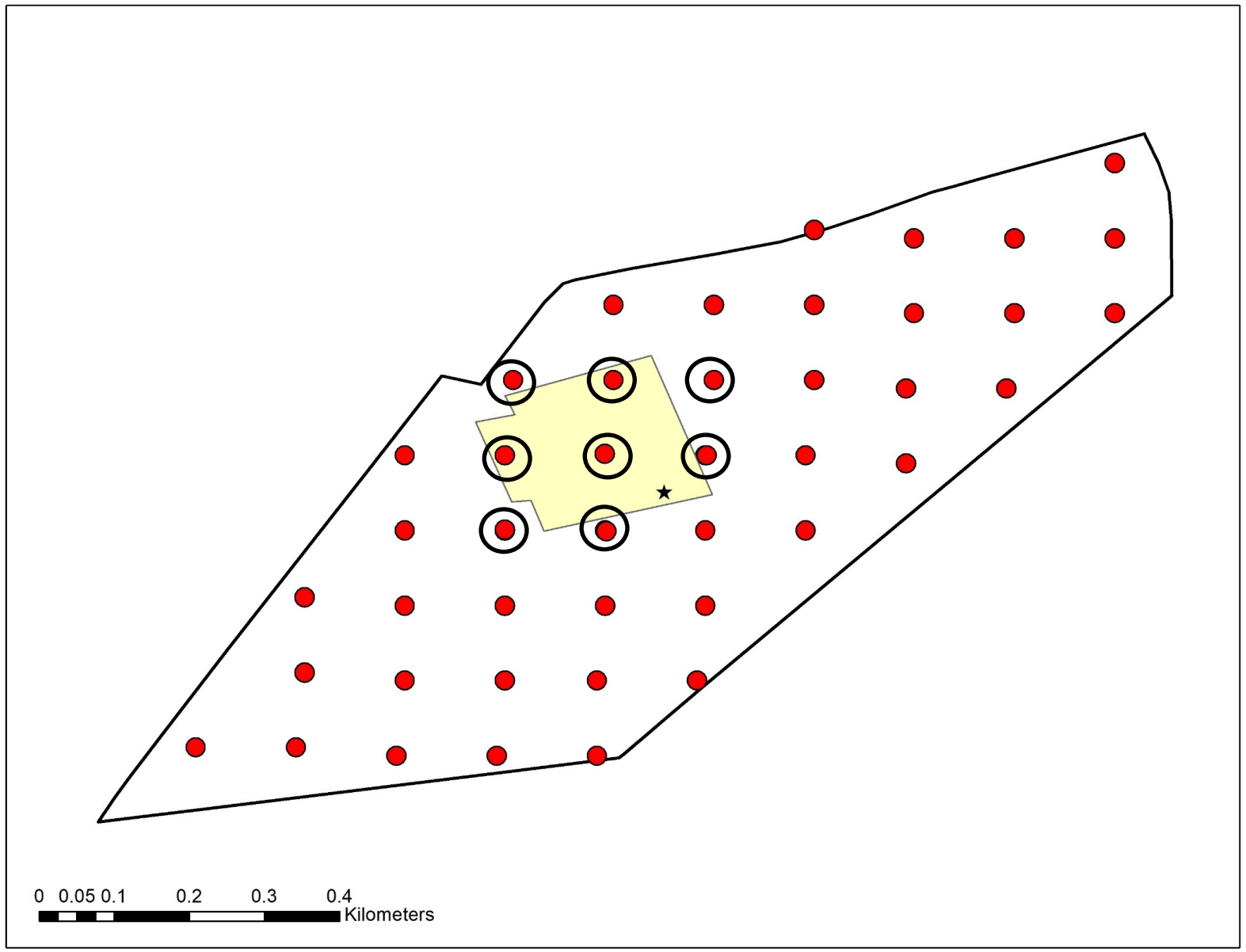
Census blocks with grids



Source with block centroid on the facility with block receptors

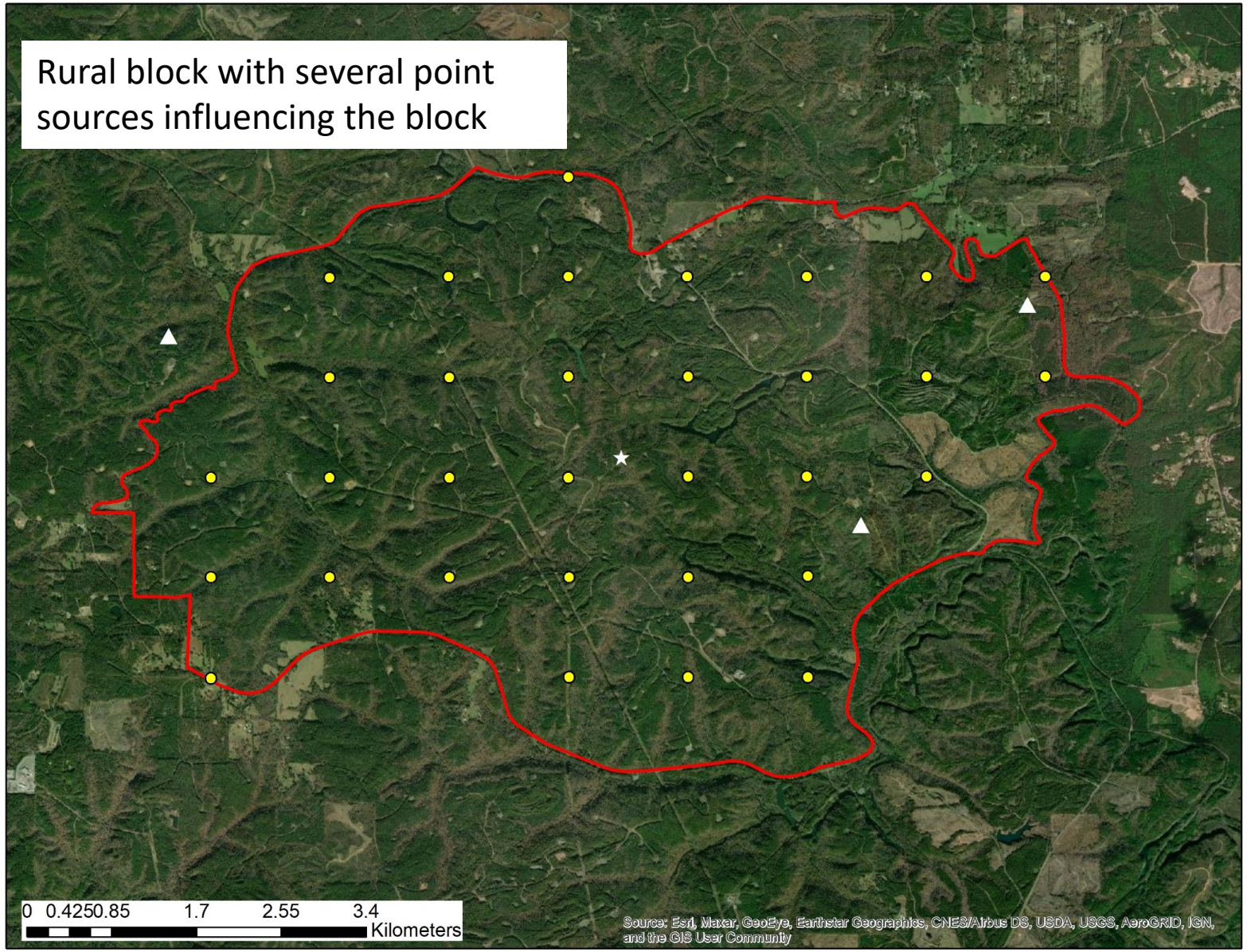
Facility concentration using centroid: 0.1 μg/m^3

Facility mean concentration using ambient receptors (> 30 m) : 0.01 μg/m^3



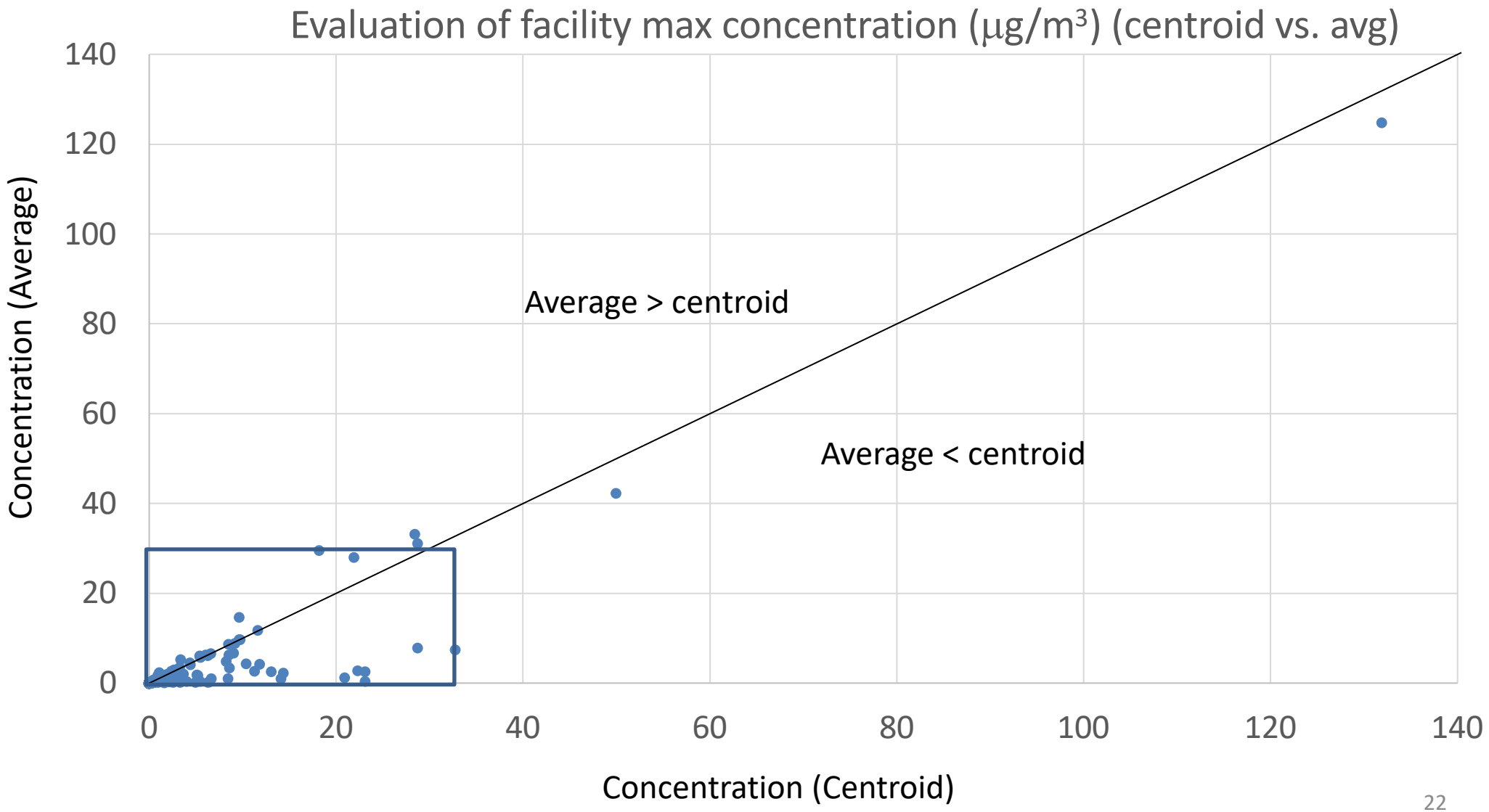
New methodology: block concentration represented by average of block gridded receptors

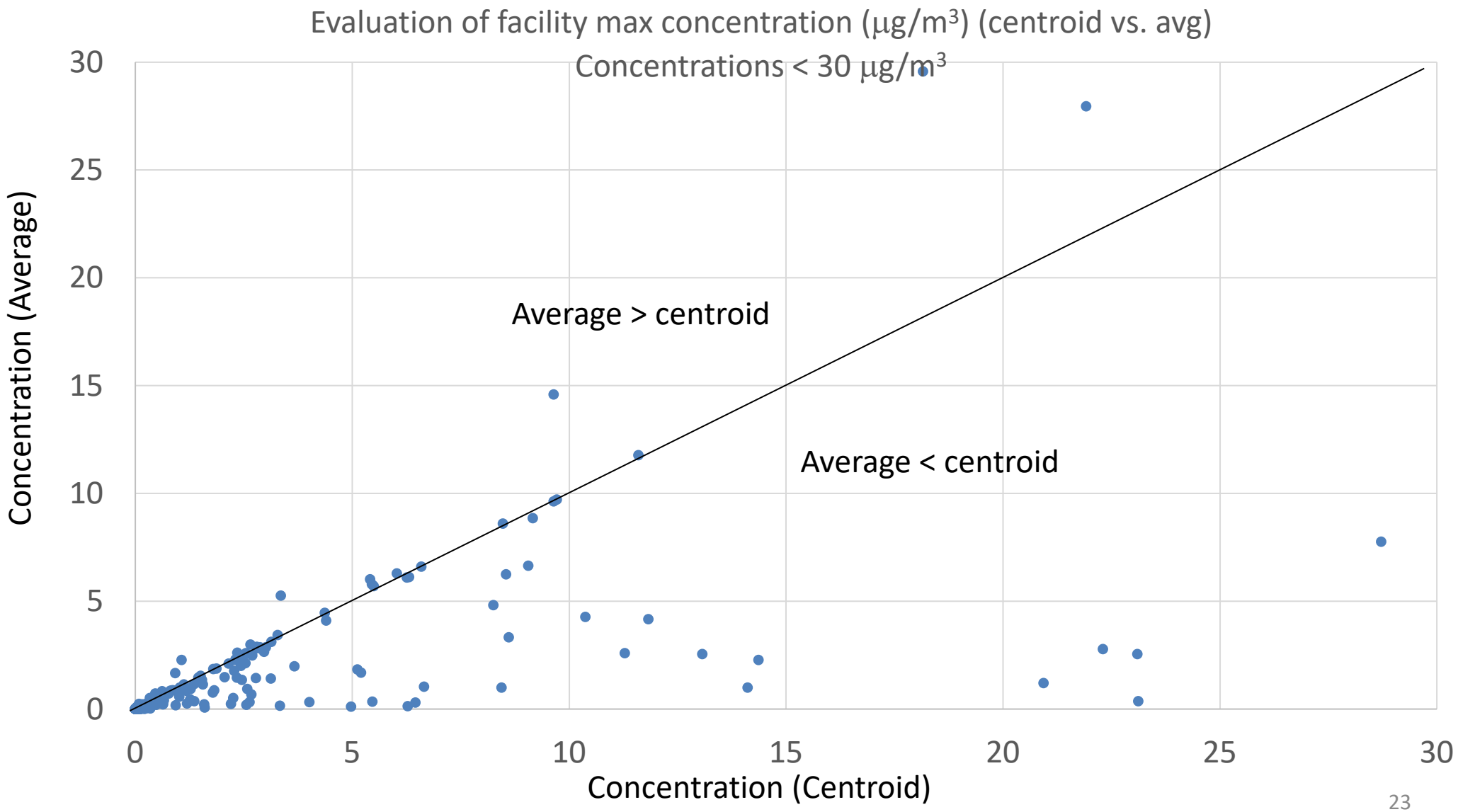
Block average concentration for each facility increased



Testing

- Have tested new census block approach with 2020 SLT review emissions for top risk facilities
  - 2020 used 2020 census so would be 1:1 comparison
- Testing shows mixed results
  - Concentrations sometimes increase with new approach as receptors are now closer to sources than centroid
  - Concentrations sometimes decrease with new approach as receptors are farther away from sources than centroid
  - Max concentration sometimes changed to a different block with new approach
- Refining “ambient air” approach
  - Better accounting for fence line/property boundaries
  - Continue to develop boundaries for facilities as we speak
    - 156 facilities have specific boundaries/non-default ambient air distance


Evaluation of facility max concentration (µg/m³) (centroid vs. avg)
Concentration (Average)
Concentration (Centroid)
Average > centroid
Average < centroid
0
20
40
60
80
100
120
140


Evaluation of facility max concentration (µg/m³) (centroid vs. avg)
Concentrations < 30 µg/m³
Concentration (Average)
Concentration (Centroid)
Average > centroid
Average < centroid
0
5
10
15
20
25
30

EPA
United States
Environmental Protection
Agency

Generating hybrid block level concentrations (cumulative, all sources)

Goal: Provide 2020 ATS concentrations in consistent manner as before and at block level

Characterization of hybrid block concentrations

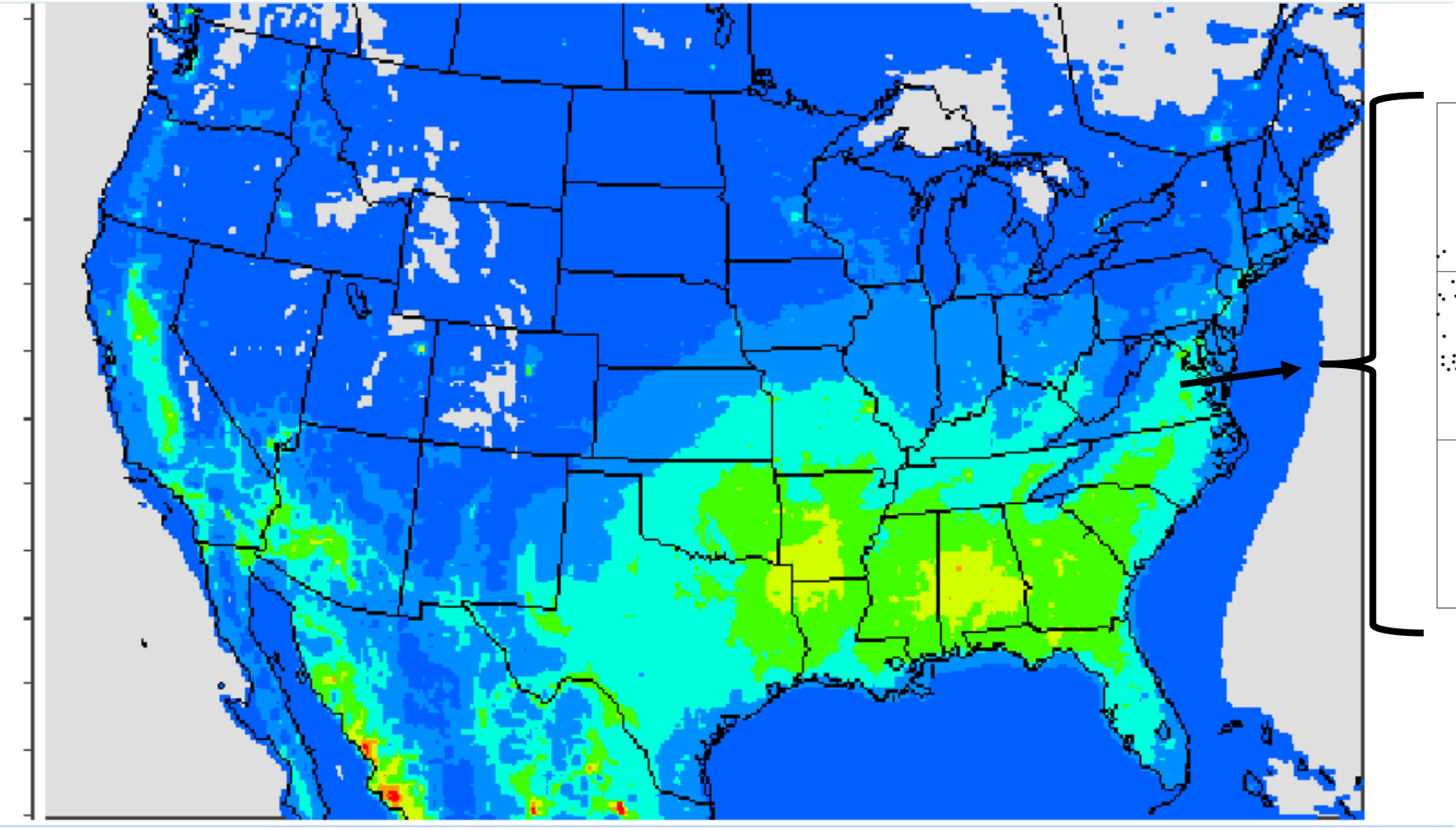
- The hybrid concentration relates the CMAQ concentrations, grid cell average total AERMOD concentration, and the individual receptor's AERMOD total concentration
- Hybrid will be calculated at each receptor (within block receptors, monitors)
- Final hybrid concentration results for the block will no longer be at the centroid, rather reflect the average of the hybrid concentrations across the receptors within a block
- The new approaches described should allow for the reporting of block level concentration results with reasonable certainty and confidence
- Thorough documentation in ATS TSD will be needed so that users understand what the concentrations represent

Hybrid equation

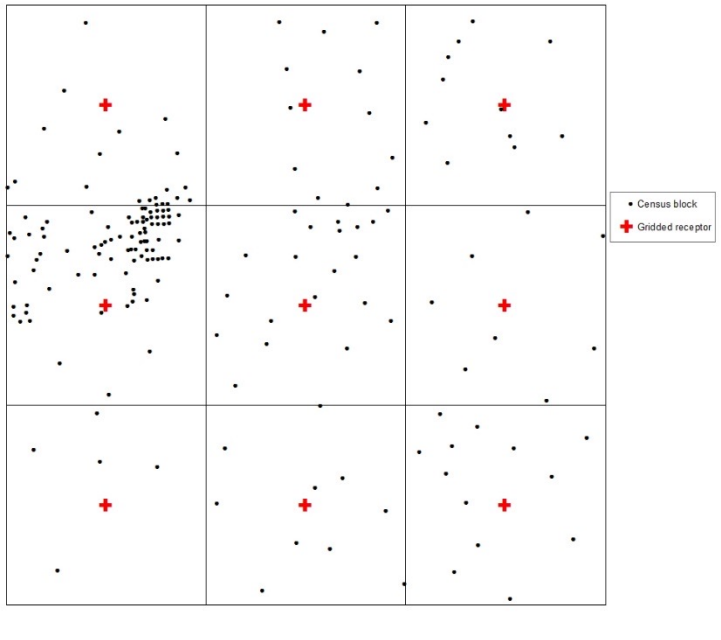
$$C_{HYBRID} = \frac{CMAQ_{prim}}{AERMOD_{avg}} \times AERMOD_{rec} + CMAQ_{fire,prim} + CMAQ_{bio,prim} + CMAQ_{sec}$$

C_{HYBRID}	Total hybrid concentration at receptor (gridded, block, monitor)
$CMAQ_{prim}$	Primary CMAQ concentration (anthropogenic primary only)
$AERMOD_{avg}$	12 km cell AERMOD average concentration (based on mini-cell averages)
$AERMOD_{rec}$	AERMOD concentration at individual receptor (gridded, block, monitor)
$CMAQ_{fire,prim}$	CMAQ primary fire concentration
$CMAQ_{bio,prim}$	CMAQ primary biogenic concentration
$CMAQ_{sec}$	CMAQ secondary concentration

Hybrid approach: graphical example



AERMOD receptors in CMAQ cell



EPA United States Environmental Protection Agency

Questions?

airtoxics@epa.gov

Caroline Farkas – farkas.caroline@epa.gov

James Thurman – thurman.james@epa.gov

Matt Woody – woody.matt@epa.gov

epa.gov/airtoxscreen