# Air Quality Data

A New Conceptual Approach

# Outline

- Goal
- Present Concept
- Problems
- New Concept
- Advantages
- Approach
- Network Design
- Example Application

# Basic Goal

Produce a complete SPATIAL picture of air quality in a cost effective manner with acceptable uncertainty

# Present Concept

- Air Quality Data (AQD) are truth (no uncertainty)
- **BUT:** Where there are no monitors there is no information

# Problems With the Present Concept

- AQD “truth” is simply what a monitor recorded at a specific place and time. Its relevance and certainty depend on its use and instrument error.
- We use monitored AQD to represent unmonitored areas (i.e., 10 ft. from the monitor) – WE ESTIMATE!
- To use AQD we must create a spatial picture (implicit interpolation) – e.g.:
  - AQD are representative of the entire area of the county in which they are taken
  - AQD provide no information outside the county in which they are taken
- For a complete spatial picture monitors are needed everywhere (including counties that have monitors) -network optimization is meaningless
- Disincentive to monitor

# New Concept

- Air Quality Concept:
  - Actual monitored or estimated (kriged) air quality are the same except for uncertainty
  - Define air quality as a estimated field of actual concentrations and their associated uncertainties
- Estimate Actual Concentration Field:
  - AQD are simply a sample of the “Actual” air quality
  - AQD are used as input to an interpolation model (kriging) to estimate the actual concentration field
  - Use area modeling to establish the best variogram for kriging
- Estimate uncertainty using area modeling

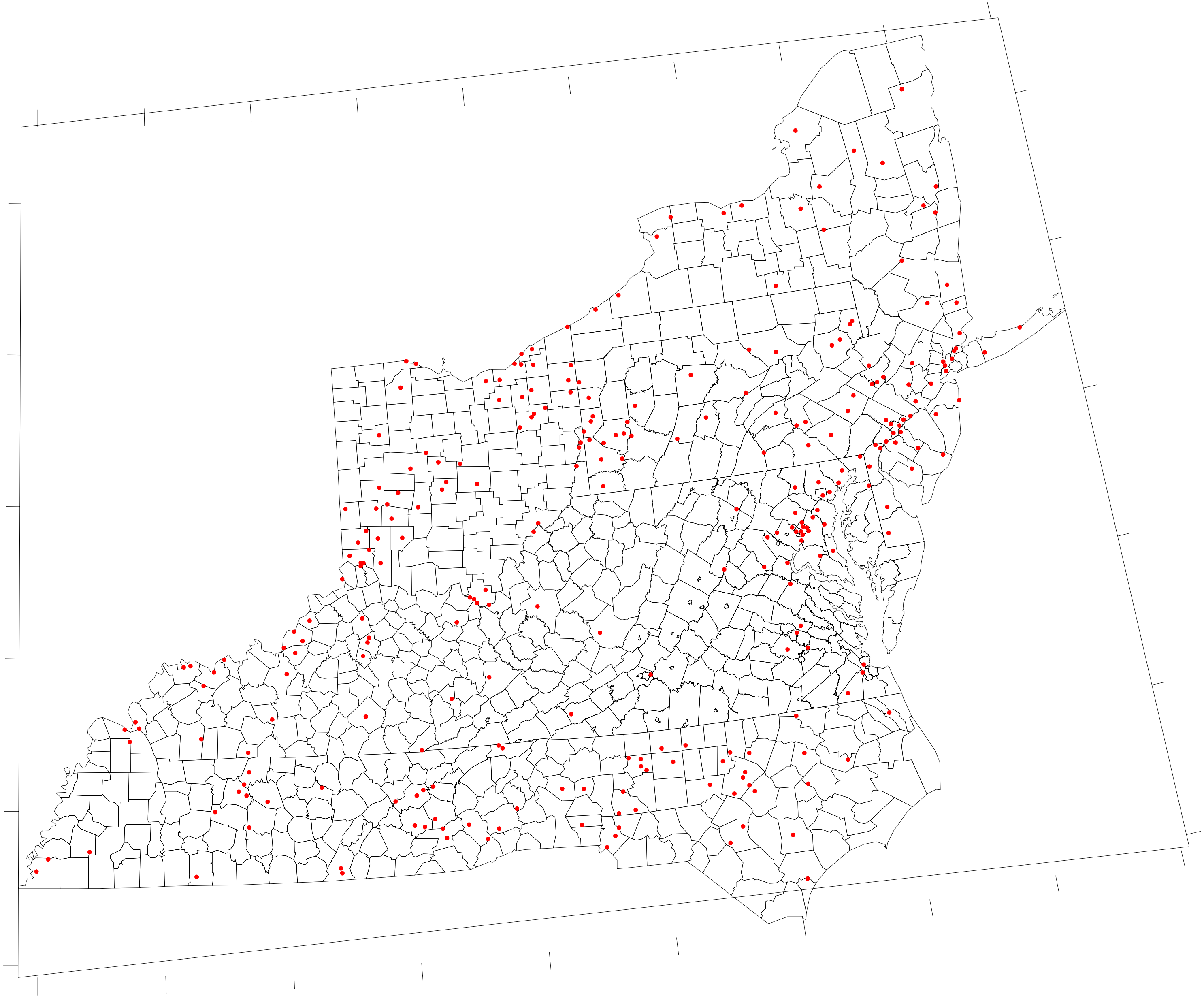
# Advantages to New Concept

- The complete field of air quality is available for policy development, trends analysis, etc.
- The estimated concentration field is robust
  - Changes to an optimized network should not significantly affect the estimates
  - Lack of county monitors does not result in NO data
- Removes monitoring disincentive
- Provides a direct blueprint for developing optimal cost-effective networks

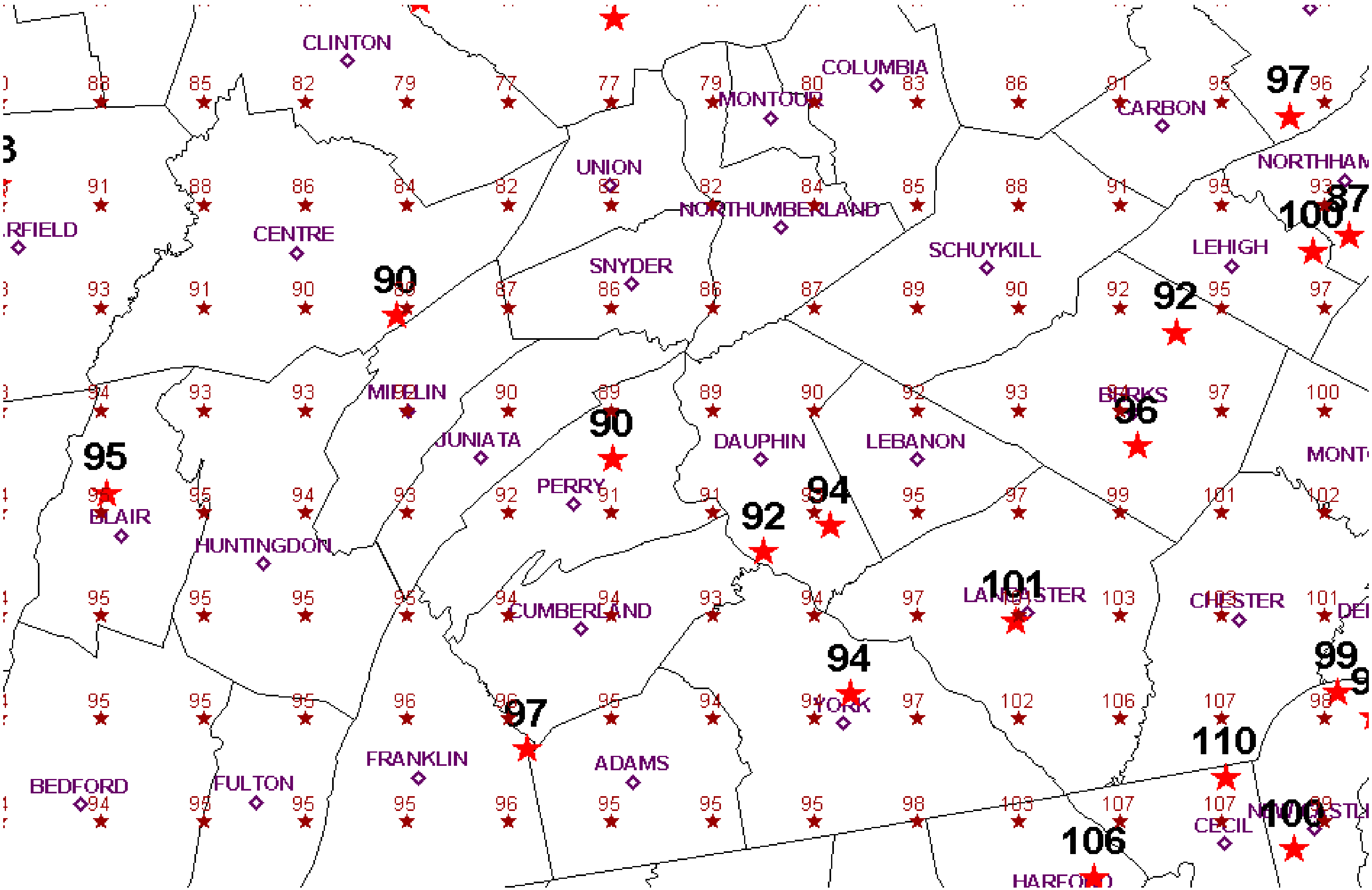
# Approach:

- Constructing actual concentration field:
  - Produce a BENCHMARK concentration field from area modeling (modeling data must adequately characterize important features of the field)
  - Establish the best variogram model for the area using the benchmark data
  - Estimate, through kriging, the actual concentration field using:
    - The variogram model constructed from the benchmark data
    - All available monitored air quality values both within and outside the area

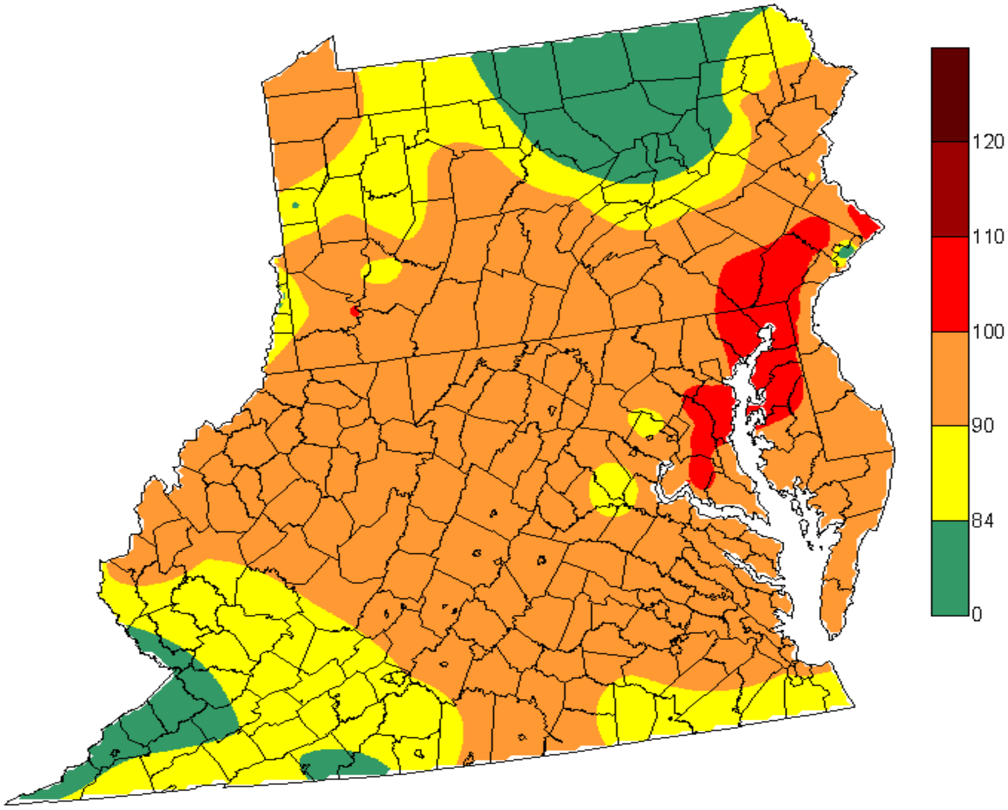
# Ozone Monitoring Network used for Kriging



1999 8hr. Ozone Design Value:  Kriged Grid with Network Overlay



# 1999 Ozone Design Values:  Kriged Contour Map

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# Approach (cont.):

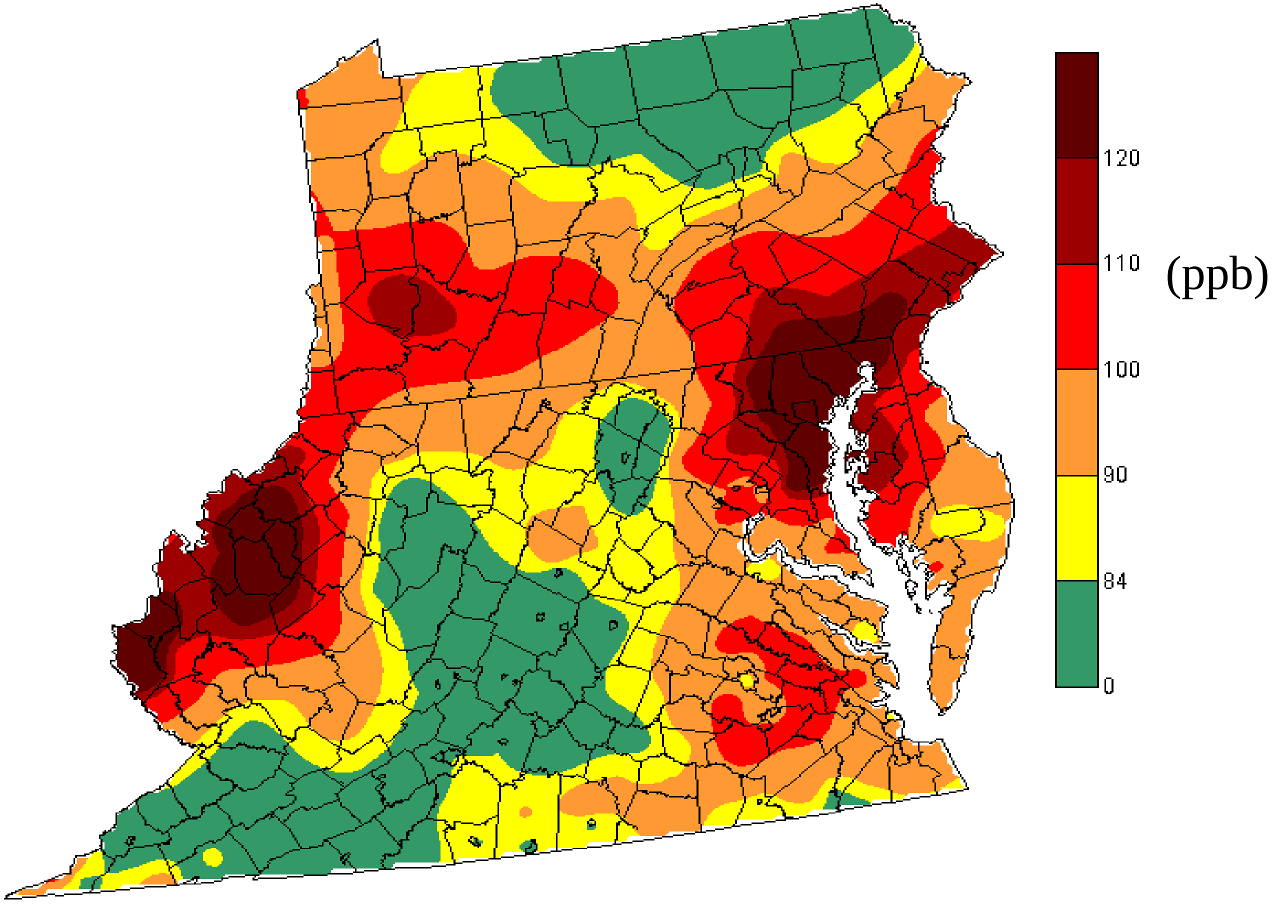
- Constructing uncertainty field
  - Develop a subset of the benchmark (modeled) data from monitor locations only
  - Estimate the actual concentration field by kriging the benchmark data subset
  - Compare the full benchmark field with the estimated field from the benchmark subset
  - Construct a field of residuals (the uncertainty field)

BENCHMARK Data Set

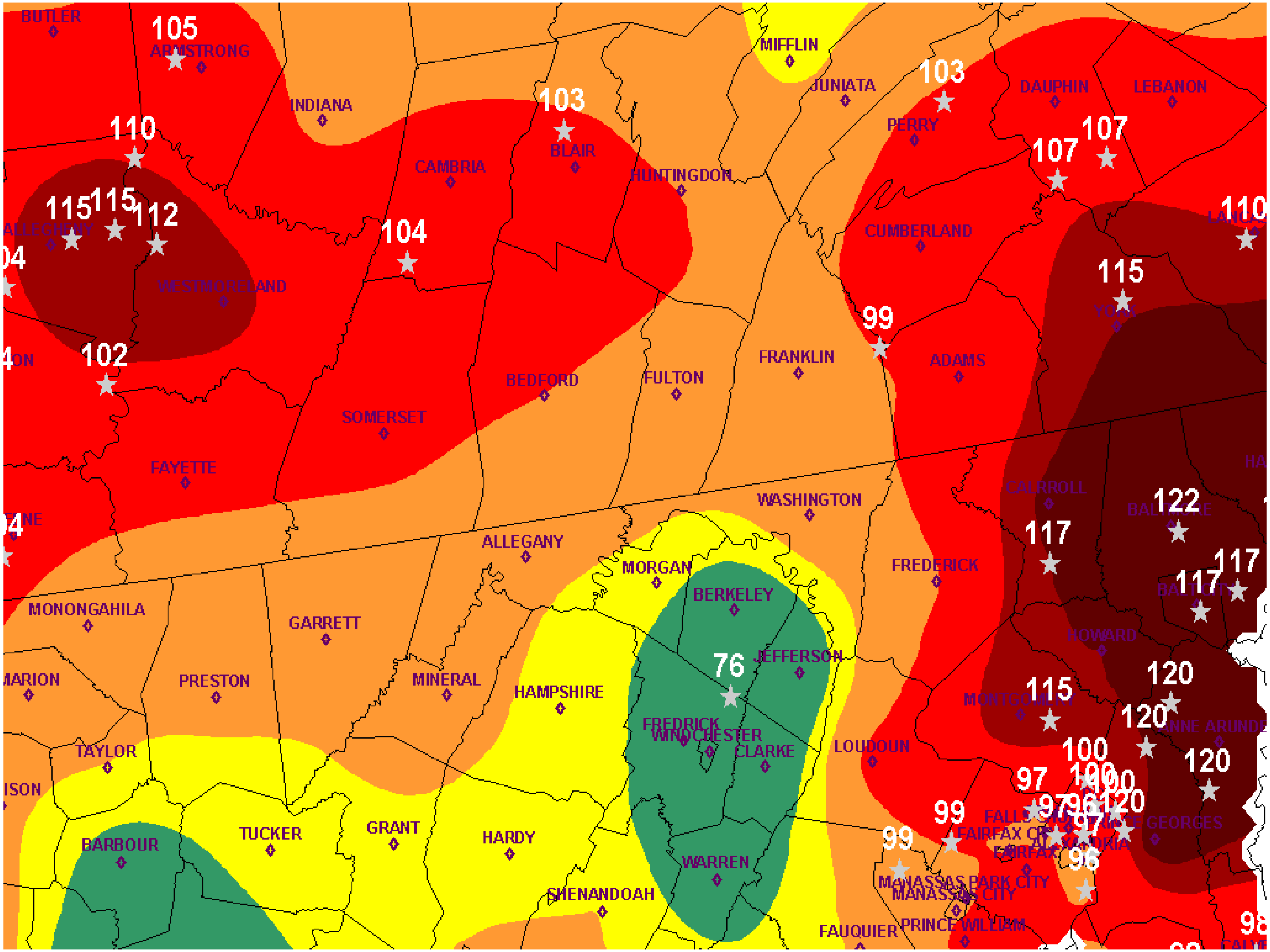
4th High 8hr. Ozone: UAM-V Model Output

1996 Emissions Inventory

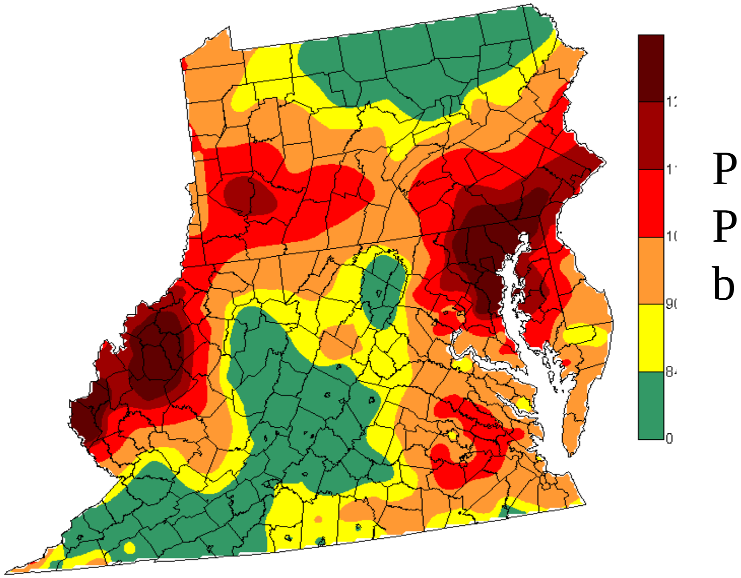
30 Days of 1995 Met



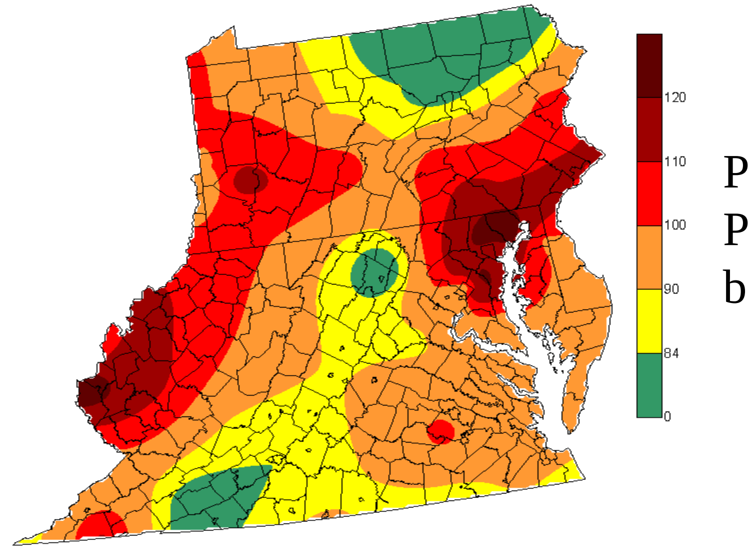
# Constructing Data Subset (modeled values at monitor locations) from Benchmark UAM-V Modeling



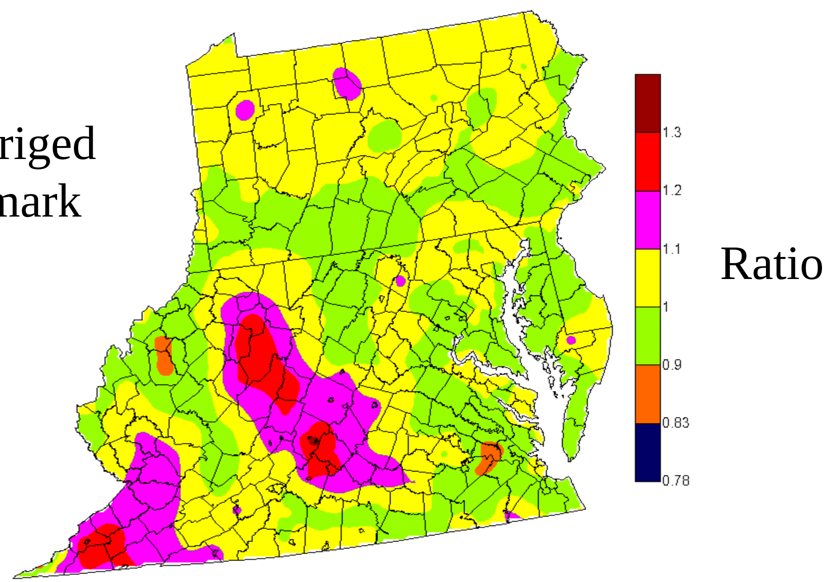
## Benchmark Data Set




## Kriged Data Set




## Ratio of Kriged To Benchmark



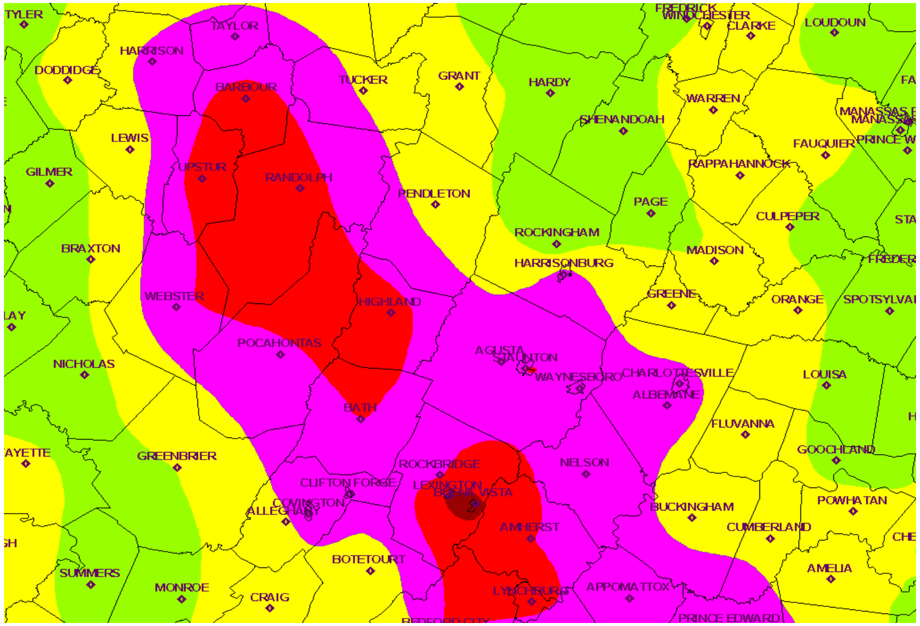
# Network Design

- PREMISE: An optimum network is one that produces minimum uncertainty for acceptable resource demand.
- GENERAL APPROACH:
  - Develop a benchmark (modeled) concentration field
  - Construct various data subsets from the benchmark data (i.e., network designs)
  - Estimate (krig) a concentration field for each network design

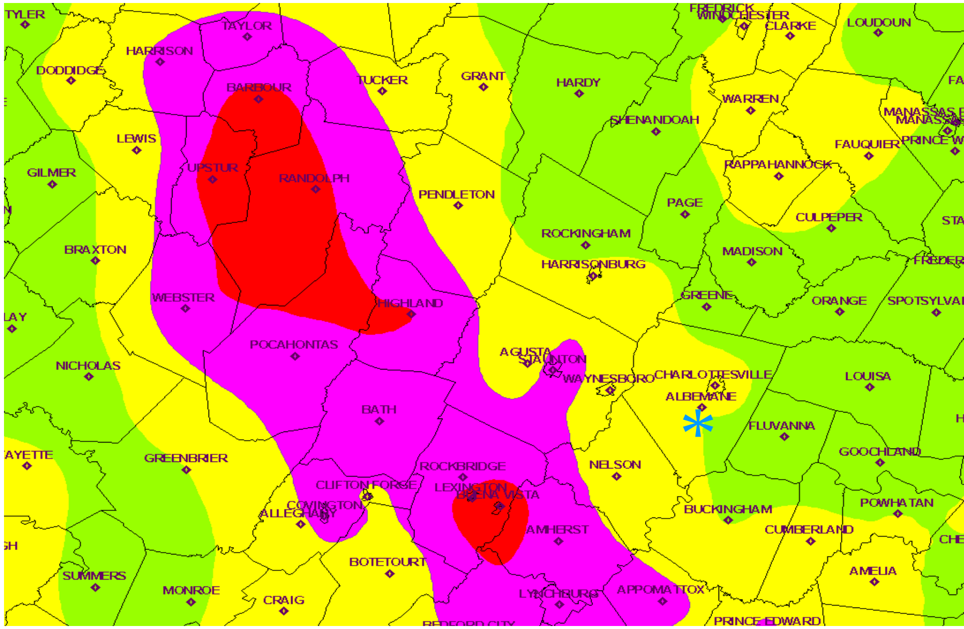
# Network Design (cont.)

- GENERAL APPROACH (cont.):
  - Compare each estimated field to the benchmark field
  - Choice the best design: establish point of diminishing returns
  - Example:
    - Existing Network Corr Coeff = .89
    - Add monitor: Albemarle county Corr Coeff = .90
    - Add Albemarle & Harrison county Corr Coeff = .91

Existing Network (Corr Coeff = 0.89)

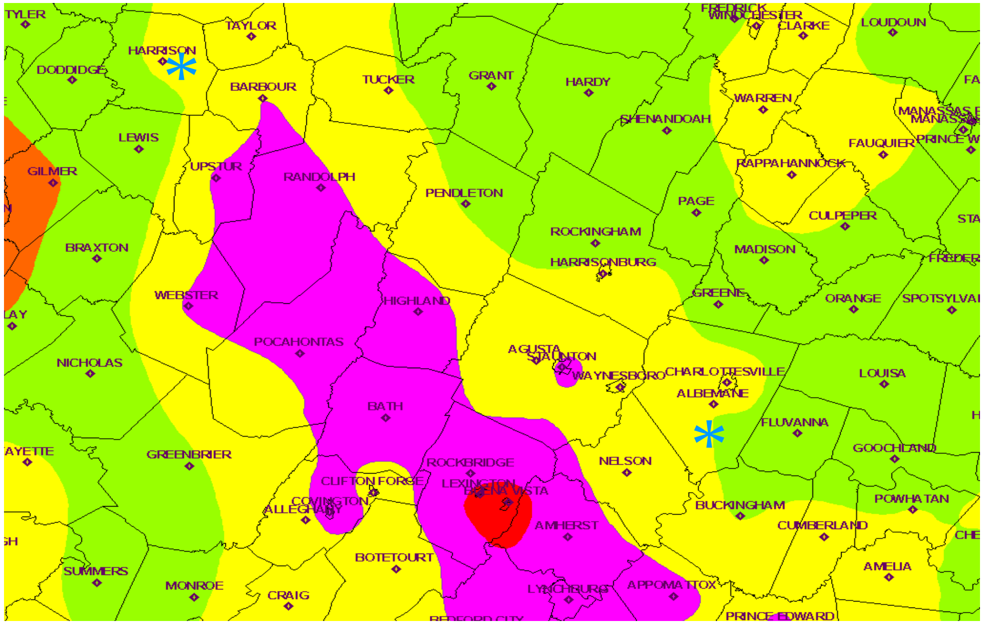


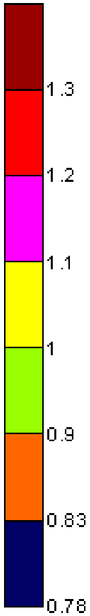

Add Albemarle (Corr Coeff = 0.90)




Add Harrison

(Corr Coeff = 0.91)

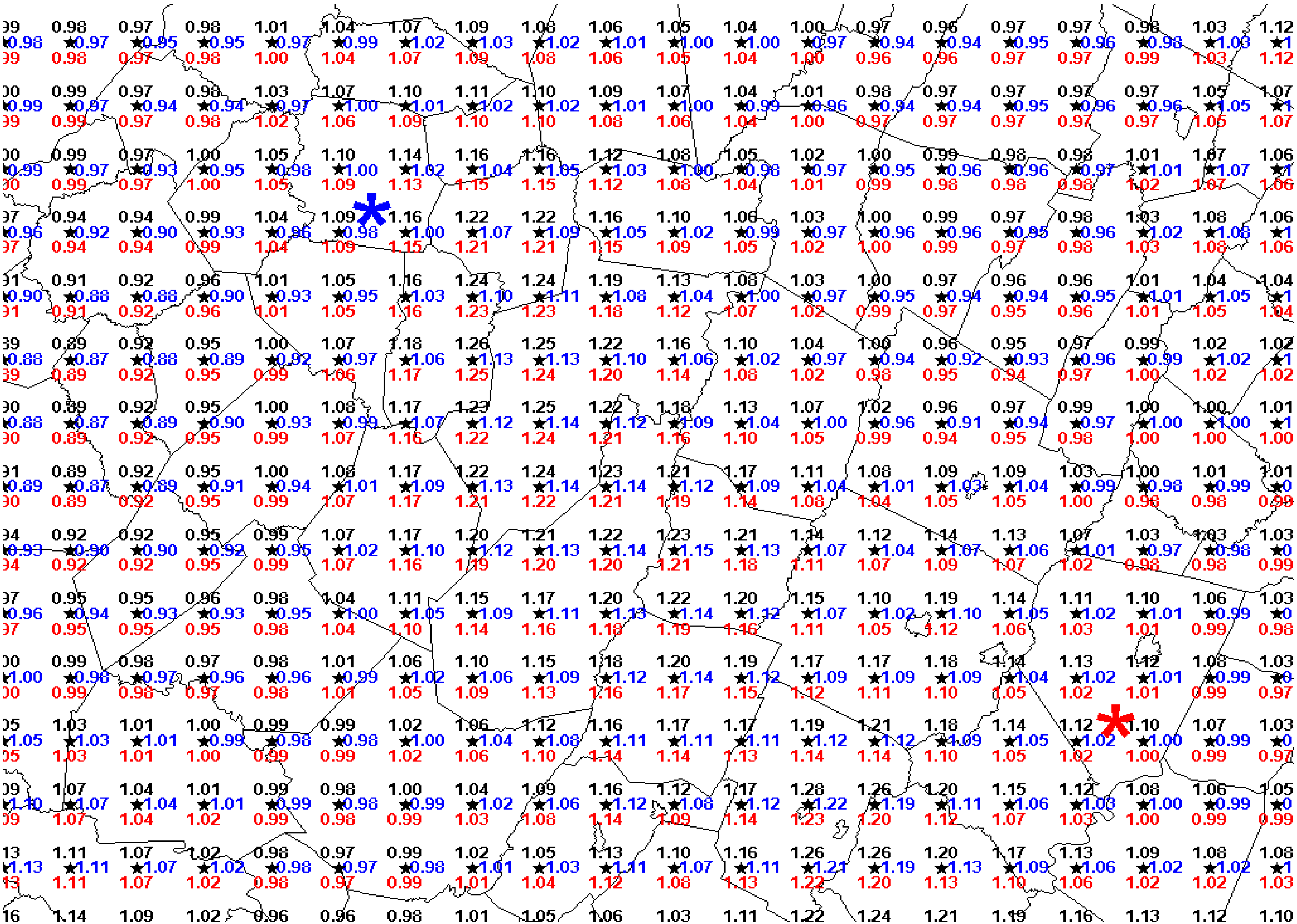



Ratio of Kriged To Benchmark

# Ratio of Kriged to Benchmark:

Black = Present Network; **Red = + Albemarle**; **Blue = + Harrison**



# Network Design (cont.)

- Plan for Optimizing Present Network
  - Develop appropriate benchmark data set (use existing modeled data if possible)
  - Develop the best variogram model for kriging
  - Develop optimization criteria
    - Comparison statistics: Correlation Coefficient; Maximum residual; Etc.
    - Resource demand
    - State preference
    - Etc.
  - Compare Benchmark with estimated “present network” field : establish baseline stats.
  - Optimize Network
    - Create potential new network
      - Examine uncertainty (residual) fields
      - Remove &/or add monitors
    - Compare new network with Baseline
    - Iterate to find optimal network

# Application of New Approach

- Use of Interpolated AQ for Region III 8hr. Ozone Attainment Designations
- PROCEDURE:
  - Estimate 1999 8hr. Ozone design value for all counties
  - Establish uncertainty field (benchmark – kriged)
    - UAMV modeled 4$^{th}$ high 8 hr. average
      - 1996 base emissions
      - 30 days met 1995 – several episodes
  - Weight estimate by uncertainty
    - The larger the residual the less weight the given to the estimate
    - Consider counties with monitors to be considerably more reliable than counties without (to reflect present EPA bias)