

# A Decision-Making Framework for Studying Ground-Level Ozone Pollution

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# Controlling Ozone Pollution

## ➤ Decision-Making Framework (DMF)

- Minimize the cost of avoiding ozone exceedance days.
- Identify reductions in emissions that will lead to new control strategies.
- Utilize rigorous statistics and optimization techniques.

## ➤ Complications

- Relationships between Ozone, nitrogen oxides (**NO<sub>x</sub>**), and volatile organic compounds (**VOC**) are complex.
- Variables are related over **time** and **space**.

## ➤ Advantages over Typical Approach

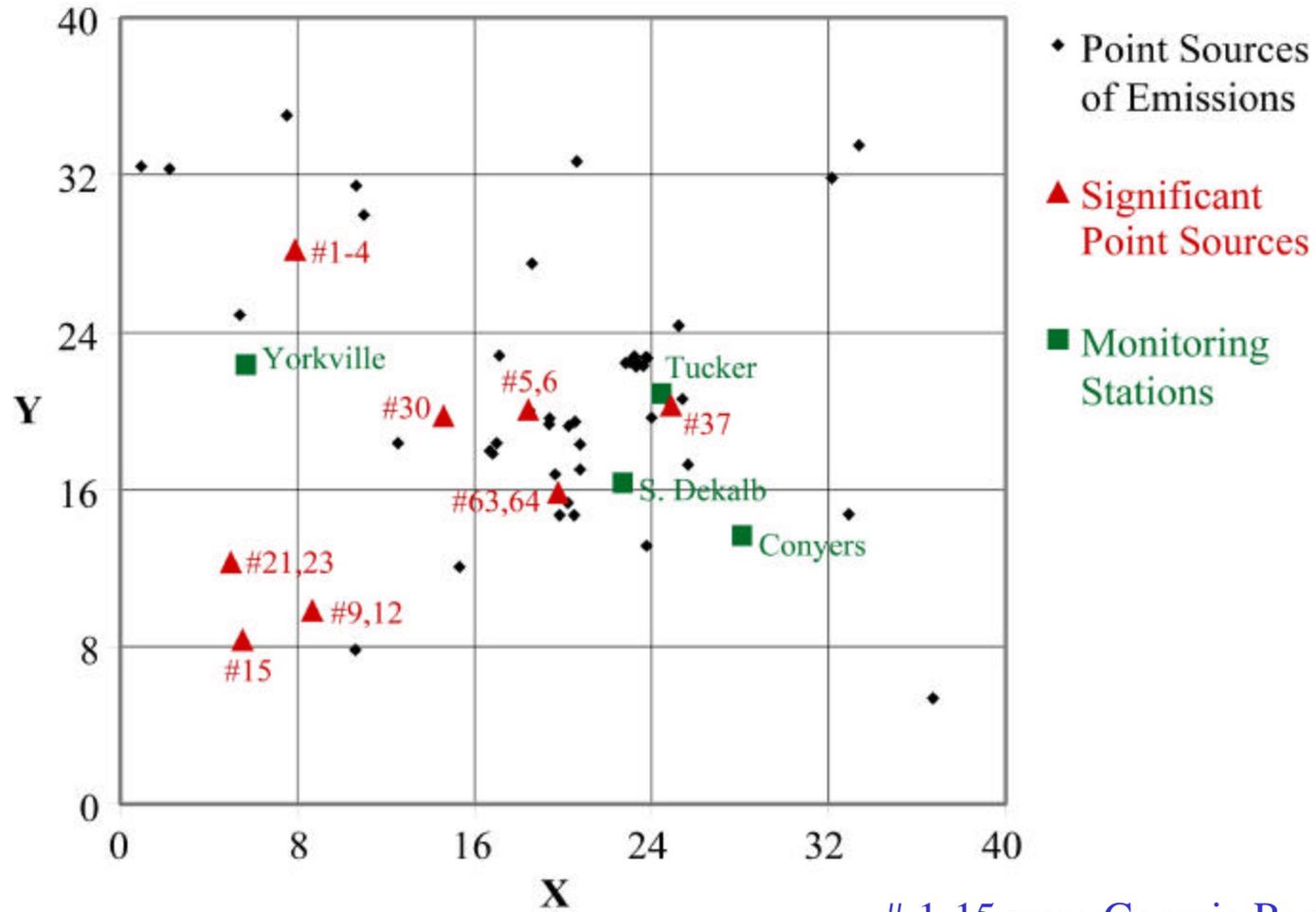
- Comprehensive approach vs. “trial and error.”
- Dynamic and focused vs. static control strategies.

## Atlanta Urban Airshed Model (UAM)

### U.S. EPA (1990)

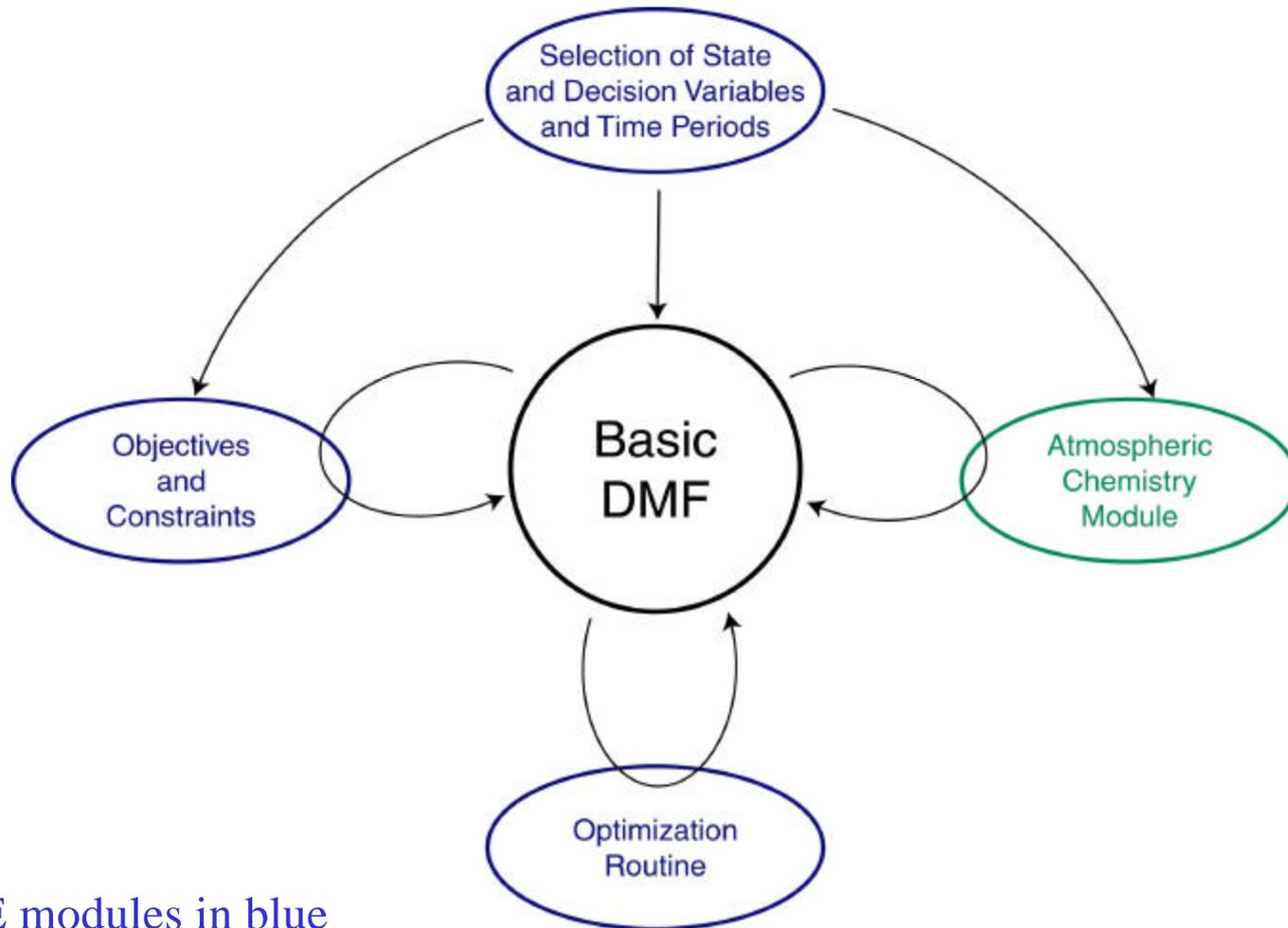
- Encompasses a 160×160 kilometer square region containing the metropolitan area.
- Spatial modeling grid: 40×40
- Point sources: 102
- Temporal modeling: 24 hours
- July 29 - August 1, 1987 episode: One of the worst on record.

# Atlanta Modeling Domain



# 1-15 were Georgia Power

# A Modular Decision-Making Framework



IE modules in blue

## Ozone Pollution Decisions

**Objective:** Minimize cost of emissions reductions to avoid ozone exceedance days.

**Constraint:** Exceedance limit → adds penalty cost

**Time Periods:** Hours or groups of hours.

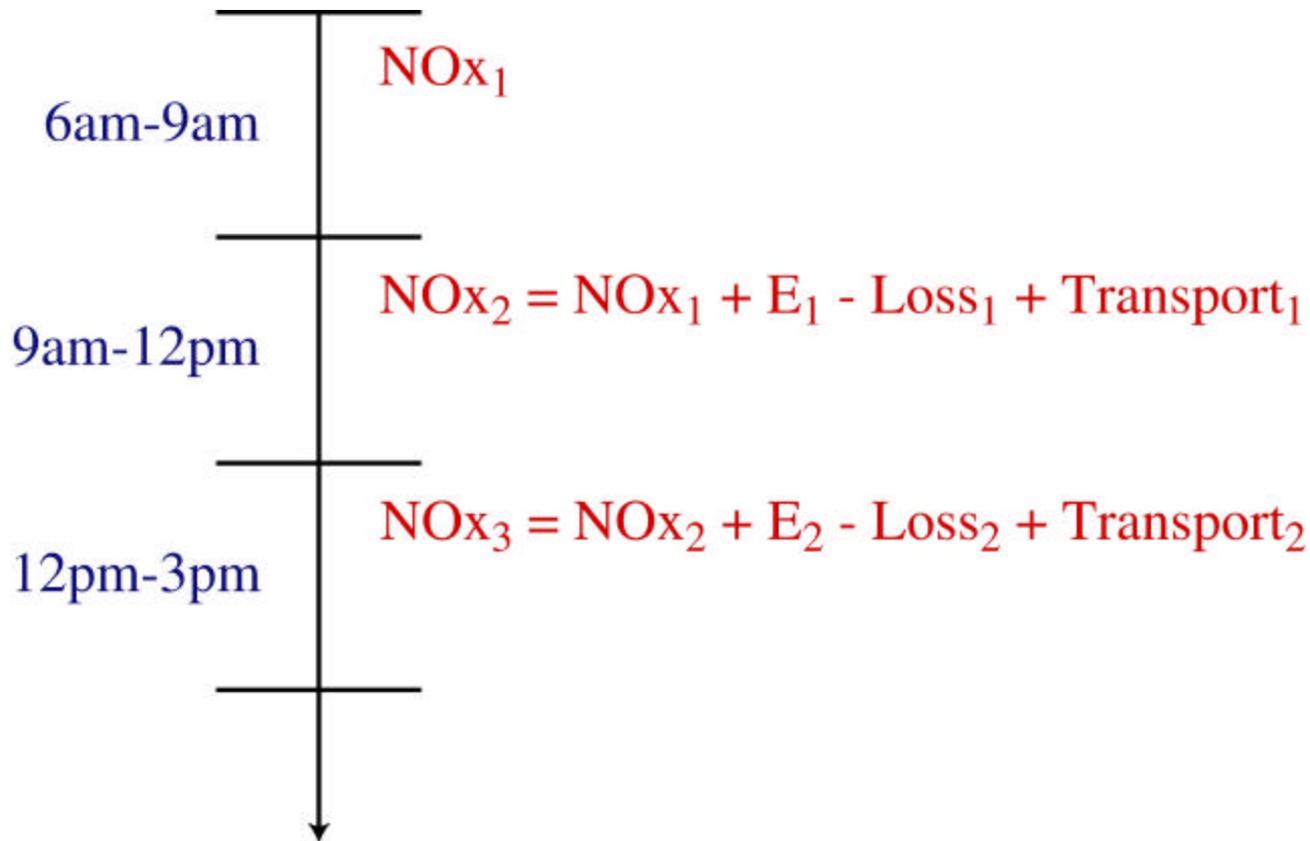
**State Variables:** Ozone, VOC, NO<sub>x</sub> concentrations at different locations and time periods.

**Decision Variables:** Reductions of VOC, NO<sub>x</sub> at specific locations in specific time periods.

**Random Variables:** Uncertainty in how Ozone, NO<sub>x</sub> change over time and space.

## Ozone Pollution Transitions over Time

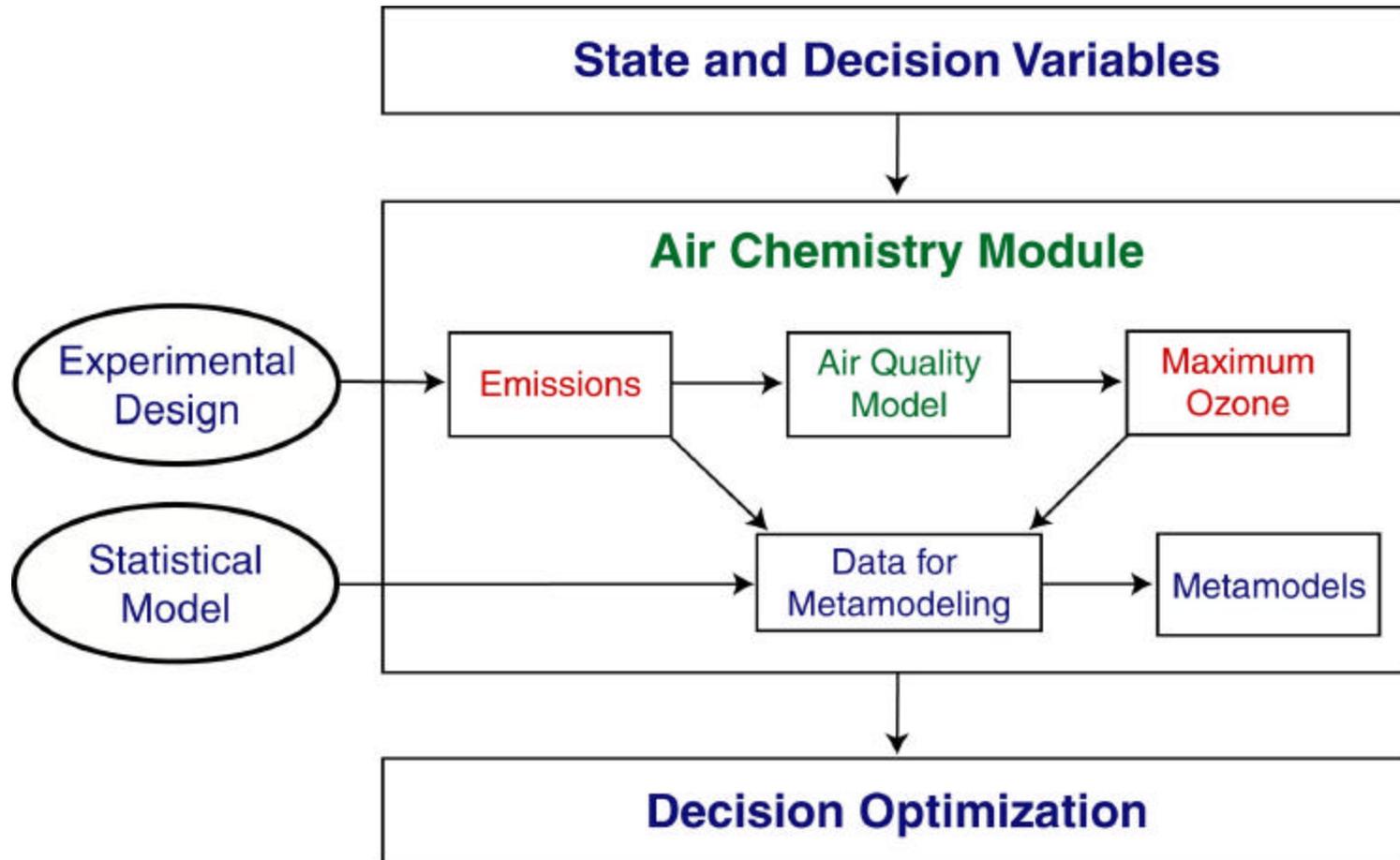
- $E_1$  = NO<sub>x</sub> emissions between 6am–9am
- $E_2$  = NO<sub>x</sub> emissions between 9am–12pm



## IE Methodologies

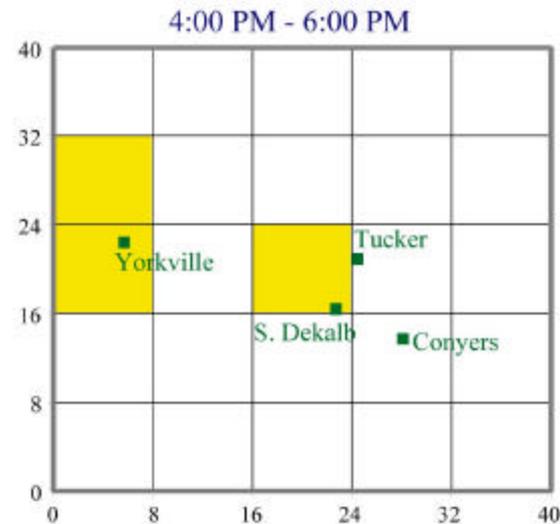
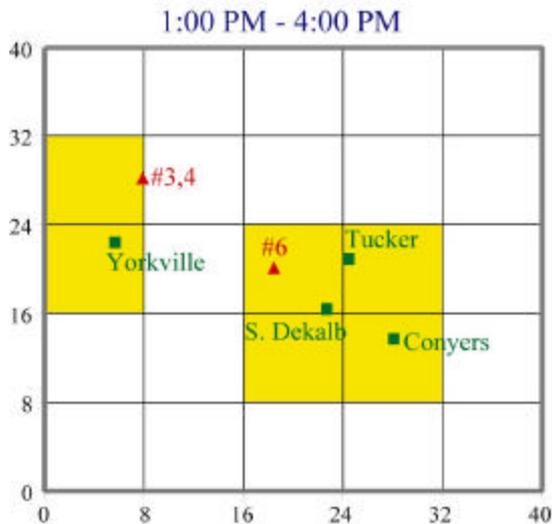
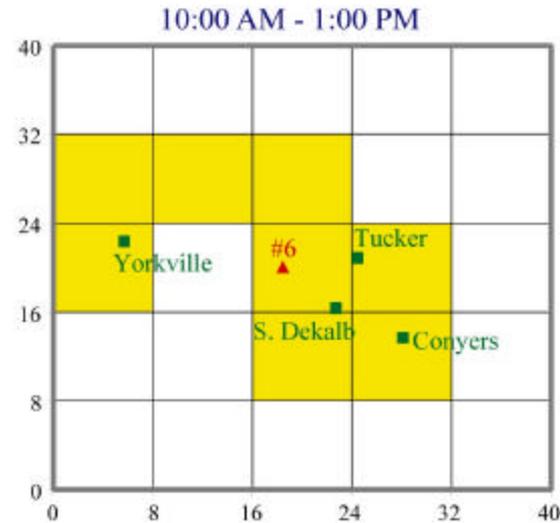
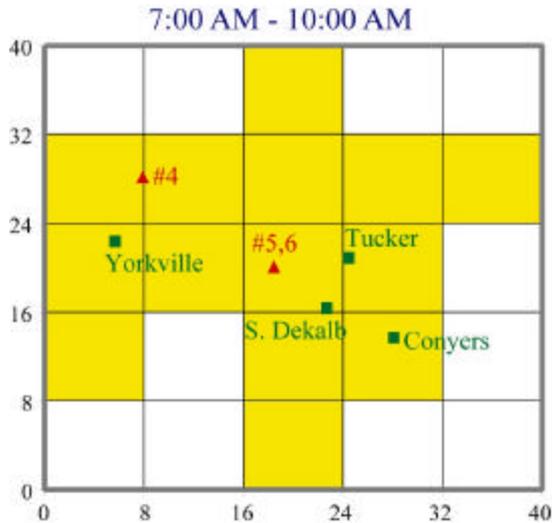
- **Optimization:** Achieve objectives within the necessary constraints.
- **Probability:** Model uncertainty in the system.
- **Statistics:** Build “metamodels” of the ozone pollution transitions, as a computationally-efficient alternative to the air quality model.
  - A “metamodel” is a model of a model.
  - **Design of Experiments:** Collect data from the three-dimensional, photochemical air quality grid model .
  - **Statistical Modeling:** Approximate the ozone pollution transition functions.

# Atmospheric Chemistry Metamodel

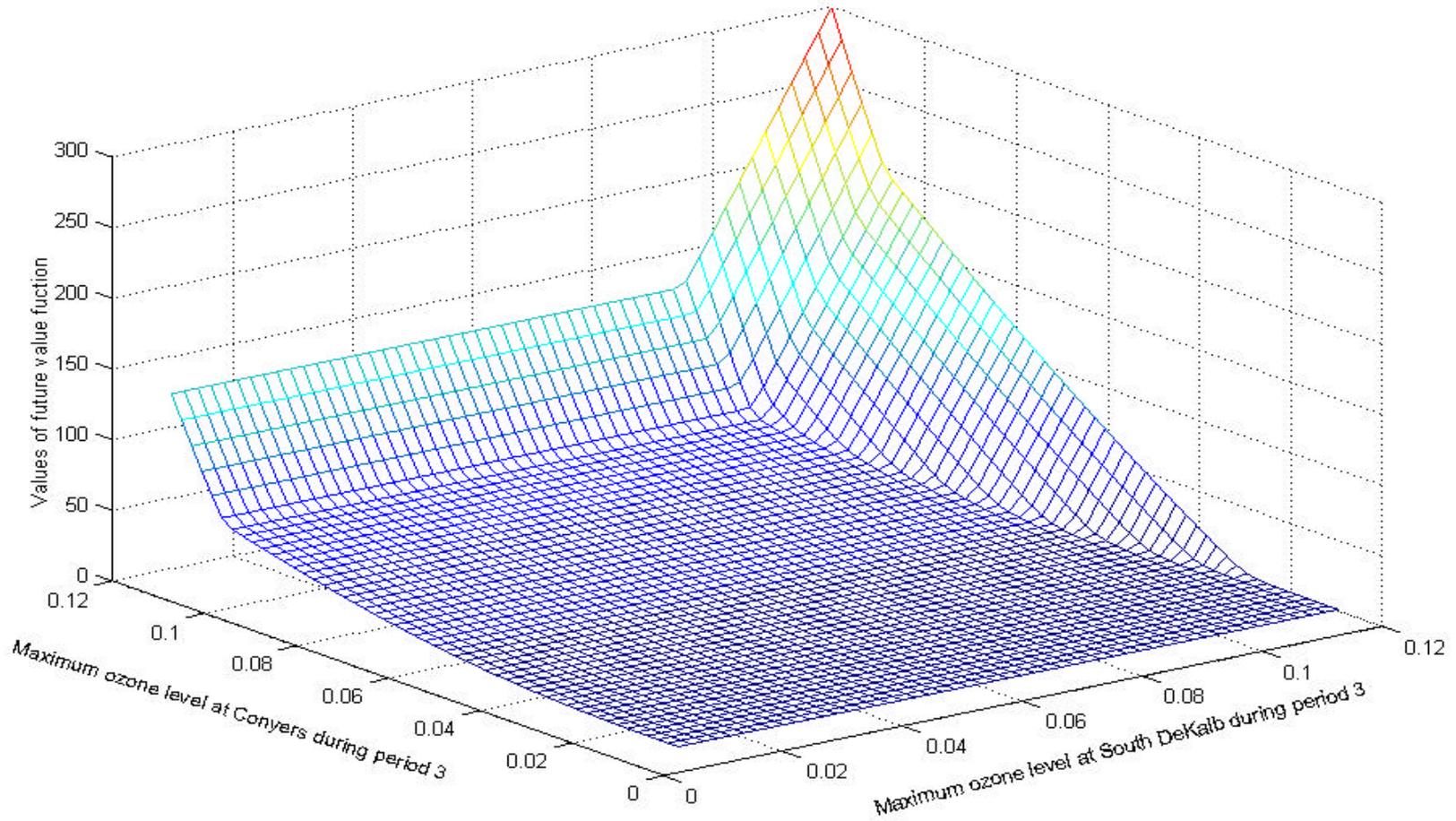


IE tasks in blue

# Emissions Reductions Decisions for Atlanta



# Optimal Value Function



## Concluding Remarks

### ➤ Goals:

- Explore the necessary emissions reductions over time and space to prevent an ozone exceedance.
- Provide information and guidance to **government decision makers** for creating new control strategies

### ➤ On-going Work:

- Test SDP solution via simulation
- Implement in a parallel computing environment

### ➤ Future Work:

- Improve transition function metamodels
- Transfer DMF to Dallas/Fort-Worth