CASE STUDY: ENVIRONMENTAL MONITORING USING REMOTE OPTICAL SENSING [OP-FTIR] TECHNOLOGY AT AN INDUSTRIAL WASTEWATER TREATMENT PLANT

Tinker Air Force Base, Oklahoma

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INVESTIGATION OVERVIEW

Outline

- Introduction
- Project Overview
- Distinctive Elements of Effort
- Air Emission Model
- Air Dispersion Model
- Coupled Model Validation / Calibration Process
- Coupled Model Results
- Comparison to Remote Optical Monitoring System
- Application to Risk Assessment
- Summary and Conclusions

TINKER AFB, OKLAHOMA

Introduction

- Tinker AFB covers 5,031 acres
  - *Only 200 acres are undeveloped*
- 765 Facilities
  - *15.3M feet^2 of industrial operations*
- Three Creek Systems
- 700-plus Air Emission Sources
- 200 Underground Storage Tanks
- 11-Miles Industrial Wastewater Lines
- Three Wastewater Treatment Plants
- 36 Restoration Sites
- Provides Logistics Support to USAF Weapon Systems
  - *B-1, B-52, E-3 Sentry, C/KC-135 aircraft*

TINKER AFB, OKLAHOMA

Introduction [CONTD]

- Tinker AFB performs Depot Level Maintenance
- Process Assessment identified four Primary Processes
  - *Depainting, Painting, Electroplating & Cleaning*
  - *Majority of processes discharge to an on-base treatment facility*
- Regulatory Requirement to quantify Air Emissions from Industrial Wastewater Treatment Facility [IWTF]
  - *Toxic Release Inventory and Air Emission Inventory*
  - *Clean Air Act Title V permit requires source & emission information*
  - *POTW NESHAP requirement*
- Efforts focus on Methylene Chloride and Phenol
  - *Both are CAA Title III Listed Hazardous Air Pollutants [HAPs]*
  - *VOC and semi-VOC examples*
  - *These chemicals account for majority of purchases / releases*

ENVIRONMENTAL MONITORING

Project Overview

- Investigation will be presented in four Major Tasks
- Coupling of Emission and Dispersion Models represents a Cost-Effective and Environmentally-Responsible Approach
  - *Coupling refers to sequential use of models [output is input]*
  - *Meet impact predictions, regulatory reporting requirements, and pollution prevention needs*
  - *Estimate emissions from IWTP process units*
    - ➢ *WATER8 air emission model developed by EPA*
  - *Estimate atmospheric dispersion concentrations*
    - ➢ *ISC-ST3 air dispersion model designed by EPA*

  Coupled Model
  - *Validate predictive accuracy of the coupled model*
    - ➢ *Comparison of coupled model predictions to field data*
    - ➢ *Comparison of coupled model predictions to OP-FTIR data*
  - *Demonstrate potential applications to include Risk Assessment*

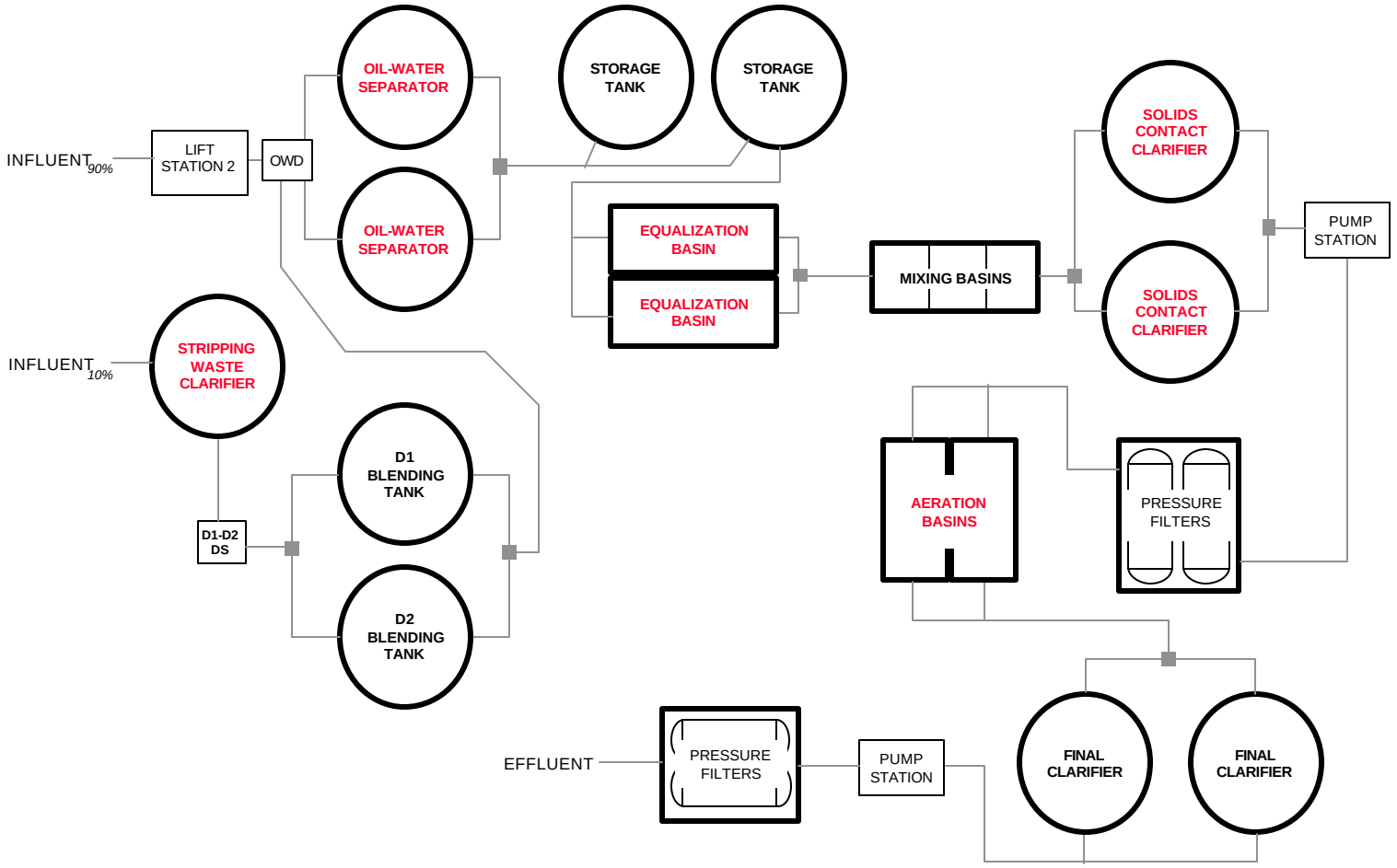
ENVIRONMENTAL MONITORING

Uniqueness of Investigation

- Distinctive Elements of Investigation
  - *Combined use of WATER8 and ISC-ST3*
  - *Literature directed to specific applications*
  - *Coupled model compared to MAAC*
  - *Literature limited to single emission sources*
  - *Literature focused at municipal wastewater treatment*
  - *Detail and size of periodic canister data*
  - *Investigation of three remote optical paths*
  - *Multiple retroreflectors that bend optical path*
  - *Evaluation of chemical depainting agents*
  - *Coupled model used in risk assessment*
  - *Completeness and comparative analysis*

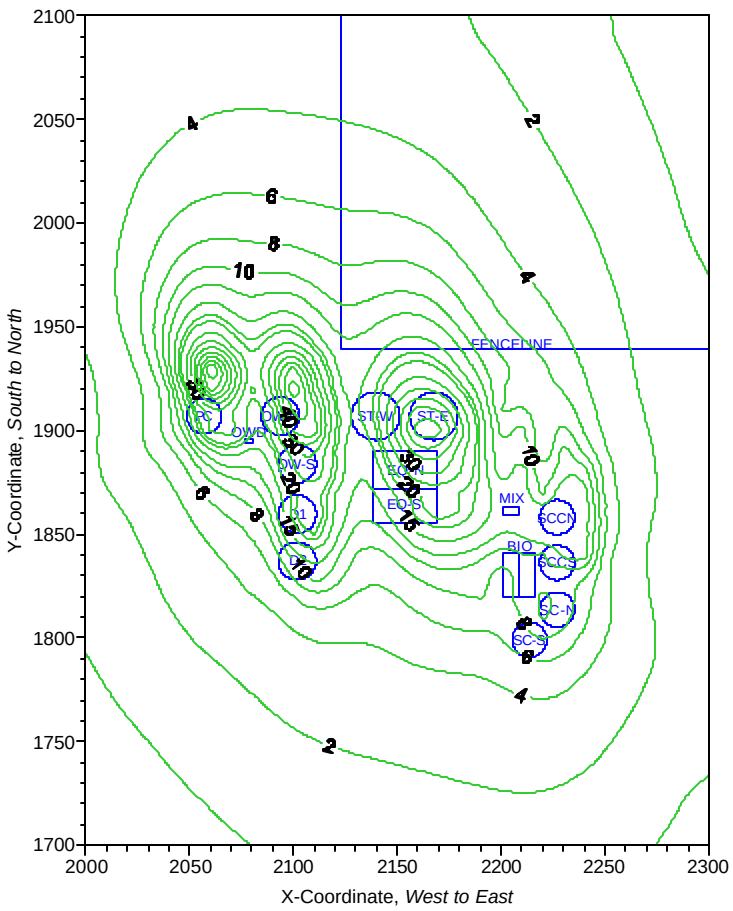
IWTP PROCESS FLOW DIAGRAM

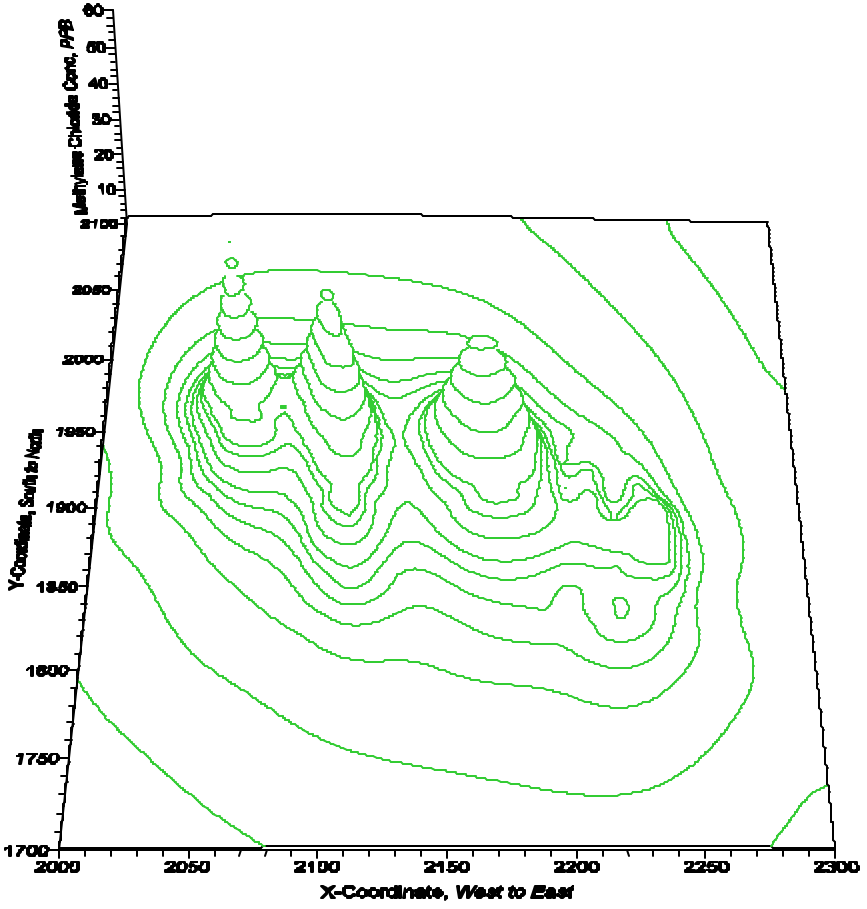
Primary, Secondary, & Tertiary Treatment



COUPLED MODEL OUTPUT

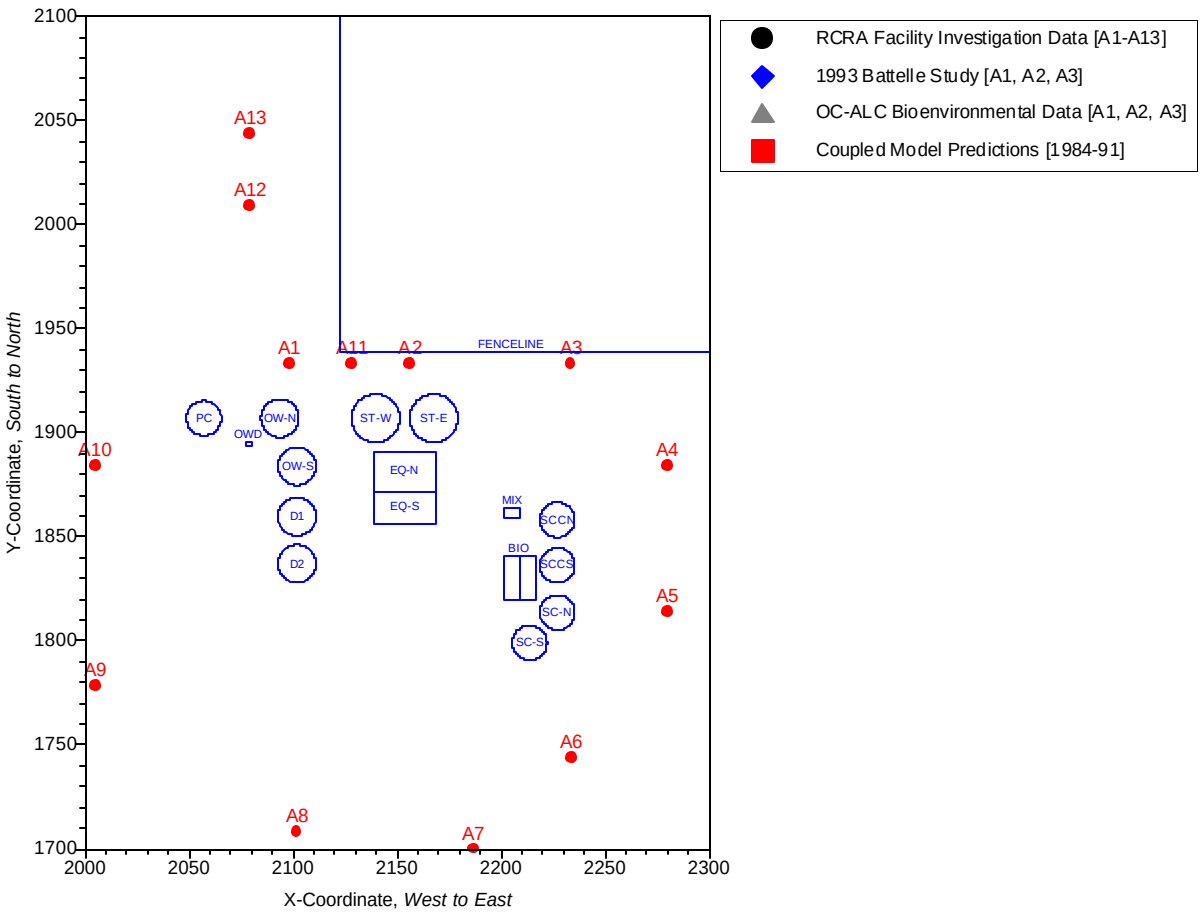
Maximum Methylene Chloride Concentrations, PPB





ENVIRONMENTAL MONITORING

Location of Periodic Canister Data



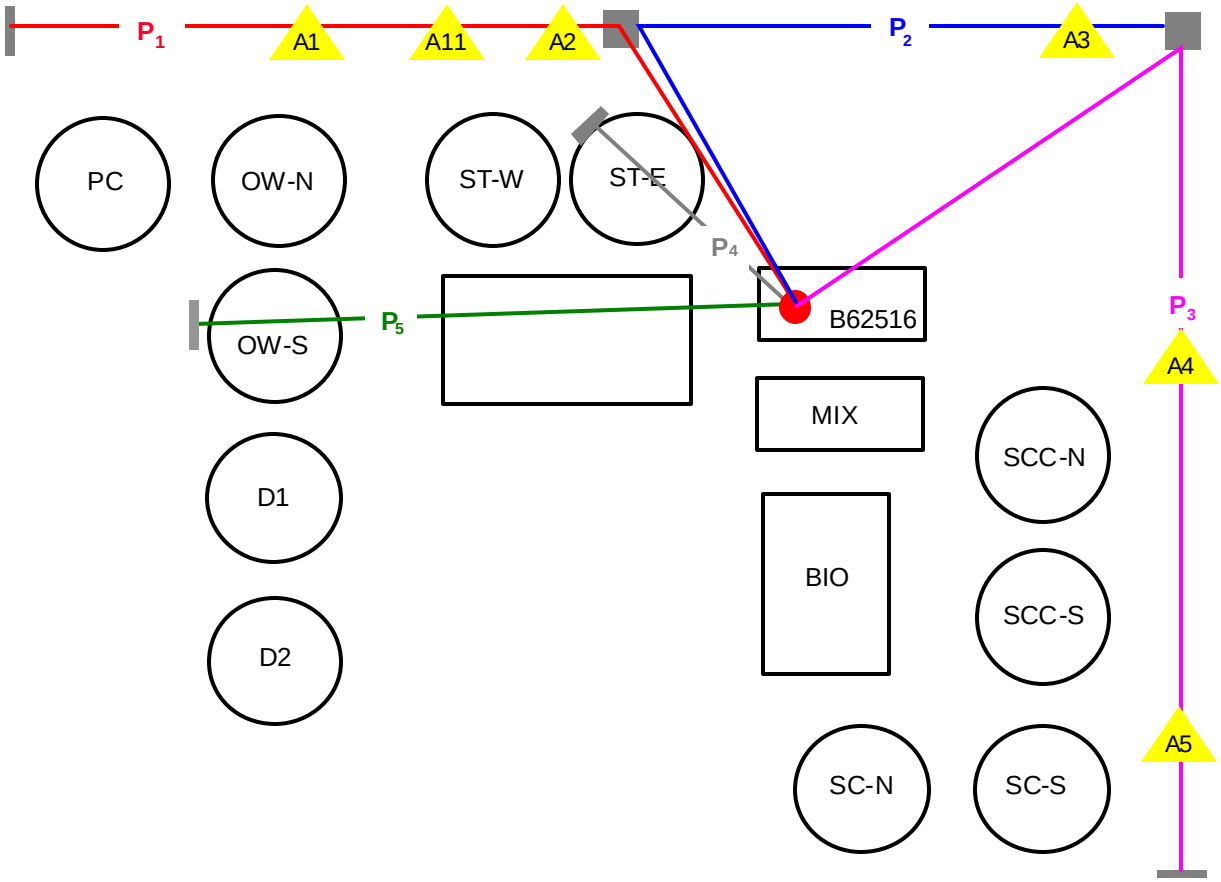
OPEN PATH MONITORING SYSTEM

Fourier Transform InfraRed Spectroscopy

- Open-Path Monitoring System measures Atmospheric Emissions
  - *Directing infrared optical energy along physical path that crosses downwind of emission source plume*
  - *OP-FTIR system used for environmental monitoring*
- Pollutants modify Spectral Signal
  - *Allows for determination of identity and quantity of pollutants*
- OC-ALC Application consist of OP-FTIR Spectrometer
  - *Operated in monostatic configuration*
  - *Designed to measure atmospheric dispersion concentrations along five distinct optical paths*
  - *Primarily concerned with fenceline concentrations [P_1, P_2, P_3]*
  - *System installed in 1995 and operational roughly three months*
    - ➢ *36 percent of collected FTIR data considered unusable*

OPEN PATH MONITORING SYSTEM

Remote OP-FTIR Optical Monitoring Pathways



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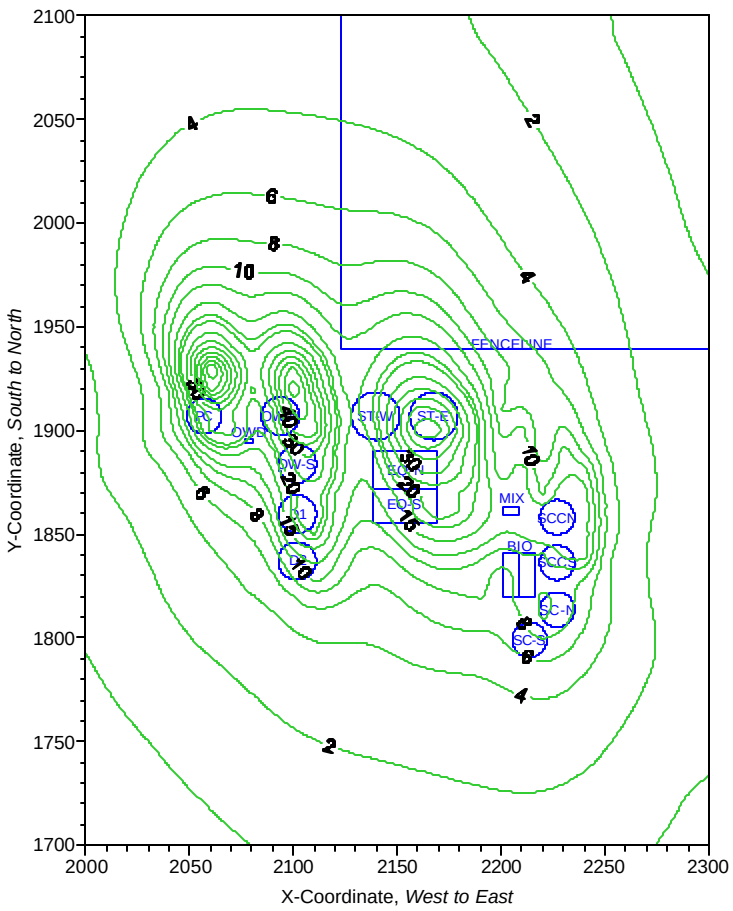
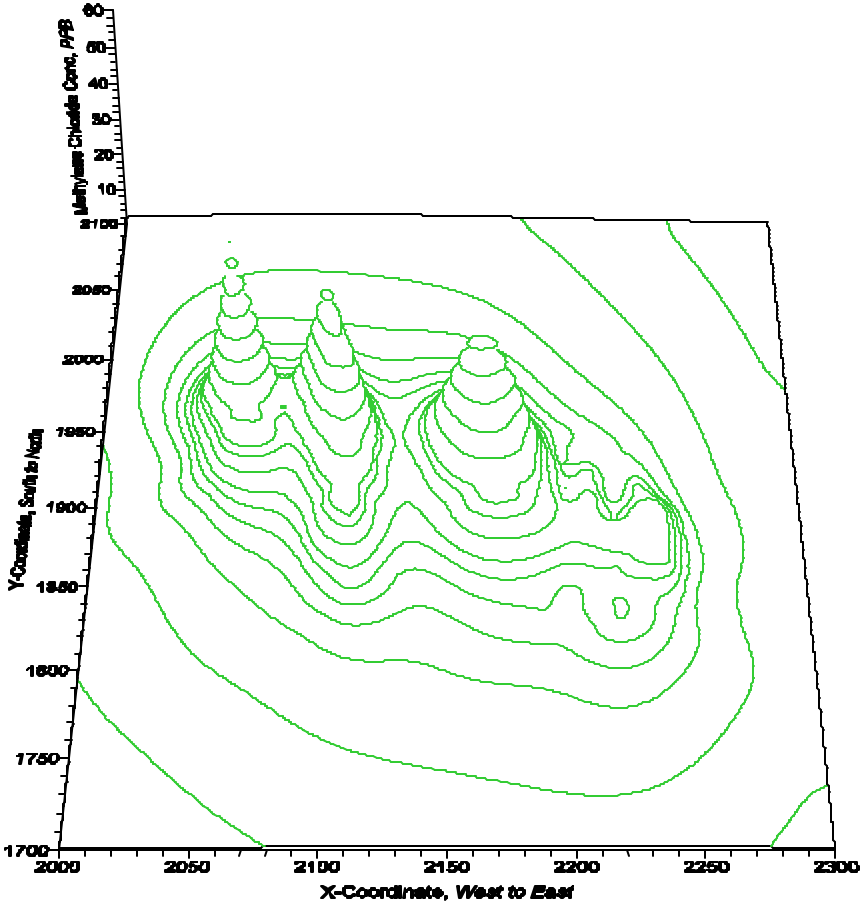
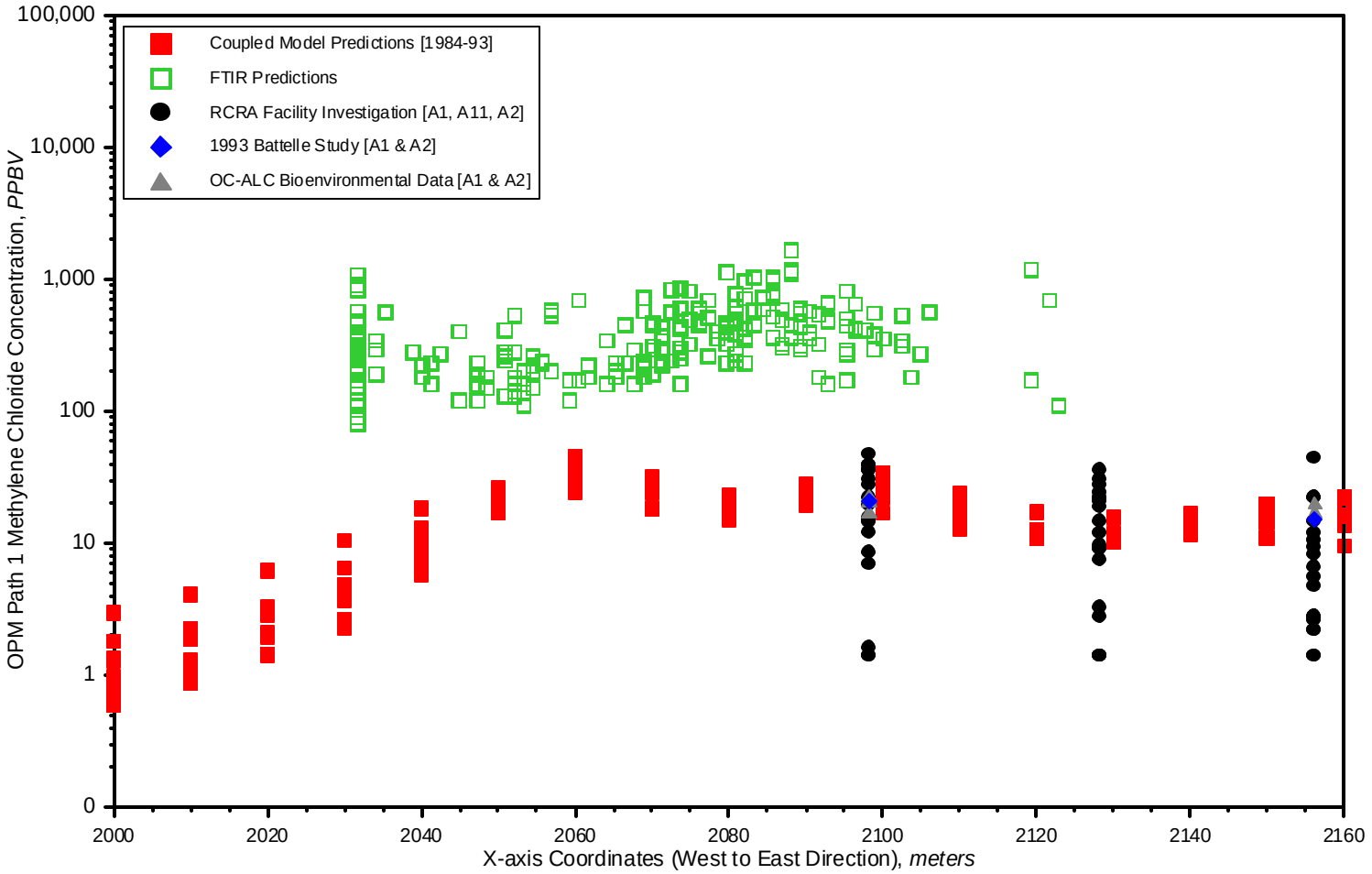




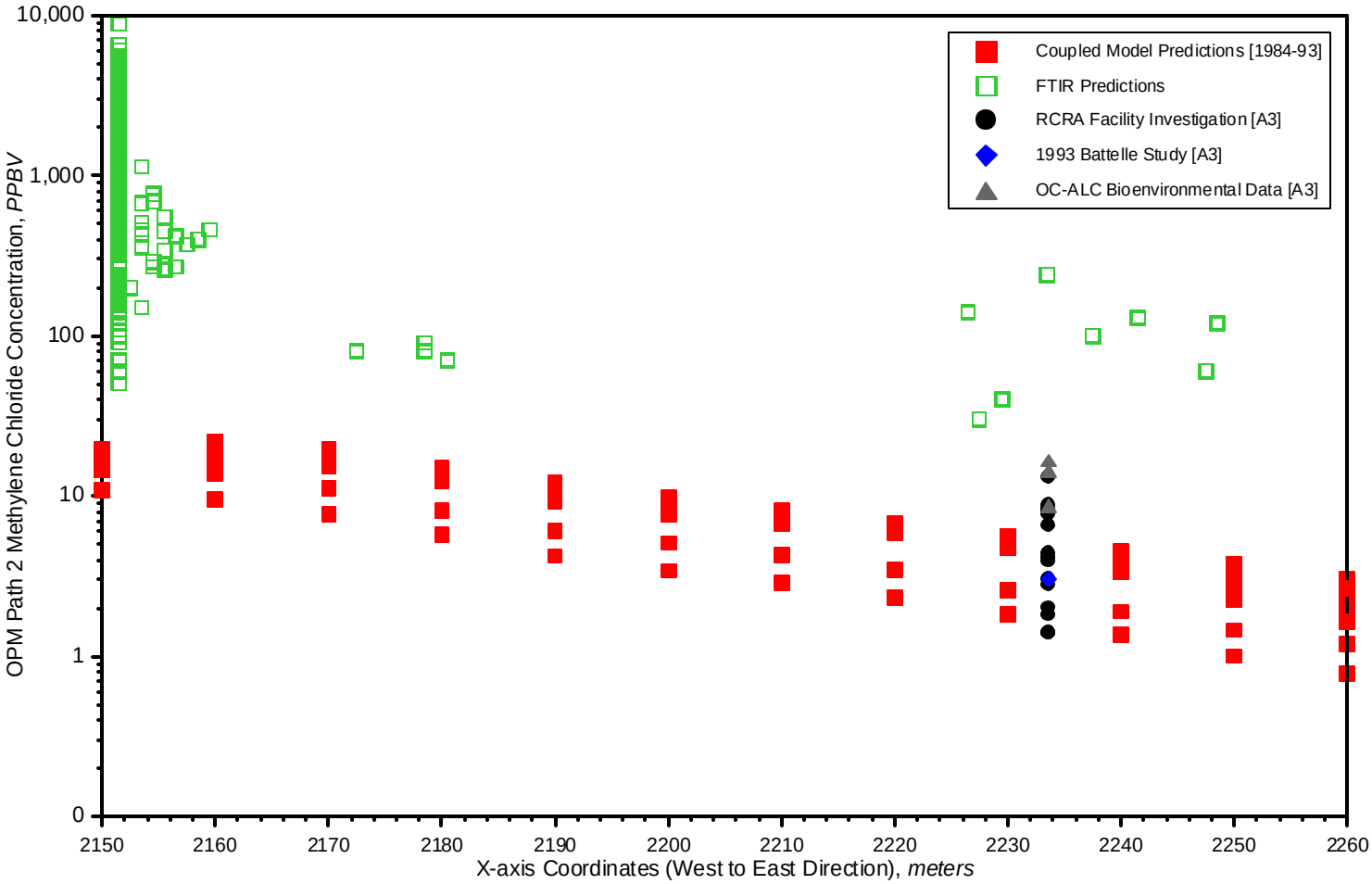
OPM SYSTEM COMPARISON

Methylene Chloride--Optical Path P1



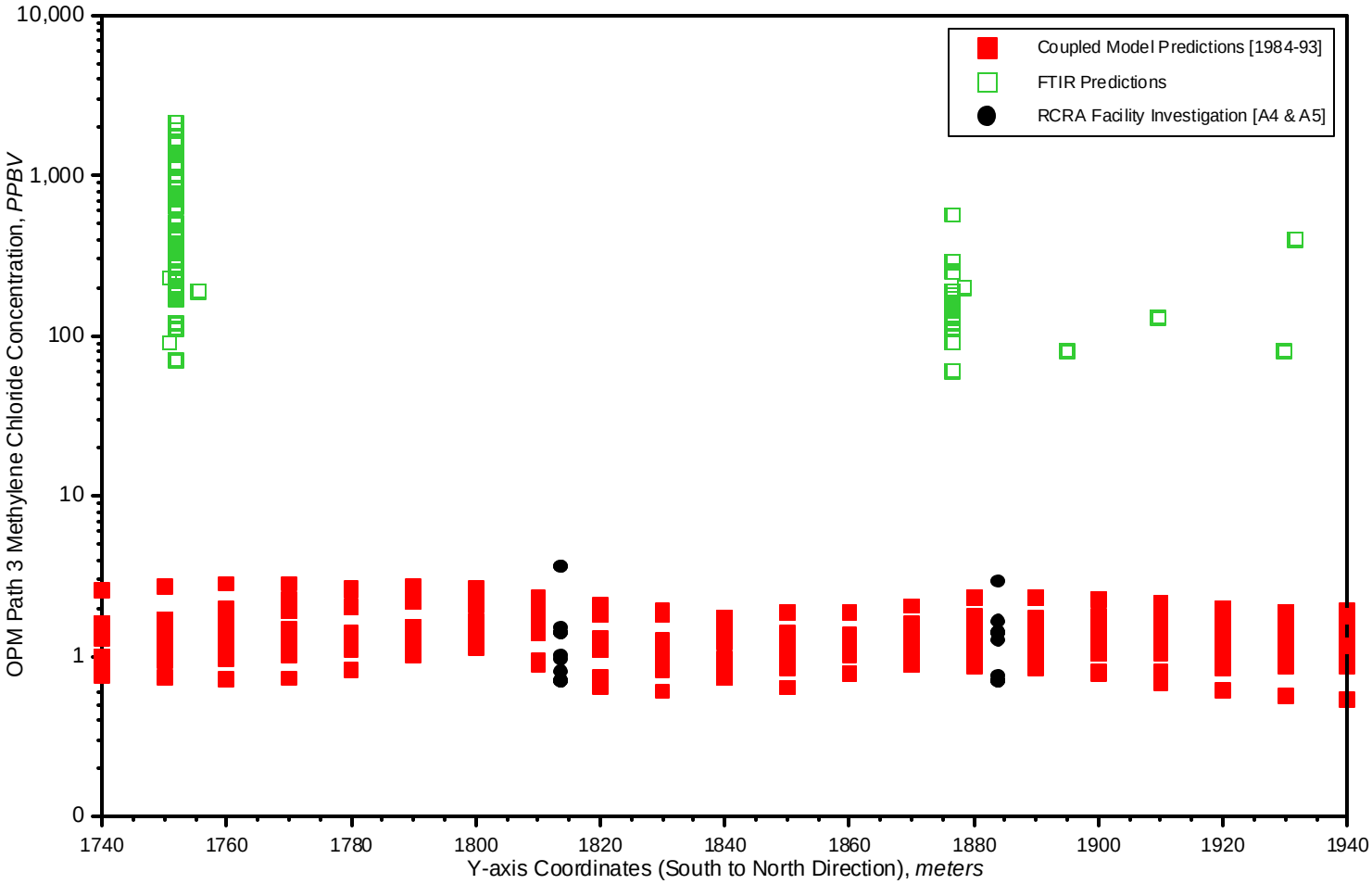
OPM SYSTEM COMPARISON

Methylene Chloride--Optical Path P2



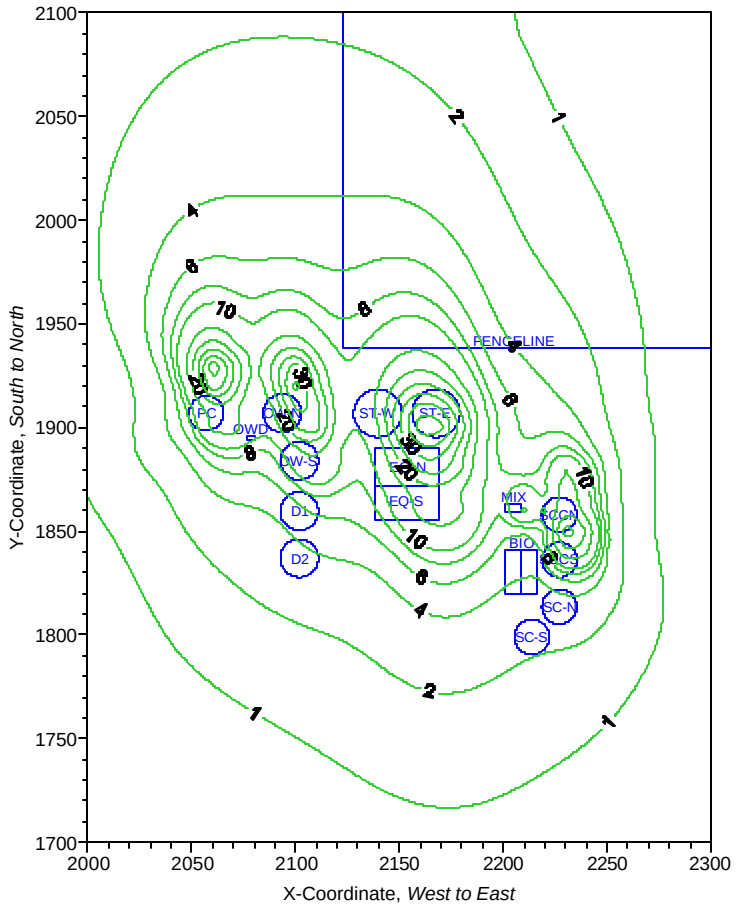
OPM SYSTEM COMPARISON

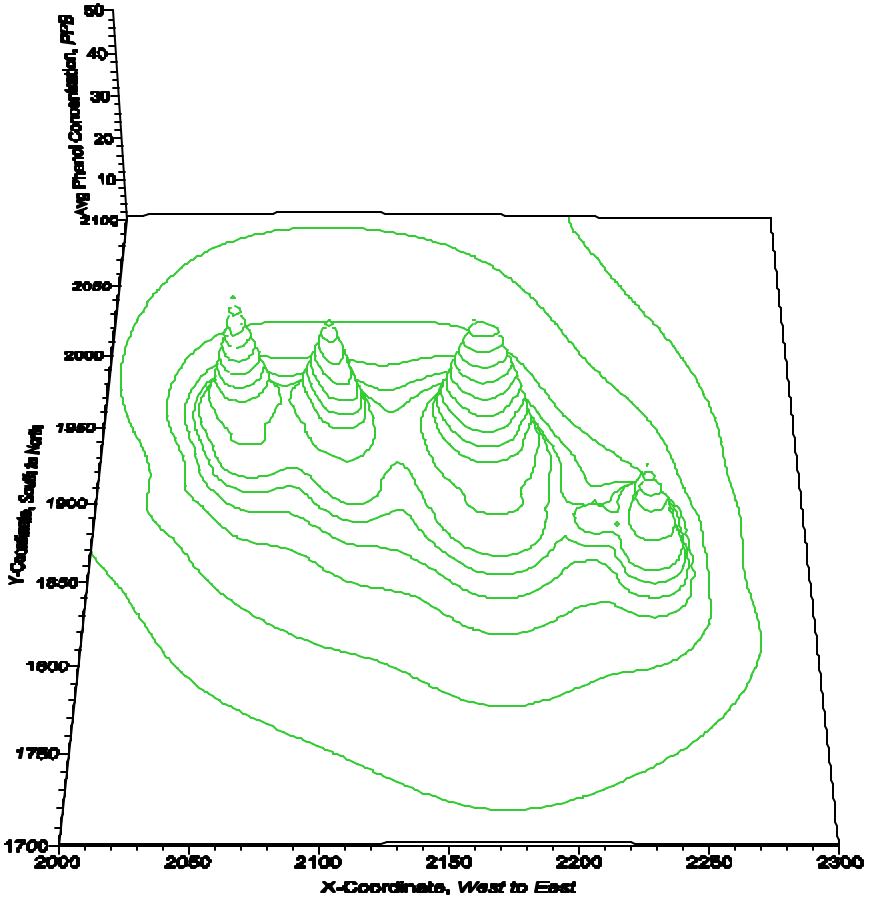
Methylene Chloride--Optical Path P3



COUPLED MODEL OUTPUT

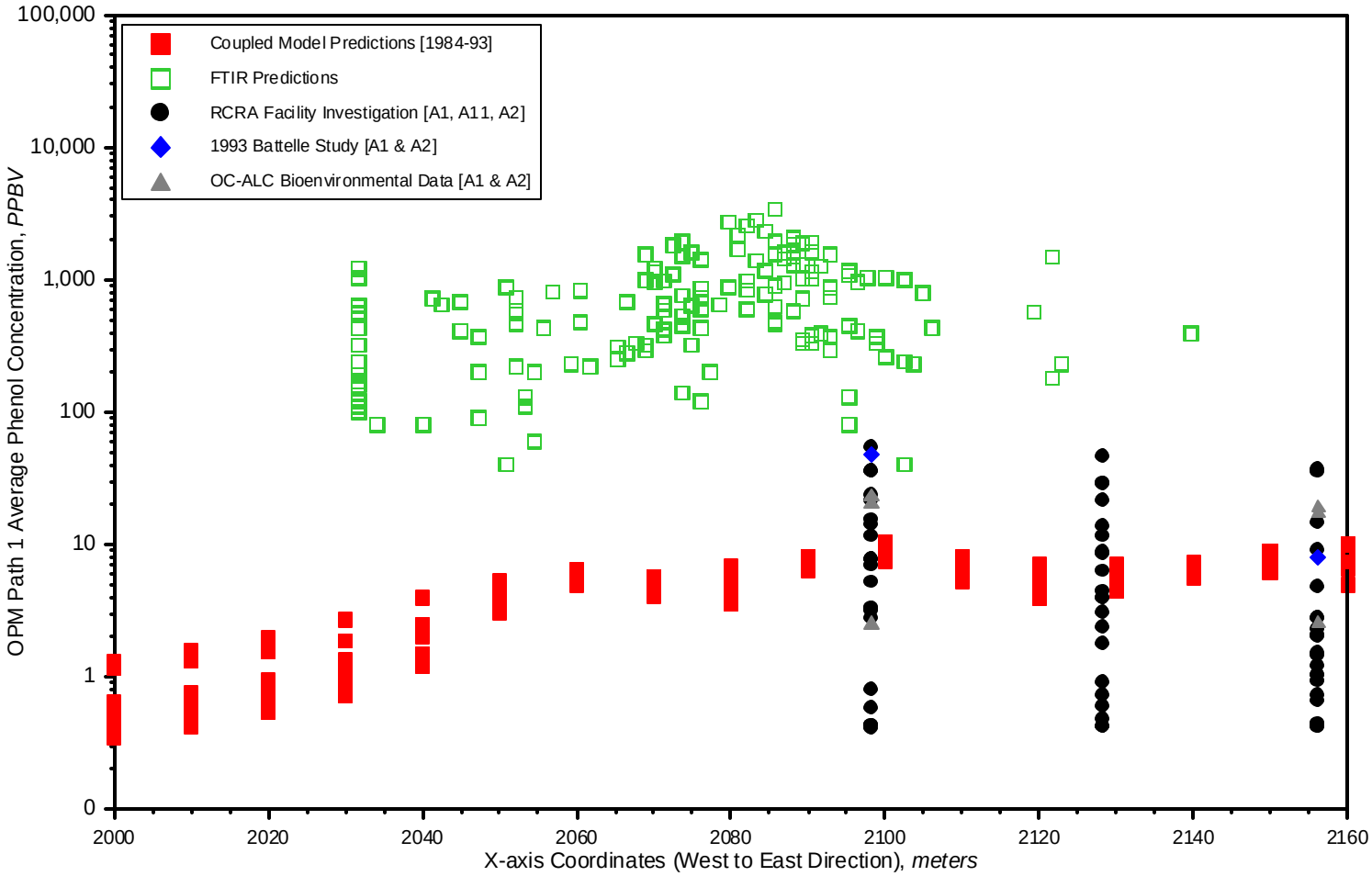
Maximum Phenol Concentrations, PPB





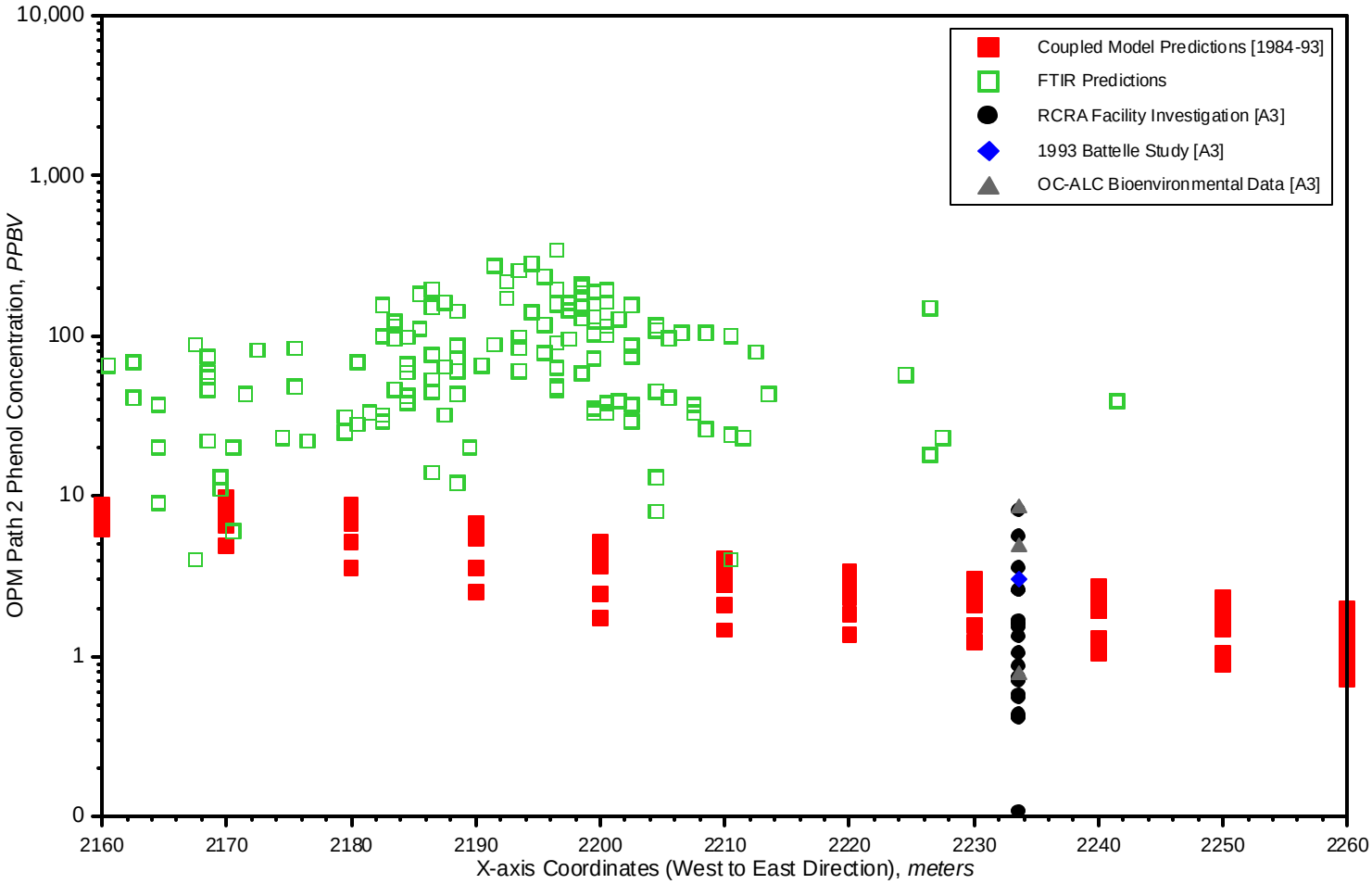
OPM SYSTEM COMPARISON

Phenol--Optical Path P1



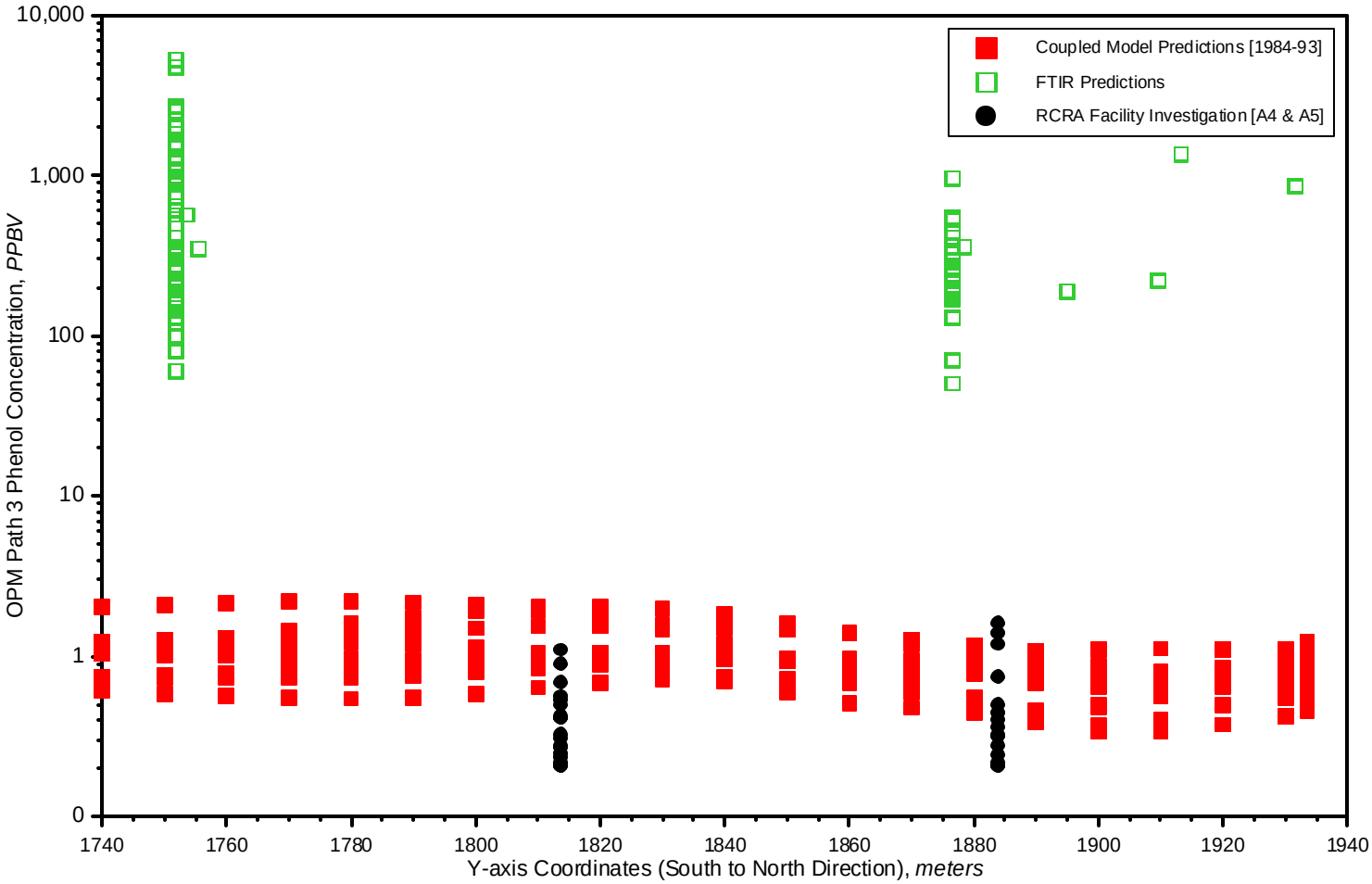
OPM SYSTEM COMPARISON

Phenol--Optical Path P2



OPM SYSTEM COMPARISON

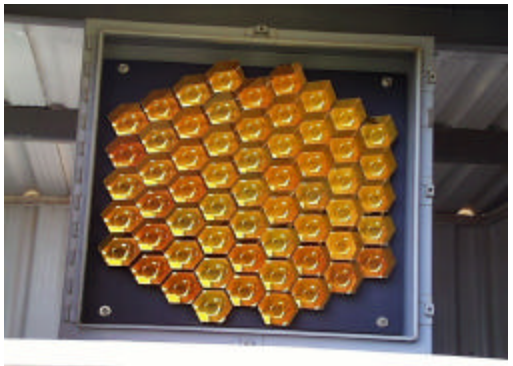
Phenol--Optical Path P3



ENVIRONMENTAL MONITORING

Summary & Conclusions

- OP-FTIR Ineffective Method of Predicting Field Data
  - *FTIR over-predicts field data along all three optical paths*
  - *FTIR data gathered over 12 months*
  - *FTIR over-predicts by orders of magnitude*
  - *No visual trends for both components*
  - *Clustering of data along optical path*
- Reliability of Technology
  - *Three months worth of data over five years*
  - *36% of data considered unusable*
- Potential Weaknesses
  - *Poor maintenance and oversight*
  - *Weather data equipment and software*
  - *No daily background spectra*
  - *Significant water vapor impacts*



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