Evaluation of Air Toxics Concentrations and Emissions for the San Juan, Puerto Rico MSA

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Acknowledgements

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- **Other ERG staff: Heather Perez and Jody Tisano**

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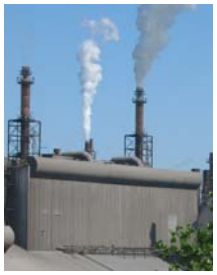
Overview of Presentation

- **Background on EPA's Urban Air Toxics Monitoring Program (UATMP)**
- **Sites of Interest/Pollutants of Interest**
- **Data Sources/Approach**
- **Results**

Questions to Guide Study

1. **How do ambient monitoring concentrations vary within the San Juan, PR MSA?**

2. **What emission sources/sinks are affecting concentration levels?**



Background of the UATMP

- **Sponsored by EPA; began in 1987**
- **Goal: Characterize the composition and magnitude of urban air pollution through ambient monitoring.**
- **EPA Regional/State/Local/Tribal agencies participate; number of sites varies by year**
- **Historically, data collected within the UATMP has been considered by EPA as the most representative data available for air toxics monitoring (Level 1 EPA QAPP).**

Background of the UATMP

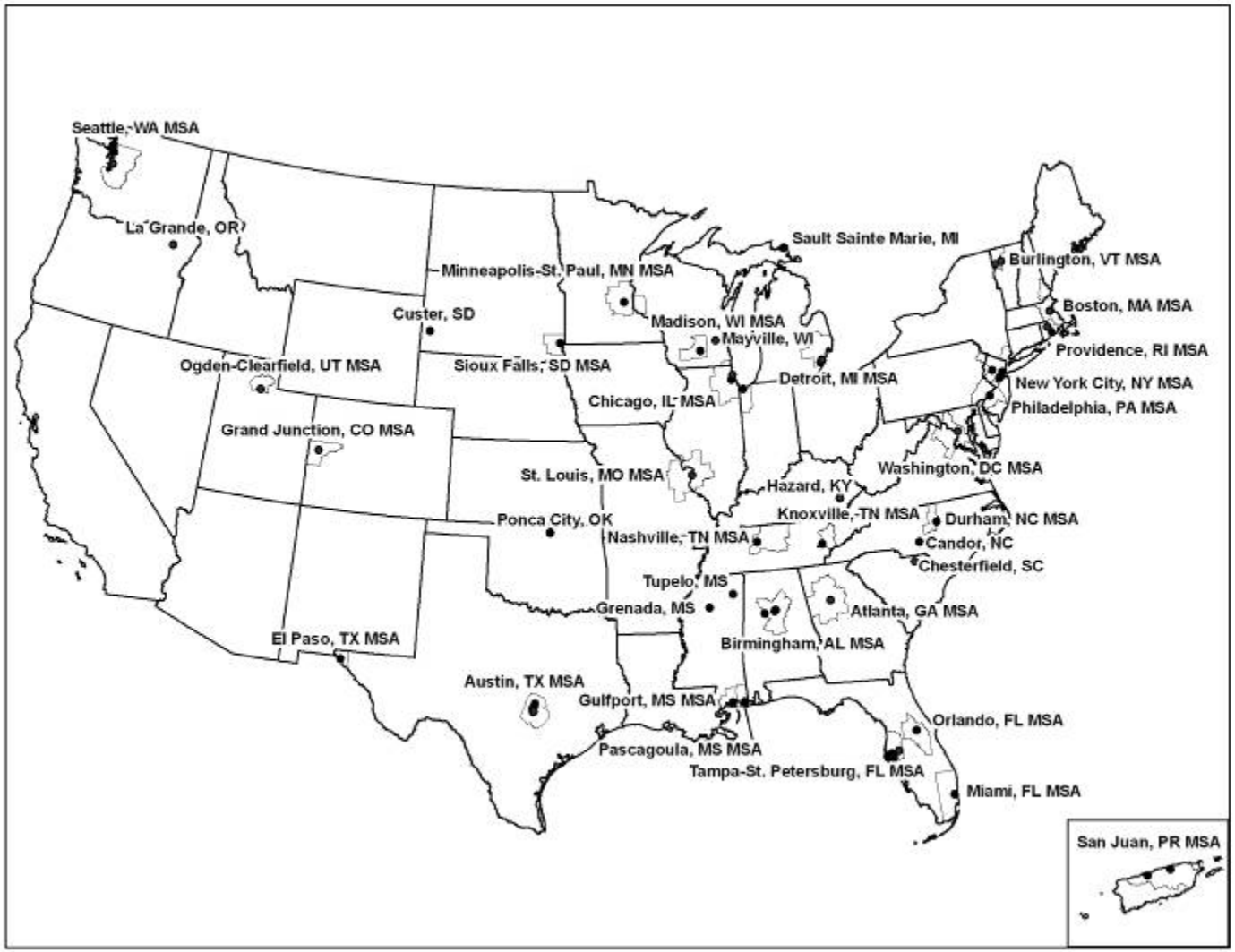
- **Pollutants Measured:**
  - **Volatile Organic Compounds (VOCs)**
  - **Carbonyl Compounds**
  - **Metals/hexavalent chromium**
  - **Semi-VOCs**
  - **Speciated Non-Methane Organic Compounds**

- **Potential of over 250 pollutant species, including over 50 hazardous air pollutants (HAPs)**

Background of the UATMP

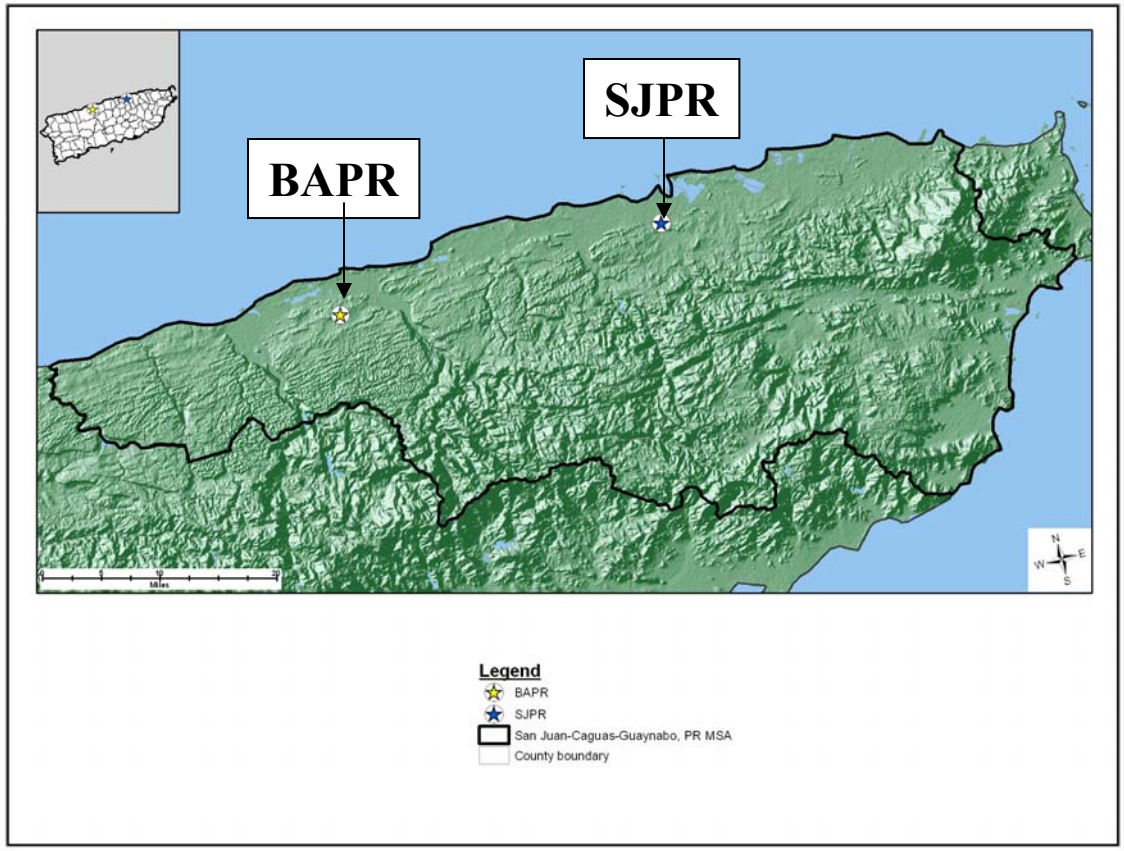
- **In 2005, 58 sites participated in the UATMP; 2 reports were produced:**
  - **Annual Report (excluding hexavalent chromium)**
    http://www.epa.gov/ttn/amtic/files/ambient/airtox/2005_uatmp_main_full.pdf
  - **Special Studies report for hexavalent chromium)**
    http://www.epa.gov/ttn/amtic/files/ambient/airtox/2005_uatmp_hex_final_report_&_apps_final.pdf

UATMP Monitoring Sites - 2005



Puerto Rico Site Information

Site ID	City	AQS Site ID	Census Tract ID	Latitude (degrees)	Longitude (degrees)	Land Use	Location Setting
BAPR	Barceloneta, PR	72-017-0003	72017590300	18.436111	-66.580556	Residential	Rural
SJPR	San Juan, PR	72-021-0006	72021030103	18.416667	-66.150833	Industrial	Suburban



Pollutants of Interest

TO-15 (VOCs) and TO-11A (Carbonyls) HAPs

Acetaldehyde	Chloroform	Dichloropropene, *cis*-1,3-	Propionaldehyde
Acetonitrile	Chloromethane	Dichloropropene, *trans*-1,3-	Styrene
Acrylonitrile	Chloroprene	Ethyl Acrylate	Tetrachloroethane, 1,1,2,2-
Acrolein	Dibromomethane, 1,2-	Ethylbenzene	Tetrachloroethylene
Benzene	Dichlorobenzene, *p*-	Formaldehyde	Toluene
Bromomethane	Dichloroethane, 1,1-	Hexachlorobutadiene	Trichloroethane, 1,1,1-
Butadiene, 1,3-	Dichloroethane, 1,2-	Methyl Ethyl Ketone*	Trichloroethane, 1,1,2-
Carbon Tetrachloride	Dichloroethene, 1,1-	Methyl Isobutyl Ketone	Trichloroethylene
Chlorobenzene	Dichloromethane	Methyl Methacrylate	Vinyl Chloride
Chloroethane	Dichloropropane, 1,2-	Methyl-*tert*-Butyl Ether	Xylenes (*m*-, *o*-, *p*-)

* = Methyl Ethyl Ketone was delisted as a HAP on December 19, 2005 (http://www.epa.gov/ttn/atw/pollutants/atwsmod.html)

Pollutants of Interest – 1999 NATA Results*

- **NATA is the national-scale air toxics assessment**
- **Administered by EPA; Useful resource in helping federal/state/local/tribal agencies identify areas of air quality concern.**
- **Starting point for NATA modeled concentrations is the National Emission Inventory (1999).**
- **Modeled concentrations are applied to cancer URE and noncancer RfC risk factors to calculate risk.**

***= information found at: http://www.epa.gov/ttn/atw/nata1999/**

1999 NATA Results for San Juan

- **Many census tracts in the San Juan, PR MSA exhibited cumulative cancer risks > 25 in-a-million**

- **Highest cancer risk for dichloromethane (71 in-a-million) in the U.S. is in a census tract in San Juan, PR (72017590300)**

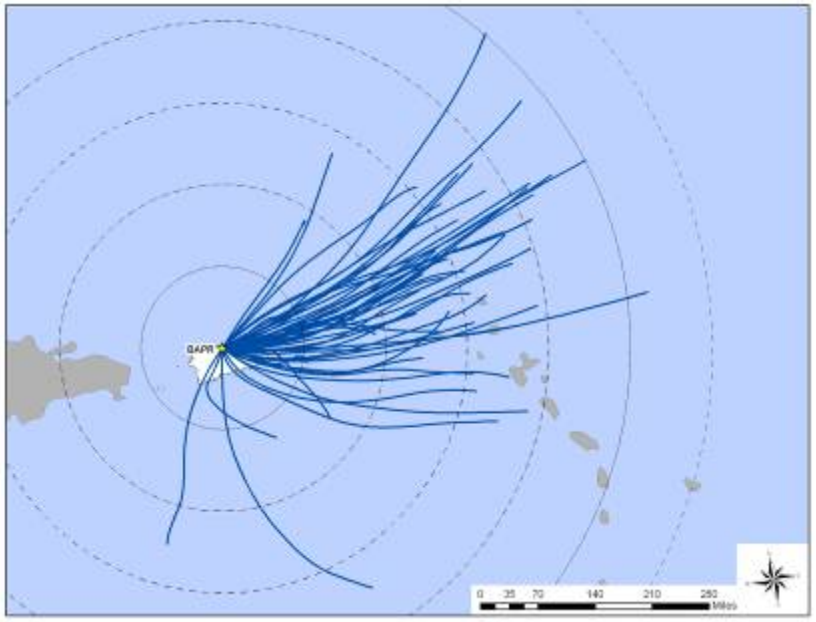
- **Cumulative census tract-level cancer risks (multiple HAPs) from mobile sources was 107 in-a-million from onroad sources and 197 in-a-million for nonroad sources**

Supplemental Data - Meteorological

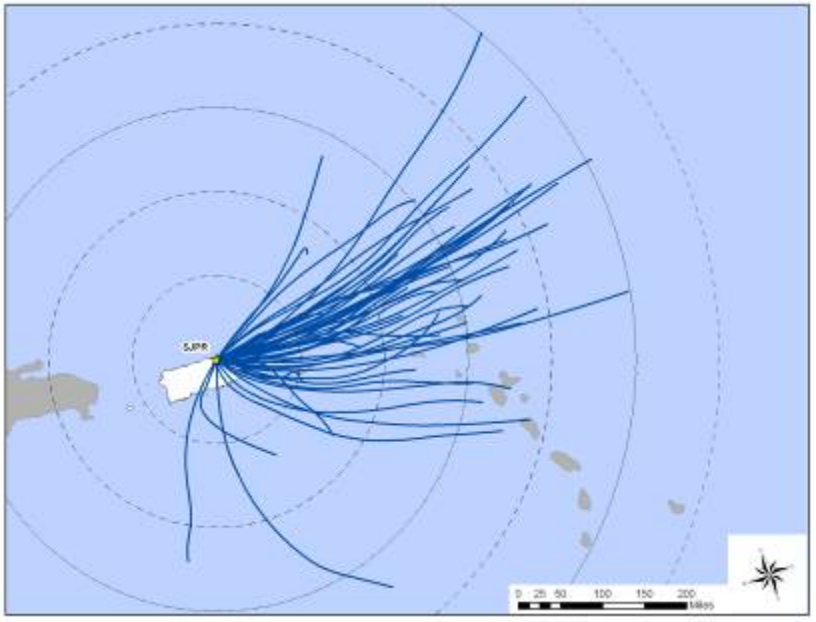
- **National Weather Service Data (NWS):**
  - **Retrieved hourly surface observations from NWS station at Luis Munoz Marin International Airport (WBAN#11641).**
  - **To match sampling period, calculated 24-hour integrated averages of temperature, pressure, and moisture.**
  - **Wind information (speed and direction) were vectorally-averaged into 24-hour averages. Each average wind was classified into one of the 16-point compass regimes.**
  - **Average wind direction on sampling days was easterly**

Supplemental Data - Meteorological

- **<u>Back Trajectories</u>: Constructed 24-hour back trajectories for all sampling days using NOAA's HYSPLIT model.**



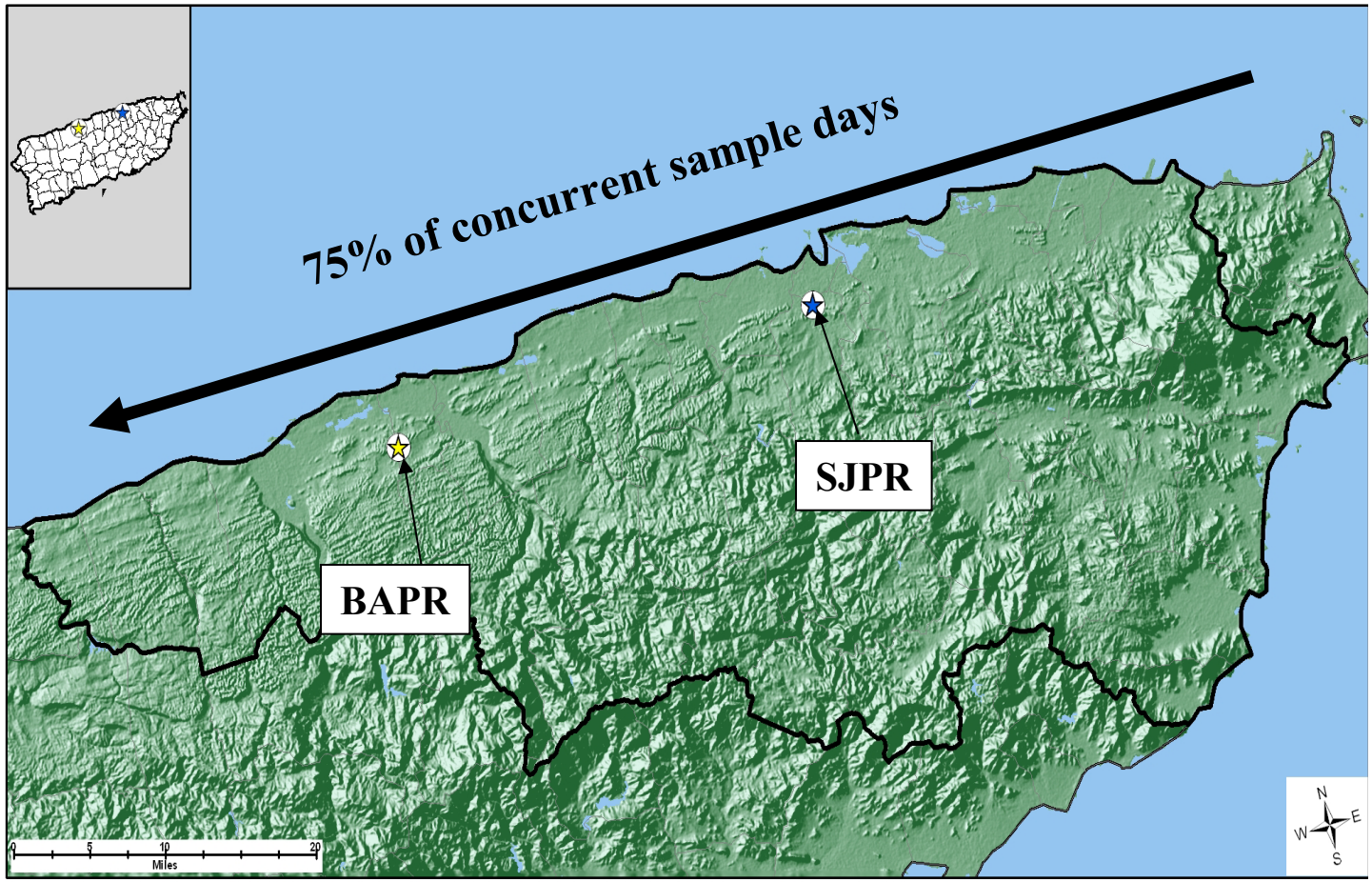
BAPR



SJPR

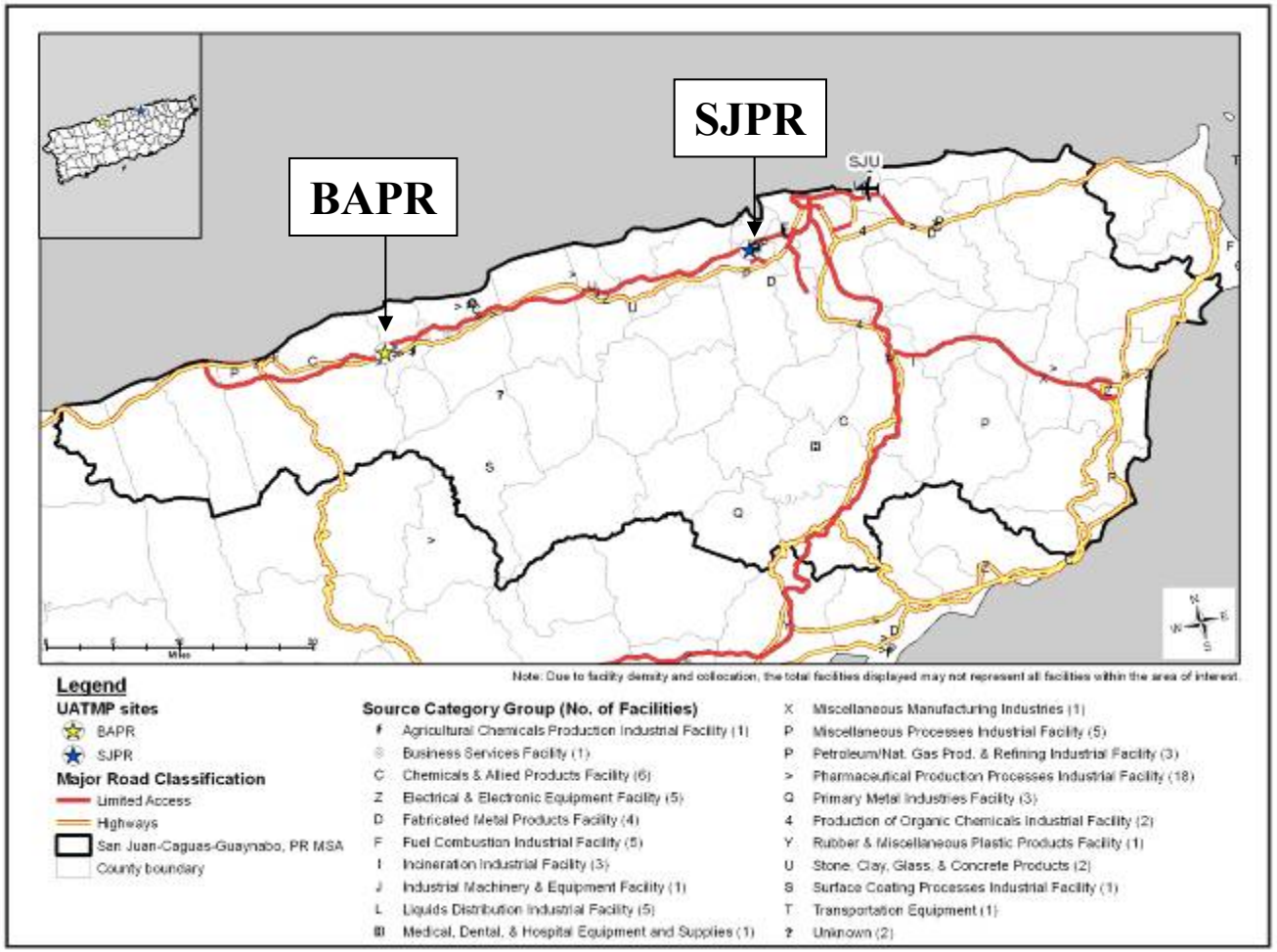
Supplemental Data - Meteorological

Predominant Wind Flow = Easterly



Supplemental Data - Emissions

- **<u>Emissions Data</u>: Retrieved 2002 NEI data for point, area nonpoint, onroad, and nonroad sources.**



Results - Sampling Detects

- **In 2005, sampling was conducted from February 27 through December 30.**
- **Under 1-in-6 day sampling, total possible of 51 samples; concurrent sampling on 38 days**
- **At both sites, 10 HAPs were detected on more than 75% of the concurrent sampling days (>28 days):**

Acetaldehyde*	**Ethylbenzene***
Benzene*	**Formaldehyde***
Carbon Tetrachloride	**Propionaldehyde***
Chloromethane	**Toluene***
Dichloromethane	**Xylenes***

*** = can be emitted by stationary and mobile sources**

Results – Concentration Averages

- **Daily Average: Average of all detected concentrations.**
  - **SJPR Top 5:**
    - **Xylenes (total)* = 10.4 ± 1.4 µg/m^3**
    - **Toluene* = 8.4 ± 1.8 µg/m^3**
    - **Acetaldehyde* = 6.3 ± 2.3 µg/m^3**
    - **Formaldehyde* = 2.2 ± 0.3 µg/m^3**
    - **Benzene* = 2.1 ± 0.3 µg/m^3**
  - **BAPR Top 5:**
    - **Dichloromethane = 6.5 ± 2.4 µg/m^3**
    - **Xylenes (total)* = 5.3 ± 0.7 µg/m^3**
    - **Toluene* = 3.9 ± 0.7 µg/m^3**
    - **Chloromethane = 2.5 ± 0.2 µg/m^3**
    - **Acetaldehyde* = 1.4 ± 0.2 µg/m^3**

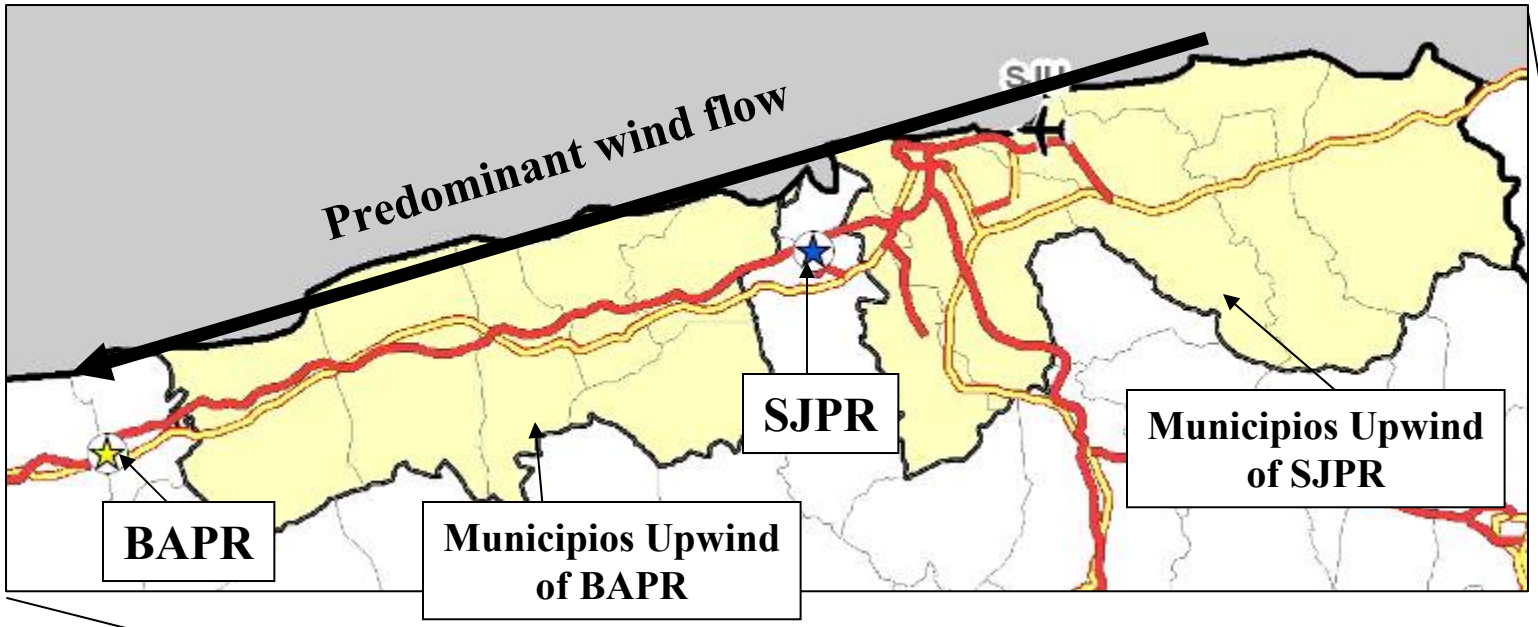
*** = can be emitted by stationary and mobile sources**

Results – Annual Emissions

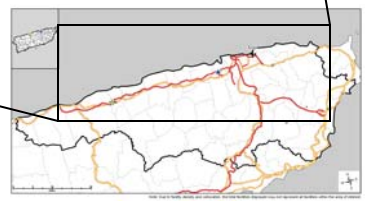
- **Acetaldehyde, Benzene, Formaldehyde, Toluene, Xylenes**

Pollutant	San Juan MSA Total Emissions (tpy)	San Juan MSA Mobile Emissions (tpy)
Acetaldehyde	321	275 (86%)
Benzene	2,146	1,965 (92%)
Formaldehyde	987	692 (70%)
Toluene	6,764	5,500 (81%)
Xylenes (total)	5,258	4,793 (91%)
Total	15,476	13,225 (85%)

Mobile Source Emissions



Pollutant	Mobile Emissions Upwind of SJPR (tpy)	Mobile Emissions Upwind of BAPR (tpy)
Acetaldehyde	99	35
Benzene	653	261
Formaldehyde	248	88
Toluene	1,825	733
Xylenes (total)	1,601	641
Total	4,426	1,758

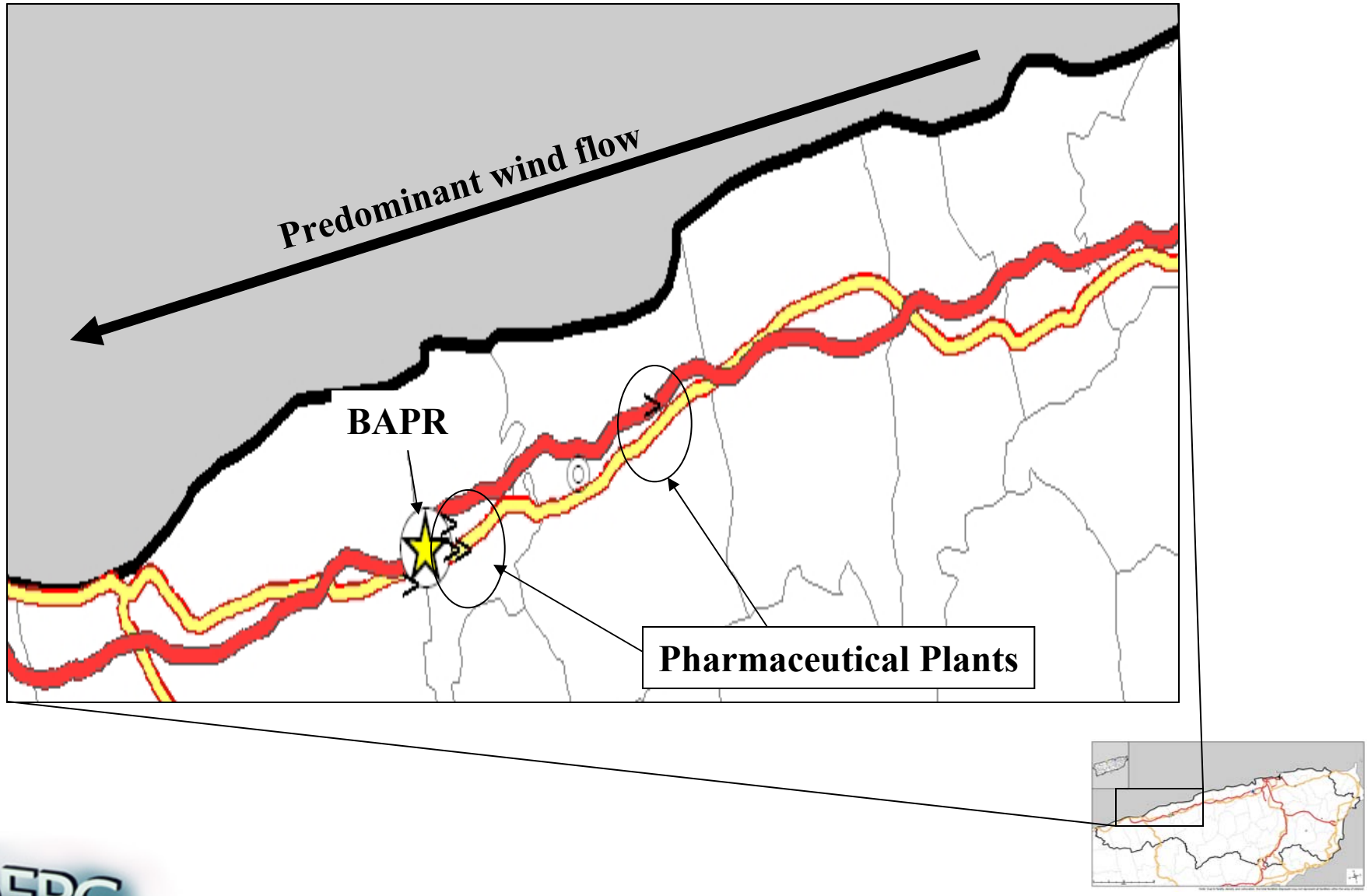


Results – Annual Emissions

- **Dichloromethane and chloromethane**

Pollutant	San Juan MSA Emissions (tpy)	Source Category	Facility	Emissions (tpy)
Dichloromethane	962	Pharmaceuticals – nearby BAPR	Abbott Healthcare	327
			Bristol-Myers Squibb	14
			Schering Plough	6
			Pfizer	4
		Pharmaceuticals – far from BAPR	Rest of MSA	186
		Solvent/paint stripping	Entire MSA	252
		Architectural surface coating	Entire MSA	106
		Other area nonpoint sources	Entire MSA	67
Chloromethane	24	Prescribed burnings	Entire MSA	14
		Architectural surface coating	Entire MSA	10

Dichloromethane point source emissions



Results – Upwind-Downwind

Easterly includes wind directions from ESE to ENE

Pollutant	# Paired Easterly Days	BAPR Concentration ($\mu g/m^3$)	SJPR Concentration ($\mu g/m^3$)	Downwind-Upwind Difference ($\mu g/m^3$)
Acetaldehyde	28	1.4 ± 0.3 $\mu g/m^3$	5.8 ± 2.6 $\mu g/m^3$	-4.4 ± 2.4 $\mu g/m^3$
Benzene	28	1.1 ± 0.1 $\mu g/m^3$	2.1 ± 0.3 $\mu g/m^3$	-1.0 ± 0.3 $\mu g/m^3$
Chloromethane	28	2.4 ± 0.2 $\mu g/m^3$	2.0 ± 0.2 $\mu g/m^3$	0.4 ± 0.3 $\mu g/m^3$
Dichloromethane	25	7.0 ± 2.9 $\mu g/m^3$	0.8 ± 0.4 $\mu g/m^3$	6.2 ± 3.0 $\mu g/m^3$
Formaldehyde	28	0.7 ± 0.1 $\mu g/m^3$	2.2 ± 0.3 $\mu g/m^3$	-1.5 ± 0.3 $\mu g/m^3$
Toluene	28	3.7 ± 0.3 $\mu g/m^3$	8.4 ± 2.3 $\mu g/m^3$	-4.7 ± 2.2 $\mu g/m^3$
Xylenes (total)	28	4.9 ± 0.3 $\mu g/m^3$	9.9 ± 1.7 $\mu g/m^3$	-5.0 ± 1.4 $\mu g/m^3$

Results – Upwind-Downwind

- **Positive downwind effects:**
  - **Dichloromethane: wind passes over 4 nearby pharmaceutical facilities**
  - **Chloromethane: suspected to have captured open burning practices to the east of BAPR**

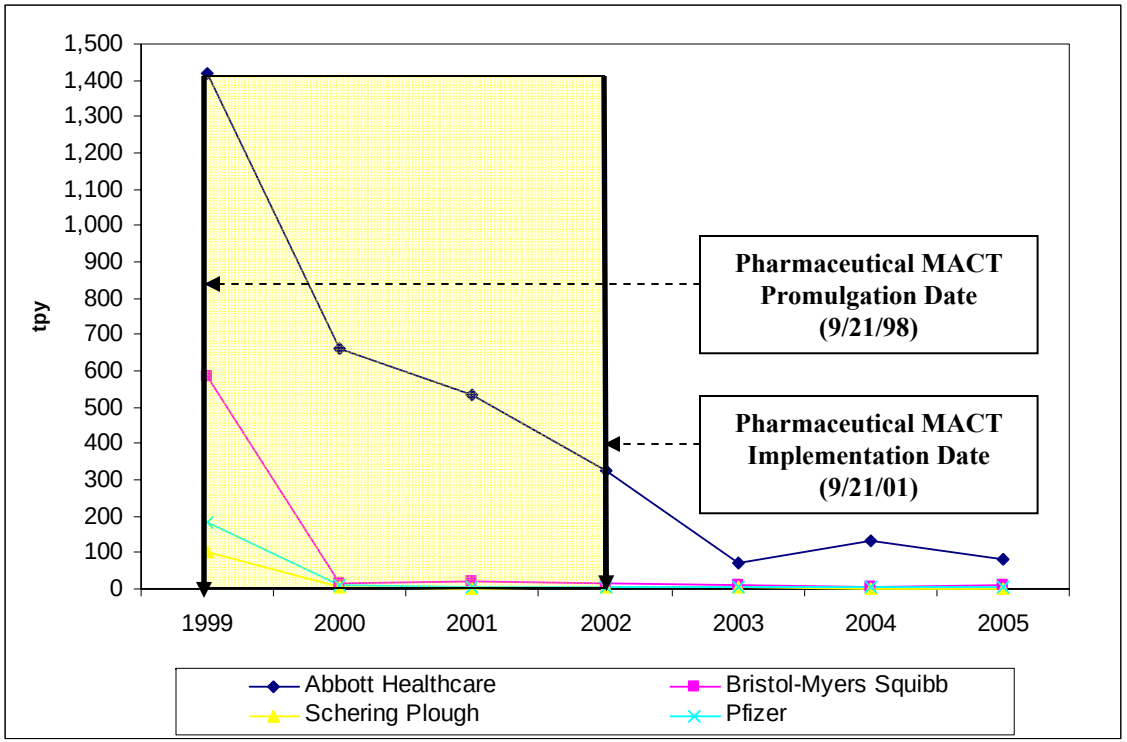
- **Negative downwind effects:**
  - **Photochemical production of ozone**
  - **Atmospheric dispersion**
  - **Orographic Lifting**

Results – Dichloromethane Emissions Trend

Pharmaceutical Facility	1999* NEI	2000 TRI	2001 TRI	2002 NEI	2003 TRI	2004 TRI	2005 TRI
Abbot Healthcare	1,419	661	532	327	72	130	81
Bristol-Myers Squibb	584	14	20	14	8	5	12
Schering Plough	100	4	2	6	3	1	2
Pfizer	183	8	6	4	3	5	5
Totals	2,286	687	560	351	86	141	100

*** = Pre-MACT data from EPA's SPPD**

Results – Dichloromethane Emissions Trend



MACT Success!
Emissions decreased by 77% from 1999 (pre-MACT implementation) to 2002 (post-MACT implementation)

Risk Success?
What will the change in cancer risk be from 1999 NATA to 2002 NATA?

Site/Census Tract	Pollutant	2005 Annual Average ($\mu g/m^3$)	2005 Theoretical Risk (in-a-million)	1999 NATA-Modeled Average ($\mu g/m^3$)	1999 NATA Risk (in-a-million)
BAPR/72017590300	Dichloromethane	6.6	3	151	71

Conclusions

1. How do ambient monitoring concentrations vary within the San Juan MSA?

   -With the exception of a couple of HAPs, concentrations were greater at the SJPR monitoring site (eastern side of the MSA) than the BAPR monitoring site (western side of MSA).

   - Both sites are near major roadways, but the emissions intensity is more than double at the SJPR site. The ambient concentrations match that trend.

2. What emission sources are affecting downwind concentrations?

   - At BAPR, the close proximity of 4 pharmaceuticals emitting dichloromethane is evident, as the air moves easterly across the MSA.

   - At SJPR, the effect of mobile sources east of the monitoring site is also evident. Concentrations tend to decrease across the MSA for most HAPs, which may be explained by: photochemical production of ozone; atmospheric dispersion; and/or orographic lifting

Conclusions

3. General Dichloromethane Conclusion

- Dichloromethane emissions have been decreasing steadily in Puerto Rico.

- The Pharmaceuticals MACT, promulgated in 1998 and implemented in 2001, appears to have greatly reduced dichloromethane emissions from 1999 to 2002 (77% decrease) for sources affecting the BAPR monitoring site.

- Cancer risk due to dichloromethane in the BAPR census tract was 71 in-a-million based on 1999 NATA. It is likely that the cancer risk will decrease significantly when NATA02 is released.

Questions?

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