

SPATIAL DATA ANALYSIS TECHNICAL EXCHANGE WORKSHOP

Sponsored by:

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Network Design – Mixed Monitoring Technologies presented by:

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Acknowledgments

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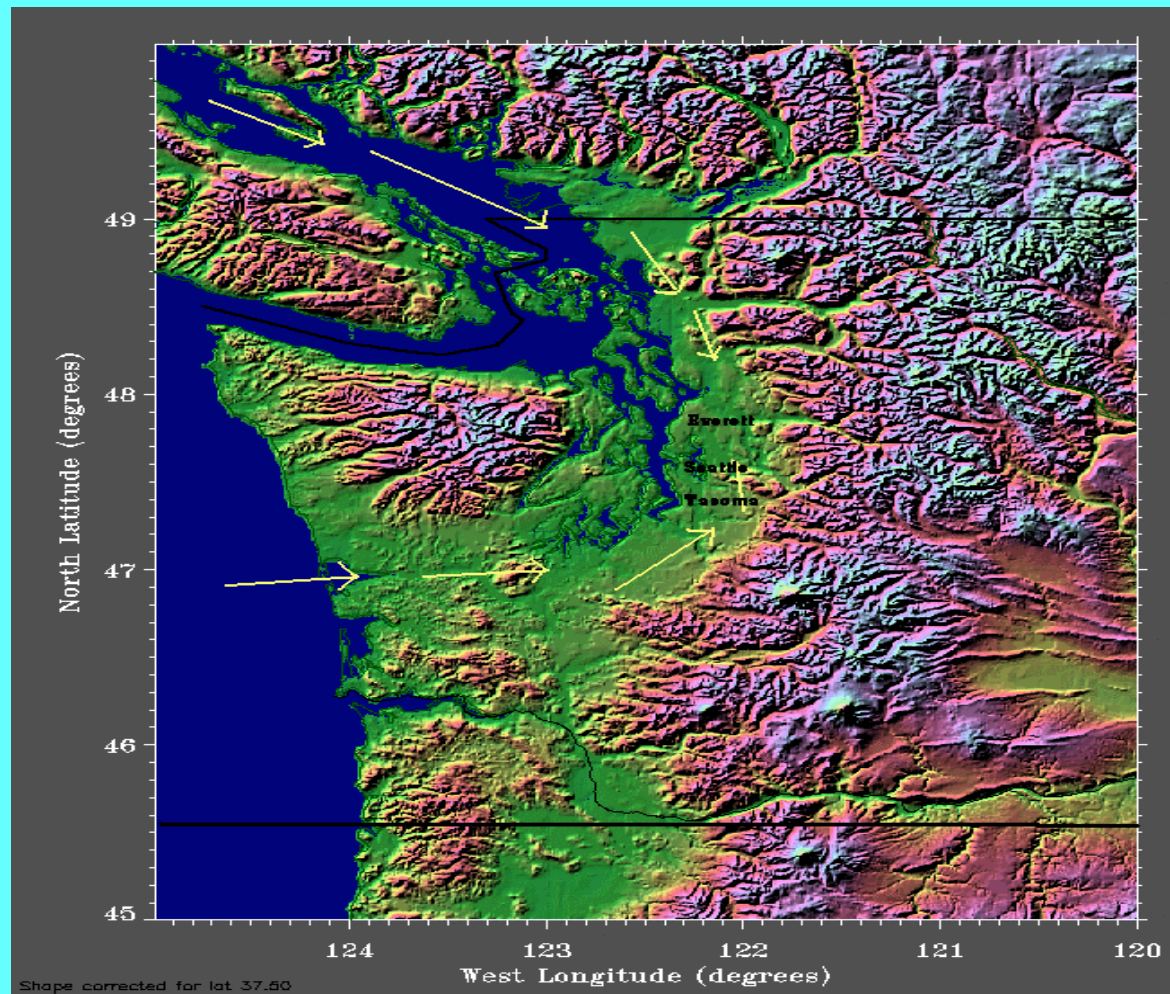
Shelly Eberly, U.S. EPA

Bill Cox, U.S. EPA

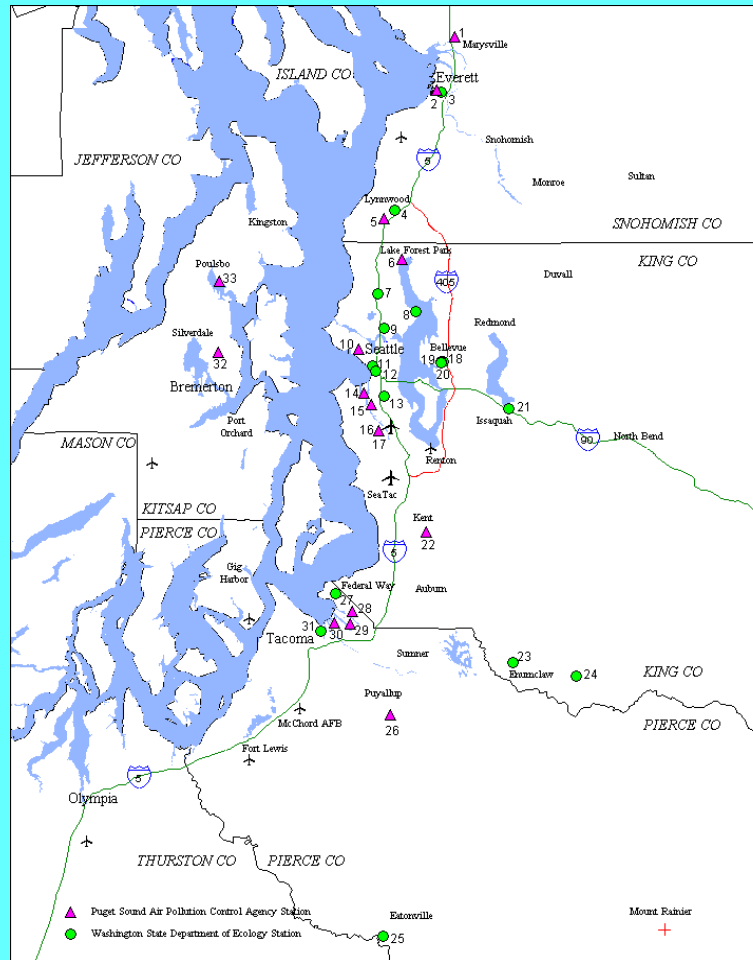
Scenario

- n PM_{2.5} monitoring in Puget Sound
 - Federal Reference Method (FRM) monitors at 14+ sites
 - Continuous monitors
 - Tapered Element Oscillating Microbalance (TEOM) monitors at 6+ sites
 - Nephelometers at 8+ sites
 - Others
- n In other words, “network” of mixed monitoring technologies

Puget Sound Picture

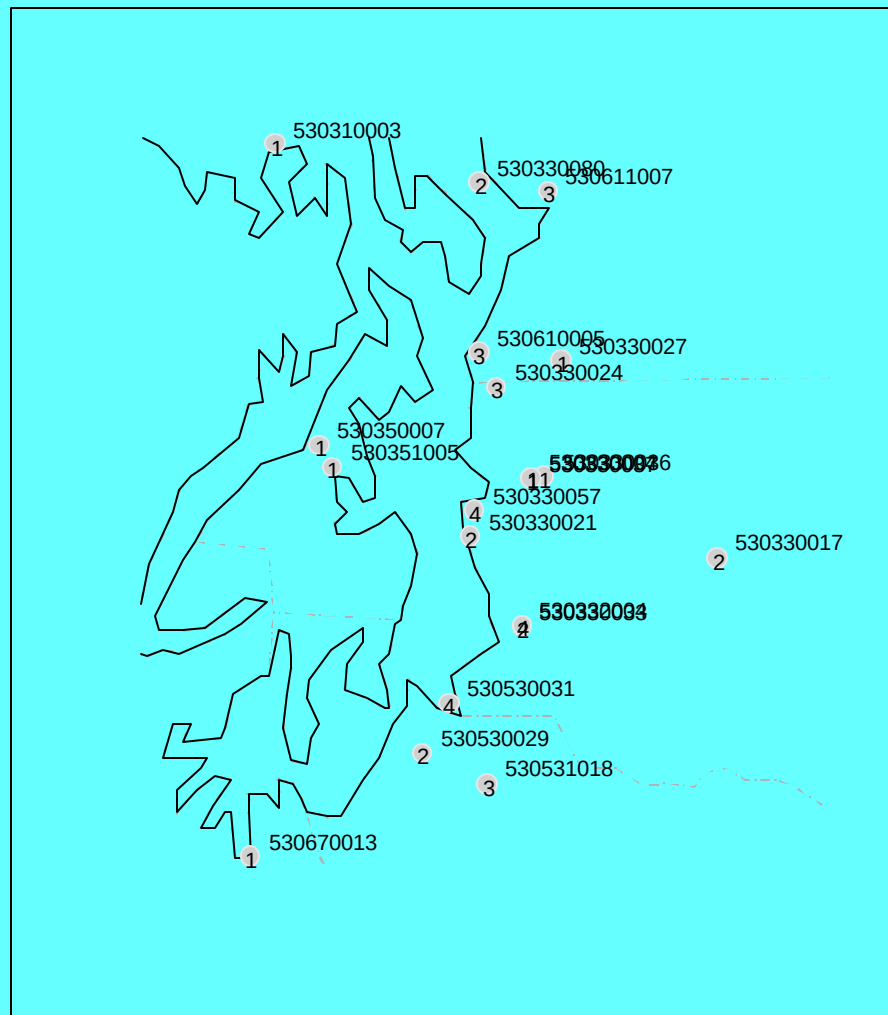


Puget Sound Picture (continued)



Puget Sound Air Monitoring Network

Data Summary Picture



Data Summary Picture (continued)

530310003	FRM					14	15	14	16	15		
530330004	FRM	28	28	27								
530330017	FRM	17	18	29	28	27	27	30	24			
530330021	NEPH				23	91	91	4				
	FRM	89	90	92	86	82	91	88	90	86	90	23
	NEPH					63	91	76	92			
530330024	FRM		9	31	27	29	30	30	25	31	14	
	NEPH		9	31	27	29	30	30	25	31	14	
	TEOM			3	27	28	30	29	24	31		
530330027	FRM			16	29	28	28	31	29			
530330033	FRM					19	28	31	30	12		
	TEOM					19	28	31	30	12		
530330036	TEOM								91			
530330037	FRM								16	30		
530330057	FRM	69	89	89	85	82	91	91	82	92	90	51
	NEPH	69	89	89	77	82	91	89	82	92	90	51
	TEOM	58	89	89	85	79	91	90	72	88	81	
	DICHOT		26	23	26	24	23					
530330080	FRM		28	28	26	39	89	83	81	87		
	NEPH		78	91	75	24	91	91	92	77		
530332004	FRM	16	27	30	31	29	28	29	31	28	28	17
	NEPH	16	23	25	31	29	28	29	31	28	27	17
	TEOM	16	27	30	31	27	9				12	
	DICHOT		24	25	25	23	20					
530350007	BAM						29	92	92			
530351005	BAM		90	91	92	92	91	91	92			
530530029	FRM								46	80		
	TEOM								46	80		
530530031	FRM	54	86	88	88	87	88	91	90	90	89	50
	NEPH	30	84	83	86	83	79	91	90	90	87	58
	TEOM	54	86	88	88	87	87	90	86	90	66	
	DICHOT		23	23	26	25	23					
530531018	FRM				61	29	26	29	25	27		
	NEPH							14	25	21		
	BAM				61	29	26	29	25	26		
530610005	FRM				26	31	30	31	27	30	17	
	NEPH				23	31	30	31	27	29	17	
	TEOM				26	29	29	30	27	27		
530611007	FRM	18	28	30	30	28	30	30	12	30	30	14
	NEPH				5	28	30	28	12	30	30	14
	TEOM	18	28	30	30	26	30	30	12	28	30	
530670013	FRM		28	30	25	27	31	30	30	30	28	

1999

2000

2001

Data Summary Picture (continued)

	FRM	NEPH	TEOM	¶
530310003	2.05			¶
530330017	1.57			¶
530330021	2.28	-0.92		¶
530330024	2.31	-1.06	2.27	¶
530330027	2.04			¶
530330033	2.36		2.39	¶
530330057	2.40	-1.12	2.49	¶
530330080	2.06	-1.48		¶
530332004	2.32	-1.13		¶
530530031	2.37	-1.10	2.49	¶
530531018	2.27			¶
530610005	2.18	-1.17	2.27	¶
530611007	2.36	-1.00	2.28	¶
530670013	2.03			

Goals

- n Evaluate/understand “performance” of current network
 - Annual average time scale
 - Seasonal resolution of interest
 - Problem addressed from spatial perspective
- n Consider alternative networks
 - With an eye toward continuous technologies
 - temporally resolved data
 - near real-time measurements
 - E.g., daily Air Quality Index (AQI) reporting, emergency control
 - Constrained (*or guided*) by regulations (CFR Part 58)
 - Treat FRMs as “gold standard” to which other methods are compared
 - Continuous methods may satisfy Class III equiv. ($\$_0$, $\$_1$, R^2 , precision)

Conceptual Model

- n Each monitor type has some associated measurement error (precision)
 - Not instrument-specific
 - Not site-specific
- n FRMs are unbiased (or, our frame of reference is to view the true spatial process through the biased eyes of an FRM)
- n Continuous monitoring may be biased
 - Linear on natural log scale
 - Specific to monitor type
 - ?? Not instrument-specific ??
 - ?? Not site-specific ??

Real World

- n Co-located FRM/continuous data used in developing area-wide bias estimate for each continuous monitor type
- n Issues
 - Uncertainty in bias parameter estimation
 - Appropriateness of spatially-homogenous bias assumption
 - Role for FRMs – dual:
 - Provide data on spatial process AND calibrate continuous monitors
 - Implies need for minimum of one co-located FRM in local “network”

Summary of Approach

- n Develop spatial model for true annual process
- n Account for uncertainties in mixed monitor type network (precision, bias, bias estimation)
- n Consider Mean Square Prediction Error (MSPE)
 - Across grid of points covering Puget Sound
 - Summary statistics (average, maximum, etc.)
 - Assess current network performance
 - Compare alternative designs (e.g., fewer FRMs, more continuous)

Summary of Approach (continued)

n Highlights

- Consistent with PM_{2.5} monitoring perspective of Federal regulations
- Incorporates uncertainty introduced by real-world treatment of data
- Development is like “peeling back the layers of an onion”