

# **Update on the HSPH/Allen Continuous Sulfate Method: The Thermo Model 5020 Sulfate Particle Analyzer**

George Allen, NESCAUM



**Air Quality Monitoring & Data Analysis  
National Conference (aka SAMWG)**

Point Clear, AL May 13, 2004

## Background

---

- SLT Monitoring Program Goal:
  - move towards real-time PM methods
  - for mass and its components
    - ==> sulfate, nitrate, carbon
- Advantages over manual integrated methods:
  - Immediate and highly time-resolved data
  - Less labor intensive (ideally)
- Continuous PM<sub>2.5</sub> rollout has been a success
  - But not without substantial effort and cost
  - Data quality issues still not resolved
  - Technologies still changing rapidly
- Continuous PM speciation is even more complex!
  - But value of highly time-resolved data is “awesome”

## Why “Awesome”?

Sub-daily data reveal temporal patterns that are *essential* for understanding the formation, transport, and fate of aerosols, and the influence of meteorology on these processes.

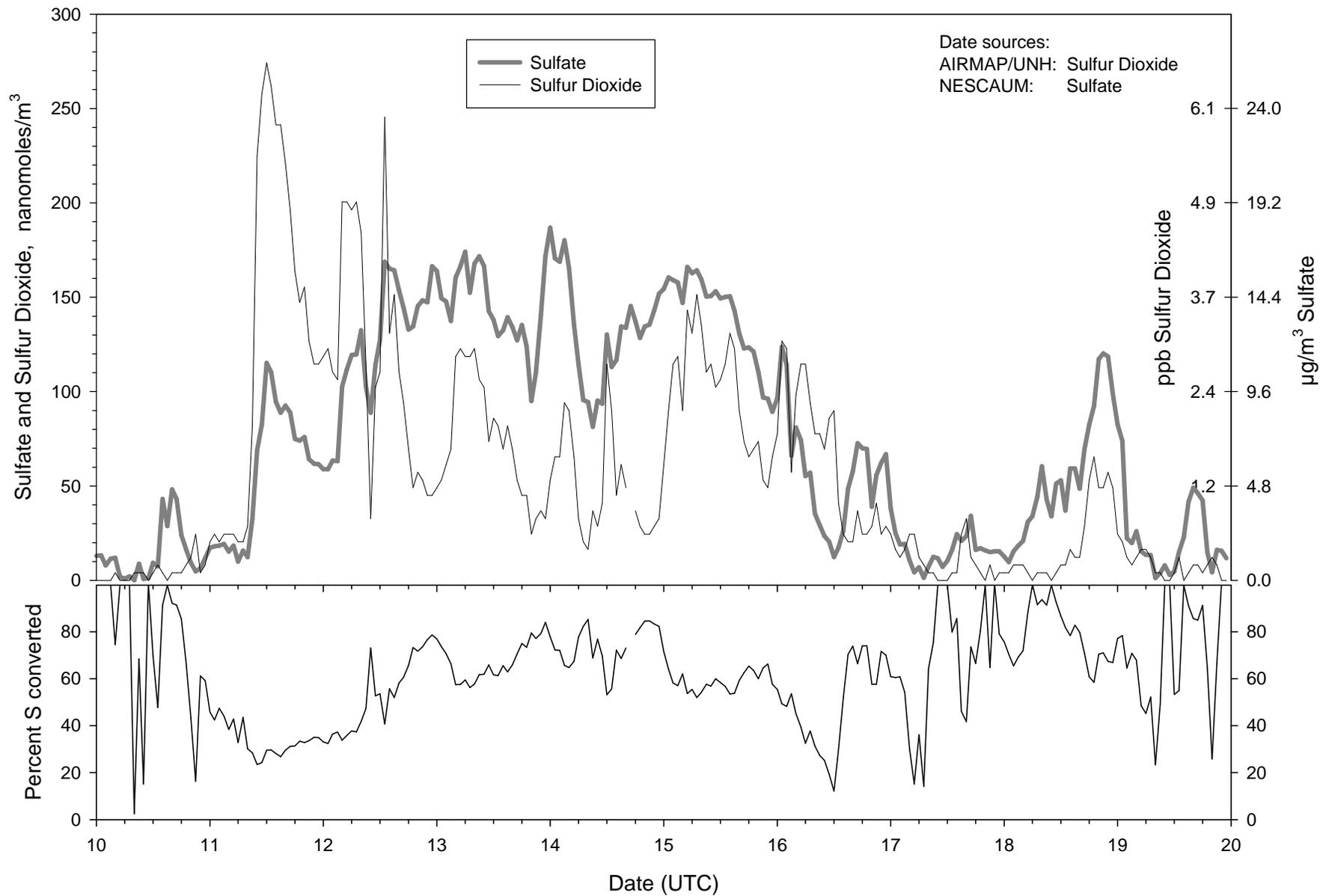
The better we understand these processes, the better we can model them... But: large changes can occur on time scales of a few hours or less; useful information is lost or attenuated in a daily 24-hour integrated sample that is captured in hourly data.

Example: Hourly sulfate and SO<sub>2</sub> data from the summit of Mt. Washington, NH (6300 feet) during the August 2002 regional haze event -- a time series of sulfate and SO<sub>2</sub>, and % of total sulfur as sulfate.

Sulfate data is from R&D version of HSPH sulfate method run by NESCAUM. SO<sub>2</sub> data courtesy of AIRMAP.

# Mt. Washington NH Summit, August 2002

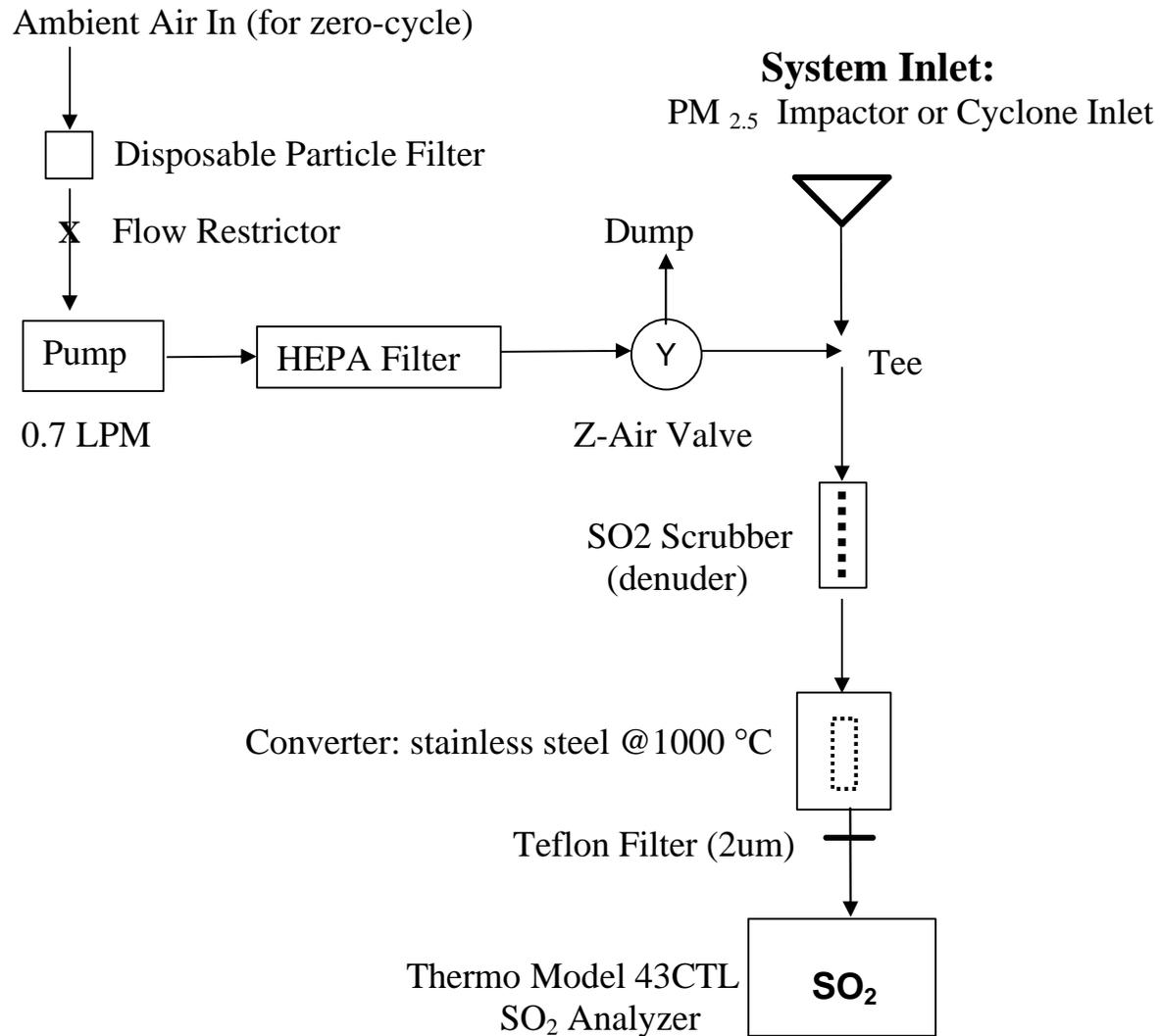
## Hourly Sulfate and Sulfur Dioxide



## Real-Time Sulfate Methods

---

- Various research-grade methods, some going back 30 years:
  - Flame photometry, IC, single particle MS, flash volatilization
  - All complex, expensive, not practical for wide SLT deployment
- New approach: continuous flow thermal catalytic conversion
  - Developed at HSPH by Allen and Harrison 2000/2001
  - Relatively simple, high conversion efficiency
  - R&D versions used at several supersites and research sites:  
St. Louis, Baltimore, NYC supersites,  
TVA, Search/Aries (ARA), Boston PM-Center, others
- Thermal conversion of  $\text{SO}_4$  to  $\text{SO}_2$  at  $1000^\circ\text{C}$  in quartz tube oven
  - SS is conversion catalyst; service interval many months
  - Detection: standard Thermo trace  $\text{SO}_2$  analyzer  
(routine system calibration is with  $\text{SO}_2$ )
  - Auto-zero accounts for baseline drift and interferences

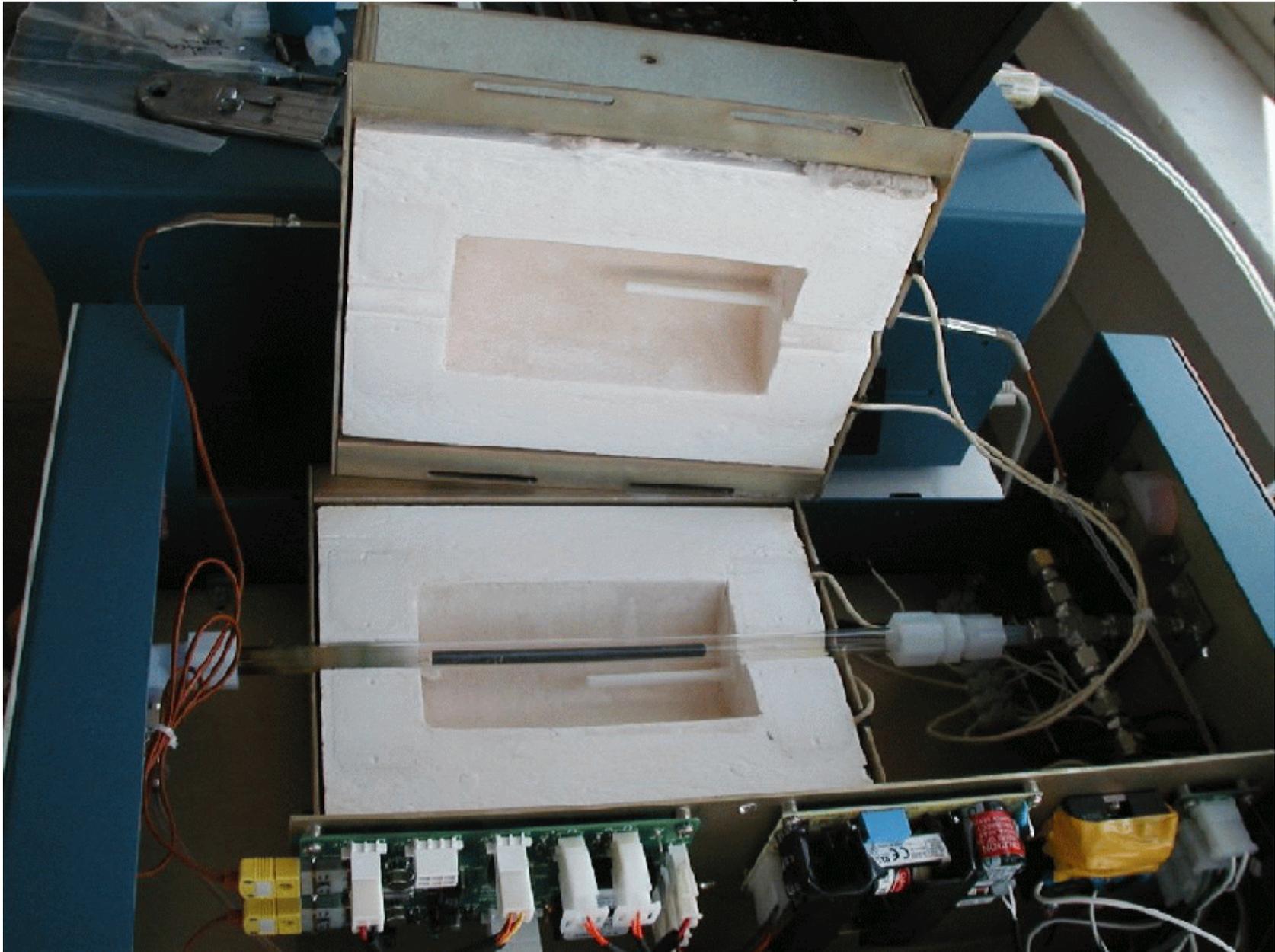


- Commercial version by Thermo Environmental
  - Suitable for wide deployment in SLT networks
  - Product Launch: June 2004 AWMA meeting
  - Prototypes running at 3 sites since mid-march 2004
  - First field deployments at Mane-Vu RAIN sites late May 2004
  - LOD: 0.5  $\mu\text{g}/\text{m}^3$  for 1-hour mean (0.25 typical)  
1  $\mu\text{g}/\text{m}^3$  for 15 minute mean (0.5 typical)
  
- Conflict of interest disclosure for commercial version of this method:
  - Financial interest in the Thermo 5020 SPA

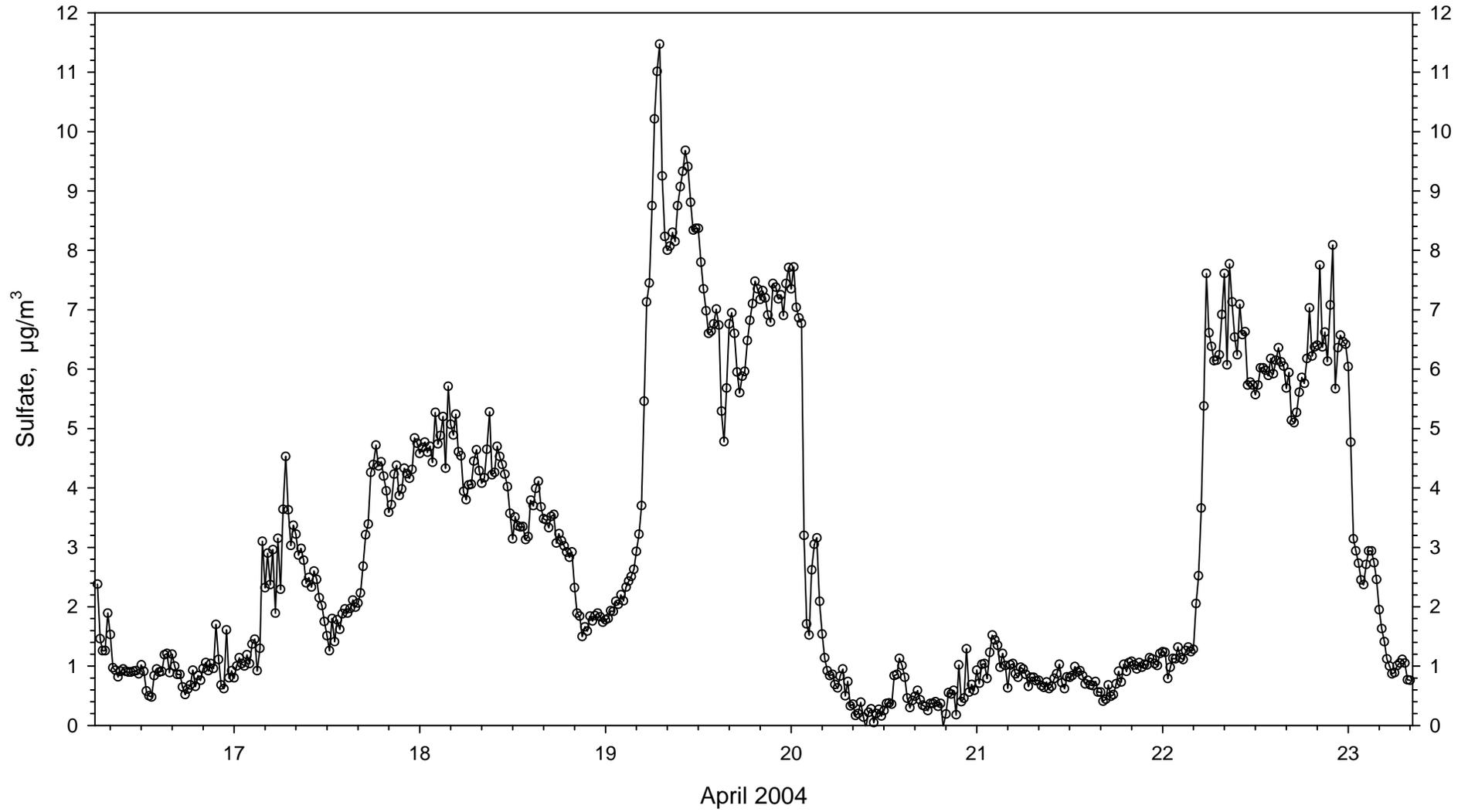
Left to right: Greggie, beta of Thermo Sulfate Analyzer, Dill plant.



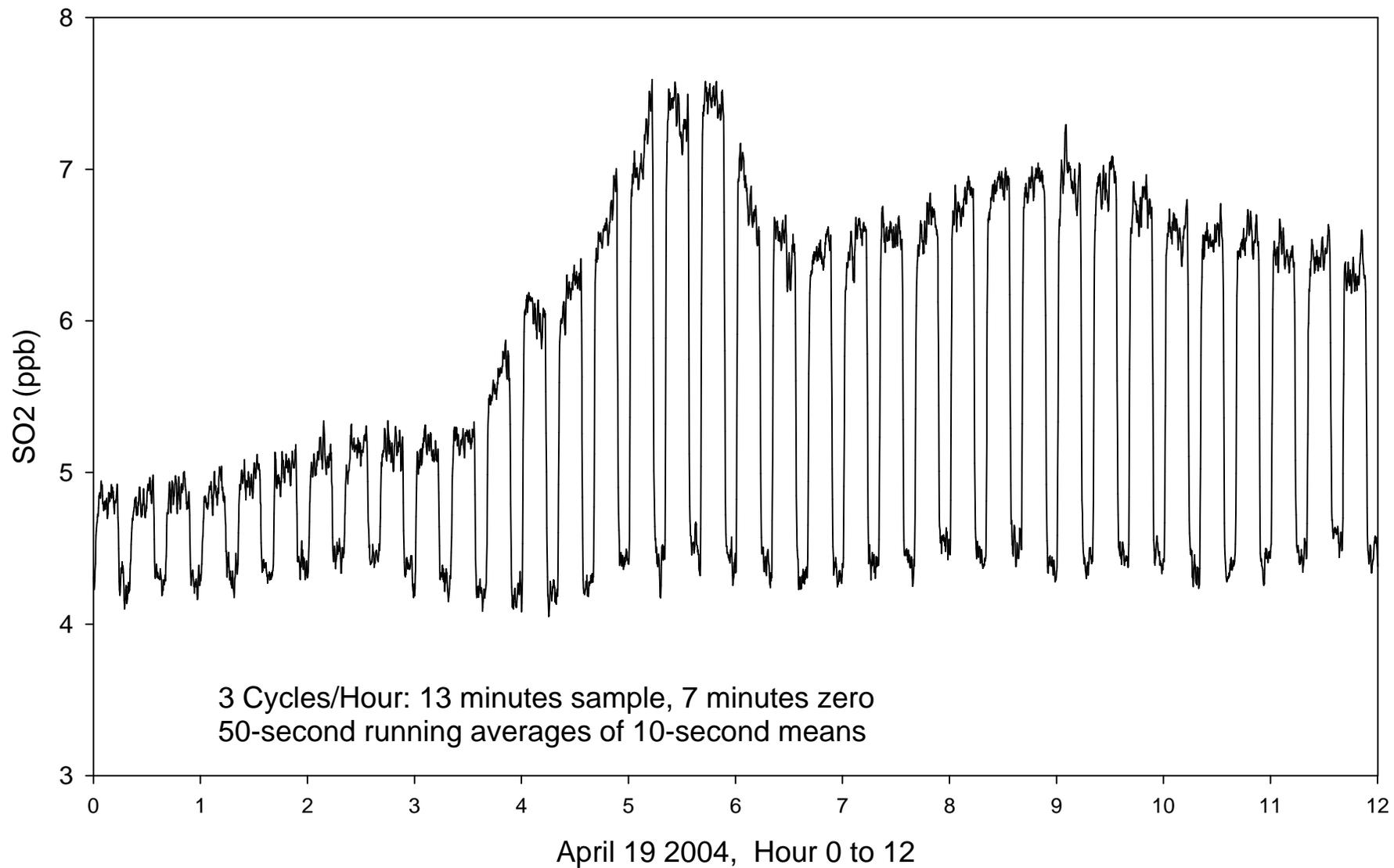
Inside of converter “blue box”; oven assembly (Thermo beta unit) :



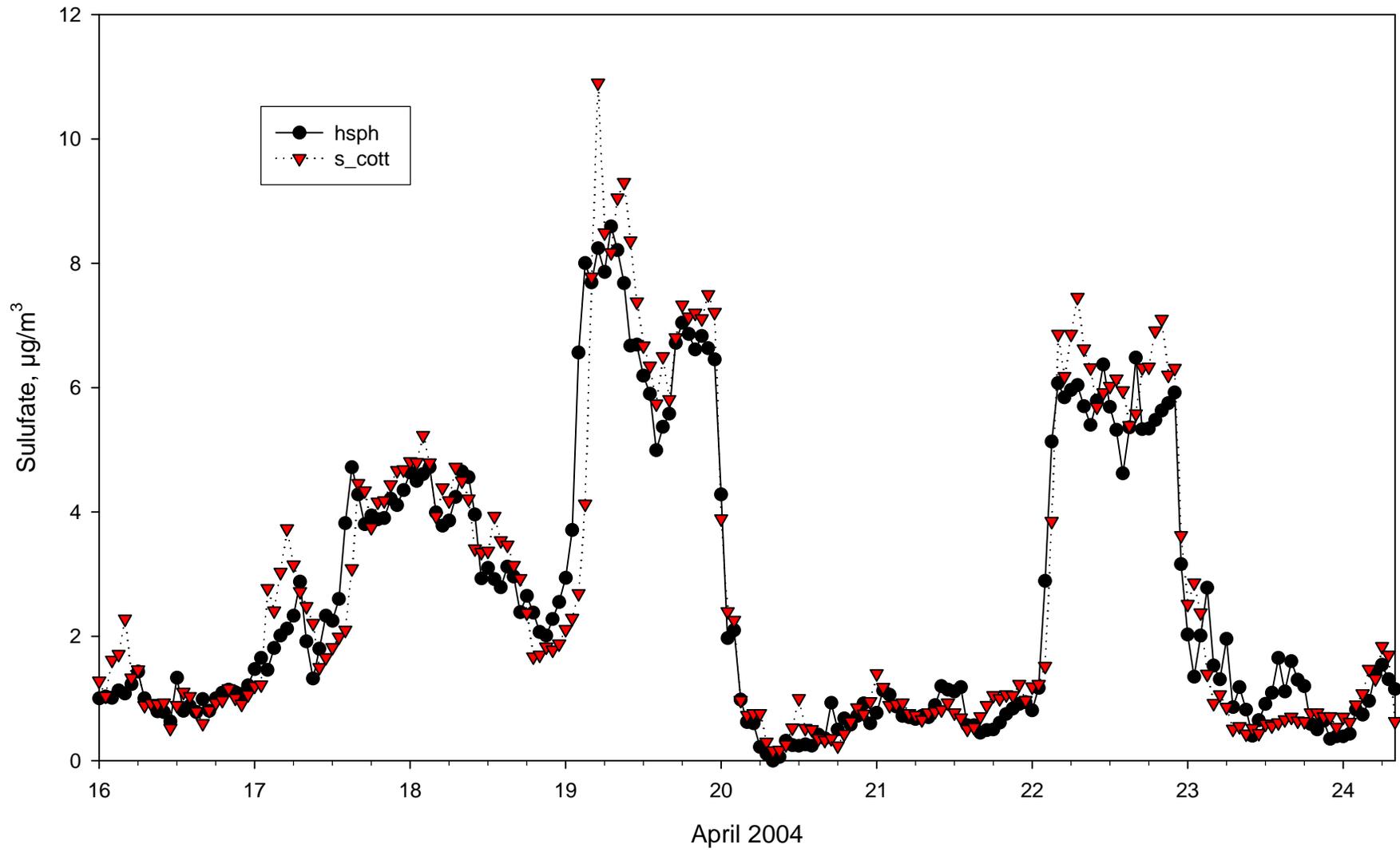
Swampscott 5020 Sulfate data, 20-minute means  
April 16 -23, 2004



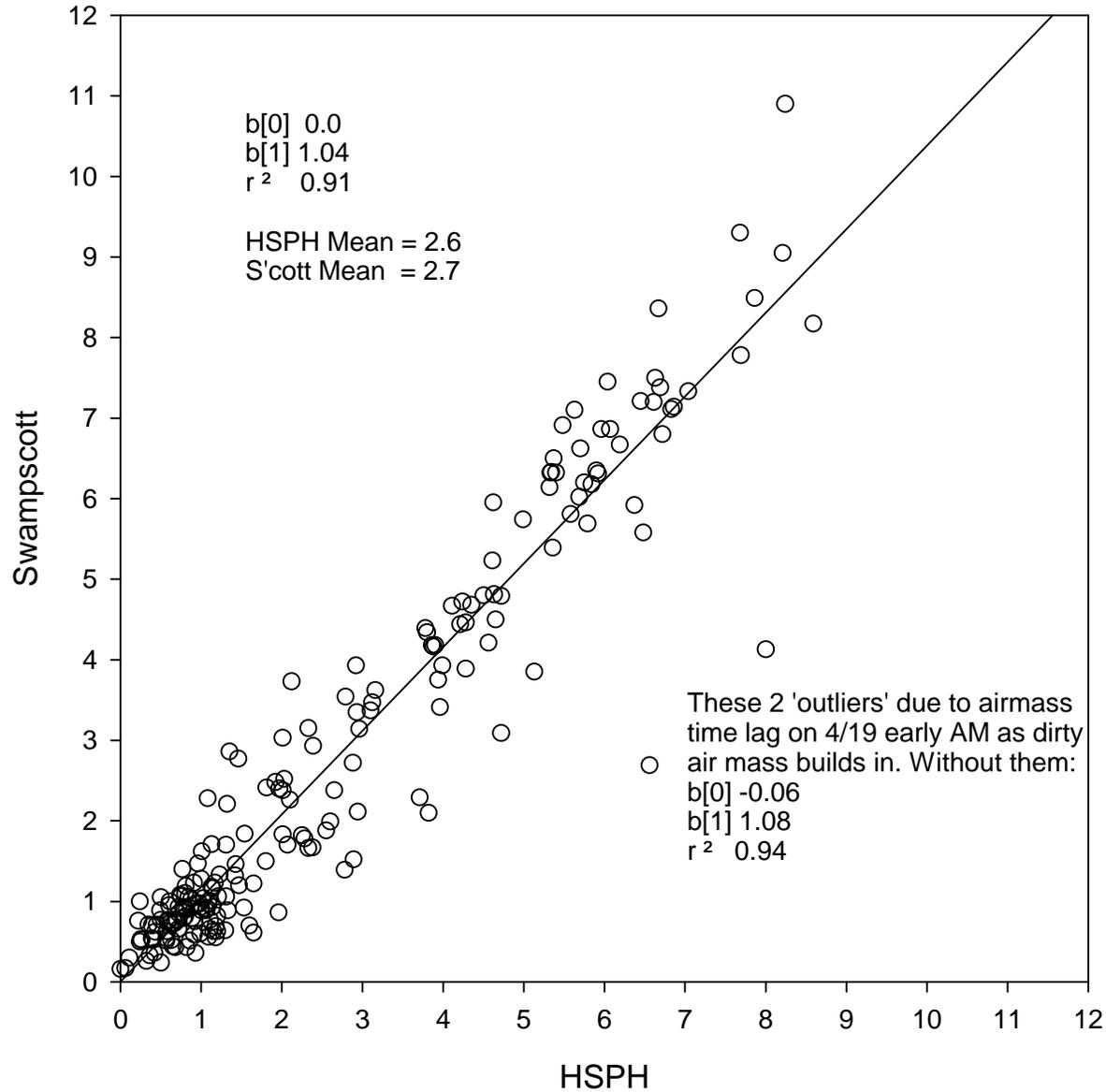
Continuous Sulfate Method: swampscott Raw SO2 data Example



HSPH and Swampscott 5020 sulfate 16 -24 April 2004



Swampscott vs. HSPH 1-hour sulfate, 16-24 April 2004  
Sites are 21.4 km apart, coastal suburban vs. urban

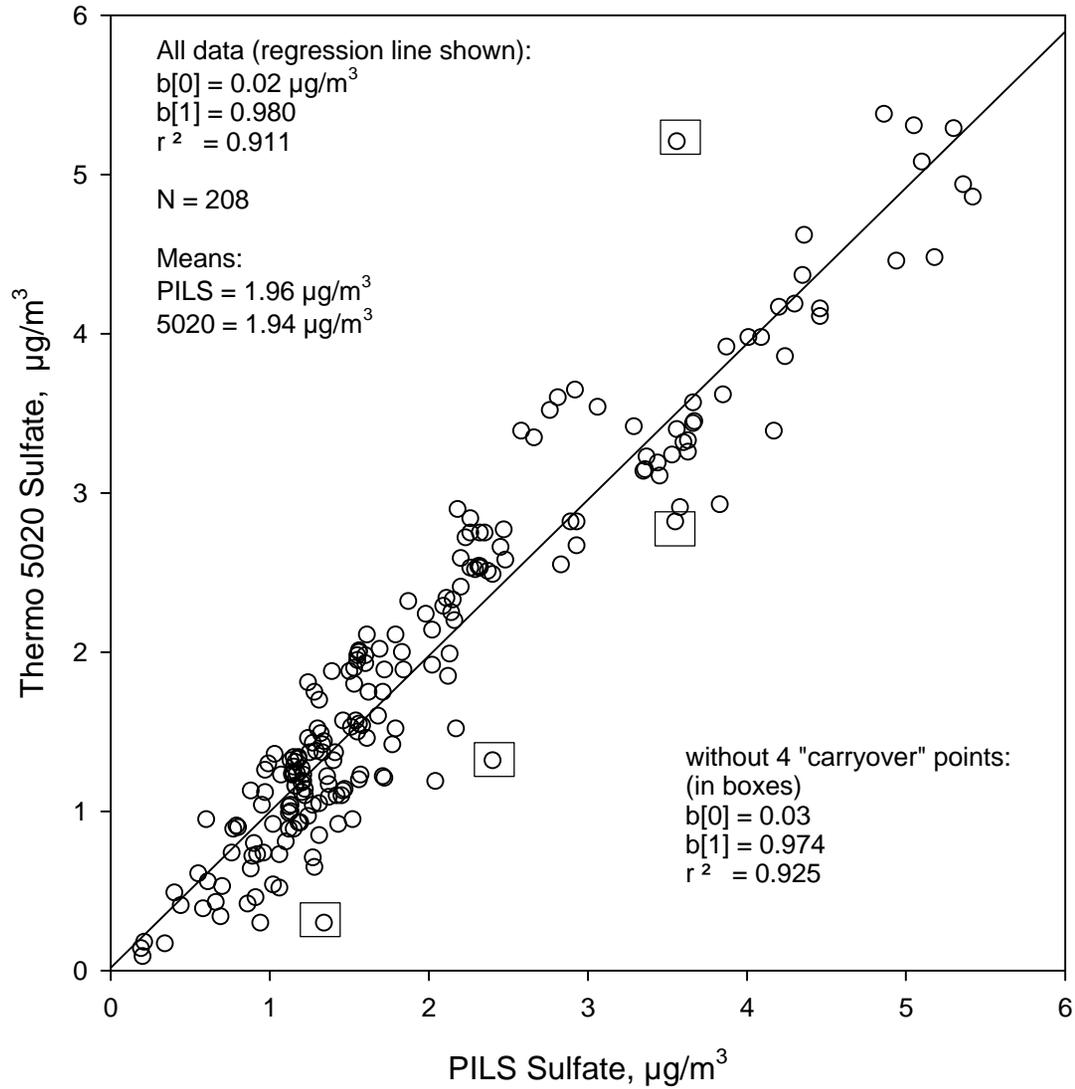


- Intensive evaluation of pre-production version at St. Louis Supersite
  - Compared to Weber PILS IC sulfate 1-hour data
  - Very good numerical agreement and correlation
  - Demonstrated extent of PILS “carryover” and SO<sub>2</sub> interference
  
- 1-Hour R<sup>2</sup>: 0.91 with all points; 0.93 without 4 “carryover” points

Data Acknowledgments:

Jay Turner and Bradley Goodwin, Washington University in St. Louis

### East St. Louis Supersite March 19-31, 2004 Hourly Sulfate Comparison



Based on 17 May 2004 data revision; PILS data edited for SO<sub>2</sub> interference

# St. Louis Supersite PILS and Thermo 5020 Hourly Sulfate

