

Decreases in elemental carbon and fine particle mass in the Rural United States

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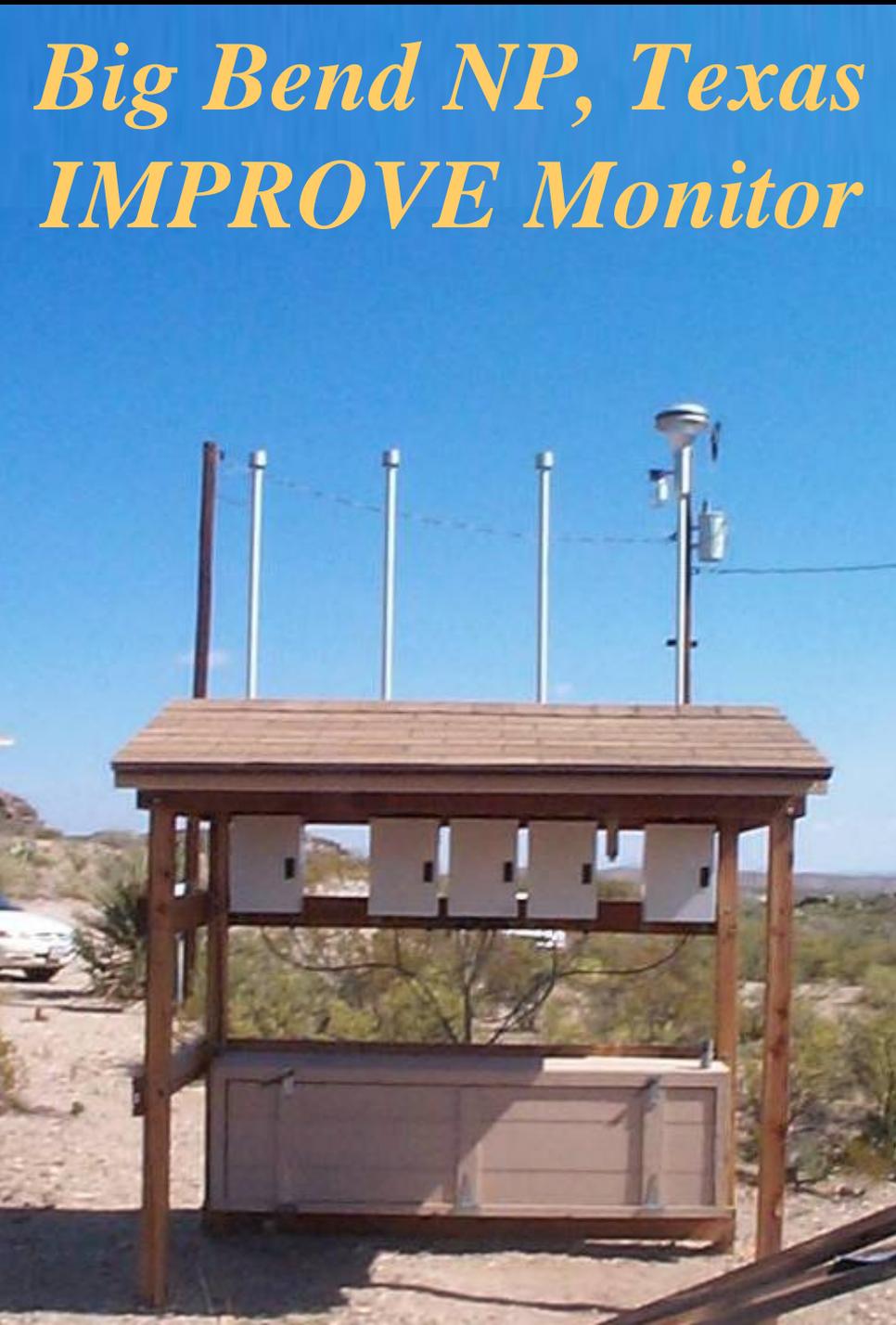


Big Bend NP, Texas

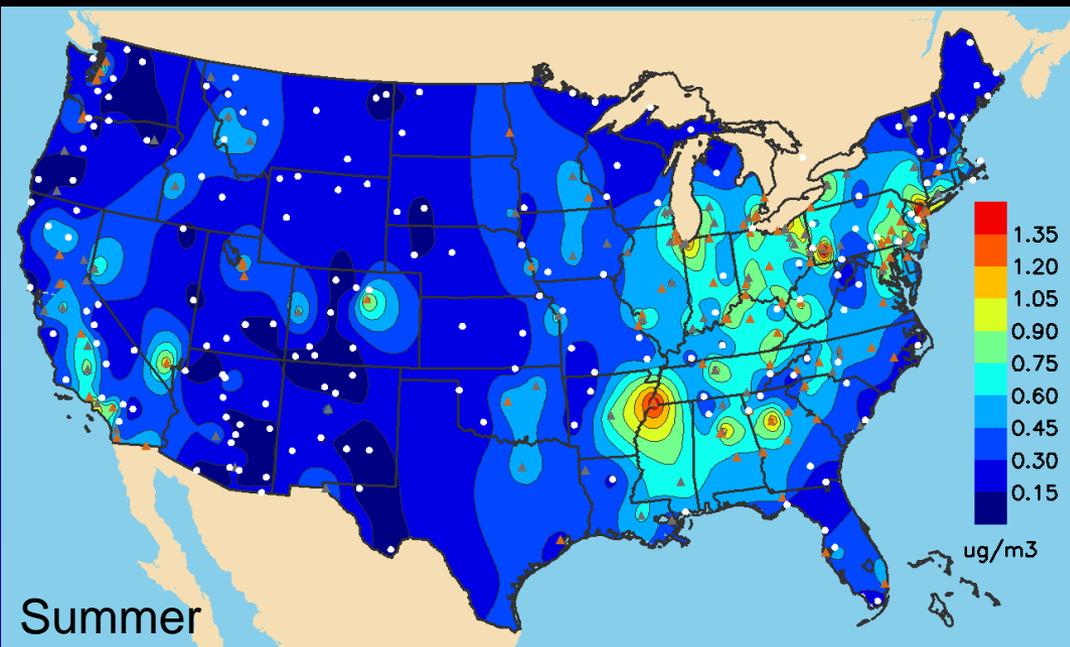
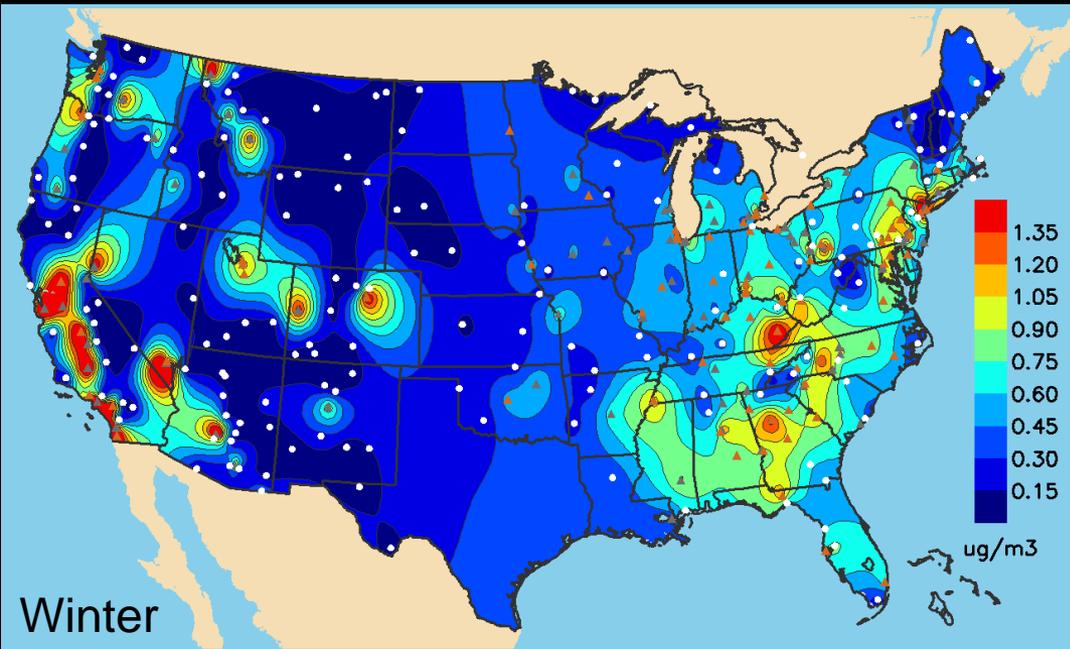
IMPROVE Monitor

IMPROVE Monitoring Network

- Collect 24-h PM samples twice per week or every third day
 - A: PM_{2.5} Gravimetric mass, elements (Na-PB – XRF, H – PESA), absorption – HIPS
 - B: PM_{2.5} SO₄, NO₃, Cl by IC
 - C: PM_{2.5} Organic and elemental carbon – Thermal Optical Reflectance
 - D: PM₁₀ gravimetric mass
- Began operation in 1988, currently has ~170 sites
- Sites primarily in remote location



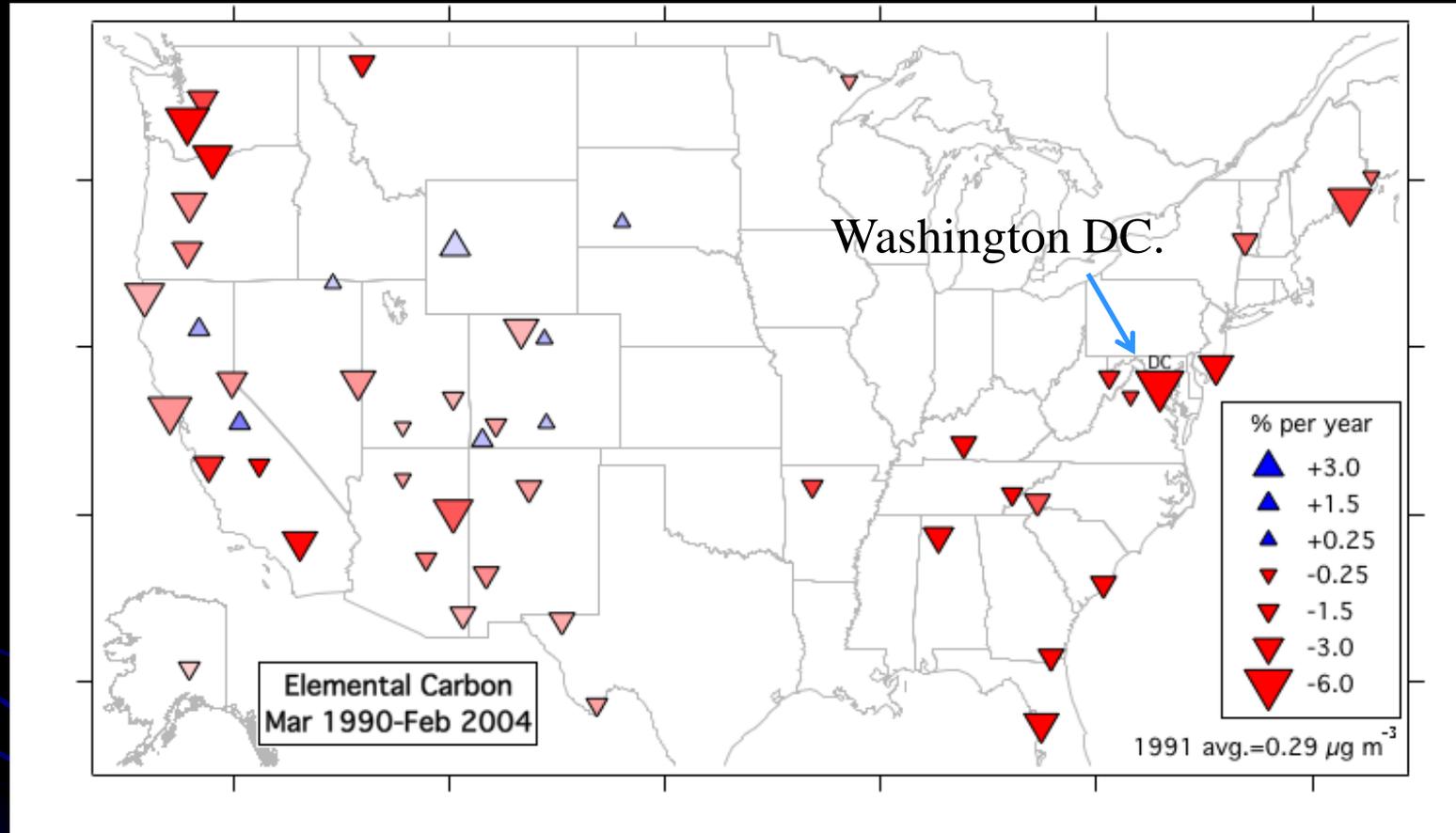
EC Concentrations 2007-2009



- Western US
 - EC is 5 to 10+ times larger in urban than neighboring rural sites
 - Winter urban peak
 - Summer rural peak
- Eastern US
 - Smaller relative urban excess compared to west
 - Seasonality is more varied from site to site

• Remote IMPROVE
▲ Urban/Suburban CSN

Widespread Decreases in Elemental Carbon



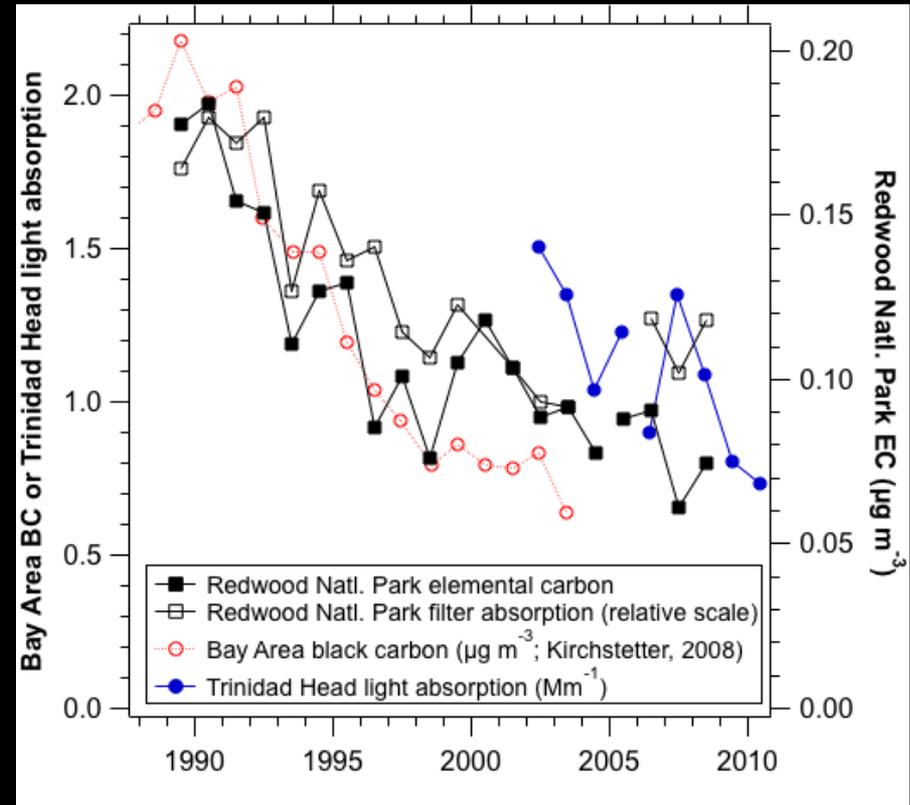
Symbol size: magnitude of trend

Color saturation: absolute amount of EC

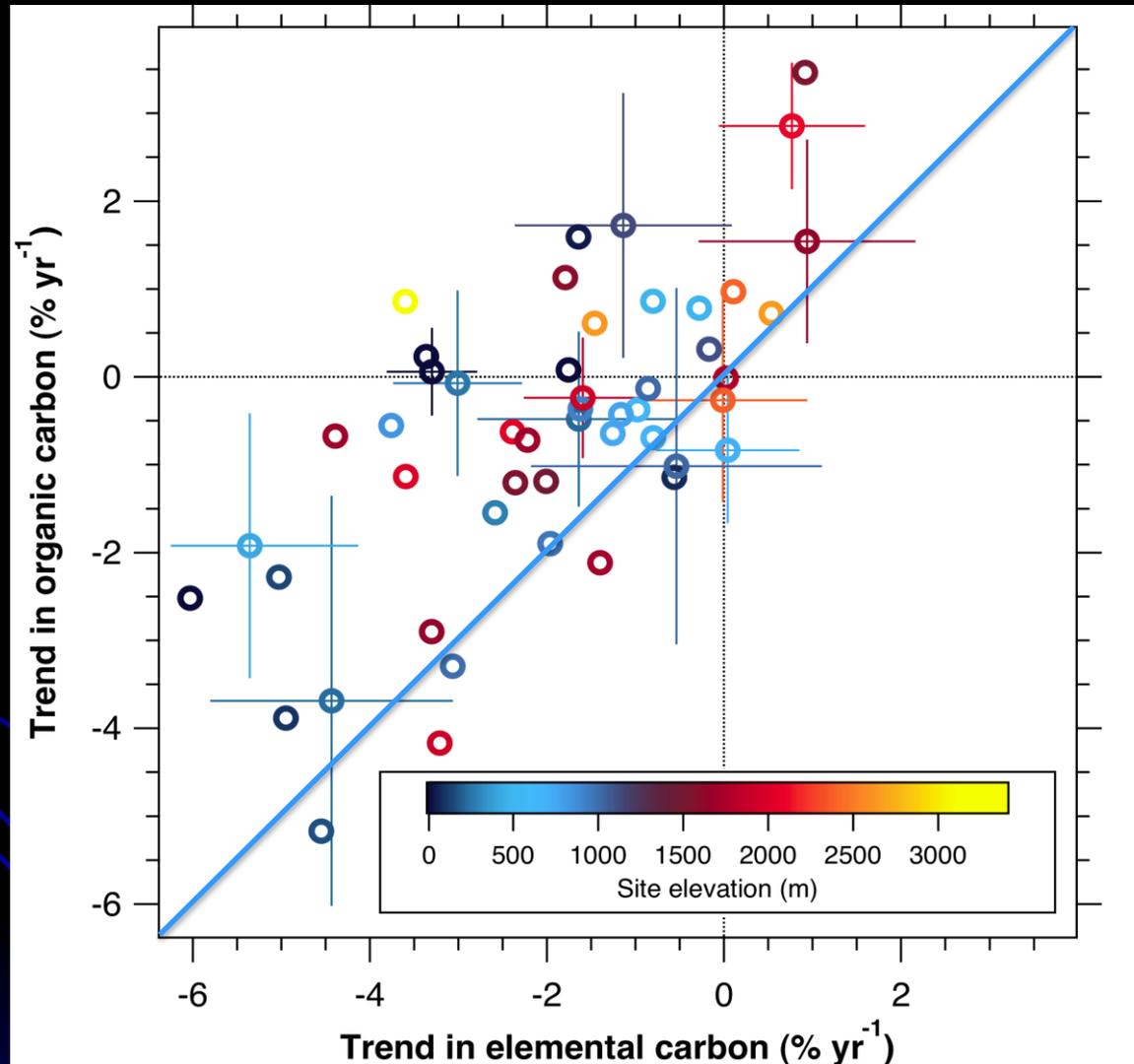
- EC trends from 1990 – 2004
- Too few sites had data before 1990 and after 2004 aging instrumentation were replaced which could potentially biases trends

Why to believe EC trends are real:

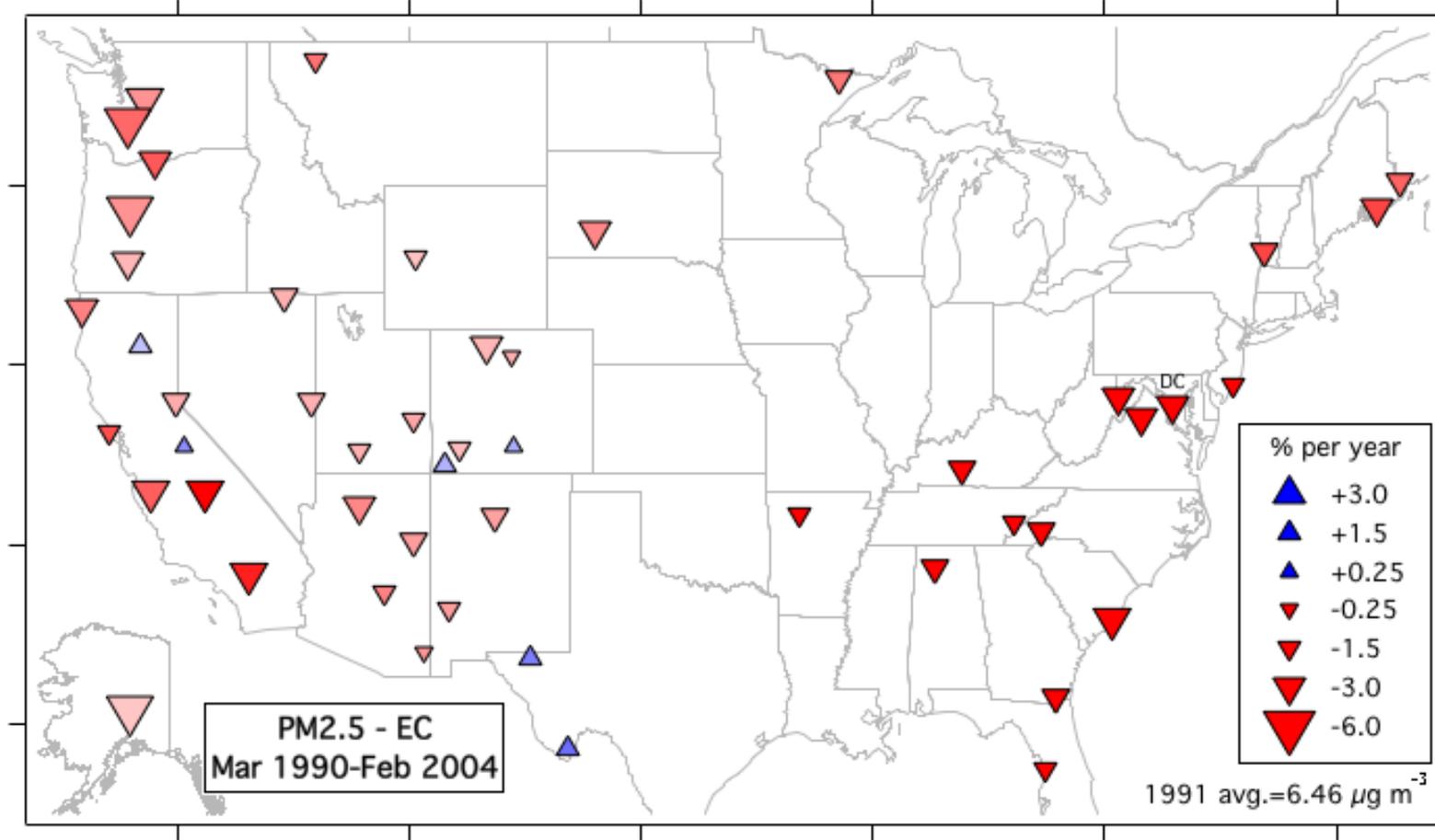
- 1) All samples used same protocol, same instruments at DRI
- 2) Internal consistency:
Similar trends from EC on quartz filters, measured blackness of teflon filters
- 3) Consistent with other data sets:



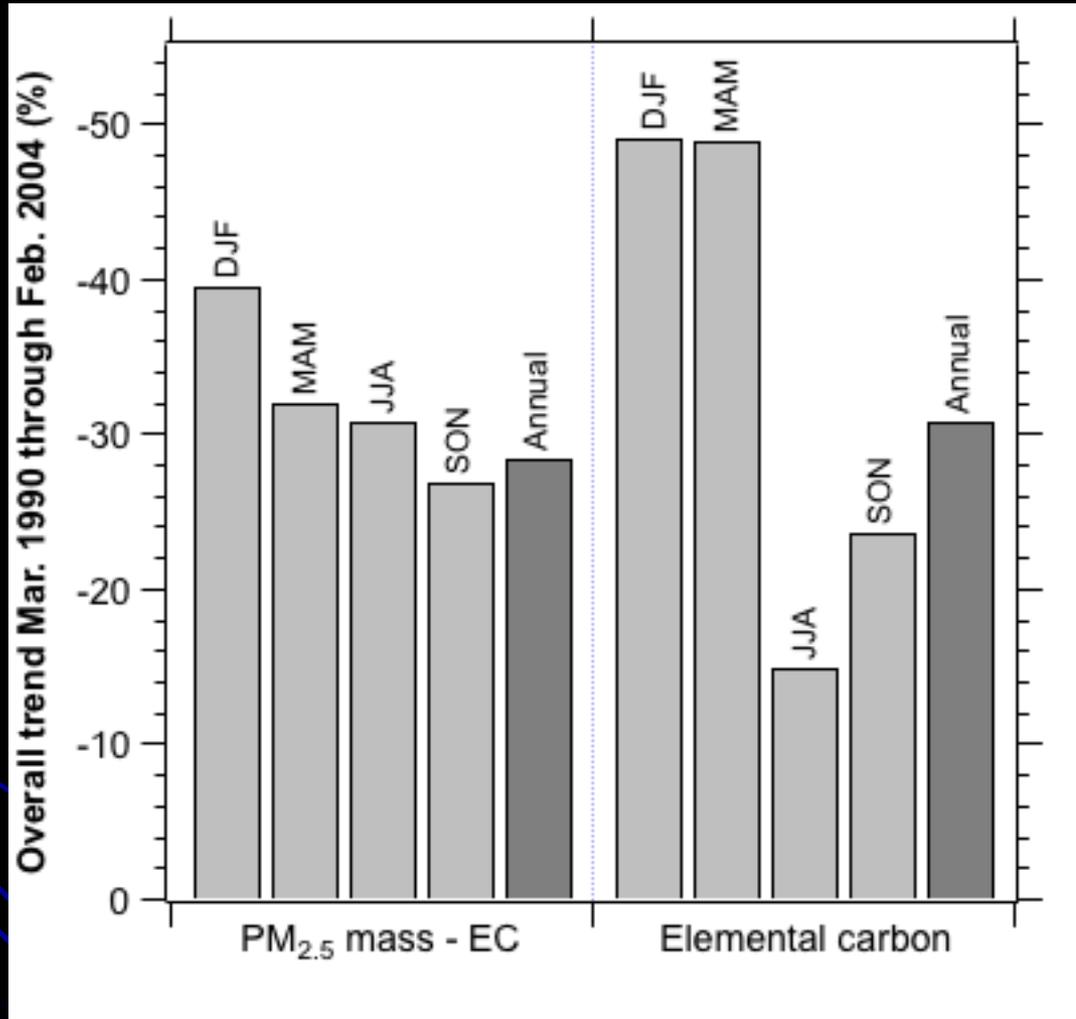
Organic Carbon also Generally Decreased



PM2.5 Mass also Decreased

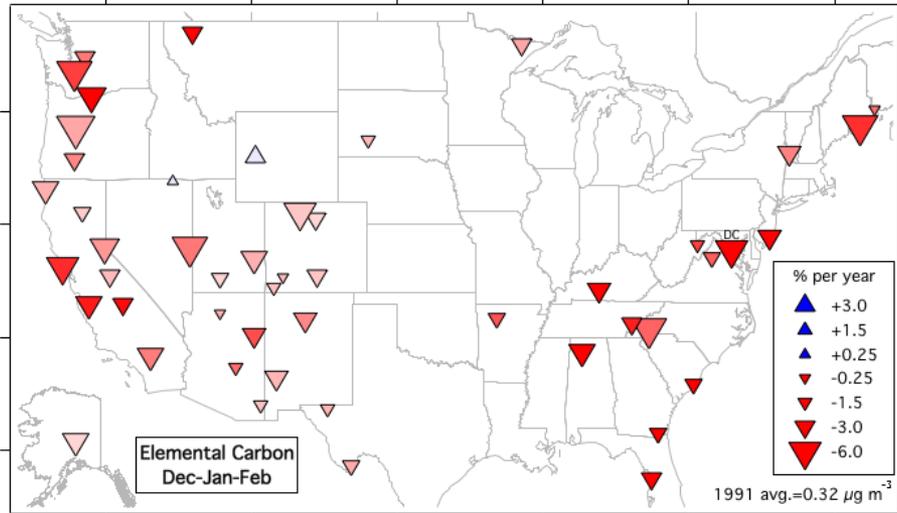


Seasonal Patterns

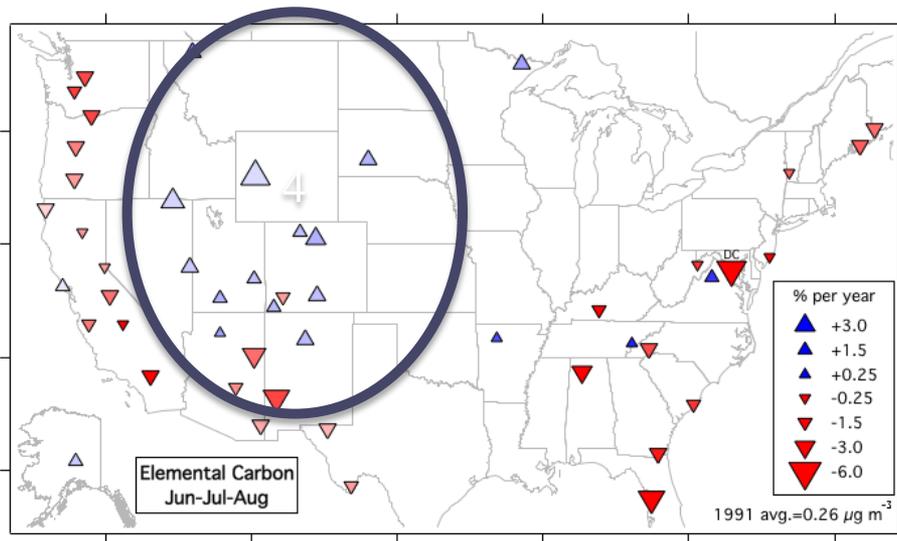


Why the large annual cycle in EC trends?

Changes in EC by Season



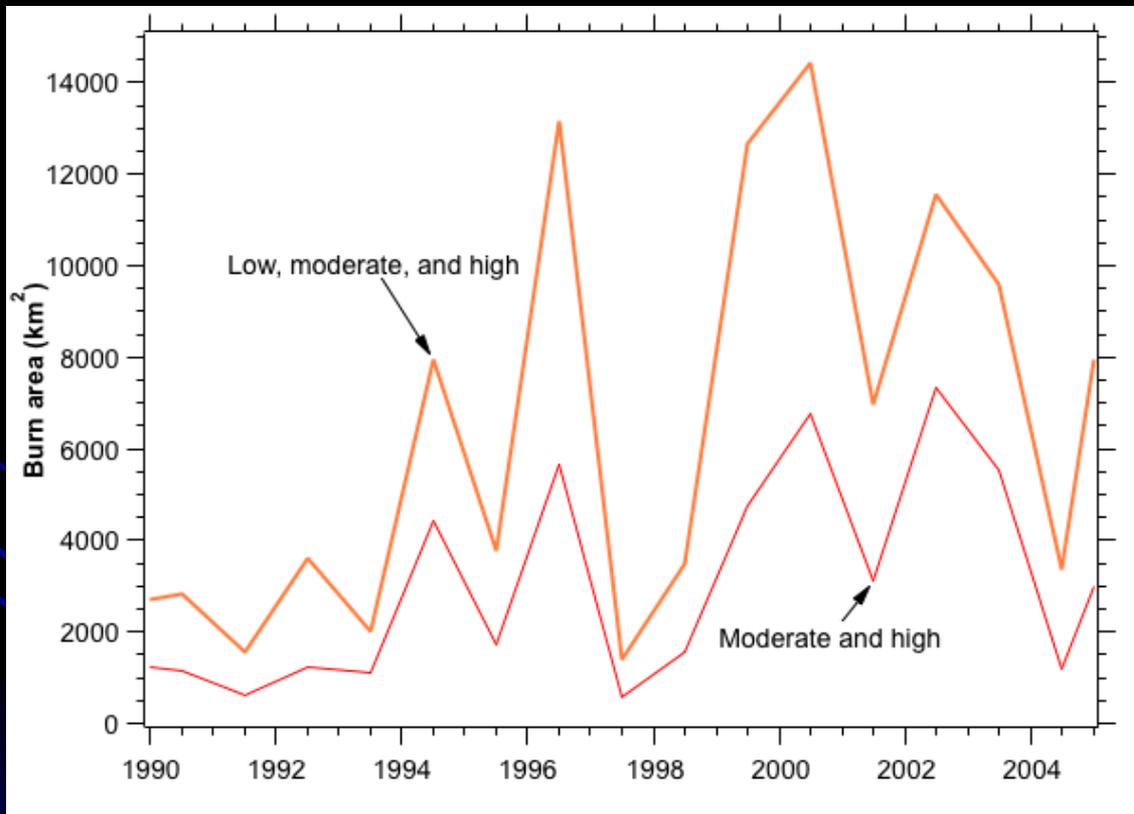
Winter:
Decreases almost everywhere



Summer:
Increases in the mountain west
Decreases on East and West Coasts

Suggested reason for seasonal

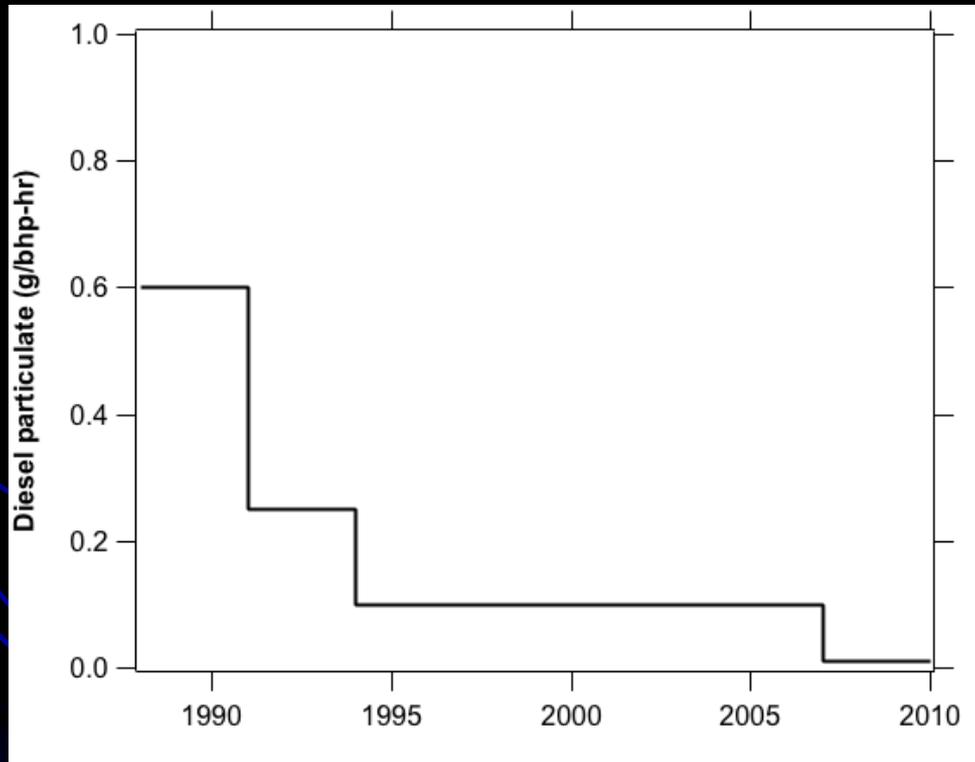
- 1) Year-round decrease in diesel emissions
- 2) Winter decrease in residential wood burning emissions
- 3) Summer increase in forest fire smoke:



source: Monitoring Trends in Burn Severity, USFS and USGS

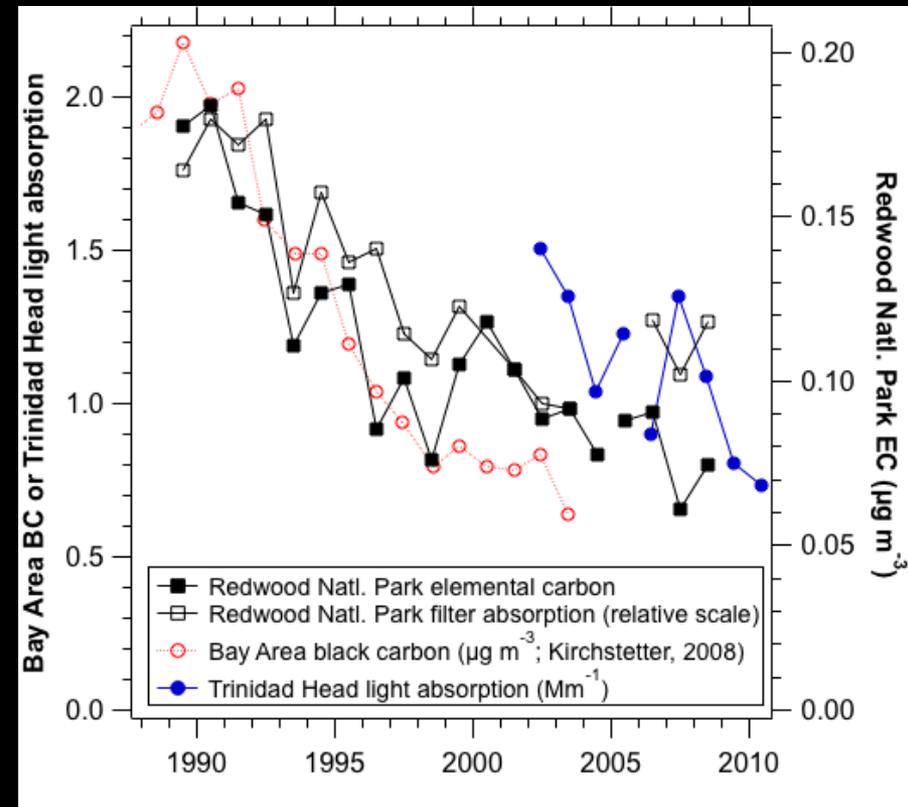
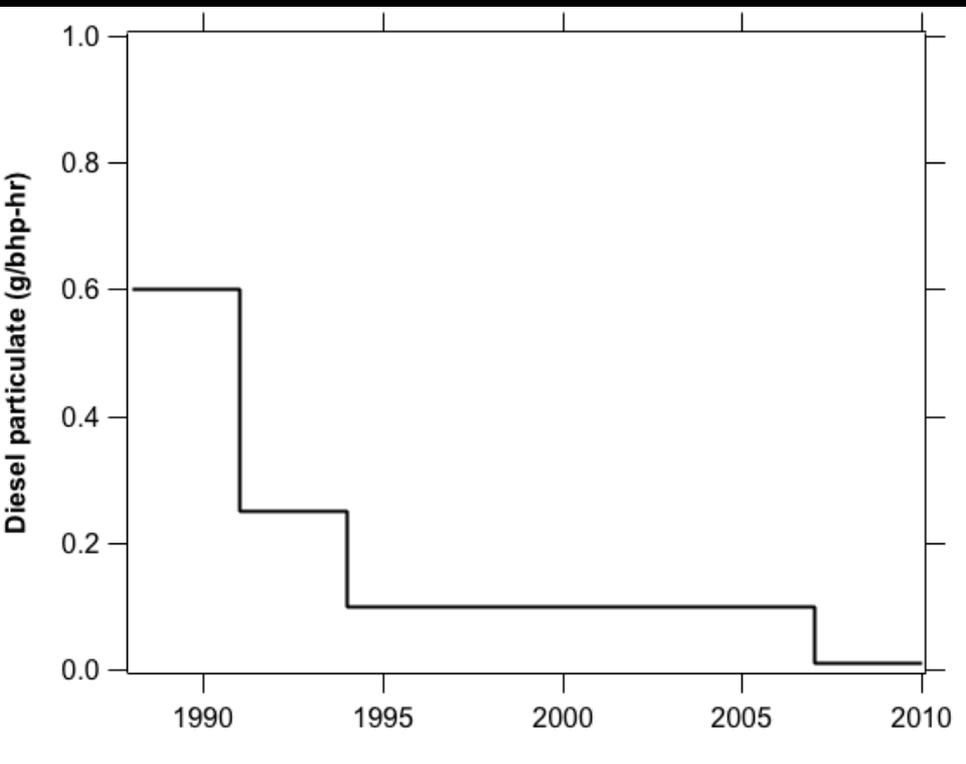
Some Relevant Emission Standards

- 1) 1988: residential wood stoves
- 2) Emissions standards for diesels (heavy on-road shown)
emissions reductions found in tunnel studies

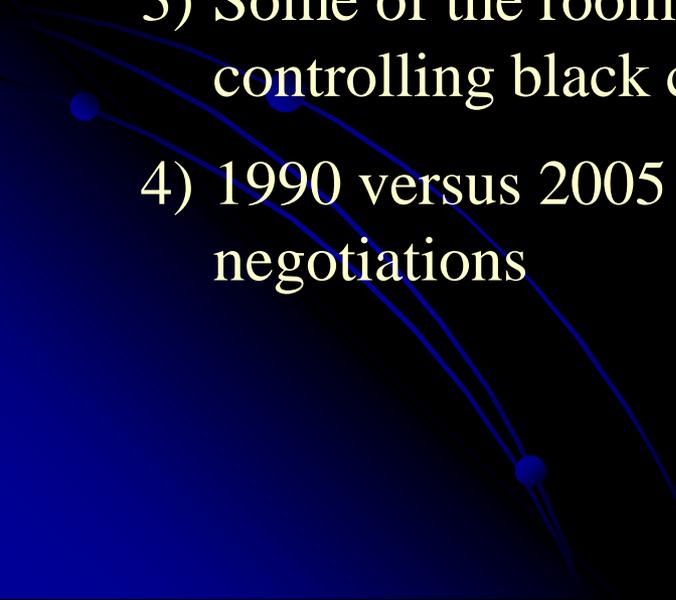


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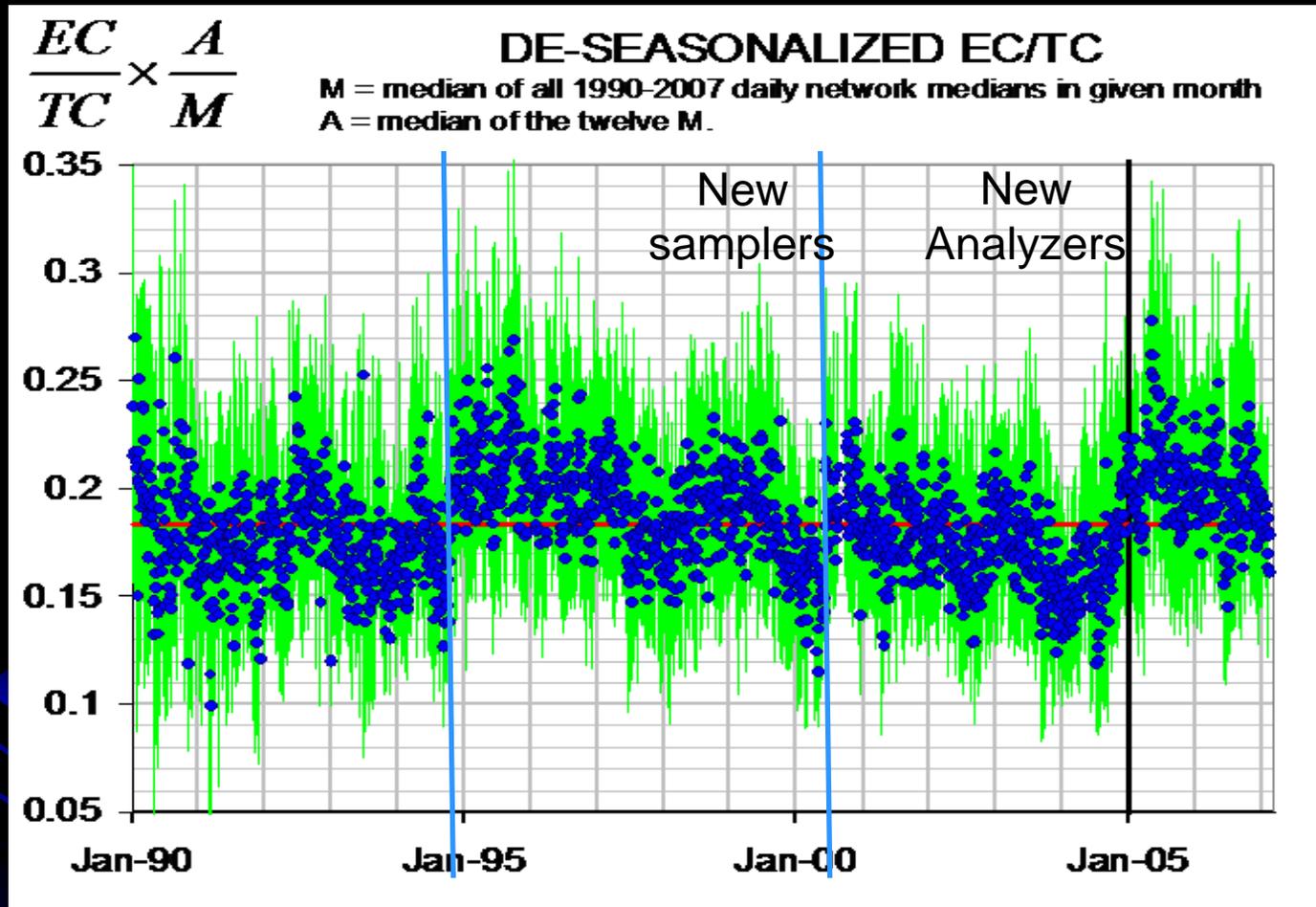
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Climate implications

- 1) Large reductions were accomplished in PM2.5, elemental carbon
 - 2) Model results (GEOS chemistry + GISS climate) show that this led to an increase in radiative forcing:
decrease in non-absorbing aerosols outweighed decrease in black carbon
 - 3) Some of the room for quick response to climate by controlling black carbon has already been used.
 - 4) 1990 versus 2005 baseline significant for climate negotiations
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Potential Measurement Artifacts



- During the course of the network operation changes have occurred that could influence trend analysis