

Elucidating the cause of decreasing carbonaceous aerosol in the US (1990-2010)

Not Dust!



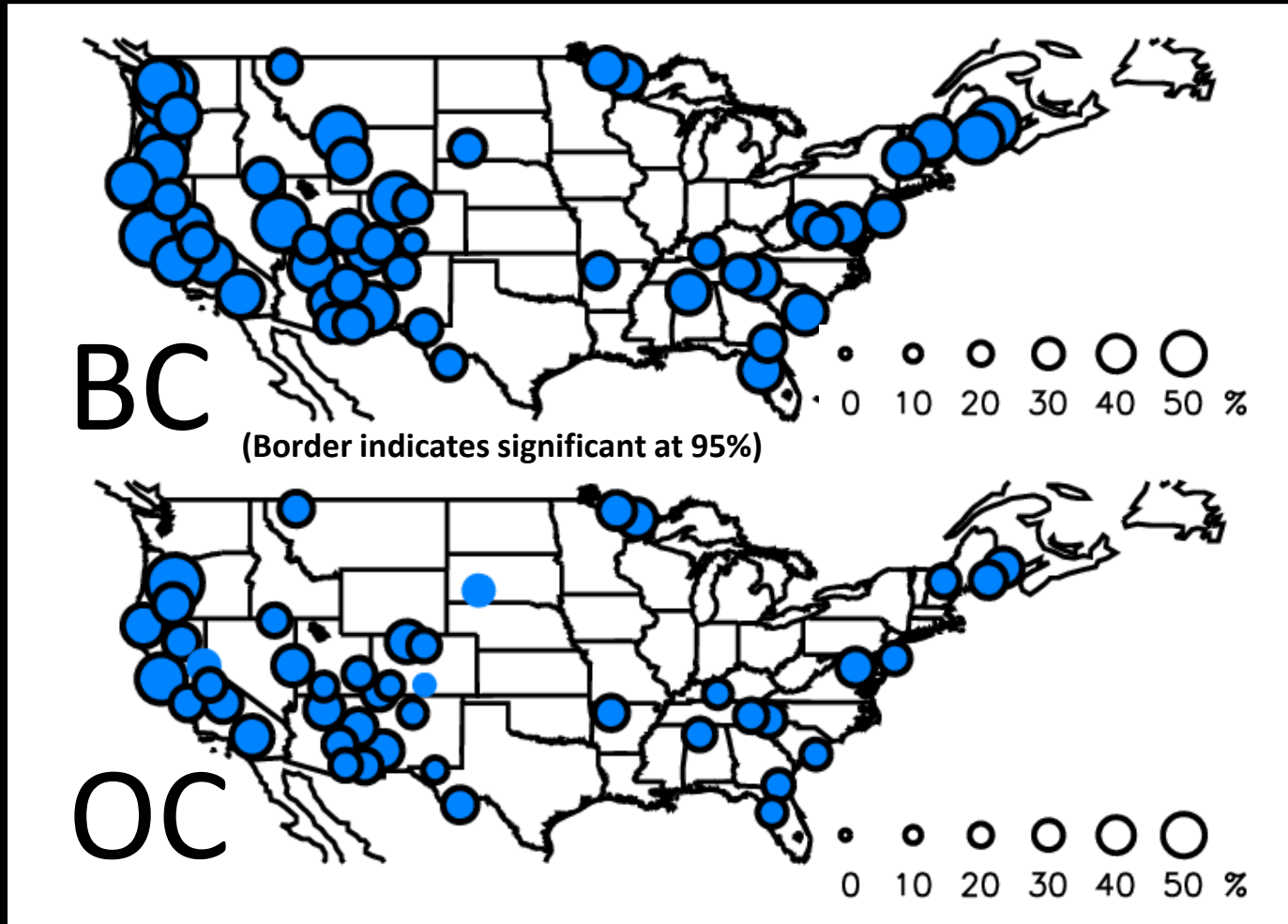
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Massachusetts Institute of Technology

MIT ATMOSPHERIC
CHEMISTRY

Fractional decline in carbonaceous aerosol (1990 vs 2010)

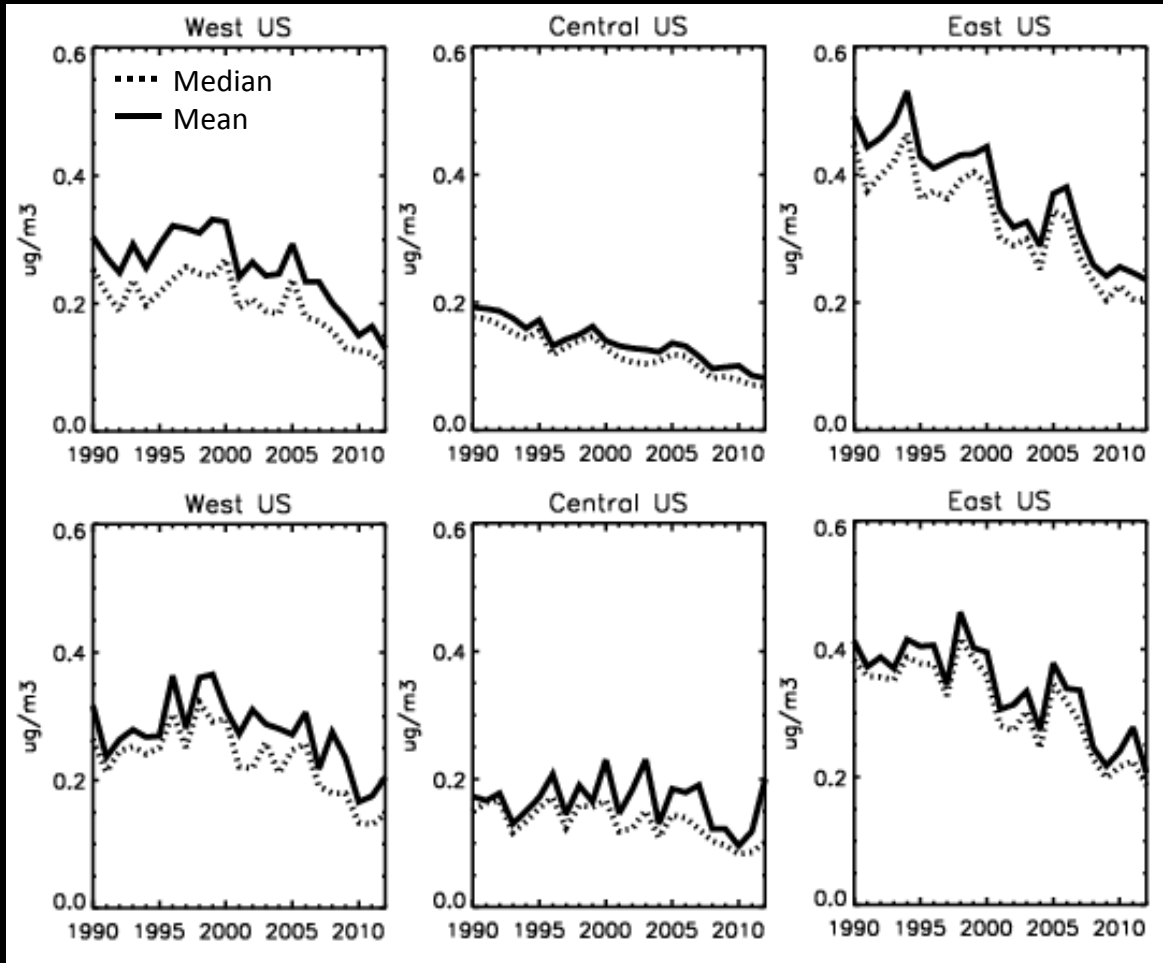


- Around 50% decline in BC across US since 1990
- Similar trends in OC (fires reduce significance)
- Observed in both urban and remote regions

Observations of black carbon (BC)

BC

Winter

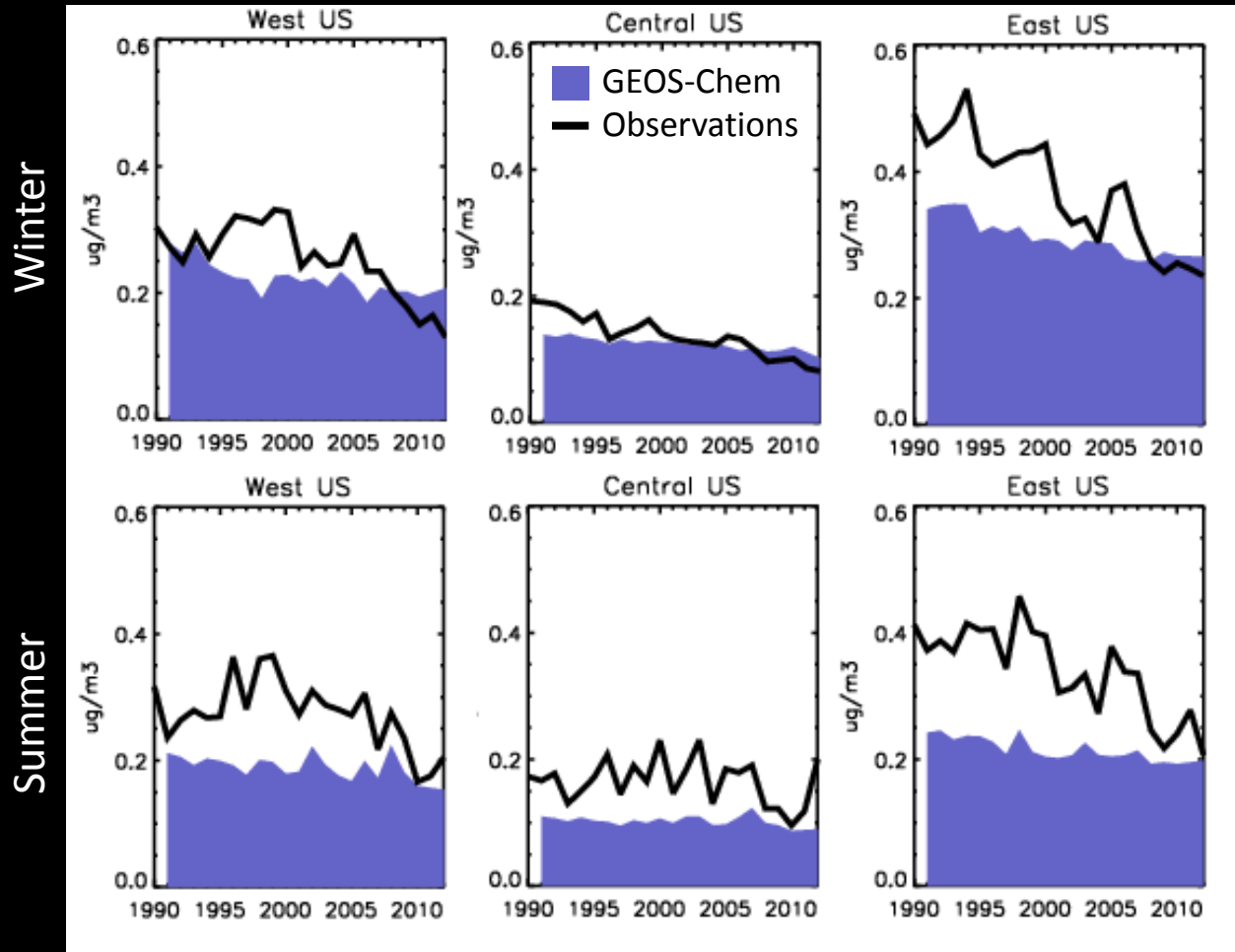


Summer

- Largest decline in the East US
- Trends consistent in both seasons

Observations and GEOS-Chem black carbon (BC)

BC

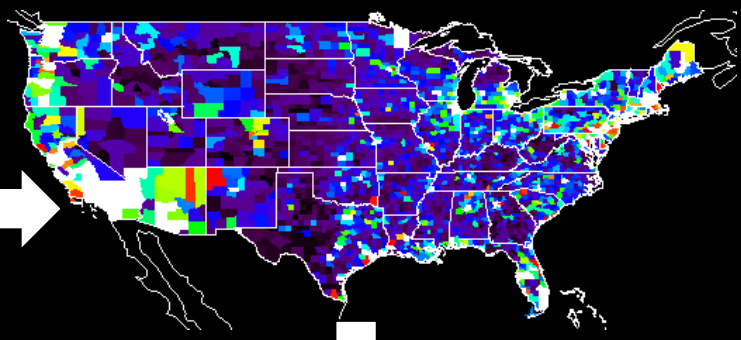


- Weaker decreasing trend in model
- Reasonable agreement in present, poor agreement in past

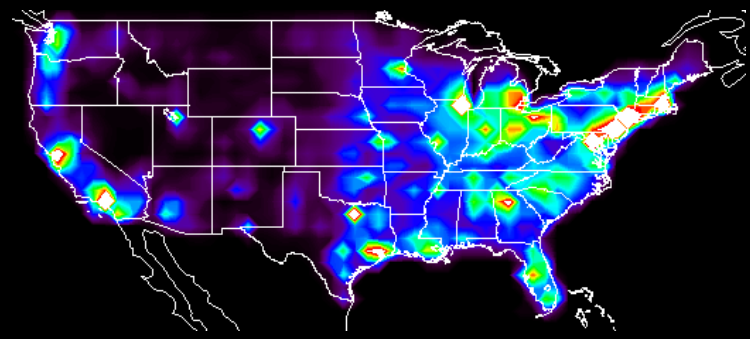
New emissions database derived from EPA PM2.5

Specific Category	Total Primary PM _{2.5}	BC	Primary OC	OC/BC	BC/PM _{2.5}
Distillate Oil Combustion	23,718	2,372	5,930	2.5	0.1
Wood Fired Boiler	56,289	2,088	19,764	9.5	0.04
Process Gas Combustion	9,457	1,378	2,850	2	0.15
PMSO ₂ Controlled Lignite Combustion	20,499	293	5,826	19.9	0.01
Stationary Diesel	4,476	3,452	786	0.2	0.77
Cement Production	17,523	514	2,221	4.3	0.03
Ind Manuf - Avg.	46,501	416	3,422	8.2	0.01
Mineral Products - Avg	23,632	347	1,242	3.6	0.01
Kraft Recovery Furnace	21,222	325	1,111	3.4	0.02

1990 countywide BC emissions



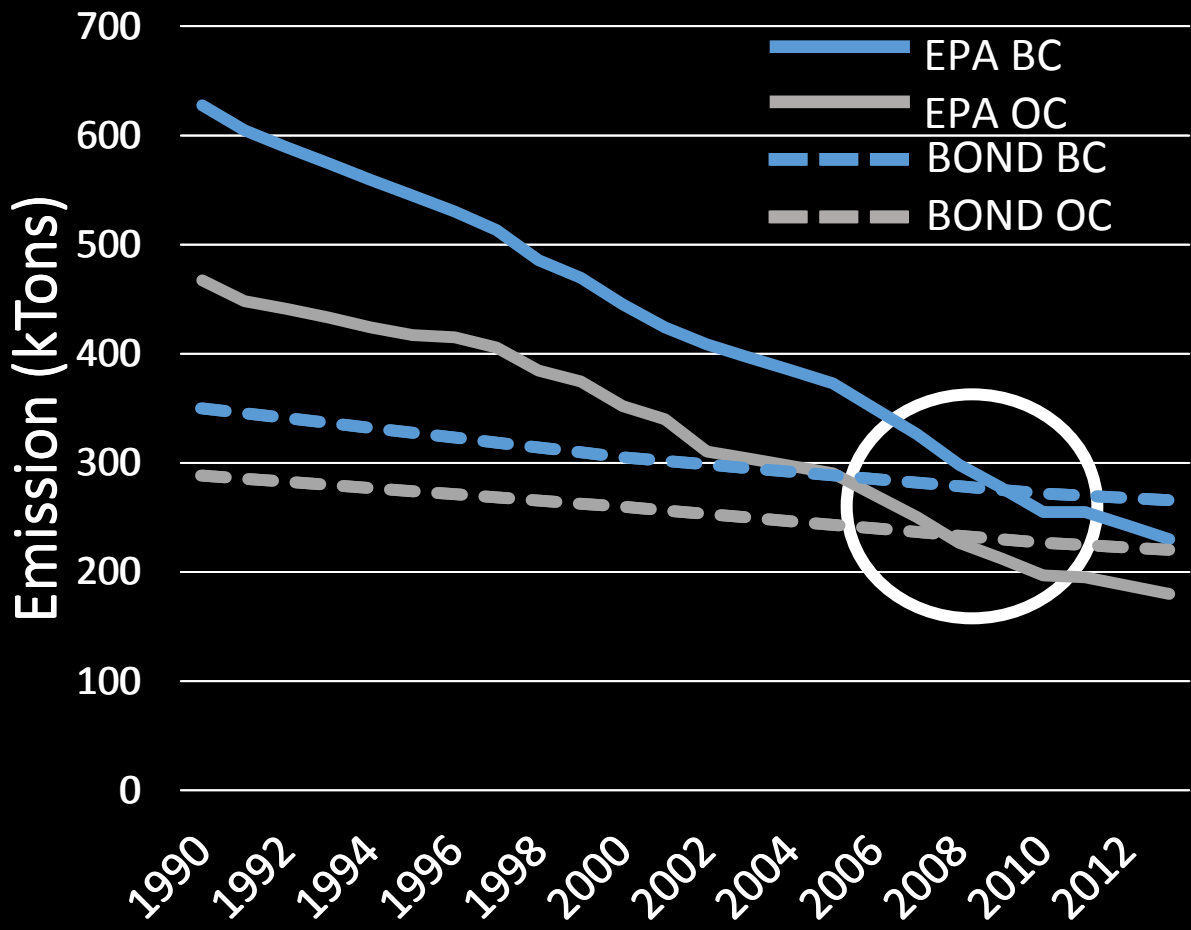
1990 gridded BC emissions



EPA countywide individual source PM2.5 emissions inventory

- BC and OC emissions inferred from detailed PM2.5 sources
- New gridded annual BC and OC database for 1990-2011

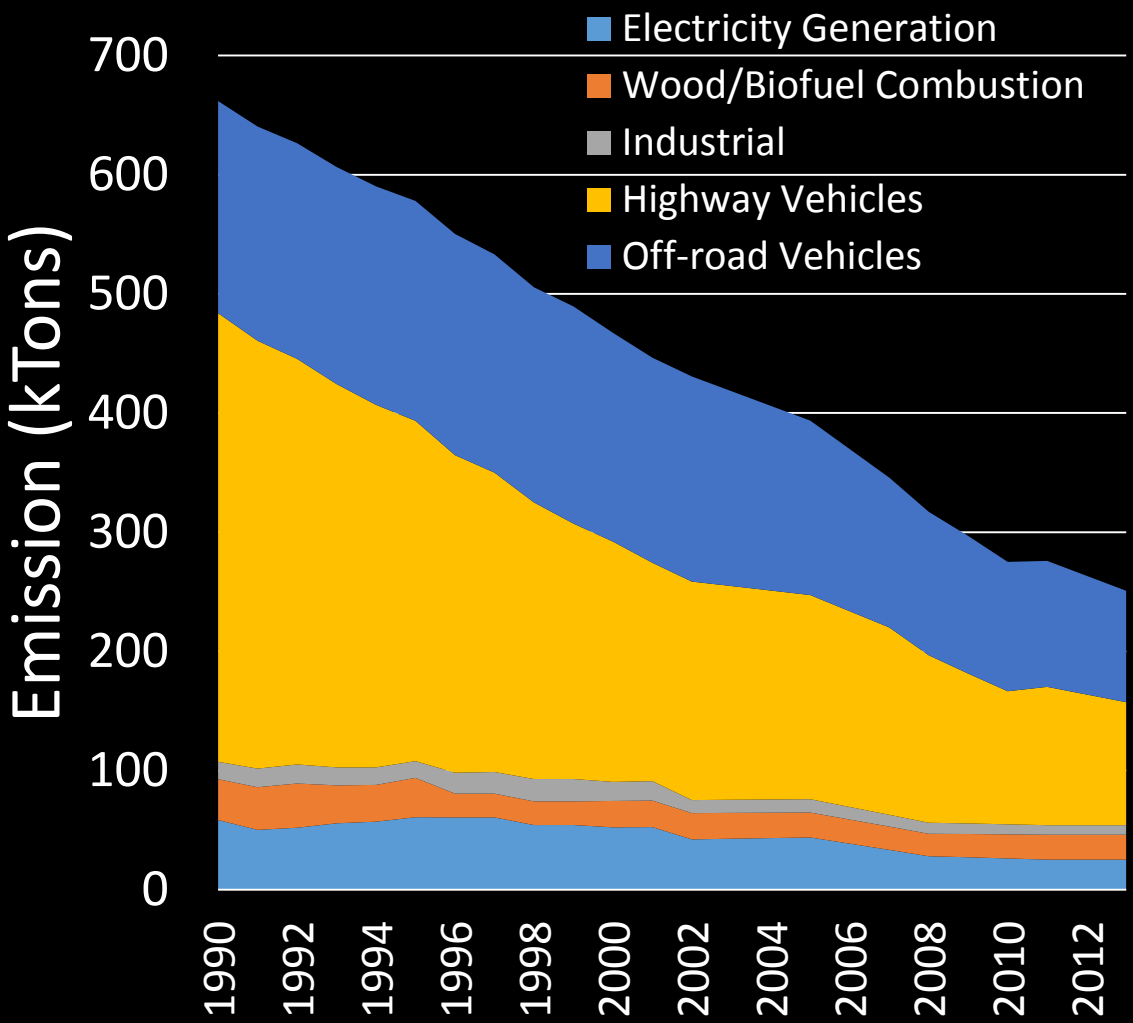
Bond and EPA-derived BC and OC emissions (US)



- Great agreement between US-wide emissions... for 2009.
- EPA emissions around 50% higher than Bond before 1995!

EPA BC emission macro-sources

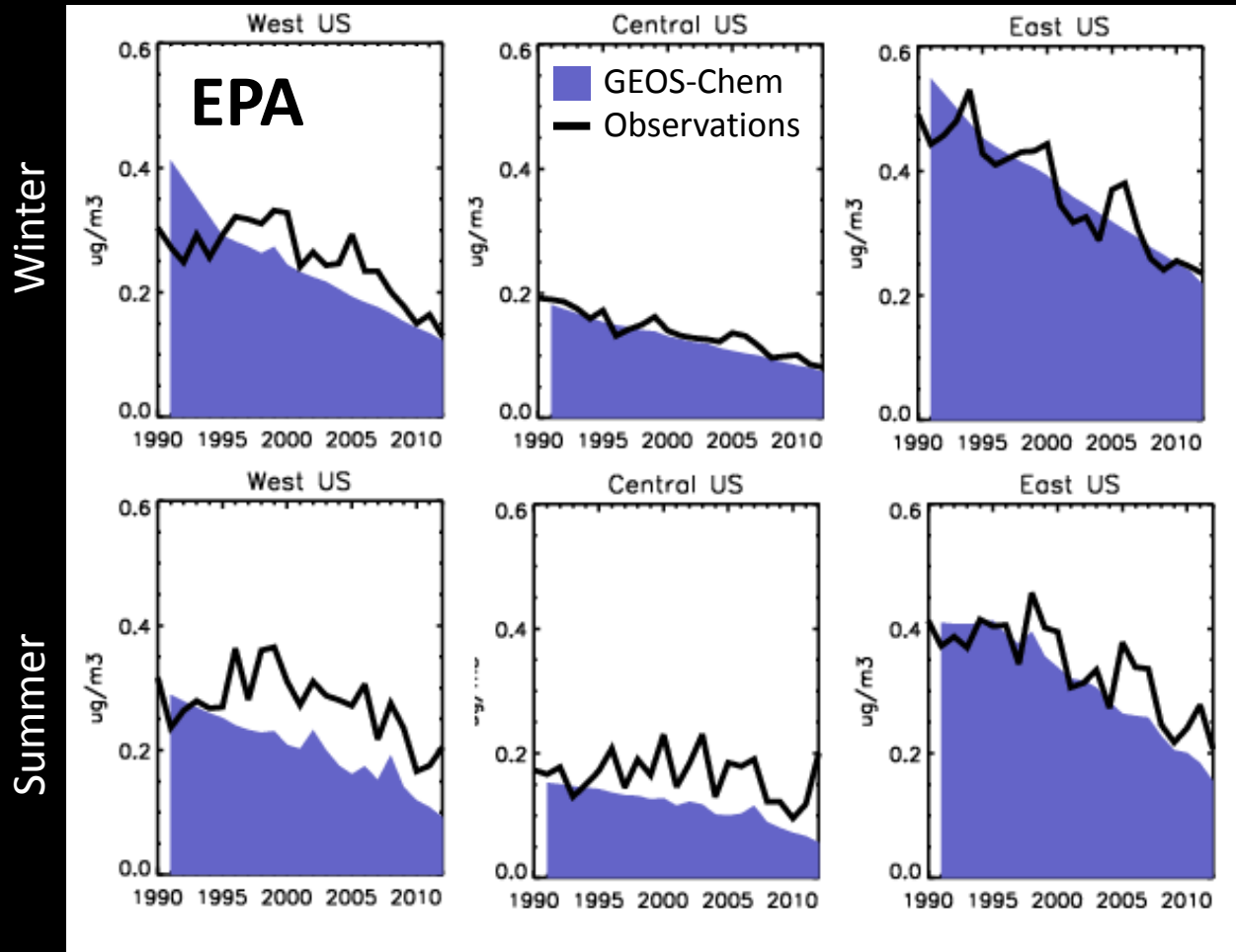
BC



- EPA data suggests strong decline in vehicular BC emissions

GEOS-Chem with EPA emissions of black carbon (BC)

BC

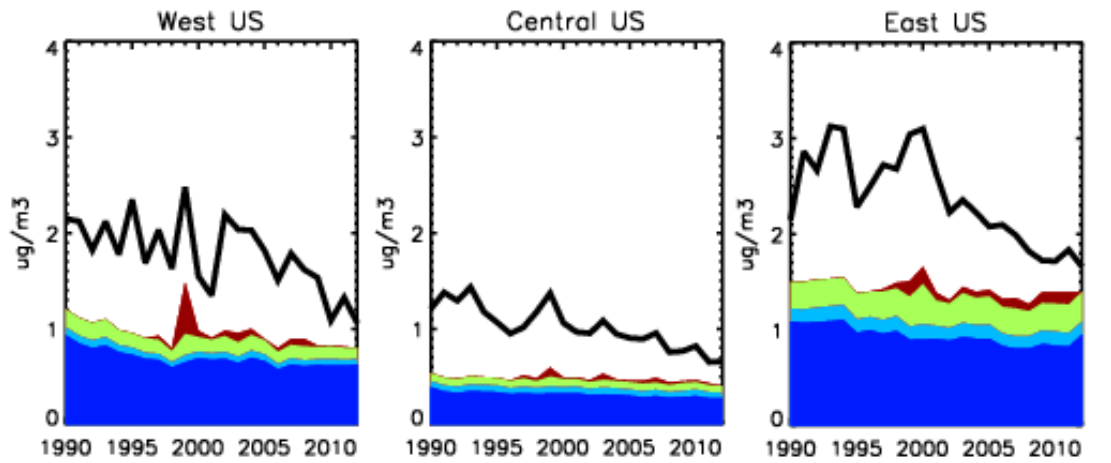


- Observed trend better captured with EPA emissions

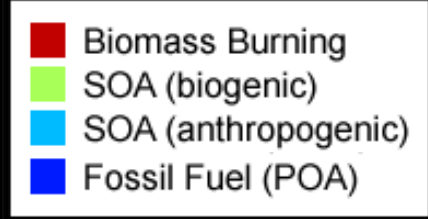
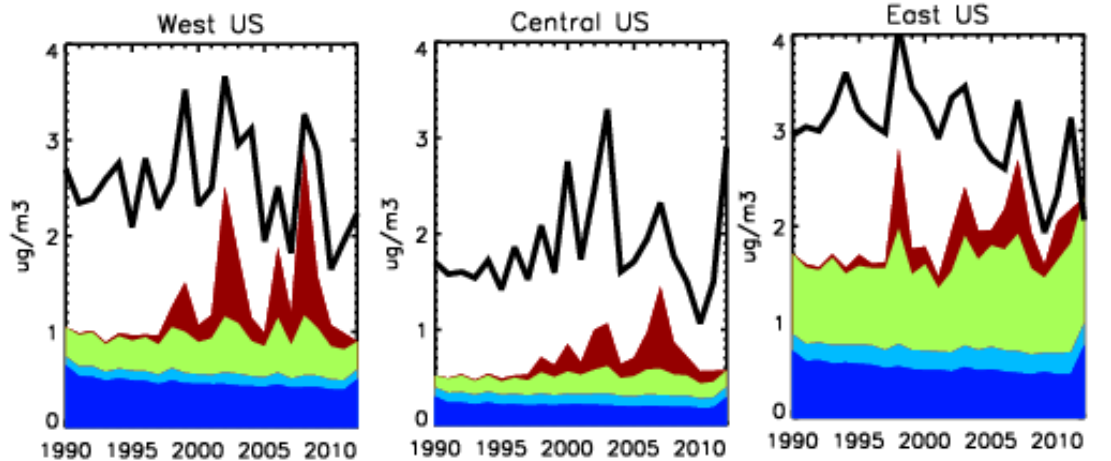
Observations of organic aerosol (OA)

OA

Winter

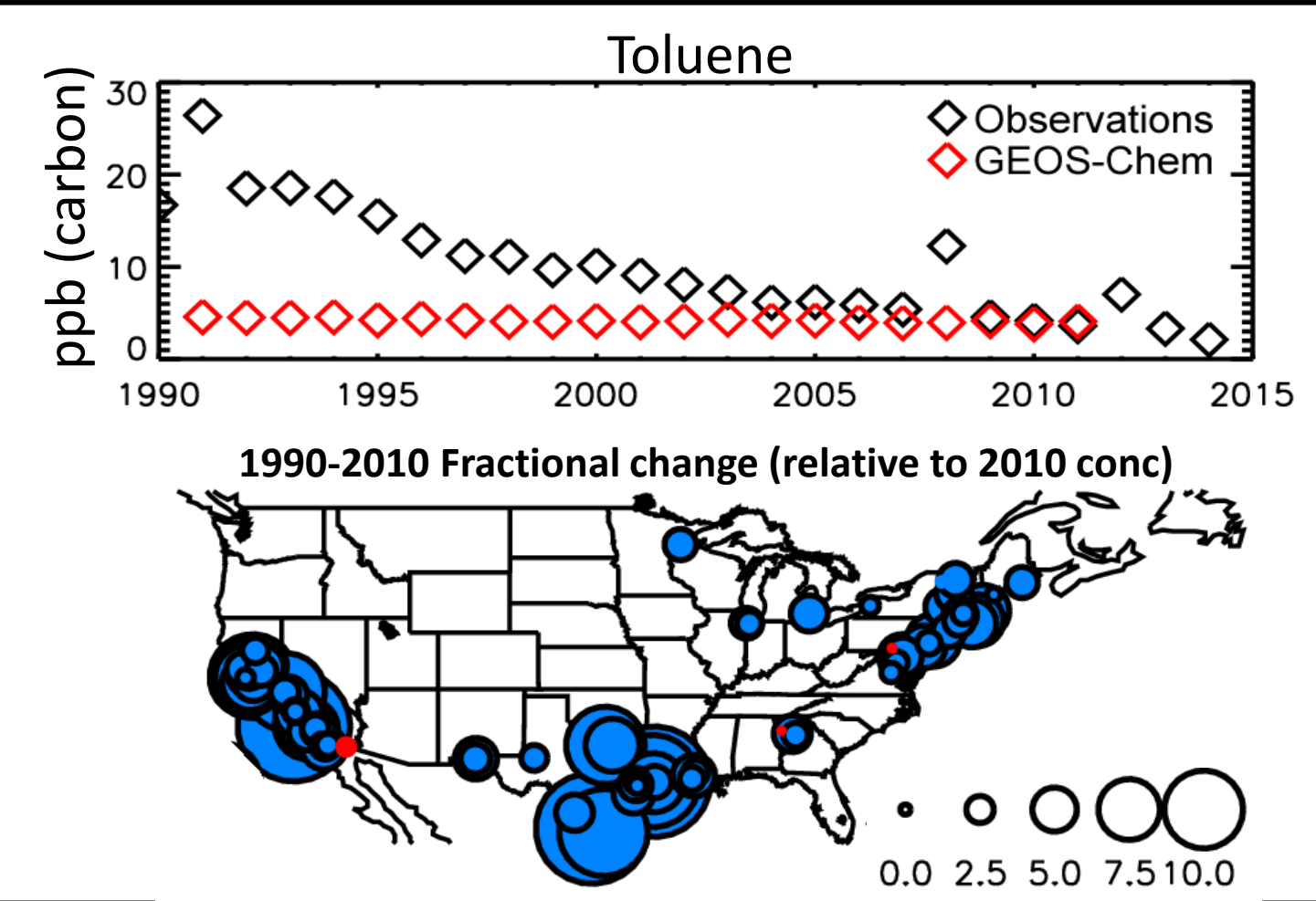


Summer



- Decreases of up to 50% across all regions
- Trends present but less clear in summer
- Model doesn't capture full OA trend

Lack of trend in aromatics in model

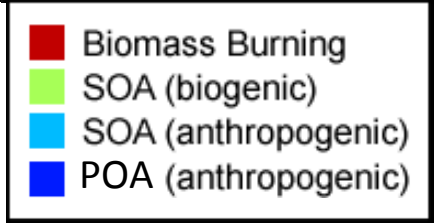
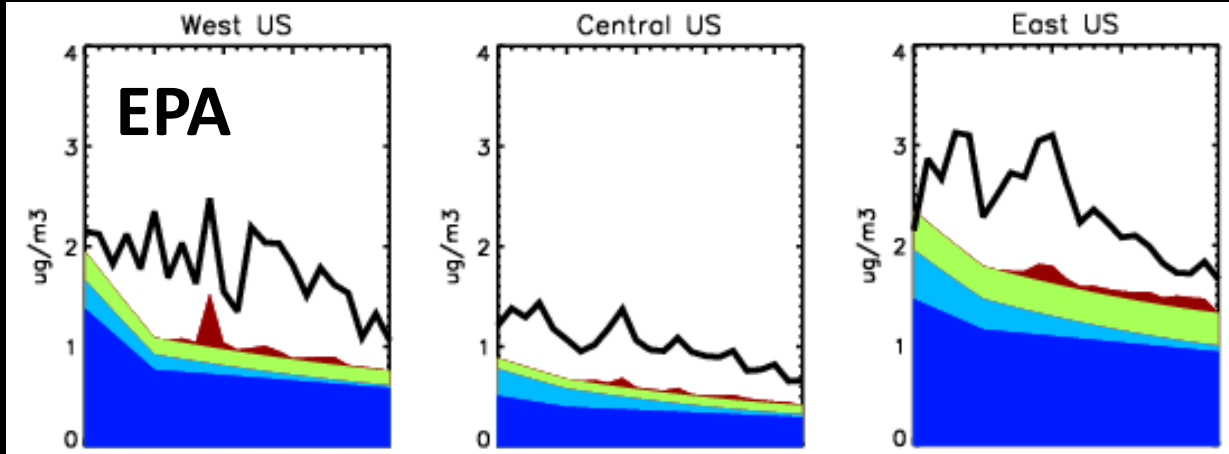


- GEOS-Chem anthropogenic VOCs 5x too low in 1990
- Implement a scaling for past emissions (from RETRO)

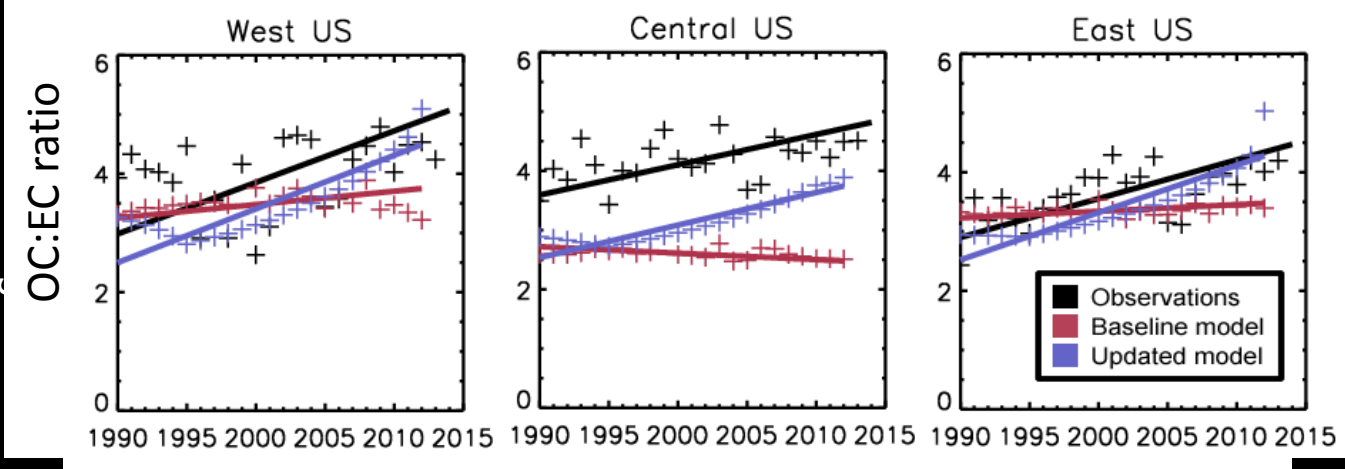
BOND vs EPA emissions of organic aerosol (OA)

OA

Winter

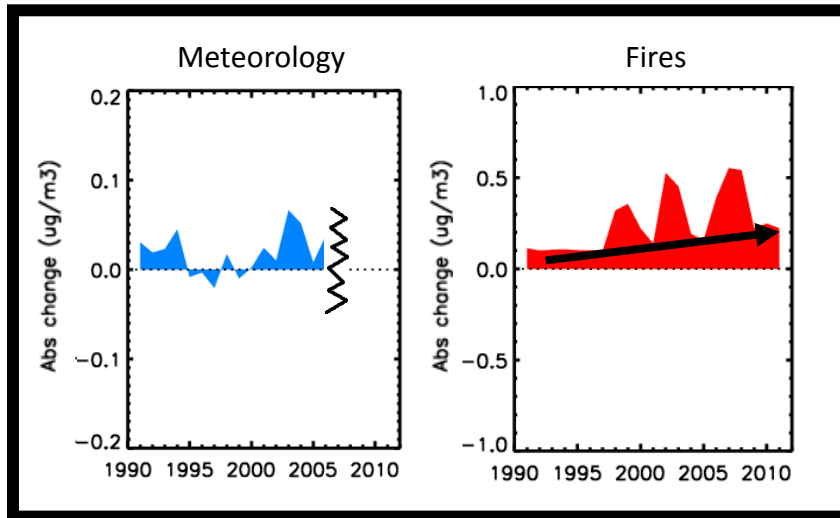


OC:EC trend

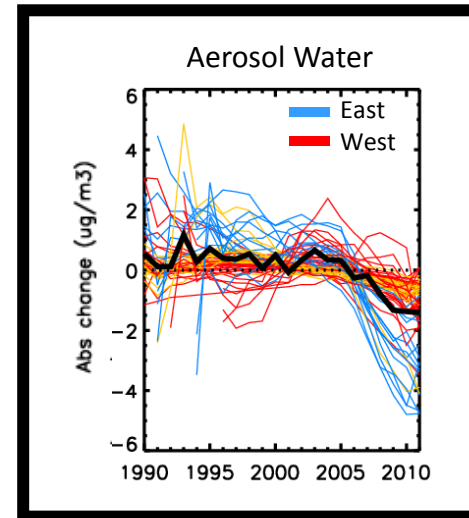


- EPA emissions and increased VOCs provide better agreement
- Model still low relative to observations... aging?
- OC:EC trend improved dramatically in model

Other contributions to trends in OA...



Model-based



Observation-based

- No clear trend in OA from meteorology (so far)
- Biomass burning trend is positive – wrong direction!
- Declining inorganics → change in aerosol water → SOA change??

Conclusions

- **Decline in carbonaceous aerosol of 30-50% in US since 1990**
 - **New EPA database indicates emissions are primary cause**
 - **BC decline driven by vehicular emission controls**
 - **OA decline likely a combination of VOC and emission controls**
- **Changes in meteorology and fires have limited impact**
- **Aerosol water changes may contribute to trend**
- **SOA aging complicates the picture!**

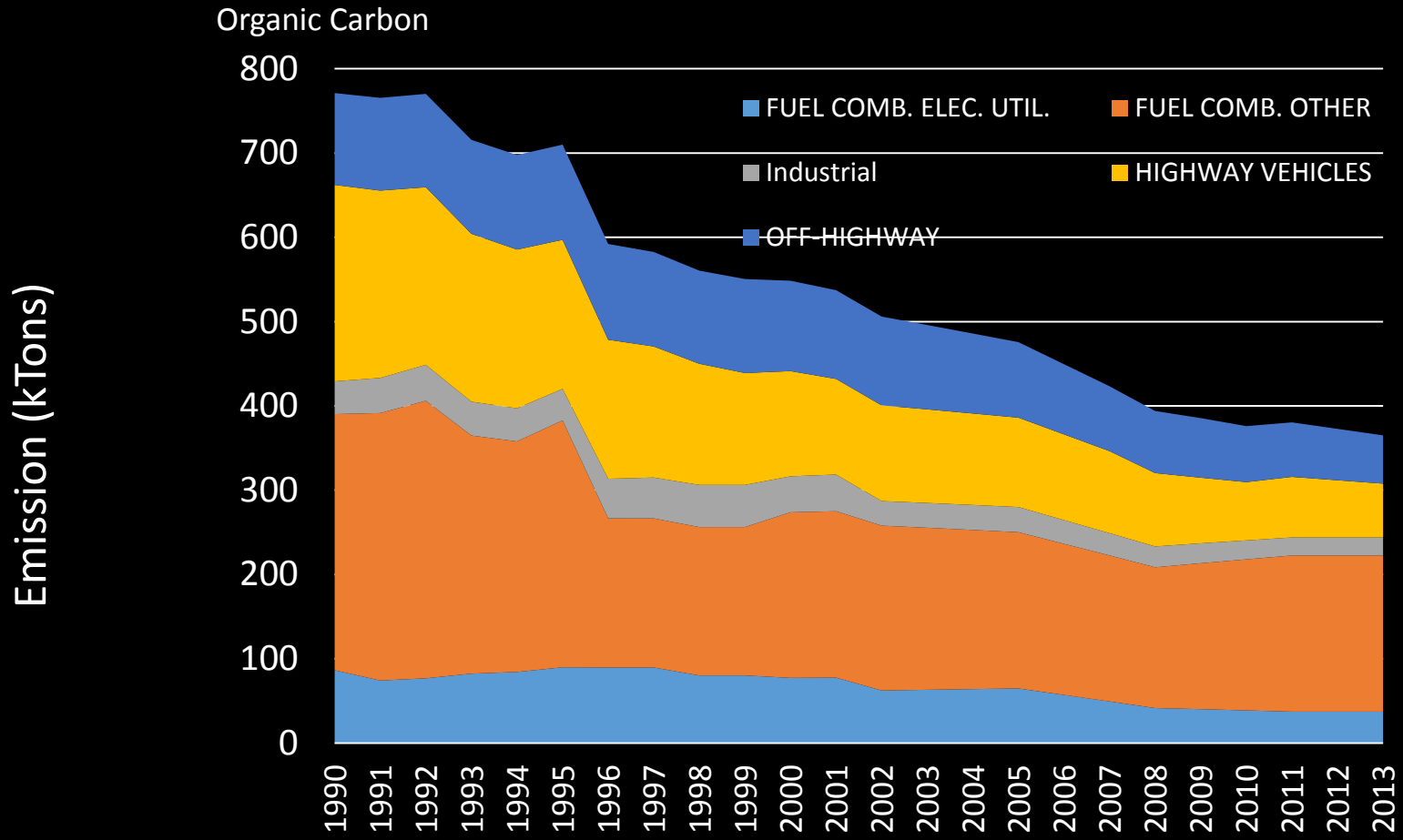
Thank you



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EPA emission



- EPA emissions suggest strong decline in vehicular emissions