

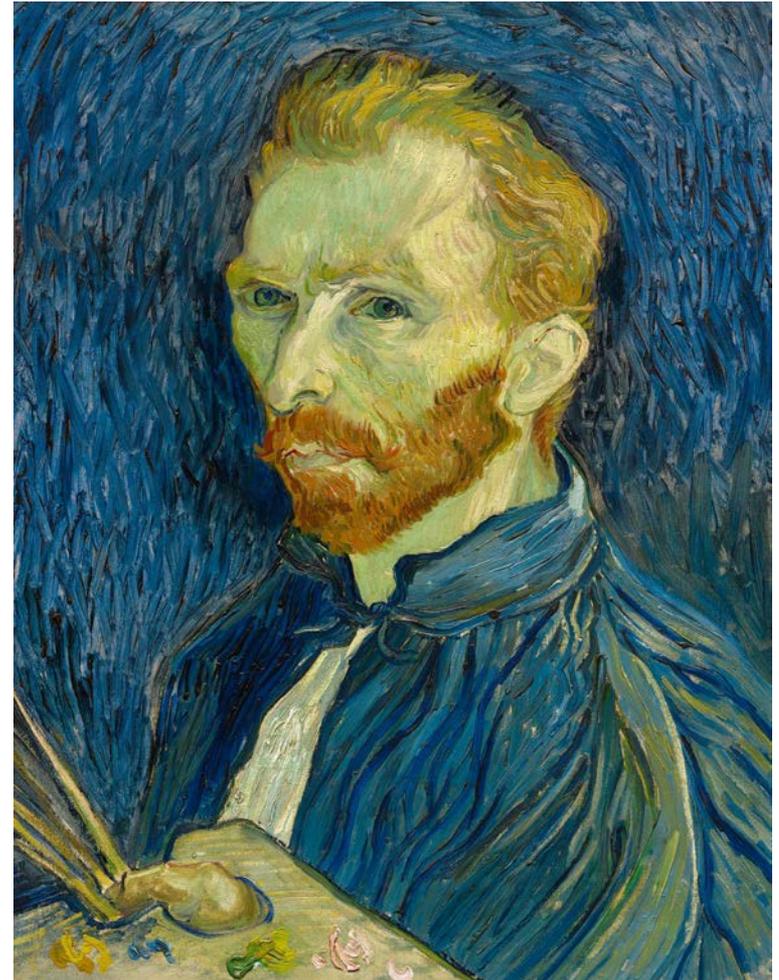
Constraining a Historical Black Carbon Emission Inventory of the United States for 1960-2000

Tianye Sun, Liang Liu, Tami C Bond, Mark Flanner, Thomas W.
Kirchstetter, Chaoyi Jiao, Chelsea V. Preble, Wayne Chang



Estimated emission

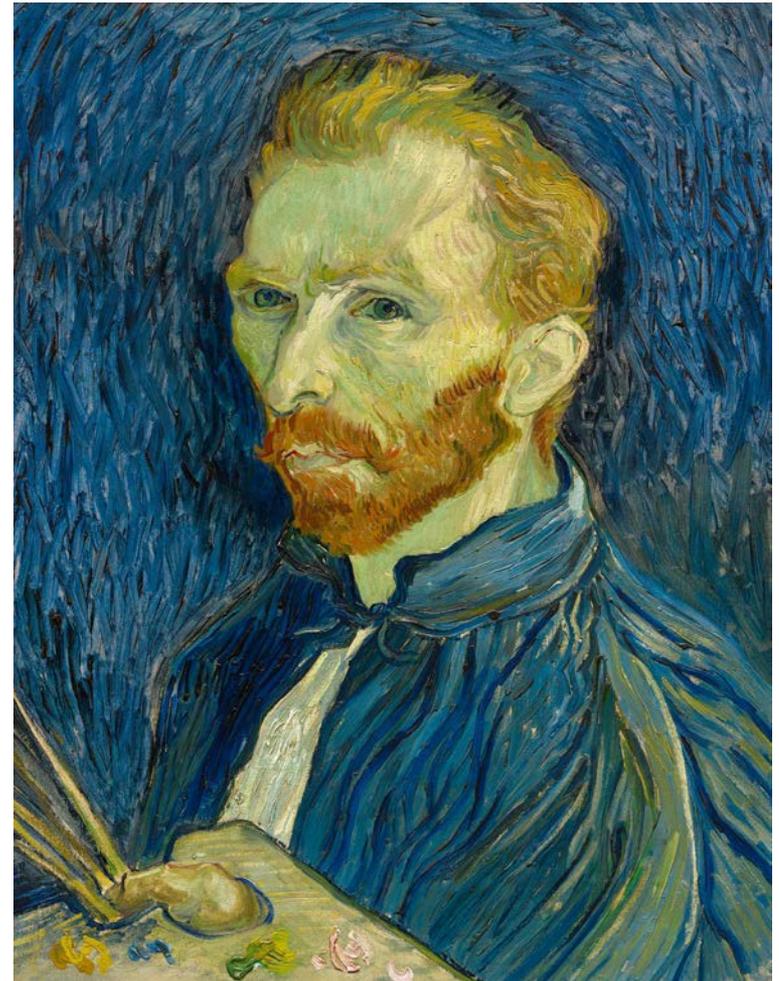
True emission



Estimated emission



True emission



Estimated emission



Estimated emission

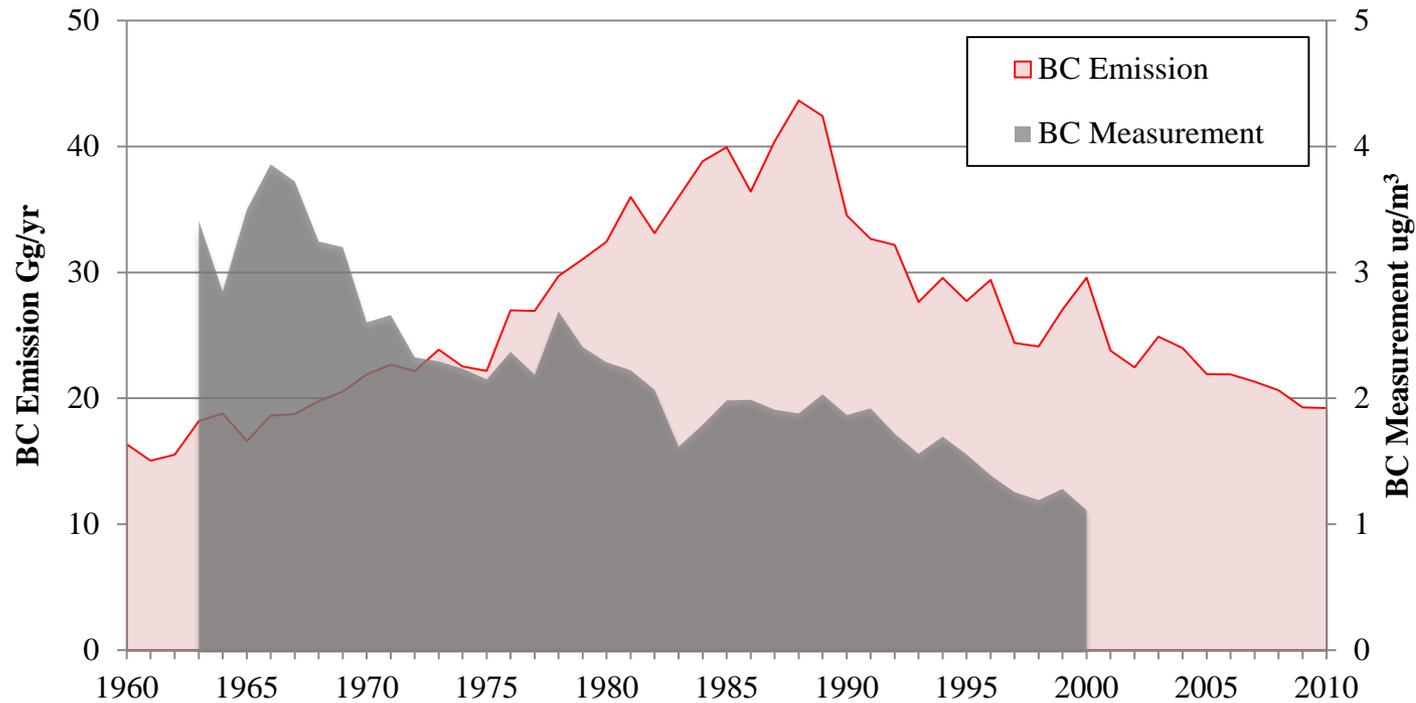


Observed concentration





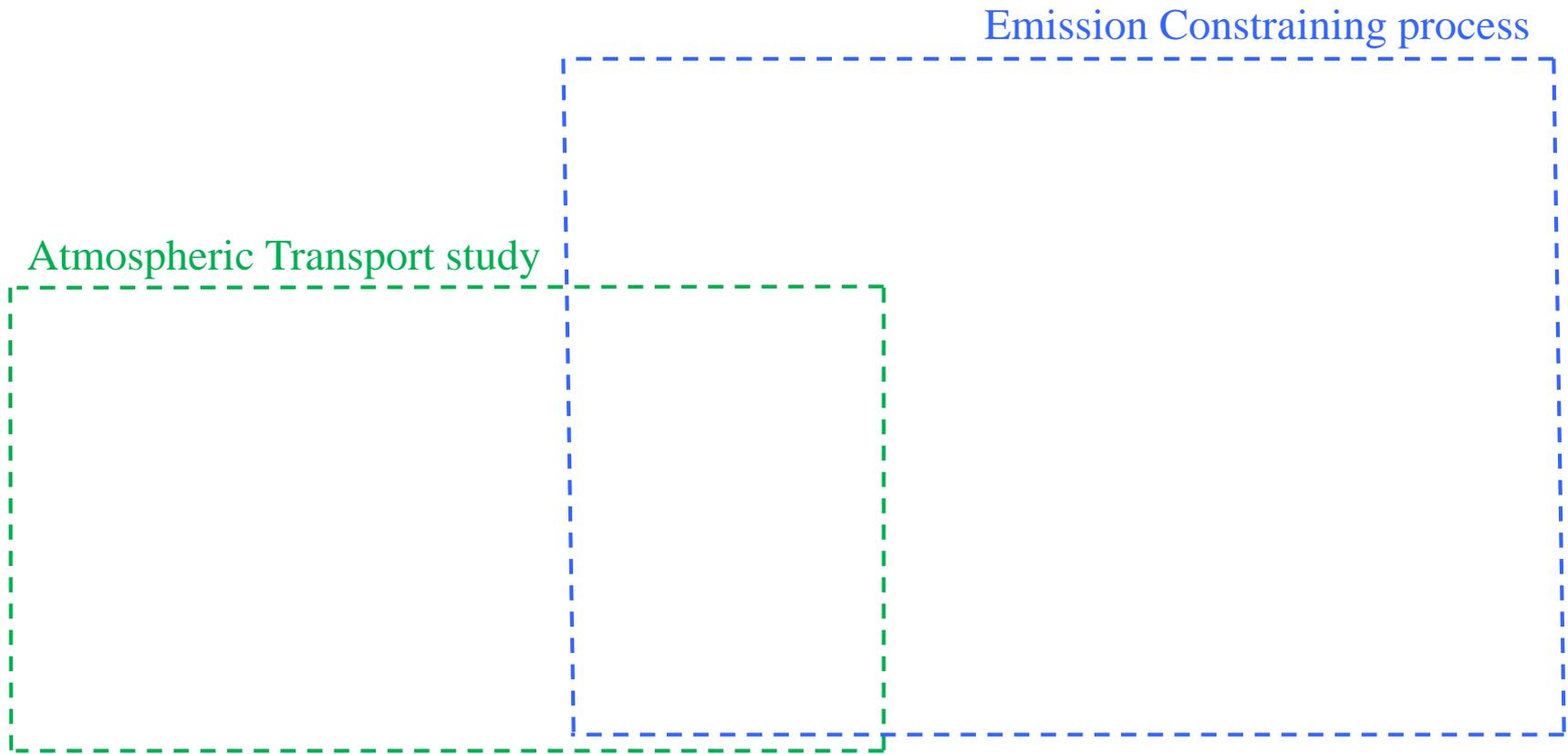
Motivation: Why Constrain BC Emission?



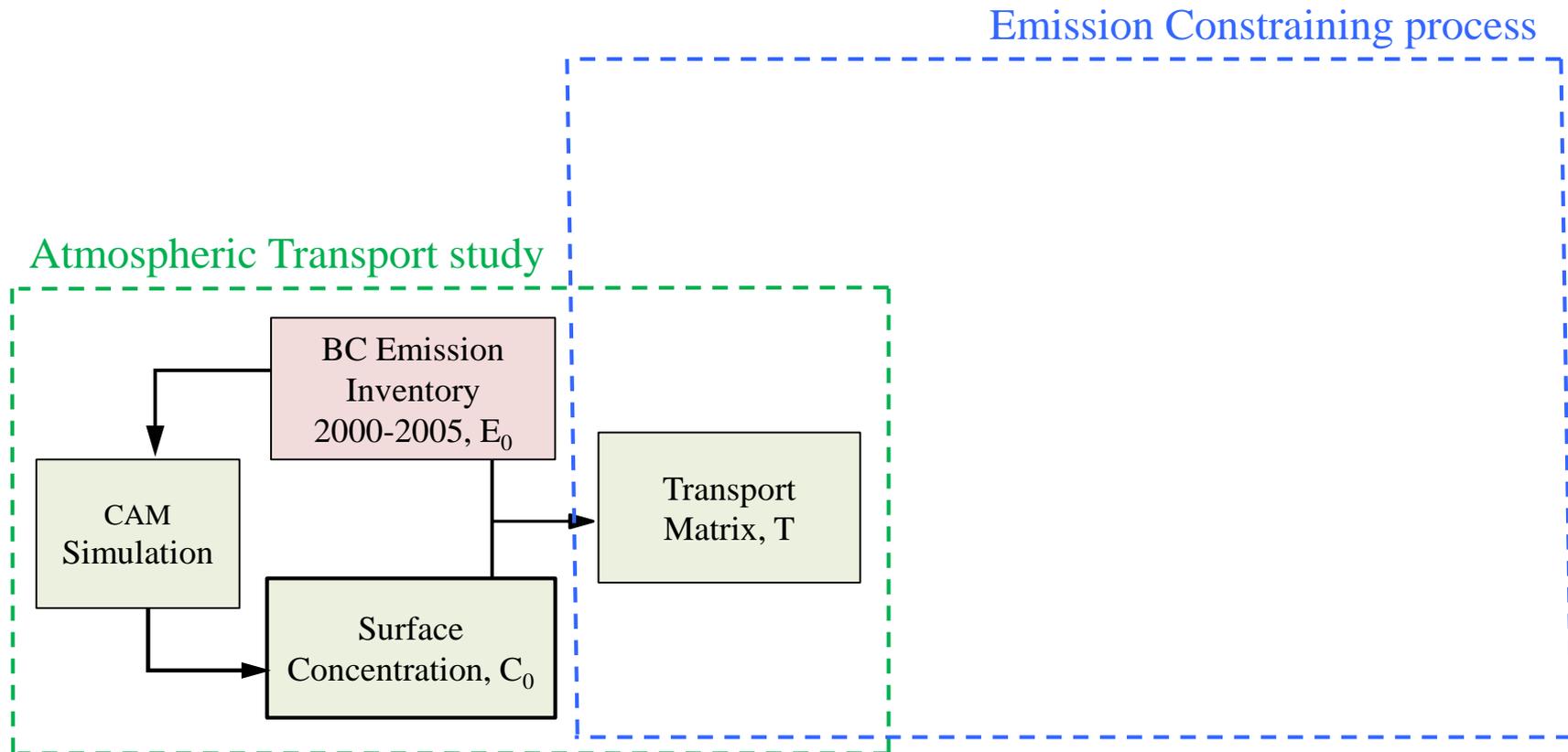
BC Emission and concentration of California

- Mismatch of the trend between long-term BC emission inventory and ambient air concentration.
- Decreasing trend is observed from measurement but not in emission inventory (peaks in 1980s).

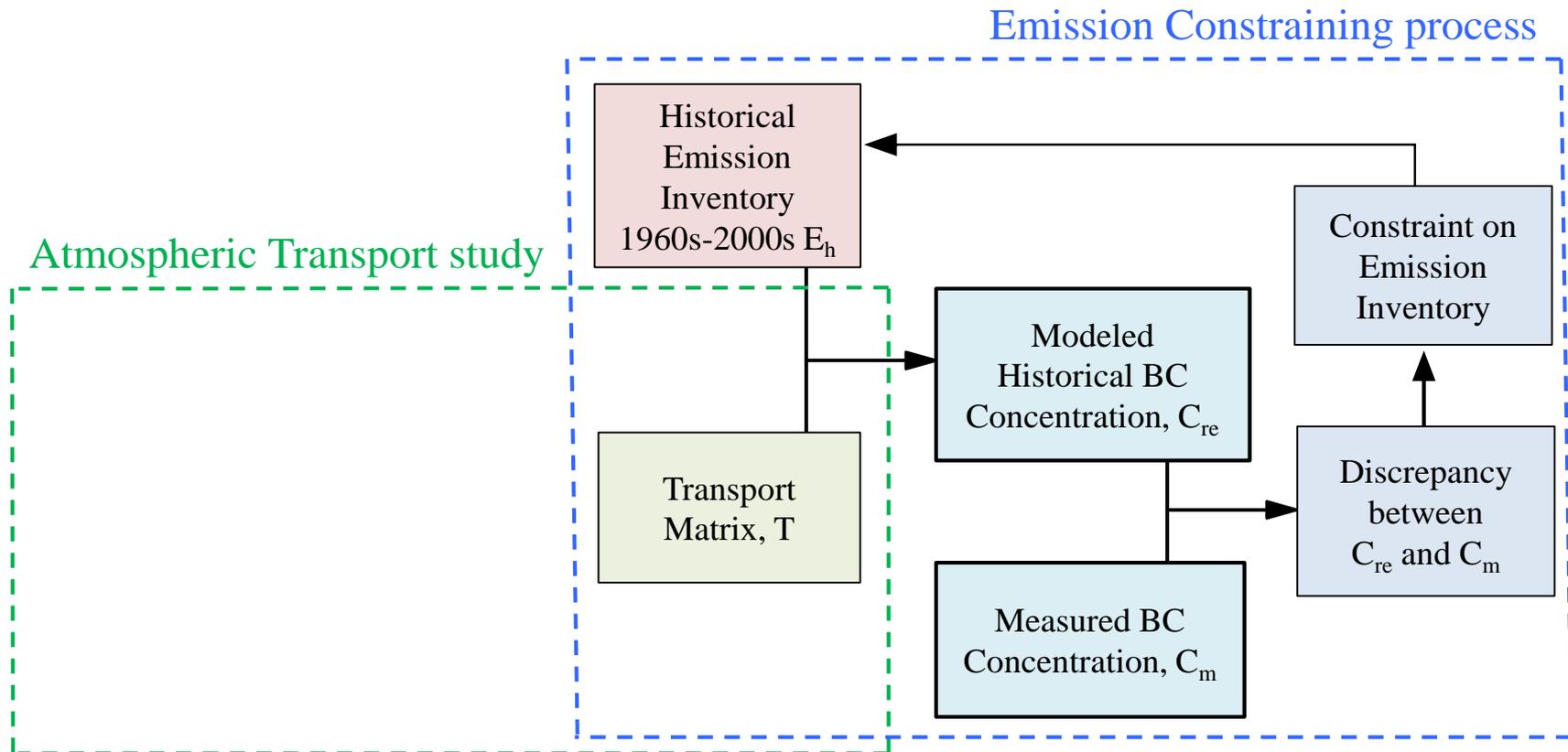
Method: How to Constrain BC Emission?



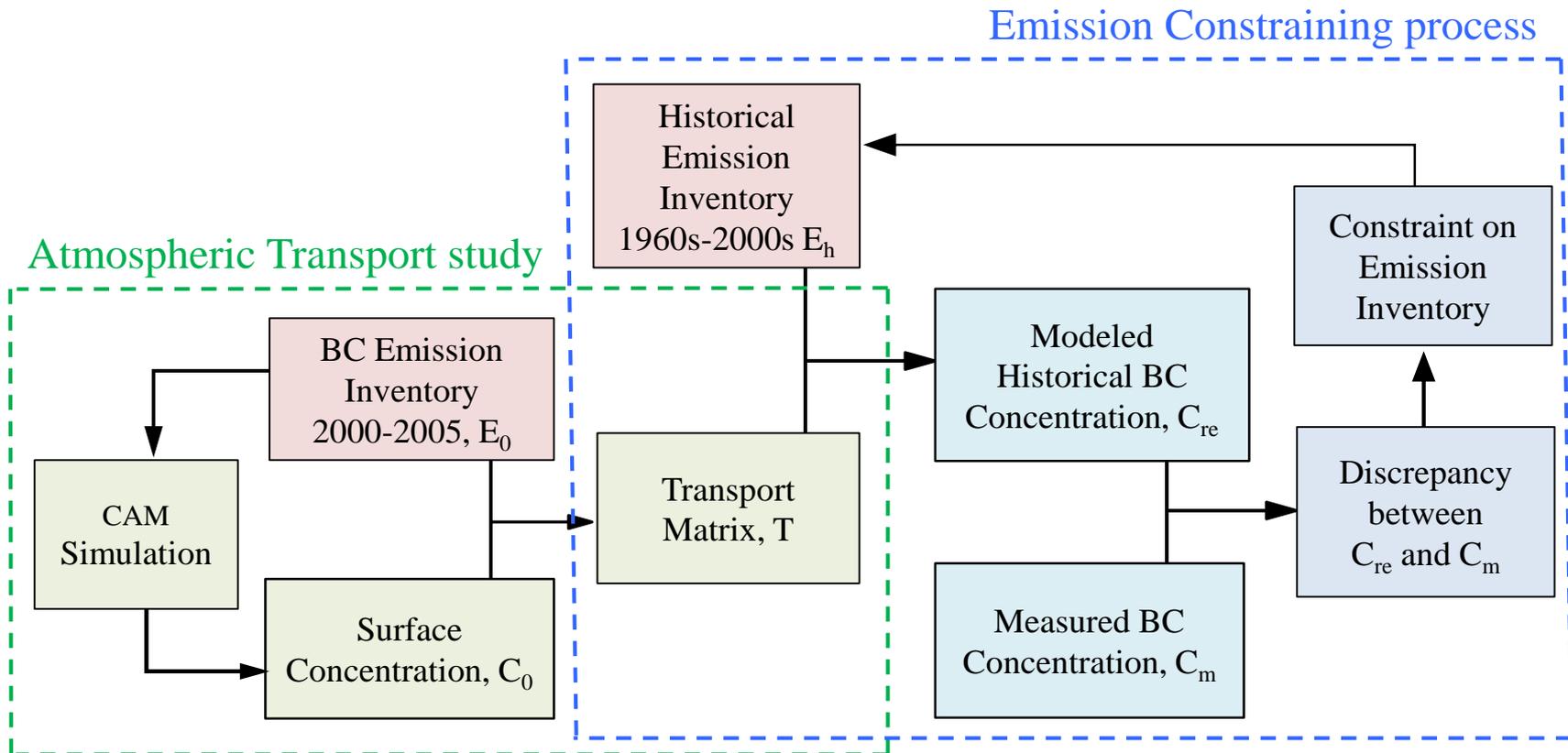
Method: How to Constrain BC Emission?



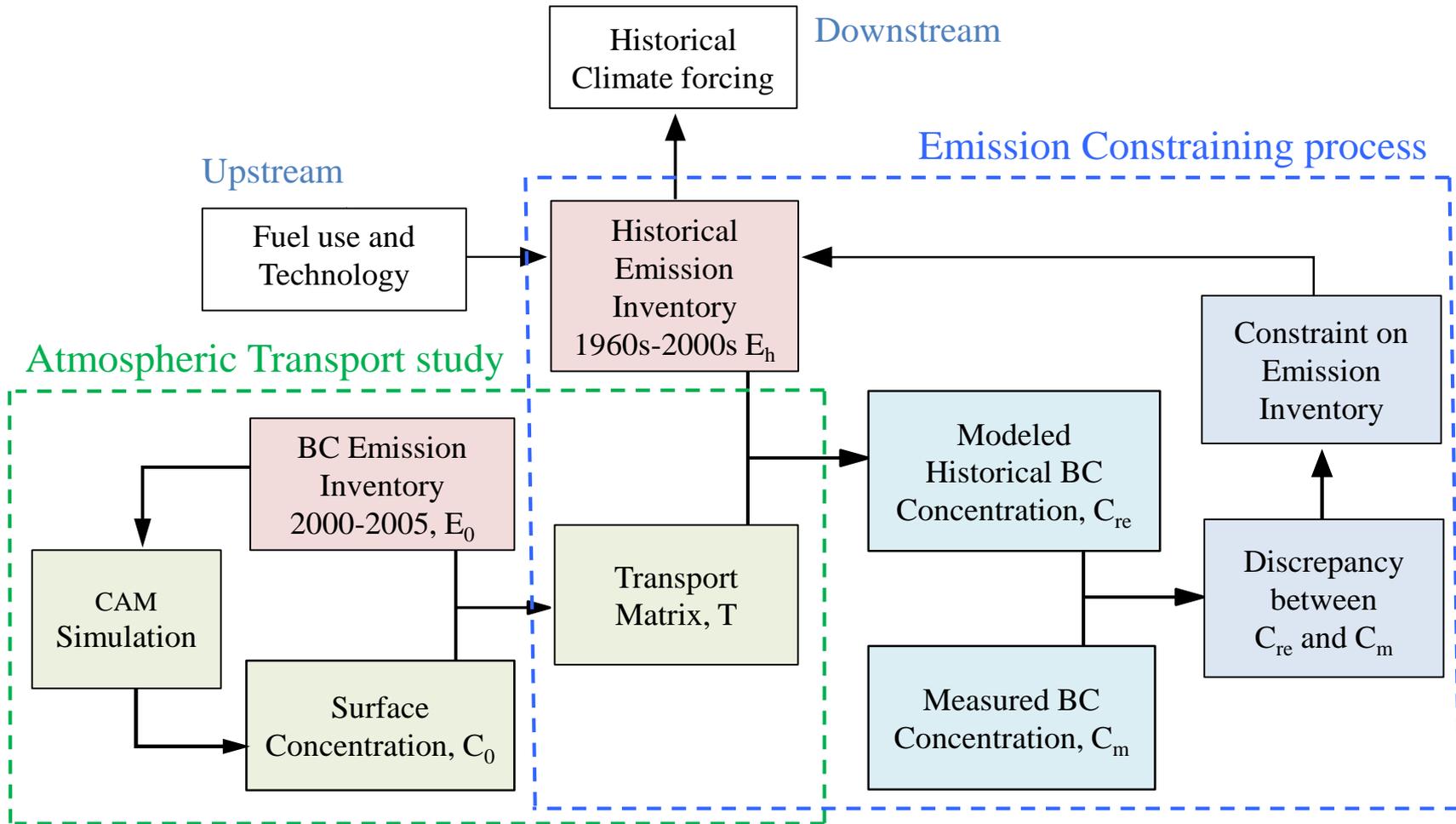
Method: How to Constrain BC Emission?



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Method: How to Constrain BC Emission?



BC Emission Inventory:

- Emission inventory of Bond et al. [2007] with updates as described Lamarque et al. [2010]

New in this work:

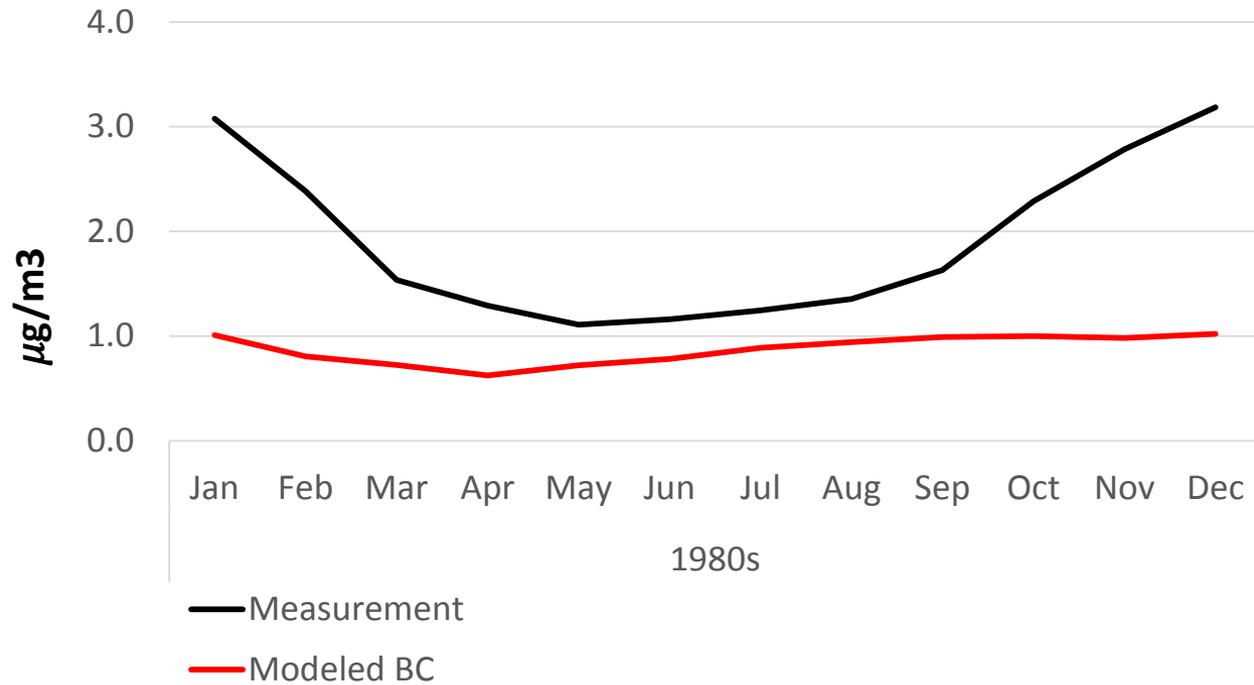
- US EIA 2010 state level activity data
- SPEW-Trend vehicle fleet model for vehicle emission

BC Measurement data

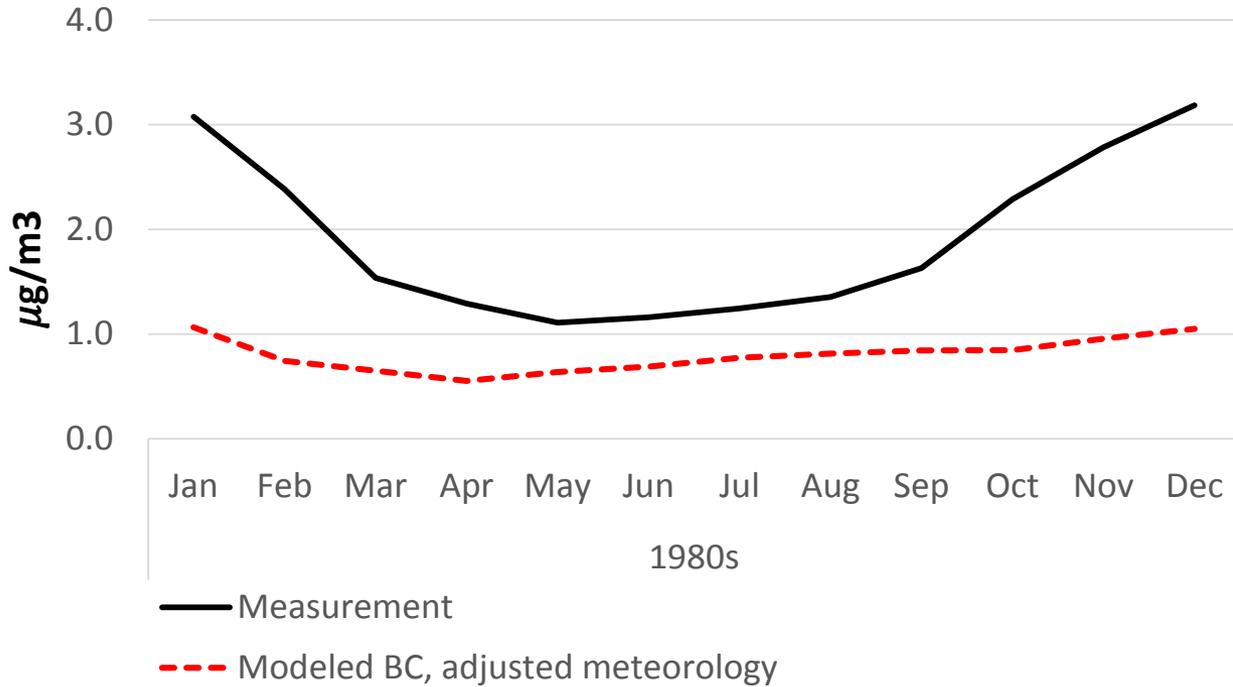
- BC concentrations are estimated from coefficient of haze (COH) data.
- Data are available for California and New Jersey for 1960-2005, for other seven states during 1965 – 1980.

Data acquired from the *California Air Resources Board (CARB)*, the *New Jersey Department of Environmental Protection (NJDEP)*, and the *Environmental Protection Agency's Air Quality System*.

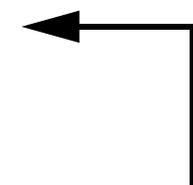
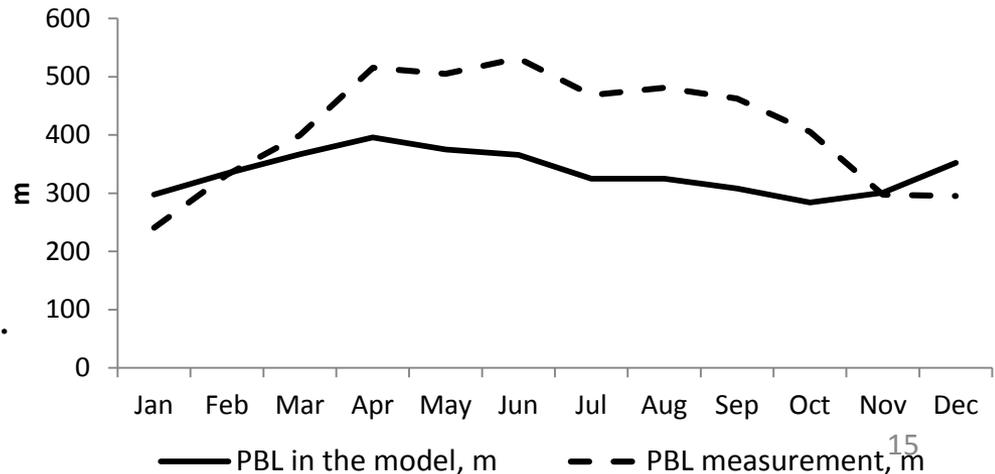
Modeled BC Concentration and Measured BC Concentration of California for 1980s



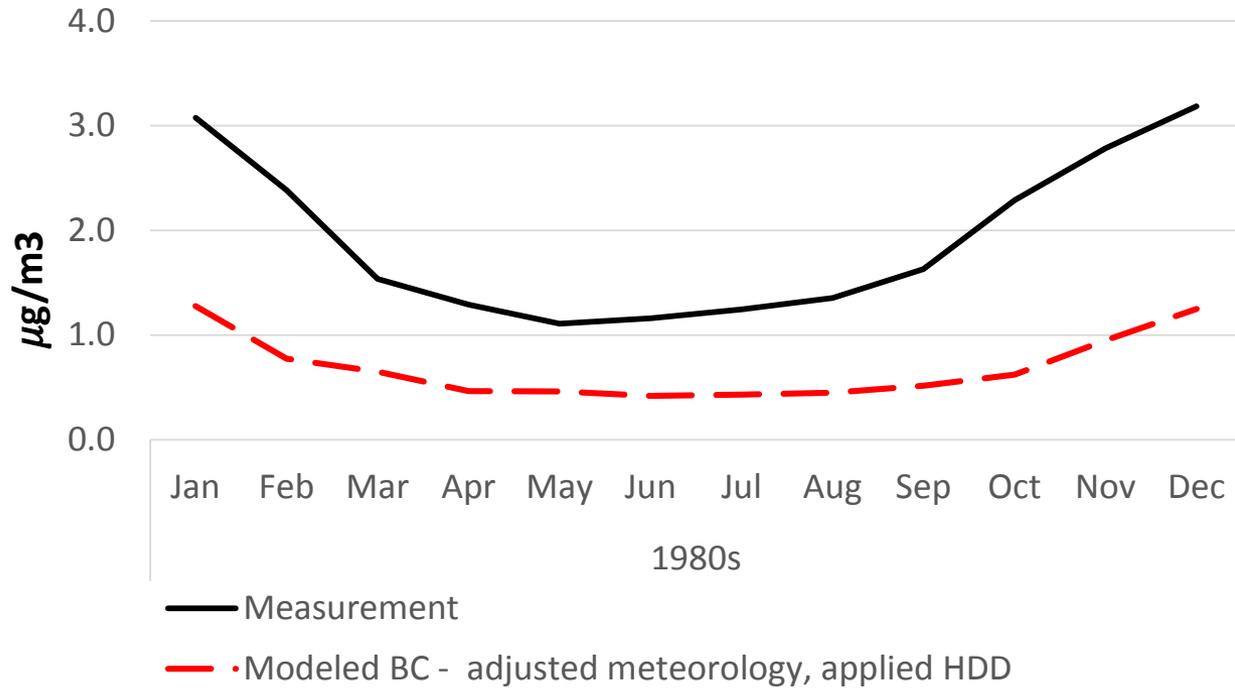
Adjust Modeled BC Concentration to Account for Error in Model Meteorology



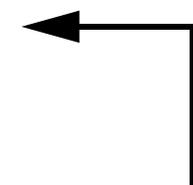
Planetary Boundary Layer for Bay Area.
 Model vs. Measurement
 (Data from MERRA, NASA)



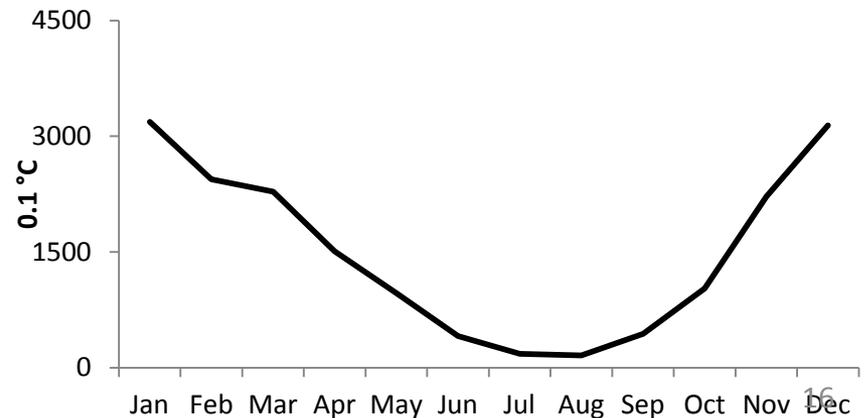
Apply Heating Degree Days to Construct Seasonality of Emission in 1980s



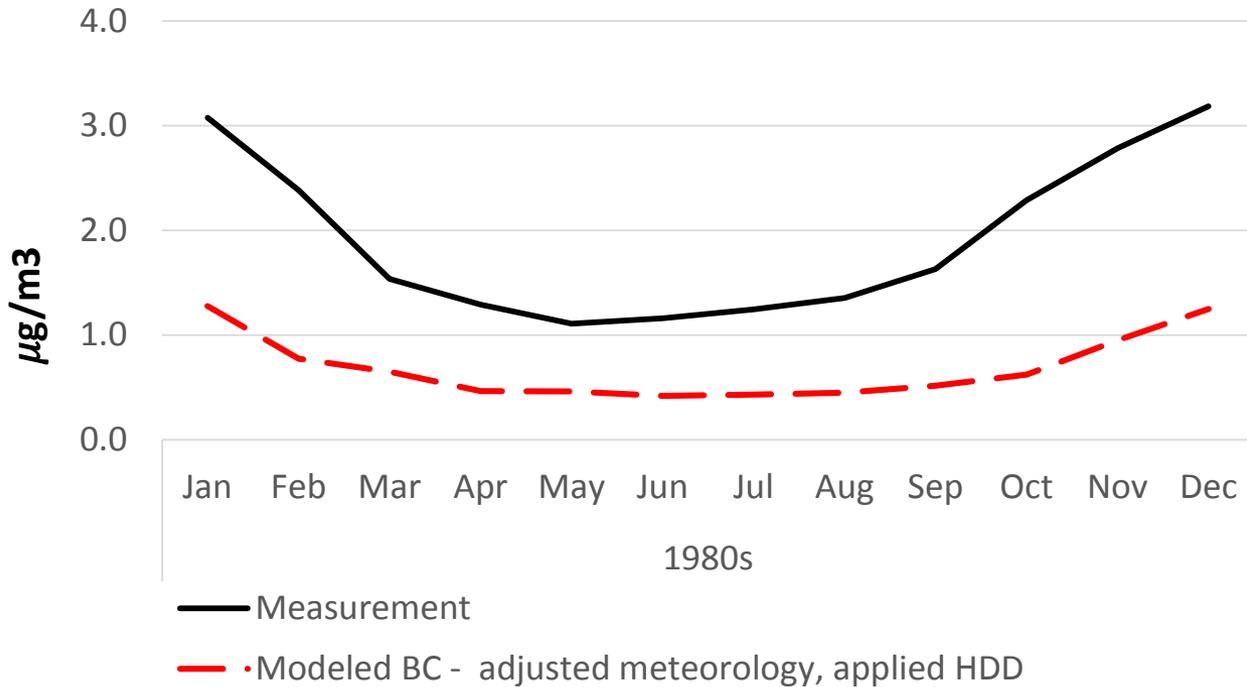
Use historical seasonal temperature record (heating degree days, HDD) to calculate seasonality of emissions



Heating degree days for California, 1980s
(Data from NOAA)

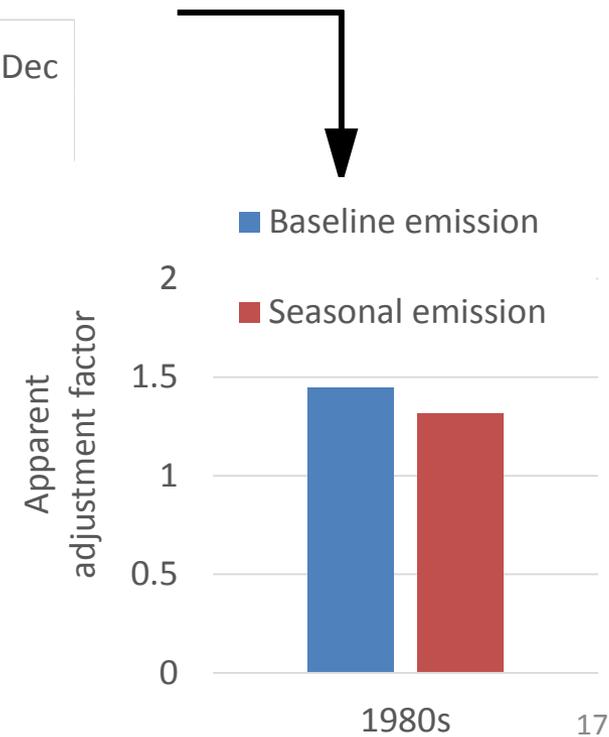


Adjust BC Emission with the remaining discrepancy with measurement for 1980s



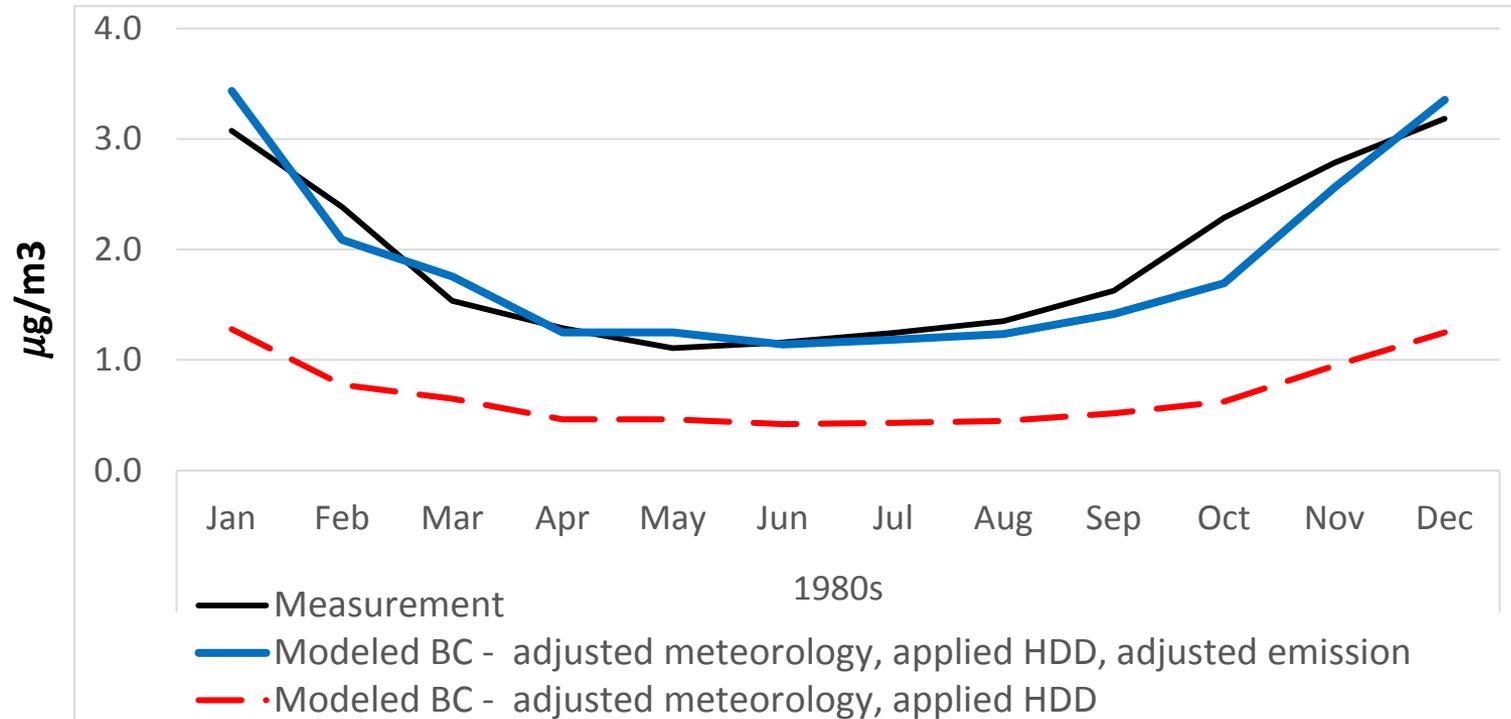
Seasonal emission is zero in summer (heating emission)

Concentration is proportional to emission.

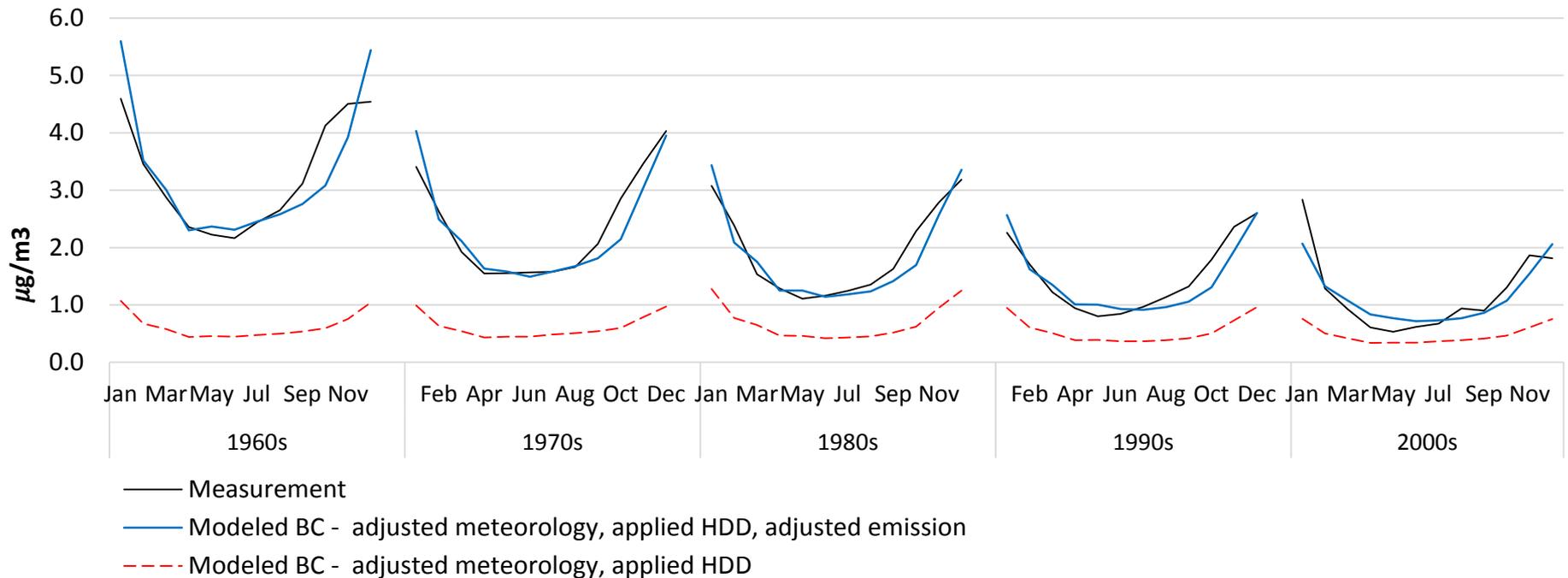


Emission adjustment factor for California BC in 1980s

Modeled Concentration from Adjusted BC Emissions for 1980s

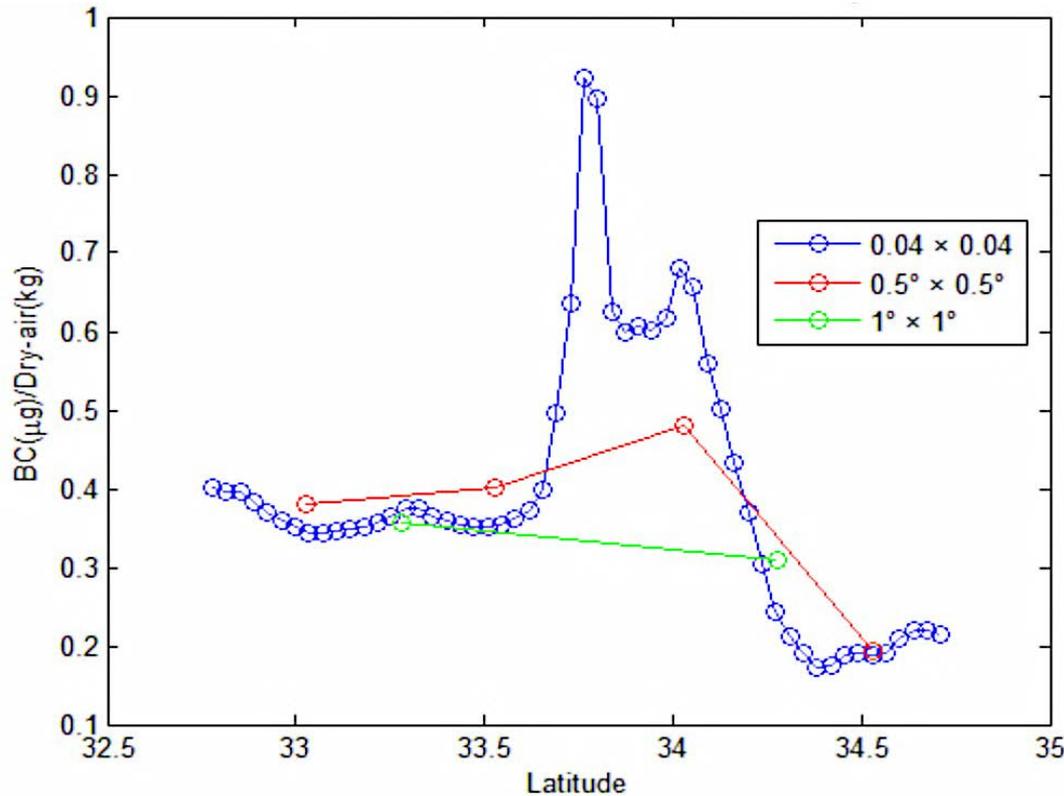


Modeled BC Concentration and Measured BC Concentration of California for 1960s- 2000s



- Decreasing trend is observed from BC measurement for 1960s -2000s, but not in emission inventory (peaks in 1980s).
- Adjusted BC emission shows an overestimation of seasonality for 1960s
- Heating Degree Days can explain most of the trend in seasonal variation of the BC measurement.

Spatial Heterogeneity in Model-Measurement Comparison



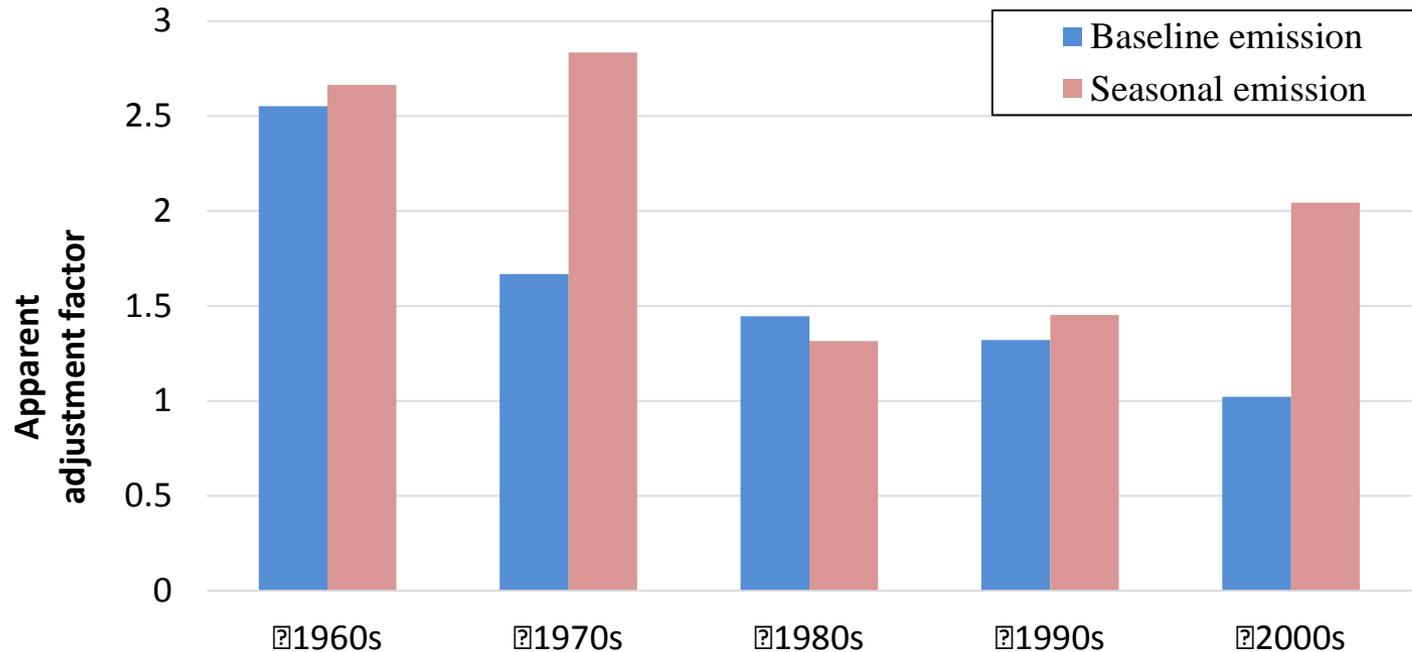
BC concentration in different resolution could be vary by a factor of two.

Emission adjustment is divided by a factor of two to account for this resolution uncertainty.

Trend is more instructive than the absolute magnitude since the measurement and the model are in different resolution

Comparison of BC concentration distribution modeled for Los Angeles with three different resolutions

Adjustment factor for Baseline Emission and Seasonal Emission for 1960s to 2000s



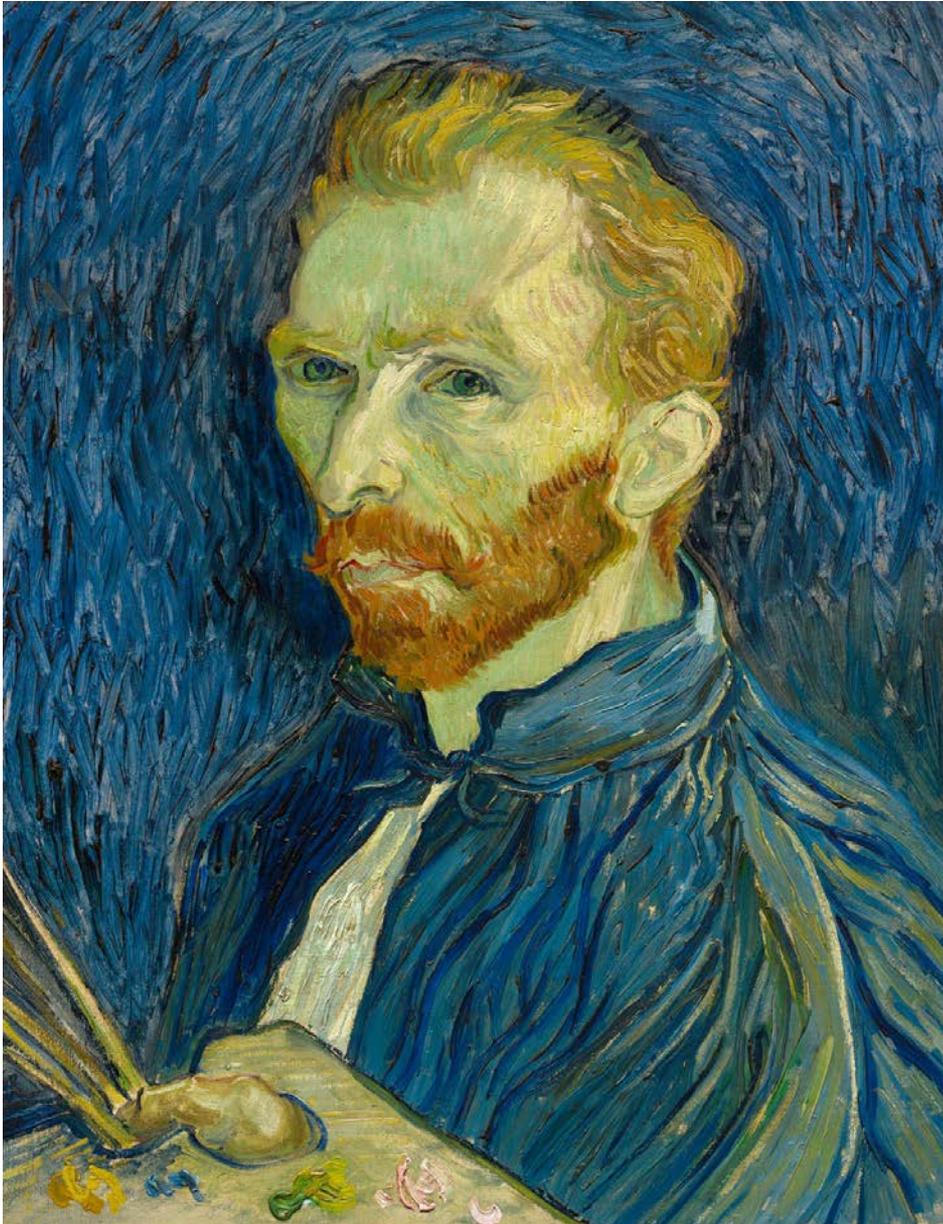
- Adjustment factors for baseline emission decrease through the study period. Emissions need a 2.5-fold increase in the 1960s.
- Adjustment factors for seasonal emission are large in 1960s, 1970s, and 2000s, and relatively small in 1980s.

Conclusion

1. Decreasing trend is observed from BC measurement for 1960s -2000s, but not in emission inventory (peaks in 1980s).
2. Heating Degree Days can explain most of the trend in seasonal variation of the BC measurement.
3. To reproduce the decreasing trend, higher emission factors are needed for 1960s to 1970s.

Future Work

1. Multi states measurements can be used as orthogonal basis to constrain historical emission from different fuel-technology sources via transport matrices.



Vincent van Gogh (Dutch, 1853 – 1890) Self-Portrait, 1889