



BAY AREA  
AIR QUALITY  
MANAGEMENT  
DISTRICT

# **Black Carbon (BC): Adverse Impacts on Global Climate and Local Health**

Summary of 2013  
Advisory Council Efforts

Presented to the  
Board of Directors  
December 18, 2013



# Executive Summary: Black Carbon (BC)

1. BC is an important climate warming pollutant with a short atmospheric lifetime
2. BC results in many adverse health effects
3. Primary sources of BC are diesel and wood smoke
4. Comprehensive climate protection requires reducing BC, in addition to CO<sub>2</sub>, methane, and other GHGs
5. BC should be incorporated into climate planning, with a climate-change point-person on staff
6. Climate protection strategies should capitalize on health co-benefits and require consideration of unintended health and climate consequences



# A Three-Year Effort: Ultrafine- & BC-Particles

**2011**: Ultrafine Particulate (UFP) sources & health effects

**2012**: UFP exposure assessment & reduction

**2013**: Black Carbon (BC)

## **Air and Climate Pollutant**

- S. Rizk, US EPA (national perspective)
- B. Croes, Calif. ARB (state perspective)

## **Measurement, Modeling, Exposure & Mitigation**

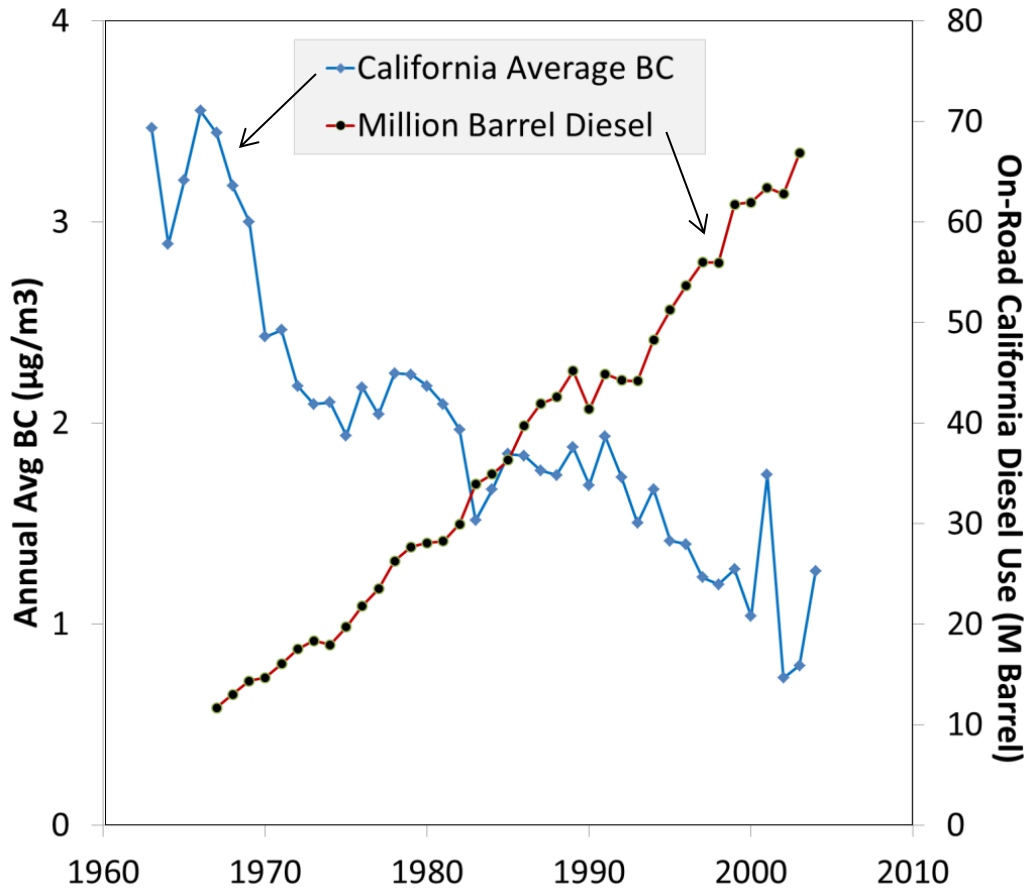
- V. Ramanathan, UC San Diego (exposure & mitigation)
- R. Harley, UC Berkeley (measurement & modeling)

## **Climate & Health Effects**

- M. Kleinman, UC Irvine (health effects)
- L. Rudolph, Public Health Institute (climate change)



# BC Definition and CA Emissions



Source: Kirchstetter et al. (2011) Black Carbon and the Regional Climate of California, CARB Contract No. 08-323

- BC aerosol is elemental carbon, highly absorbing of sunlight, and a constituent of  $\text{PM}_{2.5}$
- Primary source: diesel combustion
- Other sources:
  - biomass (wood) burning
  - lube oil burning
  - char broiling



# Direct Health Effects of BC

- Due to its small size, BC:
  - disrupts pulmonary, cardiovascular, and neurological functions
  - causes cellular damage elsewhere in the body
- Is BC directly toxic or does it carry toxic semi-volatile chemicals on its surface? Recent work shows:
  - Both BC and attached semi-volatiles contribute to adverse health effects
  - But semi-volatiles appear linked to the most serious inflammatory health effects (i.e., arterial plaque build-up and reduced heart rate variability)



# BC as a Climate Pollutant

BC is a Short-Lived Climate Pollutant (SLCP\*)  
with warming effects

- BC particles heat atmosphere by absorbing sunlight and heat from the earth, but settle out of the atmosphere in days/weeks (vs. 100+ years for CO<sub>2</sub>)
- BC deposition onto ice- and snow-pack accelerates melting

\*Other SLCPs: brown carbon, methane, and some hydrofluorocarbons

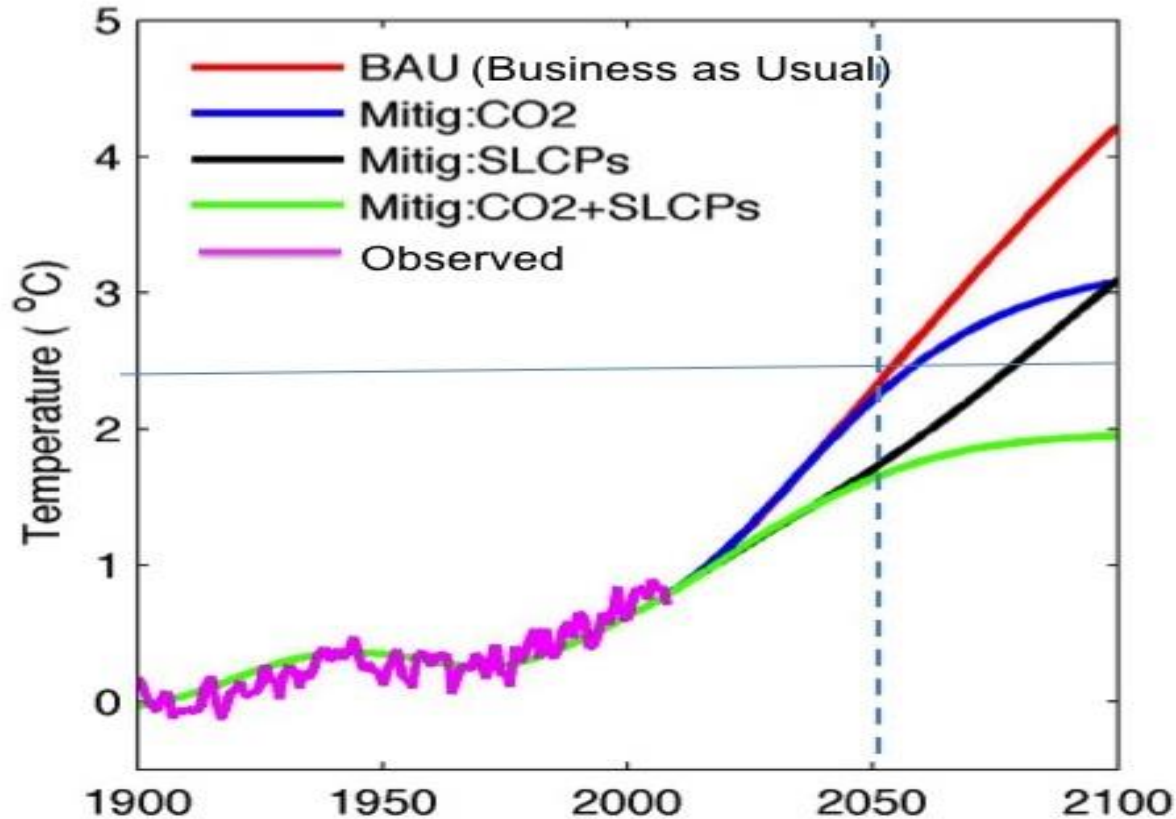


# BC's Relative Role in Global Warming

- BC's short atmospheric lifetime and its aerosol composition make comparison with GHG-induced climate impacts challenging
- Current analysis shows that:
  - BC and methane trail only CO<sub>2</sub> as warming agents
  - BC contributes ~20% of all warming



# Climate Protection Requires Control of Long-Lived Climate Pollutants & SLCPs



- Projections show that mitigating both CO<sub>2</sub> & all SLCPs (green line) could avoid about half the “business as usual” warming (red line) by 2050





# BC Influences on Climate Change

- BC-control (due to its short atmospheric lifetime) offers an effective way to reduce projected global warming and its adverse impacts over the next decades, e.g.,
  - Slowed sea-level rise (by an estimated 30% by 2050)
  - Delayed tipping-point events (e.g., ice cap elimination)
- Often co-emitted with BC is Brown Carbon (BrC), which also has adverse health effects and may warm the climate, but uncertainties about both impacts remain



# Health Effects of Climate Change

- Climate change is expected to result in costly health effects, including increases in:
  - Heat-related illness and death
  - Asthma, allergies, and other respiratory disease
  - Cardiovascular disease
  - Vector-, water- and food-borne disease
  - Other infectious disease (e.g., valley fever)
  - Mental health disorders
  - Malnutrition and food insecurity
- Health effects will disproportionately impact already vulnerable populations



# Co-Beneficial Climate & Health Strategies

- AB 32s GHG emission reduction strategies should:
  - Reduce GHGs to 1990 levels by 2020
  - Reduce emissions of PM by 1% and NO<sub>x</sub> by 15% by 2030
- Increases in modeled active-transportation mode-share from 4 up to 15 min/day results in:
  - Increased life expectancy
  - Reduced heart disease, stroke, and diabetes
  - Reduced health costs
  - Reduced GHG emissions



# Potential Unintended Consequences of Climate Protection Policies

- Co-locating housing & transit (i.e., SB 375)
  - Improves regional pollution and may increase physical activity
  - But it increases exposure to traffic-related pollutants and could increase bike/pedestrian injuries
- Encouraging active-transport on Spare the Air Days
  - Improves regional pollution and increases physical activity
  - But it may increase exposure to unhealthy air
- Tighter buildings with reduced air-exchanges
  - Will increase energy efficiency and battle climate change
  - But it may worsen indoor air exposures, especially with increased time indoors
- Strategies for mitigating one air contaminant may increase climate and/or health impacts from another



# 2013 Recommendations

1. The Bay Area Regional Climate Protection Strategy should:
  - Incorporate SLCPs, especially BC and methane, throughout
  - Include a robust emissions inventory for SLCPs
  - Include strategies for climate protection and evaluate their potential for health co-benefits and unintended consequences
  - Identify vulnerable populations
  - Identify adaptation strategies
2. Designate an Air District Climate Protection point-person on staff to lead these efforts
3. The AC should provide expertise during Climate Protection Strategy development



# Thank you!

- We appreciate your time and interest
- Questions or comments?



## 2011 AC recommendations: incorporated or being addressed

- Establish UFP monitors near traffic sources, especially in highly-impacted communities, e.g.,
  - West Oakland Port area
  - Downtown San Jose
- Track research on UFP health effects
- Develop UFP emissions-inventory, including from motor-vehicles with all fuel-types
- Track research on UFP growth, from emission to 100 meters from freeway edges
- Designate a Health Officer



## 2012 AC recommendations: incorporated or being addressed

- Integrate UFP activities with  $PM_{2.5}$  efforts
- Assess effective and energy efficient HVAC filtration systems to mitigate UFP exposure; focus on schools, sensitive receptors, commuters, and near-highway populations
- Track research of indoor-UFP: exposures, health effects, and interactions with outdoor sources





# Advisory Council

## Future Areas of Investigation

### 2014 Charge from Board

- Explore Bay Area energy future, as part of District's Climate Protection Strategy, to evaluate air quality, health, and climate impacts
- AC reported on the status of this topic in 2009

### Potential Future Topics

- Indoor air quality
- Emergency response
- Cumulative impacts
- Noise as an air pollutant
- Naturally occurring air contaminants (e.g., pollen)