# The Direct Health Effects of Temperature Increases in California

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# OEHHA Projects

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# Impacts of Climate Change

- **Climate Change Models for California Predict Higher Average Temperatures and More Heat Waves**
- **Included among the expected health effects are:**
  1. **Indirect effects on cardiovascular disease through changes in air pollution**
  2. **Direct impacts on cardiovascular and other diseases through heat-related thermal stress**

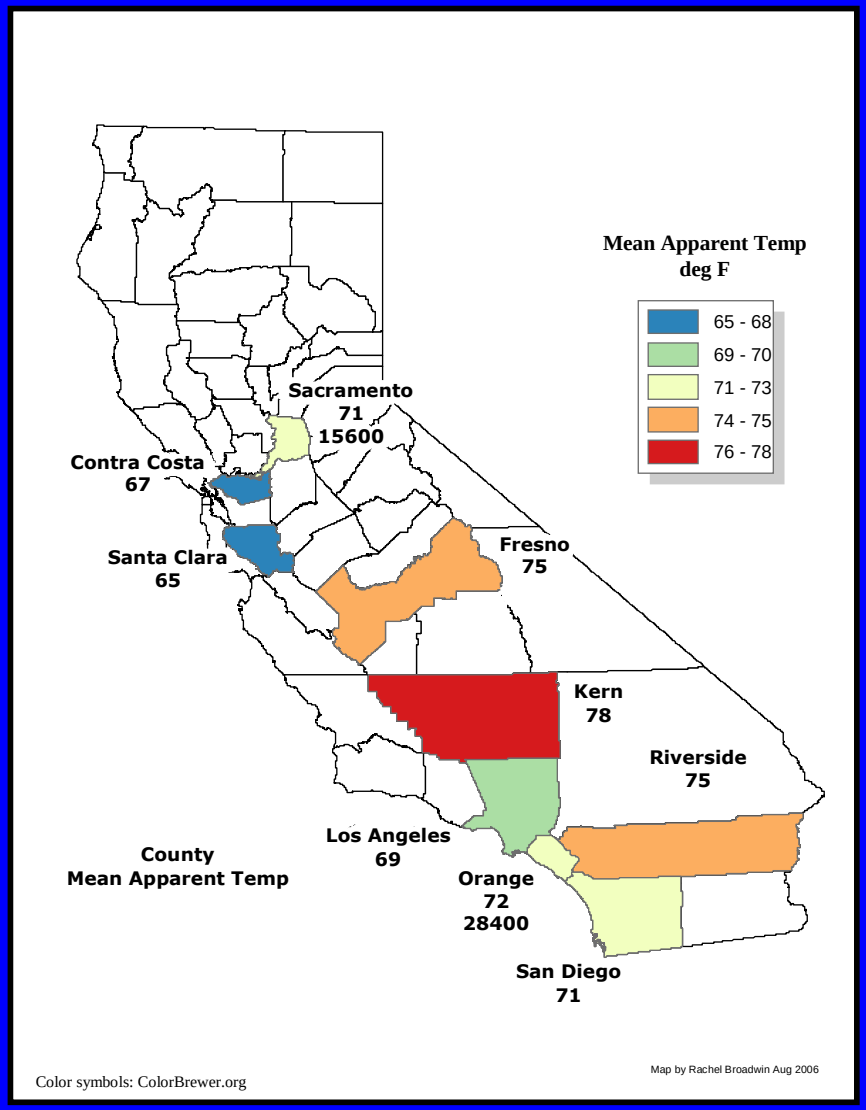
# Questions to Address

1. Do we observe direct health effects in California from higher average (non-heat wave) temperatures?
2. Are these effects independent of those from air pollution?
3. Can we identify subgroups that are particularly susceptible?
4. What were the full effects of the 2006 heat wave? How high are the effects/degree?
5. Do we observe effects of temperature and heat wave on hospital admissions?
6. Based on these results, what is the potential public health impact of future changes in climate?

# Data Collected for 9 California Counties: May-September 1999-2003

- Mean (min and max) daily apparent temperature (EPA AIRS database, ARB, NCDC)
  - Incorporates temperature and relative humidity
- Vital statistics of mortality and hospital admissions (CDPH)
  - All-cause
  - Disaggregated by disease, age and race
- Air pollutants (ARB)
  - $PM_{2.5}$, $O_3$, CO, $NO_2$

# Mean Daily Apparent Temperature (℉) for Nine California Counties, May-September 1999-2003

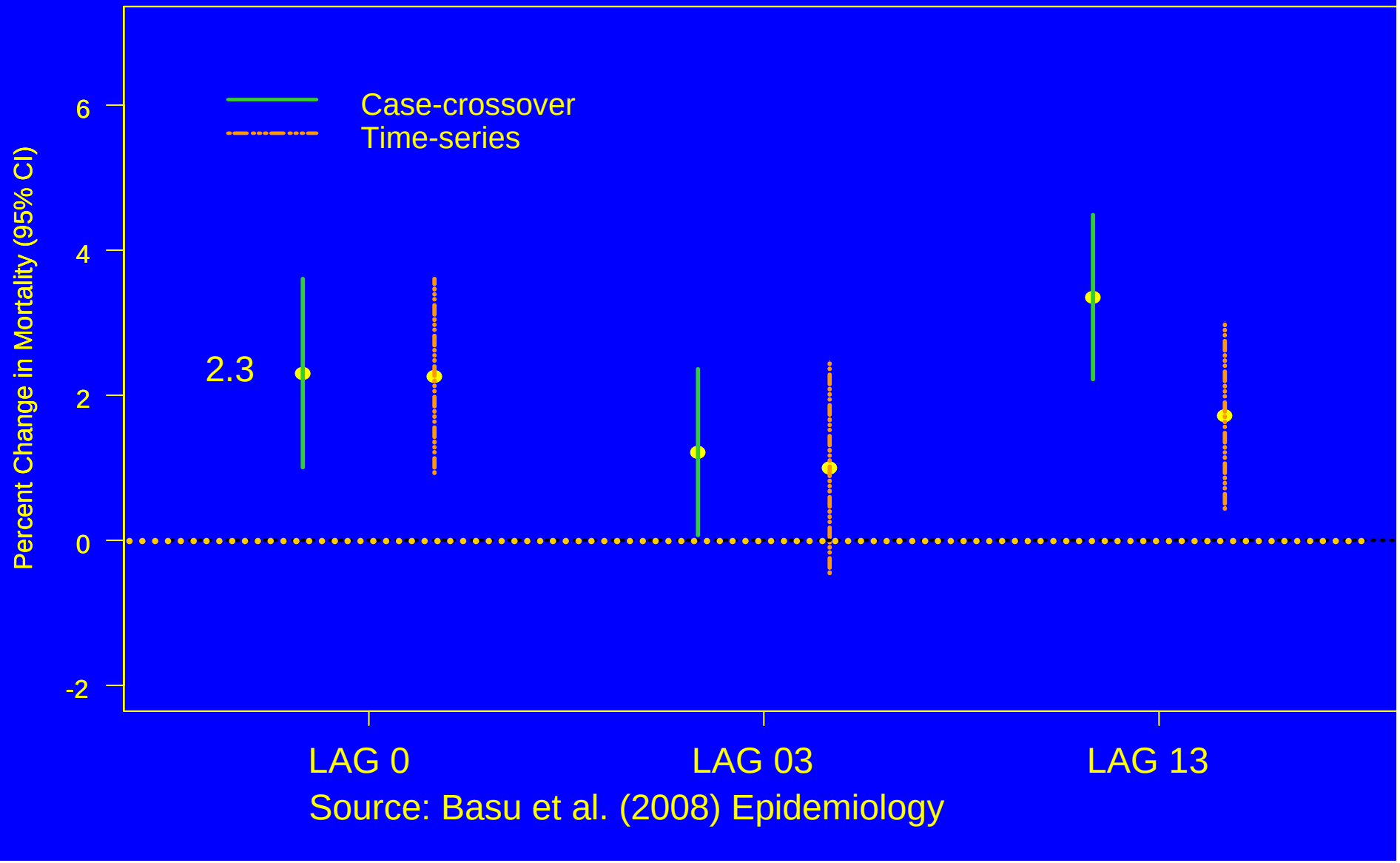


# Methodology

- Time-series and case-crossover methods
- Separate analyses by county
- County estimates combined through meta-analysis
- Parallel study by Harvard group of 9 non-CA counties

# Apparent Temperature and All-cause Mortality for Alternative Lags and Methods

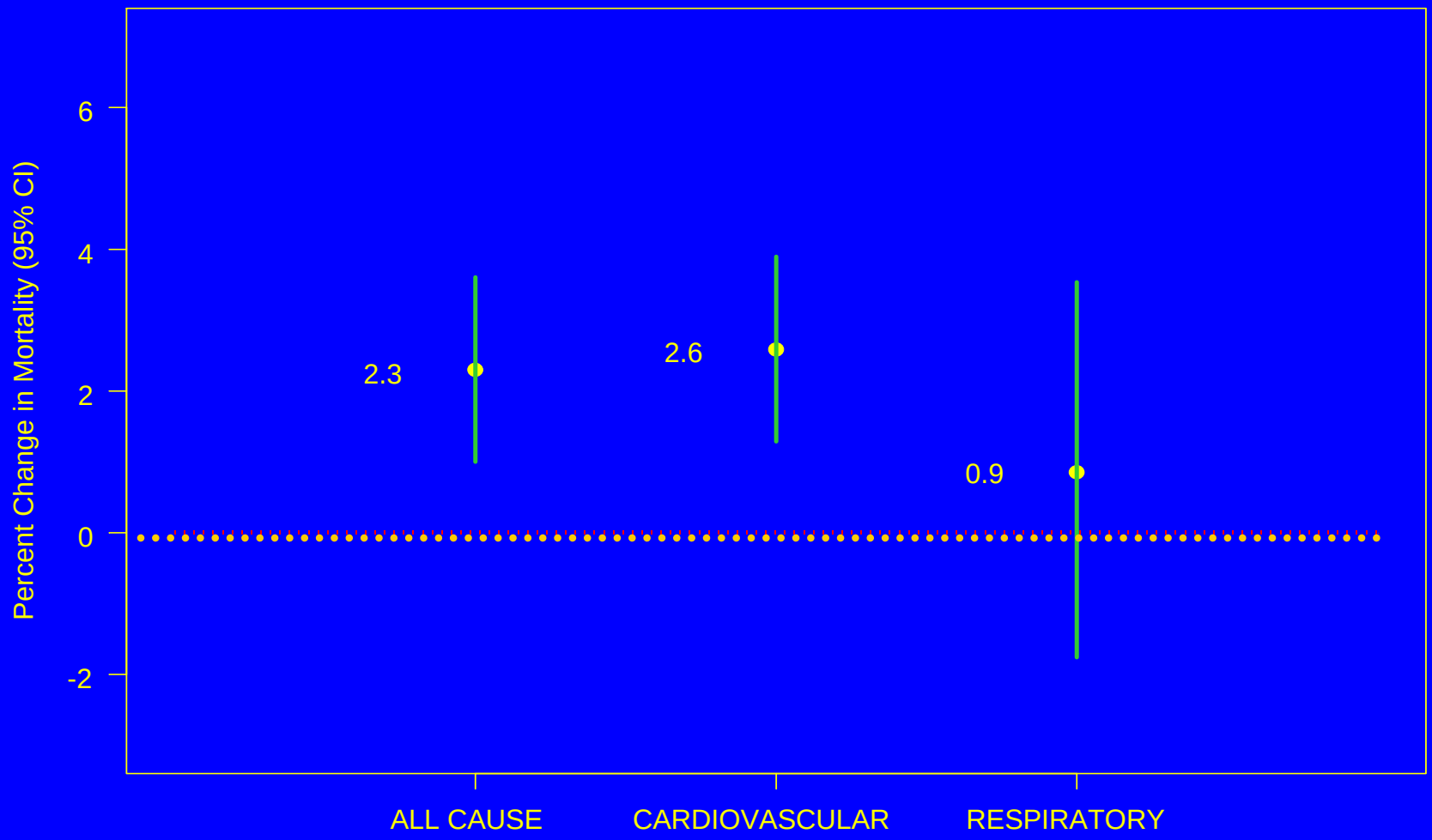
**(% change and 95% CI per 10°F from meta analysis)**




Source: Basu et al. (2008) Epidemiology

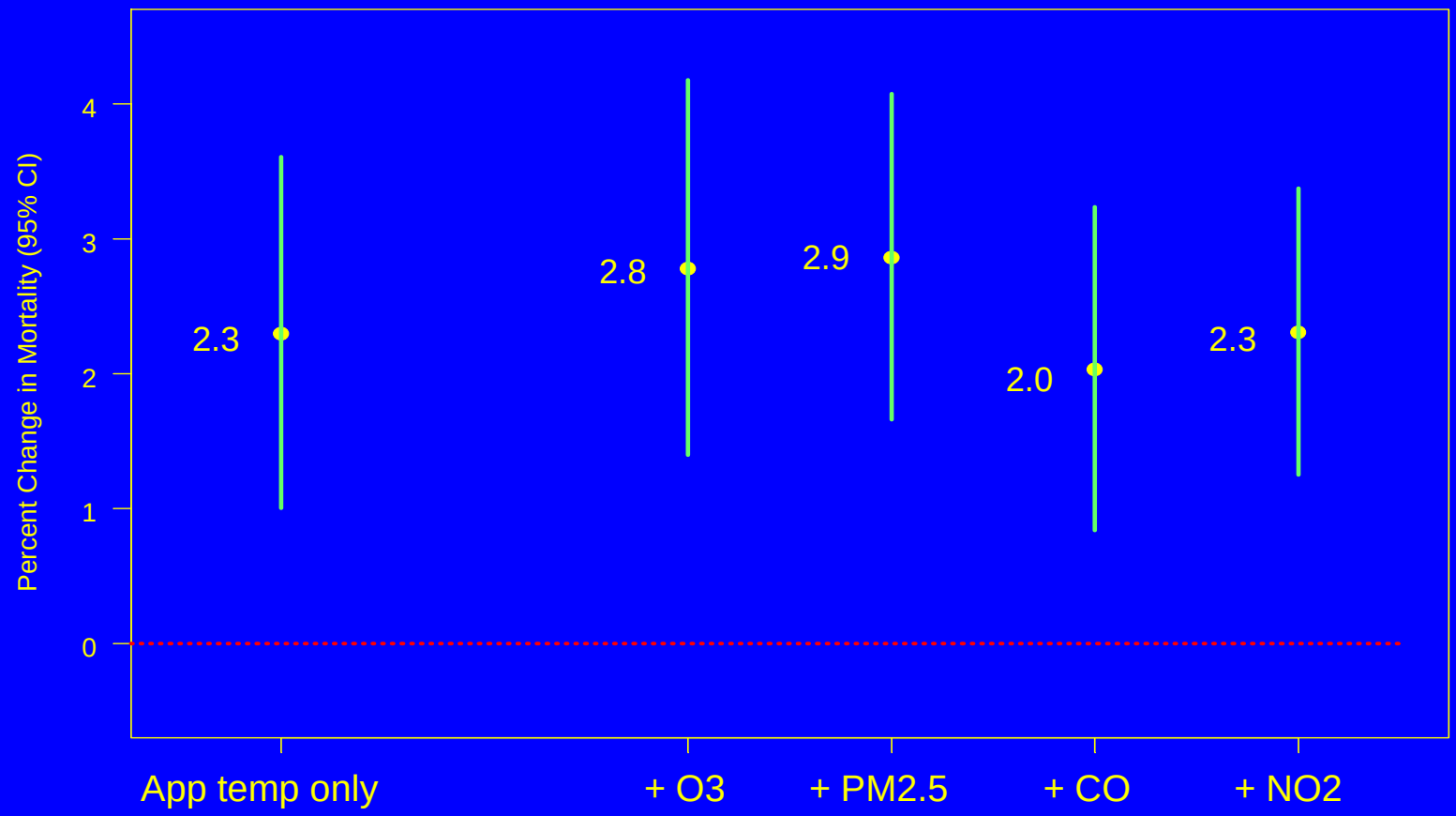
# Apparent Temperature and Disease-specific Mortality

## (% change per 10°F)



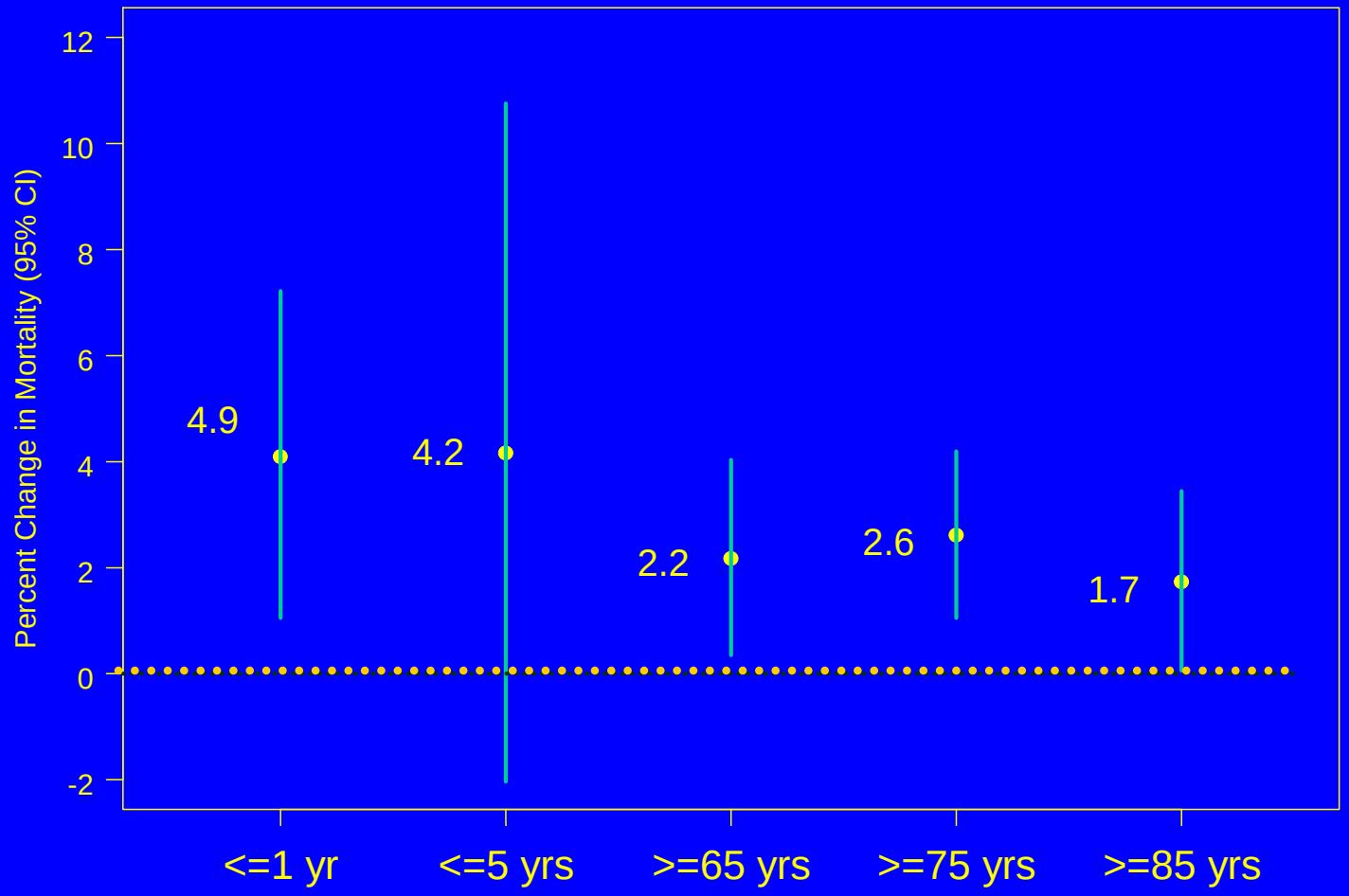
# All-cause Mortality and Apparent Temperature Adjusted by Pollutant

**(% change per 10°F)**

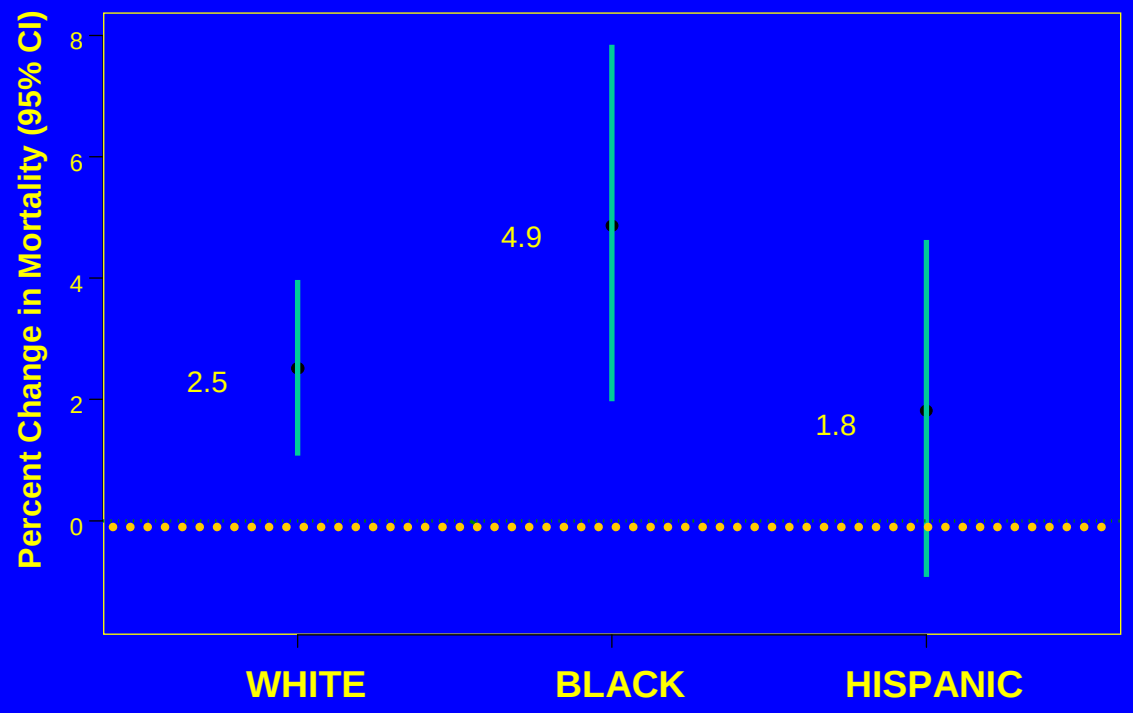


# All-cause Mortality and Daily Apparent Temperature by Age

## (% change per 10°F)



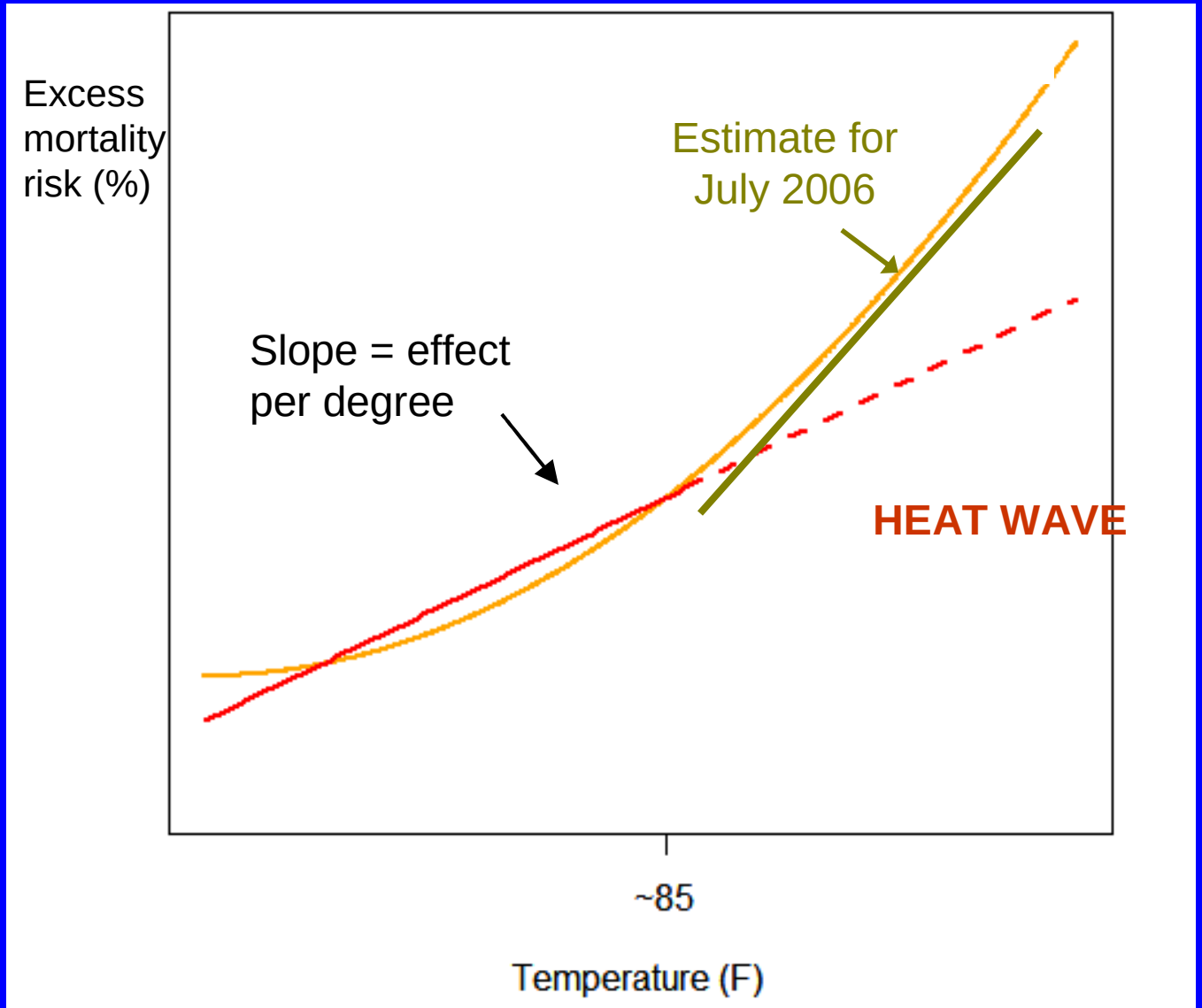
# All-cause mortality and Apparent temperature race/ethnic group



# Mortality Analysis of July 2006 Heat Wave

1. How does the mortality risk/degree change at the higher temperatures?
2. To what extent do coroner reports underestimate the total effects?
   - No consistent case definition of heat-related death
   - Multi-factorial nature of mortality

# Mortality effect per degree likely to be higher during heat wave periods



# Methodology for Analysis of Heat Wave

Estimate quantitative relation between daily mortality and apparent temperature for 9 counties that had > 5 coroner-reported deaths

- Determine county-specific % change in mortality per $^{o}F$
- Use these functions to determine expected mortality

# Results

- % change in mortality per degree during heat wave is 2-3 times greater than during years with no heat wave
- Estimated mortality is 1.5-3 times larger than coroner reports (147) for the 9 counties examined

# Summary of Findings

1. Temperature during non-heat wave periods associated with mortality
2. Greater susceptibility by age and race
   - may be due to co-morbidity, health access, poverty, diet, social isolation
3. Effects appear independent of air pollution
4. Health effects per degree greater during heat wave
5. True mortality during July 2006 heat wave may be 1.5 – 3 greater than earlier reports

# Future Work

1. Effects of temperature increases and heat wave on hospital admissions
2. Emergency room visits?
3. Birth outcomes?
4. Additional analysis of potential interaction of pollution and temperature
5. Development of indicators for heat warnings