Ozone Exposure

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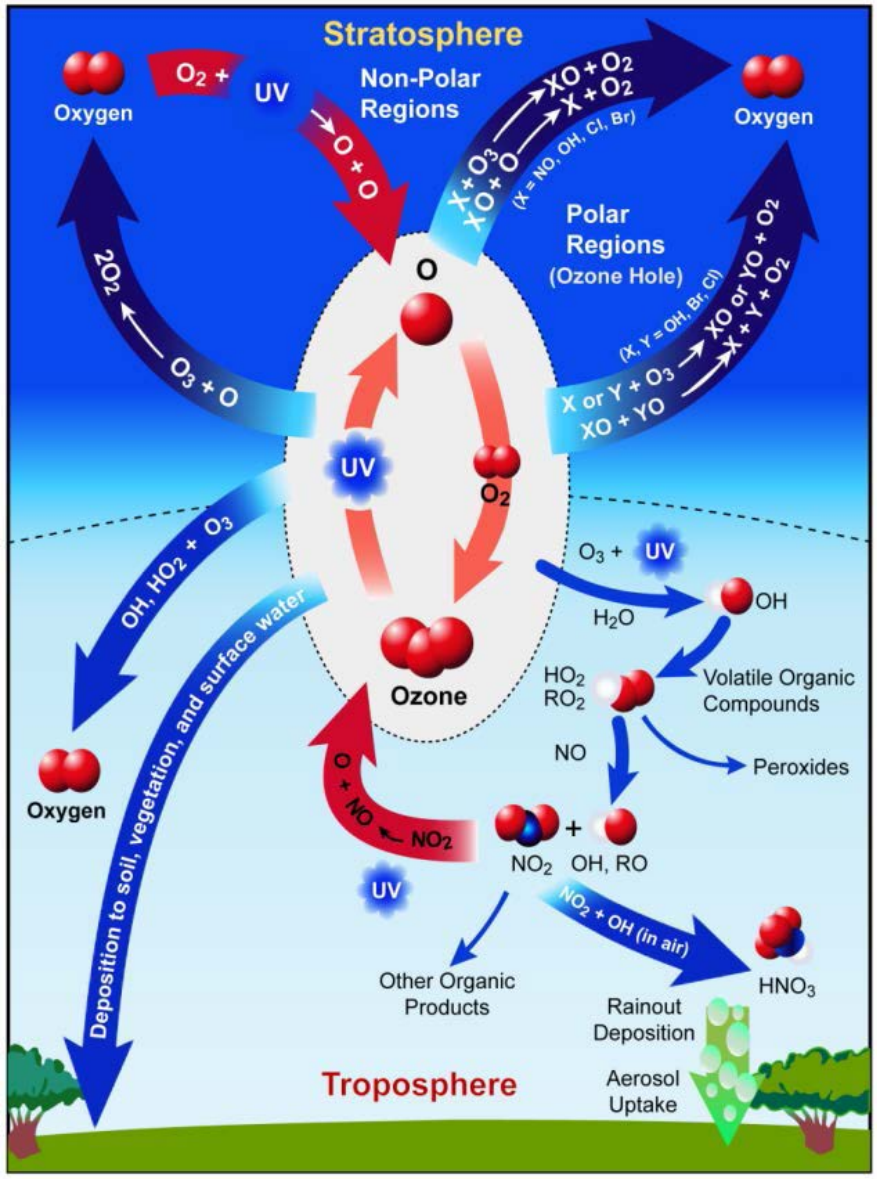
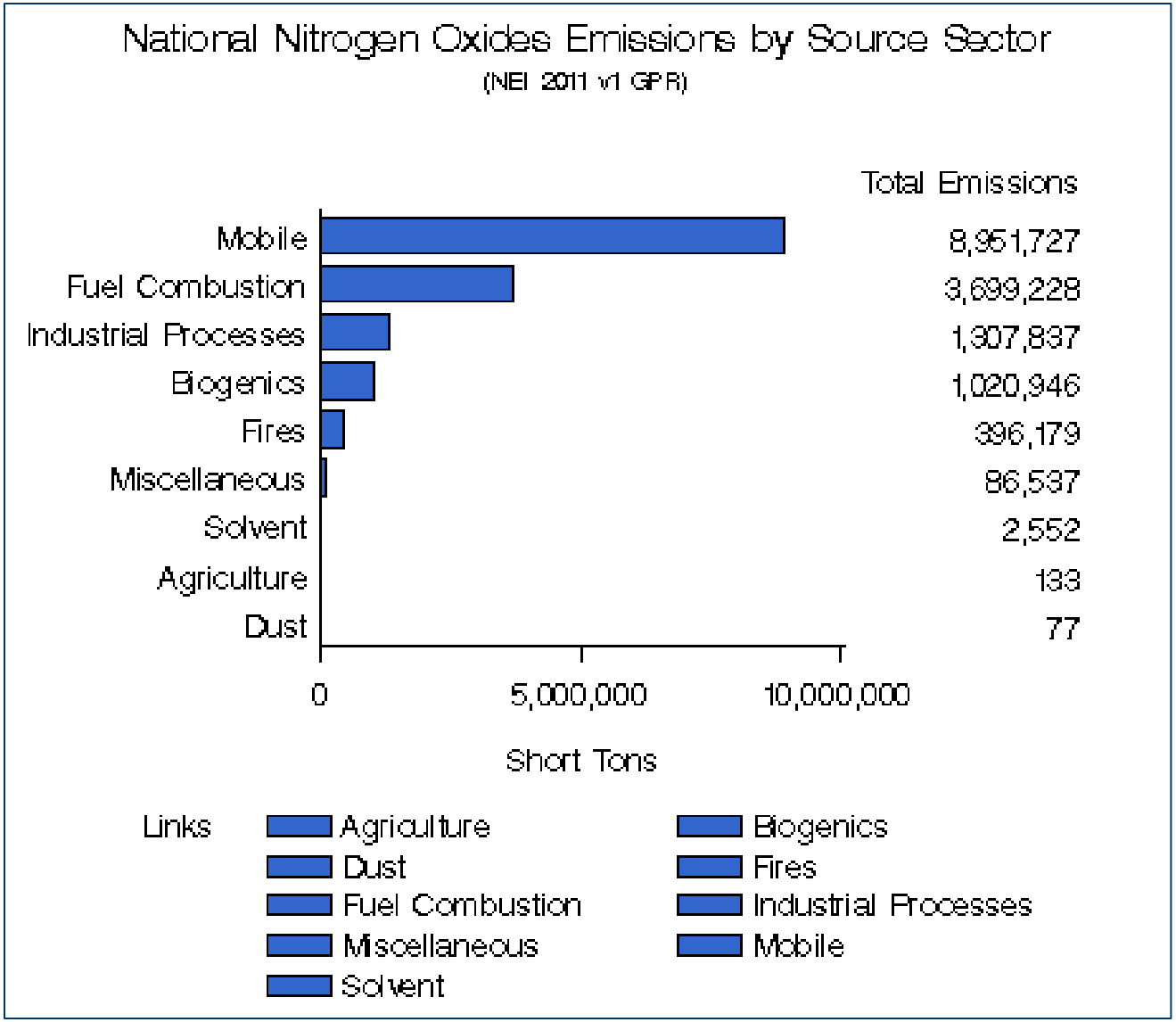
Ozone Chemistry

- Formed from a reaction between precursors and sunlight [mainly nitrogen oxides (NO_x), and volatile organic compounds (VOCs)]
- NO_x is responsible for both formation and scavenging of ozone
- Formation takes time; peaks mid-day
- Formation and transport dependent on meteorology



Source: US EPA, 2013

Outdoor Sources of Precursors - NO_x



Source: http://www.epa.gov/air/emissions/index.htm/

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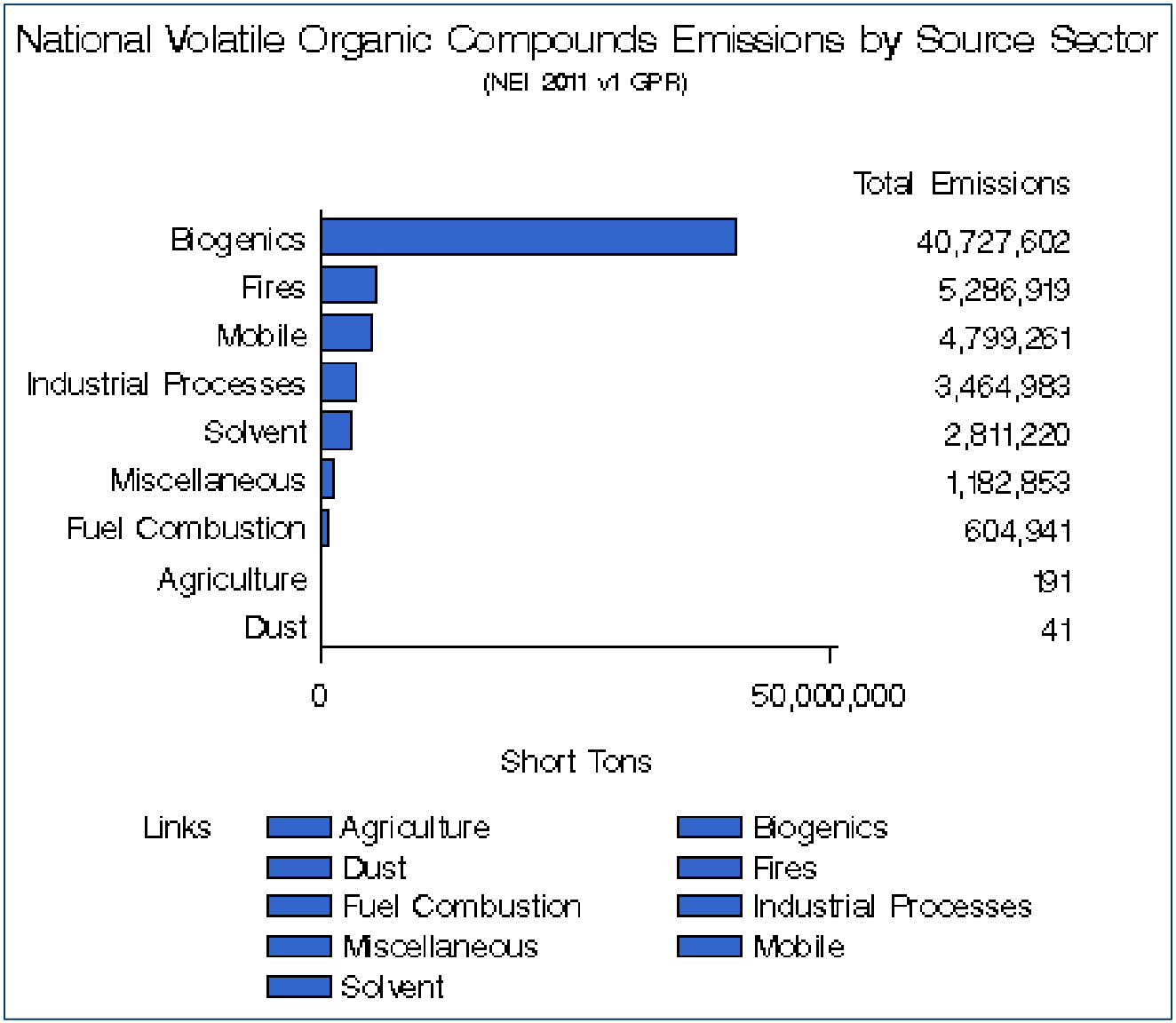
Outdoor Sources of Precursors - VOCs



Source: http://www.epa.gov/air/emissions/index.htm/

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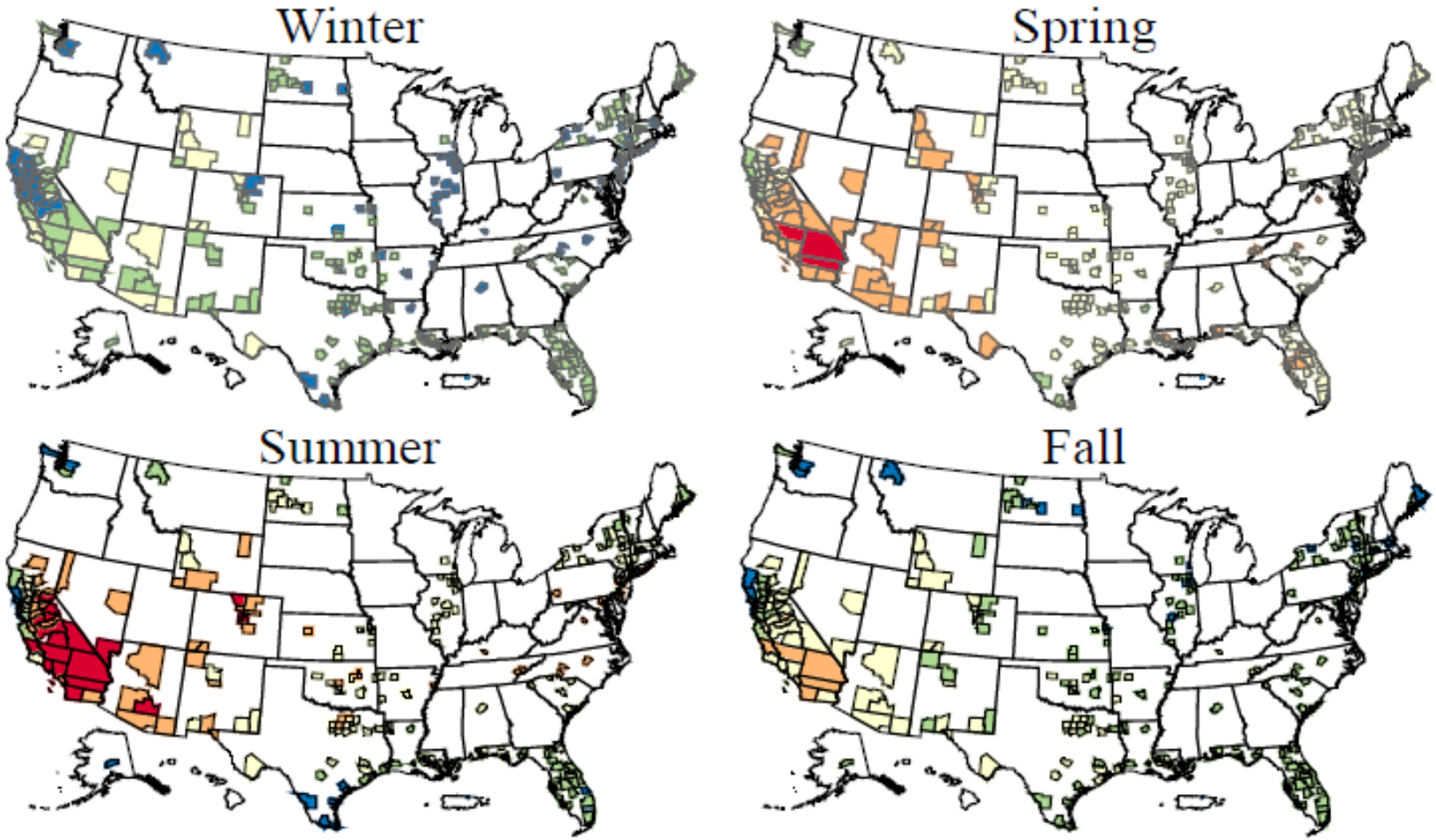
National Seasonal Ozone Levels



Highest monitor 3-yr average (2007-2009)
8-hr daily max

Source: US EPA, 2013 (ISA, Figure 3-27)

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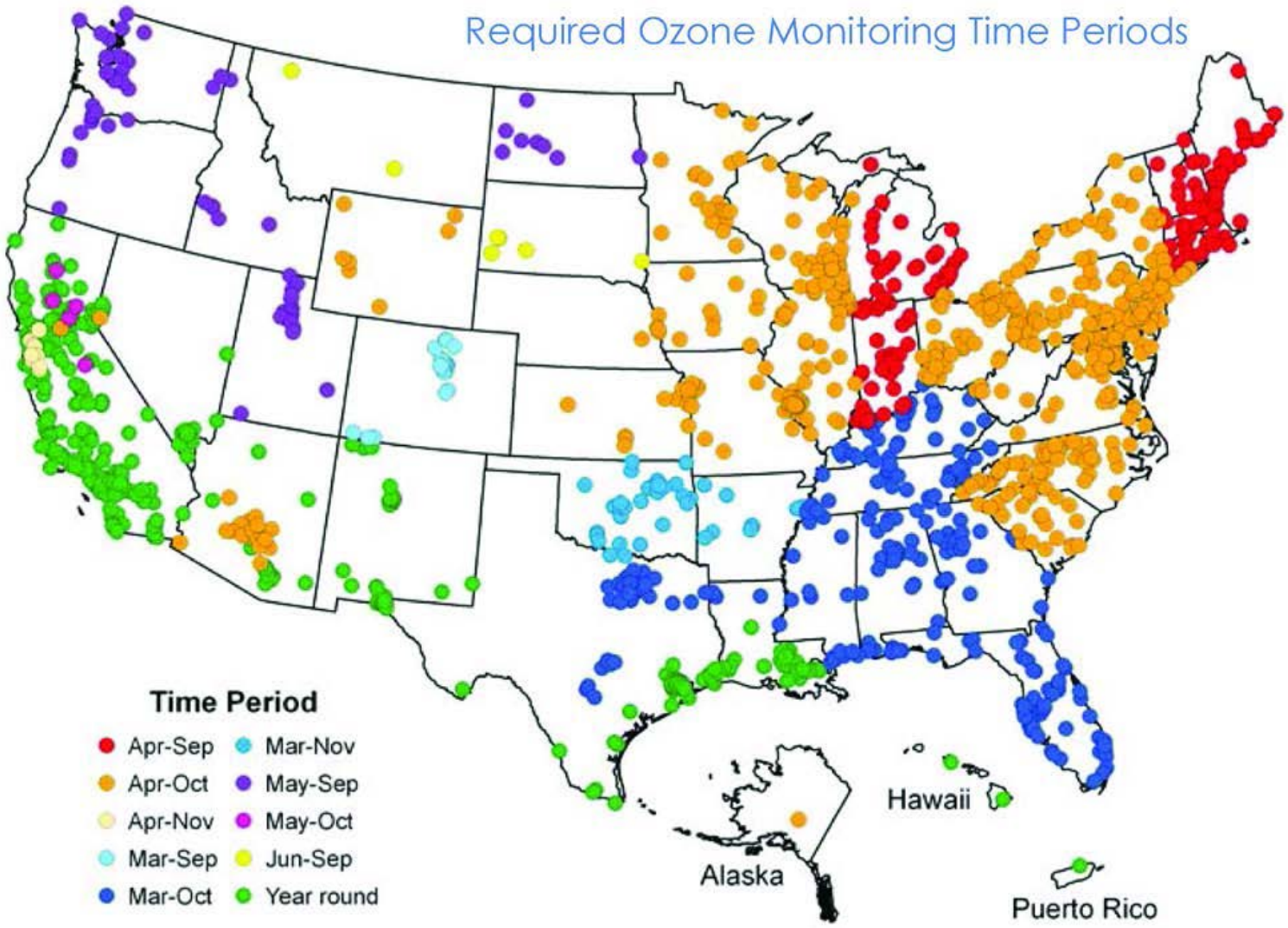
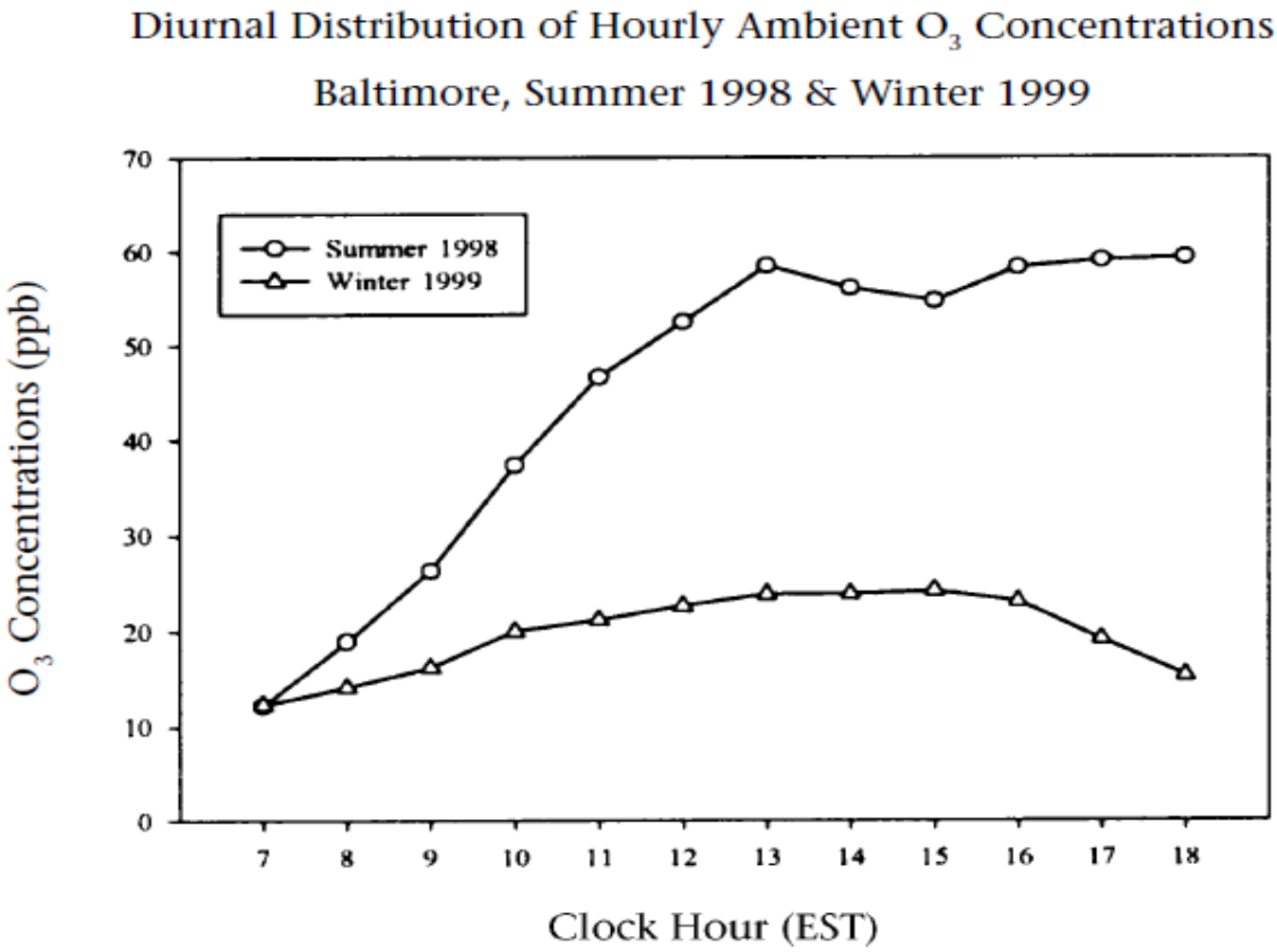
Ambient Ozone Monitoring



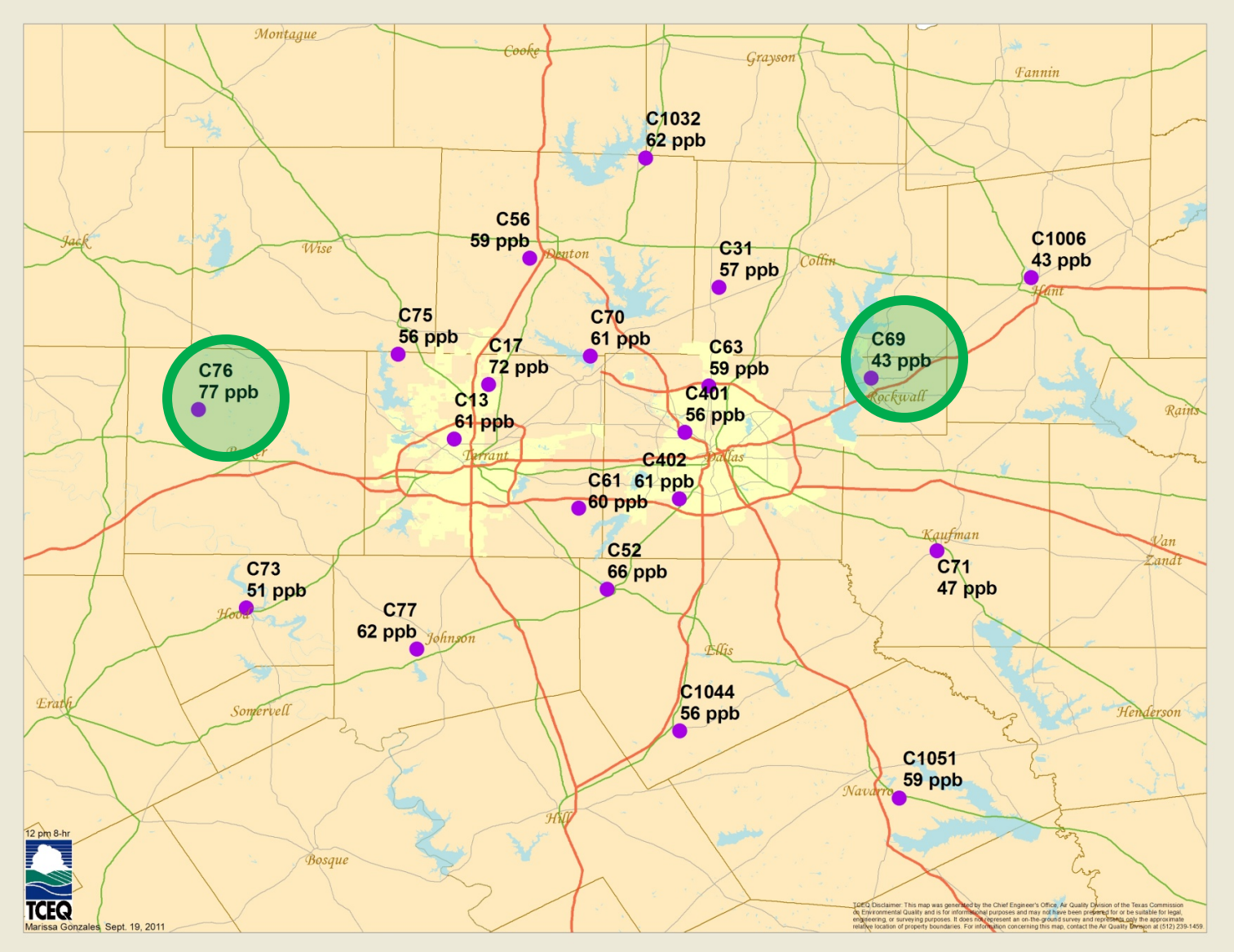
Source: US EPA, 2013 (ISA)

Seasonal Variations in Ozone Concentrations



Source: Chang *et al*., 2000

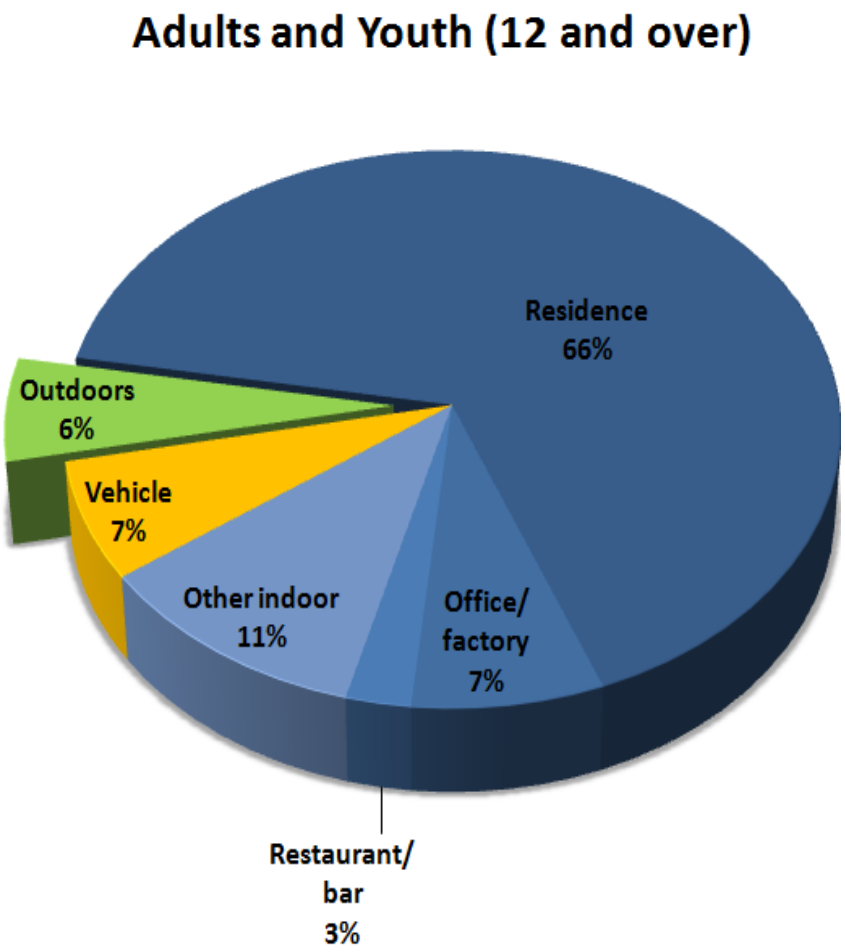
Air Monitors: 8-hr Ozone, 5:00 AM - 1:00 PM (CST)

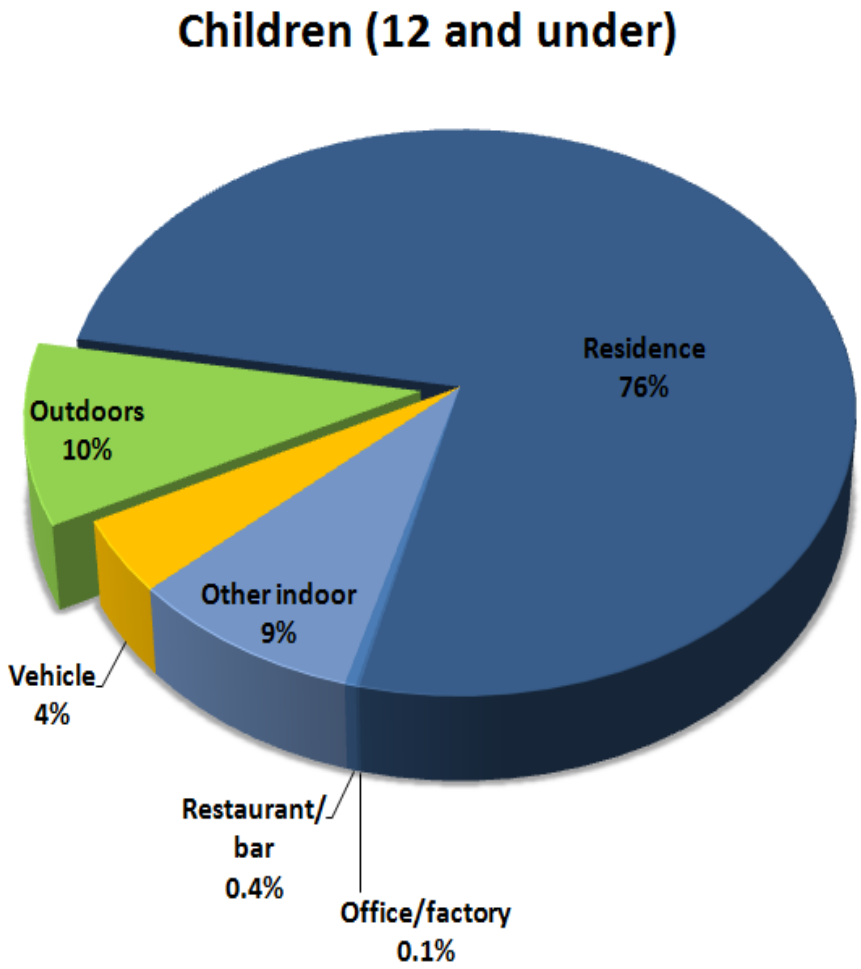


Exposure Assumptions in Epidemiology Studies

- Based on measured levels at ambient monitors
- Average of monitors in a given area, or maximum value from a single monitor
- Assume 24/7 exposure at this level
- Personal exposure are not considered

Time Spent Outdoors

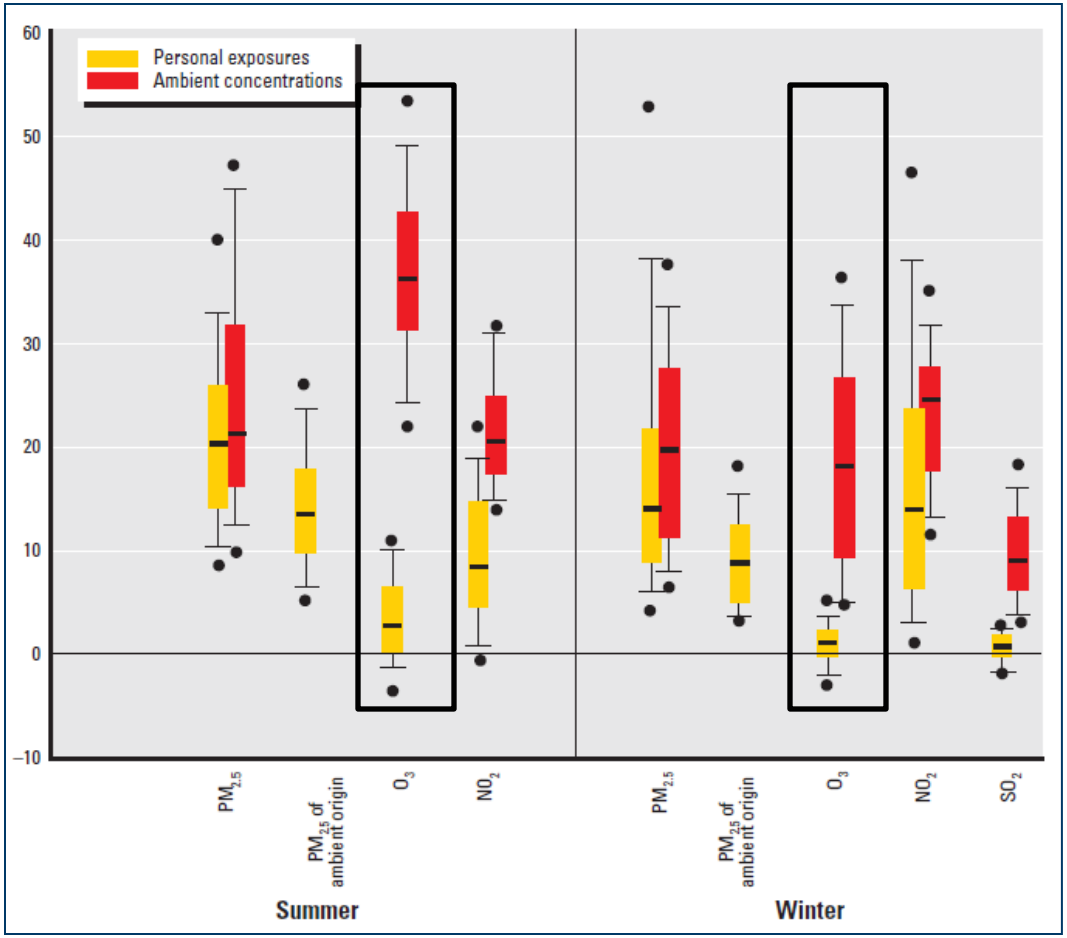




Source: Klepeis *et al.,* 2001

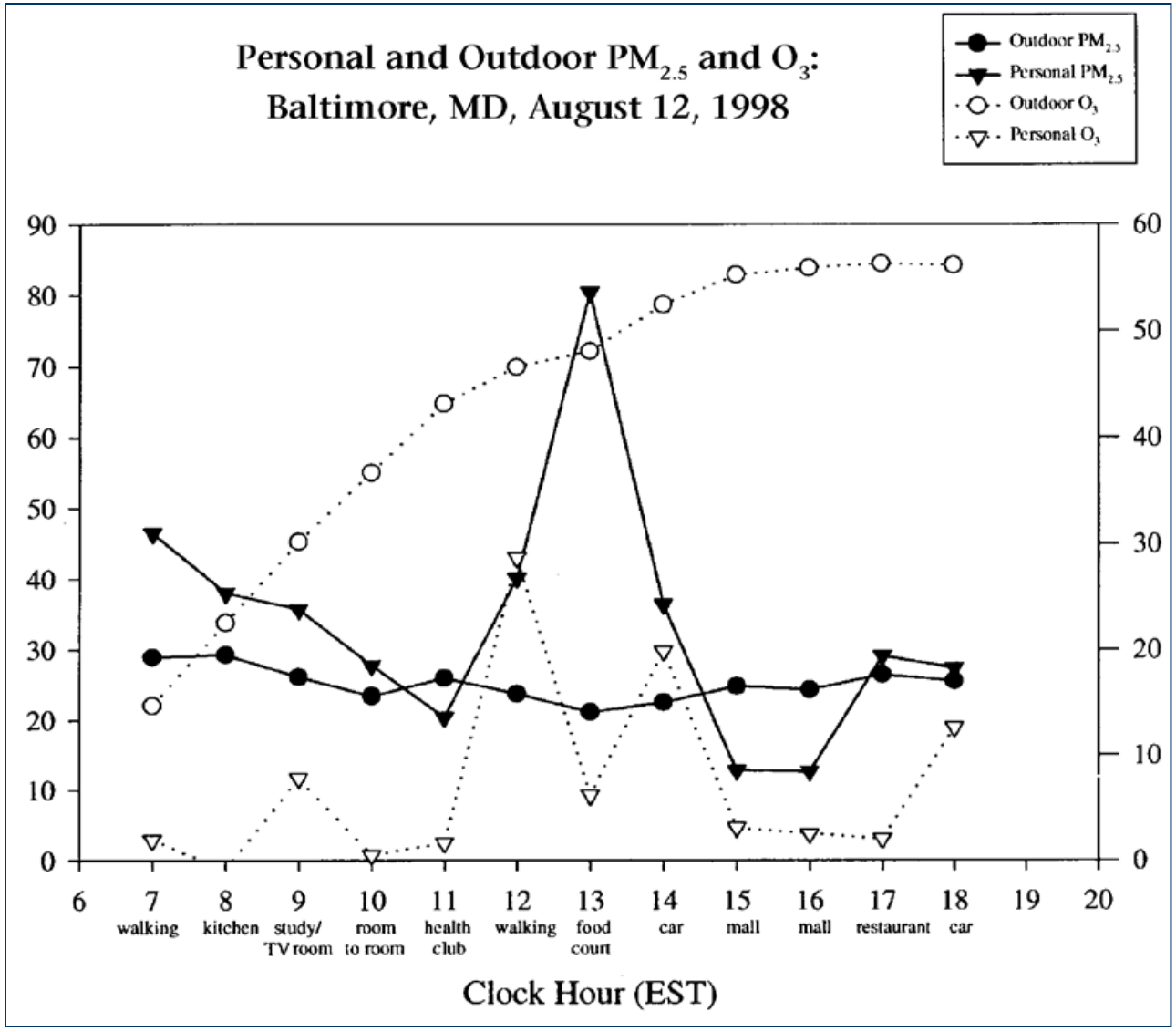
Personal Exposure Measurements

- Few studies of personal ozone measurements
- Generally, poor correlations between personal and ambient measurements (*e.g.*, Sarnat *et al*., 2001; 2005; Liard *et al*.,)



Source: Sarnat *et al*., 2001

Personal *vs.* Ambient Ozone Concentrations

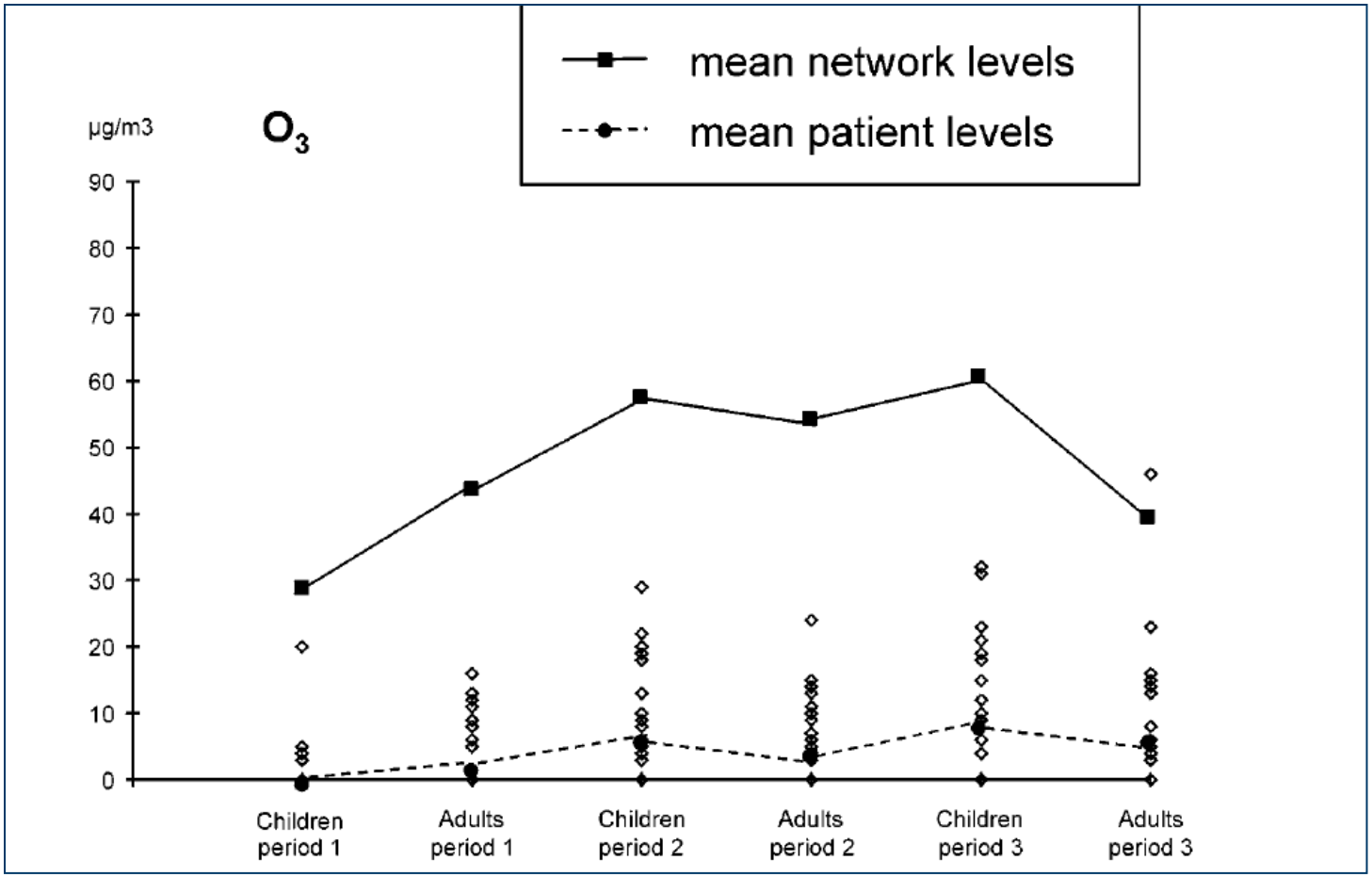


Source: US EPA, 2013 (ISA, Figure 4-1); Chang *et al.*, 2000

Personal *vs.* Ambient Ozone Concentrations

Personal exposures in a panel study of asthmatics

Paris, France 1996



Source: Liard *et al.*, 1999

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Exposure Measurement Error

- Well-recognized inherent limitation of epidemiology studies, most studies rely on central site monitors
- Magnitude of the bias depends on study design, type of error, and relationship between outcome and independent variables
- Two types of measurement error – Classical and Berkson (*e.g.,* Zeger *et al.,* 2000)
  - Classical error tends to attenuate risks
  - Berkson often no bias, but less precision; sometimes bias towards the null (inflates risks)
- In reality, it is a mix of both types of errors and bias could be in either direction
- Measurement errors in co-pollutants can complicate interpretation of co-pollutant results
- Measurement error impacts concentration-response relationships, making them appear linear thereby masking thresholds (Rhomberg *et al.,* 2011)

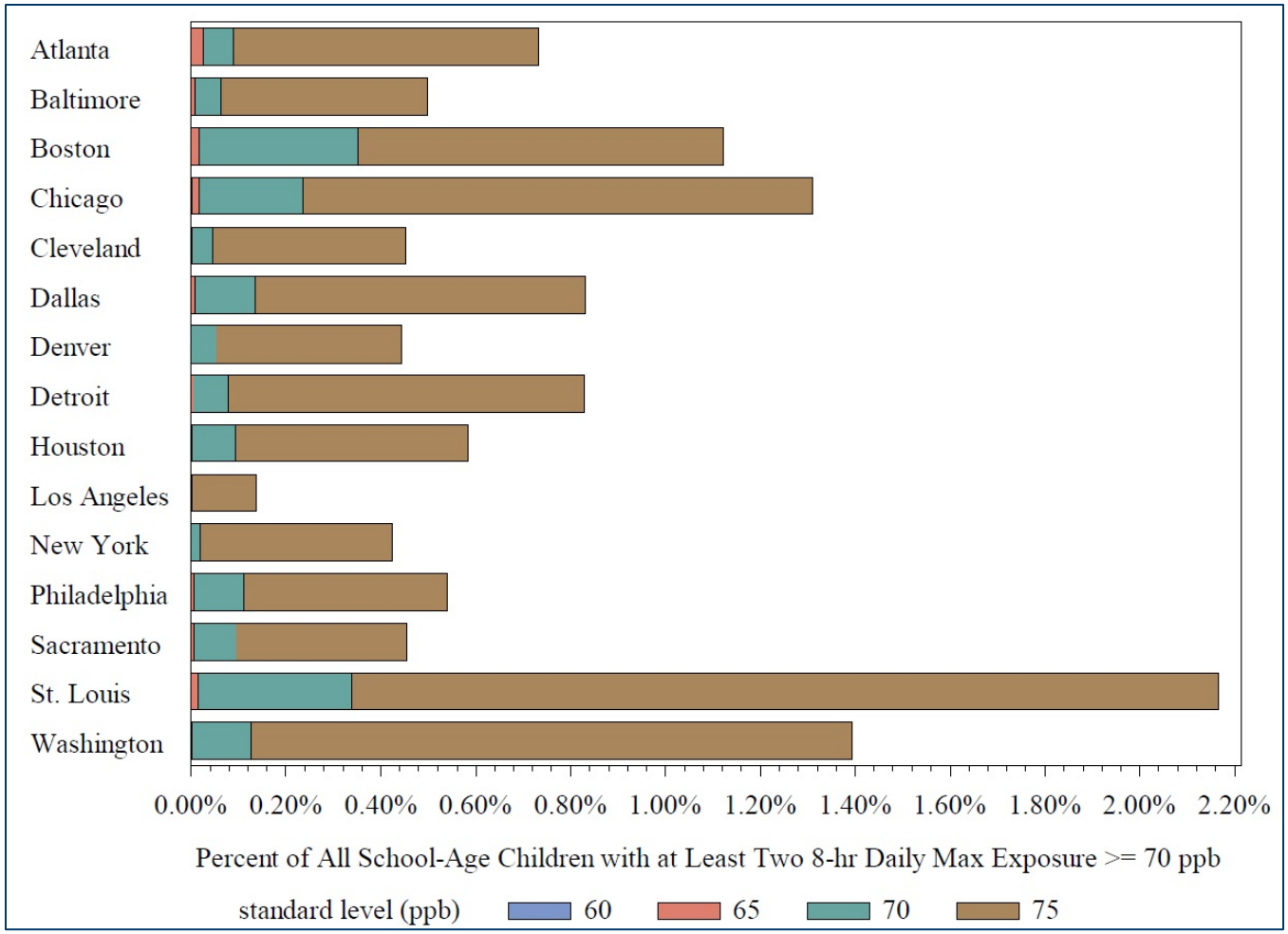
Addressing Exposure Measurement Error

- Personal exposure measurements
  - Costly and often not practical for epidemiology research
- Alternative exposure measurements (*e.g.,* modeling, land-use regression models)
- Statistical methods to correct errors (Rhomberg *et al.,* 2011)
  - Smoothing techniques (LOESS)
  - Simulation extrapolations
  - Regression calibration

Air Pollution Exposure Model (APEX)

- APEX estimates ozone exposures for selected population groups under specified ambient ozone conditions
- Generates a year-long time/activity pattern for each modeled individual composed of exposure events
  - Geographic location determines the ambient ozone concentration
  - Microenvironment determines the exposure concentration
  - Activity determines the person's ventilation (breathing) rate during exposure

Average Percent Children with ≥ 2 Daily 8-hr Max Exposures ≥ 70 ppb



Source: US EPA, 2014 (REA Figure 5F-13)

Questions?

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Gradient

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References

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