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# Mechanical vs. Natural Ventilation in Schools: Less Can Be More

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Seminar 5 -Natural Ventilation in Schools: Boon or Bust?  
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# Outline



- Natural Ventilation (N.V.)
- Climate Factors
- Contaminant Factors
- ASHRAE 62.1 Options

# Natural Ventilation (1)



- IAQ Design Tools for Schools & Collaborative for High Performance Schools (CHPS) Best Practice Manual
  - N.V. using operable windows
    - N.V. can be an effective and energy-efficient way to supplement HVAC systems – temp & humidity permitting
    - Sealed buildings with appropriately designed and operated HVAC systems can often provide better indoor air quality

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# Natural Ventilation (2)



- IAQ Design Tools for Schools & CHPS Best Practice Manual (cont.)
  - Most parts of the country require conditioning of outdoor air to provide acceptable thermal comfort for building occupants

# Natural Ventilation (3)



## Potential Benefits

- Eliminate need for cooling
- Other savings (higher ceilings = daylighting)
- Occupant adaptation

## Potential Problems

- Noise
- Uncontrolled moisture
- Outdoor sources of pollutants
- Outdoor air quality



# Climate Factors (1)

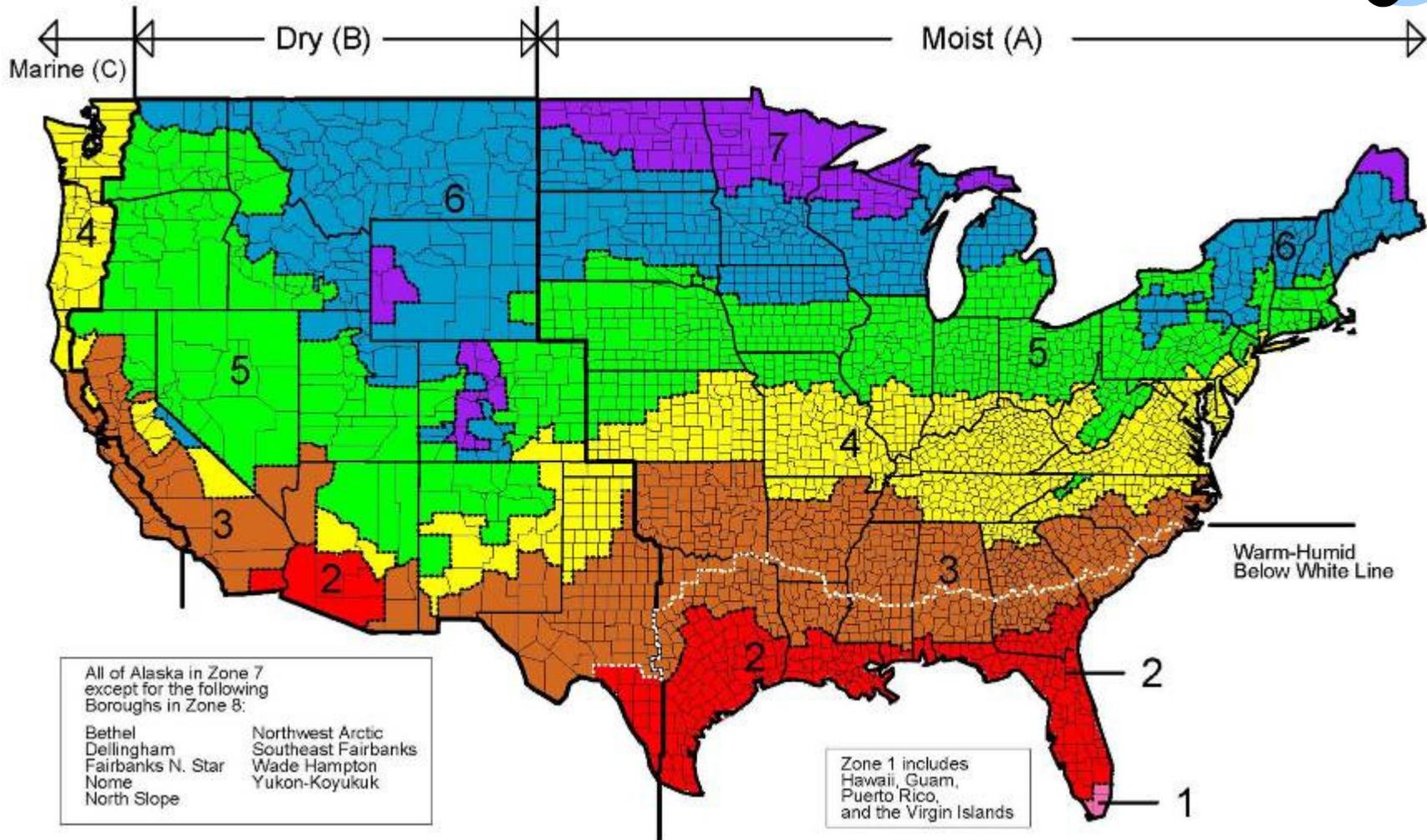


## Recommendations from Literature

(CHPS Best Practices Manual; 2005 ASHRAE Handbook Fundamentals; National Institute of Building Sciences)

- ❑ Mild Climate = Yes for N.V.
- ❑ Hot, Dry Climate = some potential for N.V.
- ❑ Hot, Humid Climate = No for N.V.
- ❑ Cold Climate = No for N.V.

# Climate Factors (2)



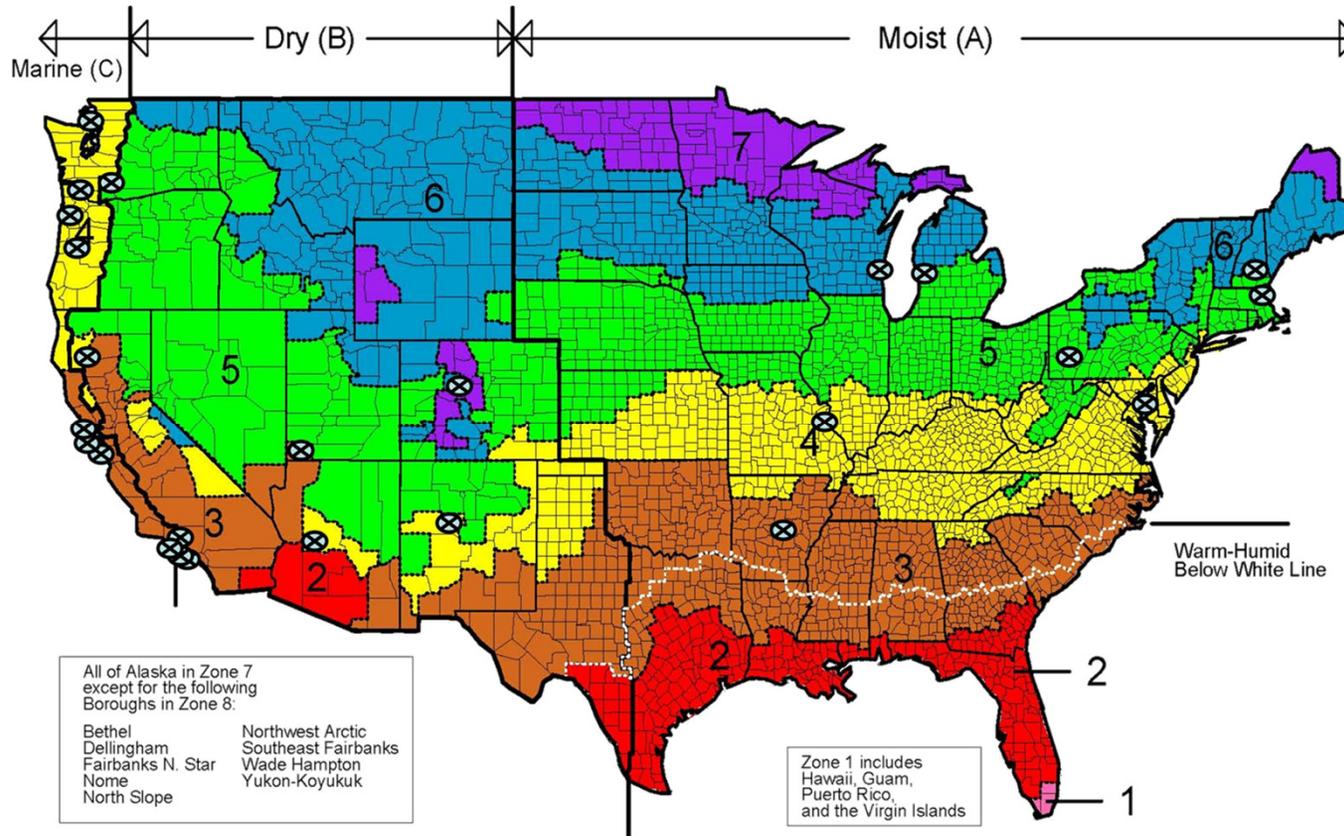
# Climate Factors (3)



- Where are buildings which have incorporated N.V.?
- New Building Institute's Getting to Fifty Database
  - Review of Getting to Fifty Database: US Buildings and K-12 Schools
  - Location of buildings which incorporated some level of N.V. in design

# Climate Factors (4)

GT 50 - US Buildings with N.V.



⊗ = Building Location

# Climate Factors (5)

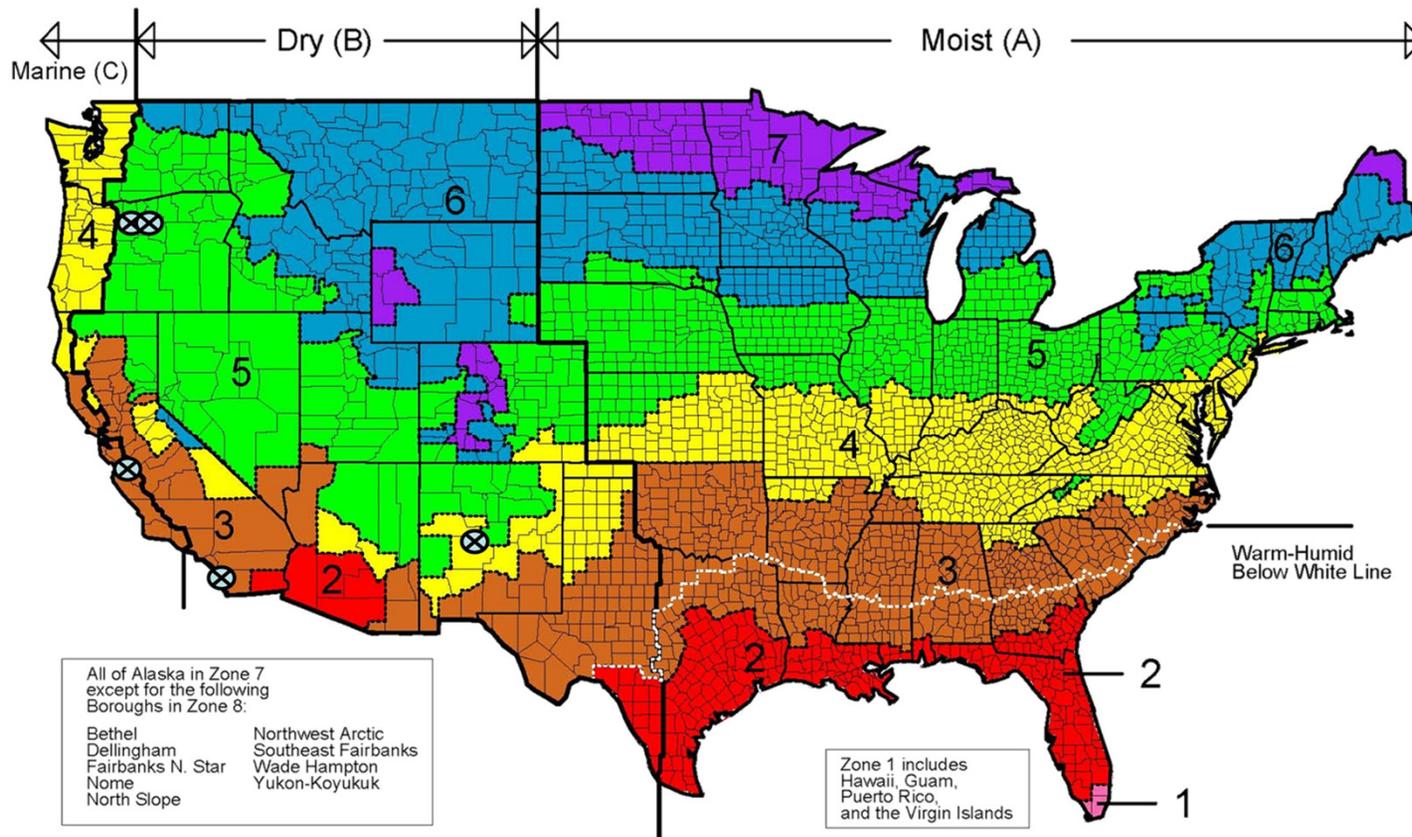


## Getting to Fifty – US Buildings with some level of N.V.

- Total Buildings = 32
- Temperatures
  - 34% in zone 4 (Mixed)
  - 31% in zone 3 (Warm)
  - 19% in zone 5 (Cool)
  - remaining 12% in zones 1, 6, & 7 (Very Hot, Cold, Very Cold)
- Humidity
  - 66% in Dry & Marine (38% in Marine, 28% in Dry)
  - 34% in Humid
- Majority of buildings = warm, mixed, cool temperatures; dry & marine humidities - Western United States

# Climate Factors (6)

GT 50 - US K-12 Schools with N.V.



⊗ = Building Location

# Climate Factors (7)



## Getting to Fifty – US Schools with some level of N.V.

- Total Schools = 11
- Total Schools with N.V. = 5
- Temperature Zones of all N.V. Schools: 3 - 5 (Warm, Mixed, Cool)
- Humidity Zones of all N.V. Schools: Dry, Marine
- Western United States

# Contaminant Factors (1)



- US EPA National Ambient Air Quality Standards (NAAQS)
- Related to Criteria Contaminants in Air:
  - carbon monoxide (CO), ozone (O<sub>3</sub>), nitrogen dioxide (NO<sub>2</sub>), sulfur dioxide (SO<sub>2</sub>); particulate matter, lead
  - particulate matter: PM<sub>10</sub>, PM<sub>2.5</sub>

# Contaminant Factors (2)

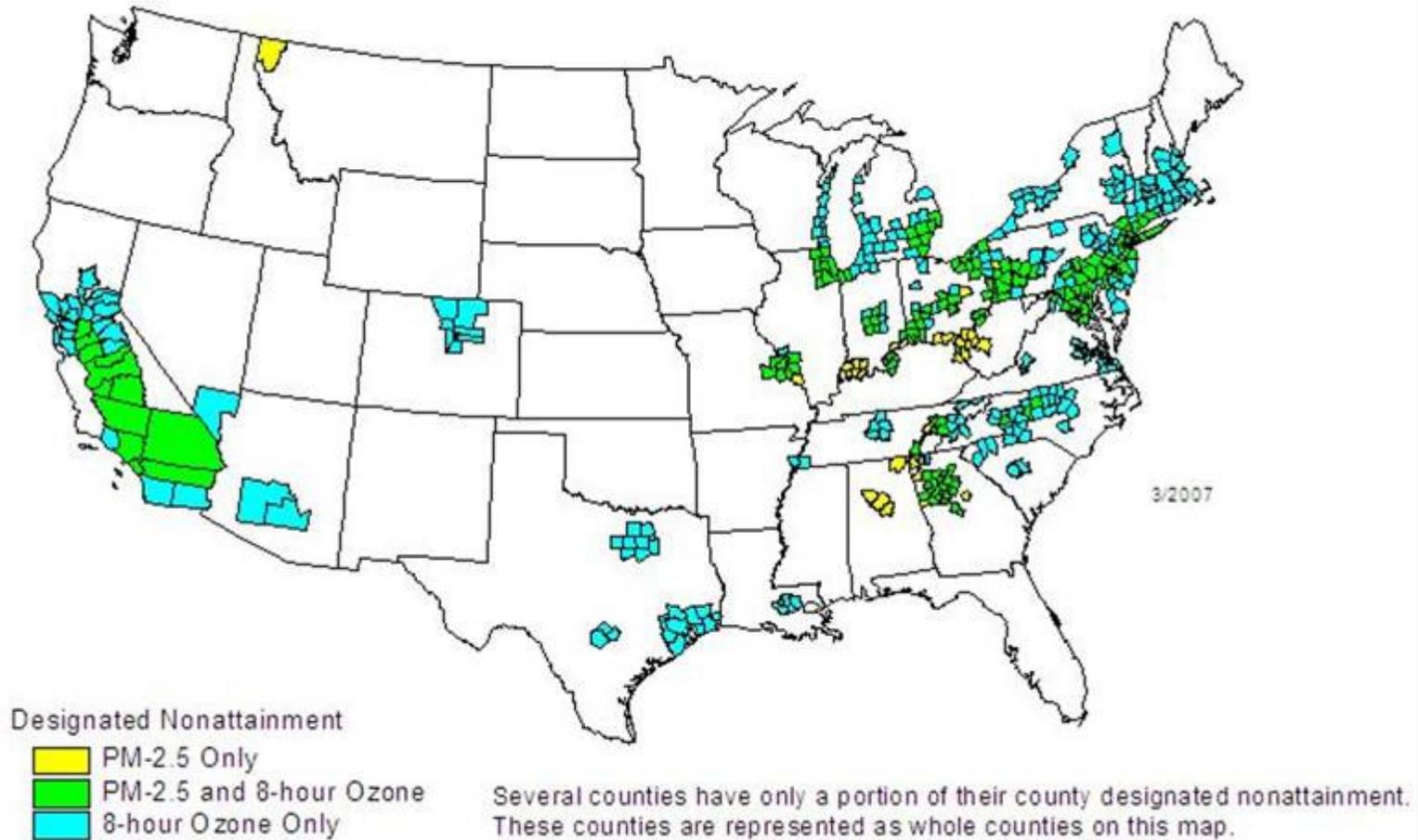


<b>Pollutant</b>	<b>Primary Std</b>	<b>Averaging Time</b>
carbon monoxide	9 ppm	8-hour
	35 ppm	1-hour
nitrogen dioxide	0.053 ppm	annual
Ozone	0.08 ppm	8-hour
	0.12 ppm	1-hour (limited areas)
sulfur oxides	0.03 ppm	annual
	0.14 ppm	24-hour
lead	1.5 $\mu\text{g}/\text{m}^3$	quarterly average
PM <sub>2.5</sub>	15.0 $\mu\text{g}/\text{m}^3$	annual
	35 $\mu\text{g}/\text{m}^3$	24-hour
PM <sub>10</sub>	150 $\mu\text{g}/\text{m}^3$	24-hour

# Contaminant Factors (3)



Counties Designated Nonattainment for PM-2.5 and/or 8-hour Ozone Standard



# Contaminant Factors (4)



- Getting to Fifty – US Schools with some level of N.V.
  - 5 Total Schools; 2 Schools in nonattainment areas
  - CA Orange County
    - Carbon Monoxide - Serious
    - 8-Hr Ozone - Severe
    - PM-10 - Serious
    - PM-2.5 - Nonattainment
  - CA Santa Clara County
    - 8-Hr Ozone - Marginal

# ASHRAE 62.1 Options (1)



- Is less natural ventilation more in your location (more occupant comfort, more air quality)?
- There are options for saving energy in ASHRAE 62.1 with the two ventilation methods
  - Ventilation Rate Procedure
  - Indoor Air Quality Procedure

# ASHRAE 62.1 Options (2)



- Ventilation Rate Procedure
  - Air filtration (gas-phase and particulate)
  - VAV, Dynamic Reset
- IAQ Procedure
  - Air filtration (gas-phase and particulate)
  - Alternate amount of outside air (lower)

# Summary



- Less N.V. can be more (comfort & air quality)
  - Climate: hot, humid, cold zones
  - Air Contaminants: nonattainment areas (site specific sources, urban areas)
- Other Options to Reduce Energy Consumption and Provide Comfort & IAQ
  - 62.1 VRP – VAV, Dynamic Reset
  - 62.1 IAQP – Possibility of less outdoor air

# References & Further Info



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