CALIFORNIA
AIR RESOURCES BOARD

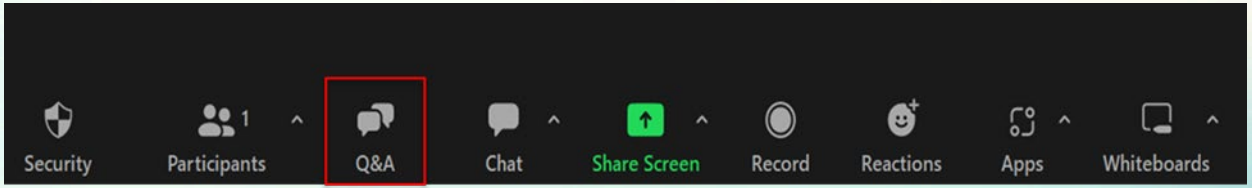
CARB Indoor NO_2 Guidelines Workshop #3
November 19, 2025

Housekeeping Items

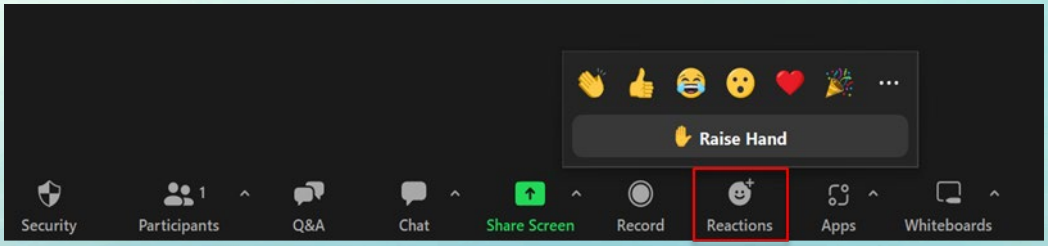
- We ask that you keep any comments to under 2 minutes. You can also submit comments at this link: https://ww2.arb.ca.gov/public-comments/public-workshop-3-updating-indoor-air-quality-guidelines-nitrogen-dioxide-submit
- If we are unable to get to your question during the Q/A session, or if you would like to submit additional information, you are welcome to email us at IAQGuidelines@arb.ca.gov and we will respond to you.
- If you are having any technical difficulties during the workshop, please email Kristi Hall at Kristi.hall@arb.ca.gov.
- This meeting will be recorded, and the presentations posted to our webpage at https://ww2.arb.ca.gov/public-workshop-3-updating-indoor-air-quality-guidelines-nitrogen-dioxide
- We will send registered participants an email when the posting is completed.

Housekeeping Items

- If you have a written question, please enter it into the Q&A using the icon at the bottom of the screen.



- If you wish to ask a question verbally, raise your hand using the reactions icon. We will unmute you during the Q/A sessions at the end of the panel.
- When called on, please identify yourself and your affiliation, and whether you have a question or comment.



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Agenda

1. Welcome 5 min – Bonnie Holmes-Gen – Research Division Health Branch Chief
2. Housekeeping and introductions 3 min –Jeff Williams
3. Presentation 25 min – Jeff Williams, Pat Wong
    a) Background and health effects
    b) Timeline and review of workshops #1 and 2
    c) Review of approaches for guidelines update
    d) Proposed guideline levels
    e) Summary and next steps
4. Updates from partner agencies (California Energy Commission, California Department of Public Health) 30 Min
5. Discussion and Q/A ~ 1hr – Bonnie Holmes-Gen (Branch Chief, Research Div)
6. Next steps and adjourn 5 min

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The need to update NO_2 guidelines

CARB's last published indoor guidelines in 2005

Health Canada and WHO have adopted more health protective guidelines

Calls for action from academia and community-based researchers

Provide guidance to inform state/local policies, future building codes, etc

Establish benchmarks for research into healthy IAQ

How are Indoor Air Quality Guidelines different from Air Quality Standards?

- Indoor Air Quality Guidelines are voluntary benchmarks for healthy concentration thresholds for indoor air pollutants to avoid health effects.
- Air Quality Standards are enforceable maximum concentration levels in outdoor air set by CARB or USEPA. These mandatory standards are based on the maximum amount of a pollutant that can be present in outdoor air without any harmful effects on people or the environment.

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Why does indoor NO_2 matter?

- NO_2 levels indoors can regularly exceed the levels of the National Ambient Air Quality Standards
- People spend approximately 90% of their time indoors
  - Rule of 1,000 (Prof. Kirk Smith)
- NO_2 emissions released indoors affects both indoor and outdoor air quality
- Sources include combustion appliances
  - Ventilation helps but does not fully address concerns

NO_2 Exposure and Health Effects

Causal short-term effects

- Controlled exposure studies
- Exacerbation of respiratory symptoms
  - Cough
  - Wheeze
  - ER/hospital visits

Long-term effects

- Asthma and increased mortality
- Susceptibility to respiratory infections
- Gas and propane stoves contribute to long-term NO_2 exposure and estimated ~50,000 cases of pediatric asthma

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Other IAQ Guideline Efforts

Current Indoor NO_2 Guidelines/Standards

Guideline	Methodology - Target Value	Agency - NO_2 Concentration (year)
1-hour indoor guidelines	Indoor level at 1 hour	California --- 250 ppb (2005) Canada ------ 90 ppb (2015) WHO -------- 106 ppb (2010)
24-hour indoor guidelines	Indoor level at 24 hours (or more)	California -- 80 ppb (2005) Canada ---------- 11 ppb (2015) WHO ---------- 13 ppb (2021)

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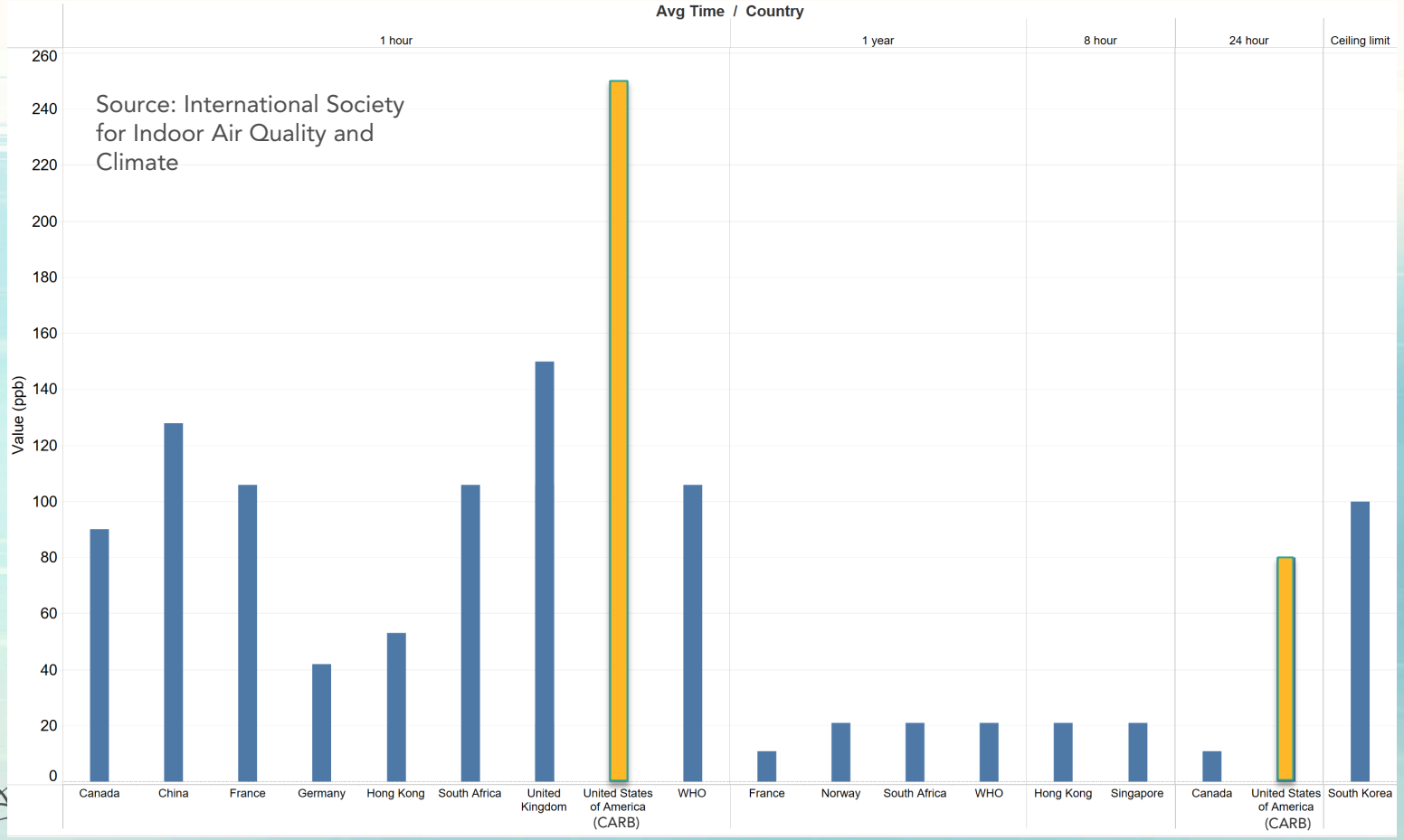
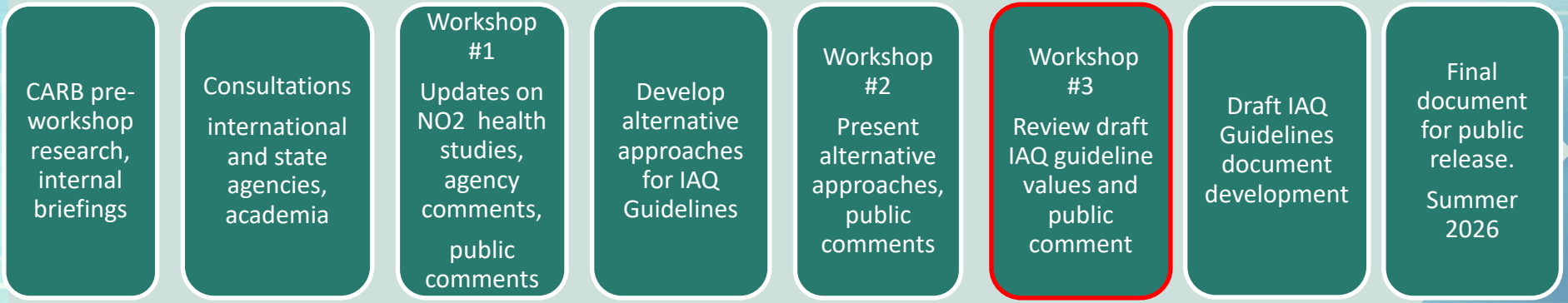
Global Indoor NO_2 Guidelines



Key Milestones - Indoor Air Quality Guidelines for NO_2



Key Takeaways Public Workshop #1

- CARB's indoor NO_2 guidelines do not reflect the latest science and need revision
- Indoor NO_2 regularly exceeds ambient standards and is a health risk
- Indoor exposures result in health disparities
- Ventilation and source reduction are key to reducing NO_2 indoors
- Community engagement and equity should be considered for guideline development

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Key Takeaways Public Workshop #2

Stakeholder feedback on how to proceed with guideline development:

- Maximize health protection in guidelines
- Strong support from public for Health Canada RfC values
- Educate stakeholders on health benefits of guidelines and difference between guidelines and mandates
- Collaborate with CBOs for outreach, education, and implementation.
- Support development of low-cost NO_2 sensors and smart range hoods.
- Consider multi-pollutant impacts and co-benefits of electrification

CARB's Proposed Approach

- Build on previous literature review and analysis by Health Canada for their guideline development
- Adopt a health protective level based upon Health Canada reference concentration (RfC)
- Review literature since 2015 for additional studies on NO_2 health impacts

Proposed Guidelines

Guideline	Description	Benefits	Challenges	Averaging time and levels
Adopt Health Protective Level	Use Health Canada's Reference Concentrations (RfCs) as the basis for California's indoor NO_2 guidelines	• Most health-protective and indoor specific • Based on robust science • Aligns with international best practices • Used by Health Canada for codes and emissions standards. Health messaging • Supported by OEHHA	May be difficult to achieve in all homes immediately	**1-hr:** 27 ppb **24-hr:** 5 ppb

Health Benefits of Proposed NO2 Guideline levels

1-hr NO2 guideline: 27 ppb

24-hr NO2 guideline: 5 ppb

- Maximum health benefit for vulnerable populations
- Guideline level based on health studies demonstrating higher frequency of days with respiratory symptoms and/or medication use in asthmatic children above these levels.

Utilization of a Health Protective Guideline Values

- Homeowners and environmental health officers have benchmarks for questions/concerns about IAQ
- Better establish “typical” indoor concentrations
- Inform building codes and ventilation standards
- Incentivize more efficient and cleaner appliances

NO_2 Mitigation Strategies

- Source reduction
  - Non-combustion appliances
  - Avoid indoor smoking, burning candles, etc
- Improved building ventilation/filtration and range ventilation
  - Use air purifiers with activated carbon
- Monitoring indoor air quality
  - Making people aware of NO_2 levels they are being exposed to and what increases those levels
  - Triggering mitigation strategies in high population areas like office buildings and schools

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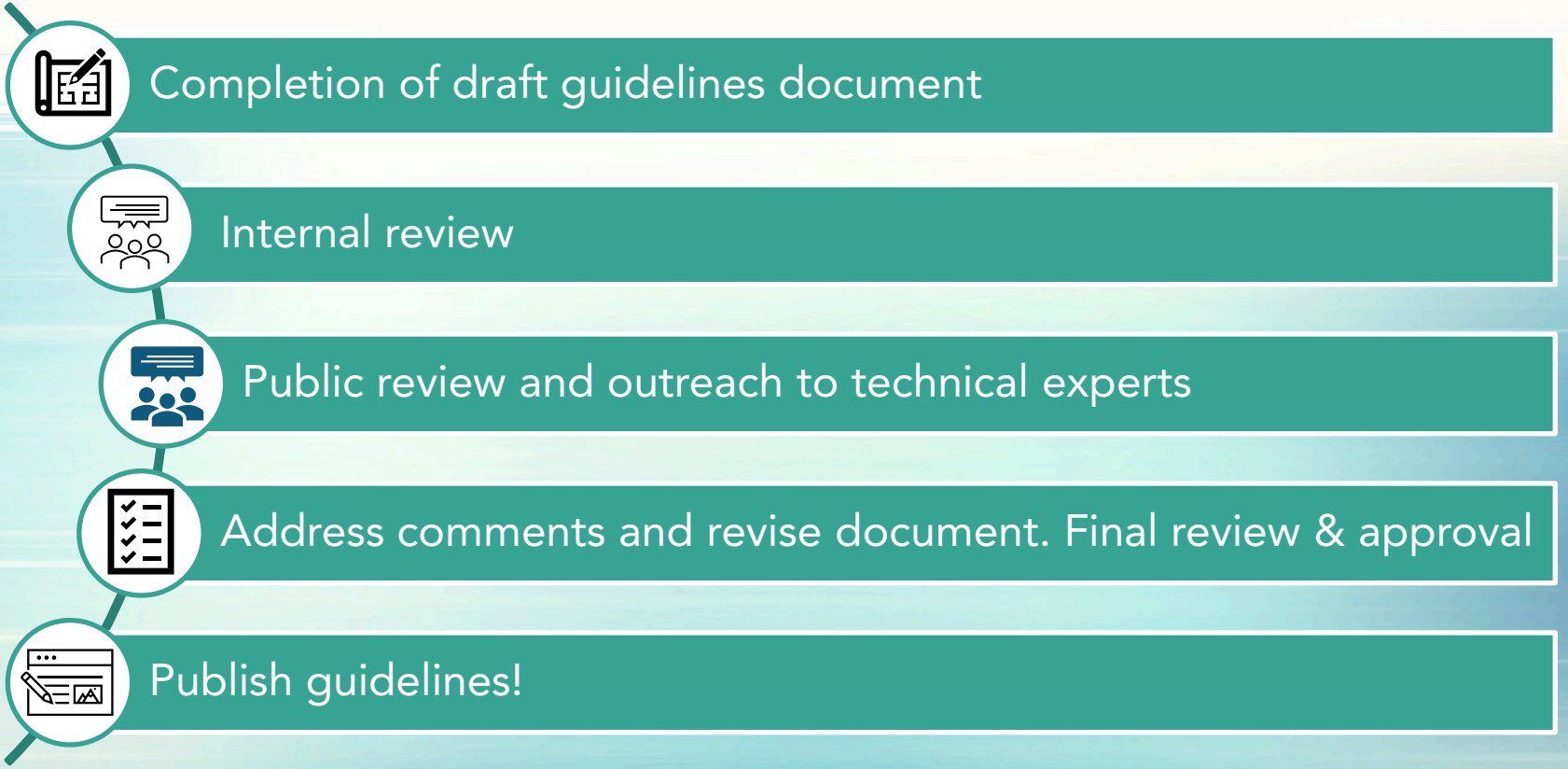
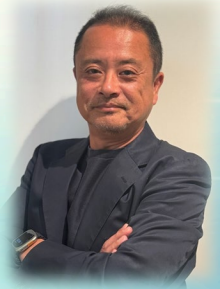
Next Steps


Completion of draft guidelines document
Internal review
Public review and outreach to technical experts
Address comments and revise document. Final review & approval
Publish guidelines!

Partner Agency Updates

Kazukiyo (Kazu) Kumagai, Ph.D. – California Department of Public Health



Maninder Thind, Ph.D. – California Energy Commission

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Thank You!

Email us
IAQguidelines@arb.ca.gov

NO_2 Guidelines Web Page
https://ww2.arb.ca.gov/our-work/programs/indoor-air-quality/indoor-no2-guidelines-update

Comments
https://ww2.arb.ca.gov/public-comments/public-workshop-3-updating-indoor-air-quality-guidelines-nitrogen-dioxide-submit

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Questions and Comments

Bonnie Holmes-Gen, Moderator

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Primary Questions

Do you believe these values are appropriate for protecting public health, especially for sensitive groups like children or people with asthma?

Do the proposed guideline values seem clear and understandable?

What do you think about the mitigation options presented and are there any others that you think should be considered?

What messages or materials would help you explain these guidelines to your community or clients?

Studies of NO_2 Concentrations in CA Residences

Study Name/Author	Study Year(s)	Homes	Mean NO_2 (ppb)	Median NO_2 (ppb)	Averaging Time	Notes
HENGH	2011-2017	66	5.8	4.5	7 days	New homes with gas appliances and mech ventilation. Integrated 1-week NO_2 measurements using Ogawa sampler
CNHS	2002-2005	29	5.2	1.6	24 hour	Homes with electric cooking
Zhao et.al.		22	18.8	16.6	7 days	New and renovated apartments with gas cooking. Passive sampler
		38	7.1	5.5	7 days	Detached homes with gas cooking. Passive sampler
Blanc et.al.	1992, 96, 99	226	13.0	---		Homes with gas stoves and wood heating
Lee et. al.	1996	119	28		6 days	Homes with gas ranges
Mullen et. al.	2011-2013	352	23/18		6 days	Kitchen/Bedroom peak concentrations Integrated passive samplers
Less et.al.	2012	24		9.2/8.7/7.6	6 days	Br/Kit/Outside concentrations

[1] https://carb.sharepoint.com/:b:/t/RDHealth&ExposureAssessmentBranch-HEAB-/EdfIQQSsIzFLumTZzWlr-7QBCv3kGALng8Gdwfzpp8BBdA?e=GvQD1r
[2] https://carb.sharepoint.com/:b:/t/RDHealth&ExposureAssessmentBranch-HEAB-/EcM4HUiU9ulEsDVvtz8ieCsBw_uchLOR2x0Oh4Yr2zup4A?e=qbio19
[3] https://carb.sharepoint.com/:b:/t/RDHealth&ExposureAssessmentBranch-HEAB-/EQ6dav-P7v9Jnz9Pp1IWZJkBabbQLNoKcc07wJSzumewFQ?e=0R21g0
[4] https://journals.lww.com/joem/abstract/2005/04000/impact_of_the_home_indoor_environment_on_adult.4.aspx
[5] https://carb.sharepoint.com/:b:/t/RDHealth&ExposureAssessmentBranch-HEAB-/ERB98Hc2V2dHtlbhkgSoe0kB3mb79V1tTDPSB61xunyoqQ?e=P7Oqyu
[6] https://carb.sharepoint.com/:b:/t/RDHealth&ExposureAssessmentBranch-HEAB-/EXsAjn0UU91Ks9DY0k6kx9MB4-yxAfrEW0rpJQLmu1SsJQ?e=5V4ize
[7] https://carb.sharepoint.com/:b:/t/RDHealth&ExposureAssessmentBranch-HEAB-/EYlIQaoKqOxDucyEOMvtMMcBv9FqvukhOI4T3_0xJBeQqg?e=Kagw4g

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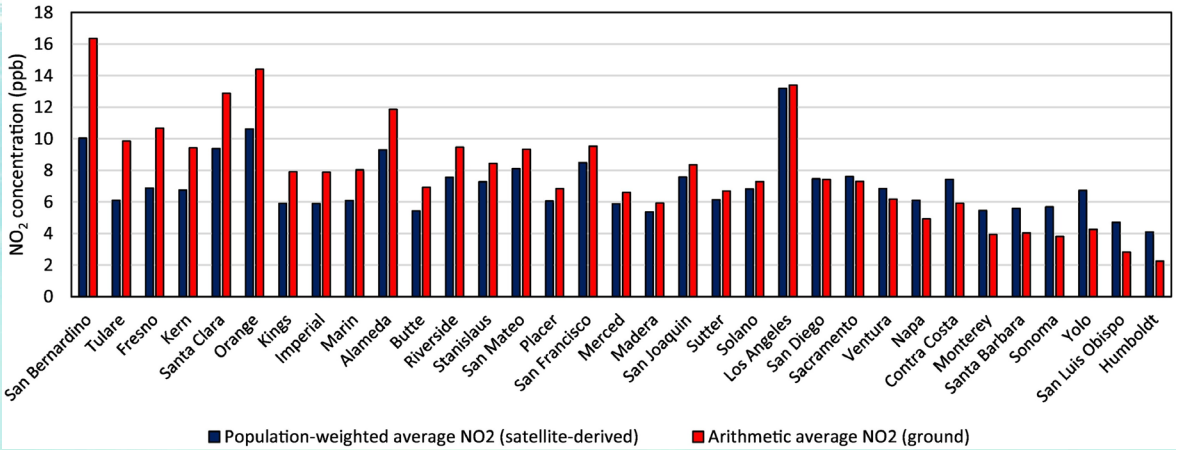
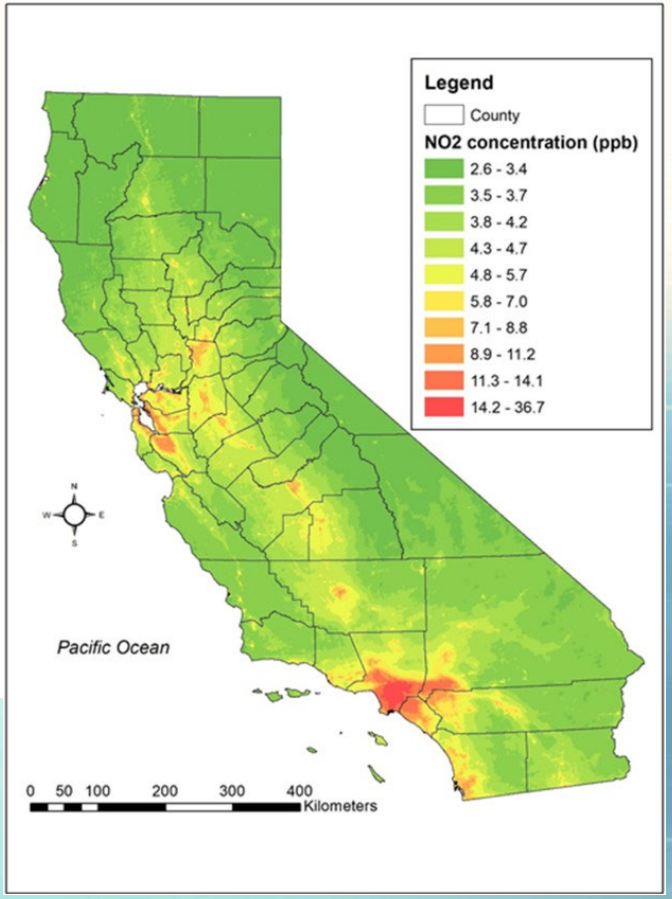

18
16
14
12
10
8
6
4
2
0
NO2 concentration (ppb)
San Bernardino
Tulare
Fresno
Kern
Santa Clara
Orange
Kings
Imperial
Marin
Alameda
Butte
Riverside
Stanislaus
San Mateo
Placer
San Francisco
Merced
Madera
San Joaquin
Sutter
Solano
Los Angeles
San Diego
Sacramento
Ventura
Napa
Contra Costa
Monterey
Santa Barbara
Sonoma
Yolo
San Luis Obispo
Humboldt
Population-weighted average NO2 (satellite-derived)
Arithmetic average NO2 (ground)


Legend
County
NO2 concentration (ppb)
2.6 - 3.4
3.5 - 3.7
3.8 - 4.2
4.3 - 4.7
4.8 - 5.7
5.8 - 7.0
7.1 - 8.8
8.9 - 11.2
11.3 - 14.1
14.2 - 36.7
N
W
E
S
Pacific Ocean
0 50 100 200 300 400
Kilometers

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