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Evaluating the Impact of Baseline Ozone in California using Ozone-Sonde Measurements at Trinidad Head, CA (THD): Overview

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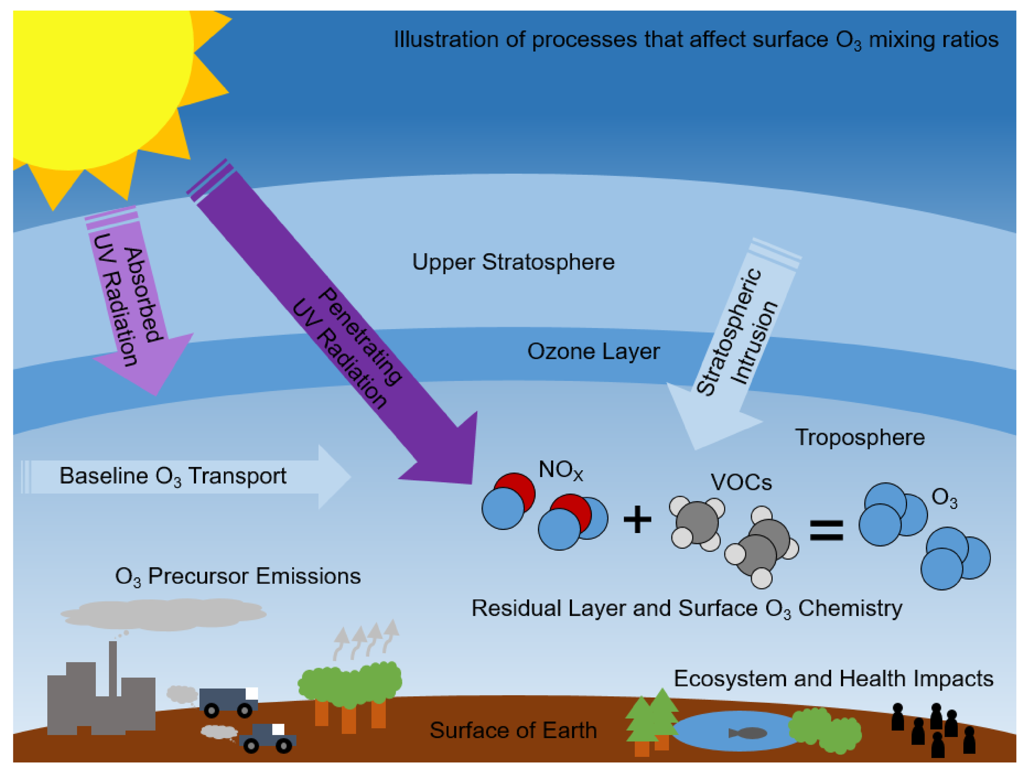
I. Background

Ozone (O_3)

- Surface O_3 is **formed through photochemical reaction** between oxides of nitrogen (**NO_X**) and volatile organic compounds (**VOCs**)
- Exposure to O_3 can **trigger health problems** such as decreased lung function and pulmonary inflammation, especially for children, elderly, and those with pre-existing health conditions such as asthma
- Ground-level O_3 can **harm** sensitive vegetation and **ecosystems**

Ambient Air Quality Standards

- Based on public health and welfare assessment, the California Air Resources Board (**CARB**) approved a **new 8-hr O_3 California Ambient Air Quality Standards (CAAQS)** of 70 parts-per-billion (ppb) in April 2005
- In October 2015, EPA followed suit and adopted the 70 ppb threshold for **8-hr O_3 National Ambient Air Quality Standards (NAAQS)**



Current Ambient Air Quality Standards for O_3

Averaging Time	CAAQS	NAAQS
1-hour	0.09 ppm	
8-hour	0.07 ppm	0.07 ppm

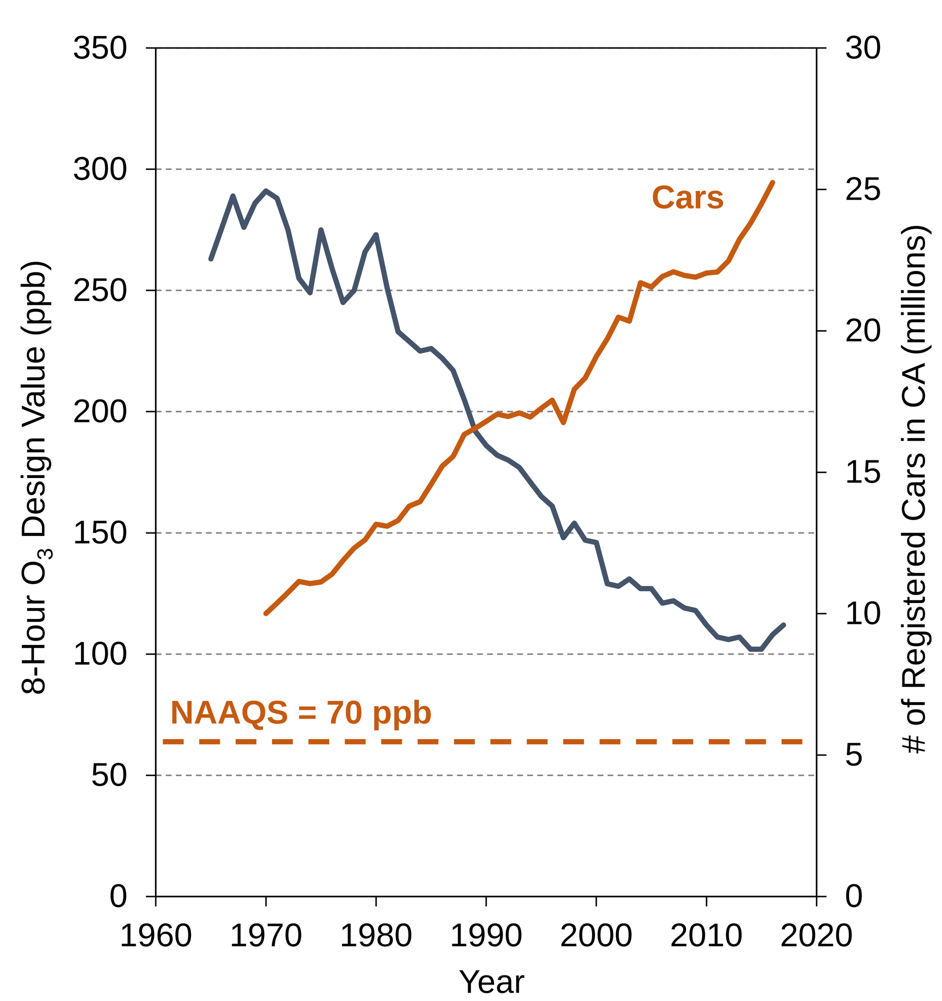
II. California's Air Quality Improvement Initiatives

Rules and Regulations Related to O_3

- California's primary O_3 reduction strategy is **concurrent VOC and NO_X emission controls**:
  - **1970s** - First automobile NO_X standards in the nation, implementation of three-way catalytic converters
  - **1980s** - Controls on power plants and boilers
  - **1990s** - Clean Air Act revision, Consumer Product Regulations, California's Reformulated Gasoline program, new standards for cleaner burning diesel and gasoline
  - **2000s** - Truck Engine Emission Standards
  - **2010s** - Advanced Clean Cars, Low NO_X Diesel Engine Emission Standards, VOC standards for consumer products

Accomplishments

- **Maximum 8-hr O_3 is a factor of 3 lower** in SoCAB despite a threefold increase in the number of on-road passenger cars, doubling of population and economic growth
- Avoidance of ~500 premature deaths in California annually from reduced O_3 levels



III. California's O_3 Challenges

Attainment of O_3 Ambient Air Quality Standards

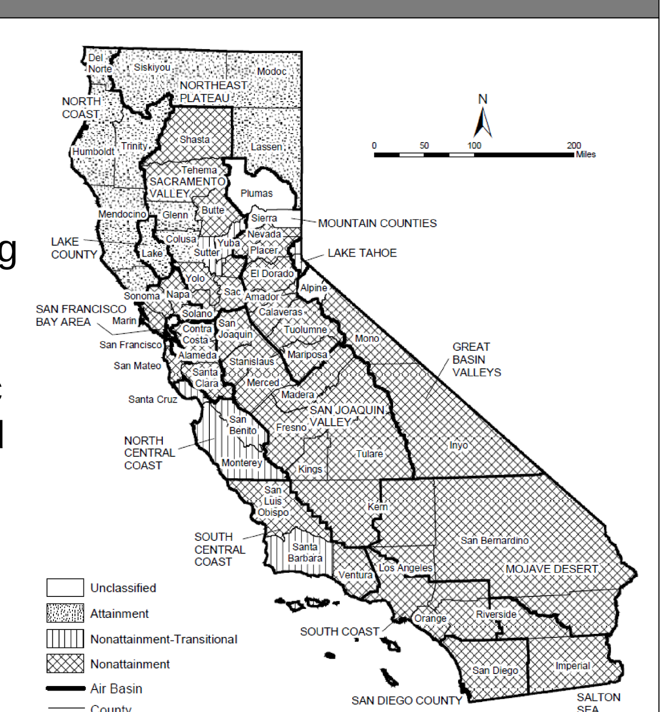
- In 2016, CARB recommended U.S. EPA to designate **19 areas** as O_3 nonattainment under NAAQS
- In 2017, CARB designated **24 areas** as O_3 nonattainment under CAAQS
- Stringent State and Federal O_3 standards makes attainment more challenging

Influence of Baseline O_3 and O_3 Transport

- Effect of changing Asian air pollution emissions and subsequent trans-Pacific long-distance O_3 transport on U.S. air quality are not fully understood/tracked
- Influence of **baseline O_3** at high elevation sites and **stratospheric intrusion** at lower elevation sites can result in **8-hr O_3 NAAQS exceedances**, both of which are not tracked extensively and cannot be controlled

Changing Contributions of O_3 Precursor Sources

- Relative importance of less characterized, non-vehicular O_3 precursor sources are growing as a result of significant air pollution emission reductions in the transportation sector



CAAQS O_3 Area Designation. *Source: CARB, Area Designations Map, June 2017*

IV. Current Research Efforts: California Baseline O_3 Transport Study (CABOTS)

Contract #14-308 UCD
$300,021
Study contribution of lower atmosphere O_3 to surface measurements in the San Joaquin Valley (SJV)

Contract #15RD007 SJSU
$281,699
Near daily ozone-sonde launches at Bodega to study vertical O_3 profiles and transport of background O_3 into California

Contract #15RD012 NOAA
$99,611
TOPAZ LiDAR profiling of O_3 to study the impact of O_3 aloft on surface air quality in the SJV

Contract #15RD021 CIRES
$4,950
CABOTS data analysis with focus on policy-relevant discussions; DOI 10.1007/s11783-016-0859-5

Contract #17RD004 NASA Ames
$65,549
Analysis of airborne O_3 measurements to improve the understanding of baseline O_3 impact on ground-level air quality in the SJV

Contract #17RD005 BAAQMD/RAMBOLL
$15,000
Improving the performance of Bay Area air quality modeling through sensitivity analyses of O_3 boundary conditions using baseline O_3 data

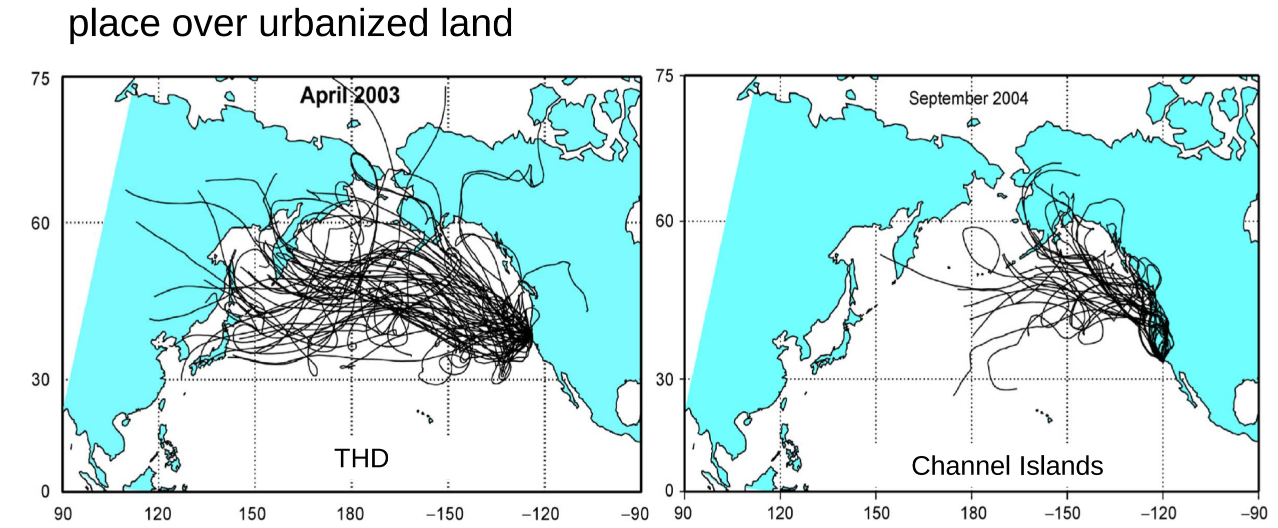
Contract #17RD010 HSU
$108,315
Continued ozone-sonde launches at THD to evaluate the transport of baseline O_3 into California

CABOTS

V. Evaluating the Impact of Baseline O_3 Using THD Data

V.1. Representative Measurement of Baseline O_3 at THD

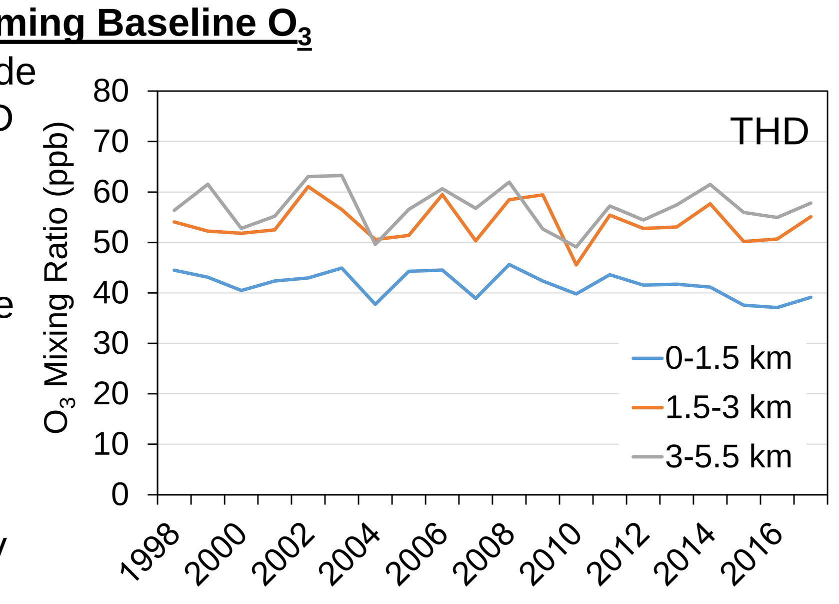
- Multiple back-trajectory model runs suggests ozone-sonde measurements at **THD well represents the trans-Pacific long-distance transported O_3**
- Other vertical O_3 profiling sites in California are frequently influenced by anthropogenic air emissions and atmospheric processes that takes place over urbanized land



Back-trajectories of air mass reaching THD and Channel Islands. ***Source: Oltmans et al., 2018, Atmospheric Environment***

V.2. Magnitude of Incoming Baseline O_3

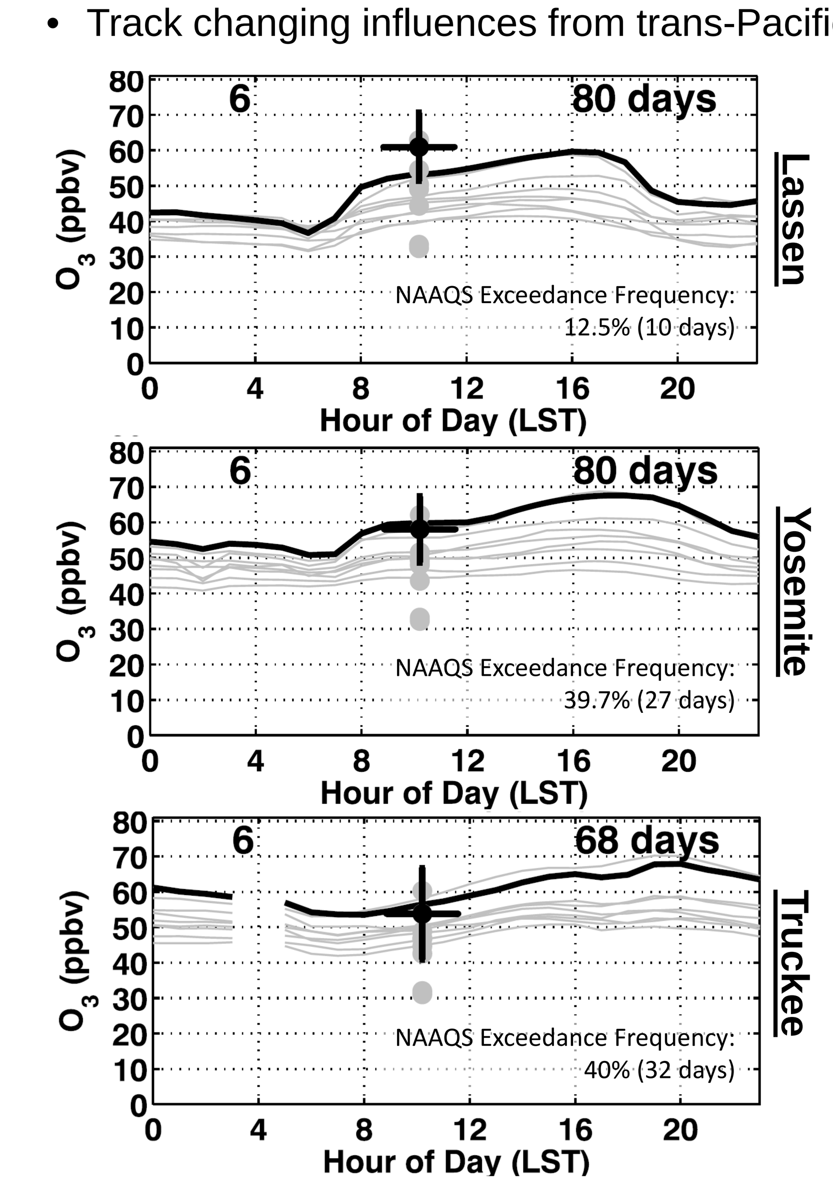
- Long-term ozone-sonde measurements at THD revealed that annual average incoming **baseline O_3 often reached 60 ppb** in the upper troposphere



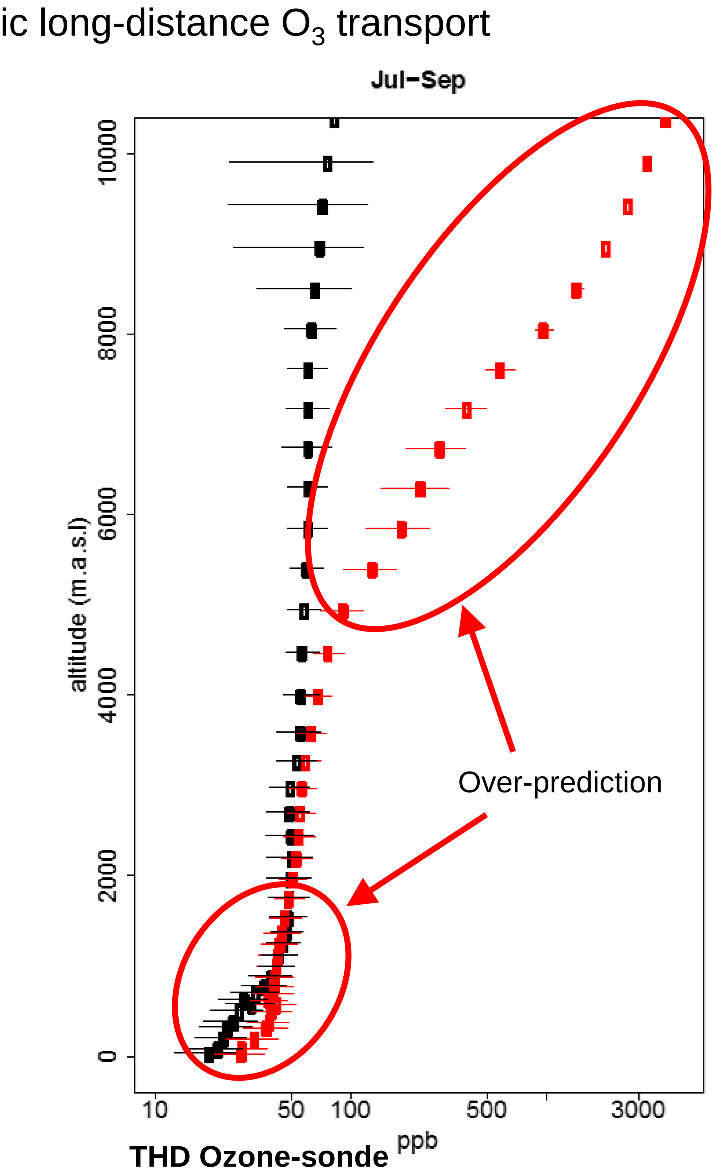
Trend of vertical O_3 mixing ratios at THD. ***Source: NOAA ESRL/GMD, https://www.esrl.noaa.gov/gmd/ozwv/ozsondes/***

V.3. Application of THD Ozone-Sonde Measurements

- Evaluation of high surface O_3 days at elevated O_3 monitoring sites for AAQS
- Improving global and regional air quality models using boundary layer height and vertical O_3 profiles to constrain O_3 mixing ratios and meteorological influences over West Coast and further down inland
- Track changing influences from trans-Pacific long-distance O_3 transport



Covariance of THD ozone-sonde and surface O_3 monitoring data based on a single self-organizing map (SOM) cluster analysis representing vertical O_3 profiles. ***Source: Stauffer et al., 2016, JGR***



Comparison between observation and modeled vertical O_3 profile near THD. ***Source: BAAQMD/CARB/Ramboll, contract #17RD005***

VI. Summary

- California has 8-hr O_3 NAAQS attainment challenges that must be addressed beyond primary emission controls
- Understanding the influences of baseline O_3 on surface measurements can identify exceptional events and will lead to a more refined development of air pollution control and mitigation strategies
- THD ozone-sonde data provides critical information that is currently being used to improve air quality modeling for State Implementation Plan development

VII. Acknowledgement

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