California Environmental Protection Agency



California Air Resources Board (ARB) Greenhouse Gas Research Program

- Overview of Methane Emission Research -



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California Global Warming Solutions Act (AB 32)

- * AB 32 charged Air Resources Board (ARB) with:
 - * Monitoring, reporting and regulating sources of emissions of greenhouse gases (GHG) that cause global warming in order to reduce emissions
 - * Determine the GHG emissions in the state
 - * Rigorous and consistent accounting of emissions
 - Monitoring compliance with any rule, regulation, order, emission
 limitation, emissions reduction measure, or market-based compliance
 mechanism

ARB Emission Inventory

- ARB develops and publishes an Annual GHG Emission Inventory
- * AB32 GHGs inventoried:
 - * Carbon dioxide (CO2),
 - * Methane (CH4),
 - * Nitrous Oxide (N2O),
 - * Fluorinated gases (F-gases) HFCs, PFCs, SF6
- * Tracks progress to California goal of reducing GHGs to 1990 level by 2020
- * Incorporates reported emissions data from large emitting entities covered under Mandatory Reporting Regulation (MRR)
- * Incorporates other State and national data using the using latest science

Importance of Methane

- Important component of Statewide GHG emissions
- * Key Short-lived Climate Pollutant (SLCP) *
 - * Average lifetime of 12 years
 - * 100 year GWP of 25
 - * 20 year GWP of 72
- * Leads to formation of ground-level ozone, an important air pollutant and a powerful GHG
- Capturing CH4 emissions can provide clean fuel, and reduce short-term climate impacts



short term: Their impact on warming more than doubles, to almost 40 percent of California's greenhouse gas inventory, when "global warming potentials" are computed over 20 years, rather than 100 years.

*IPCC Fourth Assessment Report (AR4)

Statewide Methane Inventory



ARB's GHG Research Program

ARB's GHG research program is designed to support California's

GHG emission reduction efforts

Linking ambient measurements to study emission sources



Regional Emissions Research Monitoring Towers and Aircrafts

Ambient Monitoring Towers





California's GHG Monitoring Network



Source-level Emissions Research Measurement Tools

ARB Mobile Platforms







Flux Chambers







Statewide Methane Findings

- Aircraft and GHG Network studies suggest statewide methane emissions greater than previously known
- Central Valley has majority of emissions
- Research findings have helped to improve inventory
- * Additional measurements expected to provide new information



California-specific total CH₄ emissions (nmol m⁻² s⁻¹)

Reference: Fischer and Jeong (2012), Inverse Modeling to Verify California's Greenhouse Gas Emission Inventory, CARB Contract No. 09-348

SoCal Methane Findings

- * 2007 Mt. Wilson study suggested methane emissions were underestimated
- Led to the development of regionalized inventory by ARB
- 2014 methane

 emission inventory
 and ambient
 measurements
 now well
 correlated



Reference: Hsu, et al. (2010) Atmospheric Environment, pp. 1–7

Methane Inventory Improvement for 2015 Release

- Concentrated effort to improve methane emission estimates, especially fugitives, over the last year
 - * Incorporates detailed Oil & Gas survey results
- * Adds ~3 MMTCO₂e^{*} methane from pipeline leaks and oil & gas production losses to 2012 emissions
- * ARB will release the 2000 2013 inventory in April 2015
- Other sources (e.g. abandoned wells, natural seeps) under study for future updates

*AR4 100-yr GWP

Ongoing ARB Research Efforts

- Evaluating isotopic CH4 signature of emission sources
- * Study of chemical signature of co-pollutants for source attribution
- * Long-term Carbon signature trend
- * Collaboration with Megacities Carbon Project
- * Oil and Gas Survey
- * ARB contract on methane leakage from different material types (GTI)
- Study emissions from motor vehicles, dairies, landfills, manure, oil and gas sector
- * Expanding Statewide GHG Monitoring

ARB Research Collaborators

Satellite Measurements (700 km)

Aerial Measurements (<1 km)

regon

Ground-level Measurements





<u>Towers</u> ARB, Caltech LBNL, LLNL Scripps <u>Mobile</u> LBNL Picarro UC Irvine

Field Studies UC Berkeley UC Davis Other UCs

Remote Sensing Caltech JPL Laboratory Caltech NOAA UC Irvine

Summary

- ARB's GHG Research Program critical for success of AB 32 programs
 - * Track GHG emission trends in the state,
 - * Evaluate and inform ARB GHG inventory, and
 - * Identify, implement, and validate effective emission mitigation strategies
- Current efforts are helping to improve emission inventories and source attribution for CH4 emissions
- Continued research collaborations invaluable to help California meet the short- and long-term climate goals





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Thank you!