California Air Resources Board (ARB) Greenhouse Gas Research Program

- Overview of Methane Emission Research -

Abhilash Vijayan, Ph.D., PE
Research Division
California Air Resources Board

March 12, 2014
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 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

*IPCC Fourth Assessment Report (AR4)
Statewide Methane Inventory

- Oil & Gas
- Wastewater
- Landfills
- Ruminant Digestion
- Manure Management
- Entree Fermentation
- Production
- Pipeline
- Industrial & Misc.
ARB’s GHG research program is designed to support California’s GHG emission reduction efforts.
Regional Emissions Research
Monitoring Towers and Aircrafts

Ambient Monitoring Towers

Aircraft measurements

2010 CalNex study
(May-June 2010)
California’s GHG Monitoring Network
Source-level Emissions Research

Measurement Tools

ARB Mobile Platforms

Flux Chambers
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.

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

Concentrated effort to improve methane emission estimates, especially fugitives, over the last year

- Incorporates detailed Oil & Gas survey results

- Adds ~3 MMTCO$_2$e* 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
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)**
- **Ground-level Measurements**

**CEC**
- Towers
  - ARB, Caltech
  - LBNL, LLNL
  - Scripps
- Mobile
  - LBNL
  - Picarro
  - UC Irvine
- Field Studies
  - UC Berkeley
  - UC Davis
  - Other UCs
- Remote Sensing
  - Caltech
  - JPL
- Laboratory
  - Caltech
  - NOAA
  - UC Irvine

**NASA**

**CIRPAS JPL NOAA**
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
Thank you!