The 2014 Front Range Air Pollution & Photochemistry Experiment (FRAPPÉ)

An overview for the RMNP Agriculture Subcommittee

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Colorado Department of Public Health and Environment

Overview

- Two simultaneous major research field campaigns coming to the Front Range **July 15-August 15, 2014**
  - DISCOVER-AQ (NASA)
  - FRAPPÉ (NCAR)
- Overlap with Other Studies
  - Oil and Gas Dispersion Study (CDPHE, CSU, others)
  - Ag Early Warning Pilot
  - Ongoing Efforts from CSU, CU, NOAA

Major funding agencies:

Partners:
EPA, NOAA, NPS, GO3 & others

NASA

NSF

STATE OF COLORADO 1876
Colorado Department of Public Health and Environment

FRAPPÉ Motivation

- FRAPPÉ will improve our overall understanding of air pollution in Colorado
- Air Pollution (including ozone & particulates) affects respiratory health and environment (vegetation, crop yields)
- Pollution threatens Colorado's natural beauty

  (haze, mountain views, etc.)
- Pollution contributions occur across industries and sectors

  (industry, transportation, agriculture, etc.)
- Colorado has a history of putting a priority on good air quality

Why FRAPPÉ in 2014?

- CDPHE's support of FRAPPÉ helped attract NASA's DISCOVER-AQ to Colorado
- Dovetails with other ongoing studies

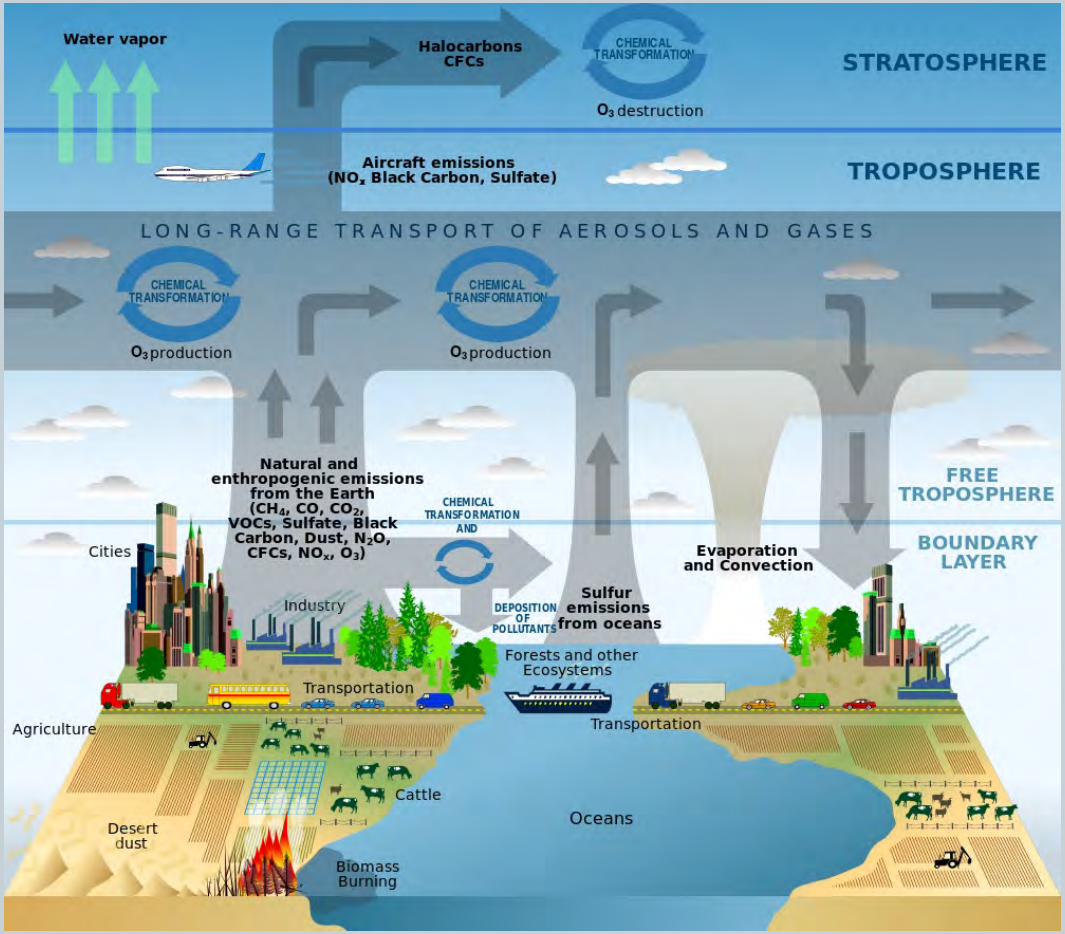
  (CSU, NOAA, CU, early warning, etc.)
- Need to validate meteorological, photochemical models and satellite observations
- Improve our understanding of emissions across all sectors
- Improve our understanding of how emissions are transported into, out of, and within Colorado

FRAPPÉ: Relevance to Colorado's Agriculture Industry

- Complex air quality problems require cooperative solutions
  (e.g. RMNP initiative, O&G cooperative rulemaking, etc.)
- FRAPPÉ will help answer industry questions about
  - emissions inventories
  - pollution transport and photochemistry
- RNMP initiative and early warning system are big steps that will benefit from the results of FRAPPÉ and DISCOVER-AQ
- FRAPPÉ will provide data on characteristic emissions across sectors and industries
  (air quality concerns from agriculture are mainly methane and nitrogen)

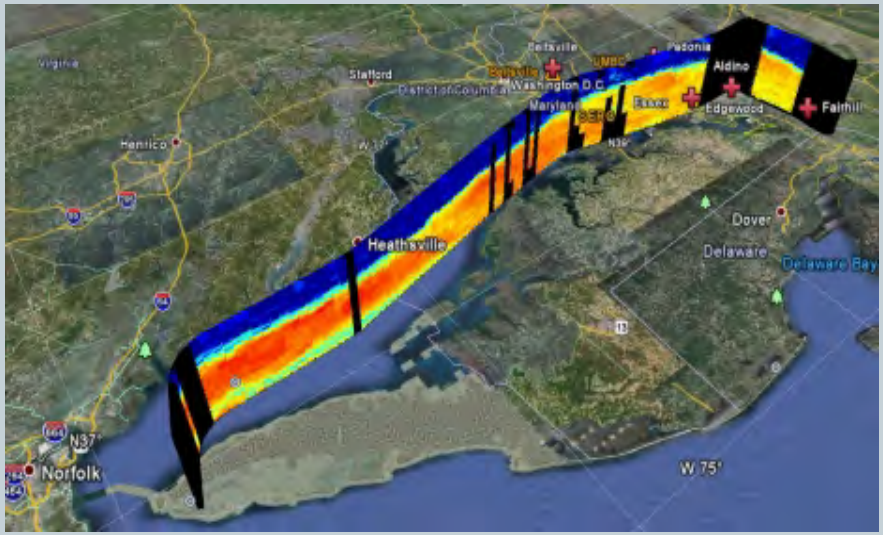
The Atmosphere, Emissions and Pollution

- The atmosphere is complex, with many emission sources and types of pollution
- Concerns include:
  - ground level ozone + precursors (VOCs, NOx)
  - particulates
  - greenhouse gases
  - nitrogen deposition
- Colorado has rapid urban and industrial growth, complex terrain and meteorology, active photochemistry



What is an Air Quality Field Study?

- Non-operational (duration ~weeks/months)
- Research-grade instruments
- Basic Science or targeted goals
- Provides a comprehensive snapshot of local and regional conditions during the study
- Intensive—highly concentrated, frequent, high quality contributions from:
  - ground sites
  - mobile laboratories
  - sondes and balloons
  - aircraft measurements
  - modeling
  - satellite measurements



Discover-AQ flight track for Baltimore

DISCOVER-AQ

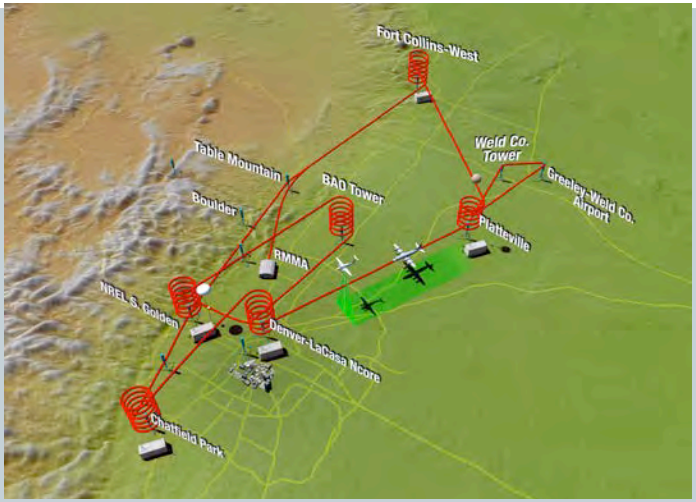
Deriving Information on Surface conditions from Column and Vertically Resolved Observations Relevant to Air Quality

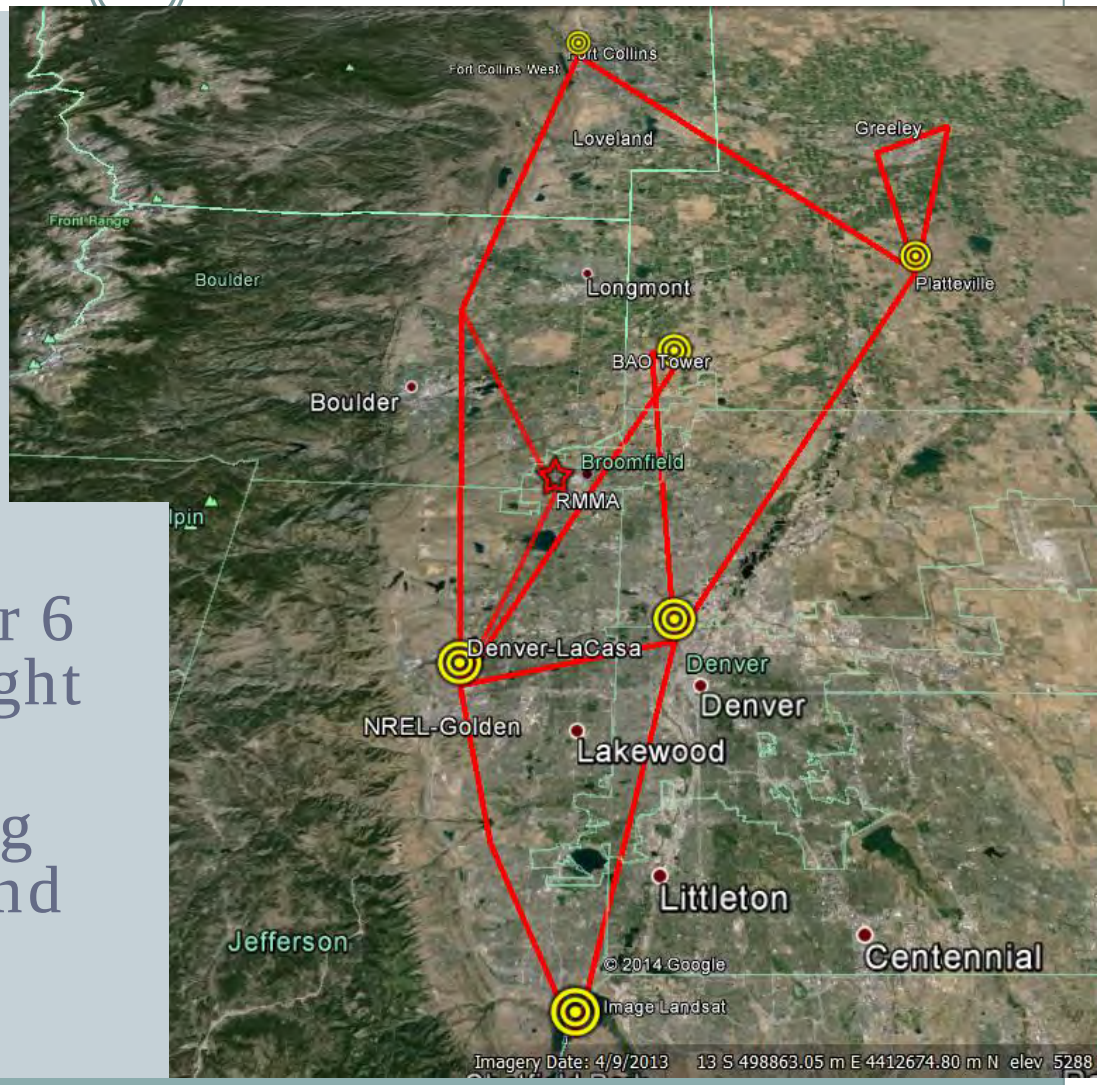
- Goal: Improve satellite capability to interpret AQ conditions near the surface (NO_2, NH_3, formaldehyde, CO, O_3, particles).
- 4 Regions: Baltimore (2011), San Joaquin Valley (2013) Houston (2013), CO Front Range (2014)
- 2 Aircraft (12-18 flights each)
- Ground measurements (6 major sites tied in with CDPHE sites)
- Ties satellite measurements with state observation networks, other research efforts

King Air twin engine turbo prop (LIDAR)

WP-3 (full AQ instrumentation suite)

DISCOVER-AQ





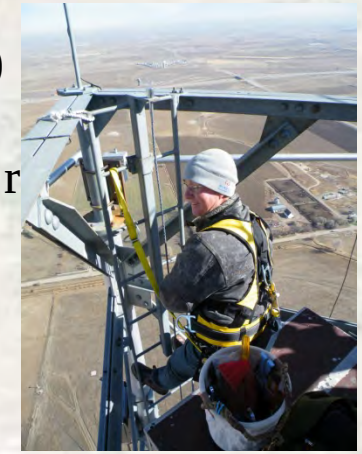
- Fixed Flight Plan
- Spirals will be flown over 6 ground sites, 3 times/flight day
- In-situ & upward-looking instruments, satellites and aircraft instruments will complement each other

FRAPPÉ

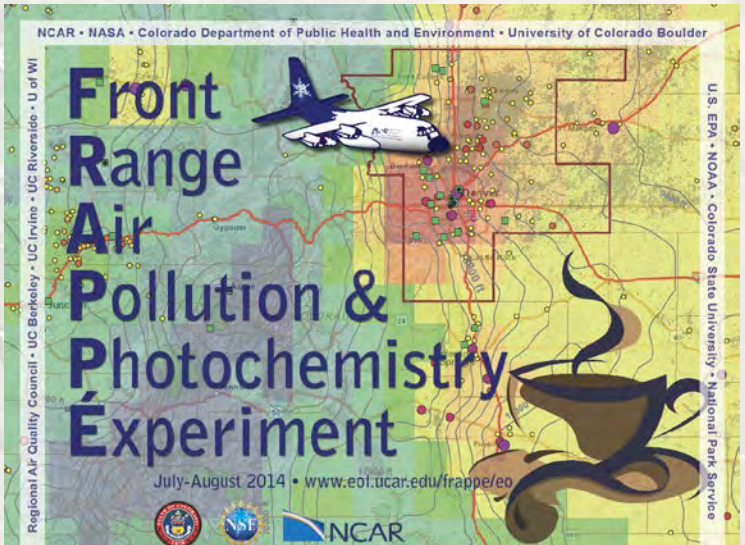
- Organized by NCAR
- Major funding from CDPHE and NSF
- 1 aircraft, 12-18 flights
- Continuous ground measurements
- Ground-based mobile lab measurements
- Joint outreach with NASA

<u>Same 6 Major Ground Sites</u>

Ft. Collins West
BAO Tower (Erie)
Platteville
Downtown Denver
NREL
Chatfield Park



& additional ground sites

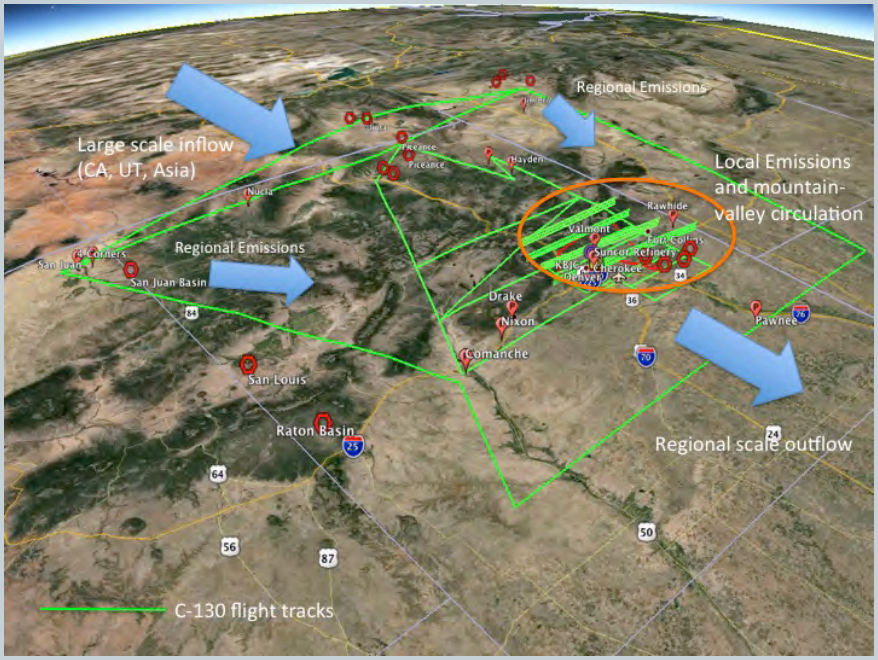


CDPHE Funded Science during FRAPPÉ

- RFP brought 20+ proposals, ($3.7M proposed,$2M granted including:
  - Augmented NCAR aircraft instrumentation, modeling & expertise
  - Funding of Aerodyne mobile lab
  - Augment and expand DISCOVER-AQ ground sites
    - BAO (Erie) ground site
    - Canisters/isotope analysis for methane + VOCs on aircraft and ground
    - Ozone tethered balloons
    - Ozone transects from planes to Divide
- Other researchers drawn to larger field campaign context
- **Outreach budget** funded by NSF (informational material, educator workshop, open house and media day, personal pollution monitors, radio, TV, newspapers, etc.)

FRAPPÉ NCAR C-130 aircraft

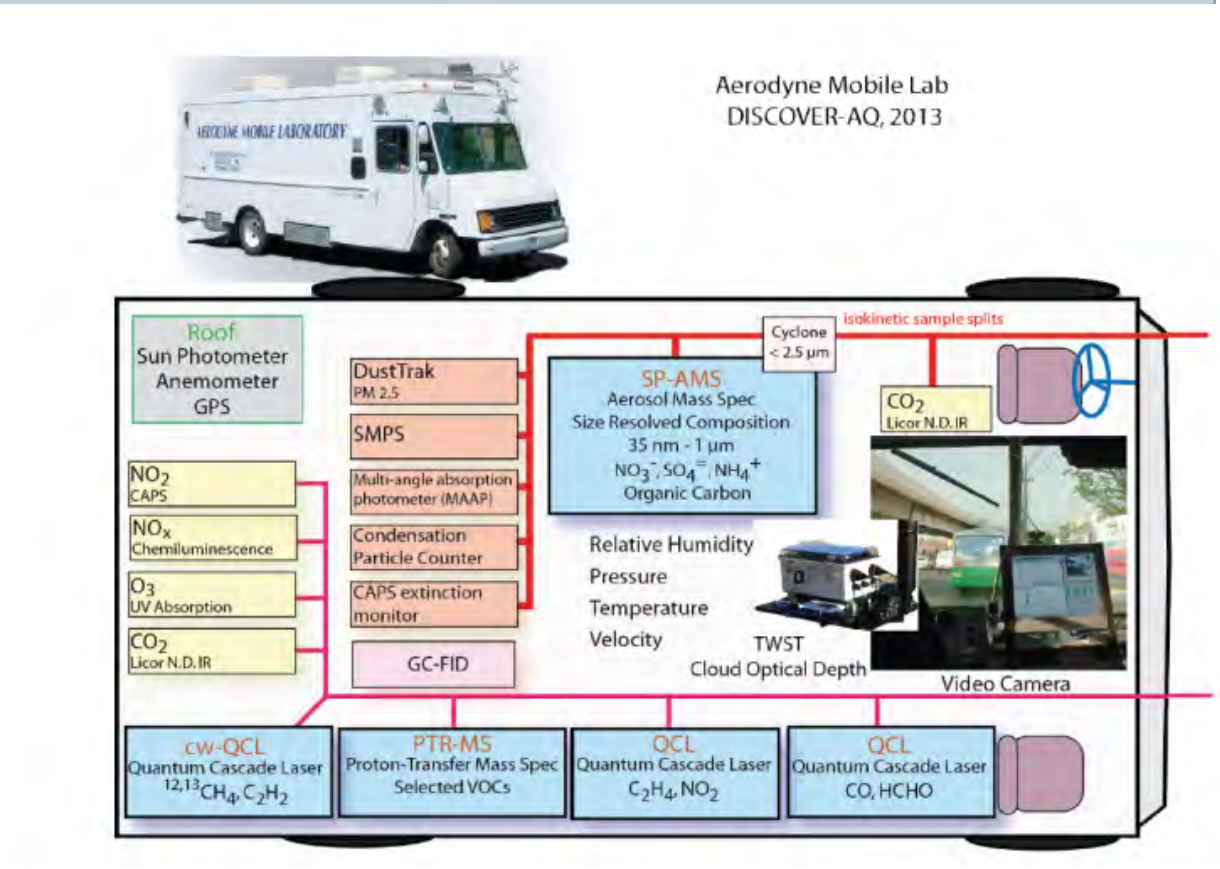
- C-130 is outfitted with comprehensive chemistry payload
- Flexible itinerary and flight path based on forecasts
  - will characterize circulation and transport patterns
  - will examine pollutant transport into and out of Colorado
  - will quantify point and area sources within and outside Front Range



- on C-130 CDPHE funded:
  - ethane, formaldehyde
  - VOCs (canisters)
  - ammonia
  - aerosol measurements
  - NO_x/NO_y measurements
  - SO_2

FRAPPÉ Mobile Lab

- Aerodyne mobile lab is effectively a ground-based aircraft
- Can get near sources, operate on-road



Source: Aerodyne, Inc.

Other Collaborators

- NPS will have a ground site near Long's Peak Ranger Station
- EPA will provide ~6 NOx instruments to be co-located with CDPHE sites
- 3 ozone LIDARs (funded by NASA)
- Modeling and Forecasts by CDPHE, NASA, NCAR,EPA, etc.
- NOAA: mobile labs, Erie tower site, wind profilers, ozone LIDAR
- CU/CIRES and CSU/CIRA researchers have received grants
- Ball Aerospace
- DOE aircraft?
- others

More information

- Outreach efforts to be coordinated by NCAR
- Open House Rocky Mountain Municipal Airport (Broomfield) 2 August, 2014
- FRAPPÉ:

  https://www2.acd.ucar.edu/frappe
- DISCOVER-AQ:

  http://www.nasa.gov/mission_pages/discover-aq/

- Other Questions: daniel.bon@state.co.us

Extra Slides

Colorado Methane Inventory