

FRAPPÉ

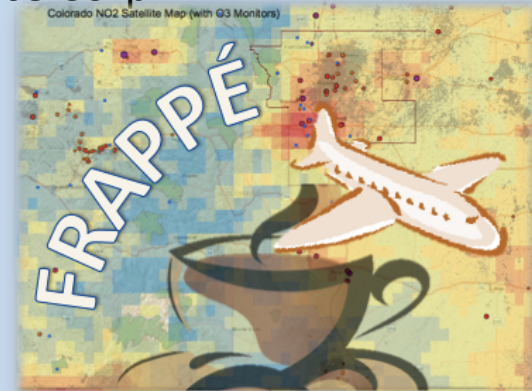
FRONT RANGE AIR POLLUTION AND PHOTOCHEMISTRY EXPERIMENT

Comprehensive observations are the key to understanding what drives AQ, improve models and allow for predictions/projections

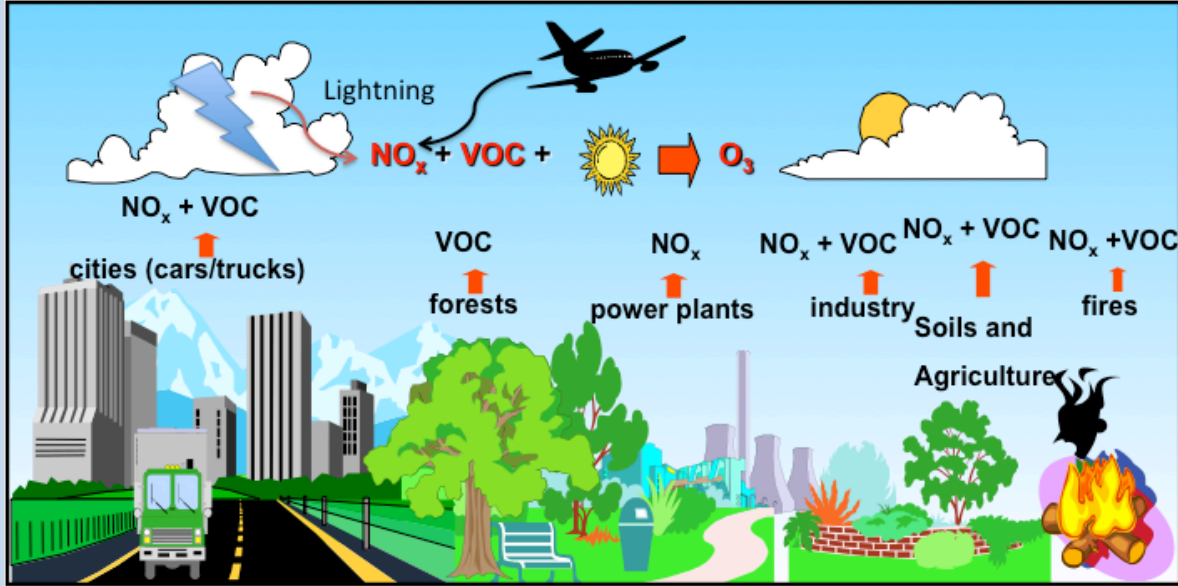
National Center for Atmospheric Research (NCAR-ACD, MMM),
NASA Airborne Science Program
Colorado Department for Health and Environment (CDPHE),
Colorado State University (CSU), University of Colorado Boulder,
CU Institute for Arctic and Alpine Research
Environmental Protection Agency (EPA) Region 8,
National Oceanic and Atmospheric Administration (NOAA ESRL),
National Park Service (NPS), Regional Air Quality Council (RAQC),
Storm Peak Laboratory (DRI), University of California, Berkeley,
University of Maryland, Caltech, Aecom, Aerospace Corp.

**Northern Colorado Front Range Metro Area
(NFRMA)
Summer 2014**

www2.acd.ucar.edu/frappe



Summertime Ozone



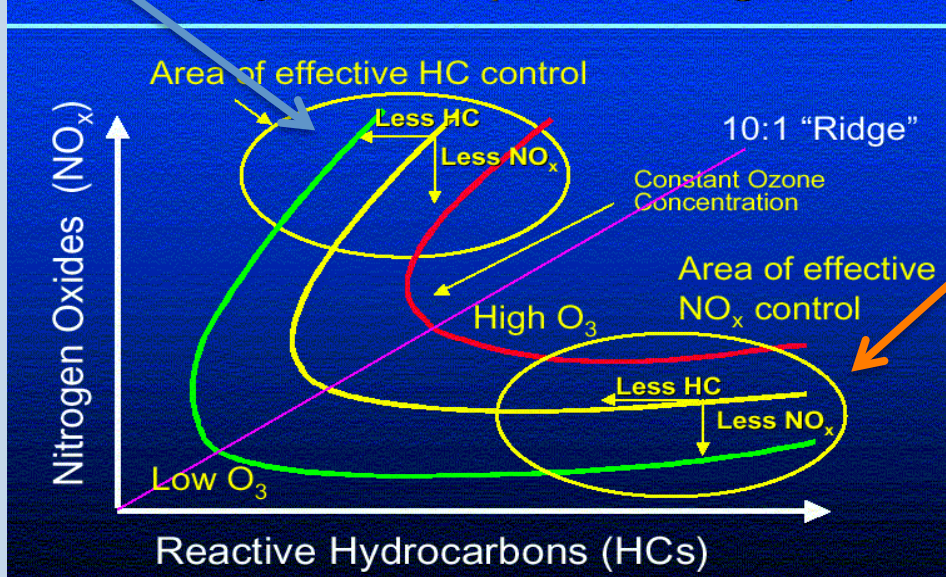
VOC limited

Ozone depends on the amount of VOCs. In these regions, controlling VOCs would reduce ozone.

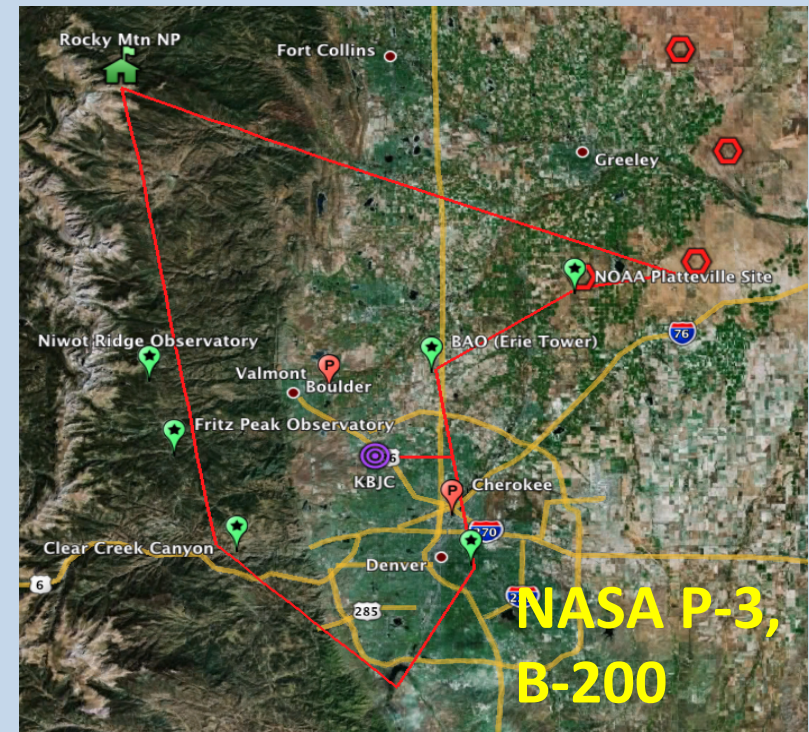
NO_x limited

Ozone depends on the amount of NO_x . In these regions, controlling NO_x would reduce ozone.

Ozone Isopleth Plot (EKMA Diagram)



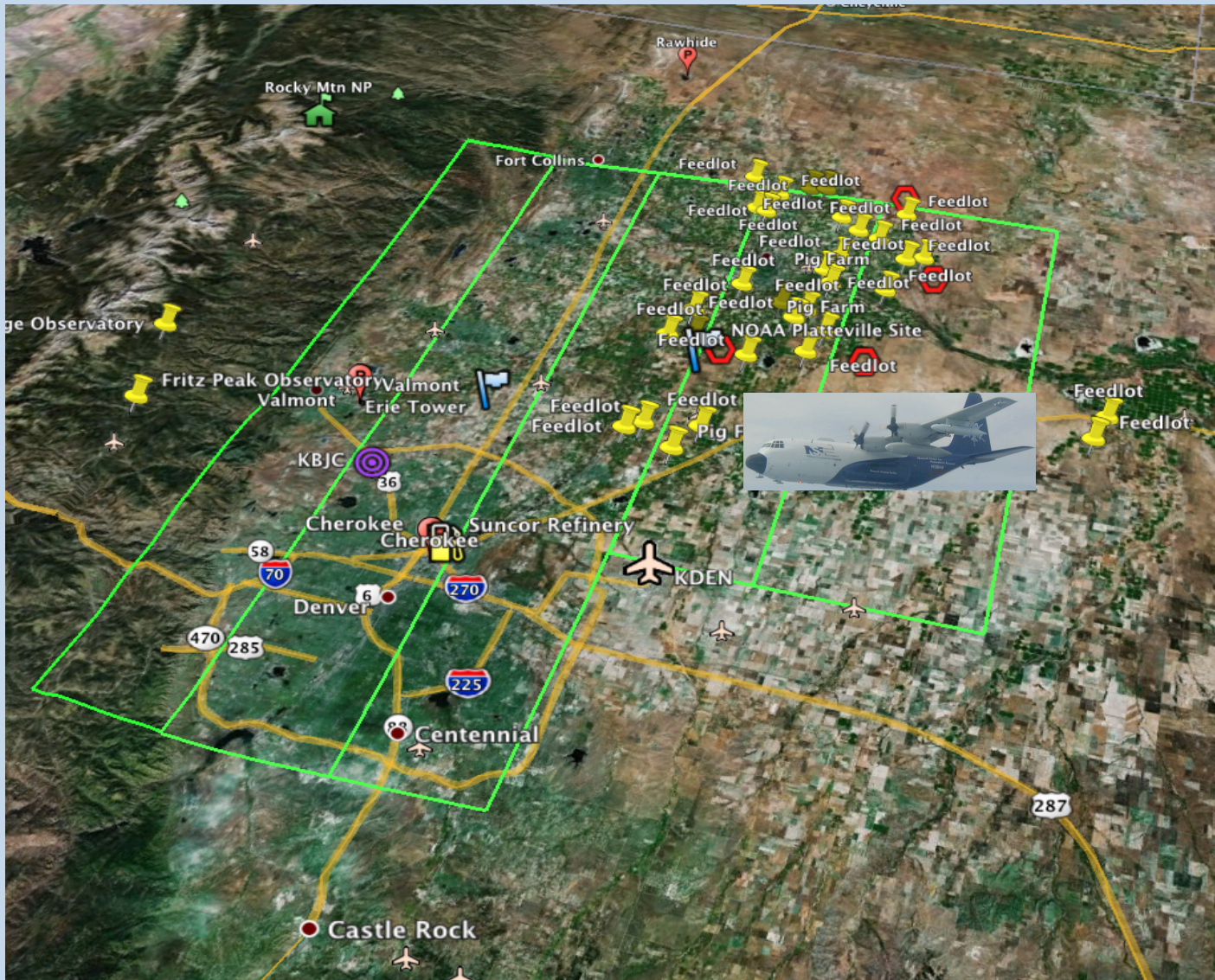
Three Complementary Field Campaigns



- **FRAPPÉ** NCAR – C130 & 2-3 ground sites in addition to existing sites (proposed to NSF) + Mobile lab (NOAA)
- **FRONT-PORCH** radars and other air motion sensing equipment (proposed to NSF)
- **NASA DISCOVER-AQ** aircraft and ground based operations (committed if C130 successful!)

Outstanding and rare opportunity for one of the most comprehensive suite of observations by combining three highly complementary campaigns!

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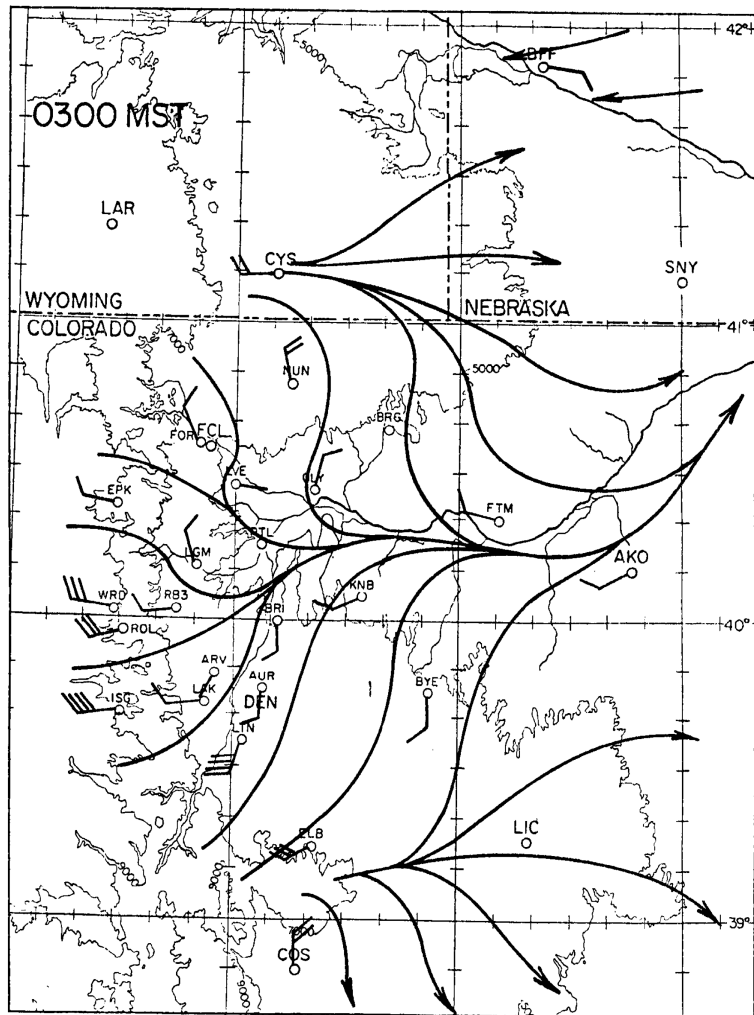


Fig. 5. As in Fig. 2, except for 0300 MST.

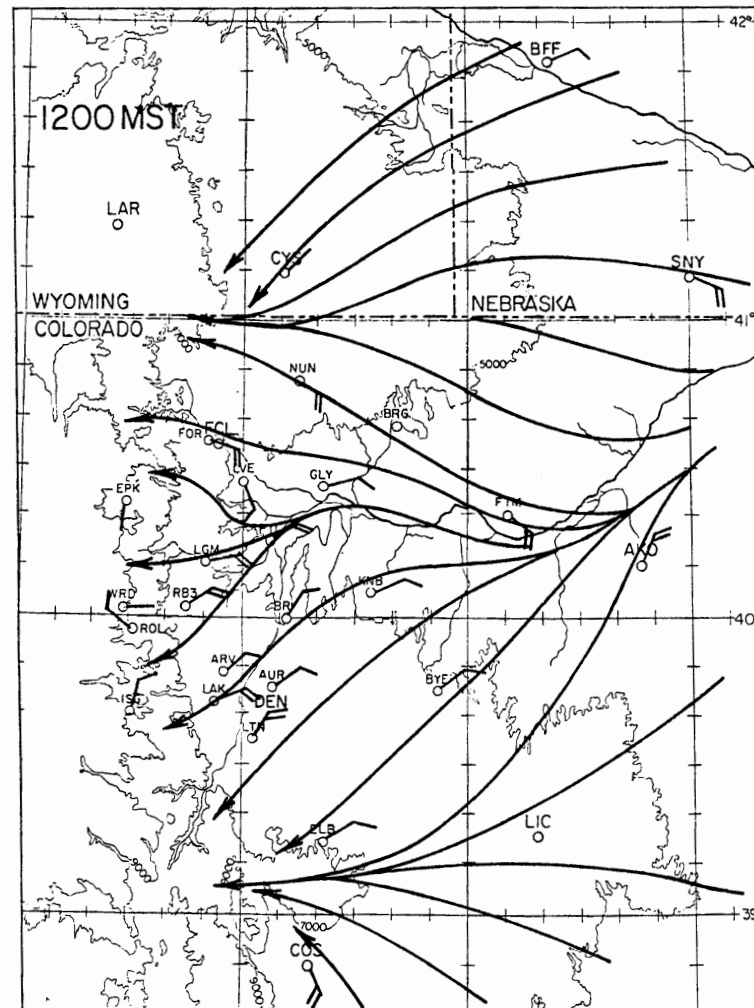
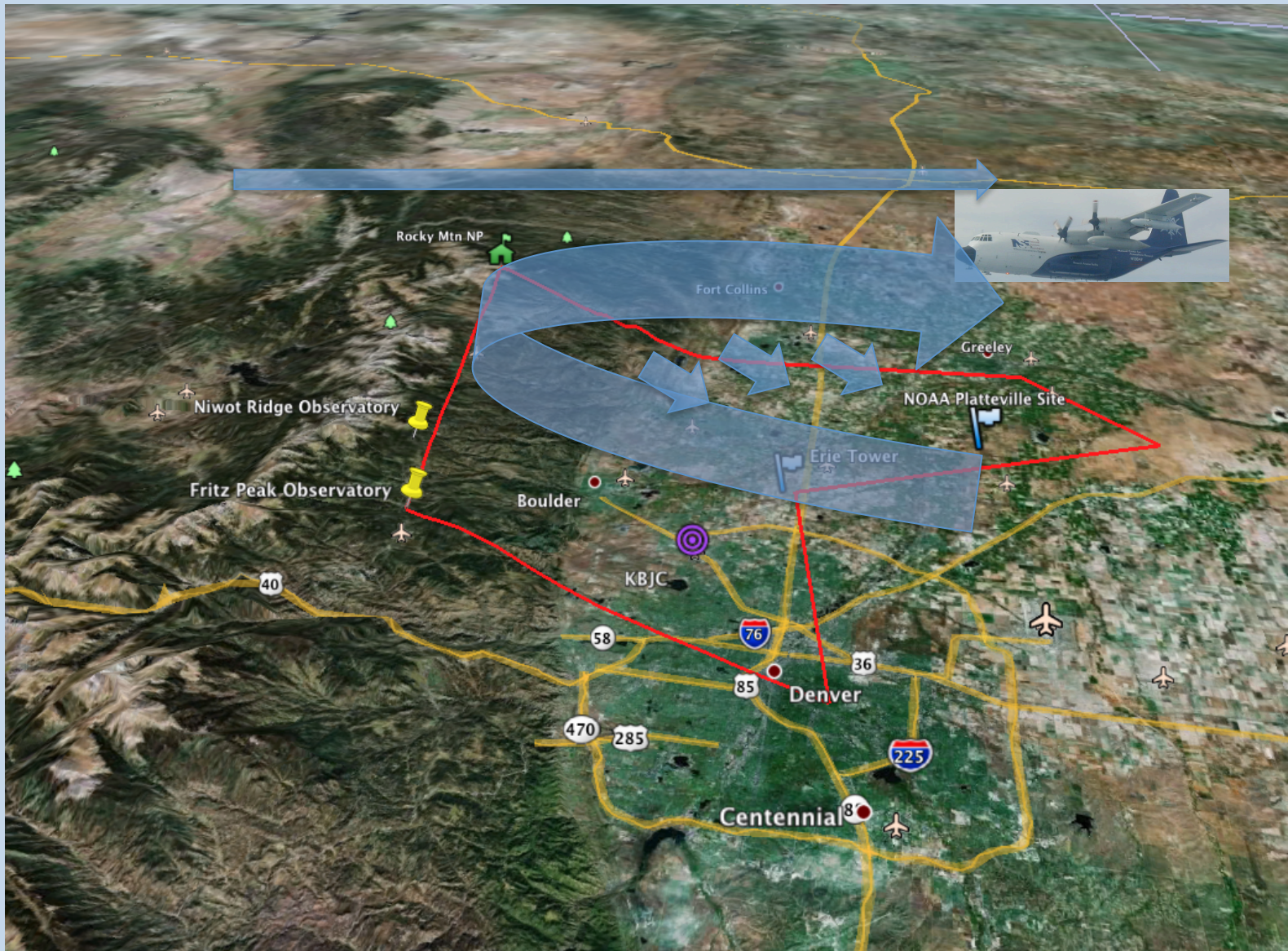


Fig. 14. As in Fig. 2, except for 1200 MST.

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- ▶ Understanding AQ requires understanding the **WHOLE ATMOSPHERE and its variability** – chemically, dynamically, physically.
- ▶ Vertical structure and mixing of emissions into the boundary layer and its evolution during the day is critical information – ***surface measurements are rarely sufficient to gain full picture.***
- ▶ Complicated flow structure due to mountain induced circulation ***make aircraft measurements critical.***
- ▶ Research adds significant value to policy/decision making.



DISCOVER-AQ

Deriving Information on Surface Conditions from Column and VERTically Resolved Observations Relevant to Air Quality (NASA Earth Venture mission)

How can satellites be used to inform about AQ?

1. Relate column observations to surface concentrations for aerosols and key trace gases
2. Characterize differences in diurnal variation of surface and column observations
3. Examine horizontal scales of variability affecting satellites and AQ modeling

Deployments and key collaborators

Maryland, July 2011 (EPA, MDE, UMd, UMBC, Howard U.)

California, January 2013 (EPA, CARB, UC-Davis & Irvine)

Texas, September 2013 (EPA, TCEQ, U. of Houston)

Colorado, Summer 2014 (EPA, NSF, NOAA, CDPHE)



DISCOVER-AQ

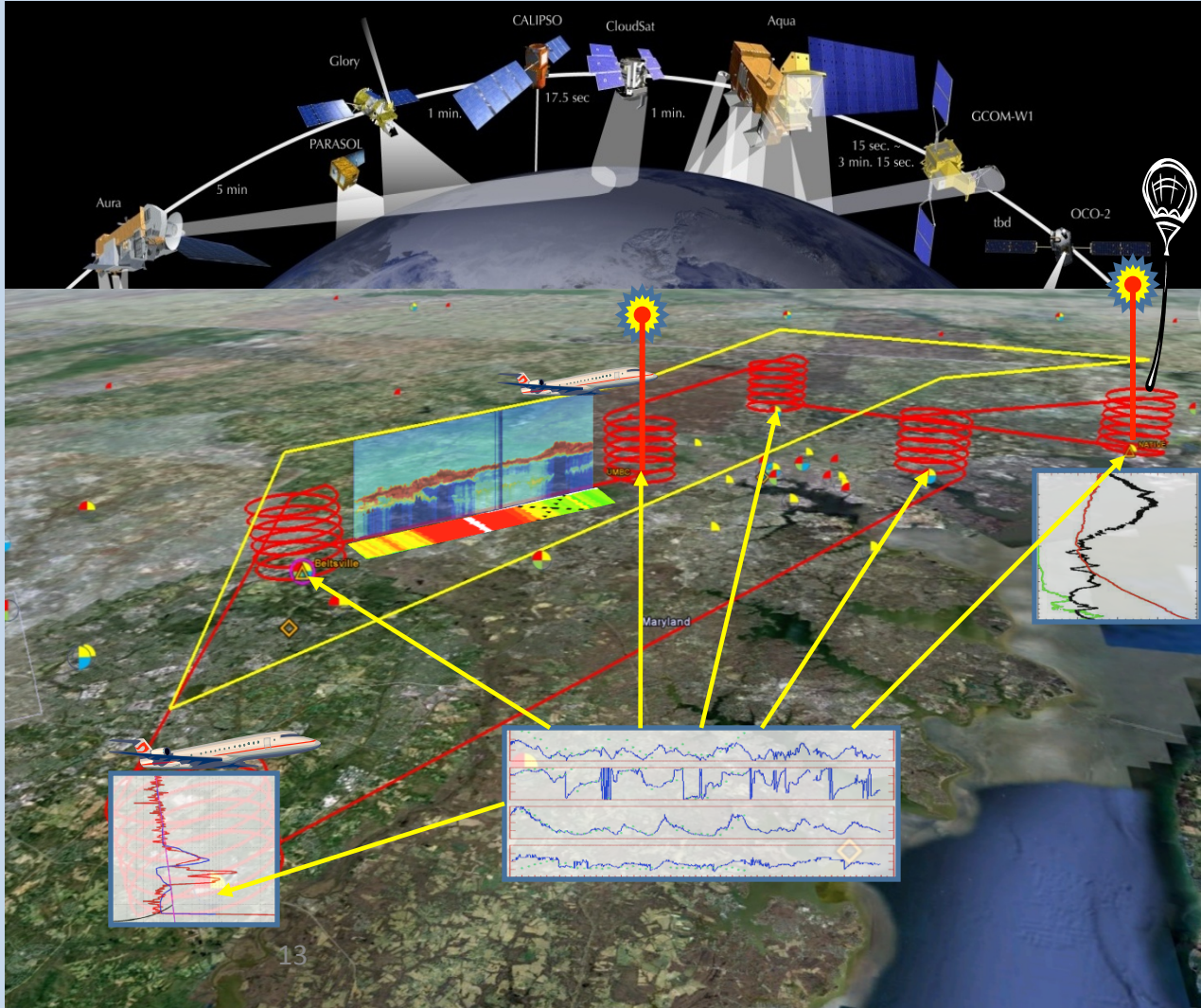
- Trace Gases and Aerosols
- Column, surface, and vertical profiling
- Diurnal Evolution
- ~15 flights over 4 weeks

NASA King Air
Column Measurements
Integrated from surface – 8 km

NASA P-3B
Vertical Profiling
Altitude Range: 500ft AGL – 5 km

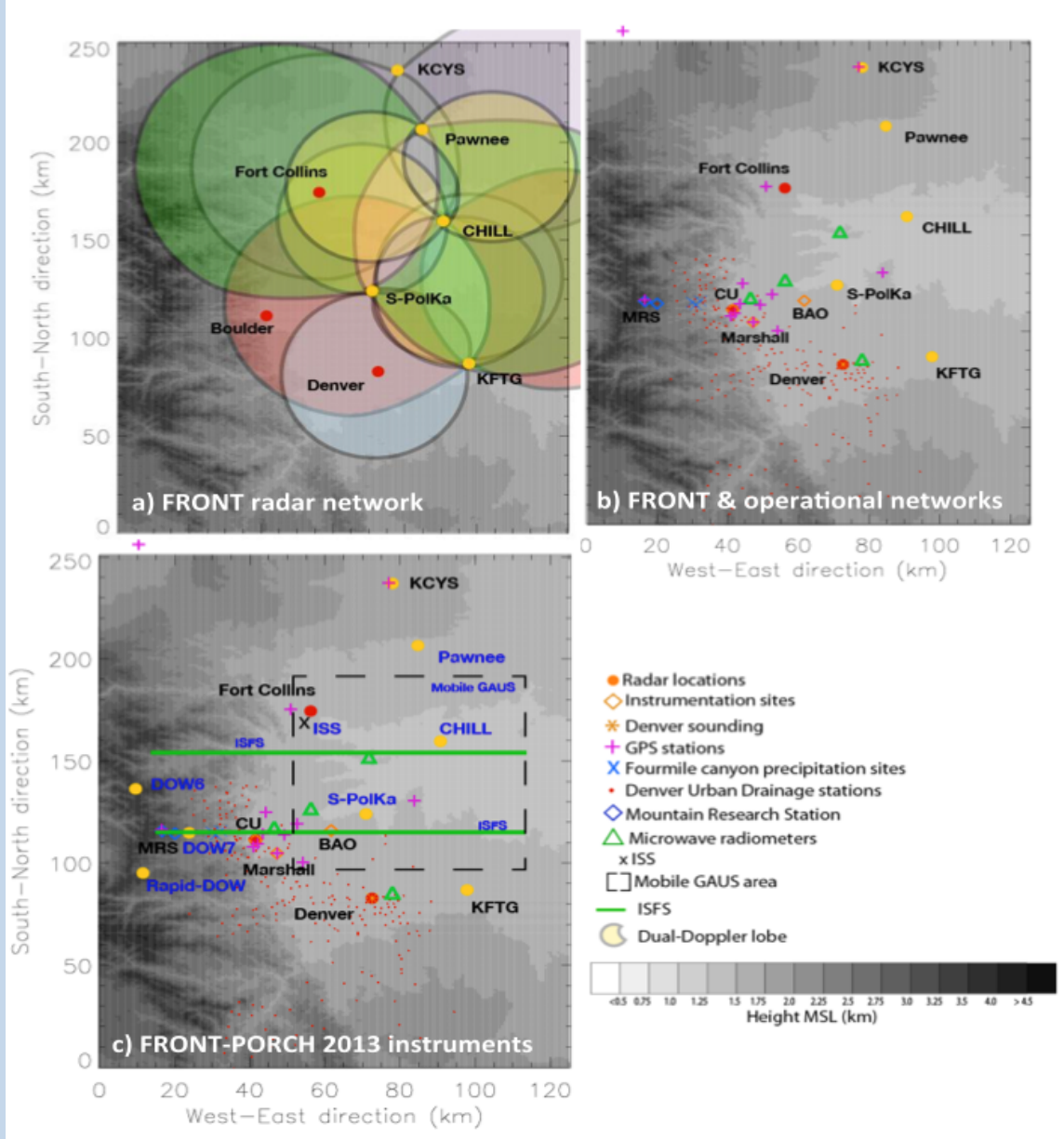
Surface
In situ
Remote sensing
Ozonesondes
Aerosol lidar
~ 4-6 ground sites

Key Measurements:
NOx, Ozone, CO, CO2, CH4,
Alkanes, Alkenes, Alkynes,
CH2O, Aldehydes, Aromatics,
Oxygenates, halogenated VOC,
OH and HO2 radicals.
Aerosols: Type, Size, Chem.
Composition, hygroscopicity



FRONT-PORCH 2014 (NCAR RAL/MMM)

- June to mid-Aug 2014
- Thunderstorm Initiation study
- Radars (fixed and mobile) and integrated sounding systems (ISS)
- High resolution Met-Forecasting (WRF)



Required Funding

- EOL (from NSF deployment pool): ~ \$1.15M
(C-130 Operation)
- ACD \$ 0
(Campaign Co-ordination, Instruments, Analysis)
- NOAA \$ 0
(Erie Tower, Platteville Site, Mobile Lab)
- NASA \$ 0
(2 aircraft, 2-4 ground sites, ozone sondes)
- Universities (~10-12 proposals) ~ \$2.0M for year 1
(Surface Measurements, Aircraft Instrumentation, Analysis)

Follow-up costs years 2-3: 1.0-2.0 M /yr

FRAPPÉ will

- **Quantify emissions of trace gases from**
 - Oil and gas extraction and related activities
 - Transportation
 - Power generation
 - Agricultural activities
 - Vegetation
- **Quantify the interaction and the overall impact of these emissions on local and regional air quality**
 - Air mass composition (organics, oxidants, NO_x)
 - Climate impact
 - Ozone and oxidant formation
 - Formation and evolution of particulates
 - Mountain induced recirculation – accumulation of pollutants
- **Quantify import of larger scale emissions and impact on local air quality**
 - UT and WY oil and gas extraction and power generation
 - California
 - Asian emissions
 - Potential wildfires
- **Develop strategies to reduce oxidant formation and improve air quality**

FRAPPÉ Measurements/Modeling

- **Aircraft:** Ozone, NO, NO₂, HNO₃, HNO₄, PANs, Alkyl Nitrates, CO, SO₂, CO₂, Methane, Ethane Alkanes, Alkenes, Alkynes, Oxygenates, CH₂O, Aldehydes, CH₃CN, HCN, NH₃, OH, HO₂ and RO₂ radicals, Halogenated tracers, Particles: size distr., type, chemical composition, physical parameters, Met. and aircraft state parameters.
- **Surface Sites:** All chemical tracers as above (depends on site), mobile vans with chemical tracers, vertical profiles (Erie Tower), column integrated measurements of aerosol parameters, vertically resolved measurements of ozone, particles (LIDAR). Proposed are also hyperspectral imaging flights (Aerospace Corp.)
- **Air Quality Modeling:** CMAQ and WRF-Chem at 3km or higher spatial resolution, CAM-Chem (large scale background)

Why FRAPPÉ needs to happen in 2014

- NASA committed if FRAPPÉ successful
- NOAA will participate if FRAPPÉ successful
- FRONT-PORCH proposed for same time frame.
- Apply research to address pressing issues
- Collaborations with local/regional/federal AQ community.
- Unprecedented opportunity to combine three separate experiments with mutual benefit and provide maximum information.

FRAPPÉ Outreach

- Schools: GO3 project; teacher and student involvement in campaign and post-campaign analysis (NSF RETI, NCAR SPARK)
- Opportunities for educators, media people etc. to be on board during flights
- NCAR/Airplanes Open House
- Denver Museum for Nature and Science – “Scientists in Action”
- Nat. Park Service – RMNP staffed real-time displays
- DIA – real time display or experiment video?
- Documentary about Denver brown cloud (James Balog)
- Summer classes at CSU
- NCAR Significant Opportunities in Atmospheric Research and Science (Undergrad Summer Program)

