

FRAPPÉ

FRONT RANGE AIR POLLUTION AND PHOTOCHEMISTRY EXPERIMENT

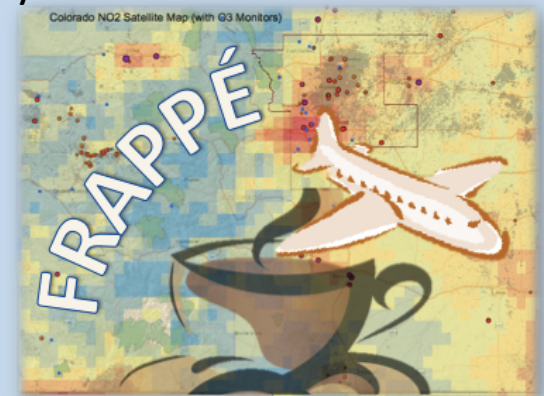
Comprehensive observations are the key to understanding what drives AQ, improve models and allow for predictions/projections

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,
Environmental Protection Agency (EPA) Region 8,
National Oceanic and Atmospheric Administration (NOAA),
National Park Service (NPS), Regional Air Quality Council (RAQC),
UC Berkeley, UC Irvine, UC Riverside, U of Wisconsin,
US Naval Academy, U of Rhode Island
U of Cincinnati, Georgia Tech, GO3 Project, Aerodyne Inc.

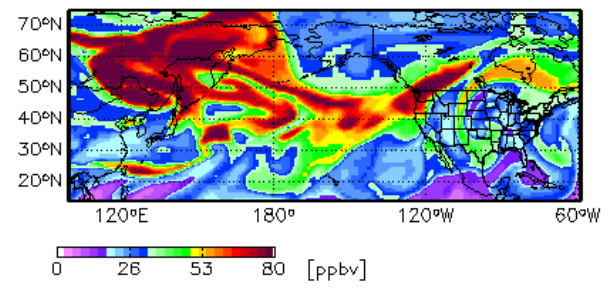
Northern Front Range Metro Area (NFRMA)
July 13-August 16, 2014

www2.acd.ucar.edu/frappe





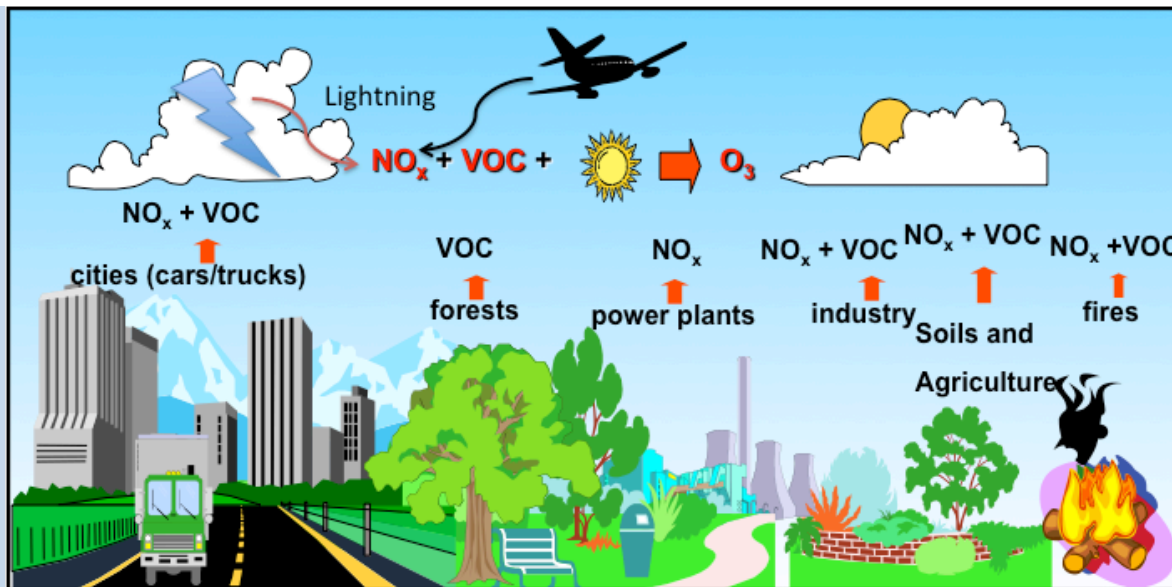
Asian CO 20060430 18 GMT at 600 hPa (4.2 km)



Summertime Ozone

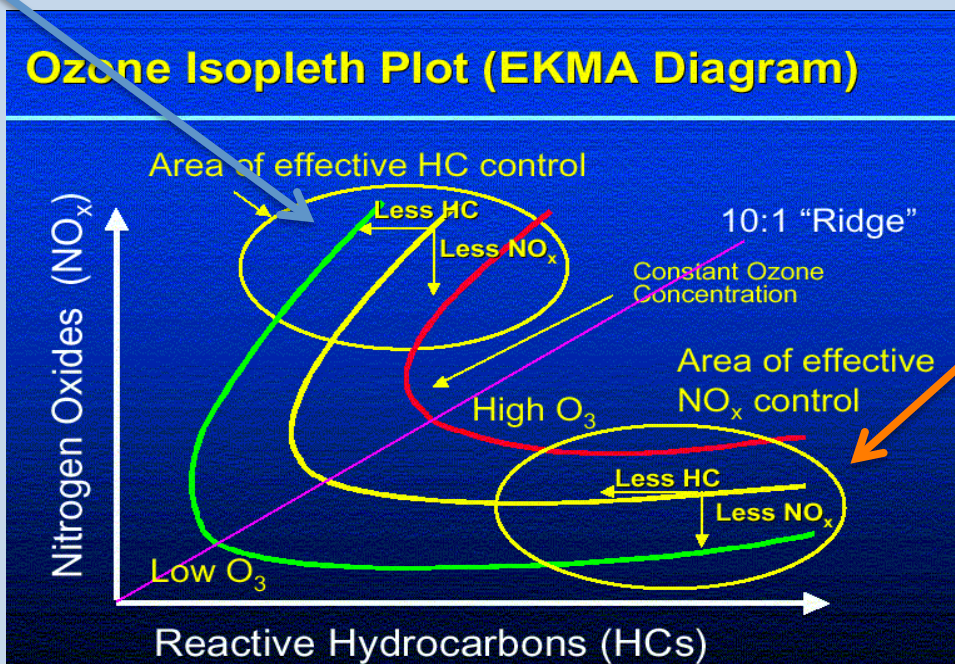
VOC limited

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

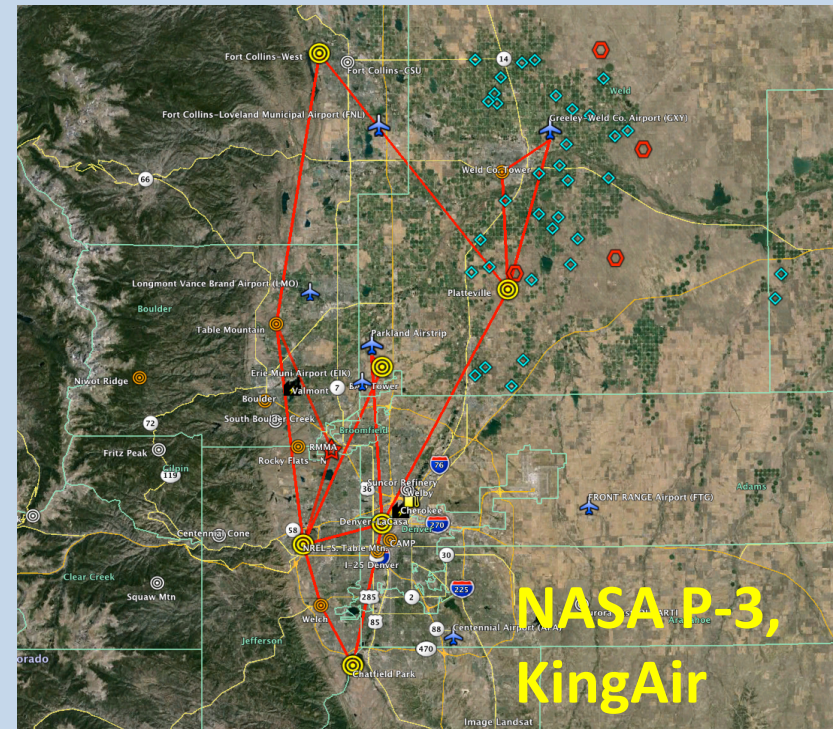
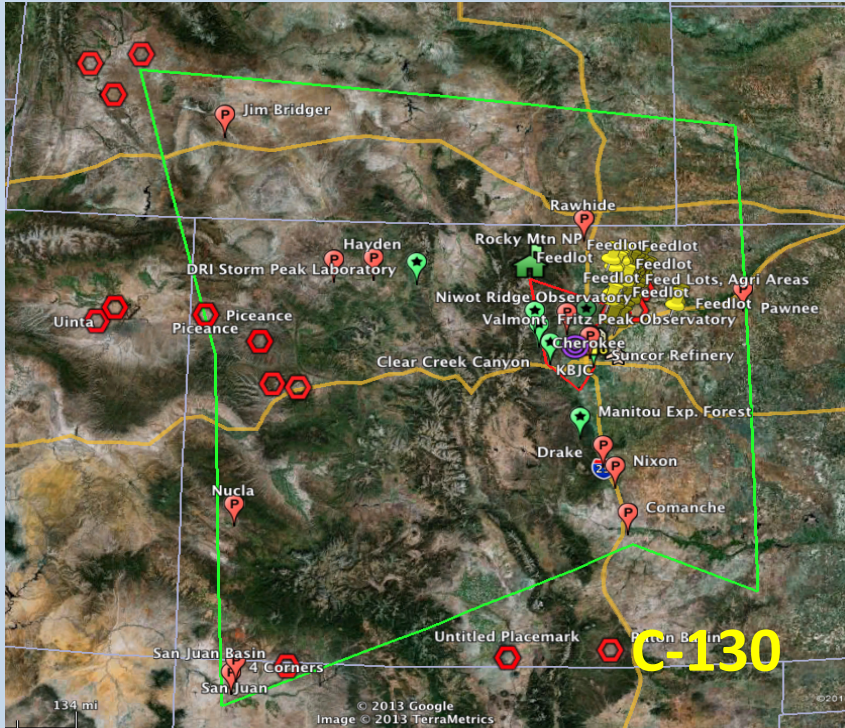


NO_x limited

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



Two Complementary Field Campaigns



- **FRAPPÉ** NCAR – C130 & 2 ground sites (BAO Tower, Golden?) + Mobile labs (NOAA, Aerodyne).
~13 flights 6 hours each (80 hours total)

- **NASA DISCOVER-AQ** aircraft and ground based operations (committed). Two Aircraft, P3 (in-situ chemistry and particulates) and KingAir (LIDAR, remote sensing).
~15 flights 8-hrs (P3), ~25 flights 3 hrs (KA)

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)⁶



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:

NO_x, Ozone, CO, CO₂, CH₄,

Alkanes, Alkenes, Alkynes,

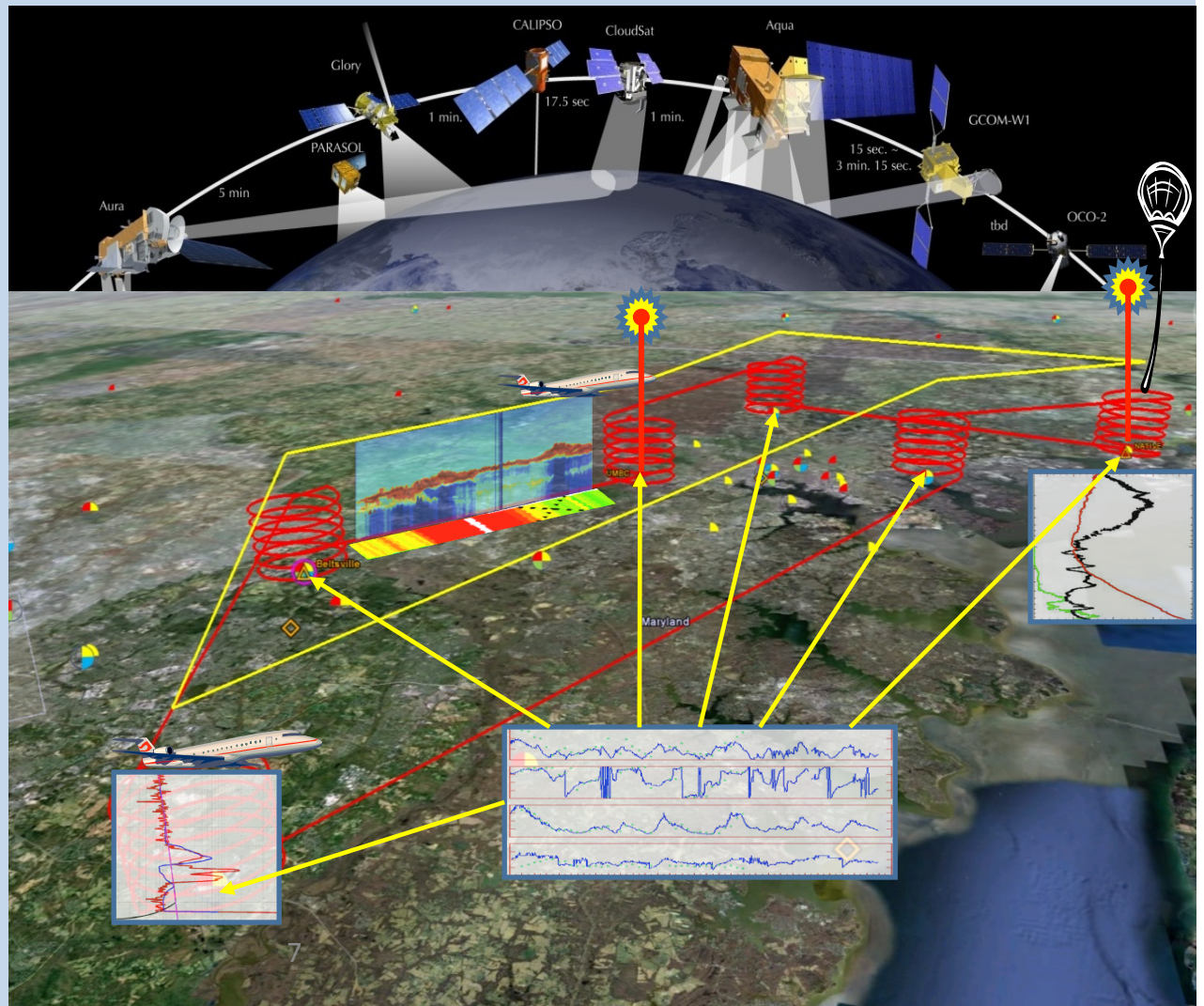
CH₂O, Aldehydes, Aromatics,

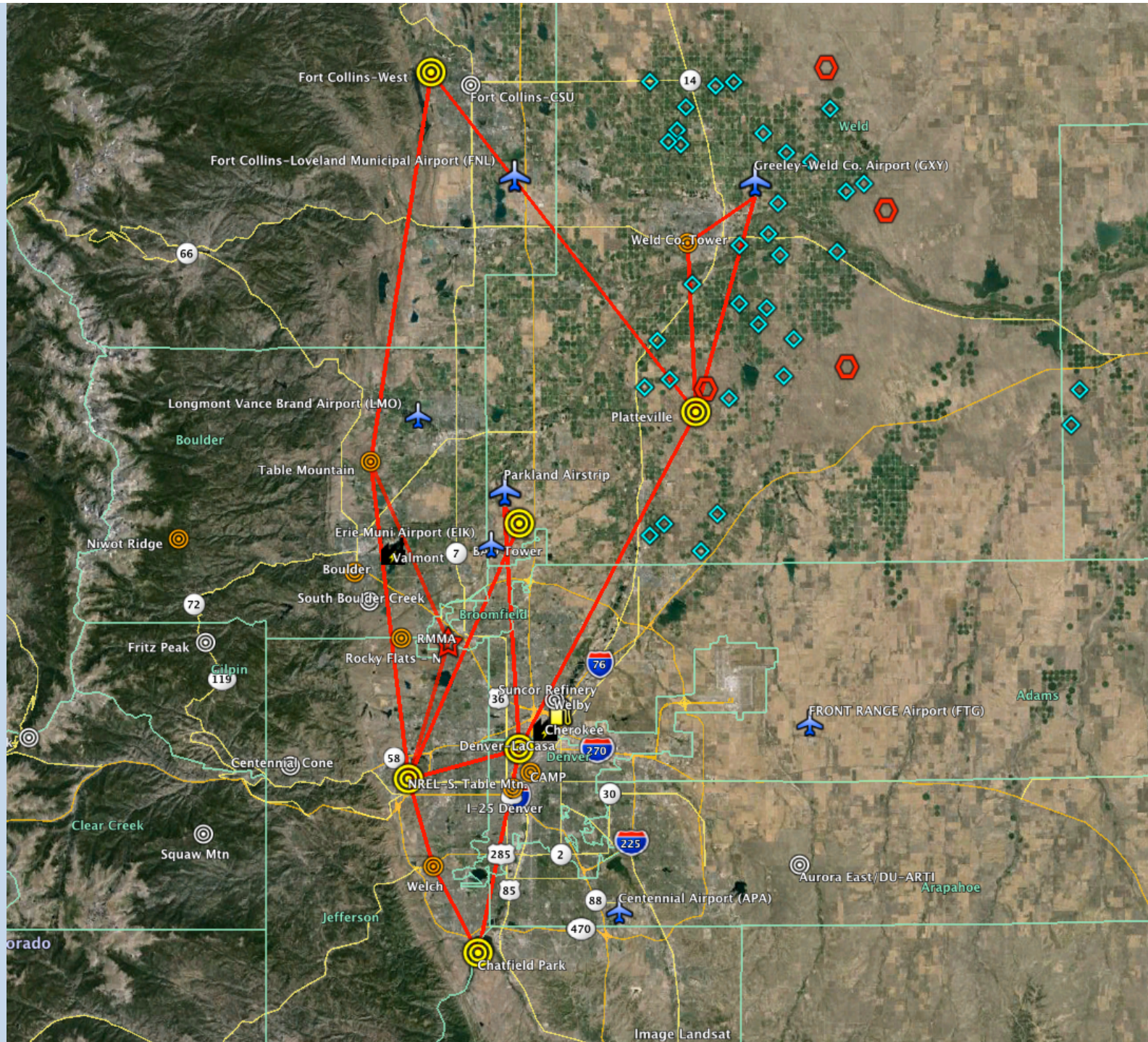
Oxygenates, halogenated VOC,

OH and HO₂ radicals.

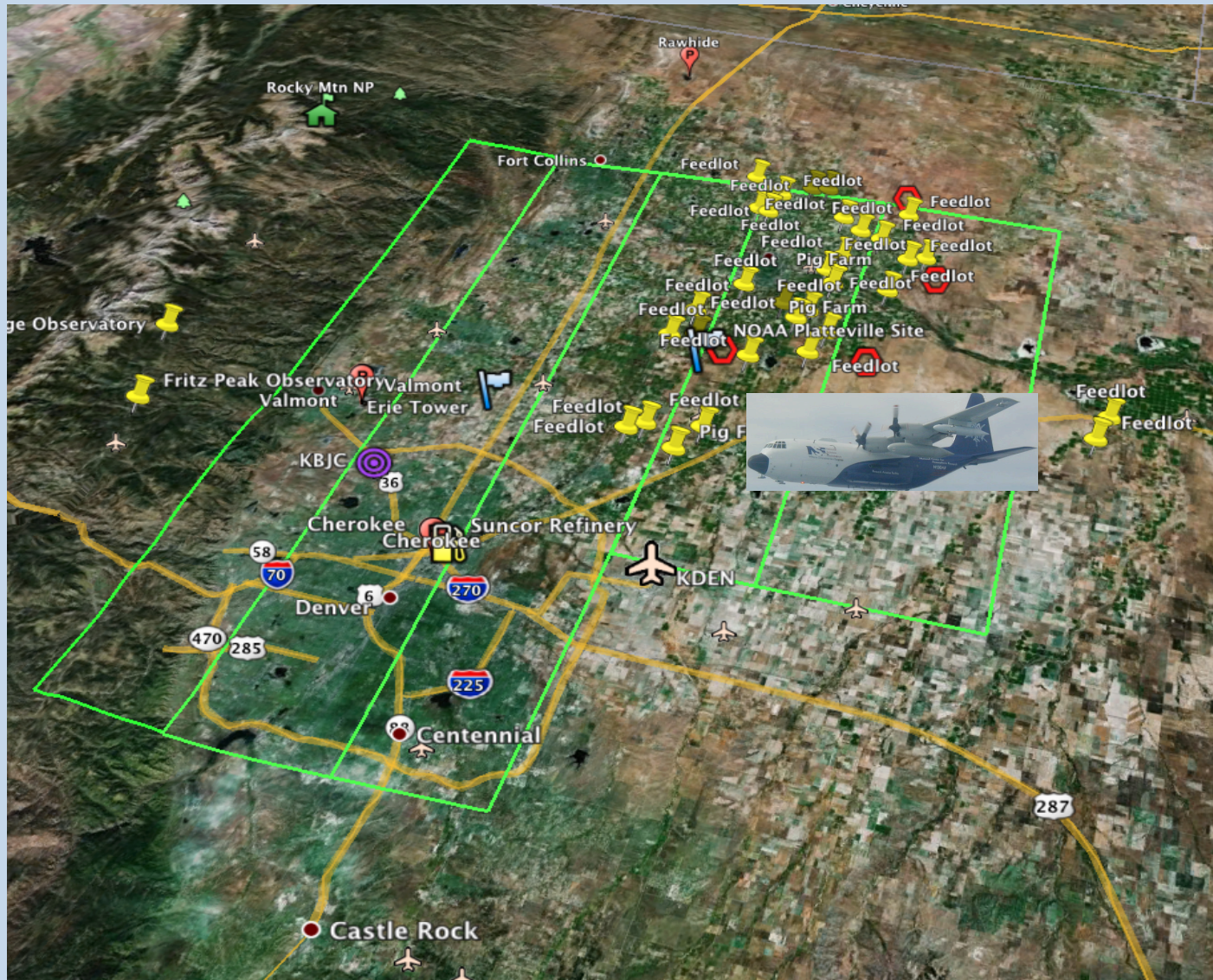
Aerosols: Type, Size, Chem.

Composition, hygroscopicity





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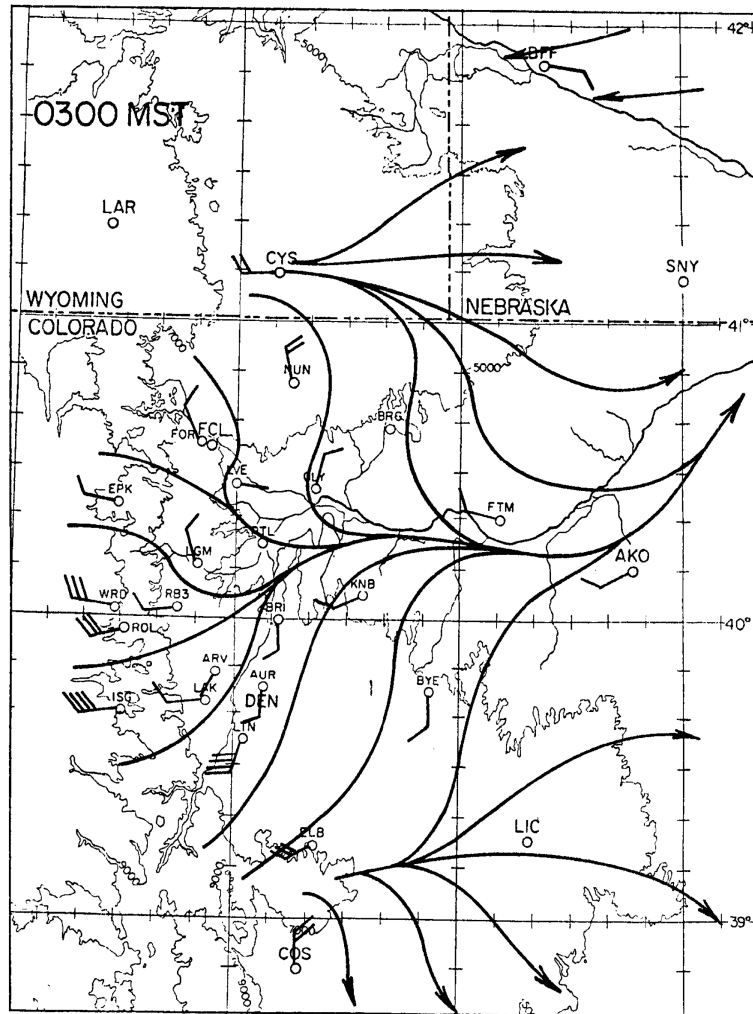


Fig. 5. As in Fig. 2, except for 0300 MST.

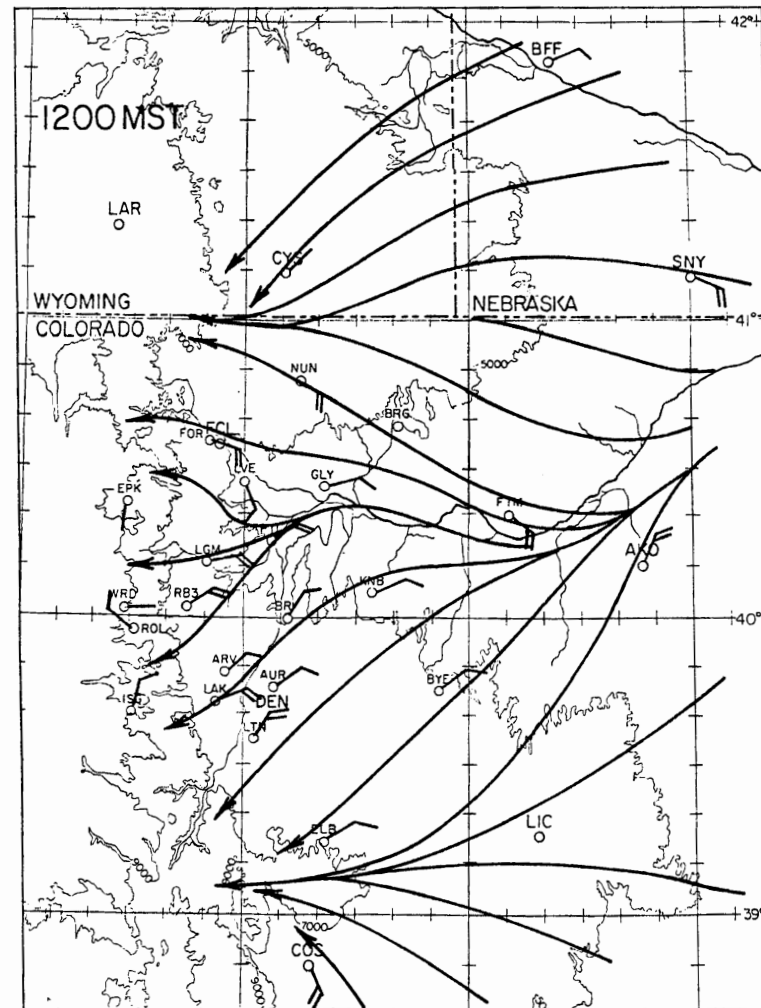
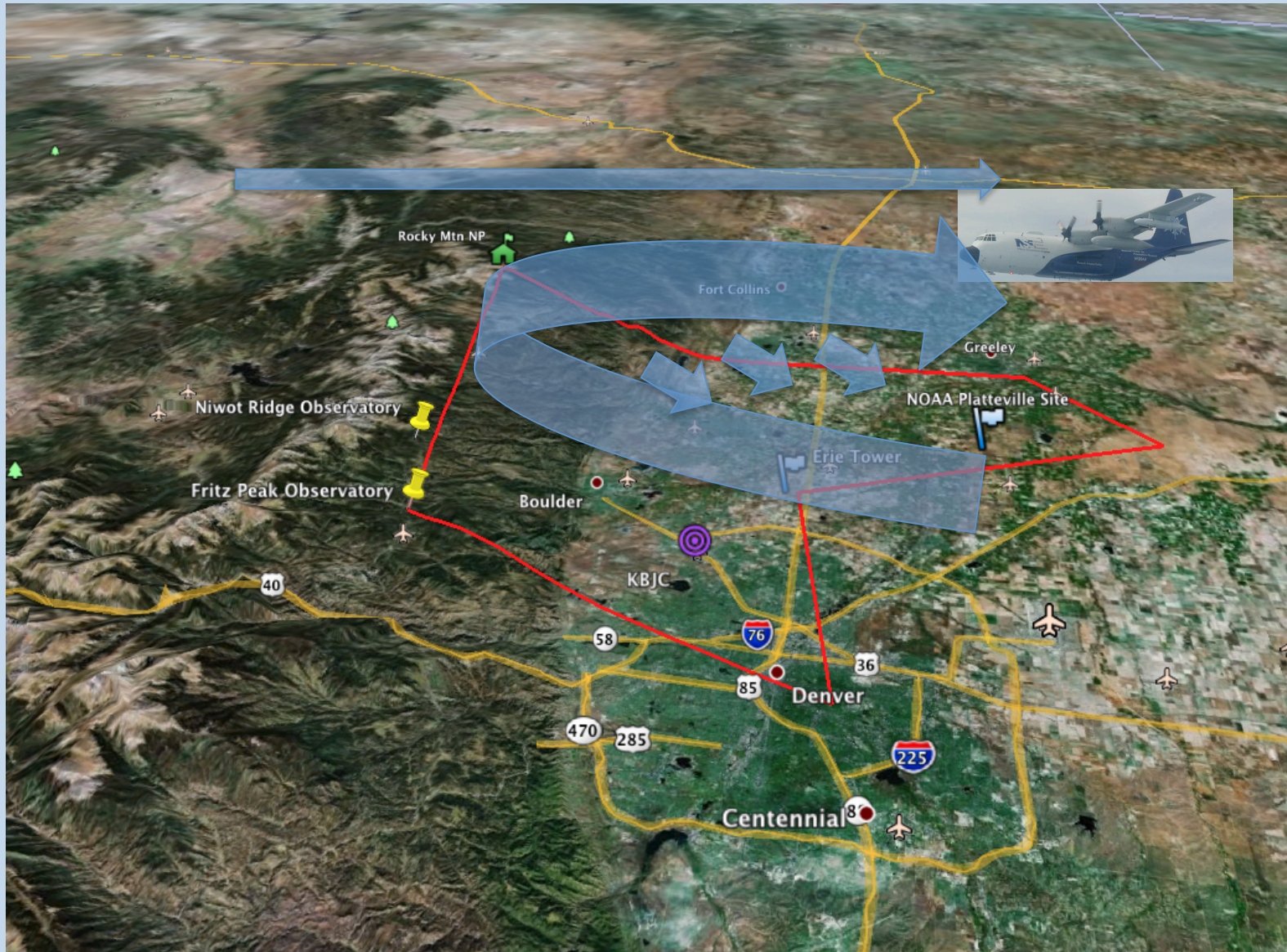


Fig. 14. As in Fig. 2, except for 1200 MST.

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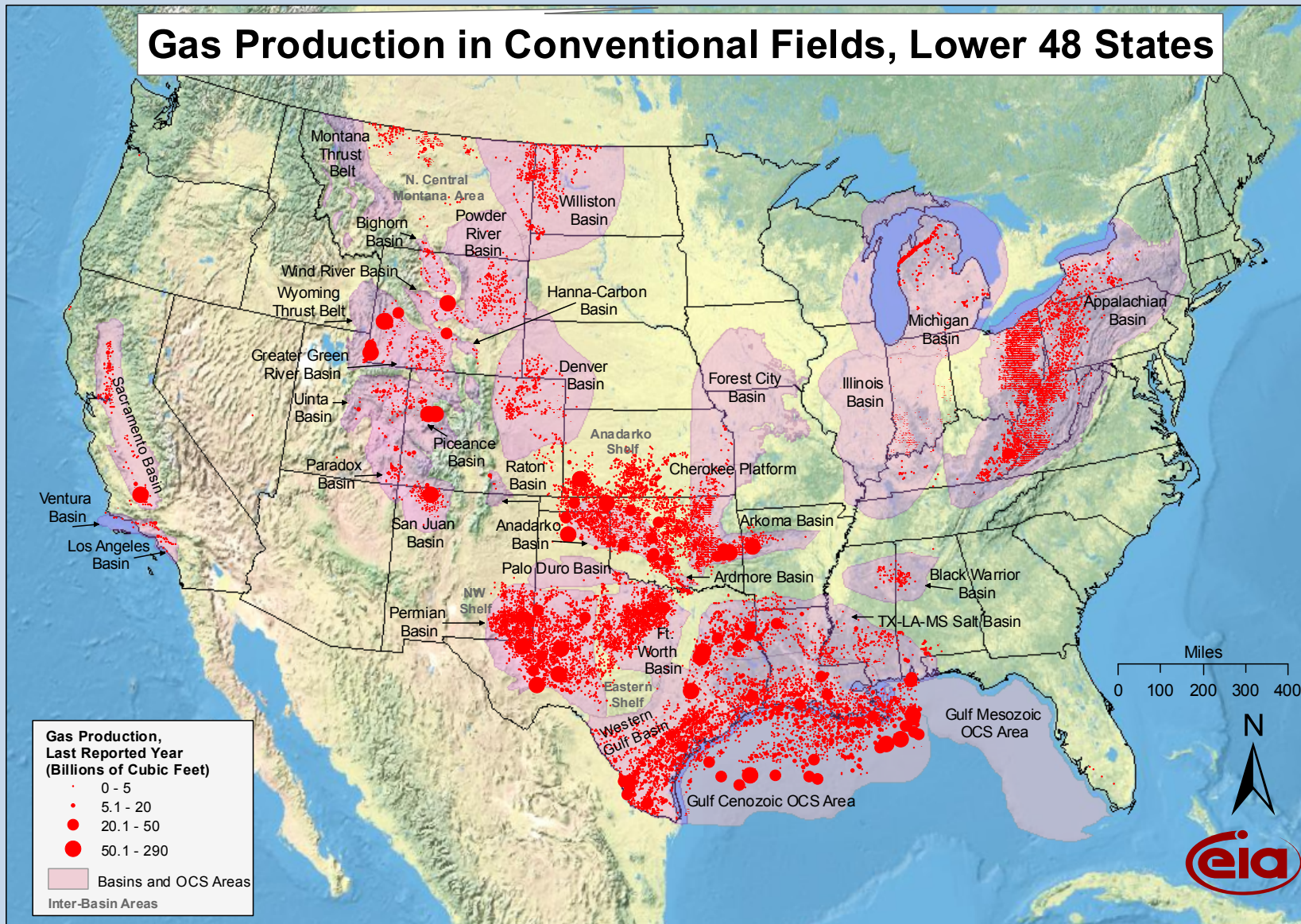
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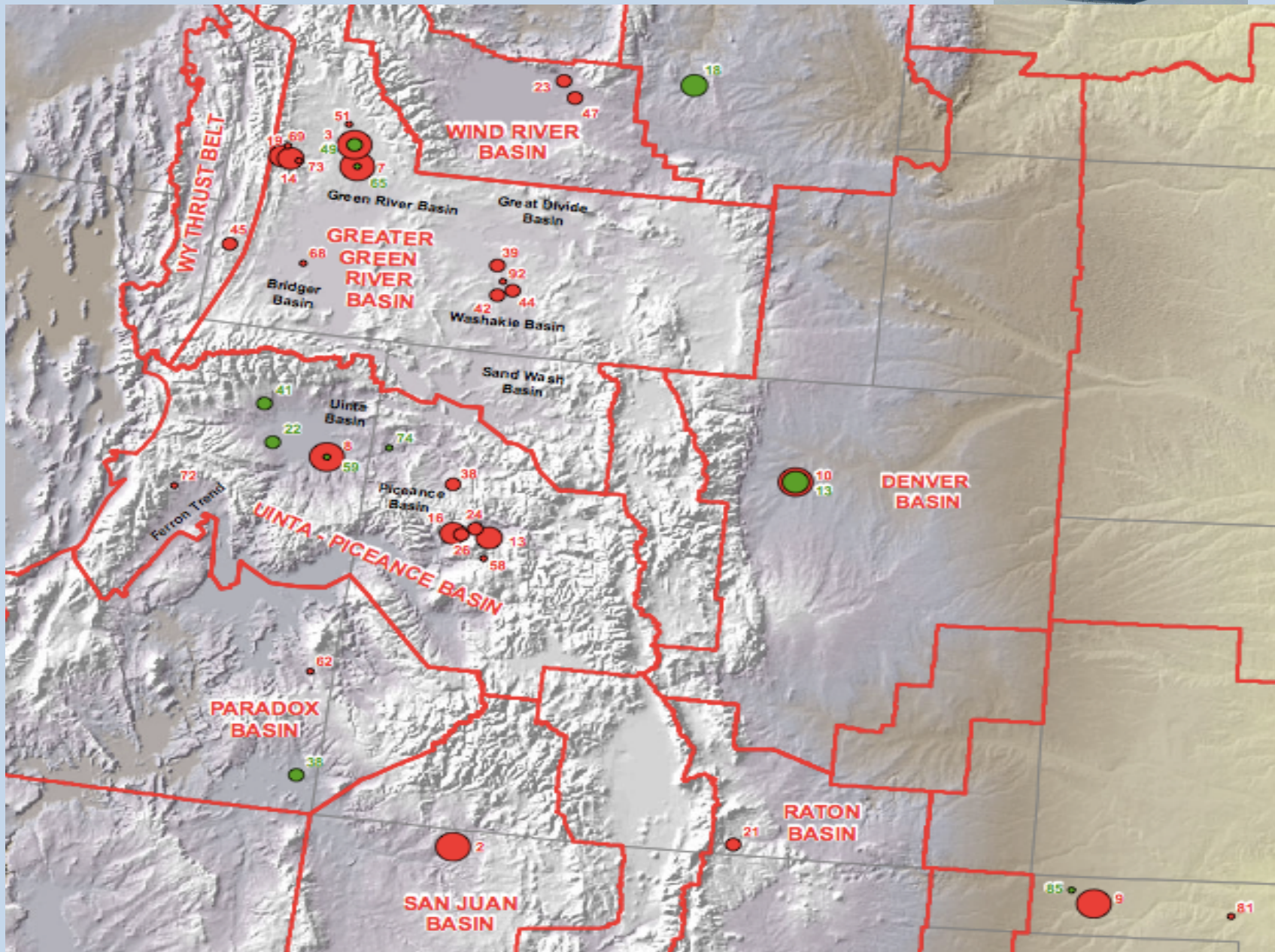


Gas Production in Conventional Fields, Lower 48 States



Source: Energy Information Administration based on data from HPDI, IN Geological Survey, USGS
Updated: April 8, 2009

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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.



FRAPPÉ will

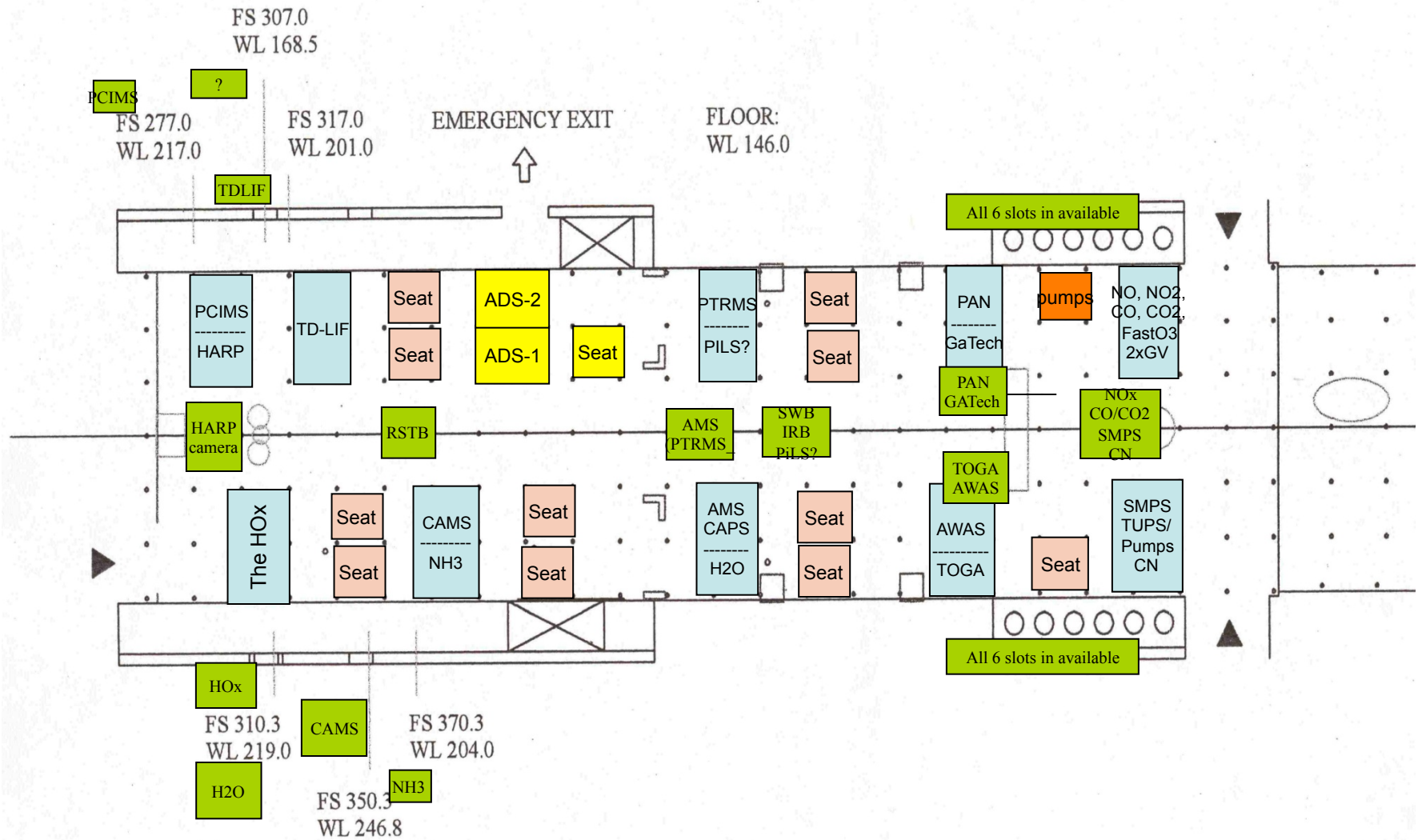
- **Quantify emissions of trace gases from**
 - Oil and gas extraction and related activities
 - Transportation
 - Power generation
 - Agricultural activities
 - Vegetation
- **Quantify the interaction and the overall impact of these emissions on local and regional air quality**
 - Air mass composition (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:** Photochemical tracers (depends on site), mobile vans with photochemical and emission tracers, vertical profiles (Erie Tower), column integrated measurements of aerosol parameters, vertically resolved measurements of ozone, particles (LIDAR).
- **Mobile Labs:** Two mobile laboratories (by NOAA and Aerodyne) - and maybe a third mobile lab – will be deployed in the region
- **Air Quality Modeling:** CMAQ and WRF-Chem at 3km or higher spatial resolution, CAM-Chem (large scale background)

Draft C-130 LAYOUT FOR FRAPPÉ

01/30/14



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)

