

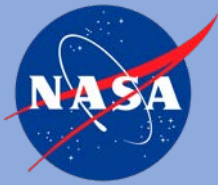
Fire Emissions in California: Analysis of Airborne Measurements of Trace Gases from Twelve Fires

Caroline Parworth,
Emma Yates, Josette Marrero, Ju-mee Ryoo and Laura Iraci

NASA Ames Research Center



Alpha Jet Atmospheric eXperiment Overview



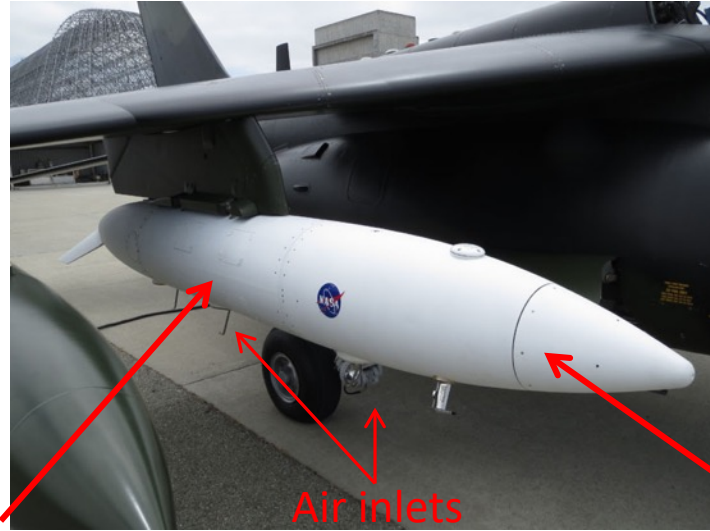
- Partnership with H211, LLC
- **Total flights to date: 229**
- Payload: O₃, CH₄, CO₂, H₂O, HCHO, 3D winds

| | |
|-----------|----------------------------|
| Ceiling | 40,000 ft (~12 km) |
| Speed | 150-550 kts (~100-280 m/s) |
| Range | ~1,000 km |
| Endurance | 2-2.5 hrs |

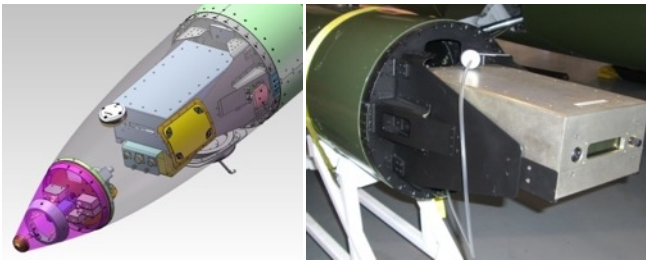
| | | | | | | | |
|--|---|--|---|---|--|--|---|
| 2007-2010 Alpha Jet acquired Modifications | 2011 1st Flt of O₃ and GHG instruments 1st Science Flight | 2012 RRV Mission 50th AJAX Flight | 2013 DISCOVER- AQ-CA Las Vegas Ozone Study 1st Flt of MMS 100th AJAX Flight (ft. Harrison Ford!) | 2014 COWGAS Exp. COMEX Mission 150th AJAX Flt | 2015 RRV Mission COMEX 1st Flt of HCHO | 2016 CalWater 2 CABOTS RRV Mission 200th AJAX Flt | 2017 Engine overhaul Air Quality studies |
|--|---|--|---|---|--|--|---|



Instrument Payload



Modified Picarro (2301-m) measures CO_2 and CH_4 located in center- and tail-sections of the wing-pod

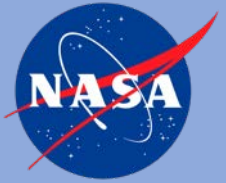


Modified 2B technologies (model 205) measures O_3 and Meteorological Measurement System (MMS) located in the front/nose section of the wing-pod



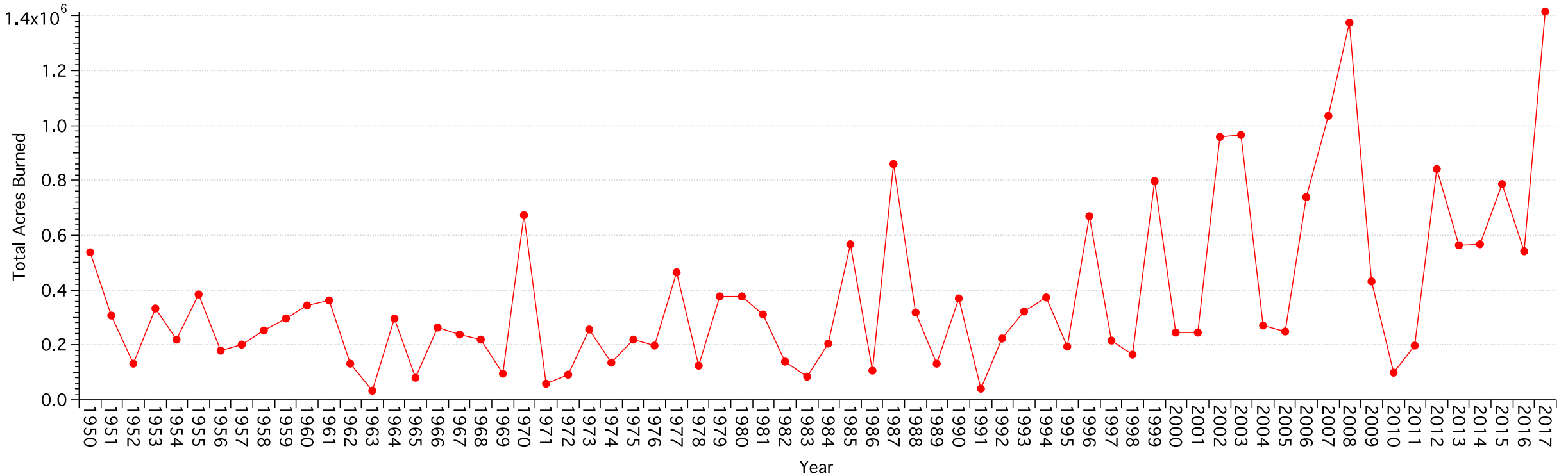
GSFC Compact Formaldehyde Fluorescence Experiment (COFFEE) measures atmospheric HCHO located in the center of the pod

California Fire History

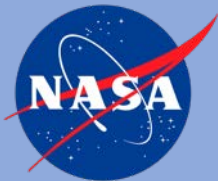


- Drought, extreme temperatures, and fuel accumulation have led to increased acres burned

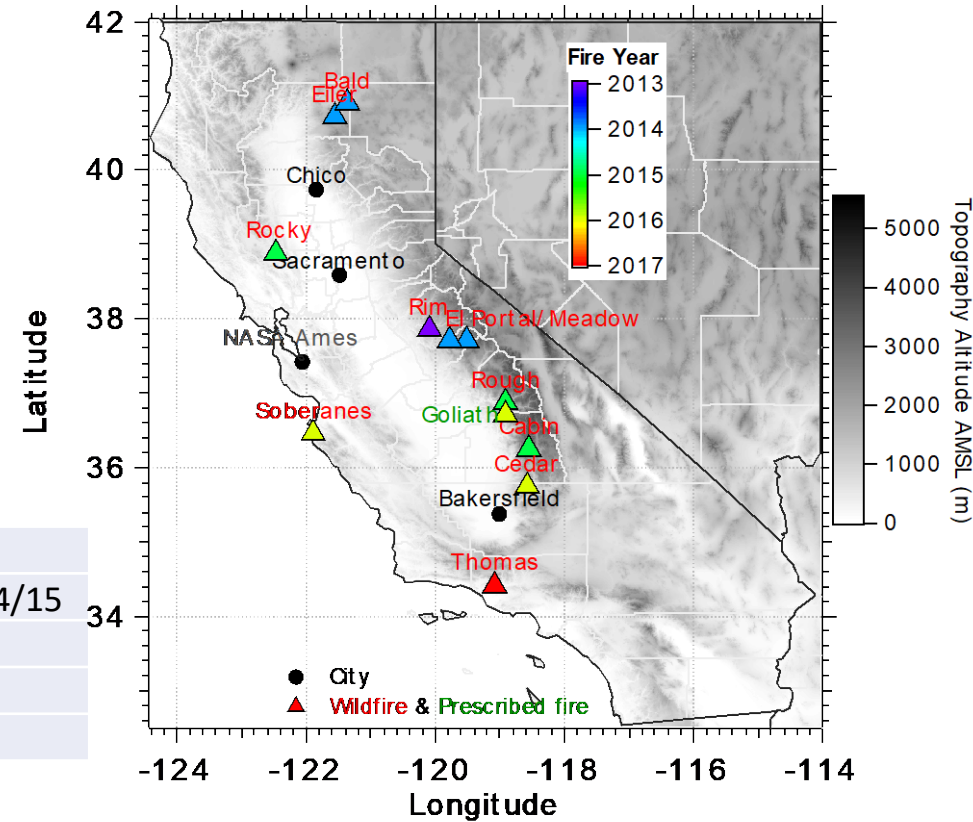
California Fires



Fires Sampled



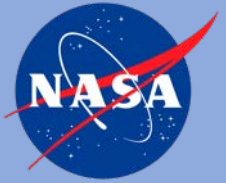
- AJAX measured 12 fires since 2013
 - 11 wildfires + 1 prescribed
 - 3 megafires ($\geq 100,000$ acres), multiple measurements
 - 1 fire in winter



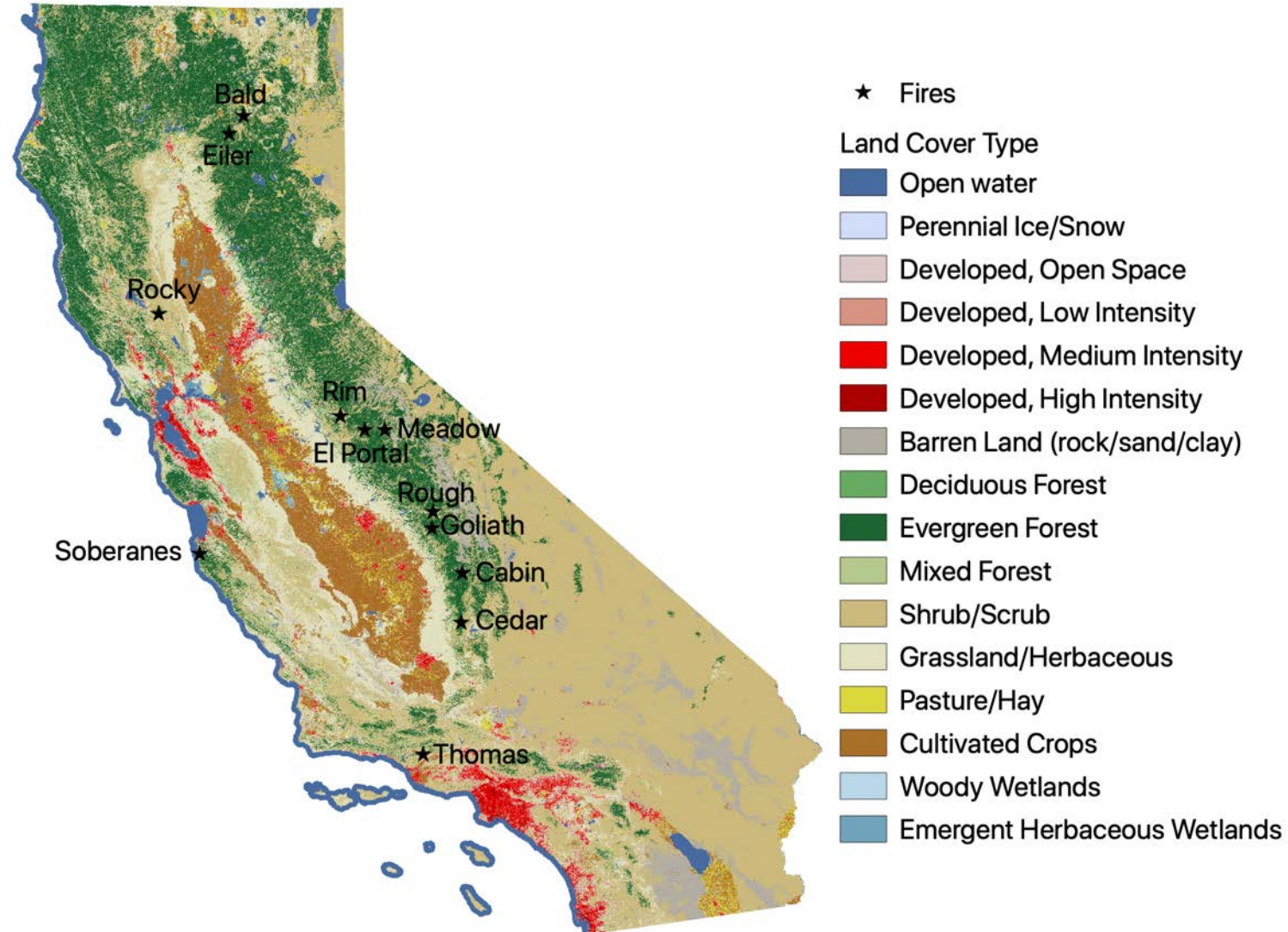
| Fire | Rim | El Portal | Bald/Eiler | Meadow | Rocky |
|------------------|-----------------|---------------|----------------|----------------|----------------|
| Duration of Fire | 8/17 – 10/27/13 | 7/26 – 8/4/14 | 7/30 – 8/15/14 | 8/15 – 9/29/14 | 7/29 – 8/14/15 |
| Acres Burned | 257,314 | 4689 | 39,736 | 32,416 | 4772 |
| Flight Dates | 8/29 9/10 | 7/29 | 8/6 | 8/13 | 9/9 |
| Flight Number | 100 101 | 136 | 137 | 138 | 141 |

| Fire | Cabin | Rough | Goliath | Soberanes | Cedar | Thomas |
|------------------|---------------|----------------|----------------|------------------------------------|----------------|-------------------|
| Duration of Fire | 7/19 – 9/5/15 | 7/31 – 11/5/15 | 6/11 – 6/17/16 | 7/22 – 10/12/16 | 8/16 – 9/30/16 | 12/4/17 – 1/20/18 |
| Acres Burned | 6980 | 151,623 | 759 | 103,242 | 29,322 | 281,893 |
| Flight Dates | 8/19 | 8/19 9/2 | 6/15 | 7/28 8/9 8/12 8/24 9/4 | 8/24 | 12/13 |
| Flight Number | 167 | 167 168 | 191 | 196 197 198 199 200 | 199 | 216 |

Land Cover



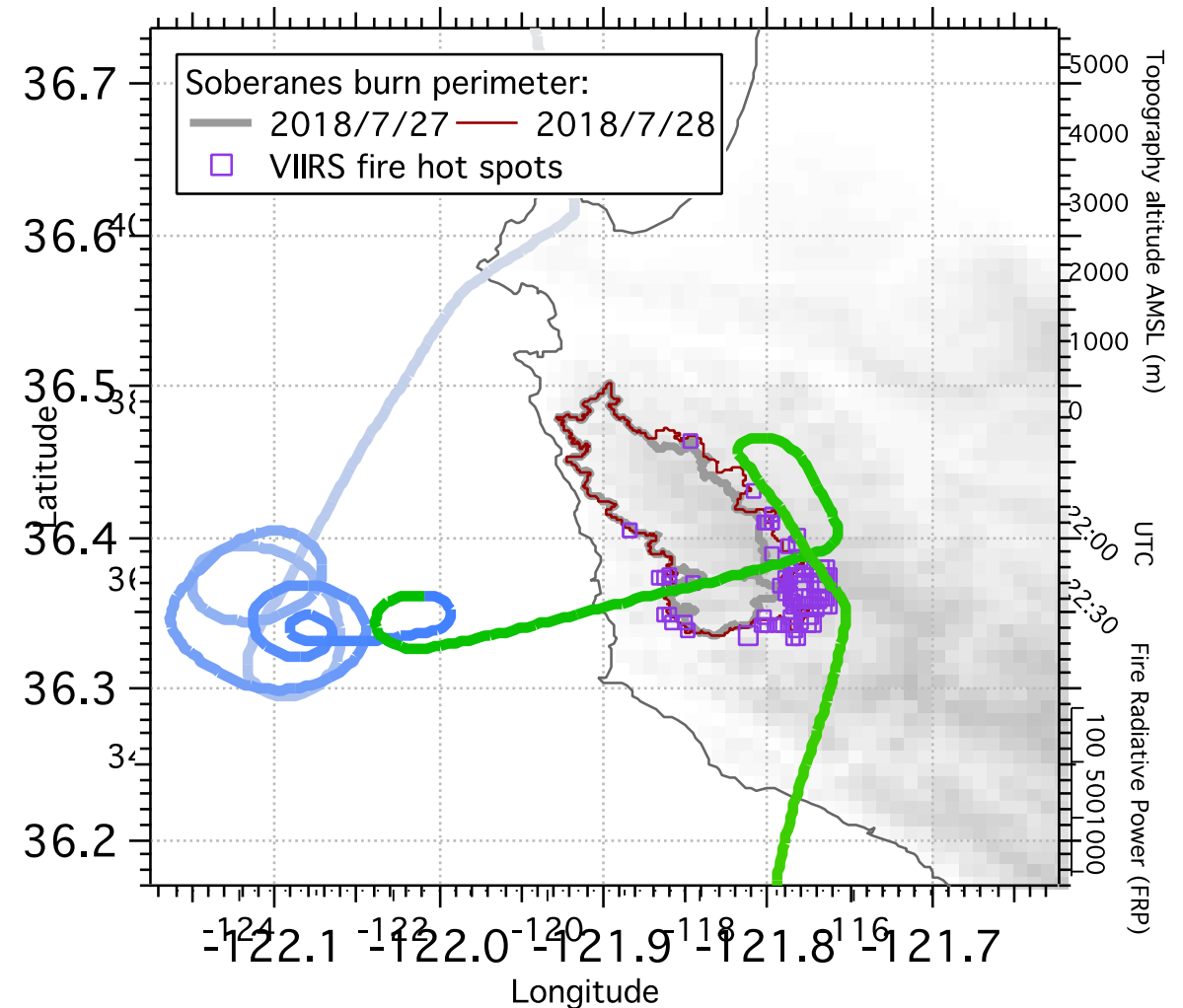
- Majority of fires took place in the Sierra Nevada Mountain Range, where primarily evergreen forests burned
- Rocky and Thomas fires were in areas consisting of shrub and grassland

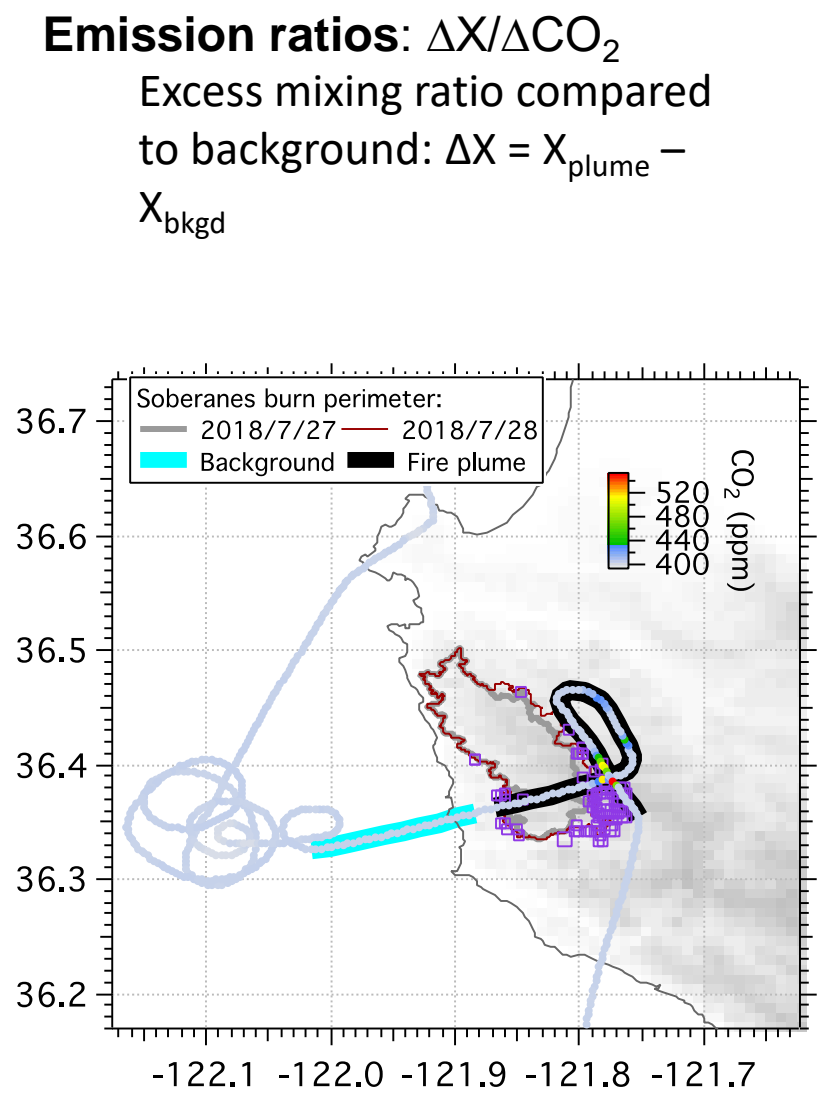
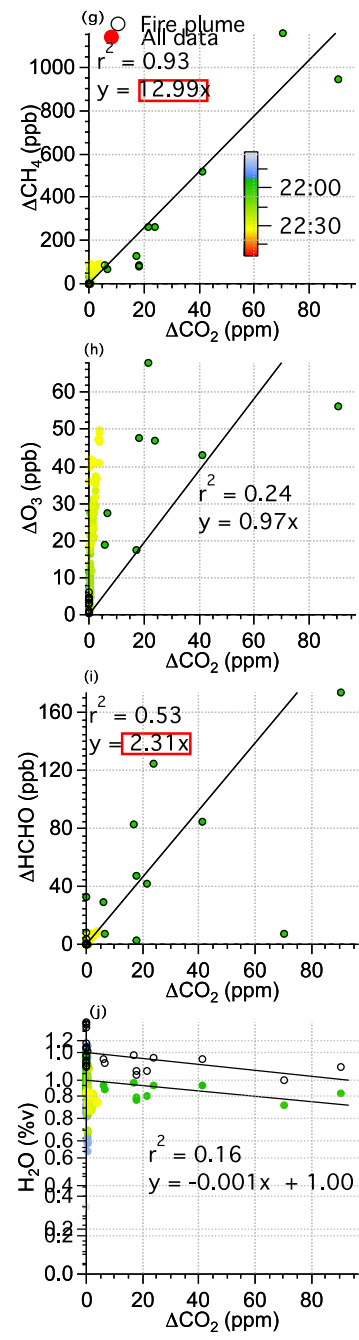
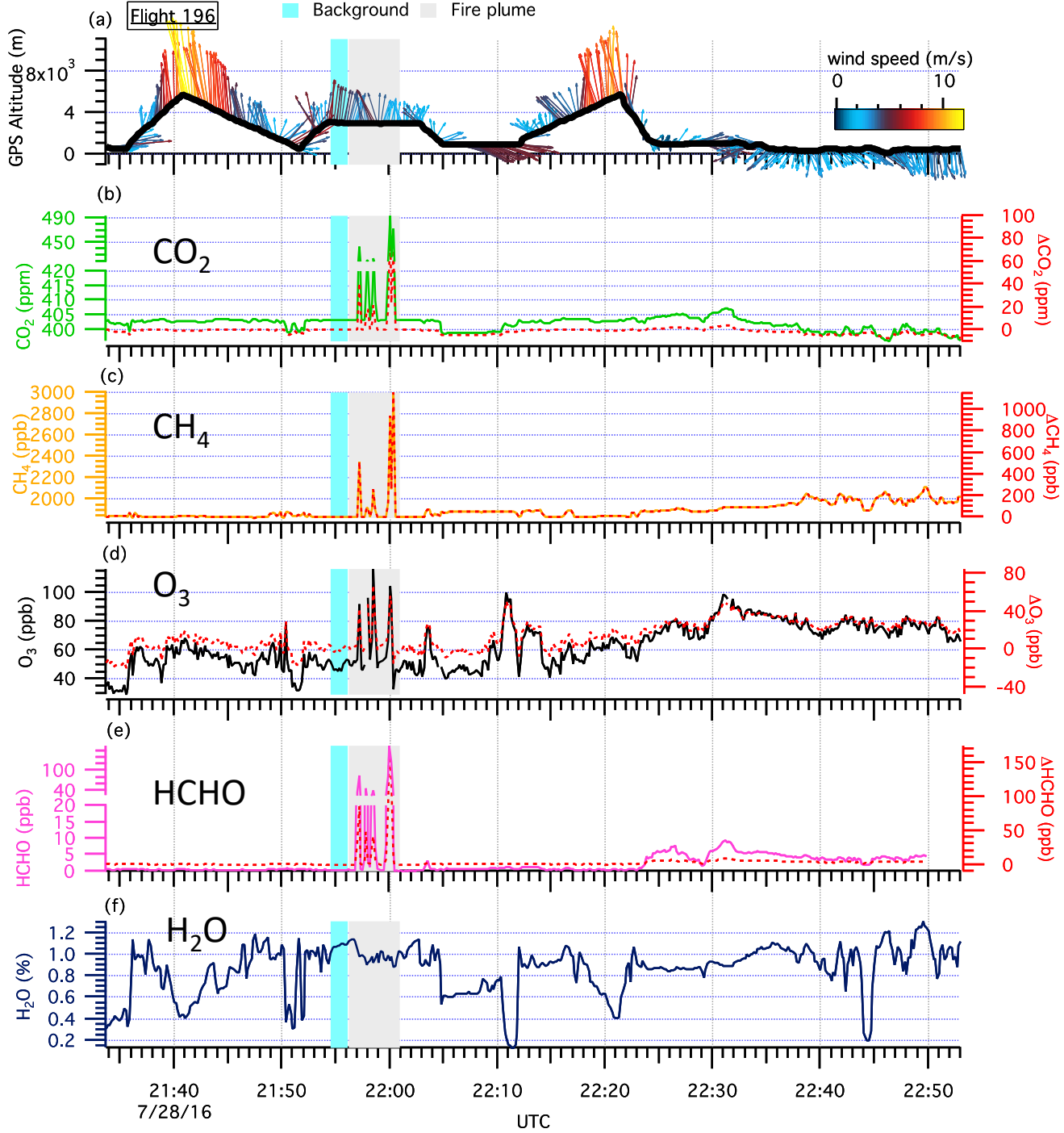


Analysis of Fire Plumes



- **Flight planning:** Pilots flew as close as possible to visible fire plumes directly above fire source when possible.
- **Plume selection:**
 - Enhancements in trace gases near VIIRS fire hot spots
 - MODIS imagery

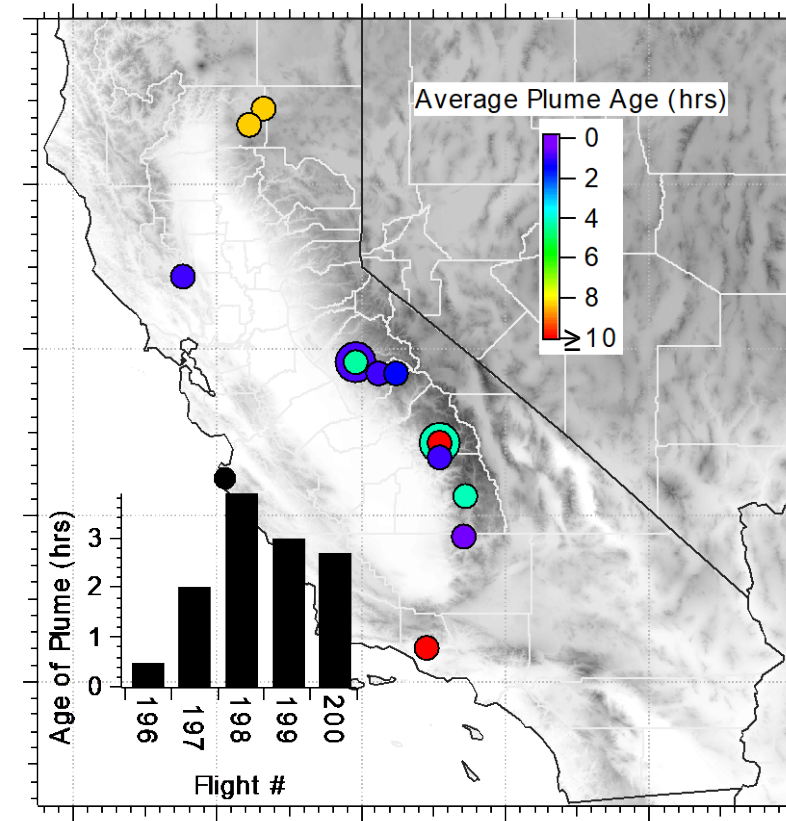
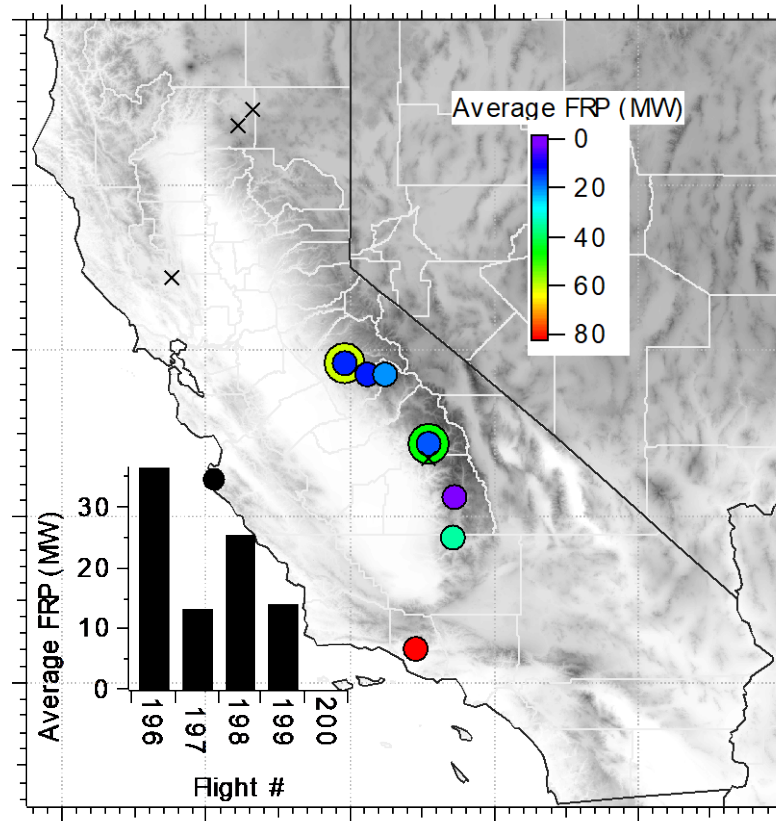
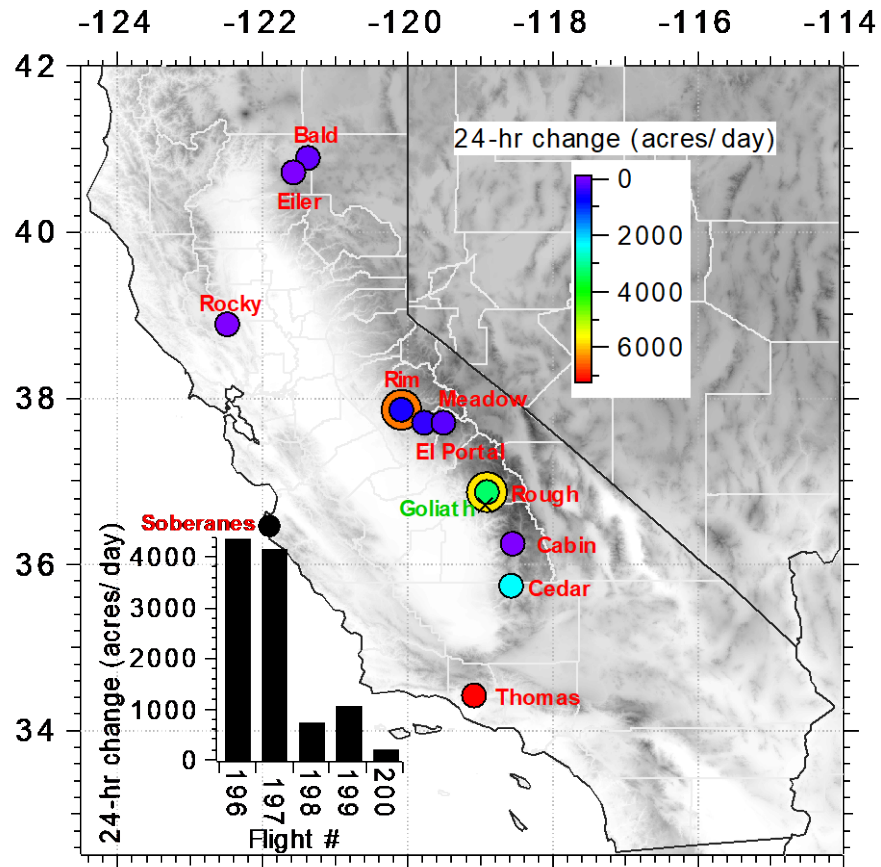




Results



• Fire conditions on flight day



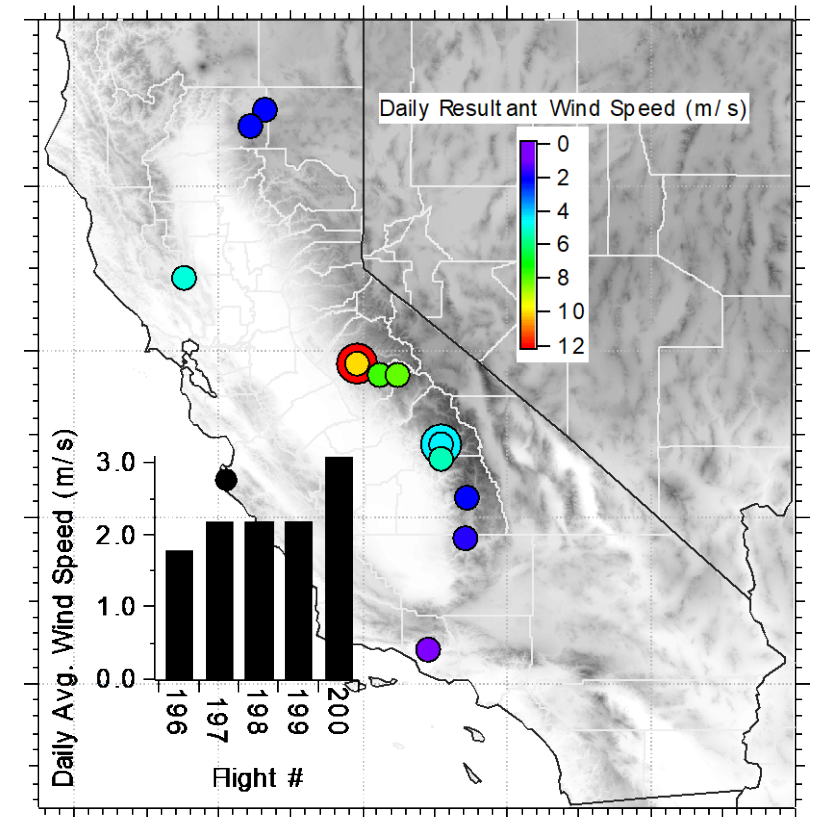
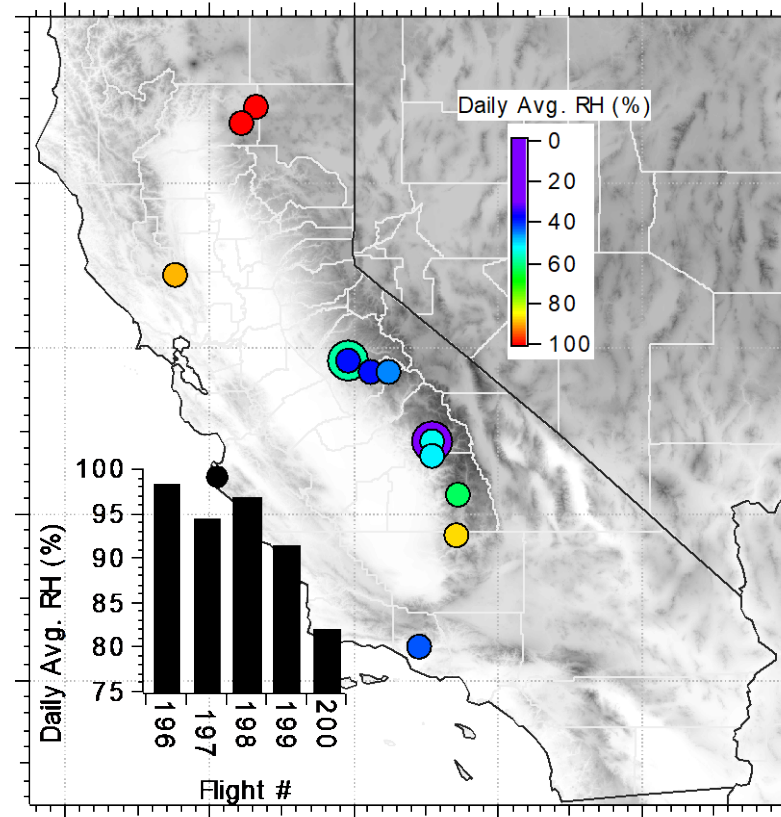
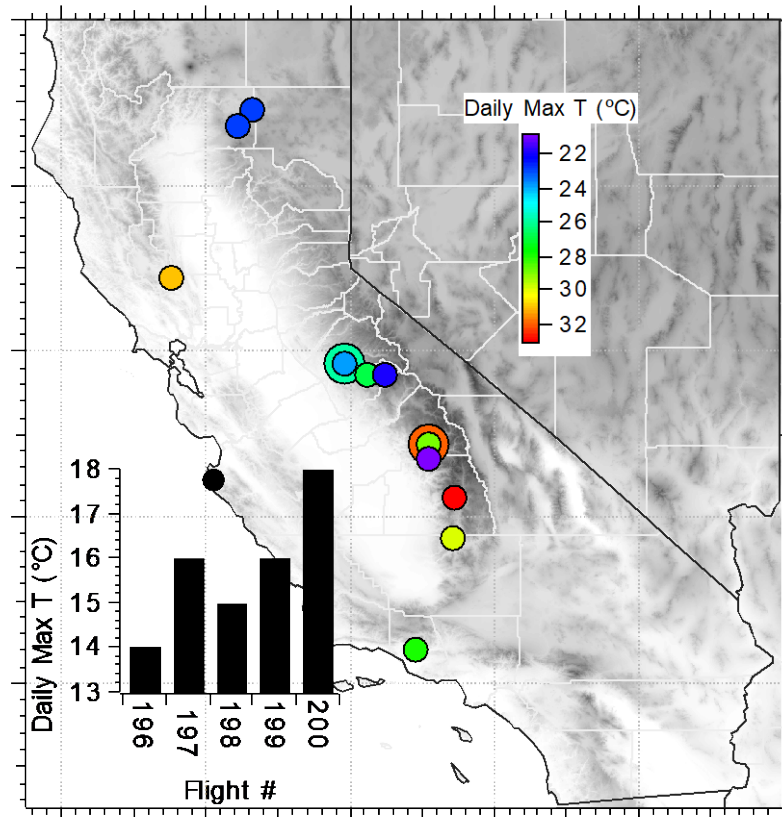
x = no data

$$\text{Plume age} = \frac{\text{sample distance from source}}{\text{average wind speed}}$$

Results

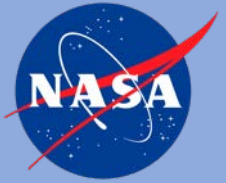


- Meteorological conditions at nearby sites

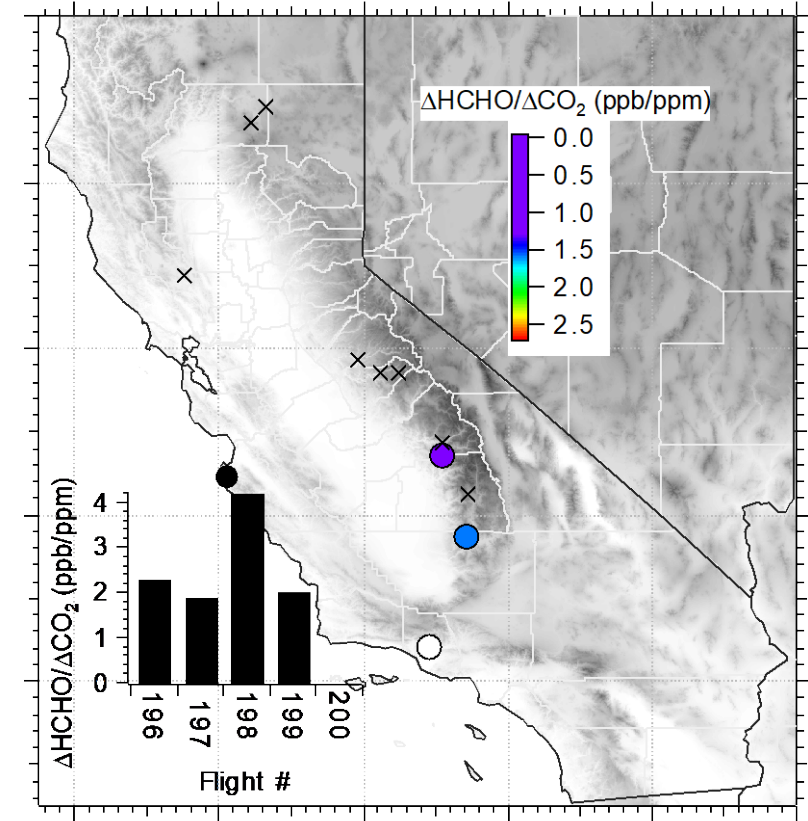
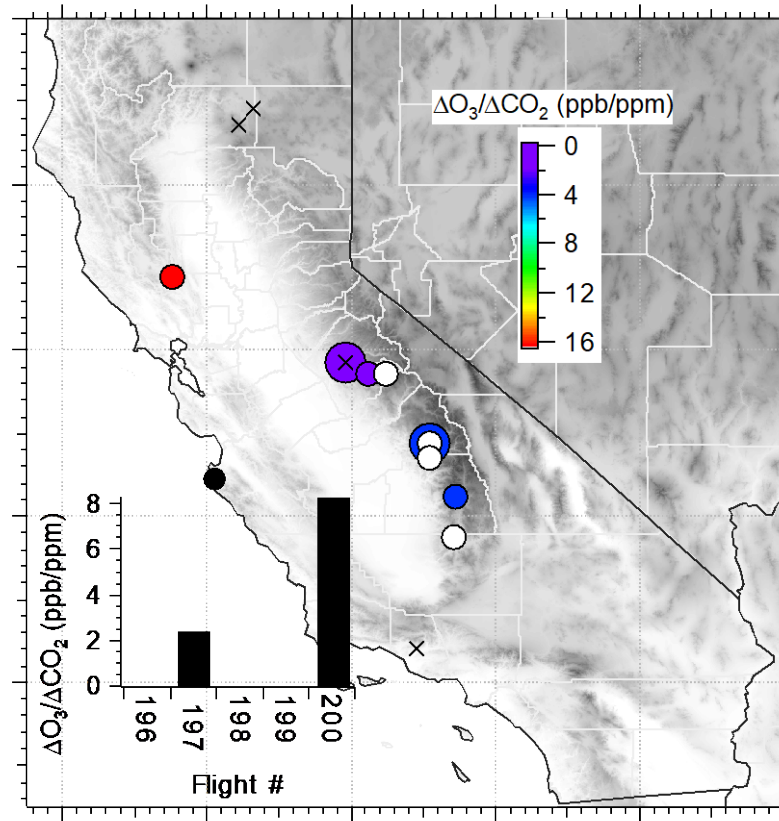
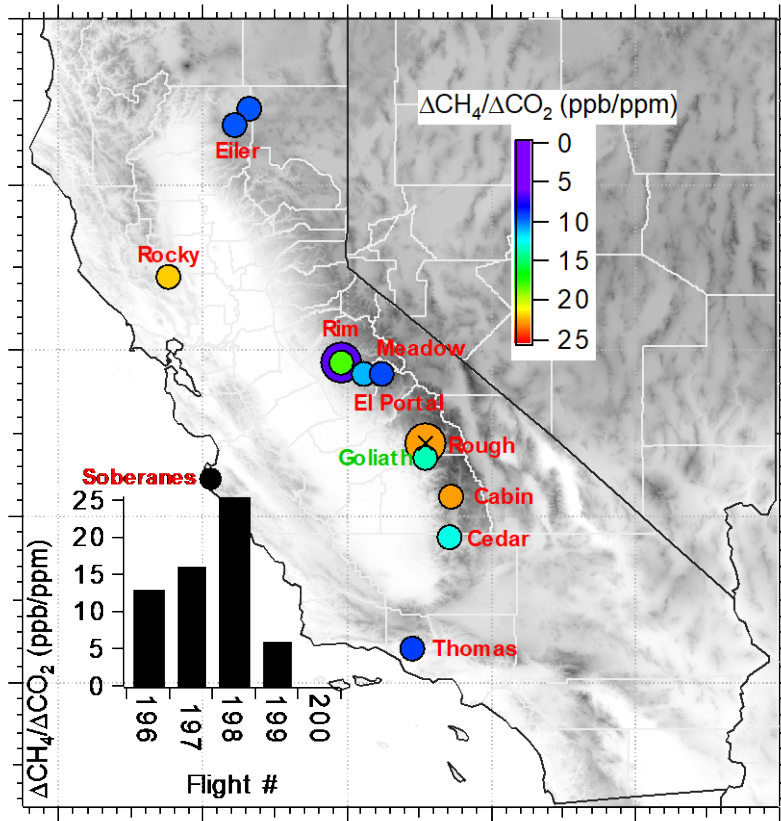


x = no data

Results



• Emission Ratios



x = no data

White circle = no significant trend

Conclusions



- Measured 12 different fires (11 wild + 1 prescribed) in California between 2013 – 2018 with a variety of vegetation, time of year, size, and meteorological conditions.
- CH₄ ERs (relative to ΔCO_2) from this work highlight a larger range than documented before.
- Most observations show little to no O₃ formation in fires.
- Found no significant trends in ERs with meteorological conditions at ground sites, FRP, or plume age.
- Increased catalog of near field emission measurements for temperate forests.
- Future work:
 - Impact of fires on local air quality
 - Modeling of emissions
 - Measuring future fires

Questions?

 @NASA AJAX

 @NASA_AJAX

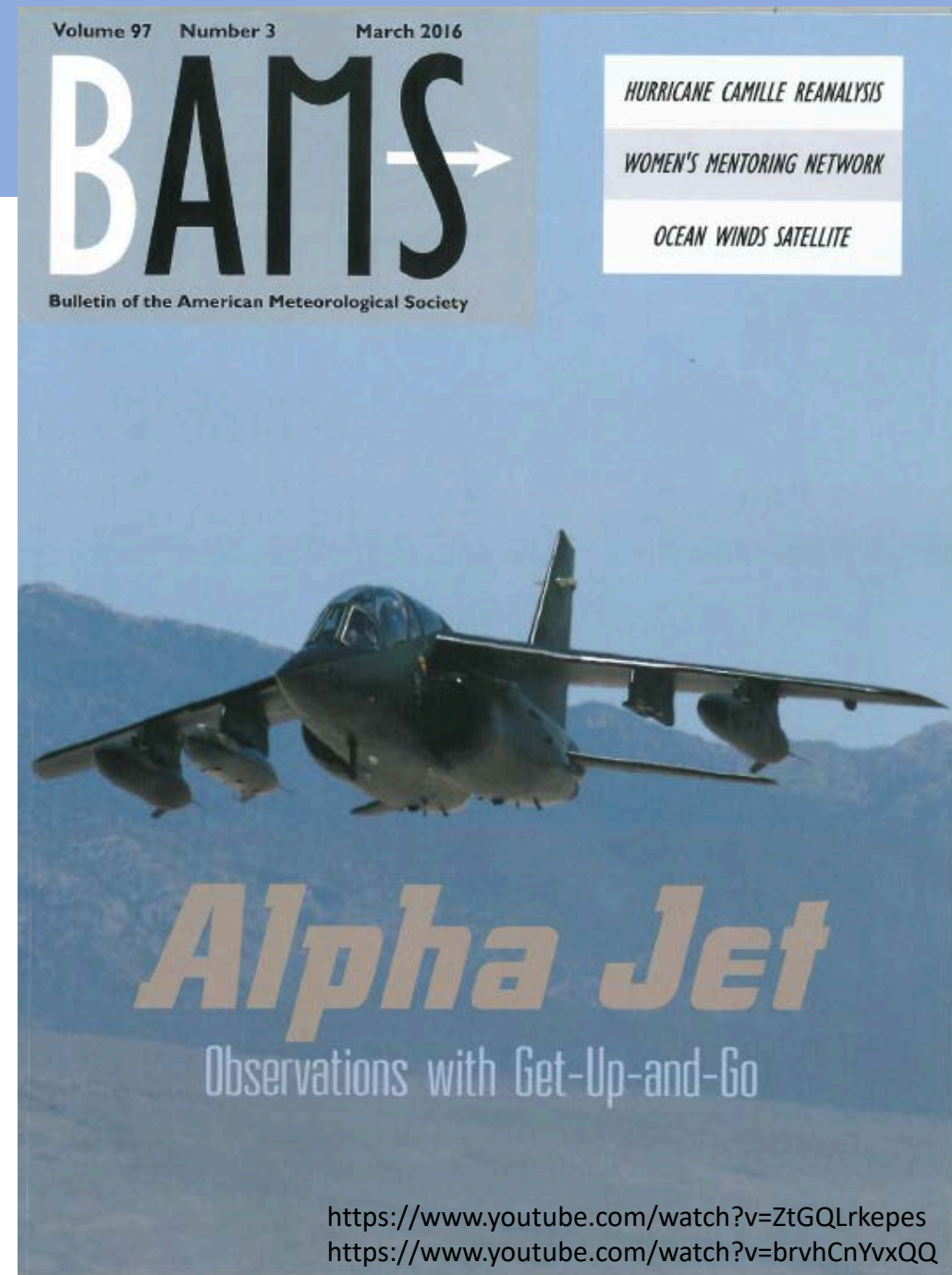
 ["NASA AJAX"](#)



AJAX Team: Emma Yates, Laura Iraci,
Caroline Parworth, Ju-Mee Ryoo

For data contact:

laura.iraci@nasa.gov



<https://www.youtube.com/watch?v=ZtGQLrkepes>
<https://www.youtube.com/watch?v=brvhCnYvxQQ>

Extra Slides

