The Alpha Jet Atmospheric eXperiment (AJAX): Past, present & future

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AJAX Overview

- Total flights: 234 between 2011 & 2019
- Payload: O$_3$, CH$_4$, CO$_2$, H$_2$O, HCHO, 3D winds
- Public Private Partnership with H211, LLC
- 22 peer reviewed publications

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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</thead>
<tbody>
<tr>
<td>2011</td>
<td>1st Flt of O$_3$, GHG instruments</td>
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<tr>
<td>2013</td>
<td>1st Flt of MMS 100th AJAX Flight</td>
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<tr>
<td>2015</td>
<td>1st Flt of HCHO SNAAX partnership</td>
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<tr>
<td>2018</td>
<td>SNAAX Replacement aircraft</td>
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<tr>
<td>2019</td>
<td>Replacement aircraft</td>
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Ceiling | Up to ~13 km, typically ~9 km
Speed   | ~100-280 m/s
Range   | ~1,000 km
Endurance | 2-2.5 hrs

AJAX flights by year and season

- Winter
- Fall
- Summer
- Spring
2018: A challenging year!

Photo courtesy of Metro Fire Sacramento
Scientific Aviation NASA Ames Airborne eXperiment (SNAAX)
2018: A happy ending
The Future: AJAX 2.0

• New (to us) Alpha Jet undergoing updates to avionics & wiring, aim to complete in Fall 2019.
• Adding NO\textsubscript{2} instrument to the payload (CO\textsubscript{2}, CH\textsubscript{4}, O\textsubscript{3}, HCHO, NO\textsubscript{2}, Met parameters)
where we fly

located in san francisco bay area

research priorities:
- air quality
- satellite/tccon cal/val
- wildfires, see caroline parworth’s talk tomorrow at 2 pm

ajax flights by location

rrv
offshore
merced
wildfires
thd
edwardsafb
sacramento

extreme o₃ nonattainment area

data sio, noaa, u.s. navy, nga, geobco
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image landsat, copernicus
data ldao-columbia, nsf, noaa
Sierra Nevada & SJV Ozone Trends

- 20-yr trends show a compression of the O₃ range.
Sierra Nevada & SJV Ozone Trends

- 20-yr trends show a compression of the $O_3$ range.

- SJV: High $O_3$ events in all seasons but defined time of day (12-5pm)

- High elevation sites (>600 m): High $O_3$ events in a defined season (dry season) but across all times of day.
The Importance of Ozone Aloft

- Correlations between AJAX O₃ and surface sites are enhanced in spring (& summer) suggesting there are common influences impact O₃ at surface sites and aloft.
- Spring 72%, summer 65% of O₃ profiles have elevated O₃ lamina.

Yates et al., An Assessment of ground level and free tropospheric ozone over California and Nevada, JGR, 2017.
Satellite Validation: TROPOMI

- Sentinel-5P/TROPOMI:
  - AJAX has 8 coincident flights
- Plans to add NO$_2$ instrument = cal/val with TROPOMI & future TEMPO satellite
Satellite Validation: GOSAT

• Proven track record of flying under GOSAT and OCO-2 (target, glint, nadir)
• Over 60 flights to Railroad Valley (RRV) under GOSAT, since 2011
  • Average difference (GOSAT_ACOS minus AJAX_ACOS) is 1.01 ppm for CO₂

Tanaka et al., Two year comparison of airborne measurements of CO₂ and CH₄ with GOSAT at Railroad Valley, NV, IEEE, 2016.
Conclusions

- AJAX has 234 flights over California/Nevada, since 2011.
- Measure O$_3$, CO$_2$, methane, formaldehyde, meteorological parameters. For data inquiries: laura.iraci@nasa.gov
- Scientific focus:
  - air quality,
  - satellite validation,
  - wildfire emissions (see Caroline Parworth’s talk at 2 pm tomorrow),
  - urban outflow and atmospheric rivers (author: Ju-Mee Ryoo)
- 2020 Plans: Fly AJAX 2.0 and add NO$_2$ to payload.
Thank you

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  Caroline Parworth   Susan Kulawik
  Ju-Mee Ryoo         Zion Young
  Kent Shiffer        Roy Vogler
  Emmett Quigley      Pilots & Crew of H211, LLC
                        Scientific Aviation

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ID #'s 19100, 19101