November 27, 2018

1. Instrument list, payload layout and updates
2. Deployment schedule
3. Logistics and operation
4. Needed information from investigators
<table>
<thead>
<tr>
<th>Instrument</th>
<th>Position</th>
<th>Species Measured</th>
<th>Investigators</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Picarro CRDS</td>
<td>1</td>
<td>CO, CO₂, CH₄, H₂O</td>
<td>Colm Sweeney</td>
<td>NOAA ESRL GMD</td>
</tr>
<tr>
<td>AIMSS Met Probe / Differential GPS</td>
<td>1</td>
<td>RH, Temp, Pres, Winds, GPS, flight data</td>
<td>Mike Robinson, Steve Brown</td>
<td>NOAA ESRL CSD</td>
</tr>
<tr>
<td>Tenax cartridge autosampler</td>
<td>1</td>
<td>Speciated VOC</td>
<td>Kelley Barsanti, Lindsey Hatch, Avi Lavi</td>
<td>UC Riverside</td>
</tr>
<tr>
<td>I-ToF CIMS</td>
<td>2</td>
<td>Acids (HNO₃, HONO, Organics), acid gases (N₂O₅, ClNO₂), Oxygenated organics, Organic nitrates, Halogens</td>
<td>Joel Thornton, Brett Palm, Carley Fredrickson, Zach Decker</td>
<td>University of Washington / NOAA</td>
</tr>
<tr>
<td>Aerosol mass spectrometer, UHSAS</td>
<td>3</td>
<td>Aerosol composition + size distributions</td>
<td>Ann Middlebrook, Ale Franchin, Kathy Hayden, Shao-Meng Li</td>
<td>NOAA ESRL CSD Environment Canada</td>
</tr>
<tr>
<td>Brown carbon PiLS</td>
<td>4a</td>
<td>Spectrally resolved aerosol absorption</td>
<td>Rebecca Washenfelder</td>
<td>NOAA ESRL CSD</td>
</tr>
<tr>
<td>Chemiluminescence</td>
<td>4b</td>
<td>NO, NO₂, O₃ (O₃ location still TBD)</td>
<td>Andy Weinheimer, Denise Montzka, Geoff Tyndall, Frank Flocke</td>
<td>NCAR</td>
</tr>
</tbody>
</table>
Additions – TRAC Sampler, Alex Laskin Purdue

TRAC sampler for collection of individual particles for spectro-microscopy analysis

- Weight: 10 lbs; Dimensions: H7”xW6.5”xD5.5”
- Input Voltage = 12-20VDC
- Power Supply Current Requirement = 1.5A
- Peak Current Draw = 1A
- Steady State Current Draw: 250mA

- Automated, pre-programmed sampling onto microscopy substrates:
- Up to 560 substrates can be loaded.
- Has been flown on board of research aircrafts before (see example papers listed below)
- The shortest time in previous airborne missions was 2 min/sample

TRAC sampler for collection of individual particles for spectro-microscopy analysis

- Electron and X-ray spectro-microscopy characterization of particle composition and their internal structures
- Data on particle-type contributions in overall particle ensembles
- Composition and mixing state of individual particles, complementing real-time optical and AMS measurements
- Parameterization of mixing state based on entropy metrics of Riemer and West
- Hygroscopic transformations of sampled particles can be also probed

Examples of our previous studies of aircraft-collected particles

Hiranuma et al, 2013  

Laskin et al, 2012  
# Twin Otter Payload Spreadsheet

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Power (kVA)</th>
<th>Weight (lbs)</th>
<th>Deployed?</th>
<th>Deployed Weight (lbs)</th>
<th>Deployed Power (kVA)</th>
<th>Position</th>
<th>Notes</th>
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<tbody>
<tr>
<td>AMS</td>
<td>1.1</td>
<td>415</td>
<td>1</td>
<td>415</td>
<td>1.1</td>
<td>3</td>
<td>From Environment Canada, Jan 25</td>
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<tr>
<td>Iodide ToF CIMS</td>
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<td>380</td>
<td>1</td>
<td>380</td>
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<td>2</td>
<td>UWFPS Weight</td>
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<tr>
<td>NCAR NO, NO2</td>
<td>1.1</td>
<td>486</td>
<td>1</td>
<td>486</td>
<td>1.1</td>
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<td>From Andy Weinheimer, Jan 10</td>
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<tr>
<td>CL O3</td>
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<td>65</td>
<td>1</td>
<td>65</td>
<td>0</td>
<td>TBD</td>
<td>Weight not included above, electrical included</td>
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<tr>
<td>BrC PiLS</td>
<td>0.42</td>
<td>106</td>
<td>1</td>
<td>106</td>
<td>0.42</td>
<td>4a</td>
<td>Does not include rack weight (flying in station 4 2-bay rack, included in NCAR weight)</td>
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<tr>
<td>CO, CO2, CH4, H2O</td>
<td>0.2</td>
<td>52</td>
<td>1</td>
<td>52</td>
<td>0.2</td>
<td>1</td>
<td>Confirmed loan from Colm Sweeney, weight confirmed w/mini pump</td>
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<tr>
<td>Met Probe</td>
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<td>7</td>
<td>1</td>
<td>7</td>
<td>0.1</td>
<td>1</td>
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<tr>
<td>Data Acquisition</td>
<td>0.1</td>
<td>10</td>
<td>1</td>
<td>10</td>
<td>0.1</td>
<td>1</td>
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<tr>
<td>UPS</td>
<td>0</td>
<td>33</td>
<td>1</td>
<td>33</td>
<td>0</td>
<td>1</td>
<td>33 lbs = 770 W / 1000 VA / 1U Li ion UPS, 87 lbs to go to 2700 W / 3000 VA / 2U</td>
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<tr>
<td>UCR VOC Sampler</td>
<td>0.2</td>
<td>30</td>
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<td>0.2</td>
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<td>Weight remains an estimate</td>
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<td>POP5</td>
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<td>NOAA 2B Instrument</td>
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</tbody>
</table>

**Equipment Subtotal**: 5.12 kVA, 1783 lbs, 1584 lbs deployed, power 4.32 kVA

| Pilots                | 360         | 1           | 360        | 2 pilots              |
| Scientists            | 360         | 1           | 360        | 2 operators           |
| Life raft             | 70          | 0           | 0          |                         |

**Crew Subtotal**: 790 lbs

**Total**: 5.12 kVA, 2573 lbs, 2304 lbs deployed, power 4.32 kVA

| Available             | 4 kVA 115 VAC | 2200        | 2200        | From Lindsey Norman, September 2016, Allows 2.75 hr (actual 3 hr) flight duration |
|                       | ~3 kVA 28 VDC | up to 7 kVA |             | Bill Dubé suggests actual power limit closer to 5 kVA total, rather than 7 |
Final Mechanical Layout for Twin Otter

- Picarro
- VOC Sampler
- Met Probe
- Flight Scientist Laptop
- TRAC Sampler
- UPS
- I-CIMS
- AMS
- BrC
- PiLS
- NO
- NO₂
- CL
- Pump
- STATION 1
- STATION 2
- STATION 3
- STATION 4

Flight Scientist

Second Scientist Jump Seat
Final Mechanical Layout for Twin Otter
Location of Inlets

Gas phase inlets: NOx, I- CIMS

Gas phase inlet: Picarro, VOC sampler

Aerosol Inlet
Location of Inlets

- **Aerosol Inlet**

**Gas phase inlets:**
- NOx, I-CIMS

**Gas phase inlet:**
- Picarro, VOC sampler
Current Payload Concerns

1. Volume – Available rack space for all instruments
2. Payload weight – Current estimate at 1584/1500 lbs = 106%
   • Extra 84 lbs = ~8.5 minutes of flight time
3. Electrical load – Current budget at 4.12/5.0 kVA = 82%
4. Heat management – Large unknown!
   • Simple model of inside T as a function of outside T suggest 40 C or above is possible
     • LT Jake Blaauboer (new point of contact at AOC for this project) will help to provide better estimates, but thinks this is manageable
     • We need information about the max allowable temperatures for each instrument
Expected Ambient and Aircraft Cabin Temperatures

Temperature vs altitude data from WE-CAN

Simple model of cabin temperature for FIREX-AQ power dissipation

- Boise elevation
- TO Max Alt
Deployment Schedule

July 15: Project Start Date

July 17 – 26: Integration at Research Aviation Facility (RAF), Broomfield CO

July 29 – 31: Test flights and transit to Boise

August 2 – September 7: Research flights

September 9-11: Transit to and de-installation at RAF

September 12: Project End Date (Last possible date, may end sooner)

180 flight hours on the schedule (!)
<table>
<thead>
<tr>
<th>SUNDAY</th>
<th>MONDAY</th>
<th>TUESDAY</th>
<th>WEDNESDAY</th>
<th>THURSDAY</th>
<th>FRIDAY</th>
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<td>17</td>
<td>18</td>
<td>19</td>
<td>20</td>
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<tr>
<td></td>
<td>Transit from Lakeland to RAF</td>
<td>Sta. 1 &amp; 2</td>
<td>Sta. 1 &amp; 2</td>
<td>Sta. 3 AMS</td>
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<tr>
<td></td>
<td>Sta. 3 AMS</td>
<td>Sta. 4a BrC PiLS</td>
<td>Sta. 4a BrC PiLS</td>
<td>Sta. 4b NOx</td>
<td>Sta. 4b NOx</td>
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<td>30</td>
<td>31</td>
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<tr>
<td></td>
<td>Test Flight #1</td>
<td>Test Flight #2</td>
<td>Transit RAF to Boise</td>
<td>First Research Flight</td>
<td></td>
<td>August 2: First research flight</td>
</tr>
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</table>

**July 15-16:** Transit from Lakeland, FL to Broomfield, CO (RAF)

**July 17-18:** Stations 1 & 2 Integration (Picarro, VOC sampler, Met probe / GPS, i CIMS)

**July 19, 22:** Station 3 Integration (AMS)

**July 23-24:** Station 4 Integration (BrC PiLS) + CL O₃

**July 25-26:** Station 5 Integration (NOₓ)

**July 29, 30:** Test flights

**July 31:** Transit from Broomfield, CO to Boise, ID
<table>
<thead>
<tr>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
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<td>2</td>
<td>Daytime Flights</td>
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<td>Daytime Flights</td>
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<td>22</td>
<td>23</td>
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<tr>
<td>DC-8 Departs Boise</td>
<td></td>
<td></td>
<td>Night Flights</td>
<td>29</td>
<td>30</td>
</tr>
</tbody>
</table>

- **August 2:** First research flight possibility
- **August 2 – 19:** Emphasis on daytime flights for best coordination with DC-8
- **August 19:** DC-8 departs Boise for Salina
- **August 19 – September 7:** Emphasis on night flights
<table>
<thead>
<tr>
<th>SUNDAY</th>
<th>MONDAY</th>
<th>TUESDAY</th>
<th>WEDNESDAY</th>
<th>THURSDAY</th>
<th>FRIDAY</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>4 Night</td>
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<td>12</td>
<td>13</td>
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<td></td>
<td>Transit Boise to RAF</td>
<td>De-installation of instruments, RAF</td>
<td>Transit RAF to Lakeland</td>
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<td>30</td>
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</tbody>
</table>

- **September 7**: Last possible research flight
- **September 9**: Transit from Boise, ID to Broomfield, CO (RAF)
- **September 10-11**: De-installation of instruments
- **September 12**: Twin Otter departs RAF
Flight Hours

Total flight hours = 180

Transits + Test flights = 20

Research flight hours = 160

Single flight day, up to 8 hours, $\frac{160}{8} = 20$ flight days

38 days in Boise

Approximately 1 flight day every 2 days

This is ambitious! We may not be able to make use of all 180 hours
Back to Back Research Flights

Example flight day (or night)

- 11 hour day for scientists, less for pilots, 6 hours of flight time
- This was our standard schedule during the Utah 2017 campaign
Flight Planning & Logistics

• Twin Otter endurance = 3 hours, insufficient to reach fires unless they are in the immediate vicinity of Boise

• Twin Otter can ferry >500 km (3 hours)

  Salt Lake City, Missoula, Oregon, Washington should easily be within range for 500 km ferry flights

  Shorter ferry flights (<200 km) requiring only 1 hour have a more limited range of accessible airfields from Boise

• Sampling from airfields remote to Boise possible either as multi-day or single day deployments

• Support truck with equipment may be required for multiple day deployments
Example single day flight schedule with short ferry (1 hour):

- 13 hour day for flight scientists and pilots (limit = 16), 8 hours of flight time (limit = 12)
- Could be supported with a ground truck that drives to remote location with equipment & ground personnel

Example single day flight schedule with long ferry (3 hours):

- 13 hour day for flight scientists and pilots, 9 hours of flight time
- May incorporate some sample time into the ferry flights depending on ferry distance / length
Logistical Planning

1. Heat load management
   • Air conditioning carts on the ground – how big and how many?
   • Heat management in the air using venting, higher altitude flying, etc.
   • Heat management during taxi, and during land and re-fuel events!!

2. Protocol for landing and refueling
   • Best if we can do this without a support truck driving to a remote airfield
   • Need to work with AOC and scientists to develop protocol to keep instruments running

3. Develop list of target airfields for remote operations from Boise
   • Determine which airfields can support these operations within 2.5 hour transit from Boise
   • May be a short list! Will simplify flight planning, but may limit fires we can sample

4. Contingency for operation at airfield other than Boise
   • If hot spots are not in Idaho, we may need to relocate (Broomfield, Salt Lake City, Missoula, Northern California, Oregon, Washington)
   • Hopefully we will determine this prior to deployment to Boise

5. Coordination between the in-situ and remote sensing Twin Otters
**Information Needed from Investigators**

1. **Power management**
   
   • We will be purchasing a UPS shortly – we need to know your maximum power on UPS need

2. **Heat management**
   
   • What is the max temperature that your instrument can operate under?

3. **Pump capacity** (related to above)
   
   • For all large instruments, is it possible to reduce pump size and / or share with others?

4. **Instrument standby mode**
   
   • Helpful to put instruments into lower power “standby” during landing / refueling
   • Does your instrument have such a state?
   • Detailed procedure for putting instrument into and taking it out of standby

The above is needed most for the four large instruments:

- I- CIMS
- AMS
- BrC PiLS
- Chemiluminesence
Questions & Comments