Instrumenting GAP-PT

16 May 2003
## Deployment of GAP Instruments

<table>
<thead>
<tr>
<th>Instrument</th>
<th>ID</th>
<th>Weight (kg)</th>
<th>Power (W)</th>
<th>Data acquisition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condensation Particle Counter **</td>
<td>CPC</td>
<td>0.87</td>
<td>2.3</td>
<td>RS-232</td>
</tr>
<tr>
<td>Optical Particle Counter **</td>
<td>OPC</td>
<td>0.27</td>
<td>5.4†</td>
<td>RS-232</td>
</tr>
<tr>
<td>Cloud Droplet Probe</td>
<td>CDP</td>
<td>1.42</td>
<td>14.0†</td>
<td>RS-232</td>
</tr>
<tr>
<td>Pyranometer **</td>
<td>CM21-A</td>
<td>0.2†</td>
<td>NA</td>
<td>datalogger</td>
</tr>
<tr>
<td>Multi-Channel Airborne Radiometer (405, 550, 875, PAR)</td>
<td>MCAR</td>
<td>0.3†</td>
<td>0.01†</td>
<td>RS-232</td>
</tr>
<tr>
<td>Cloud Condensation Nucleus Counter</td>
<td>CCN</td>
<td>3.0†</td>
<td>25.0†</td>
<td>RS-232</td>
</tr>
<tr>
<td>Digital video camera</td>
<td>DC</td>
<td>0.5†</td>
<td>0.1†</td>
<td>Flash card</td>
</tr>
<tr>
<td>Data acquisition system **</td>
<td>DAQ</td>
<td>0.41</td>
<td>7</td>
<td>--</td>
</tr>
<tr>
<td>Aerosol inlet **</td>
<td>AI</td>
<td>0.10</td>
<td>NA</td>
<td>--</td>
</tr>
</tbody>
</table>

### Estimated payload for each platform

<table>
<thead>
<tr>
<th>Payload (kg)</th>
<th>Power (W)</th>
<th>Instrumentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>above-cloud</td>
<td>3.15</td>
<td>AI, DAQ, CPC, 2*CM21, OPC, MCAR, DC</td>
</tr>
<tr>
<td>in-cloud</td>
<td>3.07</td>
<td>AI, DAQ, CPC, CDP, OPC</td>
</tr>
<tr>
<td>below-cloud</td>
<td>4.68</td>
<td>AI, DAQ, CPC, CCN, MCAR, OPC</td>
</tr>
</tbody>
</table>

** GAP-PT deployment: Total estimated weight = 2.1 kg; power = 15 W  (AI, DAQ, CPC, 2*CM21, OPC)
GAP-PT Instrumentation

**Condensation Particle Counter (CPC)**
- Weight: 0.87 kg
- Dimensions: 250 x 120 x 70 mm
- Power consumption: 2.3 W (12 VDC)
- Data output: RS-232
- Deployment: fuselage

**Optical Particle Counter (OPC)**
- Weight: 0.27 kg
- Dimensions: 96 x 135 x 50 mm
- Power consumption: 5.4 W (12 V DC)
- Data output: RS-232
- Deployment: fuselage

**Data Acquisition (DAQ)**
- Weight: 0.41 kg
- Dimensions: 95 x 120 x 55 mm
- Power consumption: 7 W (5 V DC)
- Deployment: fuselage

**Pyranometer (CM21-A)**
- Weight: 0.20 kg
- Dimensions: 80 Ø x 100 mm
- Power consumption: NA
- Data output: Analog
- Deployment: fuselage body

**Aerosol Inlet / Flow splitter (AI)**
- Weight: 0.10 kg
- Dimensions: 23 Ø x 320 mm
- Power consumption: NA
- Data output: NA
- Deployment: nose
- NOTE: splitter in fuselage
Stream lines around fuselage

Sampling of aerosols
1. Centerline on nose
2. Offset from centerline
3. Above fuselage

Note: 1 & 2 extend at least 1.5x $r_{fuselage}$ into air stream

FIG. 1. Streamlines around a single source embedded in a uniform flow.

Shrouded Aerosol Inlet

Requirements:
• sample outside influence of aircraft
  - extend from nose 1.5x \( r_{\text{fuselage}} \) (ca. 15 cm)
• oriented into the air stream at the center of the nose
• calibration (modelling / wind tunnel)
  - shroud reduction velocity
  - aerosol aspiration efficiency (at various speeds and attack angles)
• design for \( 36 \) m s\(^{-1} \)
• accommodate for 1.5 degree pitch during flight

Technical information
• \( \text{ID}_{\text{inlet}} \): 3.05 mm (0.120”)
• \( \text{OD}_{\text{tube}} \): 6.35 mm (0.250”)
• \( \text{OD}_{\text{shroud}} \): 9.53 mm (0.375”)
• weight: 37 g
• \( \frac{A_{\text{pr}}}{A_{\text{sh}}} = 0.7 \)
• flow rate: ca 10 lpm
Flow Splitter

**Technical information**
- OD: 6.35 mm (0.250”)
- ID: 4.83 mm (0.190”)
- dimensions: 23 Ø x 112 mm
- weight: 30 g
- 10° included angle

**Requirements:**
- attach directly to aerosol inlet (inside fuselage)
- shortest connection to OPC and CPC
- attach to venturi for bypass flow
- grounded
Condensation Particle Counter

Technical information
• TSI Model 3007
• Weight: 0.87 kg
• Dimensions: 250 x 120 x 70 mm
• Power consumption: 2.3 W (7-12 VDC)
• Data output: RS-232
• Deployment: fuselage

Requirements:
• deploy with optical block slightly raised and toward the nose
• staking of electronics
• power supply (7-12 VDC)
Optical Particle Counter

Technical information
• Weight: 0.27 kg
• Dimensions: 96 x 135 x 50 mm
• Power consumption: 5.4 W (12 – 15 V DC)
• Data output: RS-232
• Deployment: fuselage

Requirements:
• attach as close as possible to flow splitter
• staking of electronic components
• power supply (12 - 15 VDC)

Note: Use 6 channels for now – but goal is to use higher resolution.
Pyranometer

Technical information
• Modified CM-21
• Weight: 0.2 kg
• Dimensions: 80 Ø x 100 mm
• Power consumption: NA
• Data output: analog
• Deployment: wing

Requirements:
• no obstruction of hemispherical view
• upward and downward mounted sensors
• dome and sensor housing exposed to air stream
• staking of electronic parts
Data Acquisition

Technical information
- Advantech PCM-3350; PCM-3643
- Diamond Systems MM-16-AT
- Weight: 0.41 kg
- Dimensions: 95 x 120 x 55 mm
- Power consumption: 7 W (5 V DC)
- Deployment: fuselage

Requirements:
- shielded from RF and EMI
- grounded
- power supply (5 VDC)
- staking of electronic parts (vibration)
- maintain temperature in fuselage
- communication with flight computer (time, GPS coordinates, data transmission, storage)
Instr. Development

- Sample outside of boundary layer and bending of streamlines
  - Below the center of each wing
  - Lower aircraft fuselage
  - Upper aircraft fuselage ahead of trailing edge of wings but well behind cockpit
  - Extending into the air stream ahead of aircraft nose
- Instruments arranged to get CG in correct position and mounted to internal structure in mold
- Vibration / inlet motion -- staking electronics
- Temperature and sealing of fuselage – inlet ports to keep instruments cool
- DC power supply (output voltages and power) – 28 VDC @ 30 W generator for instruments
- Grounding of plane and instruments – separate strips for onboard computer and instruments
- Propeller will not effect aerosol measurements in front of fuselage
- Angle of attack: pitch (< 1.5°) and yaw angles (less than a couple of degrees); take off at 12°; max at 16°
- Velocity of aircraft (cruise 36 m s\(^{-1}\); min 6.5 m s\(^{-1}\); max 47 m s\(^{-1}\))
- Dimensions of fuselage (ca. 20 cm diameter)