NASA DC-8
Flying Laboratory Aircraft

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The Basic Aircraft

Aircraft Description:
- Douglas DC-8-72
- Fuselage Length: 157 ft
- Wingspan: 148 ft
- Engines: 4 ea CFM56-2-C1 High Bypass Turbofan Jet
- Crew: 2 Pilots, 1 Flight Engineer, 1 Navigator, 2 Mission Dir., 2 Safety Techs, 1 Data System Mngr.

History:
- Built in 1968
- Acquired by NASA in 1985
- Modified 1985-87
DC-8
Large Capacity, Long Range and Endurance

Capabilities
• Ceiling 42,000 ft.
• Duration 11 hours
• Range > 5,000 nautical miles
• Payload 30,000 lbs

Mission Support Features
• Shirtsleeve environment for up to 41 researchers
• Worldwide deployment experience
• Extensive modifications to support in-situ and remote sensing instruments
  – zenith and nadir viewports
  – wing pylons
  – modified power systems
  – 19 inch rack mounting
Zenith, Nadir, and 62 ° Ports:
Zenith no. 1 Sta. 330 C/L 16 x 18.0
Nadir no. 2 Sta. 420 C/L 37.25 x 30.0
Nadir no. 7 Sta. 1200 C/L 37.25 x 30.0
62 ° no. 1 Sta. 470 LH 16 x 21.25
62 ° no. 3 Sta. 1090 LH 16 x 21.25
62 ° no. 4 Sta. 1130 LH 16 x 21.25
Nadir no. 5 Sta. 1130 LH 16 x 21.25
62 ° no. 8 Sta. 1310 RH 16 x 21.25
Nadir no. 9 Sta. 1310 RH 16 x 21.25
Modified 8 deg Passenger Window Ports:
8 ° Sta. 330 LH 16 x 18
8 ° Sta. 450 LH 16 x 18
8 ° Sta. 530 RH 16 x 18
8 ° Sta. 570 L&R 16 x 18
8 ° Sta. 890 LH 16 x 18
8 ° Sta. 1010 L&R 16 x 18
8 ° Sta. 1290 L&R 16 x 18
ARCTAS DC-8 Instrumentation

UNH, Talbot
CAFS, Shetter

ATHOS, Brune

LARGE, Anderson
NOxyO3

HOxCIMS, Cantrell
DLH, Diskin
DACOM, Diskin
SAGA, Dibb

CIT CIMS, Wennberg
TD-LIF, Cohen
GTCIMS, Huey
PTR MS, Wisthaler

HOxCIMS, Cantrell
DACOM, Diskin
SAGA, Dibb

DLH, Diskin

TOGA, Apel
DFGAS, Fried

AVOCET, Vay

DC-8 Viewing Ports
DC-8 Under Wing Pylons

Each pylon is designed to accommodate an equipment package with a maximum weight of 100 lb.

Electrical power, signal, and nitrogen gas connections exist at each pylon and extend to a connector panel at station 670 on both left hand and right hand sides of the aircraft.
Dropsonde System

Accommodates dropsondes up to 20” length and 2.875” & 3.75” diameter
Optical Grade Windows

Stock full-aperture (16 in. (40.6 cm) diameter) window materials include:
- Borosilicate crown glass (BK-7)
- UV grade fused silica.

Other optical materials (all less than full aperture in size):
- High-density polyethylene
- IrTran
- Germanium
- Pyrex.
The following aircraft electrical power is supplied to the experimenters:

- 400 Hz (±1%), 115 volt (±1%), single-phase AC power, of which a nominal 40 kVA total is available
- 60 Hz (±0.1%), 115 volt (±1%), single-phase AC power, of which a nominal 40 kVA total is available
- Limited 220 volt capability
- 28 volt DC power supplies operating from 400 Hz power
- Outlet stations are spaced along both walls of the main cabin and in the cargo areas
Cabin Equipment Installations

- Accommodated by 19” racks and mountings to Brownline seat rails
- Equipment can also be located in forward & aft cargo bays that are accessible in flight
Recent System Upgrades

**Aircraft and Facility Upgrades**

- New 1-F Flight Management System
- New Terrain Awareness Warning System to meet FAA requirements
- New Digital Aircraft Flight Recorder to meet FAA requirements
- New Navigation Units with FM Immunity to meet European Standards
- New Digital COMM / NAV Control Panels
- New IRIDIUM air/ground communications for Flight Crew
- Wing tip probe upgrades

**Data Acquisition and Display System Upgrades**

- REVEAL data acquisition system
- IRIDIUM based satcom system
- X-chat capability with ground
- New gigabit ethernet based data display system
- Backward compatibility with RS-232 data stream
- High resolution LCD displays
- Dedicated Mission scientist station
- Digital video system

Systems descriptions and equipment installation requirements can be found in the Experimenter Handbook:

Currently we distribute a UDP packet at 1Hz containing the following thru REVEAL:

- UNS 1-B Latitude and Longitude
- GPS Altitude (MIDG-II), Pressure Altitude, Radar Altitude
- True Air Speed, Indicated Air Speed, Mach Number, Vertical Speed
- True Heading, Track Angle, Drift Angle, Pitch Angle, Roll Angle, Slip Angle, Attack Angle
- Static Air Temp, Dew Point, Total Air Temp, Static Pressure, Dynamic pressure, Cabin Pressure.
- Wind Speed, Wind Direction, Vert Wind Speed
- Solar Zenith Angle, Aircraft Sun Elevation, Sun Azimuth, Aircraft Sun Azimuth
- GPS_Vertical_Speed (MIDG-II)
- ADC_Baro_Altitude
- Potential Temp, Cabin Temp, Cabin Humidity
- Acceleration_X, Acceleration_Y, Acceleration_Z
- Time stamp (both IRIG and NTP available for clock synchronization)

New AIMMS-20 high precision/rate system in work (see B/U slides)
• Iridium system is 2400 bps per channel, with the 4-channel system supporting up to 9600 bps

• New INMARSAT system capable of up to 432kbps
  • Buy by bandwidth service
DC-8 Located At DAOF Palmdale, CA

Dryden Aircraft Operations Facility
Dryden Aircraft Operations Facility

Palmdale Site 9 complex provides for:
- Efficient consolidated operations of platform aircraft
- Easy access for visiting science teams
- Access to Air Force Plant 42 airfield
  - Two 12,000 ft runways

Building 703:
- SOFIA
- DC-8
- ER-2
- G-3
DAOF Layout

Science Integration Labs

ERM's

DC-8

SOFIA
Substantial Ground Support Infrastructure

2” 100PSI H2O Main

440VAC/200amp Receptacles

120VAC/20amp Receptacles
DC-8 GRIP Support
## GRIP Support – Transit Time

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>Initial Heading</th>
<th>Distance</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>KJAX</strong> (30°29'39&quot;N 81°41'16&quot;W)</td>
<td><strong>KMIA</strong> (25°47'36&quot;N 80°17'26&quot;W)</td>
<td>164° (S)</td>
<td>291 nm</td>
<td>0:40</td>
</tr>
<tr>
<td><strong>KHST</strong> (25°29'18&quot;N 80°23'01&quot;W)</td>
<td><strong>KMIA</strong> (25°47'36&quot;N 80°17'26&quot;W)</td>
<td>15° (N)</td>
<td>19 nm</td>
<td>0:03</td>
</tr>
<tr>
<td><strong>KRSW</strong> (26°32'10&quot;N 81°45'19&quot;W)</td>
<td><strong>KMIA</strong> (25°47'36&quot;N 80°17'26&quot;W)</td>
<td>119° (SE)</td>
<td>91 nm</td>
<td>0:12</td>
</tr>
<tr>
<td><strong>KFLL</strong> (26°04'21&quot;N 80°09'10&quot;W)</td>
<td><strong>KMIA</strong> (25°47'36&quot;N 80°17'26&quot;W)</td>
<td>204° (SW)</td>
<td>18 nm</td>
<td>0:02</td>
</tr>
<tr>
<td><strong>TISX</strong> (17°42'06&quot;N 64°48'06&quot;W)</td>
<td><strong>KMIA</strong> (25°47'36&quot;N 80°17'26&quot;W)</td>
<td>301° (NW)</td>
<td>990 nm</td>
<td>2:15</td>
</tr>
<tr>
<td><strong>TBPB</strong> (13°04'29&quot;N 59°29'33&quot;W)</td>
<td><strong>KMIA</strong> (25°47'36&quot;N 80°17'26&quot;W)</td>
<td>305° (NW)</td>
<td>1400 nm</td>
<td>3:11</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td></td>
<td></td>
<td>2808 nm</td>
<td>6:23</td>
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</table>
GRIP Support - Range

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>Initial Heading</th>
<th>Distance</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>KFLL (26°04'21&quot;N 80°09'10&quot;W)</td>
<td>20°00'00&quot;N 40°00'00&quot;W</td>
<td>90° (E)</td>
<td>2243 nm</td>
<td>5:06</td>
</tr>
<tr>
<td>KFLL (26°04'21&quot;N 80°09'10&quot;W)</td>
<td>10°00'00&quot;N 100°00'00&quot;W</td>
<td>233° (SW)</td>
<td>1483 nm</td>
<td>3:22</td>
</tr>
</tbody>
</table>

Total: 3725 nm 8:28

<table>
<thead>
<tr>
<th>Code</th>
<th>Source</th>
<th>Location</th>
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</thead>
<tbody>
<tr>
<td>KFLL</td>
<td>FAA</td>
<td>Fort Lauderdale [Fort Lauderdale/Hollywood Intl], FL, US</td>
</tr>
<tr>
<td>KJAX</td>
<td>FAA</td>
<td>Jacksonville [Intl], FL, US</td>
</tr>
<tr>
<td>KMIA</td>
<td>FAA</td>
<td>Miami [Intl], FL, US</td>
</tr>
<tr>
<td>KHST</td>
<td>FAA</td>
<td>Homestead [Homestead Air Reserve Base], FL, US</td>
</tr>
<tr>
<td>KRSW</td>
<td>FAA</td>
<td>Fort Myers [Southwest Florida Intl], FL, US</td>
</tr>
<tr>
<td>TISX</td>
<td>FAA</td>
<td>Christiansted [Henry E Rohlsen Airport], St. Croix, VI, US</td>
</tr>
<tr>
<td>TBPB</td>
<td>DAFIF</td>
<td>Bridgetown [Grantley Adams Intl], BB</td>
</tr>
</tbody>
</table>

Range circles extend 1980nm from KJAX, KHST, KRSW, TISX, TBPB departure points and allow for two hours dwell time at perimeter of circle (4.5 hours out + 4.5 hours back + 2 hours dwell = 11.0 hours); Range circle extends 1760nm from KFLL departure point and allows for two hours dwell time at perimeter of circle (4.0 hours out + 4.0 hours back + 2 hours dwell = 10.0 hours);
Ft. Lauderdale to Barbados transit/science flight

<table>
<thead>
<tr>
<th>From</th>
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<th>Distance</th>
<th>Time</th>
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</thead>
<tbody>
<tr>
<td>KFLL (26°04'21&quot;N 80°09'10&quot;W)</td>
<td>20°00'00&quot;N 40°00'00&quot;W</td>
<td>90° (E)</td>
<td>2243 nm</td>
<td>5:06</td>
</tr>
<tr>
<td>20°00'00&quot;N 40°00'00&quot;W</td>
<td>TBPB (13°04'29&quot;N 59°29'33&quot;W)</td>
<td>252° (W)</td>
<td>1196 nm</td>
<td>2:43</td>
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Total: 3439 nm 7:49

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<td>KFLL</td>
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<td>Fort Lauderdale [Fort Lauderdale/Hollywood Intl], FL, US</td>
</tr>
<tr>
<td>TBPB</td>
<td>DAFIF</td>
<td>Bridgetown [Grantley Adams Intl], BB</td>
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</table>
GRIP Support - Range

Ft. Lauderdale to Pacific region and Back

10N100W

<table>
<thead>
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<th>From</th>
<th>To</th>
<th>Initial Heading</th>
<th>Distance</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>KFLL (26°04'21&quot;N 80°09'10&quot;W)</td>
<td>10°00'00&quot;N 100°00'00&quot;W</td>
<td>233° (SW)</td>
<td>1483 nm</td>
<td>3:22</td>
</tr>
<tr>
<td>10°00'00&quot;N 100°00'00&quot;W</td>
<td>KFLL (26°04'21&quot;N 80°09'10&quot;W)</td>
<td>46° (NE)</td>
<td>1483 nm</td>
<td>3:22</td>
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Total: 2965 nm 6:44

<table>
<thead>
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<th>Code</th>
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<td>KFLL</td>
<td>FAA</td>
<td>Fort Lauderdale [Fort Lauderdale/Hollywood Intl], FL, US</td>
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</tbody>
</table>
# Ft. Lauderdale – Average Temperatures

<table>
<thead>
<tr>
<th>Month</th>
<th>Average Temp</th>
<th>Ave. Daily High Temp</th>
<th>Ave. Daily Low Temp</th>
<th>Record High Temp (year)</th>
<th>Record Low Temp (year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>June</td>
<td>81°F / 27°C</td>
<td>89°F / 32°C</td>
<td>72°F / 22°C</td>
<td>100°F / 38°C (1985)</td>
<td>40°F / 4°C (1983)</td>
</tr>
<tr>
<td>July</td>
<td>83°F / 28°C</td>
<td>91°F / 33°C</td>
<td>73°F / 23°C</td>
<td>101°F / 38°C (1981)</td>
<td>61°F / 16°C (1950)</td>
</tr>
<tr>
<td>Sep</td>
<td>82°F / 28°C</td>
<td>90°F / 32°C</td>
<td>73°F / 23°C</td>
<td>99°F / 37°C (1973)</td>
<td>57°F / 14°C (1994)</td>
</tr>
<tr>
<td>Oct</td>
<td>78°F / 26°C</td>
<td>86°F / 30°C</td>
<td>70°F / 21°C</td>
<td>97°F / 36°C (1980)</td>
<td>44°F / 7°C (1996)</td>
</tr>
</tbody>
</table>
## Ft. Lauderdale – DC-8 Takeoff Performance

### NASA DRYDEN RESEARCH CENTER

**3 MAR 06**

**KFL-2**

**OPS DATA SERVICES**

---

**ELEV. 39FT**

**MAX TEMP 120F**

**CPTM-3-C1**

**FLAPS 23**

**FT LAUDERDALE-HOLLYW**

**FT LAUDERDALE, FL**

**VAR 03 W**

**DC-8-70**

**TAKE OFF PERFORMANCE**

**A/C PACKS OFF**

### RUNWAY NO | 05L | 13 | 278 | 20 | MIA | C
---|---|---|---|---|---|---
0 | 350.0 | 348.0 | 348.0 | 347.6 | 358.4 | 16.9 | 17
10 | 350.0 | 343.6 | 338.6 | 348.7 | 350.4 | 85.8 | 11
20 | 350.0 | 345.4 | 339.6 | 342.7 | 340.3 | 86.7 | 9
30 | 350.0 | 342.6 | 342.3 | 342.6 | 342.3 | 94.6 | 9
40 | 350.0 | 341.6 | 342.9 | 344.3 | 344.9 | 85.3 | 11
50 | 350.0 | 340.5 | 338.6 | 346.2 | 349.7 | 88.0 | 7
60 | 350.0 | 339.3 | 337.3 | 337.0 | 329.5 | 99.0 | 11
70 | 350.0 | 338.5 | 335.3 | 336.0 | 329.5 | 97.7 | 9
80 | 350.0 | 337.5 | 327.5 | 334.6 | 329.8 | 96.2 | 11
90 | 350.0 | 336.5 | 334.5 | 334.1 | 329.8 | 81.1 | 11
100 | 350.0 | 335.5 | 333.5 | 332.5 | 329.8 | 16.7 | 11
102 | 350.0 | 335.0 | 333.0 | 334.5 | 330.0 | 20.7 | 11
110 | 350.0 | 334.5 | 332.5 | 334.5 | 330.0 | 21.7 | 11
112 | 350.0 | 334.0 | 332.0 | 334.5 | 330.0 | 19.7 | 11
114 | 350.0 | 333.5 | 332.5 | 334.5 | 330.0 | 18.7 | 11
116 | 350.0 | 333.0 | 332.0 | 334.5 | 330.0 | 17.7 | 11
118 | 350.0 | 332.5 | 331.5 | 334.5 | 330.0 | 16.7 | 11
120 | 350.0 | 332.0 | 331.0 | 334.5 | 330.0 | 15.7 | 11

### RUNWAY LENGTH

| 9000 | 8000 | 6330 | 3000 | 8930 |
---|---|---|---|---
### RUNWAY BLOWS

| 0.0 | 0.0 | 6.0 | 0.0 | 0.0 |
### HEADING CORRECT

| 441.0 | 484.0 | 441.0 | 484.0 |
### TAILWIND CORRECT

| 2502 | NA | 2476 | NA |
### LIMITED BY

| OBST | OBST | OBST | OBST |
### LEVEL OFF HT

| 1000 | 1000 | 1000 | 1000 |

**APPLY PERFORMANCE CORRECTION AS REQUIRED**

**DATED: 03/03/09**
• How long can I fly out of Ft. Lauderdale?

Assume that we takeoff in early morning with cool 74 deg F temperature
and a maximum allowable takeoff weight of 330,000 lbs

Aircraft empty weight = 155,000 lbs
Payload weight = 30,000 lbs
Fuel weight = 145,000 lbs
Total TO weight = 330,000 lbs

145,000 lbs fuel / 12,500 lbs fuel burn per hour = 11.6 hours
Less 1.5 hour reserve fuel = ~10 hours

St. Croix & Barbados have longer runways so we may be able to achieve the 11 hour flights from those locations
Frequency & Duration of Flights

• Duty day maximum = 14 hours
• Rest period minimum = 12 hours
• Maximum flight hours in 7 days = 40 hours
• Flight day = any day aircraft flies or maintenance crews complete preflight
• No fly day = aircraft made available to experimenters but does not fly
• Down day = no activity or support at aircraft
• Must schedule a down day within each 10 day (flight days + no fly days) period

• Typical flight day = aircraft available 3 hours prior to flight + flight hours +
  aircraft available for 1 hour after flight
  - Minimum time required prior to flight is 1.5 hours for preflight; any
    additional hours are as required by science team

  - Minimum time after flight is 1 hour for post flight activity; any
    additional hours are as required by science team
Frequency & Duration of Flights

• Plan on staffing to support 10 hour flight day with bursts to 11 hours in length
  • 3 hour preflight + 10 hour flight + 1 hour post flight = 14 hr duty day
  • 3 hour preflight + 11 hour flight + 1 hour post flight = 15 hr duty day
    • Only when flying out/in to home base (3 additional techs at home base)

• Always plan on 12 hr rest period for aircraft operations personnel

• Planning on additional technician staff and 2 navigators to support operations
## Flight Planning

### Example GRIP DC-8 Suitcase Flight Schedule (120 Flt Hrs)
Aug/Sep 2010

<table>
<thead>
<tr>
<th>Sunday</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
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<tr>
<td>15</td>
<td>16</td>
<td>17</td>
<td>18</td>
<td>19</td>
<td>20</td>
<td>21</td>
</tr>
<tr>
<td>Travel day 5.0 hr</td>
<td>No fly day unpacking/inst. checks</td>
<td>No fly day unpacking/inst. checks</td>
<td>Science Flight Day 10 hr</td>
<td>Science Flight Day 10 hr</td>
<td>Science Flight Day 10 hr</td>
<td>No fly day inst. checks</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>22</th>
<th>23</th>
<th>24</th>
<th>25</th>
<th>26</th>
<th>27</th>
<th>28</th>
</tr>
</thead>
<tbody>
<tr>
<td>No fly day inst. cheks</td>
<td>No fly day inst. cheks</td>
<td>Down Day (Aircraft Unavailable)</td>
<td>Science Flight Day 11 hr (includes suitcase transit)</td>
<td>Science Flight Day 8 hr</td>
<td>Science Flight Day 10 hr</td>
<td>Science Flight Day 11 hr (includes suitcase transit)</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>29</th>
<th>30</th>
<th>31</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<tbody>
<tr>
<td>No fly day inst. checks</td>
<td>No fly day inst. checks</td>
<td>No fly day inst. checks</td>
<td>No fly day inst. checks</td>
<td>No fly day inst. checks</td>
<td>Down Day (Aircraft Unavailable)</td>
<td>No fly day inst. checks</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Flight Day 11 hr (includes suitcase transit)</td>
<td>Science Flight Day 8 hr</td>
<td>Science Flight Day 10 hr</td>
<td>Science Flight Day 11 hr (includes suitcase transit)</td>
<td>No fly day packing (Aircraft Available)</td>
<td>No fly day packing (Aircraft Available)</td>
<td>Travel day 5.0 hr</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suitcase flight crew: Pilots(2) + FE(1) + Nav(2) + MD(2) + Data Mgr(1) + Techs(4) = 12</td>
<td>Allows for up to 38 science team members</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
LN2 Carriage Capability

• We have available two 35 liter dewars that we have carried in the main cabin
  • We have had as many as three 35 liter dewars on flights

• We also have three 4 liter dewars
Backup Slides
With regard to frequency, accuracy, and resolution:

Time Frequency:
Up to 20Hz, as time is sent out at the same rate as the position/velocity messages from the GPS boards. Accuracy: similar to what one expects from GPS processor, rated at 20ns! However, practically speaking, you have transfer delays: GPS board -> GPS module digital board -> CAN bus -> CPM processor, which are variable. This would put a limit of probably 1ms or so on it. The resolution in time on the standard output is limited by single-precision floating point representation for the output in decimal hours. This is limited to approximately 0.00001 hours, or 36ms, as a result. If high-performance time-tagging is ever required, we could provide 1ms accuracy / resolution, but as things stand, I'd say we're probably good to 50ms (consistent with 20Hz rate).

Pressure:
Output frequency is programmable up to 40Hz. Precision limited by thermal bias and hysteresis. Those are typically within 100Pa. Accuracy is limited by this + sensor calibration uncertainly and nonlinearity, which adds about another 50Pa. Absolute accuracy will depend also on position error characterization, which will have an uncertainty of 20 Pa or so. All combined, static pressure accuracy should be +/- 200Pa. Resolution is limited by 14bit ADC, which works out to about 6-7Pa.

Temperature:
Like all air-data parameters, the output rate is programmable up to 40Hz. The frequency response of the thermistor is much lower than this, so there is little point in setting it this high. We usually run it at a few Hz only. Resolution is 14-bit. For your probe, we'd extend the range to further than the -30C we normally use down to -50C. With dynamic heating of 20C, this puts the static temperature sensed at 200m/s -70C. The resolution works out to approximately 0.01C. Calibration accuracy is +/- 0.05C, but uncertainty in the recovery factor means total confidence in absolute accuracy probably around 0.2C (this is being verified by Tom Ratvatsky this week at NASA Glenn).

Wind vector (u,v,w) Frequency:
Real-time output of 5Hz standard, but could be extended to 20Hz assuming the differential pressure data is updated at this rate as well. Resolution in the output is 0.01 m/s, this is supported by resolution in constituent data (ground speed, TAS, flow angles). Accuracy is dominated by ability to calibrate out position errors. We can achieve consistency to the level of about 0.5 m/s on wind box calibration checks, so this is my confidence in total accuracy.

Position (GPS altitude, lat, long) Frequency:
20Hz. Resolution is currently limited by single-precision floating point accuracy for latitude / longitude, which works out to 7 significant figures. Typically, this means latitude / longitude resolution is 0.00001 deg. Accuracy is governed by the GPS system: whether WAAS is active or not, and PDOP due to constellation geometry. If WAAS / SBAS available, accuracy is good 1.2m RMS. Without SBAS, accuracy is 2-3 times worse than this.
With regard to frequency, accuracy, and resolution:

**Attitude (pitch, roll, heading):**
Output frequency is user-programmable. It is based on IMU integrated rates, which are available up to the IMU output rate, which is currently 40Hz. This can be increased to a maximum of 100Hz. Resolution on angles is 0.01 deg. With fore/aft antenna geometry, roll is determined exclusively by gyro integration anchored by g-vector sensed predominantly by the y-accelerometer. Absolute thermal bias stability of the IMU accelerometers is about 3mg, which is translates into about 0.17 deg. for accuracy. Pitch and heading accuracy limited by carrier-phase stability over the antenna baseline. With 20m antenna separation (105 wavelengths of L1 carrier), and observed phase offset estimation stability of approx. 0.1 wavelengths for your installation during maneuvers means angular accuracy 0.001 rad or 0.06 deg. was being achieved on the GPS phase calculations. Precision is limited by gyro and accelerometer noise, and phase noise on the GPS signals. Precision should be a few times better, approaching 0.01 deg.

**Angle of Attack Yaw angle:**
Output frequency user-programmable up to 40Hz. Flow angles are measured by 5-hole probe with 20Pa combined thermal bias/span stability, nonlinearity, hysteresis and calibration accuracy. At 200m/s, this uncertainty translates is 0.01 deg precision. Absolute flow angle accuracy will be governed by how well the position error effects are calibrated out from the flight data. This is usually achieved to within 0.1 deg.

**True airspeed:**
Output frequency user-programmable up to 40Hz. True airspeed accuracy governed by pitot-static accuracy of 20Pa, which at 200m/s translates into roughly 0.1 m/s, subject again to accuracy of position-error characterization. Precision is limited by noise and resolution on the pitot-static channel, which is about an order of magnitude better than the total accuracy, so we're looking at limit of about 1 cm/s.

**Aircraft velocity (eastward, northward, vertical):**
Output frequency available up to the output rate on the IMU, which is 40Hz but can be extended up to a maximum of 100Hz. Accuracy limited by GPS, which is spec'd by the Novatel boards at 0.03 m/s. Precision is governed by IMU noise / integration error, which will be down around 0.01 m/s level.

**Vertical acceleration:**
Vertical acceleration output rate limited by IMU output rate of 40Hz (up to max 100Hz). Accuracy (thermal bias stability, non-linearity) is approximately 3mg, noise (precision) is approx. 1mg.