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# Portable Air Quality Monitor and Wireless Sensor Network for Cabin Monitoring

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# Objective

- Capture a clear picture of the range of conditions in aircraft cabins using a portable sensor system

# Background

- The variety of aircraft used is large
- Aircraft variation factors:
  - Makes, models, various derivatives, engine options, cabin layouts, etc.
  - These factors can potentially affect the cabin conditions
- Conducting measurement on a few dozen flights (or even hundred of flights) is unlikely to capture the full range of possibilities

# Approach

- In order to get a complete picture one has to think in terms of measurements on thousands of flights, not hundreds
- Deploying high grade instrumentation on this many flights is not economically feasible
- A small instrument package that can collect useful environmental data and be readily carried on most any aircraft and flight is needed

# Instrument Package

- < \$1,000 each after development is completed,
- Electromagnetic interference (EMI) certified for operation during all phases of flight
- No special security procedures
- Carry-on
- Can be operated by anyone
- At least 10-16 hours without battery recharging or replacement
- Only simple, or infrequent, calibration required
- Time and date stamping for all data
- Easy interfacing to a computer for downloading to a central database



# Sensors

- **Temperature and Humidity:**
  - The relative humidity sensor has operating range of 0 to 100% RH. It has temperature operating range of -40 to 257 °F.
- **CO<sub>2</sub>:**
  - This sensor has a standard measurement range of 0 to 2000 ppm and is capable of providing a reading every 2 seconds. The sensor has a pressure reading input for correcting the effects of elevation changes.

# Sensors

- **Pressure:**

- The pressure sensor is an absolute pressure sensor with 17-bit resolution. It is capable of measuring from 40 kPa to 120 kPa and -20 °C to 70 °C.

- **Audio Noise Level:**

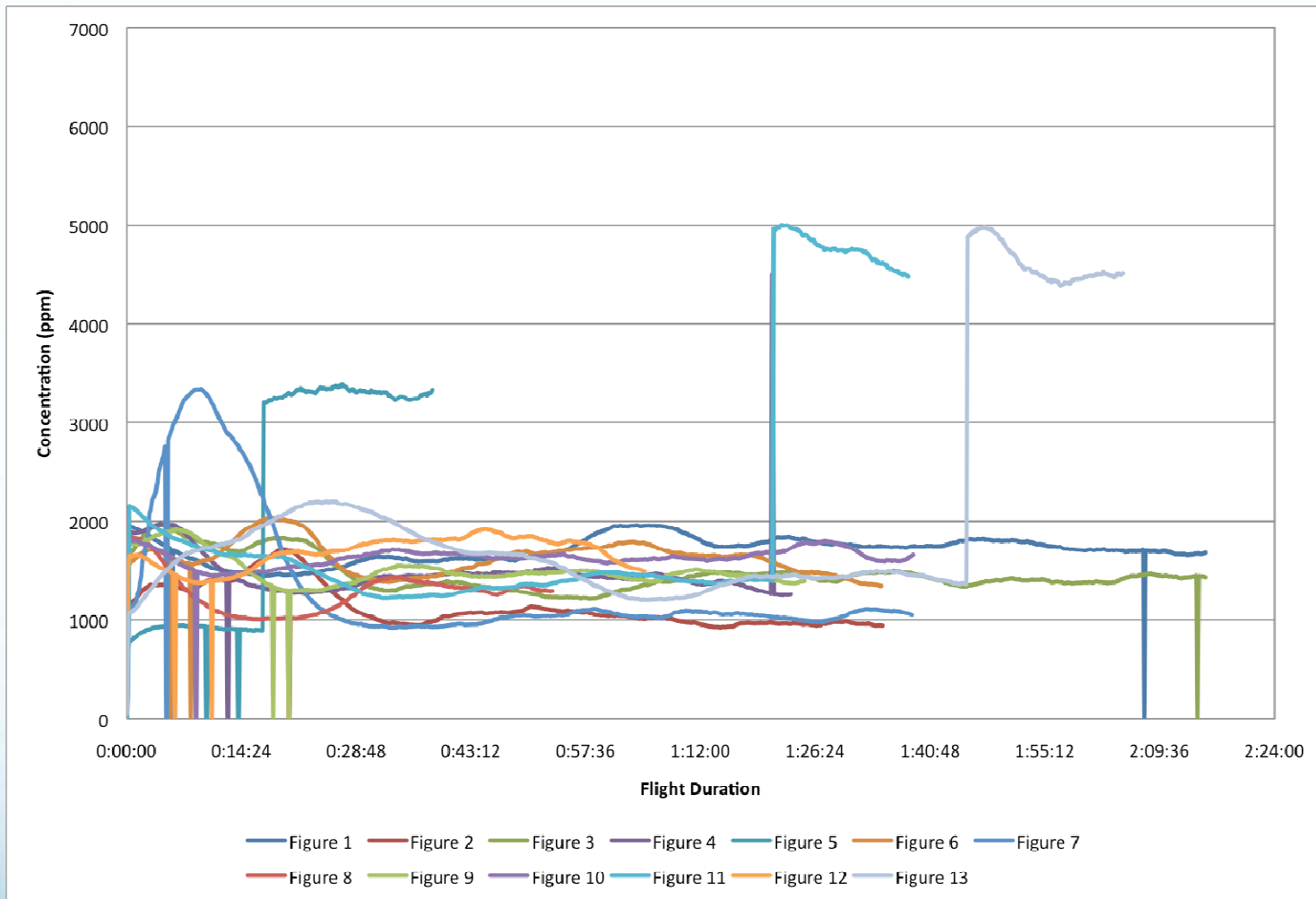
- This microphone along with amplifying circuitry was designed and calibrated to work as noise level sensor. It is capable of sensing noise levels down to -38 dB with accuracy of  $\pm 3$  dB.



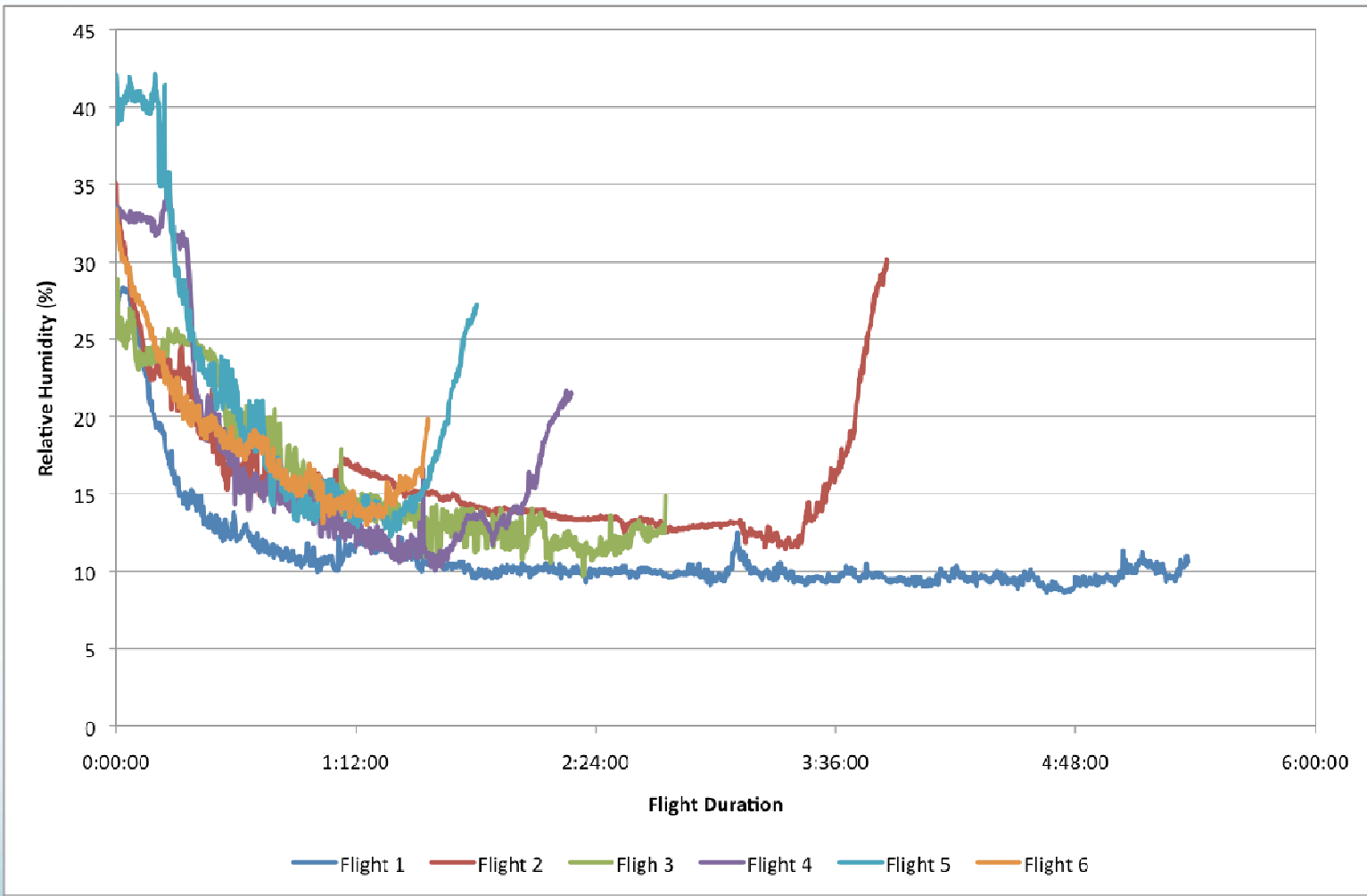
# Measurement Program

- Flights of convenience

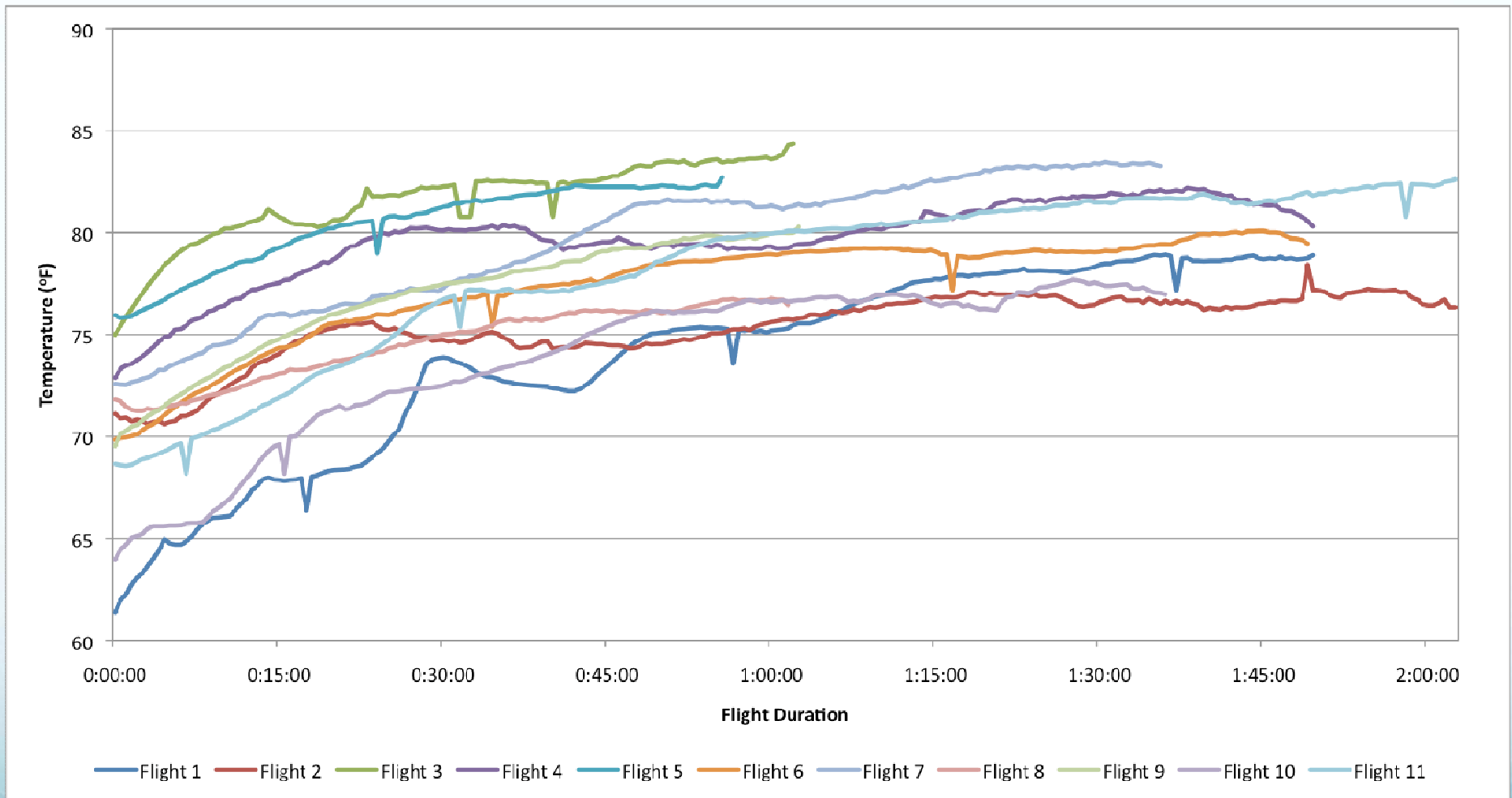
# CO<sub>2</sub>



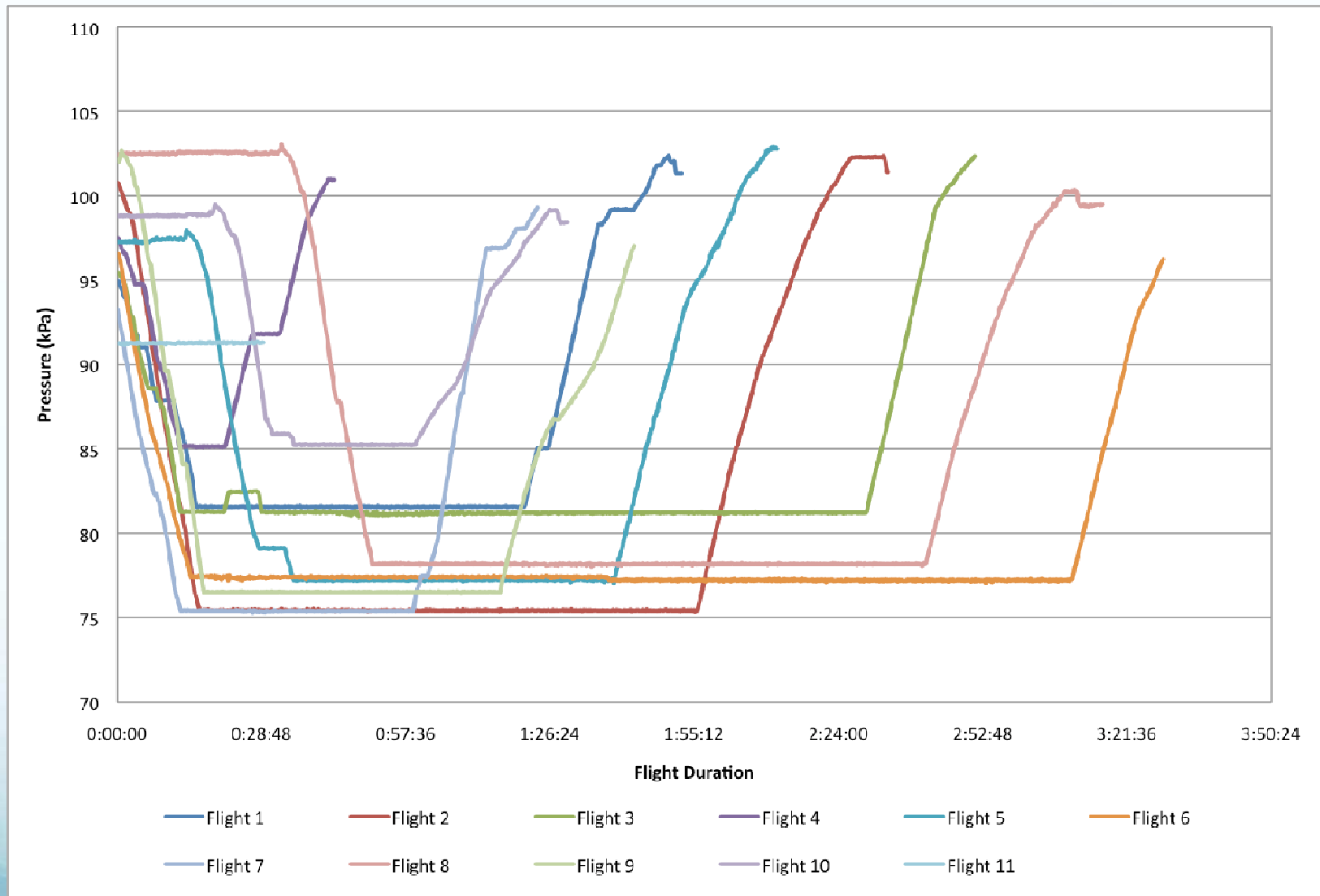
# Humidity



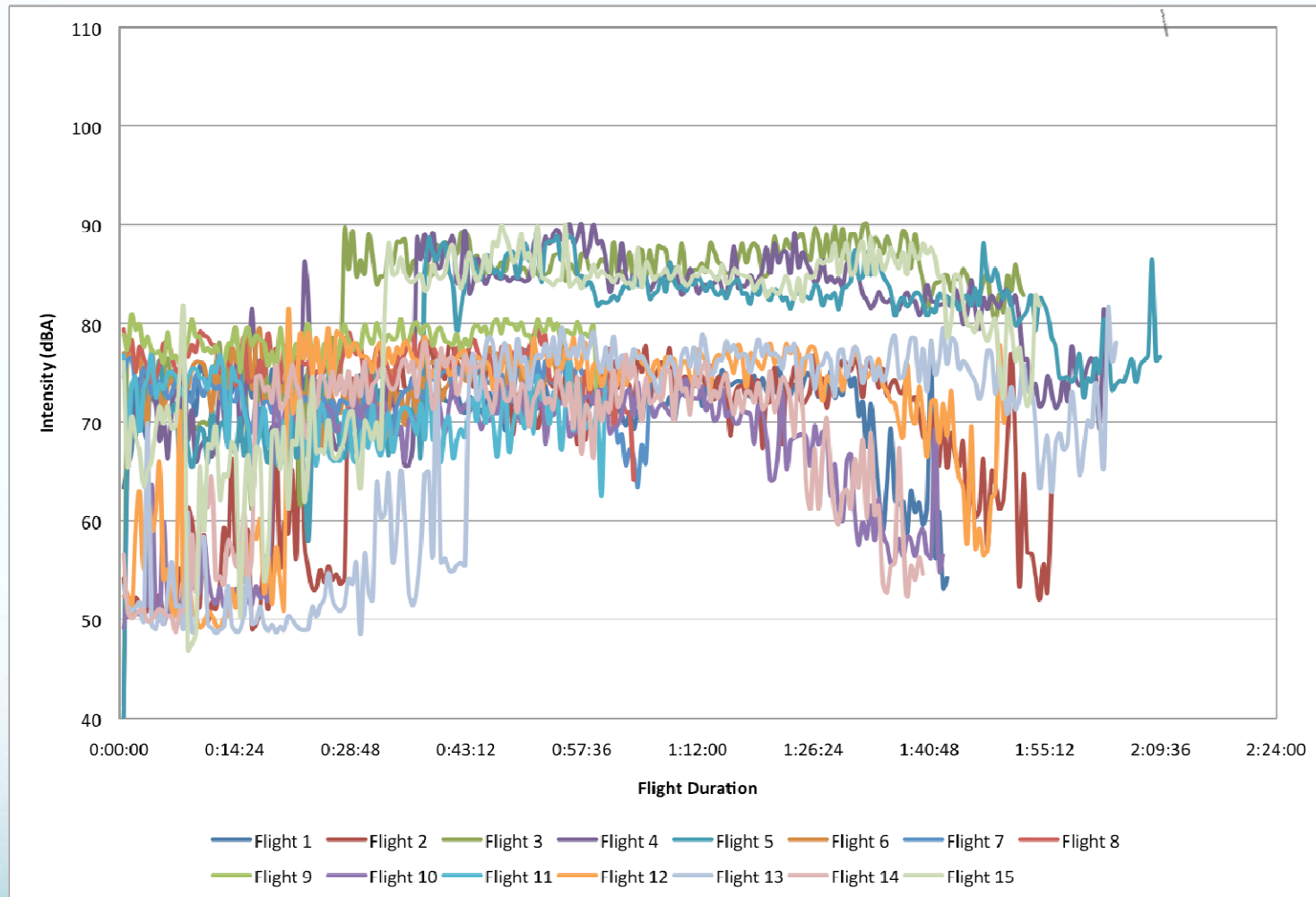
# Temperature



# Pressure



# Noise level (dBA)



# Observations so far...

- Cabin altitude typically remains below 8,000 feet
- Carbon dioxide levels are between 900ppm and 1700 ppm
- Cabin temperature ranged from 22°C to 29°C (or 71.6°F to 84.2°F)
- Relative humidity has a range at 35% to 50% at the beginning of flight dropping to 10% to 25% as the flight progresses
- Sound level of the cabin was typically around 86 dBA

# Wireless

- This sensor system is capable of forming wireless sensor network
- The wireless networking is being used in smart ECS research



# Disclaimer

This work has been funded by the FAA through Cooperative Agreement 04-C-ACER-BSU, 07-C-ACER-BSU, 04-C-ACER-KSU, 07-C-ACER-BSU. Although the FAA has sponsored this project, it neither endorses nor rejects the findings of this research. The presentation of this information is in the interest of invoking technical community comment on the results and conclusions of the research