Cabin Pressure Logging with the Adafruit Feather Adalogger M0

It is well known that the pressure inside an aircraft cabin is reduced during a flight. Cabin pressure is lowered to reduce stress on the pressurised part of the fuselage, but isn't allowed to drop to a level where the passengers and crew would be at risk of hypoxia or altitude sickness.

https://en.wikipedia.org/wiki/Cabin_pressurization

Wouldn't it be great if there was a simple way of logging the cabin pressure during your flight? Well, there is. The Adalogger M0 from Adafruit is perfect for the job. It is a very compact circuit board with a powerful Atmel SAMD21 processor on it and a slot for a micro-SD card. You can power it with a small rechargeable Lithium Polymer battery. Add to this a DS3231 Featherwing Precision Real-Time Clock and an MPL3115A2 pressure/altitude sensor and you have everything you need to log the cabin pressure during your flight. The pressure data is logged as Comma Separated Values onto the SD card and can be plotted on your PC using Python or Excel.

Shopping List:

Adafruit Feather Adalogger M0: https://www.adafruit.com/products/2796

Adafruit DS3231 Precision RTC Featherwing: https://www.adafruit.com/products/3028

Sparkfun MPL3115A2 Breakout: https://www.sparkfun.com/products/11084

Feather Stacking Headers: 2 x https://www.adafruit.com/products/2830

CR1220 Battery for the RTC: https://www.adafruit.com/products/380

>=100mAh LiPo Battery: https://www.adafruit.com/products/1570

Micro SD card (16GB is way more than adequate!)
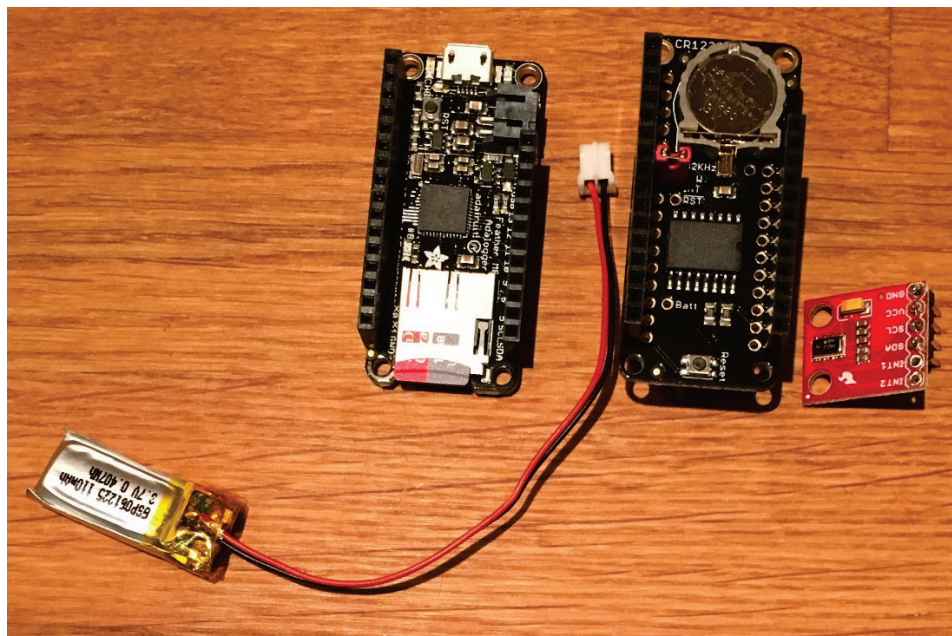
Putting it all together:
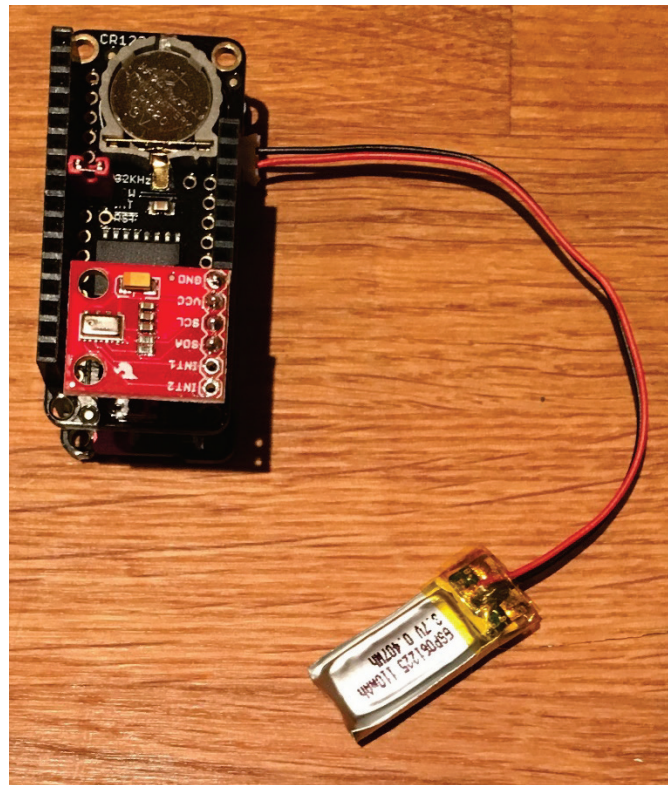
If you don't know how to solder, now is a great time to learn. Follow these instructions and solder stacking headers to both the Adalogger and the RTC Featherwing:

https://learn.adafruit.com/adafruit-feather-m0-adalogger/assembly

https://cdn-learn.adafruit.com/downloads/pdf/adafruit-feather-m0-adalogger.pdf

Solder two of the spare header pins that came with the Adalogger onto the RTC Featherwing so you can use a standard jumper shunt to link the DS3231 Interrupt to pin 16 of the Adalogger:
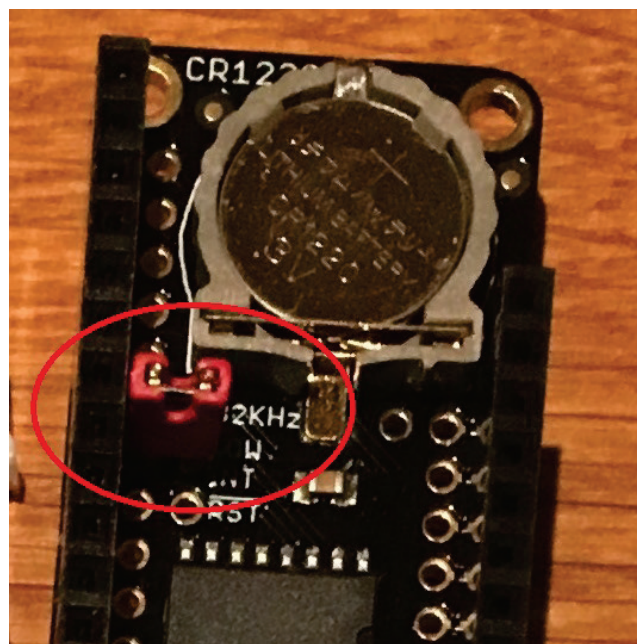
Stack the DS3231 Featherwing on top of the Adalogger. Solder another four header pins to the back of the MPL3115A2 breakout, ignore the two INT connections, then insert it into the bottom-right four holes on the DS3231 Featherwing. This links the MPL3115A2 to the I^2C clock (SCL) and data (SDA) pins, plus D5 and D6 which will provide 3.3V power and ground.

Make sure your micro SD card is formatted as FAT32, then insert it into the Adalogger. Install the CR1220 battery on the DS3231 Featherwing. Connect the LiPo battery and you are just about ready to go. The LiPo battery will recharge from your PC while you are configuring the Adalogger. A 100mAh battery will power the logger for about eight hours, logging every second (with the LEDs disabled). For longer flights, select a larger battery.

Download and install the latest version of the Arduino IDE:

https://www.arduino.cc/en/Main/Software

Follow these instructions to install the Adafruit SAMD library:

https://learn.adafruit.com/adafruit-feather-m0-adalogger/using-with-arduino-ide

https://cdn-learn.adafruit.com/downloads/pdf/adafruit-feather-m0-adalogger.pdf

Try running the Blink example. You may need to press the reset button on the Adalogger quickly twice to allow you to bootload the sketch.

Download and install the Sparkfun MPL3115A2 library and Adafruit's RTClib:

https://www.arduino.cc/en/Guide/Libraries

https://learn.sparkfun.com/tutorials/installing-an-arduino-library

https://github.com/sparkfun/SparkFun_MPL3115A2_Breakout_Arduino_Library

https://github.com/adafruit/RTClib

Download and run "Set_RTC_from_Serial.ino". Open the Tools \ Serial Monitor and you should see a message asking you for the time you want to program into the RTC. Enter the year, month, date, hour and minutes separated by spaces. Click "Send" or hit return on the second marker to set the clock. Watch the messages to check the clock has been set correctly. The DS3231 will now keep near-perfect time even if the LiPo battery goes flat. The DS3231 generates a 1Hz (1 pulse per second) interrupt which triggers an SD card write on the Adalogger.
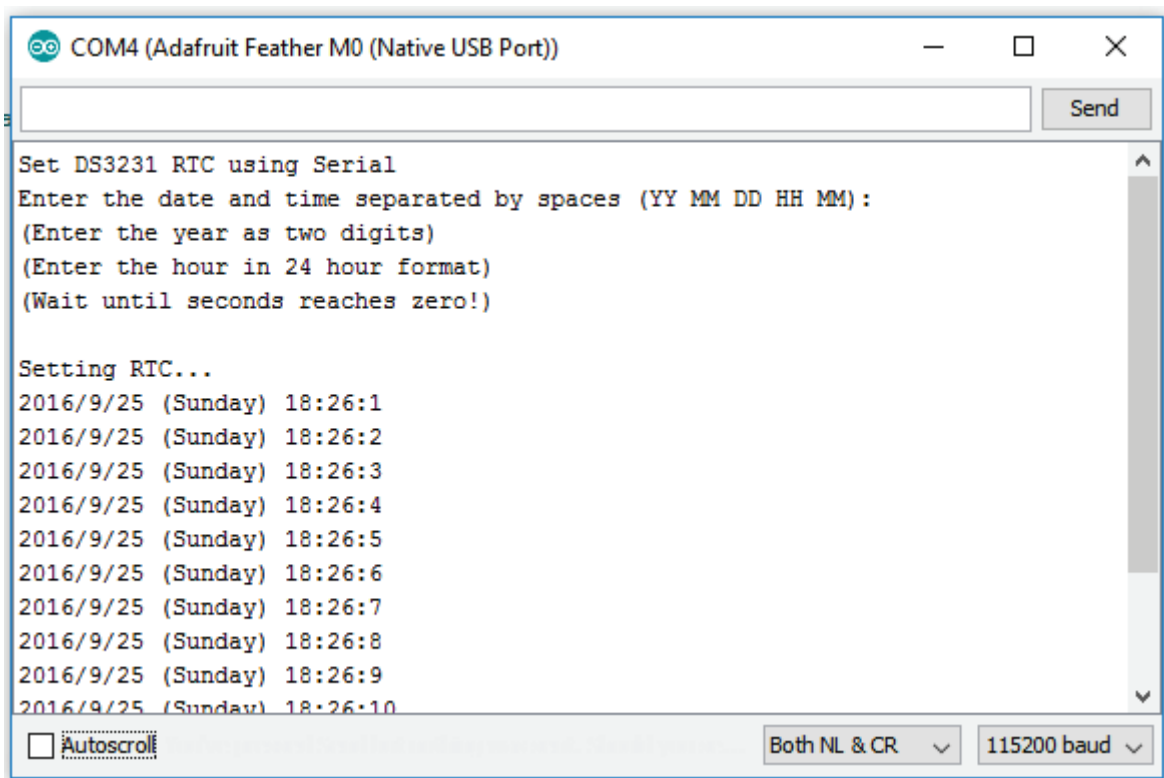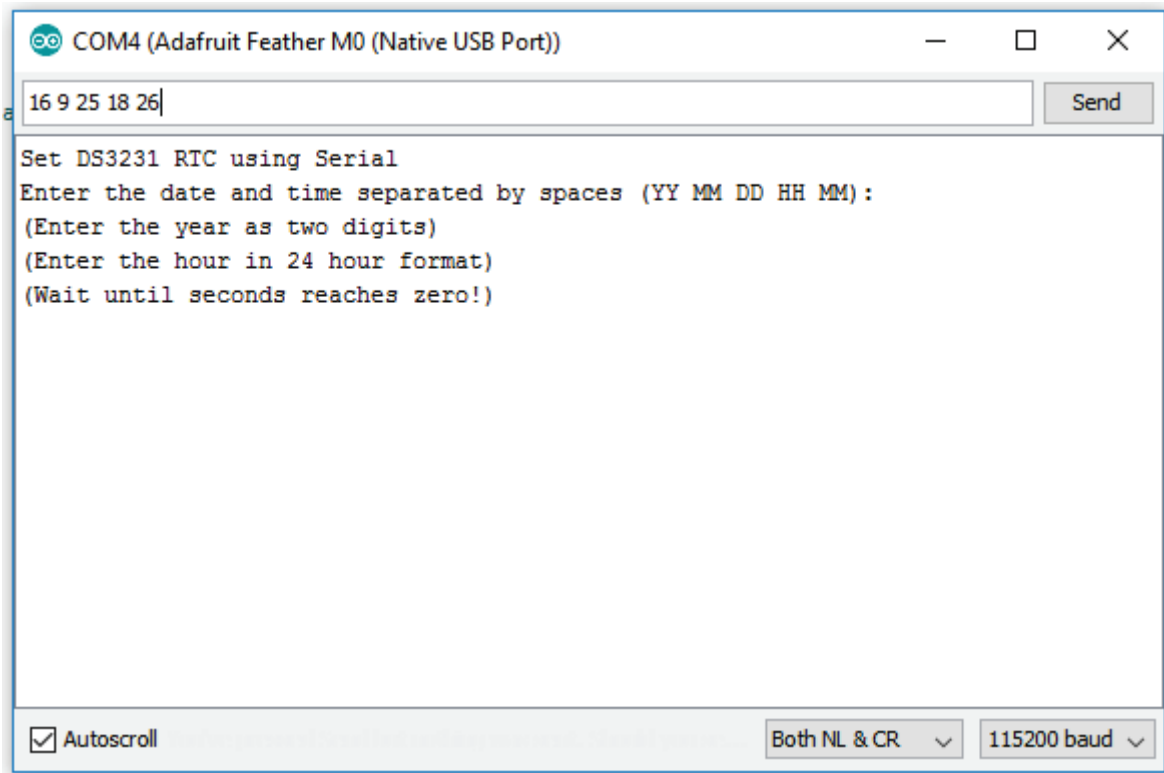
Once the RTC is set, download "Cabin_Pressure_Logger.ino" and you're all set. This code will log the pressure and temperature from the MPL3115A2 plus the battery voltage to the SD card every second. The data is stored in CSV format. A new file is created every 10 minutes to avoid your data being corrupted if you accidentally pop the SD out while it is being written to.

Excel can read CSV files, but the best way to plot the data is with Python. If you haven't used Python before, now is a great time to give it a try. Enthought will give you a complete
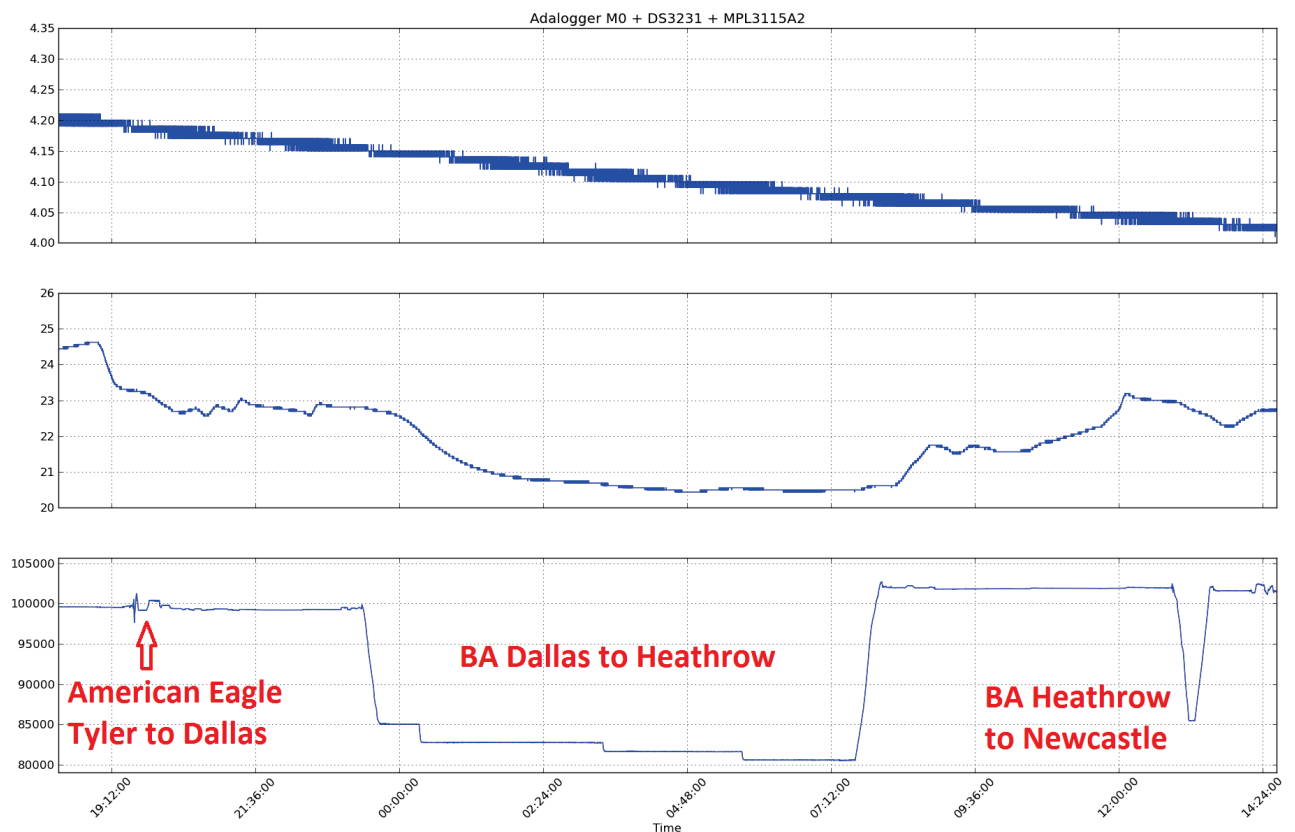
Python installation for free if you are a student or academic user. If you want a different Python distribution that is completely free and has MatPlotLib built-in, try Python X,Y: https://python-xy.github.io/

"stitcher.py" will stitch all those 10-minute CSV files together into a single CSV file. Copy the files across from the SD card, leaving them in their day subdirectories. Stitcher will only stitch files in the directories below where the Python code is located. It will ignore any files in the 'home' directory.

"stitch_plotter_Temperature_and_Pressure.py" will then read the stitched file and produce a nice plot which you can zoom and save.

Here's data from three flights from Tyler (Texas) to Newcastle via London Heathrow. The Adalogger was powered by a 1000mAh battery. The American Eagle flight from Tyler to Dallas was very short (and probably not very high!) but it is interesting that there was no obvious pressure drop during the flight. The pressure on the Dallas-Heathrow flight dropped to 0.8 atmospheres (80,000 Pascals) which is equivalent to being up a mountain 2000m (6400ft) above sea level.

Enjoy!