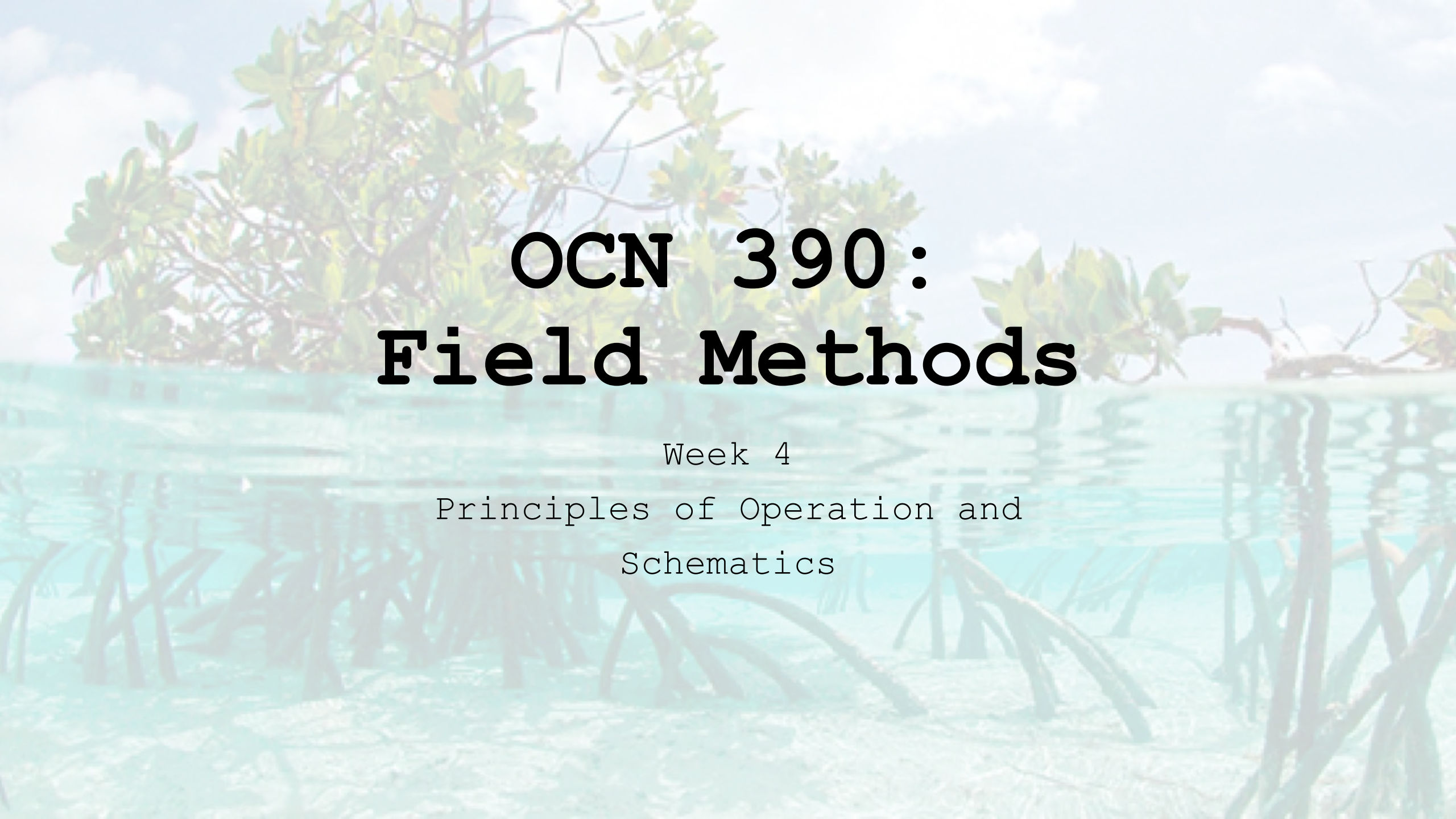


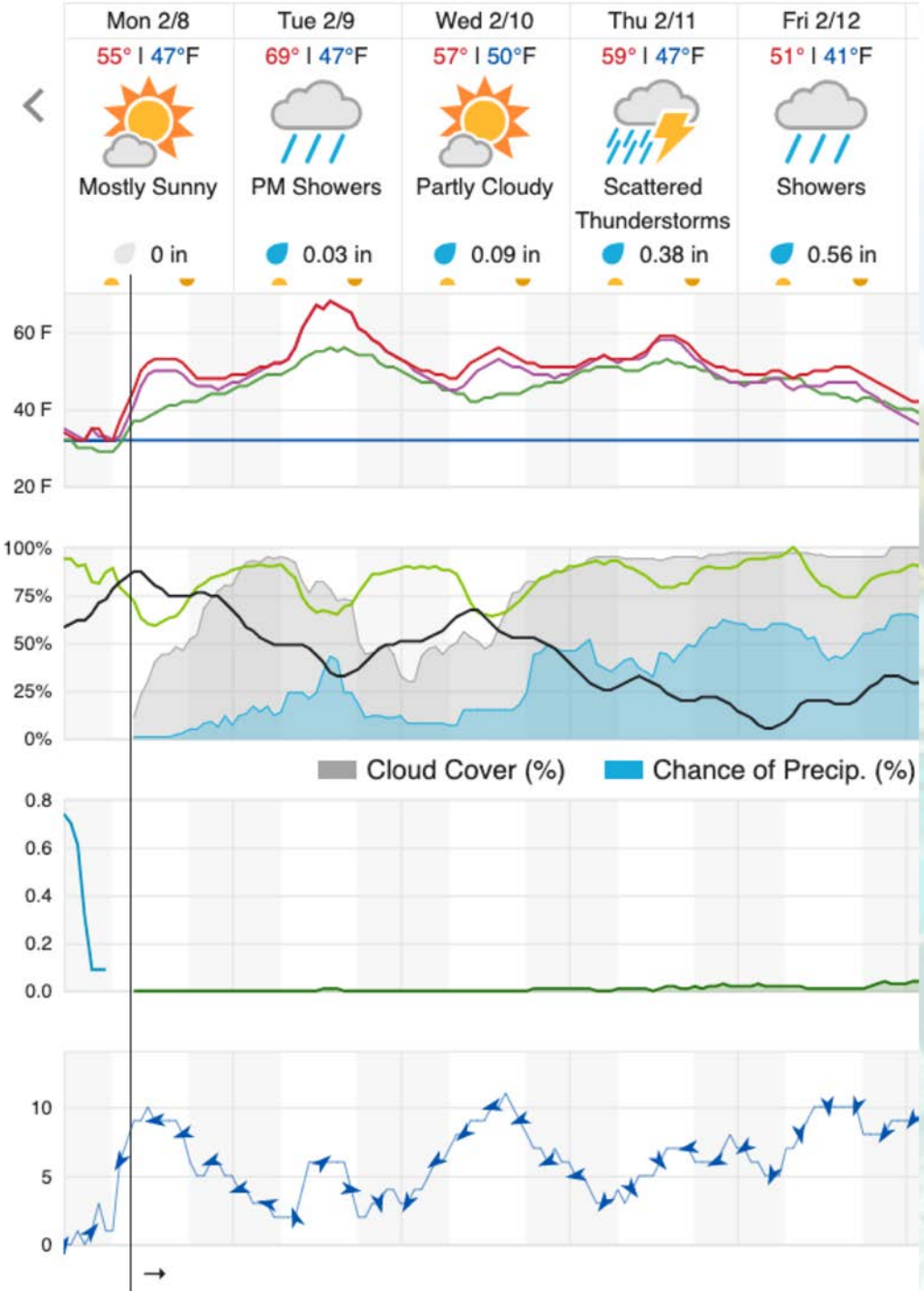
# OCN 390: Field Methods

Week 4

Principles of Operation and Schematics

# Today's plan

- Collegiate Recovery Community video
- Group discussion of principles of operation
- Lecture on sensor metrics and schematics
- Lecture by Sciences Librarian, Peter Fritzler
- Work on next assignment


Mon 2/8
55° | 47°F
Mostly Sunny
0 in
Tue 2/9
69° | 47°F
PM Showers
0.03 in
Wed 2/10
57° | 50°F
Partly Cloudy
0.09 in
Thu 2/11
59° | 47°F
Scattered Thunderstorms
0.38 in
Fri 2/12
51° | 41°F
Showers
0.56 in
60 F
40 F
20 F
100%
75%
50%
25%
0%
Cloud Cover (%)
Chance of Precip. (%)
0.8
0.6
0.4
0.2
0.0
10
5
0

# Uploading images to Canvas 3rd time's the charm?

- Last time that photos that aren't visible in discussion thread will get credit. Please reach out to me prior to noon on Friday for additional assistance if you need any!

# Principles of Operation Discussion

# Important Metrics

# Important Metrics

- Accuracy, precision


https://manoa.hawaii.edu/exploringourfluidearth/physical/world-ocean/map-distortion/practices-science-precision-vs-accuracy

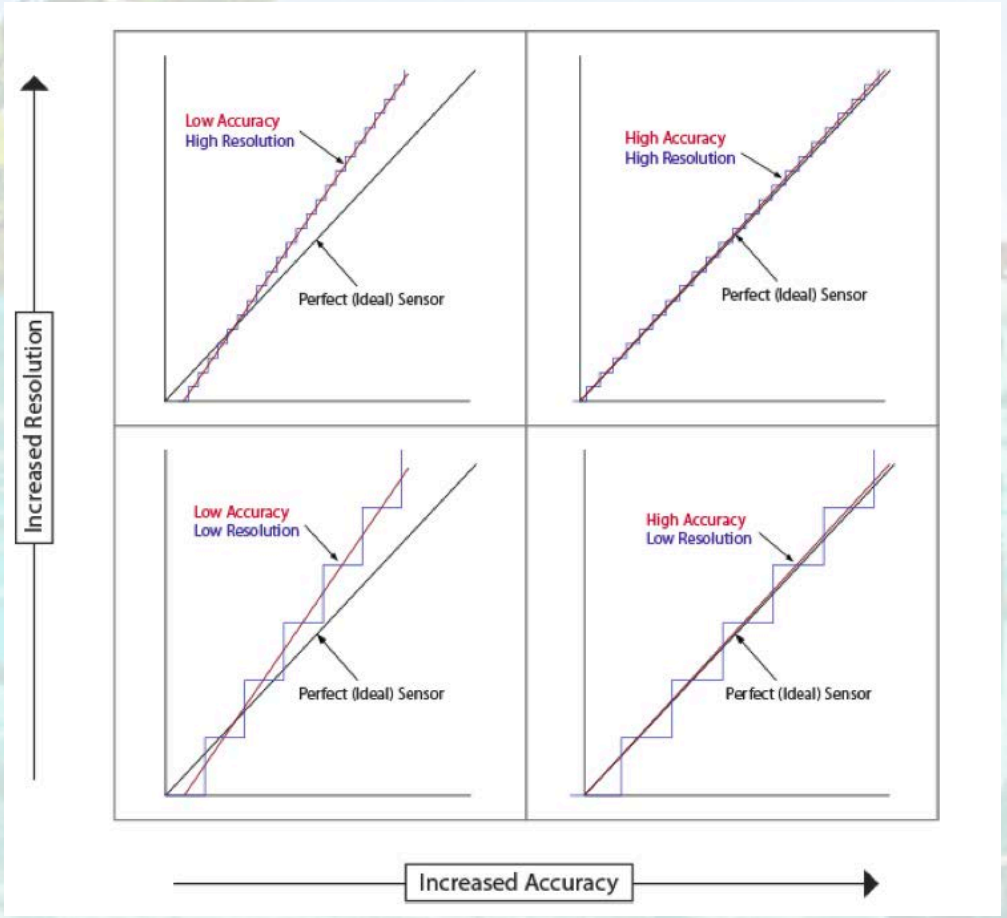
# Important Metrics

- Accuracy, precision, **stability**


https://manoa.hawaii.edu/exploringourfluidearth/physical/world-ocean/map-distortion/practices-science-precision-vs-accuracy

# Important Metrics

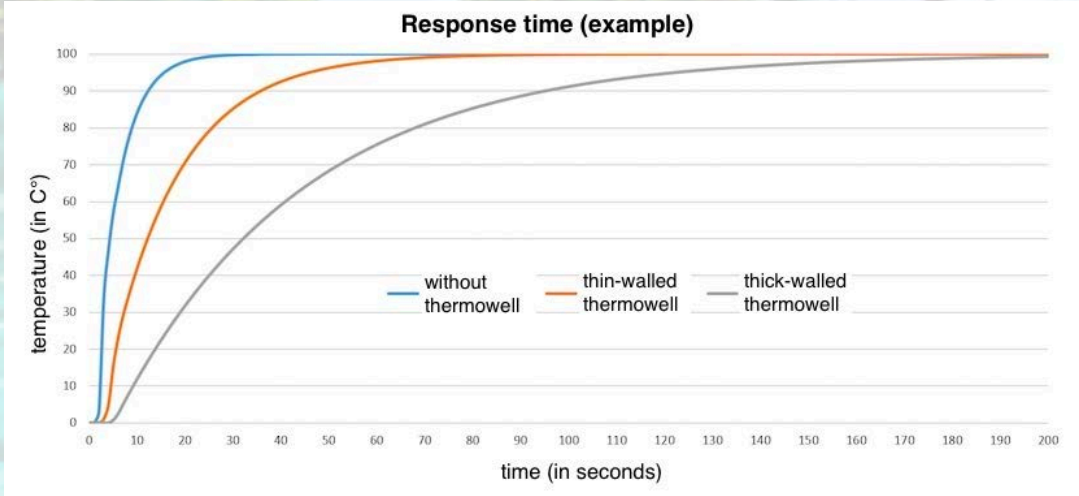
- Accuracy, precision, stability, resolution




https://www.allsensors.com/engineering-resources/white-papers/accuracy-and-precision-for-mems-pressure-sensors

# Important Metrics

- Accuracy/precision/stability/resolution
- Response time (imagine you move a thermometer from an icewater bucket to a pot of boiling water; how long will it take for the thermometer to change temps?)




https://blog.wika.us/products/temperature-products/temperature-sensors-thermowells-and-response-times/

# Important Metrics

| SPECS | VARIATIONS | DOCUMENTS | ACCESSORIES |
|---|---|---|---|

| | |
|---|---|
| Product Number | 030-8-0006 |
| Measurement range $CO_2$ | 0 to 5,000 ppm / 0 to 3%vol |
| Accuracy | ±30 ppm ±3% of reading |
| Dimensions | 51 mm x 58 mm x 12 mm |
| Operation temperature range | 0 to 50 °C |
| Power supply | 4.5 to 14.0 V DC |
| Communication | Uart ( Modbus) |
| **Outputs** | |
| OUT $_1$ linear output | 0 to 4 V DC = 0 to 2,000 ppm |
| OUT $_2$ linear output | 1 to 5 V DC = 0 to 2,000 ppm |
| OUT $_3$ digital output | 700/800 ppm |
| OUT $_4$ digital output | 900/1,000 ppm |

- What is accuracy @ current atmospheric CO2?
- Just because it works over a range of temp, pressure, salinity, etc. doesn’t mean it performs the same!

# Your Study Design

- Describe how you will account for (in)accuracy, (im)precision, (in)stability, (poor) resolution, (slow) sensor response time, etc.
- In every field or laboratory study, these things matter immensely!
- Also critical: how much do you trust the manufacturer's specifications? They have incentives to make them look as good as possible…

# NDIR/IRGA

- Non-dispersive infrared or infrared gas analysis

**Development of a Low-Cost Wireless Sensor Network for Passive *in situ* Measurement of Soil Greenhouse Gas Emissions**

**By**

**Mohamed Debbagh**

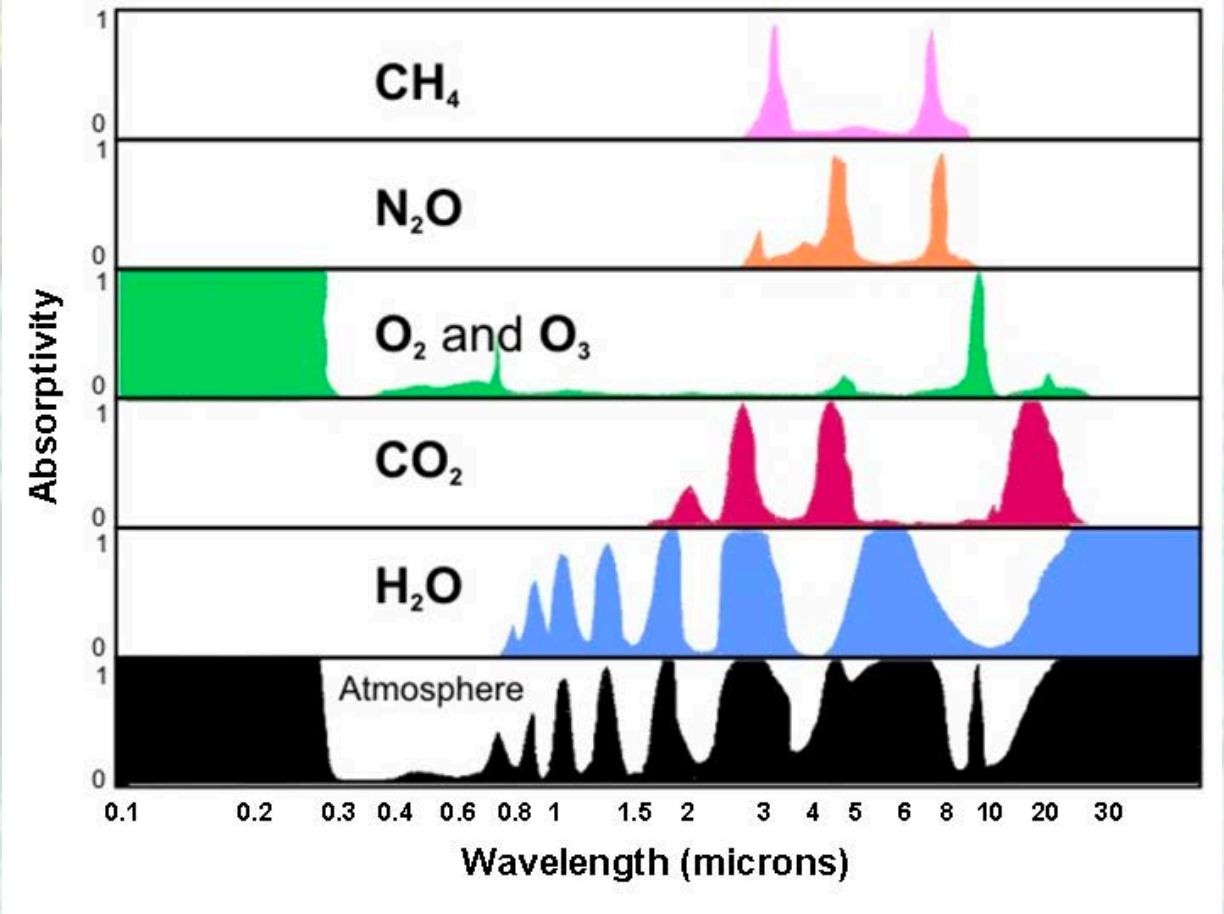
Department of Bioresource Engineering,

Macdonald Campus of McGill University

Montreal, QC, Canada

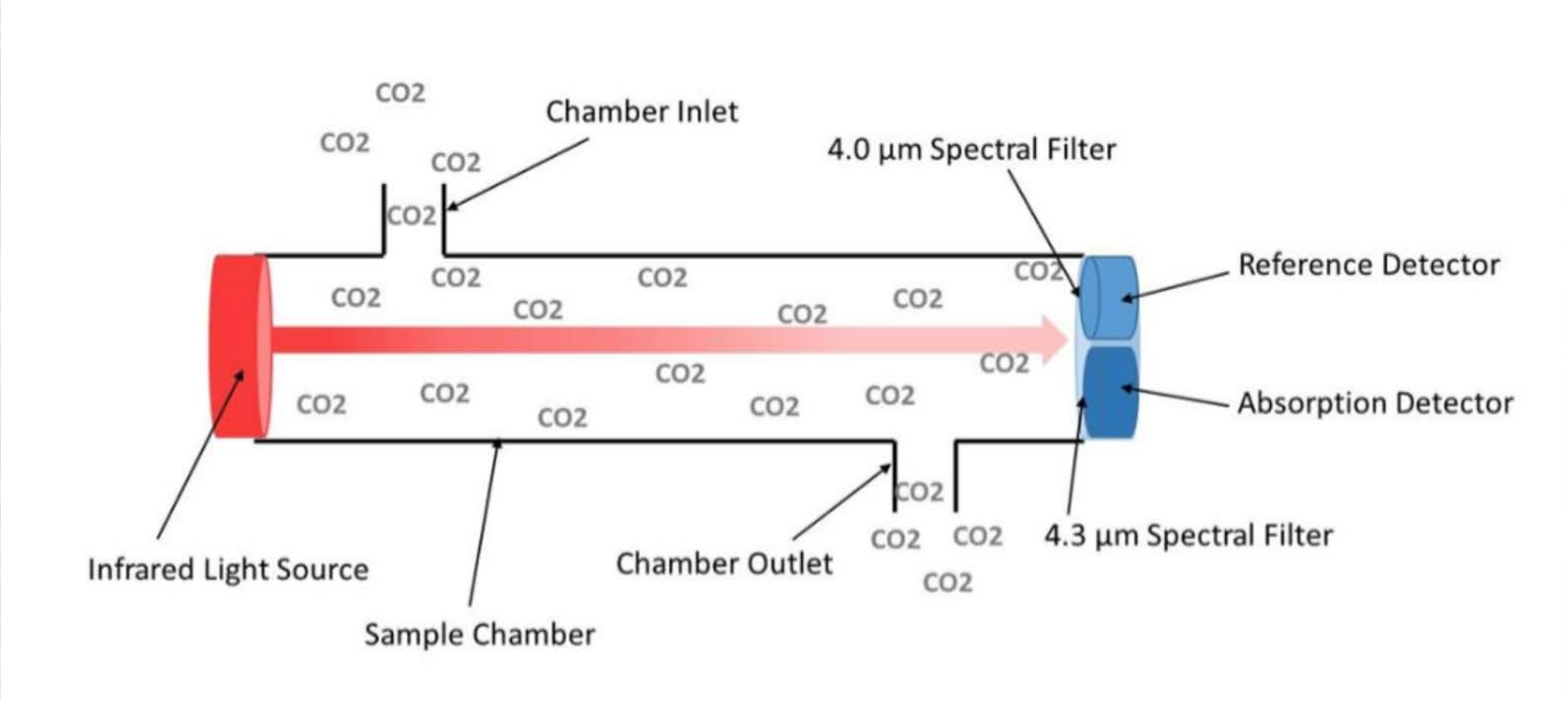
April 15, 2019

# CO2 via NDIR




https://www.e-education.psu.edu/meteo3/l2_p7.html

# CO2 via NDIR


CO2
Chamber Inlet
4.0 µm Spectral Filter
Reference Detector
Absorption Detector
Infrared Light Source
Sample Chamber
Chamber Outlet
4.3 µm Spectral Filter

# CO2 sensors

- LI-COR 830, 850, 7000
(thousands to tens of $K)

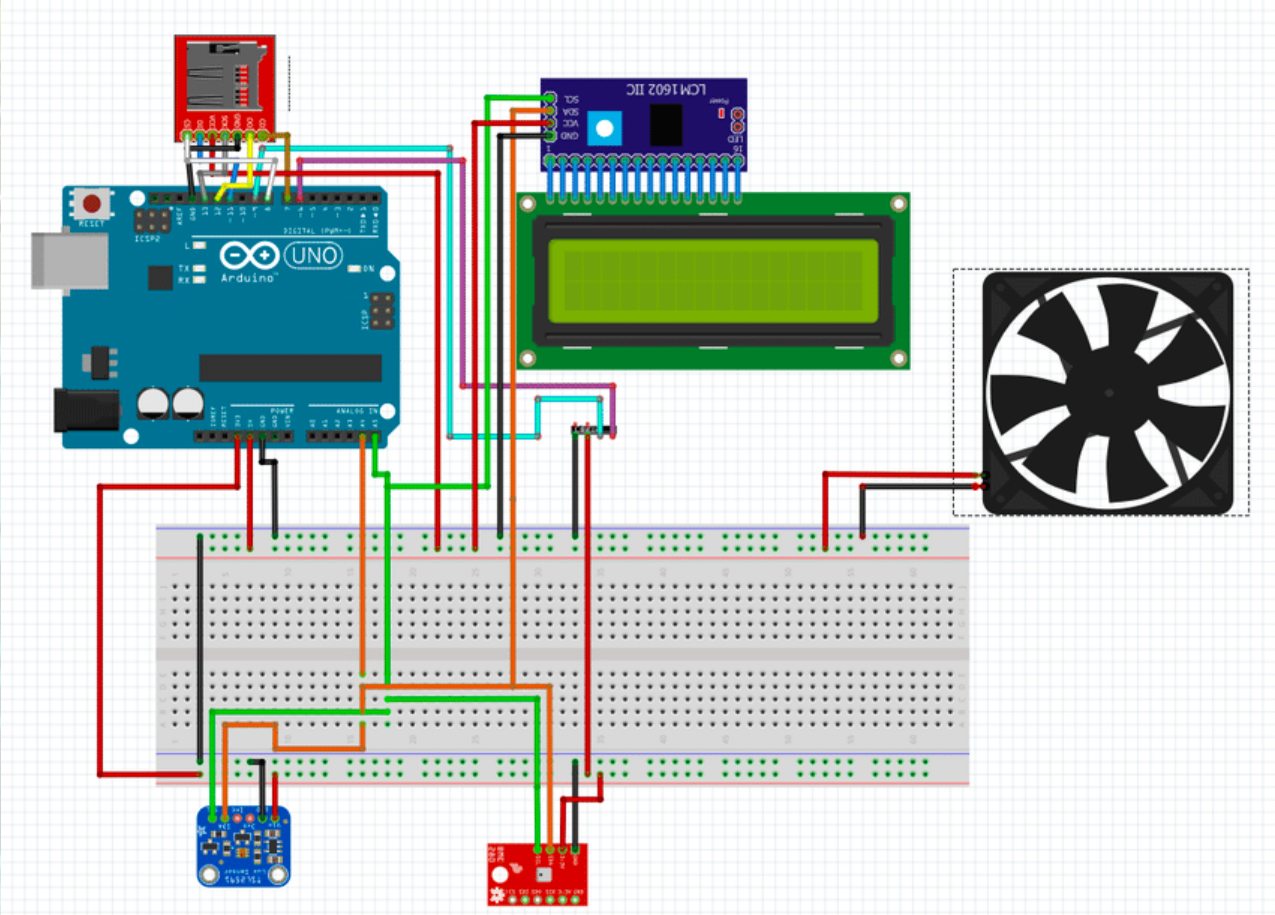

- Picarro (different tech)
(tens of $K)


- K-30, Telaire, COZIR
(tens to hundreds of $)

# Schematics/Wiring

- Team K-30: how does the K-30 communicate?
- Team Processor: what are communication options
- Team Adalogger: how will we store K-30 data? What file system? What data should we save?
- Team Arduino: where will we get code?
- Team PowerBoost: what will power inputs/outputs be?

# Wiring

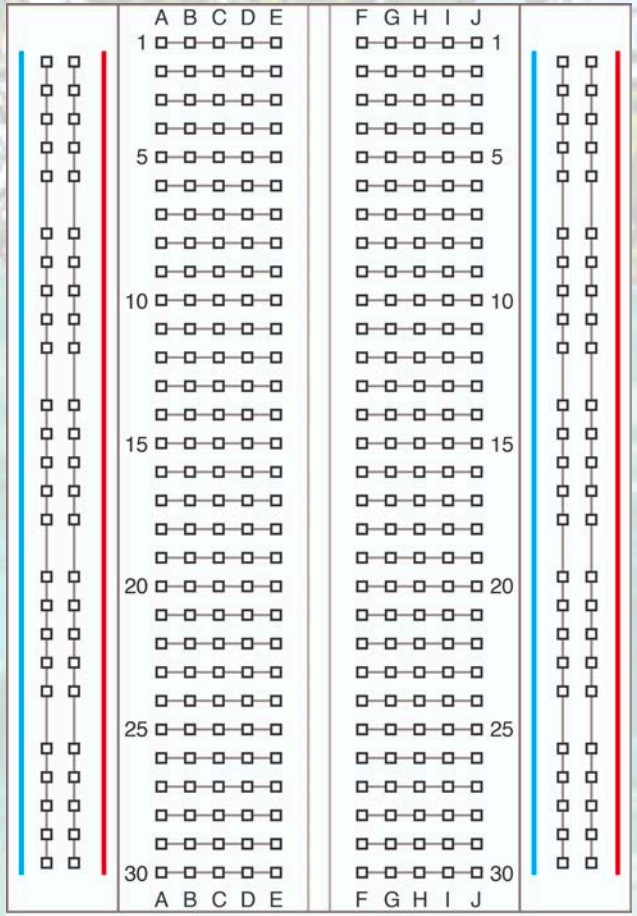



https://www.researchgate.net/publication/335970481_CO24U_Low_Cost_Carbon_Uptake_Remote_Sensing_System

# Stages of Development

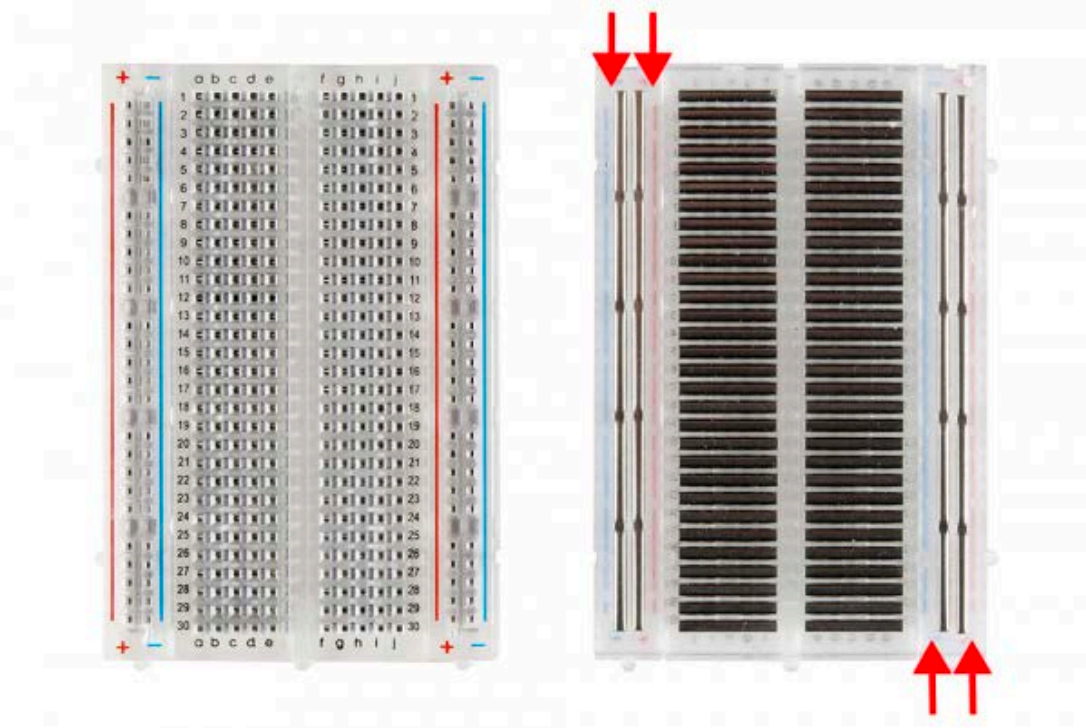
- Prototyping (breadboard, protoboard)
- Proof of concept (custom printed circuit board (PCB))
- Pilot testing (more PCBs)
- Commercial product

# Breadboard

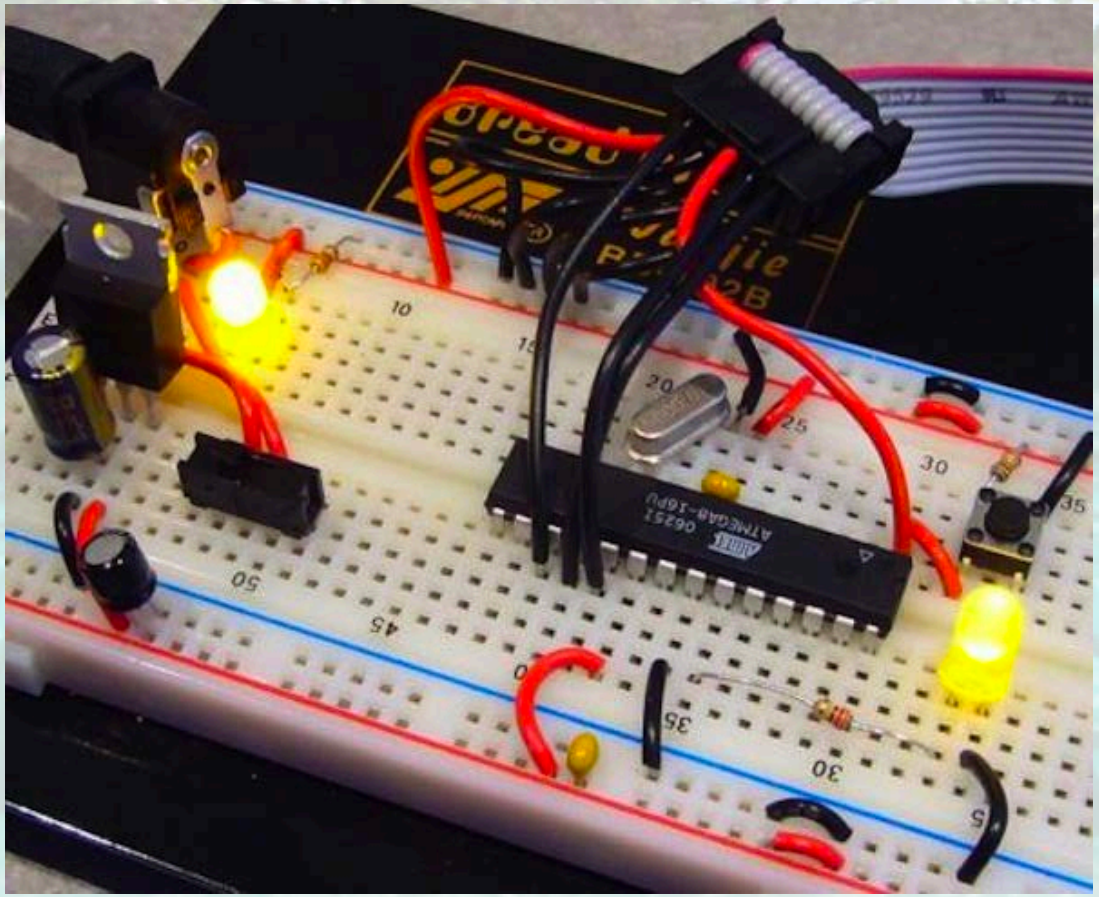



- Which way are rows/columns connected?

# Power rails and terminal strips



- Rows in middle are electrically connected
- Columns (power rails) on edge are electrically connected



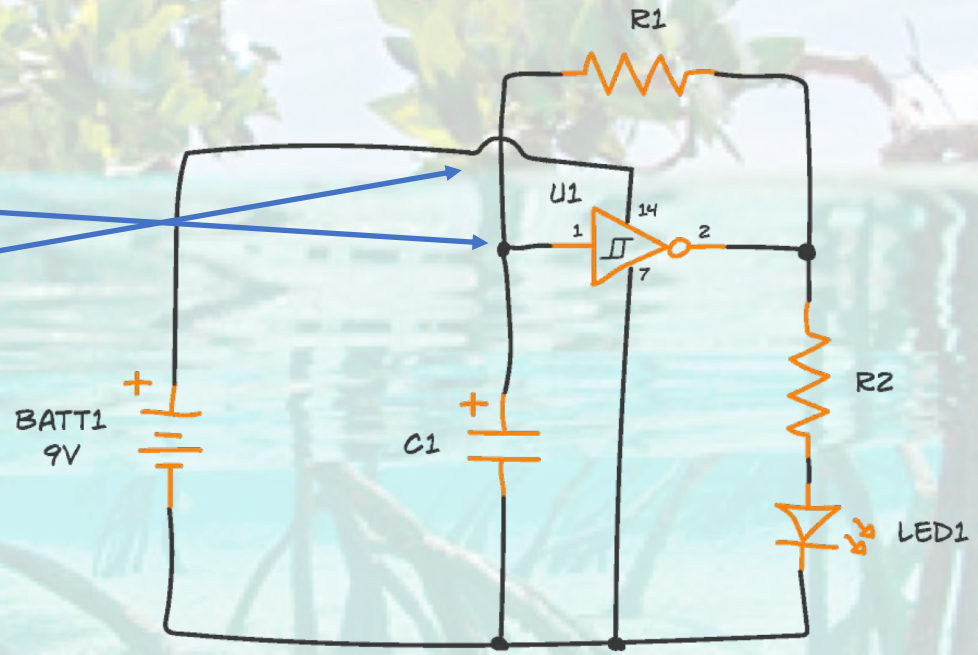
- https://learn.sparkfun.com/tutorials/how-to-use-a-breadboard/all

# Assignment for Friday

- 1: Nature journal
- 2: Hand (or CAD (e.g., Fritzing)) draw a block diagram circuit showing how you think parts should be connected
  - Focus on power and communication (**UART** = TX/RX)
  - Use https://www.instructables.com/Track-CO2-Carbon-Dioxide-Levels-With-Ardunio-and-C/ as a guide for K-30 to Arduino (Adalogger) but note that we are using a different board
  - More advanced (not required this week): Fritzing

# Grading and Symbology

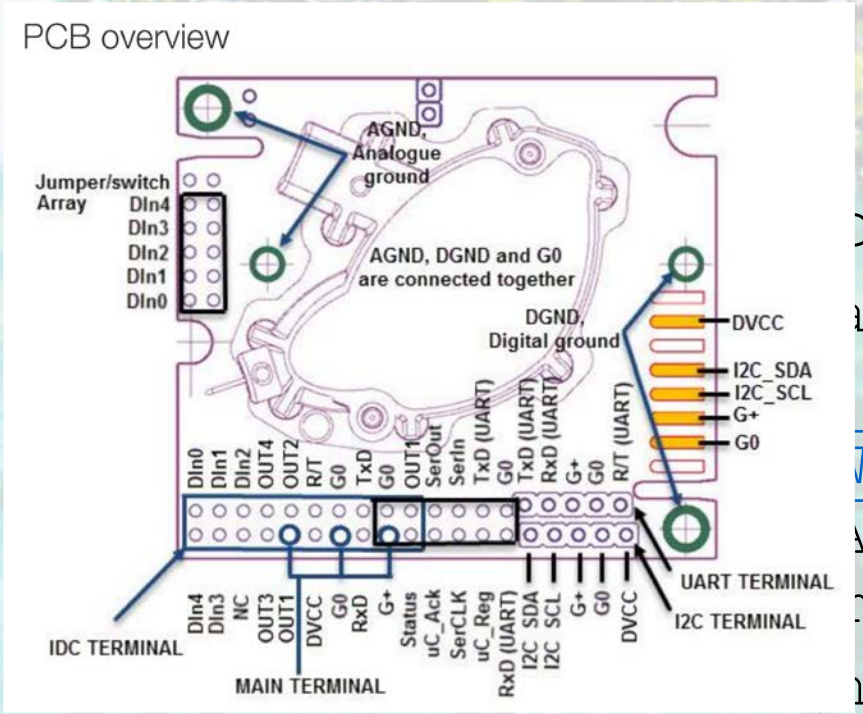
- I will be looking for:
  - All correct connections
  - Connected wires shown with dot
  - Not connected wires shown with swoop

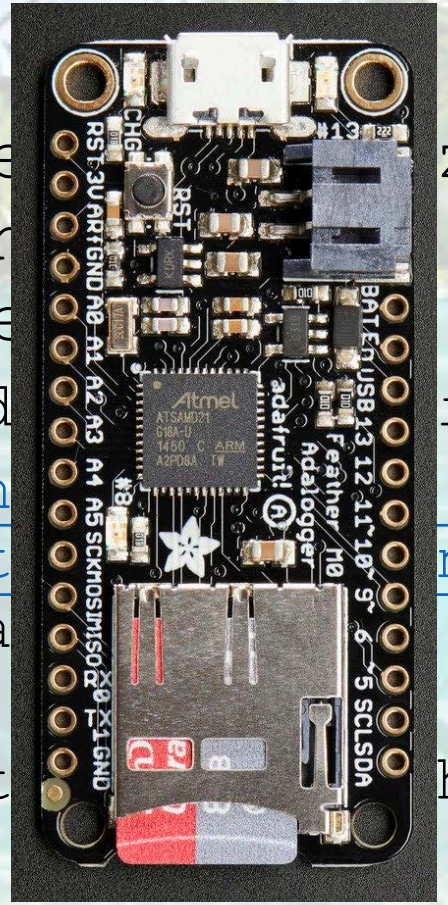



https://www.build-electronic-circuits.com/electronic-schematics/

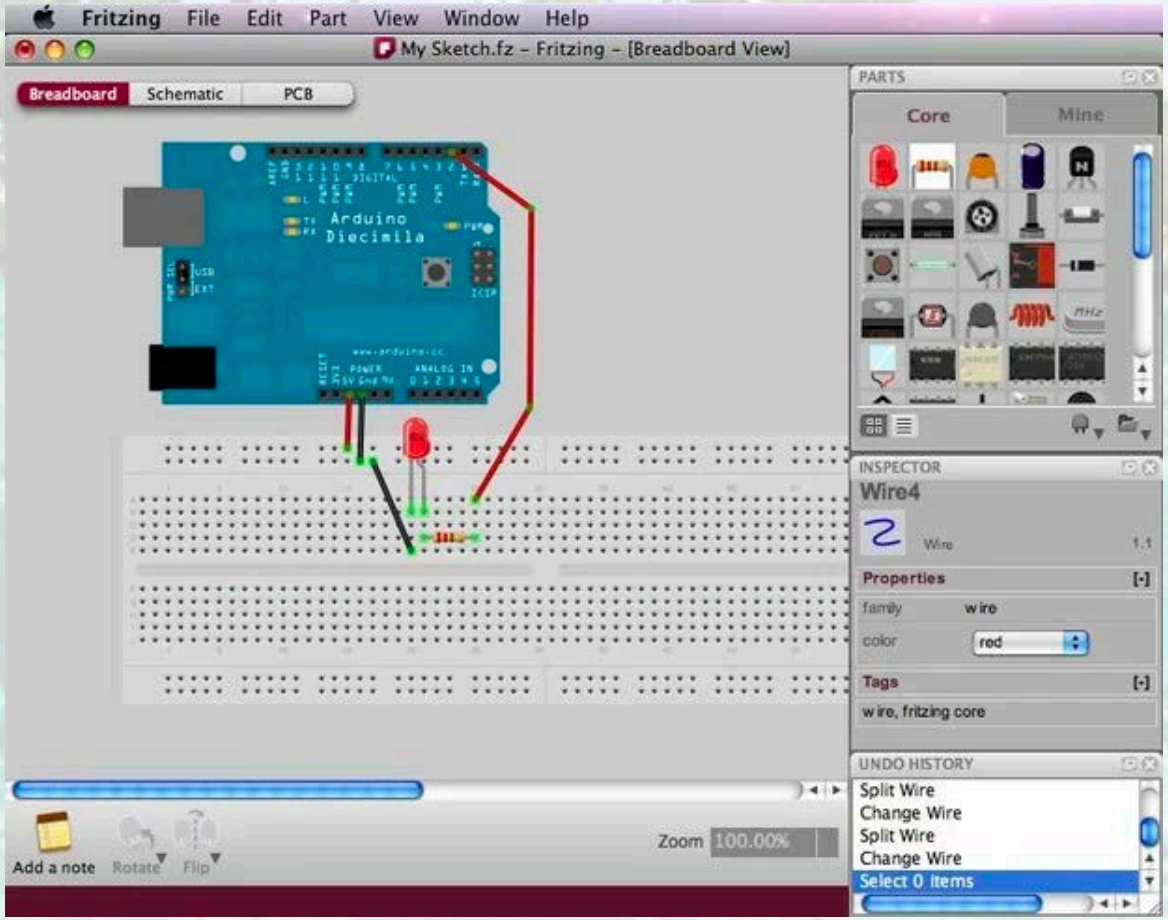
# Assignment for Friday

- 1: Nature journal



# Fritzing free circuit design software




https://fritzing.org/

# New Teams (Splitting Team Arduino)

- Team K-30 (https://senseair.com/products/flexibility-counts/k30/)
  - 1—Evan
  - 2—Stephen
  - 3—Devan
  - 4—Madison
- Team PowerBoost (https://learn.adafruit.com/adafruit-powerboost-500-plus-charger)
  - 1—Nick
  - 2—Zac
  - 3—Summer
- Team Processor (https://www.microchip.com/wwwproducts/en/ATsamd21g18)
  - 1—Billy
  - 2—Anna
  - 3—Holland
- Team Adalogger (https://learn.adafruit.com/adafruit-feather-m0-adalogger)
  - 1—Liam
  - 2—Hannah
  - 3—Danielle
  - 4—Michael
- Team Arduino software/firmware (https://www.arduino.cc/en/software)

# Zoom with Peter Fritzler, Sciences Librarian

https://uncw.zoom.us/j/81587579319?pwd=ZUxhUmtTRXMzOTEyeE5ic1EzdXBndz09