Interdisciplinary Renewable & Environmental Collaborative REU

Development of a Weather Balloon Package for Atmospheric Carbon Dioxide Measurements

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Research Experience for Undergraduates, University of North Dakota

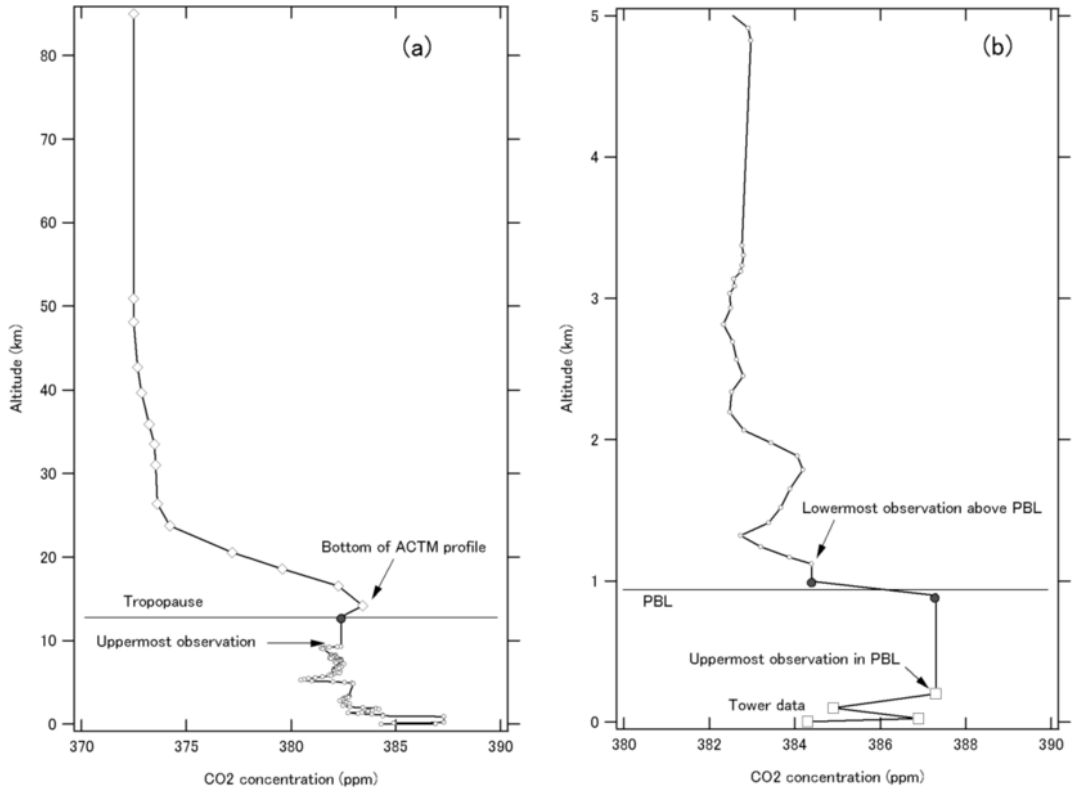
Background Information

Carbon Dioxide:

Carbon dioxide is a potent greenhouse gas that traps heat and contributes to global warming in excess, and it is also essential for plant growth and photosynthesis

Why measure carbon dioxide?

1. Filling Research gaps of carbon dioxide (Vertical Profiling)
2. Improve climate models
3. Climate Mitigation Policy Advocacy: Direct Air Capture Technology



Vertical profile of the atmospheric carbon dioxide.
Miyamoto, Y. et. al

The Conversation Article, Dr. David Delene & Elizabeth Cardoza

Miyamoto, Y. et al. (2013) Corrigendum to 'Atmospheric column-averaged mole fractions of carbon dioxide at 53 aircraft measurement sites' published in Atmos. Chem. Phys. 13, 5265–5275, 2013. *Atmospheric chemistry and physics*. [Online] 13 (18), 9213–9216.

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Research Problem

Past REU projects, included sensors for temperature, atmospheric pressure, and humidity. Last year REU, included computer modeling of projections of carbon dioxide impacts on agriculture as carbon dioxide concentration is removed from the atmosphere. A carbon dioxide sensor researched last year for testing was Equivalent carbon dioxide (eCO2); however, this sensor provided an indirect estimate of atmospheric carbon dioxide based on related gases .

Research Problem: How to development an open hardware and accessible weather ballon to accurately collect carbon dioxide measurements?

Equivalent Carbon Dioxide Sensor

<u>This year's approach:</u>

1. Utilize a more accurate carbon dioxide sensor
2. Build upon previous designs of weather ballons

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Goals & Objectives

Goals:

To successfully launch the project's weather ballon this summer and accurately collect measurements from its sensors.

Objectives:

Compare carbon dioxide measurements from this project's weather ballon launch with data from Young-Suk Oh's ballon, which uses a different technique to collect carbon dioxide.

Project Overview

1 → 2 → 3

Product Research Phase:

- Research effective carbon dioxide sensors (PAS, NDIR, and eCO2)
- Literature Review
- Review past REU projects of development of weather ballons and analyze how I can improve on typical design

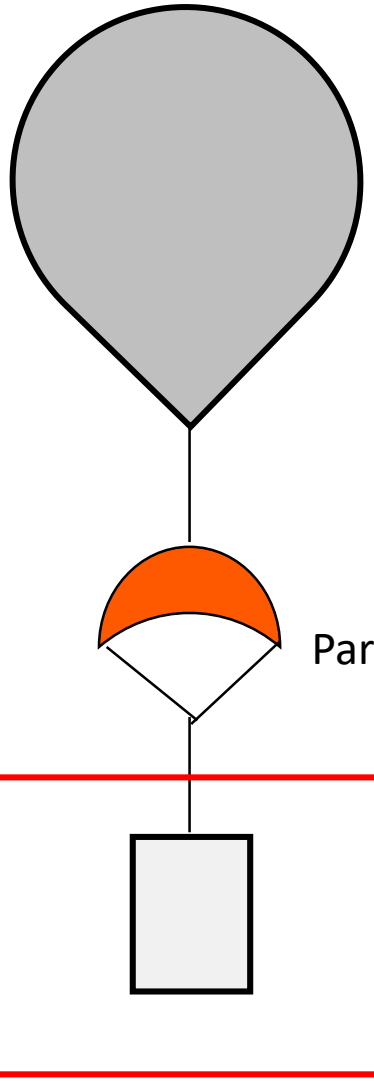
Design Phase:

- Develop the design concept for the weather ballon
- Take into consideration atmospheric conditions that might interfere with the parts
- Test individual sensors and parts before official launch

Test Phase:

- Conduct Weather ballon launch
- Compare measurements with Young-Suk Oh's ballon measurements

Design & Payload Concept

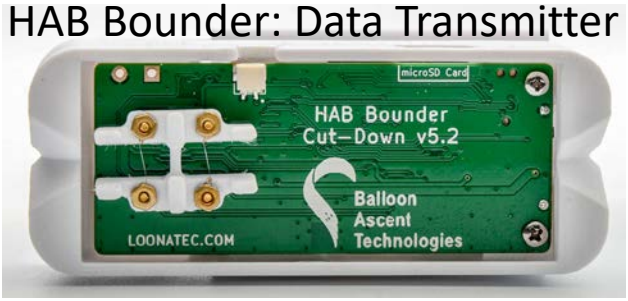


Latex Weather Balloon

Parachute

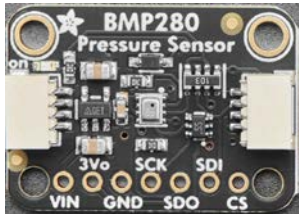
Balloon Package

HAB Bounder: Data Transmitter



Raspberry Pi 3B: Computer

BMP280: Pressure & Temperature Sensor



Carbon Dioxide Sensor:
(Under Research- Photoacoustic CO2, EE894, NDIR)

Photoacoustic CO2 Sensors

EE894

Nondispersive Infrared Sensor

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