



A HIGH-ALTITUDE BALLOON PLATFORM FOR DETERMINING REGIONAL UPTAKE OF CARBON DIOXIDE OVER AGRICULTURAL LANDSCAPES

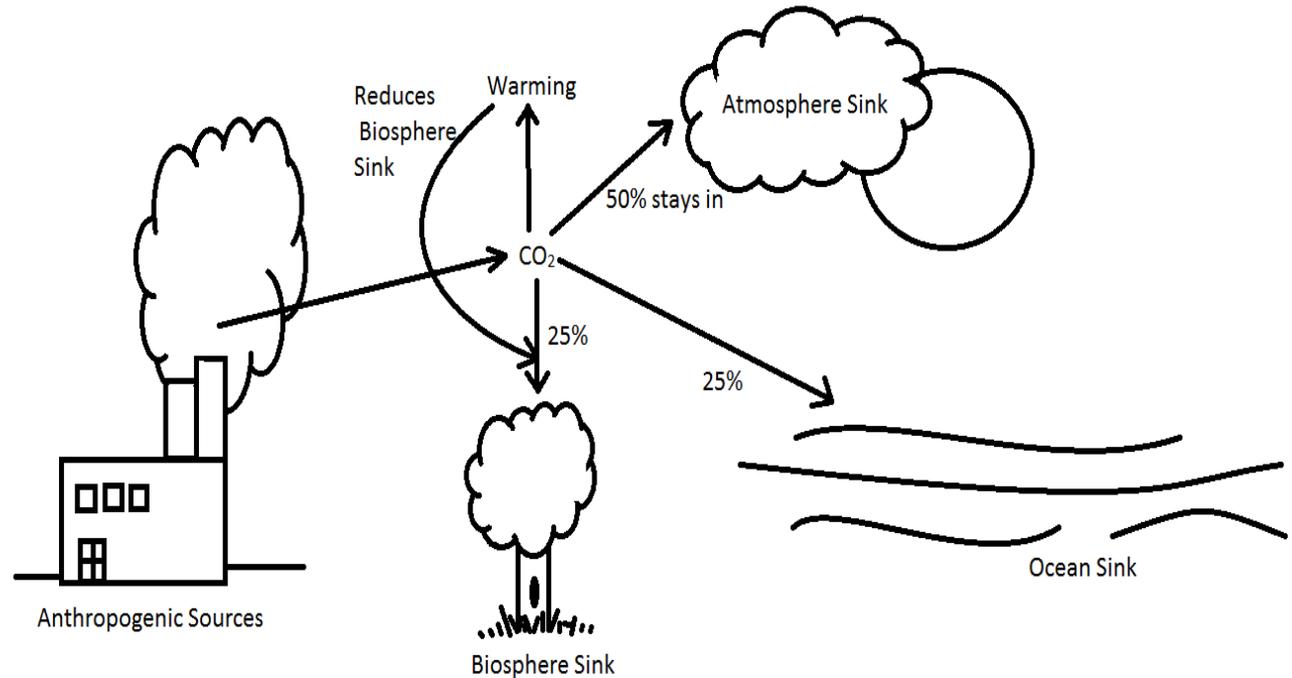
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Objective

- To quantify the amount of carbon dioxide taken out of the atmosphere over a period of time due to photosynthesis in crops
- Measure concentration of CO₂ at different altitudes and use calculations to turn that concentration into a flux
- This flux is called Net Ecosystem Exchange

The Carbon Cycle

- Crops take in CO₂ through photosynthesis and release it through respiration
- Shows an interaction between atmosphere and biosphere sinks

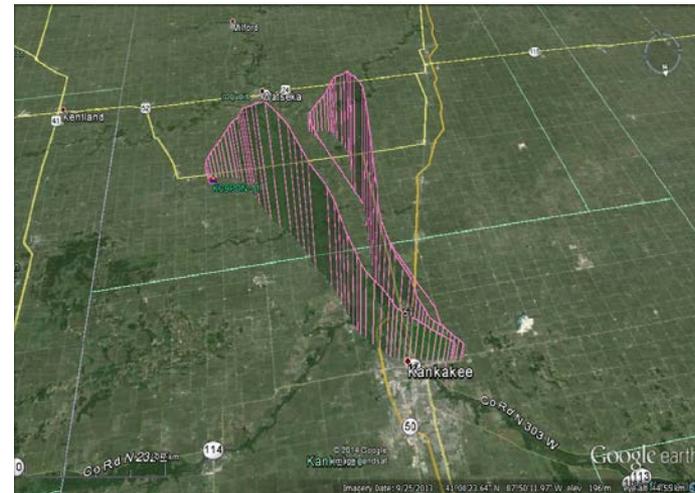
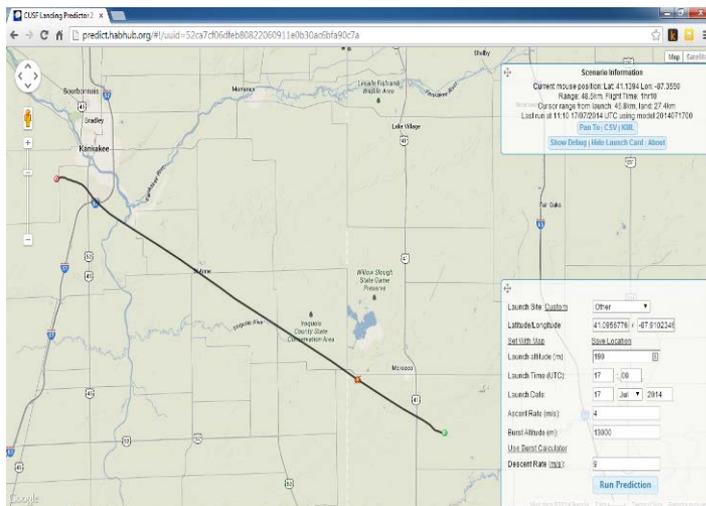


Balloons and the Carbon Cycle

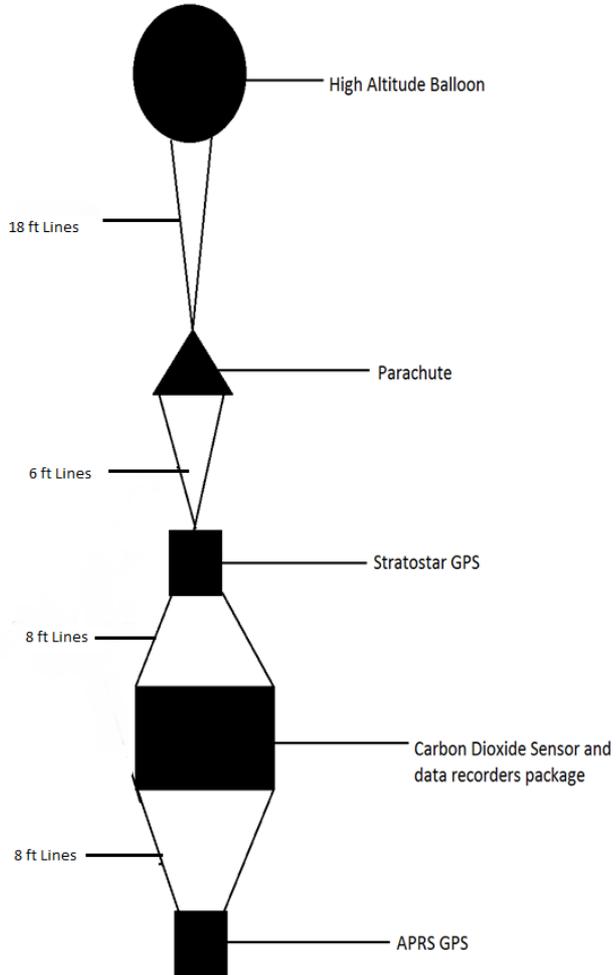
- Inexpensive compared to other methods
 - Planes, towers, satellites
- Easier set-up
- Can measure concentration at an intermediate scale

Methods

- Launch in morning and afternoon and perform calculations on difference in carbon dioxide concentration between the two flights
- Time between flights allows for substantial amounts of CO₂ to be taken in
- Landscape is primarily corn and soybean crops



Payload Setup



- ❑ Balloon- 200g latex balloon
- ❑ Parachute
- ❑ Stratostar GPS – monitors location, pressure, and outside temperature
- ❑ LI-820 Sensor with HOBO data logger- measures molar density of CO₂ and pressure
- ❑ APRS GPS- backup GPS

Calculations

- Average density of air found at 100 m intervals from 300-6,000 m

$$\frac{n}{V} = \frac{P_{average}}{RT}$$

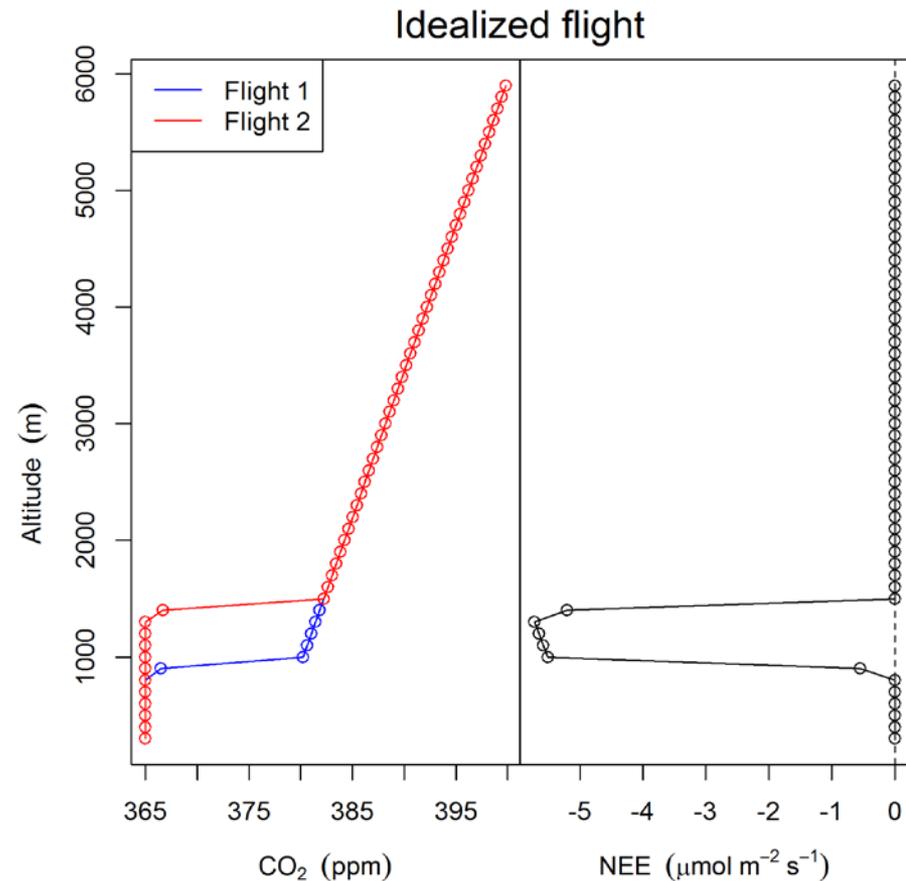
- Conversion from concentration to flux done on the difference in co2 concentration at intervals between the two flights

$$\sum_{i=3}^{60} \frac{\frac{n_a}{V} (C_2 - C_1)}{\Delta t} \times 100$$

- Negative NEE shows uptake of CO2 by crops

Ideal Flight

- Clear decrease in CO₂ concentration during the second flight
- Related to growth of the boundary layer
- As plants undergo photosynthesis, concentration of CO₂ stays low at higher altitudes
- Corresponds with negative NEE



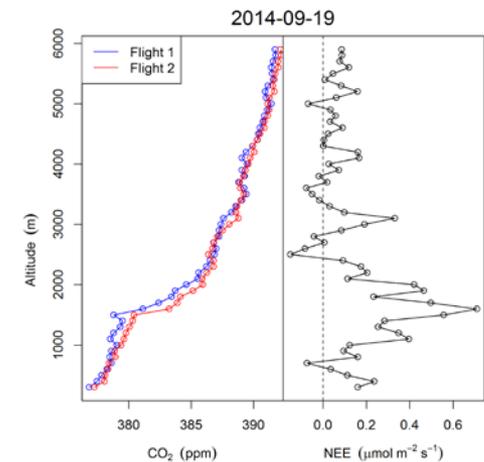
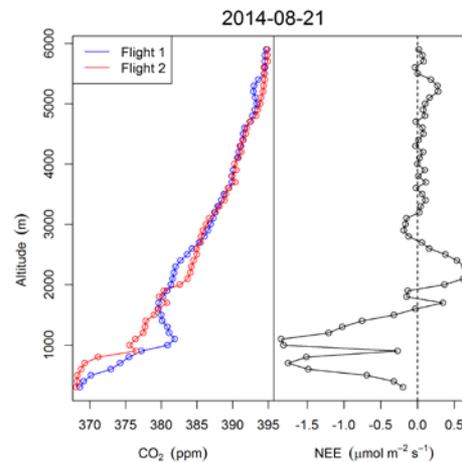
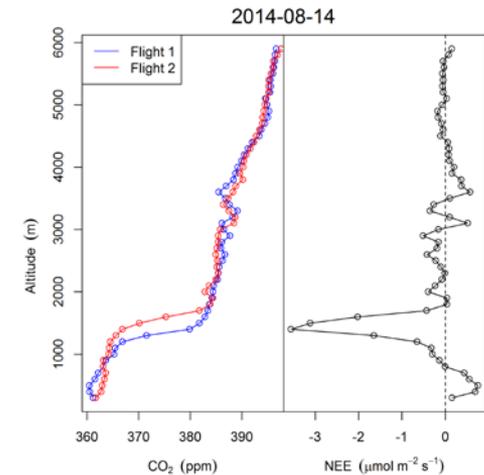
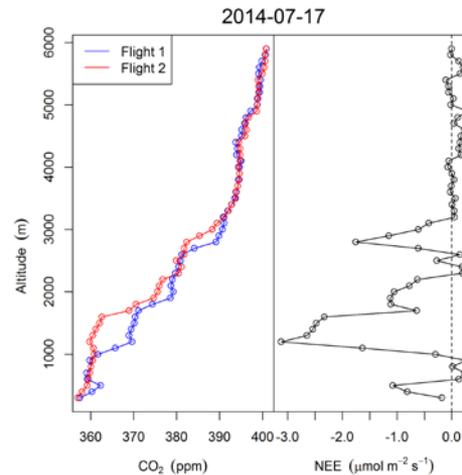
Results

- ❑ As the summer went on, NEE became less negative
- ❑ Plants are taking in CO₂ at a slower rate as the summer goes on
- ❑ Net release of CO₂ in the fall

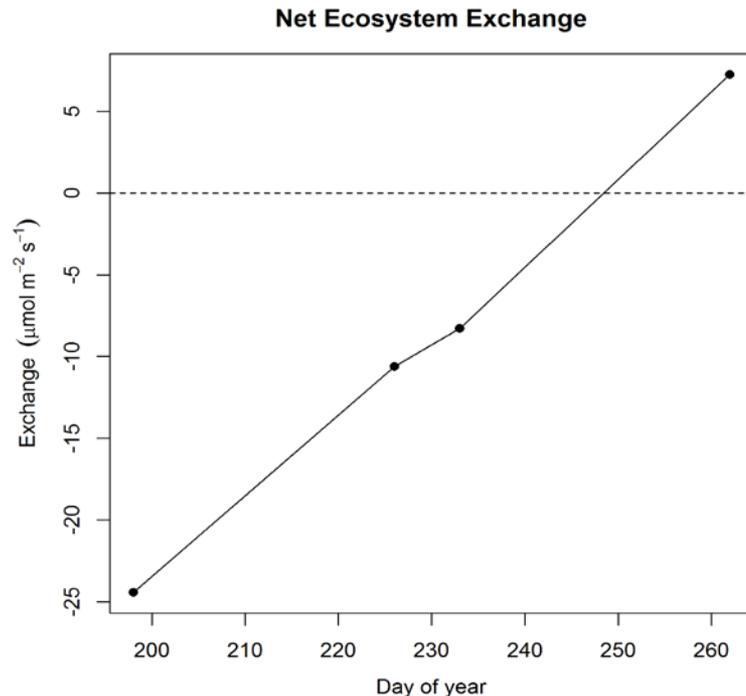
Date	Uptake ($\mu\text{mol}/\text{m}^2 \cdot \text{sec}$)
July 17, 2014	-25.62
August 14, 2014	-9.74
August 21, 2014	-9.23
September 19, 2014	5.97

Results

- Left Panel- shows concentration of CO₂
- Right Panel- shows calculated NEE
- On 7/17 ad 8/14 there's a clear increase in the height of the boundary layer
- Some discrepancies on 8/21
- Positive NEE shown on 9/19



Conclusions



- Initial proof-of-concept data have been collected
- While plants are in their peak growing season during July, NEE is the most negative
- As crops stop growing quickly and are eventually harvested, NEE becomes more positive

Next Steps

- Conduct approximately 8 launches this summer
- Compare NEE with data collected from MODIS Satellites
- Use a similar methodology to find NEE of Ozone

