

Carbon Dioxide Deficits from Direct Air Capture Computation and Verification

Motivation

Increasing atmospheric concentrations of CO₂ from anthropogenic sources are unbalancing ecosystems and are unable to be regulated through existing natural processes.

Direct Air Capture (DAC) is a novel technology that removes carbon dioxide (CO_2) from the ambient air and releases air with low CO₂ concentrations.



Top: Historic atmospheric CO₂ levels. Image derived from Florida State University's Climate Center. Bottom: Carbon cycle overview.

Atmospheric Carbon Dioxide from Natural and Anthropogenic Causes



Carbon dioxide is needed for plants to grow, thus farming communities are concerned that DAC may pose a risk to crops. DAC worst case scenarios were presented to the Morton County zoning committee. A high altitude balloon (HAB) will gather data to refine policy advisement.

Application of Findings

- The maximum affected area of a 99% effective DAC unit is estimated to be 10.6 acres.
 - Further research is needed to determine the threshold for risk of damage to plants.
 - Following the presentation of modeled results, concerns around DAC have shifted to logistics, not CO_2 defecits.
- An analysis template can be applied to any locality considering DAC.
- Further research is needed for combined effects of many DAC units.
- HAB package design will be continued.
 - Data gathered in flights will be used to revise future policy.
 - Testing package configurations will inform future research.
 - Package internal temperature, source code, container, and materials to be applied to future flights.

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Battery compartment

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Computer Modeled Prediction

DAC CO ₂ Removal	Downwind Distance	Height (Above Ground Level)	Concentration CO ₂ Removed	Atmospheric CO ₂ Concentration
40%	0 m (0 ft)	N/A	307 mg/m ³	252 ppm
	5 m (16 ft)	5.2 m	159 mg/m³	333 ppm
	30 m (98 ft)	4.1 m	12 mg/m³	354 ppm
	56 m (183 ft)	0.0 m	5 mg/m ³	417 ppm
60%	0 m (0 ft)	N/A	461 mg/m ³	168 ppm
	5 m (16 ft)	5.2 m	238 mg/m ³	289 ppm
	30 m (98 ft)	4.1 m	18 mg/m ³	410 ppm
	75 m (246 ft)	0.0 m	5 mg/m ³	417 ppm
99%	0 m (0 ft)	N/A	761 mg/m³	4 ppm
	5 m (16 ft)	5.2 m	394 mg/m³	205 ppm
	30 m (98 ft)	4.1 m	30 mg/m ³	404 ppm
	102 m (324 ft)	0.0 m	5 mg/m ³	417 ppm

around midline of plume.

Data from gaussian dispersion calculations. Range of effect calculated until within 3 ppm of annual average, (417 ppm) as this is within seasonal variance. All data points are taken from the midline of the plume.

Design of High Altitude Ballooning Package

Raspberry Pi 3B Motherboard





BMP 280 Pressure and Temperature Sensor

Raspberry Pi 3B GNSS/GPS, Down-link

SGP 30 CO₂ Sensor

SHT 31 / HTU21 D-F Temperature and Humidity Sensor