Measuring Greenhouse Gases and Atmospheric Composition from Tall Towers The University of Iowa Partnership with the National Oceanic and Atmospheric Administration

Nathaniel Massa[1], Megan Christiansen[1,2,3], Charles Stanier[1,2,3]

[1]Department of Chemical and Biochemical Engineering, The University of Iowa (CBE); [2]Center for Global Regional and Environmental Research (CGRER); [3]IIHR-Hydroscience and Engineering

Abstract:

The Stanier research group assists NOAA with operating the West Branch Iowa tall tower atmospheric observatory since 2007. Thousands of samples have been taken at the site since 2007, and the rate of increase for atmospheric carbon dioxide (CO2) is 2.44 ppm/year. The annual increase occurs superimposed on a sharp summertime drawdown due to regional net primary productivity, and fall/winter peaks due to plant decay, absence of photosynthesis, and anthropogenic emissions

Background:

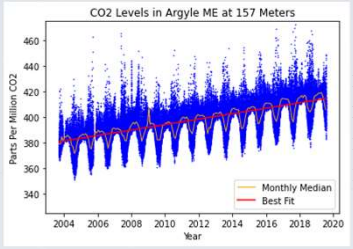
The National Oceanic and Atmospheric Administration (NOAA) operates several greenhouse gas and atmospheric composition monitoring networks. The one with the closest station to the University of Iowa is the "tall tower network" with a site in West Branch, Iowa. NOAA uses tall towers to sample the atmosphere from a greater height off the ground which makes readings reflect a larger part of the surrounding area compared to surface sampling. There are 8 tall towers. Their locations are shown on the graphic to the right except CRV in Fox Alaska. In the analysis below, the tall towers are graphed together with the iconic Mauna Loa sampling site, which has the longest instrumented sampling of carbon dioxide (since 1950s)

Methods:

All the data used to create these graphs was found on the NOAA website as a NetCDF or txt file. These files were imported into python using the library netCDF4 for the NetCDF files and python's native file reader for txt files. The files were read in as an input of two lists, one containing time, the other the readings which were graphed with respect to each other using the library pylab. Pylab was further used to plot a monthly median and best fit line generated by the library numpy. The map of the tall towers was created using a library called geopandas to read in a shape file of the U.S. from the Federal Census Bureau website. The actual visualization was handled with a different graphing library, mathplotlib.

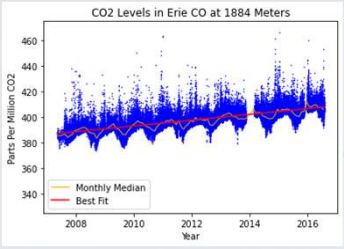
The Tall Towers CO2 Readings at Their Highest Heights:

Argyle Maine Tower (AMT):



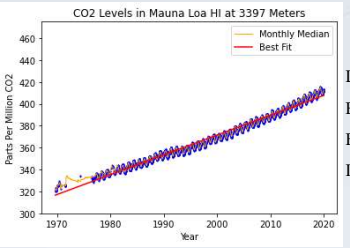
Location: Argyle Maine
Best Fit Slope: 2.14 ppm/year
Elevation: 50 masl
Intake Height: 107 m

Boulder Atmospheric Observatory (BAO):



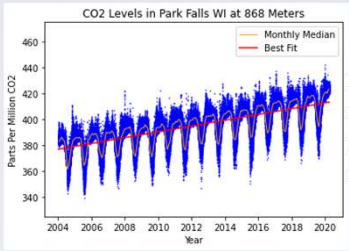
Location: Erie Colorado
Best Fit Slope: 2.26 ppm/year
Elevation: 1584 masl
Intake Height: 300 m

Mauna Loa Observatory (MLO):



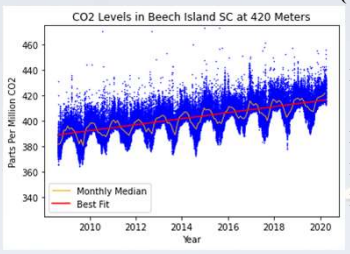
Location: Mauna Loa Hawaii
Best Fit Slope: 1.81 ppm/year
Elevation: 3397 masl
Intake Height: 0 m

WLEF-TV Tower (LEF):



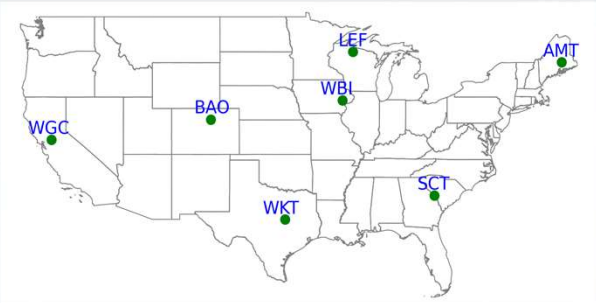
Location: Park Falls Wisconsin
Best Fit Slope: 2.24 ppm/year
Elevation: 472 masl
Intake Height: 396 m

Beech Island South Carolina Tower (SCT):

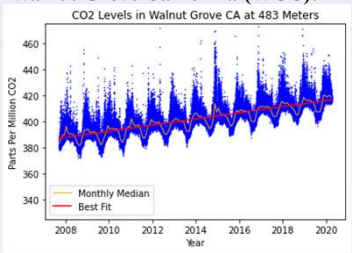


Location: Beech Island South Carolina
Best Fit Slope: 2.36 ppm/year
Elevation: 115 masl
Intake Height: 305 m

Tall Tower Locations (Excluding CRV):

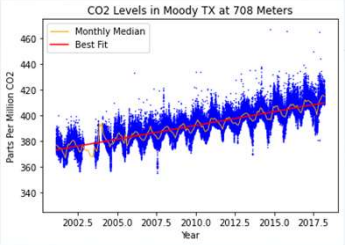


Walnut Grove California (WGC):



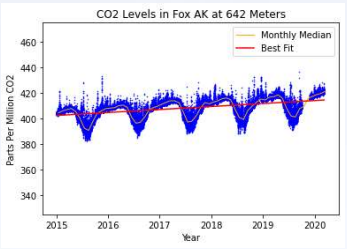
Location: Walnut Grove California
Best Fit Slope: 2.36 ppm/year
Elevation: 0 masl
Intake Height: 483 m

WKT Tower (WKT):



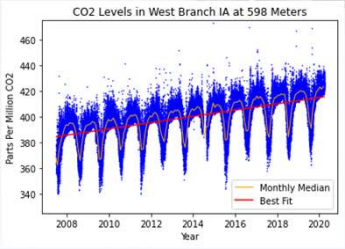
Location: Moody Texas
Best Fit Slope: 2.15 ppm/year
Elevation: 251 masl
Intake Height: 457 m

Carbon Artic Reservoir Vulnerability Experiment (CRV):



Location: Fox Alaska
Best Fit Slope: 2.34 ppm/year
Elevation: 611 masl
Intake Height: 31 m

West Branch Iowa Tower (WBI):



Location: West Branch Iowa
Best Fit Slope: 2.45 ppm/year
Elevation: 242 masl
Intake Height: 379 m

Acknowledgements:

We thank our NOAA collaborators, Don Neff, Arlyn Andrews, Jon Kofler, and Phil Handley, for their support in keeping the WBI tall tower operational and its data accurate. We also thank the IIHR professional staff for providing a means of transportation to the tall tower and an area for short term storage of tall tower related devices. We thank the ICRU fellowship program for providing funding for the maintenance and operation of the tower. Finally, we also thank Beiming Tang for his help with graphing the tall tower data in python.