Vegetation and CO_2

By Edith Johnston

Do plants and trees have a quantifiable effect on local carbon dioxide levels?

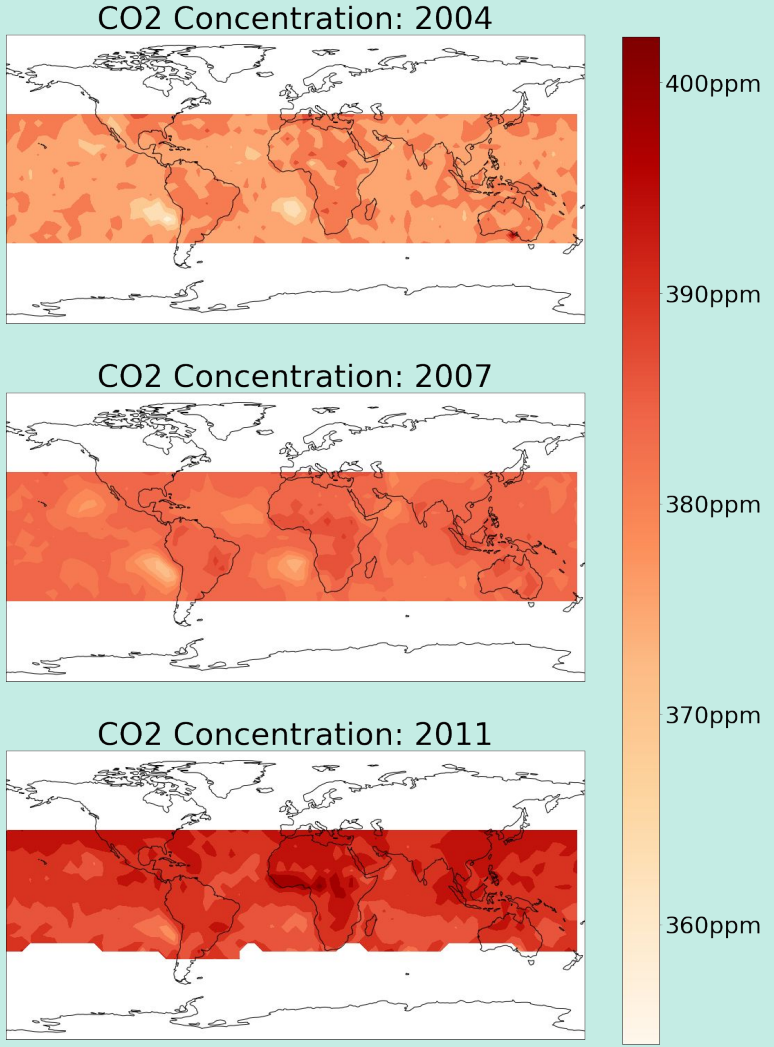
Project Goal

Data

Carbon Dioxide - TES

- Between latitudes 40S & 40N, at 14 atmospheric levels
- Required smoothing and averaging to eliminate error
  - Final resolution: 5* latitude by 5* longitude
- Consists of:
  - Observation Altitude
  - Surface Altitude
  - CO2 concentration in ppm

Tools used: Xarray, NetCDF, Numpy, Pandas

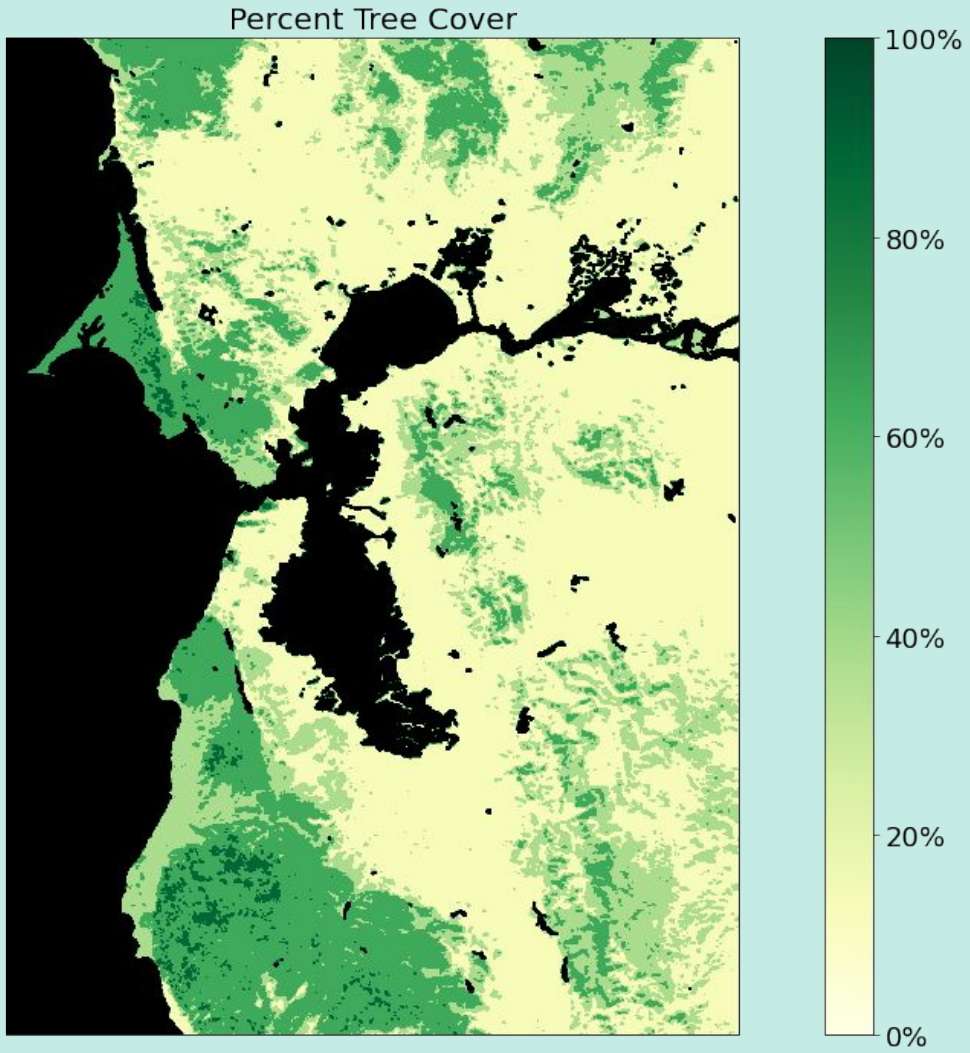


Data

Vegetation - MODIS

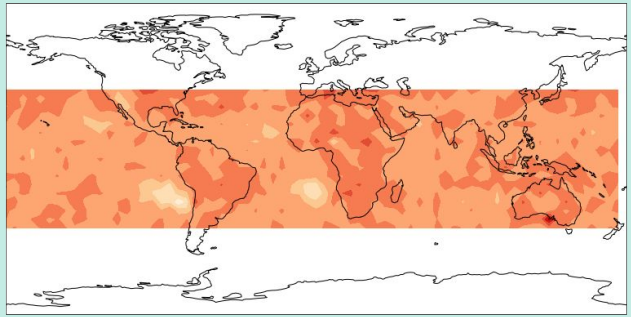
- Global
- Extremely well resolved
  - 250 m squares
  - Almost 1.5 billion data points - 250GB data
- Consists of, for each square:
  - % Tree Cover
  - % Non Tree Vegetation
  - % Non Vegetated

Tools used: Dask, Xarray, NetCDF, Numpy, Pandas, PyProj

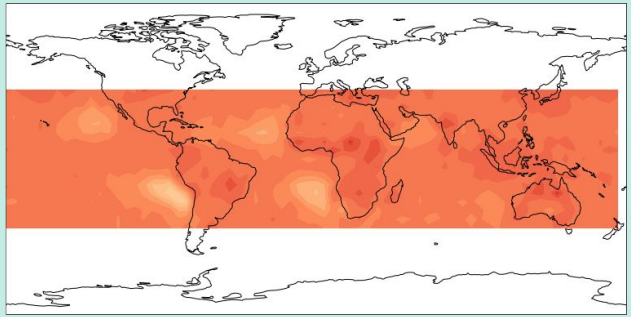


Time Series Component

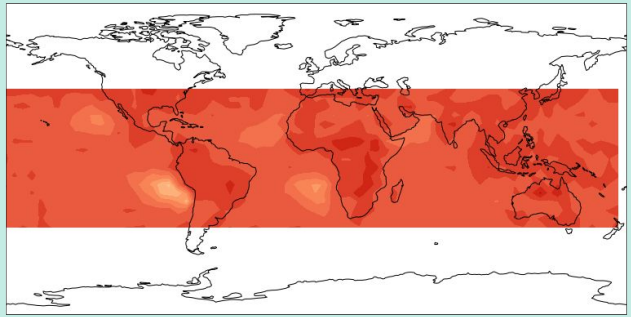
CO2 Concentration: 2004



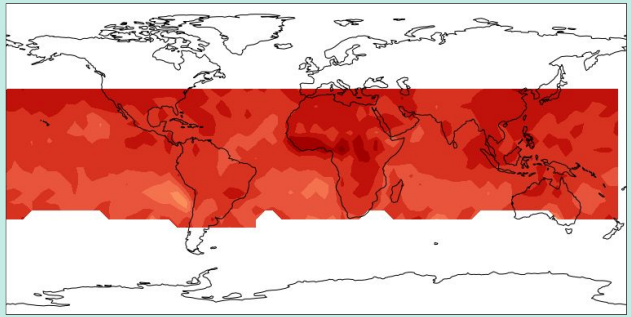
CO2 Concentration: 2006

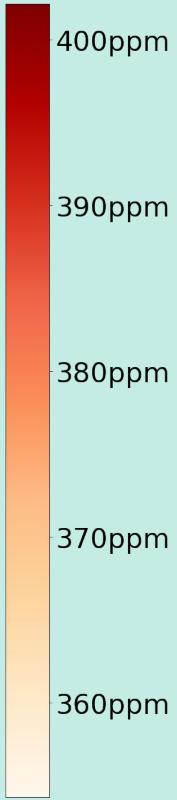


CO2 Concentration: 2009



CO2 Concentration: 2011





Regression Model

Features

- % Tree Cover
- % Non-tree Vegetation
- Surface Altitude
- Inverse of Surface Altitude
- Previous Year's CO2 Concentration

Test Data Performance

	Without Time Component	With Time Component
R^2	0.616	0.867
Mean Absolute Error	0.049	0.024
Median Absolute Error	0.025	0.009

Tools used:

Sci-kit learn, Statsmodels, Numpy, Pandas

Impact of Vegetation

- Vegetation features had lower model coefficients - no higher than 1 : 50
- Model with vegetation only:
  - R_2 - 0.052
  - Prob (F-statistic) - 3.89×10^{-45}

Limited impact - but not statistically insignificant!

Future Work

- Higher resolution CO2 data!
- More features
- Try other regression models
- Build an app

Thank you

By Edith Johnston

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Github: https://github.com/edithalice

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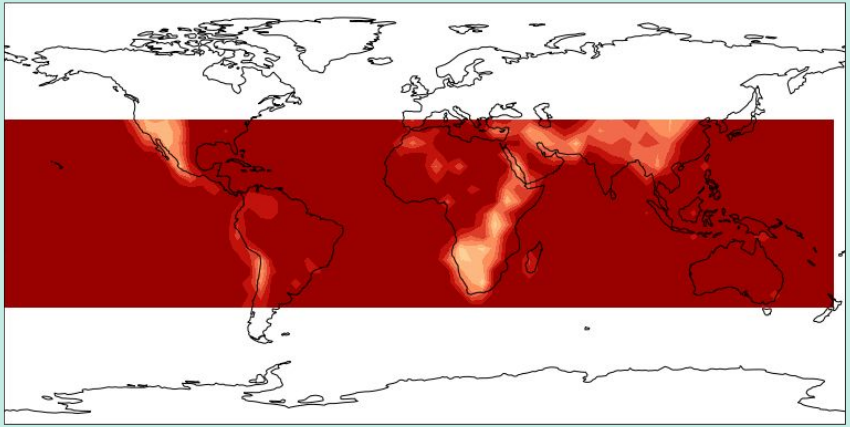
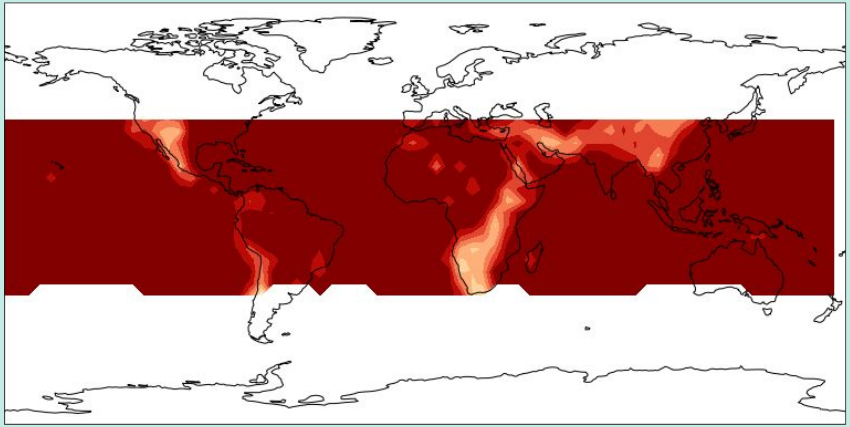
Appendix

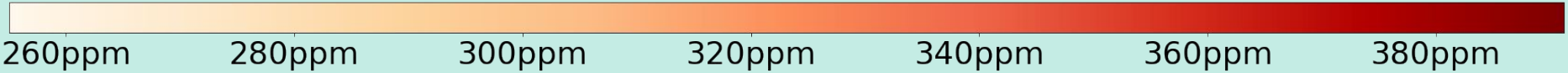
Engineered Features
Altitude Correction

Surface CO2 Concentration: 2006

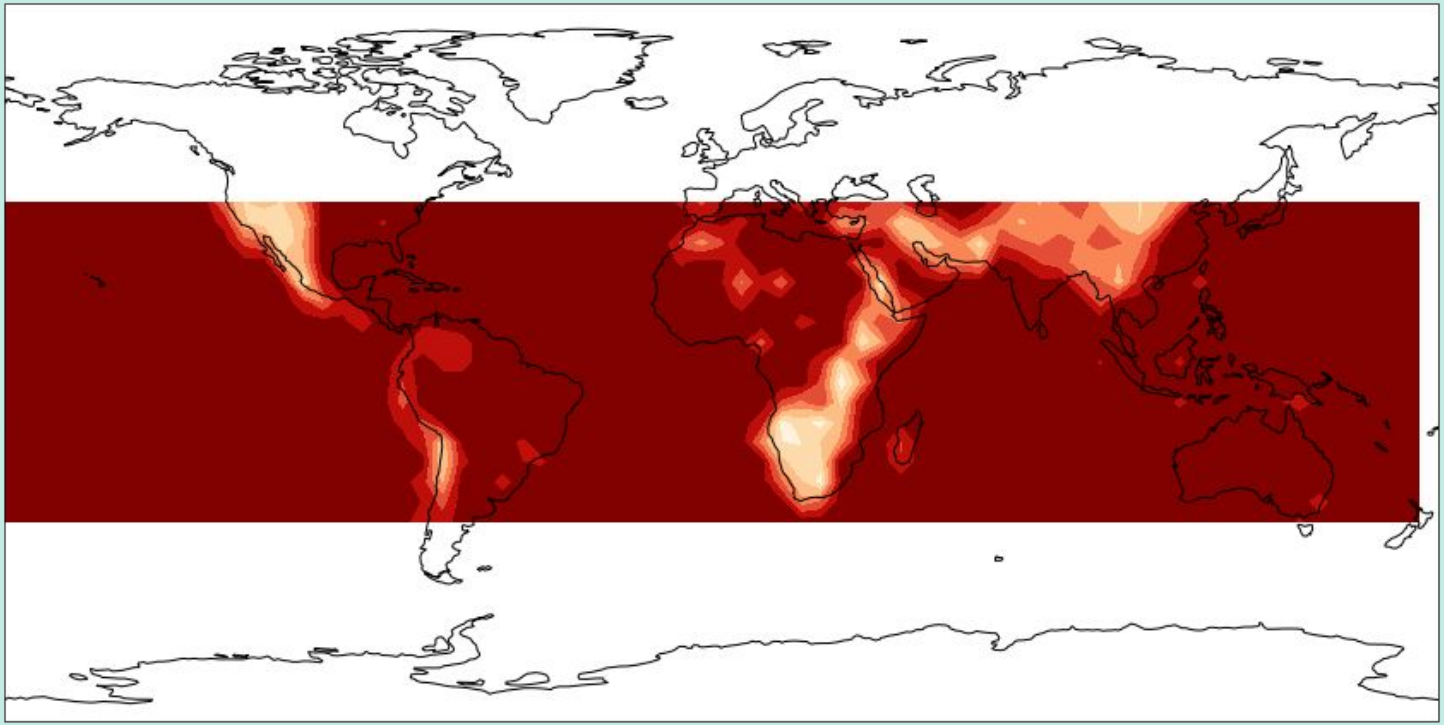


Surface CO2 Concentration: 2010



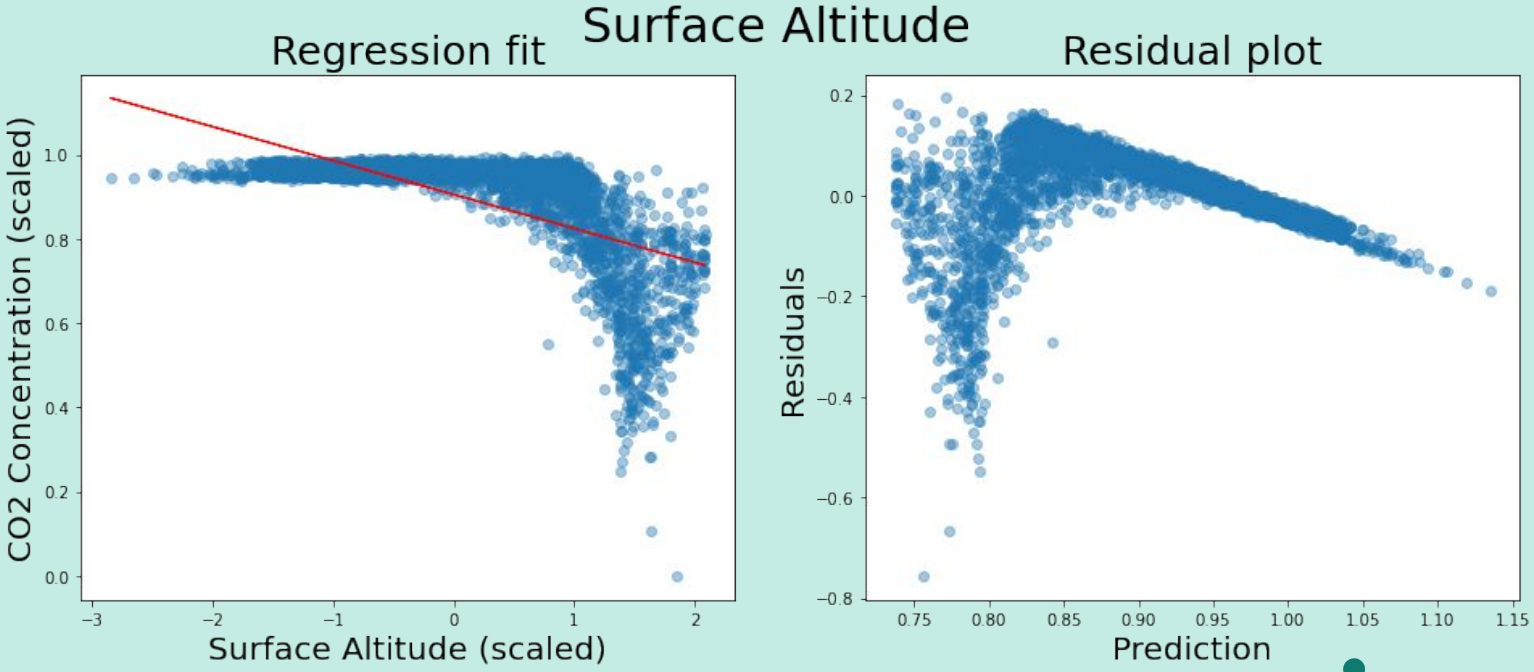


Surface CO2 Concentration: 2006



300ppm 320ppm 340ppm 360ppm 380ppm

Engineered Features
Altitude Correction



Carbon Dioxide Data

- NASA's Tropospheric Emission Spectrometer (TES)
- Vertical column of measurements
- Averaging kernel smoothing:
  - $\mathbf{A}\mathbf{x}_{\mathbf{rtv}} + (\mathbf{I} - \mathbf{A})\mathbf{x}_{\mathbf{ap}}$

Vegetation Data

- NASA's Terra MODIS Vegetation Continuous Fields
- Gridded measurements with resolution of 250m
- % Tree Cover & % Non Tree Vegetation
- Extremely large: >200GB