Problem Set #7

Assignment Learning Objectives

1. Integrate use of remote data sources
2. Performing statistical relationships to decipher atmospheric patterns
3. Strengthen link between scientific questions and generating computer programs to produce output in service of those questions.

Due 5 November 2020 by 3:00 pm

Due Online

- The final script in the PSet7 repository on your GitHub account

Due Via Blackboard

- A PDF version of your code. Make sure the honor code appears in the comment block at the beginning of the script and that it has your full typed out name. This will serve as your assertion that you have upheld the honor code.
- A PDF version of your responses to the questions.

Honor Code

You must type the full honor code into each comment block to indicate that you have upheld the code. Authorized aid for this assignment is your notes and any previous programs you have written. You are highly encouraged to work with others in the class to help diagnose bugs and work out programming logic. Any copying of someone else's code IS A VIOLATION OF THE HONOR CODE, whether from a classmate, or the Internet. *Be sure to indicate with whom you have worked in the comment block of your submission.*

Introduction

Using computers to answer scientific questions is an essential aspect of 21^st^ Century meteorology. So far this semester, computer-programming tools have been developed to work on various aspects of meteorological calculation and visualization. In this assignment there will be a series of questions to be answered that cover various temporal aspects of climate. Unlike previous assignments, this one the computer won't "answer" all of the questions, but rather you'll do a series of calculations, make some graphical output, then create formal written responses after analyzing the output of your programs.

Long-term Climate

Program Name: **climate_anomaly.py**

Program Input: NCEP/NCAR Reanalysis data via remote data access

Use monthly mean air temperature from the sig995 level

(https://www.esrl.noaa.gov/psd/thredds/catalog/Datasets/ncep.reanalysis.derived/surface/catalog.html?dataset=Datasets/ncep.reanalysis.derived/surface/air.sig995.mon.mean.nc)

And the long-term mean

(https://www.esrl.noaa.gov/psd/thredds/catalog/Datasets/ncep.reanalysis.derived/surface/catalog.html?dataset=Datasets/ncep.reanalysis.derived/surface/air.sig995.mon.ltm.nc)

Program Output: Global temperature anomaly maps for 2018 (**global_anomaly_2018.png)**; Time series of surface temperature anomalies from Jan. 1951 through Dec. 2018, with a five-year running mean (**global_average_anomaly.png**).

Written Response: Formal typed response to questions #3

Problems

1. Create a Python program that will perform calculations and create output graphics that enable the following set of questions to be answered.

   a. What does the variation in yearly global surface temperature anomalies (from the 1981--2010 long-term mean) look like across the globe for 2017, 2018, and 2019? (Graphic)

   b. What locations had the warmest and coldest anomalies for each year? Plot a marker and the anomaly value on the map from problem 1a.

2. Add to the Python program in 1a calculations and output graphics that enable the following set of questions to be answered.

   c. What are the yearly average surface temperature anomalies (from the 1981--2010 long-term mean) from Jan. 1950 to Dec. 2019 for Minneapolis, MN (44.98°N; -93.27°E)? For extra credit, compute a five-year running mean (valid at the last year of the mean) for the yearly average temperature anomalies. (Graphic)

   d. What have been the warmest and coldest years? Indicate them on the time series graphic from problem 1a with the value of the anomaly for each.

3. Create a pseudo blog post about the graphic created that allows non-scientists to correctly interpret information contained in the time series and the 2019 global anomaly map. Be sure to adequately reference the graphic in the post, as well as anything needing particular reference to explain what is in the graphic and what it means. Specifically discusses the year 2018 and how region perceptions about the year could be different as compared to the global mean average temperature anomaly based on where you live. Feel free to focus on regions of the U.S. or across the entire world, it's up to you. (Written Response)

   Notes:

   - Longitudes are in the range 0 to 360E; slicing will have to be done accordingly
   - Temperature Anomalies
     - $T_{anom} = T_{current} - T_{LTM}$

     1. Read in both current and long-term mean data
     2. Isolate the year for the analysis from the current data

3. Compute the anomaly for each grid point for the current year data (both arrays should have the same shape)

4. Compute the average anomaly for each grid point by averaging over the 12 months

- Finding max/min values of 2D data was completed in the Jupyter notebook for tabular data

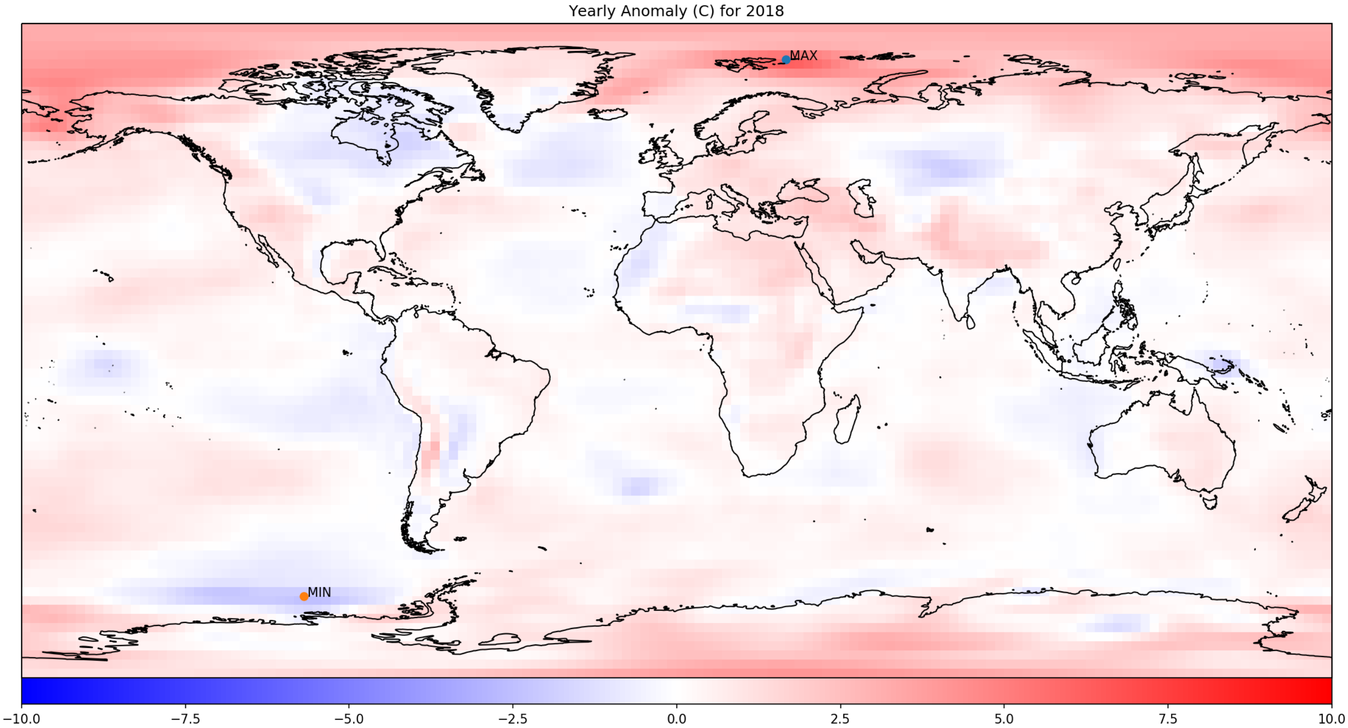
- Cyclic Points for display purposes can be accomplished with a Cartopy method

  (https://scitools.org.uk/cartopy/docs/latest/cartopy/util/util.html?highlight=add_cyclic)

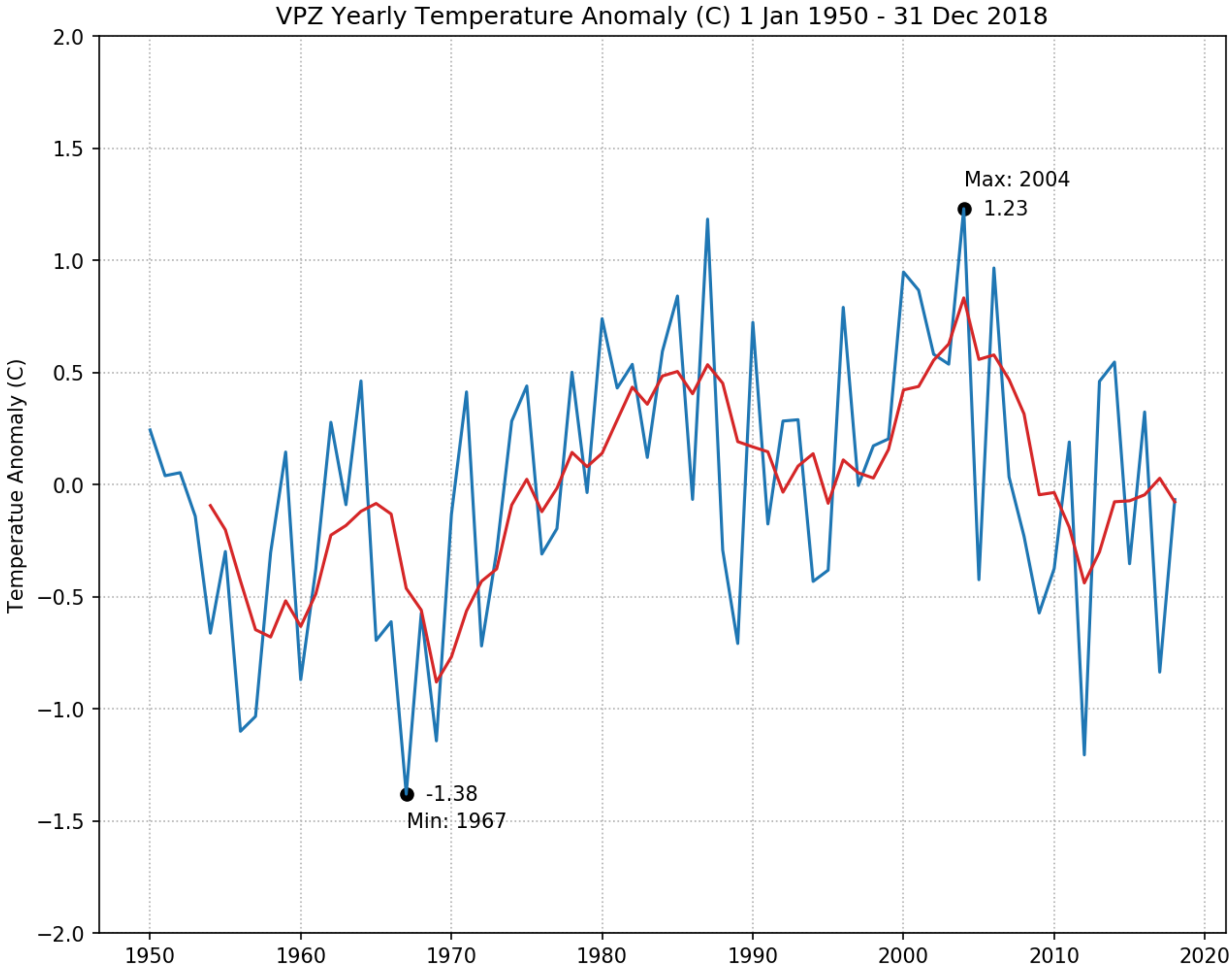
- The module xarray provides a method for computing running means. (http://xarray.pydata.org/en/stable/generated/xarray.DataArray.rolling.html)

Output Examples:

Yearly Global Mean Temperature Anomaly:



Valparaiso, IN Yearly Anomalies 1950-2019:



Evaluation Criteria

Each of the following criteria will be rated from not present/completed to exemplary, having all of the elements will yield at least a 7/10 for a particular criterion. The assignment is out of 50 points.

- Efficiently coded and correct Problem 1 (10 points)
- Efficiently coded and correct Problem 2 (10 points)
- Write-ups for Problems 1 and 2 (10 points)
- Informative and Clear Output from running code (10 points)
- Code is well documented (informative comments/descriptions of code blocks; 5 points)
- Code was regularly updated and committed to GitHub repository (5 points)