

Homework #3

Objective Analysis in the Atmospheric and Related Sciences

ATMO, HWRS, GEOG, GEOS 529: Fall 2015

Data

CPC winter and summer precipitation data for Tucson used in Homework #2.

CPC total winter (DJF) precipitation (mm) at 0.25° grid spacing for the period 1949-2014 (65 years) for the contiguous U.S.

CPC total summer (JJA) precipitation (mm) at 0.25° grid spacing for the period 1948-2014 (66 years) for the contiguous U.S.

CPC datasets are provided on the website (in ascii and standard binary format). The domain of the data spans 300 x 120 points, starting at 230.125° longitude and 20.125° N. The format of the data is a list of numbers in the ascii file, total number is the space by time dimension. Missing values are denoted with -9.99e+08. Data are written in the following structure in the file:

First loop: X dimension, 1 to 300

Second loop: Y dimension 1 to 120

Third loop: T dimension 1 to 65 or 66, depending on season

The corresponding GrADS control file is also included with the data.

Part I

Using the total winter (DJF) CPC precipitation data for Tucson, the coding tools you developed to compute the gamma distribution in Homework #2, and SPI methodology notes from Dan Edward's master's thesis from Colorado State University, compute for each year the winter and summer (three month) SPI values.

Display your results in graphical format as time series. Superimpose on your graphs the corresponding normalized Z-score for precipitation at the given timescale assuming a normal distribution (e.g. either as a dashed line or a different color).

Determine the years with highest and lowest SPI values for winter and summer. Use a threshold of SPI of plus or minus 1. Show the high and low composite years obtained for each of the categories in tabular format.

Discussion: When and why is SPI most different than the corresponding normalized Z-score for precipitation? How do the high and low composite winter and summers compare with one another? Are the "extreme" wet and dry winters and summers the same or different? Why might this be? Explain why knowledge of the three month SPI would be useful for decision making purposes by climate stakeholders.

Part II

Considering the winter and summer gridded precipitation data over the contiguous U.S., compute the departure from the normal seasonal precipitation, or precipitation anomaly, for each year.

Using the SPI composites created in Part I for each season, compute the difference in precipitation anomaly between of the high composite years minus the low composite years. For each grid point with data, display the mean value of the high composite minus the low composite divided by two. Compute the local significance at each grid point using a student's t-test for difference of means. Shade areas on the maps that exceed the 90% level. You may assume that each yearly precipitation anomaly map is independent in time in computing the degrees of freedom for the t-test. **For this part you should have two composite difference maps with local significance highlighted, one for each season.**

Discussion: Considering 3-month winter and summer SPI at Tucson, are there coherent continental- scale patterns of precipitation anomalies associated with extreme wet and dry winters and summers? How are the precipitation anomaly patterns similar or different for the two seasons? Might there be a physical explanation that explains the large-scale difference patterns you observe? I strongly suggest consideration of some background literature on western U.S. climate variability to aid in answering these questions.

Part III

For the two composite difference maps with shaded significant regions you computed in Part II, compute the corresponding field significance using a permutation resampling approach. Display the null distributions for the percentage of grid points exhibiting significant local statistical significance tests and the critical value, similar to Fig. 5.12 in Wilks from Livezey and Chen (1983). Use 500 iterations.

Discussion: Do the maps you generated in Part II indicating local significance satisfy a field significance test? Does this change in any way your conclusions from Part II? Why is field significance an important additional test to do when doing basic statistical analyses, like t-tests and z-tests, involving geophysical data on a grid?

Assignment due date: Tuesday, October 20.