Homework #3
Objective Analysis in the Atmospheric and Related Sciences
ATMO, HWRS, GEOG, GEOS 529: Fall 2013

Data

Winter precipitation data at Station #1 and Station #2 used for Homework #2.

Total winter (DJF) winter precipitation (mm) at 0.5° grid spacing for the period 1950-2009 over the contiguous United States, from the same UDEL dataset used in Homework #2, are provided on the website (in ascii and standard binary format). The domain of the data spans from 132.75° W – 64.75° W (137 points) and 19.75° N – 54.75° N (71 points). The format of the data is a list of 583,620 numbers in the ascii file. Missing values are denoted with 32767. Data are written in the following structure in the file:

First loop: X dimension, 1 to 137
Second loop: Y dimension 1 to 71
Third loop: T dimension 1 to 60

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

Part I

Using the total winter (DJF) precipitation data for Station #1 and Station #2, 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 1950-2009 the winter (three month) SPI at each station.

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 all four categories above. 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 years for each of the four categories compare with one another? Are the "extreme" wet and dry years 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 gridded precipitation data over the contiguous U.S., compute the departure from the 60-year normal winter precipitation, or precipitation anomaly, for each year.

Using the SPI composites created in Part I for each station, 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 station.**

Discussion: Considering 3-month winter SPI at these stations, are there coherent continental-scale patterns of precipitation anomalies associated with extreme wet and dry years? How are the precipitation anomaly patterns similar or different for the two stations, and how is that are related to where the stations are physically located? 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.

<u>Part III</u>

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: Friday, October 11.