**Assigned 3/29, Due 4/6 (by 5PM)**

In this exercise, we’re going to compare teleconnection patterns with the SAM, NAO and the NAM. **For all analyses in this DE, we will use winter time (Jun-Aug for SH and Dec-Mar for NH) seasonal averages, from the time period from Dec 1949 to Mar 1994.** For this you’ll use the command *T (Jun-Aug) seasonalAverage* or *T (Dec-Mar) seasonalAverage*

**[Note changes in the season and the timeframe]**

1. Compare the two main methods used to calculate the SAM index.
	1. Calculate your own annual SAM index using [this dataset](http://iridl.ldeo.columbia.edu/expert/SOURCES/.NOAA/.NCEP-NCAR/.CDAS-1/.MONTHLY/.Intrinsic/.MSL/.pressure/%28mb%29unitconvert/) and the SLP difference approach (Gong and Wang 1999 method). Recall that the Gong and Wang (1999) method calculates the SAM as the difference between normalized zonal mean pressure between 40S and 65S (P40S − P65S). This is a gridded dataset, so you will need to select the two latitude bands, calculate the mean over all longitudes for each, and then subtract them. To subtract in iridl, load both datasets into your stack, and then add “sub” at the end. [Sub](http://iridl.ldeo.columbia.edu/dochelp/Documentation/details/index.html?func=sub). **Plot this timeseries.**

**note: First it’s a good idea to calculate anomalies (yearly-anomalies) before subtracting. Also - you’ll need to calculate the yearly anomalies before you calculate the seasonalAverage, or it will give you a weird result.**

* 1. Calculate your own SAM index from EOF analysis of the SLP ***anomalies*** south of 20S (i.e. 20S-90S). [Note: make sure you calculate the anomalies and seasonal averages as in (a) before performing the EOF analysis]. Recall that the SAM is the dominant mode of climate variability in the Southern Hemisphere, so the first EOF will show the SAM pattern. (Check this by looking at the map of EOF1 before grabbing the .Ts variable below). Remember that you can find the first principle component (PC1) associated with the EOF1 using the commands:

{Y cosd}[X Y][T]svd %This line performs EOF analysis

 .Ts % This line grabs the variable Ts that contains the PCs

 ev 1 VALUES % This line grabs the first PC values

Again, the first step weights by latitude, and does svd (EOF), the second selects the timeseries, and the third selects only the first PC.

Now look at the timeseries, is it oriented the right way? (The orientation of PCs is semi-random) If not, multiply it by -1 **and then plot this timeseries**

* 1. **Make a scatterplot between these two SAM indices from (a) and (b) and calculate the correlation coefficient.** Recall the commands: [fig: scatter :fig](http://iridl.ldeo.columbia.edu/dochelp/Tutorial/MVD/Visualization/#EX3) and [T]correlate for this. How similar are the SAM indices calculated from these two different approaches?
	2. **Correlate these two SAM indices with** [this precipitation dataset](http://iridl.ldeo.columbia.edu/expert/SOURCES/.UEA/.CRU/.TS3p21/.monthly/.pre/) and [this temperature dataset](http://iridl.ldeo.columbia.edu/SOURCES/.UEA/.CRU/.TS3p21/.monthly/.tmp/) to look at austral winter SAM teleconnections (as in DE3). [Again, make sure you restrict the time range and calculate the seasonal averages first, as you’ve done for the SAM indices]. Use appropriate/intuitive color scales for the precipitation (brown to green, as in DE3) and temperature (blue to red) correlations. **Zoom into Australia** and save the plot and color bar.
	3. **Describe the similarities and differences between the teleconnection patterns in Australia for these two SAM indices. Did you expect these differences based on the correlation you found between the indices? Explain what’s driving these patterns. What are the implications of these results for interpreting teleconnections from different indices.**
1. Compare the teleconnections of the NAO and the AO/NAM
	1. Calculate your own annual NAO index using [this dataset](http://iridl.ldeo.columbia.edu/expert/SOURCES/.NOAA/.NCEP-NCAR/.CDAS-1/.MONTHLY/.Intrinsic/.MSL/.pressure/%28mb%29unitconvert/). Remember NAO is defined as the pressure difference anomaly between Portugal and Iceland. This is a gridded dataset, so you will need to select the two areas, calculate the mean over each area, and then subtract them. To subtract in iridl, load both datasets into your stack, and then add “sub” at the end. [Sub](http://iridl.ldeo.columbia.edu/dochelp/Documentation/details/index.html?func=sub). **Plot this timeseries.**

**note: First it’s a good idea to calculate anomalies (yearly-anomalies) before subtracting. Also - you’ll need to calculate the yearly anomalies before you calculate the seasonalAverage, or it will give you a weird result.**

* 1. **Make a scatter plot** between this dataset, and the [“official” NAO index](http://iridl.ldeo.columbia.edu/expert/SOURCES/.Indices/.nao/.slp/), (you **will not** have to apply the seasonalAverage to this official index, as it’s already averaged from Dec-Mar) and **calculate the correlation coefficient.** You’ll need to make sure the two have the same time range (1950 to 1994).
	2. Now use your NAO index to **calculate a correlation map** with [this precipitation dataset](http://iridl.ldeo.columbia.edu/expert/SOURCES/.UEA/.CRU/.TS3p21/.monthly/.pre/) and [this temperature dataset](http://iridl.ldeo.columbia.edu/SOURCES/.UEA/.CRU/.TS3p21/.monthly/.tmp/) over Northern Europe and Alaska (so, 4 maps). Again, use appropriate/intuitive color scales for the precipitation (brown to green) and temperature (blue to red) correlations.
1. Now calculate the NAM/AO.
	1. Remember that the NAM is defined as the first principal component of Sea-level pressures north of 20N. So use [this dataset](http://iridl.ldeo.columbia.edu/expert/SOURCES/.NOAA/.NCEP-NCAR/.CDAS-1/.MONTHLY/.Intrinsic/.MSL/.pressure/%28mb%29unitconvert/) again, restrict the ranges, calculate seasonal averages and anomalies, then add the following code to calculate the first PC timeseries:

**NOTE: You must calculate EOFs on datasets with a mean of zero. The easiest way to do this is to do a “yearly-anomalies” before you do the EOF - then calculate the seasonalAverage afterwards.**

 *{Y cosd}[X Y][T]svd*

 *.Ts*

 *ev 1 VALUES*

Again, the first step weights by latitude, and does svd (EOF), the second selects the timeseries, and the third selects only the first PC.

 b. Now look at the timeseries, is it oriented the right way? (The orientation of PCs is semi-random) If not, multiply it by -1 **and then plot this timeseries**

c. **Make a scatter plot** between this dataset, and the [“official” NAO index](http://iridl.ldeo.columbia.edu/expert/SOURCES/.Indices/.nao/.slp/), and **calculate the correlation coefficient**.

d. Now **calculate four more correlation maps** over the same region as in 2c. Again, use appropriate/intuitive color scales for the precipitation (brown to green) and temperature (blue to red) correlations.

4. **In 3-4 sentences, compare and contrast how the teleconnections in Europe and Alaska differs between the NAO and NAM/AO.**

**Deliverables:**

**1. 4 time series figures of the indices you calculated (2x SAM, NAO, NAM/AO)**

**2. 3 Scatter plots and correlation coefficients,**

1. **between your two SAM indices**
2. **between your NAO and “official” NAO.**
3. **between your NAM and the “official” NAO**

**3. 12 correlation maps (SAM 2 indices \* 2 correlation targets (T and P); NAO/NAM: 2 indices \* 2 correlation targets (T and P) \* 2 regions (AK and Europe))**

**4. Short answer to 1e & 4 (in blue)**