

The Maximum Covariance Analysis (MCA) and Plots

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The data for the analysis is in the file: **JJA_median_SITE_snow_melt.csv**

The data frame has dimension 392 by 15 (392 obs. of 15 variables).

There are 11 sites and measurements for June, July, August for a total 119-site-years (see paper for more details).

The analysis in the paper and plots are produced following the code by Marc in the box.

Code is from: <http://menugget.blogspot.com/2011/12/maximum-covariance-analysis-mca.html>

and <http://menugget.blogspot.com/2011/11/empirical-orthogonal-function-eof.html>

There are two R functions that are needed and are named **eof.mca** and **cov4gappy** and can be found in the file: **mca_functions_code.r**

The goal of the MCA is to find patterns in two space-time datasets that are highly correlated using the cross-covariance matrix. For this analysis the setup is to have fields where columns are spatial locations and rows are temporal measurements. For an MCA, the row dimension of the two fields must be identical, but the columns can be different.

The R code to produce the plots will construct the two MCA matrices of interest and plot the scaled mode 1 and give the squared covariance fraction of the mode.

The 19 sites have different years of measurements of variables, so the R code constructs matrices with temporal row measurements that have the correct dimension by filling in NA for missing values. At the end of each function, the eof.mca function is called with two fields and the results are plotted.

Below are the three figures, followed by and corresponding R code needed to produce the plots.

1. Figure 3 | Maximum covariance analysis (MCA) for the June, July, and August monthly median of the indicated anomalies.

The R source file: **SM_med_JJA_MA.R**

Has the following lines of code:

- 1) `source("/Users/bbailey/Desktop/Dona/mca_functions_code.r")`
- 2) `source("/Users/bbailey/Desktop/Dona/Dona_Allsites_GPP_med_June_SM.R")`
- 3) `source("/Users/bbailey/Desktop/Dona/Dona_Allsites_GPP_med_July_SM.R")`
- 4) `source("/Users/bbailey/Desktop/Dona/Dona_Allsites_GPP_med_Aug_SM.R")`
- 5) `source("/Users/bbailey/Desktop/Dona/Dona_Allsites_ER_med_June_SM.R")`

- 6) `source("/Users/bbailey/Desktop/Dona/Dona_Allsites_ER_med_July_SM.R")`
- 7) `source("/Users/bbailey/Desktop/Dona/Dona_Allsites_ER_med_Aug_SM.R")`
- 8) `source("/Users/bbailey/Desktop/Dona/Dona_Allsites_NEE_med_June_SM.R")`
- 9) `source("/Users/bbailey/Desktop/Dona/Dona_Allsites_NEE_med_July_SM.R")`
- 10) `source("/Users/bbailey/Desktop/Dona/Dona_Allsites_NEE_med_Aug_SM.R")`

The ten files above:

1. Sources the two functions `eof.mca` and `cov4gappy`

2-10. The 9 files will make the panel of 3x3 plots in Figure 3.

The first line of the code in each of 2-10 has the path to the dataset

`JJA_median_SITE_snow_melt.csv`

It is currently set to `/Users/bbailey/Desktop/Dona/JJA_median_SITE_snow_melt.csv`

The MODE is set to 1 for all Figures.

2. Fig. S3-S5 each have a panel of 7x3 plots.

The R source file: `All_med_JJA_MA.R`

and will produce three pdfs one for each of Fig. S3, Fig. S4, and Fig S5.

The R source file has the following lines of code, given below each Figure that produces each figure.

Fig. S3 | Maximum covariance analysis (MCA) for the monthly median of the indicated anomalies and GPP, NEE, and ER in June.

- 1) `source("/Users/bbailey/Desktop/Dona/Dona_Allsites_GPP_med_June_MA.R")`
- 2) `source("/Users/bbailey/Desktop/Dona/Dona_Allsites_ER_med_June_MA.R")`
- 3) `source("/Users/bbailey/Desktop/Dona/Dona_Allsites_NEE_med_June_MA.R")`

Fig. S4 | Maximum covariance analysis (MCA) for the monthly median of the indicated anomalies and GPP, NEE, and ER in July.

- 4) `source("/Users/bbailey/Desktop/Dona/Dona_Allsites_GPP_med_July_MA.R")`
- 5) `source("/Users/bbailey/Desktop/Dona/Dona_Allsites_ER_med_July_MA.R")`
- 6) `source("/Users/bbailey/Desktop/Dona/Dona_Allsites_NEE_med_July_MA.R")`

Fig. S5 | Maximum covariance analysis (MCA) for the monthly median of the indicated anomalies and GPP, NEE, and ER in August.

- 7) `source("/Users/bbailey/Desktop/Dona/Dona_Allsites_GPP_med_Aug_MA.R")`
- 8) `source("/Users/bbailey/Desktop/Dona/Dona_Allsites_ER_med_Aug_MA.R")`
- 9) `source("/Users/bbailey/Desktop/Dona/Dona_Allsites_NEE_med_Aug_MA.R")`