Training Workshop on Environment Statistics
Damascus, 4-8 April 2004

Applied Multivariate analysis on Precipitation and Temperature data (Barada and Awaj Basin)

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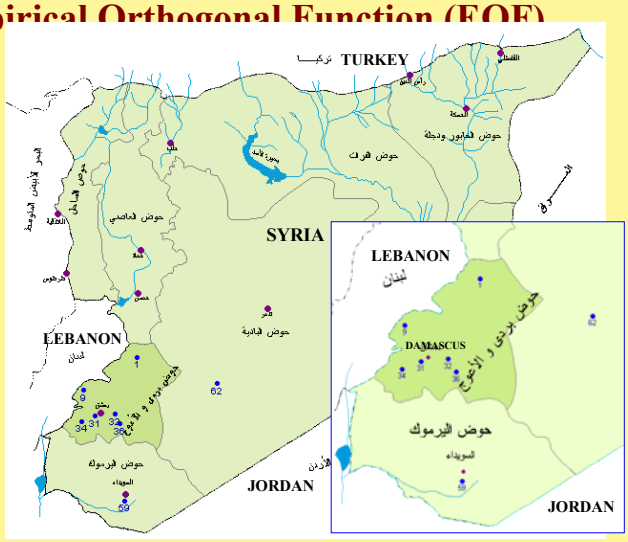
April 2004 , Damascus
From 4-8 April.

Principal Component Analysis (PCA)

Empirical Orthogonal Function (EOF)



Locations of climatic stations

Principal Component Analysis (PCA)

Precipitation

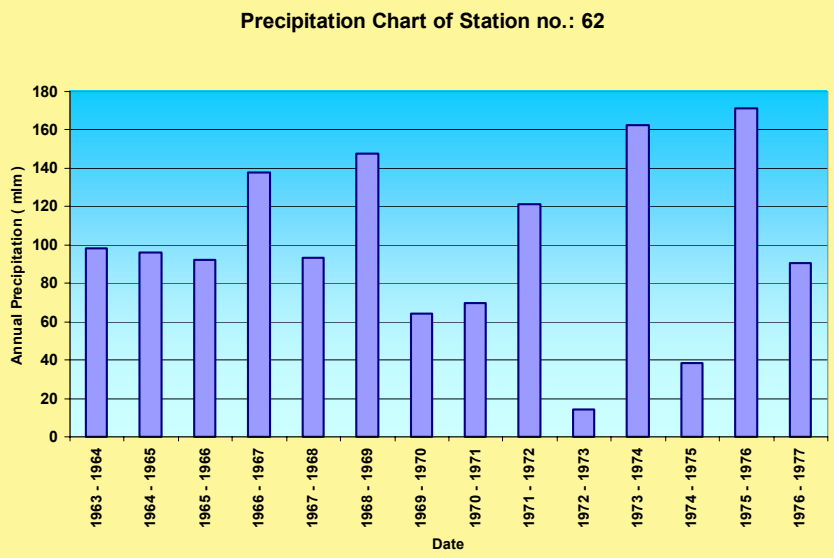
- The climate of the basin is classified as Mediterranean. It is characterized by wet cool winter and long hot dry summer.
- The principal meteorological factors which produce precipitation are cyclonic disturbances forming over the Mediterranean sea, or Atlantic ocean. In summer the subtropical region of the Azores anticyclone, establishes itself over the coastal area of the Mediterranean, thereby preventing the penetration of the cyclones from the sea into the Eastern Mediterranean region. In spring a low pressure area is formed resulting in the movement of the Khamasin wind system into Syria and adjacent areas.
- Precipitation varies over the Barada river basin from about 1000 mm. in the Zebdani highlands to about 100 mm in the eastern lowlands. It occur mainly from October to May. The period from December to February accounts for 45 to 65% of the annual precipitation. virtually no rain falls from June to September. The total amount of precipitation on the basin is 674 mm or 566 MCM (Million Cubic Meters). some 238 mm or 30 MCM on the average, fall on the Damascus plain (Selkhoprom export, 1987).

Principal Component Analysis (PCA)

Precipitation data between 1963 – 1976,For 8 Stations

sn	Year	month	1	31	32	34	36	59	62	9
1	1963	11	3,5	11,5	4,6	11	13,3	36,6	6	36,5
2	1963	12	60	40,1	27,8	33,5	22	62,3	26,9	79
3	1964	1	15,2	25,2	19	43	28,6	85,6	4,9	107,5
4	1964	2	23	76,7	67,3	123,5	43,6	108,5	6,3	177,5
5	1964	3	27,7	9	19,3	14,5	9	84,3	42,4	74,9
6	1964	4	1,5	9,4	20,2	10,5	24,2	34	5,9	21,1
7	1964	11	21,3	63,9	50,4	101	28,9	74,8	0,2	129,8
8	1964	12	10,3	36,4	28,6	42,5	21,1	54,1	32,4	25,2
9	1965	1	76,7	120,2	91,4	140,5	93,9	161,5	46,7	103
10	1965	2	16	35,7	25,2	62,5	21,6	34,6	4,8	133
11	1965	3	24,5	8,2	6,8	7	3,8	38,4	4,4	46,8
12	1965	4	20	9,6	7,7	16	7,1	46,3	6,6	47,5
⋮	⋮	⋮								⋮
79	1976	11	16,2	97,6	133,3	107	54,4	30,7	5,3	168
80	1976	12	7,5	21,3	8,3	34	11,2	26,3	3,1	74,7
81	1977	1	18,8	32,9	37,2	35	37,2	89,7	21,6	100,3
82	1977	2	4,1	11	8,6	23,5	10,7	20,4	1,6	44,6
83	1977	3	5	9,1	14,6	13,5	8,9	41,4	4,7	66,5
84	1977	4	23,4	32,7	33,7	36,1	35,7	82,7	46,6	69,3

Principal Component Analysis (PCA)



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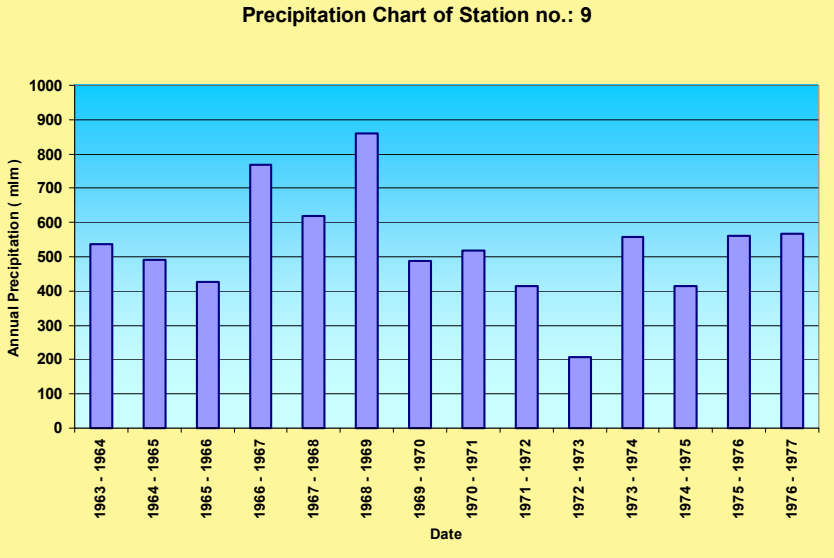
Multivariate analysis

Principal Component Analysis (PCA)



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Multivariate analysis

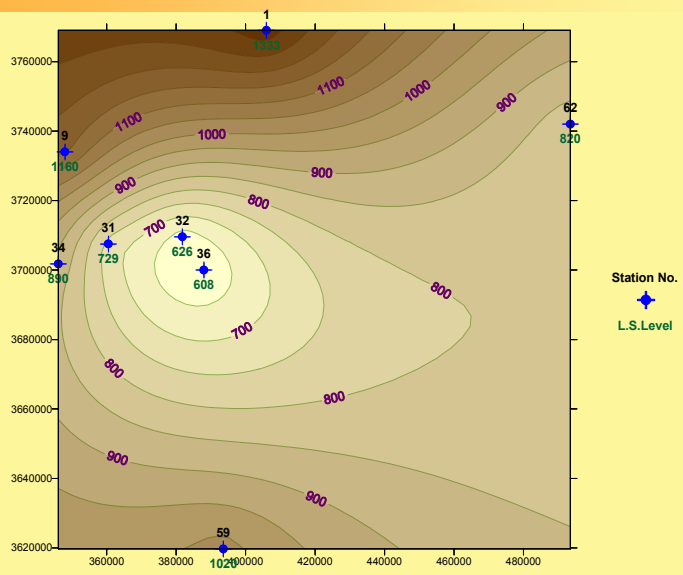
Principal Component Analysis (PCA)

The Eigenvectors for all modes and the percentage of the total variance in the observations , using PCA

Station no	X	Y	Level	67.48	14.95	7.37	3.79	3.27	1.44	1.21	0.49
				mod1	mod2	mod3	mod4	mod5	mod6	mod7	mod8
1	406000	3769000	1333	-0.28475	0.56258	0.08293	0.76706	0.06447	-0.04372	0.03315	-0.00029
31	360500	3707500	729	-0.41249	-0.12373	0.15923	-0.06915	0.14127	0.05753	-0.44705	-0.74919
32	381800	3709550	626	-0.38603	-0.04885	0.41926	-0.21950	0.19662	-0.70924	0.22718	0.17704
34	346100	3701750	890	-0.40269	-0.22228	0.09885	0.02857	0.17487	0.33198	-0.49174	0.62869
36	388000	3700000	608	-0.37722	0.07832	0.34676	-0.17159	-0.67045	0.37584	0.33314	-0.01207
59	393600	3619700	1020	-0.34445	-0.11478	-0.66398	0.05415	-0.48600	-0.39366	-0.17636	0.04584
62	493500	3742000	820	-0.24437	0.64117	-0.34900	-0.54124	0.29001	0.15898	0.06258	0.03398
9	348000	3734000	1160	-0.34195	-0.43127	-0.31512	0.18036	0.36992	0.24506	0.59969	-0.09340

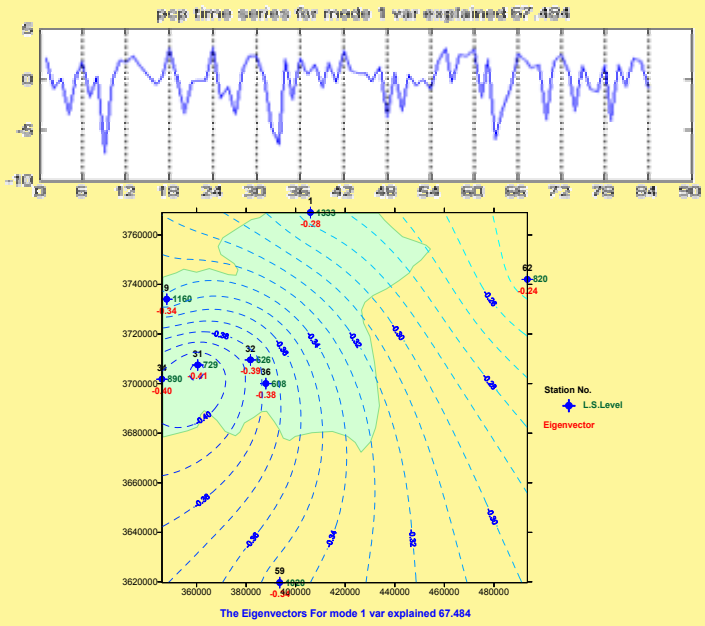
5 modes ➔ 96.8 %

Principal Component Analysis (PCA)



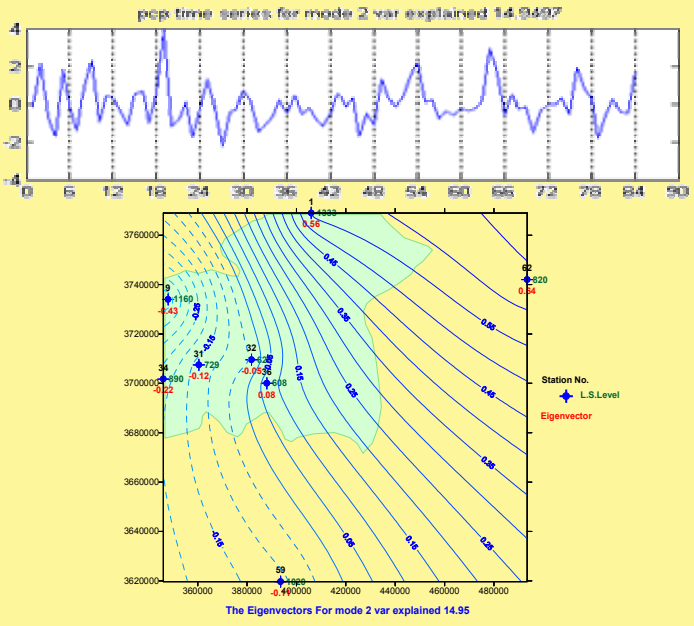
The Distribution of topographic levels

Principal Component Analysis (PCA)



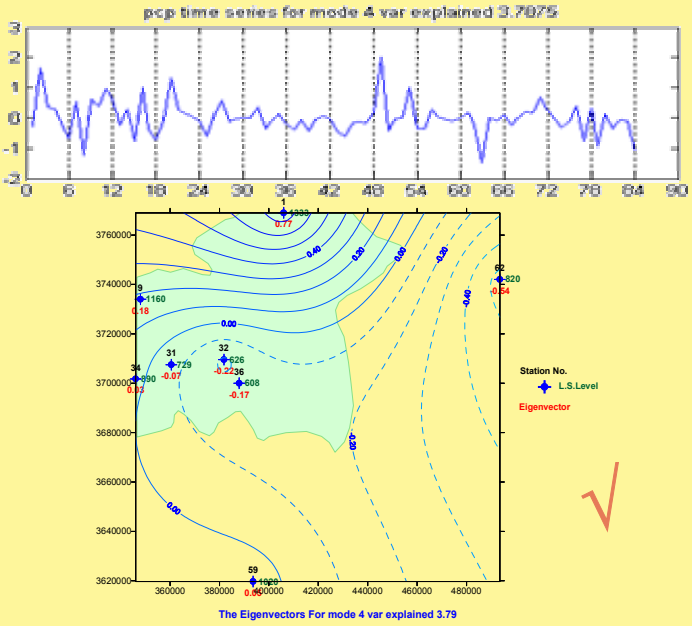
The Eigenvectors For mode 1 var explained 67.484

Principal Component Analysis (PCA)



The Eigenvectors For mode 2 var explained 14.95

Principal Component Analysis (PCA)



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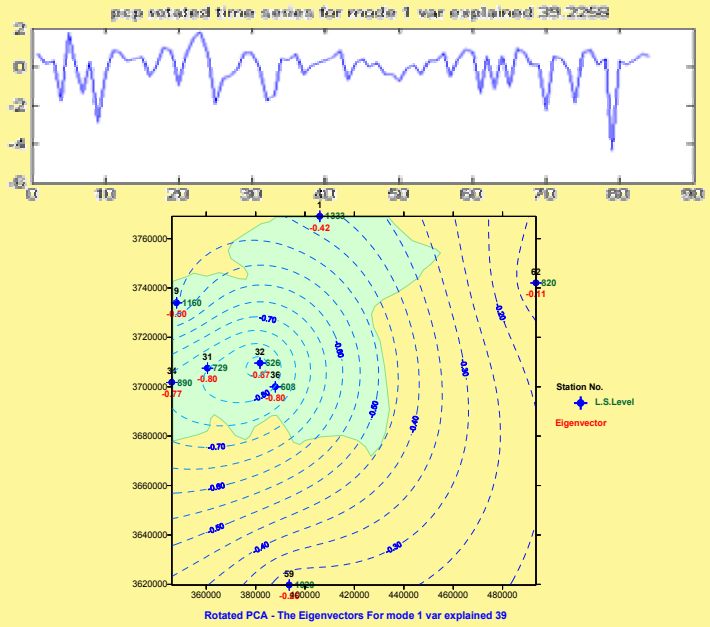
Rotated Principal Component Analysis (PCA)

The Eigenvectors for all modes and the percentage of the total variance in the observations, using Rotated PCA

Station no	X	Y	Level	39	27	24
				mod1	mod2	mod3
1	406000	3769000	1333	-0.41682	-0.04872	0.80262
31	360500	3707500	729	-0.79997	-0.49925	0.25028
32	381800	3709550	626	-0.87446	-0.28755	0.25239
34	346100	3701750	890	-0.77103	-0.56696	0.15613
36	388000	3700000	608	-0.79863	-0.25493	0.37907
59	393600	3619700	1020	-0.26214	-0.85763	0.33486
62	493500	3742000	820	-0.11288	-0.19535	0.91378
9	348000	3734000	1160	-0.49593	-0.81564	-0.03285

3 modes ➔ 90 %

Rotated Principal Component Analysis (PCA)



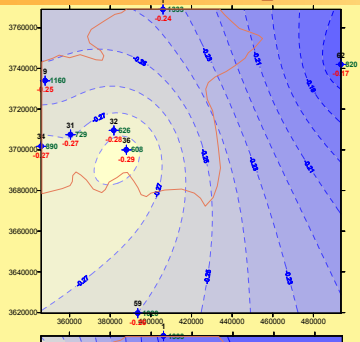
Rotated PCA - The Eigenvectors For mode 1 var explained 39

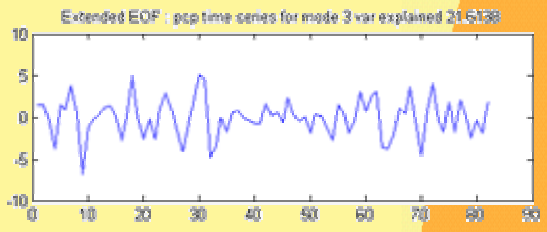
Extended Principal Component Analysis (PCA)

Station no	X	Y	Level	24.26	22.82	21.61	6.18	5.20	3.72	2.64
				mod1	mod2	mod3	mod4	mod5	mod6	mod7
1	406000	3769000	1333	-0.14386	0.09178	-0.23591	0.39580	-0.00791	-0.39160	0.05946
31	360500	3707500	729	-0.30203	0.06866	-0.26868	-0.06940	0.00881	0.06768	-0.08960
32	381800	3709550	626	-0.25591	0.06439	-0.27753	-0.02741	0.03075	-0.01467	-0.28171
34	346100	3701750	890	-0.28366	0.06900	-0.27396	-0.12253	0.03683	0.16786	-0.04629
36	388000	3700000	608	-0.24089	0.03737	-0.28586	0.05953	0.04051	-0.13339	-0.36468
59	393600	3619700	1020	-0.23088	-0.01066	-0.25993	-0.05303	-0.09413	0.14695	0.45740
62	493500	3742000	820	-0.14790	0.10812	-0.17167	0.47556	-0.20982	-0.30013	0.26279
9	348000	3734000	1160	-0.23586	0.01231	-0.25146	-0.25572	0.08094	0.35567	0.20354
1	406000	3769000	1333	0.02214	0.28565	0.03373	0.08876	-0.49978	0.22150	-0.20029
31	360500	3707500	729	0.10595	0.39531	0.00706	-0.04144	0.10995	-0.07115	-0.00644
32	381800	3709550	626	0.10233	0.36791	0.02286	-0.00657	0.04905	-0.07030	-0.01383
34	346100	3701750	890	0.08634	0.38918	-0.00558	-0.05691	0.21116	-0.03111	0.05499
36	388000	3700000	608	0.11924	0.35615	0.00660	0.04714	-0.07989	-0.01535	-0.01672
59	393600	3619700	1020	0.10074	0.32259	-0.06938	-0.11850	0.07972	0.09373	0.23783
62	493500	3742000	820	0.00379	0.25078	0.04464	-0.10833	-0.57990	0.17443	-0.10105
9	348000	3734000	1160	0.07445	0.32913	-0.06975	-0.05060	0.41093	-0.00705	0.10348
1	406000	3769000	1333	-0.22544	0.07698	0.17209	-0.34092	-0.17704	-0.40806	0.09771
31	360500	3707500	729	-0.27432	0.05453	0.29976	0.10565	0.04056	0.04209	0.08153
32	381800	3709550	626	-0.27939	0.04073	0.25733	0.06822	-0.01829	0.00214	0.27021
34	346100	3701750	890	-0.24930	0.06996	0.30851	0.16723	0.10202	0.06890	0.06709
36	388000	3700000	608	-0.27526	0.03127	0.25617	-0.10099	-0.06523	0.07048	0.20933
59	393600	3619700	1020	-0.26706	0.09074	0.18940	0.04278	0.18128	0.12775	-0.36713
62	493500	3742000	820	-0.19454	0.04498	0.13683	-0.45248	-0.01099	-0.46406	-0.15147
9	348000	3734000	1160	-0.20616	0.10537	0.25211	0.32349	0.16956	0.22024	-0.19457

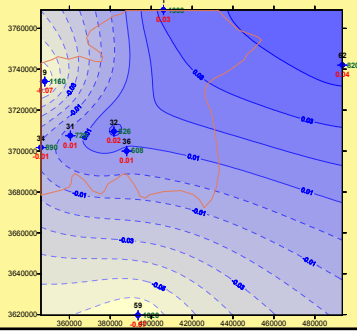
Extended Principal Component Analysis (PCA)

Nov

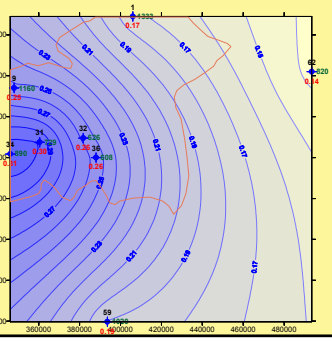




Dec



Jan



Mode 3

Var Exp. 21.61

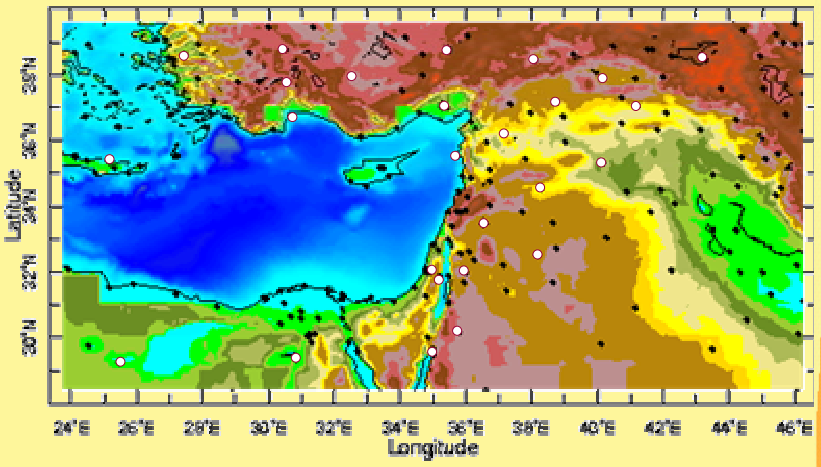
Principal Component Analysis (PCA)

The Eigenvectors for all modes and the percentage of the total variance in the observations , using PCA

Station no	X	Y	Level	67.48	14.95	7.37	3.79	3.27	1.44	1.21	0.49
				mod1	mod2	mod3	mod4	mod5	mod6	mod7	mod8
1	406000	3769000	1333	-0.28475	0.56258	0.08293	0.76706	0.06447	-0.04372	0.03315	-0.00029
31	360500	3707500	729	-0.41249	-0.12373	0.15923	-0.06915	0.14127	0.05753	-0.44705	-0.74919
32	381800	3709550	626	-0.38603	-0.04885	0.41926	-0.21950	0.19662	-0.70924	0.22718	0.17704
34	346100	3701750	890	-0.40269	-0.22228	0.09885	0.02857	0.17487	0.33198	-0.49174	0.62869
36	388000	3700000	608	-0.37722	0.07832	0.34676	-0.17159	-0.67045	0.37584	0.33314	-0.01207
59	393600	3619700	1020	-0.34445	-0.11478	-0.66398	0.05415	-0.48600	-0.39366	-0.17636	0.04584
62	493500	3742000	820	-0.24437	0.64117	-0.34900	-0.54124	0.29001	0.15898	0.06258	0.03398
9	348000	3734000	1160	-0.34195	-0.43127	-0.31512	0.18036	0.36992	0.24506	0.59969	-0.09340

5 modes ➔ 96.8 %

Canonical Correlation Analysis (CCA)



NOAA NCDC GCPC

Canonical Correlation Analysis (CCA)

sn	Year	month	1	2	3	4	5	6	… …	25	26
1	1963	11	16,9	4,7	7,5	5,9	8,7	15,1	… …	19,6	17,7
2	1963	12	15,4	-1,0	3,0	0,9	1,8	11,7		15,6	14,4
3	1964	1	10,7	-9,5	-4,3	-7,0	-5,5	5,4		12,1	11,3
4	1964	2	11,5	-5,2	-0,8	-1,3	-0,4	8,0		13,6	13,4
5	1964	3	14,2	1,5	6,0	6,6	6,4	11,5		18,2	18,4
6	1964	4	16,1	4,8	9,1	9,6	12,4	15,8		20,0	21,6
7	1964	11	16,9	4,1	5,9	6,5	8,1	14,3		19,0	15,6
8	1964	12	14,5	-3,1	3,7	2,8	2,1	11,7		15,3	14,7
9	1965	1	12,1	-7,1	0,6	-0,9	-0,5	8,9		13,2	12,8
10	1965	2	11,6	-5,3	-0,5	0,9	0,7	7,8		15,1	13,6
11	1965	3	13,7	0,2	6,0	6,8	6,8	11,6		18,8	17,3
12	1965	4	16,3	5,7	9,2	10,0	11,5	14,5	… …	21,2	20,7
⋮	⋮	⋮	⋮								⋮
79	1976	11	16,4	3,6	8,0	5,6	8,8	13,6	… …	21,8	17,4
80	1976	12	13,7	1,4	2,3	0,4	2,7	9,9		15,2	13,1
81	1977	1	12,3	-4,8	0,2	-4,1	-1,5	9,1		13,4	11,7
82	1977	2	14,5	-0,4	6,1	4,5	5,5	12,5		16,7	14,3
83	1977	3	13,5	3,1	5,1	3,9	6,9	11,5		16,3	15,7
84	1977	4	16,2	8,0	9,9	10,1	13,0	15,9	… …	21,1	21,0

Temperature of 26 station between 1963-1977

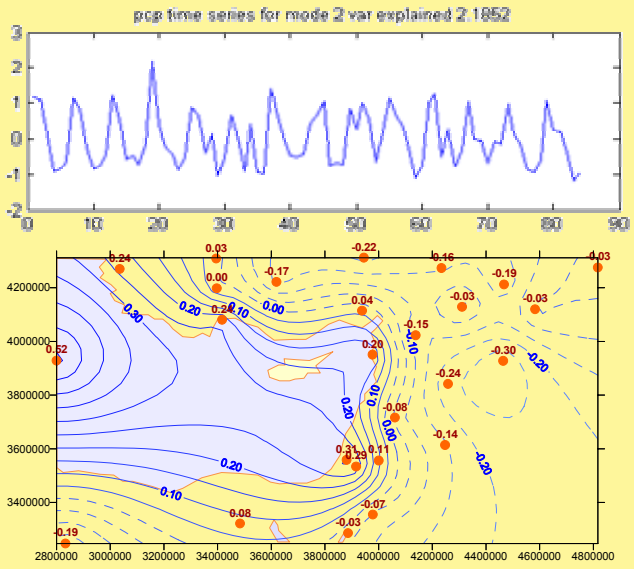
Canonical Correlation Analysis (CCA)

The Eigenvectors for all modes and the percentage of the total variance in the observations , using PCA

Station no	X	Y	93.53	2.19	1.18	0.86	0.52
			mod1	mod2	mod3	mod4	mod5
1	2799891	3928521	-0.18281	0.51655	0.08093	0.11172	0.21081
2	4816970	4275450	-0.19392	-0.02840	0.28764	-0.25909	0.18811
3	3394785	4308808	-0.19693	0.02585	0.15290	0.37069	-0.13722
4	3945200	4312144	-0.19340	-0.21990	0.21105	0.26432	-0.27327
5	4234308	4273226	-0.19728	-0.15720	0.26857	-0.00131	0.13059
6	3035625	4269890	-0.19433	0.23753	0.08610	0.35718	0.02854
7	3397009	4197613	-0.19834	0.00487	0.06941	0.34085	-0.08467
8	3619399	4222076	-0.19660	-0.16747	0.13874	0.30112	-0.13565
9	4311032	4128672	-0.20062	-0.02859	0.12737	-0.12975	0.15408
10	4467817	4212069	-0.19614	-0.18781	0.24849	-0.18569	0.18918

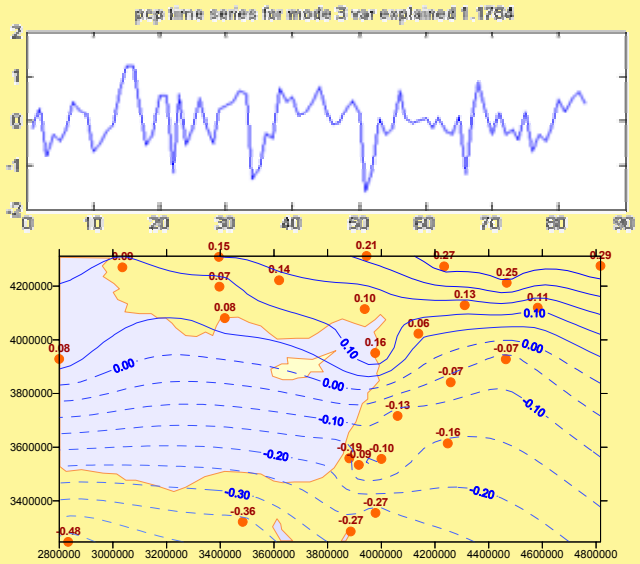
5 modes ➔ 98.3 %

Canonical Correlation Analysis (CCA)



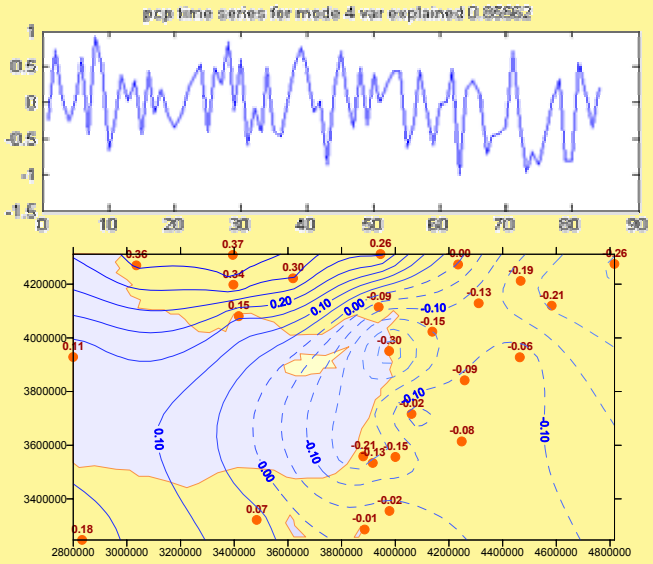
The Eigenvectors For mode 2 var explained 2.19 of monthly Temperature

Canonical Correlation Analysis (CCA)

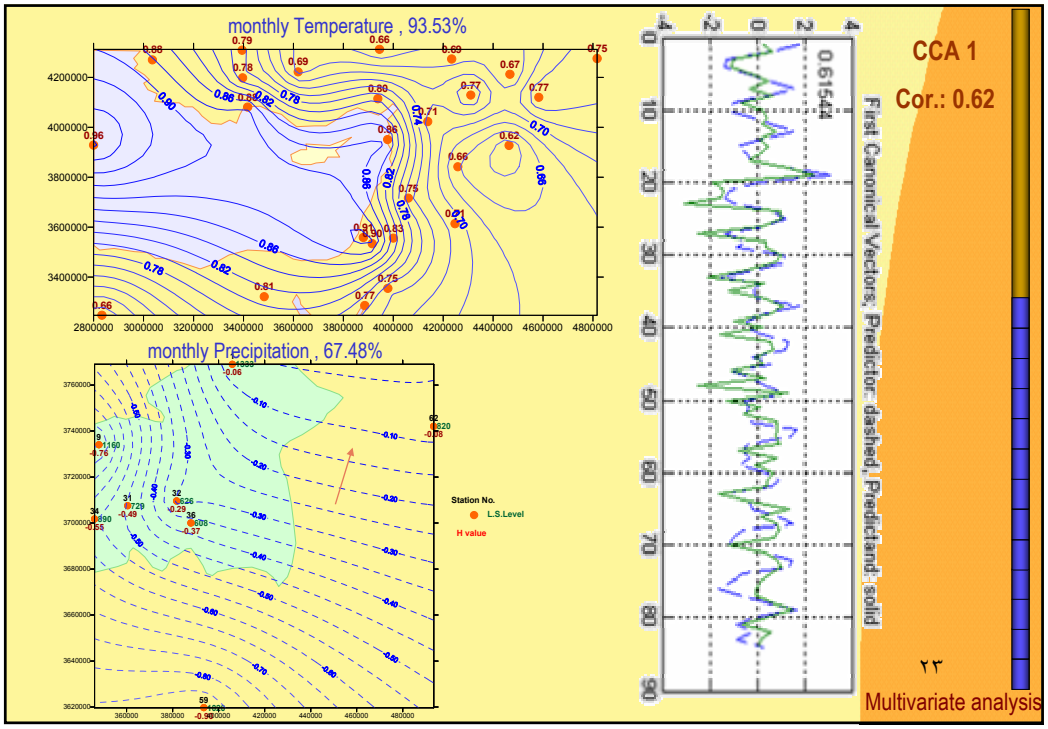


The Eigenvectors For mode 3 var explained 1.18 of monthly Temperature

Canonical Correlation Analysis (CCA)



The Eigenvectors For mode 4 var explained 0.86 of monthly Temperature


monthly Temperature , 93.53%
monthly Precipitation , 67.48%
Station No.
L.S.Level
H value
CCA 1
Cor.: 0.62
0.61544
First Canonical Vectors; Predictor: dashed, Predictand: solid
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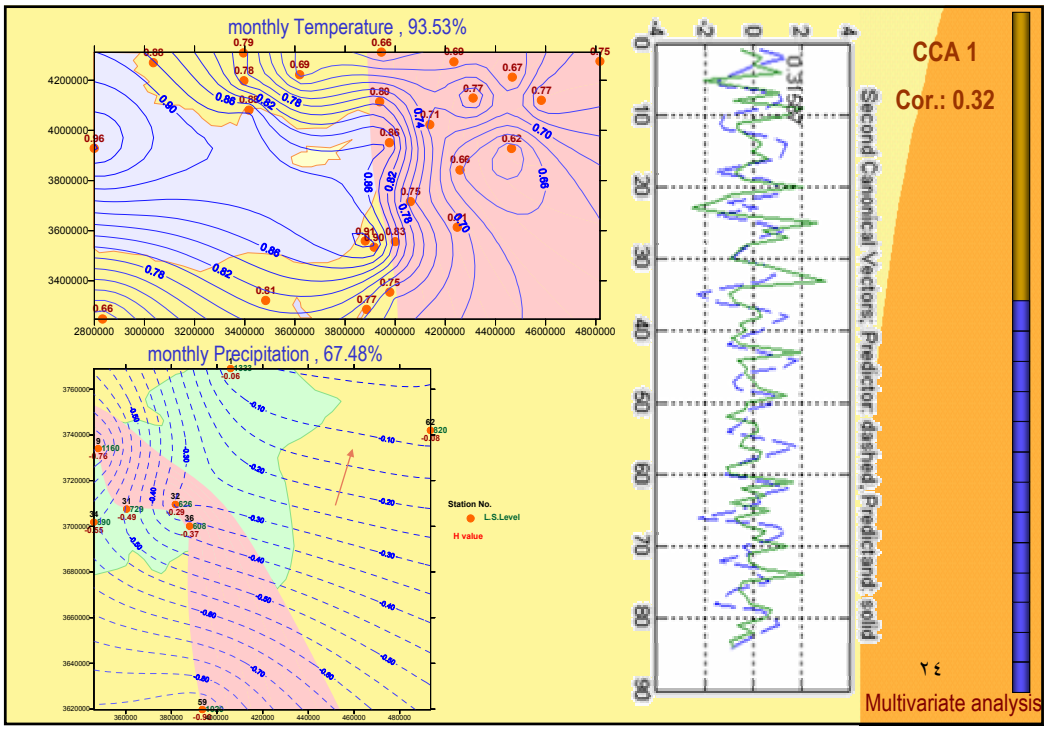
Multivariate analysis


monthly Temperature , 93.53%
monthly Precipitation , 67.48%
Station No.
L.S.Level
H value
CCA 1
Cor.: 0.32
0.31587
Second Canonical Vectors; Predictor: dashed, Predictand: solid
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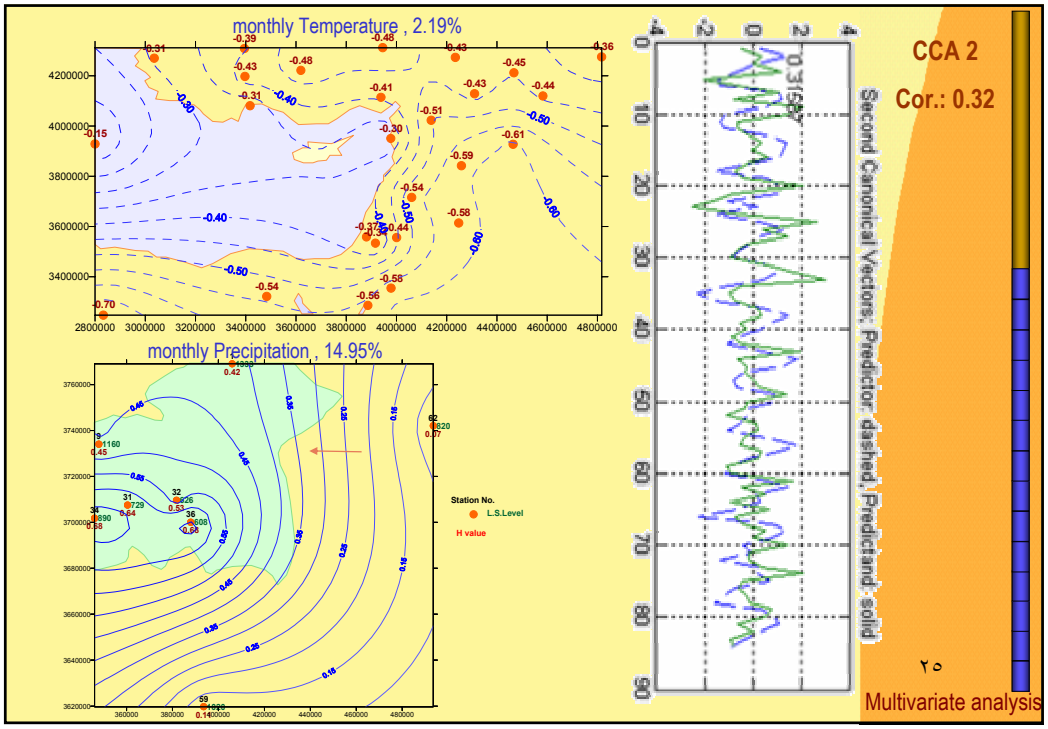
Multivariate analysis


monthly Temperature , 2.19%
monthly Precipitation , 14.95%
Station No.
L.S.Level
H value
CCA 2
Cor.: 0.32
Second Canonical Vectors; Predictor: dashed, Predictand: solid
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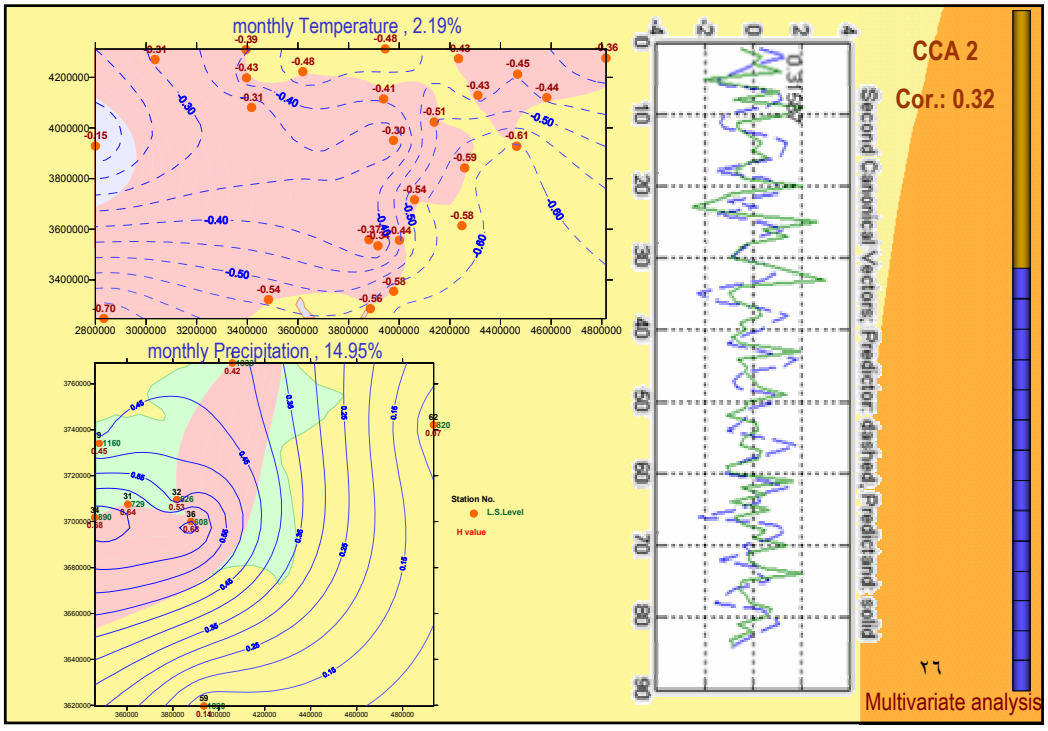
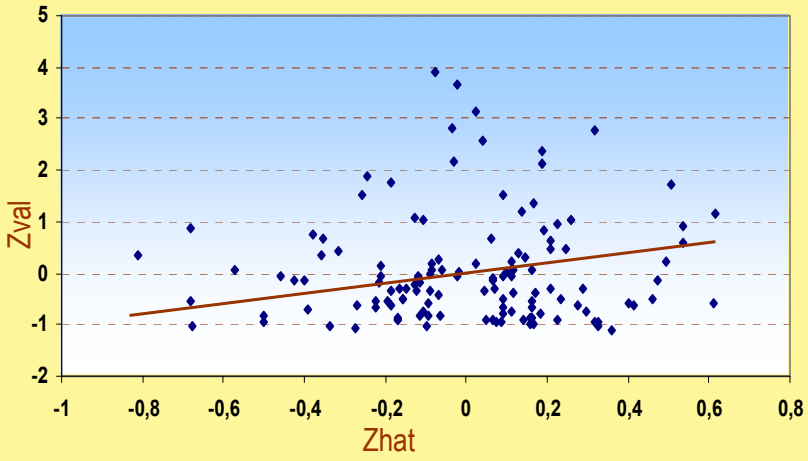
Multivariate analysis

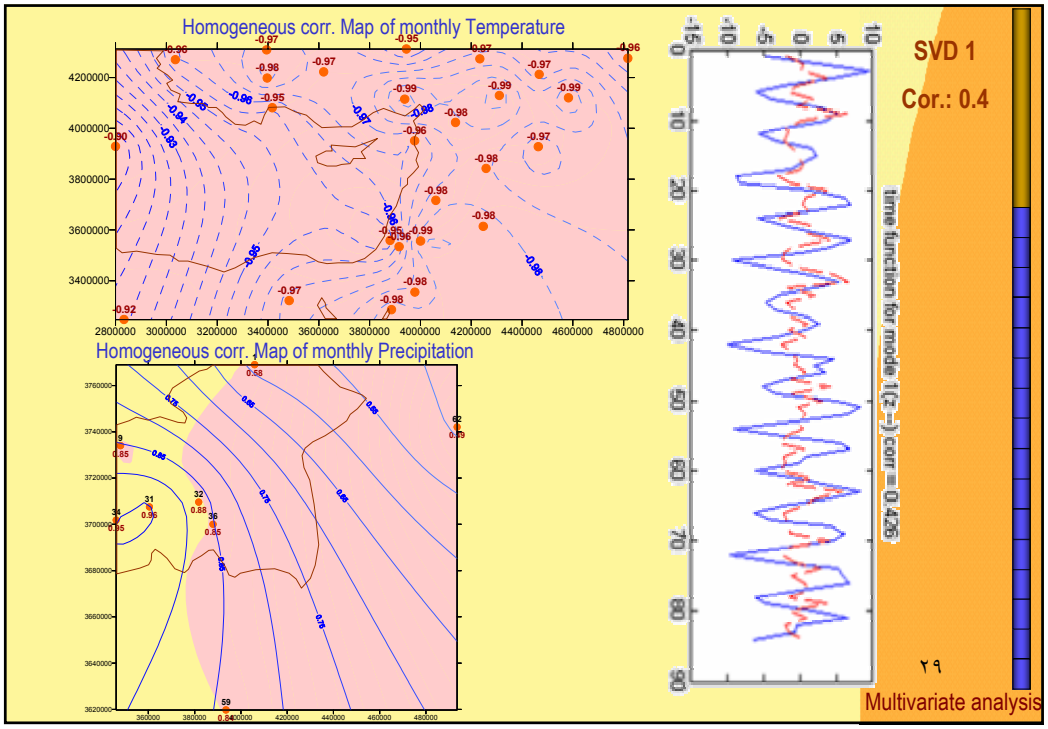

monthly Temperature , 2.19%
monthly Precipitation , 14.95%
Station No.
L.S.Level
H value
CCA 2
Cor.: 0.32
Second Canonical Vectors; Predictor: dashed, Predictand: solid
٢٦
Multivariate analysis

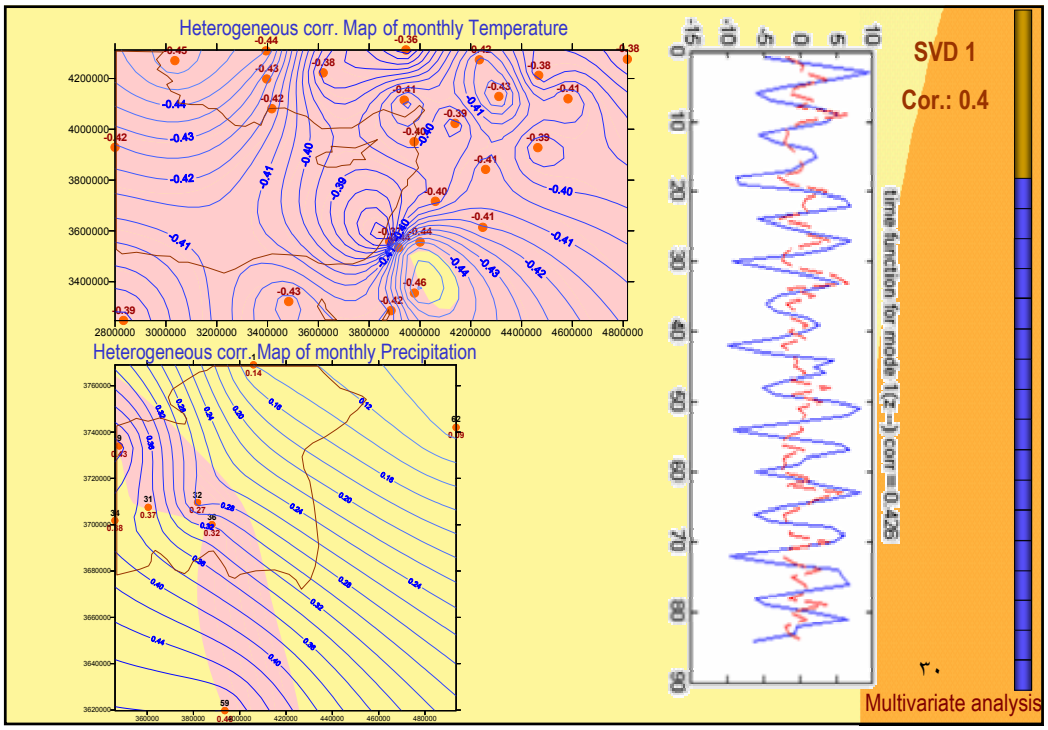
Canonical Correlation Analysis (CCA)



Corr : 0.0645

Singular Value Decomposition (SVD)


Homogeneous corr. Map of monthly Temperature
Homogeneous corr. Map of monthly Precipitation
SVD 1
Cor.: 0.4
time function for mode 1(z-j) corr = 0.426
٢٩
Multivariate analysis


Heterogeneous corr. Map of monthly Temperature
Heterogeneous corr. Map of monthly Precipitation
SVD 1
Cor.: 0.4
time function for mode 1(z-j) corr = 0.426
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Multivariate analysis

Thank you…