

XIIIth Bulgarian-Serbian Astronomical Conference
3-7 October 2022, Velingrad, Bulgaria

Analysis of meteorological observations for Bulgaria (1905-2022)

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Meteorological data

- Sources: Statistical year-book and the National Institute of Meteorology and Hydrology
- Time period 1905 - 2022
- 37 meteo-stations
- 193 time series
- 67621 monthly averaged values
- Temperature, atmospheric pressure, cloudiness, precipitation, humidity

Станция	брой средномесечни стойности
Банско	347
Берковица	239
Бургас	4271
Варна	4719
Велико Търново	1560
Видин	2483
Враца	1919
Габрово	582
Горна Оряховица	1200
Добрич	720
Казанлък	4105
Карнобат	838
Кнежа	581
Кърджали	600
Кюстендил	2639
Левски град	120
Лом	2998
Мусала	2291
Ново Село	1139
Образцов Чифлик, Русе	1476
Павликени	599
Пазарджик	720
Плевен	4236
Пловдив	2859
Радомир	479
Русе	2040
с. Рила	1078
Садово	1443
Сандански	2758
Силистра	1919
София	5012
Хасково	2784
Черни Врѳх	1151
Чирпан	720
Шумен	3004
Юмрук Чал	287
Ямбол	1345
Общо	67261

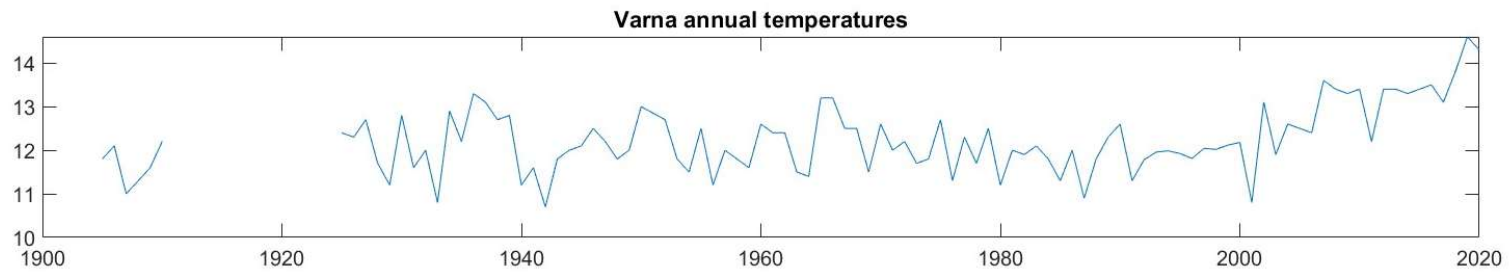
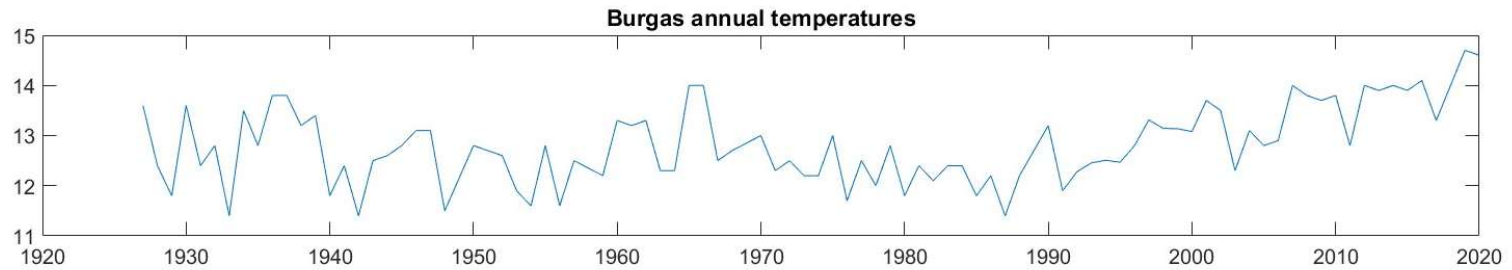
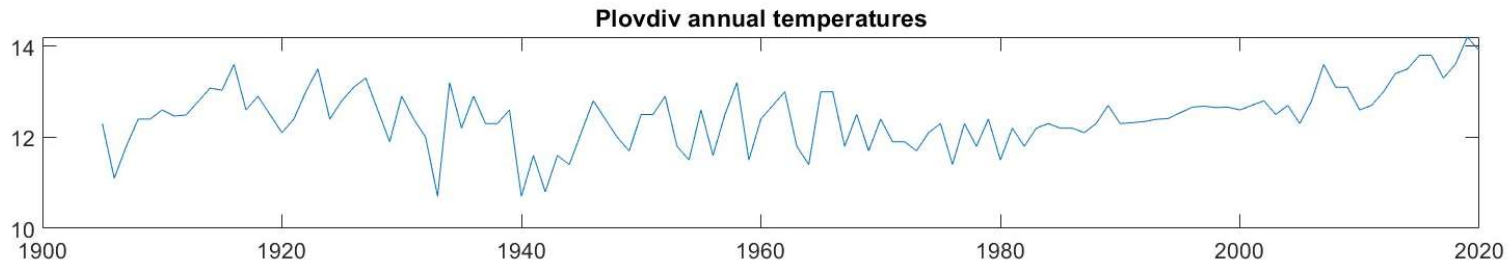
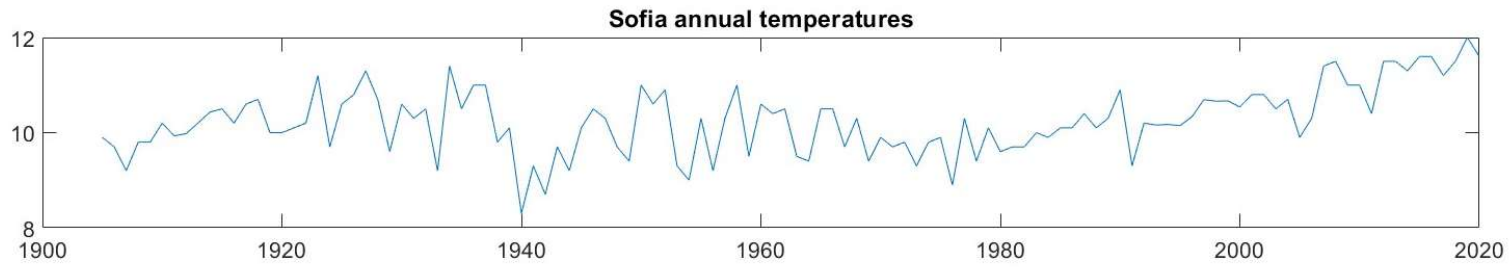
Data preparation

- Download of scanned images of statistical yearbook, stored in pdf format, from the digital library of the National Statistical Institute
- Optical character recognition using “gimageReader” and “tesseract OCR engine”
- Consolidation of the data in CSV-forma following the table structure of the statistical yearbook
- Reconstruction and aggregation of the time series for each meteo-station and measure, using scripts developed in “Python”, “Anaconda”, “Pandas”
- Data correction – work in progress

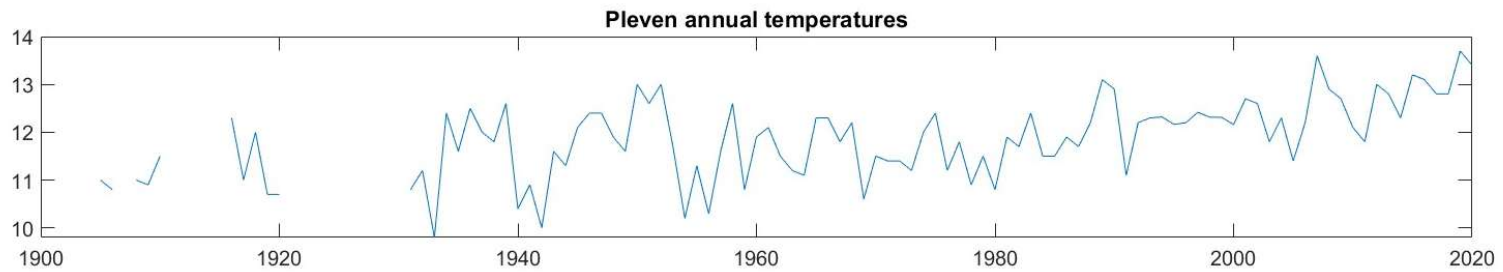
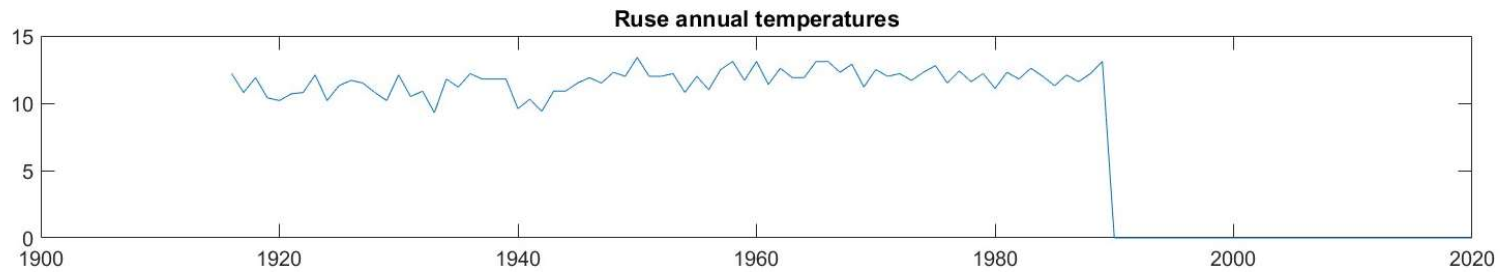
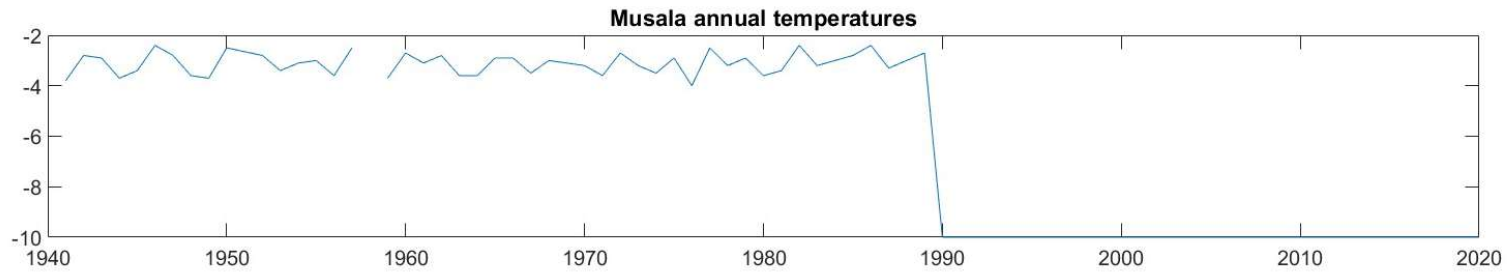
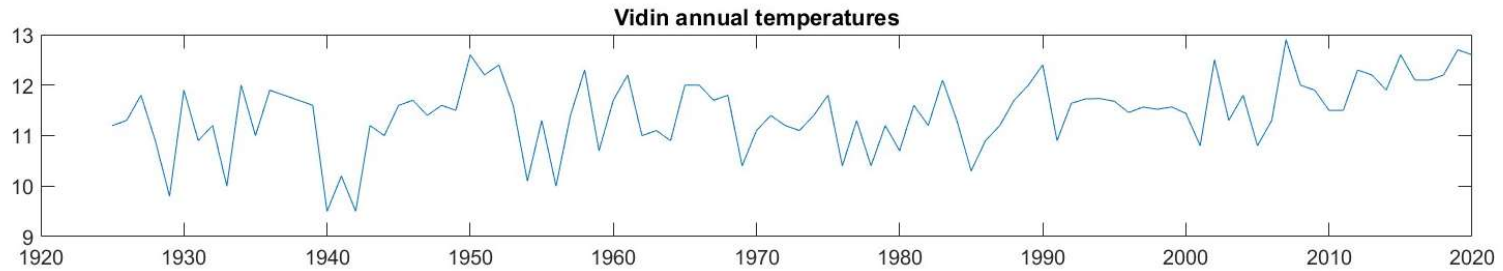
Sample of processed meteo-data in comma separated value (CSV) format

година_месец	Бургас					Мусала					Плевен					
	облачна покривка	влажност	валежи	атм. налягане	температура	облачна покривка	влажност	валежи	атм. налягане	греене слънчево	температура	облачна покривка	влажност	валежи	атм. налягане	температура
1942_january	8	84	70	762.1	-5.3	7.4	84	150.1	523.3	77.6	-14.7	7.3	78	72.6	747.1	-10.1
1942_february	9.7	88	16.3	762.6	0.8	7.6	86	67.9	526.7	93.5	-9.7	8.9	86	32.3	747.6	-3.8
1942_march	7.4	80	67.9	765.1	2.9	7.9	86	84.4	530.3	139.5	-7.2	7.4	83	56.3	749.8	0.7
1942_april	7.5	78	21.7	762.2	9.1	8.7	88	230	531.4	106.2	-5.7	7	76	43.3	746.3	10.3
1942_may	5.6	73	36.1	760.8	16.8	7.3	84	129.3	535.9	208.6	-0.3	4.7	61	27.2	746	19.3
1942_june	4.9	71	53	760	22	6.8	76	79.1	537.9	227.3	4.2	6	69	140.6	745.8	21.4
1942_july	3.6	72	41.6	761.5	22.4	5.2	77	92.6	539	296.3	5.2	3.1	61	43.3	7468	22.5
1942_august	4.4	67	0	761.6	22.9	5.6	75	39.5	539.6	248.8	5	4.1	54	6.1	747.9	22.8
1942_september	3.6	73	5.5	763.7	20	4.9	70	21.7	540.1	243.9	3.7	2.6	56	4.6	749.2	20.7
1942_october	5.6	74	32.2	764	14.5	4.7	76	48.7	536.3	183.1	-1.7	4.7	70	29.5	750.1	12.6
1942_november	7.3	79	58.5	763.5	6.7	6.1	79	176.7	531.5	125.5	-6.3	7.5	86	66.7	749.3	3.6
1942_december	7.2	83	8	768.9	3.7	4.8	86	11.7	535	172.9	-6.1	8.6	91	13	754.1	-0.5
1943_january	7.8	8	51.6	762.3	-0.6	6	8.1	158.8	526.3	121.8	-12.4	6.5	7.8	71.6	748	-5
1943_february	5.9	7.7	9.3	768	3.2	4.3	6.8	42.2	533	178.7	-9.9	4.9	7.8	2	753	1.8
1943_march	7.4	7.3	7.4	767.6	4.4	5.5	6.2	16.2	532.1	212.1	-9.2	5.5	6.1	1.2	752.8	4.7
1943_april	5.3	7	26.4	763	10.5	6.9	8.2	147.3	533.7	152	-5.4	5.8	5.6	42.5	748.6	13
1943_may	6.7	7.1	89.1	760.8	15.2	8	8.8	242.9	534.4	158.2	-2.4	6.9	7.2	135.3	746.9	15.1
1943_june	5.6	7.5	87.7	761.5	19.5	7.5	9.1	208.6	537.3	158.8	1	5.8	7.2	131.6	747.4	19.1
1943_july	3.6	7	23.5	759.4	22.3	6.2	8.3	73.3	538.2	239.3	4.2	3.7	5.5	29.7	745.4	22.8
1943_august	2	7.4	8.3	761.6	23.3	4.5	7.7	51.9	540.6	285.7	6.7	2.7	5.3	4.7	747.4	24.5
1943_september	4.5	7.8	29.5	762.9	20	5.4	7.9	43.4	540.1	240.1	4.8	4.2	6.3	45.4	748.2	20.6
1943_october	7.2	8	24.8	765.7	14.8	5.2	7.2	71.2	538.1	213.4	0.8	6.9	8.2	40.4	751.9	12.3
1943_november	7	8.4	52.8	763.4	11.5	7	7.9	46.5	533.1	128.6	-4.4	7.7	8.4	57.2	748.3	7.7
1943_december	7.2	8.4	95	766.7	5.6	6.8	8.3	82	532.7	101.9	-8.5	8.1	8.6	54.7	751.9	2.6

Annual temperature graphs



Annual temperature graphs



World Bank Climate Change Knowledge Center

<https://climateknowledgeportal.worldbank.org/country/bulgaria/climate-data-historical>

<https://climateknowledgeportal.worldbank.org/download-data>



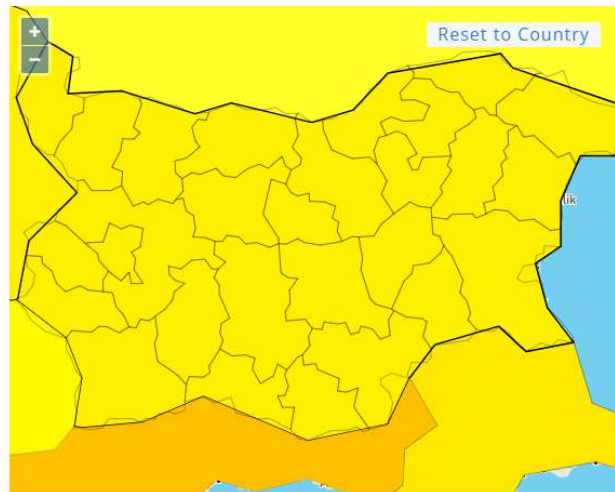
Climate Change Knowledge Portal
For Development Practitioners and Policy Makers

[USER MANUAL](#) [GLOSSARY](#) [METADATA](#) [CONTACT US](#) [LOG IN](#)

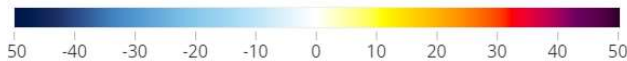
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The global surface temperature keeps rising, despite natural variability. This illustration shows the evolution of the historical record for Sofia-city, Bulgaria. Zoom-out to see global record for the latest climatology, 1991-2020.

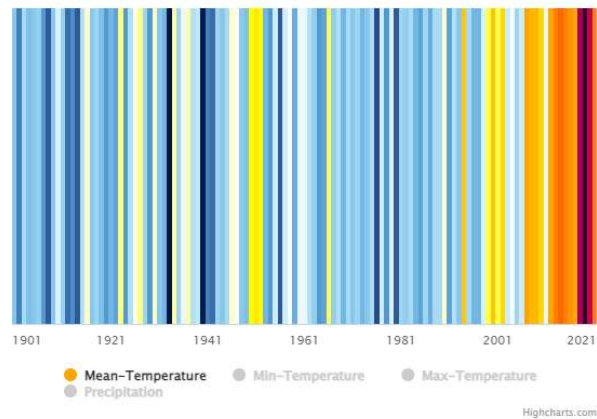
Observed Annual Mean-Temperature 1991-2020
Sofia-city, Bulgaria



TEMPERATURE (°C)



Observed Annual Mean-Temperature, 1901-2021
Sofia-city, Bulgaria



[First Nationally Determined Contribution \(2020\)](#) ^{df}

[Fourth Biennial Report \(2020\)](#) ^{df}

[Seventh National Communication and Third Biennial Report \(2018\)](#) ^{df}

PAGE SPECIFIC RESOURCES

[WBG Climate Change Action Plan \(CCAP\) 2021-2025](#) ^{df}

[Tool: Climate and Disaster Risk Screening \(WBG\)](#) ^{df}

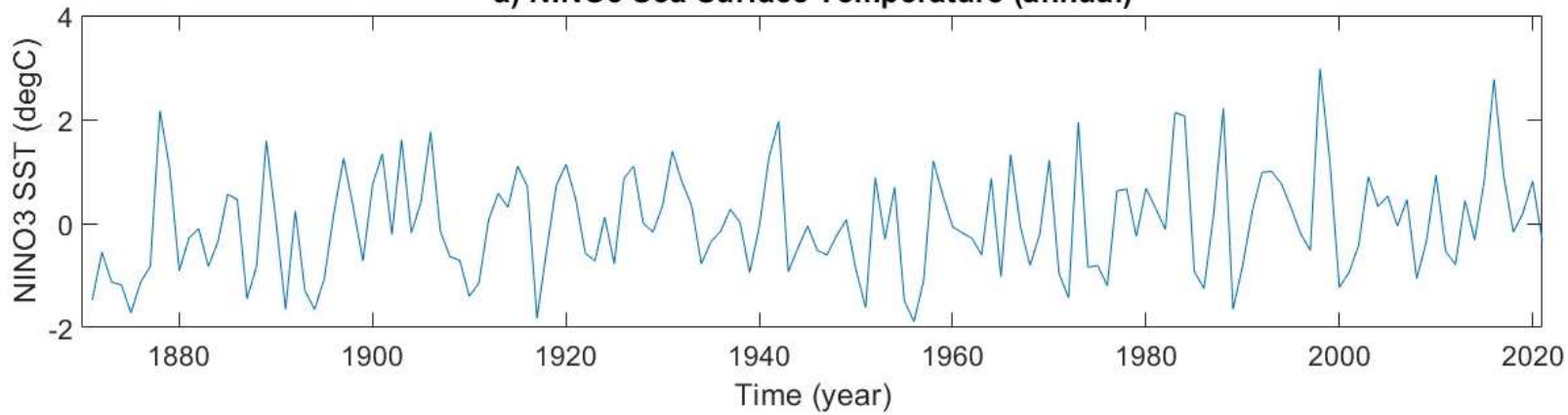
[Historical Data: Climatic Research Unit \(CRU\)](#) ^{df}

Initial analysis of meteorological data

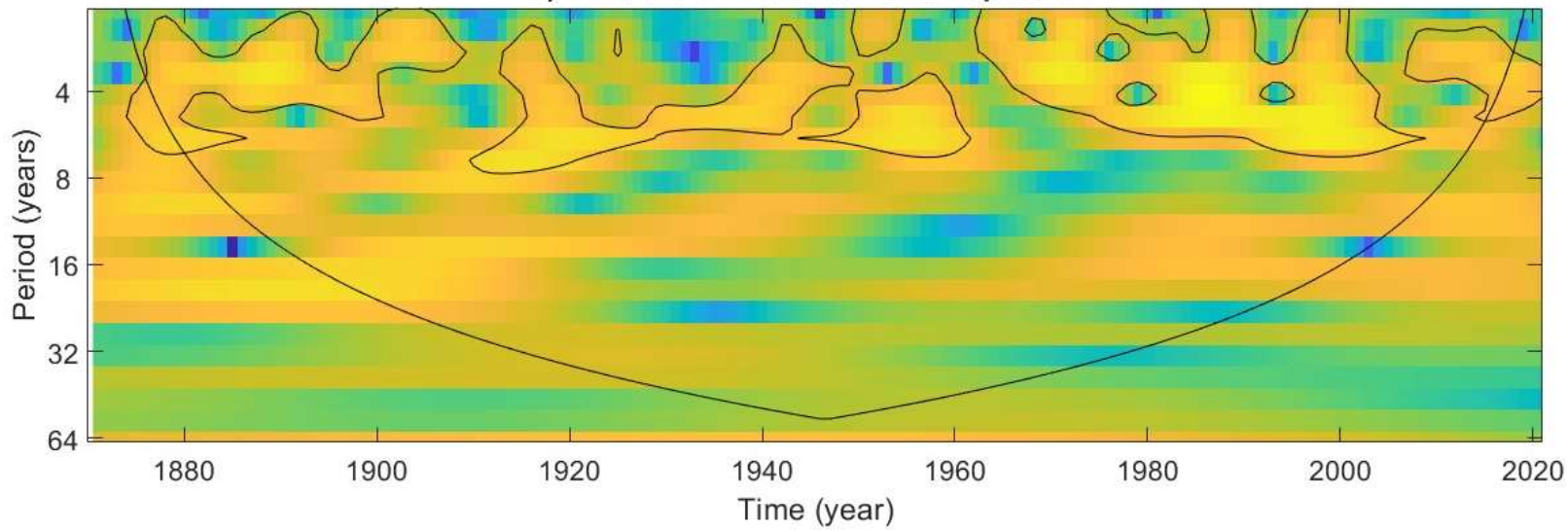
- We have selected several meteo-stations with the longest time series and are located in parts of the country with different climate characteristics, urban, mountainous, valley, seashore.
- The analytical method of choice is wavelet analysis which will allow us to identify patterns in changes of surface temperature and also to localize the different modes in time



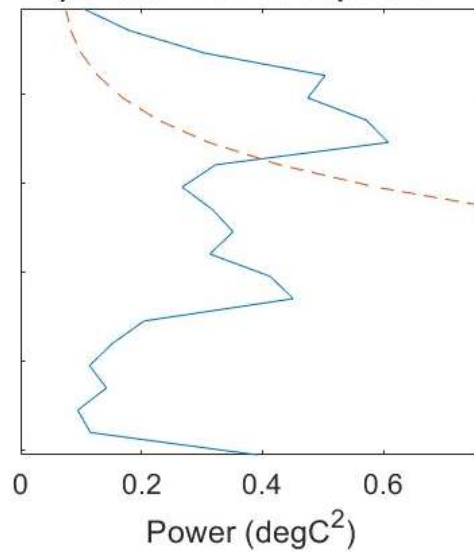
a) NINO3 Sea Surface Temperature (annual)



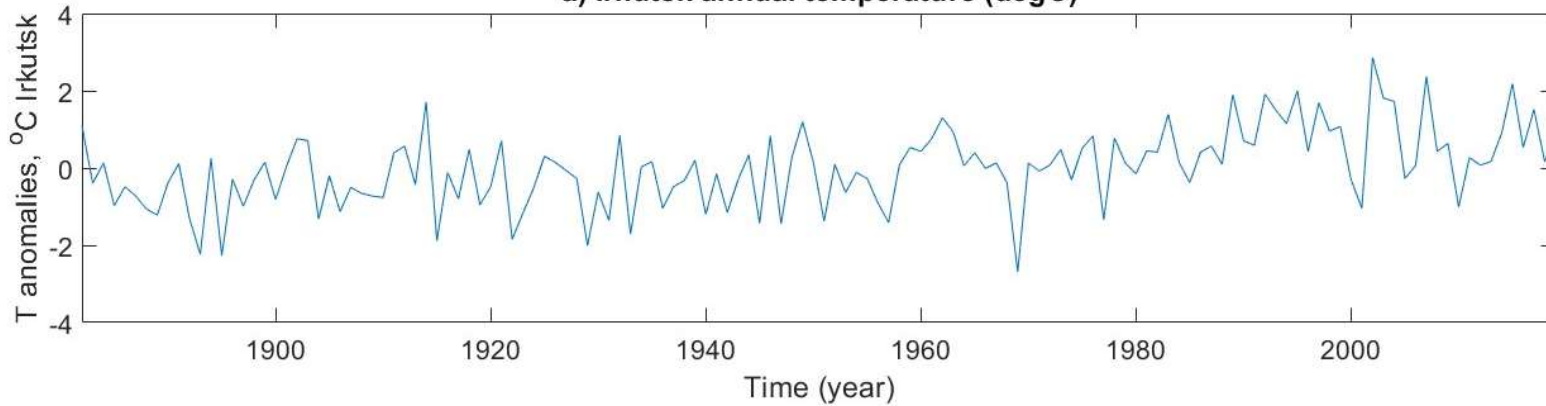
b) NINO3 SST Wavelet Power Spectrum



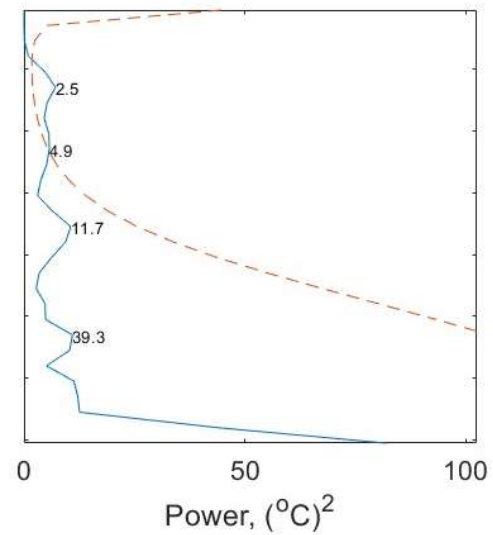
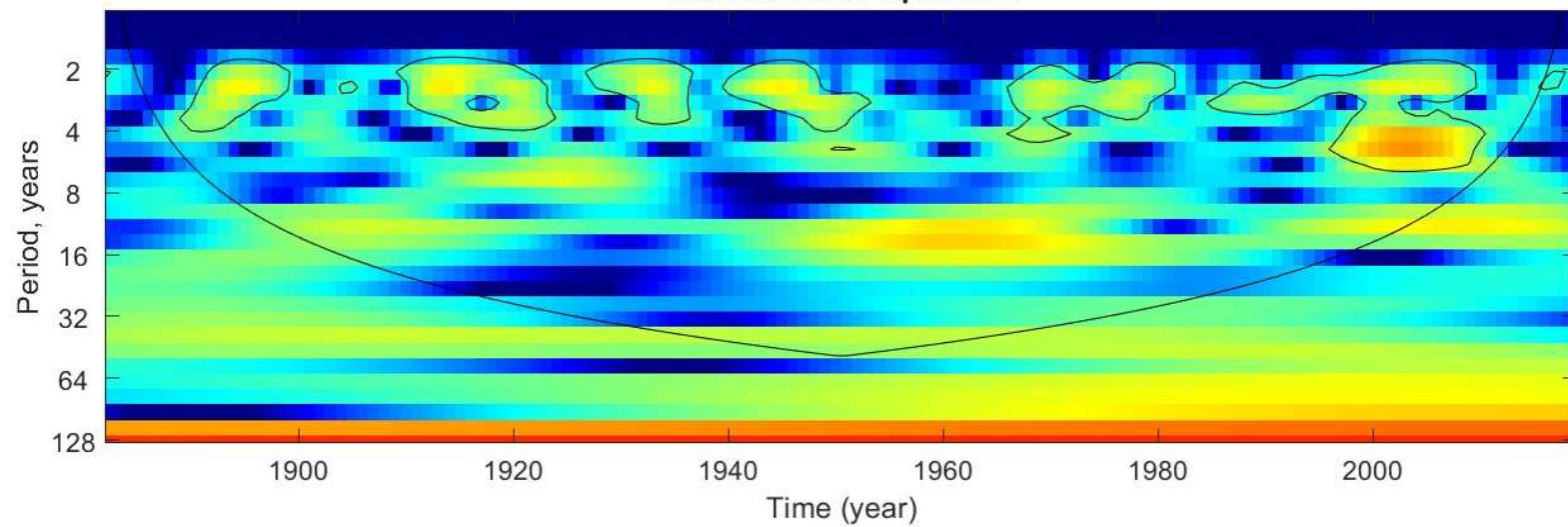
c) Global Wavelet Spectrum

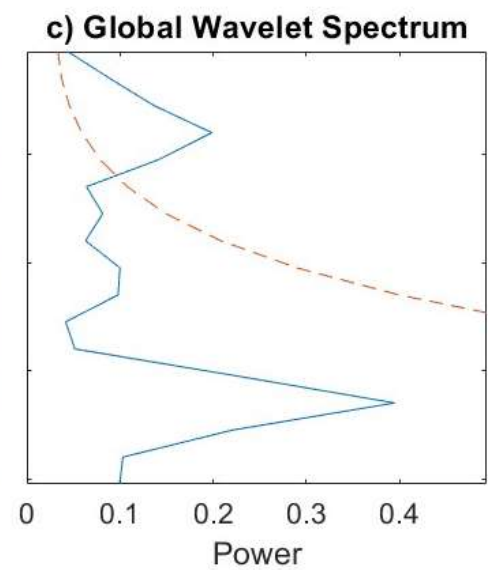
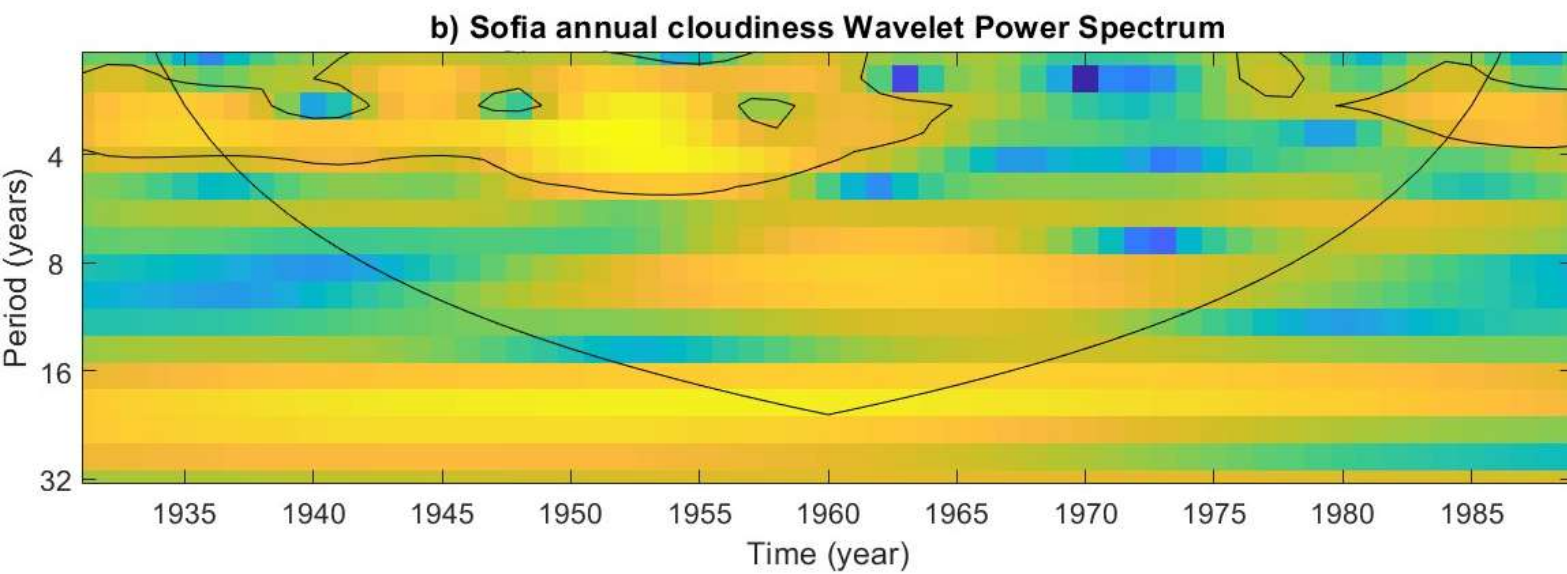
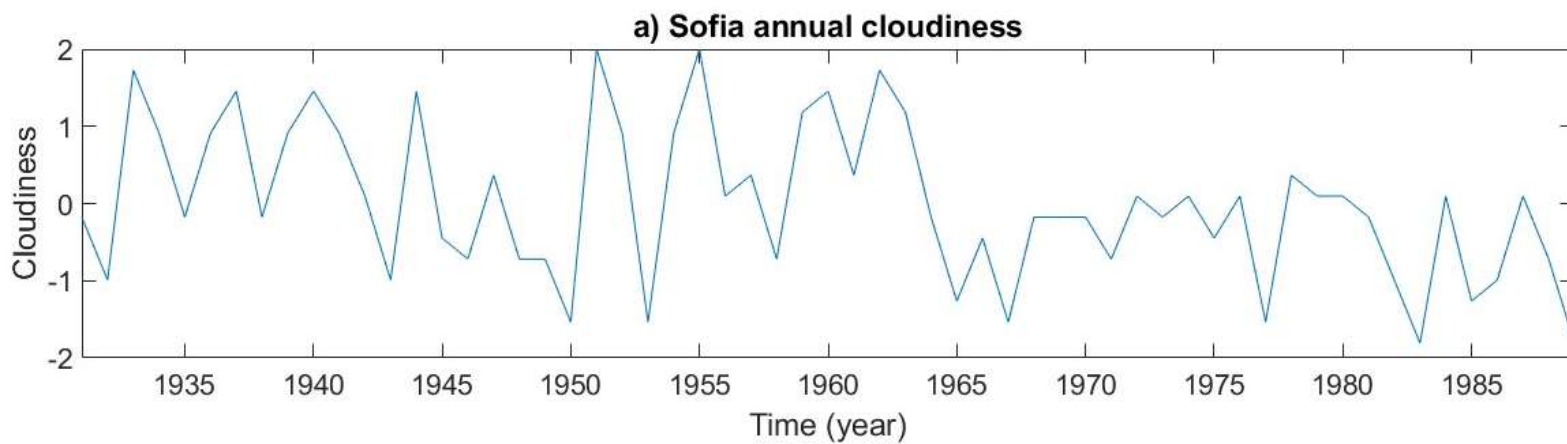


a) Irkutsk annual temperature (degC)

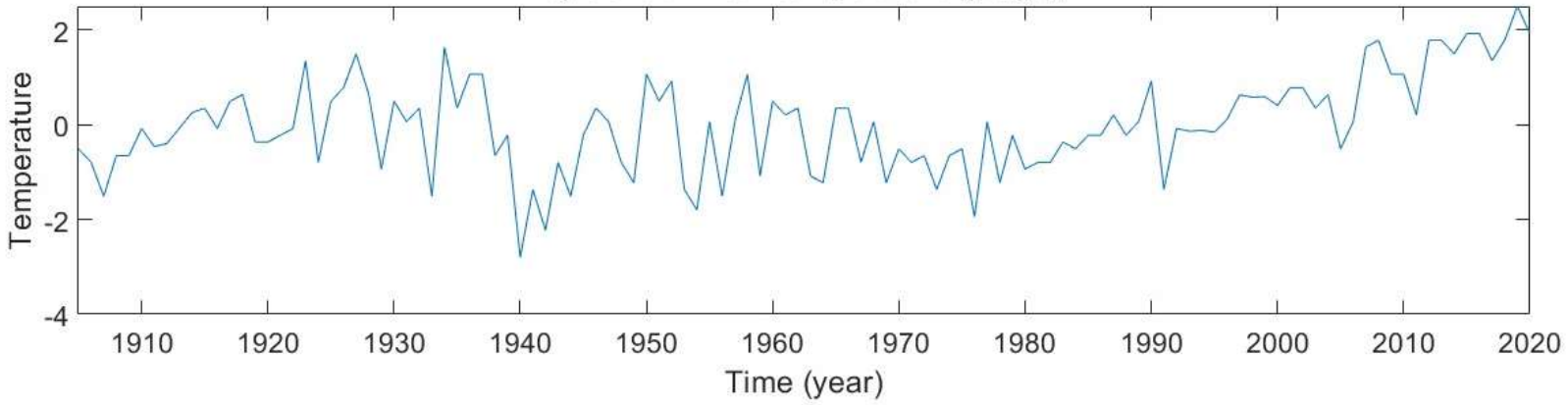


Wavelet Power Spectrum

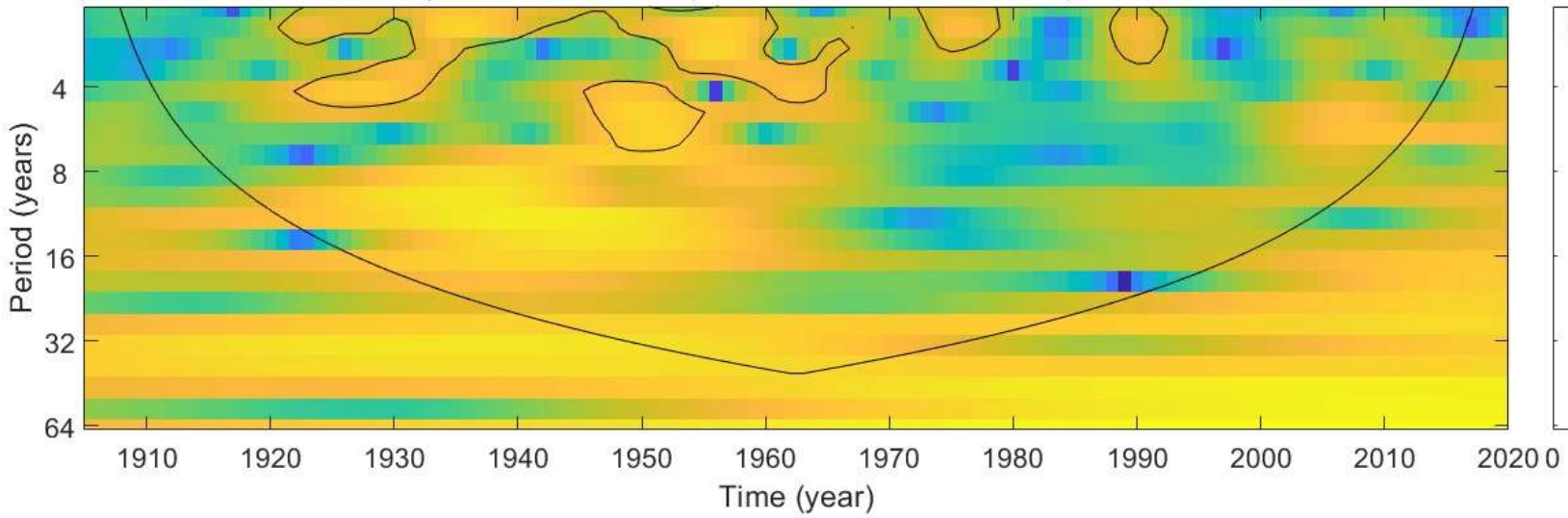




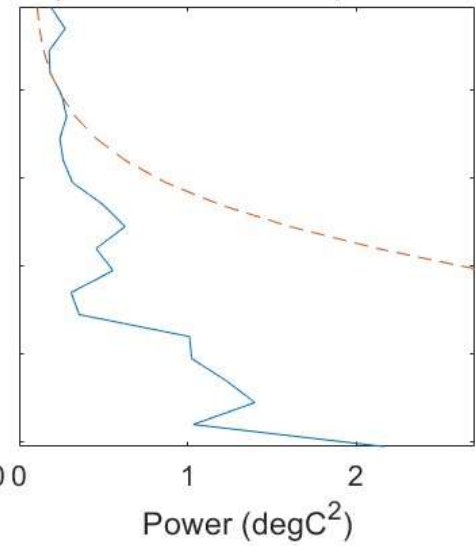
a) Sofia annual temperature (degC)



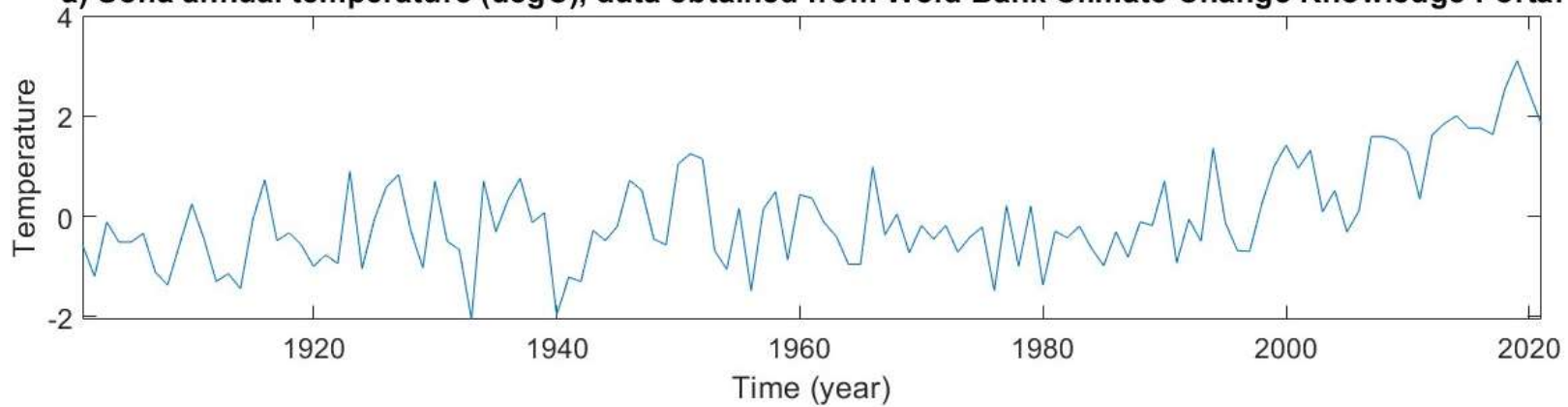
b) Sofia annual temperature Wavelet Power Spectrum



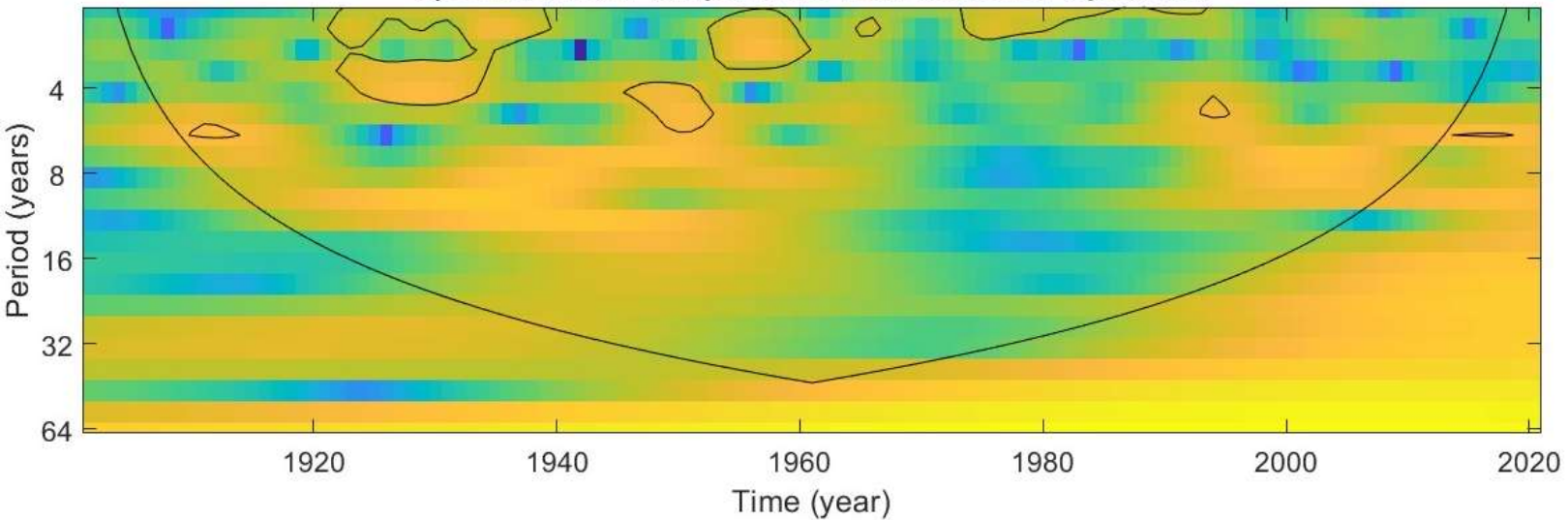
c) Global Wavelet Spectrum



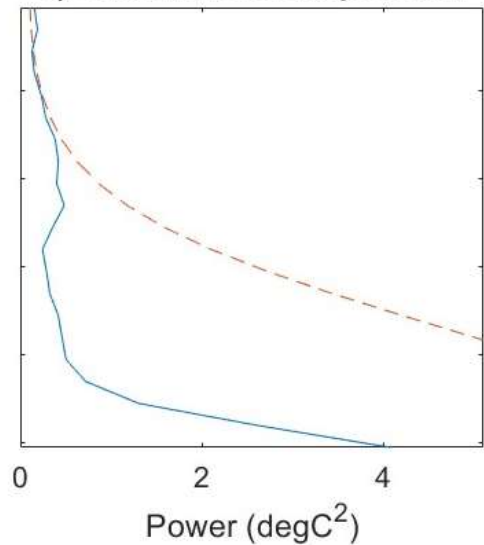
a) Sofia annual temperature (degC), data obtained from Wold Bank Climate Change Knowledge Portal



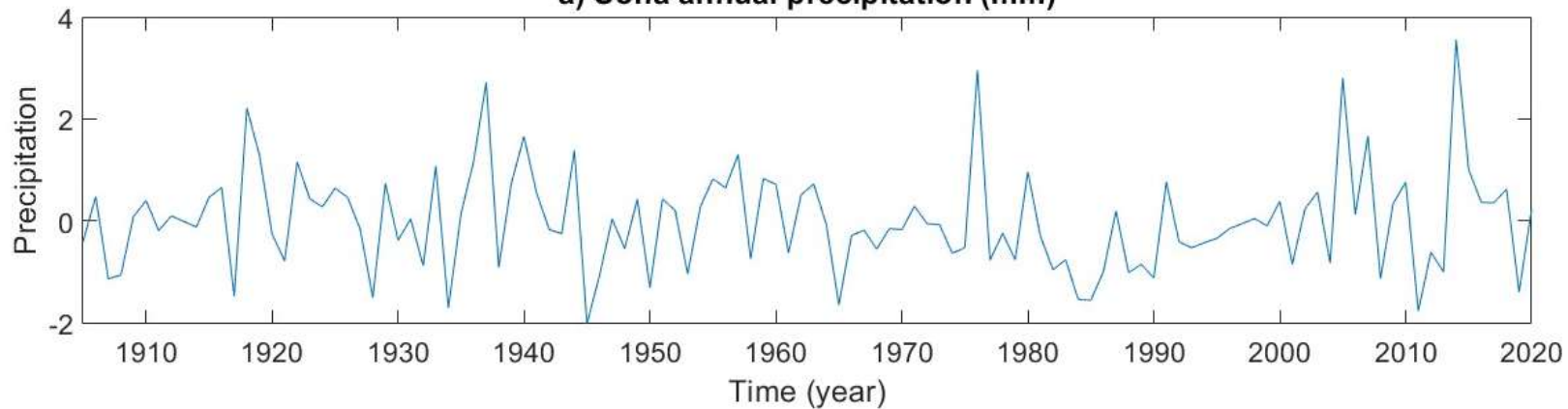
b) Sofia annual temperature Wavelet Power Spectrum



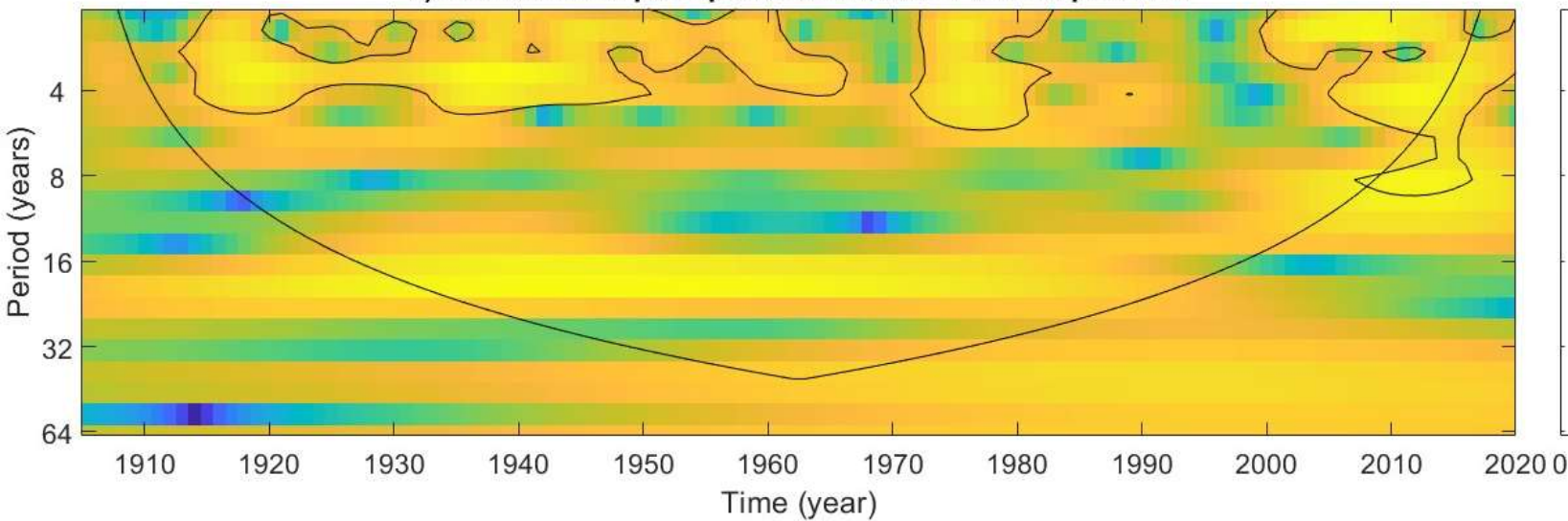
c) Global Wavelet Spectrum



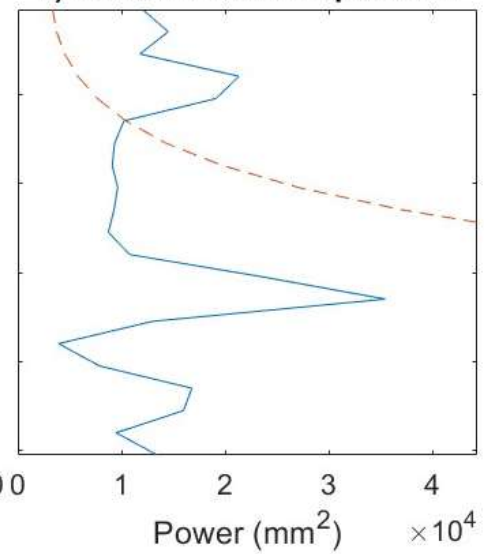
a) Sofia annual precipitation (mm)



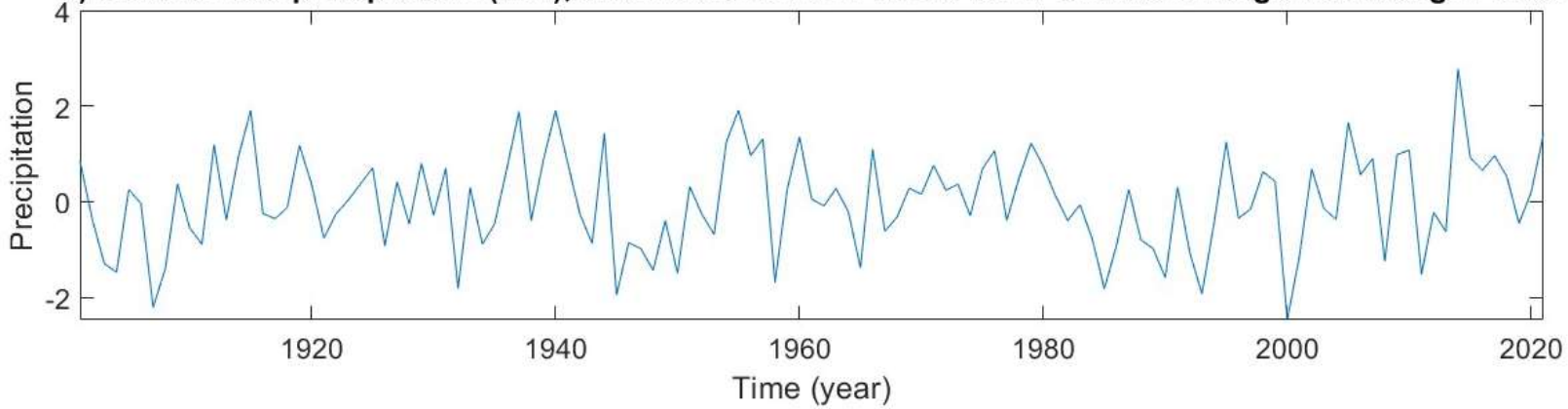
b) Sofia annual precipitation Wavelet Power Spectrum



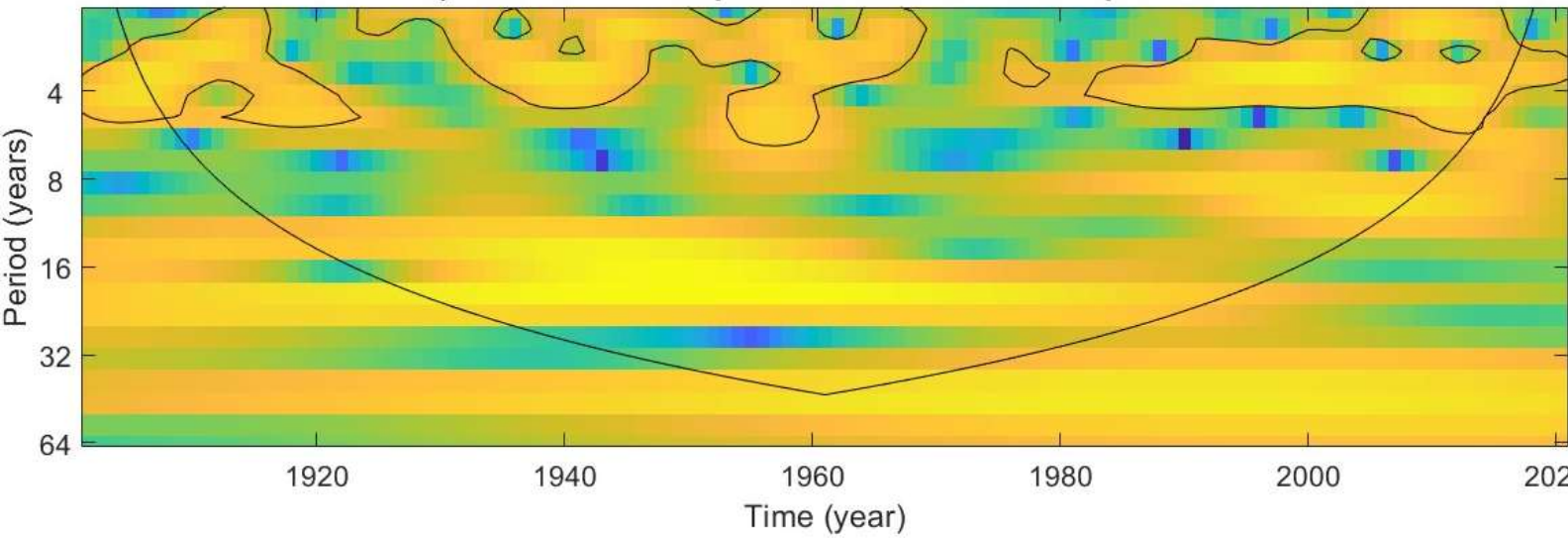
c) Global Wavelet Spectrum



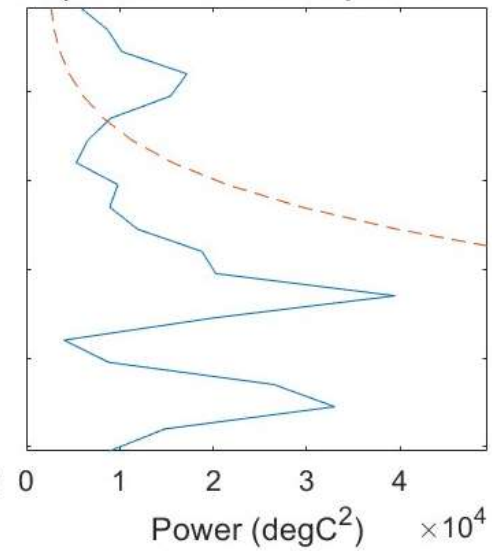
a) Sofia annual precipitation (mm), data obtained from World Bank Climate Change Knowledge Portal



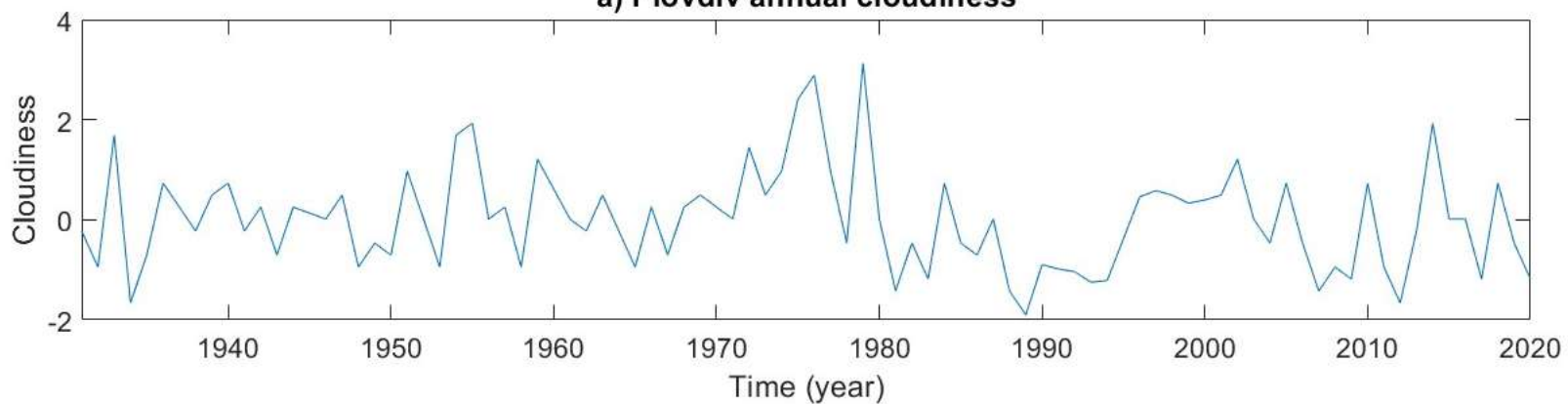
b) Sofia annual temperature Wavelet Power Spectrum



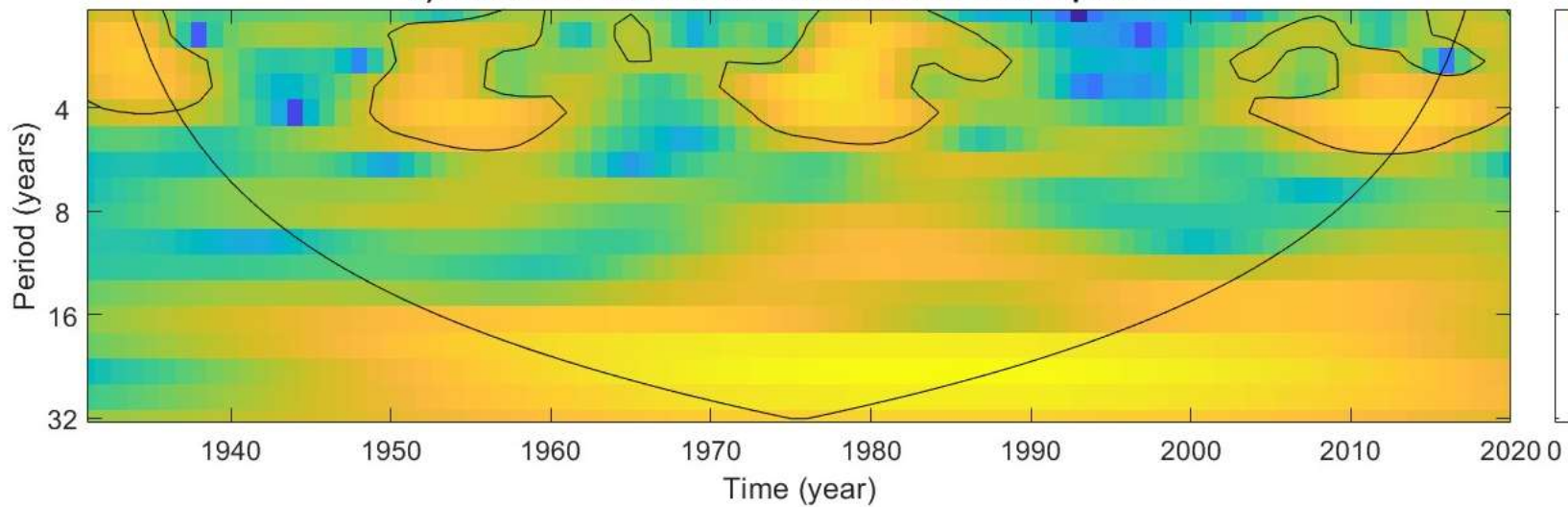
c) Global Wavelet Spectrum



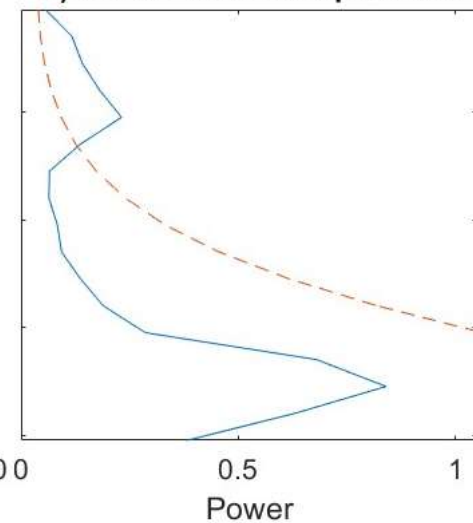
a) Plovdiv annual cloudiness



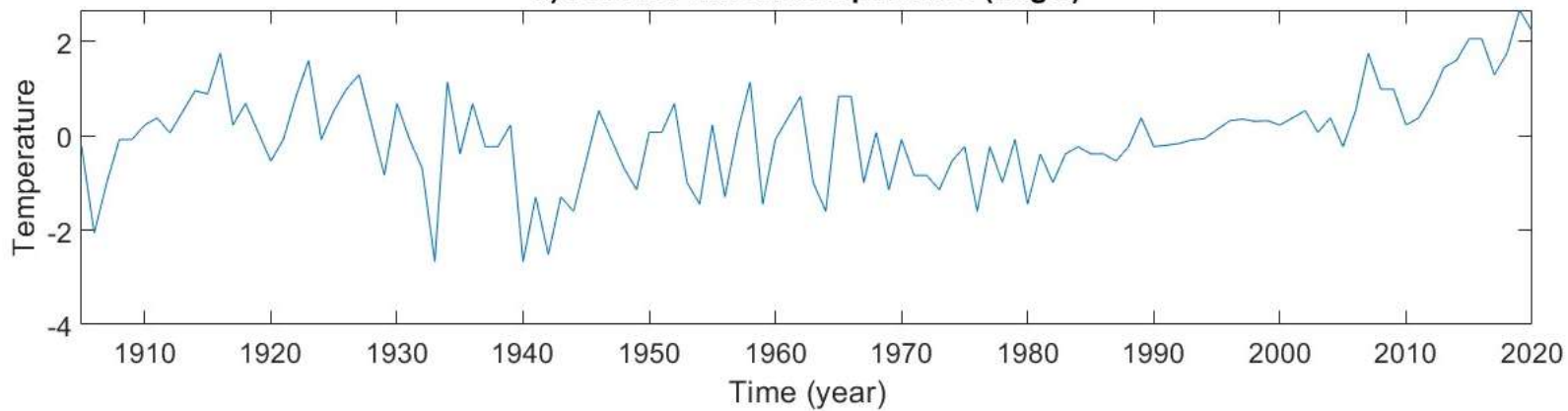
b) Plovdiv annual cloudiness Wavelet Power Spectrum



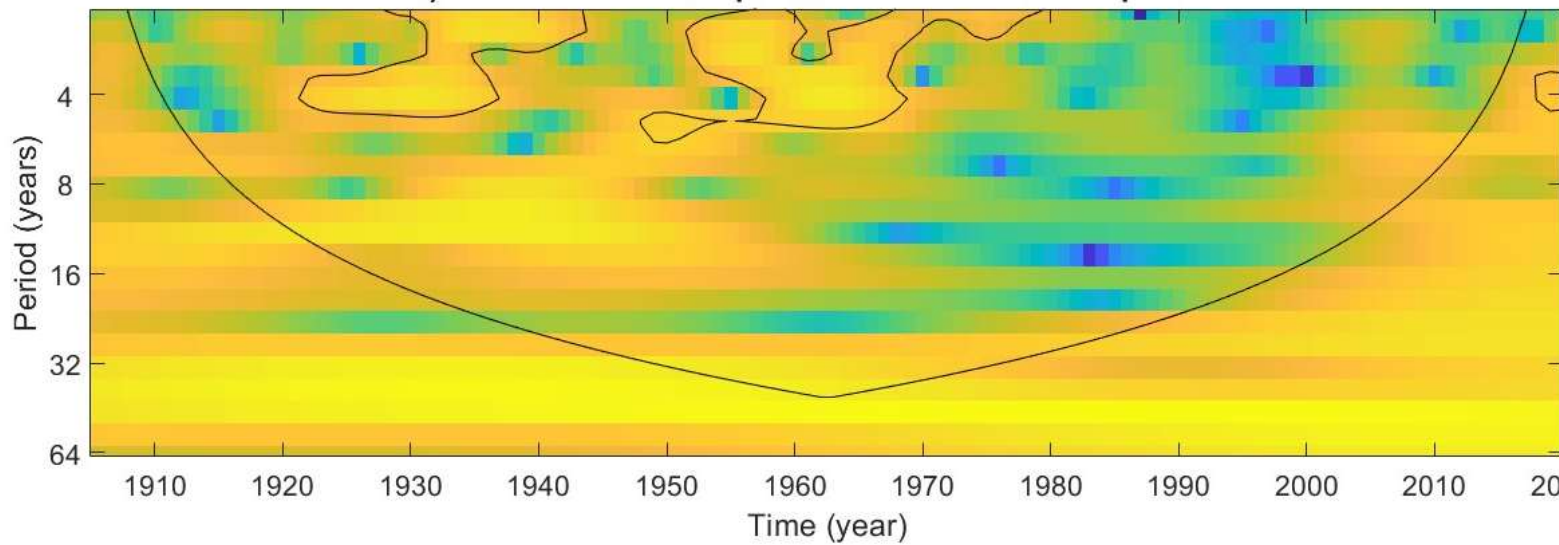
c) Global Wavelet Spectrum



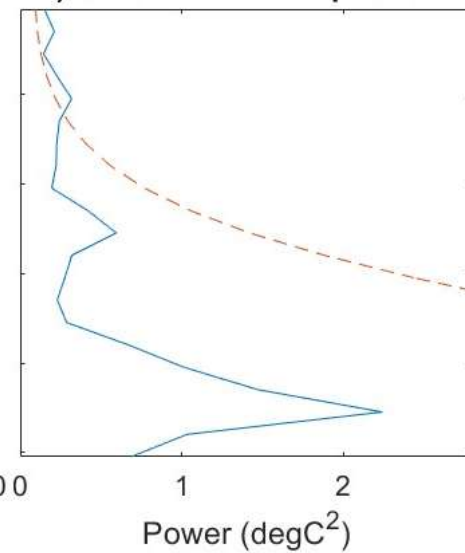
a) Plovdiv annual temperature (degC)



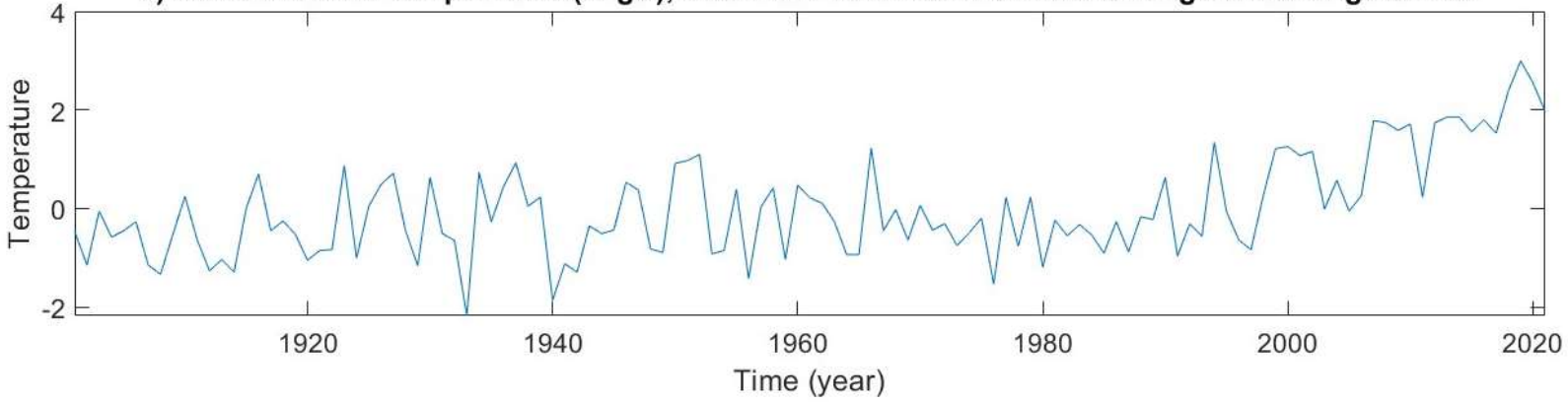
b) Plovdiv annual temperature Wavelet Power Spectrum



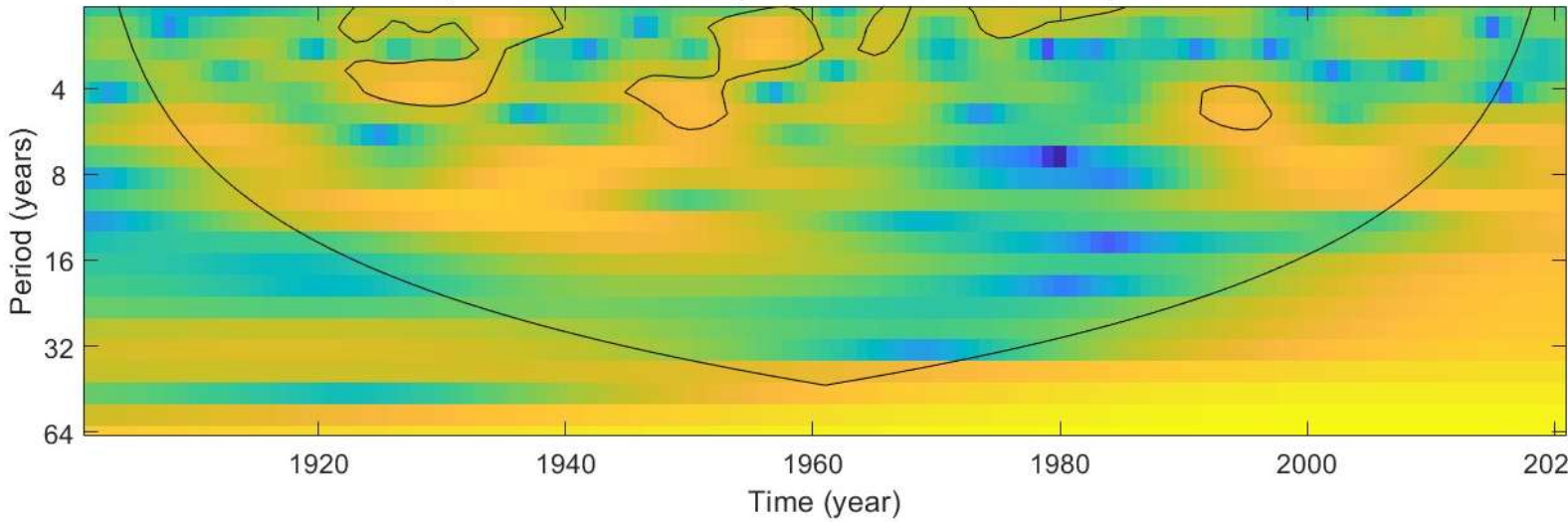
c) Global Wavelet Spectrum



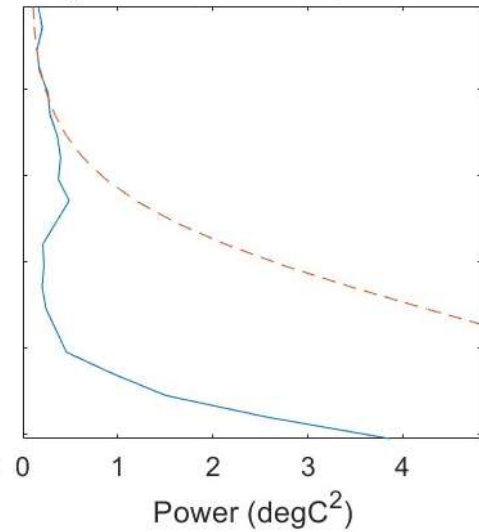
a) Plovdiv annual temperature (degC), data from Wold Bank Climate Change Knowledge Center



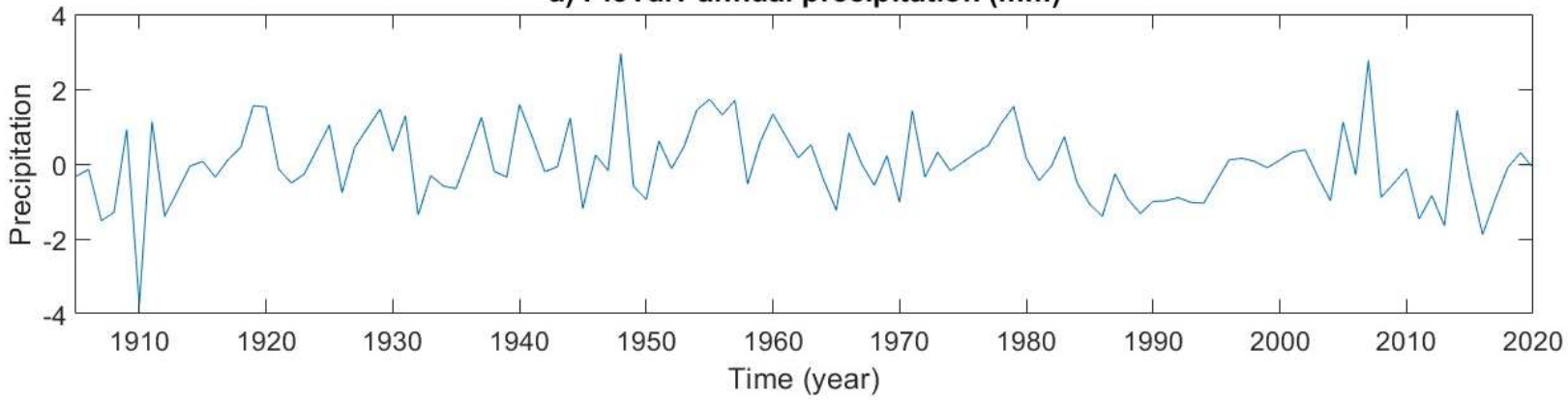
b) Plovdiv annual temperature Wavelet Power Spectrum



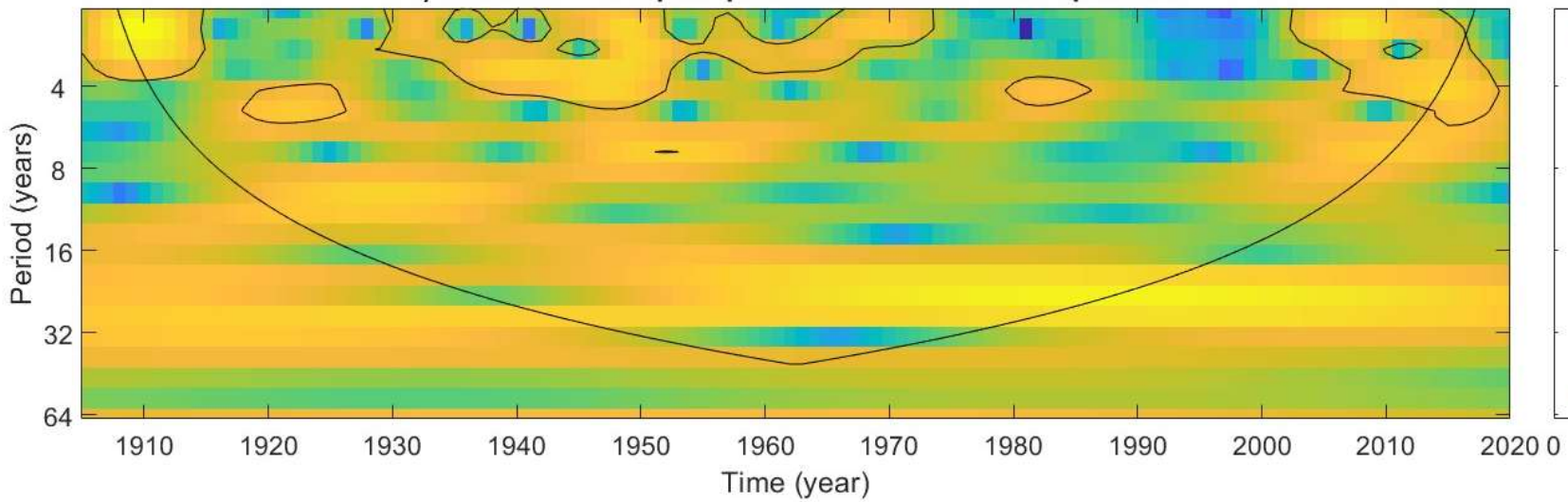
c) Global Wavelet Spectrum



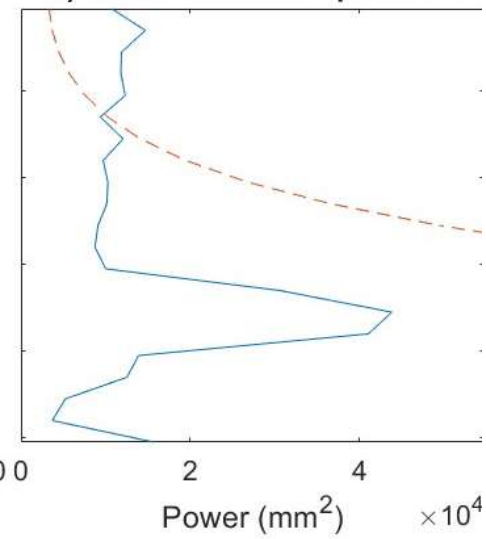
a) Plovdiv annual precipitation (mm)



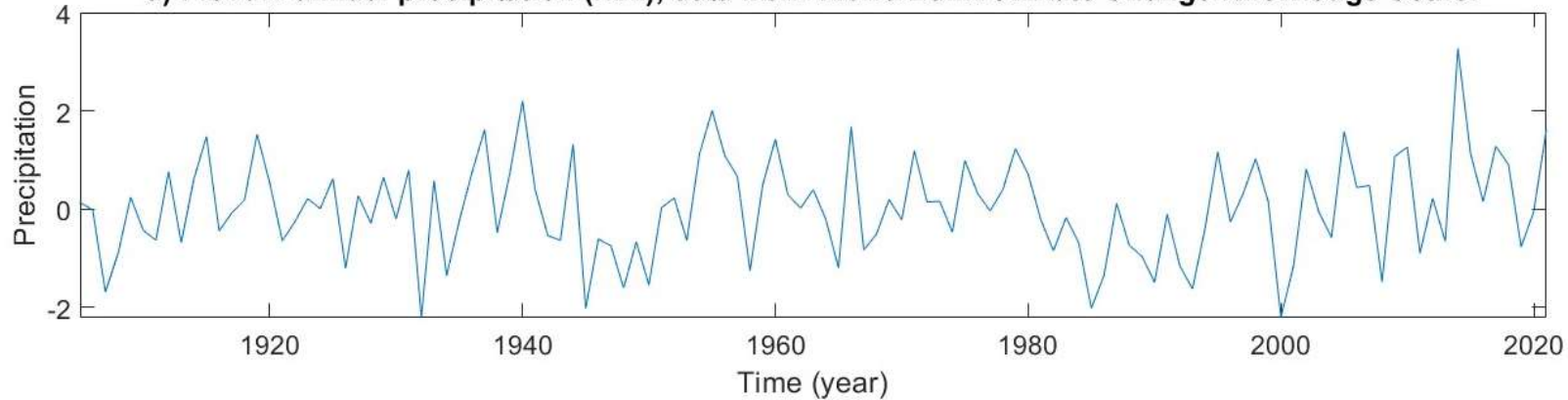
b) Plovdiv annual precipitation Wavelet Power Spectrum



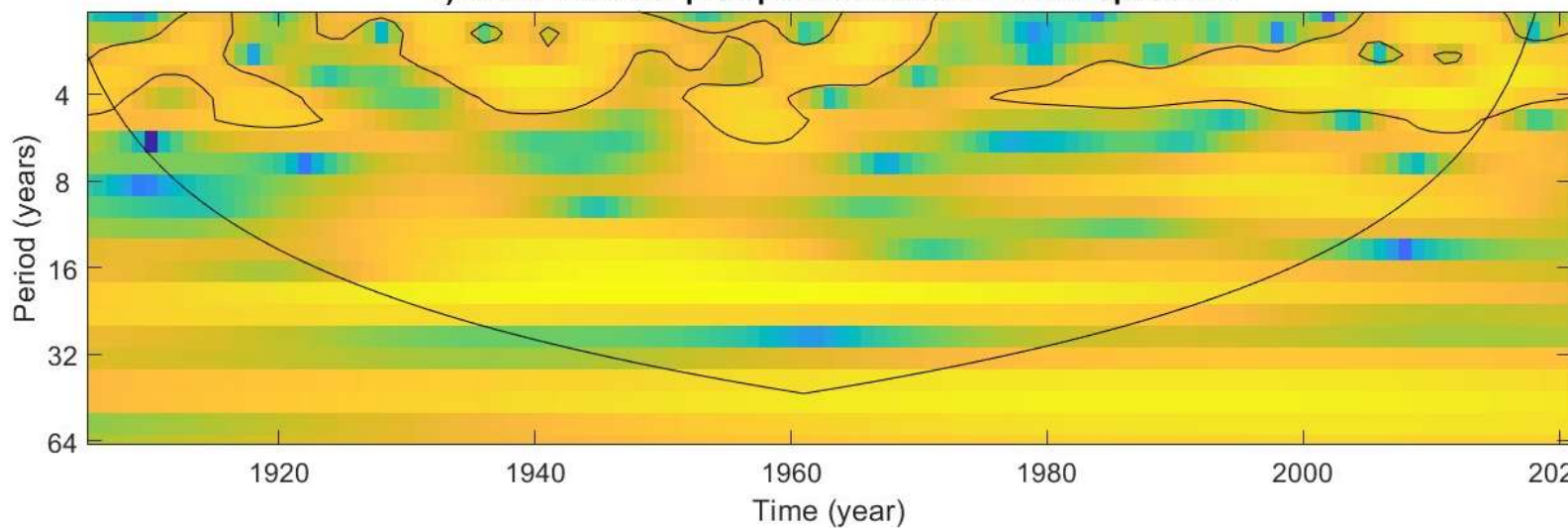
c) Global Wavelet Spectrum



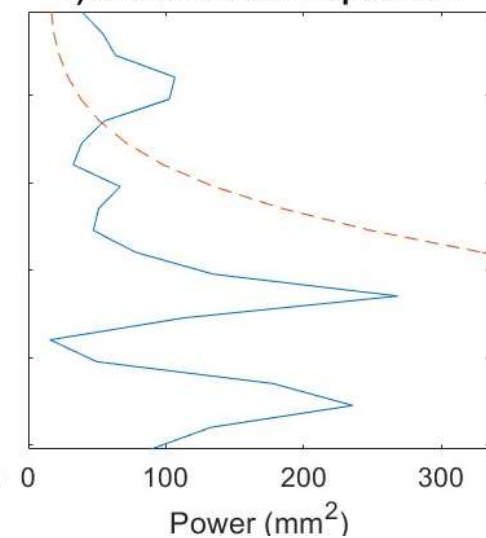
a) Plovdiv annual precipitation (mm), data from World Bank Climate Change Knowledge Cetner



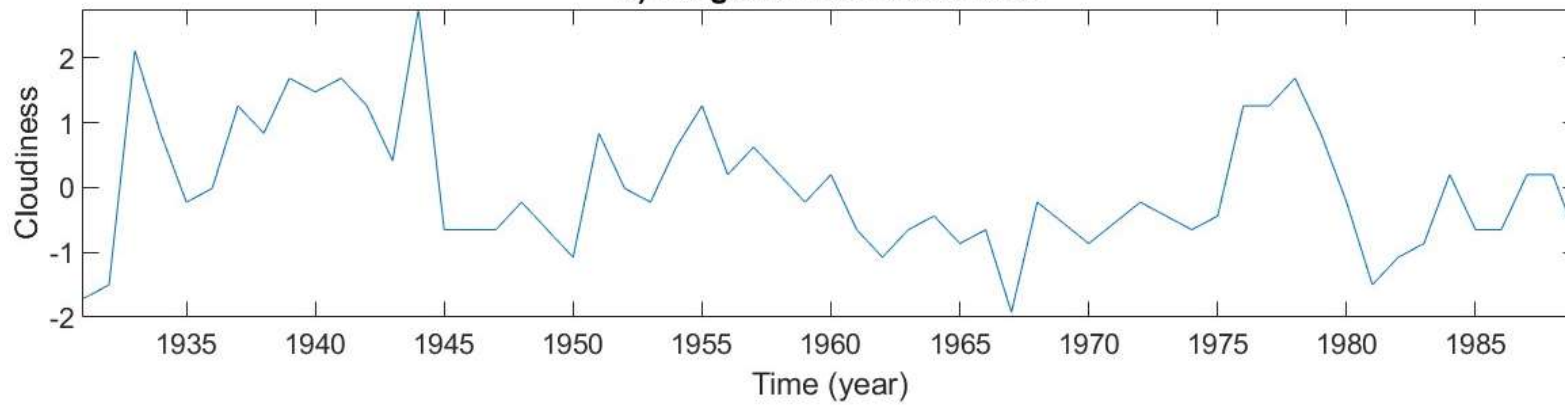
b) Plovdiv annual precipitation Wavelet Power Spectrum



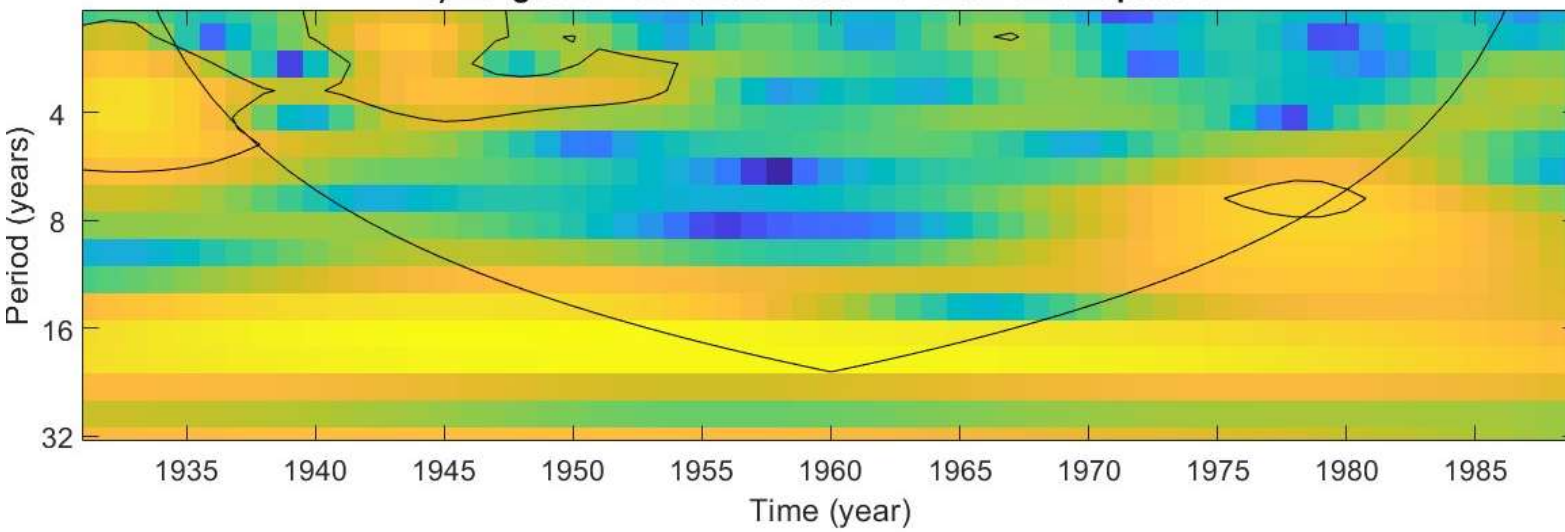
c) Global Wavelet Spectrum



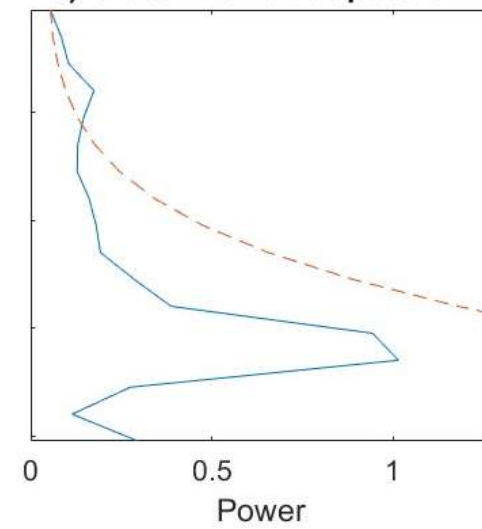
a) Burgas annual cloudiness



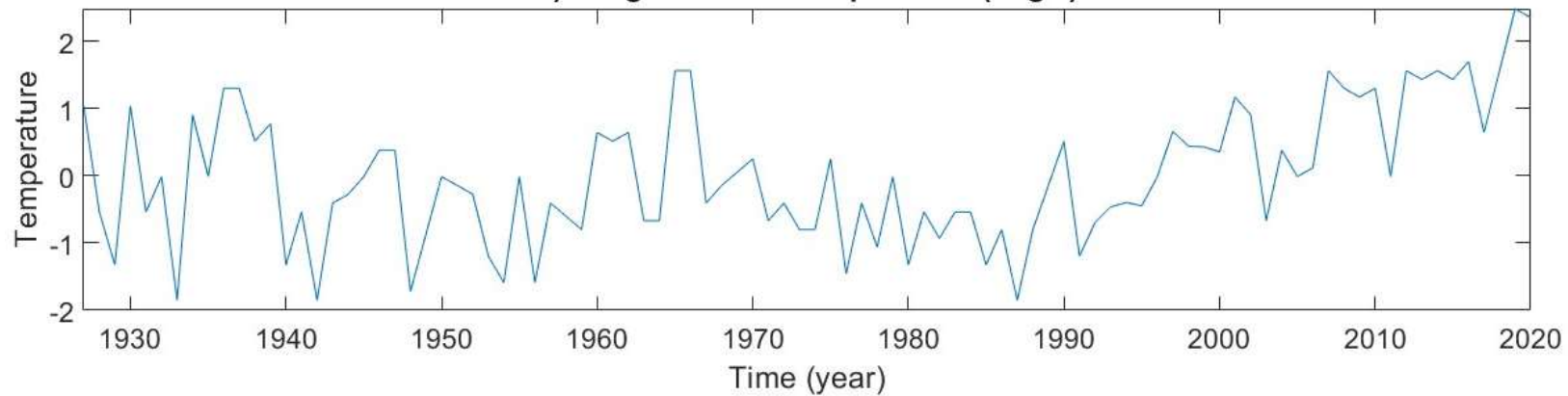
b) Burgas annual cloudiness Wavelet Power Spectrum



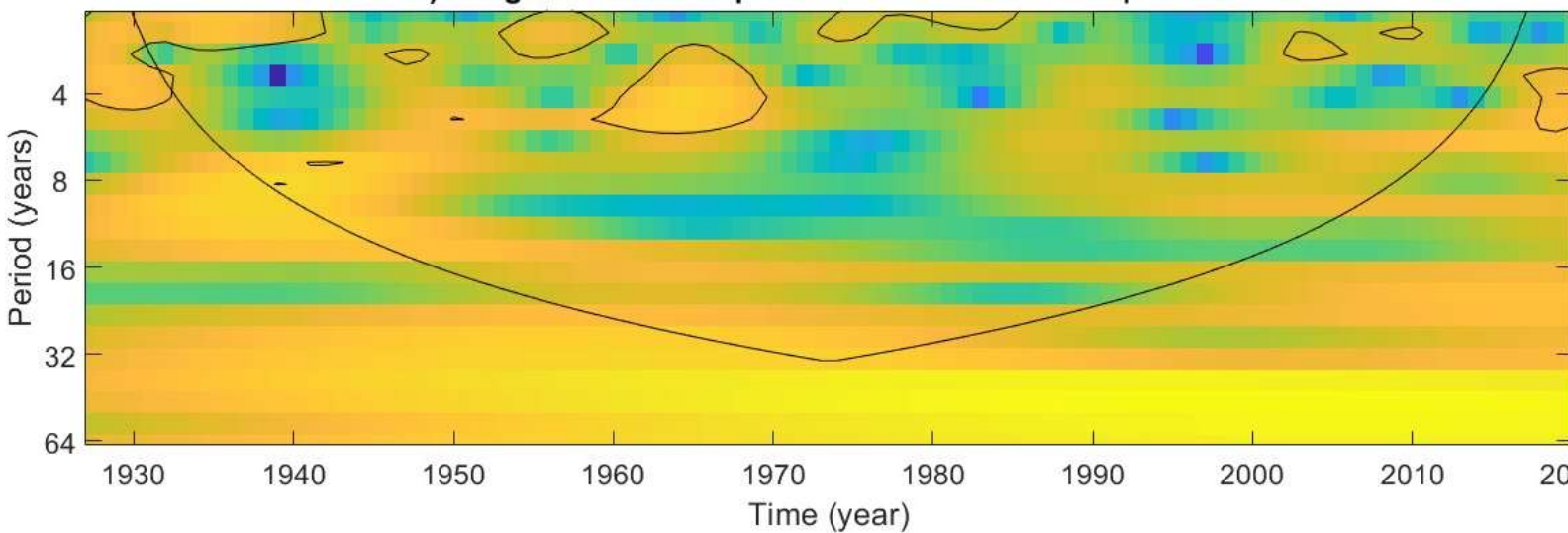
c) Global Wavelet Spectrum



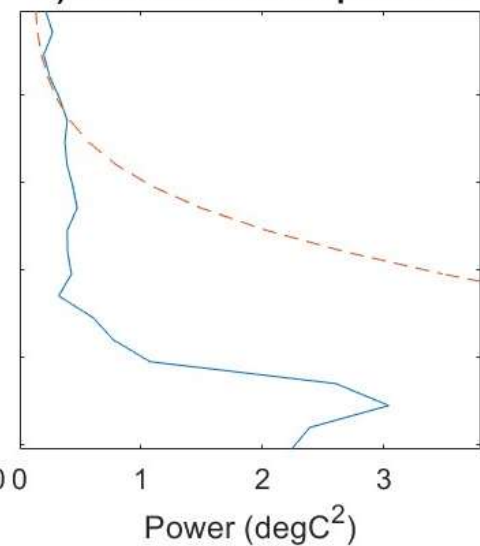
a) Burgas annual temperature (degC)



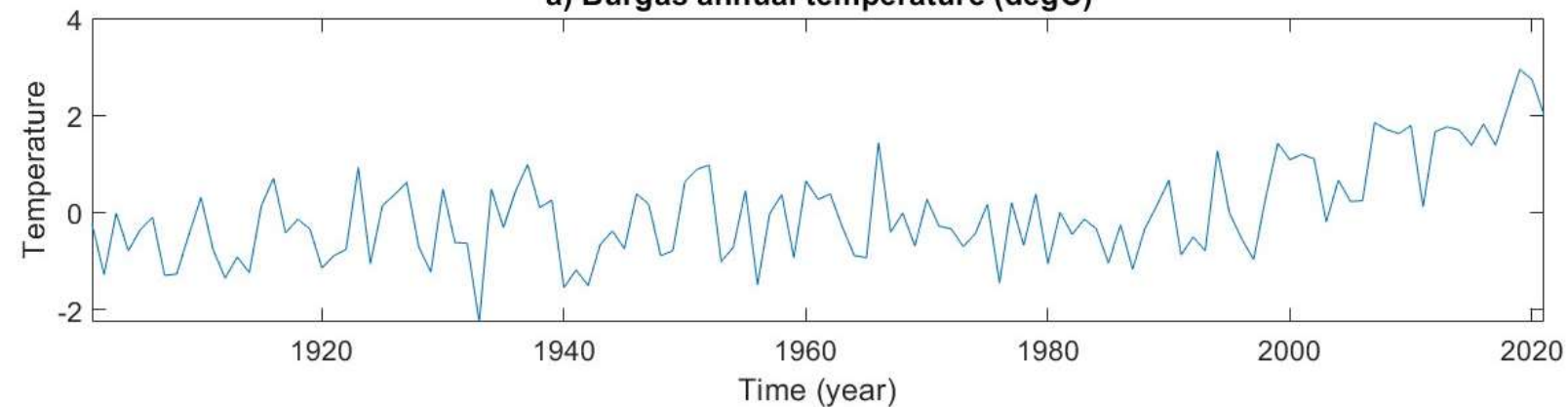
b) Burgas annual temperature Wavelet Power Spectrum



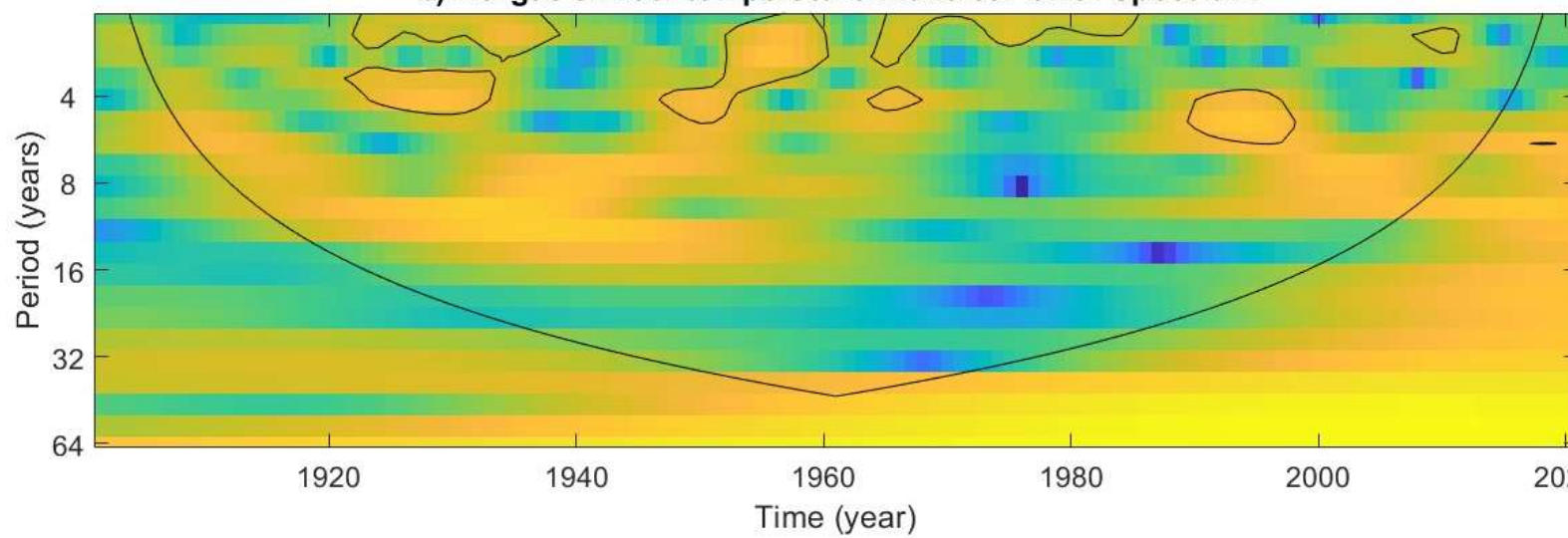
c) Global Wavelet Spectrum



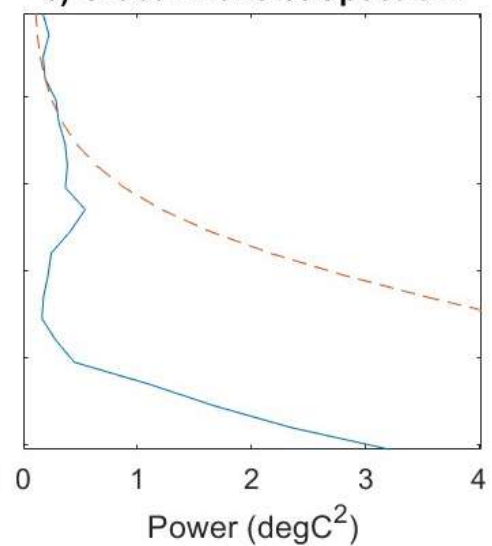
a) Burgas annual temperature (degC)



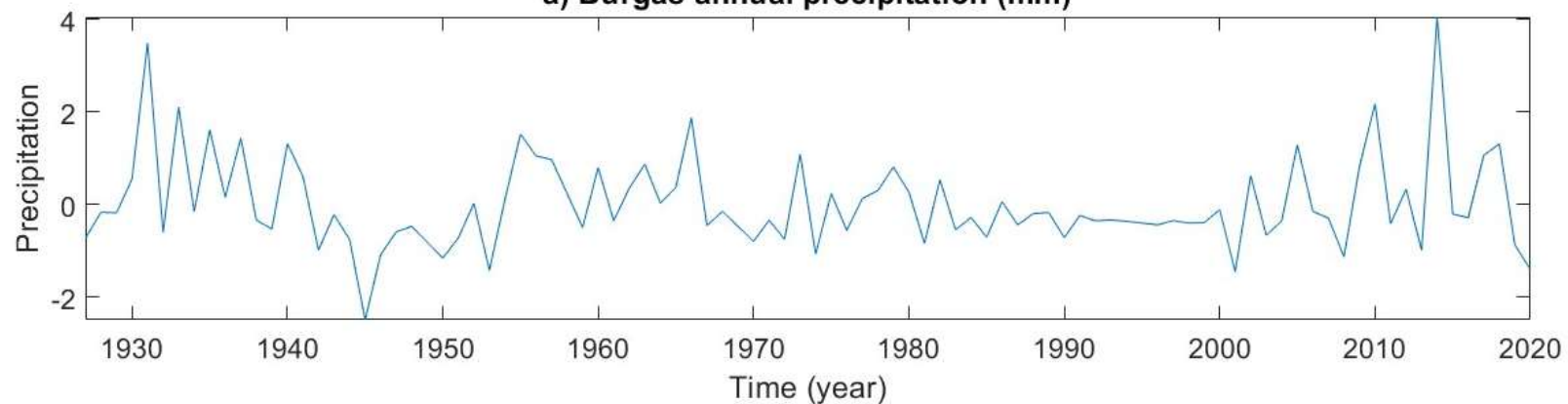
b) Burgas annual temperature Wavelet Power Spectrum



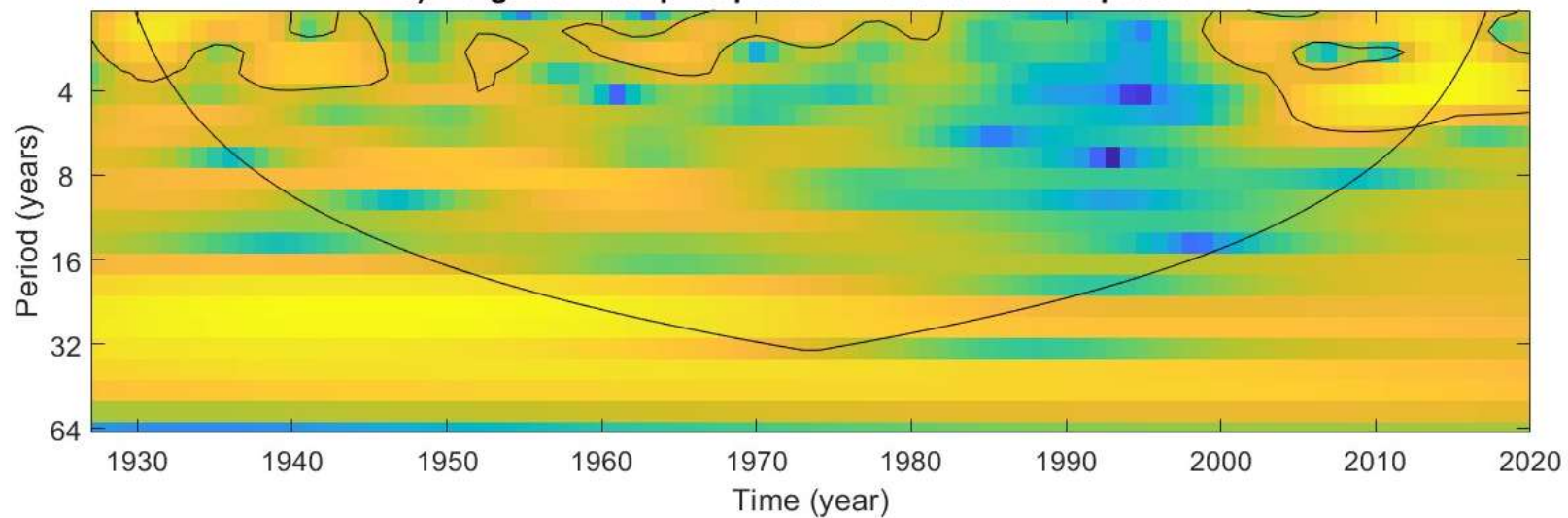
c) Global Wavelet Spectrum



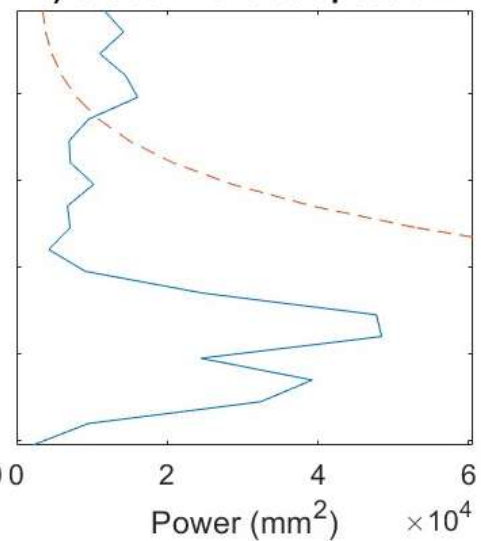
a) Burgas annual precipitation (mm)



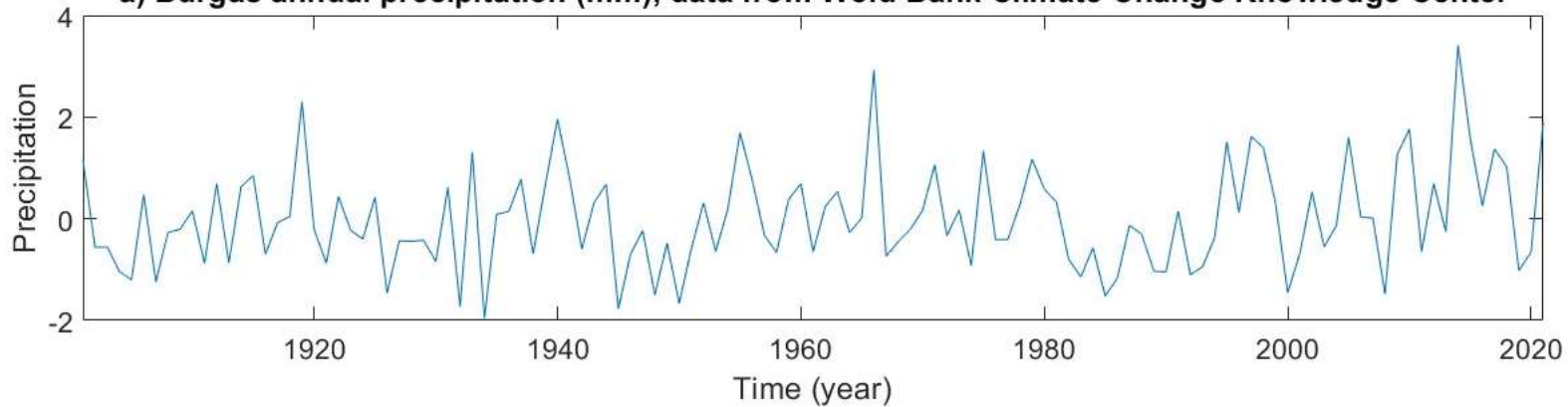
b) Burgas annual precipitation Wavelet Power Spectrum



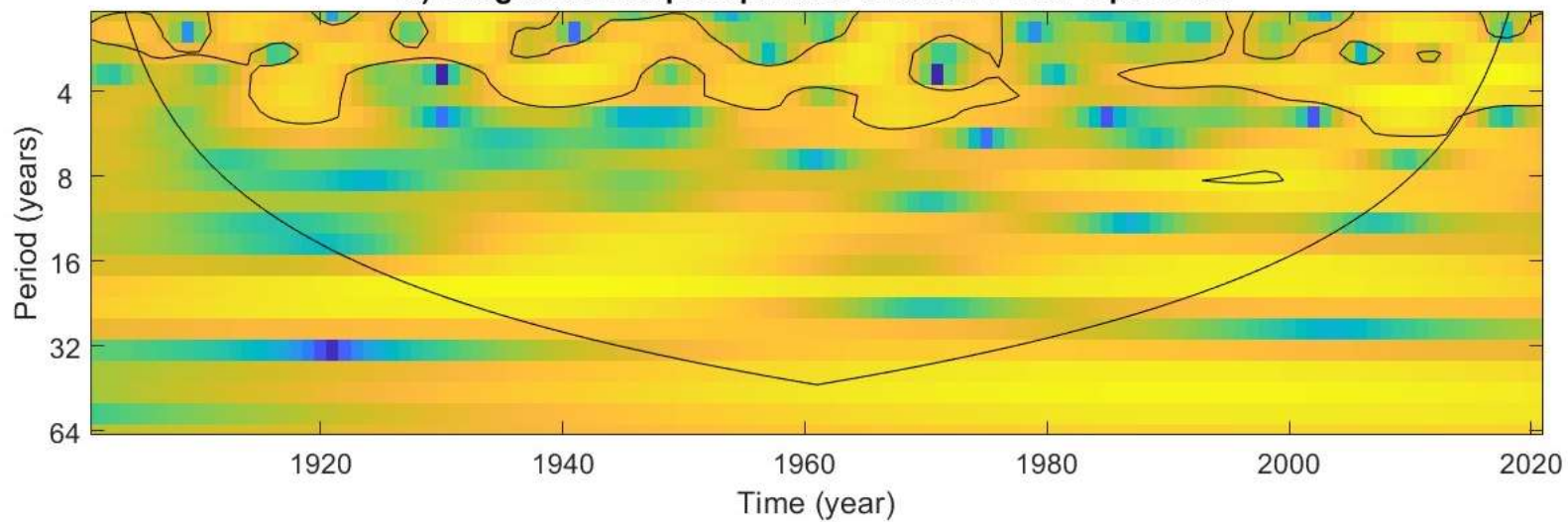
c) Global Wavelet Spectrum



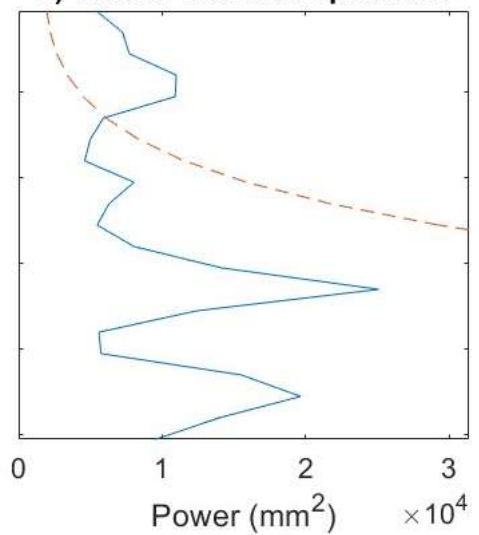
a) Burgas annual precipitation (mm), data from Wold Bank Climate Change Knowledge Center



b) Burgas annual precipitation Wavelet Power Spectrum



c) Global Wavelet Spectrum



Thank you