Solar Radiation distribution over Egypt using NCEP/CFSR solar data

By
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DECADAL AND SEASONAL DISTRIBUTION OF SOLAR RADIATION OVER EGYPT USING CFSR

Data and Methodology

CFSR dataset 6 hour basis will be downloaded from the website to study the solar distribution over Egypt. Also we are going to use the same domains over Egypt. We will divide 1979 to 2010 to 3 decades; 1st decade from 1980 to 1989, 2nd one from 1990 to 1999 and the last decade from 2000 to 2009.

We will use the same tools and methods like the previous paper, but we will extract the maps that represent shortwave solar radiation (kWh/m^2) decadal and seasonal distributions on the surface over this domain. The change in the amount of the surface solar radiation will be investigated through the trend line based on yearly average.

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Station Name	Start Date	End Date	# obs	obs average kWh/m2	CFSR Average kWh/m2	Mean Bias kWh/m2	NMB %	RMSE kWh/m2	NRMSE %	Correl
SidiBarrani	198408	200710	191	5.384	5.466	0.082	2	0.342	5	0.984
MersaMatruh	198107	200710	272	5.446	5.492	0.046	1	0.344	5.6	0.983
Rafah	199012	200412	124	5.337	5.421	0.084	2	0.551	8.2	0.954
El Arish	198601	200710	237	5.458	5.582	0.124	2	0.263	4.8	0.992
Tahrir	197901	199906	242	5.347	5.515	0.168	3	0.382	6.5	0.984
Wadi El Natroun	199904	200710	68	5.471	5.785	0.313	6	0.535	10.2	0.968
Bahtim	197901	200212	285	5.393	5.712	0.318	6	0.430	7.5	0.986
Cairo	197901	200710	317	5.205	5.739	0.534	10	0.615	11.1	0.985
Malwi	199904	200503	21	6.025	6.283	0.257	4	0.468	9.6	0.971
Asyut	198001	200710	316	5.936	6.344	0.407	7	0.525	9.3	0.978
South Valley	200005	200710	48	6.337	6.757	0.423	7	0.504	9.6	0.983
El Kharga	197901	200710	302	6.181	6.464	0.282	5	0.421	8.5	0.976
Aswan	198001	200704	299	6.290	6.496	0.206	3	0.320	7.1	0.984
Stations Average			209	5.678	5.927	0.250	4.4	0.438	7.9	0.979

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Station Name	Start Date	End Date	# obs	obs average kW/m2	CFSR Average kW/m2	Mean Bias kW/m2	NMB %	RMSE kW/m2	NRMSE %	Correl
Tamanrasset	199409	200712	160	6.331	6.215	-0.116	-2	0.265	6.1	0.976
Casablanca	197901	200602	314	5.003	5.669	0.666	13	0.768	13.4	0.982
SidiBou Said	197901	200005	257	4.731	5.012	0.280	6	0.418	6.8	0.989
Stations Aver-age			244	5.355	5.632	0.277	5.8	0.484	8.8	0.982

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SedeBoker	200301	201012	90	5.810	5.644	-0.167	-3	0.314	5.4	**0.991**
Salalah	198801	199106	42	4.620	6.469	1.849	40	1.969	54	**0.688**
Solar Village	199809	200212	51	6.159	6.438	0.279	5	0.416	9	**0.985**
Ar Riyadh	197901	198412	67	5.167	6.407	1.239	24	1.408	30.3	**0.917**
Abha	198201	198512	48	5.313	5.837	0.524	10	0.880	23.7	**0.522**
Mutribah	199401	201012	204	5.632	5.948	0.316	6	0.424	7.4	**0.988**
Kabd	199401	201012	204	5.991	5.798	-0.192	-3	0.341	5.8	**0.987**
Sabriya	199401	201012	204	5.936	5.673	-0.264	-4	0.388	6.6	**0.987**
Umm Gu-dair	199401	201012	204	6.008	5.814	0.193	3	0.319	5.4	**0.991**
Stations Average			**124**	**5.626**	**6.003**	**0.420**	**8.5**	**0.718**	**16.4**	**0.895**

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Results and discussion (Surface solar radiation distribution over Egypt)

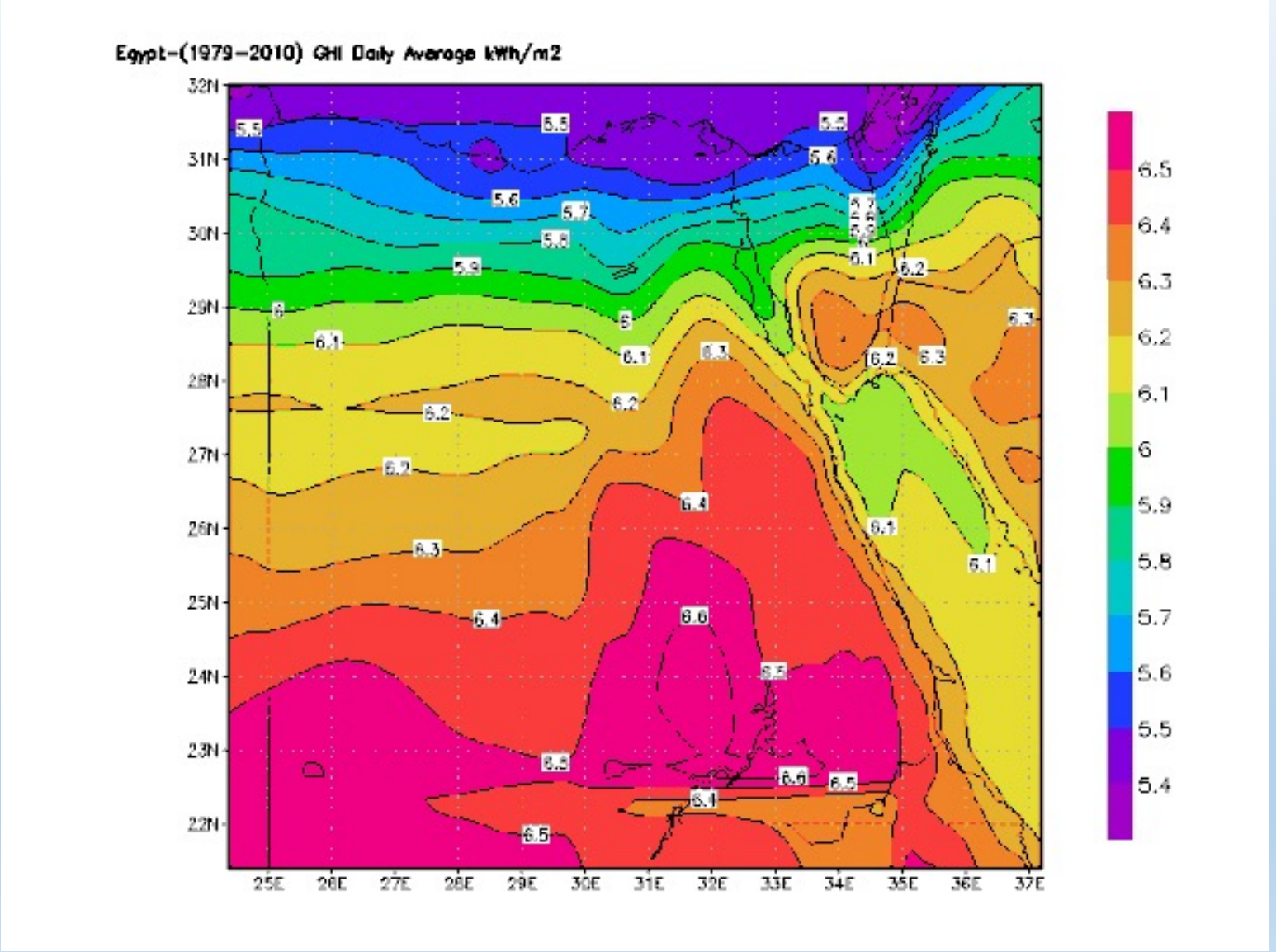

Figure (1) Solar distribution over Egypt (1979-2010)

Results and discussion (Surface solar radiation distribution over Egypt)

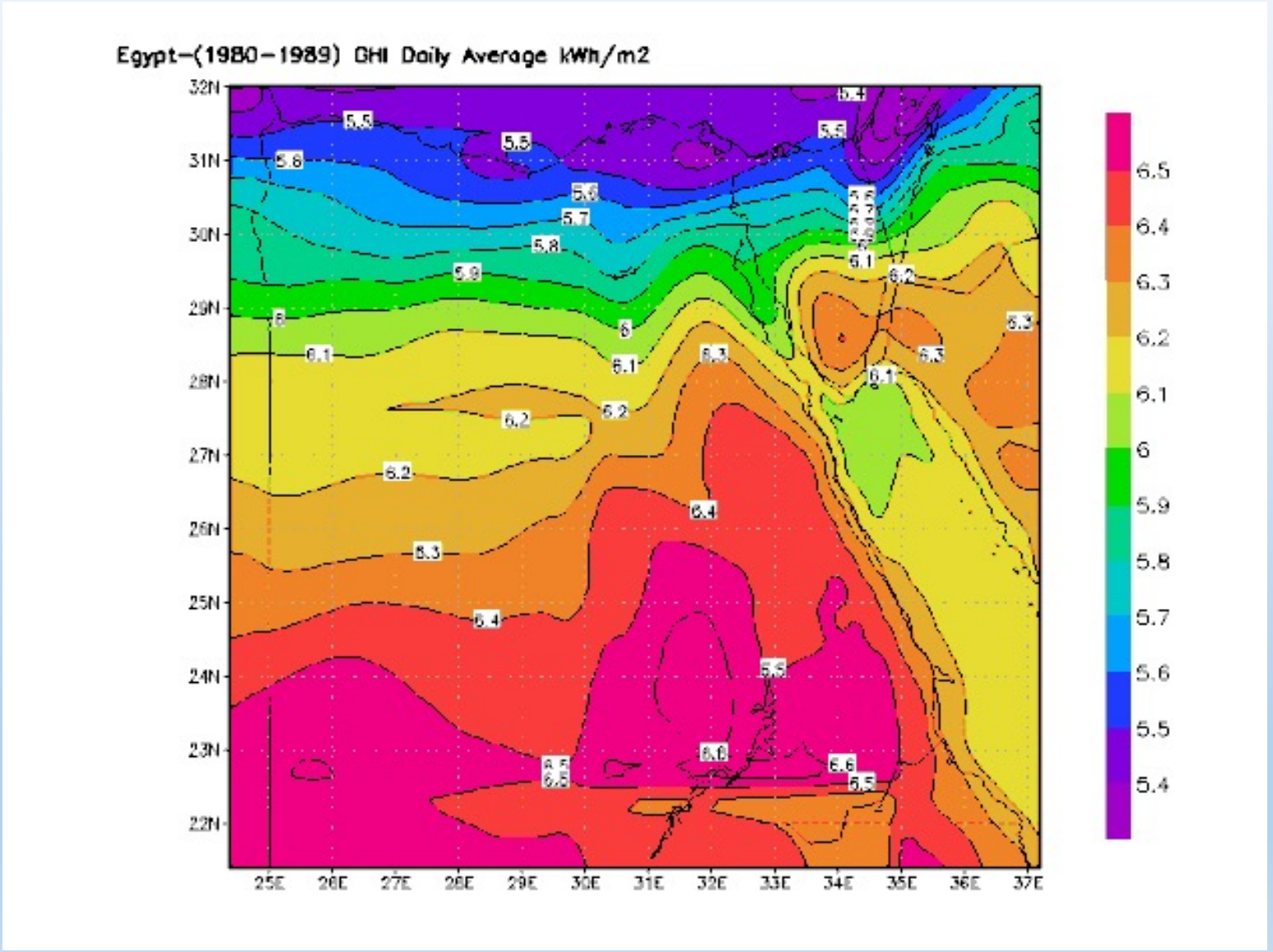

Figure (2) 1st decadal solar distribution over Egypt (1980-1989)

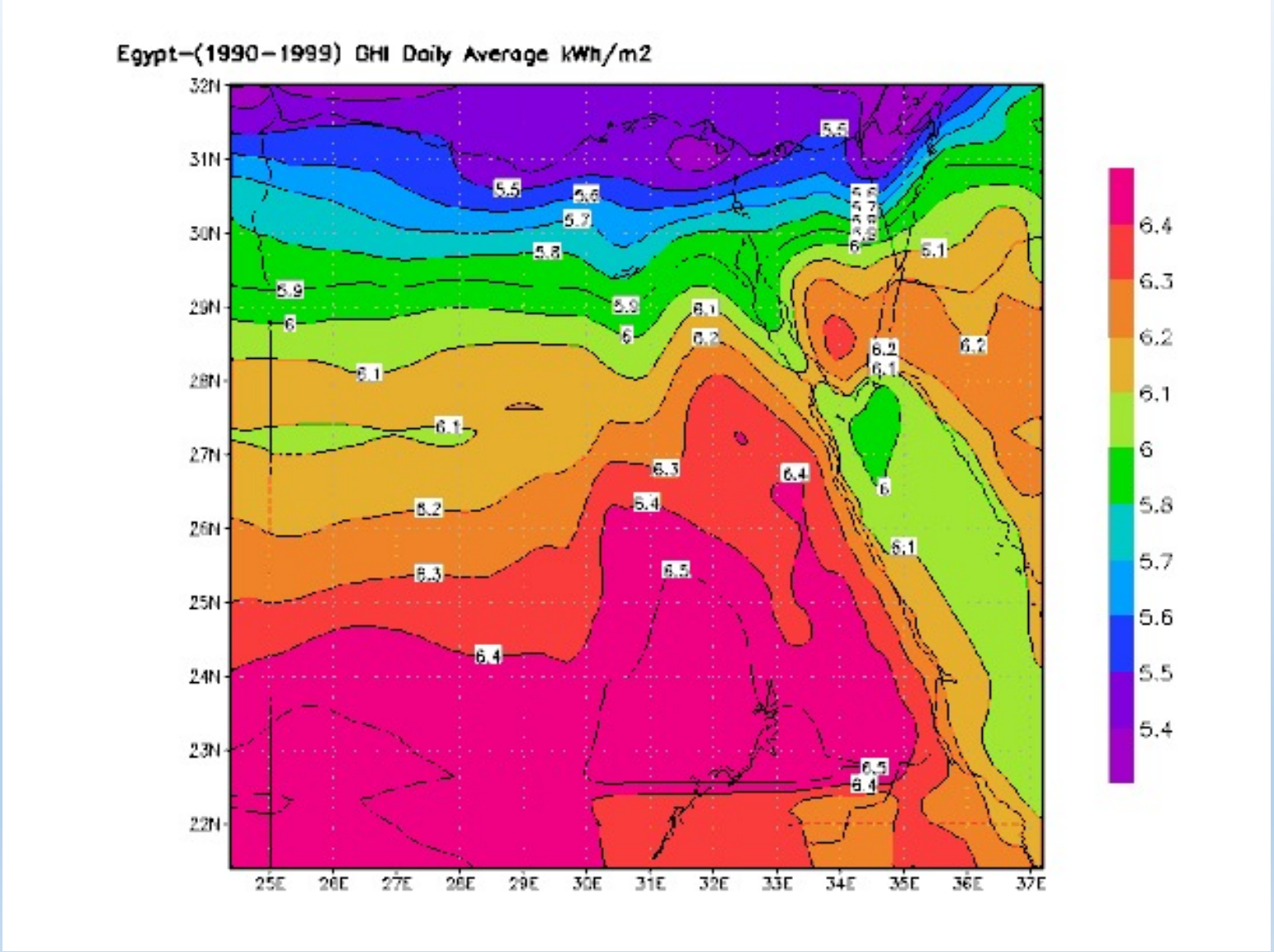

Figure (3) 2nd decadal solar distribution over Egypt (1990-1999)

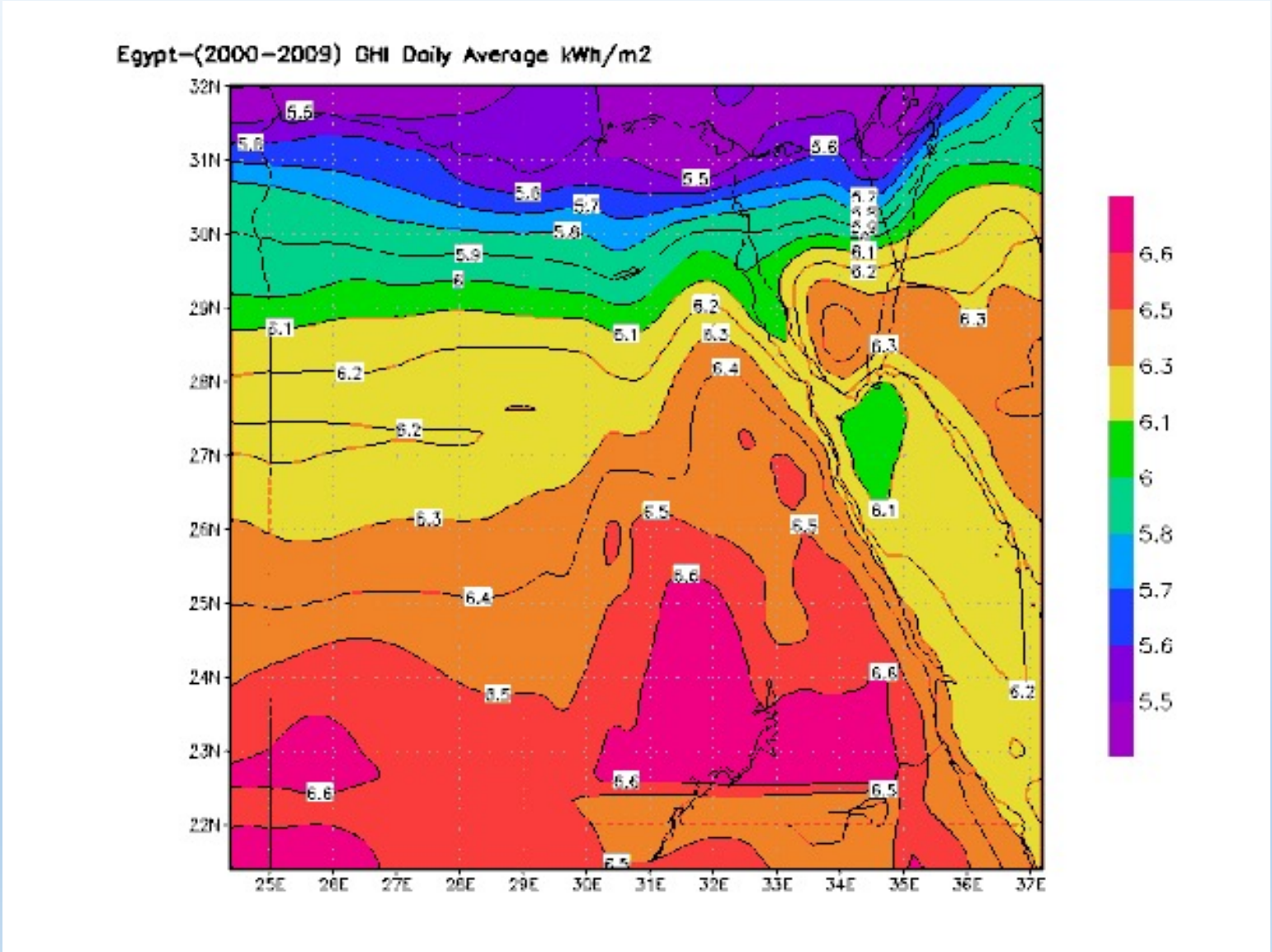

Figure (4) 3rd decadal solar distribution over Egypt (2000-2009)

Figure (1) represent daily average solar radiation received over Egypt from 1979 to 2010, from this graph it is noticed that the minimum daily average was 5.4 kWh/m^2 in the north and the maximum one was 6.6 kWh/m^2 in the south, also Upper Egypt received more solar radiation than north. Calculations based on this figure revealed that total average for Egypt domain is 6.18 kWh/m^2. Figure (2) represents the 1980s decade daily average for received solar radiation over Egypt. It is noticed that the decadal solar radiation has the same distribution as the whole period (1979-2010), but the calculation revealed that the total decade average is 6.174 kWh/m^2.

Figures (3) and (4) represent the 1990s and 2000s decade's daily average for received solar radiation over Egypt. It is noticed that the decadal solar radiation have the same maximum and minimum values, but there is a little redistribution happened especially in southern and western Egypt. And the calculation revealed that the 1990s total decade average is 6.132 kWh/m^2, while it is 6.223 kWh/m^2 for 2000s decade.

For more analysis over this domain we are going to study the solar radiation trend line during the whole period (1979-2010).

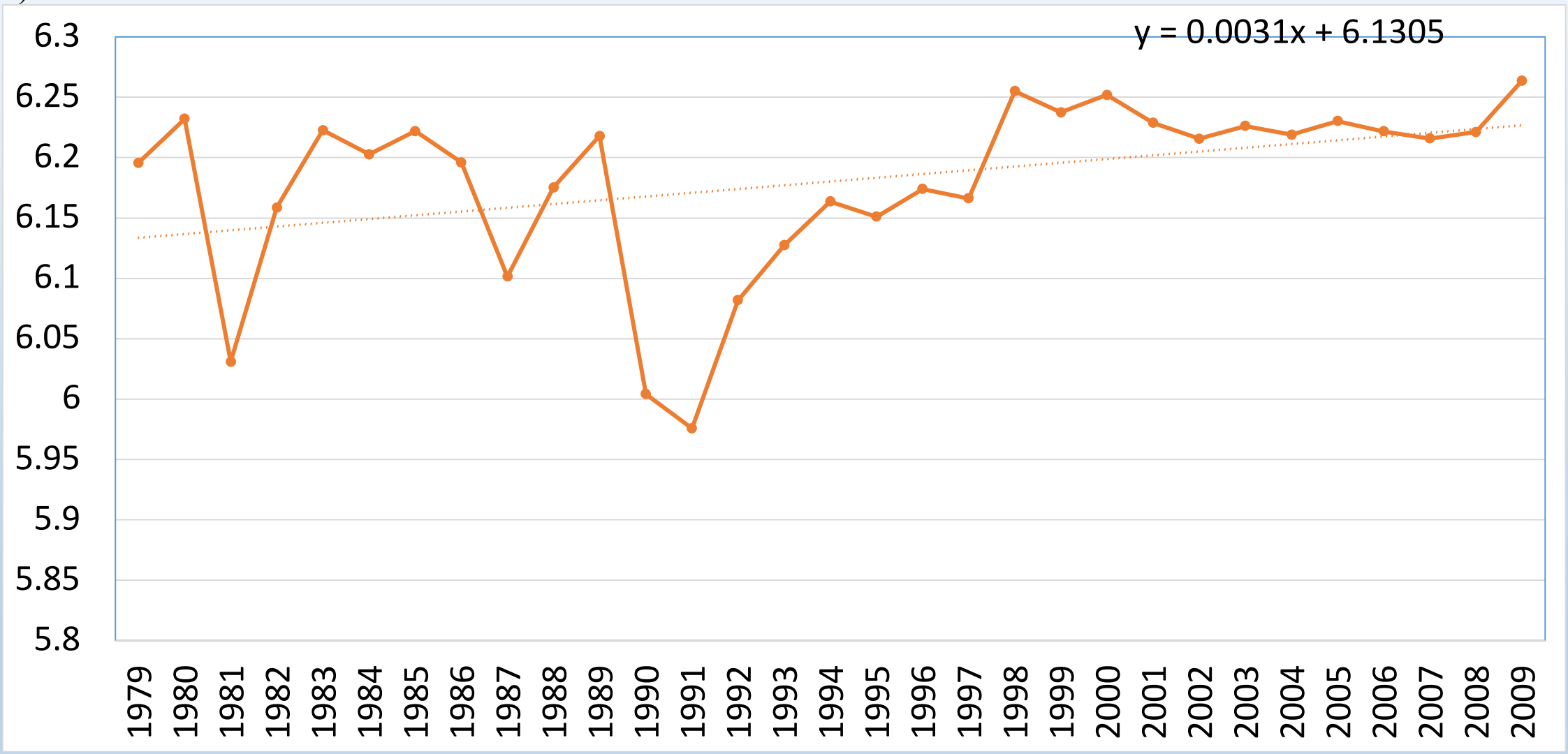

Figure (5): Surface solar radiation daily average (kWh/m^2) over Egypt (1979-2010)

For more analysis over this domain we are going to study the solar radiation trend line during the whole period (1979-2010).

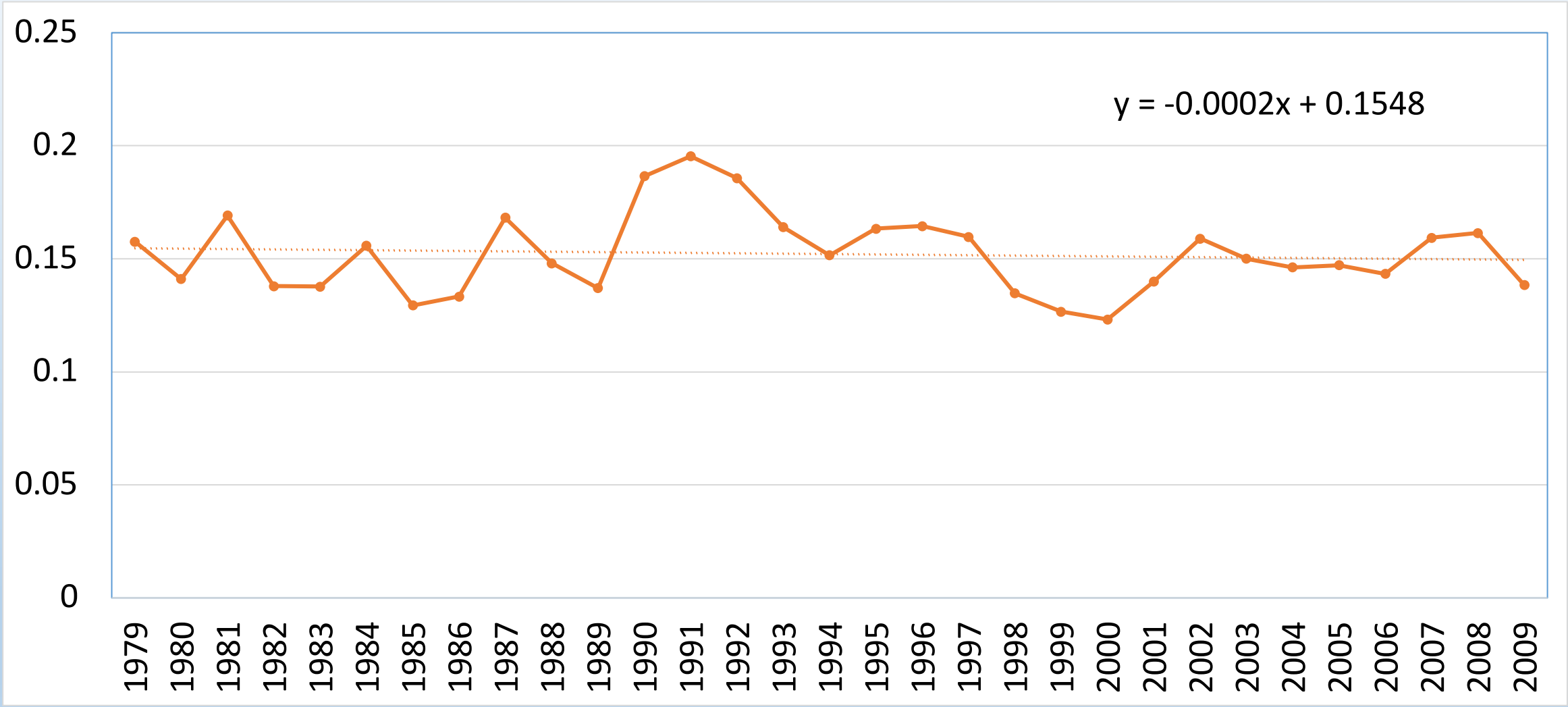

Figure (6): Total Cloud Cover (TCC) daily average over Egypt (1979-2010)

For more analysis over this domain we are going to study the solar radiation trend line during the whole period (1979-2010).

Figure (5) represents the daily average (1979-2010) over Egypt; this figure shows that there is an increase of the received solar radiation during this period. To study the reason for this increment we will check the cloud cover distribution for the same period. Figure (6) represents the total cloud cover (TCC); this figure shows decrease in the TCC over Egypt, so it could be the reason for the increase in the solar radiation at the surface.

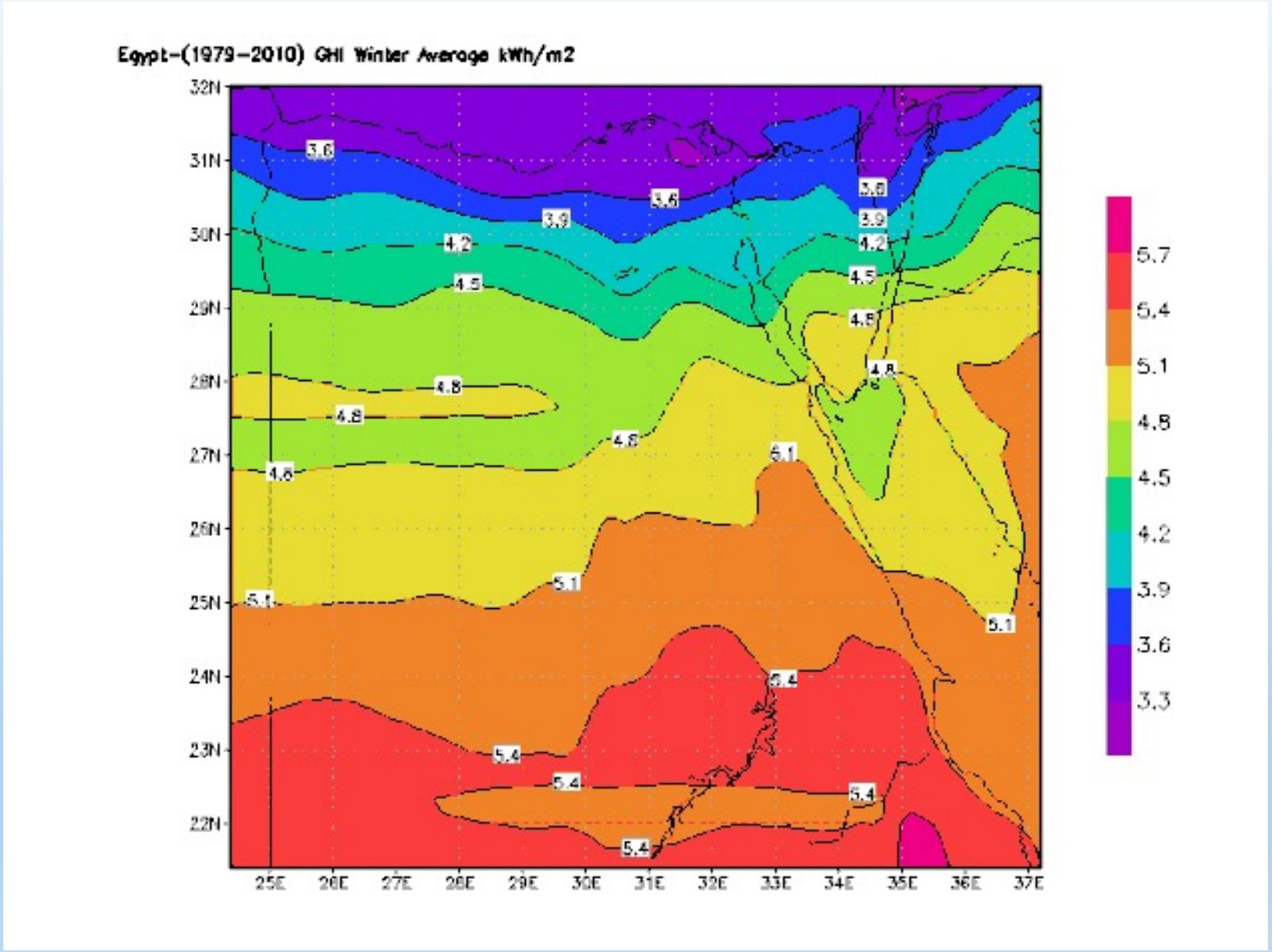

Figure (7): Solar distribution over Egypt in winter (1979-2009)

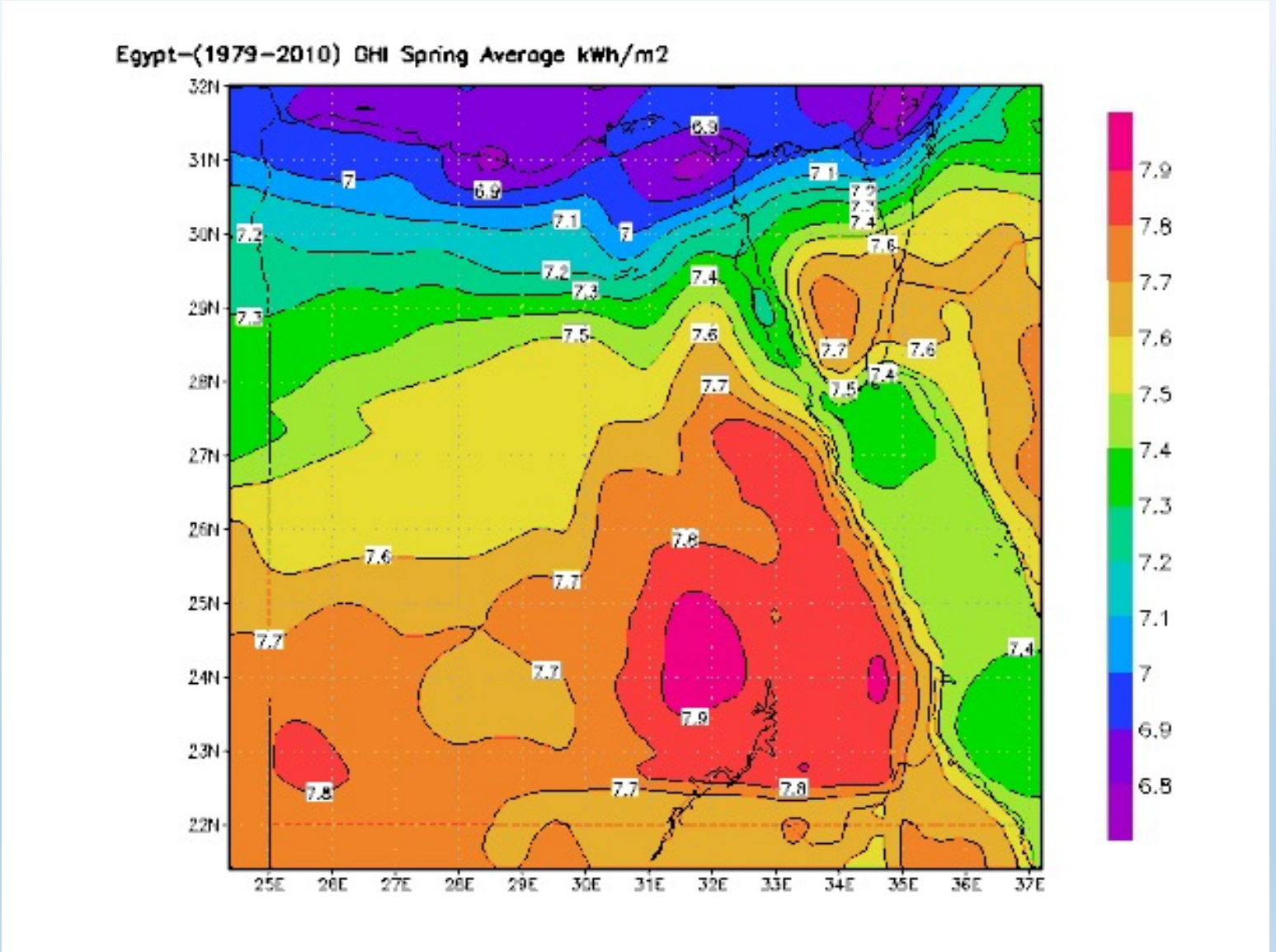

Figure (8): Solar distribution over Egypt in spring (1979-2009)

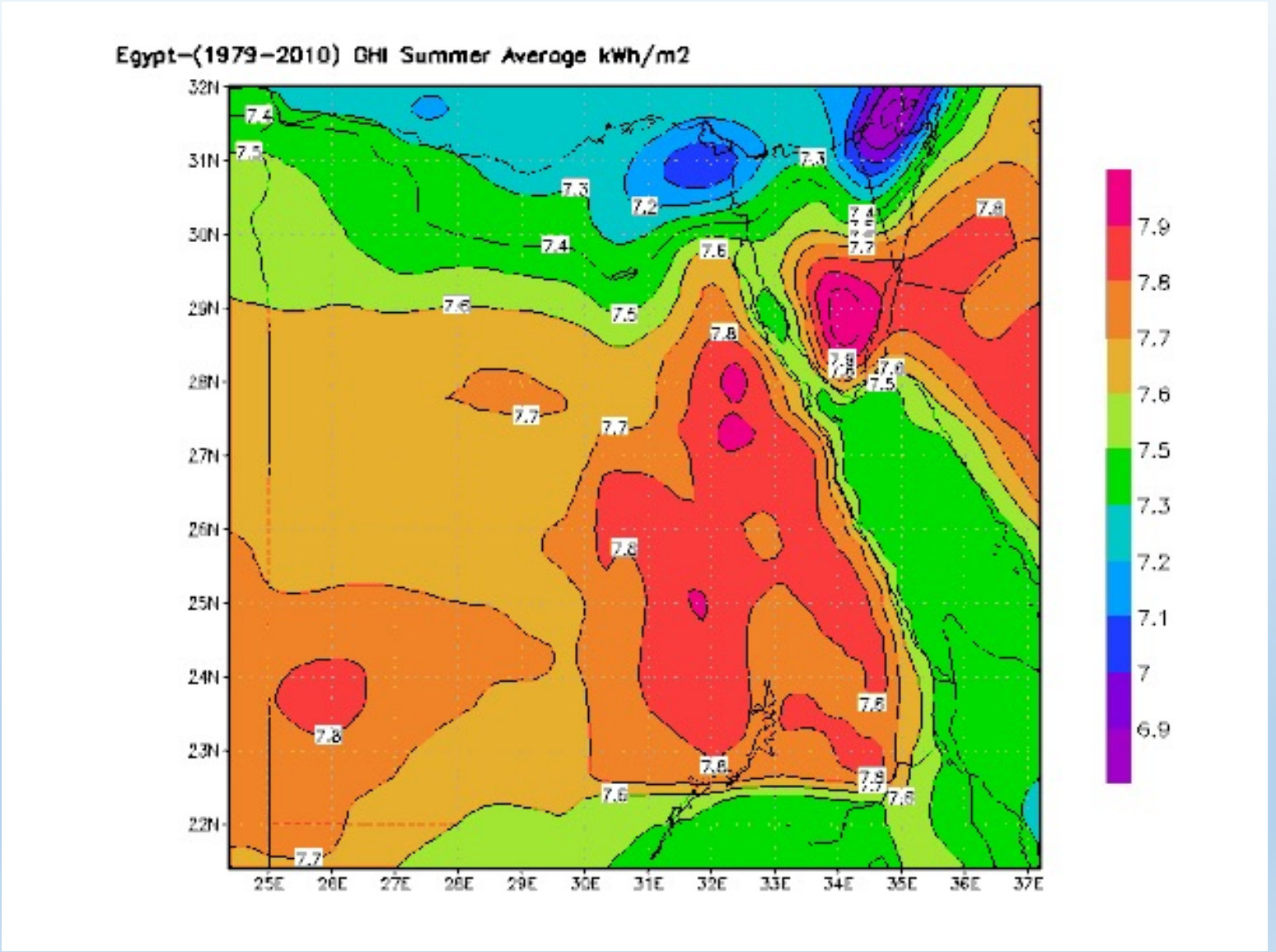

Figure (9): Solar distribution over Egypt in summer (1979-2009)

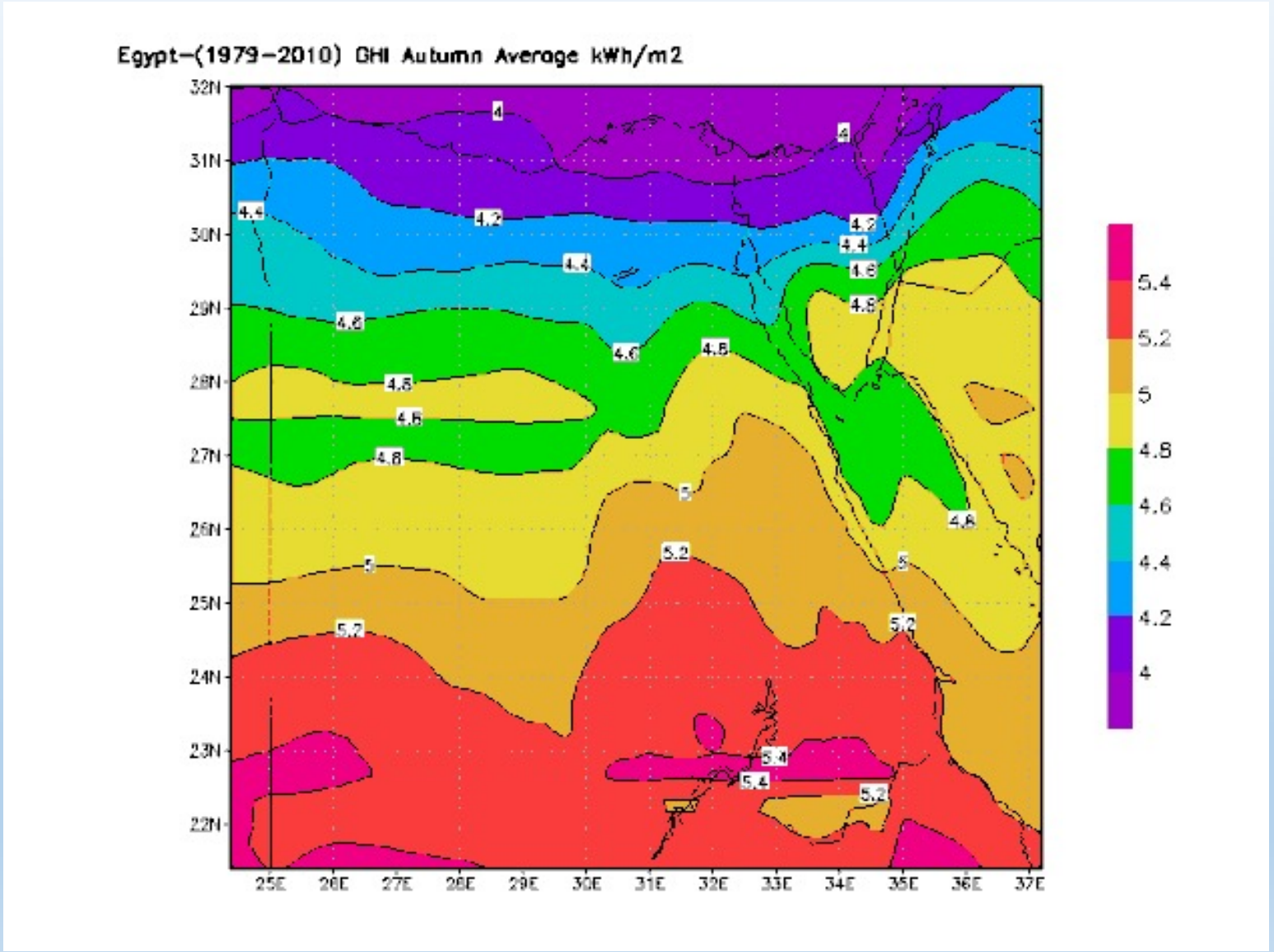

Figure (10): Solar distribution over Egypt in autumn (1979-2009)

Figure (7) represents solar radiation received over Egypt in the winter (1979-2010); from this graph it is noticed that the minimum winter daily average was 3.6 kWh/m^2 in the north and the maximum one was 5.4 kWh/m^2 in the south. And the calculation revealed that the total average for Egypt is 5.14 kWh/m^2. Figure (8) represents solar radiation received over Egypt in the spring (1979-2010); from this graph it is noticed that the minimum spring daily average was 6.9 kWh/m^2 in the north and the maximum one was 7.9 kWh/m^2 in the south. And the calculation revealed that the total average for Egypt is 7.666 kWh/m^2.

Figure (9) represents solar radiation received over Egypt in summer (1979-2010); from this graph it is noticed that the minimum summer daily average was 7.2 kWh/m^2 in the north and the maximum one was 7.8 kWh/m^2 in the south. And the calculation revealed that the total average for Egypt is 7.348 kWh/m^2. Figure (10) represents solar radiation received over Egypt in the autumn (1979-2010); from this graph it is noticed that the minimum autumn daily average was 4 kWh/m^2 in the north and the maximum one was 5.4 kWh/m^2 in the south. And the calculation revealed that the total average for Egypt is 4.563 kWh/m^2.

Q&A

Thank You

For your attention