

The Uniqueness of the Jerusalem Climate*

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Abstract

Jerusalem is shown to possess a unique climate on earth in the sense that it has the highest normal rainfall among stations with an abundance (≥ 3250 hours annually on the average) of solar radiation as well as the highest value of annual sunshine hours among the stations with similar or higher normal rainfall (~ 500 mm y^{-1}). This characteristic of having both copious amounts of solar radiation as in subtropical deserts but still have enough rainfall to be quite far from desert or semi-arid conditions is related to Jerusalem's special blessing by the author of the book of Psalms.

1. Introduction

The impetus for this investigation was two distant findings—distant in time of occurrence and in context—both relating to the climate of Jerusalem. The first was an argument made about a decade ago by Prof. D. Ashbel (personal communication, 1979) that he could not find inhabited locations which have that large amount of sun radiation like Jerusalem. He measured the global solar radiation in Jerusalem and compared it to other places in the Middle East and Europe. The second finding occurred to me just recently when I was looking for the explanation of the biblical sentence in Psalms describing Jerusalem as "beautiful for situation, the joy of the whole earth mount Zion" (Psalms, ch. 48, v. 3). The original word in Hebrew which was translated into "situation" is the word, "Nof." It appears only once in the whole Bible and its explanation is not straight-forward. In modern Hebrew, Nof means environment, panorama, or landscape observed from a high elevation or from a distance. Even Shoshan (1969), The Psalms' author does not make clear the original meaning of the word, not why it was used. I was surprised to find that one of the early well known commentators, Rabbi Bahye Ibn

*This note is dedicated to Professor Dov Ashbel who passed away on the 24th August 1989 and was considered the founder of Climatology and the pioneer of modern meteorology in Israel.

Paquda (1080 A.C.) suggested the word, Nof, to mean just climate and that Jerusalem's climate is beautiful. The purpose of this note is to show that Jerusalem's climate is, indeed, unique to the whole world as suggested by Prof. D. Ashbel based on radiation measurements and as may be implied from the biblical words in Psalms following Rabbi Bahye's interpretation.

2. The climate of Jerusalem

The focus here will be on the combination of two important climatic variables, solar radiation and rainfall. The region of Israel is clearly typified by a plentiful supply of solar radiation due to coinciding factors. First, it is located within the subtropical belt; second, it is typified by scarcity of clouds; and third, it has the desert character of the neighboring region. According to Houghton (1985, p. 1403), the average annual number of sunshine hours in Jerusalem is 3474 h. This value is particularly high due to its position on a mountain 760 m high and on the desert border; i.e., the Judean Desert with only about 100 mm annual rainfall is 20 km east of Jerusalem, Jerusalem itself has 492 mm annually. Of course, there are other locations exceeding this number of sunshine hours such as Phoenix, Arizona in the US with 3832 h or Cairo, Egypt with 3501 h. But, these as well as other locations reported in *Houghton's Handbook* with larger annual sunshine hours, consistently have significantly lower rainfall. Generally so little rainfall, that they can be considered desert-dry. Figure 1 illustrates the unique position of Jerusalem among about 70 other cities of the world. Jerusalem is represented by two stations: JER1 within the city center following the Handbook (492 mm, 3474 h) and the other, JER2, from Jerusalem's airport Atarot (with 572 mm, 3704 h). The sunshine duration for the second station follows A. Manes (personal communication), and puts it in even a more extreme location, but the following discussion will focus mainly on the handbook value, JER1, for the sake of confor-

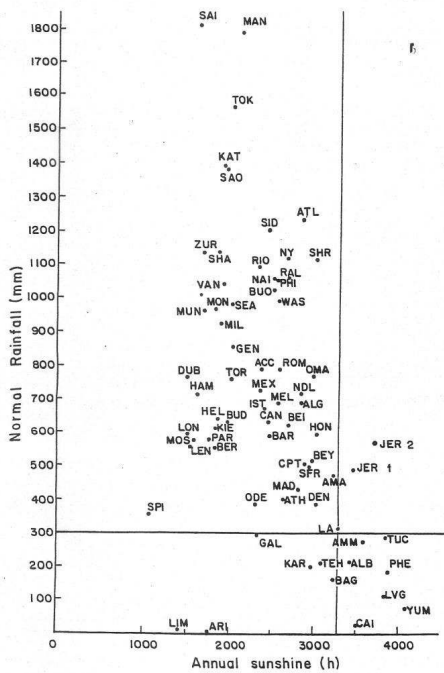


FIG. 1: Diagram for 69 stations - mostly major cities (see Table 1) - according to their normal rainfall (mm) and annual sunshine (h). Based on the data from Houghton's (1985) Handbook. Threshold lines are for 300 mm rainfall and 3250 h of sunshine. Jerusalem's stations JER1 and JER2 correspond to Jerusalem city center and Jerusalem's airport, Atarot, respectively.

mity in the comparisons with the other handbook stations. The closest to Jerusalem is Amarillo, Texas with 480 mm and 3240 sunshine hours as compared to 492 mm and 3474 h in Jerusalem. The highest rainfall station which just exceeds JER1 with the number of sunshine hours is Amman (AMM) in Jordan with 3590 sunshine hours but only 273 mm annual rainfall (492 mm in JER1). This rainfall amount fits into the category of a semi-arid climate. The sunny stations which exceed Jerusalem's normal rainfall of 492 mm include Beirut, Lebanon (BEY, 517 mm), Honolulu, Hawaii (HON, 590 mm); Omaha, Nebraska (OMA, 780 mm); Shreveport, Louisiana (SHR, 1140 mm); and Atlanta (ATL, 1240 mm) but they all stand near the 3000 sunshine hours compared to 3474 h in Jerusalem.

The critical lines of 3250 annual sunshine hours and 300 mm normal rainfall divide the figure domain into four quarters that could be classified as follows: The lower right quarter is the dry + sunny zone and the upper-left is the cloudy + rainy zone. Only a few

stations are found within the lower-left which is the dry + cloudy zone, but Jerusalem is the only station located within the fourth rainy + sunny quarter at the upper-right. This refers to all points (214) reported in the *Houghton's Handbook* (1985), (see Fig. 2) with one exception of the station Flagstaff, Arizona, with 3612 sunshine hours and annual rainfall of 530 mm. But this location is exceptionally high (2133 m) and is therefore, indicated by a star in Fig. 2 along with other stations whose altitude exceeds 2000 m. High altitude stations were excluded in this discussion because they normally present difficulties for human living, as for example the very low temperatures during winter. This is also reflected in the relatively low population in Flagstaff. In addition, the second station of Jerusalem, JER2, which is located at a distance of only about 10 km from town center and elevation of 757 m, exceeds even the Flagstaff values of rainfall and solar sunshine duration.

It should be noted that the maximum in sun duration hours in Jerusalem is also expressed in the global

TABLE 1. Stations' abbreviations in Fig. 1.

Abbr.	Full name	Abb.	Full name
ACC	Accra	LVG	Las Vegas
ALB	Albuquerque	MAD	Madrid
ALG	Algier	MAN	Manila
AMA	Amarillo	MEL	Melbourne
AMM	Amman	MEX	Mexico City
ARI	Arica (Chile)	MIL	Milano
ATH	Athens	MON	Montreal
ATL	Atlanta	MOS	Moscow
BAR	Barcelona	NAI	Nairobi
BEI	Beijing	NY	New York
BER	Berlin	ODE	Odessa
BEY	Beirut	OMA	Omaha
BUD	Budapest	PAR	Paris
BUE	Buenos-Aires	PHE	Phoenix
CAI	Cairo	PHI	Philadelphia
CAN	Canbara	RAL	Raleigh
CPT	Capetown	RIO	Rio De Janeiro
DEN	Denver	ROM	Rome
DUB	Dublin	SAI	Saigon
GAL	Galveston	SAC	São Paulo
GEN	Geneva	SEA	Seattle
HAN	Hamburg	SFR	San Francisco
HEL	Helsinki	SHA	Shanghai
HON	Honolulu	SHR	Shreveport (Louisiana)
IST	Istanbul	SID	Sydney
JER1	Jerusalem (center)	SPI	Spitzbergen
JER2	Jerusalem (airport)	TEH	Tehran
KAR	Karachi	TOK	Tokyo
KAT	Katmandu	TOR	Toronto
KIE	Kiev	TUC	Tucson
LA	Los Angeles	WAS	Washington
LEN	Leningrad	YUM	Yuma
LIM	Lima	ZUR	Zurich
LON	London		

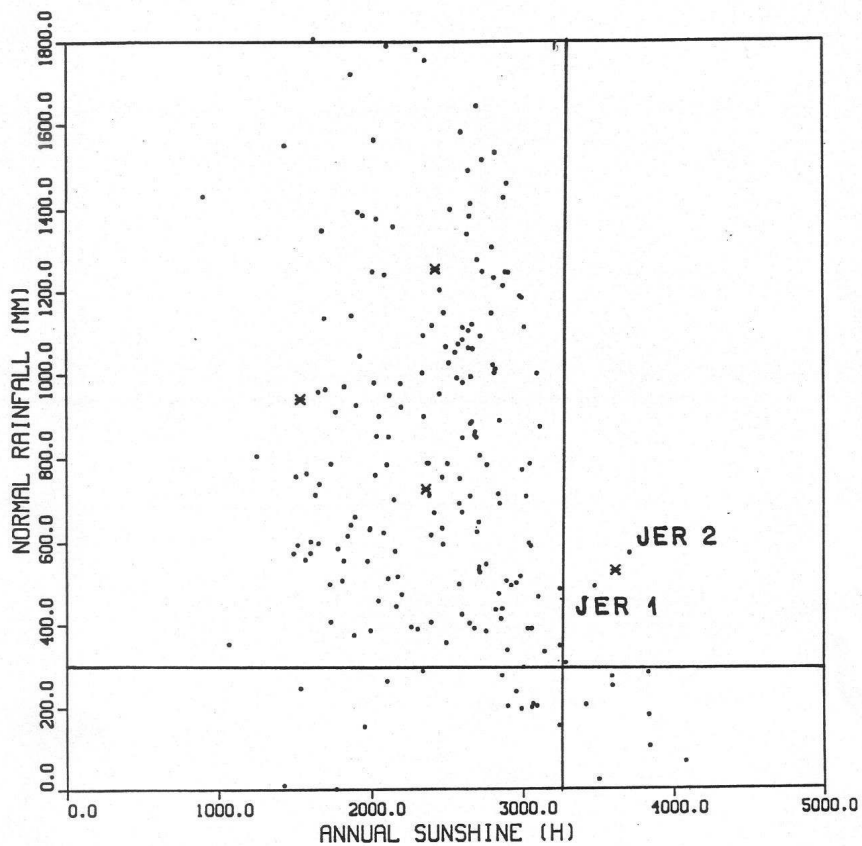


FIG. 2: As in Fig. 1 but for 202 stations out of 214 reported in Houghton's (1985) Handbook. The twelve additional stations fall outside of the diagram's range because their rainfall exceeds 1800 mm. A star * denotes stations whose elevations exceed 2000 m. The star between JER1 and JER2 represents Flagstaff, Arizona, with elevation of 2133 m.

radiation. According to Budyko (1974), Jerusalem obtains about $190 \text{ kcal cm}^{-2} \text{ yr}^{-1}$ of average annual global radiation, which is equivalent to a daily average of $5290 \text{ cal cm}^{-2} \text{ d}^{-1}$. This value is exceeded in Budyko's map in only a few places and mainly in the desert regions of Sahara, Saudi-Arabia and Arizona-Mexico. These findings illustrate that Jerusalem's climate is indeed unique to the whole world. The significance of this uniqueness will be discussed next.

3. Discussion and conclusions

There are two major natural resources for energy and life on earth: solar radiation and rainfall. Both sunshine and rain are poured free everywhere on earth in

various doses. Mankind has always realized the vitality of these resources to natural life. As other energy resources are gradually being exploited, appreciation for these two increases. Of course, we have noticed that when rainfall is abundant, sunshine hours will generally decrease, as in the tropics, yet where there is plentiful supply of solar radiation, rainfall is normally scarce, as in the subtropical deserts. The city of Jerusalem was shown to have both plentiful solar radiation as in the subtropical deserts but still has enough rainfall to be quite far from desert or semi-arid conditions. This may be the special blessing referred to by the Psalms' author who announced Jerusalem as "beautiful for situation, the joy of the whole earth, Mount Zion."

In summary, a poetic view of the unusual optimal sharing between the solar radiation and rainfall in Jerusalem was given by the great Nobel prize winner in literature, Shmuel Yosef Agnon, in his *Tehilla* (Glory) as translated by Penueli and Ukhmani (1965, p. 26):

"It was the start of the early rains. Rain was already falling and the sun was hidden in clouds. Outside Eretz* Israel people regard such a day as part of the spring. But in Jerusalem, which enjoys seven or eight months of sunshine, any day when the sun does not shine brightly seems to be winter, and folk seek shelter in the houses and the courtyards and wherever there is a bit of roof.

I went strolling here and there, drinking in the scent of the rains musically falling and screening themselves in many-colored mists, and gathering between the stones in the street, and slapping against the walls of the houses, and dancing on the roofs, and dripping and dropping into puddles and pools which were sometimes muddy and sometimes clear and gleaming

*Eretz - state or land in Hebrew.

in the beams of sun that came twinkling through at intervals between the clouds to see whether the water was easing off; for in Jerusalem the sun wants to do its duty even on a rainy day."

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