JP1.1 WILL THE REAL LOS ANGELES STAND UP: IMPACTS OF A WEATHER STATION'S RELOCATION ON CLIMATIC RECORDS (AND RECORD WEATHER)

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1. INTRODUCTION

In August, 1999, the National Weather Service (NWS) moved the official downtown Civic Center weather station to the University of Southern California (USC) campus, a 3.78 miles (almost 6 km) distance to the southwest of its previous location near city center at the Department of Water & Power (DWP). This was not the first move of the downtown weather station, but it was the largest move and one that took it away from the built-up city center and to a park-like setting on the campus of USC (fig 1). The move also moves the station almost 6 km closer to the coast, which influences local climate considerably (fig 2). The elevation also changes from the original site, which is 270 ft. (almost 90 m) above MSL to the campus site at 180 ft. (almost 60 m). Since its establishment in 1877, the Los Angeles Civic Center has had 8 different locations, from 4 feet to over 220 feet above the ground (Bruno and Ryan 2000). Climatologists have suggested making a correction to data when a station moves substantially in the vertical (Davey and Pielke 2005; Karl and Williams 1987; Peterson 2006). Other changes due to relocation can also alter climatic data significantly, so that some stations are even given a new station number (ie. WMO, COOP).

In climatic studies, where a station's time series is investigated, station relocations may cause a discontinuity in the record. This can be tested using nearby stations to see if the discontinuity is also present nearby or due to the relocation. In this case, we are fortunate in that the original location (DWP) is still in operation and can be compared to the new site.

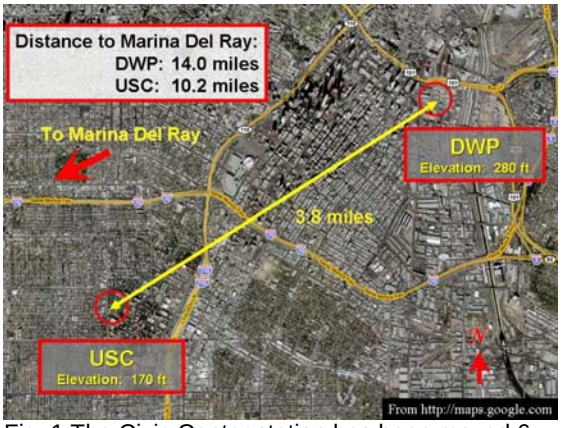

Fig. 1 The Civic Center station has been moved 6 km (3.8 mi) from downtown toward the coast.

Aerial photos show the land use differences between the two sites. The USC site resembles a park, with tall shade trees just west of the instrument shelter (fig 3). The shelter is also above a grass area. The DWP site is located on the roof of a 2-story downtown parking structure, with no immediate vegetation or obstructions (fig 4). The DWP location is also closer to where one would expect the urban heat island peak (Landsberg 1981).

From its change seaward and to lower elevation as well as its change in land use, it is not surprising that there has been a significant change to both temperature and precipitation records at the new location in comparison to the old. This study looks at the magnitude of change in the records since 1999 to see if it will bias climatic studies that require long, continuous data for downtown Los Angeles.

Fig 2 The USC campus is about 1/3 the distance to the airport and Marina Del Rey.

2. DATA AND METHODS

Monthly temperature data (mean, max and min) for LA/USC for the period August 1999 through June 2006 were available from the LA NWS website at: http://www.nwsla.noaa.gov . Monthly precipitation values for the same period for LA/USC were also from the same website. DWP records for the same period were made available by Dan Resch, LA DWP.

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Fig 3 USC weather station is situated in a park-like setting, with tall shade trees to the west.

Fig 4 DWP weather station is located atop a downtown parking structure.

3. RESULTS

3.1 Temperature

Table 1 shows the comparative Tmean, Tmax and Tmin for the USC and DWP locations. For the entire period of nearly 7 years, DWP was warmer by 1°C (1.8°F) for the maximum, about 0.5°C (0.9°F) higher for the mean, but the same for the minimum temperature. For Tmax, the largest differences are in summer and early fall, while the smallest differences are in late winter and spring. For Tmin, DWP was actually cooler than USC in spring and summer, and warmer in fall and winter, or practically the reverse of Tmax. There can be two explanations for this seasonality. The first deals with the distance from the ocean. In southern California, the cool ocean current keeps the coast cooler in summer and milder in winter than the inland areas. In comparing USC to the coastal airport, LAX, the downtown inland site is twice as warm as LAX in summer as it is in winter (Bruno and Ryan 2000). The other explanation has to do with land use. Because of the abundance of trees and grass, the park-like USC tends to be cooler during the day than the urbanized DWP. At night, the trees can block outgoing radiation, while the moisture in the watered lawns tends to absorb more heat than the drier, open DWP site. In summer, the greater sunlight would increase the differences due to land use. In winter, the trees would have more shading due to the lower sun and less heating or cooling than in an open area. Overall, both land use and distance from the ocean account for the large drop in Tmax and very little change in Tmin. At approximately 20 km (12 miles) between LA Civic (DWP) and LAX, the mean difference and annual temperatures is 1.7°C (3°F). The move of 6 km, or nearly 1/3 of that distance has resulted in 0.5°C (0.9°F), very roughly a 1/3 of the temperature differences between DWP and LAX.

3.2 Precipitation

Table 2 shows the annual differences in precipitation for USC and DWP. For the nearly 7 years, DWP averaged 1.0" (nearly 26 mm) more than USC. The differences vary considerably from +3.21" (DWP-USC) to -0.39" (+82 mm to -10 mm). The lower precipitation at USC is not surprising as rainfall in the Los Angeles Basin generally increases with elevation and distance from the coast (Bruno and Ryan 2000). Rainfall comes mainly from Pacific winter storms moving inland from a westerly direction. As the air mass is lifted by coastal mountains, precipitation usually increases with elevation on the windward slopes. DWP is about 6 km further inland than USC and over 30 m (100 ft) higher. If we compare DWP with the coastal airport station, LAX, downtown is nearly 3" greater in annual precipitation (14.77 compared to 12.01"). USC, being a 1/3 of the distance to LAX, receives exactly a 1/3 of this 3" difference less than DWP. In the rainfall year of 2004-05, this move to USC resulted in the official downtown station missing being the wettest year on record (see below).

3.3 Weather Records

In the 2004-5 water year (July 1-June 30), the USC rain total was 37.25" (946.2 mm), second only to 1883-84, which had 38.18" (969.8 mm). However, DWP recorded 38.32 (973.3 mm), which would have been the wettest year on record for downtown Los Angeles had not the station moved. On the other hand, in 2001-02 the driest year on record was broken at USC, 4.91" (about 125 mm). Had the station not moved, that water year would have just been one of the driest.

The heat waves in June and July 2006 broke several temperature records throughout the state, including several in Los Angeles, including a 119°F all-time record high for a city station on July 22nd at Pierce College, Woodland Hills. At USC, the all-time record for highest temperature minimum for the date June 4th was set with 68°F (previous record being 66°F in 1997). At DWP, the Tmin was 70°F.

The highest minimum temperature would have been broken for the three days consecutively, June 3-5, 2006. In July USC temperatures broke or tied 7 all-time records, mostly for highest minima. DWP broke or tied 9 records. July was the hottest on record at both USC and DWP. USC's average temperature was 79.9°F, while DWP averaged 80.0°F, both beating the record set in 1985 at 79.2°F. The monthly average maximum and minimum at USC was 89.7°F and 70.1°F, breaking the records of 88.8°F (1985) and 69.6°F (1984). DWP's monthly max, min were 90.3°F and 69.6°F.

4. CONCLUSIONS

By moving the official LA downtown weather station location, weather is now recorded as cooler, drier and less extreme than at its original DWP location. Climatologists have noted the problems concerning station moves. By shifting the official downtown Civic Center station to a park-like environment about 6 km closer to the beach, there appears to be a discontinuity in the records. Maximum and mean temperatures are cooler, especially Tmax. Minimum temperatures are similar for the two sites. DWP also records higher rainfall amounts, although there is great variability monthly and inter-annually. Extremes occur less often at USC than DWP.

Since the original downtown station is still operational, we suggest using DWP records as the official Los Angeles Civic Center station and making USC one of the many city COOP stations, such as its rival, UCLA.

Acknowledgments
The study would not have been possible without the assistance of Dan Resch, District Hydrographer, LA Metro Area, DWP, for providing DWP weather records.

5.0 References

Bruno, D. and G. Ryan, 2000: Climate of Los Angeles, California. NOAA Tech Memo, NWS WR-261, Western Region, Salt Lake City, UT.

Davey, C. A. and R. A. Pielke, Sr., 2005: Microclimate exposures of surface-based weather stations: Implications for the assessment of long-term temperature trends. *Bull Amer Meteor Soc*, **86**, 497-504.

Karl, T. R. and C. Williams, 1987: An approach to adjusting climatological time series for discontinuous inhomogeneities. *J Climate Appl Meteor*, **26**, 1744-1763.

Landsberg, H., 1981: The Urban Climate. New York: Academic Press.

Peterson, T. C., 2006: Examination of potential biases in air temperature caused by poor station locations. *Bull. Amer. Meteor. Soc.*, **87**, 1073-80.

Table 1. Average Tempertures for DWP, USC for Aug. 1999-Jul. 2006

	Tmax	
	DWP	USC
1999*	79.5	77
2000	75.9	74.3
2001	74.4	72.8
2002	74.9	73.5
2003	76.8	74.5
2004	76.2	74.3
2005	75.6	73.9
2006#	71.9	71.2
Avg	75.6	73.8
DWP-USC		1.8 (1°C)
	Tmin	
	DWP	USC
1999*	56.6	55.8
2000	56	55.8
2001	55.3	55.3
2002	55.1	55.4
2003	56.5	56.4
2004	56.3	56.5
2005	56.1	56.2
2006#	53.2	53.6
Avg	55.7	55.7
DWP-USC		0
* 8/1-12/31	# 1/1-7/31	

Table 2. Average Precipitation (in.) for DWP, USC for the Water Year (July1-June30) 1999-2006.

	DWP	USC
1999*	12.43	11.57
2000	17.53	17.94
2001	6.12	4.92
2002	19.7	16.49
2003	10.33	9.25
2004	38.32	37.96
2005	13.84	13.16
Avg	16.90	15.90
DWP-USC		1.00 (25.4mm)