Precipitation Assignment 2

Task review: Select two station pairs with 10 year period of record to compute the median, mean and standard error of the wet and dry day lapse rates for winter and summer period. Compare the results with adiabatic lapse rates and comment the results based on the Minder et al JGR paper.

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Group Member: Qian Cao, Jiawei He

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1. Station selection

We pick two pairs of stations in California based on the elevation difference and the completeness of the data. The first pair is Balch Power House (Point A in Figure 1) and Grant Grove (Point B in Figure 1). The second pair is Paradise (Point D in Figure 1) and Mineral (Point C in Figure 1). Detailed information of the stations is shown in Table 1.

Figure **1** Station location

2. Calculation Results

We picked 10-year data for each pair and the missing data is filled by linear interpolation. Firstly, we calculated the daily mean temperature averaging Tmax and Tmin and got the daily lapse rate, which is the daily mean temperature difference divided by the elevation difference between two stations in pair. Secondly, we separated the summer (Jul-Sep) and winter months (Dec-Feb) from the data. The rainy season is in winter for California. There is much less rain in summer than in winter. In order to have some storm days in summer, we picked a threshold for storm days, 10 mm, based on the precipitation amount in summer. The summation for daily lapse rates statistic is shown in Table 2.

In order to compare with the Minder et al JGR paper, we also calculated the monthly mean lapse rates, which are shown in Figure 2 and Figure 3. For the monthly

mean lapse rate of Tmax (the blue line), first we use the daily Tmax in the station pair to calculate the daily lapse rate of Tmax and then average it over the month in all years. So is the same with Tmin (the green line).

3. Discussion

(1) The lapse rates of storm days for both pairs are high than the wet adiabatic lapse rate and the lapse rate of dry days are lower than the dry adiabatic lapse rate. The mean lapse rate of dry days of pair two is closer to the dry adiabatic lapse rate than pair one, which means the humidity is lower at Paradise and Mineral.

(2) The results do show the seasonal and spatial variability in lapse rate indicated by Minder et al JGR paper. The mean lapse rate in summer storm days is higher than that of winter storm days. So is that in dry days. The mean lapse rate of pair two is generally higher than pair one.

In the paper it says that the lapse rates change appreciably through the year, with largest lapse rates for Tmax in spring and smallest lapse rates for Tmin in summer in their study region (cascades in WA). We plot the monthly mean value for comparison. We can see in Figure one that for pair one the smallest lapse rates for Tmin is in winter and the largest lapse rate for Tmax is in summer, which indicates that the pattern is influenced by spatial variability.

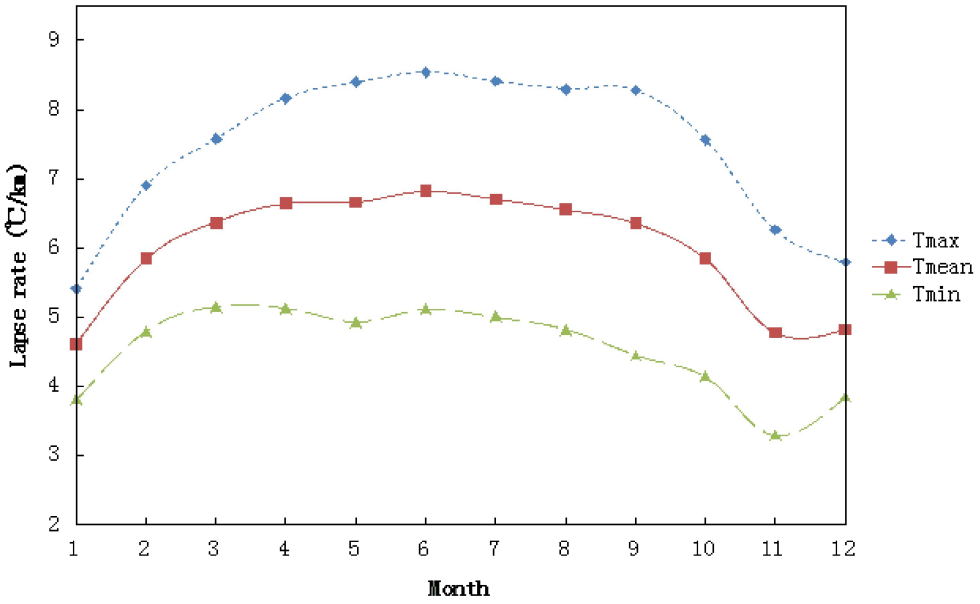

Figure **2** Mean seasonal cycle of lapse rate for pair one (2001-2010)

It also says in the paper that lapse rates of COOP Tmax exceed lapse rates of Tmin in their study region (cascades in WA) in all months. But we can see in Figure 3 that lapse rates of COOP Tmin exceed lapse rates of Tmax for pair two in all months. This may be due to station selection and spatial variability in lapse rate.

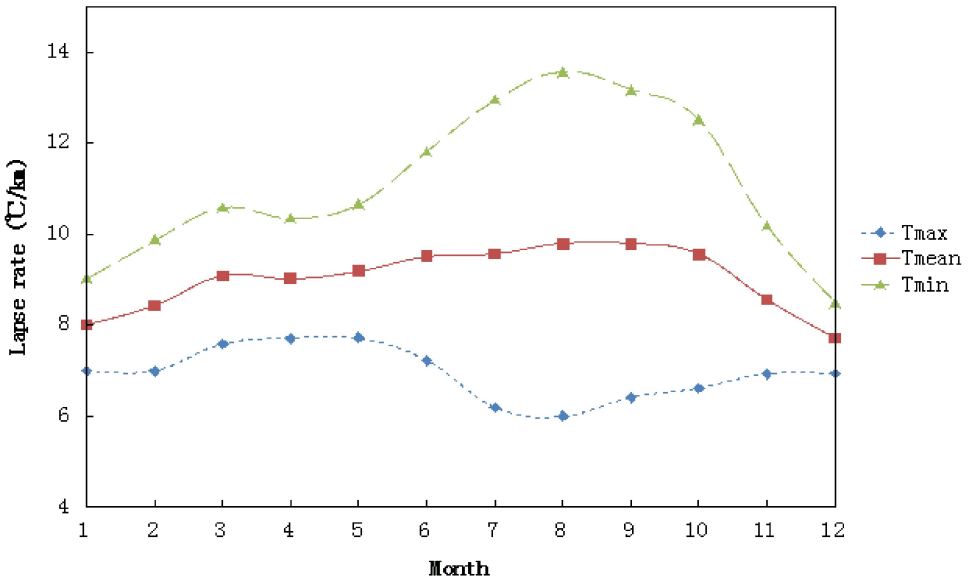

Figure **3** Mean seasonal cycle of lapse rate for pair two (1994-2003)

In general, the results indicate the seasonal and spatial variability of lapse rates. Also, the seasonal cycle varies from place to place. For example, the seasonal cycle in Washington is different from that in California. Besides, only the mean lapse rate of pair one in summer dry days is close to 6.5 ℃/km. The lapse rates for different seanson and weather ranges from -1.94 to 3.27 ℃/km compared to this value in the two station pairs we selected. So it is important to choose appropriate lapse rates for local study areas.

Table **1** Station information

	Station Name	State	ID	Latitude	Longitude	Elevation (m)	Side of Cascade	Elevation difference (m)	Calculation period
Pair one	Balch	CA	040449	36.91	-119.09	524	East	1487	2001-2010
	Grant Grove	CA	043551	36.74	-118.96	2011	East		
Pair two	Paradise	CA	046685	39.75	-121.62	533	East	953	1994-2003
	Mineral	CA	045679	40.35	-121.61	1486	East		

Table **2** Lapse rates comparison

		"storm days" criterion (mm)	Weather type	Number of days	Lapse rate (℃/km)					Adiabatic lapse rate (℃/km)		difference (℃/km)
					max	min	median	mean	standard error	wet	dry	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)		(7) - (9)
Pair one	summer	10	stormy	12	9.32	5.59	7.09	7.15	0.91	5		2.15
			dry	897	10.25	2.05	6.53	6.52	1.14		9.8	-3.28
	winter	10	stormy	226	9.51	1.67	6.24	6.07	1.40	5		1.07
			dry	606	8.95	-2.61	4.66	4.56	2.01		9.8	-5.24
Pair two	summer	10	stormy	15	11.95	3.50	7.87	7.75	2.36	5		2.75
			dry	878	15.74	2.91	9.91	9.77	2.10		9.8	-0.03
	winter	10	stormy	337	12.24	1.75	6.71	6.98	1.76	5		1.98
			dry	474	14.58	3.21	8.75	8.81	1.93		9.8	-0.99