

PRECIPITATION EVENTS IN CENTRAL CHILE AND ITS RELATION WITH THE MJO

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1.- INTRODUCTION

Precipitation in central Chile is mainly associated with eastward moving fronts and cyclonic perturbations with more than 90% of the precipitation occurring during the May – September period. The interannual variability is related to the El Niño Southern Oscillation (ENSO) (Aceituno 1988, Montecinos and Aceituno 2003), while the interdecadal behavior has been linked to the Pacific Decadal Oscillation (PDO) (Montecinos et al. 2003). However, the mechanism(s) behind the intra-seasonal variability of precipitation in central Chile remains as a topic of investigation. Thus, a pilot study that relates the precipitation in central Chile and the Madden and Julian

Oscillation (MJO) was conducted for the 1979-2001 period. For these, daily precipitation data from seven representative stations located between 30°S and 38°S (Figure 1) were used, along with the MJO index derived by Erik Maloney that it is available from 1979 to 2001 at www.jisao.washington.edu/data_sets/mjo/ (Maloney and Kiehl 2002). This index results from the first 2 principal components of the pass band filtered 30-90 day of the equatorial (5°N – 5°S) 850 hPa zonal wind from the NCAR/NCEP reanalysis (Maloney and Kiehl 2002). When the values are negative the convective regional is displaced toward the western Pacific Ocean and when it is positive the convective region is the Indian Ocean sector.

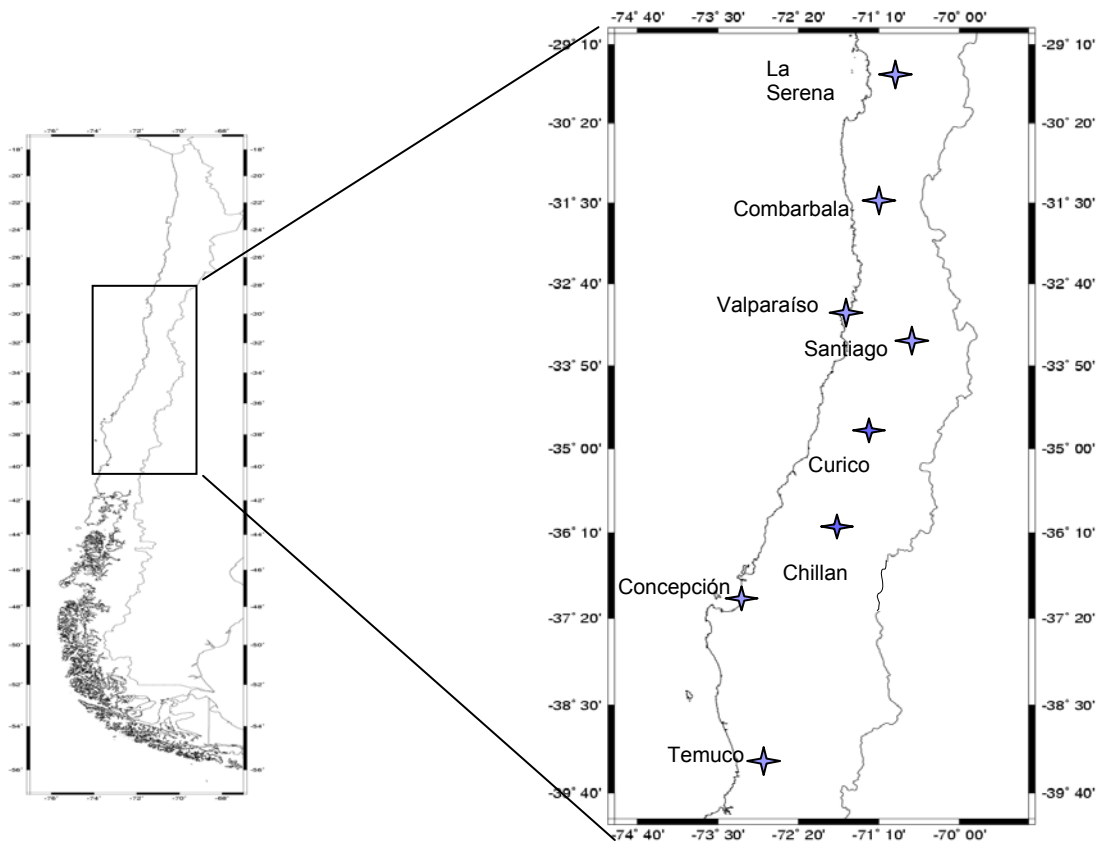


Figure 1. Location map showing the meteorological stations used for the precipitation analysis.

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2.- ANALYSIS OF DAILY DATA

The daily Maloney's index were display on an accumulated frequency distribution graph and calculated the 0.33 and 0.66 percentiles. It was considering a MJO negative (MJO-) period when the index value was below -24.6, MJO positive (MJO+) when it was above 22.9 and MJO neutral when the values were within the 0.33 and 0.66

percentile. Then, the daily precipitation data from May to September were crossed with the daily MJO index. Results are shown in Table 1 where it can be seen that north of Curicó station (~34°S) about 40% of the precipitation days concur with MJO- and only about 25% with MJO+. This percentage decreases southward. Precipitation during neutral MJO periods is about one third of the total precipitation days.

Table 1. Percentage of precipitation days when the MJO was negative, positive and neutral respect to the total precipitation days occurred during winter time (May to September) for the 1979-2001 period. Also included is the ratio between precipitation days for MJO negative and positive.

Station	MJO-	MJO+	Neutral	MJO+/ MJO-
La Serena	43.3	23.4	33.3	1.85
Combarbala	41.8	27.2	30.1	1.54
Valparaíso	39.9	26.2	33.8	1.52
Santiago	40.7	26.9	32.4	1.49
Curico	36.8	30.9	32.3	1.19
Chillan	37.0	31.4	31.6	1.18
Concepción	34.6	31.7	33.7	1.09
Temuco	34.9	31.5	33.6	1.11

Table 2 shows the mean daily precipitation considering only days with precipitation was above 0.9 mm for all years (All), only EL Niño years (All-Niño), only La Niña years (All-Niña) and only Neutral years during the rainy months May to September of the 1979-2001 period, according with the classification used by the Australian Bureau of Meteorology. It can be seen that during the El Niño years the mean daily precipitation is

higher than La Niña and Neutral years. These values are statistically significant (at least 90%) between Santiago and La Serena. Also, the total number of precipitation days as well as the number of days when the precipitation was above the normal (0.66 percentile of the respective station) and above 0.90 percentile (extreme events) are higher than La Niña and Neutral years.

Table 2. Mean daily precipitation amount and precipitation days. Indices #,\$,&,% indicate that the values are statistically significant at least 90% between them. Also included the annual mean of the days with precipitation above 0.66 (N° day > normal) and 0.90 (N° extreme days) percentiles

Station	All	All-Niño	All-Niña	All-Neutral
La Serena				
Mean precip.	12.5	14.0 ^{\$}	8.6 ^{\$}	11.9
Mean days	6.0 [#]	9.8 ^{#,&,%}	4.8 ^{&}	5.4 [%]
N° day > normal	2.0	3.8	1.3	1.7
N° extreme days	0.6	1.3	0	0.5
Combarbala				
Mean precip.	20.8 [#]	26.3 ^{#,\$,&}	15.9 ^{#,\$}	17.6 ^{#,&}
Mean days	9.3 [#]	15 ^{#,&}	5.5 ^{&}	7.3
N° day > normal	3.5	7.3	2	2.8
N° extreme days	1.3	3.5	0.5	0.8
Valparaíso				
Mean precip.	17.7	20.1 ^{\$}	15.4 ^{\$}	17.0
Mean days	20.5 [#]	31.5 ^{#,\$,&,%}	14.5 ^{,\$,&}	14.8 [%]
N° day > normal	7.6	13.5	5	6.7
N° extreme days	2.2	5.3	1.3	1.6
Santiago				
Mean precip.	13.1 [#]	17.1 ^{#,\$,&}	11.8 ^{#,\$}	11.2 ^{#,&}
Mean days	22 [#]	32 ^{#,\$,&,%}	14.5 ^{,\$,&}	17.3 [%]
N° day > normal	8.5	16.5	5	7.3
N° extreme days	2.5	5.8	1.3	1.8
Curicó				
Mean precip.	15.5	15.9	14.4	15.1
Mean days	35.6 [#]	45.3 ^{#,&,%}	27.8 ^{&}	26.8 [%]
N° day > normal	13.1	17.5	8.8	12.8
N° extreme days	4.5	6.8	3.3	4.1

Chillán				
Mean precip.	16.5	16.4 ^{\$}	14.4 ^{,\$,&}	16.4 ^{&}
Mean days	51.5 [#]	61.5 ^{#,&,%}	42.8 ^{&}	38.1 [%]
Nº day > normal	16.7	19	11.8	16.6
Nº extreme days	4.6	6	2.5	4.6
Concepción				
Mean precip.	15.0	15.1	15.7	14.8
Mean days	57.6	64.5 ^{&,%}	48.5 ^{&}	42.4 [%]
Nº day > normal	18.9	22	14.8	19.1
Nº extreme days	5.8	7.8	4.3	5.8
Temuco				
Mean precip.	10.7 [#]	9.8 ^{#,&}	10.0	11.0 ^{&}
Mean days	70.1 [#]	81 ^{#,&,%}	58 ^{&}	51.8 [%]
Nº day > normal	23.7	25.8	16.5	24.5
Nº extreme days	7.5	6.8	5	8

On the other hand, Table 3 only includes the precipitation analysis for neutral years. This approach allows a preliminary study of the behavior of the precipitation due to the influence of the MJO. Results show that the overall mean seasonal precipitation as well as mean daily precipitation are statistically higher during the

negative phase of the MJO. The number of days with precipitation above the normal and extreme daily precipitation is also higher during the MJO negative phase, although the difference between the extremes is not significant in Valparaiso and Santiago.

Table 3. Seasonal mean (May-September) and daily mean precipitation, considering only days with precipitation above 0.9 mm, for neutral conditions in the Equatorial Pacific Ocean (non present of El Niño neither La Niña). MJOneg, MJOpos and MJO_neutral columns respectively correspond to seasonal and daily mean precipitation for all days when MJO was negative, positive and neutral during the 1979-2001 period. Indices \$,&,% indicate that the values are statistically significant at 90% (red) or 95% (blue) between them. Also included are the total numbers of days with precipitation above 0.66 and 0.90 percentile of the respective station for the 1979-2001 period.

Station	MJOneg	MJOpos	MJO Neutral
La Serena			
Mean prec.	39.2 ^{,\$,&}	10.0 ^{\$}	15.3 ^{&}
Mean daily prec.	18.1 ^{,\$,&}	8.0 ^{\$}	7.6 ^{&}
Nº day > normal	12	3	5
Nº extreme days	5	1	0
Combarbala			
Mean prec.	90.4 ^{,\$,&}	37.2 ^{\$}	36.7 ^{&}
Mean daily prec.	22.8 ^{,\$,&}	13.5 ^{\$}	14.2 ^{&}
Nº day > normal	18	5	7
Nº extreme days	7	1	2
Valparaiso			
Mean prec.	117.5 ^{\$}	104.6 ^{\$}	108.2
Mean daily prec.	15.7	20.8	15.8
Nº day > normal	31	19	29
Nº extreme days	8	7	3
Santiago			
Mean prec.	110.7 ^{,\$,&}	73.2 ^{\$}	64.8 ^{&}
Mean daily prec.	12.5 ^{&}	11.7	9.3 ^{&}
Nº day > normal	37	24	26
Nº extreme days	3	2	1
Curicó			
Mean prec.	233.7 ^{\$}	138.2 ^{\$}	166.1
Mean daily prec.	17.1 ^{,\$,&}	13.2 ^{\$}	14.2 ^{&}
Nº day > normal	67	38	48
Nº extreme days	22	11	13
Chillán			
Mean prec.	362.7	268.4	225.7
Mean daily prec.	18.5 ^{,\$,&}	15.8 ^{\$}	14.3 ^{&}
Nº day > normal	86	62	51
Nº extreme days	27	17	11

Concepción			
Mean prec.	343.1 ^{\$}	280.6 ^{\$}	248.7
Mean daily prec.	16.7 ^{,\$&}	11.6 ^{&}	13.9 ^{&}
Nº day > normal	97	64	65
Nº extreme days	33	19	16
Temuco			
Mean prec.	297.5 ^{\$}	256.1 ^{\$}	231.1
Mean daily prec.	12.1 ^{,\$&}	10.2 ^{\$}	10.6 ^{&}
Nº day > normal	110	91	90
Nº extreme days	46	22	26

3.- CONCLUSION

A preliminary study of the influence of the MJO on the precipitation in central Chile suggests that there is a correlation between precipitation events and the MJO. The precipitation event above normal is more likely to occur during the negative phase of the MJO, i.e. when the active convective region is in the Pacific ocean side. On the other hand, during the positive phase of the MJO a precipitation event is less likely to occur. Synoptic-scale pattern for MJO negative indices showed

features that are similar than El Niño, i.e., a pattern that favors precipitation in central Chile. It is concluded that when the both El Niño (La Niña) and the negative (positive) phase of the MJO takes place, precipitation events are likely (less likely) to occur in central Chile, mainly north of 34 °S. These findings might have potential implications for weather prediction in the intraseasonal time scale. Further studies are planned to be carried out in due course.

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