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MJO and ENSO on Growing Season Precipitation over the Canadian Prairies

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2015 Growing Season Drought

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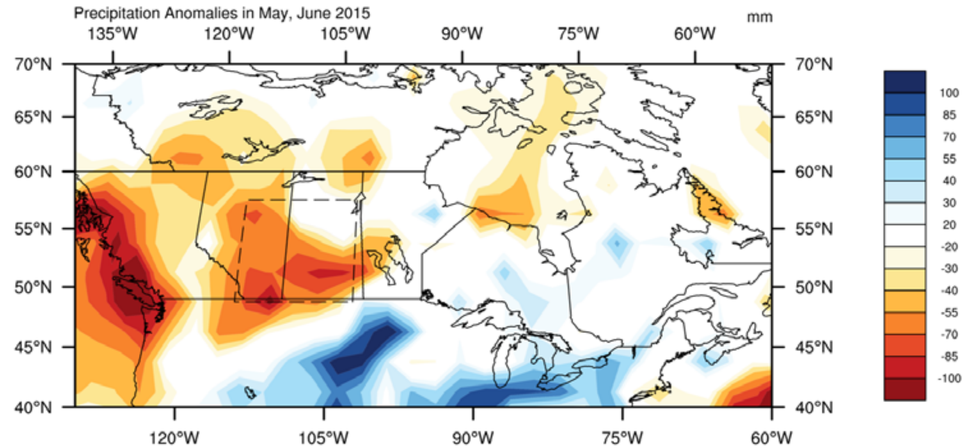
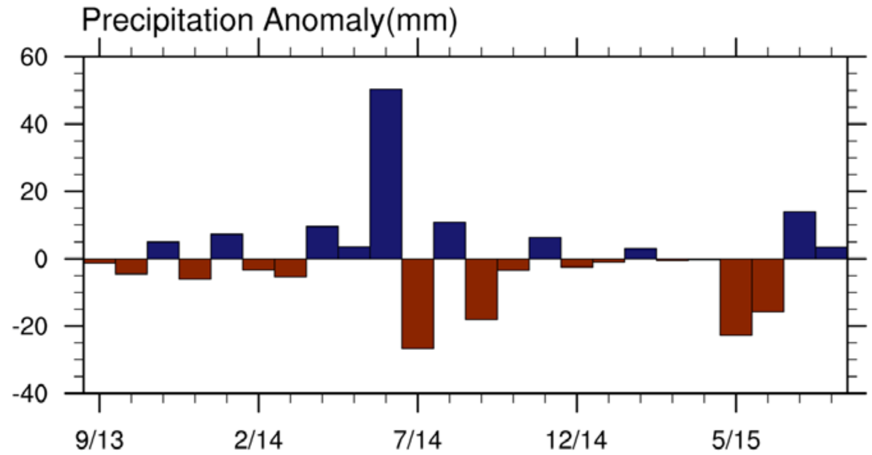
The top plot in Fig. 1 shows the precipitation anomaly in percentage relative to climatology (1981-2010 long term mean) in Canada during May and June 2015. The bottom plot in Fig. 1 presents the monthly precipitation anomaly averaged over the region encompassed by the dash lines (50N-57.5N, 115W-102.5W). The annual cycle of the regional precipitation has, on average, a dry period between February and May. Regarding the precipitation climatology, June has the largest precipitation in all months with significantly more rain than neighboring months. The May and June 2015 precipitation deficit was also accompanied by a relatively dry period from February to April , which added to the drought conditions.





SST and Circulation

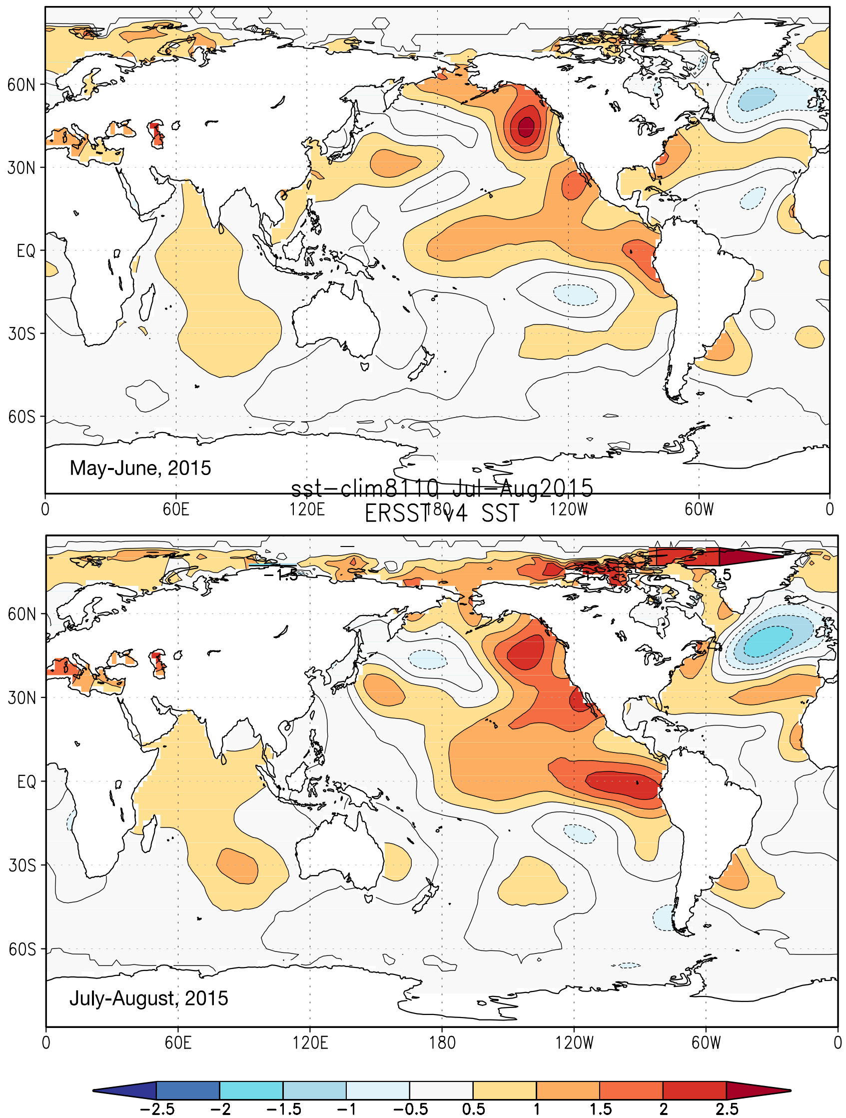


Fig. 3 The mean SST anomaly(ºC) from ERSST v4 for May-June and July-August 2015.

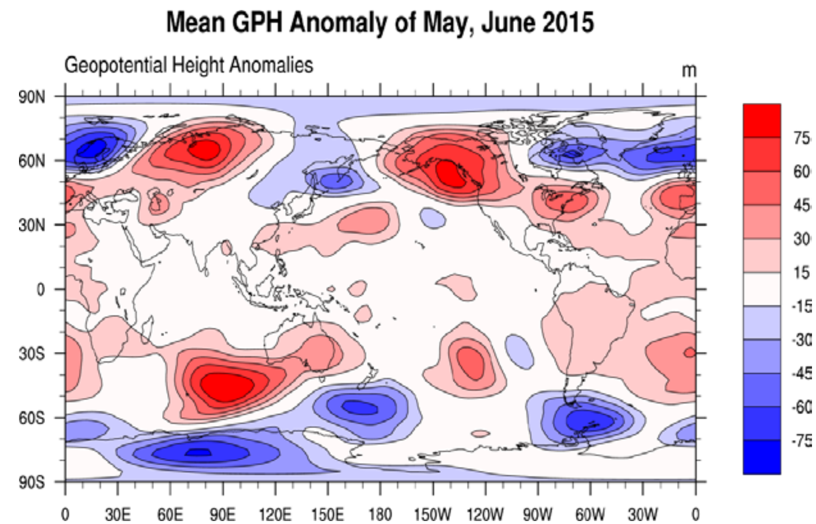


Fig. 2 NCEP GPH anomaly at 500hPa during May and June 2015 when the precipitation deficit was the largest.

GPH and SST

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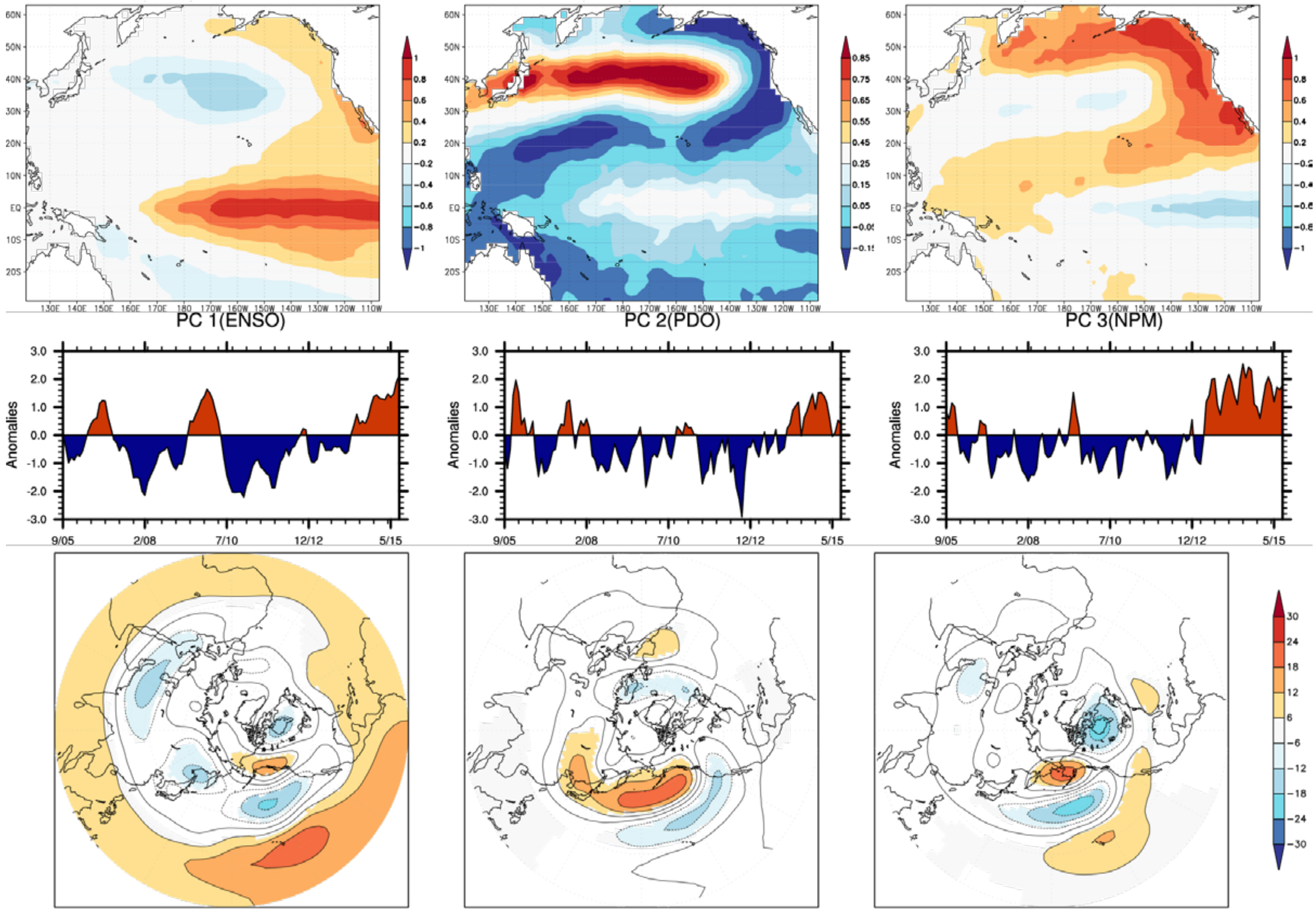
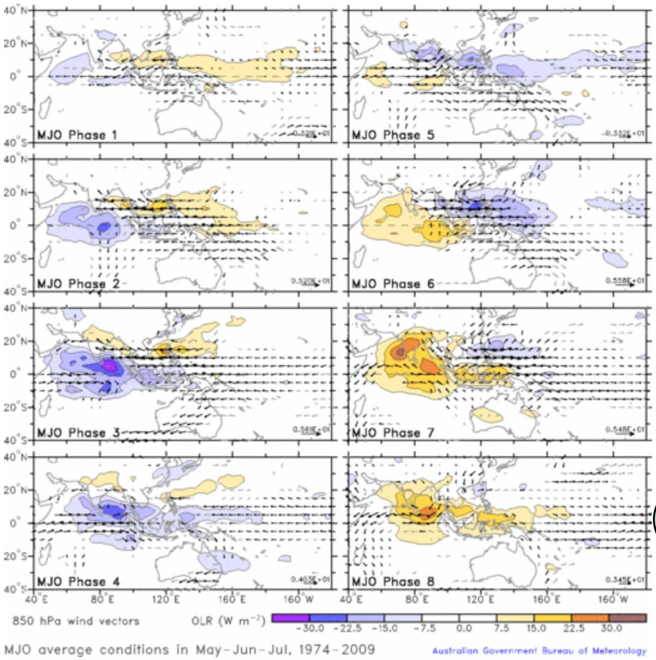
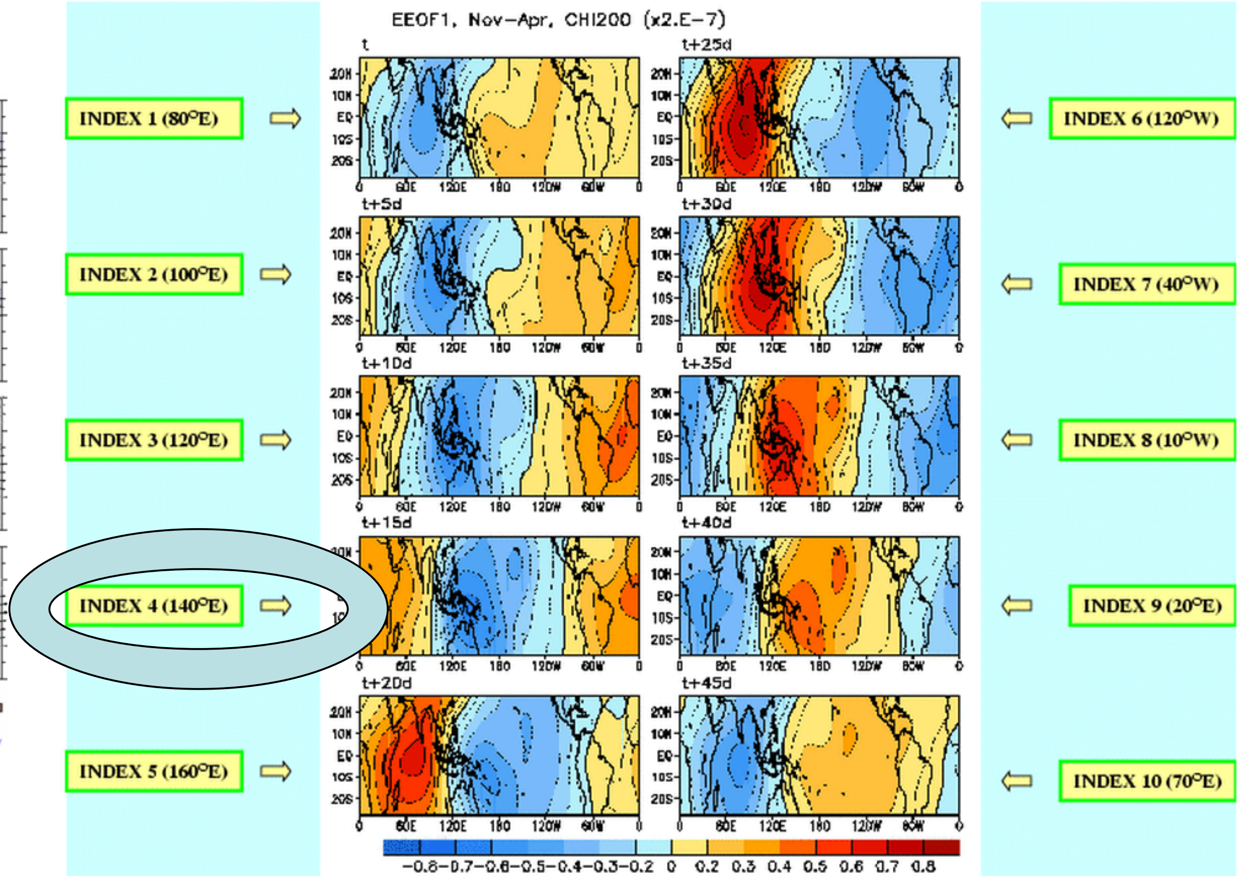


NOAA-CPC index

Wheeler and Hendon (2004)





ENSO Correlation with Growing Season Precipitation

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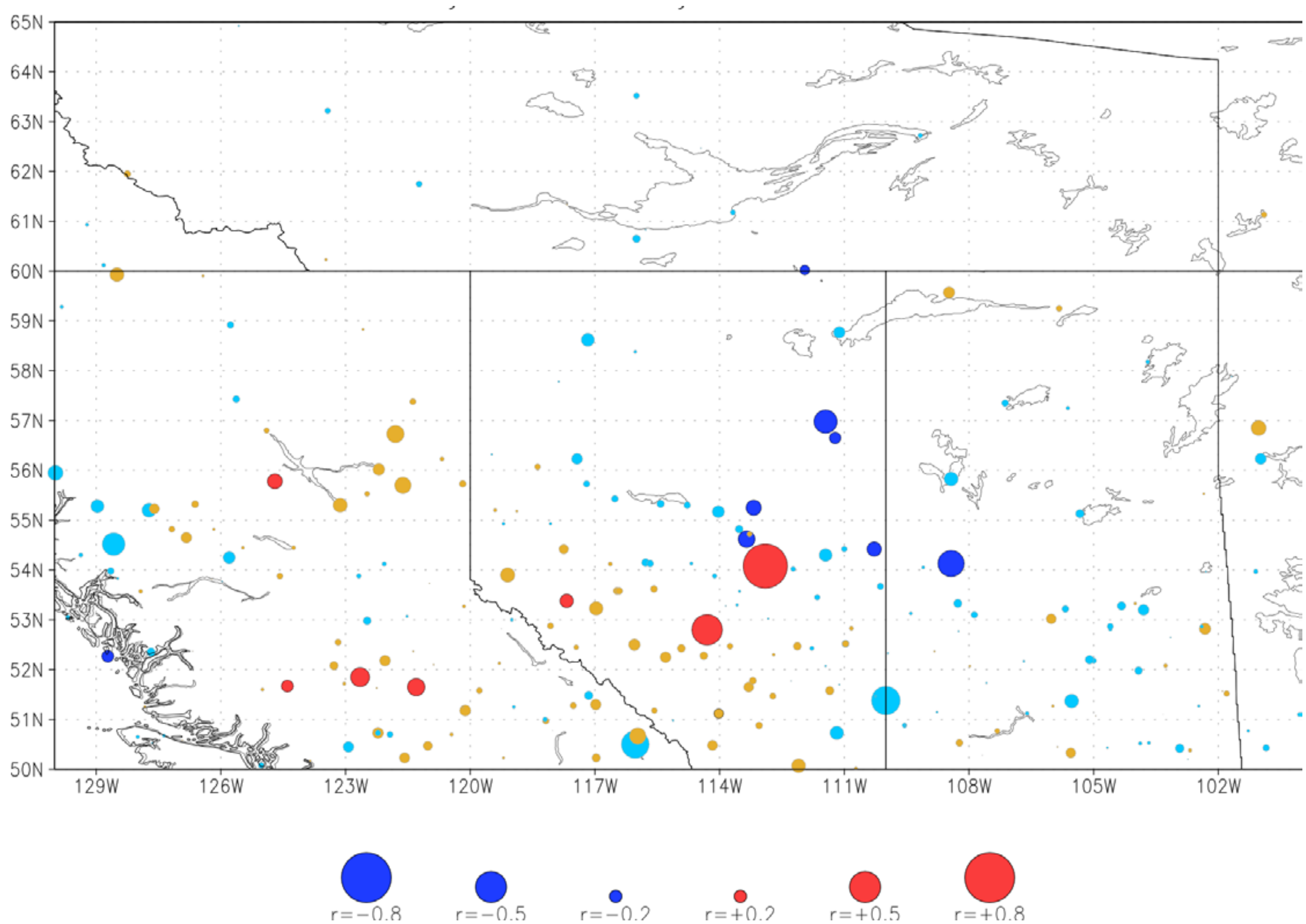

GPH Correlation of Precipitation

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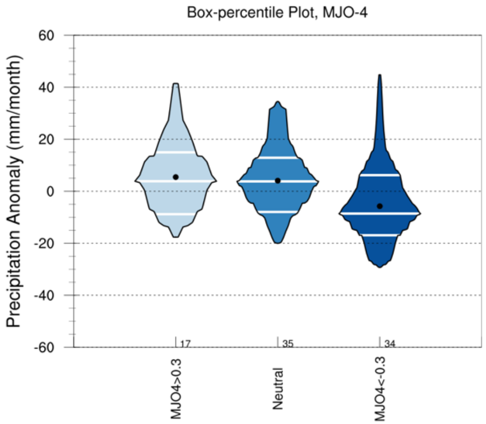
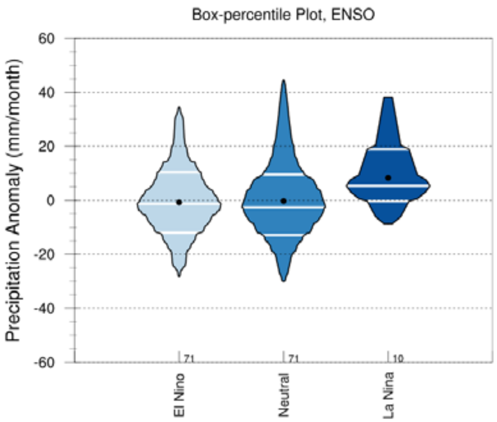
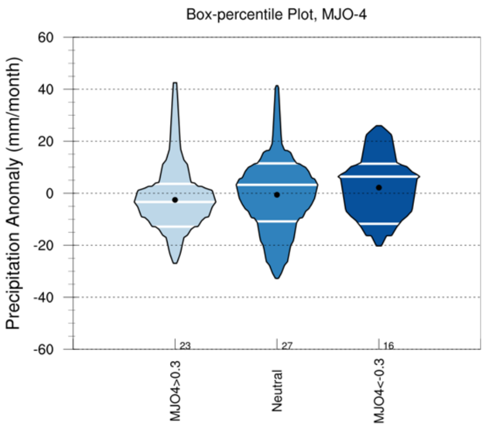
Table 1 Correlation between mean precipitation anomaly from CMAP in the prairie and MEI, MJO indices 4. MJO indices and are from 1979 to 2016. CMAP covers 1979 to 2016.

	Correlation	p-value	No. of sample
MEI	-0.096	0.24	156
MJO-4	0.18	0.023	156
MJO-4(NINO4>0)	0.33	0.0015	90
MJO-4(NINO4<0)	-0.01	0.94	66







Regression of Stream function and Velocity Potential

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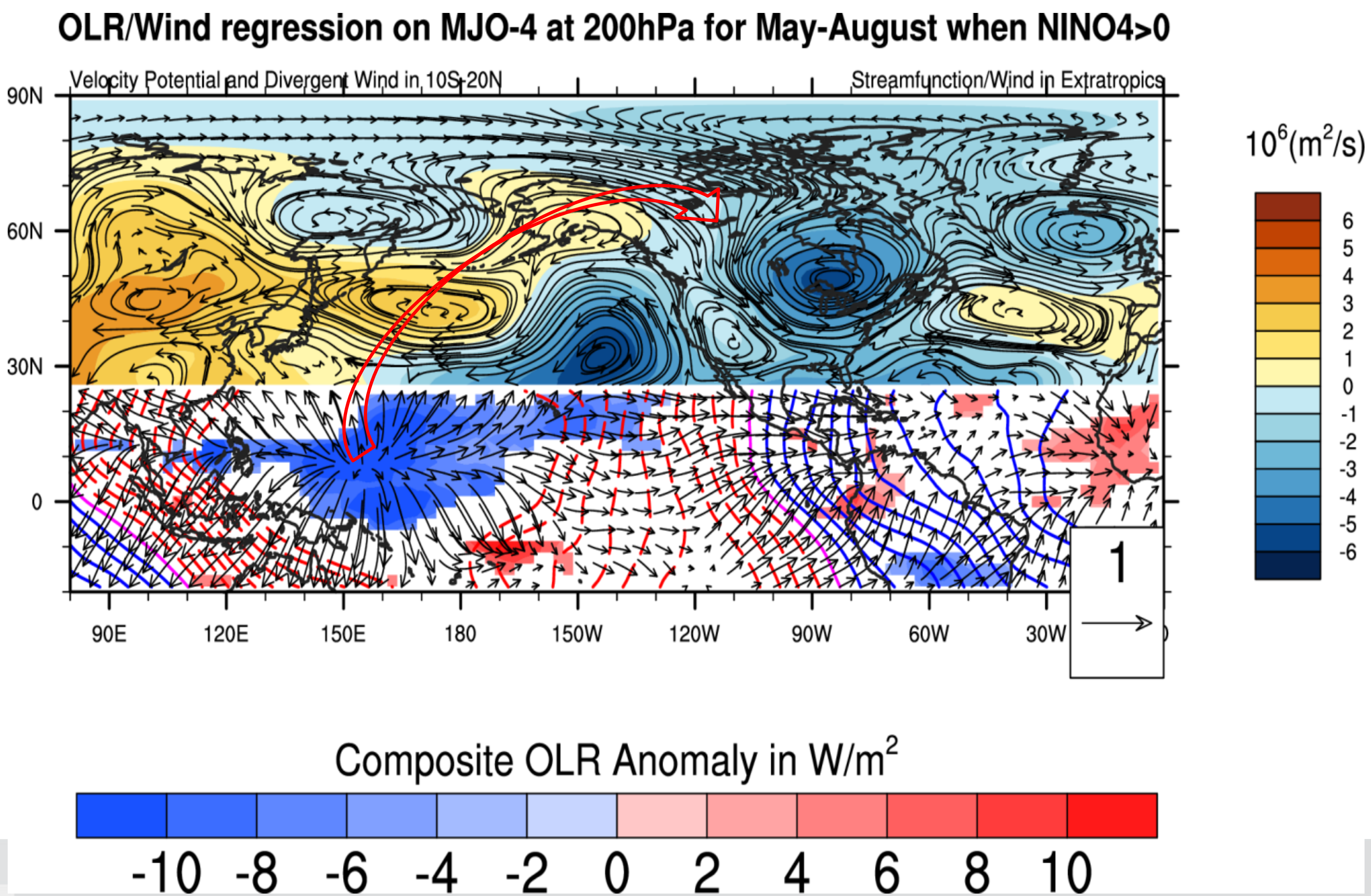
mm/day



Ray-tracing experiment

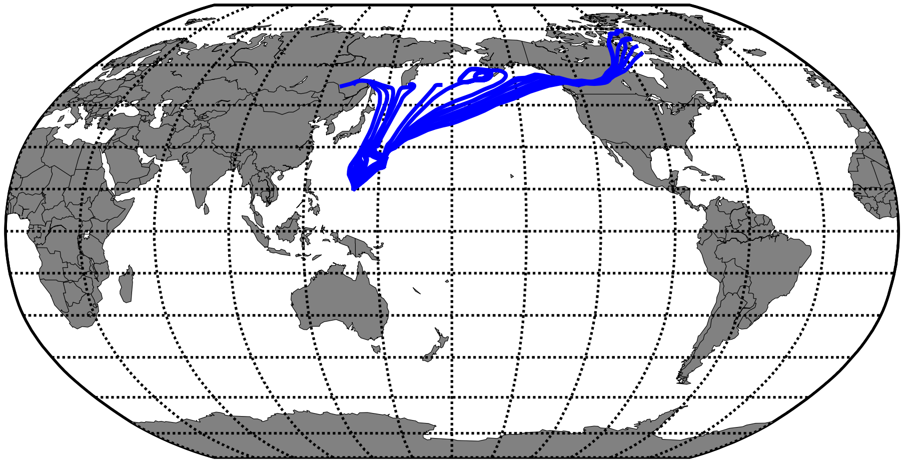
$$\left(\frac{\partial}{\partial t} + u\frac{\partial}{a\cos\varphi\partial\lambda} + v\frac{\partial}{a\partial\varphi}\right)(\nabla^2\psi + f) = 0,$$

$$C_{gx} = \overline{U} + \frac{(k^2 - l^2)q_y - 2klq_x}{K^4}$$

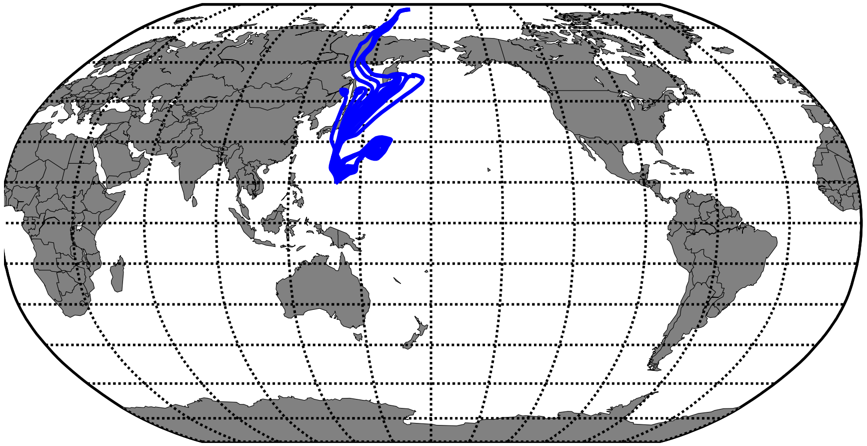
$$C_{gy} = \overline{V} + \frac{(k^2 - l^2)q_x + 2klq_y}{K^4}$$

Ray-tracing experiment

Mean May-August condition NINO4>0.5



Mean May-August condition NINO4 < -0.5



K=3, 4, 5, 6
AZ = Pi/[12,10,9,8,7,6,5,4]

Summary

- The cause of the 2015 summer precipitation deficit in the western Canadian Prairies is investigated in relation to atmospheric circulation anomalies, SST, and intraseasonal tropical convection oscillation, MJO.
- In general, MJO-4 indices demonstrated significant correlation with the meteorological drought from May to August with warm SST in central Pacific (NINO4 >0) when MJO amplitude is also often stronger.
- The new finding is that MJO phase/strength is connected to the anomalous ridge in Western Canada when NINO4 is positive through the propagation of stationary Rossby wave from the western Pacific. The connection between the Canadian Prairie precipitation deficit and MJO is stronger when NINO4 is positive because MJO amplitude is stronger when the central Pacific SST is warmer than normal (NINO4 >0).
- The underlying cause of this significant correlation between MJO-4 indices and the prairie precipitation in May-August is a stationary Rossby wave train originates from Maritime Continent and western Pacific and propagate into Canada. The SST related circulation anomaly affects the propagation of wave.
- The intra-seasonal predictability in MJO amplitude and phase can be potentially instrumental for medium-range/intra-seasonal projection of the growing season precipitation in the Canadian Prairies when the central-Pacific SST is warm.

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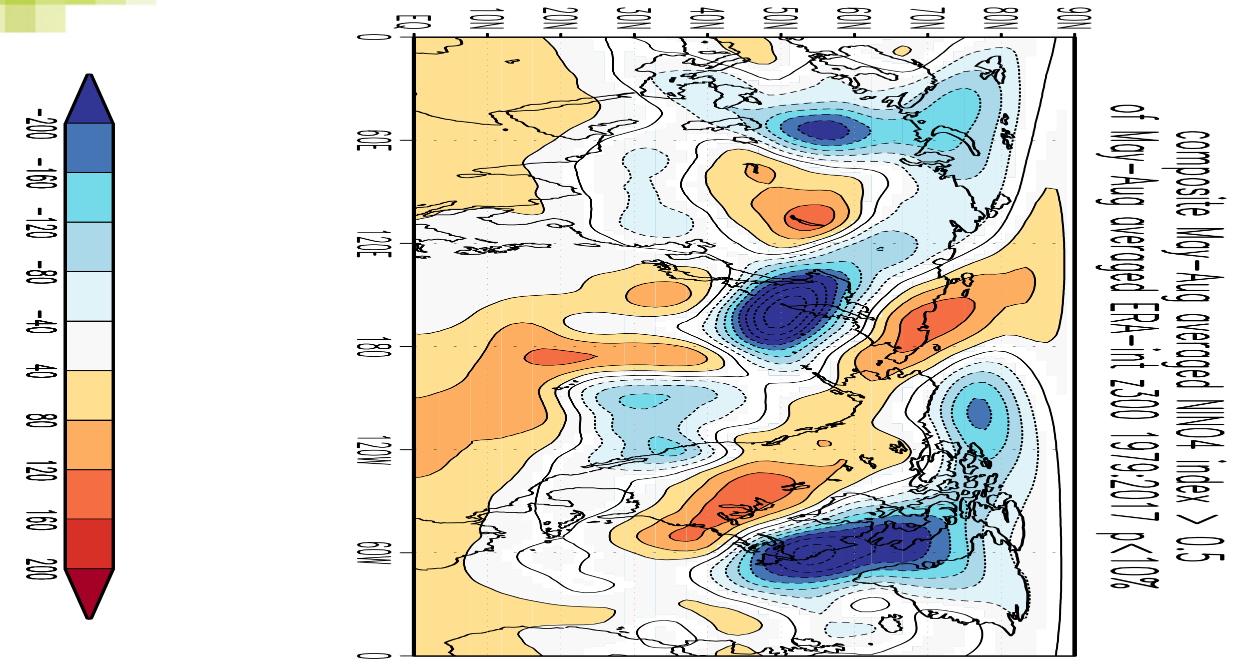

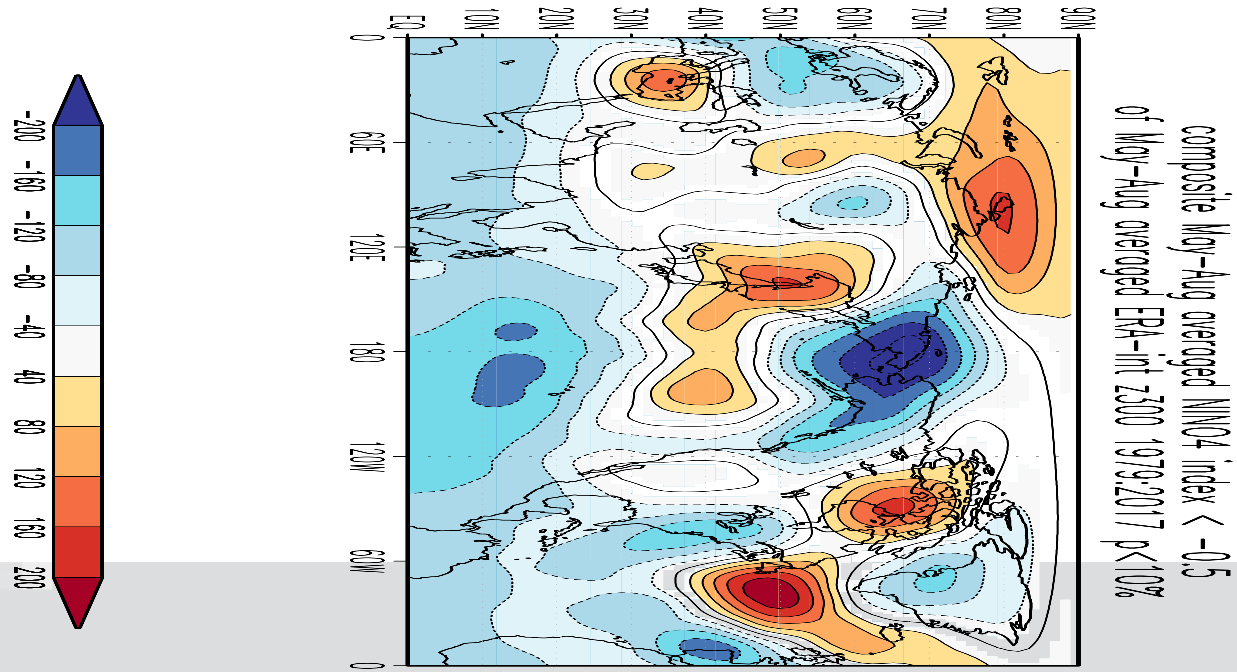

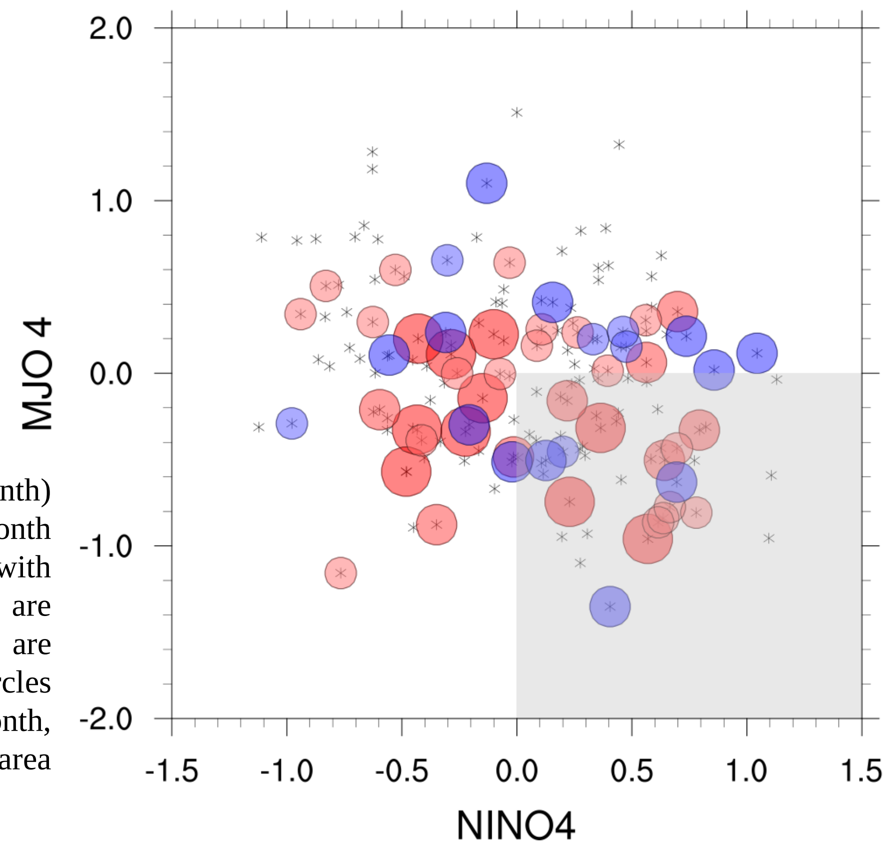

The scatterplot of monthly precipitation anomaly (mm/month) as a function of MJO-4 and NINO4. Each asterisk represents a month from May to August 1979-2016. Circled asterisk denotes a month with precipitation anomaly larger than 18 mm/month. The blue circles are months with positive precipitation anomaly and the red circles are months with negative precipitation anomaly. The sizes of circles denote the magnitudes of the anomalies (large > 30 mm/month, medium > 24 mm/month, small >18 mm/month). The shaded area denotes NINO4>0 and MJO-4 index < 0.