Historical Perspective of the 2001 and 2002 Canadian Prairie Drought

Barrie Bonsal & Matthew Regier

Environment Canada/University of Saskatchewan
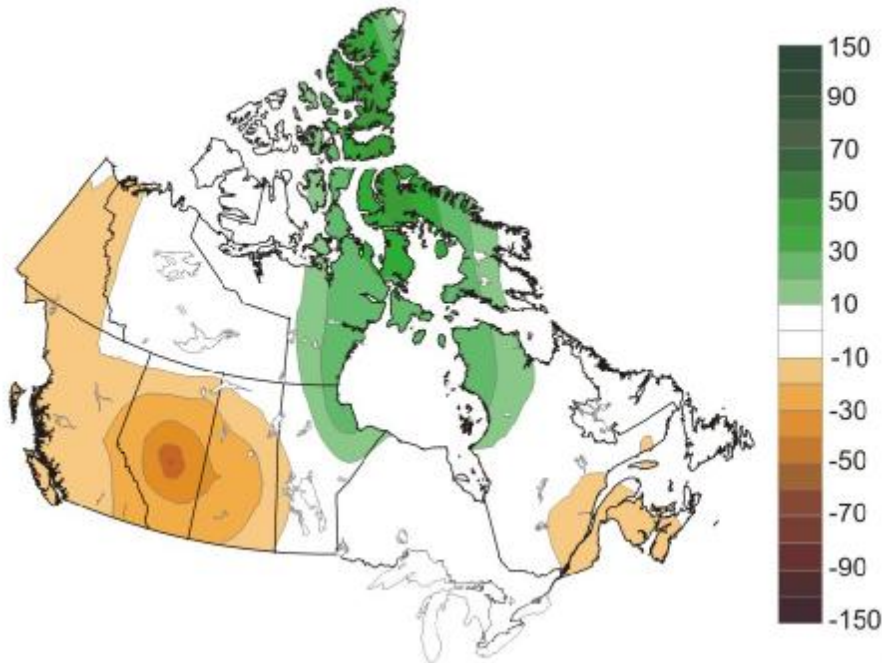
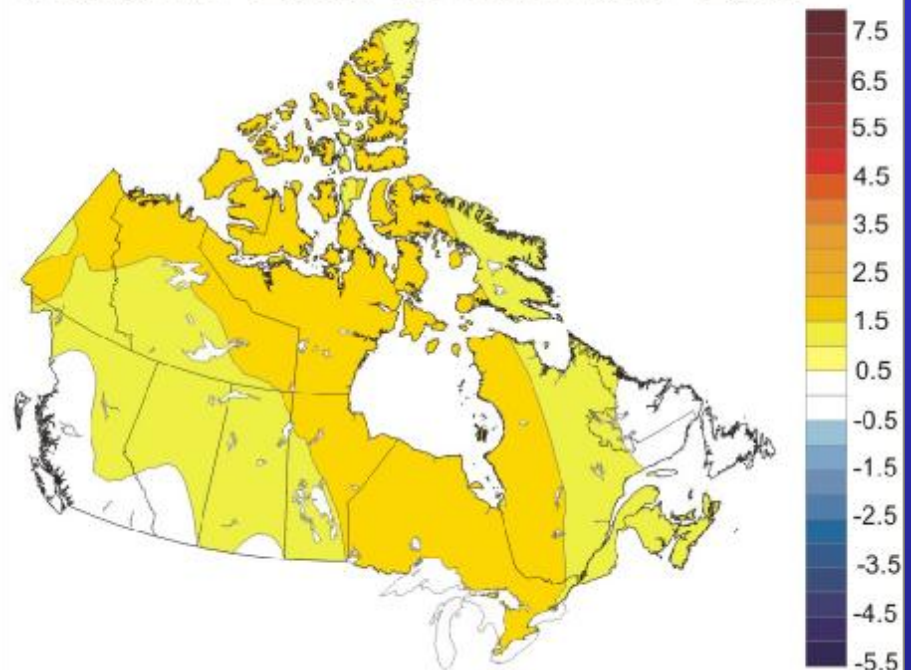Saskatoon, SK

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2001-2002 Drought

Precipitation

Temperature

Autumn 2000 to Summer 2002

Autumn 2000 to Summer 2002

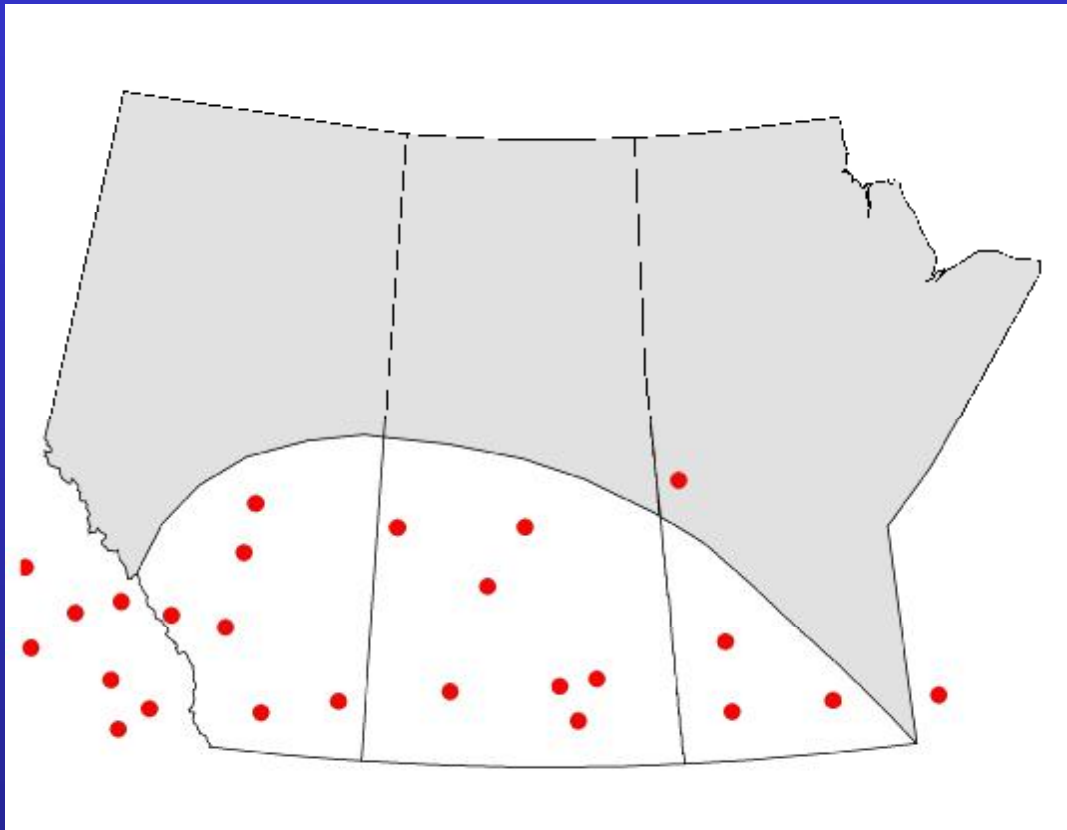Environment Canada   Environnement Canada

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Data

§ Monthly mean T & P: Adjusted Historical Canadian Climate Data set

§ Include known droughts in the early part of the 20th century; adequate spatial coverage

§ 25 stations; agricultural years (Sep to Aug) of 1915-2002

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Drought Indices

PDSI

PDSI Value	Classification
$PDSI \leq -5.0$	Exceptional Drought
$-5.0 < PDSI \leq -4.0$	Extreme Drought
$-4.0 < PDSI \leq -3.0$	Severe Drought
$-3.0 < PDSI \leq -2.0$	Moderate Drought
$-2.0 < PDSI \leq -1.0$	Mild Drought
$-1.0 < PDSI < 1.0$	Near Normal
$1.0 \leq PDSI < 2.0$	Mild Wet
$2.0 \leq PDSI < 3.0$	Moderate Wet
$3.0 \leq PDSI < 4.0$	Severe Wet
$4.0 \leq PDSI < 5.0$	Extreme Wet
$PDSI \geq 5.0$	Exceptional Wet

SPI

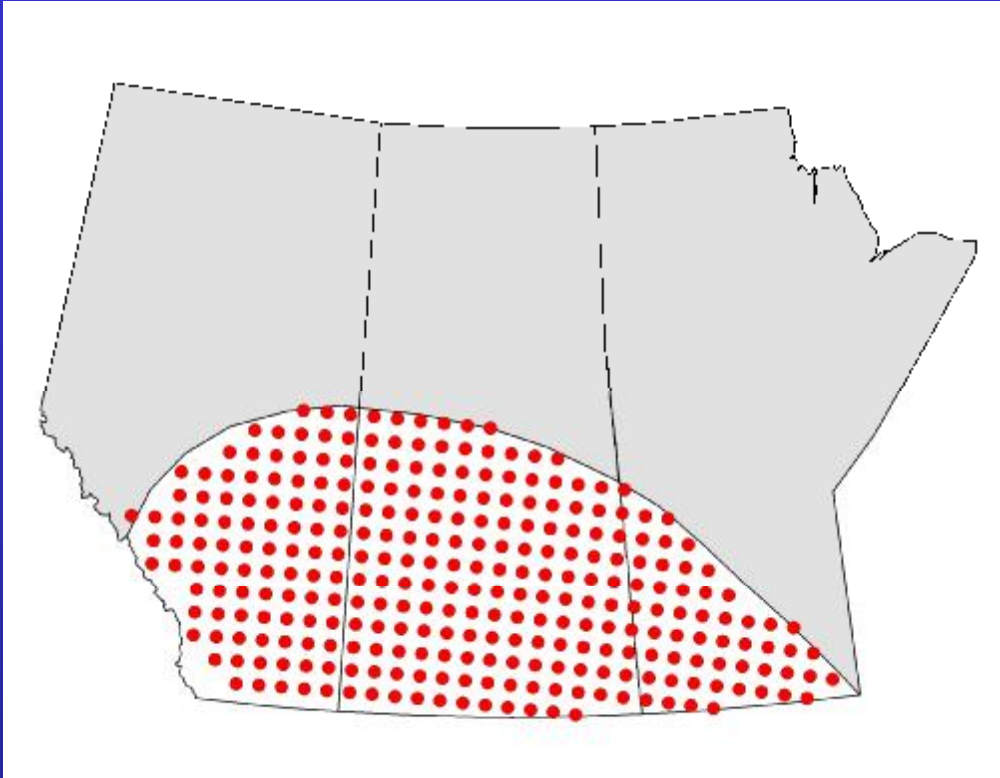| SPI Value	Classification
$SPI \leq -2.5$	Exceptional Drought
$-2.5 < SPI \leq -2.0$	Extreme Drought
$-2.0 < SPI \leq -1.5$	Severe Drought
$-1.5 < SPI \leq -1.0$	Moderate Drought
$-1.0 < SPI \leq -0.5$	Mild Drought
$-0.5 < SPI < 0.5$	Near Normal
$0.5 \leq SPI < 1.0$	Mild Wet
$1.0 \leq SPI < 1.5$	Moderate Wet
$1.5 \leq SPI < 2.0$	Severe Wet
$2.0 \leq SPI < 2.5$	Extreme Wet
$SPI \geq 2.5$	Exceptional Wet

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Gridding the Data

- § Stations are not uniformly distributed
- § PDSI and SPI station values spatially interpolated to a 50km x 50km grid using a cubic spline interpolation within MATLAB.
- § 291 grids: Study area

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Methodology

Spatial Extent:

- % of grids in severe drought (PDSI < -3.0; SPI < -1.5) and extreme drought (PDSI < -4.0; SPI < -2.0) on a summer (JJA), one-year, two-year, and five-year (agricultural year) basis over both study regions

Severity:

- Average PDSI and SPI values for all grids within the study regions (same time periods)

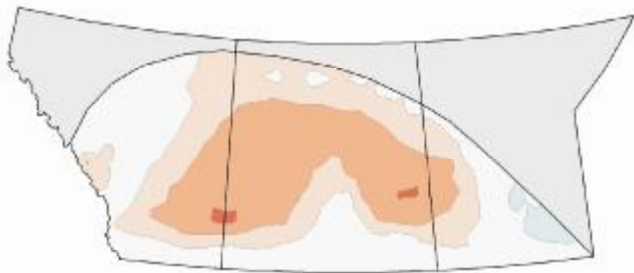- Compare the 2001-2002 drought with other droughts during the study period (1915-2002)
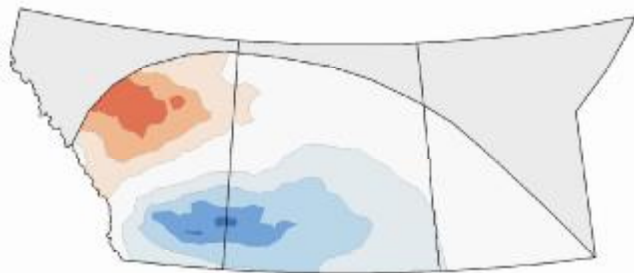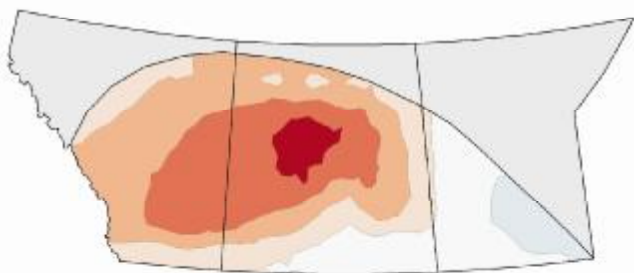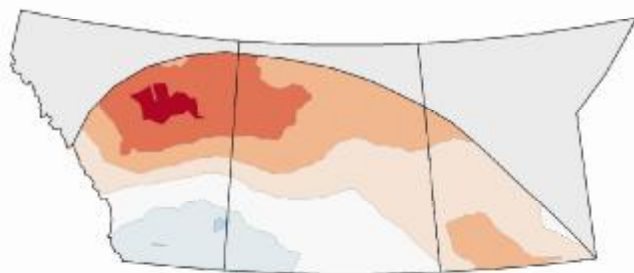
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a) Summer-2001   b) Summer-2002   SPI

c) 2001   d) 2002

e) 2001-2002   f) 1998-2002

-2.5 -2.0 -1.5 -1.0 -0.5 +0.5 +1.0 +1.5 +2.0 +2.5
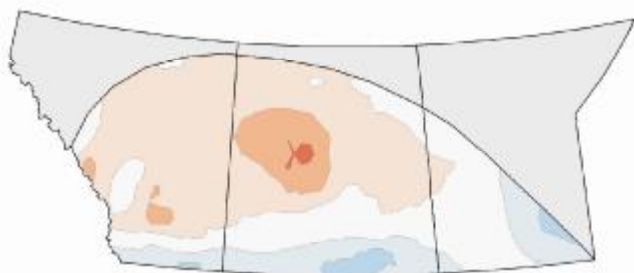
a) Summer-2001   b) Summer-2002   PDSI
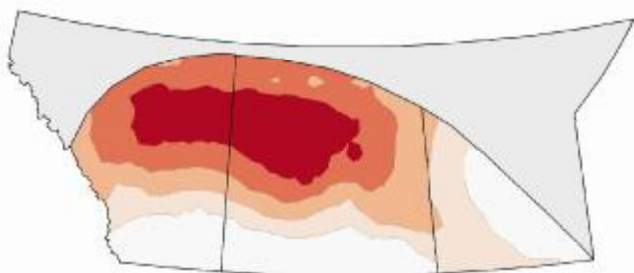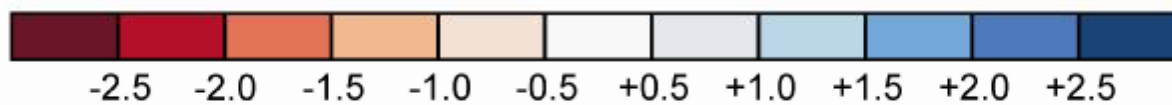
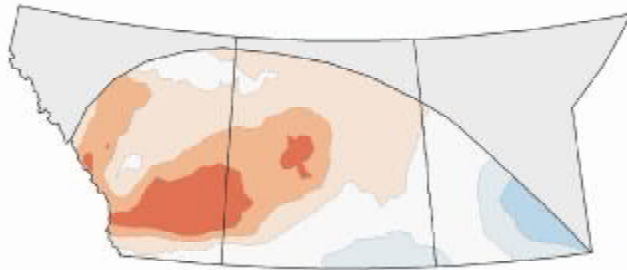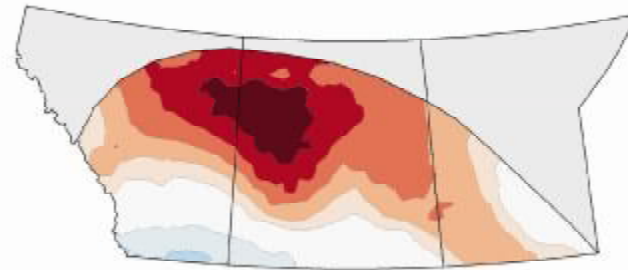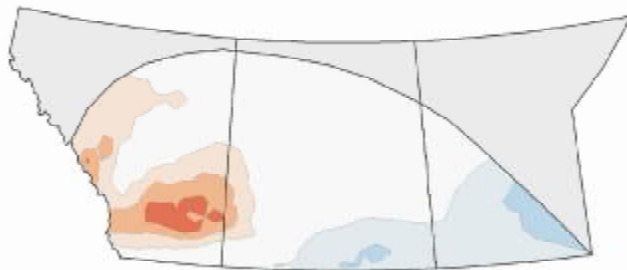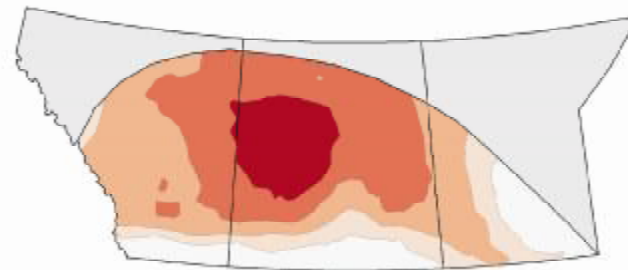c) 2001   d) 2002

e) 2001-2002   f) 1998-2002

-5.0   -4.0   -3.0   -2.0   -1.0   +1.0   +2.0   +3.0   +4.0   +5.0
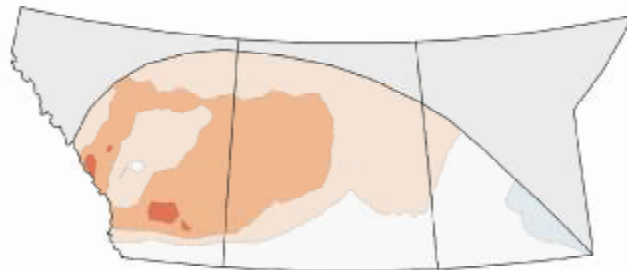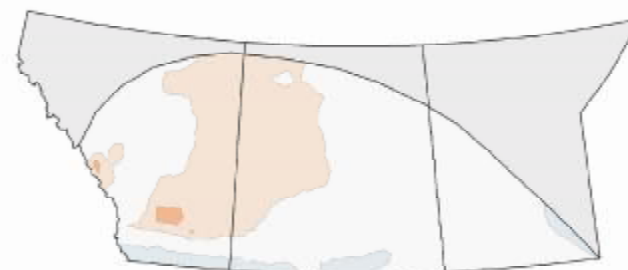
Historical Analysis – Spatial Extent
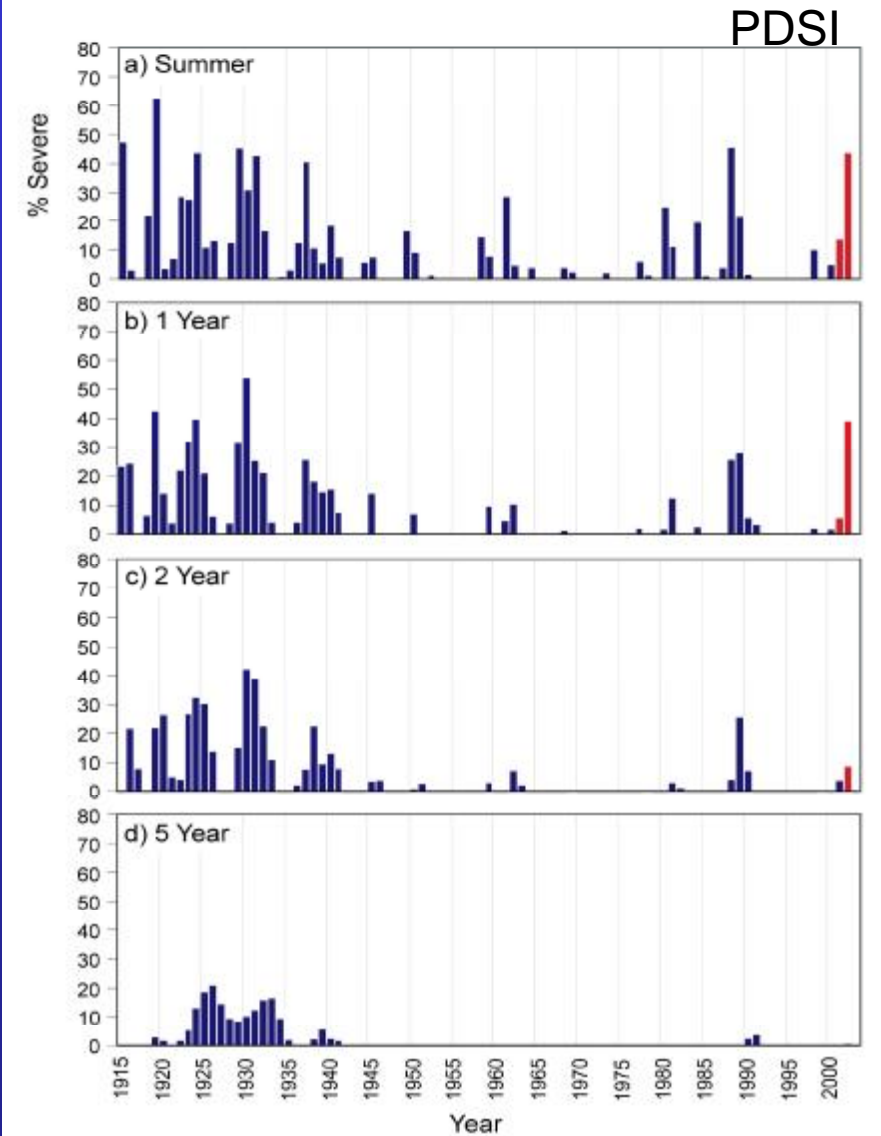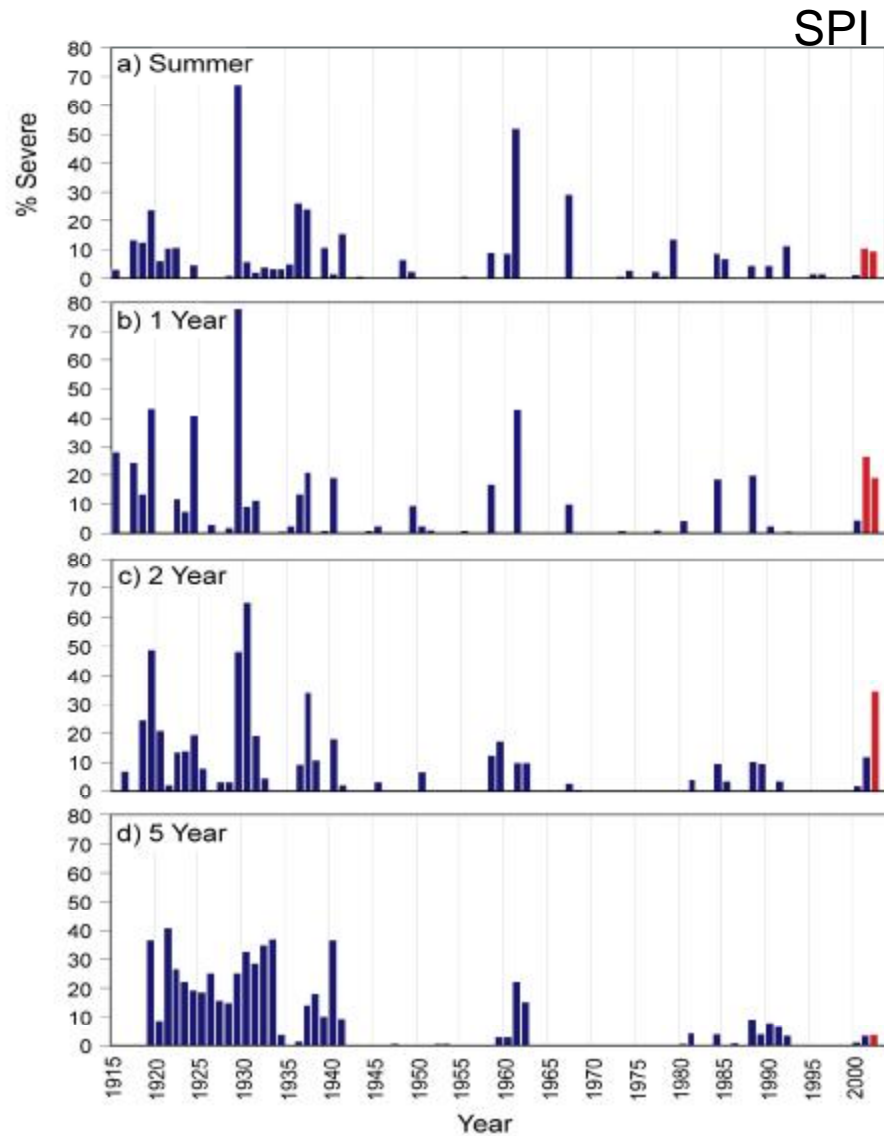
SPI Rankings

	Summer						1 Year					
Rank	% Severe (?-1.5)		% Extreme (?-2)		Average Value		% Severe (?-1.5)		% Extreme (?-2)		Average Value	
1	1929	69.6	1929	49.8	1929	-1.88	1929	76.3	1929	59.0	1929	-2.08
2	1961	50.5	1961	36.7	1961	-1.70	1961	49.5	1961	21.9	1961	-1.51
3	1967	34.3	1967	17.0	1936	-1.32	1919	46.3	1937	17.7	1919	-1.36
4	1936	32.9	1937	14.8	1967	-1.18	1924	36.4	1919	15.5	1924	-1.16
5	1937	29.3	1979	8.1	1917	-0.94	2001	33.2	1924	13.4	1936	-1.07
6	1919	24.7	1958	7.8	1937	-0.86	1937	26.5	1958	12.0	1958	-0.99
7	1979	17.0	1918	7.1	1958	-0.82	1988	24.0	2001	9.5	2001	-0.97
8	1917	15.9	1936	5.3	1979	-0.82	1984	23.7	1988	8.8	1917	-0.92
9	1941	14.8	1939	4.6	1984	-0.81	1915	21.9	1915	8.1	1937	-0.91
10	1918	14.5	1920	3.2	2001	-0.67	1917	21.6	2002	7.4	1918	-0.90
	2001 (11)	13.1	2001	0.0	2001 (10)	-0.67	2001 (5)	33.2	2001 (7)	9.5	2001 (7)	-0.97
	2002 (20)	6.4	2002 (12)	2.5	2002 (53)	0.26	2002 (12)	19.8	2002 (10)	7.4	2002 (14)	-0.74

	2 Year						5 Year					
Rank	% Severe (?-1.5)		% Extreme (?-2)		Average Value		% Severe (?-1.5)		% Extreme (?-2)		Average Value	
1	1929-30	61.5	1929-30	24.5	1929-30	-1.58	1917-21	46.6	1917-21	23.0	1917-21	-1.40
2	1918-19	55.5	1936-37	24.5	1918-19	-1.53	1936-40	44.2	1957-61	14.5	1936-40	-1.32
3	1936-37	42.8	2001-02	24.4	1936-37	-1.36	1915-19	35.3	1929-33	12.4	1957-61	-1.21
4	1928-29	41.0	1928-29	23.3	1917-18	-1.27	1929-33	32.5	1936-40	12.4	1929-33	-1.19
5	2001-02	39.6	1918-19	20.8	1928-29	-1.22	1928-32	29.0	1918-22	11.7	1915-19	-1.15
6	1917-18	27.6	1917-18	16.3	2001-02	-1.16	1957-61	28.3	1928-32	11.3	1928-32	-1.05
7	1919-20	25.8	1958-59	13.1	1919-20	-1.08	1918-22	26.1	1934-38	7.4	1916-20	-1.04
8	1958-59	21.9	1988-89	7.4	1957-58	-0.96	1926-30	21.9	1915-19	6.4	1918-22	-1.03
9	1930-31	18.4	2000-01	7.4	1958-59	-0.86	1934-38	21.9	1926-30	6.4	1934-38	-0.85
10	1957-58	15.2	1957-58	5.7	1930-31	-0.83	1927-31	19.8	1935-39	6.0	1933-37	-0.82
	2001-02 (5)	39.6	2001-02 (3)	24.4	2001-02 (6)	-1.16	1998-2002 (29)	4.9	1998-2002 (22)	0.7	1998-2002 (22)	-0.34

PDSI Rankings

Summer

ank	% Severe (?-3)		% Extreme (?-4)		Average Value	
1	1919	67.8	1919	49.8	1919	-4.05
2	1988	54.8	1988	43.8	1988	-3.31
3	2002	50.9	1937	33.6	1937	-3.07
4	1937	49.8	1931	30.0	1931	-3.00
5	1931	47.3	1915	27.6	1961	-2.38
6	1915	44.5	2002	23.7	2002	-2.35
7	1929	36.7	1929	22.6	1929	-2.22
8	1961	35.7	1924	21.9	1918	-2.19
9	1924	33.9	1961	15.2	1989	-2.18
10	1980	27.9	1922	11.3	1915	-2.13
	2001 (19)	17.3	2001 (17)	8.1	2001 (31)	-1.09
	2002 (3)	50.9	2002 (6)	23.7	2002 (6)	-2.35

1 Year

ank	% Severe (?-3)		% Extreme (?-4)		Average Value	
1	2002	48.8	1930	28.3	1919	-3.12
2	1919	46.6	1919	26.5	2002	-2.62
3	1930	43.8	2002	18.0	1930	-2.61
4	1989	35.3	1929	14.5	1989	-2.42
5	1937	31.1	1931	14.5	1937	-2.26
6	1988	31.1	1923	12.4	1931	-2.16
7	1924	28.3	1932	12.4	1988	-2.13
8	1931	24.4	1989	12.4	1932	-1.85
9	1932	23.3	1924	12.0	1938	-1.83
10	1929	22.3	1988	11.0	1920	-1.64
	2001 (27)	7.1	2001 (17)	2.8	2001 (45)	-0.12
	2002 (1)	48.8	2002 (3)	18.0	2002 (2)	-2.62

2 Year

ank	% Severe (?-3)		% Extreme (?-4)		Average Value	
1	1919-20	32.2	1929-30	16.3	1930-31	-2.38
2	1929-30	31.8	1931-32	13.4	1919-20	-2.38
3	1930-31	31.8	1918-19	12.4	1918-19	-2.31
4	1988-89	31.8	1988-89	11.3	1988-89	-2.28
5	1937-38	27.2	1923-24	11.0	1937-38	-2.04
6	1918-19	24.7	1919-20	10.2	1931-32	-2.01
7	1931-32	22.3	1930-31	9.5	1929-30	-1.92
8	1923-24	20.5	1922-23	8.1	1938-39	-1.72
9	1924-25	19.1	1937-38	7.1	1989-90	-1.65
10	1922-23	16.6	1924-25	6.0	1939-40	-1.53
	1998-2002 (15)	11.0	1998-2002 (17)	1.1	1998-2002 (11)	-1.37

5 Year

ank	% Severe (?-3)		% Extreme (?-4)		Average Value	
1	1929-33	13.8	1929-33	2.8	1937-41	-1.64
2	1928-32	11.7	1922-26	2.5	1929-33	-1.59
3	1922-26	10.6	1928-32	2.1	1918-22	-1.55
4	1921-25	10.2	1921-25	1.1	1919-23	-1.51
5	1930-34	7.8	1930-34	1.1	1936-40	-1.38
6	1927-31	7.1	1923-27	0.4	1938-42	-1.32
7	1920-24	6.7	1915-19	0.0	1930-34	-1.30
8	1923-27	6.7	1916-20	0.0	1935-39	-1.21
9	1926-30	6.4	1917-21	0.0	1917-21	-1.20
10	1935-39	6.0	1918-22	0.0	1916-20	-1.19
	1998-2002 (23)	1.1	1998-2002	0.0	1998-2002 (27)	-0.55

Severe SPI Droughts
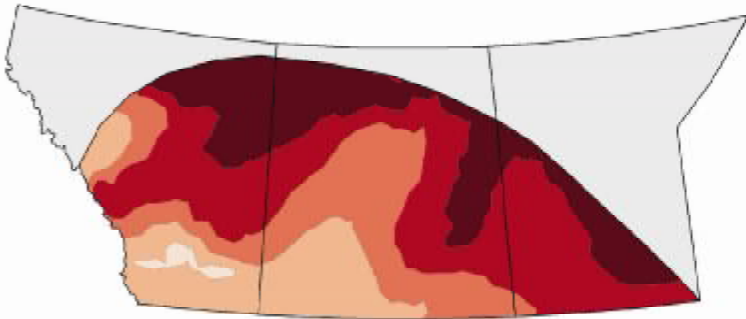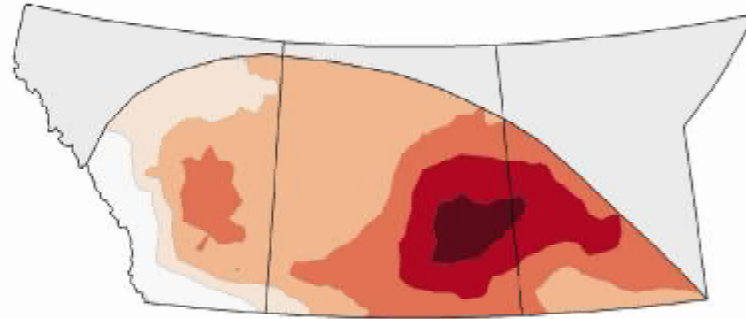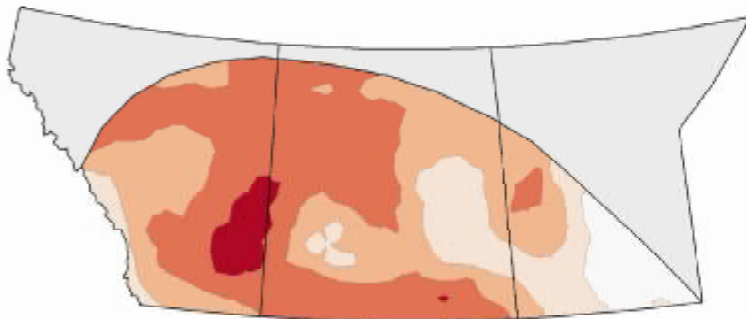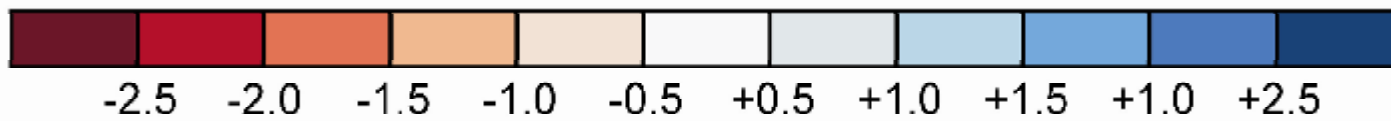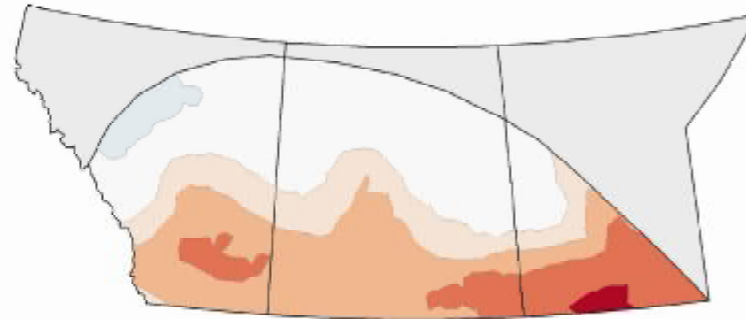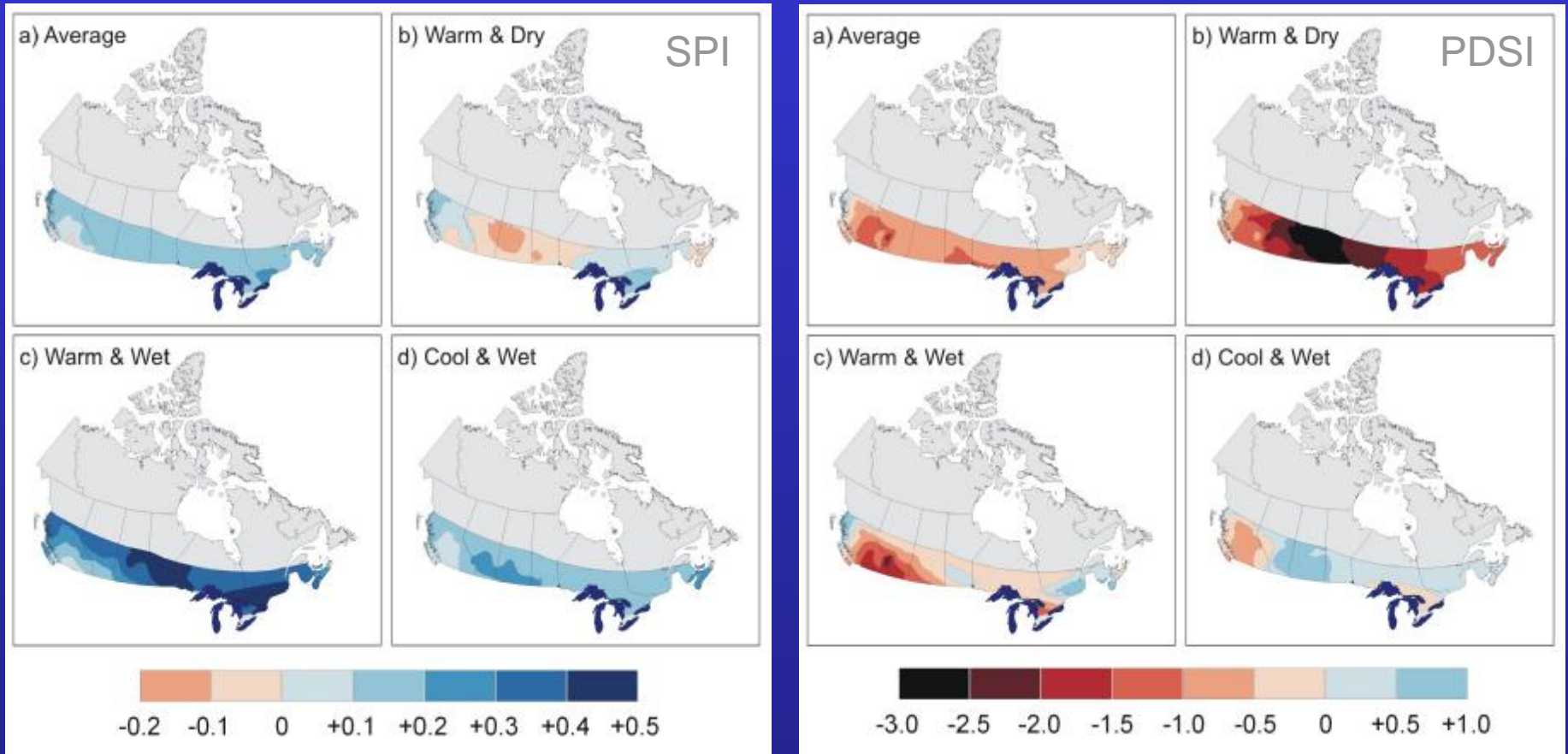
Future Droughts

Summary & Conclusions

- 2001/2002 Drought: Severe but not worst on record (on a Prairie-wide scale)

- Most severe droughts in early part of record

- PDSI lags SPI by a year or more

- Future Droughts (Preliminary findings):

  SPI – No real changes

  PDSI – Big Trouble

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Future Work

- Assessment of various drought indices

- Regional analysis within the Prairies
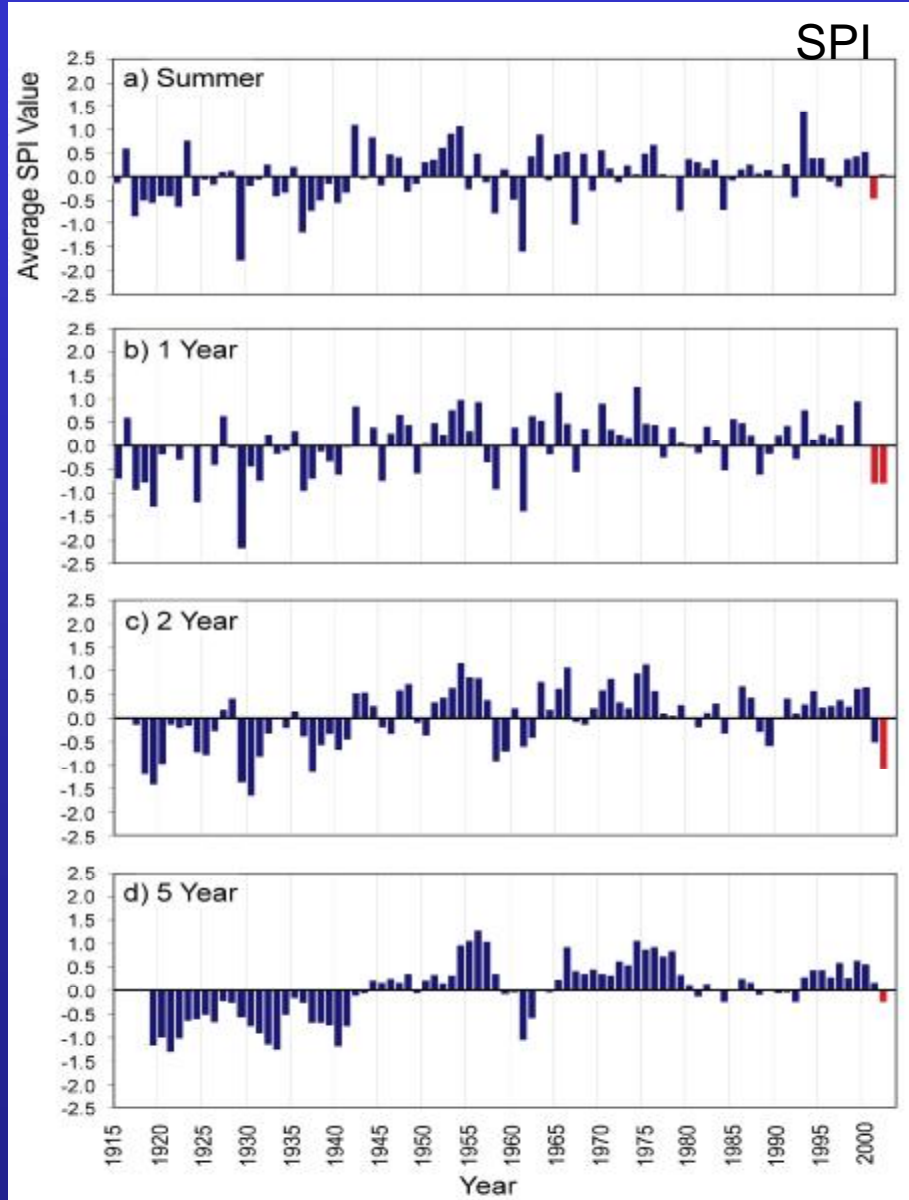
- Paleo-drought

- Future Droughts – Development of methodologies
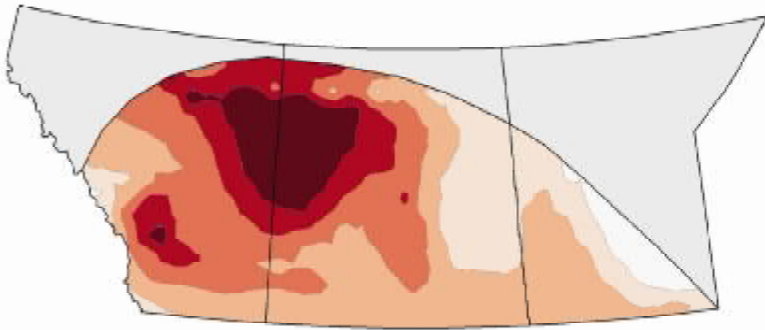
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Historical Analysis – Severity

Severe PDSI Droughts