

Drought Research Initiative (DRI)

Theme 1 Characterization - Applications to Drought Monitoring

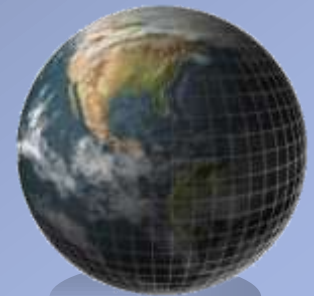


John Hanesiak
Department of Environment & Geography
Centre for Earth Observation Science (CEOS)
University of Manitoba

DRI-GEO Workshop
Winnipeg, MB, May 10-11, 2010

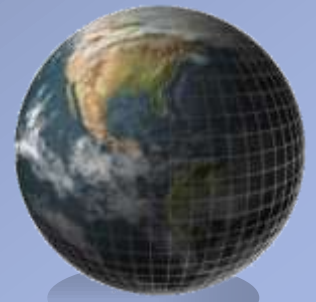
Research Questions of Theme 1

- Q1: What variables are required to quantify the characteristics of the recent drought?
- Q2: What data sources and model outputs are available for quantifying these parameters?
- Q3: How do we characterize and “close the budgets” of water and energy over the Prairies?
- Primary goal is to physically characterize the drought period through these 3 questions

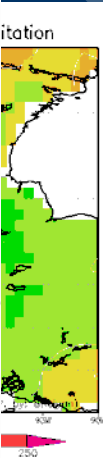
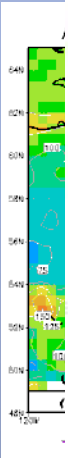
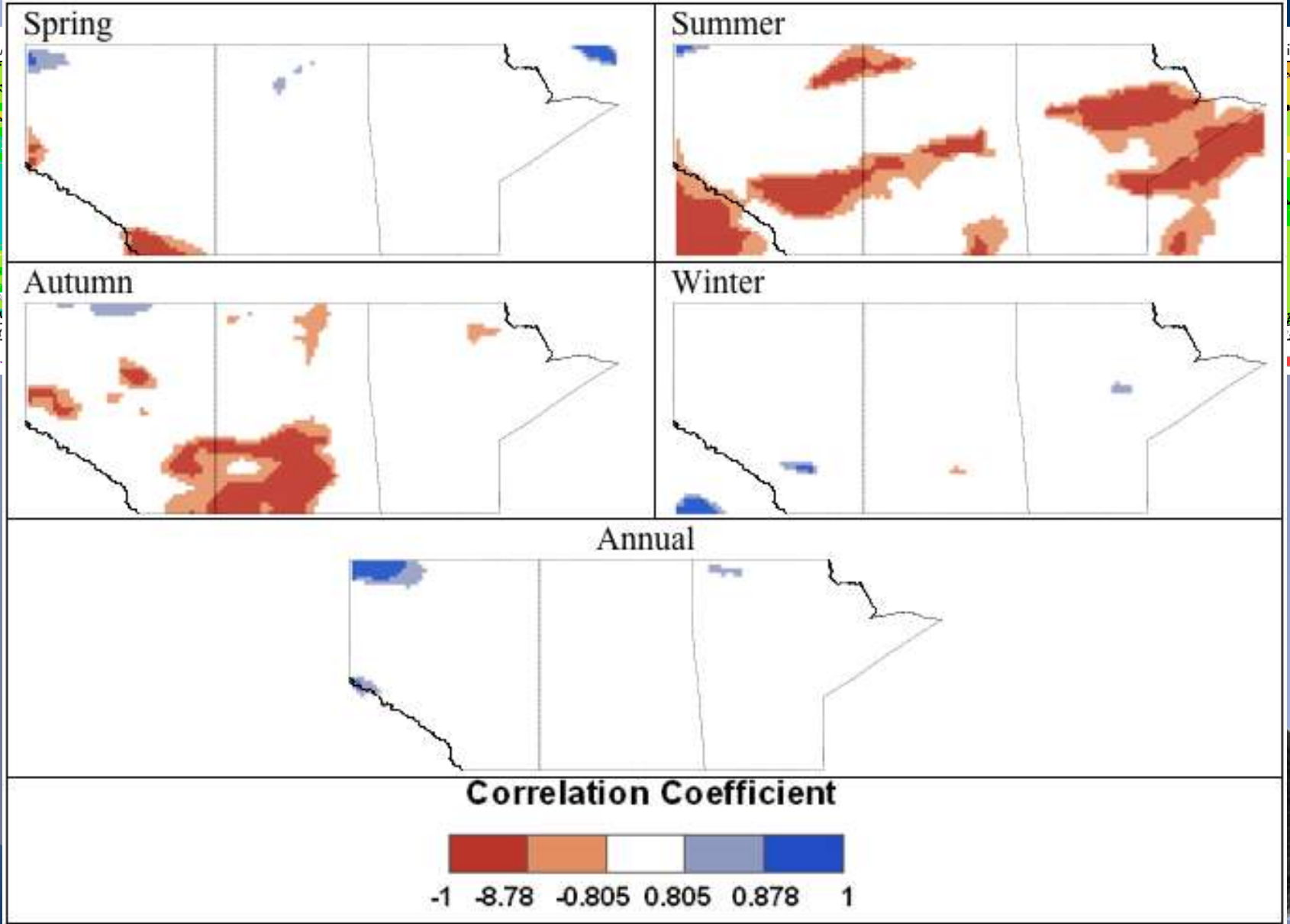


Outline

- Observations/Remote Sensing
- Modeling

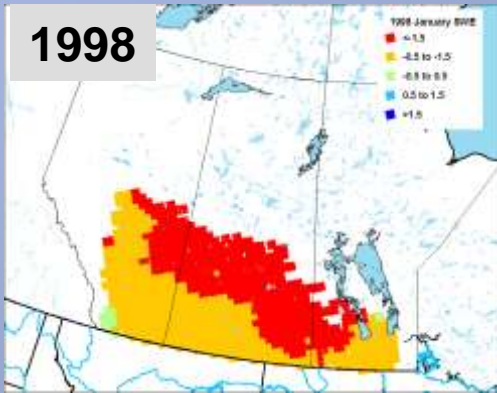


CanGrid Precipitation

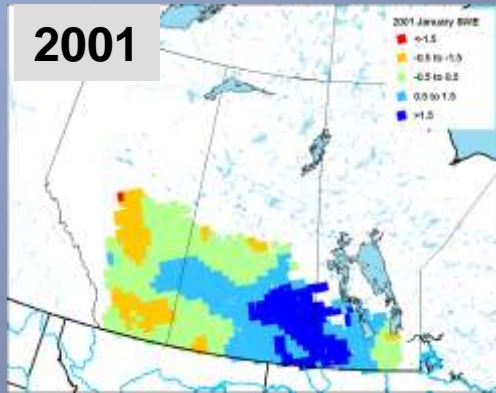


Passive Microwave Derived SWE

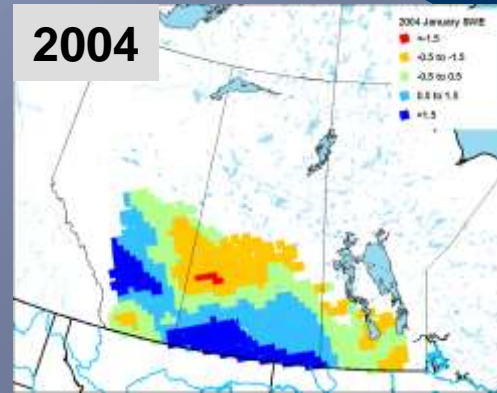
1998



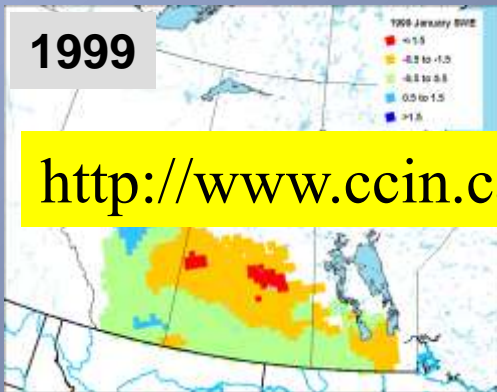
2001



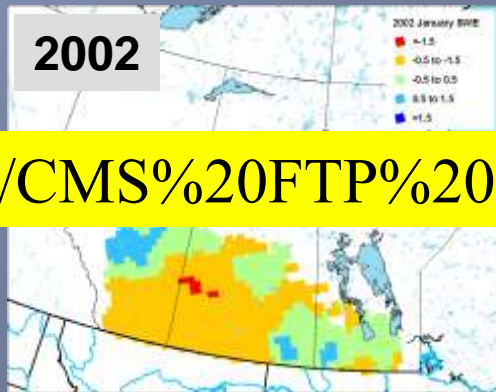
2004



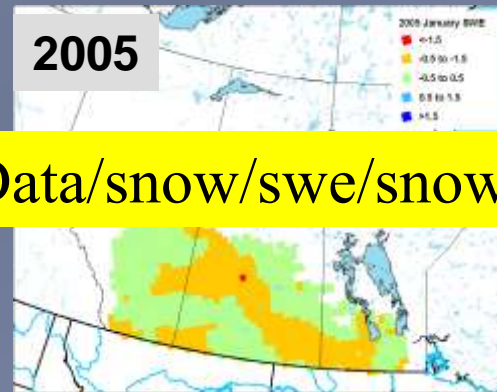
1999



2002

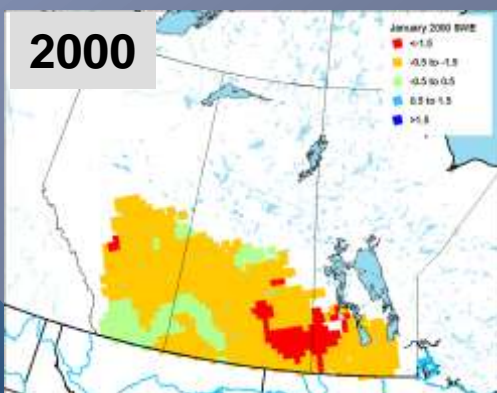


2005

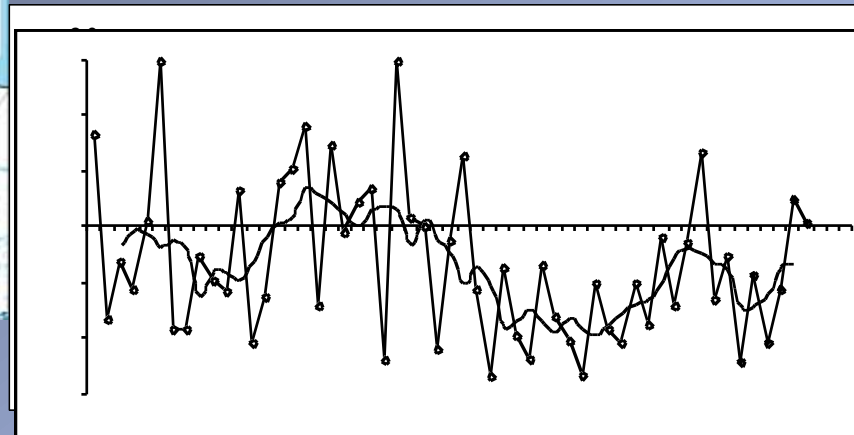
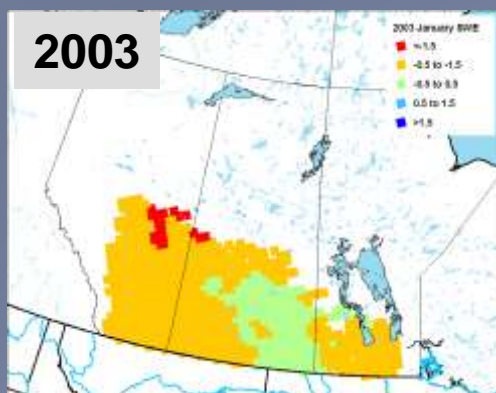


http://www.ccin.ca/CMS%20FTP%20Data/snow/swe/snow_swe.html

2000

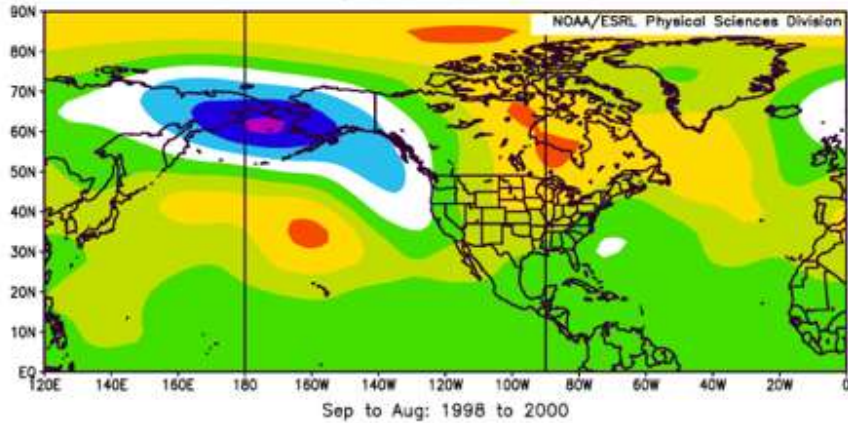


2003

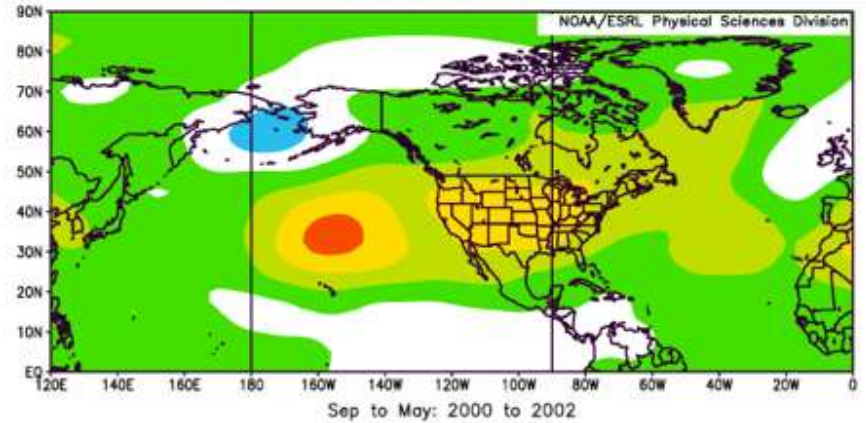
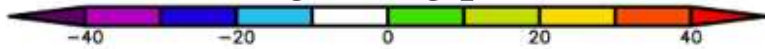


Phases

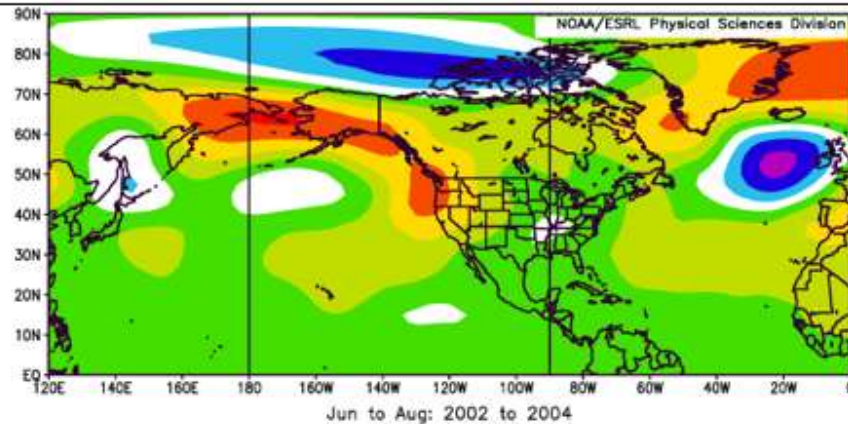
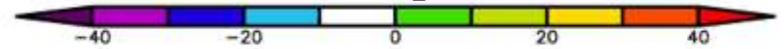
500 mb height anomalies



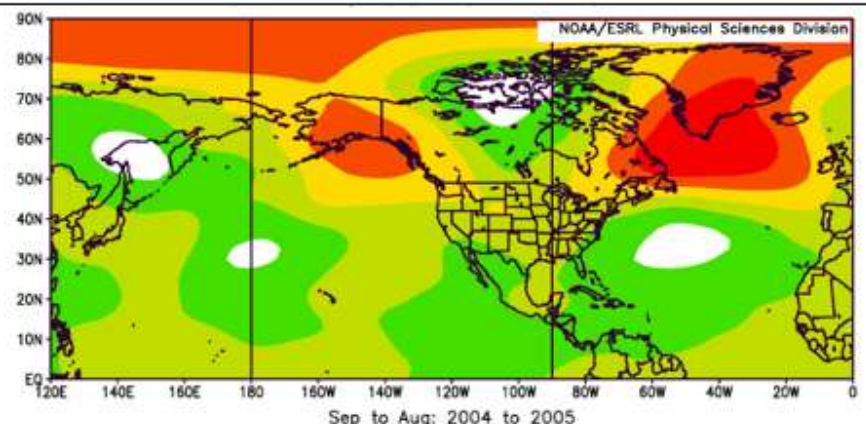
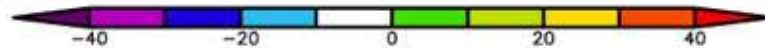
beginning phase



mature phase



mature phase - structure shift

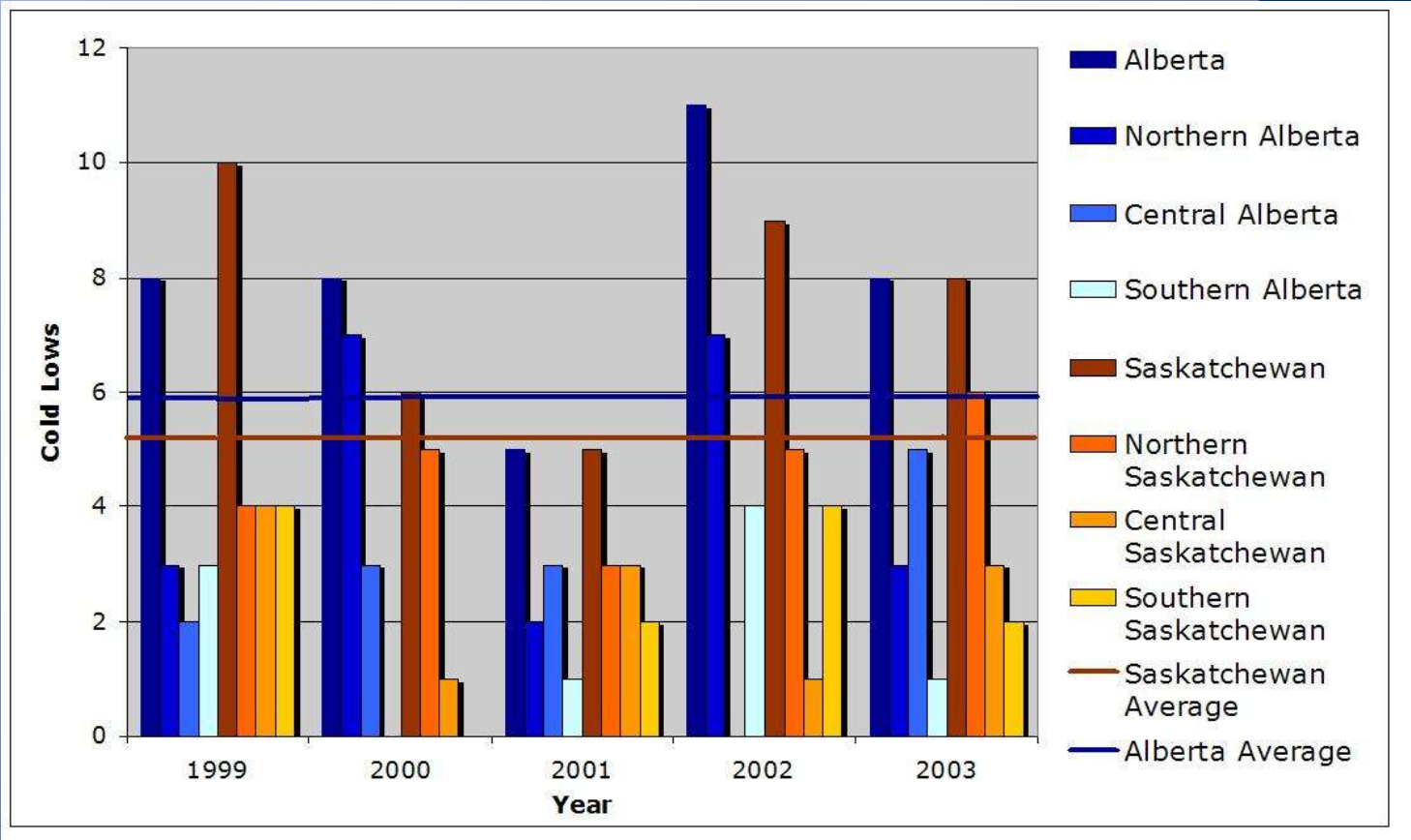


cessation phase

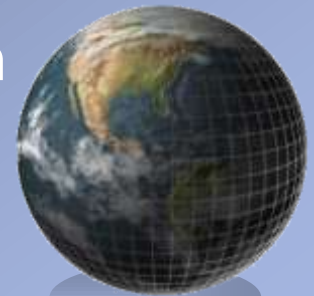


Cold Lows

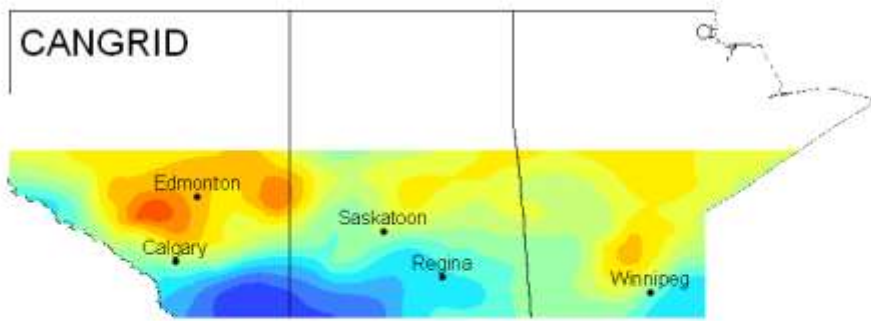
Wielki and Hanesiak



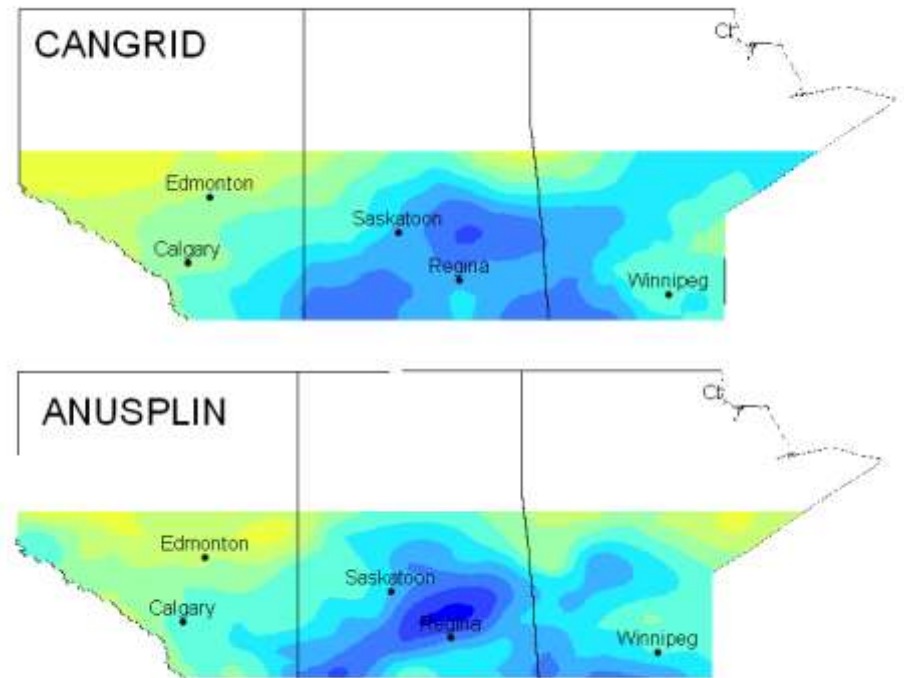
- No clear cut relation
- Fewer than normal in S.AB. in 2000 & C.AB/SK. in 2002



1-month SPI - June 2002



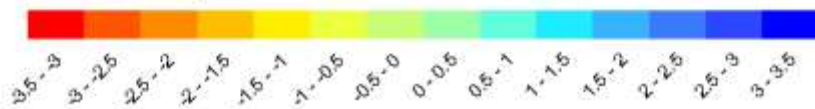
1-month SPI - August 2002



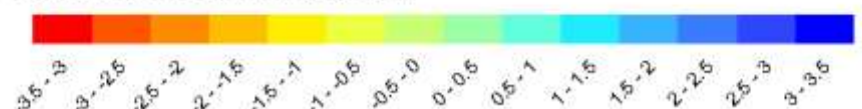
CRU **PFRA products are the only real-time sources**

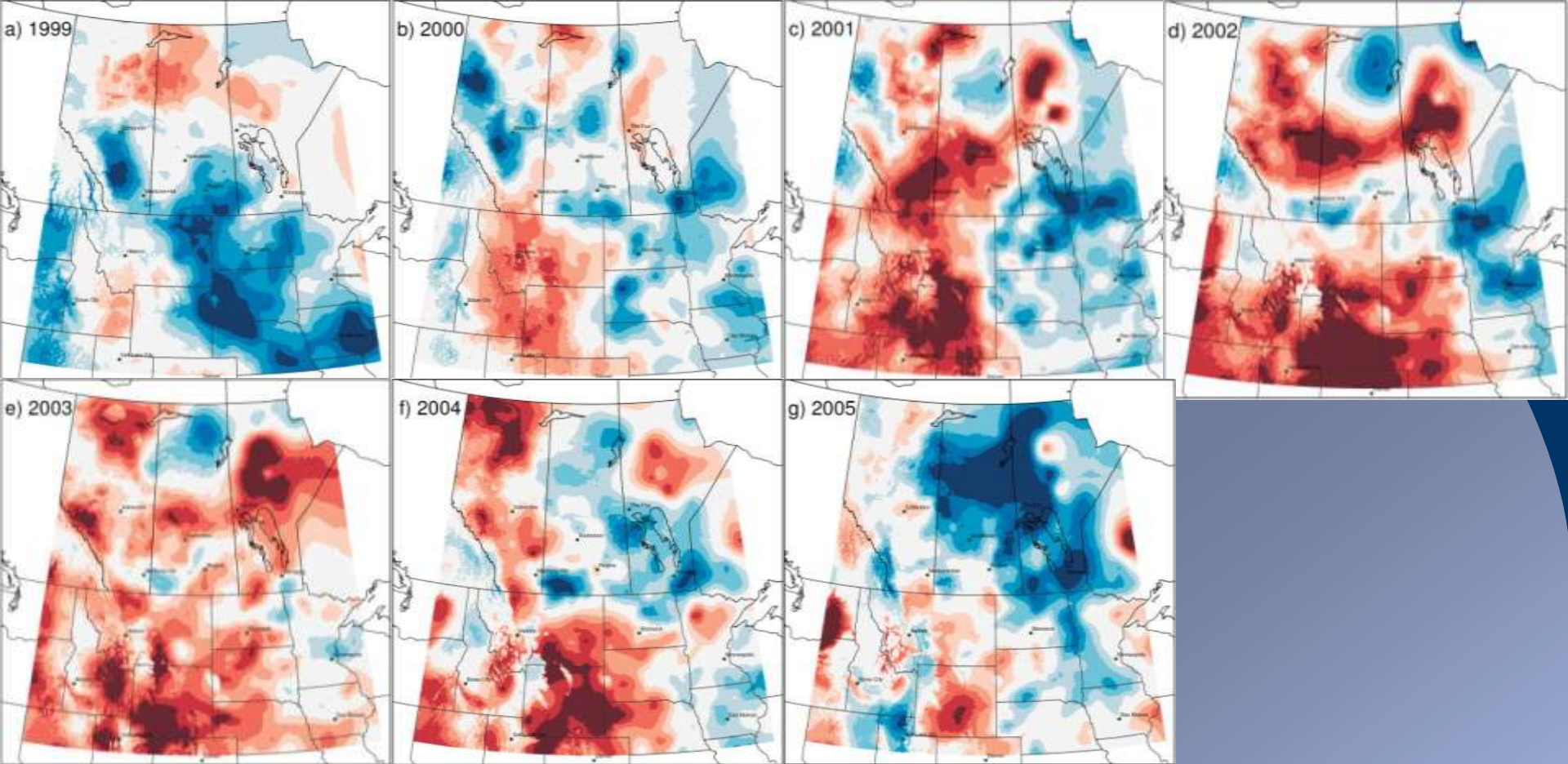


Standard Precipitation Index



Standard Precipitation Index

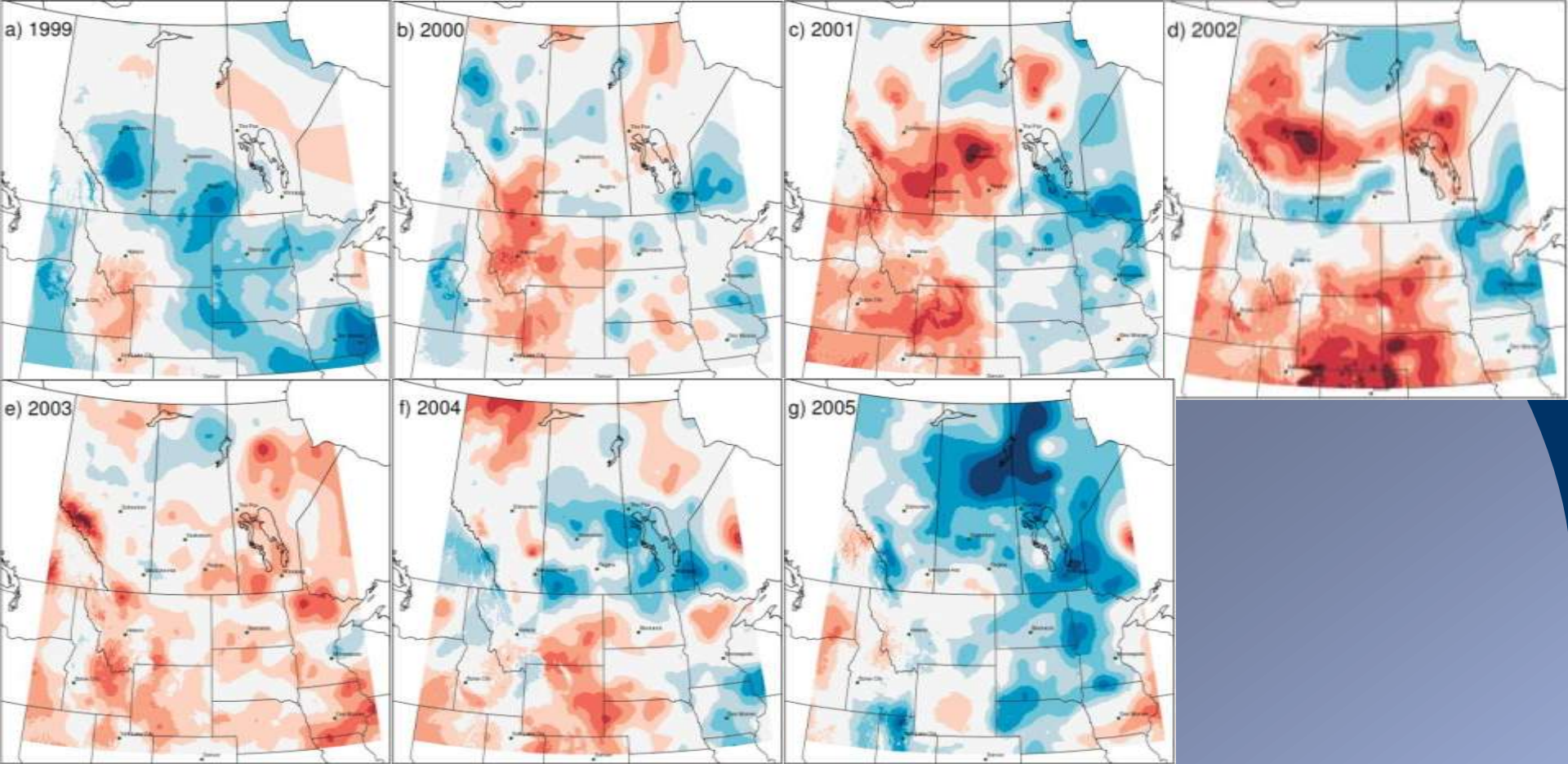




Annual PDSI

Bonsal/Wheaton





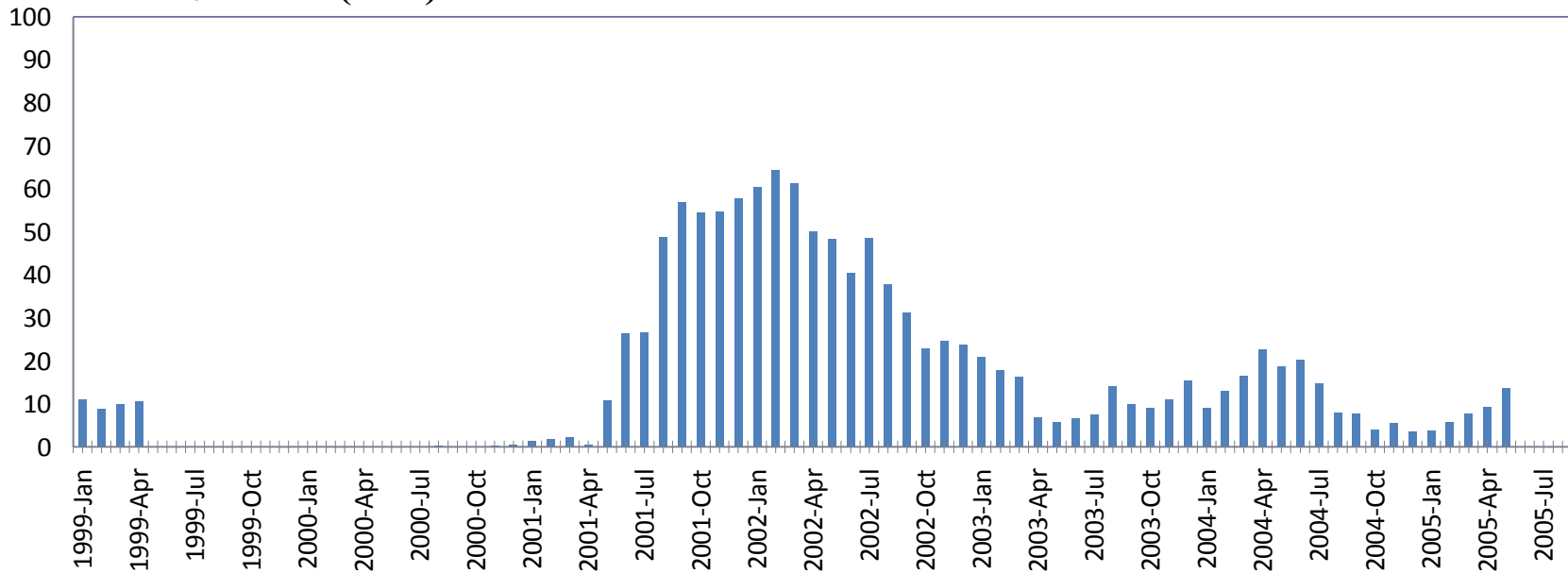
Annual SPI

Bonsal/Wheaton



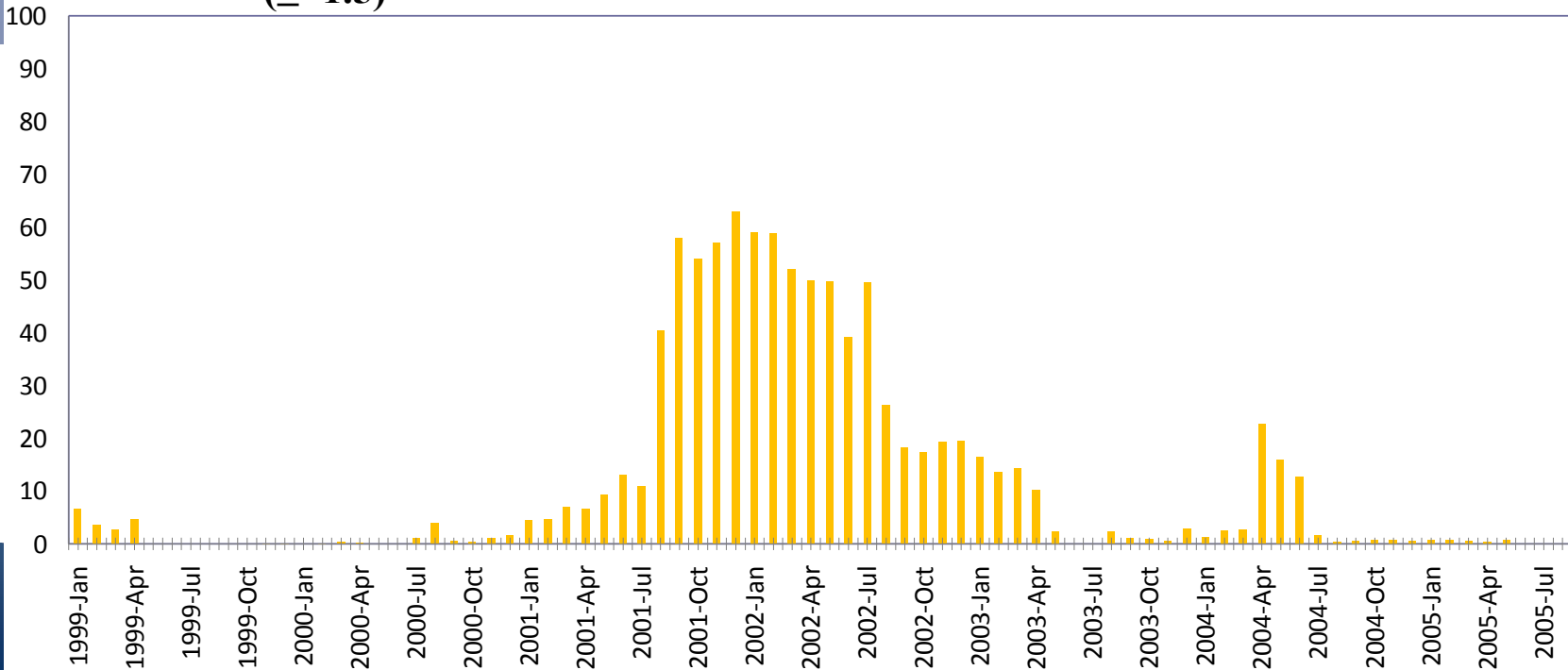
% Grids ≤ -3 PDSI

Monthly PDSI (≤ -3)

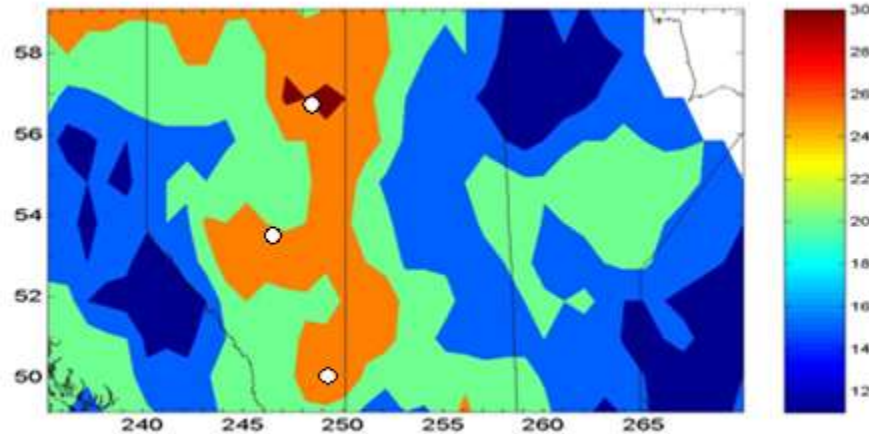


% Grids ≤ -1.5 SPI

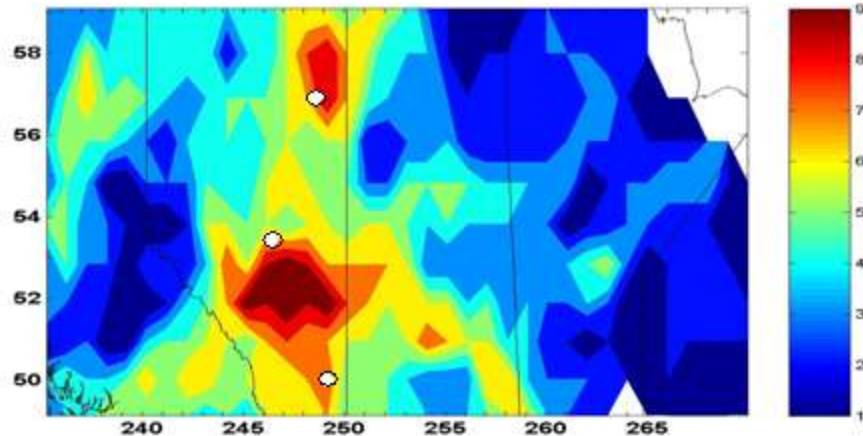
12-Month SPI (≤ -1.5)



Number of months that experienced (a) drought ($SPI \leq -0.5$) and (b) severe drought ($SPI \leq -1.5$) from September 1999 - December 2004. The white points indicate, from north to south, the locations of Fort McMurray, Edmonton and Medicine Hat.

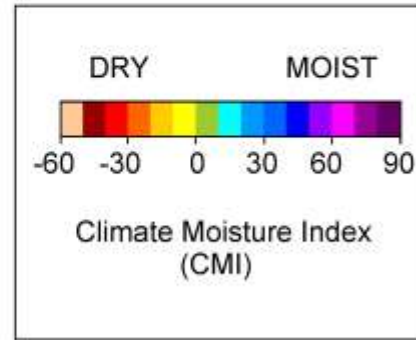
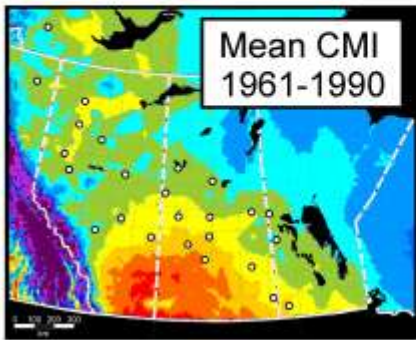
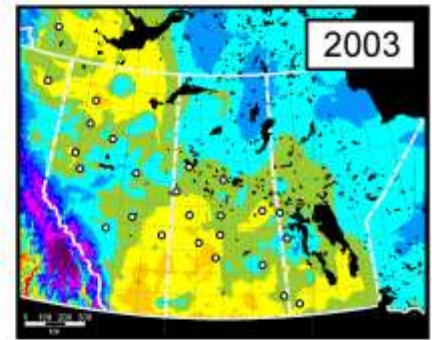
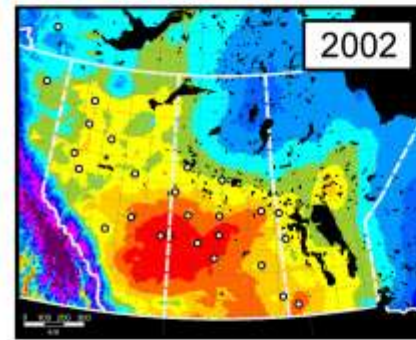
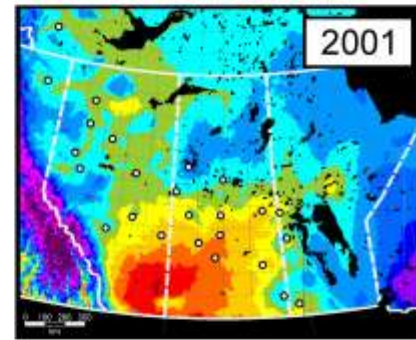
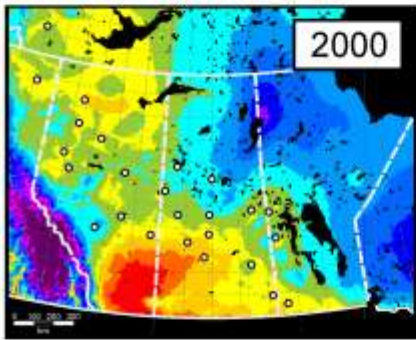
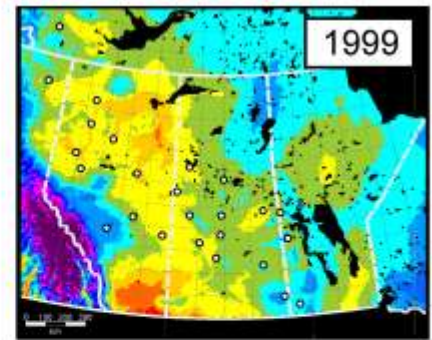
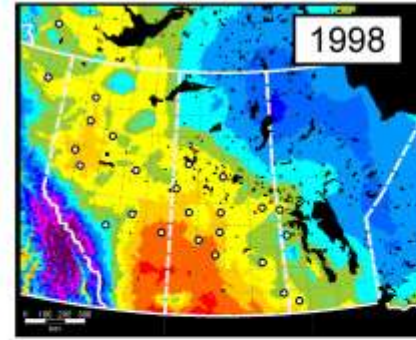
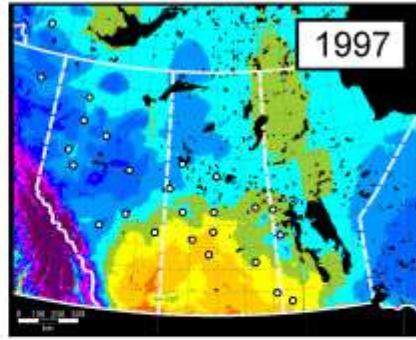
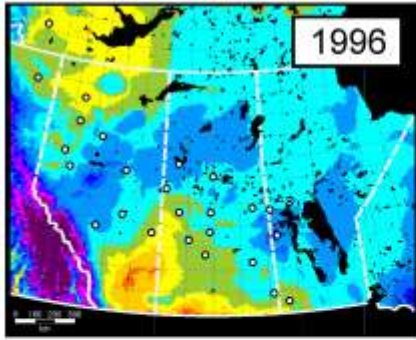


$SPI \leq -0.5$



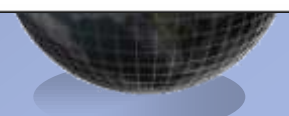
$SPI \leq -1.5$

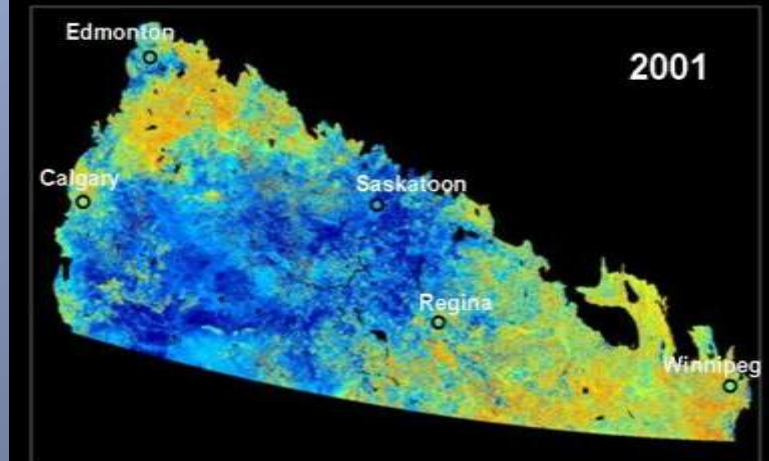
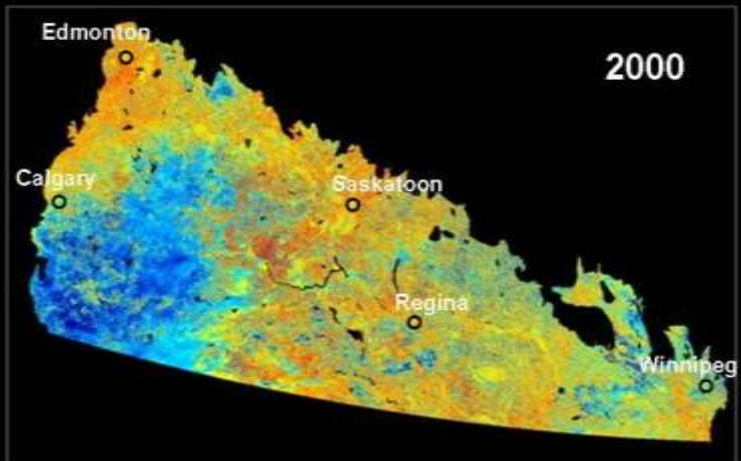




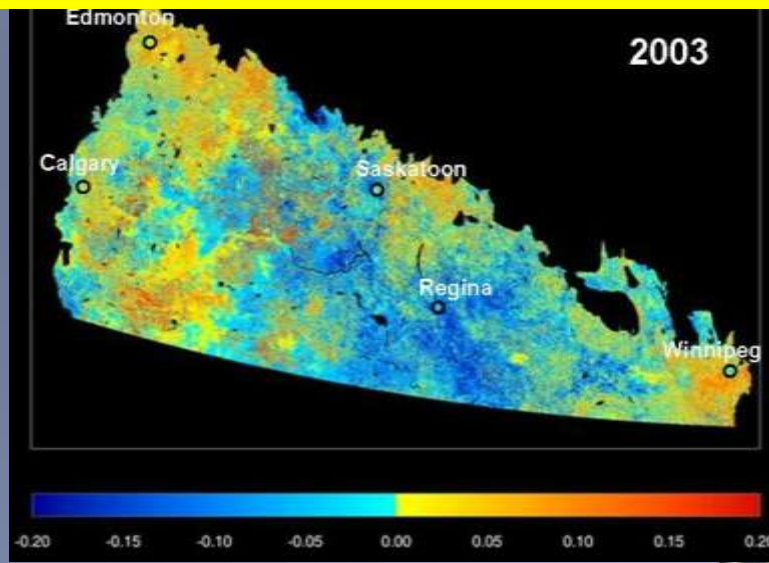
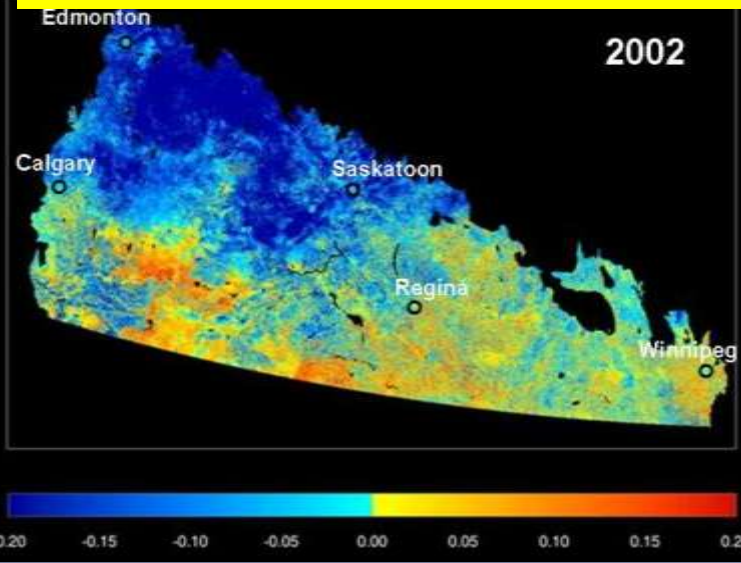
Maps by D.T. Price, M. Siltanen & D. McKenney
from Canadian gridded monthly climate
(interpolations based on ANUSPLIN)

Hogg





NDVI at <http://www26.statcan.ca/ccap/map.jsf?lang=en>
 VTI and VHI at http://www.star.nesdis.noaa.gov/smcd/emb/vci/VH/vh_currentImage.php



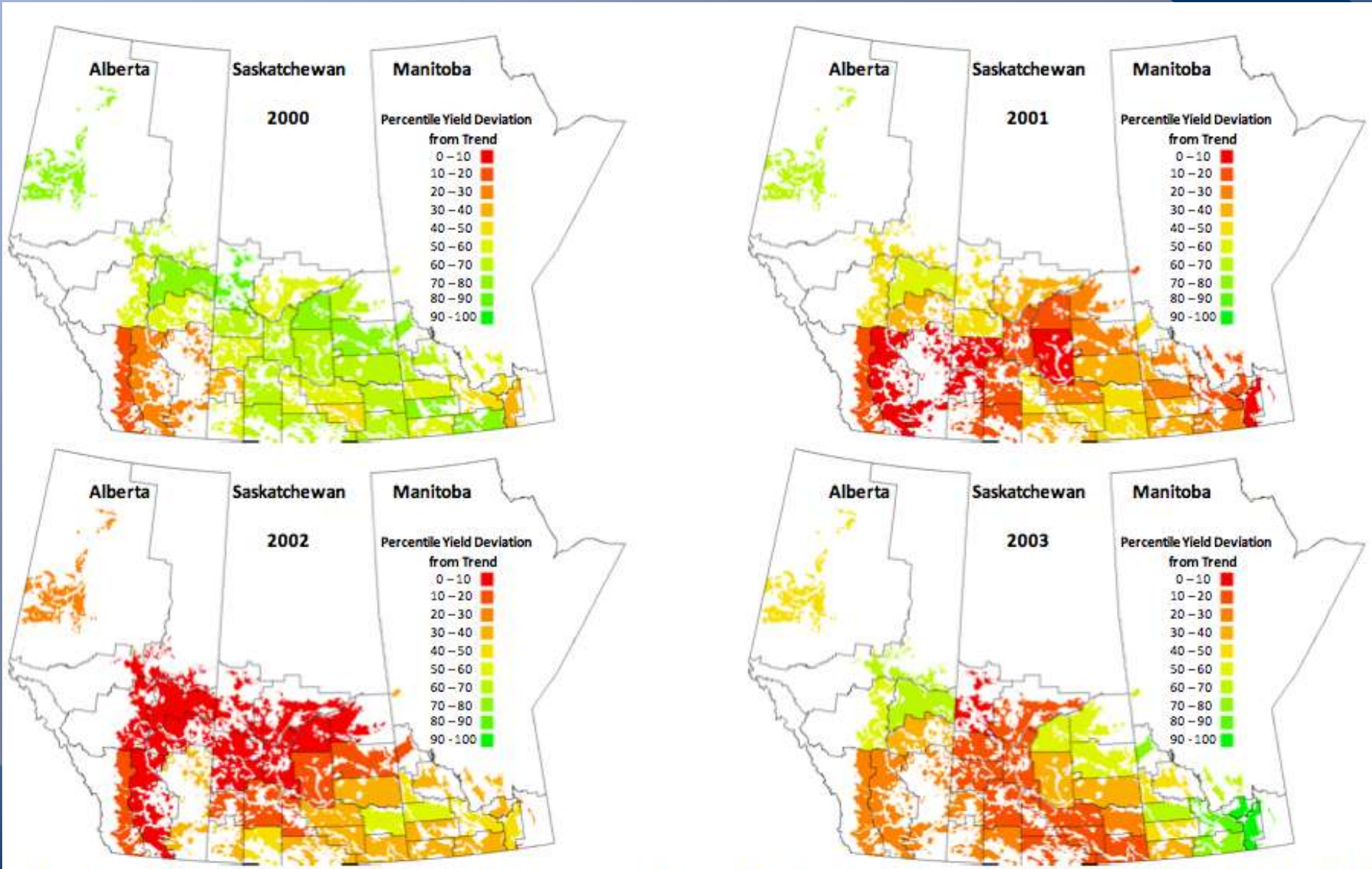
NDVI anomalies (based on 2000-08 mean) for 2000-2003
 250m spatial resolution for 10-day period of July 11-20

Yang, Wang, Trishchenko



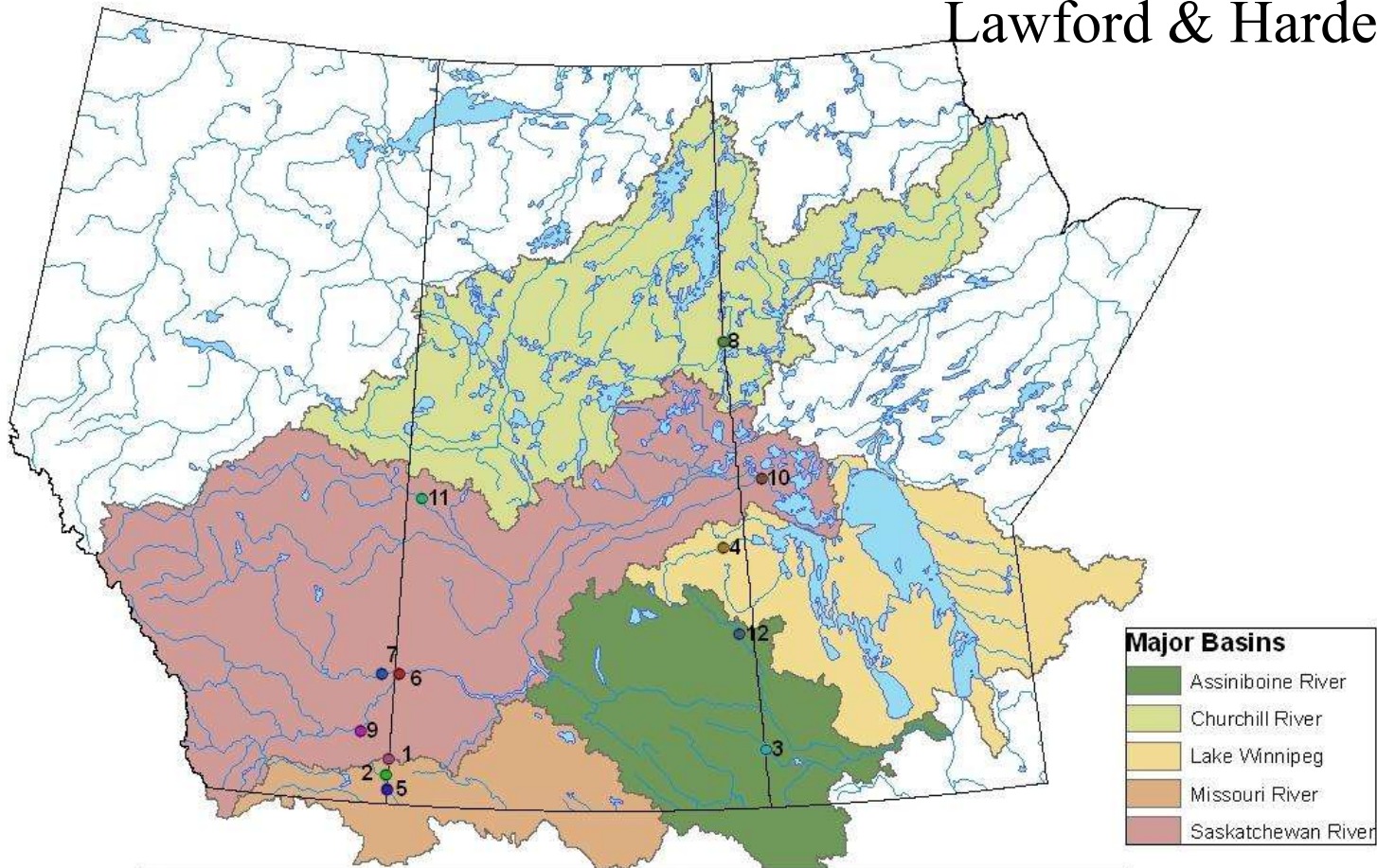
Crop Yields

Bullock

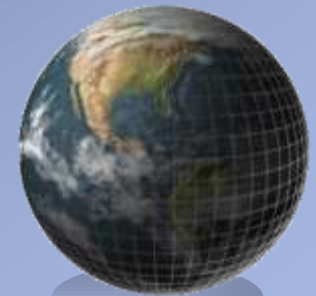


Surface Hydrology

Lawford & Harder



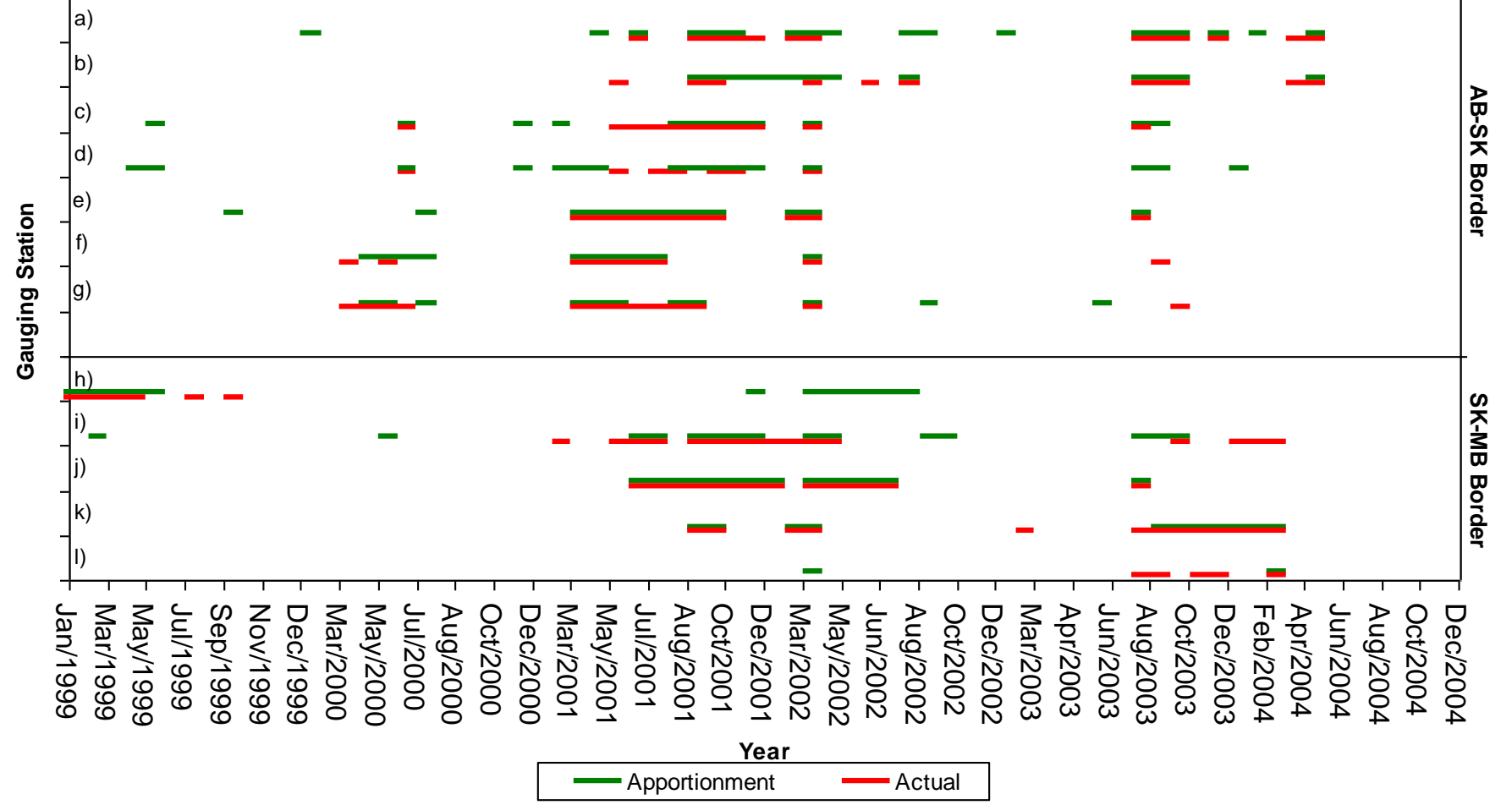
- | | |
|--|--|
| 1. BATTLE CREEK AT ALBERTA BOUNDARY | 7. RED DEER RIVER NEAR BINDLOSS |
| 2. MIDDLE CREEK NEAR THE SK BOUNDARY | 8. CHURCHILL RIVER AT SK-MB BOUNDARY |
| 3. PIPESTONE CREEK NEAR THE SK BOUNDARY | 9. SOUTH SASKATCHEWAN RIVER AT MEDICINE HAT |
| 4. RED DEER RIVER NEAR ERWOOD | 10. SASKATCHEWAN RIVER AT THE PAS |
| 5. LODGE CREEK NEAR AB BOUNDARY | 11. NORTH SASKATCHEWAN RIVER NEAR DEER CREEK |
| 6. SOUTH SASKATCHEWAN RIVER ABOVE RED DEER RIVER | 12. ASSINIBOINE RIVER AT KAMSACK |



Surface Hydrology

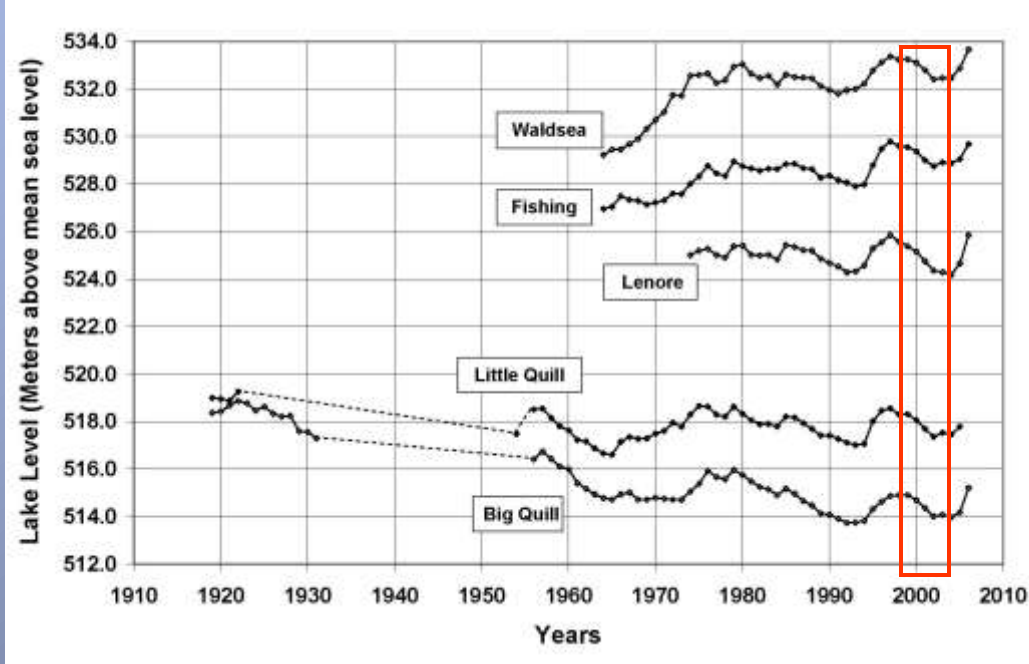
Actual and Apportionment Streamflow Drought Occurrence at Provincial Boundaries

monthly low flow that occurred only 10 percent of the time (Q10) was selected as the threshold

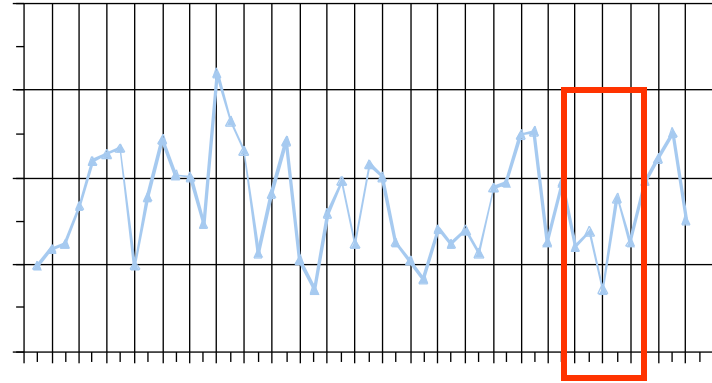


Gauging Stations: a) North Saskatchewan at Border, b) Red Deer at Bindloss, c) South Saskatchewan below Red Deer, d) South Saskatchewan at Medicine Hat, e) Battle Creek at Border, f) Lodge Creek at Border, g) Middle Creek at Border, h) Churchill River at the Border, i) Saskatchewan at The Pas, j) Red Deer near Erwood, k) Assiniboine at Kamsack and l) Pipestone Creek.

Lakes and Ponds



Number of Ponds in the Canadian prairie region - spring pond counts 1961 -2008 (thousands)



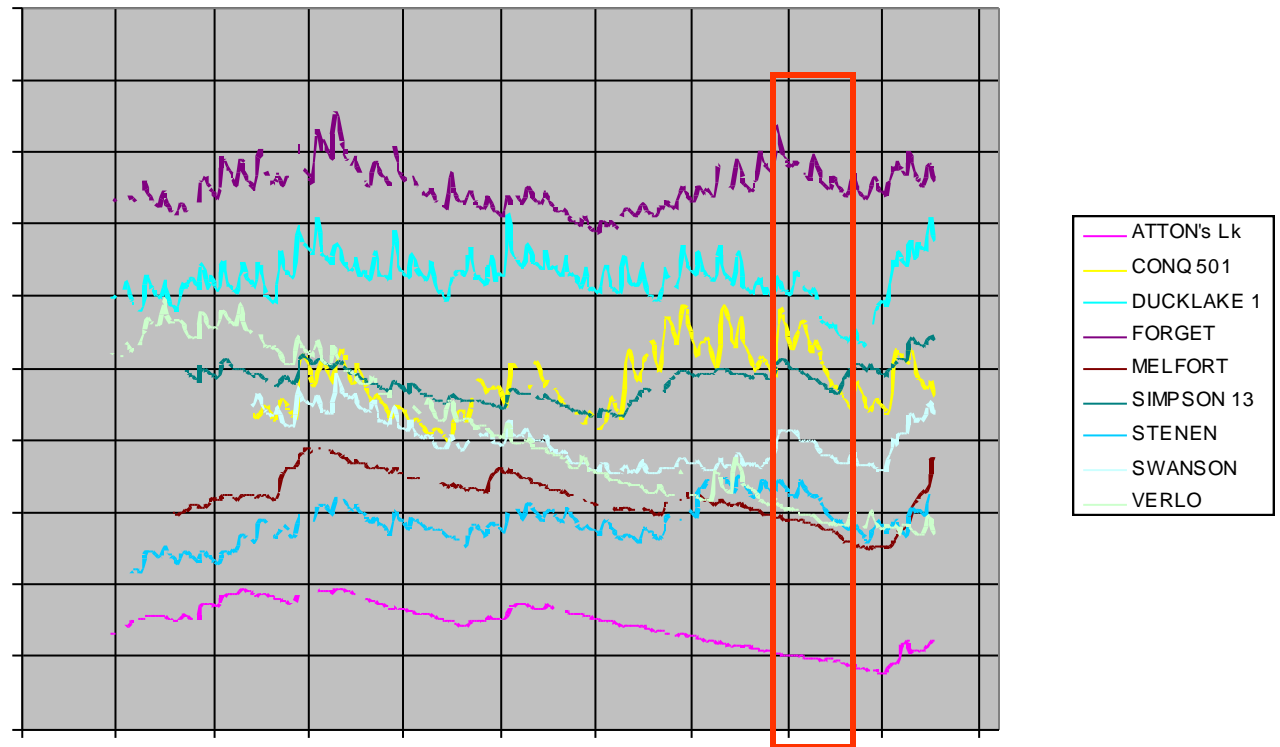
Van der Kamp

(Source: USFWS/CWS)

Year

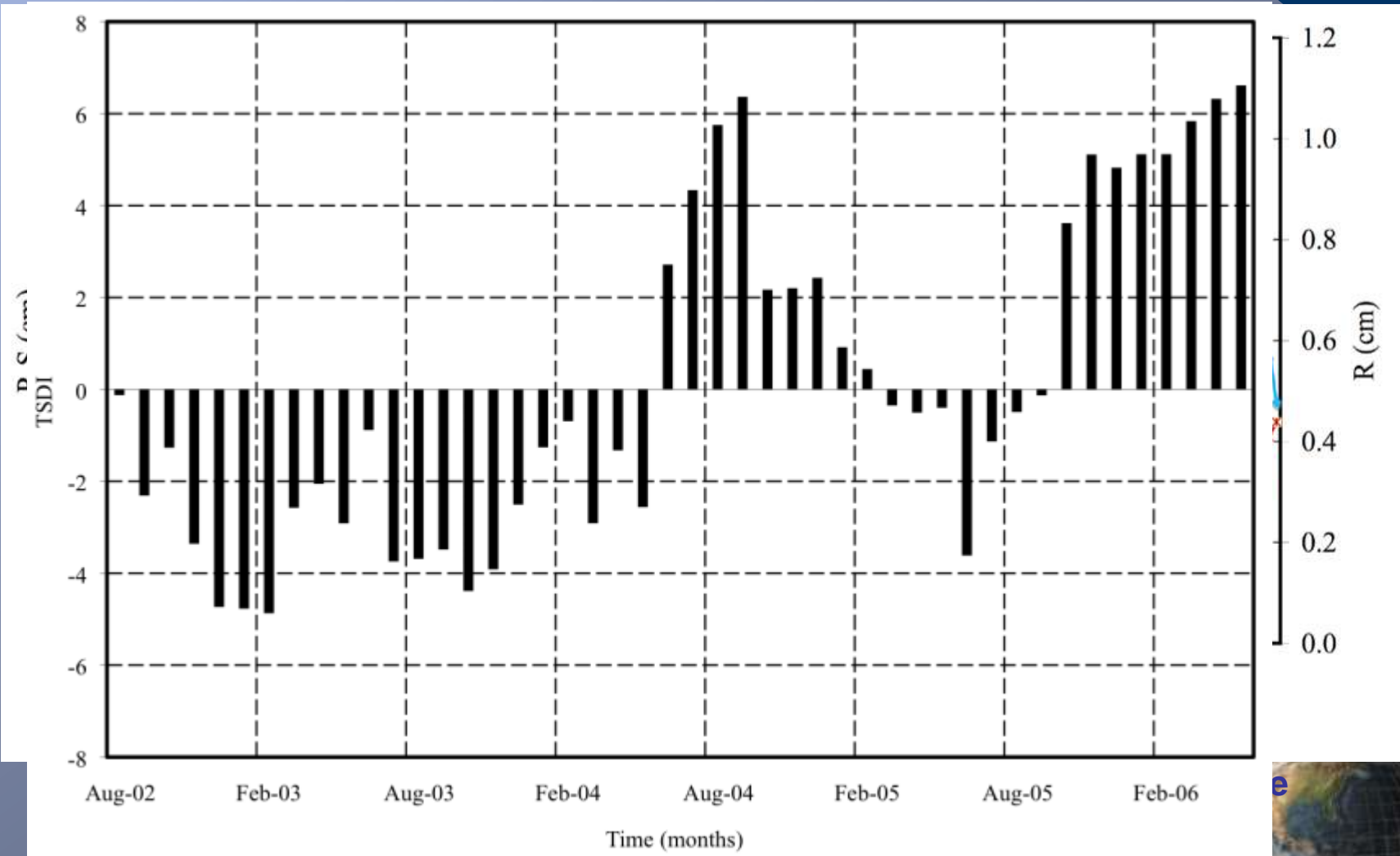
Shallow SK wells

**Shallow observation wells in SK Š water level records 1964 -2007:
water table depths below ground level (m)**



SRB Hydrology & GRACE

Yirdaw & Snelgrove

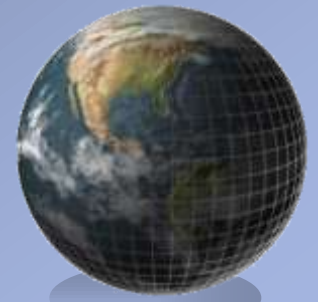


Real-Time monthly data available

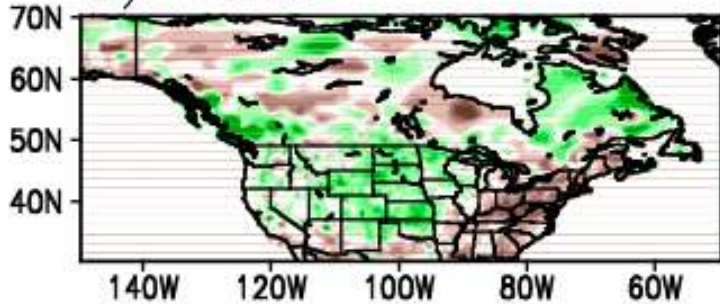


Modeling

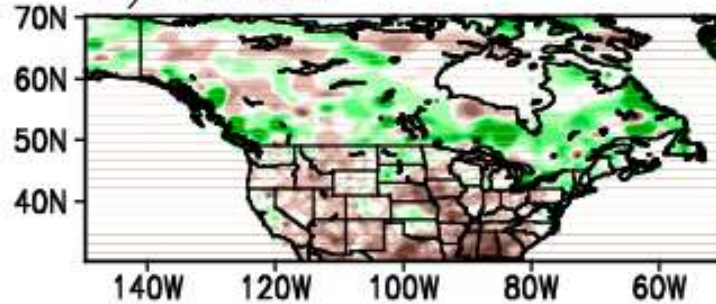
- Don't stand a chance if input data are poor !



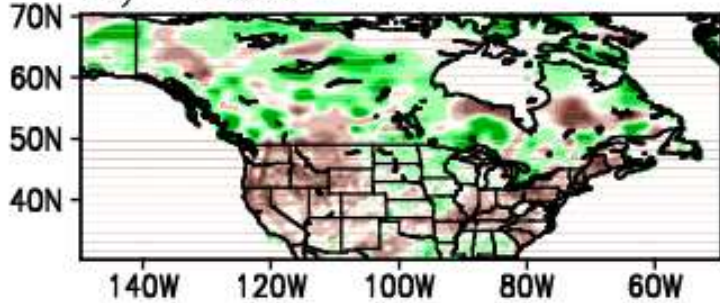
a) 1999



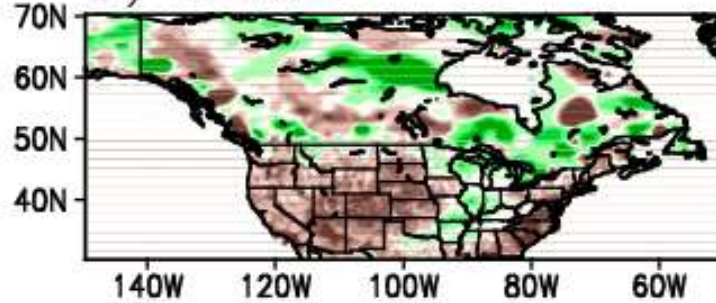
b) 2000



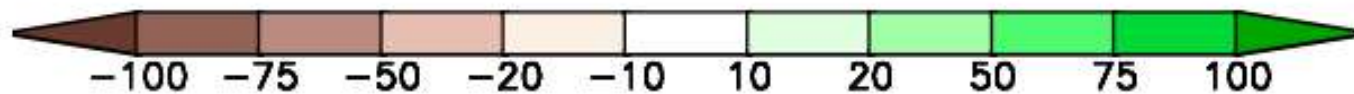
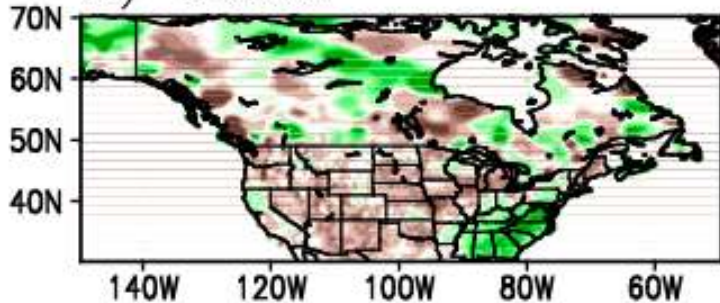
c) 2001



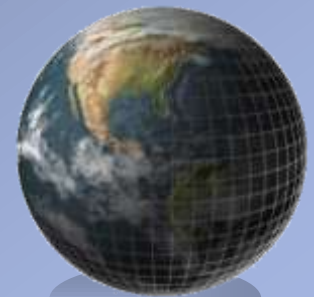
d) 2002



e) 2003

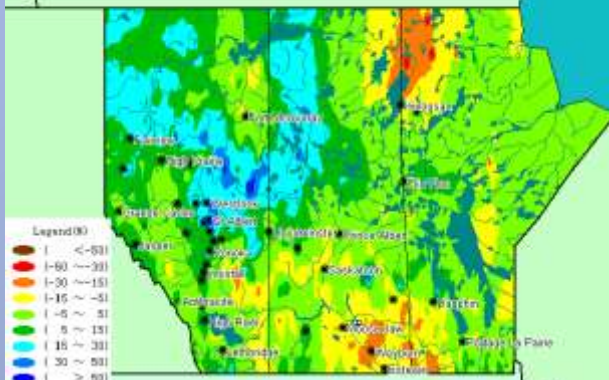


Shabbar



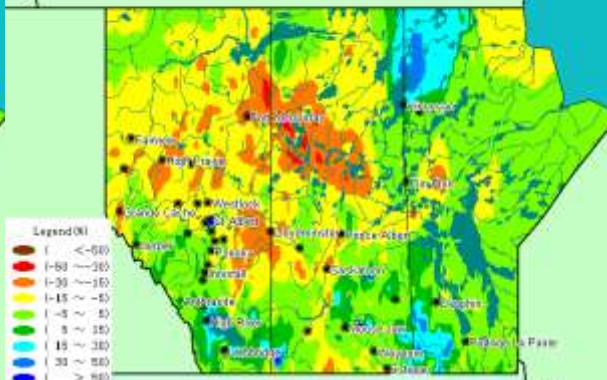
SMAPI for 0~100cm Layer

JJA,1997



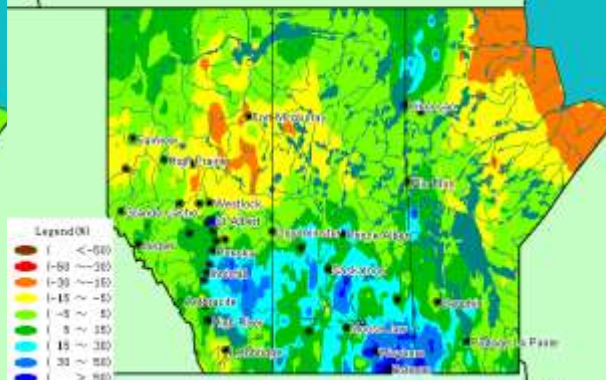
SMAPI for 0~100cm Layer

JJA,1998



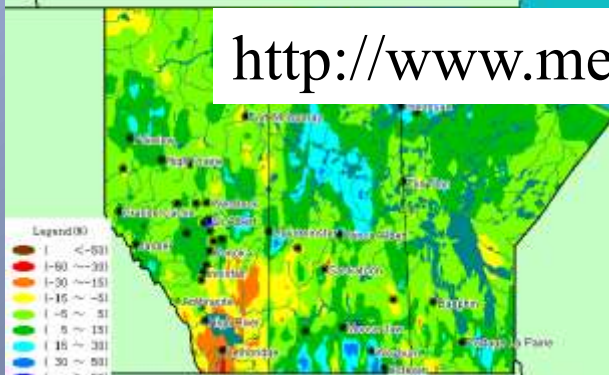
SMAPI for 0~100cm Layer

JJA,1999



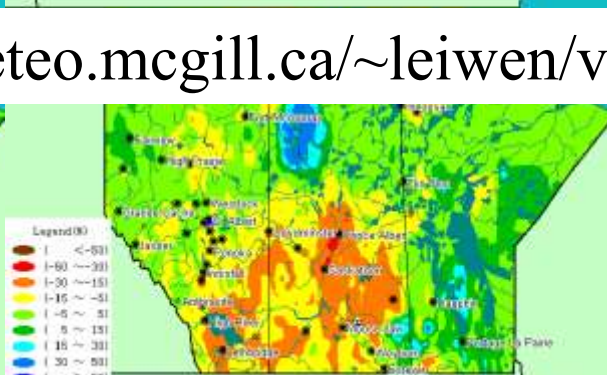
SMAPI for 0~100cm Layer

JJA,2000



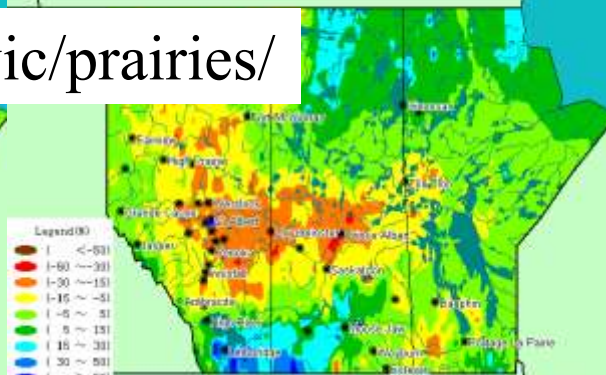
SMAPI for 0~100cm Layer

JJA,2001



SMAPI for 0~100cm Layer

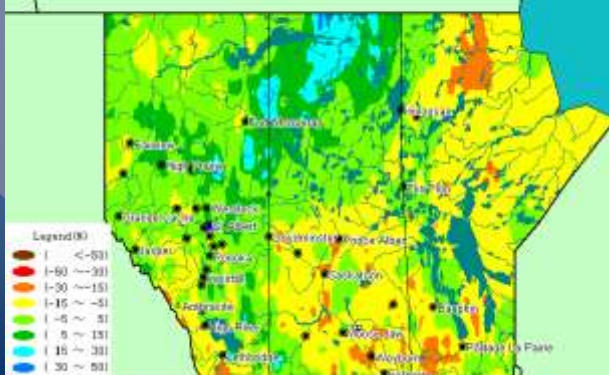
JJA,2002



<http://www.meteo.mcgill.ca/~leiwen/vic/prairies/>

SMAPI for 0~100cm Layer

JJA,2003



SMAPI for 0~100cm Layer

JJA,2004

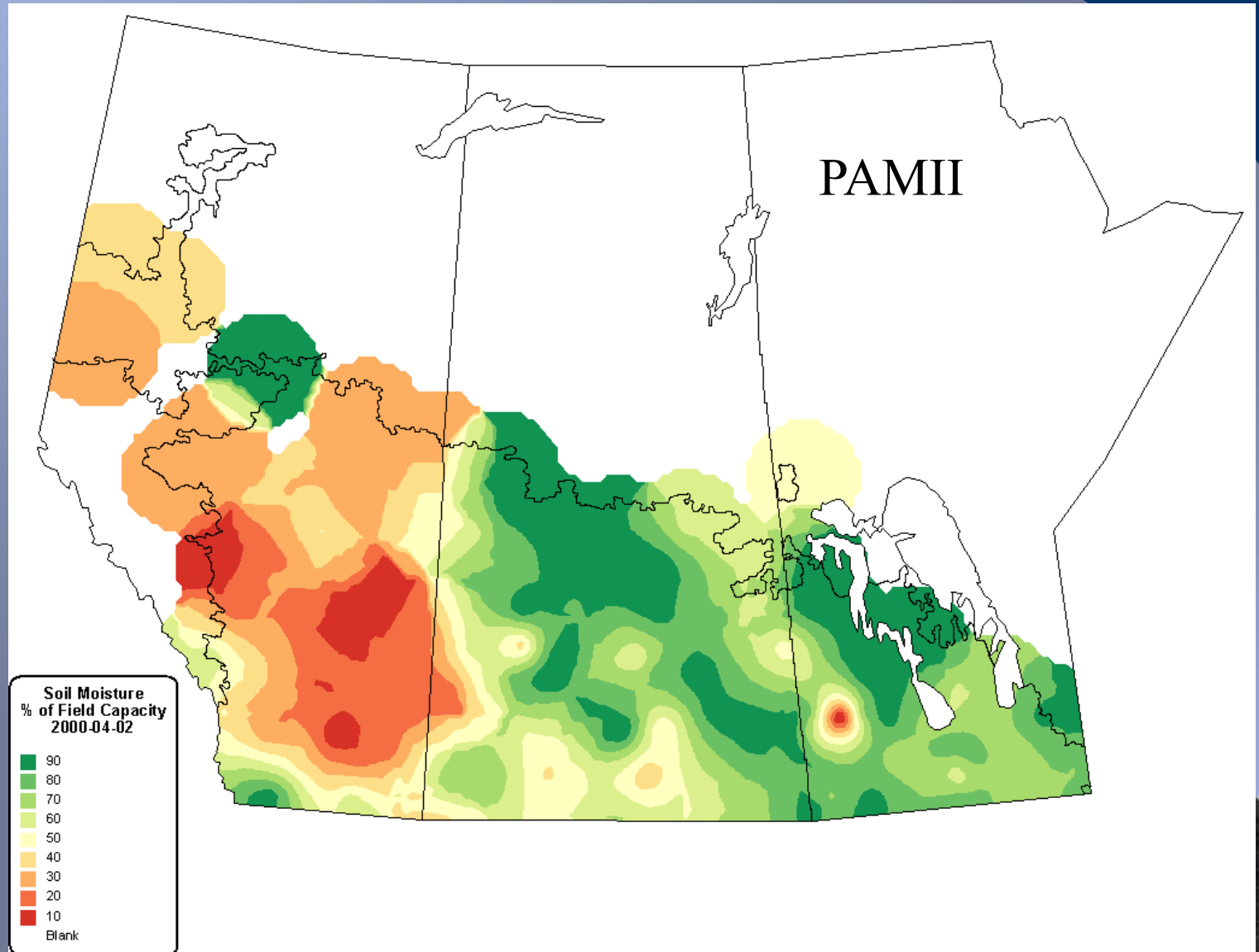


SMAPI for 0~100cm Layer

JJA,2005

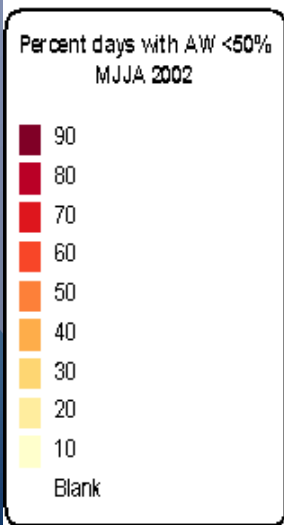


Soil Moisture (crop root-zone)



Brimelow, Hanesiak, Raddatz

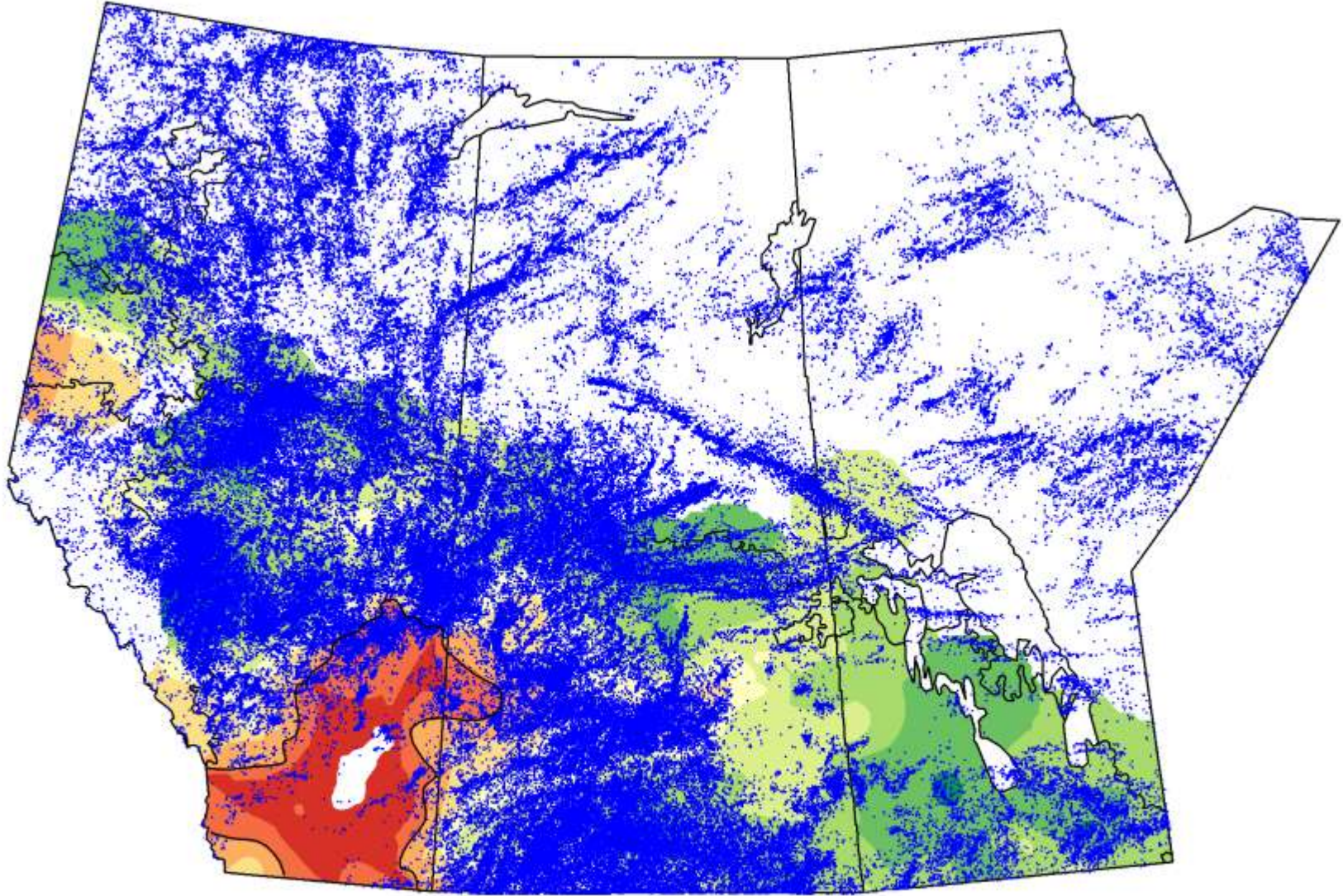
We are hoping to run model in real-time



Crop Model AW days vs NDVI

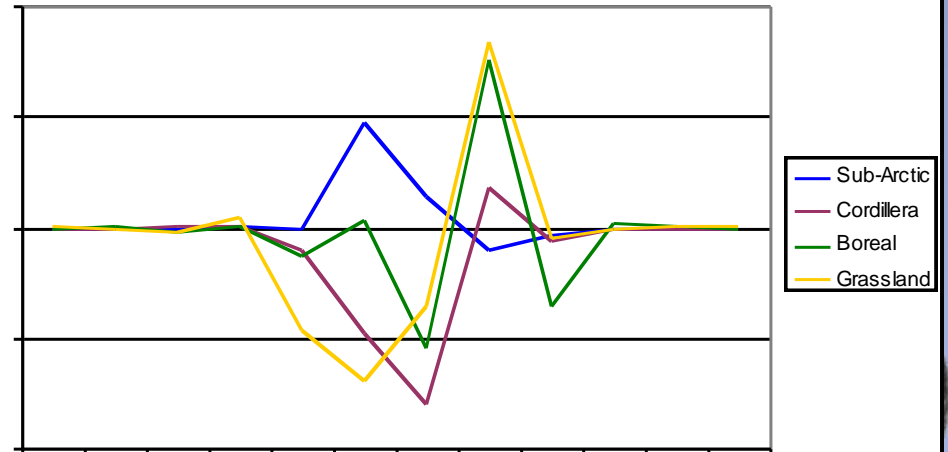
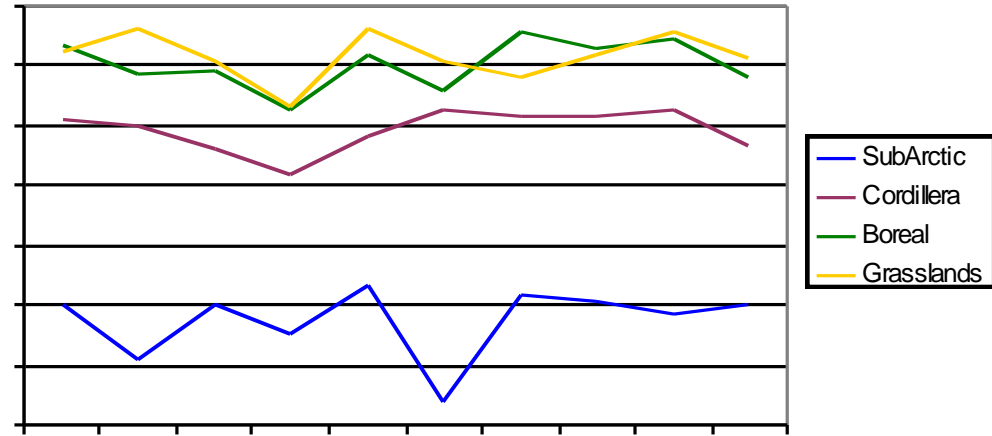
Brimelow,
Hanesiak

July 2000 Soil Moisture and Lightning



Brimelow, Hanesiak, Kusyk

Lightning



Hail and Tornado Days

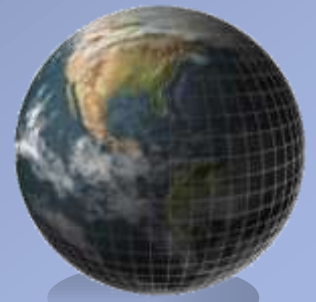
	1985-2007	2000	2001	2002
Hail	86 ± 25	<u>60</u>	<u>56</u>	69
Tor	29 ± 8	25	<u>20</u>	<u>20</u>

1998 and 2002 were the only years that \geq F2 did not occur



Surface Hydrology

- Modeling
 - MEC/MESH
 - Environment Canada / NHRI / HAL
 - Plans for operational use?



Continued Theme 1 Work

Characterization of Drought

- journal article submission fall/winter 2010
- 3-4 part articles
 - precip/temp and indices
 - surface impacts and processes
 - hydrology
 - synthesis and cohesion of drought spatial and temporal aspects (i.e. tie together atmospheric, surface hydrology and ground water)

