

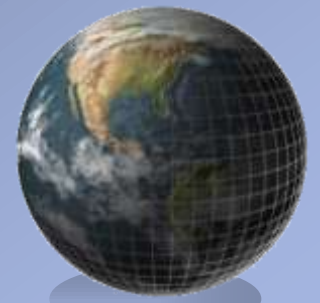
# Drought Research Initiative (DRI) Theme 1 Characterization



John Hanesiak  
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Centre for Earth Observation Science (CEOS)  
University of Manitoba

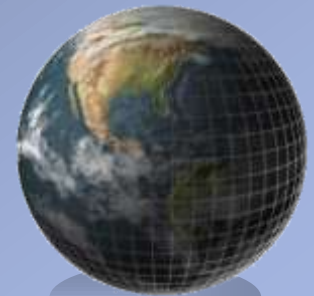
Final DRI Workshop  
Winnipeg, MB, May 12-14, 2010

15 minutes?



# 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



# Theme 1 Deliverables

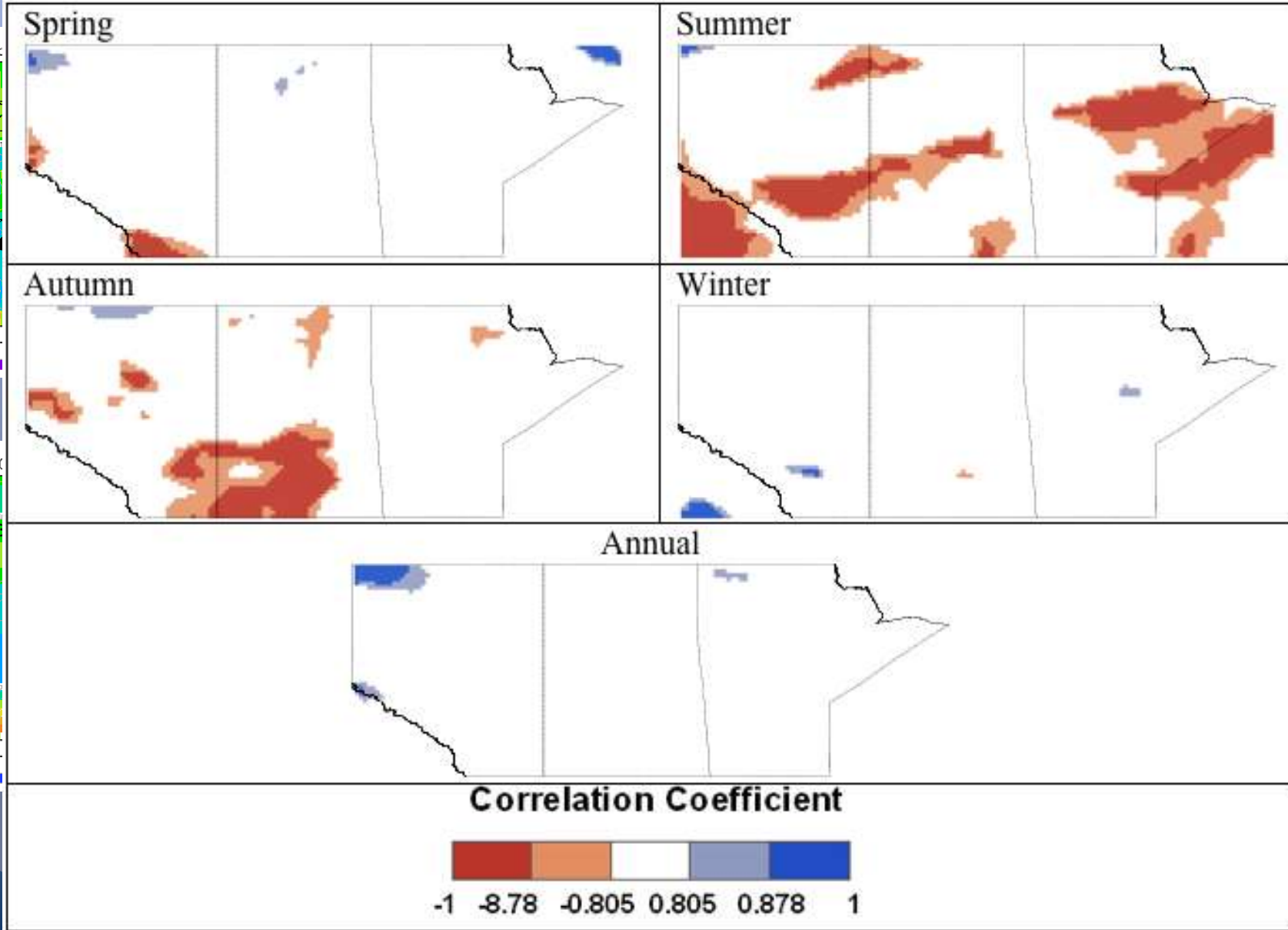
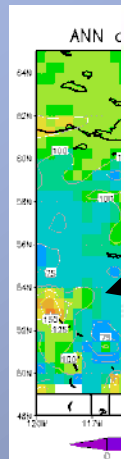
- Collective datasets archived on CDs characterizing the drought
- Outreach to user community and stakeholders through workshops and conferences
- Synthesis article on drought characterization and flow of water and energy



- Will highlight work not represented at the workshop



# CanGrid Precipitation

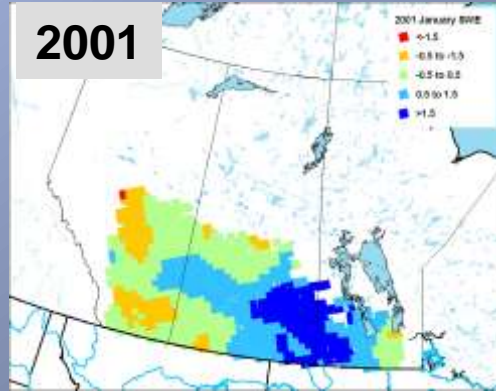


# Passive Microwave Derived SWE

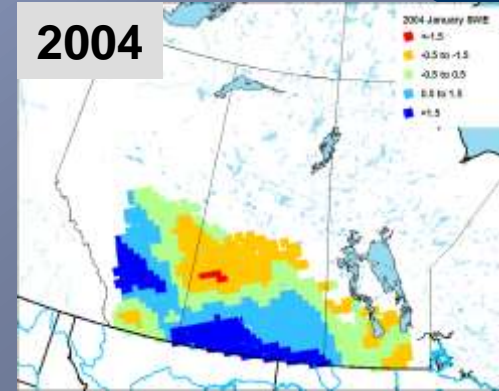
1998



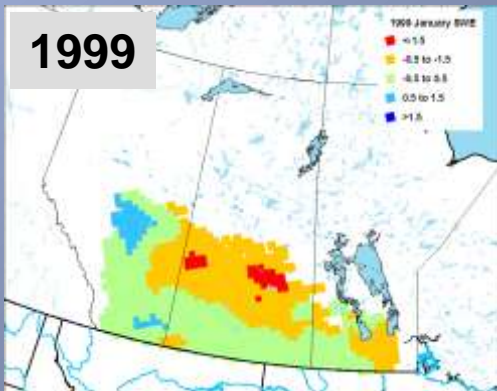
2001



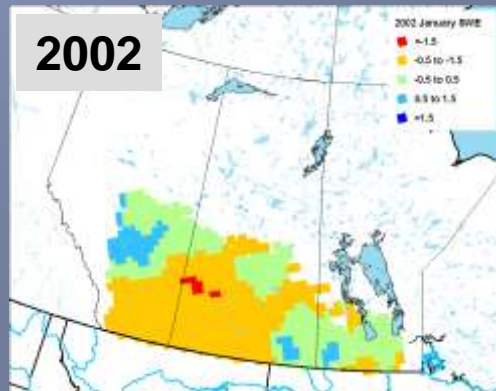
2004



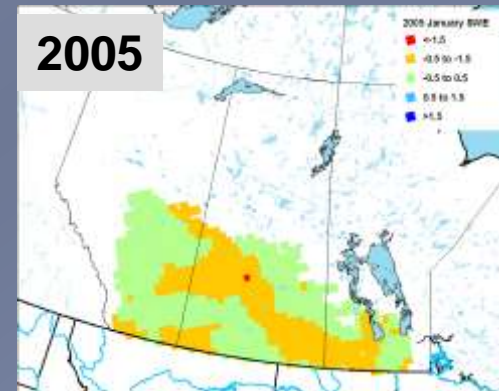
1999



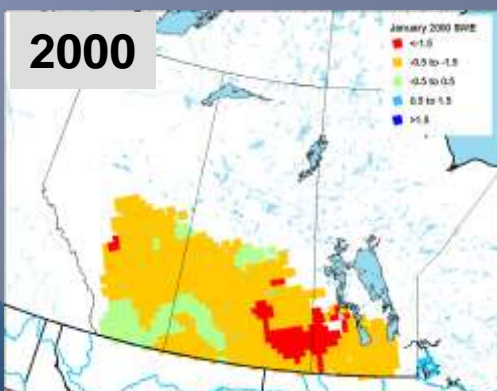
2002



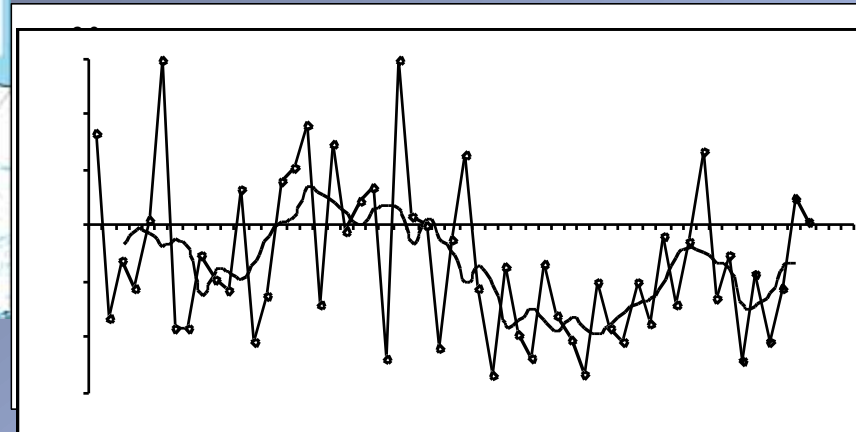
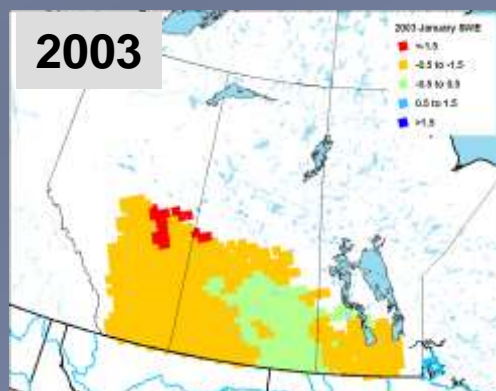
2005



2000

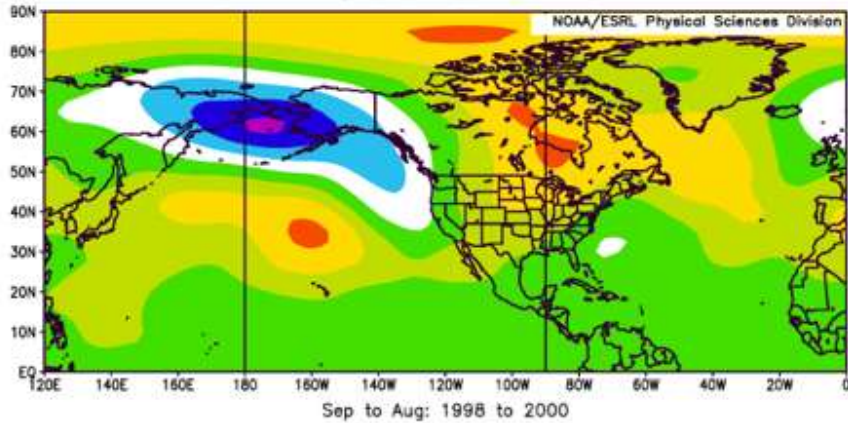


2003

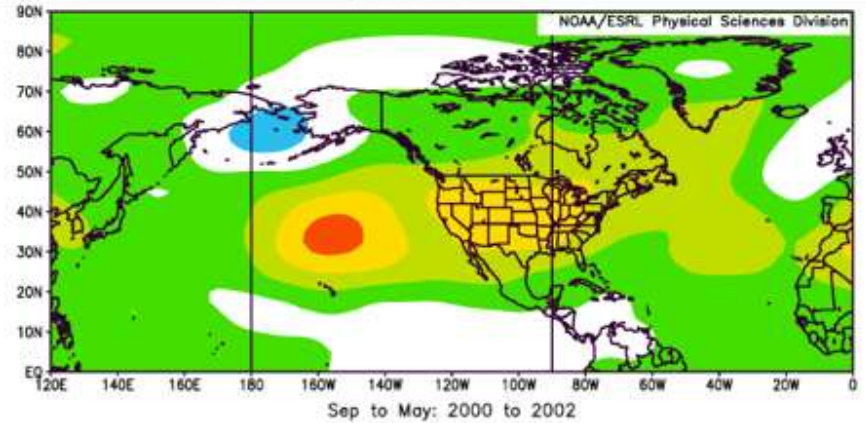
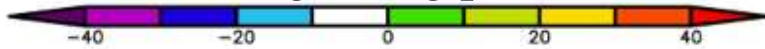


# Phases

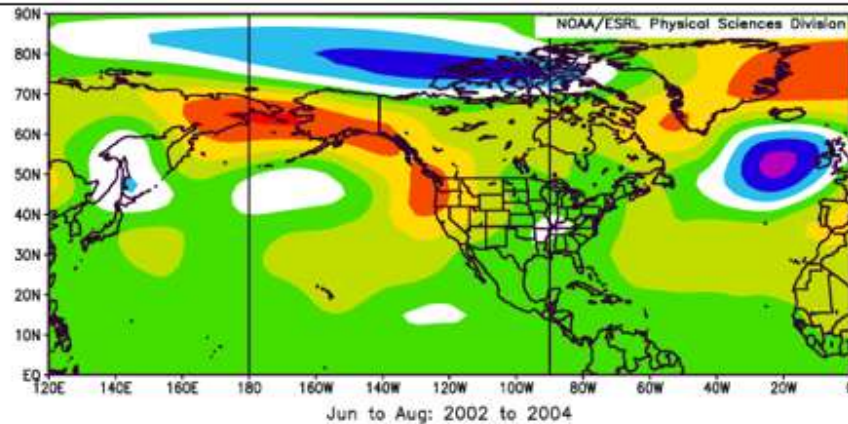
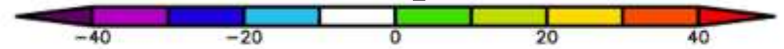
## 500 mb height anomalies



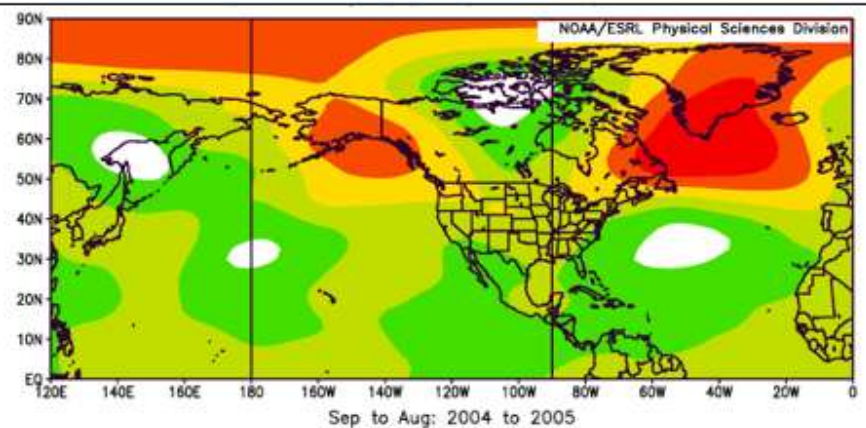
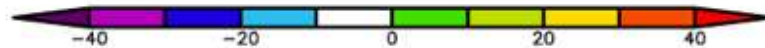
beginning phase



mature phase



mature phase - structure shift



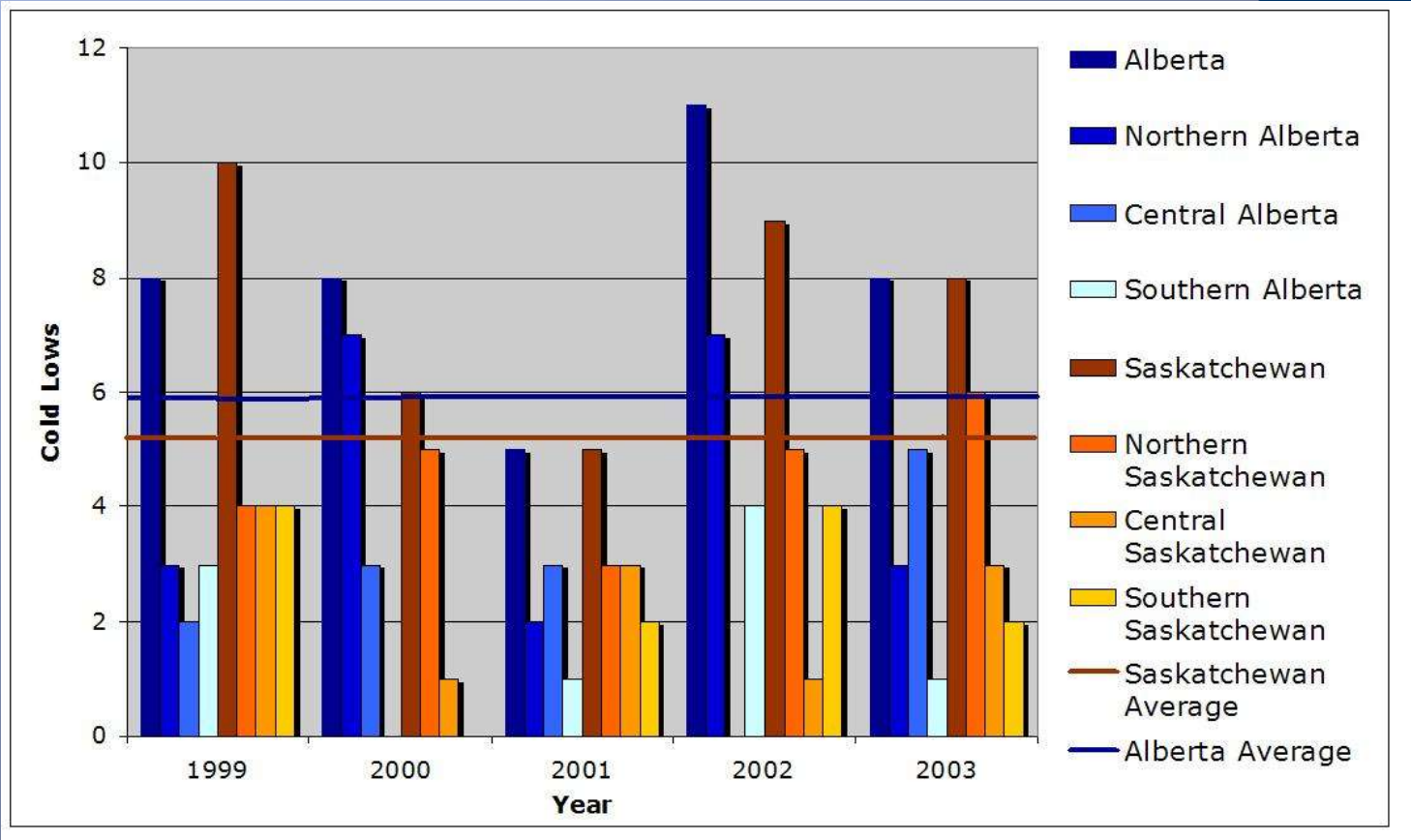
cessation phase



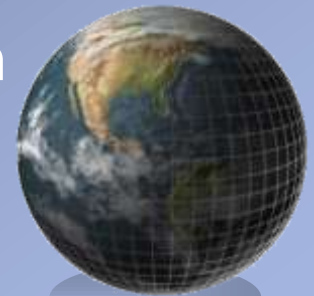


# Cold Lows

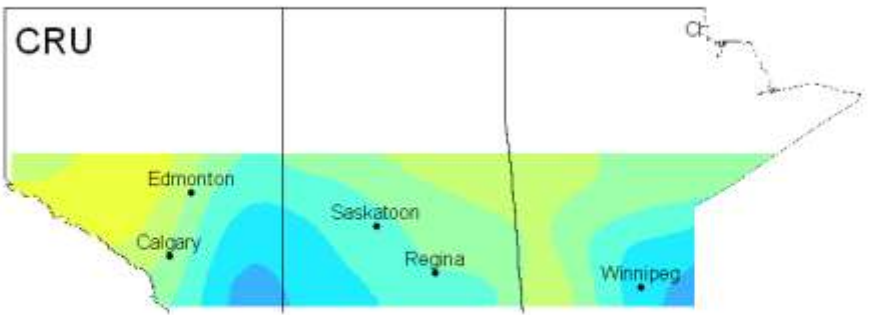
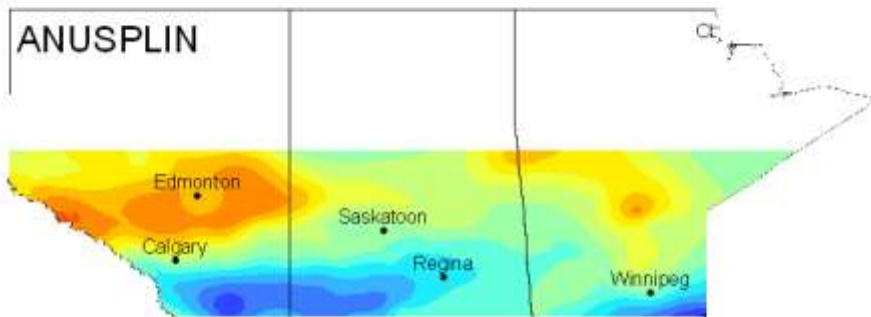
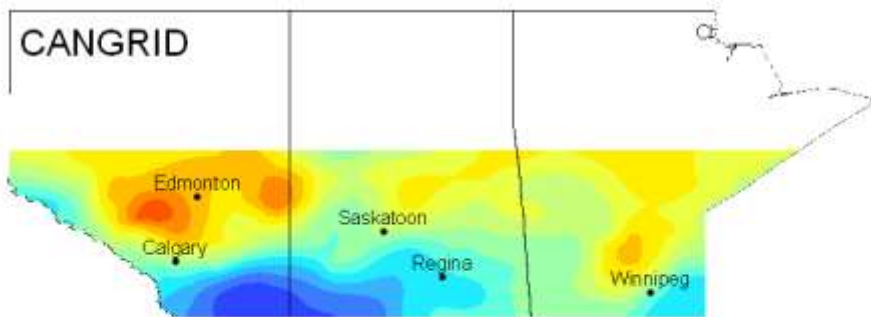
Wielki and Hanesiak



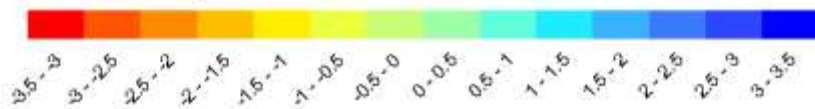
- No clear cut relation
- Fewer than normal in S.AB. in 2000 & C.AB/SK. in 2002



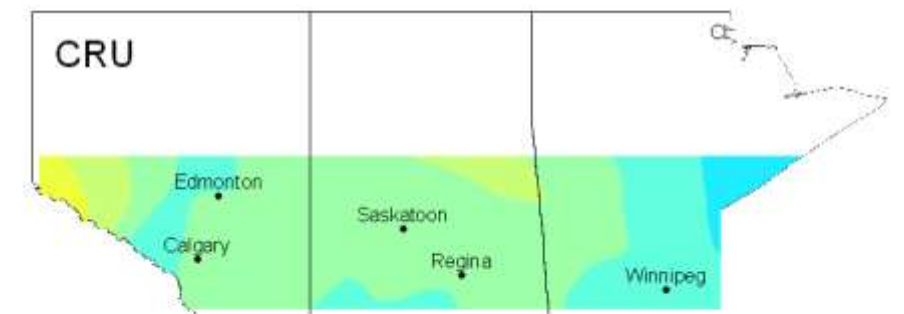
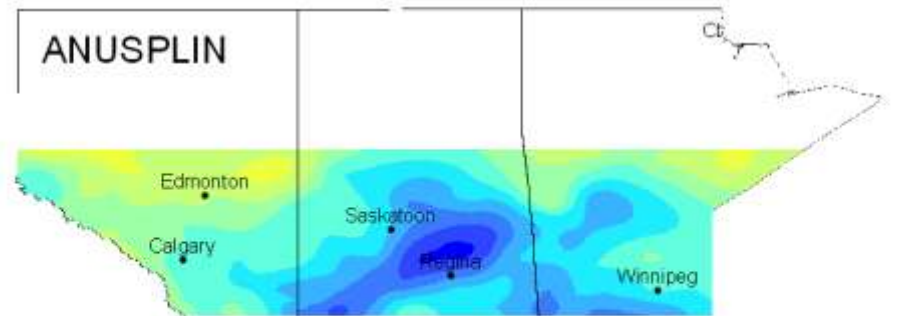
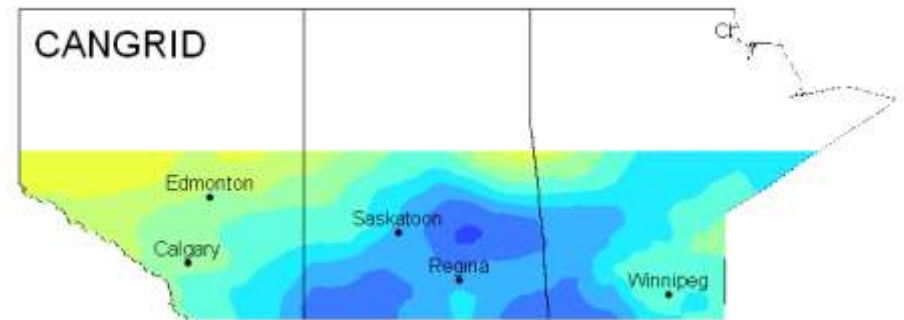
1-month SPI - June 2002



Standard Precipitation Index

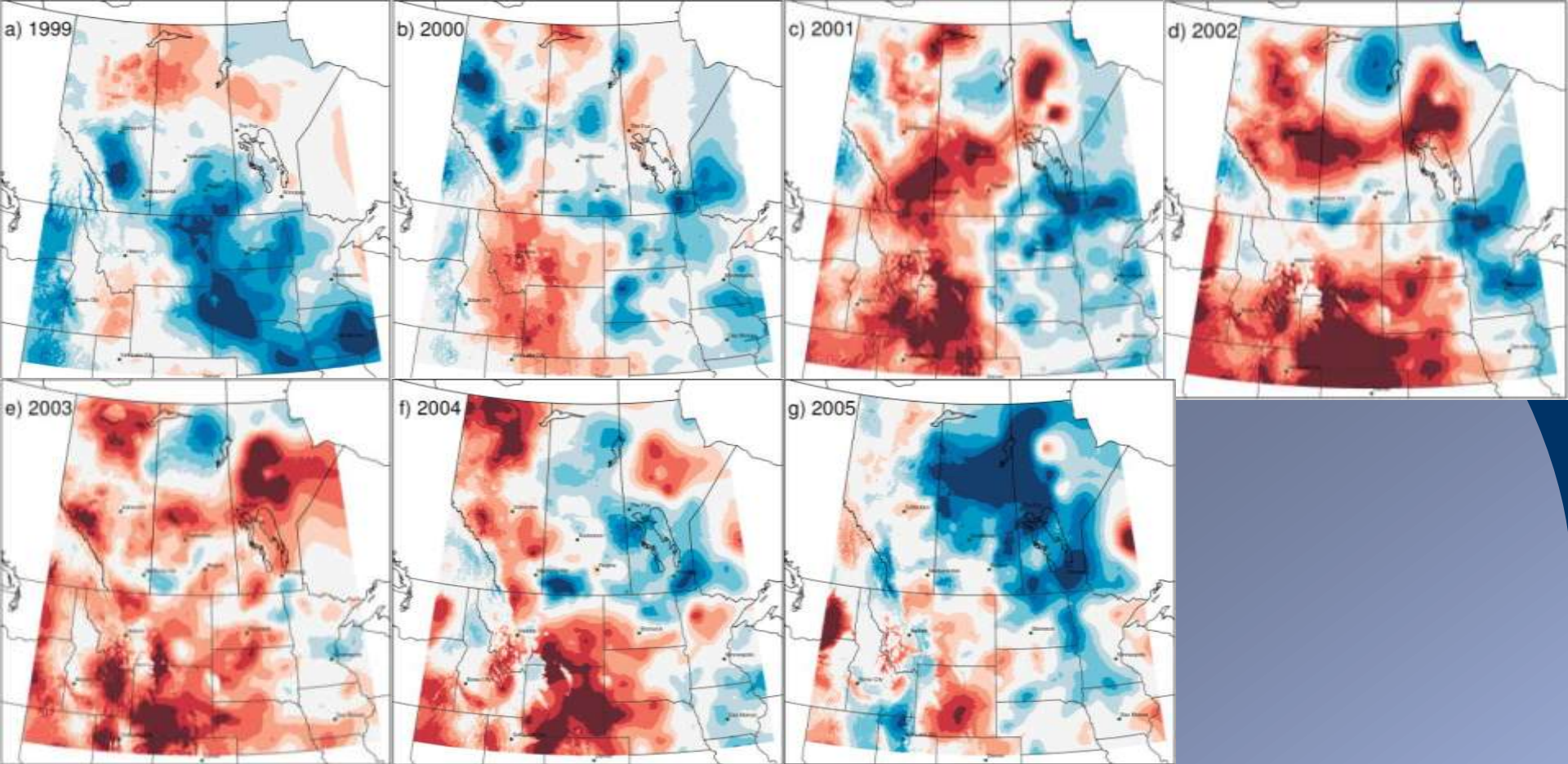


1-month SPI - August 2002



Standard Precipitation Index

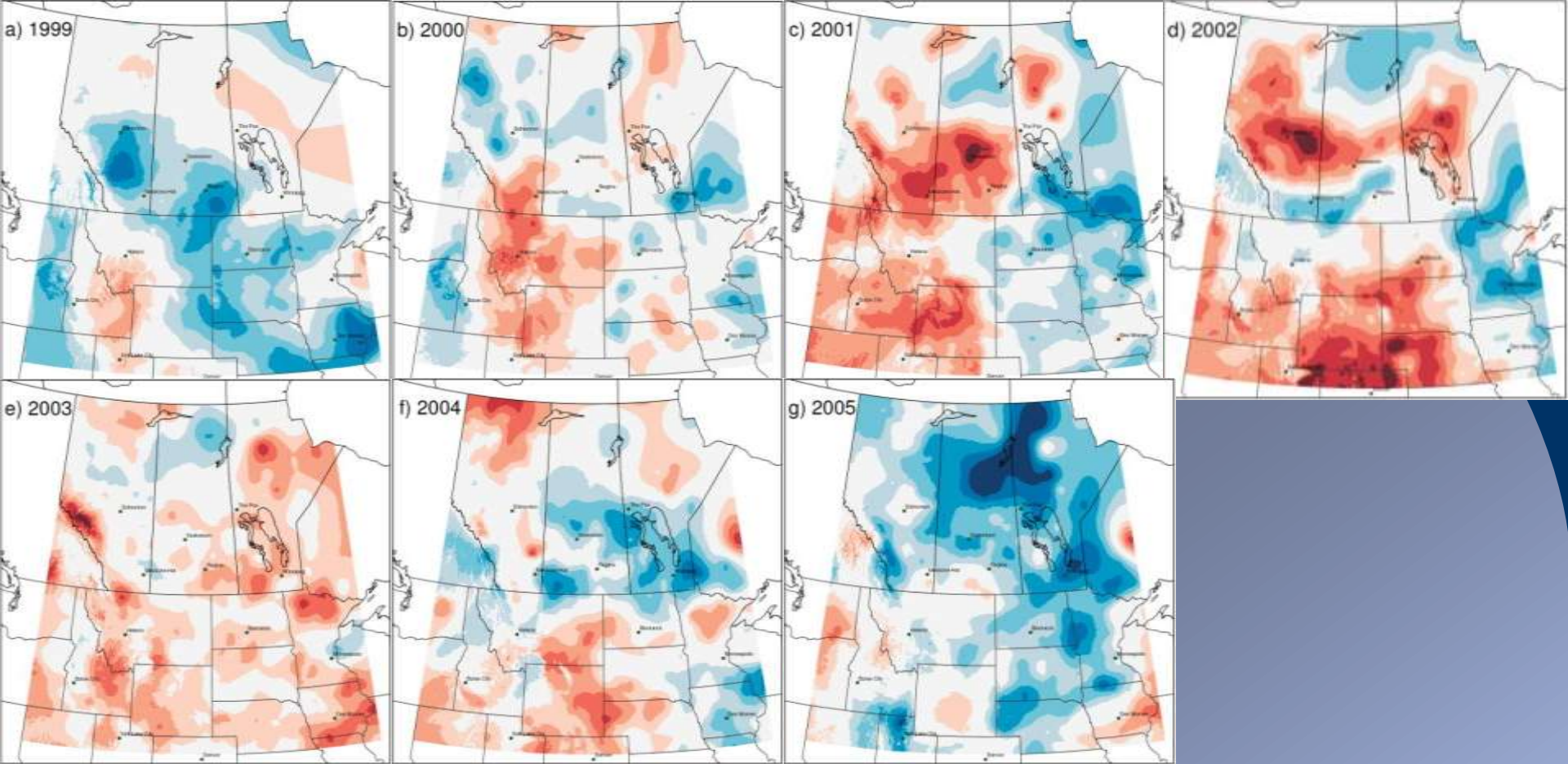




Annual PDSI

Bonsal/Wheaton





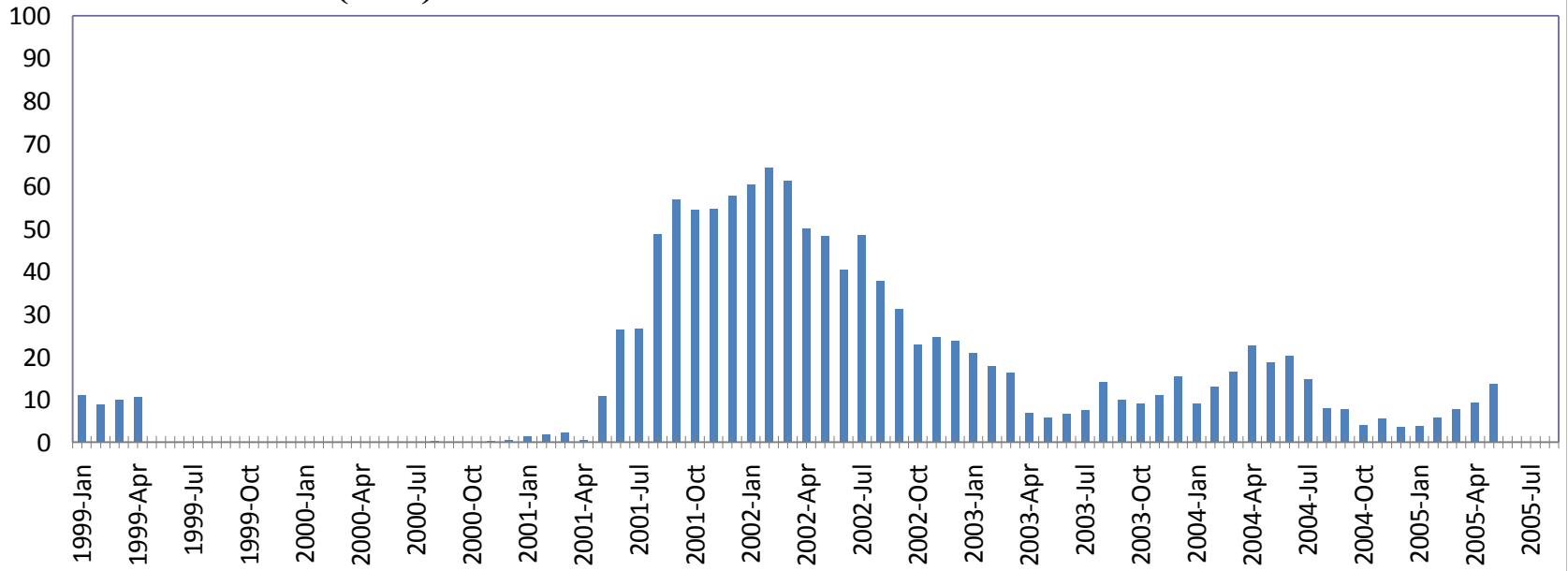
Annual SPI

Bonsal/Wheaton



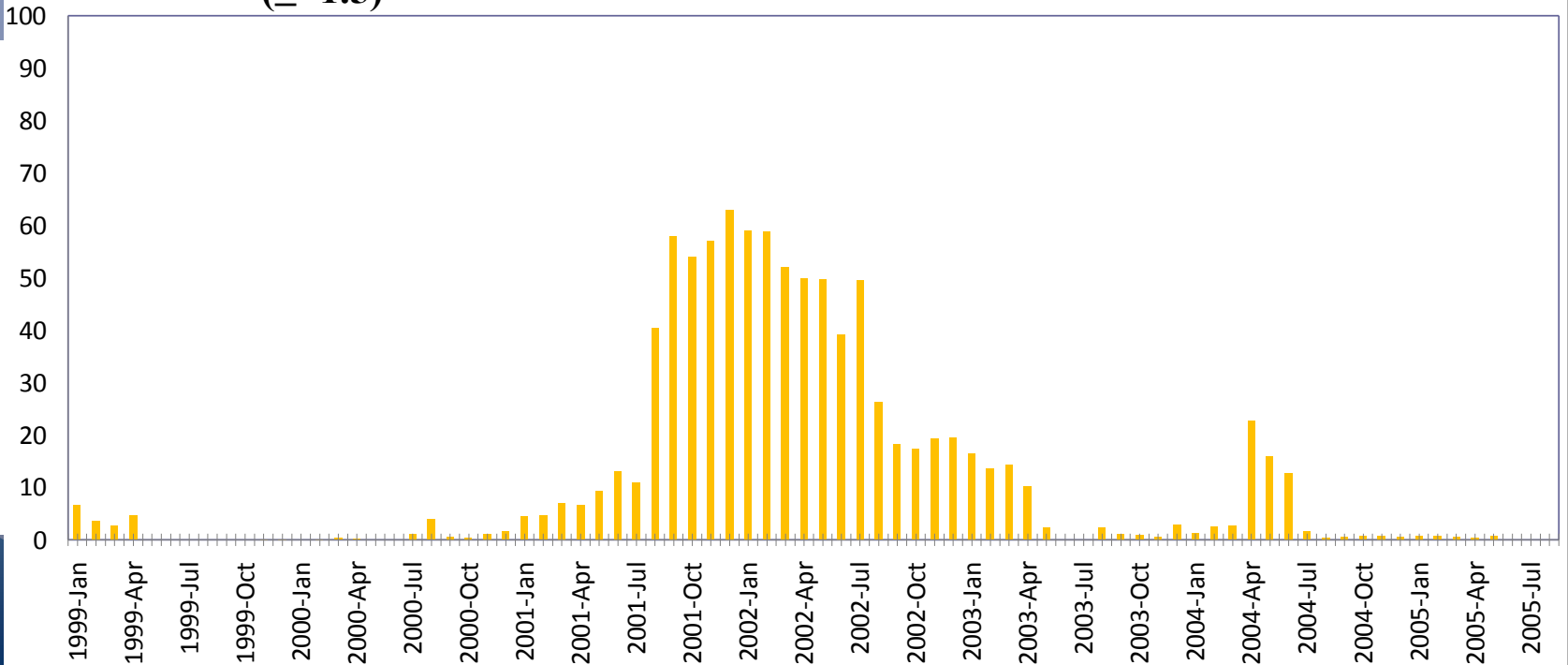
% Grids  $\leq -3$  PDSI

### Monthly PDSI ( $\leq -3$ )

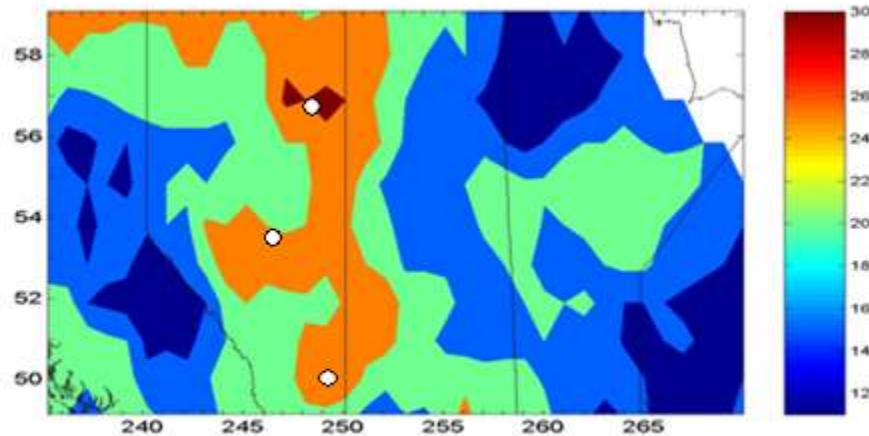


% Grids  $\leq -1.5$  SPI

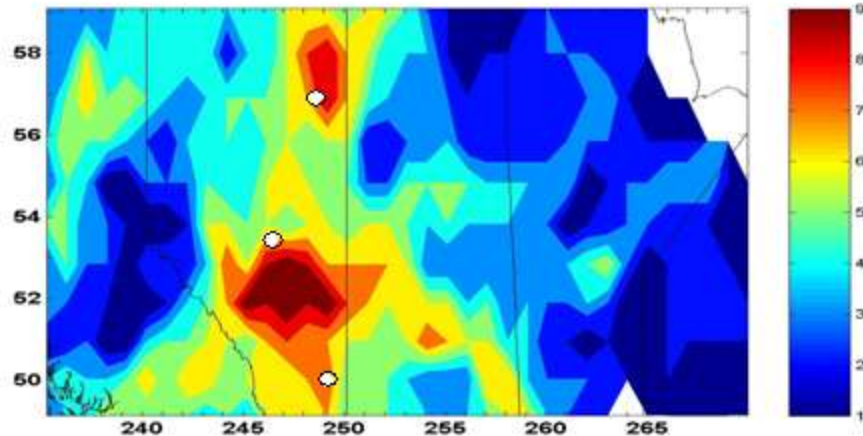
### 12-Month SPI ( $\leq -1.5$ )



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.

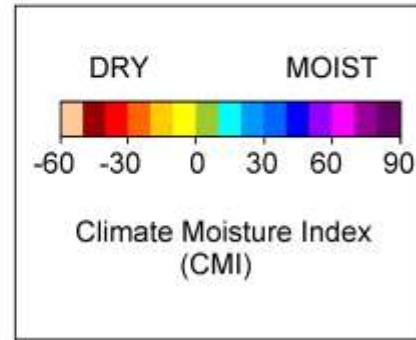
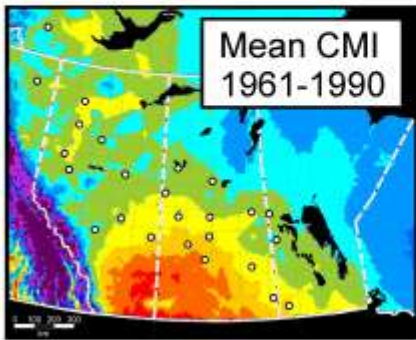
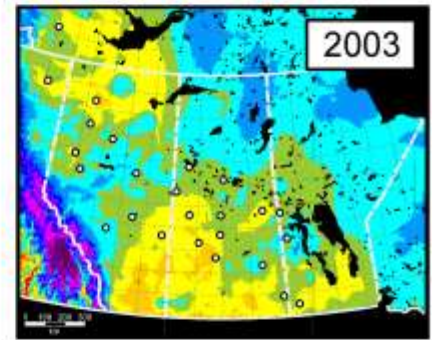
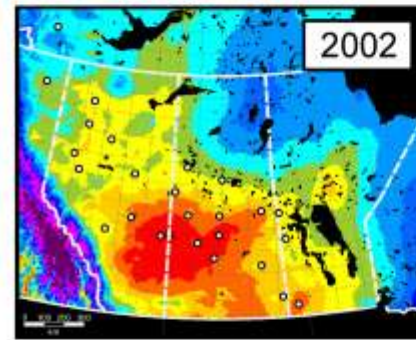
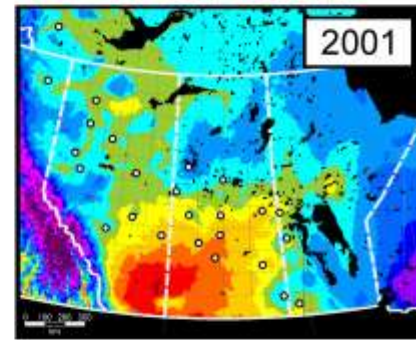
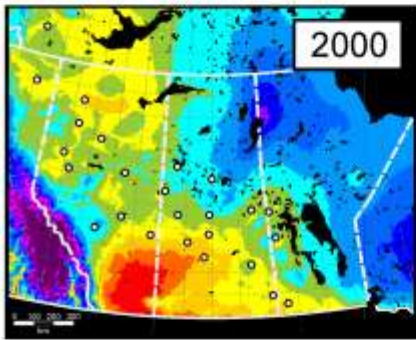
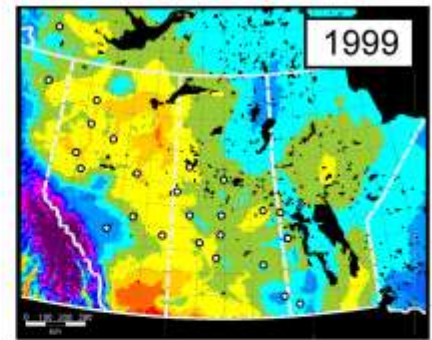
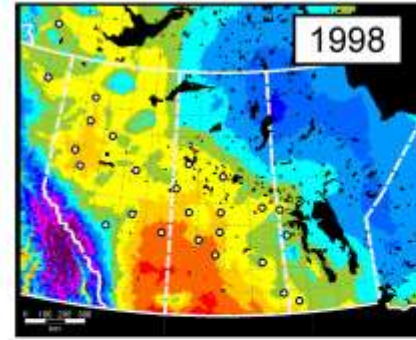
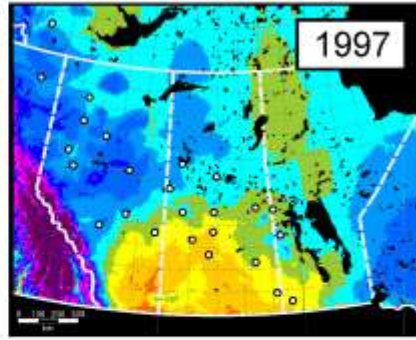
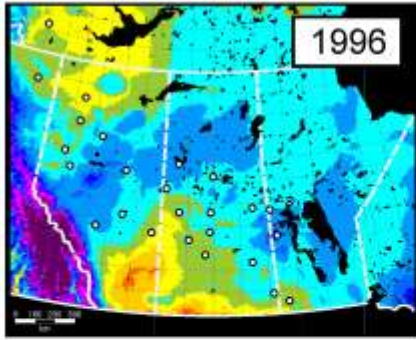


$SPI \leq -0.5$



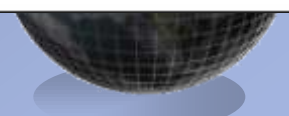
$SPI \leq -1.5$





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

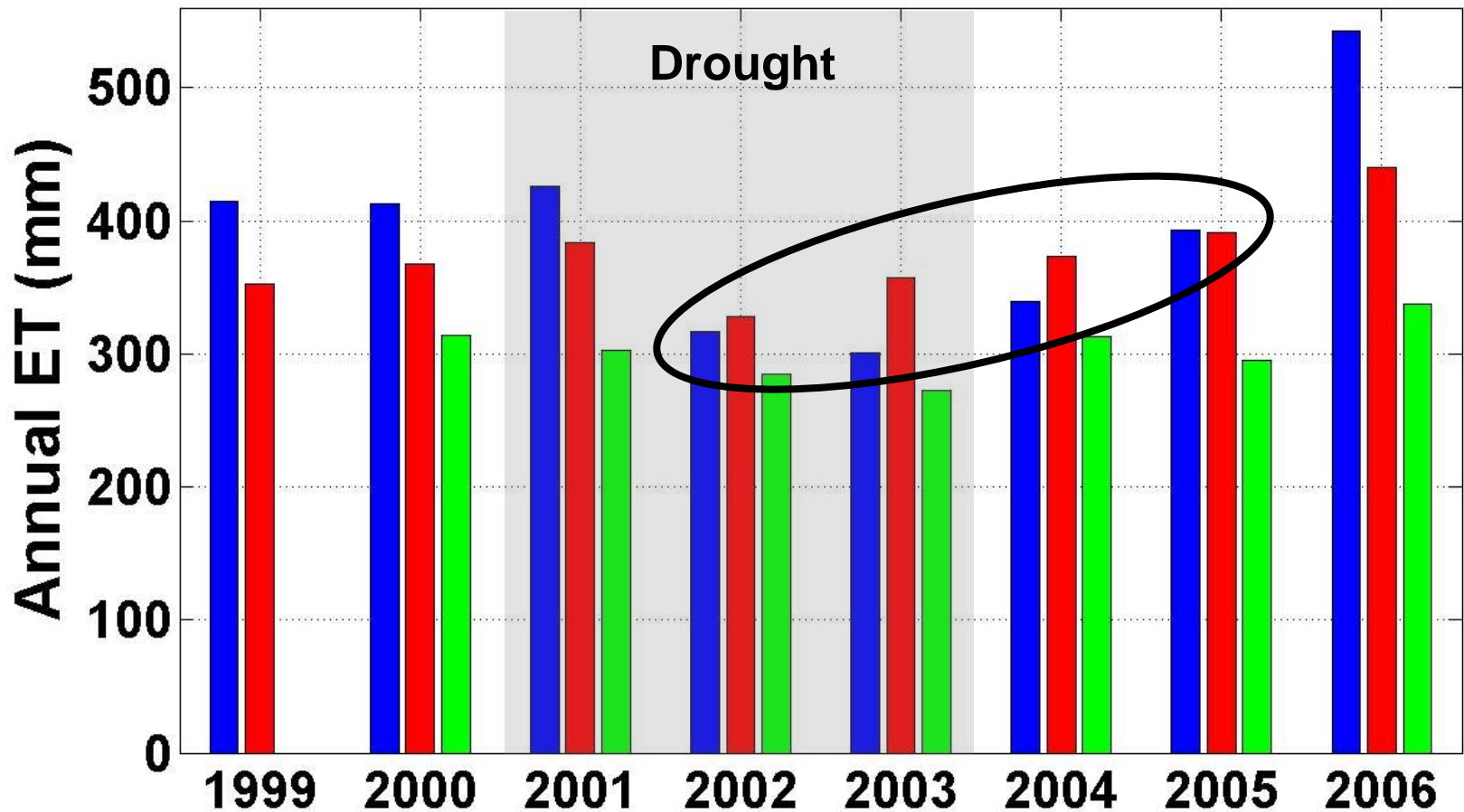
Hogg



# Annual Evapotranspiration 1999 to 2006

(adjusted by ~ +15% for energy-balance closure)

Aspen (393 80) Black Spruce (374 33) Jack Pine (303 21)

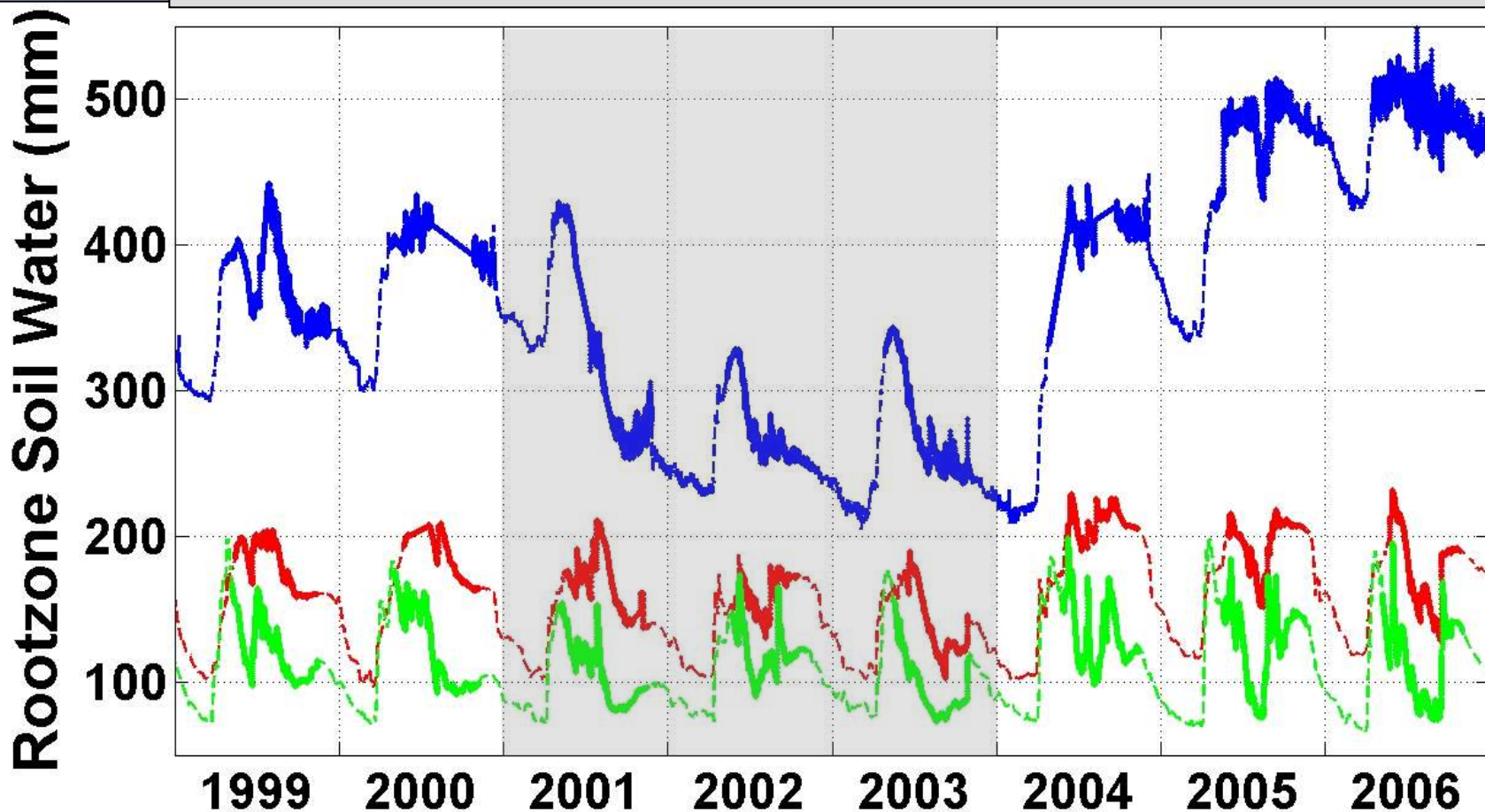


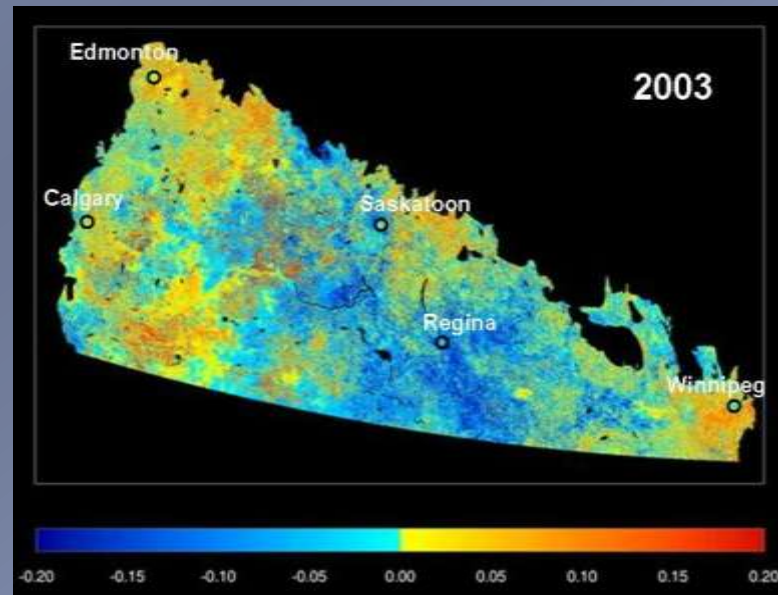
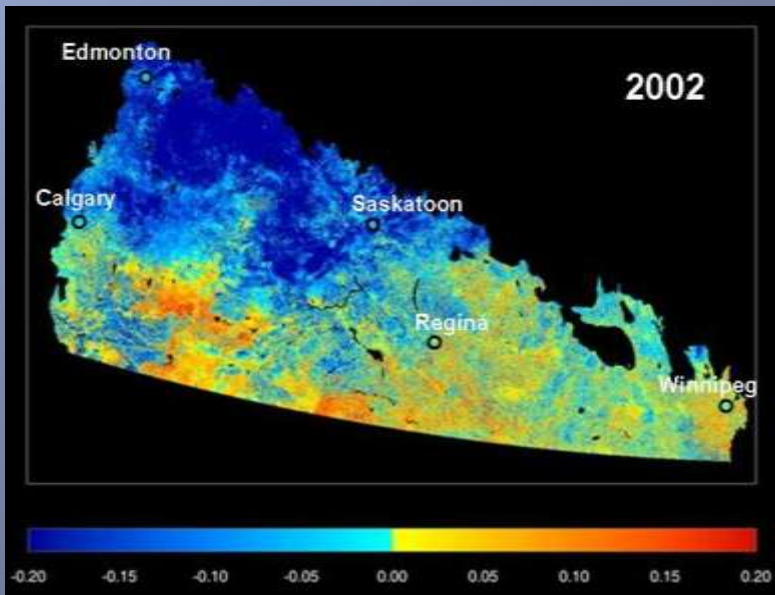
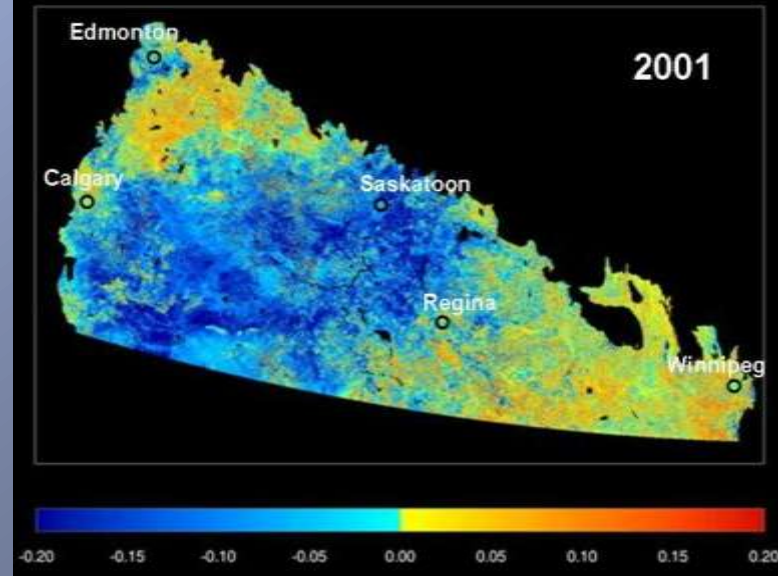
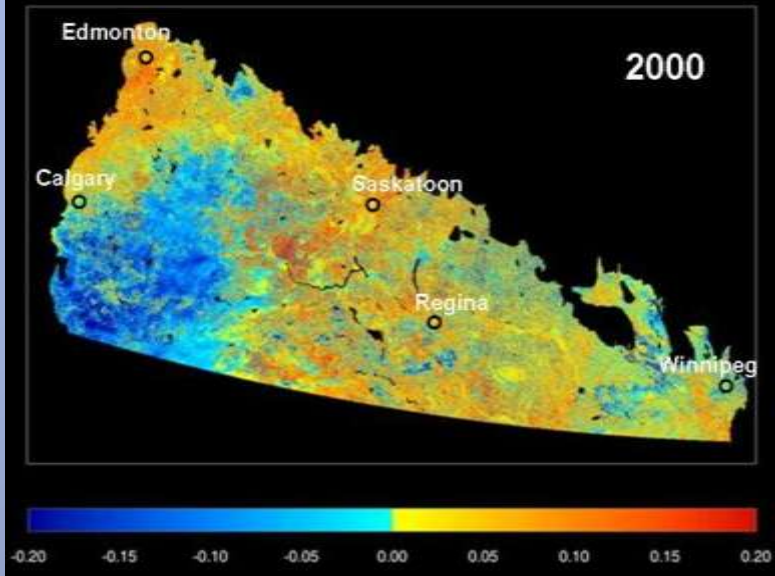


# Integrated Root-Zone Soil Water

(dashed lines indicate frozen soil)

Aspen (0-1.2m) Black Spruce (0-0.3m) Jack Pine (0-1.5m)

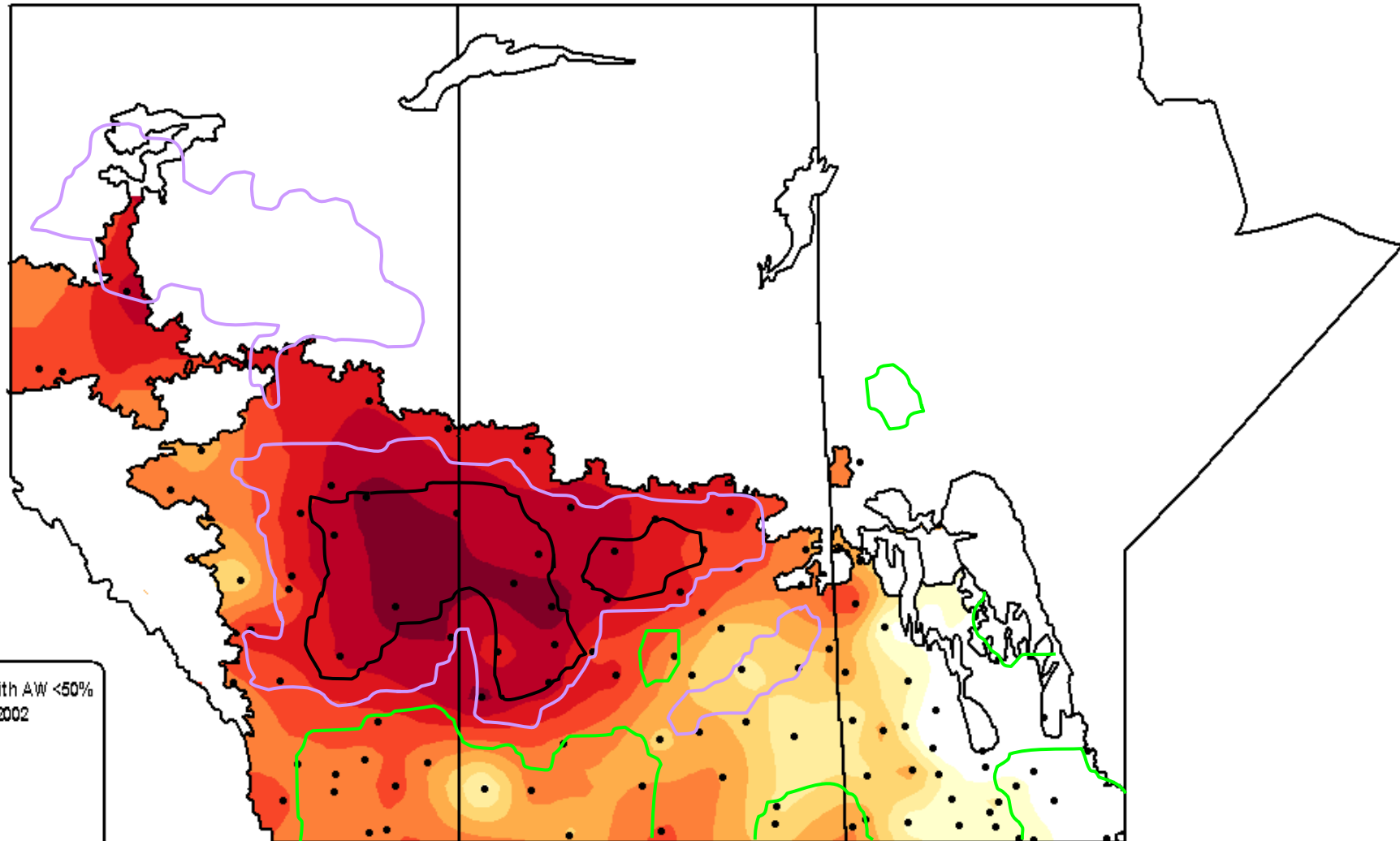




NDVI anomalies (based on 2000-08 mean) for 2000-2003  
250m spatial resolution for 10-day period of July 11-20

Yang, Wang, Trishchenko



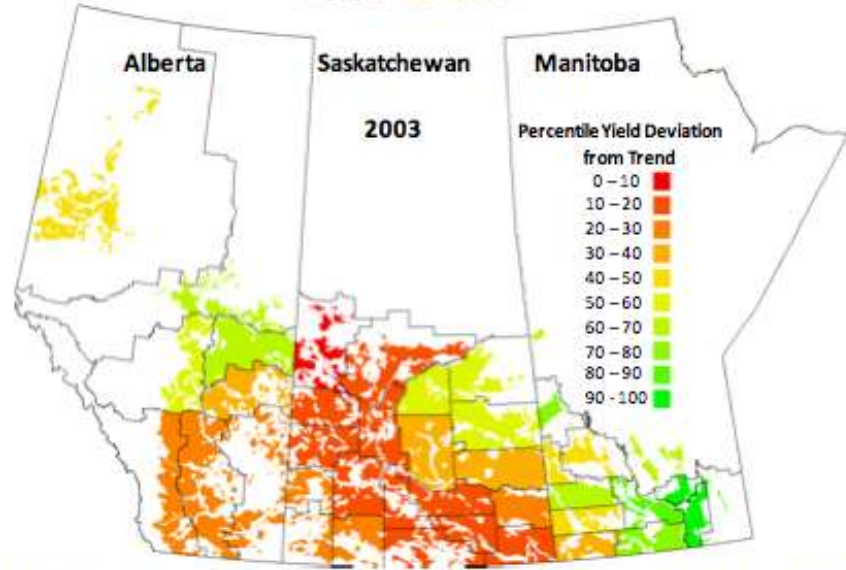
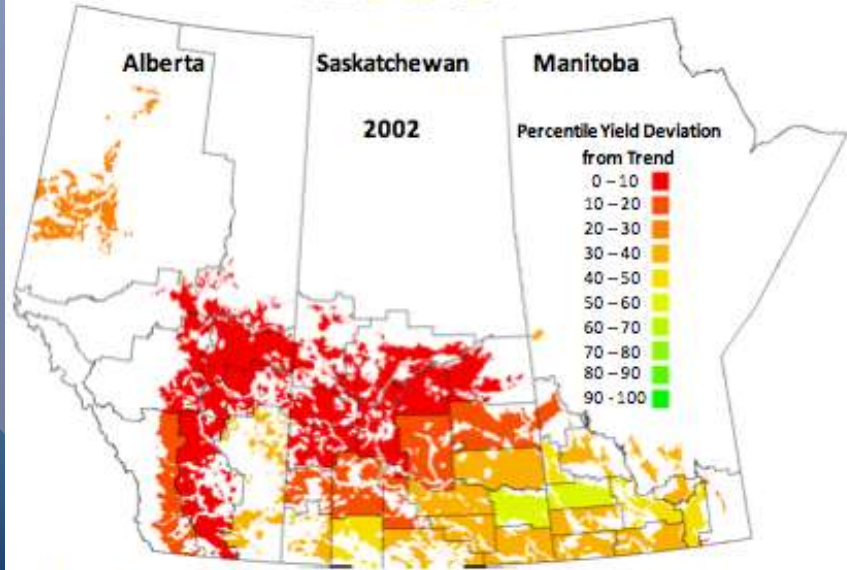
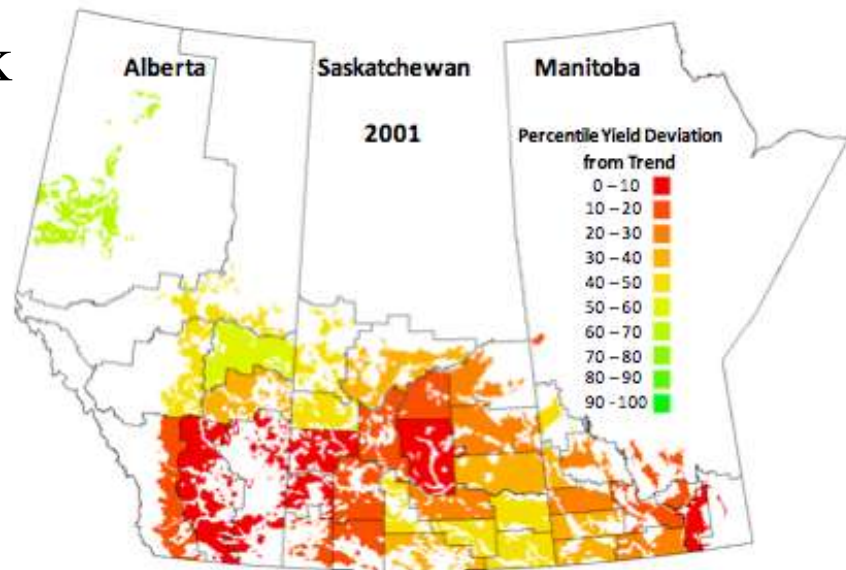
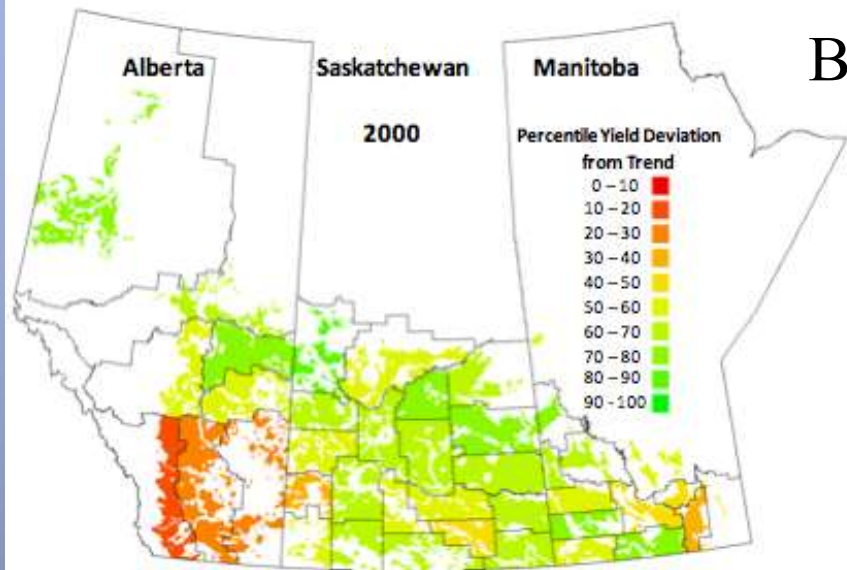


Crop Model AW aggregated days vs NDVI

Brimelow,  
Hanesiak

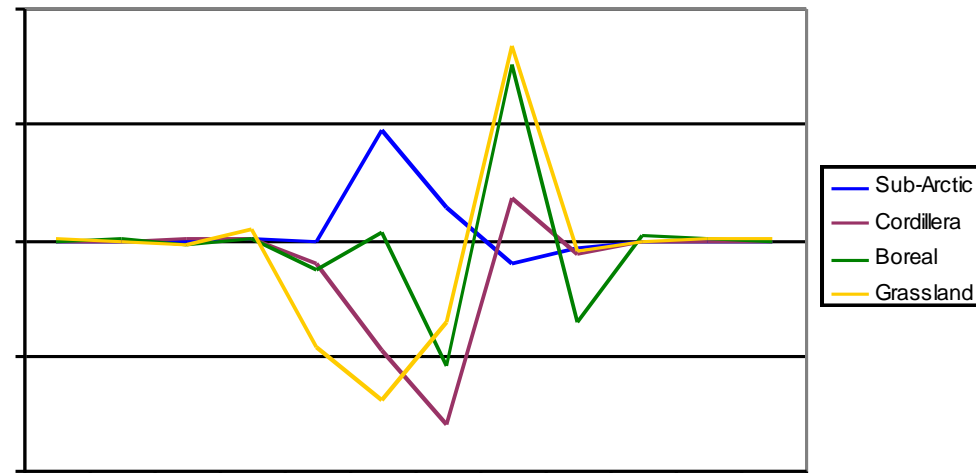
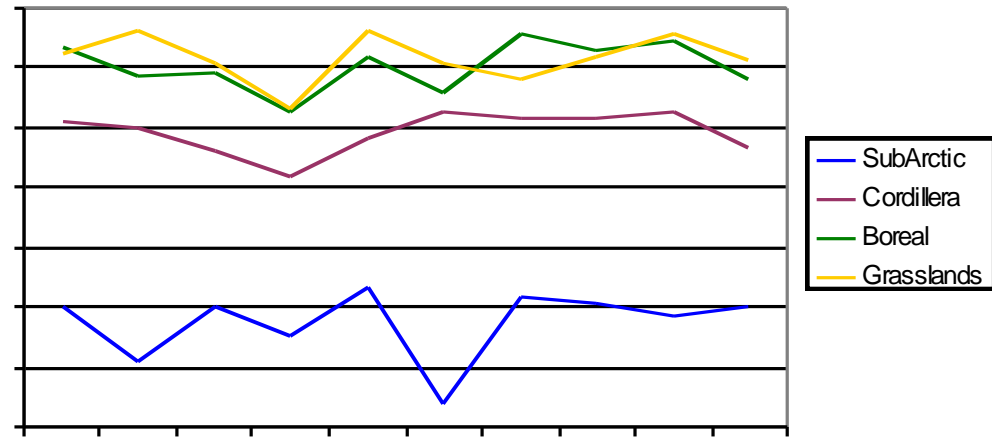
# Crop Yields - how to tell if monitoring is working!

Bullock



# Lightning

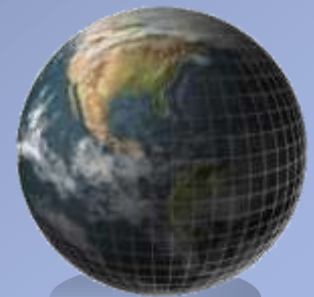
- Significant decline in CG lightning in 2002
- Drought years had much less activity than non-drought years
- Anomalous August !



# Hail and Tornado Days

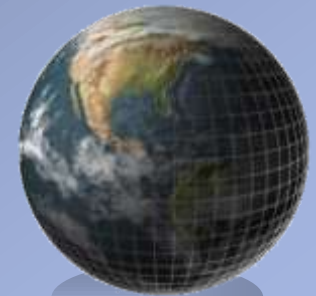
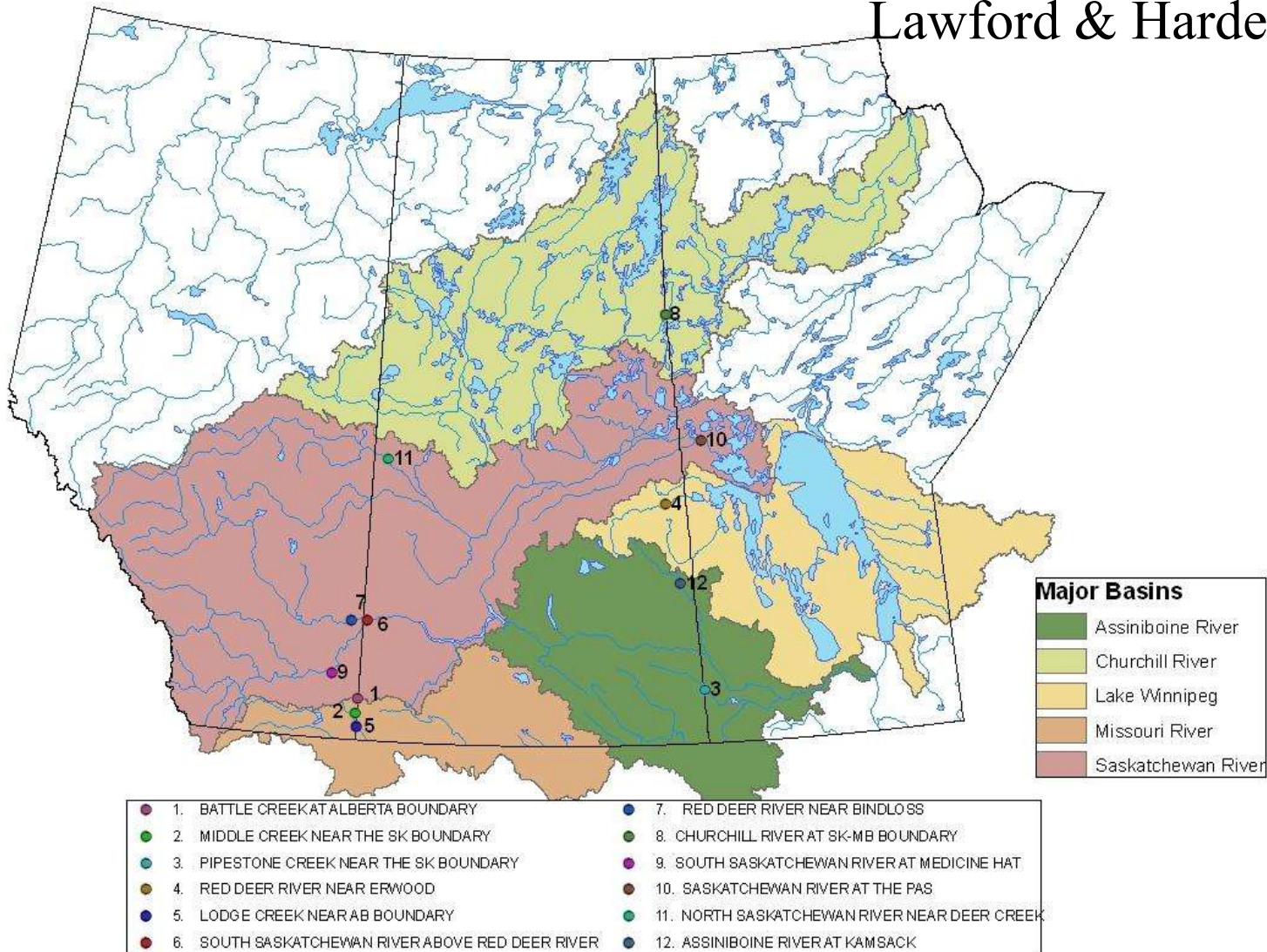
	1985-2007	2000	2001	2002
Hail	86 ± 25	<u>60</u>	<u>56</u>	69
Tor	29 ± 8	25	<u>20</u>	<u>20</u>

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



# Surface Hydrology

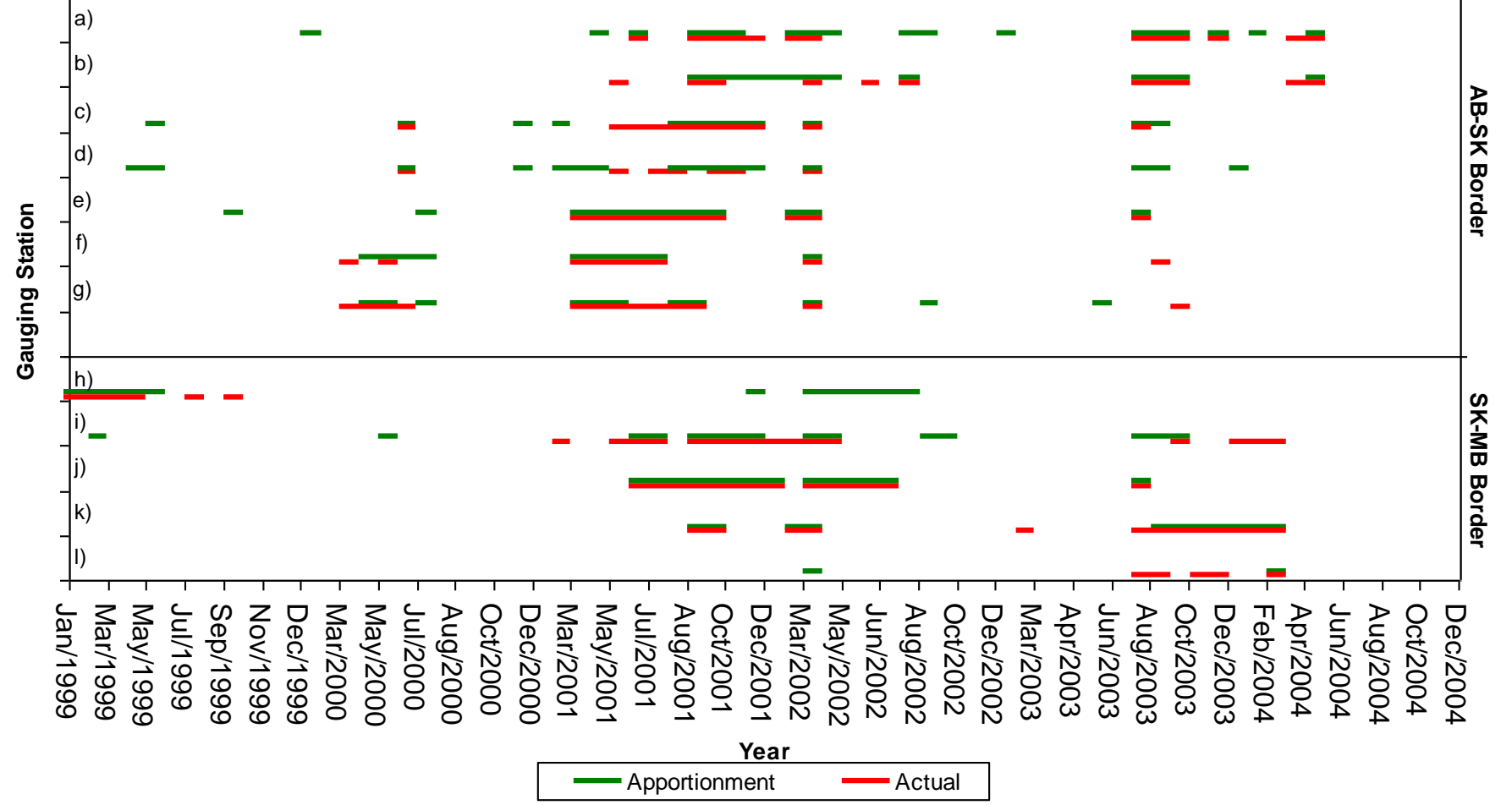
Lawford & Harder



# 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

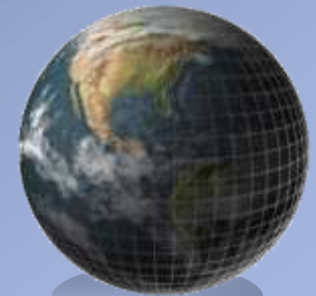


Gauging Stations: a) North Saskatchewan at Border, b) Red Deer at Bindloss, c) South Saskatchewan below Red Deer, d) South Saskatchewan at Medicine Hat, e) Battle Creek at Border, f) Lodge Creek at Border, g) Middle Creek at Border, h) Churchill River at the Border, i) Saskatchewan at The Pas, j) Red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



# Conclusions

- Have addressed Theme 1 Questions/Deliverables
- 2-3 seasons of below normal precipitation was common - more during peak of drought
  - Summer/spring or summer/fall anomalies were critical
  - Snow cover also important in many years
- Drought indices, NDVI, modeled soil moisture, crop yields, precip patterns similar
- Links to atmospheric circulation evident, although different than other droughts
- Extreme events can be important
- Surface-convection feedback appeared to be at play
- Typically 6 month to 1-year lag between precipitation anomalies and effects on forests and surface hydrology - depends on many factors.
- Drought cessation linked to large-scales - gradual in many areas - convective regime rebounded by 2004



# 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)

