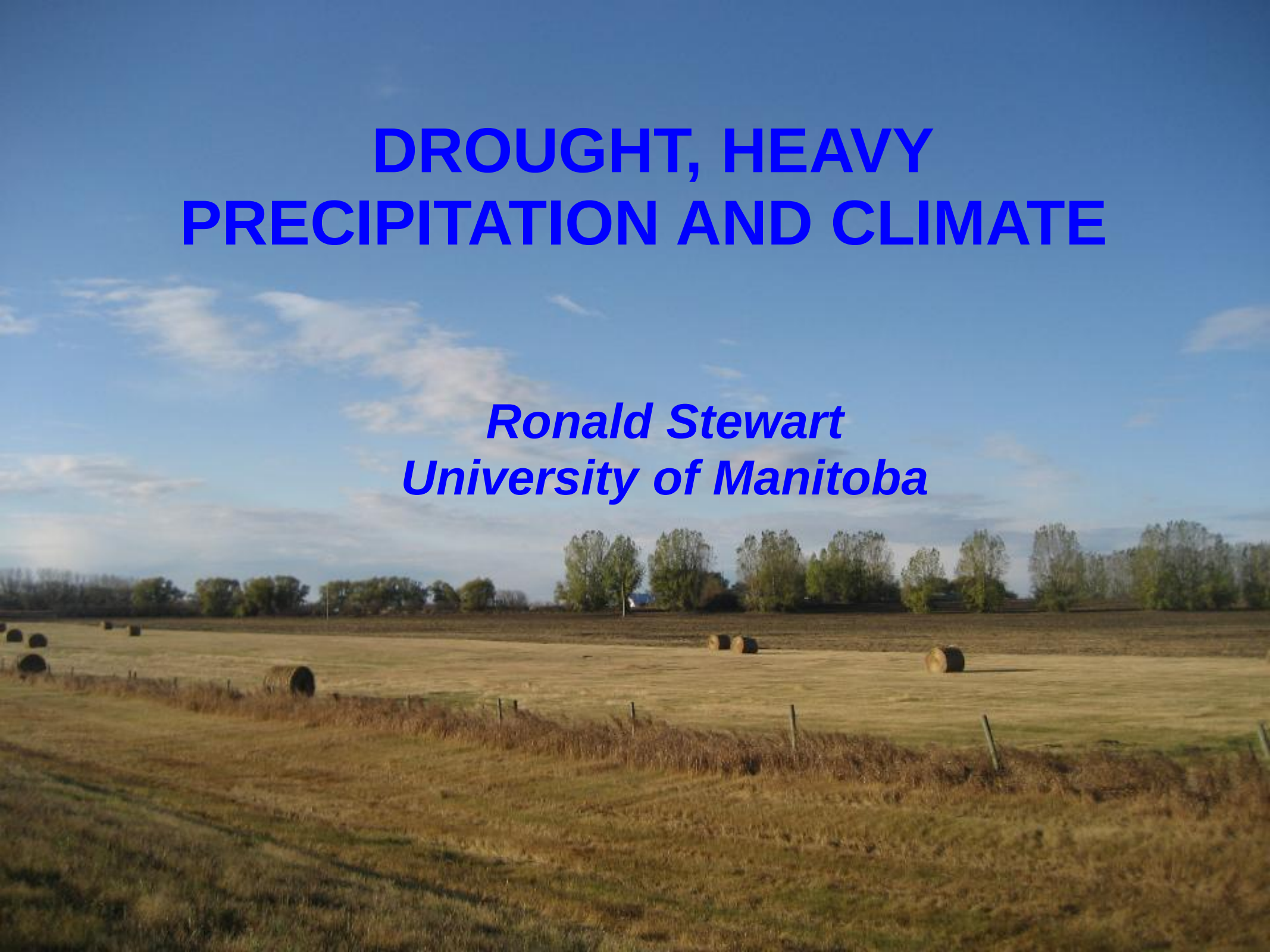
DROUGHT, HEAVY PRECIPITATION AND CLIMATE

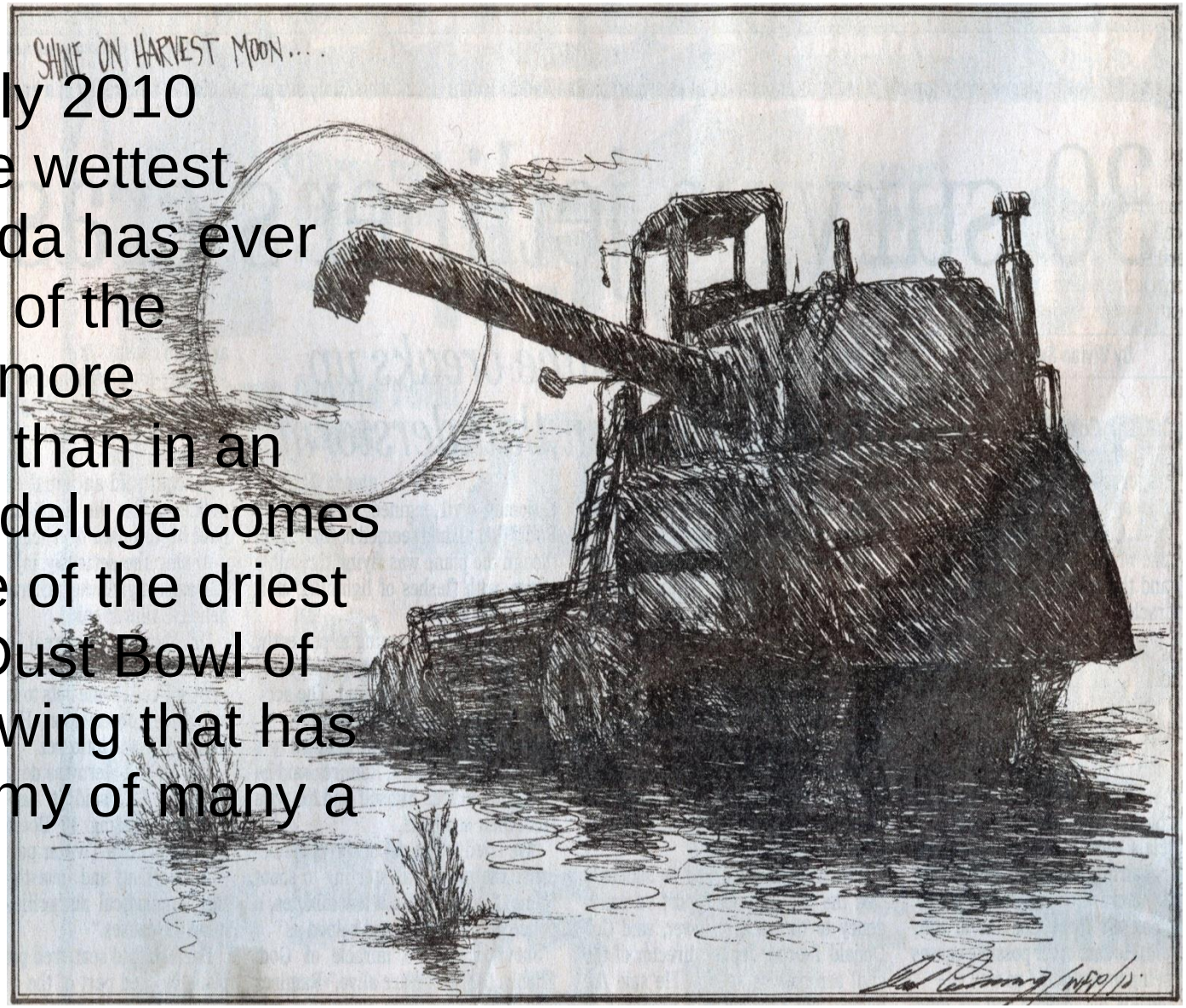
Ronald Stewart
University of Manitoba



2000-2009 TOP WEATHER STORIES

1.Vanishing Arctic ice in 2007.
2. B.C.'s year of disastrous weather -- fires, floods and freezes in 2003.
3. Prairies plagued with one of its worst growing seasons ever in 2002.
4. B.C.'s weather woes in 2006.
5. Alberta's floods in 2005.
6. The summer that wasn't for most of Canada in 2009.
7. The East's big summer soak in 2008.
8. Storm drowns and pounds Edmonton in 2004.
9. Canada dry from coast to coast in 2001.
10. 2000 tornado in Red Deer, Alta., that killed 12 and injured 140.

Globe and Mail: July 2010
This spring was the wettest Environment Canada has ever observed for much of the Prairies, with 70% more precipitation falling than in an average year. The deluge comes on the heels of one of the driest periods since the Dust Bowl of the 1930s, a wild swing that has made a public enemy of many a weatherman.



GLOBAL CONCERN

The World Meteorological Organization Secretary General has said that the media most often asks him questions about climate extremes.

OBJECTIVES

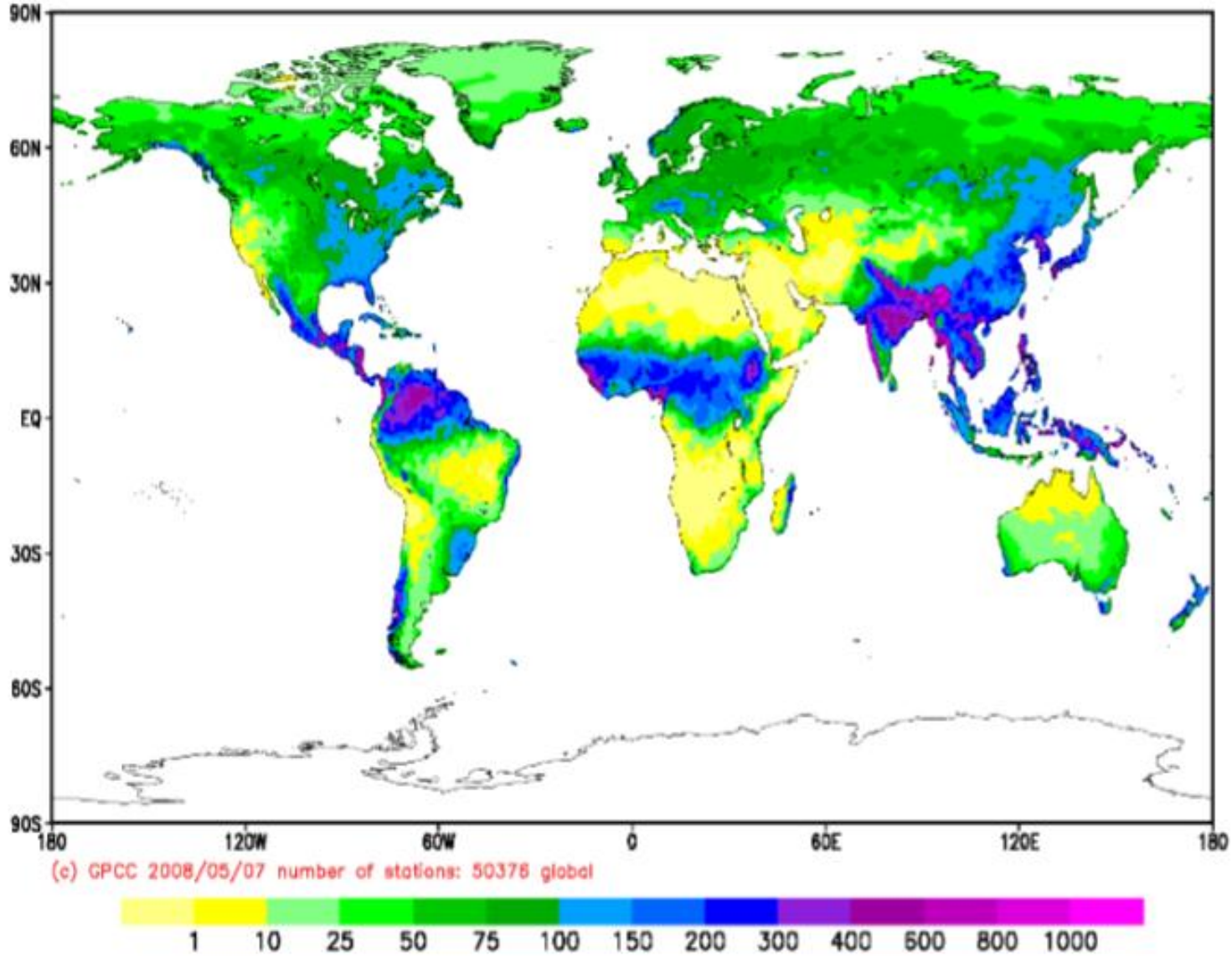
Overall: To summarize some of the connections between drought, heavy precipitation and climate

Specifics:

- **Precipitation extremes as inherent to climate**
- **Features of drought**
- **Connections with heavy precipitation**
- **Future conditions and issues**

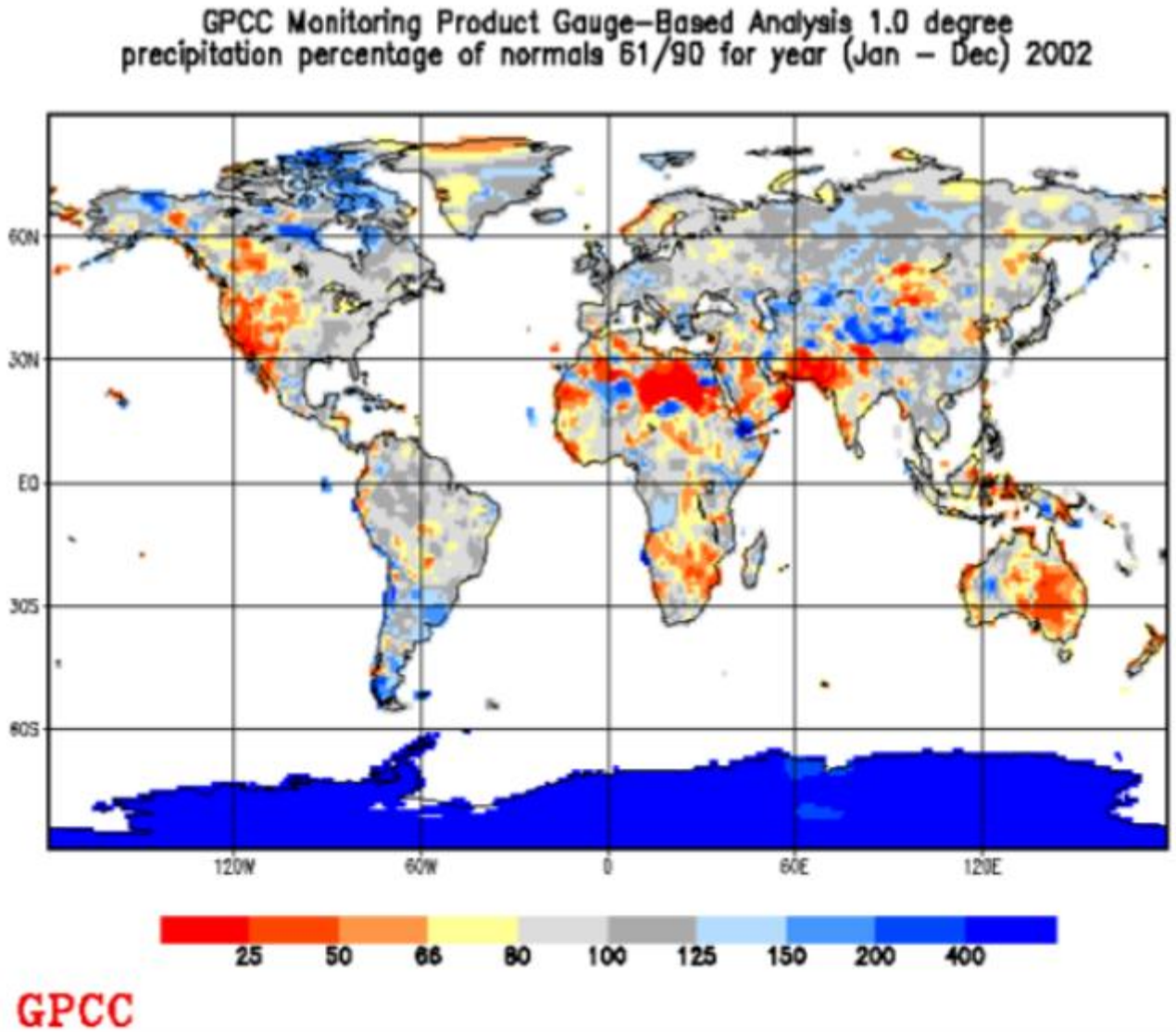
Special reference to 1999-2005 drought

JULY 10-YEAR PRECIPITATION



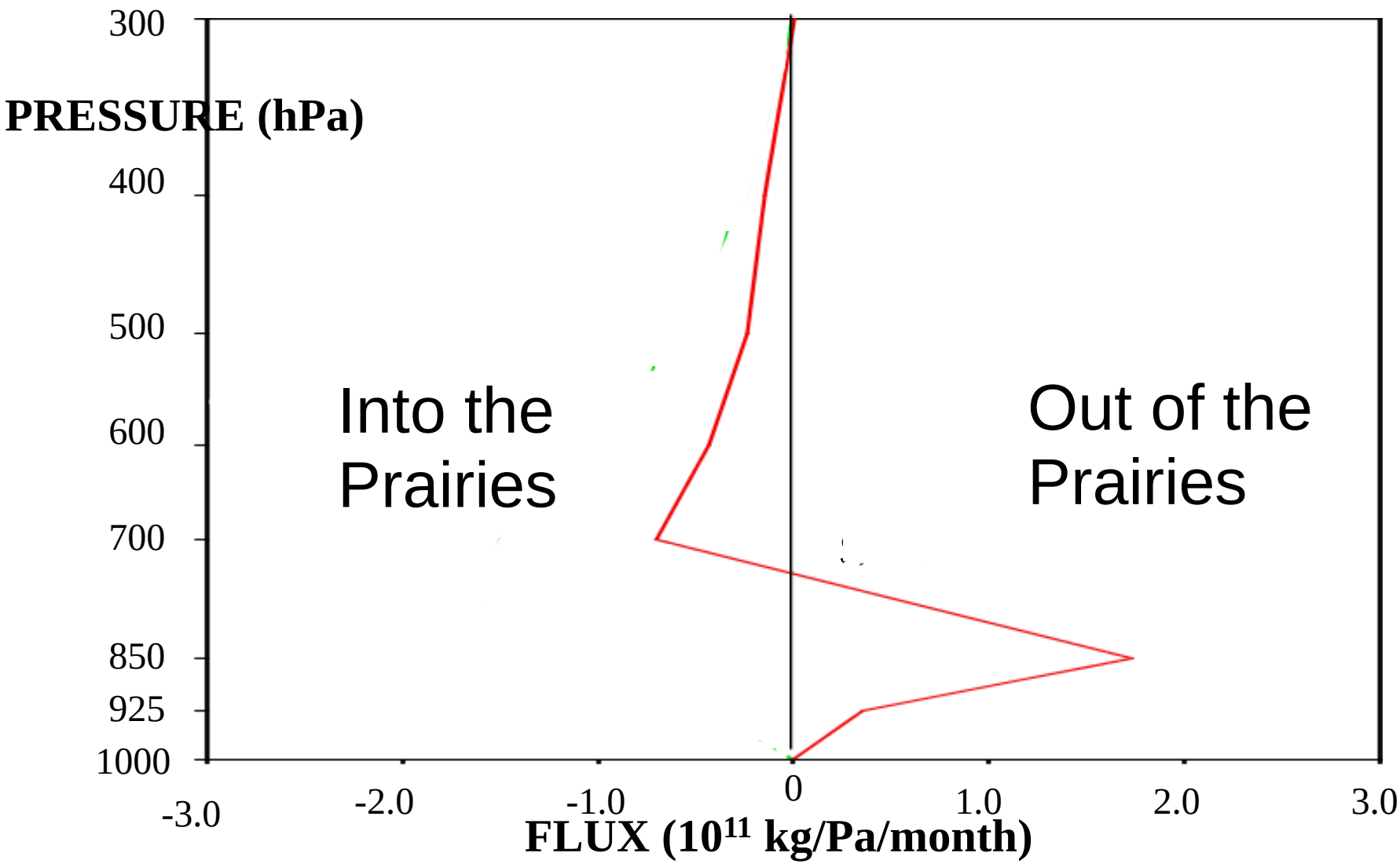
mm per month

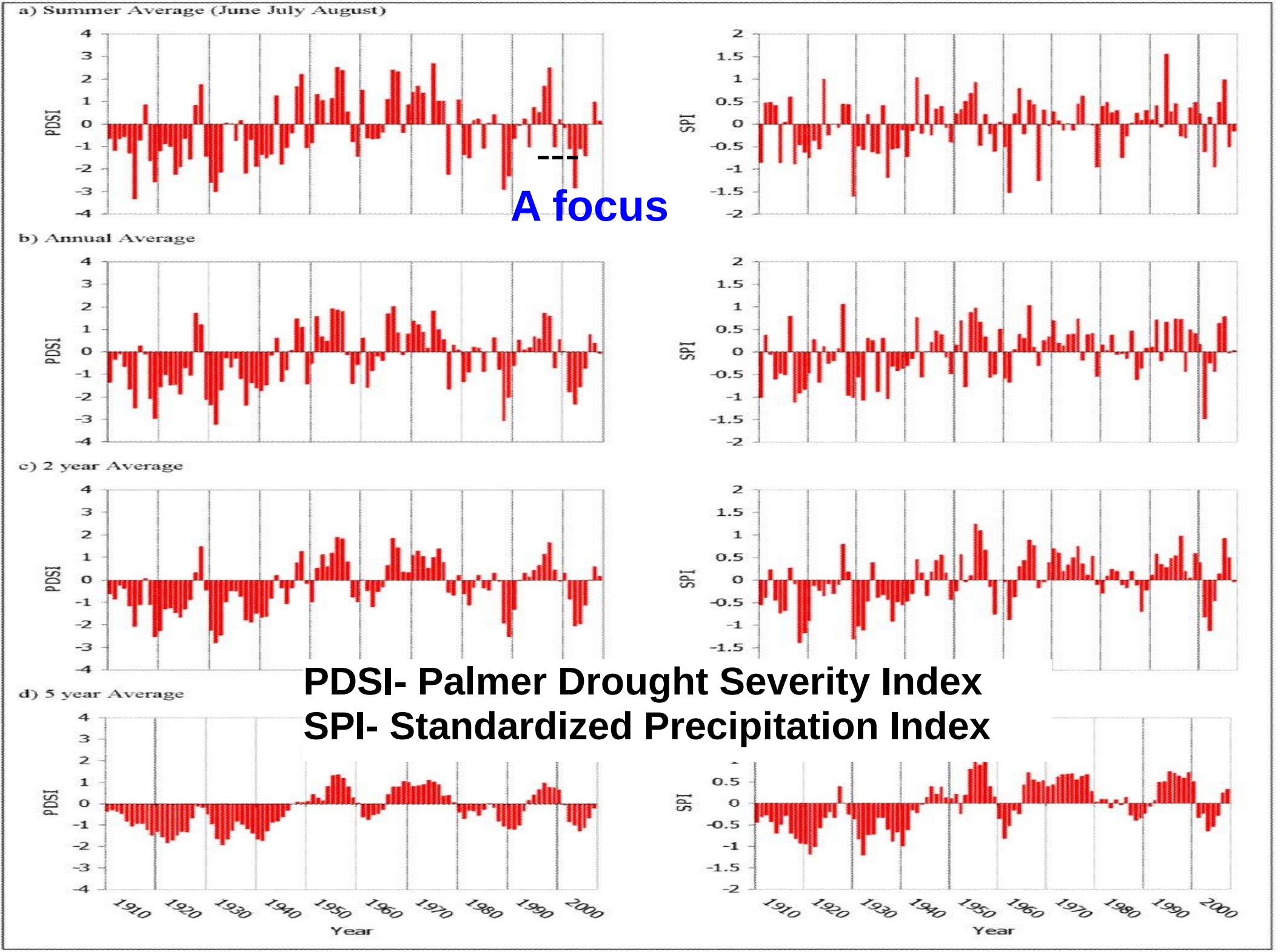
2002


GPCC Monitoring Product Gauge-Based Analysis 1.0 degree
precipitation percentage of normals 61/90 for year (Jan – Dec) 2002
60N
30N
EQ
30S
60S
120W
60W
0
60E
120E
25
50
66
80
100
125
150
200
400
GPCC

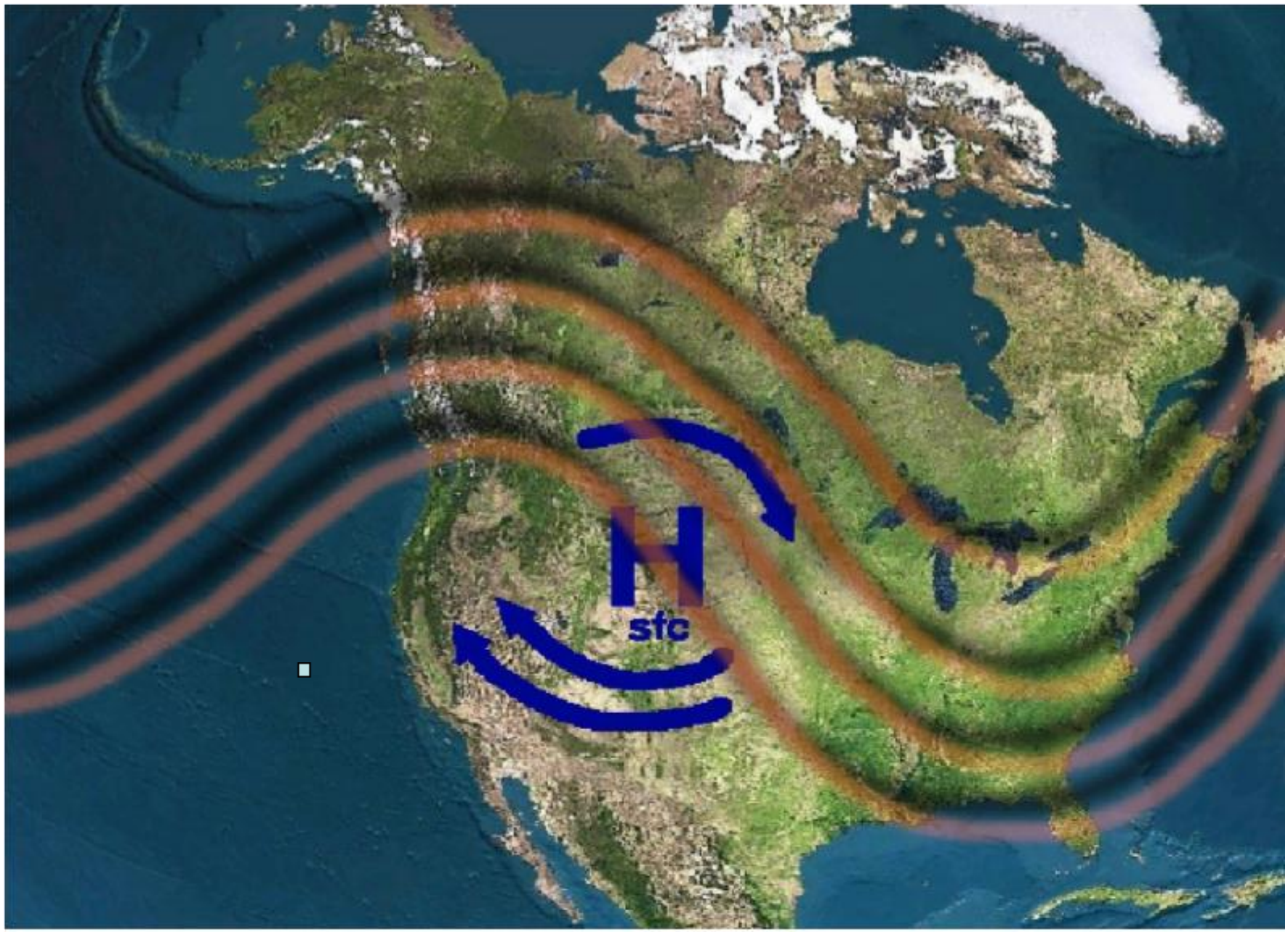

The Canadian
Prairies

VERTICAL MOISTURE FLUX PROFILE

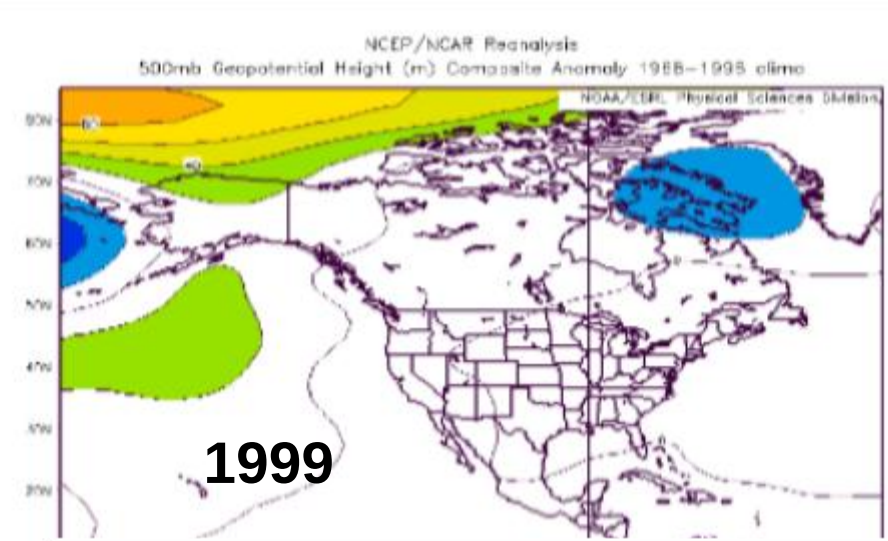


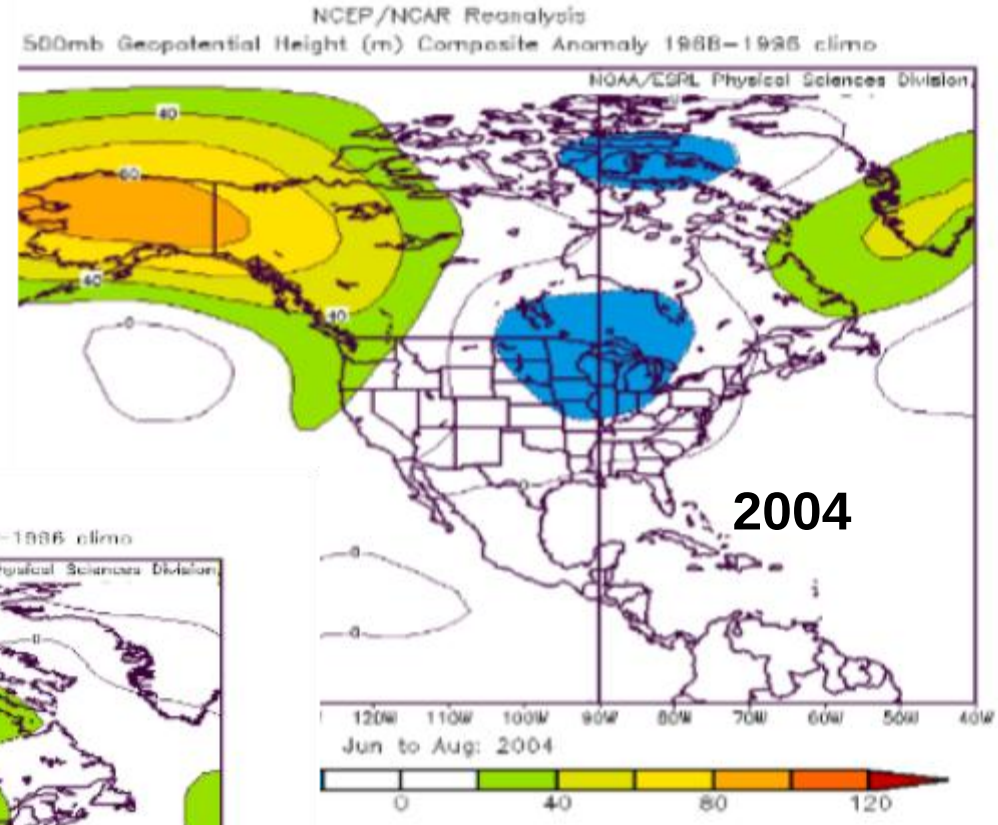

a) Summer Average (June July August)
PDSI
SPI
A focus
b) Annual Average
PDSI
SPI
c) 2 year Average
PDSI
SPI
PDSI- Palmer Drought Severity Index
SPI- Standardized Precipitation Index
d) 5 year Average
PDSI
SPI
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
Year

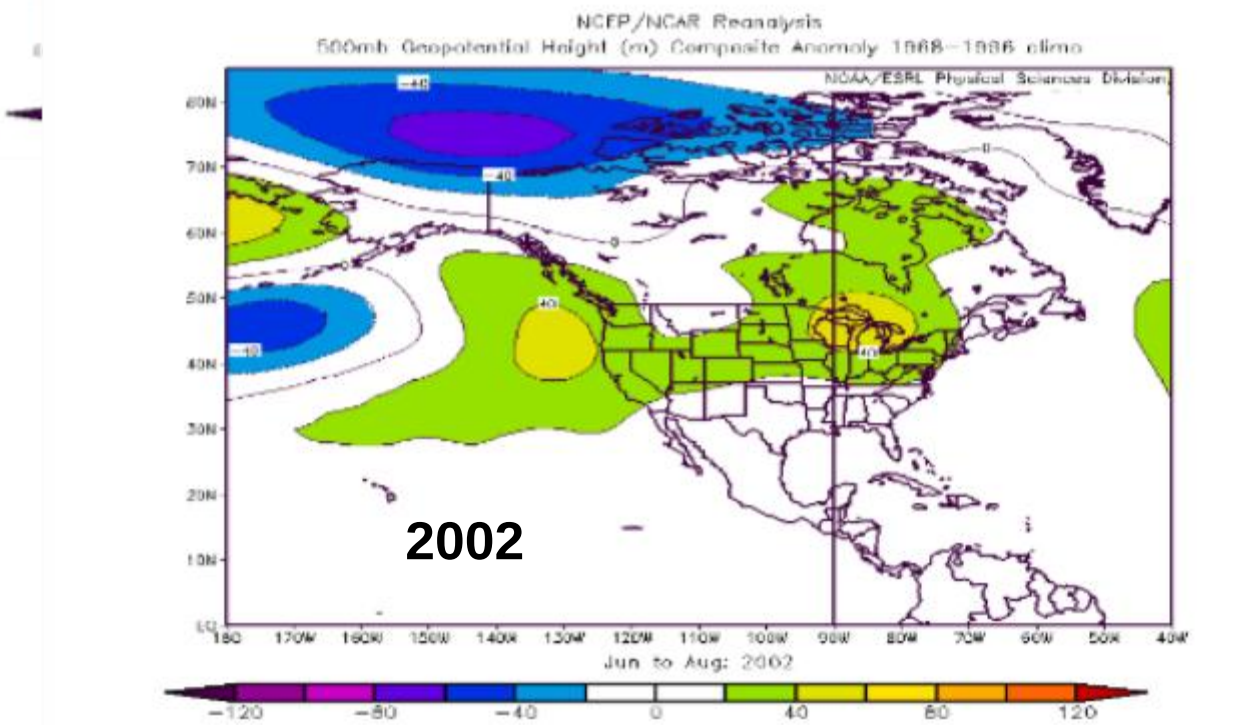
COMMON VIEW …



CONTINENTAL SCALE PATTERNS



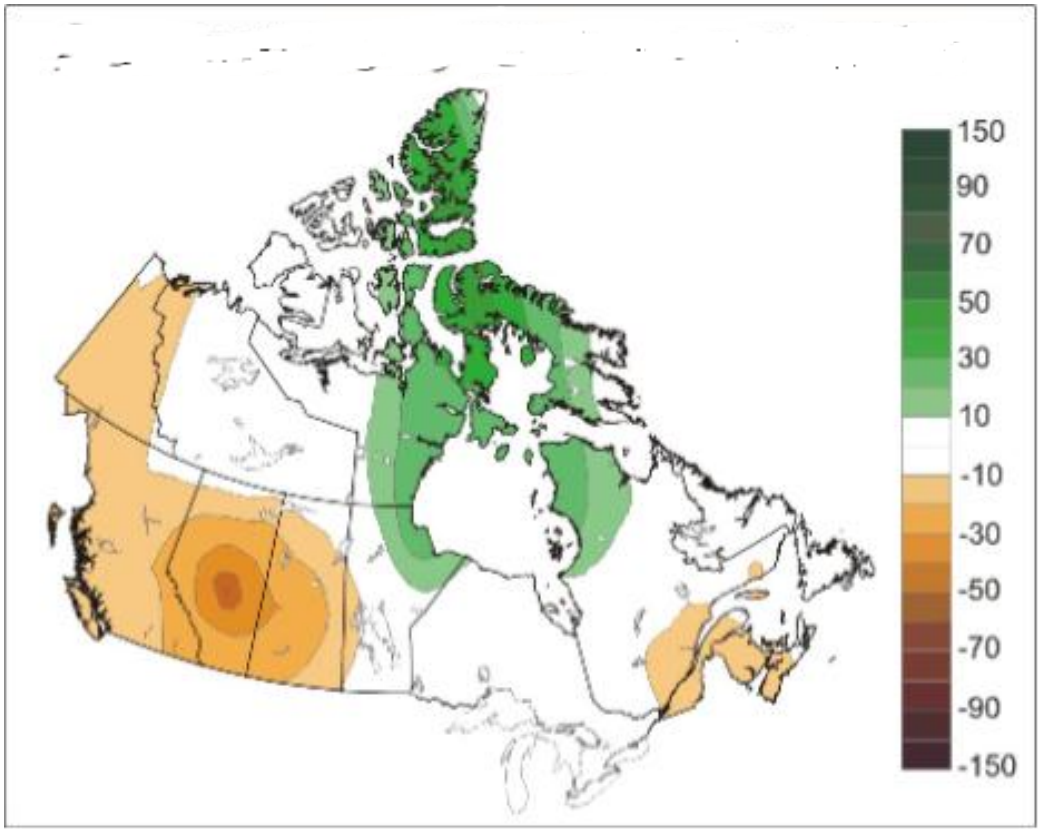




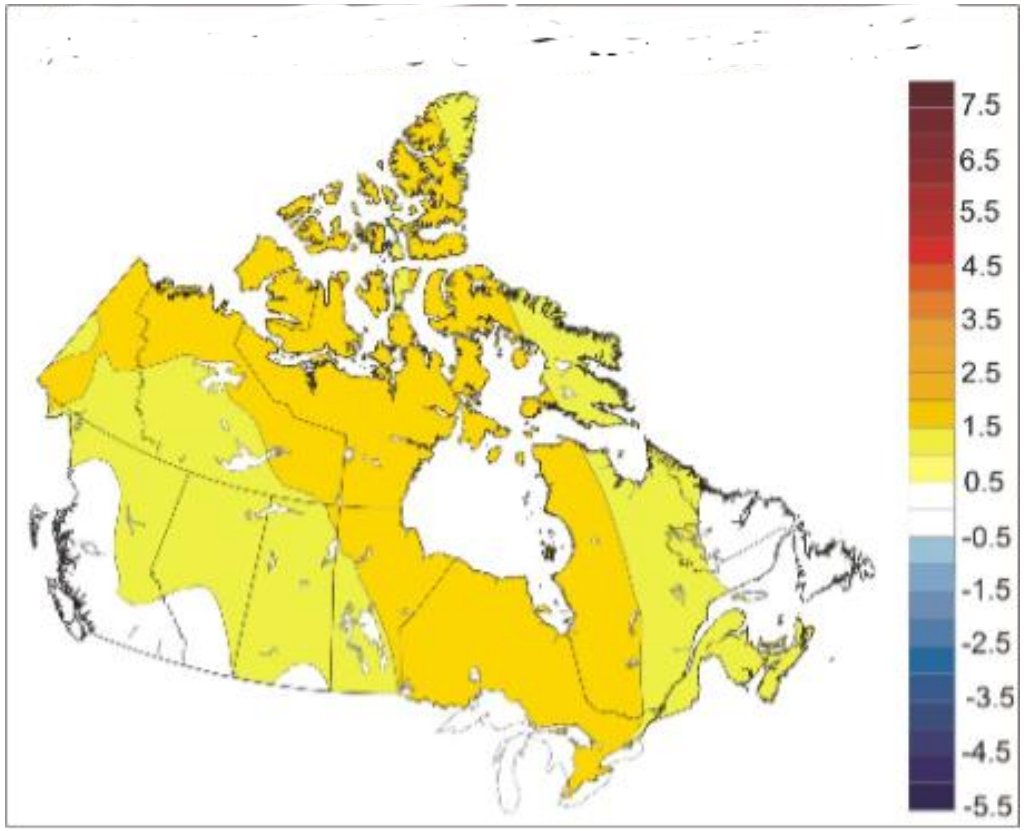
Summer 500 mb

Drought … Not Too Hot

Precipitation

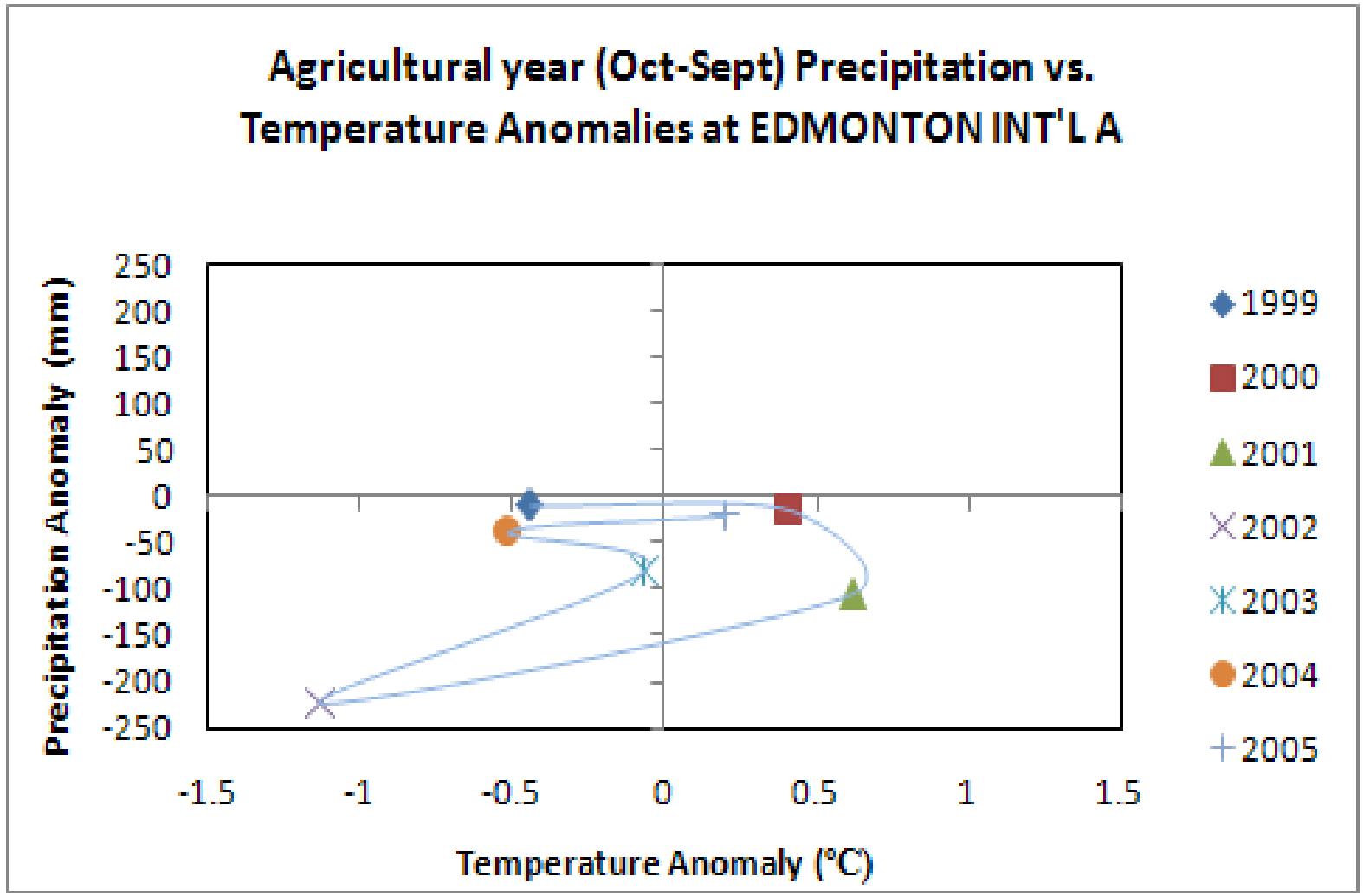


Temperature

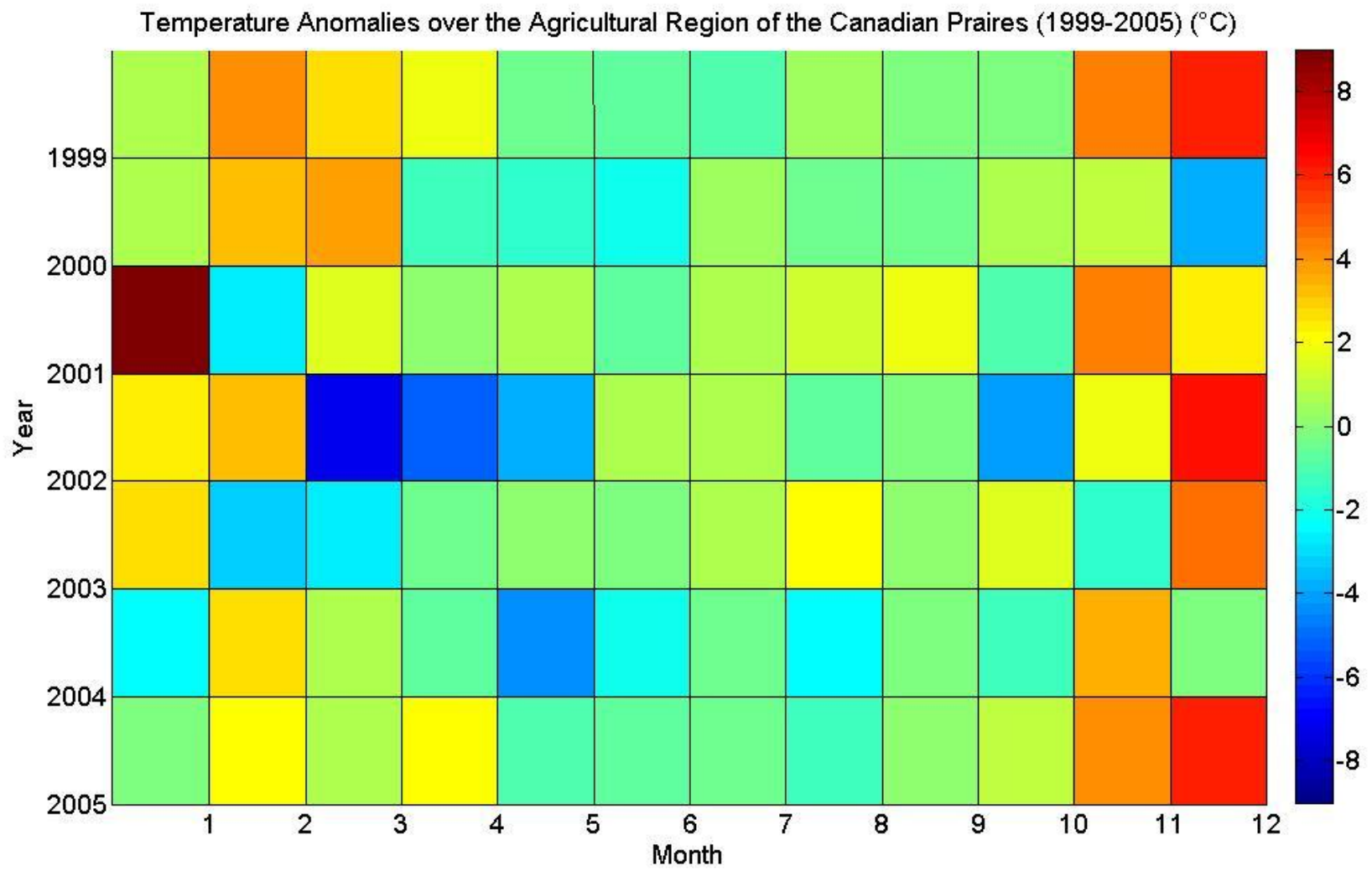


Summers of 2000, 2001 and 2002

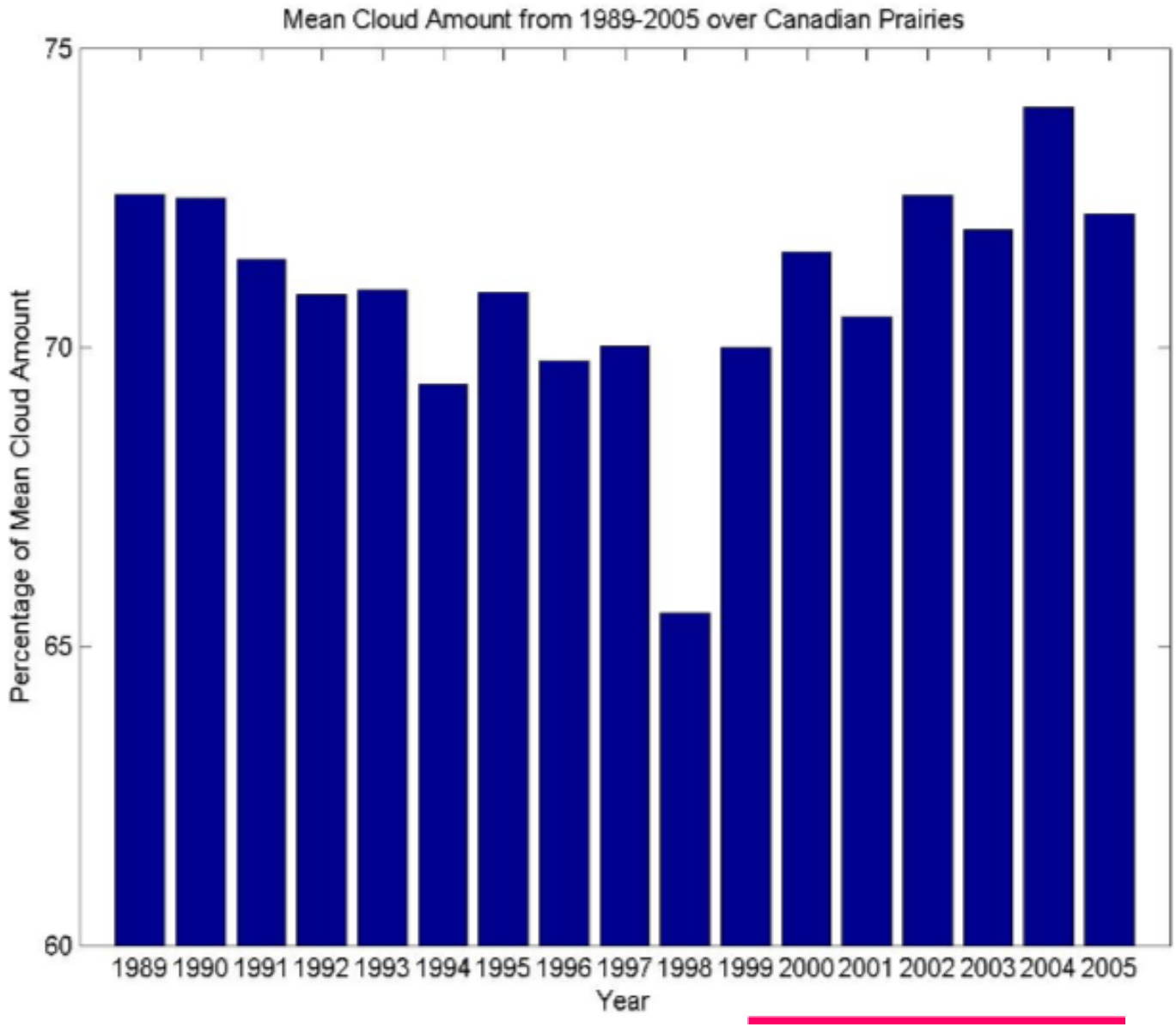
PRECIPITATION-TEMPERATURE ANOMALY
Agricultural Years (Sept-Aug) Edmonton



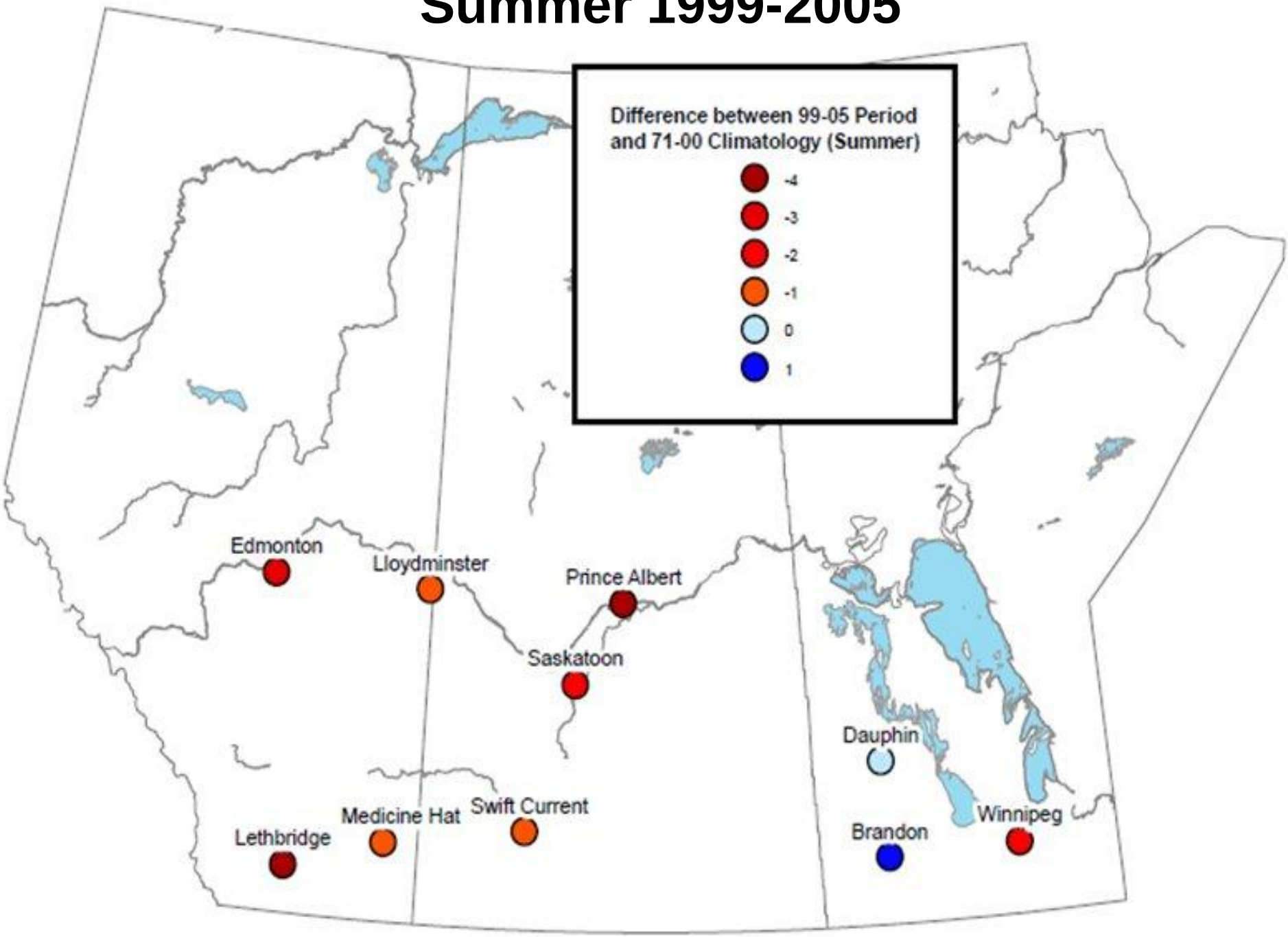
Monthly temperature anomalies: agricultural region of the Prairies



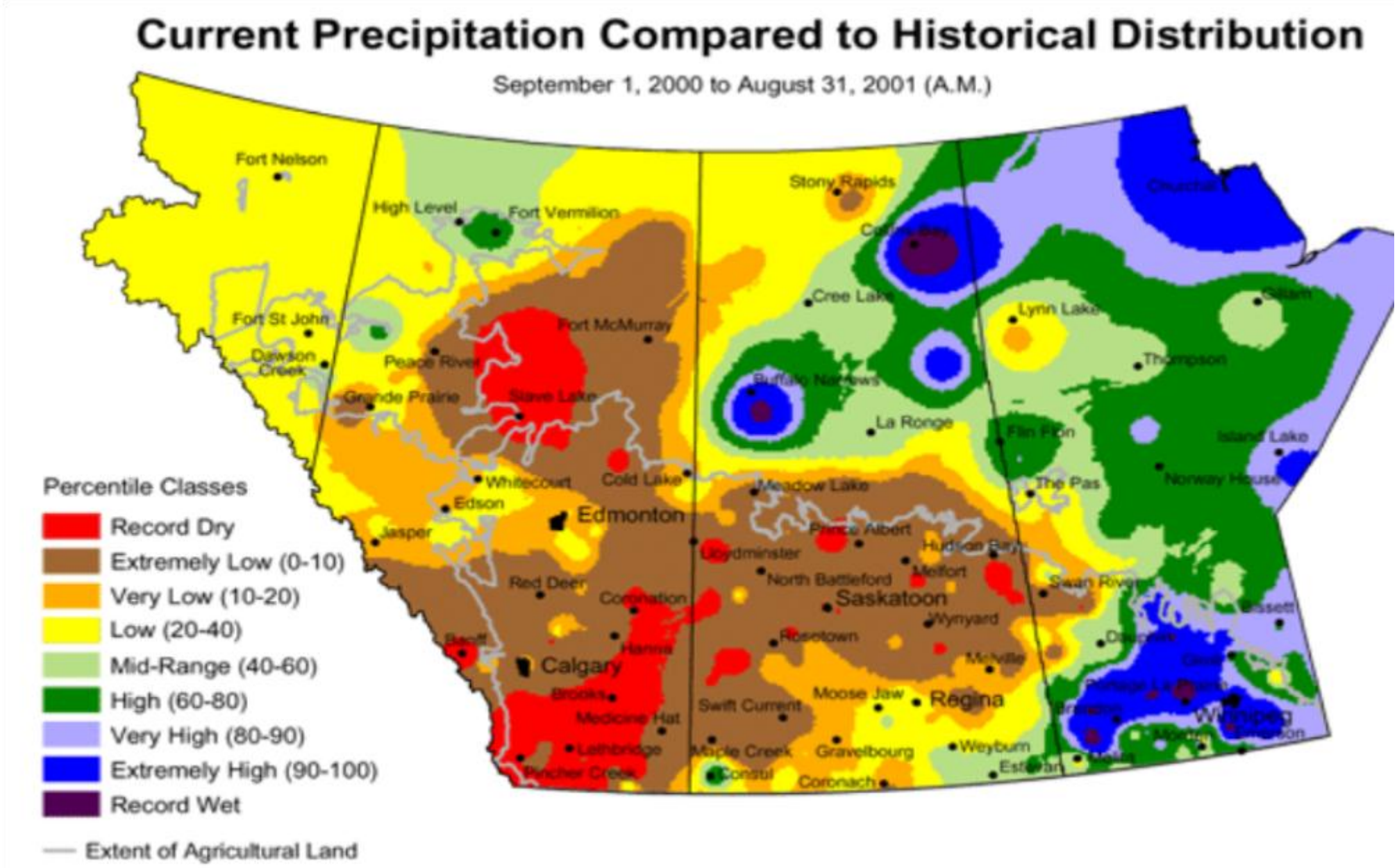
CLOUD AMOUNT



Wind-Calm Events: Summer 1999-2005

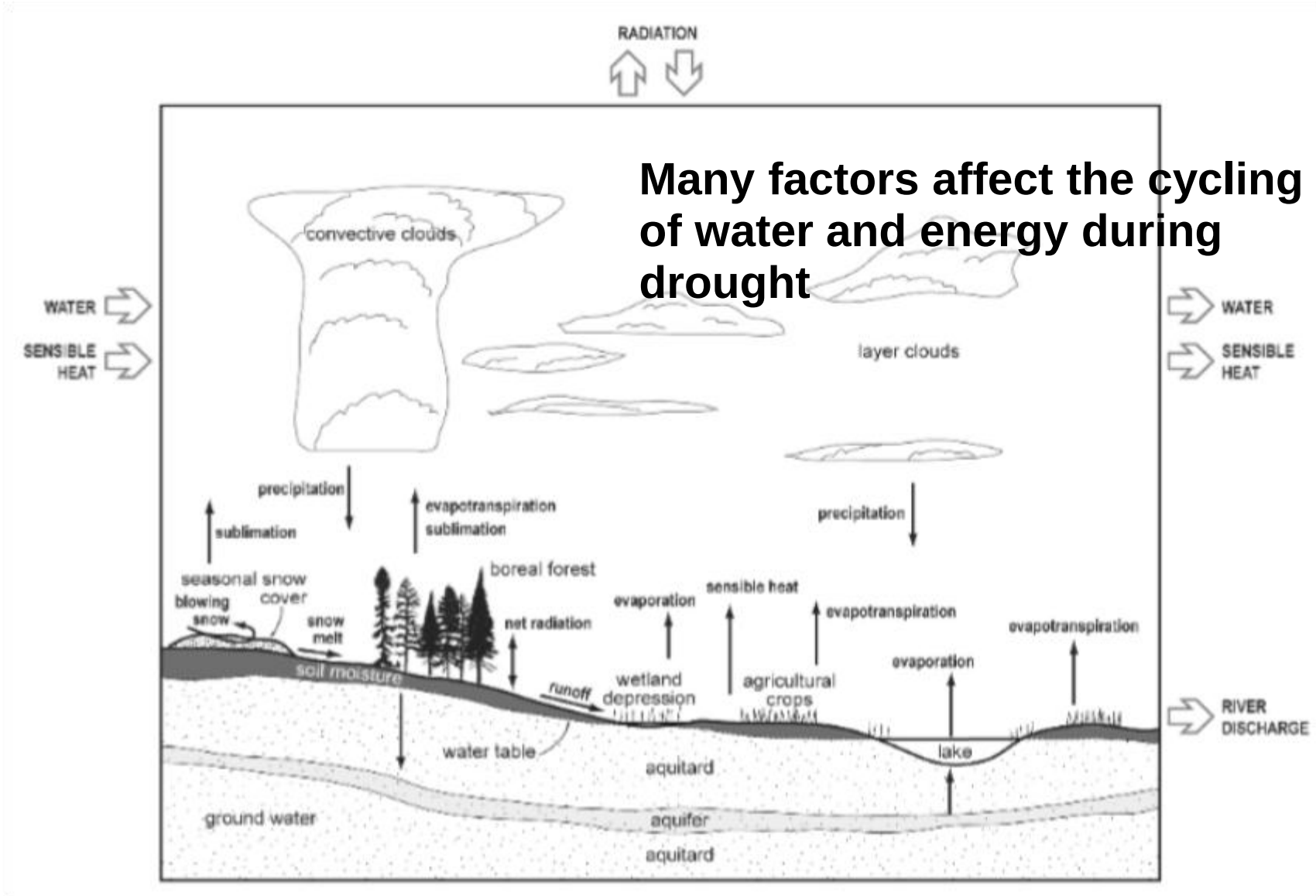


2001



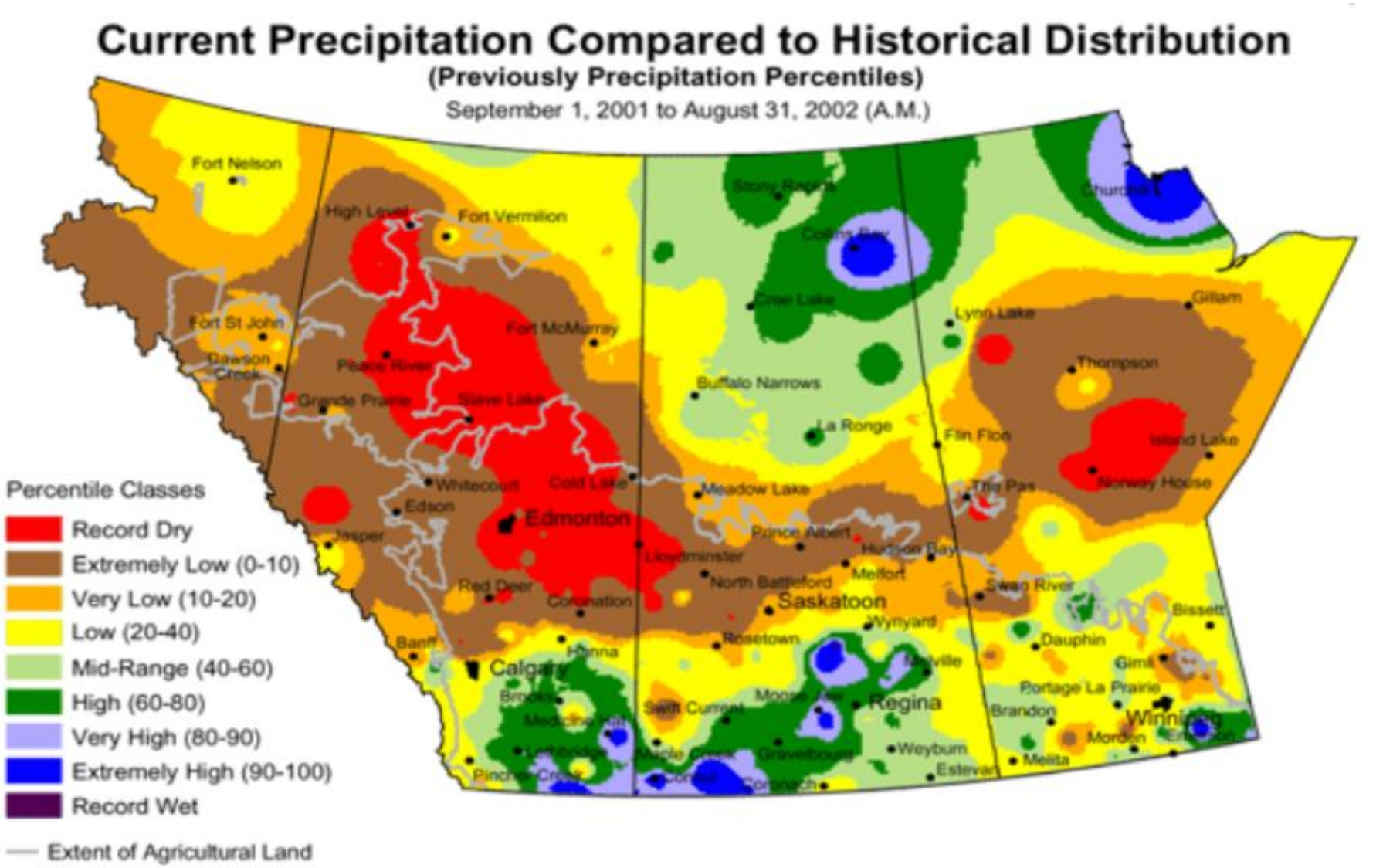
Prepared by PFRA (Prairie Farm Rehabilitation Administration) using data from the Timely Climate Monitoring Network and the many federal and provincial agencies and volunteers that support it.

WATER AND ENERGY CYCLING



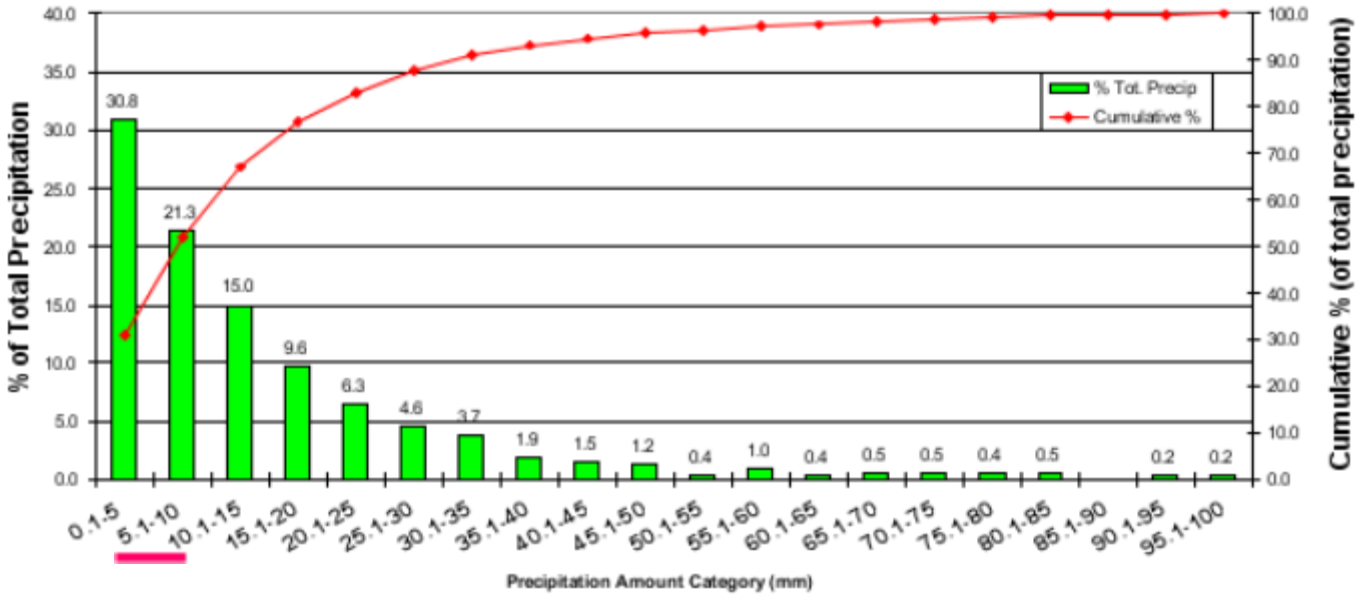
Many factors affect the cycling of water and energy during drought

CANADIAN PRAIRIES
2002



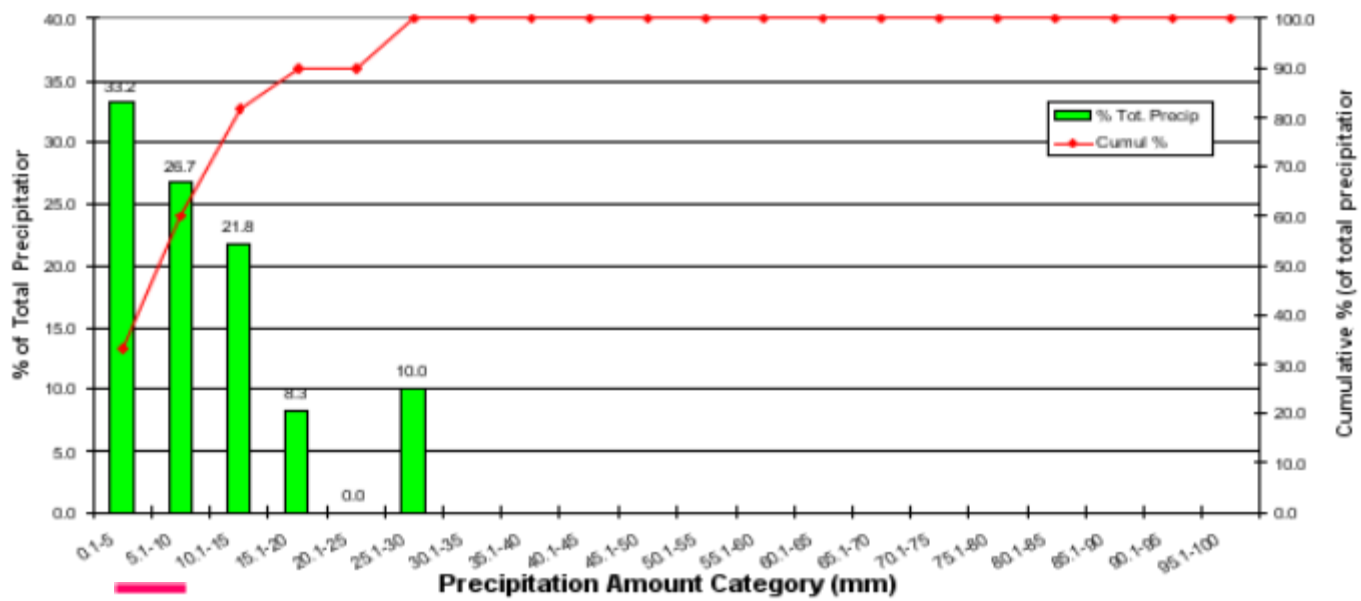
Prepared by PFRA (Prairie Farm Rehabilitation Administration) using data from the Timely Climate Monitoring Network and the many federal and provincial agencies and volunteers that support it.

Daily Precipitation Amounts



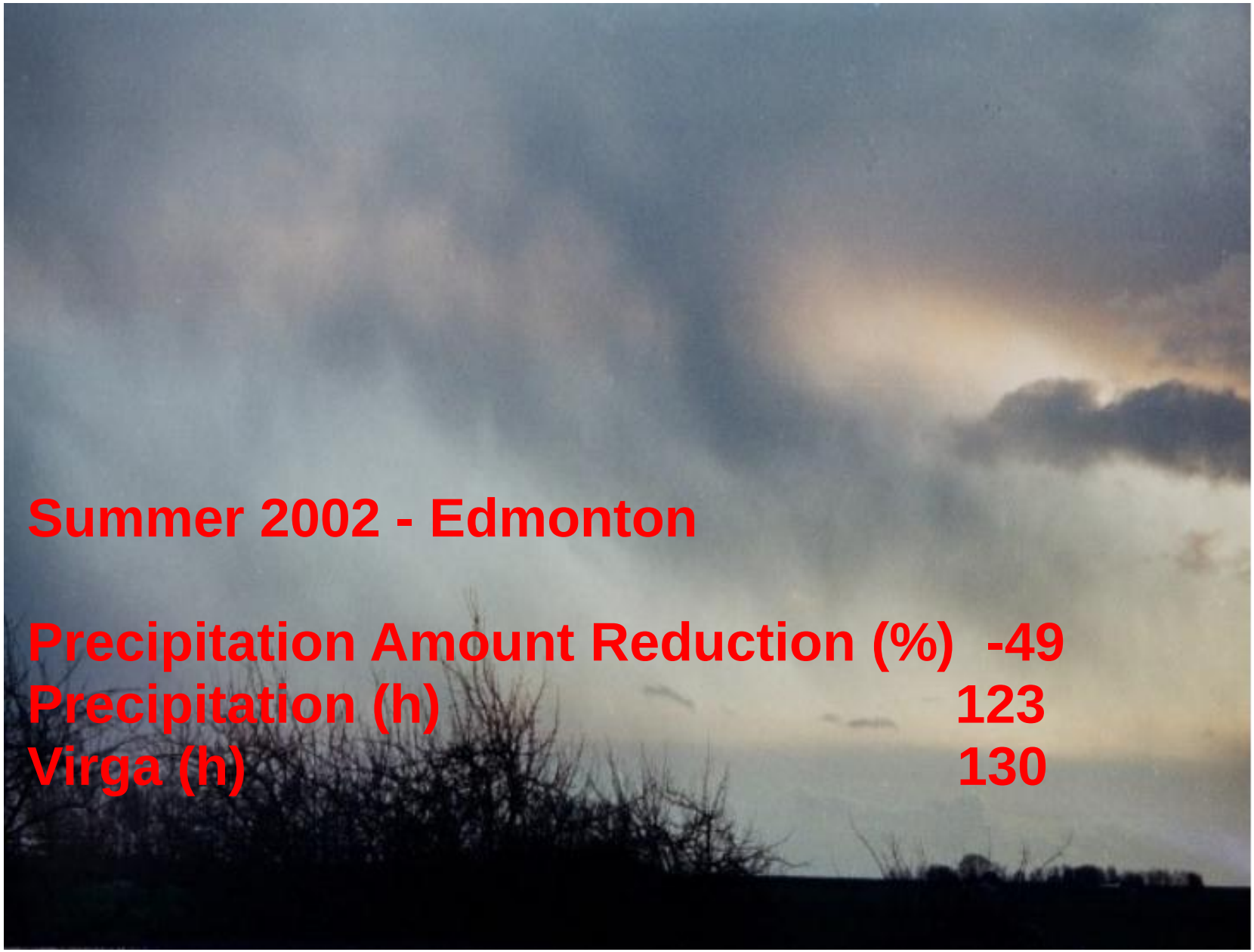
Low precipitation event:
< 10 mm

<u>Climatology</u>
Low precipitation events: 52% of total

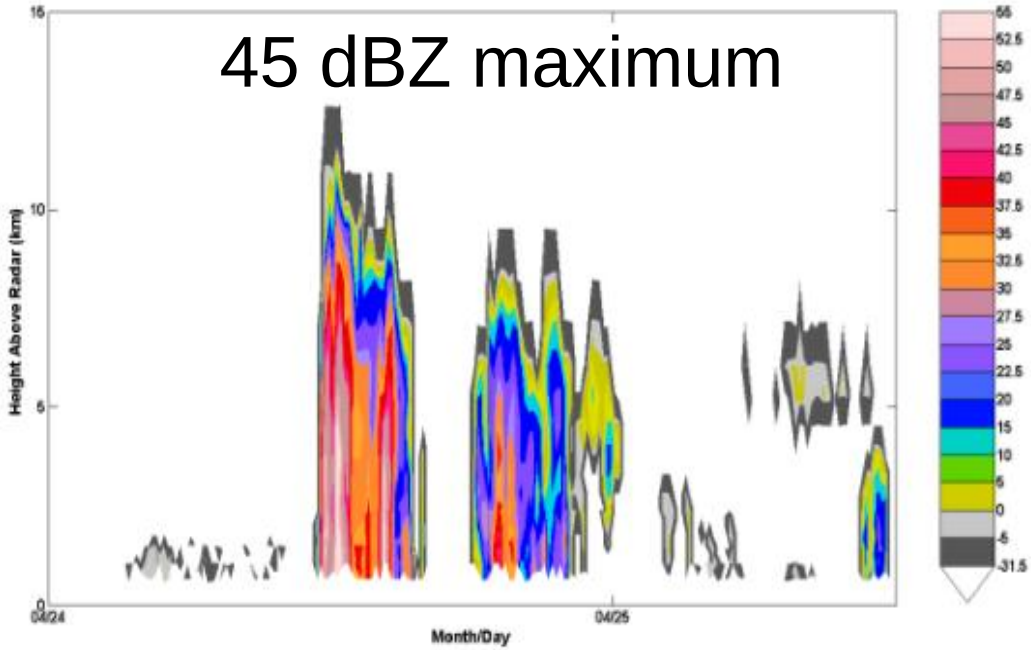


<u>Sub-drought 2002</u>
Low precipitation events: 60% of total

VIRGA


Summer 2002 - Edmonton
Precipitation Amount Reduction (%) -49
Precipitation (h) 123
Virga (h) 130

PRECIPITATION RATE

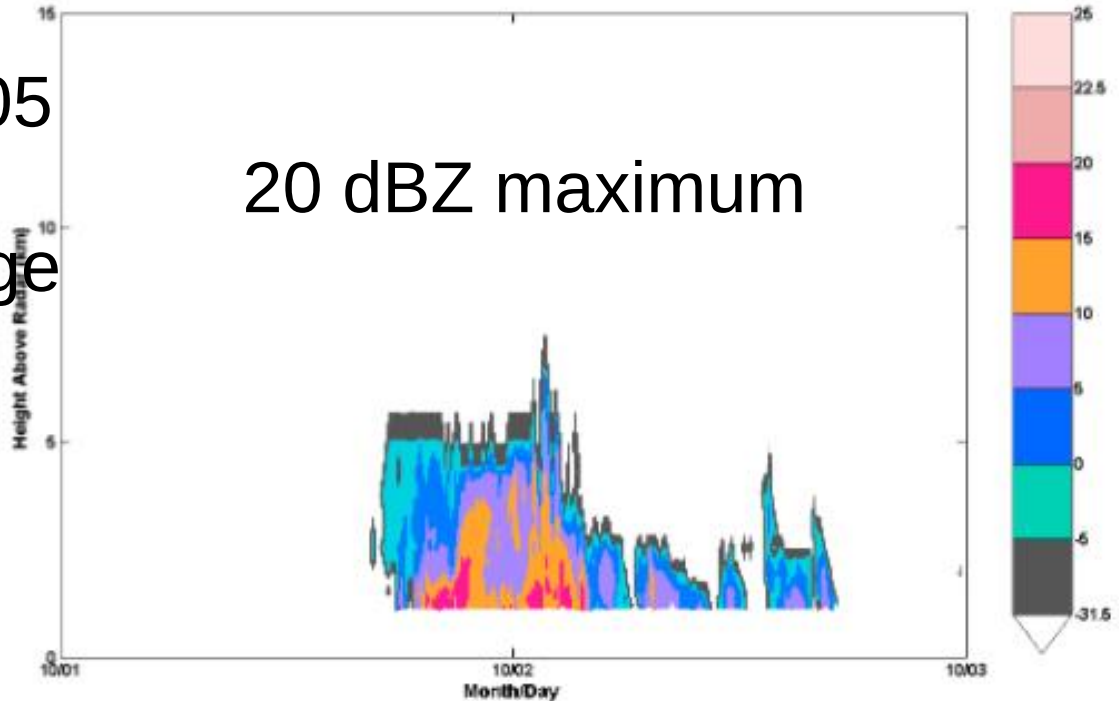


Cold Lake 24 April 2003

- Hail and rain
- 243% of monthly average accumulation

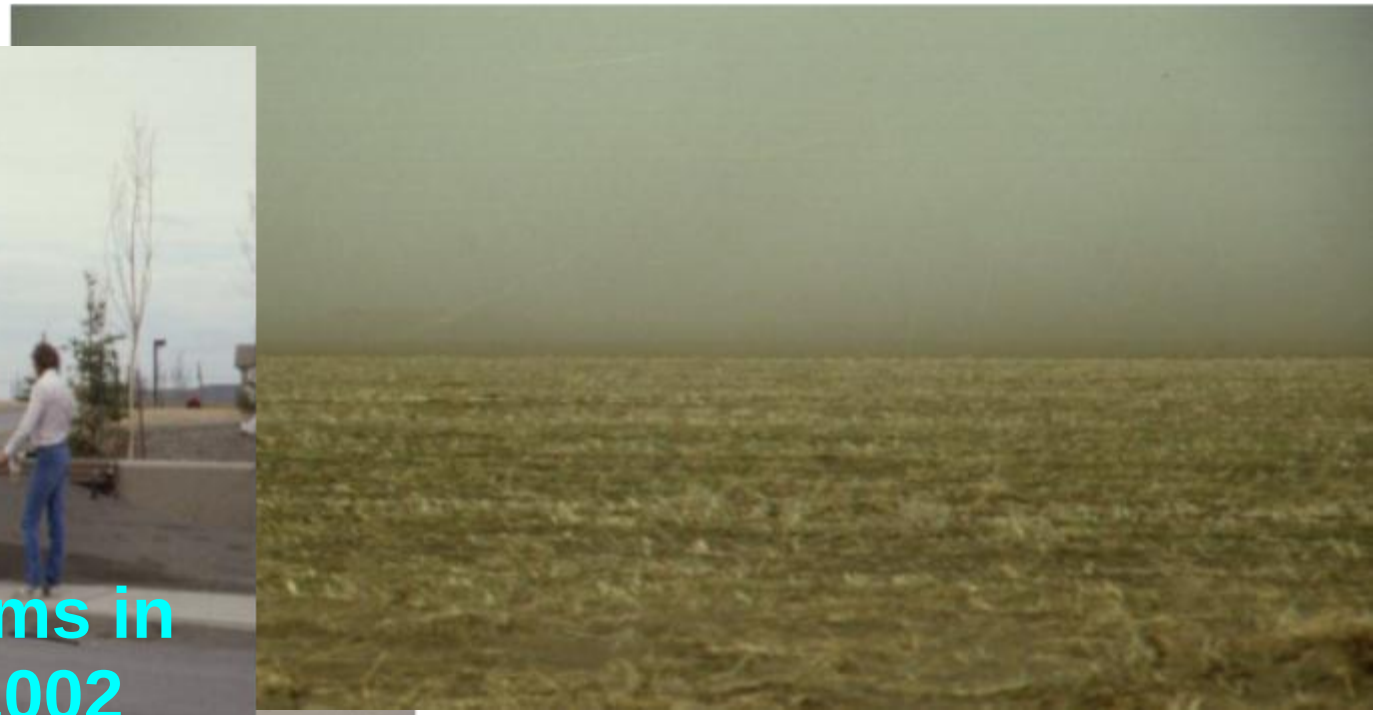
Cold Lake 1-3 October 2005

- Rain and snow
- 143% of monthly average accumulation

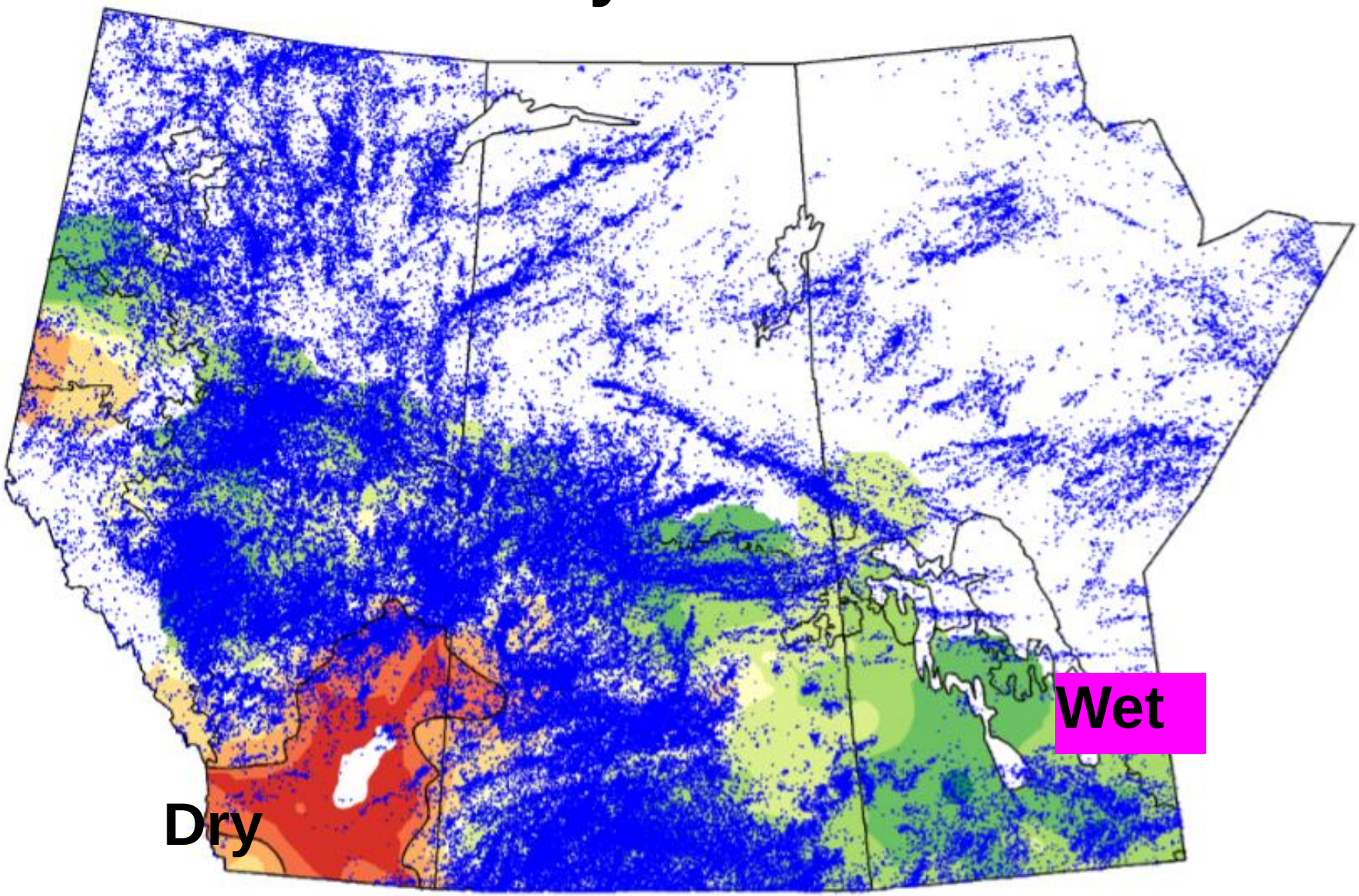


DUSTSTORMS

32 major dust storms in Saskatchewan in 2002



Soil Moisture and Lightning
July 2000



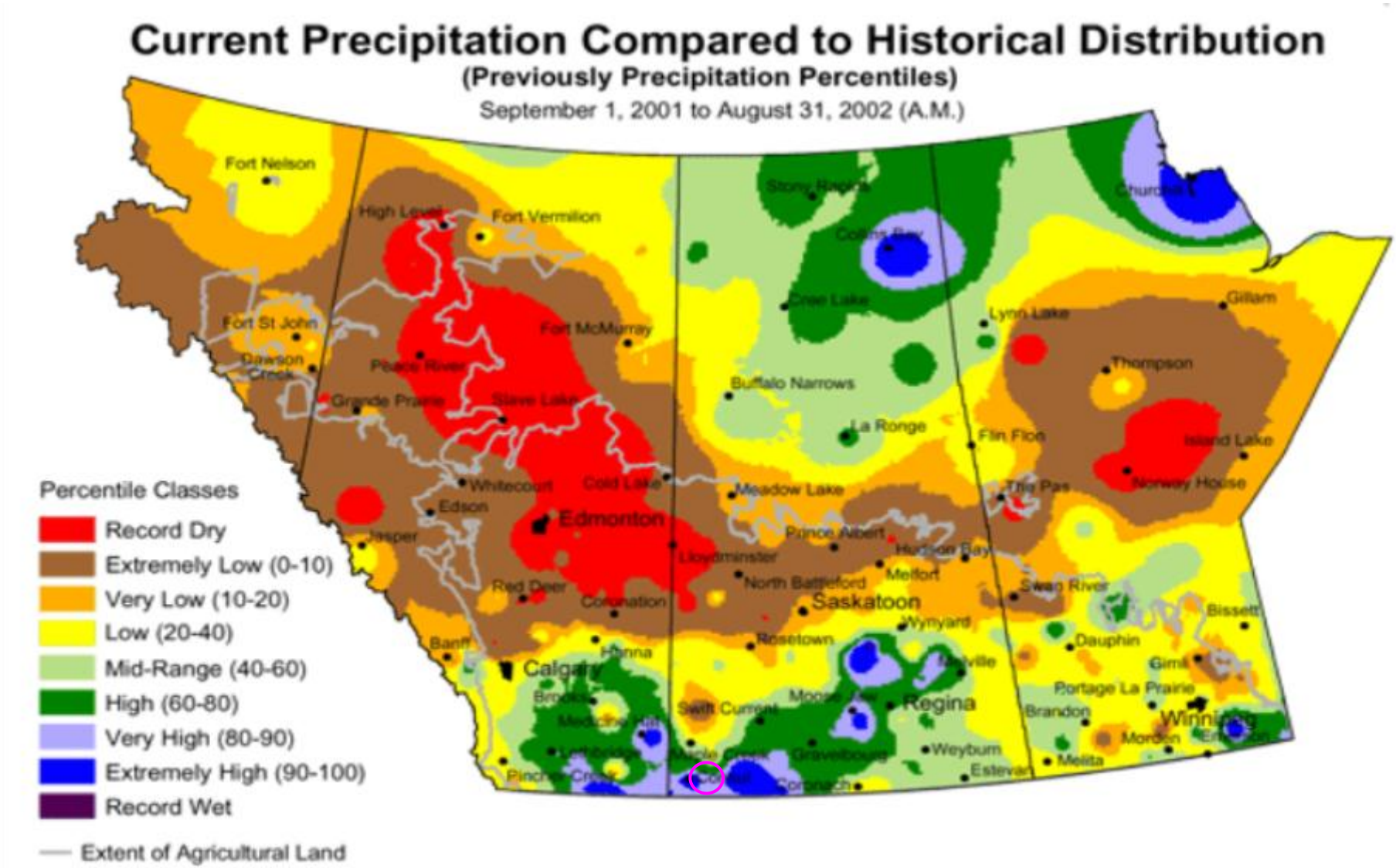
IMPORTANCE OF SURFACE FEATURES

perturbations to extremes

Less precipitation
Less evapotranspiration
Less precipitation

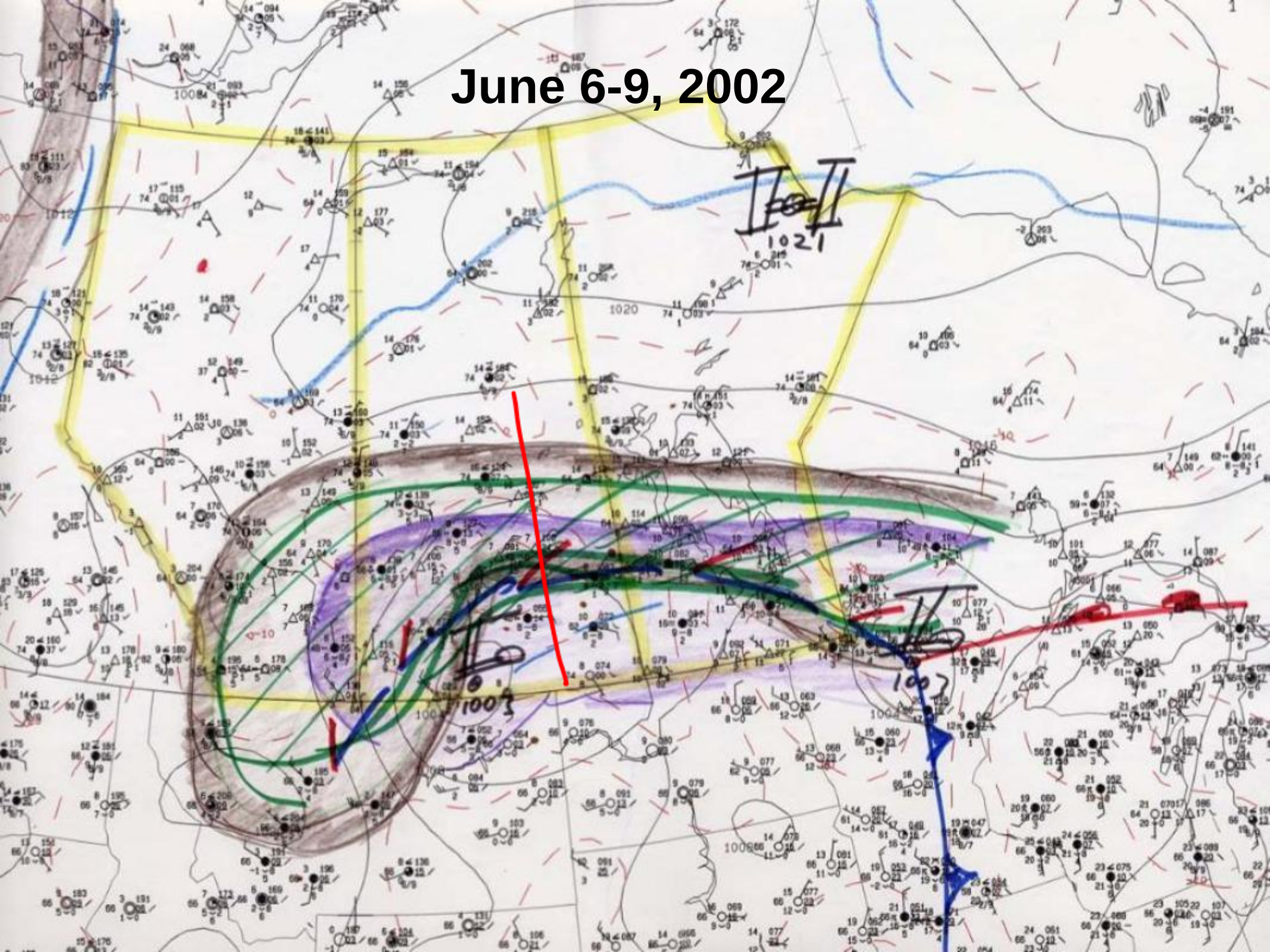
More precipitation
Greater evapotranspiration
More precipitation

CANADIAN PRAIRIES
2002

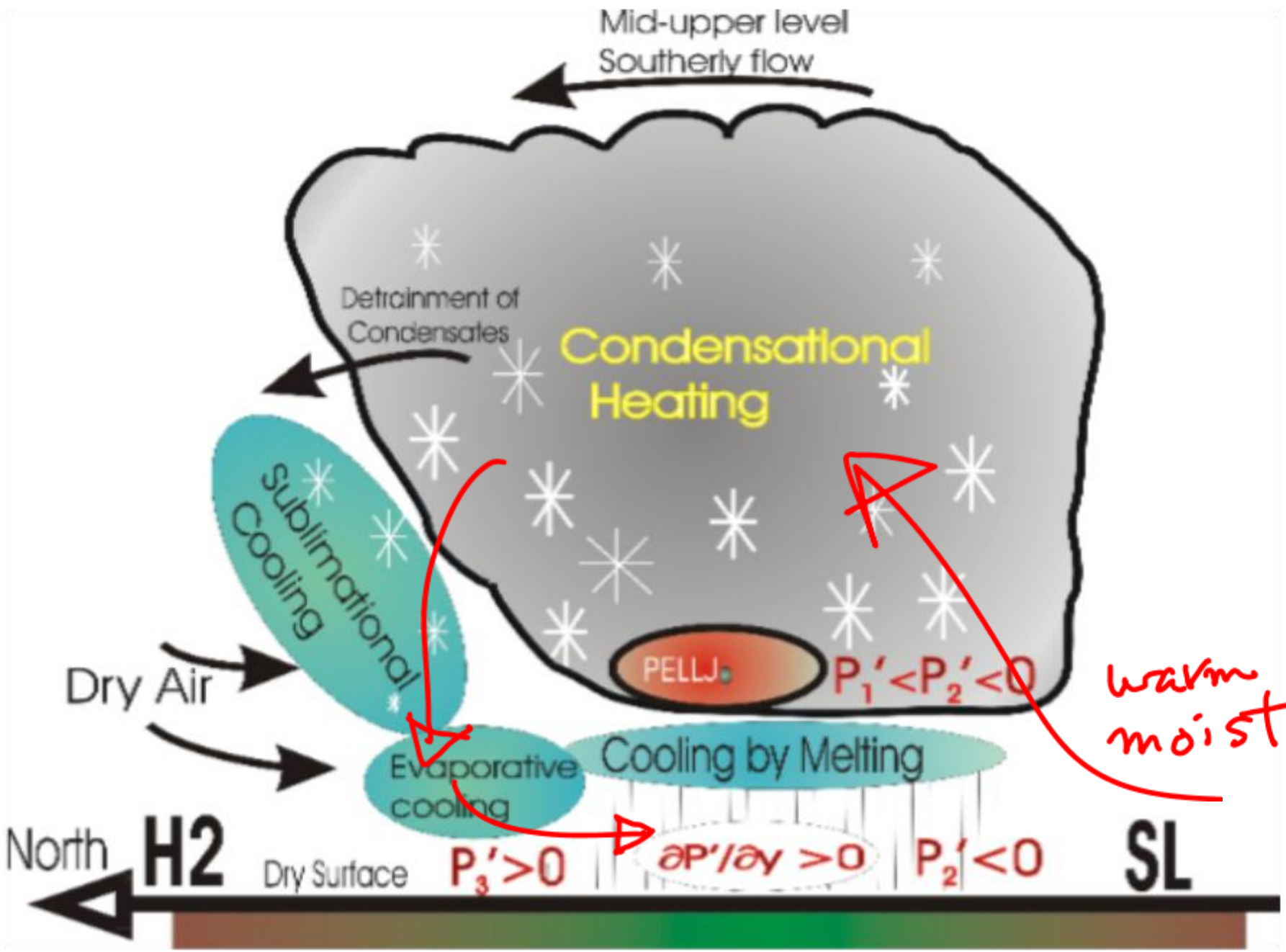


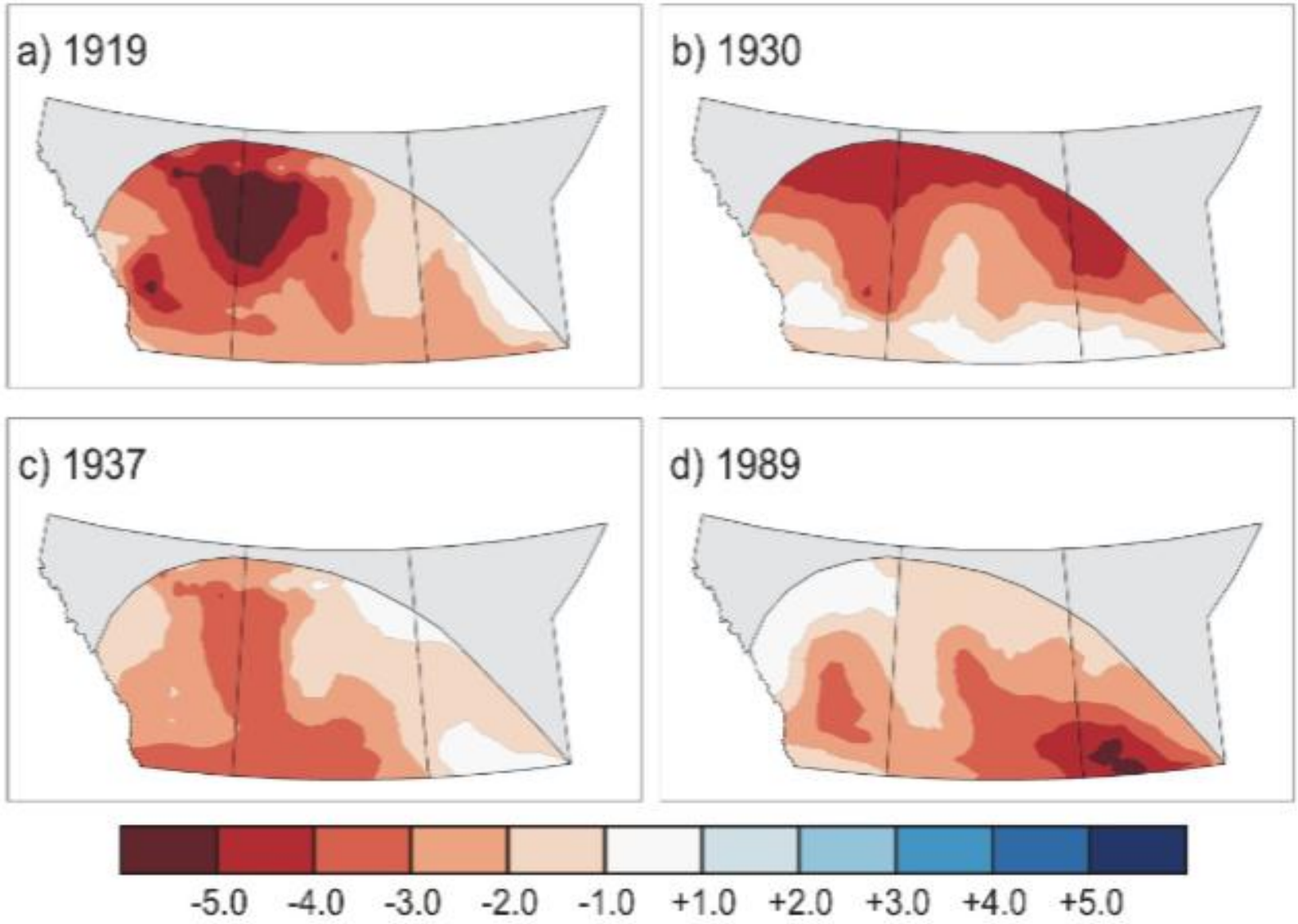
Prepared by PFRA (Prairie Farm Rehabilitation Administration) using data from the Timely Climate Monitoring Network and the many federal and provincial agencies and volunteers that support it.

Dry in April 2002 ...


June 6-9, 2002

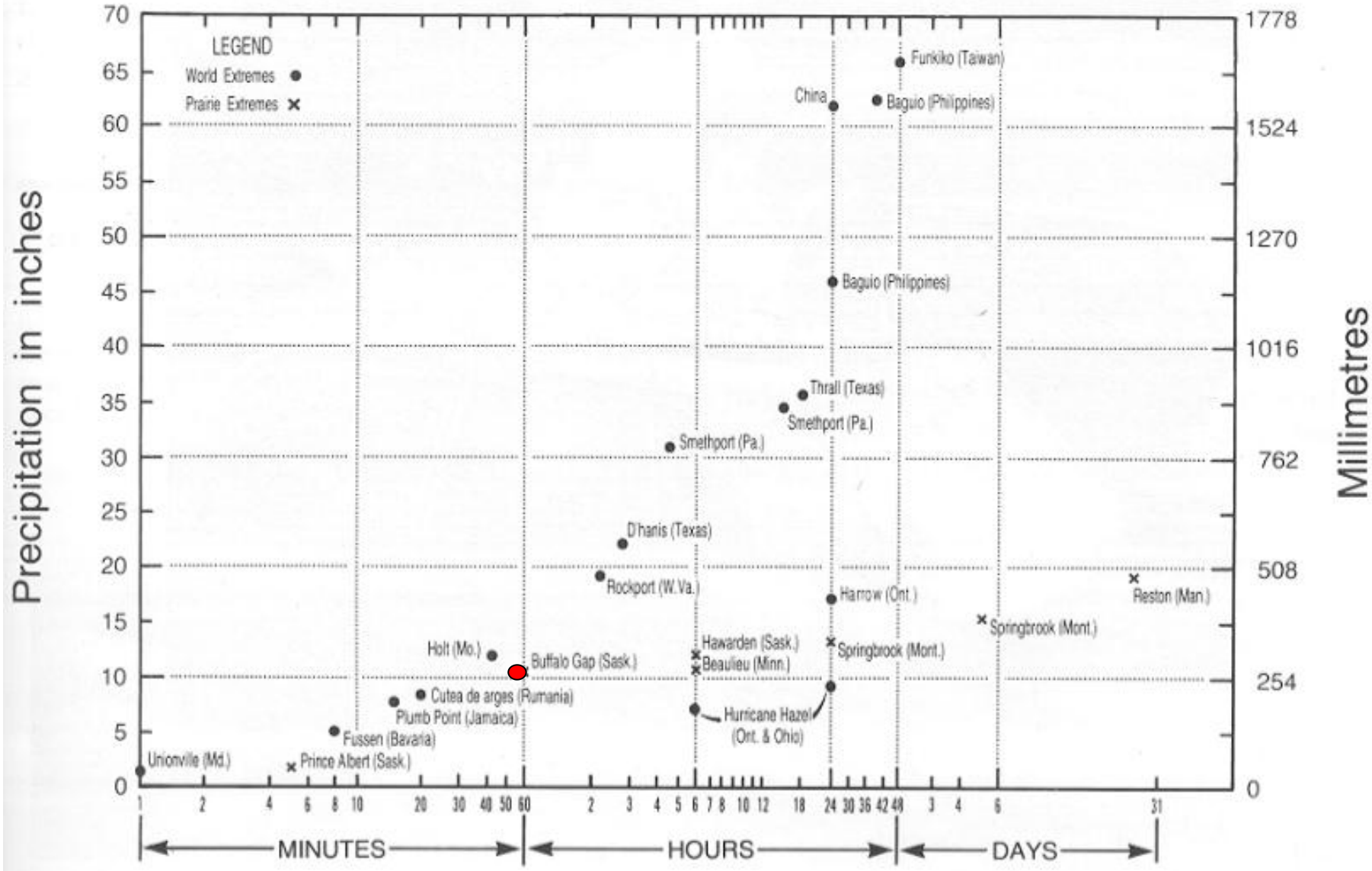
Storm- and cloud-scale feedbacks





Palmer Drought Severity Index (PDSI) for agricultural years with severe drought

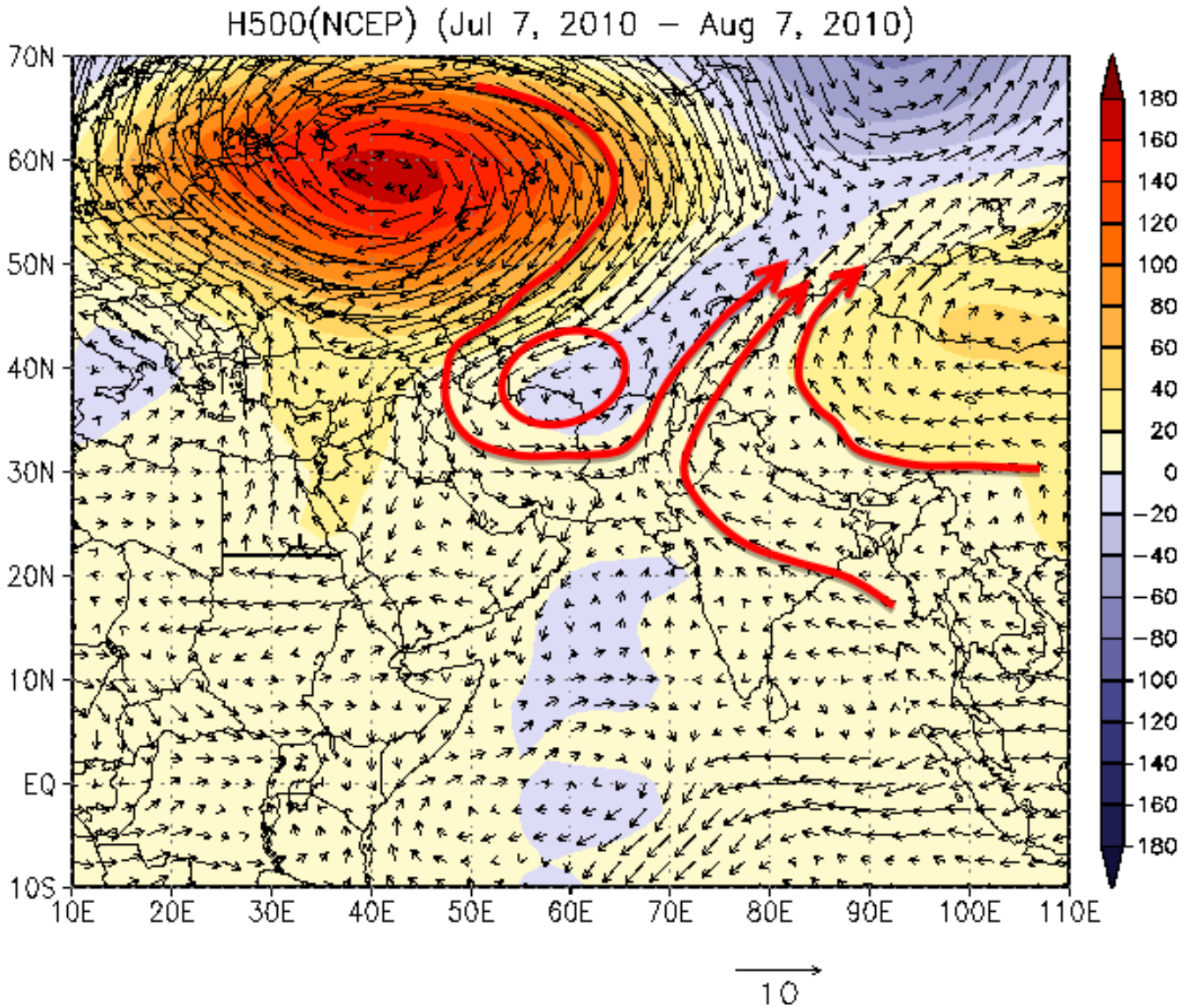
EXTREME RAINFALLS



Thanks to Danny Blair, Bill Rannie and Irene Hanuta

Adapted from Handbook on the Principles of Hydrology, D.M. Gray, ed.

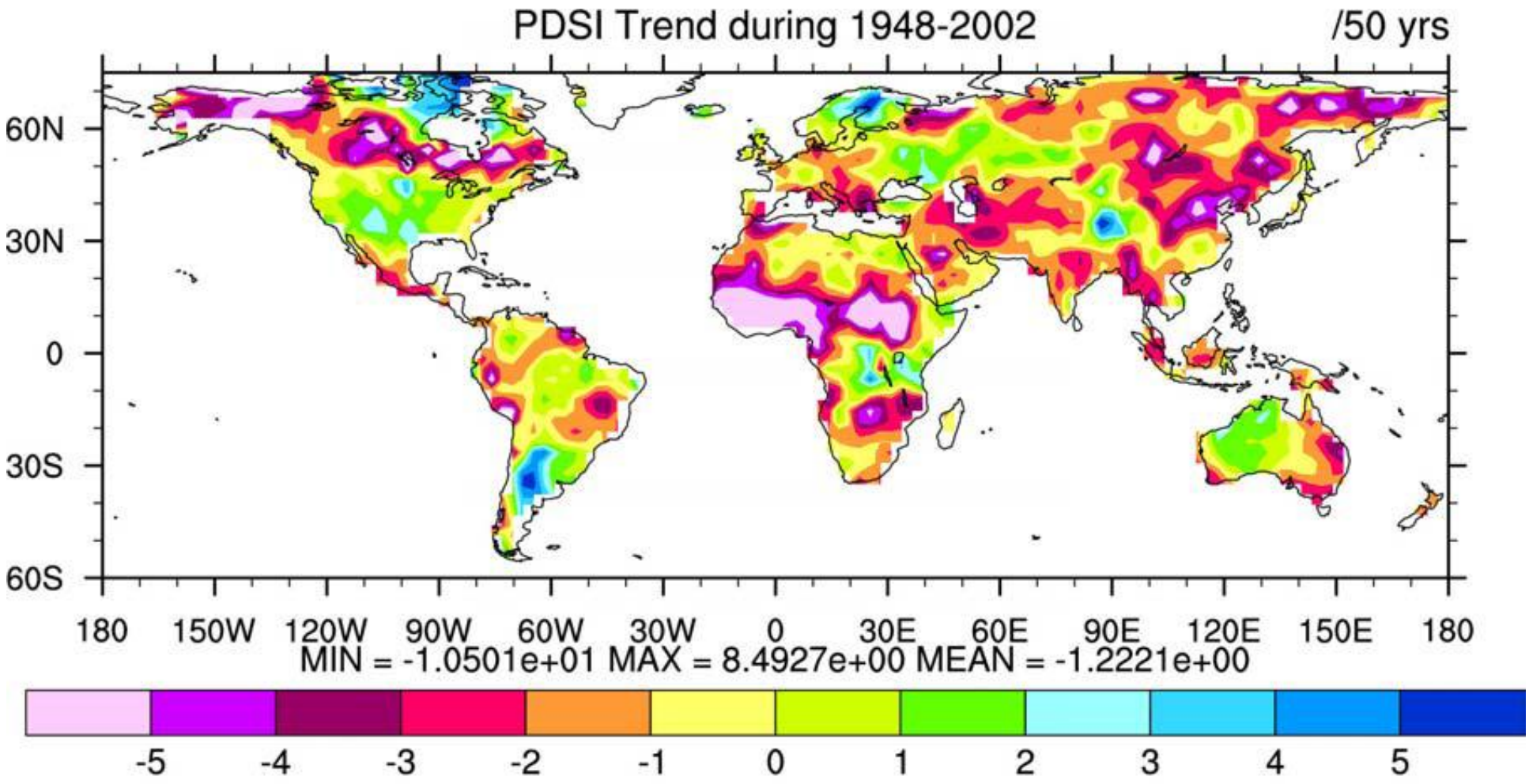
JULY-AUGUST 2010

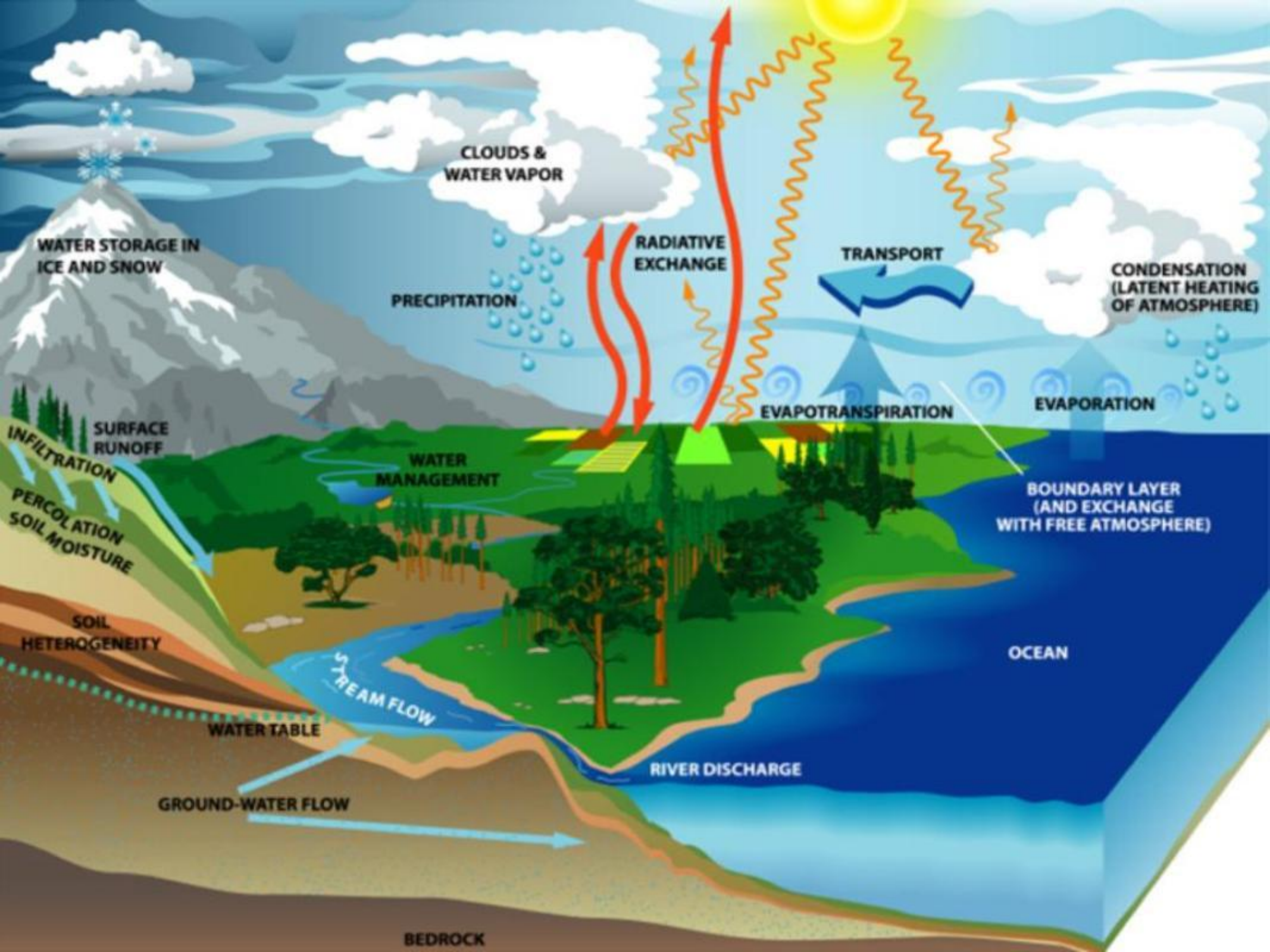


ATMOSPHERIC DROUGHT TYPES

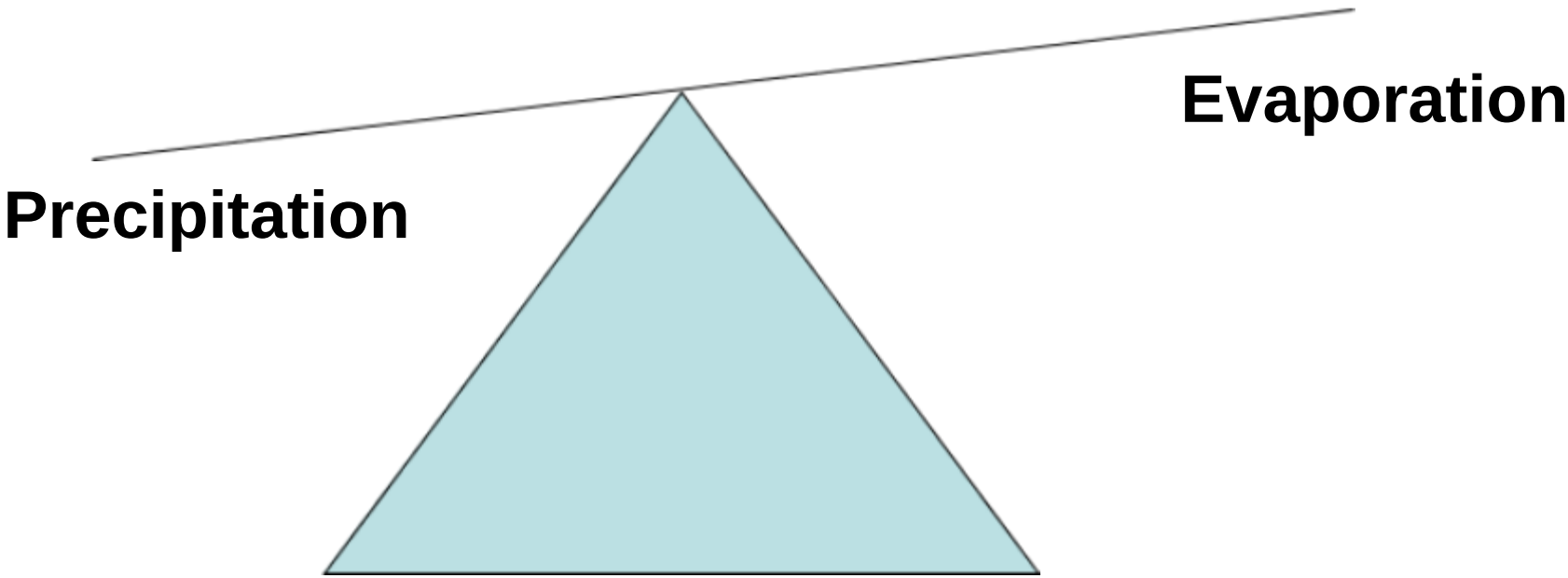
No precipitation	... or ...	Sprinkles
Virga		Chance of catastrophic rain
Steady rain		Torrential rate
Hot		Cold
Windy		Calm
Dusty		Clear
Cloud-free		Cloudy

DRYING TREND: 1948-2002



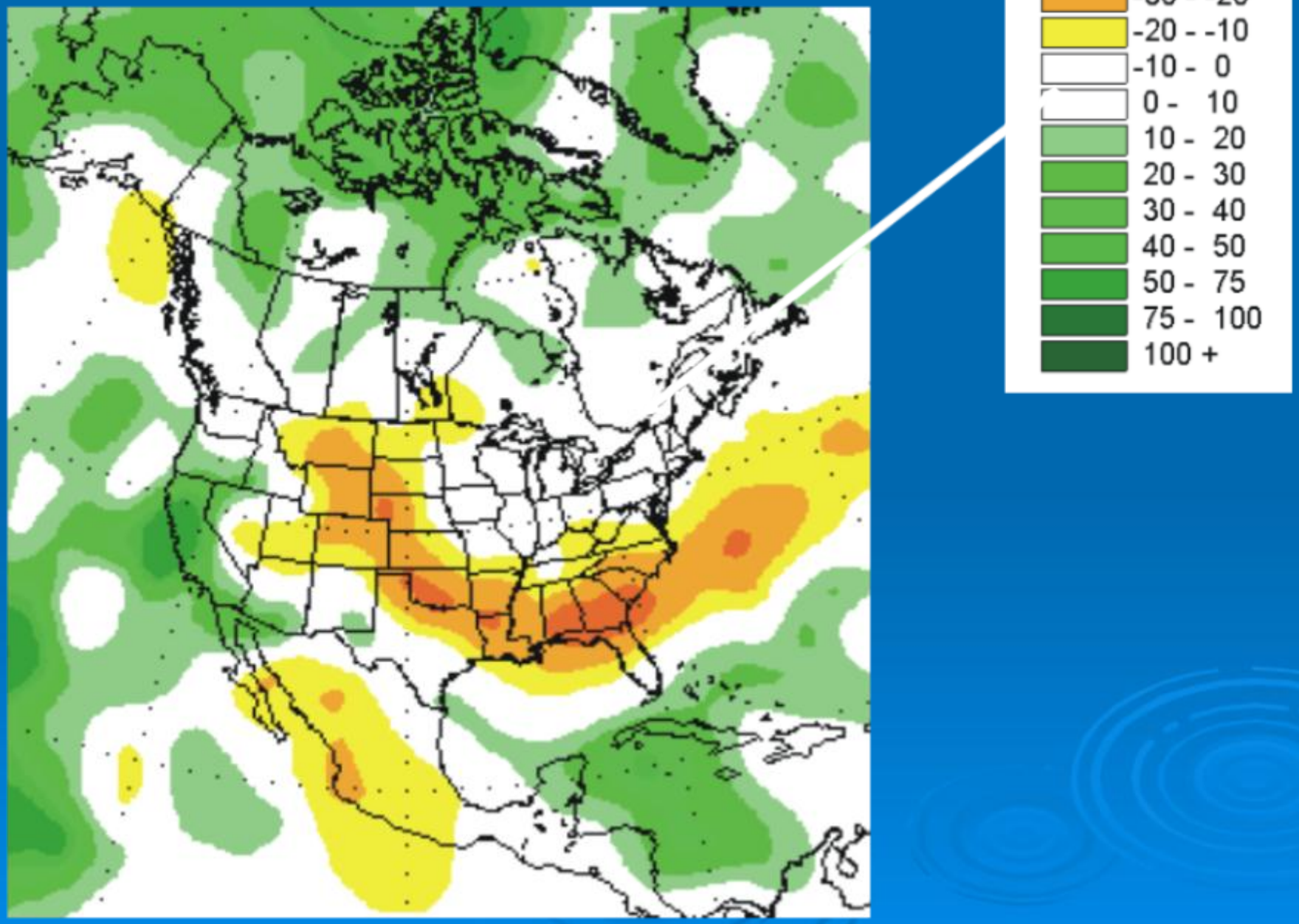

CLOUDS &
WATER VAPOR
WATER STORAGE IN
ICE AND SNOW
PRECIPITATION
RADIATIVE
EXCHANGE
TRANSPORT
CONDENSATION
(LATENT HEATING
OF ATMOSPHERE)
EVAPOTRANSPIRATION
EVAPORATION
SURFACE
RUNOFF
INFILTRATION
WATER
MANAGEMENT
PERCOLATION
SOIL MOISTURE
BOUNDARY LAYER
(AND EXCHANGE
WITH FREE ATMOSPHERE)
SOIL
HETEROGENEITY
OCEAN
STREAM FLOW
WATER TABLE
RIVER DISCHARGE
GROUND-WATER FLOW
BEDROCK

BALANCING OR NOT



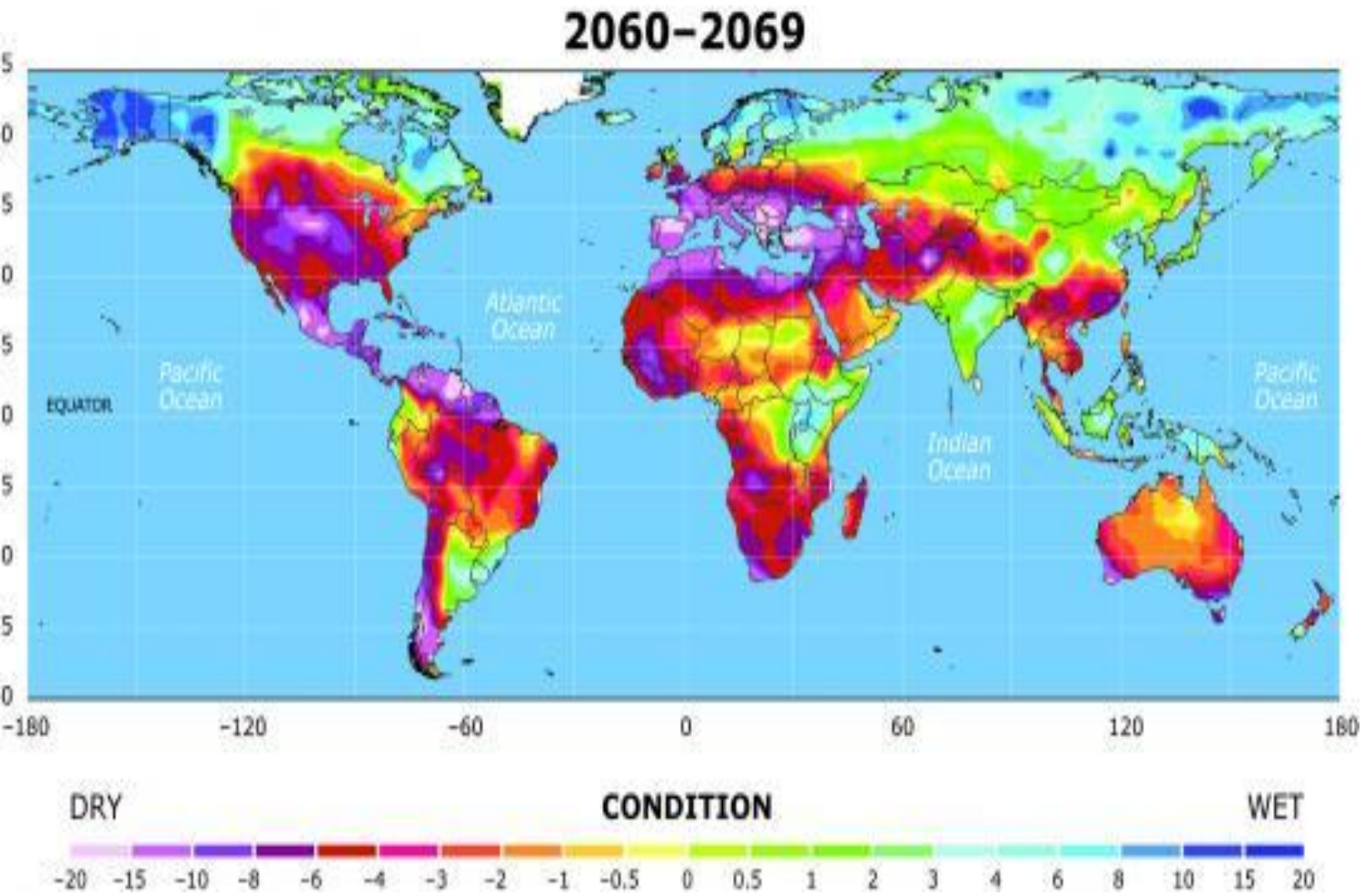
dry continental interior?

FUTURE PRECIPITATION?



Future Drought?

Oct 19, 2010 UCAR Press Release



Global climate models remain inconsistent in capturing precipitation changes and other atmospheric factors, especially at the regional scale. (Dai, 2010)


METEOROLOGICAL DATA ANALYSIS INSTITUTE OF WESTERN CANADA
AND NOW... OVER TO YOU.
LONG-TERM PROTECTIONS:
LOOMING WATER-SHORTAGE CRISIS
SHORT-TERM PROTECTIONS:

SOME SCIENTIFIC ISSUES

There are a number of critical scientific and technical issues limiting quantitative assessment of future conditions including:

scientific:

- access to moisture sources
- surface vegetation feedbacks
- cloud fields and precipitating systems
- role of dust
- ...

technical:

- spatial resolution of climate models is insufficient
- ...

PRAIRIES' ‘CLIMATE’ FORECAST

What is it?

'probably' more drought and heavy precipitation

'probably' more variability

and, not clear what 'type' of drought will occur

Why?

feedbacks acting to maintain extremes

warmer climate accelerate these feedbacks

hotter ... more rapid water cycling ... wet and dry

But?

lots of uncertainty

SUMMARY

Extremes are an inherent aspect of climate

Drought is a multi-faceted phenomenon

Heavy precipitation is sometimes occurring simultaneously

Heavy precipitation/drought couplings occur

The future for the Prairie climate is unclear but extreme with many consequences.

southern Manitoba June 2005


Thank you for your attention