

Atmospheric Moisture and Thunderstorm Drought

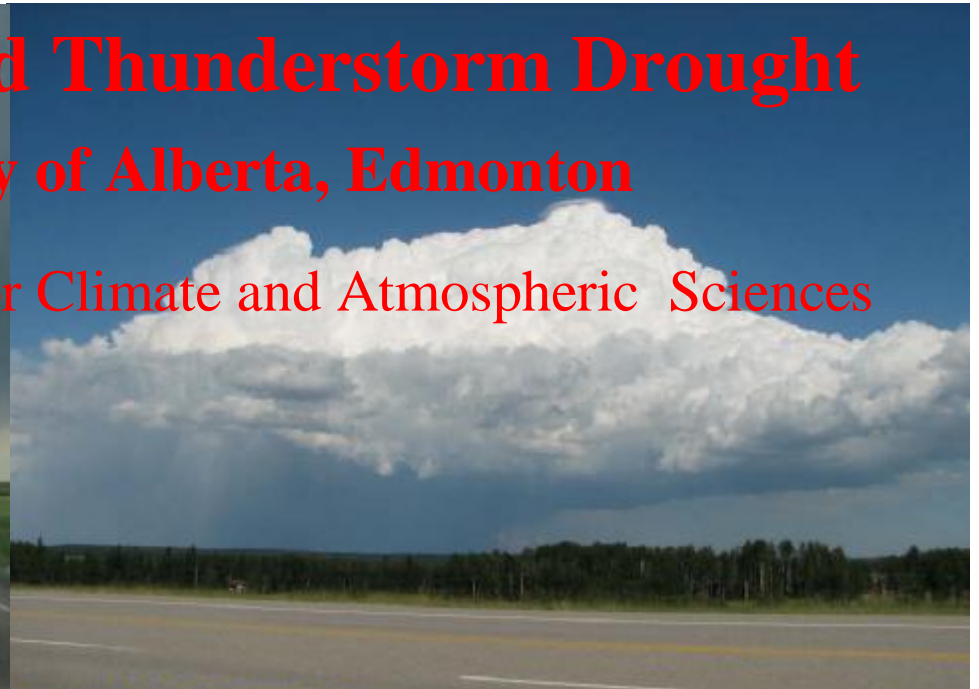
Geoff Strong - University of Alberta, Edmonton

- funded by Canadian Foundation for Climate and Atmospheric Sciences



Near Spruceview, 2116Z, 17 July 2006

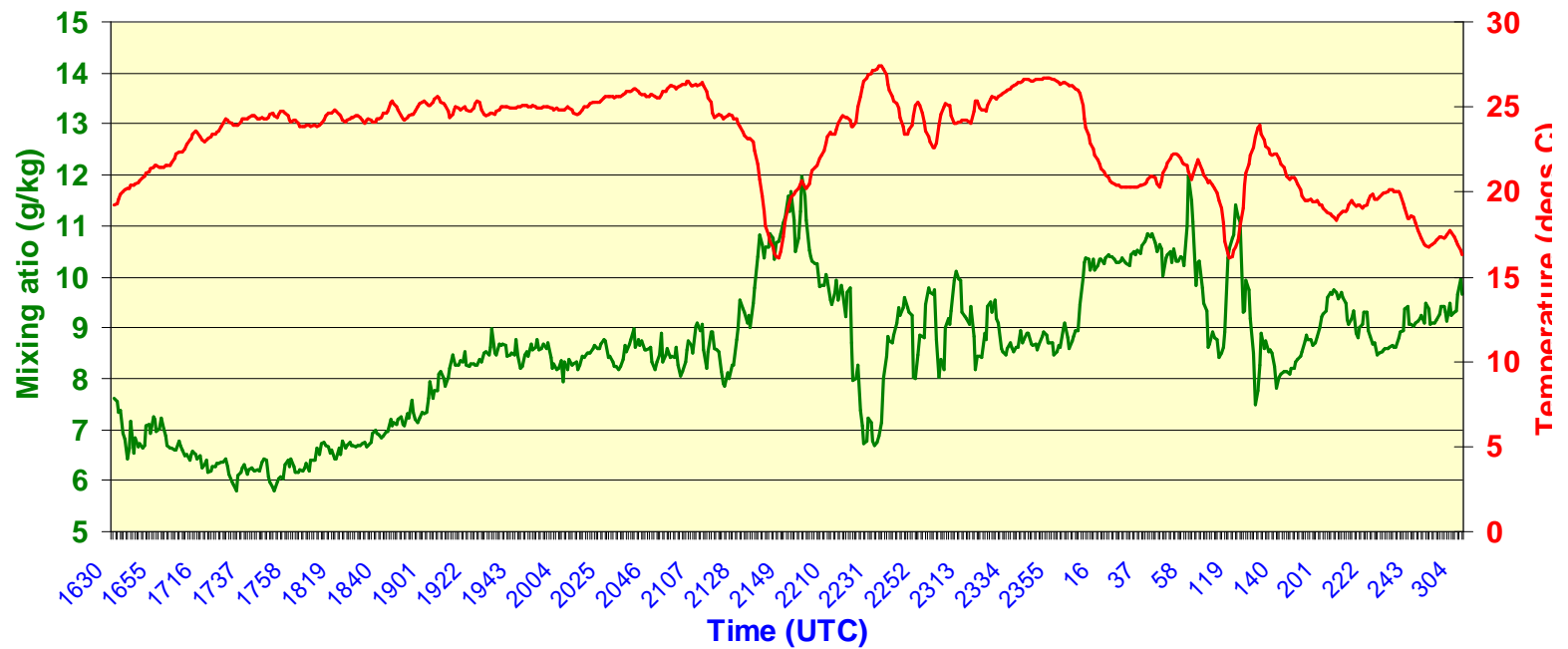
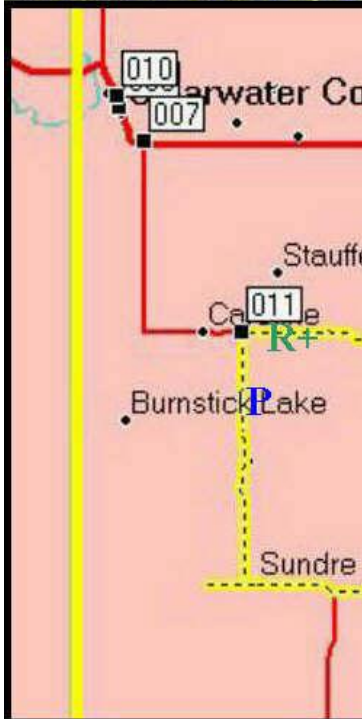
G. Strong

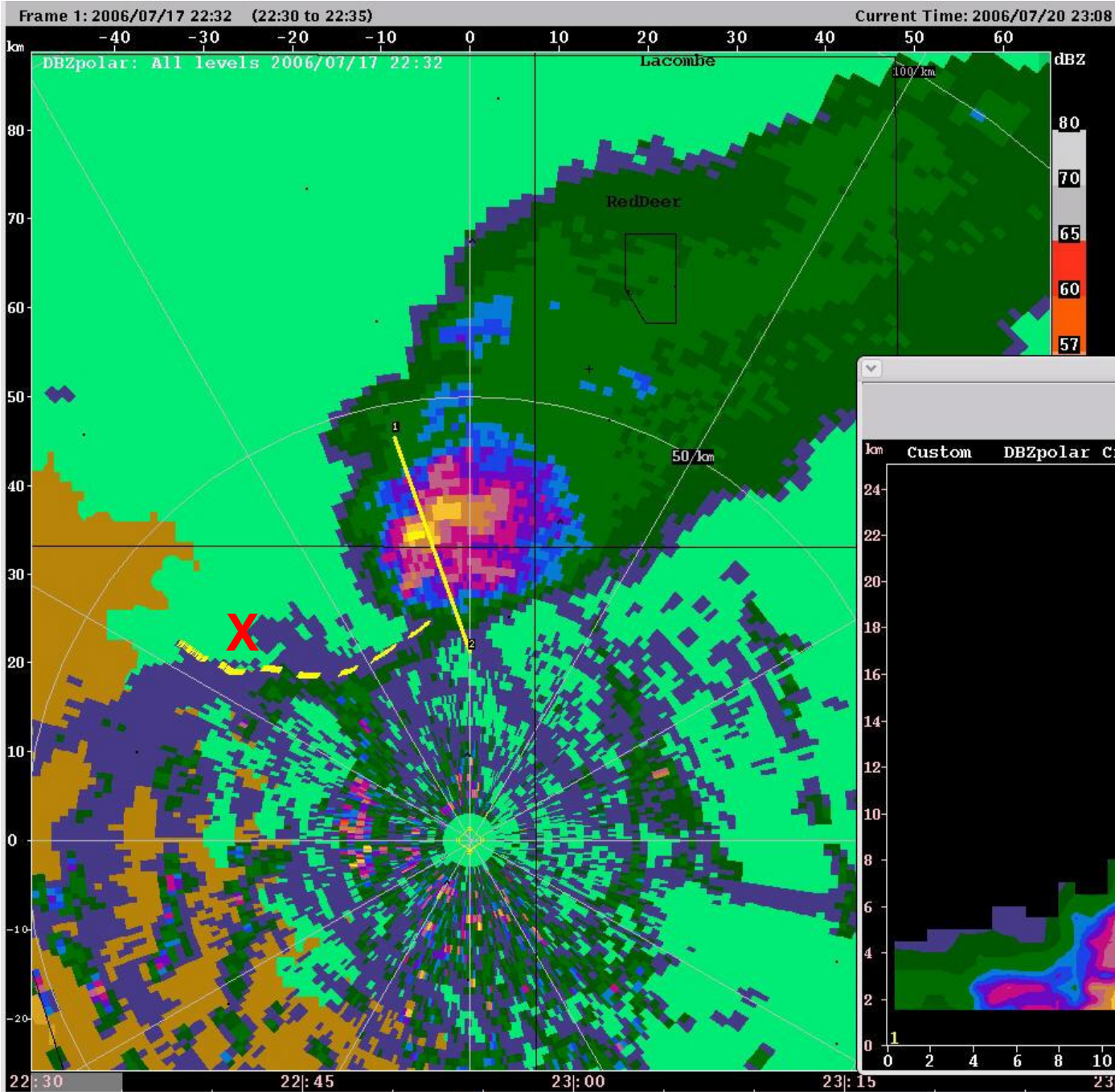


~20 km N Sunde, 2212Z, 17 July 2006

G. Strong

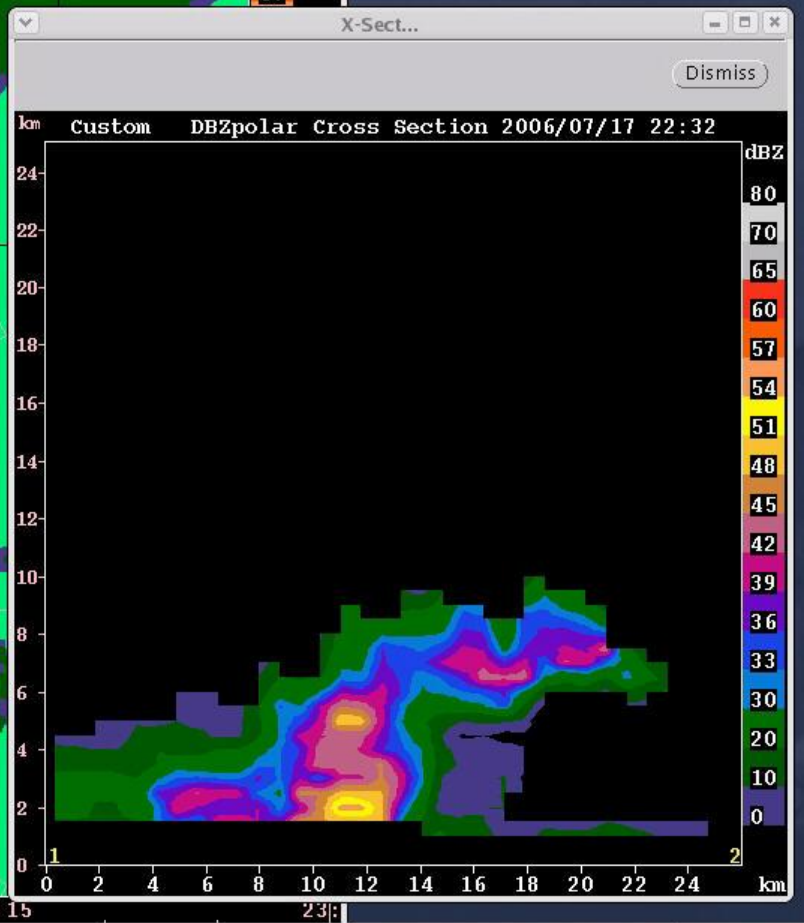
Surface Transect - 17 July 2006





WMI Radar
2232Z, 17 July 2006

T. Krauss, WMI



OBJECTIVE (within DRI):

- *To investigate links between temperature/humidity cycles and the role of thunderstorm feedback in prairie drought situations.*

Initially these links will be qualitative; therefore need some climatological basis/relation.

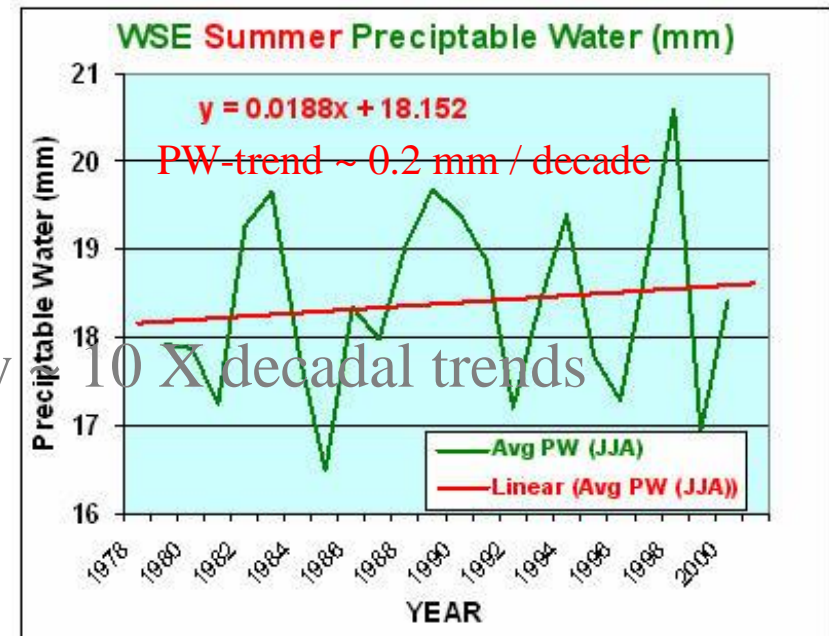
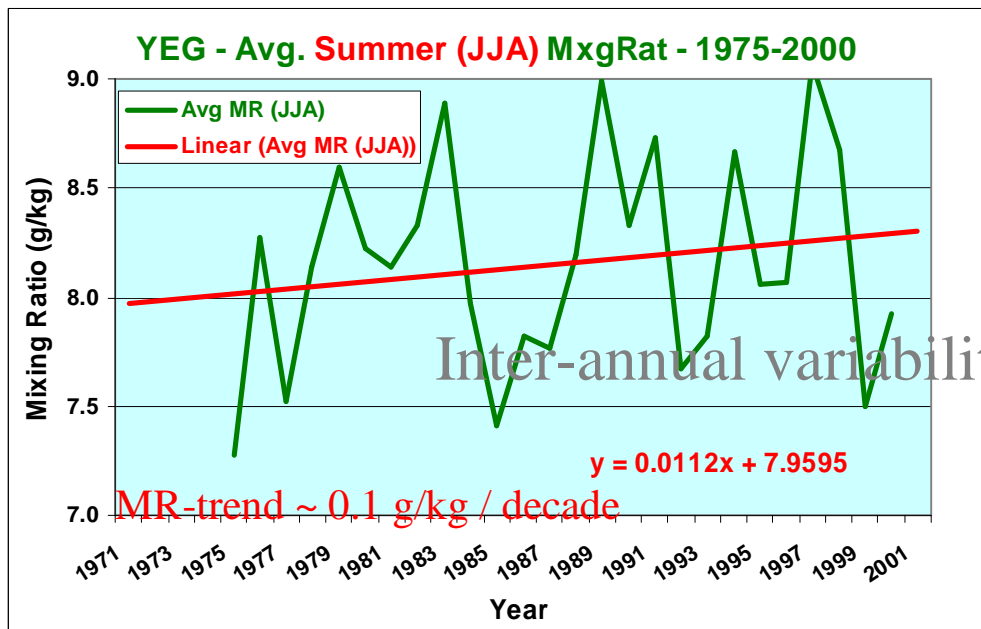
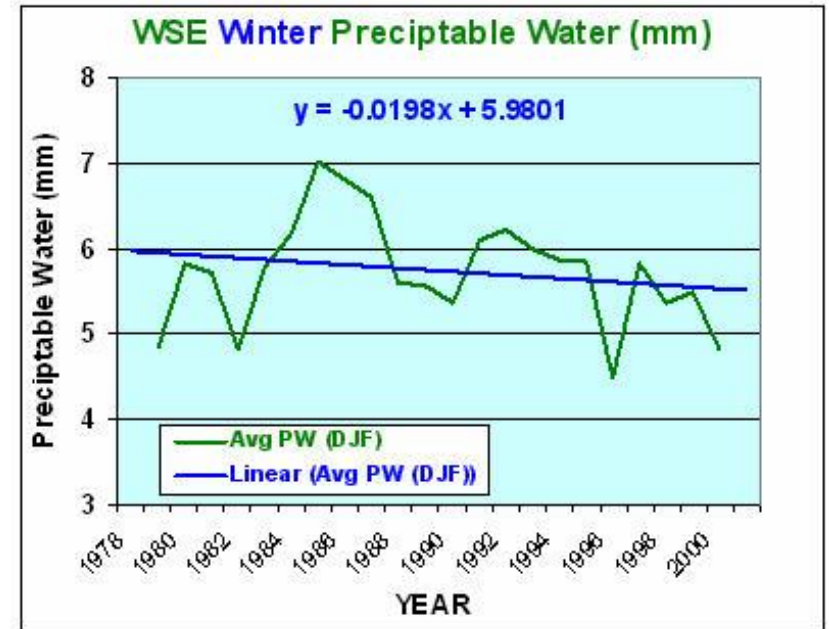
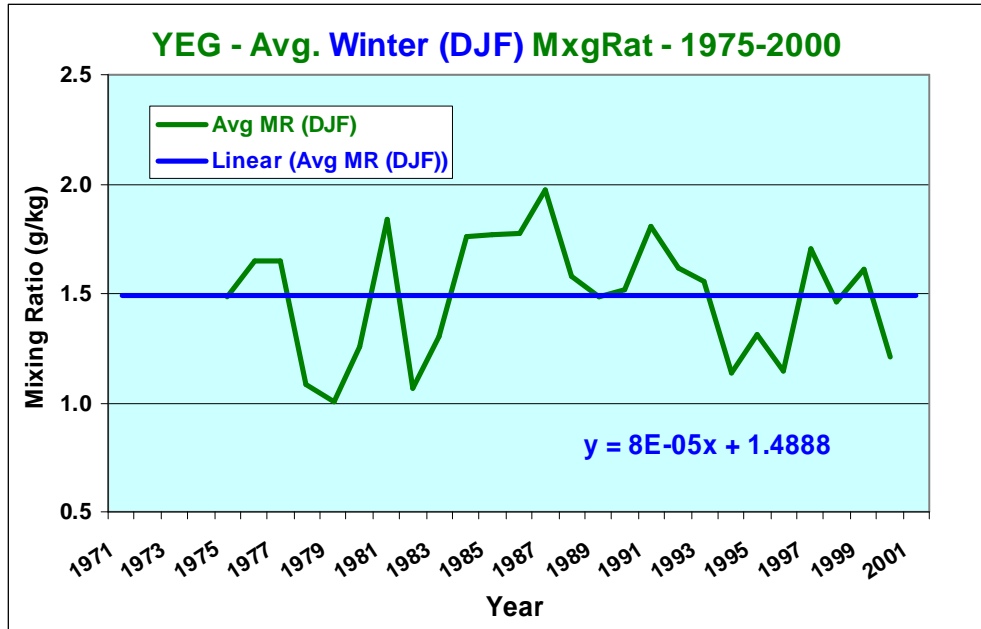
Methodology¹:

- 1971-2000 Daily surface P, T, RH (Mixing Ratio) processed to determine *short-term cycles* (of several weeks) and the *longer-term* (30-year) *trends* and *cycles*;
- compare short-term cycles with *convective outbreak periods*;
- look for links to drought initiation, periods, and cessation;
- examine (WSE) 1971-2000 daily sounding data for possible similar *tropospheric cycles*;
- investigate potential of *GPS moisture* retrieved during A-GAME periods (2003-06) for estimating *daily ET*;
- utility of continuous *GPS moisture* for *monitoring meteorological drought trends*?

Next Step: to apply these links to the 1997-2004 drought period.

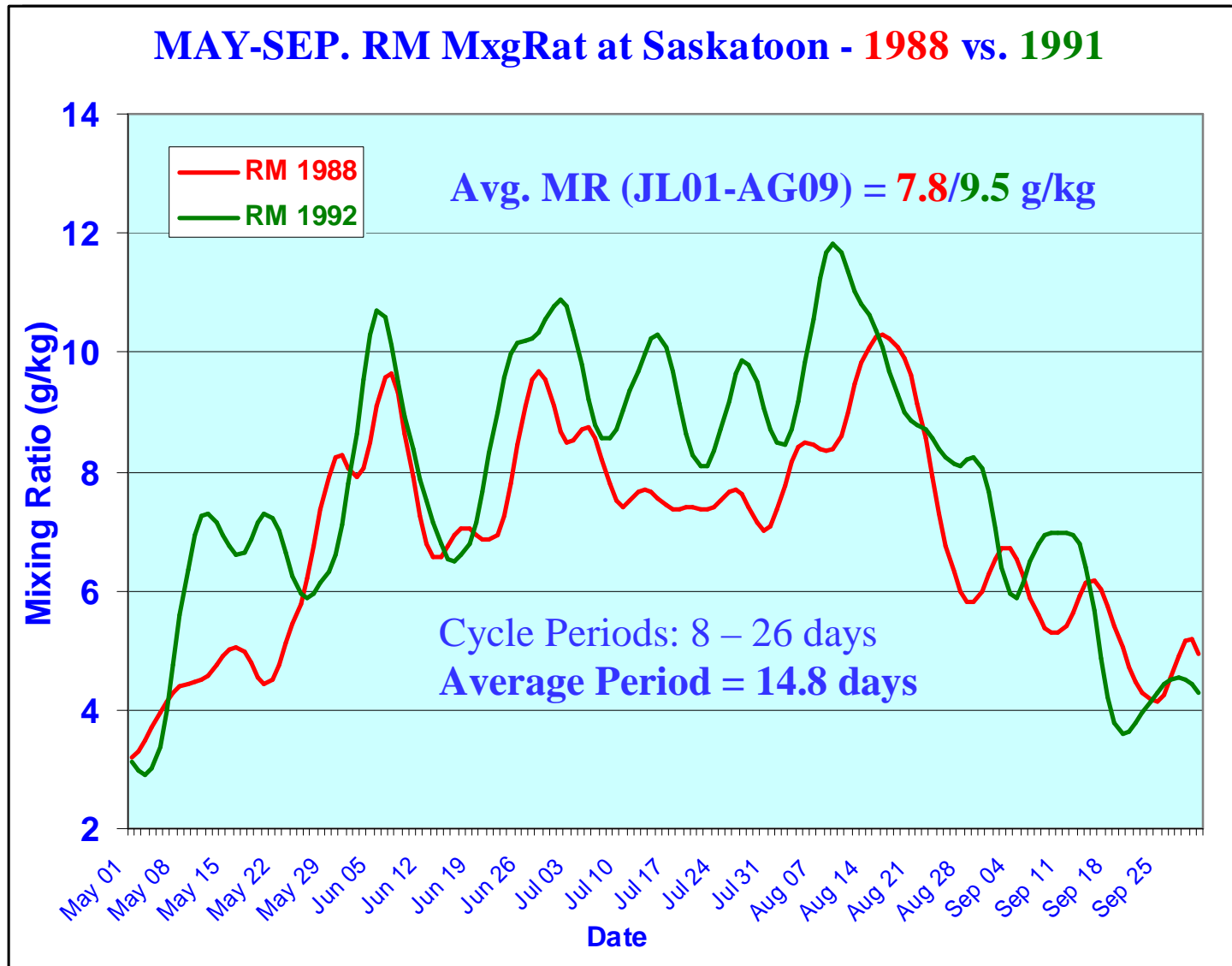
¹ Directly linked to *thunderstorm process* and *climate change* studies.

Edmonton MOISTURE (mixing ratio) Trends, 1971-2000

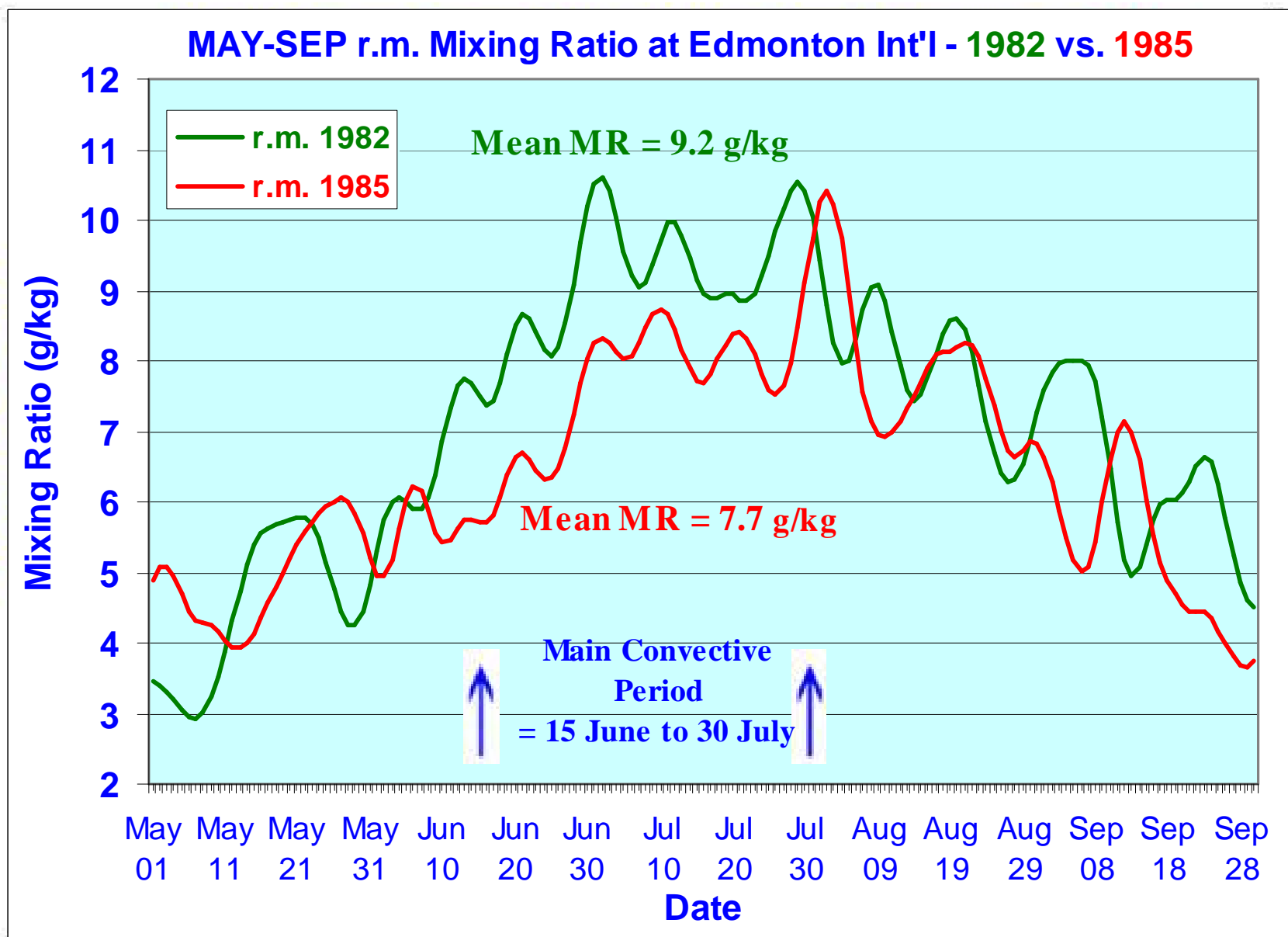


Inter-annual variability 10 X decadal trends

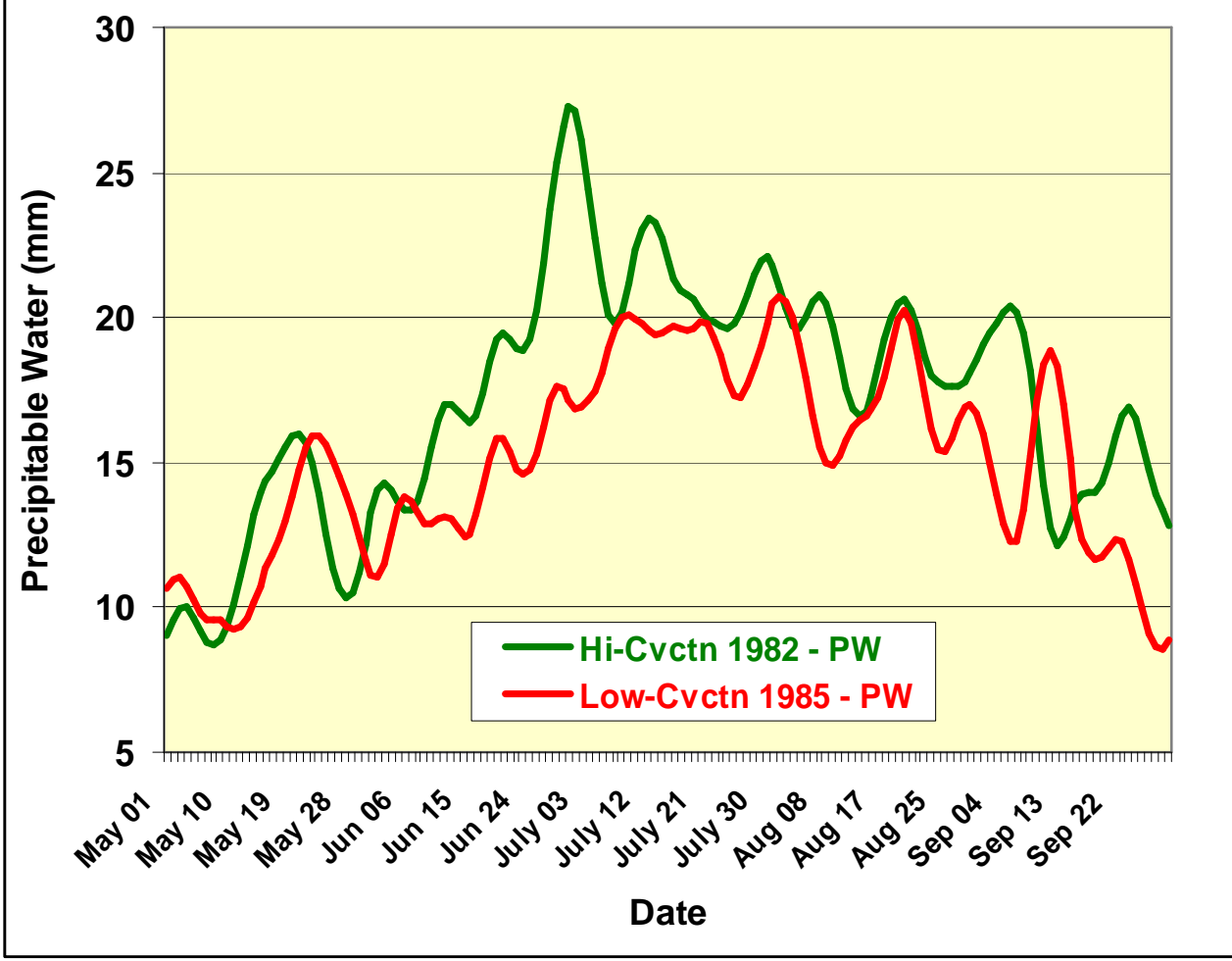
Short-term CYCLES of MOISTURE (MxgRat) at Saskatoon during hot-DRY (1988) and warm-WET (1991) Years



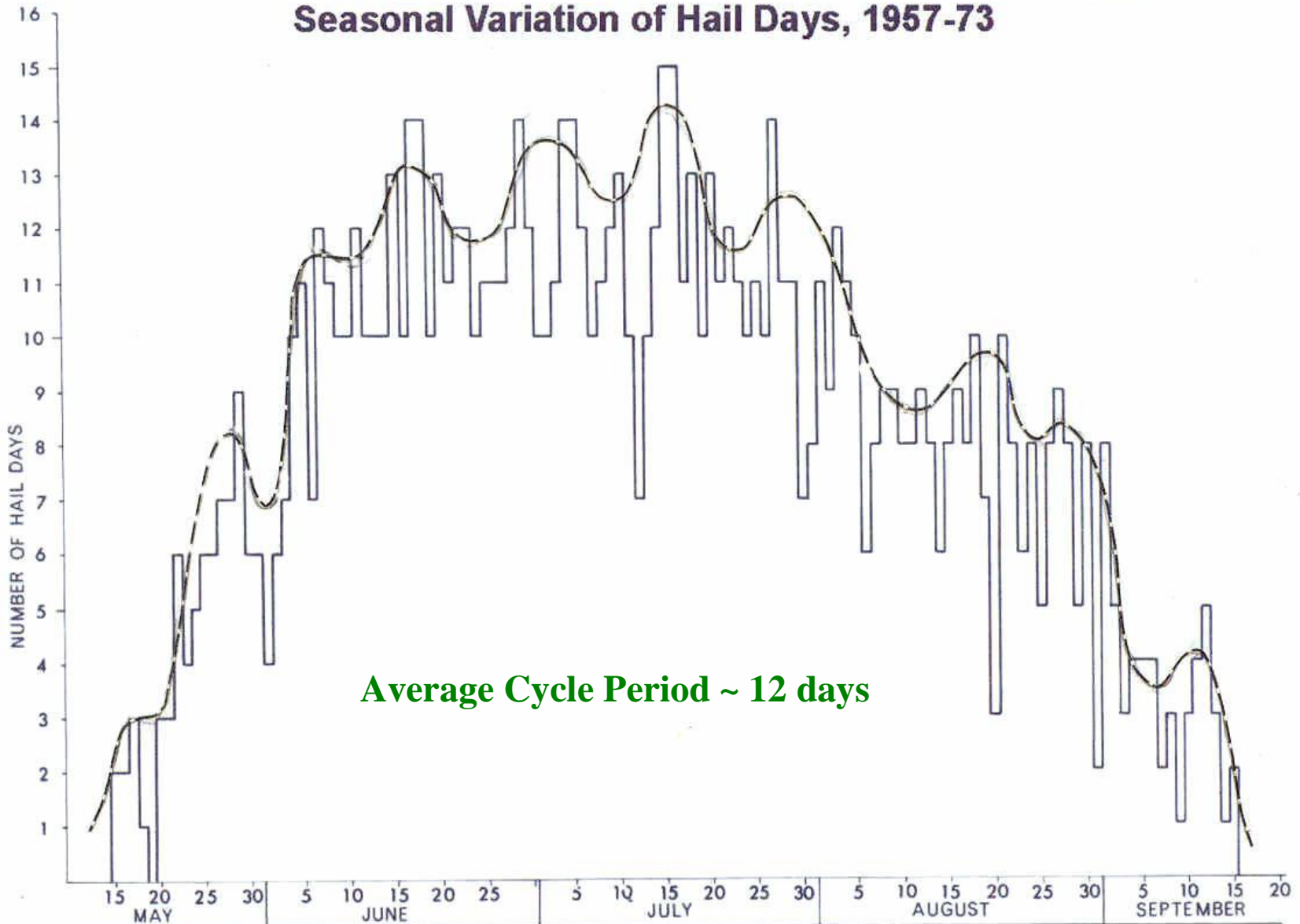
Short-term CYCLES of MOISTURE (MxgRat) at Edmonton (YEG) during high (1982) and low (1985) Convective Years



**WSE Precipitable Water (mm) for
High (1982) and Low (1985) Convective Years**



Seasonal Variation of Hail Days, 1957-73



Average Cycle Period ~ 12 days

(Preliminary) CONCLUSIONS:

Temperature:

- Summer temperatures increased by an average $0.25^{\circ}\text{C}/\text{decade}$ during 1971-2000, while winter temperatures increased by an average $1^{\circ}\text{C}/\text{dec}$.
- Short-term summer temperature cycles average 17.5-20 days.

Moisture:

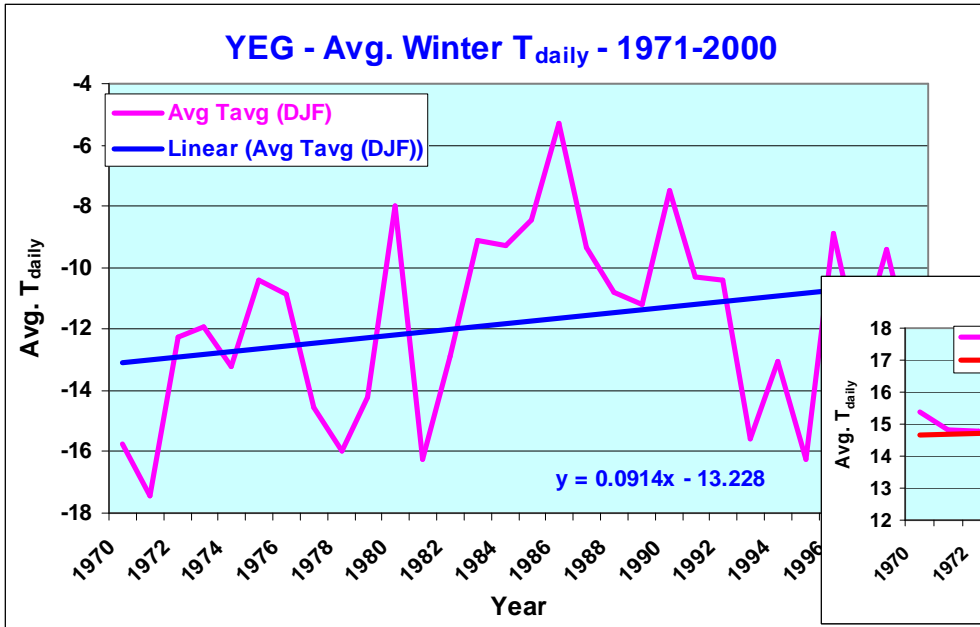
- Summer MRs increased by 0.1 g/kg/dec . during 1971-2000, while winter MRs remained essentially unchanged.
- Summer PW increased by 0.2 mm/dec . (1979-2000), while winter PW decreased by 0.2 mm/dec .
- Saskatoon: short-term summer cycles of surface moisture of ~ 15 days.
- These cycles disappear during drought once soil moisture reserves are depleted.
- Alberta: slightly higher frequency moisture cycles of ~ 12.5 days period.
- These frequency periods are coincidental with periods of thunderstorm activity (convective outbreaks).
- Mean summer mixing ratios decrease by $1.5 - 2 \text{ g/kg}$ during drought periods, enough to suppress convective precipitation and cut-off moisture redistribution across the prairies.

NEXT STEPS:

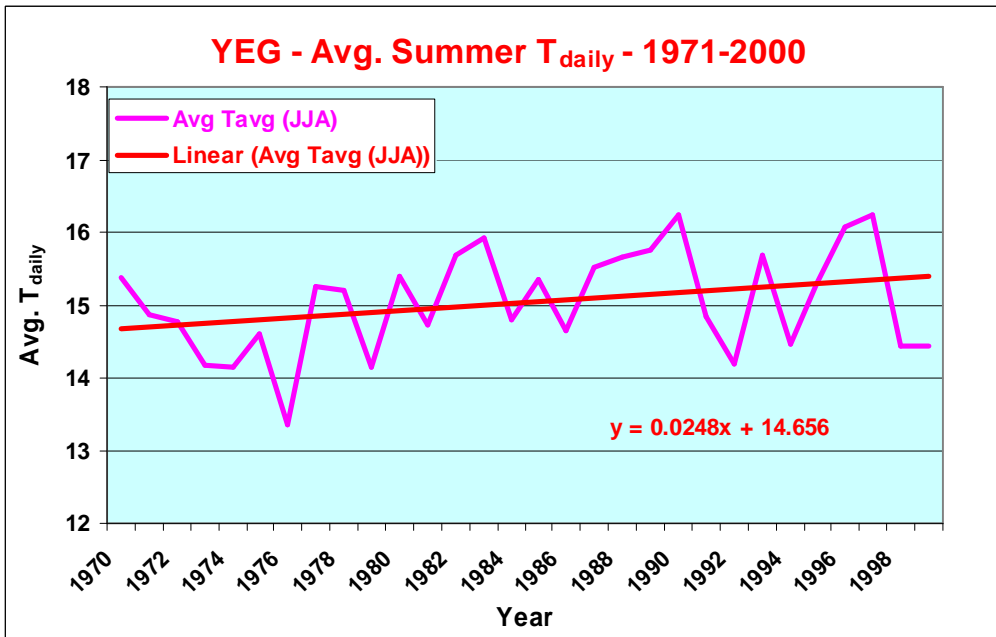
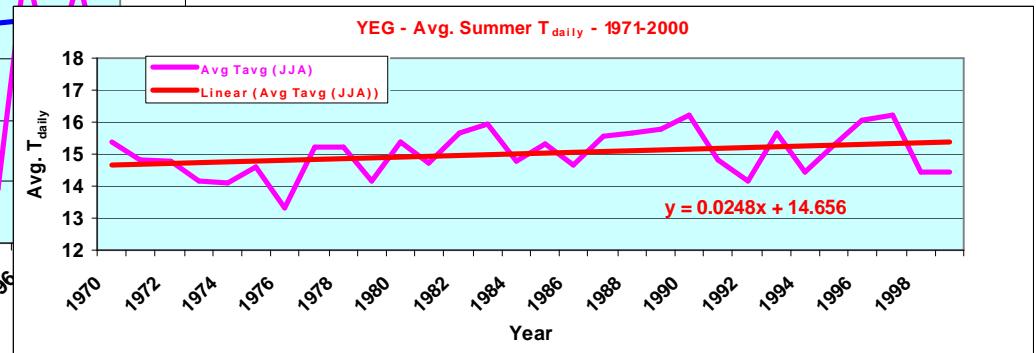
1. Complete sounding analysis of short-term periods and long-term trends for the 1971-2000 normals period – may also look at eastern prairies (YQD).
2. Complete more quantitative comparison of cycles with convective activity using (a) sounding convective indices and (b) radar analysis of convective cells.
3. Determine summer baseline MR and PW values (for drought periods); quantify impact on peak amplitude values in terms of storm activity and drought initiation/cessation.
4. Determine morning baseline MR/PW values and diurnal increases; relate to daily ET variability.
5. Use GPS moisture to establish diurnal variability due to ET (may require model output of PW)
6. Evaluate use of GPS in monitoring ET and drought conditions.

Questions?

Edmonton TEMPERATURE Trends, 1971-2000



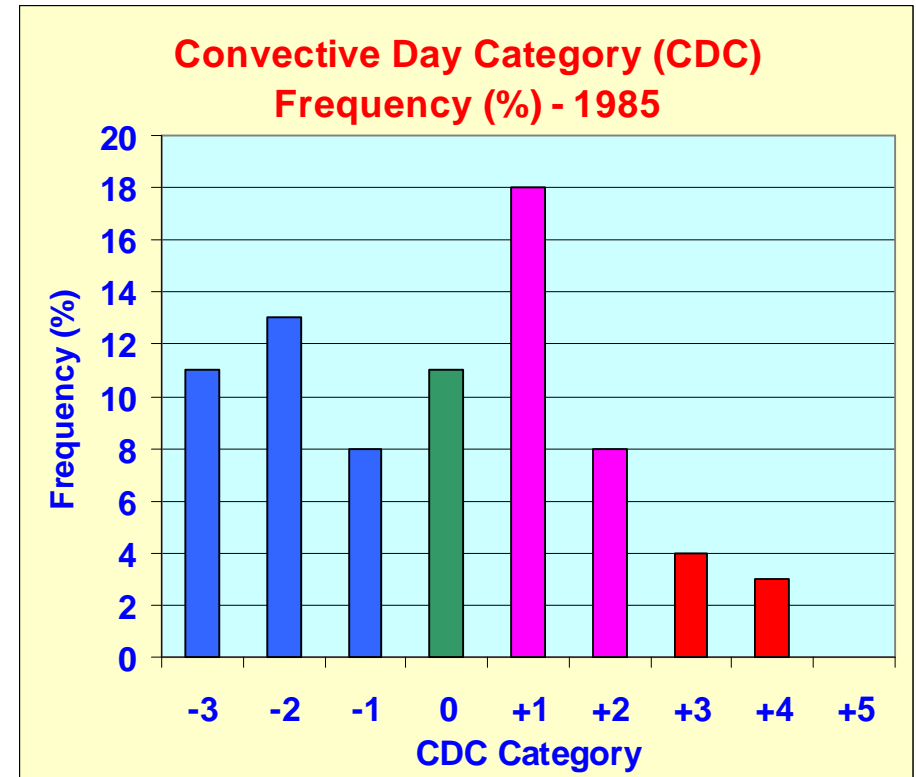
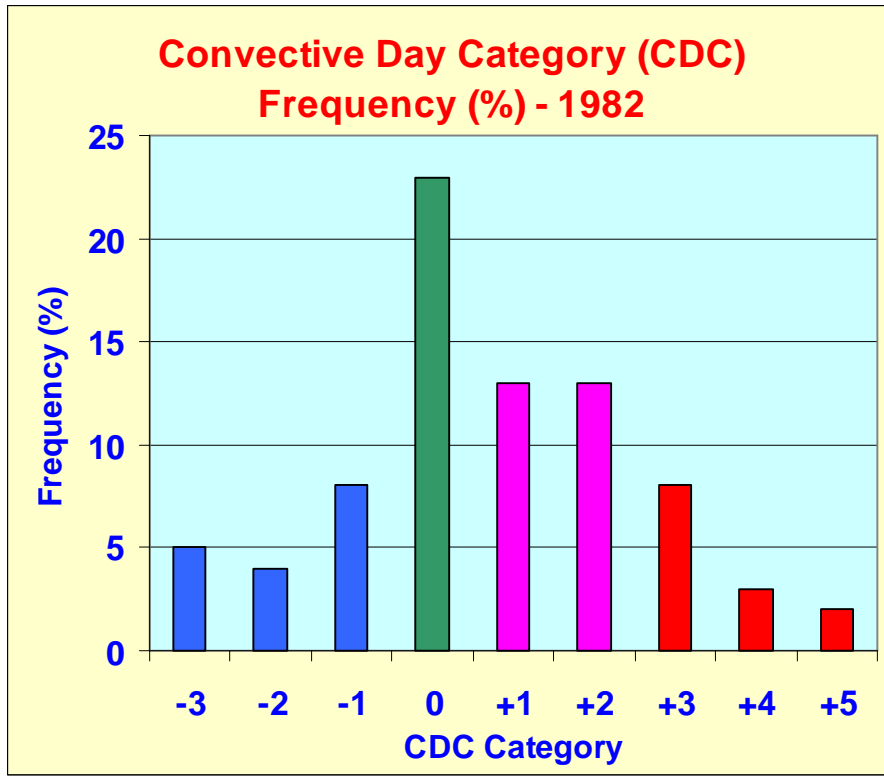
Winter T-trend ~ 1°C/decade



Summer T-trend ~ 0.25°C/decade

*We have to tread carefully with this,
as the inter-annual variability is
~ 10 times the decadal trend.*

Most vs. Least Convective summers of 1978-1985



1982 – 78.5% { PerCent of Days with CDC > -1 } **57.9% – 1985**