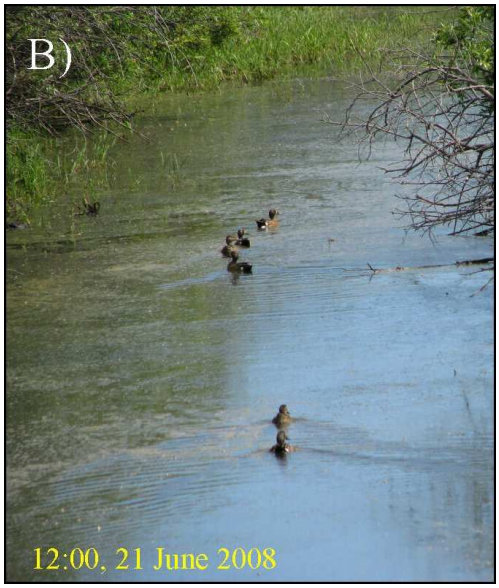
A Brief Survey of Drought Conditions between Edmonton and Saskatoon during mid-July 2009

G.S. Strong, Ardrossan, AB
Contact: *geoff.strong@shaw.ca*

Volunteer Report prepared for the Drought Research Initiative, July 2009



Cover Photos: *Prairie streamflow is primarily influent; that is, low water tables cause streams to give up water to the surrounding soils, as evident in photos A/C just weeks apart between 21 June and 31 July 2008 (~10 km northeast of the author's home base). The family of ducks (photo B) is a blow-up of the 21 June photo. During drought conditions, such as during June 2009, little or no water flows at all (photo D).*

INTRODUCTION

One outcome of the DRI teleconference discussion of the 2009 drought on 29 June was a suggestion to collect photographic and other evidence describing the severity of drought conditions. A photo survey between Edmonton and Saskatoon was suggested (Strong), and was planned for the following week. Unfortunately, this survey had to be delayed when much of Alberta and Saskatchewan received more than a week of persistent convective showers and thundershowers starting on 03 July; for example, the author's home base near Ardrossan, AB received almost 70 mm of rain during 03-09 July, a sudden welcome change from three months of severe drought conditions. The survey was finally initiated on 16 July 2009. The survey route covered, including side trip to Kenaston on 17 July, is shown in Figure 1.

While mid-July rains terminated the 2009 drought, it was a case of 'too little too late' for much of the farming community in parts of eastern Alberta and western Saskatchewan. For the most part of the transect covered in Figure 1 (basically along the Yellowhead Highway 16), however, crops appeared to have improved in that one week period, albeit some 2-3 weeks behind the typical growth cycle. These crops would now be even more dependent on adequate heat and moisture during August, when grain crops would normally be 'headed out' and ripening. The region on this route hardest hit seemed to be around Vermillion AB, where crops were generally poor, and according to local sources, some fields had already been plowed under as the crop was not even useful as cattle feed.

Figure 1: Drought photo survey route, 16-17 July 2009 (blue dots indicate GPS track).

Atmospheric Moisture along the Edmonton-Saskatoon Transect

Figure 2 provides a quick reference transect of atmospheric temperature and *mixing ratio*[1] along the route from Ardrossan AB (departed 10:40) to Saskatoon (arrived 17:00) on 16 July; note that the time scale is in 'decimal hours' for ease of plotting. There is little direct evidence of the 2009 drought in this mobile transect, since soil moisture had recovered somewhat following the seven or eight consecutive days of showers and thundershowers during the previous week. However, this transect graph does demonstrate once more the importance of daily evapotranspiration from grain crops even while passing along the near-vicinity at highway speeds; for example: (1) the transect commences with relatively low mixing ratios (8-8.5 g kg^{-1}) east of Ardrossan (acreage country with only sporadic farming plots), but jumps rapidly to 9-9.5 g kg^{-1} just east of Elk Island Park where there is a substantial agricultural area. This increase also occurred after 11:00 when one might expect a downward trend due to late-morning convective mixing into the free atmosphere. (2) The mixing ratio drops an equivalent amount in passing by areas of pasture and shrub, such as near noon. (3) Other declines in mixing ratio on Figure 2 are noted on passage through major centres such as Lloydminster, the Battlefords, and Saskatoon. The term '*urban dry island*' has been adopted to indicate moisture deficits over urban centres.

NOTE: Extensive shorter mobile transects are being carried out across Edmonton this summer to document the urban dry island, and together with data collected for small towns during the 2008 UNSTABLE field project, will be the subject of a paper later this year.

Photographic Summary

Appendix I provides clips of photos taken during the survey of 16 July (#446-498), followed by a Google-Earth map locating each photo set. A few comments on these photos are in order:

1) Figure 3 - Canola crop east of Ardrossan - on close inspection, one notes very few 'seed pods', while many flowers have not even budded, so that this crop was at least two weeks behind in its growth cycle on 16 July.
2) Figure 4 – Barley crop just west of Vegreville, with no heads yet formed, and also some 2-3 weeks behind in its growth cycle.

With adequate heat and moisture during the remainder of the growing season, these crops may well recover sufficiently as a cash crop.

3) Figure 5 – Grain crops in Vermillion County appeared to be more seriously affected by the late-spring and early-summer drought, as suggested in photo #470. Discussion with a farmer suggested that this crop is very unlikely to recover regardless of any improvements in weather patterns.
4) Figure 6 – A field of peas on the south side of Vermillion (photo #473) appears to be less severely affected by local drought conditions (uncertain whether the crop had been irrigated).

[1] The absolute humidity, mixing ratio is used to describe atmospheric moisture because it represents the actual mass of moisture in the atmosphere, and is therefore independent of elevation changes, unlike dew point temperature; it is also not dependent on the diurnal trends in temperature inherent in relative humidity.

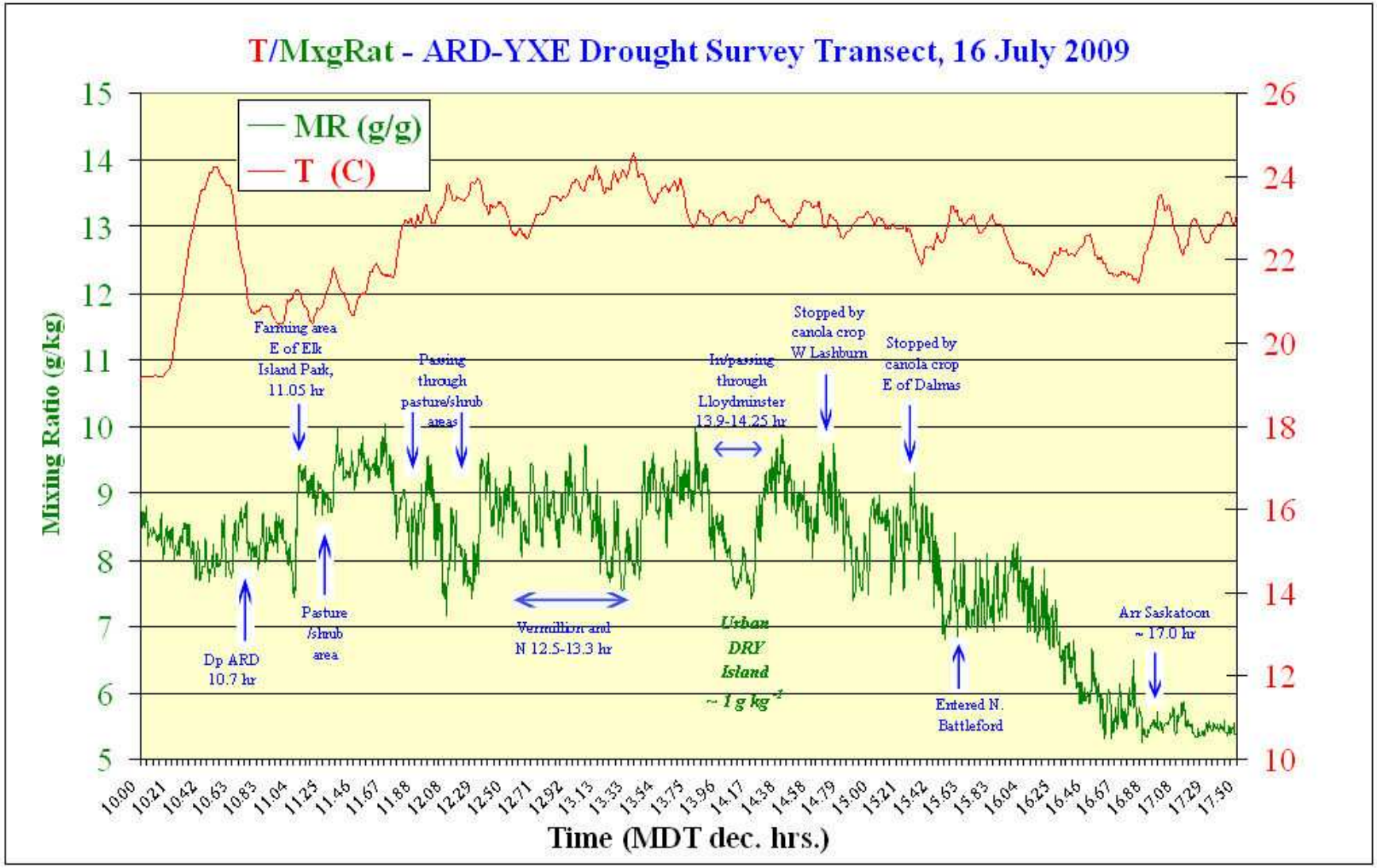


Figure 2: Mobile transect of temperature and mixing ratio from Ardrossan AB to Saskatoon SK, 10:00-18:00 (MDT), 16 July 2009.

Figure 3: Cropped portion of photo #454, two weeks behind in its growth cycle.

Figure 4: Photo #460 showing barley with no heads formed, also behind in its growth cycle.

Figure 5. Poorly developed canola 6 km north of Vermillion.

Figure 6. Less-severe drought effects on field of peas on south side of Vermillion.

5) Figure 7 – Canola 6 km east of Vermillion (photos 475-476) appearred to be on the way to recovery, with many buds set to flower in the next few days.

Figure 7. Canola 6 km east of Vermillion, with many new buds on the verge of flowering.

6) Figure 8 - This canola (8a) on the Saskatchewan side (14 km southeast of Lloydminster) appears patchy and behind in growth, but closer inspection again (8b) shows many buds on the threshold of flowering with the recent rains.


Figure 8. (a) Canola 14 km southeast of Lloydminster 16 July 2009 looking patchy and poor, but with (b) many new buds on the verge of flowering.

7) Figure 9 – A poor-looking crop on the adjacent side of the road to Figure 8), with no visible seed head, and probably poor prospects of recovery.

Figure 9. Crop with virtually no seed head 14 km southeast of Lloydminster, 16 July 2009..

The heavy rains that occurred just several days before this transect was carried out was particularly evident in the Battlefords area of Saskatchewan. Drainage ditches still contained excess water several days later on 16 July near Delmas, some 25 km northwest of North Battleford (Figure 10). The Saskatoon *StarPhoenix* reported on July 14, 2009 that a section of Highway 16 near Denholm, SK (~20 km southeast of N. Battleford) had been closed the evening before due to heavy rains that caused flash flooding (Figure 11). The water level had risen to the point where logs were floating onto the highway and the current was too strong for vehicles to pass through. This was a far cry from the drought conditions at the beginning of July.

Figure 10. Flooded drainage ditches near Delmas, SK next to drought-stunted canola crop, 16 July 2009.

Figure 11. Flooding on Highway 16 east of Denholm, SK on 13 July 2009 (from Star Phoenix, 14 July, photo by Sarah Valentine).

Effects of the preceding drought and current crops showed more positively closer to Saskatoon. Figure 12, looking southwest from Highway 16 about 30 km northwest of Saskatoon, shows a healthy and well-advanced canola crop.

Figure 12. Healthy canola crop 30 km northwest of Saskatoon, SK, 16 July 2009.

Moisture Flux Study near Kenaston, SK

A second motive for this trip was to view instrumentation set up at Kenaston, SK for a study of moisture flux differences between prairie grass and grain crops. The instrumentation is owned and managed by Environment Canada at the National Hydrology Research Centre in Saskatoon. Strong (1986, 1997, 2000, 2005) has long-maintained that daily evapotranspiration from grain crops provides a significant input to the water budget of prairie thunderstorms, and that once formed, particularly in Alberta, thunderstorms will tend to propagate towards grain crop moisture sources over the plains, though often along the periphery of any adjacent drought region.

An earlier field experiment carried out in 1992 at St. Denis, SK yielded differences in mixing ratio (measured at a standard 2-m height) of at least 1 g kg^{-1} between grass and wheat on just a 200-m baseline (Figure 13); furthermore, daily evapotranspiration averaged over 18 days exceeded 3.5 g $kg^{-1}day^{-1}$. A climatological study carried out for Alberta Environment (Strong, 2005) suggested that convective storm outbreaks closely followed peaks in cycles of atmospheric moisture, and that this was prevalent throughout the prairies. These results and the mutual reliance between convective storms and healthy grain crops on the Canadian prairies was the prime motivation for the author to be involved in the Drought Research Initiative (DRI).

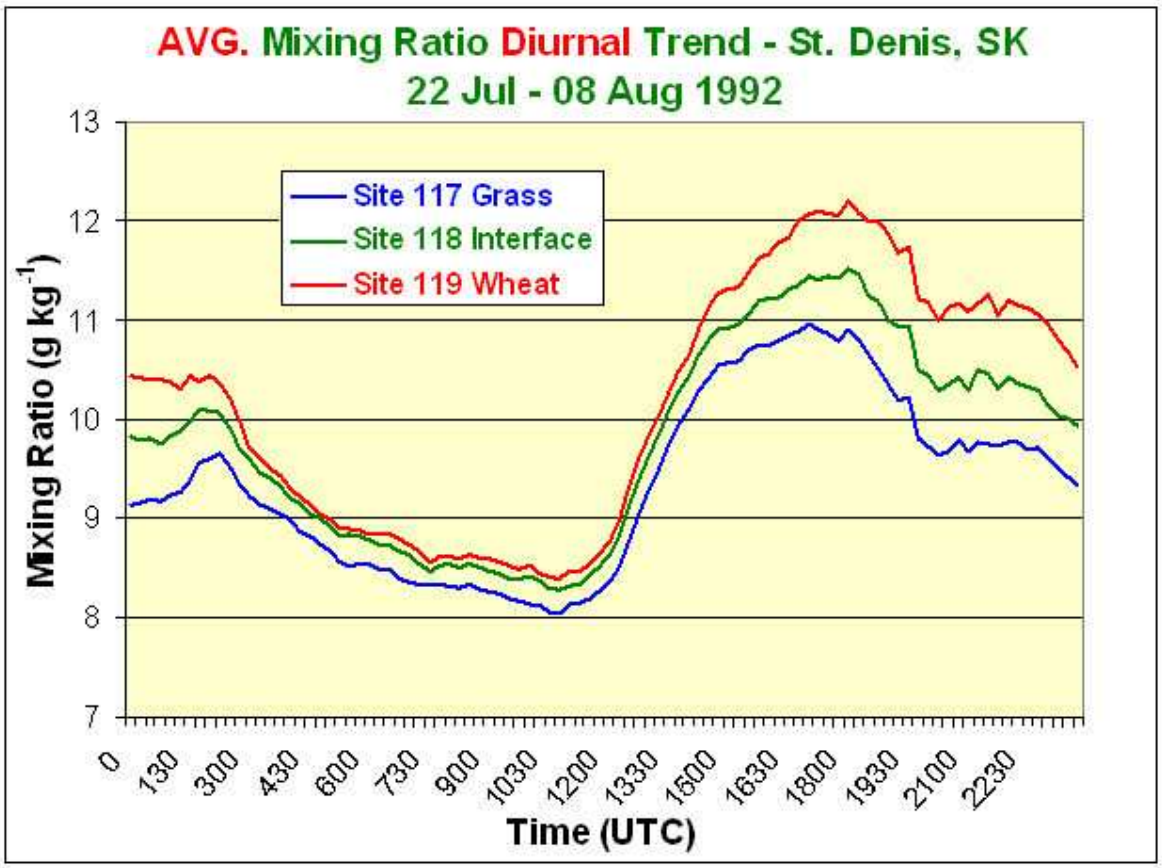


Figure 13. Diurnal trends daily evapotranspiration and differences between prairie grass and wheat crop on 180-m baseline at St. Denis in July/August 1992 (from Strong, 2007).

These concepts were reinforced during the 2008 UNSTABLE thunderstorm field experiment when similar moisture fluxes were noted during mobile transects, and significant differences in measured mixing ratios were noted between rural agricultural districts and small urban centres, causing *urban dry islands* over even small towns in agricultural districts (as noted for Figure 2 above). These moisture fluxes and the earlier St. Denis field experiment inspired the present field experiment being carried out at Kenaston. In this 2009 study, called KEEFEX (Kenaston Energy and Evapotranspiration Experiment), vertical profiles of temperature and moisture are included along with eddy correlation measurements over both grass and wheat. The barley site being serviced in Figure 14 has temperature and moisture measurements at 0.5-, 1.0-, and 3-m elevations, while the grass site has temperature and moisture sensors at 0.5, 1.5, 3.0, and 6.0 meters.

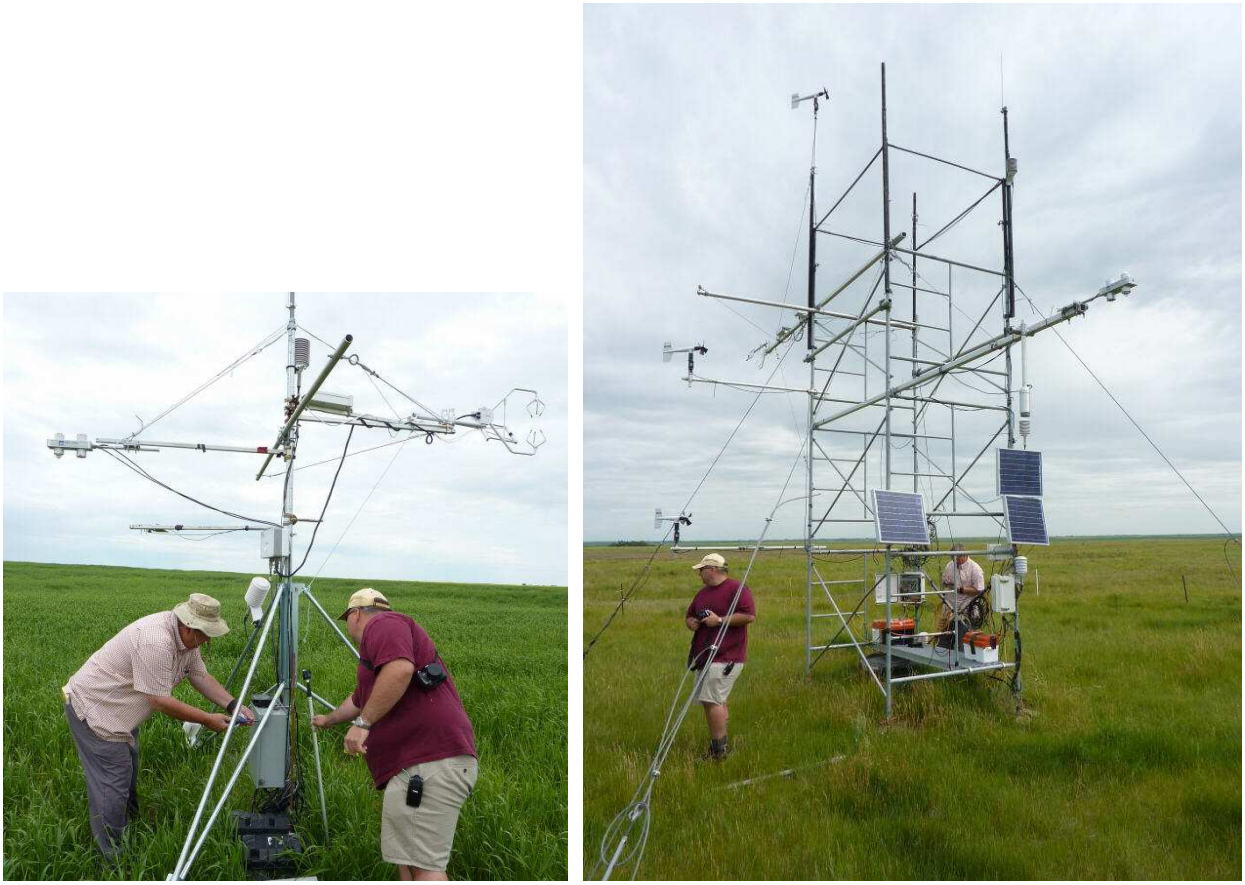


Figure 14. Servicing KEEFEX profile towers at Kenaston barley and grass sites, 17 July 2009

Final Comments

The drought photo survey carried out on 16-17 July 2009 was a practical exercise to obtain some first-hand albeit 'unofficial' (in terms of agricultural expertise) information on the severity of drought in eastern Alberta and western Saskatchewan. At the time of deciding to do this survey (DRI teleconference of 29 June), the drought had been in full swing since August of 2008. Heavy thunderstorms finally roared through the region on 03 July, ending the drought while

delaying the drought survey by two weeks, but also heralding an outbreak of convective weather that has persisted almost every day to the time of this writing (03 August).

It appears (to this unqualified observer) that crops can survive a prolonged drought as long as sufficient germination and crop emergence takes place early in the crop season. In this case, it is estimated that crop development and growth was delayed by 2-3 weeks. In much of the drought-stricken areas, another 1-2 weeks of drought might have resulted in most crops being plowed under. Instead, many of these crops have now recovered, and if sufficient heart and moisture continue through mid-August or so, near bumper crops could still result (pers. comm. with agriculture experts and the farming community).

All of this prompted the recall of a poem on the fickleness of weather:

MEAN WEATHER

Intermittent rain, I've learned,
Which forecasts tell about,
Is rain that stops when I go in
And starts when I come out.

(by Elizabeth Dolan, in "*The Breeze*", Vol. 2, No. 8, September 10, 1945. P. 6)

REFERENCES

Hrynkiw, Charmaine L., 1992. *St. Denis Humidity Sensor Field and Laboratory Tests, July – August, 1992.* Rep. for Regional Evaporation Study, Oct., 1992, 71 pp.

Strong, G.S., 1986. *Synoptic to Mesoscale Dynamics of Severe Thunderstorm Environments: A Diagnostic Study with Forecasting Applications.* Ph.D. thesis, University of Alberta, Edmonton, 346 pp.

Strong, G.S., 1997. Atmospheric Moisture Budget Estimates of Regional Evapotranspiration from RES-91. *Atmos.-Ocean*, 35: 29–63.

Strong, G.S., 2000. A multi-scale conceptual model of severe thunderstorms. *CMOS Bull.*, 28, No. 2, April, 2000: 45–54.

Strong, G.S., and C.D. Smith 2001. *Assessment and Prediction of Prairie Severe Thunderstorm Phenomena*. Sin. Rep. to Emergency Preparedness Canada, Mar. 2001, 158 pp.

Strong, G.S., 2005. *Impacts of Climate Warming on Persistent Temperature Cycles (including January thaw)*. Fin. Rep. to Alberta Environment, Mar. 2005, 147 pp.

Strong, G.S., and C.L. Hrynkiw, 2007. Atmospheric Moisture and Thunderstorm Drought. Pres. to CMOS Congress, Kelowna, June 2007.

==========

Geoff Strong
Ardrossan, AB,
03 August 2009

APPENDIX I

Drought Photo Survey, 16 July 2009

P1000446.jpg

P1000447.jpg

P1000448.jpg

P1000449.jpg

P1000450.jpg

P1000451.jpg

Drought Photo Survey, 16 July 2009

P1000452.jpg

P1000453.jpg

P1000454.jpg

P1000455.jpg

P1000456.jpg

P1000457.jpg

Drought Photo Survey, 16 July 2009

P1000458.jpg

P1000459.jpg

P1000460.jpg

P1000461.jpg

P1000462.jpg

P1000463.jpg

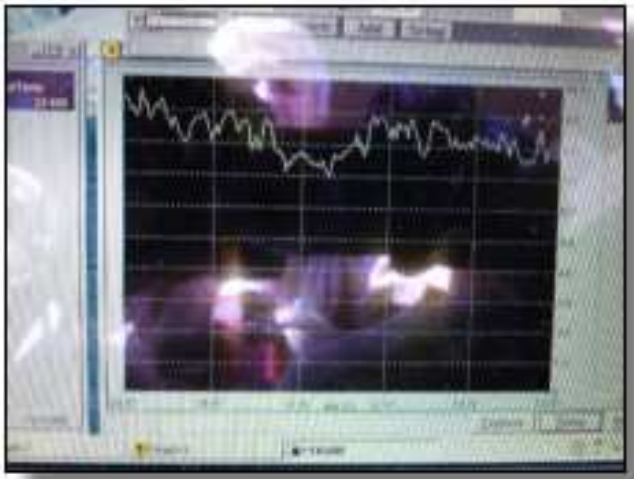
Drought Photo Survey, 16 July 2009

P1000464.jpg

P1000465.jpg

P1000466.jpg

P1000467.jpg



P1000468.jpg

P1000469.jpg

Drought Photo Survey, 16 July 2009

P1000470.jpg

P1000470a.jpg

P1000471.jpg

P1000472.jpg

P1000473.jpg

P1000474.jpg

Drought Photo Survey, 16 July 2009

P1000475.jpg

P1000476.jpg

P1000477.jpg

P1000478.jpg

P1000479.jpg

P1000480.jpg

Drought Photo Survey, 16 July 2009

P1000481.jpg

P1000482.jpg

P1000483.jpg

P1000484.jpg

P1000485.jpg

P1000486.jpg

Drought Photo Survey, 16 July 2009

P1000487.jpg

P1000488.jpg

P1000489.jpg

P1000490.jpg

P1000491.jpg

P1000492.jpg

Drought Photo Survey, 16 July 2009

P1000493.jpg

P1000494.jpg

P1000495.jpg

P1000496.jpg

P1000497.jpg

P1000498.jpg

Google-Earth map showing locations for the photos of Appendix I.