

Land Surface (*Moisture Flux*) Feedbacks on Drought and on Thunderstorms

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Tornadic storm WSW from H16 N Ardrossan at 18:11 MDT, 21 Aug. 2009 (Photo:GStrong)

Remains of storm W from Wye Rd S Ardrossan @ 19:13 MDT, 21 Aug. 2009 (Photo: GStrong)



Canadian Foundation for Climate
and Atmospheric Sciences (CFCAS)
Fondation canadienne pour les sciences
du climat et de l'atmosphère (FCSCA)



12:00, 21 June, 2008

Seasonal stream 8 km ENE Ardrossan



15:25, 31 July 2008

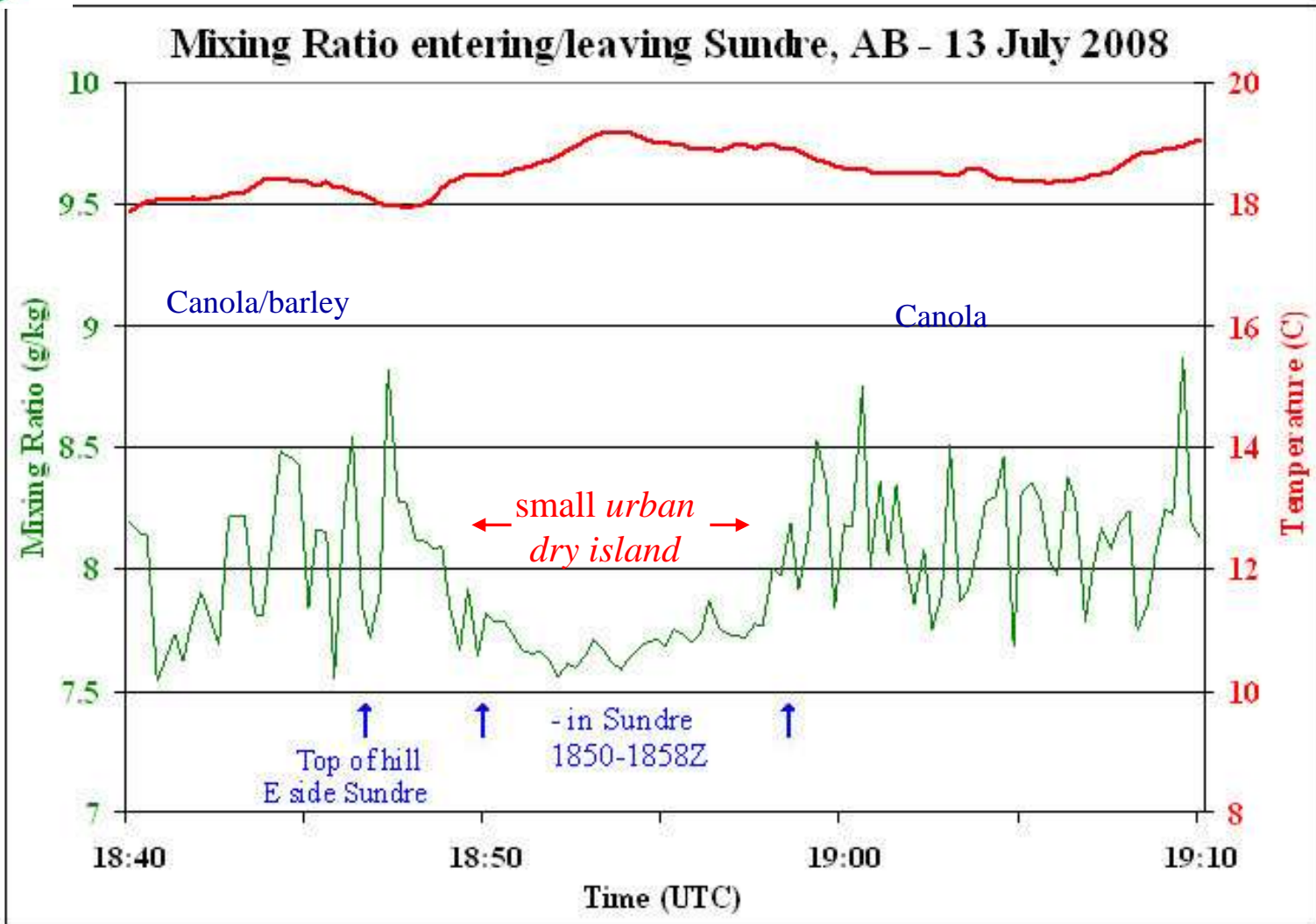
Humidity Variable:

Definition: Mixing Ratio is the ratio of the mass of water vapour (g) to the mass of dry air (kg) at a given pressure – an expression of the *absolute humidity*.

Advantage of using *mixing ratio* over other moisture variables:
=> *conservative w.r.t. elevation changes.*



Transect E-W through Sundre (pop. 2,500) 13 July 2008



2009 Edmonton Mobile Transects

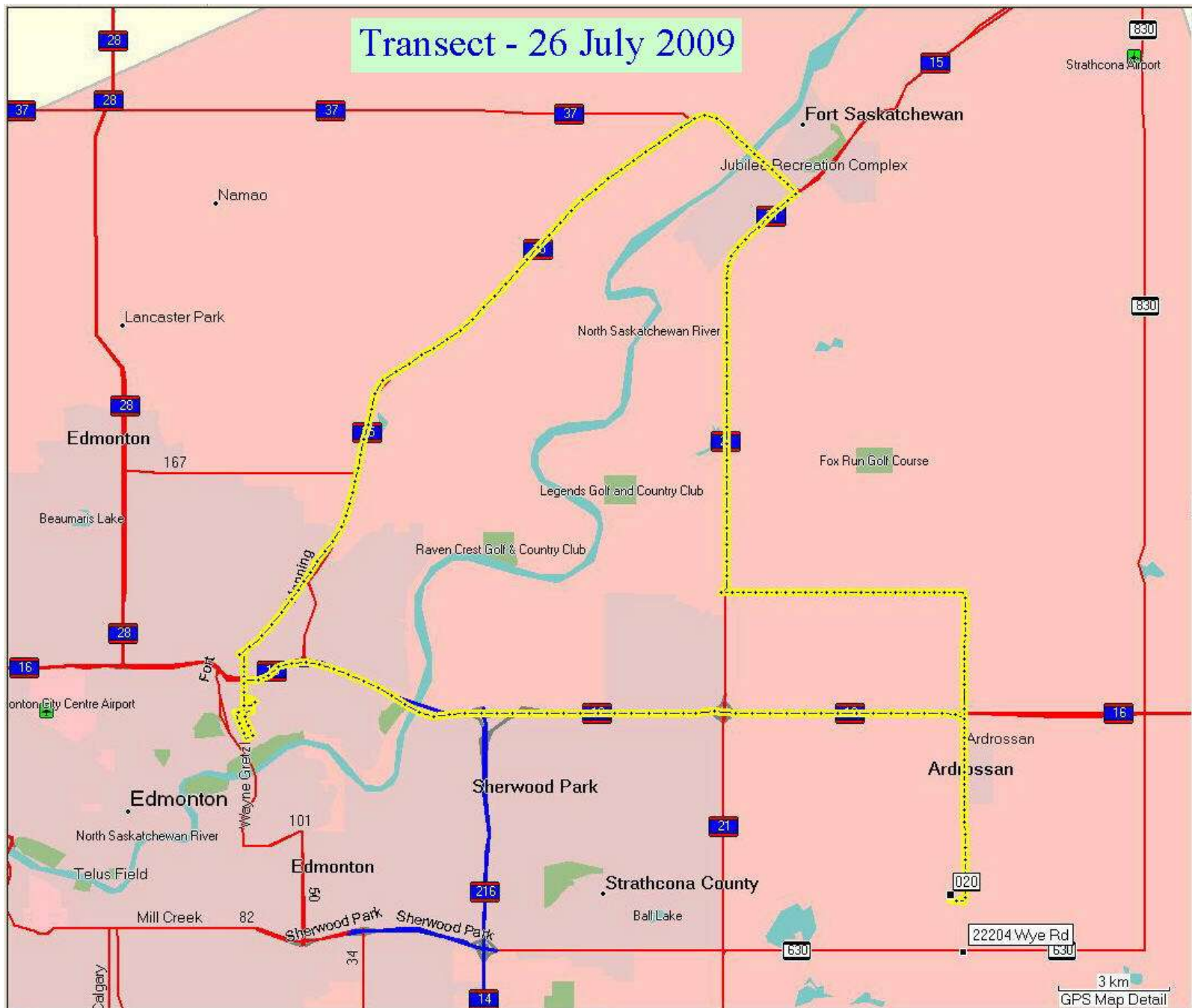
Objectives:

1. Quantify urban dry (heat) island across Edmonton (pop. 780,000) using mobile transects
 - carried out 22 transect days (more than double that no. of transects)
2. Quantify a) horiz. moisture gradient from crop - road during transects and possibly collect some b) vertical moisture profiles over a crop.
 - quantified horizontal gradient at least a dozen times
 - obtained 4 sample vertical moisture profiles (to 3 m) over canola crops

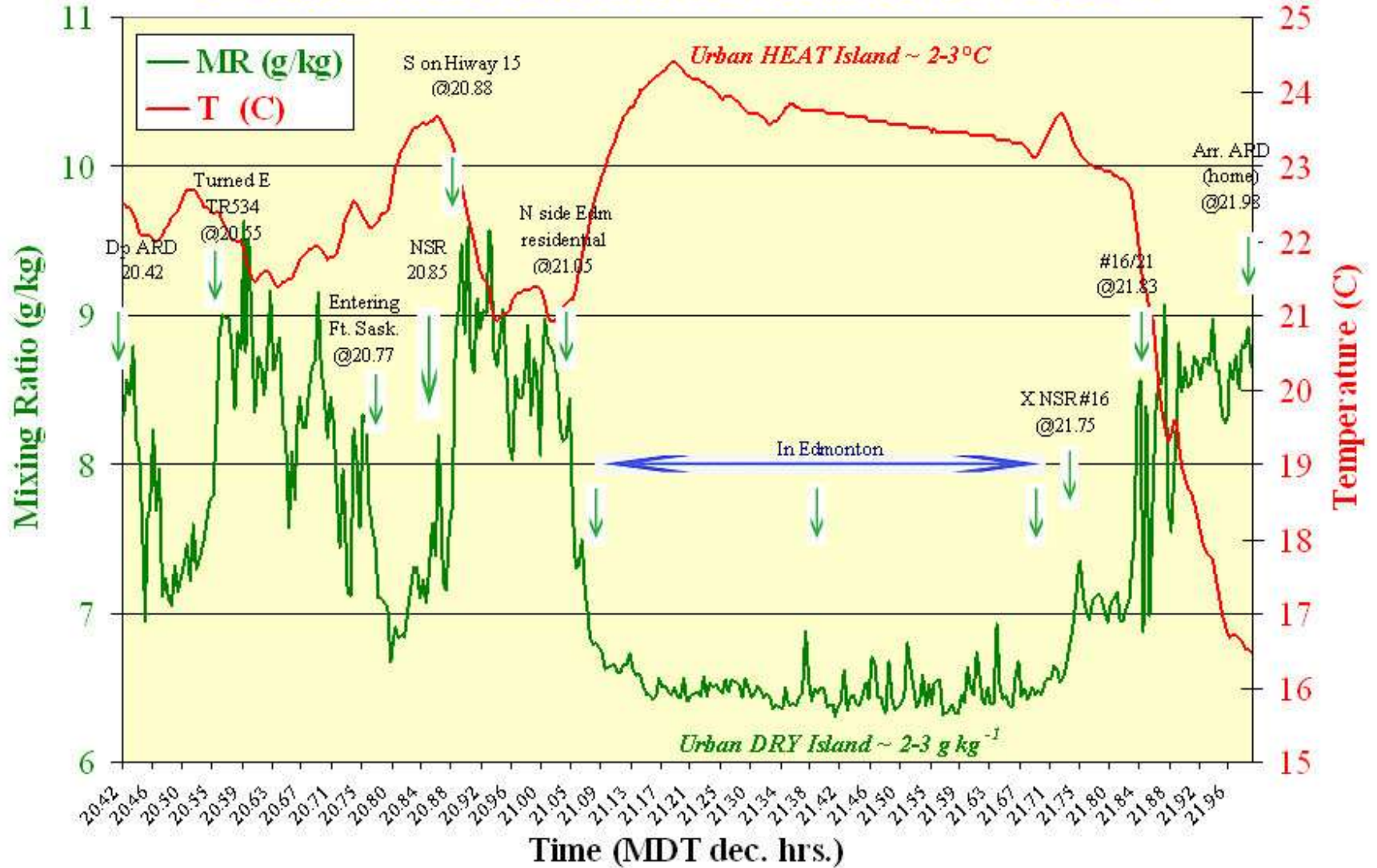
In parallel:

3. Fixed horizontal Transects and vertical Profiles (to 6 m) across pasture/barley at Kenaston SK
4. Monitor local drought conditions (photos) in Strathcona County
5. Carried out photo/data drought survey, Edmonton to Saskatoon
 - http://www.drinetwork.ca/current_drought.php

Transect - 26 July 2009



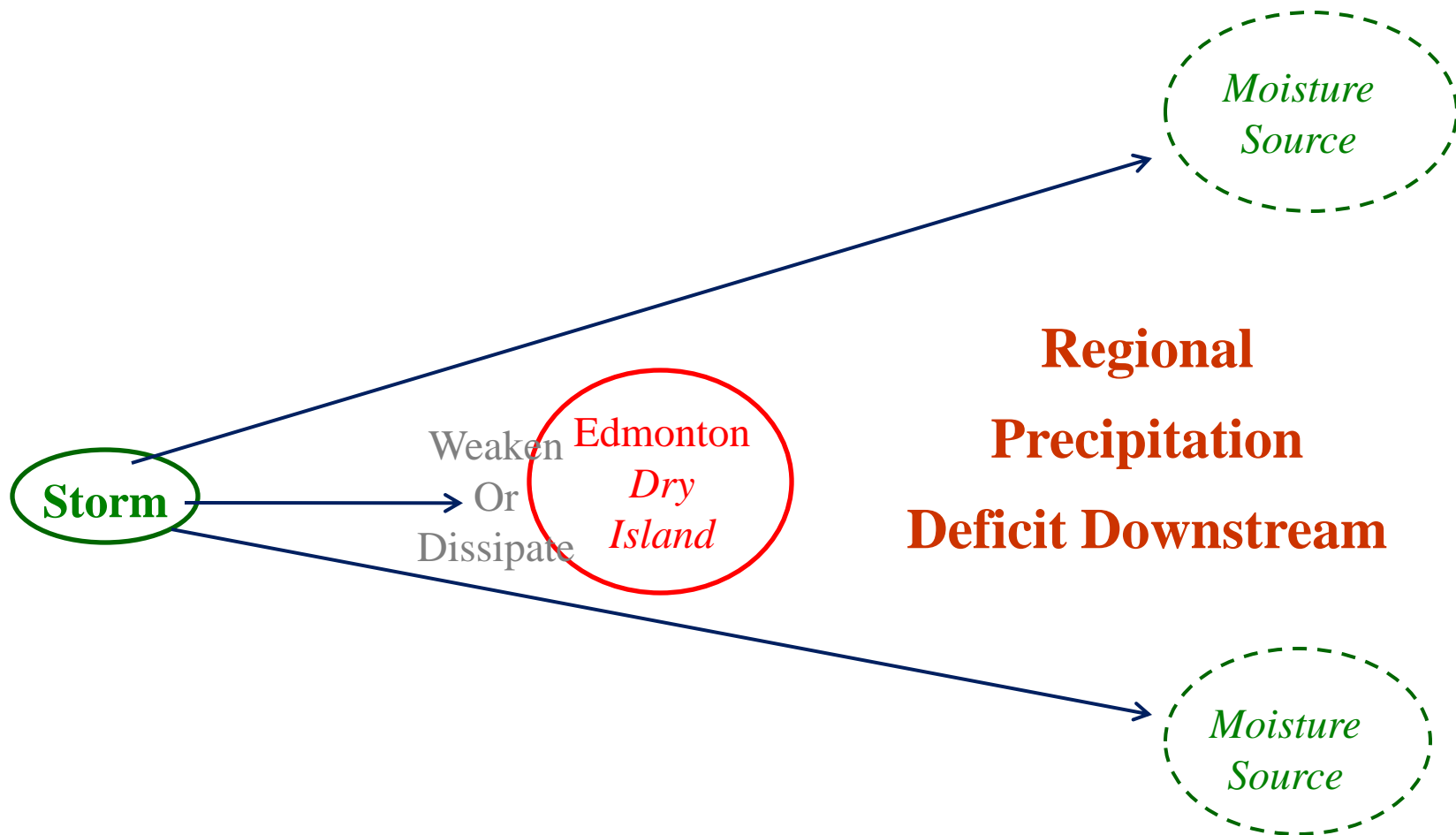
T/MxgRat Ard-FtSk-Edm-Ard Transect, 26 July 2009



QUESTIONS:

Q1: What effect might this dry island have on thunderstorms approaching from the west?

Q2: What longer-term impact might this play in terms of drought initiation and maintenance?



Does the most recent (2008-09) resurgence of the drought suggest this effect ?

North American Drought Monitor

June 30, 2009

Released: Monday July 20, 2009



<http://www.ncdc.noaa.gov/nadm.html>

Analysts:

Canada - Trevor Hadwen
Dwayne Chobanik
Richard Rieger
Mexico - Valentina Davydova
Adelina Encarnación
Elvia Delgado
Reynaldo Pascual
Fernando Romero
U.S.A. - Brian Fuchs*
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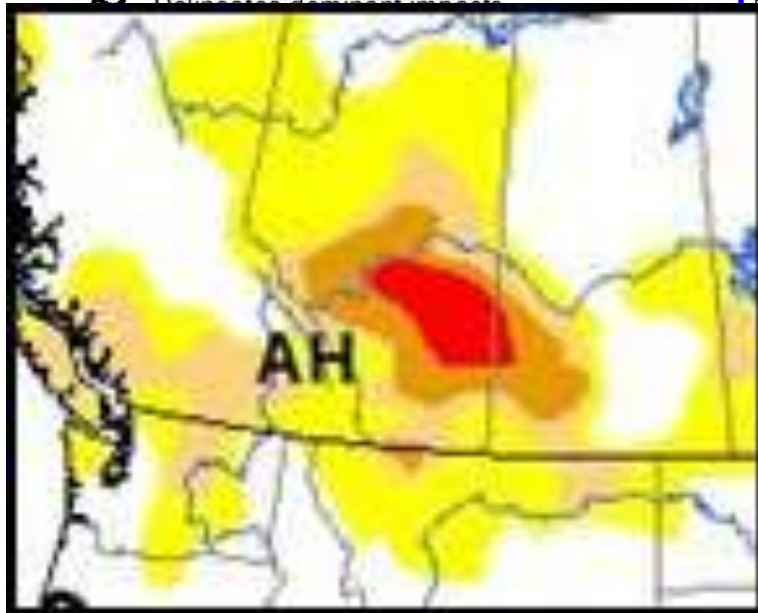
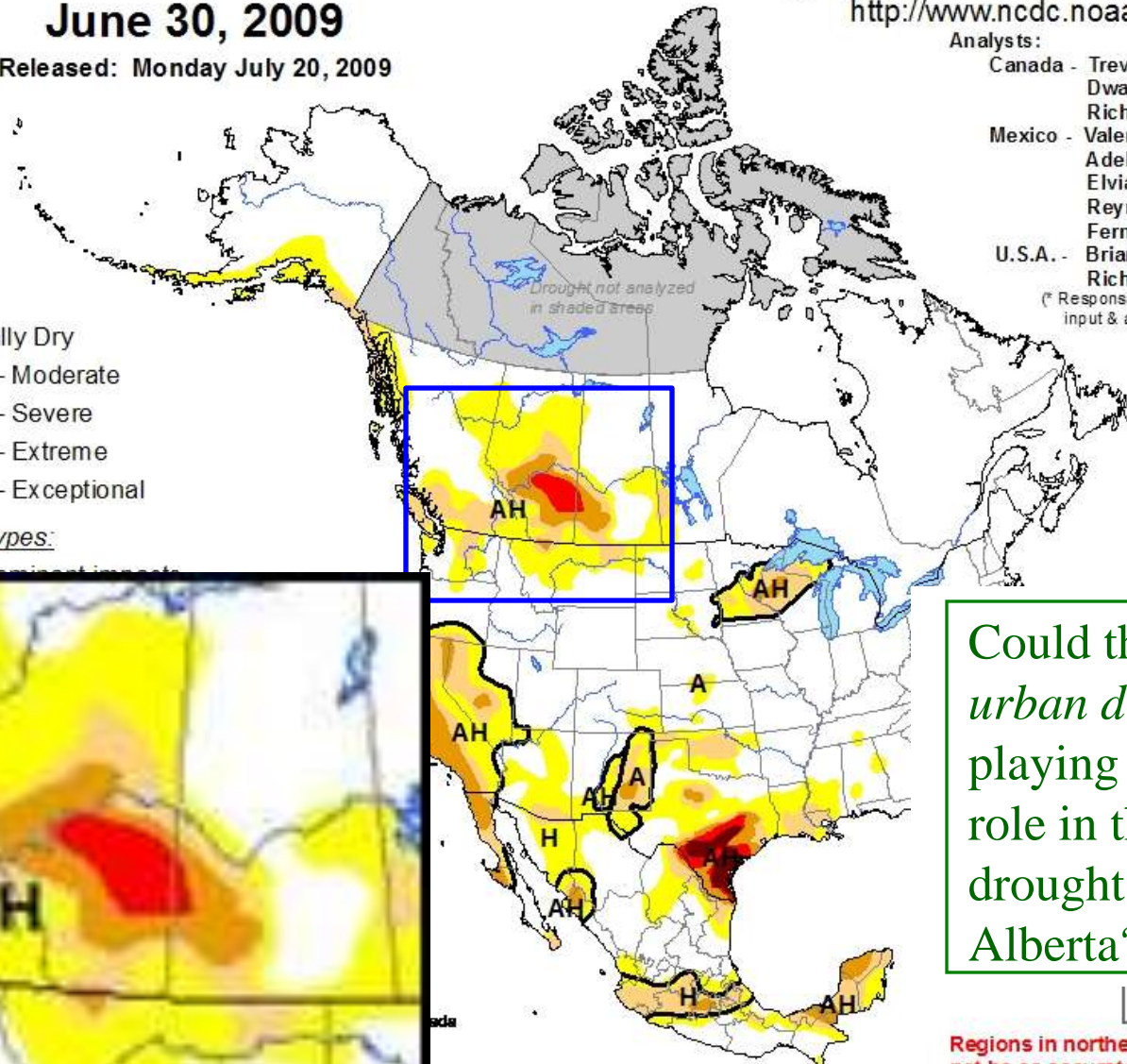
(* Responsible for collecting analysts' input & assembling the NA-DM map)

Intensity:

-  D0 Abnormally Dry
-  D1 Drought - Moderate
-  D2 Drought - Severe
-  D3 Drought - Extreme
-  D4 Drought - Exceptional

Drought Impact Types:

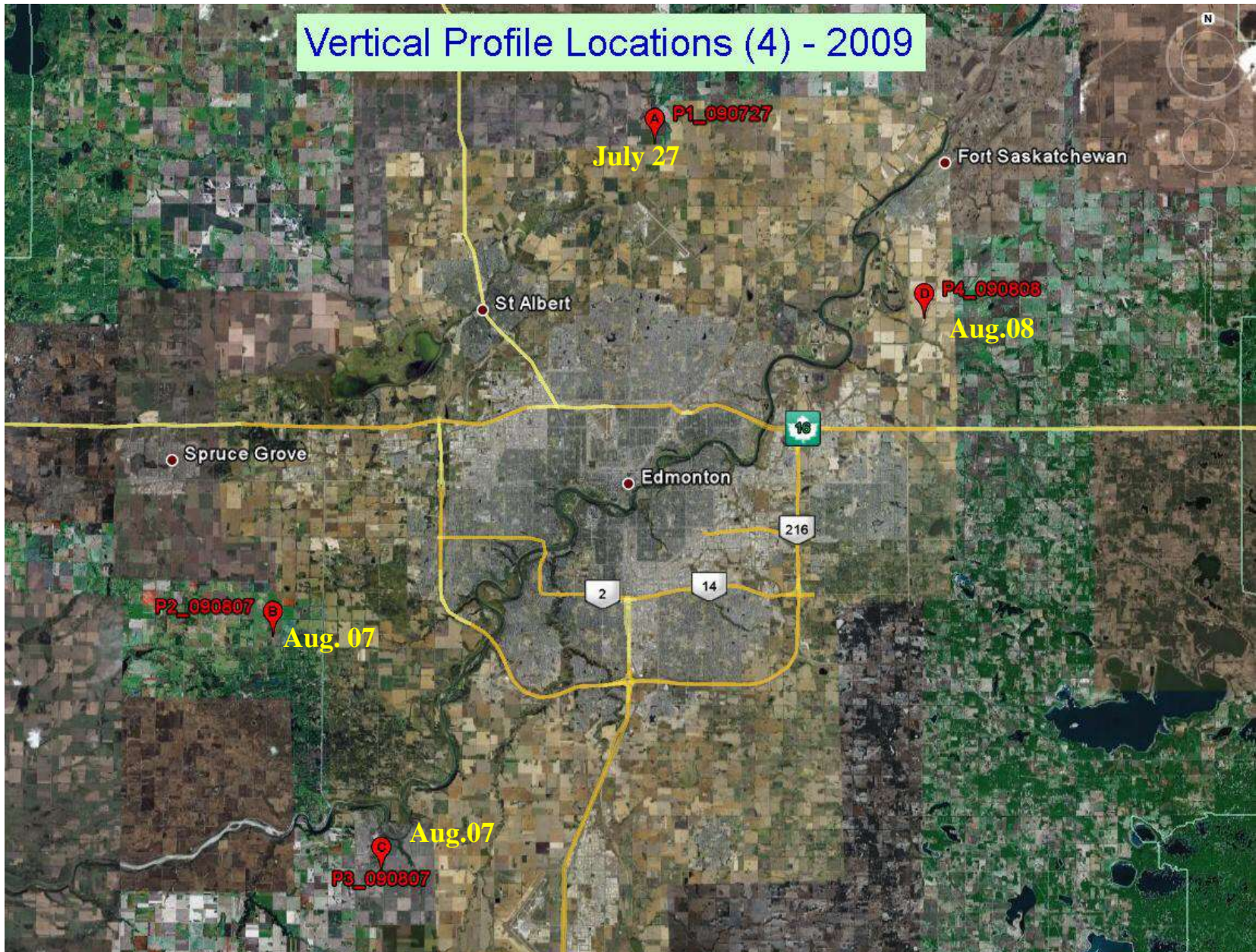
 *Palmer* dominant impacts



Could the Edmonton urban dry island be playing some critical role in the current drought over eastern Alberta?

Regions in northern Canada may not be as accurate as other regions due to limited information.

2009 Edmonton Vertical Profiles



12:05 MDT, 08 Aug. 2009

Wind Sock



Spot Profile 'P4' (S of Ft. Sask.)

- no time resolved profiles

12:19 MDT, 08 Aug. 2009



12:06 MDT, 08 Aug. 2009

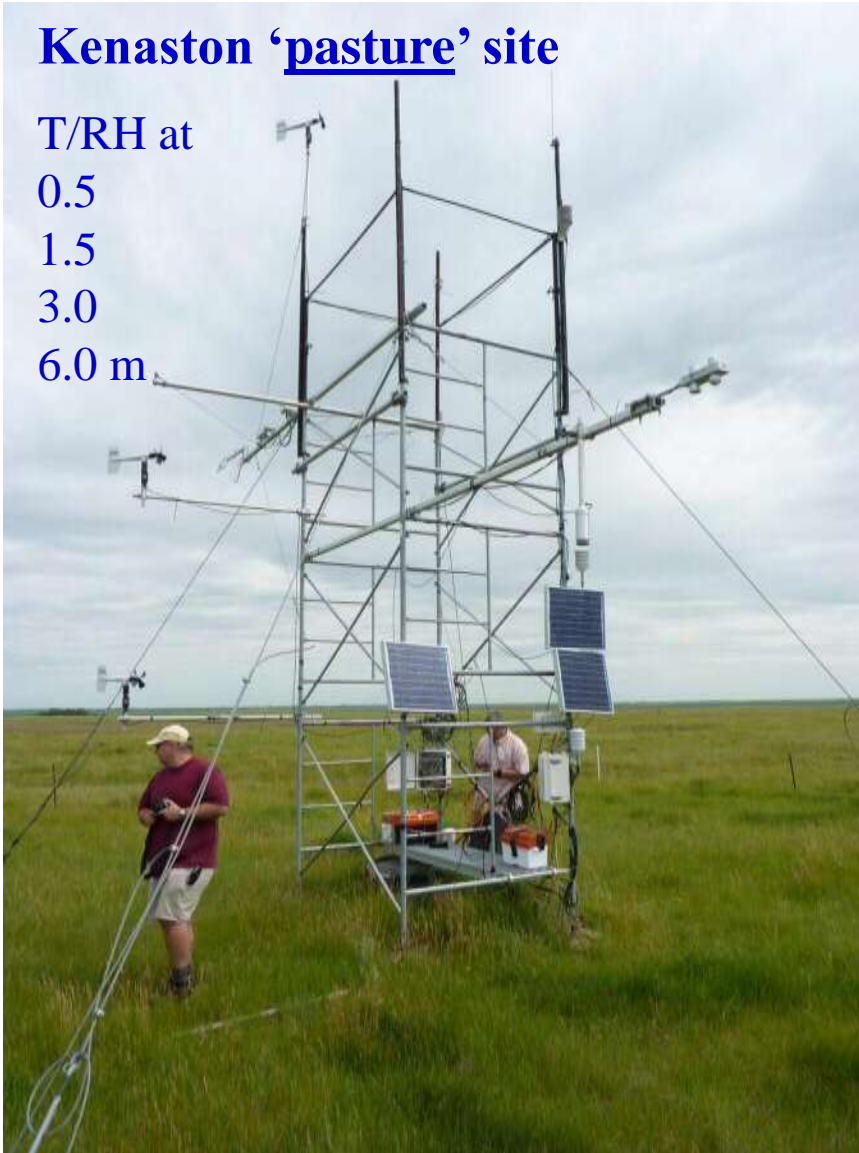


Note: Due to low precipitation and lack of soil moisture, crops were 2-3 weeks behind.

2009 Kenaston SK fixed Profiles (~ 1 km baseline)

Kenaston 'pasture' site

T/RH at
0.5
1.5
3.0
6.0 m



Kenaston 'barley' site

P/T/RH at
0.5
1.5
3.0 m



Kenaston 'transition' site

T/RH at
1.5 m

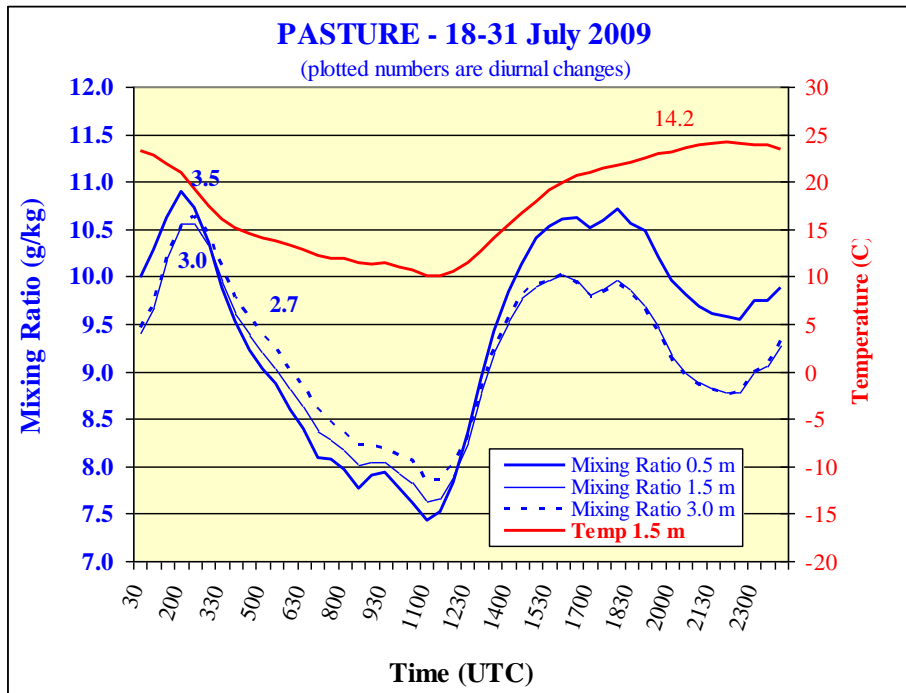
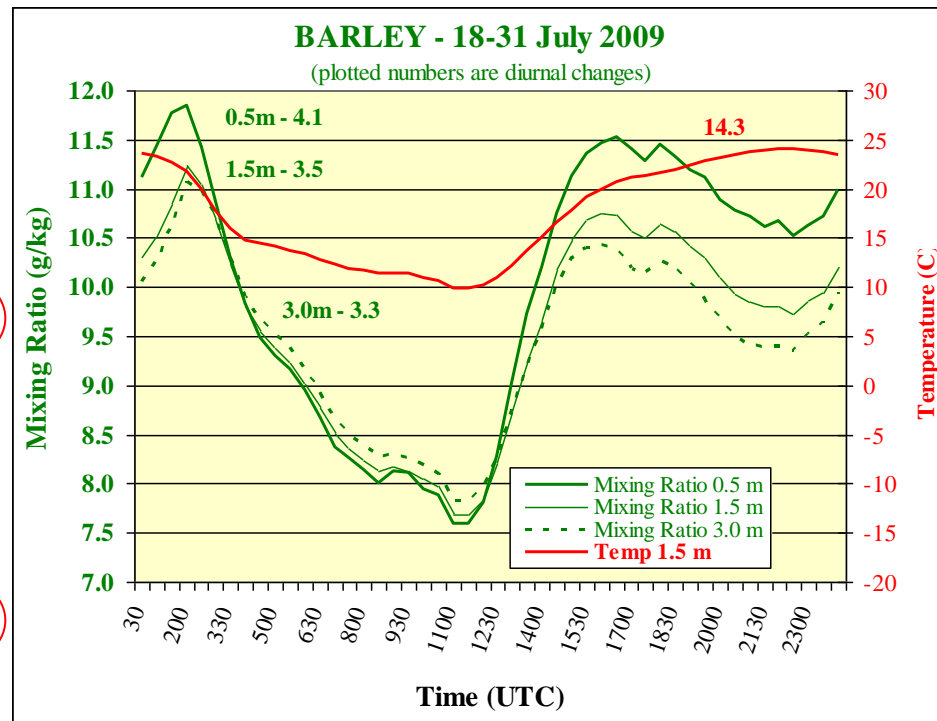


In addition: Pressure, Wind (3 levels), radiation, eddy correlation, precipitation, and soil moisture

Kenaston MxgRat Profiles

Comparison of 1992 St. Denis and 2009 Kenaston

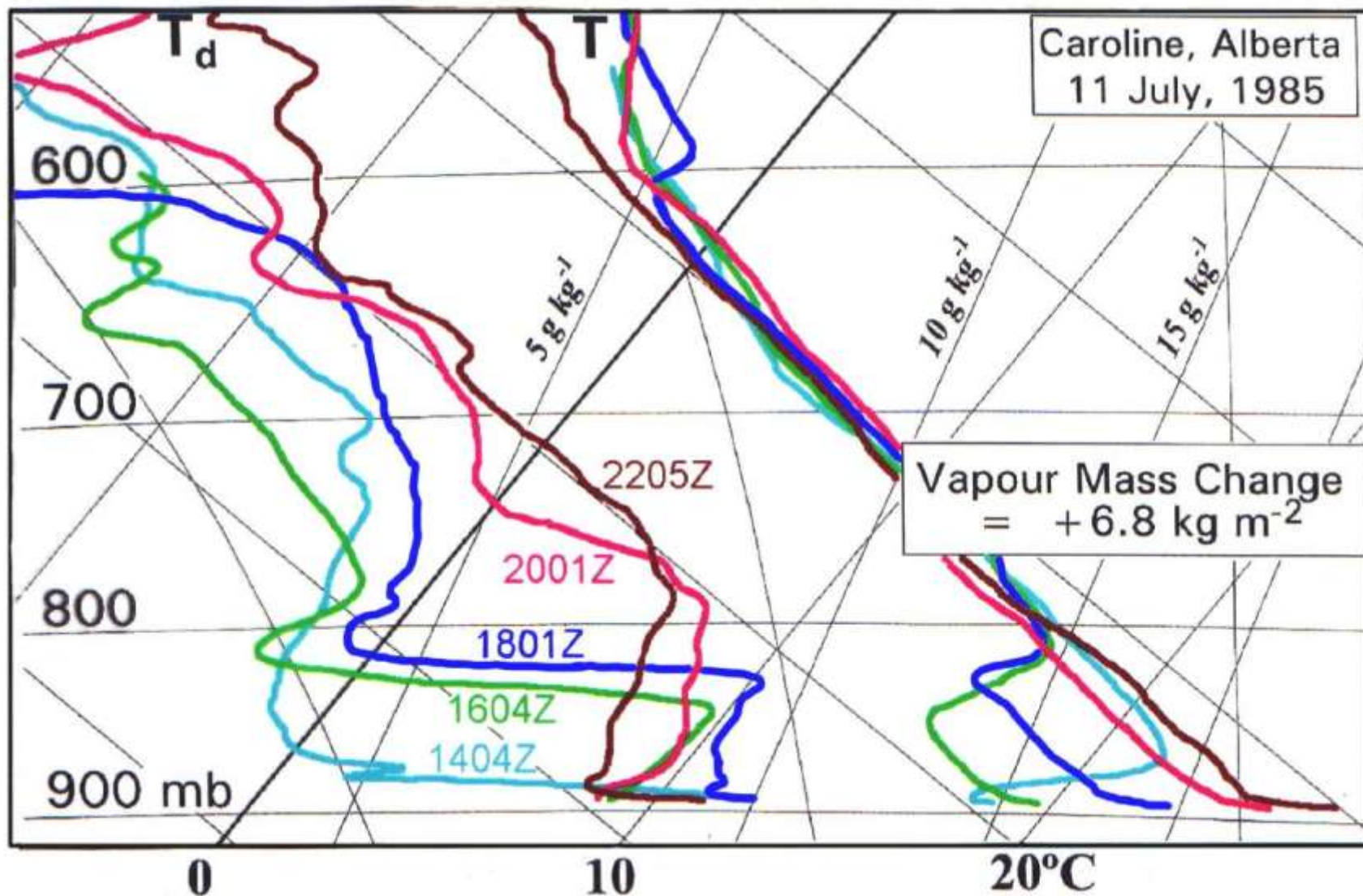
	Period (days)		Daily MAX	Daily MIN	Daily Range
1.5-m 1992 St. Denis (High soil moisture)	18	Wheat	12.2	8.5	3.7
		Grass	10.9	8.1	2.8
		Diff.	1.3	0.4	0.9
0.5-m 2009 Kenaston	14	Barley	11.8	7.6	4.2
		Grass	10.9	7.4	3.5
		Diff.	0.9	0.2	0.7
1.5-m 2009 Kenaston (Soil moisture 40% → 30%)	14	Barley	11.2	7.7	3.6
		Grass	10.6	7.6	3.0
		Diff.	0.6	0.1	0.6



SUMMARY:

- 1) Average diurnal increase (ET) is 3.3-4.2 (2.5-3.5) g kg⁻¹ over wheat (grass).
- 2) MxgRat over *barley* is 0.5-1.5 g kg⁻¹ higher than over *grass* (after 1600 UTC) [grass values may be contaminated high]
- 3) Most of diurnal increase (due to ET) occurs before 1600 UTC (1000 CST).
- 4) All 3 factors are critical to thunderstorm initiation and life cycle. → → →

Pre-storm Evolution of Capping Lid during LIMEX-85



*-The most important ABL changes occur between 14:00 and 16:00 UTC!
(08:00 and 10:00 MDT).*

CONCLUSIONS

Horizontal Profiles (Transects – applies to agricultural districts):

1. Small Towns (<5,000 pop.) – urban *heat island* ~ +0.1 C, *dry island* is -0.4 g kg⁻¹
2. Small Cities (5-15,000) – *heat island* ~ +0.2 C, *dry island*, -0.6 g kg⁻¹
3. Larger Cities (>500,000) – *heat island* +1-3 C, *dry island*, -2 to -3 g kg⁻¹
4. These results are valid for afternoon situations following mixing, which suggests that the results (dry island) may apply for the well-mixed ABL.

If so, these factors might:

- => a) dramatically affect thunderstorms approaching the city from west (Example 21 Aug.)
- b) contribute to initiation/maintenance of drought region downstream (curr. drought?)

Requires low-level soundings (16Z/20Z over/downstream of Edmonton (+ WSE)).

Vertical Profiles:

5. Inner *surface layer* over crops (lowest 1-2 m) caused by crop ET that enhances convective cloud potential significantly, providing an additional 2-4 g kg⁻¹ mixing ratio (through daily ET) above the background ABL moisture.
6. Most of the diurnal increase (ET) occurs during late-morning (14-1600 UTC), which coincides with severe storm ABL changes observed during LIMEX-85.

DROUGHT Impacts (east/south of Edmonton)



Google-Earth view of *Twin Island Lake*
~ 5 km due south from where I live



Photo of Twin Island Lake, 22 Aug. 2009

The End - Thank you!

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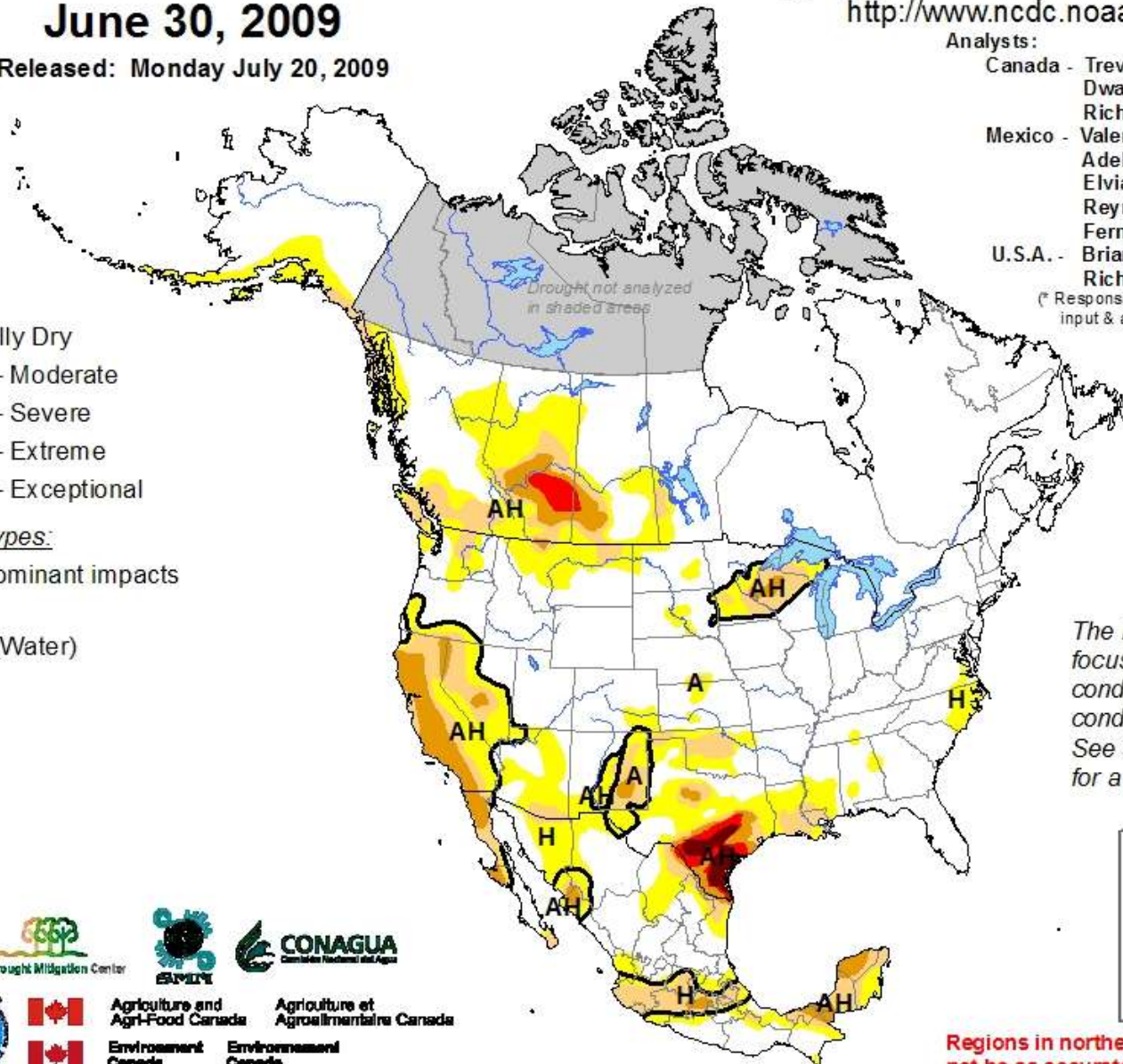
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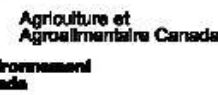
 Delineates dominant impacts

A = Agriculture

H = Hydrological (Water)



The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text for a general summary.



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T/MxgRat *Canola Profile* - **P4** (53.628N 113.232W) - **08 Aug. 2009**

