MODEL VERIFICATON, DROUGHT CHARACTERIZATION, AND THE SURFACE-CONVECTION FEEDBACK DURING DROUGHT ON THE PRAIRIES

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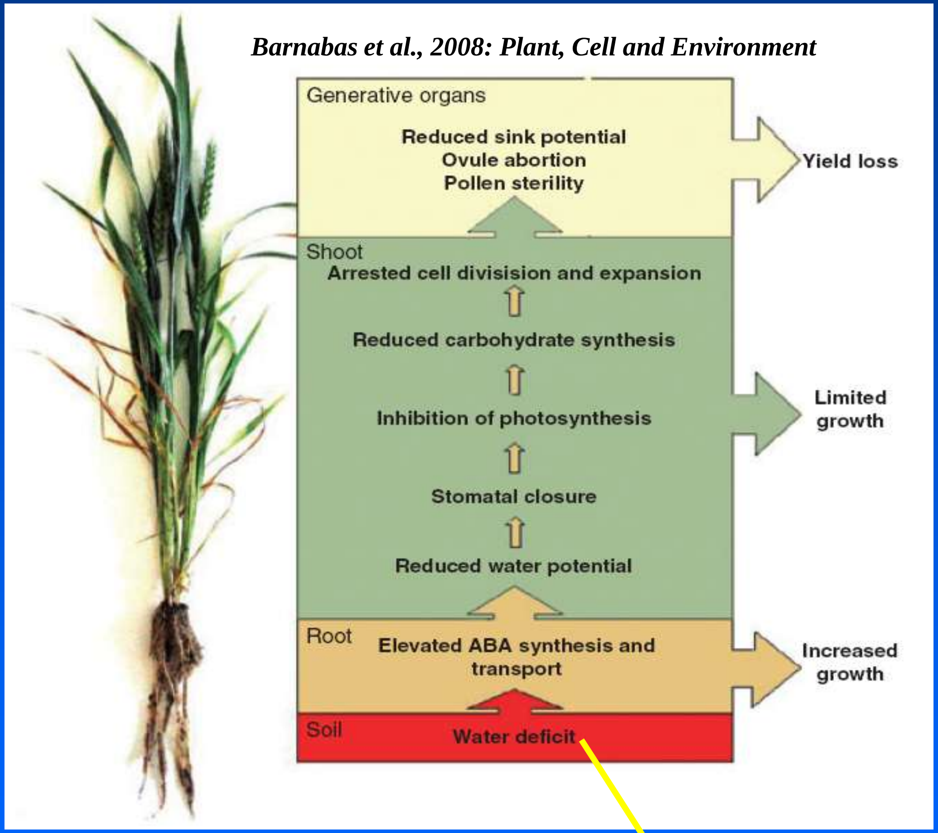
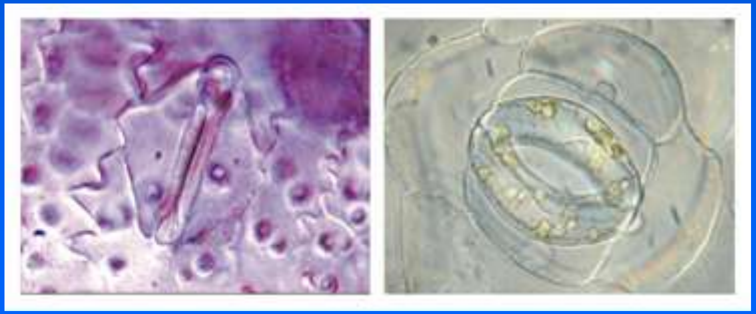
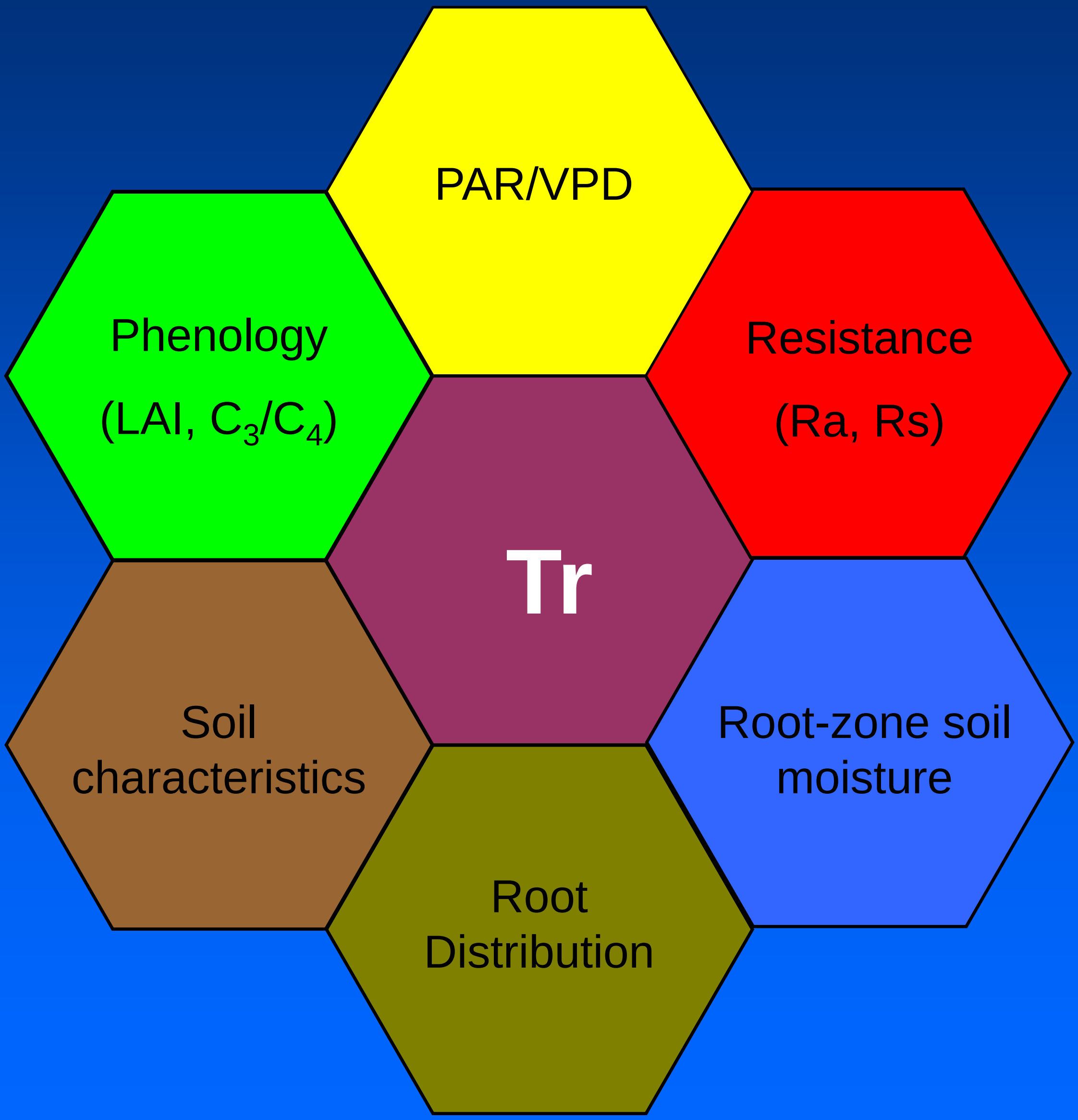
HOW DO PLANTS REACT TO WATER STRESS?



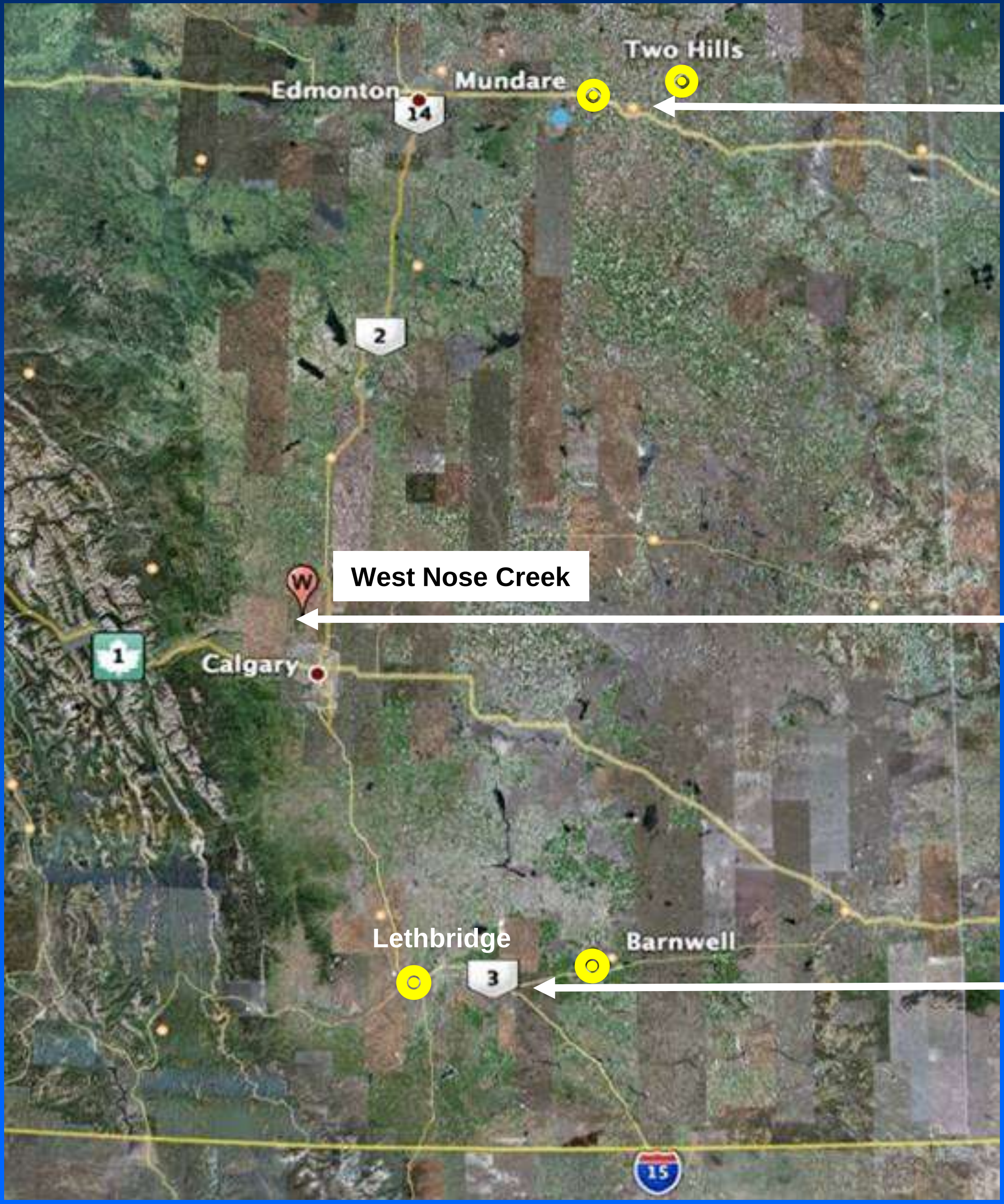


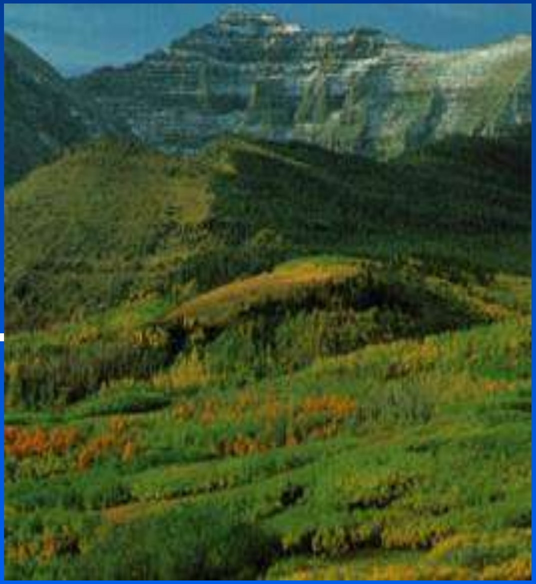
When does this happen?!

FACTORS GOVERNING THE EXTRACTION OF MOISTURE FROM SOIL BY PLANTS

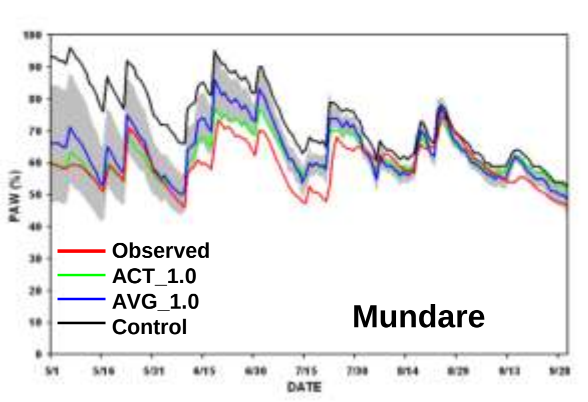


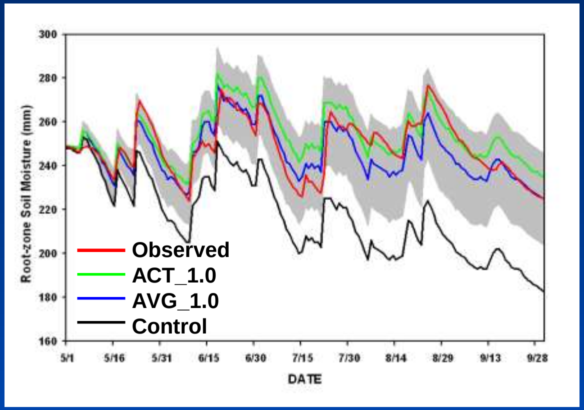
THE STUDY SITES

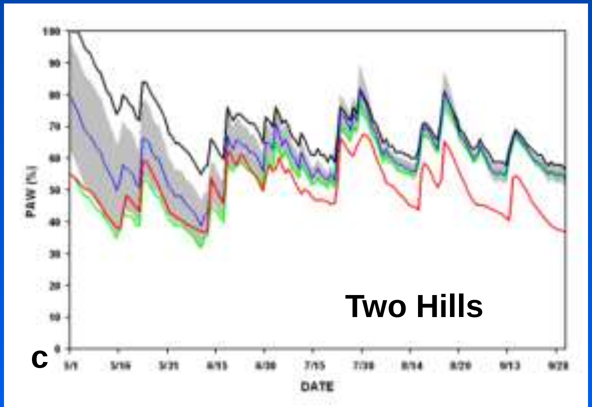


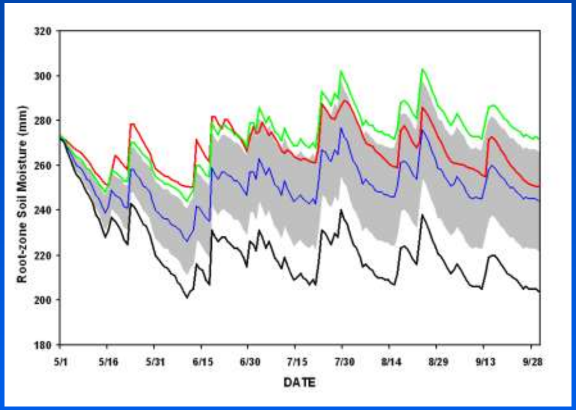


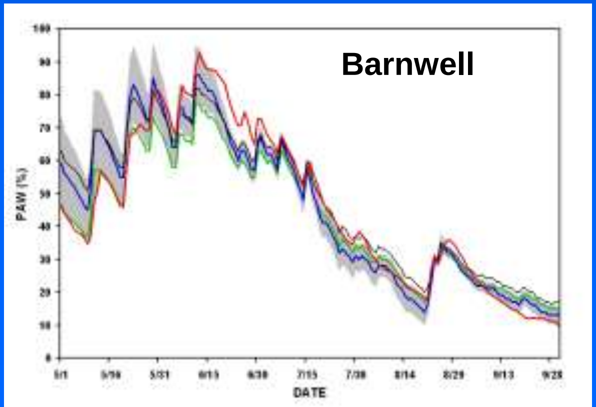
MODELLED VS. OBSERVED SOIL MOISTURE:

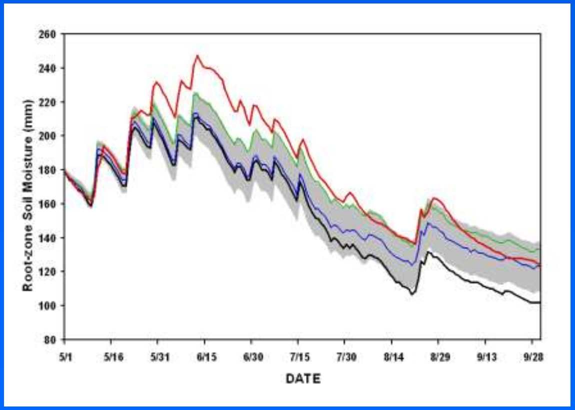












CONCLUSIONS

1. PAM-II skillful at predicting seasonal evolution & day-to-day variability of root-zone soil moisture and ET

2. PAM-II explains 65-95% of variance in RZSM at DroughtNet sites

3. Relative mean absolute errors for RZSM content at the 3 sites varied between 3% and 9% for runs using the mean soil hydraulic properties.

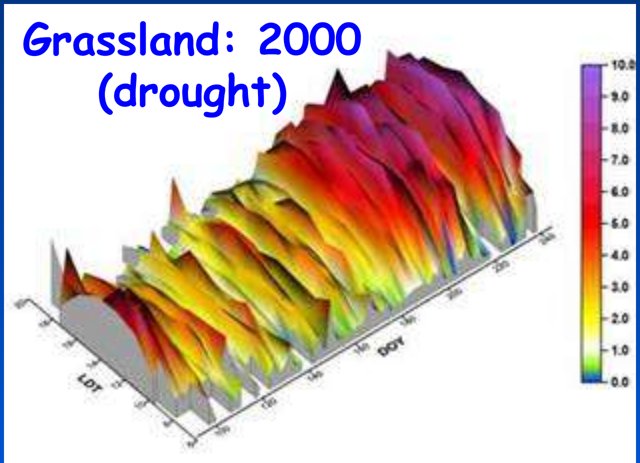
4. Simulated relative plant available moisture values were typically within 10% of the observations.

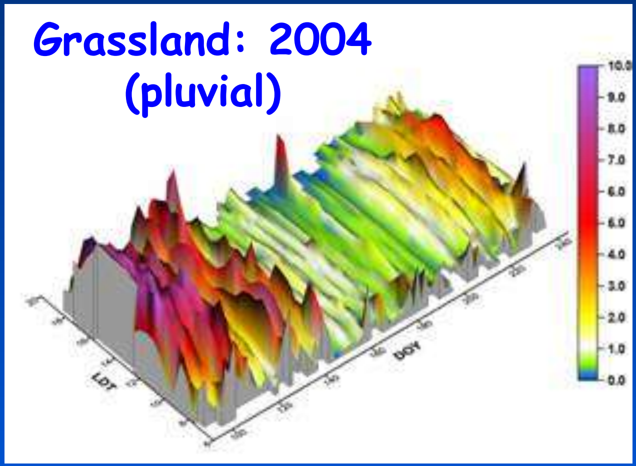
5. Skill of model runs using a particular PTF appears to be modulated by the Euclidean error of the PWP and FC estimated by that PTF.

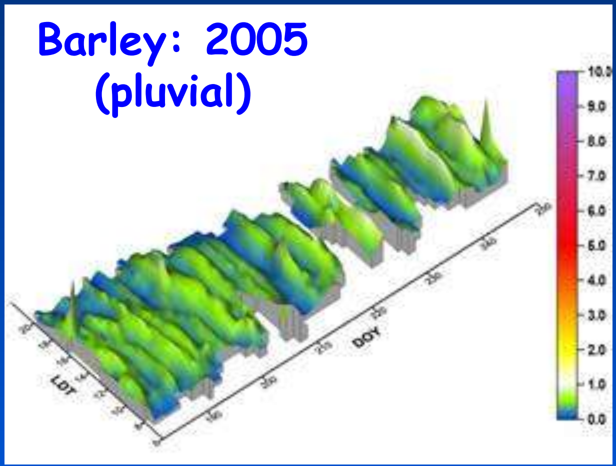
6. To improve the likelihood of an accurate soil moisture content simulation, the soil hydraulic parameters should have Euclidean errors less than 2%.

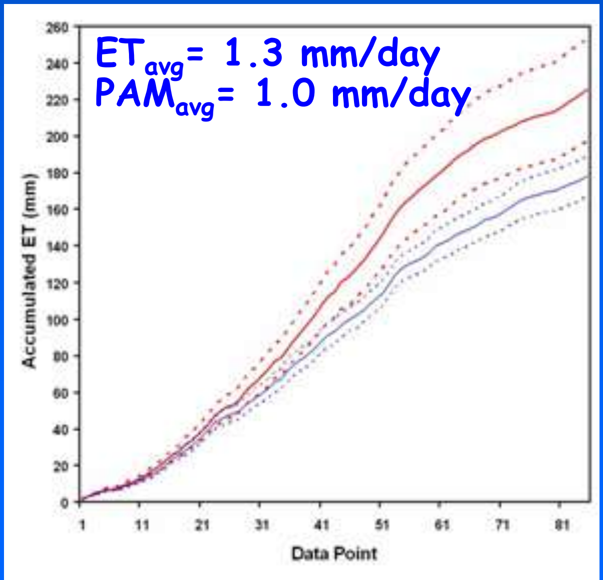
BRIMELOW, J.C.; J.H. HANESIAK and R.L RADDATZ. 2010. Validation of soil moisture simulations produced by the Canadian prairie agrometeorological model, and an examination of their sensitivity to uncertainties in soil hydraulic parameters. *Agric. Forest Met*. 150: 100-114.

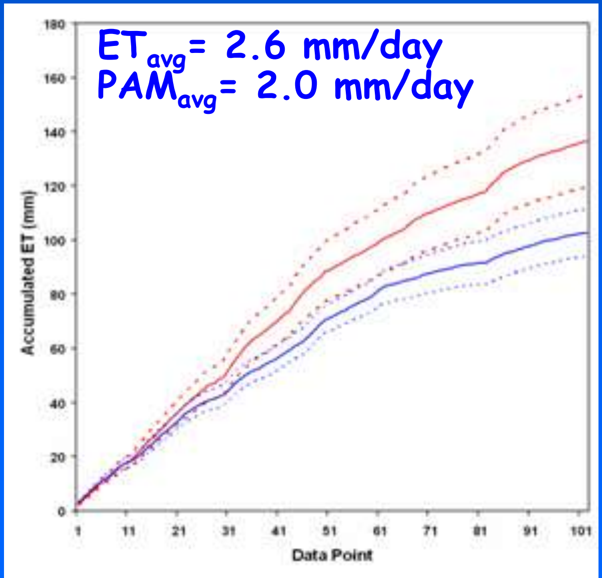
MODELLED VS. OBSERVED ET: CONTRASTING YEARS AND CONTRASTING VEGETATION

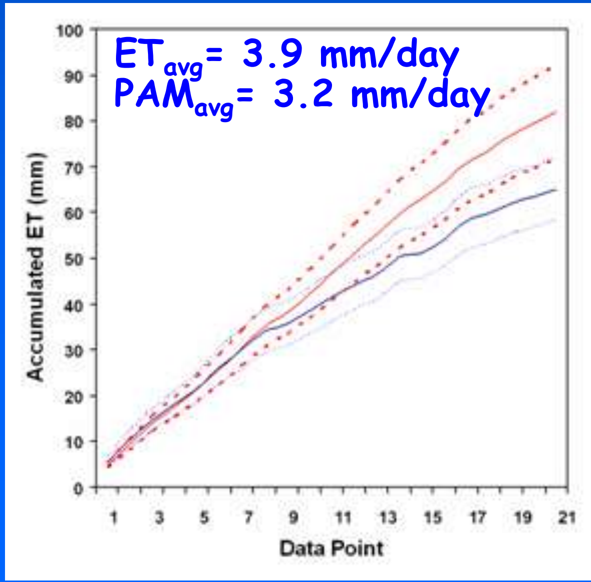












CONCLUSIONS

1. PAMII captured the salient features of the ET variability over contrasting vegetation types and for contrasting conditions.
2. At the barley site, the model explained about 50% of the observed variance in ET. PAMII displayed a negative bias (~20% relative error)
3. Mean absolute and RMSE errors for daily ET were near 1.0 mm d^{-1} for the barley site.
4. PAMII explained 70% of the variance in observed ET over the grassland. Mean absolute errors and mean RMSE errors were < 1.0 mm d^{-1}.
5. PAMII successfully captured the increase (decrease) in accumulated growing season ET for the wet (dry) growing seasons at the prairie site.
6. The optimal minimum reference stomatal resistance term was much lower for the barley (50 s m^{-1}) than for the prairie (80 s m^{-1})
7. Our research has identified several areas where future versions of the PAMII model might be improved.

BRIMELOW, J.C.; J.M. HANESIAK, R.L. RADDATZ and M. HAYASHI. 2010. Validation of ET estimates from the Canadian prairie agrometeorological model for contrasting vegetation types and growing seasons. ***In press. CWRJ.***

USING MODEL OUTPUT TO TRACK AGRICULTURAL DROUGHT

- Use climatological record to place current soil moisture values/departures in historical context

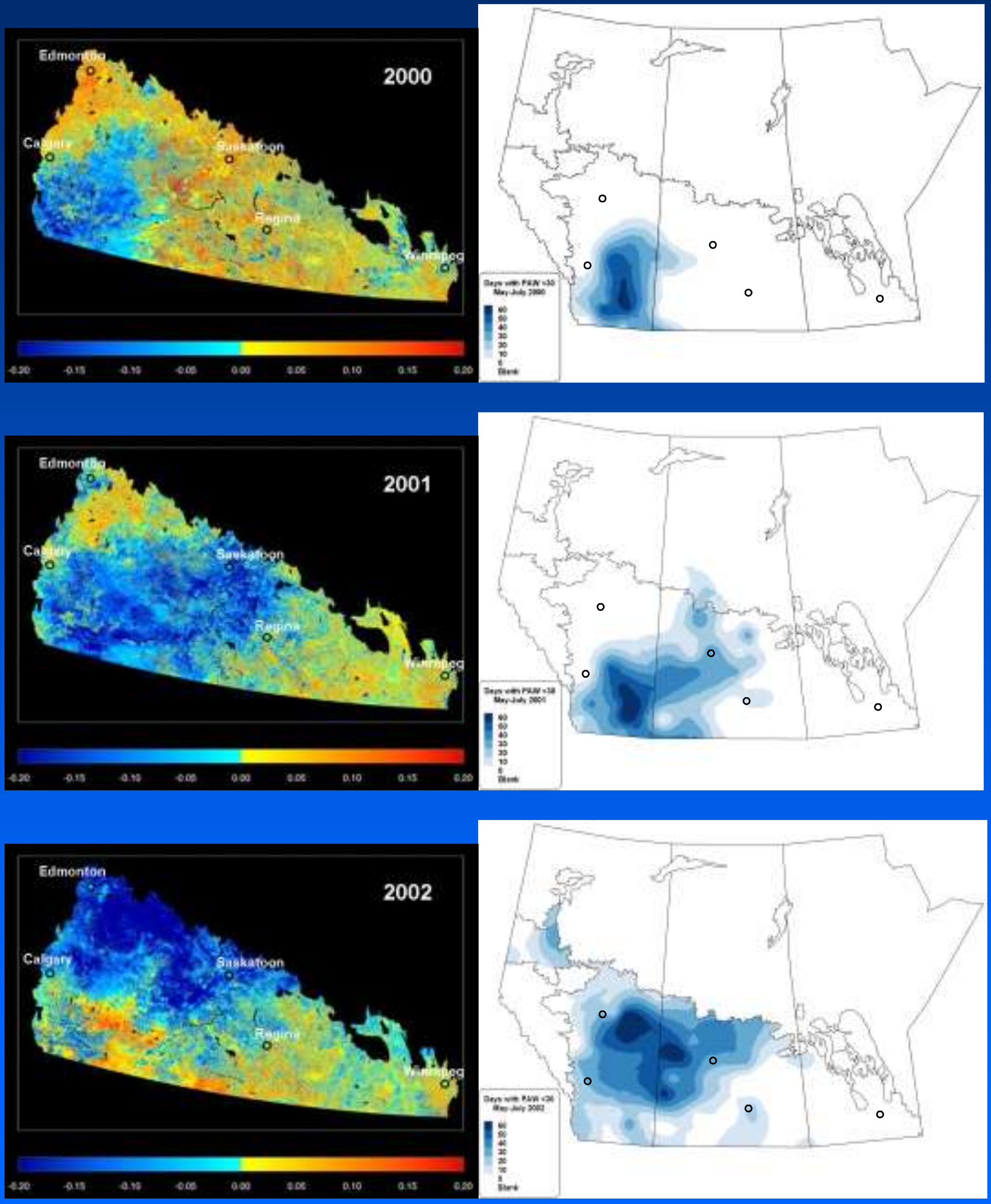
- But soil anomalies w.r.t long term data do not necessarily correlate with how plants respond to in-situ conditions

- Or, use known relationships between soil moisture and plant physiology to infer stress experienced by plants

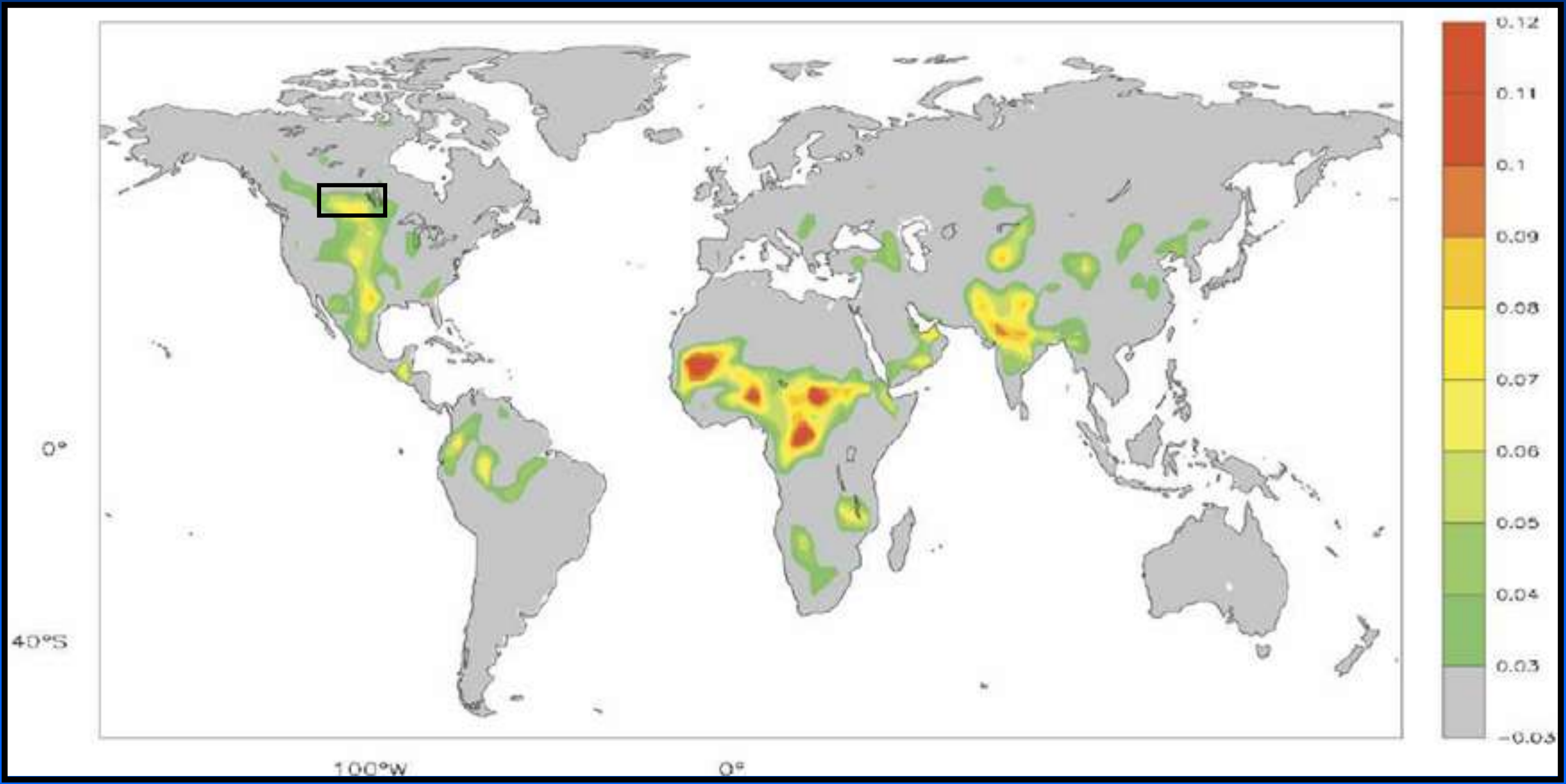
- Integrate the number of days when the available root-zone soil moisture (RZPAW) is below a critical threshold

RZPAW 30-50%: Mild stress, plant function not notably affected
RZPAW <30%: Severe stress; redirect resources to roots.

TRACKING THE 2000-2002 DROUGHT

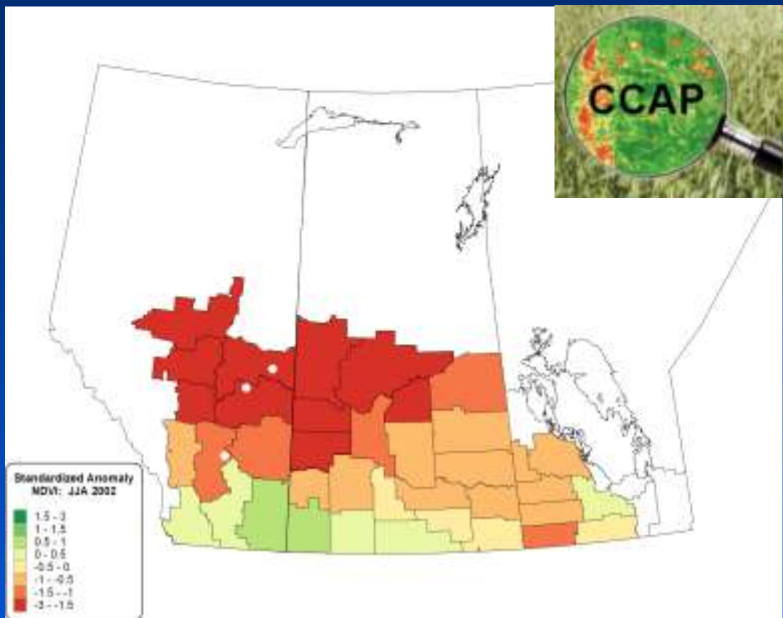


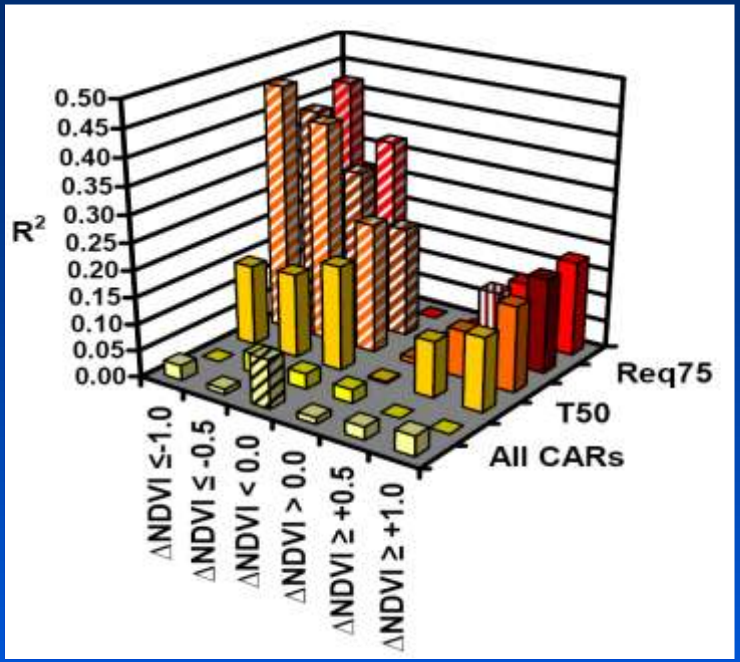
ON THE SURFACE-CONVECTION FEEDBACK DURING DROUGHT PERIODS ON THE CANADIAN PRAIRIES

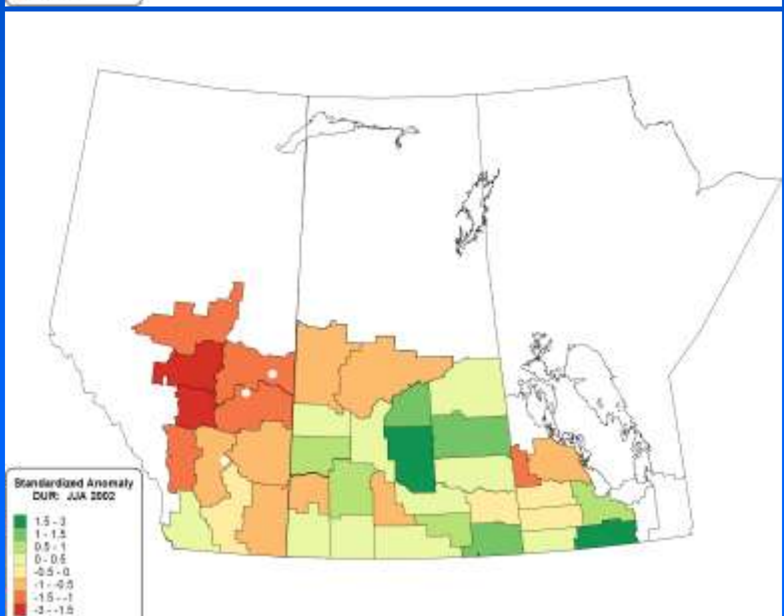


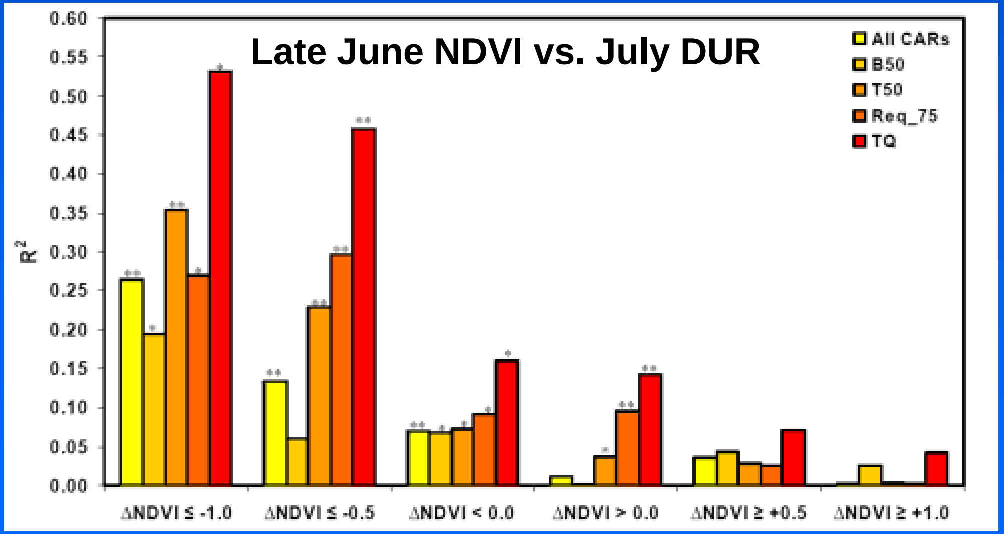
BRIMELOW, J.C.; J.M. HANESIAK, and W. BURROWS. 2010. On the surface-convection feedback during drought periods on the Canadian Prairies. *Submitted to Special DRI issue of Atmosphere-Ocean.*

RESULTS: 1999-2008









CONCLUSIONS

1. CAR size is important in governing the strength of the relationship between NDVI and DUR. If the area of the *anomaly less than 18000 km^2 (R_eq < 75 km),* relationship breaks down.

2. Additionally, the relationship strengthens as the magnitude of the anomaly increases, and is especially strong when *negative* anomalies are larger than typical inter-annual variability (ΔNDVI $\leq$ -1.0).

3. An asymmetric relationship exists between ΔNDVI and ΔDUR.

4. Positive ΔNDVI alone are not a necessary, nor a sufficient, condition for above-average lightning duration.

5. If the vegetation in late June is severely stressed, July lightning duration is highly likely also to be below average.

6. There exists an optimum lag between RZPAW and NDVI of one to three weeks, depending on soil texture.

7. Both observed and modelled data point to a critical value for RZPAW of about 35% required for significantly below-average NDVI.

FUTURE WORK

- Investigate relative roles of synoptic-scale forcing, moisture transport and instability on modulating the feedback and thunderstorm activity

- Investigate impact of stressed/lush vegetation on low-level moisture, CIN and CAPE and resultant thunderstorm activity

- Investigate possible reason/s for asymmetric relationship between ΔNDVI and ΔDUR.

- This will be achieved though an integrated analysis of *observed* lightning, NDVI and sounding data, plus NARR data (e.g., MFD, ω)

ACKNOWLEDGEMENTS

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- FLUXNET-Canada
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- CCAP (NDVI data)