SURFACE-ATMOSPHERE COUPLING DURING CONVECTIVE EVENTS

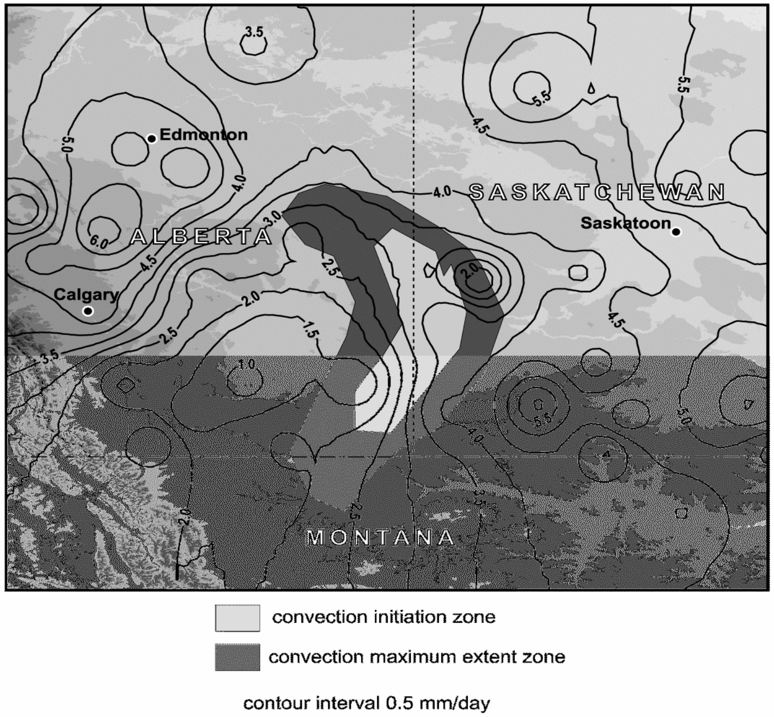
John Hanesiak
Centre for Earth Observation Science
Faculty of Environment, Earth & Resources
University of Manitoba

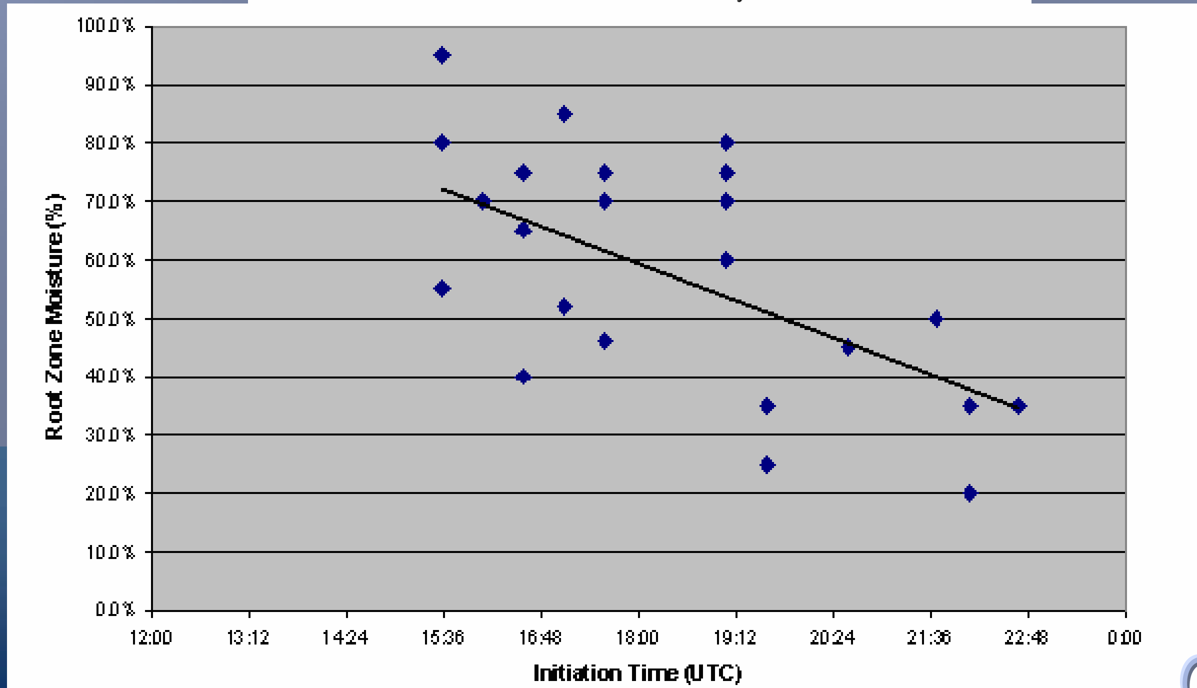
Collaborators: Raddatz, Lin

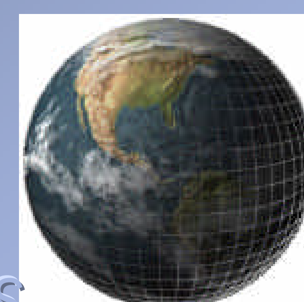
DRI meeting, Saskatoon, SK
January 11-12, 2006

BACKGROUND

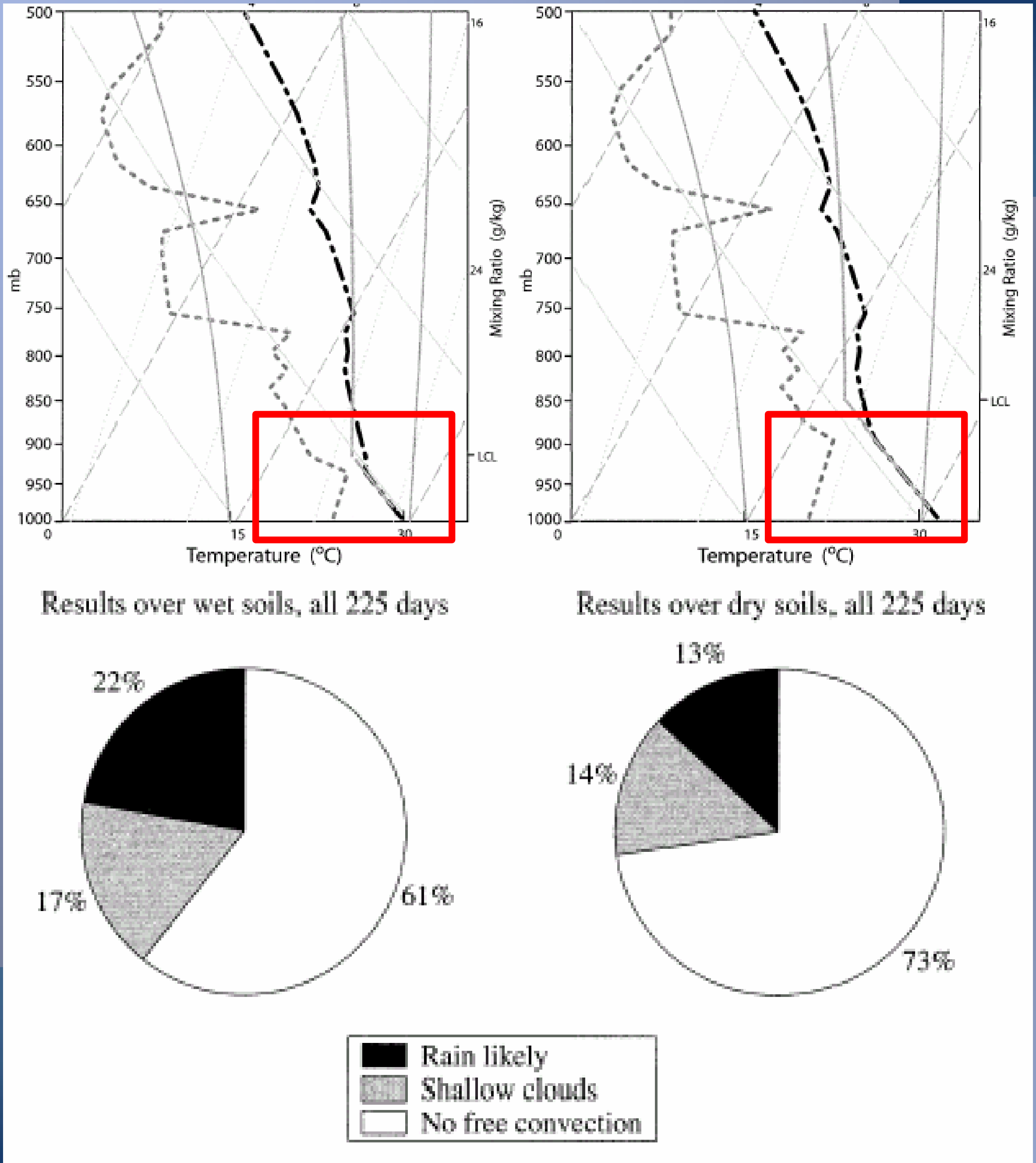
- Thunderstorms account for ~75% of prairie summer rainfall events (? 10 mm) (and 70-90% of total rain volume)
- Many summer rain events (? 10 mm) forced by mesoscale mechanisms
- About 66% of required moisture for crops must come from summer rain events
- Crops contribute significantly to ABL moisture in summer through ET
- Discontinuities in ET affect ABL moisture gradients and concomitant storms
- Crop phenology is typically not taken into account in NWPs
- Vegetation parameters are assigned mean values for land cover types
- Most NWPs forecasts of ABL moisture do not respond to departures from average growing season conditions (e.g., warmer/drier years)


Edmonton
Calgary
Saskatoon
ALBERTA
SASKATCHEWAN
MONTANA
convection initiation zone
convection maximum extent zone
contour interval 0.5 mm/day


Root Zone Moisture (%)
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
12:00
13:12
14:24
15:36
16:48
18:00
19:12
20:24
21:36
22:48
0:00
Initiation Time (UTC)



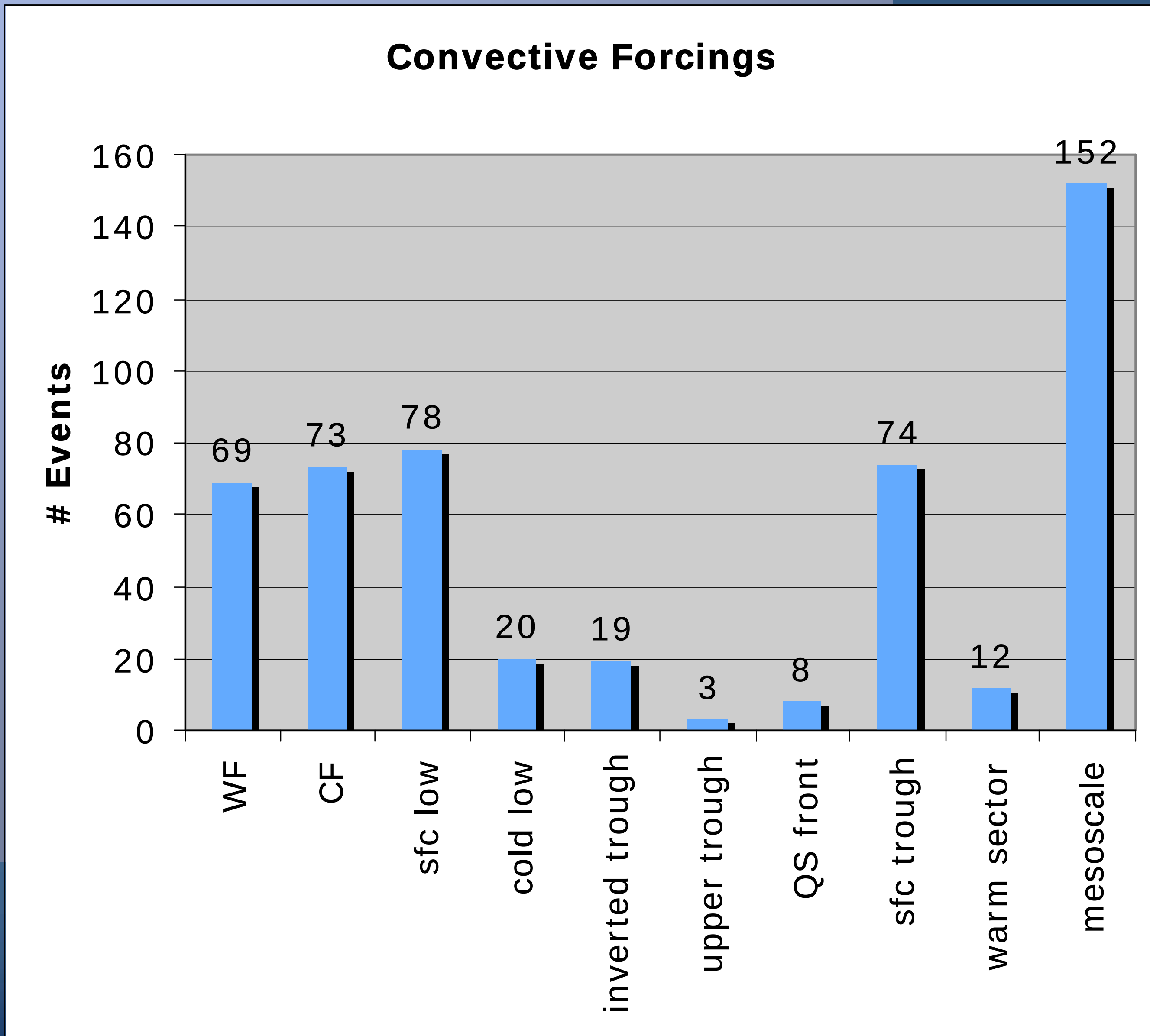
CEOS



From Findell and Eltahir 2003

CEOS

For summer rain events with ? 10 mm (2000-2004)



Mesoscale = 30%

Surface low = 15%

CEOS

RESEARCH QUESTIONS

- **Does drought enhance or perpetuate drought?**
  - Where do convective storms occur in relation to wet/dry areas?
  - Do dry areas stay dry and how does this pattern change each year and why?
  - Is there less convection/severe weather over dry areas?

- **Mesoscale processes are dominant for significant rain, but how do the dry/wet areas contribute to this and what mesoscale processes are responsible?**

- **How well does the GEM model simulate the daily and seasonal changes of soil and boundary layer moisture, respectively?**

- **Does the inclusion of crop phonology in NWPs improve the representation of atmospheric variables over wet and dry areas?**

- **Is adopting a probabilistic approach for predicting areas of convective precipitation effective at improving forecast skill?**

CEOS

METHODOLOGY

- Characterize wet/dry areas in terms of vegetation and surface sources
- Utilize rainfall, sounding, lightning, satellite, and radar data
- Link spatial patterns in soil moisture & ET over wet/dry regions to convective activity and severe weather events
- Evaluate performance of GEM forecast ABL profiles (surface fluxes) over wet /dry regions against sounding data (Raddatz's model)
- Conduct mesoscale model experiments and sensitivity studies for significant convective rain events to identify key forcing mechanisms
- Incorporate crop phenology into land surface schemes to assess impacts on convective events and mesoscale processes
- Add new trigger mechanisms and land surface schemes to GEM ensembles -- convective ensemble

CEOS

EXPECTED RESULTS

- **Gain a more thorough understanding of surface-atmosphere and mesoscale processes/feedbacks that contribute to significant rain and convective events during dry/wet periods**
- **Quantify the skill of GEM model in accurately reproducing ABL profiles and convective events during drought**
- **Develop more sophisticated representation of crop phenology in NWP models**
- **Develop a more probabilistic convective forecast approach as opposed to deterministic**

CEOS

RELEVANCE OF INTENDED RESEARCH TO DRI

- **Improve our understanding of thunderstorm process mechanisms of over drought and non-drought areas**
- **Improve our understanding of surface-atmosphere feedbacks of energy and water**
- **Improve our understanding of ET at various scales and its affect on convective activity**
- **Improve prediction capabilities**

CEOS