Dust Storms of the Canadian Prairies: A Dustier and Muddier Outlook

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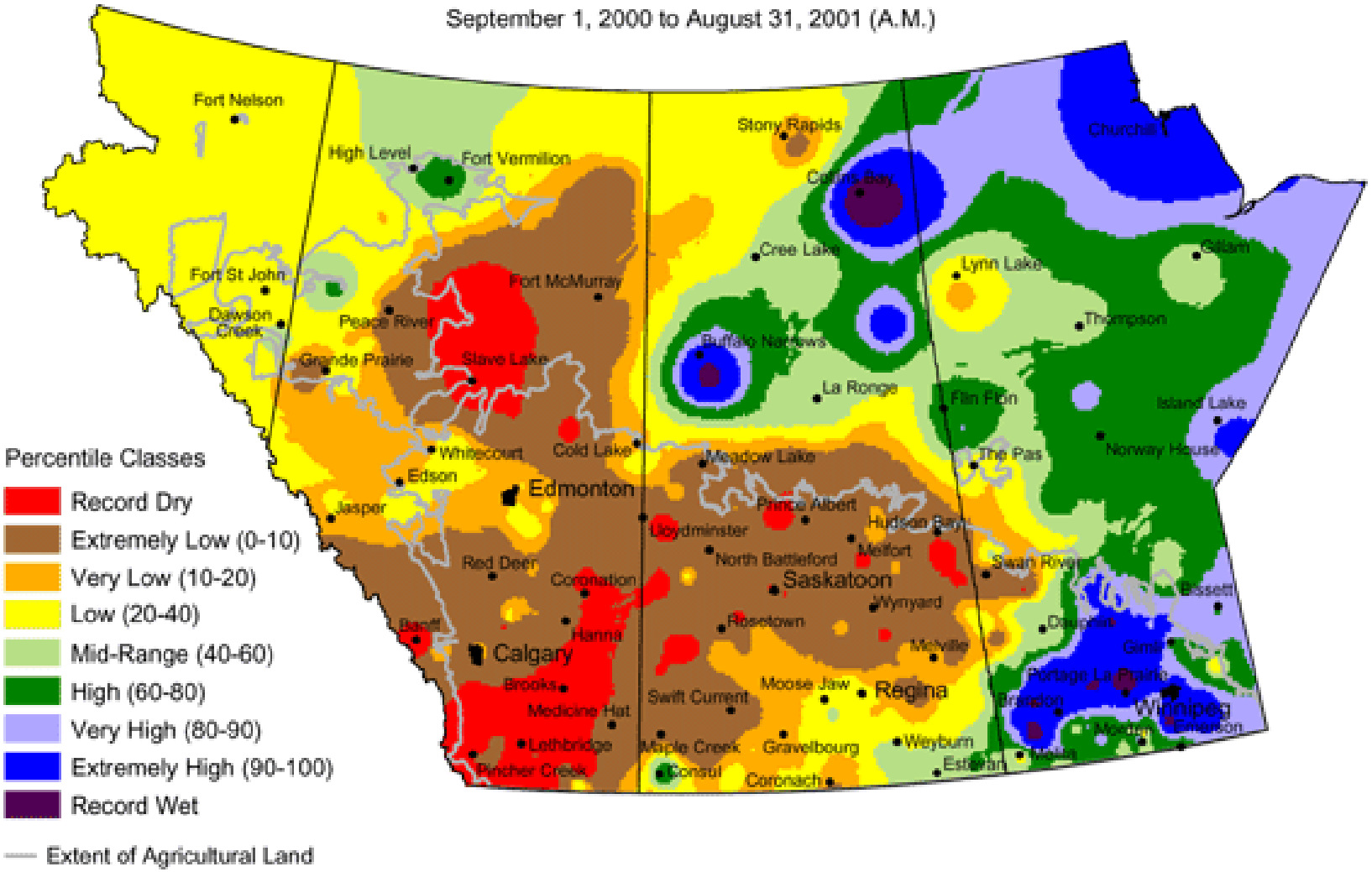
Overview

- Why find out about dust storms?
- Characteristics of Canadian Prairie dust storms
- Causes of dust storms
- Examples from the major drought of 2001-2002
- Future possible dust storms
- Adaptation to reduce dust storm risk
- Knowledge gaps

Canadian Prairie Provinces: Study Area (AAFC 2001)



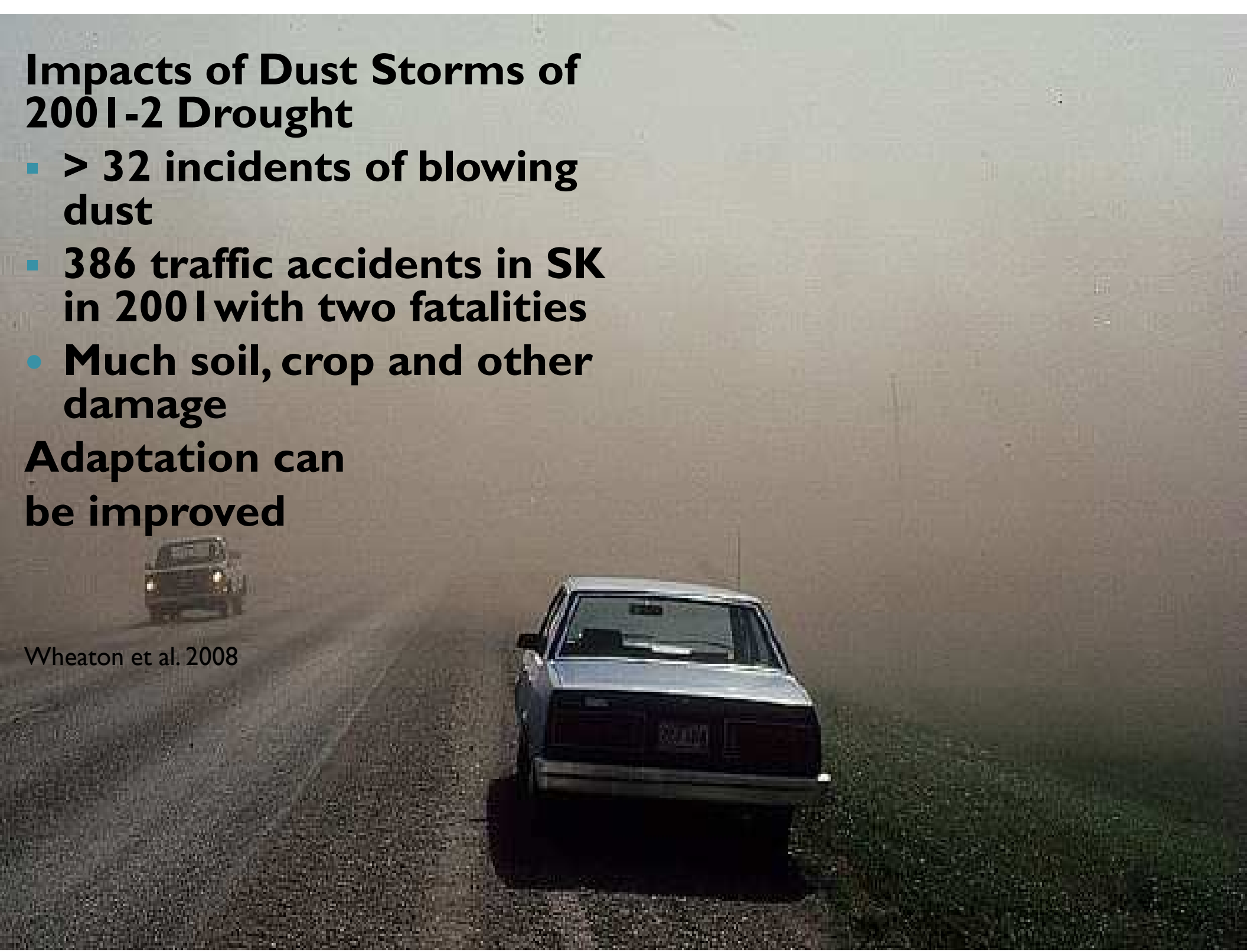
Impacts of Dust Storms are a reason to increase knowledge

- Soil lost by wind erosion has long-term and high **costs**, often taking decades or longer to restore
- Vegetation damage, lower yields, health risks, air pollution
- Many other costly, damaging effects

Impacts of Dust Storms of 2001-2 Drought

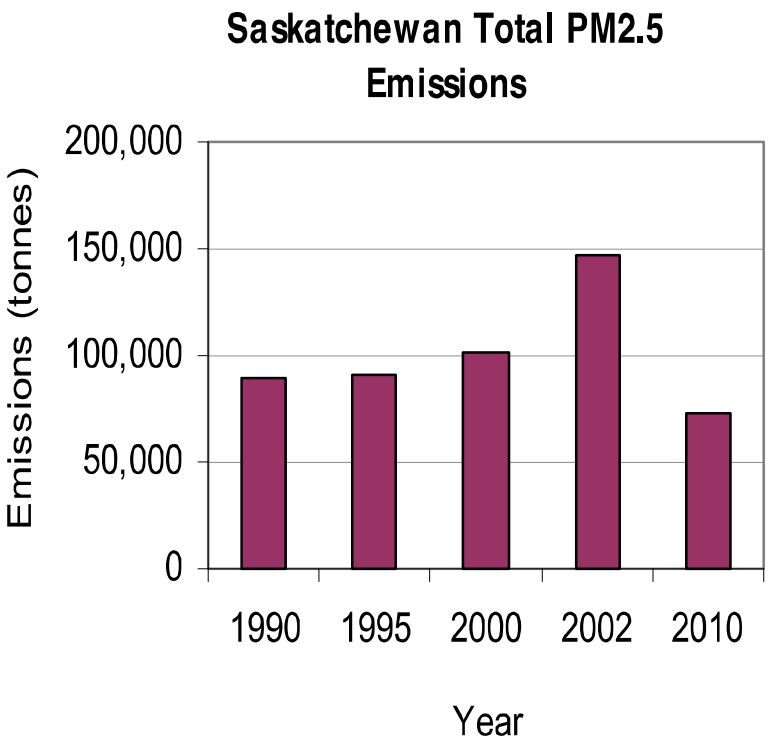
- > 32 incidents of blowing dust
- 386 traffic accidents in SK in 2001with two fatalities
- Much soil, crop and other damage

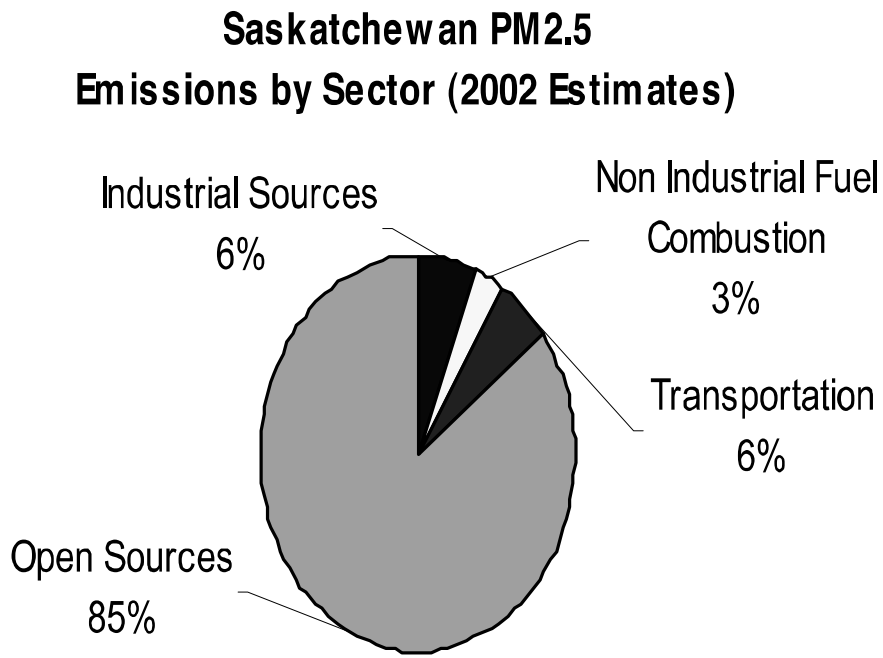
Adaptation can be improved



Wheaton et al. 2008

Particulate Emissions in Saskatchewan (Sk Ministry of Env 2006)





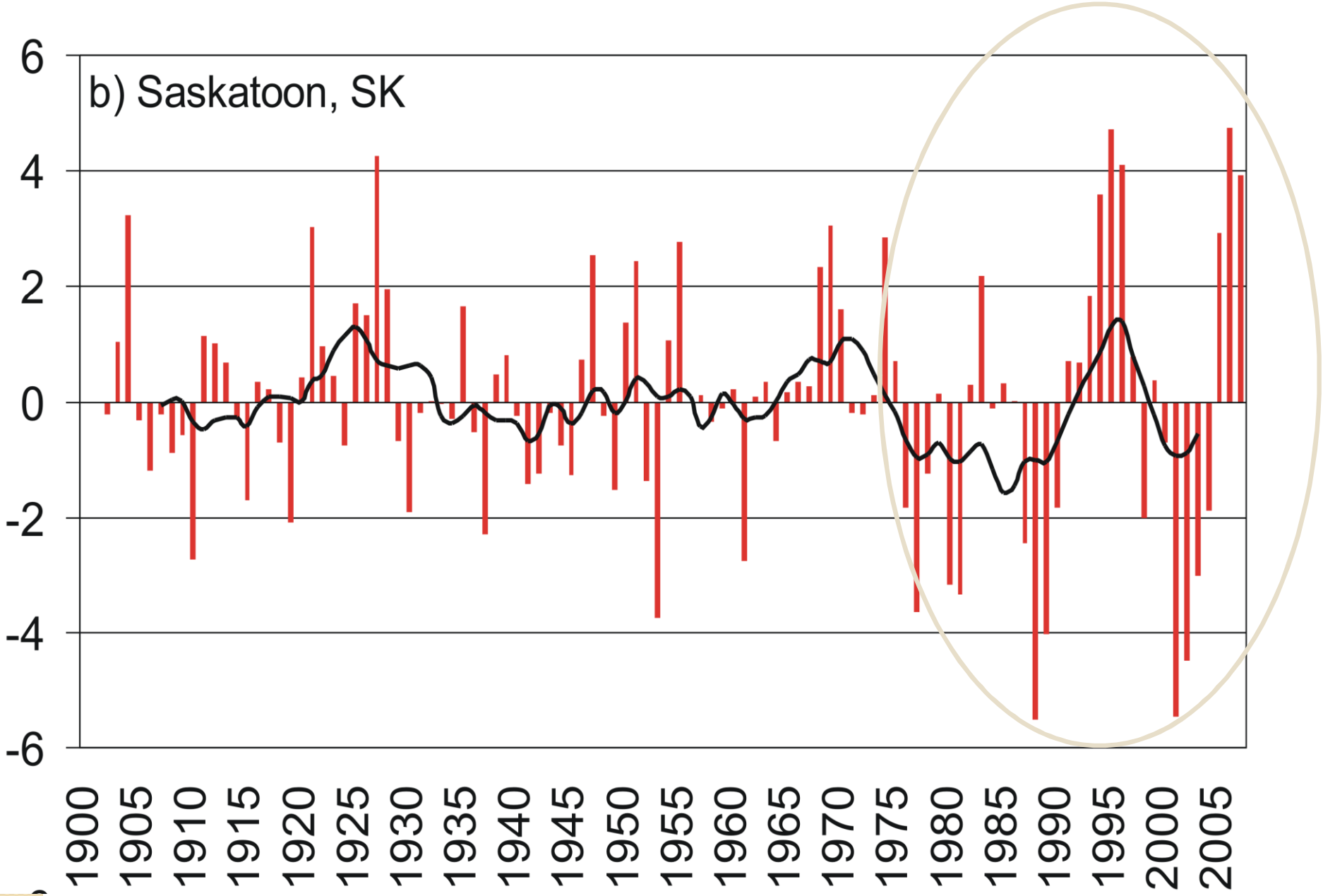
Characteristics of Dust Storms

- Peak during spring; winter snow and summer vegetation protect the soil
- Dust bowl of Canada is the south and central regions of the Prairies
- Droughts increase the risk of dust storms

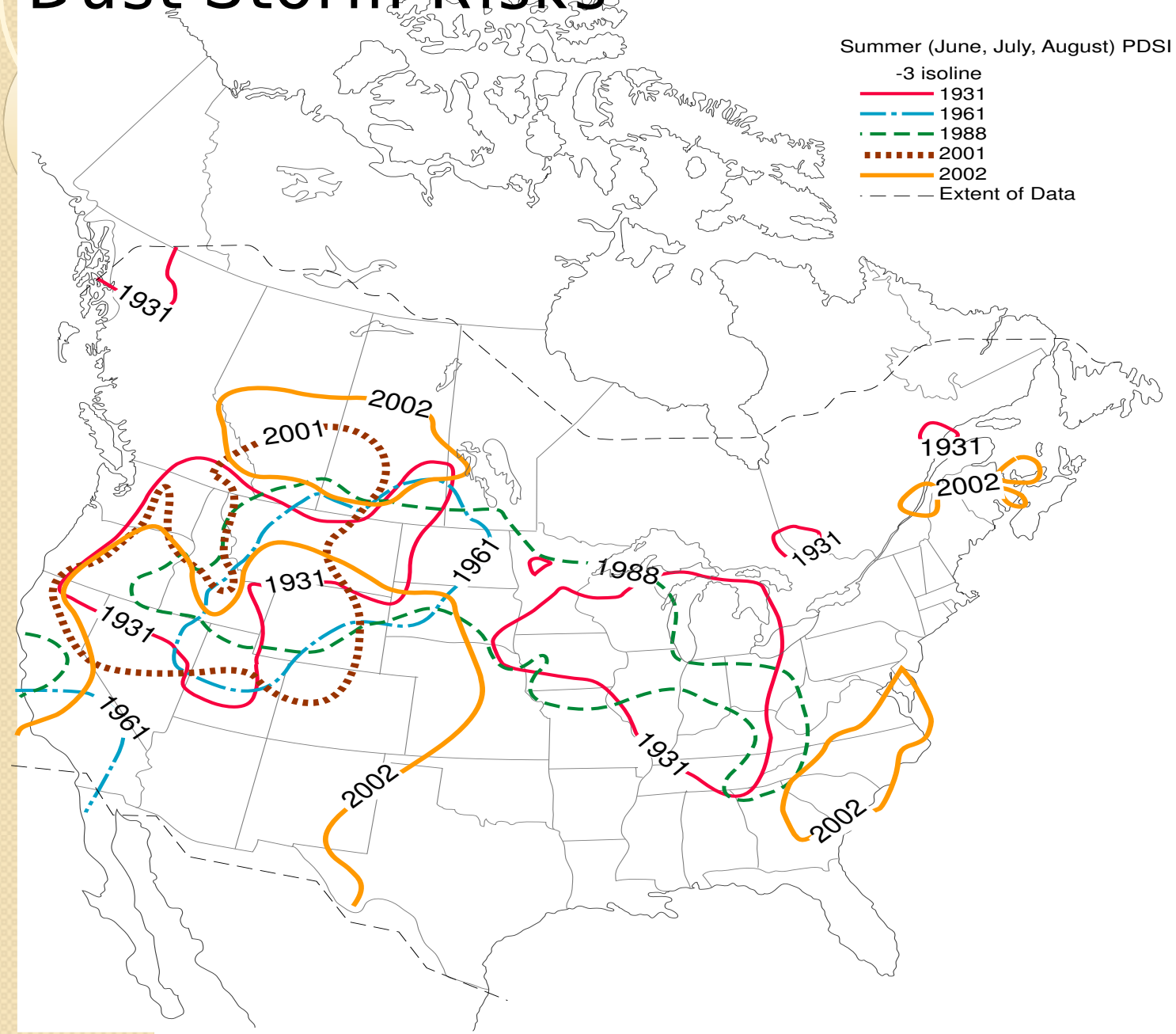
Drought Characteristics

- New findings include: 1) Northern US droughts often migrate into the Canadian Prairies and need to be watched, 2) droughts can emerge in winter and sneak into spring, 3) droughts have multiple causes and these may be changing
- Climate change drivers of drought mean that future possible droughts are expected to be worse than those of the instrumental period and perhaps of the paleo-record's mega droughts

Palmer Drought Severity Index shows much variability in last decades (Bonsal p.comm. 2013)



Drought Spatial Patterns are indicators of Dust Storm Risks

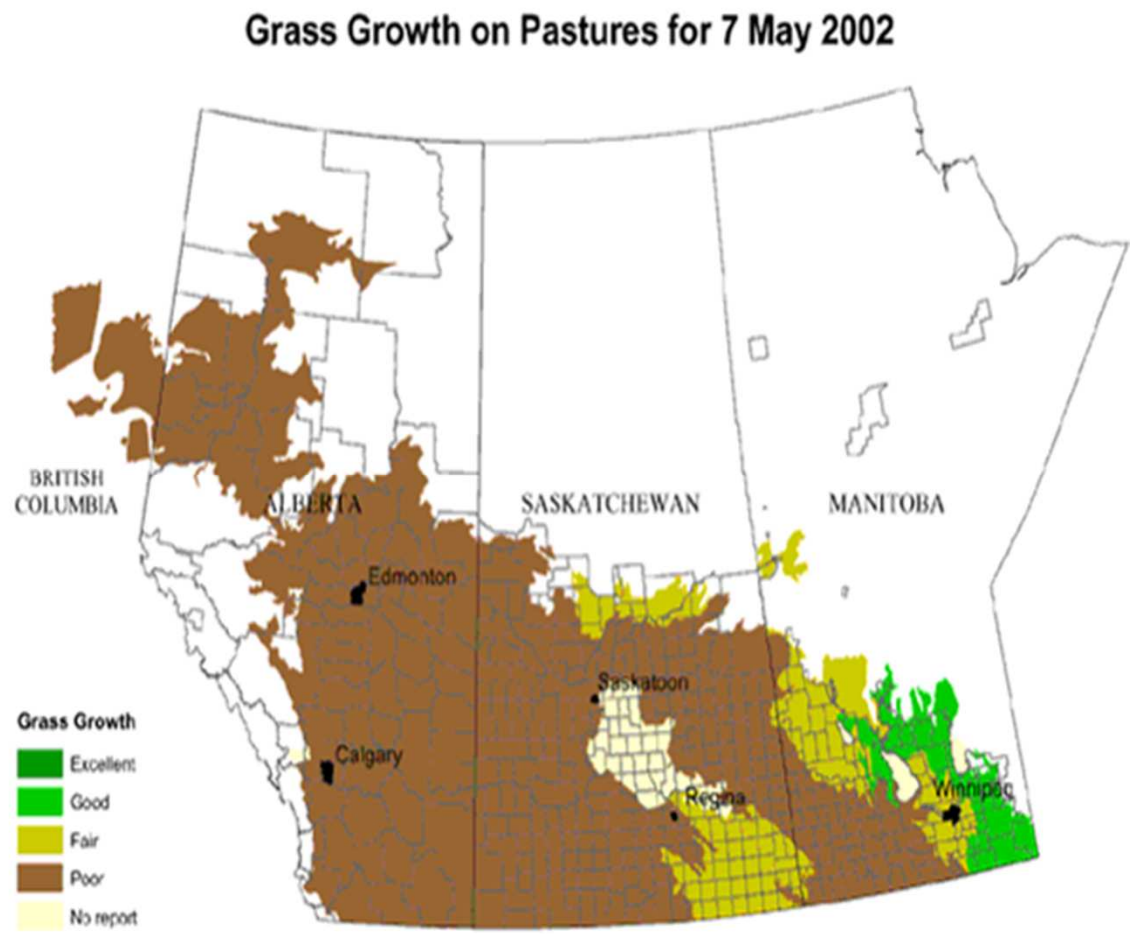


- **Preferred** area for droughts and dust storms in Canada is the southern prairie provinces
- **Northward** extension of these recent droughts appears unusual
- Wheaton et al. (2008)

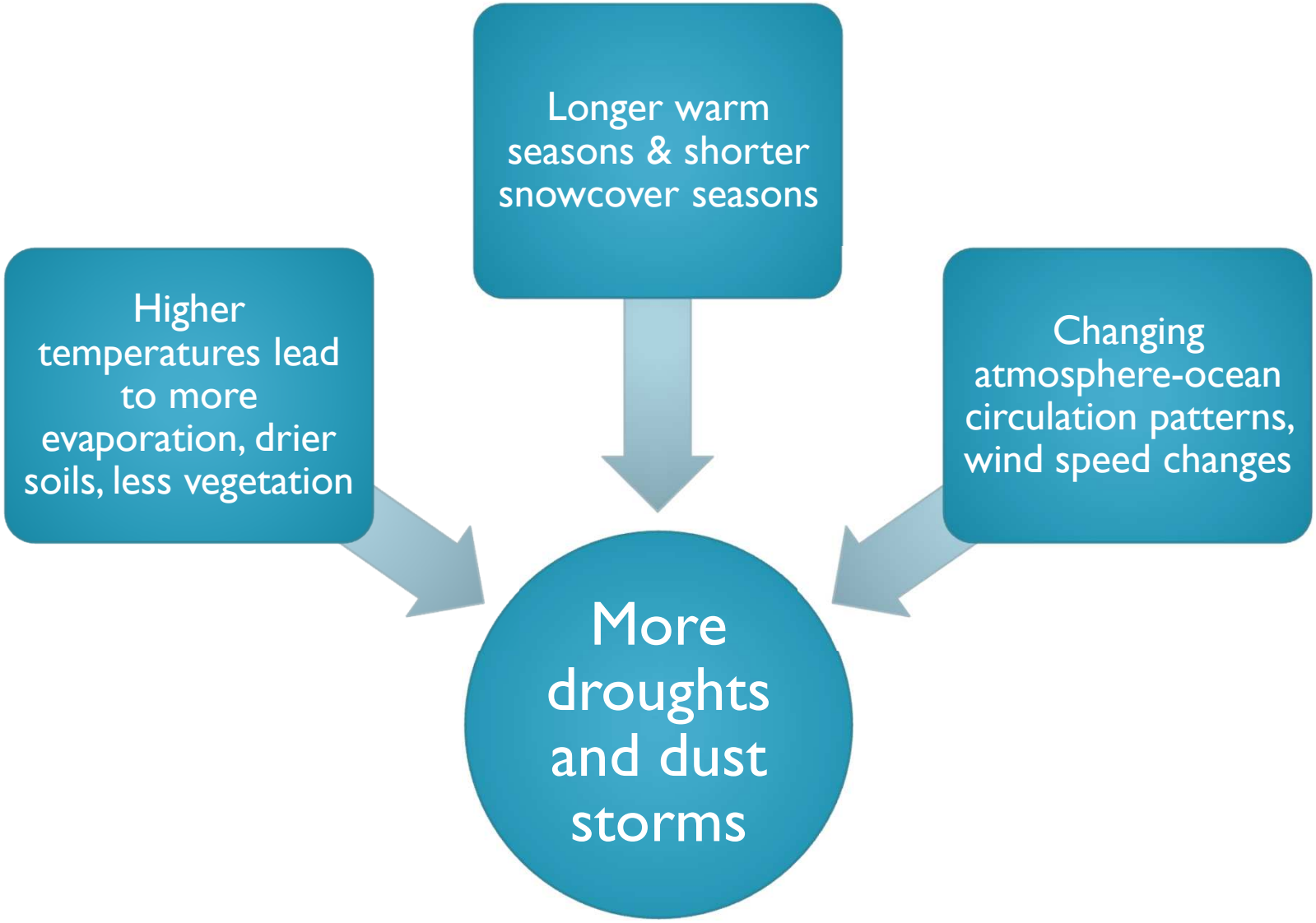
(Wheaton et al, 2005)

Dust storm risk increases with dry soils, poor vegetation cover and exposed soils (e.g., 2001-2 Drought)

- Poor **pasture** growth for all of Alberta across SK and into southwestern MB
- **Crop** growth and production losses were devastating across Canada for many crops
- Map: PFRA AAFC



Causes of Drought and Dust Storms are Changing



Snow Cover protects the Soil

- Snow-cover at end of March has decreased from about 12cm in the 1960s to near 0cm in the 2000s in central ag SK (Beaulieu and Wittrock 2013)
- Snow cover area has shrunk considerably in spring over N Hem (Brown and Robinson 2011, IPCC WG1 AR5 2013)
- Prairie precipitation is highly variable and has shown some decreases with no clear trends (Mekis Vincent 2011)
- But, expect surprises
- Photo J Wheaton March 2013

Dust Storm Trends (after Fox et al. 2012)

- Significant regime shift in the dust time series
- Substantial reduction in dust events after 1990
- Improved land management is a likely cause along with wetter years
- Only the most severe climate forcings resulted in dust events, e.g. 2001-2
- Importance of soil conservation/land mgmt

Figure 3 **Local Wind Erosion with Visibility Reduction Between Rosetown and Sovereign, Saskatchewan, About April 21, 2001** (photo by Dennis Haak, photo source is AAFC)

Photo: AAFC D. Haak

Trends in Particulate Emissions from Agriculture in Canada (Pattey and Qiu 2012)

- Wind erosion and land preparation account for most of the particulate emissions from agriculture (e.g., 82% of PM10 and 76% of PM2.5 in 2006)
- Emissions are greatest in south and central agricultural Saskatchewan (Eilers et al 2010)
- Strong drop in PM emissions from agricultural operations from 1981 to 2006 (40% for PM10 and 47% for PM2.5)
- Cause of drop mostly due to improved land management, e.g., greater use of conservation tillage, direct seeding, and much less summer fallow

Role of Land Management

Photo: PFRA

Land Management Changes partly a cause of Decreased Dust Storms

(Fox et al. 2012)

- Percentage of farms under summer fallow declined substantially from 1976 to 2006
- Direct seeding was about 10% of the cultivated area in 1991 and rose to over 60% in Saskatchewan in 2006
- Wet years also played a role
- Importance of land management

Future Possible Droughts and Changing Dust Storm Risks

Future Possible Droughts and Dust Storms? (Wheaton et al 2013)

- Chances of multi-year droughts increase
- Increases in severity and area
- Droughts overwhelm the increases in average precipitation
- Expect surprises, such as switches to extreme rainfalls (and increased risk of water erosion)

Future Possible Droughts (Bonsal et al. 2012)

- Frequency of droughts of 6-10 months increases by ~ 4 events by the 2050s
- Number of droughts at least 5 years long doubles towards 2099 and decade-long droughts triple
- More and worse droughts bring more dust storms

Wind Erosion Management:

Adaptation and Research

Photo: Wheaton Jan 2010
S of Saskatoon

Adaptation to decrease the risk of dust storms

- Increasing knowledge, preparation and implementation of strategies
- Early warnings
- Soil and water conservation measures
- Minimum tillage to maintain vegetation cover
- Establish and maintain shelterbelts
- Sustainable grazing methods

Knowledge Gaps

- Monitoring
- Modeling
- Effects of adaptation
- Effects of climate change, e.g., reduced snow and vegetative cover, increased evaporation
- Future possible wind erosion and dust storms
- Many more
- Photo: E Wheaton Jan 2010 S of Saskatoon

Conclusions

- The drought of 2001-2002 was a **stern test of farm management practices which reduce wind erosion**
- Although **wind erosion was severe**, it would probably have been much worse without the increase in soil conservation practices in the past decades
- Future possible risk increases mean improved research and adaptation are needed

Photo: PFRA, AAFC

Abstract

- **Dust Storms of the Canadian Prairies: A Dustier and Muddier Outlook**
- E Wheaton
- Dust storms are serious hazards that result in environmental, health, and socio-economic damage. Soil lost during dust storms can take decades and longer to restore, and has high agricultural costs. The objectives are to characterize dust storms in the Canadian Prairie Provinces, their impacts, adaptation, barriers to dust storm research, and to explore future possibility of dust storms. The drought-prone areas of Alberta and Saskatchewan in the Canadian Prairies have the most frequent dust storms. Droughts bring greater risks of dust storms, with the strongest relationship during the worst drought years. Examples are given from a major drought in the Canadian Prairies that peaked during 2001-2002 and produced several dust storms. At least 32 blowing dust events occurred in Saskatchewan in 2001-2002. Dust storms caused several traffic accidents and two lives were lost. Another outcome was considerable agricultural effects, including soil loss and crop damage. More frequent, severe, and longer droughts are expected in the future and this means a greater risk of dust storms. Even with the technology and expertise of the time, many dust storms occurred in 2001-2002. This indicates that much greater improvements are needed to reduce future dust storm risk.

Management Examples (AB AARD 2001)

- Maintain a vegetative cover
- Reduce or eliminate tillage
- Plant and maintain field shelterbelts
- Avoid over-grazing
- Conserve soil moisture
- Many more
- Photo PFRA, AAFC