Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada



Climate Change and Food Security

Agricultural Production under Climate Change

S. Gameda[1], B. Qian[1], P. Falloon[2], J. Gornall[2]
[1]Eastern Cereal and Oilseed Research Centre
Agriculture and Agri-Food Canada, Ottawa, Canada
[2]UK Met Office Hadley Centre, Exeter, UK

McGill Conference on Global Food Security
October 5 – 7, 2009 McGill University, Montreal, Canada

Canada

Climate Change and Implications for Agriculture

IPCC 2007

- Warming of the climate system is unequivocal
  - increases in global average air and ocean temperatures
  - widespread melting of snow and ice
  - rising global sea level
- Most of the observed increase in temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG emissions

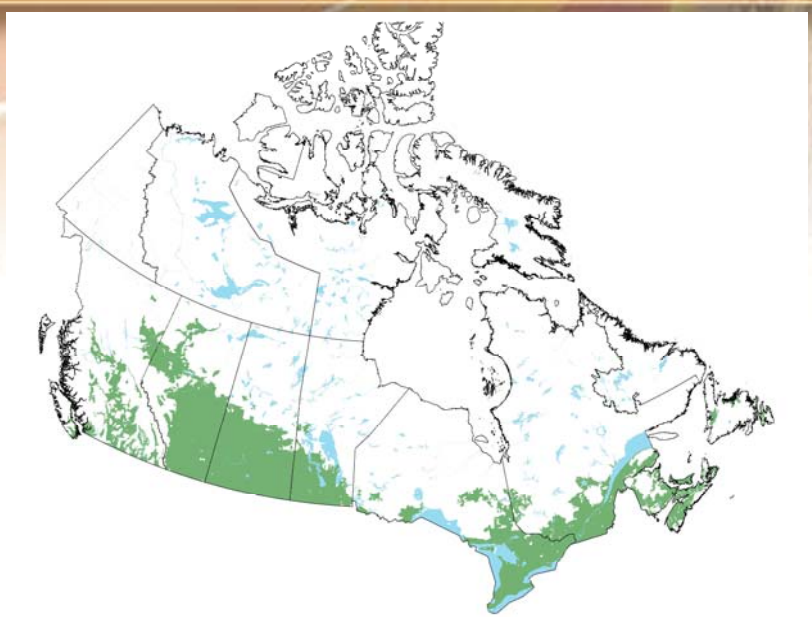
- Some projected changes of note for agriculture
  - Increase in frequency of extreme events (heat waves, droughts, heavy precipitation)
  - Decrease in water resources in many semi-arid areas

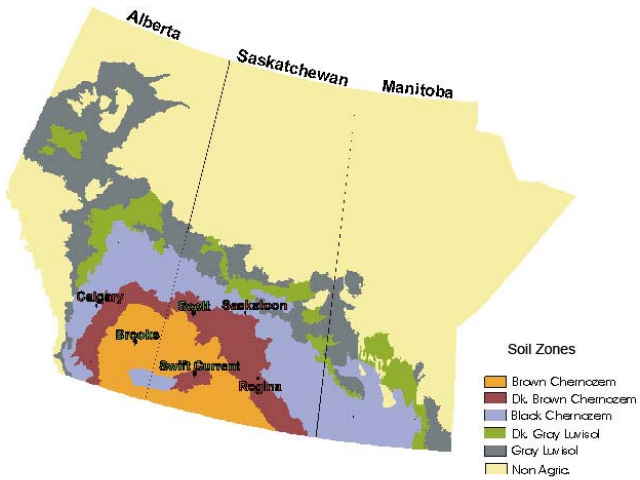
Climate Change Impacts on Canadian Agriculture

How will climate change affect agricultural production in Canada

- Growing season length
- Crop heat units
- Precipitation
- Water deficits

Climate Change Impacts on Canadian Agriculture





Canada 4th largest exporter, 5th largest importer of agricultural and food products

Canadian Prairies an important region for crop production

(80-85% of Canadian agricultural production)

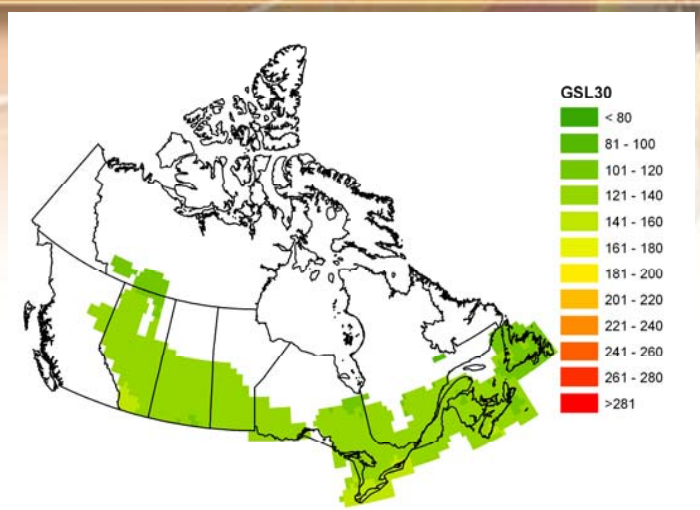
Characteristics:

- Annual temp 0 – 5 C
- Annual precip <350 – >400 mm
- ET 500 – 700 mm
- Moisture Deficit 0 – 400 mm

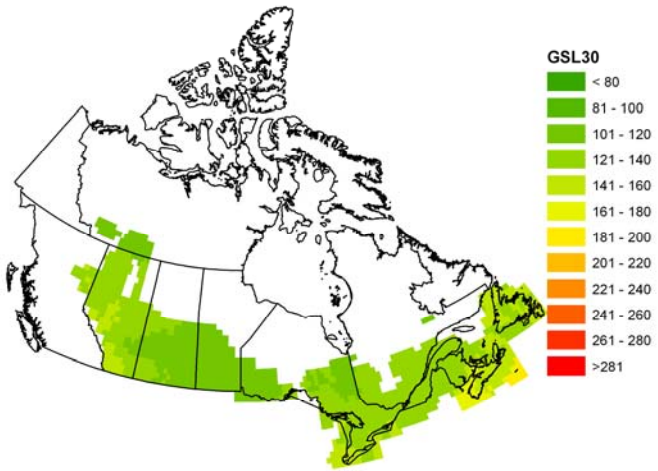
Limiting Factors:

- Growing season length
- Crop heat units
- Moisture

GSL (Cool season crops)



Baseline



A1B 2040-2069

Growing season length (GSL) based on minimum cardinal temperature for cool season crops (5ºC)

Baseline (1961-1990):

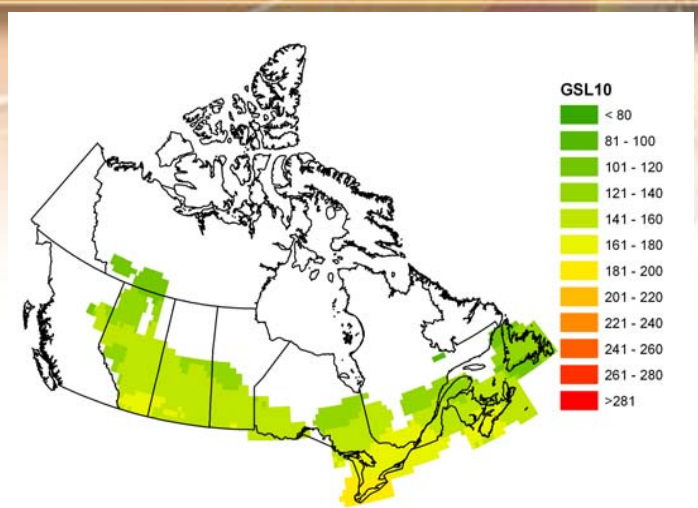
- 110 – 155 days

2050s (2040-69 CGCM3 A1B):

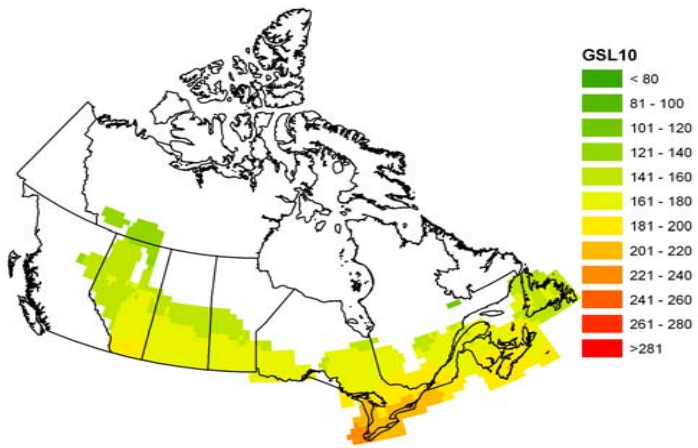
- 105 – 160 days

• *Little change in growing season length for cool season crops such as small grain cereals (wheat, barley)*

GSL (Warm season crops)



Baseline



A1B 2040-2069

Growing season length (GSL) based on minimum cardinal temperature for warm season crops (10ºC)

Baseline (1961-1990):

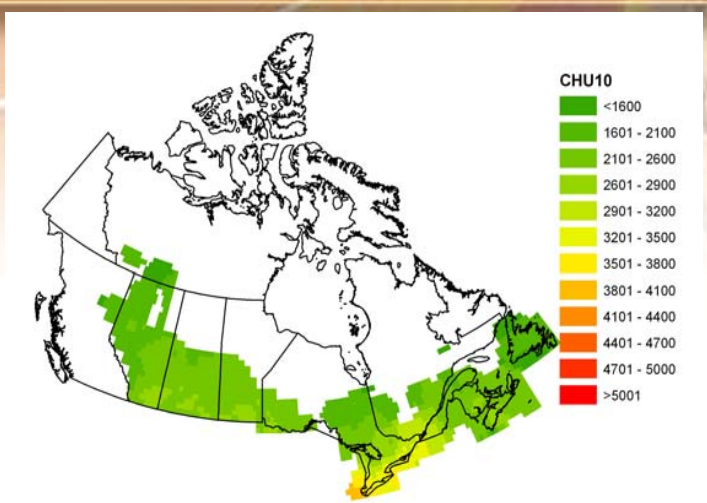
- 110 – 170 days

2050s (2040-69 CGCM3 A1B):

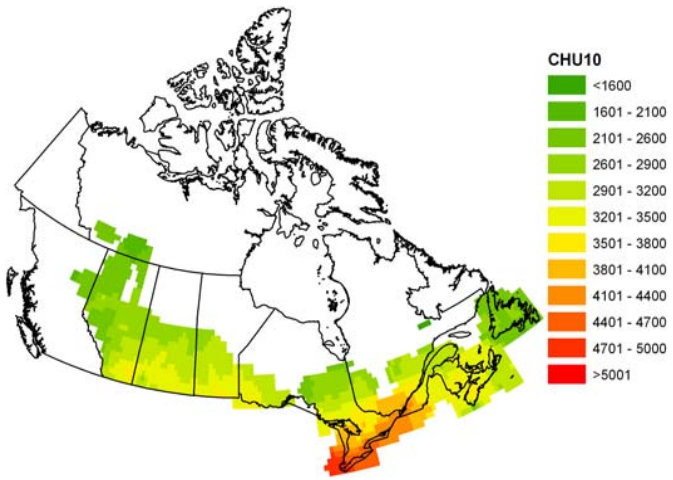
- 125 – 195 days

- Substantial *change in growing season length for warm season crops such as corn, soybeans*
- *Potential for shift to warm season crops in Canadian Prairies*

Crop Heat Units (CHU)



Baseline



A1B 2040-2069

Crop Heat Units (CHU) accumulated over the growing season for warm season crops

Baseline (1961-1990):

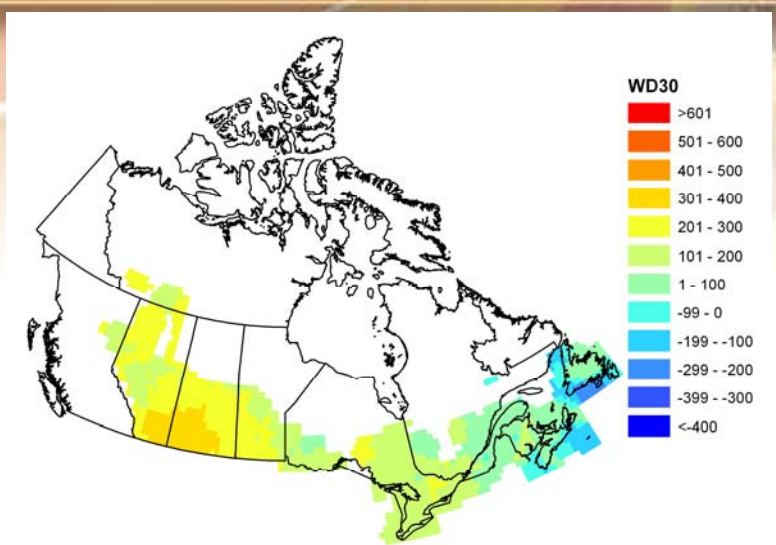
- 1350 – 2850

2050s (2040-69 CGCM3 A1B):

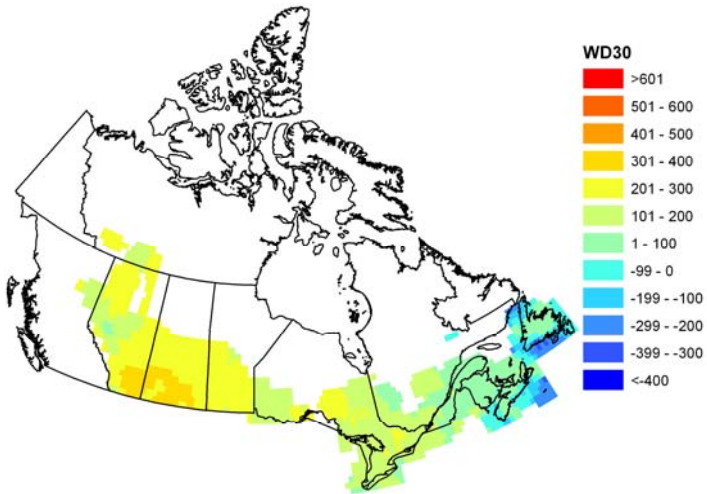
- 1930 – 3600

- Substantial increase in CHU
- *Corroborates potential for shift to warm season crops in Canadian Prairies if other factors (soil, moisture) not limiting*

WD (Cool season crops)



Baseline



A1B 2040-2069

P-PE accumulated over the growing season for cool season crops

Baseline (1961-1990):

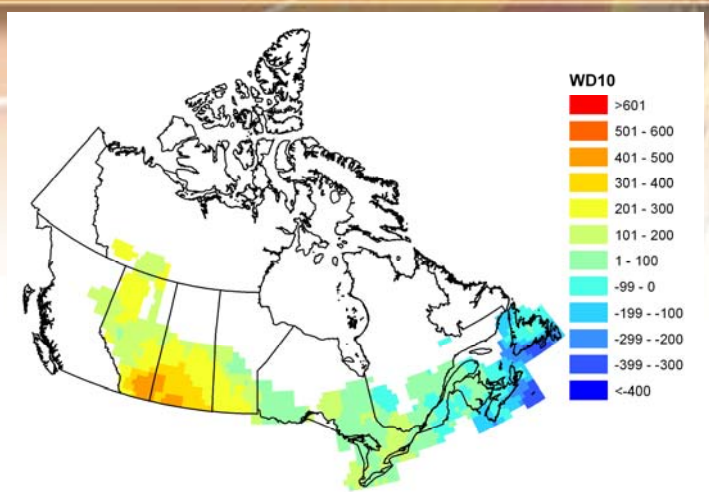
- 110 – 395 mm

2050s (2040-69 CGCM3 A1B):

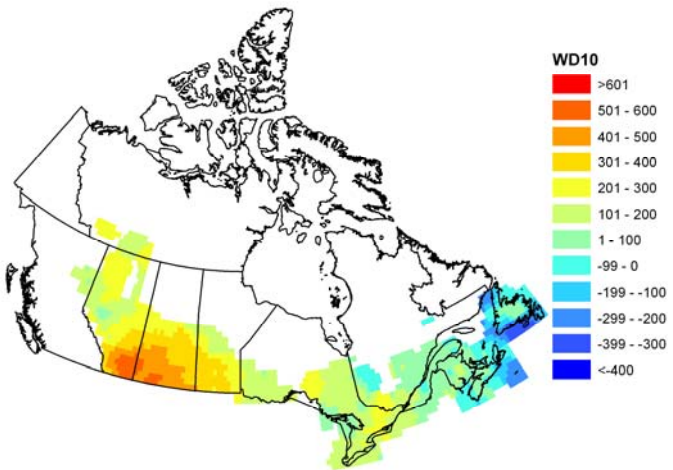
- 60 – 375 mm

• *Little change (even slight reduction) in projected water deficits for cool season crops such as small grain cereals*

WD (Warm season crops)



Baseline



A1B 2040-2069

P-PE accumulated over the growing season for warm season crops

Baseline (1961-1990):

- 75 – 475 mm

2050s (2040-69 CGCM3 A1B):

- 50 – 575 mm

• *Relatively small but discernable increase (up to 100 mm) in projected water deficits for warm season crops*

Implications for Crop Production

These projections suggest

- Potential increases in growing season length, particularly for warm season crops (corn, soybeans)
- Substantive increases in crop heat units to allow shifts to higher value crops
- Manageable increases in growing season water deficits implying no significant increase on crop moisture stress

Implications for Crop Production

These findings suggest that climate change could be beneficial for the production of annual crops in Canada

However

- Year to year variability not taken into account
- Historical and cyclical extreme weather events, mainly droughts, that have significantly affected crop production, and farm income and livelihood, have not been captured in climate change projections

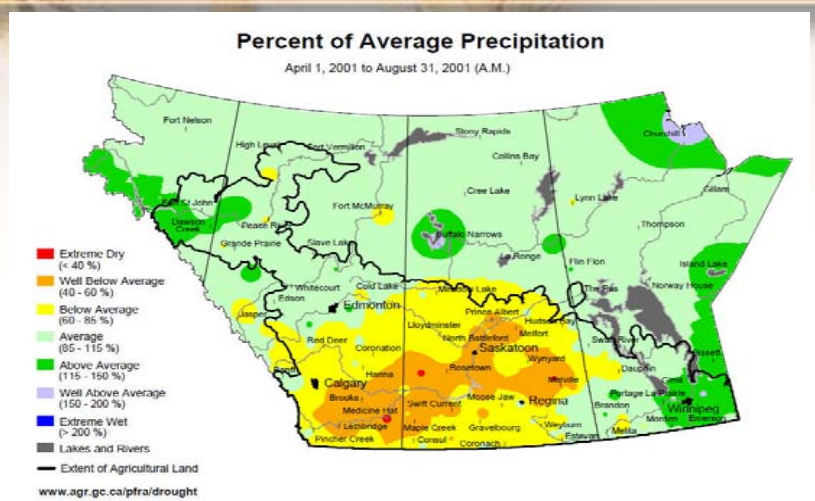
Implications for Crop Production

Significant droughts occur relatively frequently (e.g. 1984, 1996, 2001)

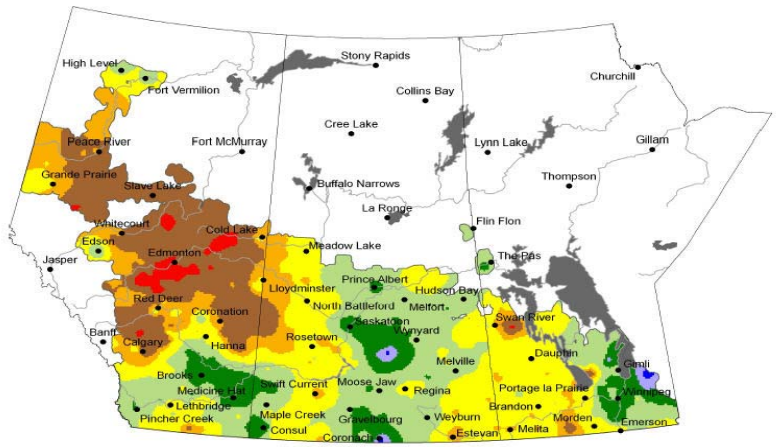
The 2001/02 drought is estimated to have resulted in economic losses in excess of $5 billion

Severe drought in 2009 leading to crop yield reductions and crop failures – economic costs still being tallied

- It is projected that the severity and frequency of these events will likely increase under climate change
- Implications for food security, both nationally and internationally, are significant

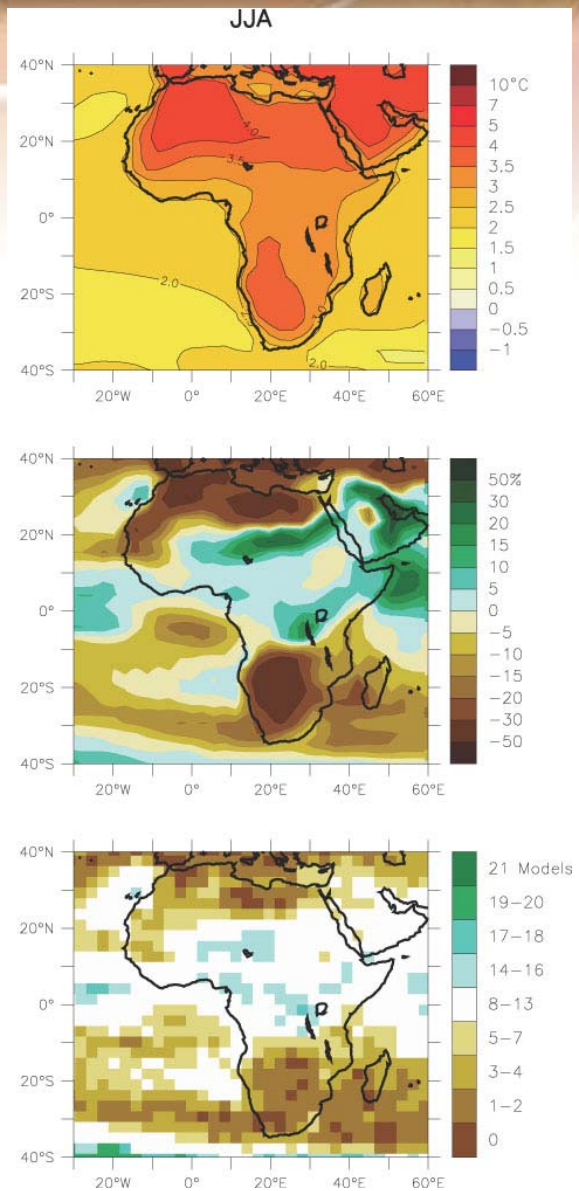


2001



2009

IPCC Projections for Agriculture in Africa



- Temperature increases of 2-5ºC (beyond optimal ranges for crop production)
- Rainfall reductions of as much as 50%
- Indications of “alarming” losses in areas suitable for agricultural production

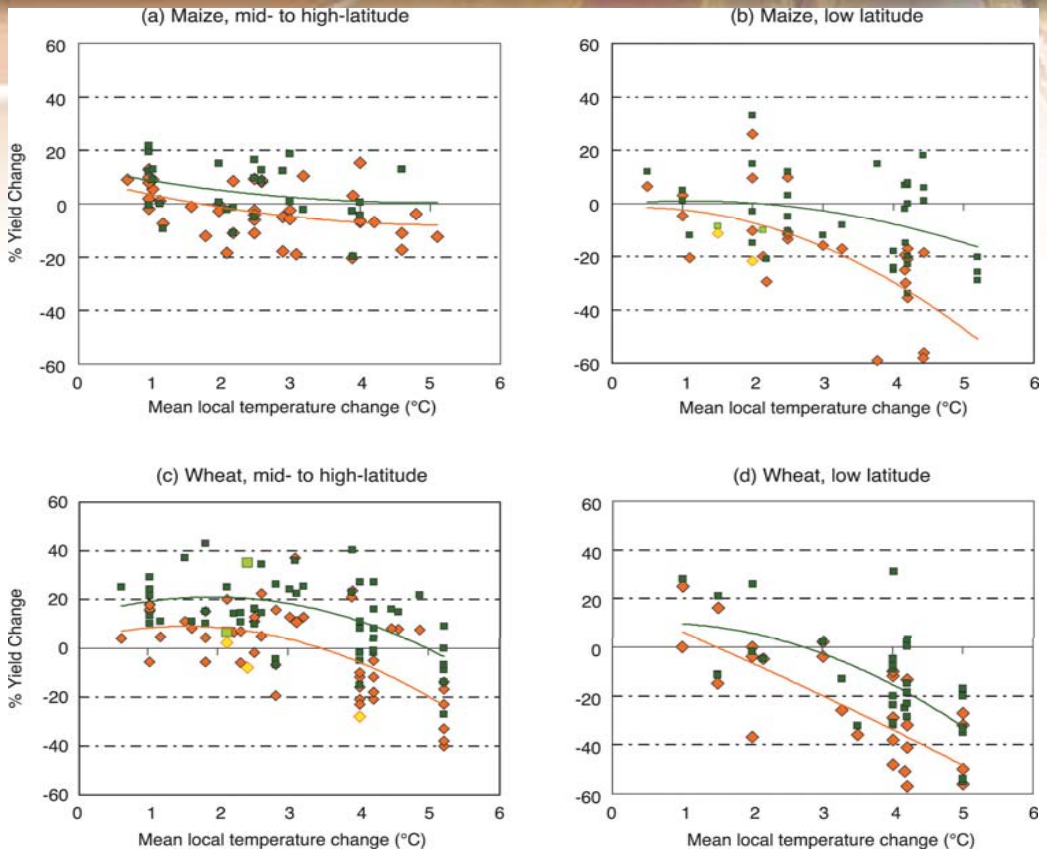
Important Factors:

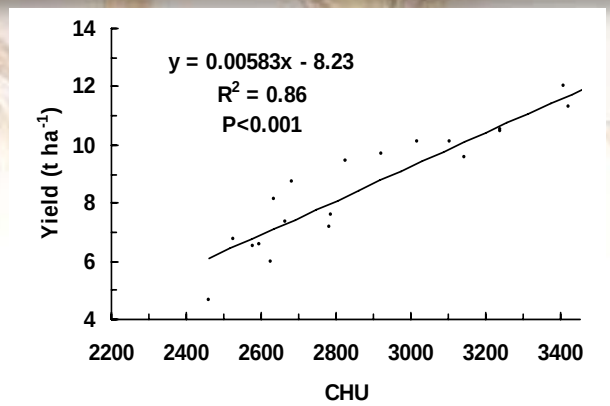
- Soil resources
- Rainfall (onset, seasonal amount, intensity)
- Temperature
- Year to year variability

GCMs weak in simulating

- Precipitation
- ENSO and similar drivers of climate variability
- Persistence and intensity of extreme events

Implications of Temperature Change (IPCC)





Corn yield v CHU

Bootsma et al. 2005

IPCC summaries indicate yield reductions with increasing temperature, with greater rates of reduction in low latitudes

Our findings suggest increased yields over the range of CHU projected for the Canadian Prairies

Evidence of Change from Current Climate

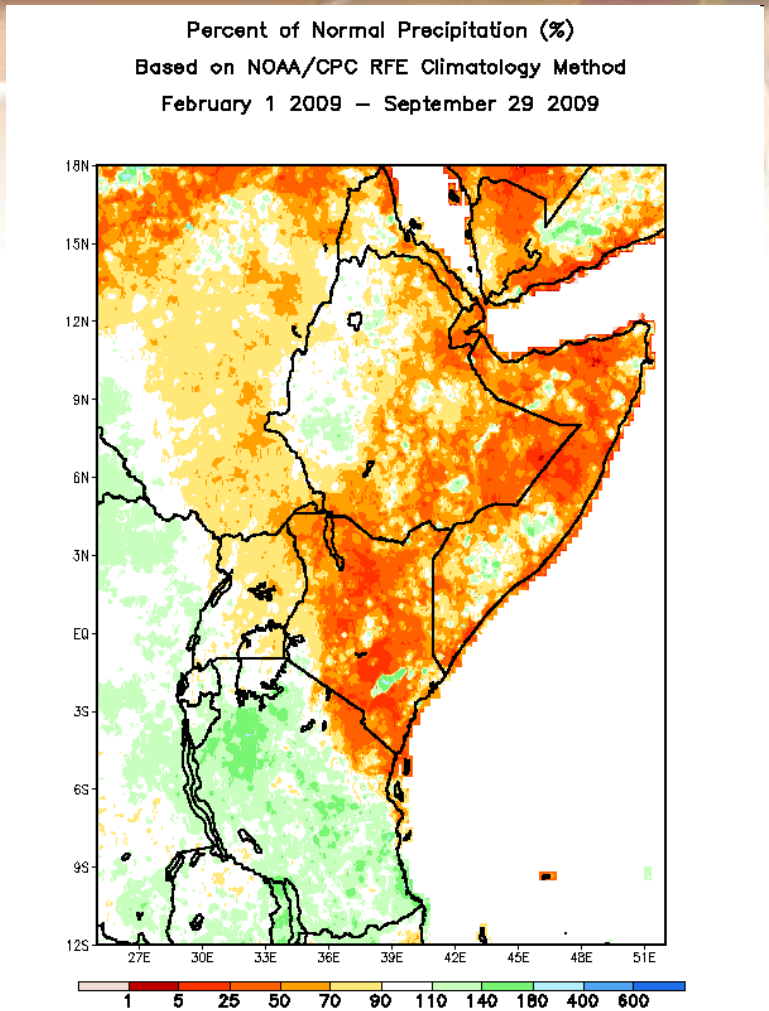
Rainfall onset, seasonal amounts and intensity a critical factor for agriculture in low latitudes

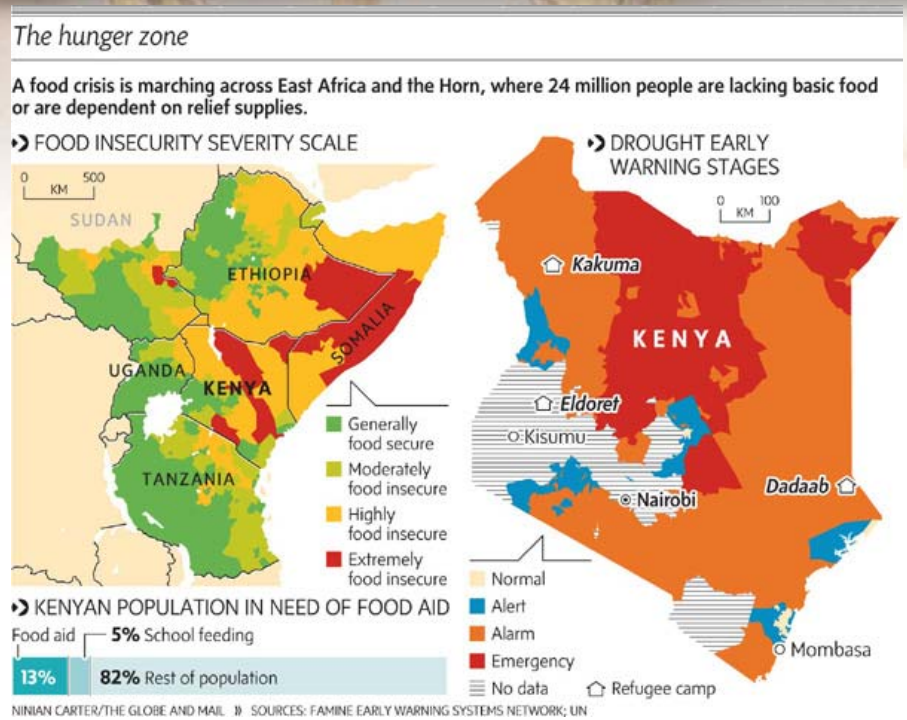
The onset and rainfall amounts of African and Asian monsoons have manifested increased variability with associated increases in risks to food security

- Greater links with ENSO, Indian Ocean SST

- Reports of significant delays in crop planting for the 2009 season
- Evidence of significant reductions in surface and groundwater resources

Impacts of Current Climate





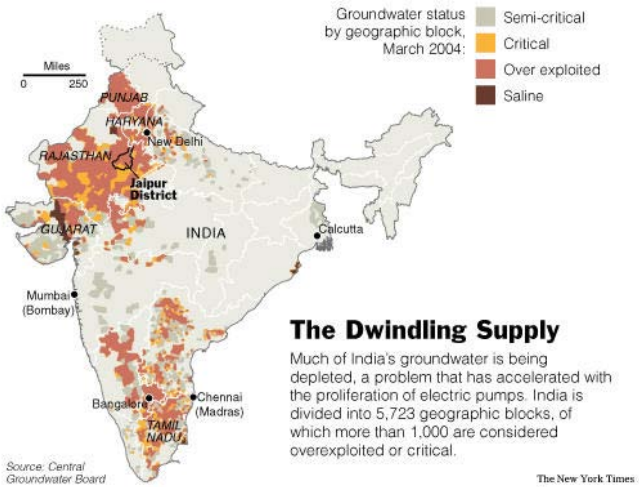
Evidence of significant rainfall departures and risks to food security

NOAA/CPC, FEWSnet

Impacts of Current Climate

Drought Puts Focus on a Side of India Left Out of Progress

Keith Bedford for The New York Times



Kenyan farmers watch their livelihoods – and food supply – disappear

Climate change is believed to be at the heart of the region's droughts.

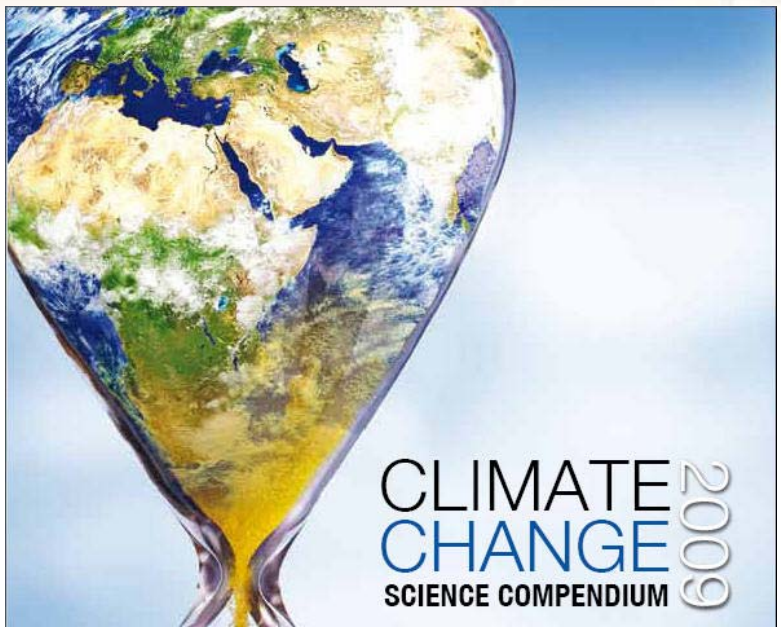
East Africa Drought In Fifth Year, Millions Hungry

Some impacts reported in the news:

- 24M in E. Africa at severe risk of hunger and destitution
- failed or unpredictable rains
- wet seasons becoming shorter
- droughts once every 2, 3 years
- severe groundwater depletion

Sources: Globe and Mail, New York Times

Recent Reports on Climate Change, Food Security



Summary

- Projected climatologies indicate generally beneficial agricultural production conditions for Canada, but harmful ones for regions in low latitudes
- The projected climate for the Canadian Prairies does not capture the cyclical droughts that occur in the region
- Climate models show low skill in simulating climate variability and extreme climatic events – events closely linked to food security
- Food security will be increasingly challenged under climate change, particularly in the low latitudes, which currently experience substantial food insecurity


Merci!
Thank You!