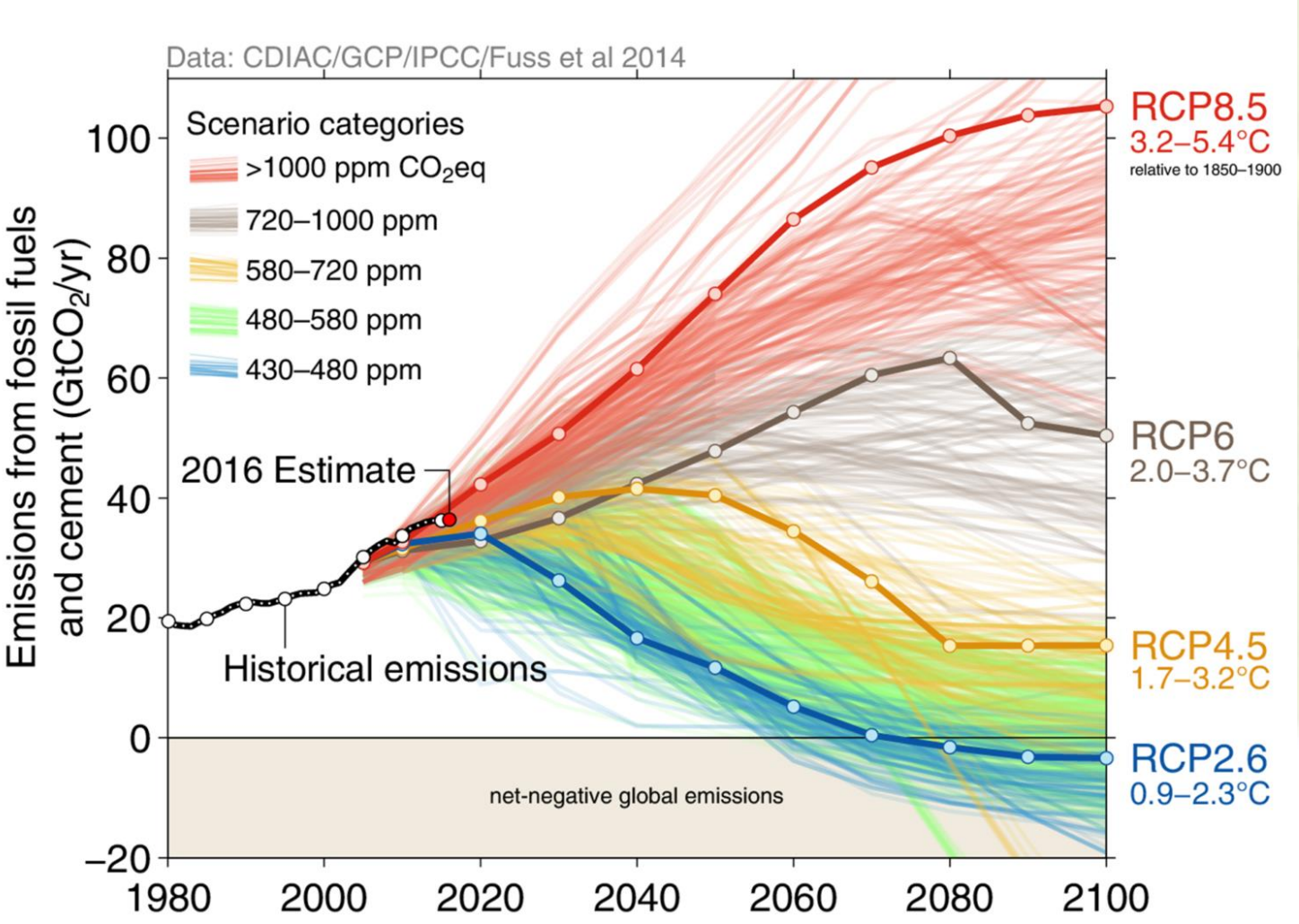
Gardening Under a Changing Climate

A Note on Models

- “All models are wrong – but some are useful”
  - - George E. P. Box

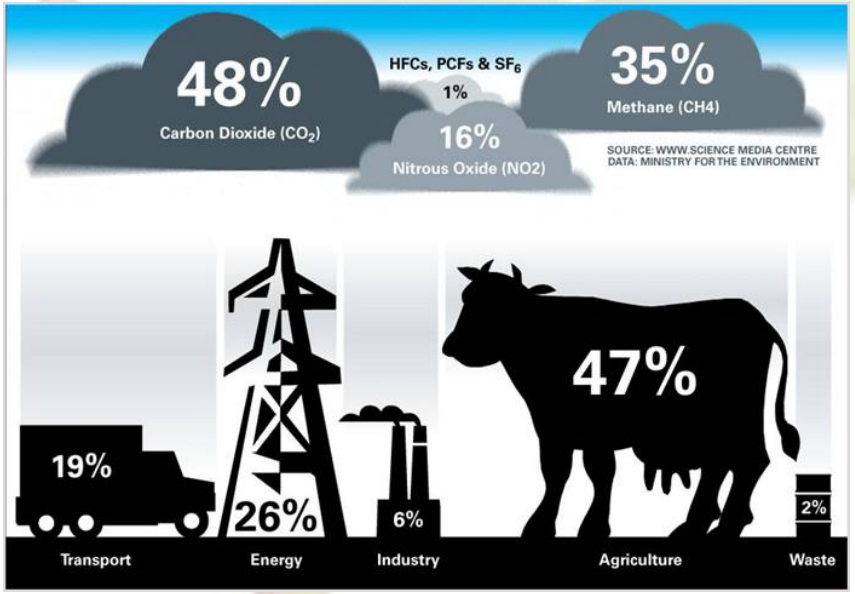
Lovat 2018

A Note on Models



A Note on Models

- The math is correct
- Where these models differ is in:
  1. Future levels of pollution
  2. How important different types of pollution will be



A Note on Models

- For the purposes of this presentation:
  - Taking most recent projections from the Government of Canada
    - Can be accessed at https://climatedata.ca
- Predictive models are generally conservative:
  - Likely, true climate change will be more extreme than is reported here

Climate Change

- Climate change overview for Montreal area:
  - Increased CO_2
  - Increased average annual temperatures
    - Increase in extreme temperature events
  - Changes in precipitation levels

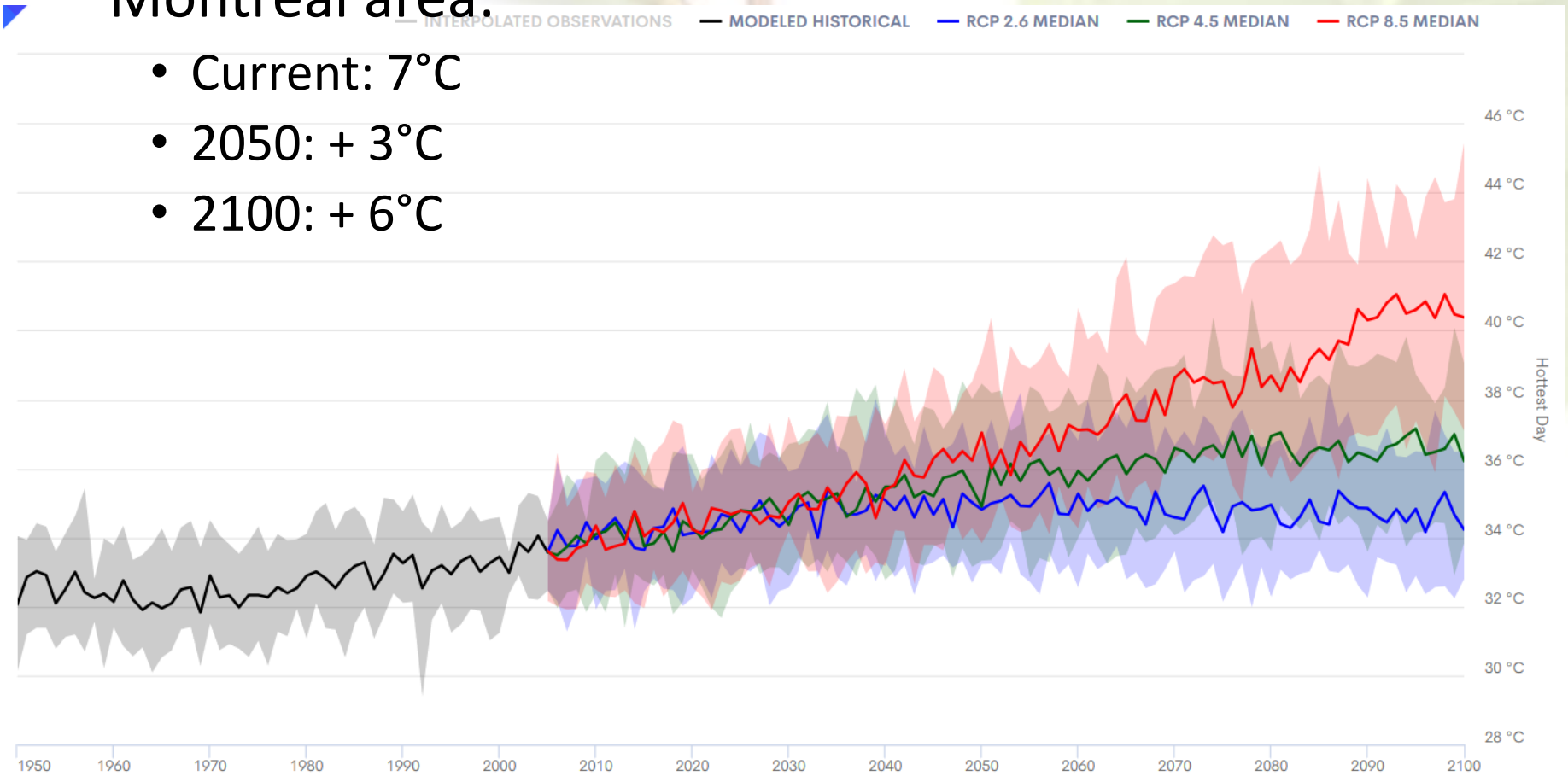
Climate Change – CO_2

- Increase in atmospheric CO_2:
  - Currently: ~ 400 ppm
  - 2050: ~ 500 ppm
  - 2100: ~ 950 ppm

- Historical context:
  - Last time atmospheric CO_2 was ~ 500 ppm:
    - 2 million years ago
  - Last time atmospheric CO_2 was ~ 900 ppm:
    - 25 million years ago

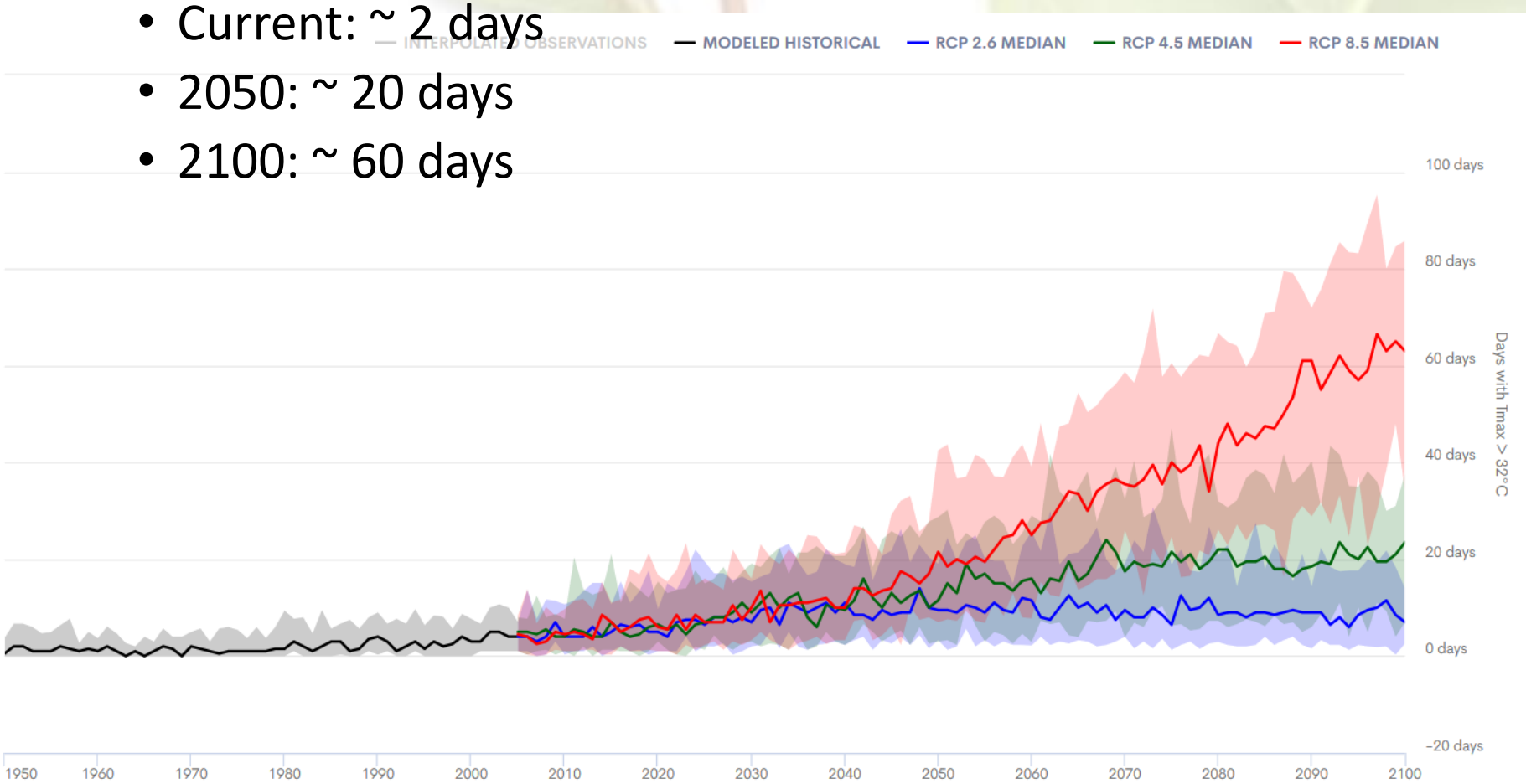
Climate Change - Temperature

- Increase in average seasonal temperature for the Montreal area:
  - Current: 7°C
  - 2050: + 3°C
  - 2100: + 6°C



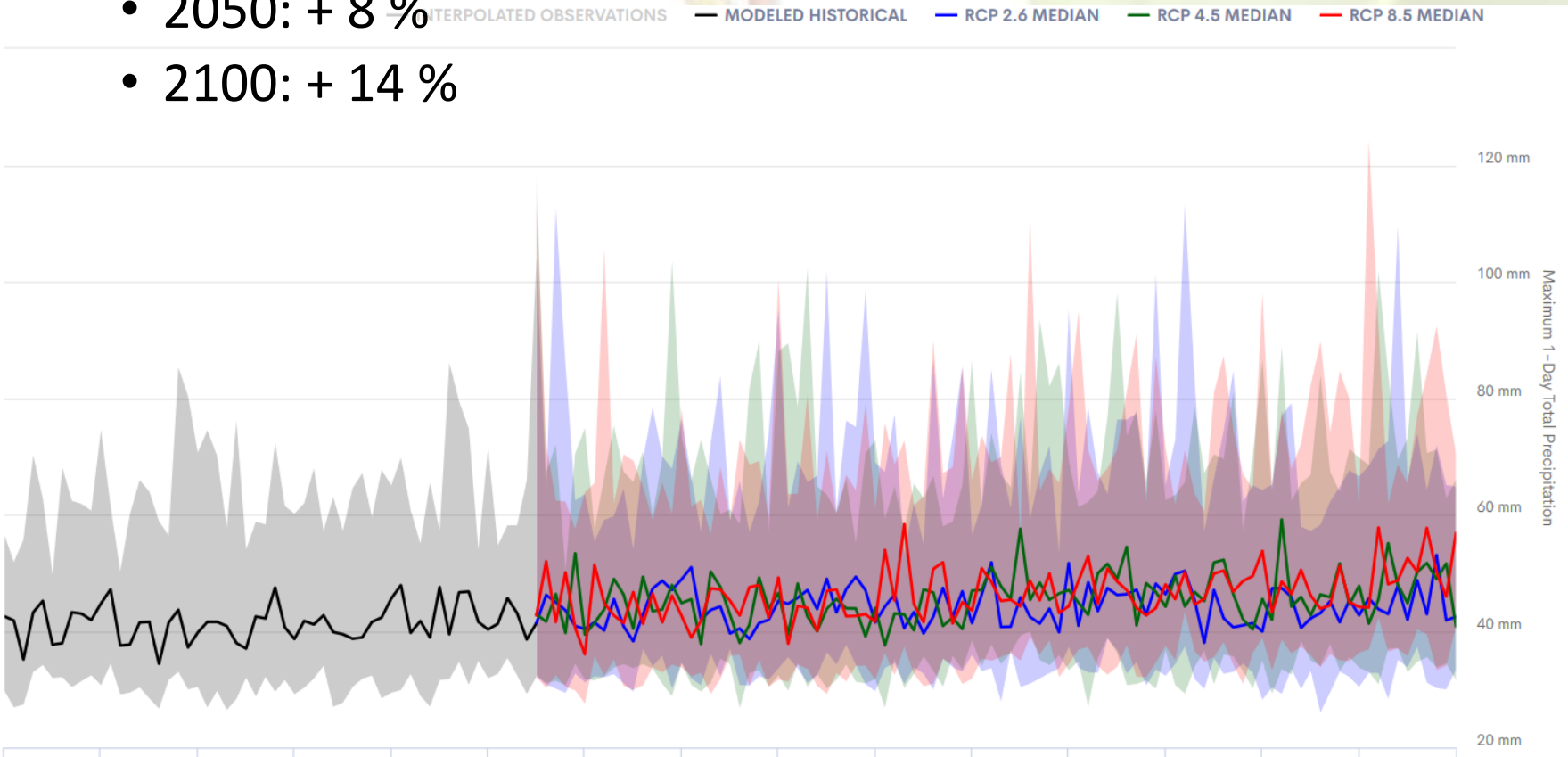
Climate Change - Temperature

- Increase in number of extreme heat days (> 32°C):
  - Current: ~ 2 days
  - 2050: ~ 20 days
  - 2100: ~ 60 days



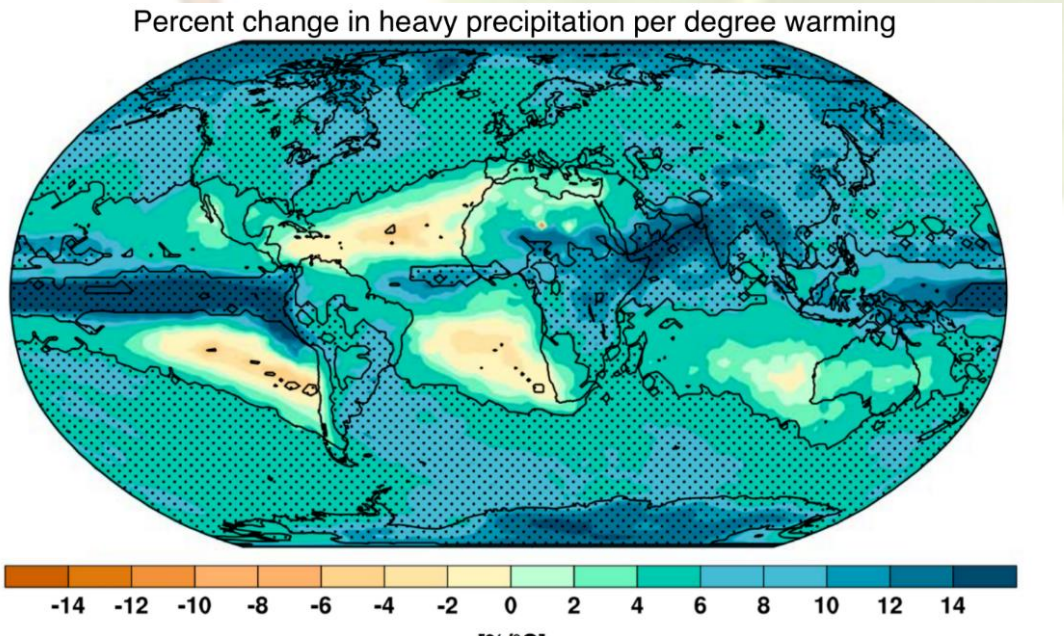
Climate Change - Precipitation

- Increases in annual precipitation:
  - Current: 1028 mm
  - 2050: + 8 %
  - 2100: + 14 %



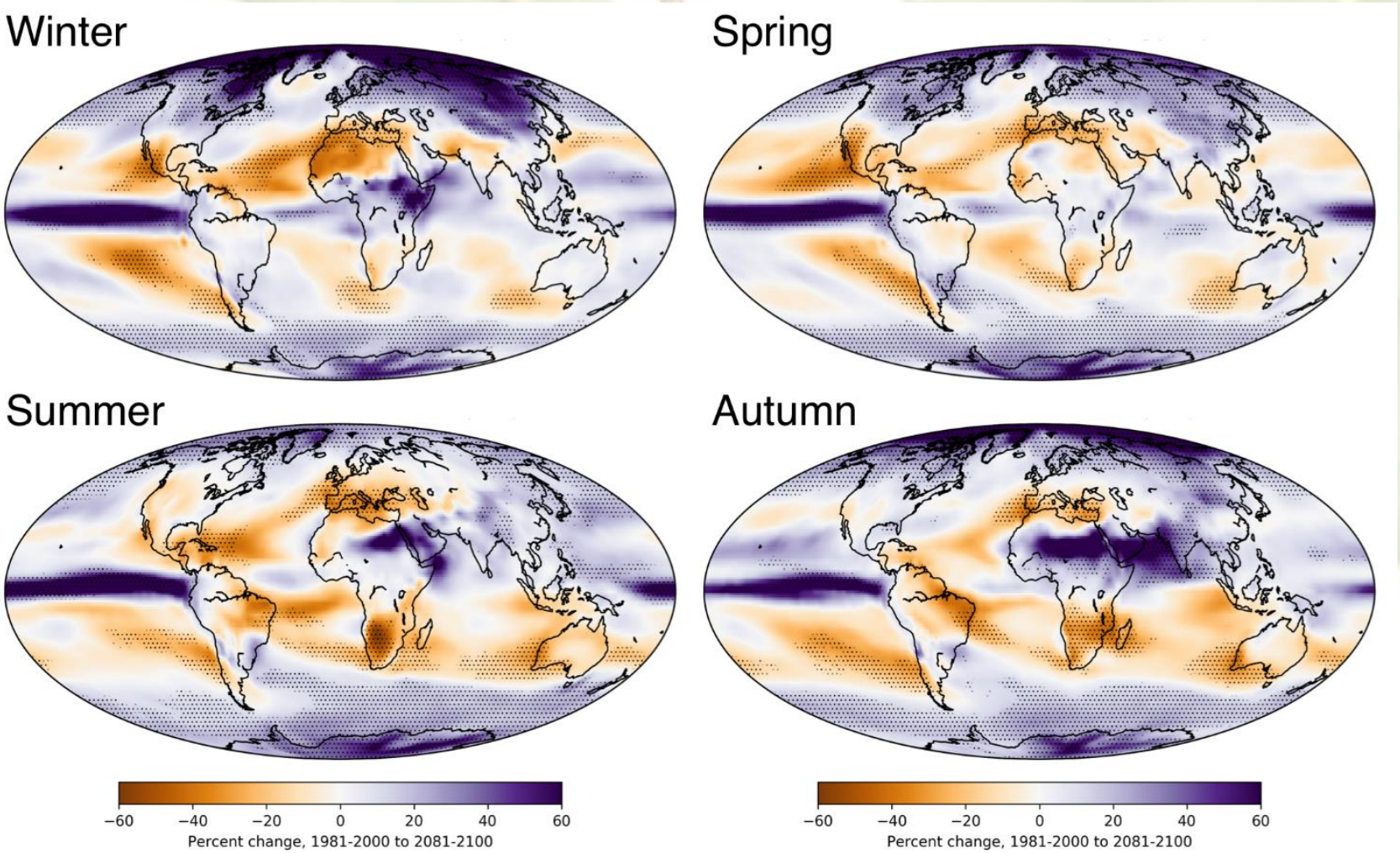
Climate Change - Precipitation

- Increased temperature:
  - Increased evaporation of soil moisture and surface water
- For every 1 °C increase in average temperature:
  - ~ 7 % more moisture in the air
- By 2100:
  - 16 – 24% increase in heavy precipitation



Lovat 2018

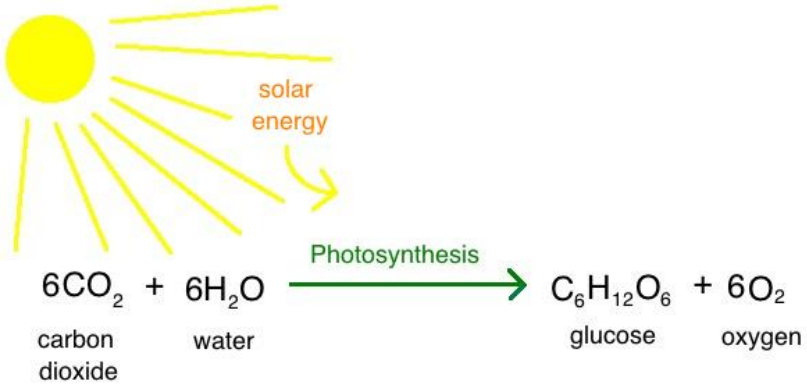
Climate Change - Precipitation

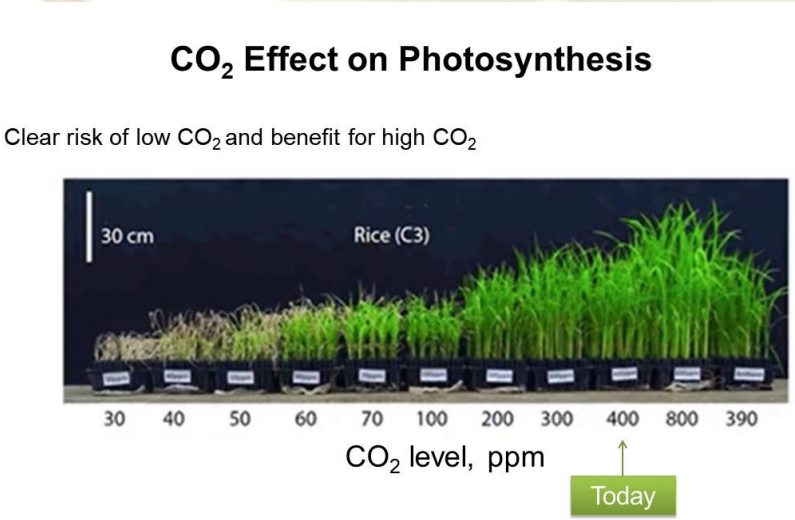


Climate Change in the Garden

Increased CO_2

- Increased CO_2 = increased rate of photosynthesis
  - Increased photosynthesis = increased energy production for the plant
    - Increased energy = increased growth
- Termed the "CO_2 fertilization effect"





CO_2 Fertilization

- Annuals increase growth the most:
  - In particular, grasses!
- Perennials will initially show increased growth
  - But then slow down over time
  - Seem to acclimate to increase CO_2

Lovat 2018

CO_2 Fertilization

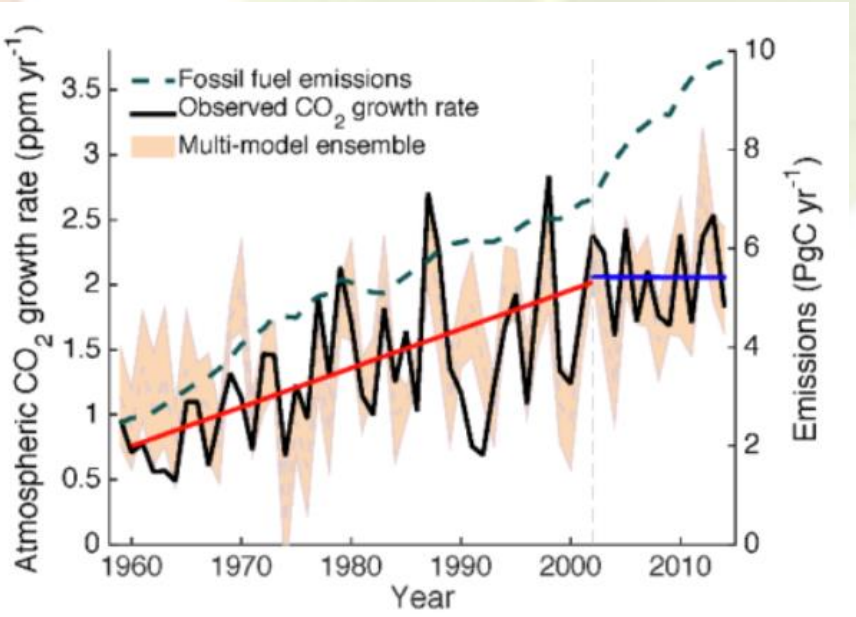
- Evidence from recent study:
  - Globally, plants have been increasing their photosynthetic rate as CO_2 increases!
    - May even be responsible for a temporary slow-down in atmospheric CO_2, despite steadily increasing human output

Article | Open Access | Published: 08 November 2016

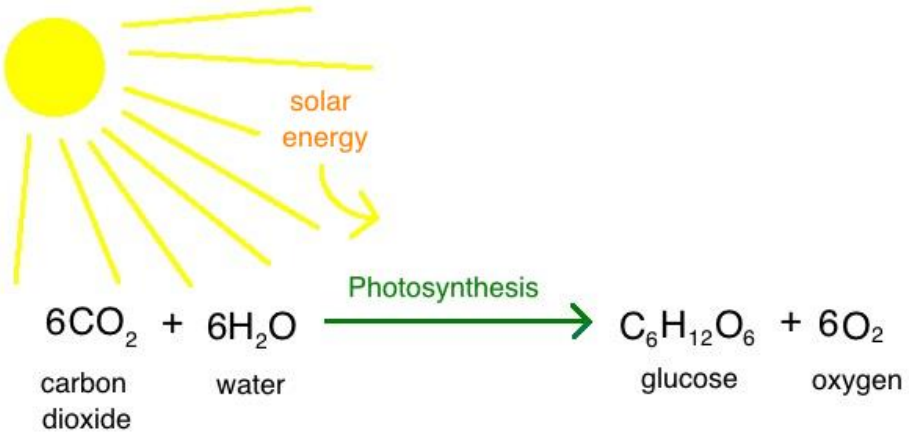
Recent pause in the growth rate of atmospheric CO_2 due to enhanced terrestrial carbon uptake

Trevor F Keenan ✉, I. Colin Prentice, Josep G Canadell, Christopher A Williams, Han Wang, Michael Raupach & G. James Collatz

Nature Communications **7**, Article number: 13428 (2016) | Cite this article



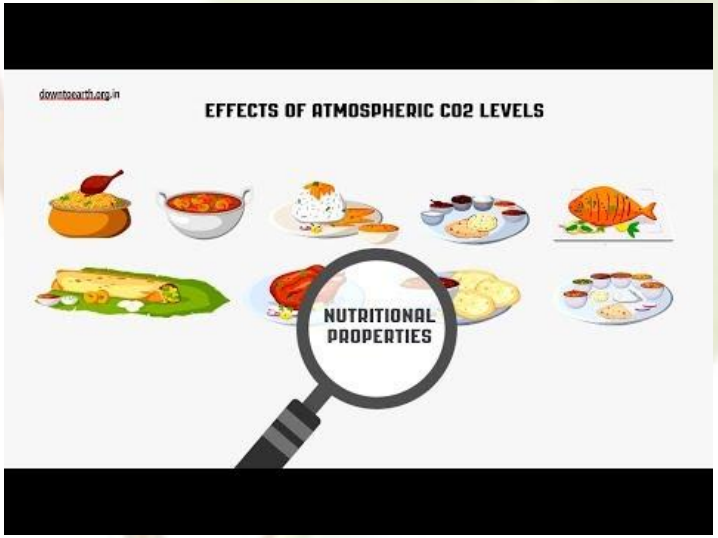
CO_2 Fertilization



- More sugars = less of everything else
  - Only so much room in a plant!
- Increased atmospheric CO_2 leading to a loss of major nutrients in plant tissues:
  - The Junk Food Effect

The Junk Food Effect

- Landmark paper from 1999 demonstrates that since 1950, nutrient levels have already fallen in our food
  - Examined 13 nutrients in 43 garden crops
  - All 43 showed declines
    - Main declines in 6 nutrients:
      - Protein
      - Calcium
      - Potassium
      - Riboflavin
      - Ascorbic acid

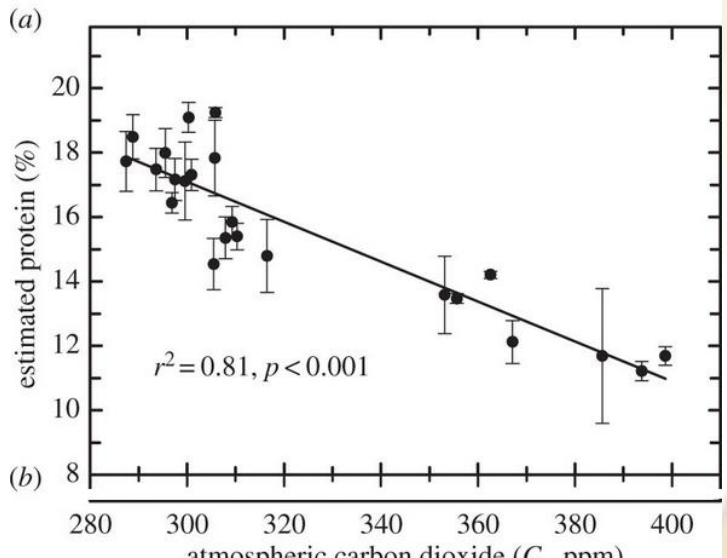


The Junk Food Effect

- Goldenrod:
  - Very important wild flowering plant species for bees in North America
- Goldenrod flowers late in the season (Sept – Oct)
  - Usually only flower at this time period, crucial for honeybees and bumblebees

The Junk Food Effect

- Protein content in Goldenrod pollen has declined by 33% since 1842
  - Protein necessary to help bees overwinter
  - May be a factor contributing to increasing colony die-offs overwinter



Increased CO_2 - Gardening

- Plants to avoid with increased CO_2:
  - Most plants will do fine under increased CO_2
- Plants that will thrive under increased CO_2:
  - Fast growing annuals:
    - Asters
    - Grasses
  - Your lawn!
  - Unfortunately, weeds will grow much faster as well!

Increased CO_2 - Gardening

- Special considerations:
  - If you want to help out pollinators:
    - Plant species with prolific pollen production!
      - Especially important in spring and fall!

Increased CO_2 - Gardening

- Spring plants for pollinators:

Creeping Phlox

Periwinkle

Increased CO_2 - Gardening

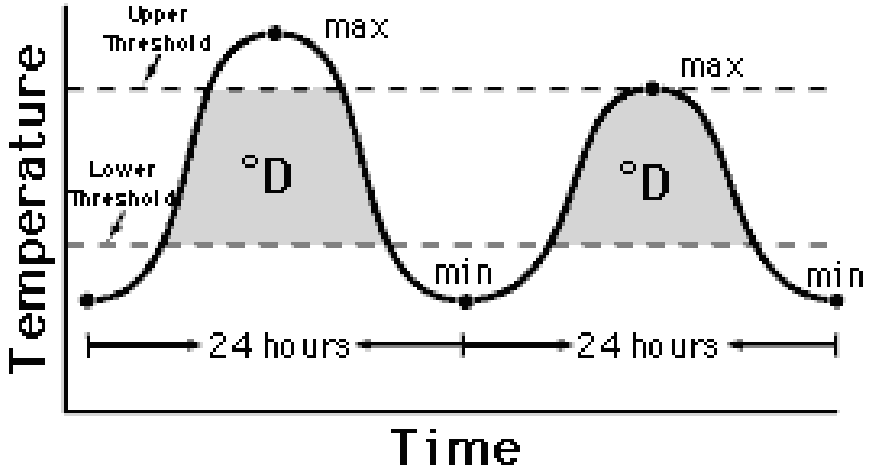
- Fall plants for pollinators:

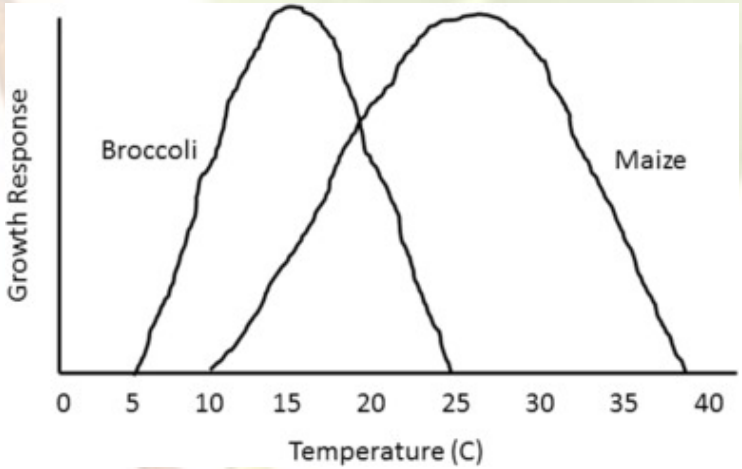
Single-flowered chrysanthemums
Aka: Daisy Mums

Stonecrop

Increased Temperature

- Temperature has a direct impact on plant growth
  - Will only grow within a certain temperature range
  - The optimal temperature range differs between species!



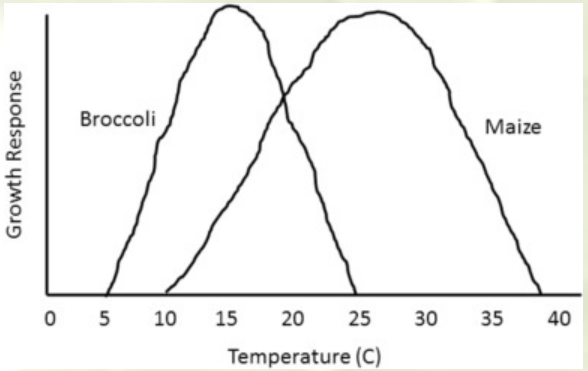


Increased Temperature

- When temperature exceeds the upper limit:
  - Growth can stop completely
    - “drooping leaves”
  - Some plants will die outright
    - Very susceptible to high temperatures

Quebec Summer 2018

- Summer 2018 in Quebec:
  - Hotter and drier than any summer in the past
- Hay harvests were down 60 – 70%
- Many vegetable crops failed completely:
  - Broccoli, cabbage, lettuce, kale



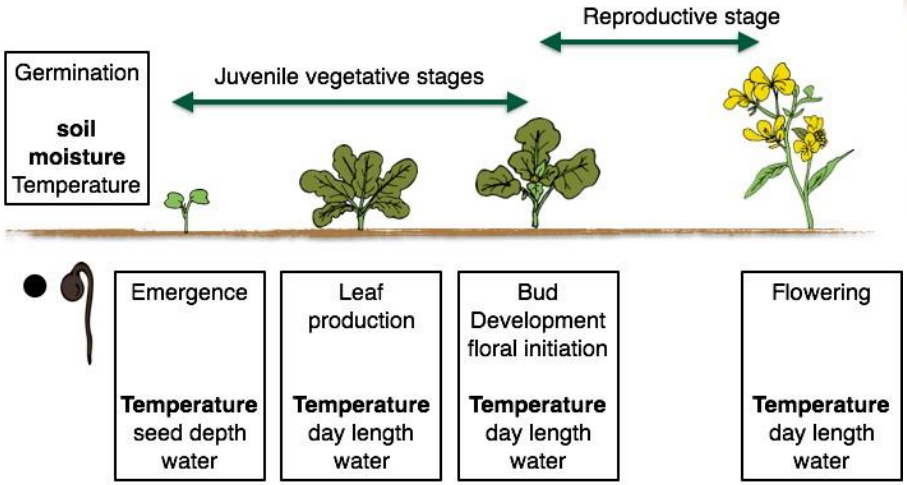
Hot summer gave Quebec farmers 'one of the worst seasons on record'

Hay prices doubled in many regions, some crops ripened faster than they could be harvested, and scorching heat kept crowds away from you-pick farms.

RENÉ BRUEMMER, MONTREAL GAZETTE Updated: August 10, 2018

Increased Temperature

- Some plant species take temperature dependency a step further:
  - Will only flower after a certain number of days at the optimal temperature



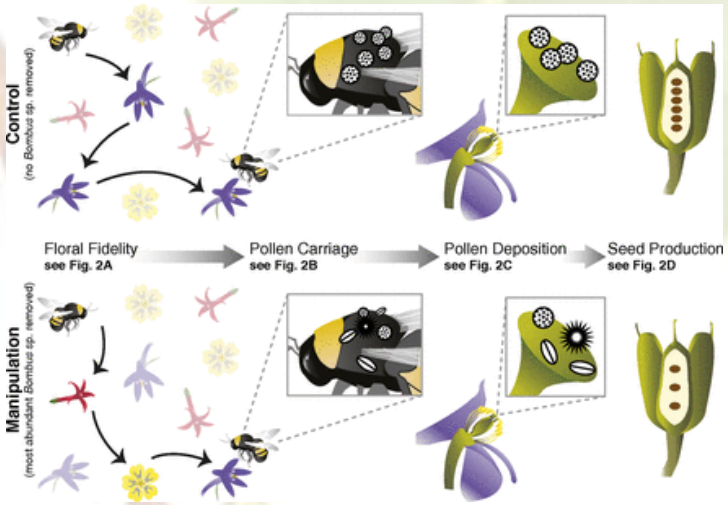
Increased Temperature - Gardening

- As temperatures increase:
  - Some plants will flower earlier in the season
    - Creeping phlox
    - Lilacs
    - Daffodils
    - Tulips
- Other species:
  - Flowering is determined by sunlight hours
    - Temperature will have no impact on flowering time

Increased Temperature - Gardening

- As flowering times shift:
  - Some plants may start to flower before pollinators are available
    - Some pollinators will no longer be able to perform their role

- Remaining pollinators:
  - Not as effective
  - Too many types of pollen on the same bee:
    - Cannot pollinate a single plant species as effectively



Increased Temperature - Gardening

- Strategies to make your garden more resistant to extreme heat:
  - Groundcovers
  - Dense gardening
  - Low-impact watering

Groundcovers

- Mulches and landscape fabric combination:
  - Great at lowering temperatures at the soil surface and retaining moisture in the soil
  - Try to avoid very dark mulch
    - This can absorb too much heat from the sun!
  - Mulch layer should be ~ 2 inch thick for effectiveness

Groundcovers

- Most effective groundcover:
  - Normal forest leaves!
    - Breakdown naturally to increase soil fertility
    - Maintain high humidity with a very thin layer
    - Best of all – they're free!

Dense Gardening

- Fill your garden densely with plants
  - Avoid “negative space” between plants
- More plants:
  - Less sunlight hitting the soil = less heat and reduced water loss
  - Water released by plants through transpiration:
    - Will help cool the atmosphere in your garden
      - Why a forest always feels cooler than an adjacent field!

Lots of Negative Space

Dense Gardening

Low-Impact Watering

- Rethink watering:
  - Frequent, short watering sessions
  - Don’t use sprinklers
    - Too much water is lost to evaporation

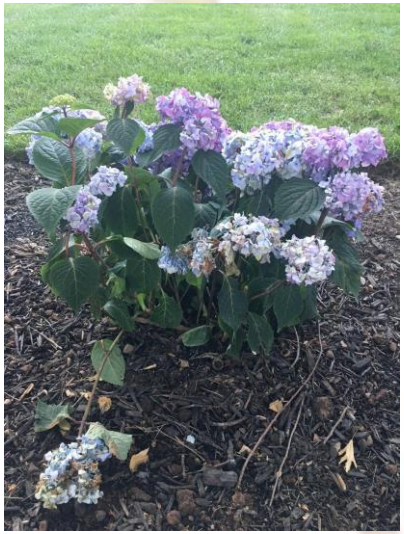
Low-Impact Watering

- Soaker hoses are best:
  - A 10 min watering session a day will be more than enough to address water loss in the soil!
    - Putting your soaker hose under the mulch is even better!
  - Set you hoses on a timer so you don't forget!

Increased Temperature - Gardening

- Plants to avoid with increased temperature:

Astilbe



Hydrangea
Trees and shrubs

Coneflowers

Increased Temperature - Gardening

- Plants that will thrive under increased temperature:

Sedums
And other succulents

Marigolds

Perennial Hibiscus

Increased Temperature - Gardening

- Plants that will thrive under increased temperature:

Butterfly Bush

Decorative grasses

“tropical” fruits

Changing Seasons

- Average increase in seasonal temperature does not just mean warmer summer temperatures
  - Seasons are changing as well

- Most impactful change:
  - Extended spring and fall seasons
  - Extreme winter temperatures

Extended Spring

- Spring is starting earlier:
  - But also ending later

- This means:
  - Extended frost possibility in the spring
  - Later start to tender annuals
  - Early emergence of pollinators
    - Potentially before any flowers are available to feed on

Extended Spring - Gardening

- Annuals:
  - Minimize late frost risk by planting later than usual
    - Mother's Day is no longer a safe guide
  - Be more cautious with spring planting in the future
    - A month of warm weather in April does not mean no risk of frost in May!

Extended Spring - Gardening

- Perennial plants:
  - Some plants can experience frost even after leaf opening and will be fine
  - Some experiencing frost will lose all leaves
    - And all flowers and fruit which may have been had this season!
- Cannot avoid frost by “planting perennials later”

Extended Spring - Gardening

- If frost does threaten:
  - Can protect plants temporarily with cover
  - Soil is warmer than the air:
    - As the soil radiates heat:
      - Will keep plants warm under the cover!

Extended Spring - Gardening

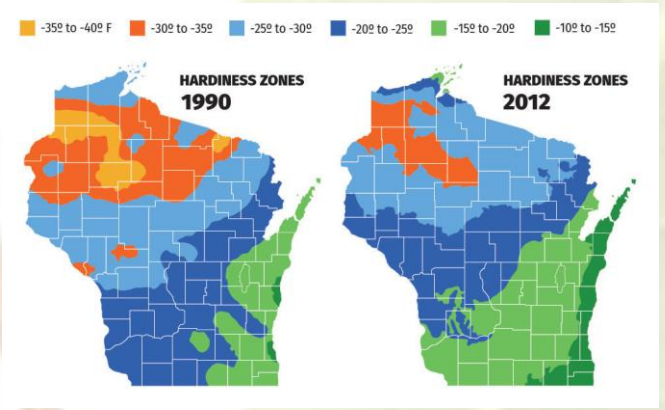
- Help pollinators by planting early flowering plants that are not frost sensitive:

Bloodroot

Crocus

Extended Fall

- Fall is extending later into the season



- This means:
  - Greater survival of garden insect pests over the winter
  - Disrupted growth for plants with dormant stages
  - Disrupted flowering for temperature-dependent plants

Extended Fall - Gardening

- Many insect pests overwinter at the base of their chosen plants:
  - Disturbing the soil under these plants before the first frost can reveal them!

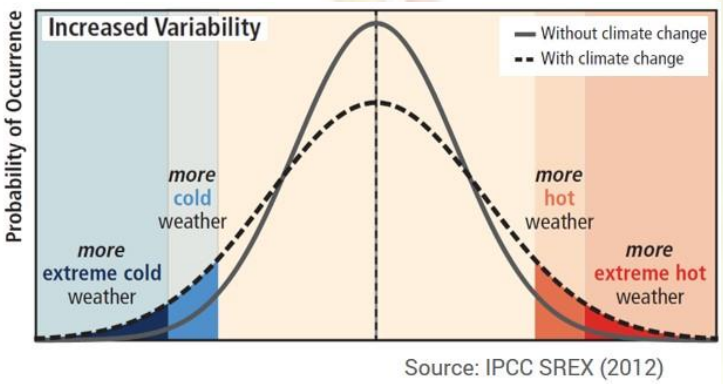
Extended Fall - Gardening

- Preventing disruption to flowering/dormant stages:
  - Not currently possible

- During extended fall seasons:
  - May see flowering of plants which should normally flower in spring:
    - Ex: lilacs
  - May see plants which have already lost leaves and become dormant start to grow again!
    - Ex: roses

Extreme Winters

- Overall averages may be increasing:
  - But so are severe periods of winter chill!



- Plants which thrive in the warmer summers:
  - May be killed by a period of winter chill
- Even some plants which survive our winters now, may struggle to survive future winters

Extreme Winters - Gardening

- Protect the roots!
  - Even if the shoot dies back from the cold
    - As long as the roots survive, the plant can recover from a period of extreme cold
- How do you protect your roots?
  - Mulch, mulch, mulch!

Extreme Winters - Gardening

- As with mulching for water conservation:
  - Forest leaves are the best!
- Fortunately:
  - Abundance of these in the fall!
- If you can:
  - Rake leaves onto your garden in the fall
    - Really helps protect your plants

Extreme Winters - Gardening

- Avoid plants with shallow roots, evergreen foliage, or “tender” perennials:

Rhododendrons

Silver Lavender

Extreme Winters - Gardening

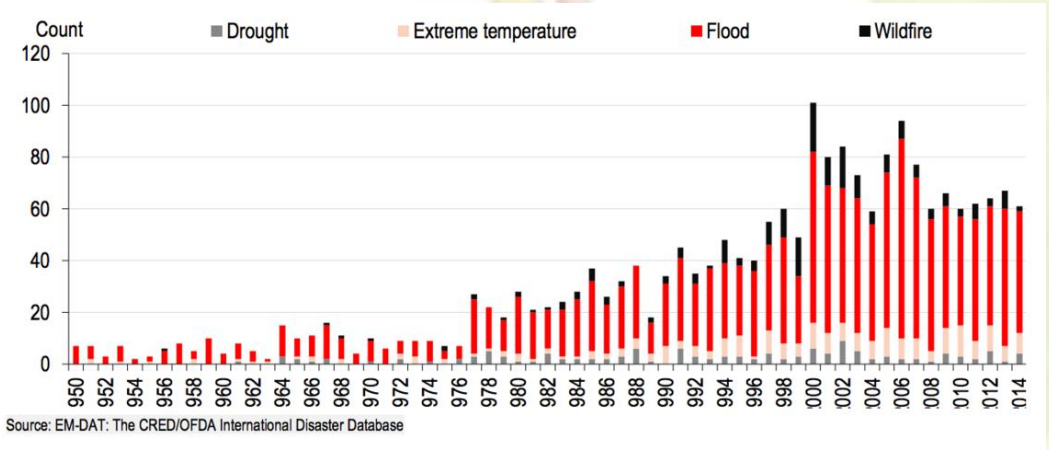
- Bulbs, groundcovers, and plants rated for colder zones than Montreal:

Siberian Poppy

Daylilies

Changes in Precipitation

- Overall increase in precipitation:
  - But the way we receive precipitation will also change



- In general:
  - Storms will be more severe (including winter storms)
  - Larger drops of rain during rainfall

Changes in Precipitation

- Heavy rainfall:
  - Greater chance of damaging plants
  - Too much rain at once:
    - More rain runs off the soil surface than is absorbed!

Changes in Precipitation - Gardening

- Growing delicate plants will become much more difficult:
  - Large heavy blooms
  - Delicate flowers

Changes in Precipitation - Gardening

- Plants with heavy flowers to avoid:

Large, hybrid tea roses

Peonies

Changes in Precipitation - Gardening

- Plants which do well under heavy precipitation:
  - Any and all groundcovers!
  - Low growing perennials

Gardening Summary

Climate Proofing Your Garden

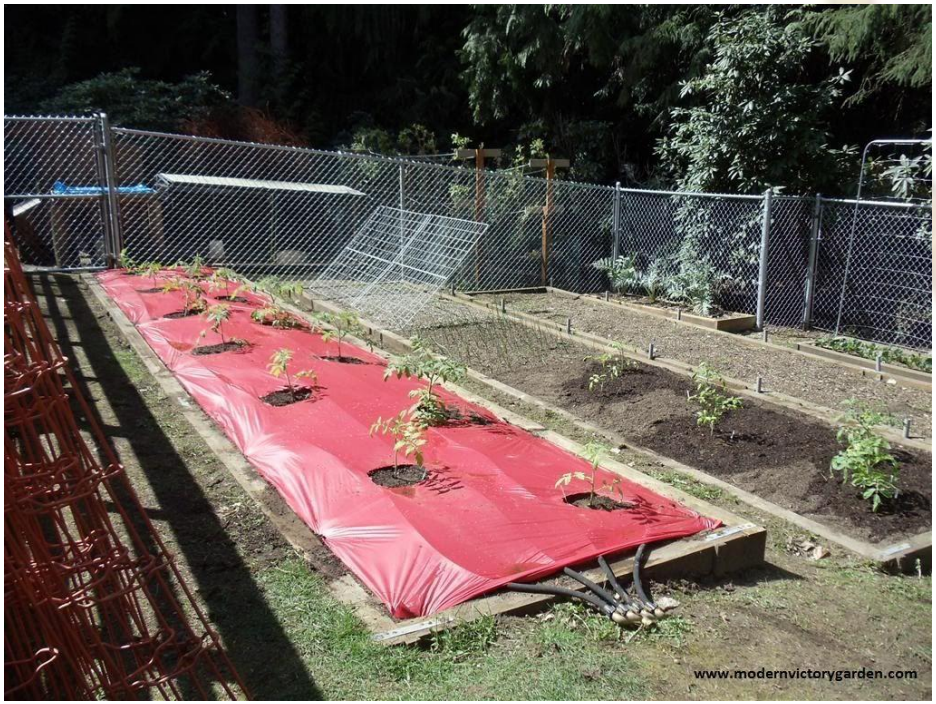
1. Plant densely

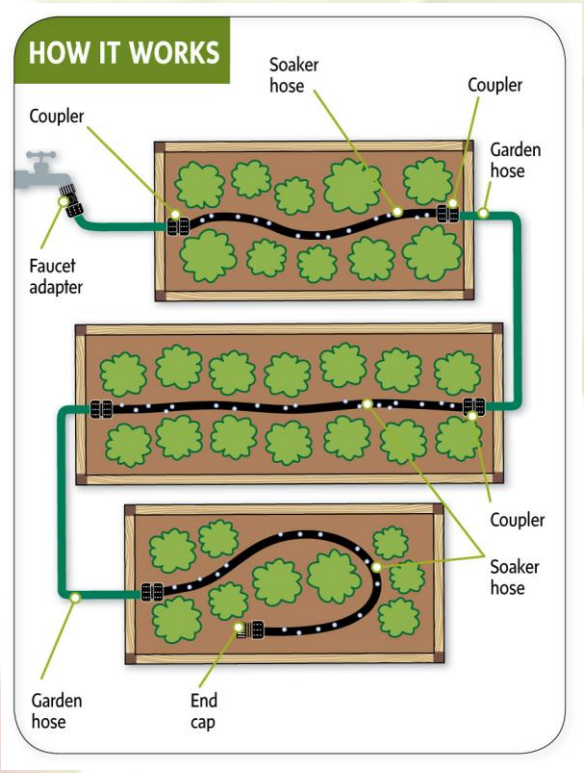
Climate Proofing Your Garden

2. Use mulches

Climate Proofing Your Garden

3. Water frequently and for short period
   - Soaker hoses are best
     - And cheap – 17.99 – 20.99 for 50'!





Climate Proofing Your Garden

4. Plant early and late flowering plants
   - Help pollinators adapt to the changing climate

Climate Proofing Your Garden

5. Try to move to plants that will be better suited to the times to come
   - And phase out plants that will have trouble surviving


Questions?