Conducting a Climate Change Analysis at the Local Scale

Presented by: Kristina Dokoska, Project Coordinator, Ontario Climate Consortium

Greenbelt Golden Horseshoe
Conservation Authorities Collaborative
March 4, 2020

Possibility grows here.

Supported by Toronto and Region Conservation Authority

Presentation Outline

1. Introduction to Climate Modeling
2. Research Scope and Process
3. Methodology
4. Results
5. Lessons Learned and Transferability

Ontario Climate Consortium

Analyzing and Applying Climate Information

Providing Planning and Research Support for Adaptation and Mitigation

Mobilizing Research through Communications and Engagement

The OCC was established in 2011 as a centre of expertise providing research and analysis services to municipalities, conservation authorities, and the broader public sector.

Project Context

- In 2018, OCC developed report on integrating future climate projections into natural environment-related policies and plans
- In 2019, this project was initiated by NECCC
- Funding provided by the Greenbelt Foundation
- NECCC engaged OCC to update climate projections across the Region
- Opportunity to update scientific methodologies used in the SENES study to the latest practices in climate modeling (e.g., longer climate normal periods, ensemble approach)

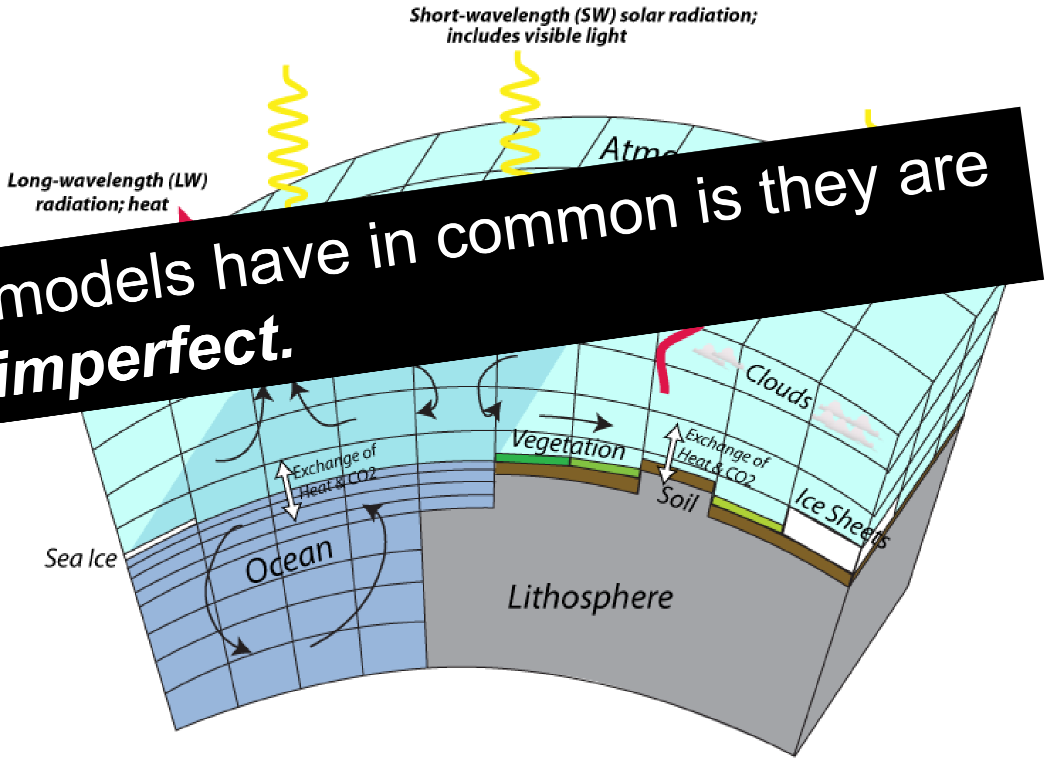
GREENBELT
Possibility grows here.

Climate Modeling – Basic Principles

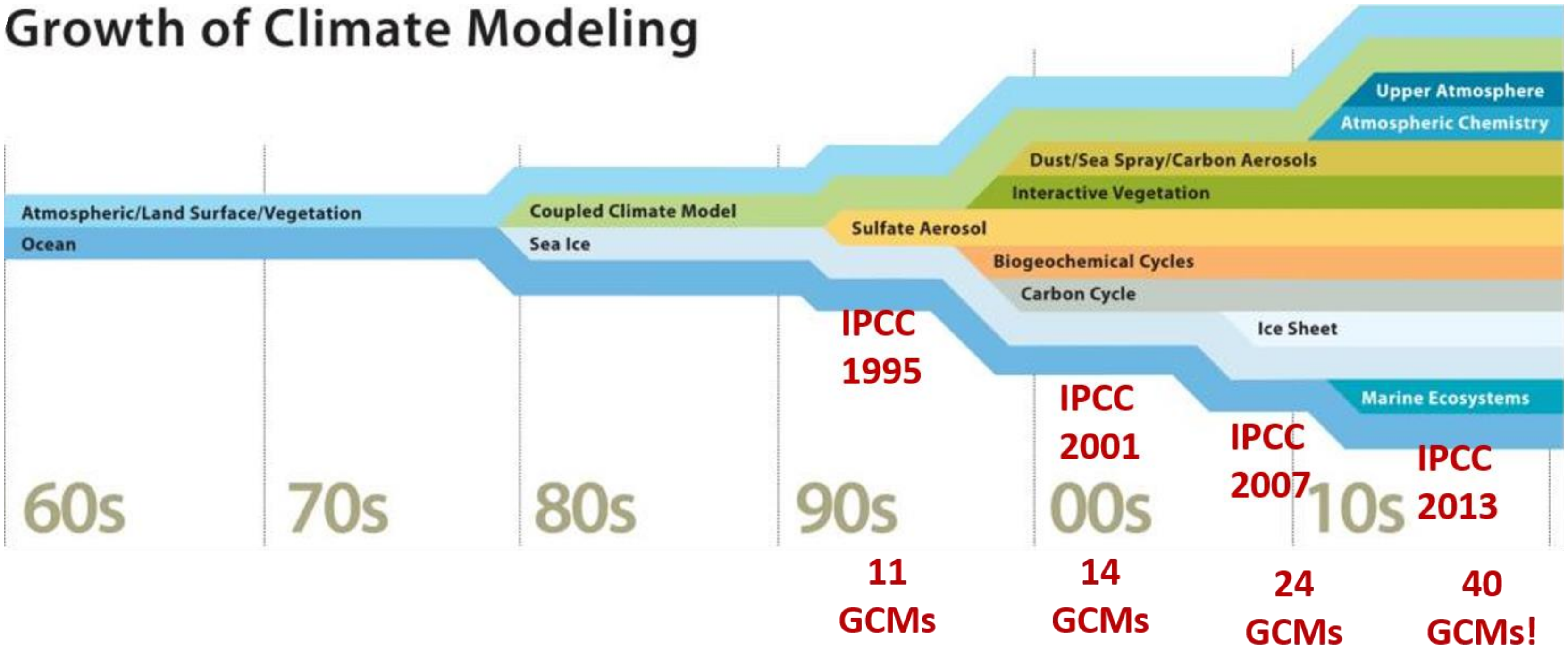
- Based on physical processes used to simulate the transfer of energy and materials through the climate system
- Use mat

The only thing all climate models have in common is they are ***imperfect.***

- Use “initial” conditions and changes in climate forcing, and repeatedly solving the equations using powerful supercomputers



A Brief History of Climate Modeling



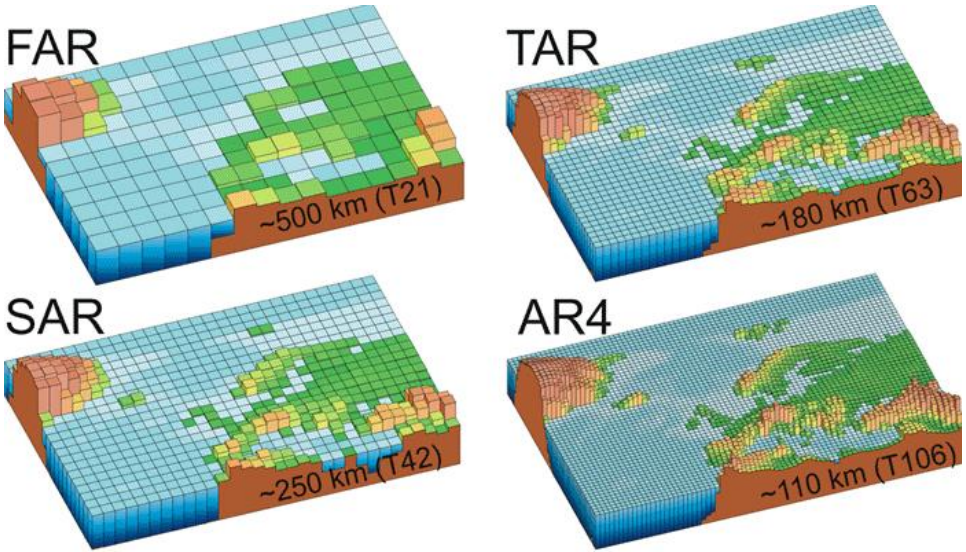
Feedback effects (e.g., polar vortex)

Convective Processes (E.g., localized extreme rainfall)

As Global Climate Models have Advanced, so has their Spatial Resolution…

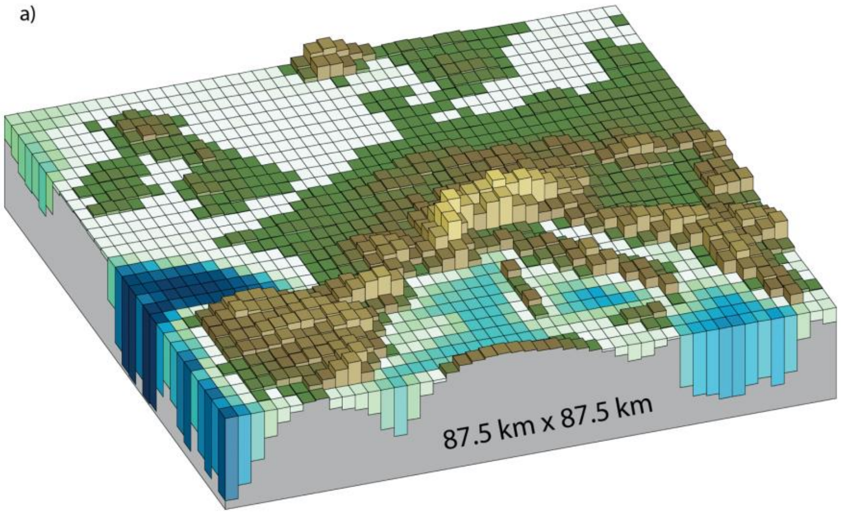
IPCC (1990)

IPCC (2001)



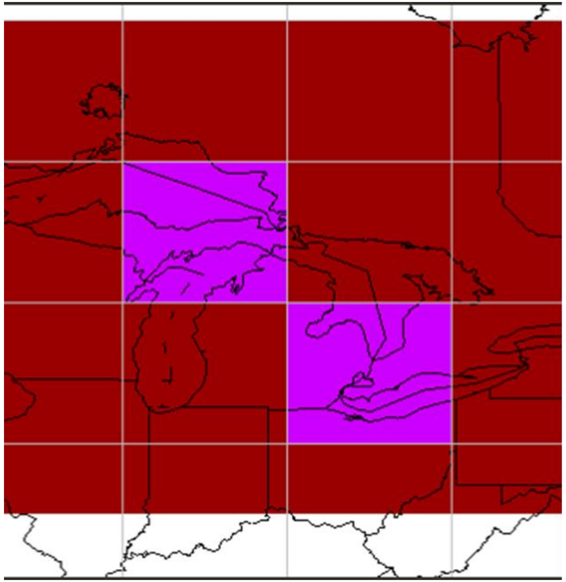
IPCC (1995)

IPCC (2007)

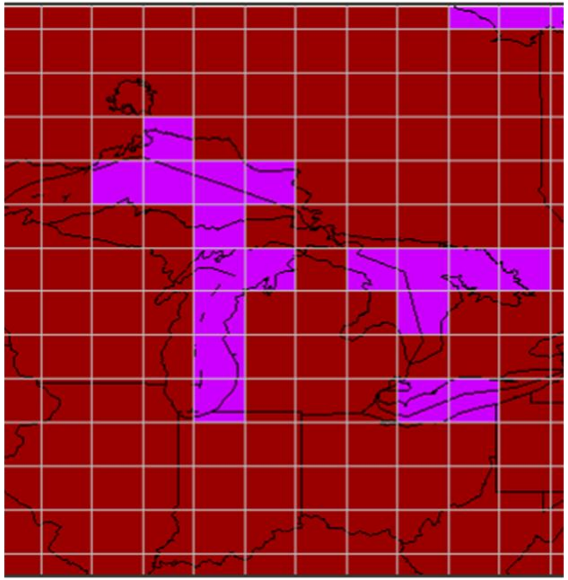


IPCC (2013) – AR5

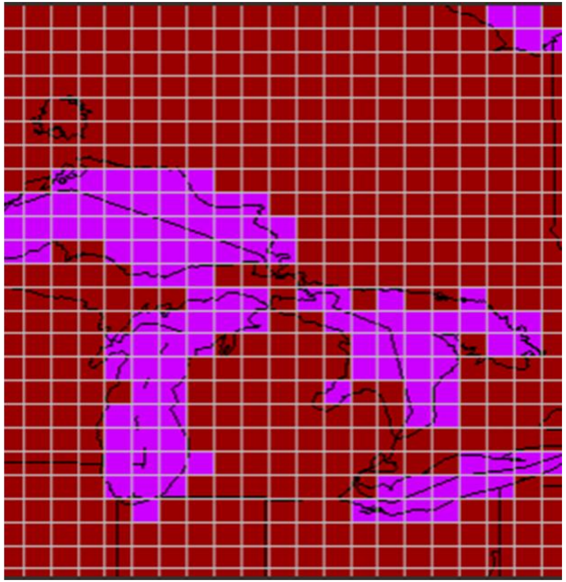
Spatial Resolution Matters particularly in the Great Lakes Basin…



IPCC 2013 GCM



Regional Climate Model
(50 x 50km)

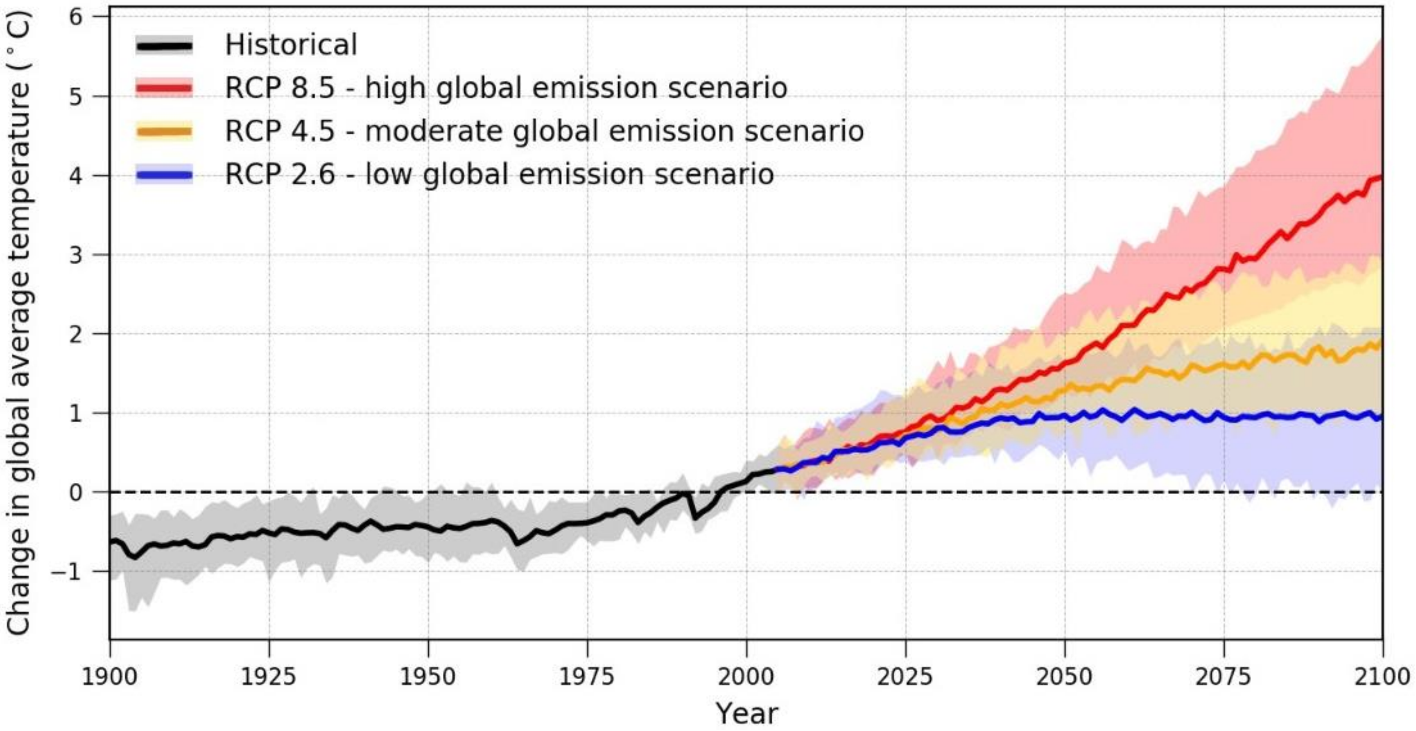


Regional Climate Model
(25 x 25km)

Which is Preferable: Using a GCM or RCM?

- It depends on the region – RCMs likely better for complex terrain, mountains, and lake regions *(IPCC, 2013)*
- Global climate models can underestimate thunderstorm activity and rainfall – need finer scale models and current data
- However, increased model resolution does not guarantee superior model performance for all variables and all time-scales (e.g., temperatures) *(Ouranos, 2016)*
- Thus, taking an ensemble approach using a compilation of RCMs can account for uncertainties & provide a balance while also providing a 'physics-based' interpretation of climate (i.e., not only mathematical)

Climate Change Scenarios



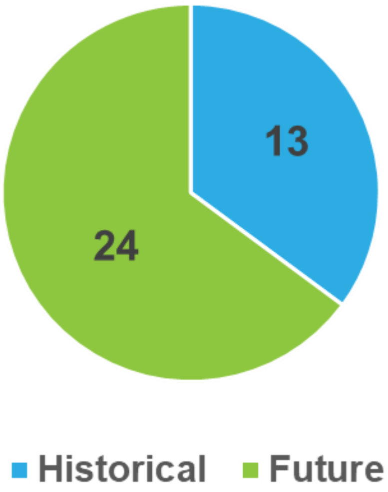
How do we actually achieve these?

What do the impacts and risks look like?

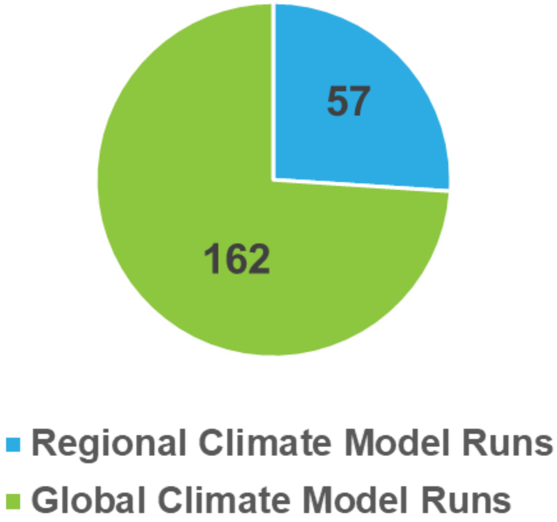
What information do these not include?

In the Great Lakes Region…

How many Climate *Portals or Sources* Exist?



What types of Climate Models have been Produced?



Noteworthy Climate Data Portals

YORK U UNIVERSITÉ UNIVERSITY

"Super-Ensemble" of GCM and RCM runs (209 model runs in total)

24 GCM ensemble statistically downscaled and bias-corrected

Climate Atlas of Canada

WISCONSIN UNIVERSITY OF WISCONSIN-MADISON

6 RCM ensemble for use specific to Great Lakes region

UNIVERSITY OF TORONTO

15 RCM runs developed to capture lake effects

Approach Used for the Region

Met Most of the Evaluation Criteria:

- 25 km by 25 km resolution
- Models run for the business as usual scenario (RCP8.5) and Moderate emissions scenario (RCP4.5)
- Daily and Hourly data
- Includes incorporation of Great Lakes
- Is a robust (good size) ensemble of 16 model runs

Approach

Obtain Data

- Confirm Study Area
- Collect Historical Data
- Future time-series for each grid cell
- Quality Control & Infilling Gaps

Historical Characterization

- Use baseline (1971-2000)
- Spatial, seasonal, long term temporal trend analyses

Future Analysis

- Bias Correction
- Determine anomalies
- Spatial, seasonal, long term temporal trend analyses

Climate Parameters

Direct Model Output (4)

- Mean Air Temperature
- Max Air Temperature
- Min Air Temperature
- Total Precipitation

Inferred or Calculated (52)

- All Threshold-based Parameters
- Extreme Precipitation
- Growing Season
- Dry Conditions
- Freeze-Thaw
- Ice Potential

Sample Results (Business-as-usual scenario)

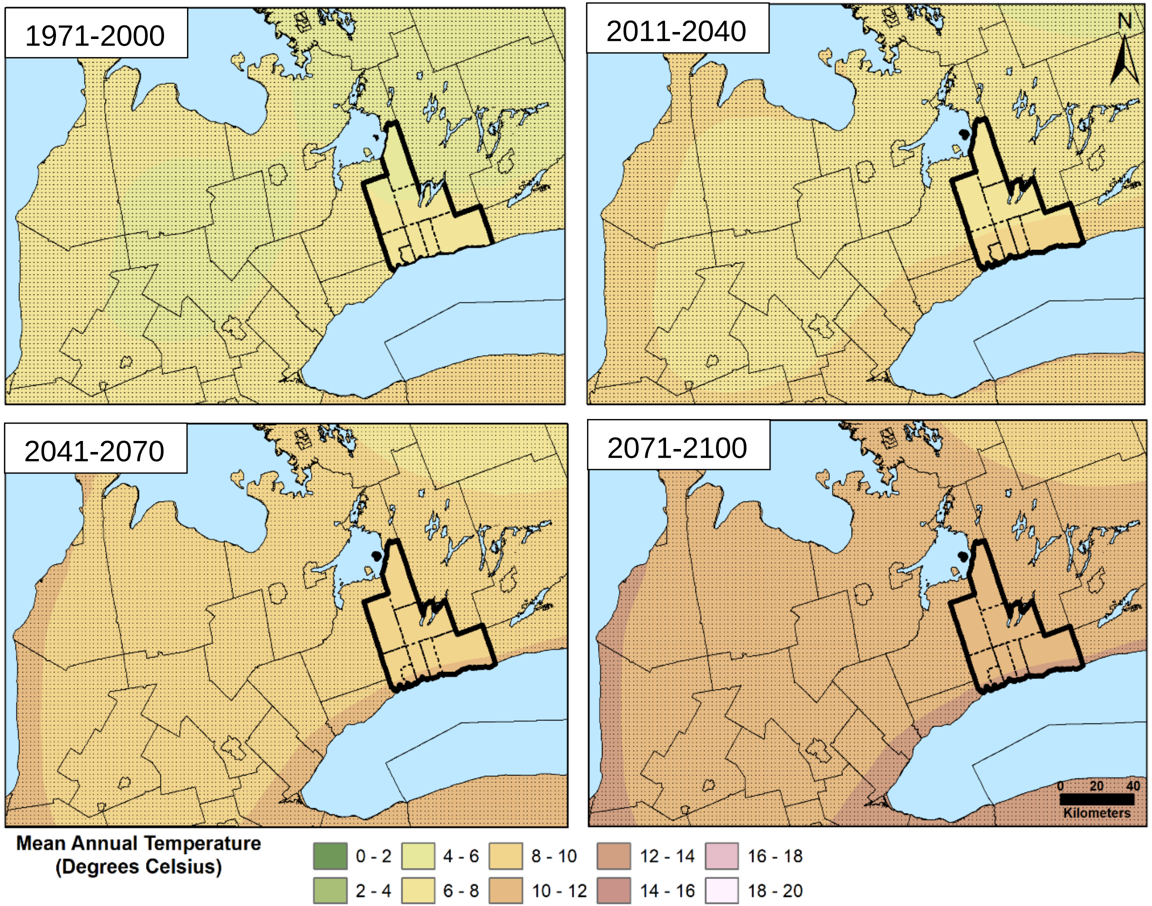
Climate Parameter	Historical (1971-2000)	Short Term (2011-2040)	Medium Term (2041-2070)	Long Term (2071-2100)	Difference from Baseline to Long Term	Trend
Mean Annual Temperature (˚C)	7.1	8.6	10.1	12.1	**+5**	↑
Days above 35˚C	0.2	1.2	4.0	10.8	**+10.6**	↑
Days above 30˚C	7.6	15.9	27.4	46.9	**+39.3**	↑
Days below -15˚C	22.7	13.1	7.9	2.6	**-20.1**	↓
Days below -10˚C	49.0	34.4	23.5	11.3	**-37.7**	↓
Total Annual Precipitation (mm)	952.4	1075.0	1117.5	1231.6	**+279.2**	↑
Max 1 Day Precipitation (mm)	33.8	35.4	40.4	44.0	**+10.2**	↑
Max 3 Day Precipitation (mm)	54.9	58.0	61.7	67.7	**+12.8**	↑

Average Annual Temperature (Business-as-usual)

By end of century:

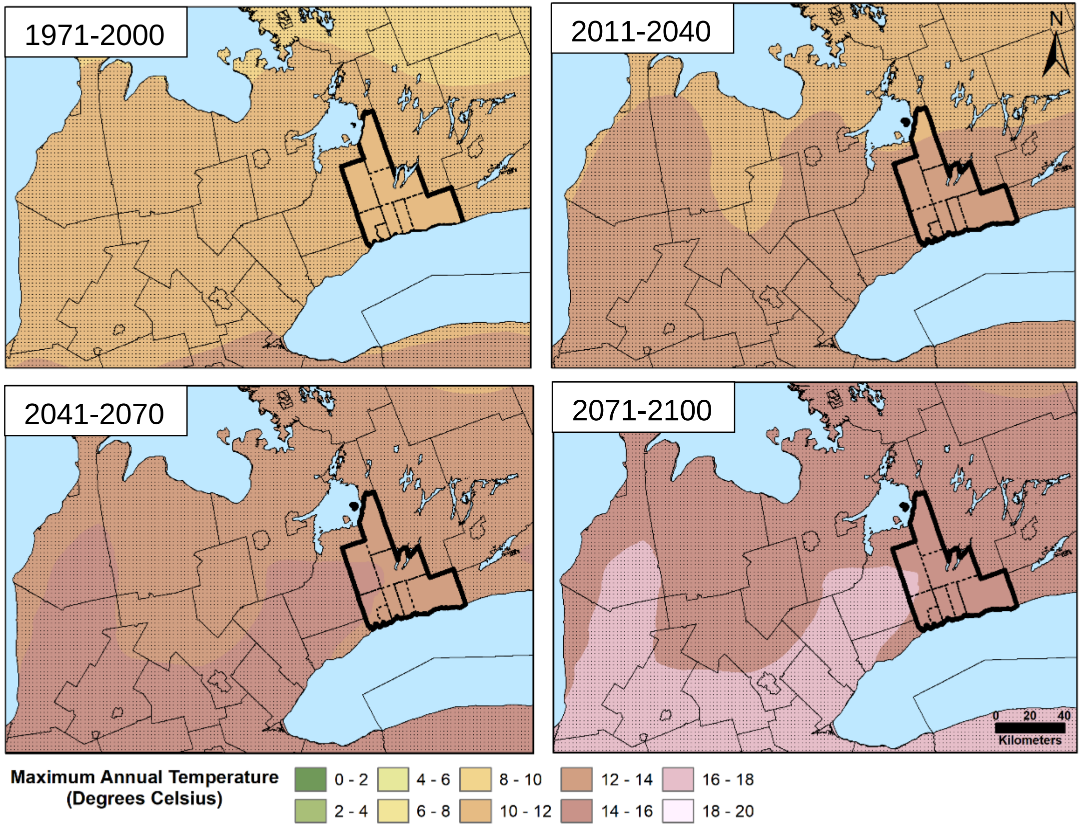
From 6-8˚C to 12-14˚C

(a 5-7˚C increase)



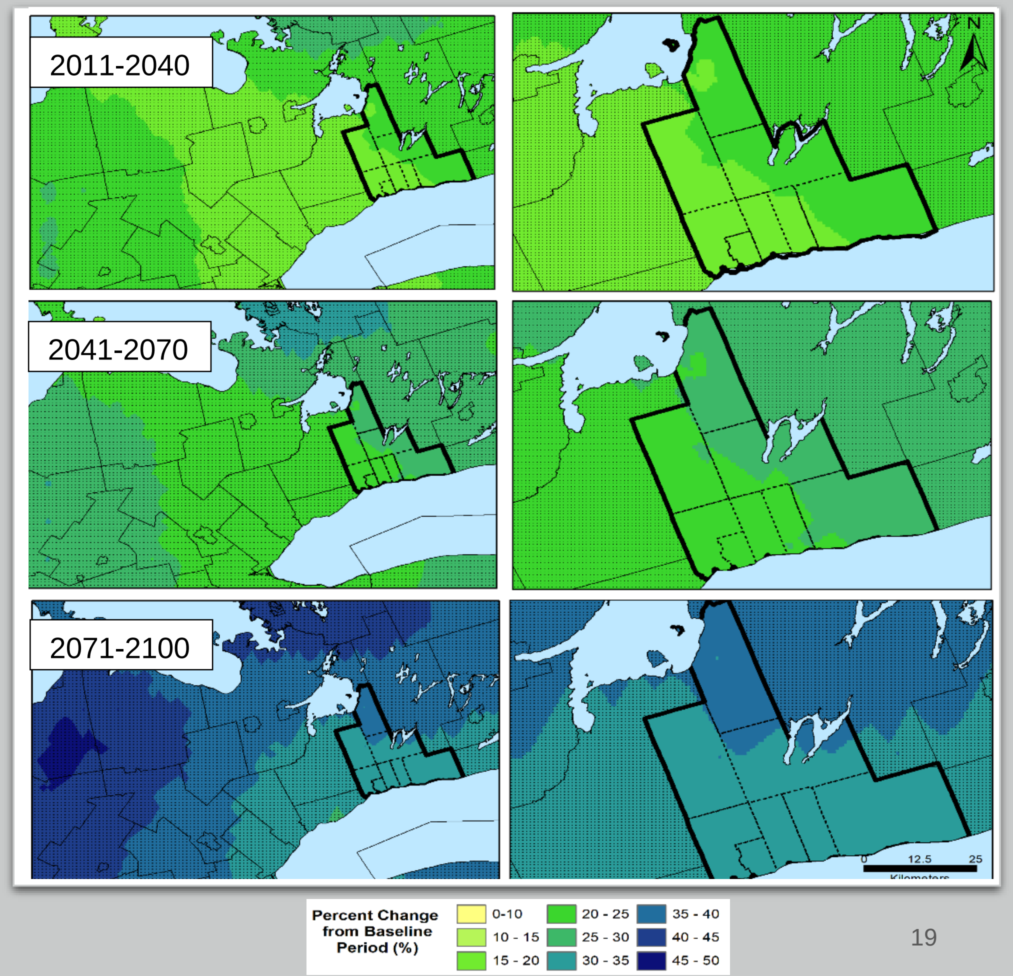
Maximum Annual Temperature (Business-as-usual scenario)

By end of century:
a 4-6˚C increase



Percent Change in Precipitation from the Baseline Period

(Business-as-usual scenario)



In Summary

It can be expected by the 2050s, if we continue to emit business as usual (without global mitigation measures), that Durham Region will be:

•Warmer (~3˚C increase)

•Wetter (~11%increase)

•More intense storms (~20% increase in 1-day maximum precipitation)

•Similar trends in freeze-thaw cycles

•Less ice potential

•Opportunities for agricultural crops to thrive, however, pests are at greater risk

Lessons Learned

Many climate data portals exist, and the landscape is evolving rapidly

Depending on the approach used to derive climate projections, results may vary

While climate data is available, users are required to understand how to undertake large data translation to access and use the best data

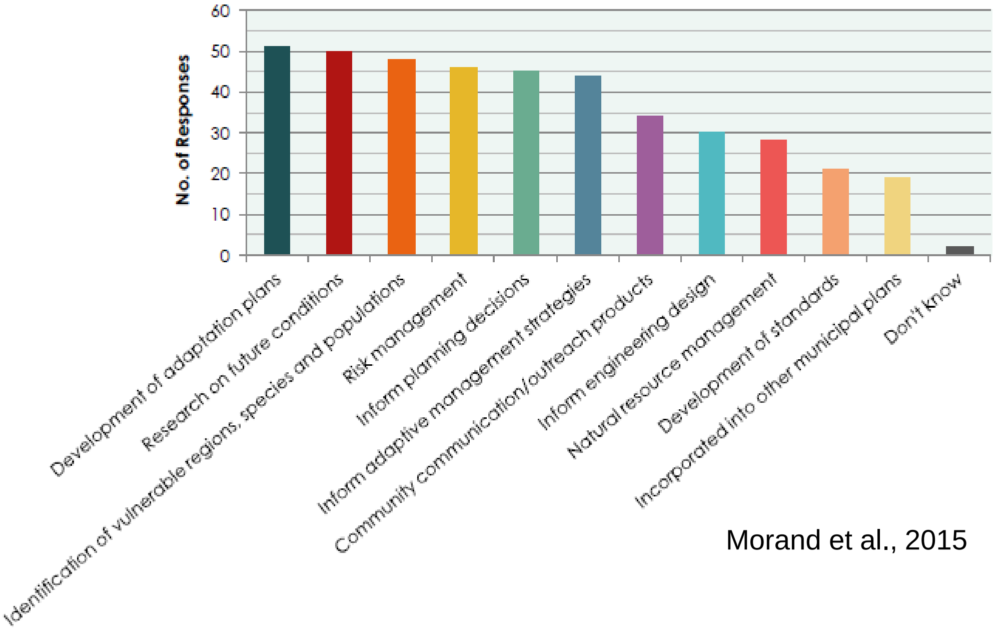
There is a need to understand what is considered ‘best’ available climate data and where it is available

There is a need to build capacity and expertise in climate science within municipalities to understand the limitations or caveats of climate data use

Practical Uses and Transferability

- Leverage existing tools and data, where possible
- Involve broad stakeholders, practitioners and academic expertise where possible for validation and review
- Acknowledge that gaps in science exist and certain parameters may not be accounted for
- Build staff capacity through training on the use and application of the climate modeling

How climate projections have been used



Morand et al., 2015

A Few Other Take-Aways when Using Climate Data

Story telling goes a long way! How much less extreme is our future if we reduce our emissions?

Make data personal – What was the average temperature when you were born? What is it now? What will it be when my child is 30?

Use fewer numbers and more visuals

Leverage the guidance that already exists around climate data

Ask technical experts “why” and what their data includes or excludes

Questions?

Thank You!

KRISTINA DOKOSKA:
KRISTINA.DOKOSKA@TRCA.CA