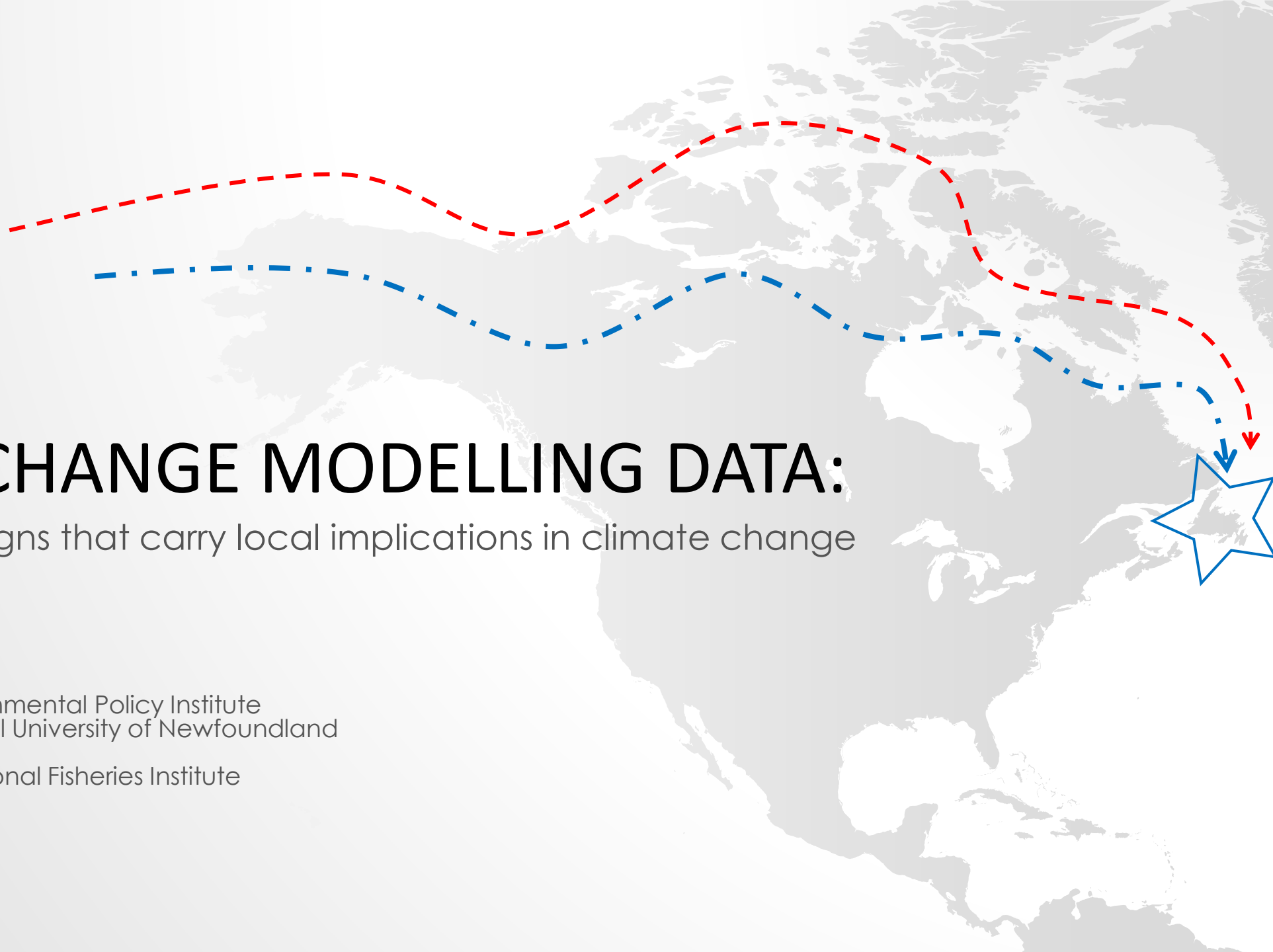

CLIMATE CHANGE MODELLING DATA:

Global model designs that carry local implications in climate change scenarios

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CLIMATE CHANGE MODELLING

- A variety of climate change models exist. What can they tell us about changes that could influence coastal areas?
- Impacts via temperature change, precipitation change, cloud cover change, and other variables should all be considered
- Additional associated impacts can be derived from projection data, by applying known variable relationships

What would be useful to do such a thing? – A tool that can bridge across the models, examining climate change projections and the differences between the models

DATA SOURCING AND INITIALIZATION

Primary data source: ***ClimGen*[1].**
ClimGen is a spatial climate scenario generator developed by the Climate Research Unit (CRU) and Tyndall Centre for Climate Change Research. ClimGen allows users to explore some of the uncertainties in future climate change at regional scales.

- Variables processed through ClimGen include:
  - **Temperature**
  - Cloud cover
  - **Precipitation**
  - Wet-day frequency
  - Vapour pressure

  + more…

- Example climate change projection datasets available:
  - Prescribed change transient scenarios
  - Prescribed change time-slice scenarios
  - **GHG emissions-based scenarios**

- Observation data from 1901-2005
- Data available for download via the internet from the University of East Anglia

[1] Osborn, T. J., Wallace, C. J., Harris, I. C. & Melvin, T. M. Pattern scaling using ClimGen: monthly-resolution future climate scenarios including changes in the variability of precipitation. *Climatic Change* 134, 353-369, doi:10.1007/s10584-015-1509-9 (2016**).**

DATA SOURCING AND INITIALIZATION

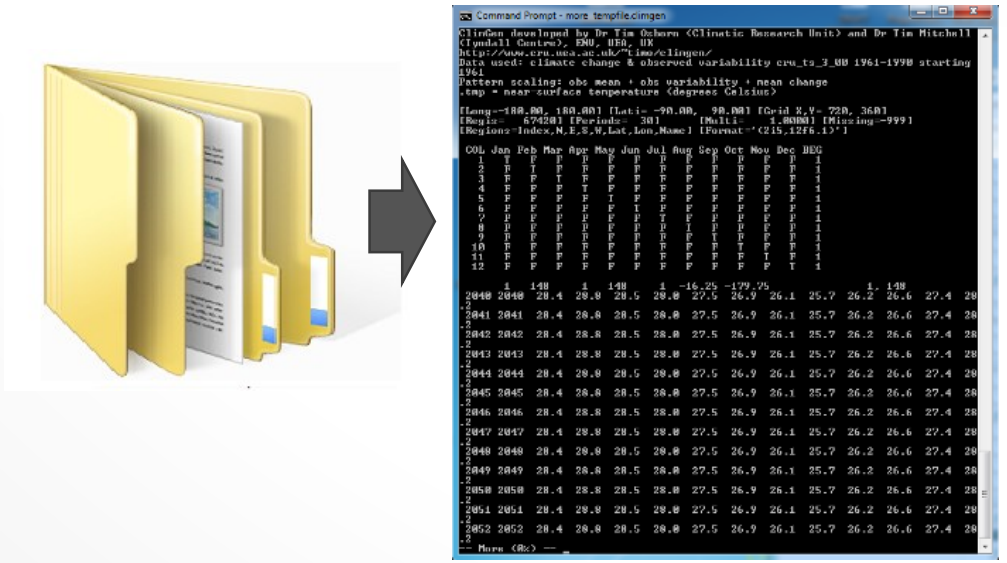
ClimGen is based on a "pattern-scaling" approach to generating spatial climate change information for a given global-mean temperature change

The pattern-scaling approach relies on the assumption that the pattern of climate change simulated by coupled atmosphere-ocean general circulation models (AOGCMs) is relatively constant

These patterns still show considerable variation between different AOGCMs, and it is this variation that ***ClimGen*** is principally designed to explore[2]

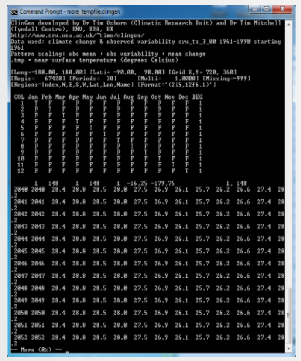
AOGCMs explored

- CGCM3 (Canada)
- CSIRO-MK3(Australia)
- ECHAM5/MPI-OM (Germany)
- IPSL-CM4 (France)
- UKMO-HadGEM1 (United Kingdom)
- UKMO-HadCM3 (United Kingdom)
- NCAR-CCSM3 (USA)



[2] https://crudata.uea.ac.uk/~timo/climgen/

DATA SOURCING AND INITIALIZATION



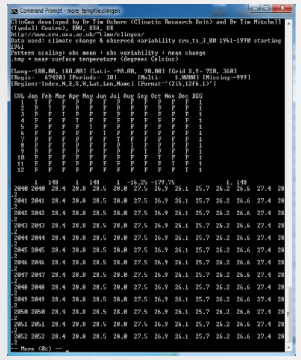
ClimGen files are organized based on variable of interest (ex. Temperature), scenario of study (ex. GHG emissions), expected global baseline temperature increase expected (ex. 2 ºC), and AOGCM explored (ex. Canada's CGCM3)

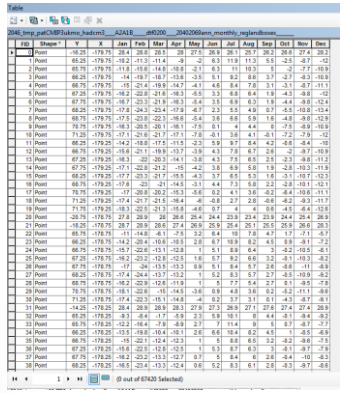
Challenge: To convert data files from text standard into more useful, highly visual, and better detailed geographical maps

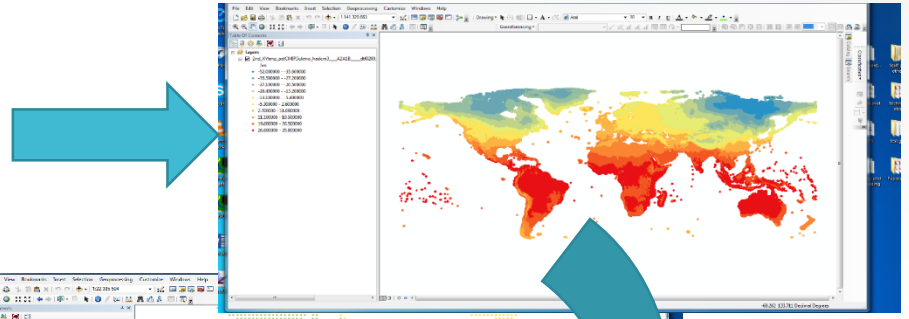
Solution:

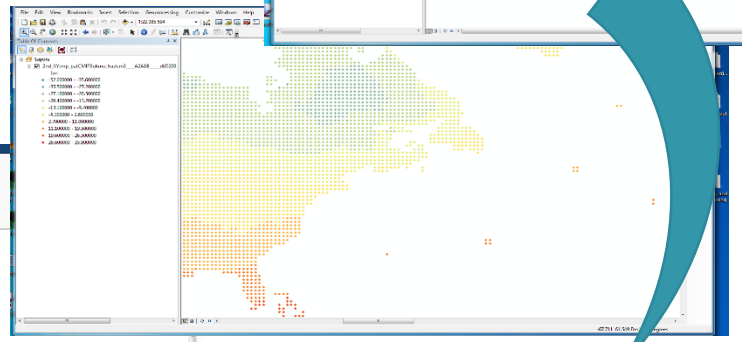
ESRI ArcGIS + python

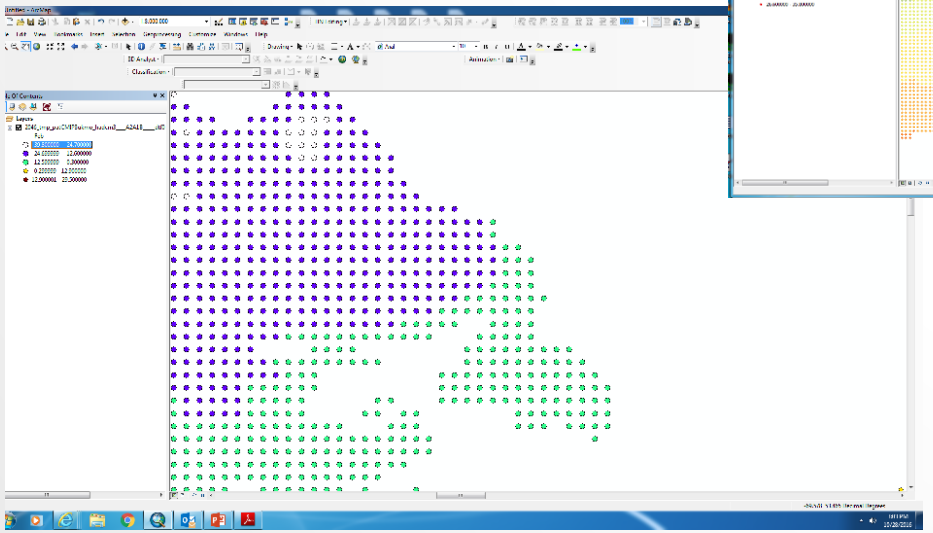
DATA HANDLING AND ANALYSIS









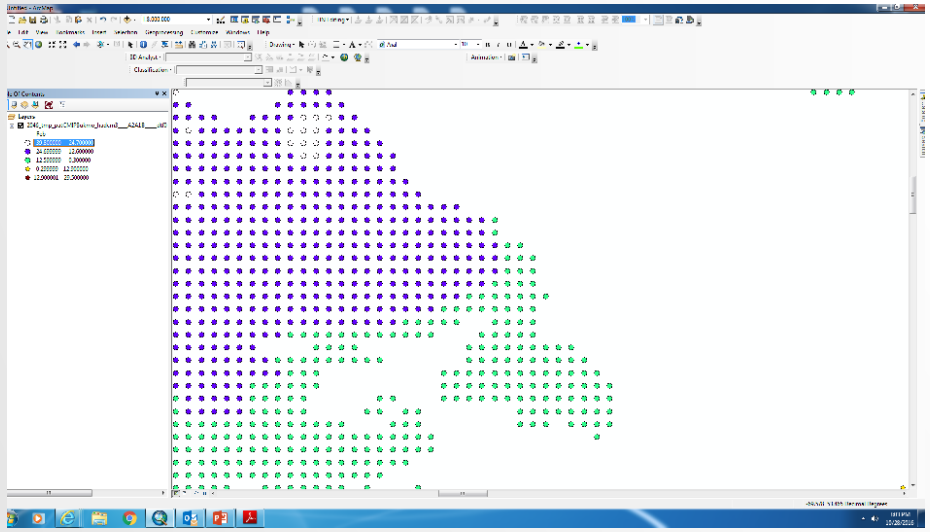


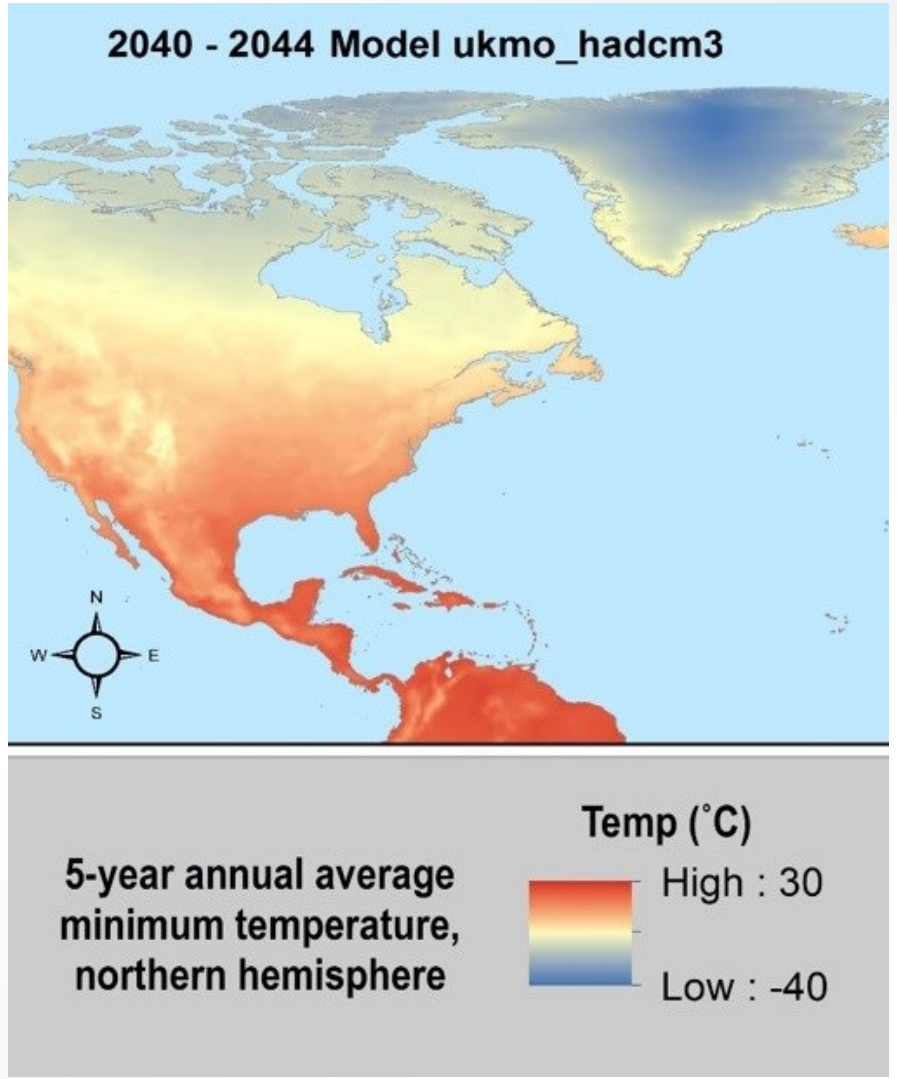
ArcGIS with Python programming enables the creation of geographical mapping, and in particular further data analysis at high data volume

DATA HANDLING AND ANALYSIS

ArcGIS ESRI + python

Spatial analysis under GIS allows the 'gaps' to be filled in…





Python programming is applied for its iterative capability in dealing with many large files

87 programs created

DATA RESULTS

The result of this work is a high-resolution, globally expansive geographical databases of climate change (CC) data

- *2040 to 2099 monthly CC projections in high resolution detailed global maps*
- *Temp (ºC) and Precip (mm) and others*
- *7 different circulation models*
- *Over 100 geodatabases*
- *Over 1 TB and still growing*

DATA APPLICATION

QUESTION

So what can we do with such data?

ANSWER

HUGE academic study purpose dataset. It can be used for climate change study directly, and for related studies asking what will be impacted as a result of climate change.

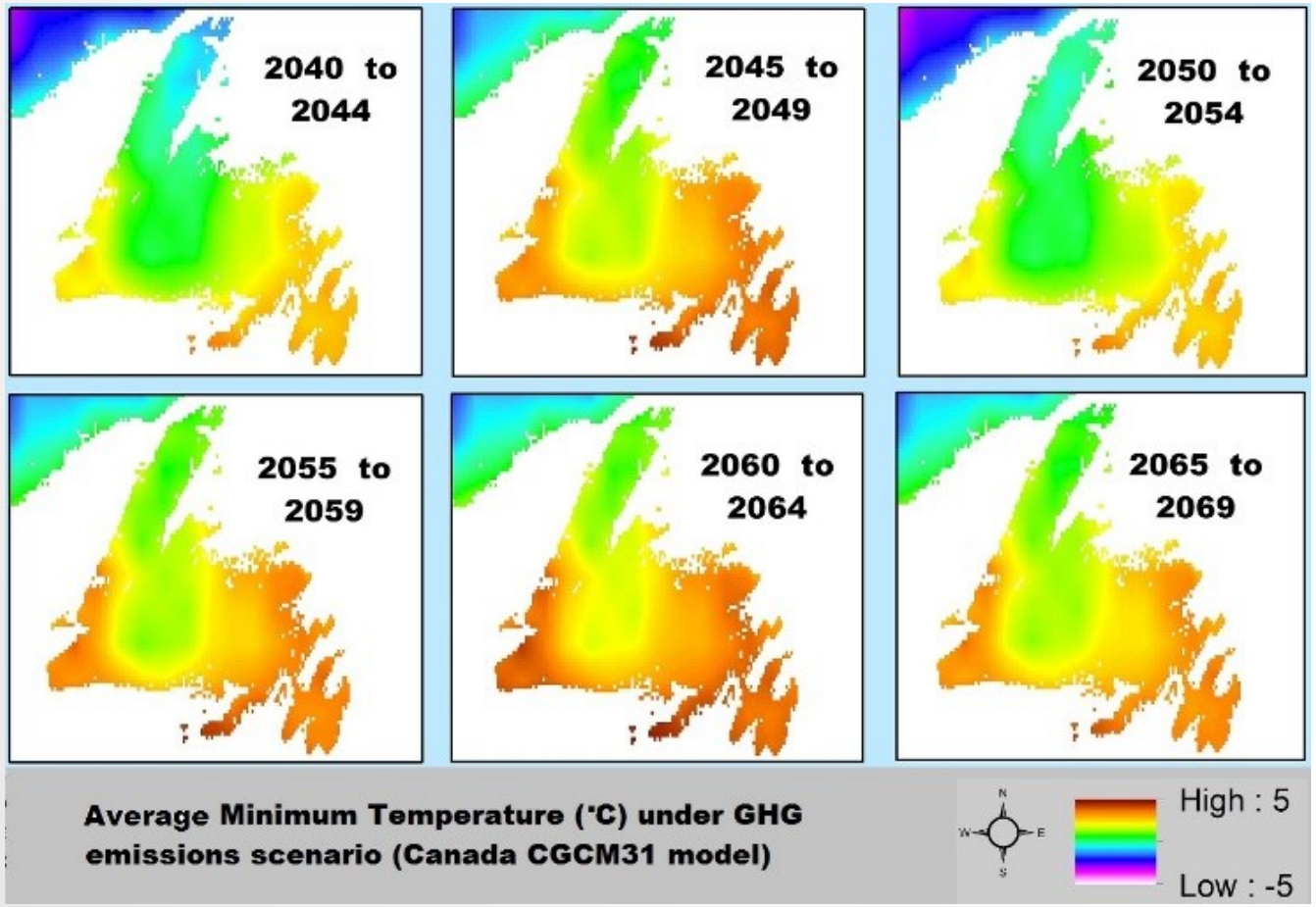
Consider:

- ***Global scale impacts***
- ***Flood zone studies***
- ***Threatened infrastructure***
- ***Sea level rise / ocean changes***
- ***Freshwater change***
- ***Regional impact***
- ***Urban vs rural implications***
- ***Fuel consumption needs***
- ***Landuse changes***
- ***Agricultural impact***
- ***Financial impact***
- ***Forestry and fisheries***
- ***Human health***
- ***Species impact***
- ***Ecosystem changes***
- ***Environmental policies***
- ***Storm frequency***
- ***Local climate change impacts***

+ many more!

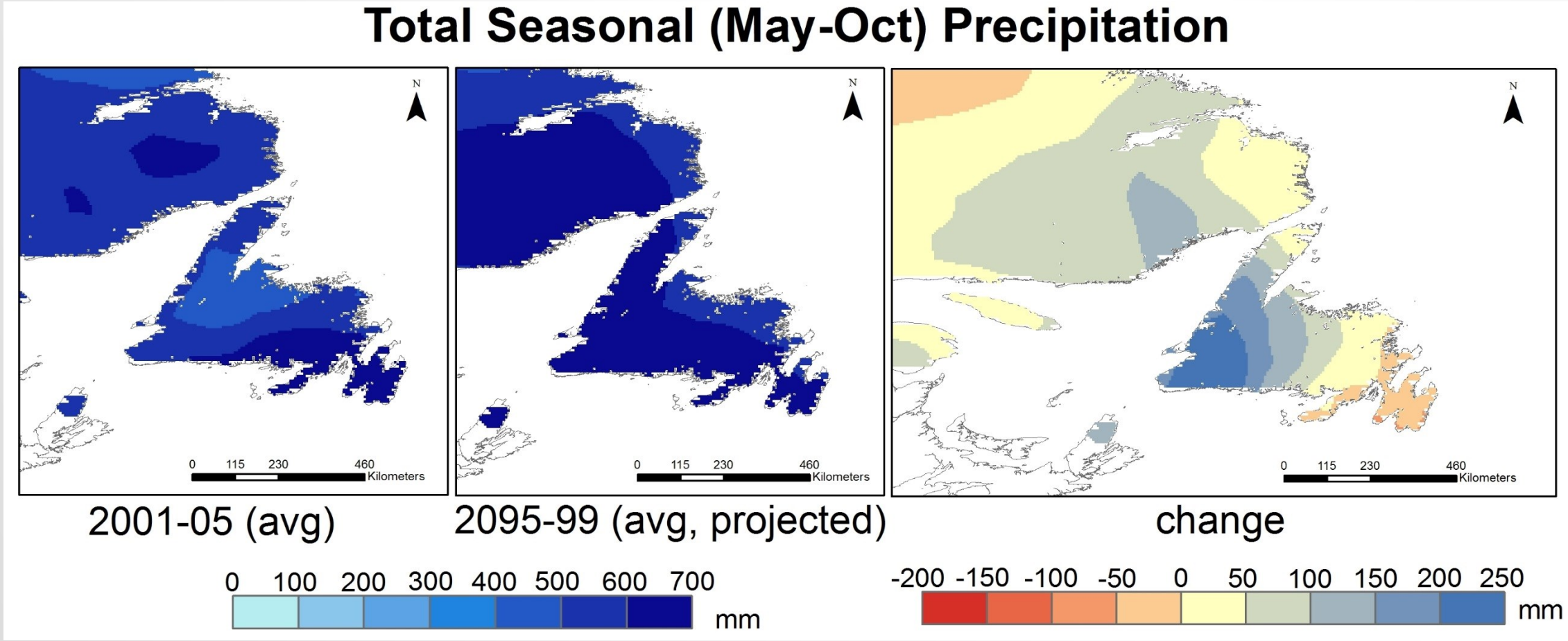
DATA APPLICATION: GLOBAL WARMING

Consider: Future projections for temperature, are not only interesting but carry many implications within the envelop of climate change. Studying these projections is often the first key stepping stone towards any comprehension, realization, agreement and mitigation planning.



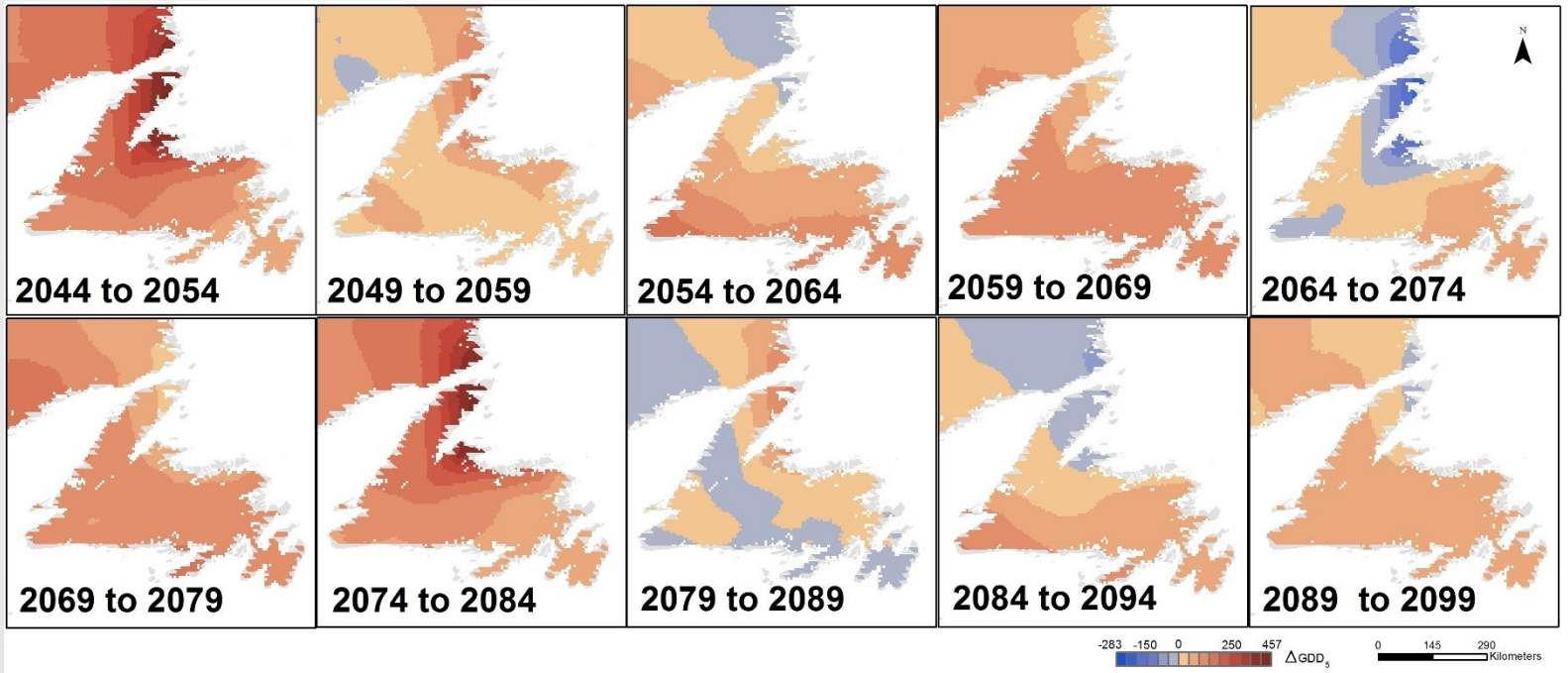
DATA APPLICATION: FLOOD POTENTIAL

Consider: Future projections for precipitation can help show the variation of rain, sleet, and snow across primary areas. Such projections can help shed light on what is necessary in the way of flood risk planning, and related infra-structure stabilization.



DATA APPLICATION: AGRICULTURE

Consider: Temperature and Precipitation, along with hours of daylight, soil type, and other factors are key components for agriculture. The importance is independent of scale, and increasingly on the radar of regional and local governance. Growing Degree Days (GDD) is vitally important as physiological link between Temperature and crop growing[2]



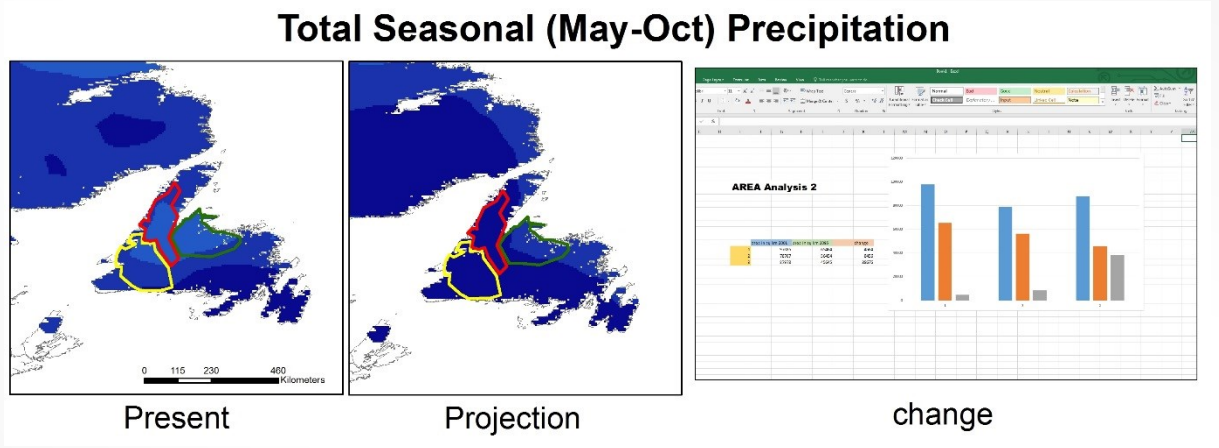
[2]King, M., D. Altdorff, P. Li, L. Galagedara, J. Holden, and A. Unc. Forthcoming, "Northward shift of the agricultural climate zone under 21st-century global climate change." In *Nature Scientific Reports.* United Kingdom: Nature Publishing Group. doi: 10.1038/s41598-018-26321-8

ADVANCED ANALYSIS

Often there is need to do further analysis on data. It might involve the geographical nature of the area being studied, or it could also be the need to quantify the area itself with a numerical representation or statistics. Various methodologies and software exists to aide in the completion of such

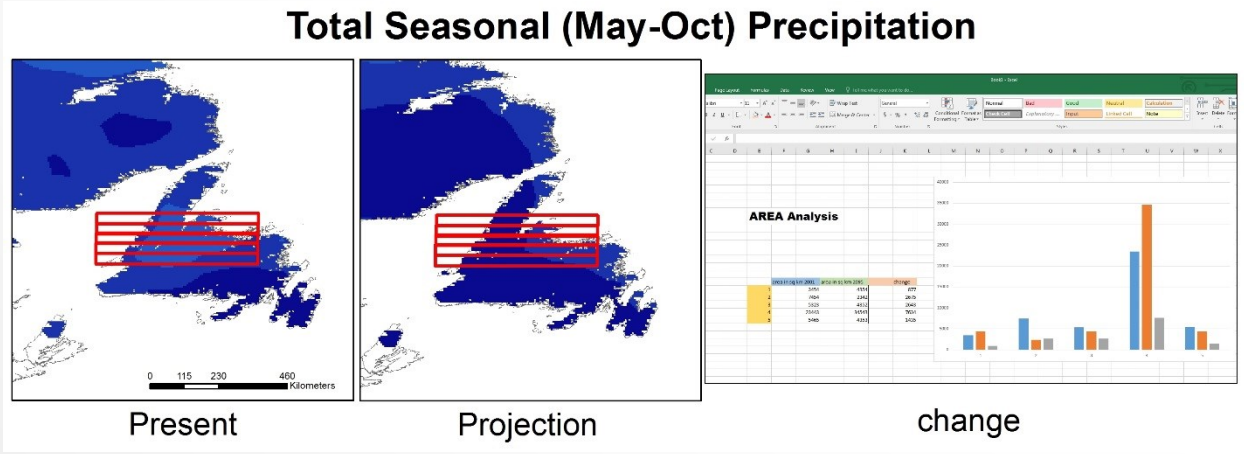
Geographical Areas of Interest

Can help study a phenomenon with regional comparison



Area Quantification

Can help calculate actual areal coverage change



DATA APPLICATION

What other ways do you think such a dataset might be useful?

It can be **Data** that opens the door to further research.

RECOMMENDATIONS

What does having climate change knowledge via scientific data support as action?

Further Research

More research, especially at deeper regional and local levels, utilizing both global and regional data

Recognition

Recognize the science behind climate change. This recognition will help strengthen awareness and acceptance - helping management react appropriately

"CC Ready"

- *Climate change data analysis can help shed light on the breadth of change one place to another*
- *Individuals and families can begin preparing*
- *Local, regional government, organizations, and other groups working together can prepare*

The Data picture can lead to the right action

SUMMARY

- **Climate change study is complex, with many factors**
- **Atmosphere-ocean general circulation models (global change models) can help estimate future climate scenarios**
- **Differences between models do exist, despite overall general agreements**
- **Climate change data is rich data and should be utilized in new and enlightening ways to help answer our research questions, guide our research direction, and inform our mitigation strategies.**

THANK YOU

--- Questions and Comments ---

Contact Details

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"There's no question that climate is changing" **–Jane Goodall**