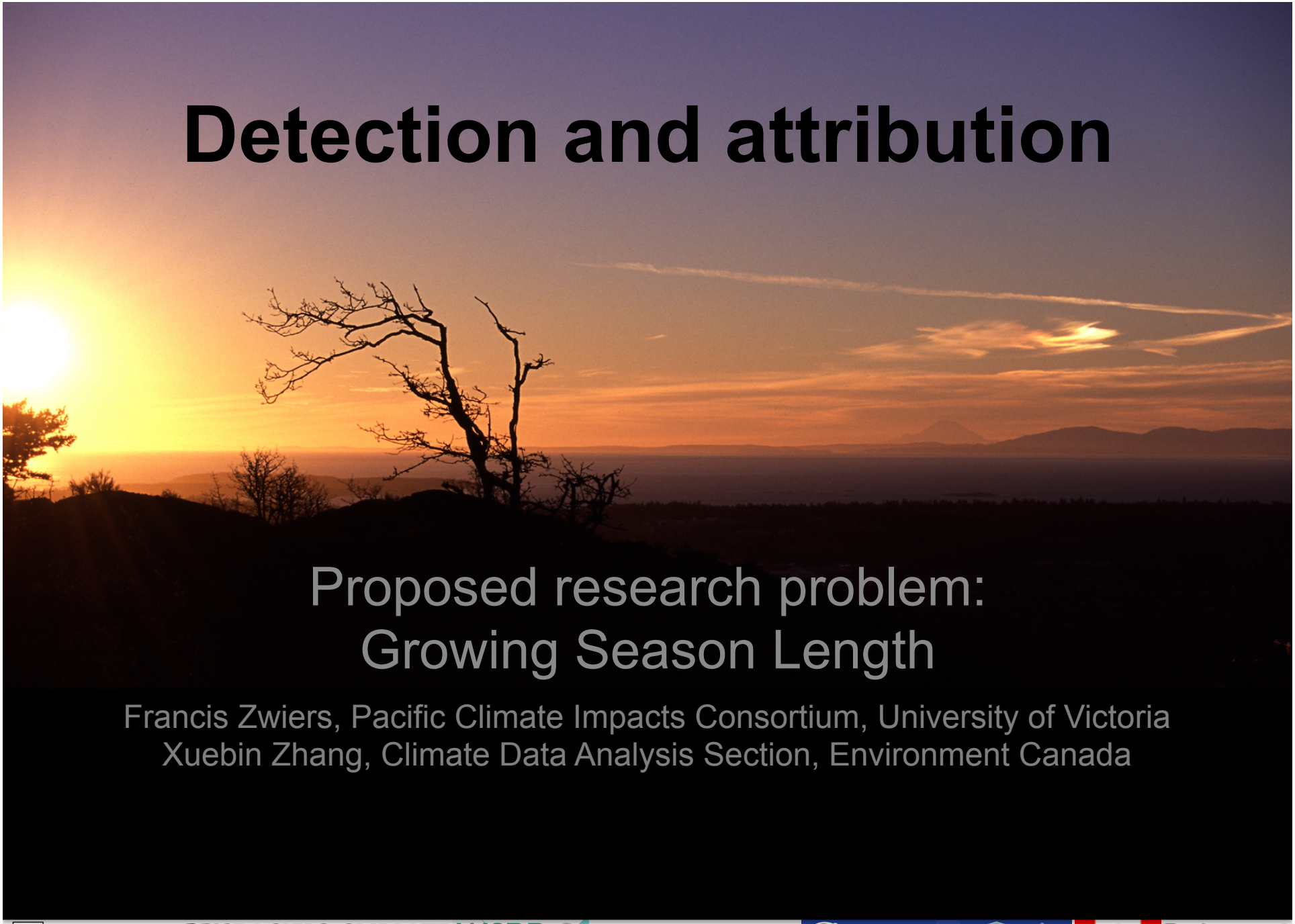

Detection and attribution

Proposed research problem: Growing Season Length

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Xuebin Zhang, Climate Data Analysis Section, Environment Canada

University of Victoria | PACIFIC CLIMATE IMPACTS CONSORTIUM | WCRP World Climate Research Programme | WMO | IOC | ICSU | ICTP The Abdus Salam International Centre for Theoretical Physics | IAEA | Environment Canada

Acknowledgements

- We are deeply indebted to several people for their support of this project
- An enormous effort was undertaken by Judy Wan to acquire and process the CMIP5 climate model output required for this project
  - Judy (Hui) Wan (Environment Canada, hui.wan@ec.gc.ca)
- Also, we express our sincere appreciation to the following for code development
  - David Bronaugh (Pacific Climate Impacts Consortium, bronaugh@uvic.ca, climdex.pcic and climdex.pcic.ncdf)
  - Yang Feng (Environment Canada, yang.feng@ec.gc.ca, R implementation of several detection and attribution formalisms)
  - Qiuzi Wen (Environment Canada, HanQiuzi.Wen@ec.gc.ca, scientific support for detection and attribution code development)

Detecting human influence in ETCCDI temperature indices

3. Detecting human influence in ETCCDI temperature indices (F. Zwiers and X. Zhang)

Both cold and warm temperature extremes have warmed since the middle of the 20th century, and a number of detection and attribution studies have demonstrated that human influence on the climate system has very likely contributed to this warming (IPCC, 2013). It is also widely accepted that human influence has affected the characteristics of warm spells/heat waves and other indicators of temperature that are related to impacts, such as the number of frost days per year (days with minimum temperature below 0C), the number of tropical nights per year (days with minimum temperature above 20C, a key factor associated with the health impacts of heat waves), and the number of warm days per year (days with daily maximum temperature above 25C). While it is generally accepted that human influence has affected these indices, this has not yet been confirmed with formal detection and attribution studies. The objective of the project is, therefore, to use formal detection and attribution methods to determine whether this acceptance, which is reported in IPCC assessments, is in fact, reasonable. This will involve (i) the careful assessment of a range of observed and simulated temperature indices that are contained in the HadEX2 observational extremes indicators dataset (Donat et al., 2013) and that have been extracted from CMIP5 simulations (Sillmann et al., 2013) respectively, and where appropriate, (ii) the application of well established detection and attribution methods (e.g., Hegerl and Zwiers, 2011) to determine whether observed changes in these indices can be attributed to human influence on the climate system. The indicators need careful assessment prior to becoming a subject of a detection and attribution analysis because model biases, or index definitions that are inappropriate for the climate to which they are applied, may create situations in which the indices become ineffective as indicators of variability or change.

The project should be feasible for students who are learning about extremes, extremes indices and detection and attribution methodology since the necessary data resources to undertake this study are readily available, and since it should be possible to distribute the work amongst several members of a team of students. For example, since is it envisioned that several indices will be studied, each member of the team could take on examination of a different index. Team discussions can then focus on understanding criteria for the evaluation of the indices, the detection and attribution methodology and how to best apply it to different indices, and the interpretation of results.

Attribution

- are observed changes consistent with

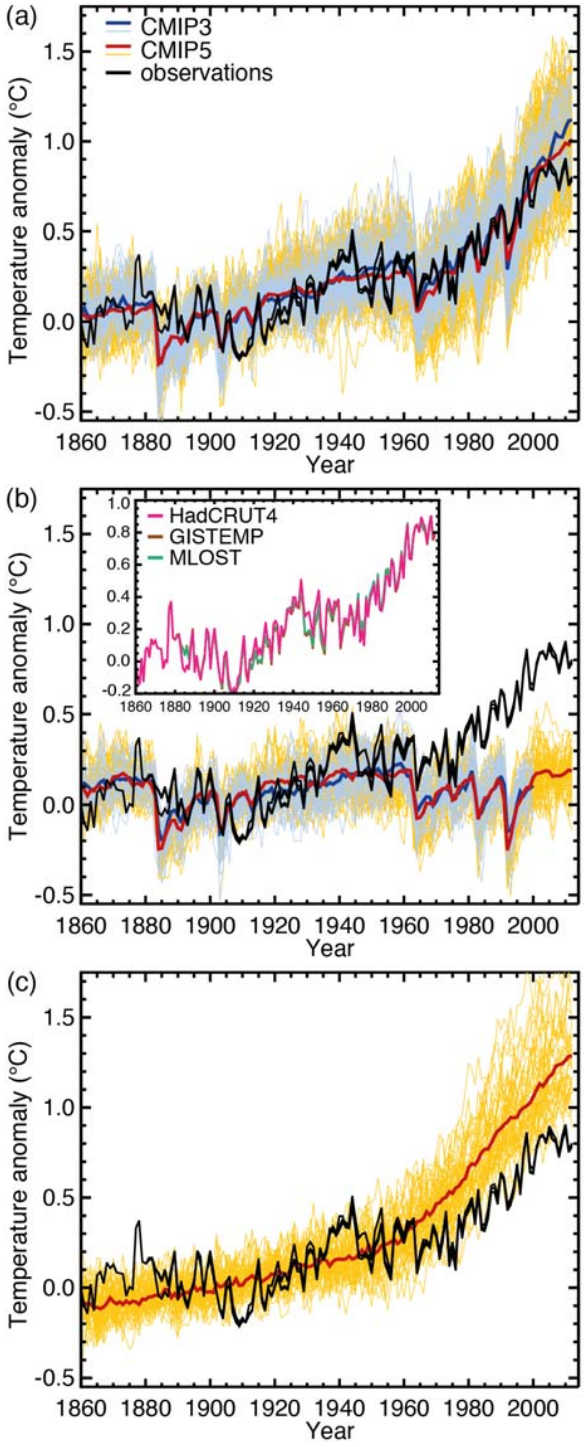
☑expected responses to forcings

☒inconsistent with alternative explanations

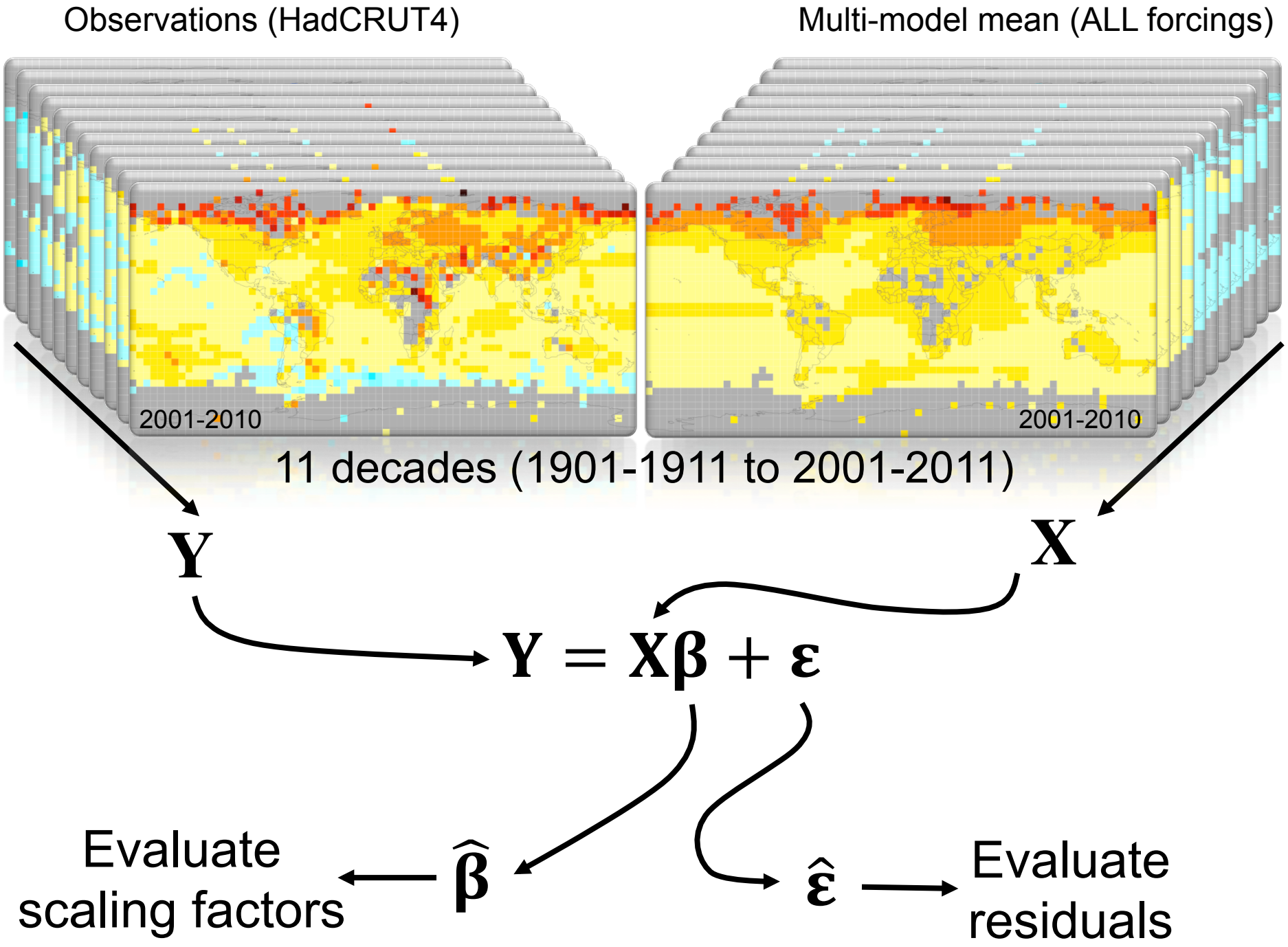
All forcing

Solar + volcanic

GHG forcing



IPCC WG1 AR5 Fig TS-9

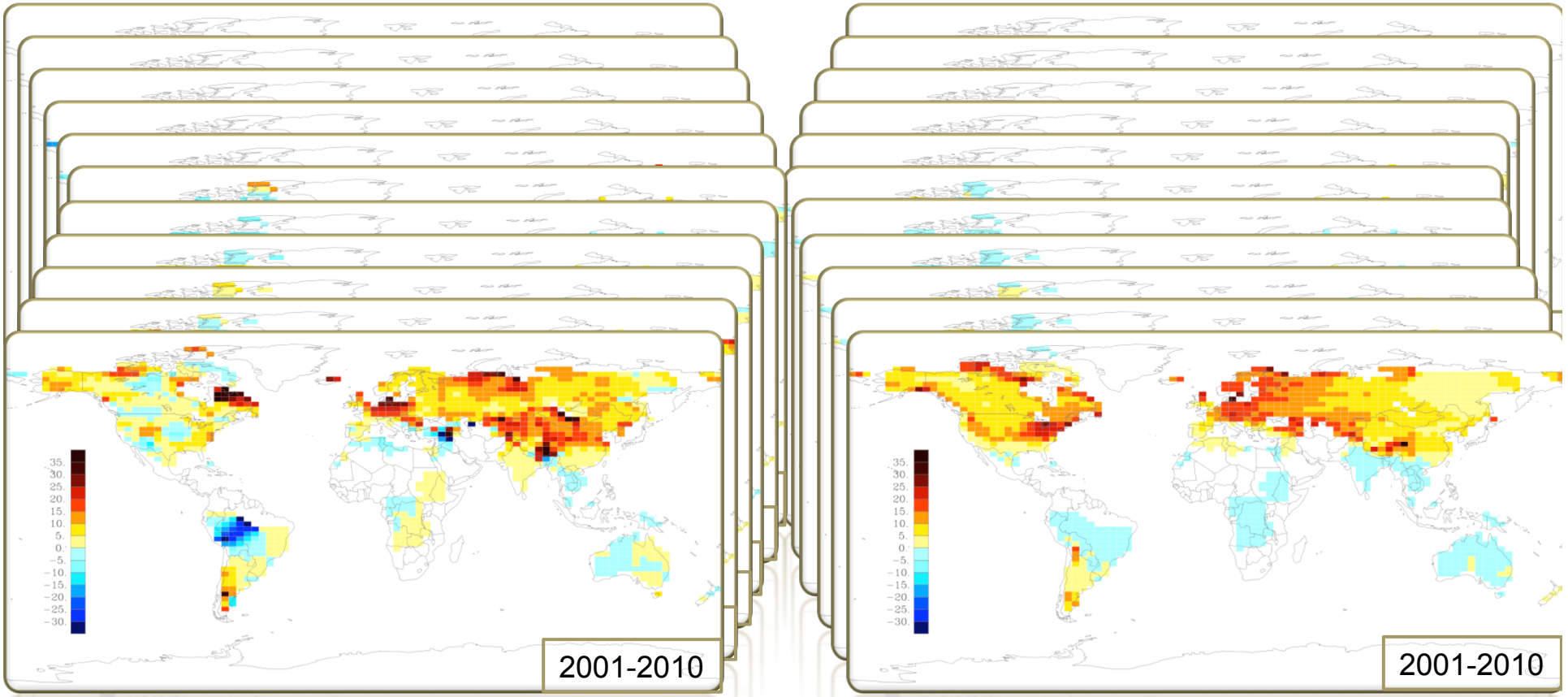

Observations (HadCRUT4)
Multi-model mean (ALL forcings)
2001-2010
2001-2010
11 decades (1901-1911 to 2001-2011)
Y
X
$\mathbf{Y} = \mathbf{X}\boldsymbol{\beta} + \boldsymbol{\varepsilon}$
$\hat{\boldsymbol{\beta}}$
$\hat{\boldsymbol{\varepsilon}}$
Evaluate scaling factors
Evaluate residuals

Proposed index to study

- Growing season length –
  - NH – year begins Jan 1st, GSL is the number of days between the first span of at least 6 days with mean daily temperature above 5°C and the first span after July 1st with at least 6 days with daily mean temperature below 5°C
  - SH – year begins July 1st, GSL is the number of days between the first span of at least 6 days with mean daily temperature above 5°C and the first span after January 1st with at least 6 days with daily mean temperature below 5°C
- Highly impacts relevant
- Want to know whether
  - Models simulate observed change well?
  - Models simulate the natural variability of GSL well?
  - Whether GSL has been affected by human influence (e.g., has it lengthened)?
  - How big has the human contribution been?
  - Has human influence has affected the likelihood of extremely long or extremely short growing seasons?

Observed GSL anomalies (HadEX2)

MIROC5 simulated GSL anomalies



$\mathbf{Y}$

$\mathbf{X}$

$$\mathbf{Y} = \mathbf{X}\boldsymbol{\beta} + \boldsymbol{\varepsilon}$$

$\hat{\boldsymbol{\beta}}$? ? $\hat{\boldsymbol{\varepsilon}}$

Resources

- Lecture notes on detection and attribution
- Relevant literature
- Code (R implementations of three variants of the D&A paradigm, together with working examples)
- Data
  - GSL from HadEX2
  - GSL has been calculated from CMIP5 models using the PCIC CLIMDEX package, interpolated to the HadEX2 spatial resolution
- Expertise
  - Extensive amount of expertise here on the data, indices, D&A, models

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