Communicating with the VIA community: A guidebook on climate scenarios

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Climate Scenarios and Services

Climate Simulations  Vulnerability, Impacts and Adaptation

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CLIMATE SCIENCES

CLIMATE SIMULATIONS and ANALYSIS

CLIMATE SCENARIOS and SERVICES

VULNERABILITY, IMPACTS AND ADAPTATION

NORTHERN ENVIRONMENT

ENERGY RESOURCES

MARITIME ENVIRONMENT

FOREST RESOURCES

WATER RESOURCES

AGRICULTURE

ECOSYSTEMS AND BIODIVERSITY

HEALTH

BUILT ENVIRONMENT

TOURISM

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Natural Resources Canada
Ressources naturelles Canada

Canada
The motivation

• Knowledge transfer from producers of climate information to users of that information

• Increase the capacity of decision-makers to include climate information in an adaptation framework
  
  – All levels of climate information can be equally valuable
  – There is no such thing as the «best» scenario
  – The same climate information can be tailored and presented differently depending on user preference and expertise
# The motivation

**Identifying climate information:**

*one of the steps in an adaptation framework*

| Step 1: Get prepared | - Build a team  
- Begin a discussion on the issues or activity sector to prioritize |
|----------------------|----------------------------------------------------------|
| Step 2: Evaluate current vulnerability | - Describe the current system conditions  
- Describe the current stresses (climatic and others)  
- Describe the adaptation capacity of the system |
| Step 3: Understand climate change | - Understand the observations  
- Understand climate simulations and futures projections  
- Understand the uncertainties |
| Step 4: Evaluate future vulnerabilities and opportunities | - Identify the impacts and opportunities linked to climate change  
- Identify the importance of non-climatic factors  
- Evaluate the vulnerability of the system |
| Step 5: Develop and prioritize adaptation measures | - Identify potential adaptation measures  
- Prioritize adaptation measures |
| Step 6: Establish a plan and put it into action | - Identify actions to undertake in order to adopt adaptation measures  
- Follow-up on impact of adaptation measures  
- Adjust the plan as need be |
The target audience

Decision-makers
- All those involved in climate change adaptation - from awareness to adaptation measures
- All sectors of activity
- Make better use of available climate information

Climate service providers
- Involved in providing information to users
- Novel way of identifying and categorizing user needs
A need to structure climate information

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A need to structure climate information

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| **BASIC**            | Increasing complexity in type of climate variable | • Synthesis tables  
                        |                                | • Climate normals  
                        |                                | • Historical trends  
                        |                                | • Maps of projected global and regional changes |
| **INTERMEDIATE**     | Increasing resolution, scale of information, or amount of data | • Spatial analogues  
                        |                                | • Scatter plots  
                        |                                | • Evolution and maps of future values  
                        |                                | • Cumulative distribution functions |
| **DETAILED**         |                                | • Temporal series  
                        |                                | • Analysis of extremes  
                        |                                | • Analysis of lower-confidence variables (synthetic scenarios/climate models) |

- **Examples of goals and purposes**
  - Raise awareness
  - Risk scanning
  - Vulnerability assessment
  - Impact study
  - Evaluate adaptation measures
  - Research and development
  - Increasing complexity in type of climate variable
  - Increasing resolution, scale of information, or amount of data

- **Example of common formats**
  - Synthesis tables
  - Climate normals
  - Historical trends
  - Maps of projected global and regional changes
  - Spatial analogues
  - Scatter plots
  - Evolution and maps of future values
  - Cumulative distribution functions
  - Temporal series
  - Analysis of extremes
  - Analysis of lower-confidence variables (synthetic scenarios/climate models)
3.2.4 – Evolution of future values

What climate information is presented in the figure?

The figure presents the evolution of the number of annual growing degree-days from 1971 to 2010 for a region surrounding Yellowknife in the Northwest Territories.

Growing degree-days correspond to the absolute difference in mean daily temperature above a threshold of 5°C. For example, if the daily mean temperature is equal to 10°C, the number of growing degree-days for that day is equal to 5. If the temperature is below 5°C, the growing degree-days are equal to zero. Annual values are obtained by adding up the growing degree-day values of all days for the year.

How is the figure constructed?

This type of figure presents the evolution of the projected values of a specific climatic variable for a particular region of interest. Hence, it not only shows the median values for specific time horizons but also how the values evolve over three time periods. A total of 70 simulations (7 from the AOGCM global ensemble and 4 from the regional CRUZ 4.2.1 model) were used to construct this figure (following post-processing).

The left panel presents the average growing-degree-day for all grid points for the region of interest shown in the shaded area. The black line shows observed values (note the observed natural variability of the climate over that time period), the blue line represents the median of the CRUZ ensemble simulation, and the grey envelope represents the confidence interval around the median. The panel uses a bias correction post-processing method.

The panel on the right shows the distribution of the 30 observed annual values of growing degree-days for the reference period (green area), as well as the distributions of the 75 projected years of three individual climate scenarios for both the 2050 (2045/2065) and 2090 (2081/2100) horizons. The plotted scenarios are selected from the total of 75 by first calculating the average delta values for all scenarios for the two time horizons. The three individual scenarios for each horizon are then chosen as those having (1) the median (blue curve), (2) the 10th (green curve) and (3) the 90th (red curve) percentile values of the average projected change out of the 75 simulations for the horizon in question. Note that these three scenarios are not necessarily the same for each horizon of interest (i.e., the scenario showing the median change in 2050 is probably not the median scenario in 2090). This panel uses a scaling post-processing method which allows a direct comparison of future scenarios with the observed distribution.

How is the figure to be interpreted?

Investigating the left panel in isolation reveals that while there is definitely a projected increase in growing-degree-days, there is also a widening of the grey envelope (representing future uncertainty) indicating that the inter-annual variability is relatively similar between the observed and future horizons.

What are the limitations/possible ways to misinterpret the figure?

In order to better understand whether there is indeed an increase in the inter-annual variability (increased fluctuations between years) we need to investigate the panel on the right. Comparing the coloured future distributions with the observed distribution highlights the fact that the distribution shape does not actually change very much in the future (similar width, tails, etc.), and what is projected is more of a simple upward shift in the distribution in the future with an increased separation between the green, blue and red curves (2045/2065 to 2081/2100). Going back to the left panel we can now much more easily conclude that, in this case, the change in width of the grey envelope is due to this increasing separation between the individual climate scenarios (large differences in emissions and climate model variability) and not because of an increase in inter-annual variability.

Source: T. Logue, D. Winkler
3.2.4 – Evolution of future values

Understanding the information presented in the figures

The figure presents the evolution of the number of annual growing-degree days from 1971 to 2000 for a region surrounding Yackandilla in the Northern Territory. Growth-degree days correspond to the absolute difference in mean daily temperature above a threshold of 5°C. For example, if the daily mean temperature is equal to 5°C, the number of growing-degree days for that day is equal to 0. If the temperature is below 5°C, the growing-degree days are equal to zero. Annual values are obtained by adding up the growing-degree day values of all days for the year.

What climate information is presented in the figure?

The left panel shows a projected increase in the number of growing-degree days from 1971 to 2000. The right panel shows the distribution of the simulations for 2050 and 2099, particularly for the median and 90th percentile distributions indicating a change in mean climate conditions. The shapes of the distributions don’t change drastically (compared to the observed) indicating that the inter-annual variability is relatively similar between the observed and future horizons.

How is the figure constructed?

This type of figure presents the evolution of the projected values of a specific climatic variable for a particular region of interest. Hence, it not only shows the median values for specific time horizons but also how the values evolve over the three periods. A total of 70 simulations (10% from the CMIP6 global ensemble and 10% from the regional CROC 4.2.2 model) were used to construct this figure (noting post-processing).

The left panel presents the average growing-degree day for all grid points for the region of interest shown in the shaded area. The black line shows observed values (not the observed natural variability of the climate over that time period), the blue line represents the median of the CMIP6 ensemble simulation, and the grey envelope represents the confidence interval around the median. This panel uses a blurring post-processing method.

The right panel shows the distribution of the 30 observed annual values of growing-degree days for the reference period (1960-1989), as well as the distributions of the 10th, 50th, and 90th percentiles of the ensemble of climate scenarios. The blue and red curves indicate the 10th and 90th percentiles, respectively.

What are the limitations/threats/possible ways to misinterpret the figure?

Investigating the left panel in isolation reveals that while there is definitely a projected increase in growing-degree days, there is also a varying grey envelope (reflecting uncertainty). An important point is that the grey envelope contains all sources of uncertainty, not just the inter-annual variability. For example, the width of the envelope could easily lead a user to mistakenly conclude that in the future, the simulations project both warmer average conditions (centered approximately in the middle of the envelope) and an increased amount of variability between individual years (inter-annual variability). However, this is not how the figure should be interpreted. The width of the envelope reflects the future horizon in the context of multiple sources of uncertainty, not only inter-annual variability for the reference period, but also uncertainty between the different SRES scenarios, i.e., more or less GHG in the atmosphere, as well as uncertainties in climate model interannual variability, e.g., how sensitive different climate models are to a given increase in GHG concentrations. It is therefore false to assume that the wider grey envelope for future horizons simply represents greater future variability, as represented by the grey envelope for the reference period.

In order to better understand whether there is indeed an increase in the inter-annual variability (increased fluctuations between years) we need to investigate the panel on the right. Comparing the coloured future distributions with the observed distribution highlights the fact that the distribution shapes do not actually change very much in the future (similar width, tails, etc.), and what is projected is more of a simple upward shift in the distribution in the future with an increased separation between the green, blue and red curves between 2050 and 2099. Going back to the left panel we can now much more easily conclude that in this case the change in width of the grey envelope due to this increasing separation between the individual climate scenarios (mainly differences in emissions and climate model variability) and not because of an increase in inter-annual variability.

Figure 11: Left: Evolution of the mean annual number of growing-degree days for the years 1971-2000 for the Greater Stann Lake region. The values are calculated using an ensemble of simulations, while the observations come from an AWAP dataset. Right: The distributions for the eastern United States region are presented. The shaded area represents the confidence interval around the median. This panel uses a blurring post-processing method.

Source: T. Logan, Ovanes
3.2.4 Evolution of future values

Key climate modeling concepts

What climate information is presented in the figure?

The figure presents the evolution of the annual growing-degree days from 1971 to 2050 for a region surrounding Yellowstone in the Northern United States.

Growing-degree days correspond to the absolute difference in mean daily temperature above a threshold of 5°C. For example, if the daily mean temperature is equal to 10°C, the number of growing-degree days for that day is equal to 5. If the temperature is below 5°C, the growing-degree days are equal to zero. Annual values are obtained by adding up the growing-degree day values of all days for the year.

How is the figure constructed?

This type of figure presents the evolution of the projected values of a specific climate variable for a particular region and future time period. It not only shows the median values for specific time horizons but also the range of values across three time periods. A total of 22 simulations of a global climate model (CMIP5) for the period 1971-2000 and 4 from the GCM and RCM models were used to construct this figure (following post-processing).

The left panel presents the observed values of the climate variable and the upper confidence interval. The blue line shows observed means of the climate variable for the time period, the blue area represents the median of the climate model simulations, and the grey envelope represents the confidence interval around the median. The panel uses a linear regression post-processing method.

The right panel shows the distribution of the 22 observed annual averages of growing-degree days for the period 1971-2000, as well as the distributions of the 10, 50, and 90 percentiles for the two time horizons. The grey envelope for the future horizon is the result of multiple sources of uncertainty, not only the inter-annual variability, but also the uncertainty in the climate model simulations and the confidence intervals provided by the CMIP5 simulations. The grey envelope for the future horizon is the result of multiple sources of uncertainty, not only the inter-annual variability, but also the uncertainty in the climate model simulations and the confidence intervals provided by the CMIP5 simulations.

What are the limitations/possible ways to misinterpret the figure?

Investigating the left panel in isolation reveals that while there is potentially a projected increase in growing-degree days, there is also a widening of the grey envelope (representing the future). An important point is that the grey envelope contains all sources of uncertainty, not just the interannual variability. For example, the widening of the envelope could easily lead a user to mistakenly conclude that in the future, the simulations project both warmer average temperatures (centered approximately in the middle of the envelope) and an increased amount of variability between individual years (inter-annual variability). However, this is not how the figure should be interpreted. The width of the grey envelope for the future horizon is the result of multiple sources of uncertainty, not only the inter-annual variability, but also the uncertainty in the climate model simulations and the confidence intervals provided by the CMIP5 simulations. It is therefore false to assume that the wider grey envelope for the future horizon is solely due to an increase in inter-annual variability, as represented by the grey envelope for the reference period.

To better understand whether there is indeed an increase in the inter-annual variability (increased fluctuations between years), we need to investigate the panels on the right. Comparing the coloured future distributions with the observed distribution highlights the fact that the distribution shape does not actually change very much in the future (similar width, tails, etc.), and what is projected is more of a simple upward shift in the future, with an increased separation between the green, blue and red curves (2045-2060). Going back to the left panel, we can now more easily conclude that, in this case, the increase in width of the grey envelope is due to the increasing separation between the individual climate simulations (interannual differences in ensembles and climate model variability) and not because of an increase in interannual variability.
Lessons learned

• Structuring the way we provide data (what is most important in deciding what information to give)
• Difficulties in separating and characterizing the categories
• Finding the correct level of language used (some jargon is necessary but it needs to remain fairly simple)
• From a Climate science specialist view point, explanations regarding reference climate data are missing
• Lessons will come with the use of the guide and feedback from users
Thank you!

Note that the guidebook is available online:
