Investigating Historical Weather Data and Its Sociocultural Impacts

Three-Week Course Module for the Data Rescue: Archives and Weather (DRAW) Project

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1. Course module description and learning outcomes

A. Course description

Investigating historical weather data and its sociocultural impacts
This course module for undergraduate and Collège d'enseignement général et professionnel (CEGEP) students focuses on introducing students to social science research methods that include crowdsourced citizen science and transcription of historical data. Students will examine historical climate and weather data from McGill University's Observatory gathered between 1874 and 1900 as citizen scientists for the Data Rescue: Archives and Weather (DRAW) project (https://test.citsci.geog.mcgill.ca). The goal of DRAW is use a citizen science website to display and transcribe meteorological and climatological records from Montreal, QC. Students will benefit from undertaking social science research methods in fields that include historical climate science, archiving and data transcription. Group research assignment work will involve students in designing and evaluating hypotheses on time periods for which they have transcribed data to examine related human social, political and cultural processes.

B. Learning outcomes

Table 1. Learning outcomes

General	Specific	Knowledge Dimension	Level of Thinking
1. Be able to explain how scientists examine Montreal's historical records of climate and weather	1.1 Describe what sources of data are available to scientists studying Montreal's historical climate	Factual	Understand/Analyze
	1.2 Examine what sources of error or gaps exist in such records due to how they were created	Conceptual	Understand
	1.3 Investigate how scientists use this data in their own research, account for any gaps/errors and compare it to other forms of data on climate and weather in Montreal	Conceptual	Create
2. Be able to employ scientific research and data transcription skills	2.1 Identify key characteristics of citizen science based research and what attributes make it good science	Factual	Apply
	2.2 Explain why it is important that logbooks from the McGill University Observatory are transcribed digitally	Procedural	Understand/Evaluate
	2.3 Create, test, evaluate and communicate your own hypothesis using data transcription processes in the DRAW Project	Procedural/ Metacognitive	Create/ Analyze
3. Be able to explain how human social, cultural and political events relate to climate and weather	3.1 Describe specific human social, cultural and political events that were impacted by weather or climate	Factual	Understand
	3.2 Evaluate how seasonal climate trends shaped the human dimensions of Montreal's society	Factual	Evaluate
	3.3 Examine interactions between an instance of weather and human behavior	Conceptual	Analyze
	3.4 Apply knowledge of the human relationship to climate and weather to your own research on the topic	Conceptual	Apply
4. Be able to apply scientific methods involving the use of historical climate records to your own research in class	4.1 Describe the climate and weather records you are examining and their relationship to human processes	Factual	Understand
	4.2 Evaluate your hypothesis about DRAW data using social science research methods and materials (newspaper archives, books, photos or other) and explain the relationship to DRAW records you have transcribed	Conceptual	Create
	4.3 Communicate your findings and consider possible contradictory explanations in relation to your research and the DRAW data you transcribed for it	Conceptual	Apply

2. Teaching philosophy and instructional strategies

A. Philosophy on student learning

Improving public understanding of climate and meteorological science requires not only using hands-on scientific processes but also engaging technical skills with topics from the humanities. At the same time, considerable resources are required to rescue, digitize, and transcribe observational meteorological data holdings of the recent past (Ryan et al., 2018). For this reason, globally and temporally complete records remain grossly incomplete with many records remaining in hard copy format or consisting of photographed images (Allan et al., 2011; Brunet & Jones, 2011).

The successes of past and current citizen science applications, such as Data Rescue@Home (www.data-rescue-at-home.org), the Community Collaborative Rain, Hail, and Snow Network (https://www.cocorahs.org/), and OldWeather.org (www.oldweather.org/), underscore the potential of crowdsourcing weather observations to engage and educate the public. In cases such as Old Weather, the dataset is being used for climate reconstruction by the 20th Century Reanalysis Project (20CR) which provides integrated historical datasets (Compo, 2011). In contrast, the DataRescue@Home (http://data-rescue-at-home.org/) project exemplified climate data rescue where citizen scientists transcribe observations and play a role in safeguarding data for analysis (Allan et al., 2011).

Data Rescue: Archives and Weather (DRAW, https://citsci.geog.mcgill.ca/) engages students in this curriculum not only by having them learn about meteorological research through transcription on its website—but also by engaging with their own Canadian heritage through archival research where they tie historic weather to human social, cultural and political events. Inquiry learning of this nature places the emphasis on students doing the work of scientists to form their own conclusions and aid actual research. This pedagogical shift has roots in educational research that demonstrates inquiry-based science instruction imparts clear scientific understandings (Anderson, 1983; Schroeder et al., 2007; Furtak et al., 2012).

As pedagogy, inquiry asks students to pose questions, evaluate evidence-based answers or explanations, and communicate findings (NRC, 2000) rather than learn facts “found in their textbook” (Rakow, 1986). The learning objectives in this curriculum are derived from educational standards on inquiry based science. They also fulfill the 1996 National Science Education Standards (NRC, 1996, 2000) and the 2013 Next Generation Science Standards in the United States, which specifically requires learning about climate and weather using climate models (NGSS, 2013).

Inquiry science fits a constructivist model of teaching that posits mental frameworks are formed continually as individuals attempt to make meaning from personal experience

(Osborne and Freyberg, 1985). Students in classrooms alter, develop and restructure their knowledge based on hands-on experience, discussions and contact with teachers (Driver, 1989). The Swiss psychologist Jean Piaget theorized that individuals develop beliefs in stages as they repeat childhood interactions with their environment and adjust their perceptions (Piaget & Inhelder, 1969). The Russian psychologist Lev Vygotsky added that social interactions are intrinsic to this process (John-Steiner & Mahn, 1996). Contemporary social constructivists have noted that these stages are fluid, active processes where learners navigate not just individual constructs but social and political norms (Phillips, 1995).

This theoretical background mirrors findings showing learning takes place best when it relates to previous student experiences and involves strong instructor guidance and scaffolding of concepts (Kirschner et al., 2006; Hmelo-Silver et al., 2007). Such findings have important implications for teaching students about weather and climate using hands-on citizen science and archival research that relates records to their own human heritage.

B. Implementing the DRAW course module

Inquiry based science learning, where students undertake hands-on scientific investigations, has been shown to reverse trends of young students becoming turned off science by making lasting improvements to attitudes and enthusiasm about scientific learning (Stake & Mares, 2001; Selim & Shrigley, 1983). Combined with citizen science, inquiry learning has the potential to involve students in meaningful scientific research.

This curriculum ties learning about climate and weather science to individual experience by taking advantage of advances in geospatial and digital technology to give students a hands-on learning experience. In this course, students learn concepts through group and individual work that allows them to transcribe real historical weather and climate data and (through their efforts) contribute to a record used by researchers.

This curriculum also helps students undertake archival research to examine how human social, cultural and political events were impacted by climate and weather. Following a view of assessment as a tool to help students build learning (Shepard, 2008), the course work and formative / summative assessments give students a chance to practice skills and ideas, receive feedback (both from instructors and peers), reflect on what they are learning and take part in the actual activities of science.

C. Performance based assessment activity

A. Background

Many of the assessments in this class will be performance-based as students practice the skills common to scientists. This document describes the group research assignment students will be asked to undertake in the course.

The group research assignment makes use of elements students will have practiced throughout the course. These include work with DRAW, undertaking archival research,

and critically examining the link between humans and climate and weather. Students will design social science hypotheses that reflect understanding of historical meteorological data and human events.

B. Project design

Student groups will be asked to transcribe a specific day or days of data on DRAW and then complete archival research that relates this weather record to human events. The hypotheses students develop will require research online and will be submitted to the course instructors for approval before students begin.

After gaining approval, students will draft hypotheses relevant to the time period and/or human event they chose, transcribe their DRAW data and conduct archival research to help disprove/approve their hypothesis. Class time will allow students to transcribe DRAW data, conduct archival research and benefit from instructor guidance. Students will be encouraged to finish research with their group outside of class as needed. Students can analyze the data in any manner in which they wish, but will be expected to generate figures, tables and maps as described in the assignment instructions.

C. Products Generated

Students will write up their research by following the prompts in the group assignment document. In addition to the sections required by the assignment instructions, students will be asked to write a reflection on their work as well.

3. Three week course plan

1. Each day of the course is designed to cover specific topics with lecture, group work and discussion before turning students loose to work with DRAW, undertake readings, conduct research and undertake a group research assignment.

2. Levels of thinking: Knowledge dimension Cognitive dimension

3. Who participates in teaching/learning strategies (although teacher will always circulate to provide guidance):
T: Teacher; **S**: Student

4. Graded Not Graded Not graded but counted toward participation

5. Reflections/self-assessment activities will happen in each class and ask students to consider what they learned and be collected.

Table 2. Daily course plan

Week	Class	Content	General Learning Objective	Specific Learning Objective(s)	Instructional/Inquiry Activities IN-CLASS TIME		Instructional/Inquiry Activities OUT-OF-CLASS TIME	
					Inform	Practice/ Feedback/ Evaluation	Readings	Practice/ Feedback/ Evaluation
1	Class 1	1. What is citizen science and data rescue? Why should anyone care? 2. The age of trained amateur scientists 3. What have historical climate scientists done so far? 4. Trends in Montreal's historical climate.	1. Be able to explain how scientists examine Montreal's historical records of climate and weather 2. Be able to employ scientific research and data transcription skills	1.1 Describe what sources of data are available to scientists studying Montreal's historical climate (Factual/ Understand and Analyze) 1.2 Examine what sources of error or gaps exist in such records due to how they were created (Conceptual/ Understand) 1.3 Investigate how scientists use this data in their own research, account for any gaps/errors and compare it to other forms of data on climate and weather in Montreal (Conceptual/ Create) 2.1 Identify key characteristics of citizen science based research and what attributes makes it good science (Conceptual/ Understand) 2.2 Explain why it is important that logbooks from the McGill University Observatory are transcribed digitally (Conceptual/ Create)	1. Introductory short lecture: What is citizen science? (**T**) 2. Lecture and discussion: The age of trained amateur scientists and what makes good science? (**T&S**) 3. Lecture: Historical climate and weather research (**T**) 4. Discussion: Trends in climate: What do you expect? (**T&S**)	- End-of-class reflection/self-assessments (**S**): Key Points	- Chapter 1 & 9: Cooper, C. (2017). *Citizen science: How ordinary people are changing the face of discovery*. New York: Peter Mayer Publishers. - Silvertown, J. (2009). A new dawn for citizen science. *Trends in Ecology and Evolution*, 1–5. http://doi.org/10.1016/j.tree.2009.03.017	- Pre exam questions (if desired)

See **Slide Deck** "Class 1: Citizen science and historical climate data: An introduction."

Week	Class	Content	General Learning Objective	Specific Learning Objective(s)	Instructional/Inquiry Activities IN-CLASS TIME		Instructional/Inquiry Activities OUT-OF-CLASS TIME	
					Inform	Practice/ Feedback/ Evaluation	Readings	Practice/ Feedback/ Evaluation
1	Class 2	1. Introducing DRAW 2. Guided student exploration of DRAW 3. DRAW Class: Transcription	1. Be able to explain how scientists examine Montreal's historical records of climate and weather 2. Be able to employ scientific research and data transcription skills	1.1 Describe what sources of data are available to scientists studying Montreal's historical climate (Factual/ Understand and Analyze) 1.2 Examine what sources of error or gaps exist in such records due to how they were created (Conceptual/ Understand) 1.3 Investigate how scientists use this data in their own research, account for any gaps/errors and compare it to other forms of data on climate and weather in Montreal (Conceptual/ Create) 2.1 Identify key characteristics of citizen science based research and what attributes makes it good science (Conceptual/ Understand) 2.2 Explain why it is important that logbooks from the McGill University Observatory are transcribed digitally (Conceptual/ Create) 2.3 Create, test, evaluate and communicate about your own hypothesis using data transcription processes in the DRAW Project (Procedural and Metacognitive/ Create and Analyze)	1. Short lecture: Welcome to being a DRAW citizen scientist **(T)** 2. Guided exploration: Examining the DRAW website and interface (**T&S**) 3. Group work: Completing transcription **(T&S)**	- End-of-class reflection/self-assessments (**S**): Pro/Con Grid of DRAW	- Chapter 1 & 9: Cooper, C. (2017). *Citizen science: How ordinary people are changing the face of discovery*. New York: Peter Mayer Publishers. - Silvertown, J. (2009). A new dawn for citizen science. *Trends in Ecology and Evolution*, 1–5. http://doi.org/10.1016/j.tree.2009.03.017	

See **Slide Deck** "Class 2: Working with DRAW." See **Handout** "DRAW data transcription class session."

Week	Class	Content	General Learning Objective	Specific Learning Objective(s)	Instructional/Inquiry Activities IN-CLASS TIME		Instructional/Inquiry Activities OUT-OF-CLASS TIME	
					Inform	Practice/ Feedback/ Evaluation	Readings	Practice/ Feedback/ Evaluation
2	Class 3	1. Introductory Lecture: The Queen's Jubilee and Boer War Riots 2. Inquiry Activity: What common traits tie climate to human events 3. Climate and Montreal city culture in 1874 4. How does climate affect our habits today?	3. Be able to explain how human social, cultural and political events relate to climate and weather	3.1 Describe specific human social, cultural and political events that were impacted by weather or climate (Factual/ Understand) 3.2 Evaluate how seasonal climate trends shaped the human dimensions of Montreal's society (Factual/ Evaluate) 3.3 Examine interactions between an instance of weather and human behavior (Conceptual and Analyze/ Conceptual and Apply) 3.4 Apply knowledge of the human relationship to climate and weather to your own research on the topic (Conceptual and Analyze/ Conceptual and Apply)	1. Short lecture: How humans and climate/weather interact (**T**) 2. Group inquiry activity: Tying climate and weather to human events (**T&S**) 3. Short lecture: Climate and the City of Montreal in 1874 **(T)** 4. Group discussion: How does climate and weather affect our habits today? **(S)**	- End-of-class reflection/self-assessments (**S**): Write a Test Question	- Chapters 1 & 11: Slonosky, V. (2018). *Climate in the Age of Empire: Weather Observers in Colonial Canada*. Washington, DC: American Meteorological Society. - Mock, C. J. (2011). Early instrumental and documentary evidence of environmental change. J.A. Matthews (Ed.) *The SAGE Handbook of Environmental Change*, 1, 345.	

See **Slide Deck** "Class 3: Climate and society."

Week	Class	Content	General Learning Objective	Specific Learning Objective(s)	Instructional/Inquiry Activities IN-CLASS TIME		Instructional/Inquiry Activities OUT-OF-CLASS TIME	
					Inform	Practice/ Feedback/ Evaluation	Readings	Practice/ Feedback/ Evaluation
2	Class 4	1. Continuing transcription and checking against other records	2. Be able to employ scientific research and data transcription skills 3. Be able to explain how human social, cultural and political events relate to climate and weather	2.3 Create, test, evaluate and communicate about your own hypothesis using data transcription processes in the DRAW Project (Procedural and Metacognitive/ Create and Analyze) 3.1 Describe specific human social, cultural and political events that were impacted by weather or climate (Factual/ Understand) 3.2 Evaluate how seasonal climate trends shaped the human dimensions of Montreal's society (Factual/ Evaluate) 3.3 Examine interactions between an instance of weather and human behavior (Conceptual and Analyze/ Conceptual and Apply) 3.4 Apply knowledge of the human relationship to climate and weather to your own research on the topic (Conceptual and Analyze/ Conceptual and Apply)	1. Group work: Completing transcription 2: How can we verify other data sources using historical climate and weather data? **(T&S)** 3. Group work and discussion: Drafting our first hypotheses using DRAW: How did what you expect in our "Trends and Climate" activity compare to what you saw working with DRAW? (**T&S**)	- End-of-class reflection/self-assessments (**S**): Check-In on the Group Research Assignment	- Chapters 1 & 11: Slonosky, V. (2018). *Climate in the Age of Empire: Weather Observers in Colonial Canada*. Washington, DC: American Meteorological Society. - Matthews, J. A. (Ed.). (2012). *The SAGE Handbook of Environmental Change: Volume 1: Approaches, Evidences and Causes Volume 2: Human Impacts and Responses*. Sage.	

See **Slide Deck** "Class 4: Google Earth and Weather Data."

Week	Class	Content	General Learning Objective	Specific Learning Objective(s)	Instructional/Inquiry Activities IN-CLASS TIME		Instructional/Inquiry Activities OUT-OF-CLASS TIME	
					Inform	Practice/ Feedback/ Evaluation	Readings	Practice/ Feedback/ Evaluation
3	Class 5	1. Introduce group research assignment 2. Discussion of social science research methods and library resources 3. Draft and review group hypotheses (**T&S**) 4. Begin final project work (**S**)	2. Be able to employ scientific research and data transcription skills 4. Be able to apply scientific methods involving the use of historical climate records to your own research in class	2.3 Create, test, evaluate and communicate about your own hypothesis using data transcription processes in the DRAW Project (Procedural and Metacognitive/ Create and Analyze) 4.1 Describe the climate and weather records you are examining and their relationship to human processes (Factual/ Understand) 4.2 Evaluate your hypothesis about DRAW data using social science research methods (newspaper archives, books, photos or other) and explain the relationship to DRAW records you have transcribed (Conceptual/ Create) 4.3 Communicate your findings and consider possible contradictory explanations in relation to your research and the DRAW data you transcribed for it. (Conceptual/ Apply)	1. Short lecture: Group research assignment instructions (**T**) 2 Group discussion: Social science research methods and library resources 3. Drafting research hypotheses and getting instructor approval (**T&S**) 4. Begin final project work with instructor supervision **(T&S)**	- End-of-class reflection/self-assessments (**S**): Check-In on the Group Research Assignment	- Del Balso, M. and Lewis, Alan D. (2012). *First Steps: A Guide to Social Research.* Chapter 8: Indirect or Nonreactive Methods, p. 196 – 209 (Available Data and Secondary Data Analysis)	- Group research assignment

See **Handouts** “Group research assignment,” “Group research assignment topics,” and “Group research assignment resources.”

Week	Class	Content	General Learning Objective	Specific Learning Objective(s)	Instructional/Inquiry Activities IN-CLASS TIME		Instructional/Inquiry Activities OUT-OF-CLASS TIME	
					Inform	Practice/ Feedback/ Evaluation	Readings	Practice/ Feedback/ Evaluation
3	Class 6	1. Guided group research assignment work	4. Be able to apply scientific methods involving the use of historical climate records to your own research in class	4.1 Describe the climate and weather records you are examining and their relationship to human processes (Factual/ Understand) 4.2 Evaluate your hypothesis about DRAW data using social science research methods (newspaper archives, books, photos or other) and explain the relationship to DRAW records you have transcribed (Conceptual/Create) 4.3 Communicate your findings and consider possible contradictory explanations in relation to your research and the DRAW data you transcribed for it. (Conceptual/Apply)	1. Guided group research assignment work (**T&S)**	- End-of-class reflection/self-assessments (**S**): Checking-In on Group Research Assignment	- Del Balso, M. and Lewis, Alan D. (2012). *First Steps: A Guide to Social Research.* Chapter 8: Indirect or Nonreactive Methods, p. 196 – 209 (Available Data and Secondary Data Analysis)	- Group research assignment - Post exam questions

4. Assessment overview, exam questions, group research assignment and rubrics

Table 3. Assessment overview

General Learning Objective	Specific Learning Objective	Primary Assessment Task
1. Be able to explain how scientists examine Montreal's historical records of climate and weather	1.1 Describe what sources of data are available to scientists studying Montreal's historical climate	Pre/Post exam questions
	1.2 Examine what sources of error or gaps exist in such records due to how they were created	Pre/Post exam questions
	1.3 Investigate how scientists use this data in their own research, account for any gaps/errors and compare it to other forms of data on climate and weather in Montreal	Pre/Post exam questions
2. Be able to employ scientific research and data transcription skills	2.1 Identify key characteristics of citizen science based research and what attributes makes it good science	Pre/Post exam questions
	2.2 Explain why it is important that logbooks from the McGill University Observatory are transcribed digitally	Pre/Post exam questions
	2.3 Create, test, evaluate and communicate about your own hypothesis using data transcription processes in the DRAW Project	Pre/Post exam questions and group research assignment
3. Be able to explain how human social, cultural and political events relate to climate and weather	3.1 Describe specific human social, cultural and political events that were impacted by weather or climate	Pre/Post exam questions and group research assignment
	3.2 Evaluate how seasonal climate trends shaped the human dimensions of Montreal's society	Pre/Post exam questions and group research assignment
	3.3 Examine interactions between an instance of weather and human behavior	Pre/Post exam questions and group research assignment
	3.4 Apply knowledge of the human relationship to climate and weather to your own research on the topic	Pre/Post exam questions and group research assignment
4. Be able to apply scientific methods involving the use of historical climate records to your own research in class	4.1 Describe the climate and weather records you are examining and their relationship to human processes	Group research assignment
	4.2 Evaluate your hypothesis about DRAW data using social science research methods (newspaper archives, books, photos or other) and explain the relationship to DRAW records you have transcribed	Group research assignment
	4.3 Communicate your findings and consider possible contradictory explanations in relation to your research and the DRAW data you transcribed for it	Group research assignment

DRAW module pre/post exam questions

Please Note: *Each of the bolded numbers in parentheses at the end of questions are correlated to learning outcomes.*

Section I: Multiple Choice Questions (2 points per question answered)

1. During the time period 1874-1900, historical climate and weather data records where taken originally by whom at the McGill University Observatory? **(1.1)**
A. Trained amateur scientists
B. Doctors
C. Professors and students
D. Lawyers
E. Scientists

2. An example of a specific human event being tied to an incidence of weather or climate: **(3.1)**
A. Use of frozen waterways for wintertime transportation of goods and peoples
B. Riots over Boer War at University of Laval quelled by wintertime blizzard
C. Montreal residents escaping to suburbs and rural areas to escape summer heat waves
D. Social activities being planned during wintertime when residents returned to Montreal
E. None of the above

3. An example of trends in climate being tied to broad human cultural patterns includes: **(3.2)**
A. People still came to celebrate during the Queen's Jubilee despite heavy rain and inclement weather in Montreal
B. Riots over Boer War at University of Laval quelled by wintertime blizzard
C. Floods, high food prices and political turbulence leading to 1917 conscription crisis
D. Social activities being planned during wintertime when residents returned to Montreal
F. None of the above

4. When a scientist takes part in publishing papers based on the data found in DRAW, he or she is undertaking what part of the scientific process: **(4.3)**
A. Formulating hypotheses
B. Skepticism
C. Communicating findings
D. Citizen science
E. All of the above

5. If a scientist uses historical climate records to find inaccuracies in the instrumental temperature record or confirm periods of warming/cooling, he or she is: **(4.2)**
A. Conducting climate reconstruction
B. Calibrating their model
C. Confirming anthropogenic climate change
D. Conducting improper research
E. Re-checking data from proxy or reanalysis data

Section II: Short answer questions (5 points per question answered)

Answer each of the following questions. Your answer to each question should be a paragraph (~50 – 75 words) in length.

1. What are two ethical concerns that had to be addressed in order for you to participate in the DRAW project? How did the researchers address those concerns in their research design? **(2.2)**

   _____
   _____
   _____

2. What are two potential sources of error in the measurement of the original climate data? **(1.2)**

   _____
   _____
   _____

3. Based on your participation in the project, what are two potential sources or error in the digital transcription of McGill's historical climate data? **(1.3)**

   _____
   _____
   _____

4. Describe the pre/post questionnaire format using concepts of survey design discussed in this course. **(2.1)**

   _____
   _____
   _____

5. What is the type of sampling method used for the questionnaires in the DRAW project? Discuss one advantage and one disadvantage of this sampling method. **(2.3)**

   _____
   _____
   _____

6. Discuss two traits common in human events that coincided with some climatic or weather related event **(3.3)**

   _____
   _____
   _____

7. Write a hypothesis you expect to be true about Montreal's past climate. Explain in a sentence whether DRAW could be used to prove or disprove this hypothesis. **(3.4)**

_____
_____
_____

8. Take a position: Explain how citizen science research may 1) improve or 2) decrease the accuracy of scientific data? Justify your argument in one or two sentences. **(4.1)**

_____
_____
_____

DRAW module pre/post short answer exam questions rubric

Question one
2—Any two of: 1) Informed consent; 2) Anonymity of responses; 3) Voluntary; 4) Participation in different parts of research; 5) Separation of grades from research (and identities of graded material vs. instructor's access to research material; 6) Risks of research; 7) Can leave at any time and 8) Data will be destroyed.
1—Any one of the above.
0—None of the above.

Question two
2—Reasonable explanations for human or instrumental error from historical meteorology (i.e., student slept through, misinterpretation of weather, misunderstanding of data entry). Gaps in the record or the historical materials. These may also include there not being as many observations per day in the past and the accuracy of instruments/technology
1—Only one of the above.
0—Nothing that is reasonable and/or fits within those broad ideas above.

Question three
2—Anything that's reasonable and related to the transcription process (i.e., entering wrong date with a row, entering incorrect information, hard to read handwriting, misinterpretation of symbols). Human error due to lack of training.
1—Only one of the above.
0—Nothing that is reasonable and/or fits within those broad ideas above.

Question four
2—Any answer that correctly describes measurement of knowledge and attitude change from pre (before the intervention with DRAW) to post (after the intervention with DRAW).
1—Any answer that contains elements of the right answer above but not the full right answer.
0—Missing any element of the right ideas above.

Question five
2—It's non-random sampling because we worked with a specific population intentionally (advantage). Disadvantage is it makes this only quasi-experimental, population not generalizable because not randomized.
1—Some element of the right answer above
0—None of the right ideas above.

Question six
2—There being climate or weather conditions that directly impact human behavior (e.g., storage of food, going home to shovel, travel methods, events planned, displacement to the countryside during summer heat waves, illness). Or any answer that gives two examples with that include these attributes.

1—Only one of the right answers above.
0—None of the right ideas above are encapsulated in the answer.

Question seven
2—Any reasonable hypothesis about the DRAW record that it actually could be used to answer.
1—An answer that is mostly reasonable but has some kind of flaw in reasoning or might not be answerable by the DRAW record.
0—Nothing is right about the answer either in its reasoning or ability to be proven/disproven by the DRAW record.

Question eight
2—A clear direct statement for/against citizen science's impact on scientific data. At least two sentences that justify the position taken.
1—Only one sentence of justification or some unclear position statement, but enough elements of a correct answer above to warrant one point.
0—No correct elements of the right answer above.

Group research assignment

DRAW Module: Group research assignment
Course: [Add your course name]
Instructor: [Add instructor name]
Semester: [Add semester]

Background
You've now learned how to transcribe data using the Data Rescues: Archive and Weather project (https://test.citsci.geog.mcgill.ca). You've also learned about trends in Montreal's historical climate and how human social, political and cultural processes can often relate to climate or weather. For this module's group research assignment, you will now put together these two skills to conduct your own research on the relationship between weather and human processes in the City of Montreal in the late 19th century. This assignment involves working in a group of 2 or 3, and each group will choose their own topic to study.

Instructions
1. Select a topic from the handout provided and let the instructor know the topic that your group has chosen. Each group will have to work on their own topic, so some topics may not be available if other groups have already selected them.

2. Write a hypothesis where you make predictions about the influence of weather on your chosen social event, if you chose this category of topic, or the effect of the extreme weather event on Montreal in general, if you chose this category of topic. The hypothesis should be a paragraph in length and include specific predictions about societal responses to weather on that date.

3. Complete a transcription of DRAW data for the date that your group selected (*see bottom of document for instructions to access a specific date). Print and save your completed work for inclusion when turning in your group research assignment. If this will help your analysis, copy and paste your transcribed data into an Excel sheet (provided) to convert the values to modern scientific units. Complete two graphs showing the change in two weather variables over the event timeframe – use an appropriate graph format (line graphs or histograms are often best for time-related data) and paste these graphs into a WORD document. Beneath each graph discuss the trend/pattern shown in a paragraph (i.e. one paragraph per graph). Include comparisons between the weather on this date with what is typical.

4. Conduct background research into either a) the risks associated with the type of extreme weather event you have chosen, or b) particular details of the social or political event that your group selected. Summarize your findings in ~2 – 3 paragraphs (~200 – 300 words) beneath your answers to the first section. Consider using websites from government agencies, universities, and historical archives, and the print collection in your institution (or any other) library to develop your answer to this question. Some potentially valuable sources are included on the topic handout sheet.

5. Go to https://news.google.com/newspapers?nid=Fr8DH2VBP9sC&dat=18860429&b_mode=2&hl=fr or search through online access at the BAnQ to find coverage for the event corresponding with your date in the Montreal Gazette or other newspaper archives. Save a .PDF or JPEG of at least one article that provides coverage or mention of your event, and paste this into your assignment.

6. Use Google Earth to identify locations in Montreal that are pertinent to your topic (e.g. locations mentioned in sources that you found, places that you believe were at strong risk due to extreme weather, etc.). Use the placemark and/or polygon tool to identify these locations, and then save and insert a Google Earth View into your assignment. Write a summary of this event beneath the Google Earth image that is about 200 – 300 words in length.

7. Revisit your research question and tentative research hypothesis and discuss what you have found in comparison with what you originally predicted in ~150 – 200 words.

8. Write a paragraph conclusion describing challenges in the research process for your group, and describe anything that was particularly interesting, surprising, or otherwise of note that you discovered in your research.

9. Complete a cover page and a works cited page in APA formatting. Use size 11 or 12 font, Times New Roman, and 1.5 or double spacing.

10. Submit a digital copy to your course instructor.

*To access a transcription page for a specific date on the DRAW website, click on “transcribe a page” in the centre top, then click on “my transcriptions” and scroll all the way down. There’s a button at the bottom which says, “View all transcribable pages” (it’s well hidden!).

Group research assignment rubric

1. Topic
2 - Clear well articulated topic as it connects to climate/weather or DRAW.
1 - Topic not entirely clear or connection to climate/weather or DRAW a little unclear.
0 - No clear topic or connections to climate/weather or DRAW.

2. Hypothesis
2 - A well-developed paragraph that makes a clear and accurate prediction about: 1) the influence of weather on the chosen social event; or 2) the effect of the extreme weather event on Montreal in general. The paragraph includes multiple specific predictions about societal responses to weather on the date.
1 - A well-developed paragraph that makes predictions about: 1) the influence of weather on your chosen social event; or 2) the effect of the extreme weather event on Montreal in general. There are minor inaccuracies in the way the relationships are described, the influence of weather on social events, or on a few details. There may also be parts of the paragraph where the response is not entirely clear or specific. Their response includes a few specific predictions about societal responses to weather on the date.
0 - The paragraph is not well-developed or does NOT contain clear or accurate predictions. The group may NOT have understood the relationship between the events and their particular weather record or has left out important details or other significant information in relation to their topic. Their response does not include multiple specific predictions about societal responses to weather on their date.

3. DRAW Transcription
a. Converted Data
2 - The data converted is the correct/appropriate data and is displayed in a way that is clearly visible.
1 - The data is correct but as imported into the assignment submitted, it might be hard to clearly read. It may also contain some inappropriate data with the correct data.
0 - Incorrect/inappropriate data or completely unreadable import into the assignment.

b. Two Graphs
2 - The assignment includes two graphs with clear titles, axis labels, data labels (if needed) and a good choice of graphs that accurately represents the data. They must have two different variables.
1 - A poor choice of type of graph is made for either of the two graphs or the graphs don't include key elements that are important to understanding what is displayed. Minor errors in representation of the data in the graph.
0 - The graphs are illegible or not included; or the data is inaccurately represented.

4. Appropriate background research
2 - The assignment contains a 2-3 paragraph literature summary (200-300 words in length) that clearly states either: 1) the risks associated with the type of extreme weather event you

have chosen; or, 2) particular details of the social or political event that your group selected. The assignment includes AT LEAST three sources that may be from websites from government agencies, universities, and historical archives, and the print collection at your institution (or any other) library (including any listed on our topic handout sheet).
1 - The assignment contains a 2-3 paragraph literature summary (200-300 words in length) that states either: 1) the risks associated with the type of extreme weather event you have chosen; or, 2) particular details of the social or political event that your group selected. It may contain minor inaccuracies, misstatements, or other unclear parts. The assignment includes AT LEAST two sources that may be from websites from government agencies, universities, and historical archives, and the print collection in your institution (or any other) library (including any listed on our topic handout sheet).
0 - The assignment contains a literature review that is less than 200-300 words or 2-3 paragraphs and doesn't clearly answer either of the prompts above. The section may contain major inaccuracies, misstatements, or other unclear parts. The assignment includes one or fewer sources.

5. Newspaper or other historical document
2 - The assignment includes a clear, easily legible newspaper or historical document.
1 - The assignment includes an unclear newspaper or historical document.
0 - The assignment does NOT include a newspaper or historical document.

6. Map
2 - The assignment contains a clear map with a well-developed paragraph that clearly explains what is contained in it AND its relationship to topic the group has researched. Locations are clearly identified on the map and relate directly to the group's topic.
1 - The map contains minor inaccuracies or the paragraph is unclear in places in explaining what is pictured in the map. Locations are mostly clear, but perhaps not specific enough.
0 - The map has major errors or the paragraph is unclear. The locations are not clearly delineated or the explanation of them in the paragraph is unclear.

7. Conclusion
2 - The original hypotheses are restated clearly and answered as to whether they were rejected or supported. They used real evidence from their own research to support their conclusion.
1 - The original hypotheses are restated but they are not all clearly rejected or supported.
0 - It's unclear what the original hypotheses were or whether the group rejected or supported them.

8. Challenges
2 - The group wrote a clear paragraph articulating well thought-out challenges they faced and how they dealt with them.
1 - The paragraph is clear but the challenges are not well thought-out or the way they faced them is not included.
0 - The paragraph is unclear or doesn't clearly include challenges and how the group faced them.

9. Cover and Works Cited Pages
1-Gave references
0-Did not give references

Group research assignment sample topics

1. For the instructor

You will want to break your students into groups of no more than three students. Each one can choose from the following topics, with some groups allowed to choose the same topic if necessary. Once a group has chosen their topic, they should let you know which one they chose and who will be in their group.

At this point, you will want to help students to craft a hypothesis about their topic and connect it with the DRAW record. In particular, be sure to stress to students that part of their task will to be to understand what traits the weather or climate they transcribe has in common with other events that impact human society. Students will also want to be able to say whether they reject or accept their hypothesis using real evidence (that strong teacher guidance will be needed in helping them to find.)

2. For the student

The following are a list of events contained within the DRAW record from which your group may choose. When you have chosen one, please seek approval from your instructor.

Socio-political events

March 3 1875 First hockey game in Montreal
May 24 1876 Inauguration of Mount Royal Park
April 20, 1877: Worst fire in Victorian Montreal
July 8, 1877: Visit of John A. Macdonald to Montreal
Jan 6 1878 Inauguration of University of Montreal
March 11 1878 Inauguration of new City Hall building
July 12, 1878: Mob violence following Orange Order Parade
Feb 9 1879 North shore railway between Montreal and Quebec City completed
May 16 1879 First demonstration of electric light in Montreal
Dec 8 1881, Feb 18 1885 Mark Twain visits Montreal
1882 first electric lighting
Jan 24, 1883: Winter Carnival; first Ice Palace
March 1885: Smallpox epidemic starts
Sept 28 1885:Anti-vaccination riots
June 28 1886 First transcontinental train leaves Montreal
Sept 19 1889 Rock slide at Quebec City
Sept 3 1894 First national Labour Day holiday
Sept 21 1892 First electric streetcar in Montreal
March 22 1894 First Stanley Cup awarded
July 1 1895 Maisonneuve monument unveiled in Place d'Armes
June 23 1896 Laurier elected first French-Canadian Prime Minister
June 27 1896 First movie theatre opens in Montreal

May 24 1897 Lion of Belfort unveiled in Dorchester Square
June 1 1898 Founding of the Sacre-Coeur hospital
1899 Construction of a dam in the Old Port to ensure no more flooding
March 10 1899 Incorporation of Loyola College (later Concordia University)
June 20 1899 Opening of first public library
Oct 30 1899 First soldiers sail for the Boer War
Nov 21/22, 1899: first car in Montreal
Feb 6 1903 Tram strike
Feb 11 1904 Founding of the Montreal Ski Club
July 1, 1906: First aviation in city
Jan 1 1906 First "Ouimetoscope" cinema
May 24 1907 Boer War memorial unveiled
June 14 1907 Blue Bonnets horse race track inaugurated
Nov 30 1907 Opening of Sainte Justine hospital
March 17 1909 Runaway train crashes into Windsor station
Dec 4 1909 Creation of the hockey league of Canada and Montreal Canadiens
Sept 2 1909 Jeanne Mance Monument unveiled
Jan 5 1910 First Montreal Canadiens hockey game
Sept 6 1909 Great Eucharistic Congress (many international attendees)
Nov 7 1913 Great Lakes storm
May 29 1914 Sinking of the *Empress of Ireland*
Oct 12, 1914: Public gathering for creation of 22nd regiment (Van Doos)
Aug 29, 1917: Riot over Military Service Act (i.e. conscription).

Other recurring events of interest are dates like Christmas, New Year's, St Patrick's (Montreal has the longest running St Partick's Day parade in North America, since 1824), and Canada Day, as well as religious holidays which change each year (Quebec was mostly a very devout population) such as Mardi Gras (usually in February), Easter (usually in April), Ascension (40 days after Easter), Corpus Christi (usually in June), August 15th, and harvest festivals. St Jean Baptiste didn't become known as the "Quebec National holiday" until after the period we're looking at here.

Warm extremes

June 4, 1871
July 1, 1878
Aug 5, 1882
Aug 20, 1884
July 7, 1897
July 10, 1911
July 10, 1912
Aug 21, 1916
July 31, 1917

Cold extremes

Jan 26, 1981
Dec 31, 1872
Jan 31, 1874
Nov 11, 1875
Jan 7, 1878
Jan 24, 1882
Jan 11, 1883
Jan 10, 1890
Dec 25, 1892
Dec 25, 1896
Jan 27, 1912
Dec 31, 1917

Precipitation extremes

Jan 9, 1874
Dec 12, 1878
July 22, 1880
Oct 23, 1885
August 15, 1888
August 31, 1893
Sept 25, 1898
June 10, 1906
Aug 11, 1917

Severe events

July 26-28 1878 Severe rain in the south of Montreal near Brome
April 24 1885 flooding
1885 Flooding, fires in Griffintown
October 22 1885 flooding especially in Montérégie
April 17 1886 Violent ice jam
April 17-28 1886 Catastrophic floods and three fires during the floods
1888 Opening of Lafontaine Park
April 3 1892 Bonsecours Market fire
June 19-23 1892 Heavy rain
June 25-30 1892 Heavy rain
June 28-30 1893 Tropical storm and heavy rain
June 27-29 1901 Violent storm
April-June 1903 Drought
Summer 1903 Drought
Autumn 1903 Drought
December 1903 Drought and famine in places

June 6-8 1906 Heavy rain and flood
June 1922 Drought and forest fire
May 1934 Drought
Summer 1934 Drought, forest fires and low lake levels
August 1935 Drought and forest fires

Group research assignments resources

The following websites and institutions are provided to aid your group in its archival research. In addition, you may wish to make use of the microfiche readers at McGill University's library or online with the Montreal Gazette.

1. The DRAW Website Educator's Corner

2. McCord Museum Photos
http://collections.musee-mccord.qc.ca/scripts/search_results.php?Lang=1&keywords=departmentID:00016

3. Bibliothèque et Archives nationales du Québec (BANQ)
http://www.banq.qc.ca/archives/index.html?language_id=1

4. Early Canadiana Online
http://eco.canadiana.ca/

5. Montreal Gazette Archives (on Google but incomplete)
https://news.google.com/newspapers?nid=Fr8DH2VBP9sC

6. **McGill Archives**
http://www.mcgill.ca/library/branches/mua

Your instructor will put these books on reserve books on reserve

Jenkins, K.(1966). *Montreal: Island city of the St. Lawrence: The romance of Canadian cities series*. New York, NY: Doubleday.
Roberts, L. (1969). *Montreal: From mission colony to world city*. Toronto, ON: MacMillina.
Collard, E.A. (1976). *Montreal: The days that are no more*. Toronto, ON: Doubleday Canada.

5. Class handouts

A Note on Handout Instructions: While these handouts include instructions and can stand alone, you will want to consult the slide deck of each relevant day for instructions as well.

DRAW data transcription class session

1. For the instructor

This is it! Now you are introducing the students to the DRAW through their own hands-on work with the website. You can start your class with the introductory slides entitled "Class 2: Working with DRAW." Since the project website is meant for the broader public, students should simply start exploring it. You can circulate and help them address any problems they might have as they create a user ID, begin to transcribe an actual record, and translate sometimes difficult handwriting. Be sure that you also try transcribing a page or two before you attempt to run this session. If possible, please have them write their affiliation as students in a particular school and class in the "bio" section. This will help the DRAW team in their research on citizen science and education.

2. For students

[YOUR SCHOOLS NAME]
Your Name:
_____

[YOUR COURSES NAME]
Group Members:
_____
_____

TRANSCRIBING HISTORICAL DATA WITH THE DATA RESCUE: ARCHIVES AND WEATHER (DRAW) PROJECT

Background

Today we begin with the focus of this module, the Data Rescue: Archives and Weather (DRAW, https://citsci.geog.mcgill.ca/) project. As you know, this project itself involves the collection and transcription of logbooks from 1871 to 1964 through citizen science and crowdsourcing. This work holds the potential to further public understanding of weather and climate and its impact on people by engaging citizens with science and cultural heritage.

Part 1: Exploring the DRAW site

Instructions

1. With a partner, Launch the DRAW website: https://citsci.geog.mcgill.ca/

2. Log in using your own username and password.

3. Spend 10-15 minutes exploring the website. You might consider clicking on these items:

- About→About the DRAW project
- About→The McGill Observatory
- Help Guide→ FAQ
- Help Guide→ Report a Problem
- Transcribe→Transcribe a Random Page
- The "Start Transcribing" or "What is DRAW" Buttons

4. Make sure you read the "About→Meteorological Observations" section. With your partner, watch the video in the section "Help Guide→Getting Started." **Ask your partner for help if you do not understand something you've seen. If you both are confused, raise your hand for an instructor.**

Questions

1. In your own words, first summarize the objective of the DRAW project. Second, in one sentence take a position on the following statement: The work we do transcribing data for the DRAW project constitutes scientific research. **Make sure you justify your answer in 1-2 additional sentences.**

2. In 1-2 sentences explain where the data being transcribed by the DRAW project comes from. (**Questions to consider: Who founded the McGill University observatory? In what time period did it operate? Who kept the records?**)

3. Choose one new item you learned from each section of the "Meteorological Observations" sections: 1) "Instruments used to take measurements;" 2) "Types of observations;" 3) "Abbreviations and symbols;" and, 4) "Notes on letters and symbols." Write one sentence below describing each of them. **Make sure you explain them in your own words. (Do not simply copy from the site.)**

Part 2: Transcribing historical weather data

Instructions (Read all the steps below before starting)

1. Today, you will start transcribing a page of historical weather observations. This will be the first part of your assignment for the DRAW module. If you get confused or forget how to do something you saw in Part 1, please use the DRAW project website's other pages to troubleshoot.

2. In your own notebook, take notes on any interesting observations you transcribe or other parts of the project you find confusing. **We will be asking you to comment on BOTH of these at the end of today's class.**

4. Raise your hand if you get stuck and one of the instructors will come to help you.

5. To get started, click on the "Start Transcribing" Button or the "Transcribe Random Page" link.

Questions

1. Using the scale below, rank how easy you found the site to use. Next, in 2-3 sentences, justify your ranking using specific examples from your own experience. (**Questions to consider: What part was hardest? What was easiest? Did any parts confuse you?**)

Easy to Use 1 2 3 4 5 Hard to Use

2. Answer each of the following questions: Do you feel like you made any mistakes while you were transcribing your page? Did you try to correct them? How often did you make them on the one page your transcribed?

3. Take a position on this statement: I learned about scientific weather and climate research by taking part in today's class. **Make sure you justify your answer in 1-2 additional sentences.**

6. Course texts

Cooper, C. (2017). *Citizen science: How ordinary people are changing the face of discovery*. New York: Peter Mayer Publishers.

Del Balso, M. & Lewis, A. D. (2012). *First Steps: A Guide to Social Research.*. Scarborough, ON: Nelson Education.

Matthews, J. A. (Ed.). (2012). *The SAGE Handbook of Environmental Change: Volume 1: Approaches, Evidences and Causes Volume 2: Human Impacts and Responses*. New York, NY: Sage.

Mock, C. J. (2011). Early instrumental and documentary evidence of environmental change. J.A. Matthews (Ed.) *The SAGE Handbook of Environmental Change*, 1, 345.

Silvertown, J. (2009). A new dawn for citizen science. *Trends in Ecology and Evolution*, 1–5. http://doi.org/10.1016/j.tree.2009.03.017

Slonosky, V. (2018). *Climate in the Age of Empire: Weather observers in colonial Canada*. Washington, DC: American Meteorological Society.

7. Literature cited

Allan, R., Brohan, P., Compo, G. P., Stone, R., Luterbacher, J. & Brönnimann, S. (2011). The International Atmospheric Circulation Reconstructions over the Earth (ACRE) initiative. *Bulletin of the American Meteorological Society*, 92, 1421–1425.

Anderson, R. D. (1983). A consolidation and appraisal of science mental-analyses. *Journal of Research in Science Teaching*, 20(5), 497-509.

Brunet, M. & Jones, P. (2011). Data rescue initiatives: Bringing historical climate data into the 21st century. *Climate Research*, 47, 29–40. https://doi.org/10.3354/cr00960

Compo, G. P., Whitaker, J. S., Sardeshmukh, P. D., Matsui, N., Allan, R. J., Yin, X., Gleason, B.E., Vose, R.S., Rutledge, G., Bessemoulin, P. & Brönnimann, S. (2011). The twentieth century reanalysis project. Quarterly Journal of the Royal Meteorological Society, 137(654), 1-28.

Driver, R. (1989). Students' conceptions and the learning of science. International *Journal of Science Education*, 11(5), 481–490.

Furtak, E. M., Seidel, T., Iverson, H., & Briggs, D. C. (2012). *Experimental and quasi-experimental studies of inquiry-based science teaching: A meta-analysis*. *Review of Educational Research*, 82(3), 300–329.

Hmelo-Silver, C. E., Duncan, R. G., & Chinn, C. A. (2007) Scaffolding and achievement in problem-based and inquiry learning: A response to Kirschner, Sweller, and Clark (2006). *Educational Psychologist*, 42(2), 99-107.

John-Steiner, V., & Mahn, H. (1996). Sociocultural approaches to learning and development: A Vygotskian framework. *Educational Psychologist*, 31(3-4), 191–206.

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006) Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist*, *41*(2), 75-86.

NGSS Lead States. (2013). *Core ideas: HS weather and climate, Next Generation Science Standards: For states, by states*. Washington, DC: The National Academies Press.

National Research Council (NRC). (1996). *National science education standards*. Washington, DC: National Academies Press.

National Research Council (NRC). (2000). *Inquiry and the National Science Education Standards: A guide for teaching and learning*. Washington, DC: National Academies Press.

Osborne, R., & Freyberg, P. (1985). *Learning in Science. The implications of children's science*. Portsmouth, NH: Heinemann Educational Books.

Phillips, D. C. (1995). The good, the bad, and the ugly: The many faces of constructivism. *Educational Researcher*, 24(7), 5–12.

Piaget, J., & Inhelder, B. (1969). *The psychology of the child*. New York: Basic.

Rakow, S. J. (1986). *Teaching science as inquiry: Fastback 246*. Bloomington, Indiana: Phi Delta Kappa.

Ryan, C., Duffy, C., Broderick, C., Thorne, P., Curley, M., Walsh, S., Daly, C., Treanor, M. & Murphy, C. (2018). Integrating data rescue into the classroom. *Bulletin of the American Meteorological Society*, *99*(9), 1757-1764.

Schroeder, C. M., Scott, T. P., Tolson, H., Huang, T., & Lee, Y. (2007). A meta-analysis of national research: Effects of teaching strategies on student achievement in science in the United States. *Journal of Research in Science Teaching*, 44(10), 1436–1460.

Selim, M.A., & Shrigley, R. L. (1983). The group dynamics approach: A sociopsychological approach for testing the effect of discovery and expository teaching on the science achievement and attitude of young Egyptian students. *Journal of Research in Science Teaching*, 20(3), 213–224.

Shepard, A. L. (2008). The role of assessment in a learning culture. *Educational Researcher*, *29*(7), 4–14.

Stake, J. E., & Mares, K. R. (2001). Science enrichment programs for gifted high school girls and boys: Predictors of program impact on science confidence and motivation*. *Journal of Research in Science Teaching*, 38(10), 1065-1088.

8. Images from the DRAW archive

Figure 1. Charles Smallwood, founder of the McGill Observatory, 1812-1873 McGill University Archives (MUA)

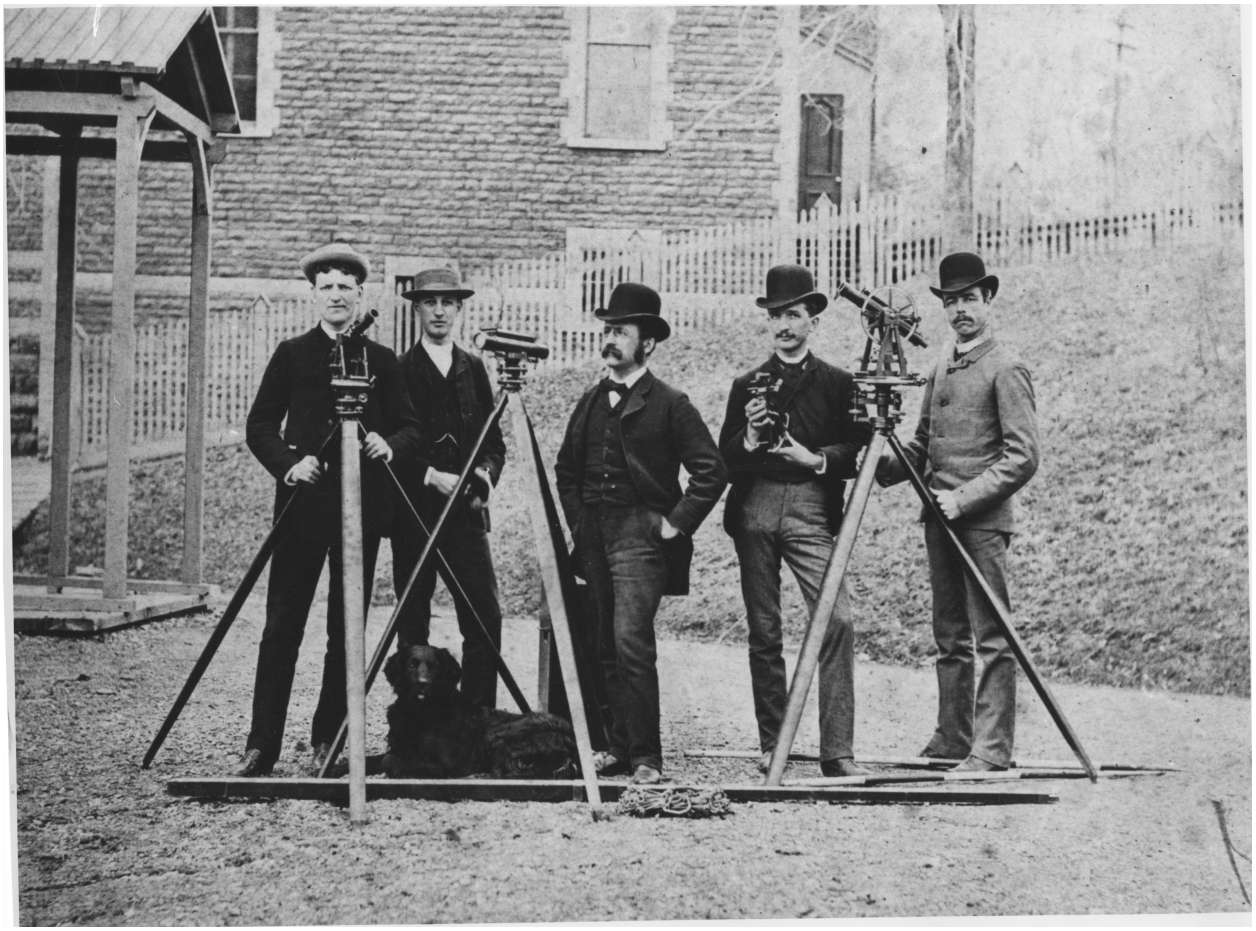
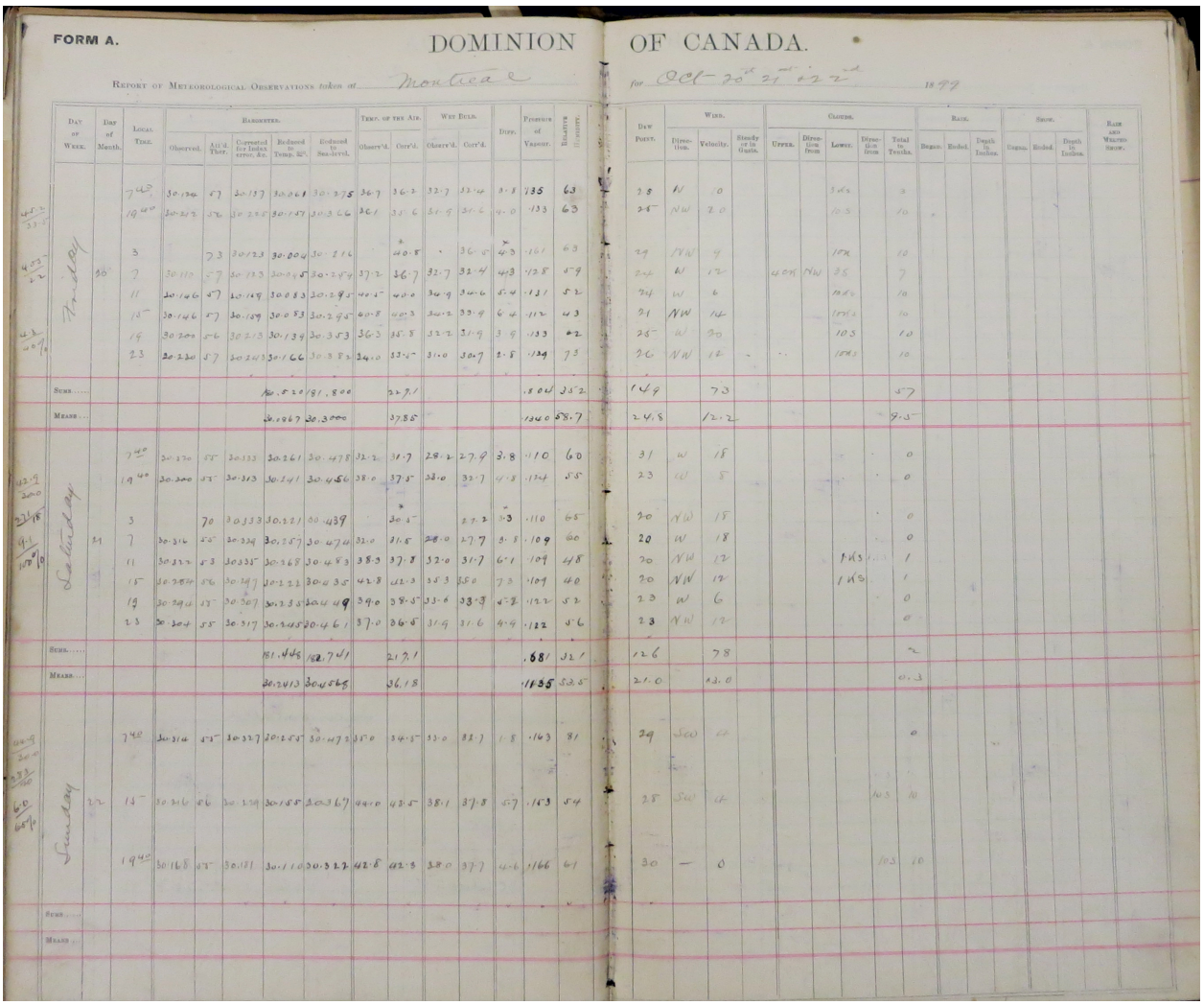


Figure 2. Clement MacLeod and students (MUA)

Figure 3. Barometer and Clocks, McGill Observatory and Time Signal, 1963

Figure 4. Snow Gauge (McGill Atmospheric and Oceanic Sciences)

Figure 5. McGill University Campus with Observatory in middle towards the left (MUA)



FORM A.

DOMINION OF CANADA.

REPORT OF METEOROLOGICAL OBSERVATIONS taken at Montreal for Oct 20th 21st & 22nd 1877

DAY OF WEEK	DAY OF MONTH	LOCAL TIME	BAROMETER. Observed.	Att'd Ther.	Corrected for Index error, &c.	Reduced to Temp. 32°	Reduced to Sea-level.	TEMP. OF THE AIR. Observ'd.	Corr'd.	WET BULB. Observ'd.	Corr'd.	DIFF.	Pressure of Vapour.	RELATIVE HUMIDITY.	DEW POINT.	WIND. Direction.	Velocity.	Steady or in Gusts.	CLOUDS. Upper.	Direction from	Lower.	Direction from	Total in Tenths.	RAIN. Began.	Ended.	Depth in Inches.	SNOW. Began.	Ended.	Depth in Inches.	RAIN AND MELTED SNOW.
Sunday	20	7 40	30.134	57	30.137	30.061	30.275	36.7	36.2	32.7	32.4	3.8	.135	63	28	N	10				5 NS		3							
		10 40	30.212	56	30.215	30.147	30.366	36.1	35.6	31.5	31.6	4.0	.133	63	25	NW	20				10 S		10							
		3			30.123	30.004	30.216		40.8		36.8	4.3	.161	69	29	NW	9				10 N		10							
	20	7	30.110	57	30.113	30.045	30.259	37.2	36.7	32.7	32.4	4.3	.128	59	24	W	12		CUM	NW	3 S		7							
		11	30.146	57	30.149	30.083	30.295	40.4	40.0	34.9	34.6	5.4	.131	52	24	W	6				10 S		10							
		15	30.146	57	30.149	30.083	30.295	60.8	60.3	34.2	33.9	6.4	.112	43	21	NW	14				10 S		10							
		19	30.200	56	30.203	30.134	30.353	36.2	35.8	32.2	31.9	3.9	.133	62	25	W	30				10 S		10							
		23	30.230	57	30.243	30.166	30.383	34.0	33.6	31.0	30.7	2.8	.139	73	26	NW	12		..		10 S		10							
	SUMS.....					30.520	30.800		327.1				.804	352	149		73						57							
	MEANS...					30.065	30.300		37.35				.1340	58.7	24.8		12.2						9.5							
Monday		7 40	30.230	58	30.233	30.261	30.478	32.2	31.7	28.2	27.9	3.8	.110	60	31	W	18						0							
		19 40	30.200	58	30.203	30.241	30.456	38.0	37.5	28.0	32.7	4.8	.124	55	23	W	8						0							
		3		70	30.333	30.221	30.439		30.5		27.2	3.3	.110	65	20	NW	18						0							
	21	7	30.316	58	30.319	30.257	30.474	32.0	31.5	28.0	27.7	3.8	.109	60	20	W	18						0							
		11	30.322	58	30.325	30.268	30.483	38.3	37.8	32.0	31.7	6.1	.109	48	20	NW	12				1 NS		1							
		15	30.284	56	30.287	30.232	30.445	42.8	42.3	35.3	35.0	7.3	.109	40	20	NW	12				1 NS		1							
		19	30.244	55	30.247	30.193	30.409	39.0	38.5	33.6	33.3	4.7	.122	52	23	W	6						0							
		23	30.264	55	30.317	30.245	30.461	37.0	36.5	31.9	31.6	4.9	.122	56	23	NW	12						0							
	SUMS.....					151.445	152.741		217.1				.681	321	126		78						2							
	MEANS....					30.2413	30.4565		36.18				.1135	53.5	21.0		13.0						0.3							
Sunday		7 40	30.314	58	30.317	30.258	30.472	35.0	34.5	33.0	32.7	1.8	.163	81	29	SW	4						0							
	22	14	30.216	66	30.219	30.158	30.367	44.0	43.5	38.1	37.8	5.7	.163	54	28	SW	4				10 S		10							
		19 40	30.168	58	30.171	30.110	30.327	42.8	42.3	38.0	37.7	4.6	.166	61	30	—	0				10 S		10							
	SUMS.....																													
	MEANS..																													

Figure 6. Image of a register sheet

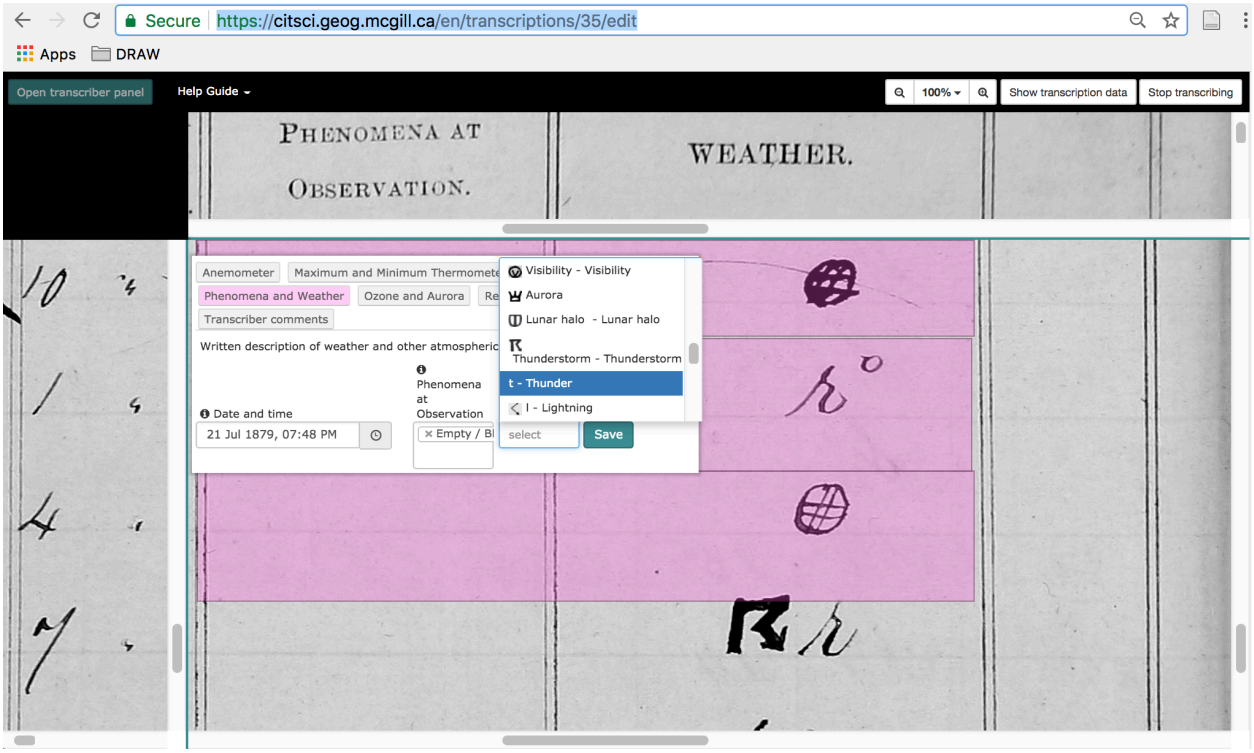


Figure 7. The transcription environment: transcribing weather symbols

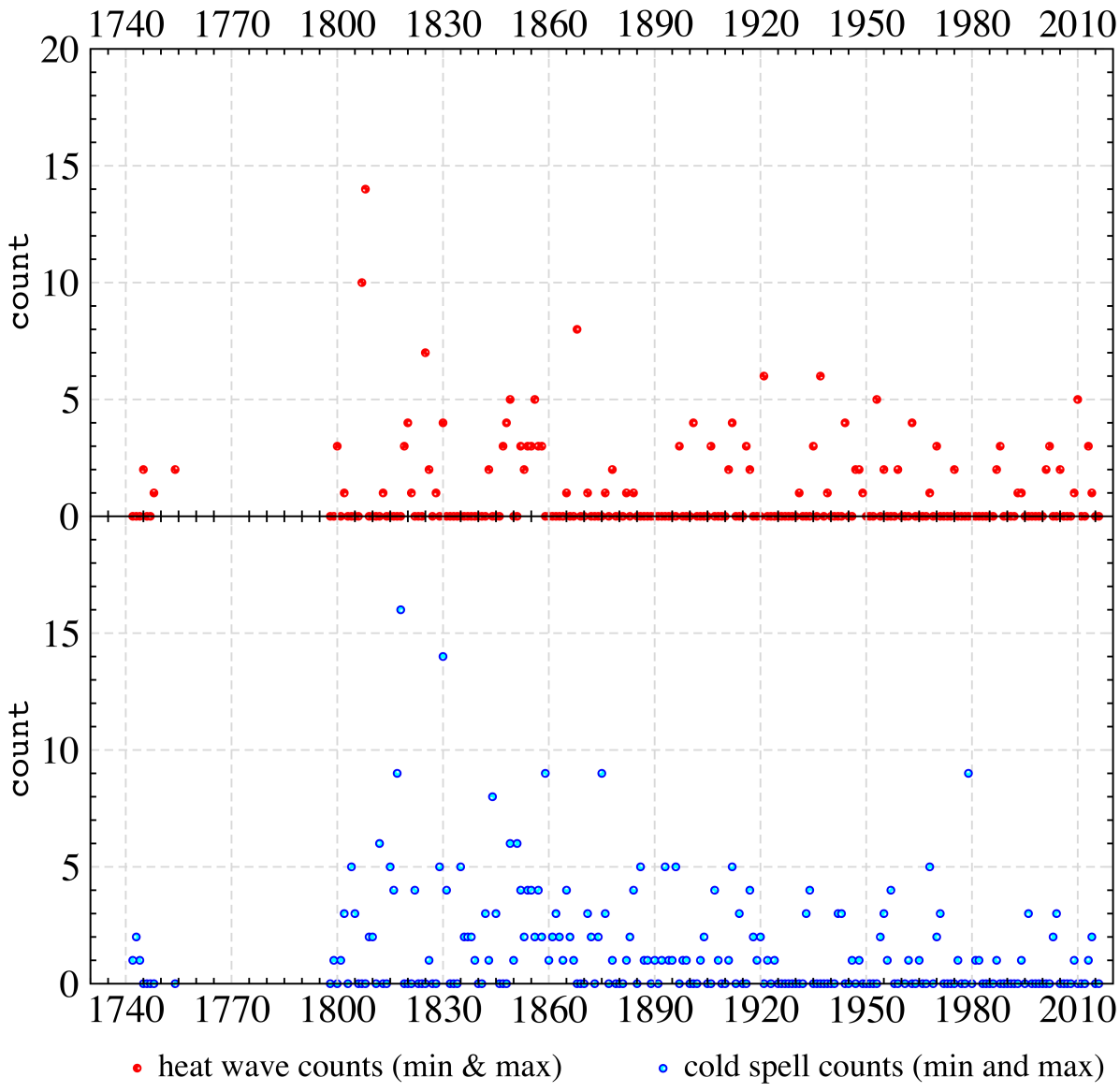


Figure 8. Example of climatic analysis with historical data: Number of heat waves and cold spells per year in the St Lawrence Valley, 1742-2014

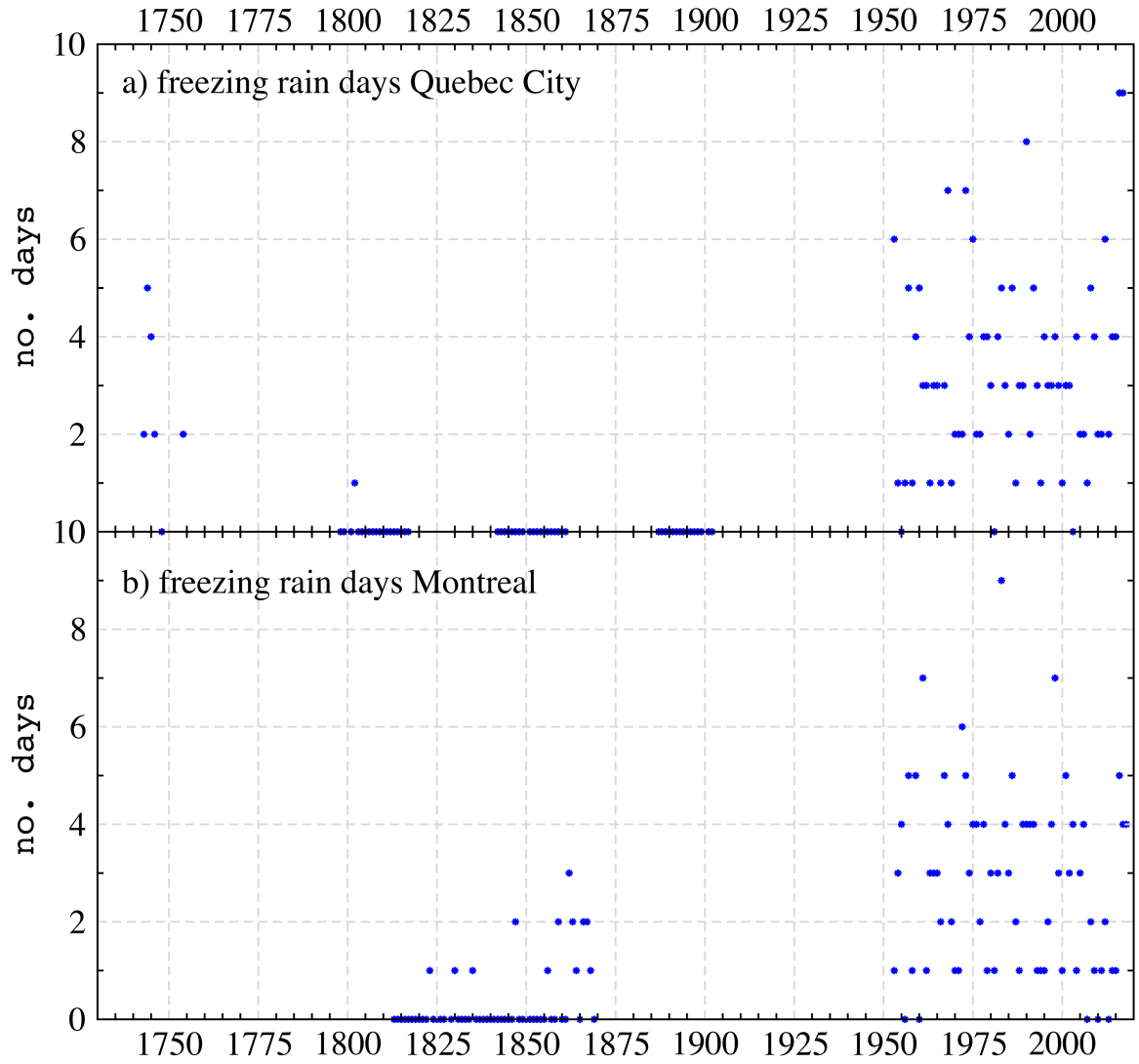


Figure 9. Why we need DRAW: To be able to study climate change, the impact of severe events and the transition between current and historical climates, we need to fill in the white spaces on these graphs