## Project goals

- Practice modeling a real-world phenomenon that is not a routine homework exercise
- Become more comfortable with open-ended problems
- Practice communicating and explaining mathematical results clearly and professionally
- Practice working in a team on a mathematical problem

### Project synopsis

You and your group members are mathematical consultants coordinating with several government agencies, including the Bureau of Land Management, the Department of the Interior, and the National Interagency Fire Center. These agencies are tasked with the development of a model to predict the length of the fire season in the a geographic region called the Great Basin. Your group is aware that fire prediction and mapping is a highly refined science, but also appreciates the value of a good initial estimate, obtained without much expense. Part of the team's objective is to conduct a sensitivity analysis, since fire season outcomes seem to be more variable in recent years. More is explained below.

Your team had an opportunity to consult with more experienced fire scientists and you discussed some of the basic ideas of wildfire prediction. They even gave you some formulas, but the notes from the meeting were lost, and you weren't too sure you understood all of it anyway. However, you do remember that they said that you can get modestly good estimates using dimensional analysis. More details are included below.

### Useful facts and objectives

- Unlike many scenarios you have trained on, this situation requires a proportionality constant that carries dimensions: namely, $[K] = L^1 M^{1.50} \Theta^{-0.50} T^{-0.50}$. You hope to estimate the constant $K$ from the data you have.
- Lacking a more sophisticated model, your team agrees that dimensional analysis might help in determining an expression for the length of the fire season, $S$, in terms of the May–June average maximum daily temperature, $Q$, and some other important quantities, namely:
  1. the January–June average accumulated precipitation, $P$;
  2. the mass density of vegetation per unit area, $\delta$; and
  3. the May–June average cumulative temperature excess, $X$. This is measured in *degree-days* $^\circ\mathrm{C}\cdot\mathrm{day}$.
- Data indicate that the May–June average maximum daily temperature in the Great Basin in 2017 was $19.29\,^\circ\mathrm{C}$. The January–June average accumulated precipitation in 2017 was $59.26\,\mathrm{mm}$. The density of vegetation is estimated to be about $12.96\,\mathrm{kg/m^2}$ in this region. The May–June average cumulative temperature excess for 2017 was $34.70\,^\circ\mathrm{C}\cdot\mathrm{day}$. Finally, the 2017 fire season lasted 93 days. You will base your model on these data.
- Weather patterns have been more highly variable in the past several years compared to historical trends. Consider the effects that slight changes to the quantities in your model will have on the length of the fire season. For the each change that you consider, compute the length of the fire season and give the percent change in season length induced by each of your changes. (Note: a contour plot is a useful tool to see the values of a function of two variables.)

Your team must now pull together all of its ideas to calculate an estimate of the Great Basin fire season in 2019 under several possible conditions. You should report all answers with three significant digits. Once you finish your calculations, your team should write a professional report restating the problem and summarizing your work and your findings. Your report will be read by the official who determine the fire management budget and strategy, so a rough report just won't do. It must clearly explain your calculations and results. Further, your report must contain at least one meaningful, carefully labeled graph that adds something to the argument your team is making.

### Timeline of project

**Preliminary check-in:** Thursday/Friday, March 7/8, with your instructor at a scheduled time.
**Final report due:** Wednesday, March 13, at the beginning of class, in Canvas.
**Group evaluations due:** Wednesday, March 13, by 11:59pm, in Canvas.
**Final interview:** Thursday/Friday, March 14/15, with your instructor at a scheduled time.
**Late papers/group evaluations:** will not be accepted.

### Preliminary check-in and final interview meetings

Your group turns in one report in Canvas and everyone in the group gets the same grade for the Written Report section for this project. The Written Report accounts for 35% of your Project 1 grade. The rest of your score (65%) is earned during the Preliminary Check-in and Final Interview meetings with your instructor. In these meetings, you will answer a question regarding the development of the report's results to demonstrate your participation in the project. Your group will also submit the introduction to your report in Canvas (see grading rubric). You are expected to participate in the project, understanding both the solution to the problem and the process by which it was obtained.

### Written report

Use Microsoft Word or another suitable word processor. Type all equations, using (for example) the Microsoft Equation Editor built into Word and standard mathematical notation. Use RStudio to make all graphs. Graphs must include proper axis labels, captions/titles, etc. Group members' names must be clearly visible on the front page of your report. Margins will not exceed 1 inch and lines are to be no more than 1.5-spaced. Use a font such as Palatino or Times New Roman with a font size of no more than 12 points.

Reports will be self-contained, i.e., the reader will not need prior knowledge or understanding of the problem to understand your report. Your calculations and conclusions will be explained in detail, as befits a professional report. This report will be read by people of varying mathematical background, so do your best to keep your report at a level accessible to the widest possible audience (in other words, try to write for the general public whenever possible). Your explanation and presentation are as important as the mathematics, but of course your mathematical analysis must be clear, complete, and correct. It should go without saying that your grammar, punctuation, and spelling will be flawless. All outside sources, including websites, used in your report must be properly cited.

### Group evaluation

Every group member is required to submit an informal group valuation *before midnight on the same day the reports are due* in Canvas. The evaluation is at most a short paragraph about how well the group worked together. The evaluation *must* include your estimate of the share of the project work that you feel each group member did, expressed as a percentage (e.g. 33%/33%/33% or 40%/30%/30%, etc.). These percentages must add to 100%—or 99% is close enough. These evaluations will be held in confidence, and used at the end of the semester, if necessary, to adjust final grades.

### A word to the wise

Make sure that your report's qualities of clarity, completeness, and correctness reflect your best abilities. Carefully read all the instructions and resources provided.

## Key for group

Formula: $S = 5.0475984 \times 10^{9} Q^{-1} P^{-4} \delta^{-1.5} X^{1.5}$

Formula if convert to meters: $S = 5.0475984 \times 10^{21} Q^{-1} P^{-4} \delta^{-1.5} X^{1.5}$