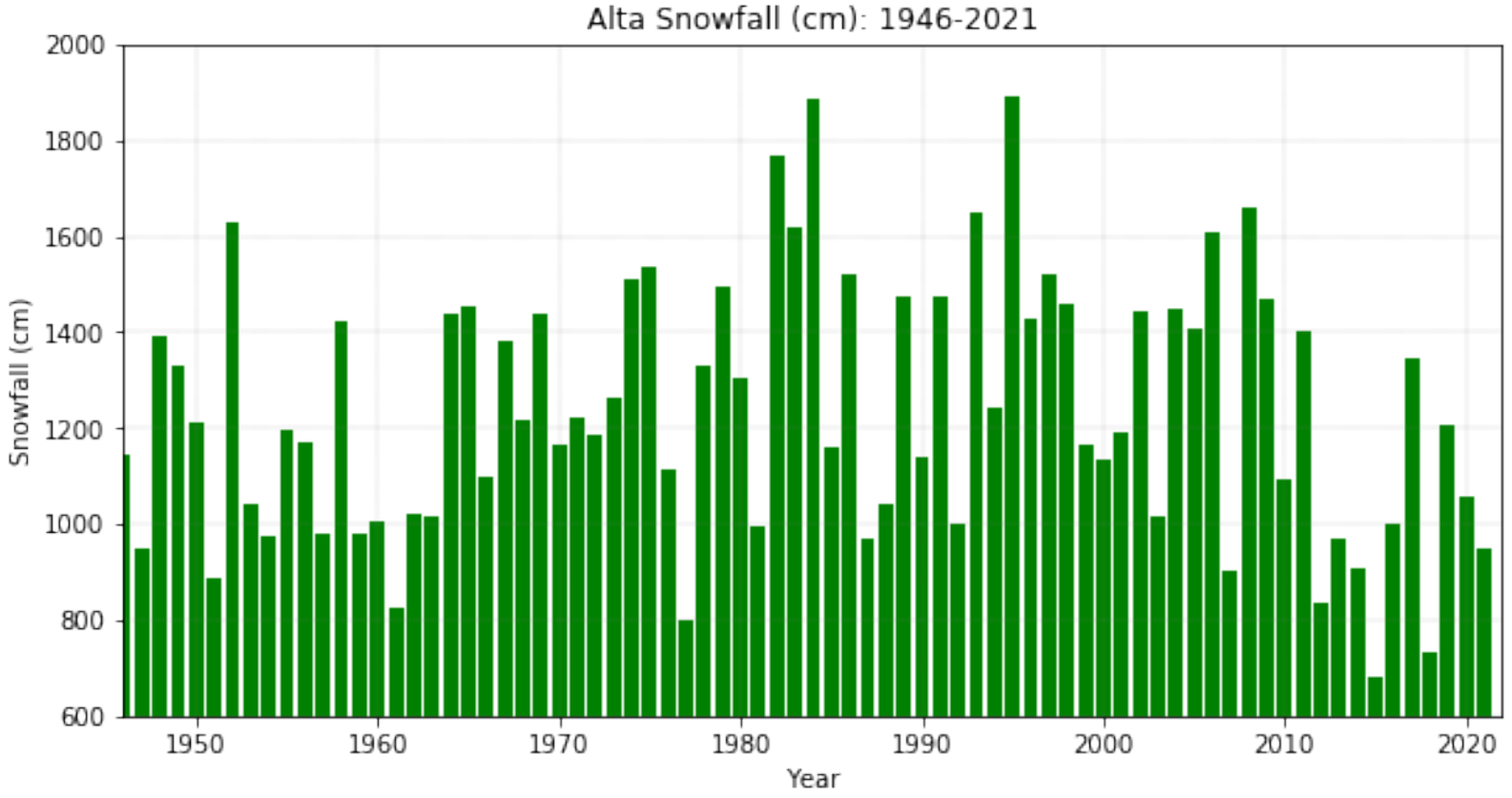
Meteorology 5340
Environmental Programming and Statistics

Contents

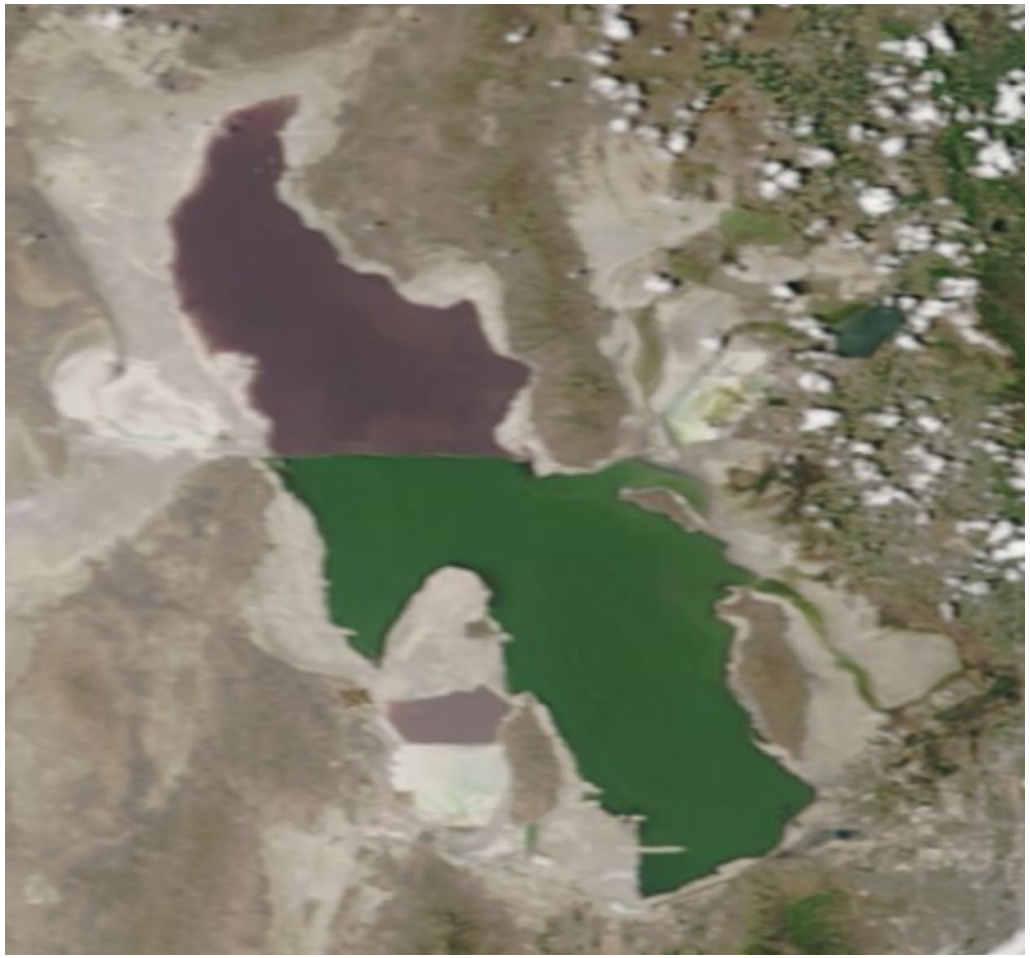
Viewing Monthly Snowfall at Alta

- https://utahavalanchecenter.org/alta-monthly-snowfall



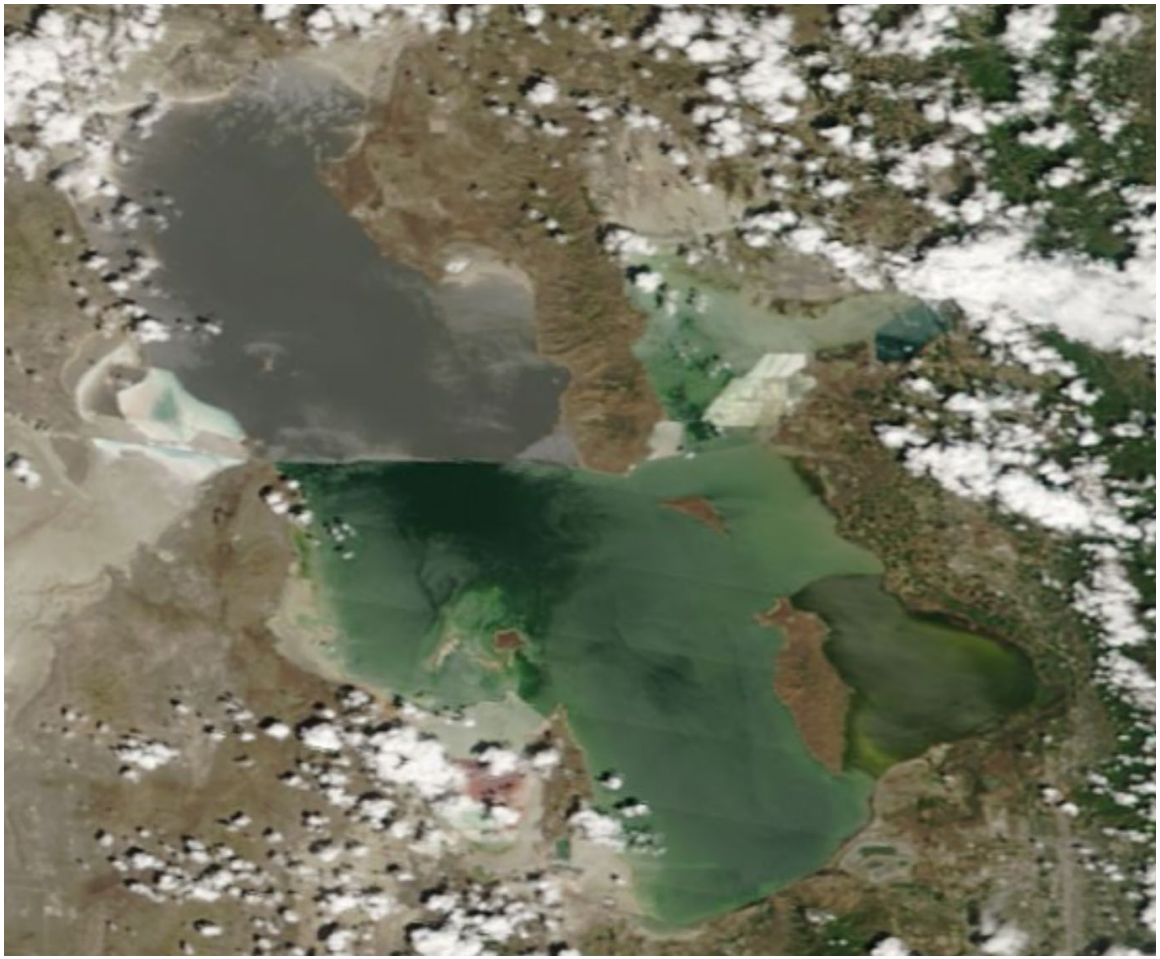
NASA Worldview

May 26, 2021



Great Salt Lake

May 26, 2000



Drought Periods from Tree Rings

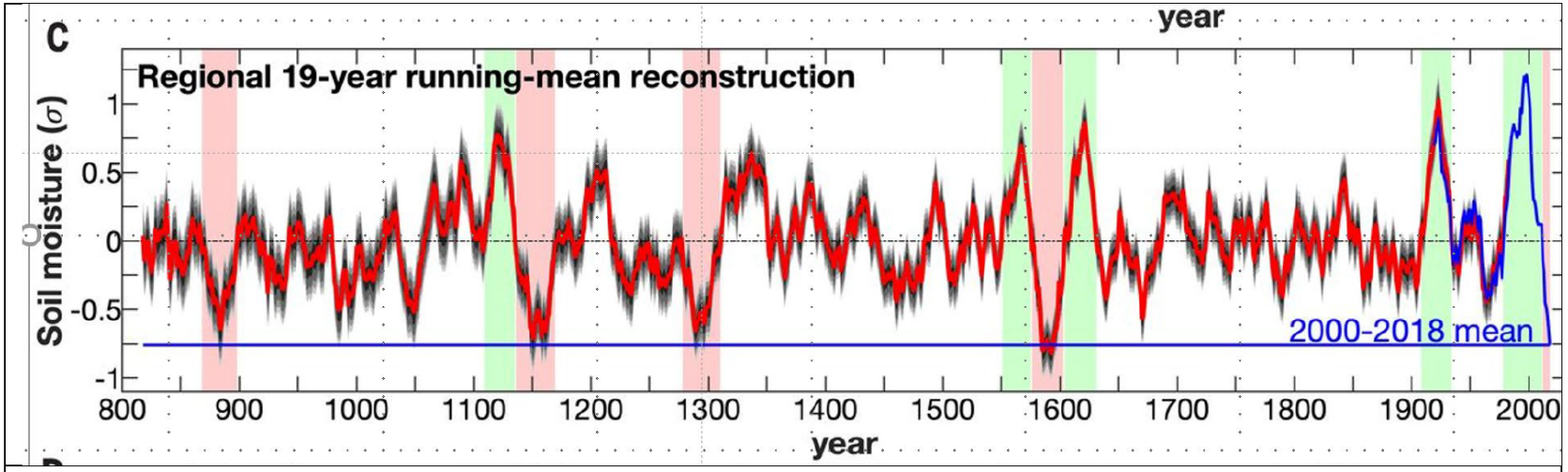
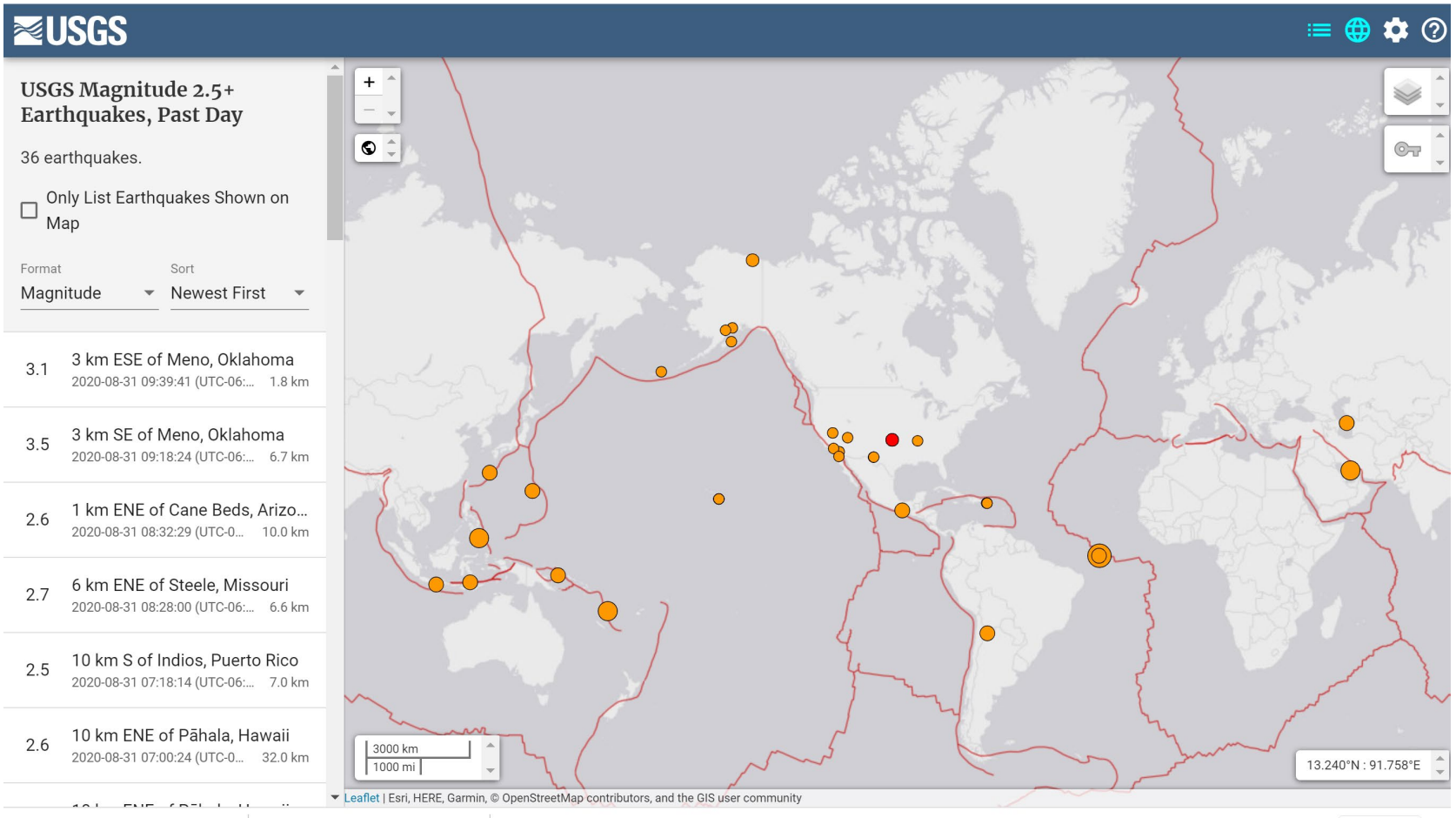
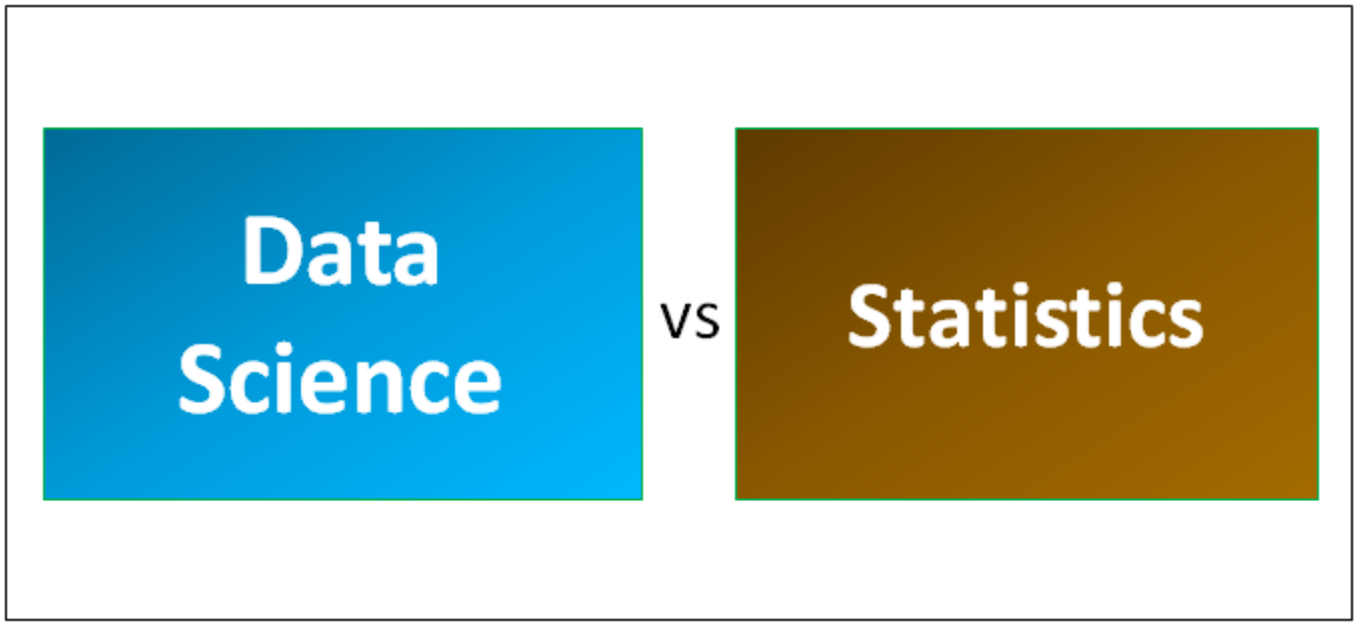


Figure 1.1. Summer soil-moisture reconstruction for the western U.S. highlighting recent megadroughts (Williams et al. 2020).

http://earthquake.usgs.gov/earthquakes/map/



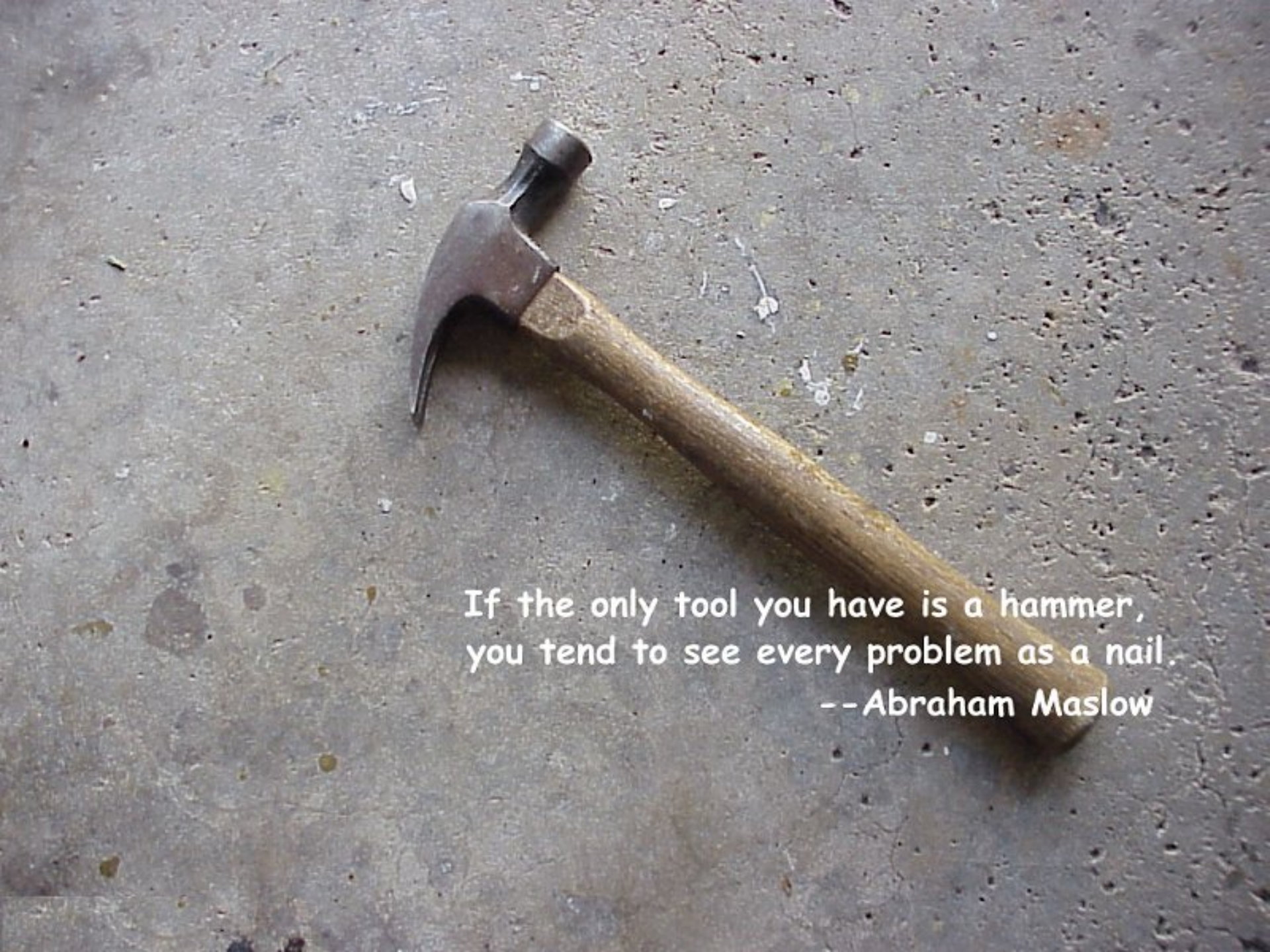


- *Data Science* encompasses computer programming, statistics, and many other subjects.
- Involves collecting, preparing, analyzing, managing, visualizing, and storing large volumes of information

- *Statistics provides* methods and approaches to analyze information and draw conclusions from that information

Problems with statistics?

- Oriented towards confirming preconceived ideas?
- Start with a technique and look for a data set to apply it to?
- There's always two sides to every issue?
- What do you think? Other examples of poor statistics?


If the only tool you have is a hammer,
you tend to see every problem as a nail.
--Abraham Maslow

The Health Risks of Being Left-Handed

Lefties Face Chance Of ADHD, Other Disorders; Brain Wiring Holds Clues

- http://www.wsj.com/articles/SB10001424052970204083204577080562692452538
- Modern lefty lore says left-handers are smarter, more creative and have an advantage over righties.
- About 10% of people are left-handed, Six of the last 12 U.S. presidents, including Barack Obama and George H. W. Bush, have been lefties.
- Babies born to older mothers or at a lower birth weight are more likely to be lefties
- On average there is no difference in intelligence between right-and left-handed people.
- Left-handed people earn on average 10% lower salaries than righties
- lefties aren't more accident prone than right-handed people and don't tend to die at a younger age.
- Left-handedness appears to be associated with a greater risk for a number of psychiatric and developmental disorders.
  - About 20% of people with schizophrenia are lefties even though 10% of people are lefties
  - 1% of general population has schizophrenia
  - Ooh! 80% of schizophrenics are righties! and 0.2% of all people are lefties with schizophrenia

Questioning traditional statistical approaches

- **Nassim Nicholas Taleb**
- http://www.fooledbyrandomness.com/
- Black Swan: extreme impact of rare and unpredictable events and human tendency to search for simplistic explanations for these events retrospectively
- Antifragile: Some things benefit from shocks and thrive when exposed to volatility, randomness, disorder, stressors, and uncertainty

Oddball statistics?

https://www.statnews.com/2016/05/09/john-oliver-bad-science/

Warning: some inappropriate language

John Oliver rips apart bad science on 'Last Week Tonight'

By MEGAN THIELKING @meggophone / MAY 9, 2016

NAS Report K-12 Education

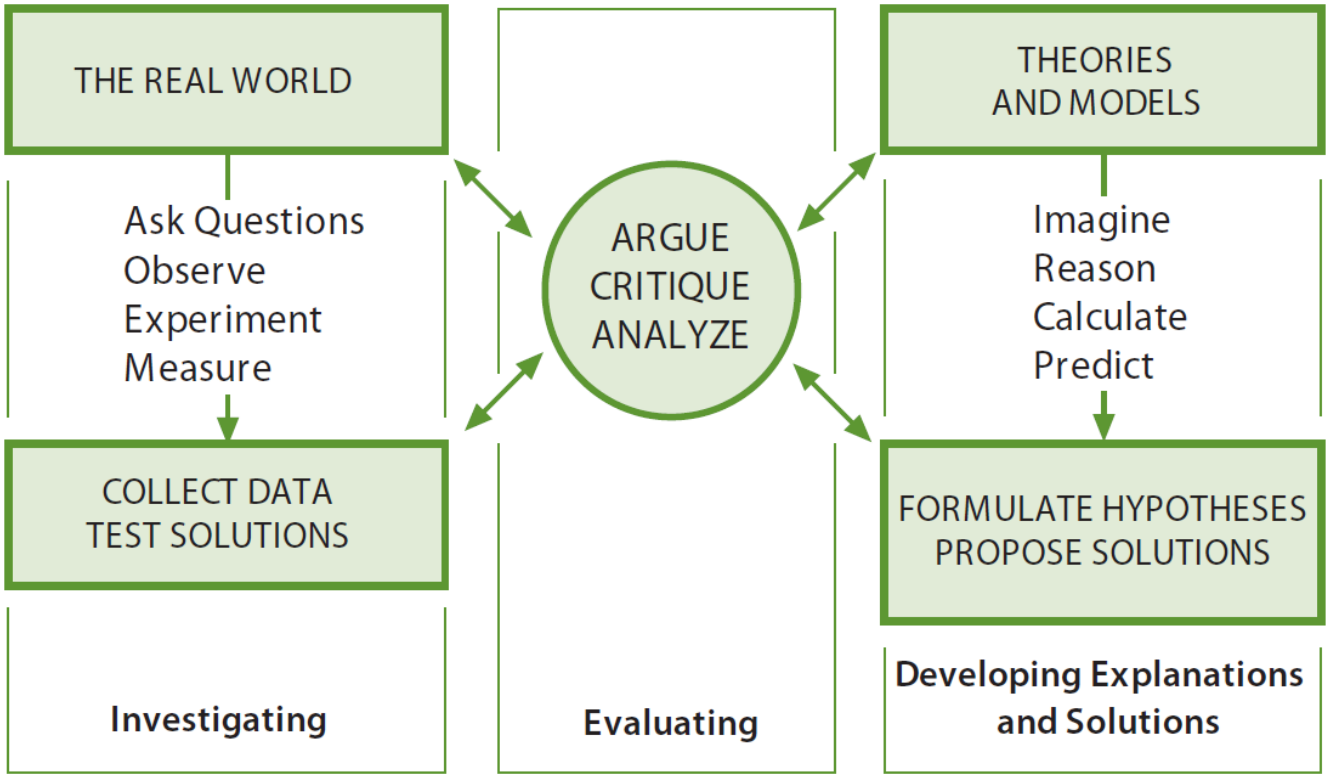


FIGURE 3-1 The three spheres of activity for scientists and engineers.

- NAS Report

Grade Band Endpoints for ESS2.D

By the end of grade 2. Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time.

By the end of grade 5. Weather is the minute-by-minute to day-by-day variation of the atmosphere's condition on a local scale. Scientists record the patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next. Climate describes the ranges of an area's typical weather conditions and the extent to which those conditions vary over years to centuries.

By the end of grade 8. Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. Because these patterns are so complex, weather can be predicted only probabilistically.

The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents. Greenhouse gases in the atmosphere absorb and retain the energy radiated from land and ocean surfaces, thereby regulating Earth's average surface temperature and keeping it habitable.

By the end of grade 12. The foundation for Earth's global climate system is the electromagnetic radiation from the sun as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems and this energy's reradiation into space. Climate change can occur when certain parts of Earth's systems are altered. Geological evidence indicates that past climate changes were either sudden changes caused by alterations in the atmosphere; longer term changes (e.g., ice ages) due to variations in solar output, Earth's orbit, or the orientation of its axis; or even more gradual atmospheric changes due to plants and other organisms that captured carbon dioxide and released oxygen. The time scales of these changes varied from a few to millions of years. Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate (link to ESS3.D).

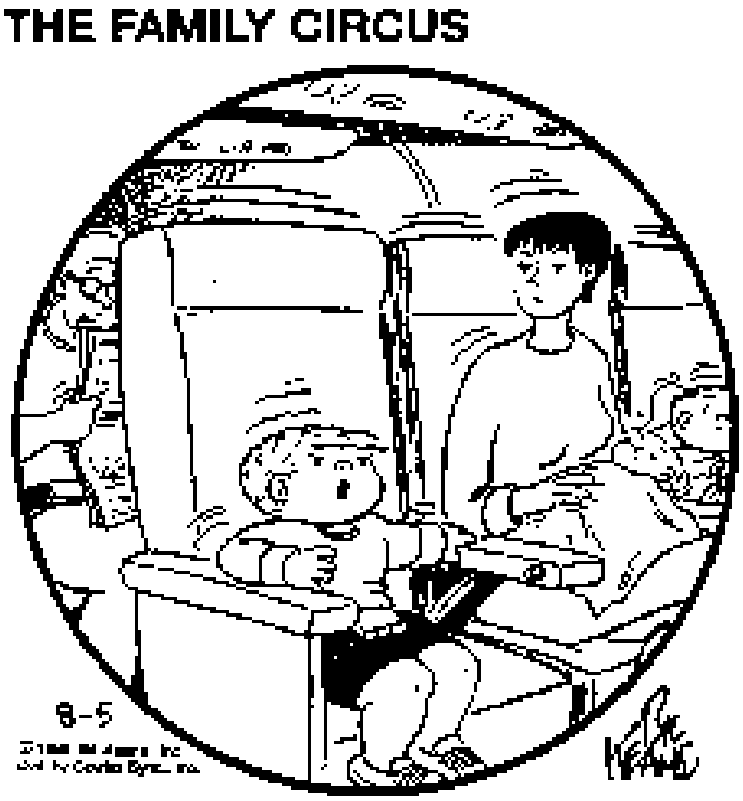
Scientific Explanations are:

- based on empirical observations or experiments
- tentative
- historical
- probabilistic
- assume cause-effect relationships
- limited
- made public
- influenced by individuals and culture

What's the Goal??

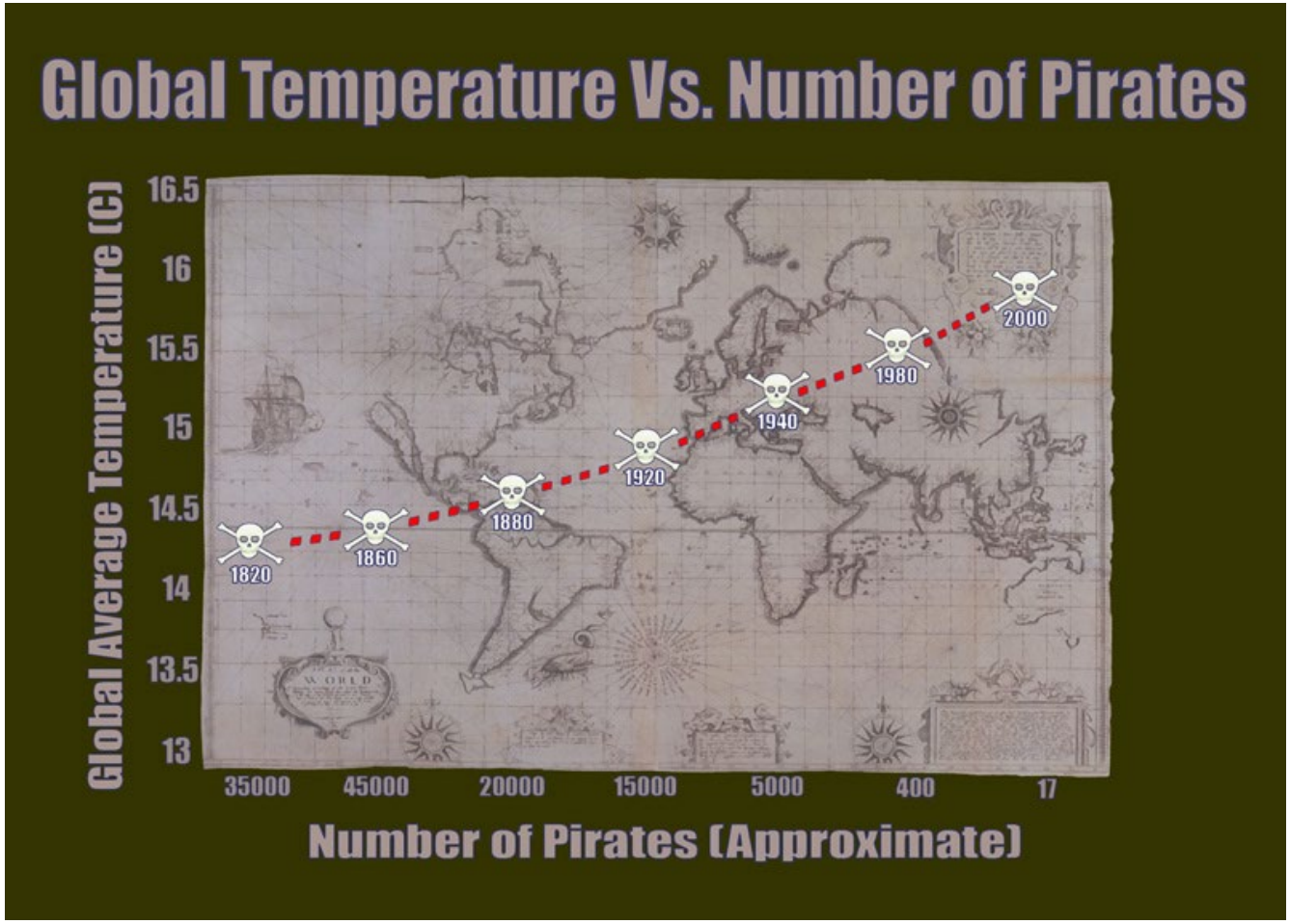
- Exploratory or descriptive statistics:
  - Organize and interpret volumes of data

- Inferential statistics:
  - Assess the underlying physical processes that generate environmental data



"I wish they didn't turn on that seatbelt sign so much! Every time they do, it gets bumpy."

Causality vs. Simultaneity?



http://www.usnews.com/news/blogs/washington-whispers/2013/03/15/apollo-7-astronaut-uses-pastafarian-chart-on-pirates-and-global-temperatures-to-argue-climate-change-isnt-real

Observations and Truth

- True value- value of a quantity sought through measurement, but unknown usually in the field
- Truth depends on application
- Assumption: average of many unbiased observations should be same as expected value of truth
- However, accurate observations may be biased or *unrepresentative* due to siting or other factors

https://www.youtube.com/watch?v=9FnO3igOkOk

Rudy Giuliani says 'truth isn't truth'

By Caroline Kenny, CNN

Updated 4:50 PM ET, Sun August 19, 2018

MO

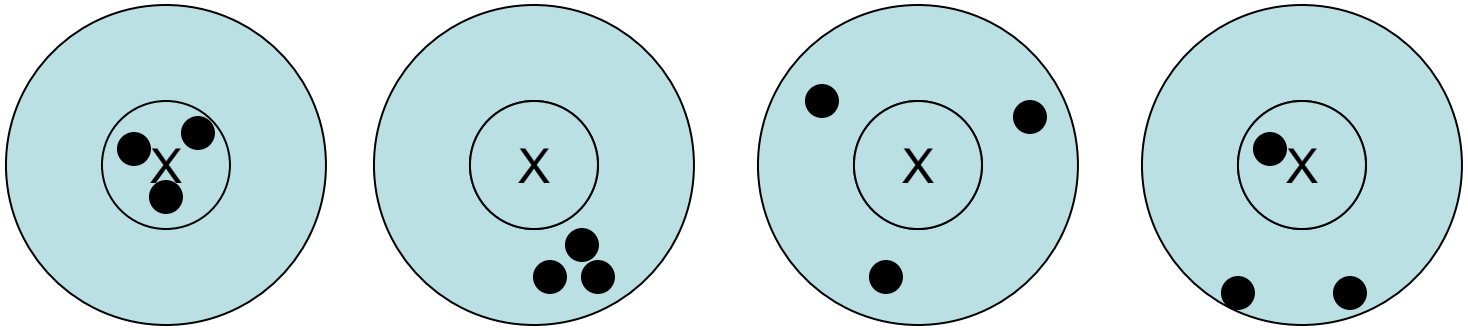
Causes of Uncertainty

- 1. we can never measure the environment with complete accuracy and precision
- 2. the environment is a chaotic system, which is a maddening combination of randomness and order arising from the characteristics of a complex nonlinear system,
- 3. our understanding of the environmental system is imperfect, so physical (and certainly statistical) models do not capture the complete behavior of the system.

Gauging Uncertainty

- Accuracy- difference in response between a standard and instrument in varying environmental conditions. A measure of how close a measurement is to the “true” value

- Precision- how well repeated measurements of some quantity agree with each other. A precise instrument can be inaccurate



Systematic vs. Random Errors

- Random- that which is not precisely predictable or determinable
- Systematic- errors arising from a consistent response of a measuring device to environmental conditions or faulty characteristics of instrumentation that occurs frequently

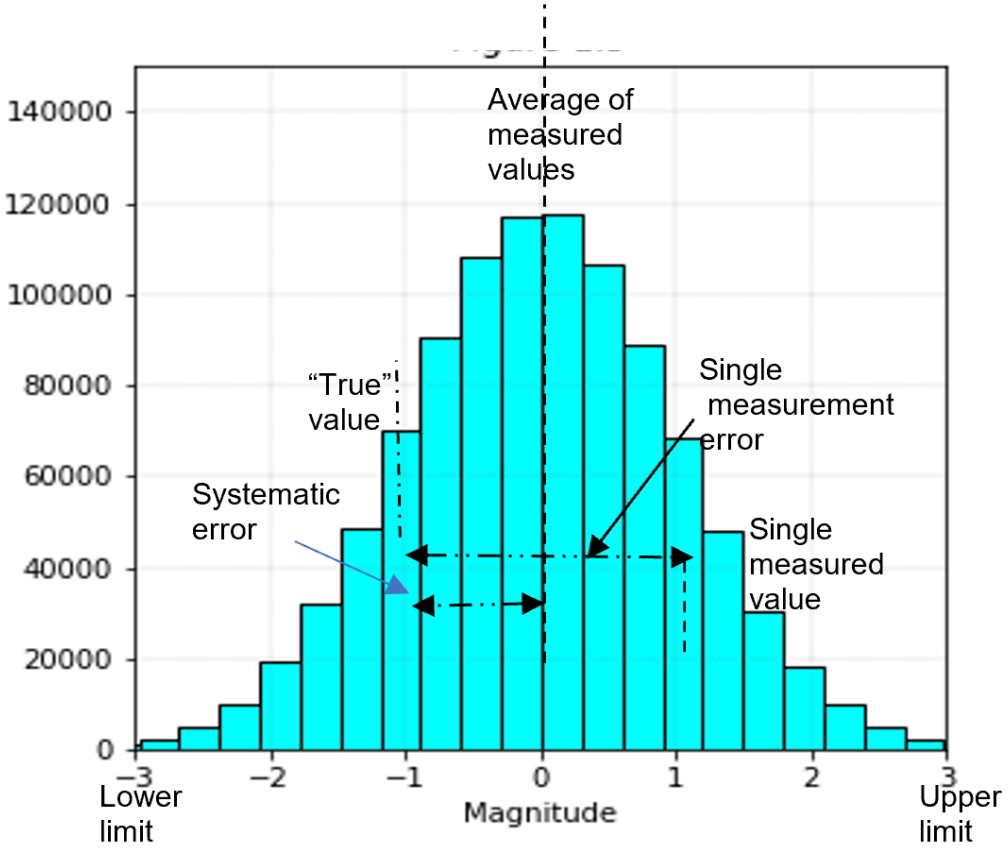


Figure 1.3. A million member sample. The True value is assumed to be -1. The systematic (average) error would be +1.

Population vs. Sample

- we never know the entire population of true values as the environmental conditions change in time or space.
- We hope that we choose a sample of observations for analysis such that each element in the population has an equal chance to be selected.
- Sampling issues
  - Trends
  - serial dependence of environmental data
  - model sample tend to be less variable than observed samples

Selecting a Sample

- Selecting the sample for analysis is a critical aspect of organizing the data and depends on the question to be addressed by the study
- rule of thumb: sample should be large enough to capture the phenomenon of interest many many times
- “Degrees of freedom”: number of independent elements in the sample;
  - usually much smaller than the total number of members in the sample in environmental data sets
- Keeping your powder dry- saving data for an independent sample to evaluate and confirm your results.
- Tendency to assume sample is drawn randomly from the population, when sample grossly underestimates the variability inherent in the population

Selfies

"It's not surprising that men who post a lot of selfies and spend more time editing them are more narcissistic, but this is the first time it has actually been confirmed in a study,"

Study Links Selfies To Narcissism And Psychopathy

The Huffington Post | By Carolyn Gregoire

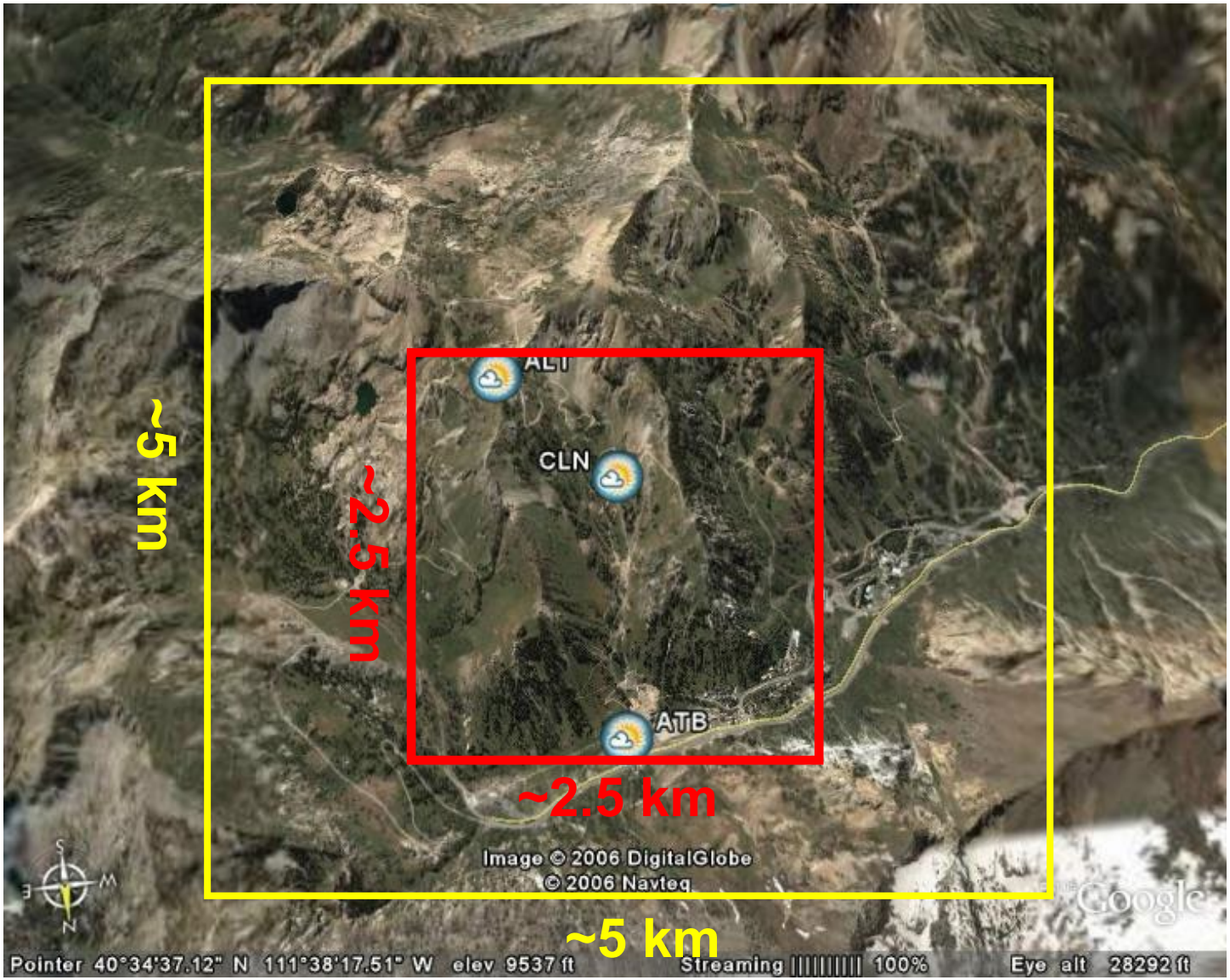
Posted: 01/12/2015 8:15 am EST | Updated: 01/12/2015 8:59 am EST

The sample included 800 men from age 18 to 40 who completed an online survey asking about their photo posting behavior on social media. The participants also completed standard questionnaires for anti-social behaviors and for self-objectification. (This study doesn't include women because the dataset, which Fox received from a magazine, did not have comparable data for women.):

Observations

- Observations are not perfect…
  - Gross errors
  - Local siting errors
  - Instrument errors
  - Representativeness errors

Representative errors to be expected in mountains
Alta Ski Area



What you should be doing

- Do you have your CHPC account?
- Follow instructions in Canvas
- Read Chapter 1 Notes
- Chapter 1 Check Your Understanding
  - Start it now-

Follow instructions in Canvas