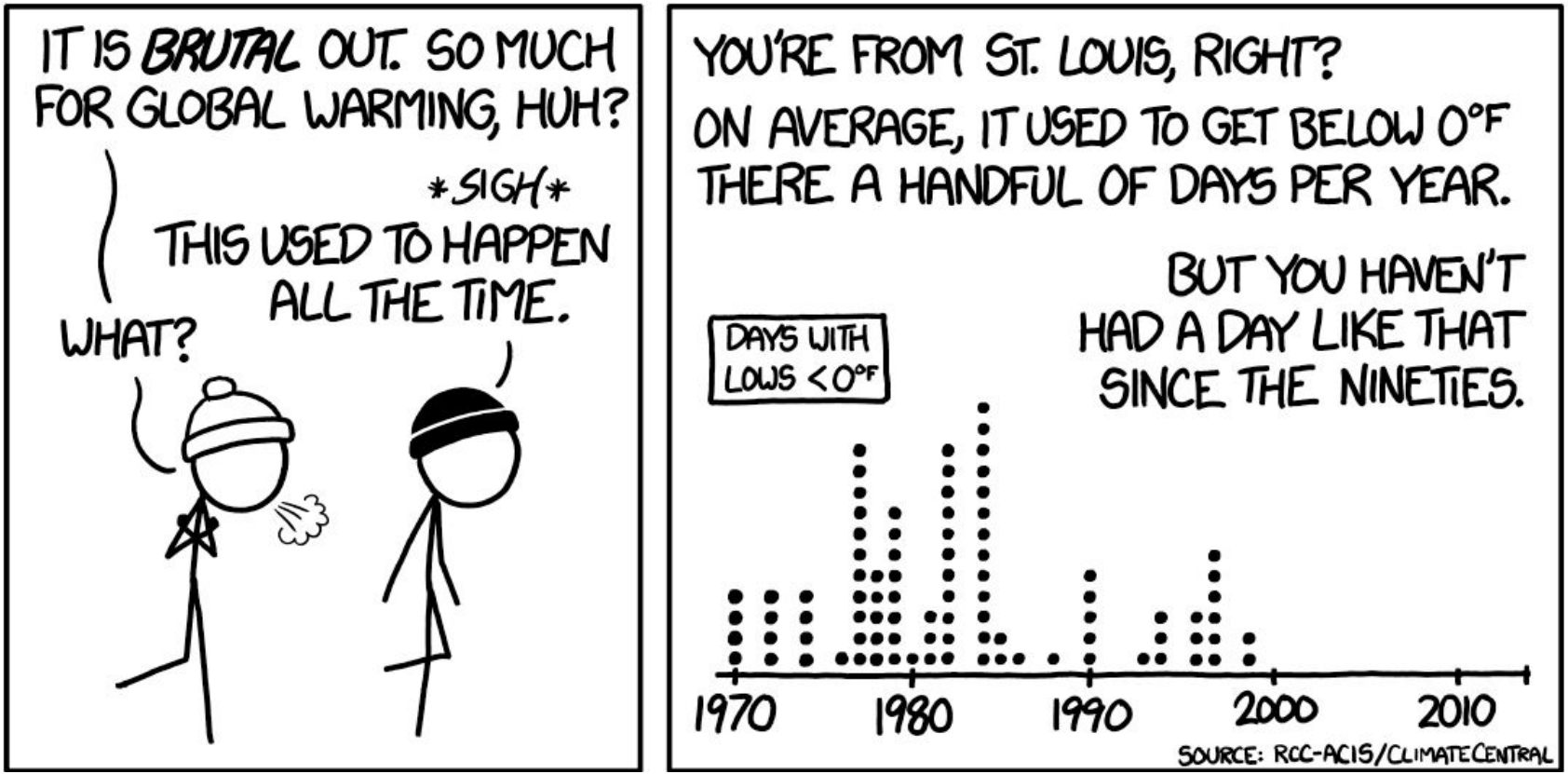
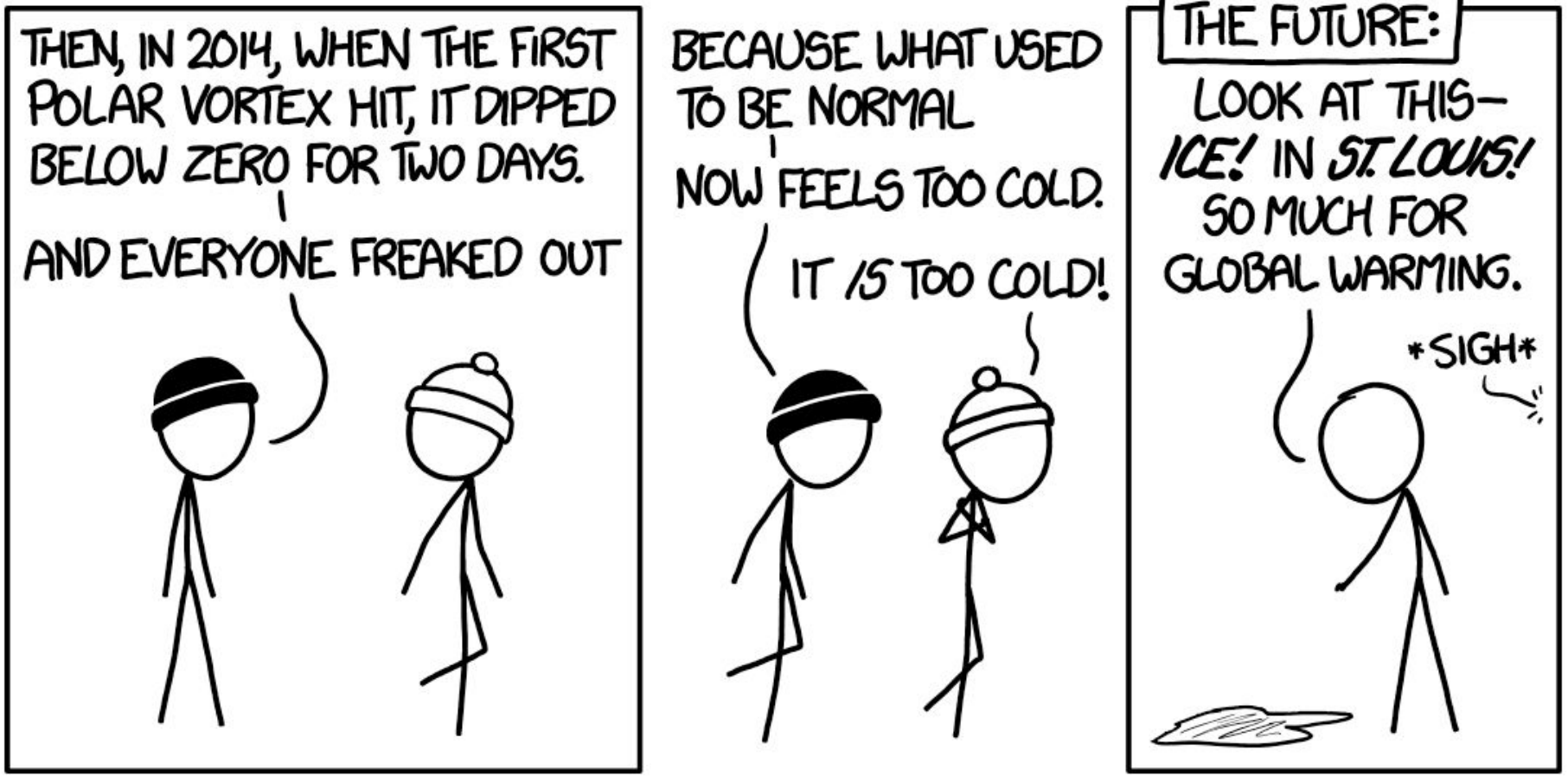
Transgressing Time Scales:

Experiments in Climate Data as Music

Judy Twedt
University of Washington
March 4, 2018


IT IS BRUTAL OUT. SO MUCH FOR GLOBAL WARMING, HUH?
WHAT?
SIGH
THIS USED TO HAPPEN ALL THE TIME.
YOU'RE FROM ST. LOUIS, RIGHT?
ON AVERAGE, IT USED TO GET BELOW 0°F THERE A HANDFUL OF DAYS PER YEAR.
BUT YOU HAVEN'T HAD A DAY LIKE THAT SINCE THE NINETIES.
DAYS WITH LOWS < 0°F
1970
1980
1990
2000
2010
SOURCE: RCC-ACIS/CLIMATE CENTRAL


THEN, IN 2014, WHEN THE FIRST POLAR VORTEX HIT, IT DIPPED BELOW ZERO FOR TWO DAYS.
AND EVERYONE FREAKED OUT
BECAUSE WHAT USED TO BE NORMAL
NOW FEELS TOO COLD.
IT IS TOO COLD!
THE FUTURE:
LOOK AT THIS— ICE! IN ST. LOUIS! SO MUCH FOR GLOBAL WARMING.
SIGH

Rapidly declining remarkability of temperature anomalies may obscure public perception of climate change

Frances C. Moore, Nick Obradovich, Flavio Lehner, and Patrick Baylis

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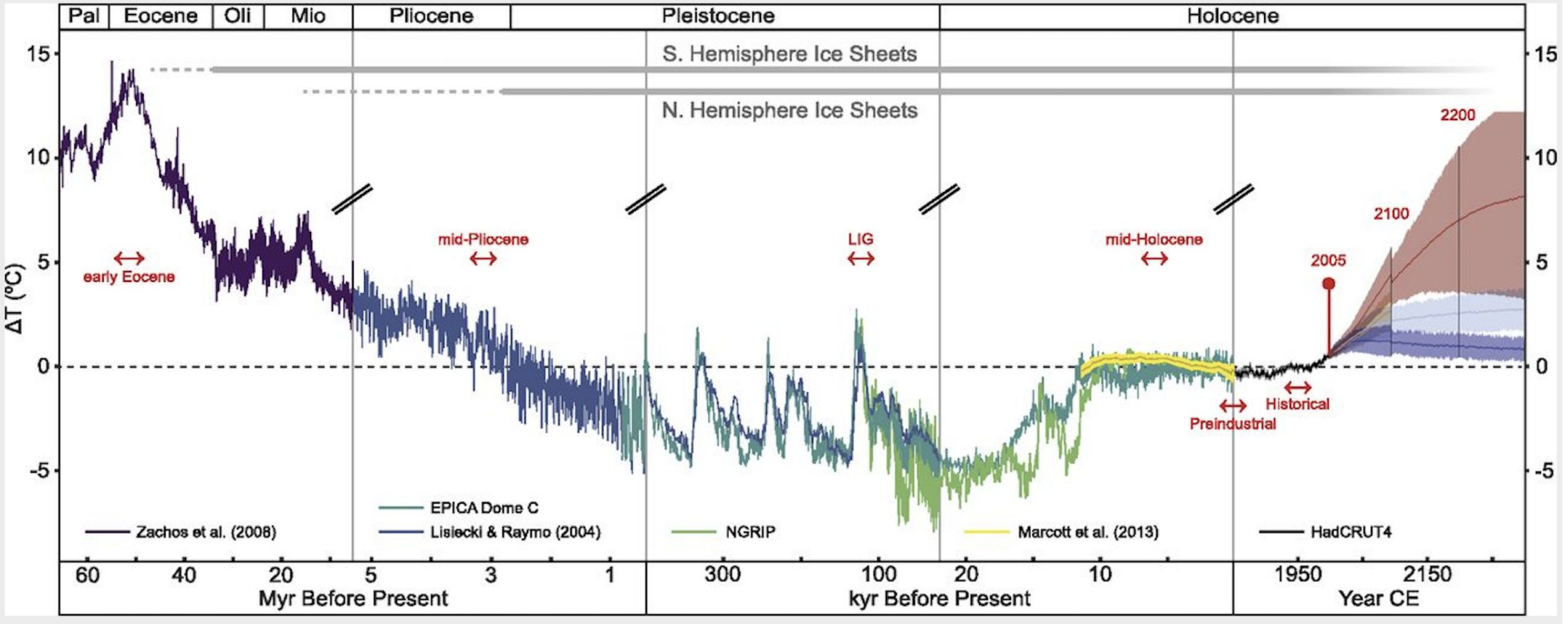
Significance

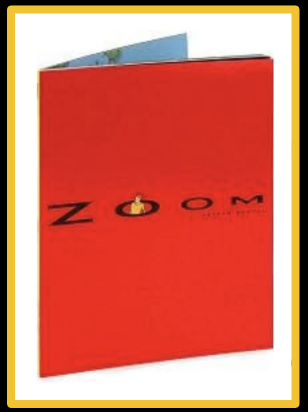
Climate change exposes people to conditions that are historically unusual but that will become increasingly common over time. What kind of weather do people think of as normal or unusual under these changing conditions? We use the volume of social media posts about weather to measure the remarkability of different temperatures and show that remarkability changes rapidly with repeated exposure to unusual temperatures. The reference point for normal conditions appears to be based on weather experienced between 2 and 8 y ago. This rapidly shifting normal baseline means warming noticed by the general public may not be clearly distinguishable from zero over the 21st century, with potential implications for both the acceptance of global warming and public pressure for mitigation policies.

Earth's Temperature over the Past 60 Million Years

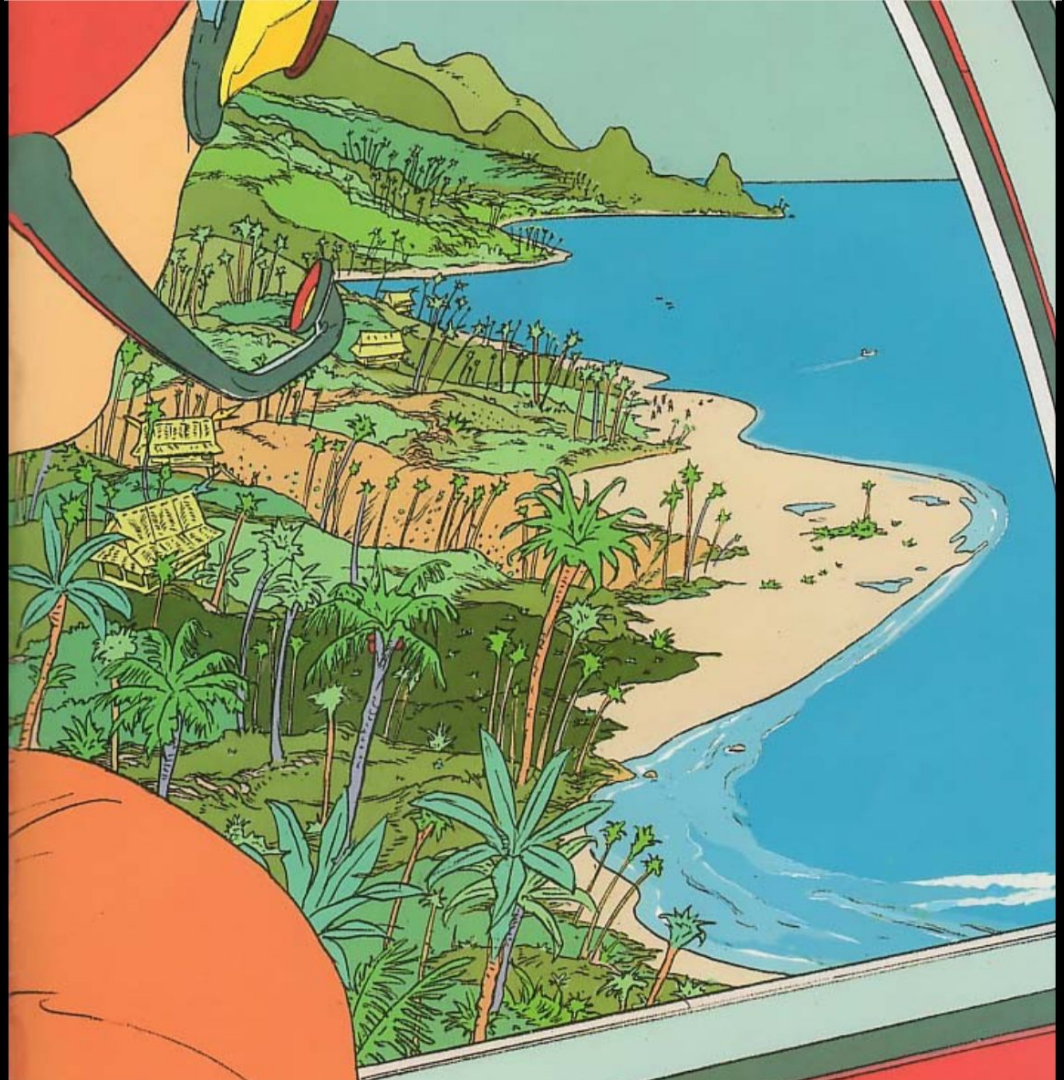


How do we help audiences develop the cognitive flexibility to hold many different time scales in their minds?

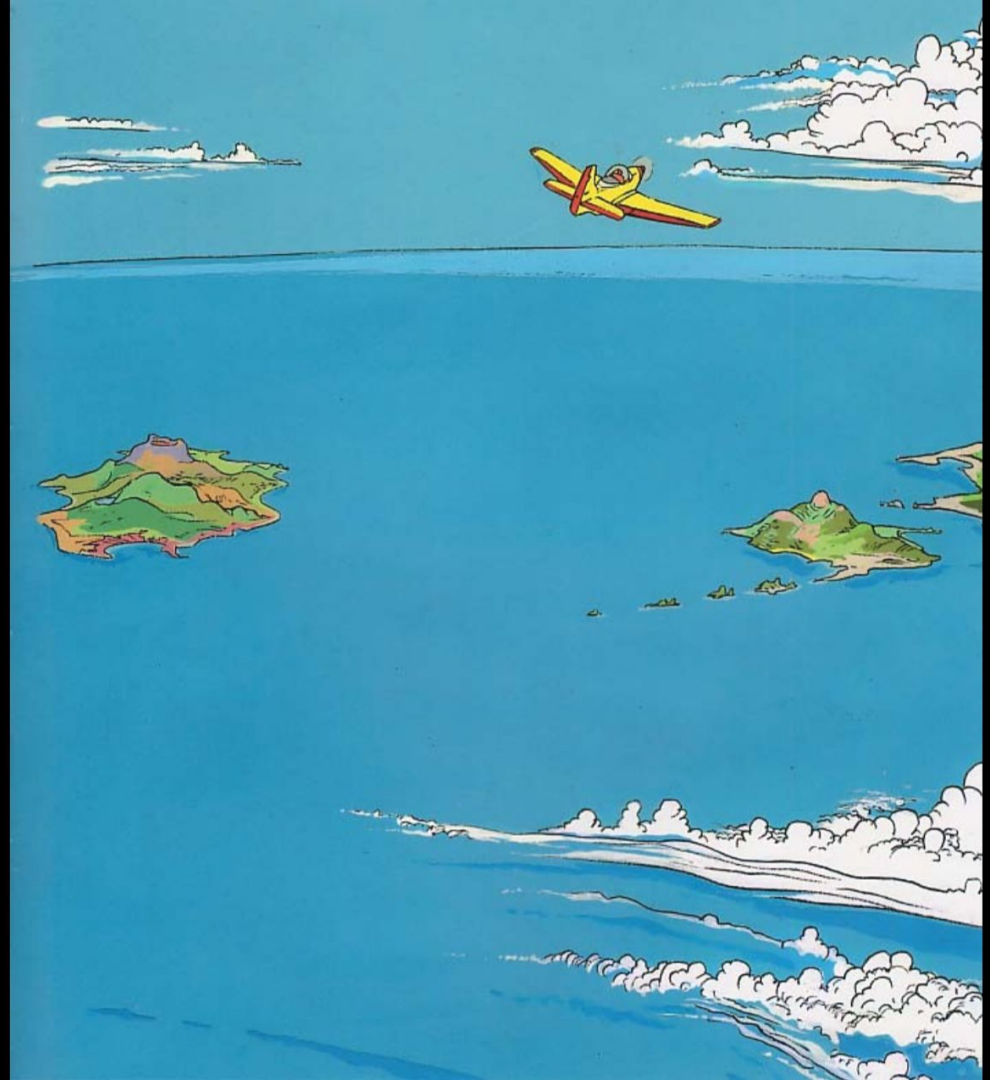
We have analogs for from visual art, inspired by satellite imagery and the microscope...

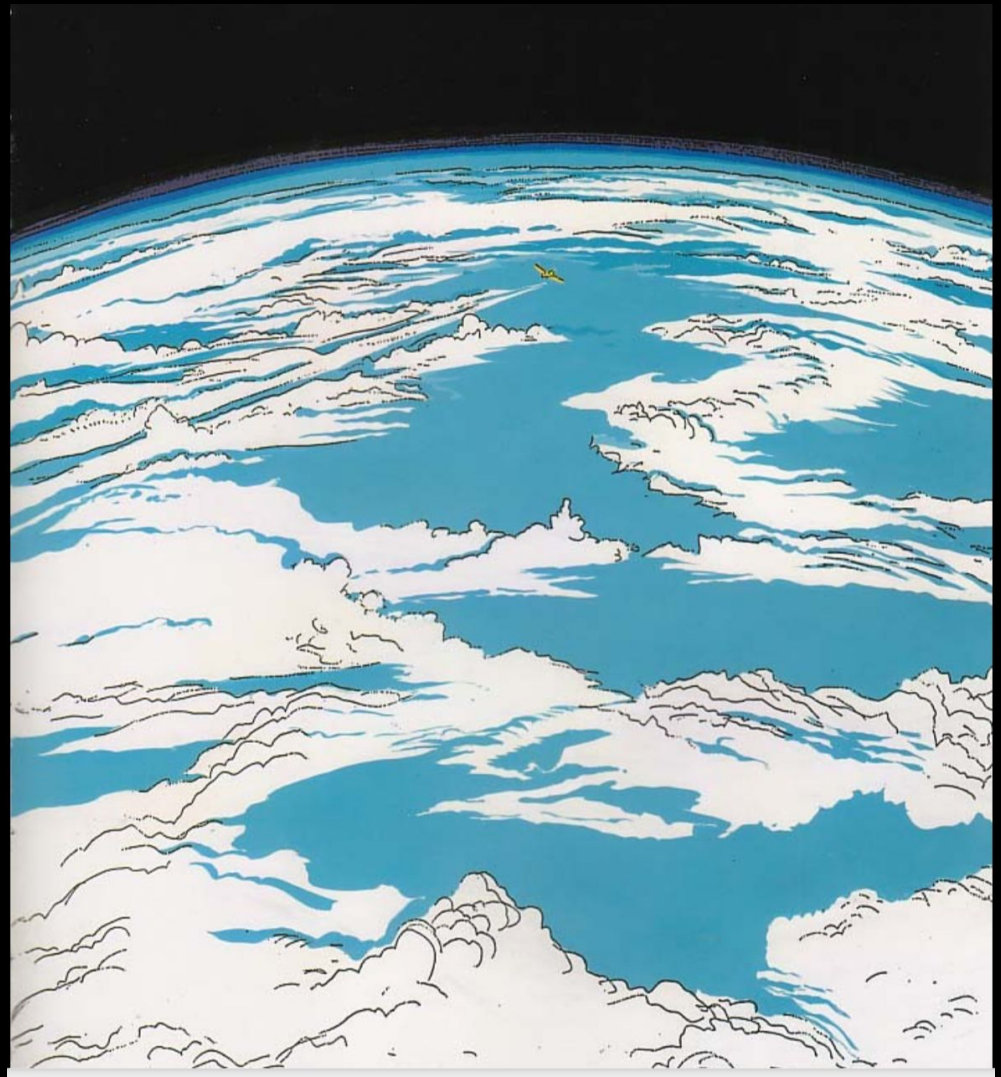


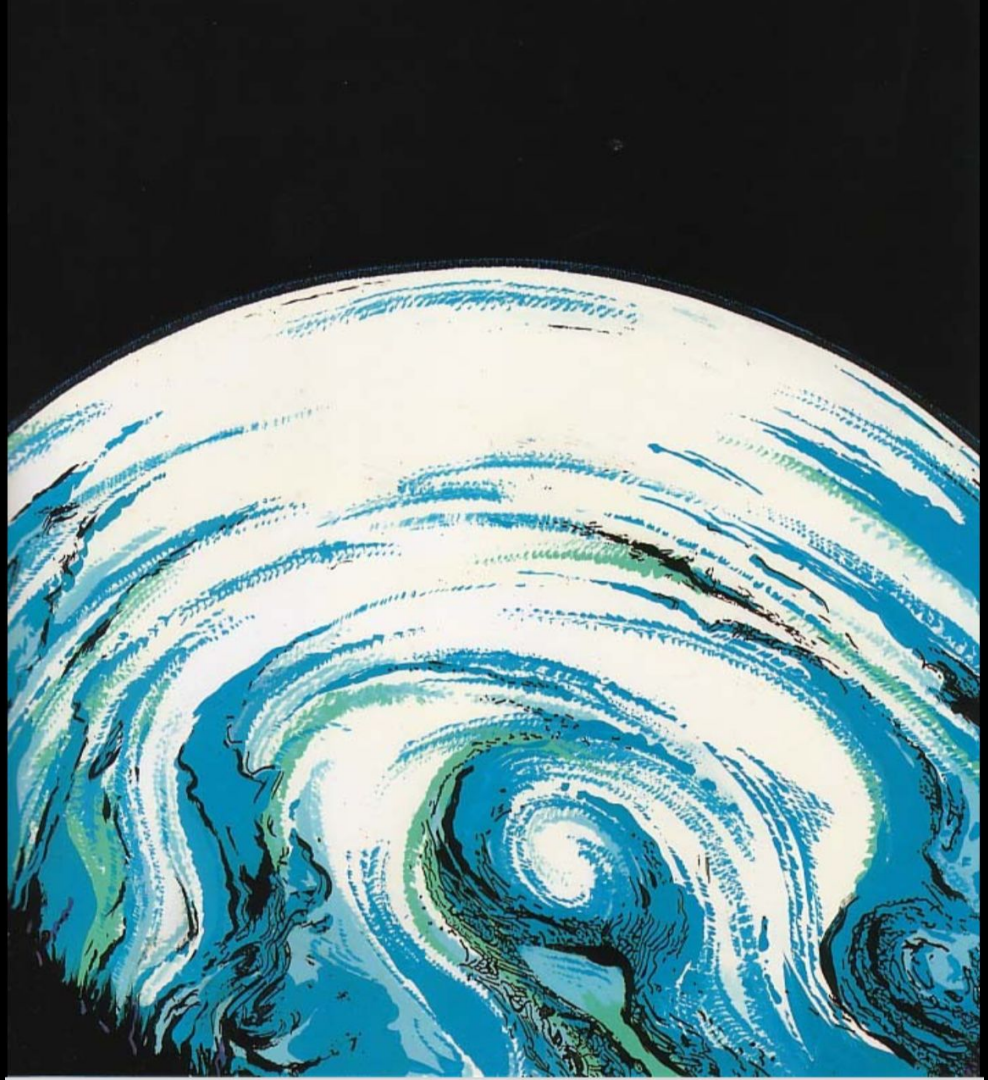
Istvan Banyai




2-27-49





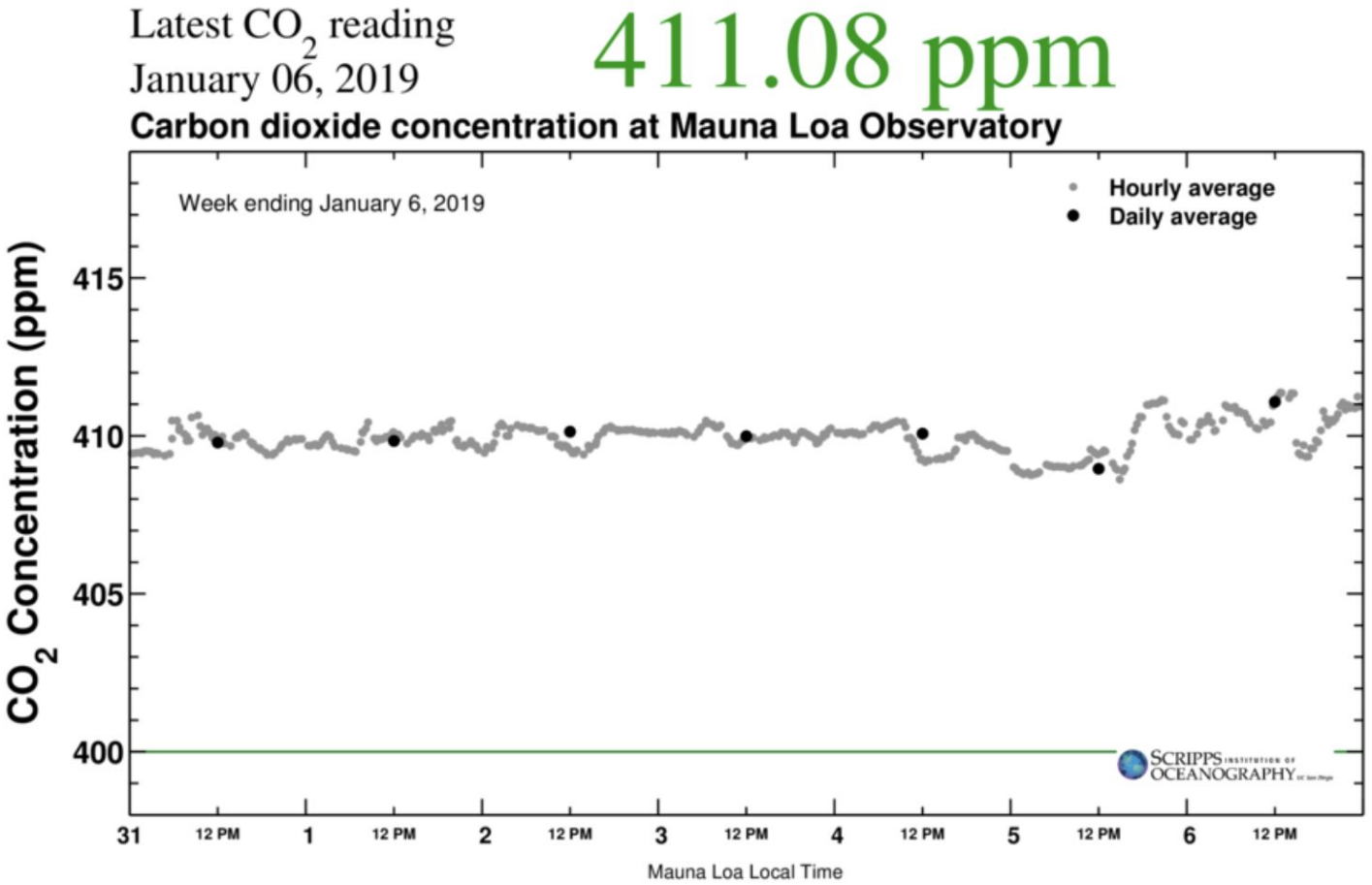


Can we adapt this exercise from zooming out on spatial scales, and teach ourselves to zoom out in time?

Data Viz Across Time Scales

NOAA's Earth System Research Laboratory
Mauna Loa, Hawaii

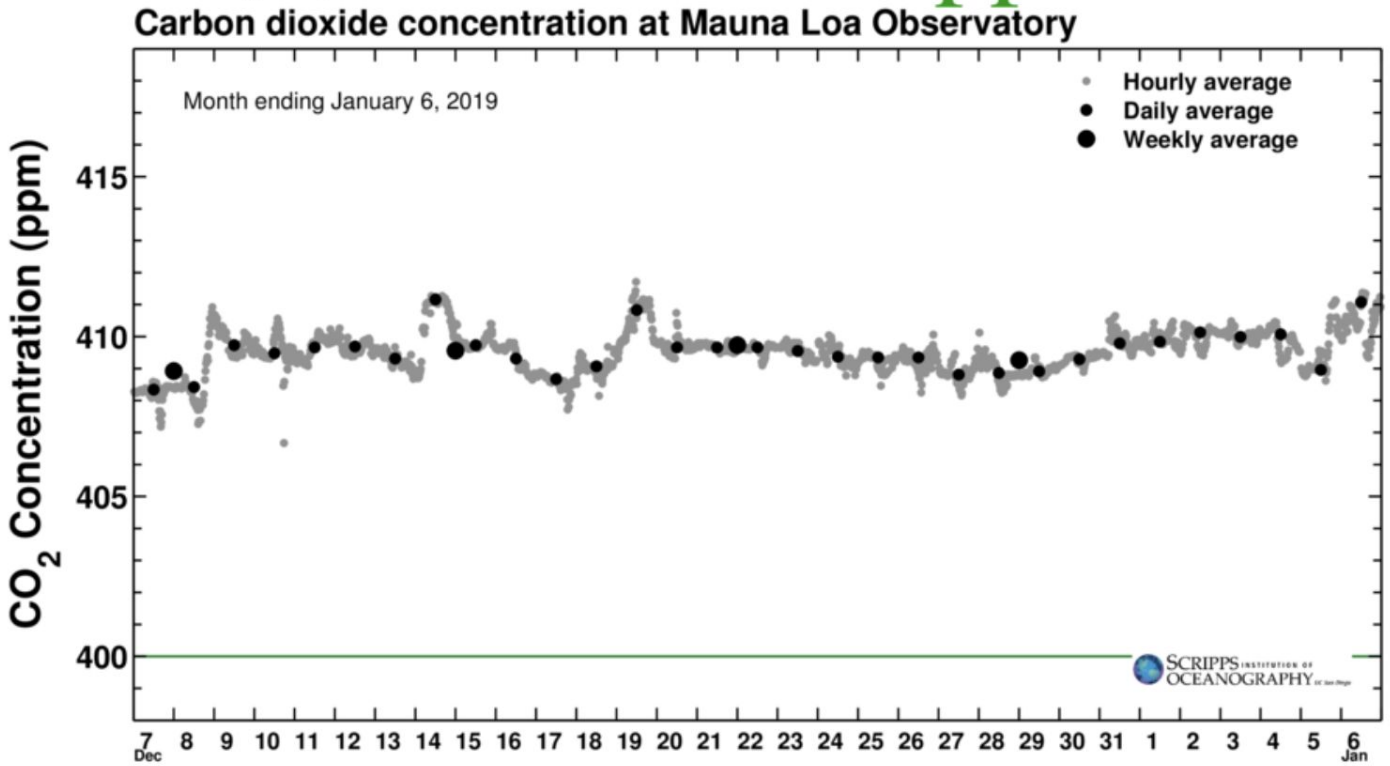
ONE WEEK


Latest CO_2 reading
January 06, 2019
411.08 ppm
Carbon dioxide concentration at Mauna Loa Observatory
Week ending January 6, 2019
Hourly average
Daily average
CO_2 Concentration (ppm)
415
410
405
400
31
12 PM
1
12 PM
2
12 PM
3
12 PM
4
12 PM
5
12 PM
6
12 PM
Mauna Loa Local Time
SCRIPPS INSTITUTION OF OCEANOGRAPHY

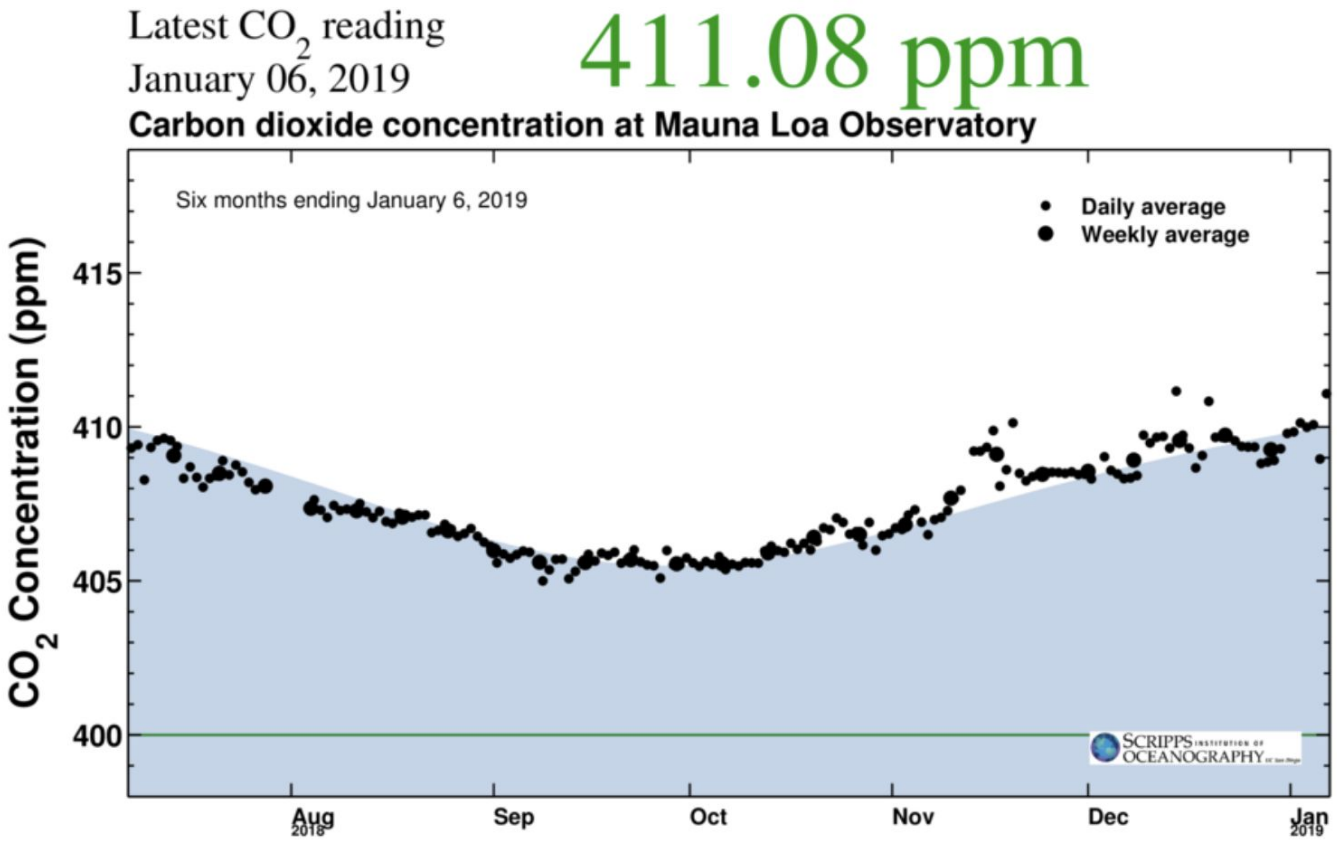
ONE MONTH

Latest CO_2 reading
January 06, 2019

411.08 ppm



SIX MONTHS


Latest CO_2 reading
January 06, 2019
411.08 ppm
Carbon dioxide concentration at Mauna Loa Observatory
Six months ending January 6, 2019
Daily average
Weekly average
CO_2 Concentration (ppm)
415
410
405
400
Aug
2018
Sep
Oct
Nov
Dec
Jan
2019
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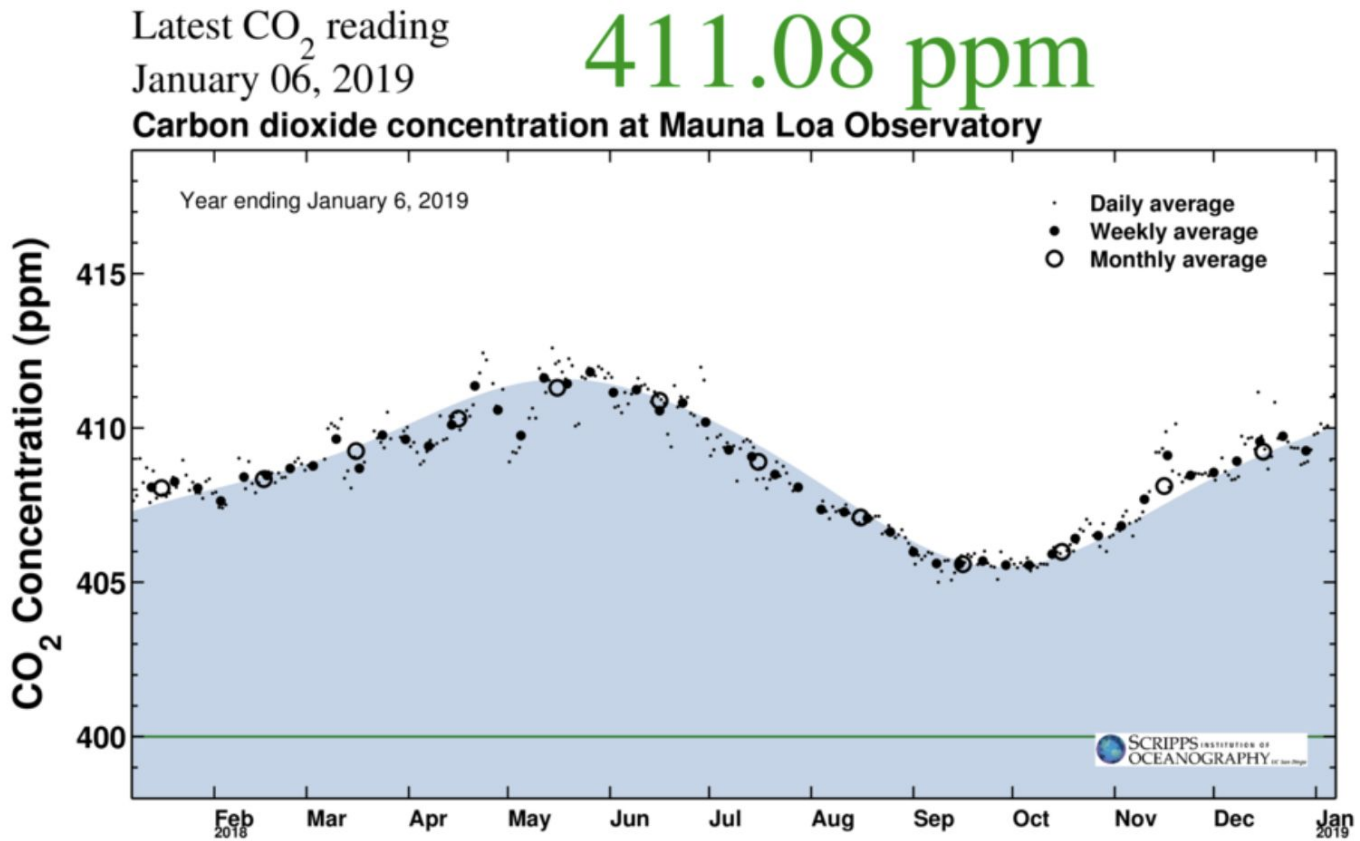
ONE YEAR


Latest CO_2 reading
January 06, 2019
411.08 ppm
Carbon dioxide concentration at Mauna Loa Observatory
Year ending January 6, 2019
Daily average
Weekly average
Monthly average
CO_2 Concentration (ppm)
415
410
405
400
Feb
2018
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
2019
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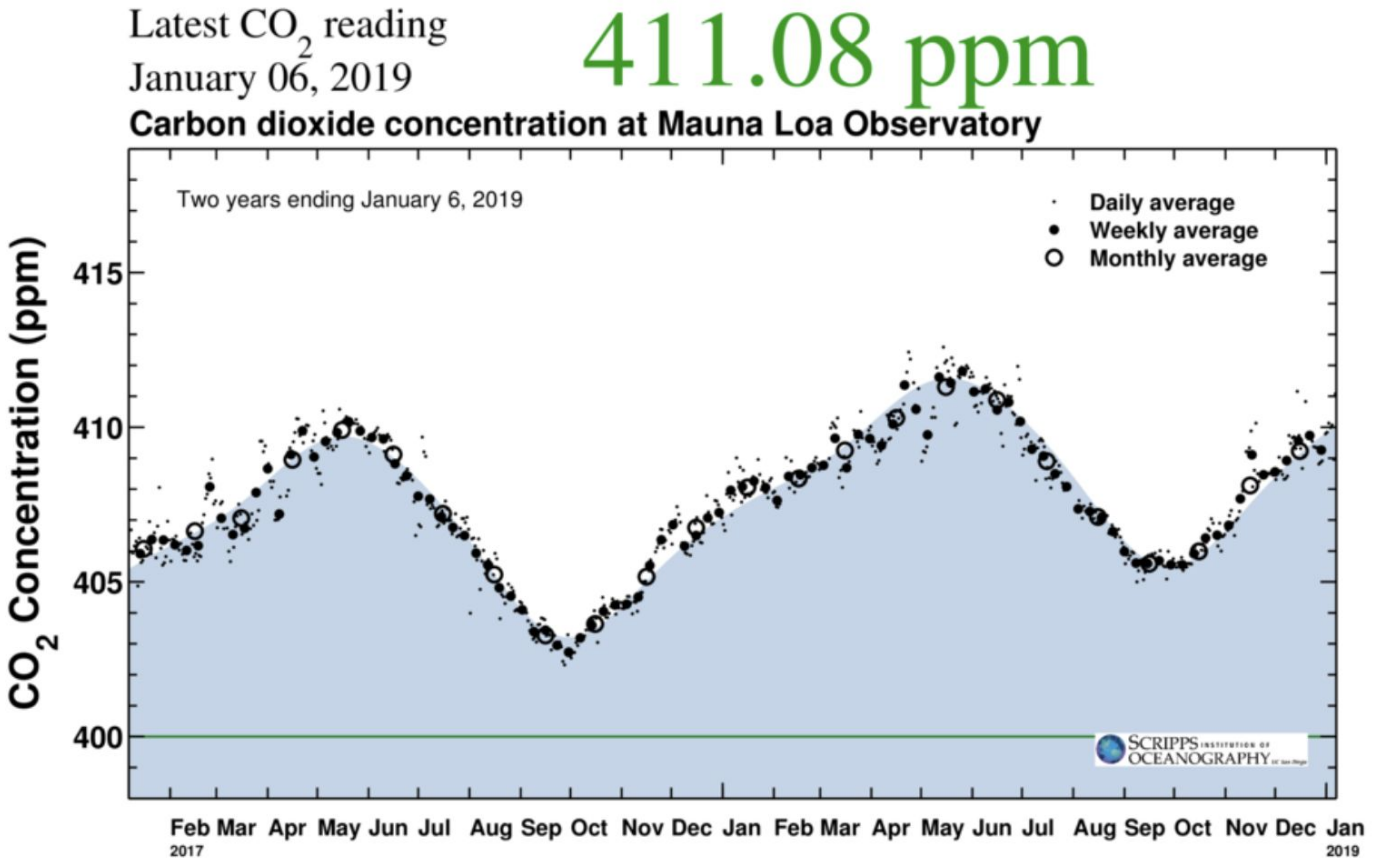
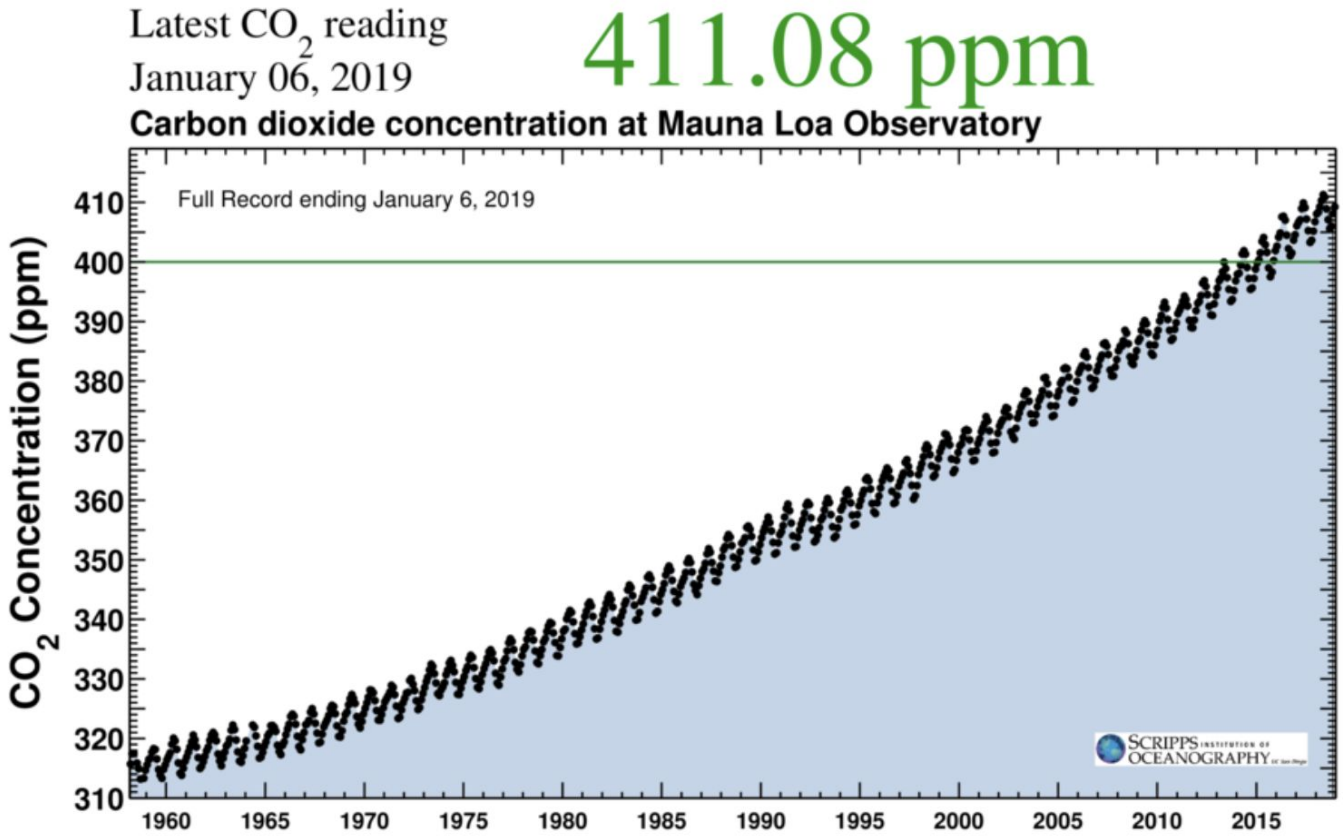
TWO YEARS


Latest CO_2 reading
January 06, 2019
411.08 ppm
Carbon dioxide concentration at Mauna Loa Observatory
Two years ending January 6, 2019
Daily average
Weekly average
Monthly average
CO_2 Concentration (ppm)
415
410
405
400
Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
2017
2019
SCRIPPS INSTITUTION OF OCEANOGRAPHY

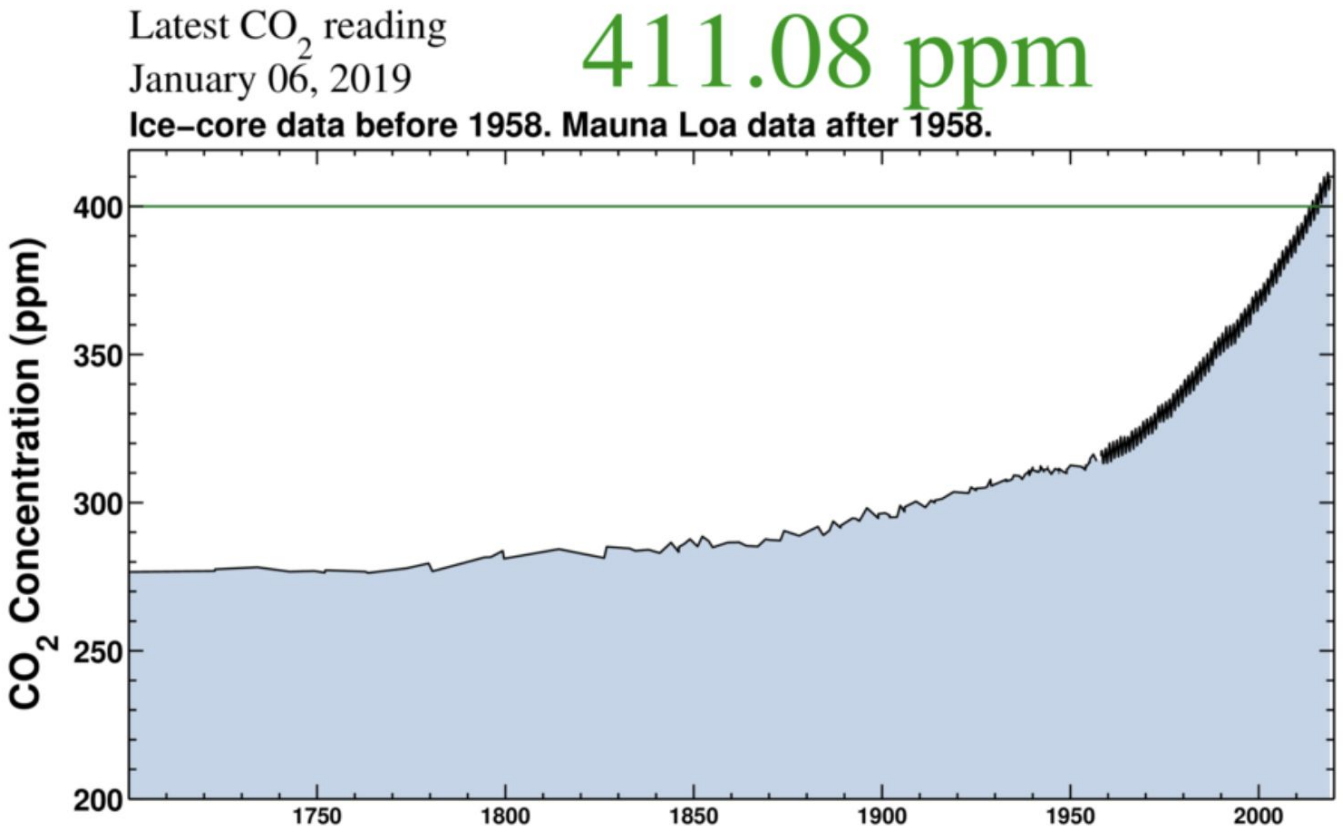
60 YEARS


Latest CO_2 reading
January 06, 2019
411.08 ppm
Carbon dioxide concentration at Mauna Loa Observatory
Full Record ending January 6, 2019
CO_2 Concentration (ppm)
410
400
390
380
370
360
350
340
330
320
310
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
SCRIPPS INSTITUTION OF OCEANOGRAPHY

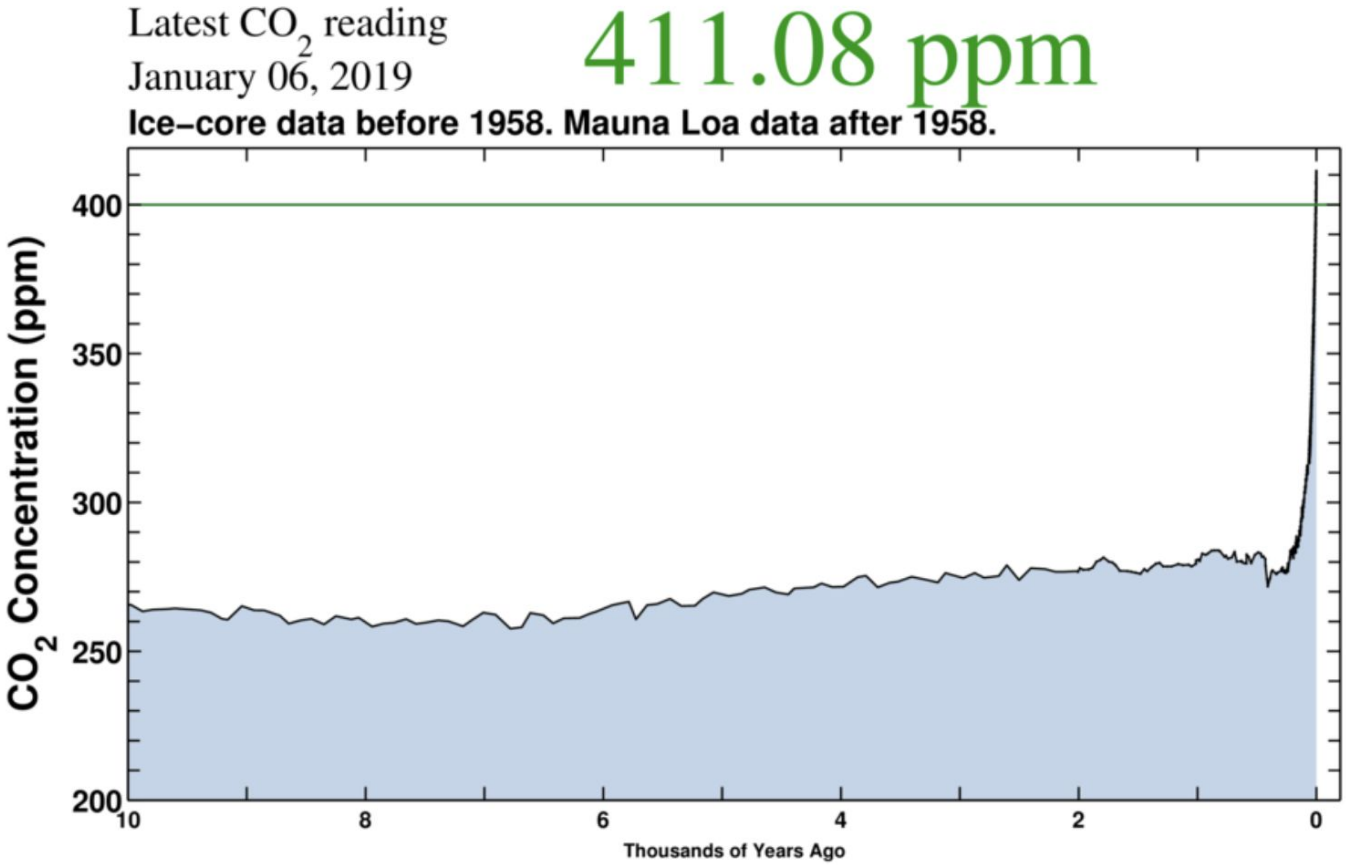
How do we know CO_2 concentrations of the past?

ICE CORES!

308 YEARS


Latest CO_2 reading
January 06, 2019
411.08 ppm
Ice–core data before 1958. Mauna Loa data after 1958.
CO_2 Concentration (ppm)
400
350
300
250
200
1750
1800
1850
1900
1950
2000

10,000 YEARS


Latest CO_2 reading
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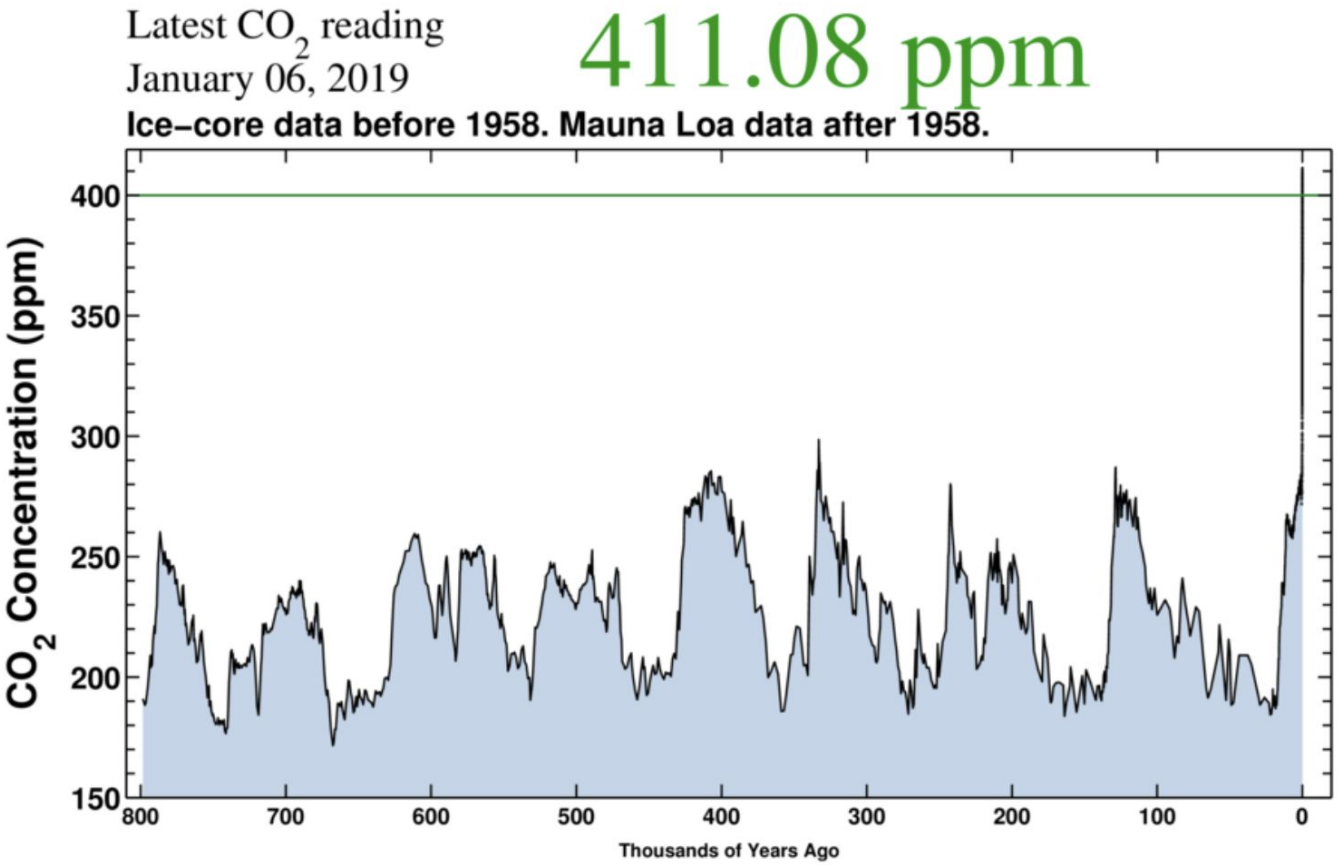
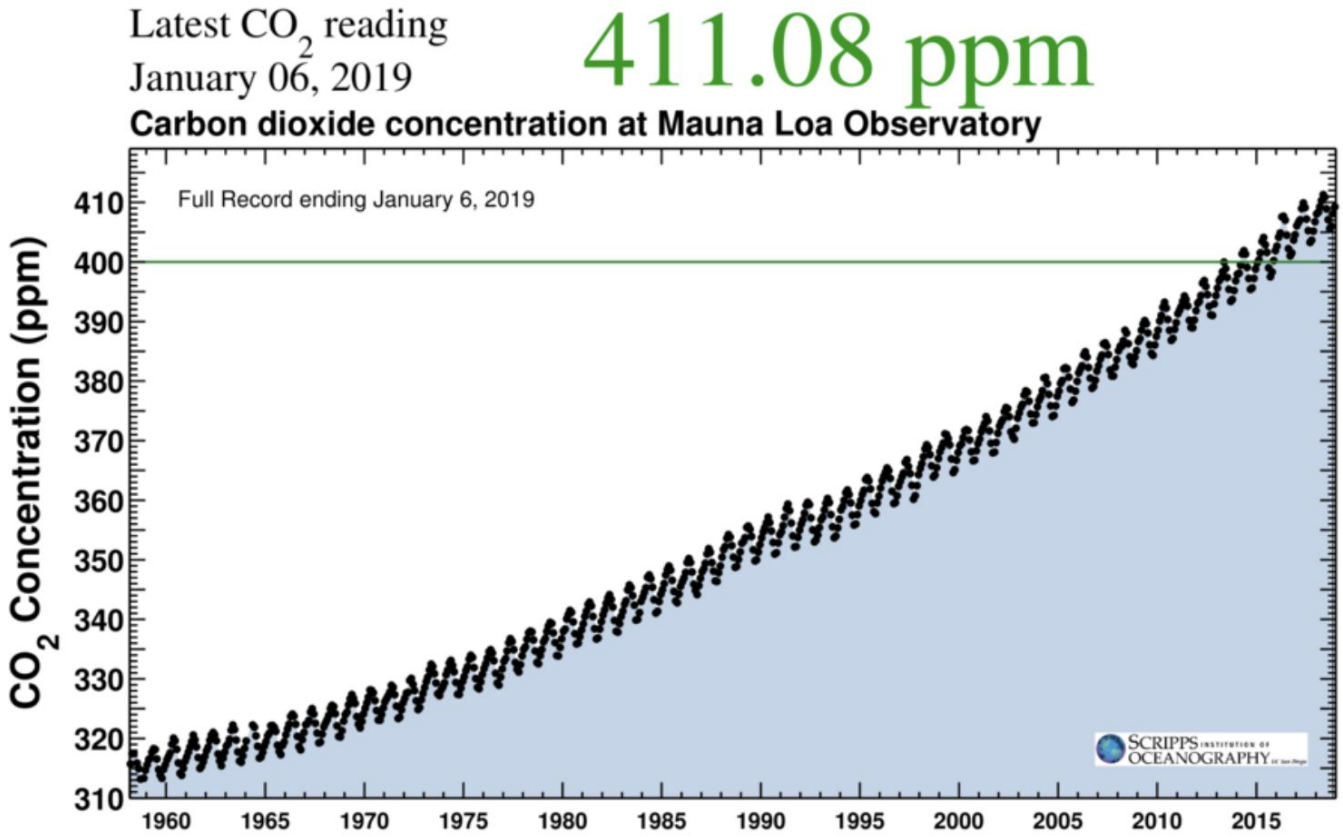
CO_2 Concentration (ppm)
400
350
300
250
200
10
8
6
4
2
0
Thousands of Years Ago

800,000 YEARS



60 YEARS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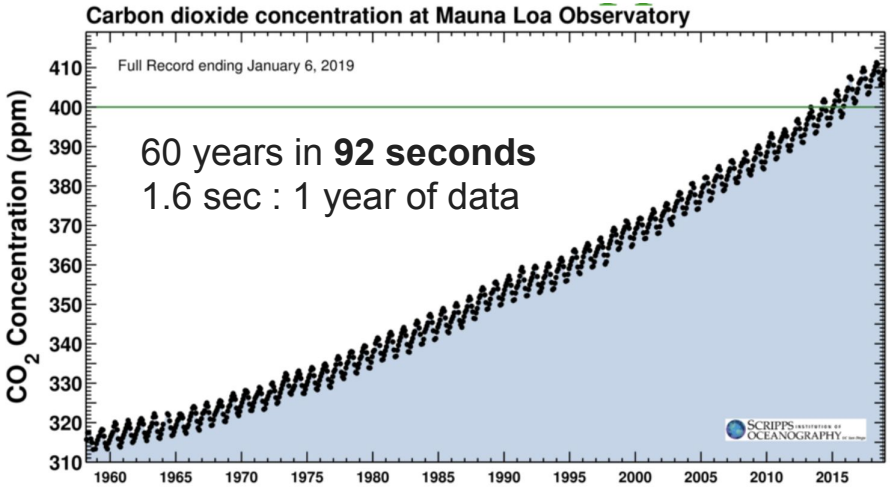
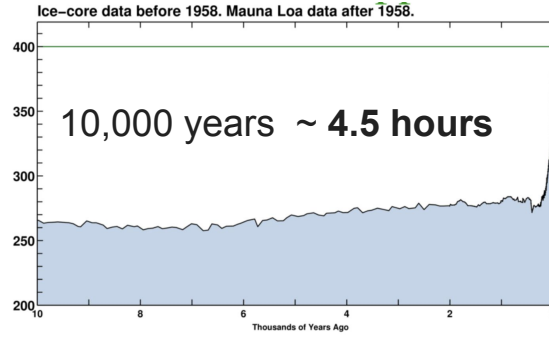
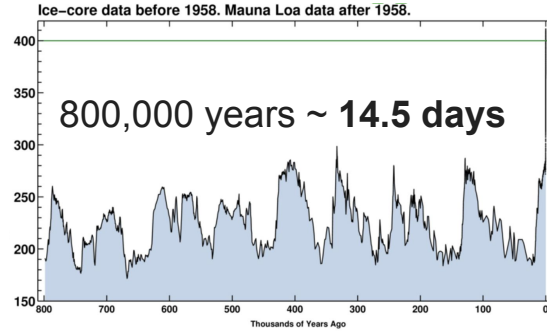
340
330
320
310
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
SCRIPPS INSTITUTION OF OCEANOGRAPHY

Data as Music

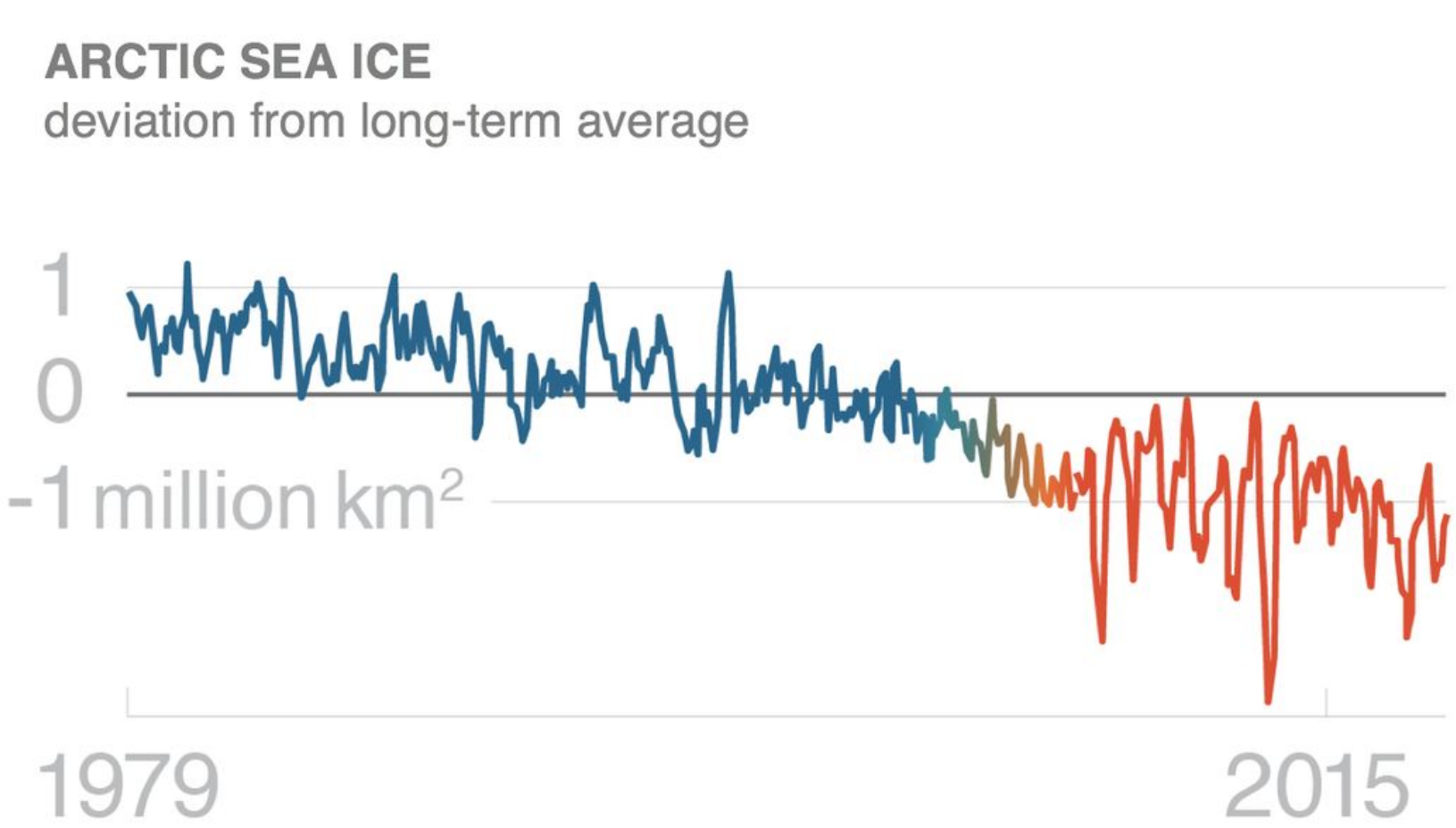

Carbon dioxide concentration at Mauna Loa Observatory
Full Record ending January 6, 2019
60 years in **92 seconds**
1.6 sec : 1 year of data
CO_2 Concentration (ppm)
SCRIPPS INSTITUTION OF OCEANOGRAPHY

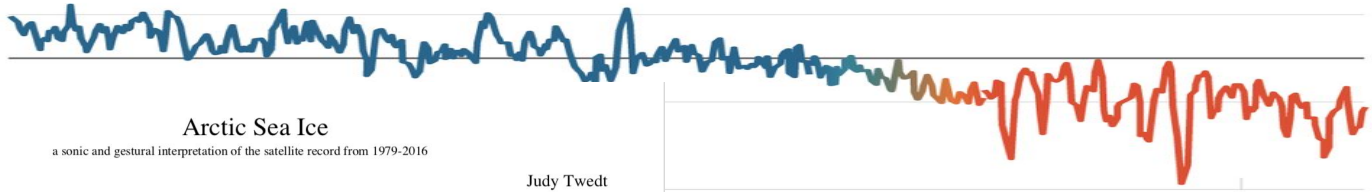

318 years ~ **8 minutes**


Ice–core data before 1958. Mauna Loa data after 1958.
10,000 years ~ **4.5 hours**
Thousands of Years Ago


Ice–core data before 1958. Mauna Loa data after 1958.
800,000 years ~ **14.5 days**
Thousands of Years Ago

This slide left intentionally blank.


ARCTIC SEA ICE
deviation from long-term average
1
0
-1 million km²
1979
2015



Arctic Sea Ice

a sonic and gestural interpretation of the satellite record from 1979-2016

Judy Twedt

1979

mp con ped.

5

9

13

17

21

mf

25 2001

f

29 2007

33 2012

cresc.

ff

37 rit.

dim.

pp

senza ped.

Teaching Kids to Make Music from Climate Data

Format:
two 2.5 hour workshops
ages 9 - 11, 12 - 18
Six students in each workshop
taught at a music school

The approach:

1. **Numbers and Notes**
    a. What is data? How do we turn numbers into notes?
    b. Group exercises in composing simple melodies with numbers, seeing how the same set of numbers can sound totally different depending on mappings and musical choices.

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2. **Climate Data from Cities around the world**
    a. What do we see from yearly averages? Five year averages? 10-year averages?
    b. Have all cities warmed over time?
    c. Discuss: why does averaging over time help us to understand climate change?

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    b. How can music help people care about climate change?

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    b. Independent composing time

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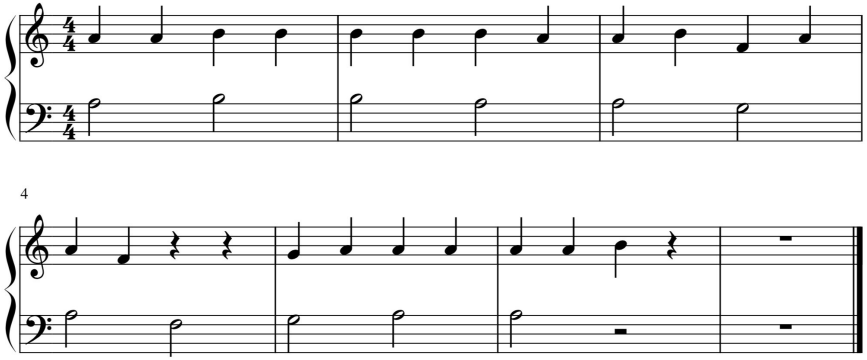
   a. Scaffold some choices for how to sonify their data
   b. Independent composing time

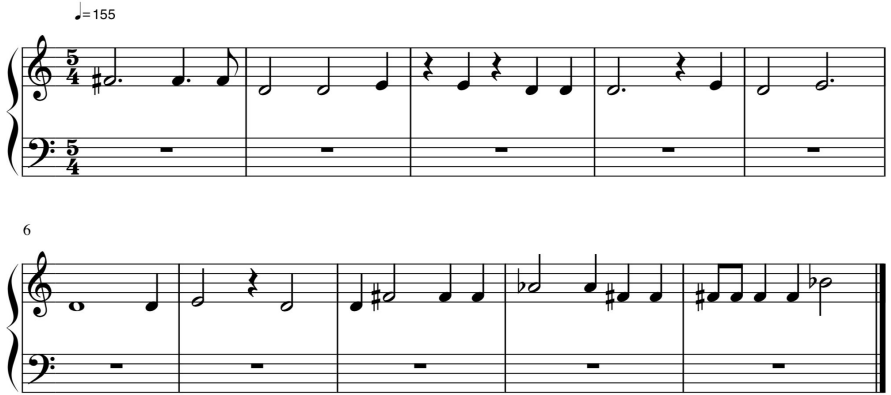
All students left with a completely sonified data set that they can build from and perform at their upcoming composers performance this spring.

Galway

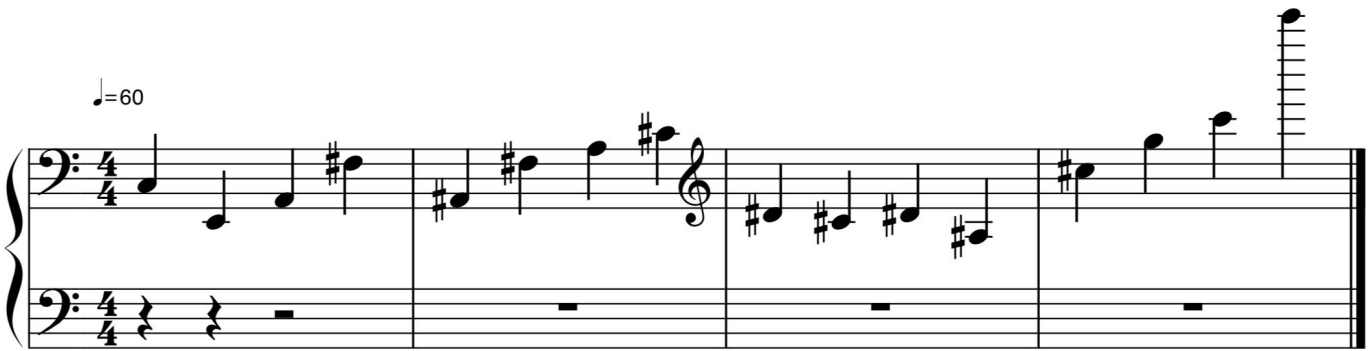


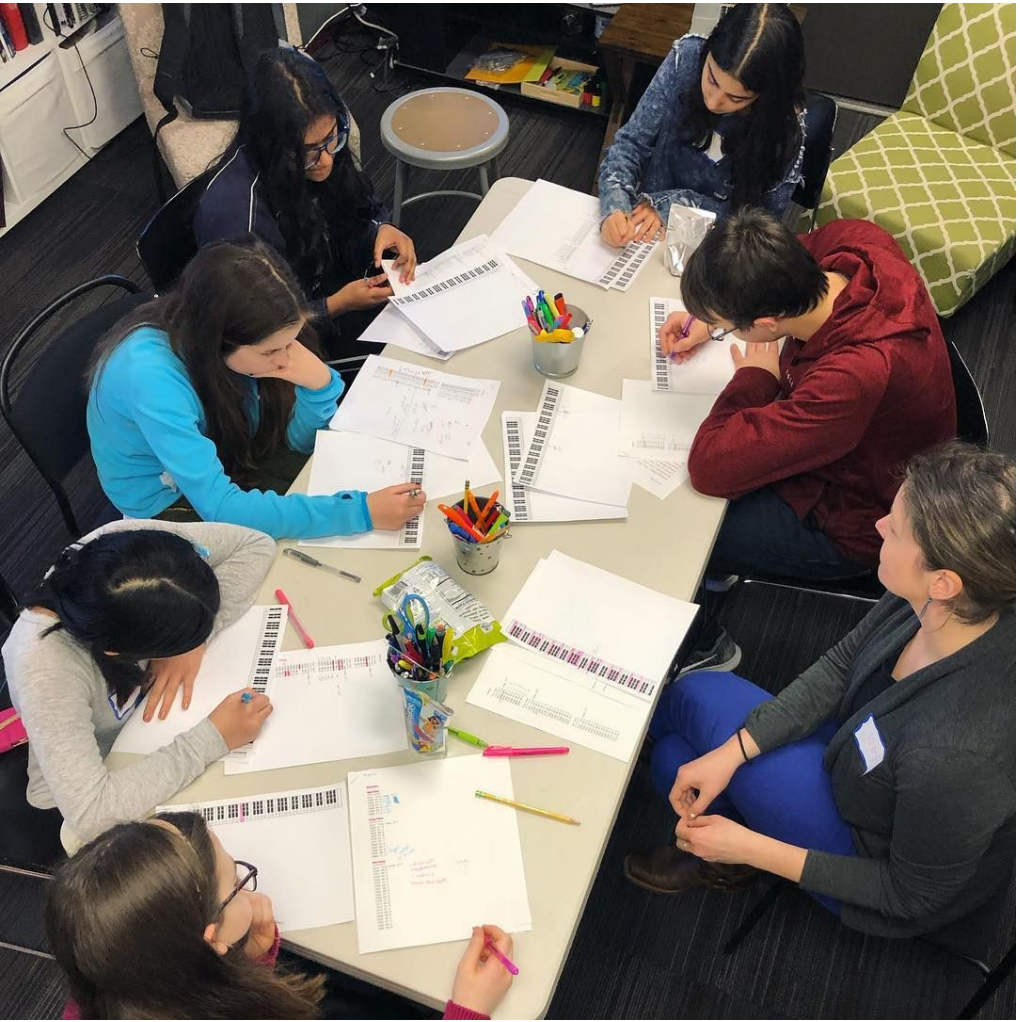
Shkodra

Me



Sydney, Australia





How do you feel when you read, think, talk, or hear about climate change?

“Climate change is very **science-y**. When I read it, I immediately assume that it means the overall climate/weather/temperature in a certain place” (12 y.o.)

“Sad because the world is changing in a bad way**.” (12** y.o**)**

“Despite understanding the consequences of climate change, I find that when I read or hear about climate change, it is a **stale topic,** and does not carry the weight that it should. It’s like listening to someone tell you about some sort of bad event, except it is too far in the future to really feel worried about it (this is a mess of an explanation).” (17 y.o)

“Honestly, whenever I hear about climate change **I think about the annihilation of the human race** as a result of an uninhabitable earth.” (12 y.o)

“I feel **sad** when I hear or learn about animals and plants that are being affected in a negative way by climate change.” (9 y.o)

“I don't know exactly what climate change is.” (9 y.o)

“I feel a sense of **fear** because we don't know how climate change will affect us.” (10 y.o)

How do you feel about climate change after making music from climate data?

"I see it more as a **tangible idea** that needs to be spread." (this student chose Colombo, Sri Lanka)

"I feel that climate change can be dangerous, but composing about climate change can help you learn more about it." (this student chose Jakarta, Indonesia)

"I find it interesting how it gives a new perspective"
(this student chose Sydney, Australia)

How does the piece that you composed sound?

"My piece jumps around because I assigned each note to a 10th of a degree. However, it increases toward the end."

"It kind of goes up and down, but in the end, the pitch really increases"

"It sounds edgy, but not too dramatic, as the temps were really close together. "

"It shows that the temperature in Galway is not as affected as other cities, and it goes up and down, but stays in the same area."

"Going up and down all the time. If it is high it stays high for some time."

Lessons Learned:

Students discovered how the evidence of warming varies across cities, both spatially and temporally.

Students made choices about what time scales to use and learned, experientially, that climate change is best felt and understood by looking at longer time averages.

Most students (9/11) chose cities from which they were born or had a personal connection.

Students have the option to continue developing their piece at home and/or with their teachers, and can perform in an upcoming spring music show.

Thank you!

Email: jtwedt@uw.edu
Twitter: @judytwedt
Web: www.judytwedt.com

Colombo

Ten Year
==========
date "avg temp (F)"
1950 86.0
1960
1970 87.0
1980 88.3
1990 87.9
2000 87.1
2010 87.9

Five Year
==========
date "avg temp (F)"
1955 86.0
1960
1965
1970
1975 87.0
1980 88.2
1985 88.5
1990 87.6
1995 89.5
2000
2005 87.1
2010 87.6
2015 88.3

Two Year
========
date "avg temp (F)"
1956 85.4
1958 86.4
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978 87.0
1980 88.2
1982 87.8
1984 88.2
1986 88.5
1988 90.3
1990
1992 87.4
1994 88.2
1996
1998
2000
2002
2004
2006 86.2
2008 87.3
2010 87.3
2012 87.7
2014 88.0
2016 88.4
2018 88.0

One Year
========
date "avg temp (F)"
1956 84.0
1957 85.4
1958 86.4
1959
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978 86.4
1979 87.3
1980 88.3
1981 88.1
1982 86.7
1983 91.4
1984 89.6
1985 88.0
1986 88.5
1987
1988
1989 90.3
1990
1991
1992 87.1
1993 87.6
1994 87.8
1995 89.5
1996
1997
1998
1978 86.4
1979 87.3
1980 88.3
1981 88.1
1982 86.7
1983 91.4
1984 89.6
1985 88.0
1986 88.5
1987
1988
1989 90.3
1990
1991
1992 87.1
1993 87.6
1994 87.8
1995 89.5
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007 86.2
2008 86.8
2009 87.4
2010 87.4
2011 87.2
2012 87.8
2013 87.7
2014 87.8
2015 88.3
2016 89.0
2017 87.9
2018 87.8
2019 89.2