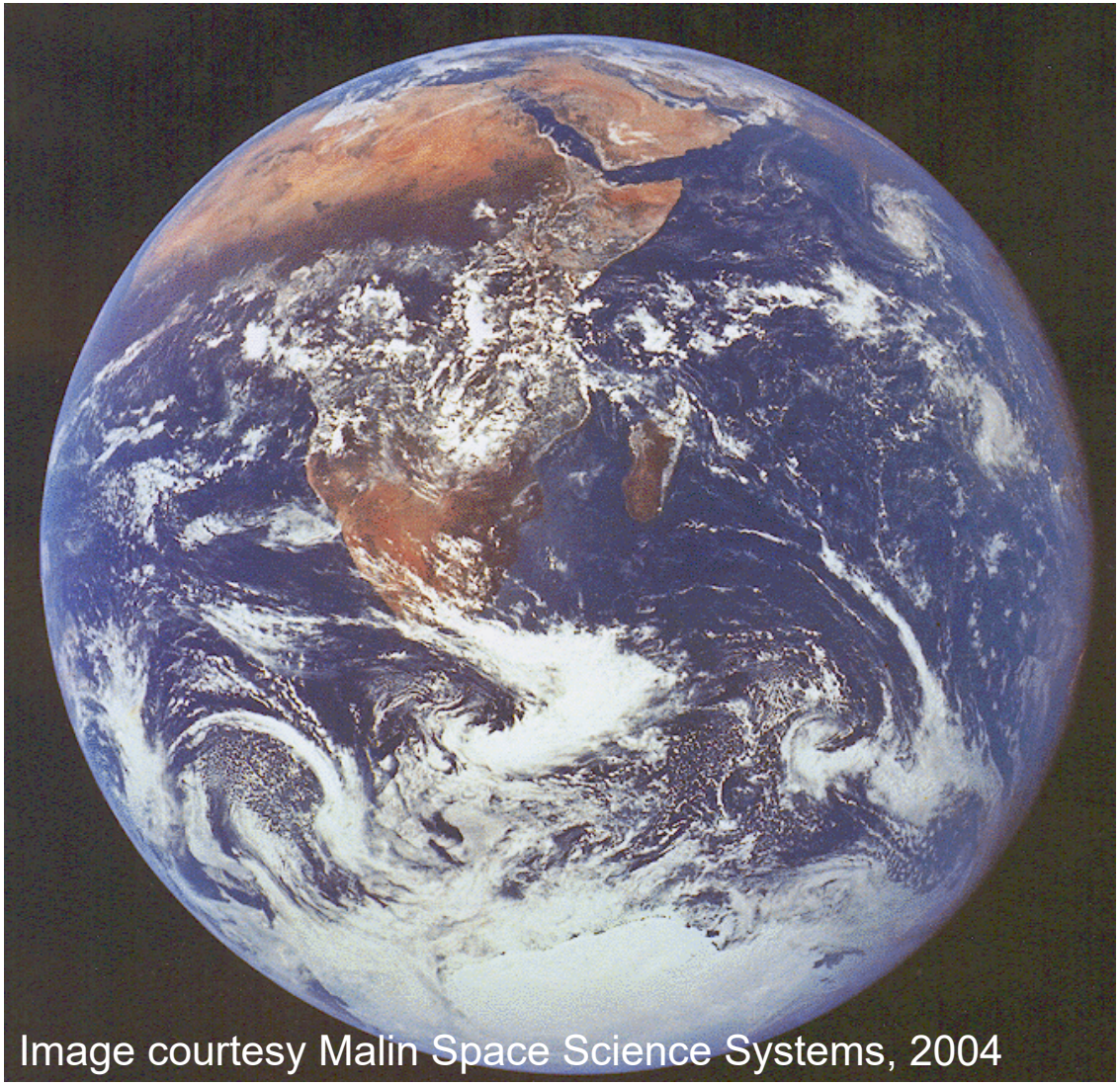
Engineering, Ethics and Society: Environmental Ethics

- Log on to UCLA_WIFI
- Go to https://onlinepoll.ucla.edu
- Wait for further instructions

Dr. Gershon Weltman
Engineering 183W, UCLA SEAS
Lecture 9

Our Environment



Lecture Contents

- The Environment: Ethical Overview
- Case Study 1: LA Smog
- Case Study 2: The Ozone Hole
- Case Study 3: Climate Change
- Case Study 4: Waste Management
- Ethical Example: A New Industrial Paradigm
- Summary

Ethical Overview

The environment affects:

- How human beings live today
- The future lives of human beings
- The future viability of animal and plant species

Many environmental problems are the result of society's technical advances, so technologists must solve them considering:

- Rights Ethics: Peoples' right to a safe and healthy environment
- Duty Ethics: We're breaking it, it's our duty to fix it
- Virtue Ethics: The new obligations of world eco-citizenship
- Utilitarianism: Most happiness for most people, balanced costs
- Pragmatism: Compromise solutions, local and/or worldwide

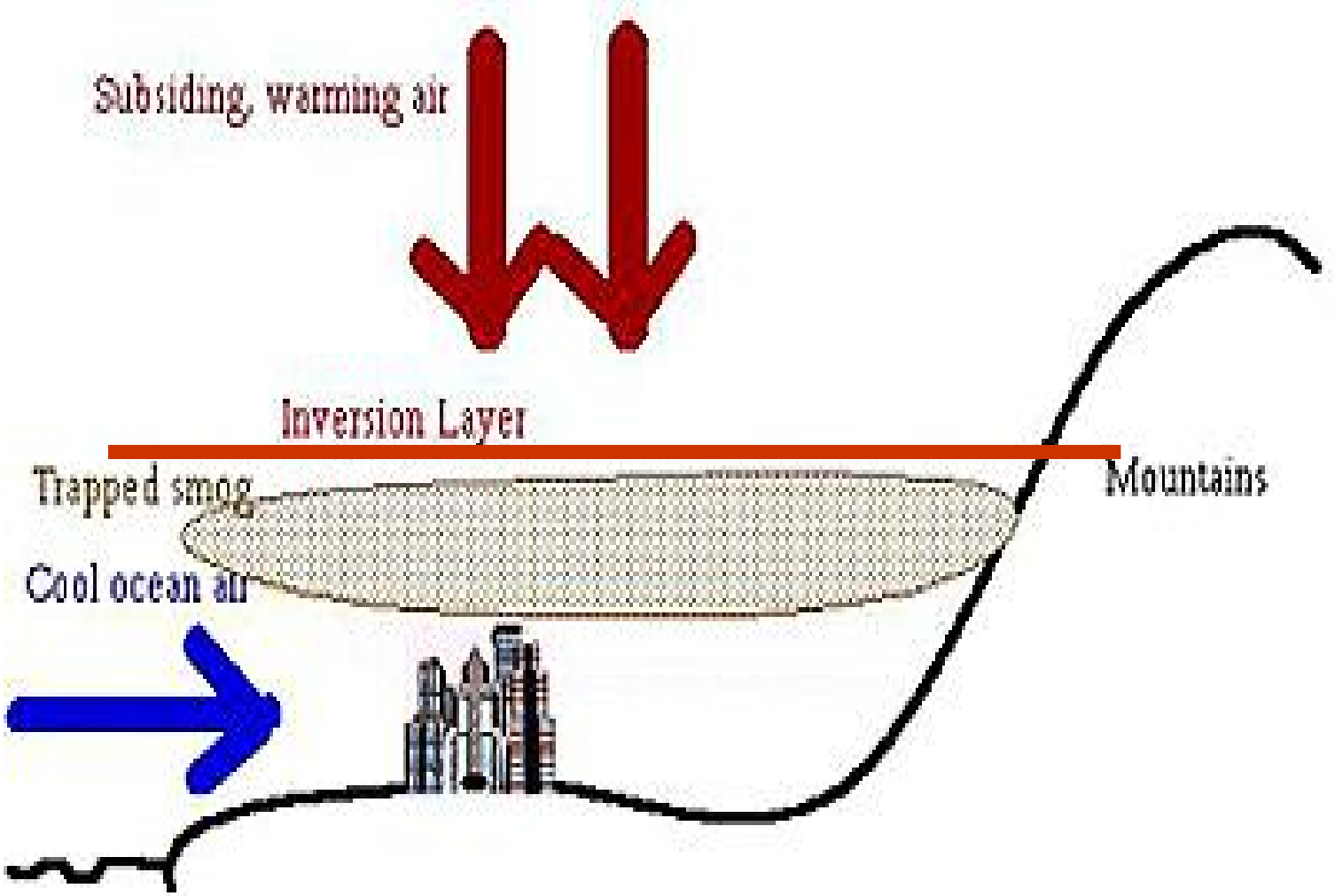
Major Environmental Problems

- Depletion of Natural Resources
- Urbanization and Industrialization
  - Smog & Air Quality
  - Chlorofluorocarbons & the Ozone Layer
  - Greenhouse Gases & Global Warming
  - Wastes & Contamination

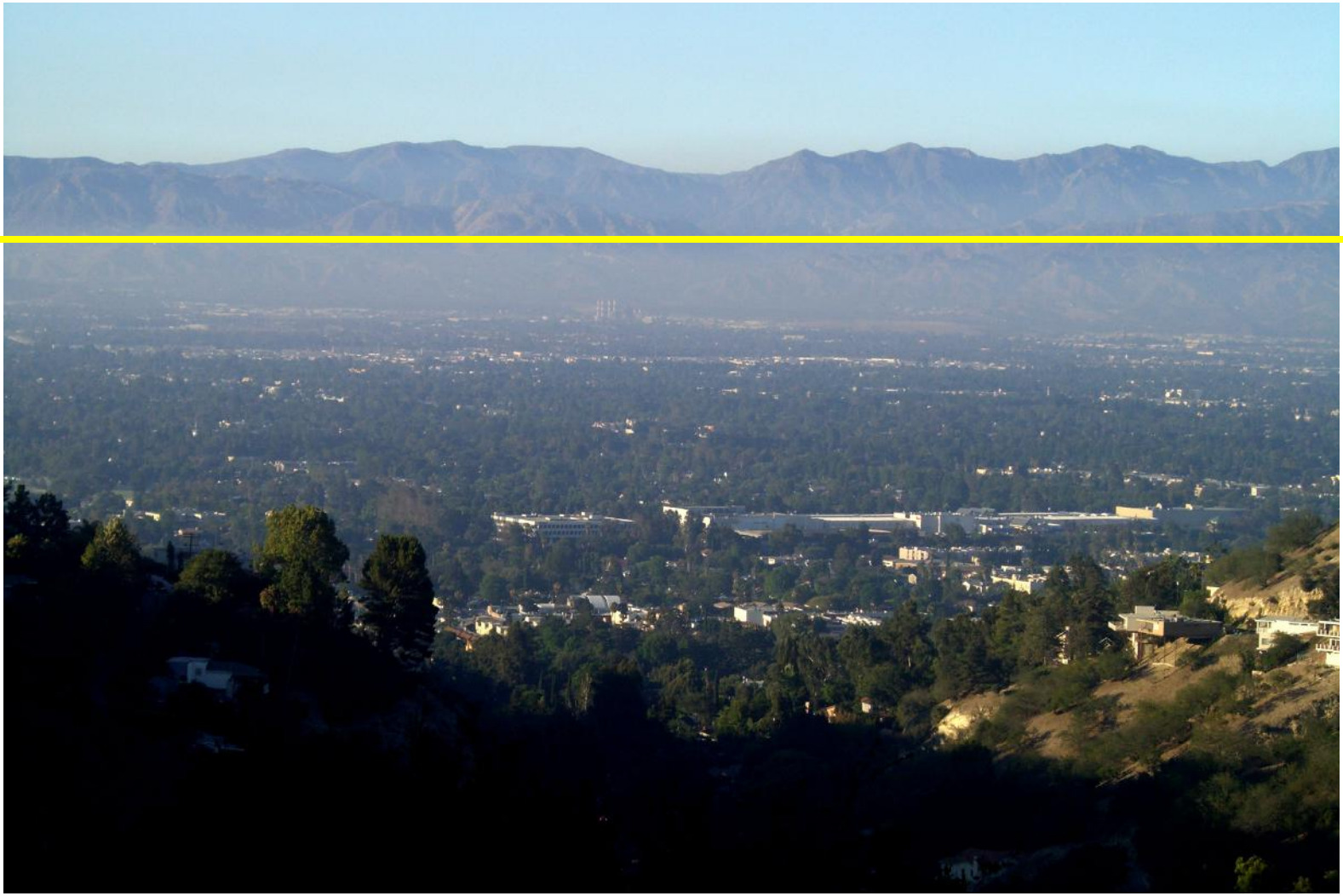
Industrial Technology
meets
Natural Phenomena

Case Study 1: Los Angeles Smog

LA's Geography Traps Smog



In the San Fernando Valley



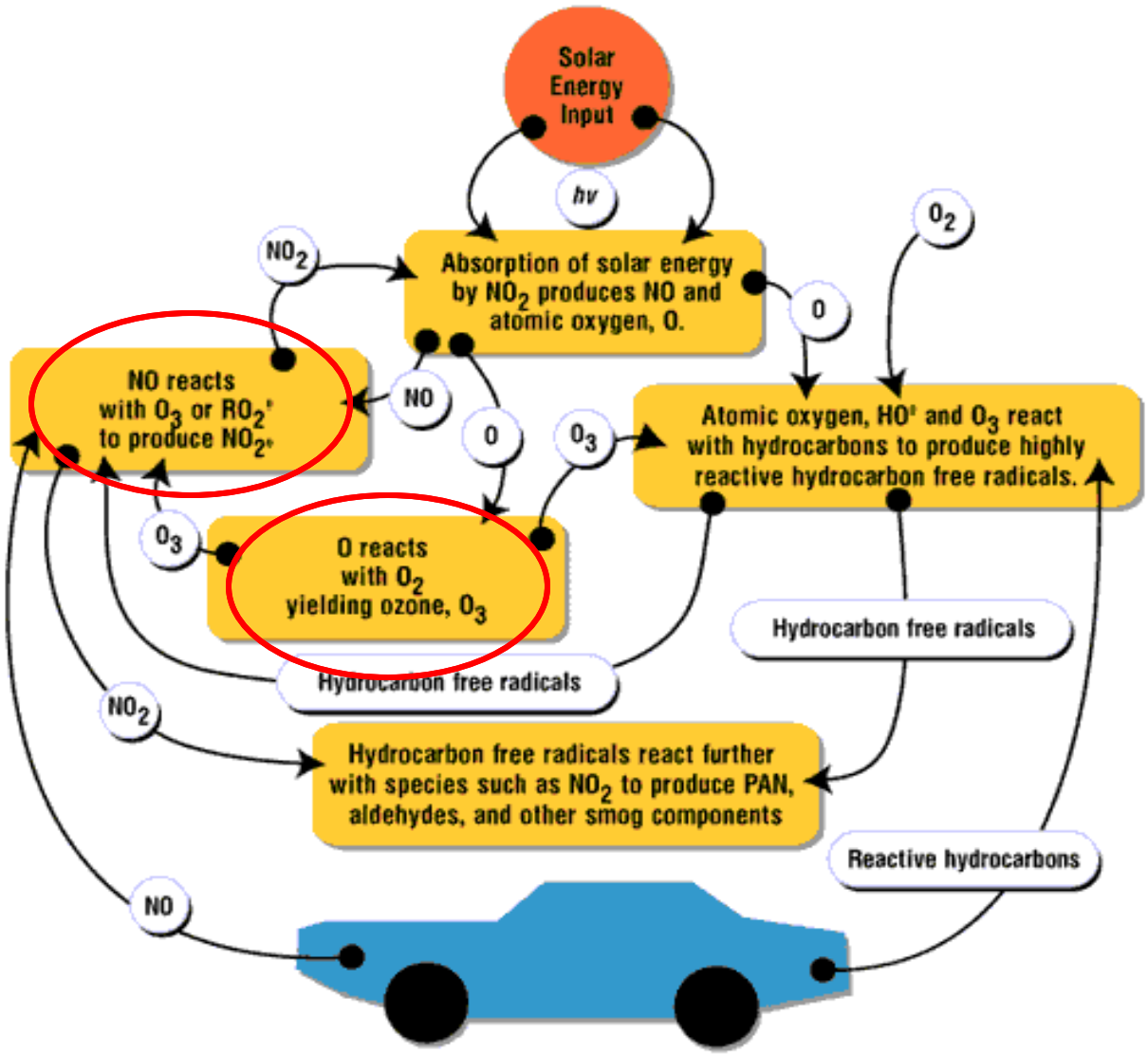
LA's Historical Smog Sources

Factories

Home Incinerators

Family Cars

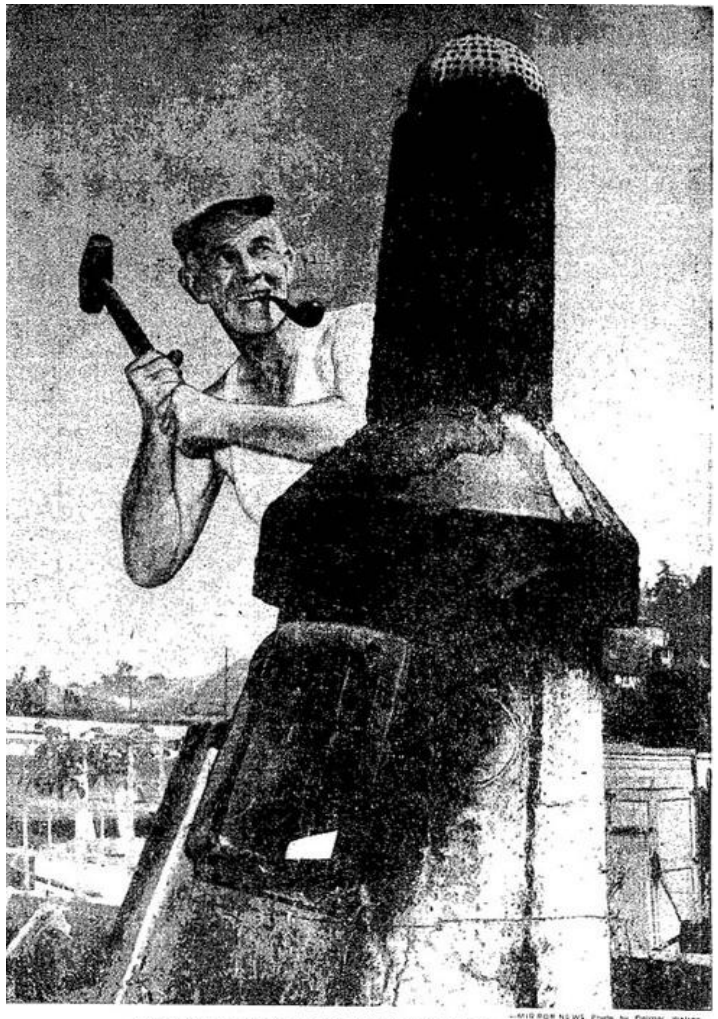
Cars Produce Photochemical Smog



http://mtsu32.mtsu.edu:11233/Smog-Atm1.htm

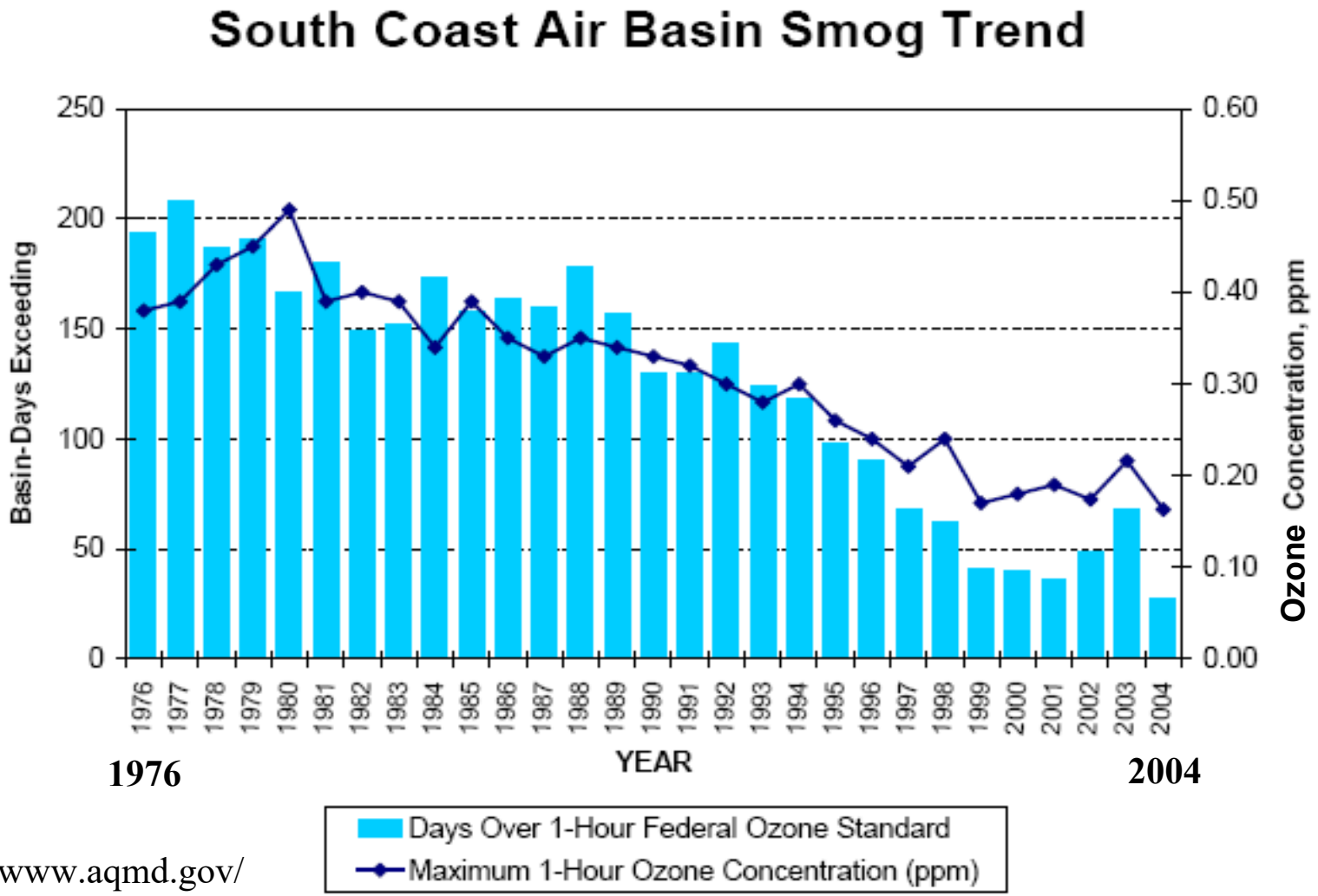
LA Smog Control

- Recognize the Problem
- Regulate Locally and Statewide
- Ban Home Incinerators
- Reduce Gasoline Effluents
  - Catalytic converters
  - Filling shields
  - Non-lead composition
- Convert Local Industry



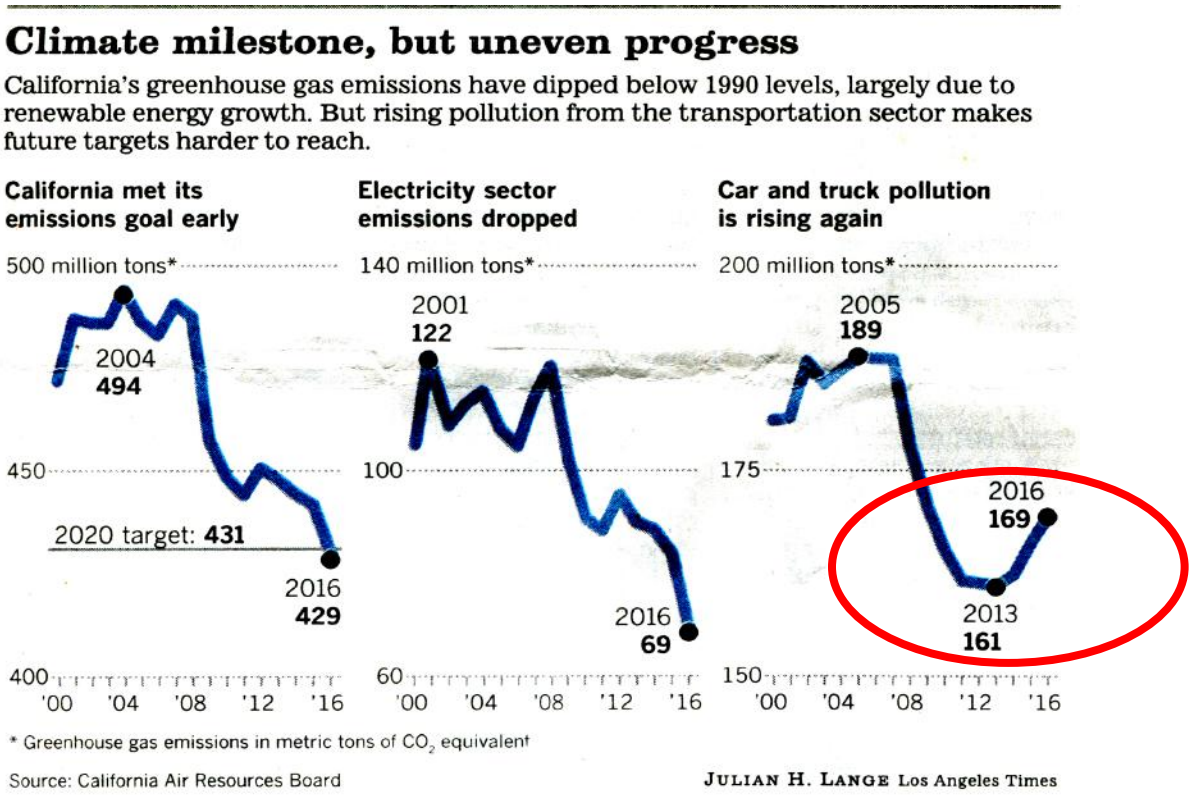
YOU, TOO, CAN GET RID OF THAT BACK-YARD EYESORE
Pop Watson, 2217 Berkeley Ave., isn't waiting for the Tuesday deadline.

Los Angeles Area Results



http://www.aqmd.gov/

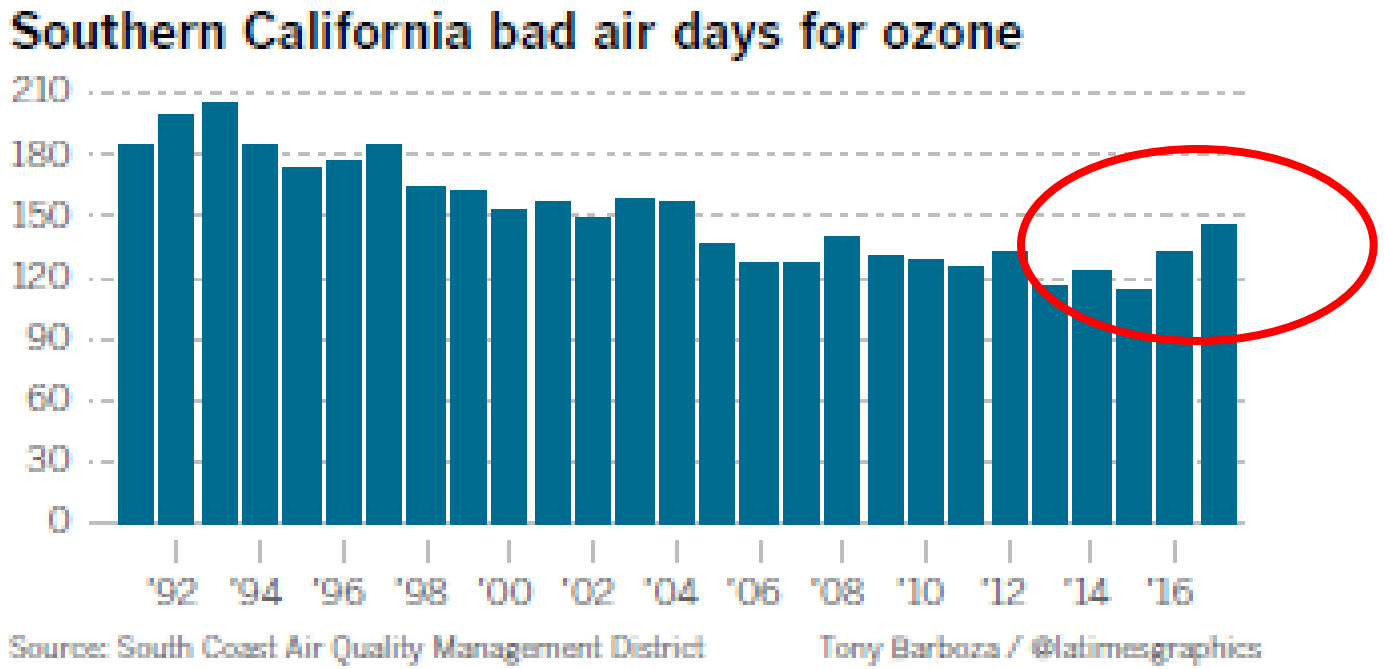
But Some Signs of Trouble I



Los Angeles Times, July 24, 2018

Recent uptick in CA car emissions is apparently due to increased mileage.

But Some Signs of Trouble II



Uptick in general area ozone tracks the general increase in car emissions.

But Some Signs of Trouble III

HER © 2018 WST

SATURDAY, SEPTEMBER 22, 2018

WALLY SKALIJ Los Angeles Times

UNHEALTHFUL summer haze is not unusual in Southern California, but this year's persistence is troubling.

L.A.'S BAD AIR DAYS

Ozone readings violated standards for nearly three months straight, the longest span in 20 years.

BY TONY BARBOZA

Stretch of smoggy days

Ozone exceeded the federal health standard for 87 consecutive days in Southern California.

87 days

'18

Longest streak in days

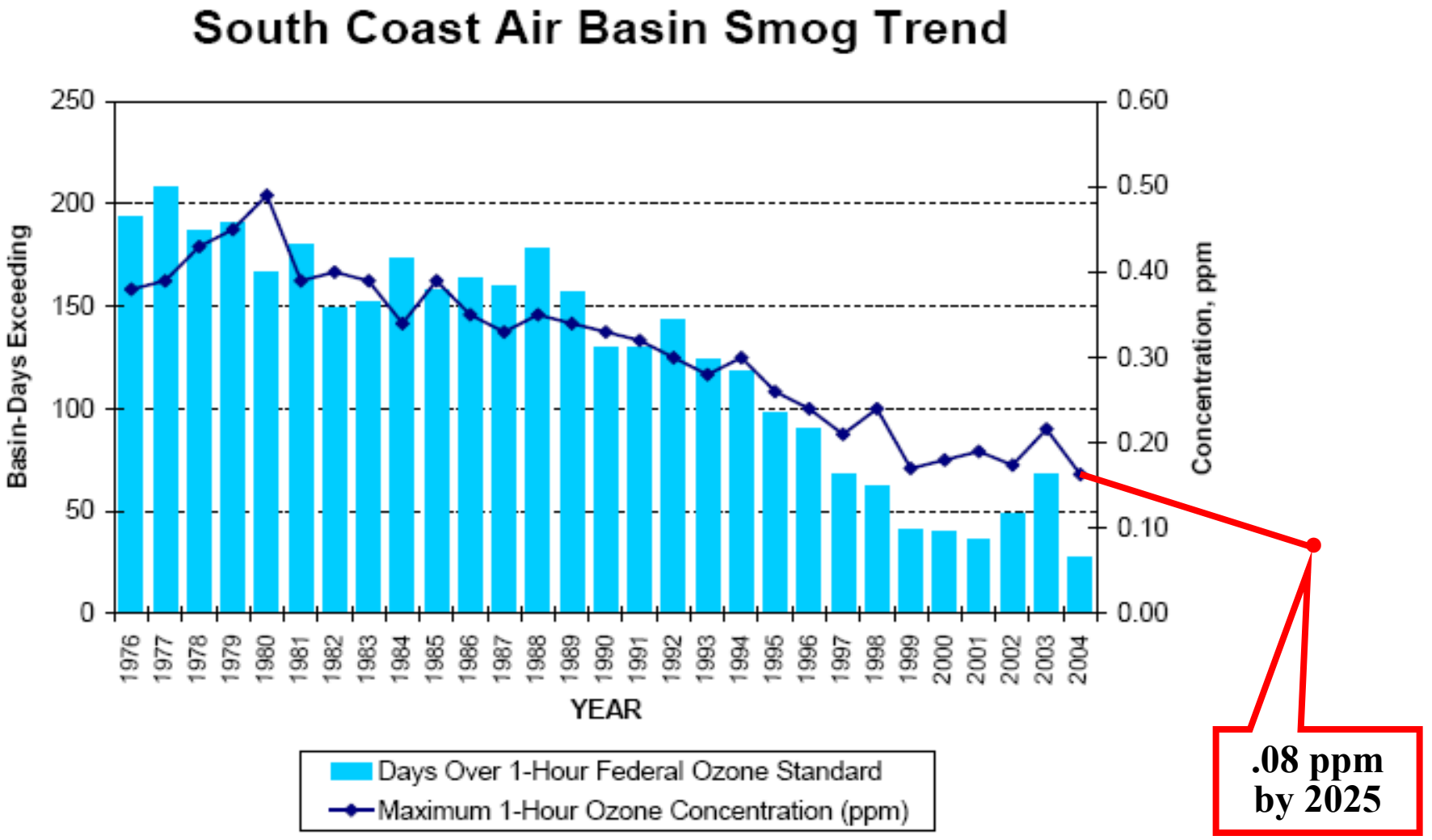
J F M A M J J A S O N D

ades of dramatic improvement.

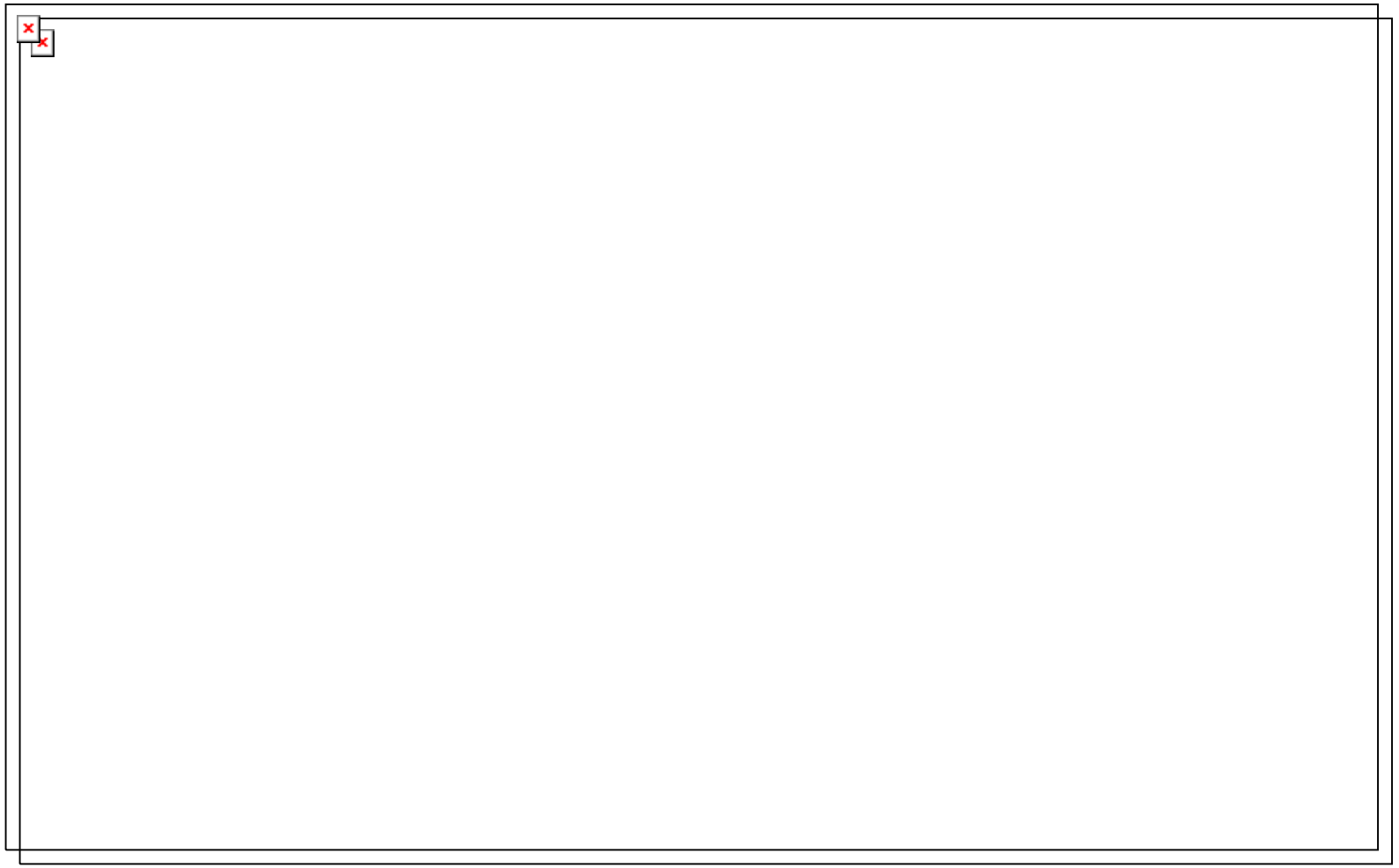
The ozone pollution spell began June 19 and continued through July and August, with every day exceeding the federal health standard of 70 parts per billion somewhere across Los Angeles, Orange, Riverside and San Bernar-

The public is starting to take notice. Will this require a new cycle of problem identification, regulation and solution? Will it be a success?

Los Angeles' New Target

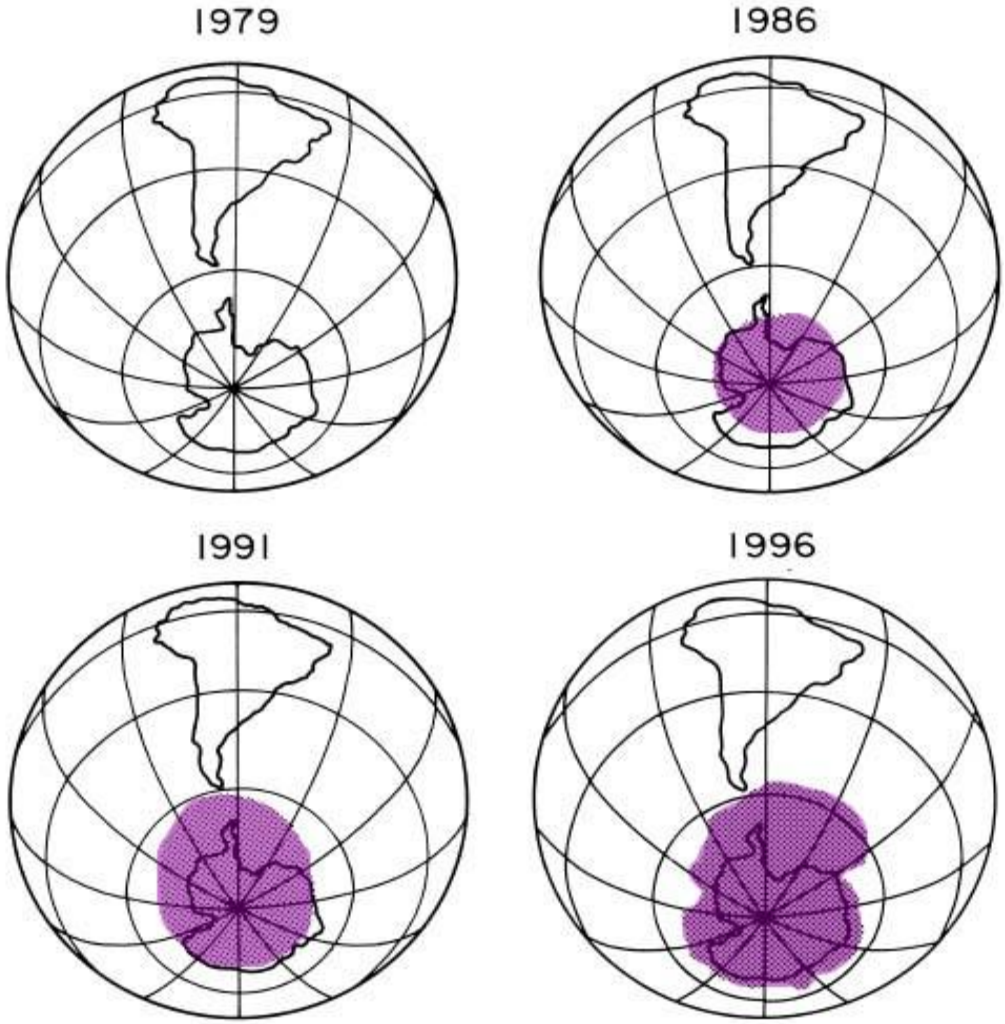


With Some Government Help



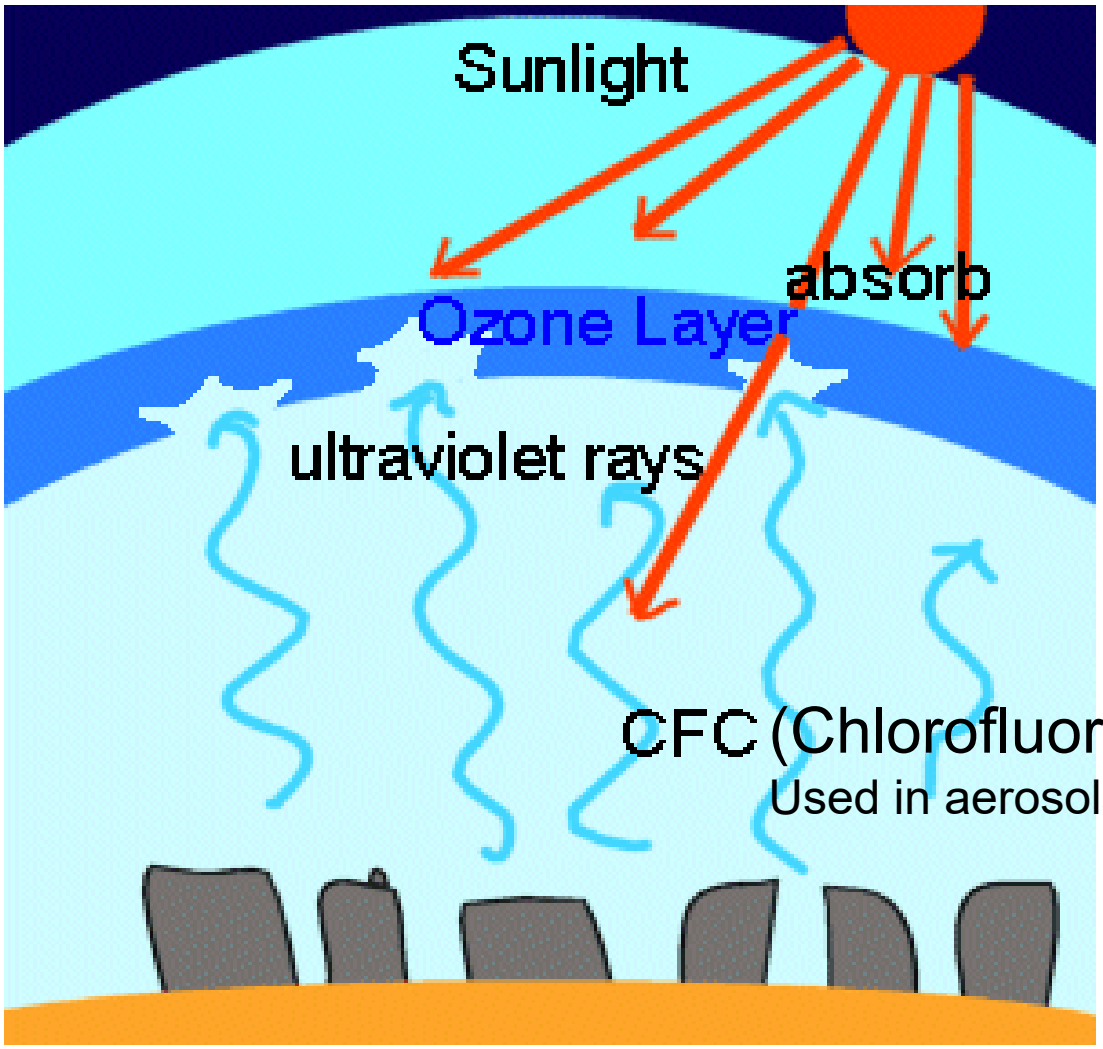
The Biden administration is reversing Trump's actions against California

Case Study 2: The Ozone Layer Hole



http://www.okiu.ac.jp/Language/contest/02/12/ozone.htm

The Cause of the Hole

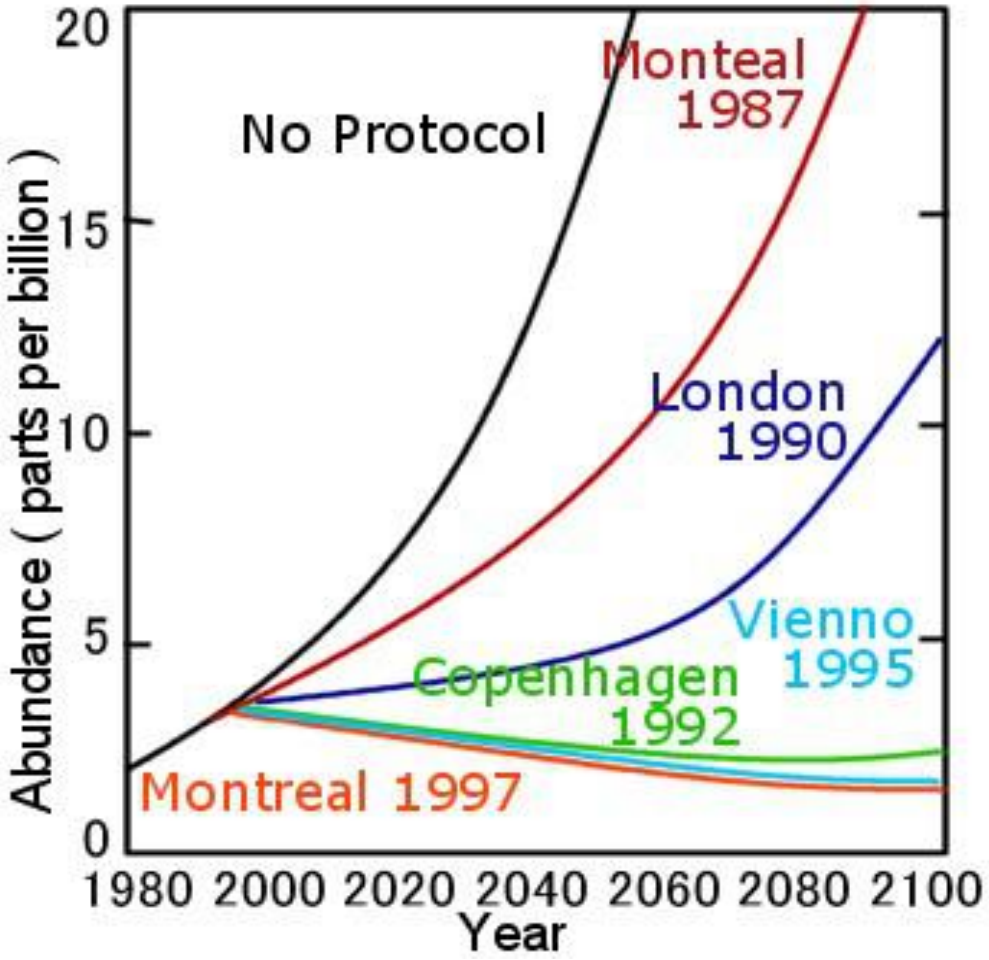


CFC (Chlorofluorocarbons)

Used in aerosols and refrigerants

http://www.okiu.ac.jp/Language/contest/02/12/ozone.htm

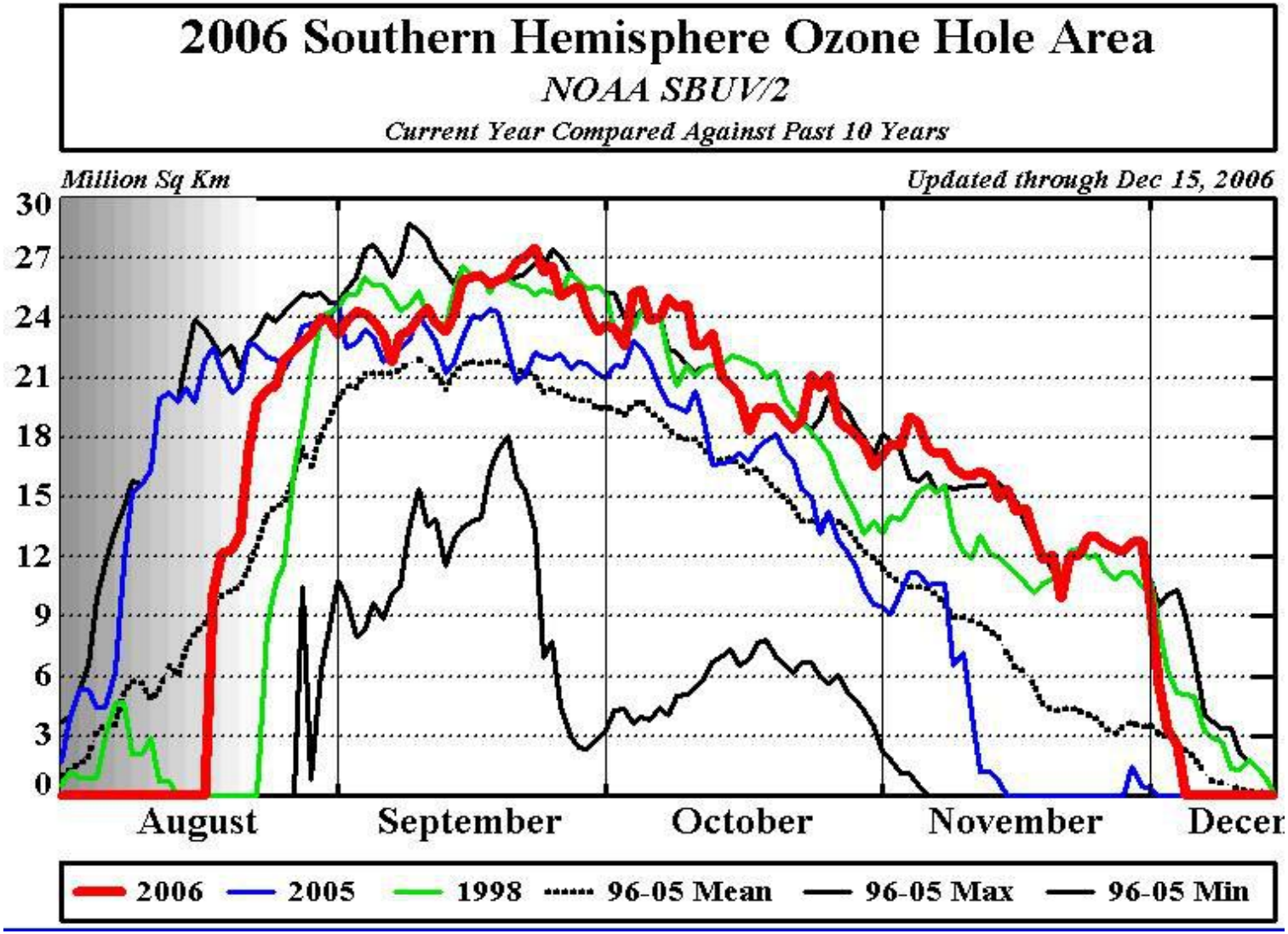
Models of Emission-Limiting Protocols



The protocols called for moving from CFCs to HFCs (hydrofluorocarbons)

http://www.okiu.ac.jp/Language/contest/02/12/ozone.htm

Initial Good Results



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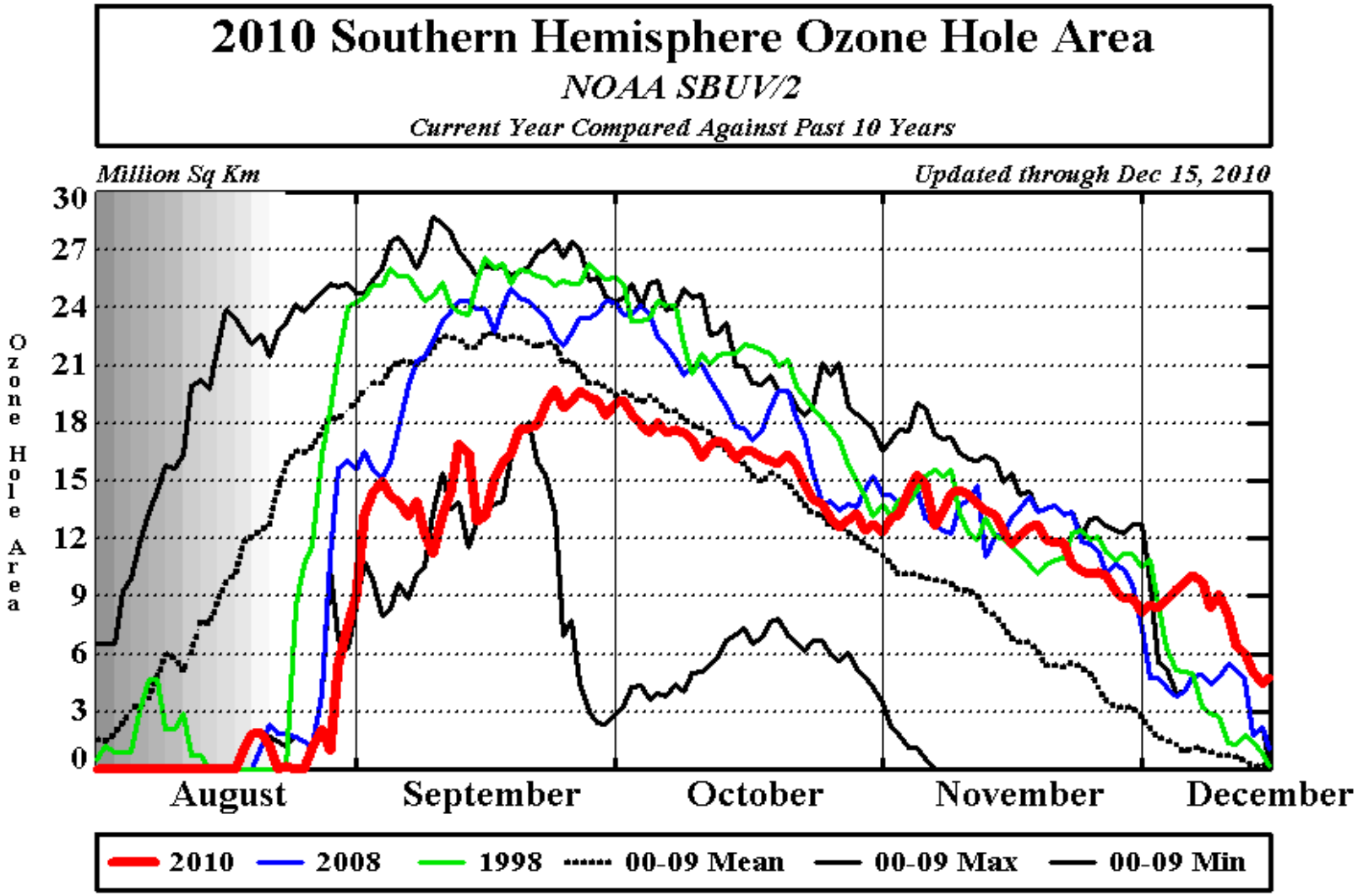
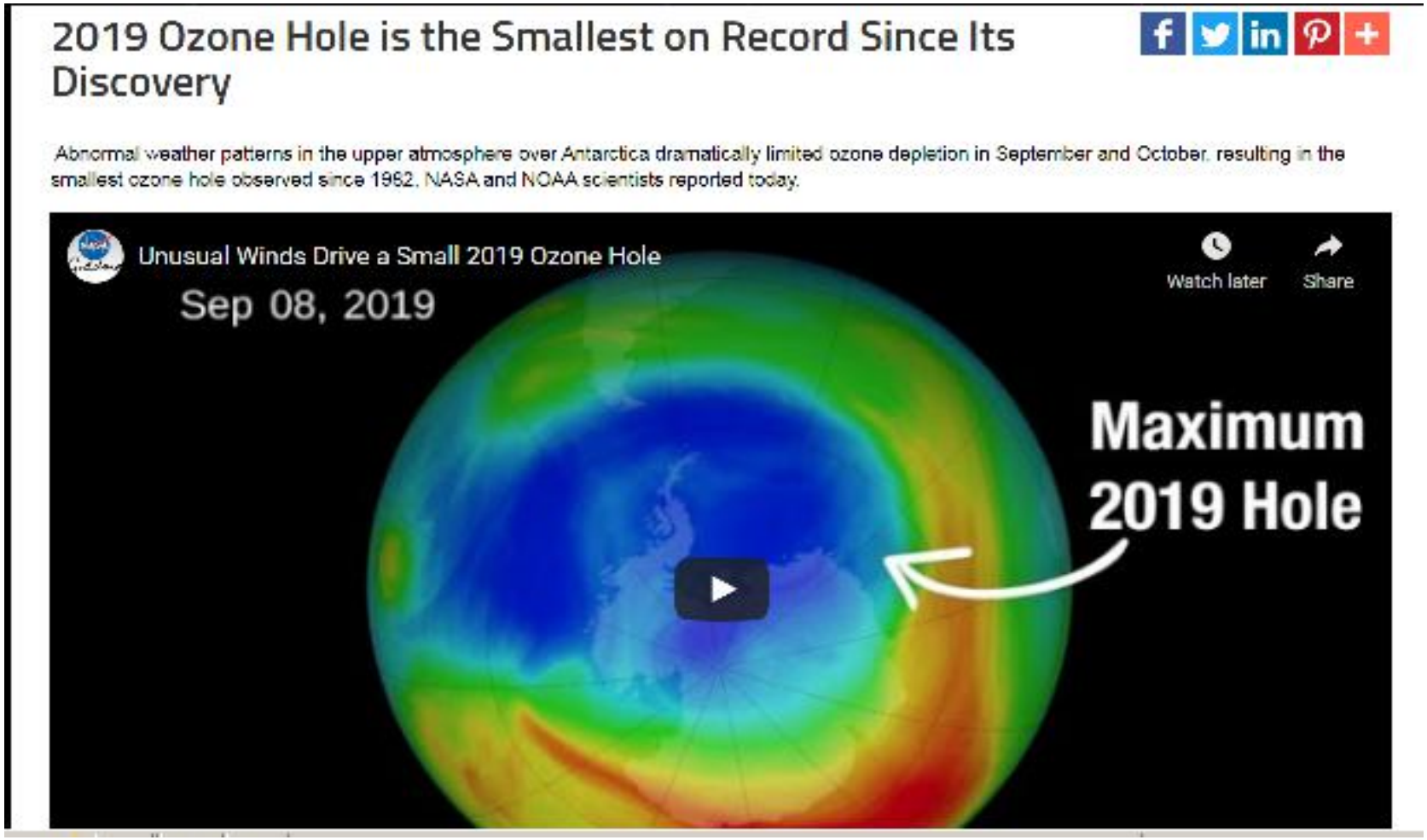
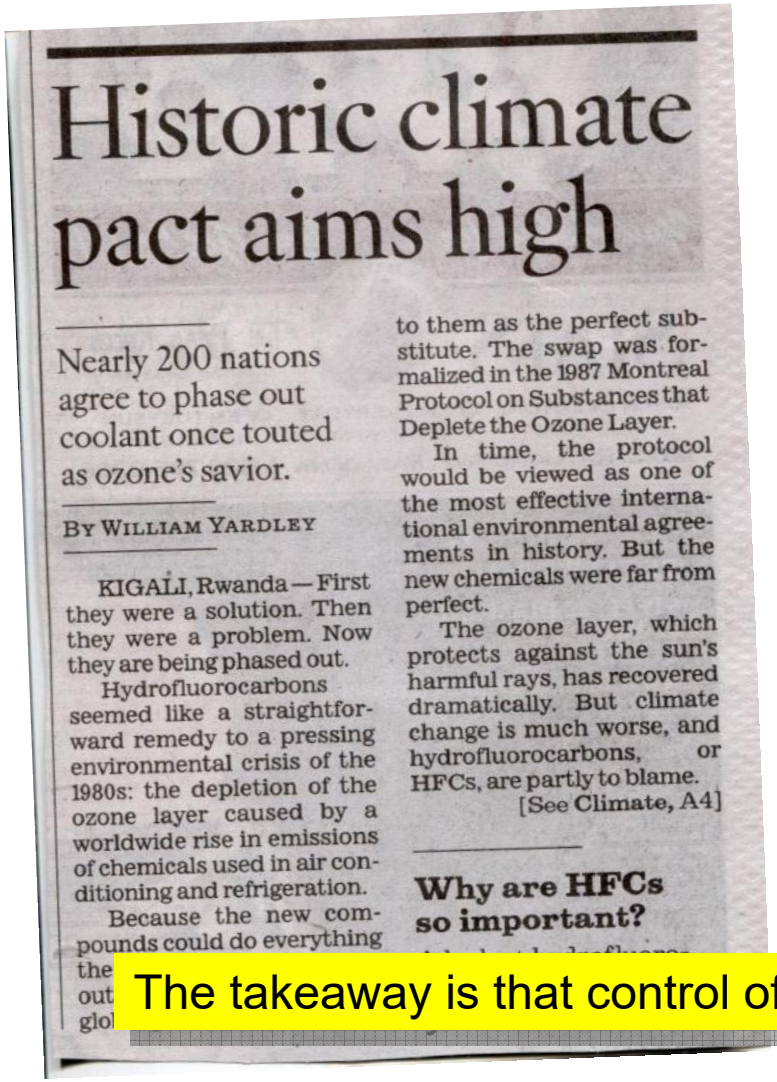


With Continued Optimism



But 1st Solution is 2nd Problem



Historic climate pact aims high

Nearly 200 nations agree to phase out coolant once touted as ozone's savior.

By William Yardley

KIGALI, Rwanda — First they were a solution. Then they were a problem. Now they are being phased out.

Hydrofluorocarbons seemed like a straightforward remedy to a pressing environmental crisis of the 1980s: the depletion of the ozone layer caused by a worldwide rise in emissions of chemicals used in air conditioning and refrigeration.

Because the new compounds could do everything the
out
glo

to them as the perfect substitute. The swap was formalized in the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer.

In time, the protocol would be viewed as one of the most effective international environmental agreements in history. But the new chemicals were far from perfect.

The ozone layer, which protects against the sun's harmful rays, has recovered dramatically. But climate change is much worse, and hydrofluorocarbons, or HFCs, are partly to blame.

[See Climate, A4]

Why are HFCs so important?

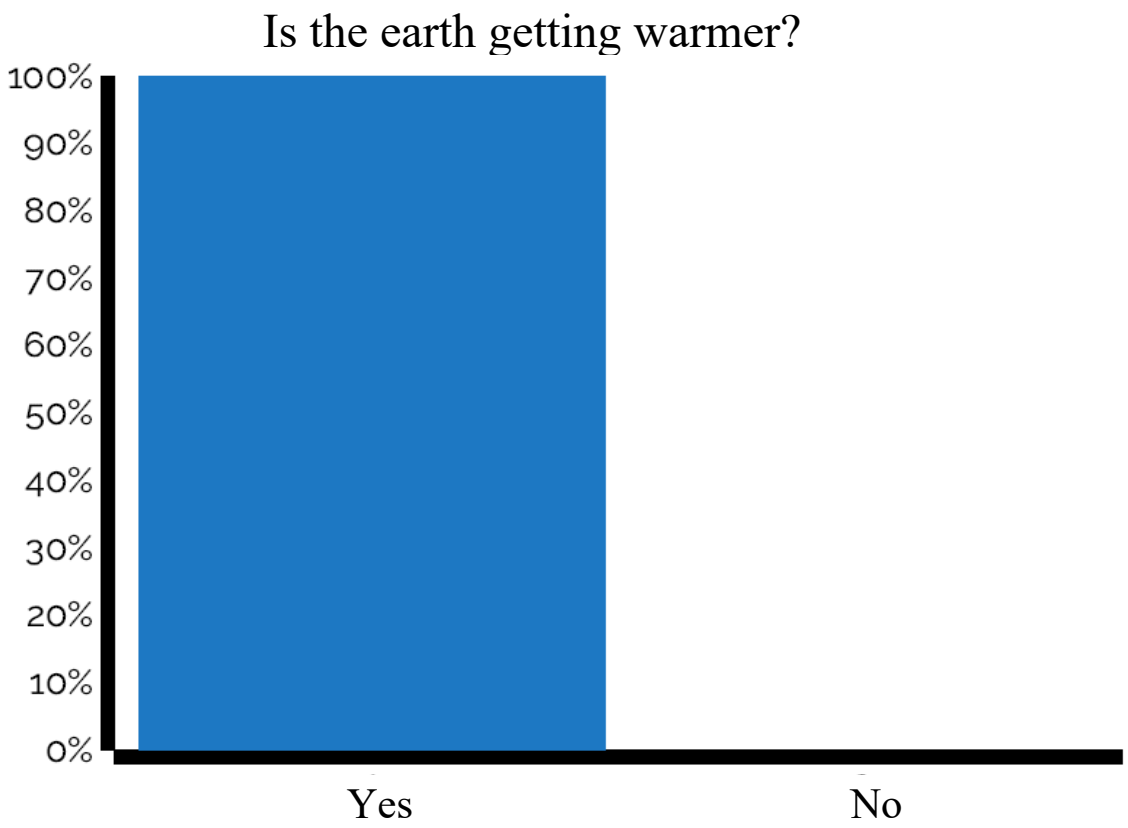
The switch from chlorofluorocarbons to hydrofluorocarbons for aerosols and refrigerants helped the ozone hole problem, but began contributing severely to an even bigger problem – **human-caused climate change**. This is being addressed by a new agreement to move away from HFCs for refrigeration, which is growing rapidly in newly wealthy populations.

The takeaway is that control of environmental problems is never ending.

Case Study 3: Climate Change

- Log on to UCLA_WIFI
- Go to https://onlinepoll.ucla.edu
- Look for Engr 183EW – Environment
- Password: 1234
- Answer the 3 multiple choice questions
- Hit “SUBMIT”
- Finish in 3-5 minutes

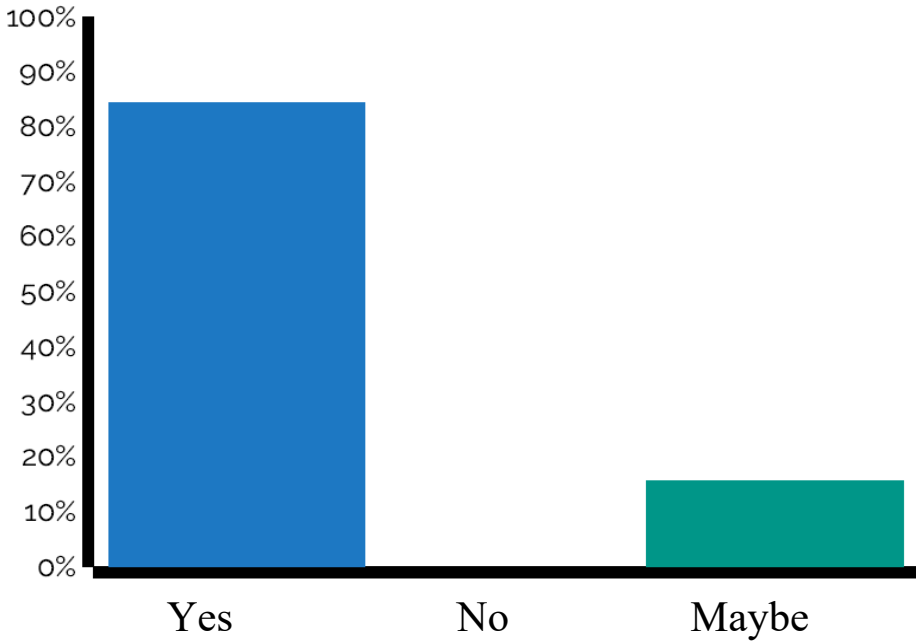
Online Poll Results 1



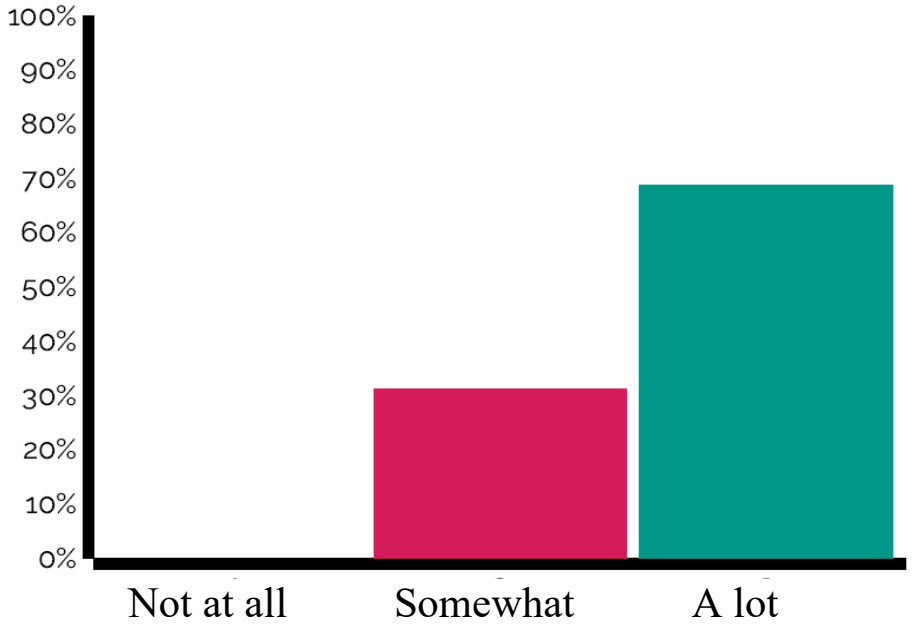
Bravo, 100% of the class believes the earth is warming. We will see that this is consistent with scientific findings.

Online Poll Results 2

Is human activity a contributing factor?



How worried should we be about this?



A full 100% of the class says yes or maybe to human contribution, and 100% is also somewhat or a lot worried – a rational level of knowledge and concern.

The Young Lead

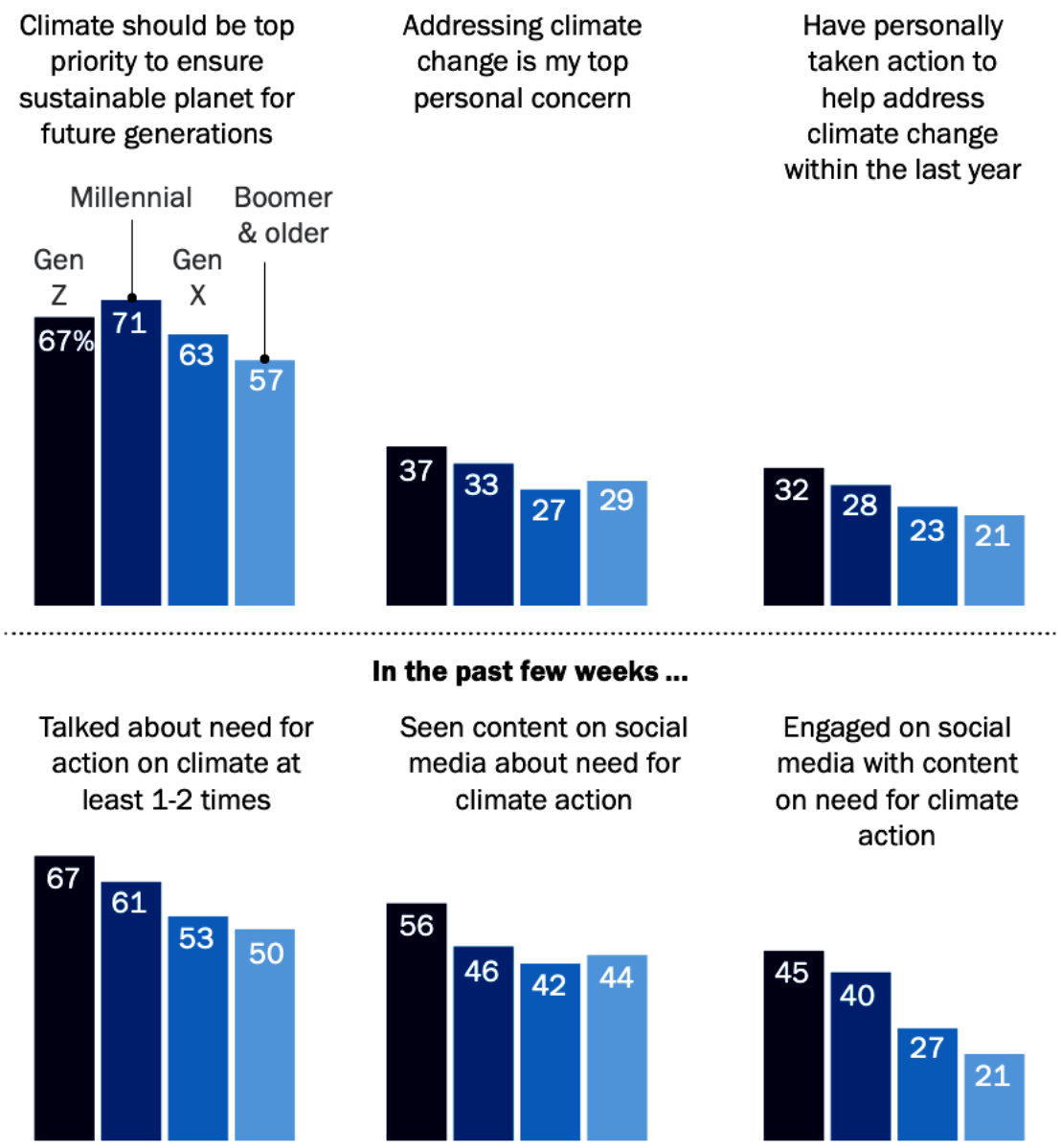
Born

Gen Z: 1997 - 2012

Millen: 1981 - 1986

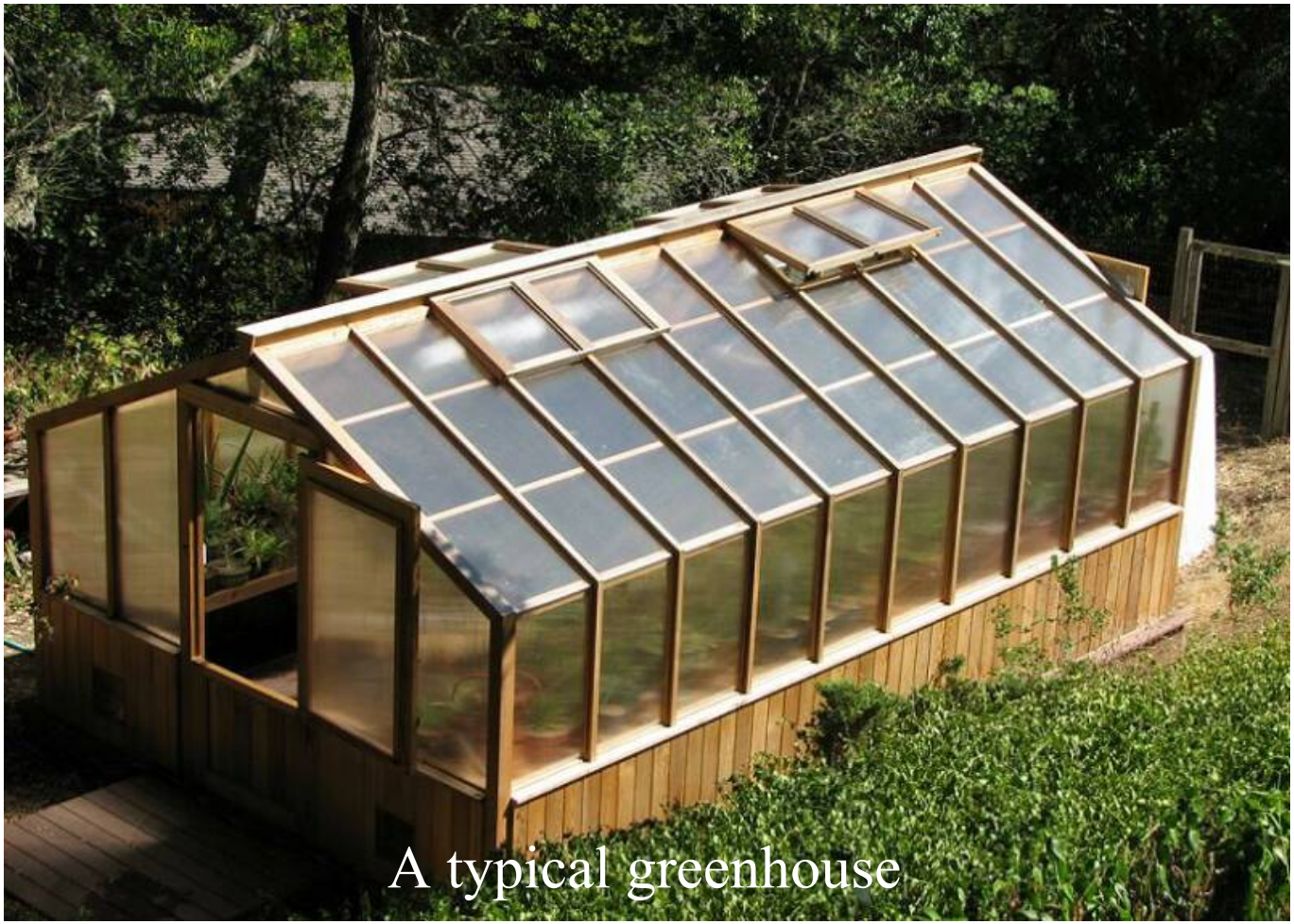
Gen X: 1965 - 1980

Boom: 1945 - 1964



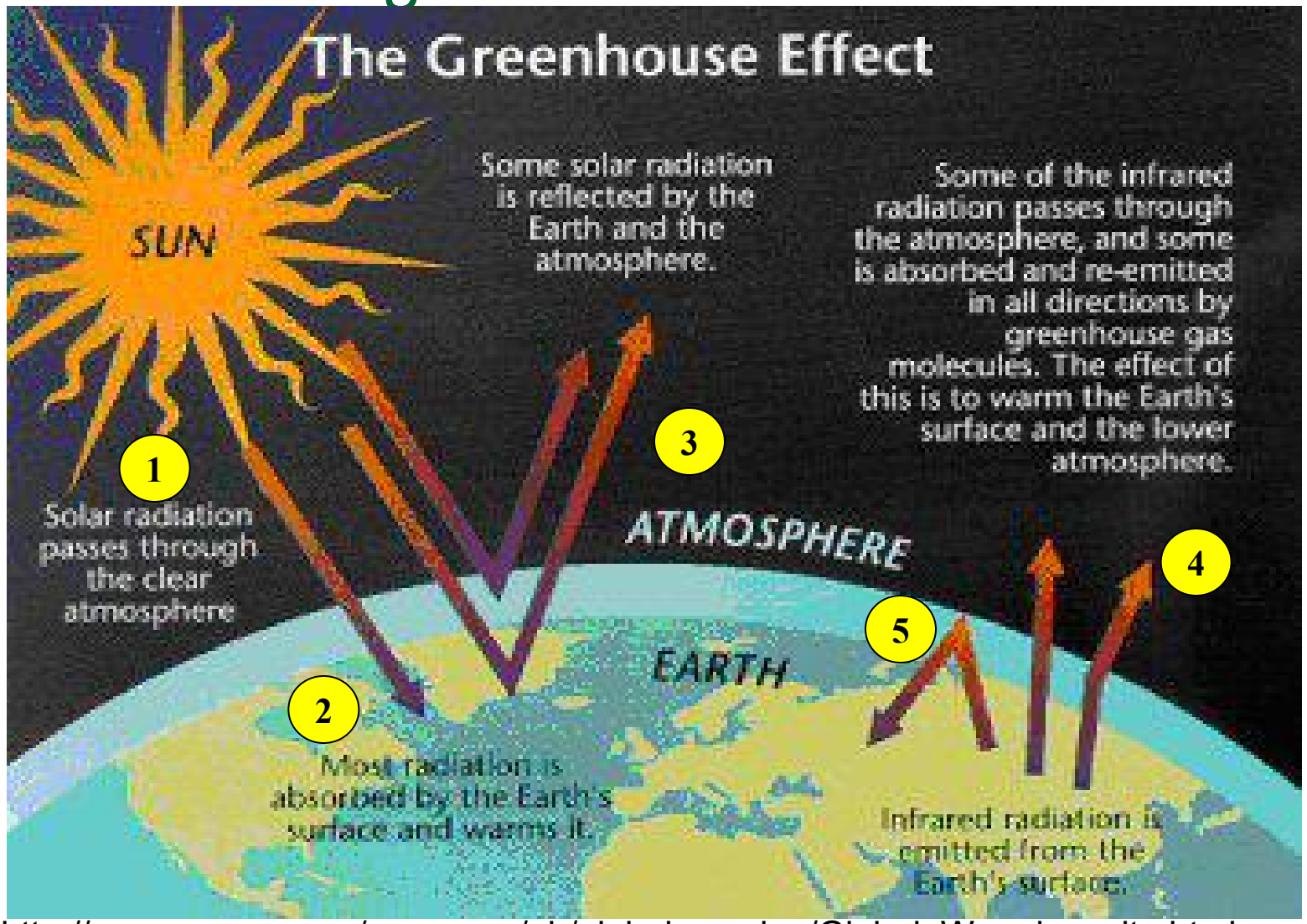
Pew Research Center; May 25, 2021

Global Warming: "*The Greenhouse Effect*"



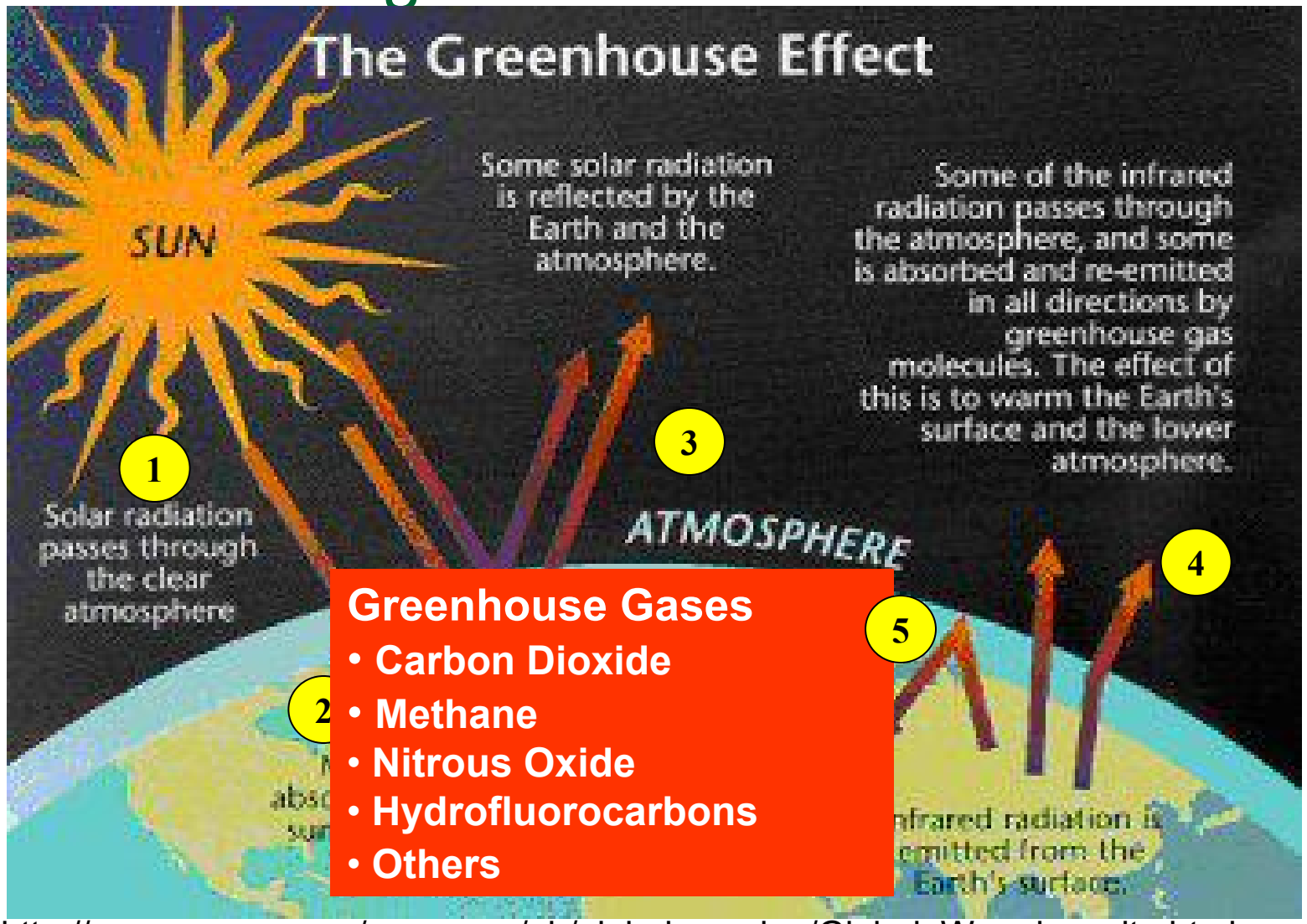
A typical greenhouse

Global Warming: The Greenhouse Effect



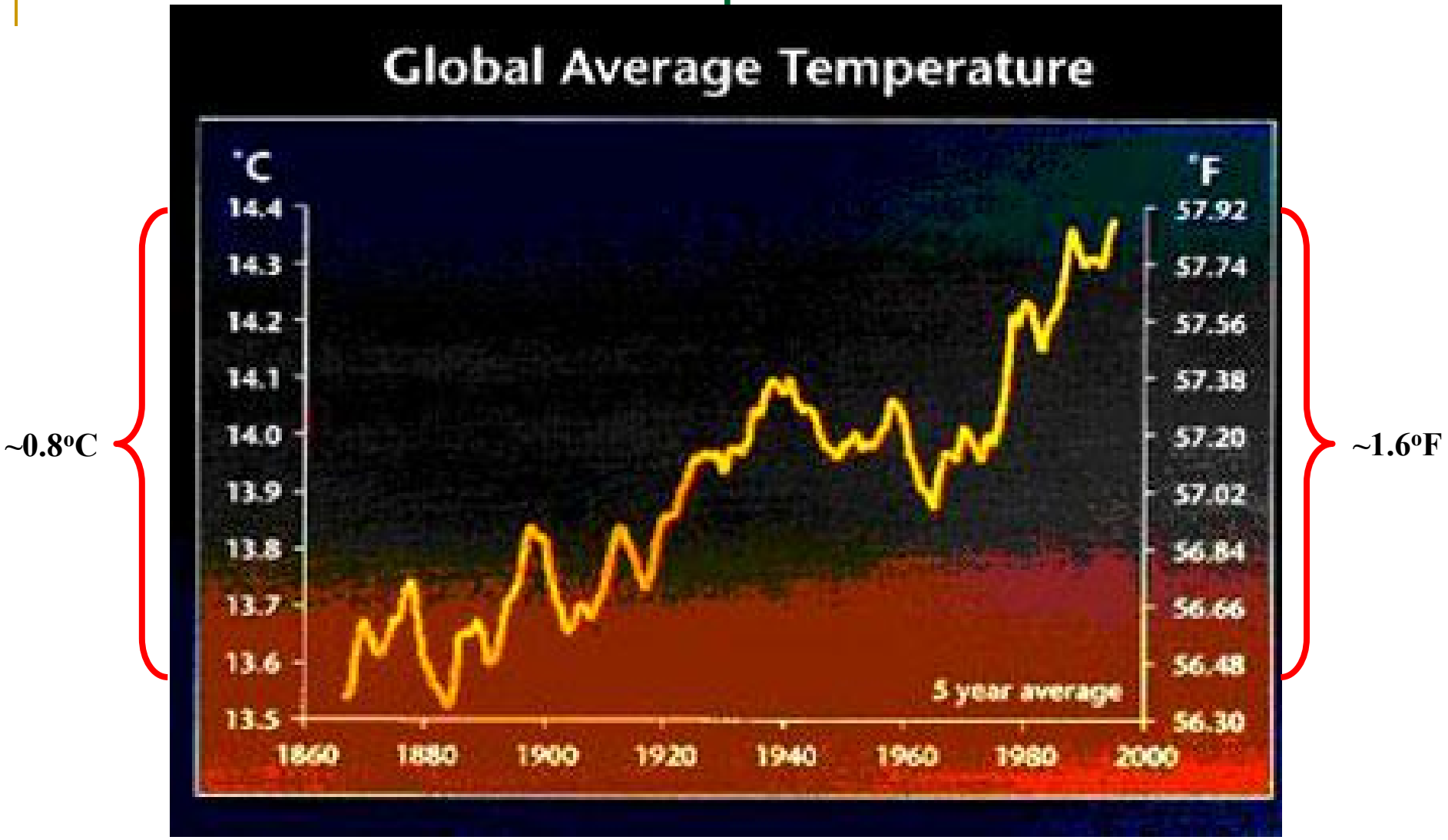
http://www.ecy.wa.gov/programs/air/globalwarming/Global_Warming_site.html

Global Warming: The Greenhouse Effect



http://www.ecy.wa.gov/programs/air/globalwarming/Global_Warming_site.html

Increase in Global Temperature



http://www.ecy.wa.gov/programs/air/globalwarming/Global_Warming_site.html

Increase in Greenhouse Gases

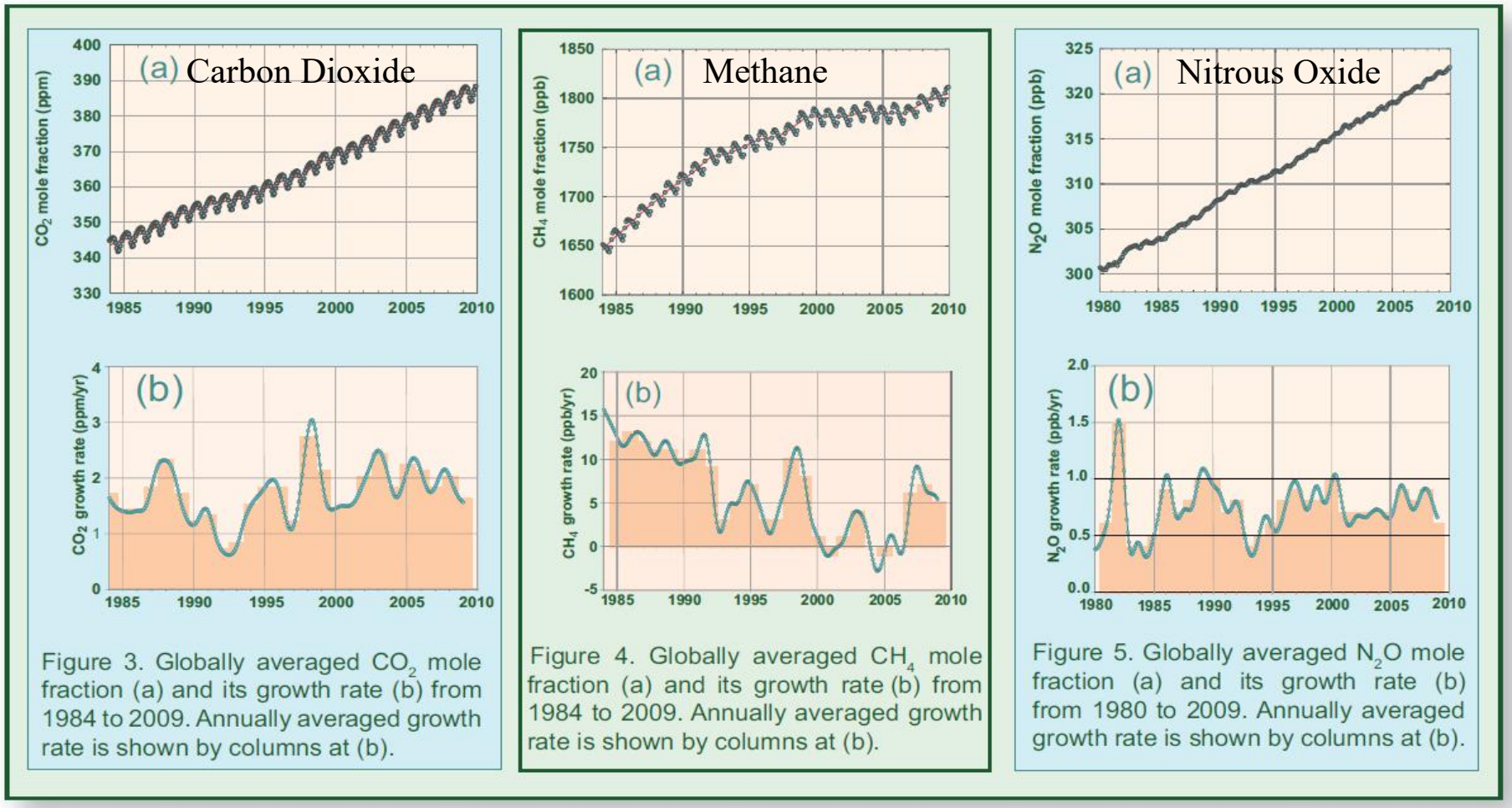


Figure 3. Globally averaged CO_2 mole fraction (a) and its growth rate (b) from 1984 to 2009. Annually averaged growth rate is shown by columns at (b).

Figure 4. Globally averaged CH_4 mole fraction (a) and its growth rate (b) from 1984 to 2009. Annually averaged growth rate is shown by columns at (b).

Figure 5. Globally averaged N_2O mole fraction (a) and its growth rate (b) from 1980 to 2009. Annually averaged growth rate is shown by columns at (b).

World Meteorological Association Bulletin, November 2010

Increase in Greenhouse Gases

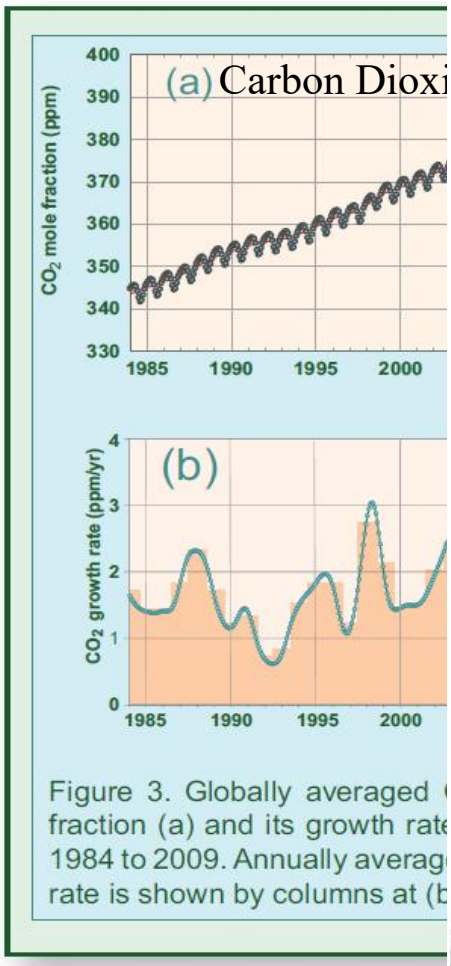


Figure 3. Globally averaged
fraction (a) and its growth rat
1984 to 2009. Annually averag
rate is shown by columns at (b

Greenhouse gas levels reach new record in 2020

U.N. report finds rate of increase surpassed previous averages, even as lockdowns led to a drop in emissions.

ASSOCIATED PRESS

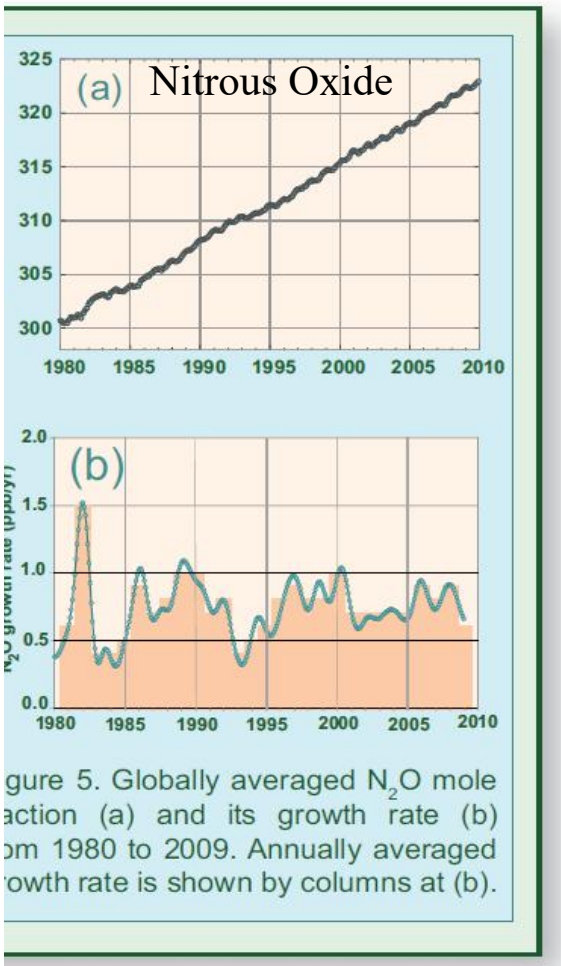
GENEVA — Greenhouse gas concentrations hit a new record high last year and increased at a faster rate than the annual average for the last decade despite a temporary reduction during pandemic-related lockdowns, the World Meteorological Organization reported Monday.

sius [2.7 to 3.6 degrees Fahrenheit] above preindustrial levels.

"We are way off track," he said.

The report draws on information collected by a network that monitors the amount of greenhouse gases that remain in the atmosphere after some quantities are absorbed by oceans and the biosphere.

"One of the striking messages from our report is that the Amazonian region, which used to be a sink of carbon, has become a source of carbon dioxide," Taalas said. "And that's because of deforestation. It's because of changes of the global local climate, especially. We have



gure 5. Globally averaged N_2O mole
action (a) and its growth rate (b)
om 1980 to 2009. Annually averaged
owth rate is shown by columns at (b).

Emitters We've Talked About

Power Plants In Colstrip, Mont. (Associated Press/Billings Gazette, Larry Mayer)

A Crowded Street In The Southern Indian City Of Bangalore. (Credit: Reuters)

The Heating Trend Continues

For U.S., 2017 was a hot and costly year

Weather and climate disasters set the nation back a record $306 billion, NOAA statistics show.

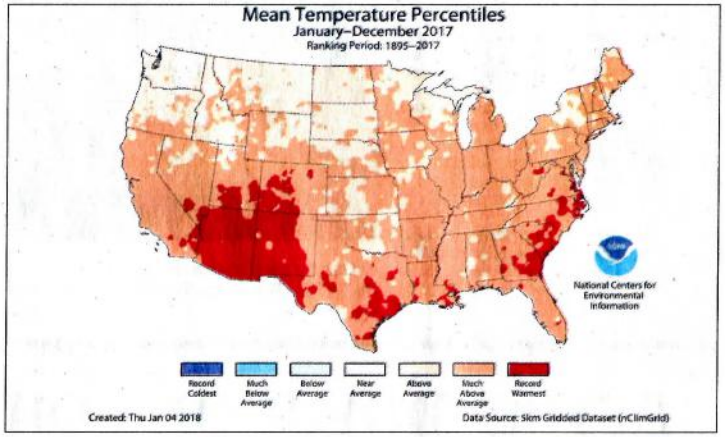
AMINA KHAN

The year 2017 was the third-warmest on record for the United States, and featured a pileup of weather and climate disasters that cost the nation a record $306 billion, according to the National Oceanic and Atmospheric Administration.

The preliminary data released by NOAA's National Centers for Environmental Information serve as another indication that climate change shows little sign of relenting — with troubling implications for the risk of extreme weather and climate events in the future.

"Clearly, 2017 underscores what we've seen in the past with regard to better mitigating our risk and enhanced frequency of weather and climate extremes," Adam Smith, an applied climatologist at NOAA, said at a briefing Monday.

Here are some highlights



National Oceanic and Atmospheric Administration

THIS MAP shows the temperature percentiles for 2017 over the contiguous United States. Several states saw their highest-ever annual temperatures.

— have taken place since 2006.

With heat hitting parts of the Southwest, the southern Plains and the Southeast, several individual states saw their highest-ever annual temperatures: Arizona, New Mexico, Georgia, North Carolina and South Carolina. Thirty-two states, including Alaska, had annual temperatures that ranked in their top-10 warmest. Some areas, such

row.

Last year also marks the 21st year in a row that the average annual temperature has been higher than the 1901-2000 average, Crouch said.

Extremes

The year 2017 also included 16 weather and climate disasters with losses exceeding $1 billion each — two inland floods, one freeze event, eight severe storms,

While those 16 "billion-dollar" events tied 2017 with 2011 for the highest number in a single year, 2017 was by far the most expensive, racking up a total cost of $306.2 billion. That far outpaced the previous record of $214.8 billion in 2005, a year that suffered Hurricanes Rita, Wilma, Dennis and Katrina. In fact, 2017 was a record year for hurricane costs alone — some $265 billion in losses out of the

include the massive Northern California fires last fall as well as the blazes that burned through Southern California in December.

Last year was also the country's 20th-wettest on record, as well as the fifth year in a row that had above-average precipitation. The year started with a very wet winter for the Northwest, but ended with the ninth-driest December on record. This helped lay the deadly groundwork for the fires that scarred California, the scientists pointed out.

"The really wet winter there allowed vegetation to flourish, and then during the typically dry summer and autumn period that vegetation dried out — providing ample fuels for wildfires," Crouch said. "It's been a pretty devastating year out west, in that respect."

What's to blame

The scientists could not say how much of the high costs of this year's major disasters was attributable to risks associated specifically with global warming and climate change, and how much was attributable to the fact that humans tend to live in cities and build vital infrastructure

Lottery results

For Saturday, Jan. 13, 2018

SuperLotto Plus
Mega number is **bold**

3-24-28-33-40—**Mega 27**
Jackpot: $14 million

Winners per category:

	No. of winners	Amount of prize(s)
5 + Mega	0	—
5	2	$18,282
4 + Mega	16	$1,142
4	288	$105
3 + Mega	503	$54
3	12,741	$10
2 + Mega	6,609	$11
1 + Mega	33,045	$2
Mega only	50,407	$1

Powerball
Powerball number is **bold**

14-25-35-58-69—**Powerball 24**
Jackpot: $50 million

California winners per category:

	No. of winners	Amount of prize(s)
5 + P-ball	0	—
5	0	—
4 + P-ball	1	$30,672
4	38	$403
3 + P-ball	75	$212
3	2,240	$8
2 + P-ball	1,760	$9
1 + P-ball	13,990	$5
P-ball only	34,351	$4

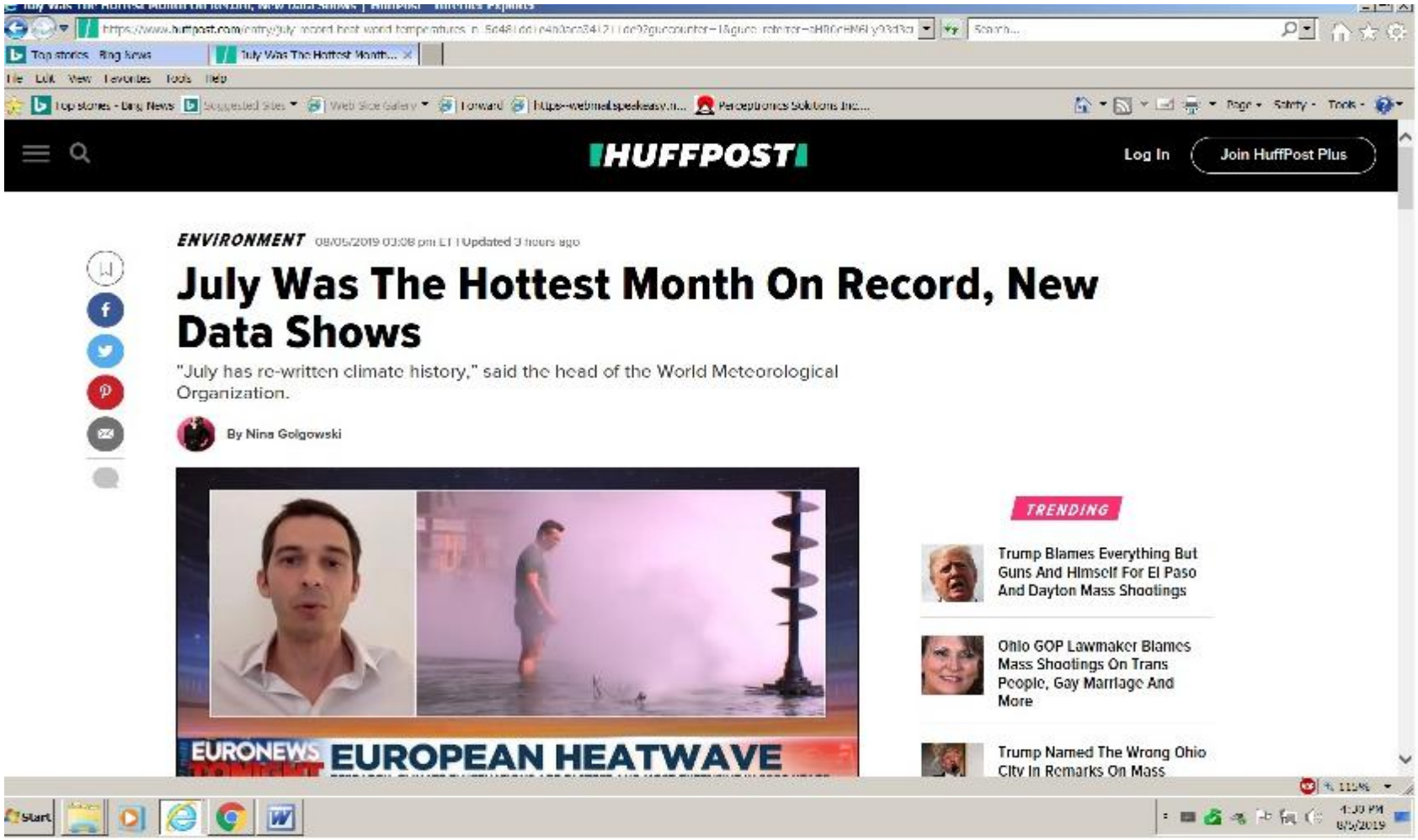
Winning jackpot ticket(s) sold in other states: None

For Sunday, Jan. 14, 2018

Fantasy Five: 13-23-25-31-37

2015 was hotter than 2014, 2016, 2017 was second hottest, 2018 was in the top four.

July 2019 Hottest Ever



July 2021 Even Hotter

People Are Noticing

$2.00 DESIGNATED AREAS HIGHER © 2017 SFVN

WEDNESDAY, JUNE 21, 2017

IRFAN KHAN Los Angeles Times

CHILDREN SPLASH in delight as water pours from the Fountain of Life in Cathedral City. Southern California's heat wave, part of the Four Corners High weather system, was forecast to peak Tuesday.

'It's just too hot'

Gripped by triple-digit heat, the Southland tries to stay cool. Death Valley hits 127.

BY LOUIS SAHAGUN, PALOMA ESQUIVEL, MEG BERNHARD AND LEILA MILLER

In Death Valley, the heat brought even the roadrunners to a stop. They stood arched to the sky with their beaks wide open, as if in a stupor, or indignant at what the sun was up to.

The landscape blurred and undulated. People moved as if they were walking through glue. When a light breeze came in the afternoon, it stung their faces so badly they had to turn away from it. Water mains burst in the baking dirt, while the "cold" tap water came out of faucets the temperature of a Jacuzzi.

Across much of inland California on Tuesday, air-conditioned cars and buildings created sealed microclimates tolerable to humans, as a heat wave centered over the Southwest brought on summer with a vengeance.

Temperatures topped 100 in the valleys and 120 in the low desert. Death Valley hit 127 — seven degrees shy of the hottest day ever recorded on the planet.

Across the region, people found refuge in malls, movie theaters, libraries, cooling centers, pools, buses and the beach.

Others had no such leeway.

Grape pickers in the Coachella Valley started before dawn, but by 9 a.m. the temperature had topped 100 degrees.

[See Heat wave, A9]

MARK BOSTER Los Angeles Times

MOISES LOPEZ takes a break from landscaping a San Gabriel Mission school to hydrate.

Vegas is on a record hot streak

The mercury reaches 117 degrees, and the heat wave hits even harder in Arizona. NATION, A6

Causes, Effects & Solutions

- Causes of Temperature Change
  - Natural Cycle? Something new?
  - Human contribution? Science Implicates us.

In 2010: Most Climate Scientists Agreed

97 out of 100 climate experts think
humans are changing global temperature

Doran et al 2009, Anderegg et al 2010

2012: Science Convinced a Skeptic

The Conversion of a Climate-Change Skeptic

By Richard A. Muller

BERKELEY, Calif.

CALL me a converted skeptic. Three years ago I identified problems in previous climate studies that, in my mind, threw doubt on the very existence of global warming. Last year, following an intensive research effort involving a dozen scientists, I concluded that global warming was real and that the prior estimates of the rate of warming were correct. I'm now going a step further: Humans are almost entirely the cause.

My total turnaround, in such a short time, is the result of careful and objective analysis by the Berkeley Earth Surface Temperature project, which I founded with my daughter Elizabeth. Our results show that the average temperature of the earth's land has risen by two and a half degrees Fahrenheit over the past 250 years, including an increase of one and a half degrees over the most recent 50 years. Moreover, it appears likely that essentially all of this increase results from the human emission of greenhouse gases.

These findings are stronger than those of the Inte

termine earth land temperature much further back in time. We carefully studied issues raised by skeptics: biases from urban heating (we duplicated our results using rural data alone), from data selection (prior groups selected fewer than 20 percent of the available temperature stations; we used virtually 100 percent), from poor station quality (we separately analyzed good stations and poor ones) and from human intervention and data adjustment (our work is completely automated and hands-off). In our papers we demonstrate that none of these potentially troublesome effects unduly biased our conclusions.

The historic temperature pattern we observed has abrupt dips that match the emissions of known explosive volcanic eruptions; the particulates from such events reflect sunlight, make for beautiful sunsets and cool the earth's surface for a few years. There are small, rapid variations attributable to El Niño and other ocean currents such as the Gulf Stream; because of such oscillations, the "flattening" of the recent temperature rise that some people claim is not, in our view, statistically significant. What has caused the gradual but systematic rise of two and a half de

mans? The carbon dioxide curve gives a better match than anything else we've tried. Its magnitude is consistent with the calculated greenhouse effect — extra warming from trapped heat radiation. These facts don't prove causality and they shouldn't end skepticism, but they raise the bar: to be considered seriously, an alternative explanation must match the data at least as well as carbon dioxide does. Adding methane, a second greenhouse gas, to our analysis doesn't change the results. Moreover, our analysis does not depend on large, complex global climate models, the huge computer programs that are notorious for their hidden assumptions and adjustable parameters. Our result is based simply on the close agreement between the sha

As our carbon dioxide emissions rise, so will the temperature.

elsewhere in the world, so its link t "global" warming is weaker than te uous.

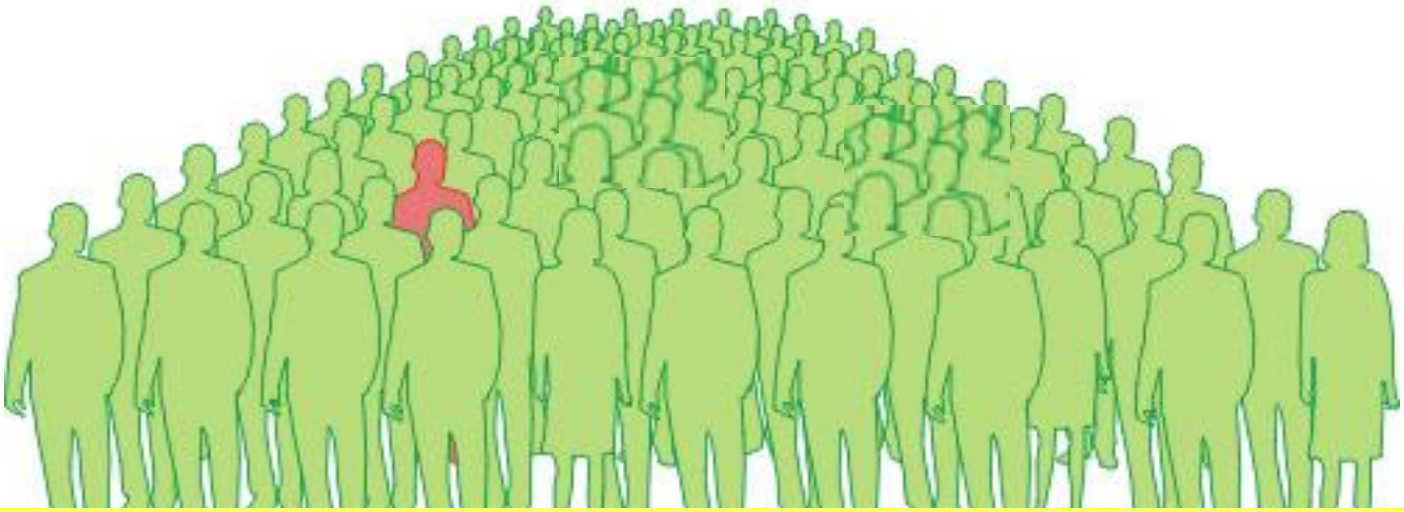
The careful analysis by our team laid out in five scientific papers no online at BerkeleyEarth.org. That si also shows our chart of temperatu from 1753 to the present, with its clea fingerprint of volcanoes and carbon d oxide, but containing no component tha matches solar activity. Four of our pa pers have undergone extensive scrutin by the scientific community, and th newest, a paper with the analysis of th human component, is now posted, alon with the data and computer program used. Such transparency is the heart the scientific method; if you find ou conclusions implausible, tell us of an errors of data or analysis.

What about the future? As carbon d oxide emissions increase, the temper ture should continue to rise. I expect th rate of warming to proceed at a stead pace, about one and a half degrees ove land in the next 50 years, less if th oceans are included. But if China conti ues its rapid economic growth (it

The New York Times, July 30, 2012

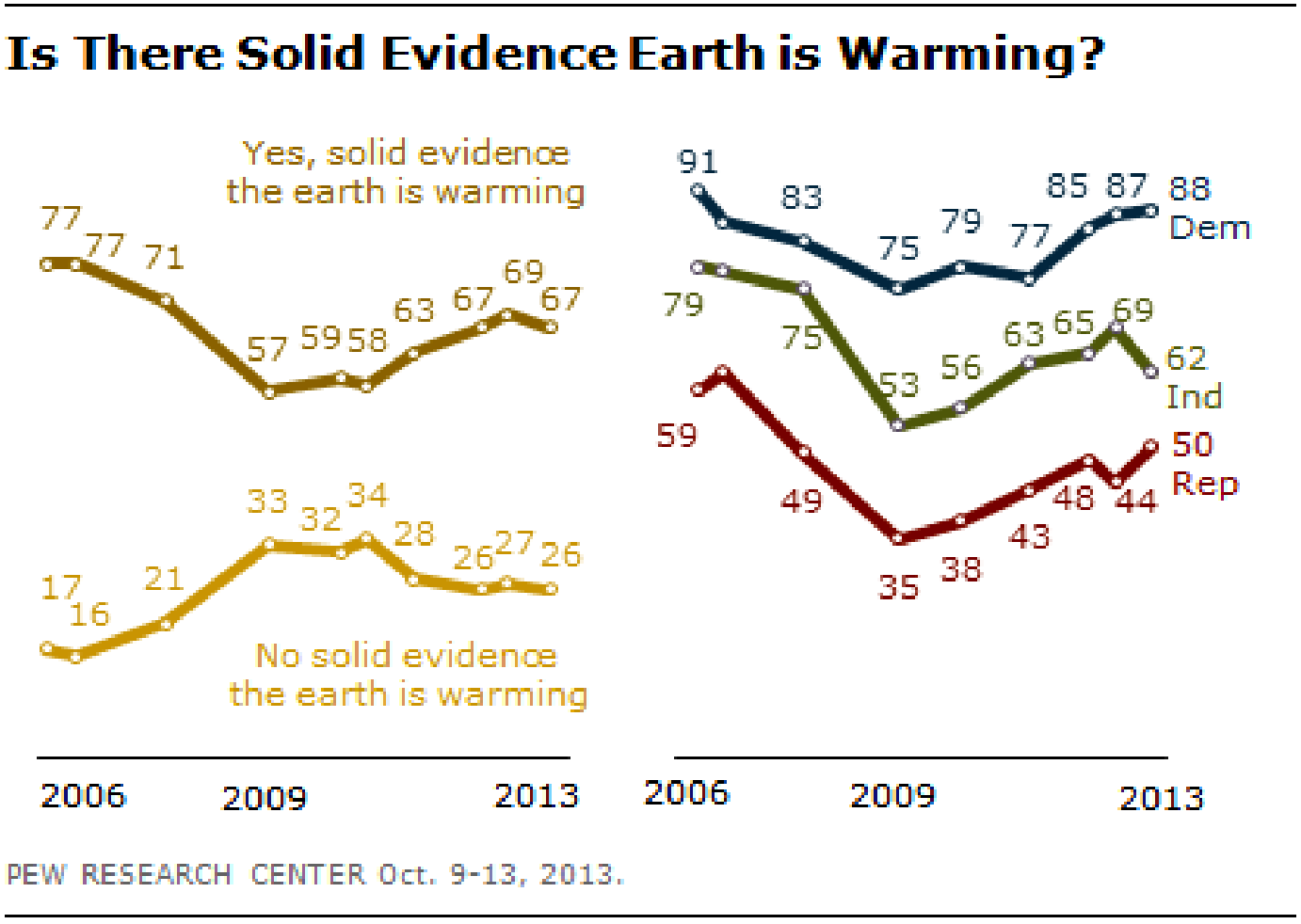
In 2021: Virtually All Climate Scientists Agree

99 out of 100 climate experts think humans are changing global temperature

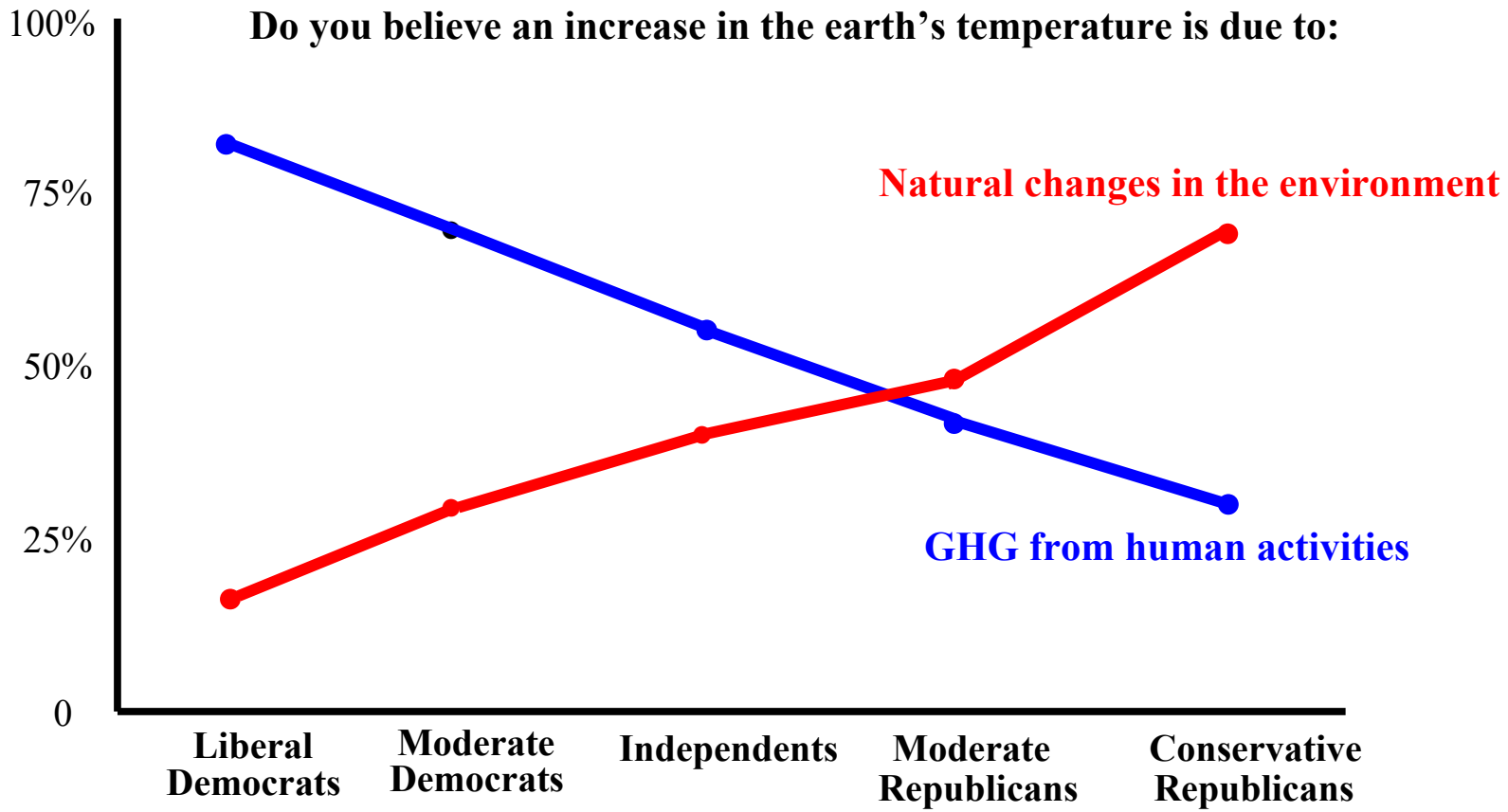


The United Nations' Intergovernmental Panel on Climate Change report issued August 9, 2021 concludes it is "unequivocal" that humans have caused the climate crisis and confirms that "widespread and rapid changes" have already occurred, some of them irreversibly.

Our Problem is Political Divisions on Basics…

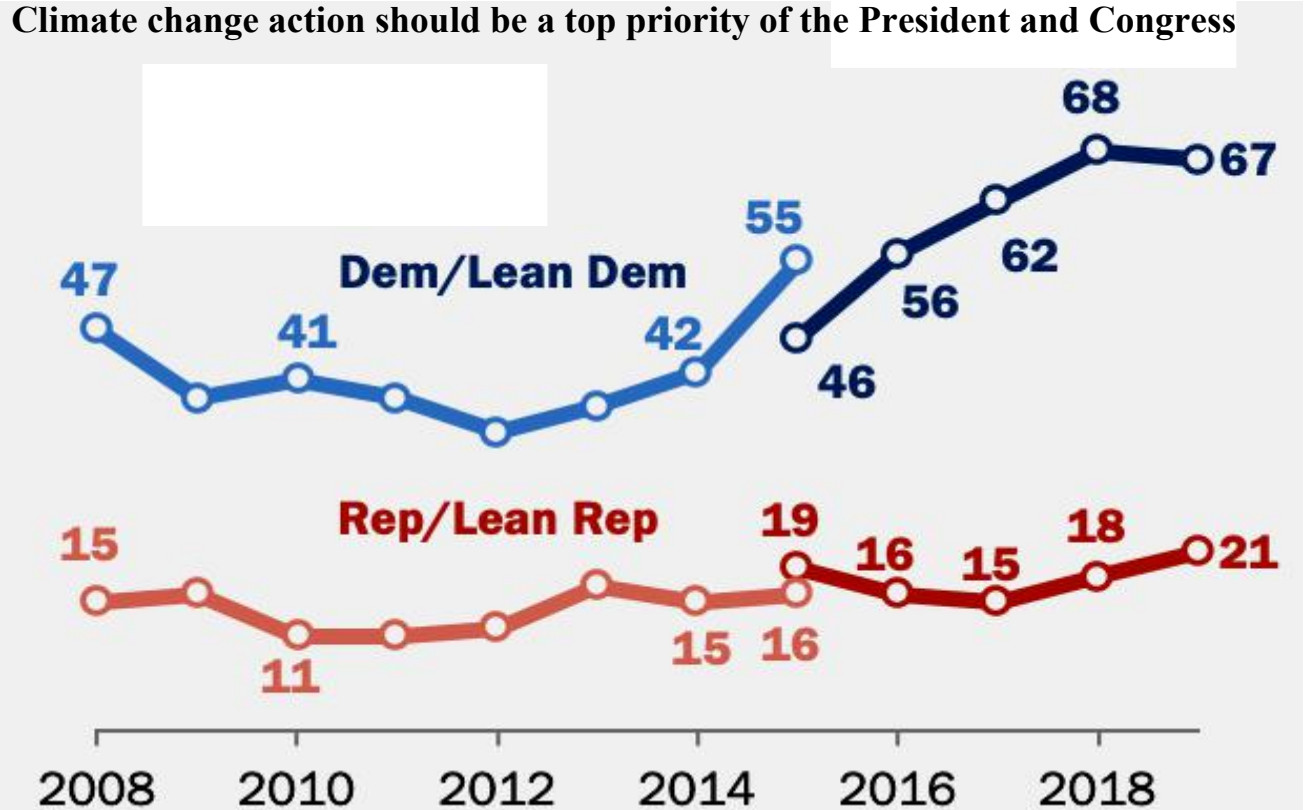


…on the Cause…



http://news.gallup.com/poll/182807/conservative-republicans-alone-global-warming-timing.aspx

…and on How to Prioritize Actions



https://www.pewresearch.org/fact-tank/2019/08/28/u-s-concern-about-climate-change-is-rising-but-mainly-among-democrats/

Causes, Effects & Solutions

- Causes of Temperature Change
  - Natural Cycle or Something New?
  - Human Contribution: What percent?
- Potential Effects & Problems
  - Heating of Oceans + Melting of Polar Ice and Glaciers:
    - Rise in Ocean Levels -- Possibly up to 15 feet
    - Rise in Ground Water Levels – Affecting infrastructure and buildings
    - Loss of Coastal Lands – In US and elsewhere
  - More Severe Weather Events: Floods, Draughts, Storms, Wildfires
  - Significant Societal Changes
    - Quality of Life: Coastal vs. inland, developed vs. undeveloped, rich vs. poor, flooded vs. arid
    - *Social Conflict: Violence and warfare in fighting over land and resources*

Some Effects Are Already Obvious…

The Coast Guard Icebreaker Healy in the Recent Arctic
(Credit: Dave Withrow/United States Coast Guard Via Associated Press)

…Storms…

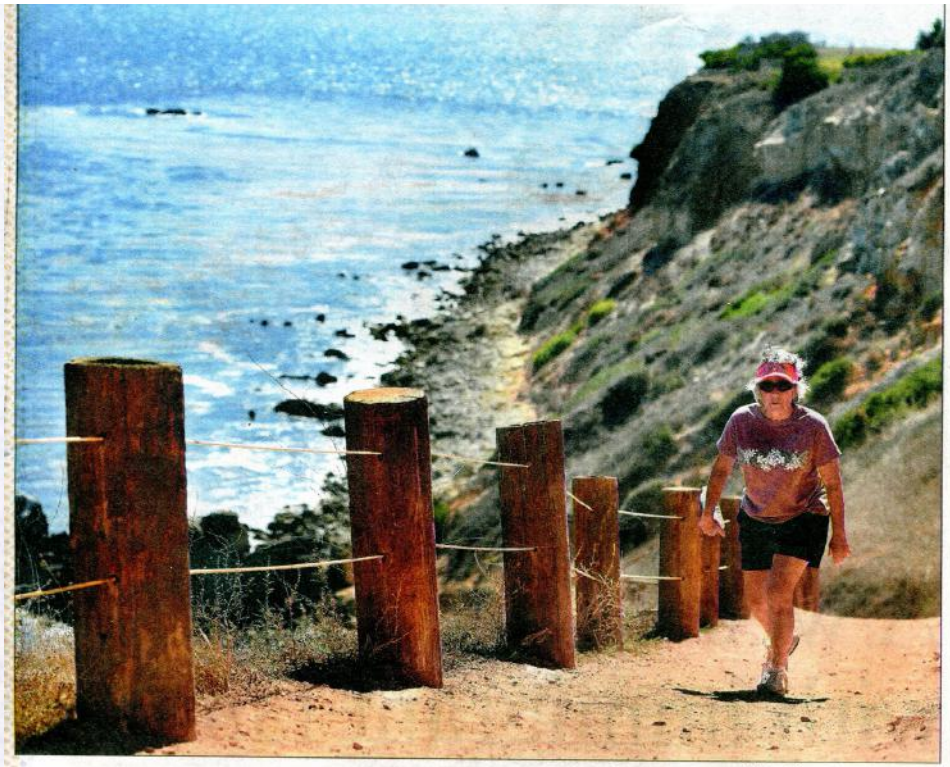
Super storm Sandy inundates the New Jersey seacoast, October 2012
(Credit: HANDOUT/REUTERS)

… Flooding…

…All Over the World…

https://www.cnn.com/2021/07/15/europe/gallery/flooding-western-europe/index.html

…Seaside Erosion…



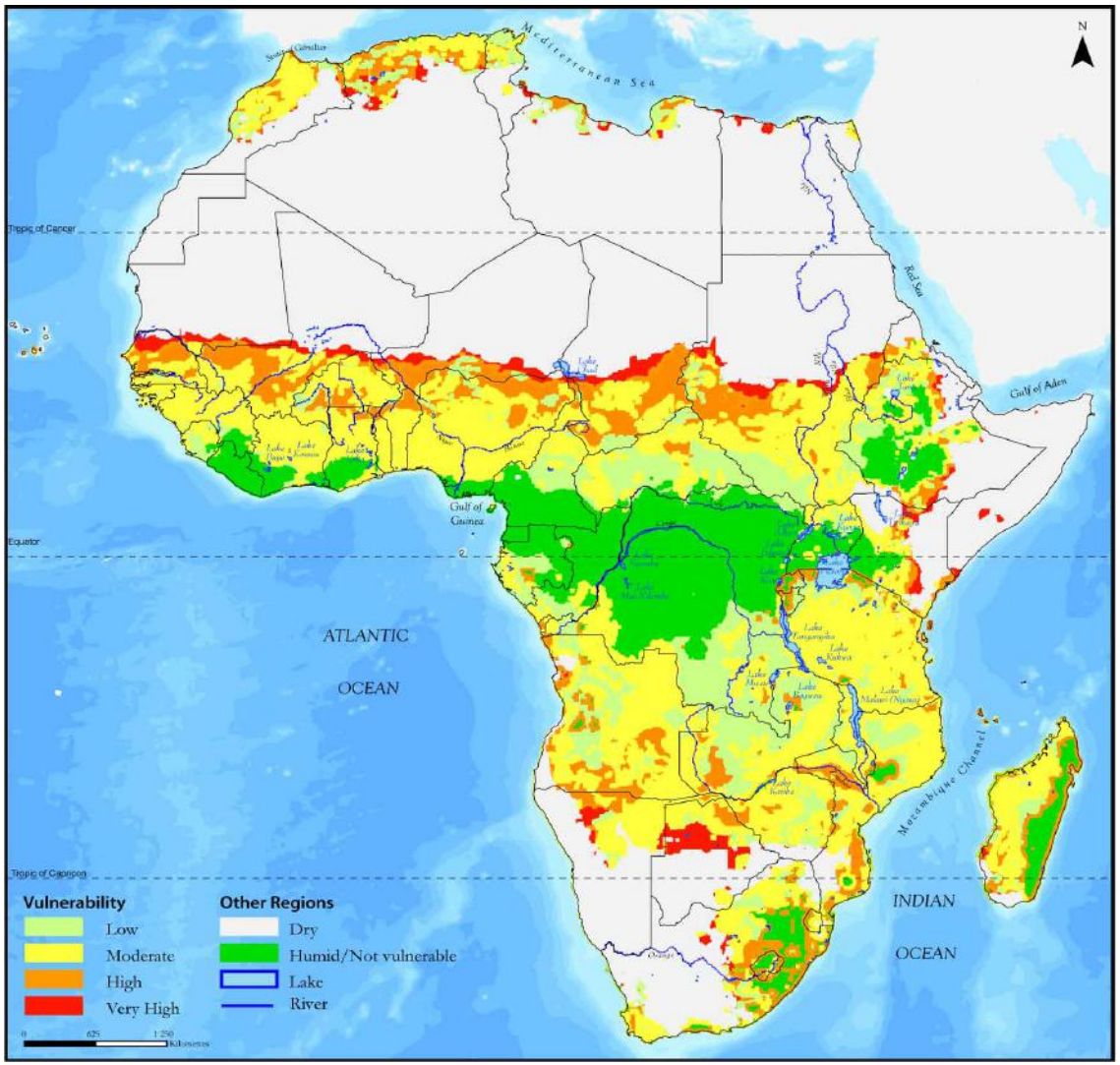
WALLY SKALIJ Los Angeles Times

MAUREEN SASSOON hikes in Rancho Palos Verdes. A study examined cliffs from San Diego to Point Conception to project the rate of bluff erosion by 2100, which could severely affect homes, parks and facilities.

Southland cliffs are on losing end of rising sea

They could recede by more than 130 feet by 2100, study says

…African Desertification...



…African Desertification…

…Warming Oceans…

2018 hottest year on record for oceans

Scientists say heat trapped by increased emissions is warming Earth's waters faster than was recognized.

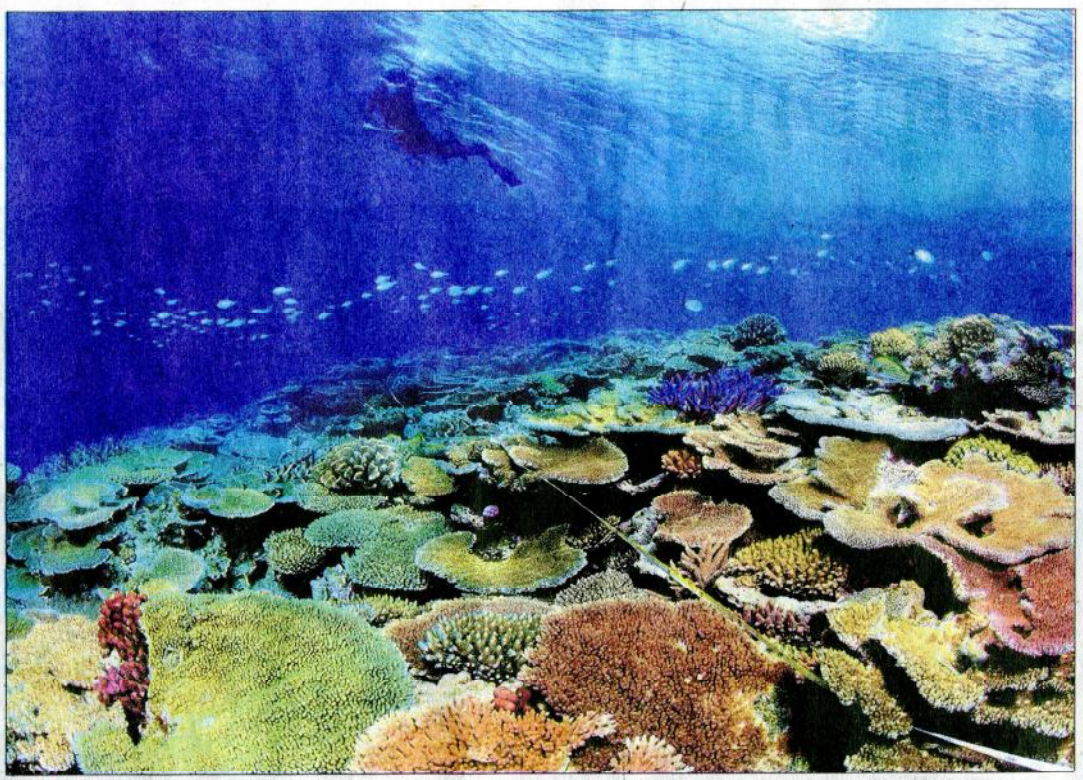
By Tony Barboza

Earth's oceans had their warmest year on record in 2018, a stark indication of the enormous amount of heat being absorbed by the sea as greenhouse gas emissions continue to rise, scientists reported Wednesday.

The analysis by an international team of scientists confirms that the oceans are heating up much faster than previously recognized and that the pace of warming has accelerated sharply since the 1990s.

Rising ocean temperatures are already having profound consequences across the globe, scientists say, contributing to more intense hurricanes, destroying coral reefs and causing sea levels to rise.

The report in the journal Advances in Atmospheric Sciences builds on a study last week that found oceans are warming 40% more, on



Tane Sinclair-Taylor James Cook University

THE LONGER oceans continue to warm, the more devastating the effects, scientists say. Marine ecosystems, including coral reefs already stressed by warming, will be unable to recover from heat waves and bleaching.

mated floats in operation since the mid-2000s that periodically descend into the ocean to measure temperature and salinity, then transmit the readings to satellites.

The new analysis is based on Argo's measurements of the upper 6,500 feet of the ocean combined with earlier readings that go back to the 1950s. Scientists compared four different estimates of ocean warming completed since the United Nations' Intergovernmental Panel on Climate Change report in 2014 and found them converging in agreement: Oceans were warming faster than prior estimates.

The findings of record ocean warming come one day before the National Oceanic and Atmospheric Administration and NASA were scheduled to release data on the average global surface temperature for 2018. The federal agencies are expected to report that 2018 was the fourth-hottest year on record, but their announcements have been delayed indefinitely by the partial government shutdown.

Once full operations are restored, it will take a least three days for scientists to finalize their reports, said Gavin Schmidt, head of the

…Local Fire Danger…

Photographs by MARCUS YAM Los Angeles Times

A HOME in Lakeport, Calif., burns Tuesday. In hot weather, some heat can be carried away by water, as moisture in the soil evaporates. But soil with little moisture, as in a drought, leaves the heat nowhere to go.

A troubling pattern of drought and heat

…Remote Fires…

A fire in Siberia in early June; Yevgeny Sofroneyev/TASS, via Getty Images

… Result in Strong Warnings

THE NEW YORK TIMES **INTERNATIONAL** MONDAY, NOVEMBER 3, 2014

U.N. Panel Issues Its Starkest Warning Yet on Global Warming

By JUSTIN GILL

COPENHAGEN — Th
ing risks of climate char
profound that they coul
even reverse genera
progress against pov
hunger if greenhouse
continue at a runaway
cording to a major ne
Nations report.

Despite growing e
many countries to ta
problem, the global sit
becoming more acute as
ing countries join the
burning huge amounts
fuels, the Intergove
Panel on Climate Cha
here on Sunday.

Failure to reduce e
the group of scientists
experts found, could thr
ciety with food shorta
gee crises, the flooding
cities and entire island
mass extinction of plant
mals, and a climate so d
altered it might become
ous for people to work
outside during the hott
of the year.

"Continued emission
house gases will caus
warming and lo
changes in all compone
climate system, increa
likelihood of severe,
and irreversible impact
ple and ecosystems," t
found.

In the starkest langua
ever used, the expert pa
clear how far society
from having any serious
limit global warming.

Doing so would requi
the vast majority of the world's reserves of fossil fuels in the ground or, alternatively, develop-

Failure to reduce emissions, the group of scientists and other experts found, could threaten society with food shortages, refugee crises, the flooding of major cities and entire island nations, mass extinction of plants and animals, and a climate so drastically altered it might become dangerous for people to work or play outside during the hottest times of the year.

"Continued emission of green-

hecked.
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oses serious risks
progress, in areas
ating poverty. Un-
case scenarios, fac-
food prices and in-
eather disasters
ely leave poor peo-
In fact, the report
already happened

on, the Obama ad-
welcomed the re-
president's science
P. Holdren, calling
r wake-up call to
mmunity that we
her swiftly and ag-
order to stem cli-
nd avoid its worst

stration is pushing
on emissions from
r plants, but faces
in Congress and

penheimer, a cli-
at Princeton Uni-
principal author of
, said that a contin-
olitical paralysis on
ld leave society de-
on luck.
greenhouse gases
ue rising at a rapid
coming decades,
would be avoided
nate turned out to
sitive to those gas-
cientists think like-

n many govern-
nd delay and delay
ng comprehensive
," Dr. Oppenheim-
e need for a lot of

Nations secretary general, Ban Ki-moon, appealed for strong action in Lima.

The group, along with Al Gore, was awarded the Nobel Peace Prize in 2007 for its efforts to call

become a small drag on overall global production, and could become a far larger one if emissions

luck looms larger and larger. Personally, I think it's a slim reed to lean on for the fate of the planet."

A Variety of Solutions

- Causes of Temperature Change
  - Natural Cycle or Something New?
  - Human Contribution: What percent?
- Potential Effects & Problems
  - Melting of Polar Ice and Glaciers Causing:
    - Rise in Ocean Levels
    - Rise in Ground Water Levels
    - Loss of Coastal Lands
  - More severe weather events: Flood, Draughts, Storms
  - Significant Societal Changes
    - Quality of Life: Coast vs. Inland, Developed vs. Undeveloped, Rich vs. Poor
    - *Social Conflict: Violence and Warfare*
- Approaches to Reversing Effects:
  - Agreement on Need
  - Targets for Temperature Control
  - Reduced Greenhouse Gas Emissions
  - Carbon Capture from the Atmosphere
  - Local Cooling and “Geoengineering”

Early Signs of Agreement…

- The U.S. and China account for about 33% of the world's carbon emission
- Their 2014 agreement was a precursor to more effective protocols, like those for smog and chlorofluorocarbons
- A worldwide agreement was the goal of the 2015 United Nations Conference on Climate Change

U.S., China aim high in climate deal

At a news conference in the Chinese capital, President Obama said he had agreed that the U.S. would cut net greenhouse gas emissions at least 26% by 2025, doubling its current pace of carbon reduction. Chinese President Xi Jinping announced a stepped-up time frame for carbon reduction and for increasing China's use of nuclear, wind and solar energy.

Republican critics on Capitol Hill, who have pledged to make it a priority to roll back the president's measures on the environment when they assume the majority in Congress next year. The White House did not immediately say whether Obama will propose legislation or use his executive powers to enact changes without lawmakers, though his environmental team expects a fight on the kinds of regulations necessary to carry out his newly set goals.

"This unrealistic plan,

[See Climate, A4]

ing announced a stepped-up time frame for carbon reduction and for increasing China's use of nuclear, wind and solar energy.

Los Angeles Times, November 12, 2014

…Resulting in Worldwide Pledges…

What Does a Climate Deal Mean for the World?

Christophe Ena/Associated Press

An event at the U.S. pavilion during the Paris climate conference, known as COP21.

A group of 195 nations reached a landmark climate agreement on Saturday. Here is what it means for the planet, business, politics and other areas.

Interactive Graphic:
China's Coastal Cities, Underwater

By DEREK WATKINS

Some cities in China will be dramatically affected by rising seas as the atmosphere warms.

Short Answers to Hard Questions About Climate Change

By JUSTIN GILLIS

The issue can be overwhelming. The science is complicated. We get it. This is your cheat sheet.

The Marshall Islands Are Disappearing

By CORAL DAVENPORT and JOSH HANER

Most of the Marshall Islands rise less than six feet above sea level. For the residents, the destructive

195 (!) United Nations countries pledge to try and reduce their carbon emissions as part of the 2016 Paris Climate Accord.

http://www.nytimes.com/pages/science/earth/index.html

…Followed by an American Retreat…

s Angeles Times

HIGHER © 2017 WST FRIDAY, JUNE 2, 2017 latimes.com

CHIP SOMODEVILLA Getty Images

PRESIDENT TRUMP announces the end of the U.S. commitment to the international climate agreement to reduce carbon emissions.

U.S. exits Paris climate pact

US joins Nicaragua and Syria outside the agreement, with unknown effects.

…Then by an American Return!

NEWS ARTS & LIFE MUSIC SHOWS & PODCASTS SEARCH

Inauguration Day: Live Updates

Biden Moves To Have U.S. Rejoin Climate Accord

January 20, 2021 · 5:42 PM ET

NATHAN ROTT

Updated 5:45pm Eastern Time

In one of his first acts in the Oval Office, President Joe Biden signed an executive order to have the United States rejoin the Paris climate agreement, the largest international effort to curb global warming.

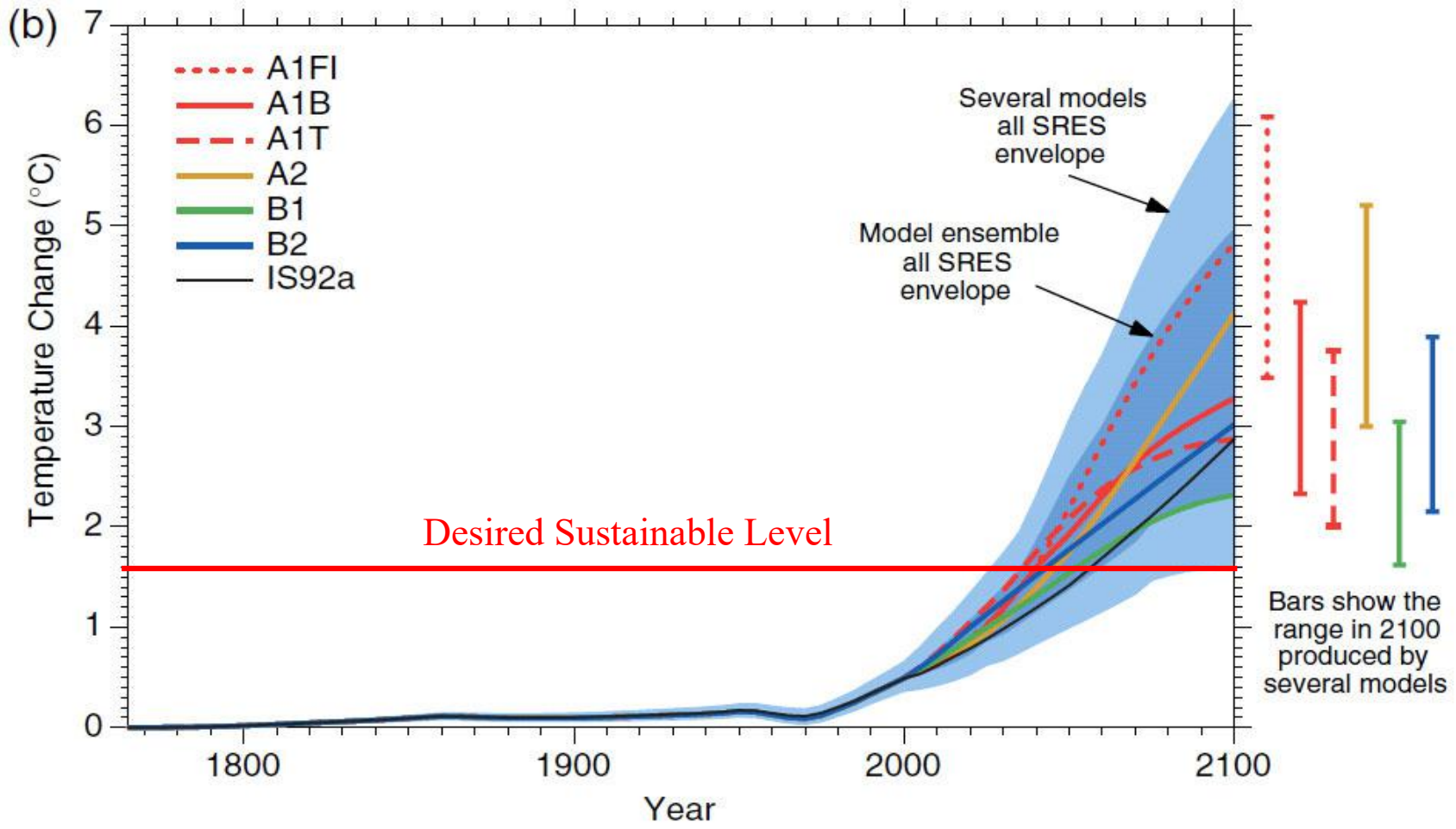
The U.S. officially withdrew from the accord to limit climate-warming greenhouse gas emissions late last year,

President Joe Biden is directing the U.S. to rejoin the

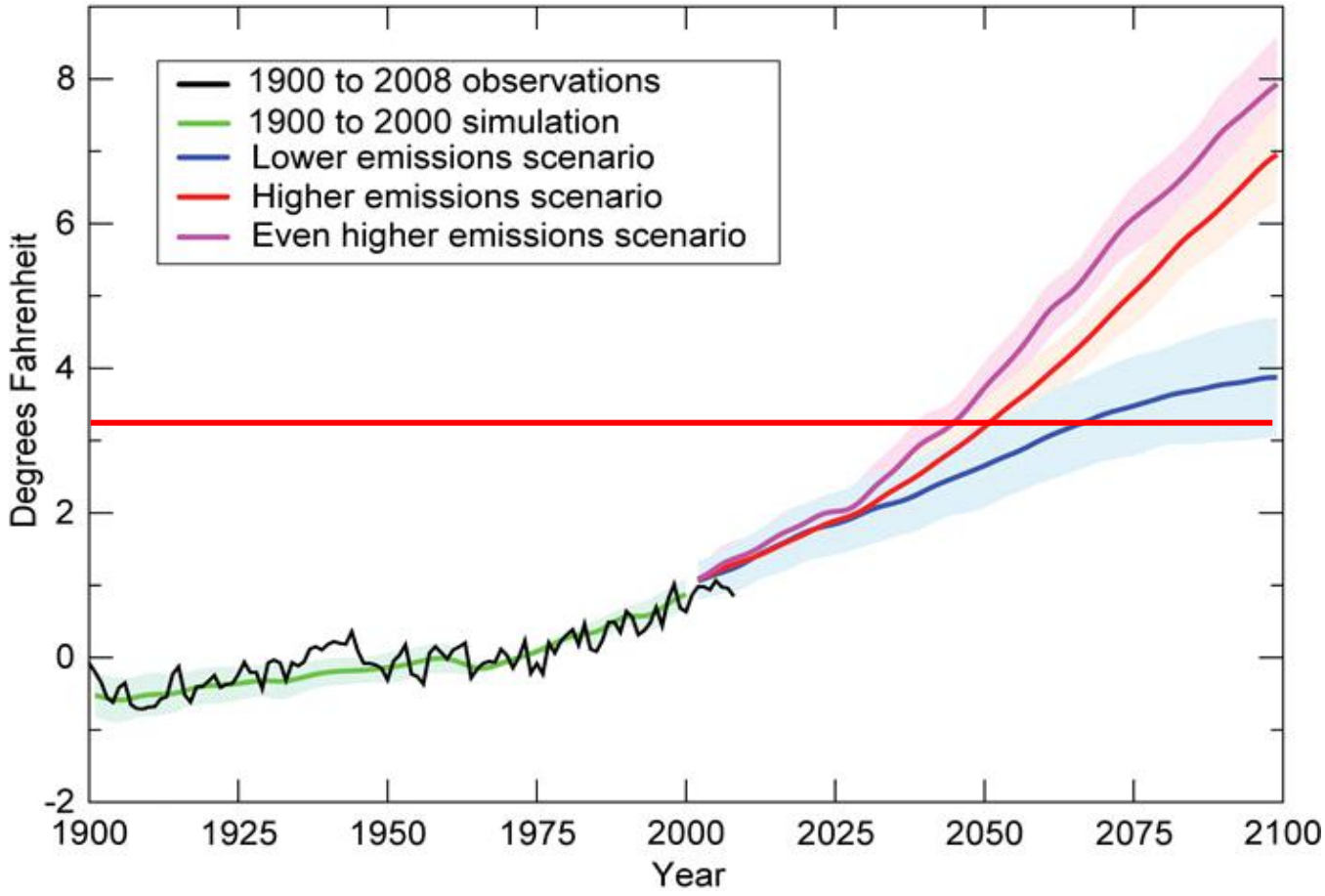
…Then by an American Return!

President Joe Biden has made fighting global warming a major part of his agenda.

Projections Based on Varied Emissions



Projections Based on Reduced Emissions



Carbon Capture: Vacuum the Air

Climeworks carbon vacuum plant, Switzerland

Carbon Capture: Vacuum the Air

State revisits giant carbon vacuums in global-warming war

By Evan Halper

WASHINGTON — Solar panels, wind turbines and electric cars will go far in helping California and the Biden administration meet their aggressive climate goals — but not far enough. As time runs short, scientists and government officials say the moment to break out the giant vacuums has arrived.

The art of industrial-scale carbon removal — sucking emissions from the atmosphere and storing them underground — has long been an afterthought in climate-action circles: too expensive, too controversial, too unproven.

But as the deadline to avert climate catastrophe barrels nearer, the Biden administration is making the technologies prominent in its plans, and California is scrambling to figure out how to put them to use.

It is no small undertaking. Installing sci-fi-type machinery to pull carbon from the air — or divert it from refineries, power plants and industrial operations — and bottle it up deep underground is a monumentally expensive and logistically daunting challenge. It is one climate leaders now have no choice but to try to meet as they race to keep global temperatures from rising more

[See Vacuums, A7]

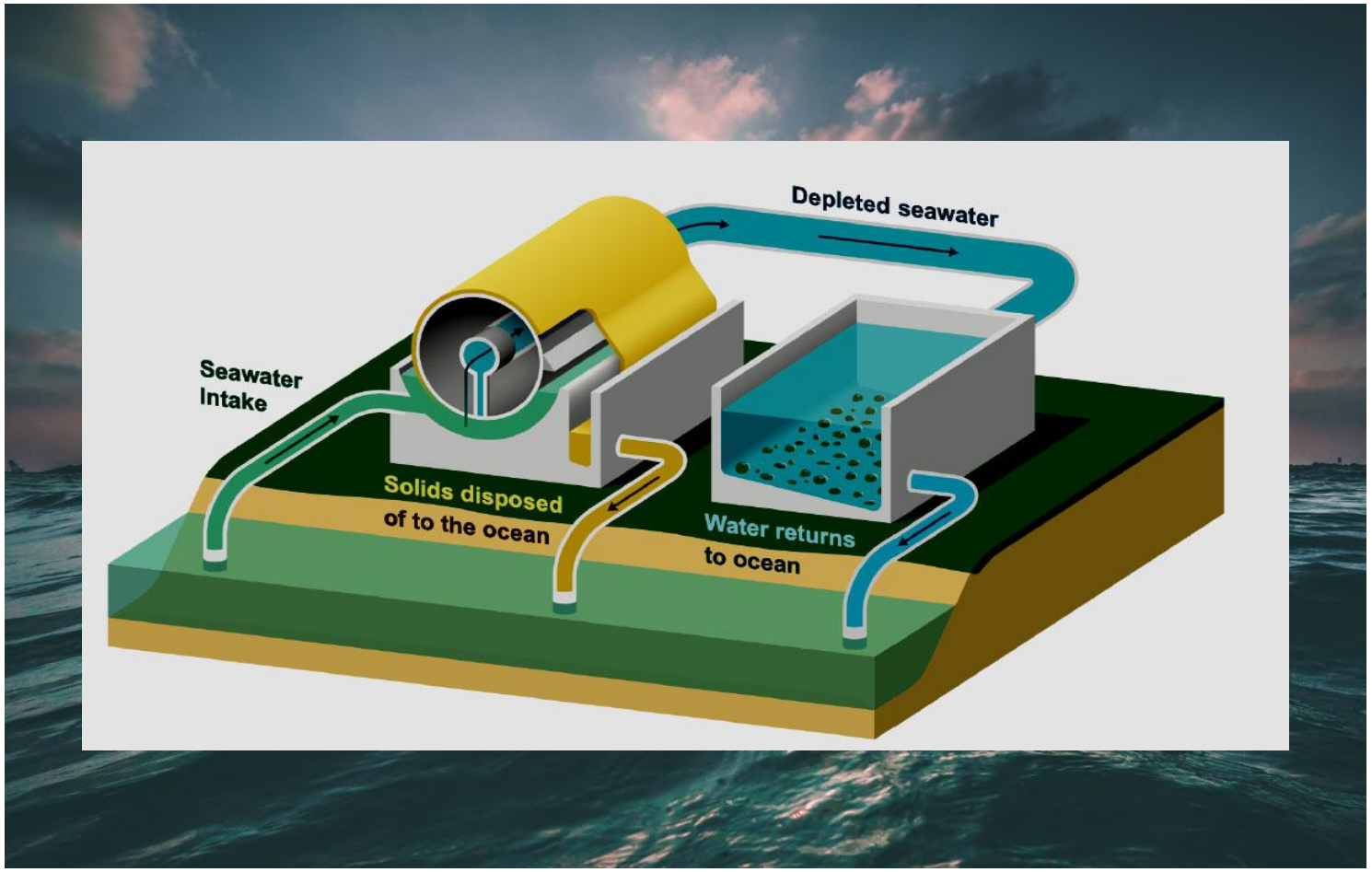
Biden raises bar in climate fight

As host, president kicks off a global summit by doubling U.S. emissions reduction goal. WORLD, A3

Carbon Engineering

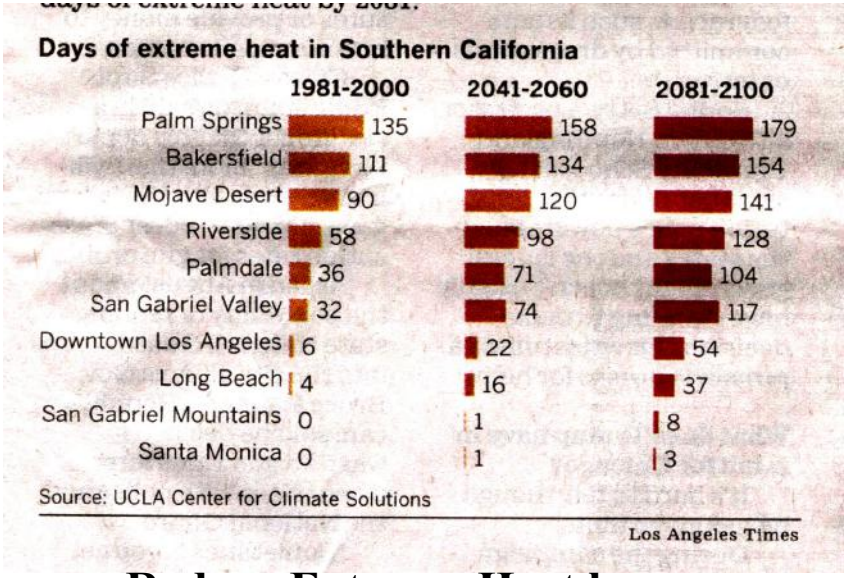
CARBON removal on an industrial scale is a costly, daunting challenge. Above, a pilot plant in Canada.

Carbon Capture: Scrub the Oceans



UCLA Institute for Carbon Management will remove CO_2 from the ocean and solidify the carbon, thus creating a natural sink for atmospheric CO_2.

Local Cooling



Reduce Extreme Heat by:

- Reflective streets
- Reflective roofs
- More trees
- Other approaches

Start with System Analysis

GENARO MOLINA Los Angeles Times

BIG CITIES such as Los Angeles, with their asphalt streets, dark roofs, sparse vegetation and car-clogged roads, are a few degrees warmer than surrounding areas, in what's known as the urban heat island effect.

L.A. seeks cool ways to stave off a sizzling future

Scientists study how to cut the city's temperature 3 degrees

Hotter days ahead

A study done by scientists at UCLA predicts that downtown Los Angeles could see nearly 10 times as many days of extreme heat by 2081.

Days of extreme heat in Southern California

	1981-2000	2041-2060	2081-2100
Palm Springs	135	158	179
Bakersfield	111	134	154
Mojave Desert	90	120	141
Riverside	58	98	128
Palmdale	36	71	104
San Gabriel Valley	32	74	117
Downtown Los Angeles	6	22	54
Long Beach	4	16	37
San Gabriel Mountains	0	1	8
Santa Monica	0	1	3

Source: UCLA Center for Climate Solutions

Los Angeles Times

BY DEBORAH NETBURN

Soak up these rainy days, Southern California. They are not going to last forever.

Summer will be here before you know it, and if recent trends continue, it will probably be a hot one.

Globally, 2016 was the warmest year on record. Here in Los Angeles, temperature records were shattered last summer during scorching heat waves that saw highs of 100 degrees for five days straight.

If you think the city is too hot, you've got company at City Hall. Los Angeles Mayor Eric Garcetti agrees, and he wants to do something about it.

As part of a sweeping plan to help L.A. live within its environmental means, Garcetti has pledged to reduce the average temperature in the metropolis by 3 degrees over the next 20 years.

It's a noble goal. Not only would it make you more comfortable, it would reduce energy consumption and improve air quality. It may even save lives — extreme heat kills more people nationwide each year than hurricanes, floods or tornadoes.

But how do you turn down [See Cooling, A12]

Los Angeles Times, February 12, 2017

Geoengineering: A Different Approach

Major volcanic eruptions cool the earth due to particles in the atmosphere

Image University Corporation for Atmospheric Research; photo by Caspar Ammann

Geoengineering: A Different Approach

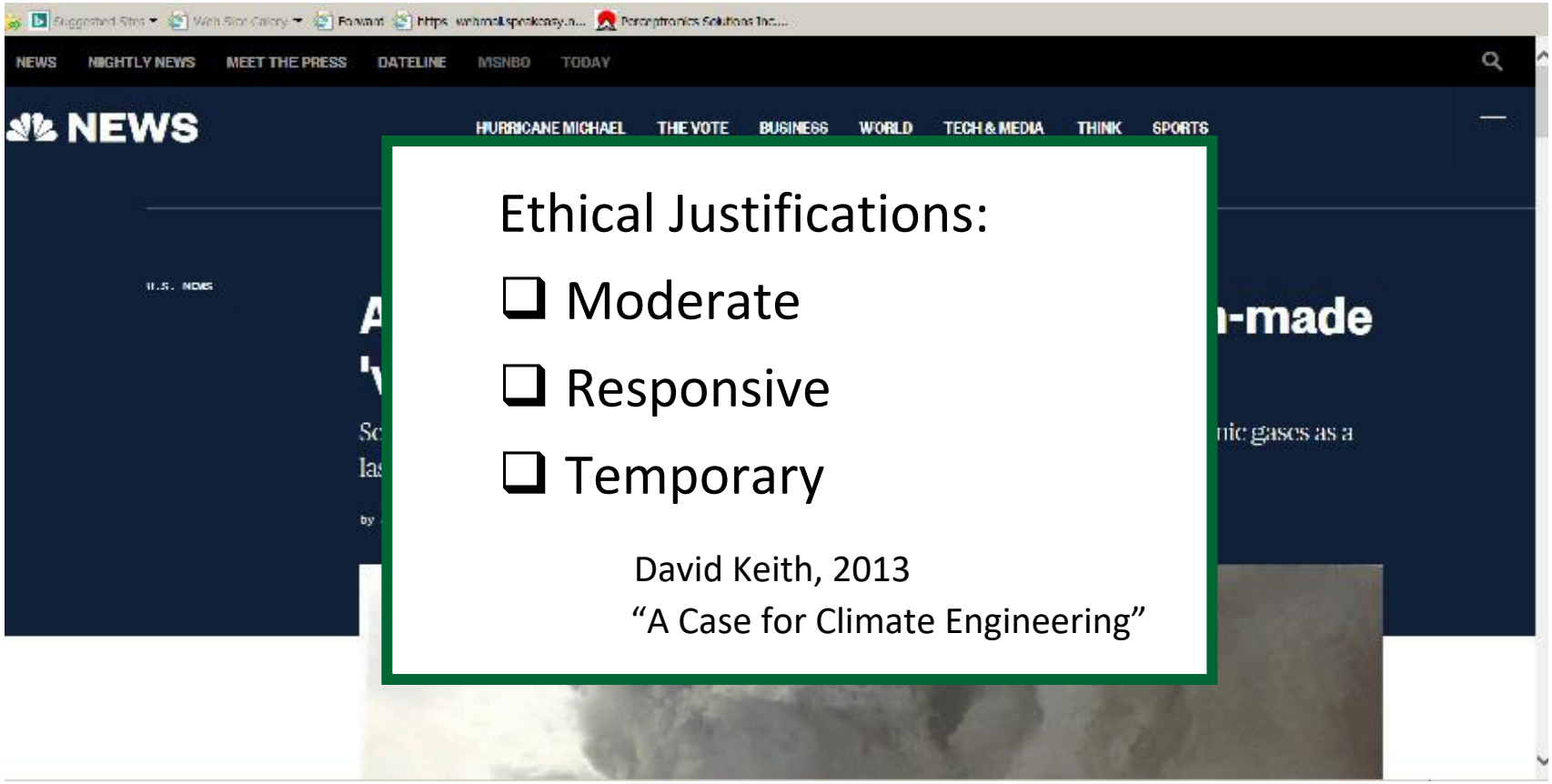
Particles in Atmosphere Emulate Volcanic Layer

Artificial Cloud Layer Decreases Warming Effect

Geoenineering: Risks vs Benefits

Is “geoengineering” a global warming solution? Is it feasible? Safe? Ethical?

A Different Approach: Climate Engineering



An Overarching Societal Approach

LATIMES.COM Los Angeles Times FRIDAY, JUNE 19, 2015 A5

Pope decries a culture of excess

[**Encyclical,** from A1] mental crisis was also a spiritual problem caused by the rise of individualism and a greed for personal happiness.

He warned that it could leave future generations to inherit a damaged world if not addressed.

"The pursuit of individual happiness has been made into an ideal in our time," he said. "Ecological sin is due to human greed, which blinds men and women to the point of ignoring and disregarding the basic truth that the happiness of the individual depends on its relationship with the rest of human beings."

He said the ecological crisis was growing in conjunction with the spread of social injustice. "We cannot face successfully the one without dealing with the other."

A draft of the more than 180-page document titled "Laudato Si" (Be Praised) had been leaked to the Italian press this week, but even long before that, parties on

BULLIT MARQUEZ Associated Press

POSTERS bearing messages for Pope Francis greet recyclers at a dump in Quezon City, in the Philippines. Free-market policies that ignore damage to people or the environment must be changed, the pope said.

also oil and, to a lesser degree, gas — needs to be progressively replaced without delay."

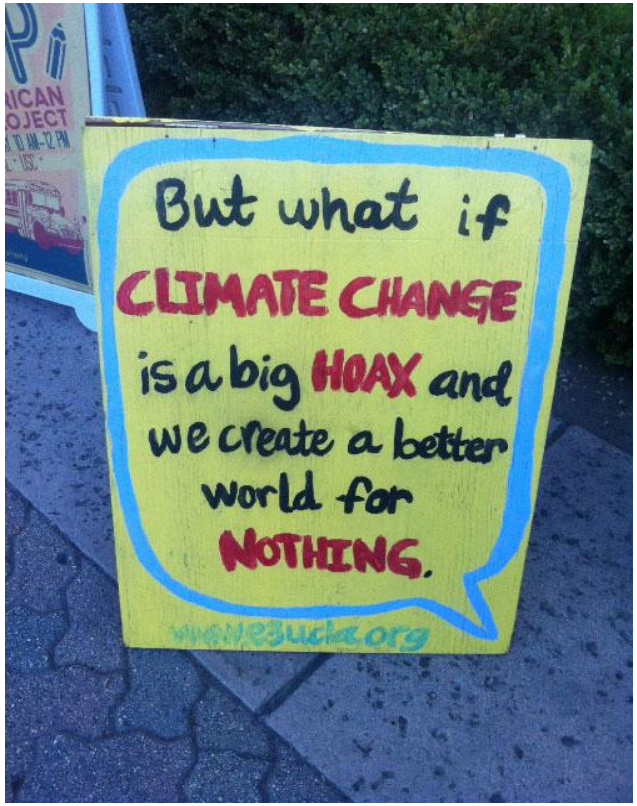
The same ingenuity that provided humanity with extraordinary technological progress has so far proved incapable of dealing with grave environmental and social problems worldwide, Francis said. This failure pointed to a deep need for humanity to change its relationship to nature, but also to one another. Free-market policies that ignored damage to people or the environment must be changed, while income and resource inequalities also need to be addressed.

What was needed, Francis wrote, was a global consensus that could lead to the planning of sustainable and diversified agriculture; better forest and marine management; development of renewable and less polluting forms of energy; and universal access to drinking water.

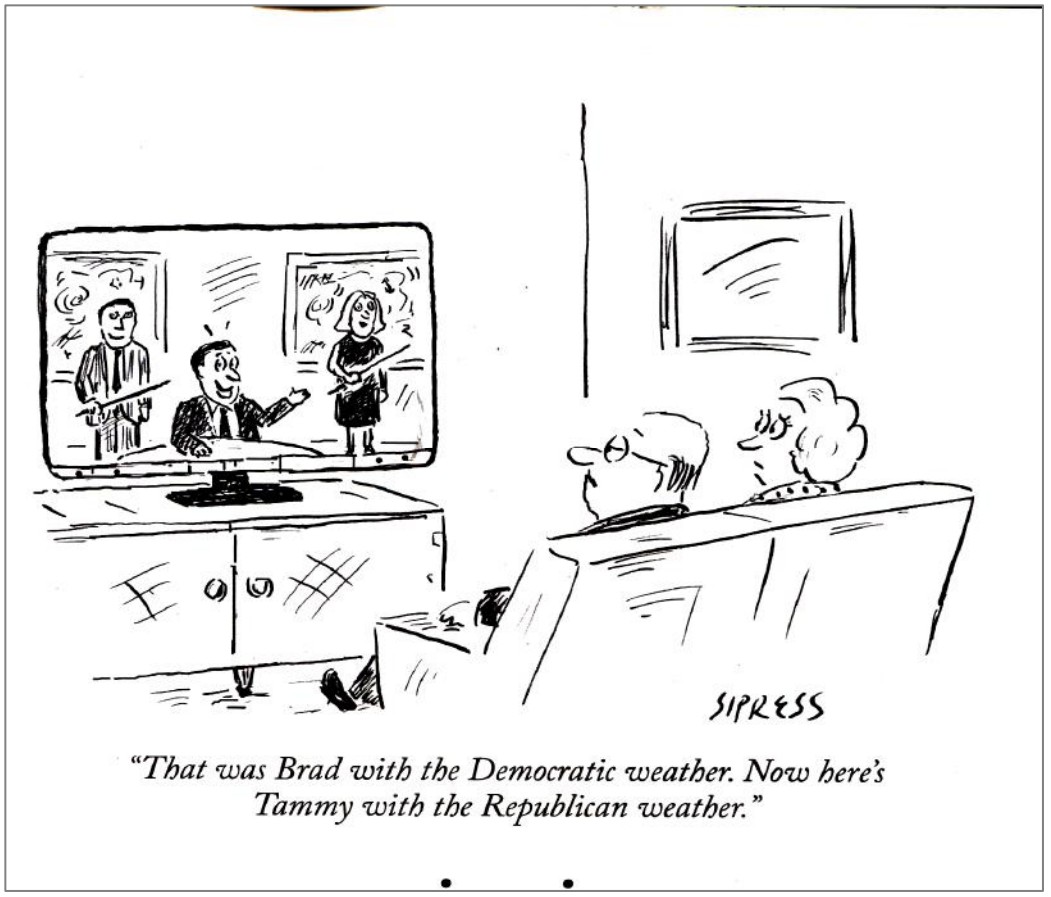
Ultimately, however, people must aim for a new life-

Pope Francis has called for policies to "drastically" reduce polluting gases, saying technology based on fossil fuels "needs to be progressively replaced without delay" and sources of renewable energy developed.

A Humorous Side



Sign on Bruin Walk 2016



David Sipress, The New Yorker, Feb 13 & 20, 2017

Case Study 4: Waste Management

- Pre-Historic: Throw it out, build on it, use it for fertilizer
- Greco-Roman: Sewer systems, landfills, dump sites, personal responsibility
- Medieval: Same approaches, little or no improvement
- Industrial Revolution: New wastes in bigger cities, waste collection services, *environmental science*, early connection to disease
- 19th Century: A *Paradigm Shift*: Germ theory shows disease associated with waste; *sanitation engineering*
- 20th Century: Growing populations, more urbanization, new types of waste; *waste management technology* – i.e., more efficient applications of old methodologies
- 21st Century: Is another *Paradigm Shift* imminent?

Waste on Today's Urban Scene

"Garbage city" (Cairo) by Bas Princen; "Tire Dump, Gorton" by David Johnson

….and in Suburban & Country Waterways

Waste Hits the Headlines

TUESDAY, NOVEMBER 19, 2013 The Washington Post E2 EE E

A worldwide problem that continues to pile up

Increase in trash is likely to keep growing into the next century

BY JOSEPH STROMBERG

If you're someone who cares about the environment, your first and foremost concern is probably climate change. After that, you might worry about such things as radioactive contamination, collapsing honeybee colonies and endangered ecosystems.

But a number of researchers are focused on a problem that has faded out of the news cycle: the piles of garbage that are growing around the world.

A recent World Bank report projected that the amount of solid waste generated globally will nearly double by 2025, going from 3.5 million tons to 6 million tons — per day. And we likely won't hit peak garbage — the moment when our global trash production hits its highest rate, then levels off — until after 2100, when we will produce 11 million tons of trash per day, according to the projection.

Why does this matter? One reason is that much of this waste isn't handled properly: Millions of plastic fragments are flooding oceans and disrupting marine ecosystems, and plenty of trash in developing countries is either

LEON NEAL/AGENCE FRANCE-PRESSE VIA GETTY IMAGES

Among the trends that trouble experts contemplating the future of solid waste: People create much more trash when they move to cities (and begin consuming more packaged products) and when they become wealthier (and increase their consumption overall).

ing this century.

How can we address the con sumption problem? One of th main things to consider is that it largely driven by people in th developing world moving to citie and improving their standard living, both signs of economi progress. But even if these demo graphic shifts continue, the pro jected rates of garbage growt aren't entirely inevitable. Ther are also cultural and policy d mensions to waste production.

For instance, the average per son in Japan creates about one third less trash than an American even though the two countrie have similar levels of GDP pe person. This is partly because Japan's higher-density living ar rangements and higher prices fo imported goods. But also, trash i many Japanese municipalitie must be disposed of in clear bag (which reveal who isn't botherin to recycle) and recyclables ar routinely sorted into dozens categories. Such policies are driv en by the limited amount of spac for landfills in the small country.

Creating similar incentives t produce less waste in other coun tries could be a way of tackling th problem. But Hoornweg and hi co-authors argue in their articl that accelerating increases i education and economic develop ment in the developing world especially in Africa, might be eve more important. That woul probably cause urban populatio

Major Industrial Waste Sources

- Energy Industries
  - Coal Mines
  - Atomic Reactors
- Clothing Industries
  - Textile Plants
  - Tanneries
- Material Industries
  - Wood Fiber Industries
  - Metal Industries
  - Liquid Material Industries
- Food Industries
  - Animal Farming and Processing
  - Fruit and Vegetable Farms
  - Canneries
  - Dairies
  - Wineries and Distilleries
  - Pharmaceutical Plants
- Chemical Industries
  - Organic Compounds
  - Acids and Bases
  - Explosives

Adverse Effects of Waste Products

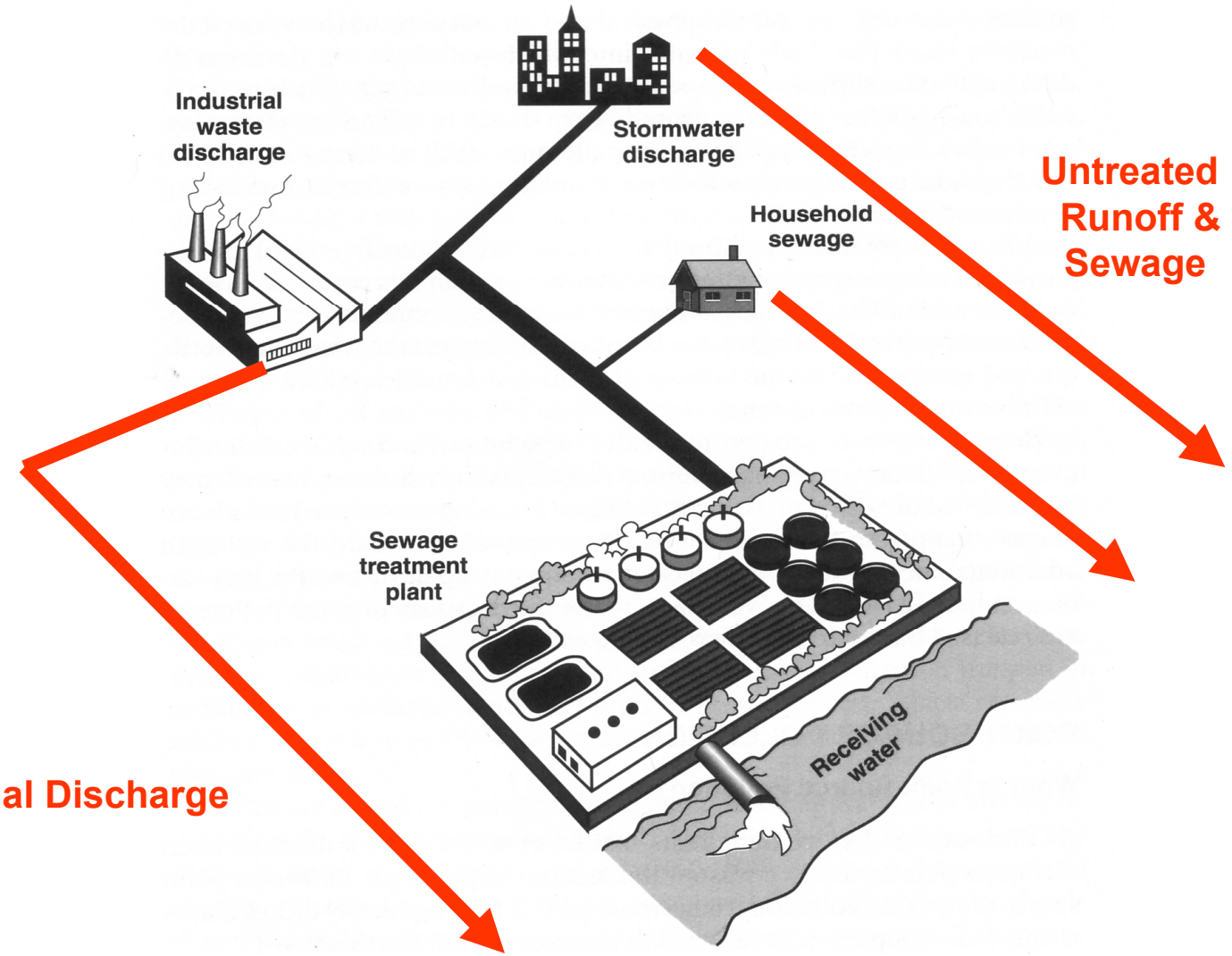
Ecological Effects

- Direct Human Health
- Plant and Animal Species Destruction
- Human Food Chain Contamination

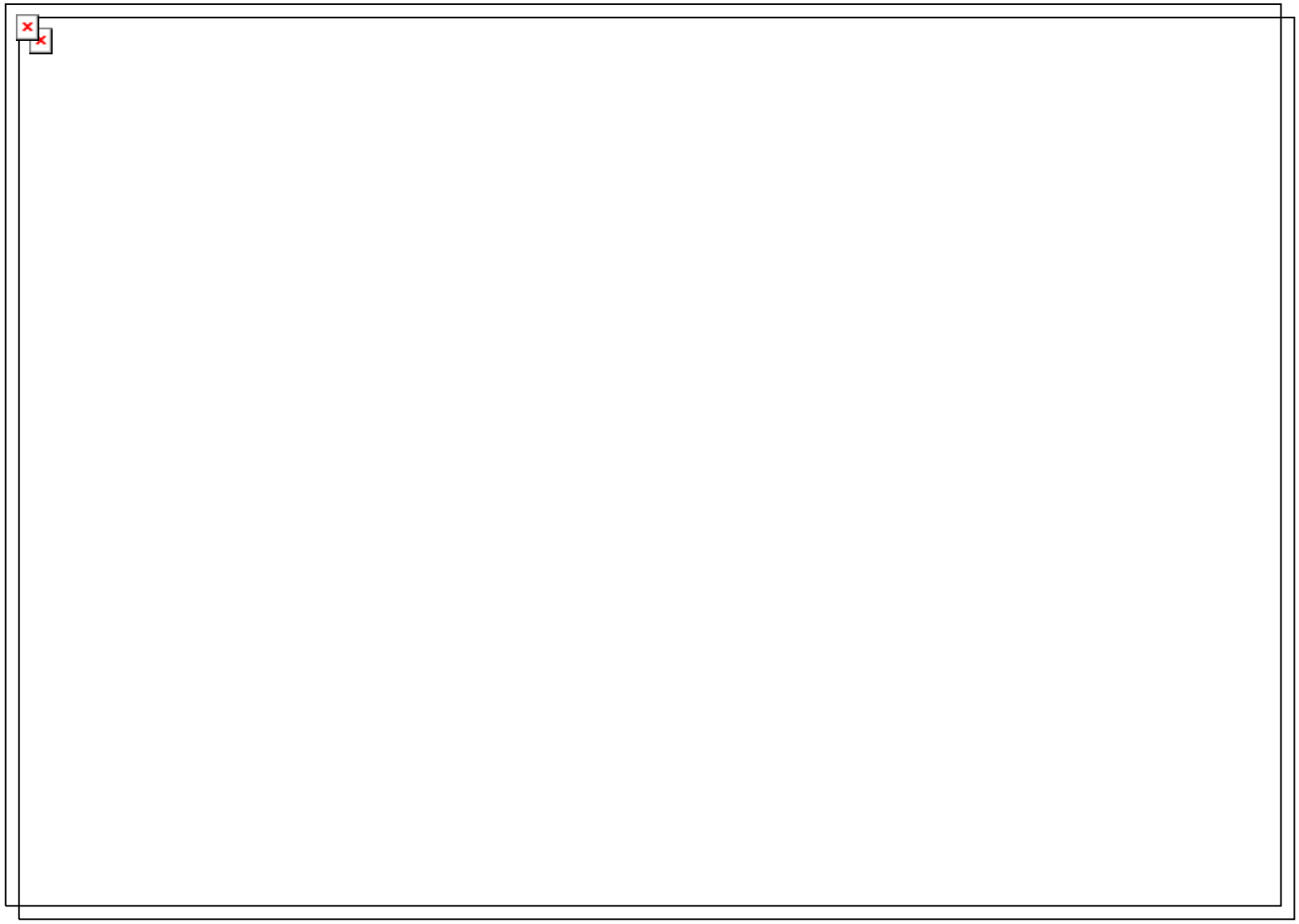
Contamination Pathways

- Rivers, Lakes, Oceans
- Ground Water
- Air Pollution
- Direct and Indirect Radioactivity

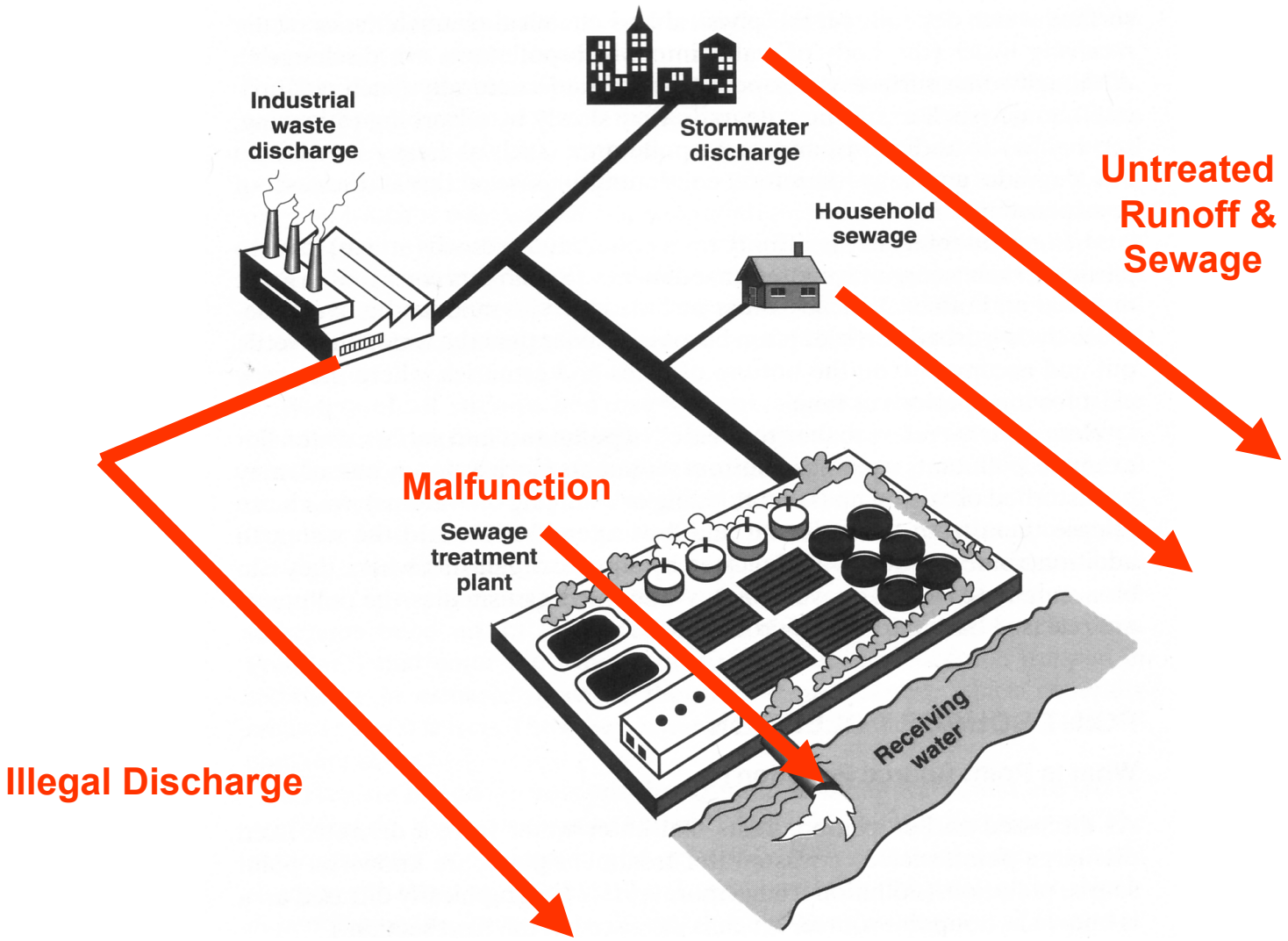
Example: Open Water Pollution



Last Year in Los Angeles



Example: Open Water Pollution



Example: Factory Farm Pollution

http://www.flickr.com/photos/sustainabletable/2950338288/

Example: Factory Farm Pollution

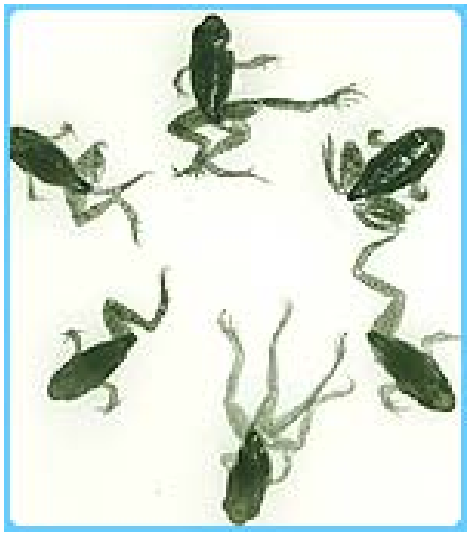
Example: Oil Drilling Pollution…

…and Oil and Gas Fracking Pollution

Sample Results: Mutations

"Frogs around the world are being born with severe deformities because of pollution, say scientists."

BBC News, 2002



[COURTESY BIOINFO]

Sample Results: New “Silent Springs”

Sample Results: Insect Disappearance

Recent studies indicate the “insect apocalypse” is coming, and ask what this means for the rest of life on Earth.

Ethical Considerations

Traditional

- *Rights* of people to a healthy and pleasant life
- *Duty* not to inflict harm on other people
  - Current populations
  - Future generations
- *Virtue* of being a non-polluter
- *Utilitarian* balance of benefits and costs
  - Immediate costs
  - Near and long term benefits
- *Pragmatic* solutions with conflicting objectives

Non-Traditional

- *Rights of Nature,* and of other Species
- *Duties to Eco-System as a whole*

Current Waste Management Strategies

Conventional

- Regulation
- Source Reduction
- Combustion/Incineration
- Physical Containment

Less Conventional

- Recycling
- Eco-Efficiency

Regulation of Waste Management

- *1969* *National Environmental Policy Act (New paradigm)*
- 1972 Clean Water Act (Rigorous control of toxic waste)
- 1974 Safe Drinking Water Act (National water standards)
- 1976 Toxic Substances Control Act (EPA tracks and controls 75,000 industrial chemicals)
- 1976 Resource Conservation and Recovery Act (Cradle-to-grave control of hazardous waste)
- 1980 Comprehensive Environmental Response, Compensation and Liability Act ("Superfund" clean-up of closed and abandoned sites after Love Canal disaster)
- 1980 Low-Level Radioactive Waste Policy Act (Regional control of normal radioactive waste disposal)
- 1982 Nuclear Waste Policy Act (Federal high-level waste disposal)
- 2002 Selection of Yucca Mt, Nevada as nuclear disposal site

Yucca Mt. Time Line

In 2002 he Department of Energy (DOE) set a new target date for the opening of the proposed Yucca Mountain repository in 2017. But the project was mired in popular and political dissent from its beginning. ***And while receipt of waste was scheduled 35 years after the original bill passage, it has not yet happened. Funding for the repository was cut off in 2011 and DOE has paid $2 billion in damages to energy firms for waste storage, which may rise to $20 billion!***

35 Years after Enabling Bill

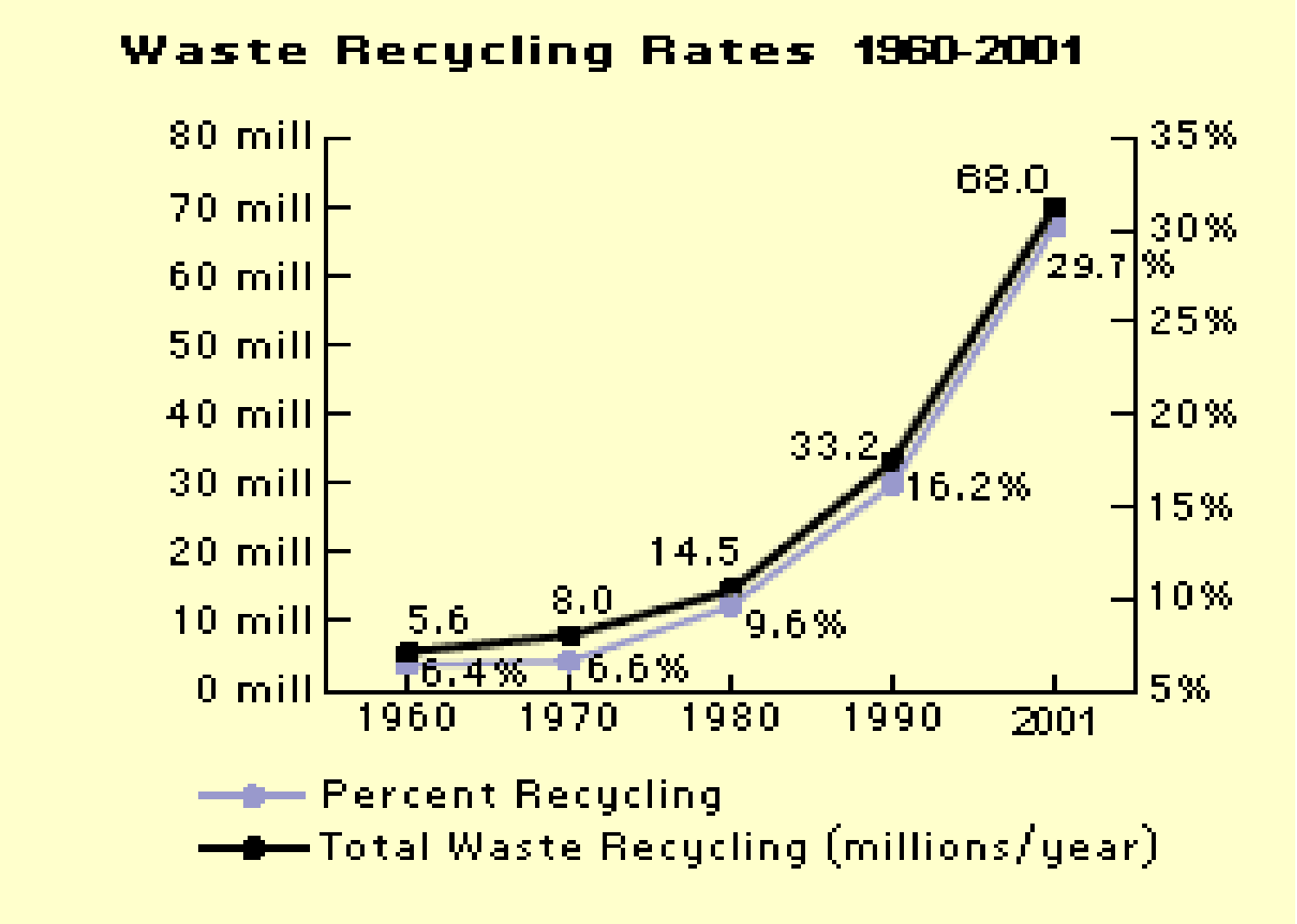
New Target Dates for Yucca Mountain

Design for License Application Complete	30 November 2007
Licensing Support Network Certification	21 December 2007
Supplemental Environmental Impact Statement (EIS) Issued	30 May 2008
Final Rail Alignment EIS Issued	30 June 2008
License Application Submittal	30 June 2008
License Application Docketed by NRC	30 September 2008
Start Nevada Rail Construction	5 October 2009
NRC Authorizes Construction	30 September 2011
Receive and Possess License Application Submittal to NRC	29 March 2013
Rail Access In-Service	30 June 2014
Construction Complete for Initial Operations	30 March 2016
Start up and Pre-Op Testing Complete	31 December 2016
Begin Receipt of Waste	**31 March 2017**

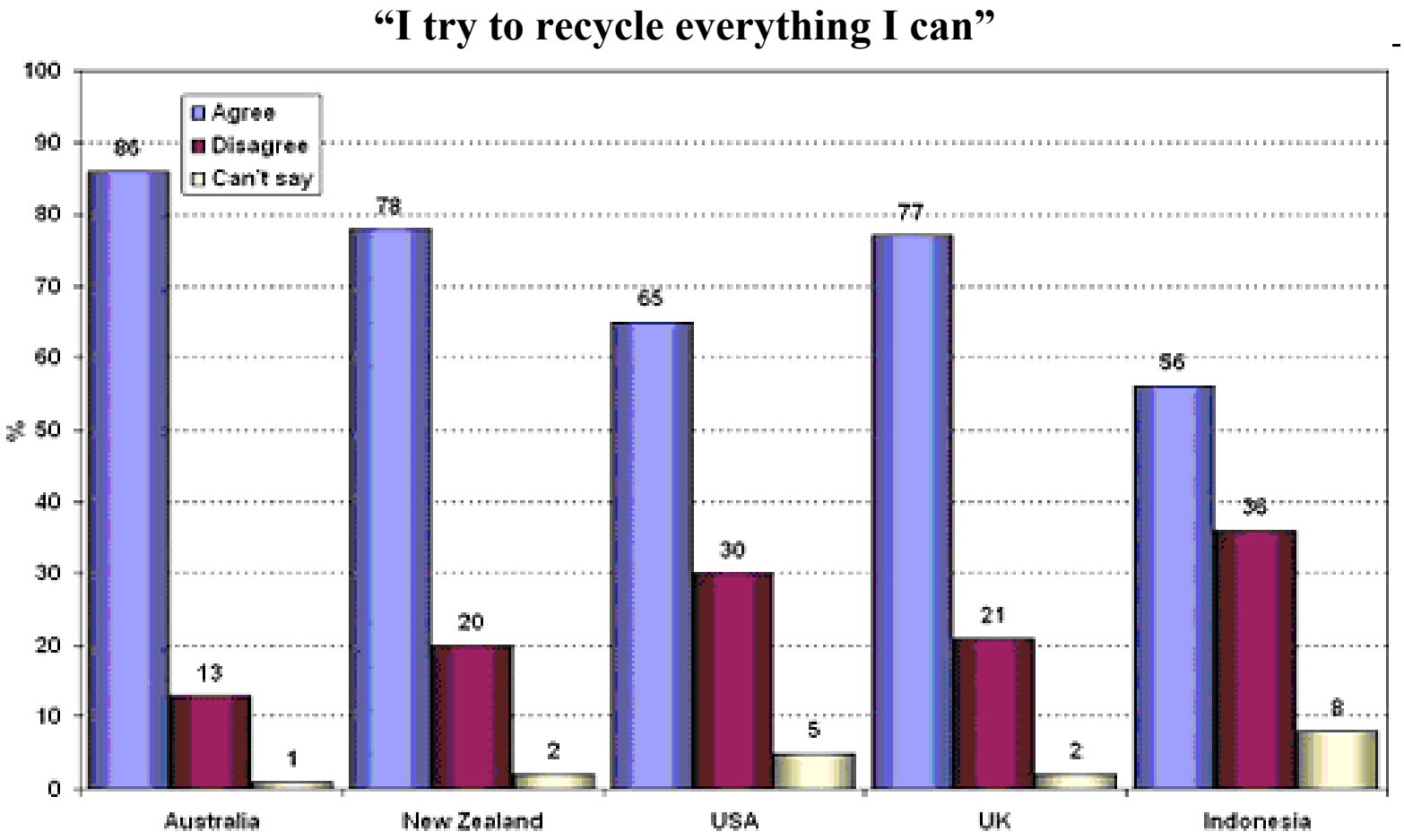
Problems with Traditional Strategies

- Regulation
  - Administrations change
  - Waste producers dispute, delay and evade
- Source Reduction
  - Technologies are expensive
  - Industries fight compliance
- Combustion/Incineration
  - Creates pollution
  - Adds to greenhouse gases
- Physical Containment (Landfills)
  - Modern materials resist biodegradation
  - Toxic leakage affects groundwater and air
  - NIMBY (Not in My Back Yard)
  - Economical available space is scarce

Recycling: Upward Trend

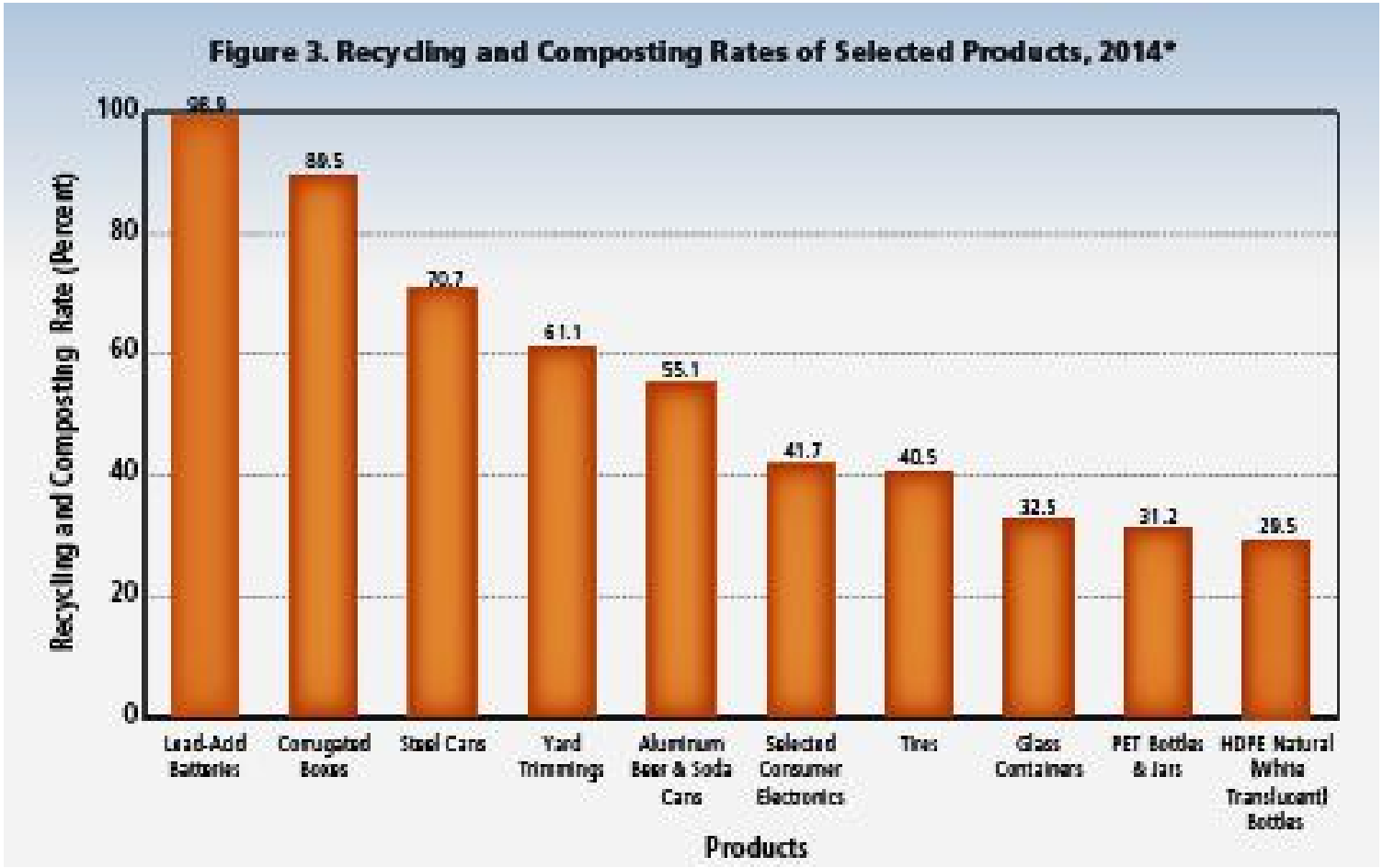


Recycling: Positive Attitudes



Survey from Roy Morgan Research http://www.roymorgan.com, The Australian, 4 May 2006

Recycling: Varied Success



US Environmental Protection Agency, Advancing Sustainable Materials Management, 2014 Fact Sheet

Recycling: Big Business…

…but Dangerous…

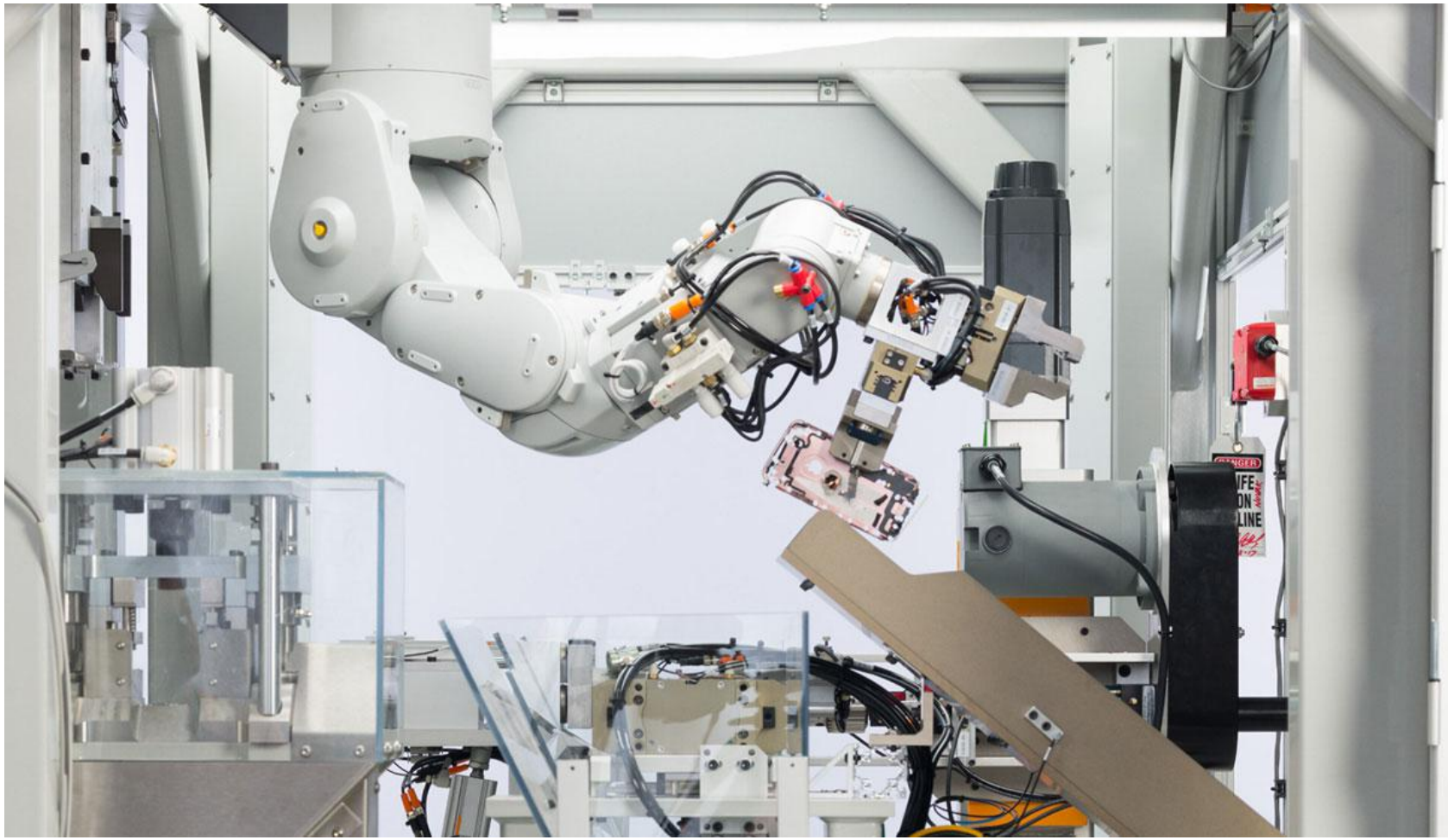
Landfill, Mumbai, India; http://images.businessweek.com/ss/09/08/0805
http://img1.photographersdirect.com/img/2293/wm/pd139285.jpg

….and a Child Labor Problem

Original page: **http://www.decentcomedy.com**

http://www.english-online.at/society

Technical Approach to a Solution…



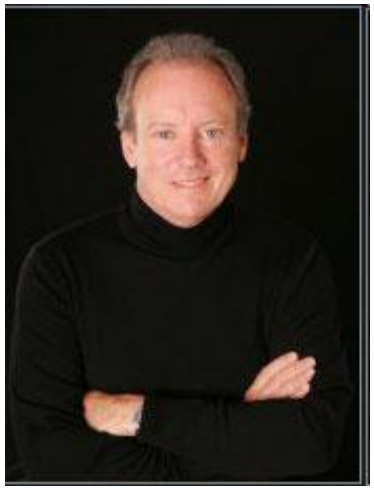
Apple's Daisy robot disassembles iPhones for recycling expensive materials

Issues with Re-Cycling Paradigm

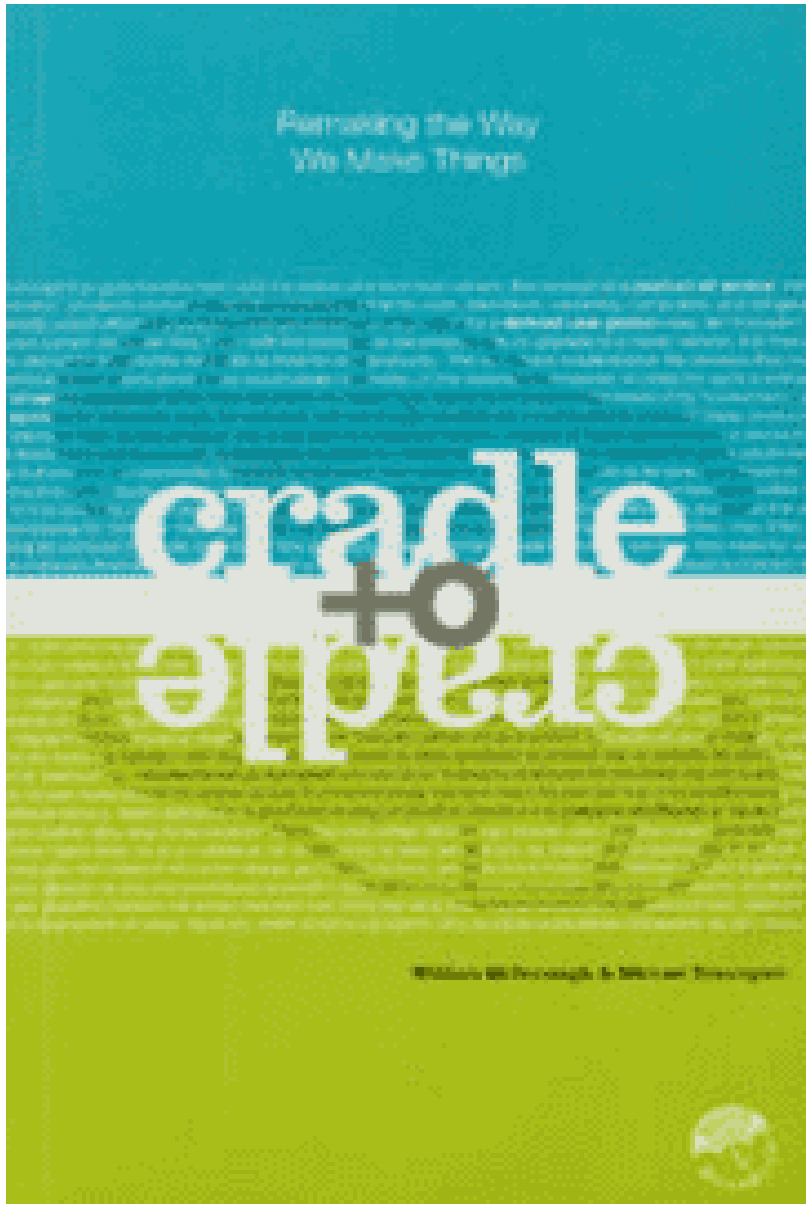
- Dangerous and Unethical
  - Toxic materials
  - Child and forced labor
- Inefficient
  - Can use more energy than it saves
  - Too much individual initiative
- Inadequate
  - Sustaining dwindling resources
  - Maintaining a fundamentally flawed system

A New Ethical Paradigm

Prof. Michael Braungart
Hamburg, Germany



William McDonough
Charlottesville, Virginia



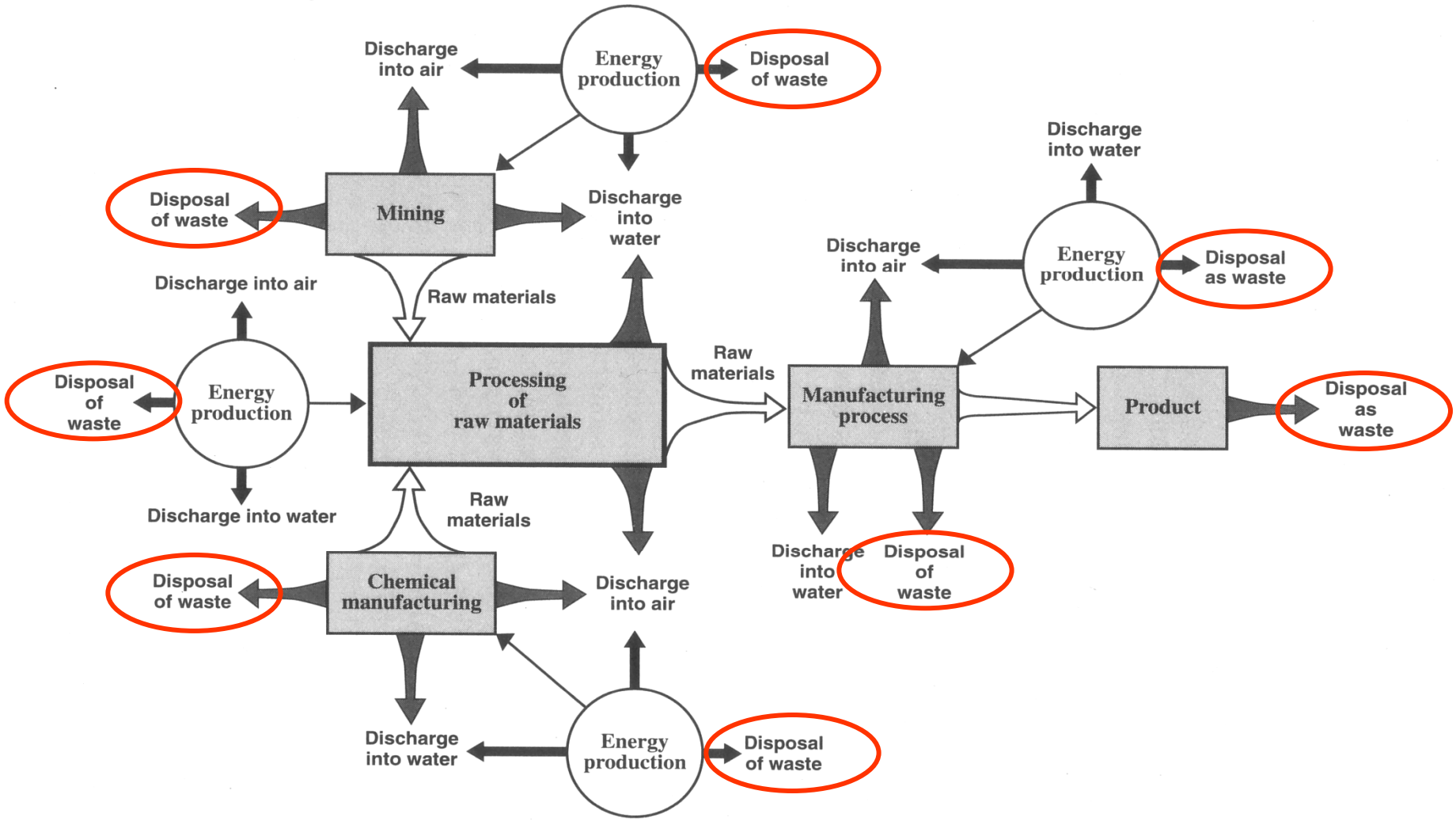
Cradle to Cradle Rationale

- Rethink the Industrial Revolution
- Redesign the way we make things
- Abandon linear processes of waste production
- Use nature as a model: Waste equals Food

Prof. Michael Braungart

"Let's start designing things with the idea that they will never become waste but will always be reused in some form or other."

Linear Process of Waste Production



The Cradle to Cradle Alternative[1]

The 1st Industrial Revolution:

- Generates gigantic amounts of waste
- Puts billions of pounds of toxic material into air, water and soil every year
- Requires constant vigilance of highly dangerous materials
- Buries valuable materials
- Necessitates thousands of complex regulations
- Creates prosperity through *destruction* of natural resources
- Erodes the eco-environment

The New Industrial Objectives:

- Factory affluent water that is cleaner than the influent
- Products that become food for plants, animals and soil or raw materials for new products
- Buildings that produce more energy than they consume
- Trillions of dollars worth of materials *accrued* each year
- A world of *abundance*, not one of limits, pollution and waste

[1]MBDC (2004) www.mbdc.com

Example: Simple C-to-C Design Protocol

Categories of chemicals in products:

- **Green** Little or no risk
- **Yellow** Low to moderate risk
- **Orange** Lack of information
- **Red** High risk

In applying the Protocol, materials in products are first inventoried and then evaluated according to their characteristics within the desired application, and placed into one of four categories (Green, Yellow, Orange, or Red) based on human health and environmental relevance criteria. After all chemicals are assessed, the materials in a product are optimized by positively selecting replacements for chemicals characterized as Red and using Green chemicals as they are available.

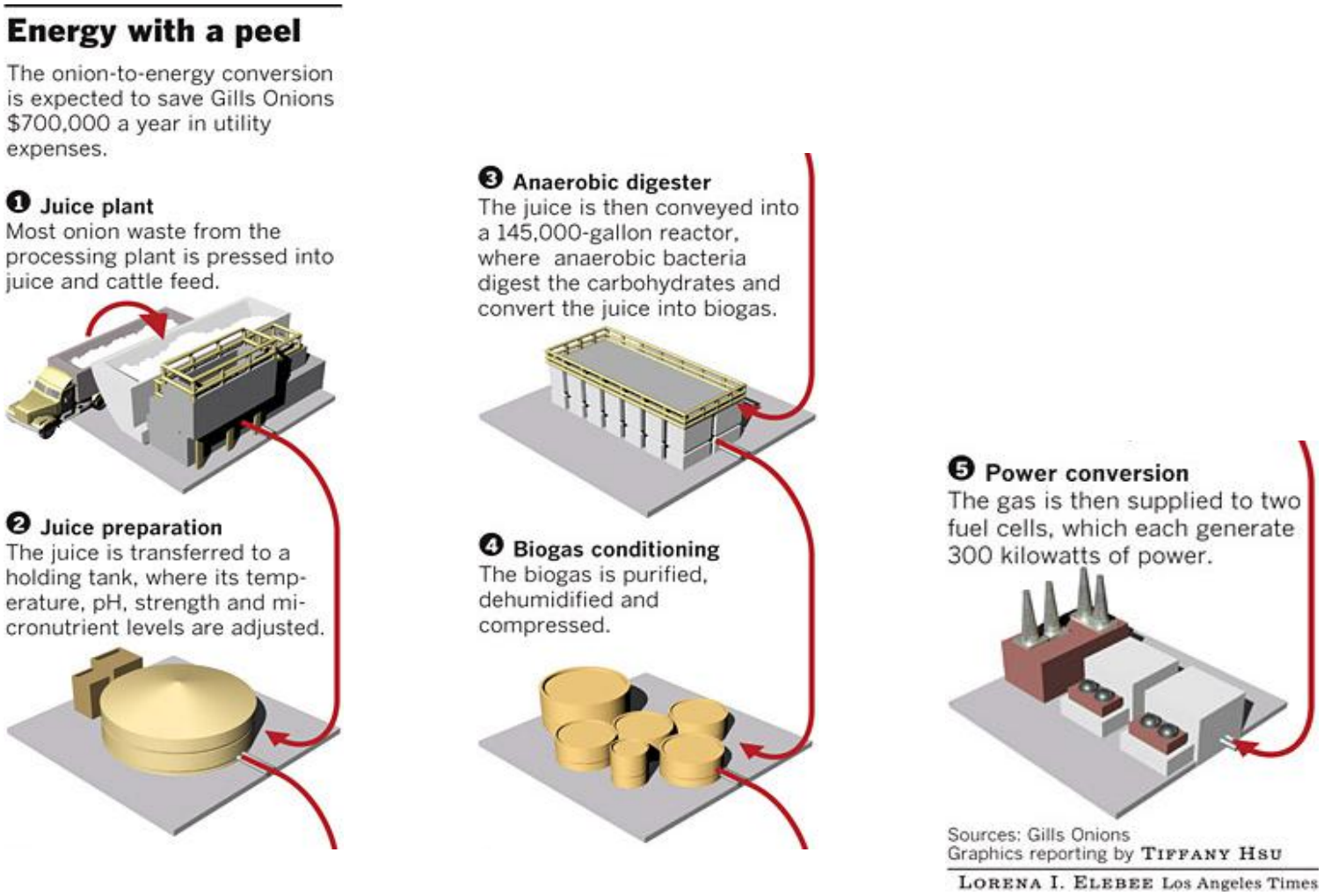
Example: Complete C-to-C Product

In 1993, William McDonough and Michael Braungart undertook a design assignment to create an attractive and functional fabric that could safely return to the environment at the end of its useful life. After extensive R&D, they devised a toxin-free blend of wool and organically grown ramie, a linen-like fiber, in a process so clean that it generates potable wastewater, and the mill turns scrap trimmings into felt which Swiss farmers use for mulch in strawberry fields.[1]

climatex® lifecycle(tm)
mcdonough braungart design chemistry

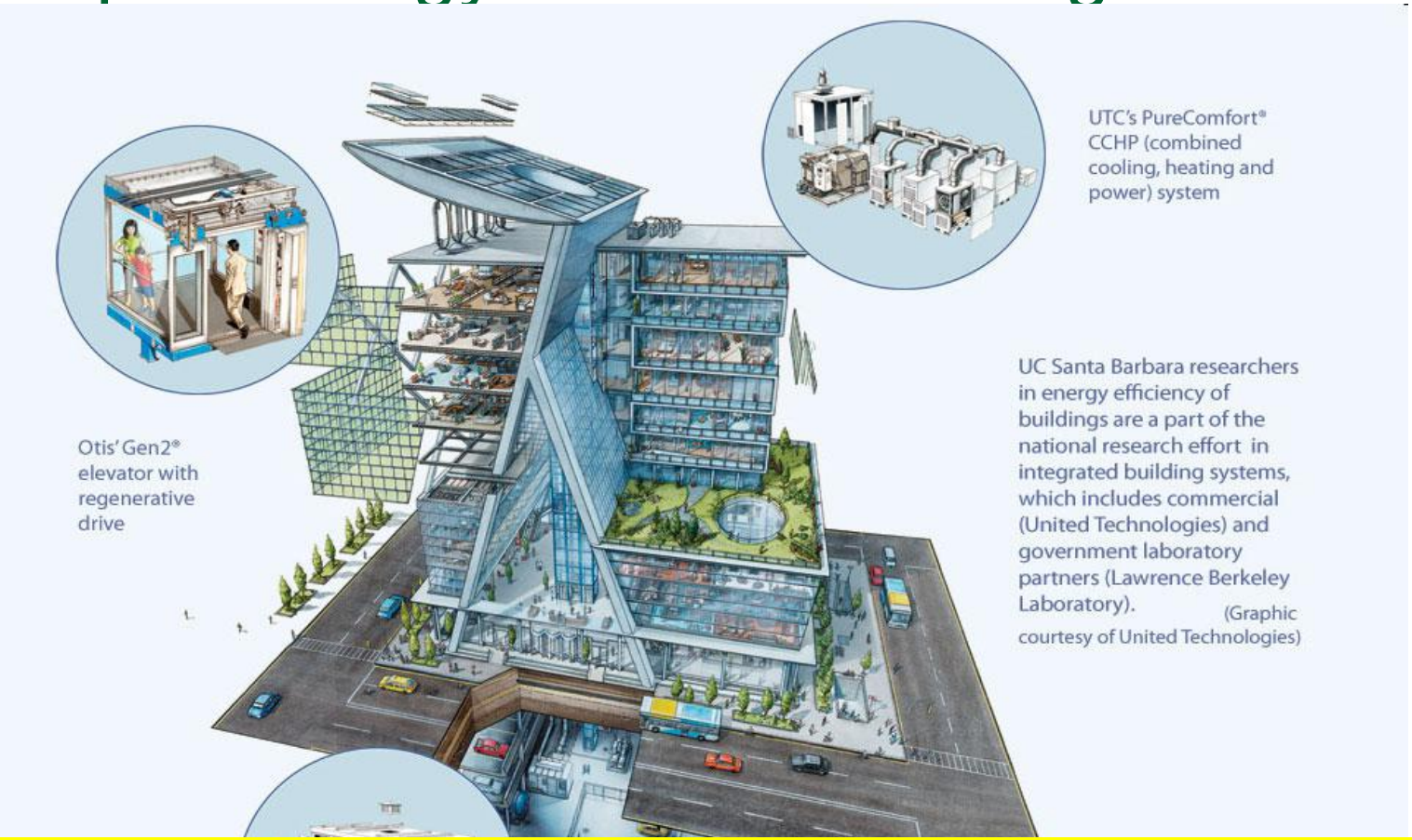
[1] www.designboom.com

Example: Energy from Onion Waste



Tiffany Hsu, Onions produce tears and energy at an Oxnard plant, LA Times, July 17, 2009

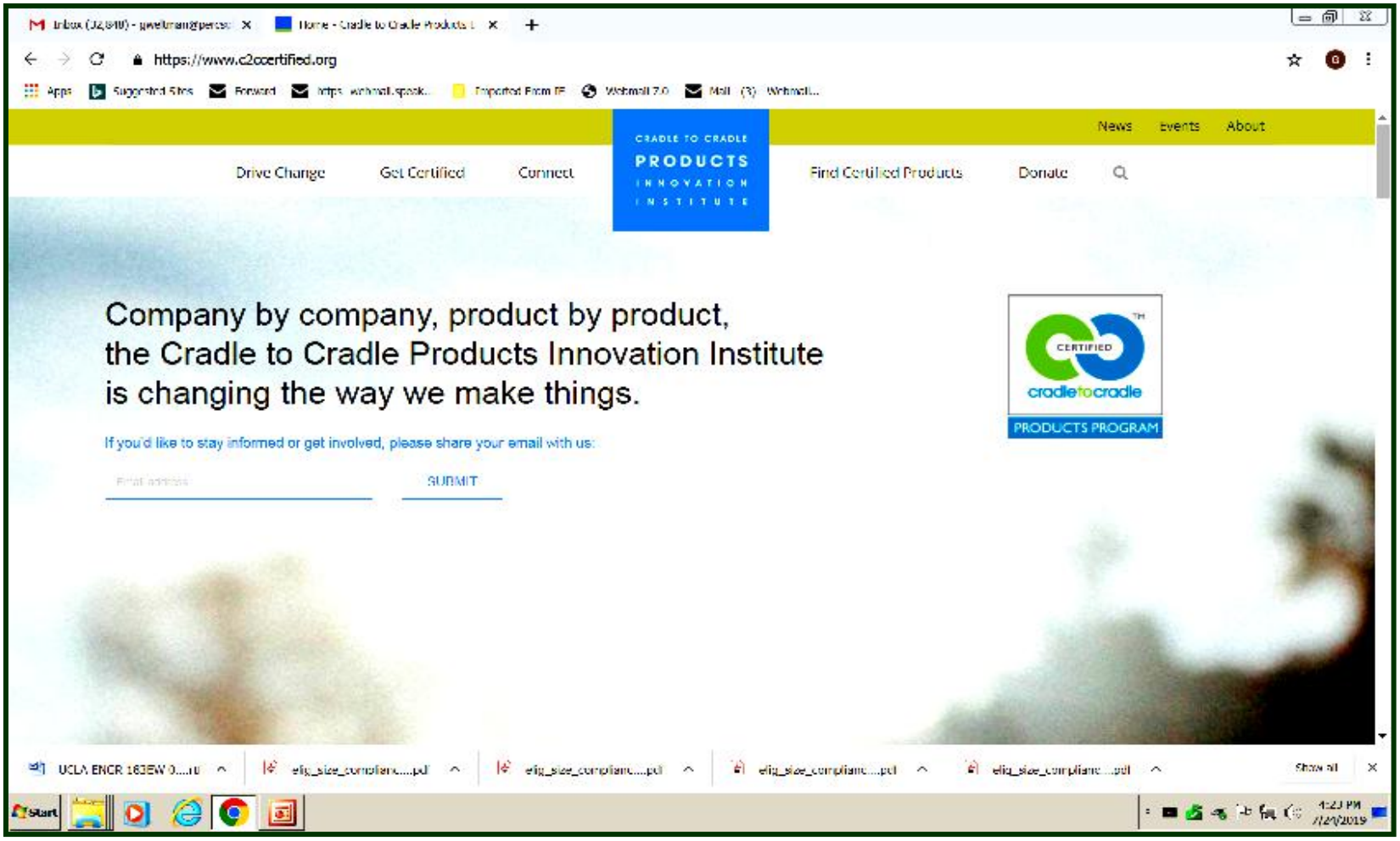
Example: Energy-Efficient Buildings



Buildings consume 39% of the total energy we use in the U.S., and 71% of all our electricity. Producing that energy generates almost half (48%) of our total carbon emissions.[1]

[1]Building Better Buildings, Convergence, UC Santa Barbara, Winter 2010

Trying to Institutionalize



Summary: Critical 21st Century Problems

- Ambitious Goals, Including:
  - Improved sources of quality water
  - Increased food production
  - “Clean” power generation and transportation
  - “Waste-free” product manufacturing and usage
  - Better quality of life for the growing human population
  - Protection of the complete ecosystem
- Difficult Ethical Engineering Requiring:
  - Understanding (and agreeing on) the problems
  - Setting correct priorities for addressing them
  - Developing innovative new solutions
  - Ensuring the solutions don’t make things worse