

Turning Back the Crimson Tide:

How to manage the unavoidable and avoid the unmanageable as Pennsylvania's climate starts to look like Alabama's



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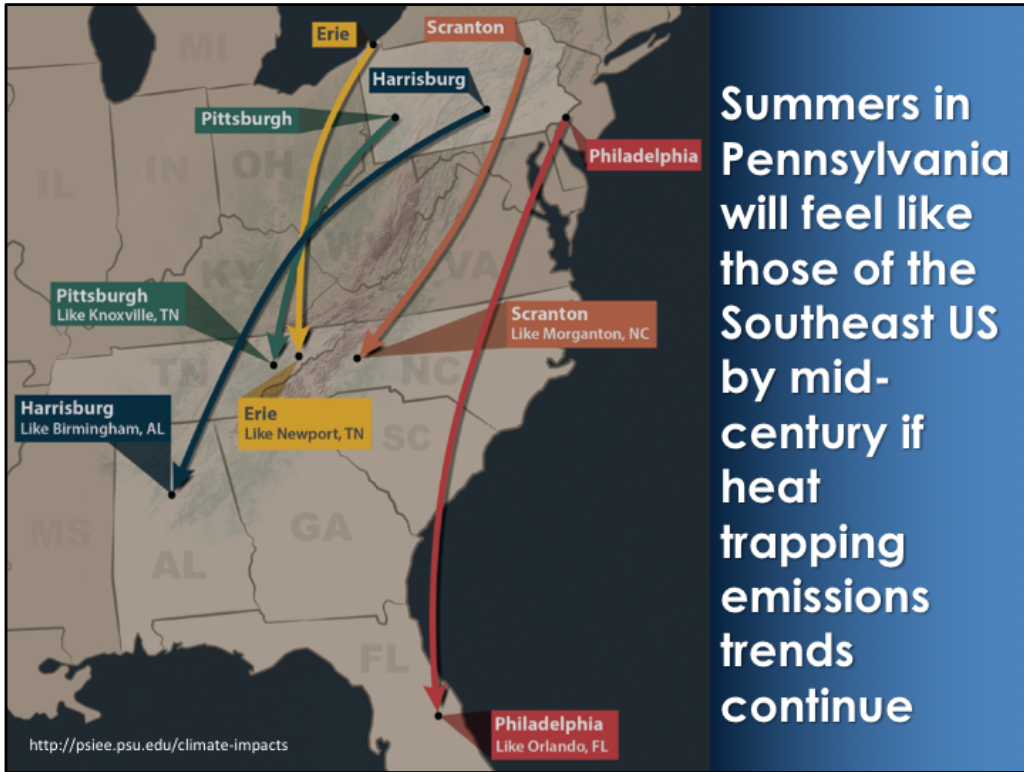
The Pennsylvania State University

U CLUB

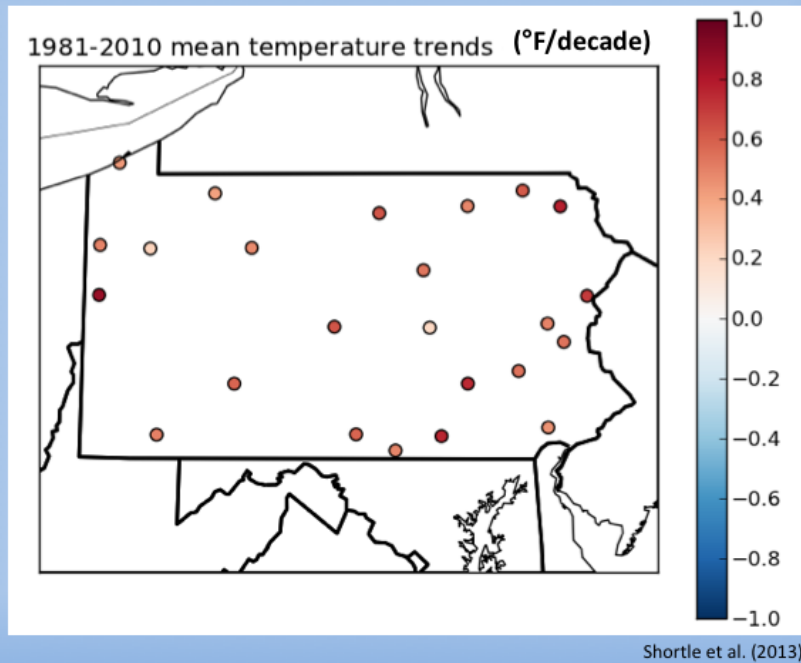


University Club Fireside Chat, State College, PA

May 17, 2016

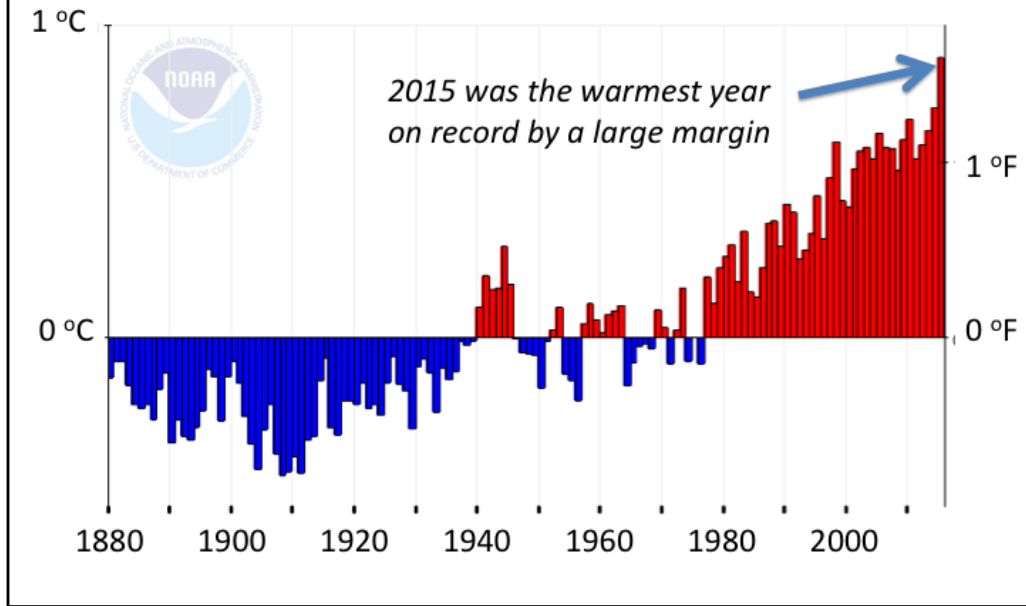


Pennsylvania is warming by 0.5 °F per decade



Shortle, J., Abler, D., Blumsack, S., McDill, M., Najjar, R., Ready, R., Ross, A., Rydzik, M., Wagener, T., Wardrop, D., 2013. Pennsylvania Climate Impacts Assessment Update, Report to the Pennsylvania Department of Environmental Protection. Environment and Natural Resources Institute, The Pennsylvania State University, University Park, Pennsylvania, 155 pp.

The Earth is rapidly warming



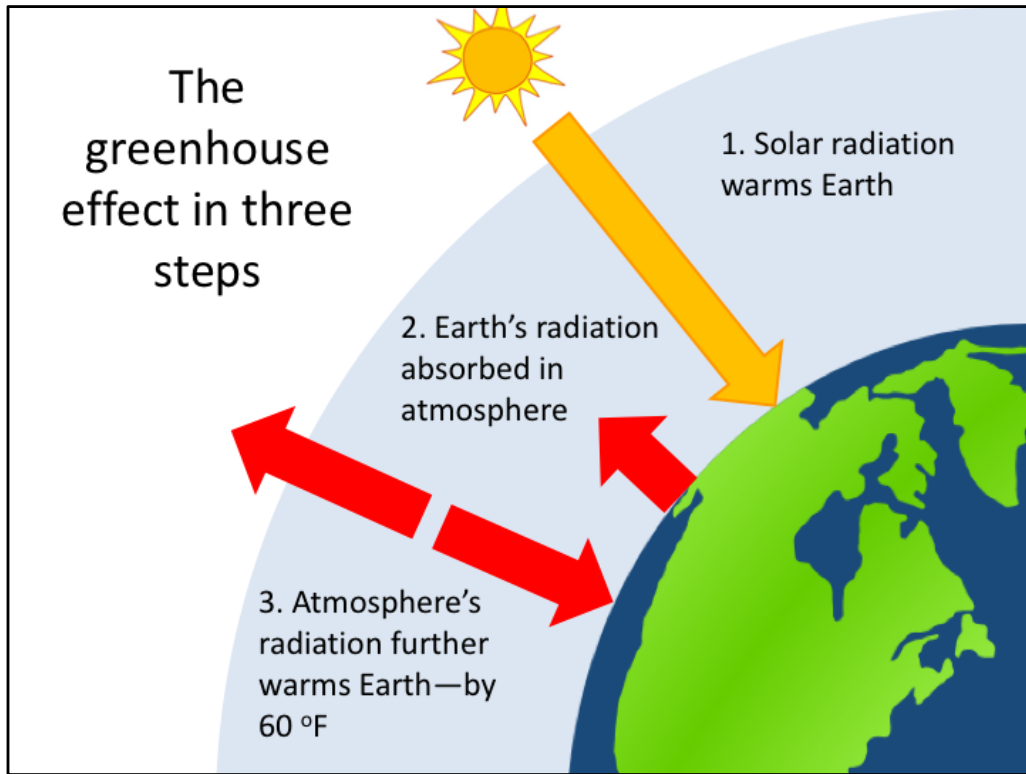
UNCHARTED TERRITORY

400,000 Years of Carbon Dioxide



Source: Luthi et al (2008) (cdiac.ornl.gov) & Keeling et al (Scripps.ucsd.edu)

CLIMATE  CENTRAL



We have known about the greenhouse effect for almost two centuries

1824: Joseph Fourier describes natural greenhouse effect

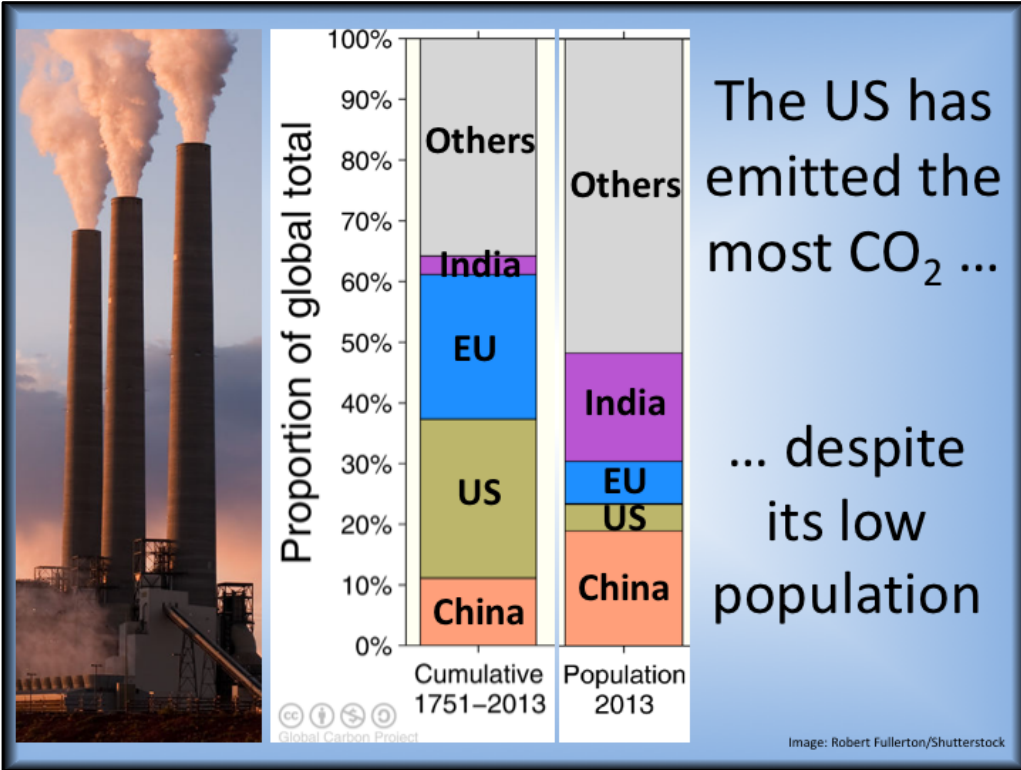


1861: John Tyndall identifies greenhouse gases

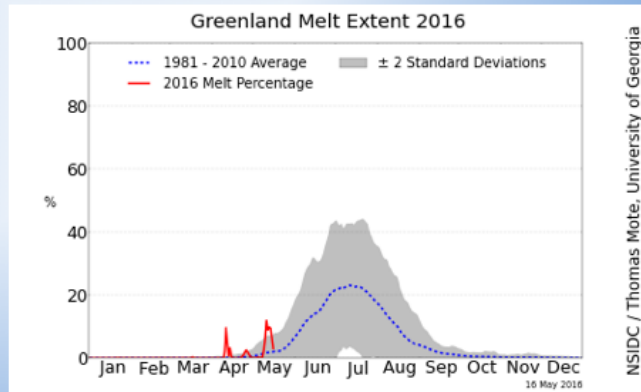
1896: Svante Arrhenius estimates greenhouse effect of fossil fuel CO₂



1938: Guy Callendar documents warming and CO₂ increase



12% of Greenland Ice sheet surface
was melting on April 11, 2016.
Typically happens in June!



NSIDC / Thomas Mote, University of Georgia

Source: National Snow and Ice Data Center & Danish Meteorological Institute

SEA LEVEL RISE

BY CENTURY

Inches:

+6

+3

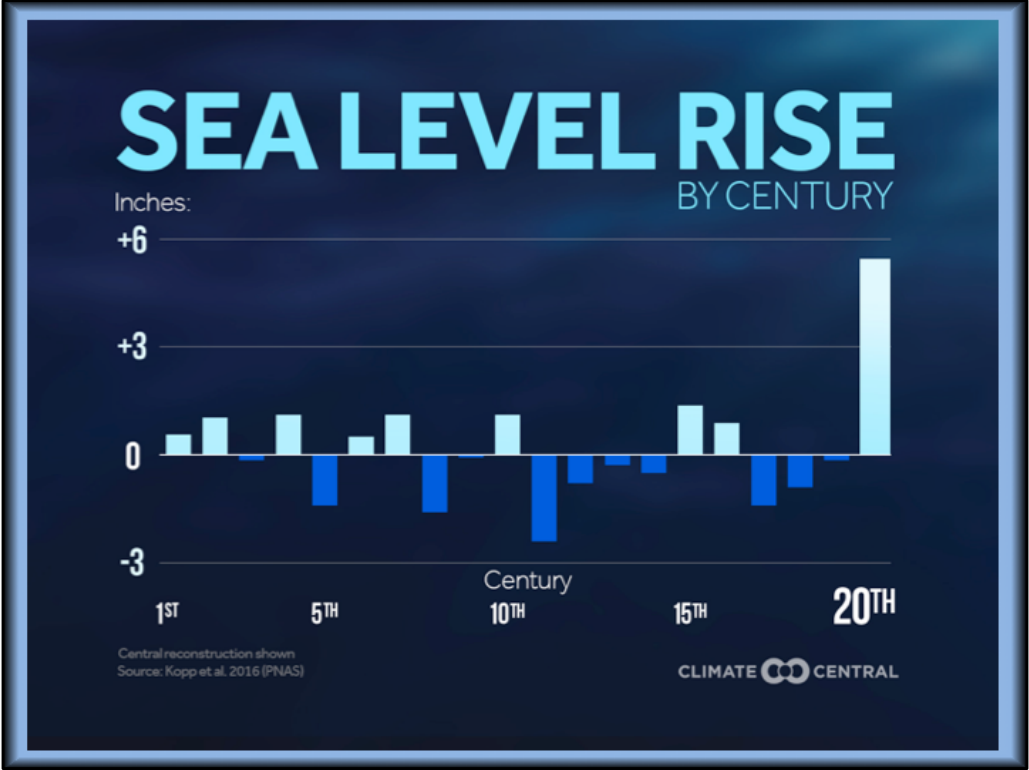
0

-3

1ST 5TH 10TH 15TH 20TH

Central reconstruction shown
Source: Kopp et al. 2016 (PNAS)

CLIMATE CENTRAL



“Sunny day” flooding in Miami



Photo source: Grist

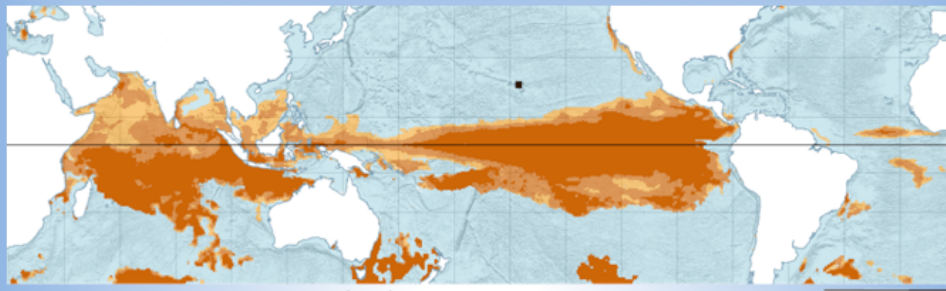
United States
COASTAL FLOOD DAYS






Orange shows human-caused global sea level rise effects
Floods totaled across 27 sites; must top NWS 'nuisance' thresholds
Source: Kopp et al. 2016 (PNAS), NOAA, & Climate Central

CLIMATE  CENTRAL

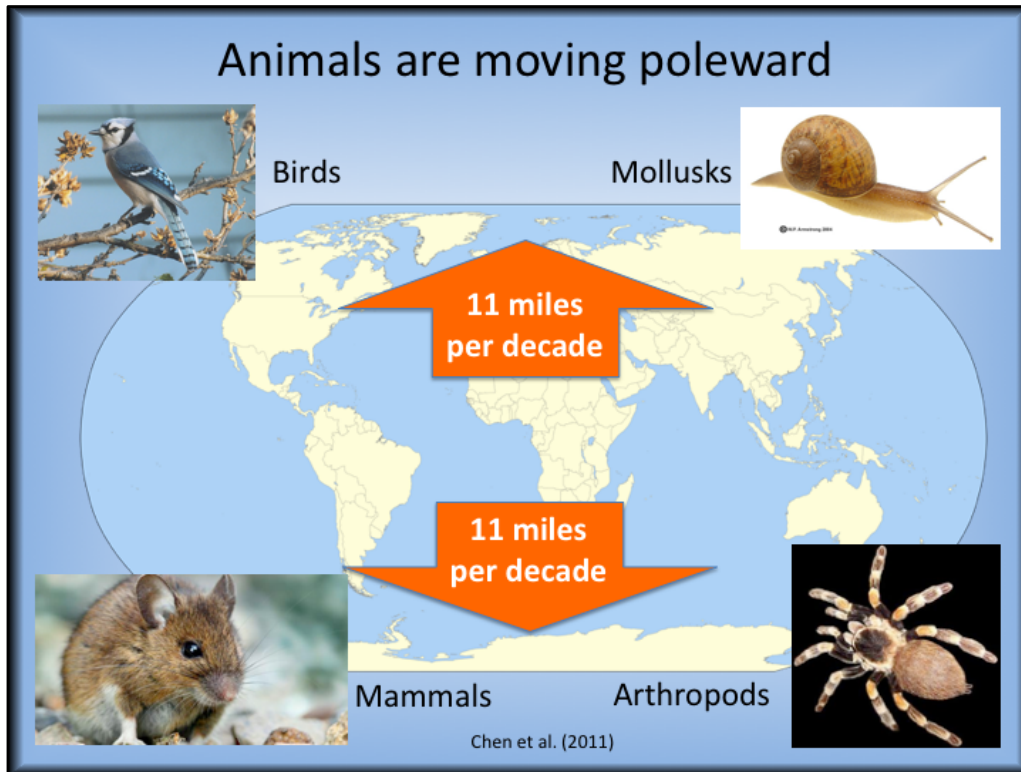
Massive coral bleaching is underway



Warning   Bleaching likely  Mortality likely

Source: New York Times



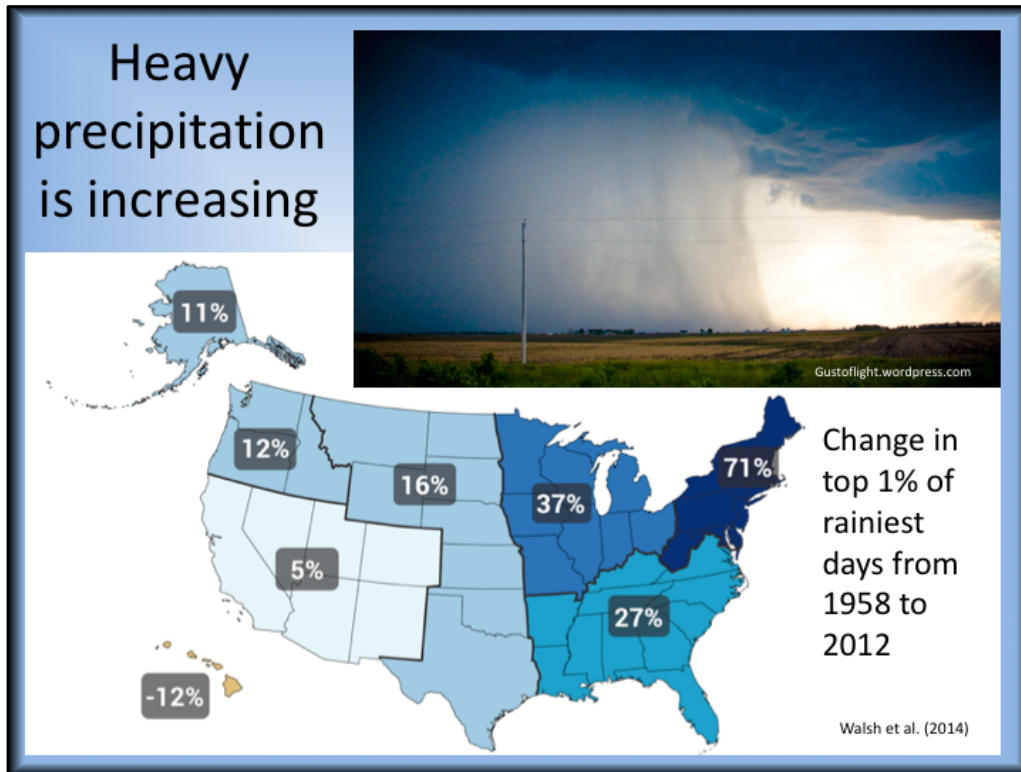


www.encyclopedia.com, waynesword.palomar.edu, dispatch.com, liveanimalist.com, en.wikipedia.org

Chen, I.C., Hill, J.K., Ohlemüller, R., Roy, D.B., Thomas, C.D., 2011. Rapid range shifts of species associated with high levels of climate warming. *Science* 333, 1024-1026.



Hallegatte, S., Bangalore, M., Bonzanigo, L., Fay, M., Kane, T., Narloch, U., Rozenberg, J., Treguer, D., Vogt-Schilb, A., 2016. Shock Waves: Managing the Impacts of Climate Change on Poverty. World Bank, Washington, DC, 207 pp.



Walsh, J., Wuebbles, D., Hayhoe, K., Kossin, J., Kunkel, K., Stephens, G., Thorne, P., Vose, R., Wehner, M., Willis, J., Anderson, D., Doney, S., Feely, R., Hennon, P., Kharin, V., Knutson, T., Landerer, F., Lenton, T., Kennedy, J., Somerville, R., 2014. Chapter 2: Our Changing Climate. In: J.M. Melillo, T.C. Richmond, G.W. Yohe (Editors), Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Change Research Program, pp. 19-67.

Birds in Western PA became smaller by 1.3% on average due to warming from 1961 to 2007



Scarlet tanager: 2% smaller



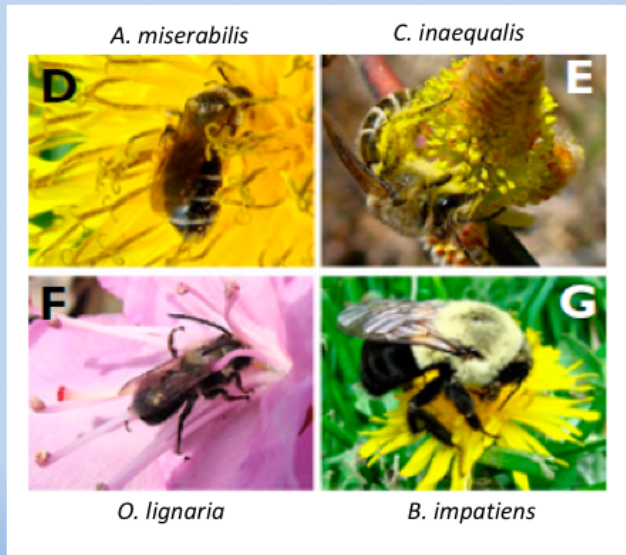
Rose-breasted grosbeak: 2% smaller

Van Buskirk et al. (2009, 2010)

Van Buskirk, J., Mulvihill, R.S., Leberman, R.C., 2009. Variable shifts in spring and autumn migration phenology in North American songbirds associated with climate change. *Global Change Biology* 15, 760-771.

Van Buskirk, J., Mulvihill, R.S., Leberman, R.C., 2010. Declining body sizes in North American birds associated with climate change. *Oikos* 119, 1047-1055.

Native bees in Northeast US are arriving in spring 10 days earlier than they used to

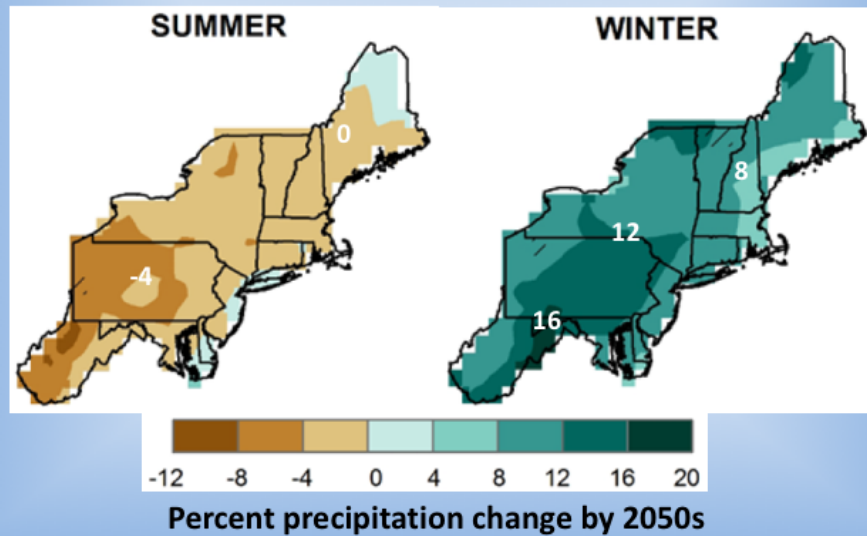


Bartomeus et al. (2011)

Bartomeus, I., Ascher, J.S., Wagner, D., Danforth, B.N., Colla, S., Kornbluth, S., Winfree, R., 2011. Climate-associated phenological advances in bee pollinators and bee-pollinated plants. *Proceedings of the National Academy of Sciences* 108, 20645-20649.

**Expect summers to
be drier ...**

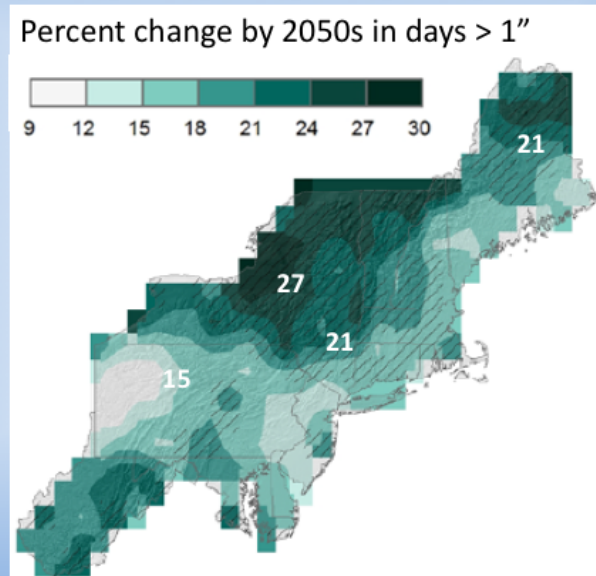
**... and winters to
be wetter**



Kunkel et al. (2013)

Kunkel, K.E., Stevens, L.E., Stevens, S.E., Sun, L., Janssen, E., Wuebbles, D., Rennells, J., DeGaetano, A., Dobson, J.G., 2013. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment, Part 1. Climate of the Northeast U.S., NOAA Technical Report NESDIS 142-1. U.S. Department of Commerce, Washington, D.C., 79 pp.

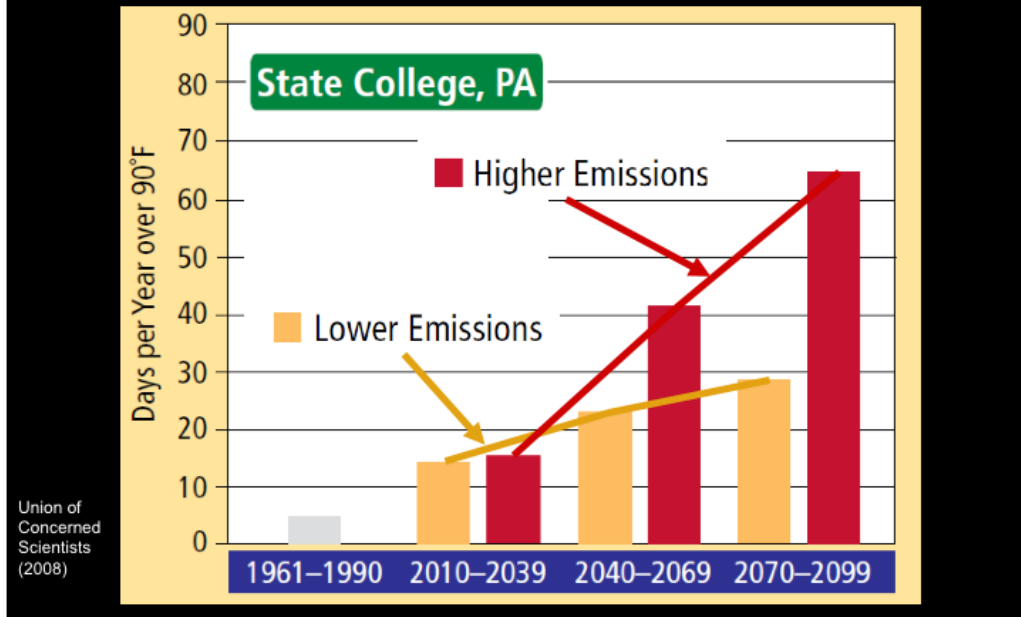
Expect heavy downpours to continue to increase



Kunkel et al. (2013)

Kunkel, K.E., Stevens, L.E., Stevens, S.E., Sun, L., Janssen, E., Wuebbles, D., Rennells, J., DeGaetano, A., Dobson, J.G., 2013. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment, Part 1. Climate of the Northeast U.S., NOAA Technical Report NESDIS 142-1. U.S. Department of Commerce, Washington, D.C., 79 pp.

The amount of climate change depends on the emissions path

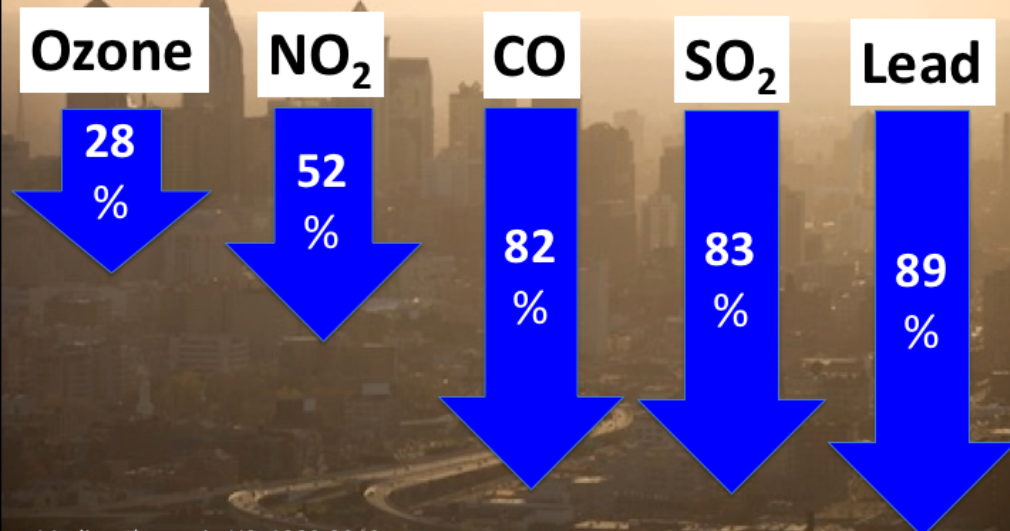


Union of Concerned Scientists, 2008. Climate Change in Pennsylvania: Impacts and Solutions for the Keystone State. Cambridge, MA, 54 pp.

One reason for hope:
Past successes

Image istockphoto

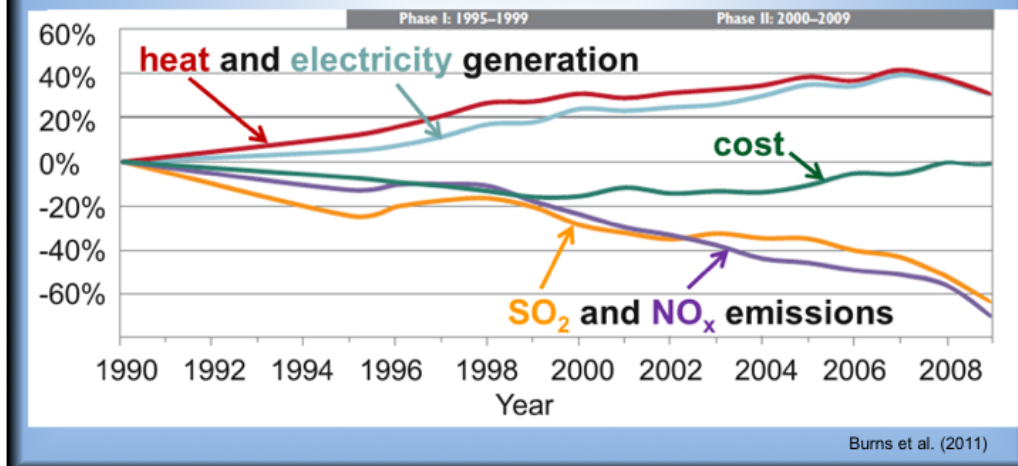
This is happening much less often than
it used to



Median change in US: 1980-2010

Data source: www3.epa.gov/airtrends ThinkStock

The Clean Air act reduced emissions and created \$170 - \$430 billion per year in health benefits—all while energy use went up and costs went down!



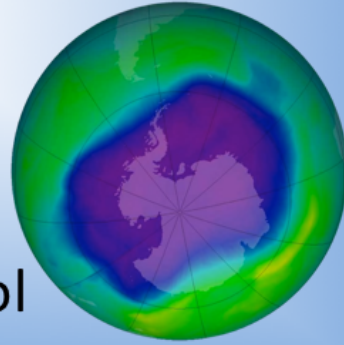
Burns, D.A., Baron, J.S., Cosby, B.J., Fenn, M.E., Lynch, J.A., 2011. National Acid Precipitation Assessment Program Report to Congress 2011: An Integrated Assessment. National Science and Technology Council, United States Government, Washington, D.C., 114 pp.

Other successes

Clean
Water Act



Endangered
Species Act



Montreal Protocol

Blog.nacwa.org, www.nwf.org

Another reason for hope:
People are responding



Paris Climate Conference 2015

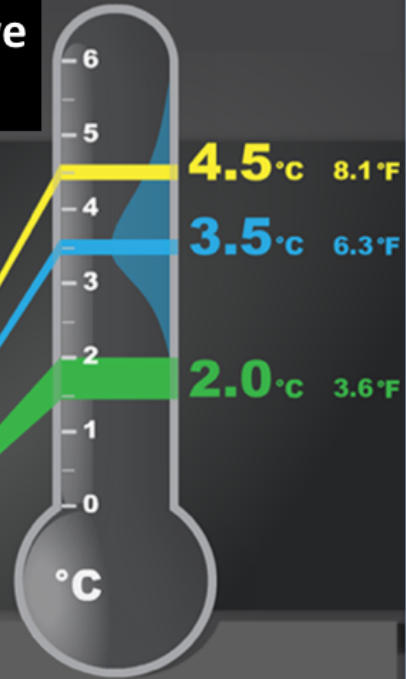
Agreement to keep global warming
well below 2.0 °C (3.6 °F)

Progress, but we have a long way to go

Increase in Global Temperature by 2100

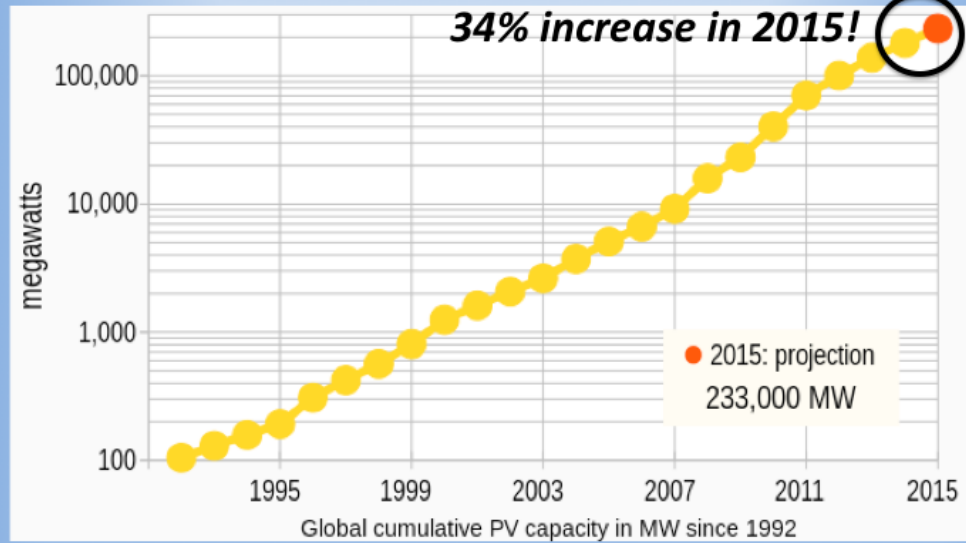
Where will proposals from the climate negotiations lead?

business as usual
proposals
goals



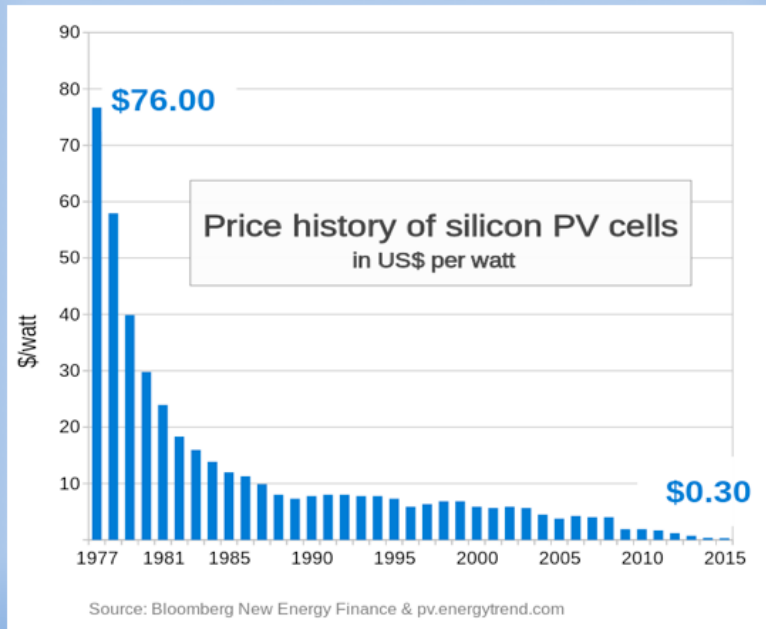
Source: Climate Interactive

Solar energy production increased 2000-fold since 1992

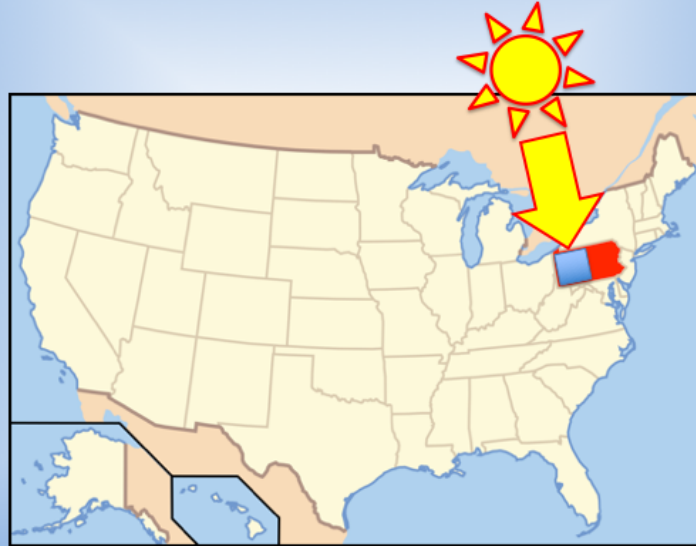


Wikimedia commons and GTM research

The cost to install solar has plummeted



The amount of solar energy falling on half of PA is enough to support all US energy needs



Three examples of national efforts:

The Clean Power Plan



inhabit.com

Efficiency standards



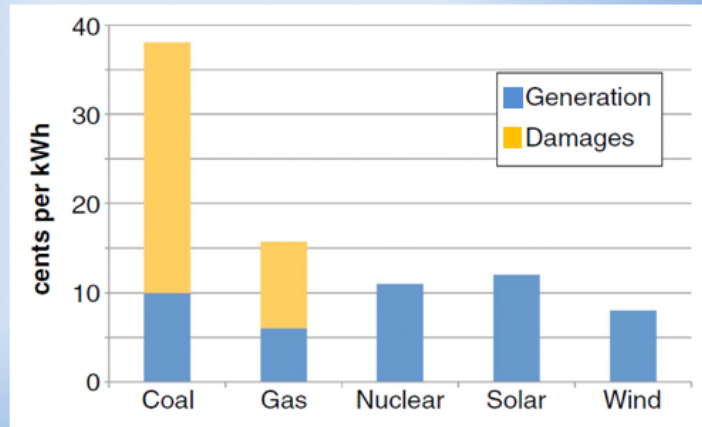
energydigital.com

Carbon Tax or Emissions Cap

 **Citizens' Climate Lobby**

When damages to agriculture and health are considered, new electricity based on renewables is cheapest

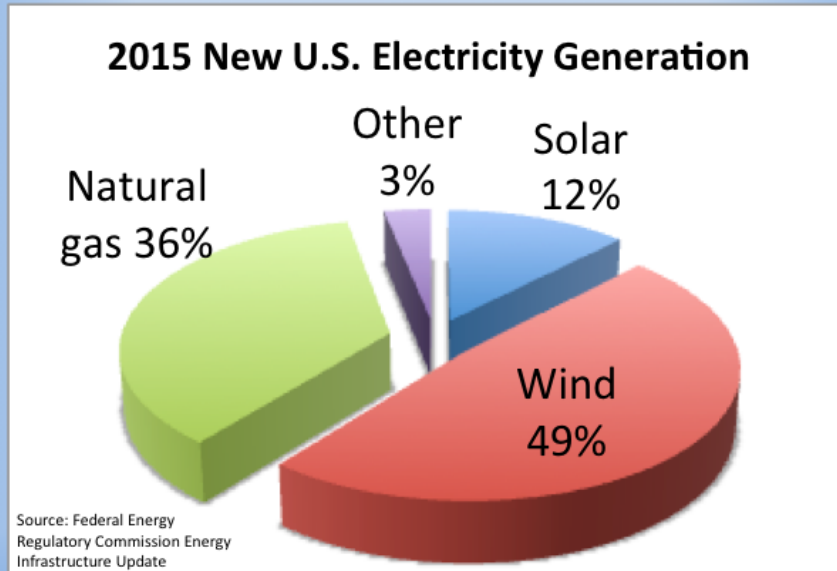
Costs of new US electricity



Shindell (2015)

Shindell, D.T., 2015. The social cost of atmospheric release. *Climatic Change* 130, 313–326.

2/3 of new electricity in the US in 2015
was renewable



Two recommendations for homes and businesses

(1) Energy audit



(2) Purchase electricity from a renewable source

PAPowerSwitch 
Pennsylvania Public Utility Commission

PA Power Switch
Pennsylvania Public Utility Commission

Site Map Glossary Rate Change Alerts Tell A Neighbor En Español

Home Switching Power **Shop For Electricity** Fixed & Variable Your Rights & Protections Ways to Save Energy FAQs

Switching power is easier than ever.

Be sure to choose:

- (1) FIXED rate
- (2) NO cancellation fee
- (3) 100% renewable energy

ZIP CODE **GO »**

Are you a commercial customer?

Do individuals need to prepare for climate change?

It depends on the time frame.

Examples

Planting a vegetable garden?



Don't worry about it

Planting a tree?



Consider passing on trees at their southern limit in PA, like the sugar maple

Do cities, states, and nations need to prepare for climate change?

Yes! Many decisions will be felt for decades.



Coastalnewstoday.com, www.eatoncounty.org, www.lakearrowhead.com, www.innovativewatertechnologies.co.in,

Education and adaptation are essential

Factsheets from the PA Climate Impacts Report



<http://psiee.psu.edu/climate-impacts>

Bottom lines about global warming:

- ◆ It's real
- ◆ It's us
- ◆ It's a serious threat
- ◆ It's solvable through emissions reductions and adaptation