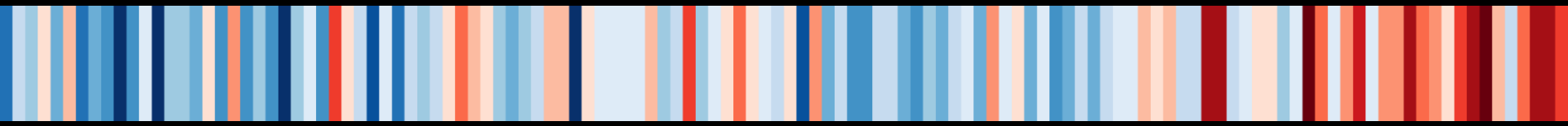
# Carbon Dioxide: What, Why, How?

Victoria Coles

University of Maryland Center for Environmental Science

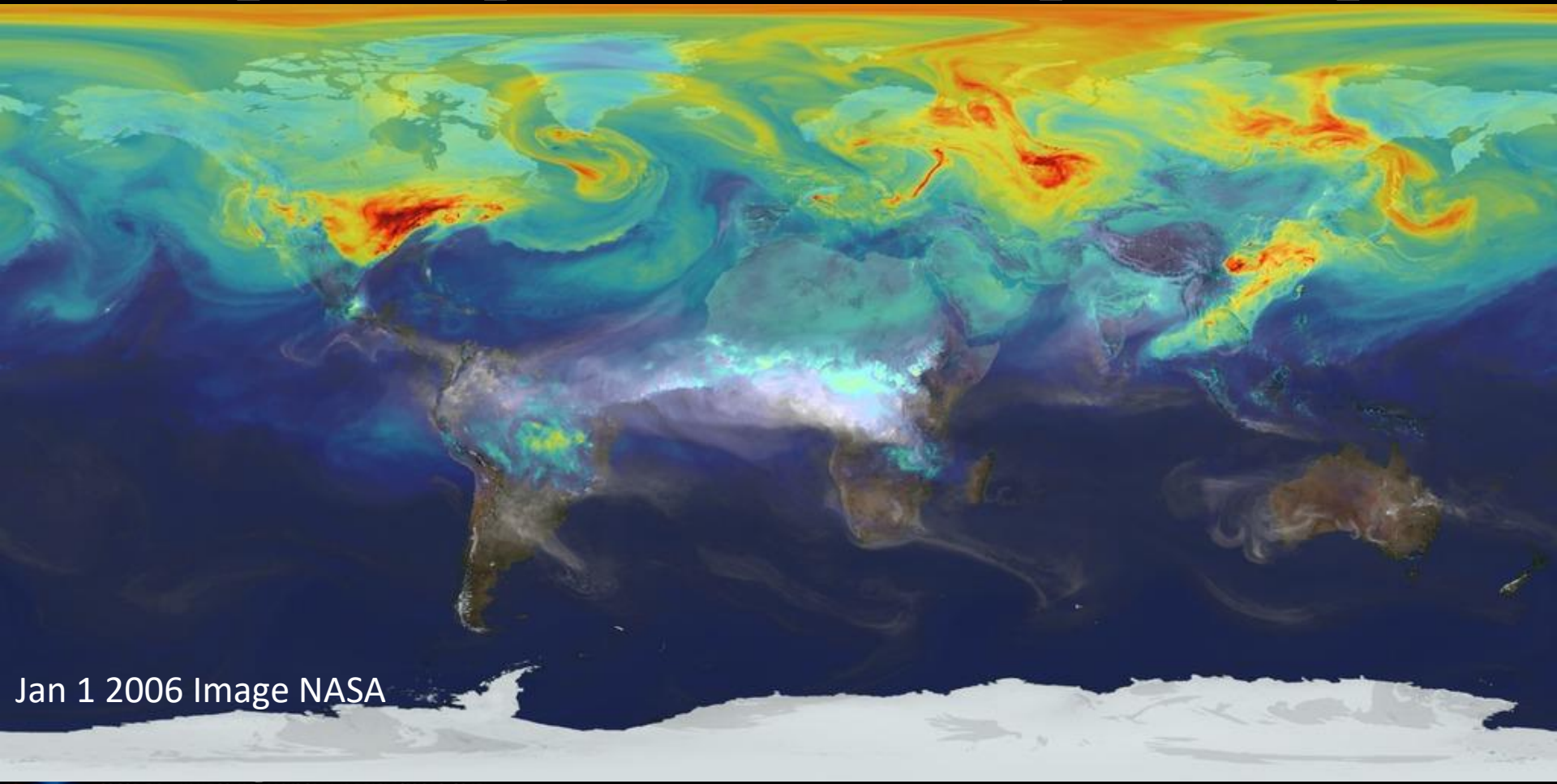
University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
HORN POINT LABORATORY



What is $CO_2$?
Why do we care about it?
How did it change in the past?
How is it changing now?
How does it affect Maryland?

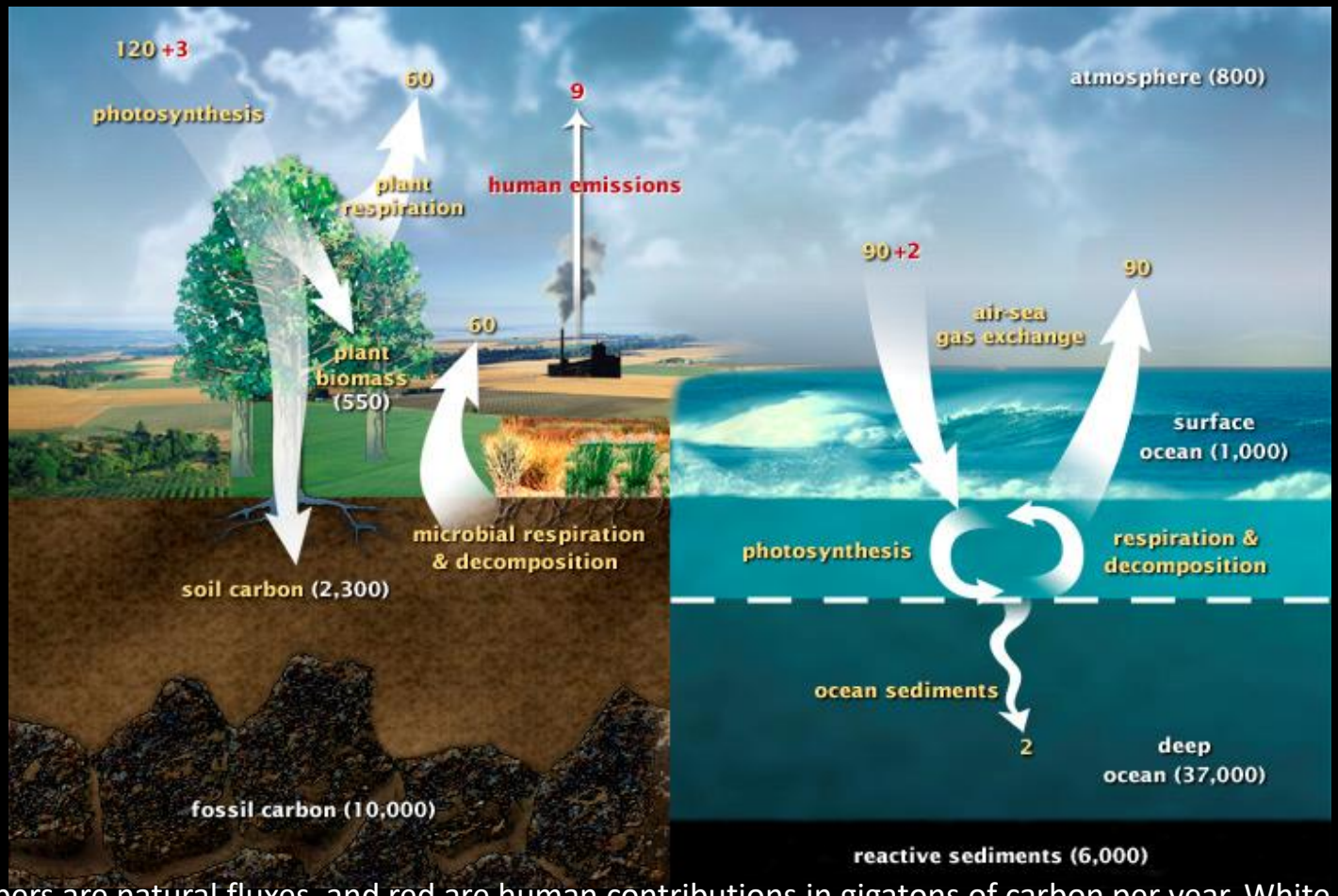
$CO_2$ is a naturally occurring gas that is absorbed by plants and stored as biomass (sugars) and released when plant biomass is used for energy

$$6CO_2 + 6H_2O + \text{sunlight energy} \rightarrow C_6H_{12}O_6 + 6O_2$$



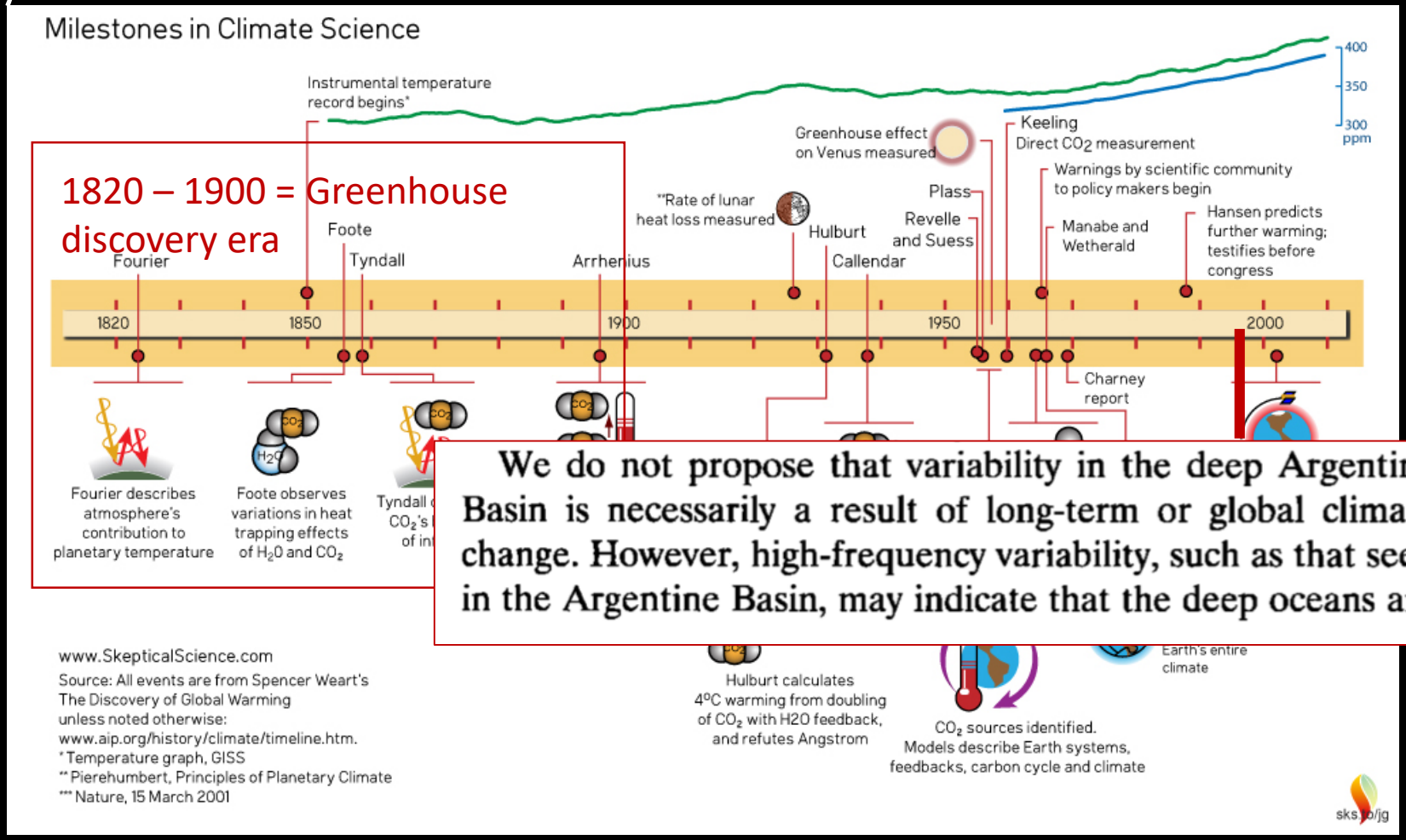
Jan 1 2006 Image NASA

Large fluxes of carbon exchange between atmosphere, land, and ocean, but human emissions create an imbalance leading to accumulation in the atmosphere.



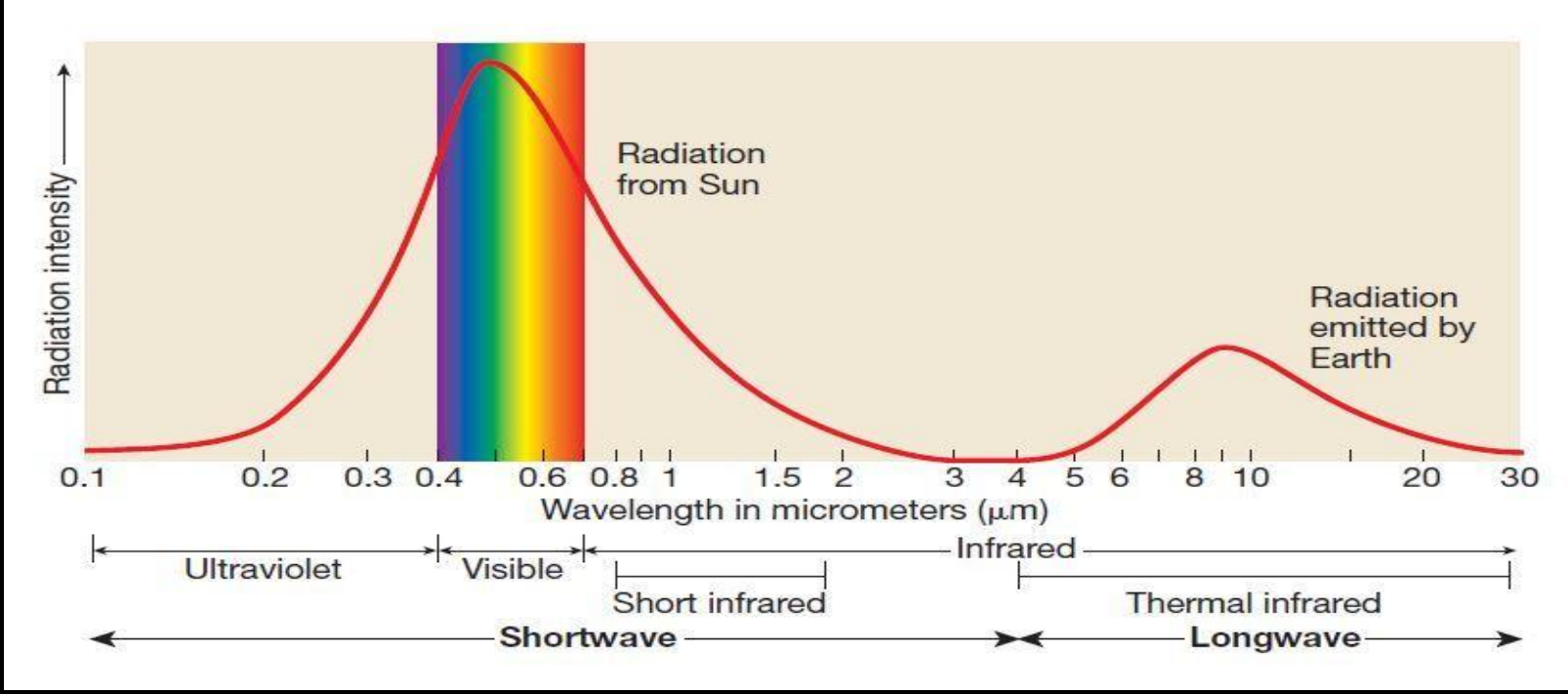

Yellow numbers are natural fluxes, and red are human contributions in gigatons of carbon per year. White numbers indicate stored carbon. (Diagram adapted from U.S. DOE, Biological and Environmental Research Information System.)

Theory of the greenhouse effect has been well understood for over 100 years.

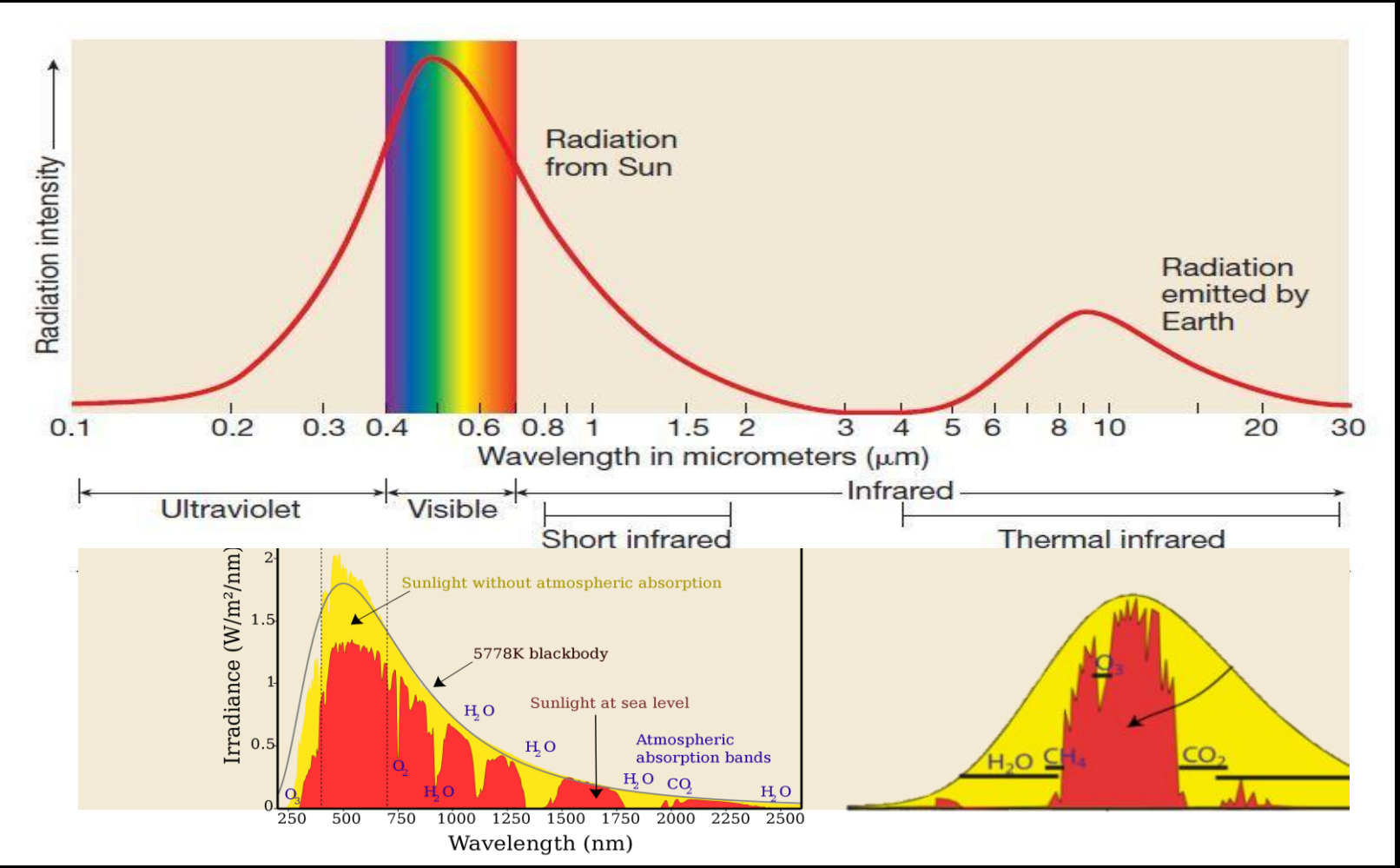



https://skepticalscience.com/graphics.php?g=59

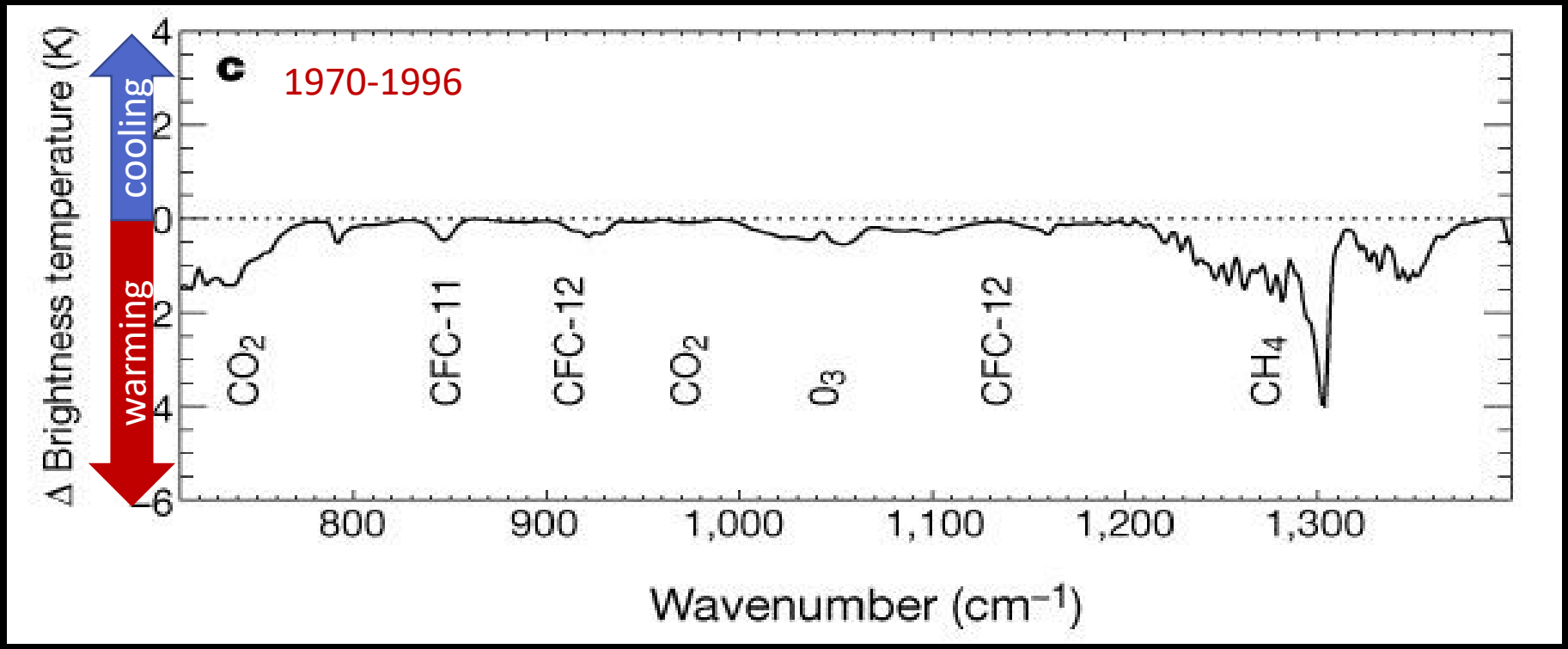
Because the sun is hot, it produces short wavelength energy.
Because the earth is cool, it produces long wavelength energy



Solar wavelength energy is not absorbed in the atmosphere by $CO_2$ (much).
Earth wavelength energy is absorbed by $CO_2$ (in a gap where water vapor is not active).

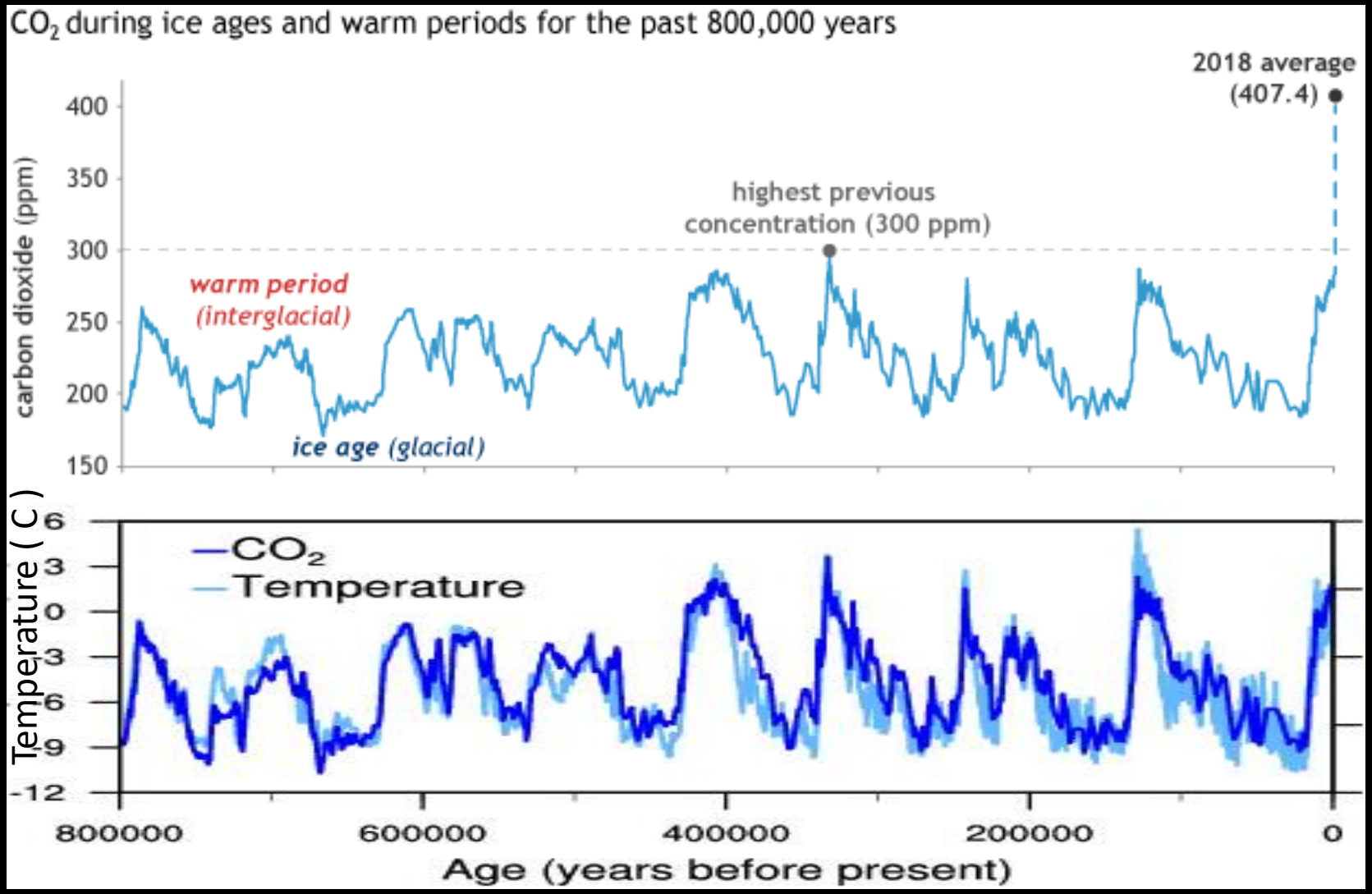


Satellite observations comparing 1970 to 1996 show warming from more longwave absorption  consistent with theory.



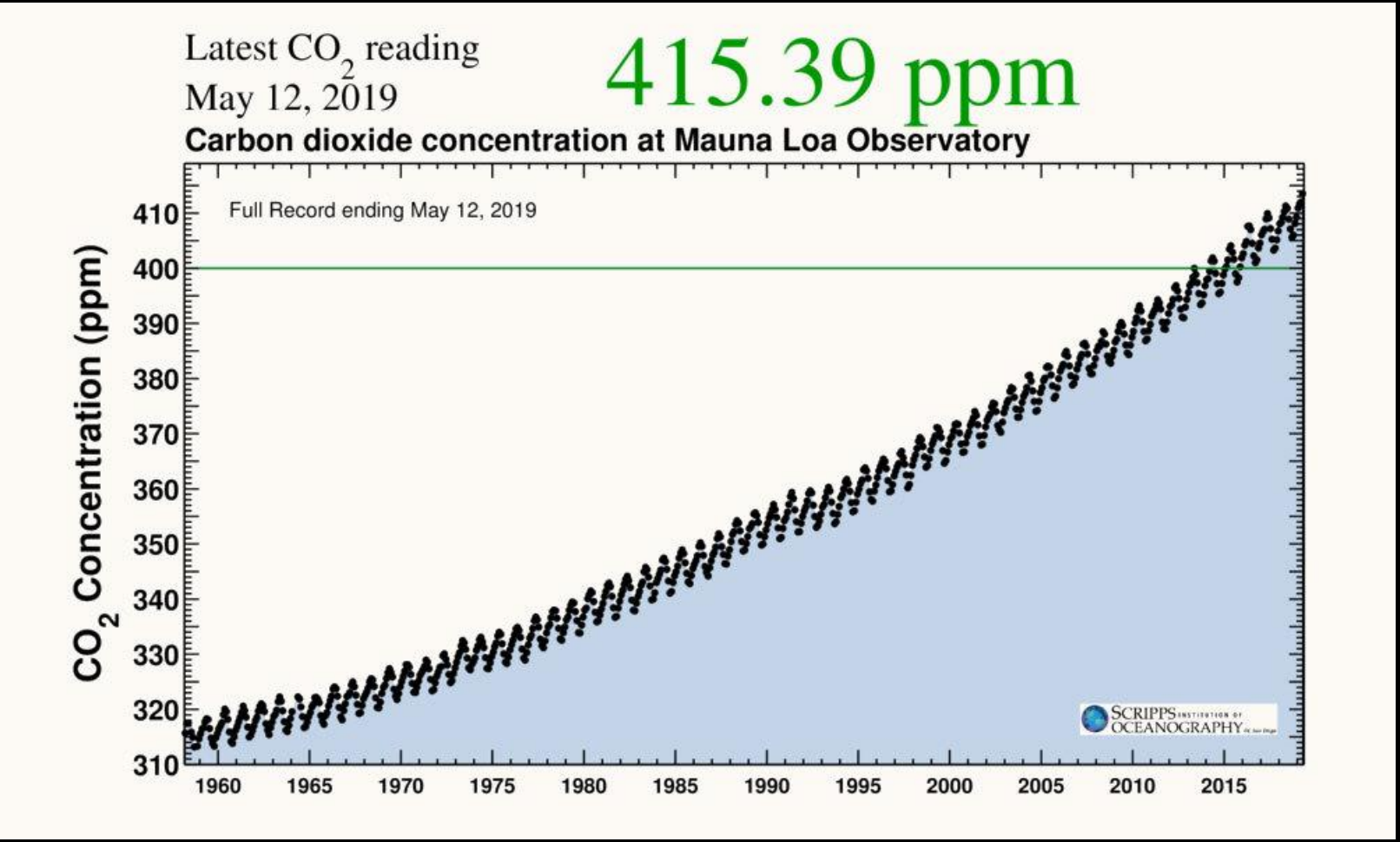

Harries et al 2001

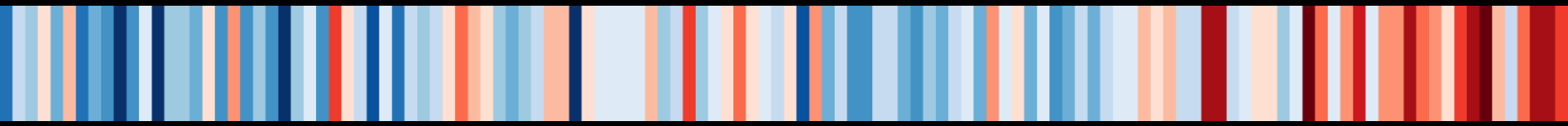
# In the past, glacial and interglacial CO2 and temperature varied together



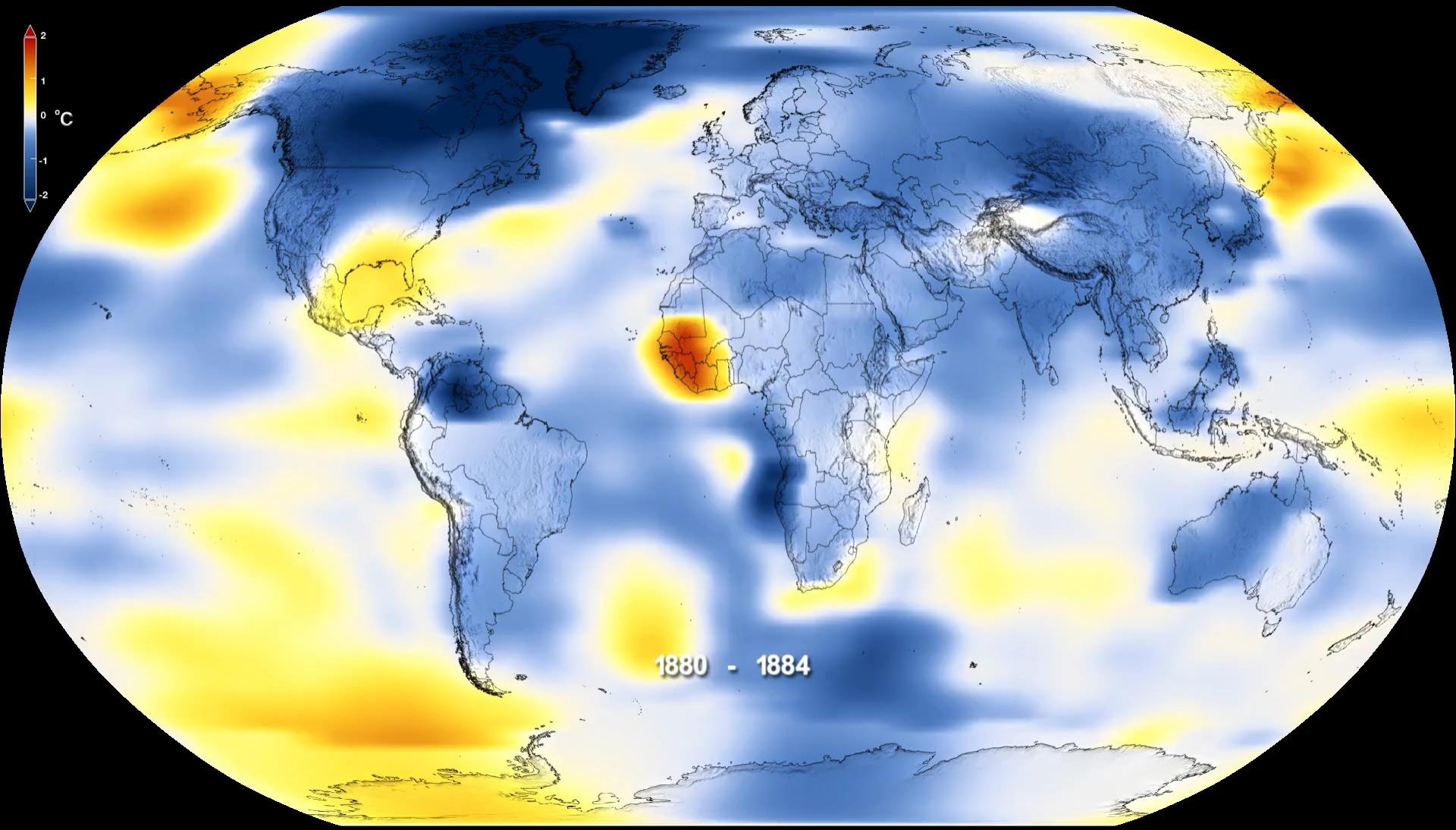

(Graphs by Robert Simmon, using data from Lüthi et al., 2008, and Jouzel et al., 2007.)
https://earthobservatory.nasa.gov/features/CarbonCycle

Humans are increasing atmospheric carbon dioxide rapidly.

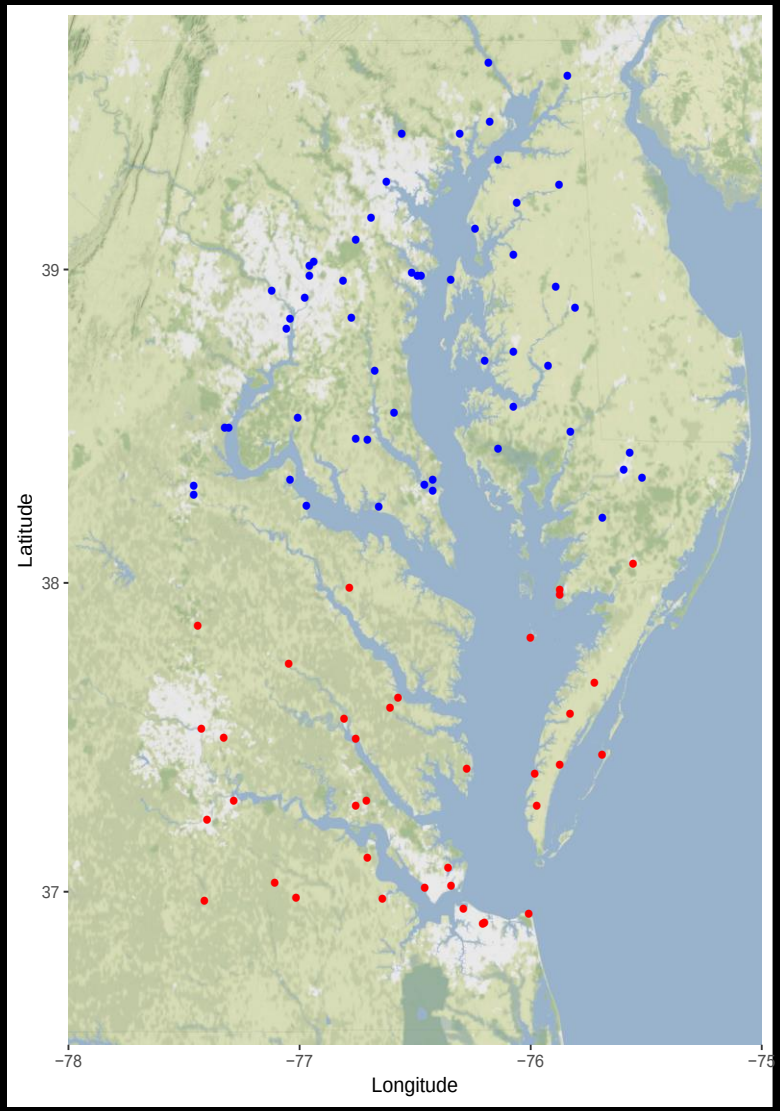




# Globally temperatures have risen sharply from 1880 to 2018

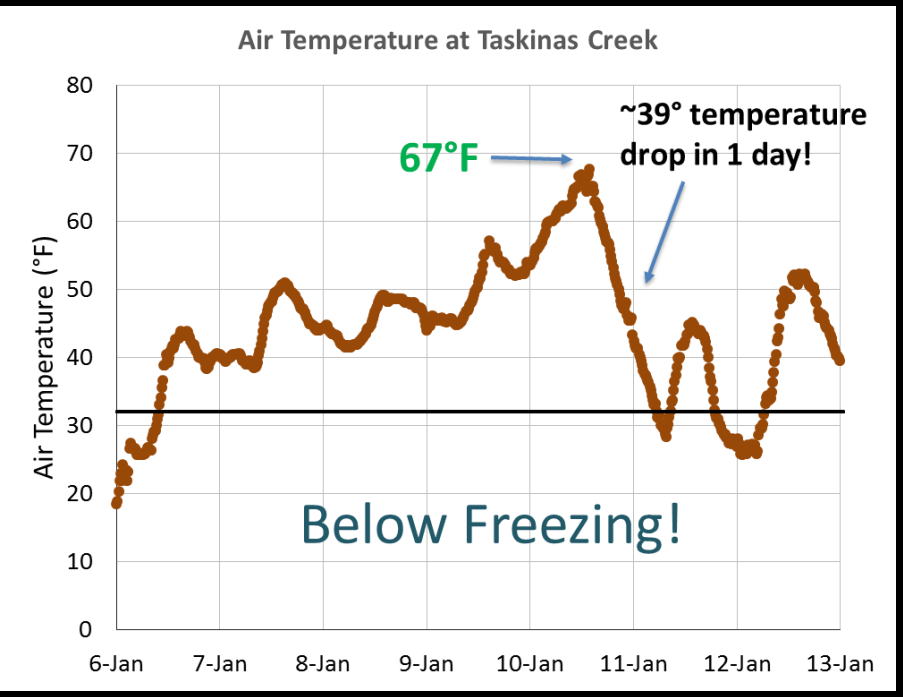


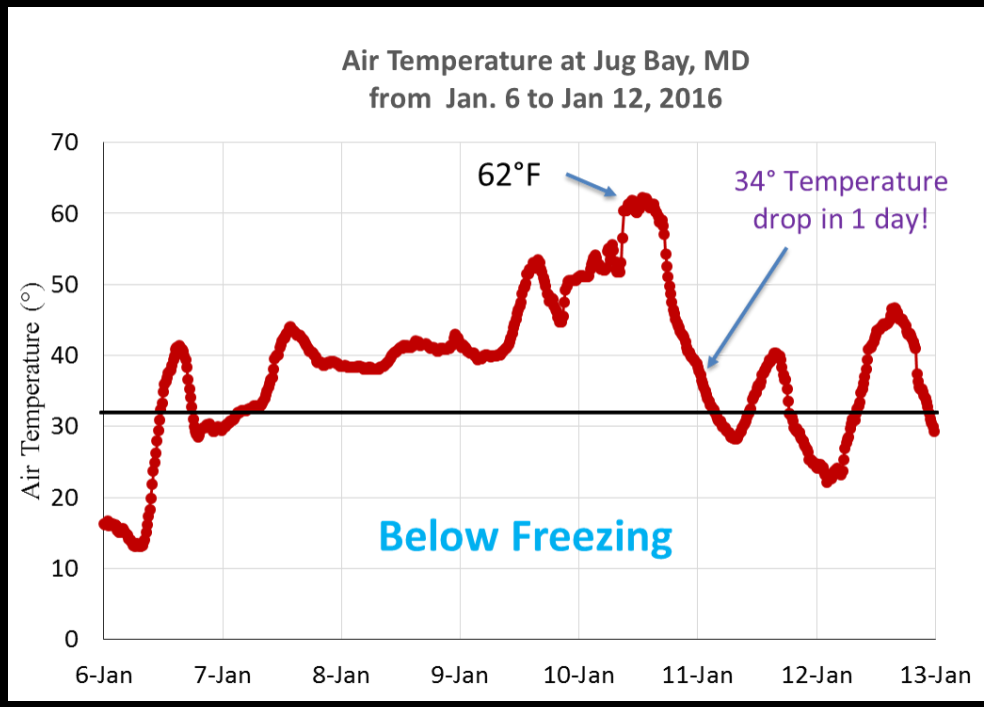
146 weather stations examined in the Chesapeake Bay nearshore region.



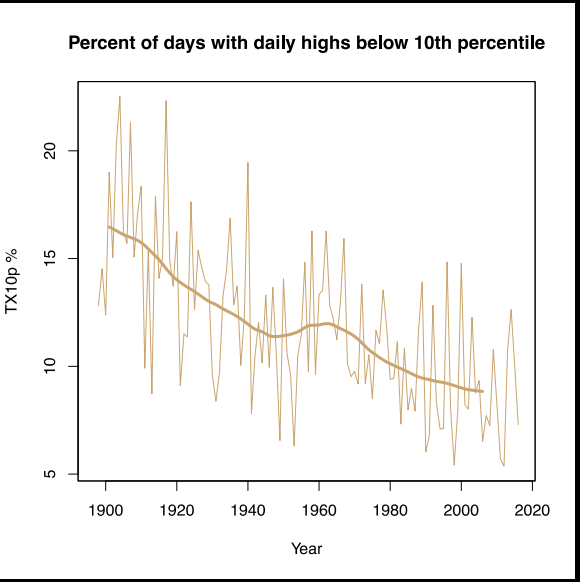
# Why Extremes?

- Climate is not weather… But climate extremes are measures of changing weather.
- Organisms, feel variability, highs, and lows (not annual means).
- Helpful in understanding environmental boundary changes, thresholds, tipping points…

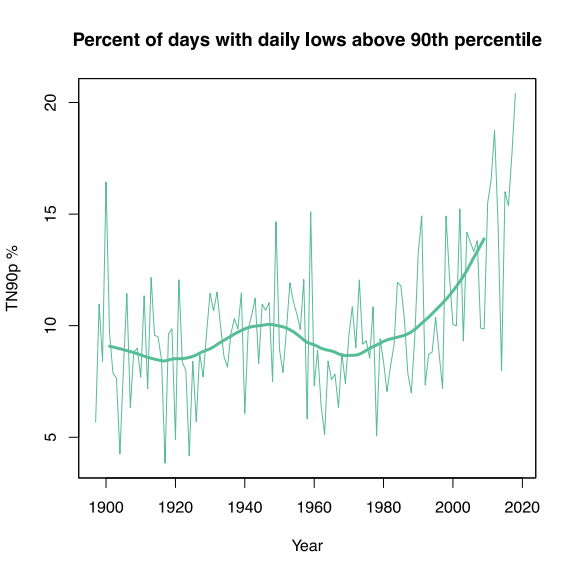


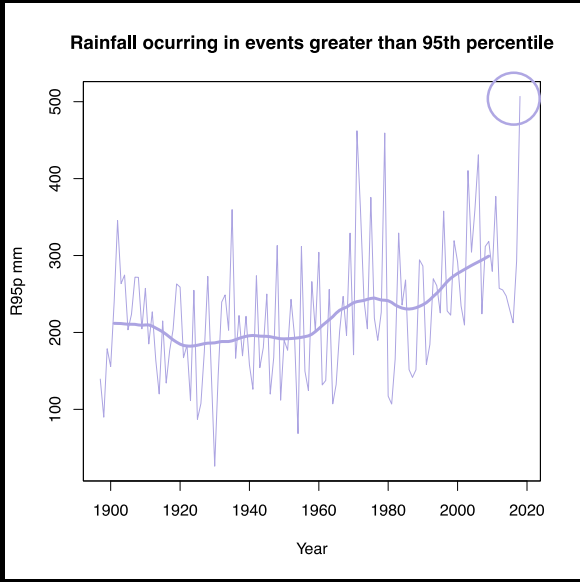
# What changes were observed over the past century for MD?




Number of cold days decreased (10th percentile)



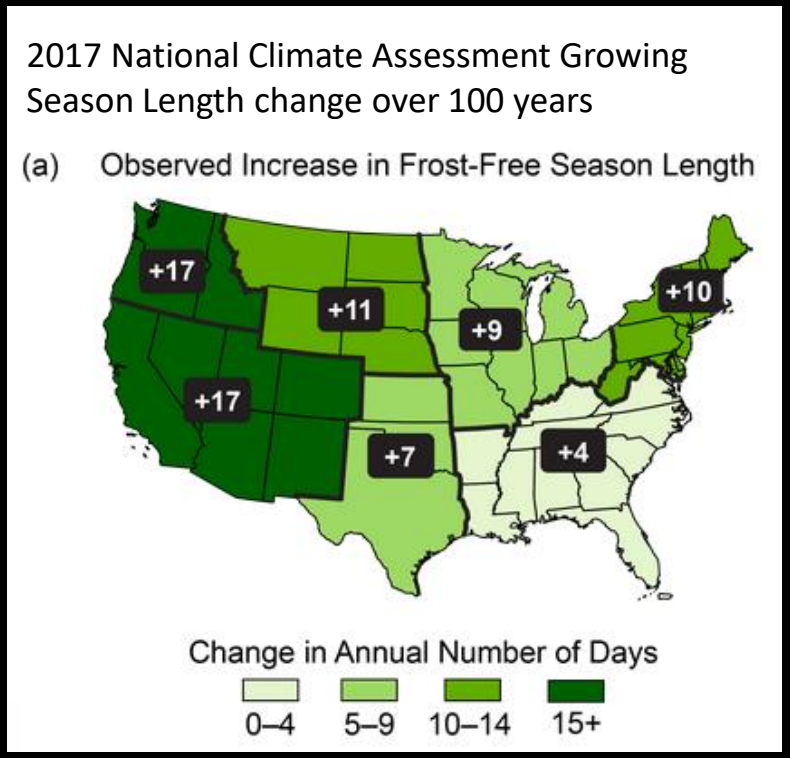

Number of warm spells (especially nighttime) increased (90th percentile)

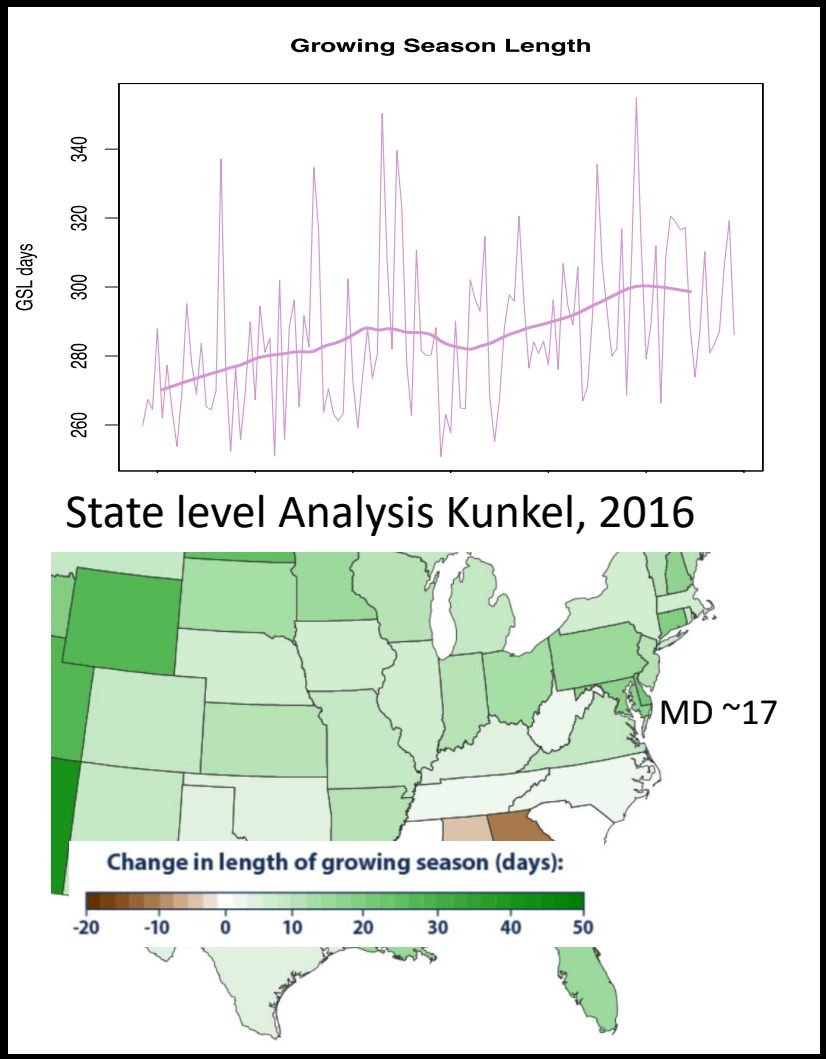



Rainfall from heavy events has increased (top 5th percentile)

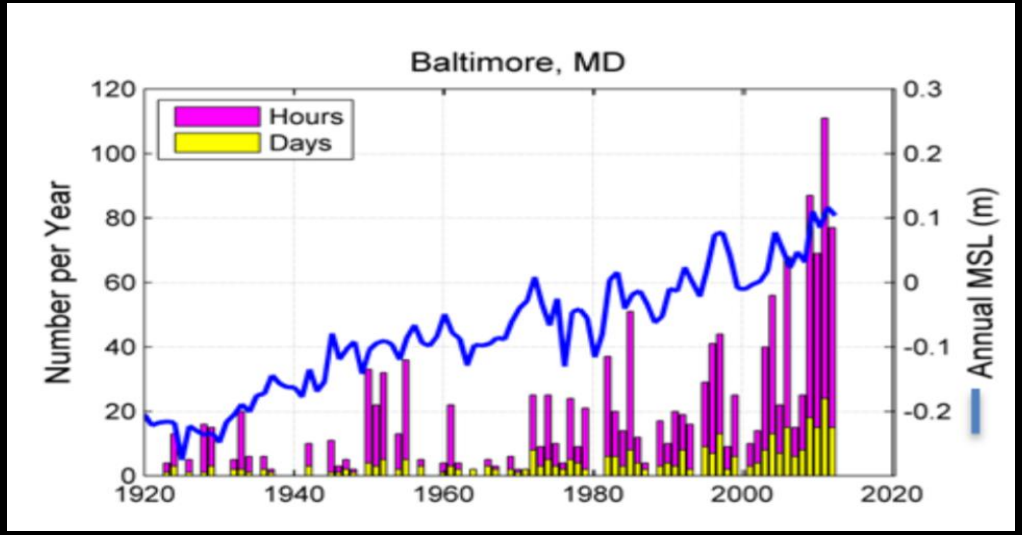
Chesapeake Bay area is not like the Northeast, or the Southeast, or like Maryland in general.

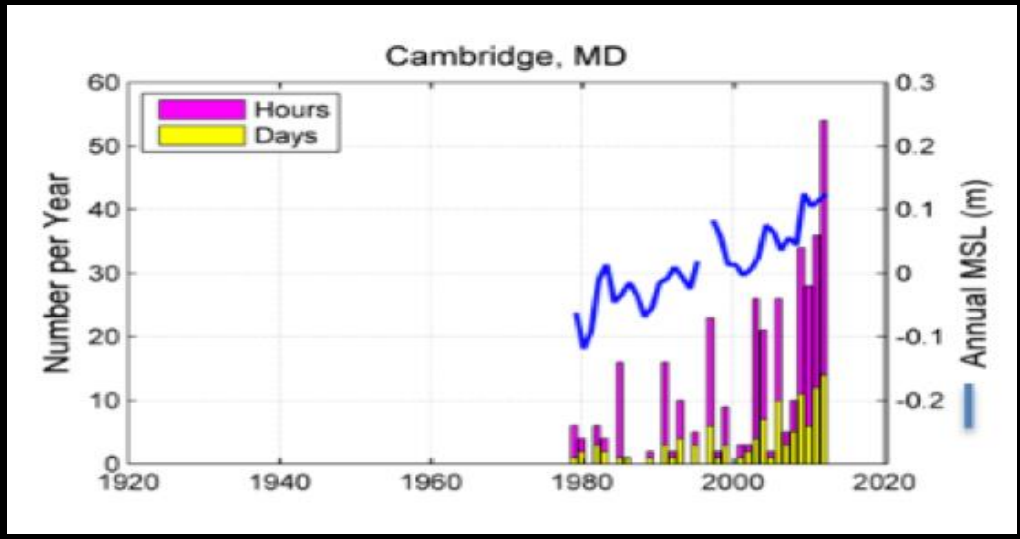
24 day increase in growing season length over past century.



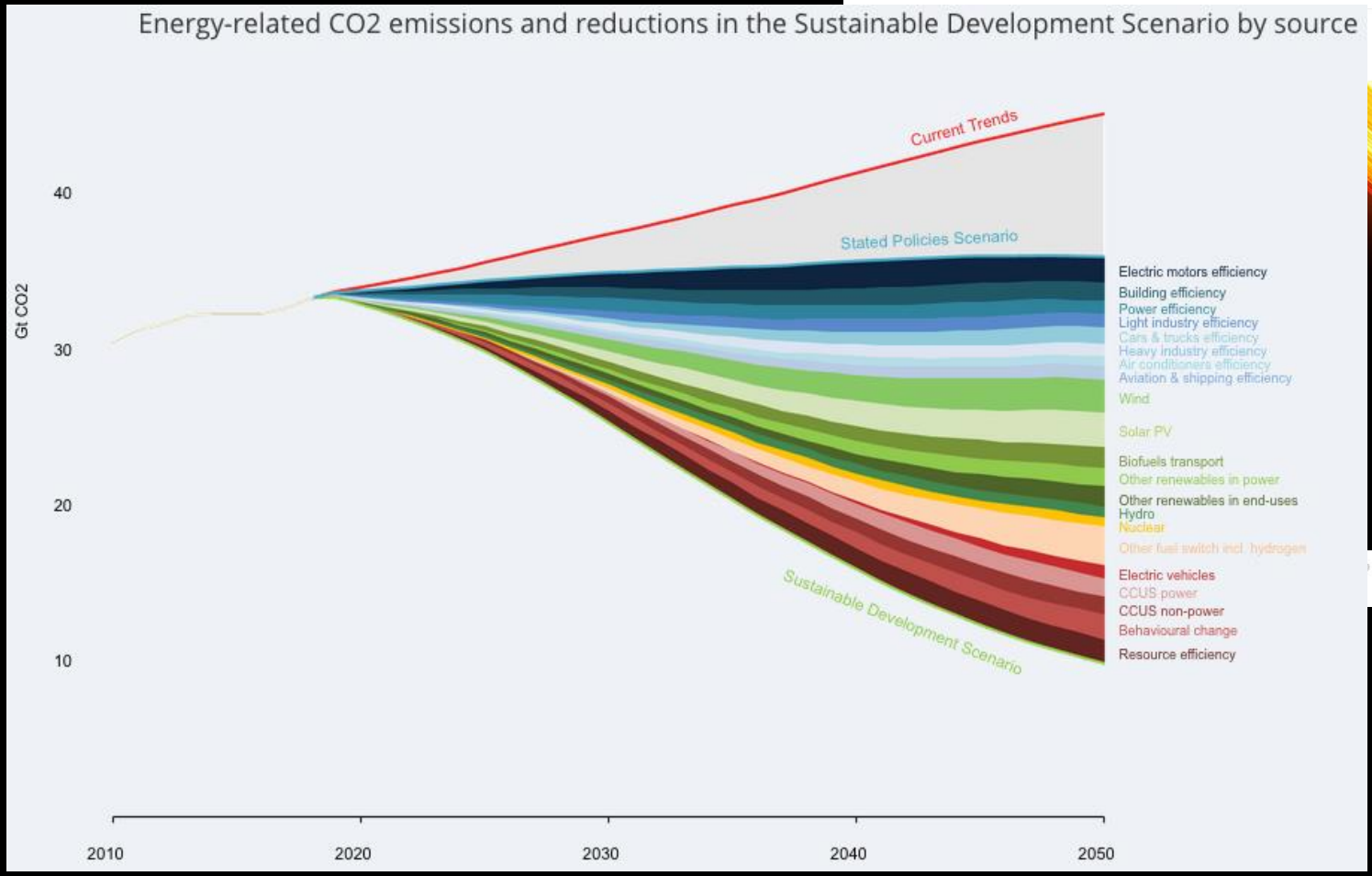
Nuisance flooding (more than 1.5 feet above high water) is increasing rapidly.

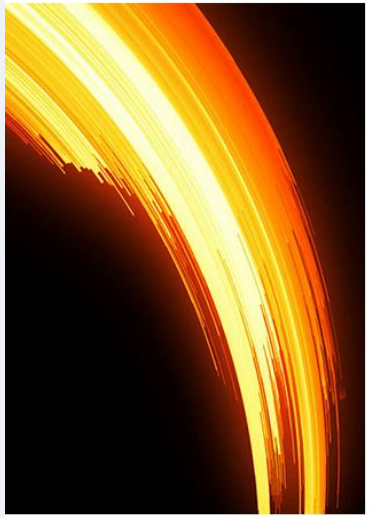


# There are paths forward…

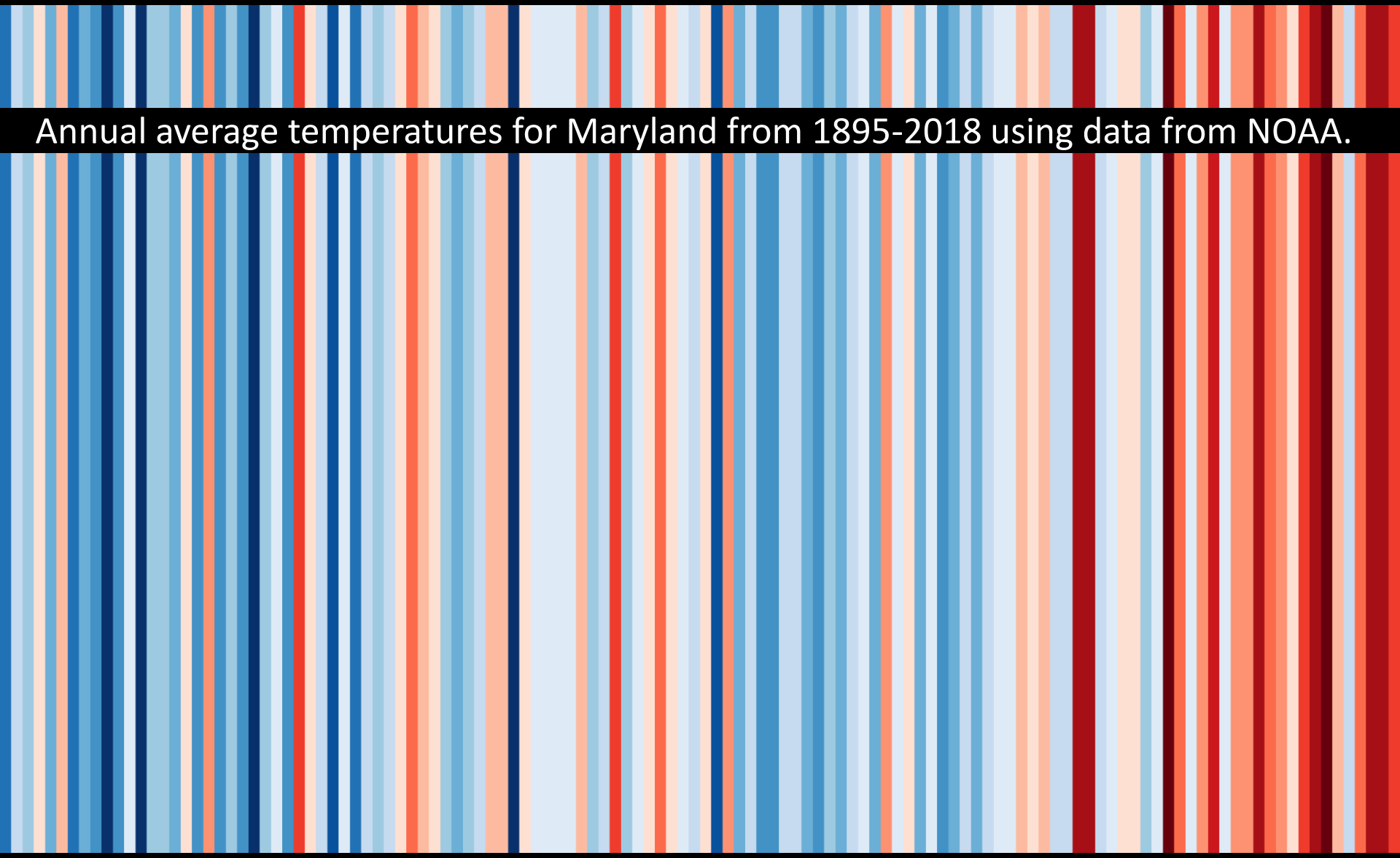
World Energy Outlook 2019 highlights deep disparities in the global energy system



put the world on a path to a secure and sustainable

https://www.iea.org/weo2019/




https://showyourstripes.info/ Courtesy Ed Hawkins