## Introduction to Earth's Climate System

# Climate Change in the Recent Past

**MODULE 2.5**

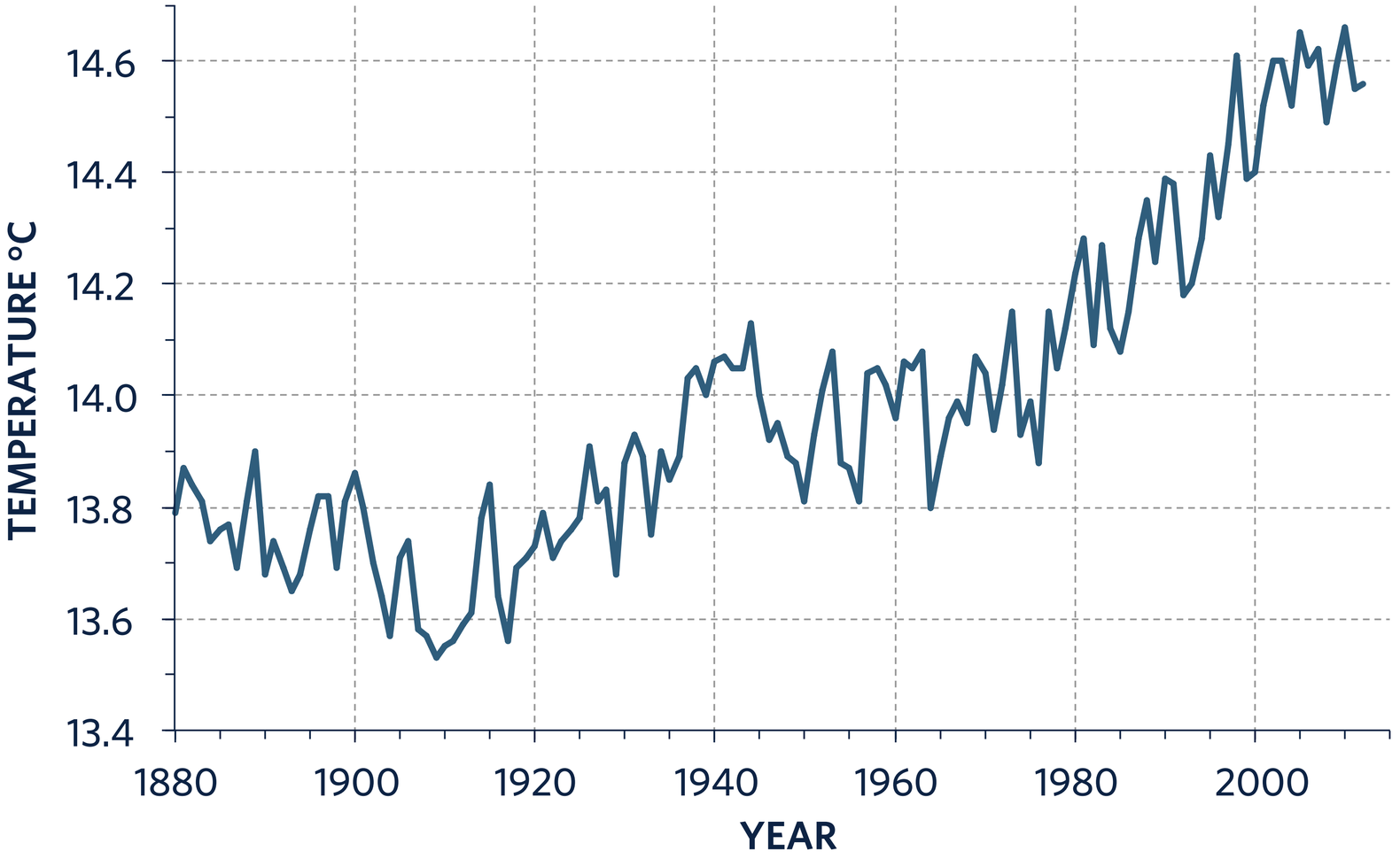
# 2.5 Climate Change in the Recent Past

**Lesson Goals:**

» Describe trajectories of various climate metrics since the Industrial Revolution (e.g. temperature, sea level, ice cover, greenhouse gas concentrations)

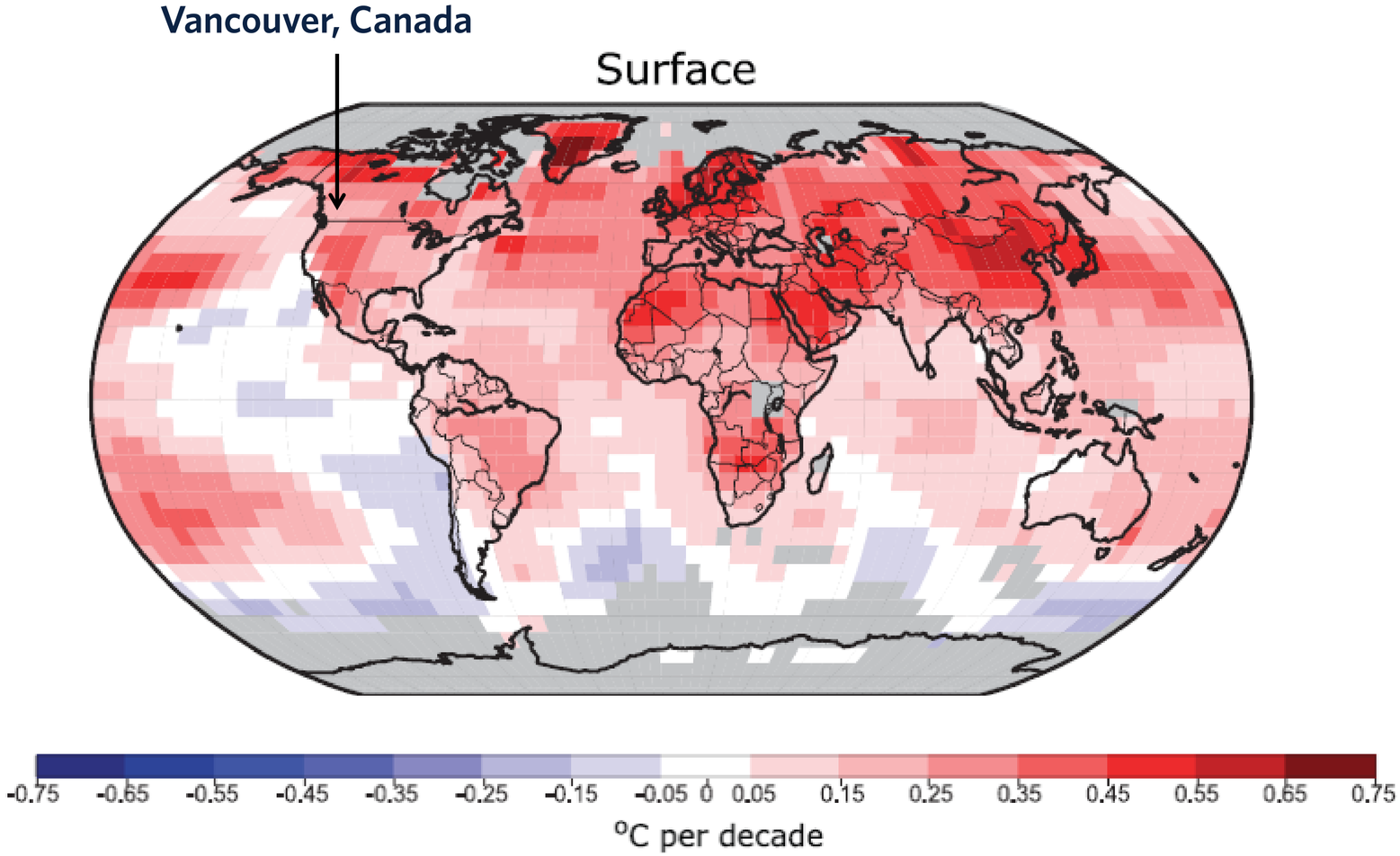
» Compare today's climate trajectories and rates of change to the climate context of the past one million years.

# Global temperatures increased about 1°C in the past century




DATA: NASA GISS HTTP://DATA.GISS.NASA.GOV/GISTEMP/TABLEDATA_V3/GLB.TS+DSST.TXT

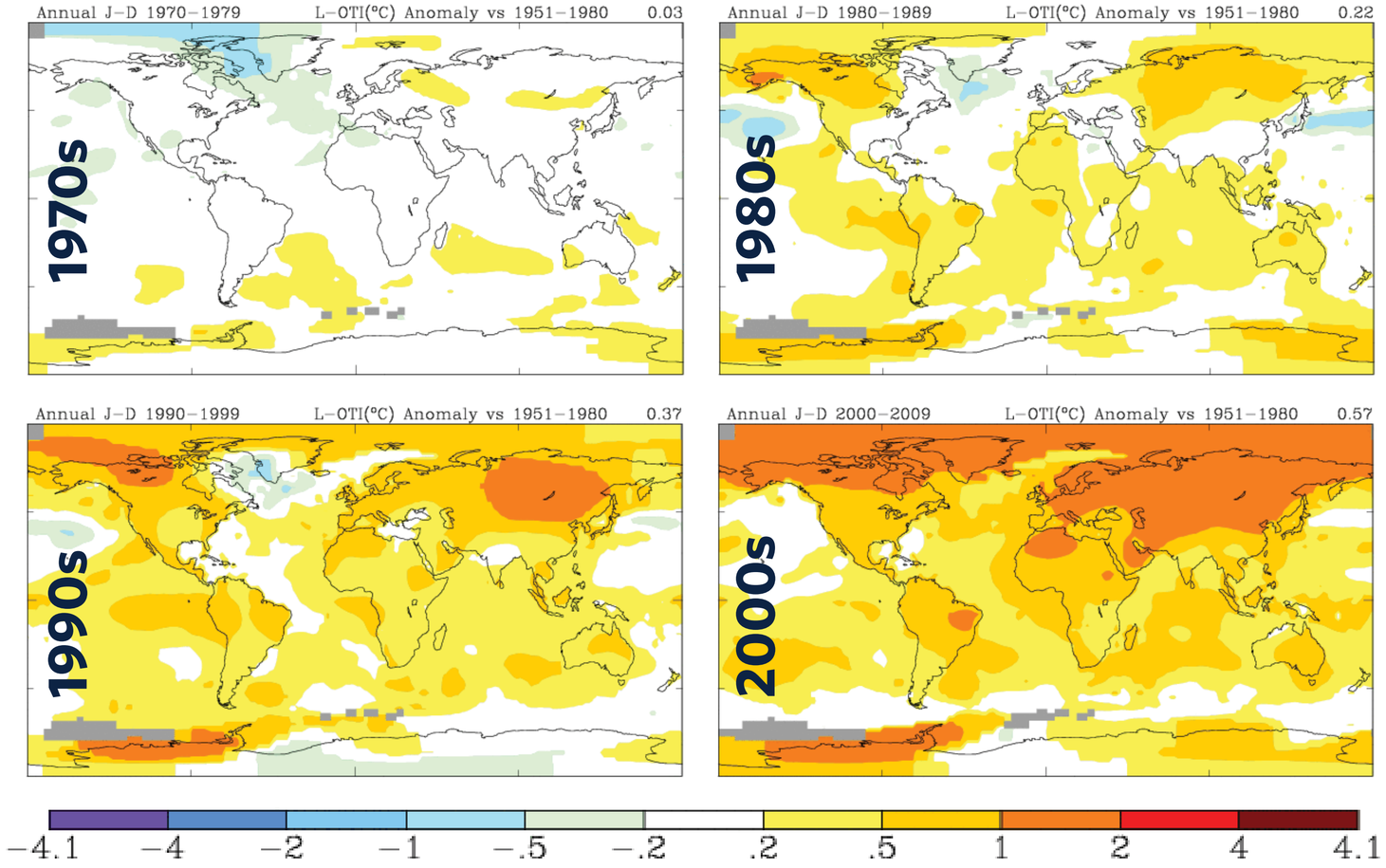
# Regional differences: Surface T




FROM 1979 TO 2005

IPCC, 2007

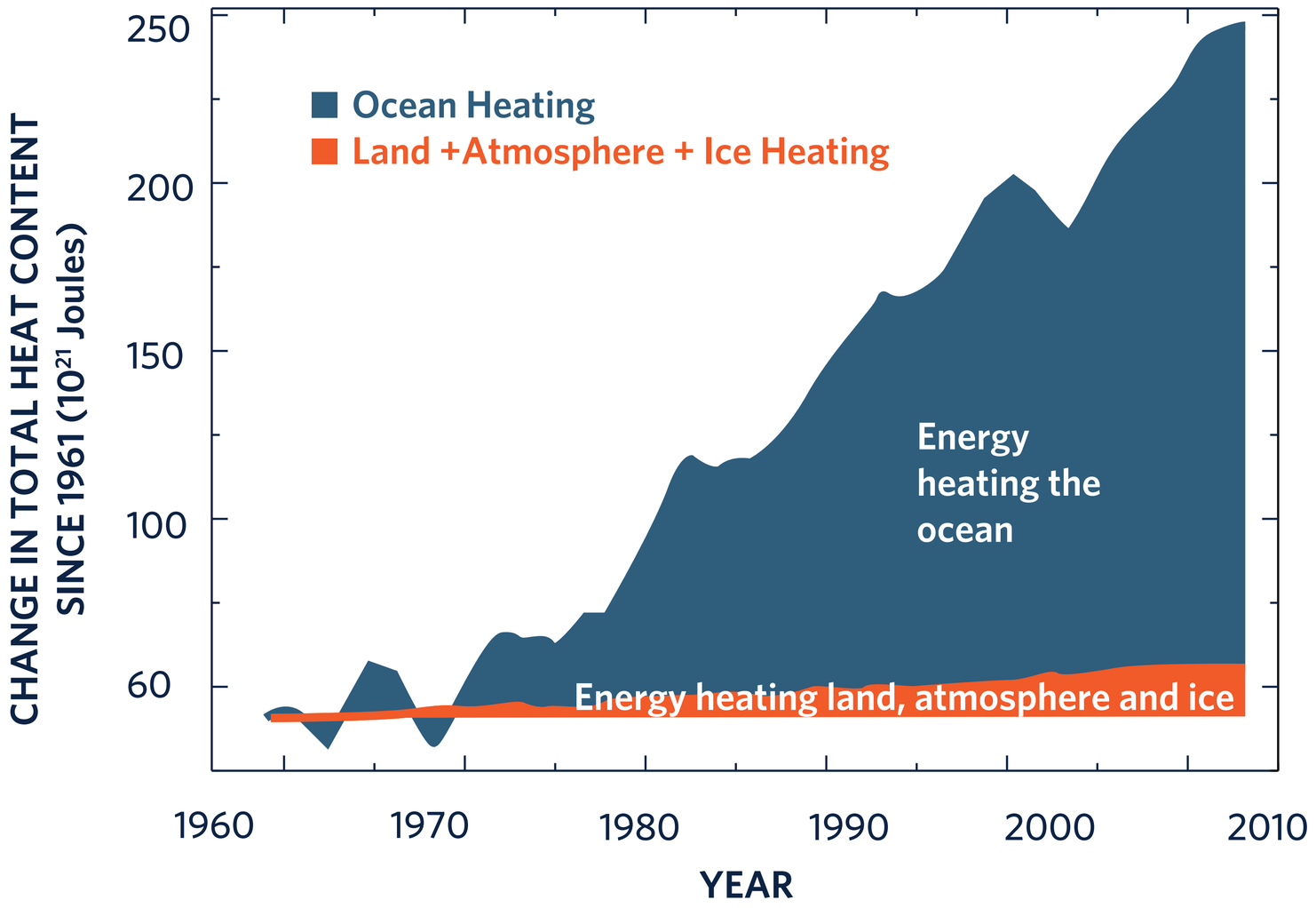
# The last four decades




SURFACE TEMPERATURE CHANGES (°C) RELATIVE TO THE 1951-1980 AVERAGE

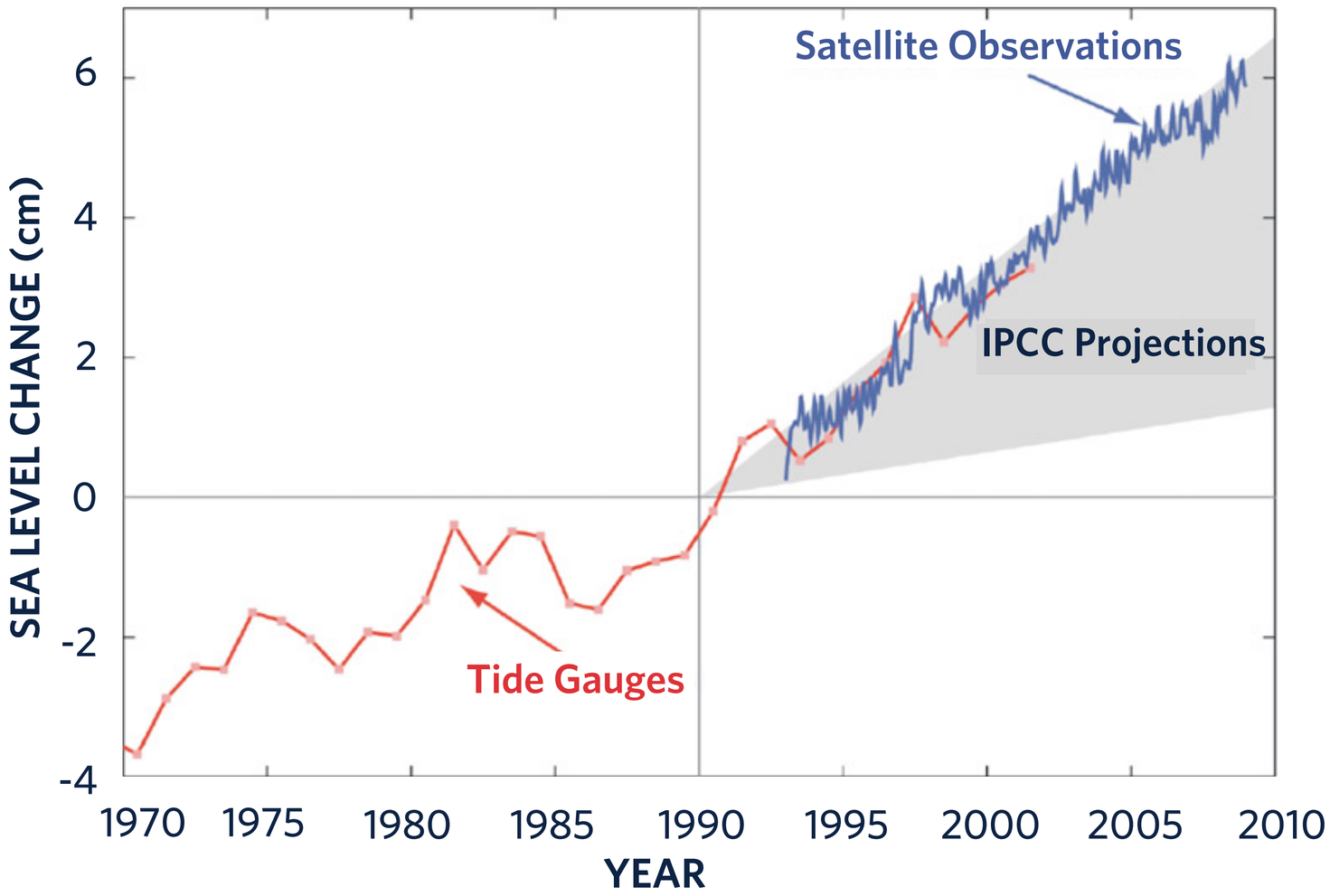
HTTP://DATA.GISS.NASA.GOV/GISTEMP/MAPS/

# Change in Earth's Total Heat Content




SKEPTICAL SCIENCE GRAPHICS, HTTP://WWW.SKEPTICALSCIENCE.COM/GRAPHICS/TOTAL_HEAT_CONTENT_2011.JPG

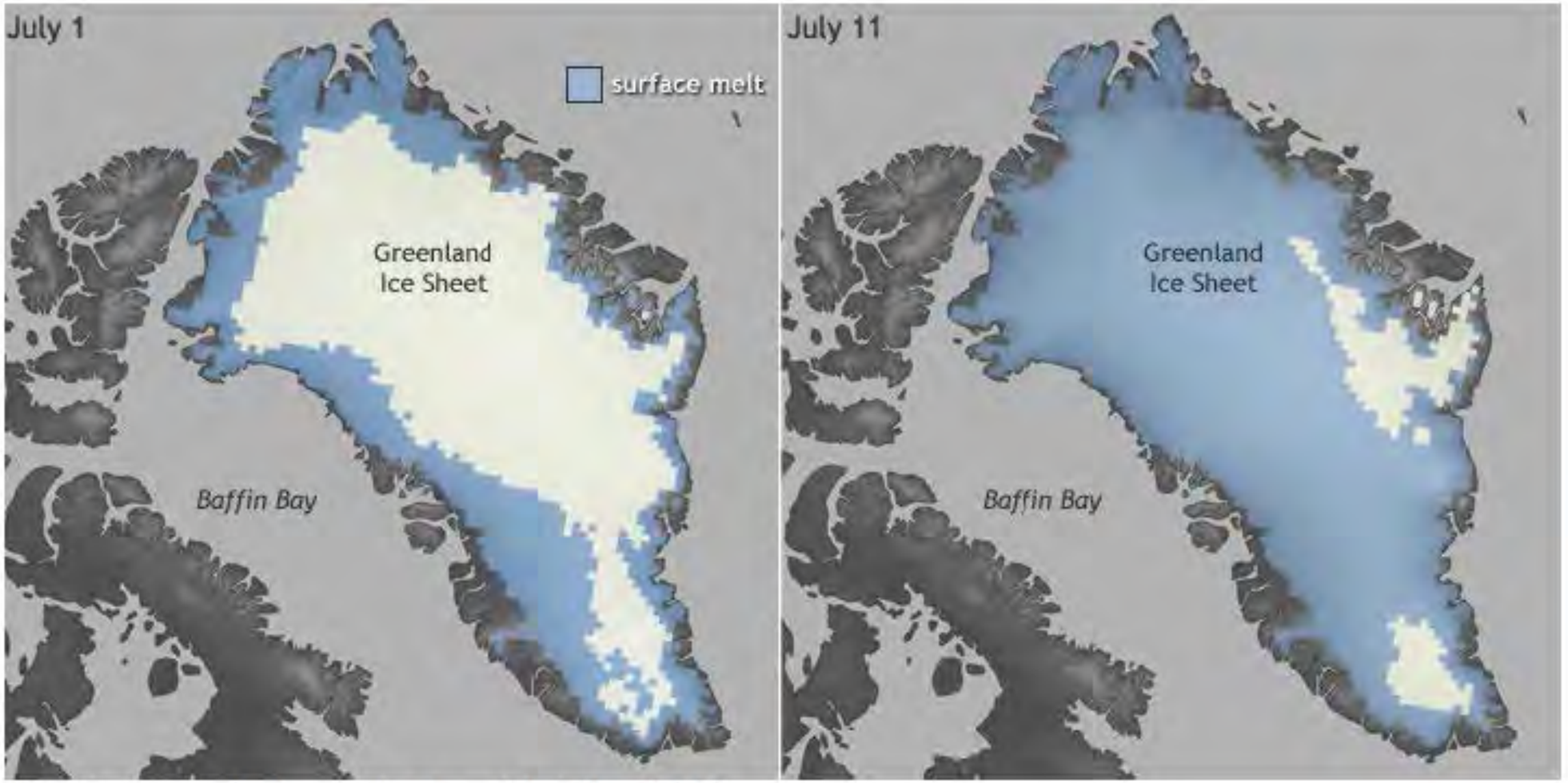
# Sea level rise




## How many cm?

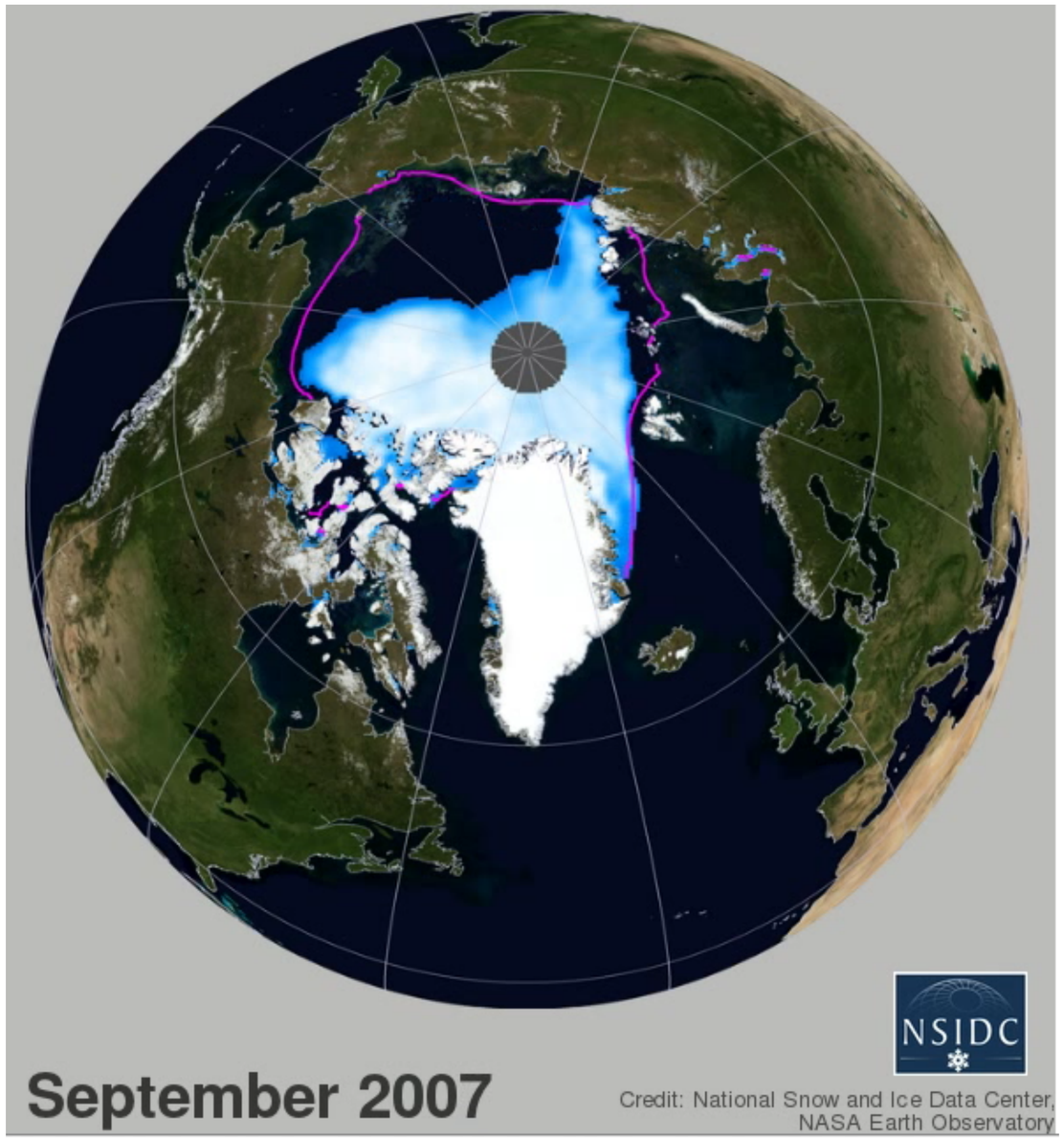
COPENHAGEN DIAGNOSIS 2009
HTTP://SKS.TO/MODEL

# Land ice: melting on Greenland



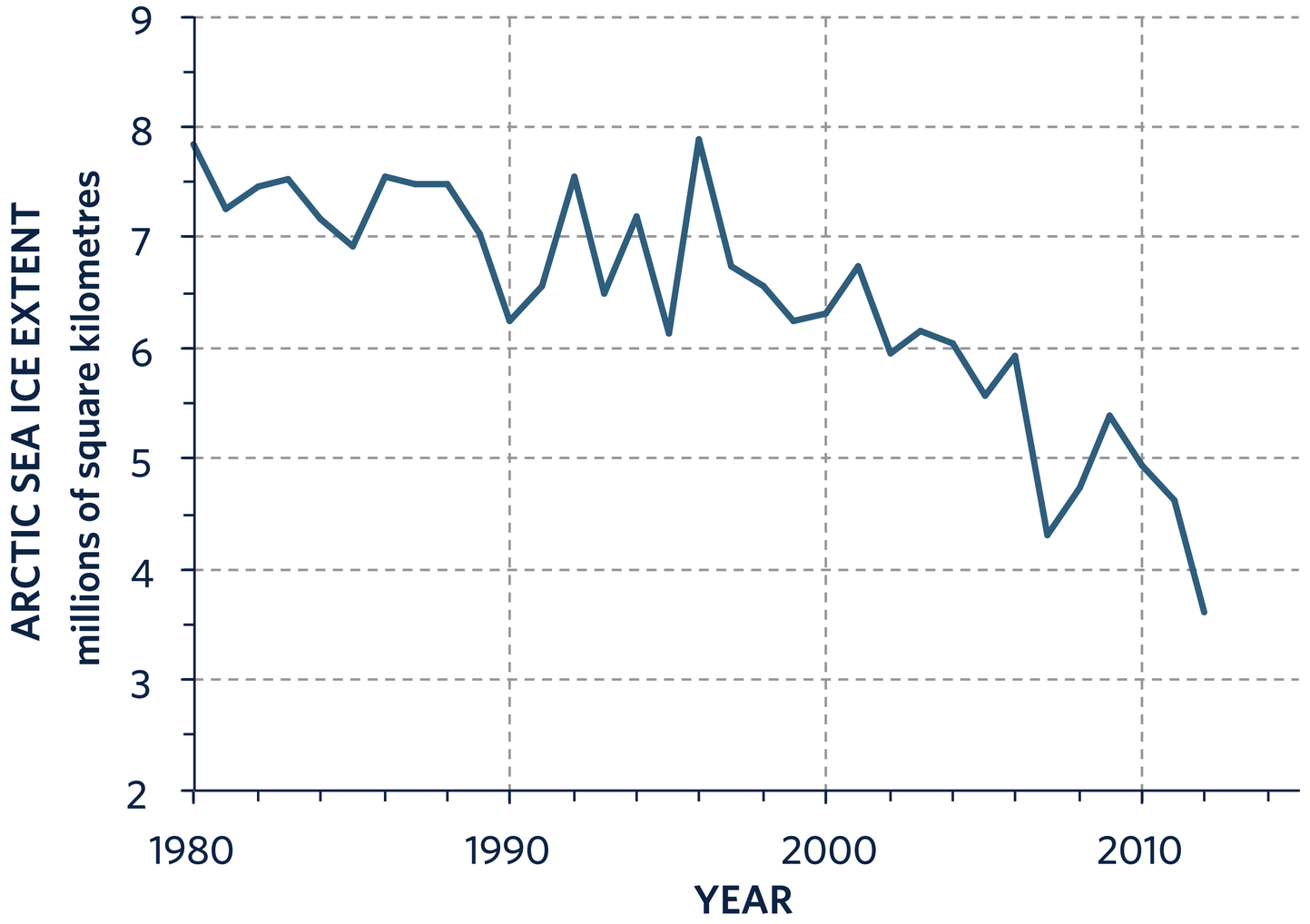

Surface melt in early & mid-July, 2012.

NOAA



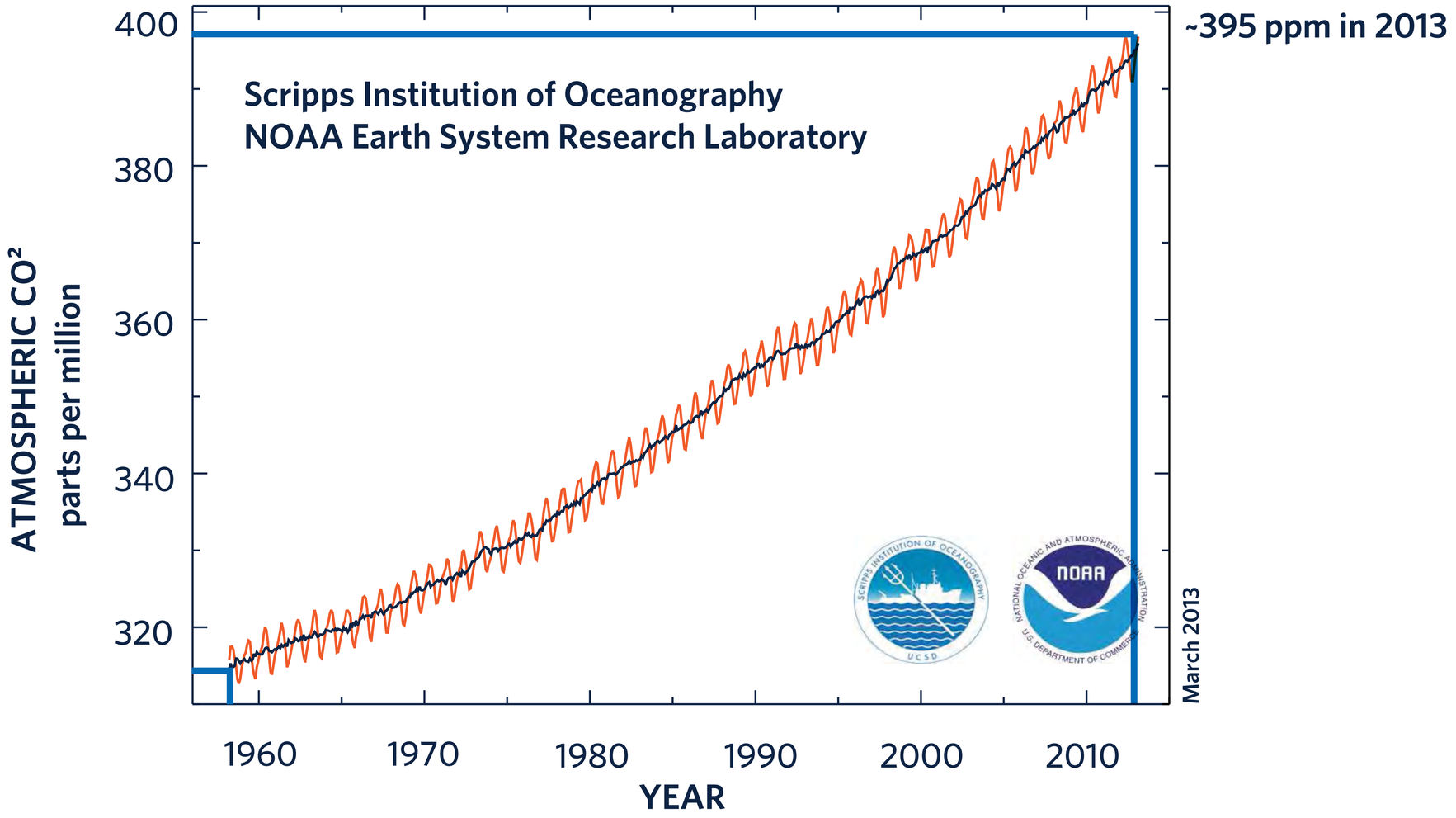

**Arctic sea ice melts and grows seasonally, with a minimum in September each year**

# September Arctic sea ice extent is shrinking



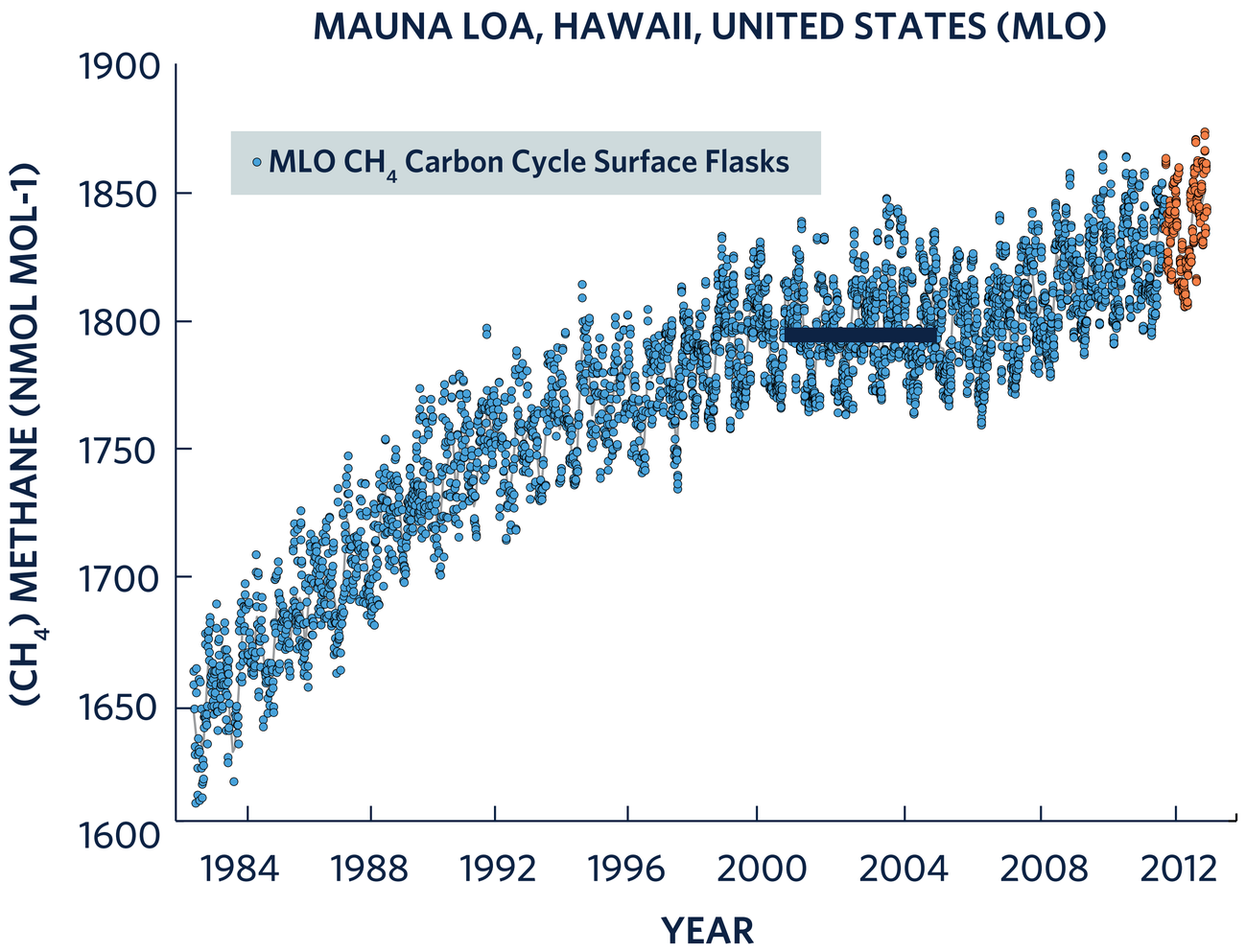

DATA: NSIDC

# Atmospheric $CO_2$ increased about 80 ppm in 55 years




NOAA, EARTH SYSTEM RESEARCH LABORATORY

# Atmospheric methane: a complex history

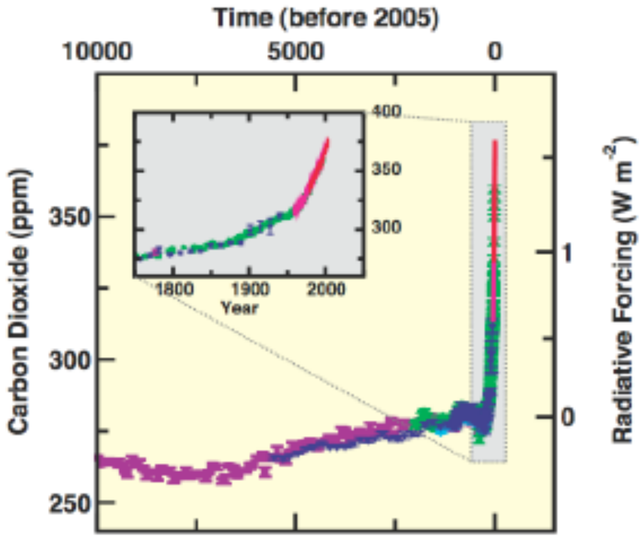



DATA: NOAA

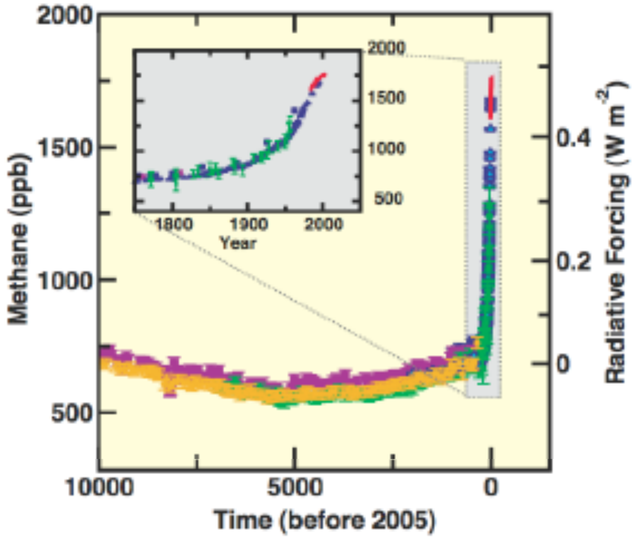
A. 1984-1990
B. 1999-2005
C. 2008-2013
D. Can't tell from these data

# Increases in Greenhouse Gases over 10,000 years

## Changes in Greenhouse Gases from ice-Core and Modern Data



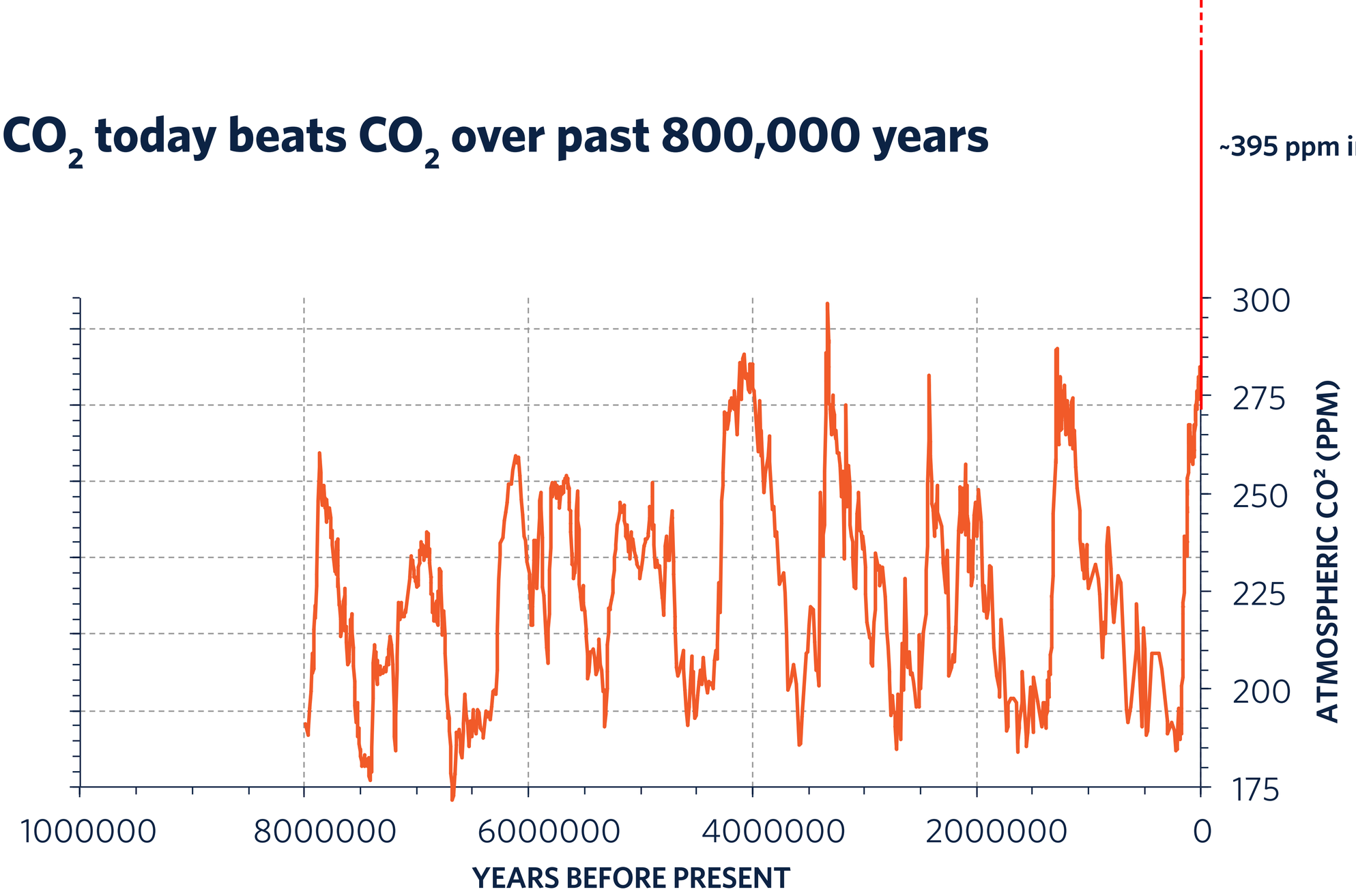

$CO_2$




$CH_4$

HTTP://WWW.IPCC.CH/
IPCC, 2007

# $CO_2$ today beats $CO_2$ over past 800,000 years




DATA FROM EPICA.

# Key Points

» Measurements of climate-related parameters indicate that recent global climate trends are toward:
  - higher temperatures,
  - higher sea levels,
  - lower summer sea ice extent,
  - melting of land ice from ice sheets on Antarctica and Greenland
  - higher concentrations of greenhouse gases

» For some of these, like greenhouse gas concentrations, the values today exceed values observed over many tens of thousands of years.

» Rates of change in some of these parameters are rapid today compared to the pre-industrial past.