

# **The Air We Breathe: It Is Not What It Used To Be!**

**Dr. Russ Schnell**

**Retired Senior Scientist**

**Global Monitoring Laboratory**

**National Oceanic and Atmospheric Administration**

**Boulder, Colorado USA 80305**

**School of Mines**

**November 2022**

# Questions for You?

1. How thick is the Earth's Atmosphere?

(90% of the Earth's air mass is under 35,00 ft or ~11,000 meters))

2. How many kilos of ( $\text{CO}_2$ ) are produced by burning a liter of gasoline?

(~3 kilos)

3. How long does  $\text{CO}_2$  stay in the atmosphere?

(100s of years)

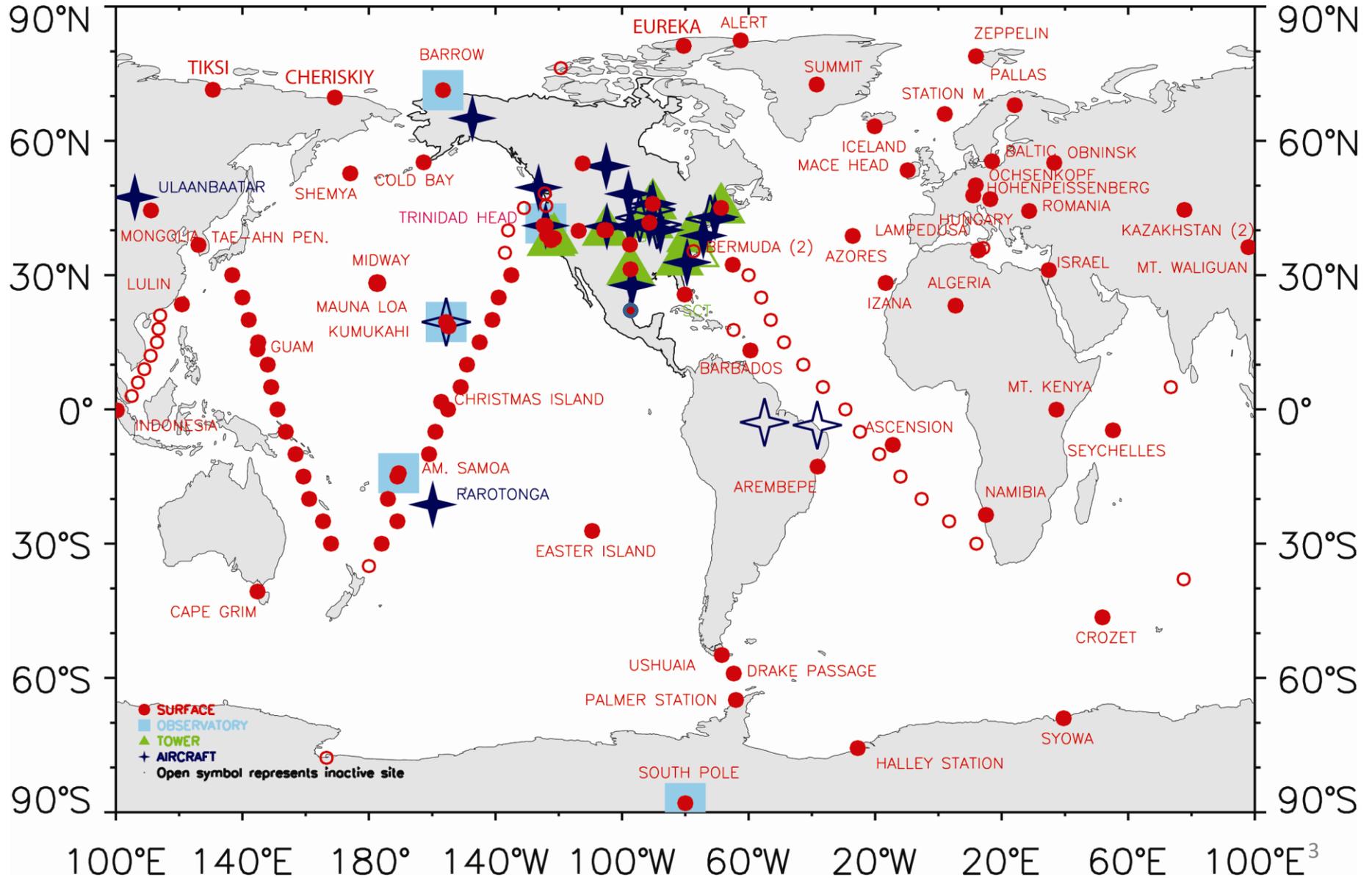
4. How long does  $\text{CH}_4$  stay in the atmosphere?

(~10 years)

5.  $\text{CO}_2$  and  $\text{CH}_4$  hold heat like a thick down blanket on your bed on a cold night.

(The Earth is heating up at a rate **thousands of times faster** than ever before)

# Where and How We Measure CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O



# Atmospheric Baseline Observatories

Mauna Loa, Hawaii



Summit, Greenland



South Pole, Antarctica



Cape Matatula, American Samoa



Temporarily Closed



Trinidad Head, California



Pt. Barrow, Alaska

# Cooperative Programs at Tiksi and Cherskyi, Siberia



# Tiksi Observatory, Russia, 2010



# 2010 Grand Opening of the Tiksi Station



US scientists were not allowed to be within miles of Putin. He had his own visit under heavy security.

# Flask Shipping, Analysis and Calibrations

Shipping Box



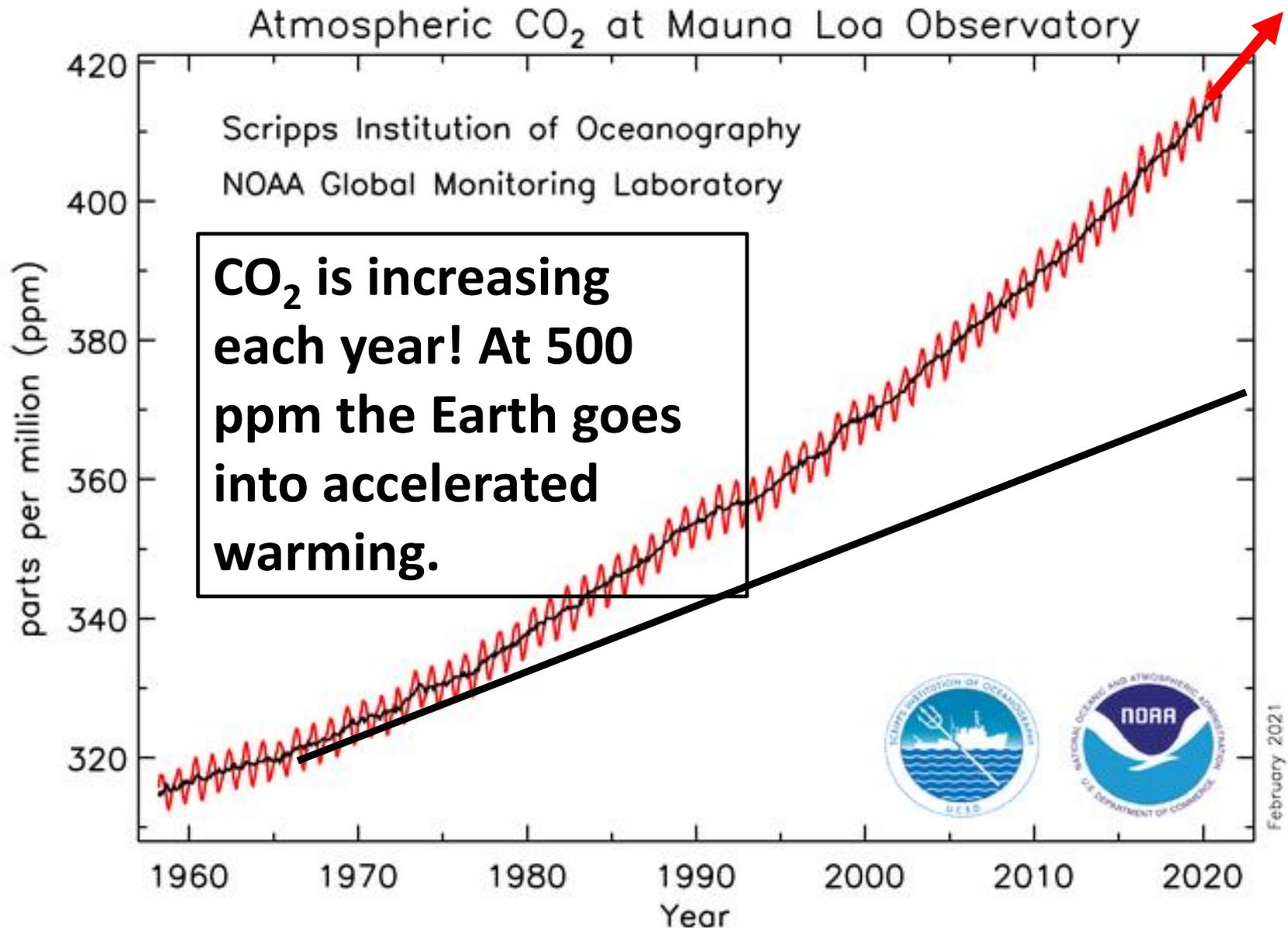
Measurement



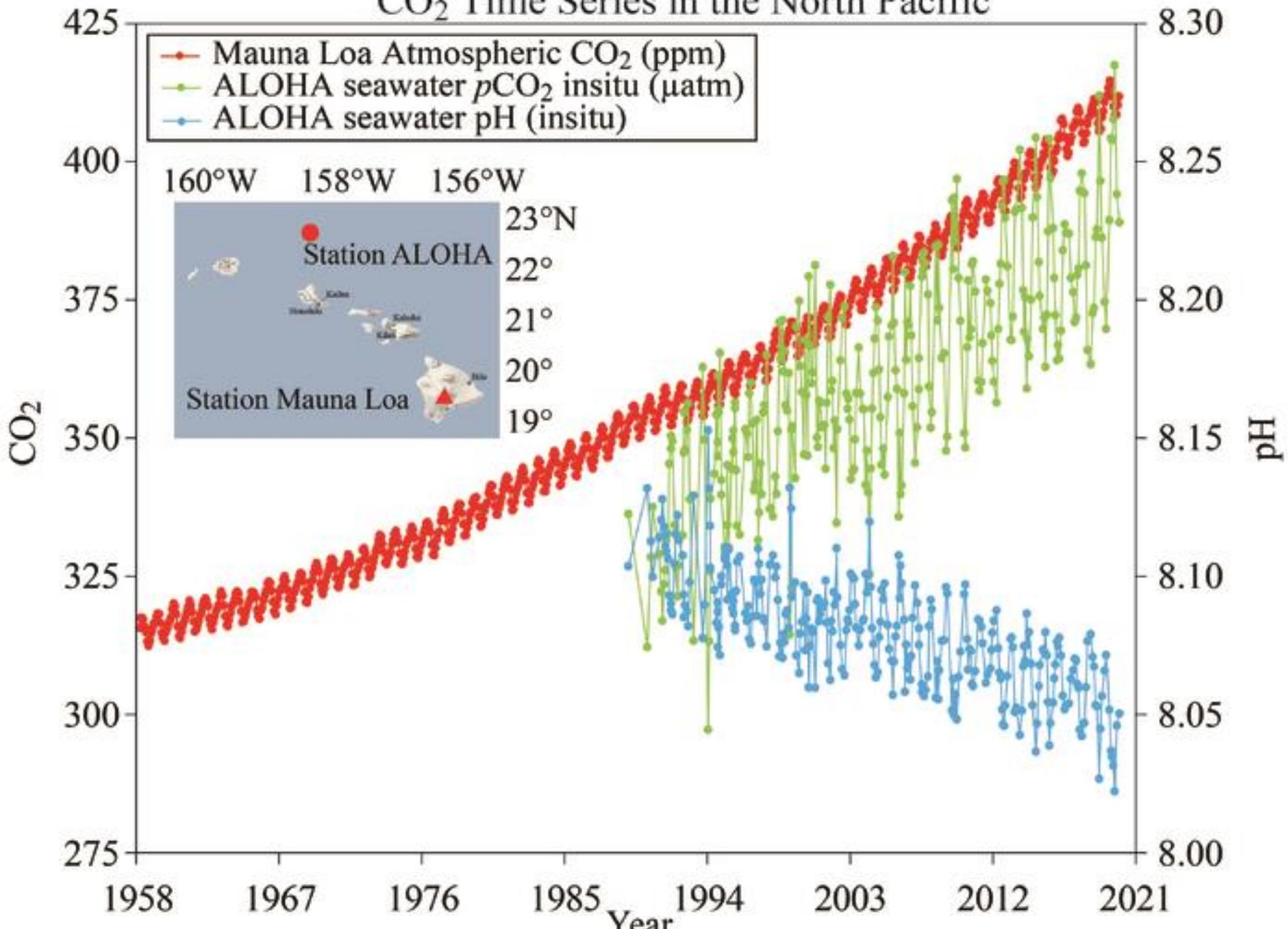
Calibration Gases

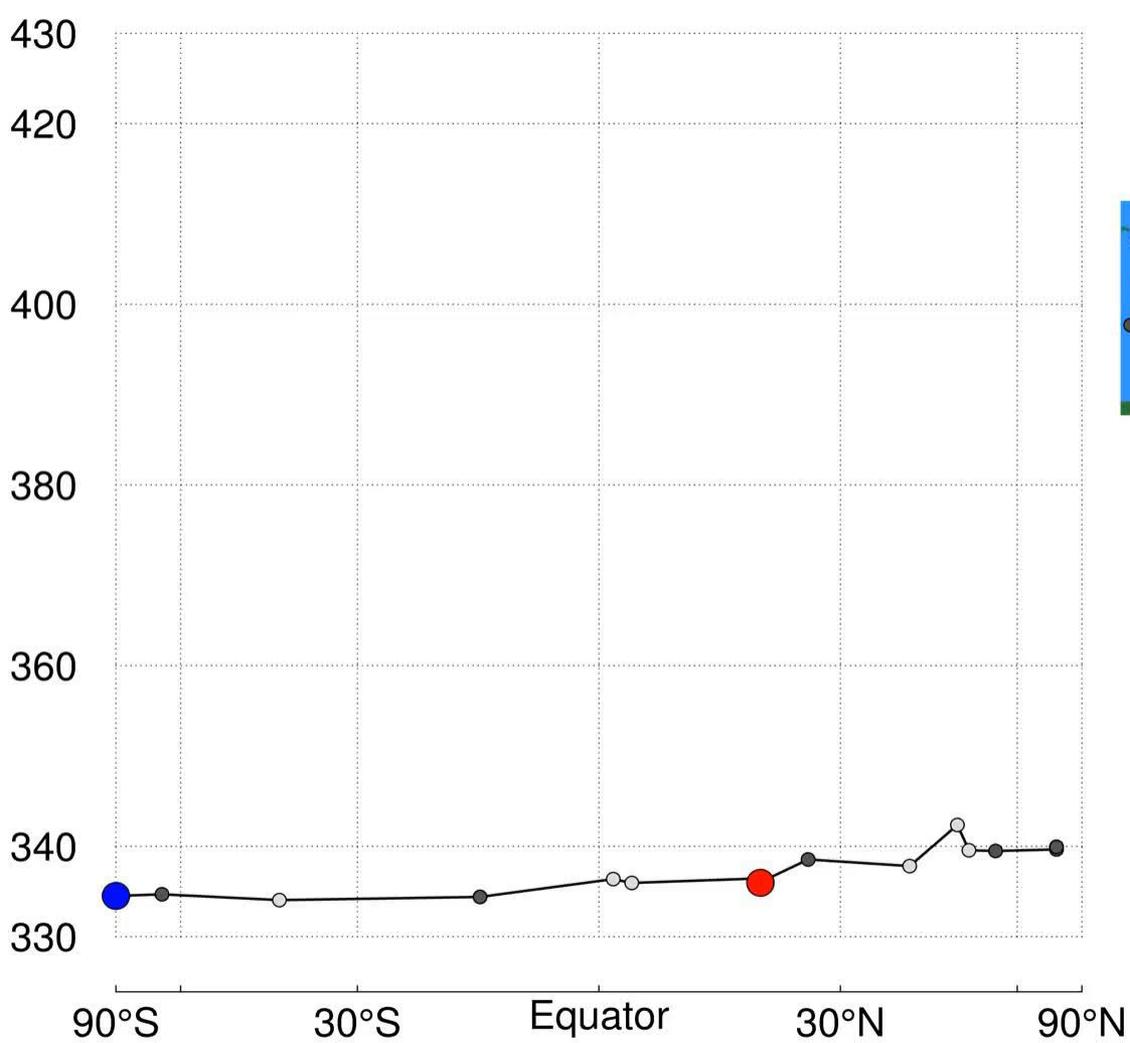


# CO<sub>2</sub> from Burning Fossil Fuels and Biomass



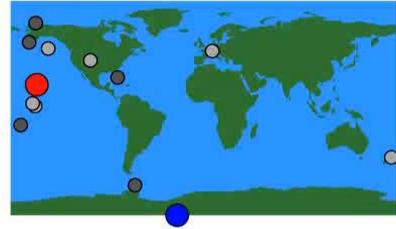
# CO<sub>2</sub> Time Series in the North Pacific



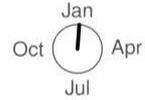


## Atmospheric CO<sub>2</sub> (ppm)

GLOBALVIEW+CO<sub>2</sub> (1979–2022); <https://gml.noaa.gov/ccgg/obspack>  
 ● Mauna Loa ● South Pole ● Background conditions ○ Local signals  
 Contact: andy.jacobson@noaa.gov



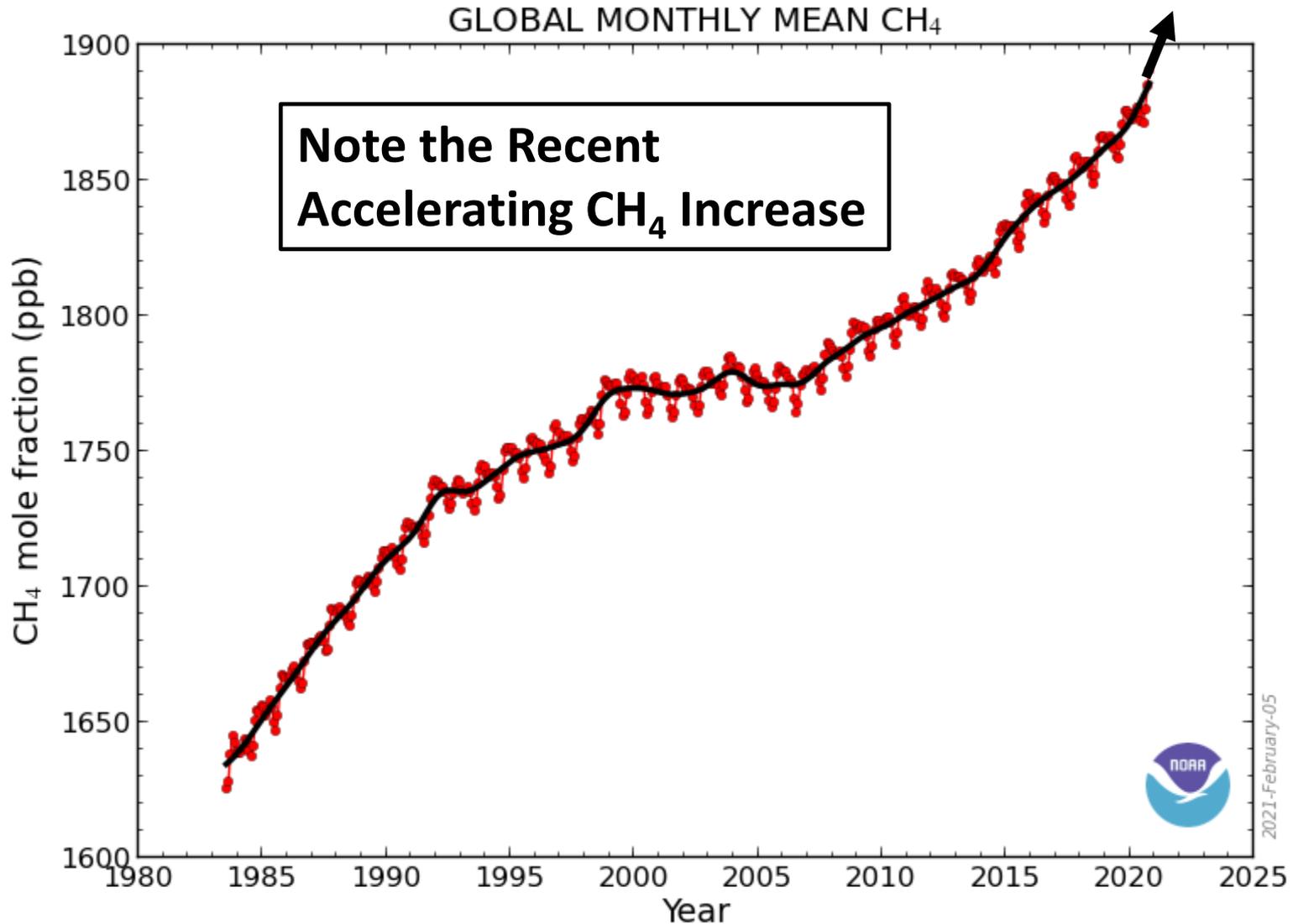
**1979**



1979 1981 1983 1985

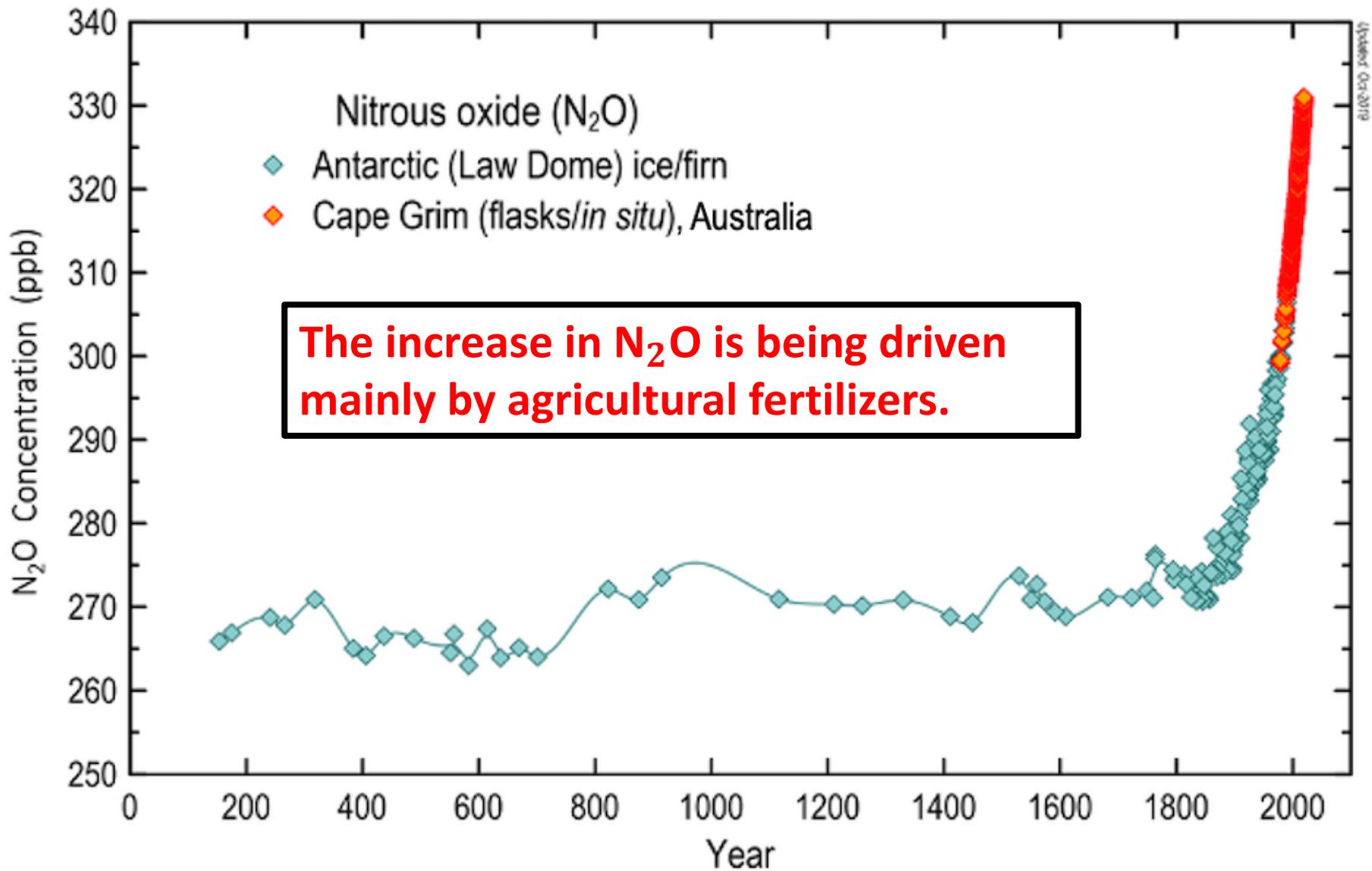
clideo.com

# CH<sub>4</sub> from Natural Gas, Combustion, Agriculture & Anaerobic Decay in Tropical Wetlands

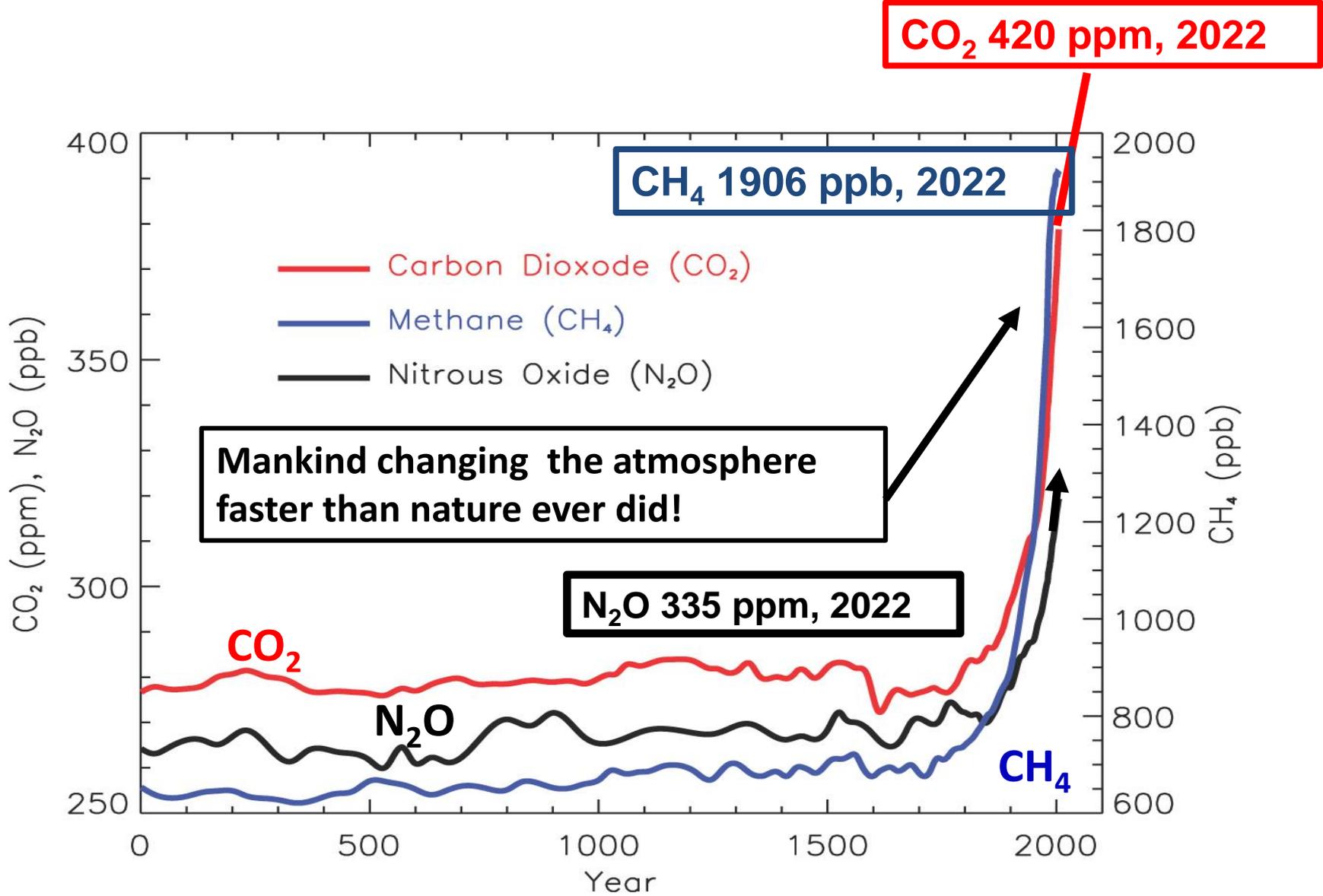


# Permafrost Methane Blast Crater, Yamal Gas Field, Russia, 2021



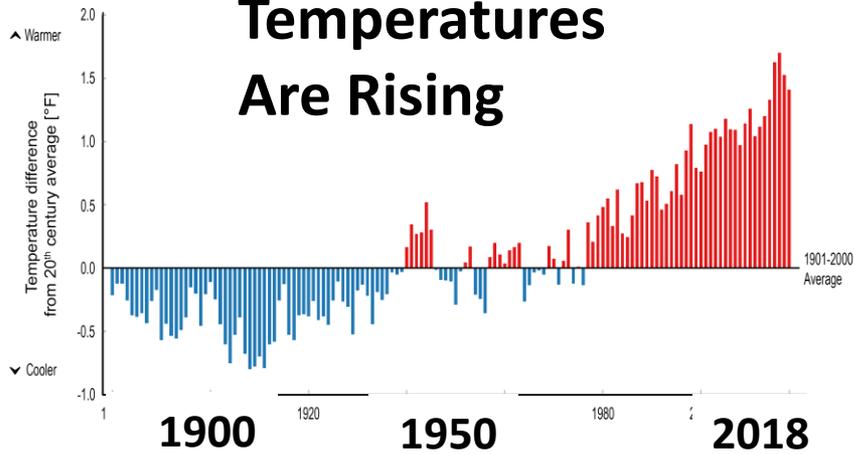


# Greenhouse Gases, Past 2000 Years

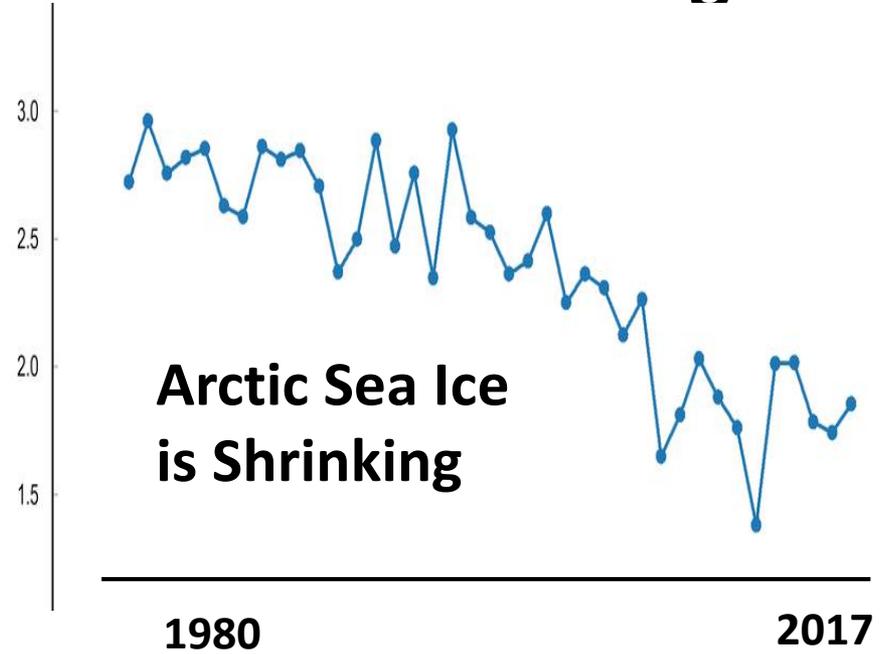


# Some indicators of Climate Change

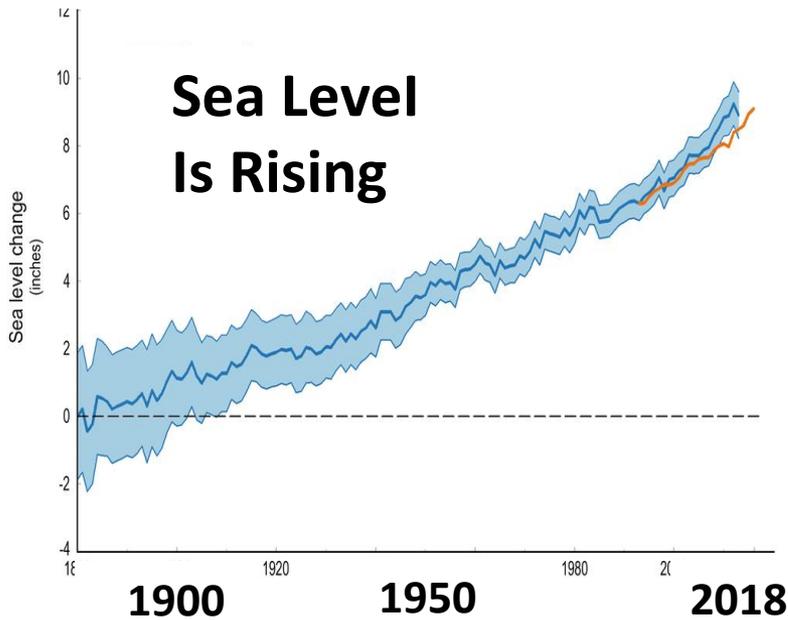
## Temperatures Are Rising



## Arctic Sea Ice is Shrinking



## Sea Level Is Rising



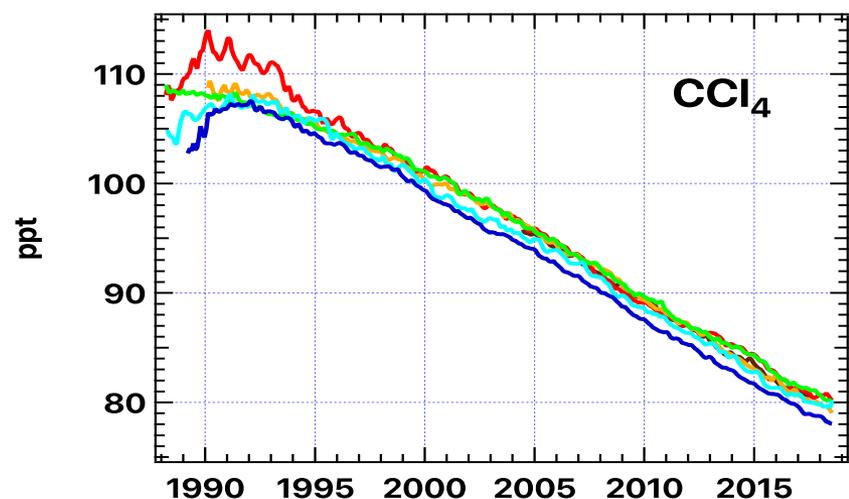
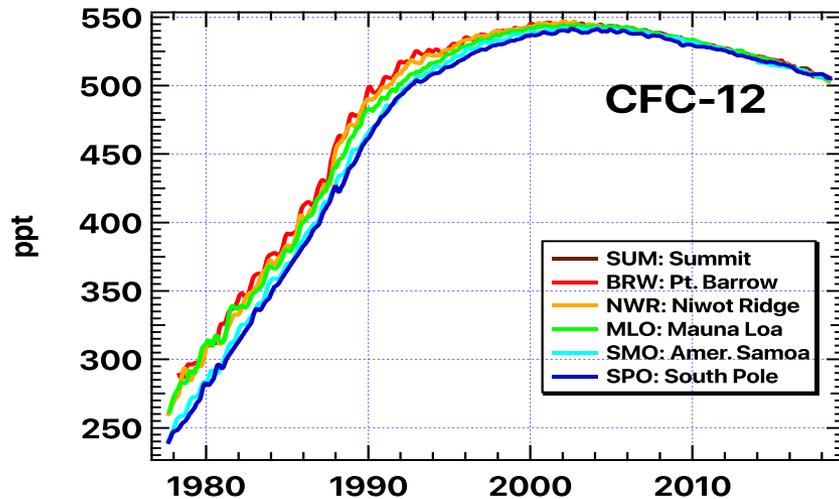
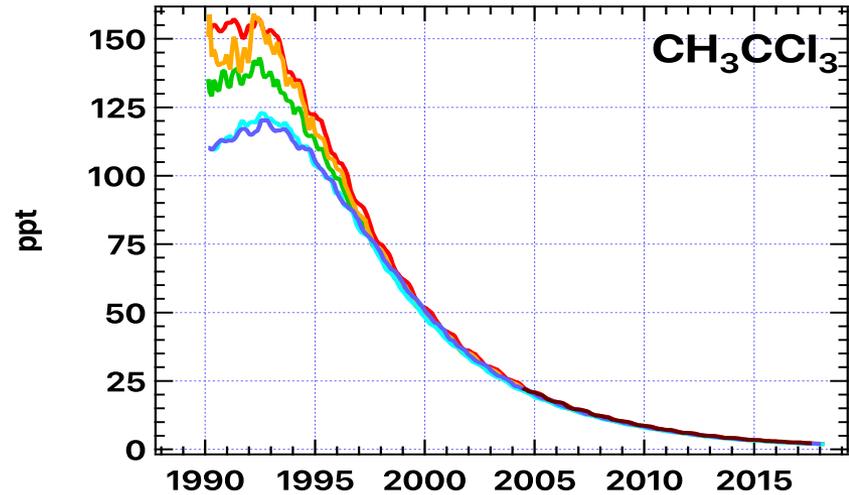
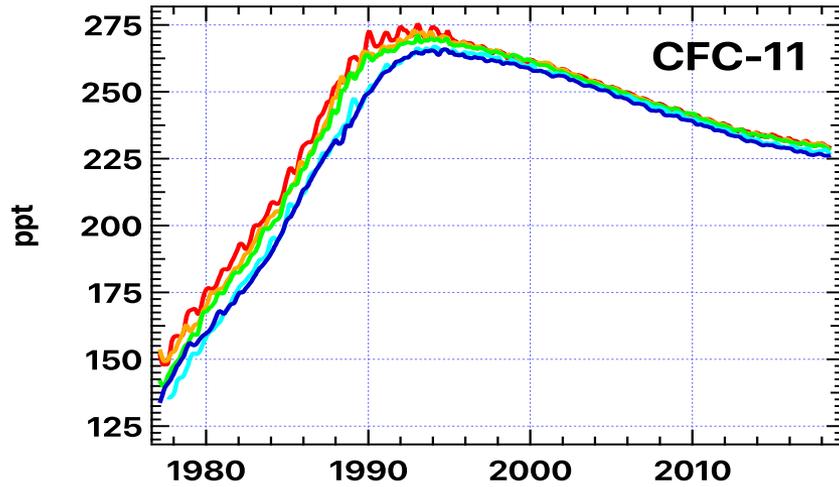
**Melting Himalayan glaciers now produce lakes and floods.**

**Glaciers supply water for 1 billion Asians.**

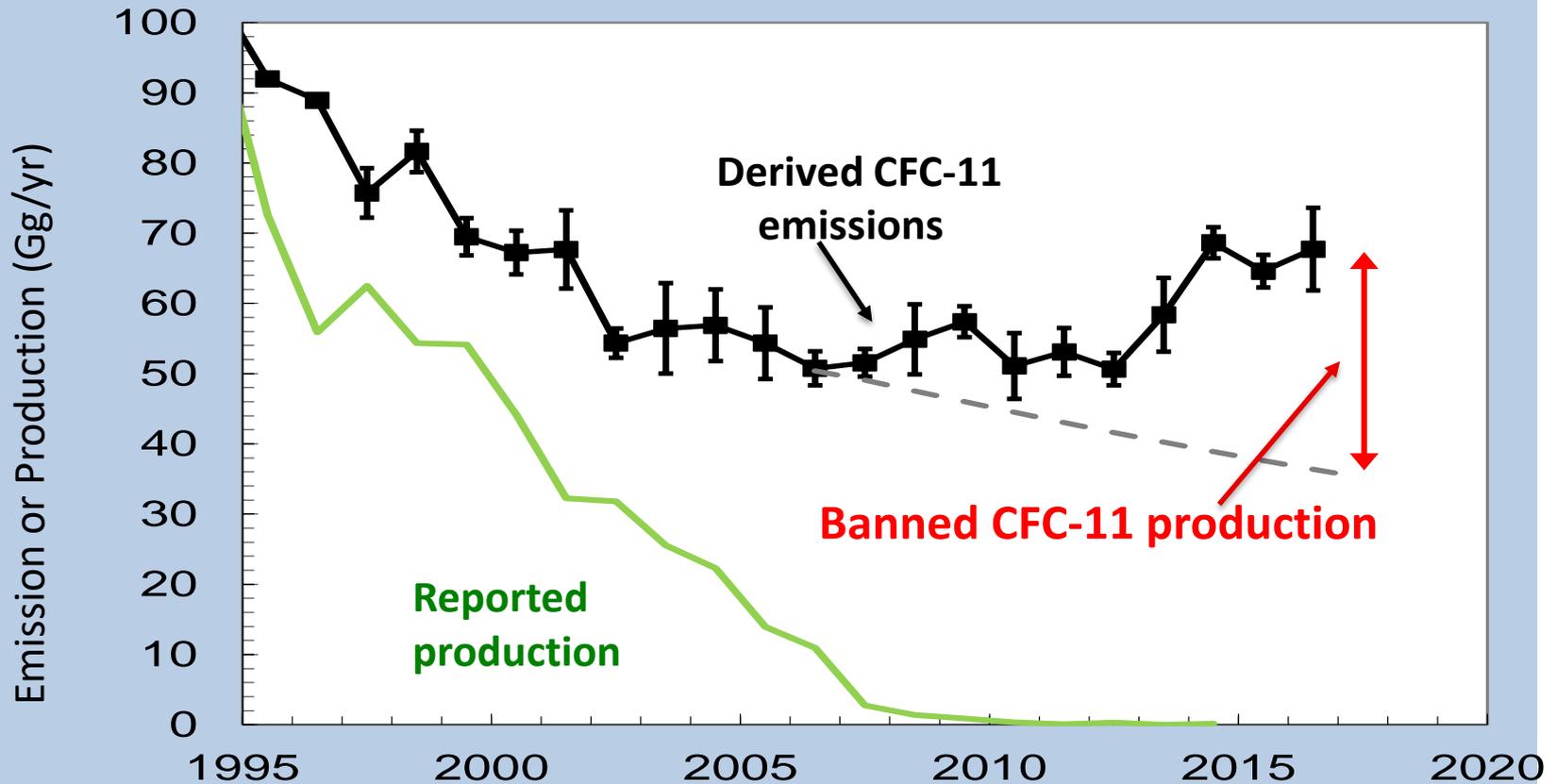
**One day the water will decrease or stop!**



# Some Good News!!!: Montreal Protocol Banned Ozone Hole producing Chemicals Are Decreasing!!



# A **violation** of the Montreal Protocol detected\*

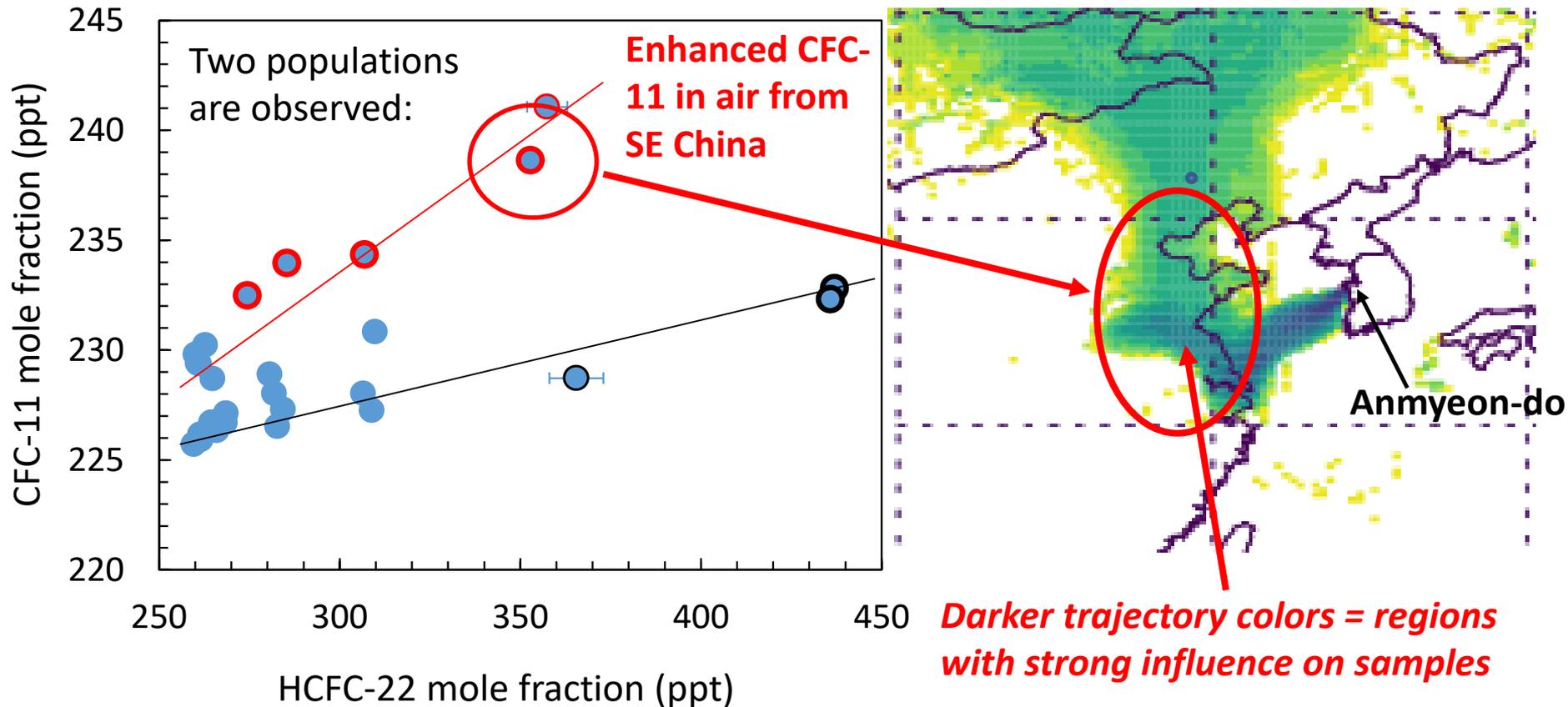


**The evidence:** global emissions of CFC-11 unexpectedly increased after production was phased out and air trajectories **pointed to eastern Asia**.

\*An unexpected and persistent increase in global emissions of ozone depleting CFC-11, Montzka et al, *Nature*, 557, 413-17 (2018).

**Cooperative efforts with Korea were developed that showed high concentrations of CFC-11 in air flowing over a city in SE China.**

**China and the UN were informed and believed.**



## **How will Global Warming Affect Earth?**

- 1) Temperature/drought increases.**
- 2) Fewer early spring frosts and later fall freezes.**
- 3) There will be greater swings in climate norms.**
- 4) Rising sea levels.**
- 5) More and larger forest fires.**
- 6) More severe hurricanes/cyclones and local storms.**
- 7) Arctic will warm faster than lower latitudes.**
- 8) More health risks.**
- 9) Species loss.**

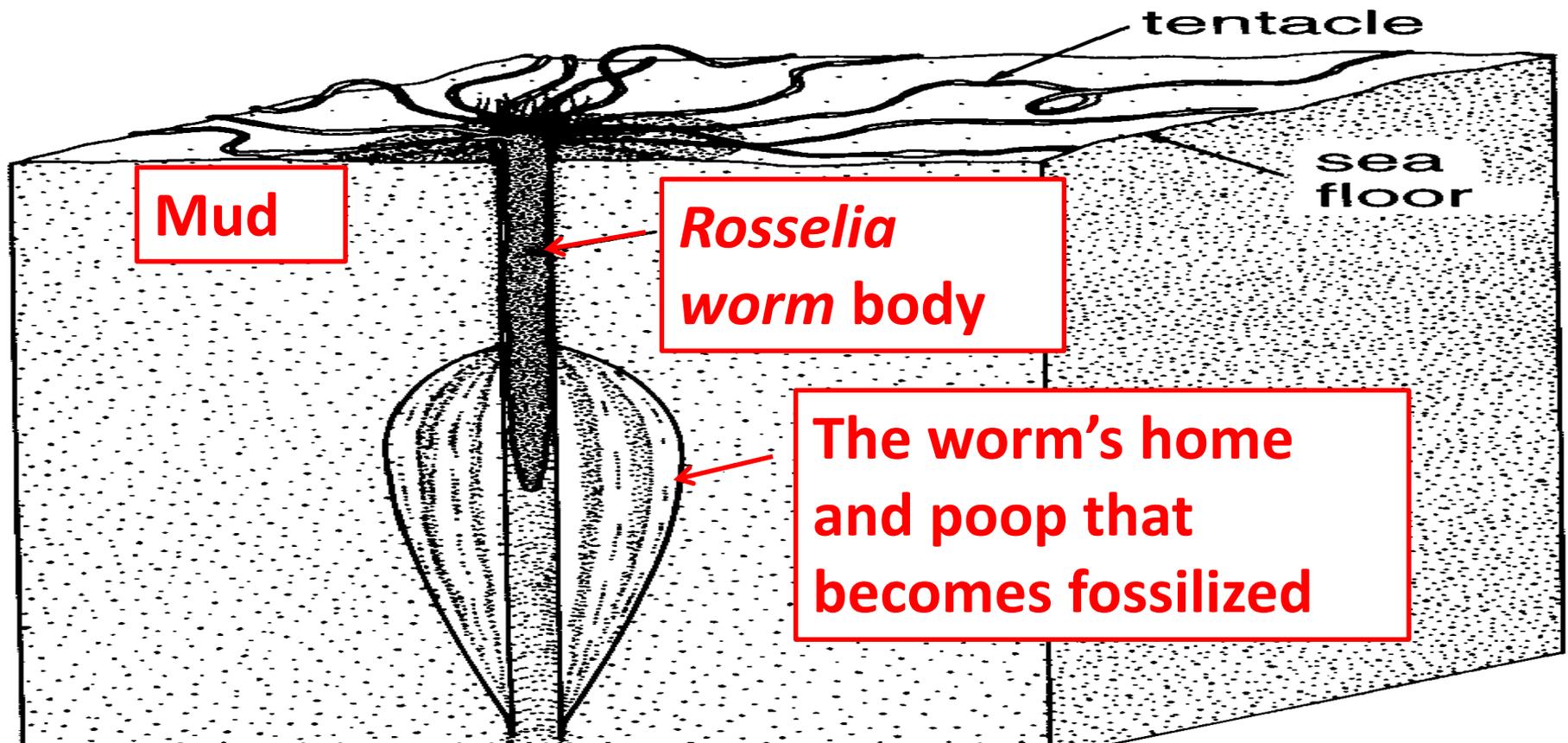
## **What could be done to reduce global warming?**

- Reduce fossil fuel consumption.**
- Capture/sequester greenhouse gases.**
- Increase fuel use efficiency.**
- Shift to solar, wind and nuclear electricity generation.**

**70 Million  
year old  
fossil Worm  
Poo found  
near Castor,  
Alberta,  
Canada.**



# Castor Creek *Rosselia* Worm in Seashore Sediment



**Thank you for the **honor** of your time.**

You may use this presentation in any form you may find useful.

I may be contacted at:

[russell.c.schnell@noaa.gov](mailto:russell.c.schnell@noaa.gov)

Cell: 720-448-6077

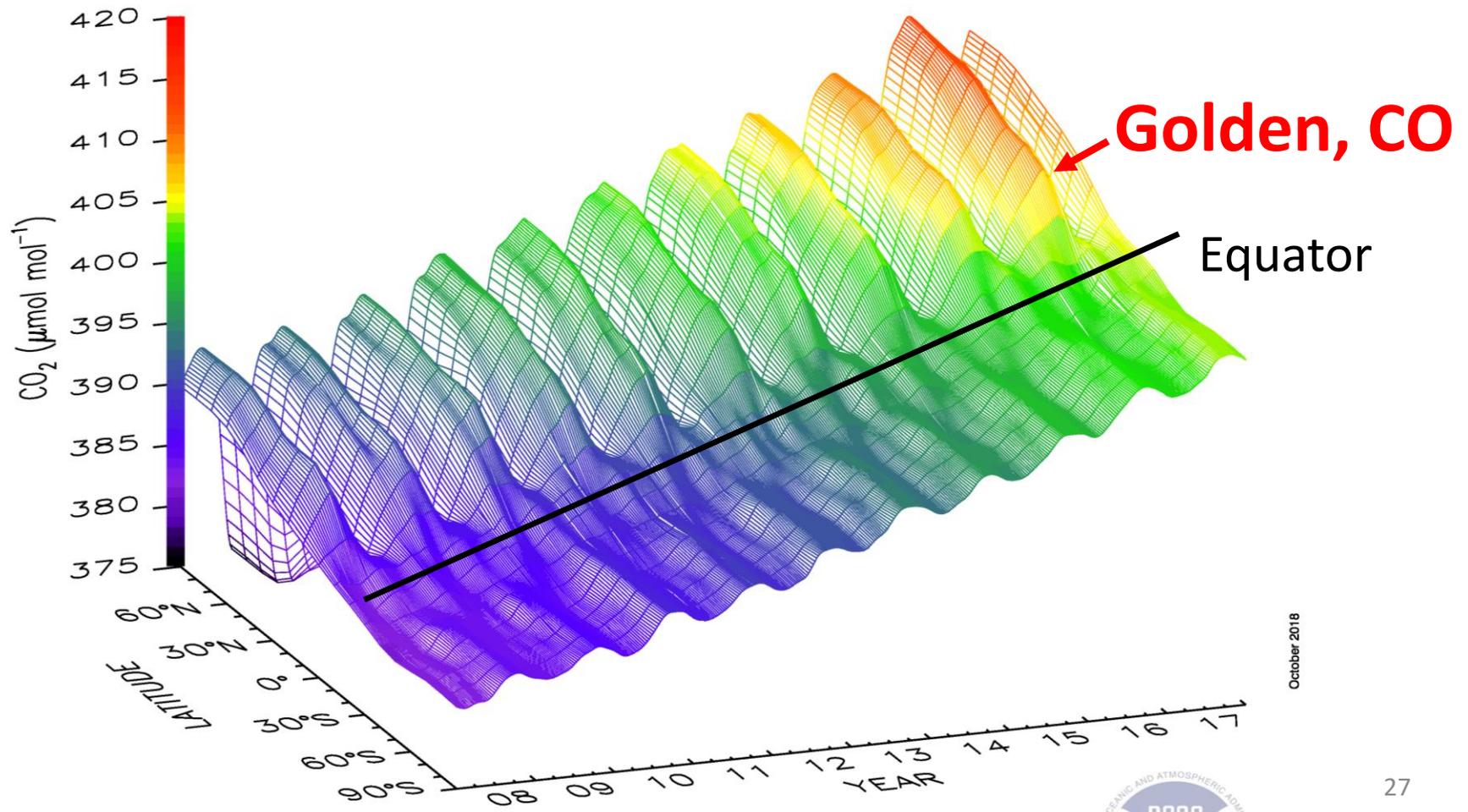


# Basics of Climate Change (very simple)

1. Sunlight warms the land and oceans.
2. This heat flows back up into the atmosphere.
3. Carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and Nitrous Oxide (N<sub>2</sub>O) hold heat just like a down blanket holds **your body** heat.
4. More CO<sub>2</sub>, CH<sub>4</sub> and NO<sub>2</sub> thickens this “blanket.”
5. The thicker “blanket” makes the Earth warmer.
6. Earth has gone through at least 4 ice ages /tropical shifts from changes in CO<sub>2</sub> and CH<sub>4</sub> over **millions of years**. Mankind is changing the atmosphere in **100s of years**. Fossil fuels are made during tropical climates.

# Global Carbon Cycle: Higher CO<sub>2</sub> in the Northern Hemisphere Reflects the Main Sources Regions

Global Distribution of Atmospheric Carbon Dioxide  
NOAA ESRL Carbon Cycle



**500 ft., tall, 8 mw tower  
in Honsea North Sea  
farm (~1,600,000 mw)**



# Polar and Grizzly Bears are interbreeding



1172550111

gettyimages  
Arterra

# Athabasca Glacier, Alberta, Canada



1918



2011