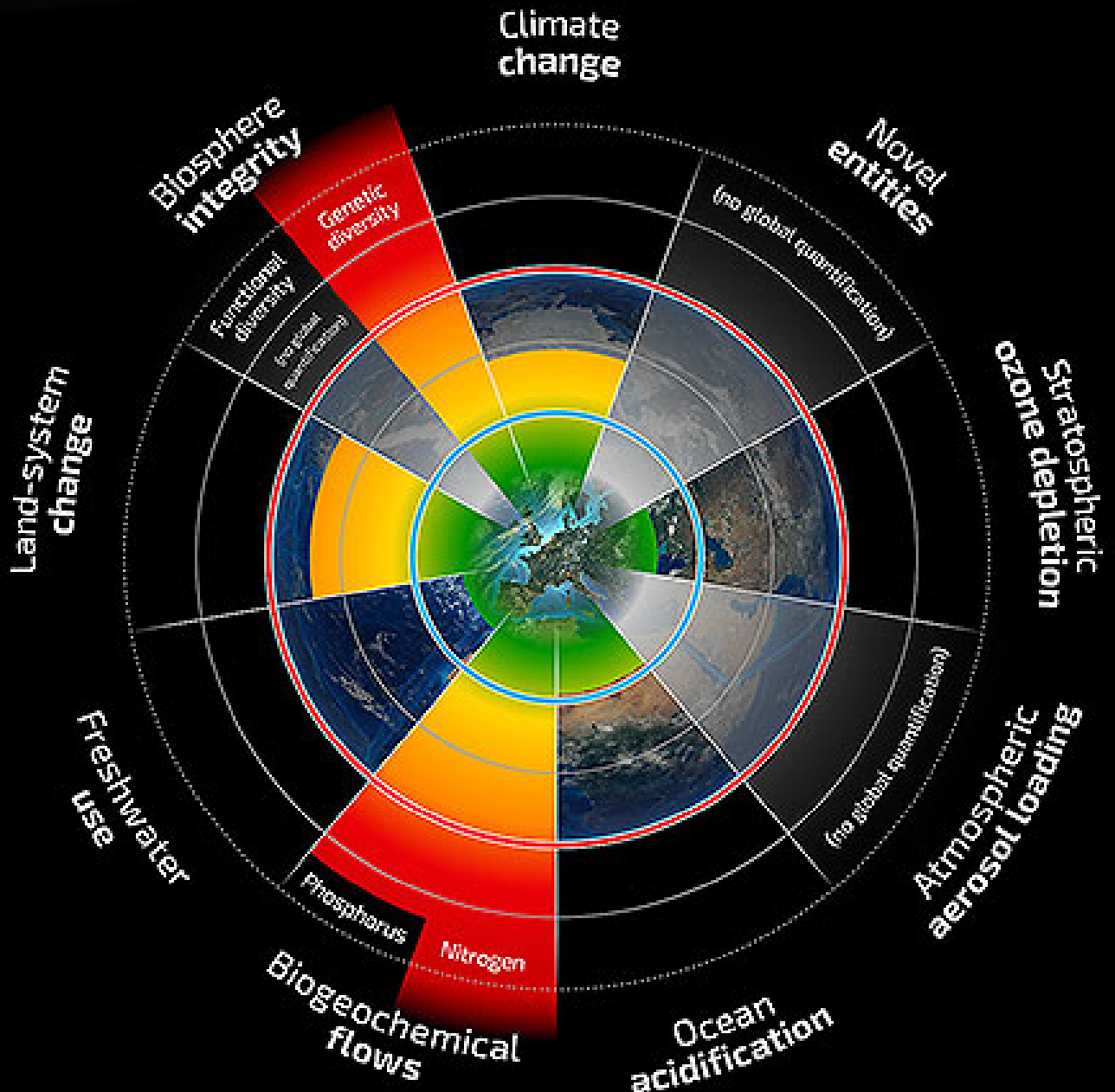
Foodprint:
Understanding the Connections Between Food and the Environment

Session 2

Carbon Footprint of Foods

Planetary Boundaries: A Safe Operating Space for Humanity



Source: Rockstrom et al.

We are already exceeding global sustainability limits for climate change, nitrogen and phosphorus cycling, land use change, and biodiversity loss.

Food plays a major role in environmental sustainability:

70% of freshwater use is for agriculture.

Biodiversity loss is driven primarily by habitat loss, climate change, and pollution.

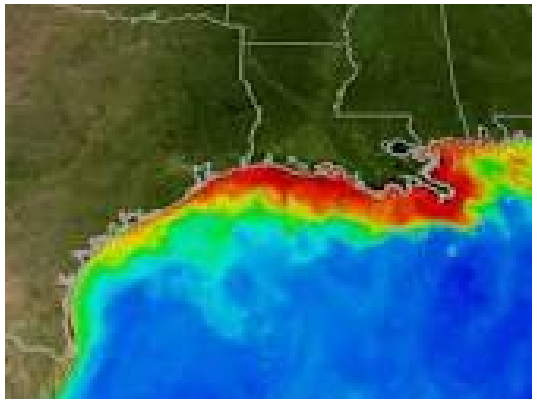
Chemical pollution

14-18% of global greenhouse gases derive from livestock alone. (U.N.)

50% of US land is used for agriculture.

Antibiotic resistance is rising.

By far, the largest source of nitrogen pollution is fertilizer.



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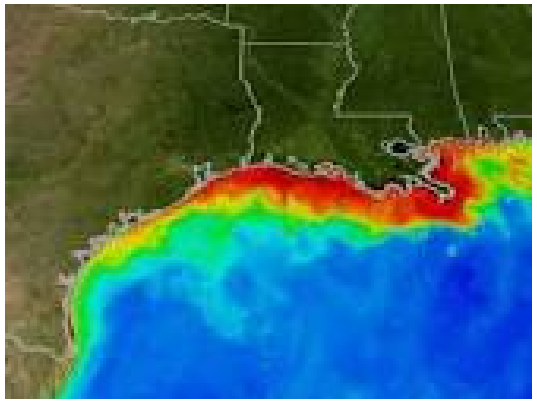
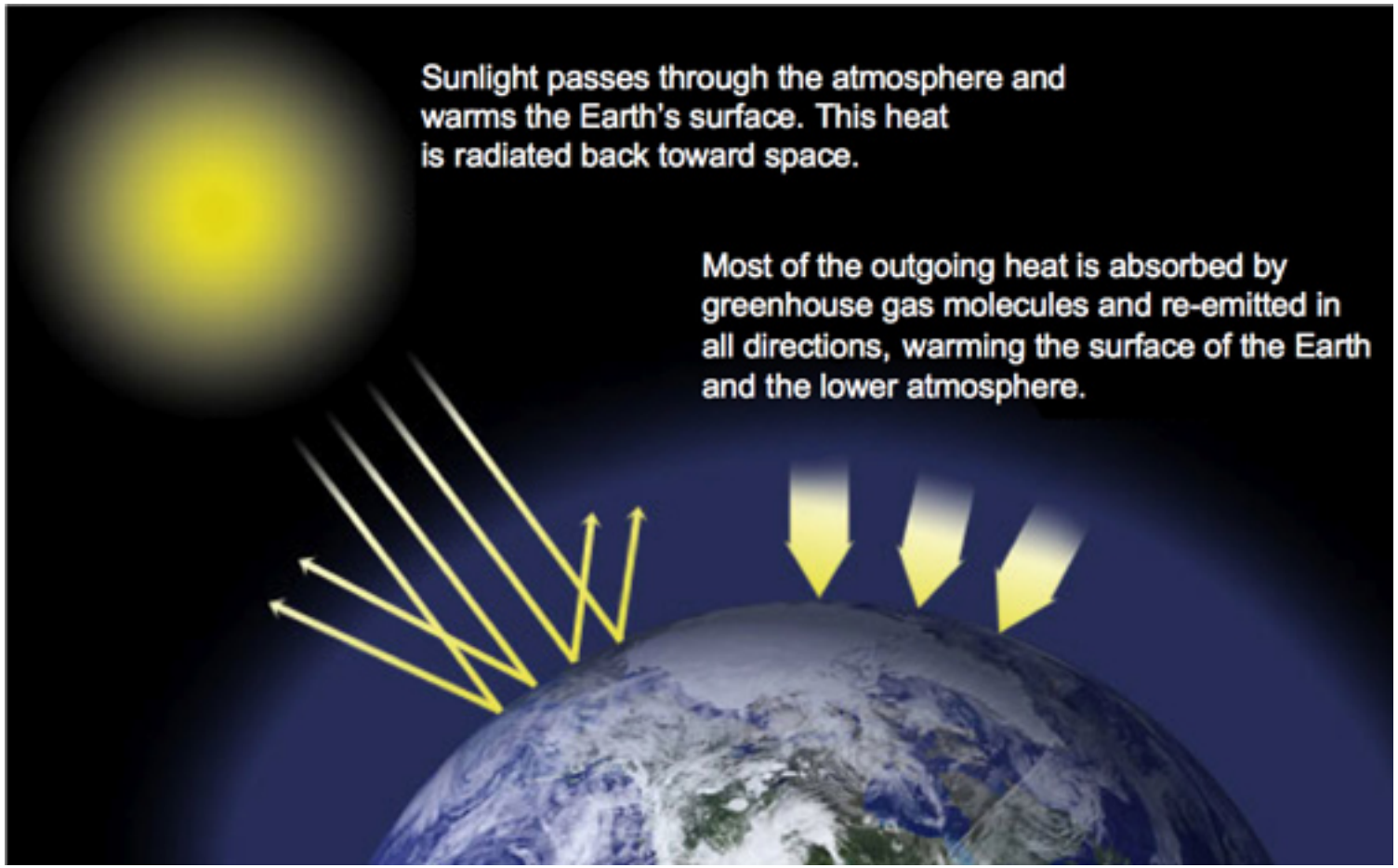


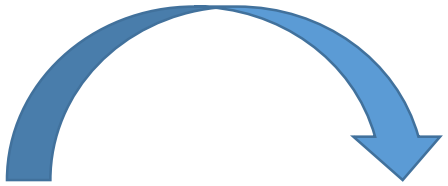
Increased population and industrialization has led to global scale environmental issues that need to be addressed.

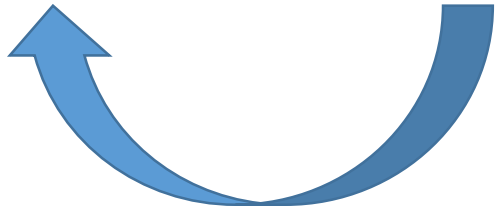


Certain gases in the atmosphere trap the sun’s heat like a blanket.

C naturally cycles through the atmosphere

CO_2

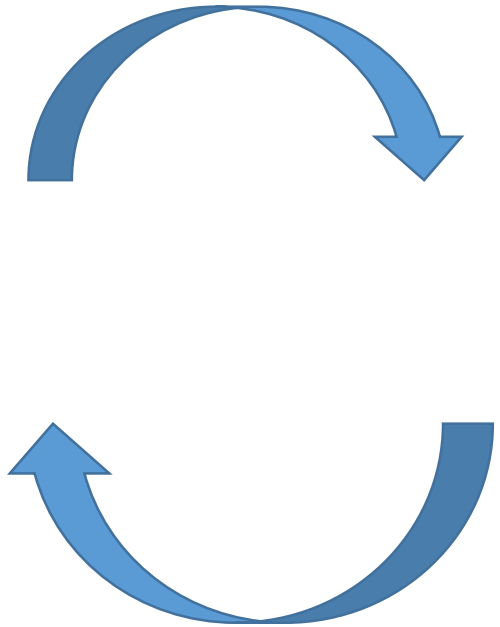




Organic Carbon

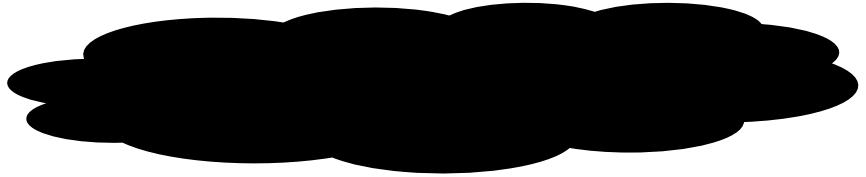
Main point #1: When we use long-buried fossil fuel, we add additional carbon to the cycle

CO_2



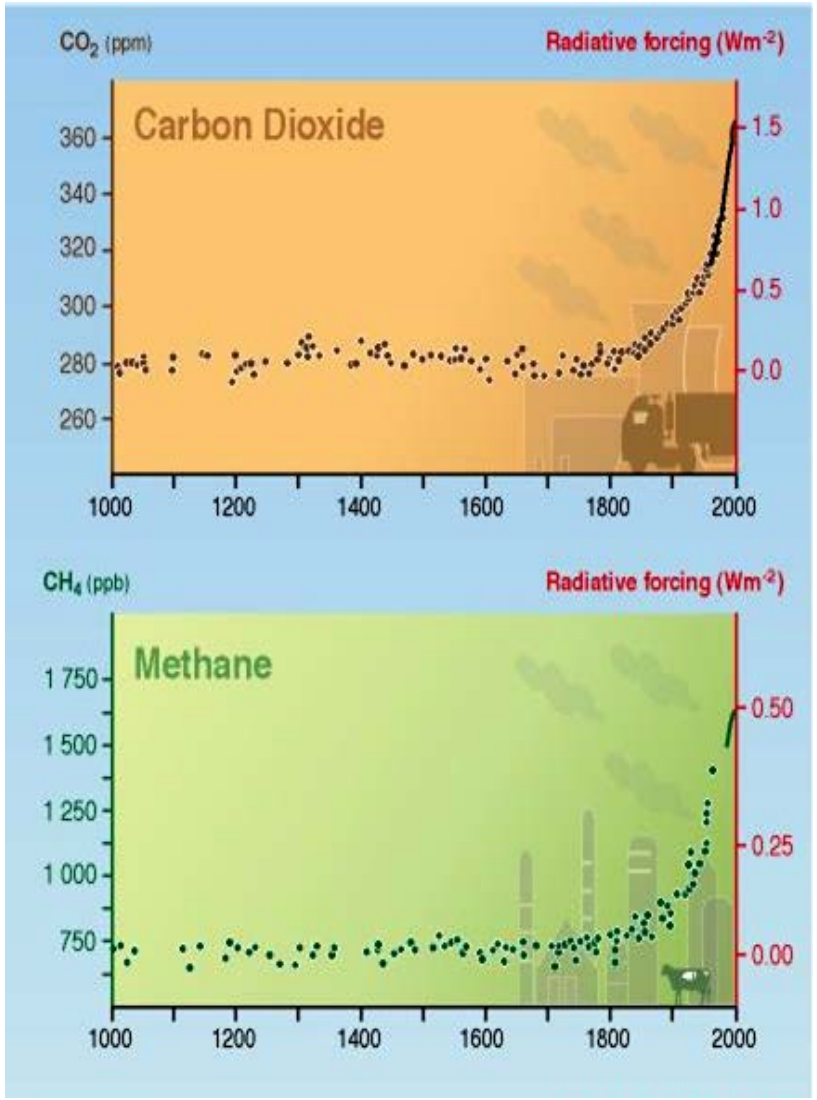
CO_2 Added to the cycle

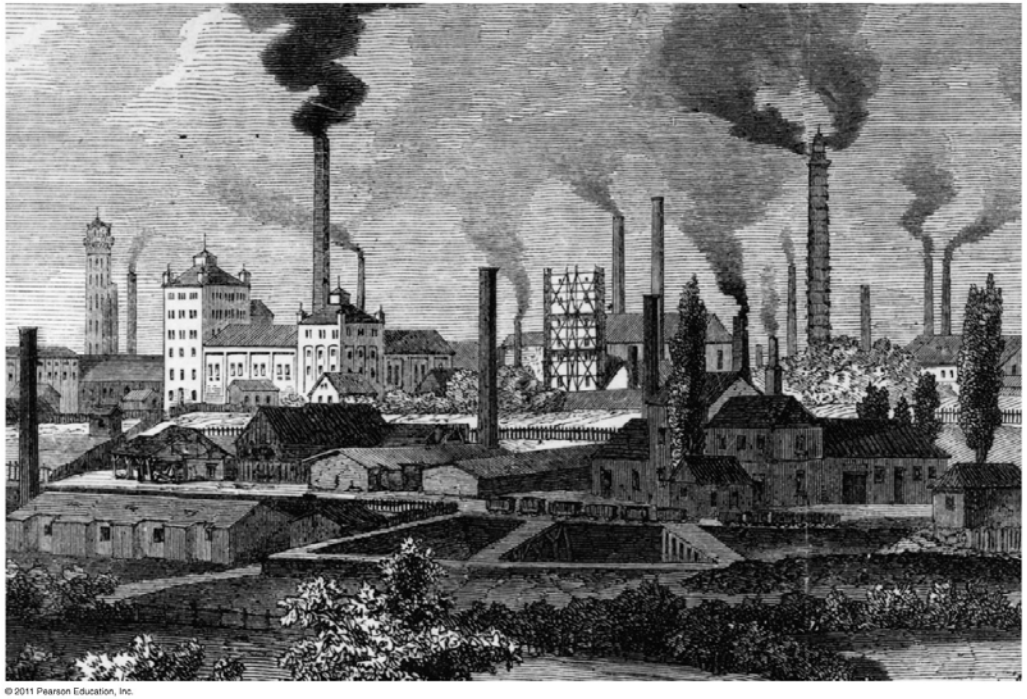
Organic Carbon



Long-buried fossil fuels

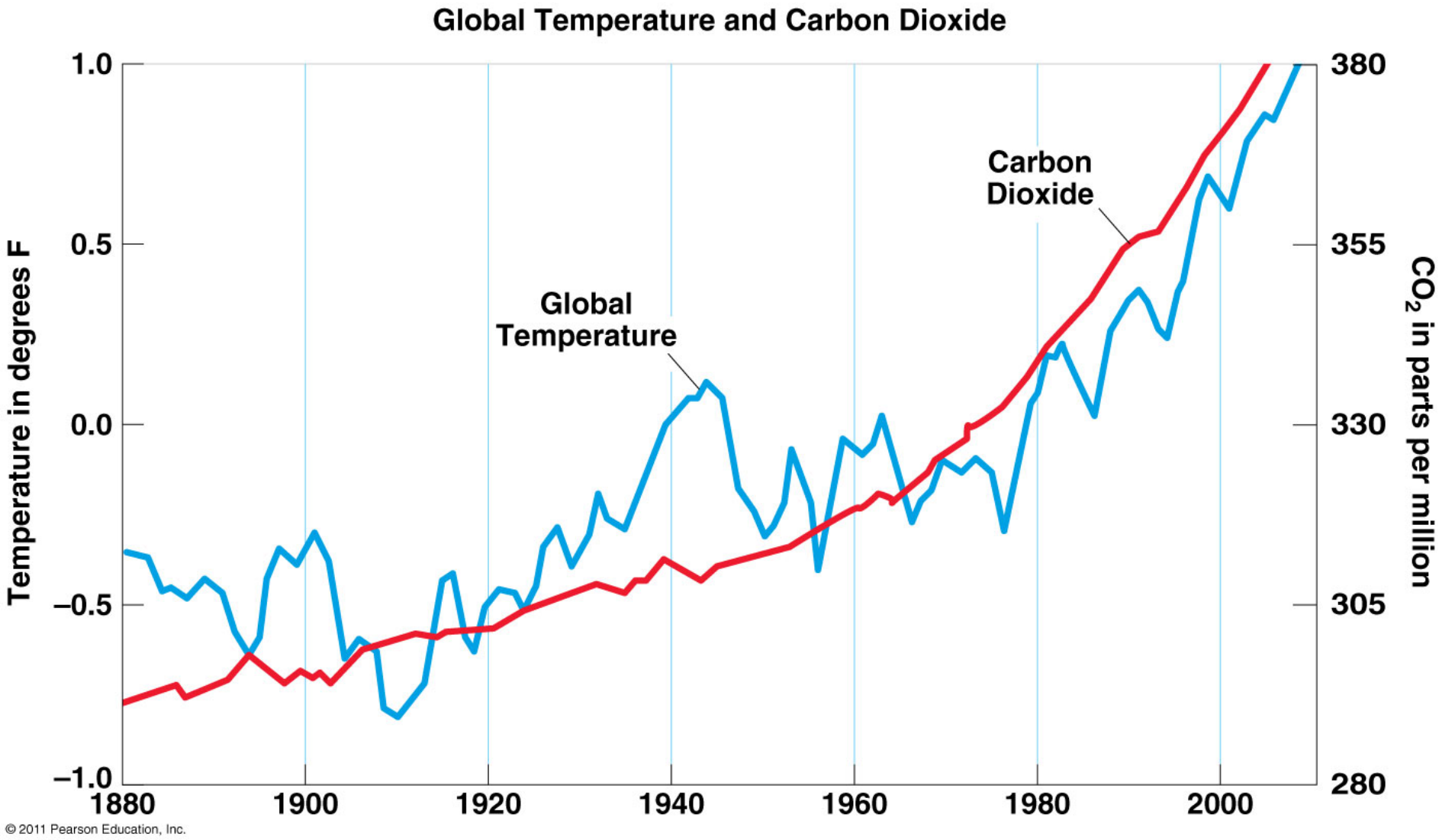
Humans use fuels that make carbon dioxide





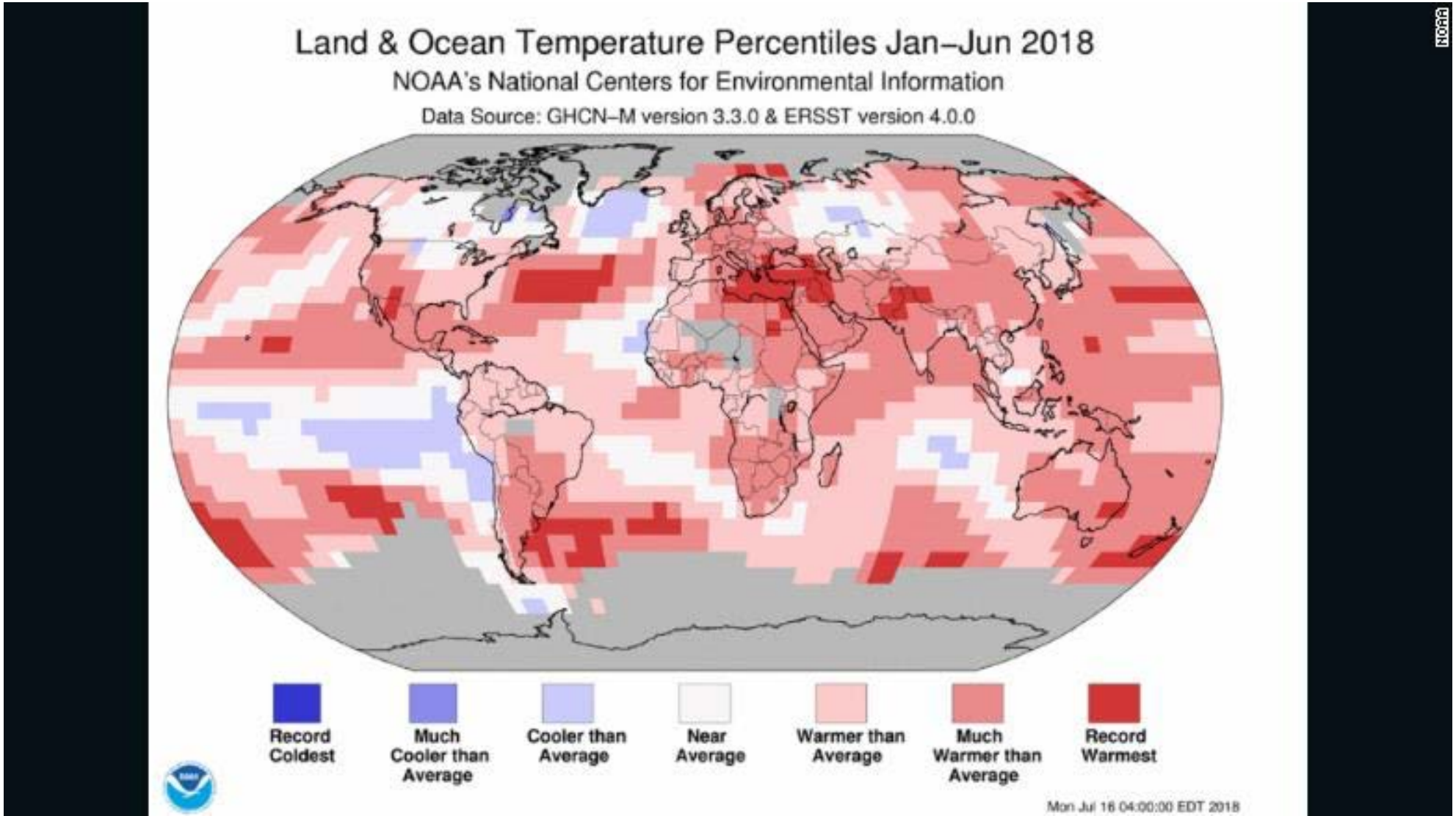
We have increased the level of carbon dioxide in the atmosphere.

Earth is warming

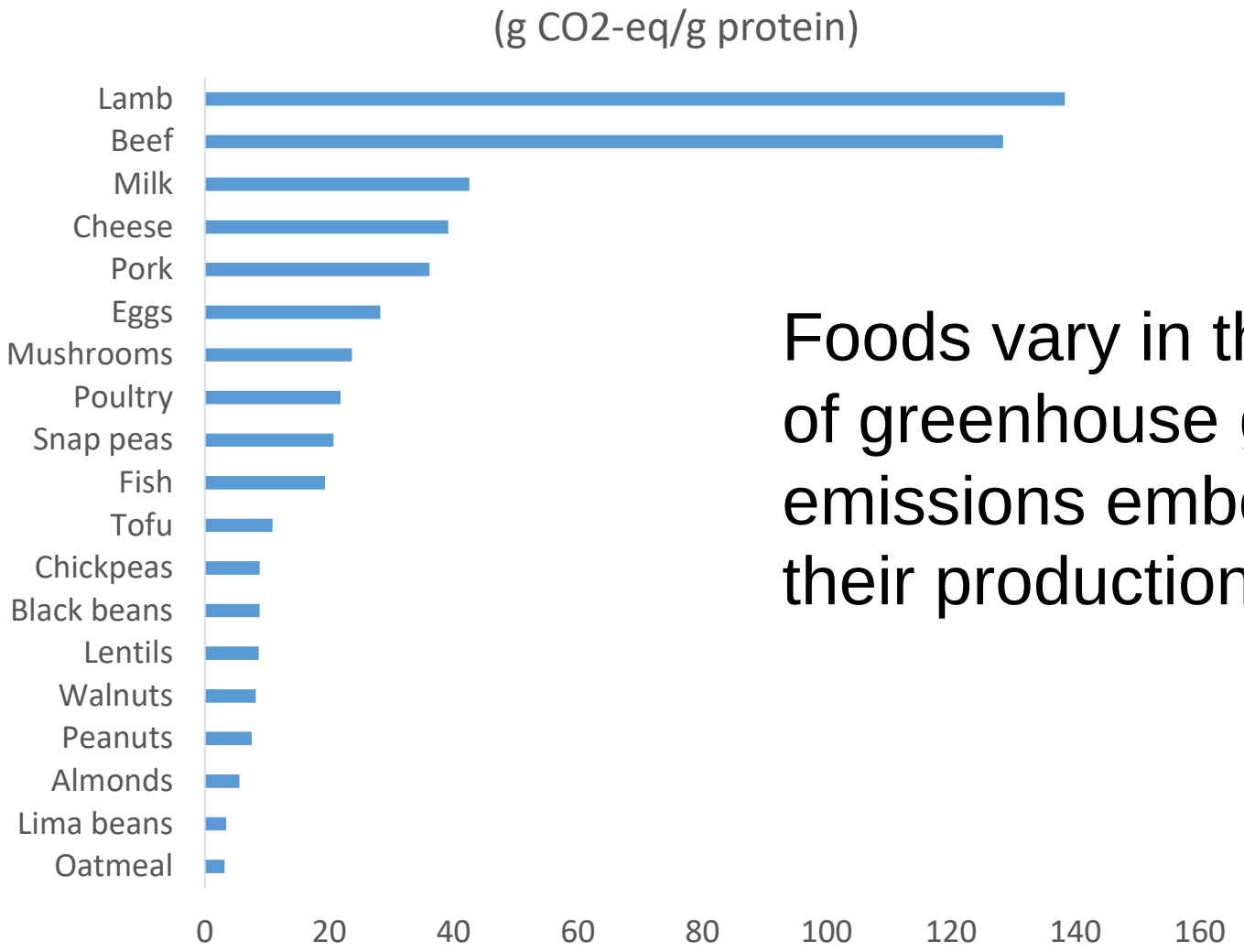


From CNN:

2018 on pace to be 4th hottest year on record



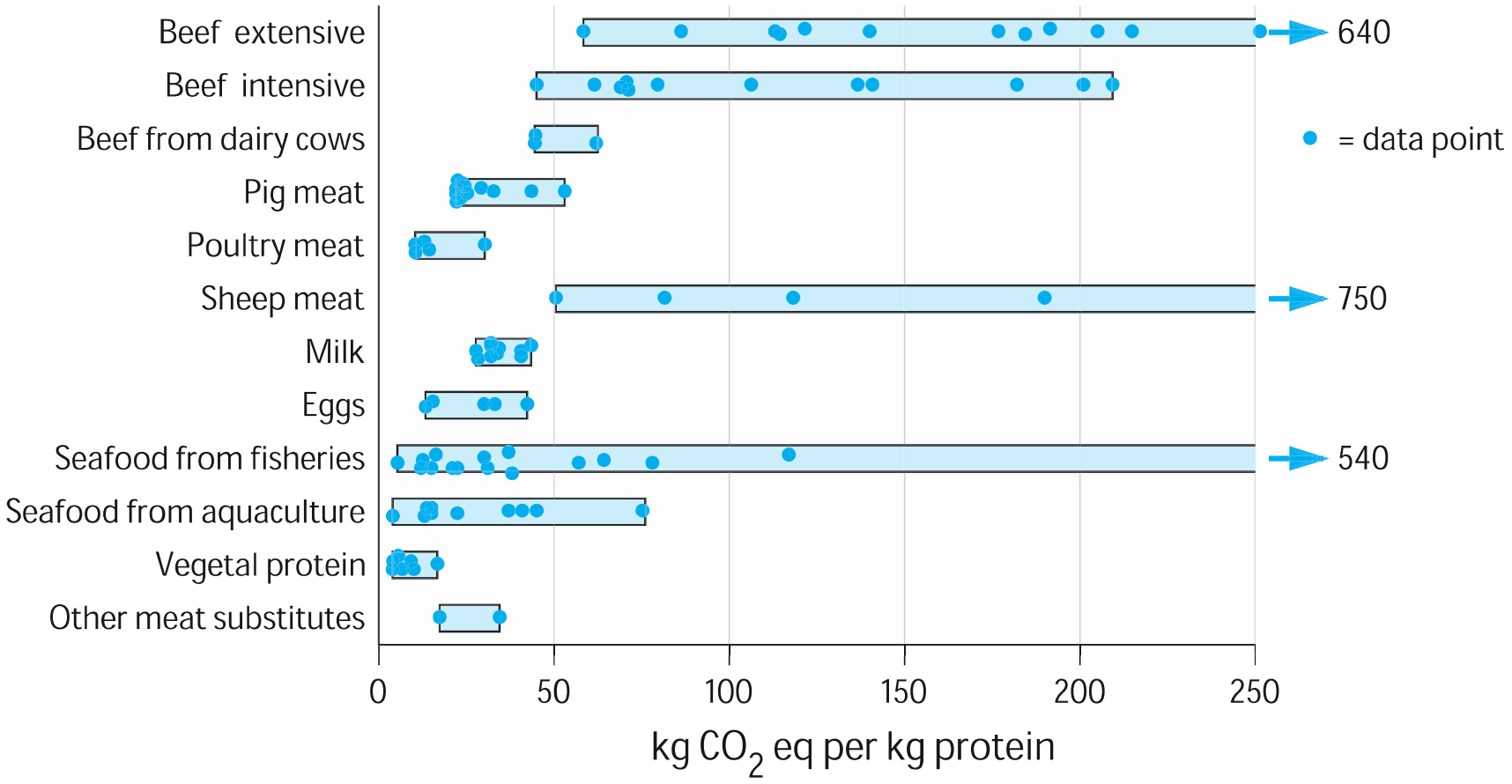
Carbon footprint of our Food



Foods vary in the amount of greenhouse gas emissions embodied in their production.

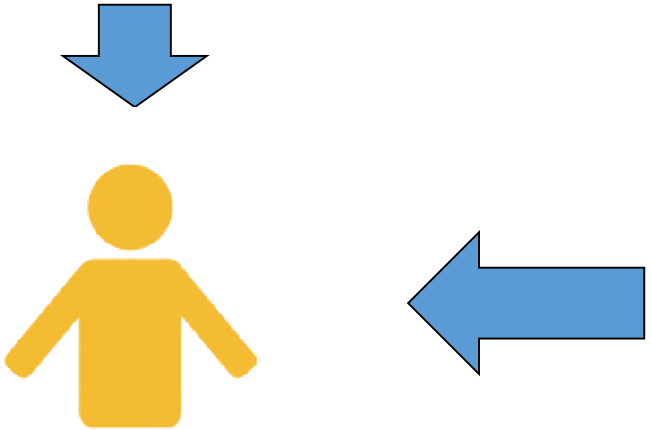
Source for data: Heller and Keoleian, 2014 and USDA Food Composition Database

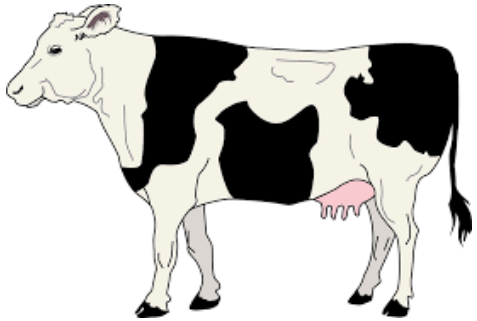
D. Nijdam et al./Food Policy 37 (2012) 760–770



Global average for beef: 26 kg $CO_{2\text{-eq}}$/kg beef
US only: 40 kg $CO_{2\text{-eq}}$/kg beef

Main point #2: Animal products generally have higher footprints than plant foods eaten directly

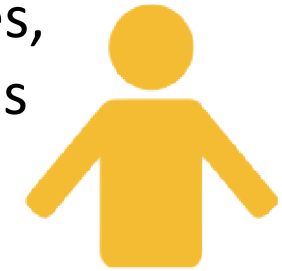


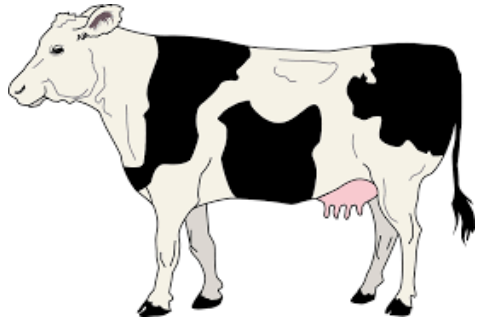


Main point #3: Ruminant animals emit some carbon as methane, which is a potent greenhouse gas

0.4-1.5 kg $CO_{2\text{-eq}}$ per kg vegetables, grains, and beans

CH_4





26 kg $CO_{2\text{-eq}}$ per kg beef

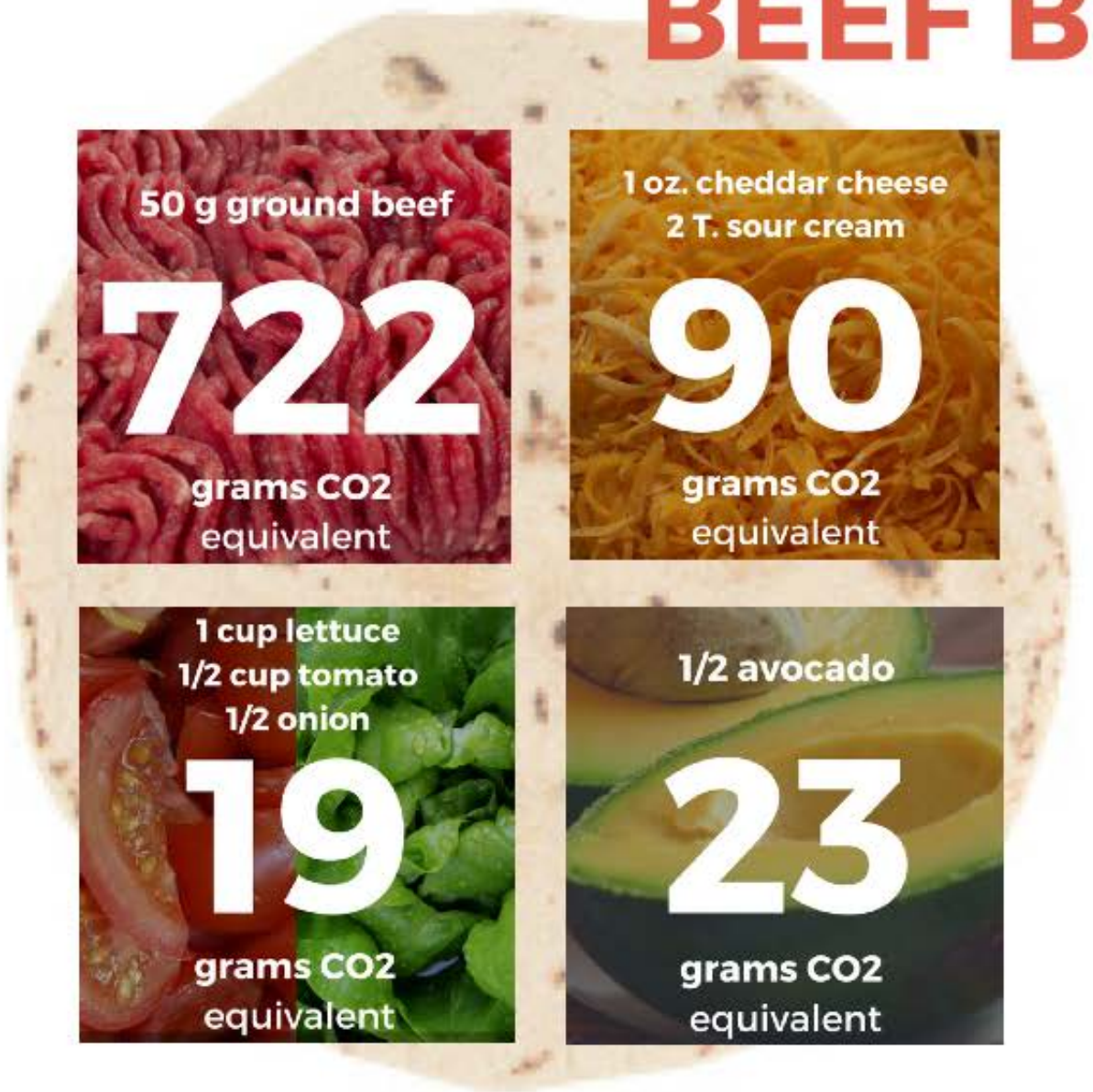
VEGGIE BURRITO

604 calories
23 g protein
33 g fiber

88
grams CO_2
equivalent

Data source: Meier and Christen, 2012. Credit for infographic: Hannah Malan and Prof. Amy Rowat

BEEF BURRITO



638 calories
28 g protein
12 g fiber

896
grams CO_2
equivalent

Data source: Meier and Christen, 2012. Credit for infographic: Hannah Malan and Prof. Amy Rowat

Black Bean Bowl for the Planet

Black Bean Bowl

254 g $CO_{2\text{-eq}}$ per bowl

Beef Chili

2,449 g $CO_{2\text{-eq}}$ per bowl

@meals4planet, meals4planet.org

Broccoli Soup for the Planet

Plant-based soup

64 g $CO_{2\text{-eq}}$ per bowl

Dairy-based soup

472 g $CO_{2\text{-eq}}$ per bowl

@meals4planet, meals4planet.org

Pancakes for the Planet

Vegan Pancakes

48 g $CO_{2\text{-eq}}$

per serving

Traditional Pancakes

201 g $CO_{2\text{-eq}}$

per serving

@meals4planet, meals4planet.org

Let's see how sandwiches stack up for GHGs:

Food	g CO_2 / serving
1 bagel (98g)	41
1 Slice of Bread (50g)	21
Hummus (15g = 1 tbsp)	20
1 Slice of Cheese (28.35g)*	277
1 Slice of Ham (28.35g) *	195
1 Slice of Roast Beef (28.35g)*	750
1 Slice of Chicken/Turkey (28.35g)*	143
1 Slice of Tomato (20.5 g)	6
1 Piece of Lettuce (9g)	9
Peanut butter (16g = 1 tbsp)	31
Jelly (20 g = 1 T)	27
Hamburger patty	2,645
Black bean patty	78

*Note: a deck of cards size of meat = 3 ounces = 3 slices

~ 200 g $CO_{2\text{-eq}}$

~ 3,000 g $CO_{2\text{-eq}}$

Scenario	g $CO_{2\text{-eq}}$
Typical lunch (n=77)	981
Willing to choose if trying to achieve lower C footprint (n=77)	212
Difference between the two sandwiches	769

769 g $CO_{2\text{-eq}}$ is 21% of the daily goal for reaching Paris Climate Accord targets

To meet the Paris Climate Accord:

447 Million Metric Tonnes CO_{2eq}

per year for the USA

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3,660 grams CO_{2eq}
per person per day

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- ✓ Transportation
- ✓ Conservation
- ✓ Consumption
- ✓ Diet

Let’s think about making guacamole from scratch

What items do you need?

Where in the store would you find these items?

Carbon footprint of the ingredients:

Ingredient	Carbon Footprint g CO_2-equivalents
3 avocados	572
3 garlic cloves	3
2 limes	67
1 tomato	37
Total	**678**

Comparing homemade to store-bought guacamole

Where in the store would you find these items for making guacamole from scratch?

Where in the store do we find the pre-made guacamole?

Refrigerated transport and packaging of guacamole

- There is a great paper by Tassou et al. (2009) that compares the carbon footprint of various types of trucks carrying food at different temperatures.
- In the paper, they give values for **g CO_2 per pallet per km** (these values are for the energy required for transportation and cooling, but exclude refrigerant leakage):
- The paper also mentions a couple of other studies that indicate the greenhouse gas emissions are approximately 20% higher for the chilled and frozen scenarios if you do consider refrigerant leakage.

	Ambient **g CO_2 per pallet per km**	Chilled **g CO_2 per pallet per km**	Frozen **g CO_2 per pallet per km**
Med. rigid truck	88	106	112
Lg. rigid truck	85	102	108
City articul.	56	69	73
32 T artic.	51	61	65
38 T artic.	48	58	61

Refrigerated transport and packaging of guacamole

- To make a 1 L plastic bottle requires about **270 g CO_2-equivalents** (Gleick and Cooley, 2009).
- Assuming around the same amount of plastic for a fairly good-sized container of guacamole, we have a total of **480 to 840 additional g CO_2-equivalents**, **just for the packaging and refrigerated transport of our bowl of guacamole.** This analysis does not take into account the energy to make the guacamole, or to keep it cold in the store.
- In general, eating foods closer to their natural state and making things from scratch is preferable, since processing, the food miles associated with various processing steps, refrigerated transport, and packaging can really make a difference!

Homemade Guacamole for the Planet

Homemade (per bowl)

680 g $CO_{2\text{-eq}}$

Store-bought (per bowl)

1200-1500 g $CO_{2\text{-eq}}$

Packaging and refrigerated transport double the carbon footprint!

Class Activity

- Download the Excel Sandwich activity onto your computer
- Follow the directions on the separate guided worksheet.