Today:
Return papers
Science Policy

I have to leave office hours by 1:15 tomorrow!
Review problems handed out tomorrow

Tomorrow and Wednesday: Ozone hole

Thursday: review
Proxy data of the week - Tatiana Feldcherova
14 percent = 65 million metric tons.

45 percent = 200 million metric tons.

80 percent = 384 million metric tons.

88 percent = 424 million metric tons.

100 percent = 478 million metric tons.

Source: Author's estimates.
Climate Stewardship Act
Brought to the senate by McCain and Lieberman
October 2003

EPA would limit GHG emissions and allow trading from
1. Electricity generation
2. Transportation
3. Industrial economic sectors
4. Commercial economic sectors
(totaling over 85% of US emissions - exempt are residential and agricultural sectors)

Target - cap emissions at the 2000 level
CO2 emissions in the US
1/3 Industry
1/3 Residential
1/3 Transportation

US accounts for 25% of global CO2 emissions
Policy Alternatives to Address Climate Change

Wind, Tidal, and Geothermal Are all non-GHG producing
Solar power is harnessed through two principal means:

(1) Solar thermal collectors, which can produce hot water and warm air for homes and industrial applications.

(2) Solar photovoltaic cells, shown here, which generate pollution-free electricity directly from sunlight.
Many countries are much more reliant on nuclear power than the U.S., which meets 20% of its energy needs from nuclear.

Lithuania, 77.2%
France 75.8%
Belgium 55.2%
Sweden 45.3%

In total, about 18% of the world’s energy needs are supplied by nuclear power.

Nuclear power generation results in no greenhouse gas emission, but waste disposal poses an environmental problem.
Hydroelectric power also generates no greenhouse gas emissions. But it can also create other environmental problems.

Provides about 15% of the world’s electricity needs.
Biomass-based fuels - for cars

Methanol or ethanol from plants (like corn)
In our gas now
No net change in CO2

Bio-diesel is spent cooking oil, exhaust smells like french fries
Projections indicate that fossil fuels will continue to dominate energy production.

This figure shows US past and future estimates.
Carbon emissions per GDP has been dropping (so what)
Currently US GHG emissions cut-backs are on a voluntary basis

Clean Air Act of 1972 - Regulates emissions of pollution that are directly harmful to humans via Environmental Protection Agency

Most strict are requirements on new construction of power plants, so older plants are being used long past their intended lifetime
Car manufacturers are regulated so average car sold meets an average fuel economy

CAFÉ = Combined Automobile Fleet Emissions

Sale of non-efficient cars subsidizes sale of efficient cars

SUVs are not included

CAFÉ standard has decreased 1.3 mpg since 1988
The Montreal Protocol: a model for addressing Climate Change?

Ozone hole discovered over Antarctica in 1984

Montreal Protocol signed in 1987 (plus amendments)

Gradually phases out the production and use of ozone-destroying CFCs, or face trade sanctions

All major industrial nations have signed
Participation in the Montreal Protocol

- Yellow = countries that signed treaty
- White = countries that have not signed treaty
Why has the effort to fight ozone depletion been so successful?

(1) CFCs and ozone destruction connected by sound science.

(2) Chemical industry fearing federal regulation, developed viable alternatives to CFCs, within a year or two.

(3) Equity issues between developed and developing nations were recognized.
   • developing nations phased out later
   • fund established by the wealthy countries

global commitment to solving the problem.
pre-industrial CO2 level was about 280 ppm
The Kyoto Protocol 1997
160 nations present. Aim to reduce emissions of GHG (primarily CO2)

Developed nations reduce emissions 7% below 1990 levels during the period 2008-2012, method is flexible

Developing countries did not agree to meet any requirements

Includes some emissions trading and joint implementation (market-based mechanisms) at the urging of the US delegation
The fate of the Kyoto protocol

Signed by Clinton in 1997, but requires senate approval

In 2001, Bush declared that the US would not participate citing the lack of participation of developing countries and the burdens it would place on the US economy.

In November 2004, Russia signed, meeting the minimum for ratification
Fusion is the reaction that fuels the sun and H-bombs. The fusion of nuclei in 1 kg of a mixture of deuterium and tritium (heavy water) would produce as much energy as the burning of 10,000 tons of coal. The main barrier to generating power from fusion is controlling the reaction.
CO₂ removal directly from the atmosphere.

Iron Fertilization:
1. Supertankers would spread millions of tons of iron over the ocean surface.
2. The iron stimulates growth of plankton, which consume CO₂.
3. Plankton die, they sink to the sea floor, burying carbon.

Alters the carbon cycle at depth.
Carbon Sequestration (thanks to classmate Steve Barry)
Inject CO2 from power plant into the deep ocean or burying it deep in the ground

Bush administration allocated 1 billion to build a proto-type coal fired power plant

Synfuels plant in N. Dakota - gasification (heating of dirty oil/coal) to produce CH4, H2 etc. Pump CO2 320km to Canadian oil fields
An illustration of a scheme to inject carbon into the ocean
What can be done?

Compare again with ozone issue

(1) Communicate more sound science on climate change via IPCC and public outreach

(2) Economically-viable alternatives to fossil fuel burning. Conservation and efficiency measures, alternative energy sources, and/or carbon sequestration,

(3) Need a truly global agreement where everyone makes commitments to reduce greenhouse gas emissions.