#### EOSC 112

## **Global warming**

#### Outline

- definitions, greenhouse gasses
- anthropogenic CO<sub>2</sub> vs natural CO<sub>2</sub> sources
- fate of anthropogenic CO<sub>2</sub>
- future projections
- sea level change and ecosystem responses

Greenhouse effect: the warming of the Earth's atmosphere caused by the absorption of infrared terrestrial radiation by gases such as  $CO_2$  and water vapor

**Global warming**: the enhanced greenhouse effect resulted from the elevated greenhouse gas concentrations due to human activities

Climate change: complex changes in the Earth's system, mainly due to the natural cycle







Table 2. Examples of human intervention in the global biogeochemical cycles of carbon, nitrogen phosphorus, sulfur, water, and sediments. Data are for the mid-1900s.				
Element	Flux	Magnitude of flux (millions of metric tons per year)		% change due to
		Natural	Anthropogenic	numan activitie
с	Terrestrial respiration and decay CO <sub>2</sub> Fossil fuel and land use CO <sub>2</sub>	61,000	8,000	+13
N	Natural biological fixation Fixation owing to rice cultivation, combustion of fossil fuels, and production of fertilizer	130	140	+108
P	Chemical weathering Mining	3	12	+400
s	Natural emissions to atmosphere at Earth's surface Fossil fuel and biomass burning emissions	80	90	+113
O and H (as H <sub>2</sub> O)	Precipitation over land Global water usage	111 × 10 <sup>12</sup>	18 × 10 <sup>12</sup>	+ 16
Sediments	Long-term preindustrial river suspended load	1 × 10 <sup>10</sup>	2 × 10 <sup>10</sup>	+200





# Global warming

#### Time scales:

- ocean, thermohaline circulation, ~ 1000s years
- terrestrial biomes, ~ 50 years ?





- entire fossil fuel reserve (~ 4000-6000 Gt(C)) is consumed during
- 30% of the world forests remain

will be reached by A.D. 2300

dissolution in the deep ocean and by the dissolution of carbonate sediments and rocks. The remaining weathering over a period > 1 million

## **Global warming**

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Year 2000

ear 2080-2100

re ('C)

Anthropogenic global climate change

IPCC estimates average global temperature will increase over the next century by 1.4 - 5.8° C

Difference between current temperature and the last ice age is only 5° C

Every year of the 1990's was among the 15 hottest of the past millennium

Night temperatures generally increased more than daytime

Precipitation rates also increased

#### EOSC 112 Effects of global warming/climate change

- Melting of polar ice caps and water thermal expansion would lead to sea level rise. By 2100, sea level may increase by <u>30-110 cm.</u> If all polar caps would melt, sea level could increase by 70-80 m submerging roughly 20% of present continents. One-third of population living in areas likely to be flooded by rising seas
- Changes in regional climatic patterns (e.g. more desert for Africa); phenology and physiology of organisms (e.g. shift and extension of the growing season and subsequent shifts in animal behaviour; world amphibian population decline...)
- Biomes will migrate pace will favor some species and kill others. More invasions. Changes in speciation within forests. Pests and agriculture. Spreading of various human diseases.





#### EOSC 112 Effects of global warming/climate change

- More evaporation would lead to more intensive storms
- · Warming of the ocean would lead to: (a) increased water column stability → decrease in productivity
- decrease in the ocean storage capacity
- (c) greater production of DMS by phytoplankton
- (d) shift in the sea ice extent (e) decrease in the deep water formation (as an extreme a shut down the thermohaline
- circulation (f) changes in trophic interactions,
- ecosystem shifts











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### 3. Disturbance of an inorganic carbon cycle

A new study published in Nature on September 29, 2005 reports that ocean acidification could result in corrosive chemical conditions that would be reached much sooner than previously thought.

Within 50 to 100 years, there could be severe consequences for marine calcifying organisms, which build their external skeletal material out of calcium carbonate, the basic building block of limestone.

Most threatened are cold-water calcifying organisms, including sea urchins, cold-water corals, coralline algae, and plankton known as pteropods-winged snails that swim through surface waters.

http://www.ipsl.jussieu.fr/~jomce/acidification/#satstate







EOSC 112 Effects of global warming/climate change 4. Change in atmospheric dust deposition Increased aridity will stimulate higher dust supply http://www.epm.oml.gov/PR/irondust.html High correlation values between phytoplankton production and dust input are indicative for trace metal (iron) limitation Eric 4 4 Low correlation coefficient high