#### **Climate Engineering**



Approximate Preindustrial Concentration is 280 umol/mol.



Adapted from Sarmiento and Gruber (2002) and updated using Sarmiento, and Hales (2007). All numeric values are in gigatons (GtC - billions of metric tons of carbon). Preindustrial reservoir are represented by black numbers and cumulative postindustrial reservoir transfers are represented by red numbers. Current fluxes are shown in smaller type; the largest flux is 6.4 GtC per year from industrialization.

#### **Technology Assessment**

**Center for Science, Technology, and Engineering United States Government Accountability Office** 

**Technical Status, Future Directions, and Potential Responses** 

- Bio-energy with CO<sub>2</sub> Capture and Sequestration
- Ocean Fertilization to increase Capture of CO<sub>2</sub>
- Enhanced Weathering of Rocks to Remove CO<sub>2</sub>
- Increase Aerosols to Scatter More Light
- Direct CO<sub>2</sub> Air Capture with <u>Geologic Sequestration</u>
- Land-use Management
- Biochar and Biomass Methods

# Bio-energy with CO<sub>2</sub> Capture and Sequestration

Biomass crop are used as fuel to generate electric. Power generation plant would capture CO<sub>2</sub> and store it in geologic formations.

**Unknown Aspects:** 

- Which types of plants are optimal for taking up the carbon dioxide from the air.
- Which kind of biomass creates the best bio-fuel
- How can the efficiency of the bio-fuel be optimized
- Process doesn't add a lot of greenhouse gasses and pollutants back into the atmosphere.

## Ocean Fertilization to Increase Capture of CO<sub>2</sub>

Living phytoplankton absorb CO<sub>2</sub> via photosynthesis and settle to the ocean bottom when they die.

**Unknown Aspects:** 

- How does the concentration of atmospheric CO<sub>2</sub> influence the photosynthesis process?
- Will the amount of microscopic plants become saturated and result in no increasing in removing CO<sub>2</sub>?
- What is the effects of increasing plankton in ecosystem?
- How does manipulating the biological pump sequestrate the CO2 into deep ocean?

## Enhanced Weathering of Rocks to Remove CO<sub>2</sub>

The weathering of silicate rocks is done through chemical reactions to form solid carbonates which could be chemically enhanced.

**Unknown Aspects:** 

- How will the storage of these carbonates or the spread of the carbonic acid affect ecosystems and wildlife in our oceans.
- Sea salt could cause a further chemical reaction with the introduced acid or carbonate that will have a negative or undesired result.

## Increase Aerosols to Scatter More Light

Add aerosol to the Stratosphere to increase the amount of light scattering to counteract the warming effect resulting from high CO2 levels.

**Unknown Aspects:** 

**Negative health effects.** 

Difficult too assess the long term effect on the natural climate and environment.

What is the threshold of sulfur saturation that would result in acid rain formation.

#### Climate Engineering Technologies Summaries

