Updated: 23 February 2020

Print version

CEE 680: Water Chemistry

Lecture #18

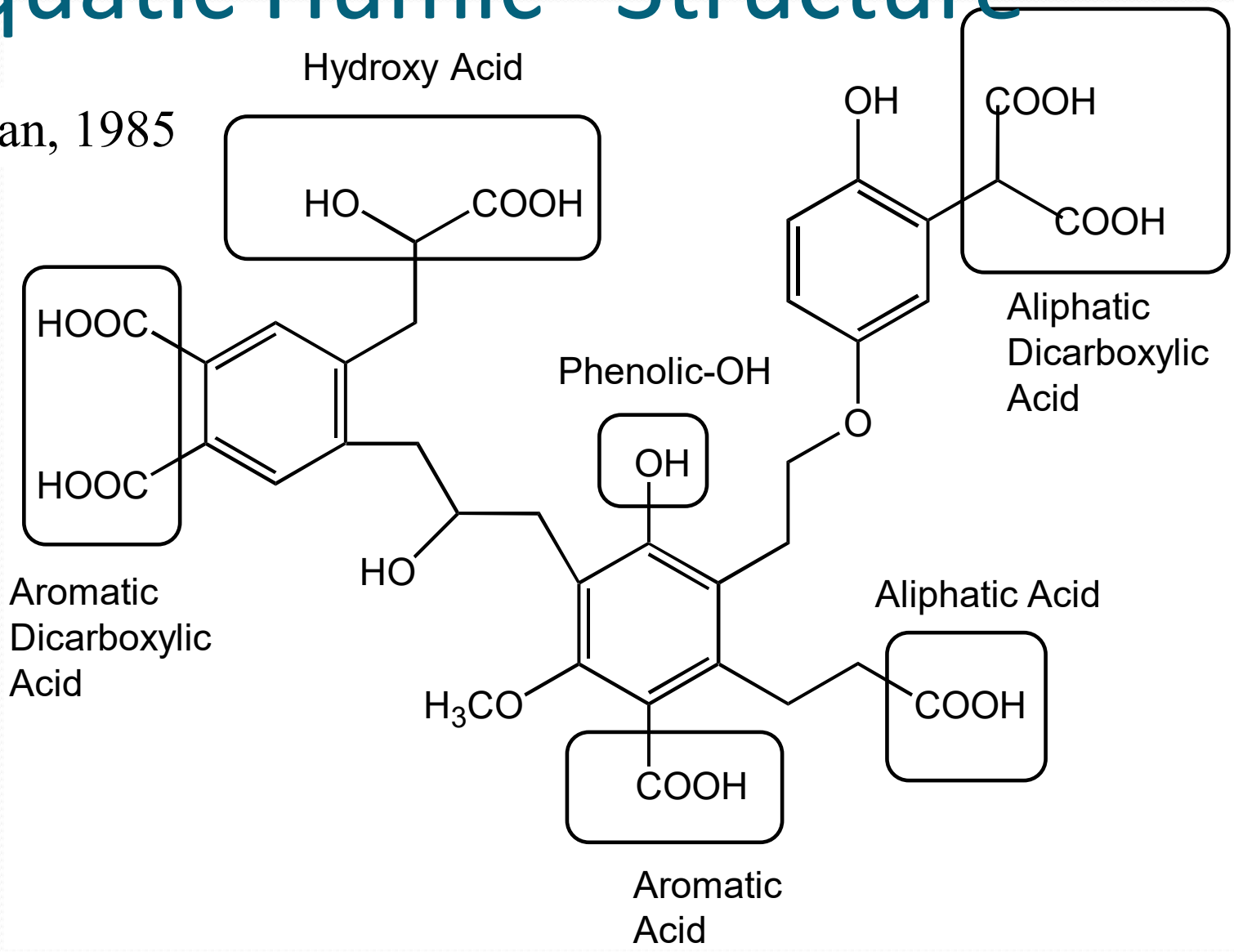
Dissolved Carbon Dioxide: Introduction

(Stumm & Morgan, Chapt.4)

Benjamin; Chapter 5.4 & 7

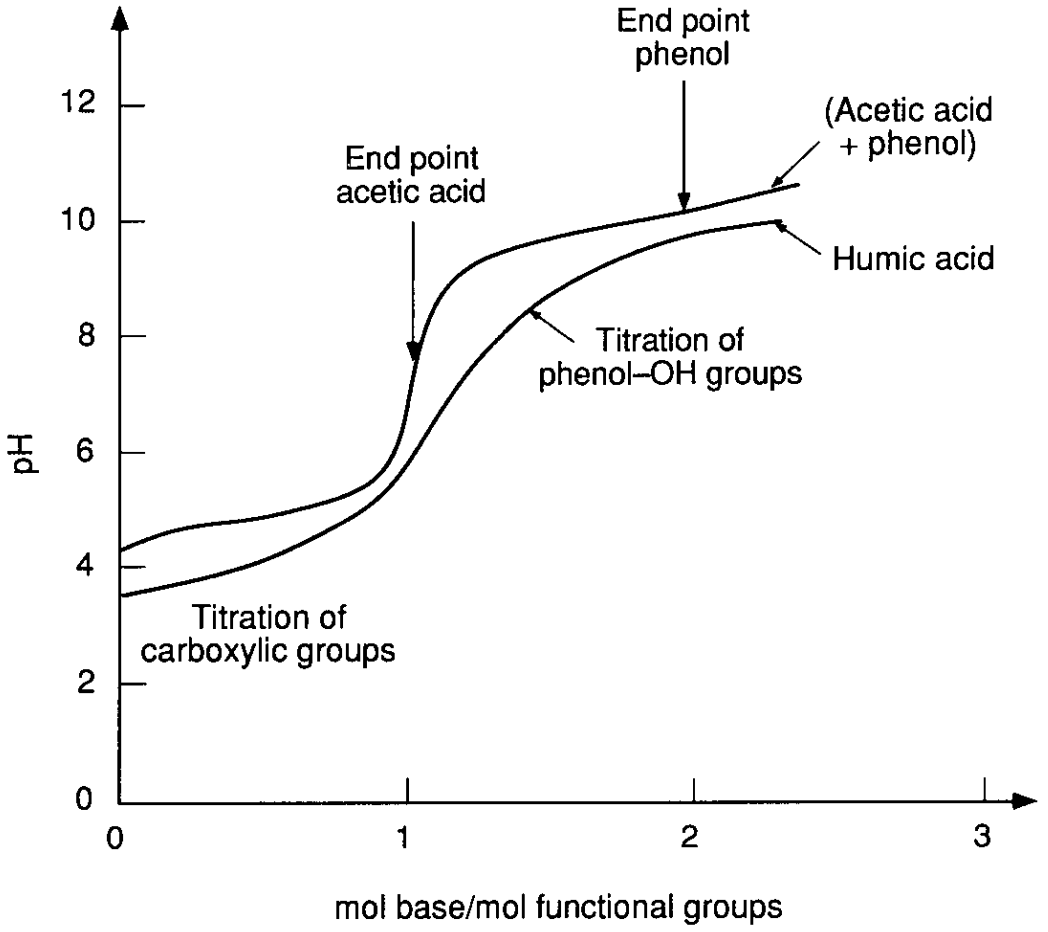
An Aquatic Humic "Structure"

From Thurman, 1985



Titration of Humics

- Model for aquatic humic substances
  - Acetic acid + phenol



Acid Neutralizing Capacity

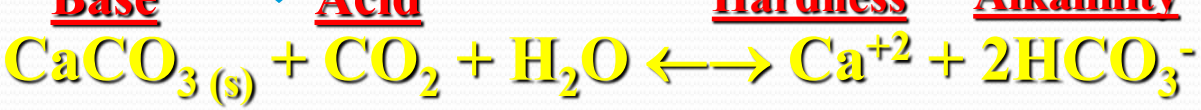
- Net deficiency of protons
  - with respect to a proton reference level
    - when the reference level is H_2CO_3, the ANC=Alkalinity

$$[ANC] = \int_{f=n}^{f=x} \beta dpH$$

  - conservative, not affected by T or P
  - In a monoprotic system:
    - $[ANC] = [A^-] + [OH^-] - [H^+]$
    - $= C_T\alpha_1 + [OH^-] - [H^+]$

Dissolved Carbon Dioxide

- Importance
  - regulating pH in natural waters, also source of carbon for autotrophic organisms
- Sources
  - volcanism, combustion, respiration, weathering



- Sinks
  - photosynthesis, precipitation

Major Forms of Carbon on Earth

Source	Mass, 10^{15} Kg	Percent
Geologic inorganic minerals	60,000	83%
Geologic organic minerals[a]	12,000	17%
Oceanic inorganics	40	0.056
Atmosphere	0.7	0.00097
All life on earth	0.6	0.00083

Ray, Table 3.3, pg. 37

Carbon Forms: Definitions

Inorganic Carbon

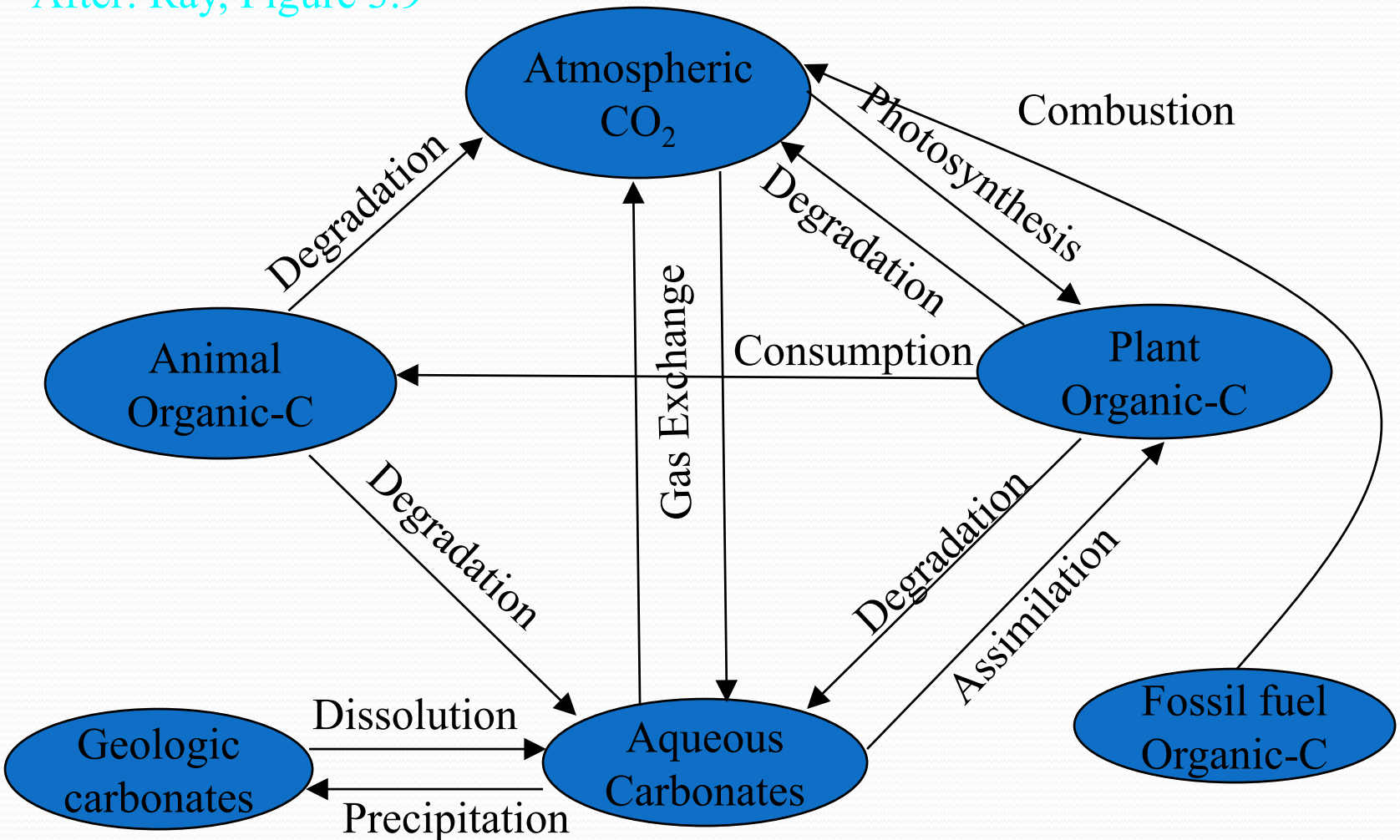
CO_2 = carbon dioxide (dissolved and gas)
H_2CO_3 = carbonic acid (dissolved)
HCO_3^- = bicarbonate (dissolved)
CO_3^{-2} = carbonate (dissolved)
$CaCO_3$ = calcium carbonate (mineral)

Organic Carbon

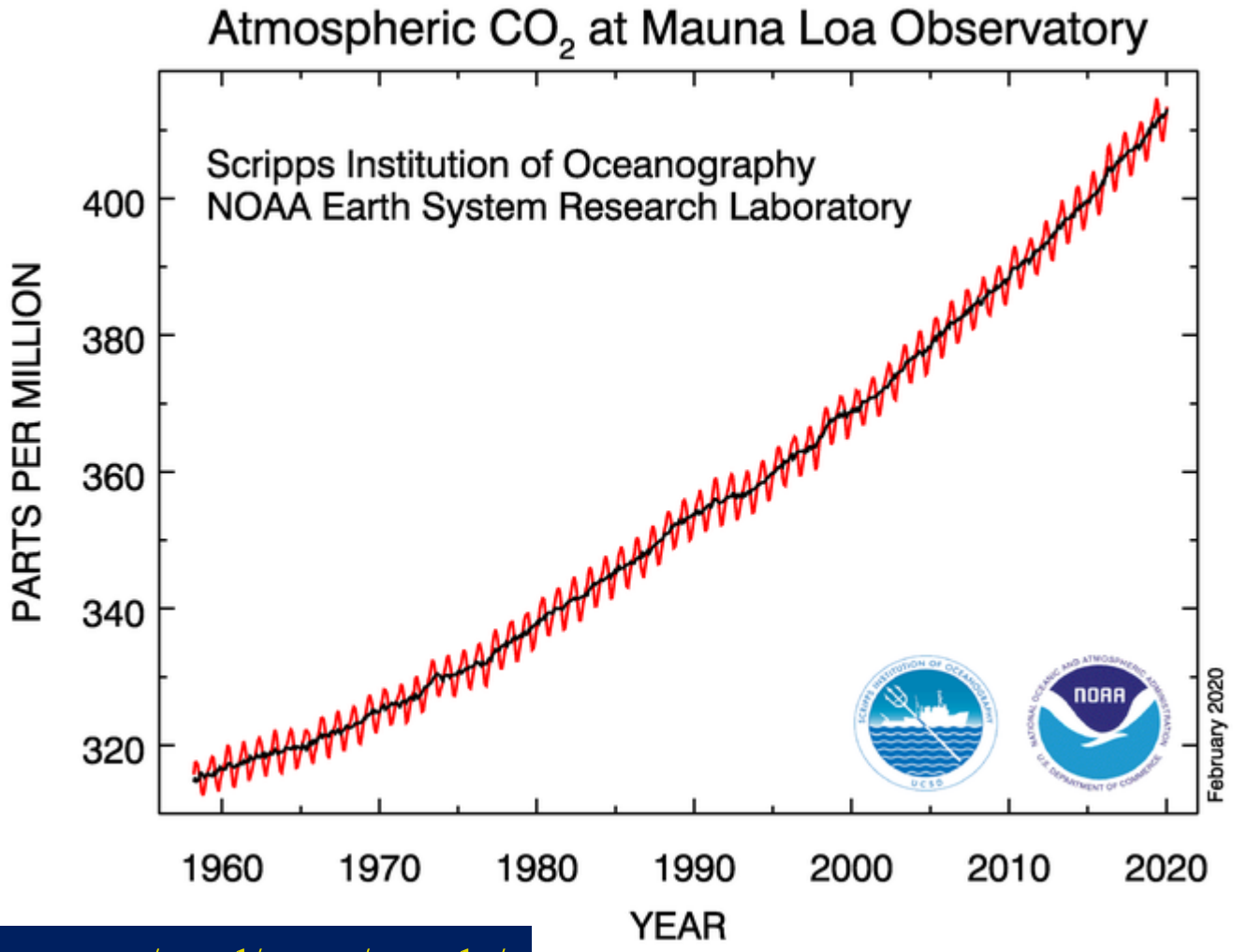
$C_6H_{12}O_6$ = glucose (a sugar)
CH_3COOH = acetic acid (a carboxylic acid)

The Carbon Cycle

After: Ray, Figure 3.9

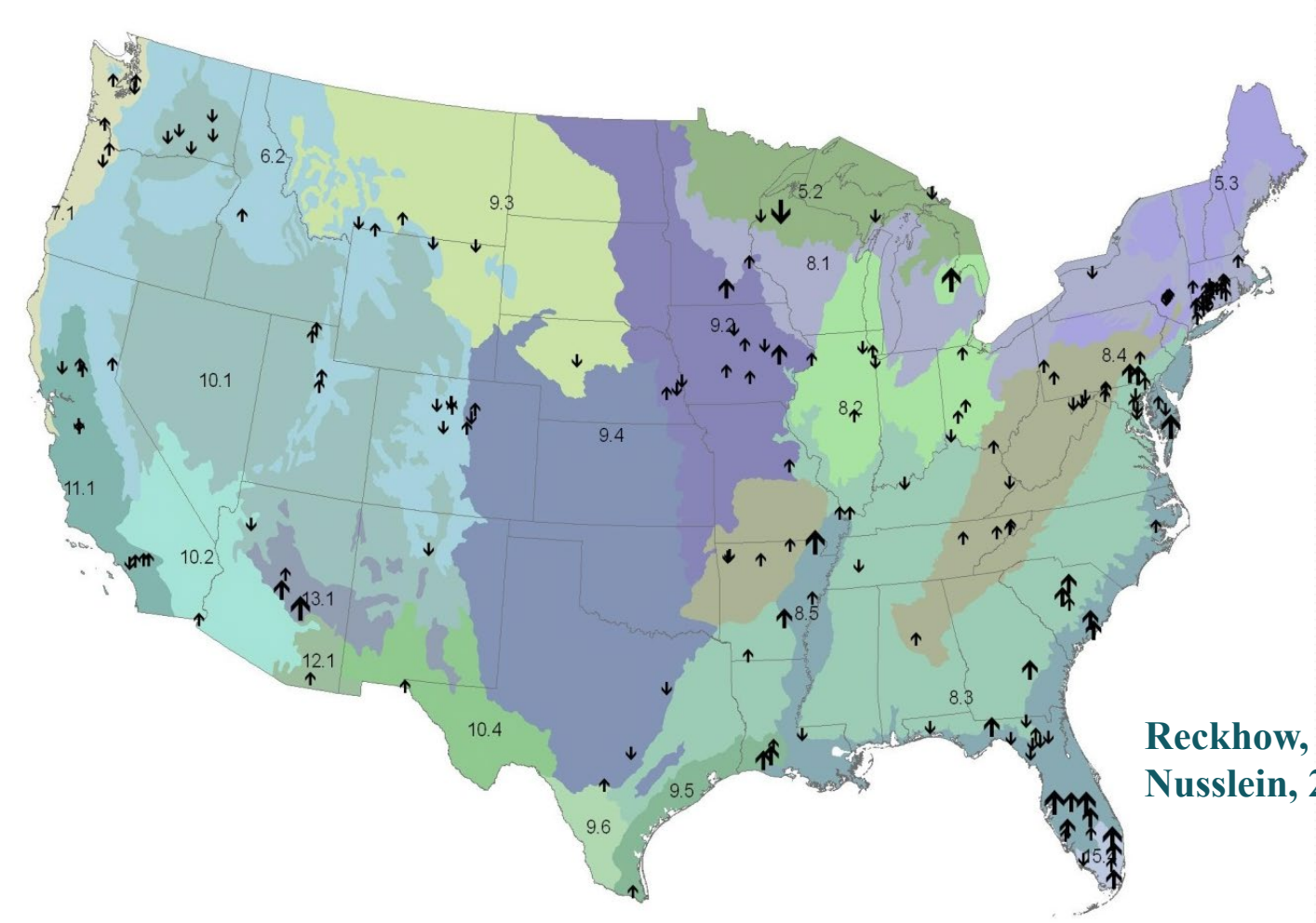


Global Carbon Dioxide



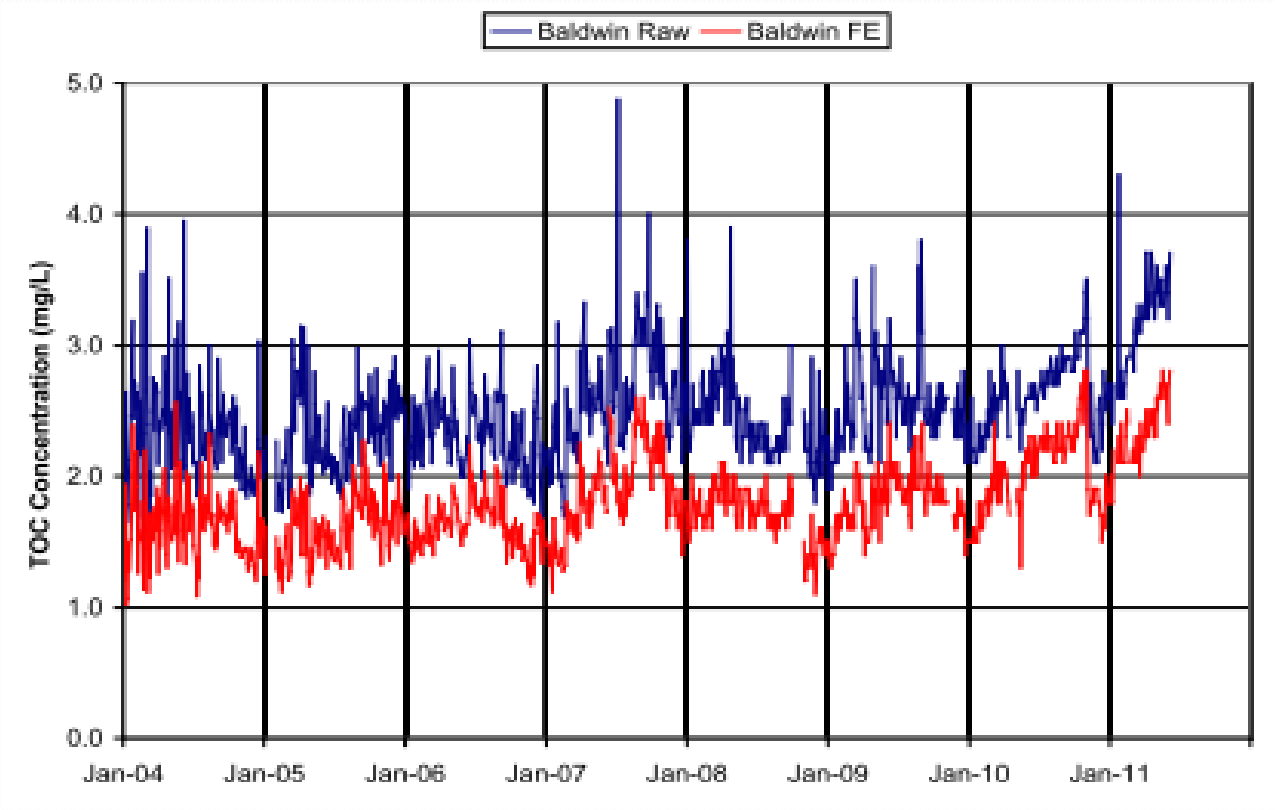
https://www.esrl.noaa.gov/gmd/ccgg/trends/

TOC Trends in US Rivers



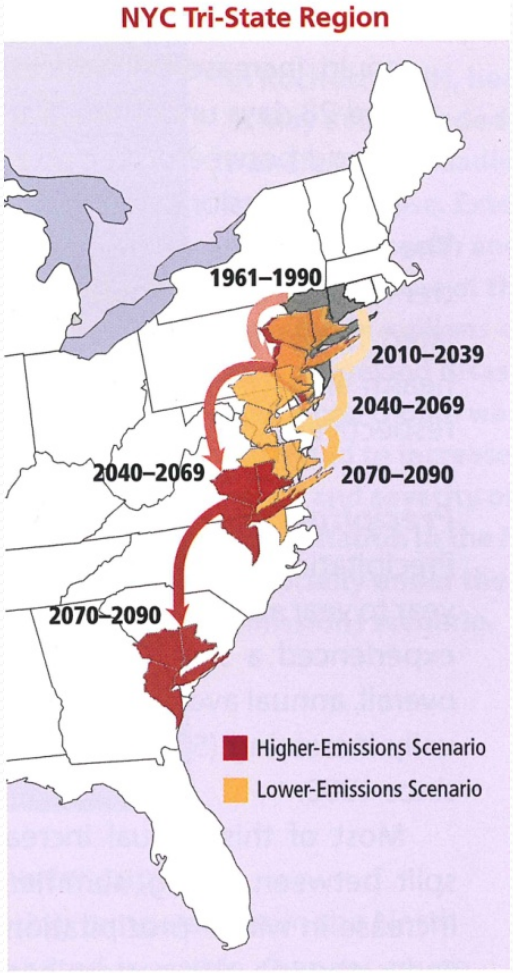
Reckhow, Rees & Nusslein, 2006

Lake Erie

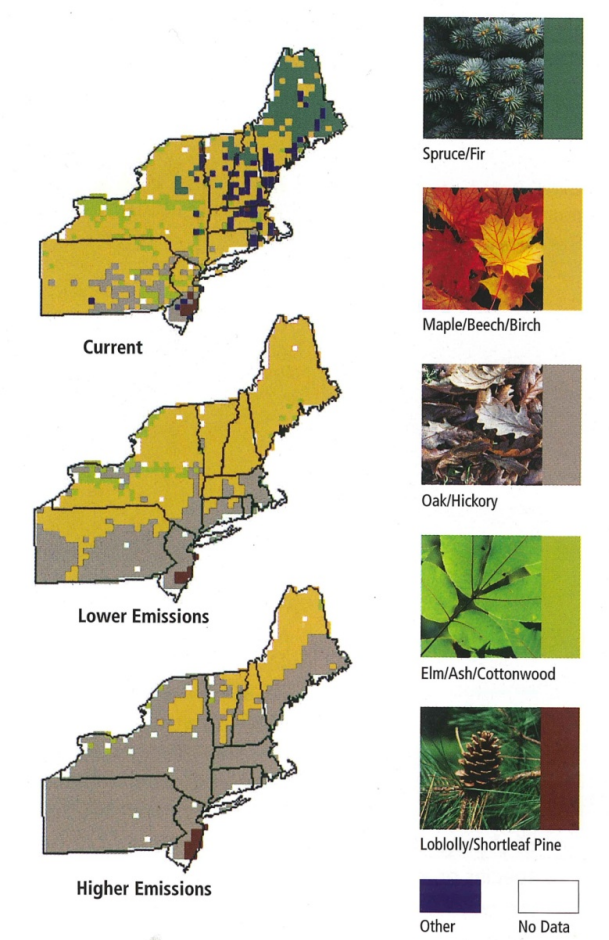


Total Organic Carbon levels from 2004 to 2011 in the Western Basin of Lake Erie (Baldwin Raw) and in treated water (Baldwin FE)

Tri-state Region



The Northeast Climate Change Report has projected increases in temperature of 8-12ºF in winter and 6-14°F in summer based on the higher emissions scenario. In general a great annual rainfall is expected, with more high flow events in winter and spring, higher intensity storms and longer annual droughts in summer. This is projected to cause a loss of spruce, fir, hemlock, maple beech and birch, and a migration to a oak/hickory forest. There may be more complete export of agriculturally-applied nutrients. The loss of hemlocks could speed up decomposition and nutrient cycling in soils, increasing nitrate runoff into streams.



- To next lecture