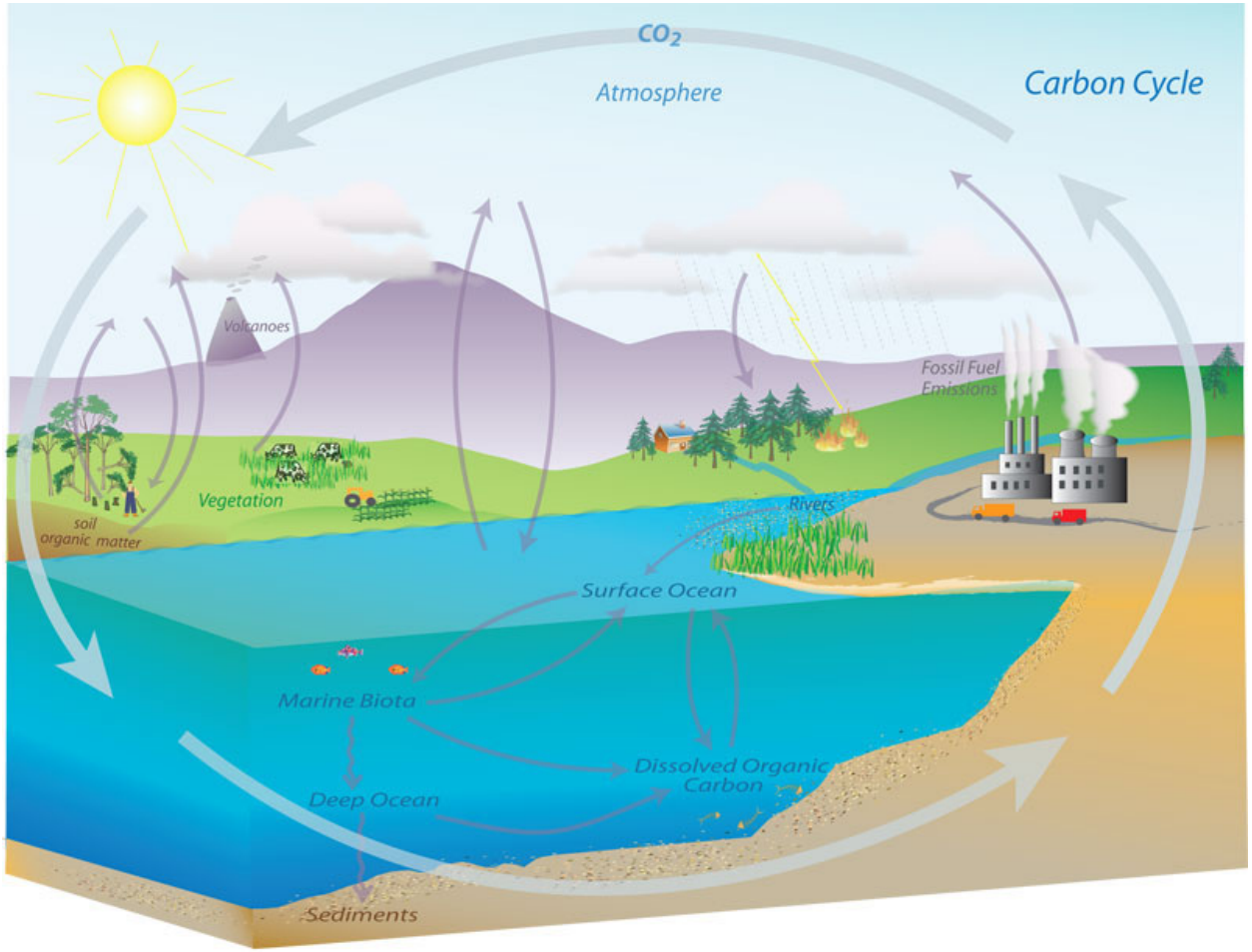
Quantitative Relationships In A Systems Diagram

Prediction of quantitative relationships in a complex system.

Example of The Carbon Cycle

The Carbon Cycle

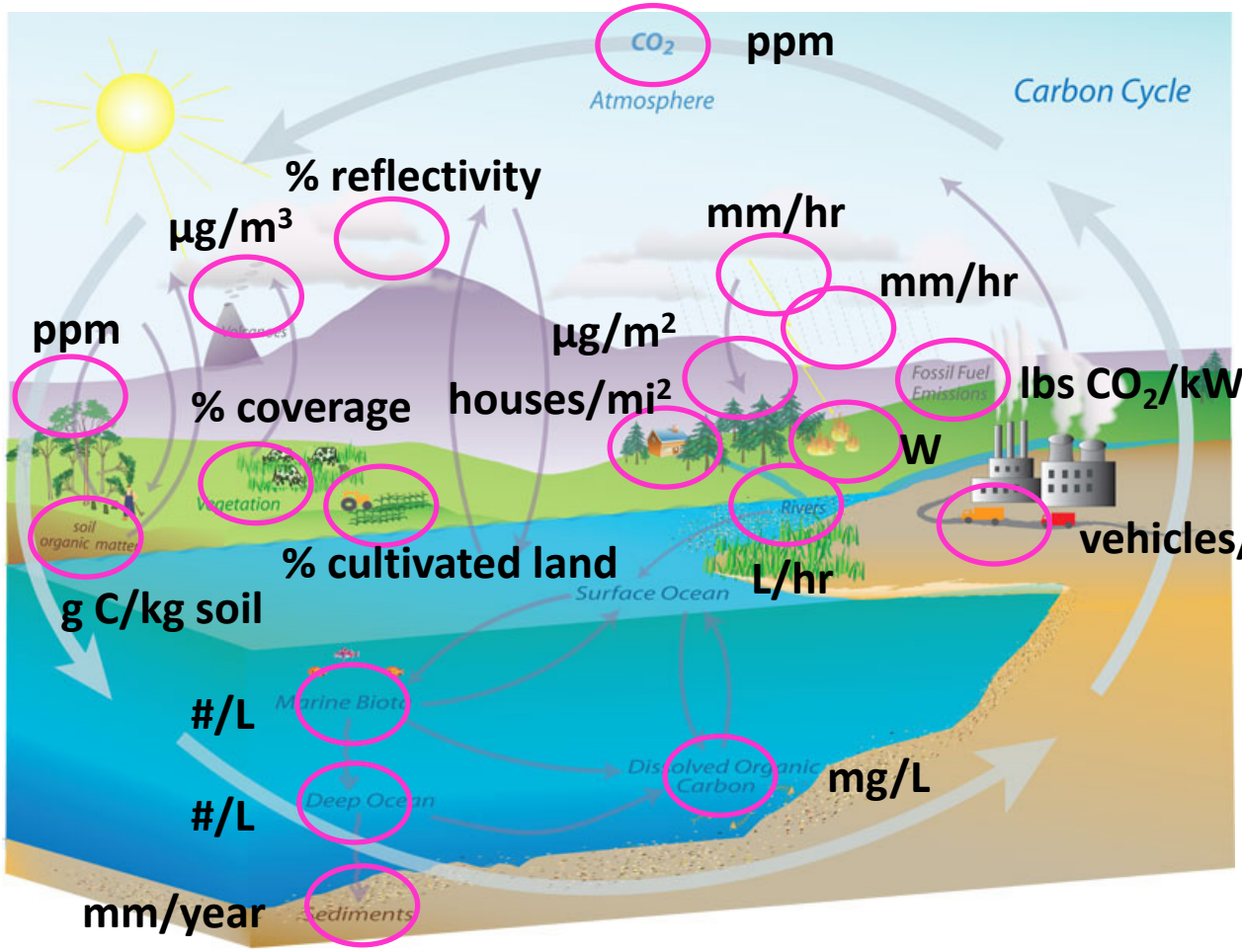


The Carbon Cycle – With Measurable Quantities Identified

Value Can Be Measured

Units of Measured Quantity

Others?



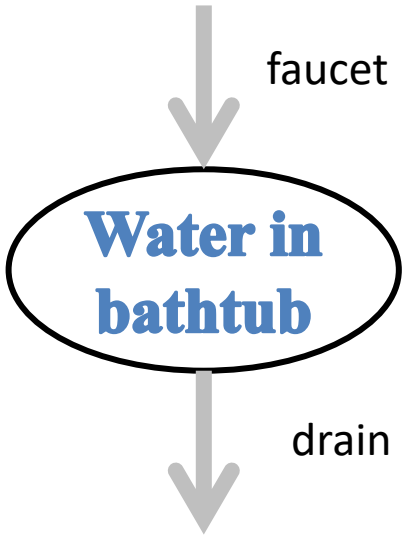
Using Quantitative Relationships In A Systems Diagram to Transform It Into a Model of a System

Example of The Carbon Cycle

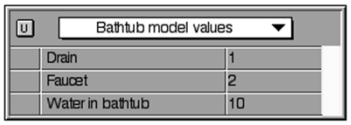
Converting a Diagram into a Model

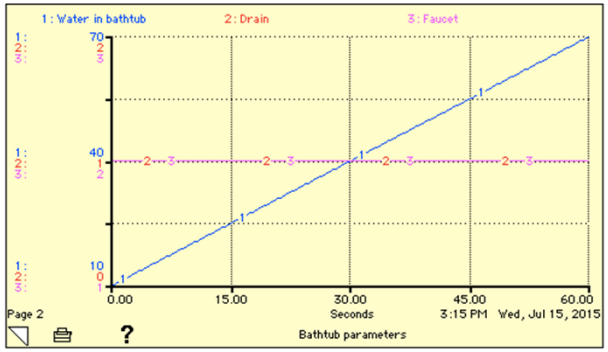
- A **diagram** illustrates connections and relationships.
- A **model** allows for a quantitative understanding and quantitative predictions by:
  - Including values for fluxes and rates
  - Including quantities for reservoirs

Diagram of a Bathtub System



Model of a Bathtub System





The Carbon Cycle – Fluxes and Reservoirs Indicated

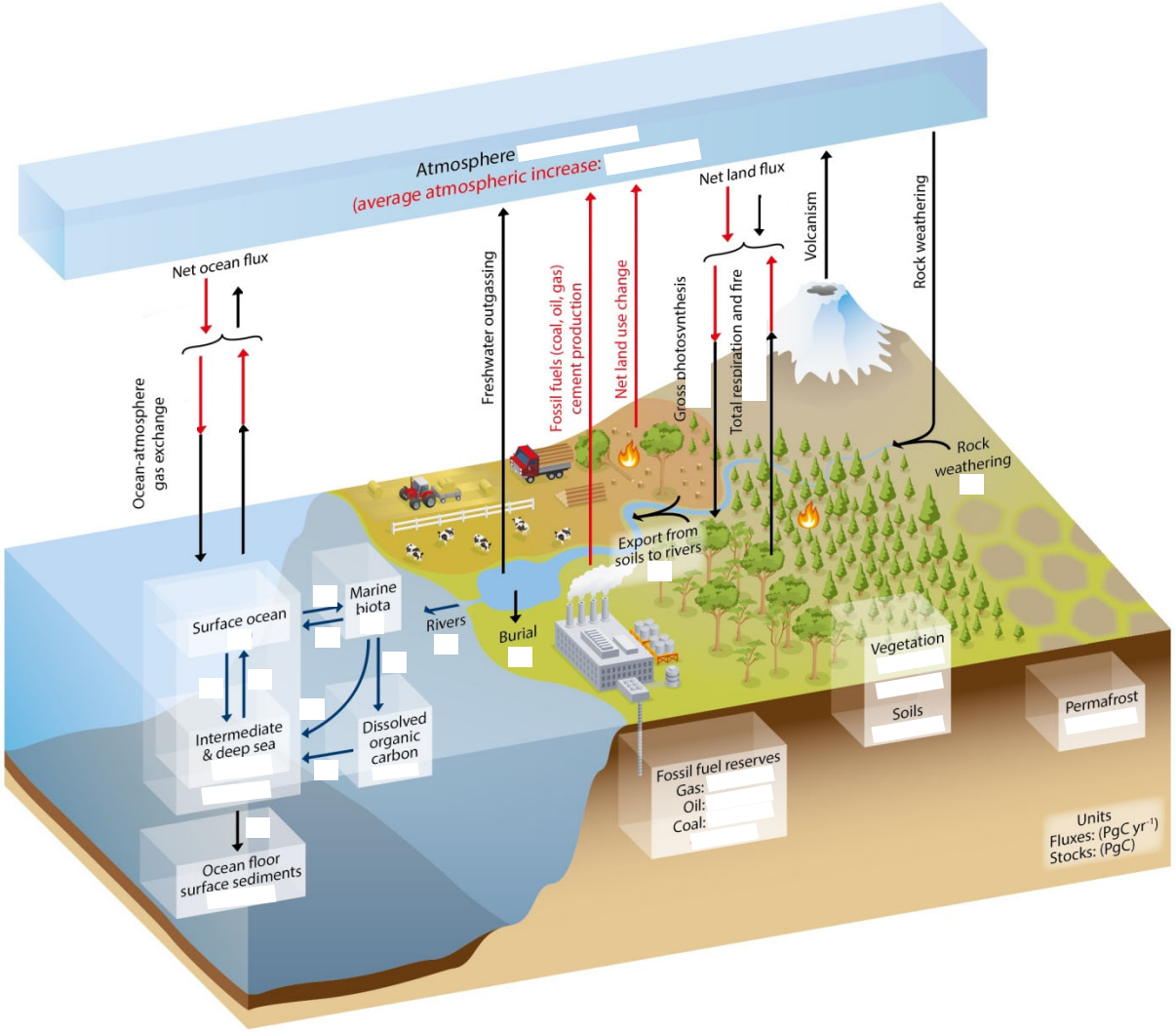
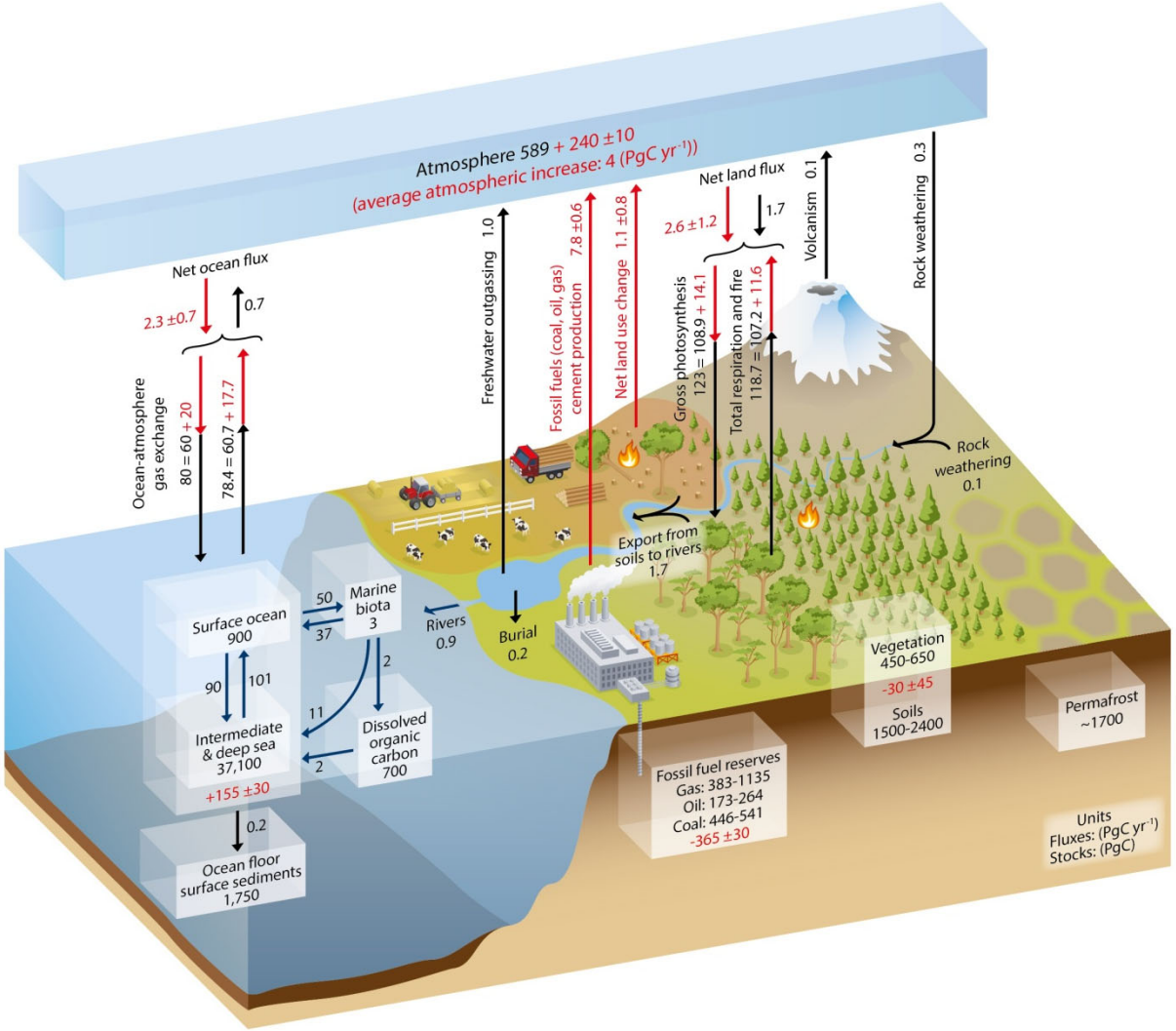


Figure 6.1 | Simplified schematic of the global carbon cycle. Numbers represent reservoir mass, also called "carbon stocks" in PgC (1 PgC = 10^{15} gC) and annual carbon exchange fluxes (in PgC yr^{-1}). Black numbers and arrows indicate reservoir mass and exchange fluxes estimated for the time prior to the Industrial Era, about 1750 (see Section 6.1.1.1 for references). Fossil fuel reserves are from GEA (2006) and are consistent with numbers used by IPCC WGIII for future scenarios. The sediment storage is a sum of 150 PgC of the organic carbon in the mixed layer (Emerson and Hedges, 1988) and 1600 PgC of the deep-sea $CaCO_3$ sediments available to neutralize fossil fuel CO_2 (Archer et al., 1998). Red arrows and numbers indicate annual "anthropogenic" fluxes averaged over the 2000–2009 time period. These fluxes are a perturbation of the carbon cycle during Industrial Era post 1750….

Ciais, P., C. et al., 2013: Carbon and Other Biogeochemical Cycles. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. p. 471,

The Carbon Cycle – Fluxes and Reservoirs Quantified



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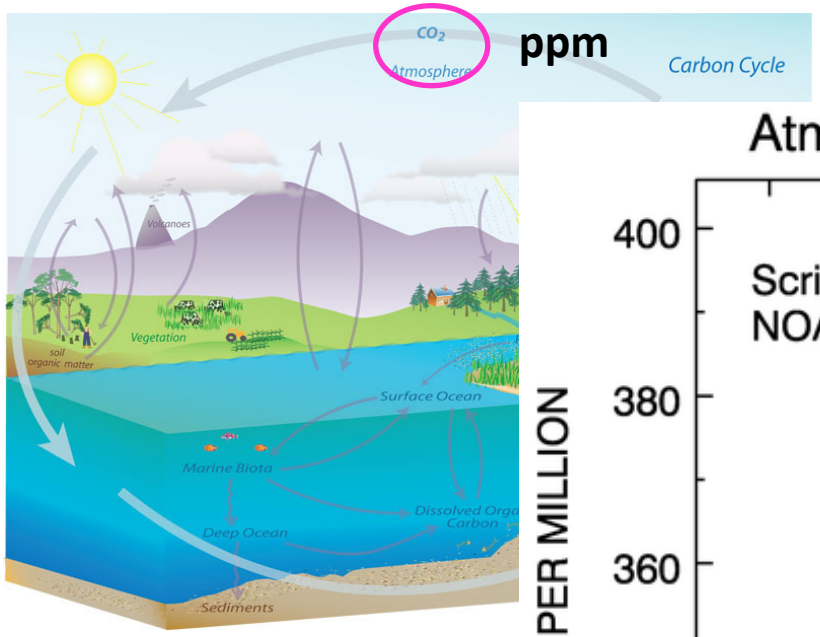
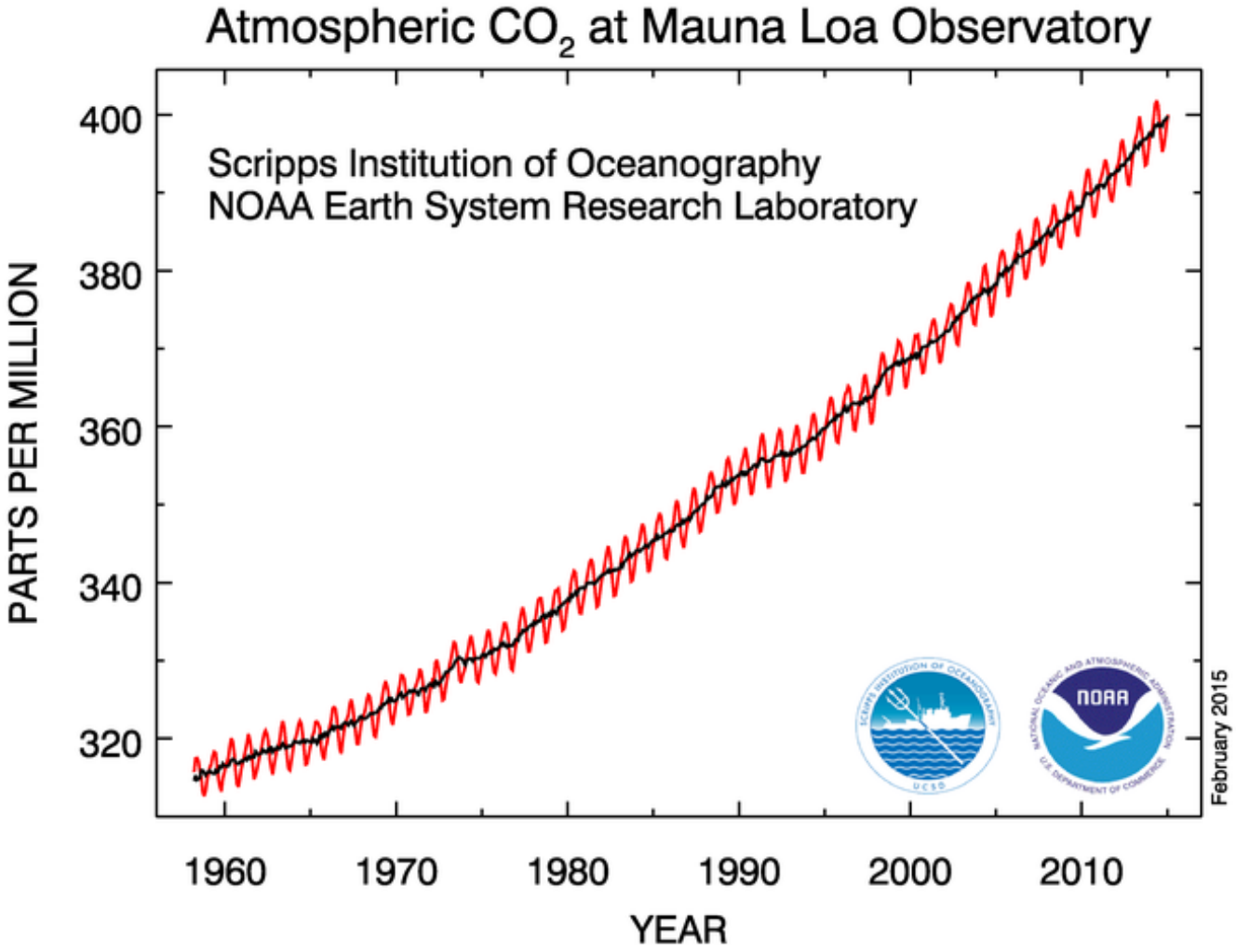
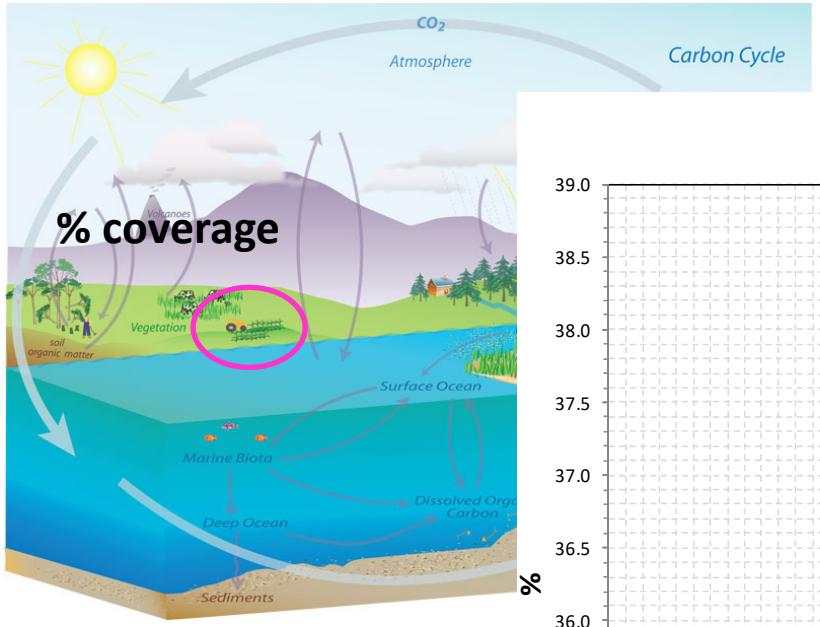
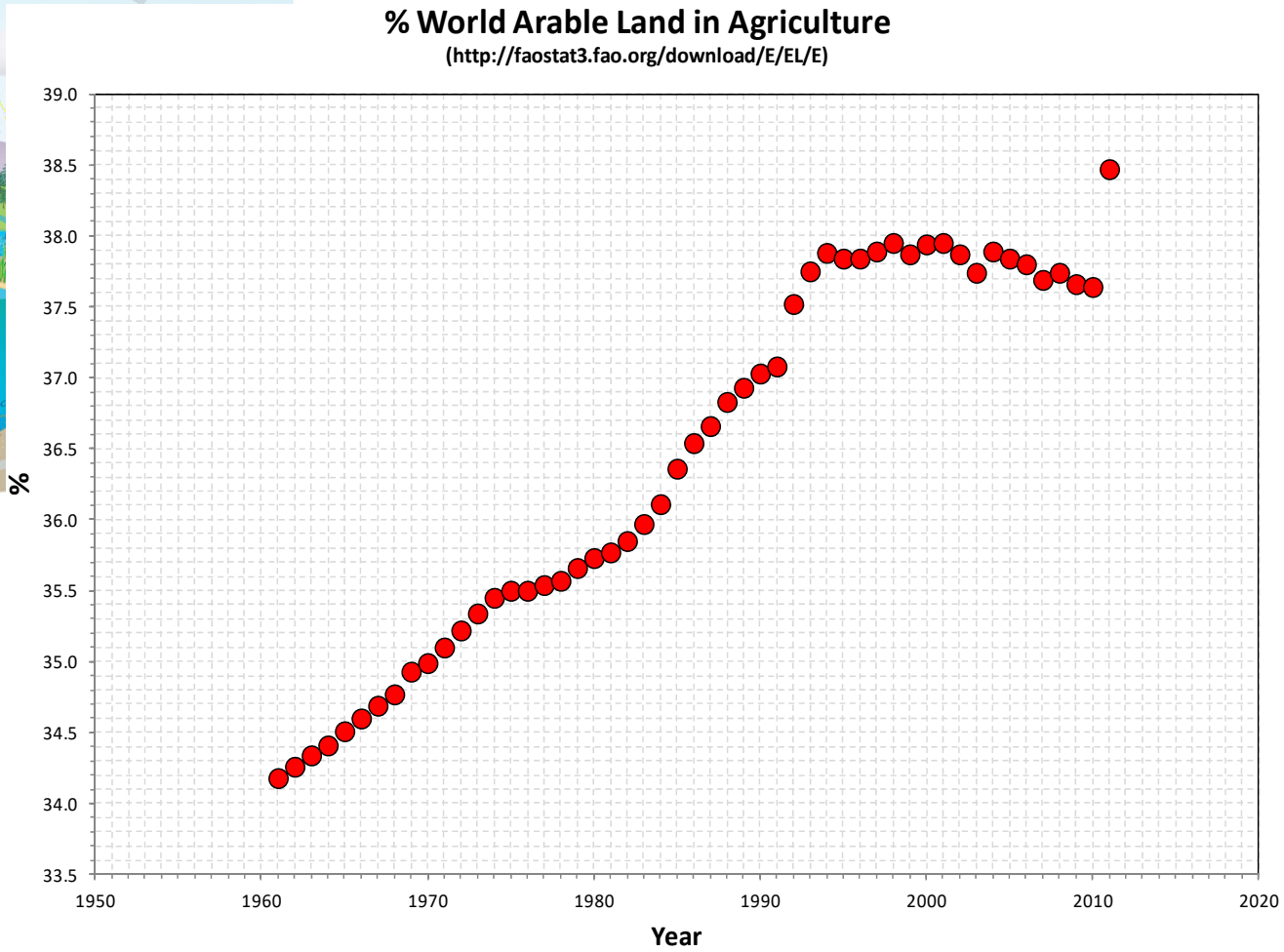
The Carbon Cycle — Atmospheric CO_2 Concentration Changes with Time





The Carbon Cycle – % Land In Agricultural Production Changes with Time





Discussion Questions

- What understanding of The Carbon Cycle do you gain from using the systems diagram that you would not get by looking only at individual relationships within the system?
- Which discipline or disciplines are contribute the most to your current understanding of The Carbon Cycle, and which one(s) will be most instrumental in helping to increase your understanding of it?
- How has your understanding of The Carbon Cycle grown or changed by labeling components and/or by including quantitative measures of reservoirs, fluxes, and/or values that change with time?
- Would the use of a system diagram such as The Carbon Cycle Diagram help you address questions about the impact of a change in policy, and thus human activity, on The Carbon Cycle? For example, what would happen if coal-fired power plants were suddenly banned, or if regulations on fisheries were suddenly lifted?