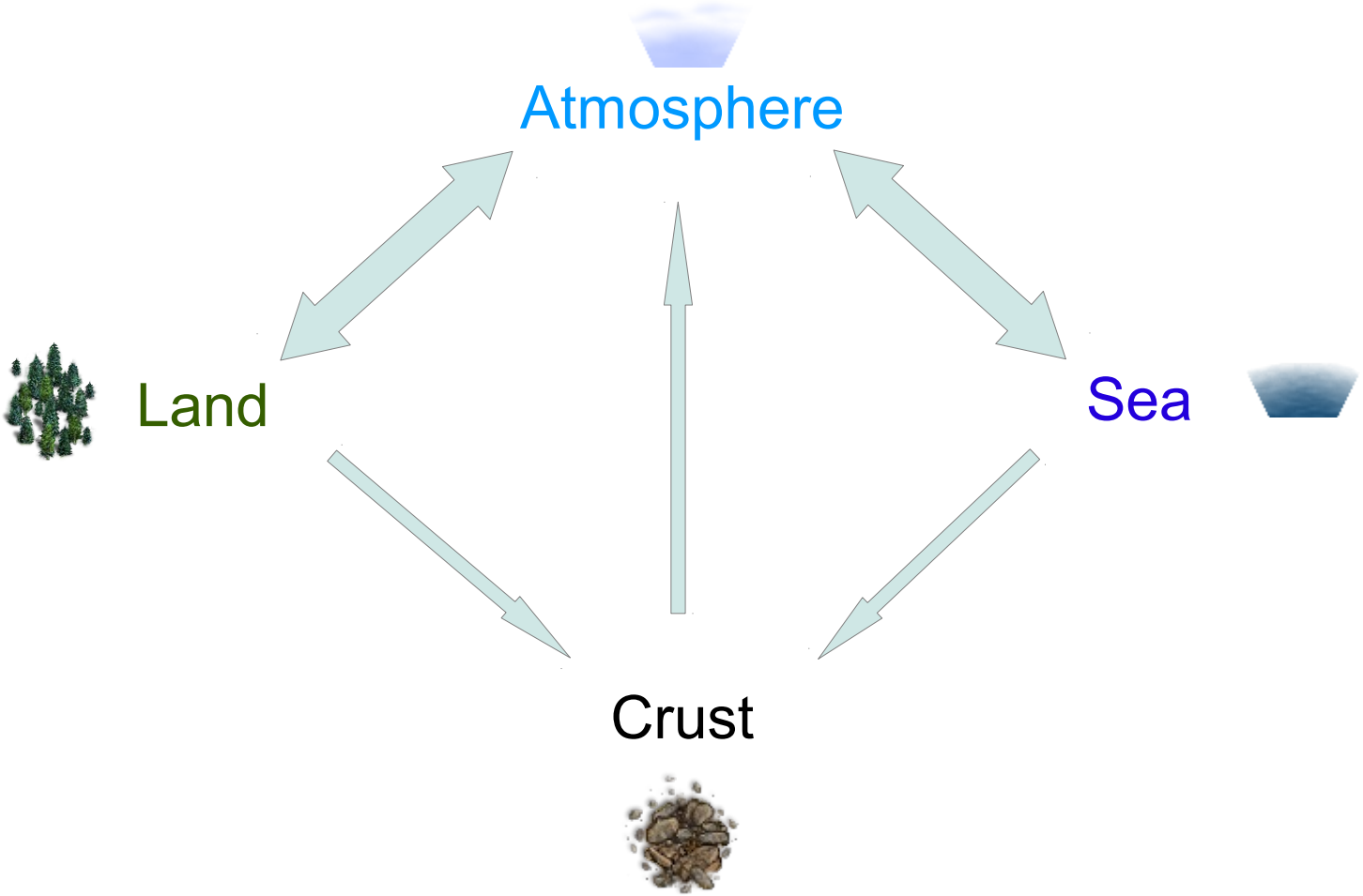
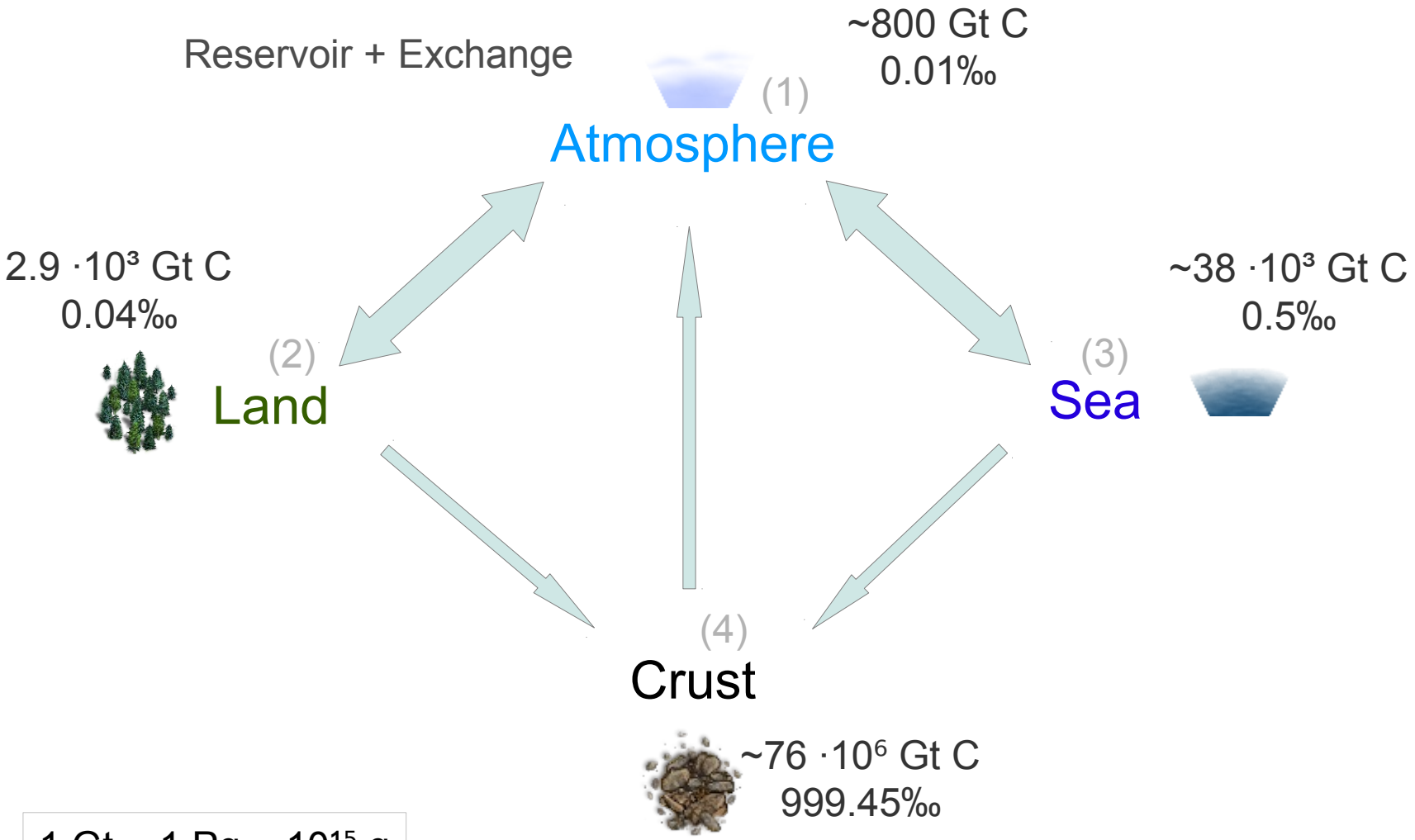
The carbon cycle

A short overview

Introduction



Total Carbon Content



1 Gt = 1 Pg = 10^{15} g

Atmosphere

~800 Gt C
0.01‰ total C

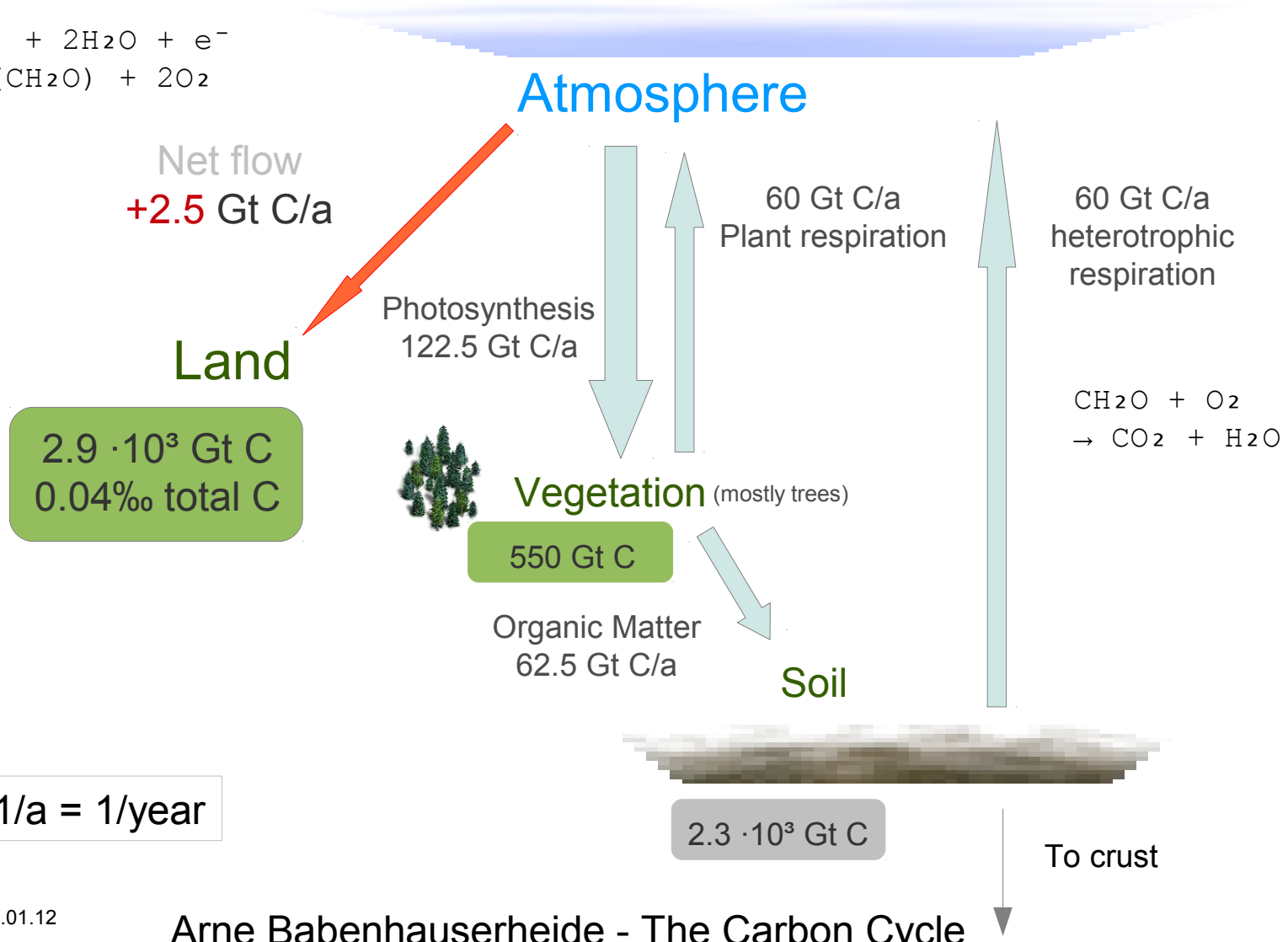
385 ppmv CO_2 ~ 800 Gt C
0.01‰ of total carbon in the cycle

CO_2

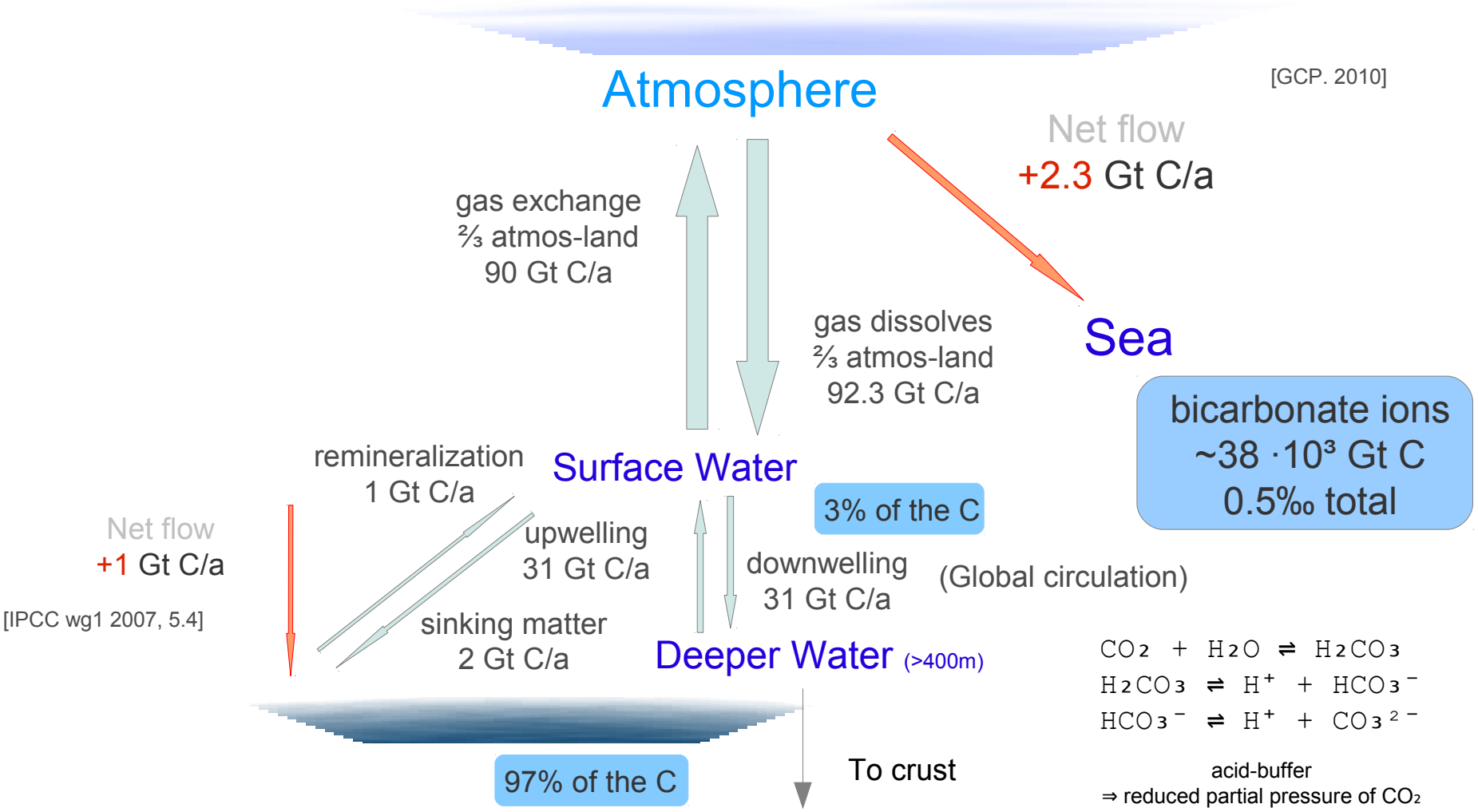
<O=C=O>

Role: repository + exchange medium

$2CO_2 + 2H_2O + e^- \rightarrow 2(CH_2O) + 2O_2$



1/a = 1/year


Atmosphere
[GCP. 2010]
Net flow
+2.3 Gt C/a
gas exchange
⅔ atmos-land
90 Gt C/a
gas dissolves
⅔ atmos-land
92.3 Gt C/a
Sea
bicarbonate ions
~38 ·10³ Gt C
0.5‰ total
remineralization
1 Gt C/a
Surface Water
3% of the C
Net flow
+1 Gt C/a
upwelling
31 Gt C/a
downwelling
31 Gt C/a
(Global circulation)
[IPCC wg1 2007, 5.4]
sinking matter
2 Gt C/a
Deeper Water (>400m)
97% of the C
To crust
CO₂ + H₂O ⇌ H₂CO₃
H₂CO₃ ⇌ H⁺ + HCO₃⁻
HCO₃⁻ ⇌ H⁺ + CO₃²⁻
acid-buffer
⇒ reduced partial pressure of CO₂

Atmosphere

[GCP. 2010]

-order 10^{-3} Gt C/a

Land

35-104 $\cdot 10^{-3}$ Gt C/a
volcanoes

8.7 Gt C/a
fossil fuels

-order 10^{-3} Gt C/a

Sea

order of 10^{-3} Gt C/a
weathering

order of $\cdot 10^{-3}$ Gt C/a
sediments

Crust

-8.7 Gt C/a

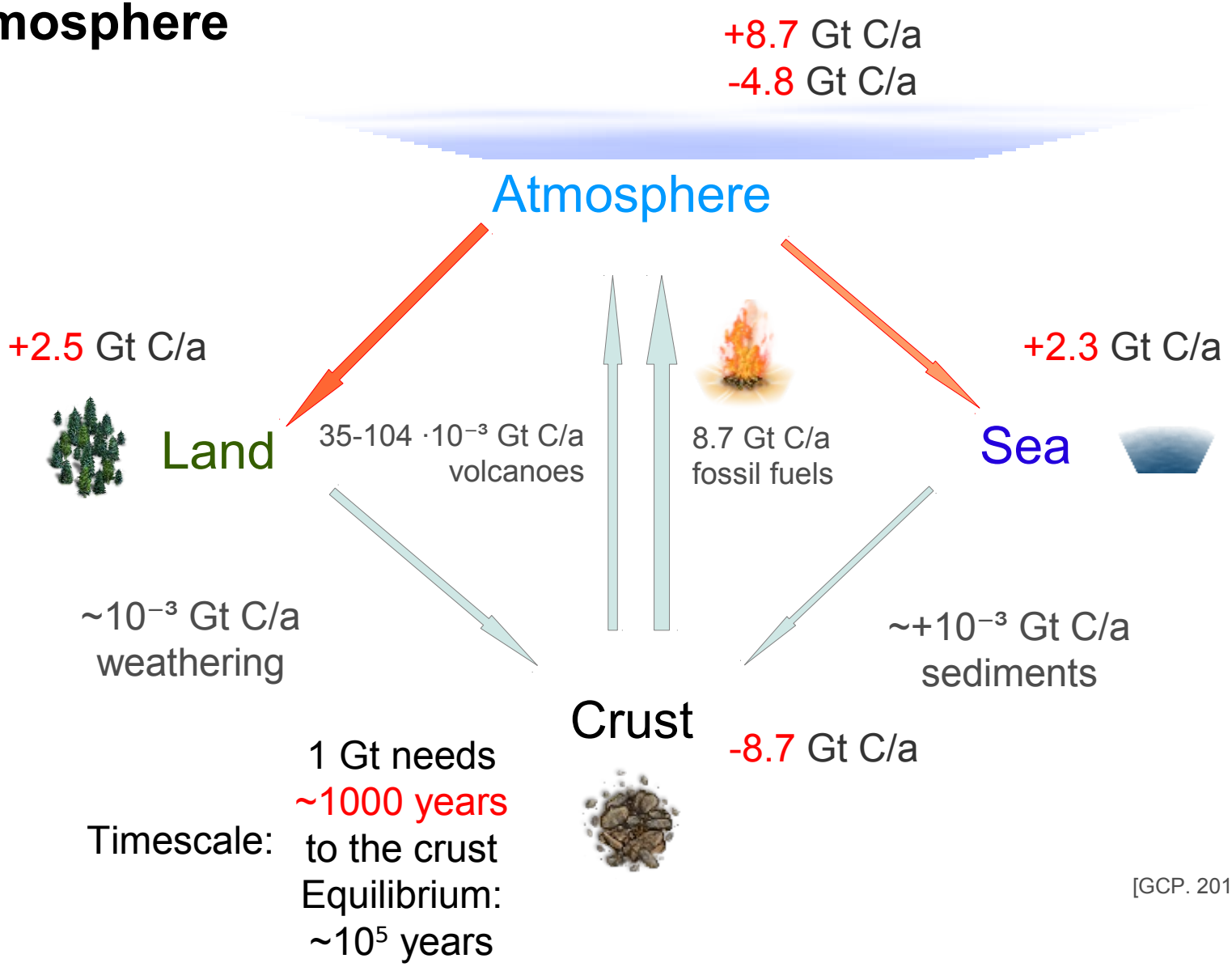
$CO_2 + H_2O \Rightarrow H_2CO_3$ (acidic rain)

$H_2CO_3 + CaCO_3 \Rightarrow Ca(HCO_3)_2$

limestone
~76 $\cdot 10^6$ Gt C
999.45‰ total

[hedges2000]
(letters to nature)

Net changes when adding a flux from crust to atmosphere



[GCP. 2010]

Summary: Carbon moves between repositories

- Repositories:
  - Atmosphere: ~800 Gt C; 0.01‰; CO_2
  - Land: 2.9 ·10³ Gt C; 0.04‰; Organic Matter in trees and soil
  - Sea: ~38 ·10³ Gt C; 0.5‰; Carbonate Ions and Carbonate
  - Crust: ~76 ·10⁶ Gt C; 999.45‰; 2000 × all others; Limestone
- Exchanges, 2 different regimes:
  - Fast: Living beings breathe: land↔atmosphere,
    dissolution: sea↔atmosphere
    - 210 Gt C/a; ¼ of the carbon in the atmosphere
  - Slow: Organic matter moves deeper, transfer to sea bottom, volcanoes
    - 2 ·10⁻³ Gt C/a
    - Connects with the crust, which contains 2000 × as much carbon as all other repositories together.
- Additional flux between the slow and the fast regime changes the amount of CO_2 in the smaller repositories on the timescale of the larger one.

References

- Unreferenced data comes from the Earth Observatory (NASA).
- The images of the repositories and the logo are from © Battle for Wesnoth and licensed under the GPL by Kathrin Polikeit, Hogne Håskjold, J.W. Bjerk, Richard Kettering, Christophe Anjard, Moritz Göbelbecker, Johanna Manninen, Kuno Raffin and battlestar. For further details see about.cfg at revision 52295 of wesnoth svn.
- Licensed under the GNU GPL v2 or later.

Thank you for your time!