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Solid Earth Discussions

Interactive comment on "The regulation of the air: a hypothesis" *by* E. G. Nisbet et al.

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As a physicist, unconstructed in biology, swimming in a biological ocean, now landing in the geosciences continent, I propose the following remarks in response to the sparkling and positive referee C 451: 1. - Rubisco carboxylation is not so sluggish. It competes successfully with oxygen, which is 660 times more concentrated. The trapping of 0,03 % CO2 is a performance. 2. - Classical "dark" respiration in plants is saturated at a low level of oxygen (<1%); 3 – Rubisco, does it cause respiration? No, but it cause photorespiration, which is light-dependent and operates (in plants) at a rate more 10 times higher than "dark" respiration. 3.- The Oxygen Compensation Point denotes the equilibrium point where the O2 production by plants, equals the consumption by all living biosystems consuming O2 by dark respiration (plants, animals, micro organisms decomposer etc). 4 - In a plot of net exchange vs O2, along the axis of the increasing O2 there is a "crossing point" (Ox) where increase of the photorespiration matches the decrease of photosynthesis (see Fig.in supplement). At this point, there is equality between photosynthesis and photorespiration, which consumes half of the gross Oxygen production. The puzzling fact is that the O_2 concentration at this crossing point (Ox) happens to be the composition of the pre-industrial atmosphere. Feedback controls, at the compensation point, can potentially operate around this point (See curves in mirror –image in André 2011ab). From this fact, the implication is that Ox is also the compensation point of the pre-industrial biosystem. A symmetrical text could be written for the CO_2 compensation point and of Cx, near of 280 ppm. 5.- Plant Specificity is defined from the observation that photorespiration (PR), and photosynthesis (P) of green parts of plants react to CO_2 and O_2 by laws that mimic the Rubisco laws. (André and Massimino 1986; André 2011a). It is easy to definite a Plant Specificity (Sp). If expressed in the same units, there is a simple factor between the two specificities, that is the ratio between external and internal CO_2 (André 2011d). Its measure is simple, from the knowledge of Cx and Ox, where P=PR and by the equation Sp= 2Ox/Cx in % ppm -1.

C452 A type of Rubisco that is very active and able to reduce CO_2 at very low level is simulated, at plant level, by the C4 plants (such as maize or sugarcane). These have a very low compensation point. They have a compression system of CO_2 which is able, with a very sluggish rubisco (André 2011b), to have a very high plant specificity coupled with and very little photorespiration. Their Cx is very low but the Ox very high if associated with a decomposer system. There is practically no negative feedback if O_2 increases. A biosystem based on such C4 plants is unstable; under a high O_2 atmosphere fires would make the O_2 control, as postulated during past high CO_2 period (e.g. paleofires in Berner 1999). Hence, it is not fortuitous that the large majority of plants are of C3 type, i.e. with high photorespiration. Moreover, André (2011b) shown that the possible gain in carboxylation by the increase of the Rubisco CO_2 affinity (factor 10) was countered during evolution by an opposite effect, the increase of the maximum rate of oxygenation higher than the rate of carboxylation. That increases the regulating effect of photorespiration, i.e. the mirror effect of curves, mentioned above,

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around the crossing points. Was co-evolution between plants and atmosphere possible? The Nisbet et al paper proposes mechanisms but more concrete explanations should be the subject of further work.

References

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Please also note the supplement to this comment:
http://www.solid-earth-discuss.net/3/C474/2011/sed-3-C474-2011-supplement.pdf

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Interactive comment on Solid Earth Discuss., 3, 769, 2011.