The minimal model of Hahn for the Calvin cycle

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There are many models of the Calvin cycle in the literature. Due to their big sizes, models were mostly numerically investigated or using reduction techniques. We investigate a simple two dimensional model of the Calvin cycle in favor of getting the most detailed insights. In a variant of the model not including photorespiration, it is shown that there exists exactly one positive solution which is unstable. For generic initial data, concentrations tend to infinity and were later tracked using Poincaré compactification. When photorespiration is included and for a suitable choice of parameters, bistability is proved. For generic initial data either the solution tends to the stable steady state at late times or all concentrations tend to zero at late times. Rigorous mathematical proofs emphasize the idea that photorespiration stabilizes the operation of the Calvin cycle, although at the price of reducing the efficiency of the carboxylation reaction. This would suggest another considering of photorespiration not as a wasteful competitive process to carboxylation, but as stabilizer which prevents overproduction in the cycle.