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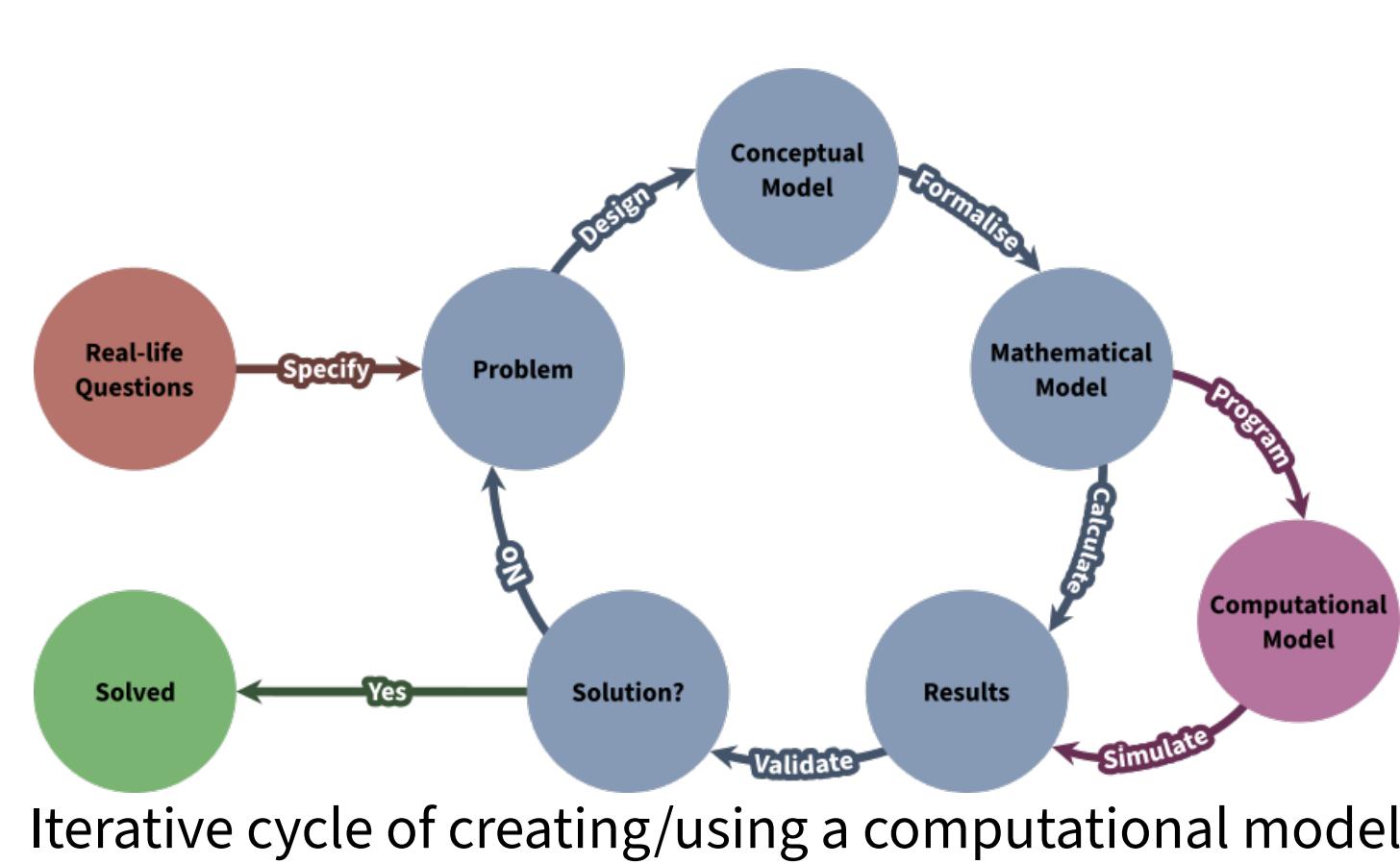


Learning Platform for Computational Photosynthesis

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Motivation

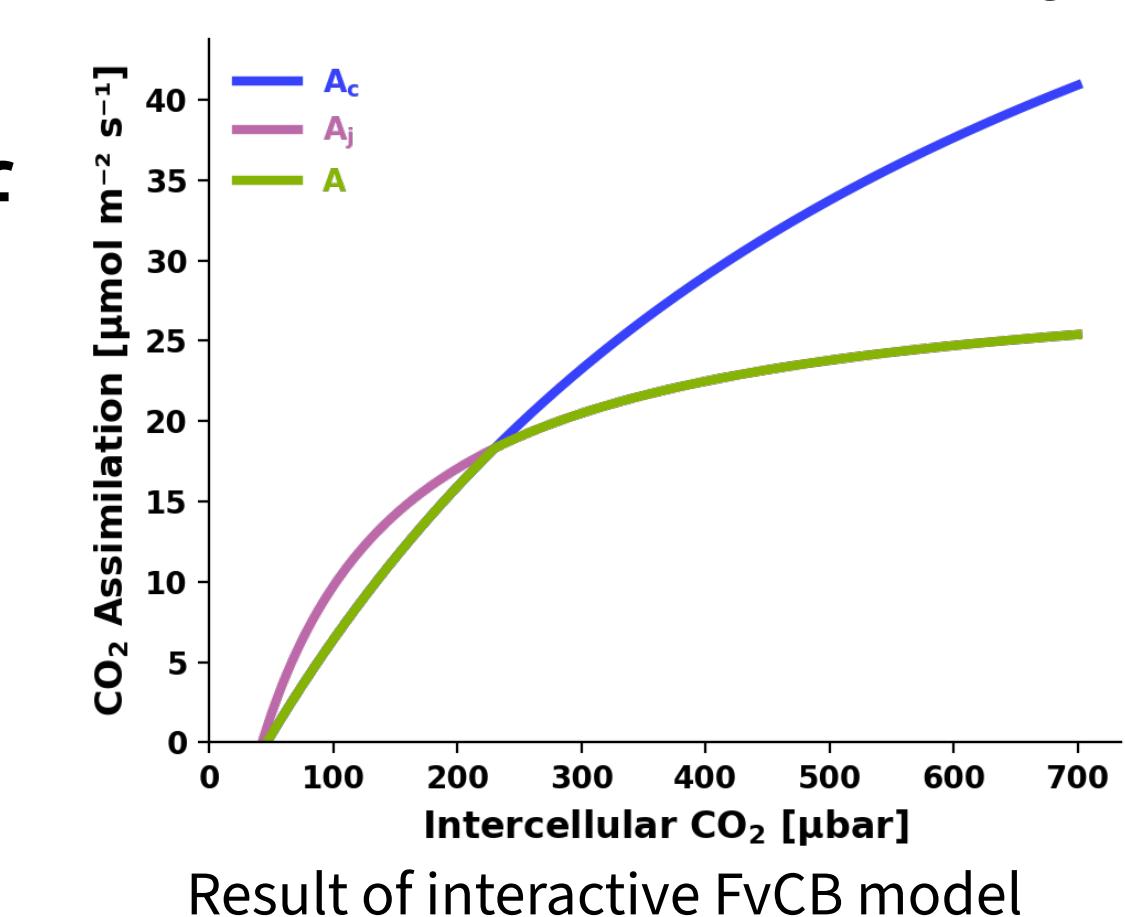
- Computational modelling allows a simplified, but cost-effective approach to system simulation
- Translation of complex construct into known mathematics



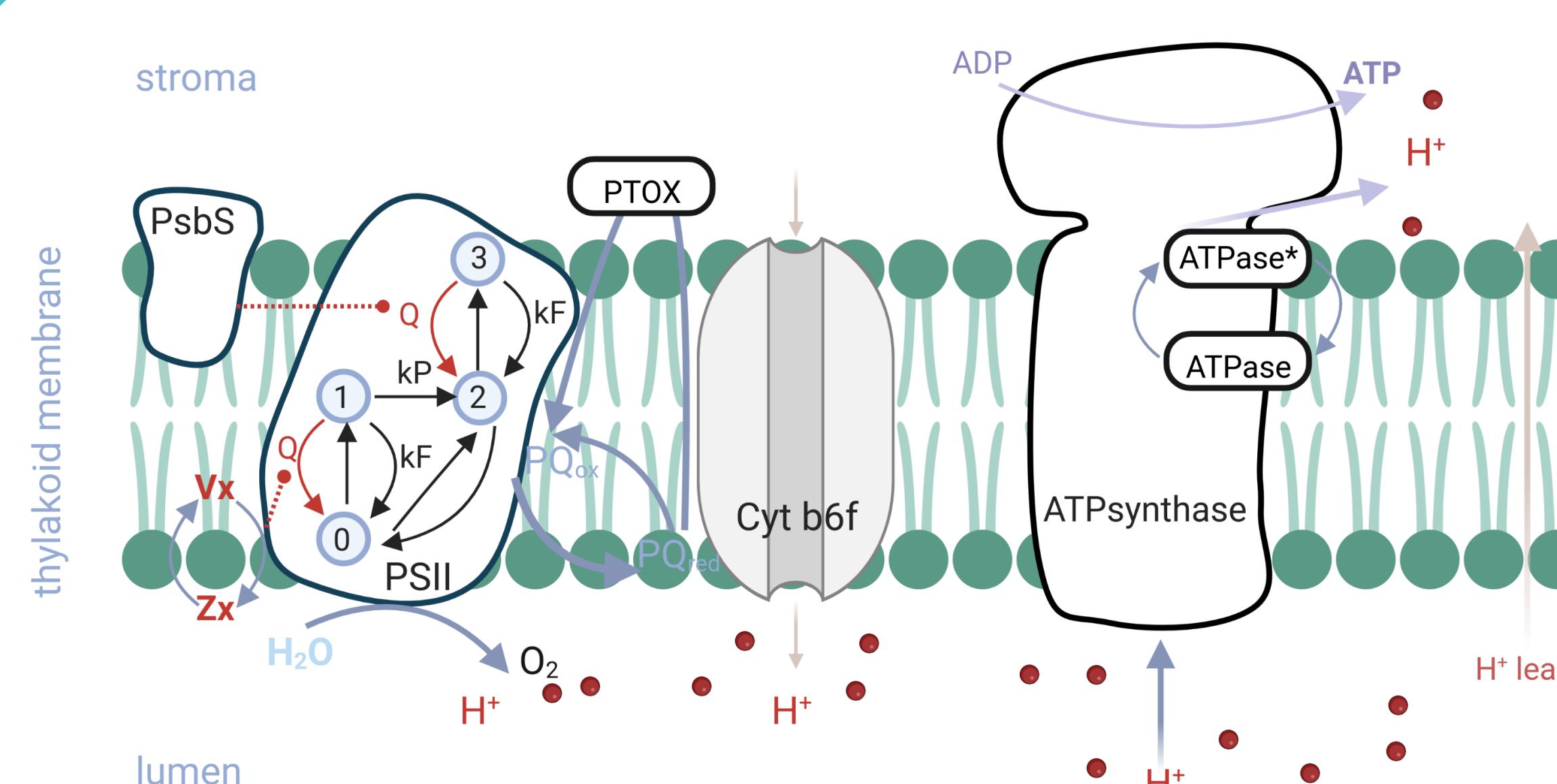
- Goes through an iterative cycle to find a viable answer to a problem
- Rise of complexity also means rise of programming need

Implementation

- No-code, simple WebApp based on Streamlit^[1]
- Separated versions based on differences of biological knowledge
- Includes different mediums to show introductory teaching materials
- Gives in-depth explanation of modelling and provides several examples of models of photosynthesis, e.g. Farquhar, von Caemmerer, Berry (FvCB) model^[2] of carbon assimilation



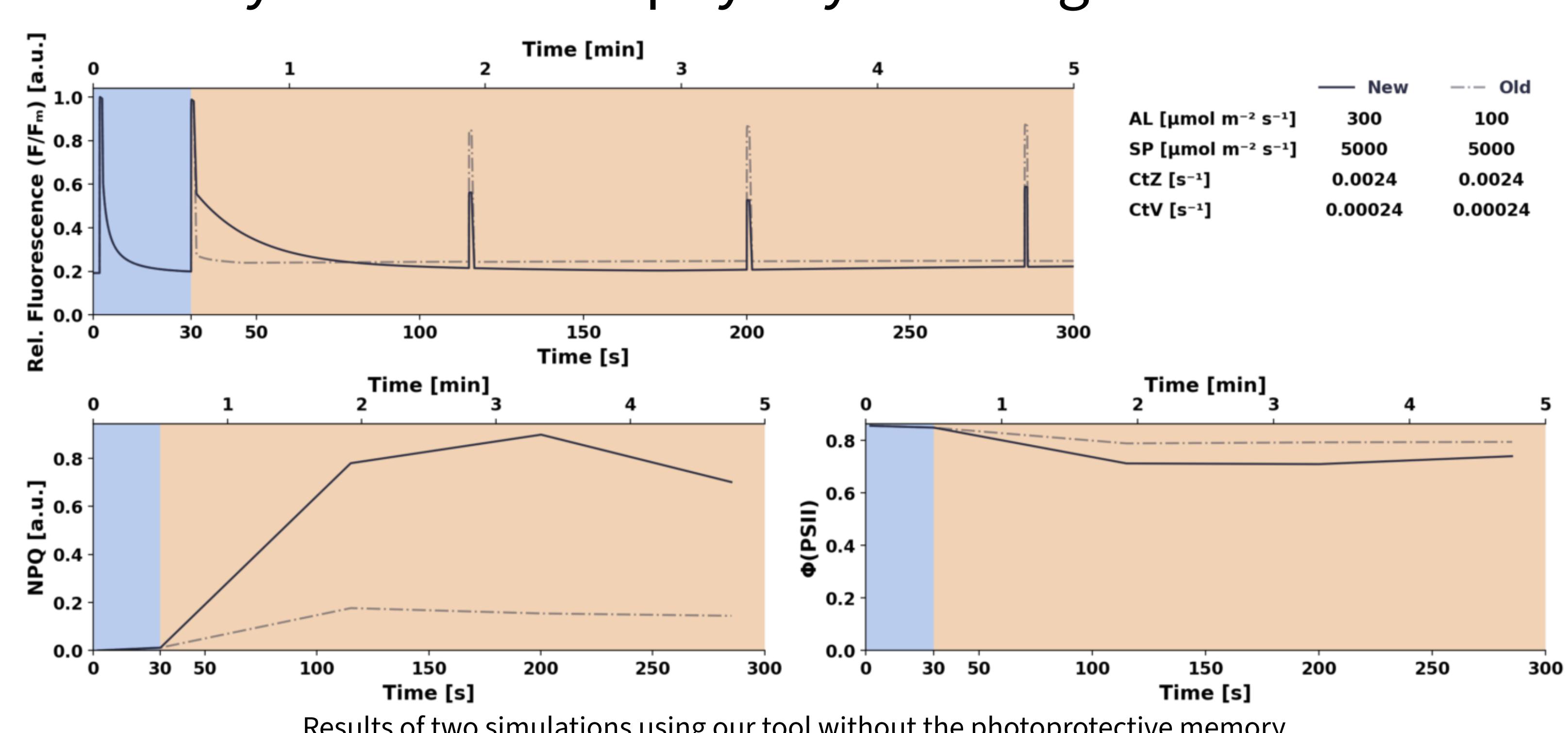
Model



- Only includes processes affecting/regulating NPQ^[3]
- Uses in-house package *modelbase* and solely Python
- Strict reductionist approach allows system of six ordinary differential equations
 - The reduced fraction of the plastoquinone pool (PQH_2)
 - The stromal concentration of ATP (ATP)
 - The luminal proton concentration (H)
 - The fraction of non-protonated proteins (PsbS)
 - The fraction of violaxanthin in the total pool of xanthophylls (V_x)
 - The fraction of active ATPase enzyme ($ATPase^*$)

Simulation

- Simulation of Pulse Amplitude Modulation (PAM) by changing specific parameters
 - Light intensity of light phase (AL)
 - Conversion rate to Zeaxanthin (CtZ)
 - Conversion rate to Violaxanthin (CtV)
 - Light intensity of saturating pulse (SP)
- Get relative fluorescence, NPQ, and PSII efficiency and compare it to prior result
- Includes guiding questions, that help with explaining and interpreting the graphs
- Additionally simulate superficial photoprotective memory of the xanthophyll cycle using the same model



Open-Source

- Project is completely available to public
- Code is modular, so own changes can easily be done locally
- Tool is available in various languages:
- We encourage making changes which we may implement in the future, e.g. more translations
- Contact us for any questions or wishes for changes!



Article

References

- [Streamlit • A faster way to build and share data apps](https://streamlit.io/), Streamlit, <https://streamlit.io/> (accessed Jun. 14, 2024)
- G. D. Farquhar, S. von Caemmerer, and J. A. Berry, "A biochemical model of photosynthetic CO₂ assimilation in leaves of C₃ species," *Planta*, vol. 149, no. 1, pp. 78–90, Dec. 1980, doi:10.1007/bf00386231.
- A. Matuszynska, S. Heidari, P. Jähns, and O. Ebenhöh, "A mathematical model of non-photochemical quenching to study short-term light memory in plants," *Biochimica et Biophysica Acta (BBA) - Bioenergetics*, vol. 1857, no. 12, pp. 1860–1869, Sep. 2016, doi:10.1016/j.bbabio.2016.09.003.

