Predicting phytoplankton growth from metabolic rates

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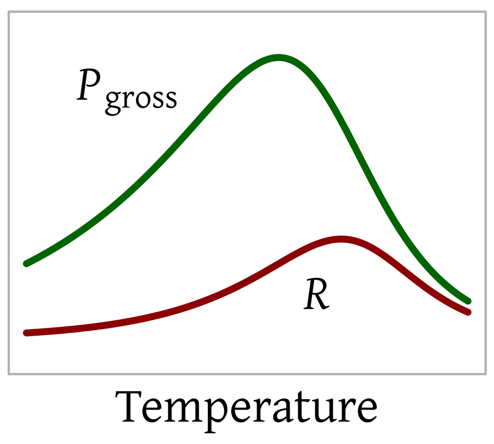
I. *Introduction*

Exponential growth is a measure of fitness in competition and evolution. Growth is partly determined by *net flux* (balance between P_{gross} and R determining the available carbon). P_{gross} and R respond to temperature.



Additional temperature dependent factors may mediate how the available carbon is translated into growth, such as efficiency, allocations to growth, or nutrient uptake.

We ask two broad questions:

(i) ***How might P_{gross} and R combine to determine the temperature response of growth?***

(ii) ***How could other mediating factors further affect growth's response to temperature?***

II. *Model & approach*

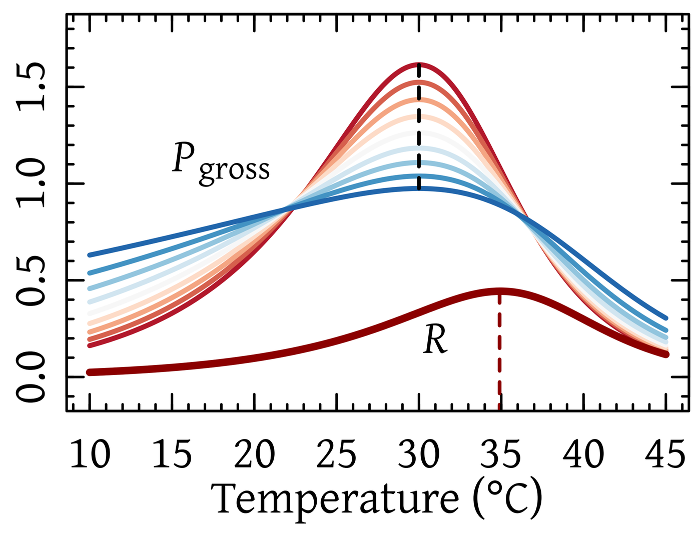
Over the course of a 24 hour period, exponential growth r is

$$r = \varepsilon\,(P_{\text{gross}} - R_{\text{light}} - R_{\text{dark}}),$$

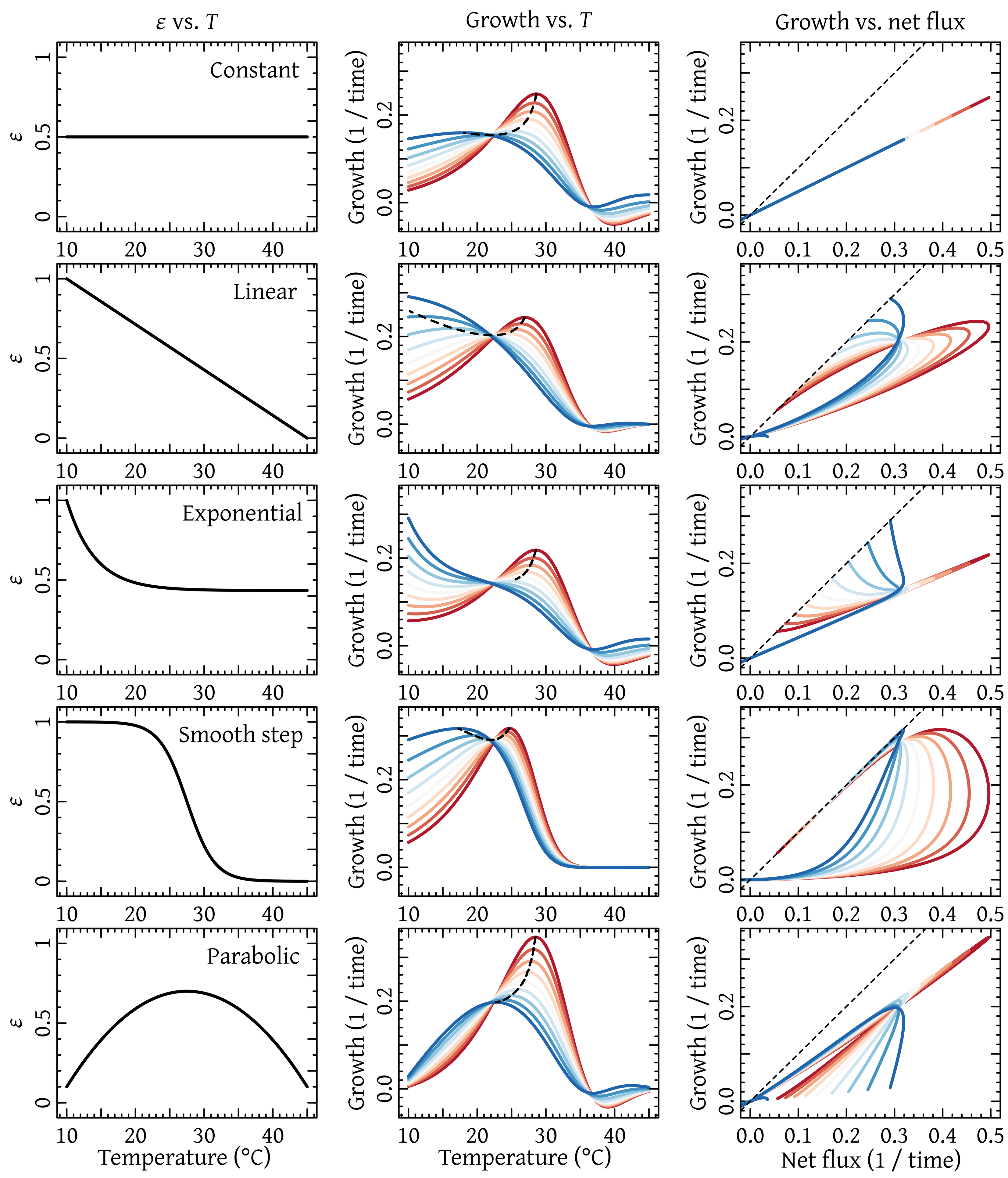
where ε is, potentially, any combination of (possibly) temperature dependent factors mediating how carbon is translated to growth. We idealise ε with five generic functions:

constant ⬩ linear ⬩ exponential ⬩ smooth step ⬩ parabolic

III. *Results: mismatch in metabolic rates*

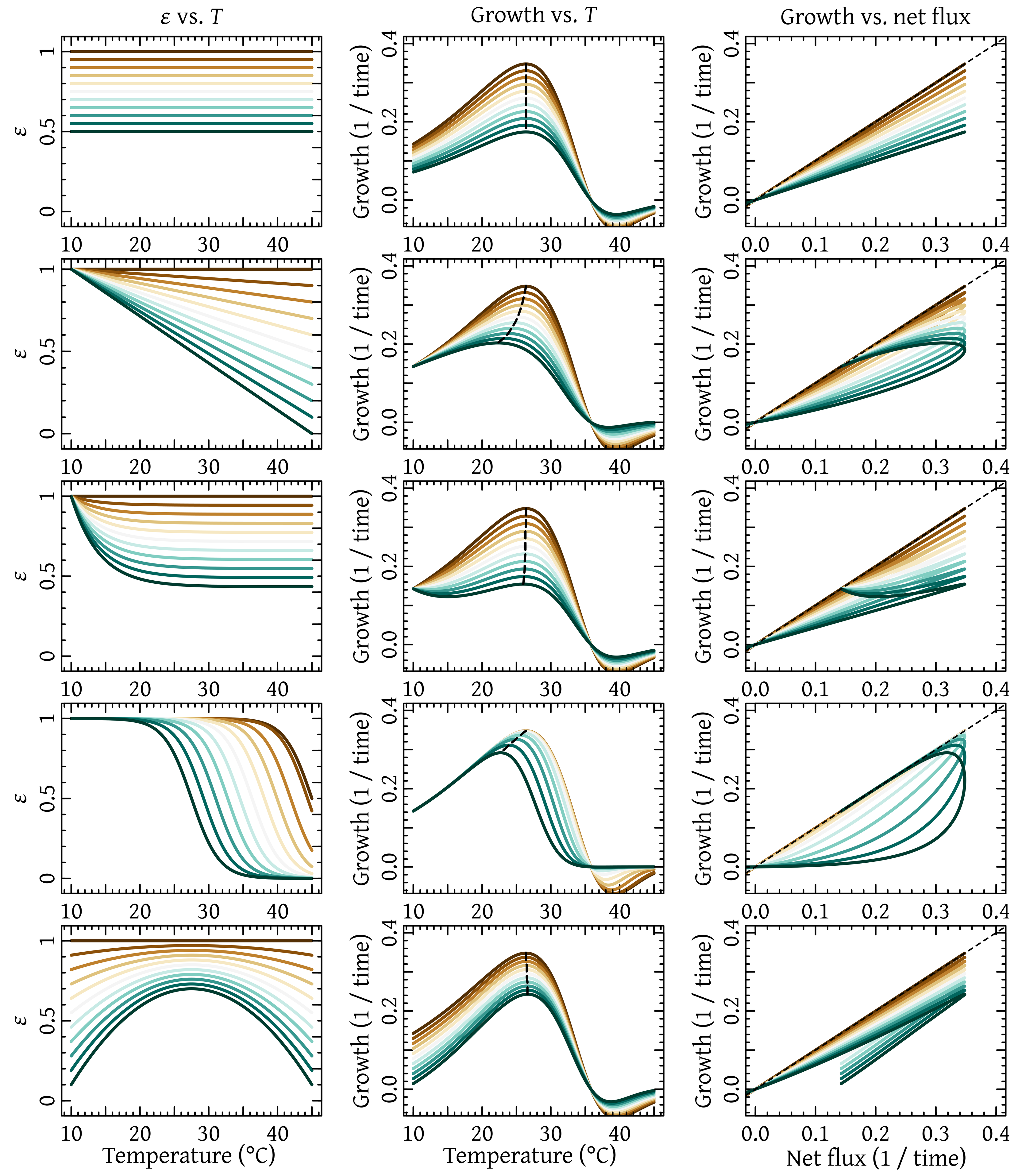


P_{gross} changes from a specialist (red) profile sharing the same activation energy as R, to a generalist (blue) curve.



IV. *Results: ε's contribution*

By using the intermediate curve of P_{gross} from **III.**, and instead varying the intensity of ε, we can show ε's contribution to shifts in the growth curve.



V. *Summary*

- As the differences between the shapes of the P_{gross} and R curves becomes more pronounced, the temperature response of growth is increasingly affected.
- Adding a temperature dependent factor ε can exacerbate impacts on the growth curve.
- Preliminary experimental data suggests ε is temperature dependent, and either linear or exponential.

VI. *Ongoing work*

- Experimental parameterisation and validation is underway.
- How do assumptions made about ε affect predictions of fitness differentials between two competing species based on metabolic rates alone?

- Padfield *et al.* (2016). Rapid evolution of metabolic traits explains thermal adaptation in phytoplankton. *Ecol. Lett.* 19:133–142.
- Kempes *et al.* (2012). Growth, metabolic partitioning, and the size of microorganisms. *PNAS* 109:495–500.