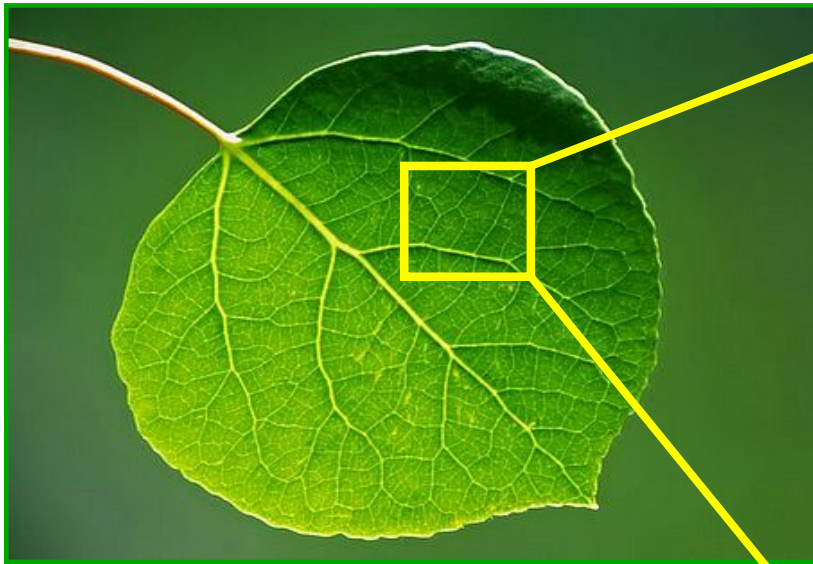
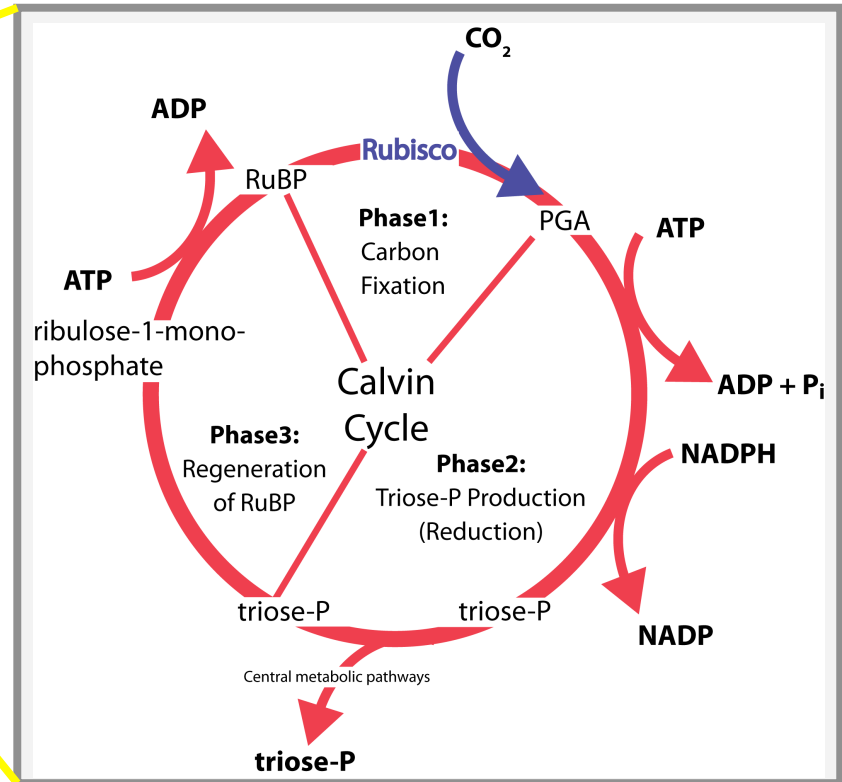


HyspIRI: Photosynthesis Products $V(c)_{max}$ and J_{max}

Phil Townsend, Shawn Serbin, Aditya Singh, Eric Kruger



A temperature-mediated photo-chemical reaction.

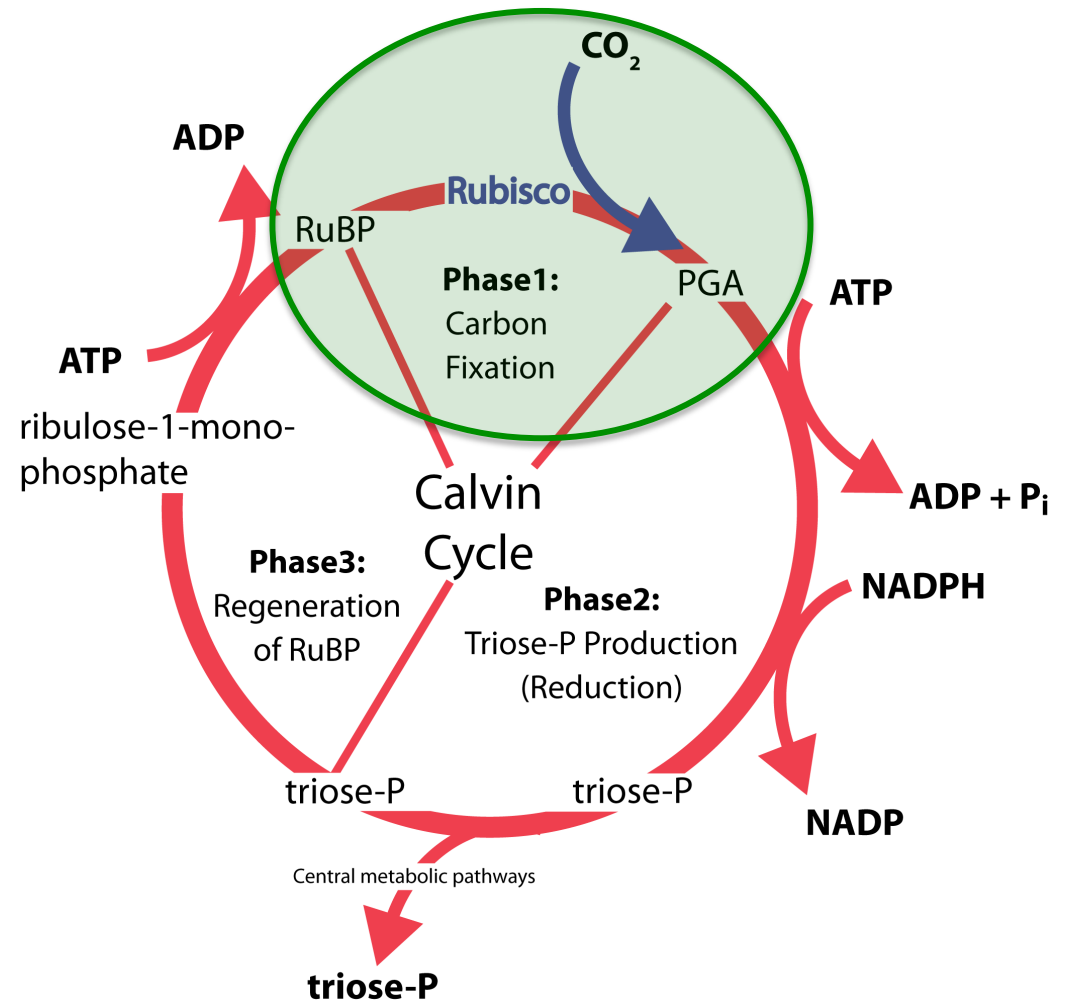
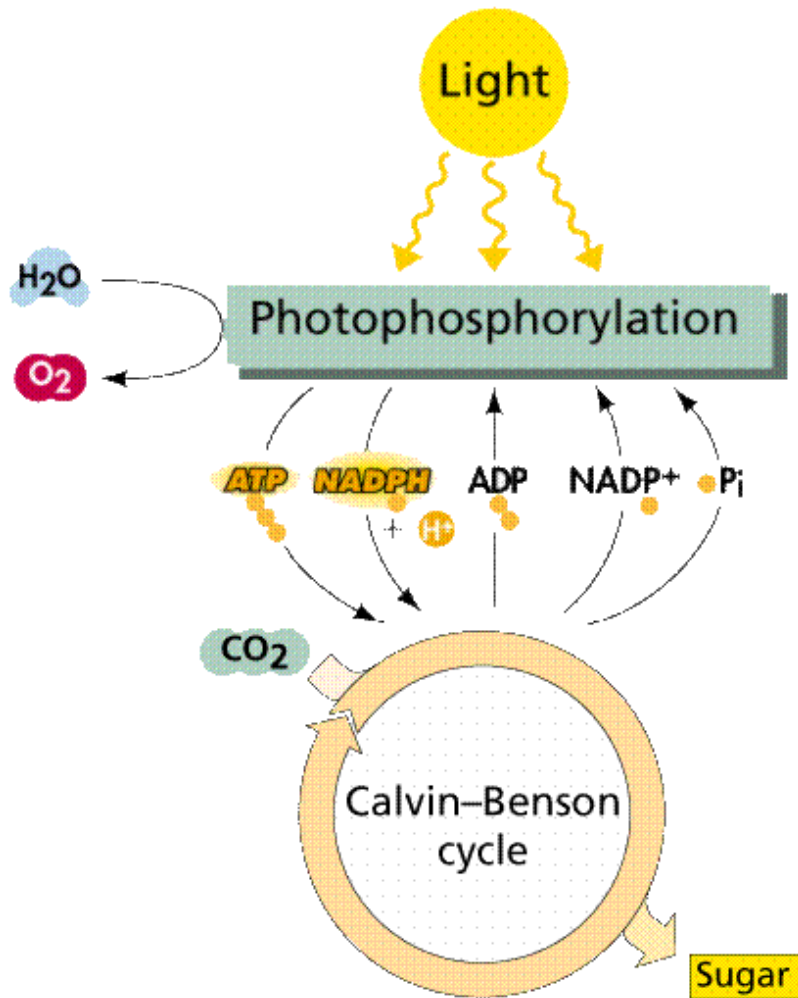


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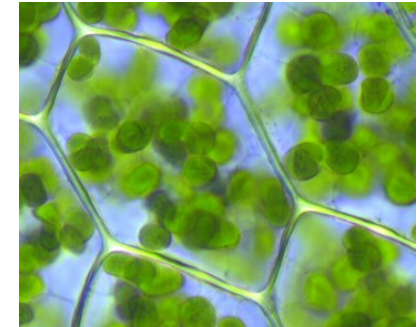
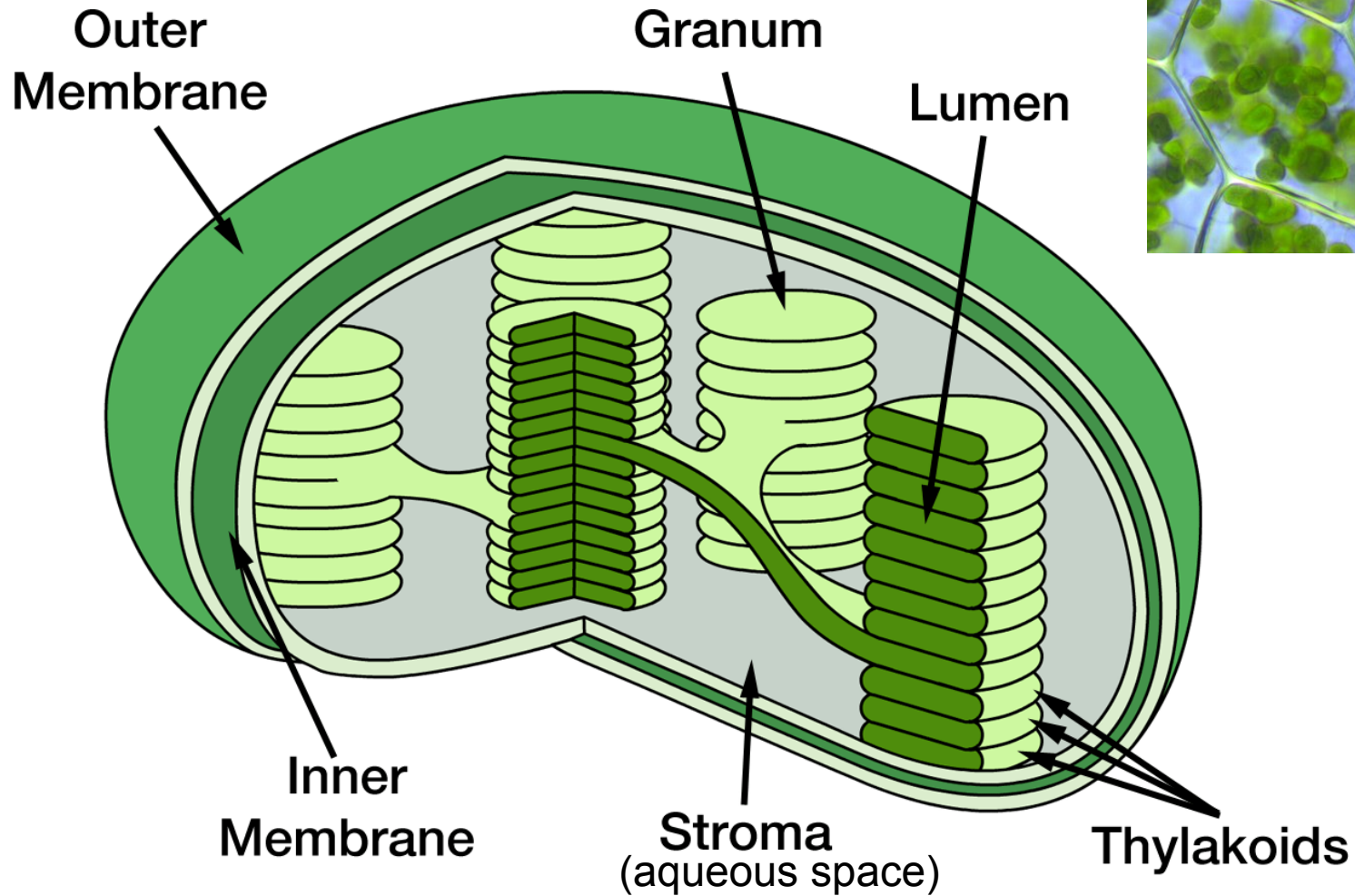


Define the product: $V(c)_{max}$ – maximum rate of carboxylation



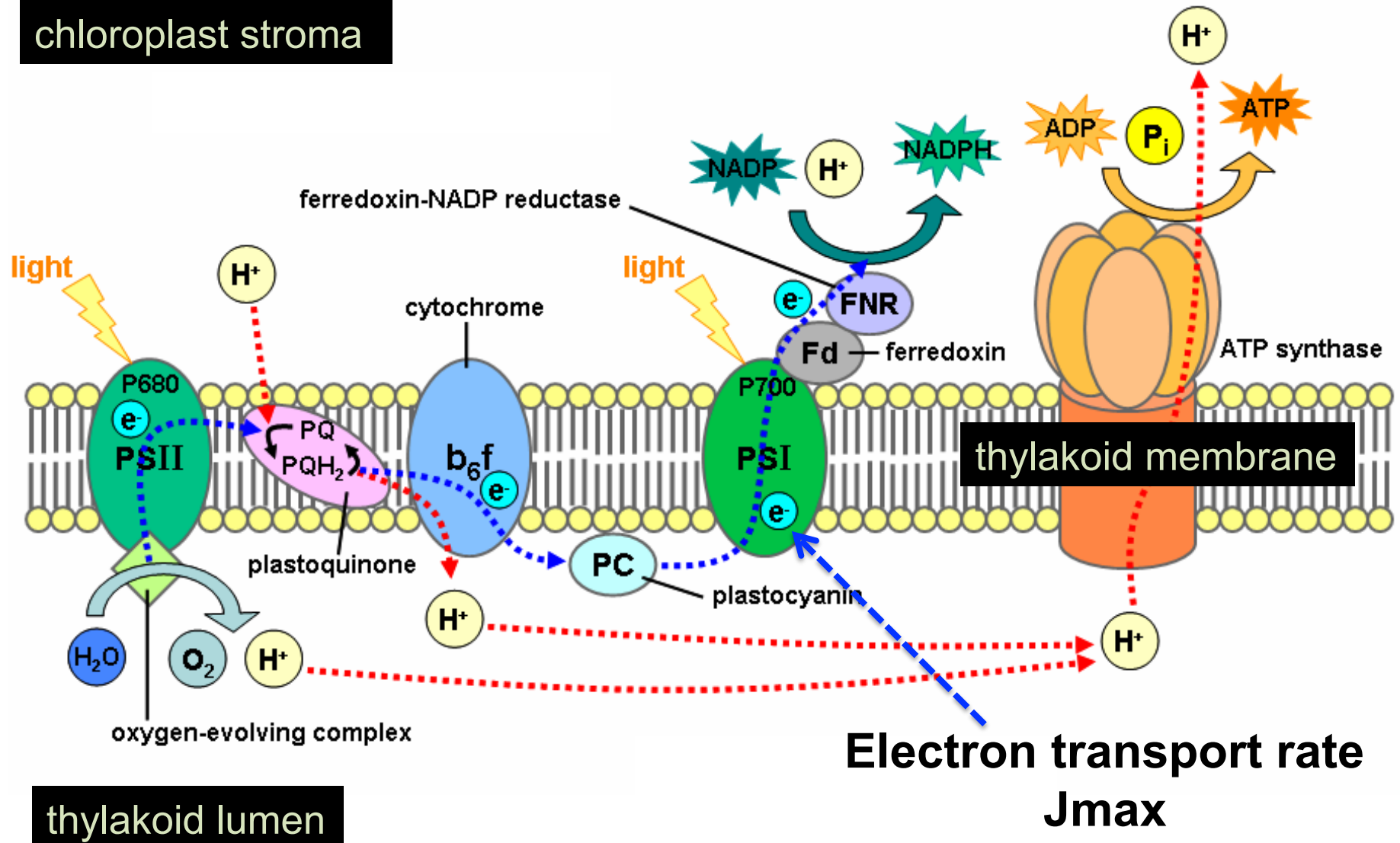
Carboxylation – initial addition of CO₂ to RuBP (catalyzed by RuBisCO). Addition of ATP and NADPH → triose phosphate

Photosynthesis – The Chloroplast



Define the Product: J_{max} – electron transport rate

chloroplast stroma



thylakoid lumen

Reason/Justification for the Product

$V_{(c)\max}$: Measurement of process by which Rubisco catalyzes RuBP with CO_2 to produce the carbon compounds that eventually become triose phosphates (G3P, PGAL)

Triose phosphates are the building block for sugars and starches.

J_{\max} : Transport of electrons through the thylakoid membrane is critical to producing NADPH and ATP, which are provide the metabolic energy necessary to produce triose phosphates.



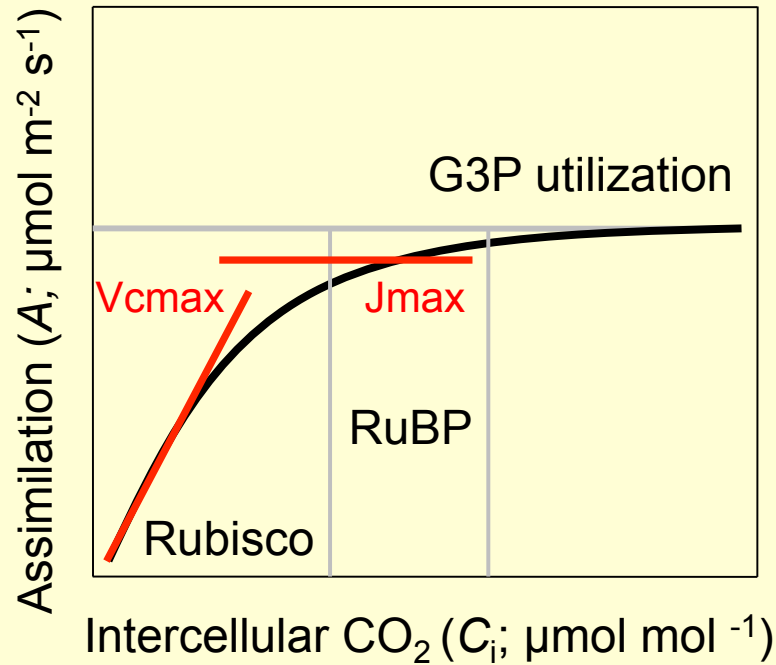
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Biochemical modeling of photosynthesis

$$A_n = \min(A_c, A_j, A_p) - R_d$$



- Limited by
 - Rubisco
 - RuBP regeneration
 - triose phosphate utilization
- Determine key metabolic variables
 - **V_{cmax}**: Rubisco activity
 - **J_{max}**: Electron transport



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Relevance to climate, data continuity, Decadal Survey, etc.

HyspIRI spectral and thermal measurements provide the opportunity to directly measure the photochemical processes associated with carbon assimilation (e.g., A_{\max}) and respiration by plants.

These HyspIRI products provide the potential to identify changes in photosynthetic processes associated with climate change (e.g., temperature), especially within species, but potentially across species.

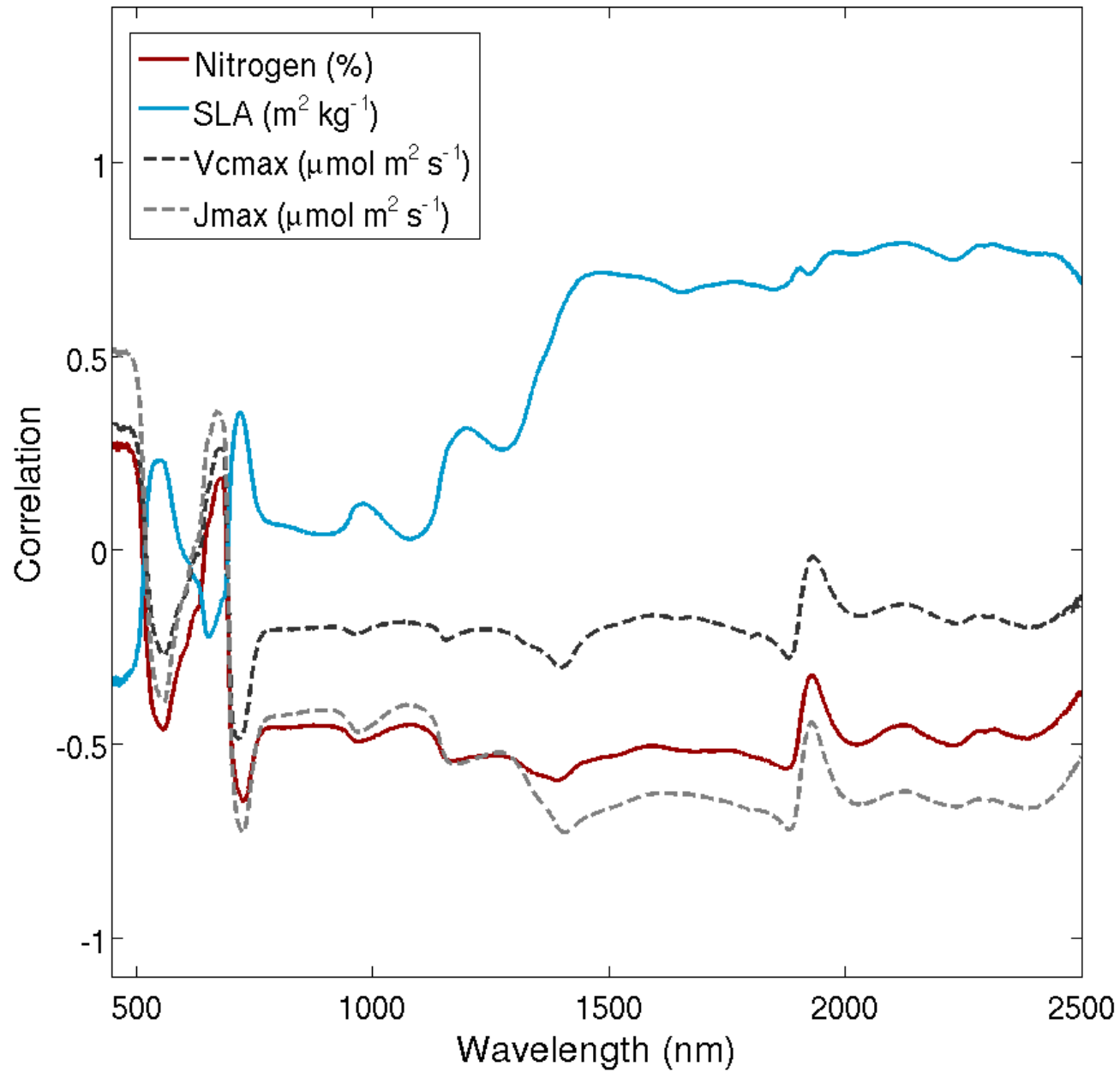


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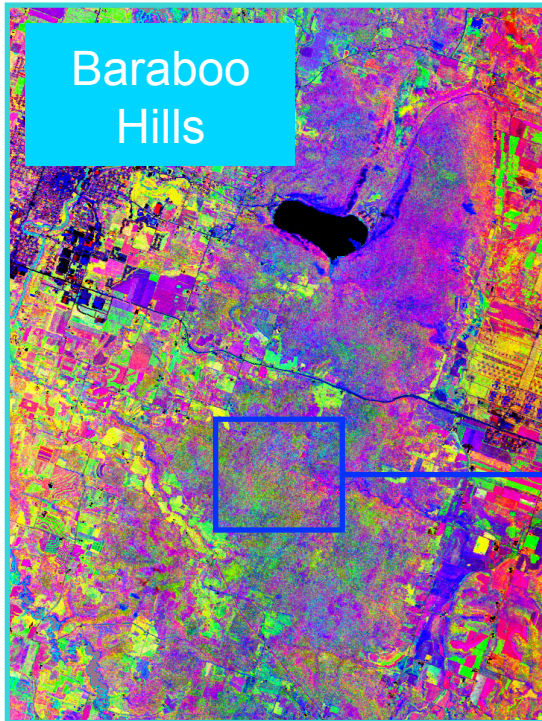
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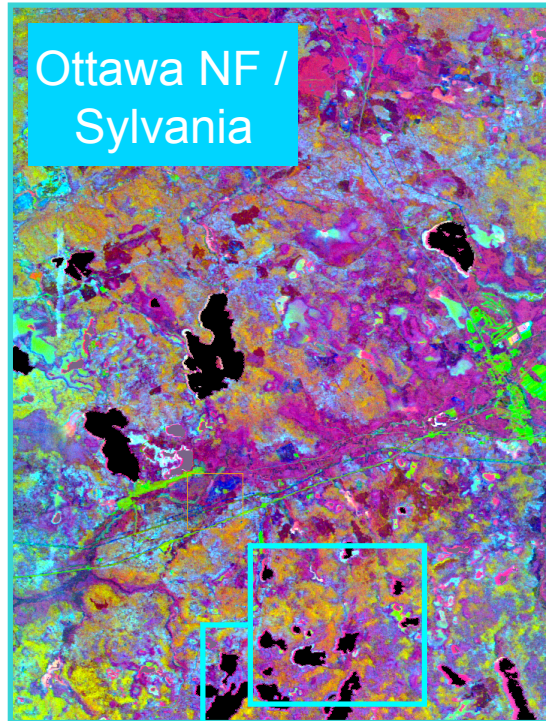
Empirical evidence: Aspen (*Populus tremuloides*)



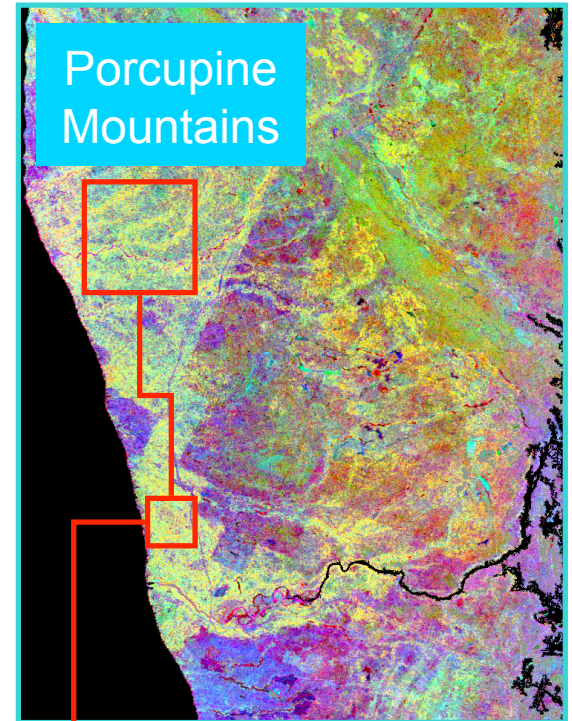
Examples: AVIRIS imagery from the Upper Midwest



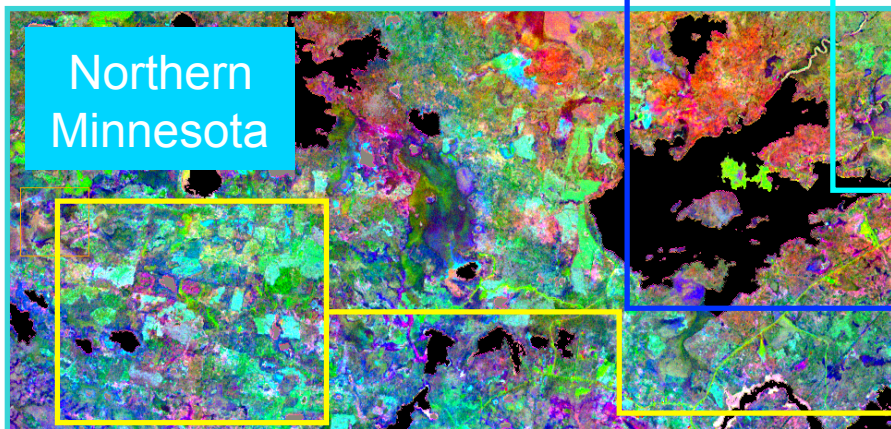
Baraboo Hills



Ottawa NF / Sylvania



Porcupine Mountains



Northern Minnesota

Old growth hemlock / Hwd

Northern hardwood

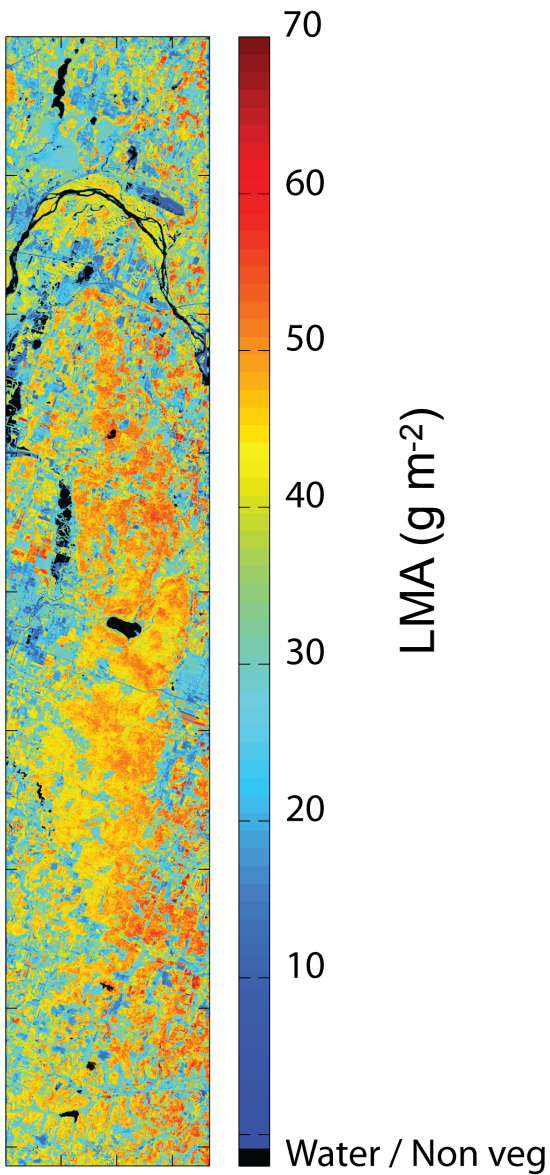
Oak / hickory

Boreal forest

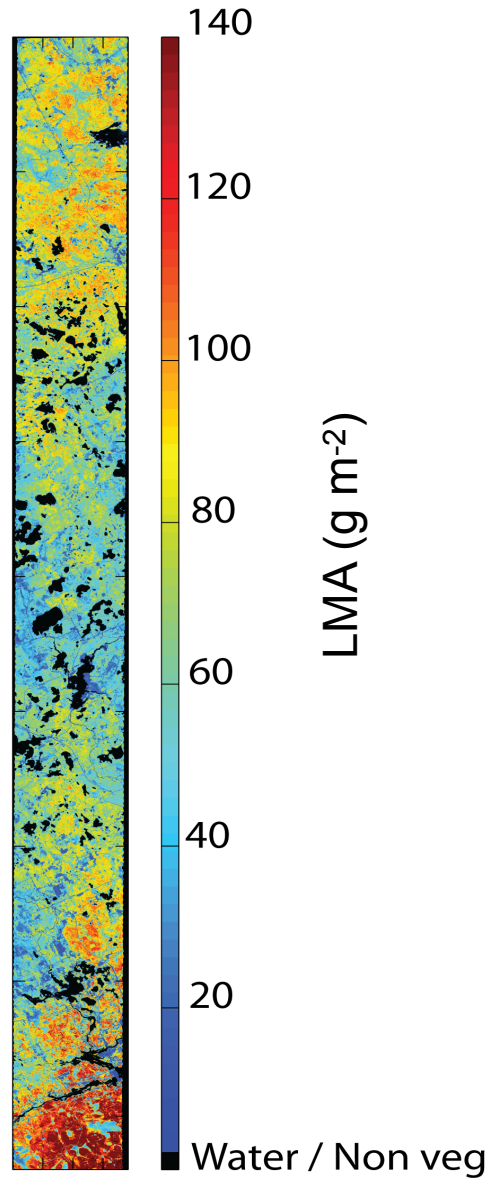


Examples: LMA – based on hypothesized relationships

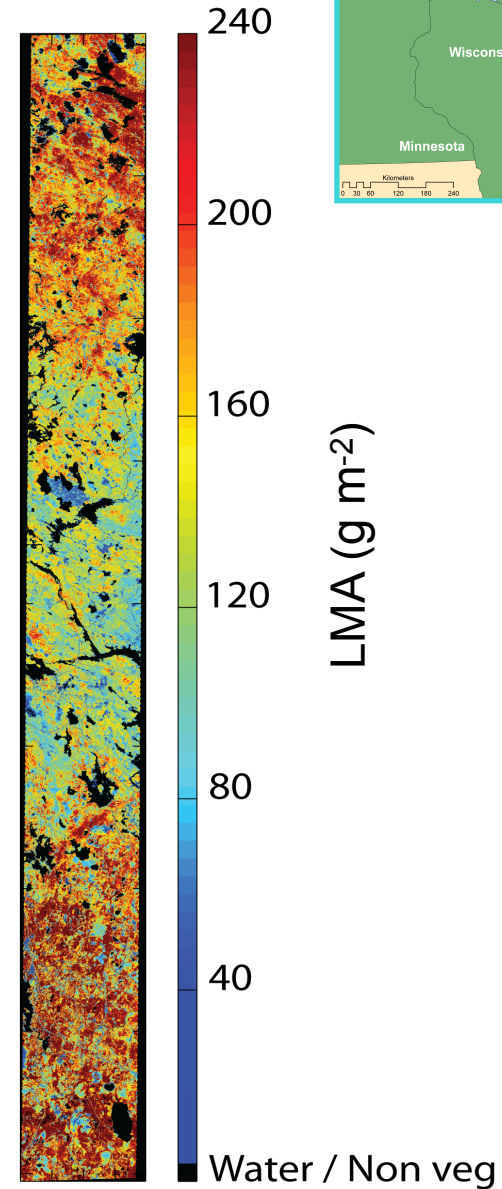
Baraboo Hills



Ottawa NF

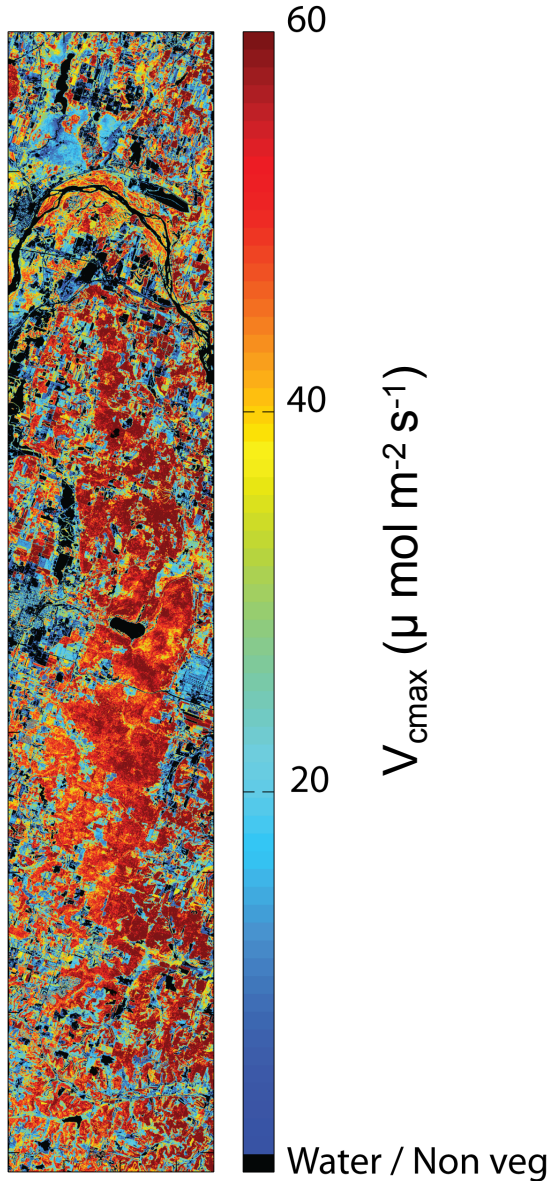


Minnesota

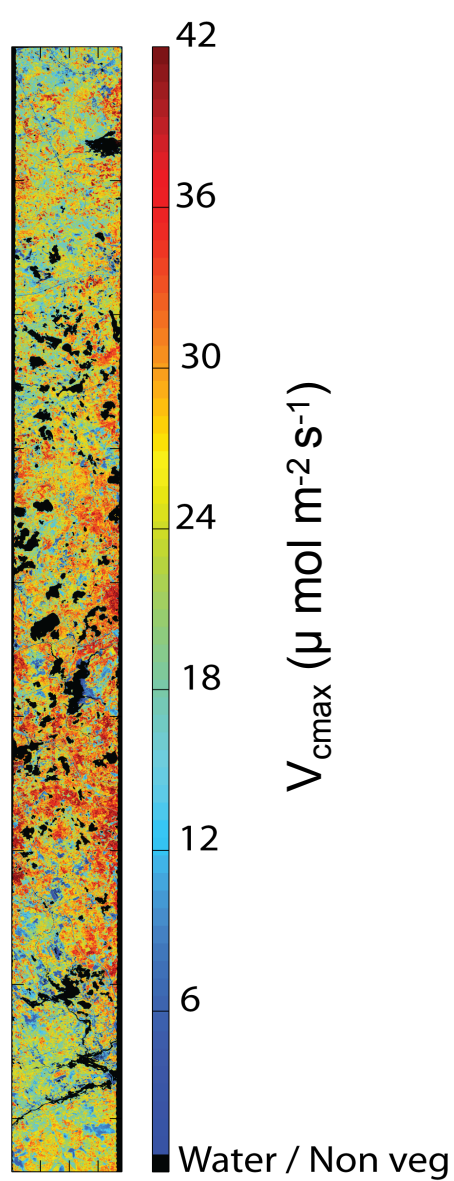


Examples: V_{cmax} – based on hypothesized relationships

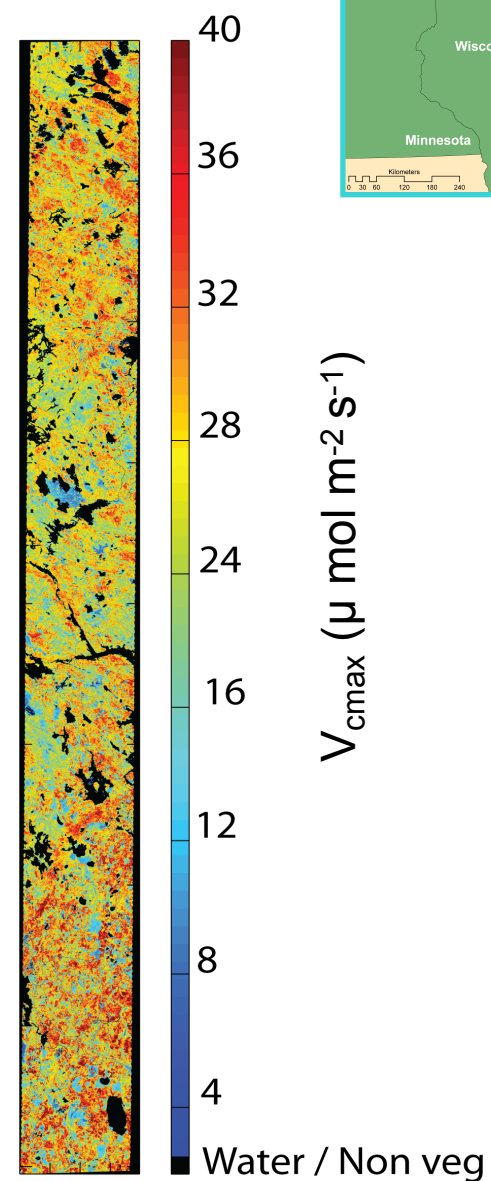
Baraboo Hills



Ottawa NF

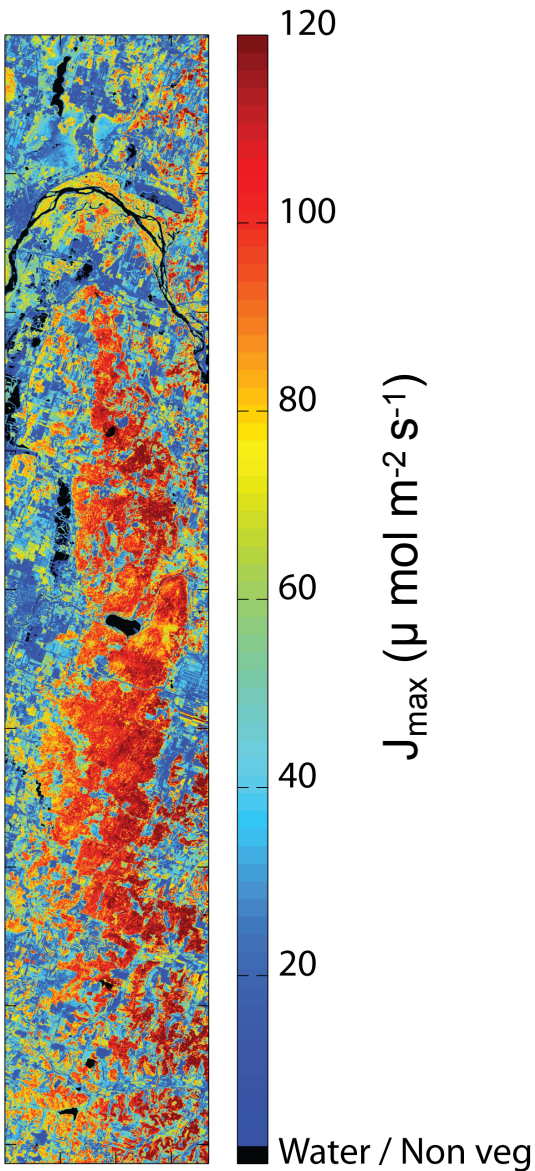


Minnesota

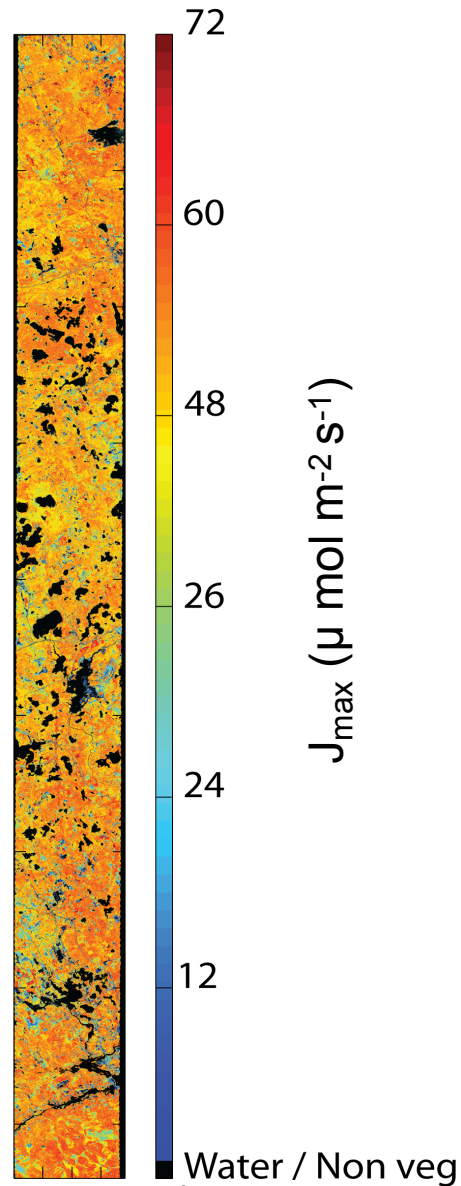


Examples: J_{\max} – based on hypothesized relationships

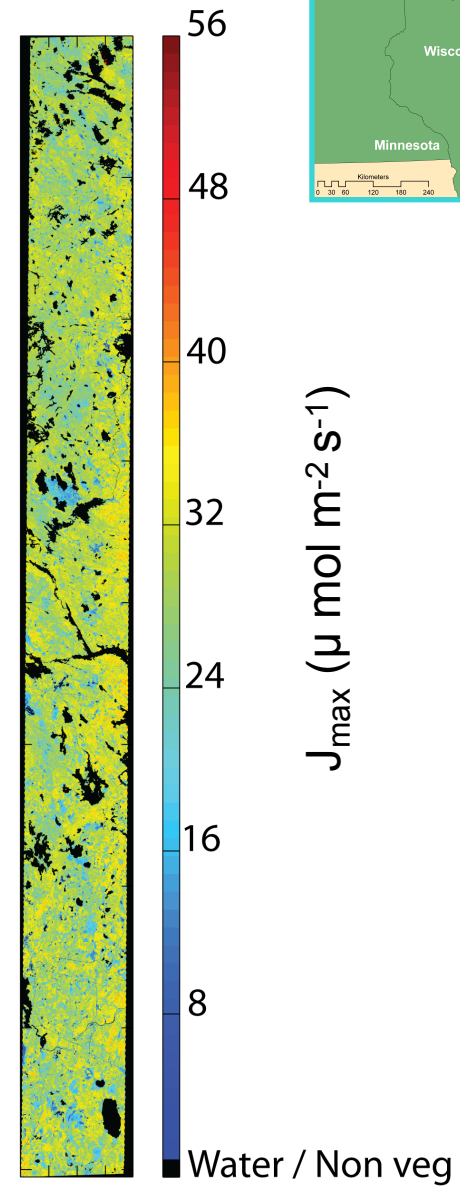
Baraboo Hills



Ottawa NF



Minnesota



How will the product will be produced?

- To test the viability of product, calibrations are required across species, and across thermal gradients.
- We hypothesize that general relationships for different T regimes (TIR) can be derived from image spectra.

Who will benefit from the product?

- Anyone interested in CO₂ assimilation by plants, and how it changes within species across temperature gradients!
- Those interested in modeling photosynthesis and ecosystem dynamics.

Links and synergy with other products

- Links to most vegetation products and products based on radiative transfer modeling.

Time is short!

More on the empirical evidence and modeling in the research talk later in the workshop.

Brainchild of Shawn Serbin, with credit to Shawn and Dylan Dillaway for conducting preliminary tests.

Thanks to a new NASA HypsIRI-funded grant (1-year grant starting soon), in which we will further test this idea.



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