Modeling fAPAR by Chlorophyll throug a Canopy ($fAPAR_{chl}$) and Leaf Water Content (LWC)

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Vegetation Photosynthesis

- **Remote Sensing approaches to estimate GPP: Monteith (1972,1977):**

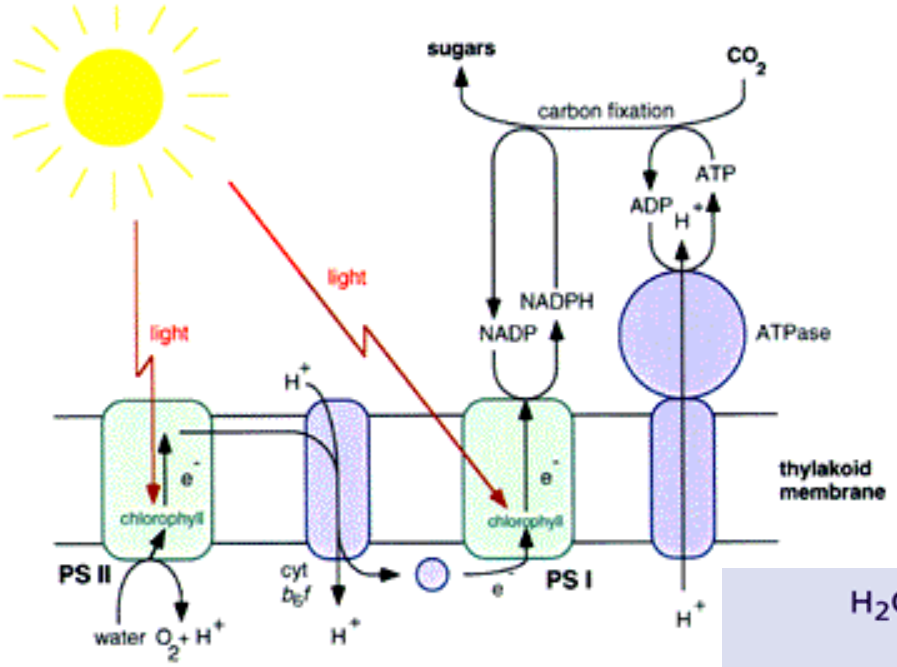
$$GPP = LUE \times fPAR \times PAR$$

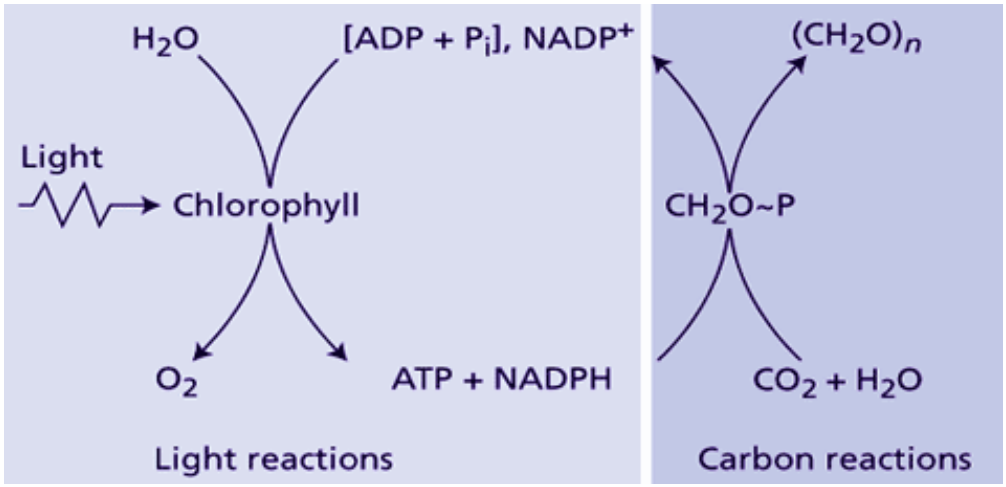
- **GLO-PEM (Prince et al., 1995) and PSN (Running et al., 1999, MODIS standard product):**

$$GPP = LUE_{canopy} \times APAR_{canopy}$$
$$APAR_{canopy} = fAPAR_{canopy} \times PAR$$

- **Are the Remote Sensing models consistent with plant physiological processes?**

Why $fAPAR_{chl}$, not $fAPAR_{canopy}$





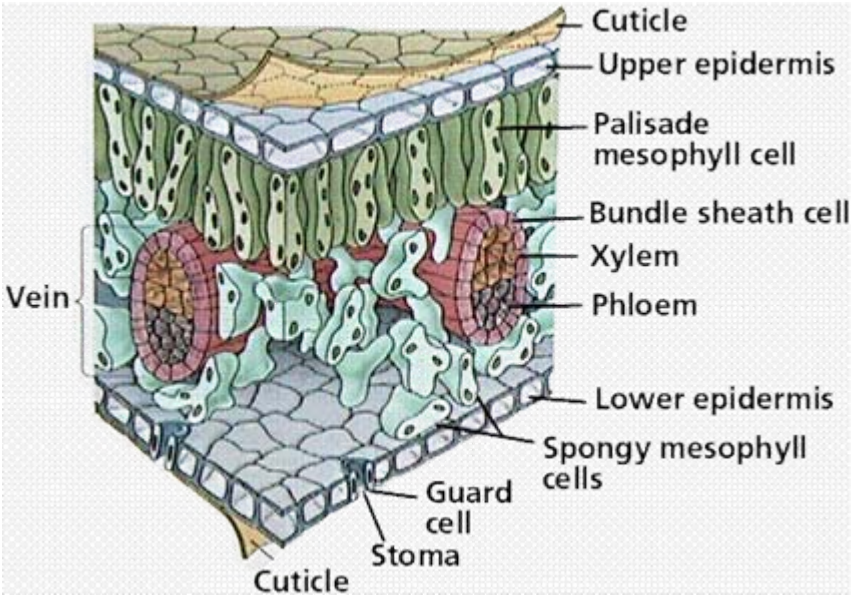
light energy

$$6\ CO_2 + 12\ H_2O \Rightarrow C_6H_{12}O_6 + 6\ O_2 + 6\ H_2O$$

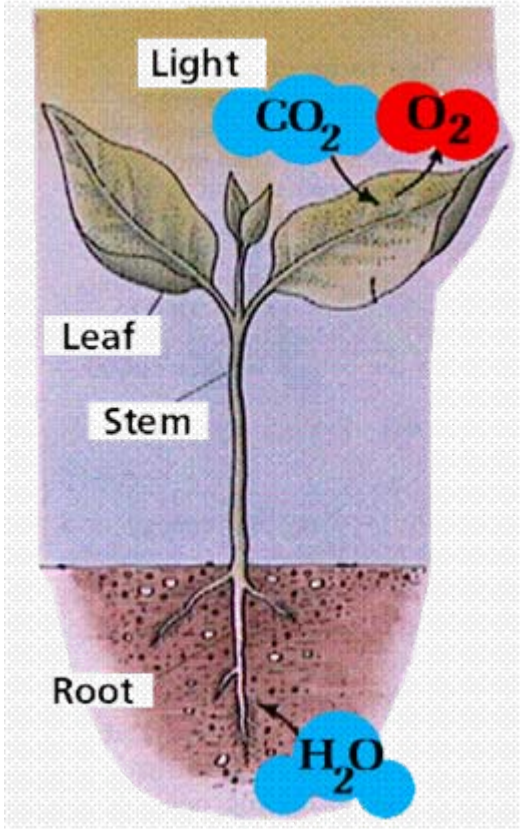
http://photoscience.la.asu.edu/photosyn/education/photointro.html

Why $fAPAR_{chl}$, not $fAPAR_{canopy}$

A leaf contains non-photosynthetic vegetation (NPV) component, including non-photosynthetic pigments, cell walls, veins, etc.



A canopy includes leaf, and non-photosynthetic vegetation (NPV), including stems, branches, senescent leaves.



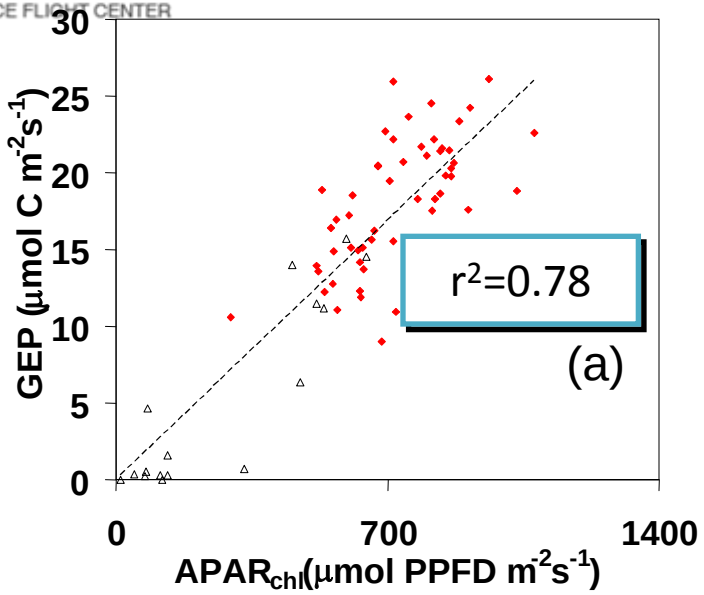
http://photoscience.la.asu.edu/photosyn/education/photointro.html

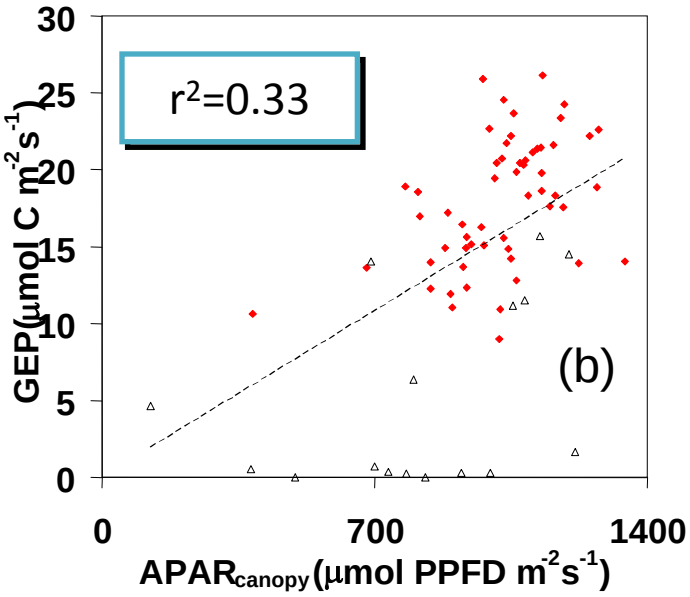
Why $fAPAR_{chl}$, not $fAPAR_{canopy}$

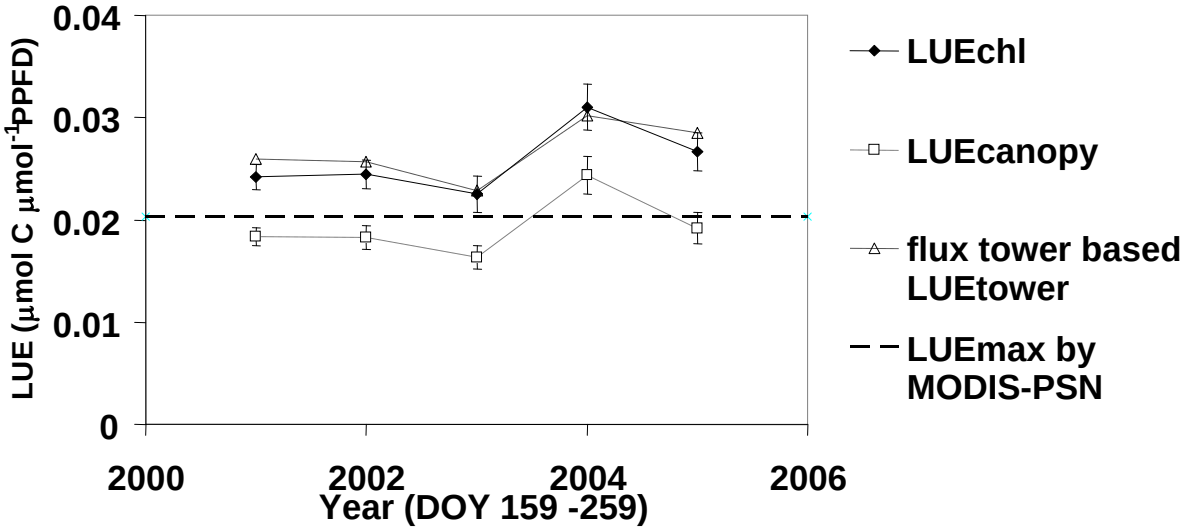
$$APAR_{canopy} = APAR_{chl} + APAR_{dry\ \ matter} + APAR_{brown\ \ pigment} + APAR_{stem}$$

$$fAPAR_{canopy} = \frac{APAR_{canopy}}{PAR_0}$$

$$fAPAR_{chl} = \frac{APAR_{chl}}{PAR_0}$$







Zhang, Q., Middleton, E.M., Margolis, H.A., Drolet, G.G., Barrd, A.A., & Black, T.A. (2009). Can a satellite-derived estimate of the fraction of PAR absorbed by chlorophyll (FAPARchl) improve predictions of light-use efficiency and ecosystem photosynthesis for a boreal aspen forest? *Remote Sensing of Environment, 113, 880-888*

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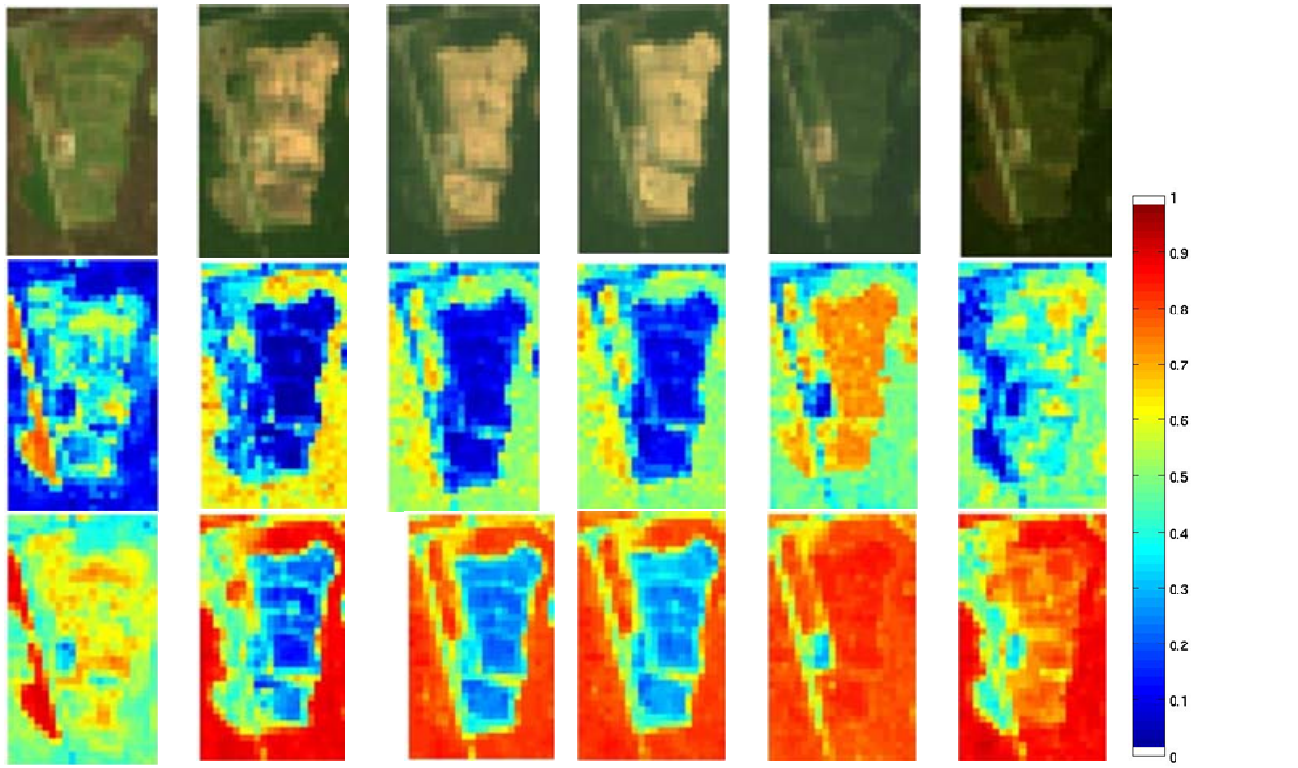
USDA-ARS HRSL Hydrology & Remote Sensing Lab Beltsville, Maryland, USA

OPE3 Optimizing Production Inputs for Economic and Environmental Enhancement (OPE3)

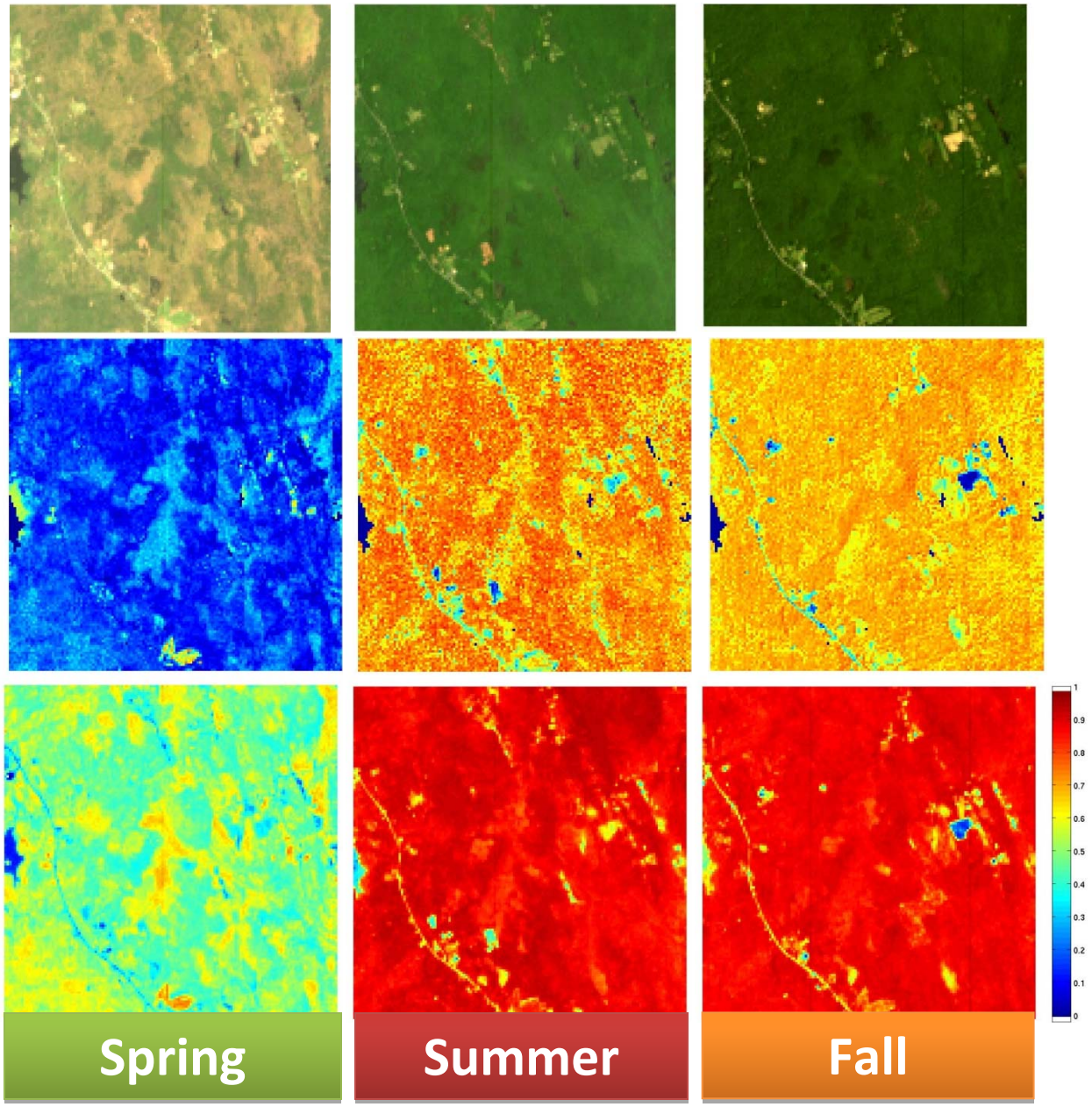


Harvard Forest, MA

EO-1 Hyperion True color

$fAPAR_{chl}$

$fAPAR_{canopy}$



Why Leaf Water Content (LWC)

$$LWC = \frac{LW}{LW + DM} = \frac{\frac{LW}{A}}{\frac{LW}{A} + \frac{DM}{A}} = \frac{C_w}{C_w + C_m}$$

LWC is useful:

- Drought monitoring
- Plant health status (water stress)
- One of the factors that down-regulate vegetation photosynthesis
- Timing of greening-up and senescence

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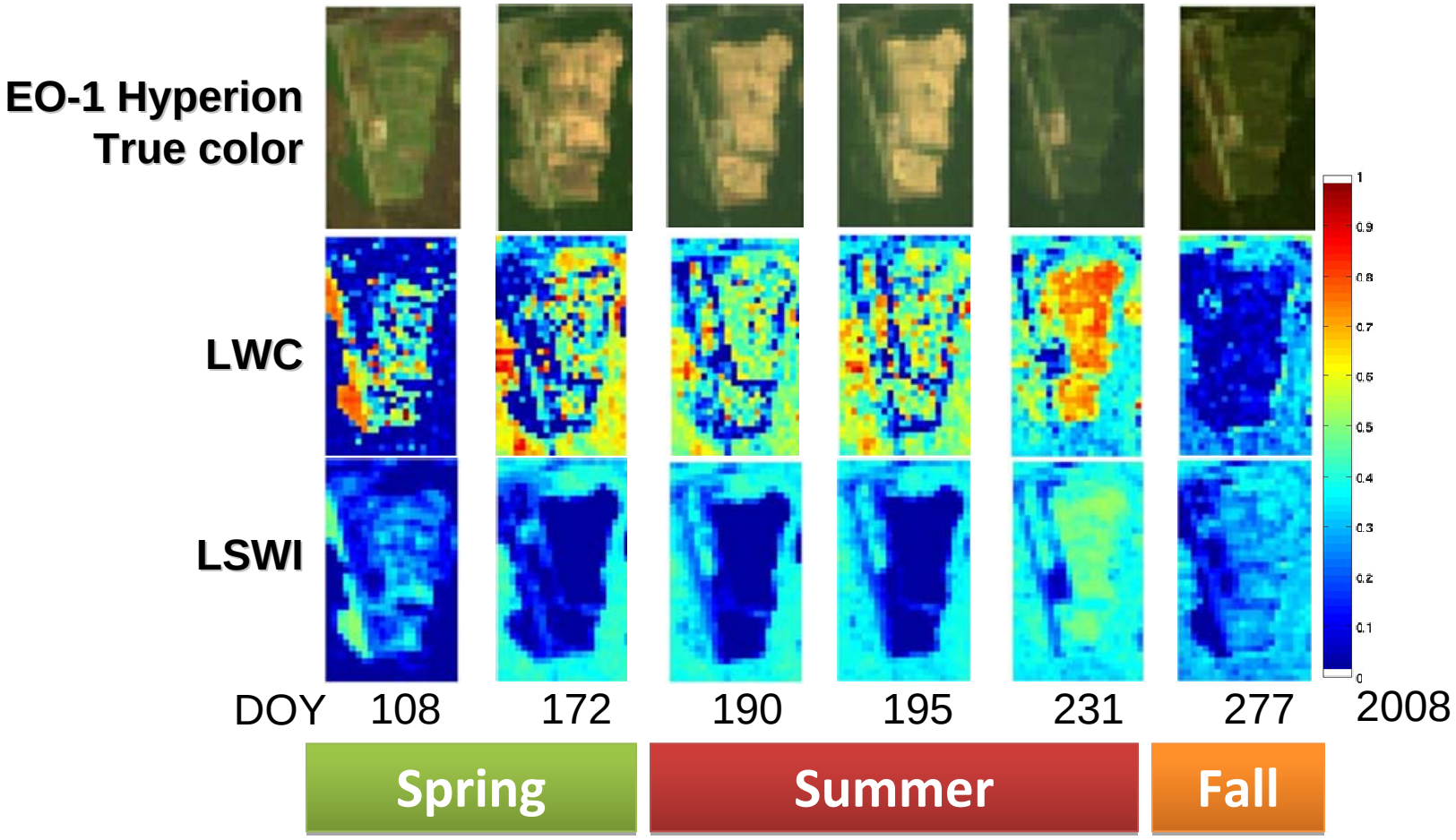

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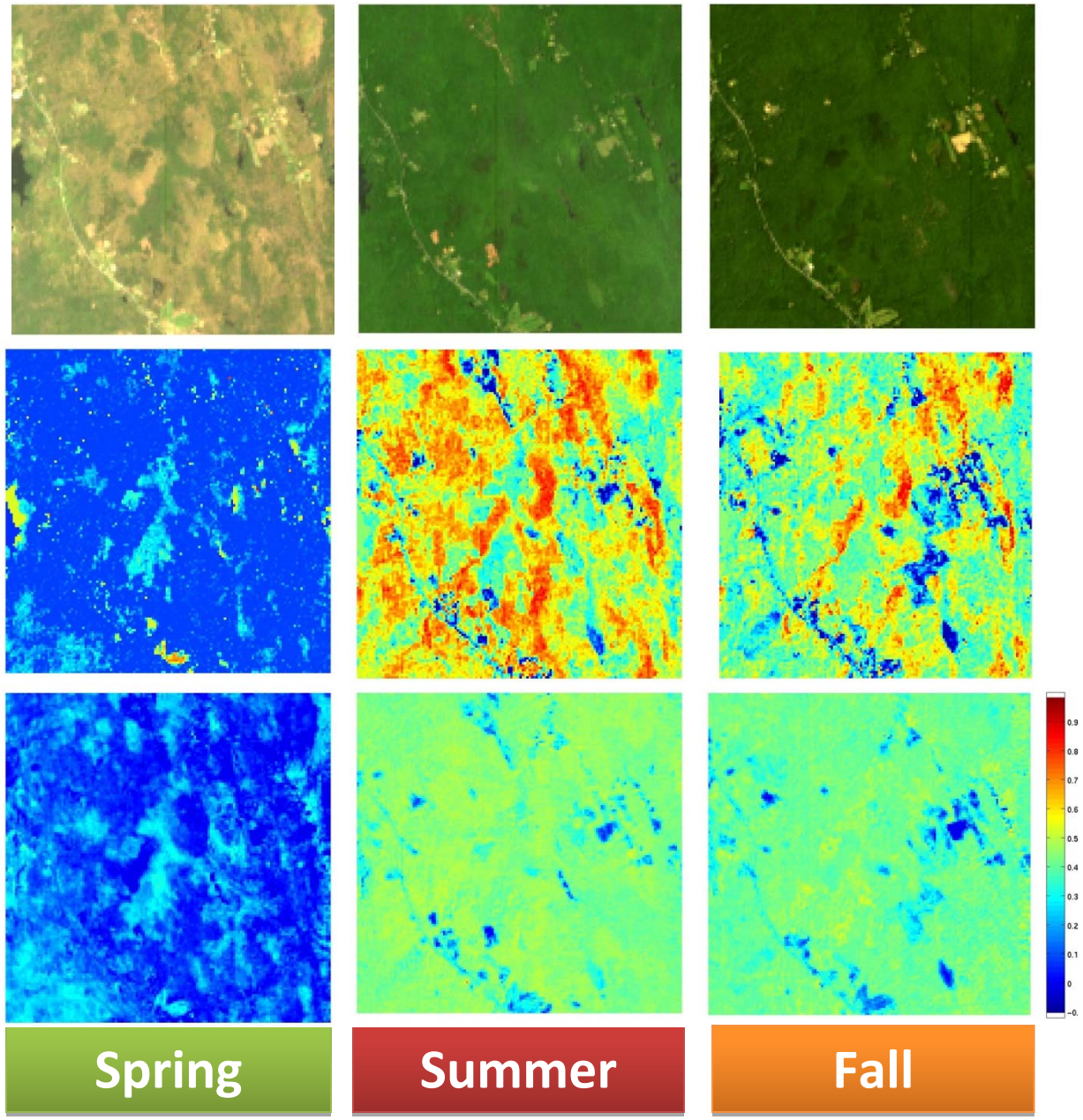

$fAPAR_{chl}$ and LWC link to:

- VQ1. Pattern and spatial distribution and ecosystems and their components [DS 195]
- VQ2. Ecosystem Function, Physiology and Seasonal Activity [DS 191,195,203]
- VQ3. Biogeochemical Cycles
- VQ4. Ecosystem Response to Disturbance
- CQ4. Ecosystem Function and Diversity [DS 194,195, 203]

Accurate assessment of spatial and temporal distribution of $fAPAR_{chl}$ and LWC will

- Provide key input parameters to carbon and climate modeling
- Understand the effects of climate change to terrestrial ecosystems
- Assess feedbacks from ecosystems to the atmosphere

Thank you!!