Modeling fAPAR by Chlorophyll through a Canopy ($f\text{APAR}_{\text{chl}}$) and Leaf Water Content (LWC)

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Vegetation Photosynthesis

- Remote Sensing approaches to estimate GPP:
  Monteith (1972, 1977):
  \[ \text{GPP} = \text{LUE} \times \text{fPAR} \times \text{PAR} \]

- GLO-PEM (Prince et al., 1995) and PSN (Running et al., 1999, MODIS standard product):
  \[ \text{GPP} = \text{LUE}_{\text{canopy}} \times \text{APAR}_{\text{canopy}} \]
  \[ \text{APAR}_{\text{canopy}} = \text{fAPAR}_{\text{canopy}} \times \text{PAR} \]

- Are the Remote Sensing models consistent with plant physiological processes?
Why $f\text{APAR}_{\text{chl}}$, not $f\text{APAR}_{\text{canopy}}$

$6 \text{CO}_2 + 12 \text{H}_2\text{O} \Rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{O}_2 + 6 \text{H}_2\text{O}$

http://photoscience.la.asu.edu/photosyn/education/photointro.html
Why $f\text{APAR}_{\text{chl}}$, not $f\text{APAR}_{\text{canopy}}$

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 $f\text{APAR}_{chl}$, not $f\text{APAR}_{canopy}$

\[ APAR_{canopy} = APAR_{chl} + APAR_{dry \text{ matter}} + APAR_{brown \text{ pigment}} + APAR_{stem} \]

\[ f\text{APAR}_{canopy} = \frac{APAR_{canopy}}{PAR_0} \]

\[ f\text{APAR}_{chl} = \frac{APAR_{chl}}{PAR_0} \]
**EO-1 Hyperion**

**True color**

\[ f_{\text{APAR}}_{\text{chl}} \]

\[ f_{\text{APAR}}_{\text{canopy}} \]

**DOY 2008**

- **Spring**: DOY 108, 172
- **Summer**: DOY 190, 195
- **Fall**: DOY 231, 277

Colors represent different values:

- Red: 1
- Orange: 0.9
- Yellow: 0.8
- Green: 0.7
- Blue: 0.6
- Light blue: 0.5
- Light green: 0.4
- Light orange: 0.3
- Light yellow: 0.2
- Light red: 0.1
- White: 0
Harvard Forest, MA

EO-1 Hyperion
True color

fAPAR$_{chl}$

fAPAR$_{canopy}$

Spring  Summer  Fall
Why Leaf Water Content (LWC)

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

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
fAPAR$_{\text{chl}}$ 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!!