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### **Title**

Using Imagers for Scaling Ecological Observations

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# Using Imagers for Scaling Ecological Observations

## Terrestrial Ecology Observing Systems

Eric Graham, John Hicks, Erin Riordan, Eric Wang, Eric Yuen

### Using Ground-Based Visible-Light Cameras to Scale: Current Projects

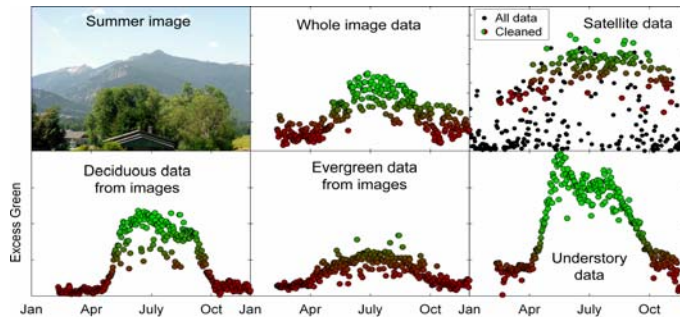
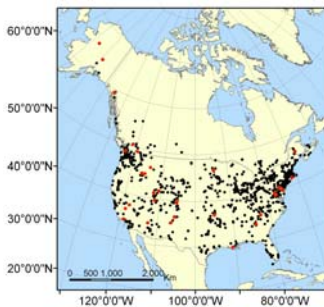


Pan-Tilt-Zoom camera

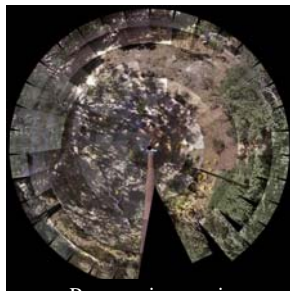
Ground-based visible-light digital cameras are being used as the top tier in multiscale observations, relating single pixels and segments of images to not only manual observations but also to measurements with environmental sensors, physiological models, and satellite remote sensing products. Projects include:

1. Expanding plant phenological observations with a nation-wide network of webcams.
2. Scaling soil surface temperatures using images, mobile sensors, and simple models.
3. Estimating photosynthesis over large areas with HDR and physiological models.
4. Scaling from a leaf to the landscape, integrating plant phenology at multiple scales.

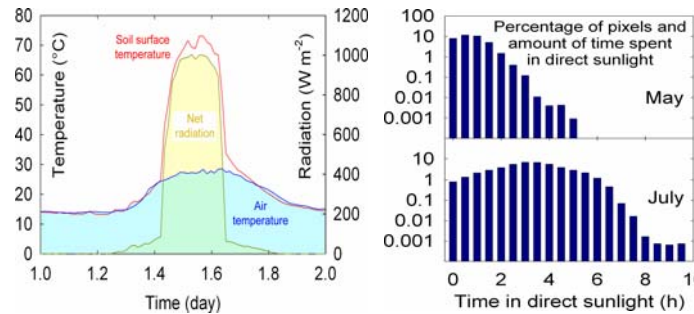
### Images, Models, and Data



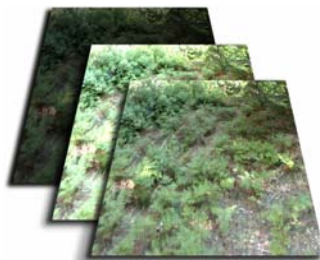
**1. A nation-wide network of webcams.** Twice-daily images from over 1000 internet-connected cameras have been collected since February 2008. The advance of Spring can be tracked as a "green-up" and related to satellite remote sensing signals.



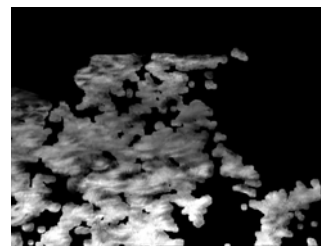
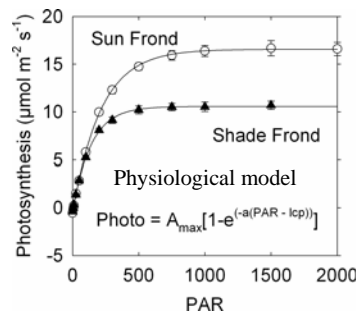
Panoramic mosaic



**2. Scaling soil surface temperatures.** Soil surface temperature tracks air temperature in the shade but rises sharply because of solar radiation. Sunflecks captured with a camera taking a panoramic mosaic can be used to estimate the radiation load for large areas of understory.

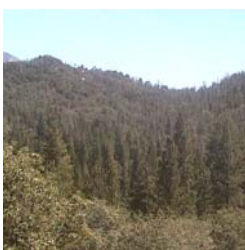


HDR image construction

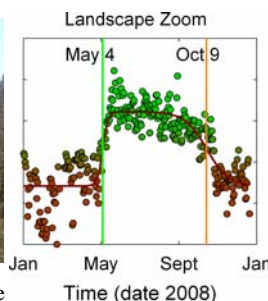


Area map of potential fern photosynthesis

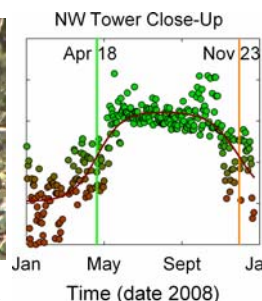
**3. Photosynthesis over large areas with HDR.** High Dynamic Range imaging captures an absolute (vs. relative) amount of reflected light in an image. For a meadow composed of similarly reflecting species, we can apply a physiological model to estimate photosynthesis over a large area.



Mixed pine-oak landscape



Oak branches, zoomed in



**4. Scaling from leaf to the landscape.** Pan-Tilt-Zoom cameras can be zoomed in on a tight focus on individual plants and then zoomed out to get a landscape view, composed of the same and similar species for an integrated "green-up" date estimation (double-sigmoid).