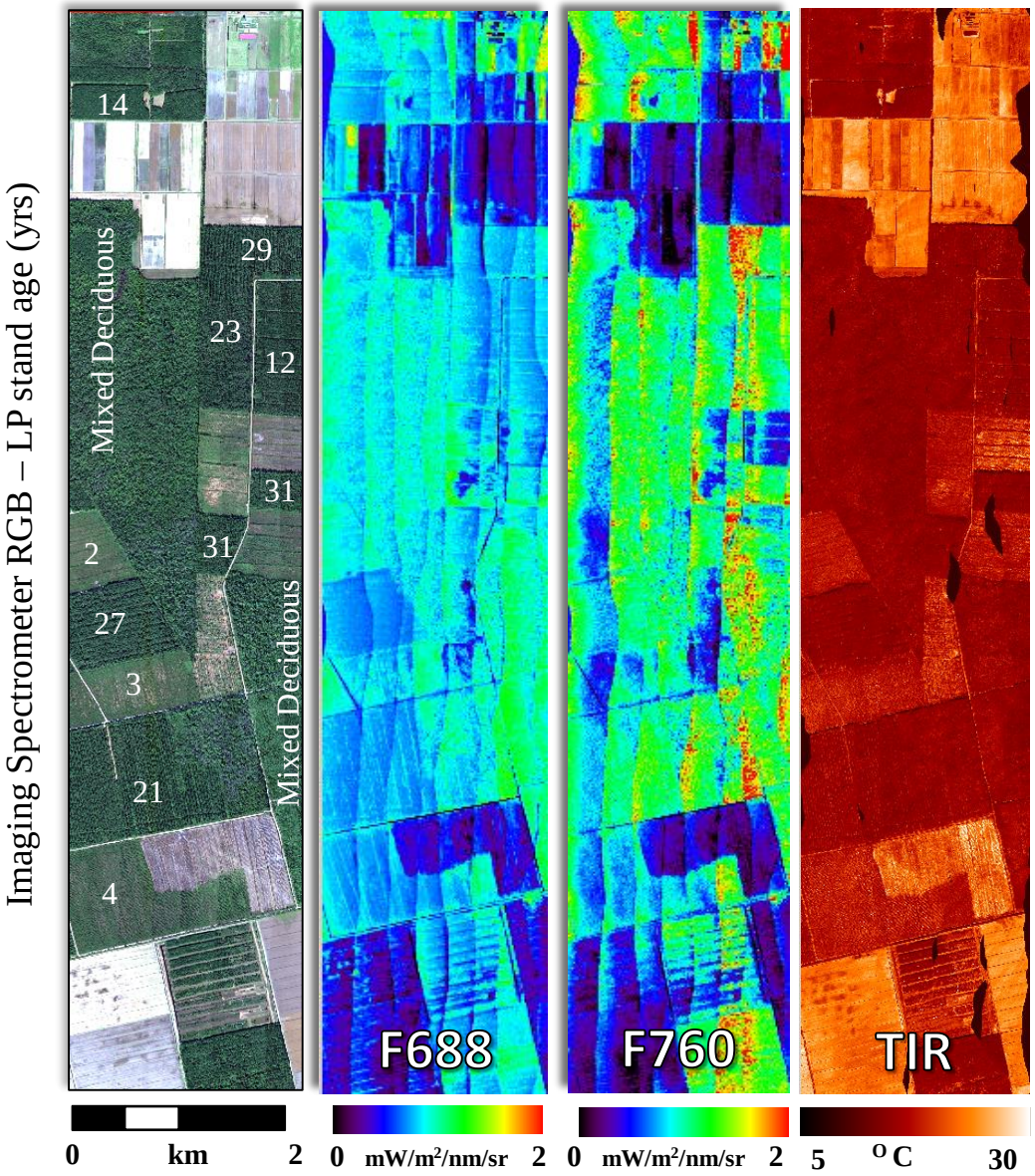
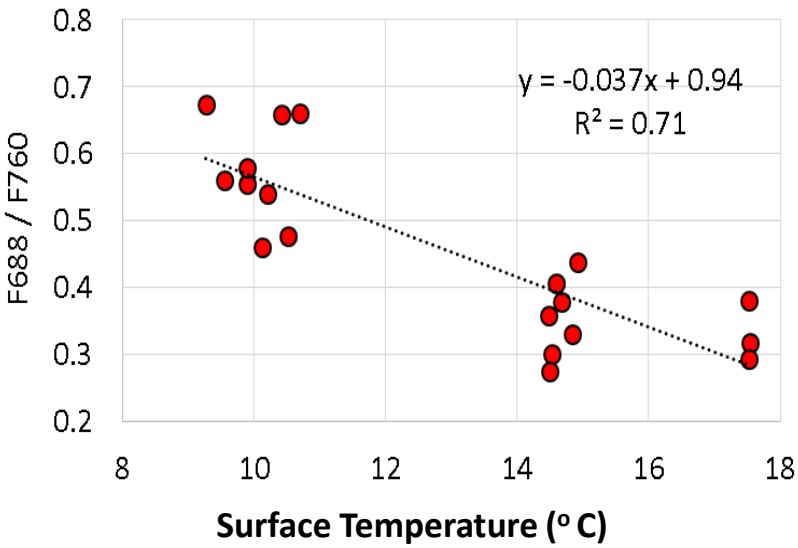
Unique Fluorescence & Thermal Imagery Reveal Photosynthetic Function

Middleton, Corp, Cook and Rascher (NASA/GSFC 618; Forschungszentrum Jülich, Germany)





Novel combination of airborne thermal (TIR) and fluorescence (F) images relate plant function to energy balance and the carbon cycle.

Both red (F688) and far-red (F760) fluorescence contribute to capturing plant responses. Their ratio expresses photosynthetic efficiency, which decreases with increasing temperature.

Results from FLEX-US 2013 NASA/ESA field campaign (G-LiHT, HyPlant). [Corp et al. 2015, ESA/FLEX-US Report 2015]

Name: Elizabeth Middleton, NASA/GSFC, Biospheric Sciences Lab
E-mail: : Elizabeth.M.Middleton @nasa.gov
Phone: 301-614-6670

References:

Corp, L.A., B. Cook, F. Pinto, E. Middleton, K. Huemmrich, P. Campbell, U. Rascher, and A. Noormets (2015). Airborne remote sensing to define ecosystem form and function over a loblolly pine plantation. Proceedings, 2015 IEEE International Geoscience and Remote Sensing symposium (IGARSS) 2015, Milan, Italy, July 26-31, 4pp.

Middleton, E.M., Y.-B. Cheng, P.K.E. Campbell, L.A. Corp, Q. Zhang, K.F. Huemmrich, D.R. Landis, W.P. Kustas, A.L. Russ, 2014. Daily light use efficiency in a cornfield can be related to the canopy Red/Far-Red fluorescence ratio and leaf light use efficiency across a growing season. Proceedings, 5th Workshop on Remote Sensing of Vegetation Fluorescence, Paris, France, April 2014, 9 pp.

Moreno, J., Y. Goulas, A. Huth, E. Middleton, F. Miglietta, G. Mohammed, L. Nedbal, U. Rascher, W. Verhoef. (2015). Report for mission selection: FLEX. An Earth Explorer to observe vegetation fluorescence. Fletcher, K. (Editor). European Space Agency. Noordwijk, the Netherlands. 197 pp.

Data Sources: NASA Goddard's LiDAR Hyperspectral Thermal Airborne Imager open access data products available at: gliht.gsfc.nasa.gov. HyPlant data products from Forschungszentrum Jülich, Germany. HyPlant is the prototype instrument for the FLEX mission.

Technical Description of Figures:

Graphic 1 (left): Airborne imagery were collected in the FLEX-US Campaign in October 2013 over the Parker Tract loblolly pine plantation in North Carolina. The four strips show (from left to right): the red-green-blue reflectance composite from the HyPlant Dual spectrometer; the red and far-red fluorescence retrieved from the HyPlant IBIS spectrometer; and the thermal data from G-LiHT. The original 2 m pixels are aggregated to 14 m to match the LiDAR data (not shown).

Graphic 2 (right): The relationship of the red/far-red fluorescence ratio (F688/F760) is plotted vs. the retrieved surface temperature. A significant relationship was observed between SIF and surface temperature.

Scientific significance, societal relevance, and relationships to future missions:

Fluorescence observed from remote sensing platforms directly responds to vegetation physiological function. We demonstrate that fluorescence, especially both critical retrievals in the red and far-red spectrum, can be retrieved at high spatial resolution (~14 m) from aircraft. The FLEX-US campaign collected a unique combination of LiDAR, hyperspectral reflectance, fluorescence, and surface temperature imagery. Several atmospheric chemistry satellites provide far-red fluorescence at a coarse spatial scale. The FLEX-US campaign tested new technologies and methods for cal/val of FLEX mission products. Currently, missions optimized for retrieval of both the red and far-red fluorescence are under development. Our data show the benefit of combining thermal information with fluorescence to estimate photosynthetic efficiency in response to environmental conditions, a capability that will be possible with the FLuorescence EXplorer (FLEX) mission and from the ISS when both ECOSTRESS and OCO-3 are deployed. This research is leading to improved measurement and modeling of plant productivity and responses.