Jet Propulsion Laboratory
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1st Orbiting Carbon Observatory-3 (OCO-3)
Science Data Applications (SDA) Meeting, 07 June 2017
Jet Propulsion Laboratory, Pasadena, CA

OCO-3 Mission Overview

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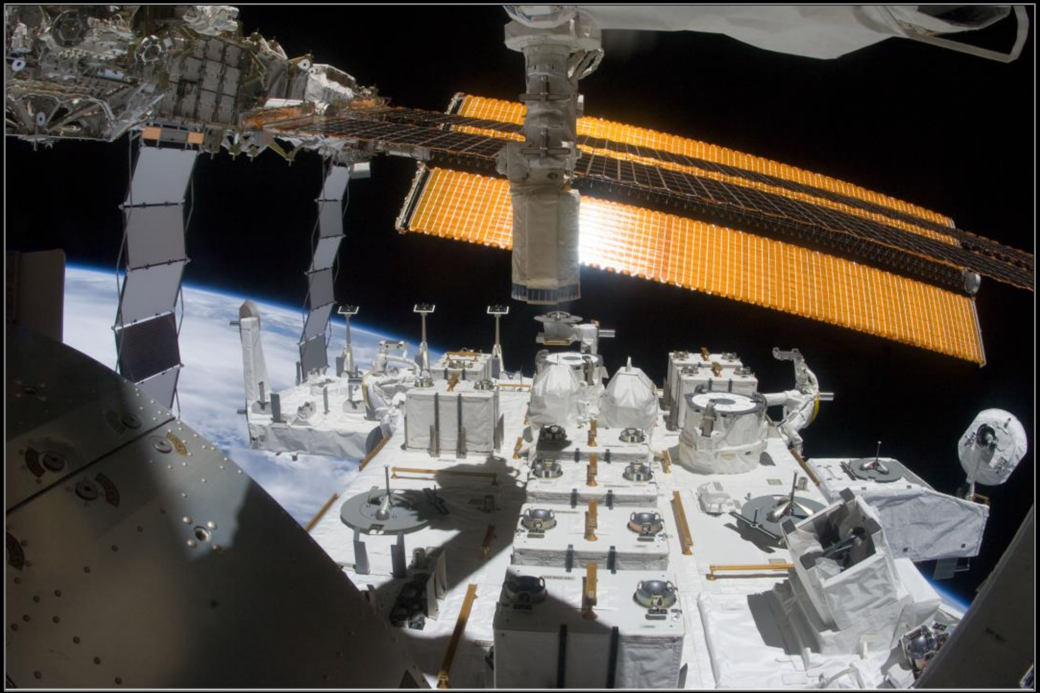

[Credit: NASA]

Clearance No. XXXXXXX

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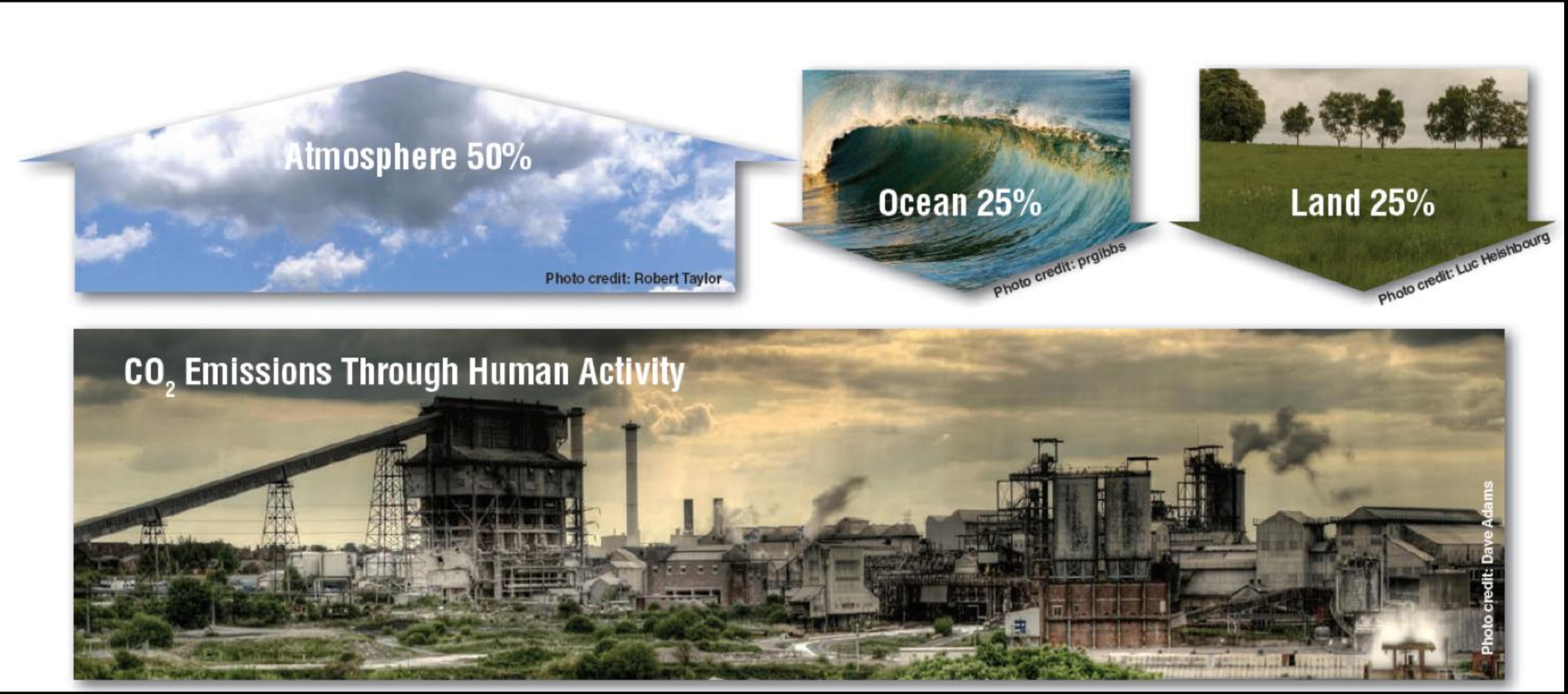
Where is the Carbon Dioxide (CO_2) Going?



[Credit: NASA/JPL]

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Original OCO Mission Lost

[Credit: NASA]

[Credit: Matt Rogers, CSU, Fort Collins]

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OCO-2 to Celebration 3 Years of Operations!

[Credit: NASA]

[Credit: NASA/KSC]

OCO-3 is a NASA-directed mission on the International Space Station (ISS)

Primary Mission Objectives: Collect the space-based measurements needed to quantify variations in the column averaged atmospheric carbon dioxide (CO_2) dry air mole fraction, X_{CO2}, with the precision, resolution, and coverage needed to improve our understanding of surface CO_2 sources and sinks (fluxes) on regional scales (≥1000 km). The precision requirement is identical to that of OCO-2. Operations on ISS allows latitude coverage from 51 deg N to 51 deg S.

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For OCO-3…

Precision: 0.3% (1-2 parts per million)

Resolution: <4.5 km^2 (single footprint)

Coverage: 51 deg N to 51 deg S (min)

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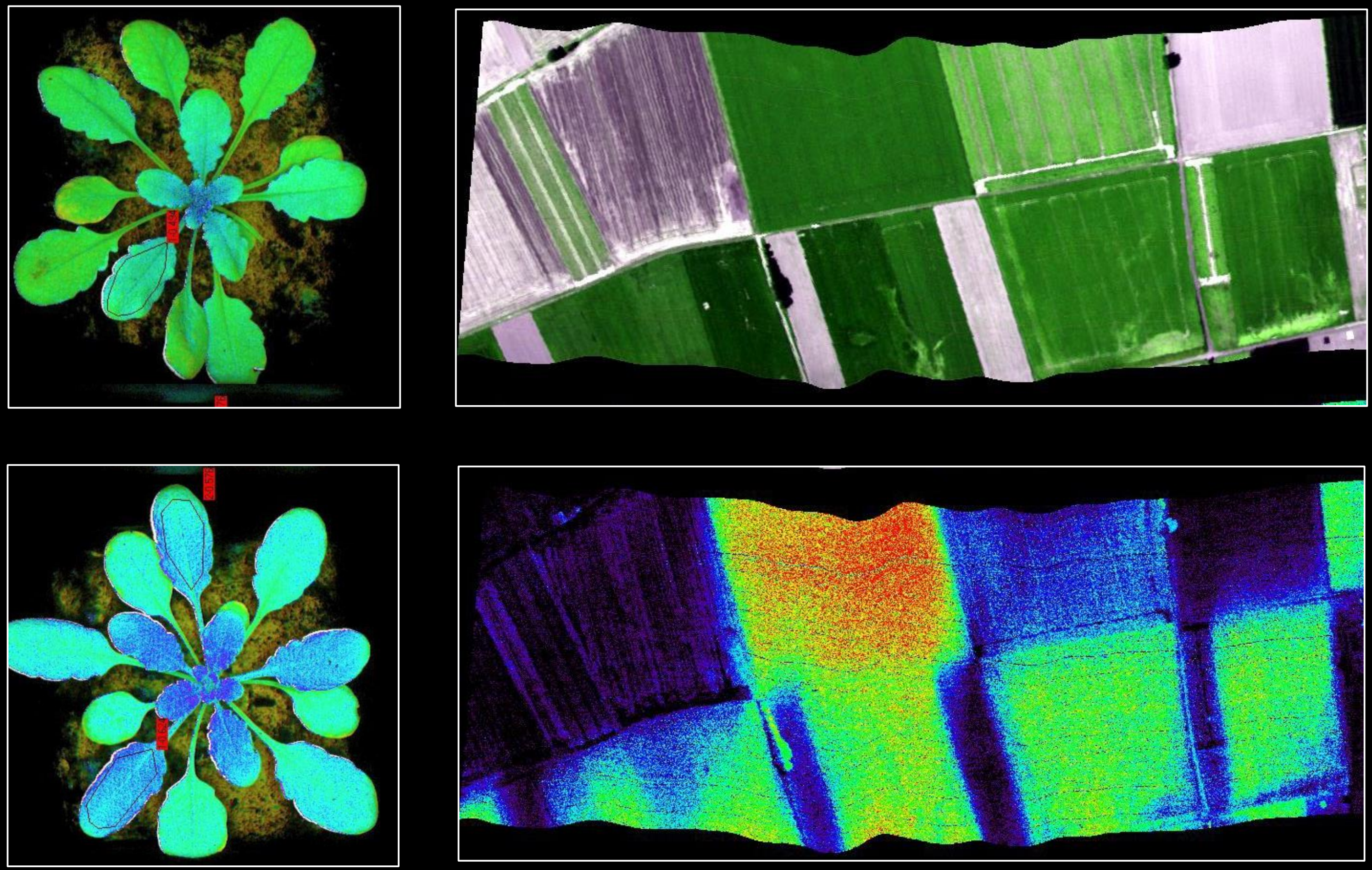
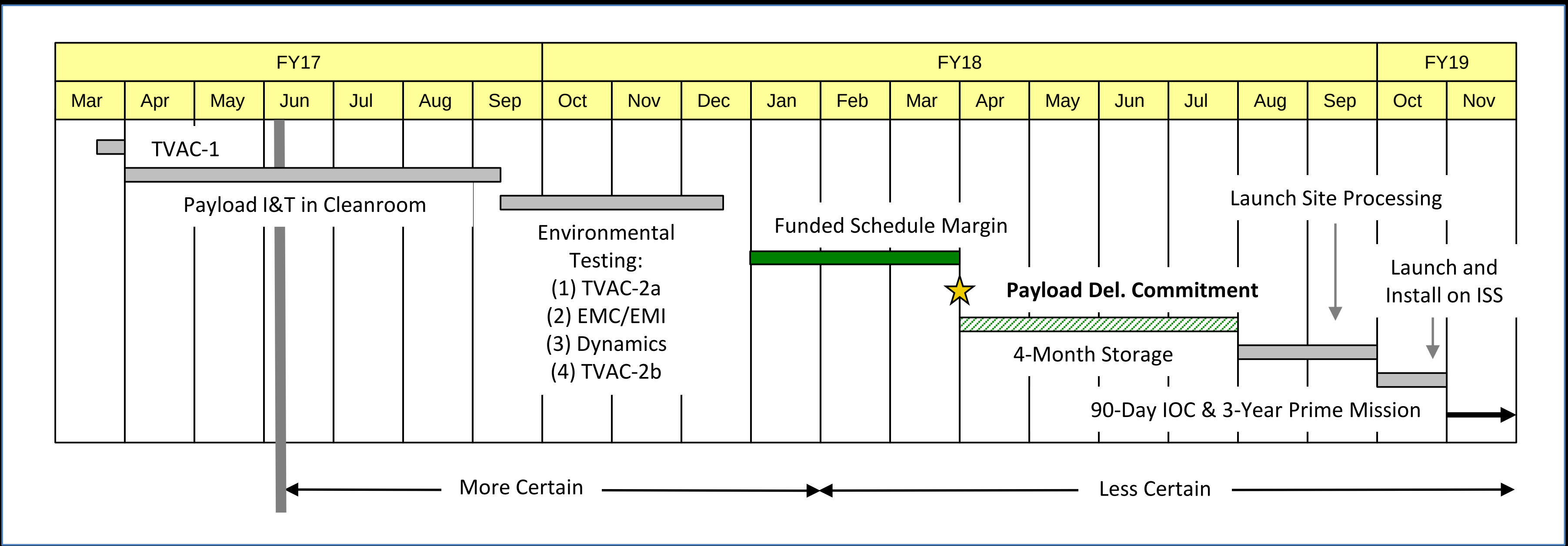
Solar-Induced Fluorescence (SIF)



[Credit: ESA / U. Rascher, Forschungszentrum Jülich]

Near-Term Commitment is Payload Delivery



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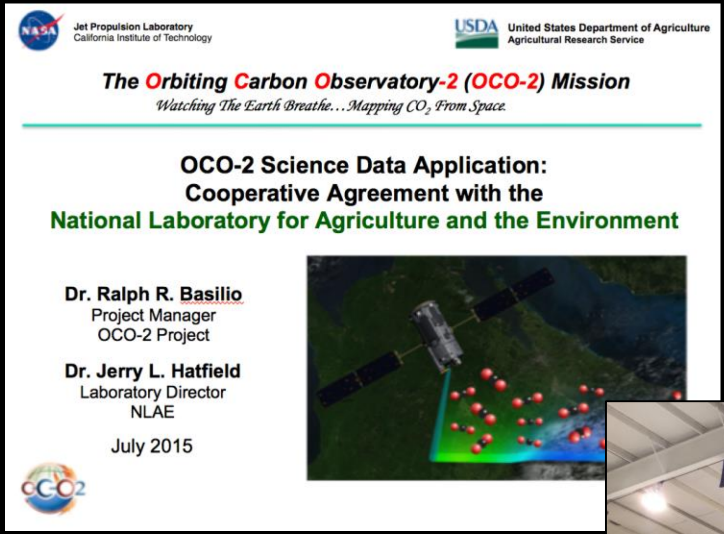
OCO-3 Payload in the Cleanroom

[Credit: NASA/JPL]

OCO-2 Science Data Applications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United States Department of Agriculture
Agricultural Research Service

The Orbiting Carbon Observatory-2 (OCO-2) Mission

Watching The Earth Breathe…Mapping CO_2 From Space

OCO-2 Science Data Application:
Cooperative Agreement with the
National Laboratory for Agriculture and the Environment

Dr. Ralph R. Basilio
Project Manager
OCO-2 Project

Dr. Jerry L. Hatfield
Laboratory Director
NLAE

July 2015

[Credit: NASA]


AGU PUBLICATIONS

Geophysical Research Letters

RESEARCH LETTER
10.1002/2016GL070775

Key Points:
- GPP scales linearly with SIF from instantaneous to monthly time scales
- Aggregating ecosystem GPP-SIF functions yield a representative landscape relation that matched one obtained directly using tall tower GPP
- GPP-SIF relations showed sensitivity to plant physiology but not spatiotemporal scale

Supporting Information:
- Supporting Information S1

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Multiscale analyses of solar-induced florescence and gross primary production

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Abstract Solar-induced fluorescence (SIF) has shown great promise for probing spatiotemporal variations in terrestrial gross primary production (GPP), the largest component flux of the global carbon cycle. However, scale mismatches between SIF and ground-based GPP have posed challenges toward fully exploiting these data. We used SIF obtained at high spatial sampling rates and resolution by NASA's Orbiting Carbon Observatory-2 satellite to elucidate GPP-SIF relationships across space and time in the U.S. Corn Belt. Strong linear scaling functions ($R^2 \geq 0.79$) that were consistent across instantaneous to monthly time scales were obtained for corn ecosystems and for a heterogeneous landscape based on tall tower observations. Although the slope of the corn function was ~56% higher than for the landscape, SIF was similar for corn (C_4) and soybean (C_3). Taken together, there is strong observational evidence showing robust linear GPP-SIF scaling that is sensitive to plant physiology but insensitive to the spatial or temporal scale.

1. Introduction

Terrestrial gross primary production (GPP) is the largest global carbon (C) flux [*Beer et al.*, 2010]. Accurately representing GPP in coupled carbon-climate models is thus of great importance, but a lack of observational constraints at regional to global scales has impeded the development and evaluation of models [*Friedlingstein*, 2015]. Therefore, obtaining better constraints on spatiotemporal variations in GPP is a subject of great interest [*Anav et al.*, 2015]. The advent of satellite-based monitoring of solar-induced fluorescence (SIF) has opened new avenues for probing regional-to-global photosynthesis [*Frankenberg et al.*, 2011b; *Joiner et al.*, 2011, 2014; *Guanter et al.*, 2014; *Porcar-Castell et al.*, 2014; *Duveiller and Cescatti*, 2016]. An important advantage of SIF is that it is more tightly coupled to physiological processes than vegetation indices such as the normalized difference vegetation index (NDVI) [*Rossini et al.*, 2015] or enhanced vegetation index (EVI) that are not sensitive to dynamic changes in physiological functioning and light-use efficiencies (LUEs). For instance, the onset and shutdown of photosynthesis, which is not mechanistically linked to leaf greenness, is better constrained by SIF [*Joiner et al.*, 2014]. However, to fully exploit the potential of SIF, a better understanding of the relationship between SIF and GPP is needed to construct seasonal and annual budgets. This is particularly important for agroecosystems where despite a similar coupling between the electron transport rate (ETR) and fluorescence, different electron-use efficiencies (EUEs) and carbon-use efficiencies (CUEs) can give rise to different SIF-GPP relationship in C_3 and C_4 crops [*Y. Zhang et al.*, 2014]. In the Corn Belt, which is dominated by corn (C_4) and soybeans (C_3), the GPP of the latter is only ~55% of the former [*Suyker and Verma*, 2012]. Understanding how C_4 and C_3 photosynthesis affects the relationship between SIF and GPP is thus important for utilizing SIF toward reliable estimation of local and regional budgets of photosynthetic carbon assimilation.

The existence of a relationship between fluorescence and the ETR of photosystem II is well established at molecular to leaf levels over short time scales, largely based on active fluorimetry measurements [*Baker*, 2008]. In contrast, remote sensing measures passive fluorescence induced by solar irradiance, with significant knowledge gaps regarding quantitative relations with photosynthesis [*Porcar-Castell et al.*, 2014]. Empirically, model and flux tower GPP scales linearly with SIF observed (e.g., Global Ozone Monitoring Experiment 2, (GOME-2) or Greenhouse Gases Observing Satellite (GOSAT)) at coarse spatial resolution and biweekly to annual time scales [*Frankenberg et al.*, 2011b] in a fashion that is somewhat ecosystem

…ET AL. MULTISCALE GPP-SIF RELATIONS 1

[Wood et al., 2016]

OCO-3 Doesn't Only Provide Data Continuity

OCO-2 science data applications provides an excellent opportunity for familiarization and collaboration, but it will always be an exploratory sampling mission

OCO-3, by taking data at different times of the day and the ability to map as many as 100 areas per day, and therefore, increasing observation frequencies, will provide even greater opportunities