EO-1/HYPERION: NEARING TWELVE YEARS OF SUCCESSFUL MISSION SCIENCE OPERATION AND FUTURE PLANS

Elizabeth M. Middleton[a*], *Petya K. Campbell*[b], *K. Fred Huemmrich*[b], *Qingyuan Zhang*[c], *Yen-Ben Cheng*[d], *David R. Landis*[e], *Stephen G. Ungar*[c], *Lawrence Ong*[f], *and Nathan H. Pollack*[f]

[a] Biospheric Sciences Laboratory, NASA/Goddard Space Flight Center (GSFC), Greenbelt, MD 20771, USA
[b] Joint Center for Earth Technology/Univ. Maryland Baltimore Co. (JCET/UMBC), Baltimore, MD 21228, USA
[c] Universities Space Research Association (USRA), Columbia, MD 21044, USA
[d] Earth Resources Technology, Inc. (ERT), Laurel, MD 20707, USA
[e] Sigma Space Corp., Inc., Lanham, MD 20706, USA
[f] Science Systems and Applications, Inc. (SSAI), Lanham, MD 20706, USA
*Corresponding author, email: Elizabeth.M.Middleton@nasa.gov

1. INTRODUCTION

The Earth Observing One (EO-1) satellite is a technology demonstration mission that was launched in November 2000, and by July 2012 will have successfully completed almost 12 years of high spatial resolution (30 m) imaging operations from a low Earth orbit. EO-1 has two unique instruments, the Hyperion and the Advanced Land Imager (ALI). Both instruments have served as prototypes for NASA's newer satellite missions, including the forthcoming (in early 2013) Landsat-8 and the future Hyperspectral Infrared Imager (HyspIRI). As well, EO-1 is a heritage platform for the upcoming German satellite, EnMAP (2015). Here, we provide an overview of the mission, and highlight the capabilities of the Hyperion for support of science investigations, and present prototype products developed with Hyperion imagery for the HyspIRI and other space-borne spectrometers.

2. THE HYPERION IMAGING SPECTROMETER

The Hyperion has demonstrated the viability and value of satellite-based imaging spectroscopy from a low earth orbit. Hyperion covers the 0.4 to 2.5 µm range with 242 overlapping spectral bands (196 of which are well calibrated) at approximately 10 nm spectral resolution and 30 m spatial resolution, and can image a 7 km x 100 km land area per image. Currently, the stability of the Hyperion measurements is within ±1.5%, with a "moderate fidelity". Hyperion data have a lower SNR (~ 160:1, 0.4-1.0 µm; ~ 40:1, 1.0-2.5 µm) as compared to the current "Classic" Airborne Visible/Infrared Imaging Spectrometer (AVIRIS-Classic), but its SNR is comparable to that for data obtained with the original 1995 AVIRIS sensor [1]. As of early 2012, there have been over 54,000 scenes of both Hyperion and ALI imagery collected around the world. The 2011 collections are shown in **Fig. 1**. and archived at the USGS EROS Data Center. The full spectrum and relatively narrow spectral resolution of the Hyperion has enhanced the development of passive Earth remote sensing techniques, and enabled significant advances in detecting land surface categories and vegetation properties due to improved accuracy when used with spectral classifiers. The Hyperion imagery also demonstrated that heat emission from some important Earth processes (e.g. lava flows and wildfires) can be measured using data in the 0.4 - 2.5 µm range, i.e. without the need of a thermal instrument.

Science and Applications for Ecosystems

Here, we highlight the use of Hyperion data for ecosystem and vegetation information retrieval and use. For example, Hyperion imagery have proven successful in discriminating land cover types, species mapping, and for deriving Vegetation Indices. Bio-physical products have emerged for forest canopy nitrogen, primary production, LAI and vegetation canopy closure, vegetation fractional cover, as well as canopy greenness, wetness and pigment content. An example of an ecosystem product developed by the EO-1 Project is provided in **Fig. 2**. A partial list of cited literature is provided here, showing that Hyperion data have successfully been utilized for many forest related studies [1-11], as well as agriculture, pastures, savannas, and wetlands [12-18]. Special topics address nitrogen content [19-21], invasive species [22-23], ecosystem fragmentation [24-25], and tower fluxes [26]. Many studies investigated cross sensor capabilities [27,3,5,10,22,24] and new hyperspectral methods [9,11,28]. A complete list of EO-1 publications can be viewed at the EO-1 web site (http://eo1.gsfc.nasa.gov/new/ SeniorReviewMaterial_References.doc).

3. SUMMARY

The EO-1 mission has exceeded its primary goals to enable more effective (and less costly) hardware and data strategies for Earth science orbital missions in the 21st century. Both the Hyperion and ALI have paved the way for future, essential Earth observing satellite missions.

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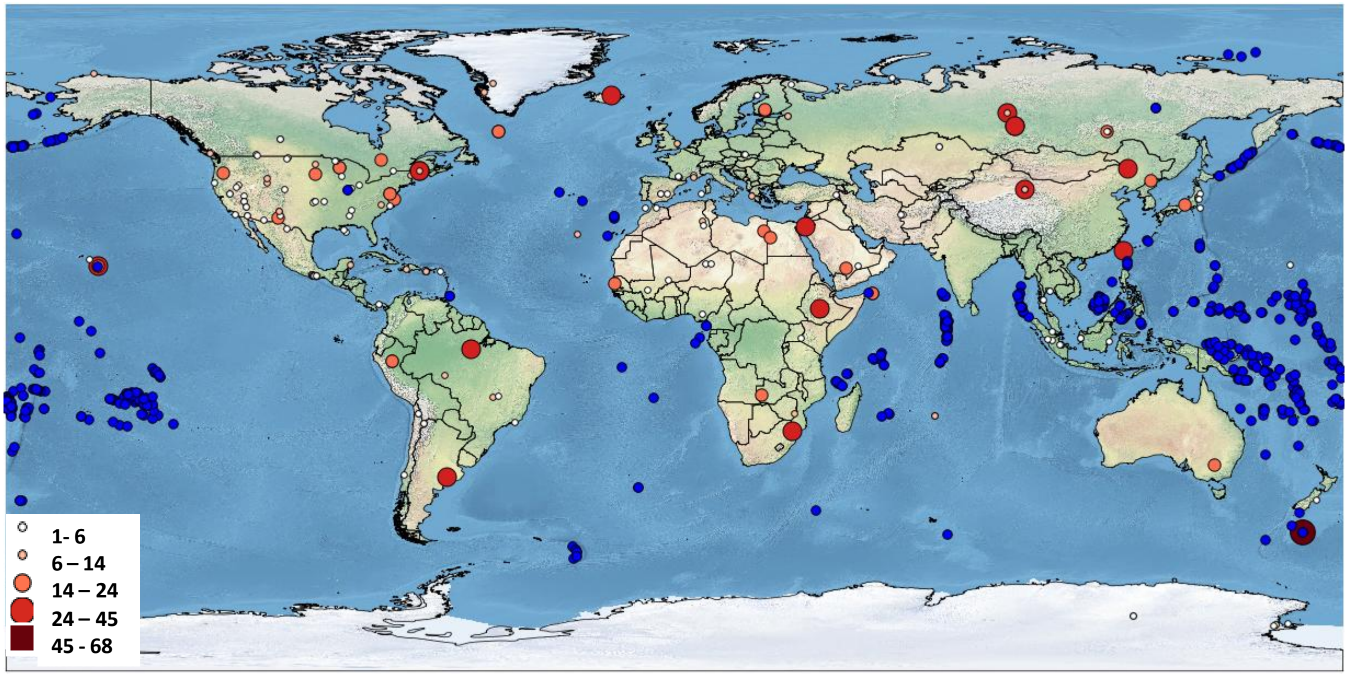
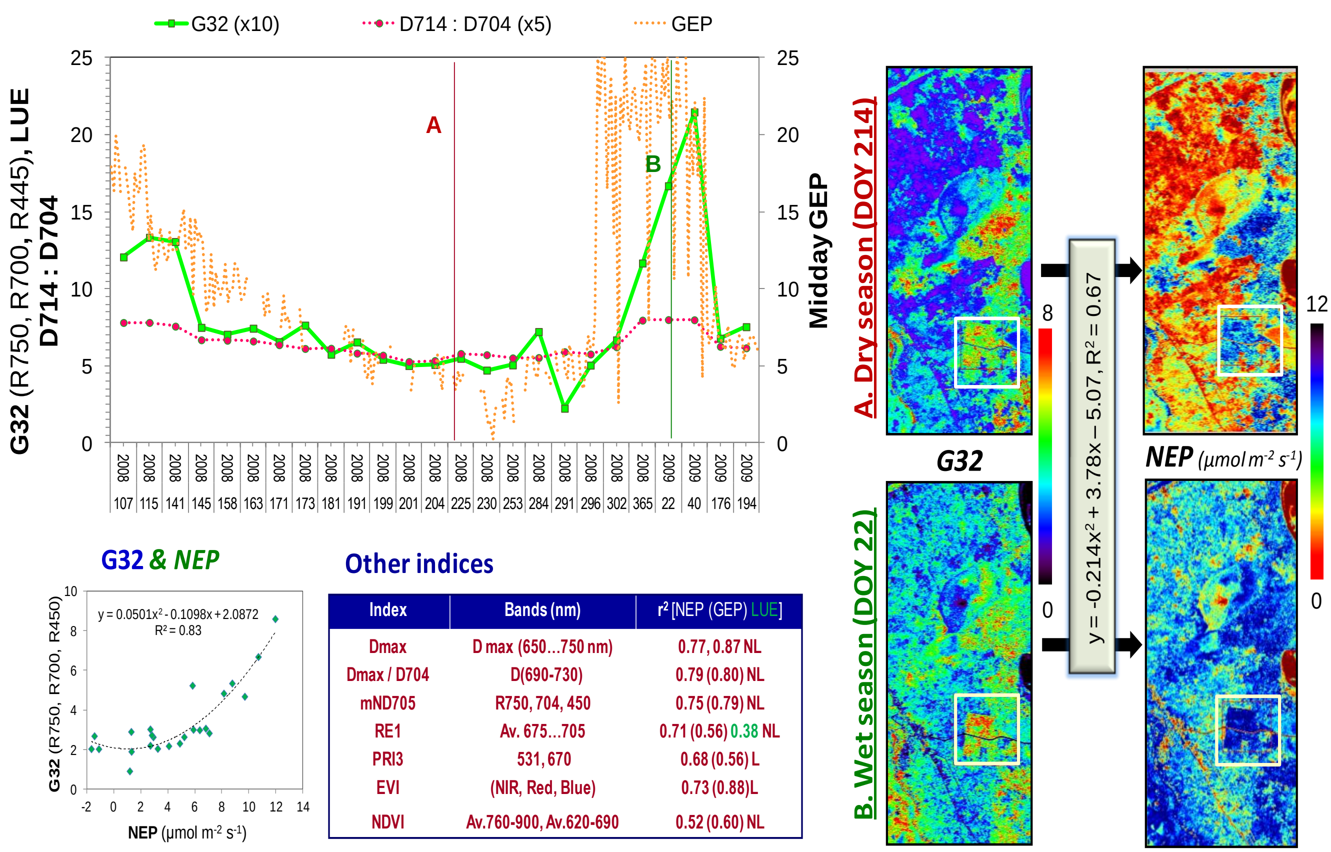


Figure 1: *EO-1 Hyperion Collections during 2011 (successful relative to requests).*



Index	Bands (nm)	r² [NEP (GEP) LUE]
Dmax	D max (650…750 nm)	0.77, 0.87 NL
Dmax / D704	D(690-730)	0.79 (0.80) NL
mND705	R750, 704, 450	0.75 (0.79) NL
RE1	Av. 675…705	0.71 (0.56) 0.38 NL
PRI3	531, 670	0.68 (0.56) L
EVI	(NIR, Red, Blue)	0.73 (0.88)L
NDVI	Av.760-900, Av.620-690	0.52 (0.60) NL

Figure 2: *Remote sensing results are shown for EO-1/Hyperion vs. mid-day CO_2 fluxes at a flux tower site in Mongu, Zambia in Africa. A spectral bio-indicator associated with chlorophyll content, G32 (using bands at 750, 700, and 445 nm), best captured the CO_2 dynamics related to ecosystem phenology over 3 years (2008-2010).*