To Facilitate the Use of HyspIRI Data

Tools for On-line Products and Analysis

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\textsuperscript{1}JCET/UMBC and \textsuperscript{2}NASA/GSFC
Level 0: Digital Numbers

Level 1: 1A - Level 0 reconstructed, time-referenced and annotated with ancillary information; 1B - TOA radiance, Cloud screened images.

Level 2: Description - Swath data. Products: surface reflectance (%), Land Surface Temperature (LST, day or night); Surface Spectral Emissivity (day or night)

Level 3: Description - Swath and Gridded data, Terrain corrected products.

Level 4: Description – Time series, Model outputs, Multi-sensor data fusion, Assimilation with other data types (e.g., ET, Fire fuel & fuel moisture)

- Regional Scale (60m-1km): For specific sites, watersheds, geographical units or global samples of ecosystems
- Global Scale (gridded, ¼-1 deg+): For modeling ecosystems/general cover categories
HyspIRI Products (Summary)

**Products**

- **VSWIR Sensor**
  - TOA radiance spectra
- **TIR Sensor**
  - TOA radiance bands
- **Combined**
  - ?

**L1A**

- Land Surface Temperature (LST)
- Swath

**L2**

- Surface Reflectance (%)
- Local/Regional

**L3**

- End-member abundance, Fractional vegetation cover
- Scene/Region, Global, Terrain corrected
- Canopy constituents (CCs, pigments, water, nitrogen)
- Land cover classifications
- Albedo
- New indicators of ecosystem function, disturbance, diversity

**L4**

- Fractional land cover, FVC, LAI, End-members, CCs
- Time series
- Data fusion
- Model outputs
- Plant functional types (PFT), LUE, GPP, NEP
- Day/night, seasonal LST & emissivity differences by LC & FVC, Damage and fire suscept.
Currently Existing Tools and Databases

- Data and sensor co-location tools
- Conversion of L1A to L2 at local to regional scale
- Cloud prediction and detection
- Download of swaths or scenes of data
- Spectral libraries for major cover types, vegetation species
- Tools for spectral analysis and assessments: propriety and non-propriety
- Tools for land cover analysis and determinations: propriety and non-propriety
Current Tools - *Examples*

- **Visualization and Image Processing of Environmental Resources (VIPER)** - Advanced Spectral Mixture Analysis (UCSB, Roberts et al.)
- **WINVICAR** (JPL, Hook et al.) – work with thermal emissivity data from ASTER, MASTER, other EOS data as well
- **Processing Routines in IDL for Spectroscopic Measurements** (PRISM, USGS, Kokaly et al.)
- **BEAM** (C. Brockman/ESA) – data management, viewing and pre-processing for Envisat, PRISM, CHRIS/Proba, AVNIR, MODIS, MERIS, etc.
- **Open Source Software Image Map (OSSIM, OSGeo)**
- **ENVI, ERDAS Imagine, PCI Geomatica, other ...**
- **EO-1 tools for tasking, data management and prototyping**
Real Time Satellite Tracking

Co-locating of HyspIRI data, co-locating with other sensors

## Earth Observing 1 (EO-1) Campaign Manager on-line Tool

### Scenario/Campaign Tasking Requests for UAV 3

<table>
<thead>
<tr>
<th>Tasking Request:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Title:</strong> California</td>
</tr>
<tr>
<td><strong>Description:</strong> California</td>
</tr>
<tr>
<td><strong>Category:</strong> 41.2</td>
</tr>
<tr>
<td><strong>Latitude:</strong> 37.123</td>
</tr>
<tr>
<td><strong>Longitude:</strong> -122.38</td>
</tr>
<tr>
<td><strong>Country Code:</strong> US</td>
</tr>
<tr>
<td><strong>Country:</strong> United States</td>
</tr>
<tr>
<td><strong>Name:</strong> United States</td>
</tr>
<tr>
<td><strong>Zone Number:</strong> 06</td>
</tr>
<tr>
<td><strong>Zone Name:</strong> Northern California</td>
</tr>
<tr>
<td><strong>Region Name:</strong> Oregon, California and Nevada</td>
</tr>
<tr>
<td><strong>Region Number:</strong> 0</td>
</tr>
<tr>
<td><strong>Admin Code:</strong> 0A</td>
</tr>
<tr>
<td><strong>Admin Name:</strong> California</td>
</tr>
<tr>
<td><strong>Nearby:</strong> Norchko, Sarqoune, Shregag (historical), Metlah, Pekwan (historical), Pecwan, Johnsons, Waseck, Wight Place, Martins Ferry (historical)</td>
</tr>
<tr>
<td><strong>Created At:</strong> Fri, 19 Sep 2008 02:32:12 -0000</td>
</tr>
<tr>
<td><strong>Updated At:</strong> 2008-09-19</td>
</tr>
</tbody>
</table>

### Map Data

![Map Data](image)

**Tasking Request:**

- **Title:** California
- **Description:** California
- **Category:** 41.2
- **Latitude:** 37.123
- **Longitude:** -122.38
- **Country Code:** US
- **Country:** United States
- **Name:** United States
- **Zone Number:** 06
- **Zone Name:** Northern California
- **Region Name:** Oregon, California and Nevada
- **Region Number:** 0
- **Admin Code:** 0A
- **Admin Name:** California
- **Nearby:** Norchko, Sarqoune, Shregag (historical), Metlah, Pekwan (historical), Pecwan, Johnsons, Waseck, Wight Place, Martins Ferry (historical)
- **Created At:** Fri, 19 Sep 2008 02:32:12 -0000
- **Updated At:** 2008-09-19

**Feasibilities:**

- **Zone Number:** 06
- **Zone Name:** Northern California
- **Region Number:** 0
- **Region Name:** Oregon, California and Nevada
- **Admin Code:** 0A
- **Admin Name:** California
- **Nearby:** Norchko, Sarqoune, Shregag (historical), Metlah, Pekwan (historical), Pecwan, Johnsons, Waseck, Wight Place, Martins Ferry (historical)
- **Created At:** Fri, 19 Sep 2008 02:32:12 -0000
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**Map Data**

[Map data](image) ©2008 Europa Technologies - Terms of Use

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http://geobpms.geobliki.com/
Cloud Prediction, utilizing historic data and weather satellites

Landsat 7 Lowest cloud level for acquisitions during the first year

International Satellite Cloud Climatology Project (Rossow et al. 1989)

Hyperion Cloud Cover (HCC)

<table>
<thead>
<tr>
<th>Band (µm)</th>
<th>Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.55</td>
<td>Snow/ice/cloud test</td>
</tr>
<tr>
<td>0.66</td>
<td>Red reflectance test</td>
</tr>
<tr>
<td></td>
<td>Vegetation ratio test</td>
</tr>
<tr>
<td>0.86</td>
<td>Desert/sand test</td>
</tr>
<tr>
<td>1.25</td>
<td>Snow/ice/cloud test</td>
</tr>
<tr>
<td></td>
<td>Desert/sand test</td>
</tr>
<tr>
<td>1.38</td>
<td>High cloud test</td>
</tr>
<tr>
<td></td>
<td>Ice/low cloud test</td>
</tr>
<tr>
<td>1.65</td>
<td>Snow/ice/cloud test</td>
</tr>
<tr>
<td></td>
<td>Desert/sand test</td>
</tr>
</tbody>
</table>

Mandl, Griffin et al. 2003
EO-1 SensorWebs serve as a Pathfinder for Event Assessments and Enabling of Rapid Response Remote Sensing

First responder

Region of Interest (ROI)


Workflow Engine

Data Processing Node

SensorML

Capabilities

Documents

Web Coordinate Transformation Service (WCTS)

Web Processing Service (WPS)

Web Coverage Service (WCS)

RSAC

Ingest Sensor Data Node

UAV Sensor Data Node

EOI Satellite

SensorML

Capabilities

Documents

Web Feature Service (WFS)

Sensor Planning Service (SPS)

Sensor Alert Service (SAS)

Sensor Observation Service (SOS)

Satellite Data Node
The U.S. Geological Survey is dedicated to providing extensive data to the global science community. However, certain data sets require additional procedures to gain access to them. Commercial satellite scenes of U.S. sites are licensed only for U.S. users. Please log in to find what additional data sets may be available.

1. Select your dataset(s)

- Aerial Photography
- AVHRR
- Gal/Val Reference Sites
- Commercial
- Declassified Data
- Digital Elevation (Related Links)
- Digital Line (Graphs (Related Links)
- Digital Maps (Related Links)
- EO-1
  - EO-1 Ancillary
  - EO-1 Hyperion
- Forest Carbon Sites
- Global Land Survey
- Landsat Archive (Related Links)
  - L7 SLC-off (2003–present)
  - L8 TM
  - L8 MSS
  - L7 Int'l Ground Stations (Search Only)
- Landsat Legacy
- Landsat MLCR

Selected Datasets
- EO-1 Ancillary
- EO-1 Hyperion

Display Tooltips

Help

2. Enter your search criteria

Address/Place Name:
Zip Code Search:

From (mm/dd/yyyy): 01/01/1990 TO (mm/dd/yyyy): 12/31/2020

Search

Options:
- Search these months only.

Area Selected

- Degree/Minute/Second
  - North
  - West

Number of Results

Find the first 10 records

(Note: Results will contain this number of records for each individual data set selected.)
Tools to Download Regions of Interest

- Calibration sites
- EOS Product Validation sites
- Observations Networks
- Regional and local applications
Tools and Prototype Reflectance Product Algorithms
albedo; fAPAR; LAI; spectrum derivatives; chlorophyll, N, water content.....

EO-1 Toolkit
http://eo1.geobliki.com/

GeoBliki EO1
Sensor Web Enabled (SWE) Data Node

Sensor Tasking
- Current Schedule
- NASA EO-1
- My Tasks
- All Tasks

GeoTools
- Atmospheric Correction

Atmospheric Correction Server

EO-1 Product Prototypes

Reflectance (%)
Wavelength (nm)

RGB Color Composite Bands 752, 609, 508 nm
1 km
30 m

reflectance
water
corn
forest
Developing Higher level EO-1 Hyperion Science Products

<table>
<thead>
<tr>
<th>Pixel size</th>
<th>Vegetation Indices*</th>
<th>Albedo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>V1</td>
<td>PRI</td>
</tr>
<tr>
<td>30 m</td>
<td>1.81</td>
<td>-0.14</td>
</tr>
<tr>
<td>60 m</td>
<td>1.88</td>
<td>-0.15</td>
</tr>
</tbody>
</table>

* Reported means, no statistically significant differences established

- Enabling conventional users to conduct their own assessments, using software such as ENVI (Agricultural stress and Red edge Greenbelt, MD)
Hyperion fractional end-member abundance results presented as color images: (b) clear-water; (c) DOM; (d) phytoplankton; (e) SIM; (f) RMS error.

Townsend et al. 2003

Plot N 2.02 – 3.17%
Leaf N 1.23 – 4.12%

AVIRIS

10/23/07
EO-1 Hyperion Witch Wildfire

Fuel moisture, NDWI

AVIRIS

Roberts et al.
**Time Series for CEOS Cal/Val Sites**

**Temporal variation in spectral characteristics**

<table>
<thead>
<tr>
<th>Year</th>
<th>Jul. day</th>
<th>ρ (%) (mean and standard deviations)</th>
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<tbody>
<tr>
<td>2003</td>
<td>68</td>
<td>0</td>
</tr>
<tr>
<td>2002</td>
<td>81</td>
<td>-5</td>
</tr>
<tr>
<td>2003</td>
<td>148</td>
<td>10</td>
</tr>
<tr>
<td>2005</td>
<td>169</td>
<td>15</td>
</tr>
<tr>
<td>2003</td>
<td>180</td>
<td>20</td>
</tr>
<tr>
<td>2003</td>
<td>244</td>
<td>25</td>
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</tbody>
</table>

**Reflectance differences**

<table>
<thead>
<tr>
<th>Acquisition (Julian day)</th>
<th>ρ - mean(ρ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>68</td>
<td>-1</td>
</tr>
<tr>
<td>81</td>
<td>-0.5</td>
</tr>
<tr>
<td>148</td>
<td>0</td>
</tr>
<tr>
<td>169</td>
<td>0.5</td>
</tr>
<tr>
<td>180</td>
<td>+1</td>
</tr>
<tr>
<td>244</td>
<td>-2</td>
</tr>
</tbody>
</table>

Example from Ivanpah playa: Natural color composite (RGB: 651, 549, 447), Getis Gi* statistics (band 549), Reflectance Mean and Standard Deviation.
Seasonal Dynamics of Major Land Cover Types, USDA ARC, Greenbelt, MD

<table>
<thead>
<tr>
<th>Cover Type</th>
<th>Hyperion, 2008</th>
<th>V1</th>
<th>PRI</th>
<th>REIP</th>
<th>Dmax</th>
<th>WBI</th>
<th>Albedo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>13-Jun</td>
<td>1.03</td>
<td>-0.04</td>
<td>712</td>
<td>0.36</td>
<td>0.96</td>
<td>0.461</td>
</tr>
<tr>
<td></td>
<td>18-Aug</td>
<td>1.81</td>
<td>-0.06</td>
<td>722</td>
<td>0.75</td>
<td>1.09</td>
<td>0.197</td>
</tr>
<tr>
<td></td>
<td>3-Oct</td>
<td>1.15</td>
<td>0.04</td>
<td>721</td>
<td>0.51</td>
<td>0.98</td>
<td>0.155</td>
</tr>
<tr>
<td>Forest</td>
<td>13-Jun</td>
<td>1.12</td>
<td>-0.06</td>
<td>712</td>
<td>0.89</td>
<td>1.00</td>
<td>0.257</td>
</tr>
<tr>
<td></td>
<td>18-Aug</td>
<td>1.56</td>
<td>-0.03</td>
<td>722</td>
<td>0.51</td>
<td>1.01</td>
<td>0.140</td>
</tr>
<tr>
<td></td>
<td>3-Oct</td>
<td>1.61</td>
<td>-0.10</td>
<td>712</td>
<td>0.42</td>
<td>0.94</td>
<td>0.127</td>
</tr>
<tr>
<td>Water</td>
<td>13-Jun</td>
<td>0.15</td>
<td>0.01</td>
<td>712</td>
<td>0.16</td>
<td>1.23</td>
<td>0.058</td>
</tr>
<tr>
<td></td>
<td>18-Aug</td>
<td>0.52</td>
<td>0.02</td>
<td>712</td>
<td>0.10</td>
<td>1.46</td>
<td>0.031</td>
</tr>
</tbody>
</table>
|            | 3-Oct         | 0.62| -0.07| 712  | 0.08 | 0.93| 0.036  

Bright Target

\[ r^2 = 0.94 \]
Calibration and Validation Tools

Goal: Uncertainty assessment of high spectral and spatial resolution products, Confirmation/validation of high temporal resolution multi-spectral GLCPs and trends

Calibration & Validation of HyspIRI products to field/tower data

Simulation of Data and Products from Other Sensors

Multi-Spectral
- AVHRR
- Landsat
- MODIS
- VIIRS

High Spectral Res.
- EnMAP, DLR
- PRISMA, ASI
- CHRIS - Proba

High temporal res. & Historic Data and Model Outputs

Correlate
Provide Context

After CEOS WGCV/LPV (LCP Simulation and inter-comparison, Morrisette et al. 2006; and Shunlin Liang, UMD)
Tools/Products to be Developed

• Tools combining the use of TIR and High Spectral Resolution Data
• Different tools for local & regional and for continental & global scale L1A to L2, analysis and detection
• Work with time series - download of composites at regions of interest, on-line evaluation of spectra at ROI
• Change Event Delineation and Characterization - incl. clouds, fires, volcanoes, water properties
• Cal/Val tools – at select sites time series collection, simulation of other sensors, simulation of global products
• Spectral database/libraries for major FLC, FVC and PFT types
WE NEED YOUR INPUT!

Petya.Campbell@nasa.gov