Continuity of the Web Enabled Landsat Data (WELD) Product Record in the LDCM Era

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MODIS Land Products

**Energy Balance Product Suite**
- Surface Reflectance
- Land Surface Temperature, Emissivity
- BRDF/Albedo
- Snow/Sea-ice Cover

**Vegetation Parameters Suite**
- Vegetation Indices
- LAI/FPAR
- GPP/NPP

**Land Cover Suite**
- Land Cover/Vegetation Dynamics
- Vegetation Continuous Fields
- Vegetation Cover Change
- Fire and Burned Area
The Science and Applications Communities want and need higher-level Landsat Products like the MODIS Land Products.

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Web-enabled Landsat data (WELD) - a consistent seamless near real time MODIS-Landsat data fusion for the terrestrial user community

Funded by NASA
NNH06ZDA001N Making Earth System data records for Use in Research Environments (MEASURES)

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$3.3 million + USGS Distribution Cost Share
5 years, Spring 2008-2013
Landsat Satellite Series
The longest Land surface observation record

WELD process 10 years of CONUS and Alaska 30m Landsat ETM+ data (in MODIS era)
Currently, WELD 30m products generated using all Landsat 7 ETM+ acquisitions in US archive with cloud cover < 80%
WELD Weekly Products

Week 28: July 8 - 14 2008
WELD Weekly Products

Week 29: July 15 - 21 2008
WELD Seasonal Products
Summer (June, July, August) 2008
WELD Seasonal Products
Fall (September, October, November)
WELD Seasonal Products
Winter (December, January, February)
WELD Seasonal Products
Spring (March, April, May) 2009
WELD Annual Products
(December 2009 - November 2010)
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Designed to be easy to use for science and applications, including development of other higher-level products.
Available Years:

**CONUS**

2003 - 2011

**Alaska**

2003 - 2011

WELD product distribution
What You See Is What You Get  from USGS EROS

http://weld.cr.usgs.gov/
9 years for CONUS and Alaska (36TB) currently online

~0.5 million files, >60TB, have been distributed to >890 users
Landsat Satellite Series
The longest Land surface observation record

WELD process 30m Landsat TM & ETM+
Global Archive
Global Long-Term Multi-Sensor Web-Enabled Landsat Data Record

Funded by NASA
NNH12ZDA001N-MEASURES

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$4.8 million + Massive USGS Distribution Cost Share
5 years, Spring 2013+
~ 2.5 million global Landsat 4, 5 and 7 acquisitions in the U.S. archive (each ~220MB)

Landsat repatriation from other space agencies may double number of scenes in the archive in the next 5 years.

- L4 TM (red): > 50,000
- L5 TM (green): > 1.2 million
- L7 ETM+ (blue): > 1.3 million
Global WELD Proof of Concept


~2.5 weeks to generate @ WELD Lab SDSU

Generated from 6,796 L1T acquisitions in USGS EROS archive with cloud cover < 40%

MODIS Land Sinusoidal Projection
NASA Earth Exchange (NEX) WELD Processing

- 9PB on-line storage, 50PB tape storage
- 512 cores readily accessible
- 180,000 total available cores

Data Repository (over 400 TB of data)
Computing (9PB, 180,000 cores)
Collaboration (over 250 members)

Pleiades
NASA's fastest supercomputer

ARC
Distributed Active Archive Centers
Global WELD prototype, Landsat 7 ETM+, 7300 May 2010 acquisitions, processed on NASA Earth Exchange (NEX) Supercomputer.
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Planned Global WELD Production on NEX
monthly 30m products, fusion of contemporaneous Landsat 4, 5, 7
6 epochs of 36 months

Landsat repatriation from other space agencies will provide more Landsat data in earlier epochs

Number of Landsat scenes in U.S. archive

Process in reverse chronological order
First products (36 months 2010 epoch) planned to be available from USGS EROS late 2013
Planned Global 30m land cover change between consecutive epochs to be generated at EROS

Grey-scale = no change
Blue/Cyan = increase in bare ground,
Red/Yellow = decrease in bare ground

Proof of Concept 5 Years of WELD driven Bare Ground Change: Dallas – Fort Worth
Also, continued WELD Production at SDSU weekly, monthly, seasonal and annual 30m products, fusion of contemporaneous Landsat 4, 5, 7 for every year back to 1984.
Landsat Satellite Series
The longest Land surface observation record

WELD process LDCM data (CONUS)
Continuity of the Web Enabled Landsat Data (WELD) 
Product Record in the LDCM Era: 
Product Data Processing, Evaluation and Distribution Strategies


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$1.1 million 
5 years, Fall 2012+
4 WELD LDCM Tasks - Investigate

1. WELD product continuity into the LDCM era
   • generation of WELD LDCM products

2. WELD LDCM product performance
   • quality assessment
   • validation
   • characterization of the consistency of the WELD TM, ETM+, LDCM product time series

3. The utility of the WELD product record to develop “higher-level” derived products
   • collaboration with Sci. Team, NASA & USGS staff, academia

1. Expansion of the WELD internet product distribution interface to support WELD LDCM products
WELD LDCM Prototyping 14 WELD 5000 x 5000 30m pixel tiles (red), that encompass Ameriflux towers (green triangles) and AERONET sites (white squares).

Screen shot of a Google Earth rendering of OGC WMS compliant 2009 CONUS annual WELD true color browse.
WELD LDCM Schedule

• Year 1
  – understand the LDCM L1T format
  – QA of the first light LDCM L1T data
  – secure the L1T data flow to SDSU
  – WELD LDCM algorithms: reflectance and brightness temperature, band saturation, NDVI

• Year 2
  – WELD LDCM algorithms: cloud masks, angular geometry computation, re-projection, resampling and tiling, compositing, radiometric/BRDF normalization
  – WELD product QA
  – make products available to the science team and affiliates for evaluation
  – refine algorithms and products as needed
WELD LDCM Schedule

• **Year 3**
  – generate one year of CONUS WELD LDCM products
  – make products and browse imagery available
  – undertake QA and any needed refinements

• **Year 4**
  – validate products
  – characterize the Landsat TM, ETM+ LDCM WELD product time series
  – generate 4+ years of 14 tiles of WELD products available for assessment of their utility for development of “higher-level” products
  – develop WELD LDCM internet distribution interface

• **Year 5**
  – assess the capability for expansion globally/institutionalization
WELD Projects Metrics of Success

• Science relevant long-term consistent 30m global WELD products 1984-2017
  – demonstrably used for climate – people - environment research

• Provision of simple, intuitive and elegant internet product distribution interface
  – high user statistics
  – copied by other agencies and other DAACs

• Operationalization
  – Integration of WELD-like capability into an operational Landsat higher-level product generation system at a Federal agency
    • near-real time Landsat monitoring/change detection capability
    • OGC or similar web compliant imagery and product distribution for burgeoning commercial sector