

RealEarth

MUG Meeting - Sep 2023

David Parker

RealEarth

Overview

- [RealEarth](#)
- Conceived as a way for scientists at SSEC to easily visualize the output of their work
- Built on open-source GIS tools to enable visualization of mixed-resolution geolocated raster and vector data (images and shapes)

RealEarth

Overview

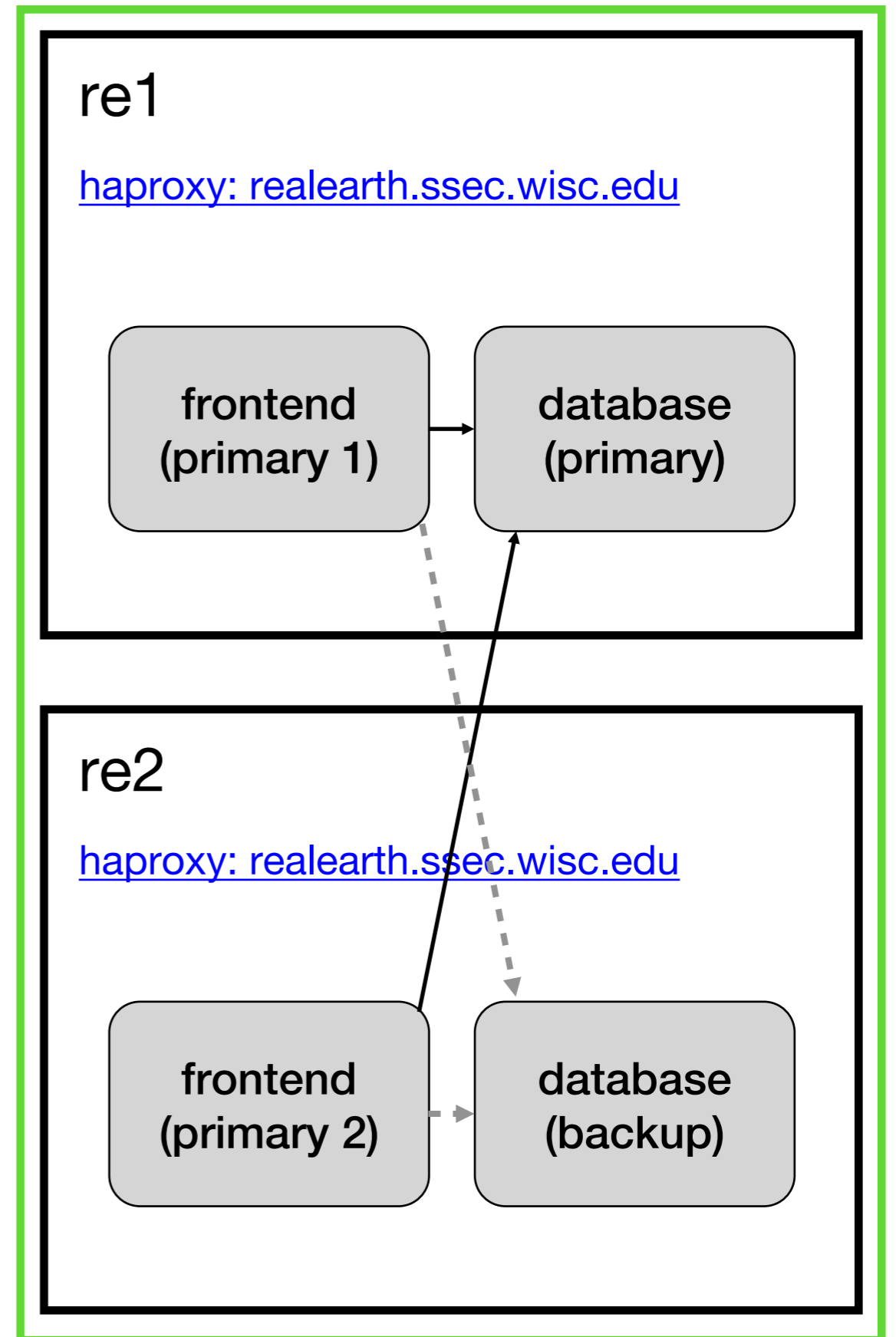
- [RealEarth](#)
- Conceived as a way for scientists at SSEC to easily visualize the output of their work
- Built on open-source GIS tools to enable visualization of mixed-resolution geolocated raster and vector data (images and shapes)
- Allows easy colocation of products in time and space
- Supports pan/zoom and animation
- Default viewer is flat Leaflet slippy map, Cesium globe view is optional, etc.
- API endpoints for easy access

RealEarth

Head Nodes

- Redundant HAProxy backends
- Expandable
- Interchangeable

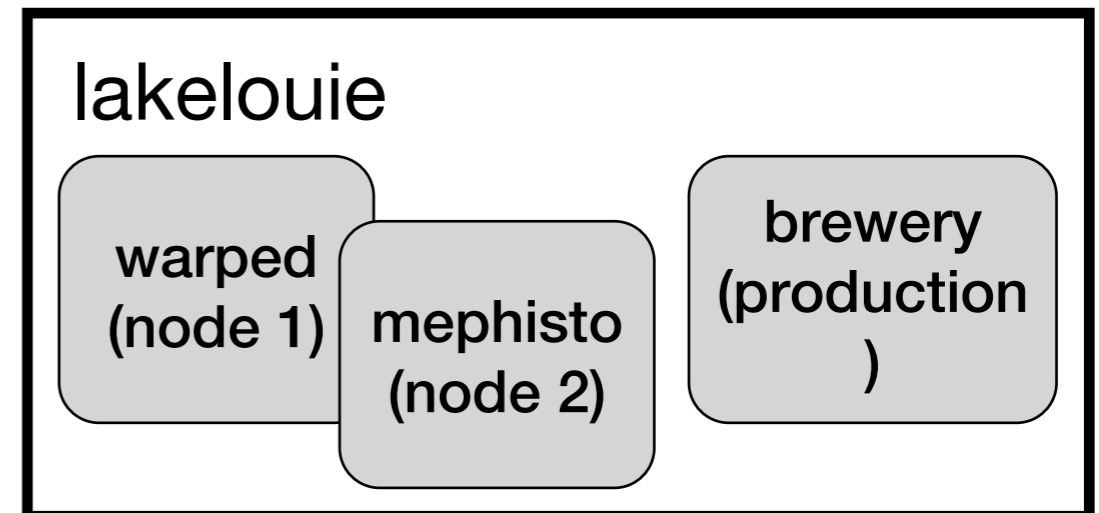
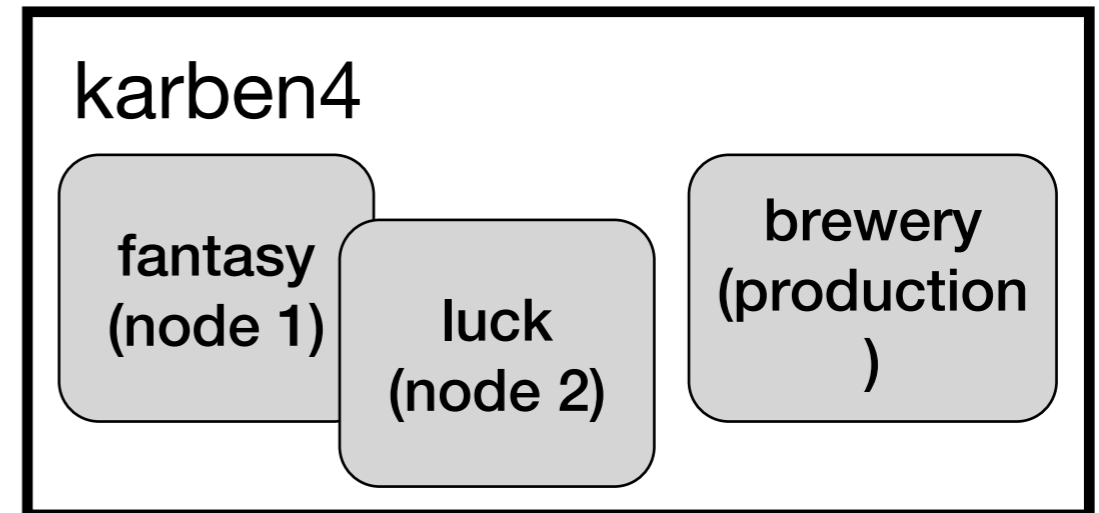
<https://realearth.ssec.wisc.edu>



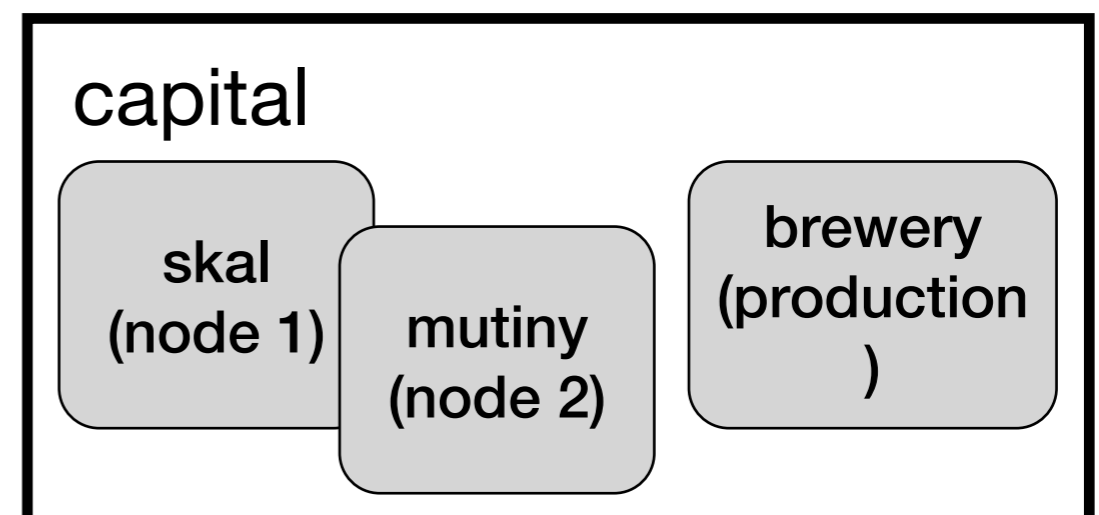
RealEarth

Data Nodes

- 15 hosts
 - 24-48 cores
 - 64-128gb memory
 - Many TBs disk
- 22 Identical VMs serving RealEarth products
 - Provisioned as necessary
- Nine product generation VMs



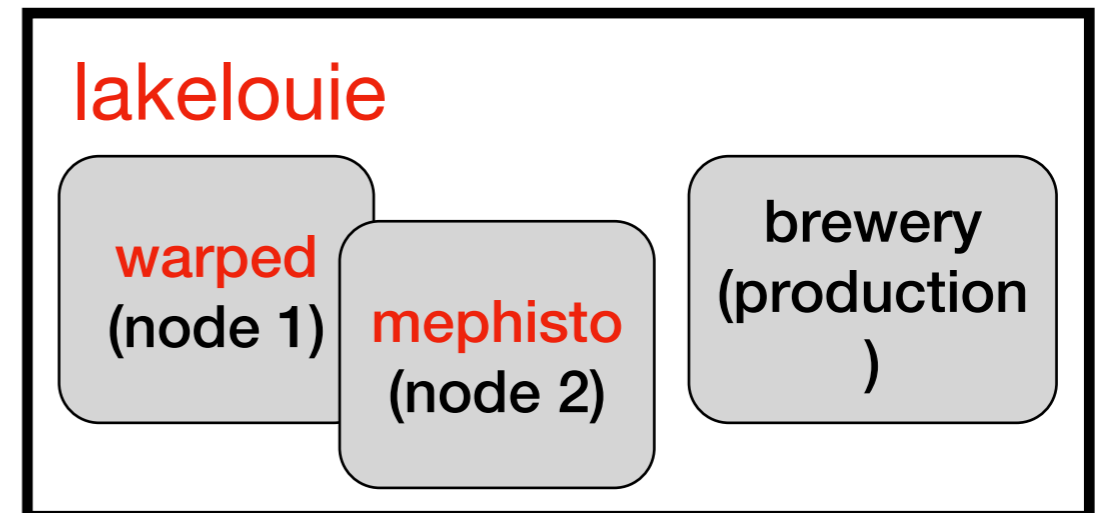
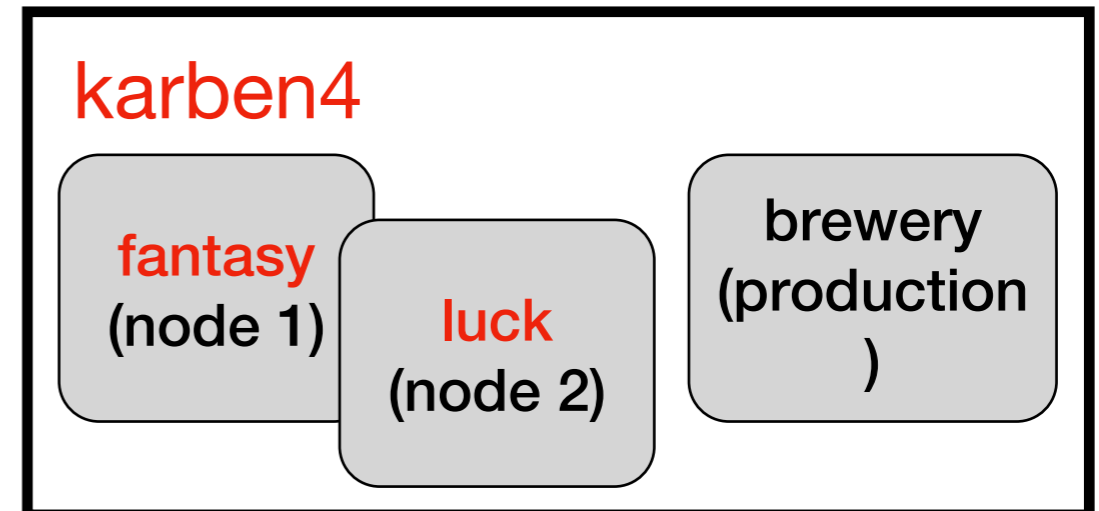
... many more...



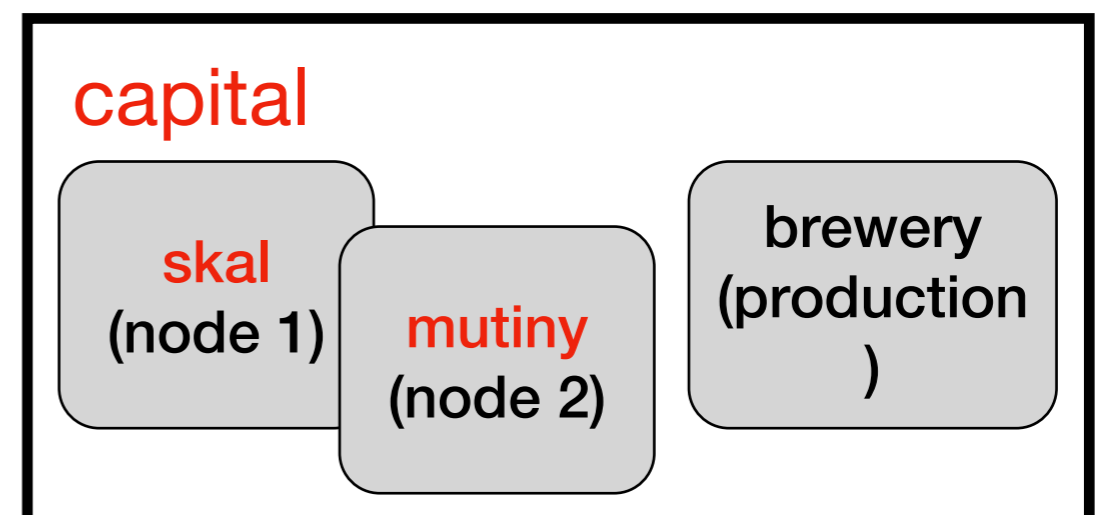
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RealEarth

Federation

User requests - Session round-robin

HAProxy

realearth.ssec.wisc.edu

re1: frontend
(primary 1)

re2: frontend
(primary 2)

SSL, sessions, cache, etc

[Grafana stats](#)

API calls

karben4

fantasy
(node 1)

luck
(node 2)

brewery
(production
)

lakelouie

warped
(node 1)

mephisto
(node 2)

brewery
(production
)

... many more...

capital

skal
(node 1)

mutiny
(node 2)

brewery
(production
)

RealEarth

Products

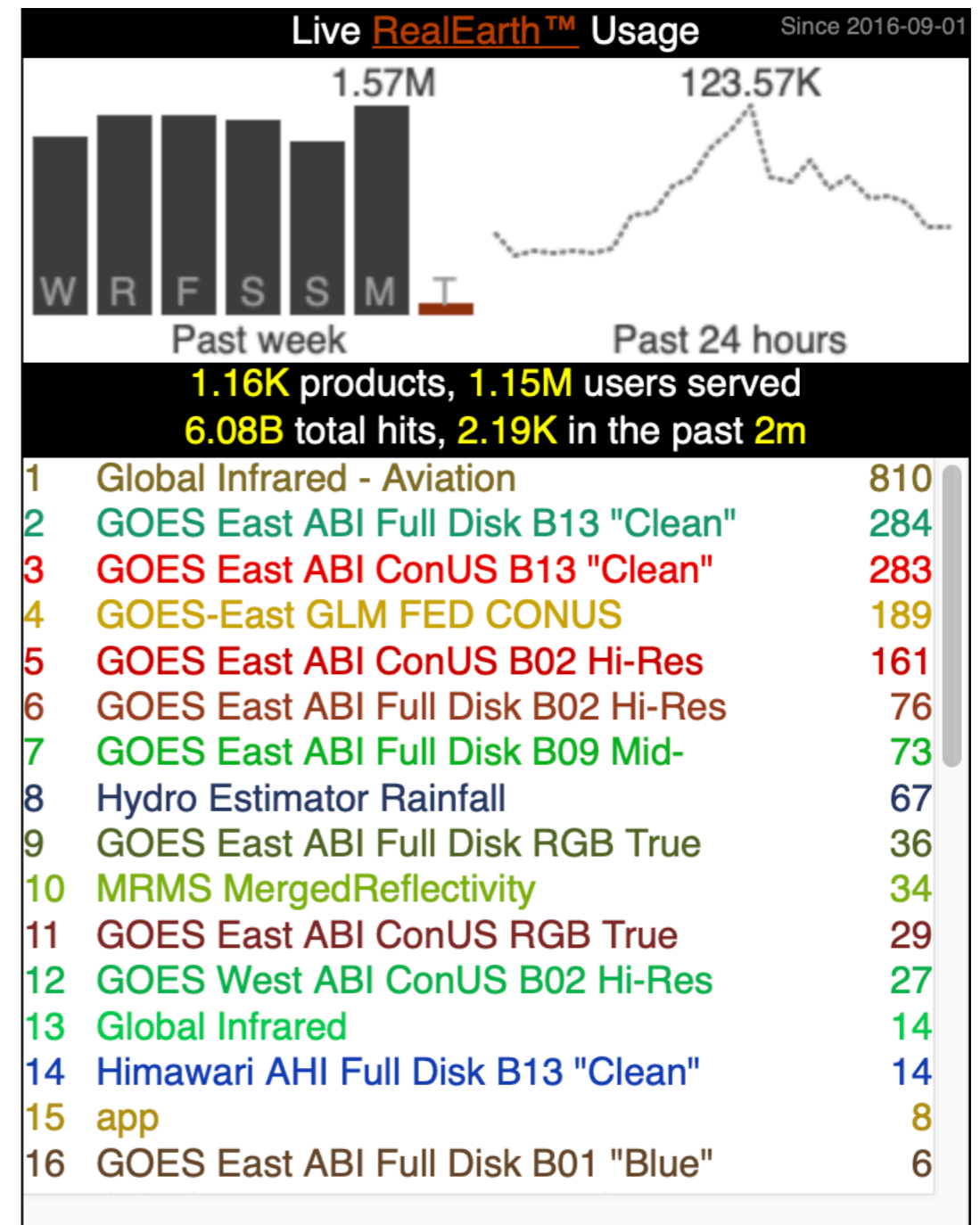
- >1,100 products
- 26 collections
- 139 categories
- [Product List](#)
- [Admin Overview](#)

```
{
  "id": "globalir",
  "dataid": "globalir",
  "duplicate": false,
  "reingest": false,
  "name": "Global Infrared",
  "description": "This product is a global composite of im",
  "owner": "",
  "url": "",
  "categories": [
    "Global"
  ],
  "order": 0,
  "orderclause": "",
  "opacity": 100,
  "type": "raster",
  "displaytype": "tile",
  "projection": "epsg:4326",
  "marker": "",
  "probe": "value",
  "units": "C",
  "maxzoom": 7,
  "seedpolicy": 6,
  "seedlatbound": 85,
  "static": false,
  "released": true,
  "status": 0,
  "optimizeflag": 0,
  "fetch": false,
  "centerproperty": null,
  "declutter": true,
  "cluster": true,
  "declutterexempt": null,
  "outputtype": "png24",
  "resample": "nearest",
  "processing": "",
  "scalemin": "0",
  "scalemax": "0",
  "minutes": "90",
  "timewindow": "0",
  "showlegend": true,
  "merge": "none",
  "mergeproducts": "",
}
```


RealEarth

Usage

- >6 billion hits
- ~1.15m unique IPs
- [Live Usage](#)
- [Admin Activity](#)



Product Creation

Breweries - Polling

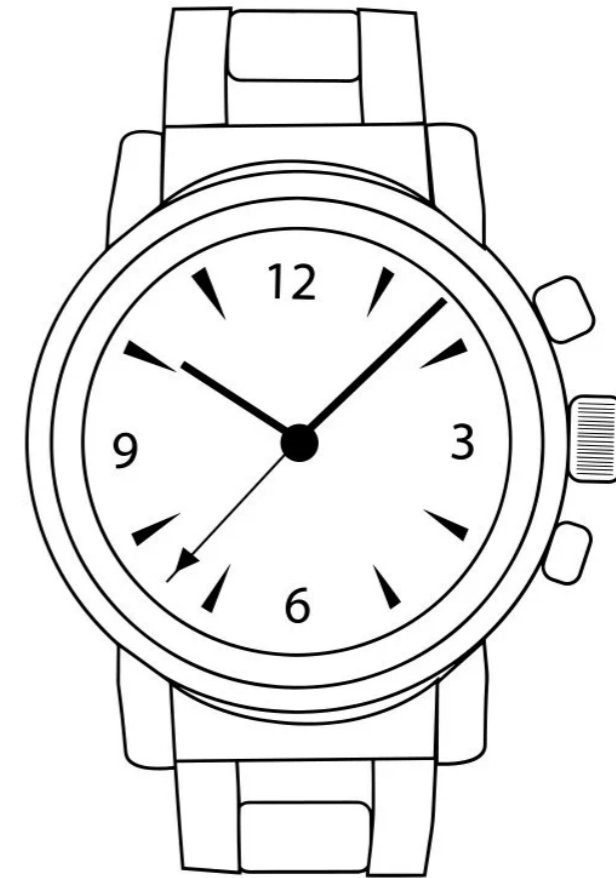
- Cron entries trigger McIDAS-X processing
- Legacy VM dating from 2009
- Russ Dengel wrote a LOT of code—including custom FORTRAN McX commands—to create product imagery from SDS holdings



Product Creation

Breweries - Polling

- Cron entries trigger McIDAS-X processing
- Legacy VM dating from 2009
- Russ Dengel wrote a LOT of code—including custom FORTRAN McX commands—to create product imagery from SDS holdings



The spirit of [PAW](#) lives on!

Product Creation

Breweries - RabbitMQ

- AMQPFind listens for new data messages
- Himawari, ABI, VIIRS
- Trigger processing on message reception
 - Pass to Python script to parse payload dictionary
 - Launch McX mcenv session to fetch and process data



Product Creation

Breweries - RabbitMQ

- AMQPFind listens for new data messages
- Himawari, ABI, VIIRS
- ~~• Trigger processing on message reception~~
- Queueing with separate process thread
 - Don't miss messages
 - Avoid saturating resources



Product Creation

Breweries - McIDAS-X



- Running on every single RealEarth VM in the federation
- Integral part of product generation for 100s of products
- Can accept AREAs as input
- GeoTIFF writer creates rasters that are ingested directly
- CSV vector data converted to GeoJSON for ingest

Product Creation

Breweries - Scrape & Fetch



- PHP and Python classes to manage remote data mirroring
 - FTP
 - HTTP(S) w/auth
 - Local directory
- Custom processing using GDAL, Python, and shell scripts

Product Creation

External Sources

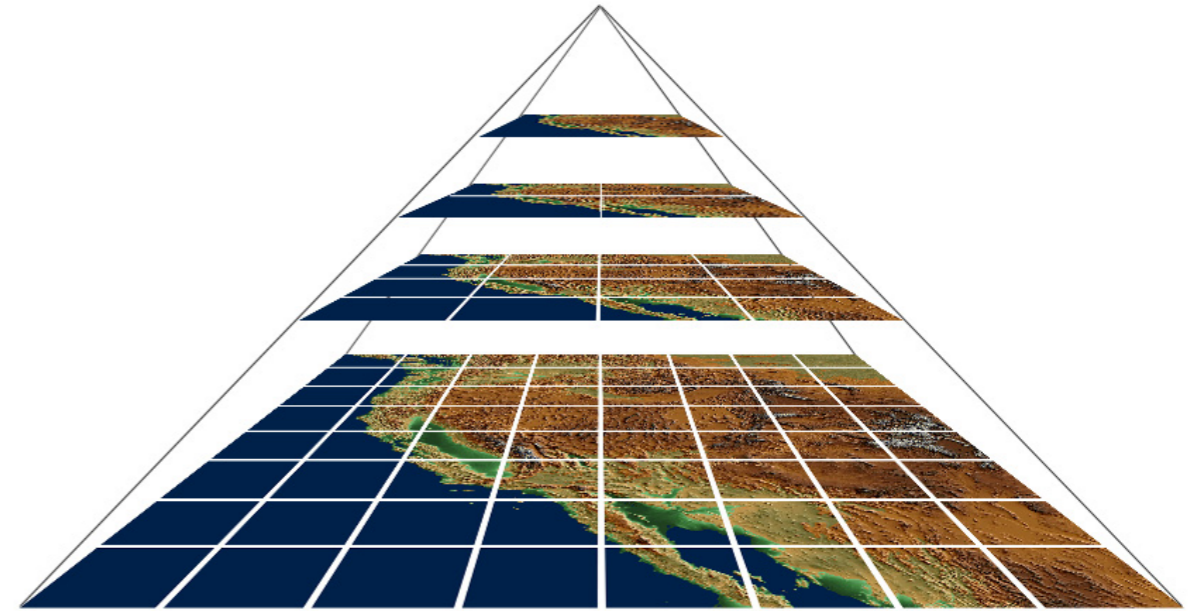


- External users can create and manage products
- 520 external users registered as product managers
- Can upload using a shell script or [web form](#)
- Happy to help anyone set up a [user account](#)

Data Ingest

Raster Imagery

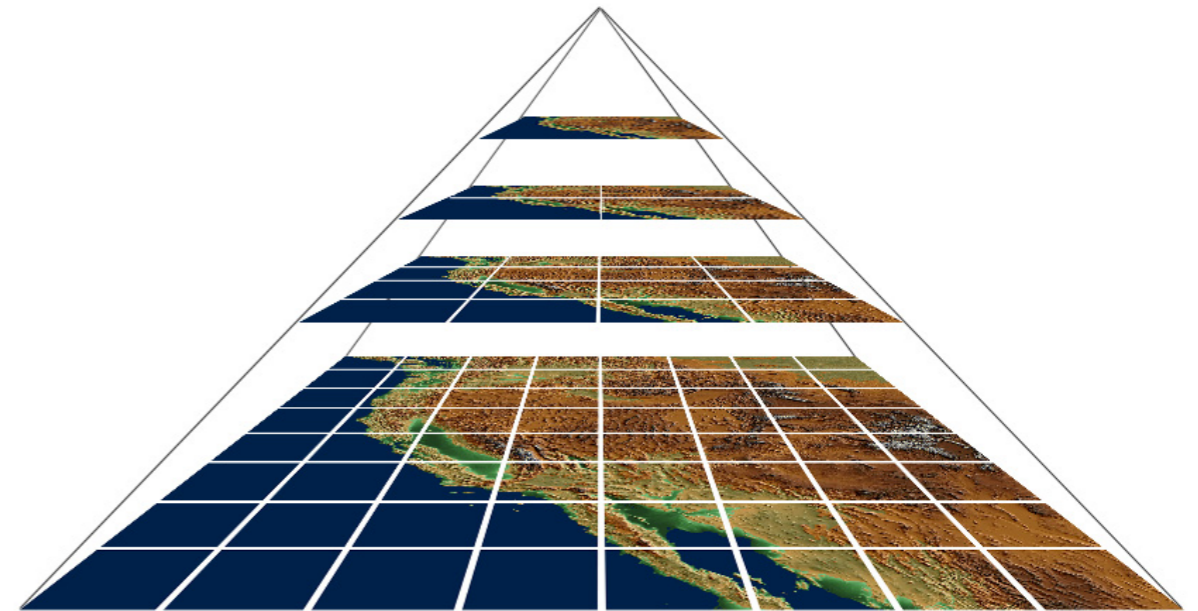
- GeoTIFF format (also COG)
- Overviews added for all zoom levels
- Tiles are optionally pre-seeded for better performance
- Multi-band, multi-byte
- Enhancements can be added to 1-byte data



Data Ingest

Raster Imagery

- GeoTIFF format (also COG)
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- **Multi-band, multi-byte**
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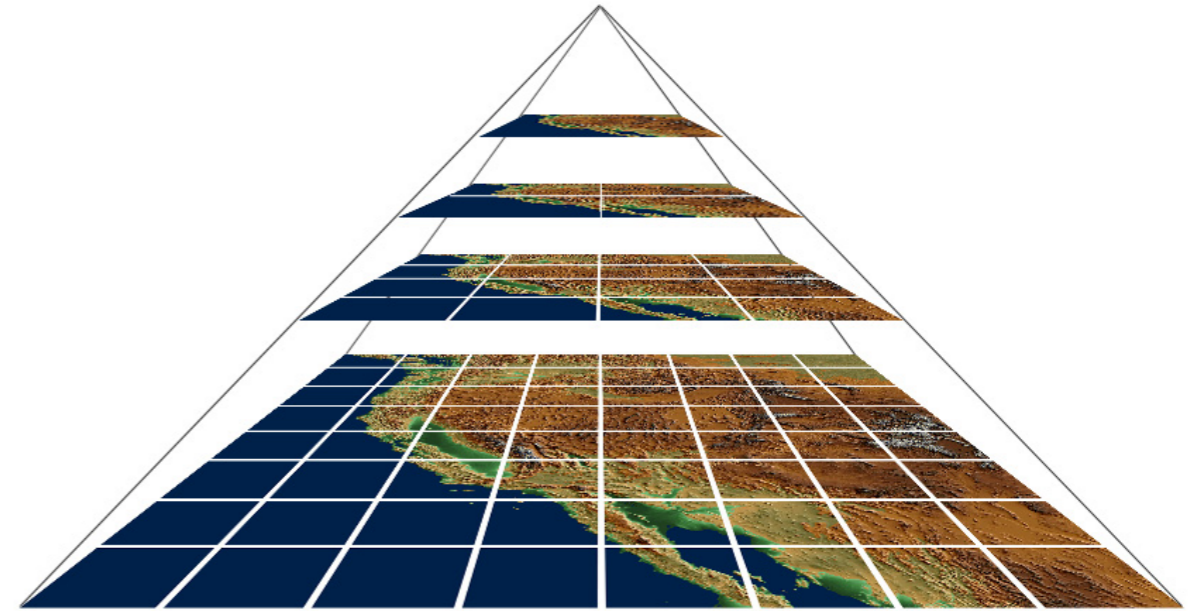


- **Band combinations**
- **Calibrated data values**

Data Ingest

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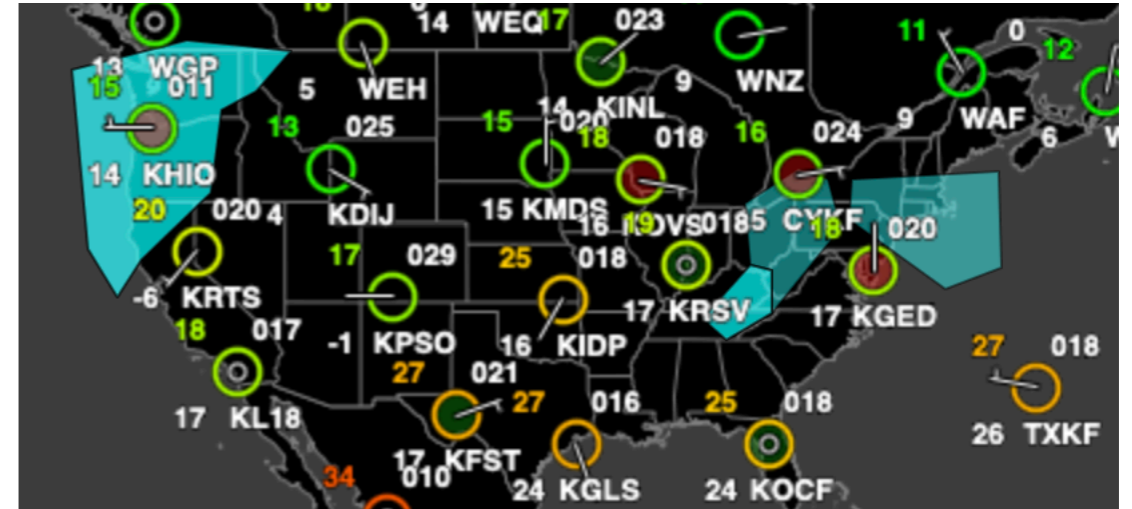


- Transparency masking
- Variable opacity
- Honor NODATA

Data Ingest

Vector Imagery

- GeoJSON format
- Can be viewed as shape objects (point, line, polygon) or rendered into tiles (raster)
- Points can be rendered using Canvas drawing techniques



Data Ingest

Time Steps

- Each time step is unique
- Data for each time step can be split and uploaded as a "part" and merged geospatially on the fly
- Time steps can be aggregated through time into a single display
- "Time" dimension was a novel idea for GIS in 2009

Data Ingest

mapserver



- <https://mapserver.org/>
- OGR-compliant web mapping server
- Speaks WMS/WMTS/WFS, etc. to GIS clients
- mapscript API for fine-grain control
- GDAL tools used for data translation and mapping

Data Ingest

mapserver



- <https://mapserver.org/>
- OGR-compliant web mapping server
- Speaks WMS/WMTS/WFS, etc. to GIS clients
- **mapscript API for time-grain control *** key feature
- GDAL tools used for data translation and mapping
- Each time step is a Layer
- Time steps are transient
- Allows aggregate sources
- Dynamic band combinations

Data Volume

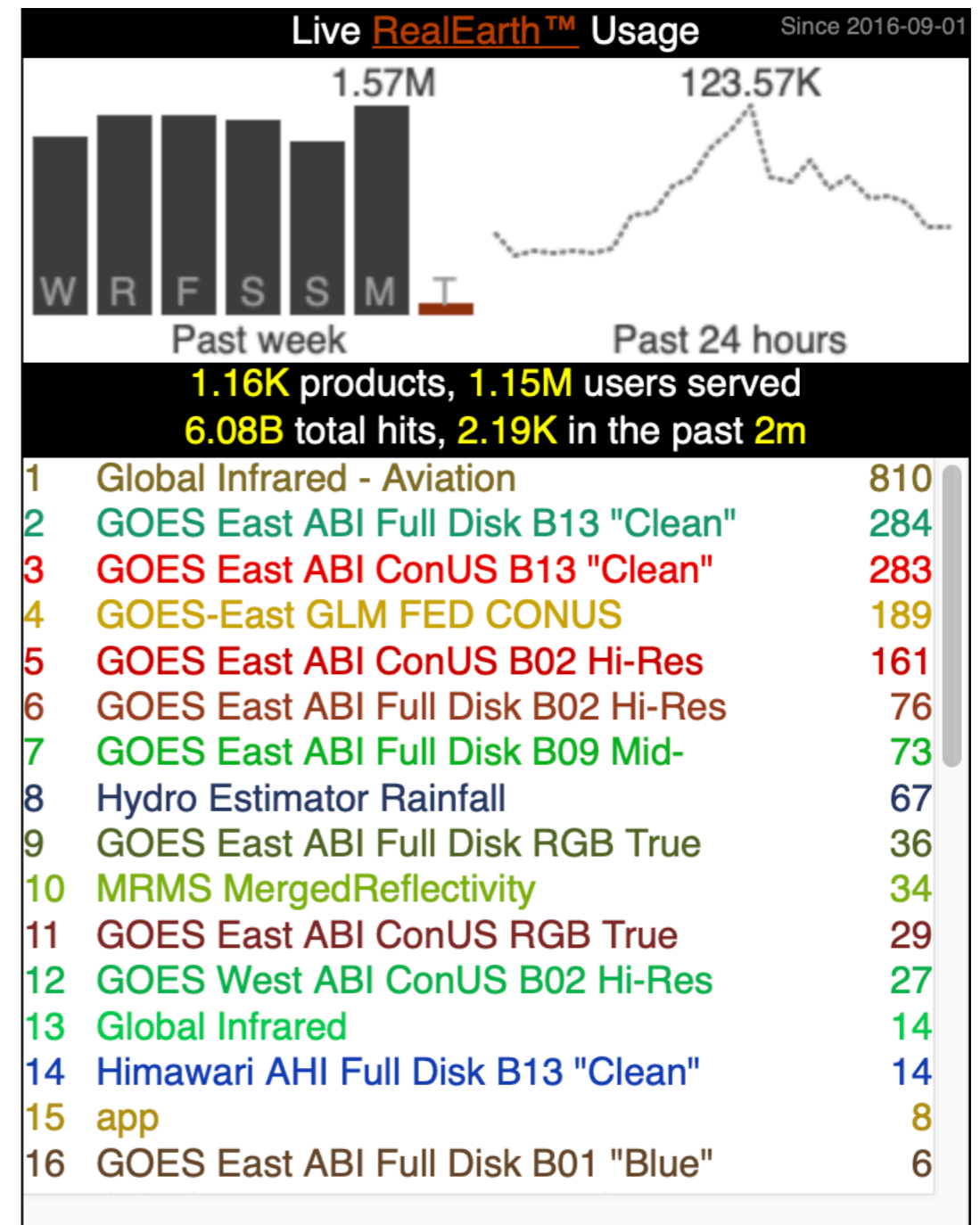
Incoming

- Tens of 1,000s of time steps per hour
 - GOES-16 alone accounts for ~4,300 individual time steps per hour
- Each product defines a data cylinder based on # of time steps or absolute time range
 - Some keep months of 1-min data

Data Volume

Outgoing

- Steady 1.5 - 2 million requests served each day
- Spikes to 3+ million during severe weather events
- Embedded and used around the world
 - Hobby websites
 - State agencies in the Americas and Asia



Project Support

Distinct uses at SSEC

- Non-federated instances of RealEarth
- Separate authentication and access

Project Support

Distinct uses at SSEC

- Non-federated instances of RealEarth
- Separate authentication and access
- Boeing
- Global flood monitoring
- Cloud product development
- GEONETCast (GNC-A)
- ProbSevere LightningCast
- MyRadar
- Fire detection

Wildfires

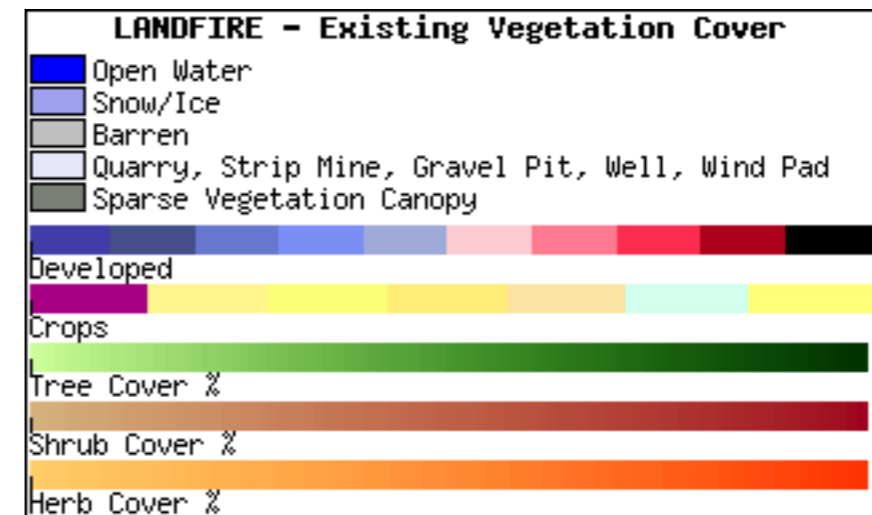
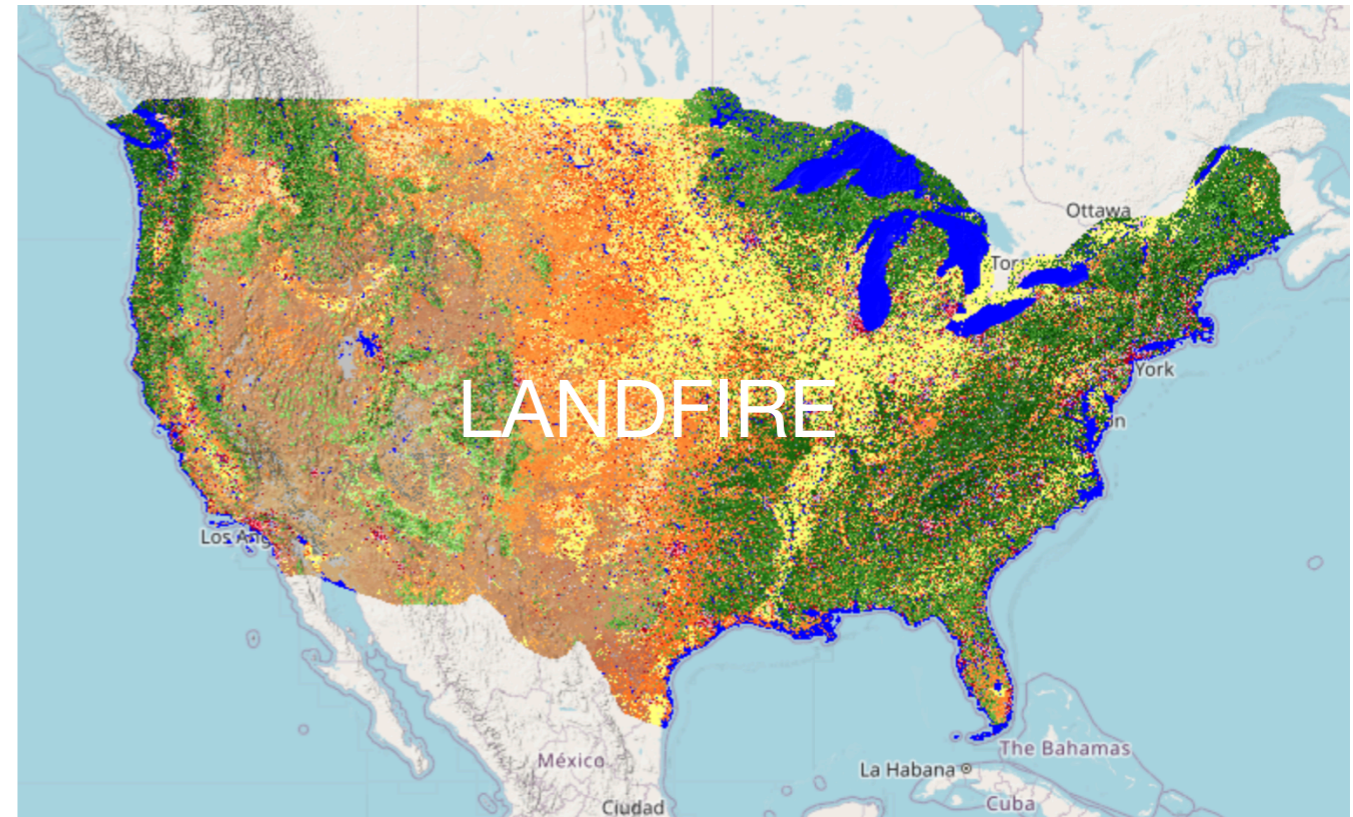
Case Study

- Integrate GIS data with satellite observations

Wildfires

Case Study

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- Land cover and fuel type



Wildfires

Case Study

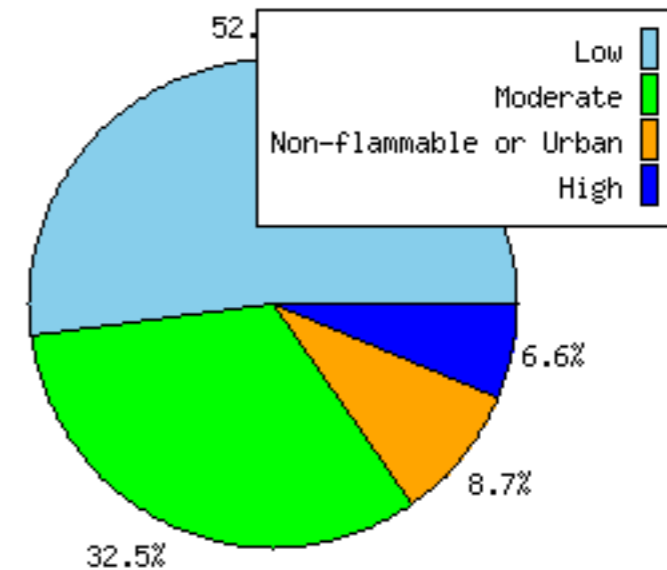
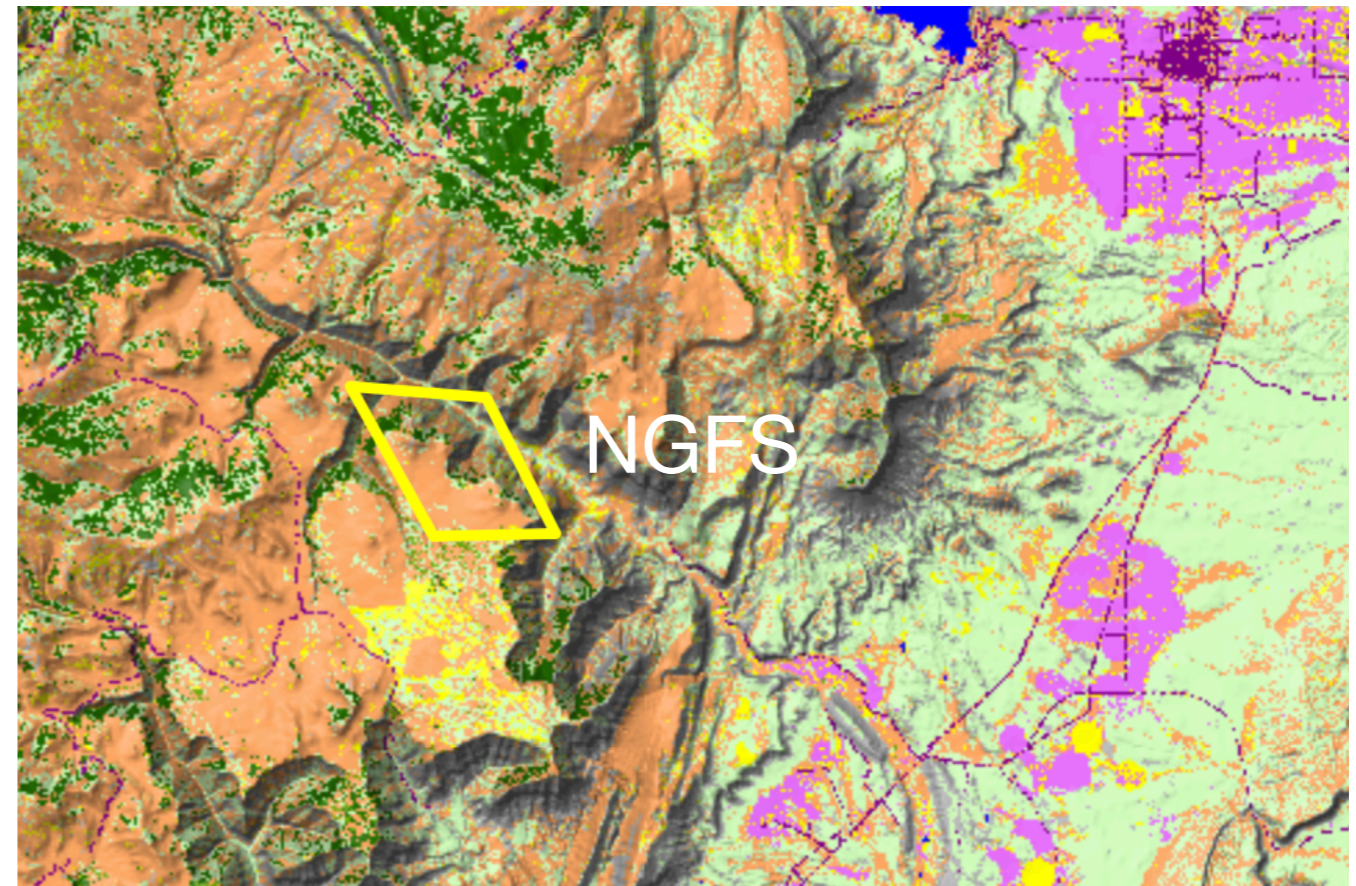
- Integrate GIS data with satellite observations
- Land cover and fuel type
- Fire perimeters



Wildfires

Case Study

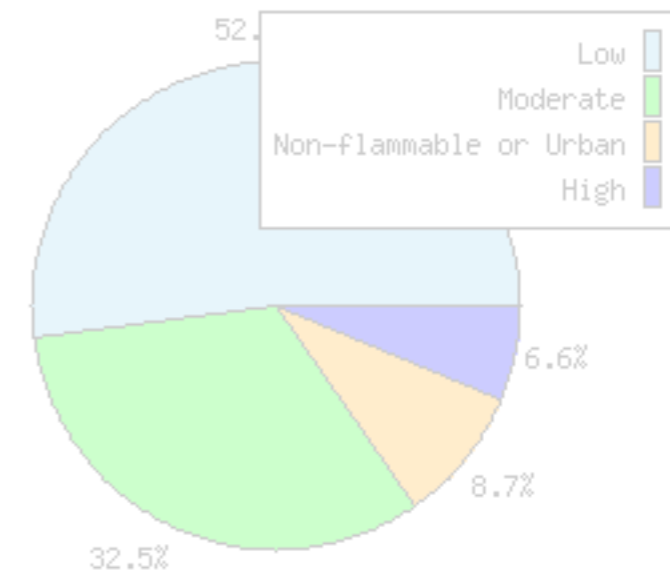
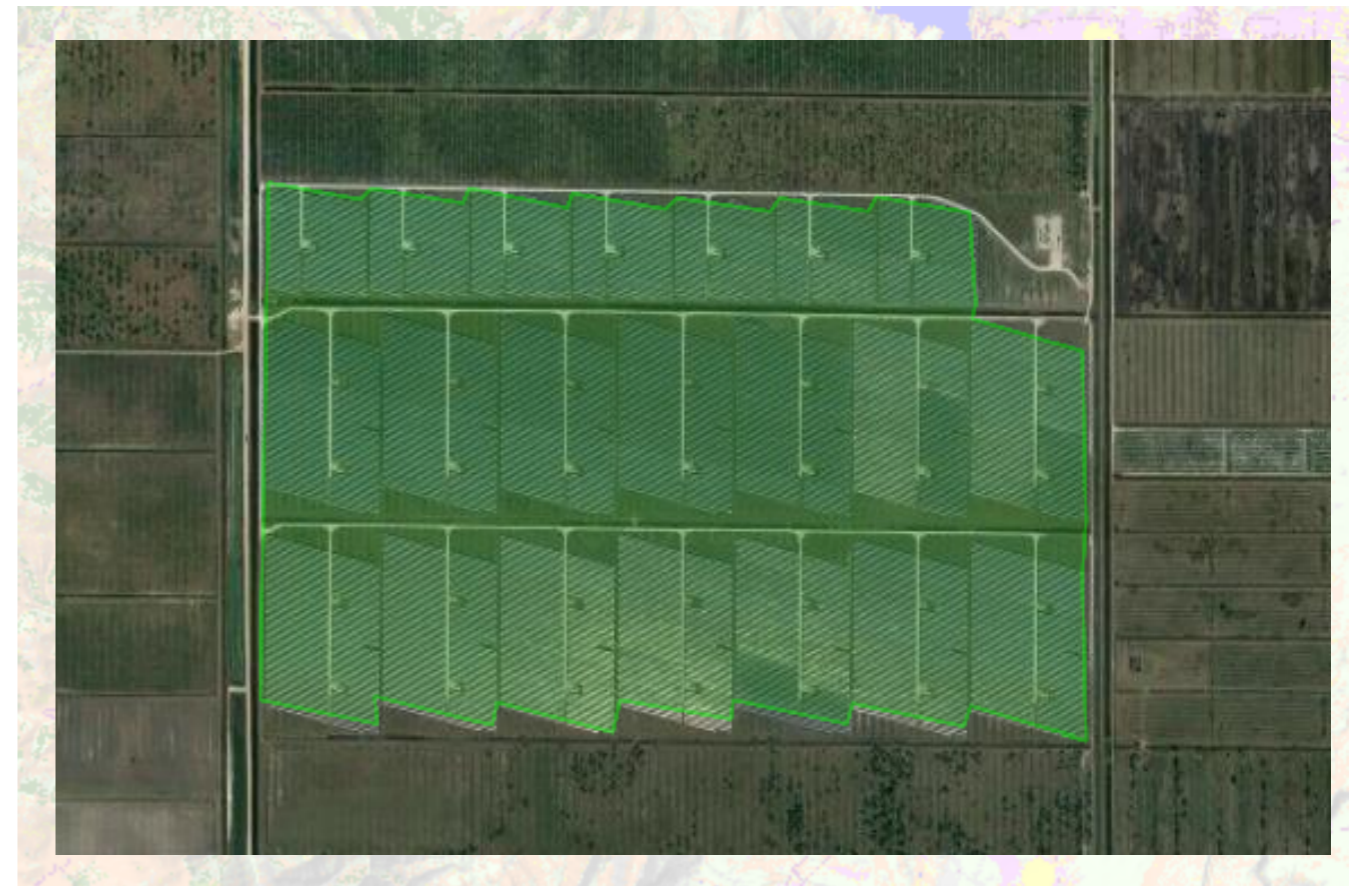
- Integrate GIS data with satellite observations
- Land cover and fuel type
- Fire perimeters
- Fire detection pixels
- Histogram of land cover and fuel types



Wildfires

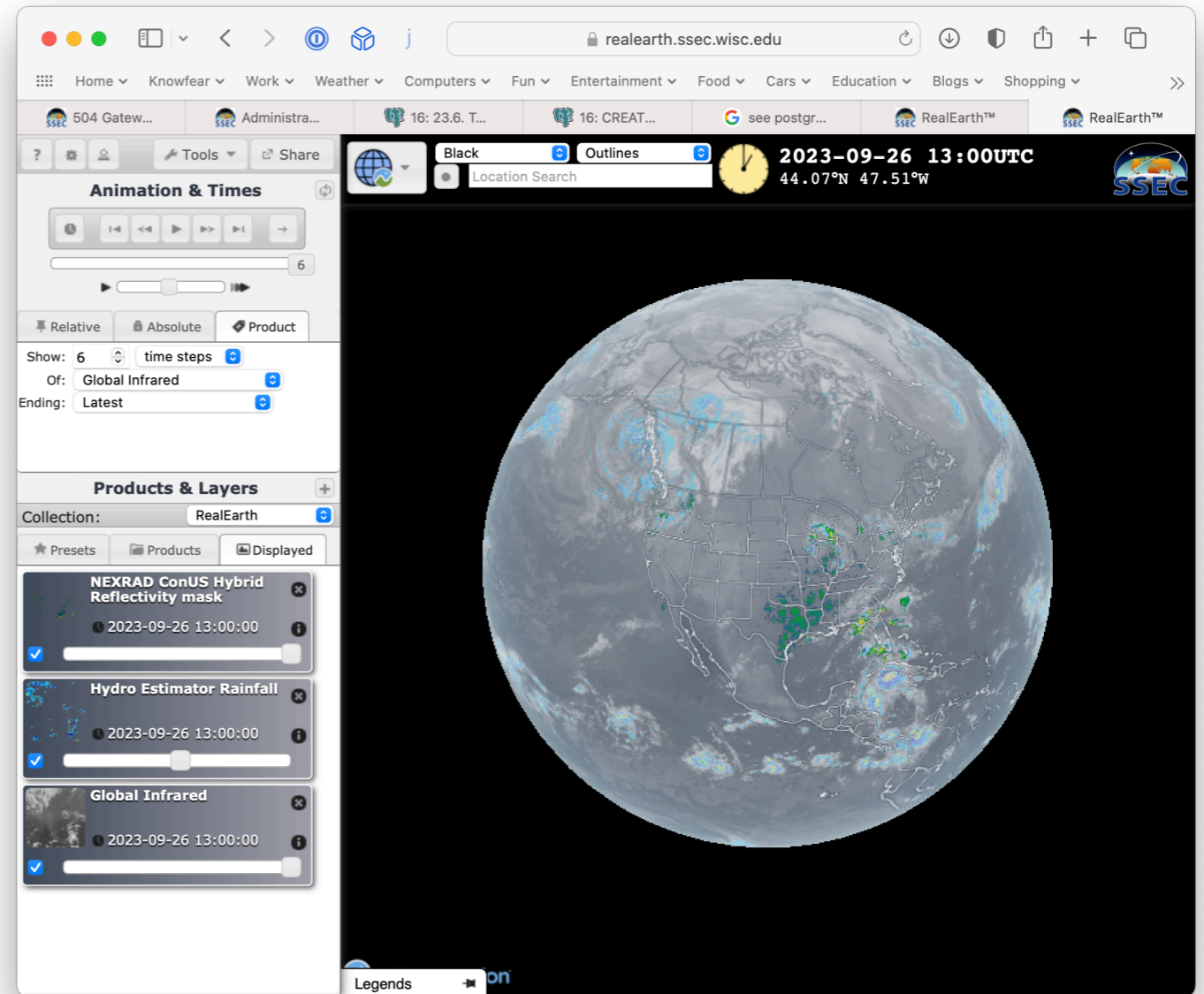
Case Study

- Integrate GIS data with satellite observations
- Land cover and fuel type
- Fire perimeters
- Fire detection pixels
- Histogram of land cover and fuel types
- [Solar farm identification](#)



RealEarth

Live Demo



- [Basic](#)
- [Globe](#)
- Basemaps, Labels, Other controls (share, draw, etc.)

- [Station models](#)
- [Probe](#) & [Feature tracking](#)
- [Parts / Time aggregation](#)