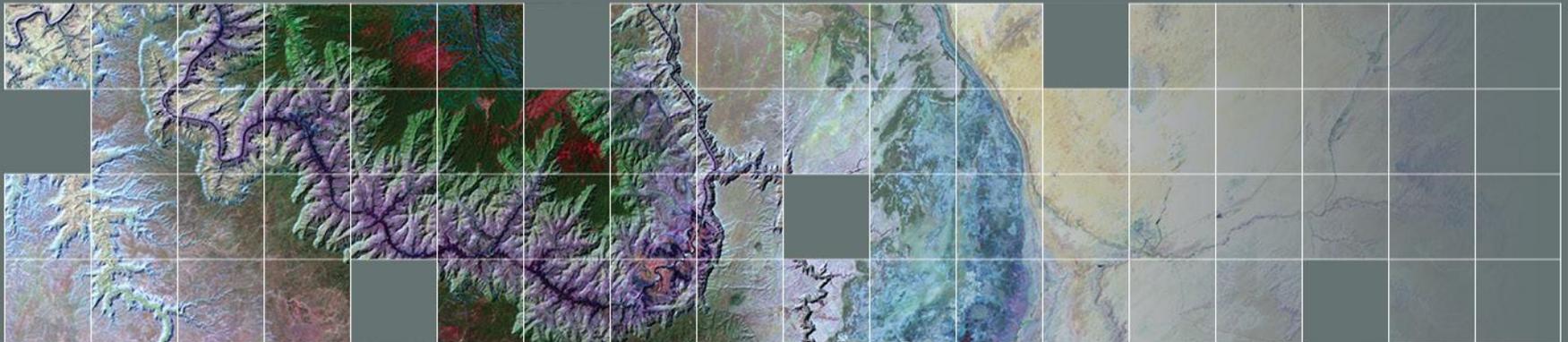


Climate and Land Use Change

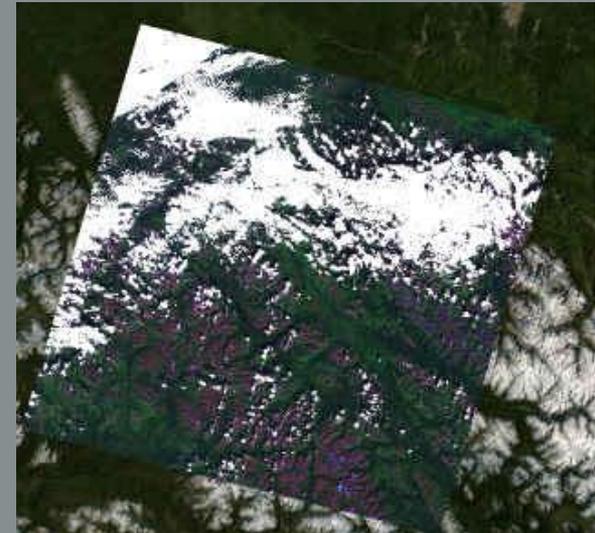
**Earth Resources Observation and Science (EROS) Center**

# Landsat Product Status



# Landsat 8 Quality Assessment Band

Bit	Flag Description	Values
0	Designated Fill	0 for image data 1 for fill data
1	Dropped Frame (Reserved)	0 for image data 1 for dropped frame
2	Terrain Occlusion	0 for normal data 1 for terrain occlusion
3	Reserved	Reserved for a future 1-bit class artifact designation
4-5	Water confidence	00 = None or Unset 01 = 0-35% confidence the pixel is water 10 = 36-64% confidence the pixel is water 11 = 65-100% confidence the pixel is water
6-7	Reserved	Reserved for a future 2-bit class artifact designation
8-9	Vegetation confidence (Reserved)	Same as water confidence
10-11	Snow/Ice confidence	Same as water confidence
12-13	Cirrus confidence	Same as water confidence
14-15	Cloud confidence	Same as water confidence



Browse image with Cloud Mask

### Confidence Levels

00 = none or unset  
 01 = 0-33% confidence  
 10 = 34-66% confidence  
 11 = 67-100% confidence

### At-launch

16-bit QB rolls off of the Online Cache with the L1 Product  
 8-bit QB available with the Full Resolution Browse

<http://landsat.usgs.gov/L8QualityAssessmentBand.php>



# Status of QA Band Validations

QA Bit	Flag Description	See5 CCA	ACCA	AT-ACCA	Cirrus	CFMask
0	Designated Fill					
1	Dropped Frame					
2	Terrain Occlusion					
3	<i>Reserved</i>					
4-5	Water		★	✓		✓
6-7	<i>Reserved (Cloud Shadow)</i>					✓
8-9	<i>Reserved (Vegetation)</i>					
10-11	Snow/Ice		★	✓		✓
12-13	Cirrus	✓			★	
14-15	Cloud	★	✓	✓		✓

- ✓ Capable of filling this QA flag, but not currently used.
- ★ Currently used in L8 Products for this QA flag.

Scene Artifacts (no validation necessary)

No Validation Performed

Cloud validation performed on 20 Landsat 8 scenes and 103 Landsat 7

Cirrus validation performed on 22 Hyperion scenes



# Landsat 8 CCA Validation Results

Tested on...		Pixels Correct	Pixels False	Pixels Ambiguous	Cloud Errors (omission)	Clear Errors (comission)	Thin as non-clear
<b>See5-rE</b>	20 L8 Scenes	78.71%	17.15%	4.13%	19.45%	4.49%	54.86%
<b>ACCA</b>	20 L8 Scenes	84.98%	5.85%	9.17%	7.43%	2.16%	72.95%
<b>AT-ACCA</b>	20 L8 Scenes	88.15%	10.62%	1.23%	14.43%	5.09%	57.13%
<b>FMask</b>	20 L8 Scenes	94.19%	5.81%	<i>n/a</i>	0.81%	5.68%	76.35%

# Other CCA Validation Results

	Tested on...	Pixels Correct	Pixels False	Pixels Ambiguous	Cloud Errors (omission)	Clear Errors (comission)	Thin as non-clear
<b>See5-rE</b>	103 L7 Scenes	88.50%	7.30%	4.20%	12.10%	4.50%	71.33%
<b>ACCA</b>	103 L7 Scenes	79.90%	4.30%	15.80%	7.80%	2.30%	79.66%
<b>AT-ACCA</b>	103 L7 Scenes	89.80%	8.50%	1.70%	12.30%	6.30%	69.81%
<b>FMask</b>	103 L7 Scenes	90.97%	9.03%	<i>n/a</i>	8.64%	9.24%	85.49%
<b>Cirrus CCA</b>	22 Hyperion Scenes	76.80%	23.20%	<i>n/a</i>	4.40%	26.30%	
<b>Cirrus CCA</b>	22 Hyperion Scenes (without playas)	91.90%	8.10%	<i>n/a</i>	4.80%	8.70%	

# Landsat SR Derived Spectral Indices

- **Landsat Surface Reflectance Data Products Used as Input**
  - Normalized Difference Vegetation Index (NDVI)
  - Enhanced Vegetation Index (EVI)
  - Soil Adjusted Vegetation Index (SAVI)
  - Modified Soil Adjusted Vegetation Index (MSAVI)
  - Normalized Difference Moisture Index (NDMI)
  - Normalized Burn Ratio (NBR)
  - Normalized Burn Ratio 2 (NBR2)

[http://landsat.usgs.gov/documents/si\\_product\\_guide\\_sr\\_samples.pdf](http://landsat.usgs.gov/documents/si_product_guide_sr_samples.pdf)

# Future Landsat CDRs & ECVs

- Land Surface Temperature CDR
- Burned Area Extent ECV
- Surface Water Extent ECV
- Snow Covered Area ECV
- Biomass ECV
- Global Land Cover ECV

These images are subsets of Landsat 5 Thematic Mapper (TM) scene Path 23 Row 34, acquired May 30, 1995. R to L: Natural color composite of a Level-1 product; Results of Top-of-Atmosphere corrections; Results of Surface Reflectance processing



<http://remotesensing.usgs.gov/ecv/index.php>

# Product Maturity – Provisional Status

FY13

FY15

Maturity Index	Research		Intermediate Operational Capacity		Full Operational Capacity	
	1	2	3	4	5	6
<b>Software Readiness</b>	Conceptual development	Significant code changes expected	Moderate code changes expected	Some code changes expected	Minimal code changes expected. Stable, portable and reproducibility	No code changed expected. Stable and reproducible, portable and operationally efficient
<b>Metadata</b>	Little or none	Research grade	Research grade: Meets international standards; ISO or FGDC for collection, netCDF for file	Exists at file and collection level. Stable allows provenance tracking and reproducibility of dataset.	Complete at file and collection levels; stable; allows provenance tracking and reproducibility of the data set	Updated and complete at file and collection level. Stable. Allows provenance tracking and reproducibility of dataset. Meets current international standards for dataset.
<b>Documentation</b>	Draft ATBD; paper on algorithm submitted	ATBD Version 1+; paper on algorithm submitted	Public ATBD; Peer-reviewed publication on algorithm	Public ATBD; Draft Operational Algorithm description (OAD); Peer-reviewed publication on algorithm; paper on product submitted	Public ATBD. Review version of OAD. Peer-reviewed publication on algorithm and product	Public ATBD and OAD; Multiple peer reviewed publications on algorithm and product
<b>Product Validation</b>	Little or none	Stage 1 – Minimal, assessed from small (<30) locations and time periods with <i>in situ</i> or other reference data	Stage 2 – Accuracy assessed over significant set of locations and time with <i>in situ</i> or other reference data; results <b>published in peer reviewed journal</b>	Stage 2 – Validation and uncertainty continues with version changes; Differences understood	Stage 3 - Consistent uncertainties statistically quantified with <i>in situ</i> or other reference data over multiple locations and time; Uncertainty and consistency with similar products estimated over most environmental conditions by multiple investigators	Stage 4 - Observation strategy designed to reveal systematic errors through independent cross-checks, open inspection, and continuous interrogation; quantified errors as new product versions released and time series expands
<b>Public Access</b>	Restricted to a select few	Limited data availability to develop familiarity	Data and source code archived and available; caveats required for use	Data and source code archived and publicly available; uncertainty estimate; Known issues public. Periodically updated.	Record is archived and publicly available with associated uncertainty estimate; Known issues public. Periodically updated.	Record is publicly available from Long-Term archive. Regularly updated.
<b>Utility</b>	Little or none	Limited or ongoing	Assessments of demonstrated positive value	May be used in application by other investigators; assessments demonstrating positive value	May be used in applications by other investigators; assessments demonstrating positive value	Used in published applications; may be used by industry; assessments demonstrating positive value

# CDR/ECV Product Development Schedule

CDR/ECV	Target Provisional	Target Public Release
Surface Reflectance	2011 March	2012 October
Land Surface Temperature	2015 June	2015 December
Burned Area	2014 December	2015 June
Surface Water Extent	2014 December	2015 June
Snow Covered Area	2015 August	2015 December
Biomass	2015 September	2016 June

## Criteria for Public Release

- Algorithms published in peer reviewed journal
- Methods for validation published in peer reviewed journal
- Stakeholder engagement in product evaluation and feedback
- Uncertainties are acceptable but need to be characterized, quantified, and documented

LC80290302013089LGN01



L8 Radiance



L8 Top of Atmosphere



L8 Surface Reflectance

LE70290302013089EDC00



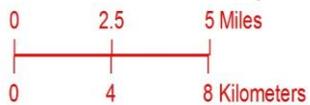
L7 Radiance



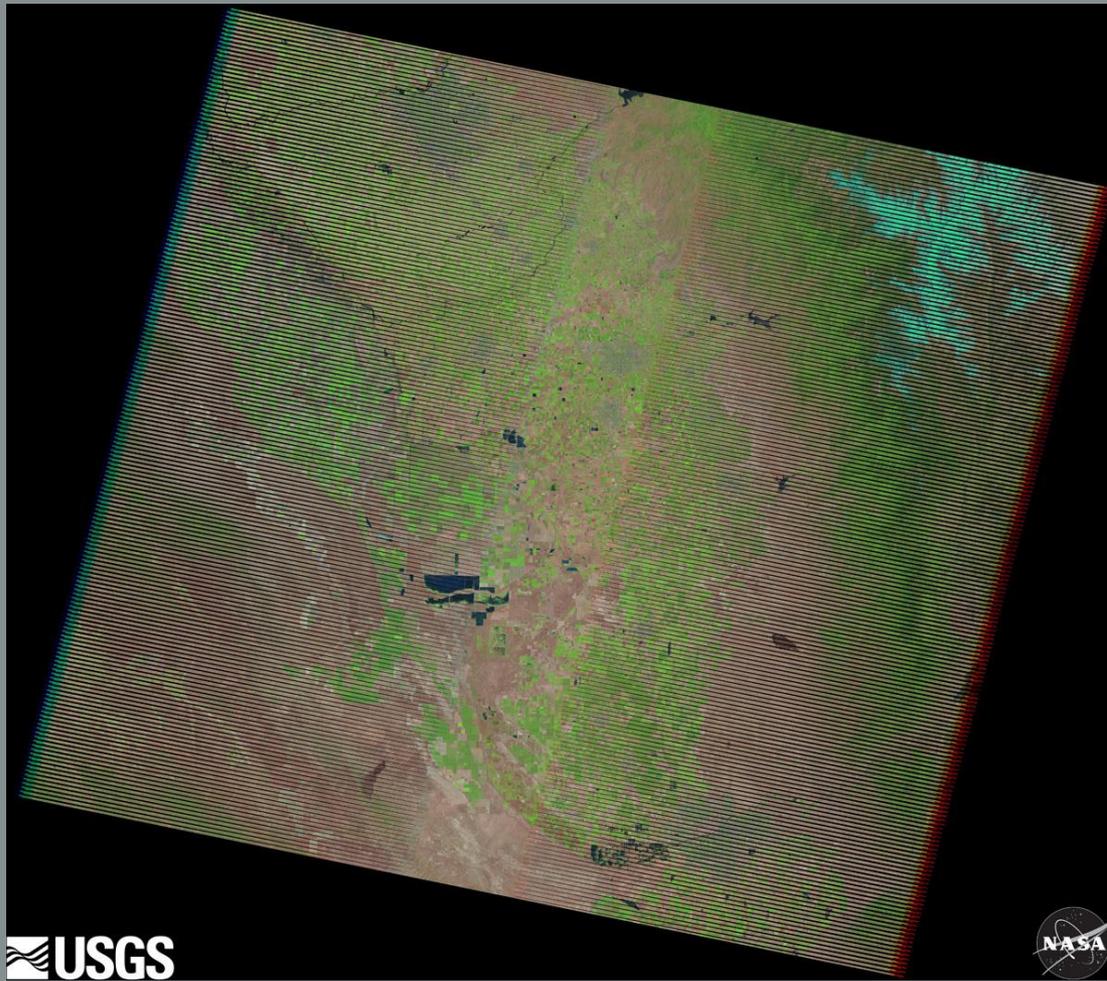
L7 Top of Atmosphere



L7 Surface Reflectance



# Landsat 7 ETM+ June 24, 2011

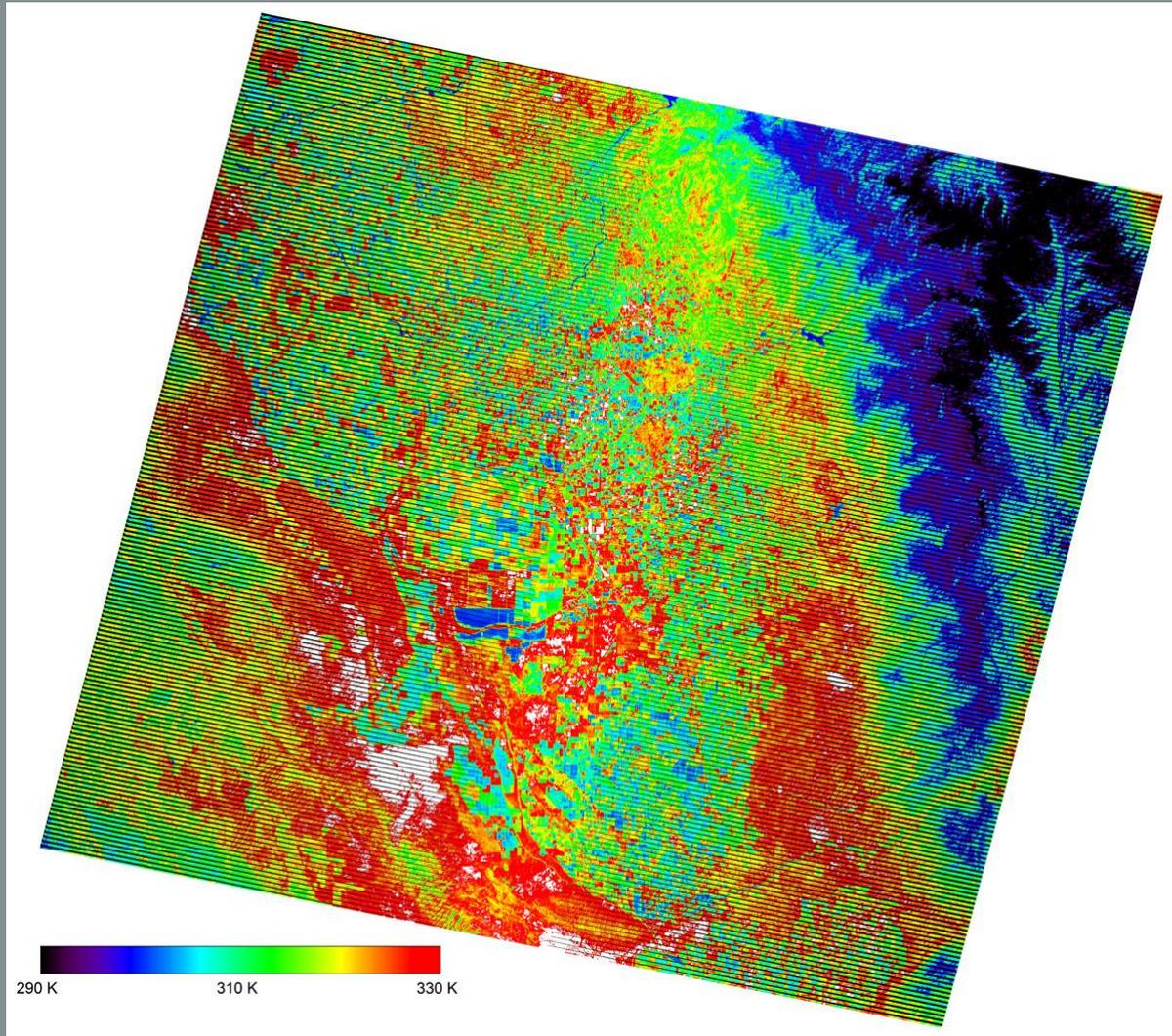


 USGS

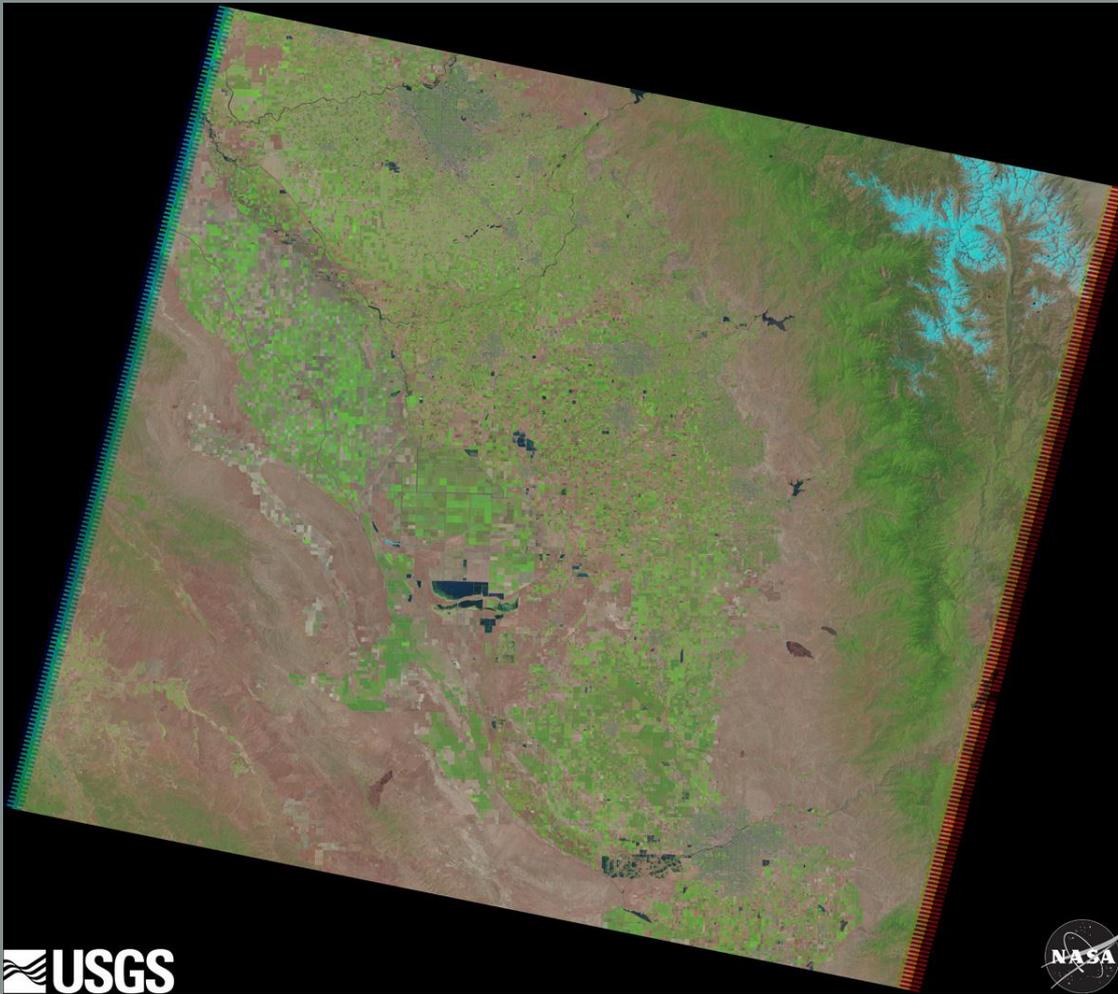


 USGS

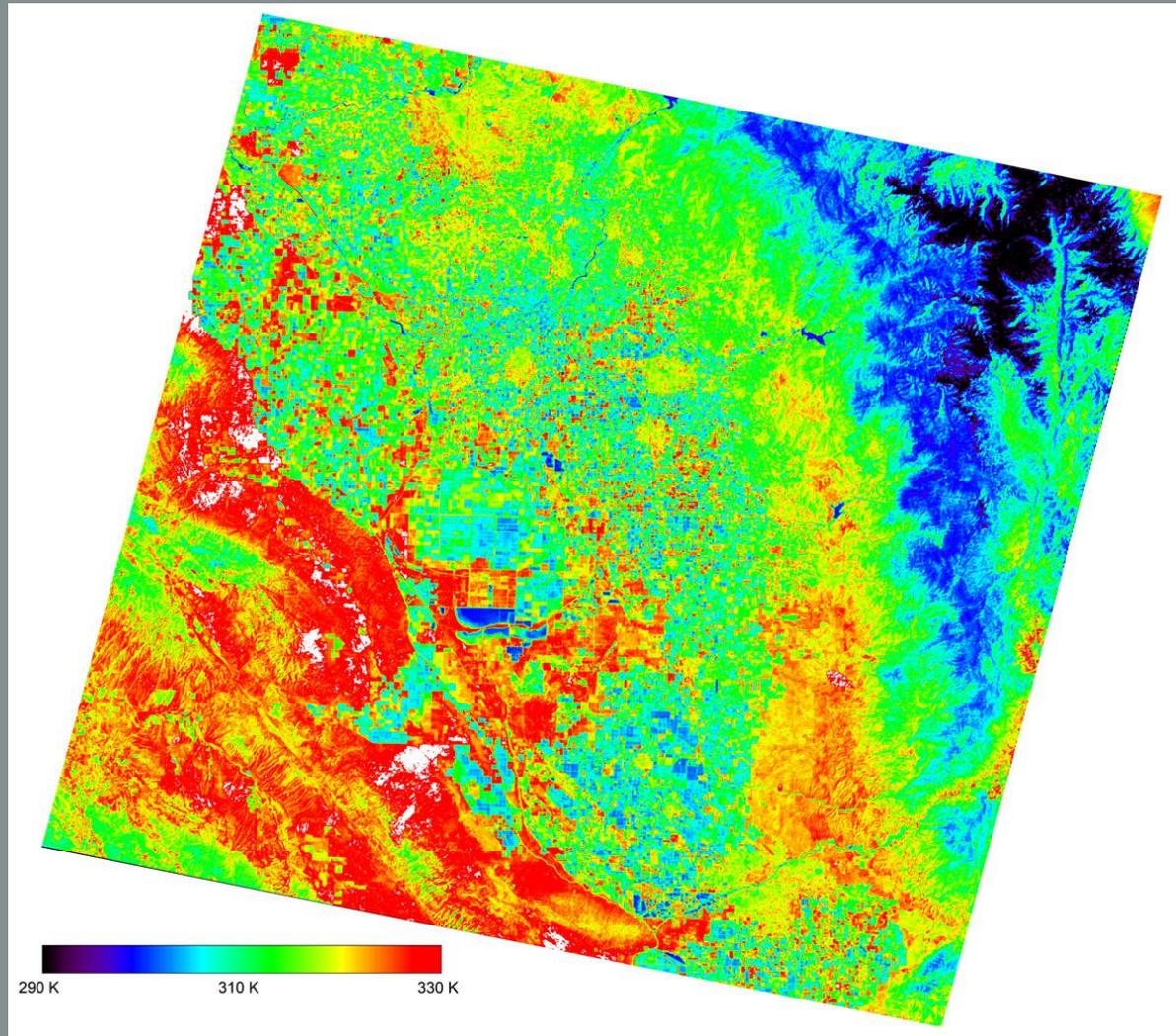
# Landsat 7 ETM+ June 24, 2011

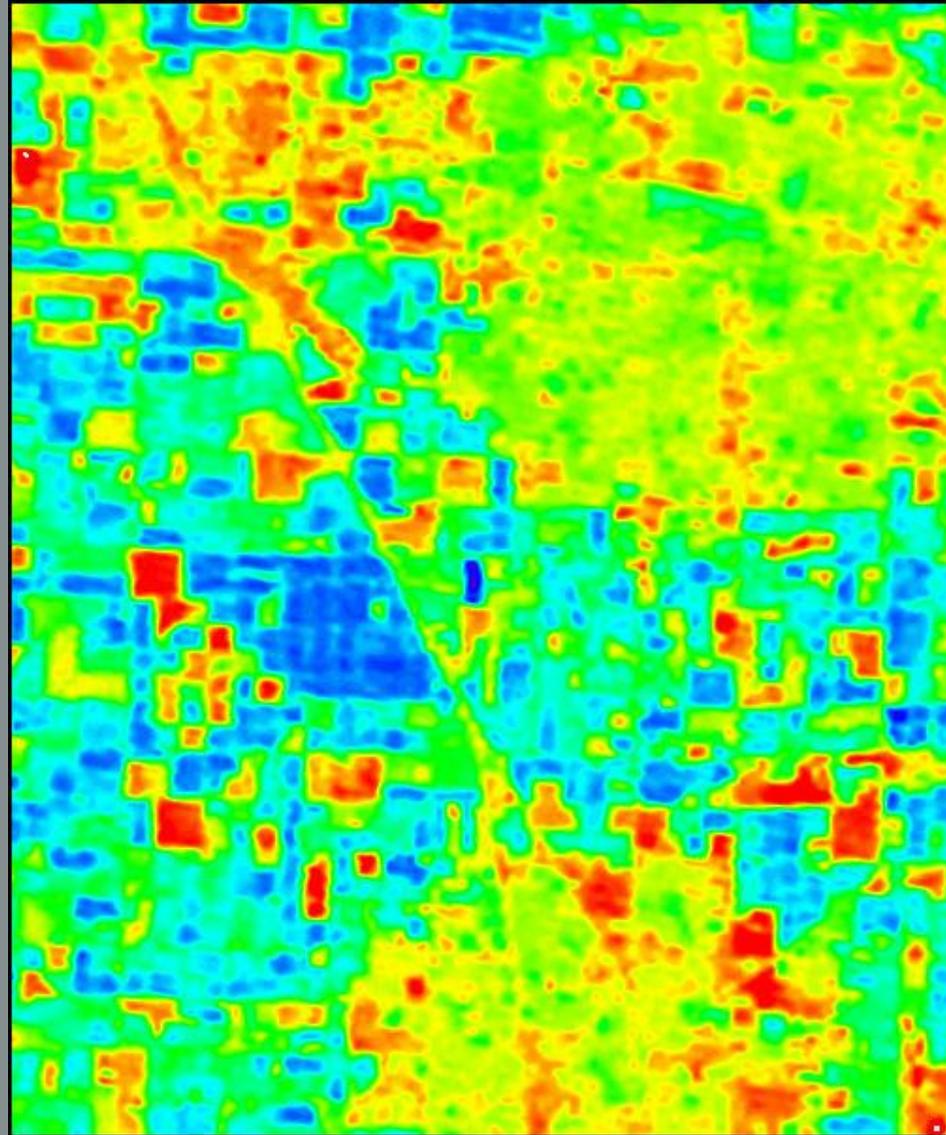


# Landsat 5 TM July 2, 2011

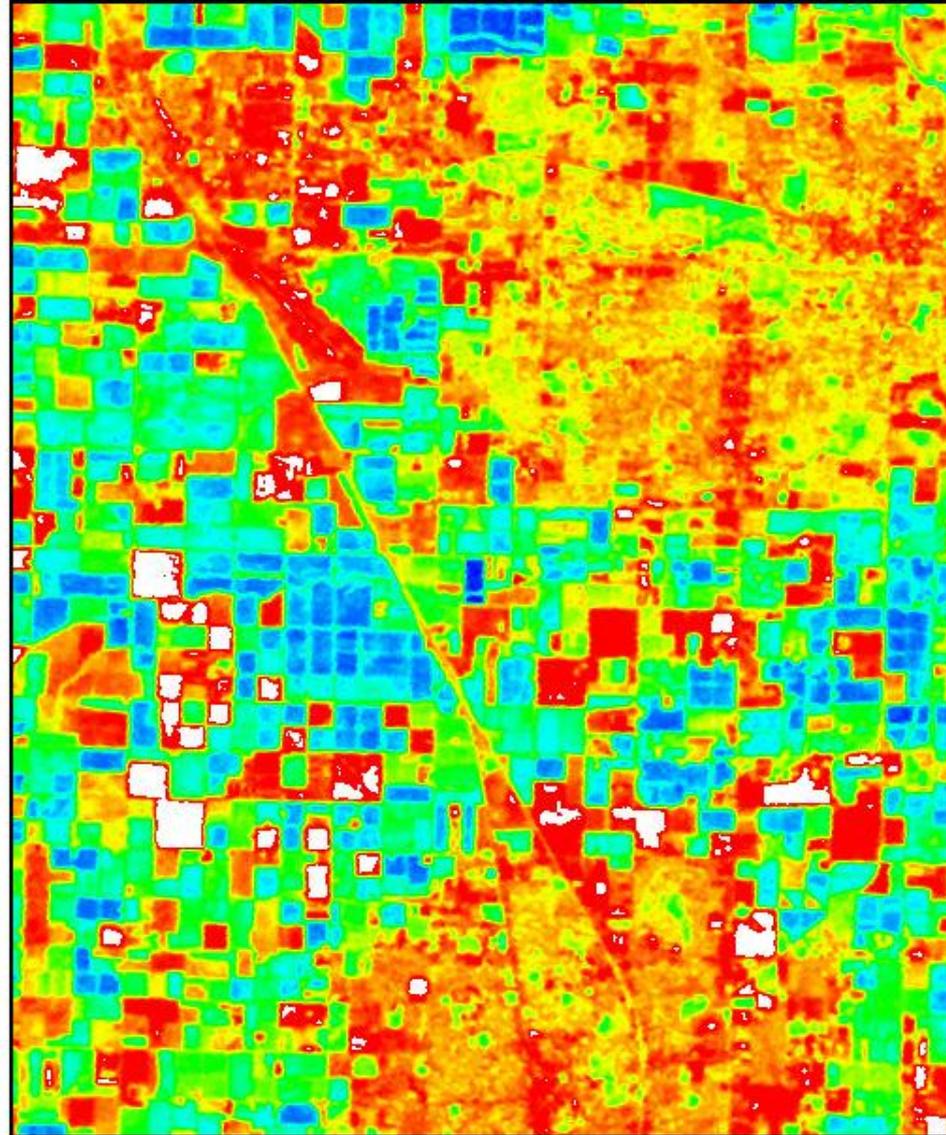


# Landsat 5 TM July 2, 2011

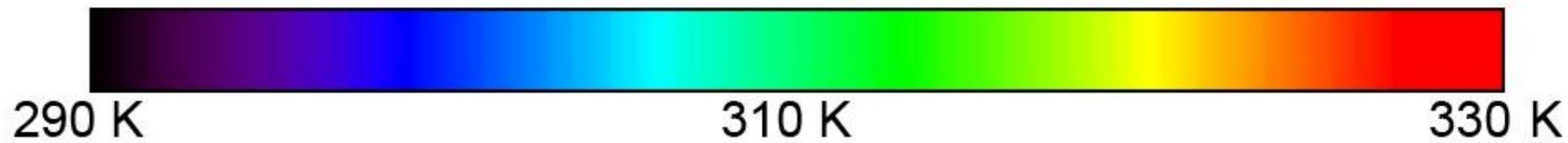




Landsat 5 TM  
7/2/2011



Landsat 7 ETM+  
6/24/2011



290 K

310 K

330 K