Illustration courtesy of USGS

Beyond LDCM

Land Observation Repeat Frequency to Achieve OLOS Goals

Samuel N. Goward
Geography, U. Maryland

Darrel L. Williams
GST Inc

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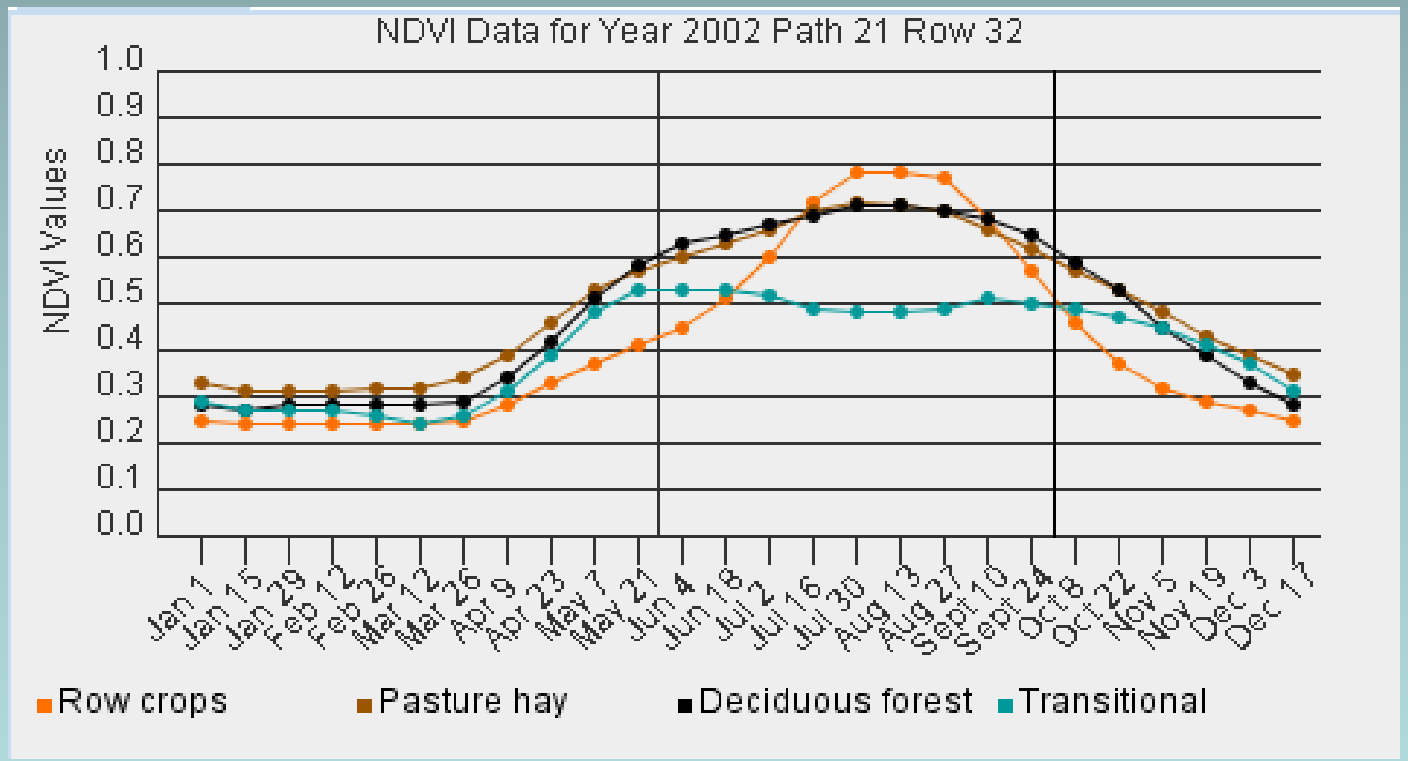
Operational Land Observatory System (OLOS)

Inter-annual land dynamics

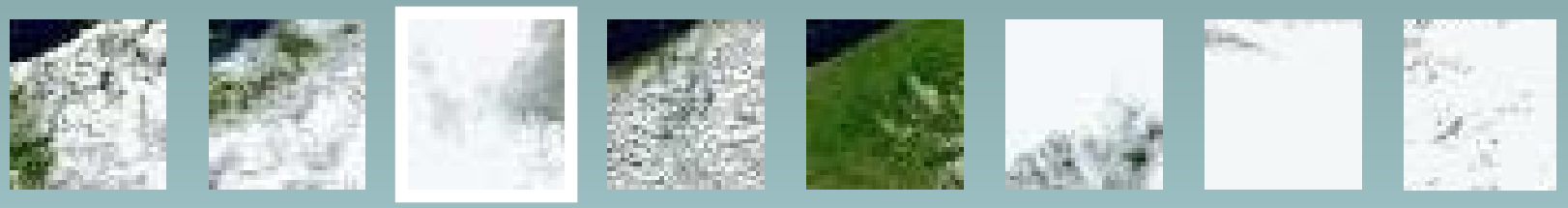
- Defined by within-year vegetation seasonality



For best results, clear views ~ once each week

Cloud Contamination
Serious Problem in Humid Regions

- For best results, clear views ~ once each week



Example 8-day coverage from MODIS in NE PA

- Observations acquired on day 3
- In 8 days only one date is nearly cloud-free
- Could take many weeks to get clear views with 16-day repeat

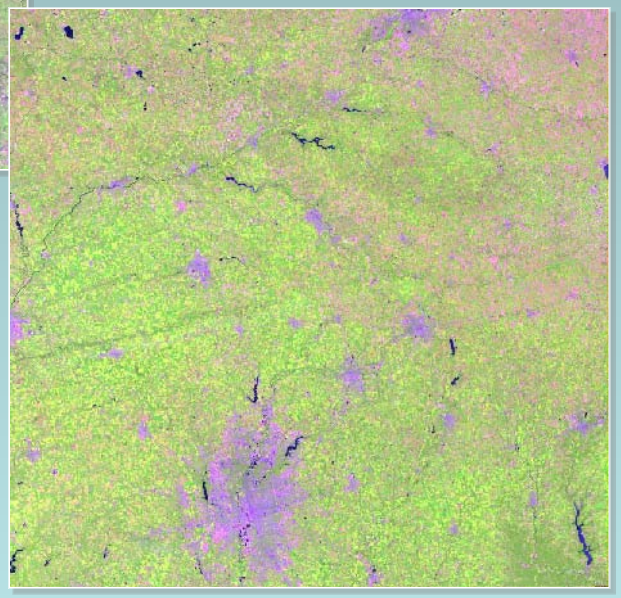
What Temporal Repeat Provides Weekly observations?

Approach

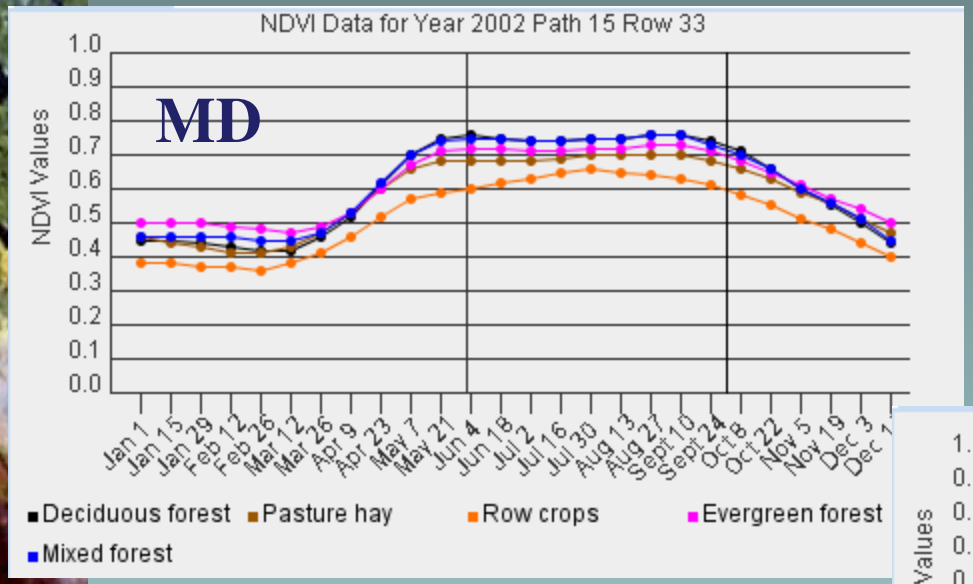
- MODIS Terra Landsat-size chips
  - **Daily surface reflectance images**
  - **8 years (2001-08)**
- 3 eastern US sites
  - Maryland (p15r33)
  - Pennslyvania (p17r31)
  - Indiana (p21r32)
- Cloud Cover Visual Analysis
- Repeat Frequency Cycles
  - 16, 8, 4, 2, 1 day
  - Assumes 180 km swath

MD p15r33

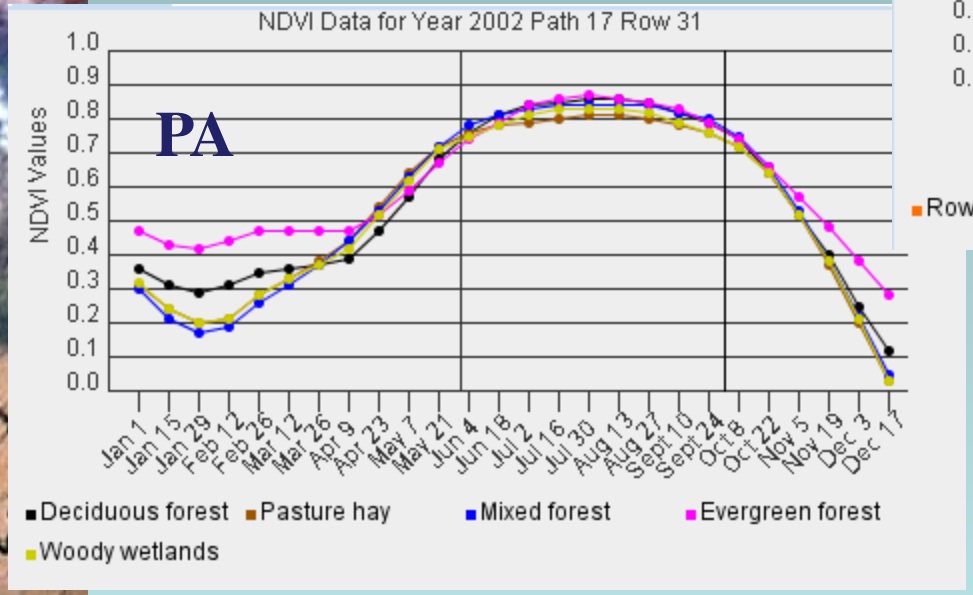
PA p17r31

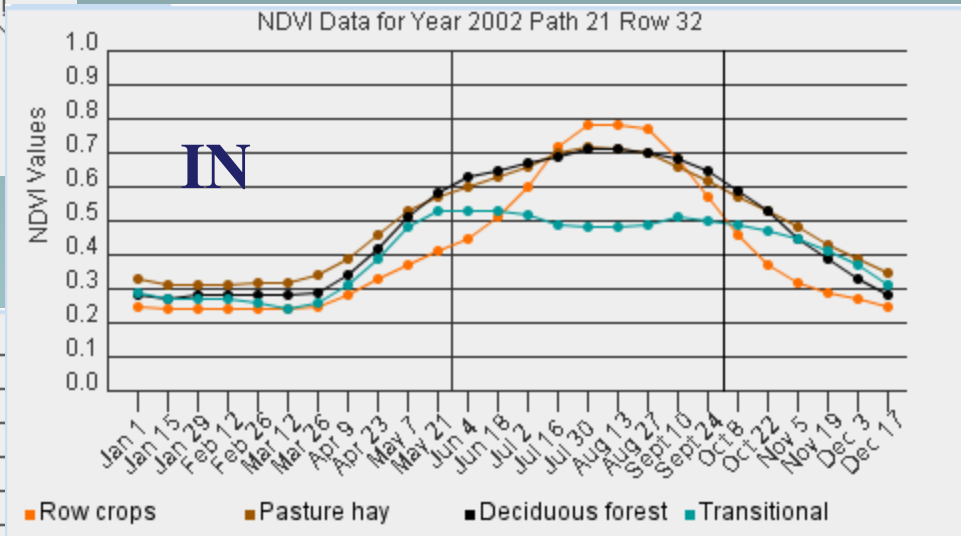


IN p21r32



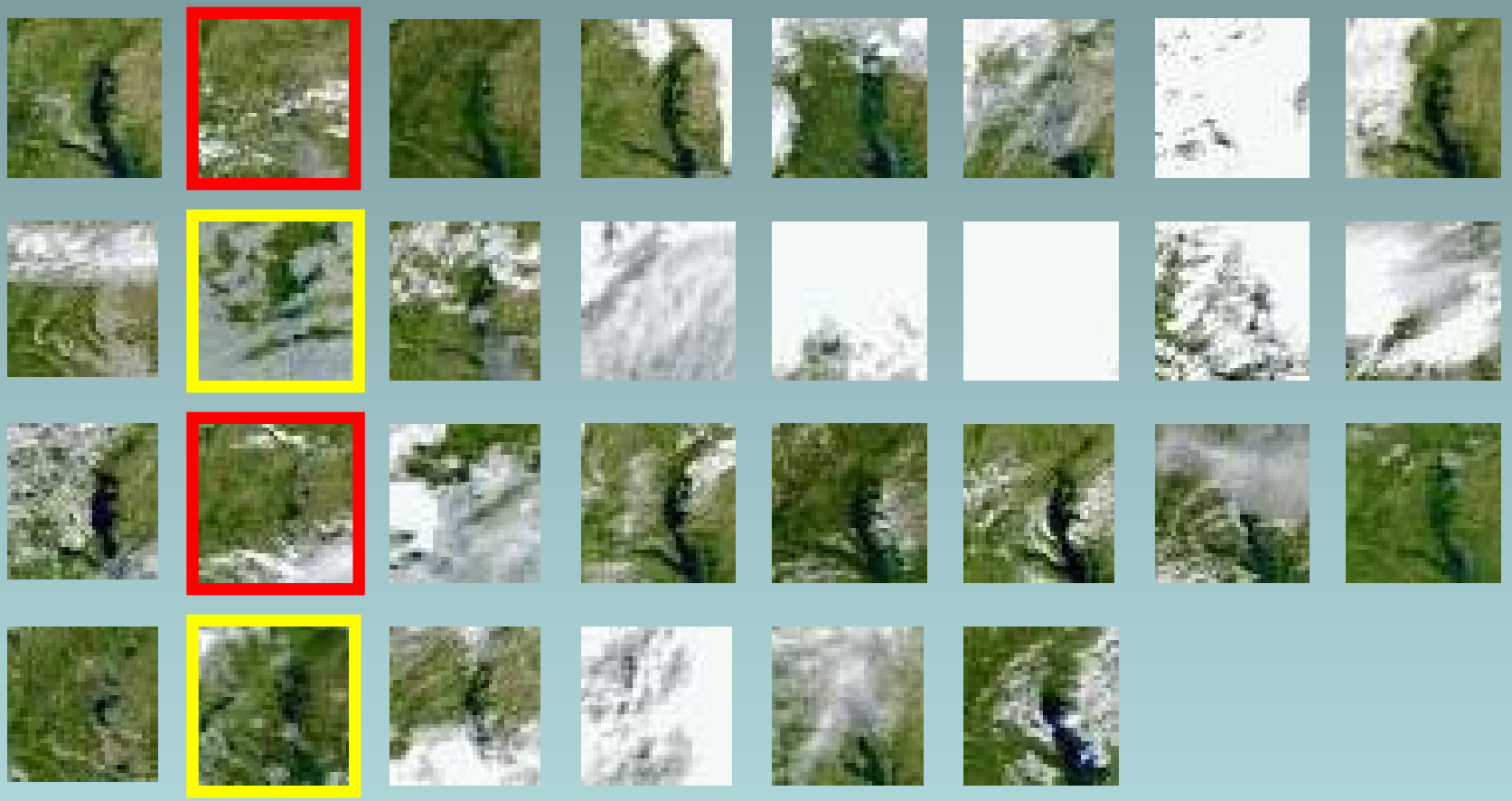
PA





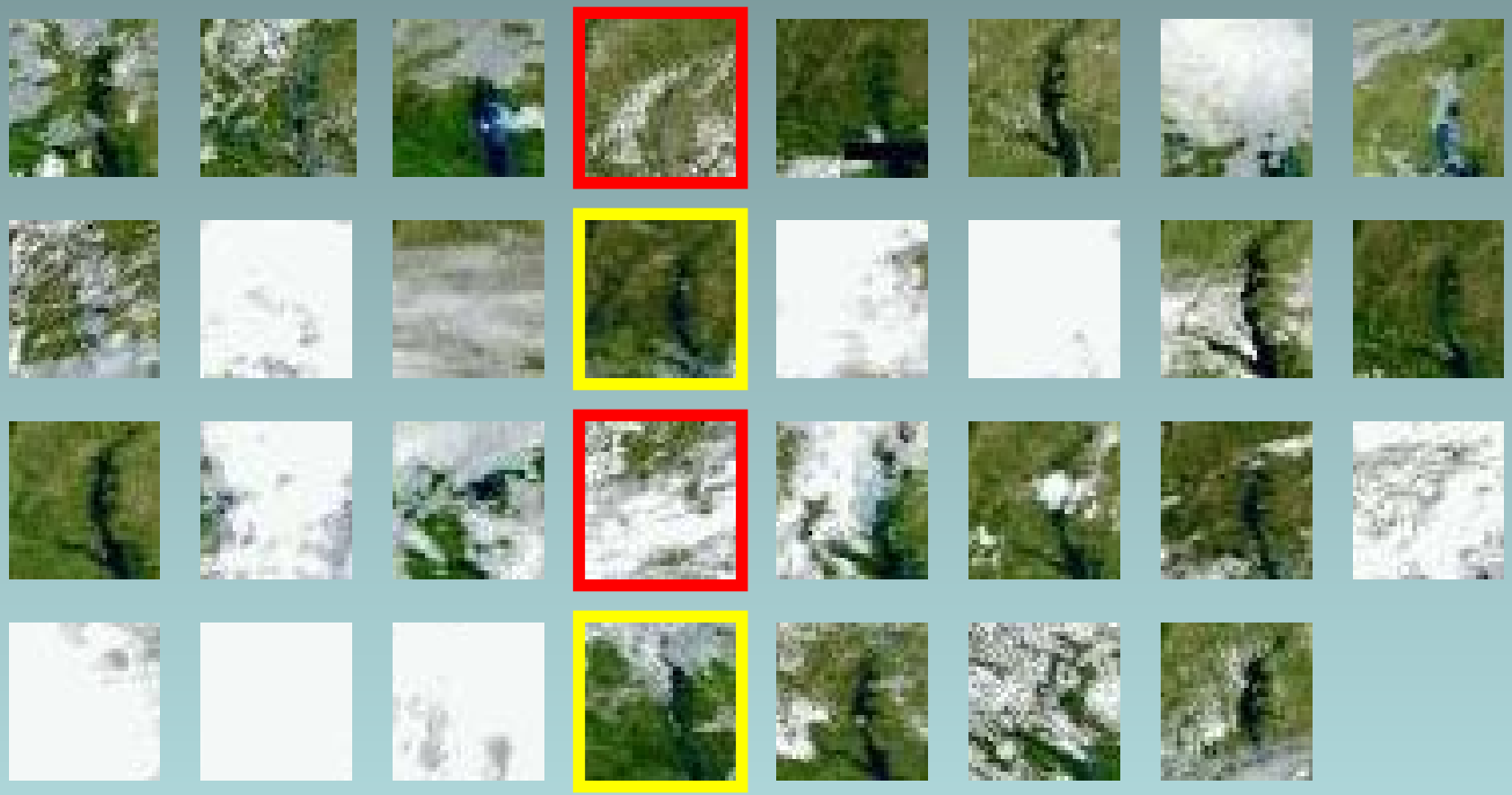
Note: These NDVI plots are available as part of USGS GLOVIS website – at least for USA scenes

MD p15r33 June 2002



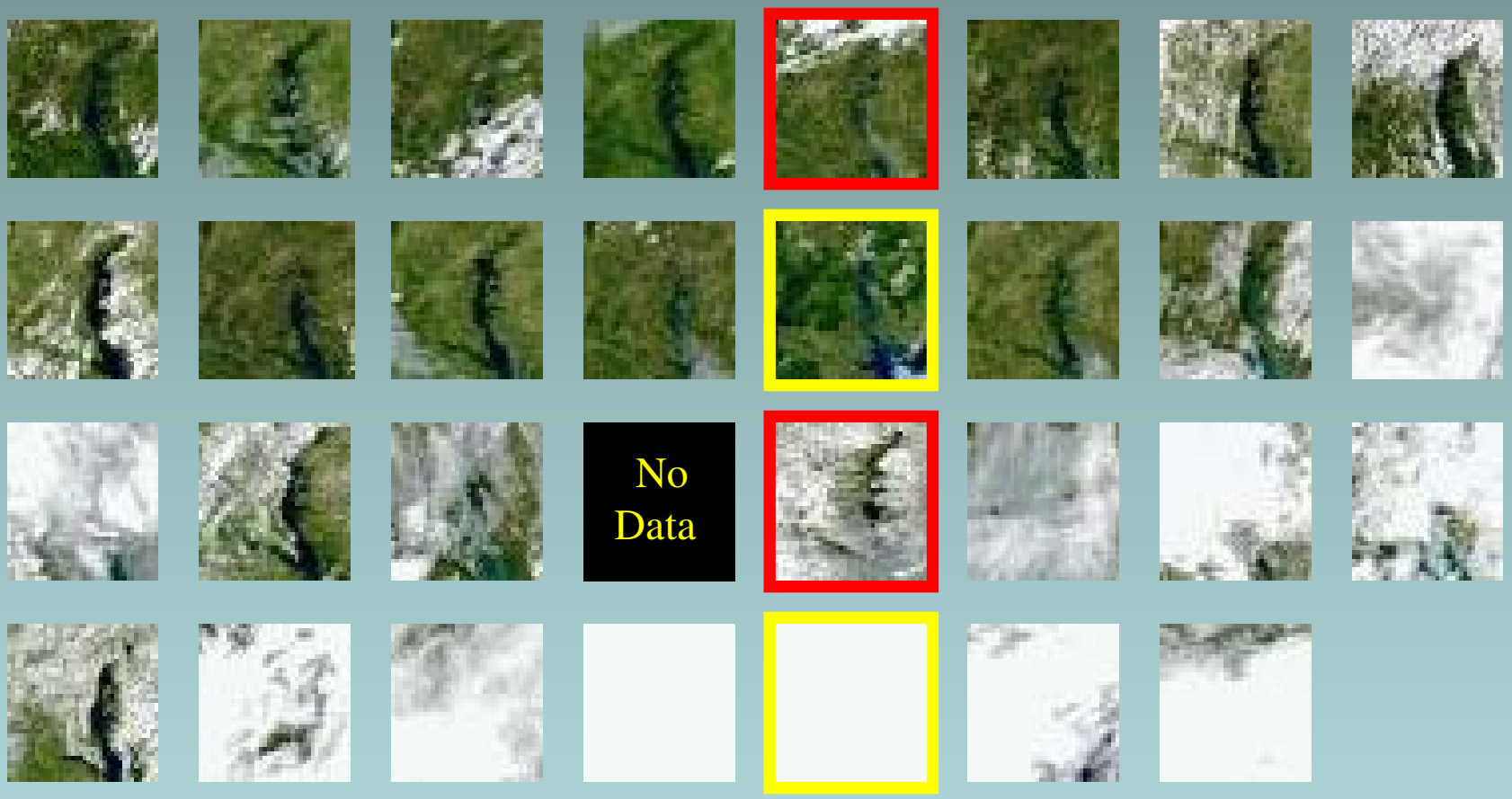
Note: “8 day / week” calendar being shown; images highlighted correspond to Landsat 5 and 7 observation dates

MD p15r33 July 2002



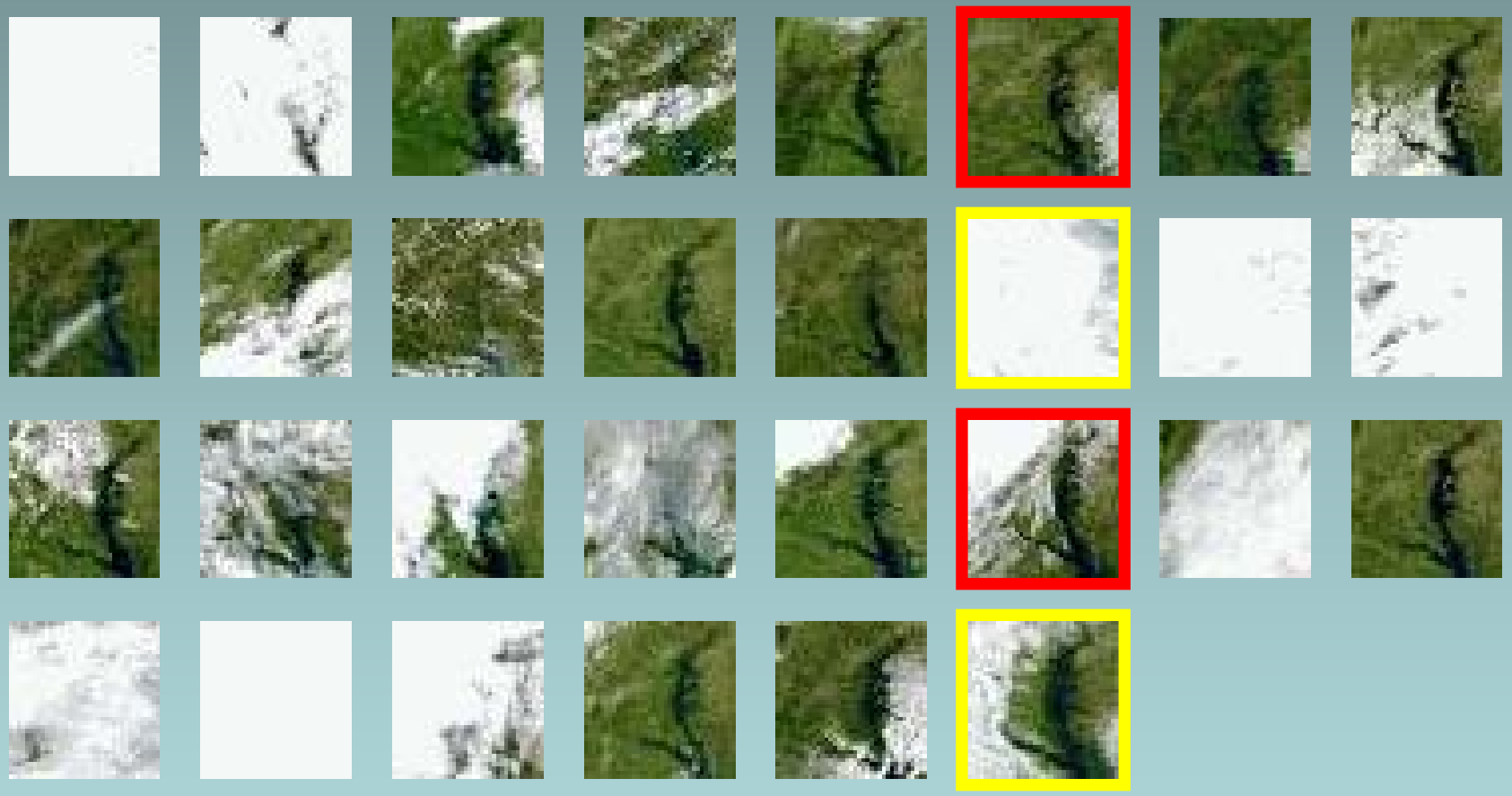
Note: “8 day / week” calendar being shown; images highlighted correspond to Landsat 5 and 7 observation dates

MD p15r33 August 2002



Note: “8 day / week” calendar being shown; images highlighted correspond to Landsat 5 and 7 observation dates

MD p15r33 September 2002



Note: “8 day / week” calendar being shown; images highlighted correspond to Landsat 5 and 7 observation dates

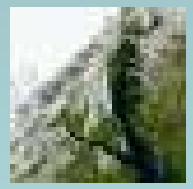
Analysis Method

- **Visual assessment of cloud cover in MODIS chips**
- **Each image assigned a rank of 1 - 4 based on the apparent cloud cover present in an individual chip / scene**

- **Examples**

Clear
rank = 1

Mostly Clear
rank = 2

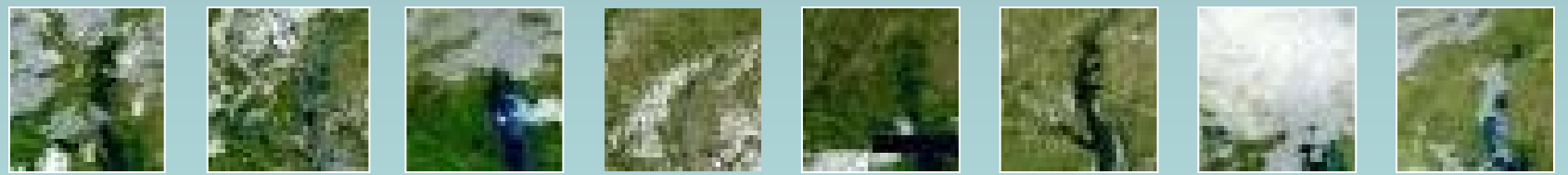


Mostly Cloudy
rank = 3

Cloudy
rank = 4

Observation Goal

- Growing season period (June 1 – Sept 30)
- One clear or merged clear per 8 days
- Merged Clear is two or more “mostly clear” observations in a given 8 day time window



Maryland Results

Daily Repeat

Year	Success Rate
2001	76.9%
2002	86.7%
2003	80%
2004	66.7%
2005	86.7%
2006	86.7%
2007	73.3%
2008	73.3%

Cumulative: 78.8%

Two Day Odd

Year	Success Rate
2001	69.2%
2002	80.0%
2003	66.7%
2004	26.7%
2005	60.0%
2006	53.3%
2007	53.3%
2008	26.7%

Cumulative: 54.2%

Two Day Even

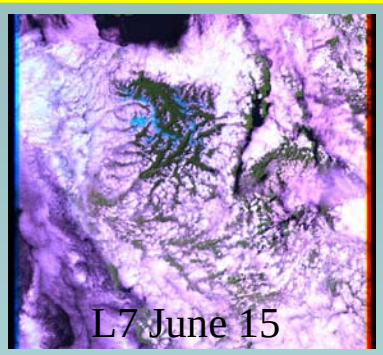
Year	Success Rate
2001	69.2%
2002	66.7%
2003	66.7%
2004	46.7%
2005	66.7%
2006	73.3%
2007	66.7%
2008	73.3%

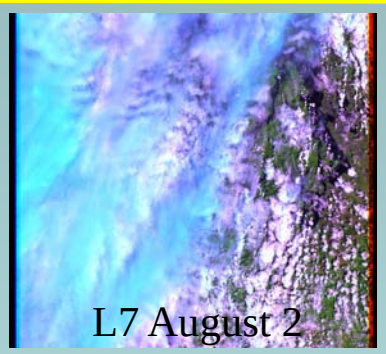
Cumulative: 66.9%

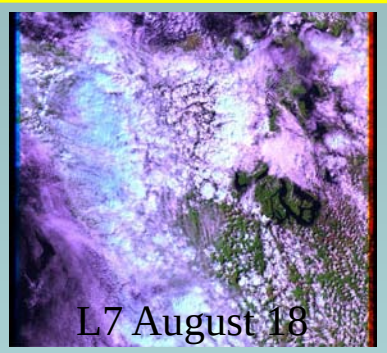
Average of ~ 12 of 15 possible clear views

Significant range of results for two day repeat observations depending on weather cycles – these cycles can / will change over time

8-day repeat coverage for Olympic Peninsula, Washington







These images were acquired by Landsat 5 and Landsat 7 from June through August, 2001. They illustrate how "successful coverage" by a satellite can vary significantly as a function of weather patterns. For this year, if you were relying on Landsat 5, you would be very happy – if Landsat 7, not so happy.

Illustration courtesy USGS

Indiana Results*

Daily Repeat

Year	Success Rate
2001	92.3%
2002	86.7%
2003	93.3%
2004	80%
2005	93.3%
2006	93.3%
2007	100%
2008	100%

Cumulative: 92.4%

Two Day Odd

Year	Success Rate
2001	61.5%
2002	73.3%
2003	93.3%
2004	73.3%
2005	73.3%
2006	93.3%
2007	80%
2008	93.3%

Cumulative: 80.5%

Two Day Even

Year	Success Rate
2001	53.8%
2002	86.7%
2003	40%
2004	66.7%
2005	80%
2006	66.7%
2007	100%
2008	73.3%

Cumulative: 71.2%

* Better probability of cloud free acquisitions than in Maryland

Observation Frequency Summary

- Cloud cover dominates acquisition success (duh!)
- How many "Landsat-like" systems are needed?
  - for mid-latitude eastern North America,
  - daily overpasses would be needed to provide near-weekly useable coverage!
- Image merging / compositing of partly cloudy scenes would help