

# Landsat 7-8 Acquisition Improvements

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Presented By:

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# Landsat Long Term Acquisition Plan

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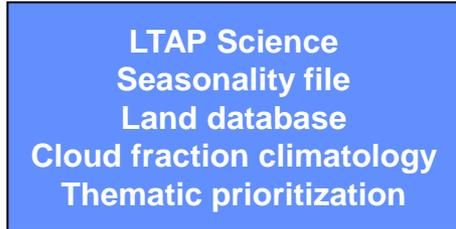
- **Long-term monitoring science mission**
  - ◆ Vegetated day-lit descending land – core mission
  - ◆ Snow and ice day-lit descending land – Landsat 8
- **Special Requests and Campaigns**
  - ◆ Ascending day-lit land – Persistently-cloudy high-latitude areas
  - ◆ Ocean monitoring – Vegetation; Oil seeps and spills; Ships
  - ◆ Night monitoring – Volcanoes; Urban heat island/city lights; Fire; Geothermal
  - ◆ Priority descending land – Emergency; Field campaigns
    - Will attempt to shift maneuvers and calibration activities
  - ◆ Calibration and validation

# Landsat Schedulers

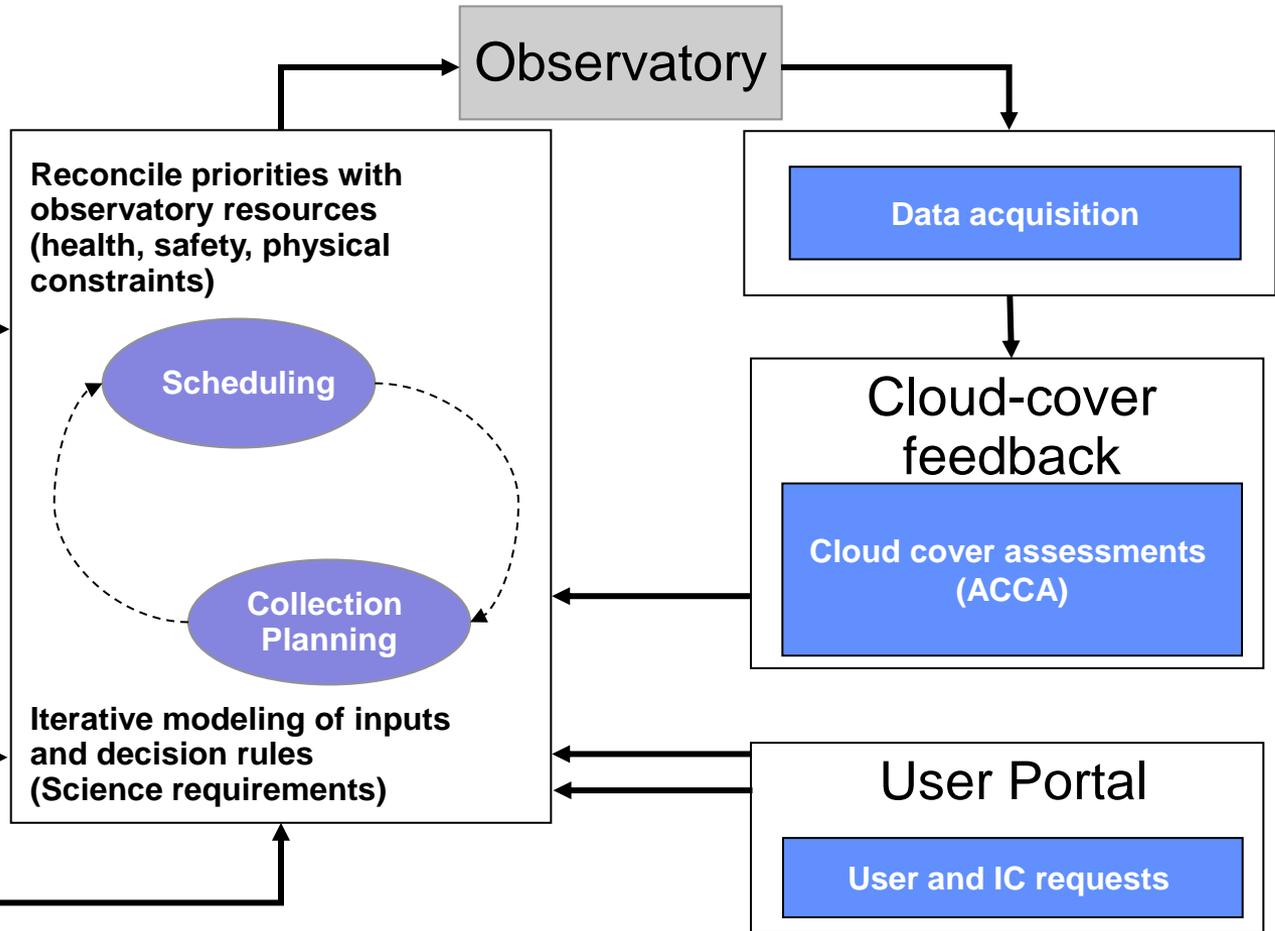
## CVT & MOC



## Science Office



## NCEP



# Long-Term Acquisition Plan Controls

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- **Vegetation phenology quantified by discrete seasonality records or continuous NDVI probabilities**
- **Cloud predictions better than cloud climatology increase probability of acquisition**
- **Sun elevation constraints**
  - ◆ Landsat 7 (15° N & 5° S)
  - ◆ Landsat 8 (5° N & 5° S)
- **Automatic Cloud Cover Assessments of acquired images identify successful acquisitions**
- **Missed opportunity boost**
- **Thematic Campaigns – requirements not well represented by seasonality: reefs, agriculture, volcanoes, glaciers,... night, ocean, emergency**

# The evolving LTAP...

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- **Landsat 7:**

- ◆ Focus acquisitions on continental land masses
  - Increased total acquisitions from 300 (2010) to 438 scenes/day (470 in NH summer – 86% and 357 in NH winter – 99%)
- ◆ Reduces wear and tear on the instrument
  - Reduced ETM+ duty cycle from 15.1% to 14.4% and power cycles from 28.6 to 17.8

- **Landsat 8**

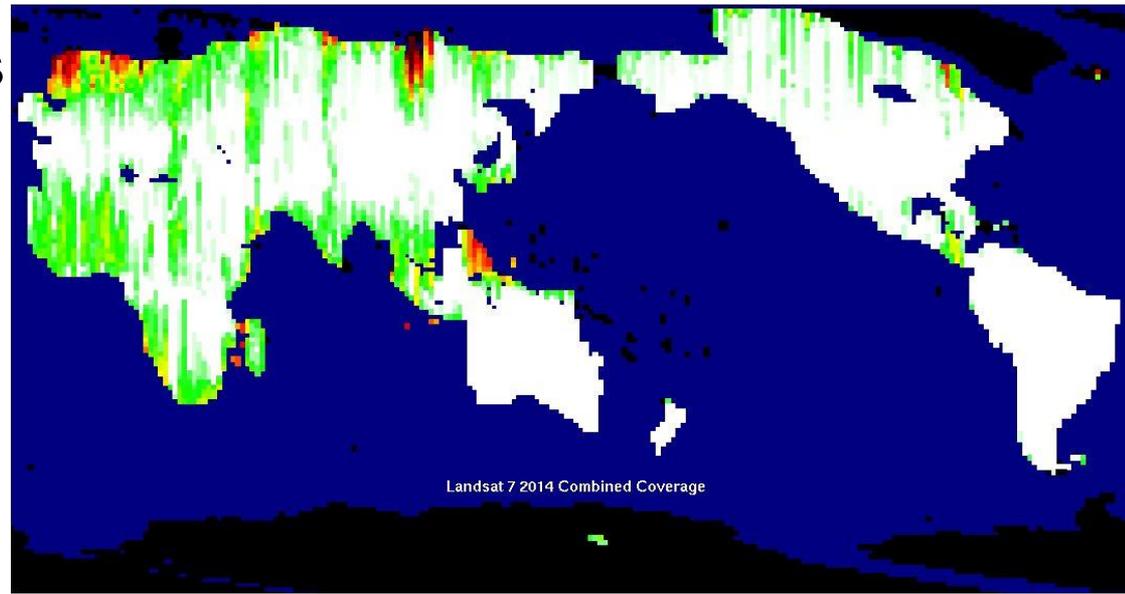
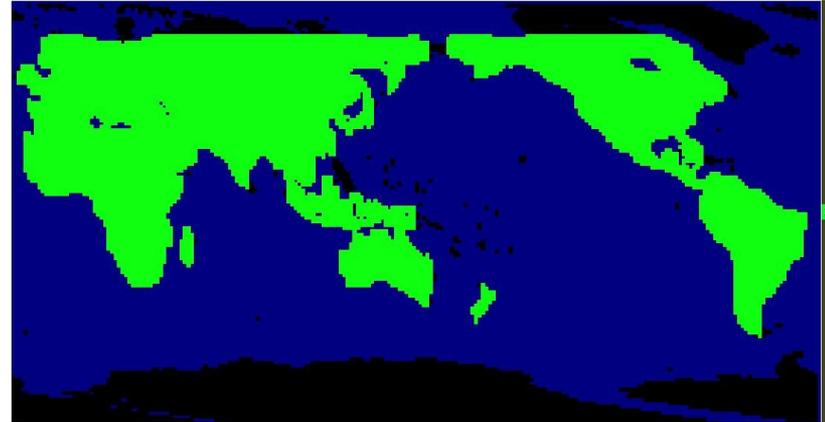
- ◆ SIGNIFICANT increase in acquisitions from 400 prelaunch, to 550 at commissioning, to 725 scenes/day in July 2014 (July 2014 – Jan 2015 - 96% - 20 images/day rejected)

- **Changes in philosophy**

- ◆ Phenology has little impact – cloud avoidance and physical constraints are primary controls (and sun light...)
- ◆ Large campaigns are not used over land scenes, whereas night, ocean and ascending campaigns are significant

# Landsat 7 Current Status

- **Acquire only continental land masses**
  - ◆ minimize revisit time and
  - ◆ maximize interval lengths
- **Most rejects are due to**
  - ◆ duty cycle and
  - ◆ memory constraints
- **No daily limits**
- **Map of % acquired in 2014**



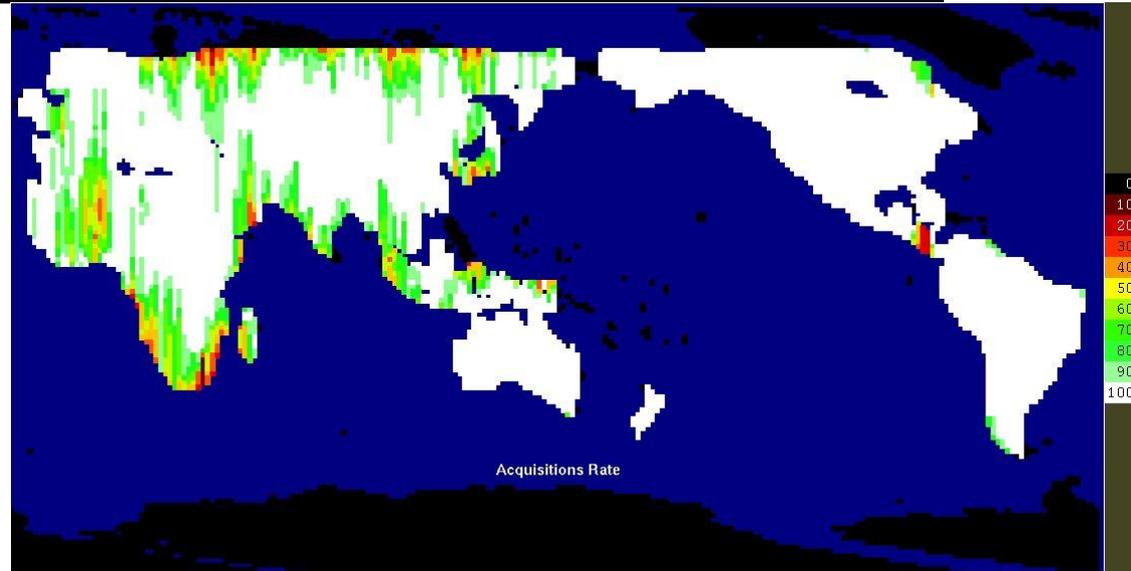
# Landsat 7 Current Investigations

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- **Tune Landsat 7 Continental Model**
  - ◆ Acquire as many images as possible
  - ◆ Acquire the best possible images
  - ◆ Do nothing to shorten the mission
- **Reduce duty cycle rejections by relaxing constraints**
  - ◆ Propose gradual increase in duty cycle to 105% of current
  - ◆ Careful monitoring of telemetry
  - ◆ Acceptable risk given near end-of-mission?
  - ◆ Duty cycle rejections tend to shift to memory rejections
- **Increase download opportunities**
  - ◆ Add International cooperators as “bent-pipe” LGN stations
  - ◆ Adds operational margin in anticipation of future memory board losses

# Landsat 7 Models

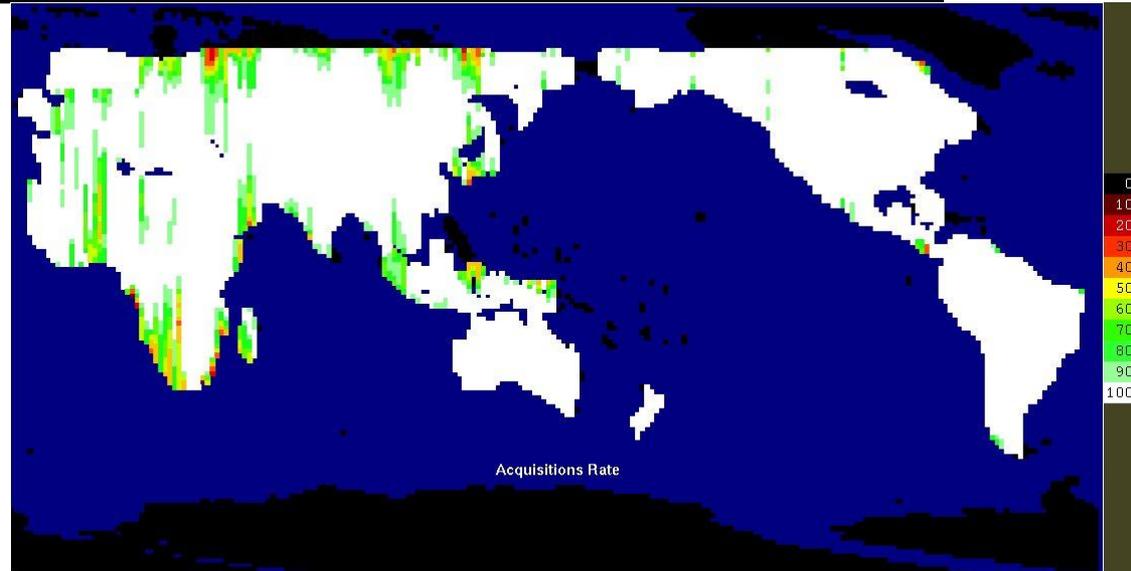
- **Baseline Continental model**
  - ◆ No islands
  - ◆ No Antarctica
  - ◆ No row 9 and above (Row 10 has 4 revisits per cycle)
  - ◆ Current duty cycle constraints
  - ◆ Current LGN (Landsat Ground Network) contacts



Daily Average Metrics	Baseline
Acquisition Rate (LGN)	460 scenes/day (93.4% of candidates)
ETM+ duty cycle	15.0%
ETM+ power cycles	17.9
SSR Capacity Rejects	0.23
ETM+ Duty Cycle Rejects	31.5

# Landsat 7 Models

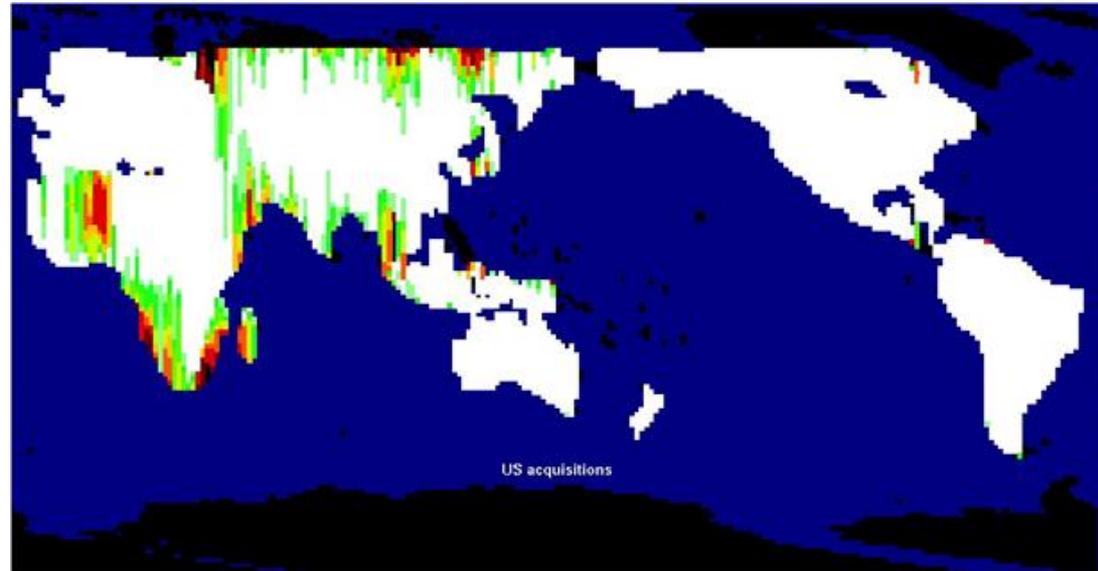
- Relaxed ETM+ duty cycle constraints (105%)
- Current LGN contacts



Daily Average Metrics	Relaxed Duty Cycle Constraints
Acquisition Rate (LGN)	475 scenes/day (96.5% of candidates)
ETM+ duty cycle	15.4%
ETM+ power cycles	17.3
SSR Capacity Rejects	1.75
ETM+ Duty Cycle Rejects	15.0

# Landsat 7 Models

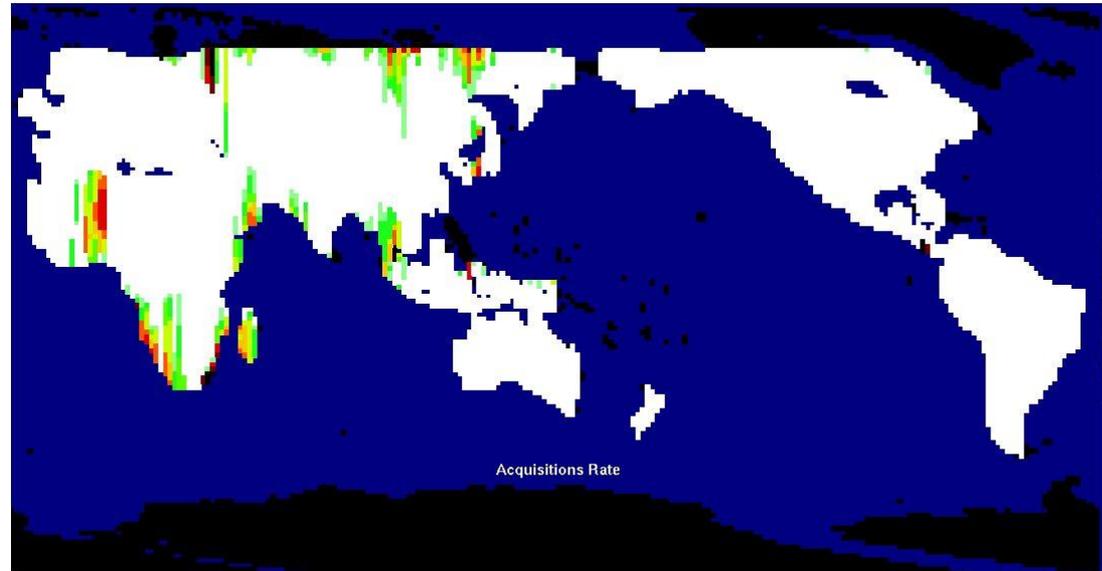
- Current LGN contacts + NSG (Germany)
- No relaxation of duty cycle constraints
- Adding LGN contacts without relaxing constraints is not effective



Daily Average Metrics	NSG Bent-Pipe Station
Acquisition Rate (LGN)	459 scenes/day (93.3% of candidates)
ETM+ duty cycle	15.0
ETM+ power cycles	18.0
SSR Capacity Rejects	0
ETM+ Duty Cycle Rejects	32.2

# Landsat 7 Models

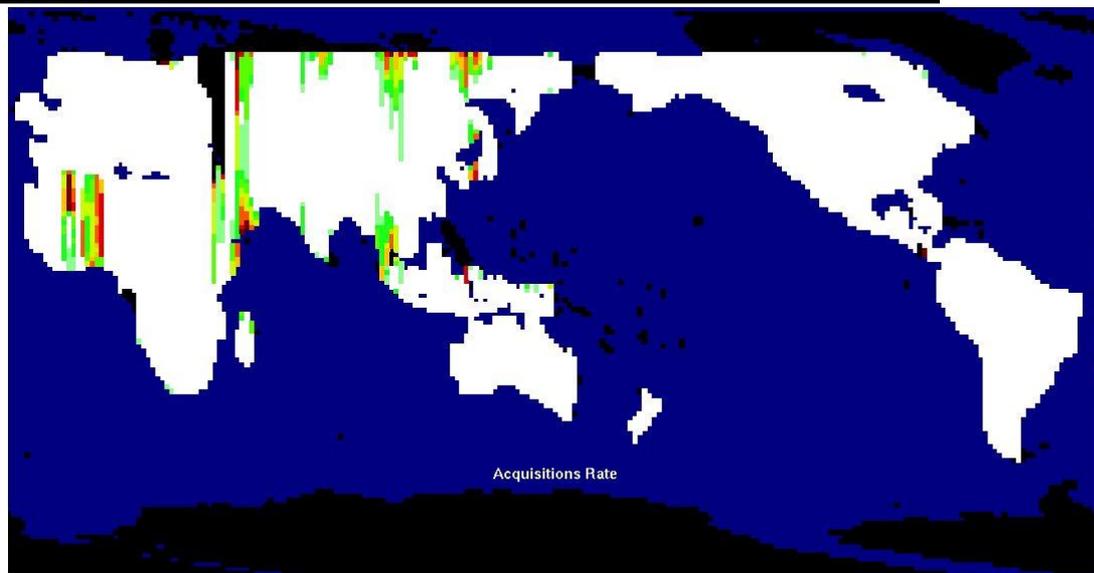
- Relaxed ETM+ duty cycle constraints (105%)
- Current LGN contacts plus NSG (Germany)
- Provides good yield, but harms distribution



Daily Average Metrics	NSG Bent-Pipe with Relaxed Duty Cycle
Acquisition Rate (LGN)	475 scenes/day (96.5% of candidates)
ETM+ duty cycle	15.5
ETM+ power cycles	17.8
SSR Capacity Rejects	0
ETM+ Duty Cycle Rejects	16.4

# Landsat 7 Models

- Relaxed ETM+ duty cycle constraints (105%)
- Current LGN contacts plus NSG (Germany) + JSA (South Africa)
- Additional stations
  - ◆ Guaranteed IC coverage results in more duty cycle rejections
  - ◆ Removes flexibility in placement of rejections
  - ◆ Additional ground stations would require duty cycle relaxation of as much as 119%
  - ◆ Remove guaranteed IC cover would improve distribution of scenes
- Interval ends (coasts) have greatest duty cycle cost



Daily Average Metrics	JSA + NSG Bent-Pipe with Relaxed ETM+
Acquisition Rate (LGN)	469 scenes/day (95.3% of candidates)
ETM+ duty cycle	15.3%
ETM+ power cycles	17.9
SSR Capacity Rejects	0
ETM+ Duty Cycle Rejects	22.4

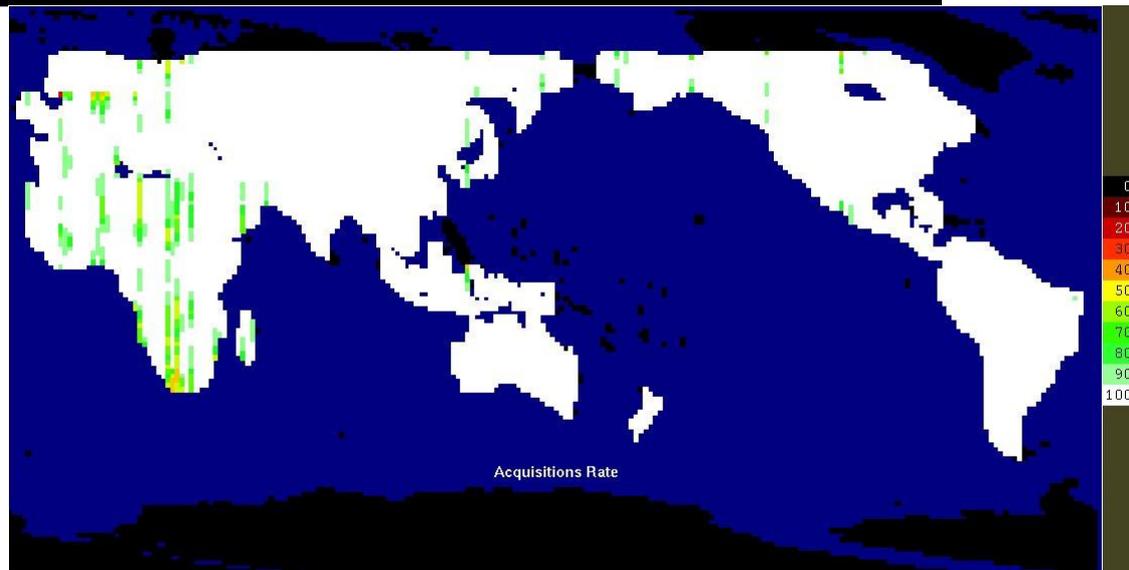
# Model Result Summary

Daily Average Metrics	Baseline	Relaxed Duty Cycle (105%)	+ NSG	Relaxed Duty Cycle (105%) + NSG
Scenes/day	460	475	459	475
% Candidates	93.4%	96.5%	93.3%	96.5%
ETM+ duty cycle	15.0%	15.4%	15.0%	15.5%
ETM+ power cycles	17.9	17.3	18.0	17.8
SSR Capacity Rejects	0.23	1.75	0	0
ETM+ Duty Cycle Rejects	31.5	15.0	32.2	16.4

- **To achieve gains the Duty Cycle needs to be relaxed**
- **Adding Ground Stations alone limits effective distribution of acquisitions**
- **A combination of a 105% reduced duty cycle and adding NSG as a “bent pipe” LGN station is good compromise (Extra channel at SGS also works).**
- **Additional tuning will be needed to prevent the excessive lost of images in some coastal areas, which will have a duty cycle cost elsewhere**
- **As we approach End-of-Mission, should we loosen constraints more?**

# Landsat 7 Models

- Relaxed ETM+ duty cycle constraints (unconstrained)
- All rejections are caused by memory constraints
- How far do we want to push the system?
- What is the value of the extra images (26 images/day)
- Clip North to row 16 eliminates duty cycle constraints....



Daily Average Metrics	Unconstrained
Acquisition Rate (LGN)	486 scenes/day (98.8% of candidates)
ETM+ duty cycle	15.85%
ETM+ power cycles	17.25
SSR Capacity Rejects	5.2
ETM+ Duty Cycle Rejects	0

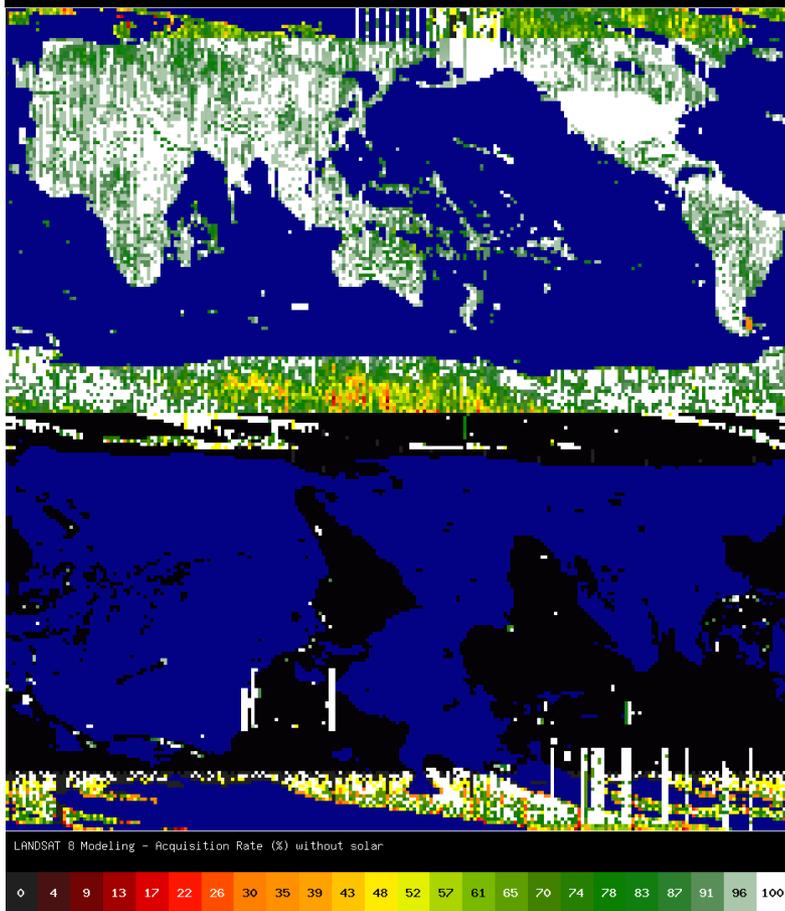
# Landsat 8 Evolution

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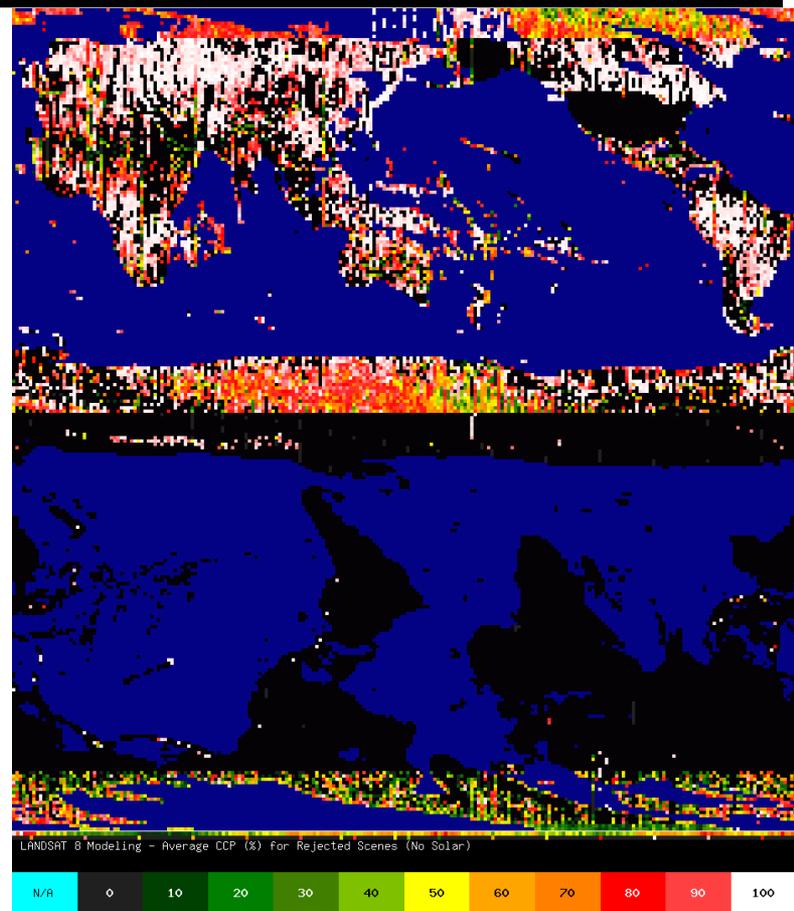
- **Current status (Oct 2014 – Jan 2015 at 725 images/day)**
  - ◆ Acquiring 422 of mid-latitude day-lit land scenes (98% of candidates)
    - beyond 54° Latitude (rows 20 and 105) there is more than 50% sidelap yielding an 8-day revisit period
  - ◆ Acquiring 274 of high-latitude day-lit land scenes (91%)
  - ◆ Acquiring 9 descending day-lit water scenes/day (99%)
  - ◆ Acquiring 11 special request ocean images/day (88%)
  - ◆ Acquiring 10 special request night images/day (92%)
  - ◆ Acquiring 7 special request day-lit ascending images/day (90%)
- **Opportunities**
  - ◆ Increase night, ocean, ascending imaging within current daily limits?
    - By how much? Current average 28 images/day (5%)
    - Currently zero sum game: more special requests fewer core images
  - ◆ Acquire all descending day-lit land scenes?
    - If we acquire all descending day-lit land images, how many night, ocean, ascending images should be acquired?

# Landsat 8 Acquisitions

2014-01-28 – 2015-01-27



- Percent acquisitions



- Average Cloud Cover Prediction for rejected scenes

# Landsat 8 Choices

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- **Request permission to acquire all land?**

- ◆ What are the additional download and storage costs?
- ◆ What is the value of the additional high-latitude data?
- ◆ Are there health and safety issues?

- **Night images**

- ◆ What is the value to the Landsat user community?
- ◆ Is the night imaging community well represented in the LST?
- ◆ There will always be physical constraints on night imaging.
  - Plans are in place to reduce constraints, but these won't be in place until Fall 2015
  - We are acquiring 10 images/night with no problems.
  - We have tested 90 images/night with problems
  - Any increase would be at the expense of high latitude data.

# Landsat 8 Choices

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## ● Ocean images

- ◆ What is the value to the Landsat user community?
- ◆ We are currently acquiring 20 images/day – mainly NOAA, large Gulf of Mexico request, Arctic and IC requests.
- ◆ What is a reasonable cap to prevent overwhelming land imaging? Plus some pressure to increase Landsat 7 ocean acquisitions which has duty cycle implications.

## ● Ascending images

- ◆ What is the value to the Landsat user community?
- ◆ We are currently acquiring 7 images/day – Arctic/Antarctic
- ◆ What is a reasonable cap...

# An Evolving Scheduling Paradigm

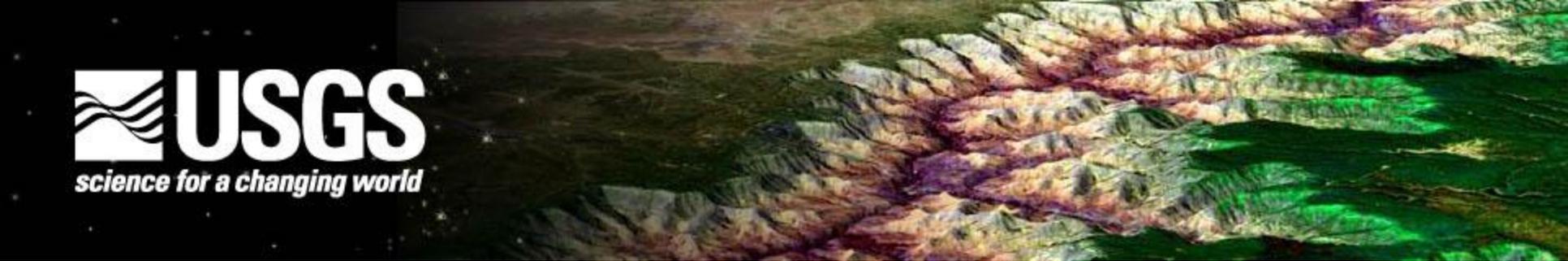
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## ● Landsat 7

- ◆ Maximize repeat coverage of continental land masses
- ◆ Maximize health and safety of mission
- ◆ Coordinate acquisitions with Landsat 8
- ◆ Increase ground station contacts and relax duty cycle constraints to maximize acquisitions between now and end-of-mission

## ● Landsat 8

- ◆ Remove daily-limit from descending day-lit land scenes?
- ◆ Is the philosophy of acquiring all mid-latitude scenes sound?
- ◆ How do we set limits on special requests?
  - Most special requests will be for emergency response, ascending, night and ocean scenes
  - Adjudication of special requests, if we open User Portal to all?

The top of the slide features a topographic map of a mountainous region, with colors ranging from green and yellow to purple and blue, indicating elevation and terrain features.

# Thank You!

## Questions?