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Landsat Science Team: Landsat 10 and Beyond Synthesis, Questionnaire & Discussion

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Landsat Science Team: Landsat 10 and Beyond Synthesis Overview

Forms of feedback for synthesis:

- (1) Individual LST member contributions via a power point slide
- (2) LST working groups: temporal, spatial, spectral & radiometric requirements
- (3) LST short questionnaire designed around temporal, spatial, spectral & radiometric requirements

End goal of the synthesis:

- To obtain evidence-based information from the LST to support drafting of a Landsat 10 and beyond measurement science requirements recommendation.

Landsat Science Team Member Feedback

L10 thoughts summary: single mission continuity, higher spatial & temporal resolution, new veg. bands

(David Roy)

Spectral

- reflective λ bands as L8 OLI - observation continuity
- add new red-edge bands - canopy chlorophyll content retrieval (MERIS, Sentinel-2 heritage) + perhaps narrow 760nm for SIF (OCO-2, GOSAT heritage)
- thermal λ bands as L8 TIRS (2 thermal bands for split-window land surface temperature retrieval) on L10 satellite OR on free-flyer satellite in same orbit ± minutes of L10 - observation continuity, reliable cloud masking and combined reflective & thermal λ applications

Spatial

- 10m / 15m reflective λ bands - better capture human activity, e.g., small holder and sub-field scale agriculture, urbanization, landscape fragmentation; and enable more meaningful integration with high resolution active (e.g., Lidar) and passive (e.g., commercial) data
- (10 / 15 × *n*)m thermal λ bands, where *n*=small integer
- sub-pixel geolocation - time series applications
- drop the panchromatic band as redundant

Radiometric

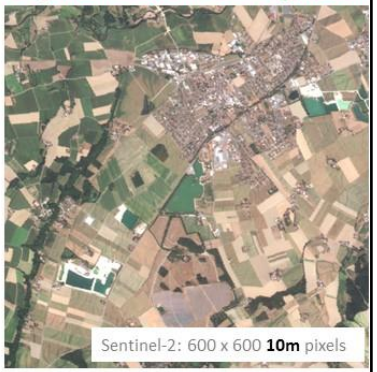
- 12 bit & SNR - observation continuity (or 13-14 bit if can make clear rationale for certain H_20 and ice applications with 10m / 15m pixels)

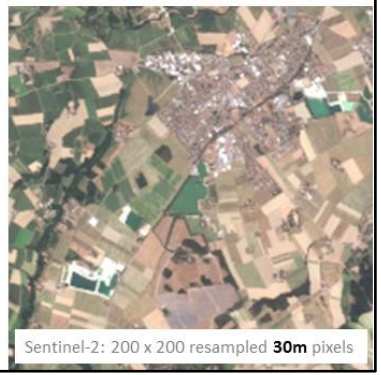
Temporal

- ~10 day repeat (orbit: circular, inclination >90°, diff. altitude and FOV than L8) higher than one-Landsat 16-day and closer to nominal two-Landsat 8-day repeat - change applications & improved cloud-free surface observation; - continuity of global, including polar, sun-synchronous coverage; - expectation that can integrate data with ESA Sentinel-2 & NASA VIIRS class data as needed while providing standalone Landsat mission continuity and U.S. moderate resolution reflective λ sovereignty

Field of View

- Increase FOV from 15° to 22°; trade study to consider increased repeat cycle - swath width - BRDF - image storage complexity - data rate factors





Landsat Science Team Working Group Feedback

SNR impact on science and other stuff

Part 1

John R. Schott, Aaron Gerace, Curtis E. Woodcock, Shixiong Wang, Zhe Zhu, Randolph H. Wynne, Christine E. Blinn, The impact of improved signal-to-noise ratios on algorithm performance: Case studies for Landsat class instruments, Remote Sensing of Environment, Available online 13 May 2016, ISSN 0034-4257, http://dx.doi.org/10.1016/j.rse.2016.04.015. (http://www.sciencedirect.com/science/article/pii/S0034425716301791)

Part 2

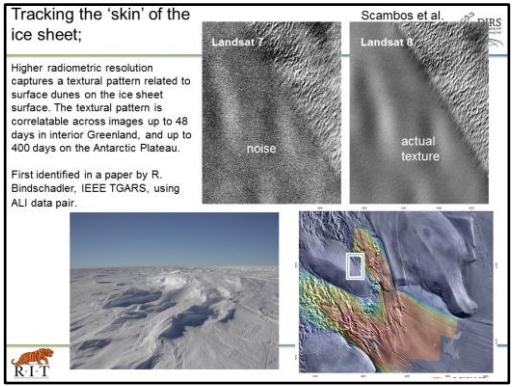
Yongwei Sheng, UCLA

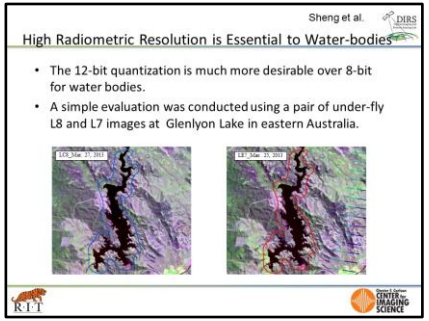
Part 3

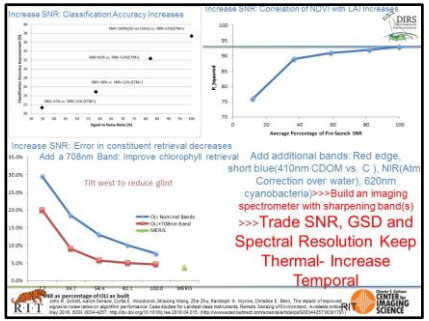
Ted Scambos, NSIDC

Part 4

Ryan Ford, Anthony Vodacek and John Schott, RIT







Landsat Science Team: Landsat 10 and Beyond Question #1

State briefly what your application is:

- (1) Land cover, condition, and change [land use intensity & human systems]
- (2) Characterize forests and change [structure, disturbance, recovery & composition]
- (3) Agricultural monitoring [ET, type, growth, condition, yield & production]
- (4) Vegetation assessments [phenology, condition, & disturbance]
- (5) Expanding application priorities [surface reflectance, water quality, snow/ice characteristics, albedo & burned area]

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Landsat Science Team: Landsat 10 and Beyond Question #2

What is the minimum number of cloud-free observations you need for your Landsat science and application and why ?

- (1) Discrete vs. continuous signals of interest, their cycles, and their variability
- (2) Seasonal phenology vs. rapid change in terms of observational requirements
- (3) Targeted 3-5 day revisit for weekly phenomena that are weather sensitive
- (4) Application/geographic dependences on monthly, seasonal & annual compositing
- (5) Clearly define what a ‘cloud-free’ observation means – considering smoke & haze

Landsat Science Team: Landsat 10 and Beyond Question #3

Beyond continuity, do you require an increase in spatial resolution for your science and applications? If so, what is the optimal visible, near-infrared, and/or shortwave-infrared spatial resolution for your Landsat application, and why ?

- (1) Convergence on 10 meter resolution for VNIR and SWIR bandwidths
- (2) Small scale feature identification and boundary delineation [fields and water bodies]
- (3) Application beneficiaries [food/national security, anthropogenic development/impacts, urbanization, burned area]
- (4) 30 meter spatial resolution is adequate, could sample higher resolution to baseline
- (5) Spatial resolution harmonization with Sentinel-2

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Landsat Science Team: Landsat 10 and Beyond Question #4

Are there new spectral measurements that would enhance your Landsat application without compromising current spectral continuity ? If so, what are they are, and why ?

- (1) Measurements for improved atmospheric correction to surface reflectance
- (2) Measurements for improved cloud detection and screening
- (3) Convergence on narrow red edge, yellow, and SWIR bandwidths
- (4) Spectral resolution improves discrimination of surface types
- (5) Five ‘No’s in the context of land cover classification

Landsat Science Team: Landsat 10 and Beyond Question #5

Are thermal infrared measurements important for your Landsat application ? If so, why ?

- (1) Clear utility for cloud detection and screening
- (2) Useful for surface energy balance, snowmelt detection, evapotranspiration, & water temperatures
- (3) Adds context to time series analysis and studies
- (4) Multiple applications could benefit from improved surface temperature products
- (5) Underutilized measurement with the potential to expand its scientific use

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Landsat Science Team: Landsat 10 and Beyond Question #6

Beyond current specifications, do you have a need for an increase in signal-to-noise? If so, what is it, for what bands, and why ?

- (1) Explicitly ‘No’ eight separate times
- (2) Achieve Landsat 8 OLI’s radiometric performance
- (3) SNR results for required improvements are limited currently
- (4) Target SNRs remain unknown for several applications

Measurement/Application Driven Requirements

Temporal

Spatial

Spectral

Radiometric

Primary = P / Secondary = S Assignments

manage forest	surface reflectance
snow cover extent	calibration
ice morphology	forest dynamics
AG monitoring	forest recovery
forest change	CDOM
water quality	chlorophyll-a
evapotranspiration	snow grain size
land use	veg. phenology
manage water	minerals
soils	urbanization
crop stress	crop growth
land cover	surface albedo
veg. disturbance	aerosols
ecological succession	veg. stress
water vapor	burned area
land use intensity	forest composition
human impacts	crop area
forest structure	ice flow
forest biomass	surface temperature
LAI	fire detection
canopy chlorophyll	deforestation
SIF	snow impurities
cyanobacteria	crop type
drought stress	surface anisotropy
contaminants	crop residue
land change	cloud cover
parcel size	suspended solids

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Requirements Trade Space Example

Temporal

veg. phenology (P)
snow grain size (S)

Spatial

urbanization (P)
parcel size (P)

Spectral

veg. phenology (S)
water quality (P)
snow grain size (P)
water vapor (P)

Radiometric

water quality (S)

Primary = P / Secondary = S Assignments

manage forest	surface reflectance
snow cover extent	calibration
ice morphology	forest dynamics
AG monitoring	forest recovery
forest change	CDOM
water quality	chlorophyll-a
evapotranspiration	snow grain size
land use	veg. phenology
manage water	minerals
soils	urbanization
crop stress	crop growth
land cover	surface albedo
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Objectives for the Landsat 10 and Beyond Discussion

- (1) Build on LST member, LST working group, and LST questionnaire information to structure the discussion
- (2) Reach consensus on a Landsat 10 and beyond report architecture
- (3) Converge on Landsat 10 and beyond measurement requirement priorities
- (4) Agree on the mechanics for contributing to the Landsat 10 and beyond report

Landsat 10 and Beyond Measurement Prioritization

- (X) Add new spectral bands?
- (X) Move towards narrow bandwidth sampling?
- (X) Finer spatial resolution?
- (X) More frequent temporal coverage?
- (X) Improved radiometric performance?

Landsat 10 and Beyond Measurement Prioritization Scoring

LST LANDSAT 10 & BEYOND MEASUREMENT PRIORITIES SCORING

CHOICES: Rank from 1 to 5

____ Add new spectral bands

____ Move towards narrow bandwidth sampling

____ Finer spatial resolution

____ More frequent temporal coverage

____ Improved radiometric performance

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Landsat 10 and Beyond Measurement Prioritization Scoring Results

	R1	R2	R3	R4	R5
Add new spectral bands?	**1**	**3**	**9**	**11**	**0**
Move towards narrow bandwidth sampling?	**2**	**2**	**8**	**6**	**5**
Finer spatial resolution?	**4**	**14**	**4**	**1**	**0**
More frequent temporal coverage?	**17**	**4**	**1**	**1**	**0**
Improved radiometric performance?	**0**	**1**	**2**	**4**	**17**

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