Analysis Results of the NASA Commercial Data Buy

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NASA Small Satellite Data Buy Pilot Project

- The current Pilot Project is the first phase of this Data Buy
- Digital Globe data have been available at NASA GSFC through the NASA-NGA agreement (e.g., some LCLUC Program members used it intensively)
- Planet data have been used by some NASA-affiliated scientists using special agreements on individual basis
- No supervised, systematic evaluation of data quality and value for NASA research and applications has been conducted
- Spire (radio occultation data) is on a different schedule (about 2-month delay), separate meeting, separate results delivery
  - Not discussed in this presentation

Task Development

- The Pilot Project started about 9 months ago
- Short Proposals were submitted to augment the ongoing NASA-funded projects in Research and Applications
- 30+ proposals on LCLUC, Ocean Biology, Cryosphere, etc.
- Goal: to develop a systematic assessment of the commercial data from three vendors

Digital Globe Data Availability Issues

- Data are often unavailable over fire events outside of the United States
- SWIR data are not readily available

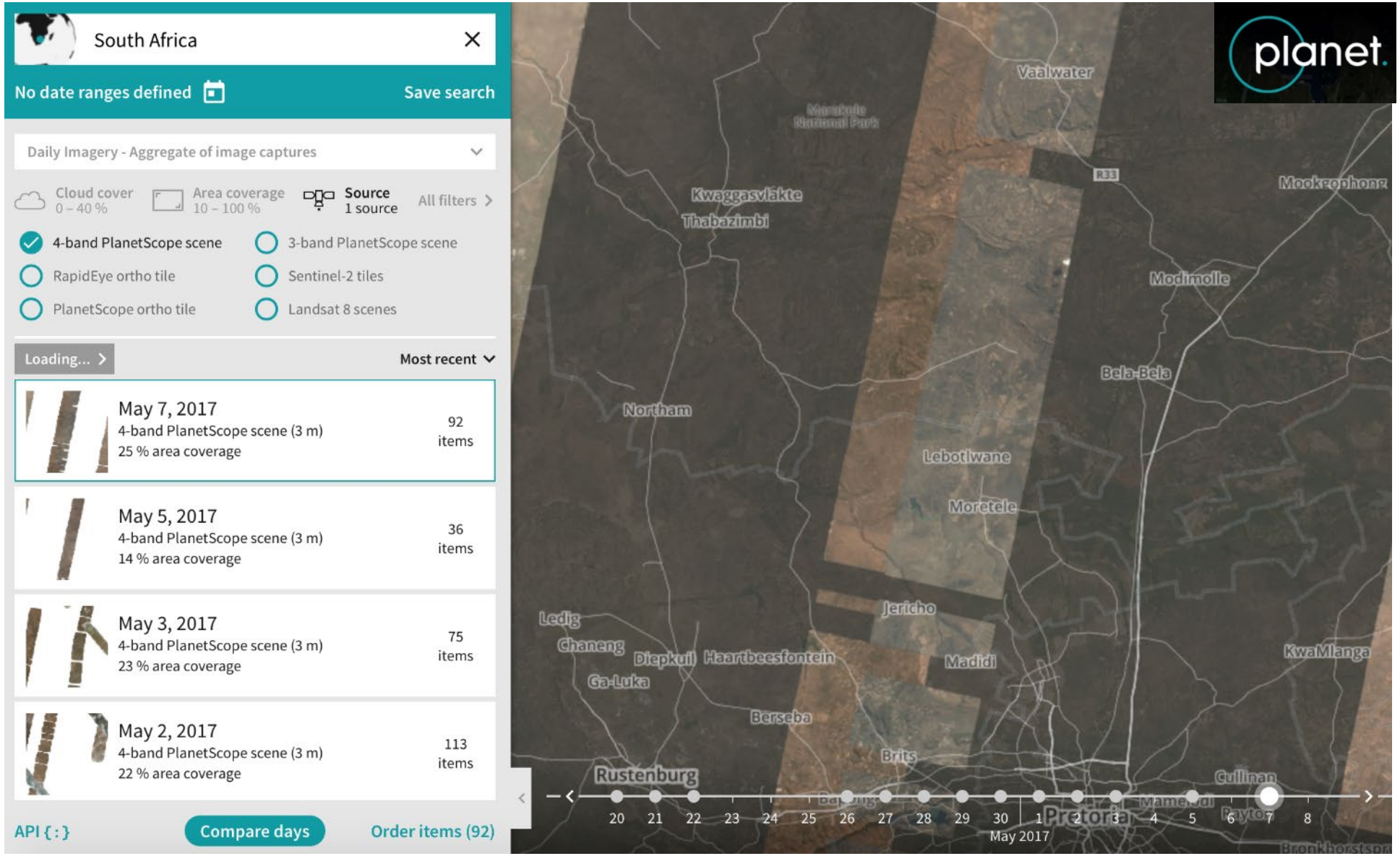
DG Image Quality Issues

- Cloud cover and glint issues: cloud cover and sun angle/view angle thresholding needs improvement
  - Some scenes had much more cloud cover than expected
- Atmospheric correction is a challenge
- WV3 images are often not orthorectified
- Band striping in WV2 scenes
- The SWIR bands are lower spatial resolution & not well aligned with the other WV3 spectral bands
- Spatial offset between tiled sub-scenes
- Calibration
  - Issues with instructions for implementing the latest calibration updates (files are shipped with the original pre-launch calibrations and it is up to the user to implement the latest calibrations)
  - WV2 gain/offset correction was time consuming & had contradictory information
  - WV3 SWIR bands gave negative values over coastal water pixels when converted from Top of Atmospheric reflection using radiometrically corrected coefficient

PlanetScope Availability Issues

- Planet GUI for data downloading has not been too efficient (has had long lag times; the data would be in fetching status for days; limit of 100-scenes per download is a major constraint)
  - **A significant progress has been made on a GUI-based bulk downloader tool (can download up to 10,000 assets at a time)**
- The lack of SWIR data reduces the data usefulness in some applications
- Downloading Usable Data Mask 2 is not possible through the GUI
- However, the methods for downloading, acquiring, and using Planet data as a commercial source are much easier than the current CAD4NASA process for DigitalGlobe

Planet Explorer GUI: easy and intuitive



Planet Image Quality Issues

- Inconsistency (highly variable reflectance values) across multiple days
  - The quality/sharpness of PlanetScope products are not uniform across satellites
- Strong glint effects (very noticeable in water quality studies)
- The geometric correction accuracy is not good in some images over coastal regions
- Band-to-band offsets of several pixels over terrain with nontrivial relief; 1-2 pixel registration errors were noted (for Dove Classic sensors – the parallax issues)
- Cloud issues
  - Some of the water pixels are mis-classified as clouds in the UDM file (glint?)
  - The cloud mask provided in UDM2 is not sufficient to select cloud-free scenes
    - The UDM seems to be missing thin clouds, miss cloud edges, high cirrus clouds, and small "popcorn" clouds and their shadows: UDM captures ~ 30% of clouds/cloud shadows; UDM2 captures ~ 50% (getting completely cloudy images over Greenland)
- Calibration
  - Calibration is not consistent across images
  - NIR data issues: Planet vs Landsat (correlation<0.5) and Sentinel2 (uncertainties up to 0.06 reflectance units)

Evaluation of High Resolution Data For Landslides Studies

PI: Dalia Kirschbaum (NASA/GSFC); Co-I: Pukar Amatya (USRA), Thomas Stanley (USRA), Robert Emberson (USRA)

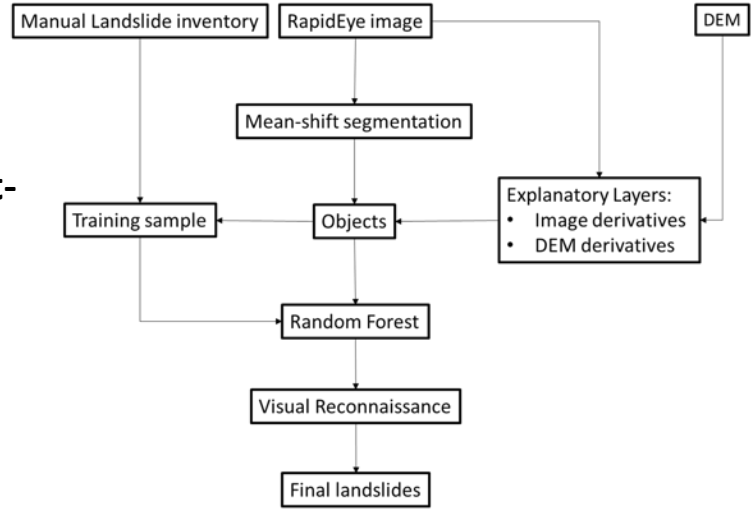
Project Title: Multi-sensor geohazard assessment along key transportation corridors in high mountain Nepal

Objectives:

I. Create multi-temporal landslide inventories along key highway corridors in Nepal.
II. Test the suitability of Planet imagery for landslides related multi-temporal mapping.
III. Demonstrate how Planet imagery could be used to support rapid response landslide mapping.

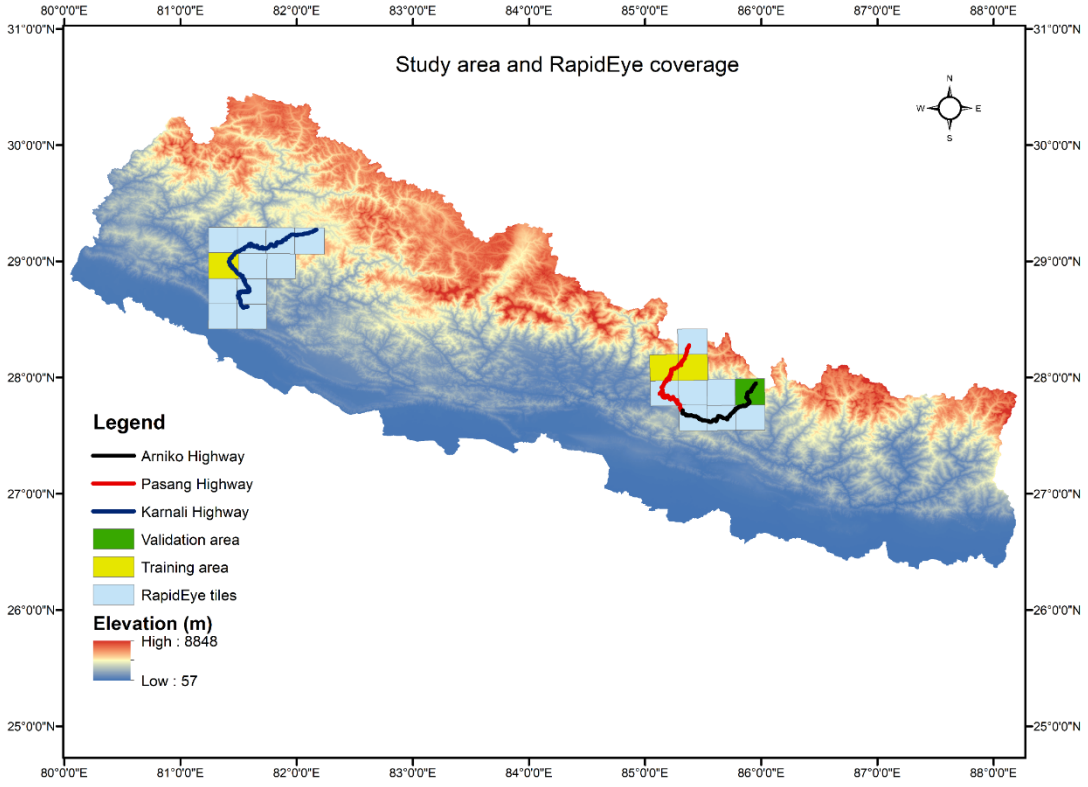
Methodology:

- Landslides mapped using open source Python based algorithm combining object-oriented analysis with machine learning (Random Forest).
- Inventories compiled and validated using machine learning and visual mapping.



Study Areas:

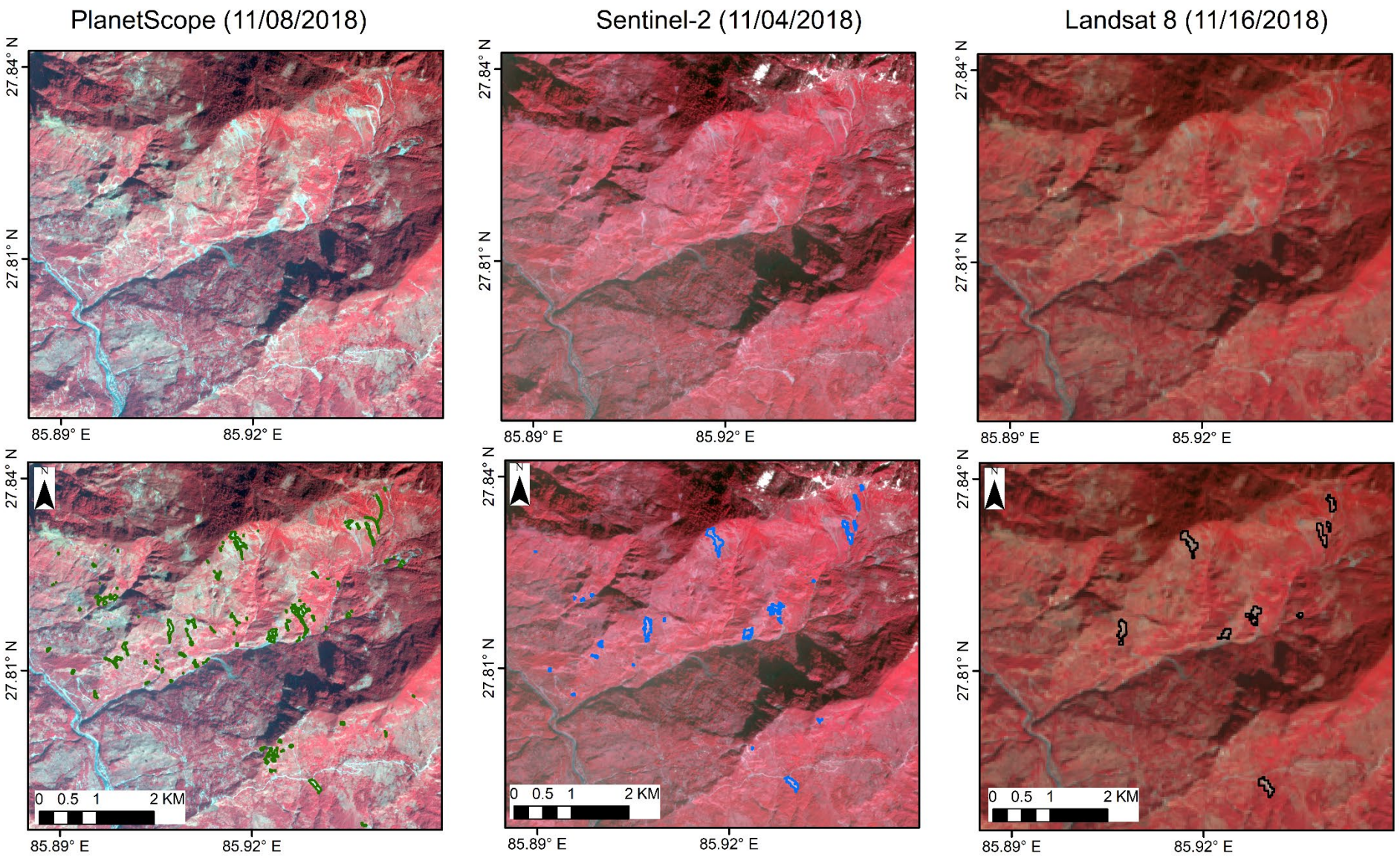
I. Nepal
II. Worldwide in support of disaster events



Highway locations in Nepal and RapidEye coverage.

Landslide Detection along the Arniko Highway, Nepal

Pukar Amatya (USRA) and Dalia Kirschbaum (GSFC)



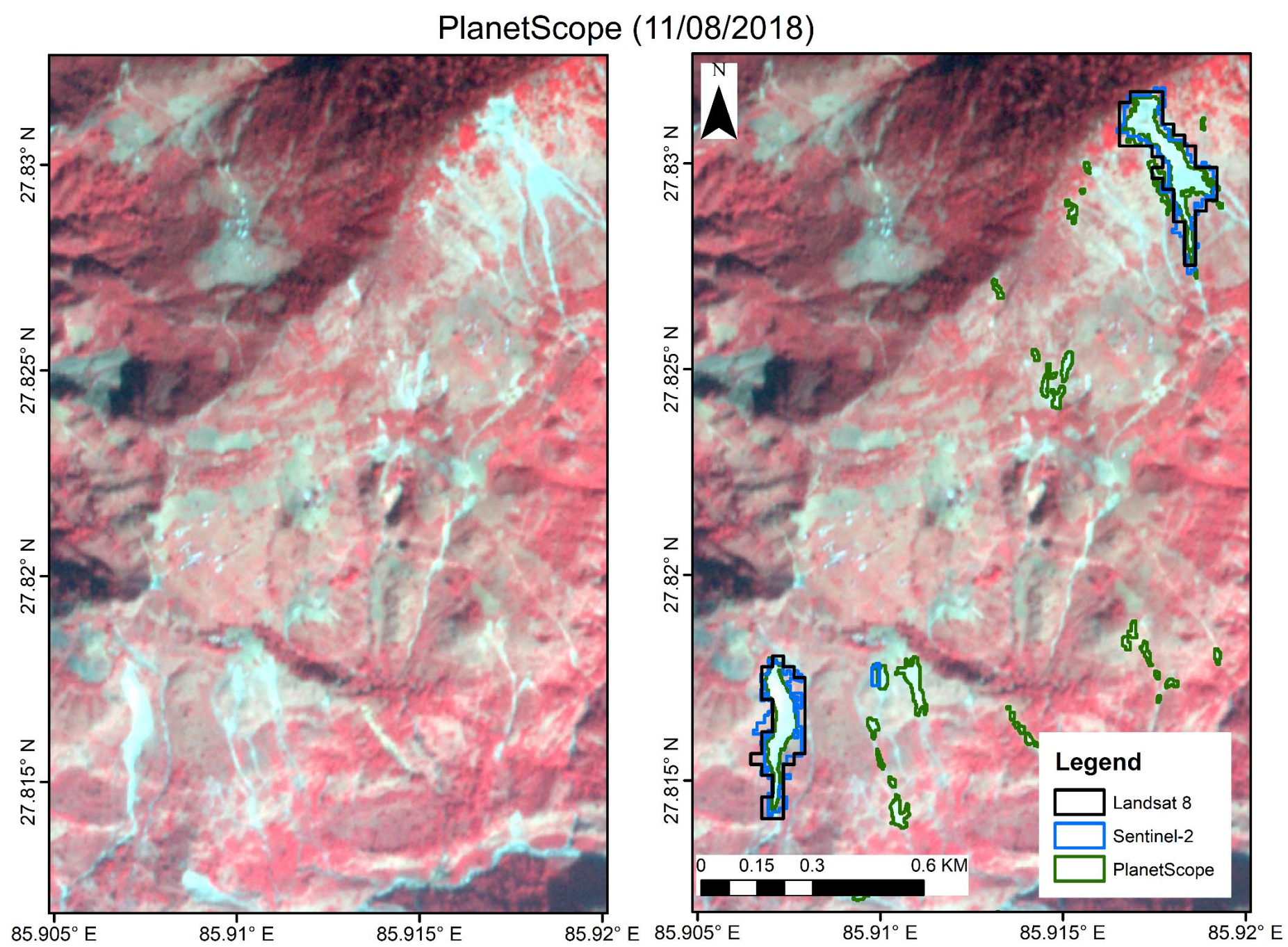
A landslide detection algorithm was developed to rapidly detect landslides. This analysis compares the ability to resolve landslide features for PlanetScope, Sentinel-2 and Landsat 8 over the same region within Nepal. Results highlight that the high resolution of PlanetScope imagery allows us to detect up to 94% more landslides when compared to the other products.

Number of landslides detected:

PlanetScope = 176
Sentinel-2 = 46
Landsat 8 = 11

Percentage of landslides missed relative to PlanetScope:

Sentinel-2 = 74%
Landsat 8 = 94%



In addition to higher percentage of landslides detected, the area delineation is also more accurate compared to Landsat 8 and Sentinel -2.

The algorithm developed as part of this Data Buy activity has allowed us to process PlanetScope and RapidEye imagery over many highways within Nepal as well as map landslides following several extreme weather events.

Having accurate and robust inventories of landslides is critical for improving landslide modeling efforts.

Pukar Amatya (USRA) and
Dalia Kirschbaum (GSFC)

Evaluation of High Resolution Data for Burned Areas Studies

PI: David Roy, Michigan State University
CO-I: Haiyan Huang, Zhongbin Li, Hankui Zhang, Lin Yan, South Dakota State University
Project Title: Commercial satellite data evaluation for burned area mapping & validation of Landsat-8 Sentinel-2 African burned area product

Description of research activity

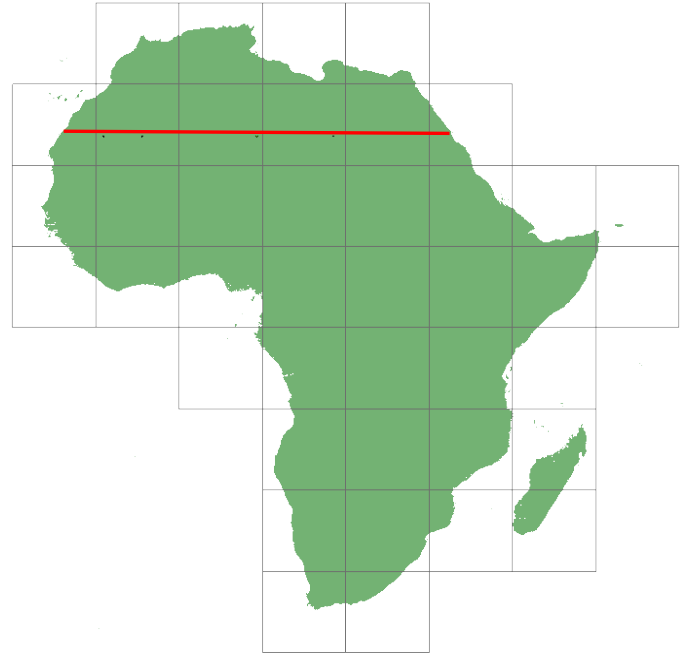
Landsat-8 Sentinel-2 30m burned area product generation

Region

Africa, including Madagascar, south of the Tropic of Cancer (23.44° N)

Evaluation approach(s)

- assess pre-processing needed to enable reliable comparison of the PLANET VIS NIR bands and WorldView-3 VIS NIR SWIR bands with contemporaneous 30m burned area product
- assess spectral and spatial suitability of PLANET and WorldView-3 for burned area mapping
- across a range of environments / fire conditions

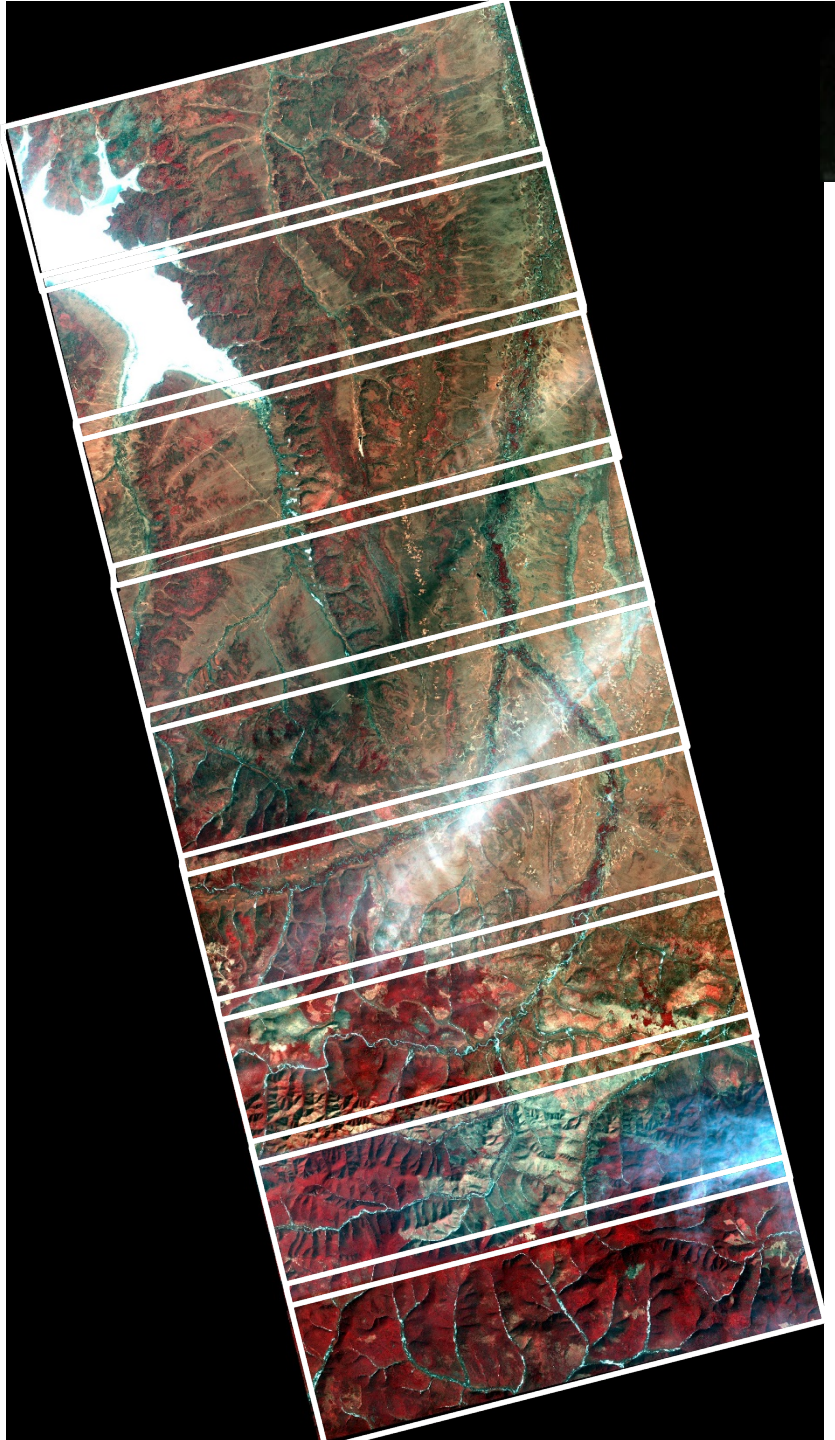


9 PLANET images in the same orbit

each 8500 × 4500 3m pixels
(25.5 × 13.5 km)

False color surface reflectance
(820 nm, 630 nm, 545 nm)

Russia
54.31°N, 127.78 °E
May 4 2018



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each 8500 × 4500 3m pixels
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False color surface reflectance
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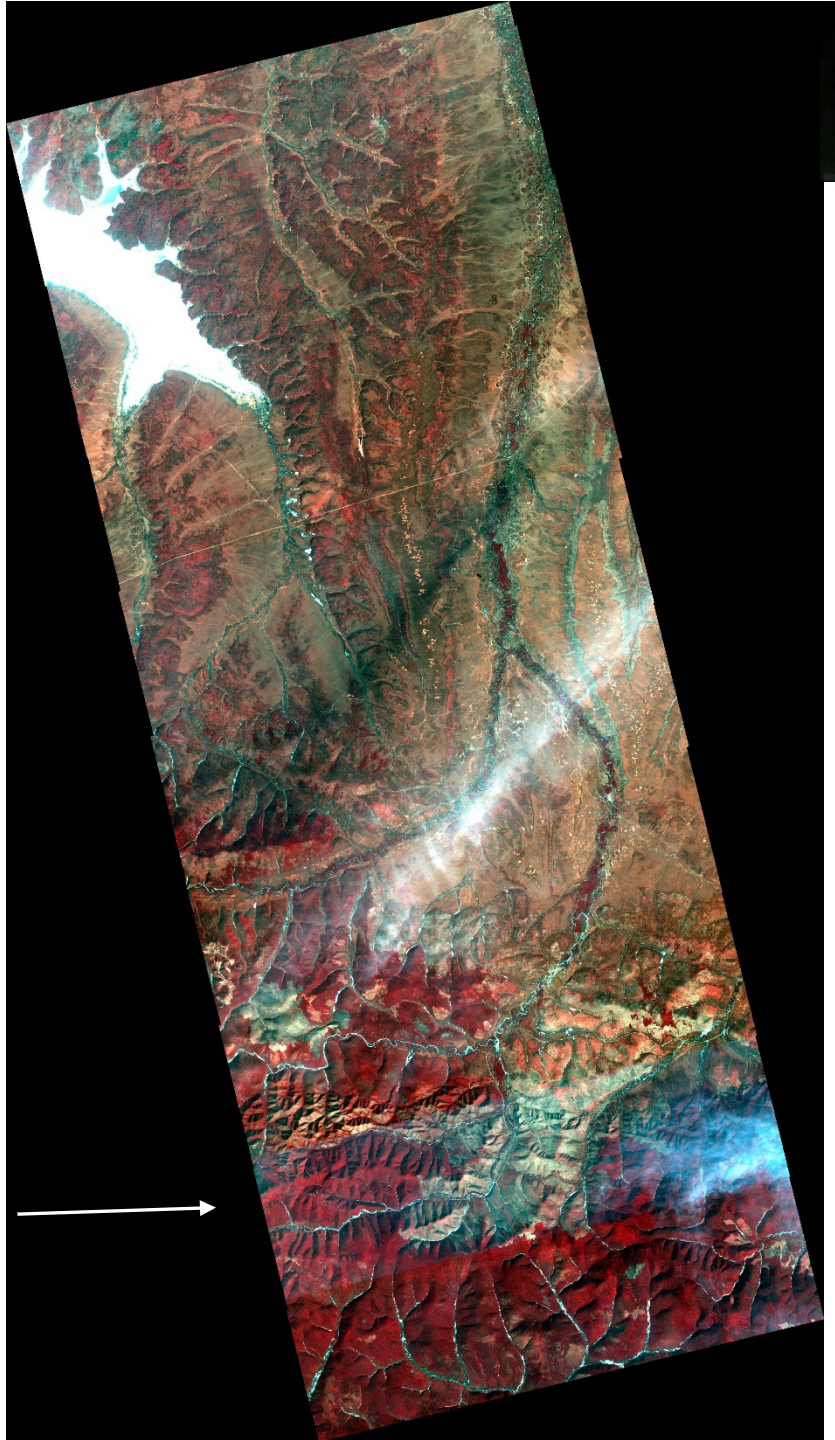
Russia
54.31°N, 127.78 °E
May 4 2018

ISSUE: between image atmospheric correction discontinuities (particularly problematic over high AOD e.g., smoke from fires)

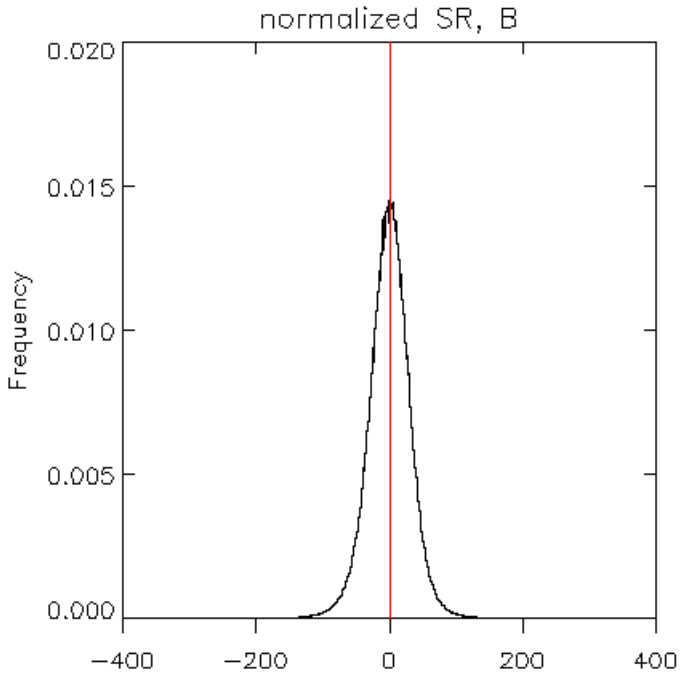


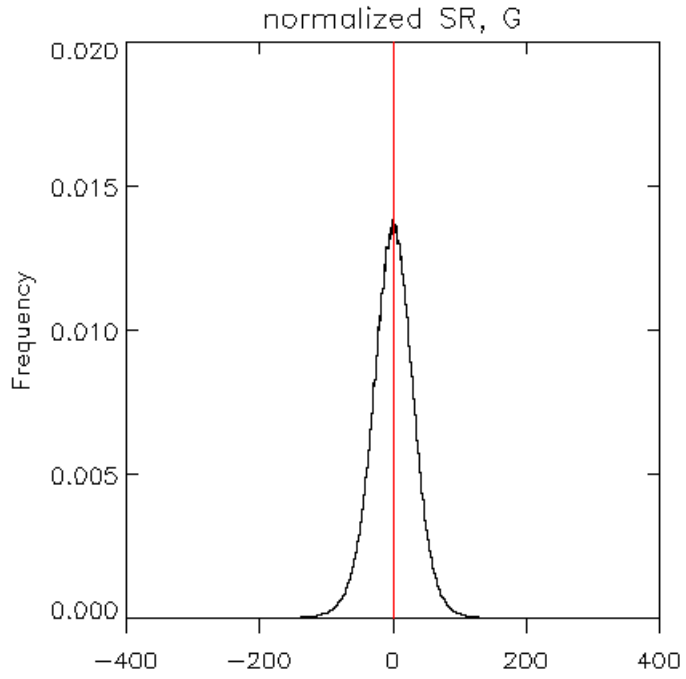
Histograms of surface reflectance differences in the PLANET Image overlap regions

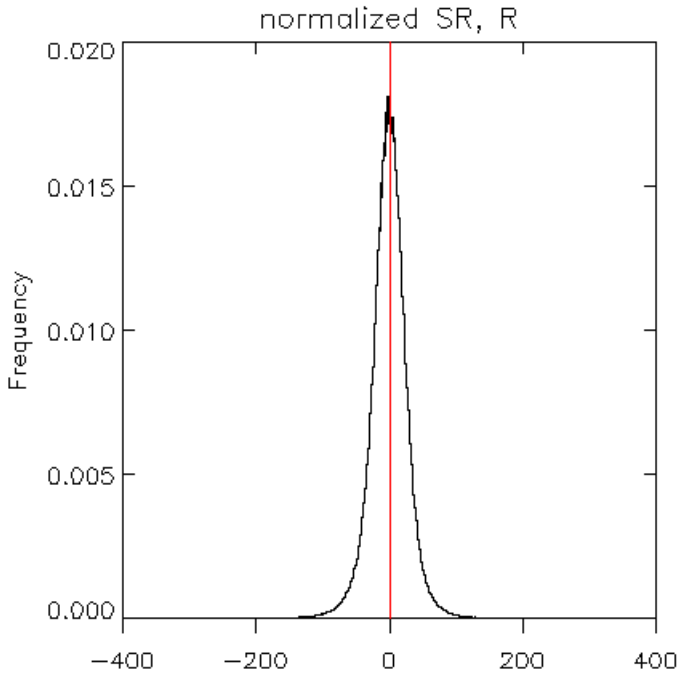
(× 10,000)

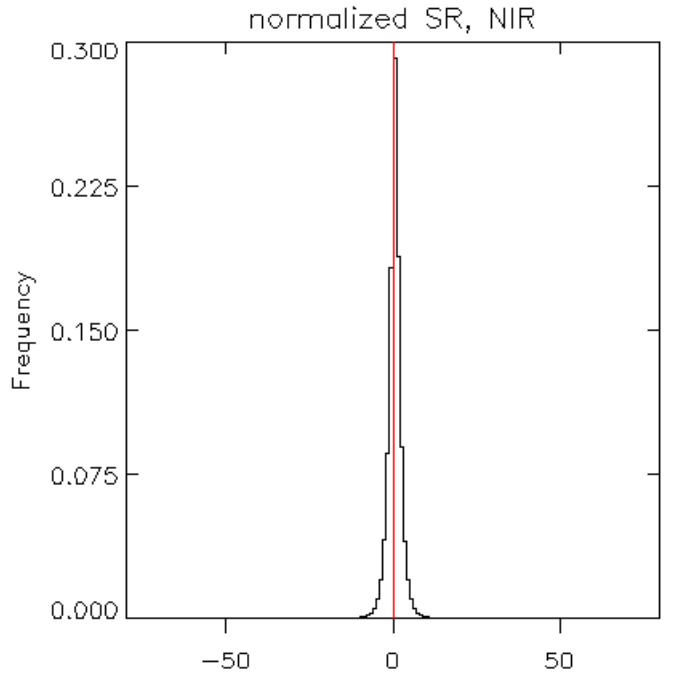
Developed a reflectance normalization least-squares-adjustment (LSA) approach

After Normalization



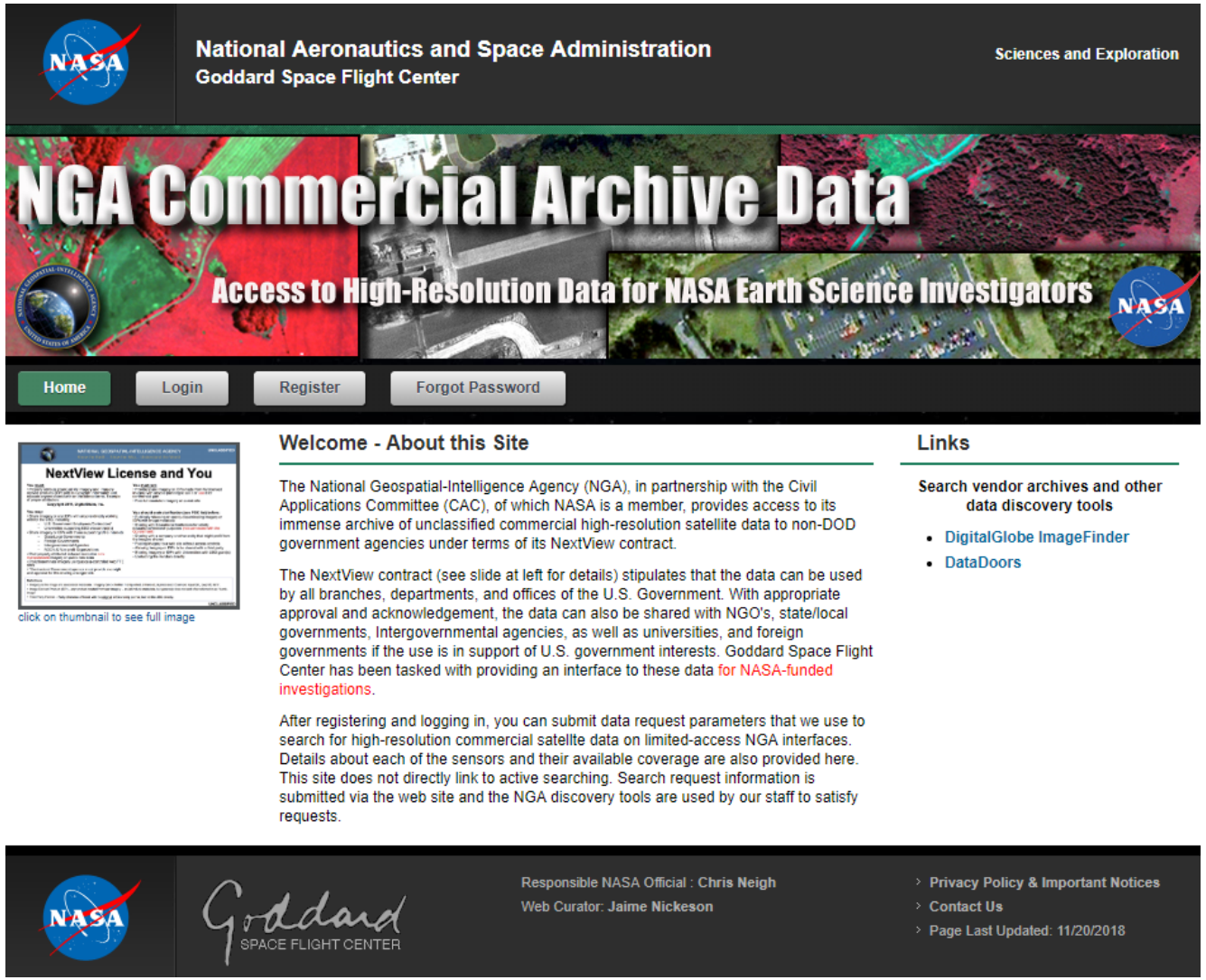






World View 3

NASA CAD access: easy and intuitive



However:

– not able to interactively browse archive contents (“human in the loop” email process)

- slow to find WV3 data where we have contemporaneous PLANET data
- some WV3 spectral bands not in the NASA CAD archive

ISSUE: many WV3 images over burned locations are not orthorectified

Los Padres National Forest
California
December 7 2017

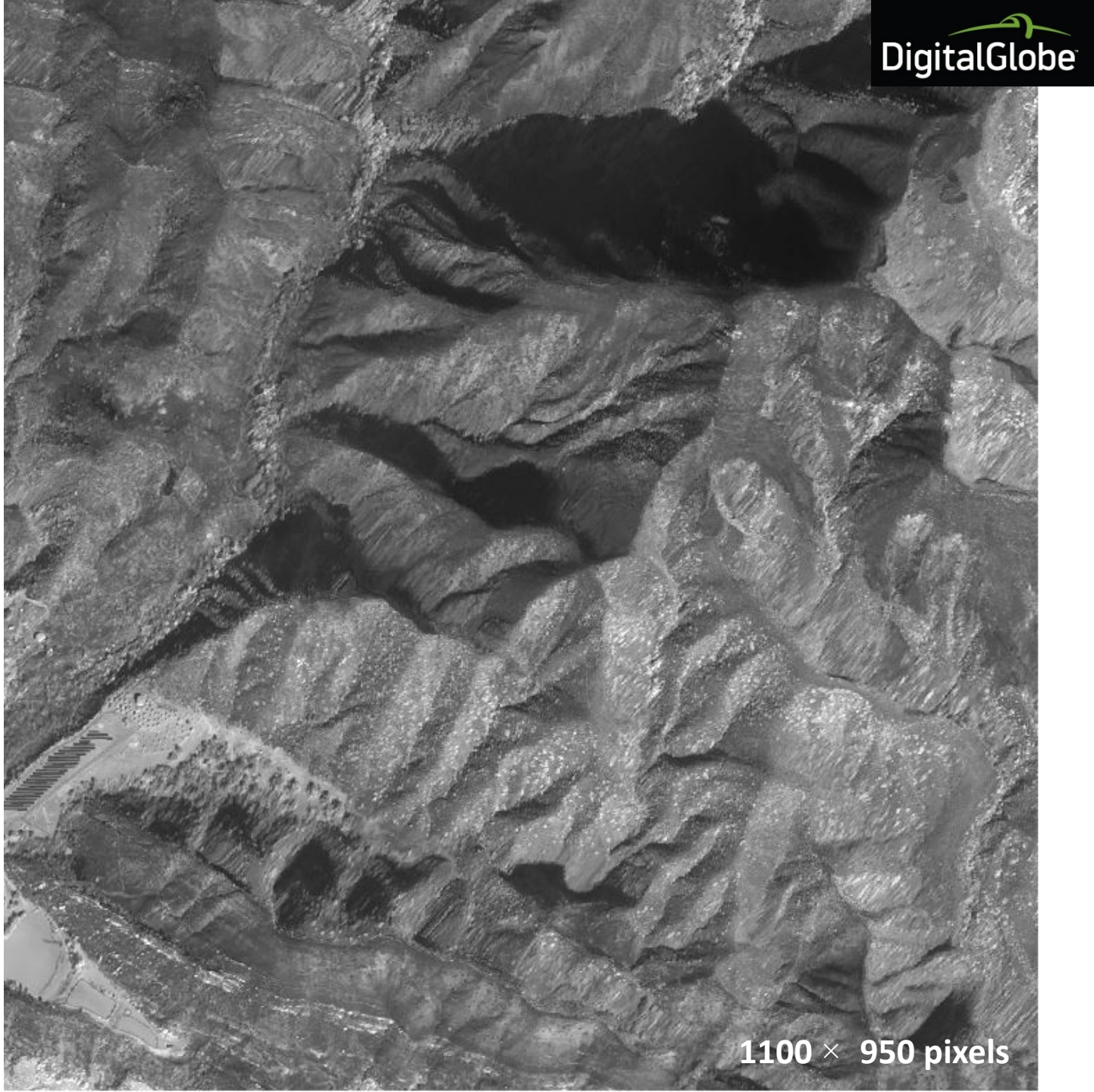
World View 3

1.24 m NIR (948 nm)

Orthorectified using 1/3 arc-sec (~10 m) USGS 3D Elevation Program (3DEP) DEM

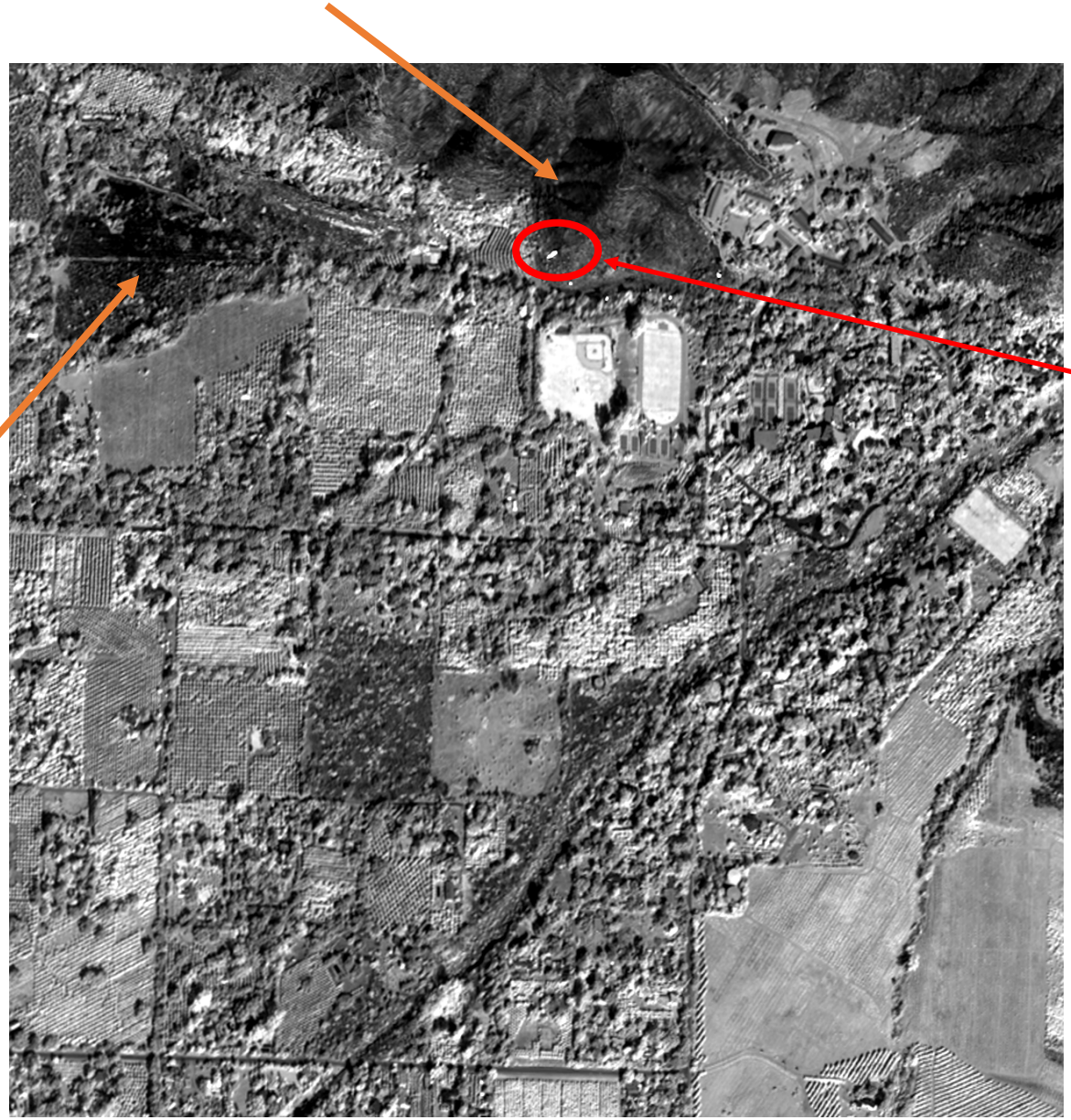
ISSUE: high res. DEM unavailable outside US

Los Padres National Forest
California
December 7 2017



World View 3

1.24 m NIR (948 nm)



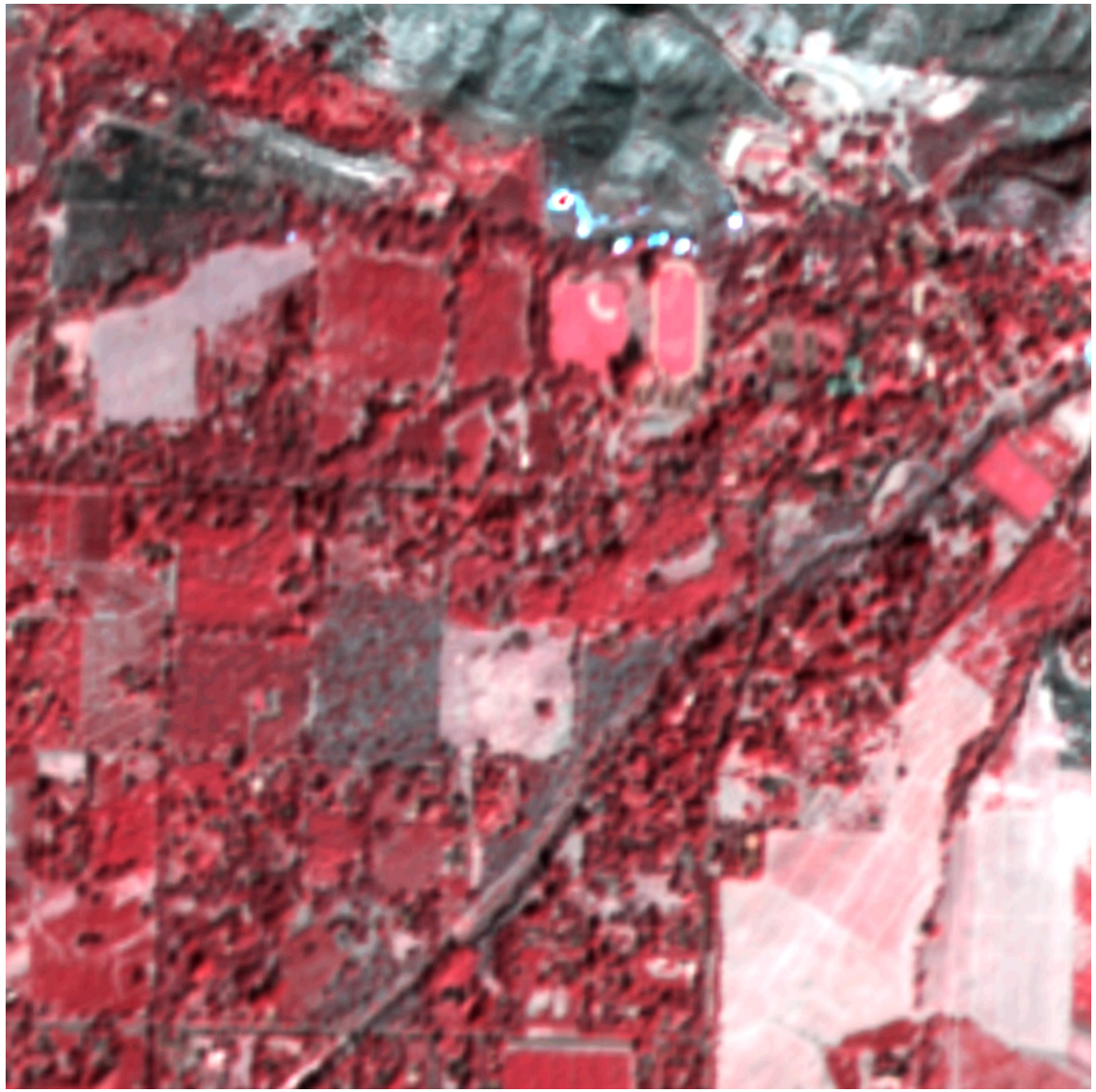
Los Padres National Forest
California
December 7 2017

1.6 × 1.6 km

World View 3

3.7 m SWIR
(1210, 1570, 1660 nm)
Resampled to
1.24 m

ISSUE: SWIR bands lower spatial resolution & not well aligned with other bands



Los Padres National Forest
California
December 7 2017

1.6 × 1.6 km

World View 3

3.7 m SWIR
(1210, 1570, 1660 nm)
Pansharpened and co-registered to 1.24 m

Los Padres National Forest
California
December 7 2017

1.6 × 1.6 km

Planet

3 m NIR (948 nm)

December 4 2017

537 × 537

1.6 × 1.6 km

Los Padres National Forest
California

World View 3

1.24 m NIR (948 nm)

1300 × 1300

1.6 × 1.6 km

Los Padres National Forest
California
December 7 2017

Usefulness: Digital Globe

- WV2 was able to see snow under trees because of the higher spatial resolution => utility in understanding snow in forested areas
- The higher resolution of Worldview 3 (vs Planet) makes it easier to delineate burned area edges
- Allows for much more accurate detection of tree crowns, roads, logging, and other fine-scale resolution of tropical landscapes
- Best Quality
  - higher resolution
  - dependable radiometric quality
  - Reasonable cloud identification
  - Good positional accuracy

Usefulness: Planet

- Using Planet data improved results in
  - urban flood detection - better than using conventional methods and data sources
  - mapping for islands, small-scale agriculture, selective logging, settlement disturbance, macroalgae on the ocean surface
  - both in the spatial structure of crop types & their compositional analysis
- PLANET atmospherically corrected data are more convenient to use and more frequently available than the poorly registered Top of Atmosphere Worldview 3 data (even though the 1.24 m resolution enables more precise burned area delineation)
- Planet imagery's high spatial resolution and temporal frequency makes it ideal for visual displays and delineating the fine edges of burn areas when compared to Landsat (with its low temporal frequency)
- Planet ortho-rectified products are significantly more accurate than their basic products (Decent geolocation of orthorectified products, but not enough for quantitative analysis)

RapidEye and Skysat Data Analysis

- RapidEye
  - Provides a 10-year time series
  - A large percentage of useable images, but much fewer available than from WorldView or PlanetScope
  - Larger images as compared to Planet
  - Red edge bands provide additional advantages for vegetation studies
  - RapidEye radiometric and geometric information look reasonable (as compared to DG WV images)
    - Correction of the images to account for differences due to viewing geometry and BRDF effects is required to increase the usefulness of the time series
  - Sun glint presents problems
- Skysat
  - Usefulness: video
  - Clouds issues
    - Planet's Explorer claimed to have under 20% cloud coverage, but most of the imagery was completely covered by clouds and were unusable for scientific purposes
    - The current Skysat cloud filtering algorithm does not work properly - the old filter (UDM1) is used; the newer, improved, UDM2 filter is only available for Planetscope 4band scenes
  - The georeferencing is inconsistent

Thank you