



# Eliminating the Undifferentiated Heavy Lifting in EO

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SKYWATCH

“Stop spending money on  
undifferentiated heavy lifting.”

- Dr. Werner Vogels, Amazon CTO (2013)

We believe that Earth Observation  
data should be accessible to  
everyone



However, this is currently **cost prohibitive** for most.

Data costs are the largest barrier  
to wide scale EO adoption

But wait a minute...

1000x lower launch costs

100x smaller satellites

100x lower sensor costs

500,000x lower data costs

# 1 GB Data Storage

1990: \$10,000

Today: \$0.02

So why is cost still the largest  
barrier to wide scale EO adoption?

EO Data consumers bear the  
high costs of:

# Minimum order sizes



Painful integrations (often manual)

Slow turn around times

Operators must pass on their  
high costs to be profitable

These **high costs** come from two  
main areas:

# 1. Lack of automation

## 2. Failure to abstract complexity

# A brief history of EO data delivery

1970's:  
Punchcards delivered by truck



1980's:  
Tapes delivered by mail

1990's:  
Desktop GIS emerges,  
niche use cases

2000's:  
50+ EO **satellites** in orbit,  
data storage **costs drop** significantly,  
it's **slow**, with logistical challenges

2010's:

The dawn of cloud computing,  
acceleration of commercial EO,  
venture capital funding

2015-2020:

Rise of low cost, high revisit “good enough” imagery,  
bottlenecked by immature data distribution platforms

2020 and beyond:  
Widespread EO adoption for ML and AI,  
autonomous fulfillment from large market  
driven demand

In this new world, there will be  
winners and there will be losers.

Some organizations have spent tens of millions on data management platforms that deliver very little intrinsic value.



Organizations who abstract this  
undifferentiated heavy lifting will  
ultimately win.

The *old way* of building software:

1. Hire a talented and expensive  
team

2. Build a set of requirements that end up changing over time

3. Execute a project plan,  
encounter obstacles

4. End the project late and over budget, spending big \$\$\$

The **new** way of building  
software:

1. Find a product that does what you need as a cloud service



2. Turn it on today, pay a fraction of what you would to build it yourself

3. Focus the capital you saved on  
your product

Similarly...

The *old way* of delivering satellite  
data:

1. Build large data centres with massive tape storage units and maintain a delicate balance of cost and availability

2. Deal with **slow**, manual,  
**human-based** image processing

3. Build **large** sales teams focused on regional **territories** alongside a network of **resellers**

4. Live with **data** being ordered  
and delivered **days or weeks** apart



5. Struggle with low volumes of customers due to data complexity

The *new way* of managing and  
delivering satellite data:

# 1. Real-time view of global demand

## 2. Robust and highly available data catalog

3. Automated ordering, pipeline processing, and delivery to a customer via API

# 4. Cost optimized cloud storage with low latency

# 5. Collection optimization and predictive demand

# 6. Abstraction



# Case Study

A incumbent's traditional delivery

vs.

An new space startup's machine to  
machine (M2M) delivery

# The Incumbent

# Complex pricing grid

High Resolution Archive Pricing

High Resolution Archive Pricing (50cm)	<u>WorldView-1</u>	<u>WorldView-2</u> <u>WorldView-3</u>	<u>QuickBird</u> <u>(60cm)</u>	<u>GE-1/</u> <u>WV-4</u>	<u>IKONOS</u> <u>(80cm)</u>	<u>Pléiades</u> <u>1A/1B</u>
Panchromatic	\$14.00	\$14.00	\$14.00	\$14.00	\$10	\$12.50
3-Band Pan-Sharpened	n/a	\$17.50	\$17.50	\$17.50	\$10	\$12.50
4-Band Pan-Sharpened	n/a	\$17.50	\$17.50	\$17.50	\$10	\$12.50
Panchromatic + 4-band Multispectral Bundle	n/a	\$17.50	\$17.50	\$17.50	\$10	\$12.50
8-Band Multispectral	n/a	\$19	n/a	n/a	n/a	n/a
8-Band Panchromatic + Multispectral Bundle	n/a	\$19	n/a	n/a	n/a	n/a

Notes:

- The minimum order area for archive imagery, for all sensors, is 25 sq. km with a 2km minimum order width.
- To receive archive pricing, QB,WV2,WV1, GE1 & IK imagery has to be **older than 90 days in archive**. No hold on Pleiades imagery.
- Airbus default licensing is for 1-5 users; DigitalGlobe default licensing is single user -- pricing uplifts apply for additional users.

Source: <http://www.landinfo.com/satellite-imagery-pricing.html>

New tasking option	Priority	Description	Nominal collection window
Priority plus	Very high	Emergency : Tasking is guaranteed within 4days from the order if feasible. No feasibility study report is provided and no guarantee for tasking, cloud cover and/or tilt angle constraint.  Assured : After feasibility study, the tasking on specified date has highest priority among commercial orders. No guarantee for cloud cover.	4 days or specific date
Priority	Higher	Feasibility proposal is provided. if acquisition is not completed during the collection window, user changed its priority to Standard or update collection window to continue acquisition	4 weeks
Standard	Standard	Feasibility proposal is provided if acquisition is not completed with maximum number (10) of acquisitions during the collection window, one image among collections must be purchased.	12 weeks or more

Source: <http://www.si-imaging.com/purchase/>

# Regional Sales Team, Email based sales quotes

## New tasking options

For many image requests, a matching image can already be located in the archives. If no image data is available in the archives, new KOMPSAT-3A images can be ordered and processed.

Search and order process shall be handled by the sales partner. For more information, please contact us by email at [sales@si-imaging.com](mailto:sales@si-imaging.com)

<http://www.si-imaging.com/purchase/>

## Talk to Sales

There's a DigitalGlobe product, service or capability for every geospatial need. Just tell us a little bit about yourself and your requirements and a member of our expert sales team will be in touch.

First Name *	Last Name *
E-mail *	Company/Organization *
Title *	Phone *
Select Country... *	Tell us about yourself... *

<https://www.digitalglobe.com/contact/sales-inquiries>

## DAILY IMAGERY AT YOUR FINGERTIPS

Connecting with a Planet expert is usually the best way to get started. We also have an extensive [Partner Network](#) of resellers and distributors who leverage Planet's unique data offerings to create solutions and services that serve our target markets.

Tell us a little about your interest in satellite imagery and one of our sales experts will follow up.

**Have a technical question?**  
Check our [Frequently Asked Questions](#) page, if you still have questions, reach out to our [Support](#) team.

First Name *	Last Name *
Company *	Job Title *
Industry...	Primary Email *
Phone Number *	
Country	

<https://www.planet.com/contact-sales/>

PDF order forms,  
Offline payments



## Order Form

Customer		Supplier		Contact		Ship To Address	
Phone Number	Purchase Order #			Ship Via	Date Ordered	Date Shipped	Salesperson

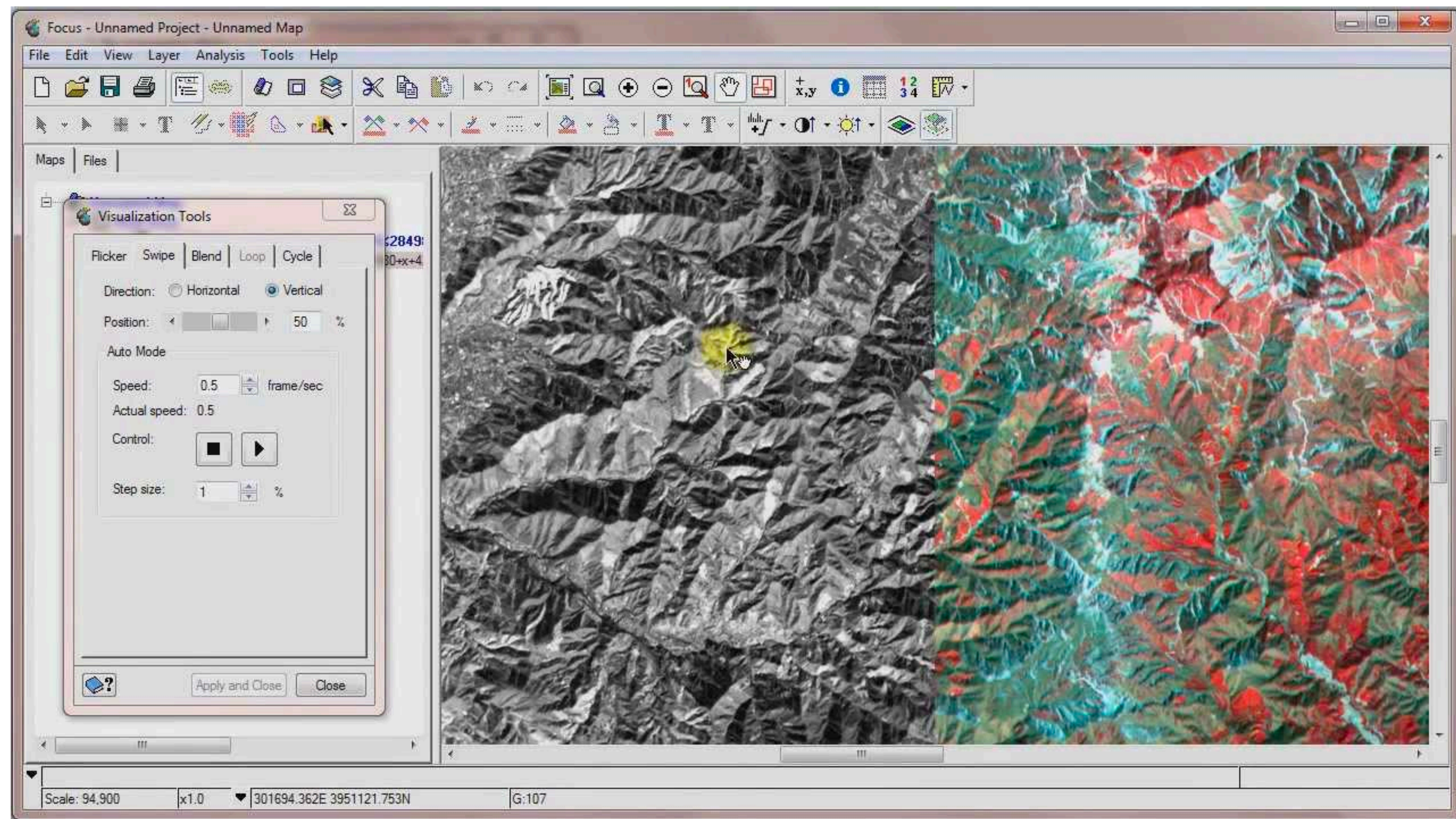
[illegible]

Special Instructions

Sub Total	
Discount	
Sales Tax	
Freight	
TOTAL DUE	

Human-based **manual** image  
processing using **desktop** software





Source: <https://www.youtube.com/watch?v=hw1oZeNRodk>



# FTP Delivery

Remote site: /dl1/RE-RMS1YcmHuGIRfbOT-6545\_ApolloMap\_MNT2

?

/

?

dl1

?

RE-RMS1YcmHuGIRfbOT-6545\_ApolloMap\_MNT2

?

2012-10-09

?

2012-10-12

?

1560108\_2012-10-11\_RE3\_3A\_144104

Filename	Filesize	Filetype	Last modified	Permissions	Owner/Group
..					
2012-10-09		File folder	10/9/2012 8:48:00 AM	drwxr-xr-x	ftp ftp
2012-10-12		File folder	10/11/2012 11:45:00 PM	drwxr-xr-x	ftp ftp
6545_ApolloMap_MNT2_aoi.dbf	77	DBF File	10/11/2012 11:45:00 PM	-rw-rw-r--	ftp ftp
6545_ApolloMap_MNT2_aoi.prj	143	PRJ File	10/11/2012 11:45:00 PM	-rw-rw-r--	ftp ftp
6545_ApolloMap_MNT2_aoi.shp	1,004	SHP File	10/11/2012 11:45:00 PM	-rw-rw-r--	ftp ftp
6545_ApolloMap_MNT2_aoi.shx	108	SHX File	10/11/2012 11:45:00 PM	-rw-rw-r--	ftp ftp
6545_ApolloMap_MNT2_delivery.dbf	13,441	DBF File	10/11/2012 11:45:00 PM	-rw-rw-r--	ftp ftp
6545_ApolloMap_MNT2_delivery.kmz	6,554	KMZ File	10/11/2012 11:45:00 PM	-rw-rw-r--	ftp ftp
6545_ApolloMap_MNT2_delivery.md5	2,900	MD5 File	10/11/2012 11:45:00 PM	-rw-r--r--	ftp ftp
6545_ApolloMap_MNT2_delivery.prj	143	PRJ File	10/11/2012 11:45:00 PM	-rw-rw-r--	ftp ftp
6545_ApolloMap_MNT2_delivery.shp	5,676	SHP File	10/11/2012 11:45:00 PM	-rw-rw-r--	ftp ftp
6545_ApolloMap_MNT2_delivery.shx	428	SHX File	10/11/2012 11:45:00 PM	-rw-rw-r--	ftp ftp
deliver_README.txt	2,589	Text Docu...	10/11/2012 11:45:00 PM	-rw-rw-r--	ftp ftp

Source: <https://apollomapping.com/blog/rapideye-ftp-delivery>

Massive product sizes, no  
industry standard format

**JP2**

**GEOTIFF**

**HDF**

**OGC**

**GRIB**

**WMTS**

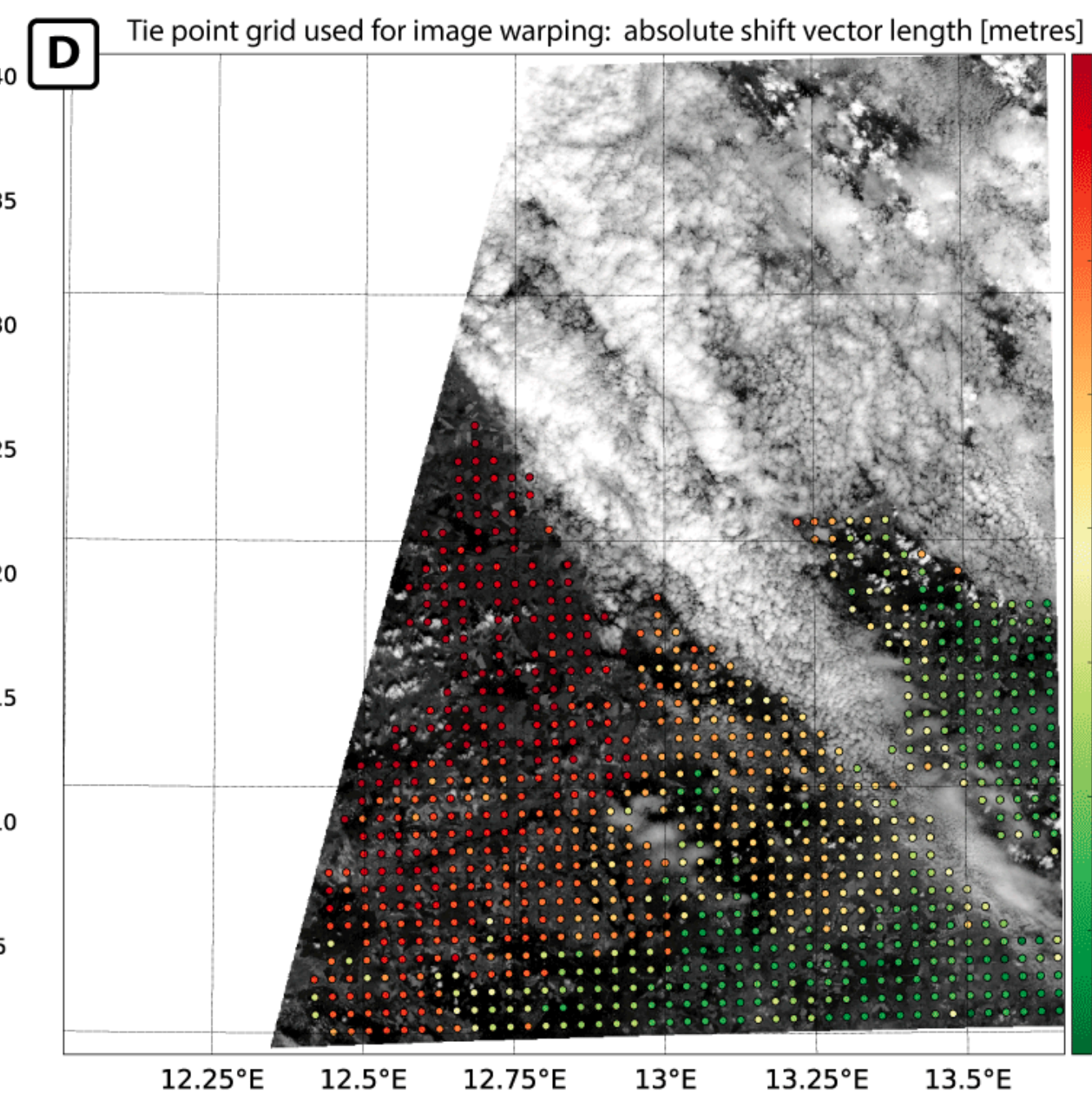
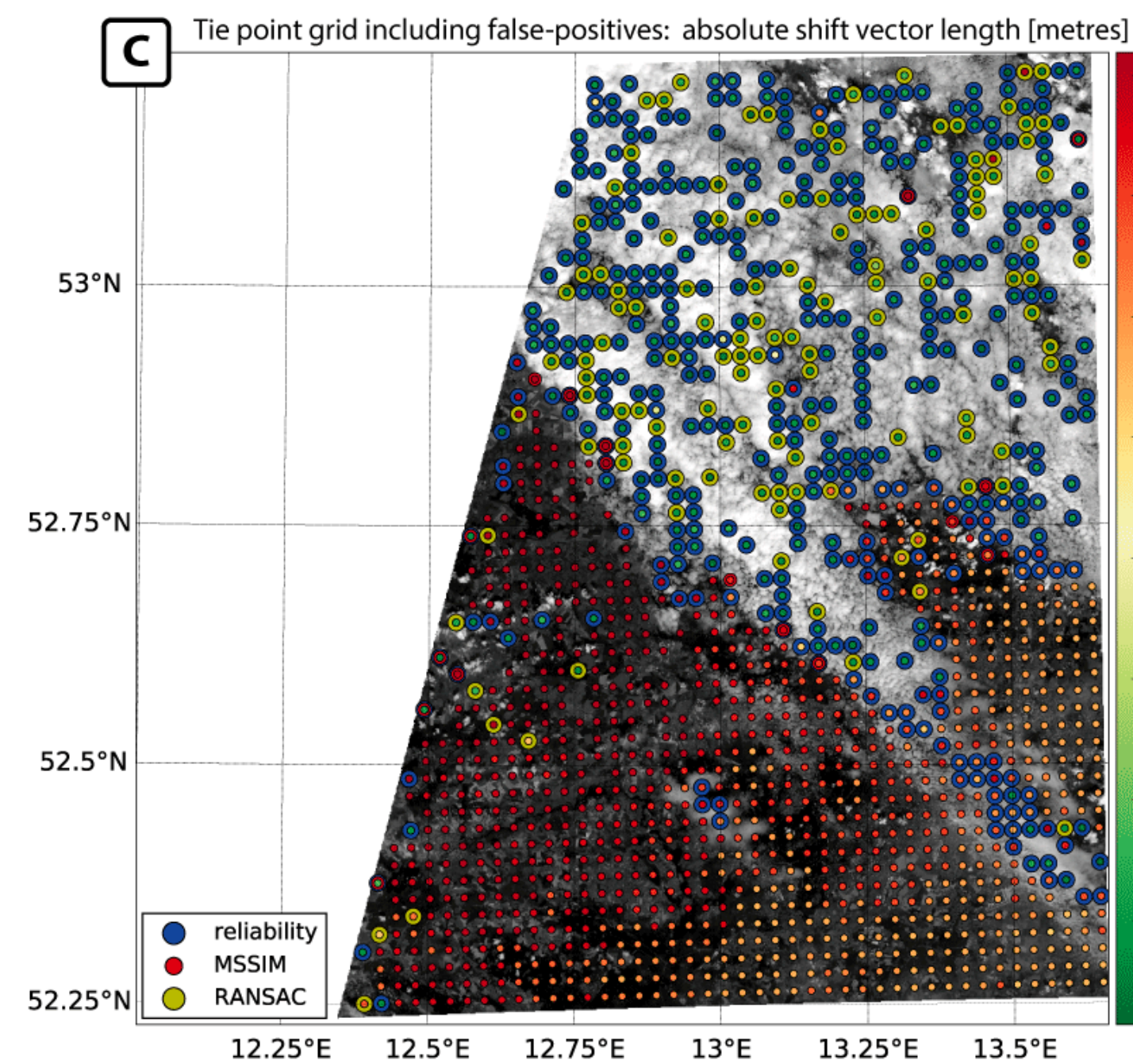
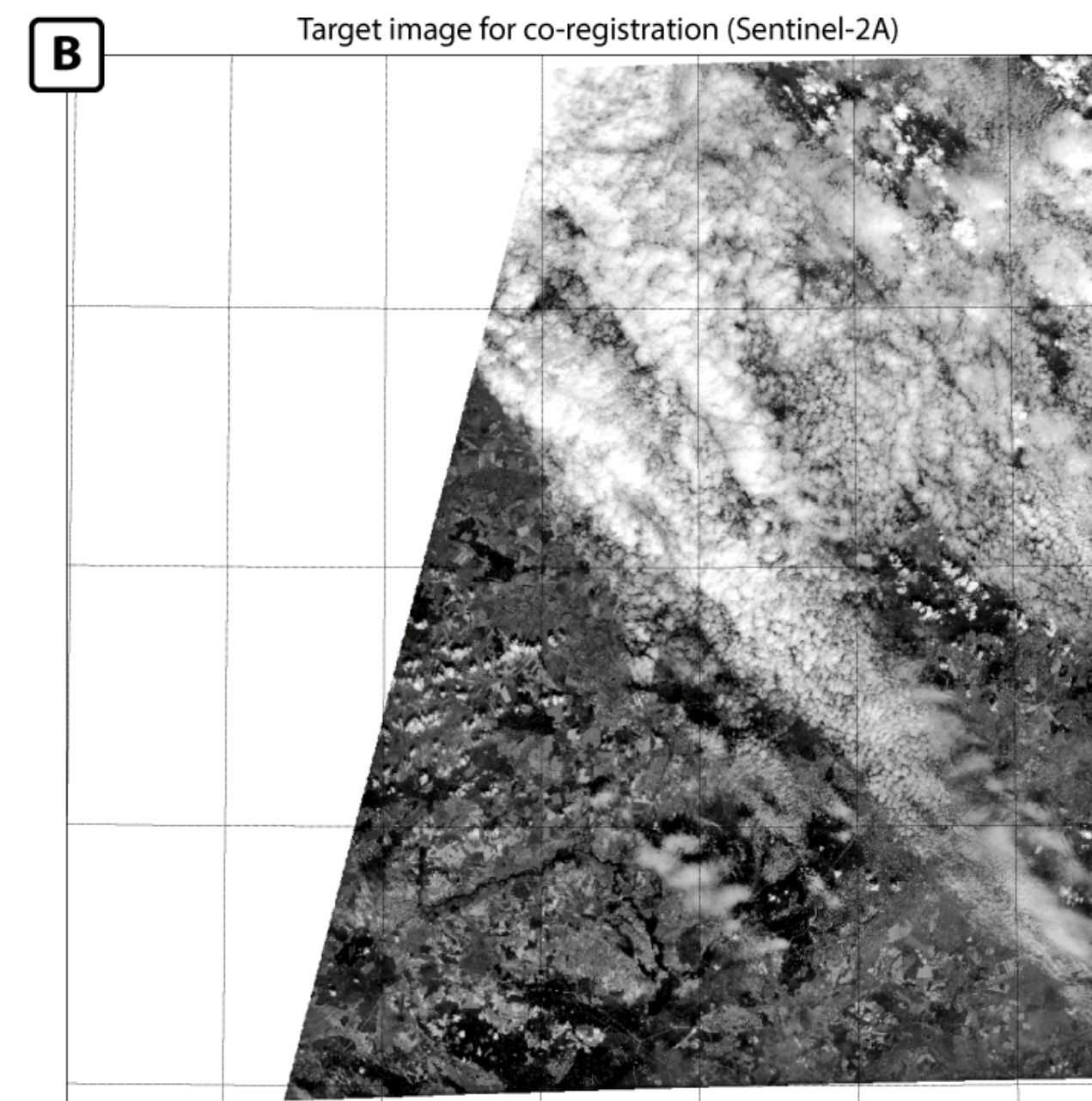
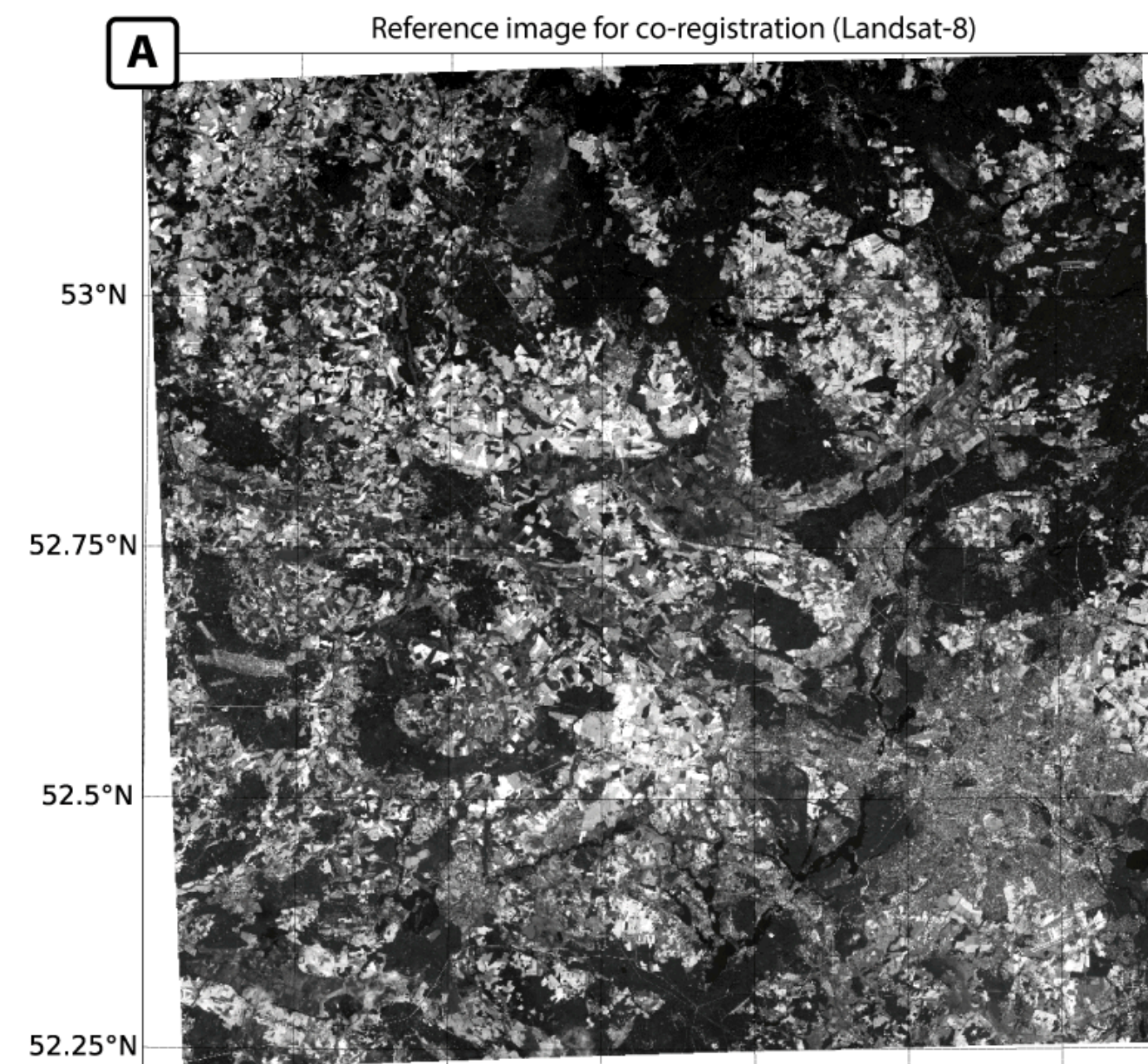
**GEOMS**

**EOSDIS**

**STAC**

# Varying degrees of product accuracy





Source: <https://www.mdpi.com/2072-4292/9/7/676>



# Frustration

# Manual effort

# High Cost

# The New Space Model (M2M)

Instant quotes and feasibility via  
API or web console

A global market with virtually zero  
distribution cost

# Integrated Pay as You Go billing



No minimums

# Automated Processing, Zero Humans

Delivery within minutes of  
acquisition

# Standardized format (ARD)

Co-registered,  
highly accurate

# Simple

# Fast

# Low Cost



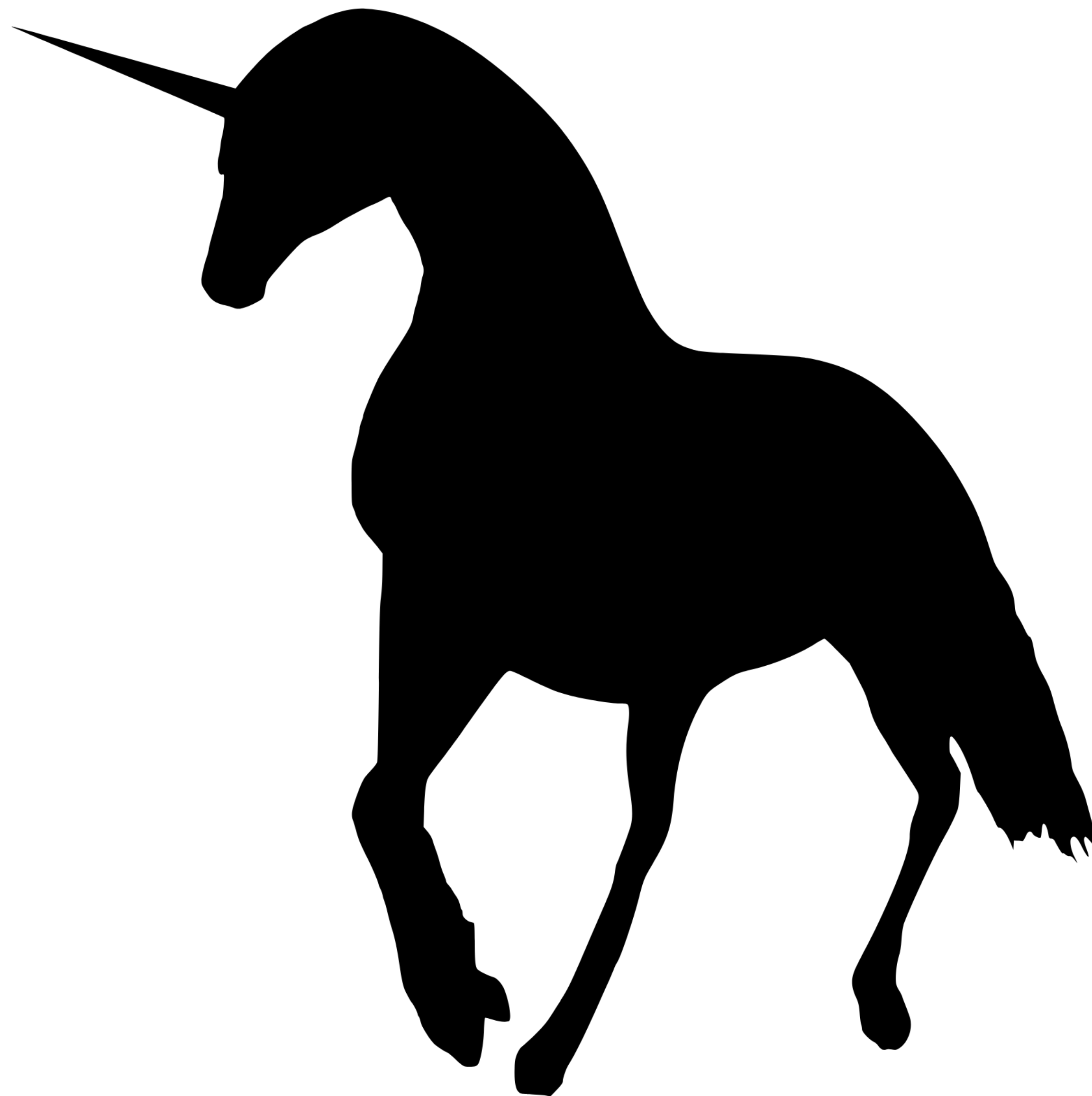
Delighted customers

Now...

I know what you are thinking

Ideas are interesting,  
execution is everything.

This is a concept, right?



Source: <https://svgsilh.com/image/3212222.html>

Actually, this is *available* today.

Let's go behind the scenes on an  
abstracted component



# Automated Processing, Zero Humans

# Serverless microservices

“Big Data” strategy - divide big work  
load into parallel image processing  
transactions

# How does SkyWatch process satellite imagery?

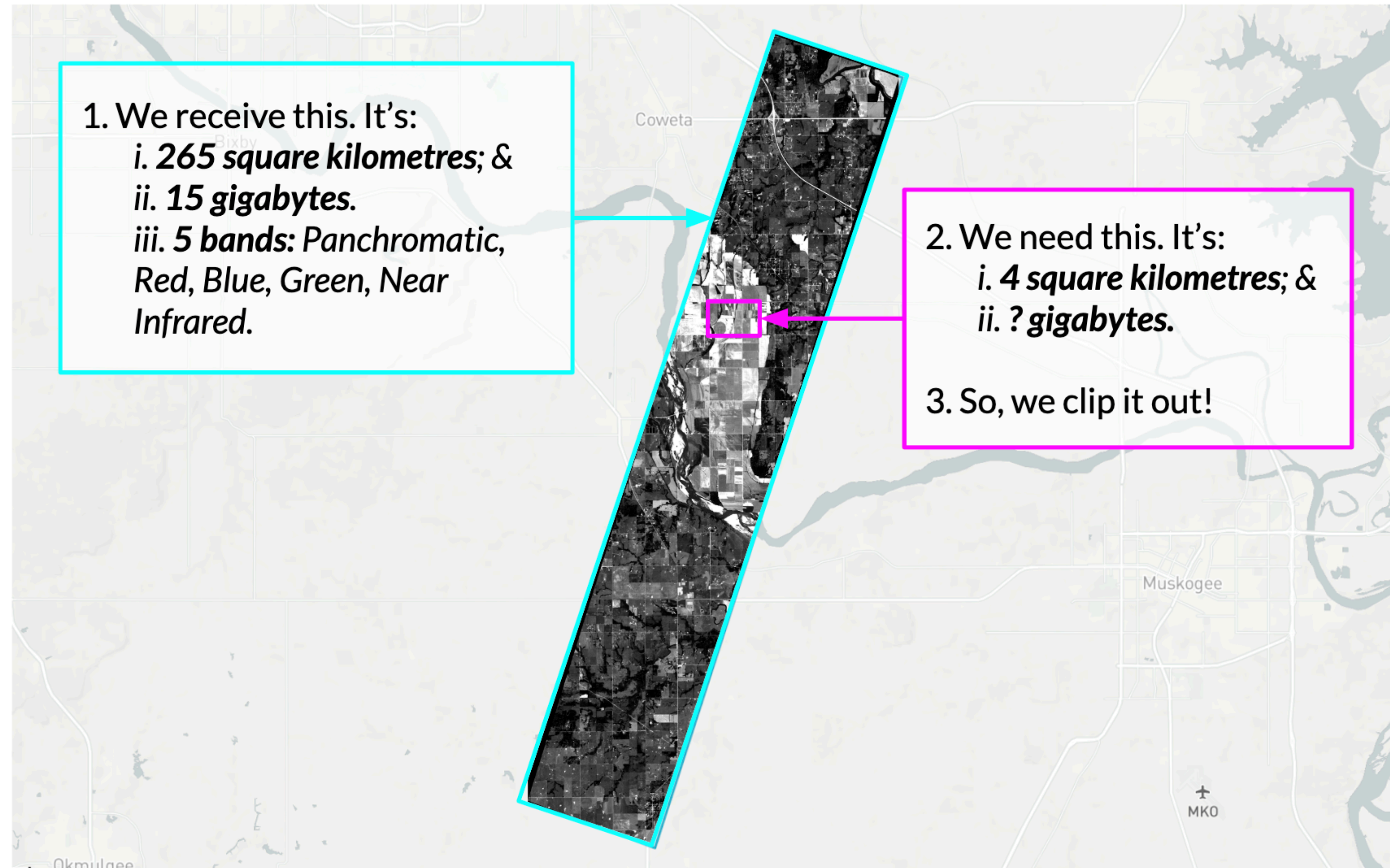
1. Clipping
2. Tiling
3. Band Coregistration
4. Pan-sharpening
5. Atmospheric Correction
6. Cloud Masking
7. Image Enhancements
8. Orthorectification
9. Geo-referencing
10. Tile Assembly
11. Export

## Use Case:

Delivering a high-resolution Normalized difference vegetation index (“NDVI”) of a farm in Oklahoma. The end result can be displayed in a web, iOS, or Android-based application, or inputted directly into the firmware of an autonomous farm vehicle.

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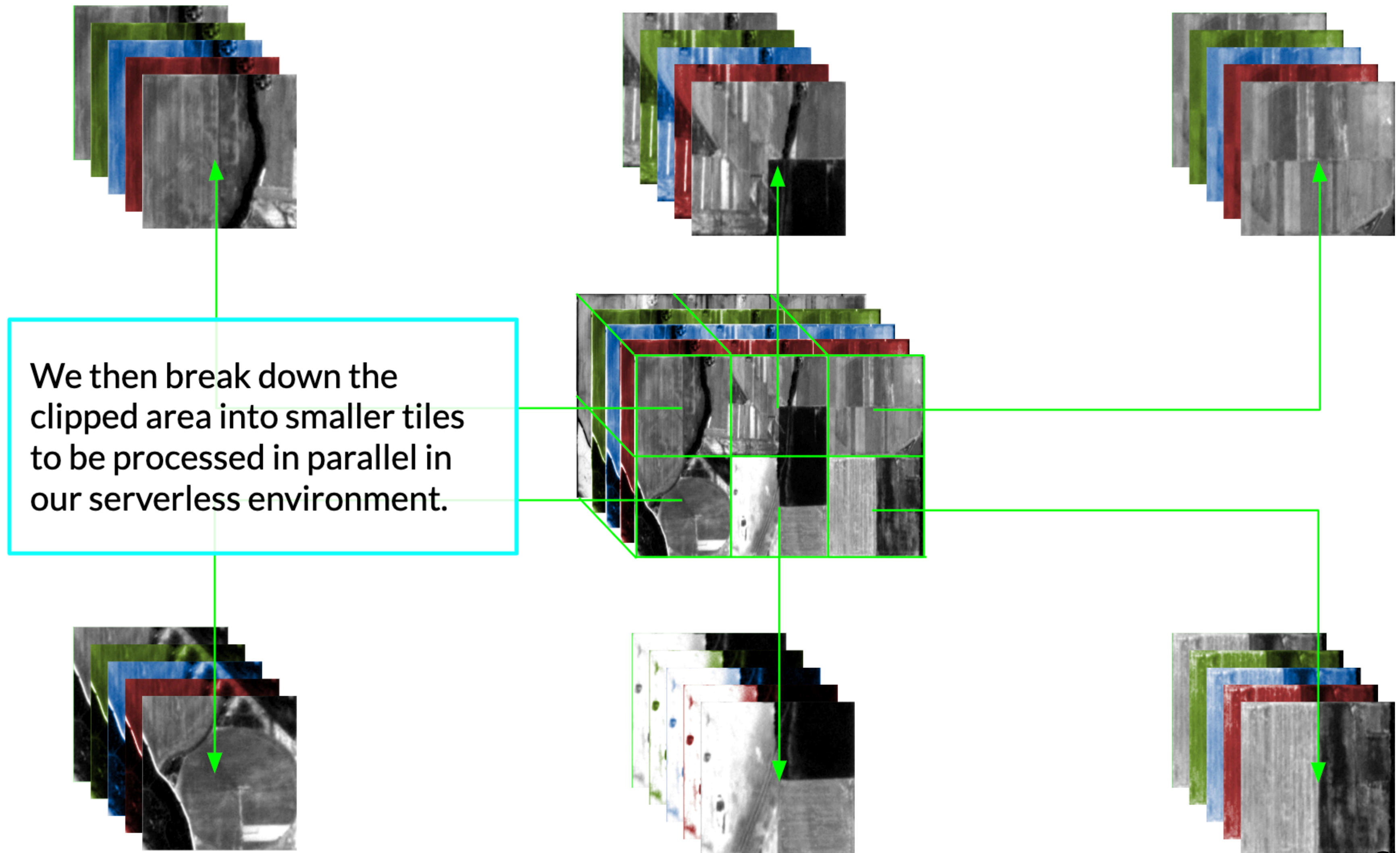
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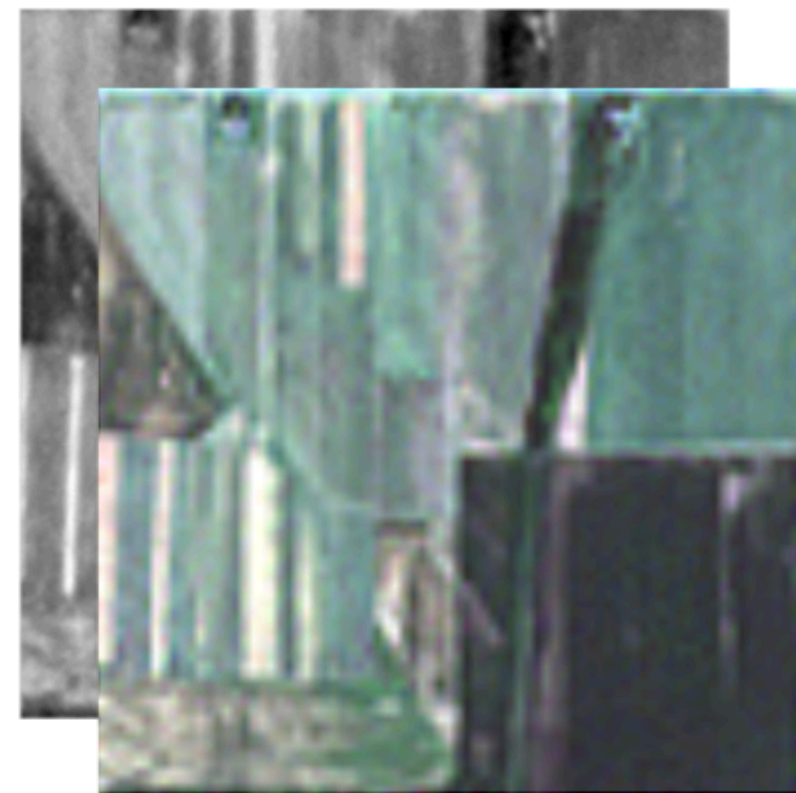
We then coregister and merge the Red, Blue, and Green spectral bands, producing a true color image.





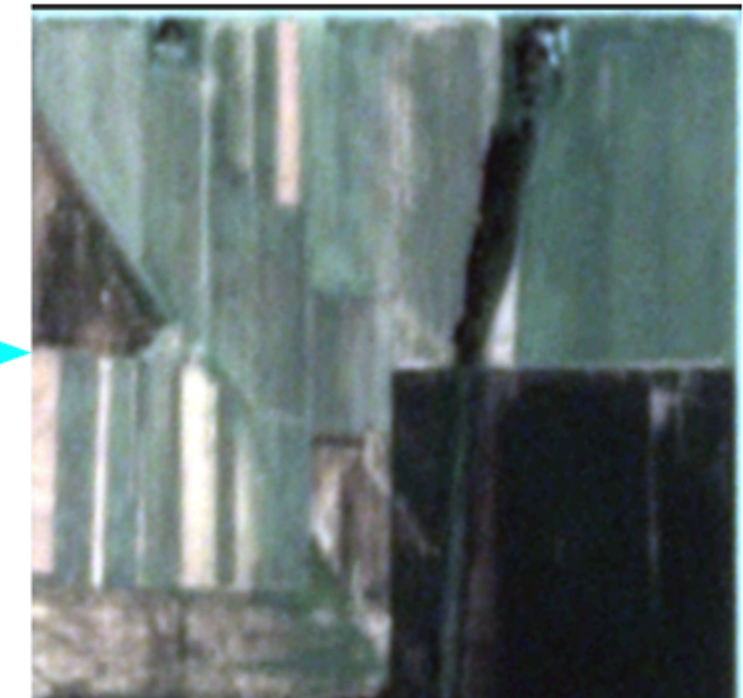
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*Before Pan-Sharpining*

To get the highest resolution image possible with colour, we sharpen our previous result with the panchromatic band, which in this case will provide 2x higher resolution.



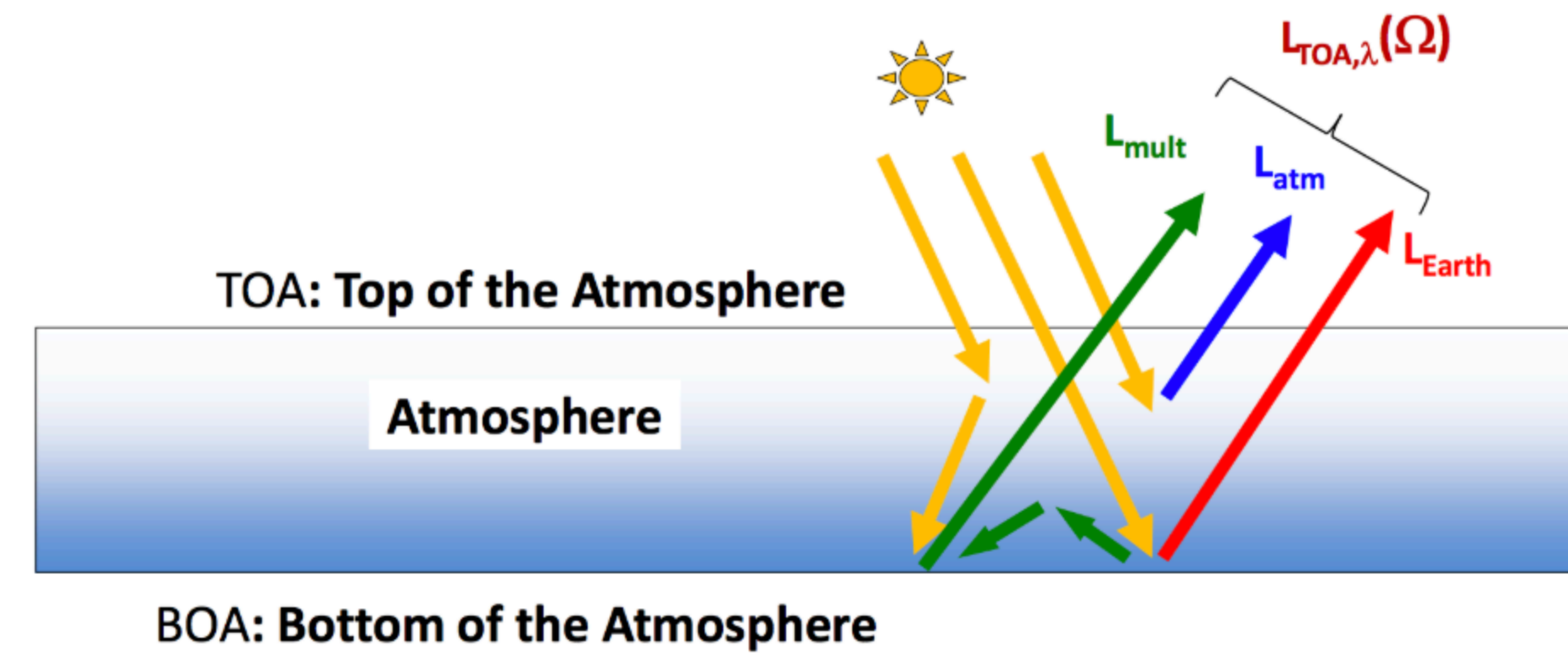
*After Pan-Sharpining*



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Satellite sensors usually pick up noise and distortion caused by the atmosphere. This includes atmospheric gases like  $H_2O$ ,  $C_2O$ , &  $CH_4$ . We need to remove this distortion from the image for a true representation of the Earth's surface. Click [here](#) for more info.



Atmospheric Corrections Applied



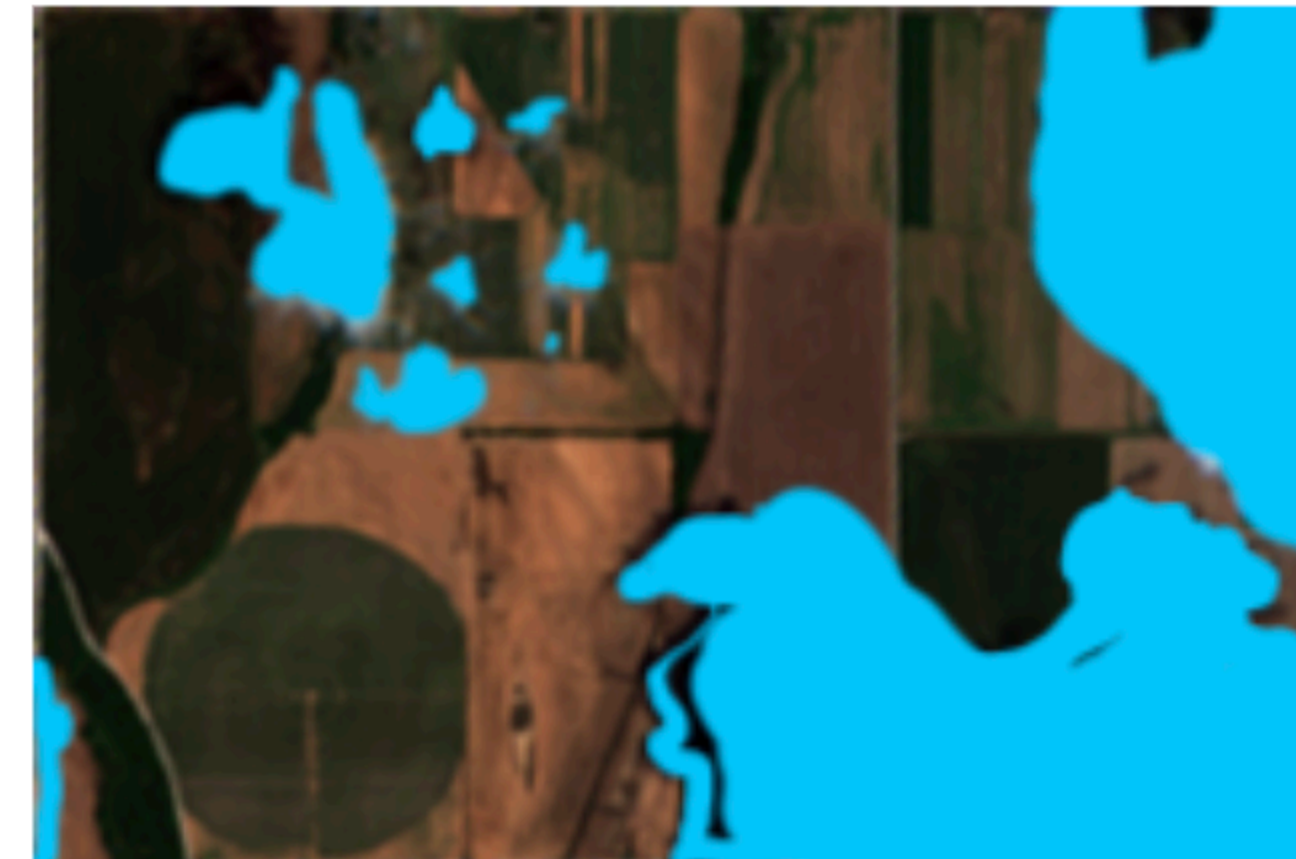
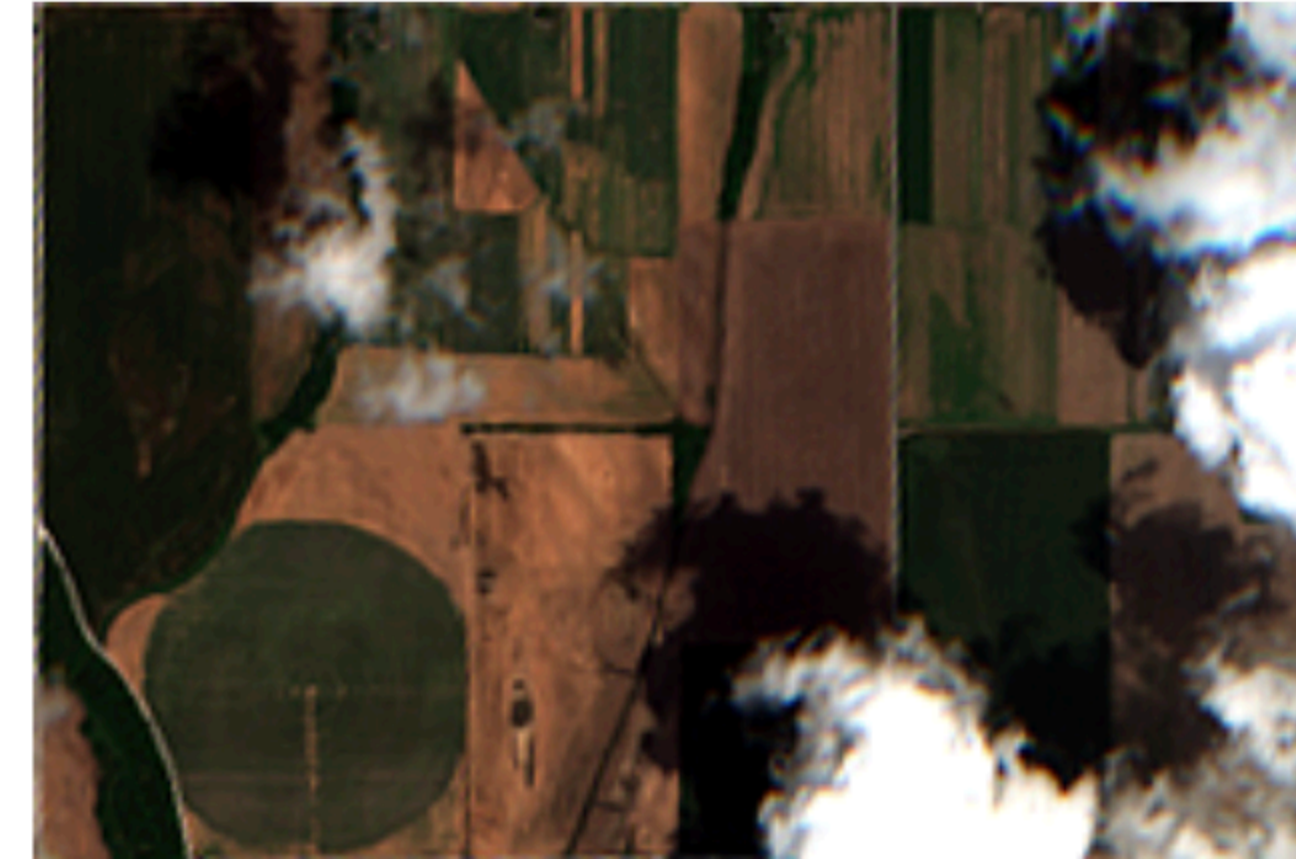


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Clouds cover 70% of the Earth at any given moment. While we didn't have any clouds in the image being selected for delivery, there were clouds in a image selected previously, but then discarded because of the cloud cover.

On the top-right is the first image pulled for our request. On the bottom-right is the image with a cloud mask applied. By default, SkyWatch only delivers images where more than 85% of the pixels in the image are valid. As you can see by the cloud mask, the clouds account for more than 25% of the image, not meeting our requirements.

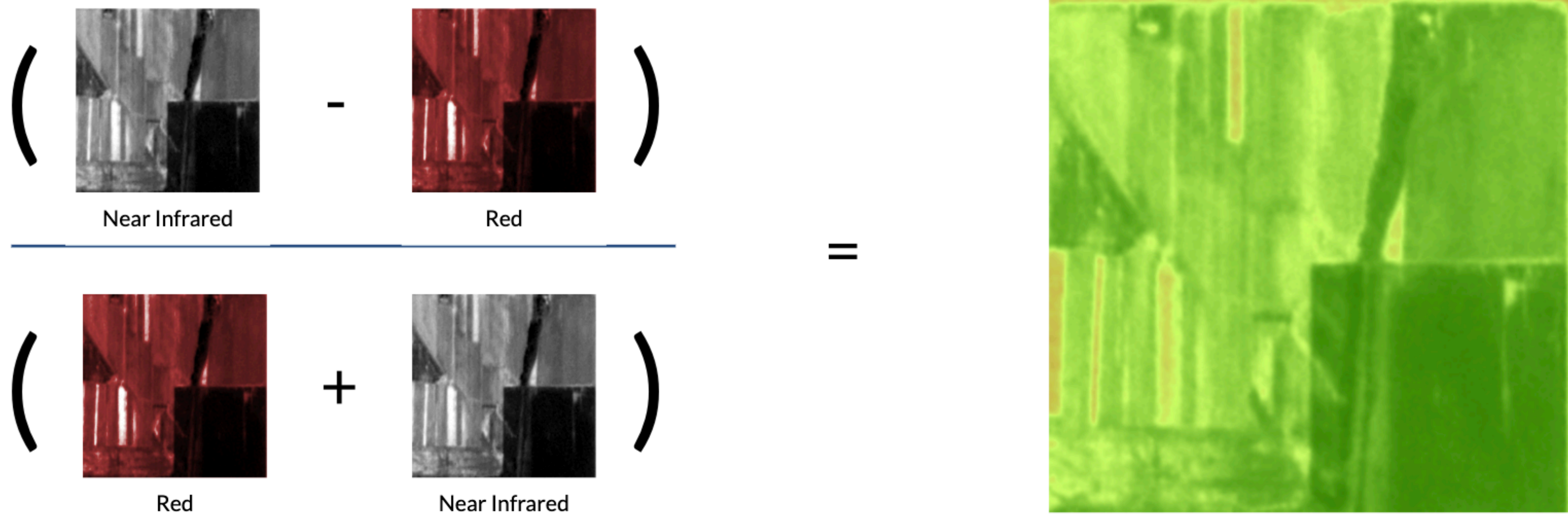




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Image Enhancements is a stage where further enhancements like sharpening, colour balancing, and contrasting takes place. In this particular instance, it is also the stage where our NDVI is formatted.

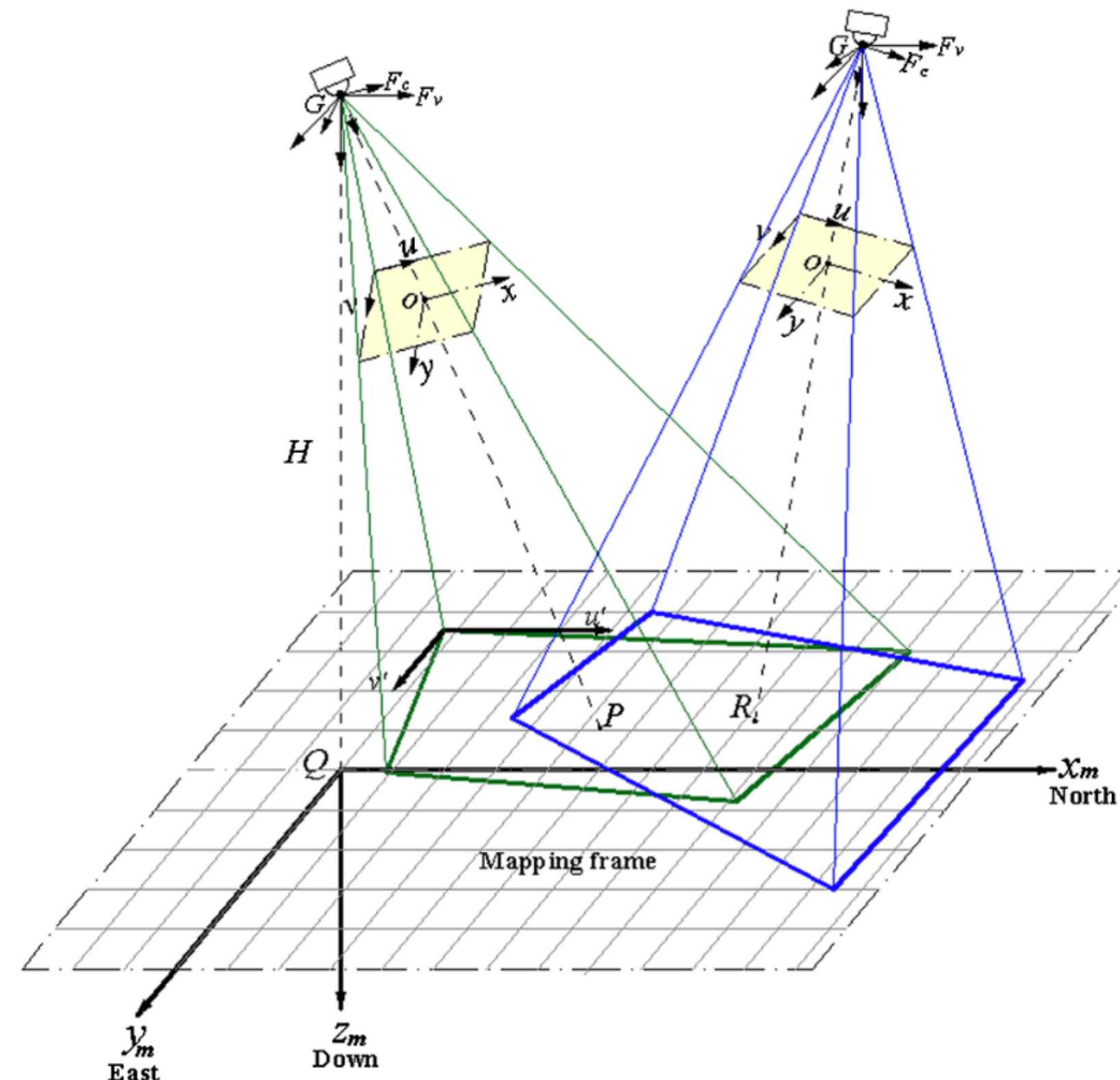


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Satellite images are rarely captured from the same angle.

In order to build a useable time-series of imagery, satellite images need to be orthorectified to look as though they were taken at the nadir. This allows the processing software to align and co-register the pixels in a time-series for further analysis.



$F_c$ : camera frame;  $F_v$ : vehicle frame;  $m$ : mapping frame.

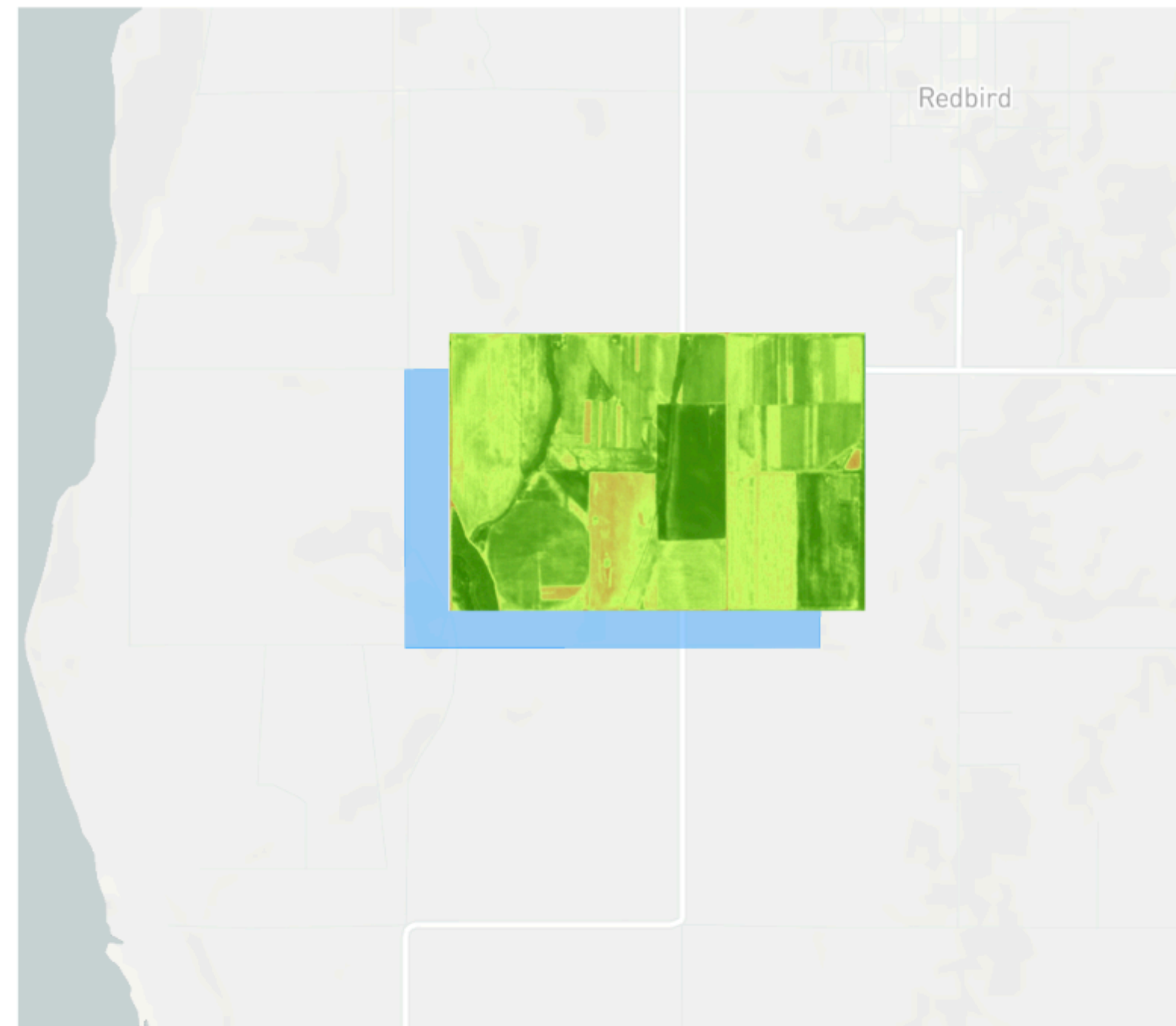


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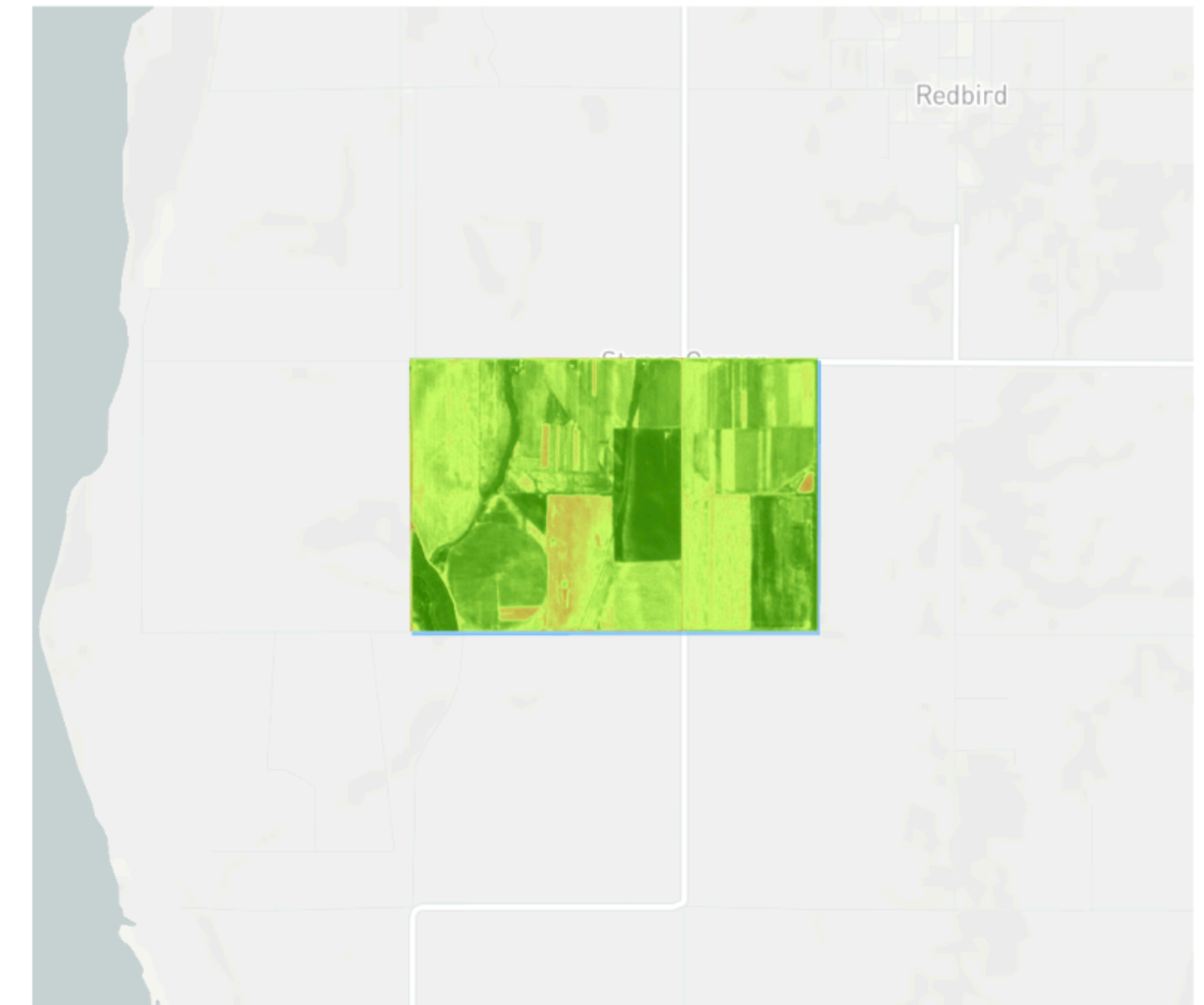
## BEFORE

Each satellite image holds the lat/long coordinates of each of its corners in its metadata. Unfortunately, it is normal for these coordinates to be inaccurate by up to 50 metres.



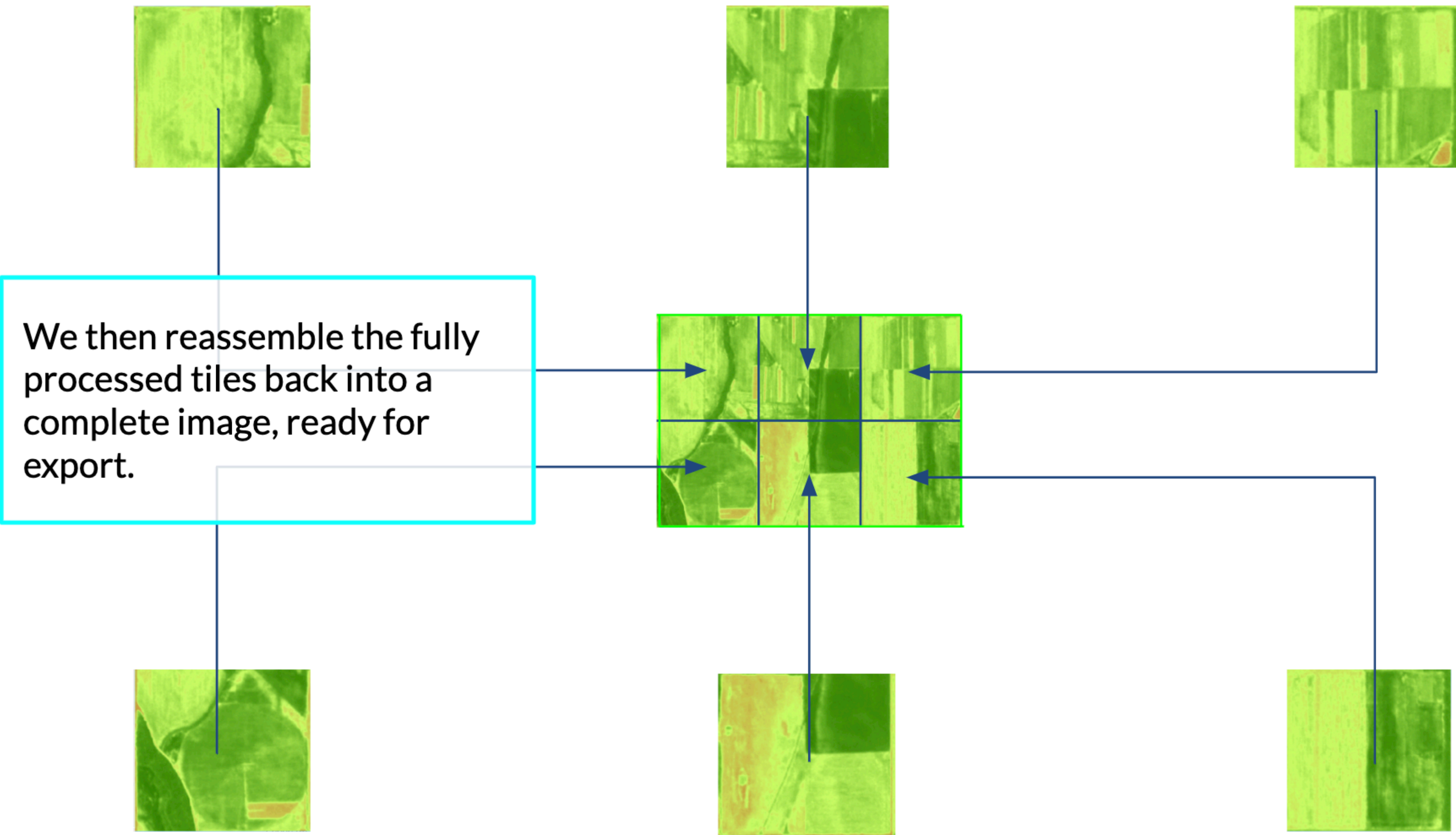
## AFTER

SkyWatch uses Ground Control Points (“GCPs”) to spatially calibrate imagery in our automated processing chain.



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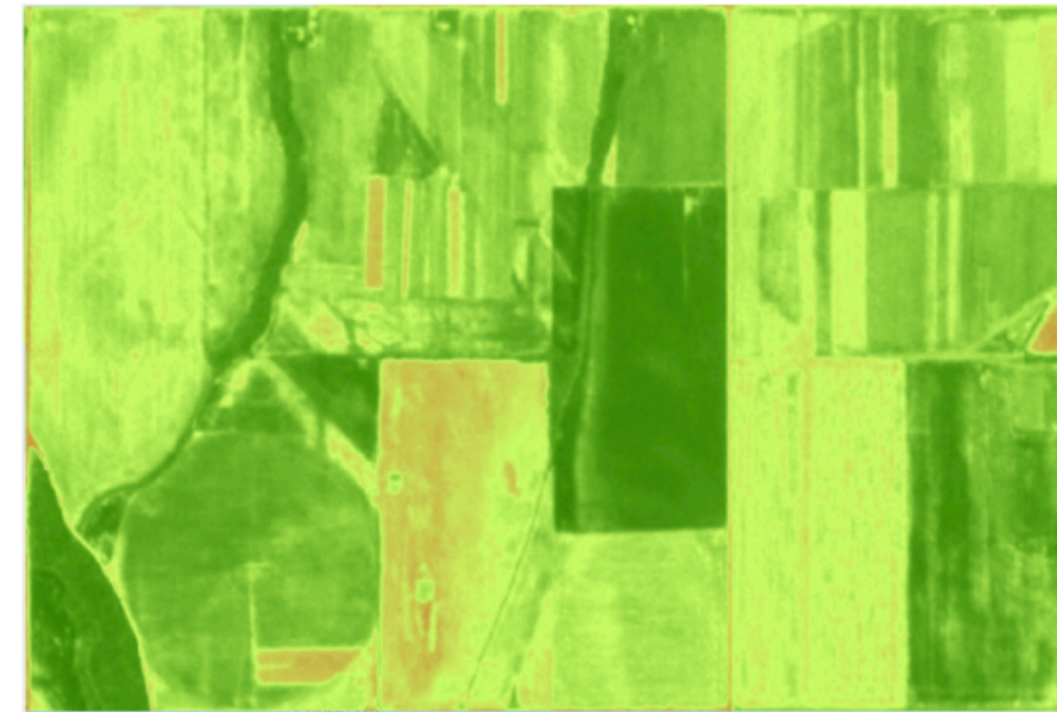
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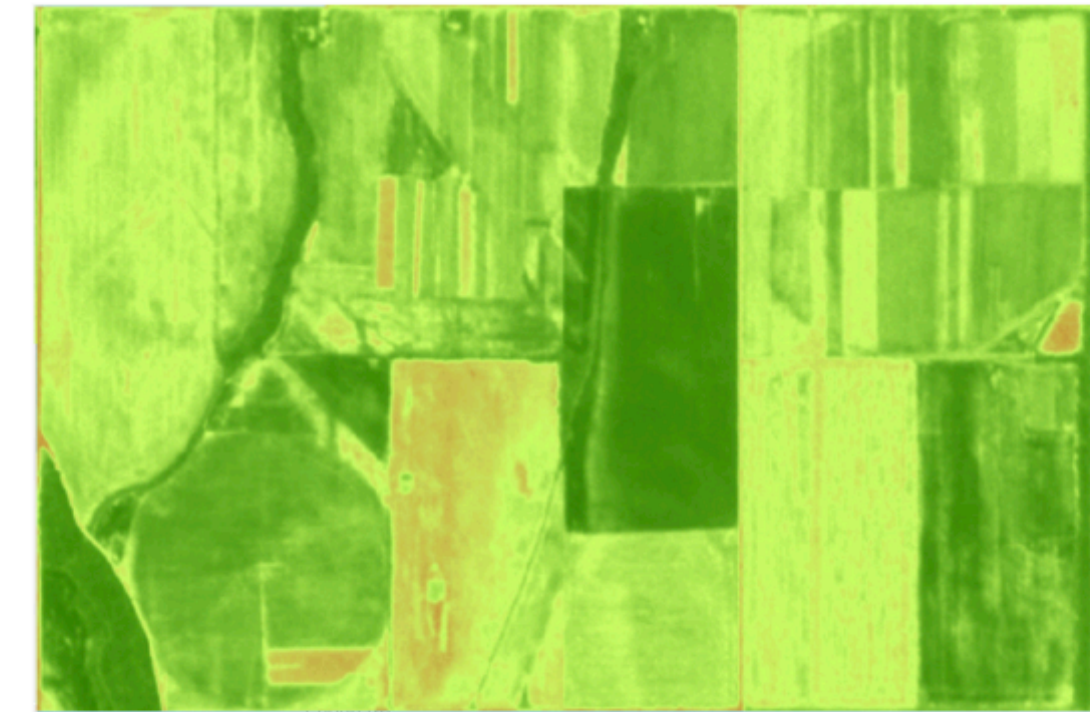
Finally, SkyWatch exports every result in three formats:..



*Thumbnail  
Preview*



*PNG  
(Web Friendly)*



*GeoTIFF  
(For analysis)*

This happens in minutes



Demand increases

Costs are drastically reduced

The end user needs to know  
nothing about EO

They get **normalized** data ready for  
their use case with **no additional work**

They look like heroes

All due to...

# Abstraction

“The purpose of abstraction is not be be vague, but to create a new semantic level in which one can be precise.”

- Edsger Dijkstra





Stop doing the heavy lifting

Start simplifying

# Thank You!

SKYWATCH

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**@joelcumming**

**skywatch.com/earthcache**

**skywatch.com/terrastream**