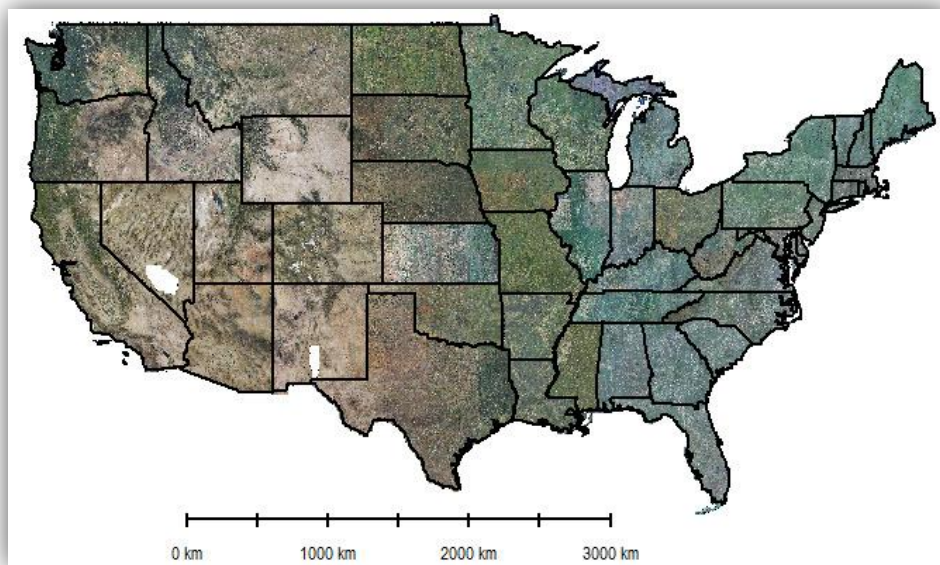


Unique 2015/2014/2013 NAIP State-level Imagery Mosaics (Basemaps for 48 Contiguous U.S. States & at 1m-resolution)



See the big picture and the detail

One state, one imagery mosaic – extremely easy to use

Three types of mosaics available: Natural color, color infrared, NDVI composites

Consistent 1m-resolution, ~90 Terabytes of processed natural color data in raw binary

Developer of the unique, large-sized NAIP state-level mosaics

BigData Earth Pty Ltd

28 April 2016

Introduction

BigData Earth Pty Ltd have sourced the original U.S. digital ortho photos (aerial imagery) from the USDA National Agriculture Imagery Program (NAIP). The NAIP program is administered by USDA FSA (Farm Service Agency) and aims to acquire ortho imagery that has been collected during the agricultural growing season in the U.S. The NAIP ortho imagery, tailored to meet FSA requirements, is a fundamental national geospatial dataset for many environmental applications. The most recent NAIP ortho imagery from the 2015 season in the tile form was just released in February 2016.

Data and Processing

The NAIP ortho imagery is typically produced at a high resolution (i.e. 1m). For the overwhelming majority of users, it is difficult to use numerous separate tiles (i.e. ~350,000 separate tiles from 2015/2014/2014 NAIP). There is a need to develop **state-level** imagery mosaics for their effective use in large-scale enterprise mapping projects. (So far only major companies including Google and ESRI have incorporated the NAIP imagery from earlier seasons in consumer-level web mapping. USDA only distributes **county-level** mosaics.)

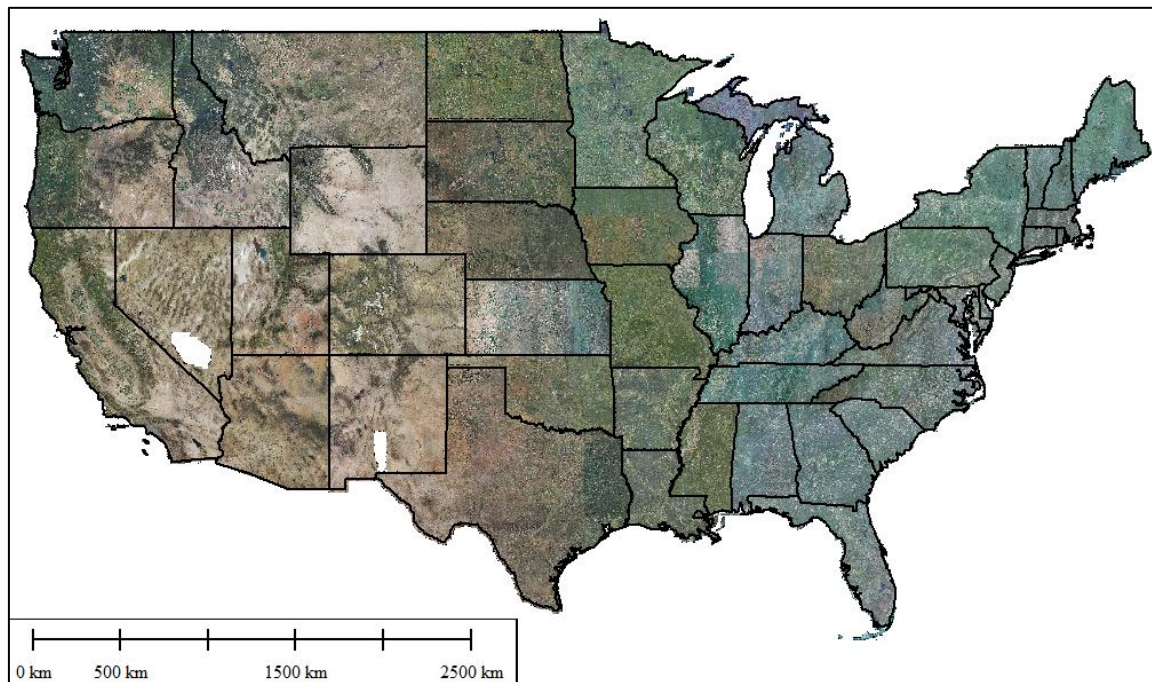
While the concept of making seamless mosaics from many hundreds or thousands of separate tiles (at the state level) is straightforward, even with very advanced and expensive image processing software this process of mosaicking could take enormous resources and deep expertise, including disk spaces, fast computing, and specific image processing knowledge. To make a mosaic with a file size as large as a few terabytes, many weeks of computing may be needed.

We at BigData Earth have performed the following major image processing steps: (1) acquiring all raw data (except for a few defense or security sensitive zones where no ortho images are released) and replacing any corrupted files; (2) projection and re-projection all tiles if necessary; (3) stitching all separate tiles together and removing black edges across neighboring tiles; and (4) compressing each large-sized state-level mosaic (commonly large than one terabyte in file size) into popular, highly-efficient and optimized JPEG2000 format, which is compatible with all GIS, image processing and mapping software.

Features of the processed unique state-level mosaics (data products) in JPEG2000 format

- Extremely easy to use and manage, compatible with all geospatial mapping software
- Complete NAIP imagery series from the most recent 2015, 2014 and 2013 seasons
- Consistent 1m-resolution under the popular WGS 84 Web Mercator projection
- Virtually zero or minimized cloud covers
- Vibrant colors as the ortho imagery was captured during the agricultural growing season or “leaf on” conditions
- Local copy on external hard drives enabling rapid access and customization, instead of downloading millions of separate slippy map tiles from third-party web mapping servers (e.g. WMS)
- ~180 Terabytes of clean processed data in raw binary (RGB and CIR composites) and ~9 Terabytes in compressed JPEG2000 format, involving more than 1.5 Petabytes of temporary storage during processing
- Saving time and computing resources (avoiding months or years of data downloading and specialized image processing), and increasing efficiency for enterprise mapping projects
- Natural color (RGB), color infrared (CIR), and NDVI color mosaics available
- Complementary to the existing small-sized county-level mosaics
- Various spatial resolutions (from 1m to 2m, 5m, and 10m) that can be customized
- Unique, cost-effective processed data products

Imagery Product 1: Processed NAIP state-level mosaics (Natural color RGB composite)



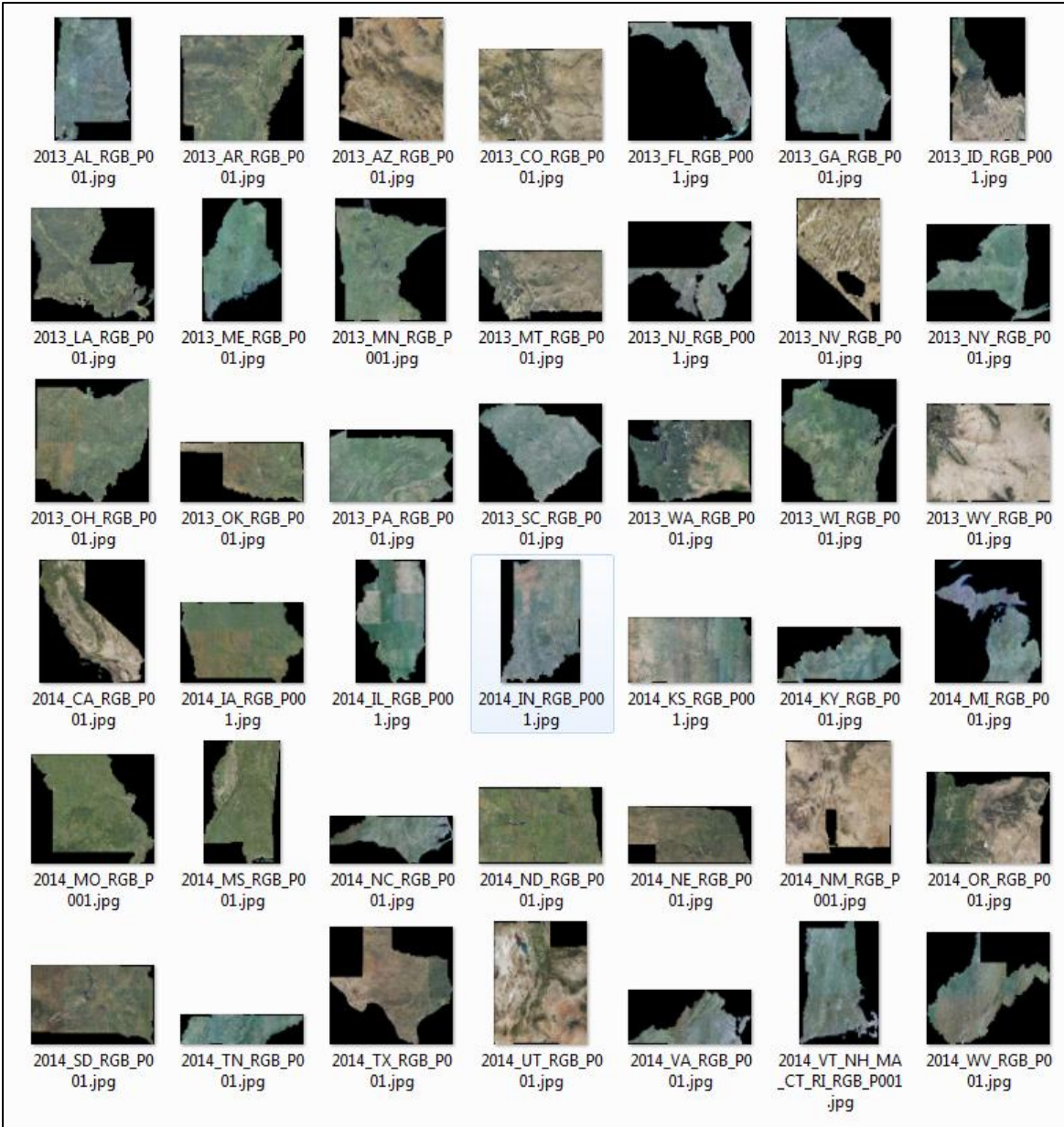
2014/2013 NAIP:

All state-level mosaics (natural color RGB) in the same projection (WGS 84 Web Mercator)

~60 Terabytes of processed data at 1m-resolution;

~2.5 Terabytes of compressed mosaics at 1m-resolution;

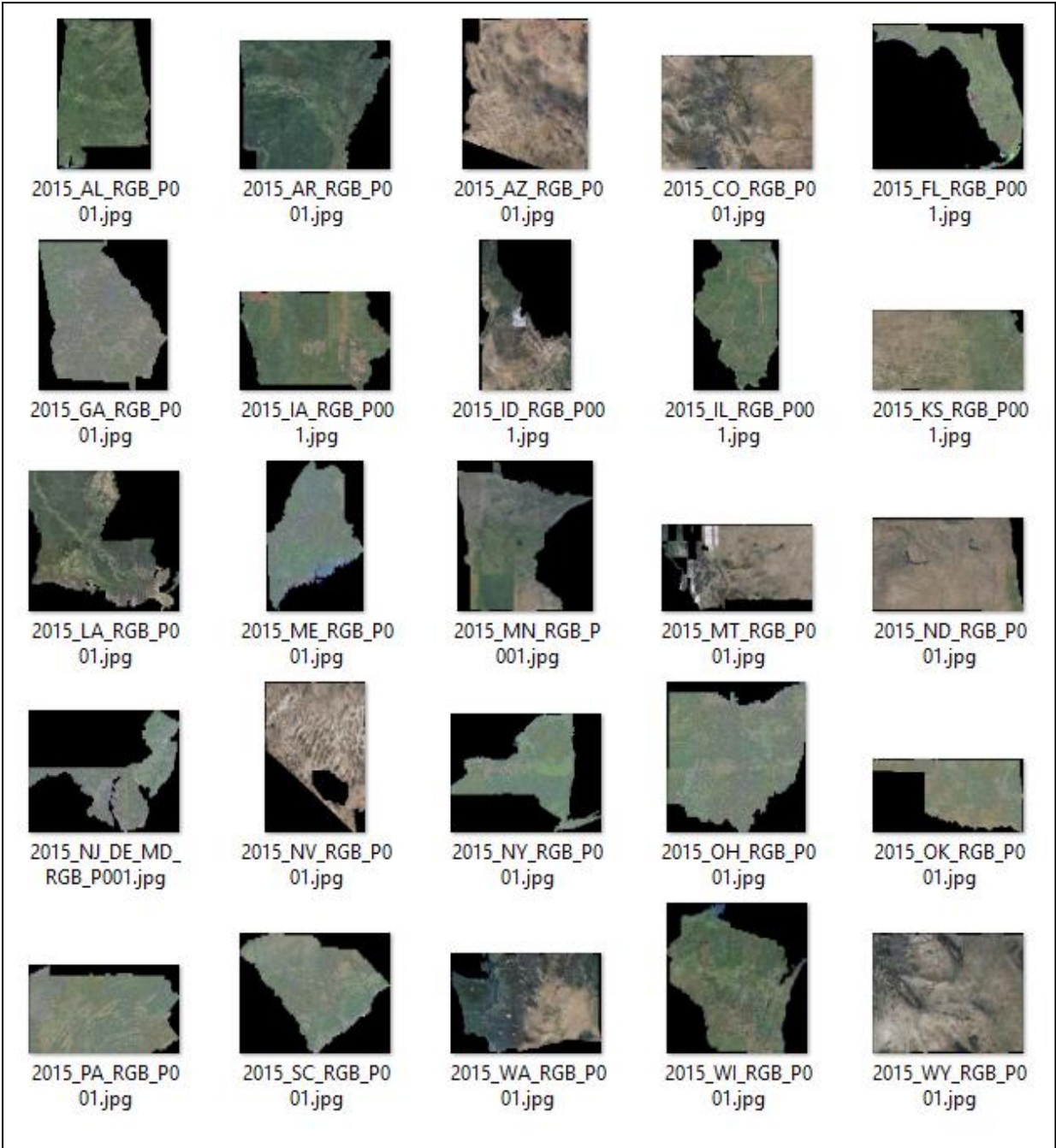
~230 Gigabytes of compressed mosaics at 5m-resolution.



2014/2013 NAIP: Natural color mosaics by state (overviews were produced at 1km resolution; i.e. 1,000,000 - 1000, x 1,000 - times smaller than the 1m-resolution full mosaic)

2014/2013 NAIP natural color state-level mosaics: Specifications for each of the 48 contiguous U.S. states

ID	State_ID	State_Name	Image_Year	Processed_Mosaic_Image_File_Name_By_State	Mosaic_Width_Pixels	Mosaic_Length_Pixels	Mosaic_Res1m_Raw_Data_File_Size (Gigabytes)	Mosaic_Res1m_Compressed_JPEG2000 (Gigabytes)	Mosaic_Res5m_Compressed_JPEG2000 (Gigabytes)	Notes
1	AL	Alabama	2013	2013_AL_RGB.jp2	404,000	646,000	729.18	44.05	4.19	
2	AR	Arkansas	2013	2013_AR_RGB.jp2	557,000	475,000	739.21	45.71	4.06	
3	AZ	Arizona	2013	2013_AZ_RGB.jp2	655,000	775,000	1,418.29	110.40	8.01	
4	CA	California	2014	2014_CA_RGB.jp2	1,149,000	1,351,000	4,337.07	224.15	13.97	
5	CO	Colorado	2013	2013_CO_RGB.jp2	787,000	592,000	1,301.72	113.53	8.00	
6	CT	Connecticut	2014	2014_VT_NH_MA_CT_RI_RGB.jp2	432,000	668,000	806.27	28.70	3.66	Mosaic for 5 states - VT, NH, MA, CT and RI
7	DE	Delaware	2013	2013_NJ_DE_MD_RGB.jp2	627,000	507,000	888.17	19.40	1.84	Mosaic for 3 states - NJ, DE and MD
8	FL	Florida	2013	2013_FL_RGB.jp2	857,000	827,000	1,980.19	50.26	4.19	
9	GA	Georgia	2013	2013_GA_RGB.jp2	536,000	630,000	943.47	50.37	4.82	
10	IA	Iowa	2014	2014_IA_RGB.jp2	732,000	478,000	977.60	52.97	3.34	
11	ID	Idaho	2013	2013_ID_RGB.jp2	697,000	1,135,000	2,210.29	126.15	7.86	
12	IL	Illinois	2014	2014_IL_RGB.jp2	460,000	816,000	1,048.74	24.08	2.61	
13	IN	Indiana	2014	2014_IN_RGB.jp2	377,000	589,000	620.41	16.13	2.07	
14	KS	Kansas	2014	2014_KS_RGB.jp2	836,000	446,000	1,041.75	39.22	3.66	
15	KY	Kentucky	2014	2014_KY_RGB.jp2	857,000	389,000	931.43	22.35	3.04	
16	LA	Louisiana	2013	2013_LA_RGB.jp2	585,000	545,000	890.79	37.00	3.15	
17	MA	Massachusetts	2014	2014_VT_NH_MA_CT_RI_RGB.jp2	432,000	668,000	806.27	28.70	3.66	Mosaic for 5 states - VT, NH, MA, CT and RI
18	MD	Maryland	2013	2013_NJ_DE_MD_RGB.jp2	627,000	507,000	888.17	19.40	1.84	Mosaic for 3 states - NJ, DE and MD
19	ME	Maine	2013	2013_ME_RGB.jp2	467,000	723,000	943.36	56.73	5.18	
20	MI	Michigan	2014	2014_MI_RGB.jp2	899,000	1,035,000	2,599.69	50.92	6.01	
21	MN	Minnesota	2013	2013_MN_RGB.jp2	870,000	972,000	2,362.69	71.85	7.63	
22	MO	Missouri	2014	2014_MO_RGB.jp2	752,000	666,000	1,399.31	93.84	6.09	
23	MS	Mississippi	2014	2014_MS_RGB.jp2	404,000	645,000	728.05	62.92	4.37	
24	MT	Montana	2013	2013_MT_RGB.jp2	1,344,000	773,000	2,902.69	110.87	11.61	
25	NC	North Carolina	2014	2014_NC_RGB.jp2	996,000	384,000	1,068.59	26.51	3.40	
26	ND	North Dakota	2014	2014_ND_RGB.jp2	843,000	526,000	1,238.90	39.03	4.31	
27	NE	Nebraska	2014	2014_NE_RGB.jp2	982,000	466,000	1,278.55	30.29	3.28	
28	NH	New Hampshire	2014	2014_VT_NH_MA_CT_RI_RGB.jp2	432,000	668,000	806.27	28.70	3.66	Mosaic for 5 states - VT, NH, MA, CT and RI
29	NJ	New Jersey	2013	2013_NJ_DE_MD_RGB.jp2	627,000	507,000	888.17	19.40	1.84	Mosaic for 3 states - NJ, DE and MD
30	NM	New Mexico	2014	2014_NM_RGB.jp2	676,000	791,000	1,493.98	71.75	7.02	
31	NV	Nevada	2013	2013_NV_RGB.jp2	676,000	1,008,000	1,903.83	113.50	7.15	
32	NY	New York	2013	2013_NY_RGB.jp2	891,000	703,000	1,750.07	68.80	6.05	
33	OH	Ohio	2013	2013_OH_RGB.jp2	488,000	529,000	721.27	32.57	3.15	
34	OK	Oklahoma	2013	2013_OK_RGB.jp2	968,000	478,000	1,292.78	44.52	4.03	
35	OR	Oregon	2014	2014_OR_RGB.jp2	913,000	680,000	1,734.61	101.18	10.06	
36	PA	Pennsylvania	2013	2013_PA_RGB.jp2	655,000	388,000	710.06	51.61	4.86	
37	RI	Rhode Island	2014	2014_VT_NH_MA_CT_RI_RGB.jp2	432,000	668,000	806.27	28.70	3.66	Mosaic for 5 states - VT, NH, MA, CT and RI
38	SC	South Carolina	2013	2013_SC_RGB.jp2	544,000	435,000	661.16	30.95	2.91	
39	SD	South Dakota	2014	2014_SD_RGB.jp2	857,000	555,000	1,328.91	44.66	4.65	
40	TN	Tennessee	2014	2014_TN_RGB.jp2	968,000	241,000	651.80	26.82	3.41	
41	TX	Texas	2014	2014_TX_RGB.jp2	1,469,000	1,411,000	5,791.22	174.00	16.16	
42	UT	Utah	2014	2014_UT_RGB.jp2	565,000	741,000	1,169.74	115.90	7.18	
43	VA	Virginia	2014	2014_VA_RGB.jp2	948,000	425,000	1,125.69	28.43	3.38	
44	VT	Vermont	2014	2014_VT_NH_MA_CT_RI_RGB.jp2	432,000	668,000	806.27	28.70	3.66	Mosaic for 5 states - VT, NH, MA, CT and RI
45	WA	Washington	2013	2013_WA_RGB.jp2	885,000	586,000	1,448.98	61.62	7.16	
46	WI	Wisconsin	2013	2013_WI_RGB.jp2	690,000	737,000	1,420.82	49.44	5.74	
47	WV	West Virginia	2014	2014_WV_RGB.jp2	557,000	502,000	781.23	17.74	2.51	
48	WY	Wyoming	2013	2013_WY_RGB.jp2	788,000	631,000	1,389.24	48.21	5.08	
Total							65,763.23	2,782.74	249.17	
							~60 Terabytes	~2.5 Terabytes	~230 Gigabytes	




2015 NAIP: Natural color mosaics by state (overviews were produced at 1km resolution; i.e. 1,000,000 - 1000, x 1,000 - times smaller than the 1m-resolution full mosaic)

2015 NAIP natural color state-level mosaics: Specifications for each of 27 U.S. states
(including 23 states to replace 2013 NAIP coverage, and 4 states to replace 2014 NAIP coverage)

ID	State_ID	State_Name	Image_Year	Processed_Mosaic_Image_File_Name_By_State	Mosaic_Res1m_Width_Pixels	Mosaic_Res1m_Length_Pixels	Mosaic_Res1m_Raw_Data_File_Size (Gigabytes)	Mosaic_Res1m_Compressed_JPEG2000 (Gigabytes)
1	AL	Alabama	2015	2015_AL_RGB.jp2	404,000	646,000	729.18	60.10
2	AR	Arkansas	2015	2015_AR_RGB.jp2	557,000	475,000	739.21	55.35
3	AZ	Arizona	2015	2015_AZ_RGB.jp2 (+)	655,000	791,000	1,554.32	148.94
4	CO	Colorado	2015	2015_CO_RGB.jp2	787,000	592,000	1,301.72	100.10
5	DE	Delaware	2015	2015_NJ_DE_MD_RGB.jp2(*)	627,000	507,000	888.17	23.57
6	FL	Florida	2015	2015_FL_RGB.jp2	857,000	827,000	1,980.19	53.98
7	GA	Georgia	2015	2015_GA_RGB.jp2	536,000	630,000	943.47	53.57
8	IA	Iowa	2015	2015_IA_RGB.jp2	732,000	478,000	977.6	80.20
9	ID	Idaho	2015	2015_ID_RGB.jp2	697,000	1,135,000	2,210.29	135.53
10	IL	Illinois	2015	2015_IL_RGB.jp2	460,000	816,000	1,048.74	86.20
11	KS	Kansas	2015	2015_KS_RGB.jp2	836,000	446,000	1,041.75	121.00
12	LA	Louisiana	2015	2015_LA_RGB.jp2	585,000	545,000	890.79	22.84
13	MD	Maryland	2015	2015_NJ_DE_MD_RGB.jp2(*)	627,000	507,000	888.17	23.57
14	ME	Maine	2015	2015_ME_RGB.jp2	467,000	723,000	943.36	60.86
15	MN	Minnesota	2015	2015_MN_RGB.jp2	870,000	972,000	2,362.69	107.01
16	MT	Montana	2015	2015_MT_RGB.jp2	1,344,000	773,000	2,902.69	168.97
17	ND	North Dakota	2015	2015_ND_RGB.jp2	843,000	526,000	1,238.90	46.90
18	NJ	New Jersey	2015	2015_NJ_DE_MD_RGB.jp2(*)	627,000	507,000	888.17	23.57
19	NV	Nevada	2015	2015_NV_RGB.jp2	676,000	1,008,000	1,903.83	121.53
20	NY	New York	2015	2015_NY_RGB.jp2	891,000	703,000	1,750.07	92.85
21	OH	Ohio	2015	2015_OH_RGB.jp2	488,000	529,000	721.27	36.57
22	OK	Oklahoma	2015	2015_OK_RGB.jp2	968,000	478,000	1,292.78	53.55
23	PA	Pennsylvania	2015	2015_PA_RGB.jp2	655,000	388,000	710.06	49.13
24	SC	South Carolina	2015	2015_SC_RGB.jp2	544,000	435,000	661.16	40.07
25	WA	Washington	2015	2015_WA_RGB.jp2	885,000	586,000	1,448.98	109.13
26	WI	Wisconsin	2015	2015_WI_RGB.jp2	690,000	737,000	1,420.82	136.23
27	WY	Wyoming	2015	2015_WY_RGB.jp2	788,000	631,000	1,389.24	207.32
TOTAL							34,827.62	2,218.64
							(~34 Terabytes)	(~2.2 Terabytes)
* Multiple states share the same large-sized regional mosaic.								
+ The size of the Arizona state mosaic is changed from 655,000x775,000 pixels in 2013 NAIP to 655,000x791,000 in 2015 NAIP.								
This is the only state with the change of mosaic sizes from 2013 NAIP to 2015 NAIP.								

NAIP state-level mosaic (RGB composite) example

State	California (CA)
Source	2014 NAIP Imagery with 11,119 separate tiles
Resolution	1m
Projection	WGS 84 Web Mercator (http://en.wikipedia.org/wiki/Web_Mercator)
Mosaic Image Size	1,149,000 x 1,351,000 pixels
File Size (raw data)	~4.3 Terabytes for 3-band RGB imagery composite
Format	JPEG2000 (compression rate 1:10)
Processed data products (mosaics) available	RGB Composite: 224 Gigabytes single JPEG2000 file
Overview of RGB composite	
Notes	2012 RGB mosaic is also available. Mosaics at coarser resolutions (2m, 5m, 10m) are also available.

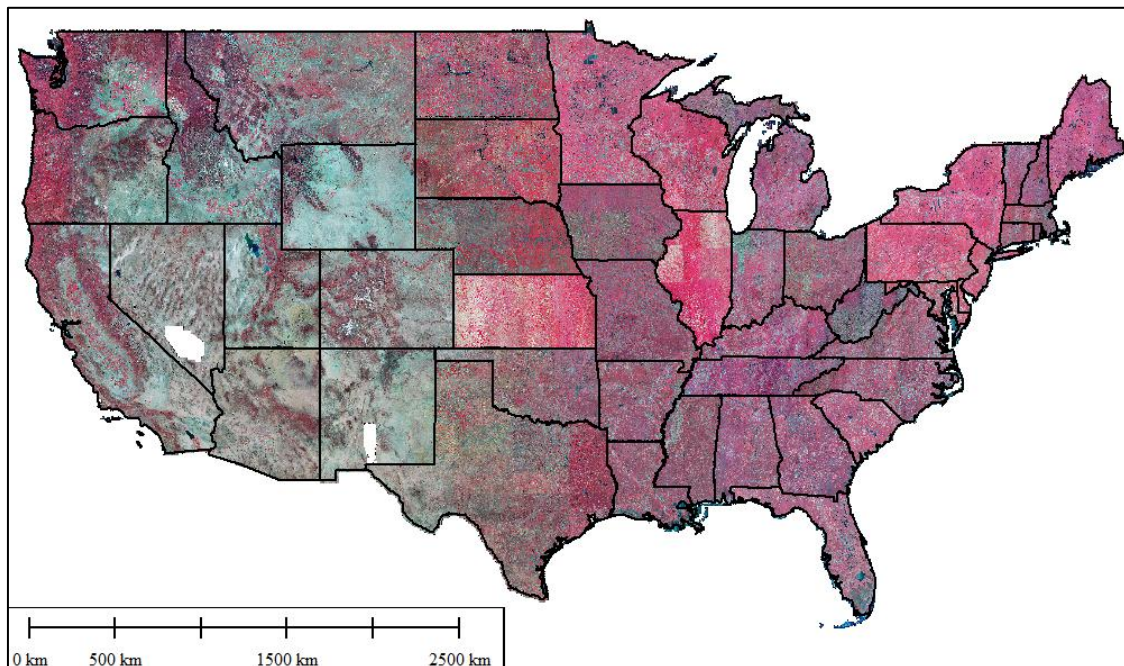


Example of the state-level mosaic (RGB composite at **1m resolution**)



Example of the statewide mosaic (RGB composite at **5m resolution**)

Imagery Product 2: Processed NAIP state-level mosaics (color infrared composite)



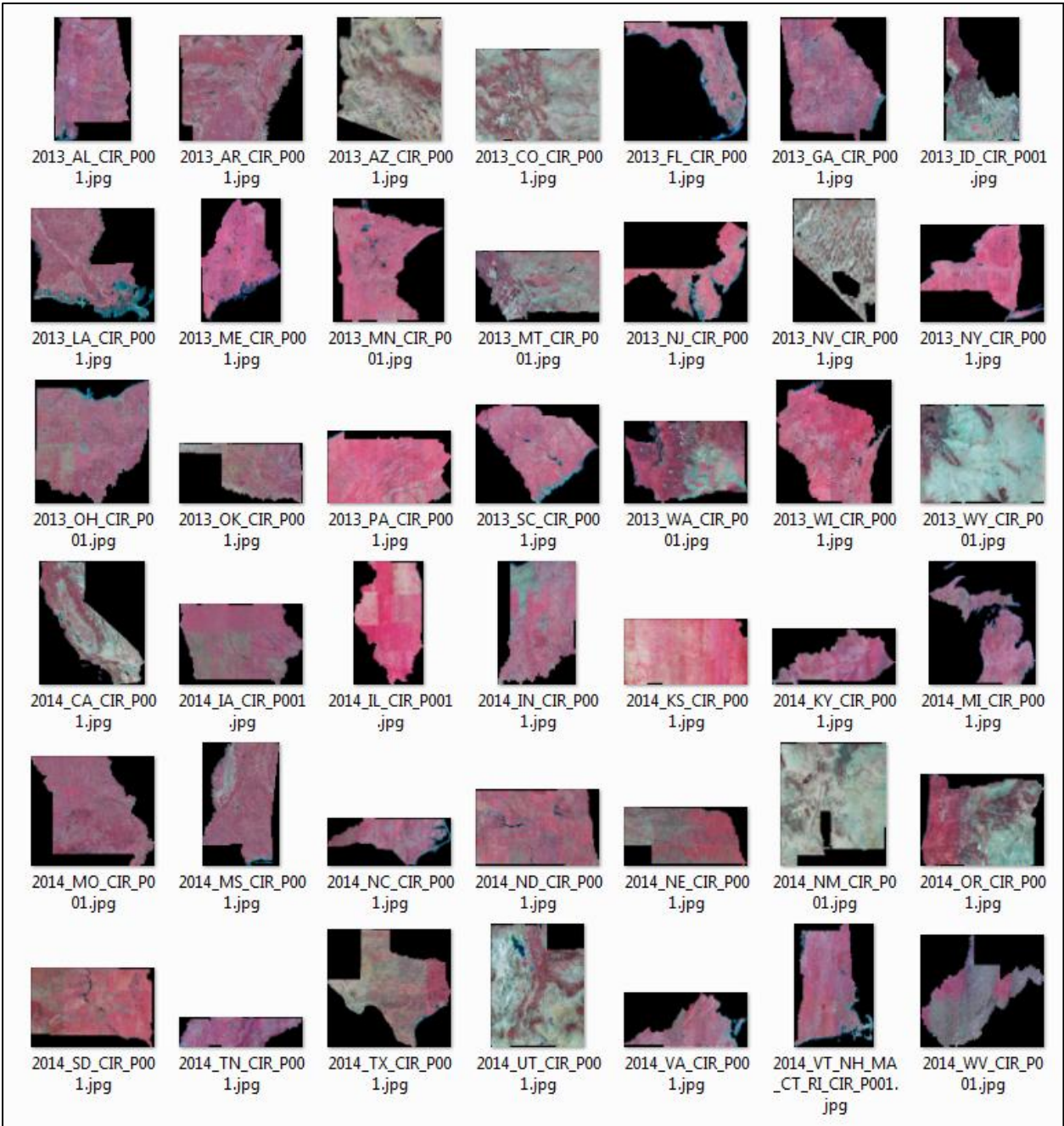
2014/2013 NAIP:

All state-level mosaics (color infrared) are in the same projection (WGS 84 Web Mercator)

~60 Terabytes of processed color infrared data at 1m-resolution;

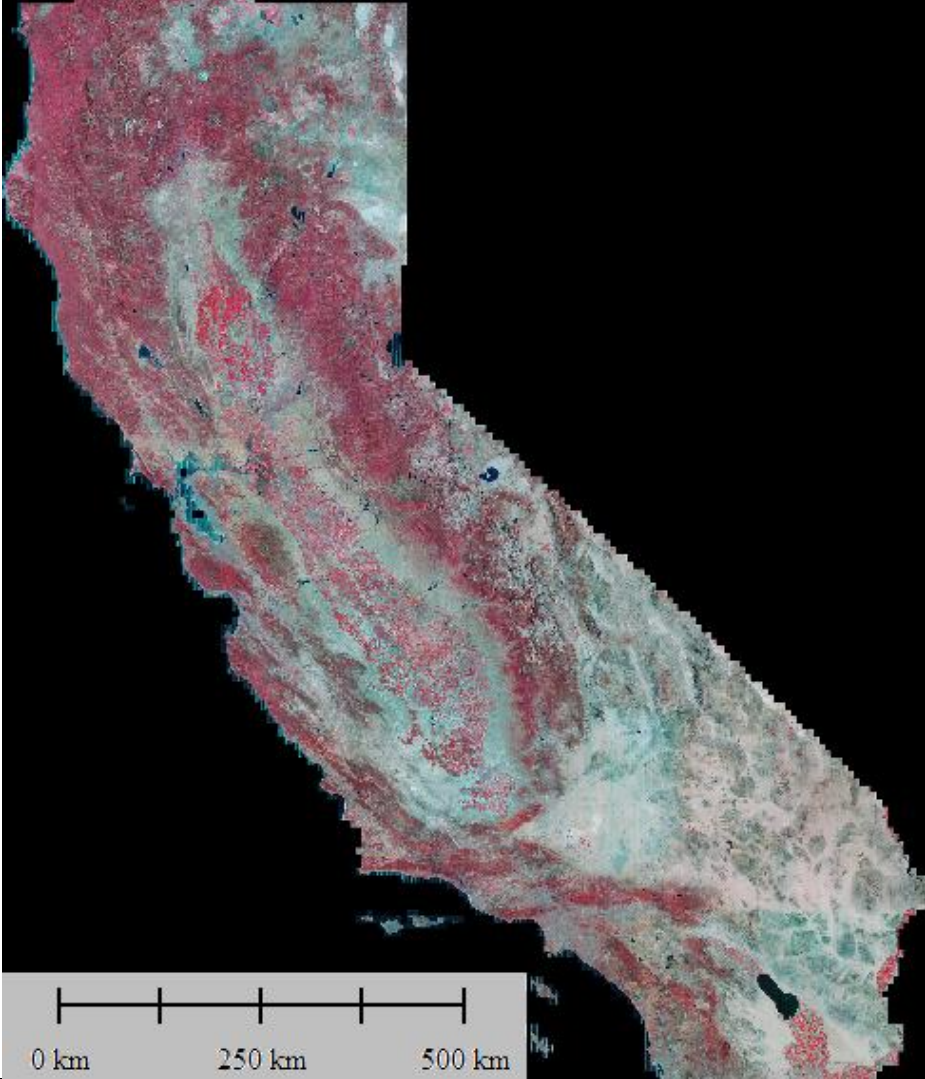
~3.0 Terabytes of compressed mosaics at 1m-resolution;

~275 Gigabytes of compressed mosaics at 5m-resolution.



2014/2013 NAIP: Color infrared mosaics by state (overviews were produced at 1km resolution; i.e. 1,000,000 - 1,000 x 1,000 – times smaller than the 1m-resolution full mosaic)

Statewide mosaic (color infrared composite) example

State	California
Source	2014 NAIP Imagery with 11,119 separate tiles
Resolution	1m
Projection	WGS 84 Web Mercator (http://en.wikipedia.org/wiki/Web_Mercator)
Mosaic Image Size	1,149,000 x 1,351,000 pixels
File Size (raw data)	~4.3 Terabytes for three-band CIR (color infrared) imagery composite
Format	JPEG2000 (compression rate 1:10)
Processed data products (mosaics) available	CIR Composite: 262 Gigabytes single JPEG2000 file
Overview of CIR composite	
Notes	2012 CIR mosaic is also available. Mosaics at coarser resolutions (2m, 5m, 10m) are also available.




Example of CIR false-color composite (at 1m resolution)



Example of CIR false-color composite (at 5m resolution)

Imagery Product 3: Processed NAIP state-level mosaics (NDVI color composite)

State	California
Source	2014 NAIP Imagery with 11,119 separate tiles
Resolution	1m
Projection	WGS 84 Web Mercator (http://en.wikipedia.org/wiki/Web_Mercator)
Mosaic Image Size	1,149,000 x 1,351,000 pixels
File Size (raw data)	~1.4 Terabytes for single-band NDVI imagery composite
Format	GeoTIFF, JPEG2000, etc.
Overview of NDVI color composite	
Notes	2012 NDVI color mosaic is also available. Mosaics at coarser resolutions (2m, 5m, 10m) are also available.

Applications (e.g. an example relating to the Precision Agriculture business, 5m resolution)



State-level imagery product 1: natural color composite



State-level imagery product 2: color infrared composite



State-level imagery product 3: NDVI color composite