

Drone imagery processing using Agisoft Metashape: single- workstation and high-performance computing cluster applications

tinyurl.com/maptime-metashape

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Roadmap



- Brief photogrammetry introduction
- Metashape vs. Pix4D (commonly used)
- Hardware considerations
- Flavors of Metashape (GUI, batch, scripting)
- Metashape GUI
- Scripting with Metashape
- Parallel computing using Metashape and the Farm Cluster





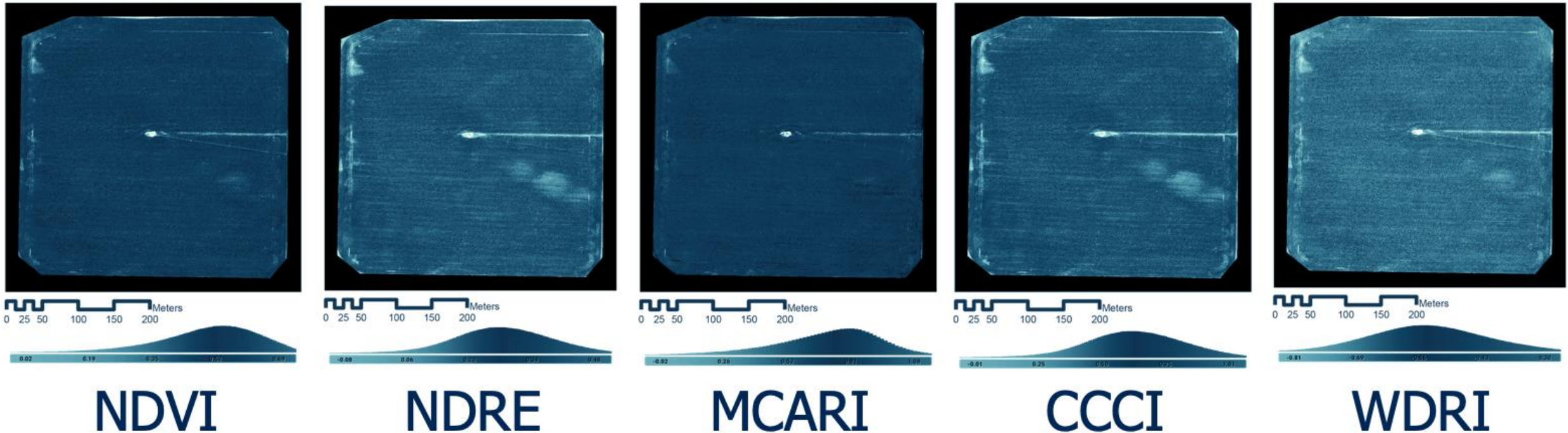
So you have access to a drone for research, now what?

- FAA Pilot Exam & Registration
- UCD UAS Flight Operations
- Site selection and Mission Planning for your imagery goals
- Successful mission(s), imagery catalogued, and backed up
- Post-processing and photogrammetry
- Additional spatial analyses (e.g. Spectral Indices)
- Additional geostatistical analyses (deep learning, Ag management zone identification)

Function		
Camera selection	+ (time to market)	-
Radiometric calibration	+ (for camera)	+ (need calibration text file)
Digital Elevation Model	+	+
Orthomosaic	+	+
Point Cloud generation	+	+
Batch processing GUI	-	+
Python scripting	- (need Pix4DEngine)	+

Pix4D Mapper GPU accelerated steps	Metashape GPU accelerated steps
Initial Processing (Step 1/3)	Image Matching
Point Cloud and Mesh (Step 2/3)	Depth maps reconstruction
rayCloud (point cloud inspired 3D reconstruction)	Depth maps based mesh
	DEM and tiled model generation
	Texture blending

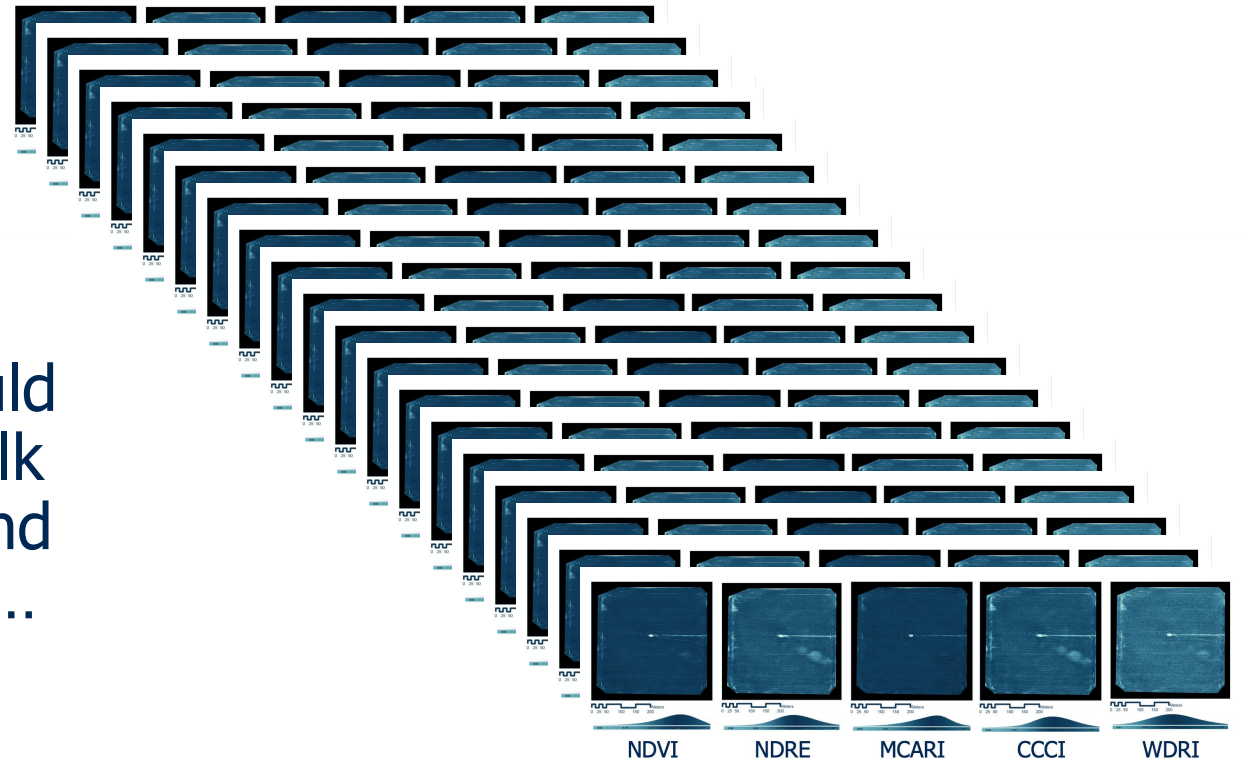
If all you need are small-batch index calculations, Pix4D might be fine



Altum data collected and processed in Pix4D by Alex Chisholm, July 22, 2019; 90-m mission

However, depending on how much data you have to process, you may want to batch or script...

Alex led 20 missions in 2019...would have been nice for him to just walk away instead of having to point and click and use the index calculator...

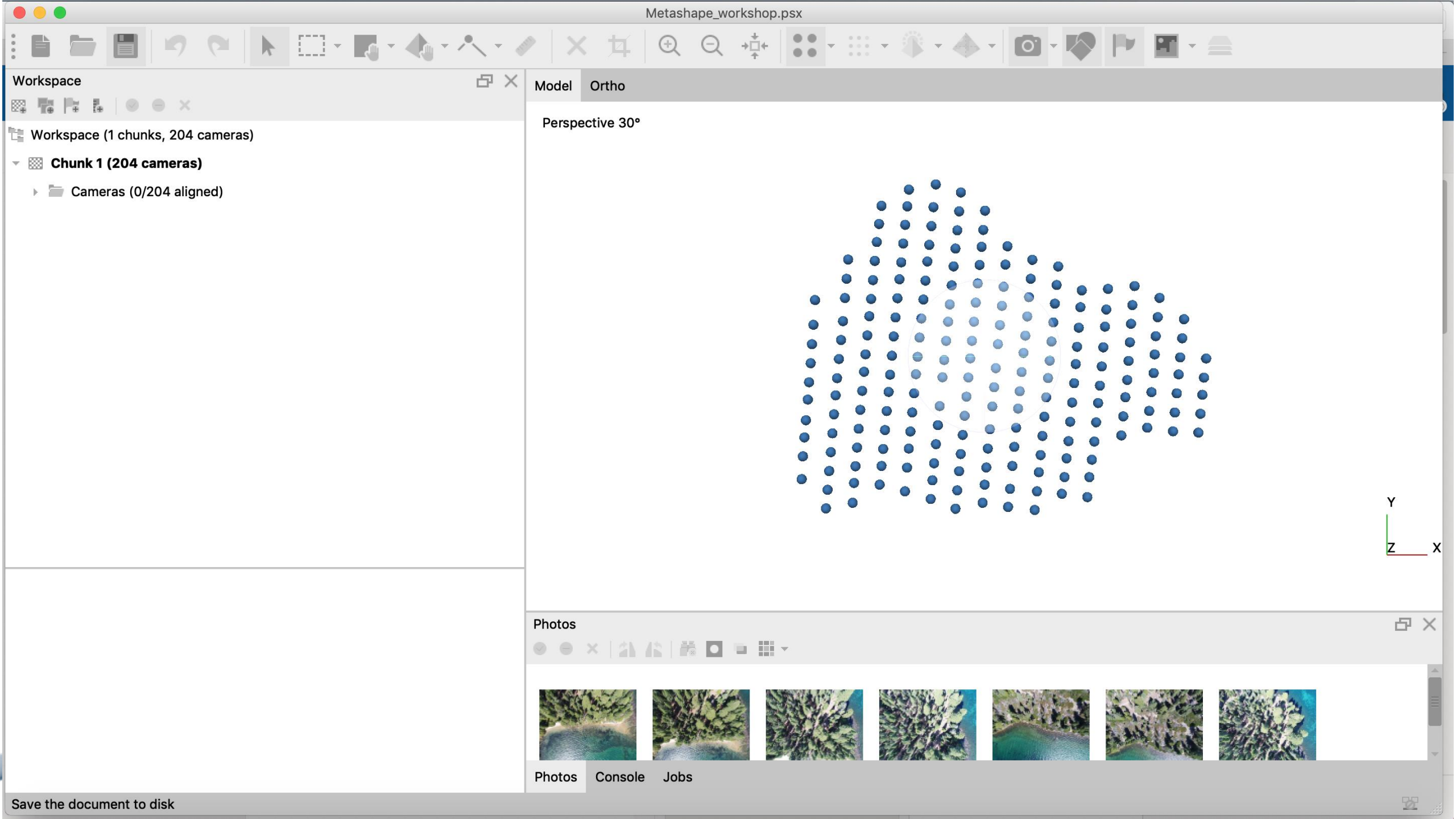


GUI Demo: Add photos (Workflow -> Add folder;
add the **sample_rgb_photoset** folder to the
Chunk 1)

<https://github.com/MicheleTobias/MaptimeDavis/tree/master/Metashape>

or

tinyurl.com/maptime-metashape



GUI Demo: Align Photos

Align Photos

General

Accuracy: High

☒ Generic preselection

☒ Reference preselection Source

☒ Reset current alignment

Advanced

Key point limit: 40,000

Tie point limit: 4,000

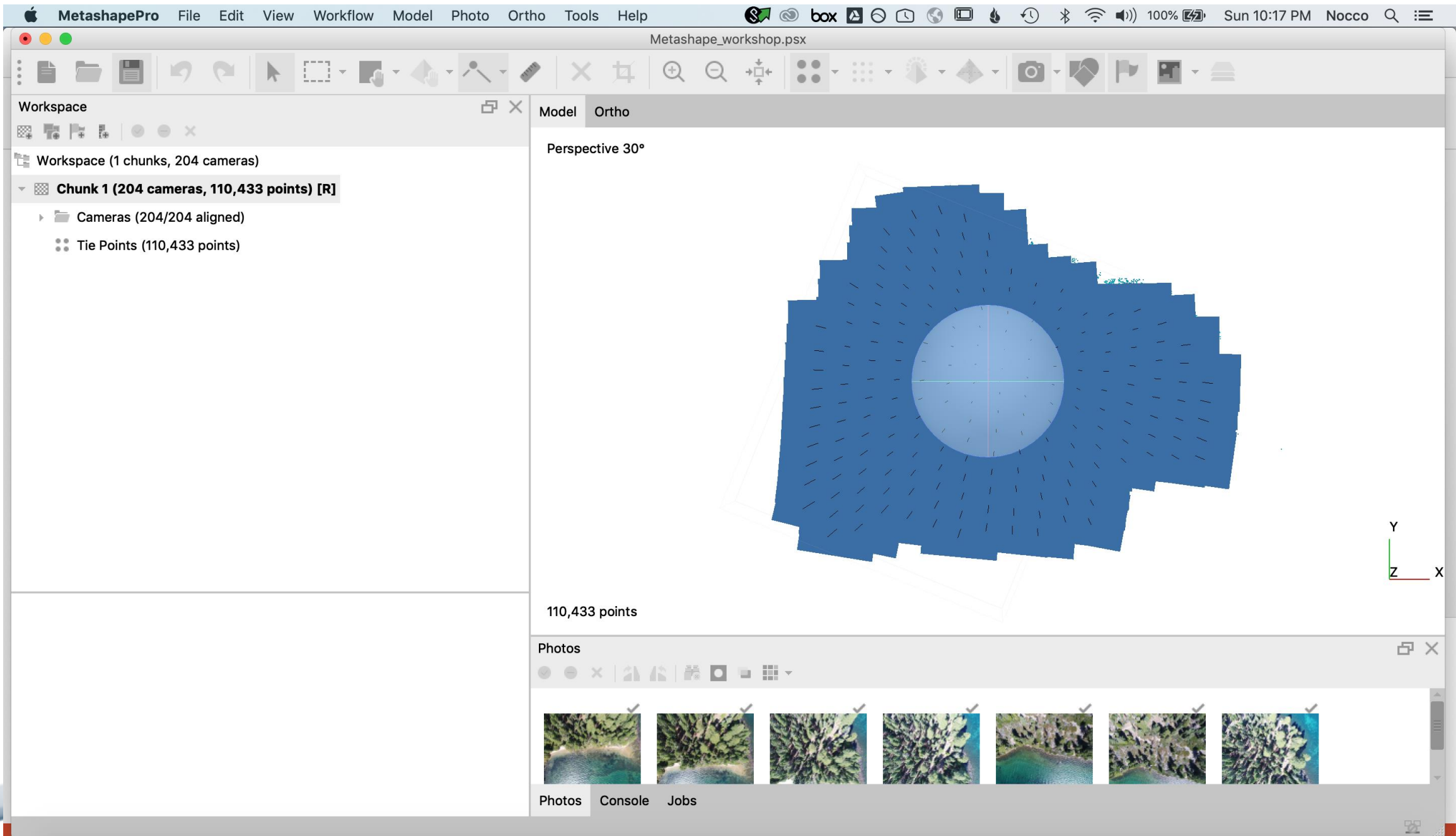
Apply masks to: None

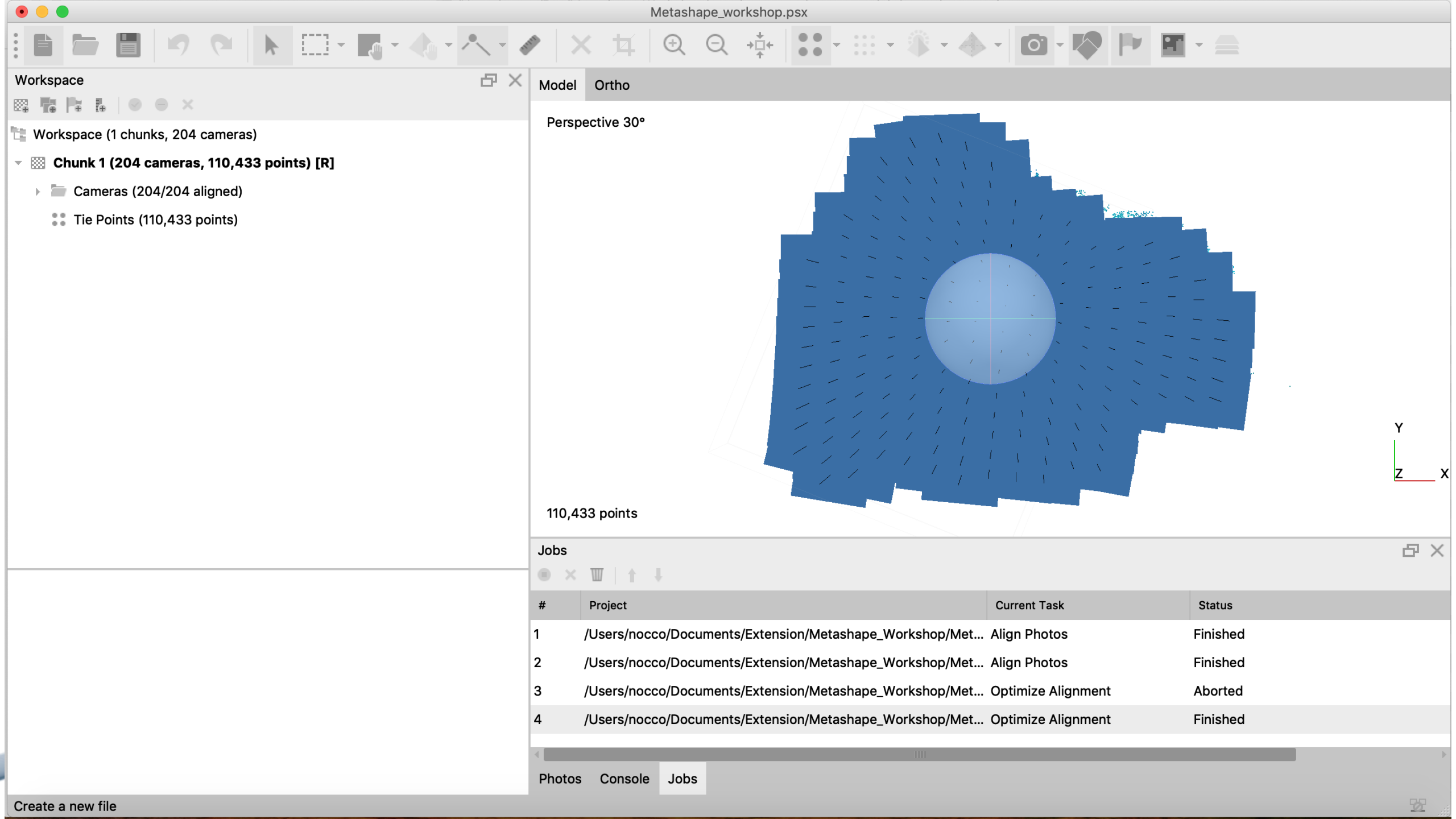
☐ Guided image matching

☒ Adaptive camera model fitting

Cancel

OK





Workspace

Workspace (1 chunks, 204 cameras)

Chunk 1 (204 cameras, 110,433 points) [R]

Cameras (204/204 aligned)

Tie Points (110,433 points)

Model Ortho

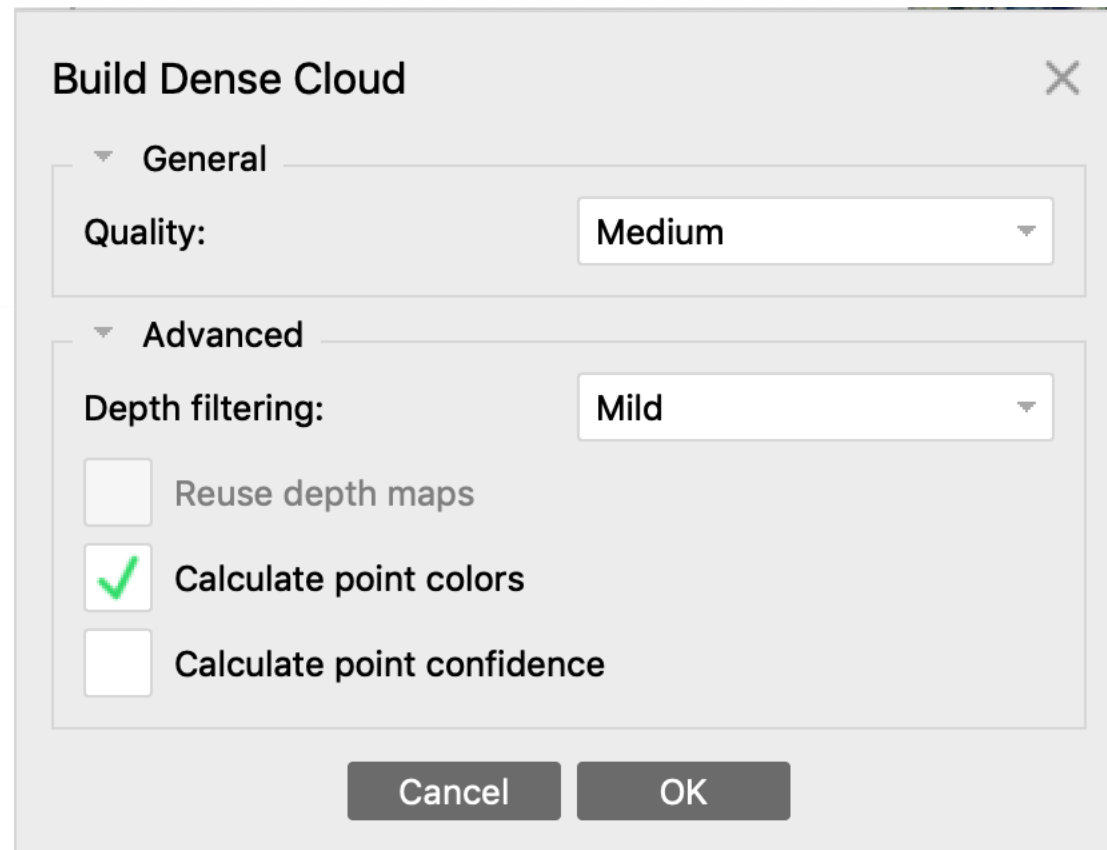
Perspective 30°

110,433 points

Jobs

#	Project	Current Task	Status
1	/Users/nocco/Documents/Extension/Metashape_Workshop/Met...	Align Photos	Finished
2	/Users/nocco/Documents/Extension/Metashape_Workshop/Met...	Align Photos	Finished
3	/Users/nocco/Documents/Extension/Metashape_Workshop/Met...	Optimize Alignment	Aborted
4	/Users/nocco/Documents/Extension/Metashape_Workshop/Met...	Optimize Alignment	Finished

GUI Demo: Build Dense Cloud



The image shows a software dialog box titled "Build Dense Cloud" with a close button (X) in the top right corner. The dialog is organized into two sections: "General" and "Advanced".

General Section:

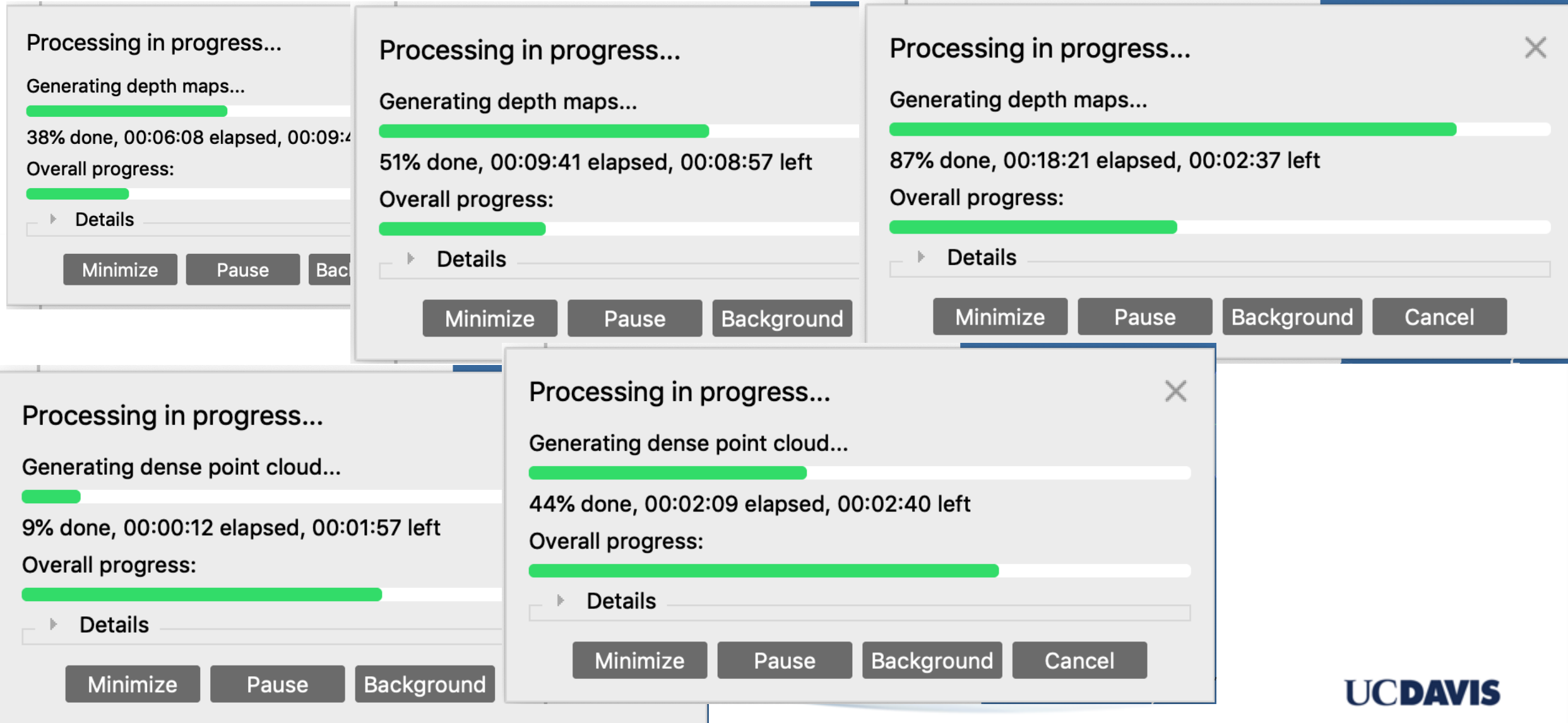
- Quality:** A dropdown menu currently set to "Medium".

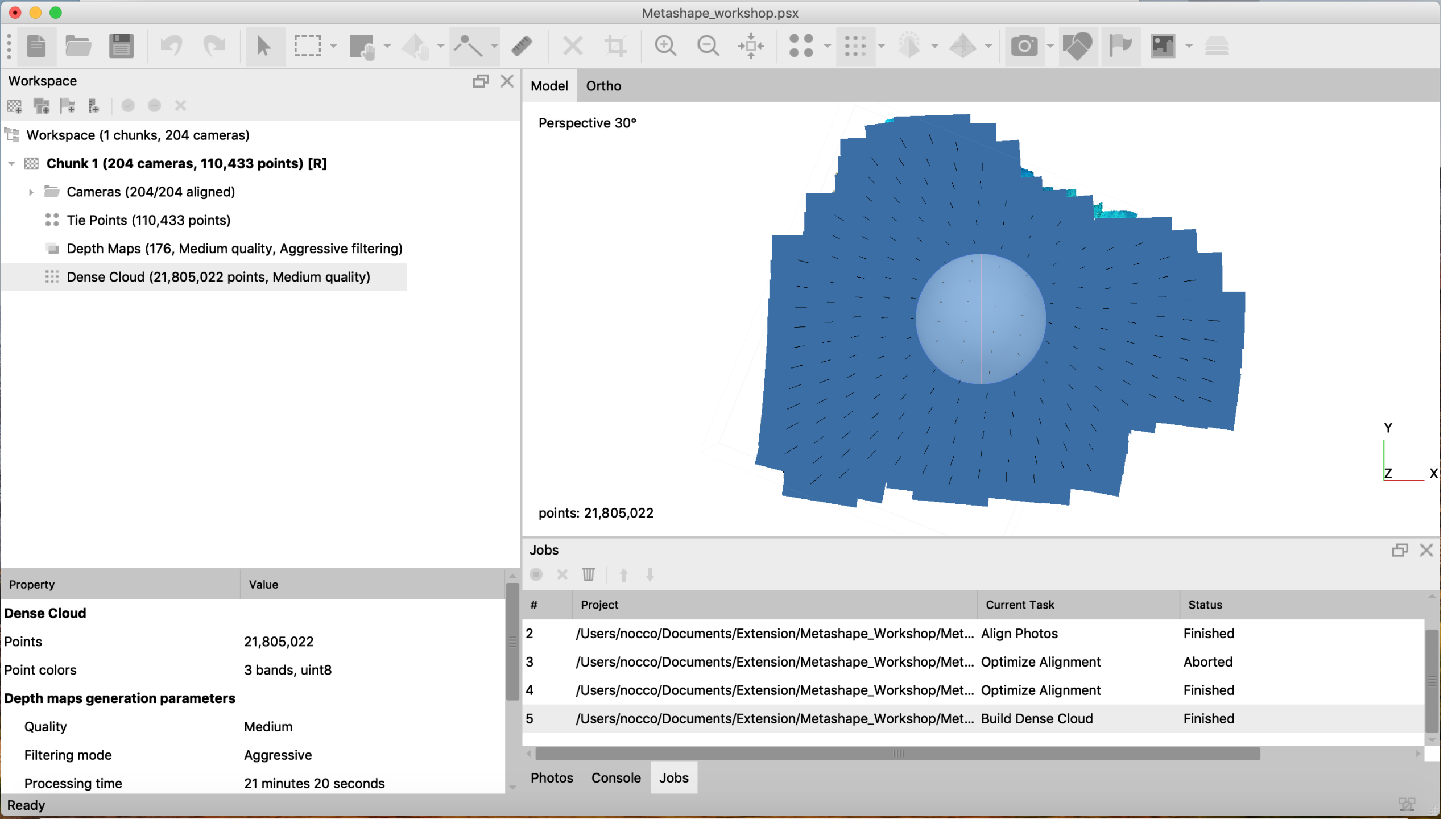
Advanced Section:

- Depth filtering:** A dropdown menu currently set to "Mild".
- Reuse depth maps:** An unchecked checkbox.
- Calculate point colors:** A checked checkbox, indicated by a green checkmark.
- Calculate point confidence:** An unchecked checkbox.

At the bottom of the dialog are two buttons: "Cancel" and "OK".

GUI Demo: Build Dense Cloud





Workspace



Model

Ortho

Perspective 30°

points: 21,805,022

Jobs

#	Project	Current Task	Status
2	/Users/nocco/Documents/Extension/Metashape_Workshop/Met...	Align Photos	Finished
3	/Users/nocco/Documents/Extension/Metashape_Workshop/Met...	Optimize Alignment	Aborted
4	/Users/nocco/Documents/Extension/Metashape_Workshop/Met...	Optimize Alignment	Finished
5	/Users/nocco/Documents/Extension/Metashape_Workshop/Met...	Build Dense Cloud	Finished

Photos Console Jobs

Property

Value

Dense Cloud

Points 21,805,022

Point colors 3 bands, uint8

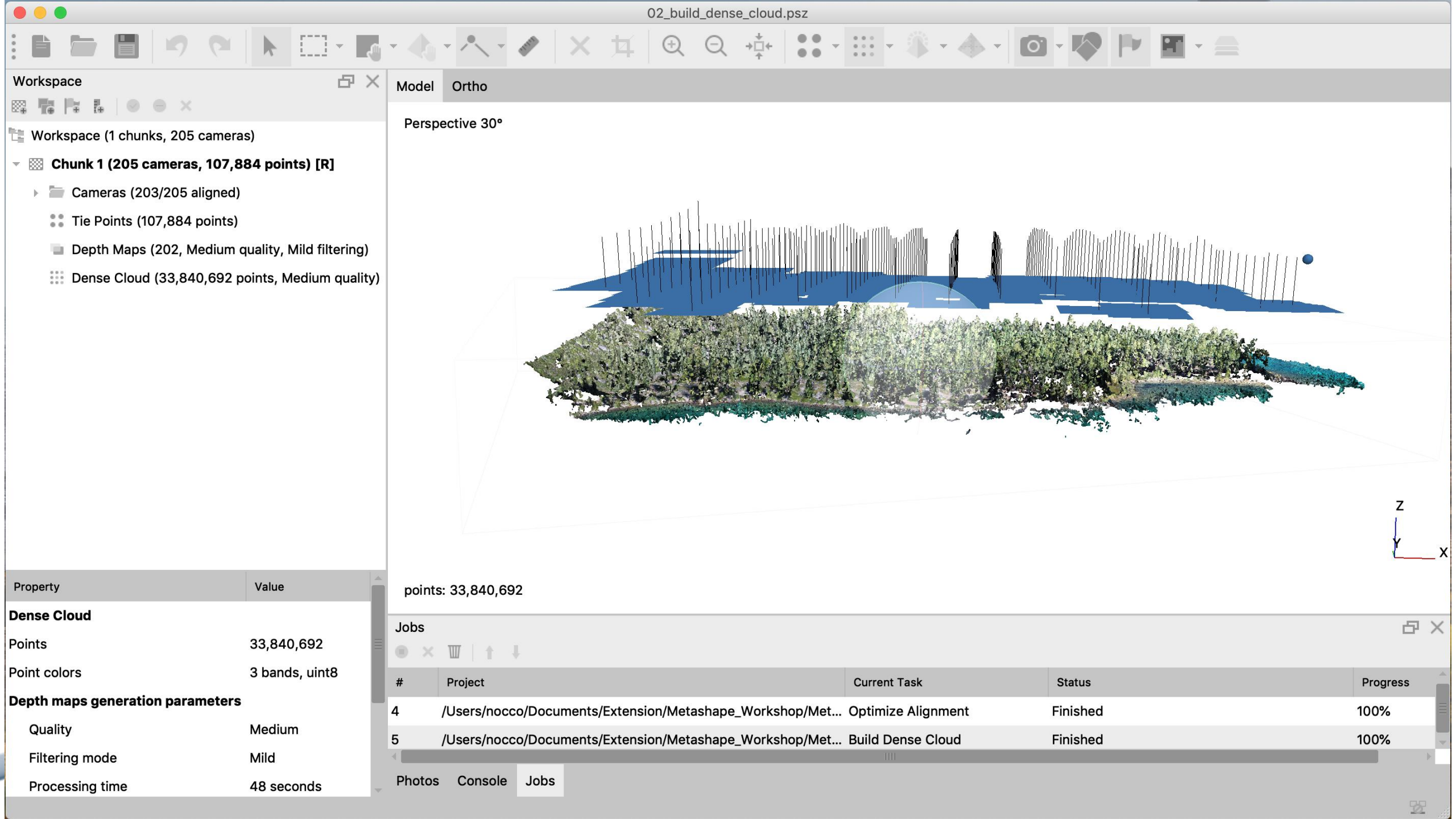
Depth maps generation parameters

Quality Medium

Filtering mode Aggressive

Processing time 21 minutes 20 seconds

Ready



Workspace



Workspace (1 chunks, 205 cameras)

▼ Chunk 1 (205 cameras, 107,884 points) [R]

► Cameras (203/205 aligned)

Tie Points (107,884 points)

Depth Maps (202, Medium quality, Mild filtering)

Dense Cloud (33,840,692 points, Medium quality)

Property

Value

Dense Cloud

Points 33,840,692

Point colors 3 bands, uint8

Depth maps generation parameters

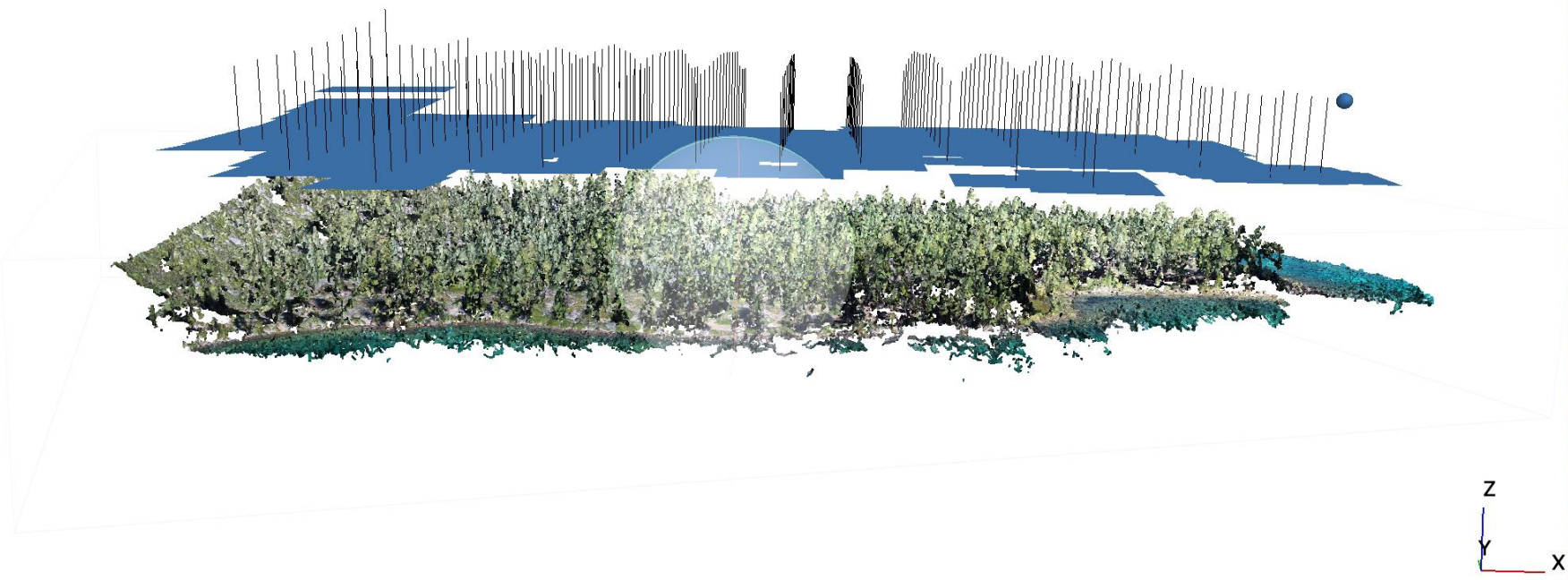
Quality Medium

Filtering mode Mild

Processing time 48 seconds

Model Ortho

Perspective 30°



points: 33,840,692

Jobs



#	Project	Current Task	Status	Progress
4	/Users/nocco/Documents/Extension/Metashape_Workshop/Met...	Optimize Alignment	Finished	100%
5	/Users/nocco/Documents/Extension/Metashape_Workshop/Met...	Build Dense Cloud	Finished	100%

Photos Console Jobs

GUI Demo: Build DEM

Build DEM

Projection

Type: ☒ Geographic ☐ Planar ☐ Cylindrical

WGS 84 / UTM zone 10N (EPSG::32610)

Parameters

Source data: Dense cloud

Quality:

Interpolation: Enabled (default)

Point classes: All Select...

Advanced

Region

☐ Setup boundaries: 751834.261 - 752792.129 X

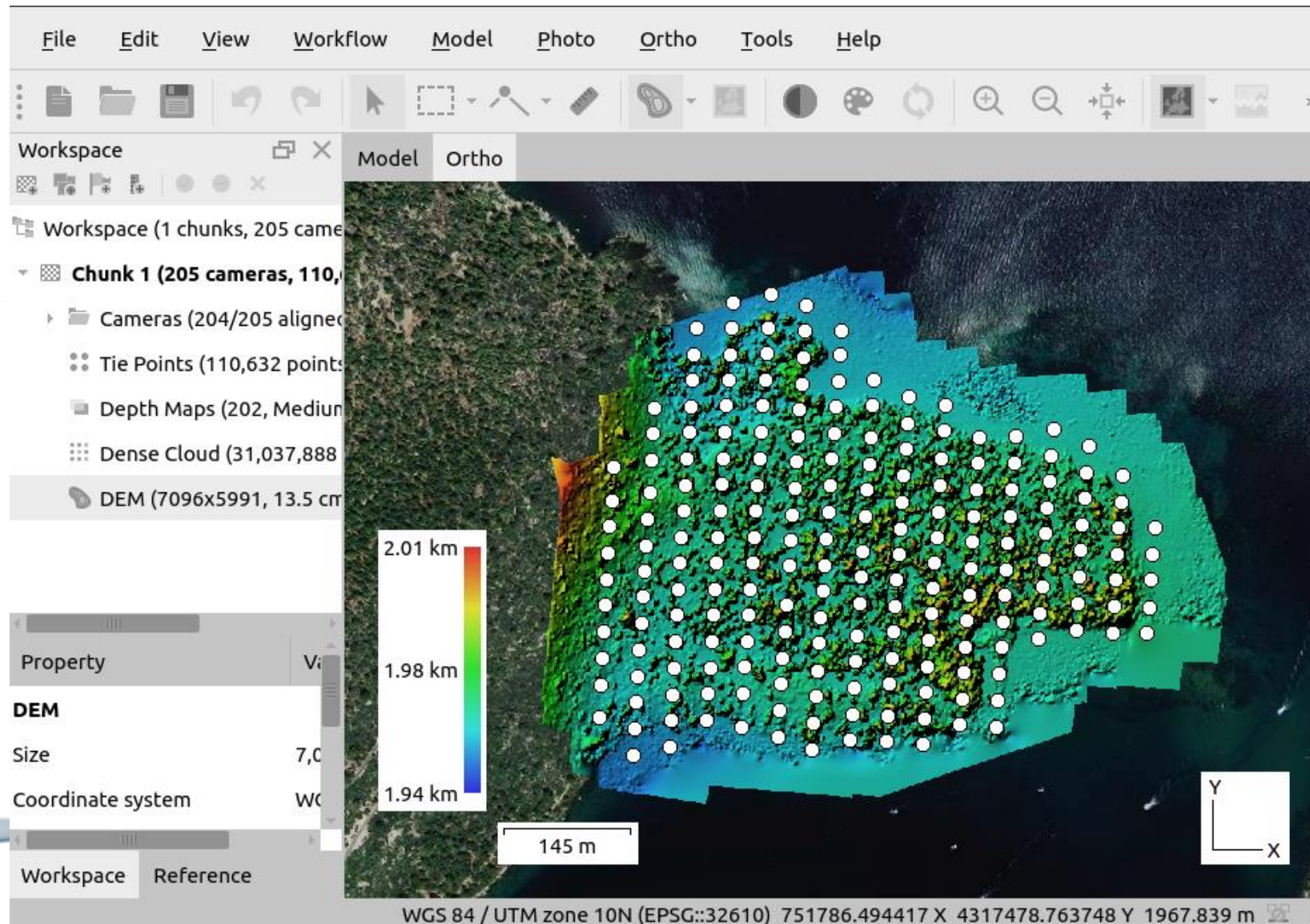
Reset 4316720.765 - 4317530.975 Y

Resolution (m): 0.135033

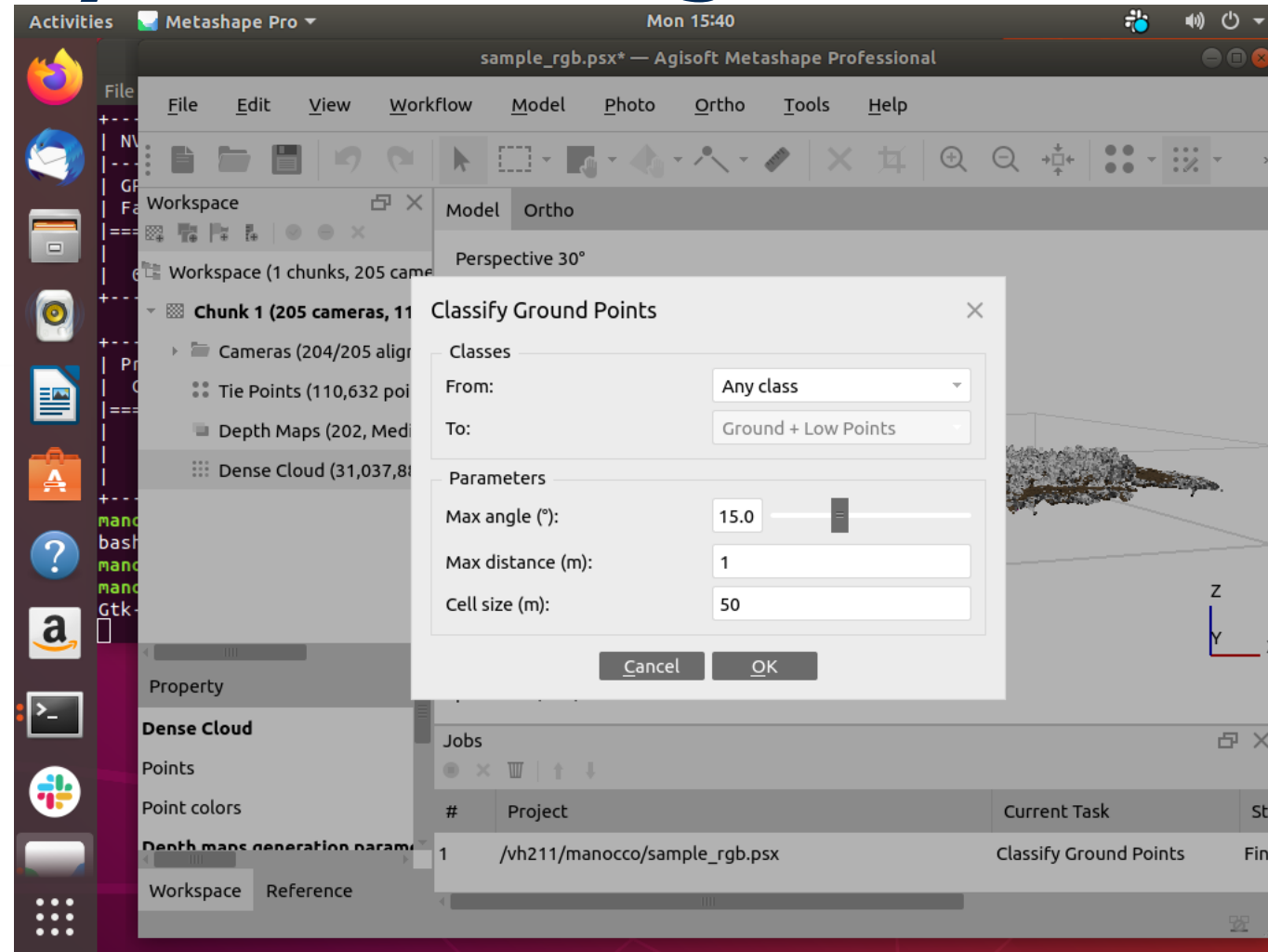
Total size (pix): 7090 x 5997

Cancel OK

GUI Demo: Build DEM



What if you want a digital terrain model?



GUI Demo: Build Orthomosaic

Build Orthomosaic

Projection

Type:

☒ Geographic☐ Planar☐ Cylindrical

WGS 84 / UTM zone 10N (EPSG::32610)

Parameters

Surface:

DEM

Blending mode:

Mosaic (default)

☒ Refine seamlines

☒ Enable hole filling

☐ Enable back-face culling

☒ Pixel size (m):

0.0338424

X

Metres...

0.0338424

Y

☐ Max. dimension (pix):

4096

Region

☐ Setup boundaries:-X

Estimate

-Y

Total size (pix):x

Cancel

OK

Build Orthomosaic

Projection

Type:

☒ Geographic☐ Planar☐ Cylindrical

WGS 84 / UTM zone 10N (EPSG::32610)

Parameters

Surface:

DEM

Blending mode:

Mosaic (default)

☒ Refine seamlines

☒ Enable hole filling

☐ Enable back-face culling

☒ Pixel size (m):

0.0338424

X

Metres...

0.0338424

Y

☐ Max. dimension (pix):

4096

Region

☐ Setup boundaries:

751978.621

-

752755.914

X

Estimate

4316827.182

-

4317436.481

Y

Total size (pix):

22968

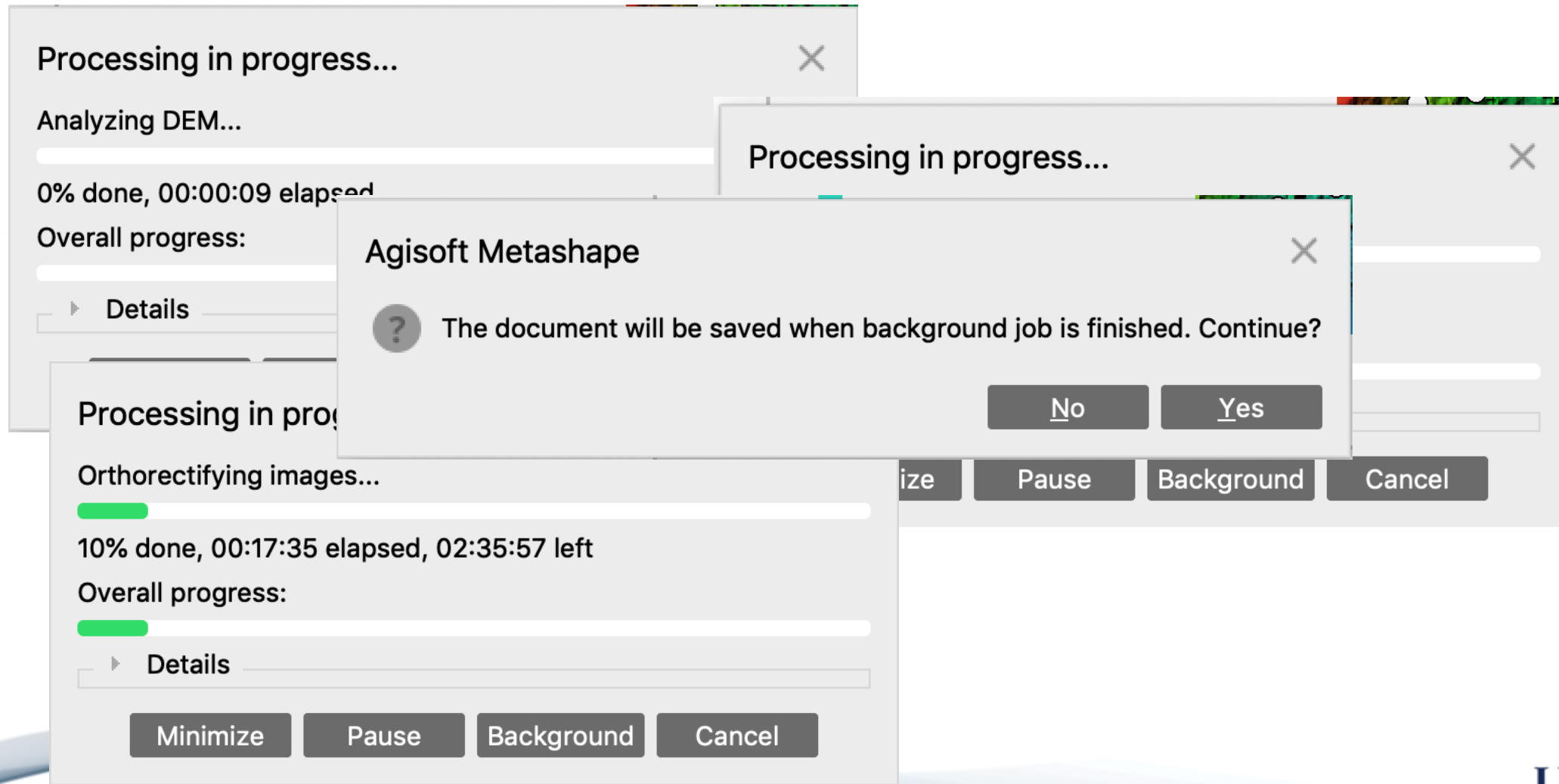
x

18004

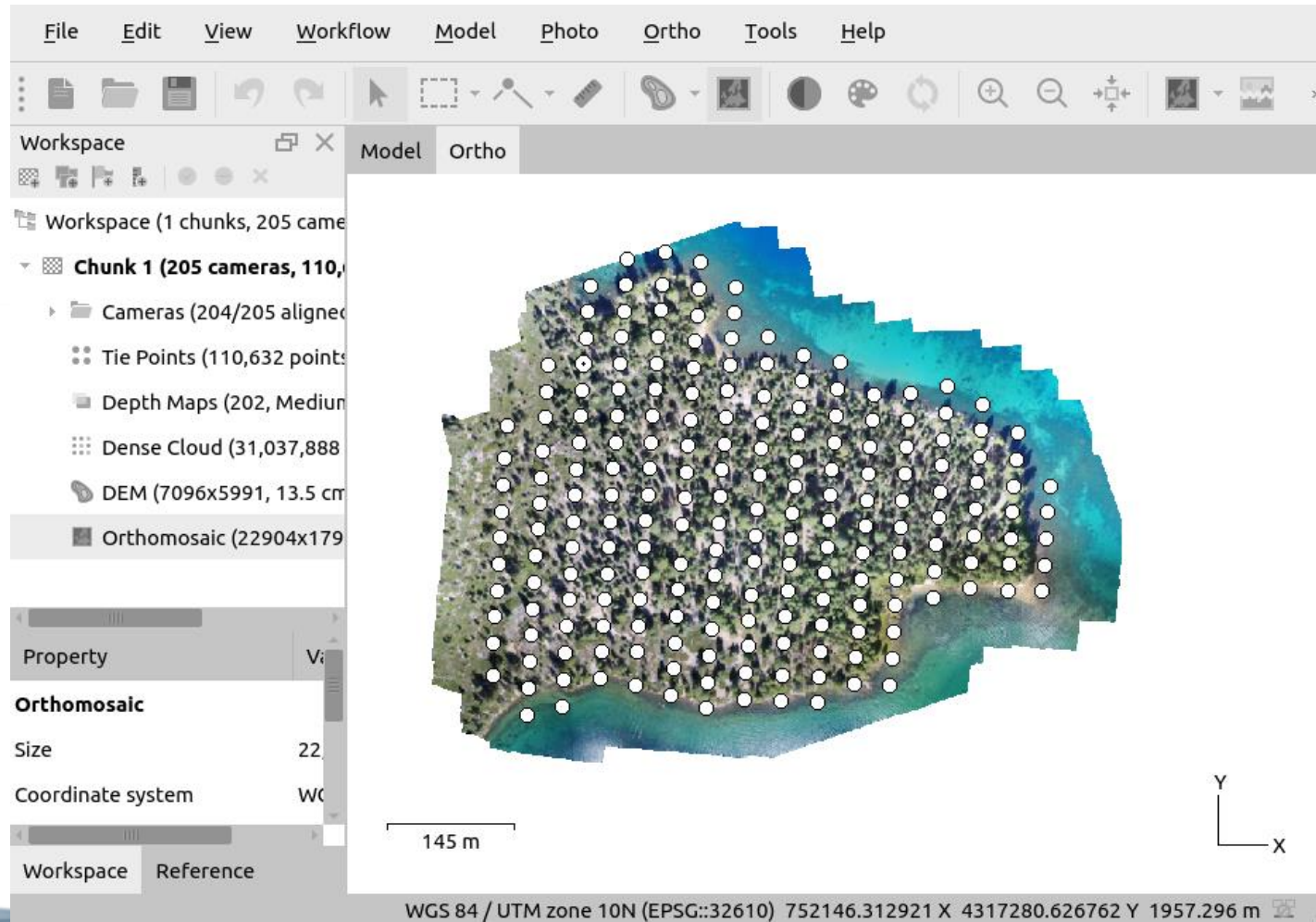
Cancel

OK

GUI Demo: Build Orthomosaic



GUI Demo: Orthomosaic



GUI Demo: Export DEM and Orthomosaic

[File menu]

Export DEM

Coordinate System

WGS 84 / UTM zone 10N (EPSG::32610)

Raster

☒ Pixel size (m): 0.13537 X

Metres... 0.13537 Y

☐ Max. dimension (pix): 4096

☐ Split in blocks (pix): 10000 x 10000

Raster transform: None

No-data value: -32767

Region

☐ Setup boundaries: 832.558 - 1793.141 X

Reset 1720.240 - 1531.240 Y

Total size (pix): 7095 x 5990

☐ Write KML file ☐ Write World file

☐ Write tile scheme

Compression

Image description:

☒ Write tiled TIFF ☐ Write BigTIFF file

☒ Generate TIFF overviews

☐ Write alpha channel

Export Orthomosaic

Coordinate System

WGS 84 / UTM zone 10N (EPSG::32610)

Raster

☒ Pixel size (m): 0.0338424 X

Metres... 0.0338424 Y

☐ Max. dimension (pix): 4096

☐ Split in blocks (pix): 10000 x 10000

Raster transform: None

Background color: White

Region

☐ Setup boundaries: 980.652 - 1755.778 X

Reset 1827.995 - 1436.346 Y

Total size (pix): 22904 x 17976

☐ Write KML file ☐ Write World file

☐ Write tile scheme

Compression

Image description:

TIFF compression: LZW

JPEG quality: 90

☒ Write tiled TIFF ☐ Write BigTIFF file

☒ Generate TIFF overviews

Can now use orthomosaic in QGIS, etc

GUI Demo: Radiometric calibration (multiband)



GUI Demo: Radiometric calibration (multiband for Altum)

<https://agisoft.freshdesk.com/support/solutions/articles/31000148381-micasense-altum-processing-workflow-including-reflectance-calibration-in-agisoft-metashape-professi>

Panel Reflectance Values

Please use the following form to request the specific reflectance values for your calibrated reflectance panel.

Name *

First Name

Last Name

Email Address *

Panel Serial Number *

What software will you be using to process the data? *

- ☐ Pix4D
☐ AgiSoft
☐ Other



SUBMIT

Select Reflectance Panel		
Filter: <input type="text"/>		
RP04-1923118-OB		
RP04-1923118-OB		
	Wavelength (nm)	Reflectance
1	250	0.535168
2	251	0.534525
3	252	0.534302
4	253	0.533966
5	254	0.533576
6	255	0.532931
7	256	0.532406
8	257	0.531824
9	258	0.531253
10	259	0.530893
11	260	0.530457
12	261	0.529948
13	262	0.529218
14	263	0.52891
15	264	0.528235
16	265	0.527593
17	266	0.526951

GUI Demo: Radiometric calibration (multiband for Altum)

Calibrate Reflectance

Images

Label	Panel
 IMG_000...	RP04-1923118-OB (5/6)
 IMG_063...	RP04-1923118-OB (5/6)

Locate panels

Panel Calibration

	Band	Reflectance
1	Blue	0.515673
2	Green	0.517058
3	Red	0.516777
4	Red edge	0.515792
5	NIR	0.513904
6	LWIR	

Select panel...

Parameters

☒ Use reflectance panels

☐ Use sun sensor

Reset

Cancel

OK

GUI Demo: Batch processing

Batch Process

Order	Job Type	Applies To
<input checked="" type="checkbox"/>	1 Align Photos	All Chunks
<input checked="" type="checkbox"/>	2 Optimize Alig...	All Chunks
<input checked="" type="checkbox"/>	3 Build Dense ...	All Chunks
<input checked="" type="checkbox"/>	4 Build DEM	All Chunks
<input checked="" type="checkbox"/>	5 Build Orthom...	All Chunks
<input checked="" type="checkbox"/>	6 Export Ortho...	All Chunks

Add... Edit... Remove

☒ Save project after each step

Cancel OK

Scripting Demo: UC Metashape GitHub repo

<https://github.com/ucdavis/metashape>

The screenshot shows the GitHub repository page for 'ucdavis / metashape'. At the top, it displays the repository name and navigation links for Watch (5), Star (3), and Fork (3). Below this is a tabbed interface with 'Code' selected, and links for Issues (7), Pull requests (0), Actions, Projects (0), Wiki, Security, and Insights. The repository description is 'Easy, reproducible Metashape photogrammetry workflows'. A summary bar shows 113 commits, 6 branches, 0 packages, 0 releases, and 3 contributors. Below this is a section for the latest commit by 'youngdjn' titled 'Update README.md', with a link to 'View license'. A table lists the repository's files and folders, including 'R', 'calibration', 'config', 'python', 'shell', '.gitignore', 'LICENSE', and 'README.md', each with a brief description and the time since the last commit.

ucdavis / metashape

Watch 5 Star 3 Fork 3

<> Code Issues 7 Pull requests 0 Actions Projects 0 Wiki Security Insights

Easy, reproducible Metashape photogrammetry workflows

113 commits 6 branches 0 packages 0 releases 3 contributors View license

Branch: master New pull request Create new file Upload files Find file Clone or download

youngdjn Update README.md Latest commit 3cf95e3 5 days ago

R	Improve for command-line running	last month
calibration	Adding more calibration panel examples that have been used at UC Davis	4 months ago
config	Better commenting of example yml	6 days ago
python	Allow "path" and "project" keys from YAML to include "Metashape"	6 days ago
shell	Streamlining cluster scripts, more example ymls	2 months ago
.gitignore	Ignore PyCharm files	4 months ago
LICENSE	Create LICENSE	4 months ago
README.md	Update README.md	5 days ago

Scripting Demo: Config file set-up

- Configuration file: `example_config_file/config_example.yml`

```
1 # This is an example yaml configuration for a metashape run
2
3 ##### Project-level parameters:
4
5 # Project to load. If not a blank string, this will open an existing project at the path specified. If a blank string, creates a new
6 # Even if opening an existing project, all processing on it is saved as a new project (path and name specified below). The original p
7 # When no project is specified, photos are automatically added to the new project as the first step. When a project is specified, pho
8 load_project: ""
9
10 # The path to the directory of flight photos
11 # If there are multiple photo folders, set path to the folder that contains all the photo folders
12 photo_path: "/storage/uav/photosets/sample_rgb_photoset"
13 multispectral: False # Is this a multispectral photo set? If RGB, set to False.
14
15 # Path for exports (e.g., points, DSM, orthomosaic) and processing log. Will be created if does not exist.
16 output_path: "/storage/uav/metashape_outputs/sample"
17
18 # Path to save Metashape project file (.psx). Will be created if does not exist
19 project_path: "/storage/uav/metashape_projects/sample"
20
21 # The identifier for the run. Will be used in naming output files. Recommended to include a photoset name and processing parameter se
22 run_name: "sample_rgb_photoset_run001"
23
24 # CRS EPSG code that project outputs should be in (projection should be in meter units and intended for the project area)
25 project_crs: "EPSG:26910" # 26910 is UTM 10N
26
27 # Enable metashape "fine-level task subdivision" which reduces memory use by breaking processing into independent chunks that are run
28 # Assuming there's enough memory, it seems to run 10-20% faster by disabling subdividing. But large projects can run out memory and f
```

Scripting Demo

- The command line call (use paths specific for you):

```
python ~/repos/metashape/python/metashape_workflow.py  
        ~/projects/forest_structure/metashape_configs/config001.yml
```

Scripting Demo: Batch using a shell script

```
python ~/repos/metashape/python/metashape_workflow.py ~/projects/forest_structure/metashape_configs/config001.yml  
python ~/repos/metashape/python/metashape_workflow.py ~/projects/forest_structure/metashape_configs/config002.yml  
python ~/repos/metashape/python/metashape_workflow.py ~/projects/forest_structure/metashape_configs/config003.yml
```

Scripting Demo: Python code (have a look under the hood)

```
27  ## Parse the config file
28  cfg = read_yaml.read_yaml(config_file)
29
30  ### Run the Metashape workflow
31
32  doc, log, run_id = meta.project_setup(cfg)
33
34  meta.enable_and_log_gpu(log)
35
36  if cfg["load_project"] == "": # only add photos if this is a brand new project, not based off an existing project
37      meta.add_photos(doc, cfg)
38
39  if cfg["calibrateReflectance"]["enabled"]:
40      meta.calibrate_reflectance(doc, cfg)
41
42  if cfg["addGCPs"]["enabled"]:
43      meta.add_gcps(doc, cfg)
44
45  if cfg["alignPhotos"]["enabled"]:
46      meta.align_photos(doc, log, cfg)
47
48  if cfg["optimizeCameras"]["enabled"]:
49      meta.optimize_cameras(doc, cfg)
50
51  if cfg["buildDenseCloud"]["enabled"]:
52      meta.build_dense_cloud(doc, log, run_id, cfg)
53
54  if cfg["buildDem"]["enabled"]:
55      meta.build_dem(doc, log, run_id, cfg)
56
```

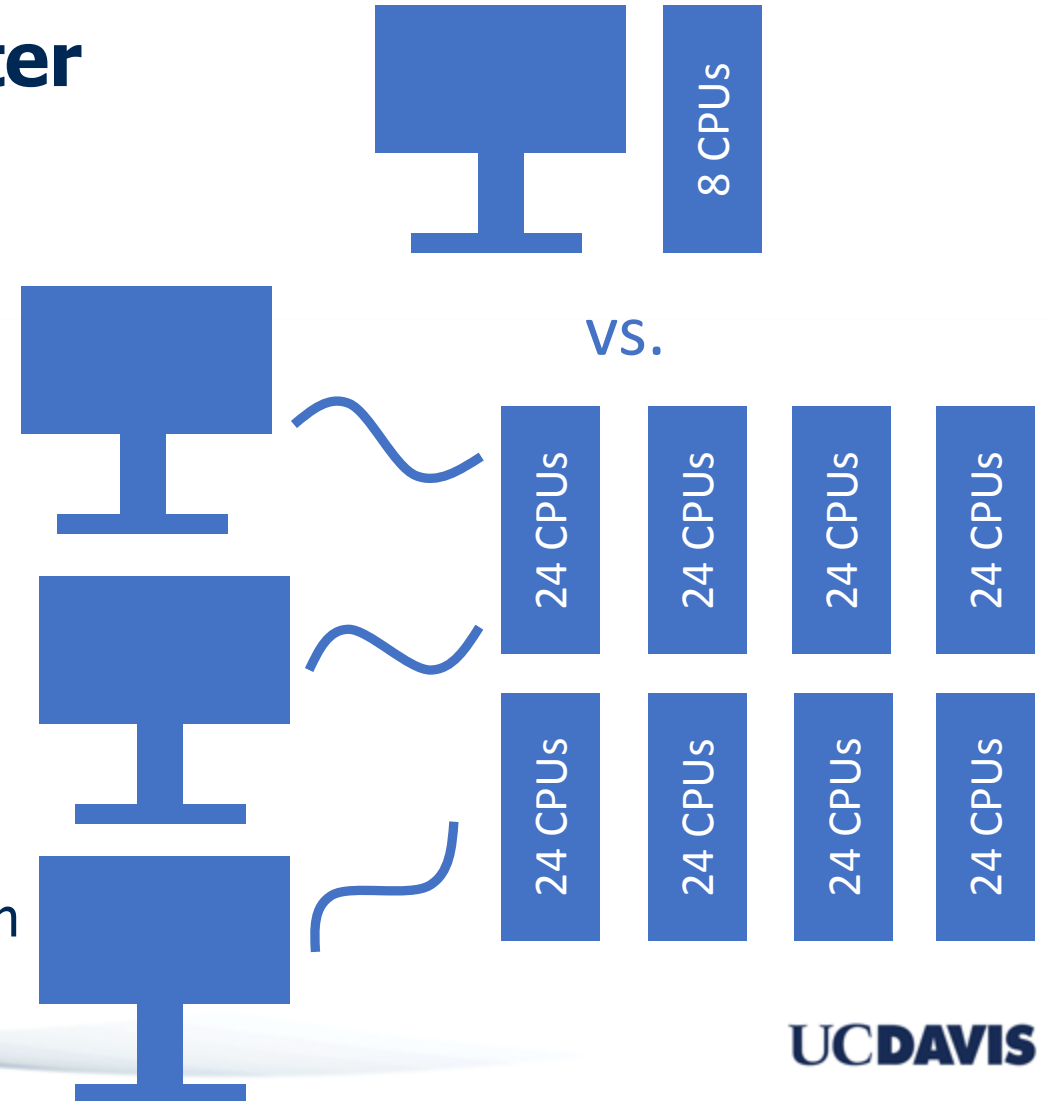

Parallel computing / computing clusters

Advantages of a computing cluster

- (Usually) more CPUs per machine
- Many machines ("nodes")
- Shared pool of resources
 - Lower cost

CAES 'farm' cluster

- 8 free nodes with 24 CPUs
- More powerful nodes available
- <https://wiki.cse.ucdavis.edu/support/systems/farm>



Using the 'farm' cluster

```
$ ssh djyoung@farm.cse.ucdavis.edu
Welcome to Ubuntu 18.04.4 LTS (GNU/Linux 4.15.0-70-generic x86_64)

1 updates could not be installed automatically. For more details,
see /var/log/unattended-upgrades/unattended-upgrades.log

*** System restart required ***
A transfer node, c11-42, is available for rsync, scp, sftp, gzip, wget, etc.
From outside the Farm cluster use port 2022 to access the transfer node.
ssh -p 2022 username@farm.cse.ucdavis.edu
scp -P 2022 src username@farm.cse.ucdavis.edu:/destination

REMINDER: Farm does not back up user data. Please ensure your data is backed up offsite.

*** Feb 13 2020:
* 10:16am - Transfer node (port 2022) has been restored for now.

Email help@cse.ucdavis.edu for help with Farm.

Downtime scheduled for the first Wednesday of Oct and April.
* The next scheduled downtime is Wednesday April 1st at 11:59pm.

If interested in contributing to farm, the rates for 5 years are:
$ 1,000 per 10TB, served from redundant servers with compression
$ 8,800 per parallel node (256GB ram, 48 cores/96 threads, 2TB /scratch)
$17,500 per GPU node (Nvidia Tesla V100, dual Xeon 4114, 2TB /scratch)
$22,700 per bigmem node (1TB ram, 48 cores/96 threads, 2TB /scratch)

Last login: Mon Feb 24 14:07:25 2020 from 168.150.28.111
Module slurm/19.05.3 loaded
Module openmpi/4.0.1 loaded
djyoung@farm:~$
```

Using the 'farm' cluster

- Remember the command-line call

```
python ~/repos/metashape/python/metashape_workflow.py  
~/projects/forest_structure/metashape_configs/config001.yml
```

- Prepare shell script (farm_python.sh)

```
#!/bin/bash -l  
  
# Any necessary setup goes here (env. vars, font, print host name)  
  
# Run the workflow, with two command-line arguments  
python ${1} ${2}
```

- Submit job

```
sbatch -p med --time=12:00:00 --job-name=MetaInt -c 24 --mem=32G  
shell/farm_python.sh python/metashape_workflow.py  
config/example.yml
```

Come to Drone Camp, our UC ANR UAV Short Course for Ag and Forest Imaging

- June 22-25 2020 in Monterey, CA
- <http://igis.ucanr.edu/dronecamp/>

Thank you!

Acknowledgement: Dr. Alex Mandel

Contact us: djyoung@ucdavis.edu, changingforests.com
manocco@ucdavis.edu, @mallika_nocco
irrigationlab.com (coming Apr 2020!)

Farm computing options comparison

Machine/node type	Computing time	Cost ballpark
Dell Alienware gaming PC with Nvidia RTX 2080 Ti and 16 CPUs	1 day	\$3,000
Free original farm nodes (24 CPUs)	30 days	Free
New farm bigmem nodes (96 CPUs)	5 days	\$22,700
Potential future farm GPU node (8 x RTX 2080 Ti)	2 days (using only 1 of the 8 GPUs)	\$25,000 (if split 8 ways, \$3,125 per user)