

# A Method for Generating a Scalar Field Contain Radius Values

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## Description

At times it is desirable to be able to visualize or filter a point cloud based on radial values.

This is mostly applicable when manipulating point clouds that have a circular or spherical shape.

The technique below outlines an approach that can be used to convert the standard X and Y coordinates of a point cloud into a scalar field containing radius values.

The technique involves use of the free tool, [Cloud Compare](#), and a few manual steps as well as use of a batch file that has been prepared to do most of the heavy lifting.

The batch file contains calls to the Cloud Compare via command line. The result is a new point cloud with a radius Scalar field based on the data from the input Point Cloud.

Cloud Compare version that was used for this technique is: **beta release: 2.13. alpha (01/25/2023)**

**Note.** Other beta releases had a bug in the `-SF_OP_SF` command that prevented the third step from working properly.

## Steps

### 1. Prepare the Point Cloud

- a) [OPTIONAL] - Remove points outside the area by using appropriate tools such as:
  - i) Any filtering methods
  - ii) "Segment" tool
  - iii) "Cross Section" tool
  - iv) etc

**Note 1:** *Cleaning points past the boundary of the circle area of interest will allow you to easily use the "Global Box Center" values in the next step. You want the bounding box to be up tight to the area of interest. This results in the geometric center of the circular area of interest to be in the center of the bounding box. (See figure 1)*

**Note 2:** *Batch file script will also run faster if you remove unneeded points)*

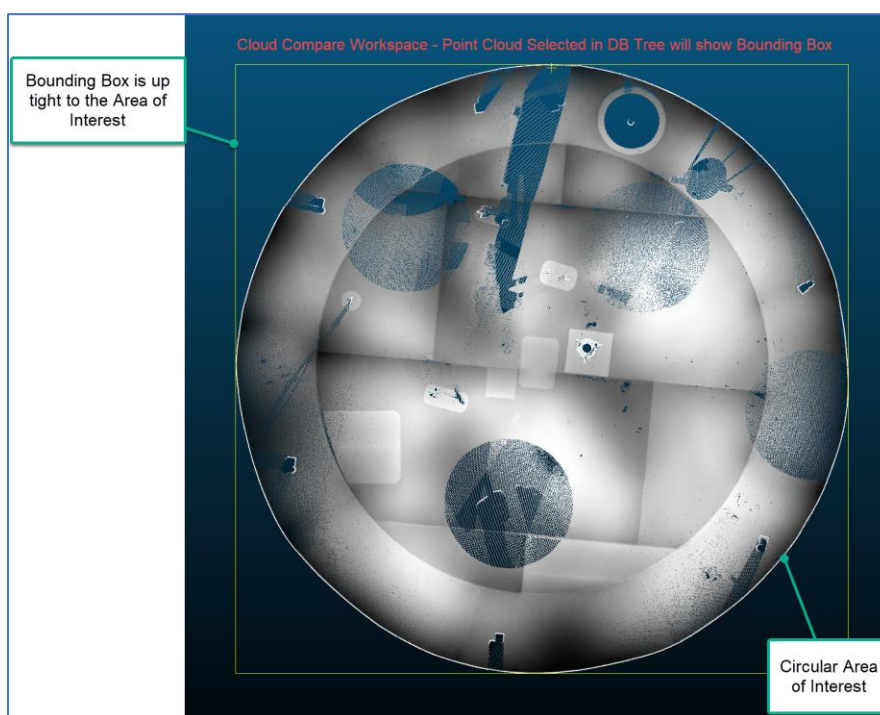


Figure 1 - Cloud Compare Workspace showing top-down view of area of interest inside Bounding Box

## 2. Transform Point Cloud

**Transform the Point cloud so that  $X=0$  and  $Y=0$  are located at the position where you want the radius measurements to originate.** (Generally, you want the origin to be at the geometric center of the region of interest)

Use any of the methods identified below:

- 2.1. Manually move point cloud so that the origin is at the desired location with “**Translate/Rotate**” tool then go to step 3.
- 2.2. Transform the point cloud by using specific X and Y coordinates by using Method 1, Method 2 or any other method you desire.
  - **Method 1:** Determine the X and Y coordinates identifying the location of where you want the radius measurements to be started from using point picking tool or other methods then go to step 2.3
  - **Method 2:** If you have isolated the geometric shape within a boundary box that has the radius center located in the center of the bounding box, you can retrieve the x, y coordinates from the “**Global Box Center**” (see figure 2), then go to step 2.3

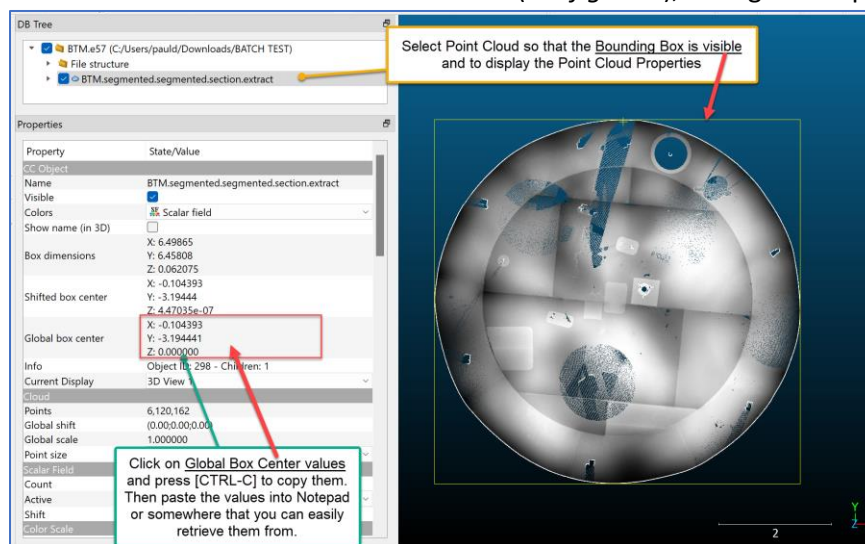


Figure 2 - Cloud Compare – top-down view of area of interest centered in Bounding Box

### 2.3. Apply Transformation

- Confirm the desired Point Cloud is **selected in the DB Tree**
- Press CTRL-T to bring up “Apply Transformation” window.
  - Alternatively, you can click “Edit” from menu bar then click “Apply Transformation”.
- Switch to the “Axis, Angle” tab and copy/paste the X and Y values you obtained from step 2.2 into the corresponding locations in the “Translation” section (see figure 3)

**Note:** Make sure to check the “Apply Inverse transformation” checkbox (see figure 3).

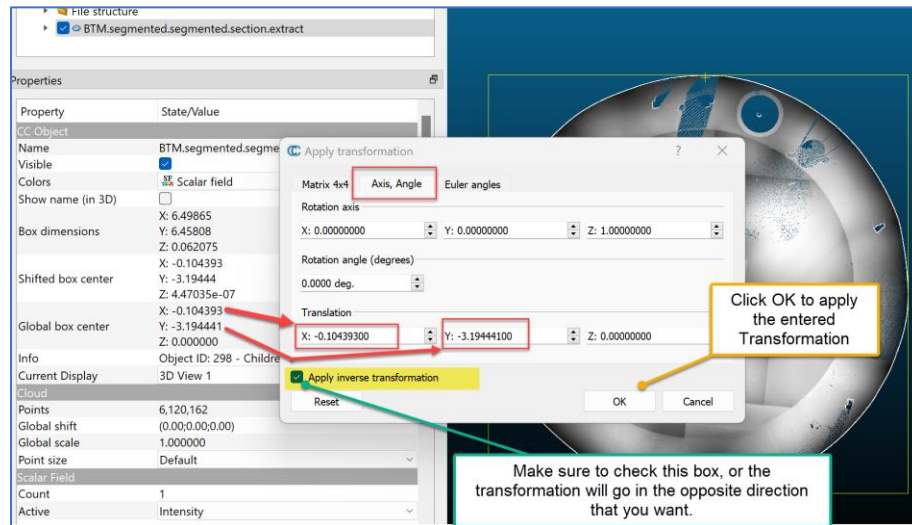


Figure 3 - Cloud Compare – Preparing to Apply Transformation

- Click “OK” button and the point cloud will be translated so that point cloud will have x=0 and y=0 at the desired location. (Global Box Center will be at X=0 and Y=0 if you choose those coordinates)

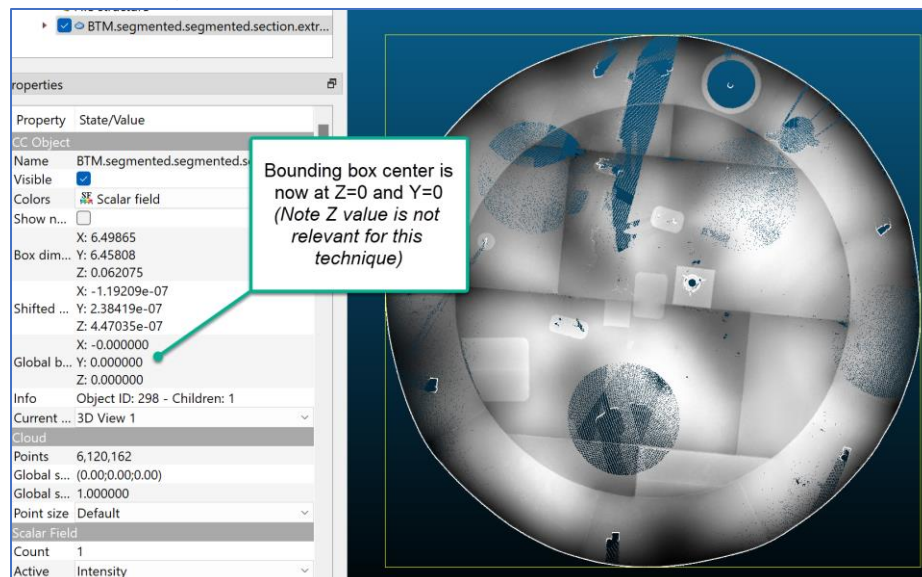


Figure 4 - Cloud Compare - After applying Transformation.

- 2.4. Select the translated point cloud and save it somewhere that you can easily access for the next step. (Recommended to use cloud compare BIN format, but can be any file type that the command line operations will accept)

### 3. Run the batch file on your prepared Point Cloud.

The Point cloud file that was edited and saved in the step 2.4 is used as input for the Batch file processing.

- 3.1. Drag and drop the file you created in the previous step onto the Batch file.
  - Locate the file created in step 2.4 and drag/drop it onto the batch file prepared for this step:  
**Note 1:** Default batch file name is: *“CC\_Create Radius SF From XY Coordinates.bat”* but can be anything you want if you use the script in Appendix A.
  - Console window will open and start processing the Point Cloud file.
- 3.2. Once the processing is complete, processing will pause so you have an opportunity to review the console window. Once ready, press any key to close the console window.

**Note:** Default name of the final Point Cloud file is: *“Radius\_SF.bin”* which should be created in the same directory location as the original point cloud.

**Note 2:** Scalar field containing the radius measurements will be called: *sqrt(pow2(coord. Y))*

#### 4. Review the Newly Generated Point Cloud

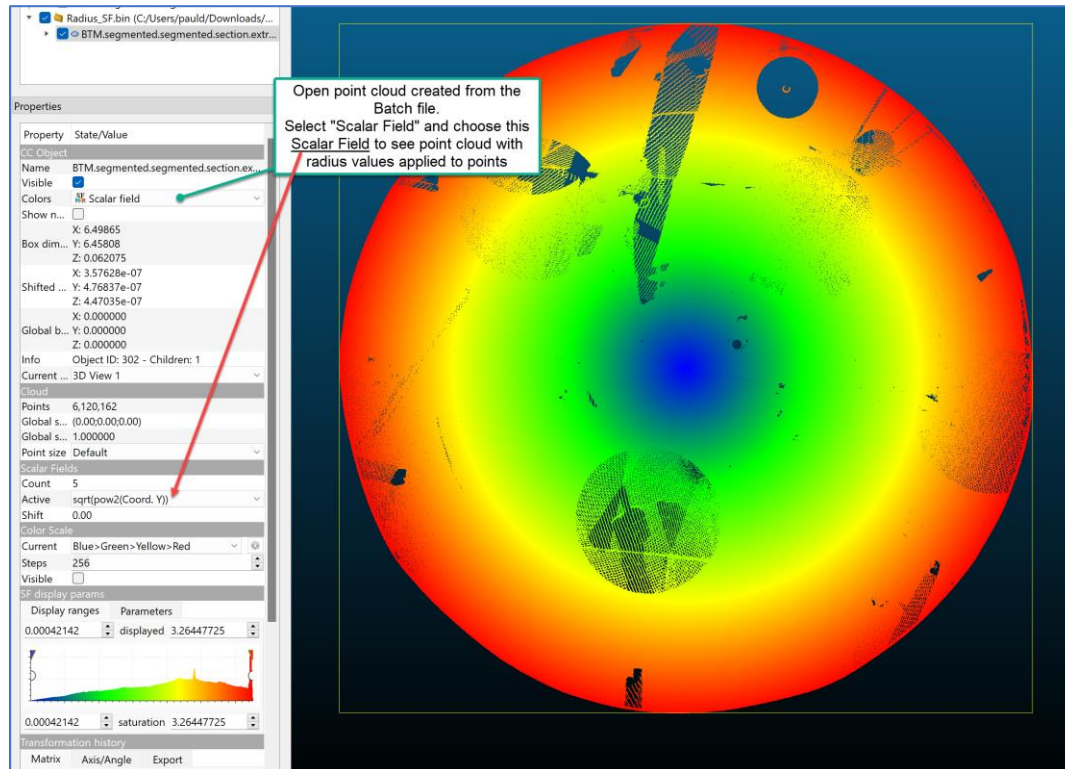


Figure 5 - Cloud Compare - Review Point Cloud with Radius Values as Scalar Field



## 5. Use the new Scalar field for Filtering.

5.1. Select the point cloud in the DB Tree

5.2. In properties select:

- Colors = **Scalar Field**
- Active =  **$\sqrt{\text{pow2}(\text{Coord. Y})}$**

5.3. Adjust the Scalar Field “**Display ranges**” to achieve the filtering you desire. (See figure 6)

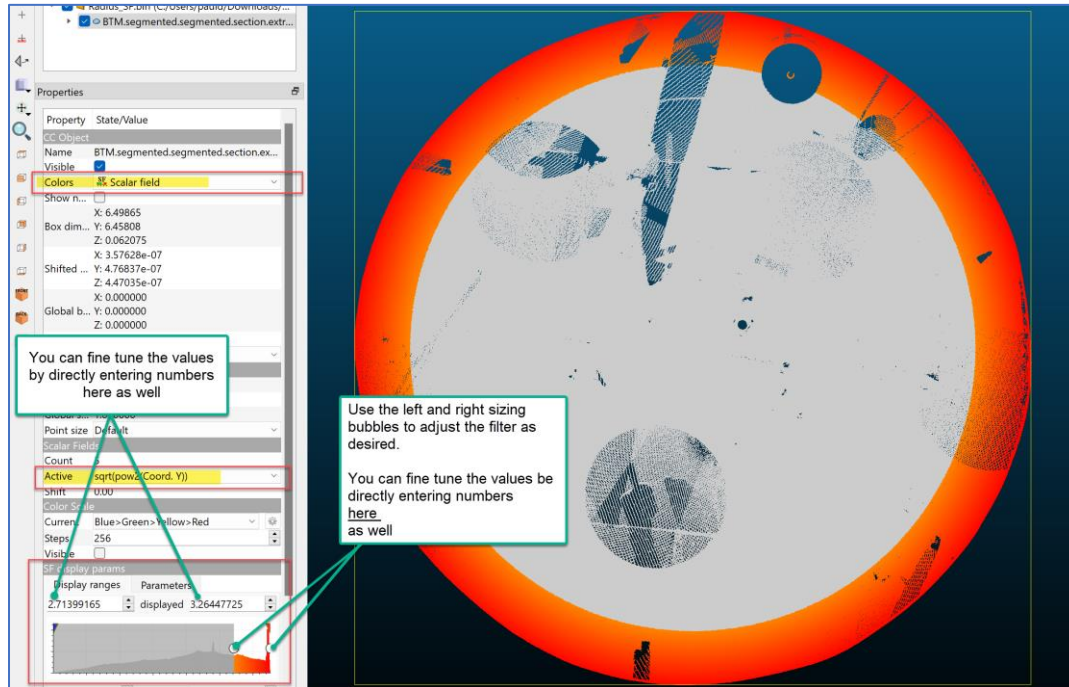


Figure 6 - Cloud Compare - Set up the filtering by adjusting the SF Display values

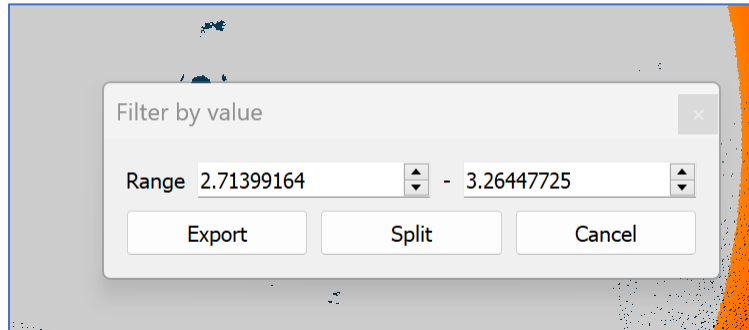
#### 5.4. Split the point cloud based on the filtered values.

- Click the **“Filter by Value”** button on the toolbar. (See Figure 7). Alternatively click menus: **Edit – Scalar Fields – Filter by Value**



Figure 7 - Filter By Value toolbar button

- Range values you chose in step 5.3 will be auto populated.



- Click **“Split”** Button to split the point cloud into 2 separate pieces based on the filtered values. (See Figure 8)

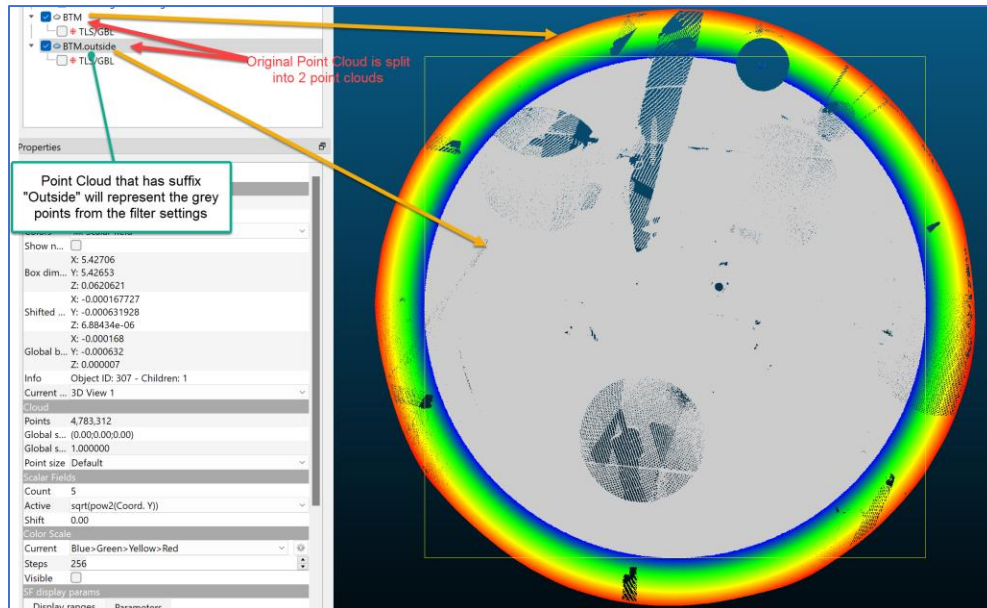


Figure 8 - Cloud Compare - Original Point Cloud is split into 2 separate point clouds based on radius filtered values.



## Appendix A – Batch File Contents

The following text can be copied and pasted into a plain text file.

The text file must then have the file extension changed to \*.bat to indicate that it is a Batch Processing file.

```
REM Batch File to convert X and Y Point coordinates into radius measurement to be used for radial
filtering operations
REM HOW TO USE: DRAG AND DROP A POINT CLOUD ONTO THIS BATCH FILE
REM PREREQUISITES:
REM     Input file must have x = 0 and Y = 0 at the center of where the radius should be measured from
REM     Final Point Cloud will have a new SF containing radius values that can be used for filtering or
other purposes
REM PAUSE

@echo On
    ECHO Input File is %1
    ECHO Input File path is %~f1
    SET filedrive=%~d1
    SET filepath=%~p1

REM =====
REM STEP 1:
REM Delete any existing Scalar Fields then Export X and Y Coordinate to Scalar field (creates Scalar field
[Coord. X] and [Coord. Y])
    REM "C:\Program Files\CloudCompare\CloudCompare.exe" -SILENT -O %1 -AUTO_SAVE OFF -REMOVE_ALL_SFS
-SAVE_CLOUDS FILE 'SFS_Removed.bin'
    REM SET inputFile="%filedrive%%filepath%SFS_Removed.bin"
    REM ECHO Input File is %inputFile%

    "C:\Program Files\CloudCompare\CloudCompare.exe" -SILENT -O %1 -AUTO_SAVE OFF -REMOVE_ALL_SFS -
COORD_TO_SF X -COORD_TO_SF Y -SAVE_CLOUDS FILE 'Step1.bin'
    SET inputFile="%filedrive%%filepath%Step1.bin"
    SET tempFile1="%filedrive%%filepath%Step1.bin"
    ECHO Input File is %inputFile%
REM Output: new file called: Step1.bin
REM =====

REM =====
REM STEP 2:
REM Scalar field Arithmetic creates [Coord. X^2] and [Coord. Y^2]
REM Previous Step created 2 new scalar fields so we increment the variables to operate on the newly
created SFs
    REM NumScalarFields is 1 based and Index is zero based so subtract 1 to get the correct starting
point for index value
    set /A NumScalarFields = -1
    set /A sfIndex1 = 0
    set /A sfIndex2 = 1
    ECHO sfIndex1 is %sfIndex1%
    ECHO sfIndex2 is %sfIndex2%
    "C:\Program Files\CloudCompare\CloudCompare.exe" -SILENT -O %inputFile% -AUTO_SAVE OFF -
SF_ARITHMETIC %sfIndex1% pow2 -SF_ARITHMETIC %sfIndex2% pow2 -SAVE_CLOUDS FILE 'Step2.bin'

    SET inputFile="%filedrive%%filepath%Step2.bin"
    SET tempFile2="%filedrive%%filepath%Step2.bin"
    ECHO Input File is %inputFile%
REM Output: new file called: Step2.bin
REM =====

REM =====
REM STEP 3:
REM Scalar field Arithmetic A^2 * B^2 = C^2
REM Previous Step created 2 new scalar fields so we increment the variables to operate on the newly
created SFs
```

```
set /A sfIndex1 = %sfIndex2% + 1
set /A sfIndex2 = %sfIndex1% + 1
ECHO sfIndex1 is %sfIndex1%
ECHO sfIndex2 is %sfIndex2%

REM "C:\Program Files\CloudCompare\CloudCompare.exe" -SILENT -O %inputFile% -AUTO_SAVE OFF -SF_OP
%sfIndex1% add %sfIndex2% -SAVE_CLOUDS FILE 'Step3.bin'
REM for -SF_op_SF: the modification is done in place (i.e. the FIRST scalar field listed in
command is directly modified)
REM We put the second scalar field in first position so the modified SF for next step will be
sfIndex2
"C:\Program Files\CloudCompare\CloudCompare.exe" -SILENT -O %inputFile% -AUTO_SAVE OFF -SF_OP_SF
%sfIndex2% add %sfIndex1% -SAVE_CLOUDS FILE '3_Plus_4.bin'
SET inputFile="%filedrive%%filepath%3_Plus_4.bin"
SET tempFile3="%filedrive%%filepath%3_Plus_4.bin"
ECHO Input File is %inputFile%
REM Output: new file called: 3_Plus_4.bin
REM =====

REM =====
REM STEP 4:
REM Scalar field Arithmetic SQRT of C^2
REM Previous Step modified existing SF at index sfIndex2. This is the one we want to modify in this step
"C:\Program Files\CloudCompare\CloudCompare.exe" -SILENT -O %inputFile% -AUTO_SAVE OFF -
SF_ARITHMETIC %sfIndex2% sqrt -SAVE_CLOUDS FILE 'Radius_SF.bin'
REM Output: Final file called: Radius_SF.bin
REM =====

REM =====
REM STEP 5:
REM Clean up temporary files created along the way
del %tempFile1%
del %tempFile2%
del %tempFile3%

REM =====
REM DONE

Pause
```