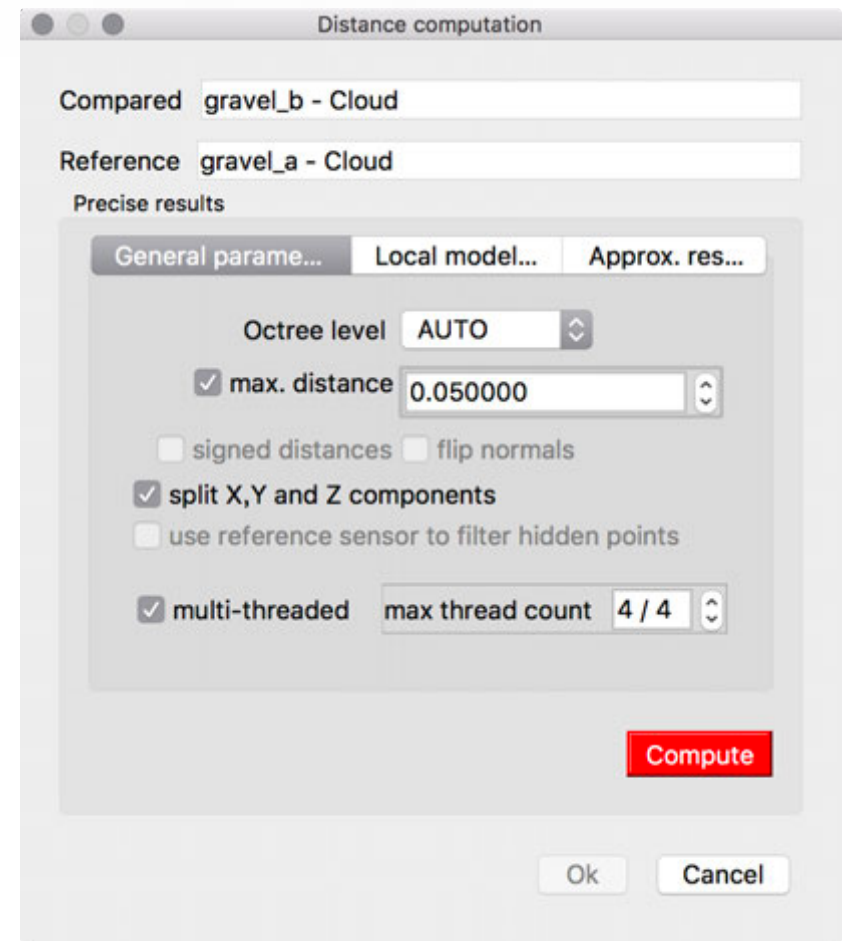


# 距離計算

LEVEL 03  
distances

# 点群間距離 cloud-to-cloud distances

- 二つの点群を選択 (Shift+クリック)
  - Tools > Distances > Cloud/Cloud Dist.
- gravel\_aを基準 (Reference) に ←Swap
- パラメータ設定
  - max. distance = 0.05 m
  - split X, Y, and Z components: YES
  - → « Compute »
    - > OK



# 点群間距離

# cloud-to-cloud distances

CloudCompare v2.8 [64-bit]


DB Tree

- project2.bin (/Users/y/Downloads)
  - gravel\_a - Cloud
  - gravel\_b - Cloud.registered
  - segment\_in
    - gravel\_b.laz (/Users/y/Downloads)
      - gravel\_b - Cloud
  - Viewport #1

Properties

Property	State/Value
Name	gravel_a - Cloud
Visible	<input checked="" type="checkbox"/>
Show name (in ...)	<input type="checkbox"/>
Colors	RGB
Box dimensions	X: 0.28737 Y: 0.16228 Z: 0.03789
Box center	X: 0.124955 Y: 0.06489 Z: 0.017945
Info	Object ID: 18016 - Children: 0
Current Display	3D View 1
Cloud	
Points	620,351
Global shift	(0.00;0.00;0.00)
Global scale	1.000000

3D View 1



Console

```
[22:19:37] New point size: 4
[22:21:36] Viewport 'Viewport #1' has been updated
[22:25:05] [GL Filter] Filter initialized
[22:25:05] Note: go to << Display > Shaders & Filters > No filter >> to disable GL filter
```

# 点群間距離

# cloud-to-cloud distances

CloudCompare v2.8 [64-bit]


DB Tree

- project2.bin (/Users/y/Downloads)
  - gravel\_a - Cloud
  - gravel\_b - Cloud.registered
  - segment\_in
  - gravel\_b.laz (/Users/y/Downloads)
    - gravel\_b - Cloud
    - Viewport #1

Properties

Property	State/Value
Name	gravel_b - Cloud
Visible	<input checked="" type="checkbox"/>
Show name (in ...)	<input type="checkbox"/>
Colors	RGB
Box dimensions	X: 0.288717 Y: 0.175458 Z: 0.0714362
Box center	X: 0.123162 Y: 0.0724161 Z: 0.01778
Info	Object ID: 18042 - Children: 0
Current Display	3D View 1
Cloud	
Points	752,970
Global shift	(0.00;0.00;0.00)
Global scale	1.000000

3D View 1

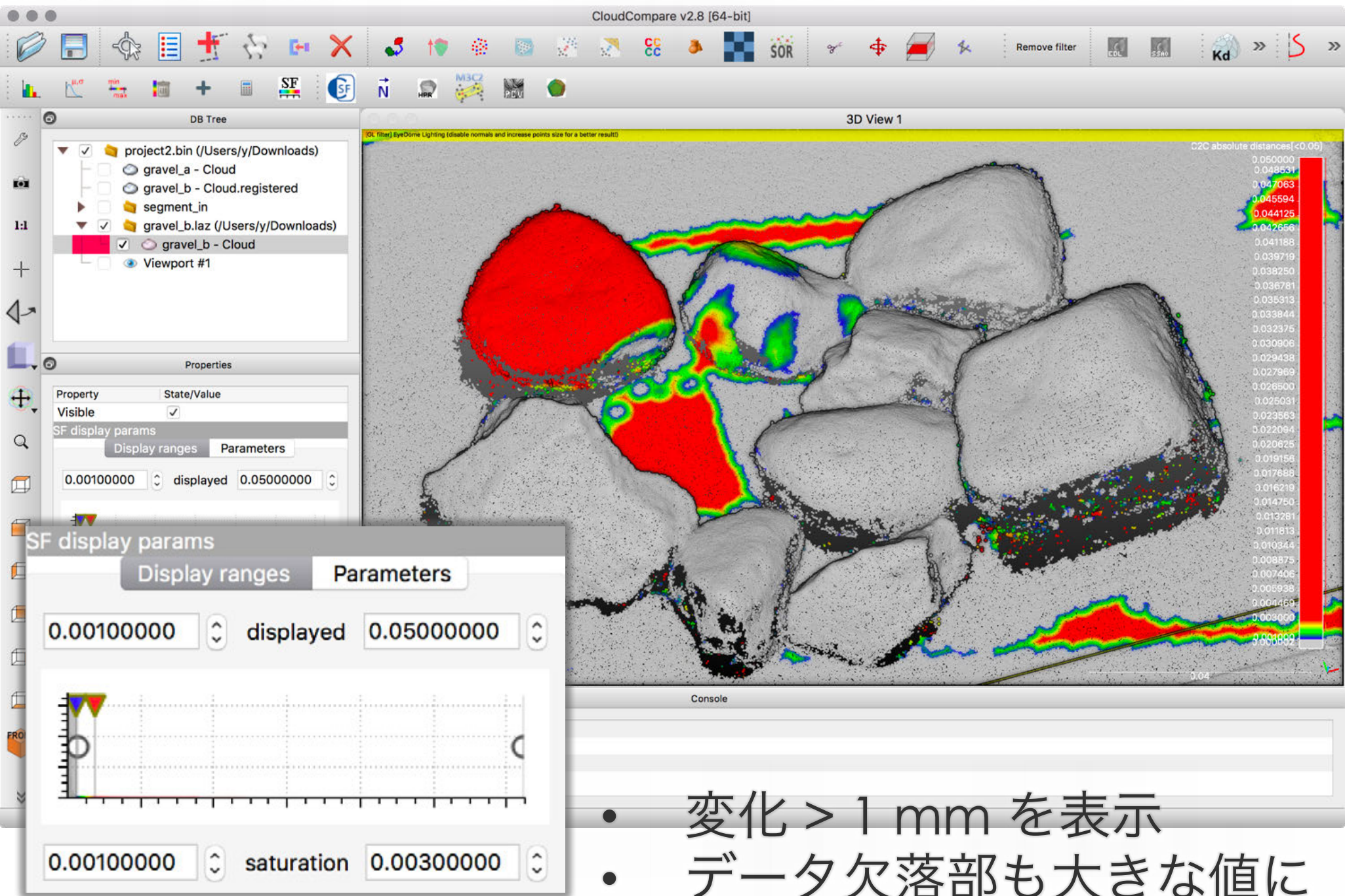


Console

```
[22:19:37] New point size: 4
[22:21:36] Viewport 'Viewport #1' has been updated
[22:25:05] [GL Filter] Filter initialized
[22:25:05] Note: go to << Display > Shaders & Filters > No filter >> to disable GL filter
```

# 点群間距離

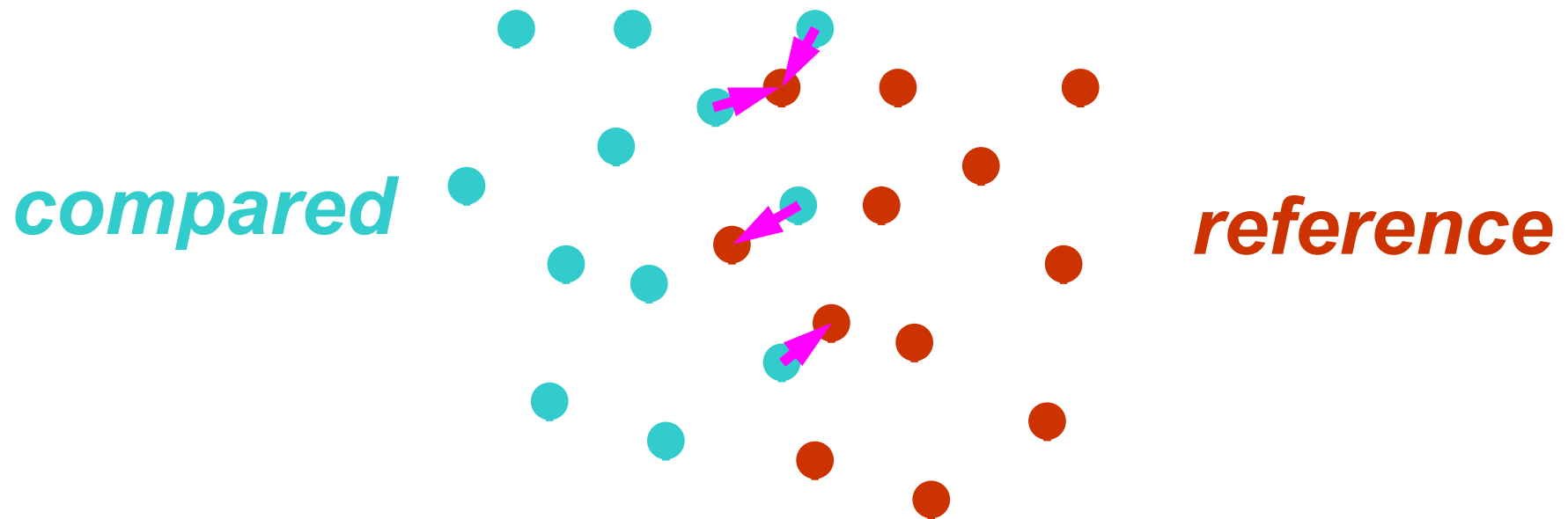
# cloud-to-cloud distances



- 変化 > 1 mm を表示
- データ欠落部も大きな値に

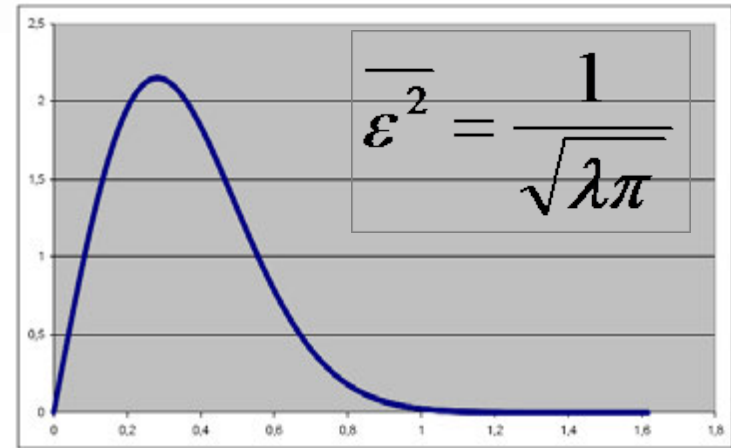
# 点群間距離の算出方法 C2C distance

- デフォルトでは、比較される点群の各点について、基準点群の最近隣の点までの距離が算出される
  - 対称的ではない
  - = 基準と比較を入れ替えると結果も若干異なる



# C2C distances のコンセプト

- 基準となる点群が十分に高密度であれば、比較点群で算出される最近隣の点との距離は、実際の距離に近くなる
- 理論：TLSによる点群はポアソン分布に従う
  - 誤差は点群密度に依存する
- 基準点群は高密度である必要がある
- 基準点群は比較点群の領域を十分にカバーする必要がある



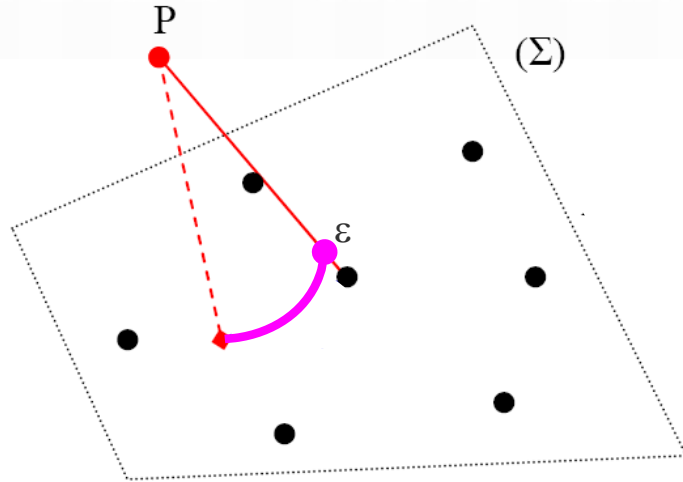
N.N. distances in a random  
Poisson process

(Girardeau-Montaut, 2016)

# 基準点群が高密度でない場合は？

- “Local modeling”

基準点群を補間（補完）するモデルを生成



✓ NONE

Least Square Plane

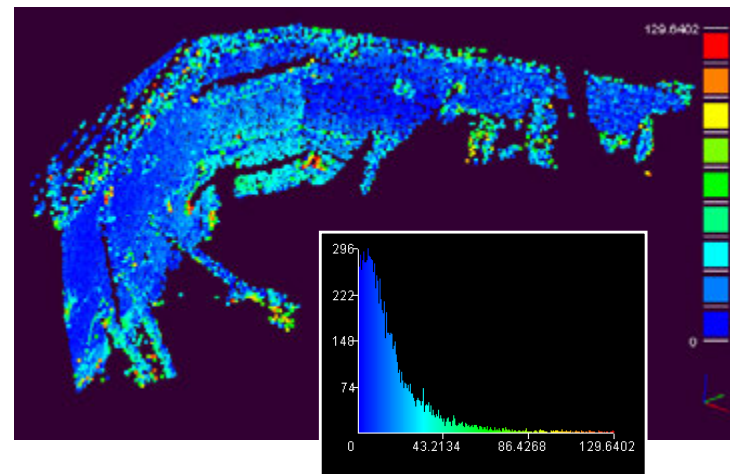
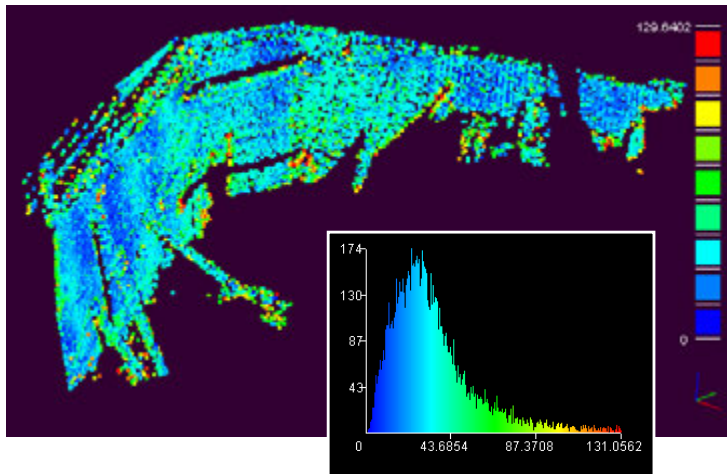
2D1/2 Triangulation

Quadric

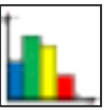
(Girardeau-Montaut, 2016)

— measured distance  
- - - real distance

**Local modelling**  
**(2 to 5X slower)**

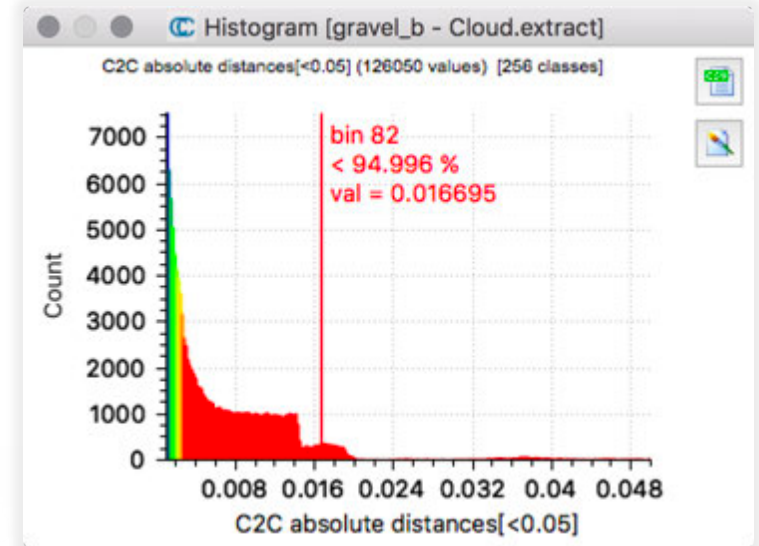
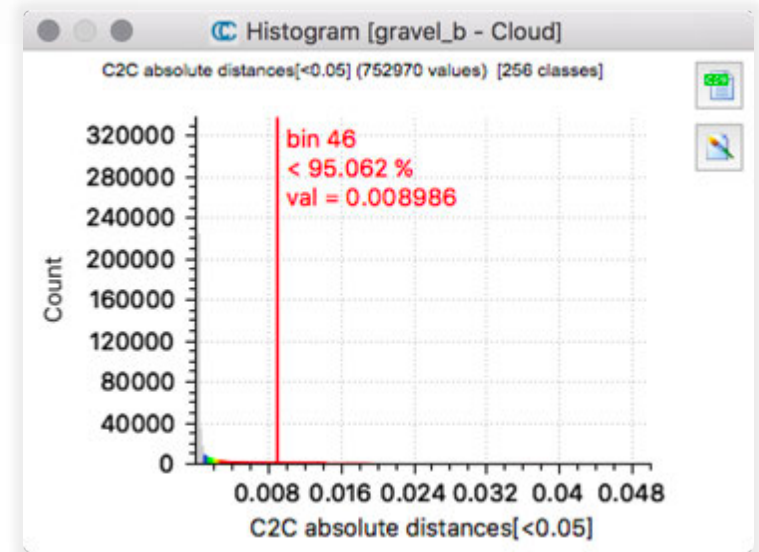






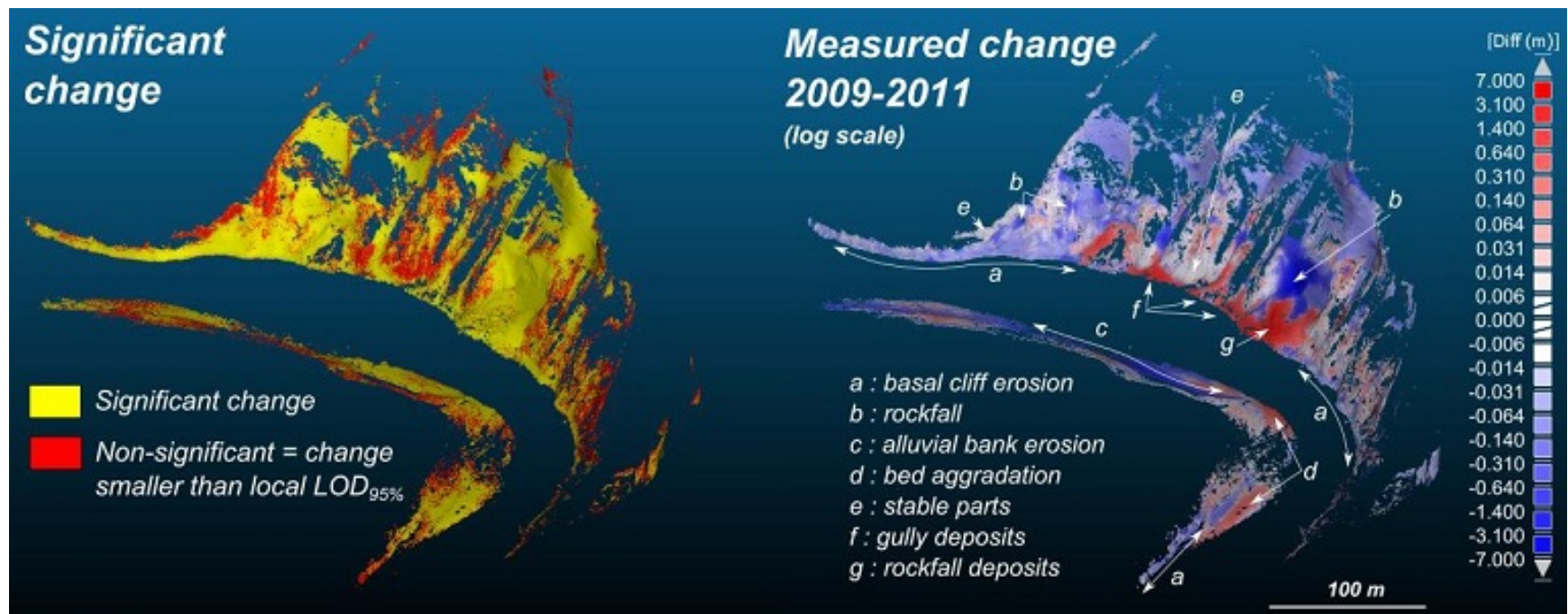
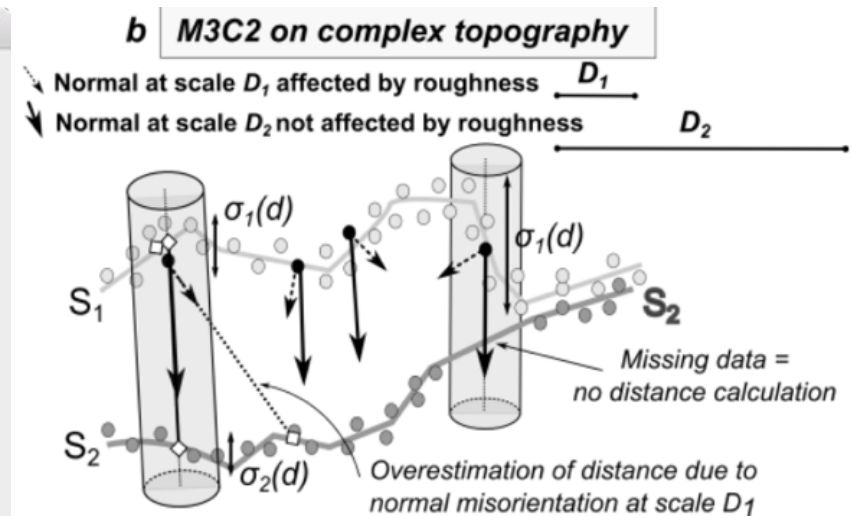
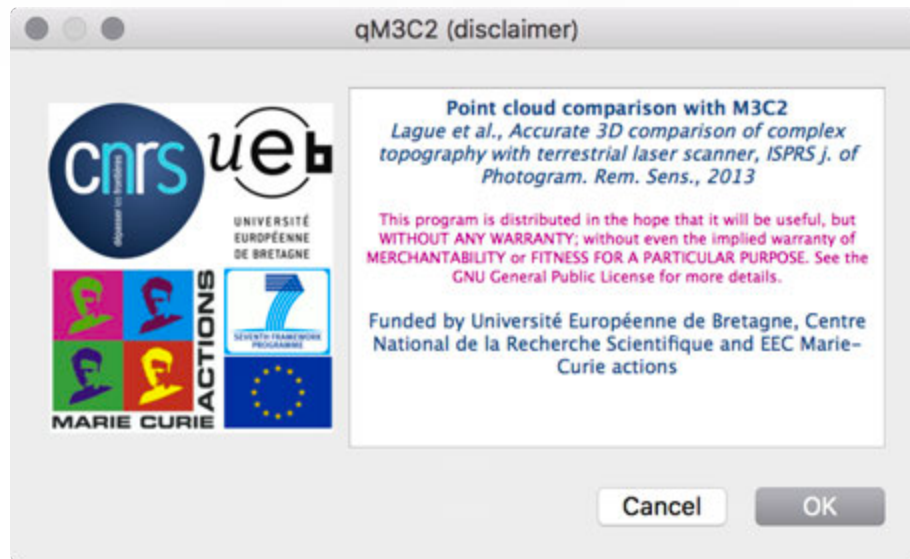
# 距離のヒストグラム表示

- gravel\_bを選択、ヒストグラムを表示
  - Edit > Scalar fields > Show histogram
  - → <1 mm の値に集中
- 余分な値を除外
  - Edit > Scalar fields > Filter by value
  - [0.001 0.05] >> Export
- 出力した点群でSFのヒストグラムを表示
  - プロパティのカラースケールで色変更可能
  - X, Y, Z各方向の値 (Split有効時)



- None
- Scan Direction
- Classification
- C2C absolute distances[<0.05] (Z)
- ✓ C2C absolute distances[<0.05] (X)
- C2C absolute distances[<0.05] (Y)

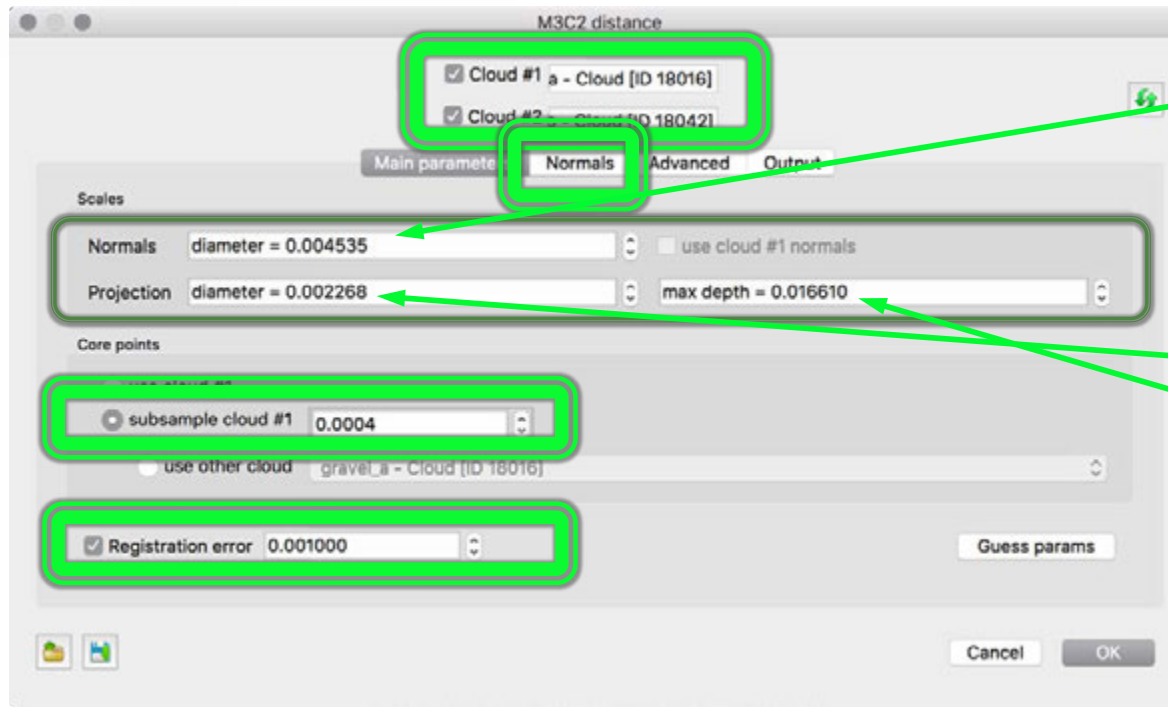
# M3C2 プラグイン



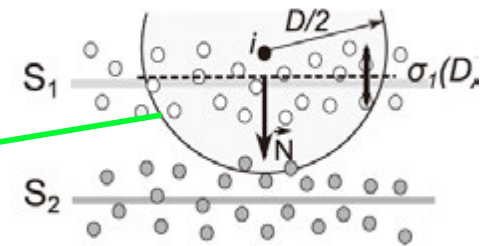
Lague, D., Brodu, N. and Leroux, J., Accurate 3D comparison of complex topography with terrestrial laser scanner: application to the Rangitikei canyon (N-Z), 2013, *ISPRS journal of Photogrammetry and Remote Sensing*

# M3C2距離

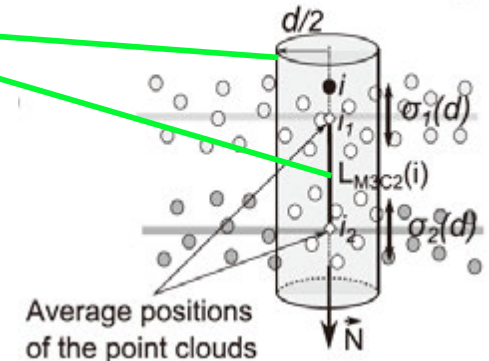
- 二つの点群を選択 (Shift+クリック)
  - Plugins > M3C2 distance
- パラメータ設定
  - Cloud #1: gravel\_a, Cloud #2: gravel\_b
  - “Guess params”
  - subsample cloud #1: 0.0004 (= 0.4 mm)
  - Registration error: 0.001 (= 1 mm)
  - Normals: default



Step 1 : Calculation of normal  $\vec{N}$  at a scale  $D$  around the core point  $i$ .



Step 2 : Average distance between the two clouds measured at a scale  $d$  along  $\vec{N}$



# M3C2距離 gravel\_a

CloudCompare v2.8 [64-bit]

DB Tree

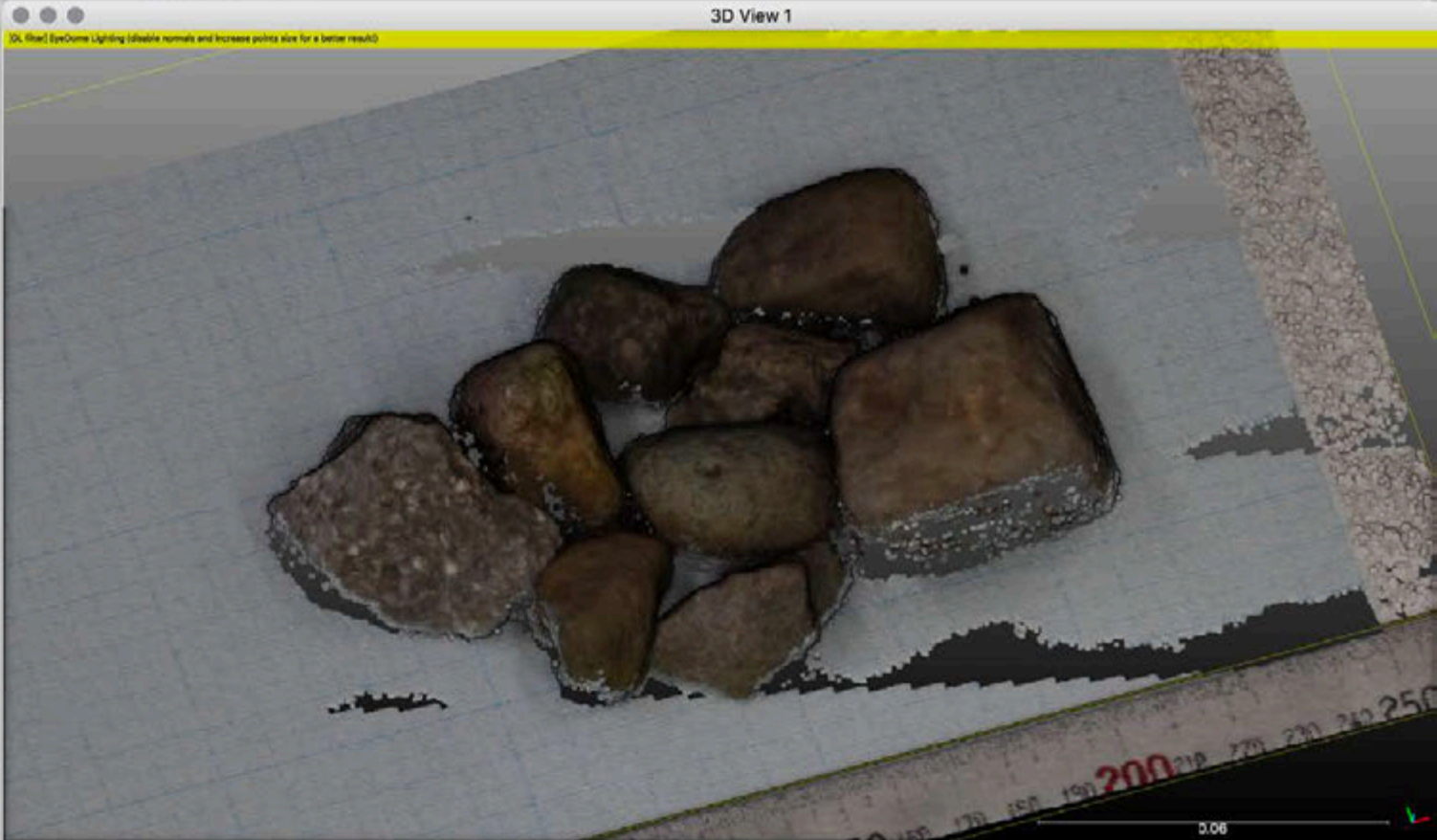
- project2.bin (/Users/y/Downloads)
  - gravel\_a - Cloud
  - gravel\_b - Cloud.registered
  - segment\_in
  - gravel\_b.laz (/Users/y/Downloads)
    - gravel\_b - Cloud
    - Octree
  - Viewport #1
  - gravel\_a - Cloud.subsampled [min di...
  - M3C2 output scale=0.001134

Properties

Property	State/Value
CC Object	
Name	gravel_a - Cloud
Visible	<input checked="" type="checkbox"/>
Show name (in ...)	<input type="checkbox"/>
Colors	RGB
Box dimensions	X: 0.28737 Y: 0.16228 Z: 0.03789
Box center	X: 0.124955 Y: 0.06489 Z: 0.017945
Info	Object ID: 18016 - Children: 1
Current Display	3D View 1

3D View 1

3D View [EvoDome Lighting (Disable normals and increase points size for a better result)]



Console

```
[06:51:42] New point size: 6  
[06:51:43] New point size: 5  
[06:51:44] New point size: 6  
[06:51:44] New point size: 7
```

# M3C2距離 gravel\_b

CloudCompare v2.8 [64-bit]

DB Tree

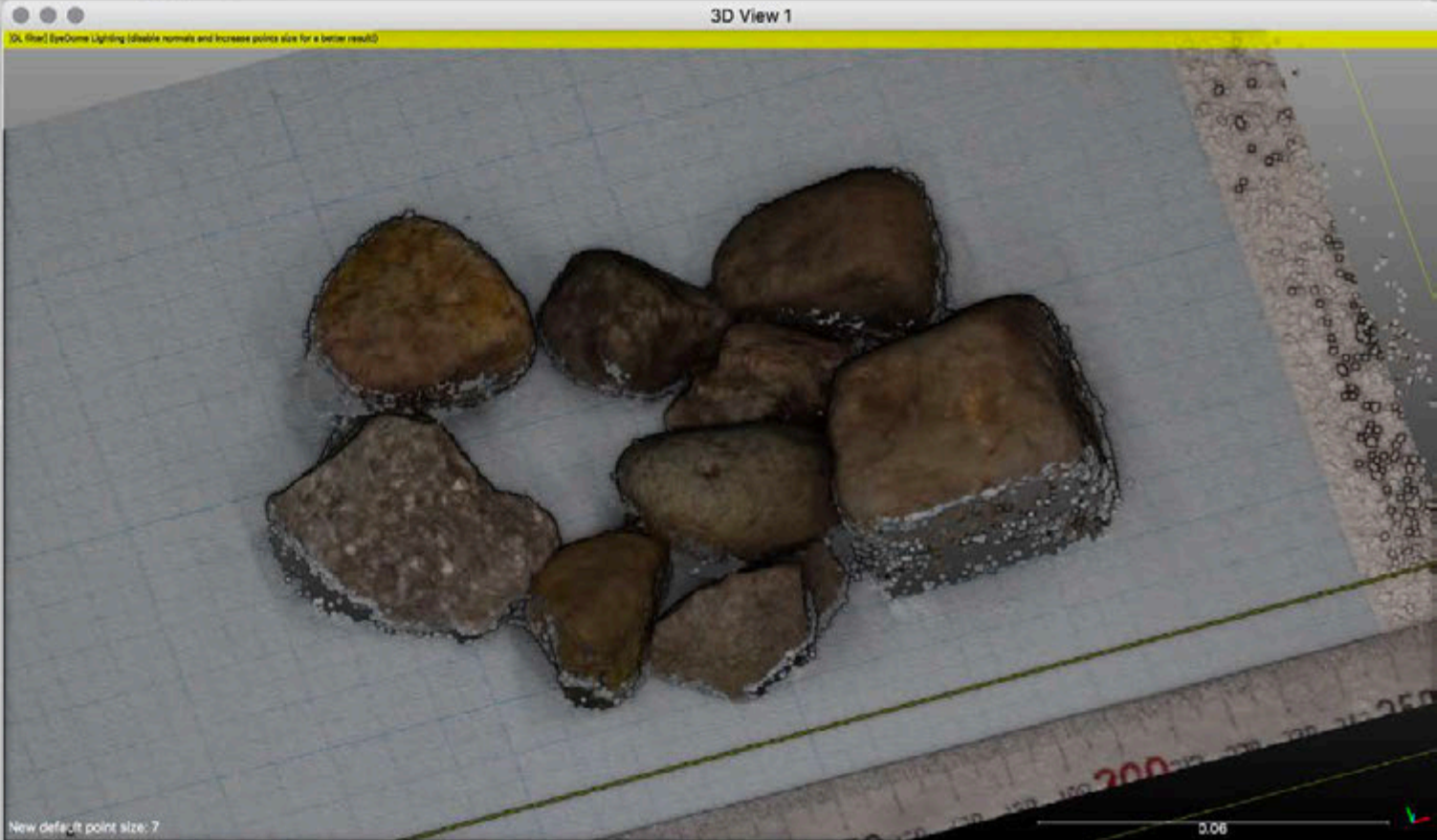
- project2.bin (/Users/y/Downloads)
  - gravel\_a - Cloud
  - gravel\_b - Cloud.registered
  - segment\_in
  - gravel\_b.laz (/Users/y/Downloads)
    - gravel\_b - Cloud
    - Octree
    - Viewport #1
    - gravel\_a - Cloud.subsampled [min di...
    - M3C2 output scale=0.001134

Properties

Property	State/Value
CC Object	
Name	gravel_b - Cloud
Visible	<input checked="" type="checkbox"/>
Show name (in ...)	<input type="checkbox"/>
Colors	RGB
Box dimensions	X: 0.288717 Y: 0.175458 Z: 0.0714362
Box center	X: 0.123162 Y: 0.0724161 Z: 0.01778
Info	Object ID: 18042 - Children: 1
Current Display	3D View 1

3D View 1

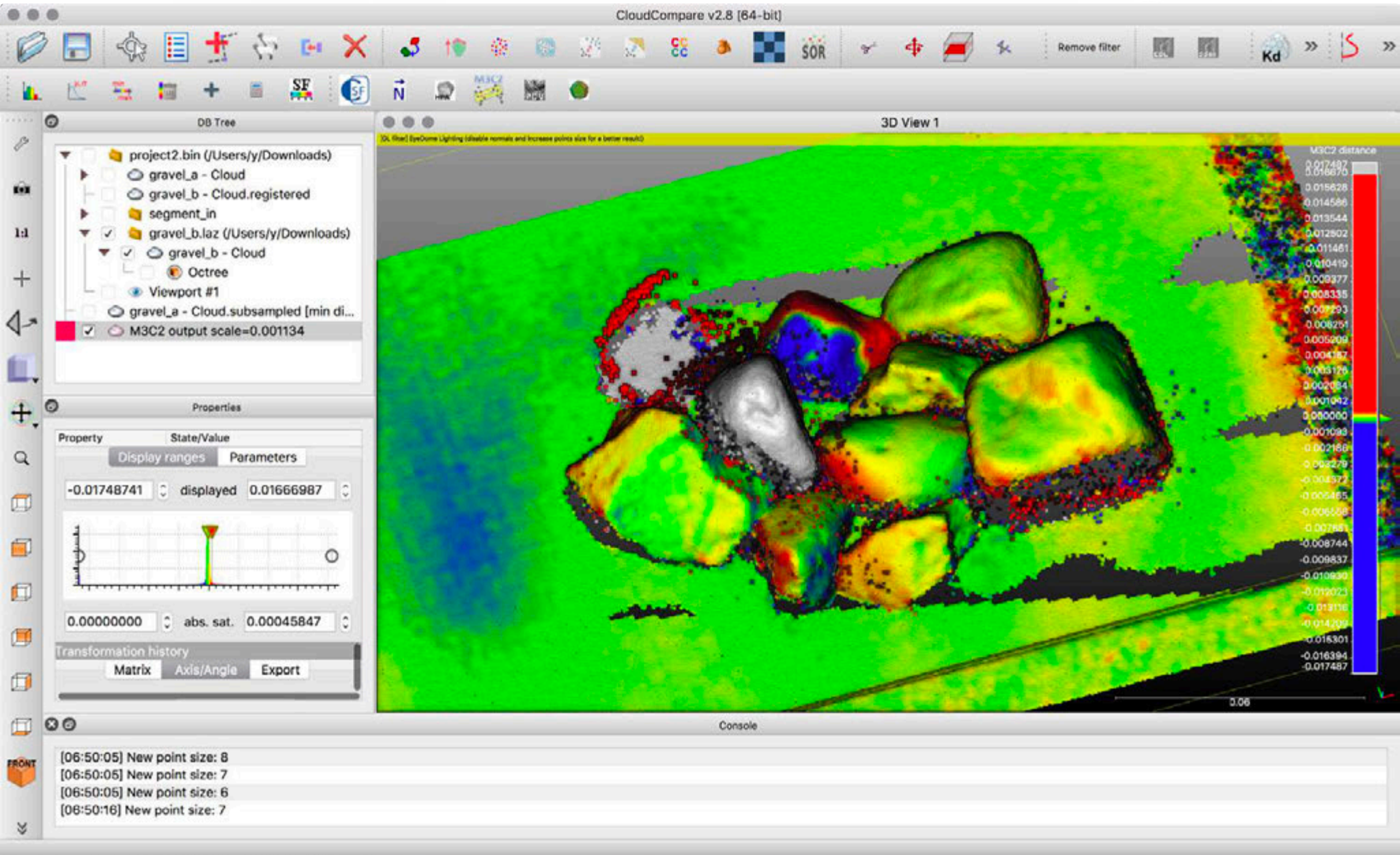
DX, flat! EyeDome Lighting (disable normals and increase point size for a better result)



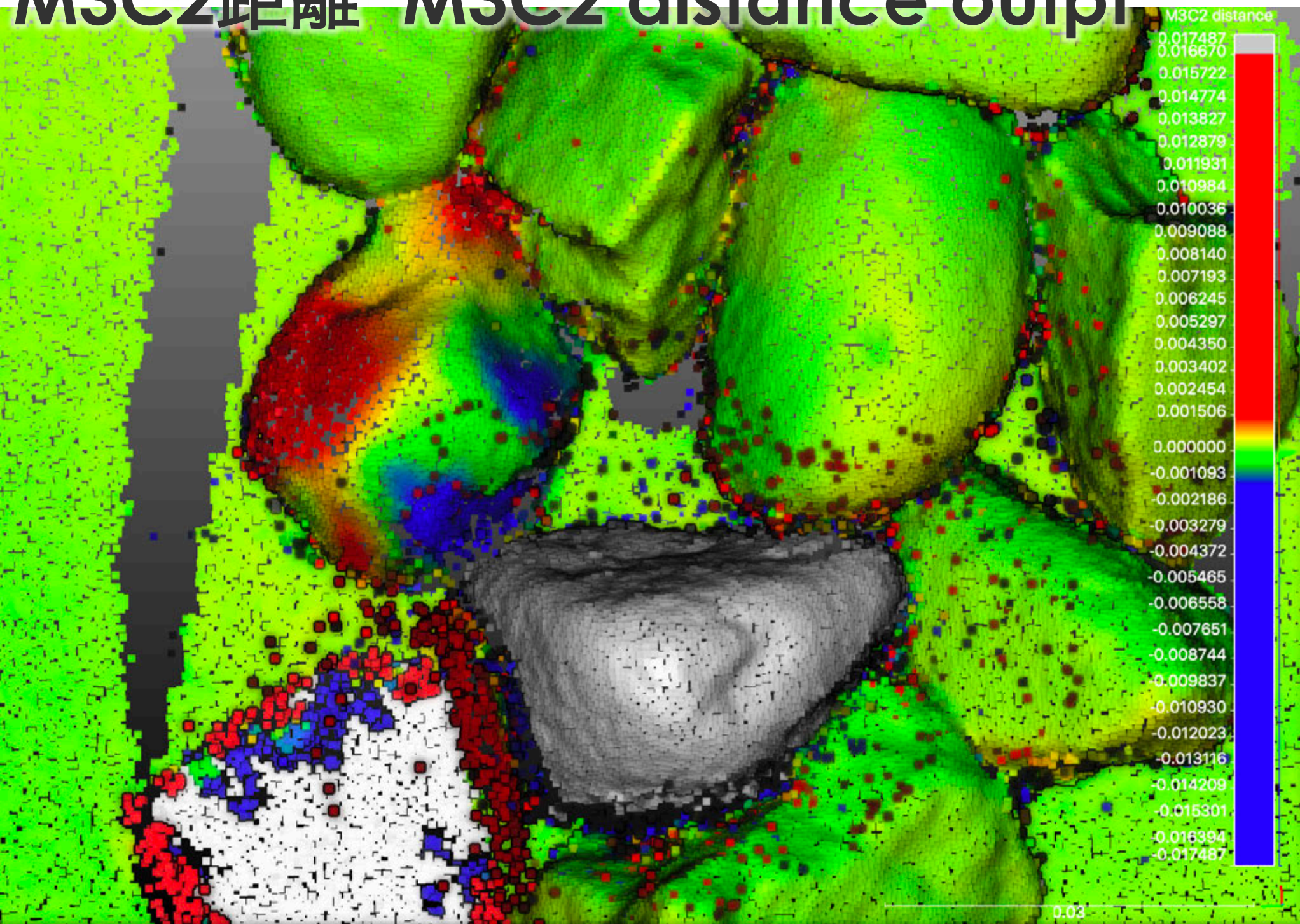
Console

```
[06:51:42] New point size: 6  
[06:51:43] New point size: 5  
[06:51:44] New point size: 6  
[06:51:44] New point size: 7
```

# M3C2距離 M3C2 distance output



# M3C2距離 M3C2 distance output



# M3C2距離 normal dip [0-90°]

The screenshot displays the CloudCompare v2.8 [64-bit] interface. The main 3D View 1 shows a point cloud of a rock formation with a color scale for normal dip ranging from 0.000000 (red) to 90.000000 (yellow). The DB Tree on the left shows the project structure, including 'project2.bin' and 'M3C2 output scale=0.001134'. The Properties panel shows the active property is 'Dip (degrees)' with a color scale of 'Dip [0-90]' and 256 steps. The Console window at the bottom shows the following output:

```
[06:53:16] [M3C2::auto] Population per cell: 2985.7 +/- 592.4
[06:53:16] [M3C2::auto] Valid normals: 189/189
[06:53:16] [M3C2::auto] Mean relative roughness: 0.0784047
[06:53:16] [M3C2::auto] The previous scale was better for normals!
```



# M3C2距離 normal dip direction [0-360°]

