ESTIMATING TURBIDITY NEAR A DREDGE OPERATION USING A WEATHER BALLOON-MOUNTED CAMERA

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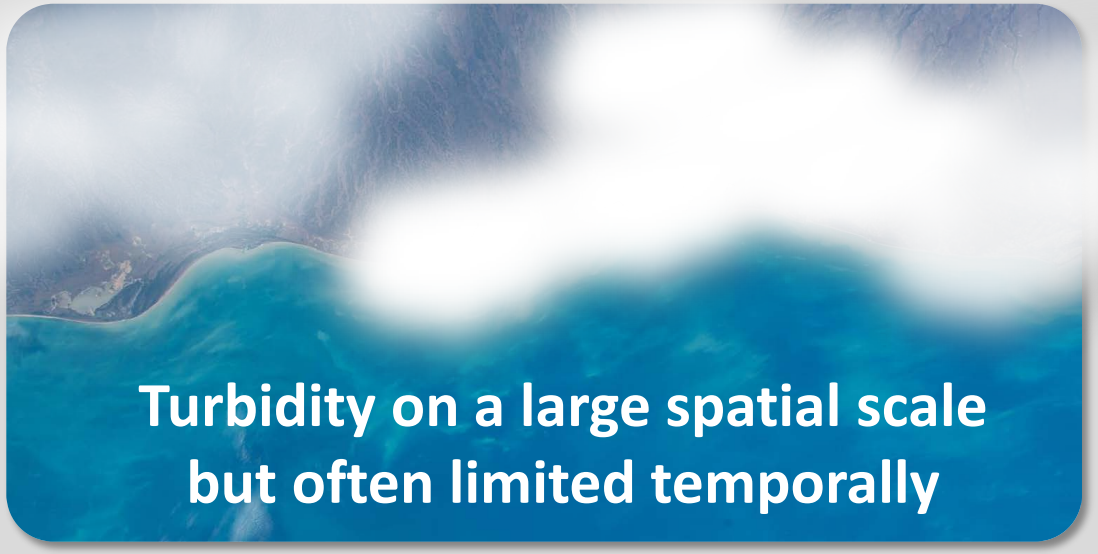
Monitoring a dredge plume

- Dredging operations suspend sediment (excavation, transport, and placement)
- Predicting and monitoring spatial and temporal extent of suspended sediment plumes important

Remote Sensing

Satellite & Manned Aircraft



Turbidity on a large spatial scale but often limited temporally

Drones

Drones can remotely sense small areas but with higher temporal resolution

Why a weather balloon?

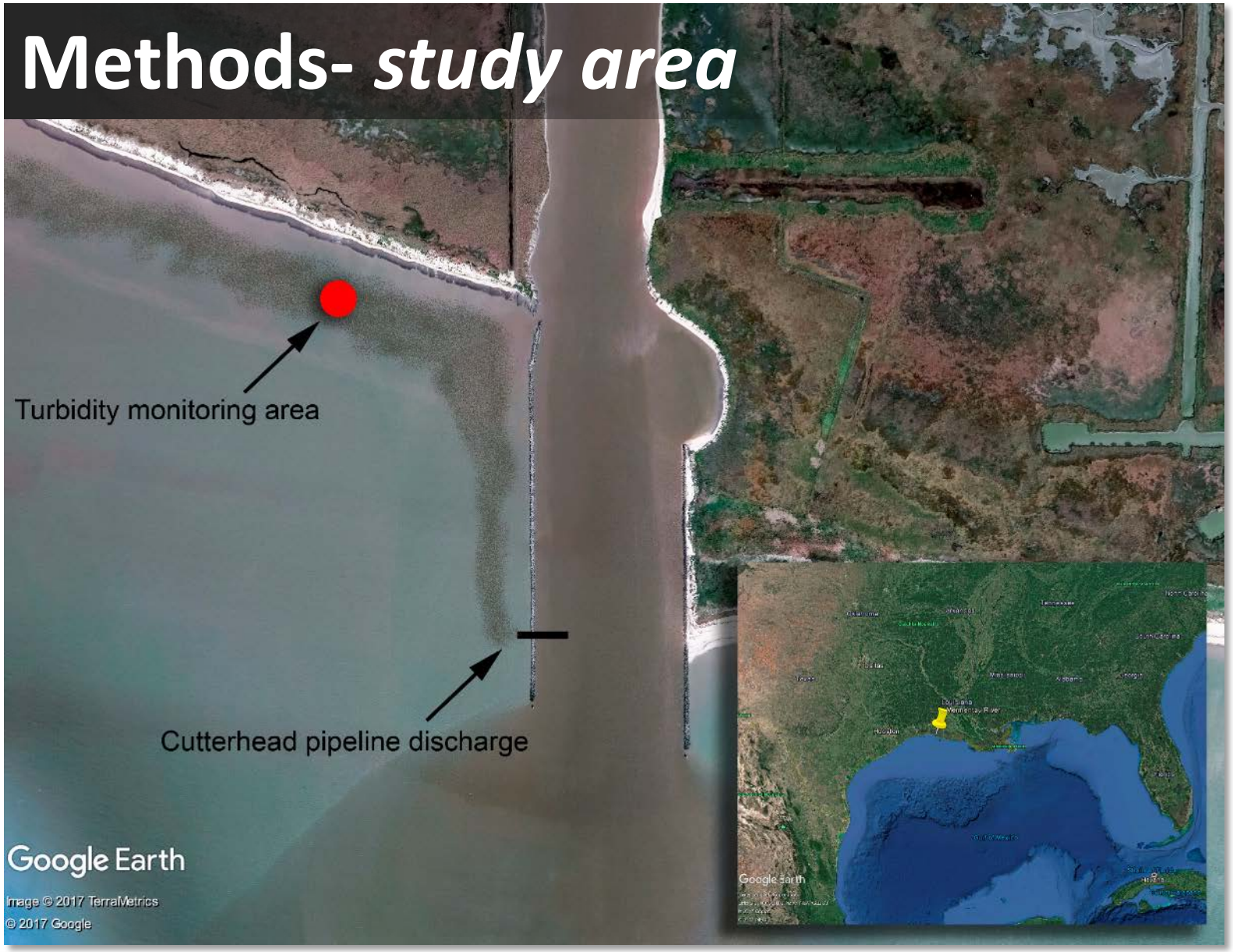
Objective

Develop a low-cost monitoring system consisting of a weather balloon-mounted consumer grade digital camera to acquire turbidity reflectance in the visible bands (400-700 nm) of a shallow coastal area affected by a pipeline discharge of dredged sediment.

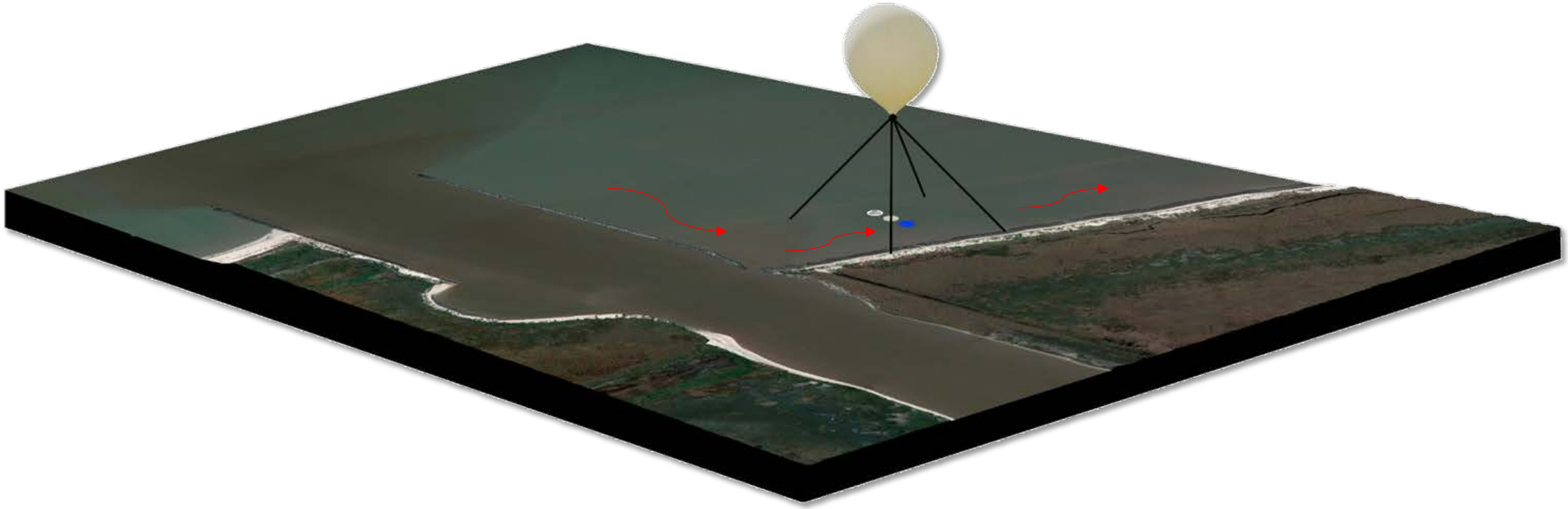
Questions:

- Will the balloon fly?
- Can a computer script be used for data processing?
- Will reflectance targets help increase image sensor sensitivity?
- Is there a relationship between reflectance and turbidity?

Methods- *study area*



Methods- *study area*



Methods- *camera and settings*

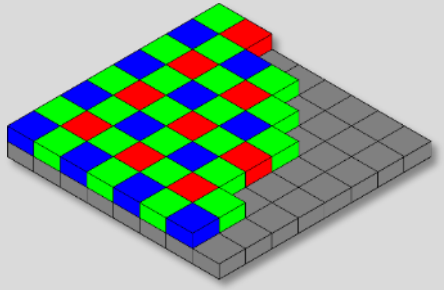
Digital Camera

Settings

- USB powered by external battery
- image size 16 MP 4:3; RAW+JPG
- shutter speed 1/1000
- 2.8 fixed aperture
- Interval 5 sec
- ISO-50

Bayer Sensor

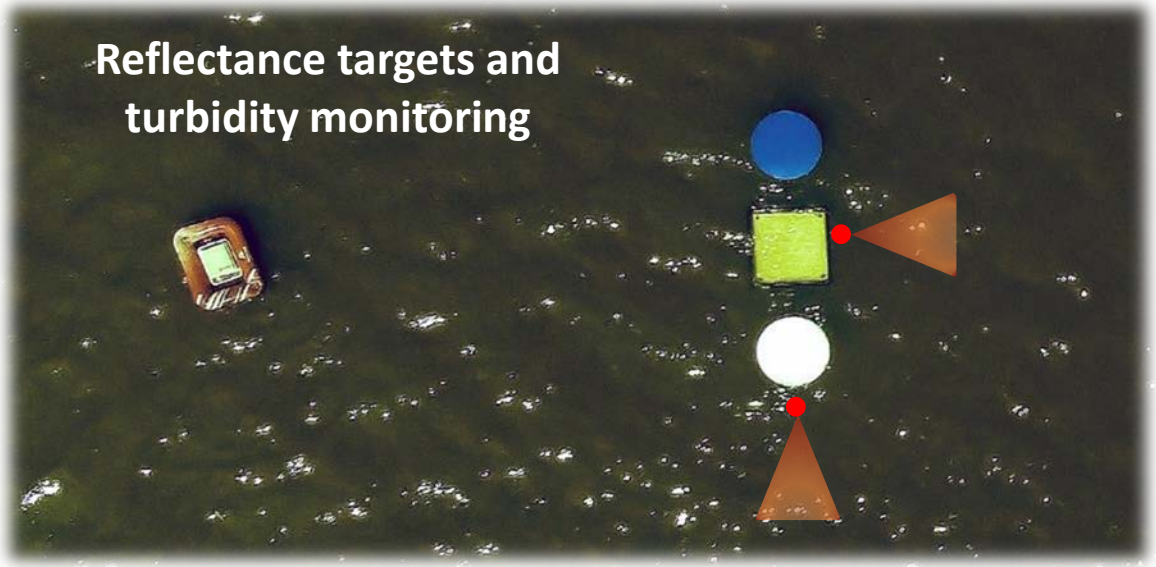
A custom white balance (R1, B1) was used in an attempt to enhance the capture of green colors in order to increase the likelihood of detecting changes in turbidity.



Picavet System

Weather Balloon Deployment

Reflectance targets and turbidity monitoring



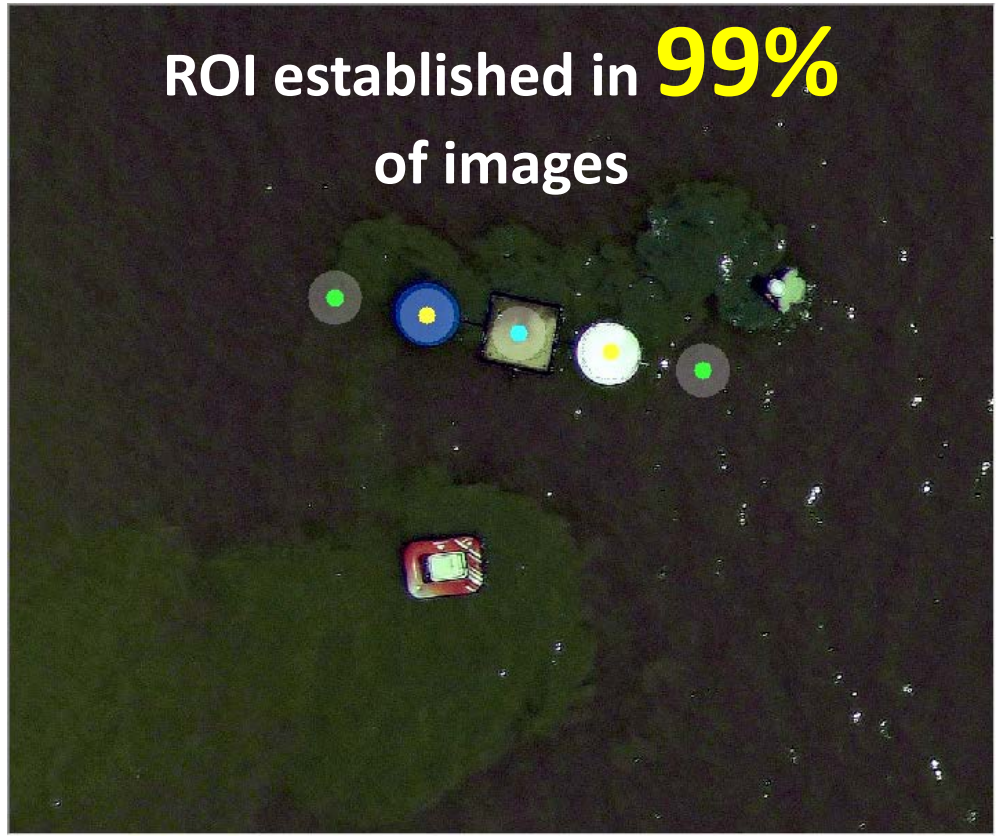
Submerged target

Align balloon/targets

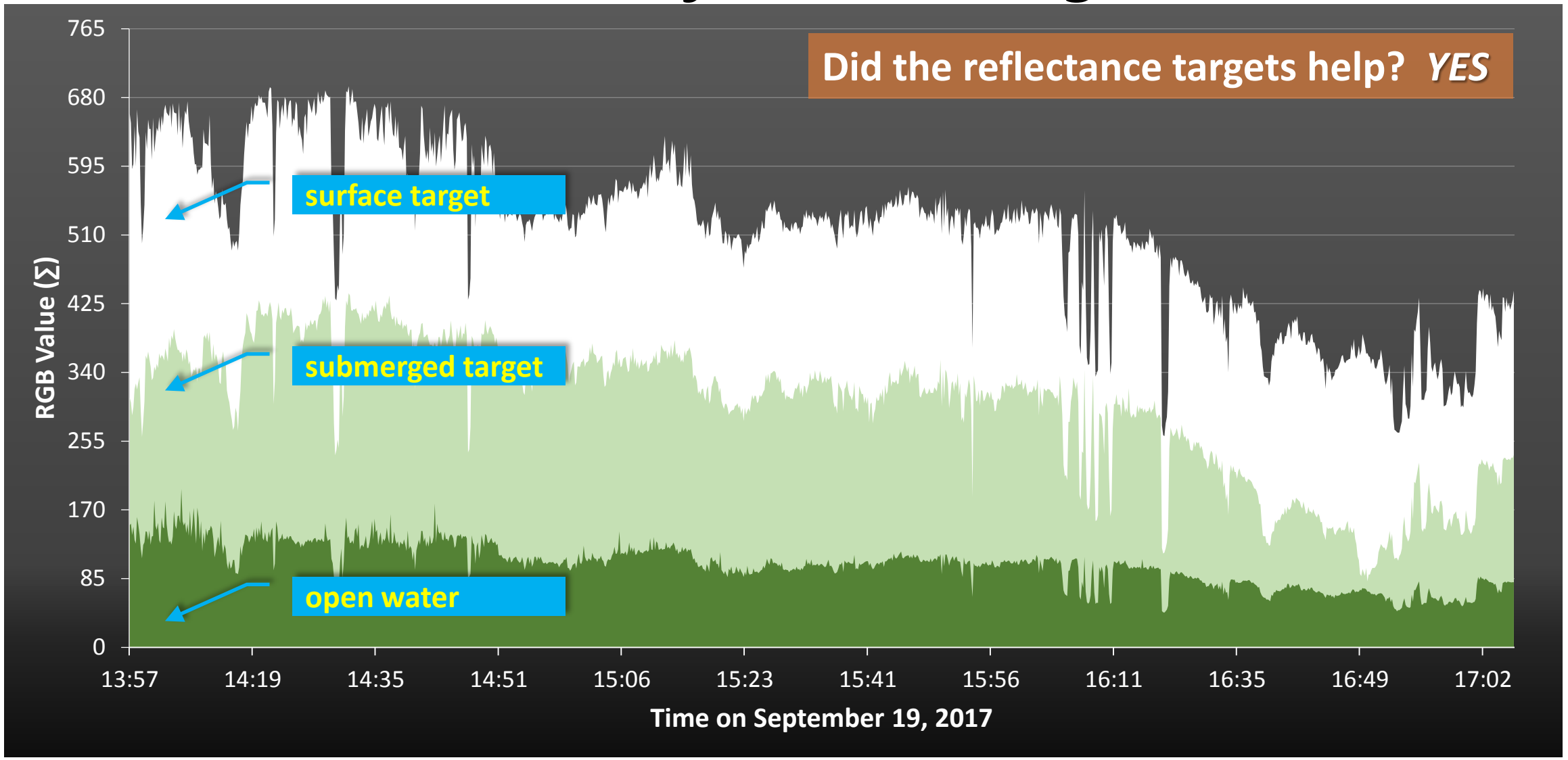
Results

Will the balloon fly? *Yes*

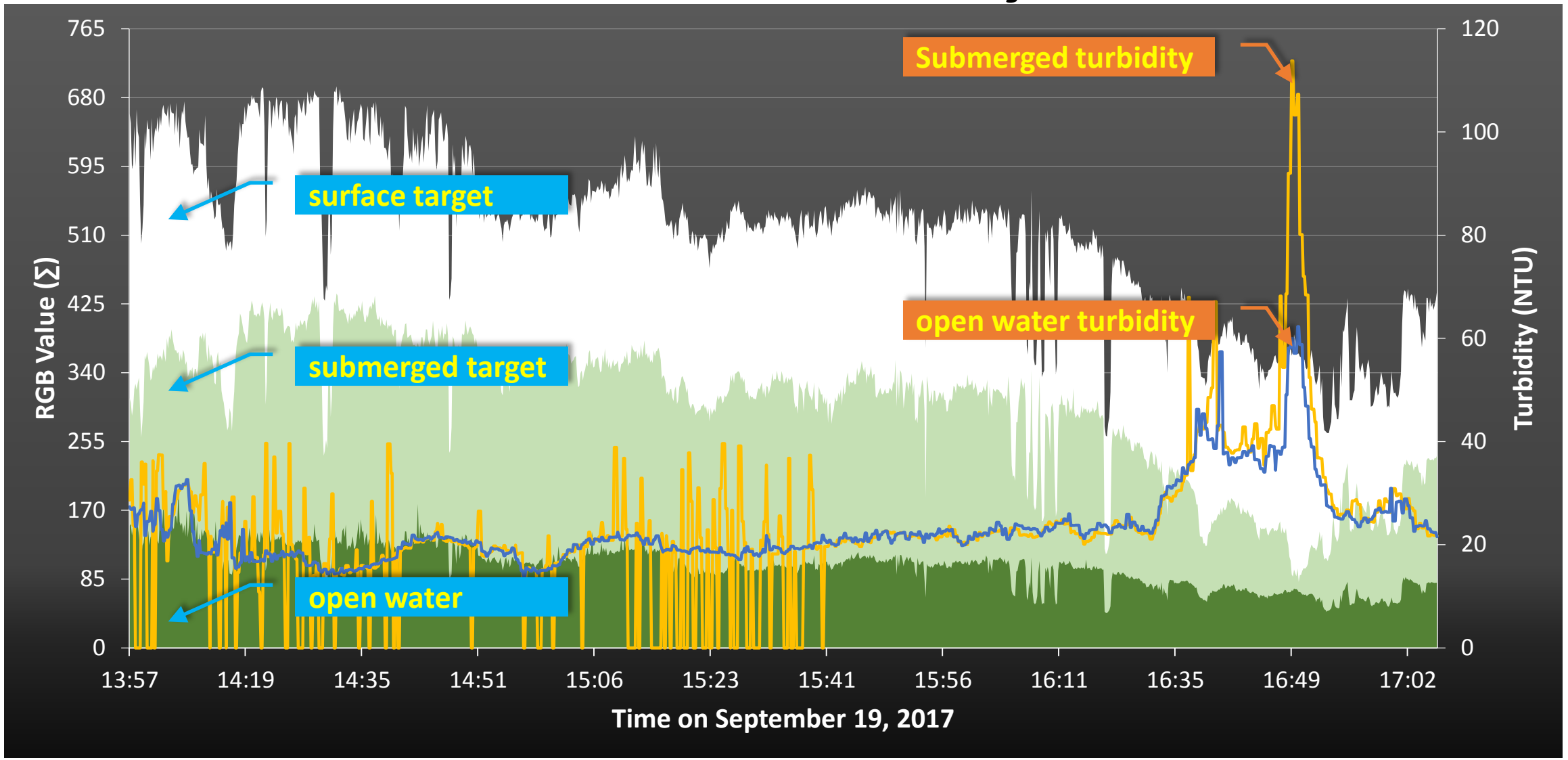
Will the script work? *Yes*



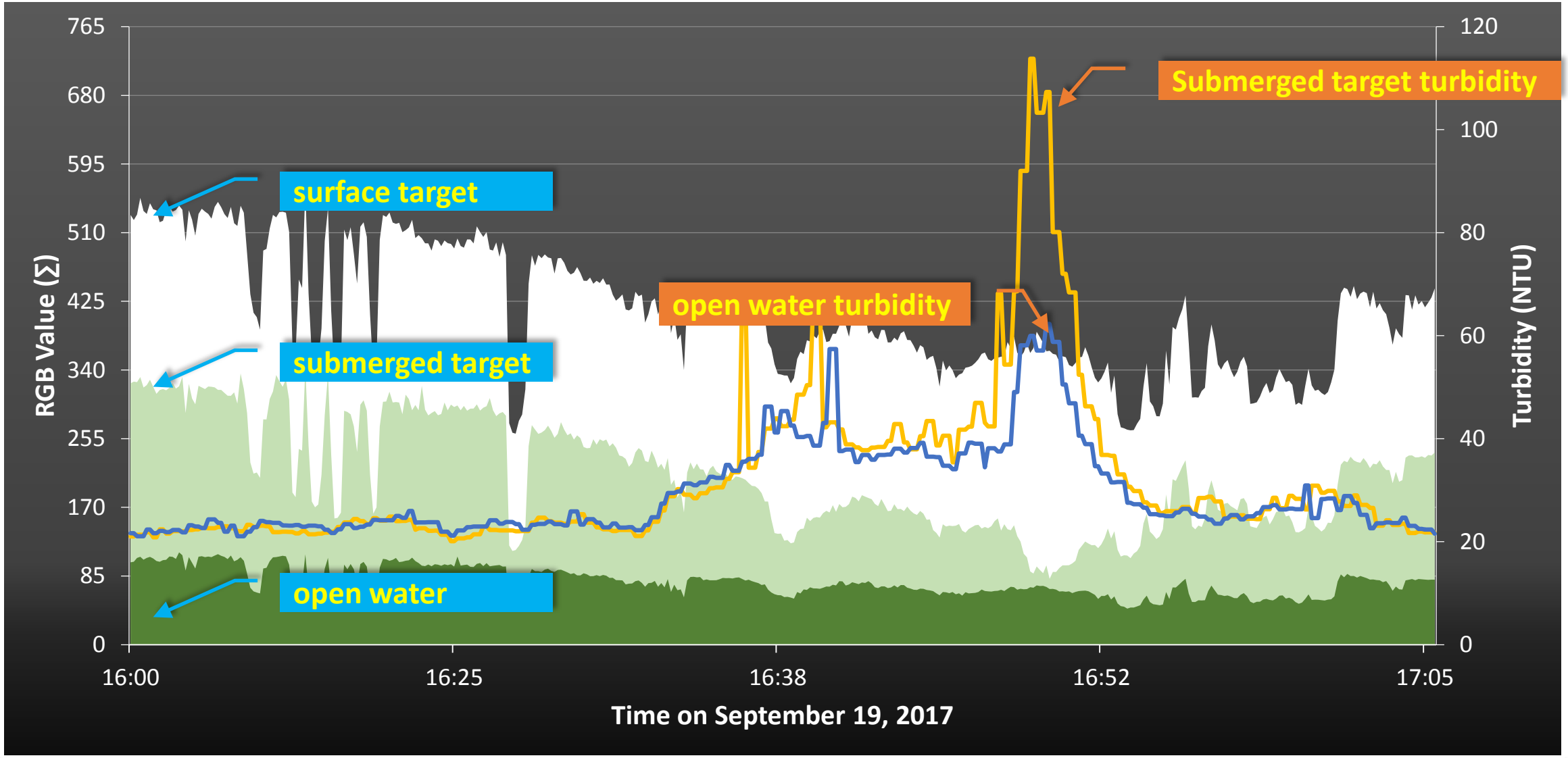
Results- *reflectance targets*



Results- *turbidity*

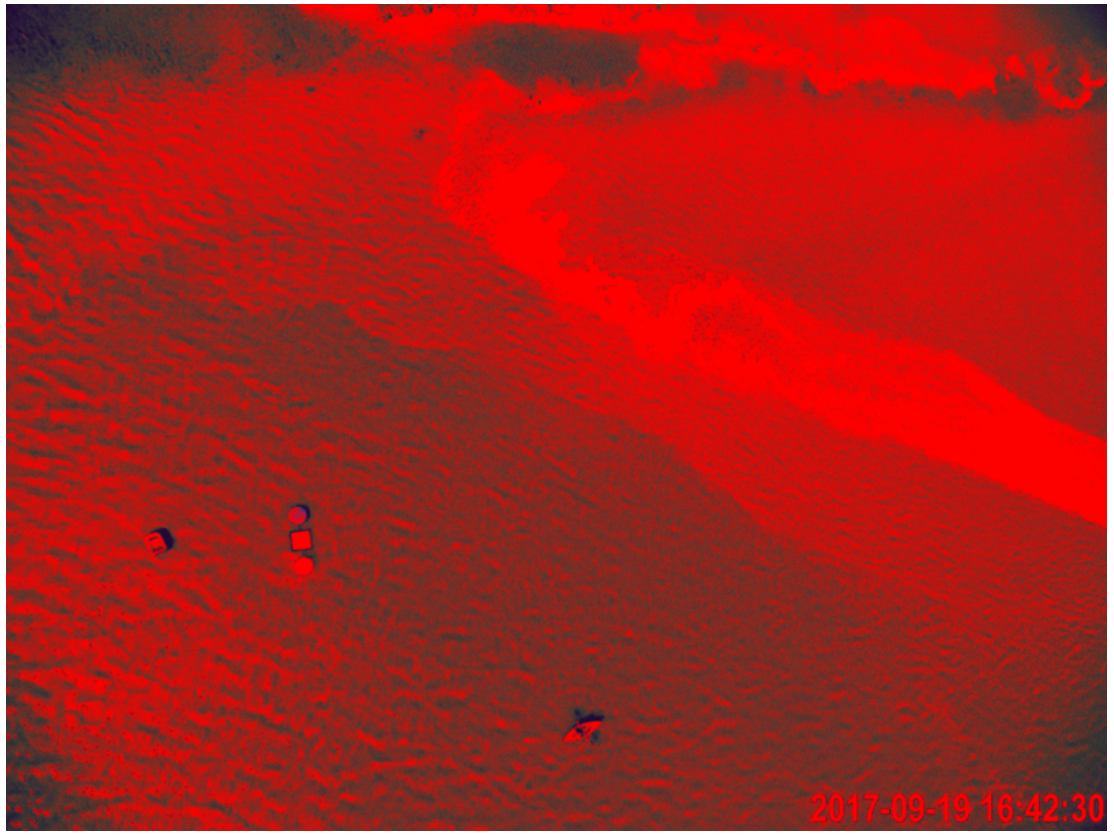


Results- *turbidity*



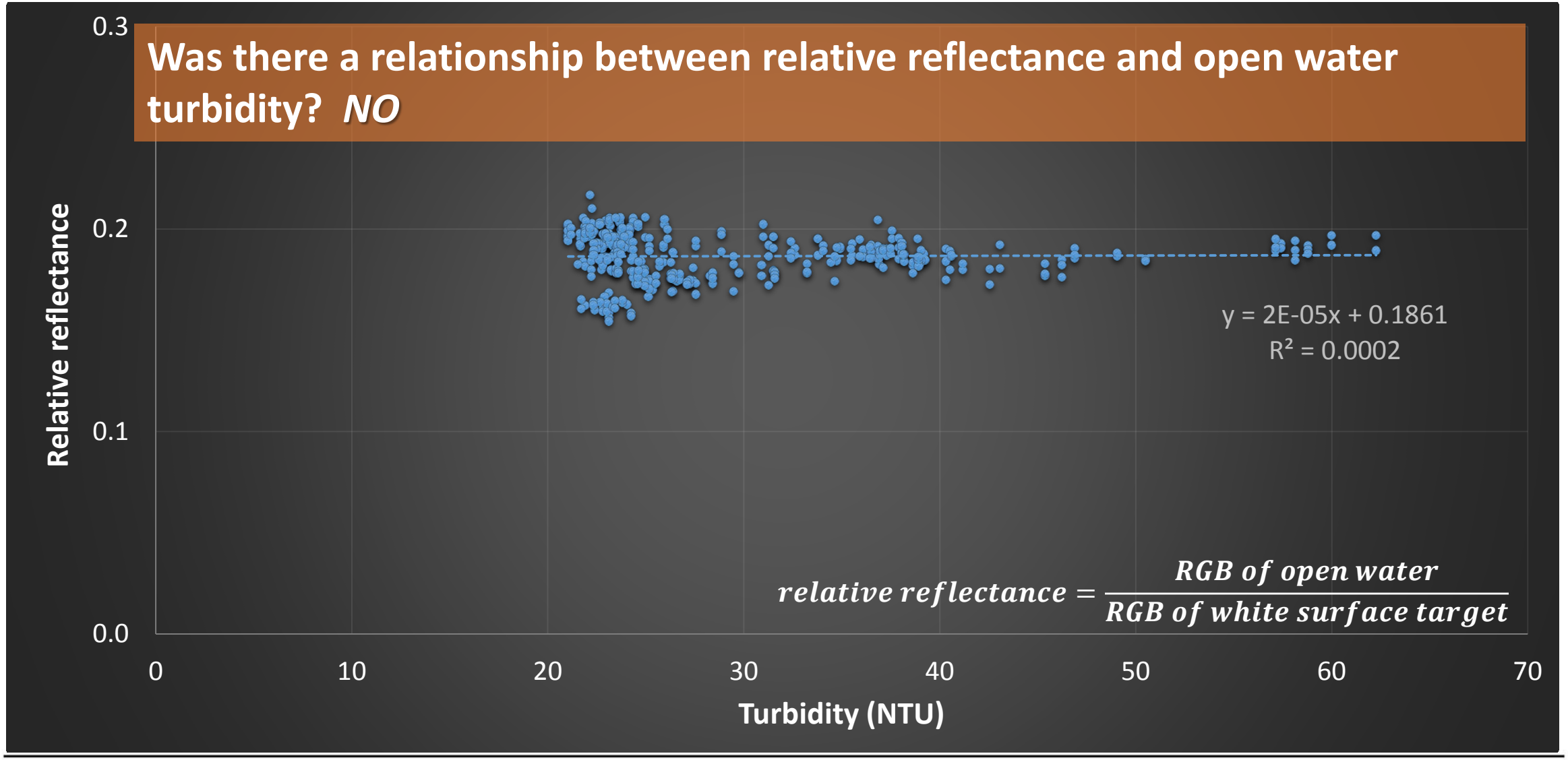
RGB

Color Threshold (ImageJ)

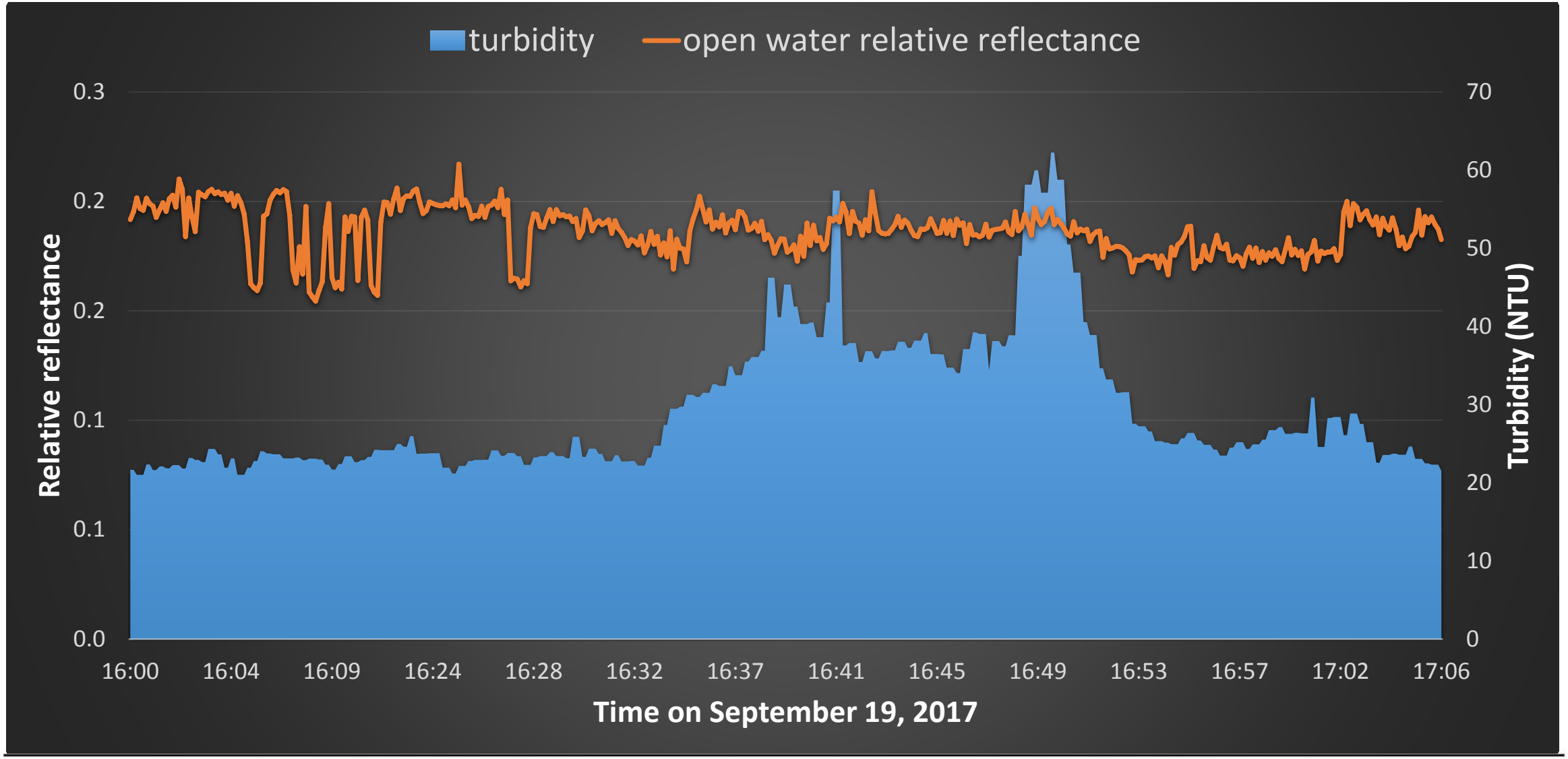


Results

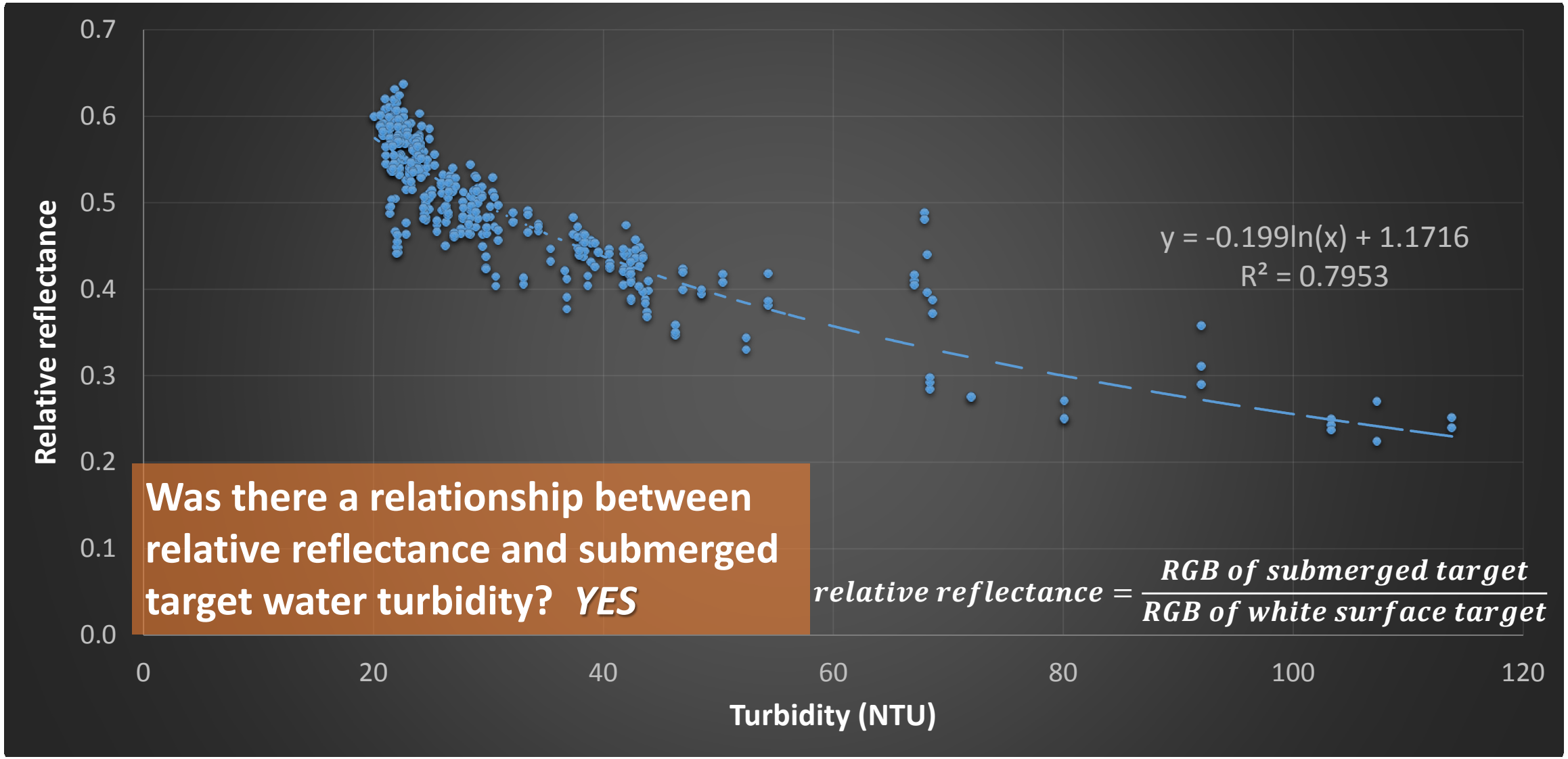
Was there a relationship between relative reflectance and open water turbidity? *NO*



Results


turbidity
open water relative reflectance
Relative reflectance
0.3
0.2
0.2
0.1
0.1
0.0
Turbidity (NTU)
70
60
50
40
30
20
10
0
16:00
16:04
16:09
16:24
16:28
16:32
16:37
16:41
16:45
16:49
16:53
16:57
17:02
17:06
Time on September 19, 2017

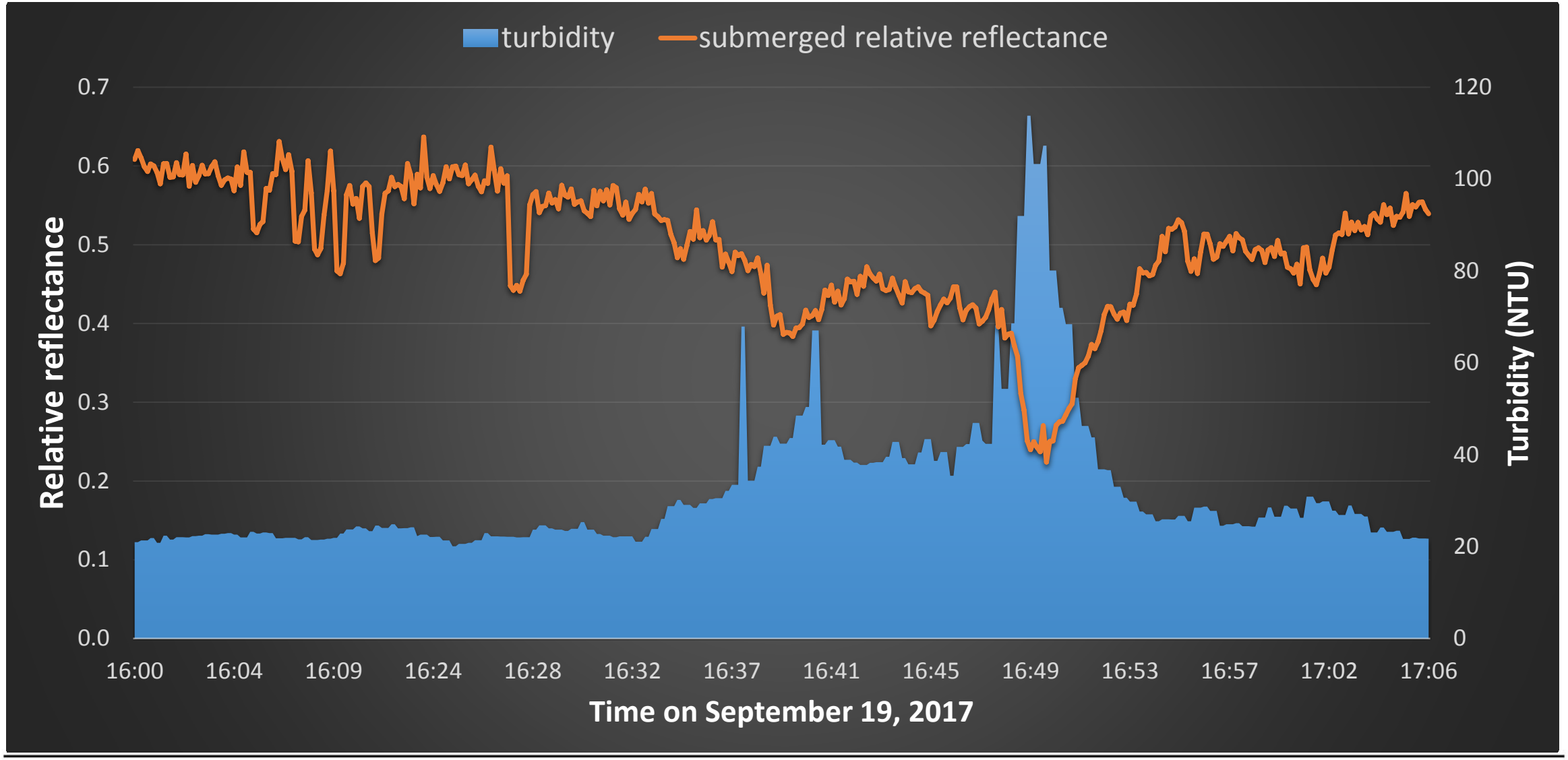
Results



Was there a relationship between relative reflectance and submerged target water turbidity? ***YES***

$$relative\ reflectance = \frac{RGB\ of\ submerged\ target}{RGB\ of\ white\ surface\ target}$$

Results


turbidity
submerged relative reflectance
Relative reflectance
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Turbidity (NTU)
120
100
80
60
40
20
0
16:00
16:04
16:09
16:24
16:28
16:32
16:37
16:41
16:45
16:49
16:53
16:57
17:02
17:06
Time on September 19, 2017

Conclusions

A low-cost turbidity monitoring system consisting of a weather balloon-mounted consumer grade digital camera was achieved.

Relying on open water RGB under these field conditions did not provide an accurate estimate of turbidity.

Surface & submerged targets increased spectral reflectance & reduced the uncertainty of monitoring & predicting turbidity.

Supports the design & implementation of relatively low-cost monitoring systems for remotely sensing turbidity plumes.