Ocean Data Collection: Measurement methods and Data Quality

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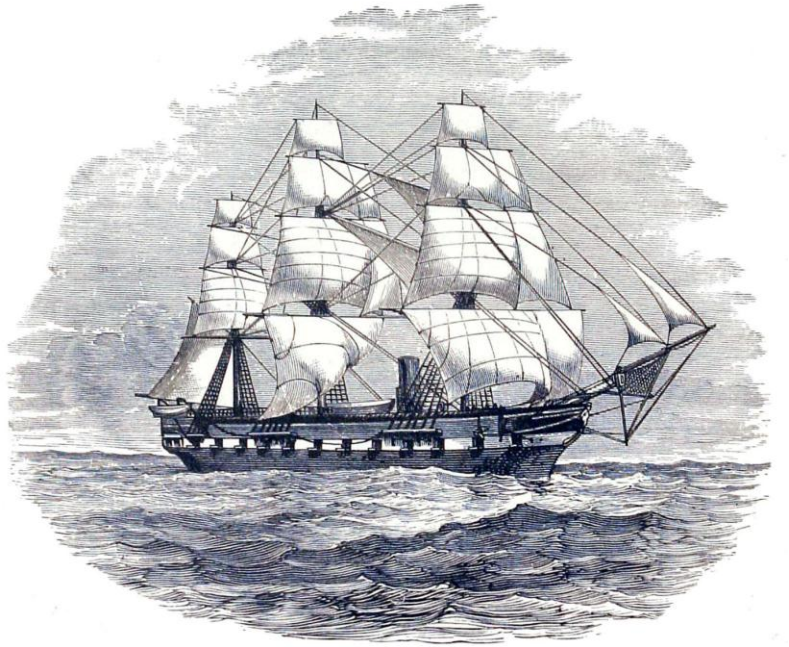
Progression of Observations

- Vessels: 1700s
- Buoys: 1940s
- Satellite and Aircraft – 1960s
- AUV – 1980s
- USV & UUV – 1990s

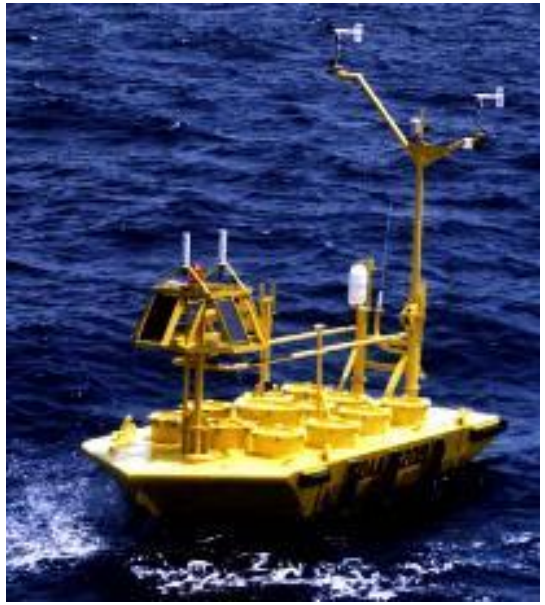
Vessels

- Only option available at the time
- Could cover Ocean basins and large transects quickly
- Lacked time series capabilities. (tried but dangerous and expensive).
- Lead to development of Ocean Buoys



Buoys

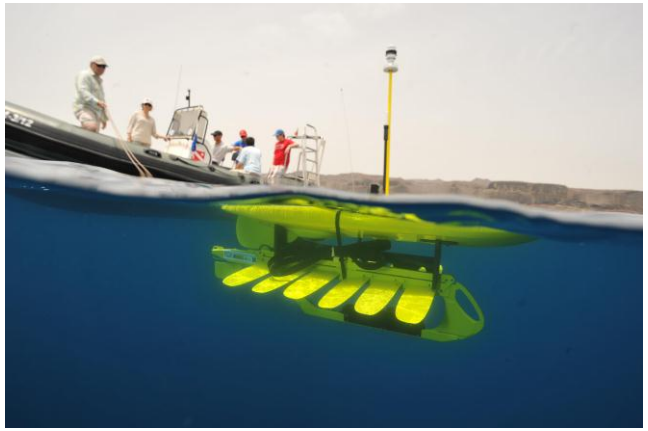
- Weather ships in the early 1930s to alert pilots of bad weather.
- Expensive and loss of crews.
- Nomad buoy developed in 1940s.
- Provided cheap long term time series datasets.



AUV

- Originated from desire to decouple tow bodies
- Increased survey resolution and speed.
- Great high resolution bathymetry and precision surveys.

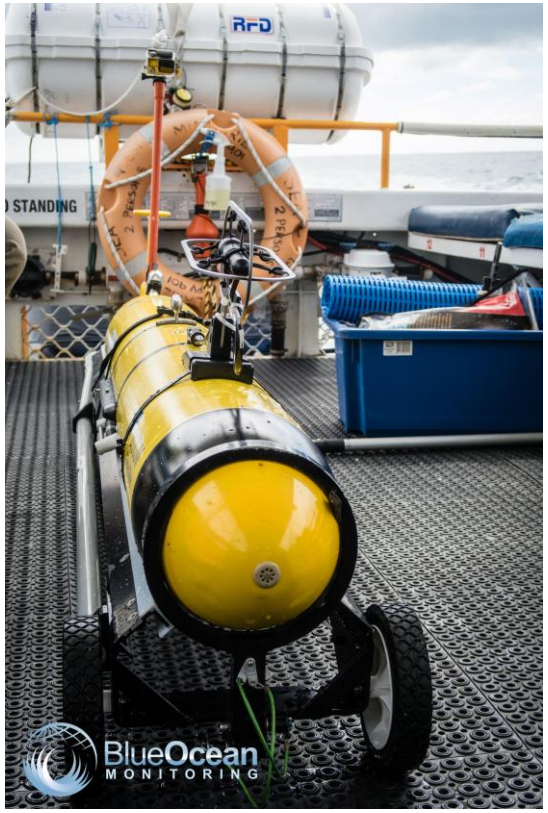
USV & UUV



- General autonomous category.
- Allow for oceanographic collection in remote areas
- Can be used as standalone system or compliment vessel missions

About Blue Ocean Monitoring

- Largest commercial operator of gliders in the world.
- Focused on high quality environmental and geochemical data collection
- Pushing the boundaries for sensor size, endurance, and speed.



Importance of Real-Time Data and Data Quality

- Provide accurate information to warn and alert of high winds and waves.
- Validate modeling and Ground Truth Satellites

Message Length

Payload:	46047
Satellite:	180 W
BCH Address:	B15A90E6
Msg Date:	03/24/2011 12:54:25
Meas Date:	03/24/2011 13:00:00
DAMS Quality:	41-0NN
Status:	G

```
1
460
SXUS70 KWAL 241254
 B15A90E6 083125425"27037 1250 46047 46/// /096024(/105024) 10131
30170(30172) 40170(40172) 22200 00138 333 921035(921035)
WWW095024(104024)W086027(099027)W071025(087026)W067024(083024)W06
8021(084022)W073018(088019)W08704131(10304331)W077023(091024)W007
(007) G45722N323996W119540312 CCC283(283)C298(297)C158(168)
BI1479/1271/0000/0000/1250/1275 SP20000 SP30000 DFFFFF
GGG0040(0040)
ADCP_w•X@P@FD`AM@Hx@D@ER@YPA@@@PGDaA@CTDDIX@P@[@@`E@BPCPAp@BLa|@@
NxD_SuOBQlF@PTr@LL@Wp@@@INW|`d@@@@@@@@@@@B@@@D@BpLXCBlpDP@@@MxEE`
Cm_@G•Cp@c@EHE@@@@CAXU_ZIdTUIb`y|@@PBHw}S\B@@@[`T@@@@TBpLXCBlpDP@
ANo}|@@P@•o•i•v@@APC|•q@@fO|@@@T@h•~N••o•@pCQ•xC••_|B@@L@Zo|@@@X@
•_}H•pD@@`C{•rc•@P@K@N_•@•|@@@D@z••f•o{•A@Cd•sc•~•|H@Lo•fo•z•q@@y
o~t••••Ap@E@FO••_•{•pd@To•|•pT@BpBA•~{•A`@@@gq|^wq•`G}•\GAq\Gu{^w
q{^gi|_Gmz_Giy^Wew]GIx]GIs\gey^Gaz]w]x\wEo]FmkZFup\V}m[FeeZfIbWFL
@@x~QdYNNdH~Q[Fym[uq\WFAVVE][TEIQUDeKRTq@PC}CNst~Oc}@PDH|OSp~LsTt
Ms@sLsPrMCLuKs@oLbhlJrt@A@@@@FL@@@Ad@@@@Y@@@@FL@@@Ac@@@@X`@@@v@@@
@I`@@@CX@@@@FL@@@Ad@@@AX`@@@f@@@@Ia@`@CWaP@BTXkPKZR WP9~QjIKbdcKtqkcK{]
```

GOOD MESSAGE

Message Length

Payload:	46047
Satellite:	180 W
BCH Address:	B15A90E6
Msg Date:	03/24/2011 14:54:25
Meas Date:	03/24/2011 15:00:00
DAMS Quality:	39-0NP
Status:	P

```
1
395
SXUS70 KWAL 241454
 B15A90E6?083145425"29028 1450 46047 46/// /152011(/156011) 10131
30179(3px<ul0#~b~fe7tED|WGOMgMumOFN`UfFnwdOfoOl•lglmEM~W


LHLMloufJaofMV
DhionCulbGGnJ~"LcDolC_fCCefC\ FcNgDm}NkIeFl~"dlogfD]ddmOlFt
feAEmE}LnFmOMTNegMDgeoudOagFeGMV NaLmdJWlinGd@t
oO`}Ee`Tu8`GNEO FMddFD(LnNHdelDOu4  dDO]dNeT NaJUfCi\<fcKul`C~_4
lc@dzlMMdZoEEepOdkBPDeIjRFLbg}OOgMdU
NmOhfW3  19} 2eEMG_GGe`tU ;4/*'7=;;5:55-12-7&4 ?7 45
 3 '=/ $?=  = /? ;!=?9%  .(?1?)
7 ? ± ?=5 ?5 =?  5?;79'6?; 57 2-8 756
57 9+5?   6 $%9 65?.ı %72;=755/=uI%)L_2\"\ 5
<@ x+PEYL3t1L*e"7'}v['yZ•j[ Qq5zz Wk 39-0NP 180W
```

How to automate message check

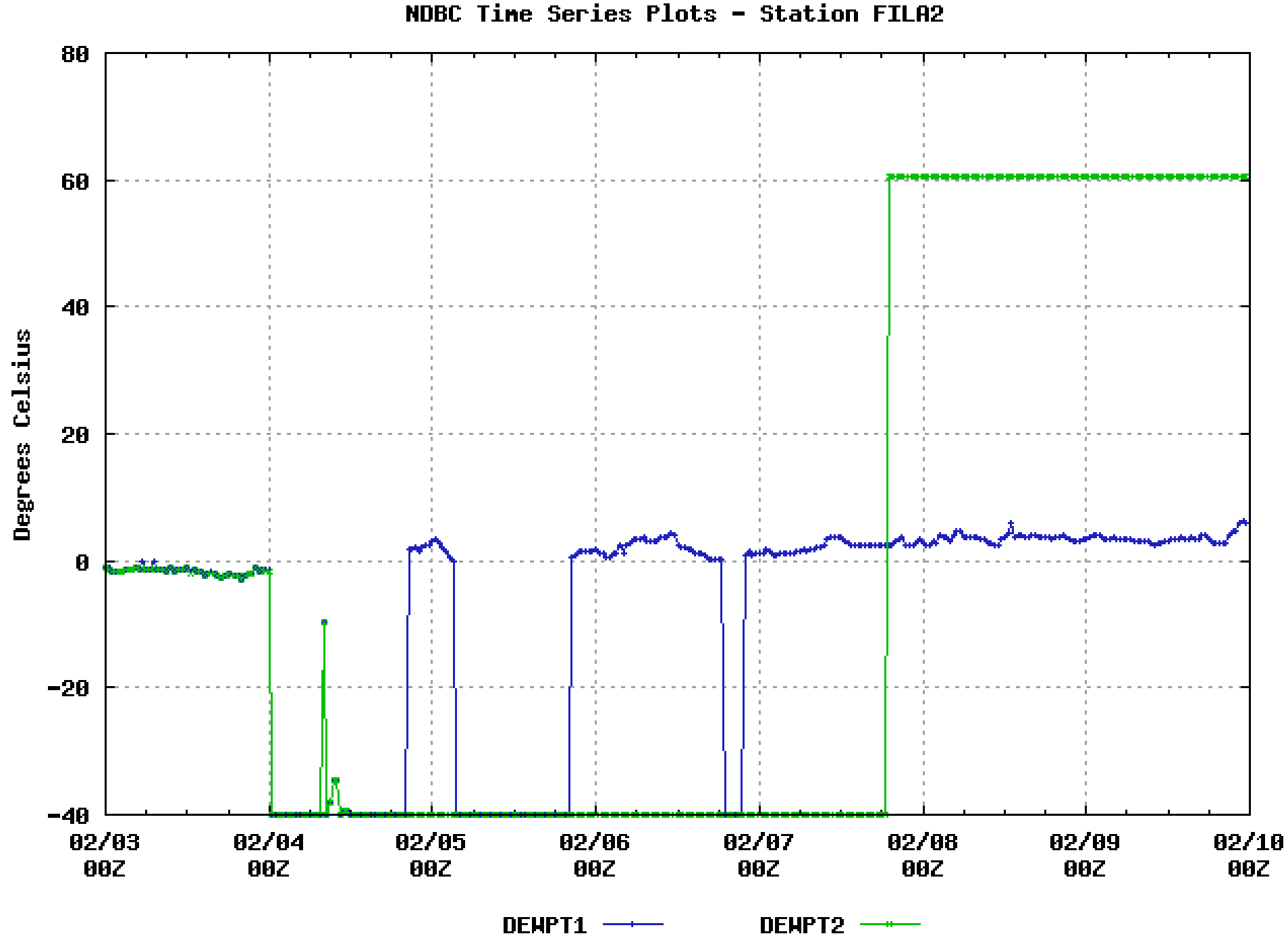
- USE ENDING CHARATERS
- >>> OR ~~~
- CRC checksums work as well

Transmission Checks

- Try and decode simple data.
- DO NOT RELEASE Binary data (I.E. waves, ADCP)

Range Checks

- Physically Impossible Ranges
- Take sensor range from manufacturer - 1
- Can be used to catch drift.


NDBC Time Series Plots - Station FILA2
Degrees Celsius
80
60
40
20
0
-20
-40
02/03 00Z
02/04 00Z
02/05 00Z
02/06 00Z
02/07 00Z
02/08 00Z
02/09 00Z
02/10 00Z
DEWPT1
DEWPT2

Wind Direction

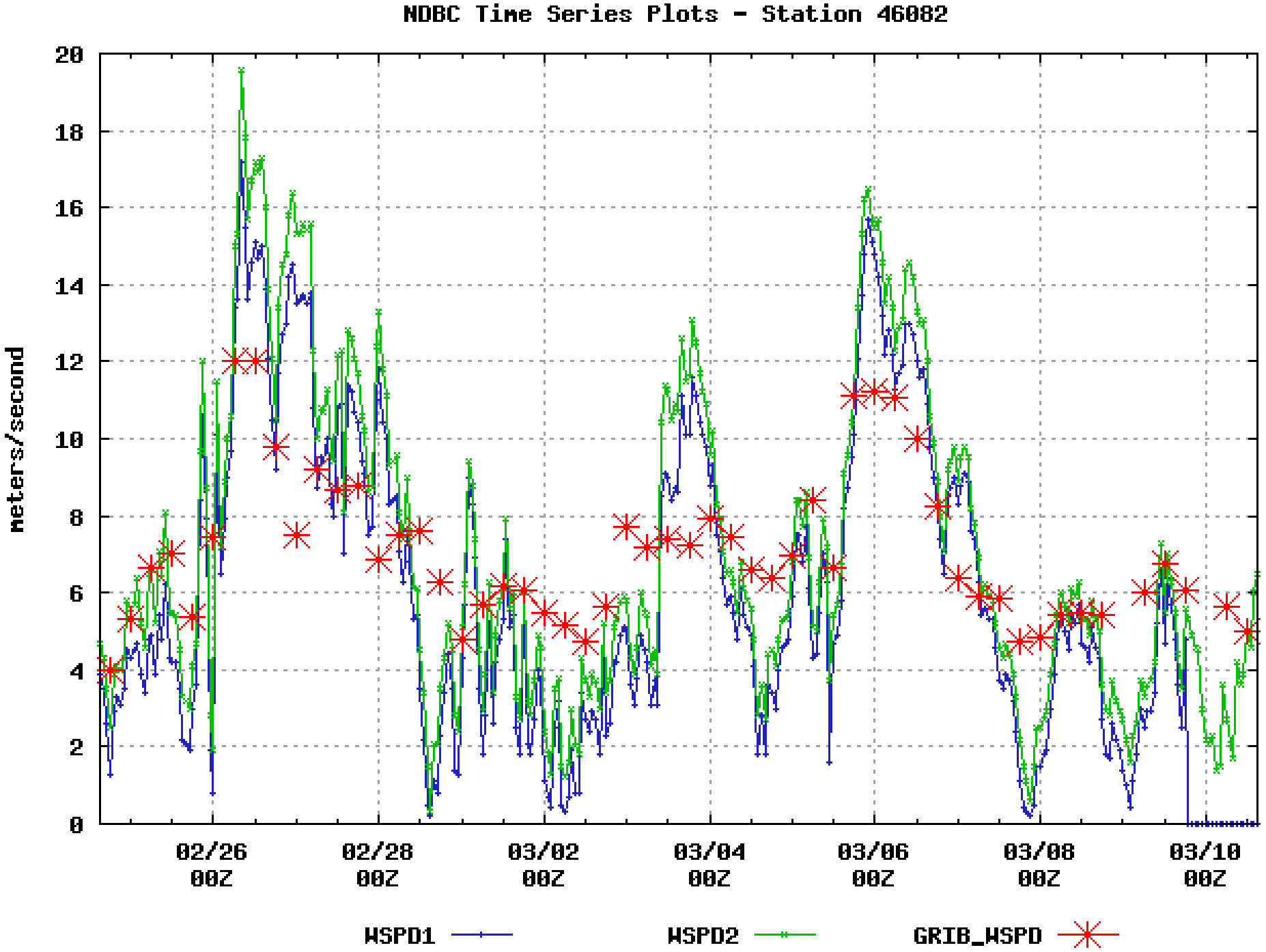
DELTA_WDIR = ABS(WDIR1 – WDIR2)

DELTA_WDIR1 = ABS(WDIR1(i) – WDIR1(i-1))

DELTA_WDIR2 = ABS(WDIR2(i) – WDIR2(i-1))

IF WSPD1 and WSPD2 > 2.5m/s && DELTA_WDIR >25

RELEASE WDIR WITH SMALLEST DELTA.


NDBC Time Series Plots - Station 46082
meters/second
20
18
16
14
12
10
8
6
4
2
0
02/26
00Z
02/28
00Z
03/02
00Z
03/04
00Z
03/06
00Z
03/08
00Z
03/10
00Z
WSPD1
WSPD2
GRIB_WSPD

CODING

IF VAL(i) & VAL(i-1)… VAL(i-n)

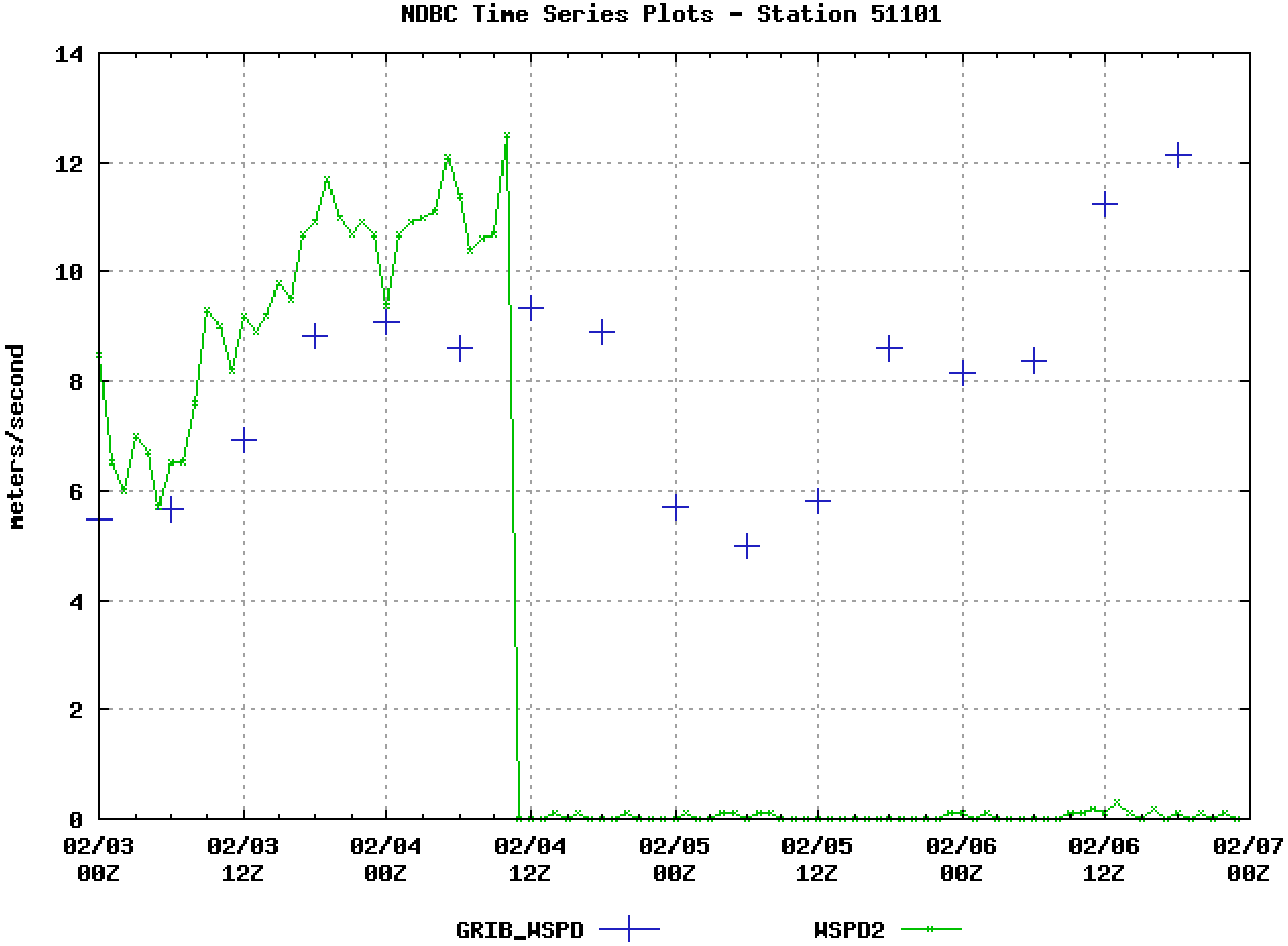
DO NOT RELEASE FLAG STUCK SENSOR

TIME CONTINUITY (NDBC)

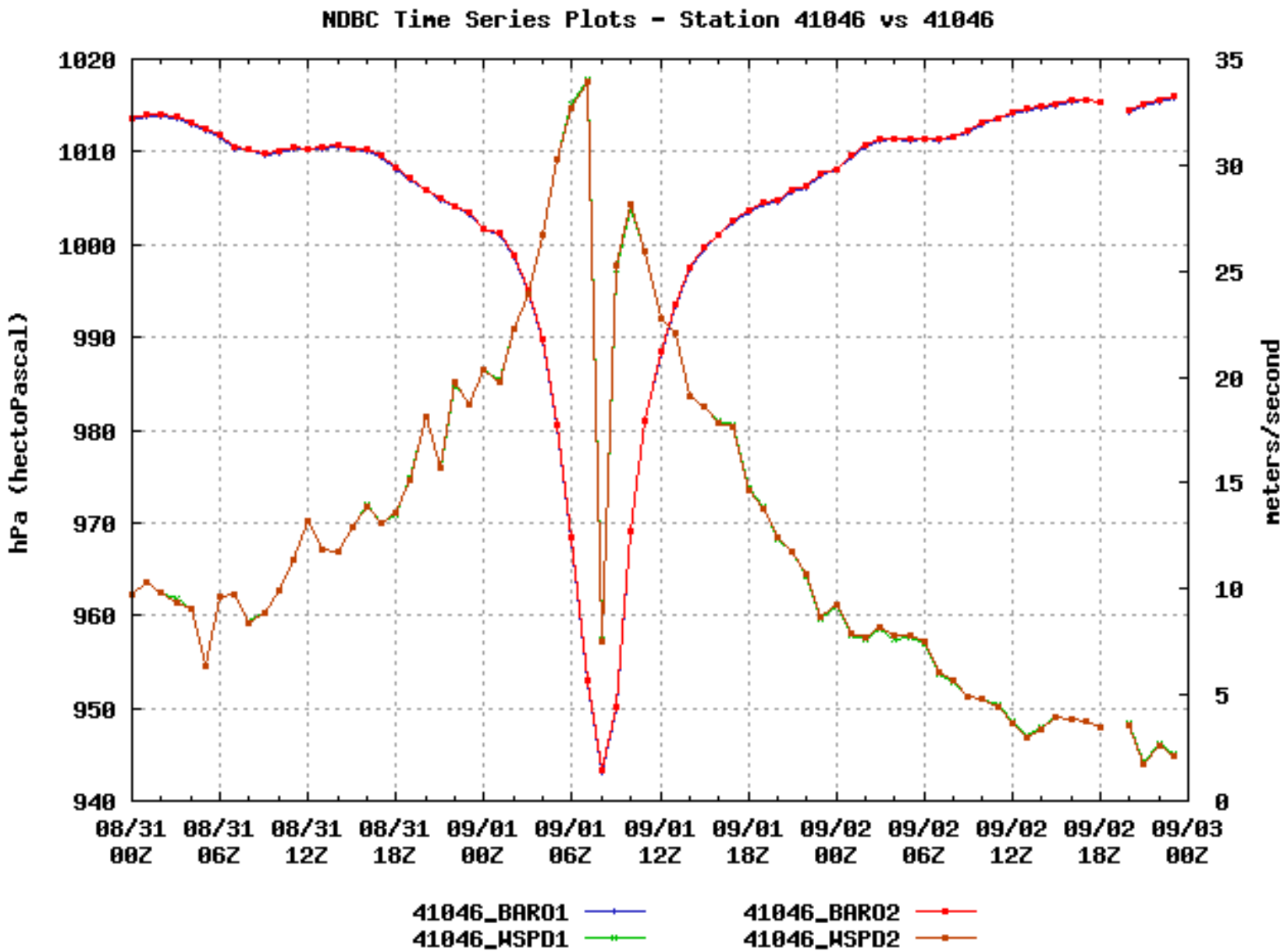
- V(t) = .58*Sigma*(t)^1/2

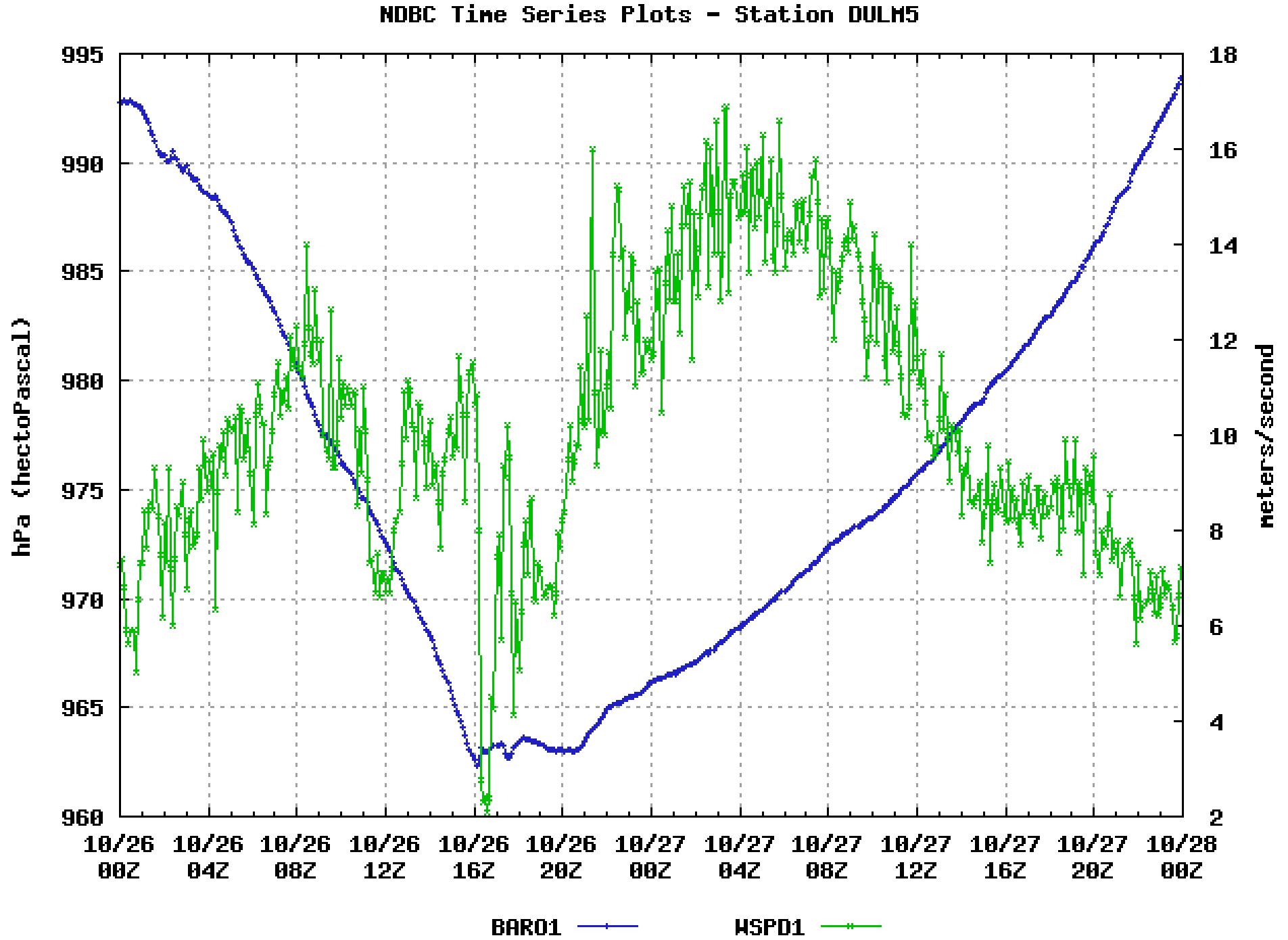
- Sigma is standard deviation determined from climatology + 50%.
- OR Sigma 3-4 Standard Deviations
- If not using seasonal values Sigma is constant.

.58*Sigma = .58*constant = C


NDBC Time Series Plots - Station 51101
meters/second
14
12
10
8
6
4
2
0
02/03 00Z
02/03 12Z
02/04 00Z
02/04 12Z
02/05 00Z
02/05 12Z
02/06 00Z
02/06 12Z
02/07 00Z
GRIB_WSPD
WSPD2

Wind Speed and Barometer



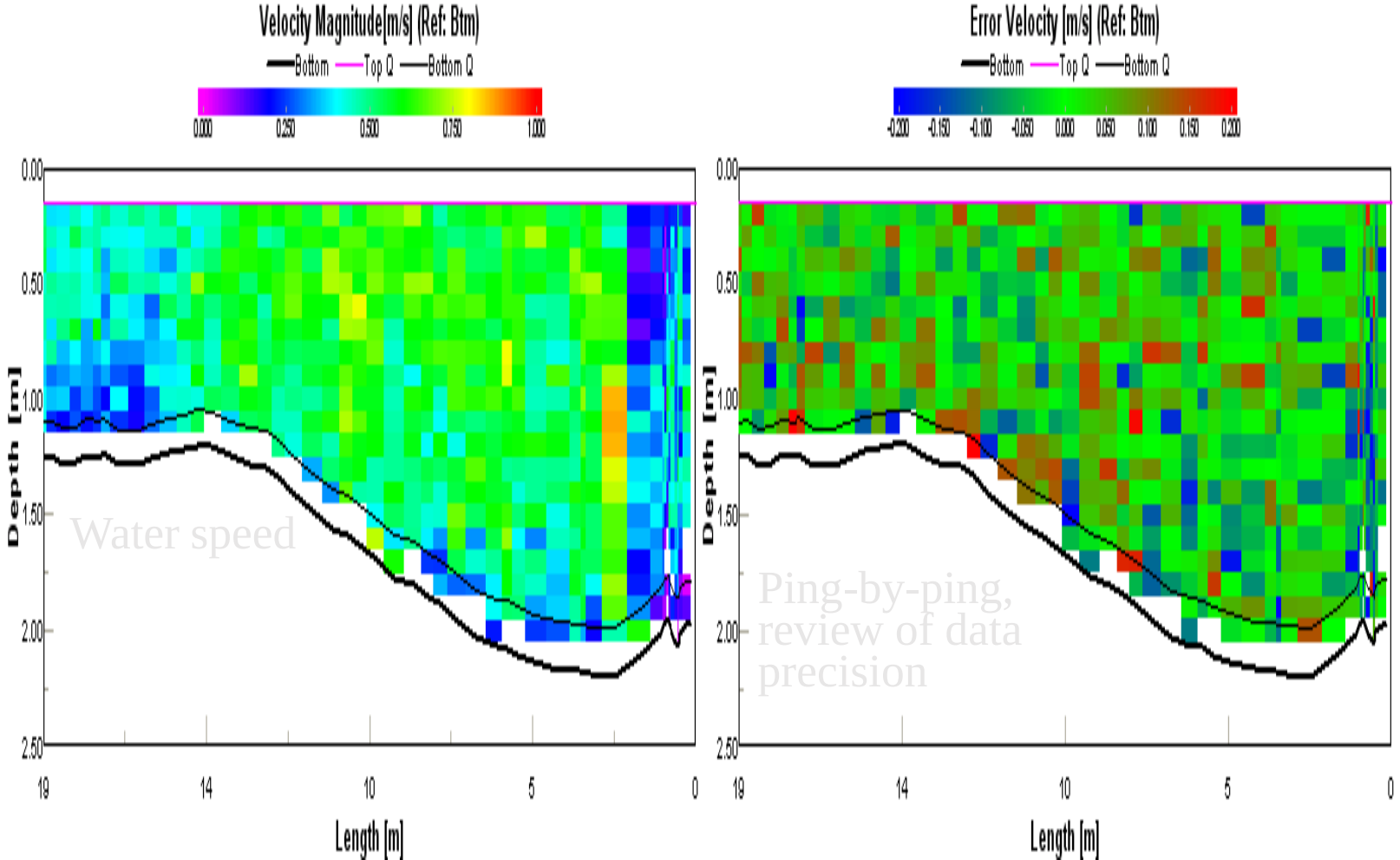

NDBC Time Series Plots - Station DULM5
hPa (hectoPascal)
meters/second
995
990
985
980
975
970
965
960
18
16
14
12
10
8
6
4
2
10/26 00Z
10/26 04Z
10/26 08Z
10/26 12Z
10/26 16Z
10/26 20Z
10/27 00Z
10/27 04Z
10/27 08Z
10/27 12Z
10/27 16Z
10/27 20Z
10/28 00Z
BARO1
WSPD1

ADCP - Error Velocity

- Measures variability of velocity data
- Provides a far more sensitive screen for data quality than can be achieved by inspecting echo intensity
- Screens each ping for unacceptable noise in the data
  (e.g., due to fish, turbulence, or eddy variability), maximizes the volume of high quality signal recorded
- Detects consistent obstructions from solid scatterers (causing bias in the data)

ADCP - Error Velocity

- < 15cm/s – Good (release)
- 15-30cm/s – Suspect
- >30cm/s – Bad



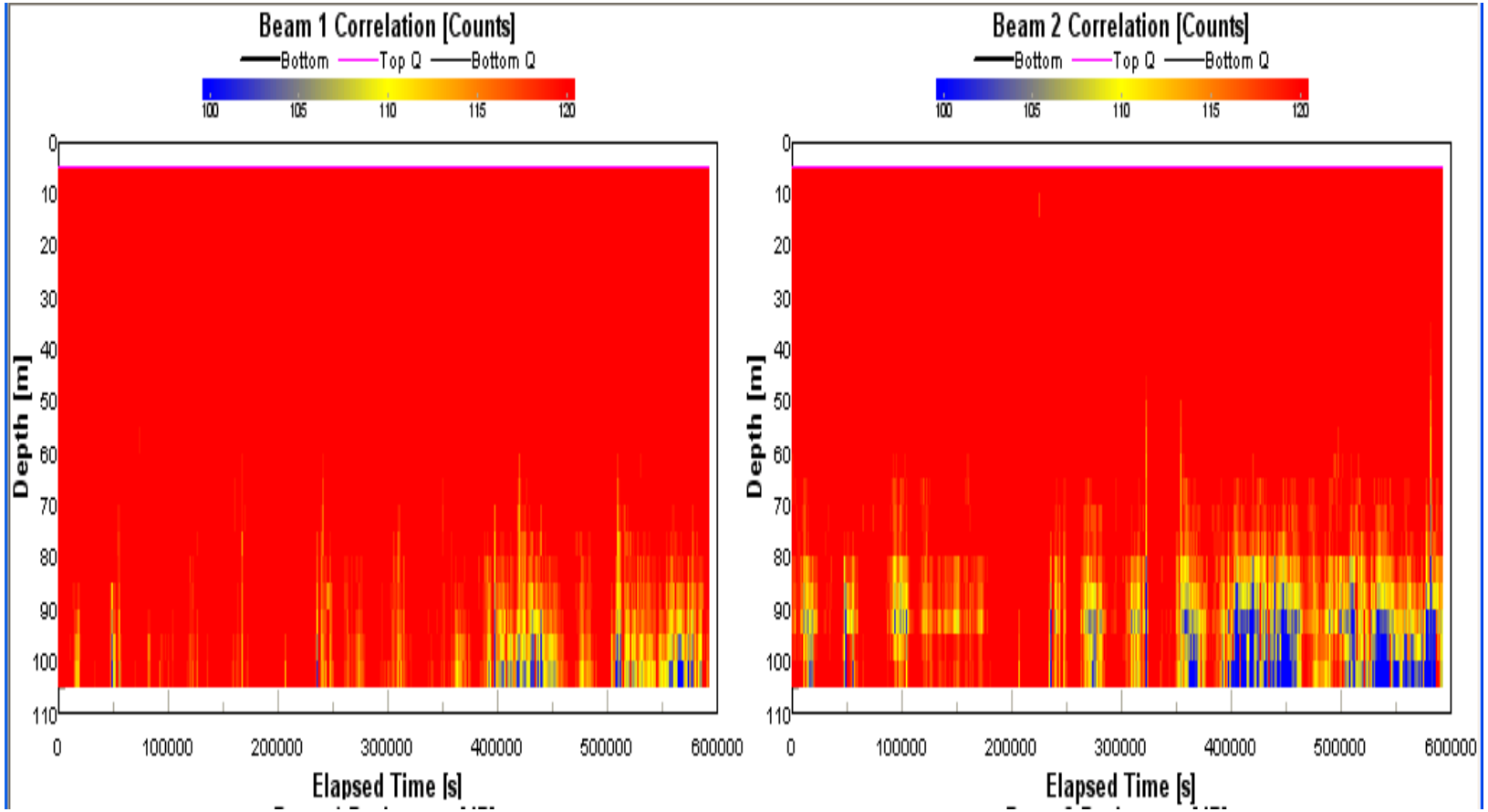
ADCP – Correlation Magnitude

- Helps Determine consistency of measurement.

- Low signal-to-noise ratio in returned echo
- Too much variability in the velocity signal returned from depth cell
  - Rapidly varying scatterers
  - Diverse Doppler shifts

ADCP – Correlation Magnitude

- 75KHz - >= 64 - 3 beams (release)

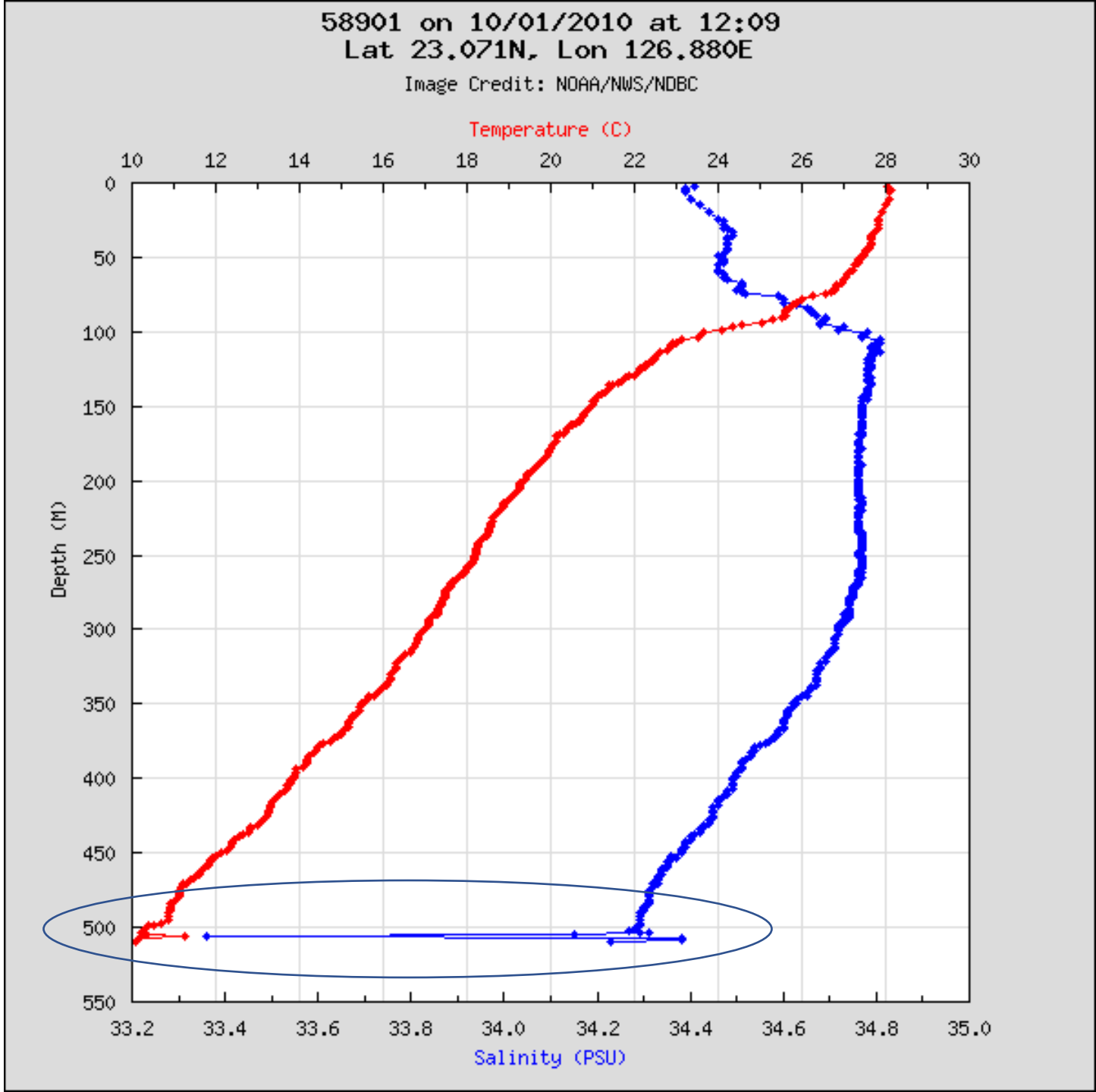


T,S Profile QC

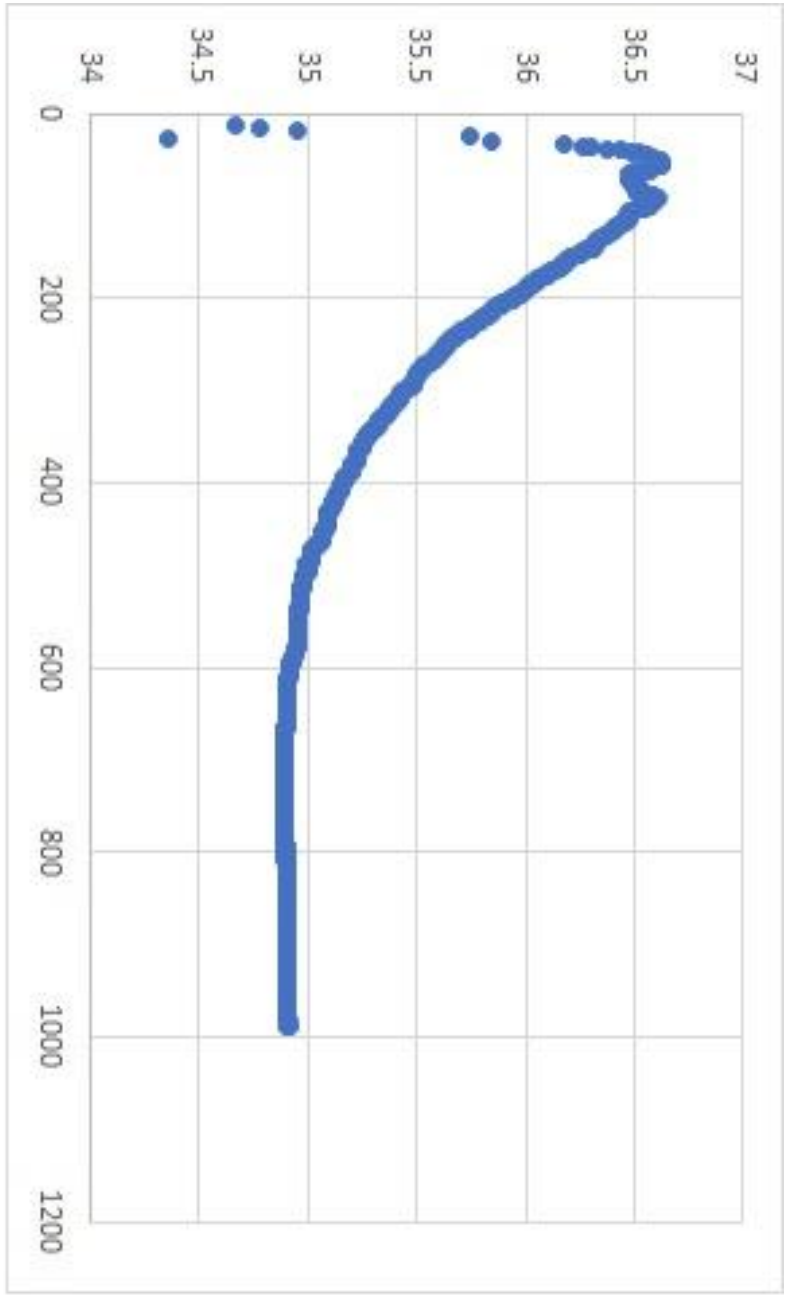
- Follow Global Temperature Salinity Profile Program (GTSPP) guidelines.
- Check Time is within 10 days
- Remove duplicate depths
- Run range check
- Spike Check and Time Continuity check.

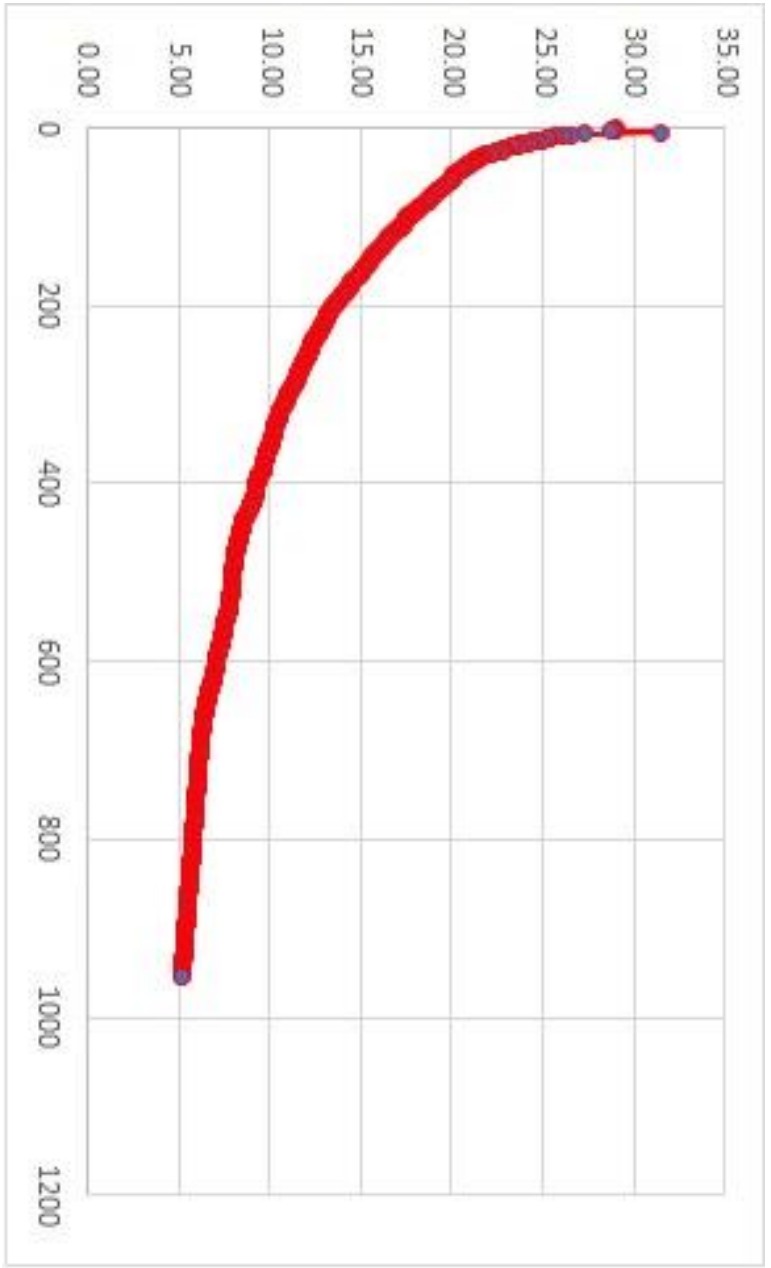
Example

- Spike at 500m on Temperature and Salinity
- Good or Bad?



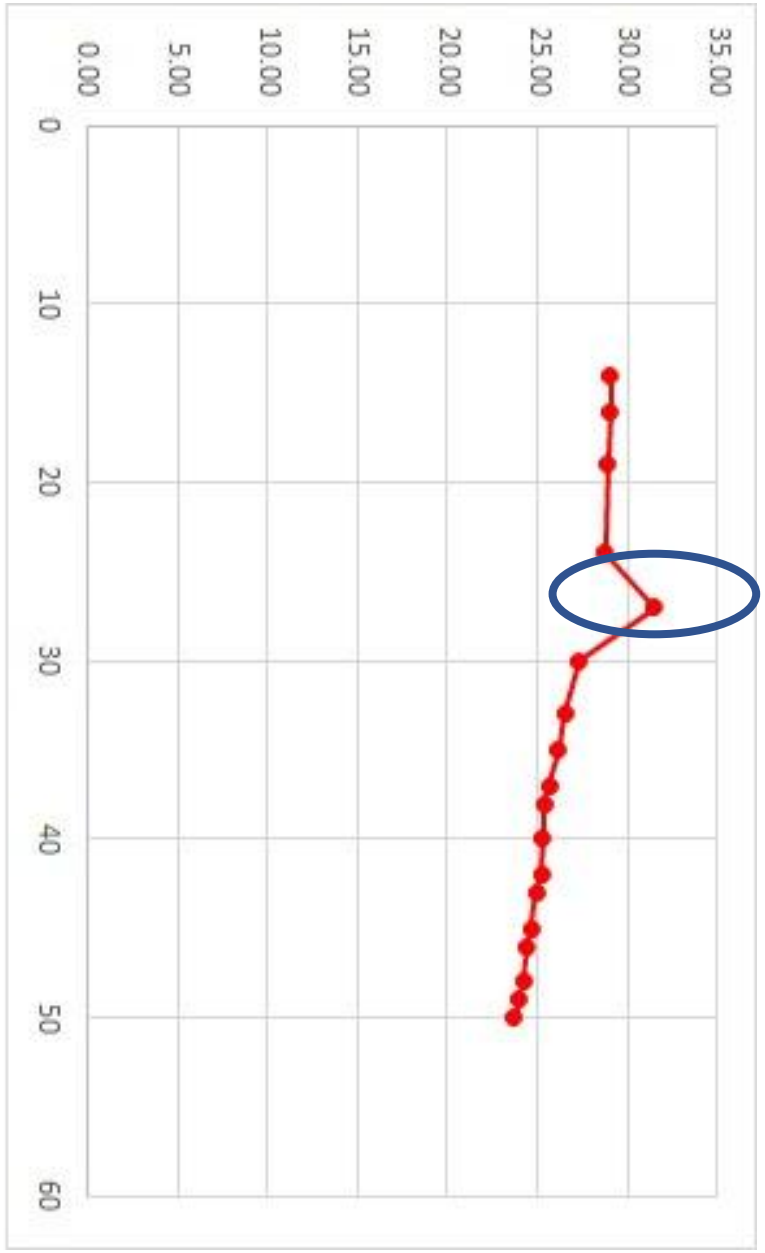
GTSPP

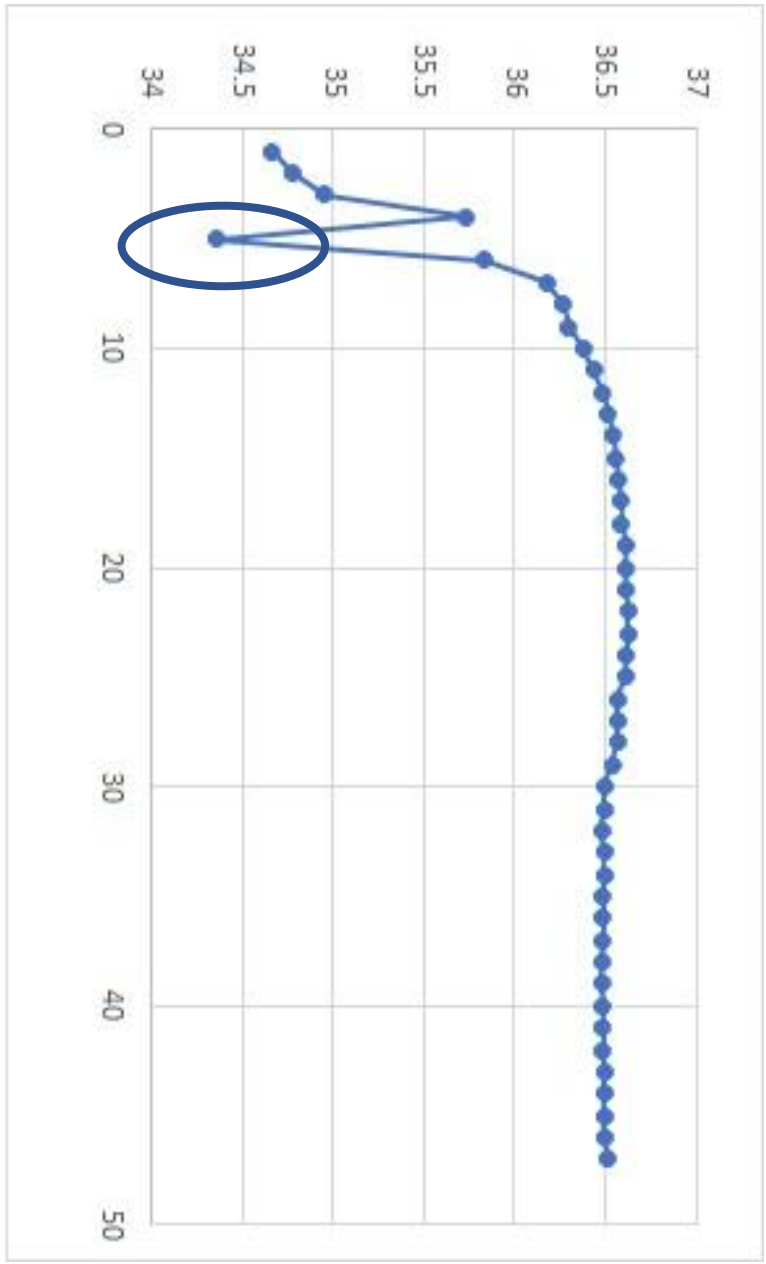

37
36.5
36
35.5
35
34.5
34
0
200
400
600
800
1000
1200


35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
0
200
400
600
800
1000
1200

GTSPP Spike

Temperature Change = 2.8
Salinity Change = 1.4





GTSPP Spike

- $|V2 – (V3+V1)/2|-|V1-V3|/2 > \text{Threshold}$

- V1 = 28.75
- V2= 31.54
- V3=27.35

- $|31.54 – 28.05| - .7 = 3.49 - .7 = 2.79 > 2$
- Do not release

Thanks!

- Marinha do Brazil/CHM
- NOAA/National Data Buoy Center
- Teledyne RDI – Paul Devine
- Blue Ocean Monitoring – Ben Hollings

Resources for Real time Data Quality

- http://www.ndbc.noaa.gov/NDBCHandbookofAutomatedDataQualityControl2009.pdf

- RTQC – Temperature and Salinity Profiles
- https://www.nodc.noaa.gov/GTSPP/document/qcmans/MG22rev1.pdf