The Inverse Barometer Effect in Puget Sound Tide Heights

David Burch
Starpath School of Navigation, Seattle, WA
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Part I
All 2008 incidents of pressures above 1030 mb at Cherry Pt, Puget Sound

Part II
All 2008 incidents of pressures below 1004 mb at Cherry Pt, Puget Sound

The data are from http://tidesandcurrents.noaa.gov

There are many factors that can cause the observed tide height to differ from the predicted tide heights found in tide books. Atmospheric pressure studied here is only one, and in many circumstances or regions this is not the most important effect. Wind speed and direction creating unaccounted for wind-driven currents is another factor, as is unseasonable river run off.

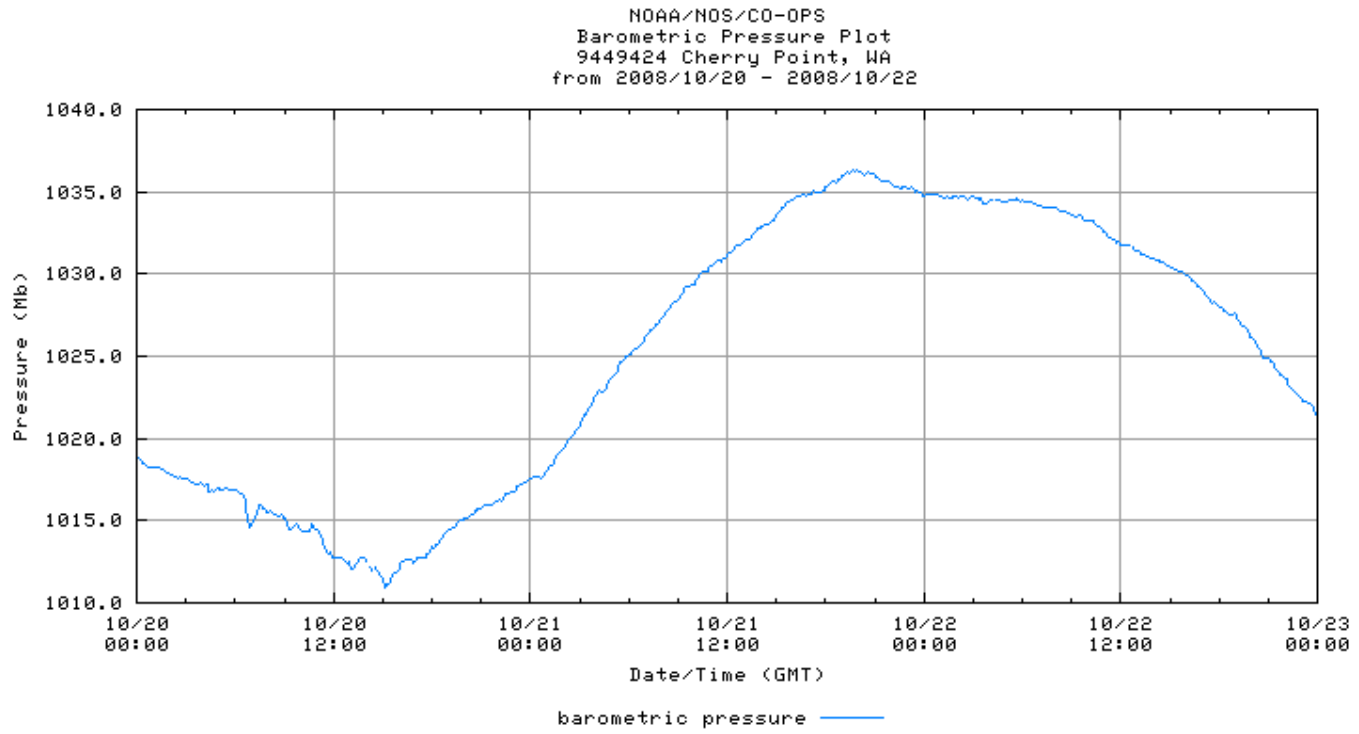
The effect of atmospheric pressure on water level is called the "inverse barometer effect" (IBE). We show here that this effect can be observed and anticipated in at least one tide station in Puget Sound, that of Cherry Point, near Edmonds, WA. The theoretical magnitude of the effect is about 1cm of tide height for each 1 mb of pressure difference from the seasonal mean.

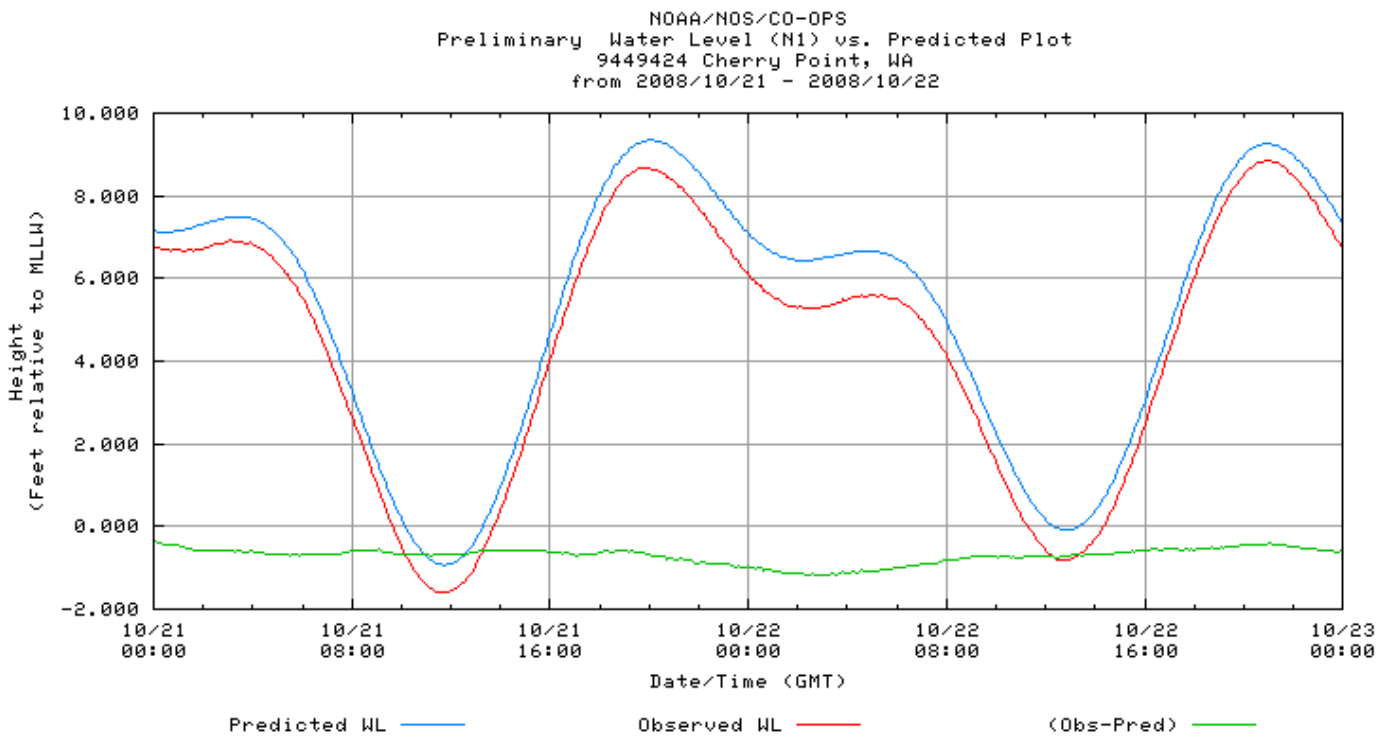
In the data presented we see both the rise in tide height in lower than normal pressure as well as the lowering of tide height in higher than normal pressures. This simple theory accounts for the observations quite well, considering the large uncertainties of the model.

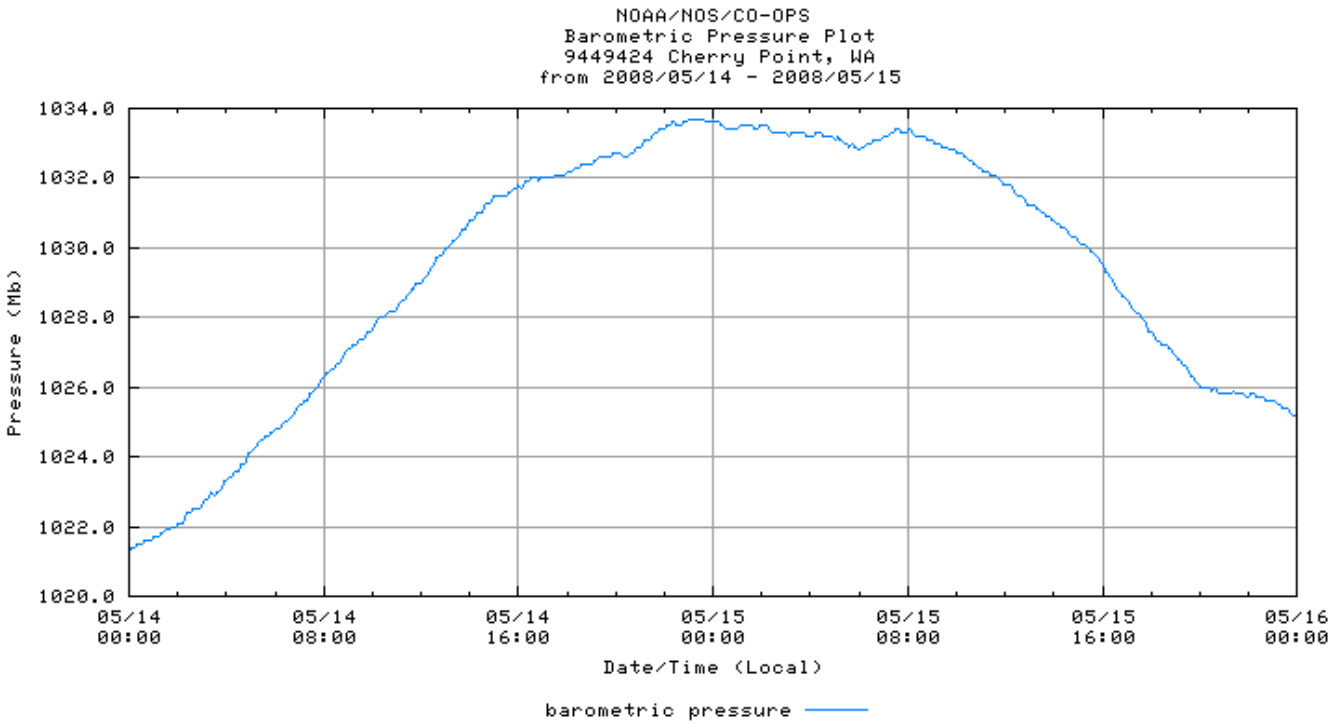
The mean surface pressure in Puget Sound is about 1017 ± 1mb throughout the year. So we have looked at pressure incidents that exceed the mean by ± 13 mb. The standard deviation of the mean in Puget Sound is about 5 mb in the summer (June, July) and about 11 mb in the winter (Dec, Jan). The dates covered are Jan 1 to Oct 26, 2008. All incidents that meet these pressure criteria are included.

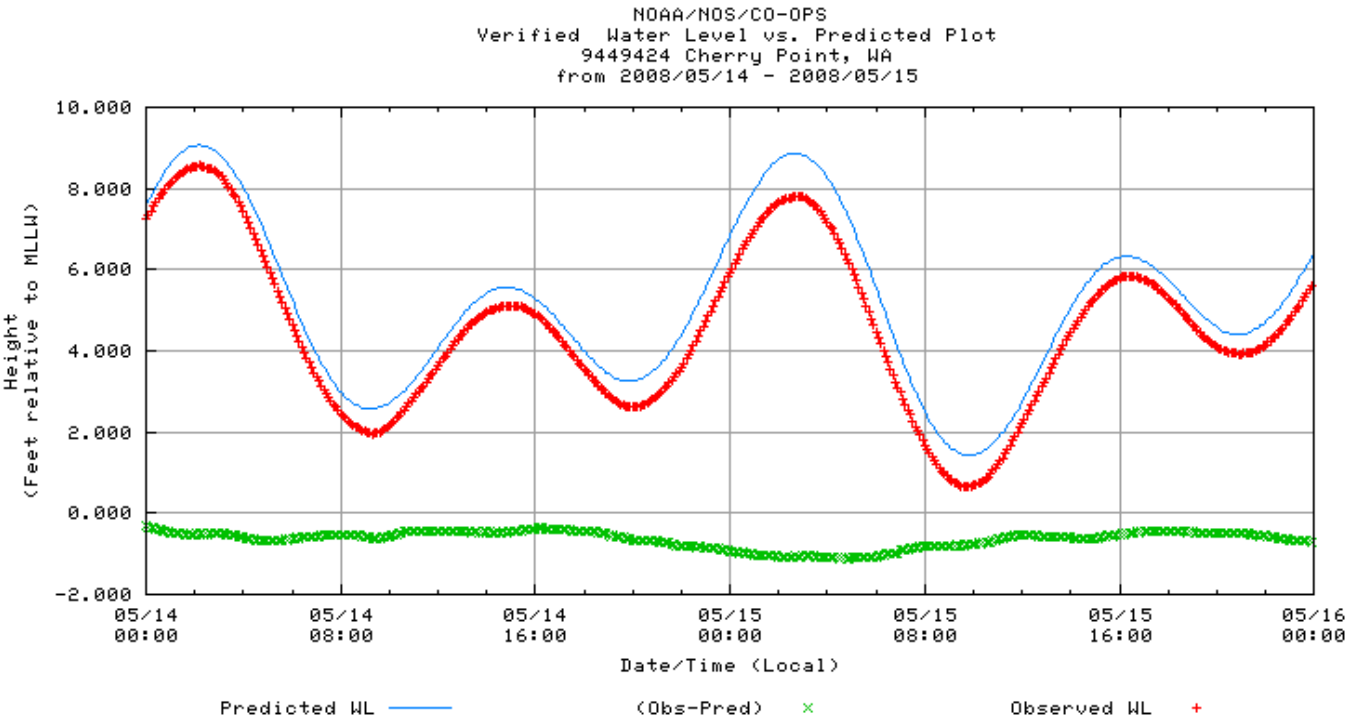
The IBE is discussed in the author's text *The Barometer Handbook* (www.starpath.com/barobook).

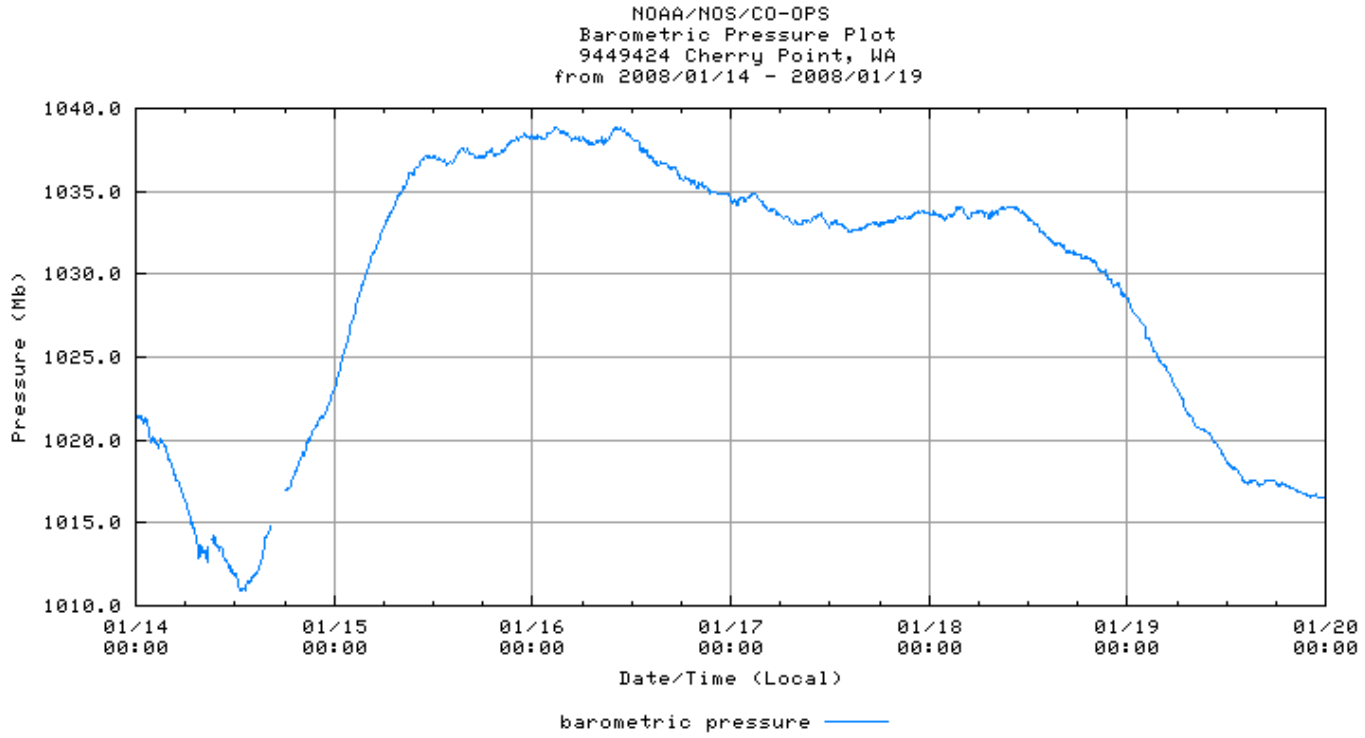
Part I
Pressures Above 1030 mb

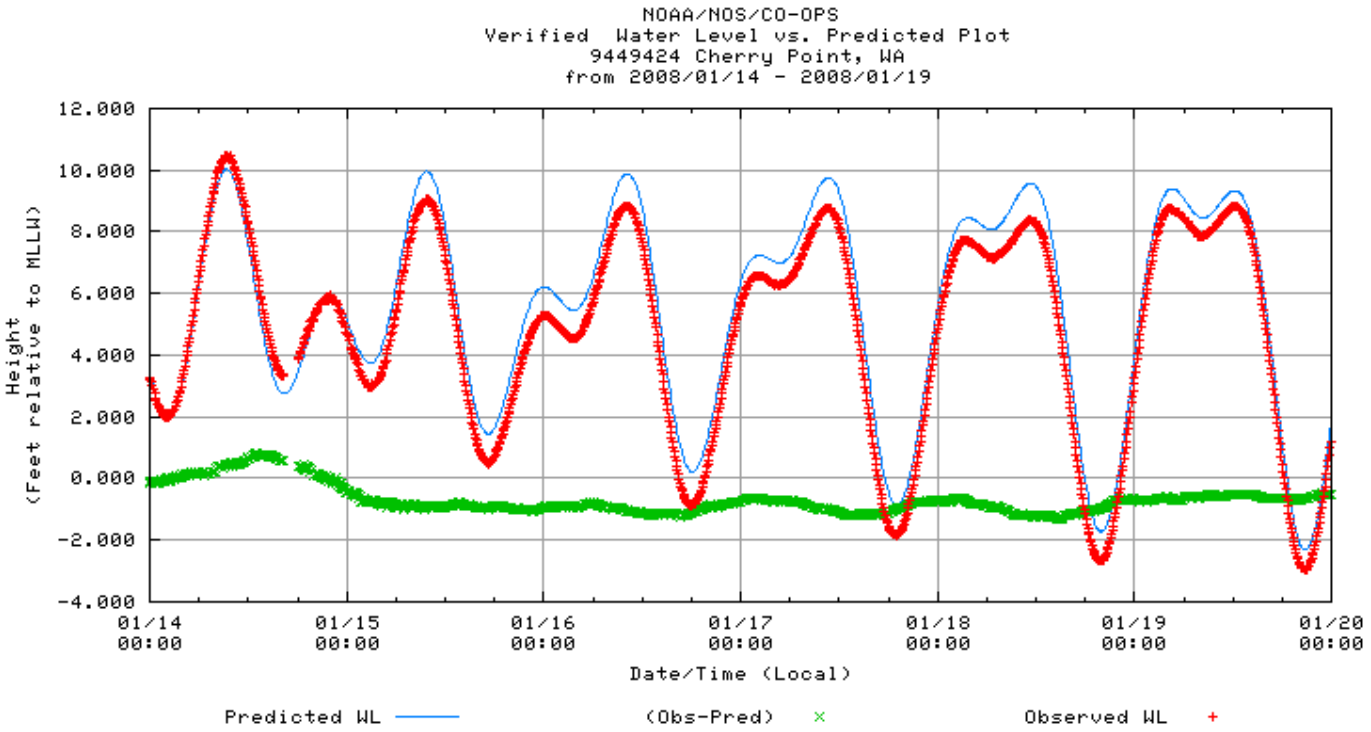

NOAA/NOS/CO-OPS
Barometric Pressure Plot
9449424 Cherry Point, WA
from 2008/10/20 - 2008/10/22
Pressure (Mb)
1040.0
1035.0
1030.0
1025.0
1020.0
1015.0
1010.0
10/20 00:00
10/20 12:00
10/21 00:00
10/21 12:00
10/22 00:00
10/22 12:00
10/23 00:00
Date/Time (GMT)
barometric pressure


NOAA/NOS/CO-OPS
Preliminary Water Level (N1) vs. Predicted Plot
9449424 Cherry Point, WA
from 2008/10/21 - 2008/10/22
Height (Feet relative to MLLW)
10.000
8.000
6.000
4.000
2.000
0.000
-2.000
10/21 00:00
10/21 08:00
10/21 16:00
10/22 00:00
10/22 08:00
10/22 16:00
10/23 00:00
Date/Time (GMT)
Predicted WL
Observed WL
(Obs-Pred)

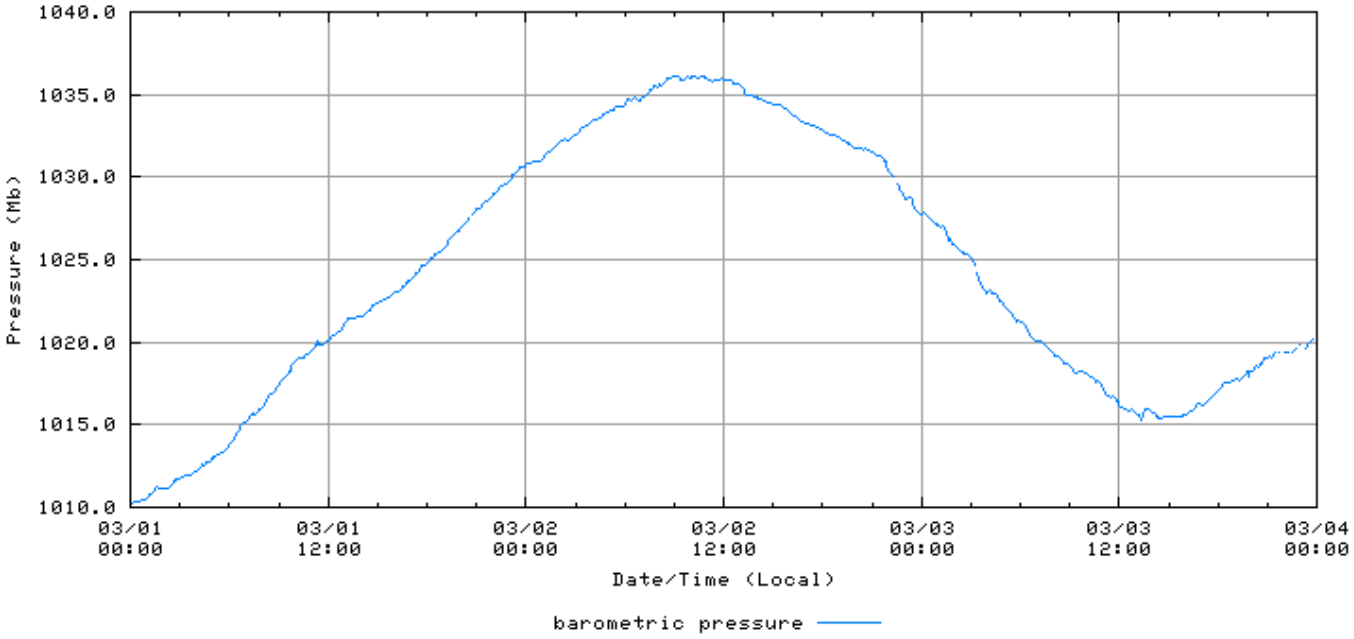

NOAA/NOS/CO-OPS
Barometric Pressure Plot
9449424 Cherry Point, WA
from 2008/05/14 - 2008/05/15
Pressure (Mb)
1034.0
1032.0
1030.0
1028.0
1026.0
1024.0
1022.0
1020.0
05/14 00:00
05/14 08:00
05/14 16:00
05/15 00:00
05/15 08:00
05/15 16:00
05/16 00:00
Date/Time (Local)
barometric pressure


NOAA/NOS/CO-OPS
Verified Water Level vs. Predicted Plot
9449424 Cherry Point, WA
from 2008/05/14 - 2008/05/15
Height (Feet relative to MLLW)
10.000
8.000
6.000
4.000
2.000
0.000
-2.000
05/14 00:00
05/14 08:00
05/14 16:00
05/15 00:00
05/15 08:00
05/15 16:00
05/16 00:00
Date/Time (Local)
Predicted WL
(Obs-Pred)
Observed WL

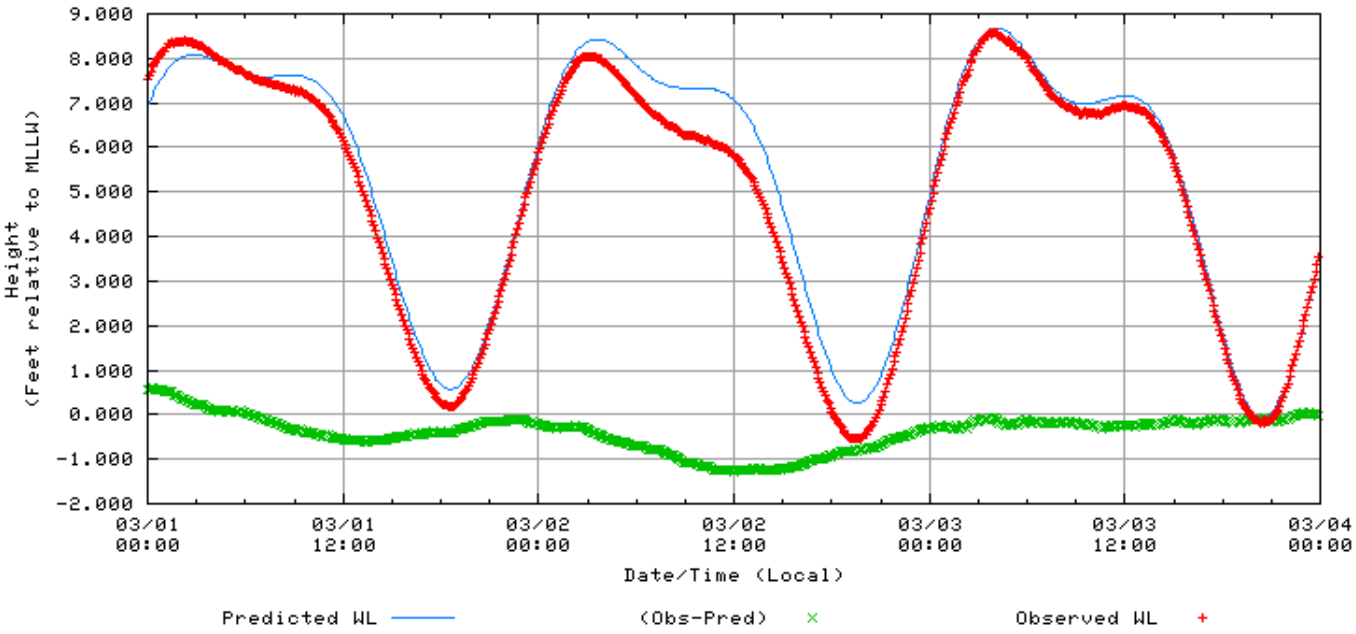

NOAA/NOS/CO-OPS
Barometric Pressure Plot
9449424 Cherry Point, WA
from 2008/01/14 - 2008/01/19
Pressure (Mb)
1040.0
1035.0
1030.0
1025.0
1020.0
1015.0
1010.0
01/14 00:00
01/15 00:00
01/16 00:00
01/17 00:00
01/18 00:00
01/19 00:00
01/20 00:00
Date/Time (Local)
barometric pressure

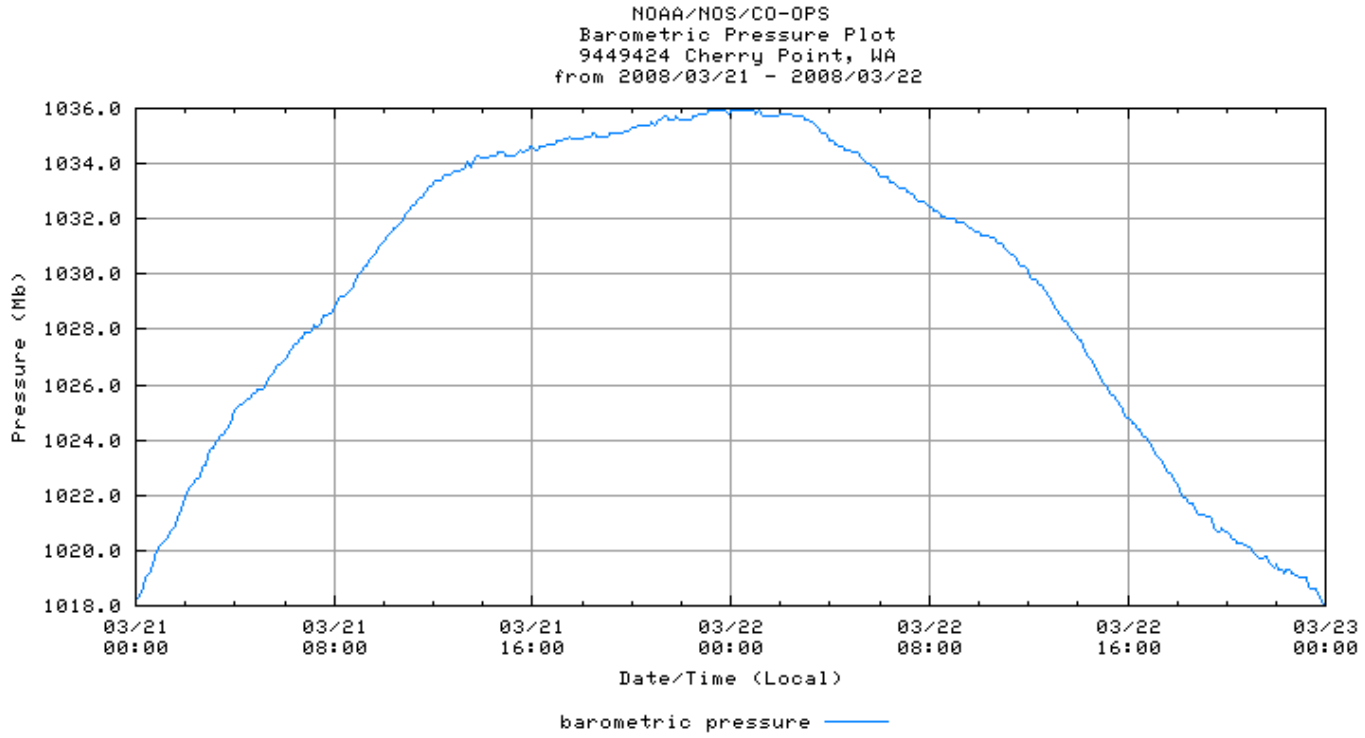

NOAA/NOS/CO-OPS
Verified Water Level vs. Predicted Plot
9449424 Cherry Point, WA
from 2008/01/14 - 2008/01/19
Height (Feet relative to MLLW)
12.000
10.000
8.000
6.000
4.000
2.000
0.000
-2.000
-4.000
01/14 00:00
01/15 00:00
01/16 00:00
01/17 00:00
01/18 00:00
01/19 00:00
01/20 00:00
Date/Time (Local)
Predicted WL
(Obs-Pred)
Observed WL

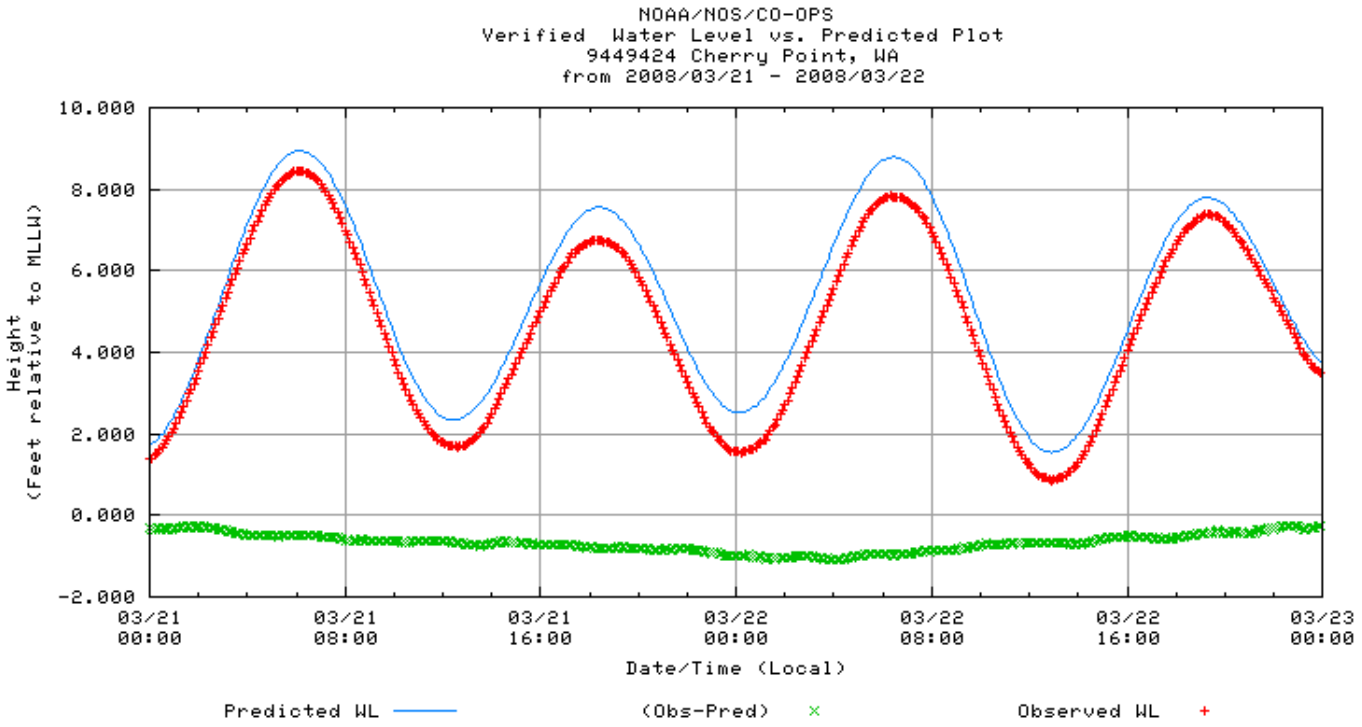
NOAA/NOS/CO-OPS
Barometric Pressure Plot
9449424 Cherry Point, WA
from 2008/03/01 - 2008/03/03

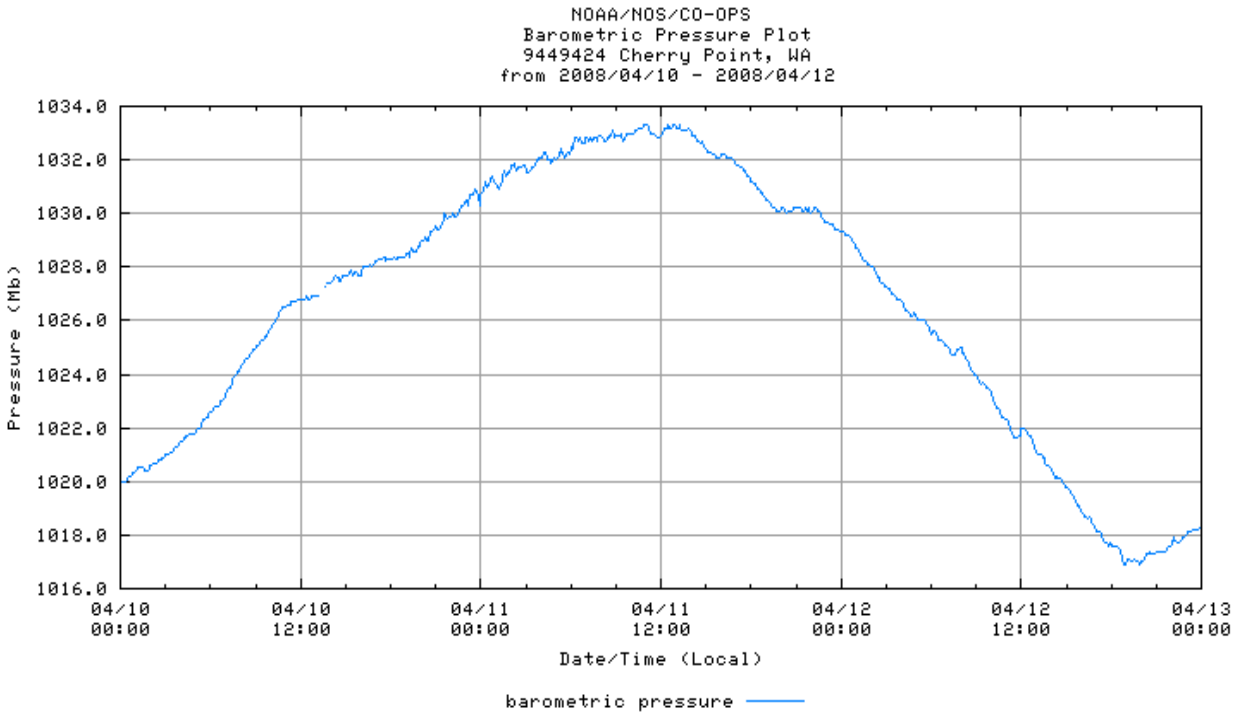


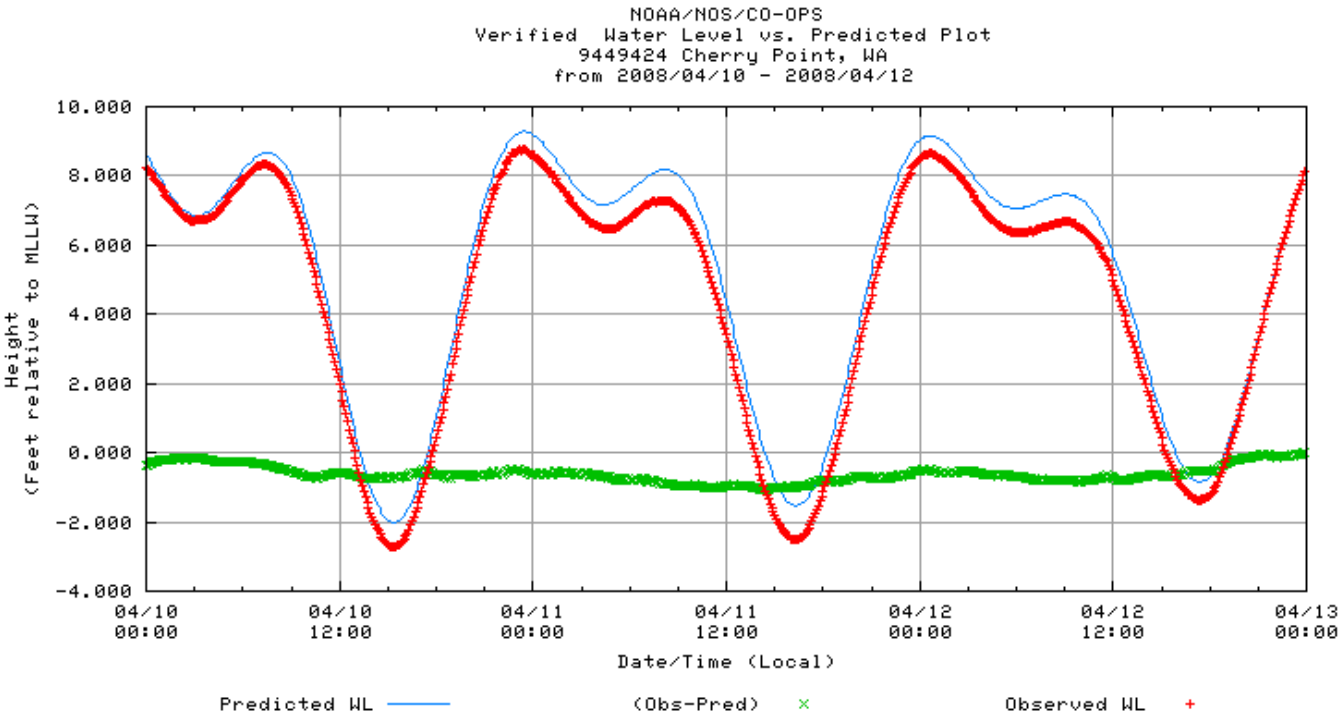
NOAA/NOS/CO-OPS
Verified Water Level vs. Predicted Plot
9449424 Cherry Point, WA
from 2008/03/01 - 2008/03/03

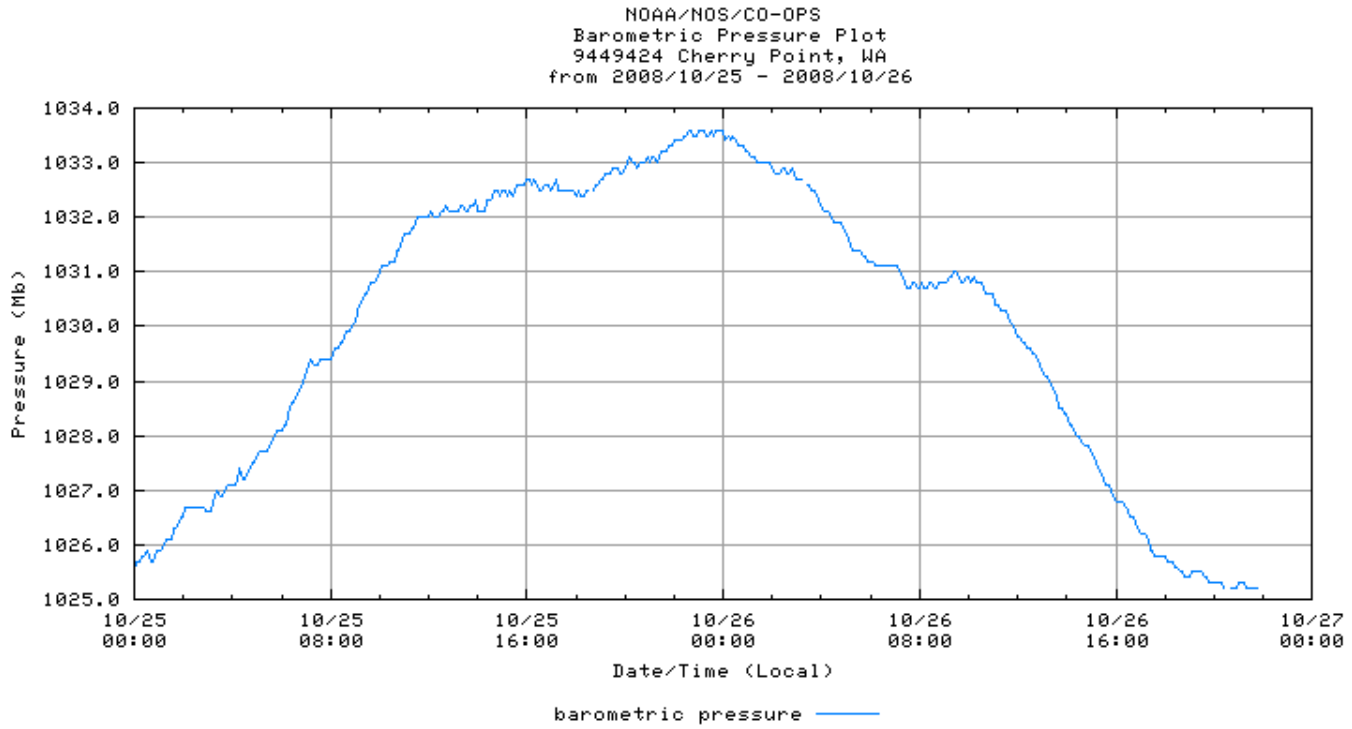


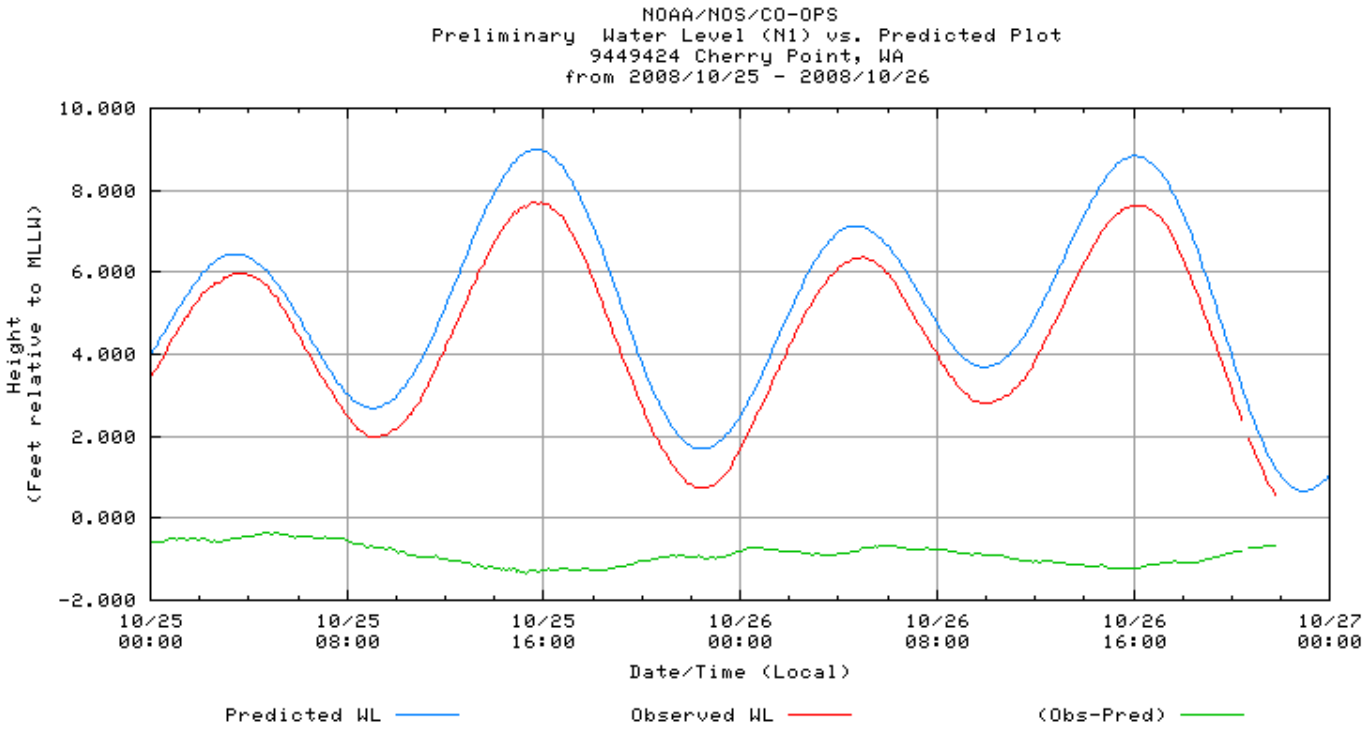

NOAA/NOS/CO-OPS
Barometric Pressure Plot
9449424 Cherry Point, WA
from 2008/03/21 - 2008/03/22
Pressure (Mb)
1036.0
1034.0
1032.0
1030.0
1028.0
1026.0
1024.0
1022.0
1020.0
1018.0
03/21 00:00
03/21 08:00
03/21 16:00
03/22 00:00
03/22 08:00
03/22 16:00
03/23 00:00
Date/Time (Local)
barometric pressure


NOAA/NOS/CO-OPS
Verified Water Level vs. Predicted Plot
9449424 Cherry Point, WA
from 2008/03/21 - 2008/03/22
Height (Feet relative to MLLW)
10.000
8.000
6.000
4.000
2.000
0.000
-2.000
03/21 00:00
03/21 08:00
03/21 16:00
03/22 00:00
03/22 08:00
03/22 16:00
03/23 00:00
Date/Time (Local)
Predicted WL
(Obs-Pred)
Observed WL


NOAA/NOS/CO-OPS
Barometric Pressure Plot
9449424 Cherry Point, WA
from 2008/04/10 - 2008/04/12
Pressure (Mb)
1034.0
1032.0
1030.0
1028.0
1026.0
1024.0
1022.0
1020.0
1018.0
1016.0
04/10 00:00
04/10 12:00
04/11 00:00
04/11 12:00
04/12 00:00
04/12 12:00
04/13 00:00
Date/Time (Local)
barometric pressure

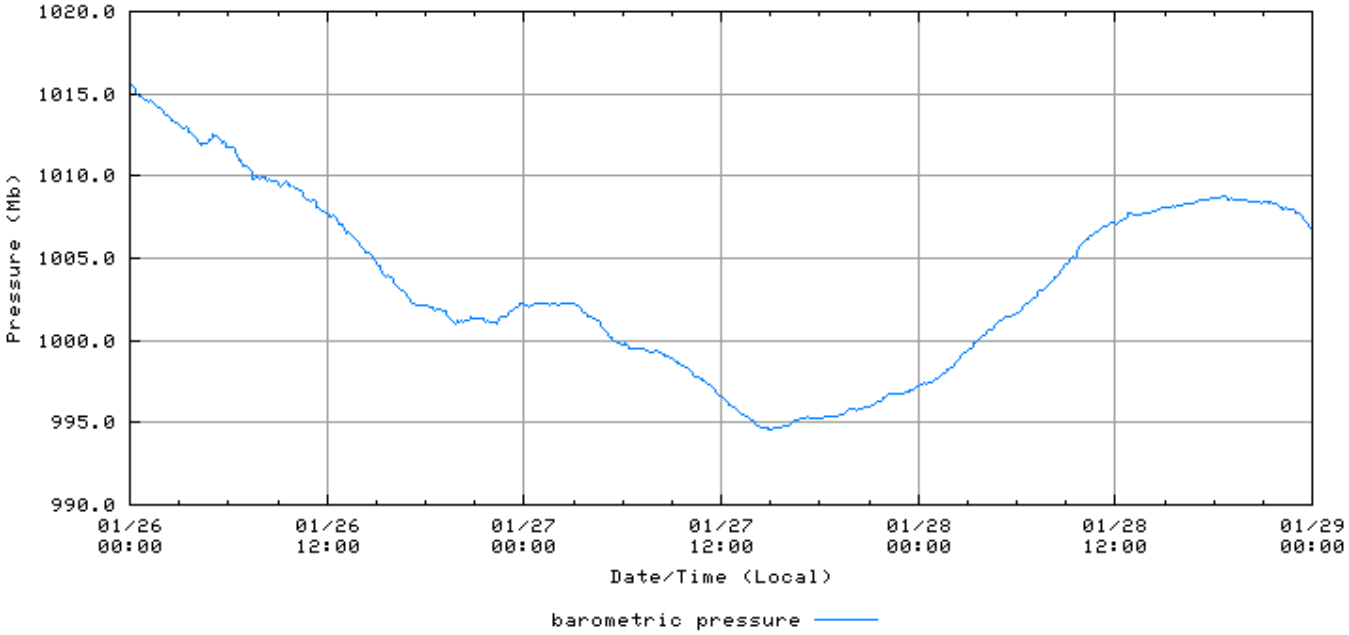

NOAA/NOS/CO-OPS
Verified Water Level vs. Predicted Plot
9449424 Cherry Point, WA
from 2008/04/10 - 2008/04/12
Height (Feet relative to MLLW)
10.000
8.000
6.000
4.000
2.000
0.000
-2.000
-4.000
04/10 00:00
04/10 12:00
04/11 00:00
04/11 12:00
04/12 00:00
04/12 12:00
04/13 00:00
Date/Time (Local)
Predicted WL
(Obs-Pred)
Observed WL


NOAA/NOS/CO-OPS
Barometric Pressure Plot
9449424 Cherry Point, WA
from 2008/10/25 - 2008/10/26
Pressure (Mb)
1034.0
1033.0
1032.0
1031.0
1030.0
1029.0
1028.0
1027.0
1026.0
1025.0
10/25 00:00
10/25 08:00
10/25 16:00
10/26 00:00
10/26 08:00
10/26 16:00
10/27 00:00
Date/Time (Local)
barometric pressure

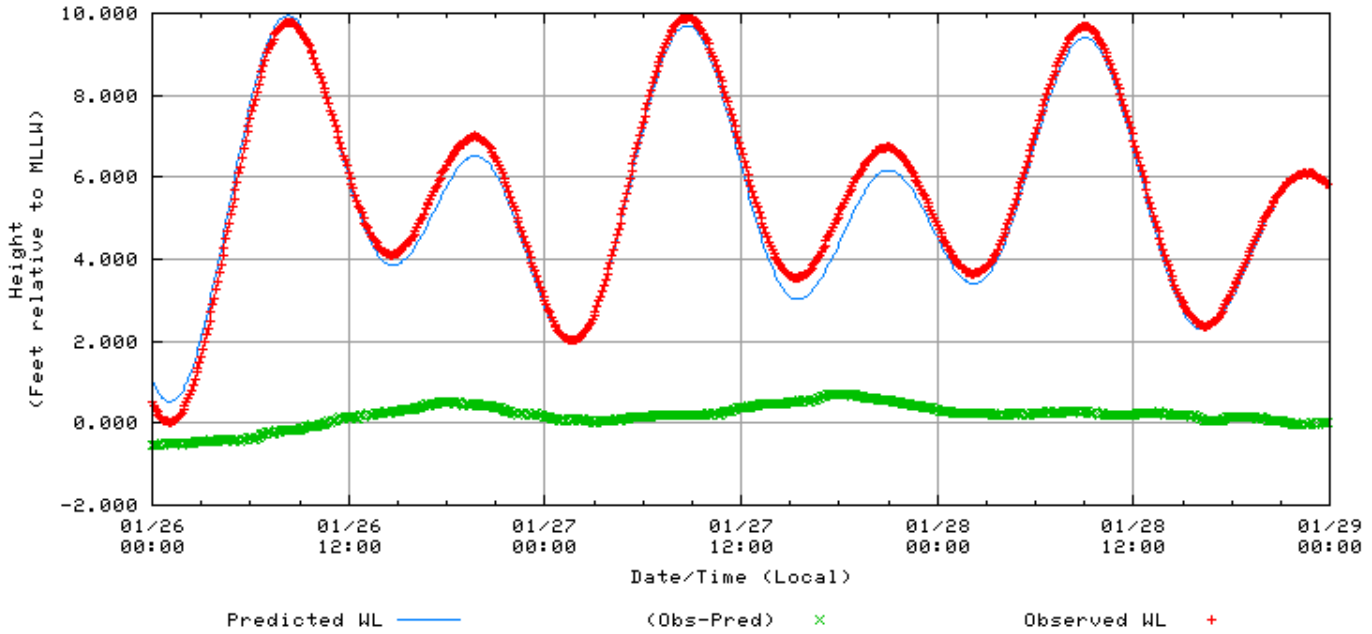

NOAA/NOS/CO-OPS
Preliminary Water Level (N1) vs. Predicted Plot
9449424 Cherry Point, WA
from 2008/10/25 - 2008/10/26
Height (Feet relative to MLLW)
10.000
8.000
6.000
4.000
2.000
0.000
-2.000
10/25 00:00
10/25 08:00
10/25 16:00
10/26 00:00
10/26 08:00
10/26 16:00
10/27 00:00
Date/Time (Local)
Predicted WL
Observed WL
(Obs-Pred)

Part II
Pressures Below 1004 mb

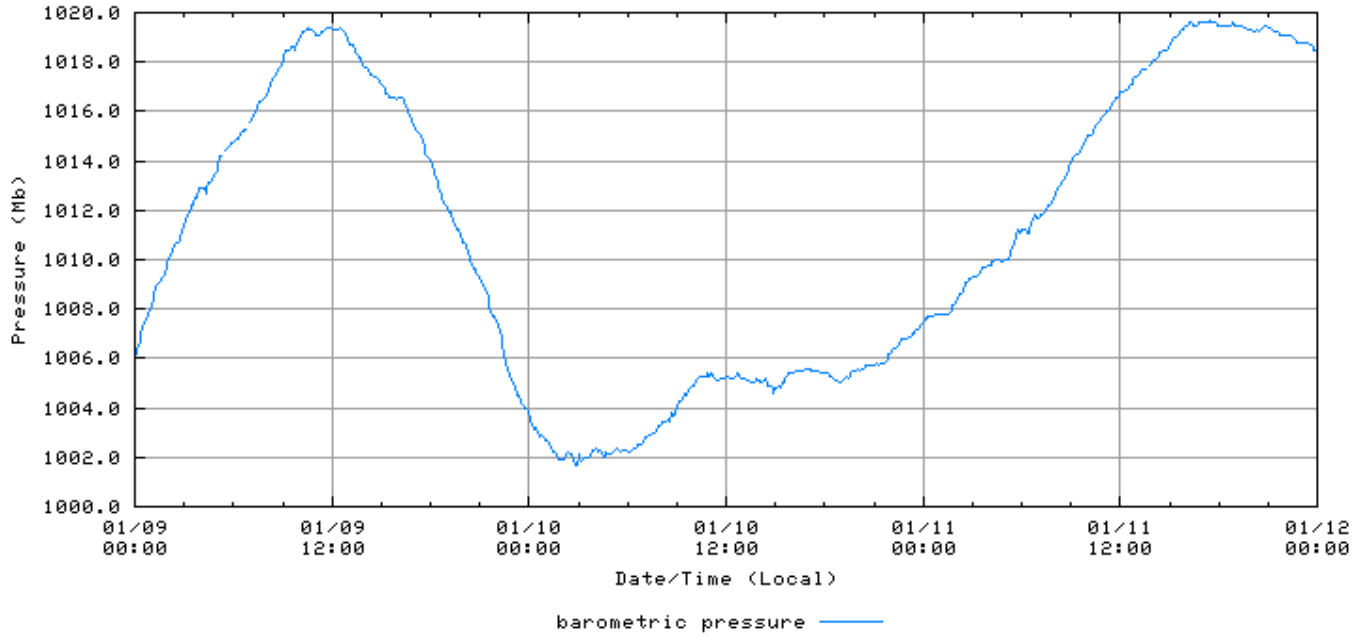
NOAA/NOS/CO-OPS
Barometric Pressure Plot
9449424 Cherry Point, WA
from 2008/01/26 - 2008/01/28



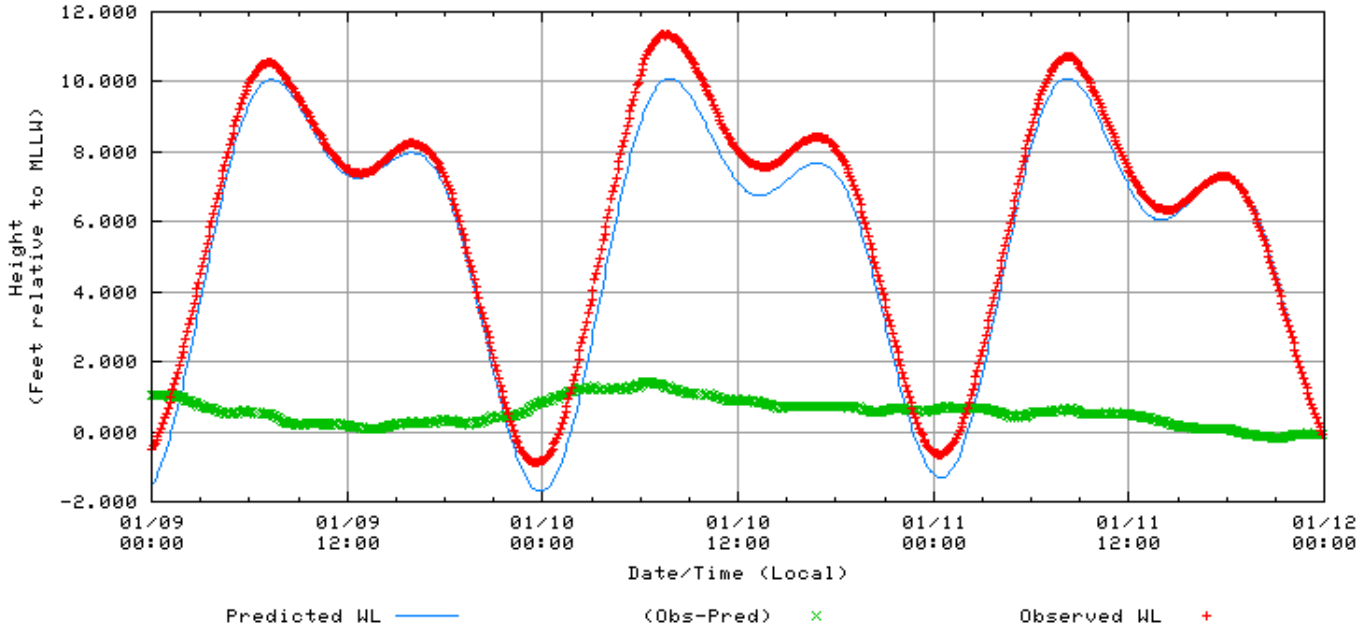
NOAA/NOS/CO-OPS
Verified Water Level vs. Predicted Plot
9449424 Cherry Point, WA
from 2008/01/26 - 2008/01/28



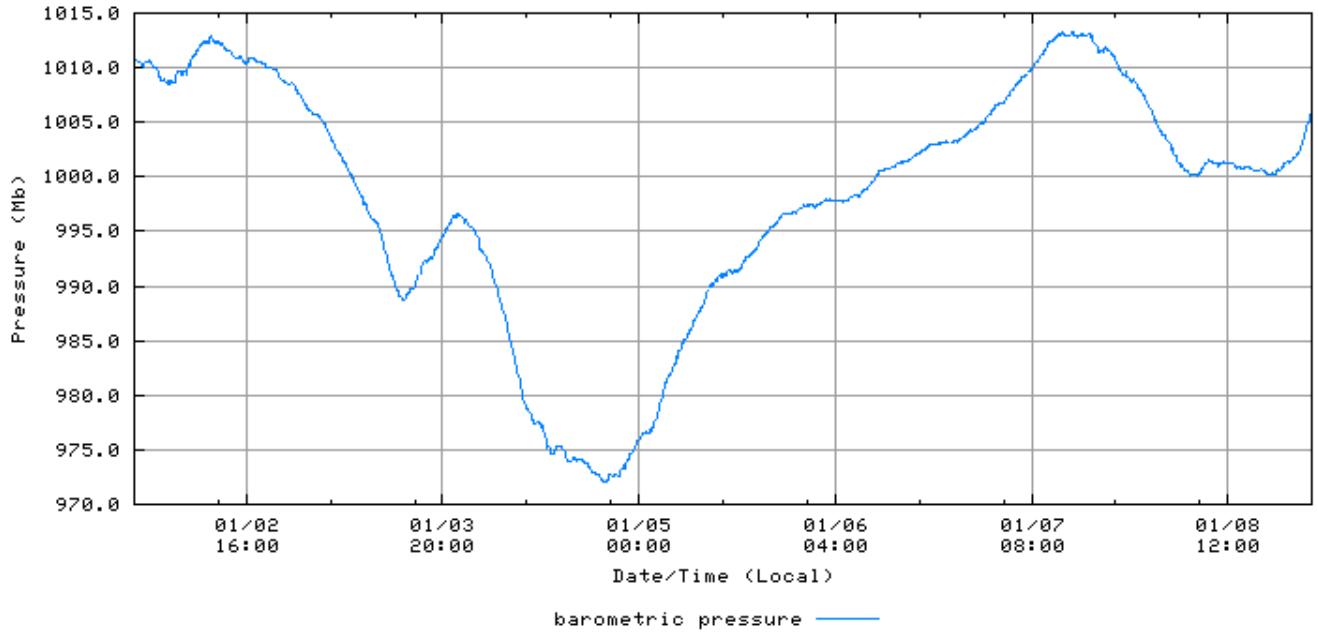
NOAA/NOS/CO-OPS
Barometric Pressure Plot
9449424 Cherry Point, WA
from 2008/01/09 - 2008/01/11



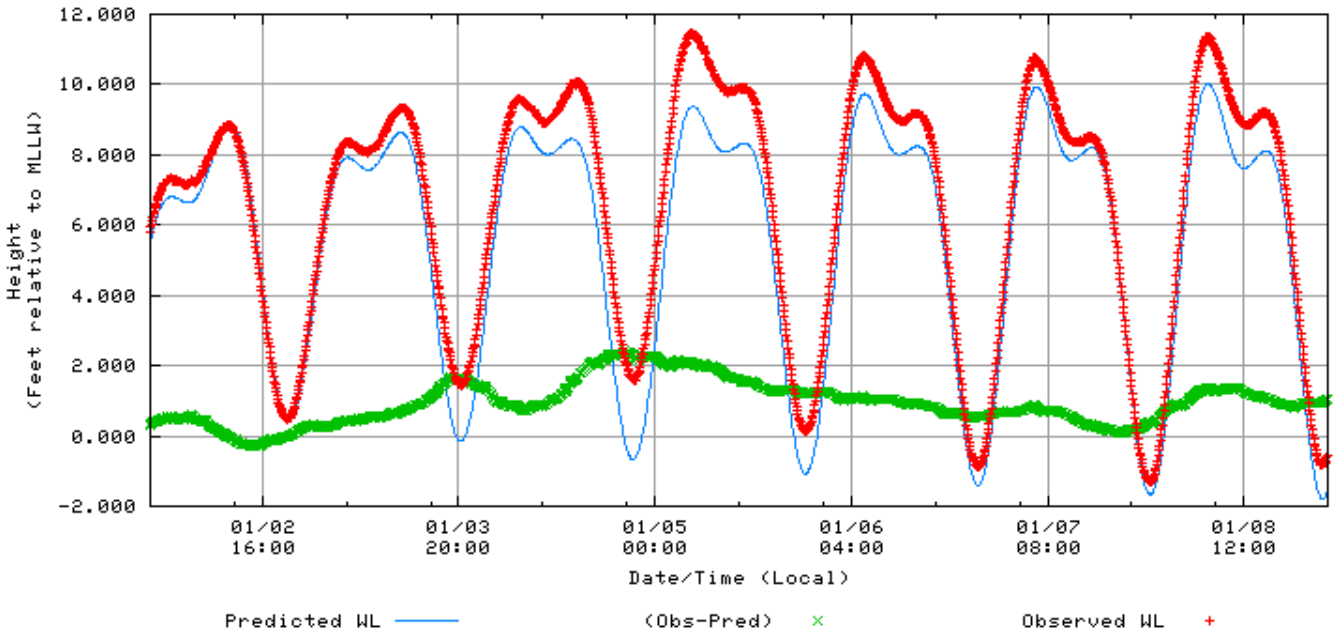
NOAA/NOS/CO-OPS
Verified Water Level vs. Predicted Plot
9449424 Cherry Point, WA
from 2008/01/09 - 2008/01/11



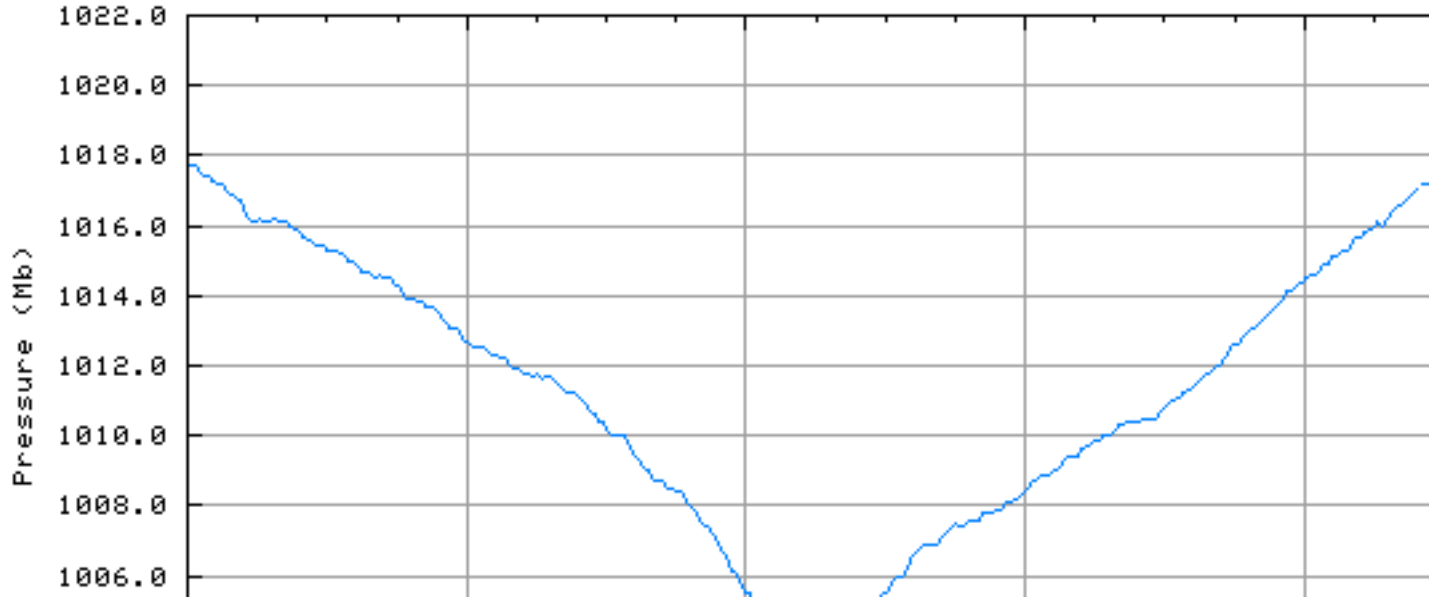
NOAA/NOS/CO-OPS
Barometric Pressure Plot
9449424 Cherry Point, WA
from 2008/01/02 - 2008/01/08



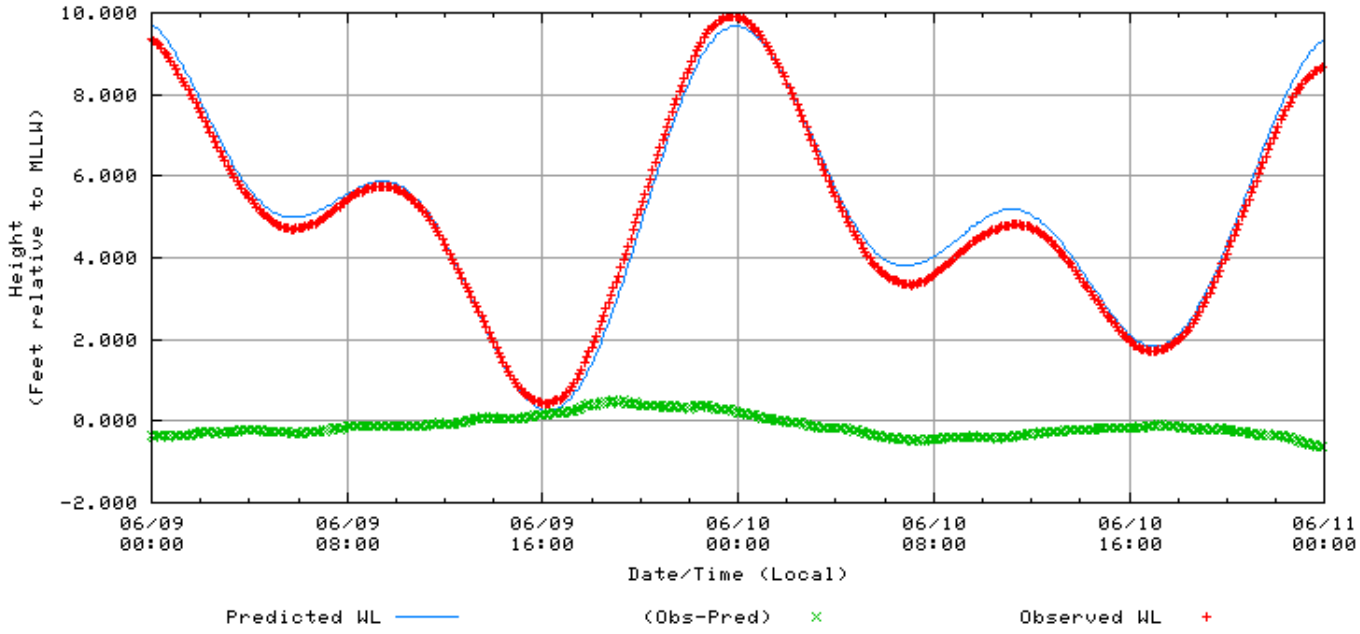
NOAA/NOS/CO-OPS
Verified Water Level vs. Predicted Plot
9449424 Cherry Point, WA
from 2008/01/02 - 2008/01/08

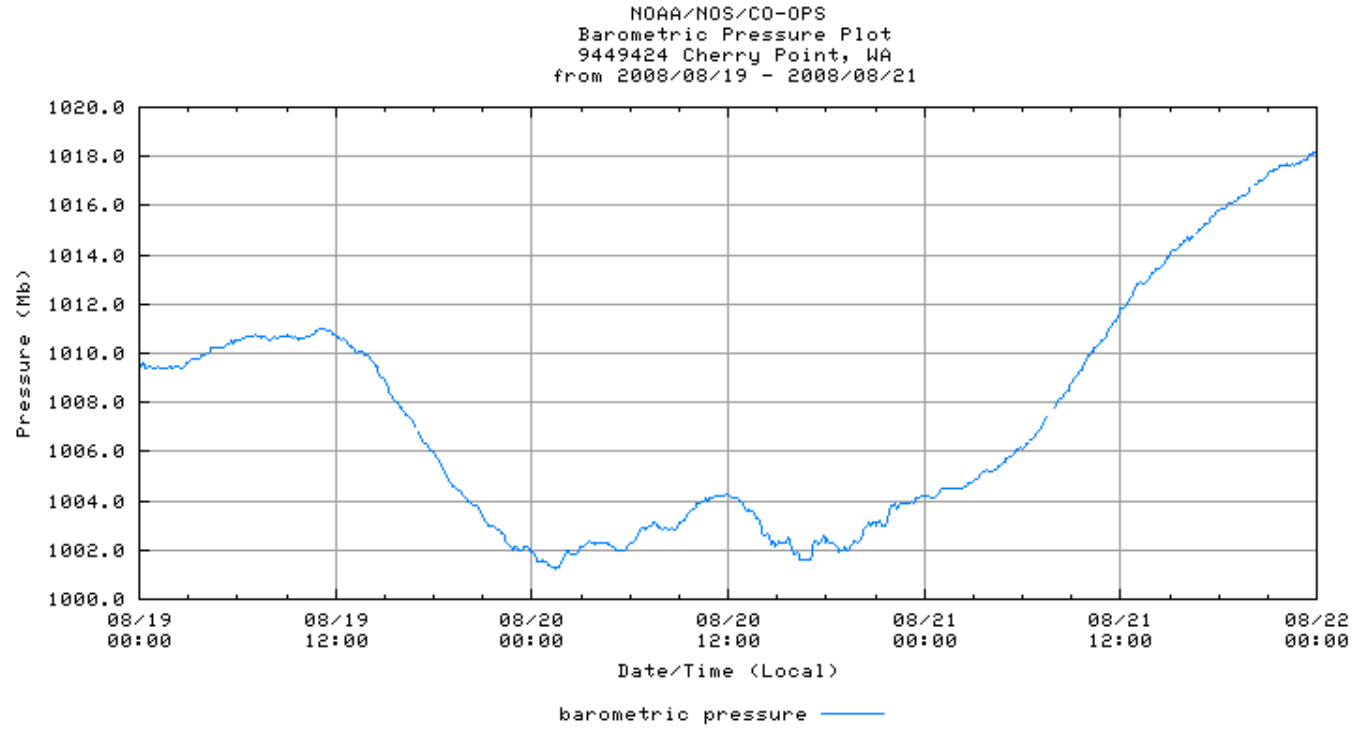


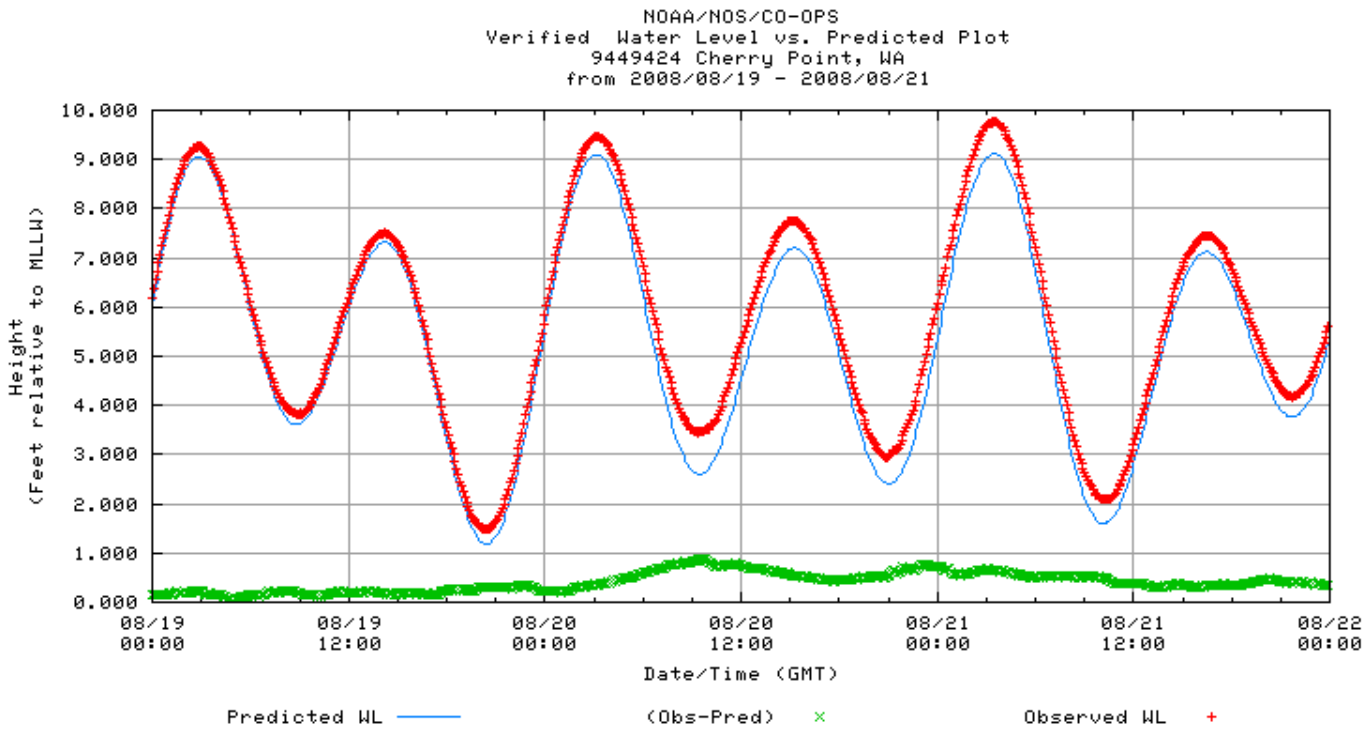
NOAA/NOS/CO-OPS
Barometric Pressure Plot
9449424 Cherry Point, WA
from 2008/06/09 - 2008/06/10

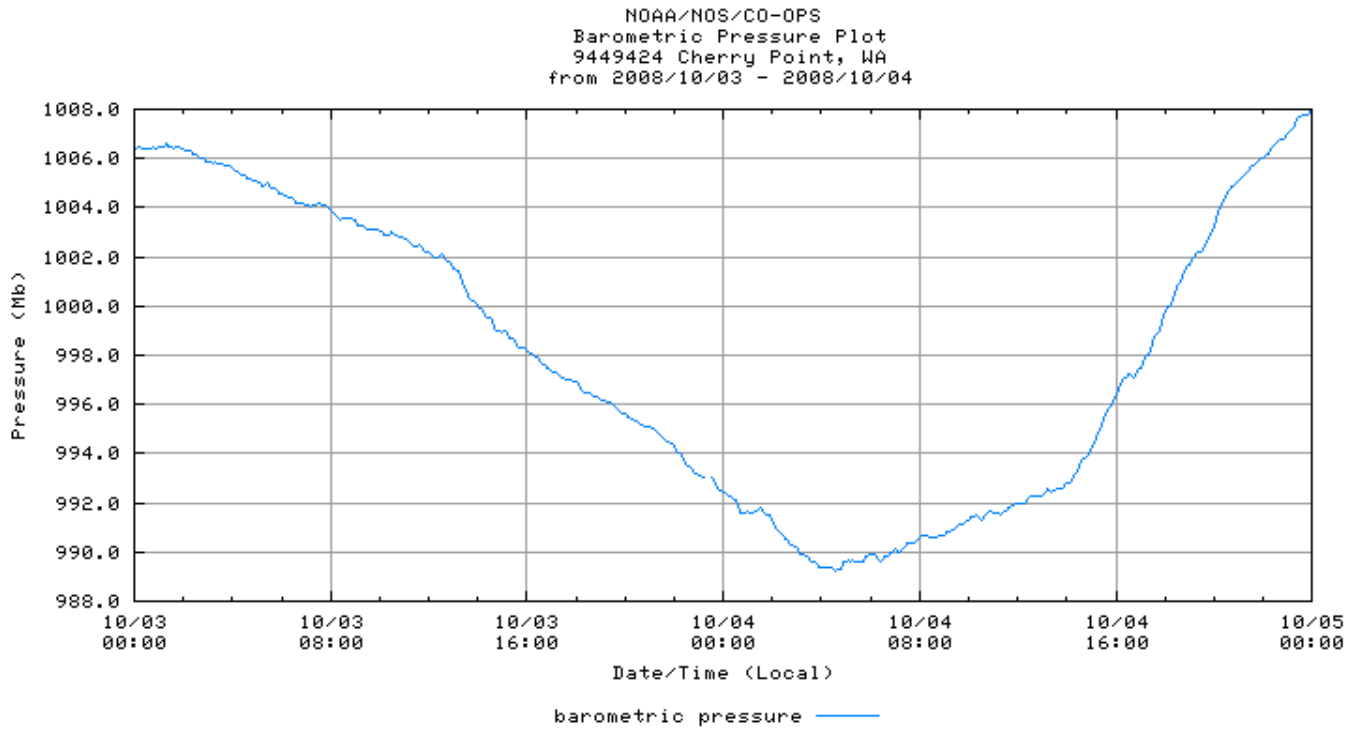


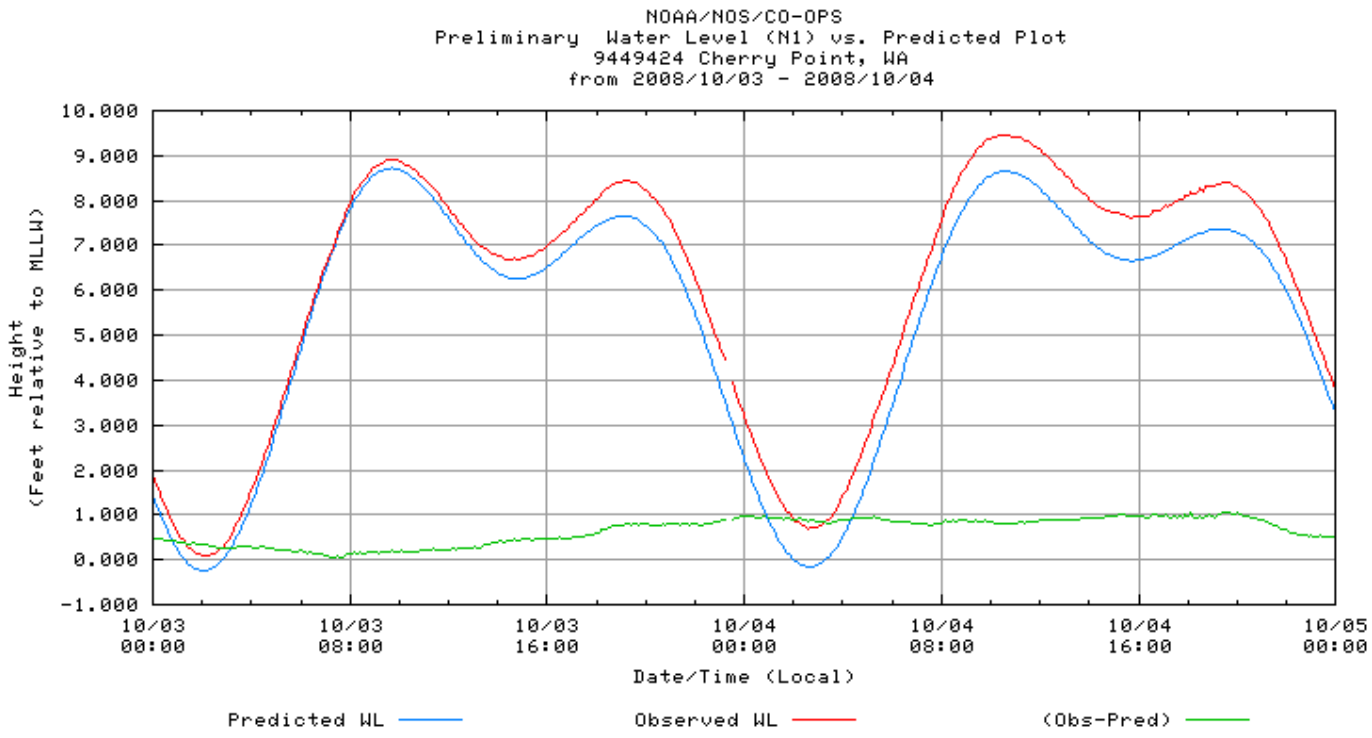
NOAA/NOS/CO-OPS
Verified Water Level vs. Predicted Plot
9449424 Cherry Point, WA
from 2008/06/09 - 2008/06/10




NOAA/NOS/CO-OPS
Barometric Pressure Plot
9449424 Cherry Point, WA
from 2008/08/19 - 2008/08/21
Pressure (Mb)
1020.0
1018.0
1016.0
1014.0
1012.0
1010.0
1008.0
1006.0
1004.0
1002.0
1000.0
08/19 00:00
08/19 12:00
08/20 00:00
08/20 12:00
08/21 00:00
08/21 12:00
08/22 00:00
Date/Time (Local)
barometric pressure


NOAA/NOS/CO-OPS
Verified Water Level vs. Predicted Plot
9449424 Cherry Point, WA
from 2008/08/19 - 2008/08/21
Height (Feet relative to MLLW)
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
08/19 00:00
08/19 12:00
08/20 00:00
08/20 12:00
08/21 00:00
08/21 12:00
08/22 00:00
Date/Time (GMT)
Predicted WL
(Obs-Pred)
Observed WL


NOAA/NOS/CO-OPS
Barometric Pressure Plot
9449424 Cherry Point, WA
from 2008/10/03 - 2008/10/04
Pressure (Mb)
1008.0
1006.0
1004.0
1002.0
1000.0
998.0
996.0
994.0
992.0
990.0
988.0
10/03 00:00
10/03 08:00
10/03 16:00
10/04 00:00
10/04 08:00
10/04 16:00
10/05 00:00
Date/Time (Local)
barometric pressure


NOAA/NOS/CO-OPS
Preliminary Water Level (N1) vs. Predicted Plot
9449424 Cherry Point, WA
from 2008/10/03 - 2008/10/04
Height (Feet relative to MLLW)
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
-1.000
10/03 00:00
10/03 08:00
10/03 16:00
10/04 00:00
10/04 08:00
10/04 16:00
10/05 00:00
Date/Time (Local)
Predicted WL
Observed WL
(Obs-Pred)