Gardline Group

VORF Validation

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HYDROGRAPHY and MARINE SPATIAL DATA INFRASTRUCTURE

Bradfield College - 27 October 2009

VORF Validation

- Opening remarks.
- Validation trial.
- Examples illustrating benefit of VORF.

- Update on the validation process.
- Future plans for VORF.

VORF Validation

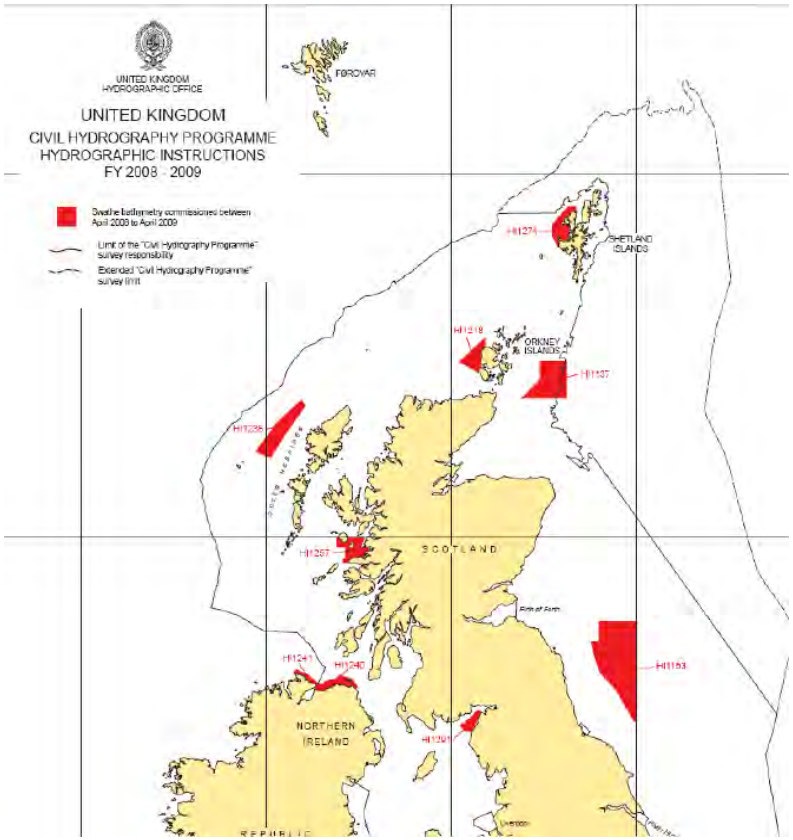
Software Testing

- Verification - does it do what we want?
- Validation - does it give the correct answer?

Validation Methods

- Discussions started in late 2007.
- Different strategies considered.
  - Deployment of GPS buoys with tide gauge.
  - Locate GPS and tide gauge on offshore platforms.
  - Re-visit previous gauge locations and acquire GPS data.
  - Deploy tide gauge and log small GPS dataset.

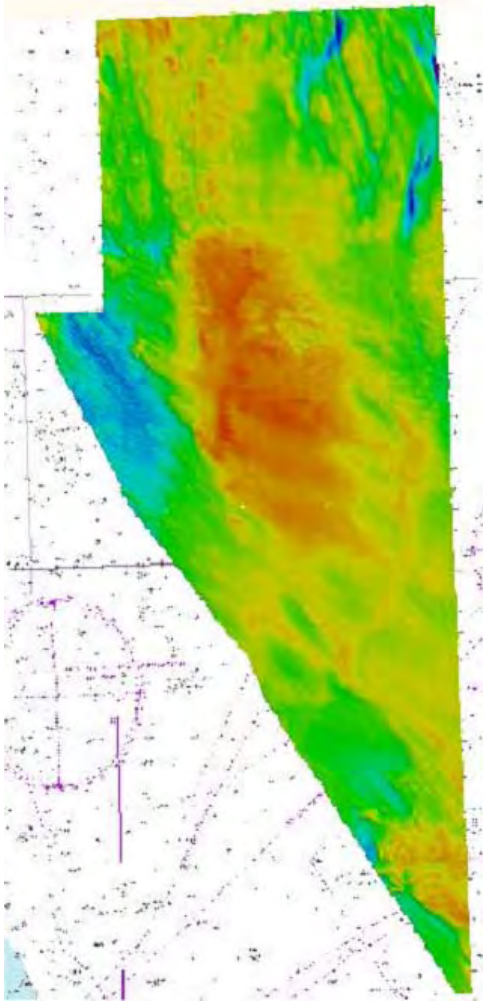
Civil Hydrography Program



- Tridens1 engaged on CHP survey – HI 1153
- Cost effective trial

Methodology

- Ensure gauge synchronized to GPS time.
- Deploy tide gauge for 2 months.
- Ensure vessel can record water level height above ellipsoid to 5cm.
- Record GPS data for period of 8 hours which spans one high and one low water.



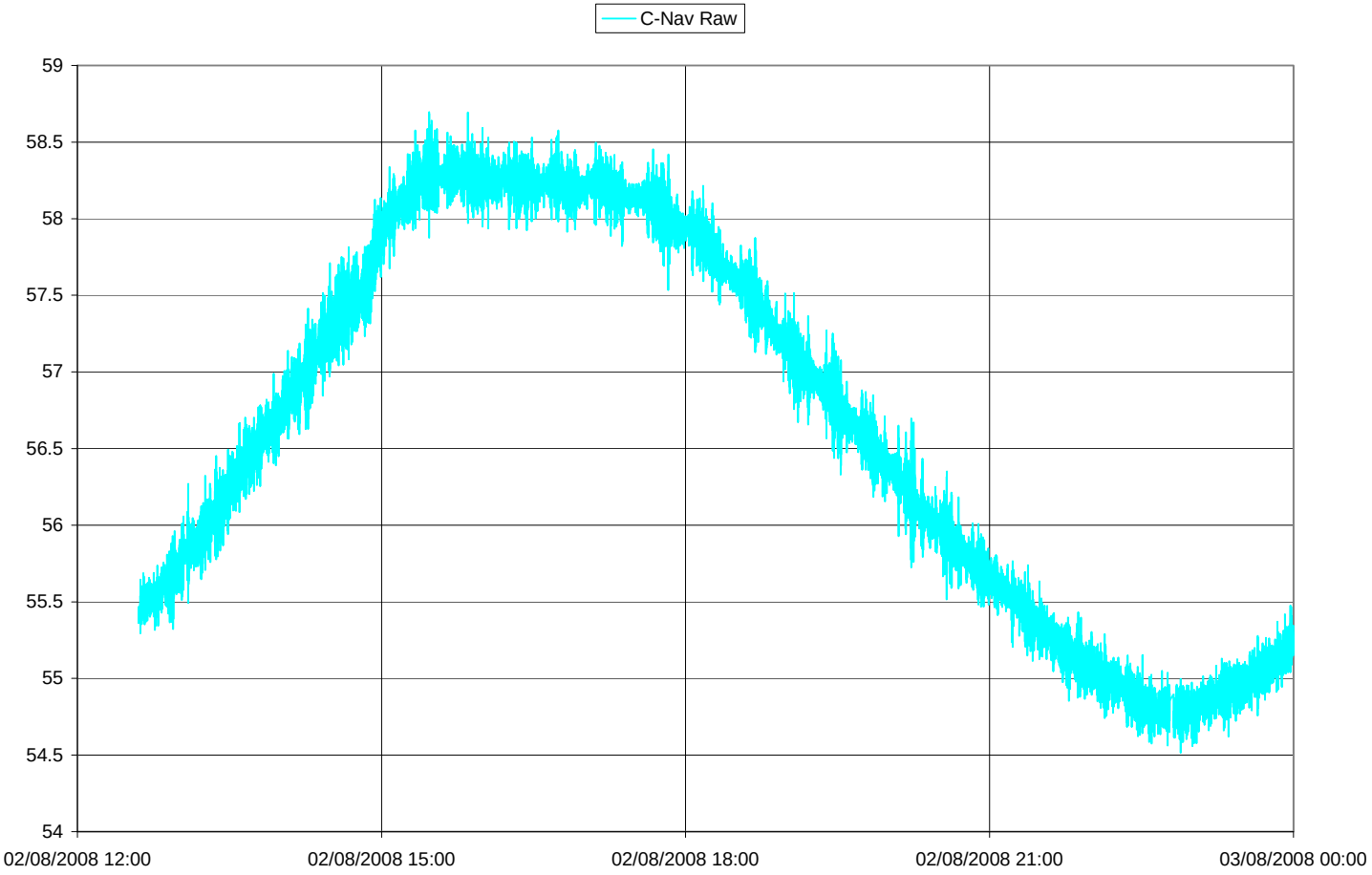
Data Recording

- Tidal data : Seabed Anderra WLR.
  - Two months deployment, 10 minute sample rate.
- Dual-frequency GPS data : C-Nav 2050 receiver.
- Real-time GcGPS solution : C-Nav PPP solution.
- Multibeam Bathymetry : Kongsberg EM710 (1x1).
- Motion sensor data : Seapath 200, Heave,Pitch,Roll

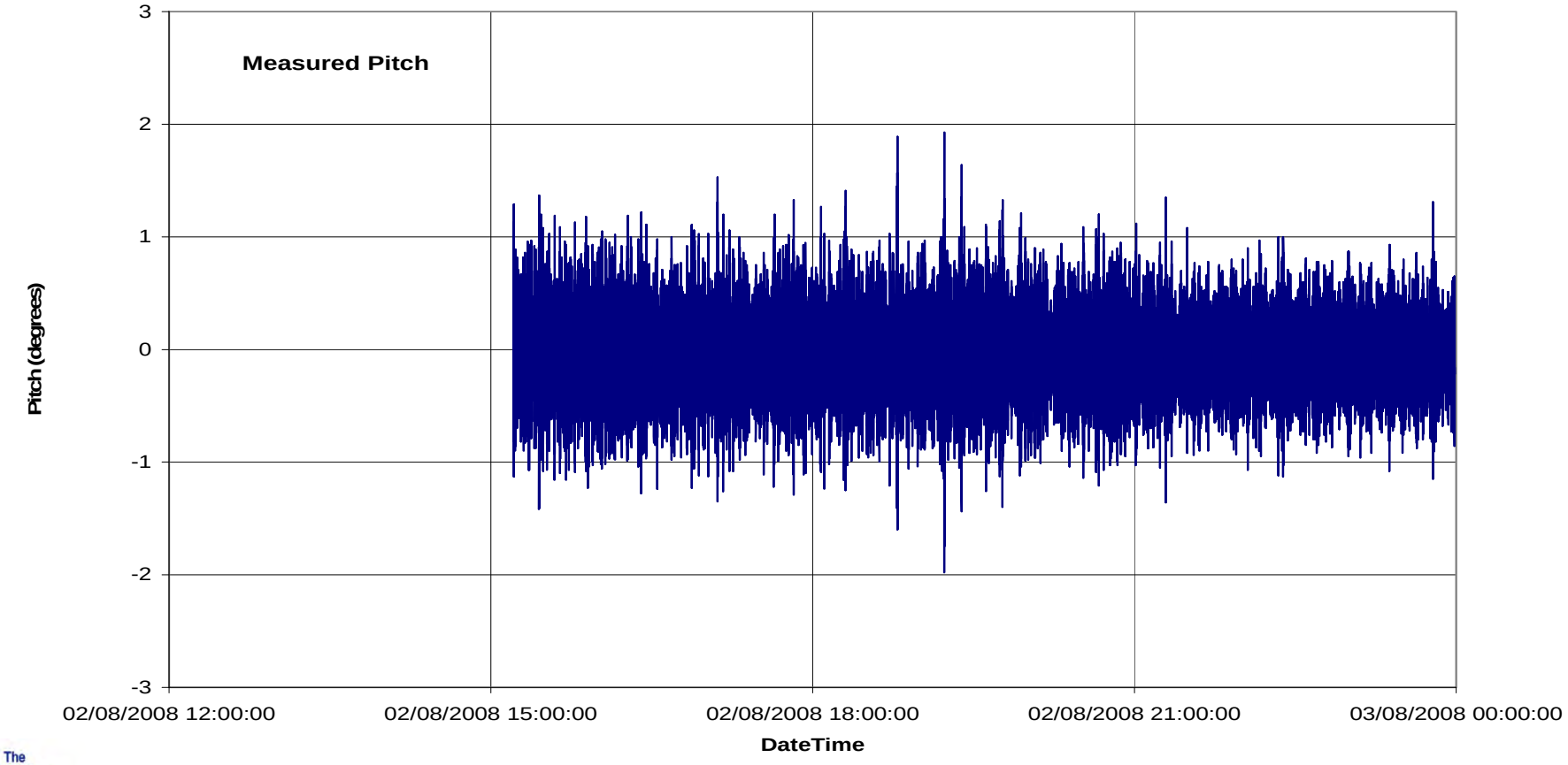
GPS Processing

- Two solutions, real-time and post-processed.
- Precise Point Positioning (PPP) technique.
- Precise orbit and clock parameters.
  - Real-time C-Nav solution.
  - Post-processed using TerraPos software.
- Both solutions reported in ITRF 2005 reference frame.

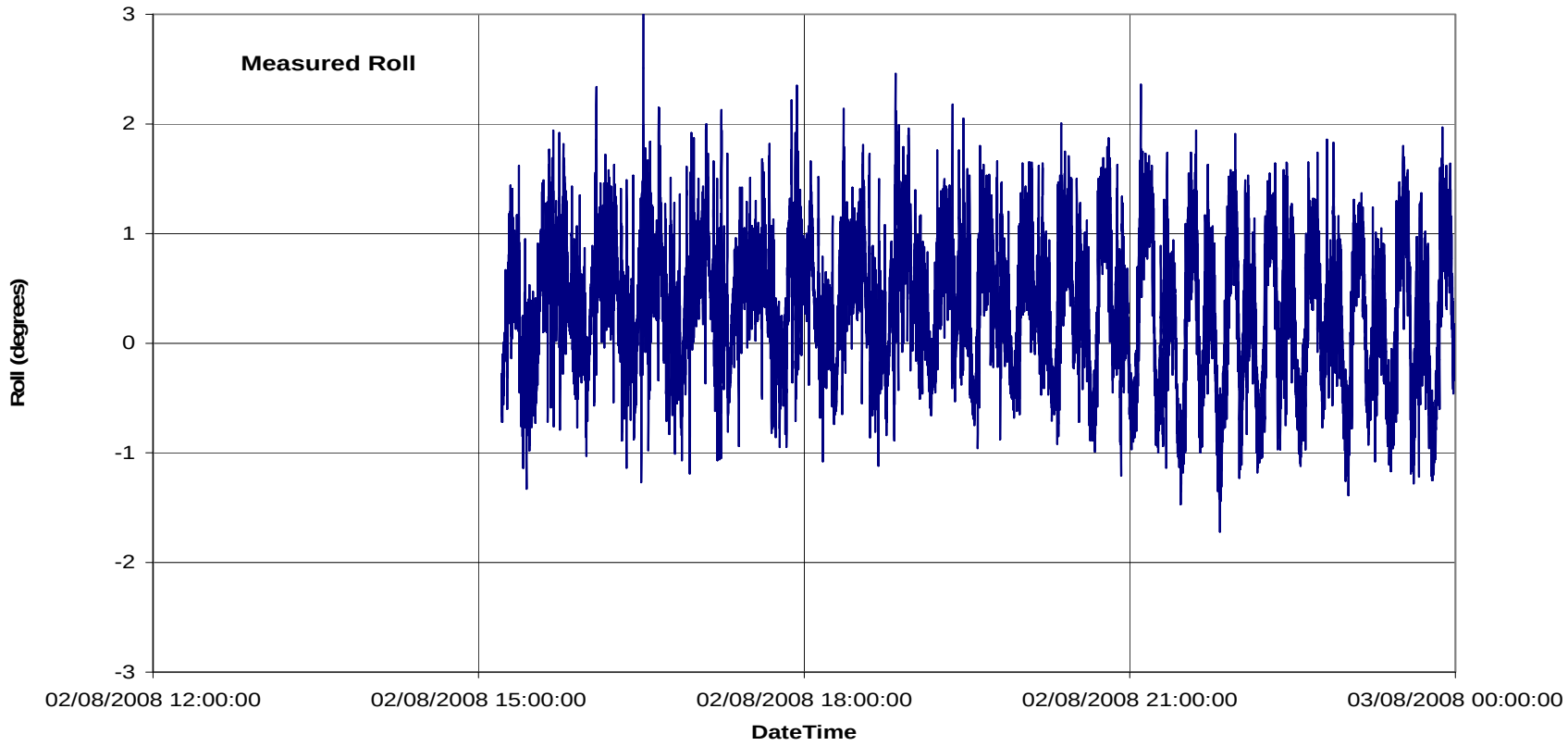
- C-Nav elevations referred to GRS-80 ellipsoid - Raw



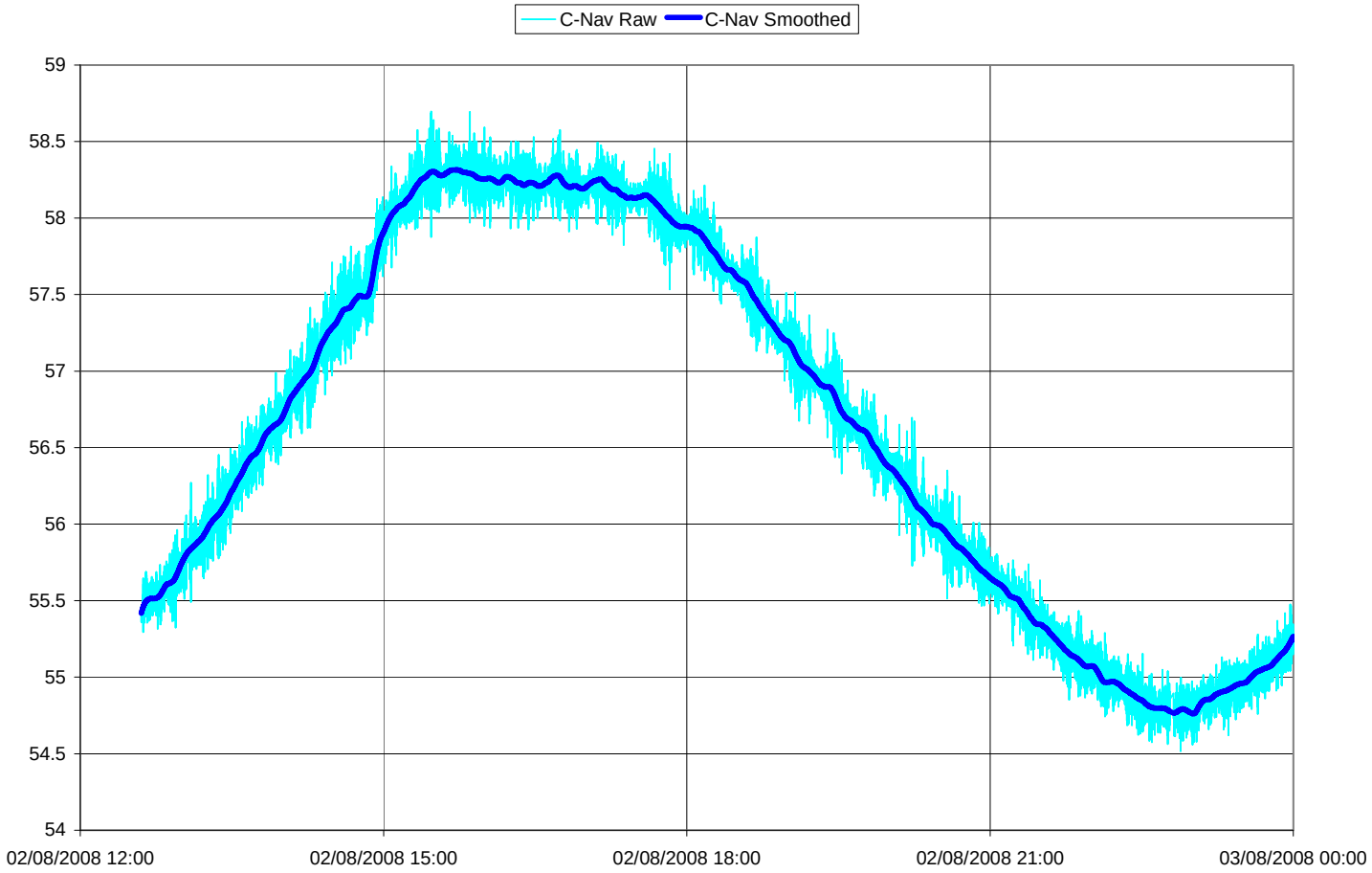
Measured Pitch : Mean Bias -0.03



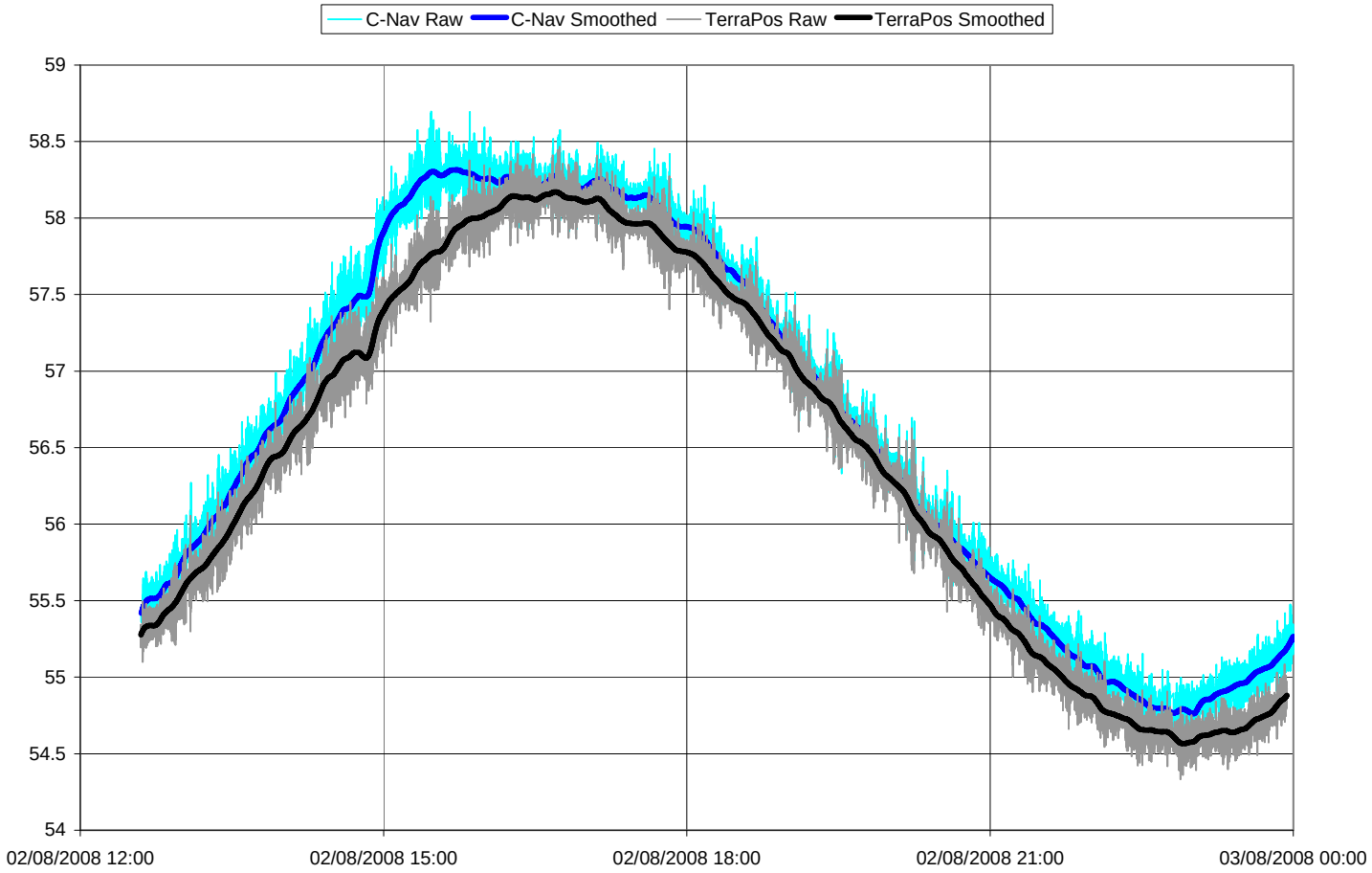
Measured Roll : Mean Bias +0.34



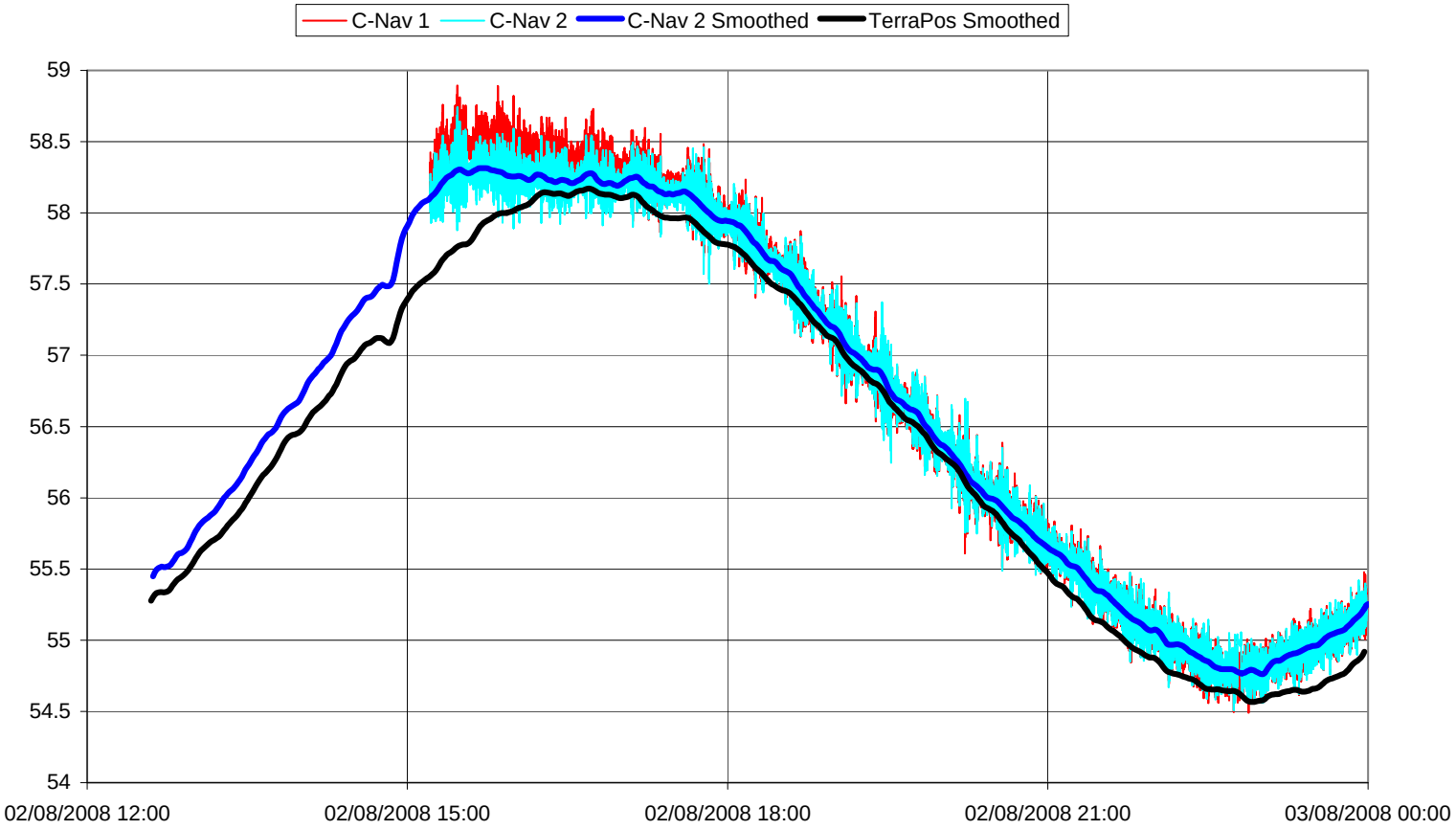
- C-Nav elevations referred to GRS-80 ellipsoid - Smoothed



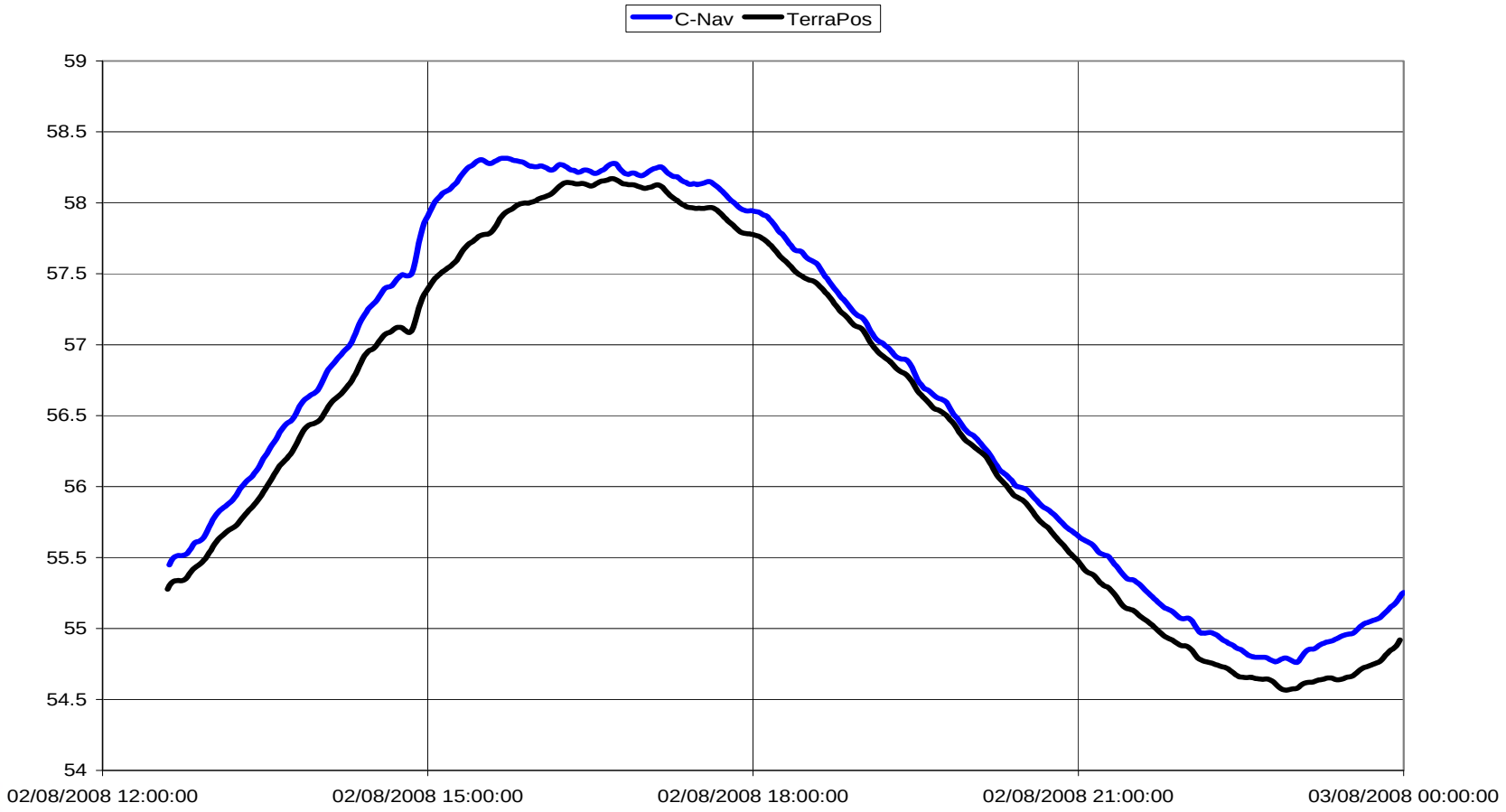
- TerraPos elevations referred to GRS-80 ellipsoid.



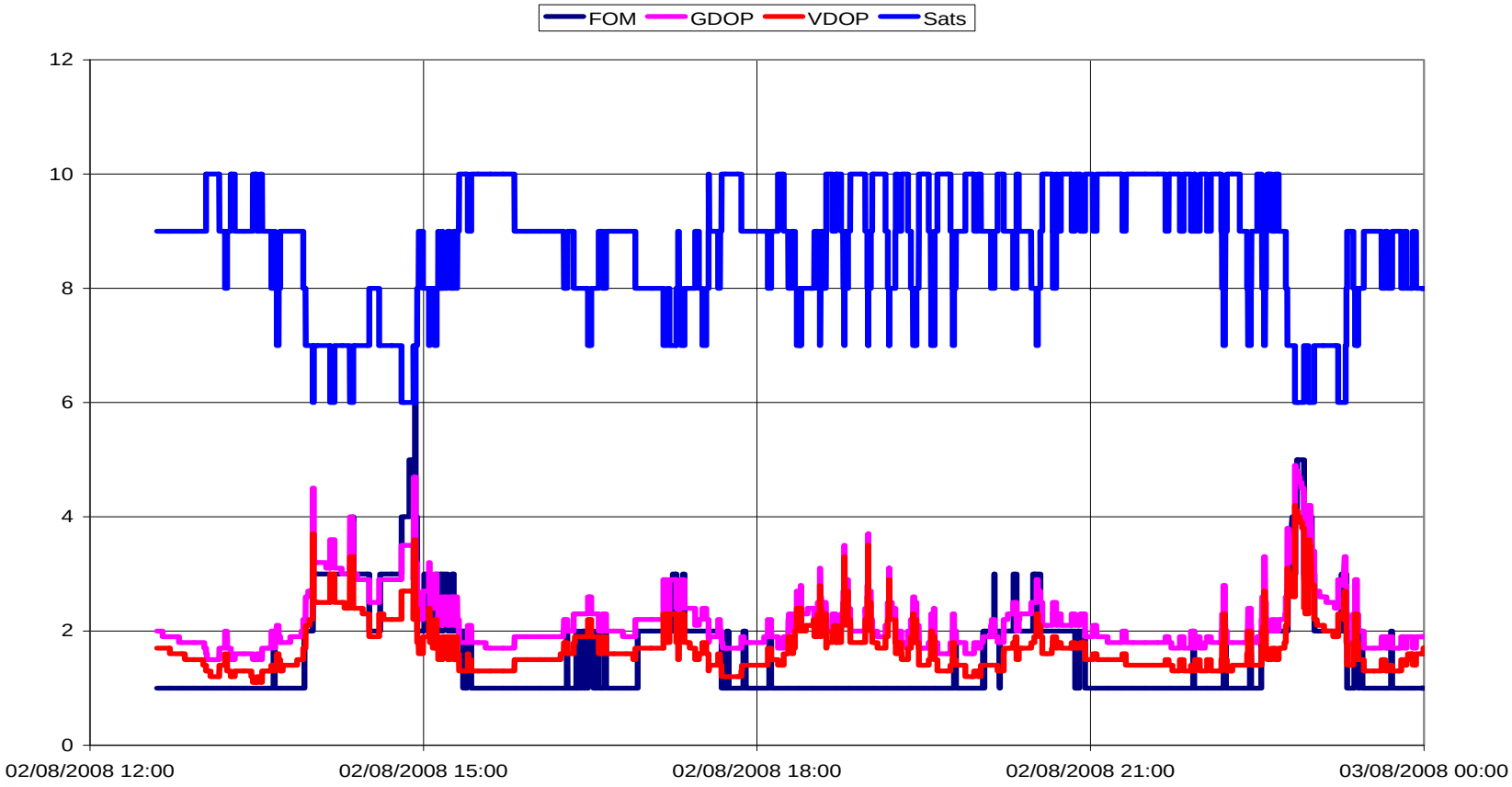
Comparison of C-Nav systems



Real-Time v Post-Processed Solution



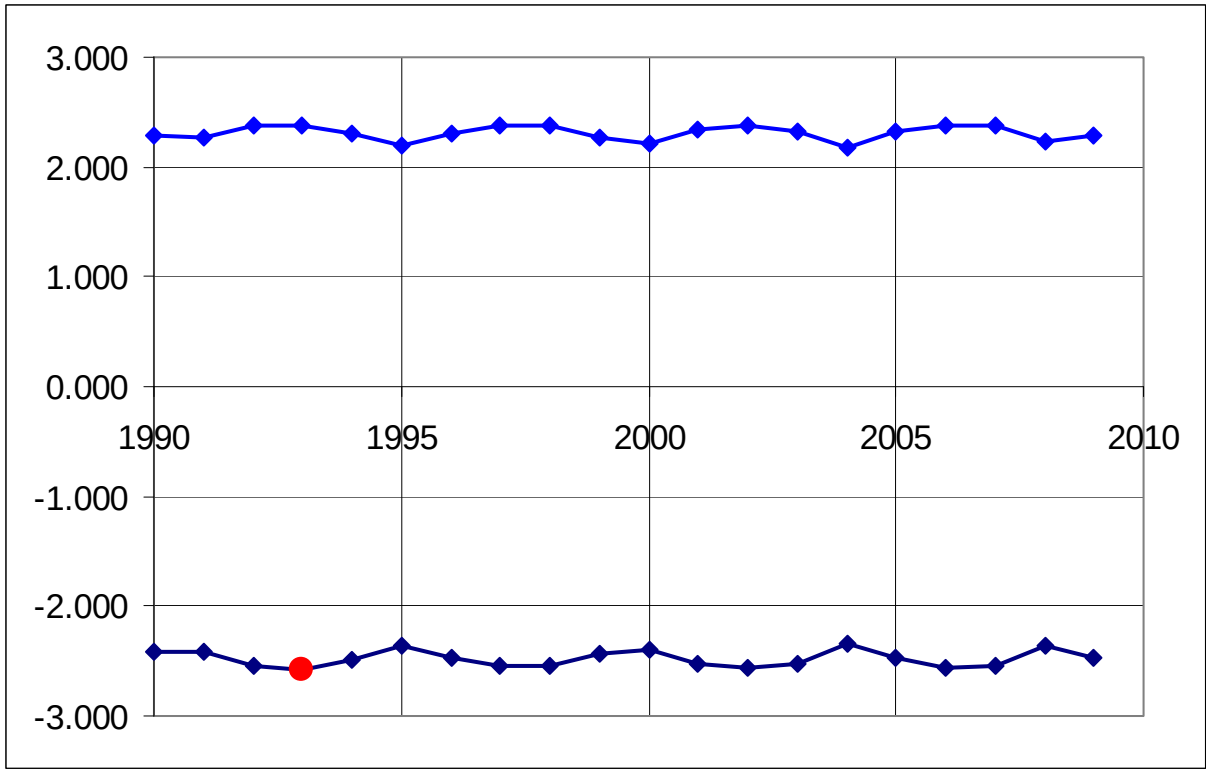
C-Nav Quality Figures



Tidal Analysis

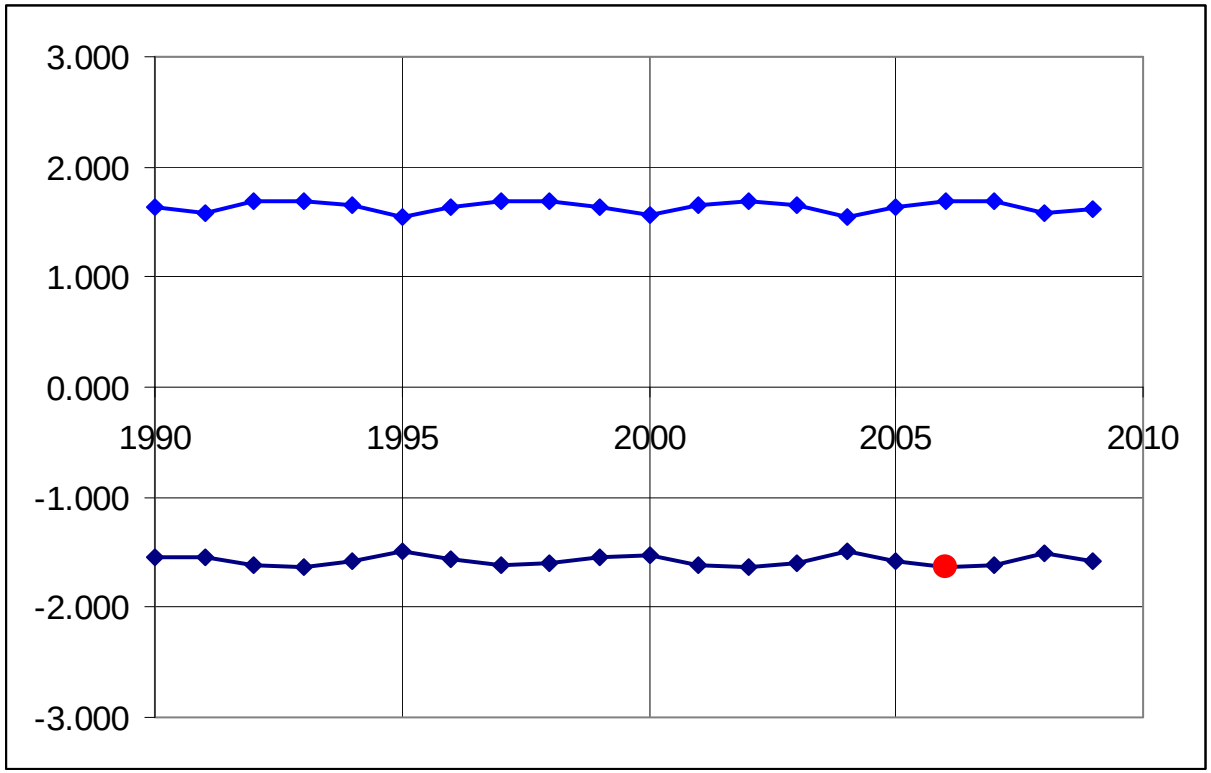
- Harmonic analysis, yielding 34 harmonics
- Harmonics used to generate predictions.
- 19 year Metonic cycle.
- Extract Maximum and Minimum levels.
- Lowest Minimum = LAT.

Tidal Analysis – TG2

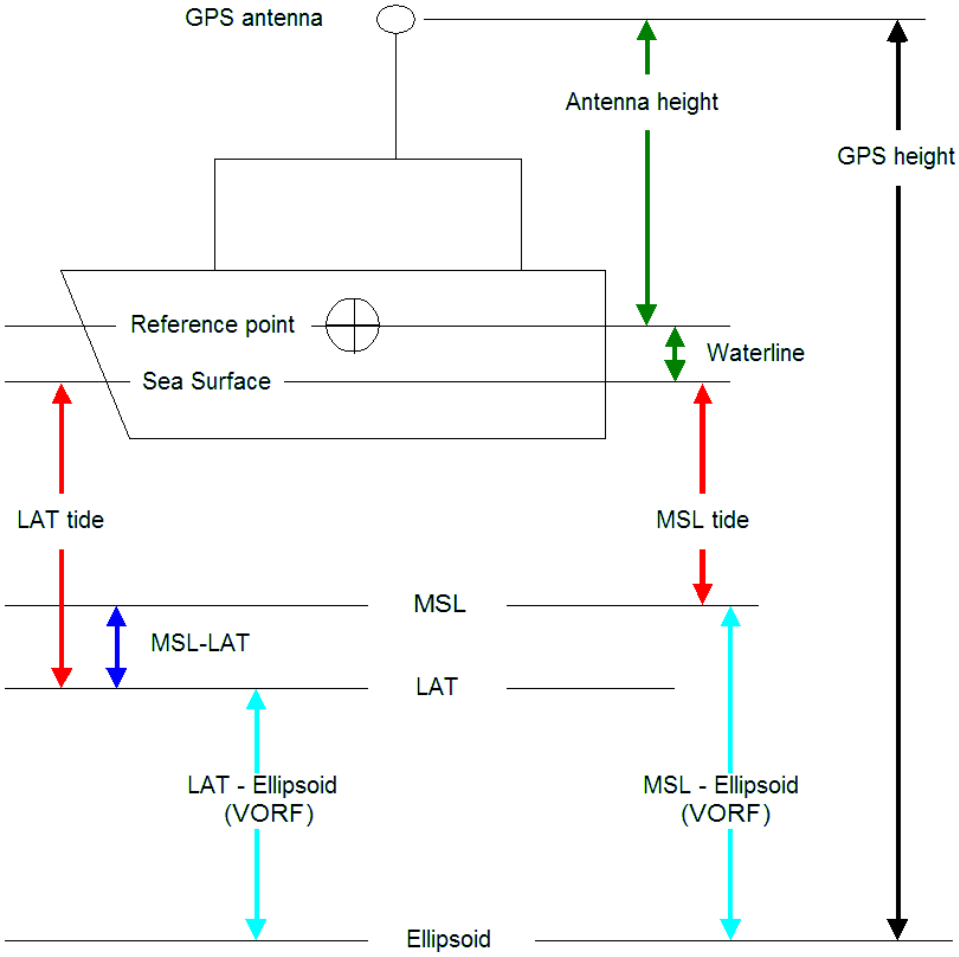


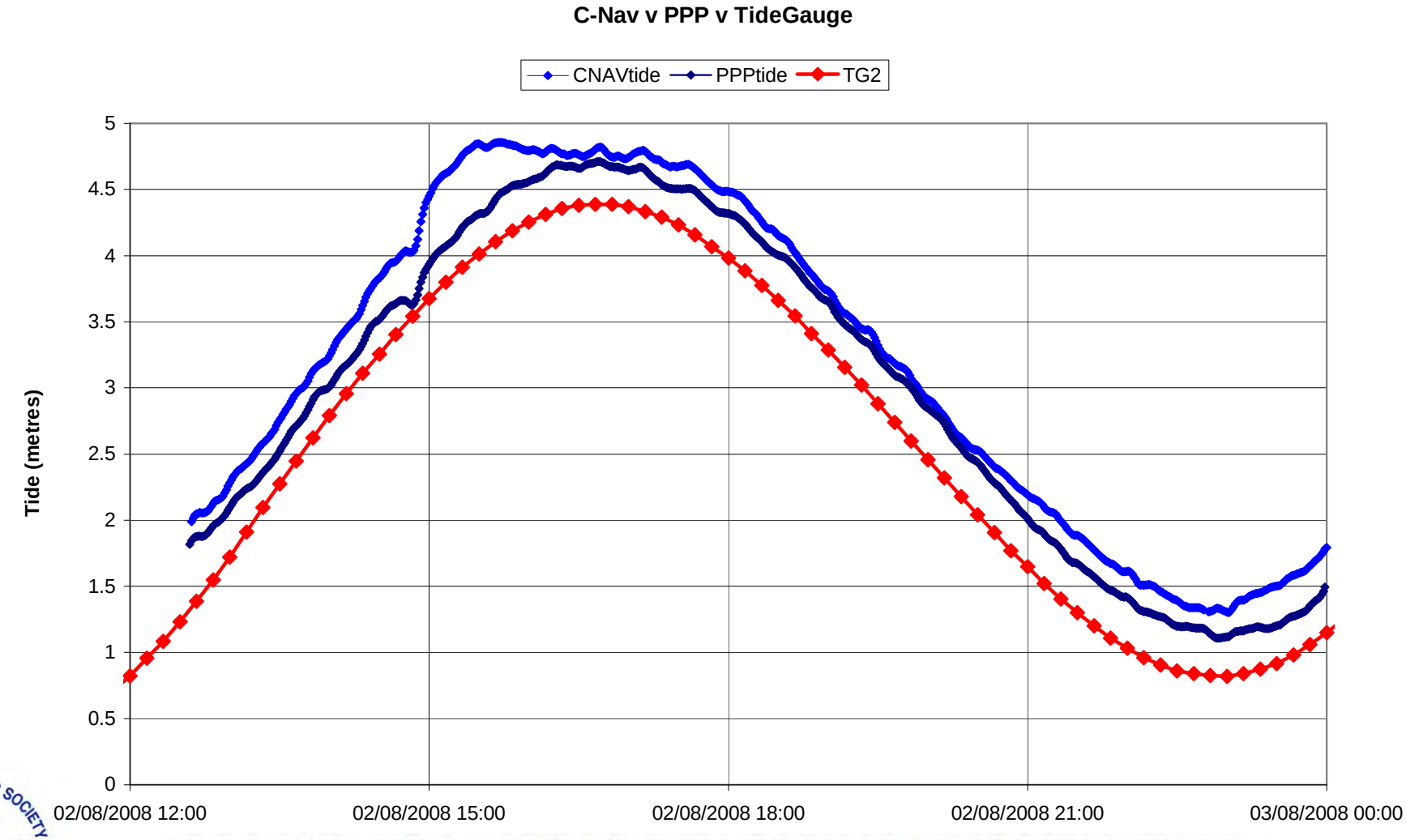
Year	Min Tide	Max Tide
1990	-2.418	2.291
1991	-2.415	2.265
1992	-2.540	2.372
1993	**-2.573**	2.386
1994	-2.494	2.314
1995	-2.355	2.199
1996	-2.475	2.314
1997	-2.545	2.375
1998	-2.540	2.369
1999	-2.436	2.274
2000	-2.398	2.216
2001	-2.530	2.344
2002	-2.564	2.370
2003	-2.520	2.326
2004	-2.347	2.172
2005	-2.472	2.331
2006	-2.568	2.383
2007	-2.539	2.384
2008	-2.364	2.229
2009	-2.468	2.290

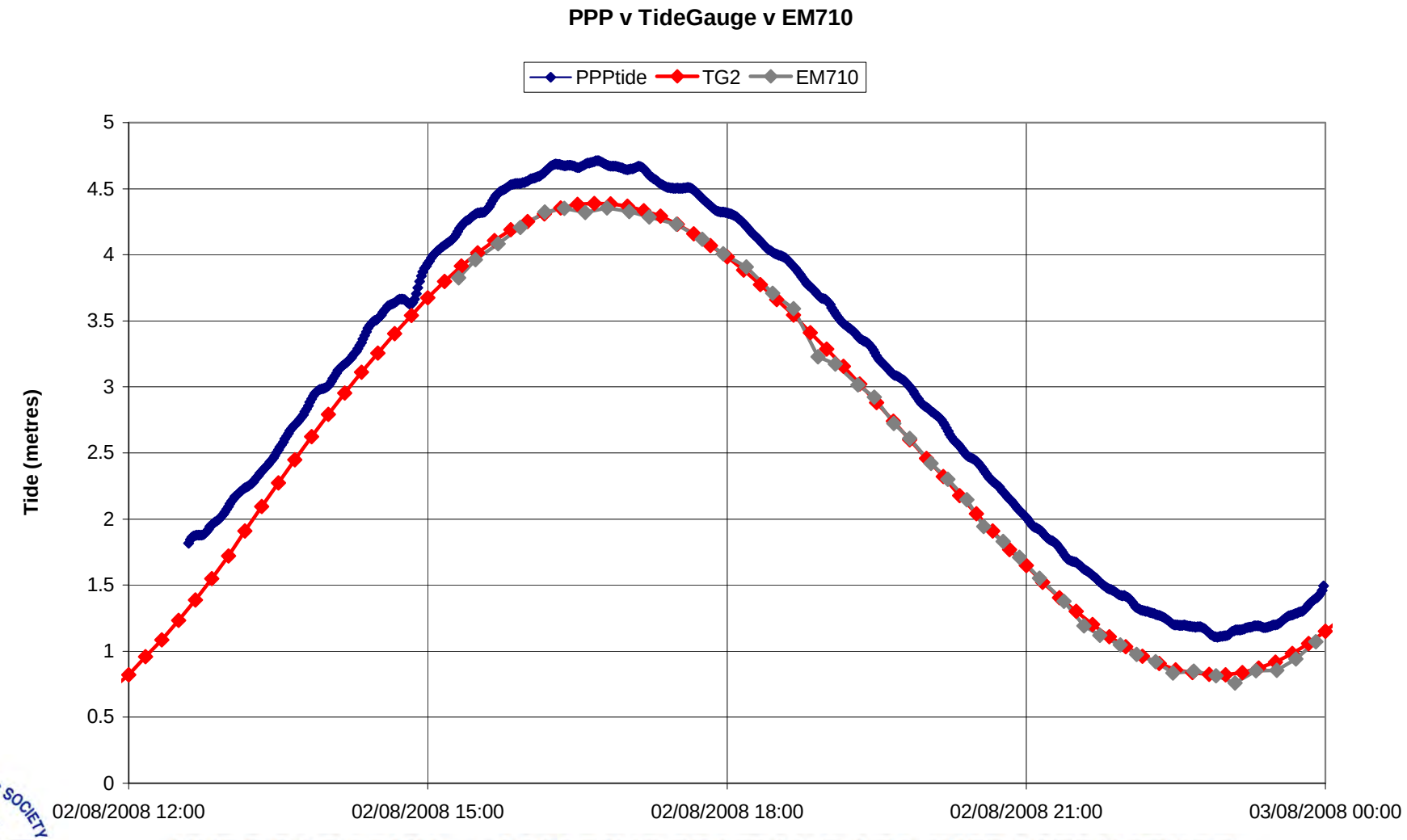
Tidal Analysis – TG1

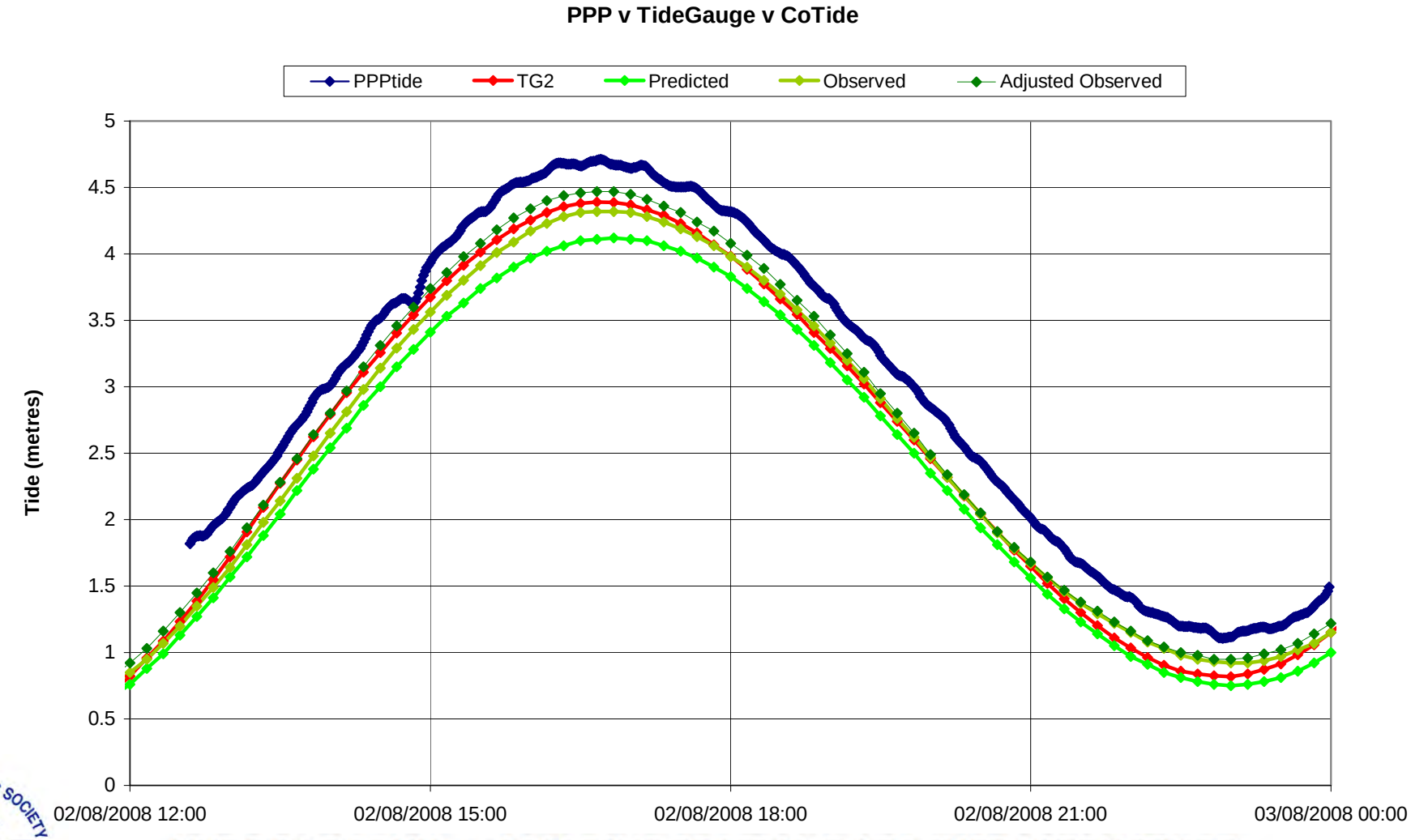


Year	Min Tide	Max Tide
1990	-1.541	1.630
1991	-1.545	1.582
1992	-1.620	1.681
1993	-1.633	1.694
1994	-1.577	1.654
1995	-1.492	1.542
1996	-1.571	1.632
1997	-1.611	1.683
1998	-1.604	1.686
1999	-1.540	1.626
2000	-1.534	1.559
2001	-1.612	1.658
2002	-1.634	1.684
2003	-1.601	1.653
2004	-1.495	1.541
2005	-1.586	1.630
2006	**-1.641**	1.686
2007	-1.617	1.694
2008	-1.506	1.586
2009	-1.578	1.617


GPS antenna
Antenna height
GPS height
Reference point
Waterline
Sea Surface
LAT tide
MSL tide
MSL
MSL-LAT
LAT
LAT - Ellipsoid
(VORF)
MSL - Ellipsoid
(VORF)
Ellipsoid

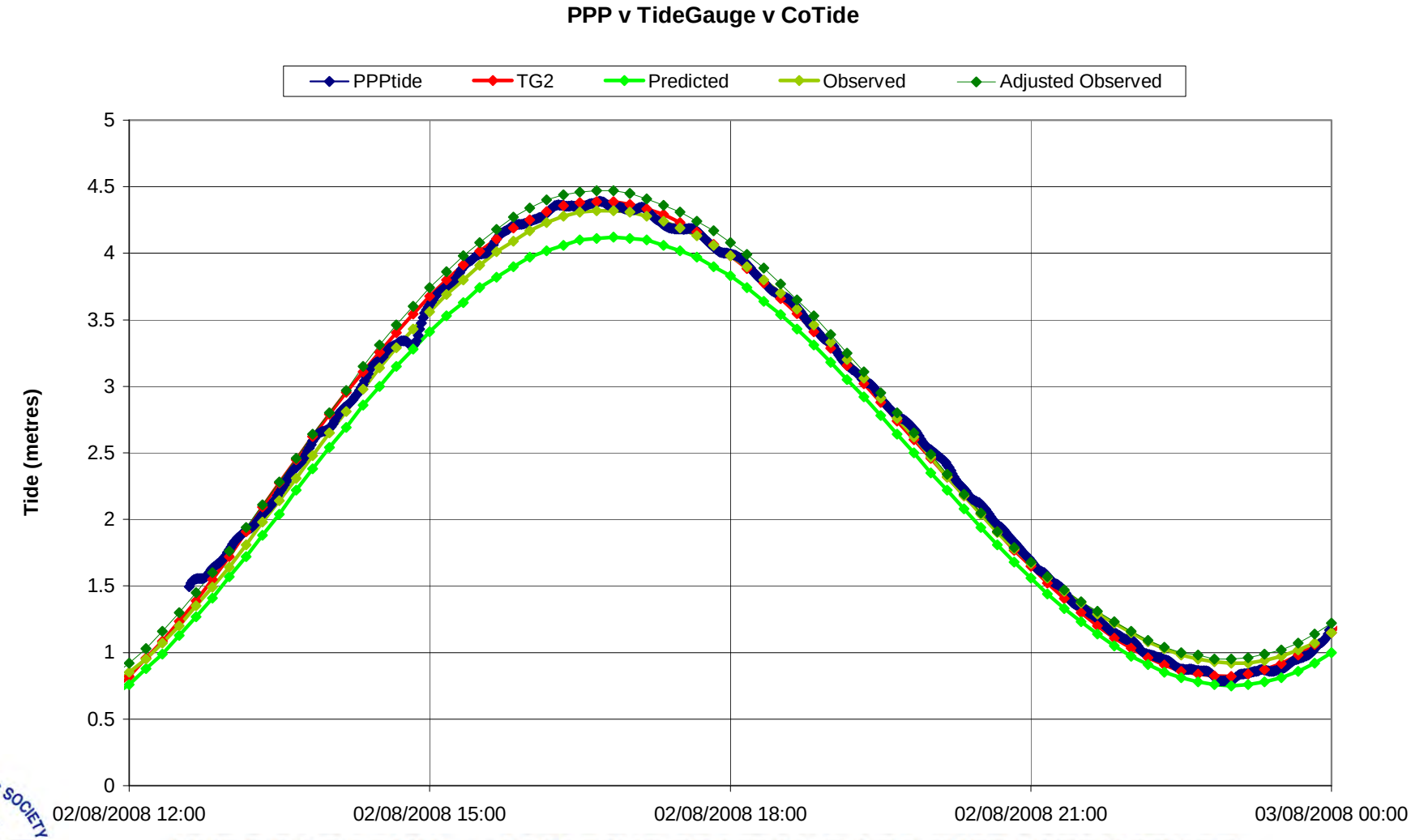

C-Nav v PPP v TideGauge
CNAVtide
PPPtide
TG2
Tide (metres)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
02/08/2008 12:00
02/08/2008 15:00
02/08/2008 18:00
02/08/2008 21:00
03/08/2008 00:00


PPP v TideGauge v EM710
PPPtide
TG2
EM710
Tide (metres)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
02/08/2008 12:00
02/08/2008 15:00
02/08/2008 18:00
02/08/2008 21:00
03/08/2008 00:00


PPP v TideGauge v CoTide
PPPtide
TG2
Predicted
Observed
Adjusted Observed
Tide (metres)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
02/08/2008 12:00
02/08/2008 15:00
02/08/2008 18:00
02/08/2008 21:00
03/08/2008 00:00

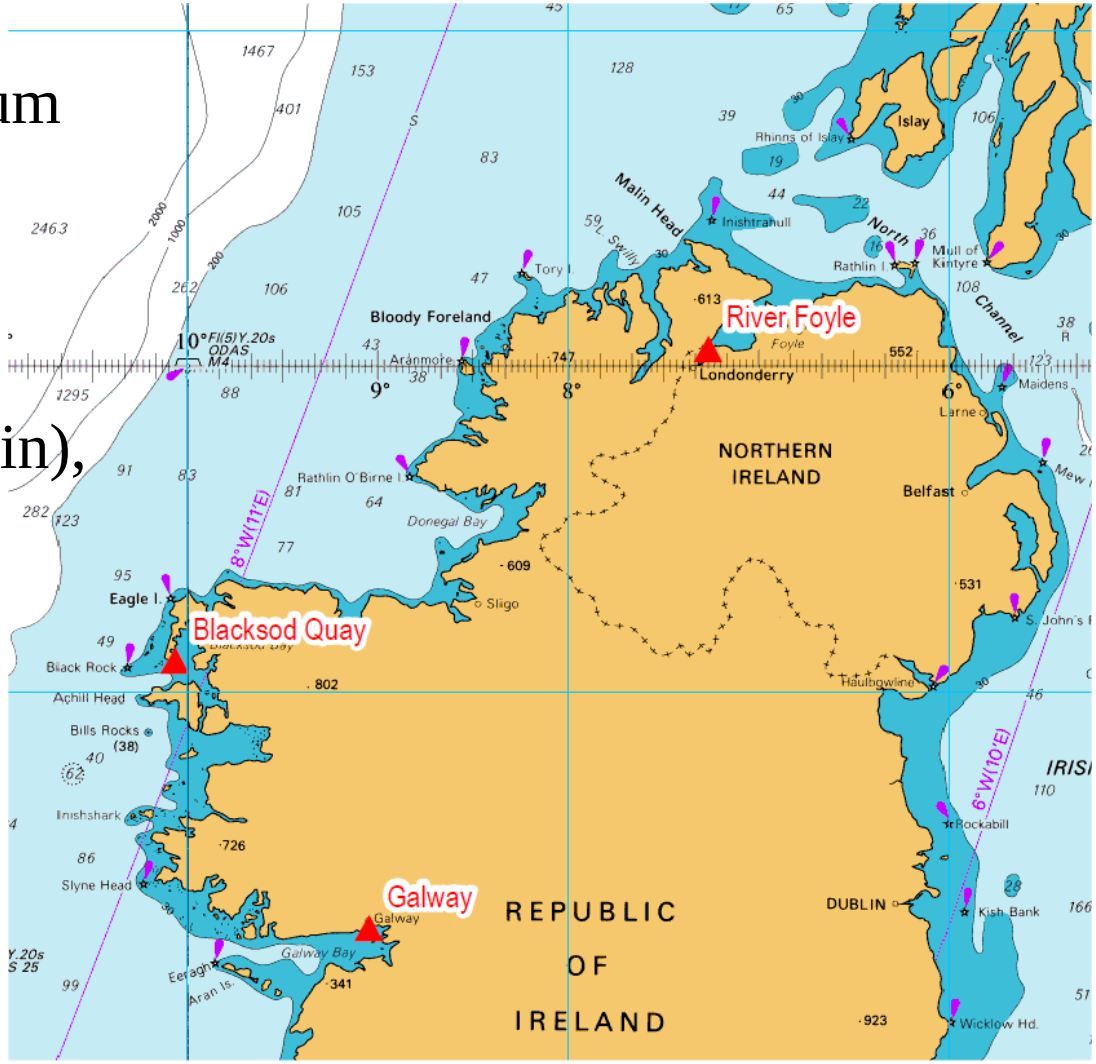
TG2	MSL (ITRF)	LAT	dLAT
VORF	46.110	2.719	-0.146
TG Analysis	-	2.573	
Co-tidal Estimate	-	2.380	0.193
DNSC08	46.093	-	

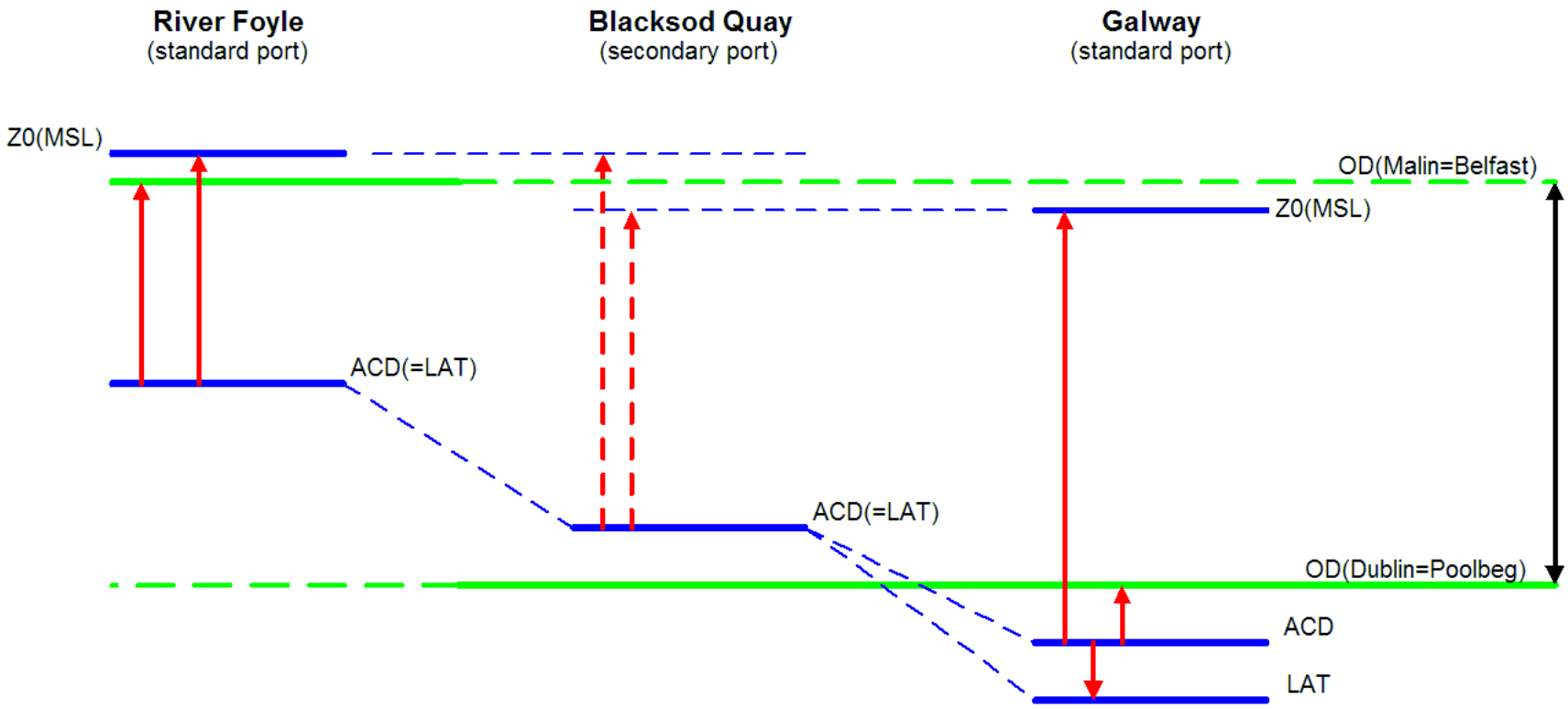
TG1	MSL (ITRF)	LAT	dLAT
VORF	46.080	1.831	-0.190
TG Analysis	-	1.641	
Co-tidal Estimate	-	1.530	0.111
DNSC08	46.089	-	

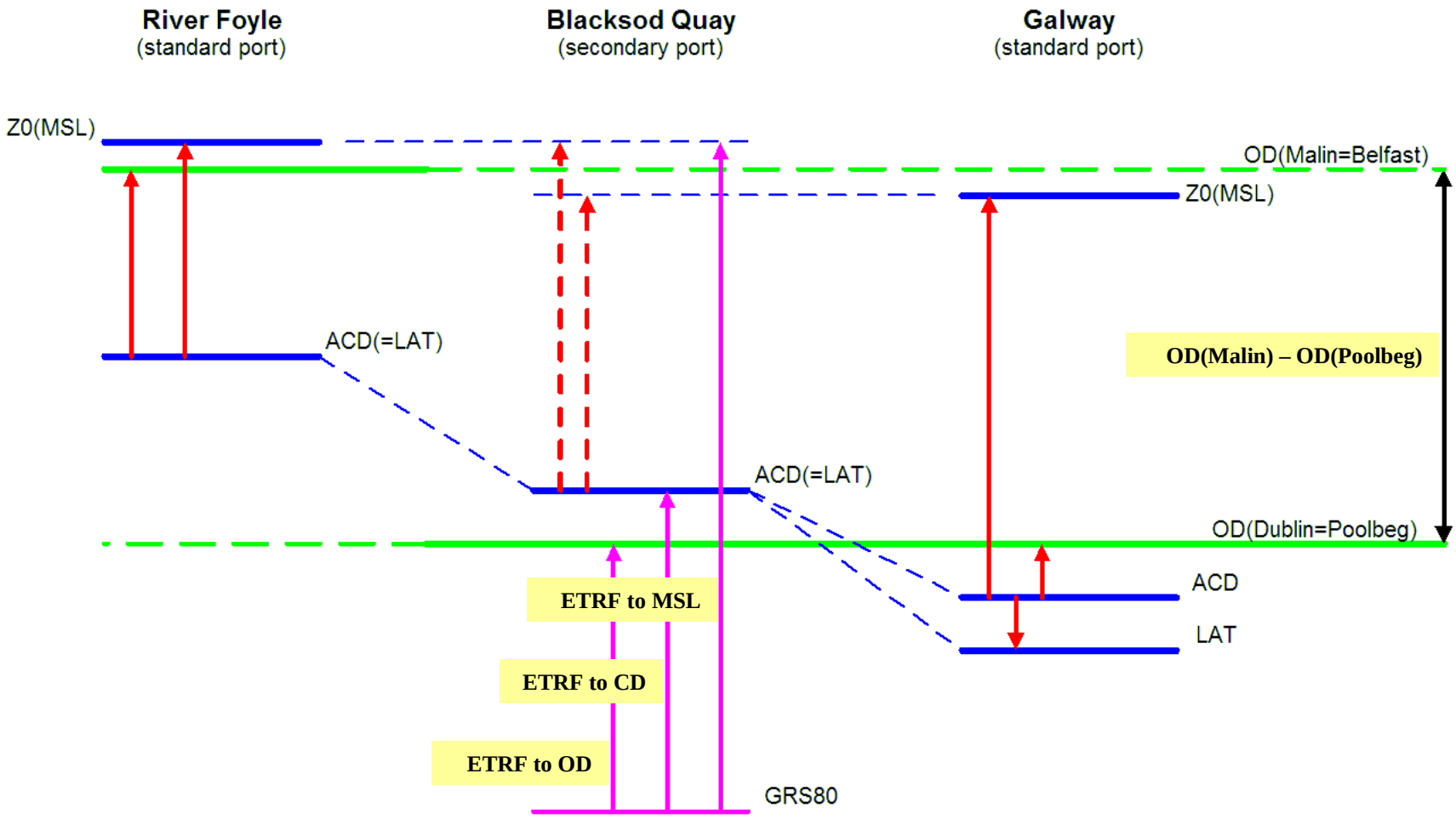

PPP v TideGauge v CoTide
PPPtide
TG2
Predicted
Observed
Adjusted Observed
Tide (metres)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
02/08/2008 12:00
02/08/2008 15:00
02/08/2008 18:00
02/08/2008 21:00
03/08/2008 00:00

Example A- Unknown Datum

- Blacksod Quay
- Tides required to OD (Malin), to tie with land mapping.
- Tides supplied to CD.
- What's the offset?
- ATT does not specify…..




River Foyle
(standard port)
Blacksod Quay
(secondary port)
Galway
(standard port)
Z0(MSL)
OD(Malin=Belfast)
Z0(MSL)
ACD(=LAT)
ACD(=LAT)
OD(Dublin=Poolbeg)
ACD
LAT



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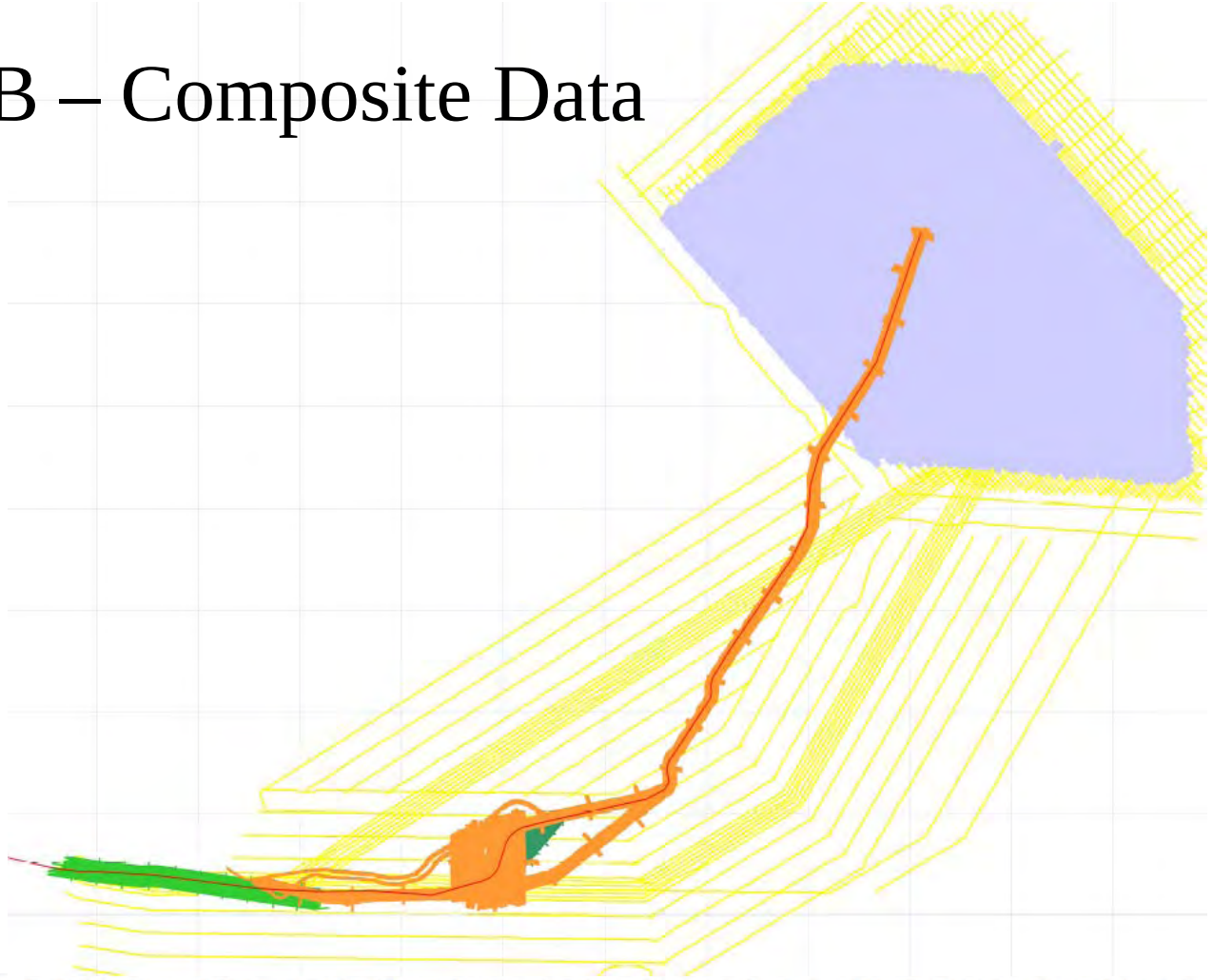
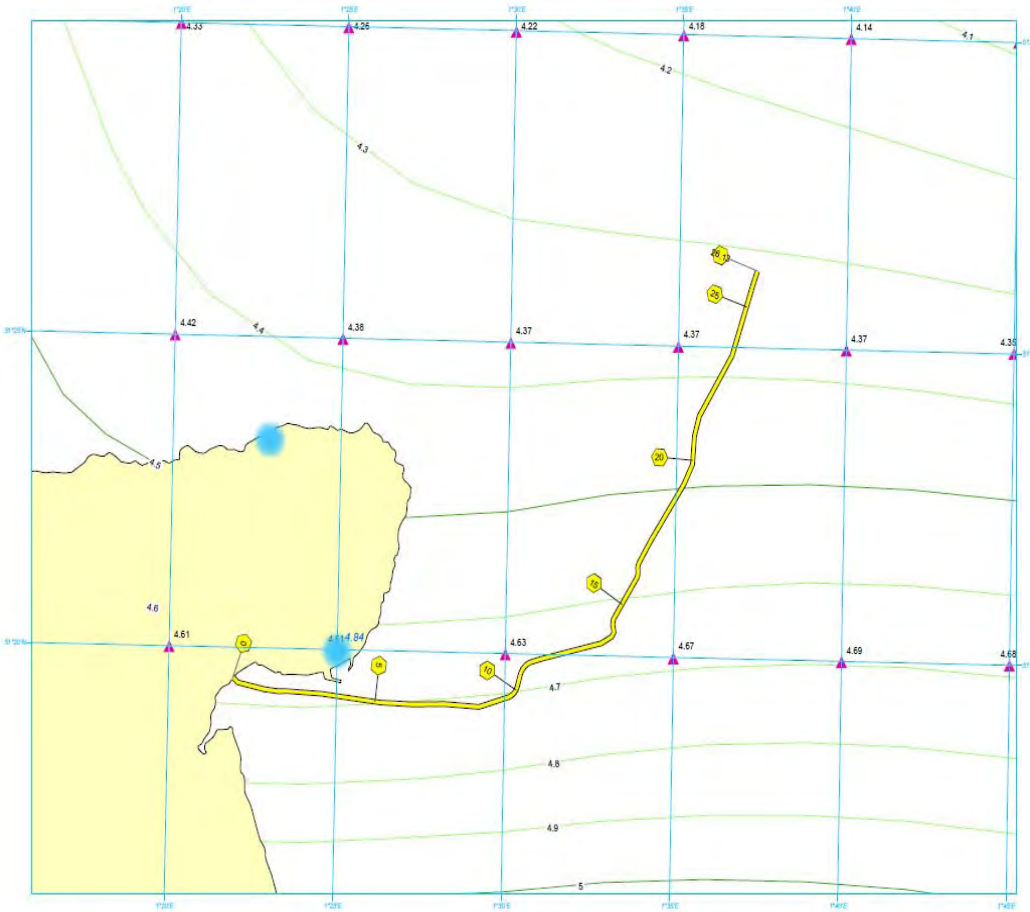
Example B – Composite Data

- SBES 2005
- MBES 2007
- SBES 2008

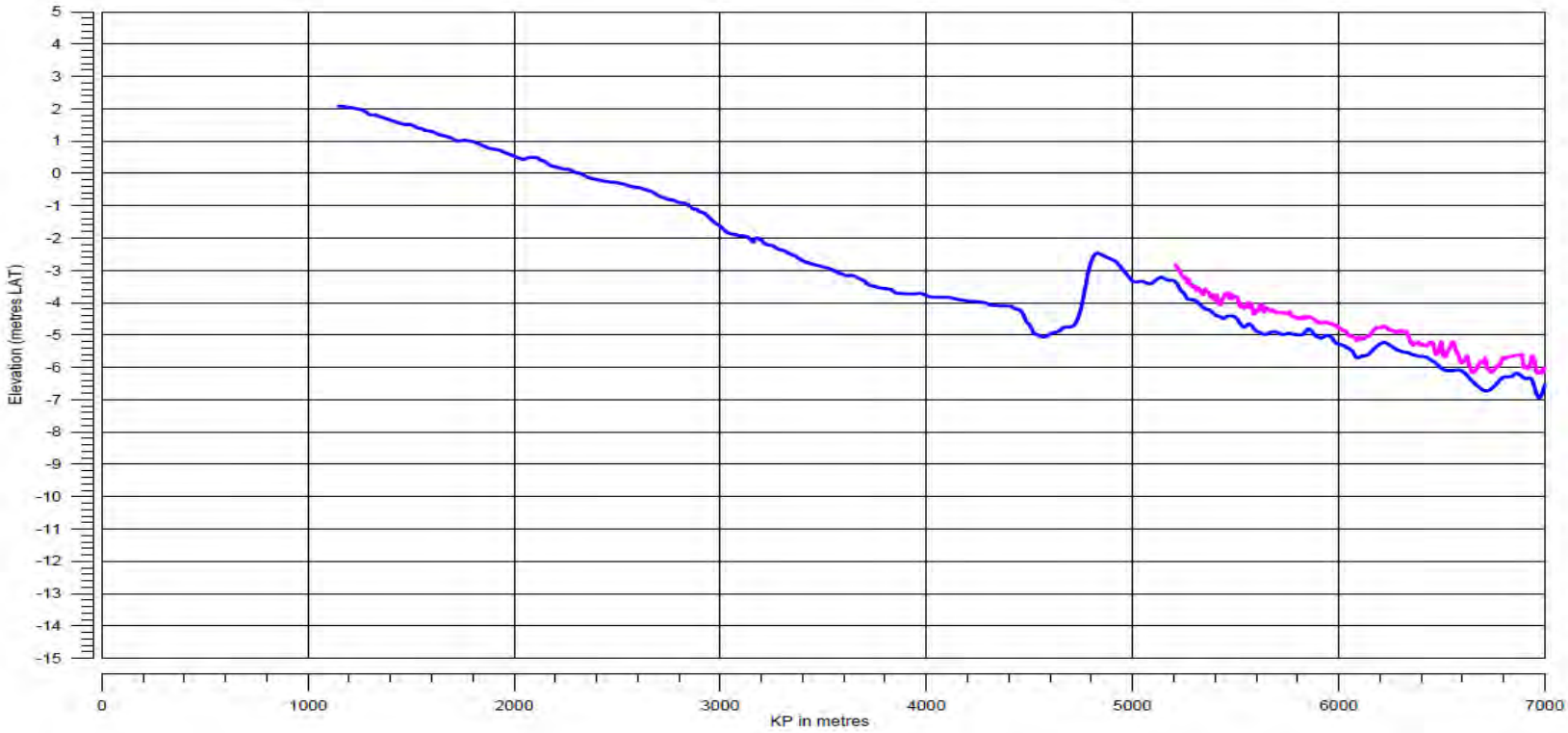


Different Vertical Datum

- SBES 2005 – CD (Ramsgate)
- MBES 2007 – LAT (Margate)
- SBES 2008 – CD (Ramsgate)



Result – A mis-tie between datasets!



Reduce to Common Vertical Datum

- What is LAT height referred to CD at Ramsgate?
- Reference to ATT, in the absence of any other data, suggests an "interpolated" value of +0.15?

Standard Port	LAT (b)
Falmouth	0.0
Plymouth (Devonport)	0.0
Dartmouth	-0.2
Torquay	+0.1
Portland	-0.2
Poole Harbour	0.0
Cowes	+0.1
Southampton	-0.1
Portsmouth	+0.1
Chichester Harbour	+0.2
Shoreham	+0.1
Dover	+0.2
Margate	+0.1
Sheerness	0.0

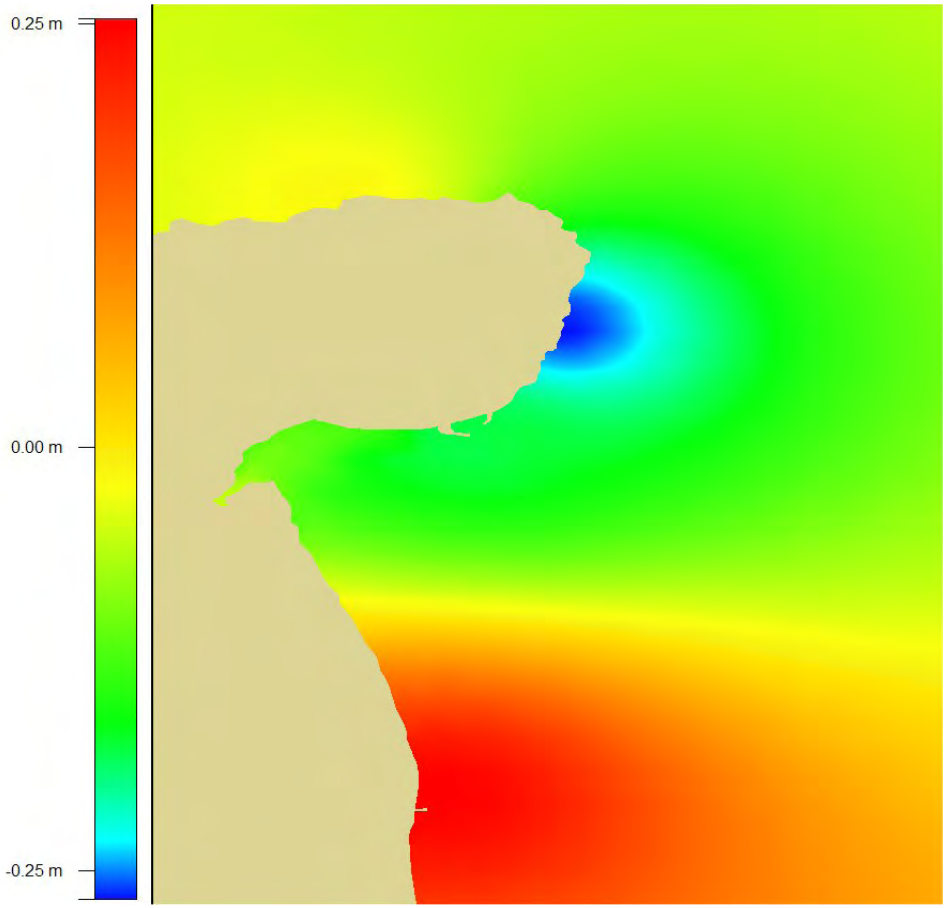
Reduce to Common Vertical Datum

- Analysis of Ramsgate tide, based on IHB constituents should give a better estimate.
- 25 constituents, gives Zo of 2.45m, compared with ATT Zo of 2.73m
- LAT is –2.98m.
- Assume Zo is ATT figure of 2.73m, then LAT is –0.25m below CD.

VORF

LAT referred to CD

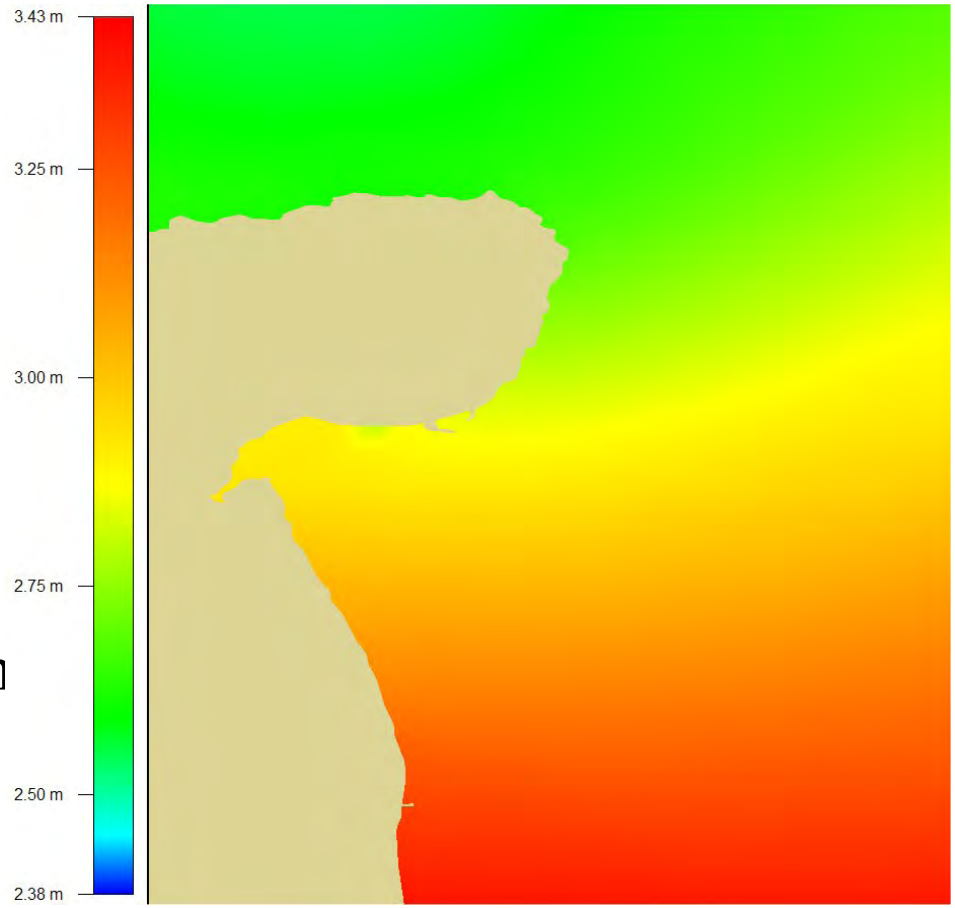
- Confirms LAT below CD.
- Predicts figure of –0.18m
- Illustrates problem of using CD as a vertical datum.



VORF

LAT referred to MSL

- A true tidal reference surface.
- Linkage to land and satellite datums.
- Linkage to legacy datums, such as CD.



Vertical Offshore Reference Frame

Do we need it? Yes!

When do we need it? Now!

Thank-you