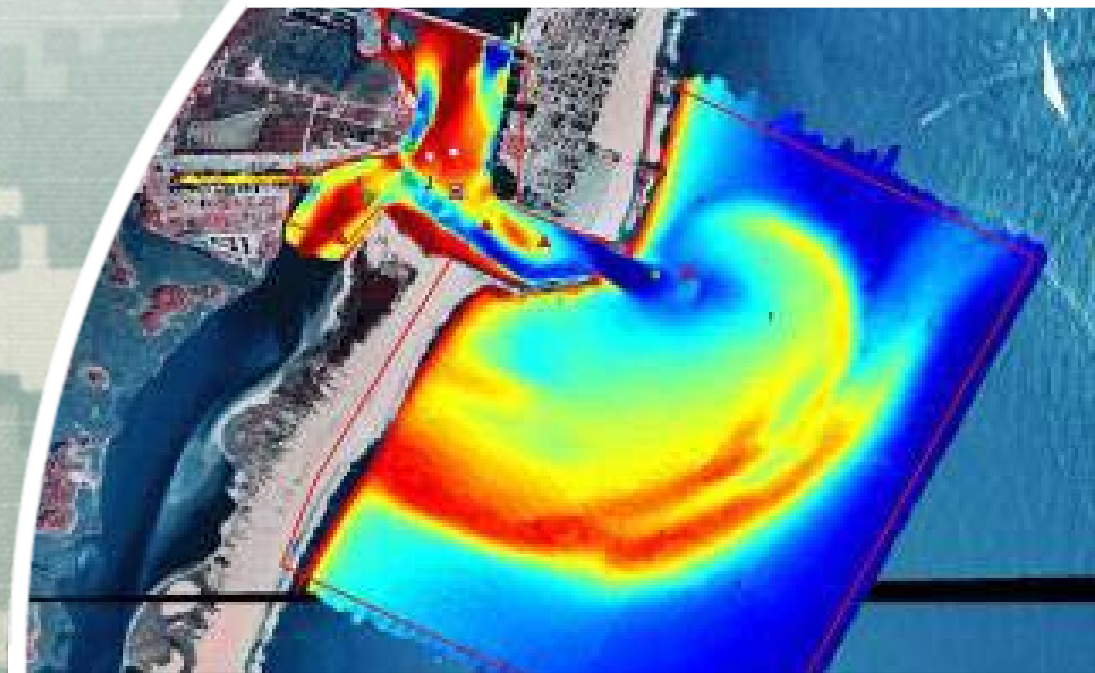
CMS Applications to Grays Harbor, WA Calculation of Storm Processes for a Navigation Project

Lihwa Lin, PH.D

Research Hydraulics Engineer

U.S. Army Engineer Research and Development Center

2 Dec 2009



US Army Corps of Engineers

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Wave, Current, Suspended Sediment Data Collection, Grays Harbor, WA

Data collection in USACE studies

- September – November 1999:

  wave, current, water level, suspended sediment concentration, wind data, covering the area from the entrance to Grays Harbor and along the entrance at eight stations (Sta 0 – Sta 7)

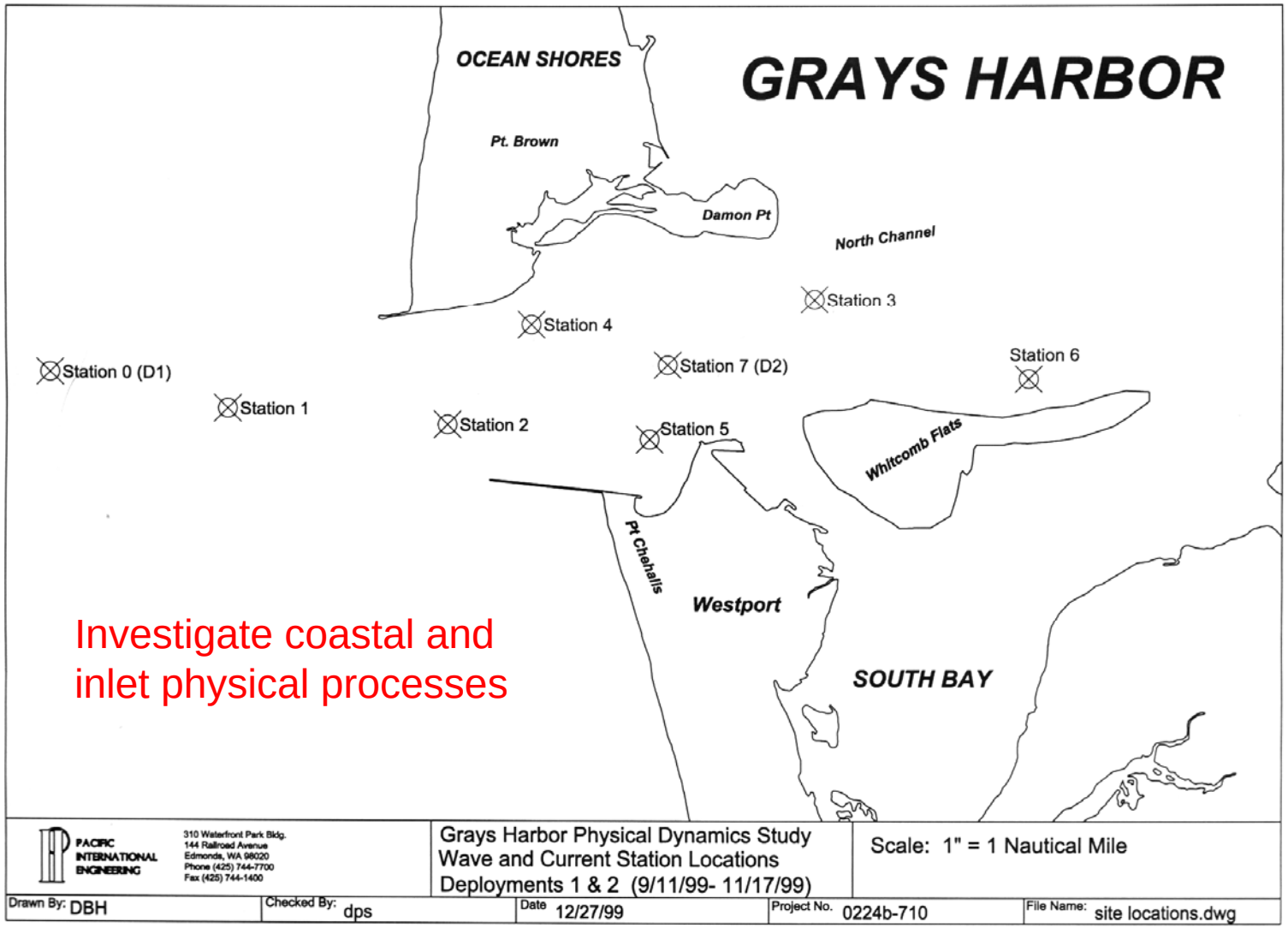
- March – April 2002:

  wave, current, water level, wind data at Half Moon Bay north shore (HMB2)

- December 2003 – February 2004:

  wave, current, water level, wind data at the Half Moon Bay region (HMB1 – HMB4)

Data Collection Stations September-November 1999

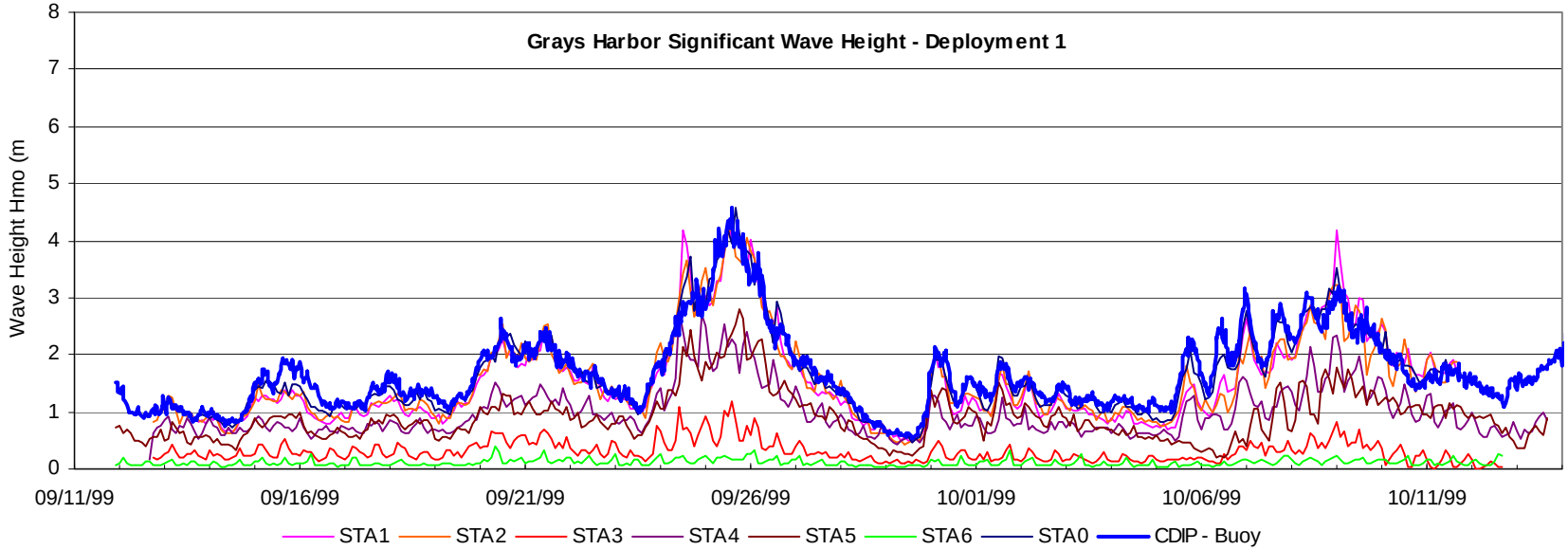


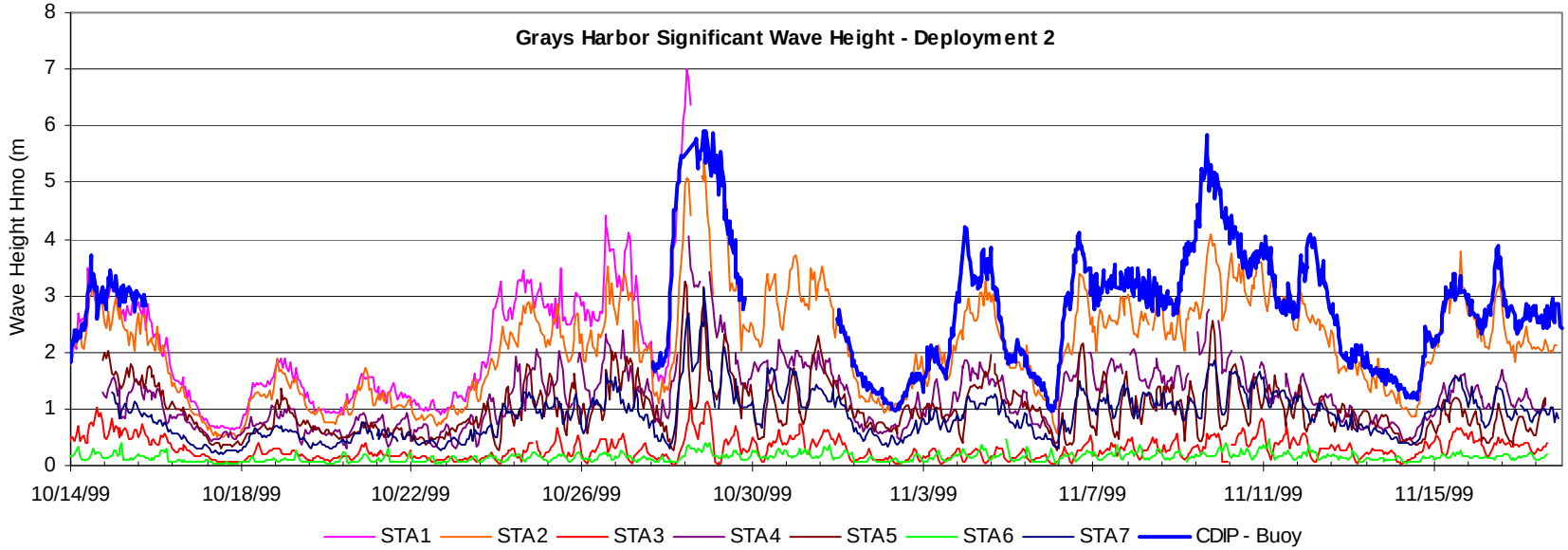
Investigate coastal and inlet physical processes

Wave and Current Station Info

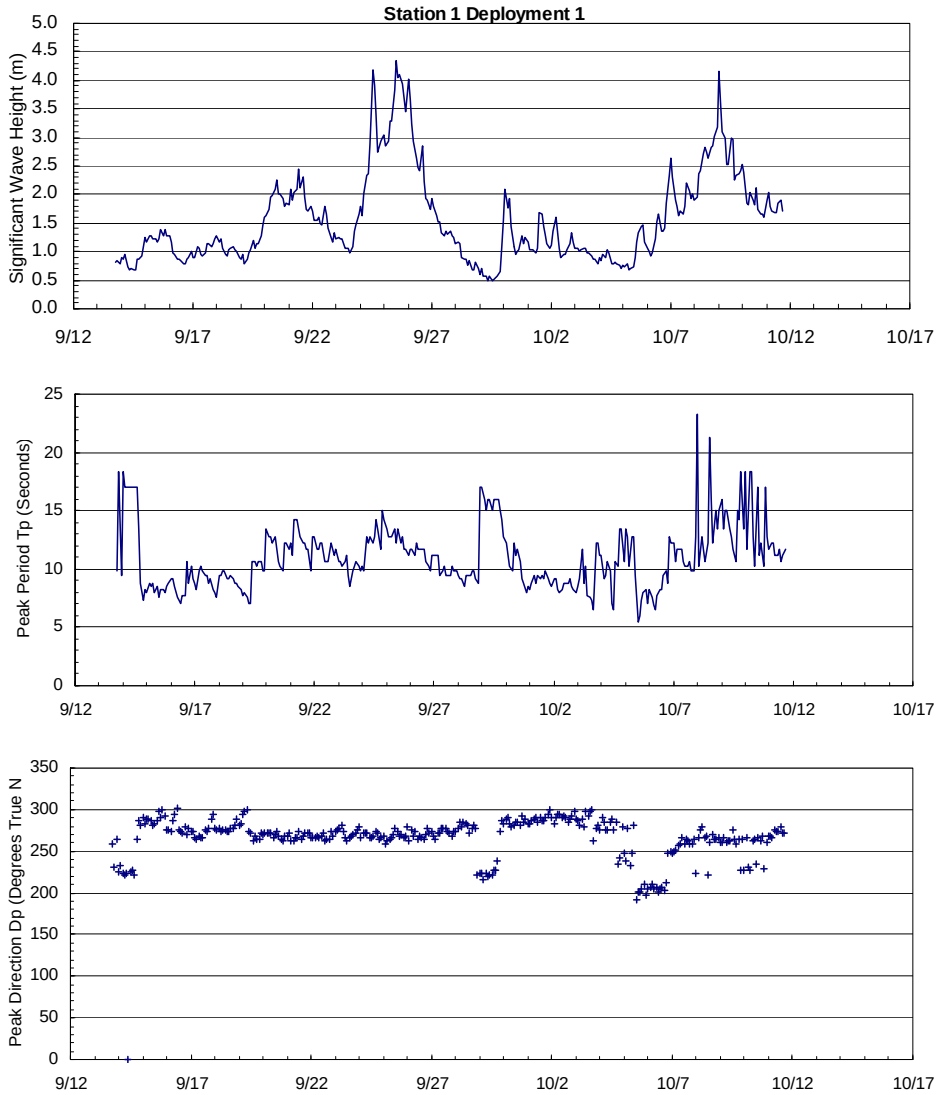
		WA State Plane S. Zone NAD83					Deployed	Recovered
	Station	Easting	Northing	Depth (m) MLLW	Latitude	Longitude	Date-Time (UTC)	Date-Time (UTC)
Deployment 1	0	705282.6	599924.4	16.8	46.91759	-124.24353	1999/09/13 16:47	1999/10/11 16:50
	1	713901.7	598213.5	13.7	46.91401	-124.20876	1999/09/13 17:06	1999/10/11 17:00
	2	724449.4	597435.9	12.7	46.91324	-124.16645	1999/09/12 16:23	1999/10/11 17:35
	3	741749.6	603377.0	13.4	46.93169	-124.09838	1999/09/12 17:22	1999/10/12 18:08
	4	728309.1	602282.8	9.8	46.92700	-124.15192	1999/09/12 16:55	1999/10/13 18:02
	5	733915.8	596621.2	8.6	46.91221	-124.12847	1999/09/11 22:00	1999/10/13 18:16
	6	752027.3	599613.2	8.6	46.92266	-124.05661	1999/09/11 21:26	1999/10/12 18:24
Deployment 2	1	713951.7	598203.9	13.0	46.91400	-124.20856	1999/10/12 17:34	1999/11/17 22:20
	2	724469.4	597434.3	12.3	46.91323	-124.16637	1999/10/12 17:09	1999/11/17 22:00
	3	741784.5	603393.6	11.5	46.93174	-124.09825	1999/10/13 17:40	1999/11/17 16:33
	4	728368.1	602232.0	10.3	46.92687	-124.15168	1999/10/14 17:55	1999/11/17 16:11
	5	733917.9	596576.0	7.0	46.91208	-124.12845	1999/10/14 17:40	1999/11/17 15:53
	6	752054.2	599609.0	8.3	46.92265	-124.05650	1999/10/13 17:18	1999/11/17 16:53
	7	734895.2	600291.5	15.3	46.92238	-124.12523	1999/10/14 21:59	1999/11/17 22:55

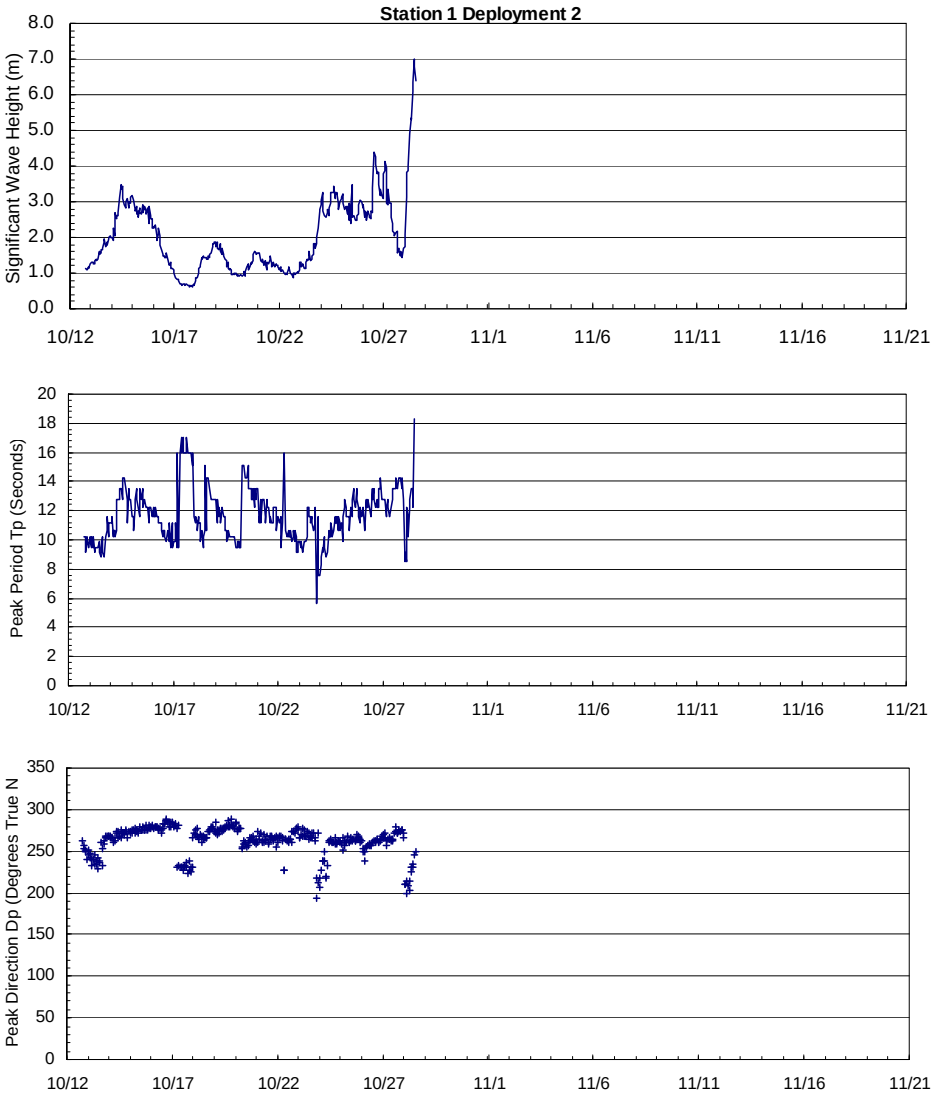
Wave Height


Grays Harbor Significant Wave Height - Deployment 1
Wave Height Hmo (m
0
1
2
3
4
5
6
7
8
09/11/99
09/16/99
09/21/99
09/26/99
10/01/99
10/06/99
10/11/99
STA1
STA2
STA3
STA4
STA5
STA6
STA0
CDIP - Buoy

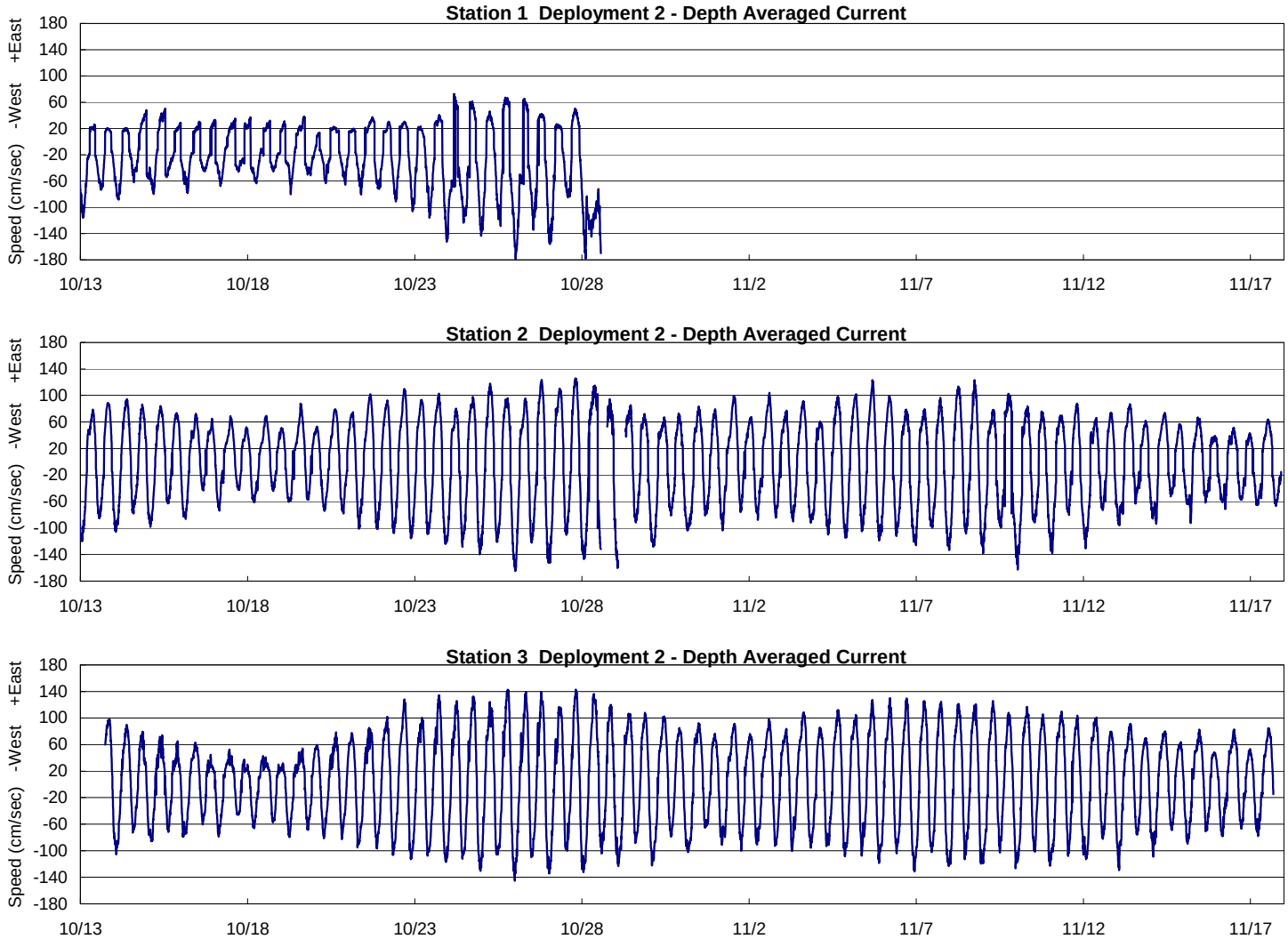

Grays Harbor Significant Wave Height - Deployment 2
Wave Height Hmo (m
0
1
2
3
4
5
6
7
8
10/14/99
10/18/99
10/22/99
10/26/99
10/30/99
11/3/99
11/7/99
11/11/99
11/15/99
STA1
STA2
STA3
STA4
STA5
STA6
STA7
CDIP - Buoy

Sample Wave Data, Sta 1





Sample Current Data, Sta 1-3

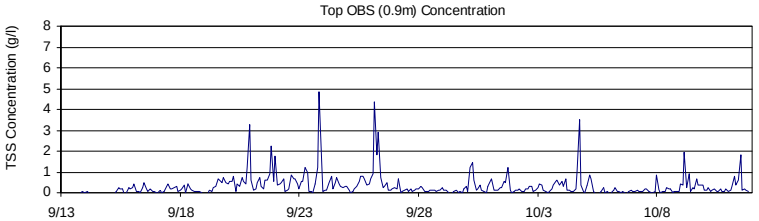


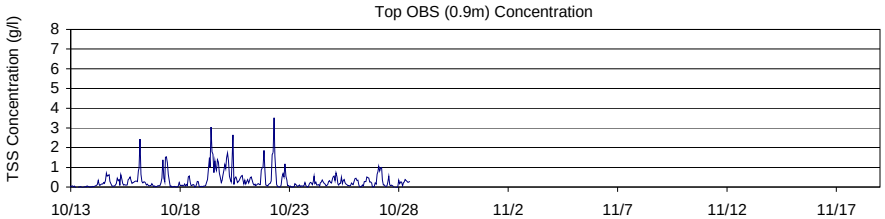
OBS Data Info

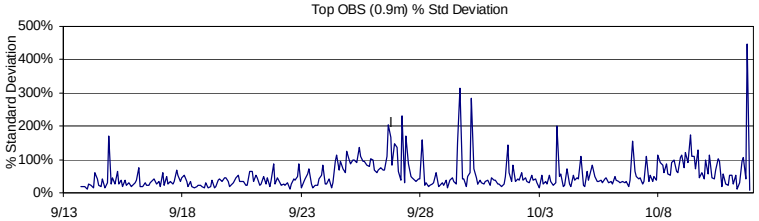
(Optical Backscatterence Sensor; sediment concentration)

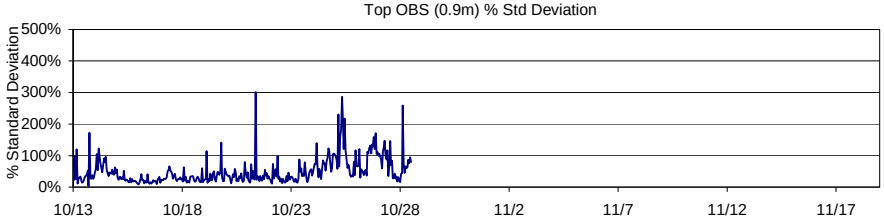
			Grays Harbor Sediment Concentration Standard					
Station	Serial #	Orientation	0 g/l	1.5 g/l	3 g/l	6 g/l	12 g/l	24 g/l
			Instrument "counts"(mean of 1000 samples)					
0 & 7	1404	UP(0.9m)	115	6278	11883	23875	36070	52448
0 & 7	1407	Down(0.6m)	147	6200	12277	20281	37283	52083
1	1397	UP(0.9m)	93	6790	12169	24403	36776	52798
1	1405	Down(0.6m)	111	6393	12530	24168	37367	54446
2	1398	UP(0.9m)	125	6102	12362	25613	37260	54783
2	1399	Down(0.6m)	179	6265	11802	25716	37493	54643
3	1396	UP(0.9m)	110	6352	11250	20867	34706	51239
3	1409	Down(0.6m)	75	5360	11675	20314	35345	50754
4	1400	UP(0.9m)	93	5684	11796	27675	38714	54917
4	1401	Down(0.6m)	183	5757	12182	26744	39190	54165
5	1406	UP(0.9m)	91	5895	11564	27661	38172	54777
5	1408	Down(0.6m)	172	6041	11693	27403	38582	55059
6	1402	UP(0.9m)	106	6031	10997	20726	32216	48828
6	1403	Down(0.6m)	93	5215	11127	19872	33140	46773

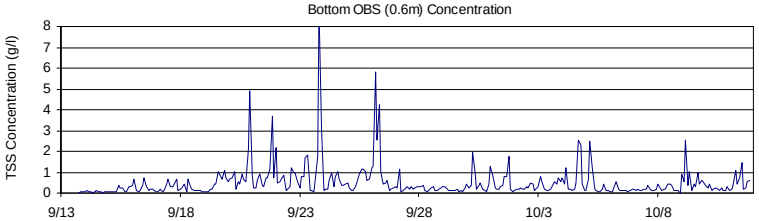
Sample OBS Data, Sta 1

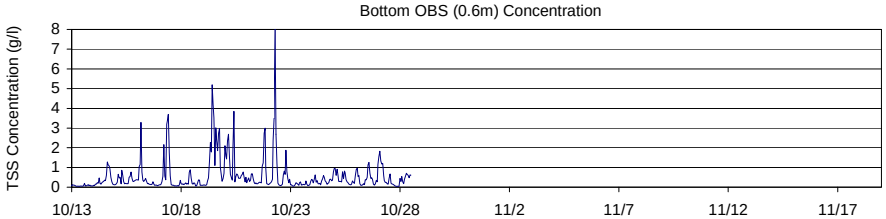


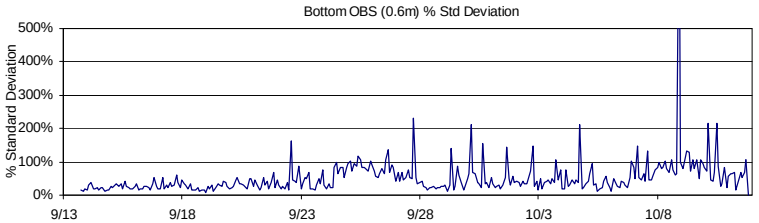


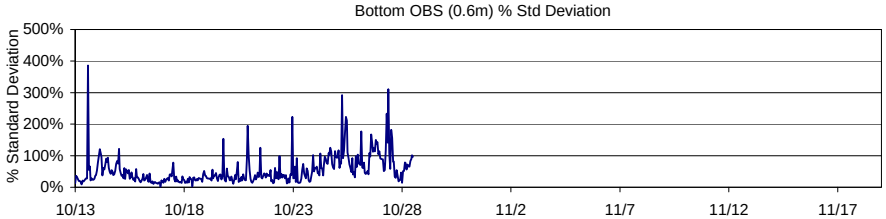


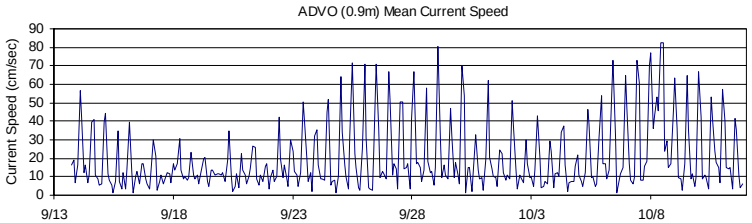


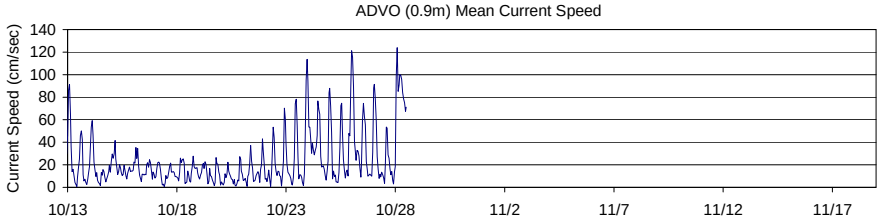




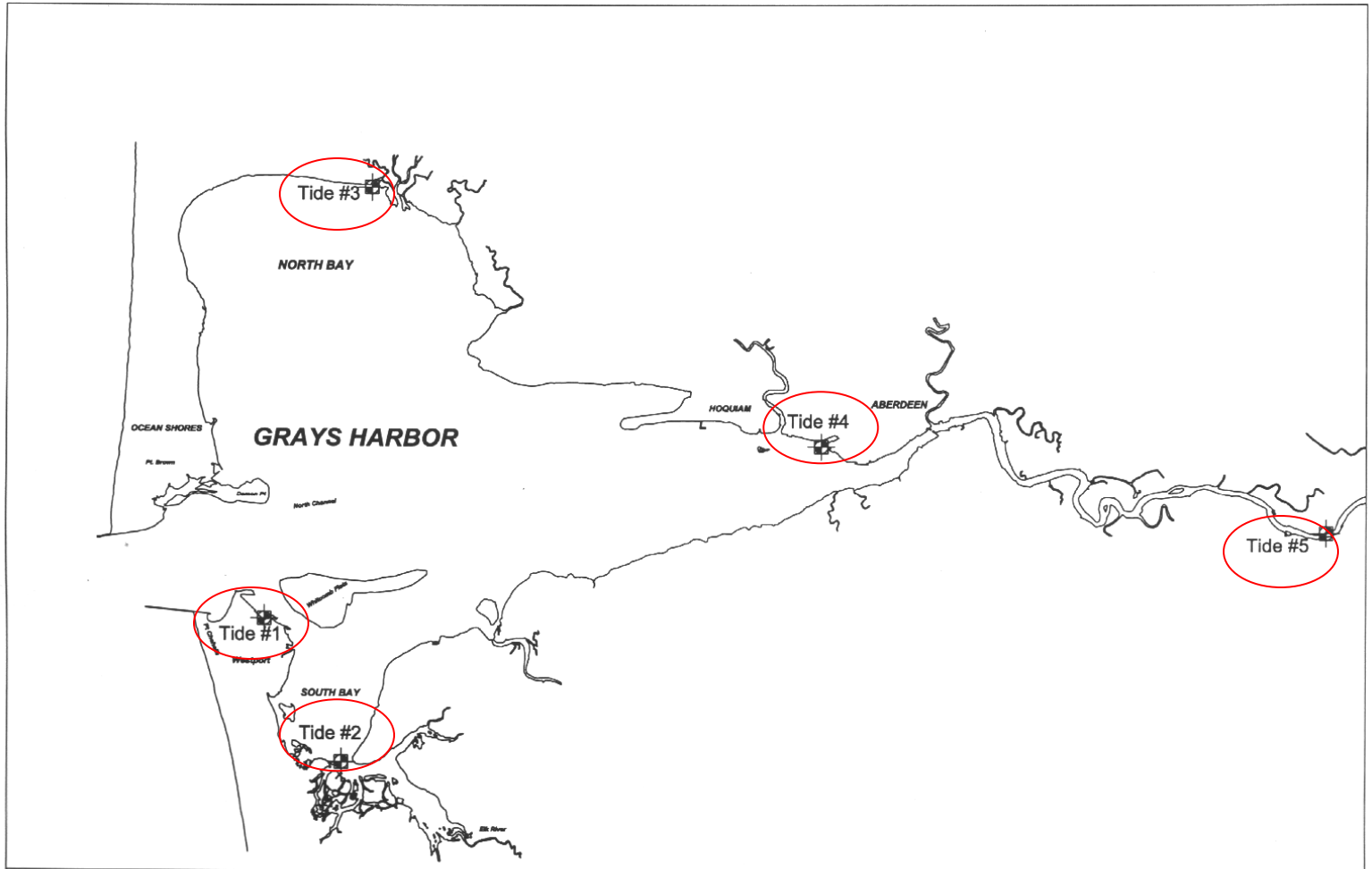








Water Level Station Map



PACIFIC INTERNATIONAL ENGINEERING
310 Waterfront Park Bldg.
144 Railroad Avenue
Edmonds, WA 98020
Phone (425) 744-7700
Fax (425) 744-1400

Grays Harbor Physical Dynamics Study
Tide Station Locations

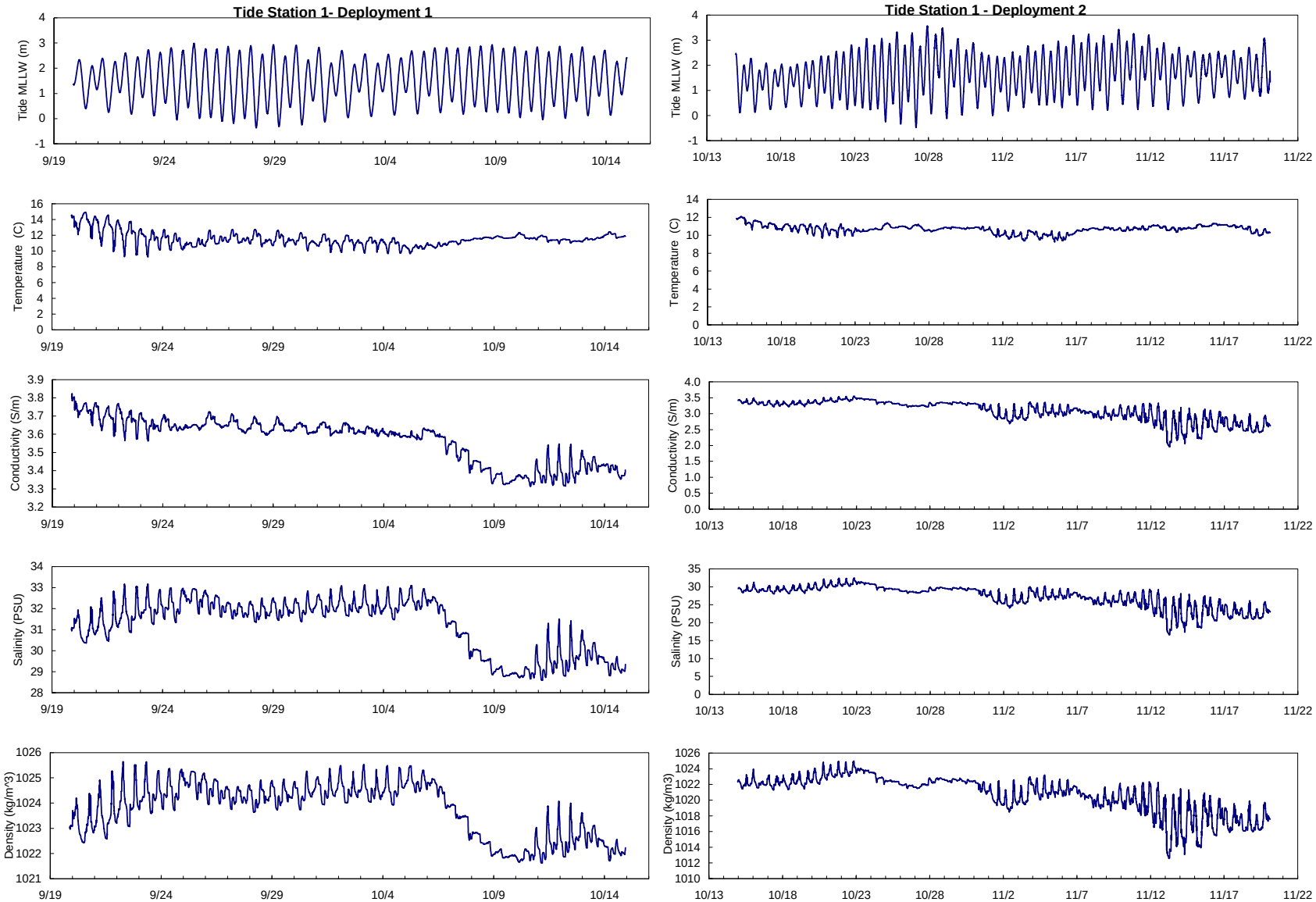
Scale: 1" = 2.5 Nautical Miles

Drawn By: DBH	Checked By: dps	Date 12/27/99	Project No. 0224b-710	File Name: site locations.dwg

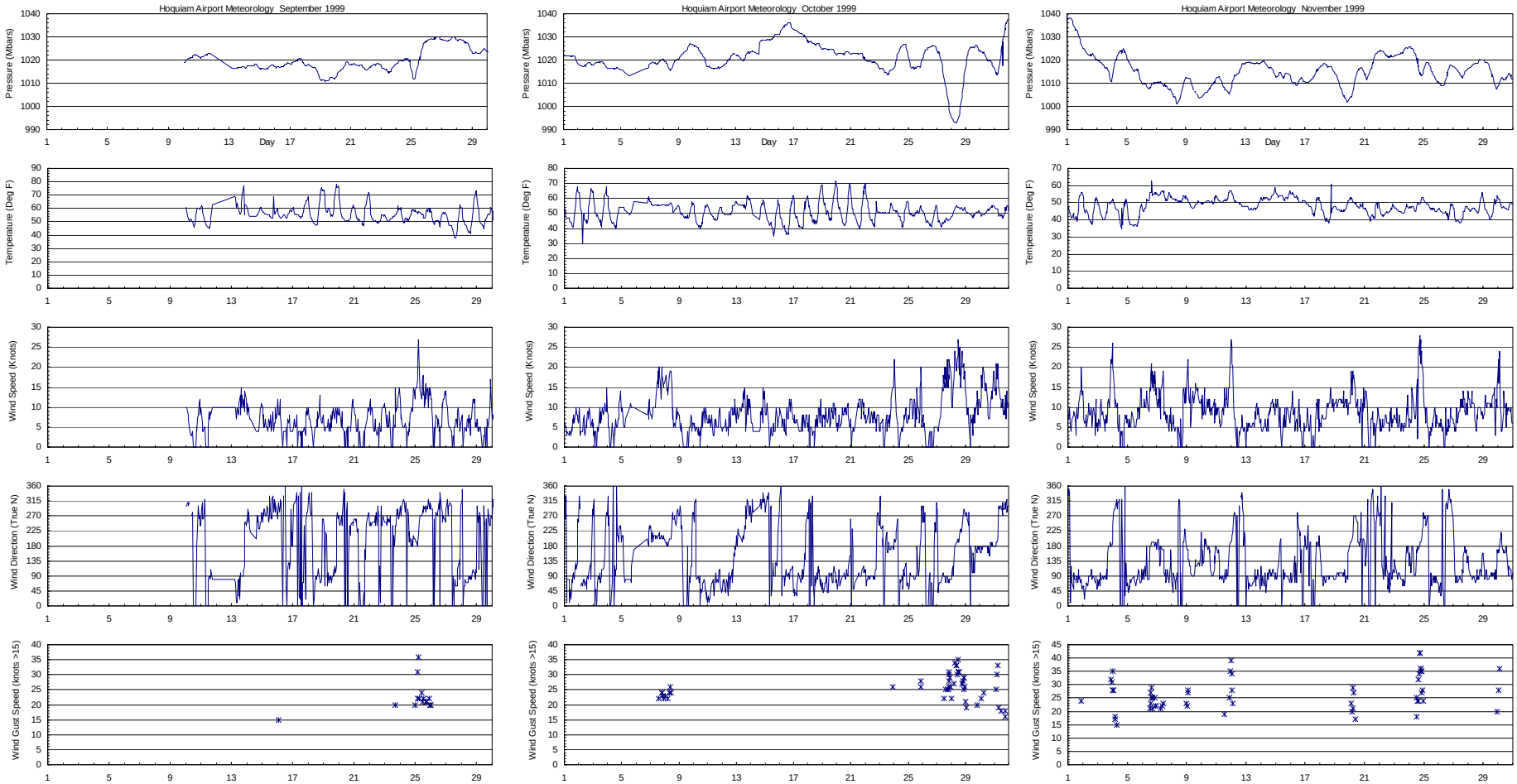
Water Level Station Info

		Sensor Elevation*		Location NAD83	
Tide Station	Monument Surveyed to	NAVD 88 (m)	MLLW (m)	Latitude	Longitude
Tide #1 (USCG1)	"Tidal 2 1952"	-2.20	-1.74	46.9047	124.1051 (Estimated)
Tide #2 (Bay Bridge)	"Gunville2"	-2.29	-1.83	46.8622	124.0695 (Actual)
Tide #3 (North Bay)	GH County digital Mon	-0.99	-0.53	47.0415	124.0655 (Actual)
Tide #4 (Aberdeen)	"Tidal 5 1934"	-2.05	-1.59	46.9659	123.8584 (Estimated)
Tide #5 (Montesano)	NW Corner Sect. 14 T17N R8W. W.M.	-0.75	-0.29	46.9453	123.6321 (Estimated)
Tidal 2 1952		4.65	5.11		

Sample Water Level, Sta 1

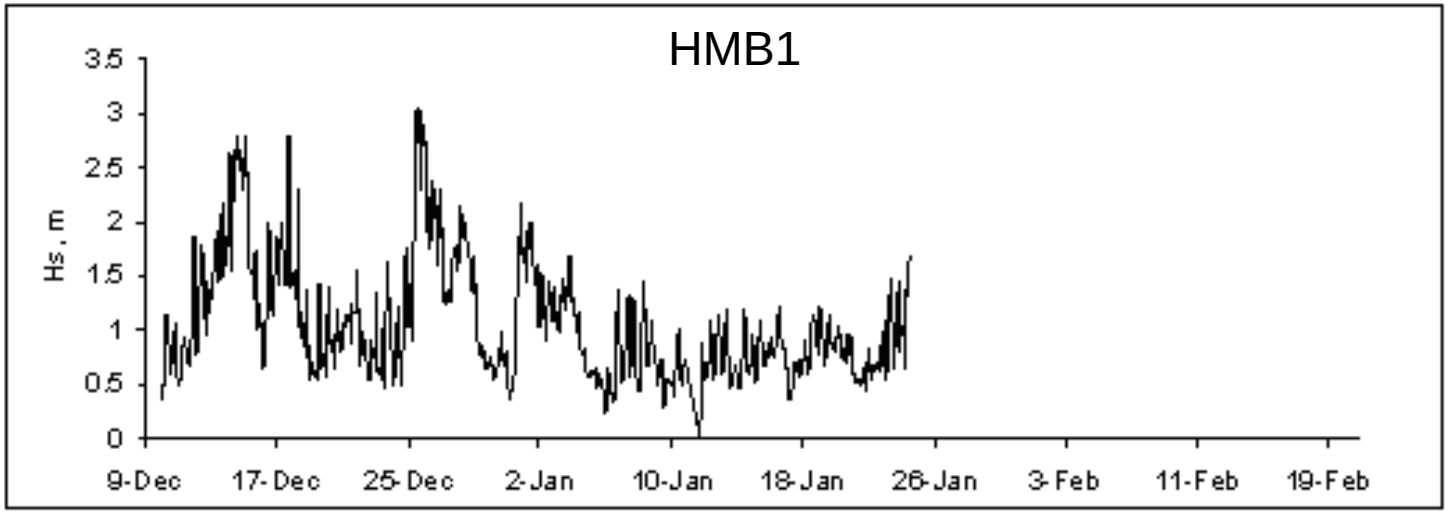


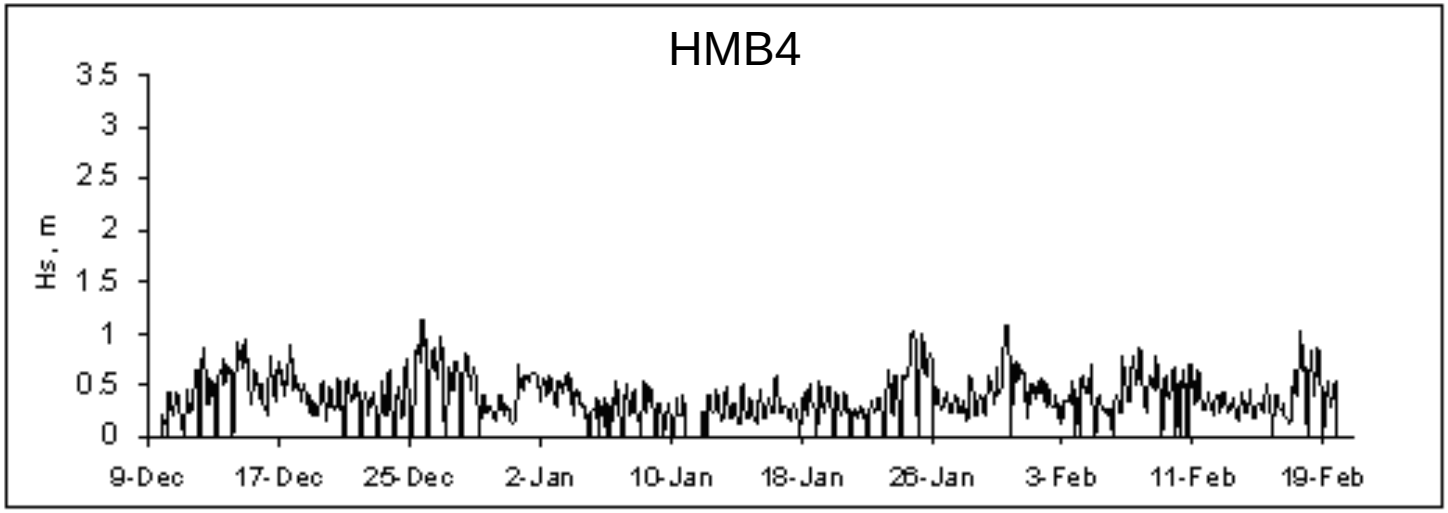
Hoquiam Airport Meteorological Data



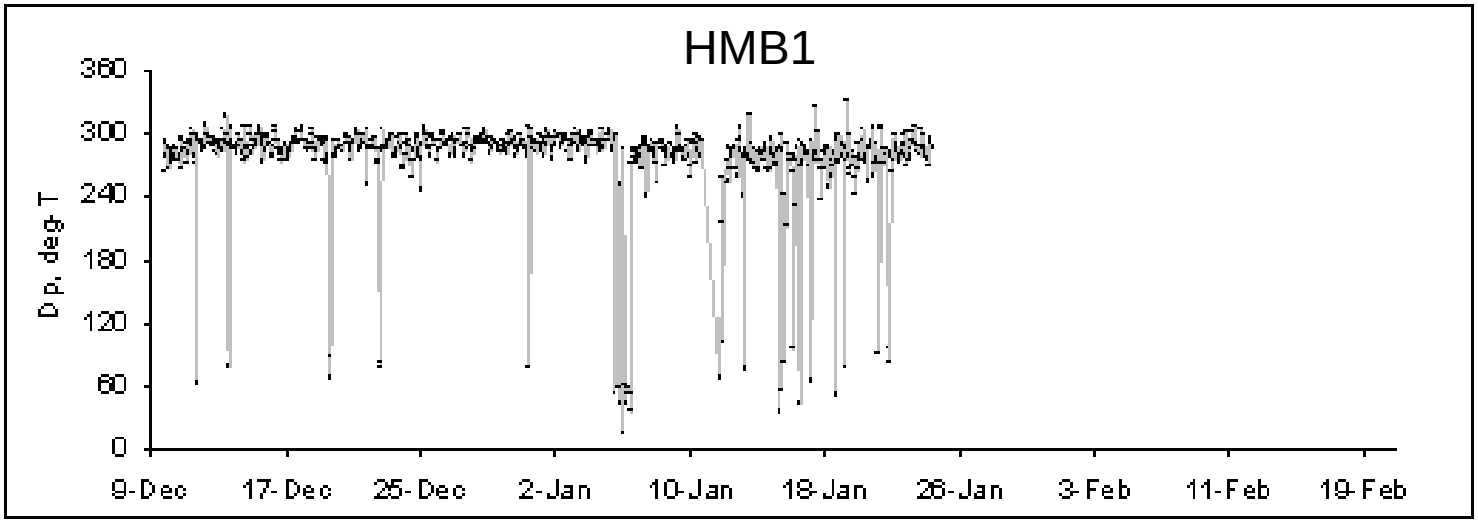
Data Stations: March – April 2002
November 2003 – February 2004

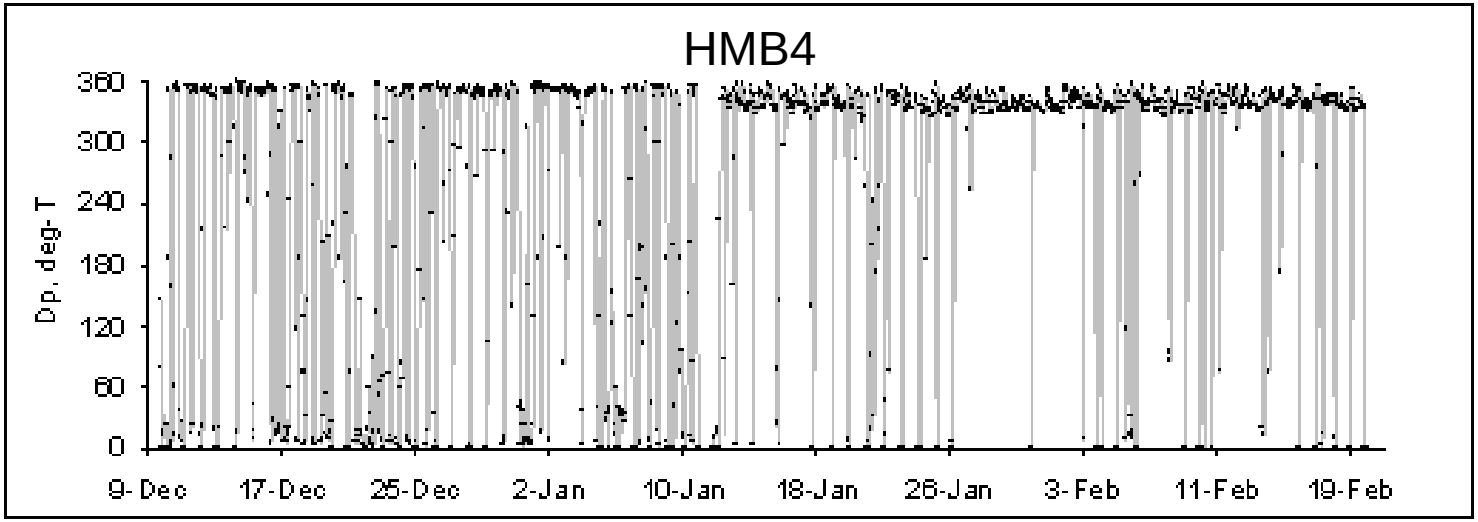
Wave Height, HMB1 & HMB4



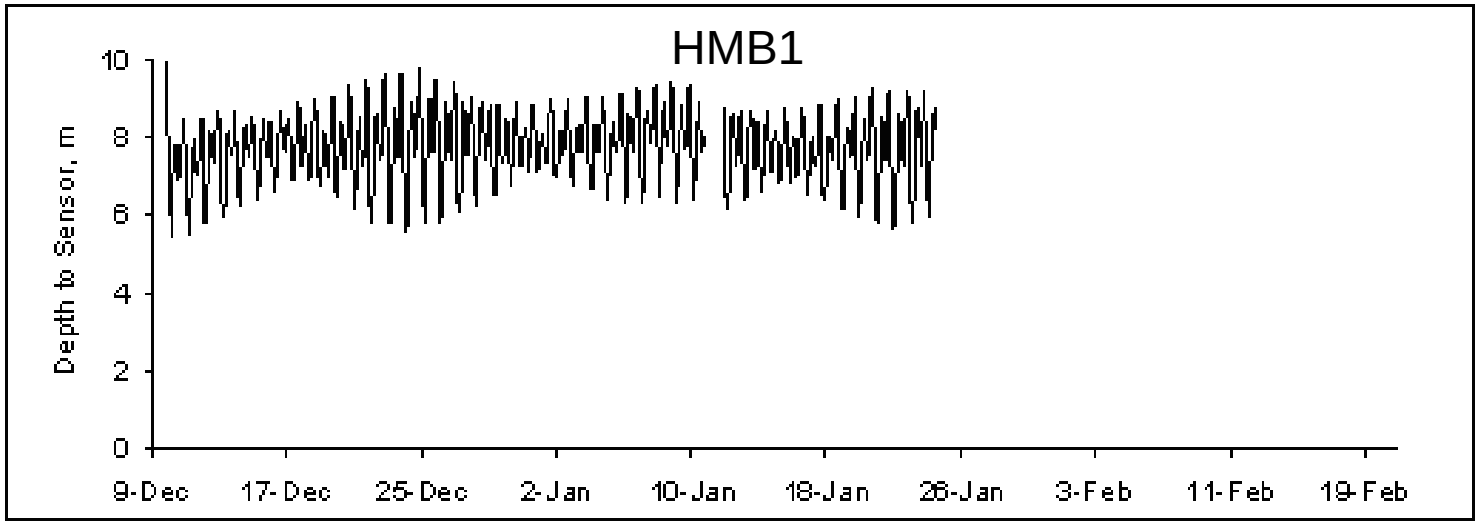


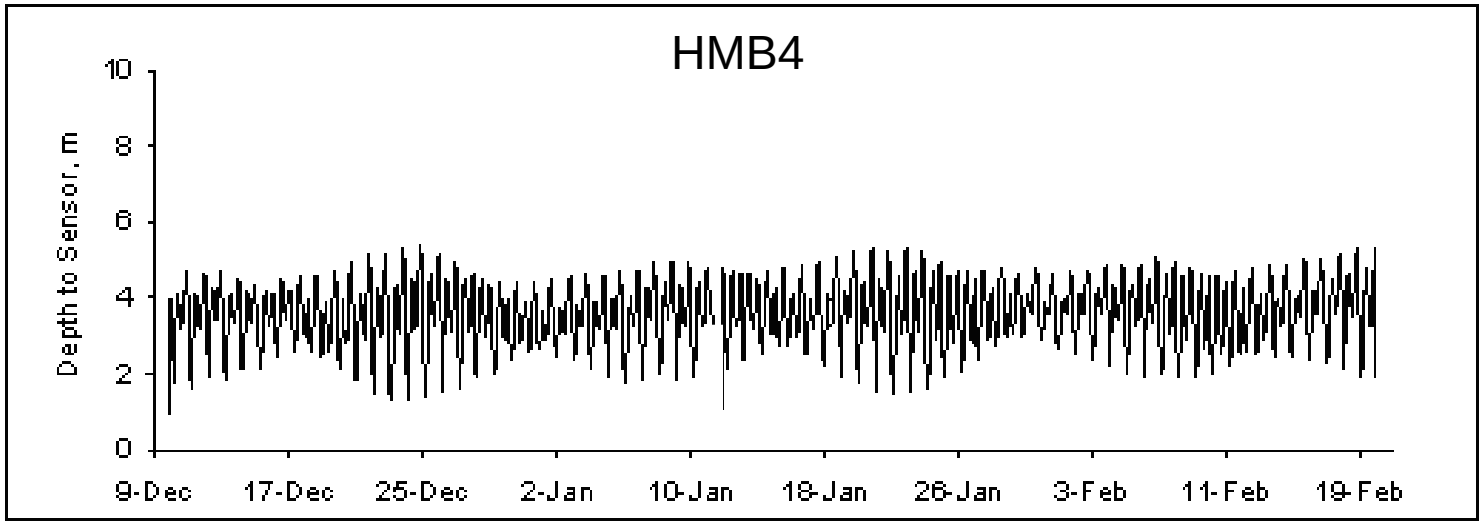
Wave Direction, HMB1 & HMB4



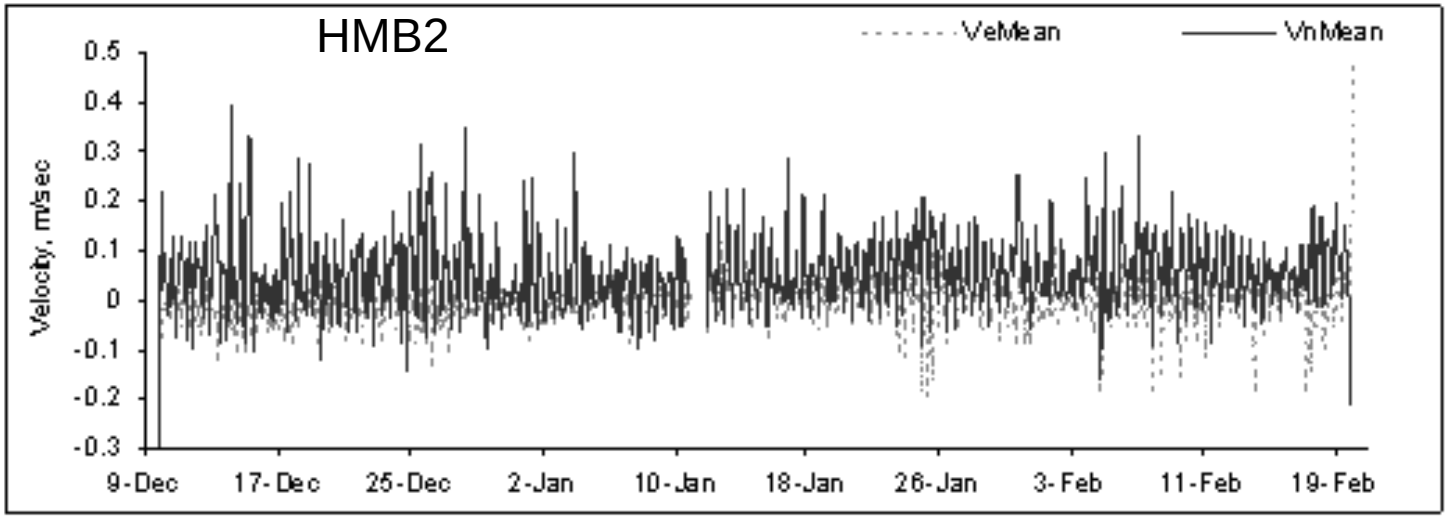


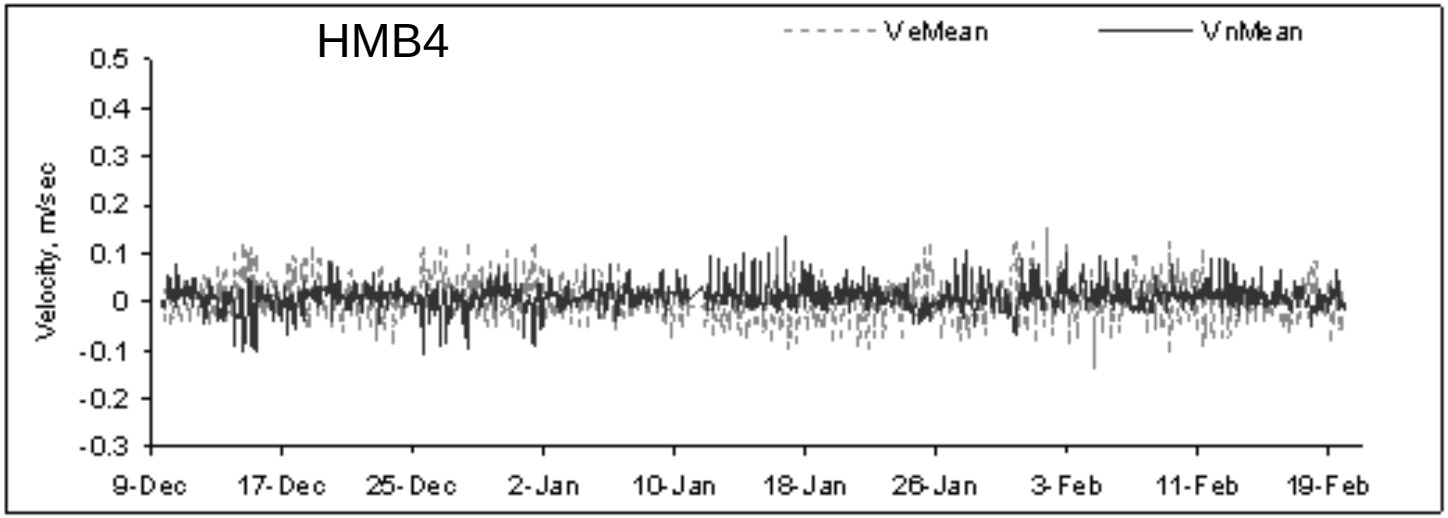
Water Level, HMB1 & HMB4



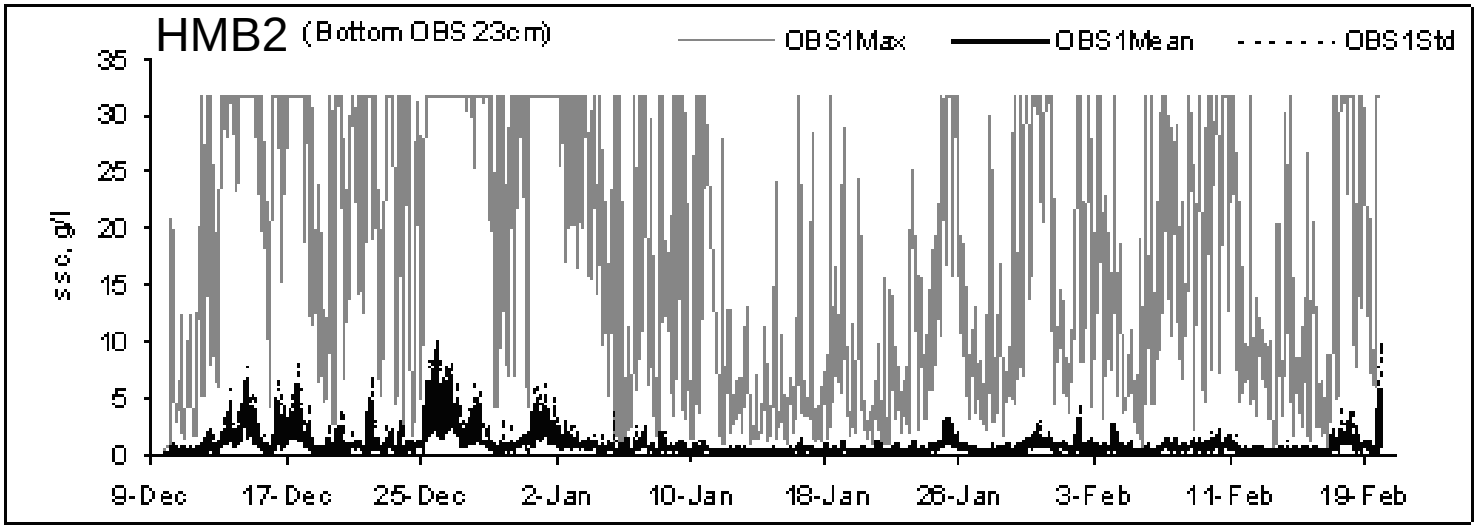


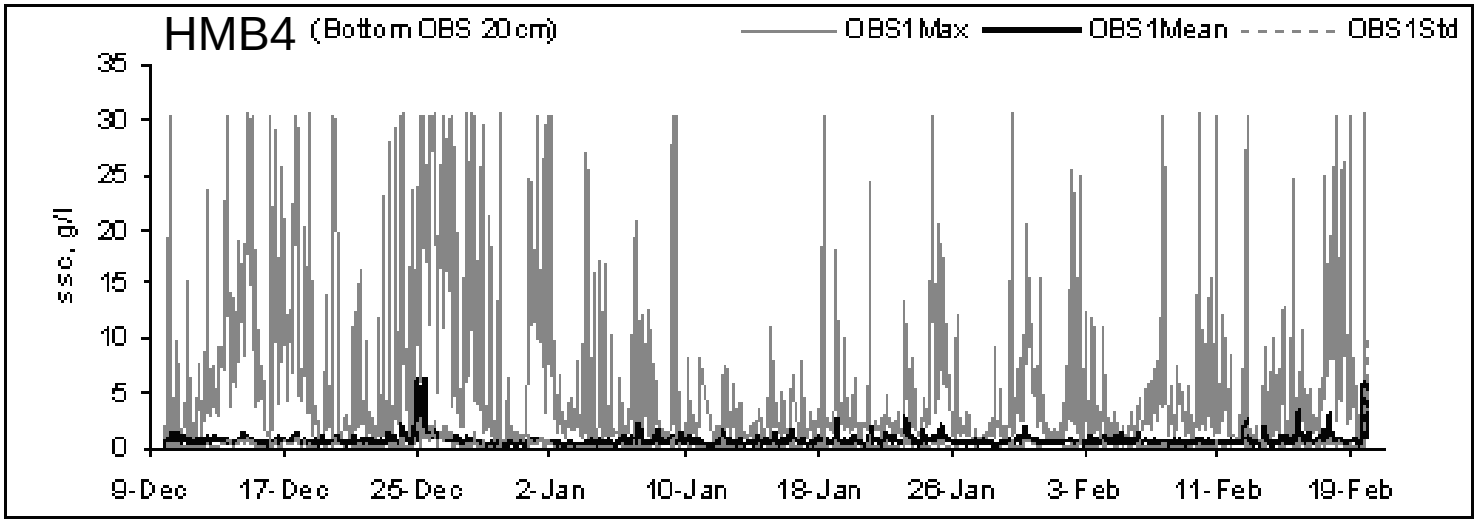
Current Velocity, HMB2 & HMB4





Bottom OBS, HMB1 & HMB4

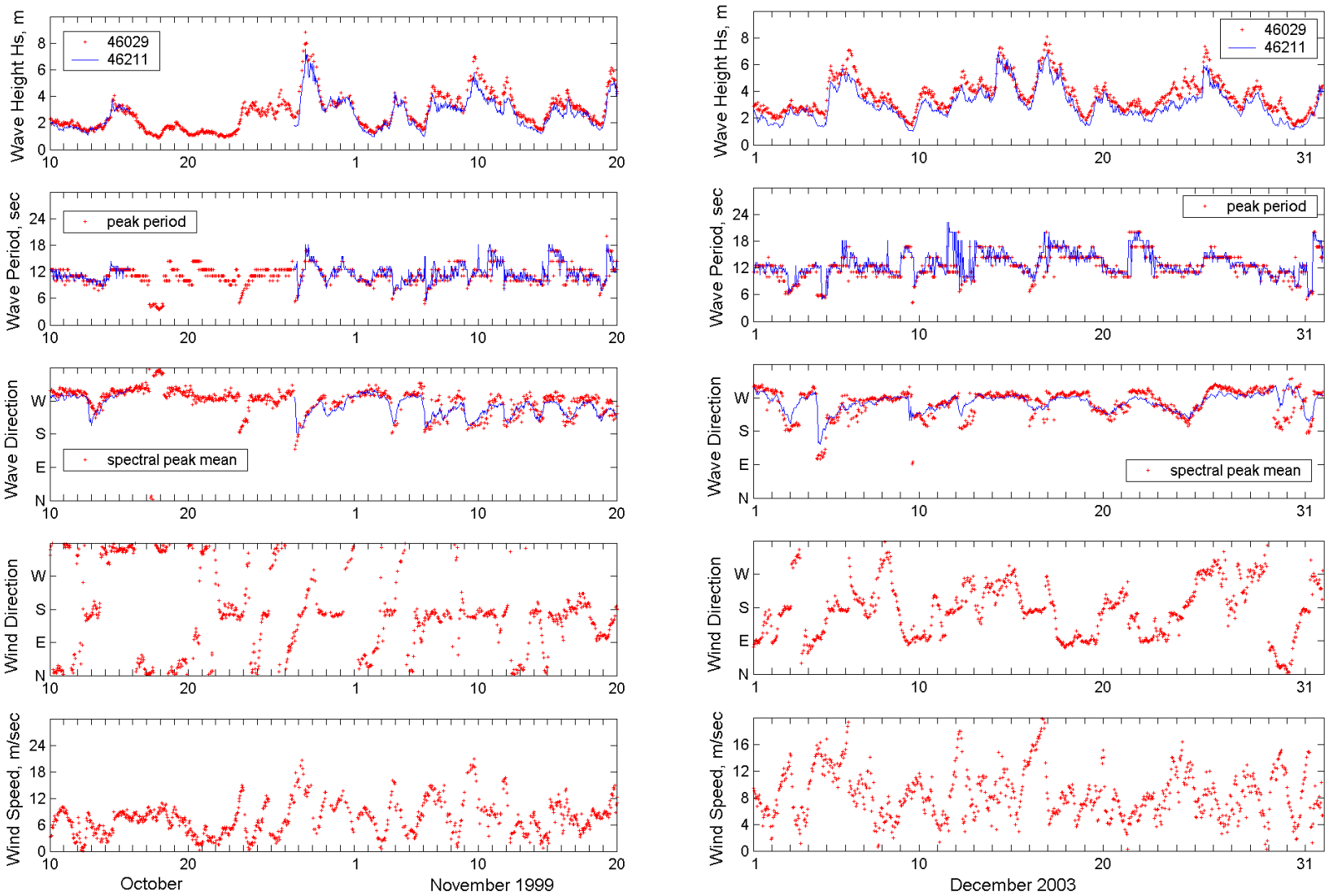




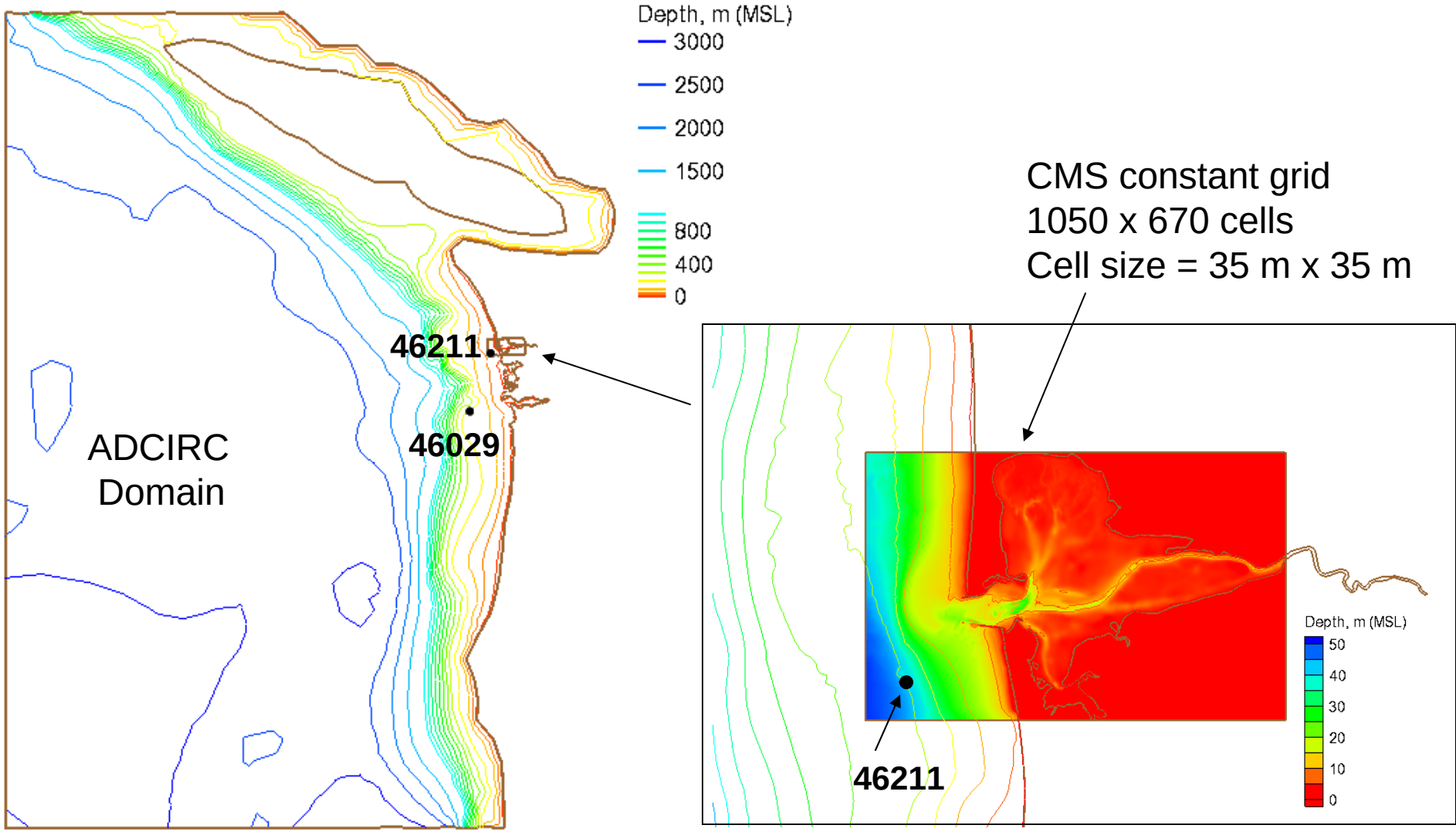
CMS Simulations

- 13 October – 12 November 1999
- 10 – 31 December 2003
- Incident waves from CDIP Buoy 46211 (036)
- Bathymetry data from DEM and NWS database
- Wind data from Buoy 46029 and NOAA stations
- Boundary conditions by regional ADCIRC

Buoy Wind Wave Data

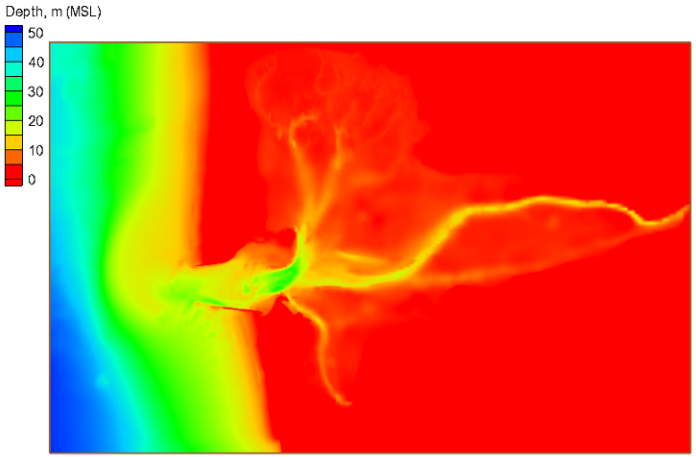


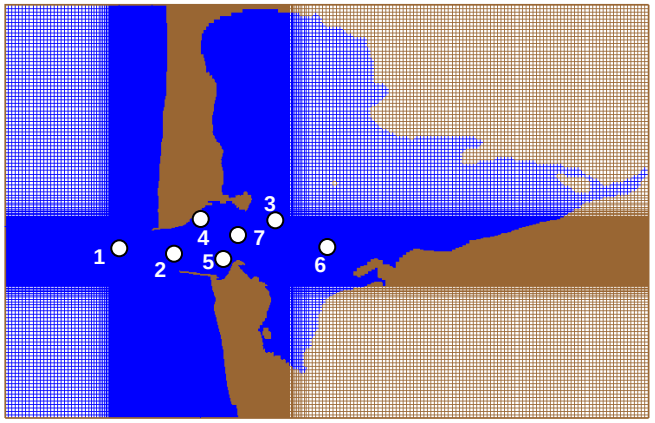
ADCIRC & CMS Domain for 1999 Run



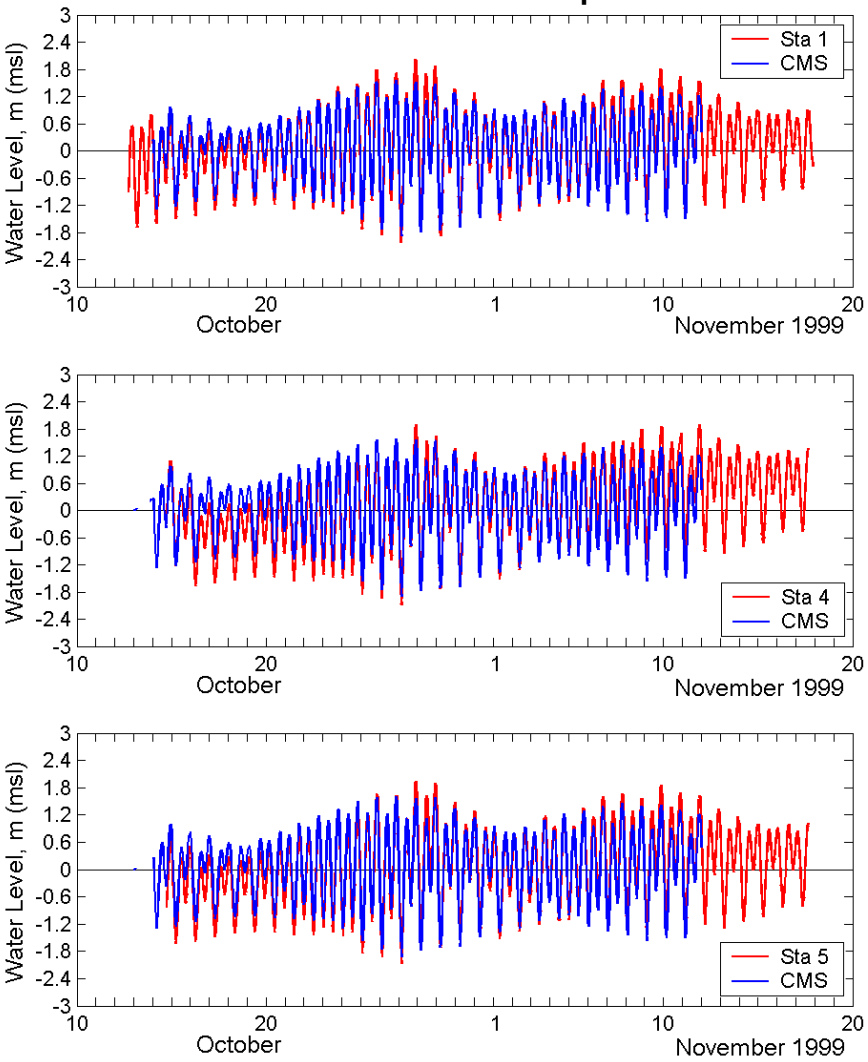
CMS Variable Grids for 1999 Run

400 x 240 cells
Cell size: 40 m x 30 m to 200 m x 200 m

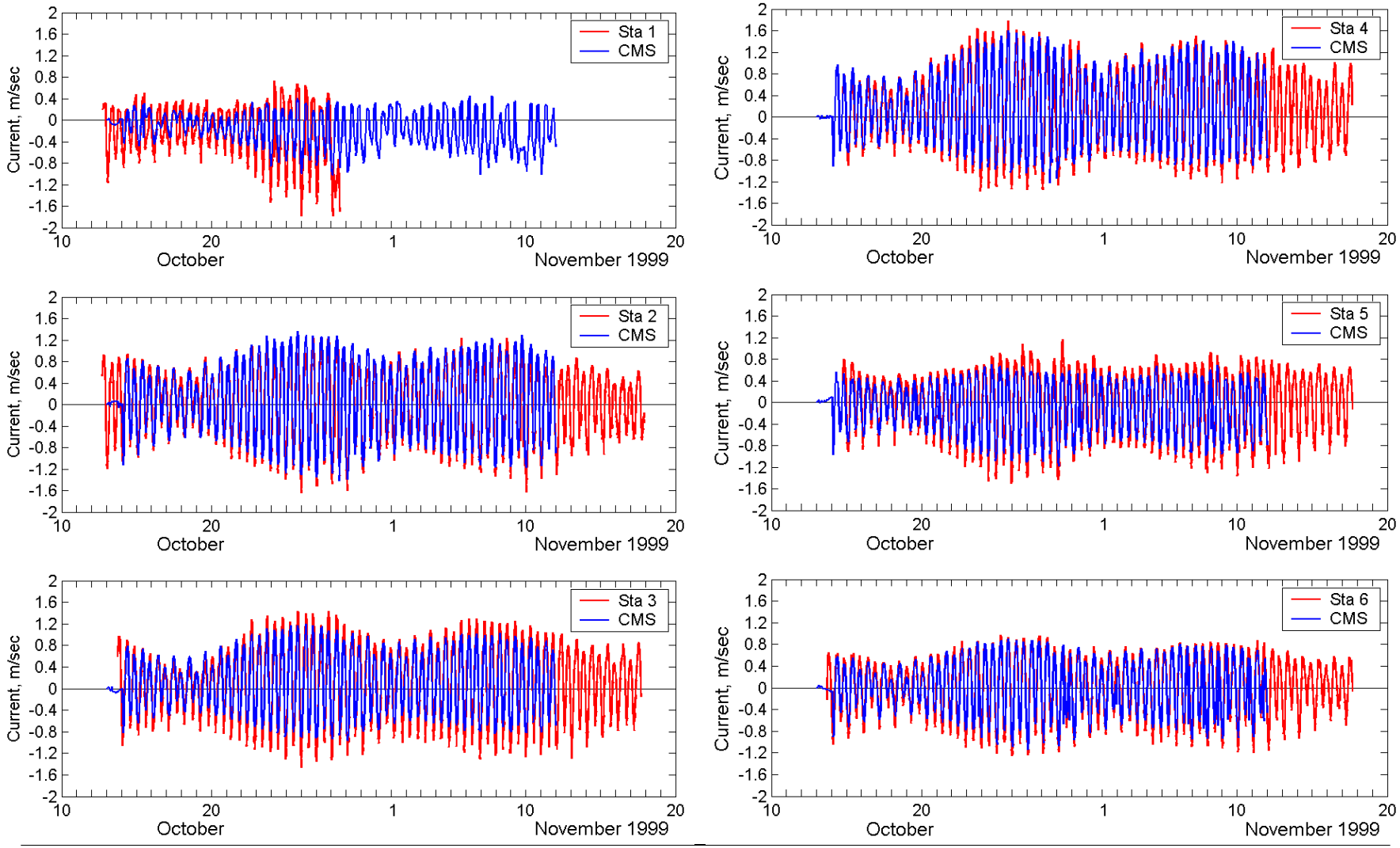




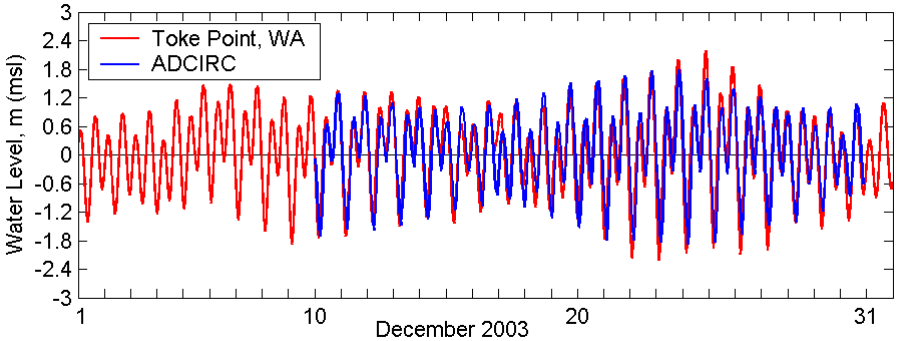
Water Level Comparison

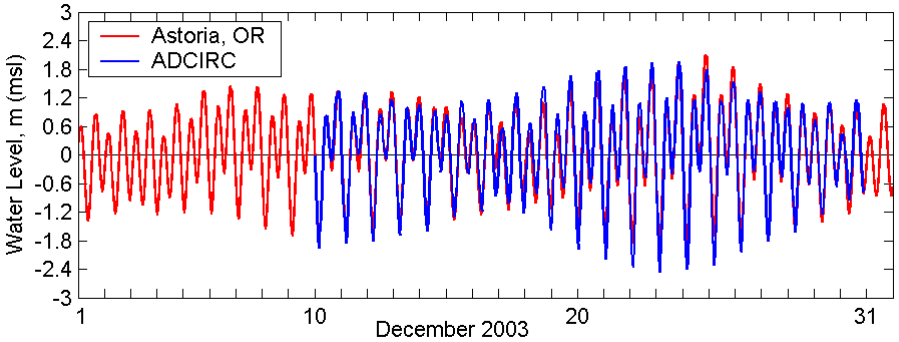


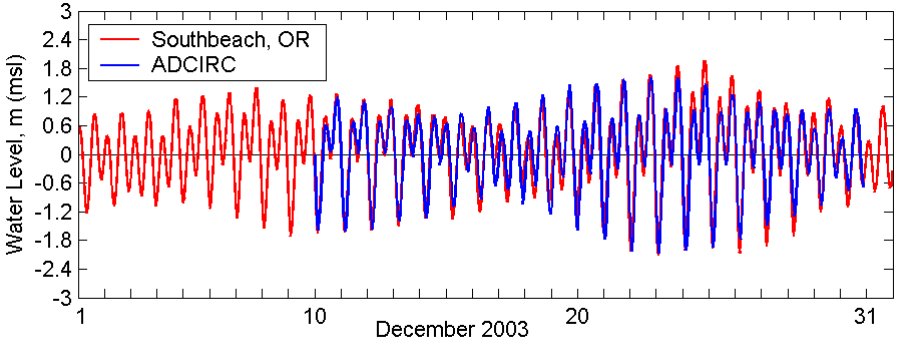
Current Velocity Comparison

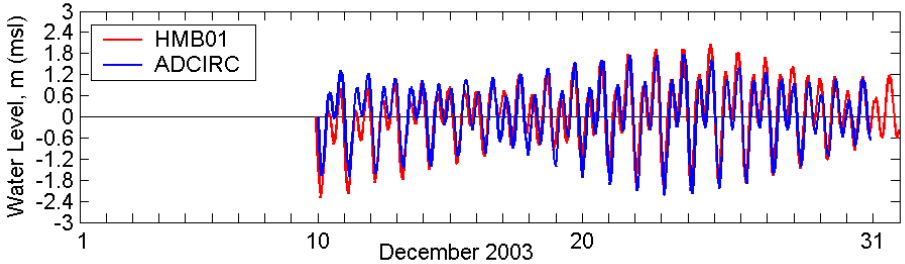


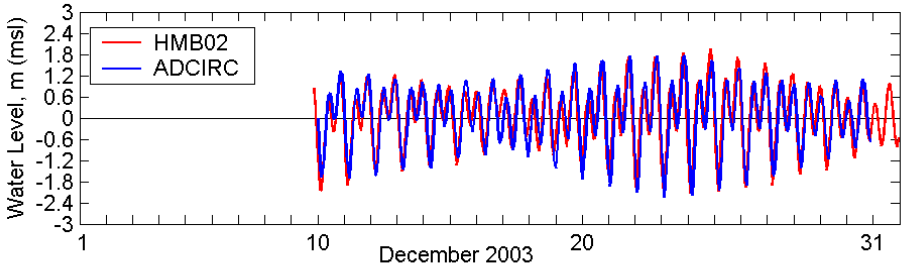
Water Level Comparison, 10-31 Dec 2003

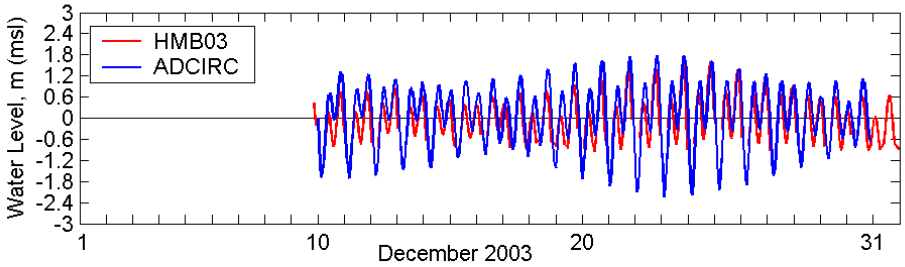


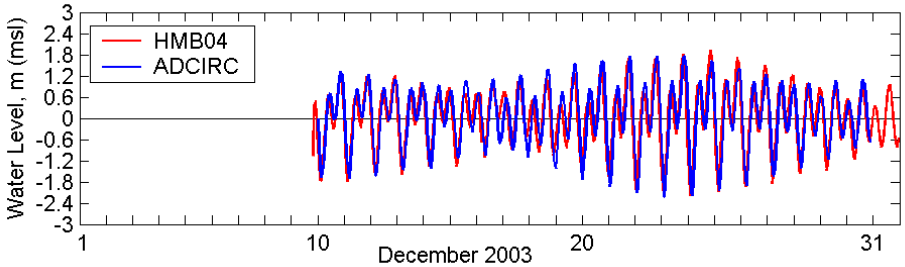










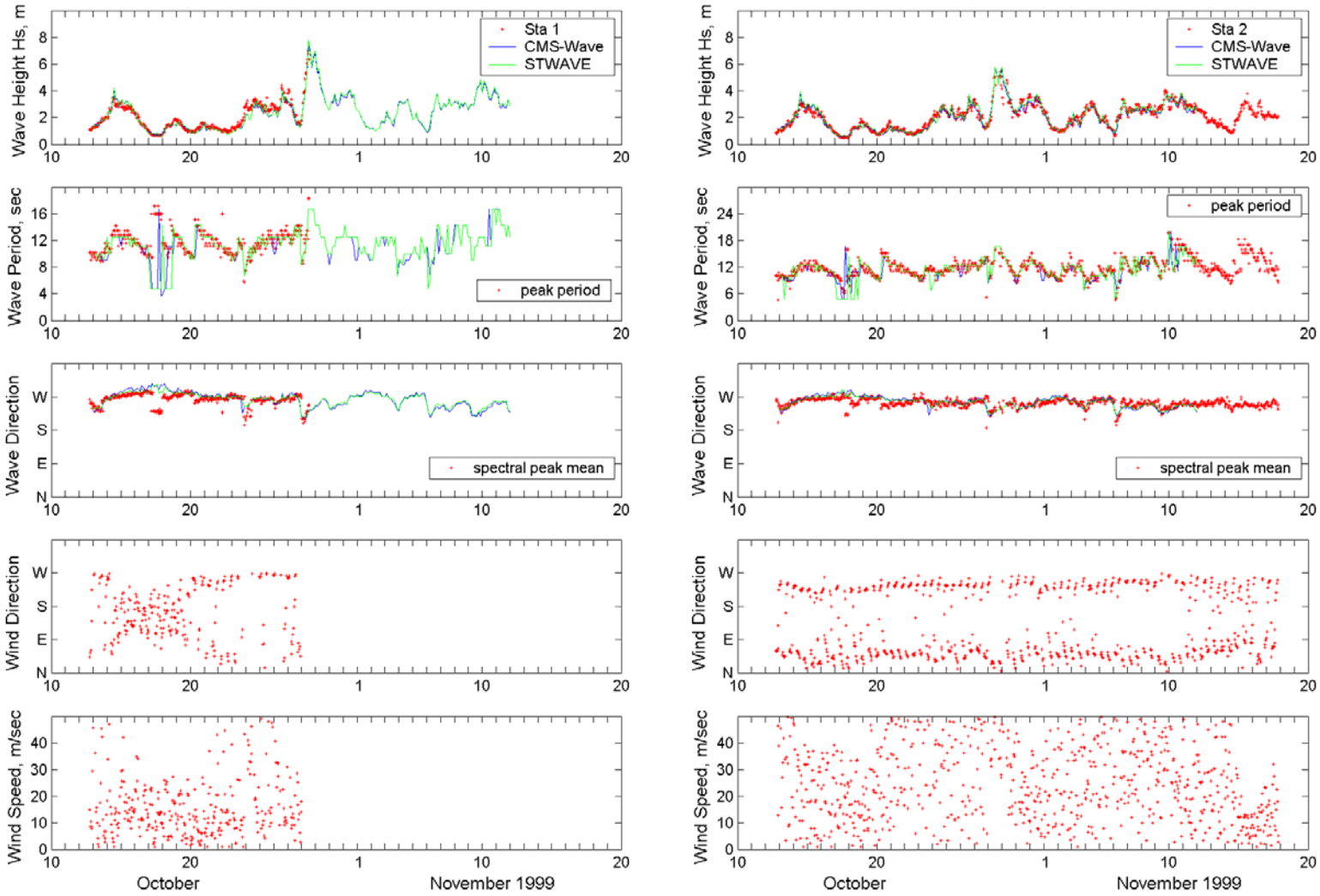


Run-Time Comparison*

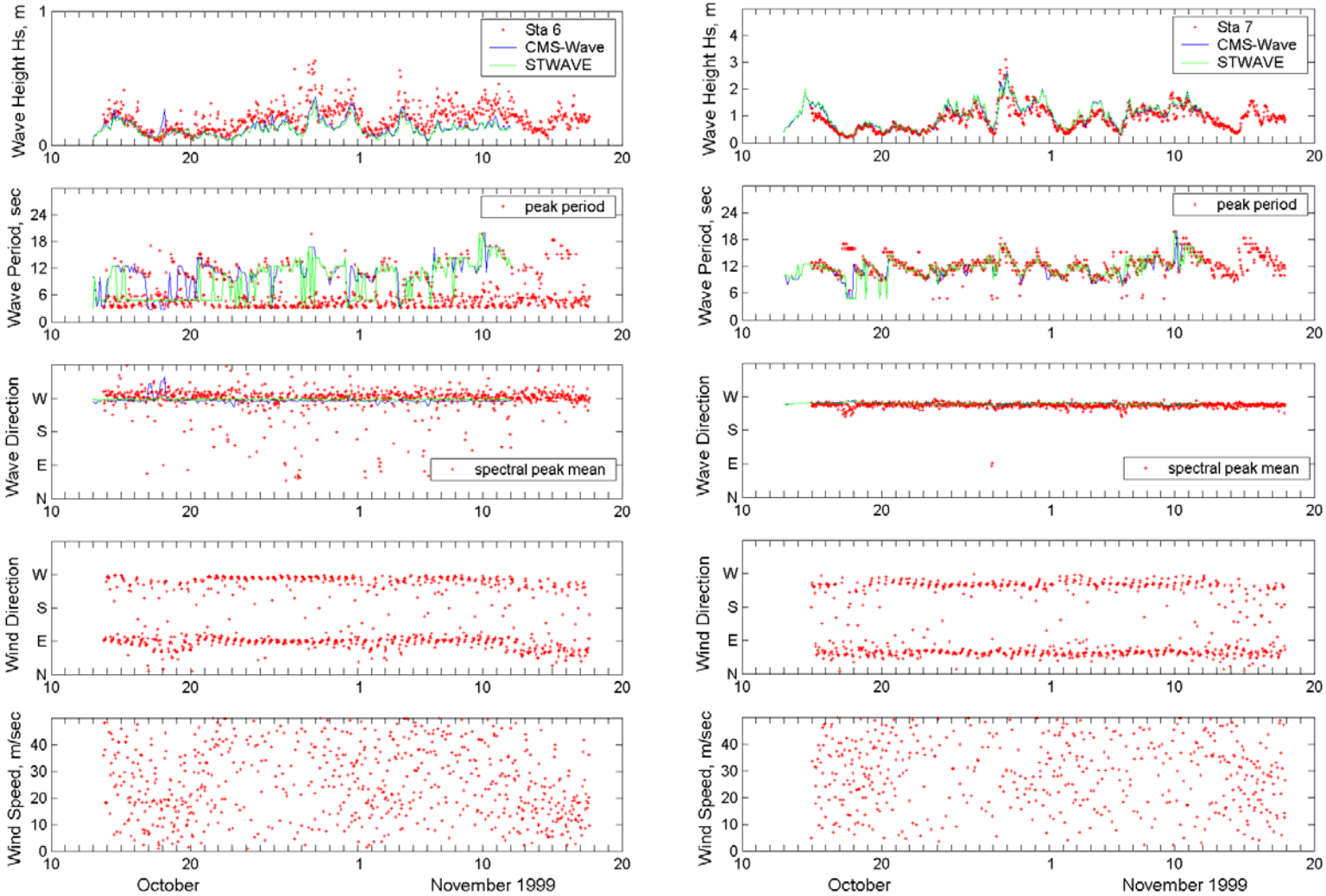
Simulation	CMS-Wave Variable grid (400 x 240 cells)	CMS-Wave Square grid (1050 x 670 cells)	STWAVE Square grid (1050 x 670 cells)
October – November 1999 Run (30 days)	5 hr	16 hr	56 hr
December 2003 Run (21 days)	3.5 hr	12 hr	42 hr

* Based on one-single processor on a 2.5 GHz PC

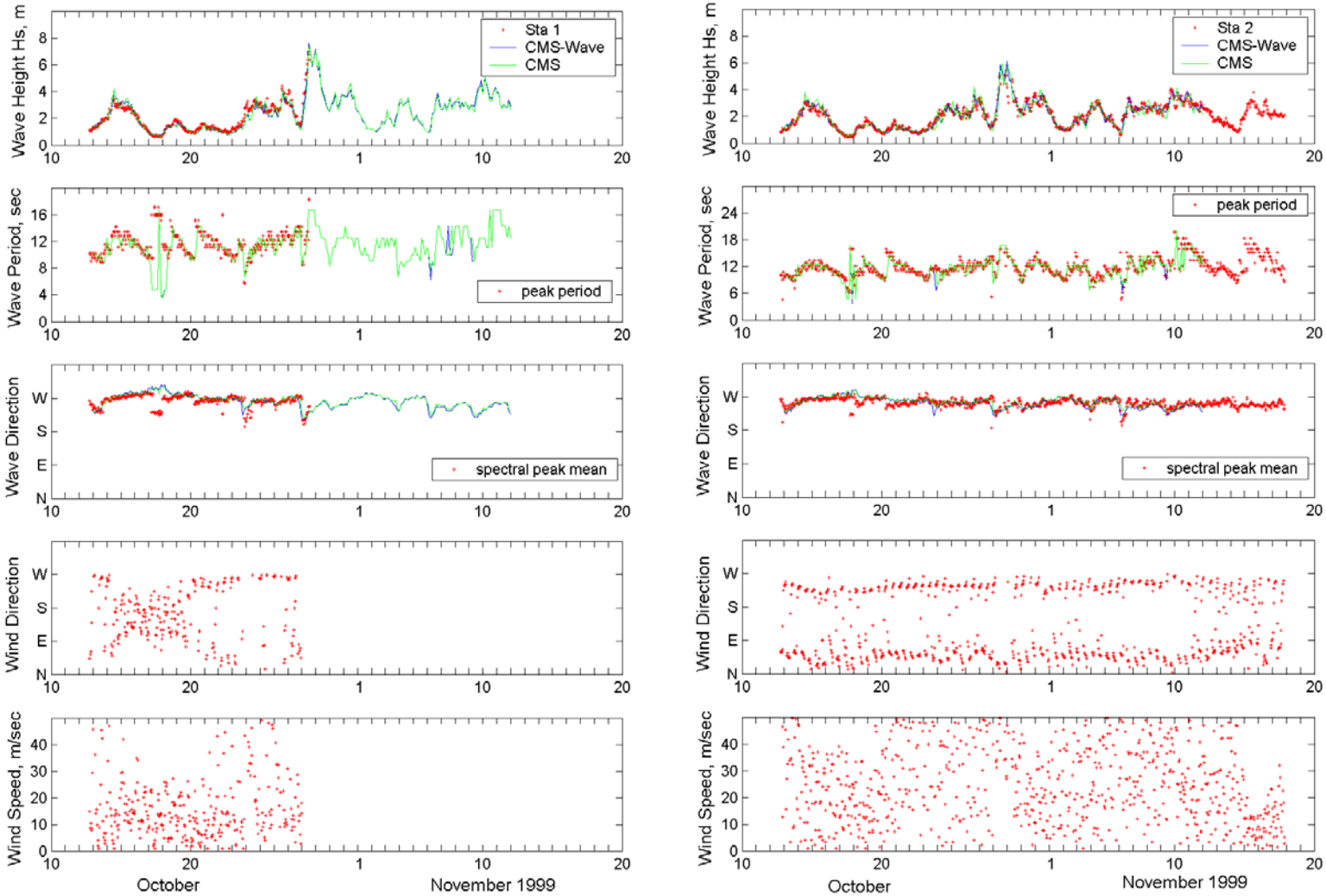
Wind and Wave Plot – Sta 1 and 2 Square-Grid Run



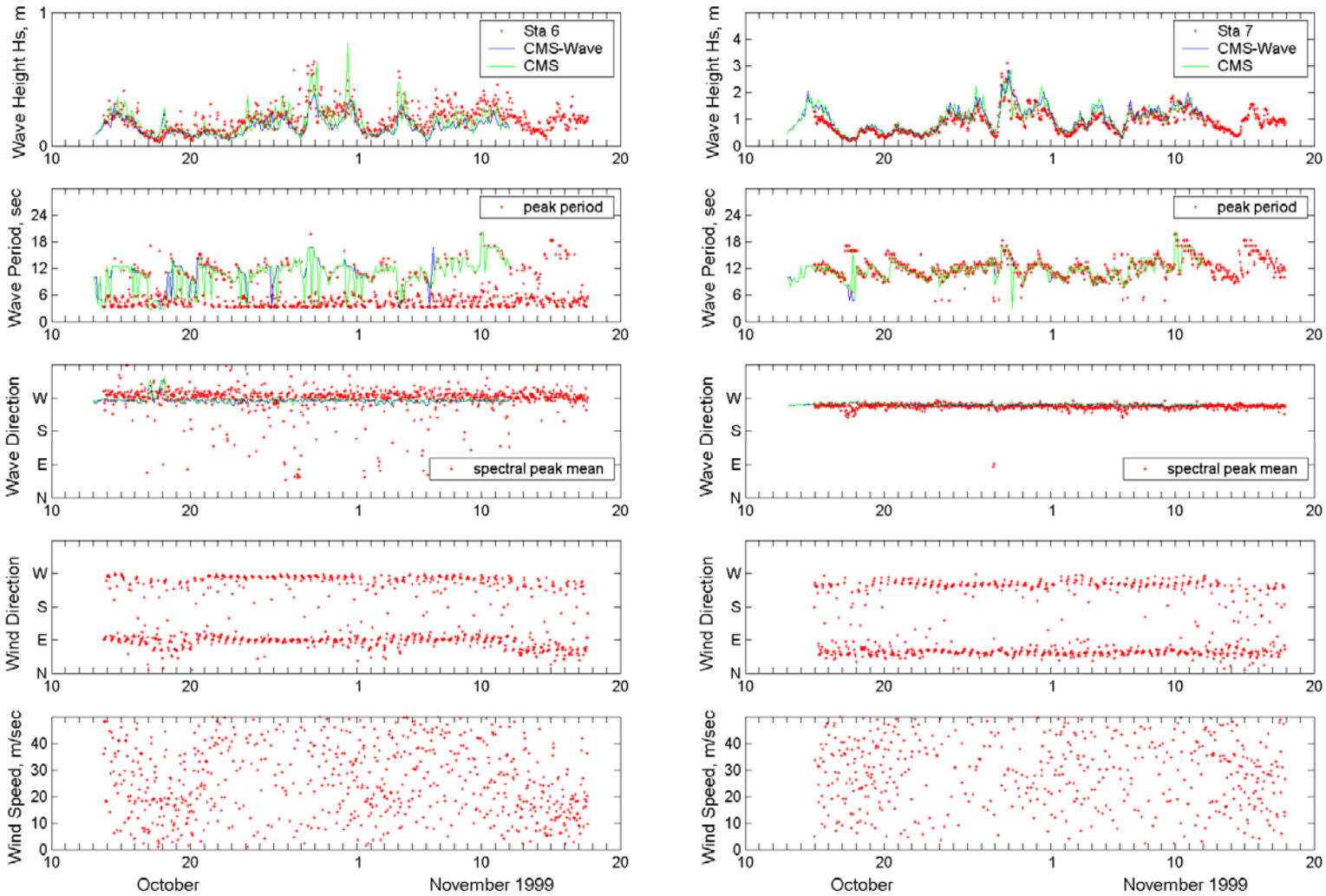
Wind and Wave Plot – Sta 6 and 7 Square-Grid Run



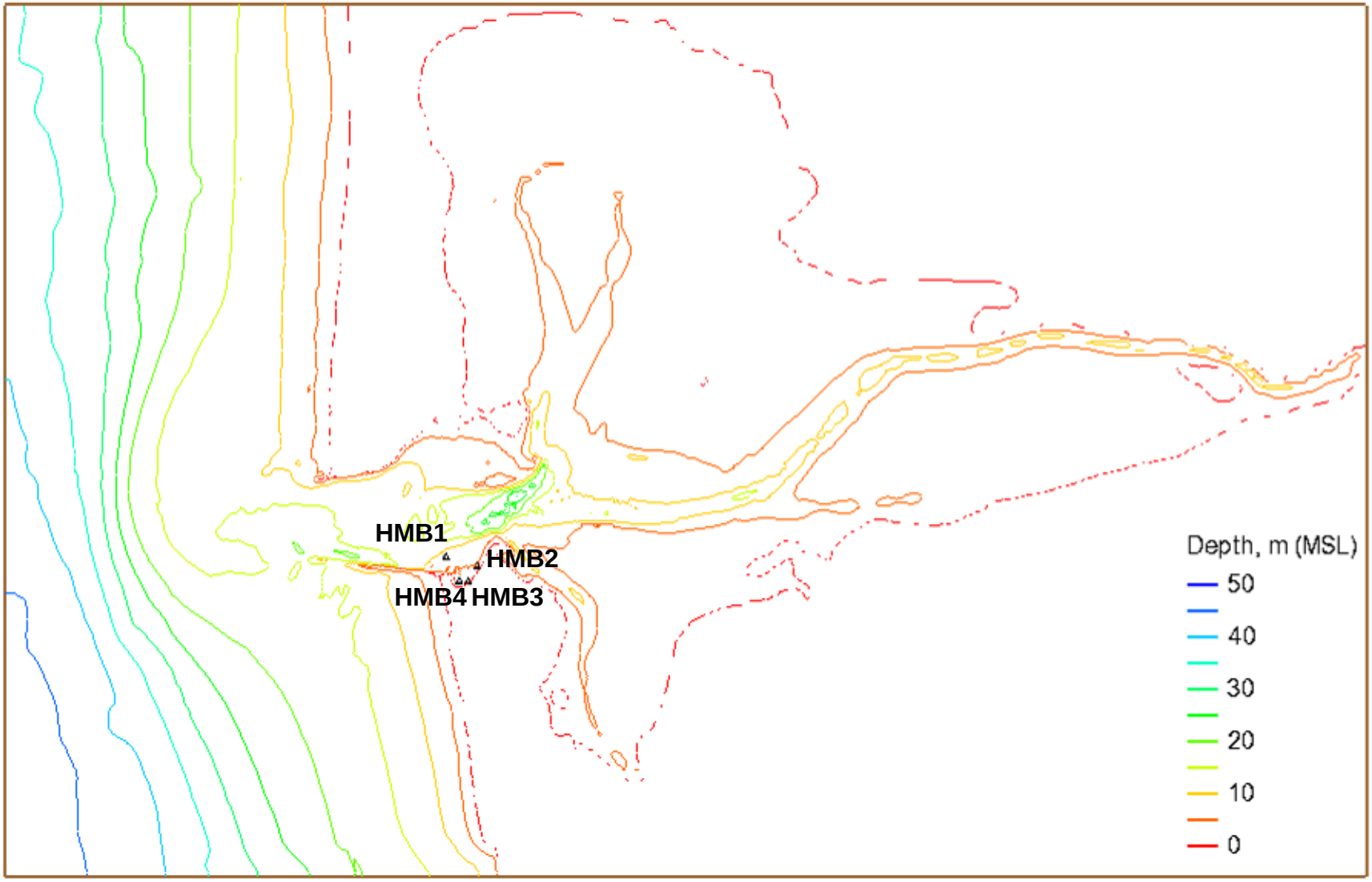
Wind and Wave Plot – Sta 1 and 2 Variable-Grid Run



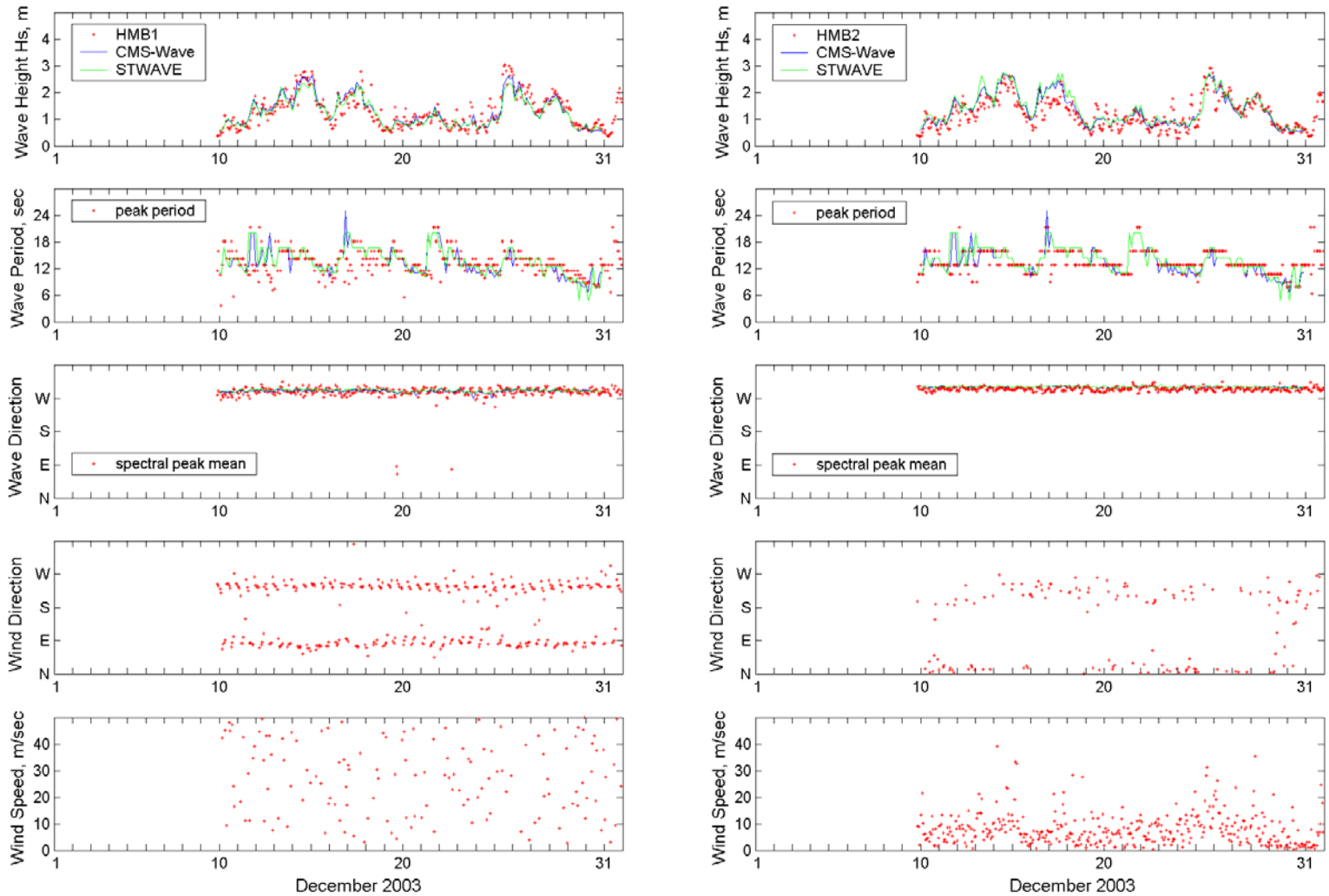
Wind and Wave Plot – Sta 6 and 7 Variable-Grid Run



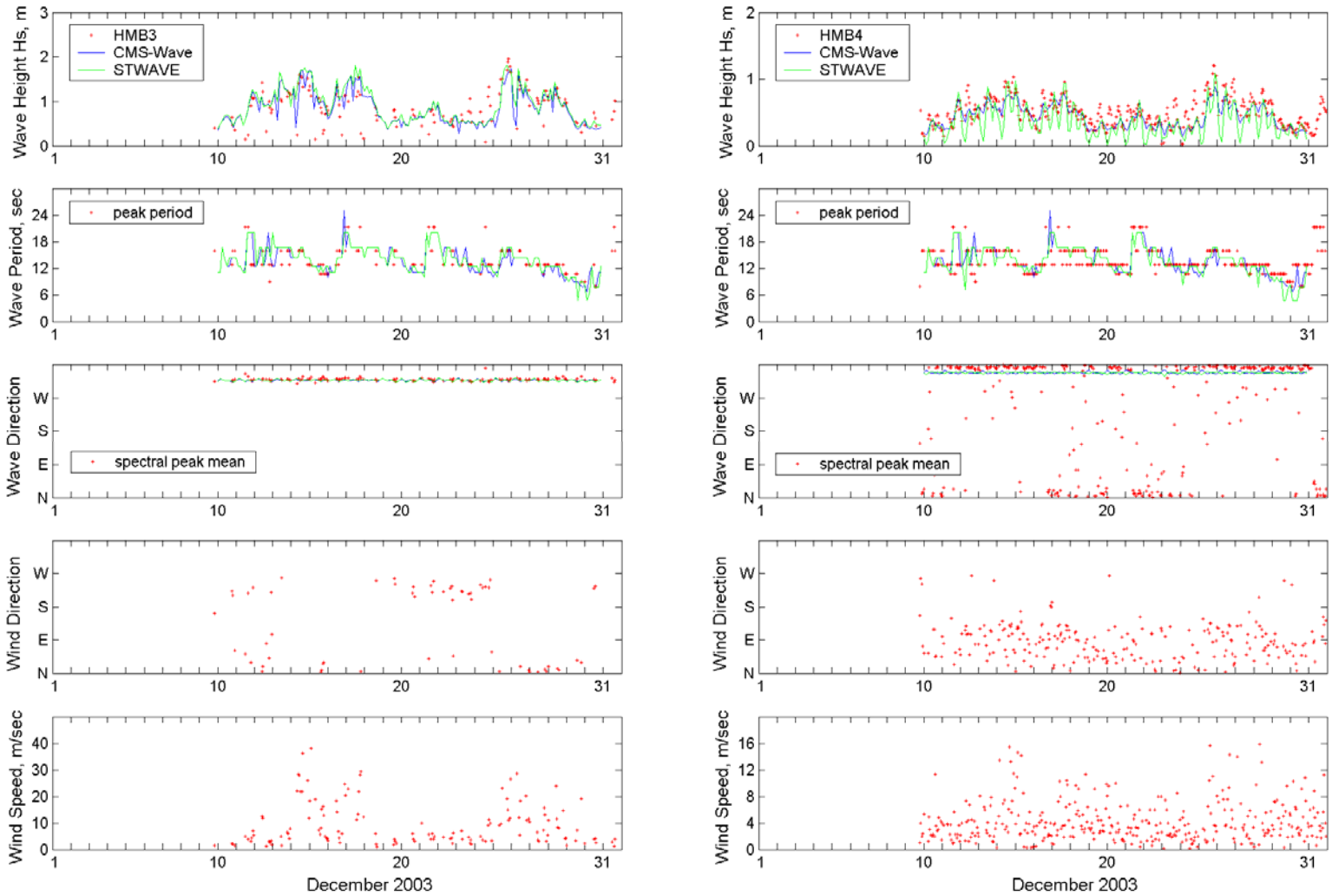
CMS Domain and HMB Stations



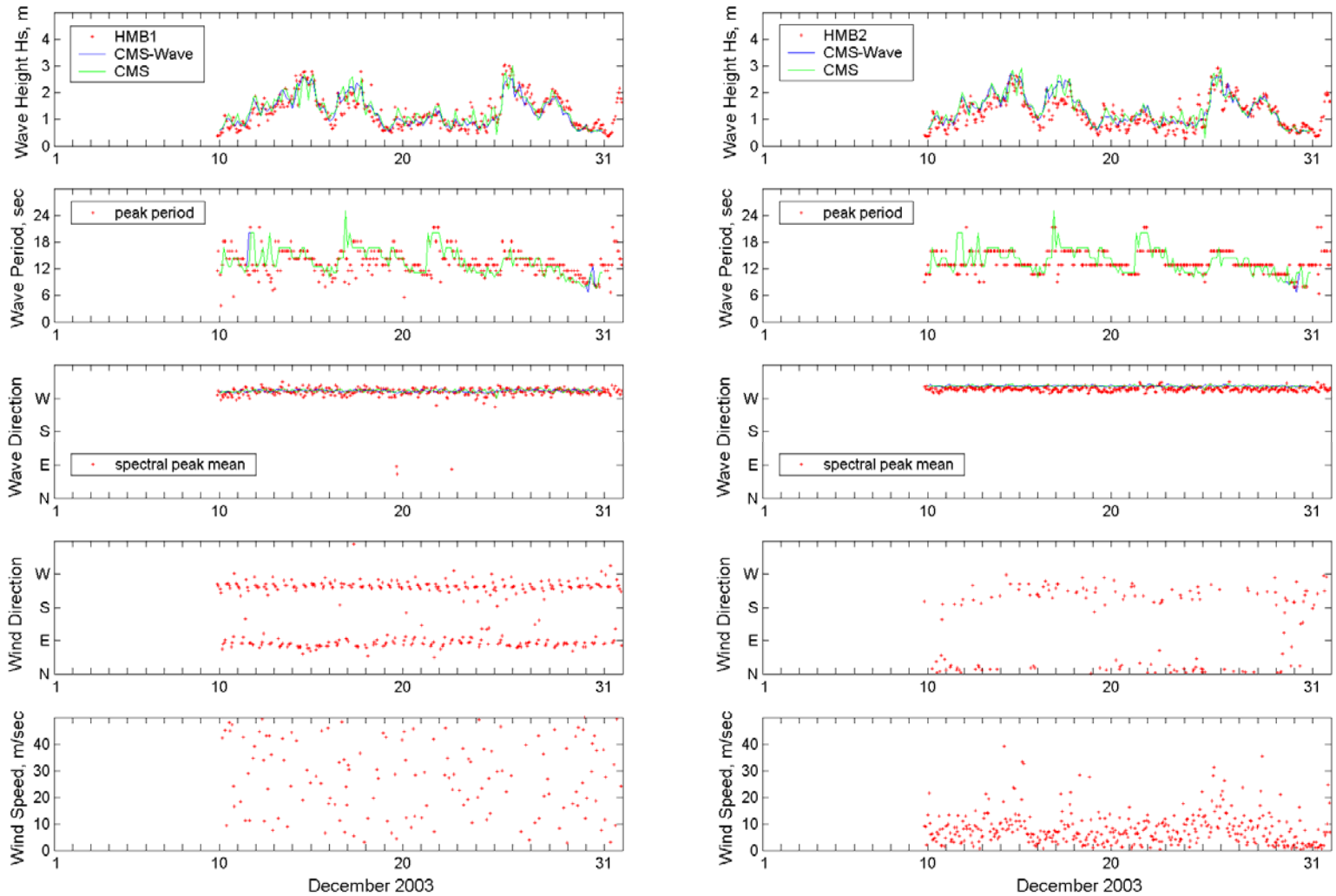
Wind and Wave Plot – HMB1 & HMB2 Square-Grid Run



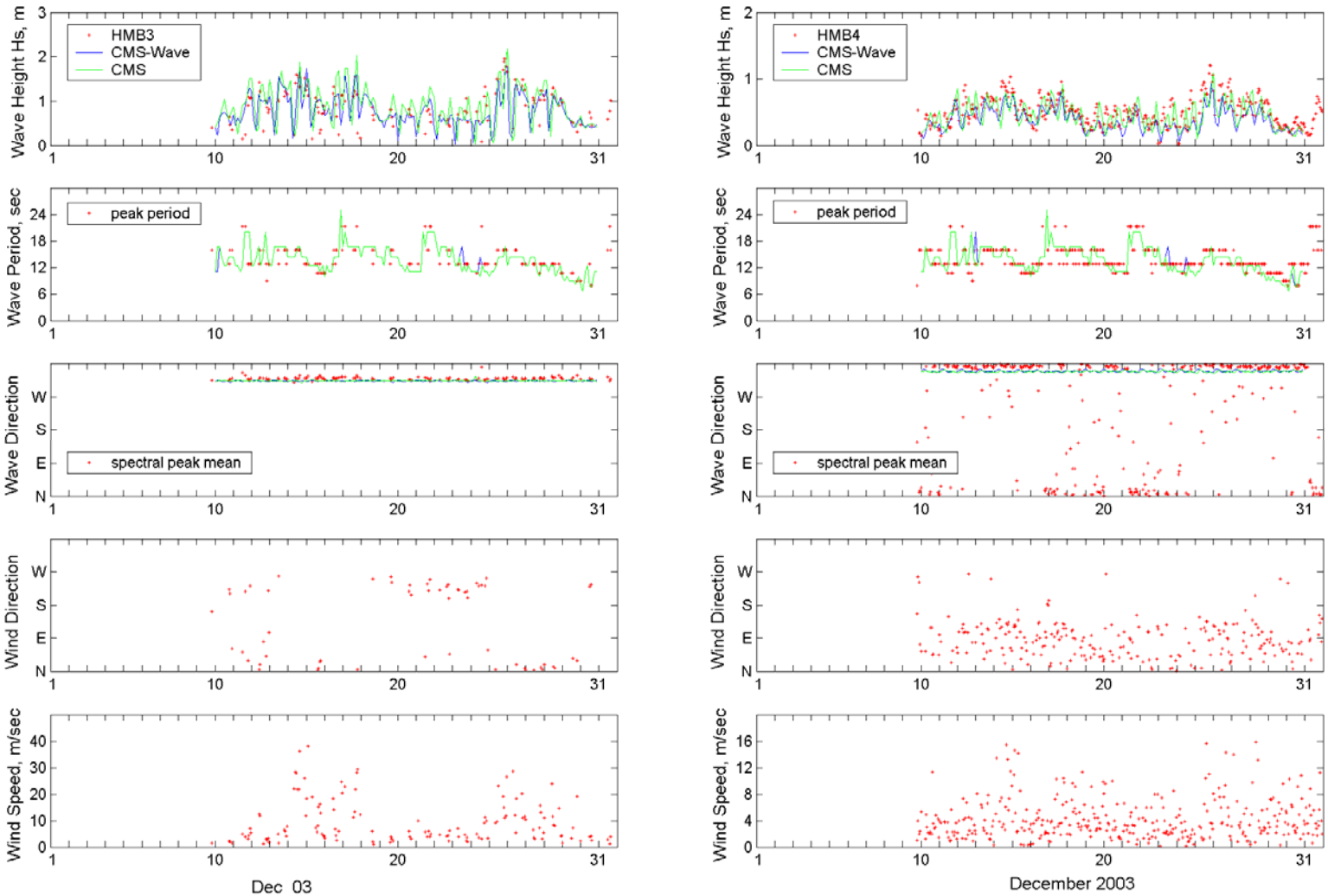
Wind and Wave Plot – HMB3 & HMB4 Square-Grid Run



Wind and Wave Plot – HMB1 & HMB2 Variable-Grid Run



Wind and Wave Plot – HMB3 & HMB4 Variable-Grid Run



Conclusions

- CMS-Wave and STWAVE comparisons on the same square grid shows CMS-Wave is ~ 3.5 times more efficient than STWAVE. CMS-Wave produces better wave diffraction (HMB4).

- CMS-Wave runs more efficient on a variable grid than square grid – 3 times faster in the Grays Harbor runs.

- CMS-Wave coupled to CMS-Flow produces better wave results in the wave diffraction area (HMB4) and inside the bay (Sta 6).