

Appendix K

Tidal Current Constituents

Appendix K. Tidal Current Constituents

The hourly ADCP current meter data was analyzed to compute the principle component current ellipse parameters. Components for the seven largest harmonic constituents (M2, K1, S2, N2, O1, P1, and M4) were extracted from the data, and summarized in the following table at four depths. At each depth, the current meter record was averaged over the 10 meter interval centered on the depth before calculating the ellipse parameters using a least square fit method. The tidal current ellipses are summarized by four parameters (see Figure K-1):

semi-major axis (sema) – the maximum current velocity, given in cm/s

semi-minor axis (semi) – the current velocity perpendicular to the major axis, in cm/s

angle – inclination of the semi-major axis from the east (x-) axis; in degrees, positive counter-clockwise.

phase – temporal lag of the currents, or the time of maximum velocity relative to a chosen origin of time. Expressed in degrees; time lag is the ratio of the phase angle to 360 degrees, multiplied by tidal harmonic period.

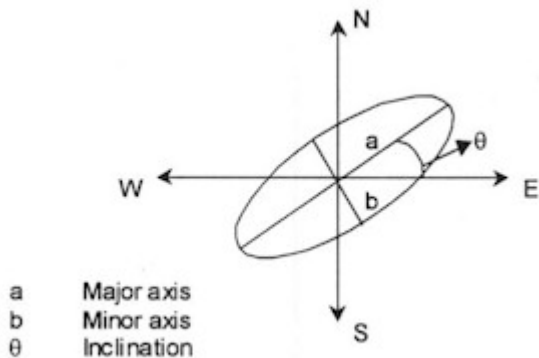


Figure K-1. Tidal current ellipse parameters. The major axis is twice the semi-major axis, similarly the minor axis is twice the semi-minor axis. The phase angle is not shown.

Meter	Depth	Mean	angle	M2				K1				S2				N2				O1				P1				M4			
				sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase
1	20	6.0	306	18.4	0.3	305	245	10.2	0.6	306	38	5.4	0.6	302	27	4.3	0.2	305	5	4.8	0.5	121	53	5.4	0.0	313	22	1.2	0.6	292	326
	60	8.6	304	19.4	0.7	307	254	11.2	0.7	310	38	5.3	0.1	306	56	3.4	0.0	309	11	5.5	0.2	311	237	4.8	0.1	300	44	3.0	0.8	321	347
	100																														
	140																														
	180																														
2	20	6.0	83	18.8	1.0	286	270	11.8	1.6	281	86	5.8	0.6	80	261	3.4	0.7	290	31	7.0	0.6	280	298	2.9	1.2	56	346	2.6	0.5	203	340
	60	2.9	342	22.4	1.8	286	271	7.8	0.3	295	100	4.4	1.3	285	90	4.9	0.1	295	8	6.5	0.5	301	308	4.5	0.7	312	90	1.3	0.6	314	134
	100	7.7	302	21.2	1.7	291	276	6.2	0.9	298	101	4.6	1.0	288	97	5.1	0.5	282	15	5.5	0.2	300	296	4.9	1.0	303	70	3.1	1.7	90	294
	140	10.9	287	26.2	1.6	290	286	8.0	2.3	291	66	5.2	0.1	288	106	5.2	1.0	289	22	4.6	1.7	320	271	1.5	0.1	325	23	2.4	0.1	39	3
	180	8.6	290	28.0	0.4	288	281	8.5	2.2	285	8	4.9	1.2	286	76	5.9	0.1	288	4	4.3	1.6	100	11	2.6	0.5	270	348	4.3	0.3	312	273
3	20																														
	60	3.3	91	17.0	0.8	306	255	6.4	0.0	321	92	6.3	0.5	305	64	4.7	0.4	313	3	3.7	0.5	317	296	1.1	0.3	328	78	1.9	0.6	344	134
	100	2.7	353	21.9	1.0	301	244	6.1	0.6	342	83	5.0	1.3	305	62	5.9	0.4	302	349	2.8	0.0	336	279	2.1	1.8	338	70	1.3	0.0	296	86
	140	5.7	312	22.8	1.3	313	265	8.3	1.2	313	56	6.0	0.9	309	70	4.1	1.3	318	13	3.3	0.5	342	255	1.8	1.3	307	107	1.5	0.0	56	288
	180																														
4	20	27.7	250	6.1	3.4	311	246	33.6	1.6	265	15	19.4	3.7	263	326	2.6	0.4	310	341	6.7	6.2	331	41	23.3	3.3	267	318	1.7	0.9	24	37
	60	3.2	98	13.8	1.1	314	253	4.5	0.1	343	69	3.3	0.7	333	72	3.3	0.0	311	346	2.9	0.4	351	269	1.2	0.0	287	281	1.1	0.6	329	129
	100	1.2	79	17.0	2.3	310	252	4.6	0.1	340	76	2.6	1.8	321	78	3.3	0.3	315	359	2.6	0.8	357	249	2.5	0.5	285	289	1.8	0.1	341	158
	140	1.9	273	14.2	1.8	322	285	4.9	0.3	351	74	3.7	0.4	312	59	3.0	0.9	320	24	2.6	0.2	335	261	2.4	0.9	280	302	2.1	1.1	352	331
	180																														
5	20	2.5	19	9.1	1.2	69	55	9.9	0.2	235	8	2.1	1.0	250	25	2.5	0.1	238	334	2.0	0.7	351	236	7.6	0.4	41	262	1.7	0.4	251	302
	60	1.3	31	11.8	0.0	62	69	3.3	0.3	249	6	2.7	0.5	248	40	2.5	0.2	243	356	3.4	0.1	58	7	2.9	0.7	248	328	0.6	0.1	149	329
	100																														
	140																														
	180																														
6	20	12.8	104	17.3	3.0	274	267	9.1	1.4	282	99	4.1	0.4	269	84	3.1	1.3	289	25	5.8	1.1	274	323	2.2	1.3	322	111	2.5	0.1	157	0
	60	4.7	110	19.0	0.1	291	277	6.4	0.8	284	79	4.2	0.5	282	87	4.0	0.2	294	16	2.0	0.7	283	336	0.7	0.2	46	314	3.0	0.6	309	117
	100	3.8	240	19.8	2.0	275	269	3.3	0.2	279	68	4.2	0.7	292	91	4.9	0.9	277	12	2.2	0.1	101	59	2.5	0.1	285	26	2.0	0.4	61	112
	140	10.6	266	21.0	2.1	272	269	5.1	0.2	273	41	4.8	0.1	280	81	4.2	0.3	267	2	4.9	0.3	89	59	3.5	0.1	281	43	1.8	0.4	307	305
	180	16.3	270	19.0	0.4	281	281	7.1	0.1	277	35	4.8	0.4	265	53	4.6	0.1	283	27	6.0	0.8	94	55	3.2	0.3	270	34	2.1	1.0	269	52
7	20	1.6	301	27.3	2.4	351	286	13.9	0.7	349	75	8.4	1.1	347	69	4.6	1.3	350	13	7.9	0.8	347	272	3.9	0.8	350	101	4.6	0.7	342	284
	60	5.1	319	26.0	2.0	347	285	12.7	0.7	340	66	7.0	0.1	343	66	4.3	0.7	354	8	6.8	0.2	340	280	2.9	0.3	321	85	2.9	0.5	11	317
	100	6.2	316	23.0	1.6	345	275	11.3	0.7	339	67	7.1	0.1	342	58	4.6	0.7	343	356	5.0	0.4	332	291	3.4	0.6	349	78	1.9	0.2	341	54
	140																														
	180																														

Meter	Depth	Mean	angle	M2				K1				S2				N2				O1				P1				M4			
				sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase
8	20	6.3	141	26.7	3.1	280	273	11.3	0.2	277	62	9.1	0.4	278	47	6.1	1.5	286	358	6.7	0.3	276	274	3.7	0.1	279	61	1.4	0.5	284	295
	60	4.3	161	31.6	3.8	296	274	12.2	1.3	288	63	9.1	0.6	303	67	6.3	1.6	301	17	7.4	0.1	291	271	3.8	0.6	263	79	2.2	1.7	246	12
	100	4.5	221	28.0	0.2	295	284	14.1	1.5	282	80	9.3	1.5	293	73	6.2	2.0	294	26	8.3	0.6	288	274	6.0	0.3	99	280	1.9	1.0	12	161
	140	7.2	270	28.1	0.7	292	286	15.3	0.9	281	86	9.3	0.6	283	75	6.6	1.0	292	33	9.0	0.0	281	283	5.5	0.3	276	92	3.5	0.2	305	95
	180	9.8	286	31.2	0.6	293	288	13.9	0.5	281	86	10.4	0.4	292	76	6.1	0.1	296	36	8.8	0.5	277	279	3.4	0.7	285	98	3.4	0.8	105	286
9	20	15.2	146	24.7	7.6	324	254	9.2	0.2	309	58	8.1	3.2	326	40	5.0	2.4	321	325	4.2	0.5	295	281	5.1	0.1	312	72	2.8	0.4	341	336
	60	11.8	240	26.1	1.0	329	247	8.8	0.6	320	35	10.0	0.5	341	30	6.5	0.7	331	334	4.8	0.0	301	243	1.1	0.2	280	52	5.6	3.7	55	354
	100																														
	140																														
	180																														
10	20	8.9	91	12.0	2.1	340	252	7.3	1.6	357	354	5.8	0.0	318	20	4.0	0.6	308	318	2.2	0.8	24	228	5.8	0.3	1	346	1.8	0.3	110	342
	60	5.5	90	14.1	3.5	325	244	6.1	1.1	10	63	5.3	0.4	336	45	4.8	1.2	334	358	3.5	1.4	26	275	1.4	0.4	360	52	1.5	0.0	86	340
	100	5.5	59	14.9	5.8	10	284	6.0	1.3	11	67	6.8	0.1	20	87	4.6	0.8	14	32	3.8	1.2	34	300	2.0	0.3	9	34	1.5	0.6	280	85
	140	6.8	48	23.4	0.5	27	306	10.7	1.3	22	77	5.7	1.3	38	96	4.3	0.1	51	48	6.3	0.2	30	284	3.5	0.4	17	83	1.3	0.3	11	301
	180																														
11	20	2.0	58	3.9	0.4	336	237	2.4	1.0	19	14	2.9	0.5	304	354	1.3	1.1	300	271	1.9	0.1	25	250	1.5	0.1	27	356	1.1	0.5	246	29
	60	2.0	96	7.4	0.8	334	240	3.3	0.8	22	80	2.6	0.6	354	42	3.5	0.9	333	348	2.2	0.6	34	284	1.6	0.4	19	82	2.0	0.6	111	348
	100	1.0	64	9.2	3.3	22	304	5.5	0.5	32	92	3.2	0.1	6	100	3.6	0.2	2	32	3.4	0.3	31	298	1.7	0.5	40	96	1.4	0.4	89	358
	140	2.1	21	13.7	2.4	30	318	5.8	0.4	31	87	3.3	0.2	16	115	3.0	1.3	72	57	3.3	0.2	35	288	2.2	0.3	23	95	2.2	0.4	8	334
	180																														
12	20	1.7	299	3.4	0.4	207	336	2.3	0.9	0	326	1.5	0.6	45	95	1.0	0.2	201	11	2.1	0.3	32	244	1.9	0.6	16	309	1.7	0.3	212	4
	60	3.2	39	4.3	0.5	25	246	1.6	0.1	40	70	1.5	0.2	33	28	1.3	0.0	11	344	0.8	0.1	47	240	1.3	0.1	32	81	1.5	0.3	27	312
	100																														
	140																														
	180																														
13	20	2.2	207	11.9	1.8	77	273	7.9	1.1	294	254	4.0	0.1	83	27	2.1	0.4	75	357	4.3	1.7	275	84	3.0	1.7	25	111	1.0	0.5	318	114
	60	4.7	97	13.8	1.6	85	272	6.8	0.3	91	65	2.7	0.5	83	49	3.1	0.1	92	17	4.3	0.4	84	278	2.8	0.2	85	87	0.5	0.2	88	331
	100	3.9	91	13.5	0.1	89	272	6.2	0.4	85	63	2.7	0.1	92	53	2.4	0.0	90	18	3.1	0.1	82	269	2.2	0.0	93	78	1.0	0.1	50	355
	140	0.6	142	13.8	1.0	263	80	5.2	0.5	80	57	3.5	0.0	77	40	3.0	0.7	81	20	1.5	0.1	84	293	0.9	0.2	259	286	0.6	0.4	3	325
	180																														
14	20	1.3	66	13.3	0.5	70	268	8.0	0.1	70	54	3.2	0.0	67	56	2.1	0.4	81	359	4.4	0.4	76	264	2.0	0.2	82	71	1.2	0.1	77	292
	60	1.7	67	13.0	0.1	71	268	7.4	0.5	70	60	2.6	0.2	67	46	2.1	0.0	72	357	3.9	0.1	69	264	1.7	0.2	60	84	0.9	0.1	55	282
	100	0.5	326	12.6	0.5	69	258	5.9	0.6	62	53	2.7	0.1	62	41	2.0	0.4	63	354	1.6	0.3	53	264	0.5	0.1	36	349	0.5	0.1	312	100
	140	1.8	341	11.3	0.8	59	249	3.8	0.6	54	39	2.5	0.2	63	30	2.9	0.1	54	358	1.2	0.2	42	259	0.5	0.2	26	277	1.0	0.2	52	95
	180	1.7	261	11.0	1.9	42	233	2.7	0.3	40	30	2.5	0.4	52	37	3.1	0.9	28	4	0.8	0.6	74	296	0.9	0.2	40	339	0.3	0.1	87	53

Meter	Depth	Mean	angle	M2				K1				S2				N2				O1				P1				M4			
				sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase
15	20	8.5	202	34.5	6.3	334	224	9.2	1.4	317	0	7.2	1.0	339	15	7.3	1.5	336	328	2.5	1.8	111	22	0.7	0.4	5	8	2.1	0.3	74	360
	60																														
	100																														
	140																														
	180																														
16	20	3.1	97	14.2	2.0	1	237	4.6	1.4	84	89	4.1	1.1	4	0	2.7	0.4	348	329	3.7	1.5	282	100	2.5	0.6	359	124	1.8	0.4	335	134
	60	3.4	69	11.1	5.5	15	250	4.3	0.3	56	63	3.2	0.3	32	41	3.1	0.2	360	357	2.2	0.7	257	72	1.4	0.8	48	57	1.0	0.5	126	307
	100	2.4	75	11.7	2.2	56	288	4.7	0.8	44	72	3.3	0.0	41	61	2.3	0.6	67	50	1.6	1.0	76	273	2.0	0.3	22	31	1.2	0.2	279	80
	140	2.1	150	13.9	1.8	49	280	4.8	0.4	44	58	2.9	0.4	37	59	3.0	0.9	68	41	3.5	0.2	70	256	2.9	0.1	47	67	1.9	1.3	329	1
	180																														
17	20	1.3	264	8.2	2.6	25	242	3.7	1.2	64	44	1.6	0.6	23	30	2.3	0.1	341	315	2.5	0.4	270	84	1.3	0.2	317	240	1.6	0.8	8	167
	60	1.6	294	8.3	1.5	40	254	4.1	0.1	59	57	2.5	0.0	46	45	2.4	0.9	43	356	1.6	0.2	66	248	0.9	0.2	80	60	1.5	0.7	0	181
	100	0.7	297	8.2	0.4	72	279	4.4	0.4	57	64	2.0	0.6	71	57	2.0	0.7	71	17	1.5	0.2	71	276	0.5	0.2	49	0	0.2	0.0	136	348
	140	1.9	60	9.1	2.2	78	269	4.4	0.5	66	69	1.3	0.1	61	53	1.9	0.1	108	21	2.4	0.5	58	289	0.4	0.3	16	43	1.5	1.3	334	38
	180	9.0	51	5.3	0.2	226	24	8.1	0.6	69	45	0.6	0.3	292	54	3.4	0.1	95	6	2.6	0.0	25	259	2.8	1.2	220	24	3.9	3.1	276	65
18	20	1.2	112	10.0	0.9	68	276	4.8	0.0	60	15	2.1	0.2	69	45	1.8	0.6	87	72	2.3	0.0	249	27	0.8	0.4	346	270	1.1	0.1	221	345
	60	2.4	82	9.9	0.3	72	271	4.6	0.3	68	34	2.2	0.0	73	47	2.0	0.0	80	33	2.1	0.1	255	70	1.1	0.2	68	40	0.7	0.1	257	353
	100																														
	140																														
	180																														
19	20	1.2	214	14.0	0.3	291	252	1.0	0.5	299	37	3.0	0.3	297	71	3.7	0.2	288	340	0.5	0.0	339	26	1.5	0.4	266	295	0.7	0.0	327	126
	60	1.2	183	13.1	0.1	306	239	1.6	0.0	286	346	1.9	0.3	303	47	2.4	0.3	306	322	0.9	0.3	293	113	0.7	0.2	324	296	1.3	0.3	119	330
	100																														
	140																														
	180																														
20	20	5.1	157	18.1	0.9	98	79	4.3	0.9	351	53	3.5	0.8	267	86	5.4	0.8	281	3	1.9	1.3	79	52	4.4	2.3	252	341	2.1	0.1	194	346
	60	3.8	207	17.4	0.2	288	265	5.5	0.3	304	61	4.7	0.0	287	84	4.2	0.5	281	8	2.9	0.0	291	266	1.6	1.1	267	53	2.7	0.6	337	130
	100	7.3	249	16.0	2.0	283	265	6.4	0.2	271	54	4.7	0.4	276	74	3.7	1.0	276	13	3.9	0.7	85	70	2.5	0.6	284	67	0.6	0.3	20	59
	140	10.8	277	14.6	1.1	103	76	8.8	0.1	259	44	4.3	0.1	271	62	2.9	0.0	286	4	3.8	0.7	78	80	3.4	0.8	78	267	1.1	0.0	67	327
	180																														
21	20	12.5	97	18.1	2.8	88	81	5.0	1.2	293	78	5.2	0.8	267	72	3.9	0.6	271	7	2.5	1.1	305	300	2.0	1.2	288	75	1.4	0.1	129	334
	60	6.8	94	21.2	0.7	279	275	7.5	0.1	276	66	5.9	0.2	283	85	4.2	0.5	279	12	3.2	0.9	283	289	3.4	0.2	290	91	1.8	0.1	311	128
	100	1.6	161	21.0	0.8	278	273	8.9	0.1	274	69	6.6	1.0	282	93	4.9	0.2	281	12	4.2	0.9	275	291	3.1	0.3	281	95	2.2	0.4	125	308
	140	6.6	263	21.5	1.7	282	277	10.5	1.0	272	63	5.7	0.3	277	86	4.5	0.1	281	15	5.8	0.2	271	276	3.5	0.4	281	87	1.2	0.2	70	267
	180	12.9	269	16.4	0.3	283	270	12.9	2.1	271	70	3.1	0.5	252	51	3.5	0.2	282	356	2.6	0.9	310	235	1.5	0.5	356	3	1.1	0.0	125	19

Meter	Depth	Mean	angle	M2				K1				S2				N2				O1				P1				M4			
				sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase
22	20	13.1	98	17.8	1.3	81	79	5.2	2.2	283	24	4.4	2.2	240	57	4.3	0.1	264	8	5.5	0.3	98	62	7.0	1.6	265	30	1.3	0.2	41	334
	60	8.9	85	22.6	0.6	92	88	7.4	0.2	273	55	7.0	0.1	277	78	4.2	0.6	269	5	3.5	0.8	87	85	3.2	0.5	280	80	0.6	0.4	323	80
	100	2.2	83	23.3	1.8	272	271	9.1	0.5	268	58	6.9	1.1	281	87	5.2	0.5	271	7	4.9	0.2	277	274	3.2	0.1	263	75	1.0	0.0	124	307
	140	3.9	267	23.0	1.7	275	276	11.7	0.5	266	61	6.0	0.4	273	85	5.2	0.3	275	15	5.2	0.4	86	91	3.6	0.6	91	279	1.7	0.1	56	248
	180																														
23	20	9.6	90	21.3	1.0	88	82	6.2	1.5	281	48	6.4	0.5	265	75	4.8	0.2	270	1	3.9	0.3	285	269	3.9	0.3	255	39	1.1	0.3	87	57
	60	6.9	86	23.1	0.1	271	269	7.8	0.6	263	44	7.0	0.1	278	85	4.7	0.4	268	4	4.3	1.0	272	282	4.4	0.2	267	71	0.8	0.0	9	12
	100	2.2	91	22.1	1.2	270	271	9.4	0.0	264	51	6.4	0.8	277	80	5.1	0.0	267	11	4.7	0.0	273	276	4.1	0.6	271	77	0.3	0.0	47	269
	140	1.9	245	20.5	0.5	274	272	11.0	0.2	272	53	5.6	0.3	270	85	4.6	0.5	275	14	5.5	0.1	88	84	3.3	0.2	275	88	0.5	0.2	58	246
	180	4.8	268	18.3	0.6	280	272	11.5	0.6	280	50	4.8	0.6	278	88	4.1	0.0	280	8	5.6	0.2	98	78	3.0	0.1	288	88	2.3	0.5	106	289
24	20	7.8	87	23.3	0.8	86	77	8.5	0.9	275	69	7.2	0.1	265	69	5.0	0.4	268	356	4.3	0.4	94	84	2.0	0.8	87	283	1.3	0.2	72	13
	60	5.5	77	22.8	0.4	84	84	6.2	0.4	262	46	6.6	0.1	265	75	5.1	0.2	262	351	4.3	0.3	81	88	3.1	0.1	274	51	0.7	0.1	85	356
	100																														
	140																														
	180																														
29	20	4.8	216	38.7	1.3	342	240	8.0	0.2	335	10	10.4	0.5	343	31	5.9	0.7	340	334	4.9	0.7	157	22	1.2	0.5	326	54	3.2	0.6	141	34
	60																														
	100																														
	140																														
	180																														
30	20	5.3	103	36.7	1.1	274	270	8.1	0.6	268	46	12.0	1.1	274	53	6.2	0.9	276	349	5.8	0.7	97	56	2.1	0.2	89	328	2.4	0.2	106	18
	60	3.6	151	33.4	0.5	277	264	8.3	0.2	276	40	11.6	0.2	275	54	5.4	0.9	283	355	3.7	0.8	85	42	0.9	0.4	323	89	1.9	1.1	71	359
	100																														
	140																														
	180																														
31	20	11.2	119	35.8	5.2	287	273	14.4	0.5	282	69	10.6	0.7	288	56	5.8	0.7	283	5	6.3	0.3	277	282	5.5	0.6	265	83	2.4	0.3	284	348
	60	4.8	126	32.1	3.7	283	276	15.6	4.4	273	74	9.7	0.9	280	62	6.0	0.4	283	10	6.4	1.4	268	292	5.1	2.8	67	269	1.5	0.2	298	89
	100	2.2	255	30.2	3.0	278	272	13.4	3.3	267	76	9.1	0.9	289	63	5.6	0.8	280	12	6.6	1.8	267	286	3.8	1.2	45	295	1.8	0.0	283	103
	140	6.4	270	28.9	2.1	279	271	12.7	1.0	270	79	9.4	1.6	292	69	5.3	0.8	283	18	5.8	1.6	263	286	3.1	1.1	67	277	2.0	0.7	103	301
	180	11.3	273	31.6	2.0	286	266	11.7	0.3	272	79	7.4	0.7	277	73	4.5	0.6	278	18	5.1	0.9	260	321	5.0	1.5	277	50	4.3	1.5	308	120
32	20	6.3	144	38.0	5.1	278	267	12.5	1.9	276	51	9.1	0.8	281	50	6.5	1.2	275	15	8.8	0.4	87	74	4.7	0.5	278	88	4.6	0.7	277	313
	60	2.9	275	30.4	5.0	268	276	14.1	0.1	265	68	8.6	0.1	271	53	5.1	0.1	275	8	9.7	0.5	81	84	5.6	0.2	83	280	3.8	0.3	237	329
	100	6.0	279	25.8	3.5	259	281	17.4	1.2	251	67	7.8	1.3	263	65	3.9	0.5	263	3	11.8	1.0	77	92	5.4	0.7	61	257	3.9	0.2	240	357
	140	6.0	249	20.5	2.2	75	100	17.0	1.3	251	63	7.0	0.7	256	51	3.4	0.3	251	337	12.1	0.6	71	93	5.7	1.1	248	61	5.8	0.6	232	6
	180																														

Meter	Depth	Mean	angle	M2				K1				S2				N2				O1				P1				M4			
				sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase
33	20	7.6	186	42.9	6.2	308	250	11.2	0.5	302	31	11.6	1.4	310	43	7.1	0.9	309	347	6.4	1.3	113	50	2.9	0.1	304	74	3.9	0.7	292	289
	60																														
	100																														
	140																														
	180																														
34	20	12.1	187	49.9	11.8	317	248	11.6	0.5	309	38	15.1	3.1	322	41	8.1	2.5	318	343	7.7	0.8	113	62	2.7	0.4	312	99	2.2	0.7	46	34
	60																														
	100																														
	140																														
	180																														
35	20	5.0	138	20.5	6.5	344	224	2.7	1.1	340	12	6.7	2.1	346	16	3.7	1.6	325	299	1.9	0.3	118	341	1.7	0.2	348	77	3.3	2.9	93	14
	60	2.9	102	15.6	4.2	18	248	2.8	1.7	51	55	4.6	0.6	41	59	3.4	0.2	30	334	2.3	1.2	190	352	1.6	0.1	52	88	1.9	0.6	351	109
	100	3.1	100	20.9	1.6	57	272	3.8	1.0	43	11	6.4	0.3	61	71	4.2	0.1	66	358	3.1	1.1	226	19	0.7	0.2	296	0	2.5	0.4	245	15
	140	3.2	180	22.7	0.3	61	280	6.0	0.6	72	33	4.8	0.4	66	80	2.8	0.3	62	17	3.0	1.2	252	36	0.9	0.1	131	4	2.0	0.1	237	41
	180																														
36	20	3.0	124	25.9	6.9	302	267	8.9	1.8	314	55	8.0	2.5	312	58	4.5	1.0	289	350	4.9	0.3	305	260	2.2	1.7	93	274	1.3	0.4	2	191
	60	1.2	207	26.5	3.0	313	278	11.0	1.7	313	54	7.1	0.5	320	68	4.7	0.9	312	16	6.3	0.5	318	266	3.0	0.8	282	68	2.0	0.9	1	272
	100	1.2	273	23.9	1.1	321	286	9.8	0.3	321	61	6.2	1.2	328	74	4.3	0.6	329	25	6.1	0.5	331	274	2.7	0.2	305	87	0.7	0.1	310	268
	140	1.6	287	21.7	3.4	332	293	10.7	1.1	329	62	5.9	0.8	330	81	3.9	0.4	327	21	6.1	0.5	337	278	2.6	0.5	330	52	1.2	0.6	90	52
	180	1.8	345	21.9	4.5	337	297	10.2	1.3	336	68	5.7	1.0	327	82	3.0	0.6	331	26	5.7	1.3	335	273	2.7	0.8	333	96	1.6	0.5	97	63
37	20	6.6	89	14.4	2.1	78	273	11.0	0.4	75	62	2.6	1.9	78	40	2.4	0.4	62	336	4.3	0.1	72	270	1.4	0.2	39	306	1.1	0.4	208	340
	60	2.5	112	14.4	0.3	84	275	6.2	1.1	84	57	2.4	0.8	82	65	2.9	0.8	92	20	4.7	1.3	90	289	2.0	0.2	265	296	1.4	0.5	33	320
	100	1.6	103	12.1	0.9	75	267	6.9	0.1	80	52	2.4	0.0	71	38	1.9	0.3	54	2	4.4	0.1	80	283	0.9	0.0	303	346	1.7	0.4	59	338
	140	0.9	103	13.8	0.1	78	264	5.1	0.4	85	59	2.6	0.0	67	33	2.7	0.1	74	25	2.8	0.9	87	277	0.8	0.4	247	321	1.1	0.3	99	29
	180																														
38	20	5.7	72	16.5	1.7	65	273	8.7	0.3	60	57	3.3	0.8	66	54	3.1	1.0	44	343	2.7	0.1	71	254	1.4	0.0	305	273	1.4	0.2	219	16
	60	0.8	145	16.0	0.4	75	274	6.9	0.8	71	60	3.2	0.3	79	61	3.3	0.8	89	12	4.2	0.5	70	282	1.8	1.3	48	86	0.8	0.5	310	40
	100	0.7	224	12.2	0.4	63	261	5.7	0.5	71	48	2.7	0.2	64	34	1.9	0.0	54	6	3.9	0.1	65	281	1.4	0.4	255	336	1.5	0.1	17	359
	140	2.2	66	12.1	0.1	60	262	4.3	1.1	61	61	3.0	0.3	51	23	2.3	0.1	44	17	3.6	0.4	64	269	1.6	0.7	292	343	0.5	0.1	70	13
	180	1.0	85	13.5	0.1	61	264	5.3	0.6	56	104	2.1	0.7	75	38	2.7	0.2	47	48	2.3	0.5	59	246	3.9	0.2	57	46	1.3	0.8	159	3
39	20	8.8	36	32.8	1.6	44	78	5.7	2.1	53	255	6.2	1.3	227	30	3.0	0.0	242	6	1.7	0.8	314	310	4.7	0.1	12	207	2.9	0.1	27	318
	60																														
	100																														
	140																														
	180																														

Meter	Depth	Mean angle		M2				K1				S2				N2				O1				P1				M4				
		sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase			
40	20	14.2	42	24.8	1.1	46	79	7.4	2.9	56	249	6.0	0.1	233	38	3.0	0.2	233	5	3.1	0.3	74	103	3.9	0.1	9	201	2.2	0.5	52	265	
	60	42.8	352																													
	100																															
	140																															
	180																															
41	20	11.3	58	16.9	0.6	59	86	7.7	2.4	251	61	4.2	1.0	240	40	2.0	0.1	208	21	2.9	0.1	271	301	3.2	0.3	195	357	1.2	0.5	310	13	
	60	3.9	309	20.8	3.4	264	286	9.1	2.4	260	47	5.8	0.2	252	64	5.1	0.1	282	16	5.2	1.0	88	92	2.5	1.9	101	288	2.5	1.2	286	323	
	100	9.1	306	25.8	1.8	73	99	8.8	3.2	242	54	6.4	0.4	258	46	4.8	0.6	251	344	4.4	1.9	80	81	3.5	0.7	300	84	3.2	0.2	301	251	
	140	10.7	307	29.5	0.3	68	89	10.1	0.5	64	250	6.9	0.3	262	38	5.3	0.3	241	341	4.7	2.0	61	65	5.2	2.0	237	33	2.6	0.5	80	350	
	180	10.3	301	30.7	0.5	70	85	8.0	1.7	251	59	5.5	0.5	261	33	5.2	0.3	252	358	5.5	1.3	80	69	5.9	2.0	231	51	4.0	1.1	88	315	
42	20	3.2	42	15.1	1.8	65	89	5.5	0.2	253	19	2.5	0.0	244	46	2.5	0.2	211	357	2.7	0.5	274	273	2.3	0.2	84	348	1.7	0.6	257	0	
	60	3.5	258	14.2	0.5	267	288	6.8	0.2	262	56	3.9	0.4	276	93	4.7	1.4	266	37	4.1	0.4	75	93	0.9	0.7	88	299	1.1	0.8	332	347	
	100	4.7	272	13.6	1.6	268	277	6.2	0.6	76	278	3.1	0.2	253	60	2.7	1.4	269	37	5.0	0.5	84	90	4.5	0.5	282	98	1.4	0.7	34	345	
	140	3.8	281	12.5	1.6	88	91	7.2	0.8	260	69	3.5	0.6	272	59	1.5	0.4	269	75	3.8	0.5	268	307	1.3	0.4	58	22	1.4	0.0	89	24	
	180	3.0	250	11.5	8.1	338	342	11.0	5.3	29	263	7.1	1.3	316	8	3.6	0.1	287	324	7.9	0.1	87	24	10.7	3.9	308	70	9.8	3.3	122	22	
43	20																															
	60	1.3	59	9.4	0.7	71	104	4.4	0.5	252	39	3.0	0.1	256	67	3.1	0.1	251	28	2.5	0.1	72	81	1.4	0.5	54	242	1.1	0.1	60	302	
	100	0.8	277	2.7	0.1	82	75	3.3	0.3	238	57	1.3	0.1	249	56	1.0	0.0	257	347	1.7	0.1	73	18	2.2	0.2	231	358	1.4	0.2	64	344	
	140																															
	180																															
44	20	3.0	124	25.9	6.9	302	267	8.9	1.8	314	55	8.0	2.5	312	58	4.5	1.0	289	350	4.9	0.3	305	260	2.2	1.7	93	274	1.3	0.4	2	191	
	60	1.2	207	26.5	3.0	313	278	11.0	1.7	313	54	7.1	0.5	320	68	4.7	0.9	312	16	6.3	0.5	318	266	3.0	0.8	282	68	2.0	0.9	1	272	
	100	1.2	273	23.9	1.1	321	286	9.8	0.3	321	61	6.2	1.2	328	74	4.3	0.6	329	25	6.1	0.5	331	274	2.7	0.2	305	87	0.7	0.1	310	268	
	140	1.6	287	21.7	3.4	332	293	10.7	1.1	329	62	5.9	0.8	330	81	3.9	0.4	327	21	6.1	0.5	337	278	2.6	0.5	330	52	1.2	0.6	90	52	
	180	1.8	345	21.9	4.5	337	297	10.2	1.3	336	68	5.7	1.0	327	82	3.0	0.6	331	26	5.7	1.3	335	273	2.7	0.8	333	96	1.6	0.5	97	63	
45	20	3.1	117	14.7	1.4	339	220	3.0	2.0	335	54	1.6	0.4	327	6	2.1	0.5	350	333	1.6	0.5	266	81	1.9	0.8	113	43	1.9	0.3	105	342	
	Deploy 7	60	3.0	78	6.9	4.3	55	250	3.6	0.3	26	5	1.1	0.6	45	58	1.6	0.6	12	316	1.5	0.1	273	30	2.5	0.3	207	18	3.6	1.9	275	340
	100																															
	140																															
	180																															
46	20	8.2	161	33.6	10.8	300	248	8.5	0.4	292	53	6.4	2.4	307	47	6.4	1.8	301	2	4.3	0.8	101	67	3.2	1.0	283	28	6.3	0.1	97	36	
	60	4.7	271	23.4	4.3	110	63	10.4	0.2	285	37	4.0	0.5	290	21	7.2	1.9	285	1	7.0	1.4	101	54	3.8	0.2	80	270	3.2	0.1	76	90	
	100																															
	140																															
	180																															

Meter	Depth	Mean	angle	M2				K1				S2				N2				O1				P1				M4			
				sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase	sema	semi	angle	phase
47	20	5.8	74	8.7	0.0	358	209	2.9	0.8	94	26	3.8	1.7	334	340	1.6	0.0	86	23	2.0	0.5	135	326	3.9	0.4	327	356	2.9	0.4	132	353
	60	1.3	150	6.7	4.7	7	244	5.7	1.4	43	91	2.4	0.2	38	64	2.5	1.3	356	321	1.8	0.9	74	259	2.3	0.9	23	267	1.8	0.7	348	150
	100	0.3	160	13.8	2.9	53	300	5.5	1.2	59	92	2.5	0.6	239	304	2.8	0.5	43	61	3.9	0.3	64	280	1.2	0.2	55	95	1.1	0.4	336	317
	140	1.6	36	11.7	1.2	56	301	7.6	1.3	72	85	1.6	0.1	35	113	3.1	0.5	56	63	4.0	0.3	49	268	2.9	0.7	353	62	2.3	1.9	317	355
	180																														
48	20	14.4	58	12.1	2.6	96	73	6.6	1.1	273	53	5.4	1.5	252	48	2.0	0.8	278	344	3.0	0.0	19	296	4.3	1.3	77	28	0.8	0.5	255	73
	60	3.9	48	11.4	0.2	101	61	4.8	1.7	346	82	2.1	0.1	326	91	2.6	0.0	304	23	2.3	0.9	328	250	2.2	0.5	249	23	2.1	0.0	106	337
	100	0.5	179	8.5	4.5	342	299	7.2	0.5	13	74	2.9	0.0	15	159	1.4	1.2	328	37	3.8	0.6	2	273	4.4	0.9	226	12	1.6	0.3	29	318
	140	1.1	212	12.0	3.0	3	317	5.1	3.2	360	36	2.1	1.8	222	344	1.9	0.9	34	91	5.3	0.5	4	254	6.4	1.1	349	111	2.3	0.0	358	338
	180																														
49	20	1.8	111	19.7	0.4	49	80	8.9	3.8	298	31	2.7	2.3	248	68	3.7	1.9	287	48	3.4	1.5	308	22	5.7	1.2	311	127	4.2	2.7	149	5
	60	2.8	191	20.9	0.2	66	85	4.6	0.6	78	266	3.0	1.4	229	34	3.4	1.3	256	37	2.6	0.6	31	68	3.9	0.8	233	345	1.7	0.4	253	71
	100	1.2	209	21.1	0.4	64	85	4.9	0.0	65	249	2.3	0.3	224	35	4.1	0.1	239	37	3.8	0.5	46	75	2.6	0.7	245	347	2.5	0.1	61	245
	140	1.3	282	20.7	0.3	59	82	5.3	0.5	232	31	1.4	0.4	245	22	4.7	0.3	236	28	5.3	0.8	54	76	3.1	0.7	57	239	2.8	0.1	44	233
	180	1.9	290	19.5	0.5	57	73	9.3	0.5	239	10	2.1	0.3	63	282	4.9	0.2	236	5	7.1	0.4	58	72	6.5	0.7	62	284	2.5	0.4	44	225
50	20																														
	60	3.3	323	19.1	0.8	296	282	6.4	1.1	294	52	3.3	0.3	291	74	3.8	0.1	298	40	3.9	0.6	292	274	3.6	0.4	90	277	1.4	0.1	47	299
	100	2.6	296	18.5	1.0	291	274	7.2	0.2	293	81	3.5	0.2	288	74	3.3	0.2	295	28	3.3	0.3	295	293	1.7	0.1	107	295	1.7	0.0	15	4
	140	1.0	137	18.9	0.2	285	265	8.1	0.7	292	88	4.0	0.2	291	83	3.2	0.2	281	24	3.2	0.7	294	287	2.0	0.2	258	360	0.5	0.2	322	334
	180	3.7	108	20.1	1.0	282	261	8.1	0.2	277	86	4.7	0.9	289	80	4.1	0.1	275	15	3.9	0.5	288	269	3.5	0.7	276	339	0.5	0.1	61	343
51	20	13.1	65	15.8	1.5	91	68	4.1	3.4	280	301	5.0	3.2	270	87	5.6	1.7	267	325	2.7	0.3	317	51	9.4	3.5	106	289	1.2	0.8	74	12
	60	3.3	21	13.8	0.8	91	76	6.5	0.1	262	37	5.9	0.0	267	83	5.9	0.4	265	354	1.0	0.8	311	291	3.7	1.0	117	326	1.0	0.2	142	357
	100	1.5	332	13.6	0.6	85	77	5.7	1.2	257	32	4.5	0.9	71	258	4.5	1.2	262	353	1.6	0.1	83	49	2.2	0.3	278	93	1.1	0.2	69	298
	140	0.8	98	13.8	0.3	86	80	6.1	0.1	270	28	4.8	0.4	86	272	5.2	0.5	271	6	1.7	0.3	102	71	4.0	0.2	89	271	0.4	0.4	304	52
	180	1.9	178	12.1	2.3	90	77	2.7	0.2	288	38	4.5	0.2	274	84	5.9	0.1	271	356	3.5	0.1	93	62	6.5	0.2	267	67	0.6	0.2	340	295
52	20	10.4	47	13.0	1.2	63	61	9.8	1.1	237	354	3.9	0.0	60	289	5.5	0.7	240	340	1.2	0.4	56	72	2.8	0.6	76	284	1.4	0.3	47	97
	60	1.6	341	9.2	0.4	63	54	4.1	0.2	256	39	2.5	0.7	238	53	4.0	0.6	238	332	3.0	0.4	65	44	2.2	0.2	234	353	0.6	0.1	346	219
	100	1.0	277	8.2	0.2	52	45	1.5	0.4	236	24	2.9	0.2	52	239	3.2	0.2	234	322	1.4	0.1	60	68	3.0	0.1	239	358	0.6	0.0	16	325
	140																														
	180																														
53	20	8.1	77	20.0	0.3	87	73	9.4	0.4	257	328	6.5	1.0	275	67	4.8	1.3	257	346	2.6	0.7	6	67	12.3	2.4	86	317	1.3	0.5	357	124
	60	2.3	94	18.4	2.0	75	66	6.8	0.7	248	48	5.0	0.5	261	73	6.7	0.8	253	342	3.0	0.4	70	59	2.1	0.5	338	123	1.4	0.1	248	7
	100	1.7	267	15.9	1.7	57	56	6.7	0.4	240	27	4.3	0.4	60	250	6.1	0.4	236	334	1.9	0.4	50	52	1.8	0.4	344	146	1.4	0.1	225	7
	140																														
	180																														

