Coastal Engineering Research Board
73rd CERB Meeting

Wave Climate and Beach Nourishment

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Wave Climate Factors to Consider

- Frequency and directional spectra
- Importance/prevalence of bi-directional spectra
- Long distance propagation of swell
- Some examples of swell and potential influence on longshore and cross-shore sand transport

Shamal
Extratropical cyclones
NE Monsoon
Tropical Storms
SW Monsoon
Persian Gulf
Gulf of Oman
Gulf of Aden
ARABIAN SEA
SAUDI ARABIA
RUB' AL KHALI
OMAN
YEMEN
IRAN
IRAQ
AFGHANISTAN
PAKISTAN
INDIA
SOMALIA
THAR DESERT
DECCAN
Al Basrah
Shīrāz
Yazd
Kandahār
Quetta
Zāhedān
Kermān
Lahore
Faisalābād
Ludhiāna
Multān
Bahāwalpur
New Delhi
Rahīmyār Khān
Bīkāner
Sīkar
Jaipur
Sukkur
Lārkāna
Jodhpur
Pāli
Kota
Bhīlwāra
Udaipur
Nawābshāh
Mīrpur Khās
Hyderābād
Karāchī
Ahmadābād
Vadodara
Rājkot
Porbandar
Jūnāgadh
Bharūch
Sūrat
Burhānpur
Jālgaon
Mālegaon
Aurangābād
Kalyān
Mumbai
Pune
Sāngli
Bijāpur
Kolhāpur
Belgaum
Gadag
Hubli
Mangalore
Ad Dammām
Manama
Al Hufūf
Dubayy
Al 'Ayn
Masqat
Riyadh
Shaqrā'
Sanaa
Aden
Amarah
Alwaz
Sirsa
Pānīpat
Gangānagar
Dera Ghāzi Khān
Sāhiwāl
Yamunānagar
Shekhūpura
Jhang Sadar
Kandahār
DASHTELUT
UNITED ARAB EMIRATES
QATAR
KUWAIT
AN NAFŪD
AD DAHNĀ'
ETHIOPIA
OGADEN
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Al Kasab
Ra's Al-Khaymah
Umm Al Qaywayn
Ajman
Sharjah
Dubai
Fujairad
Al Batinah
Muscat
0
50
100
Kilometers

Baird

Wave Climate of the Batinah

- NE winter monsoon and northern Shamals have always been considered the key wave generating weather systems
- Therefore most harbors open to southeast
- But - sand builds up on southeast side of these harbors
- Importance of Arabian Sea swells

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0 250 500 750 Meters

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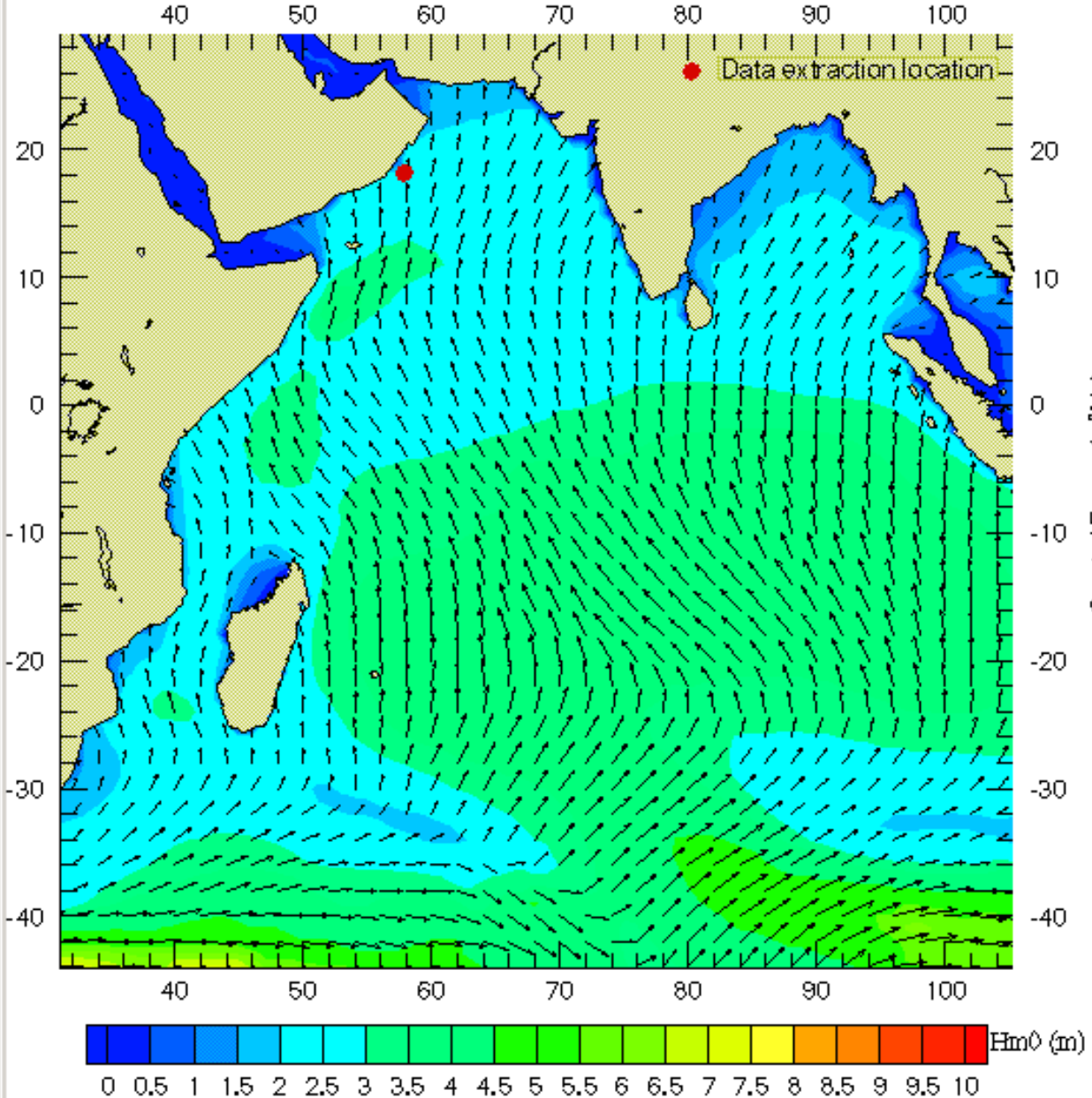
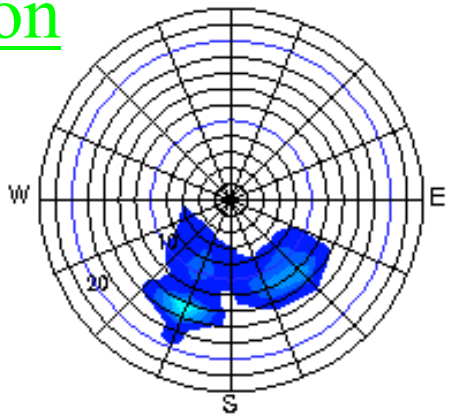
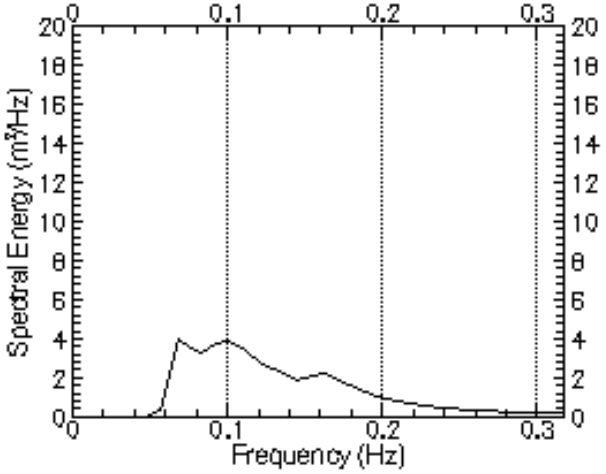
98091518

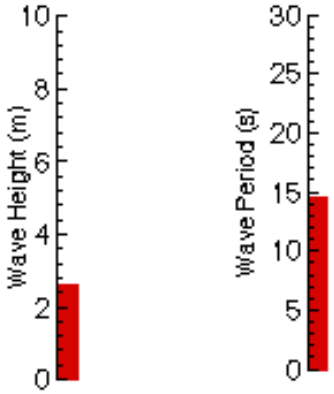
Indian Ocean Wave Simulations
June to August, 1998

Animation



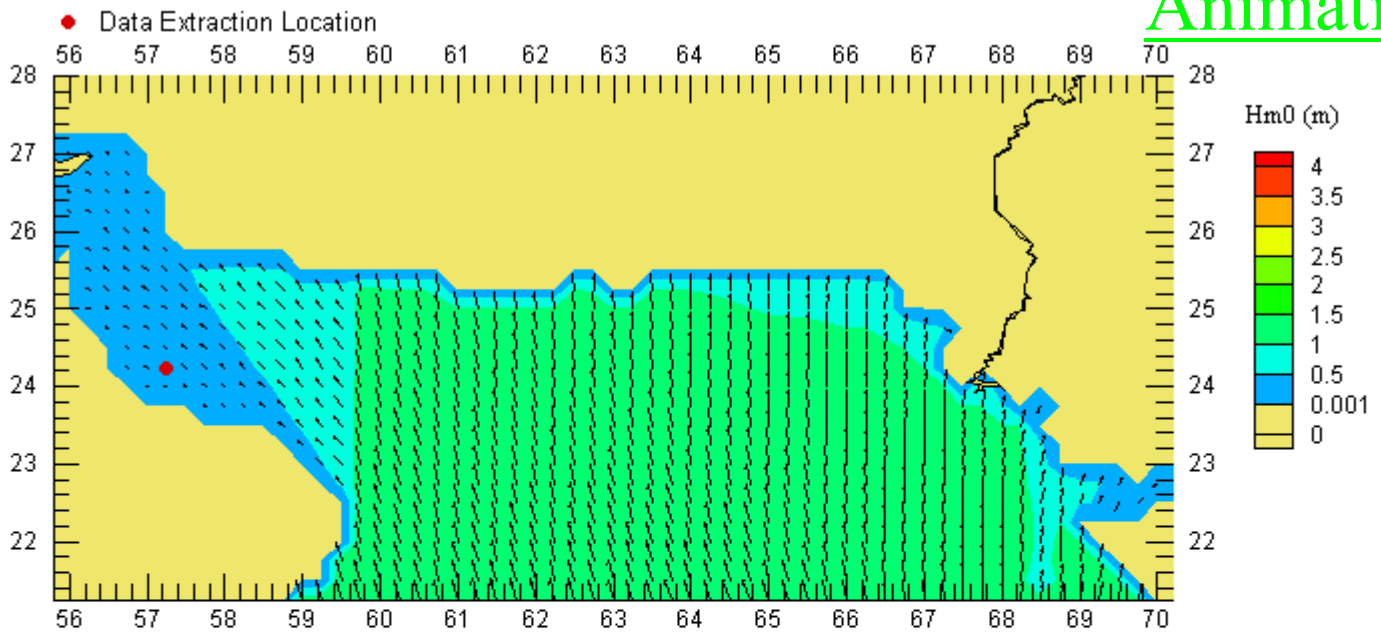




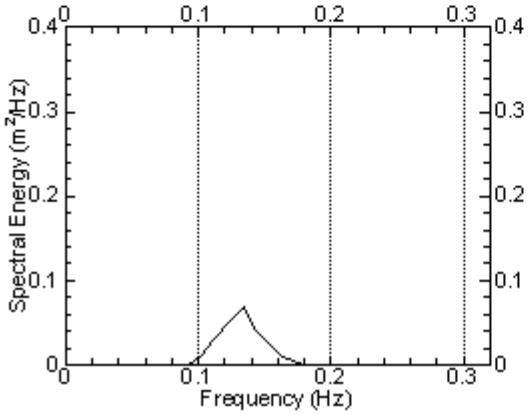


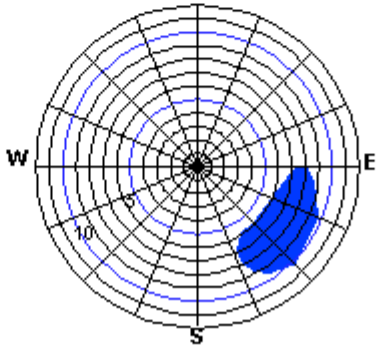
Gulf of Oman Wave Simulations

Animation



Site-Specific Data





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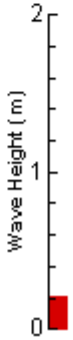
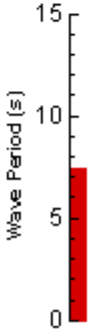
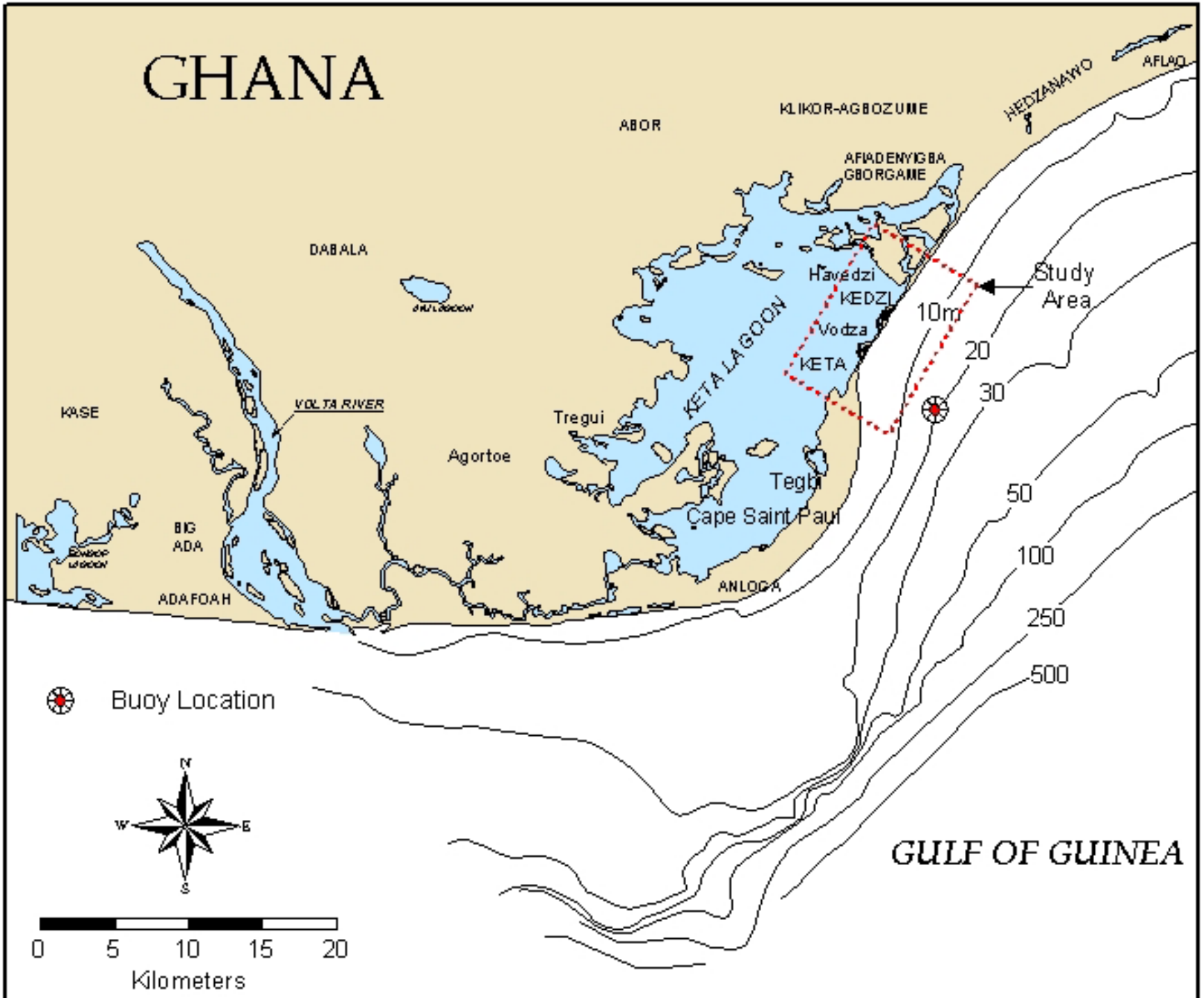
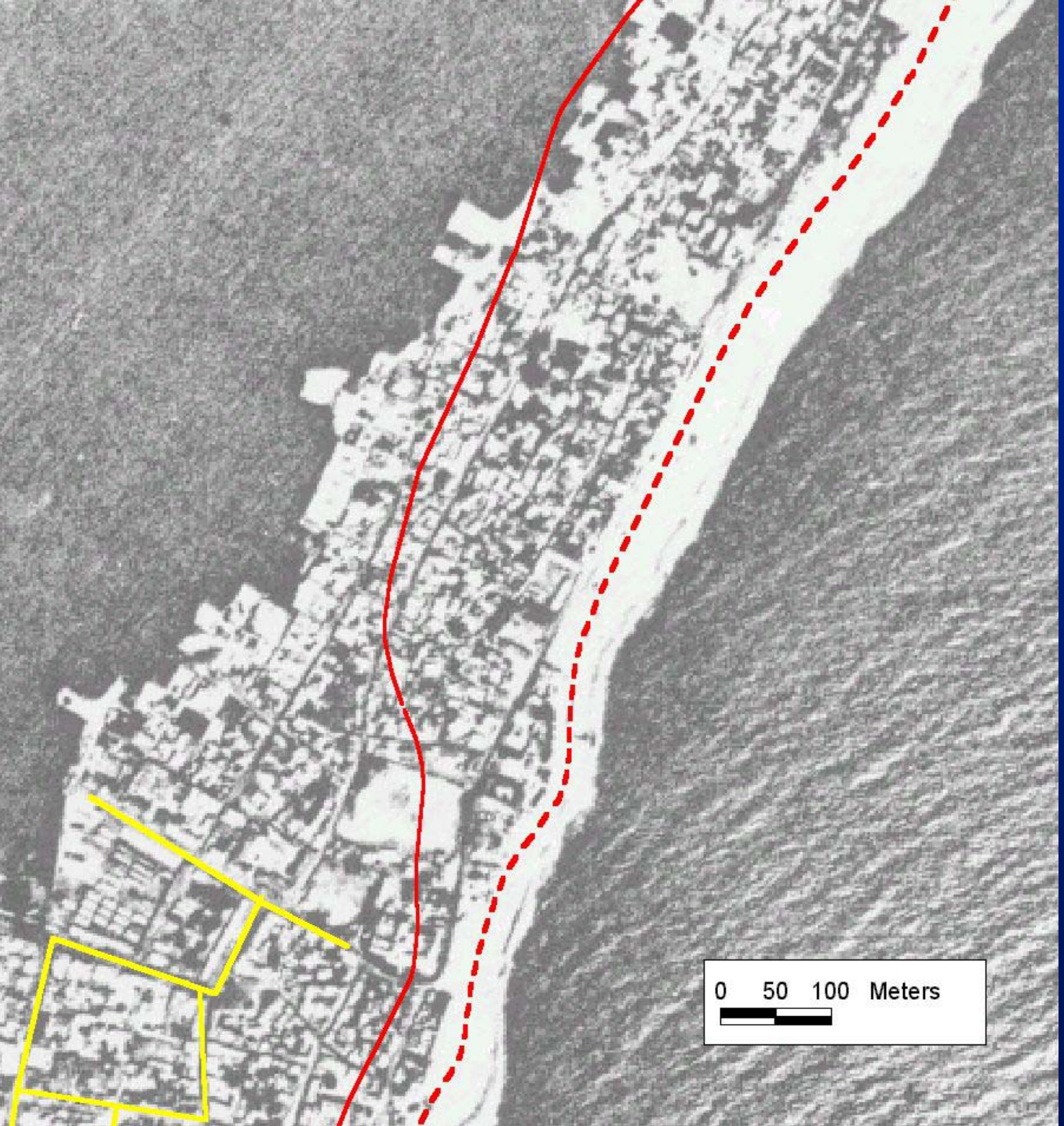


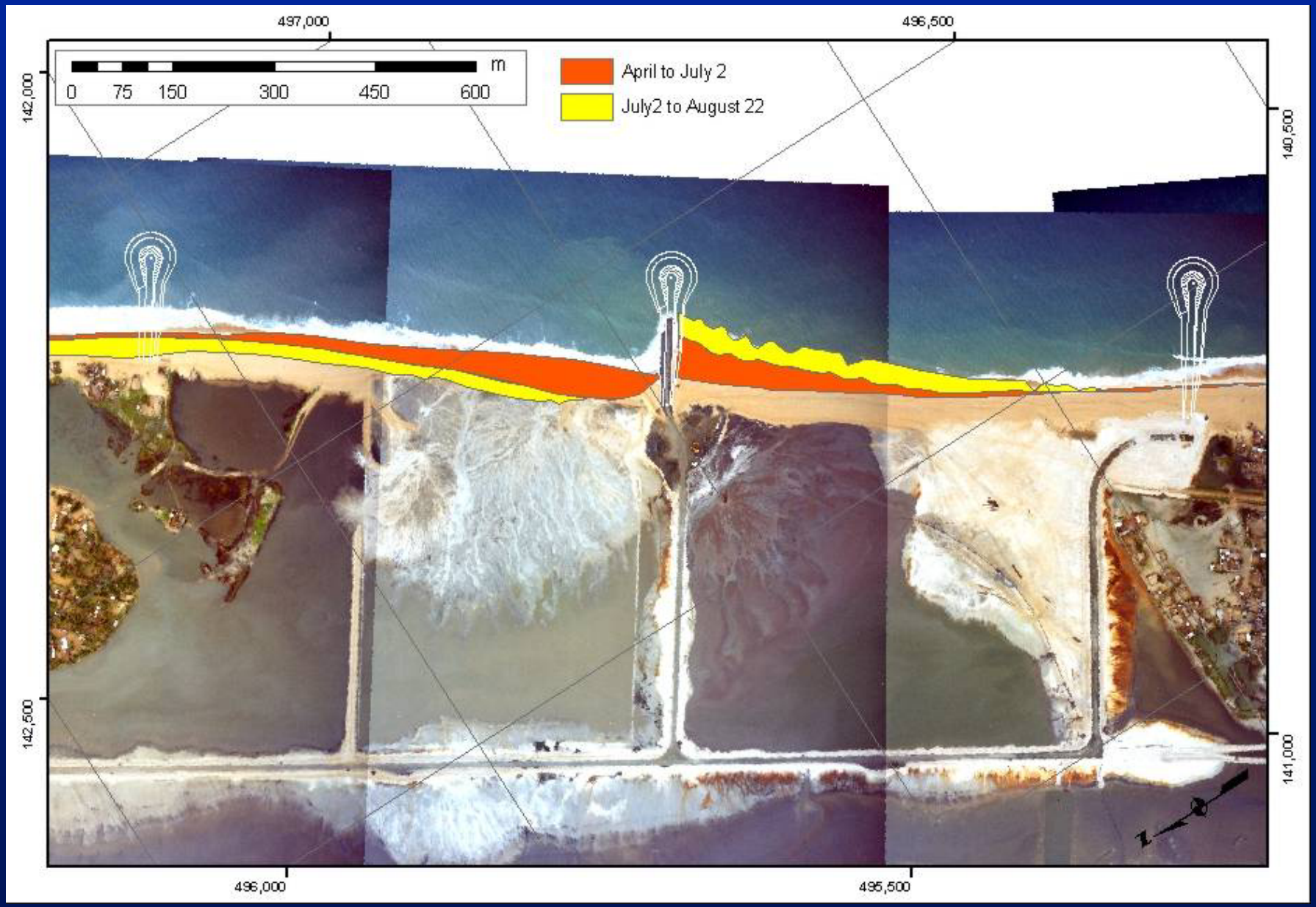



GHANA
ABOR
KLIKOR-AGBOZUME
NEDZANAWO
AFLAO
AFIADENYIGBA
GBORGAME
DABALA
Havedzi
KEDZI
Vodza
KETA
KETA LAGOON
Study
Area
10m
20
30
50
100
250
500
KASE
VOLTA RIVER
Tregui
Agortoe
Tegbi
Cape Saint Paul
BIG
ADA
ADAFOAH
ANLOGA
Buoy Location
N
W
E
S
0
5
10
15
20
Kilometers
GULF OF GUINEA

0 50 100 Meters



1960 vs. 2001 shorelines


497,000
496,500
142,000
142,500
140,500
141,000
496,000
495,500
m
0
75
150
300
450
600
April to July 2
July2 to August 22

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Predicted LST - 2001

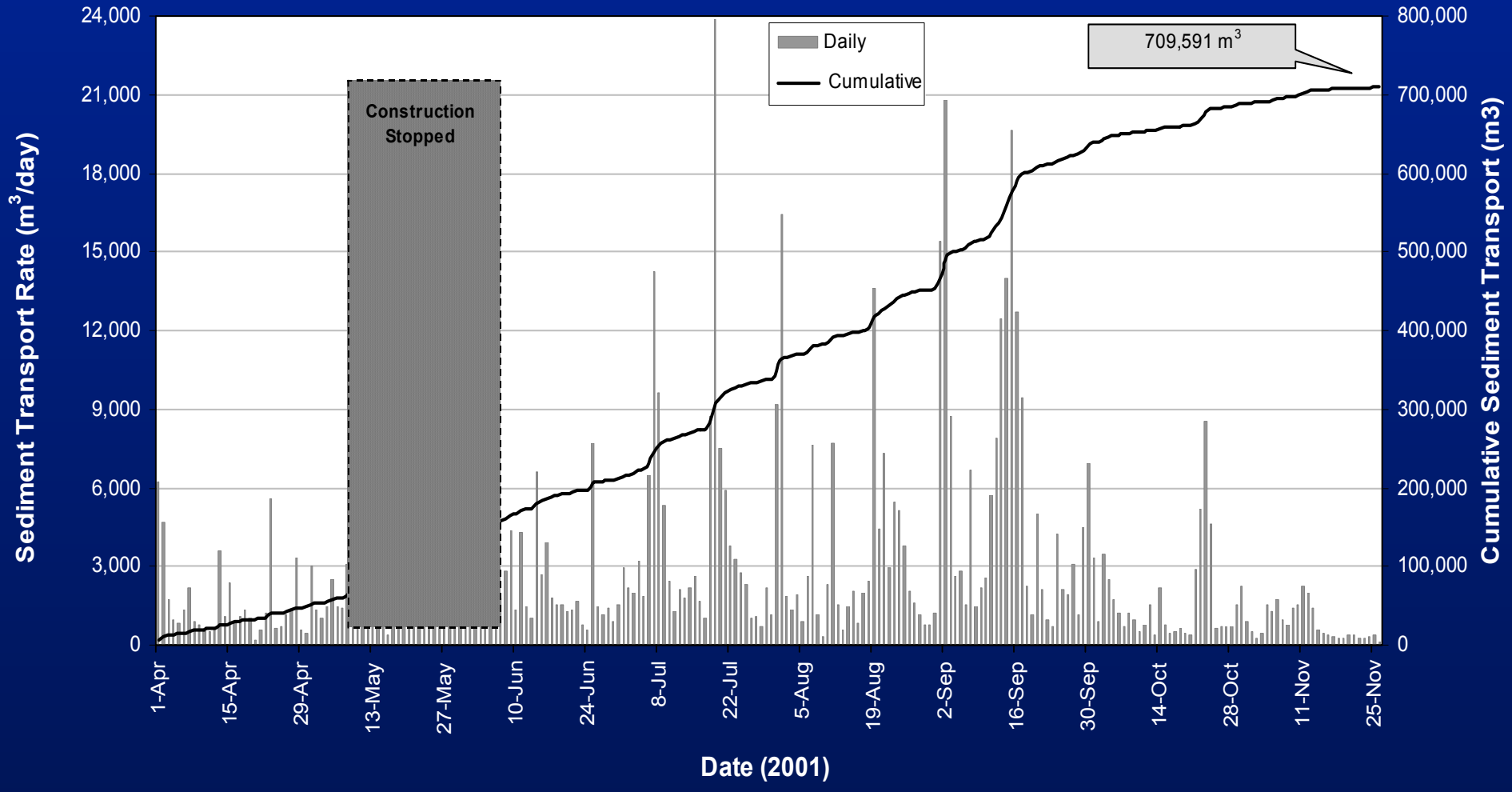

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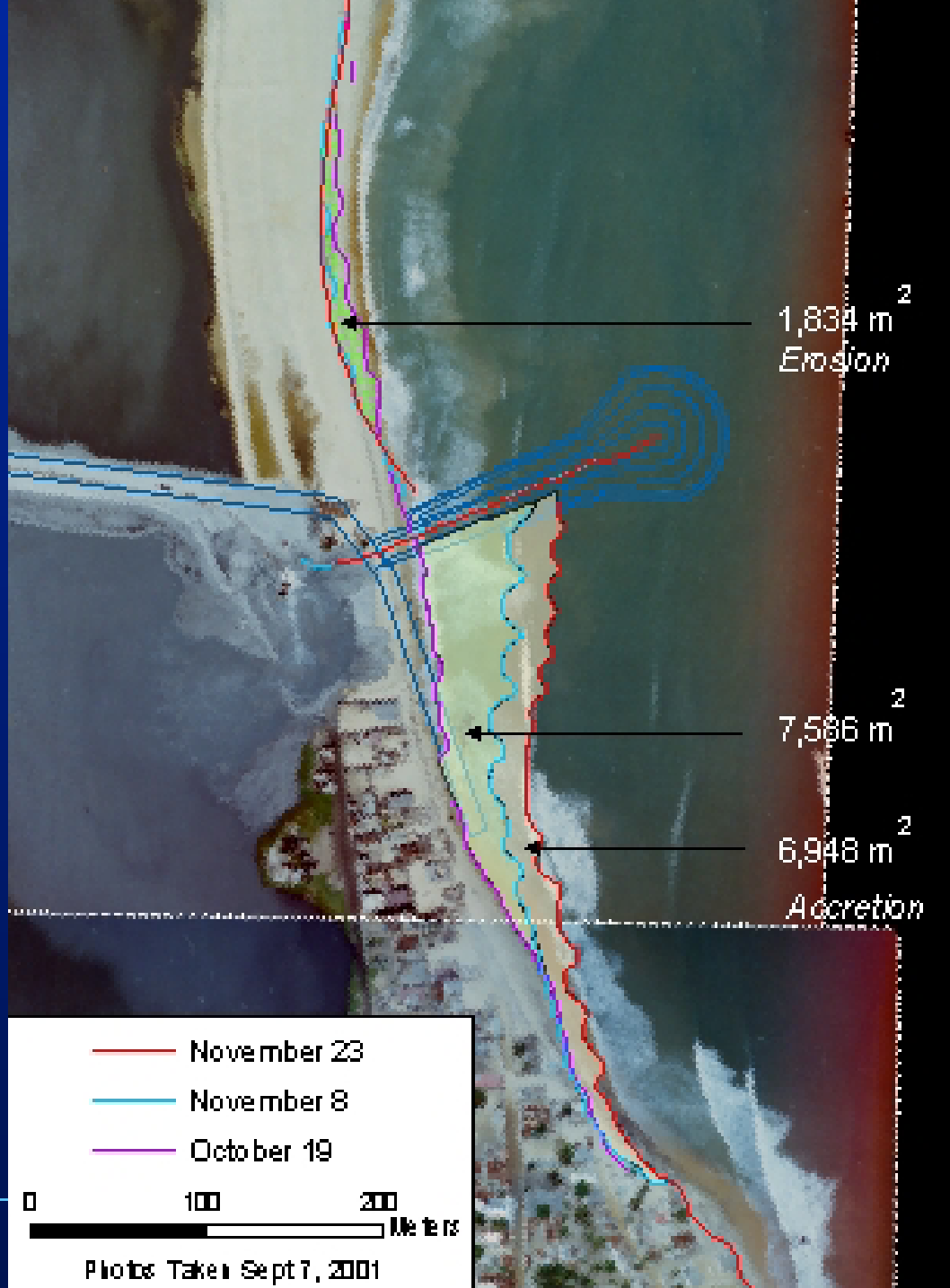
Figure 13 - Longshore Sediment Transport at Headland 5

Accretion and Erosion Areas around Headland 2



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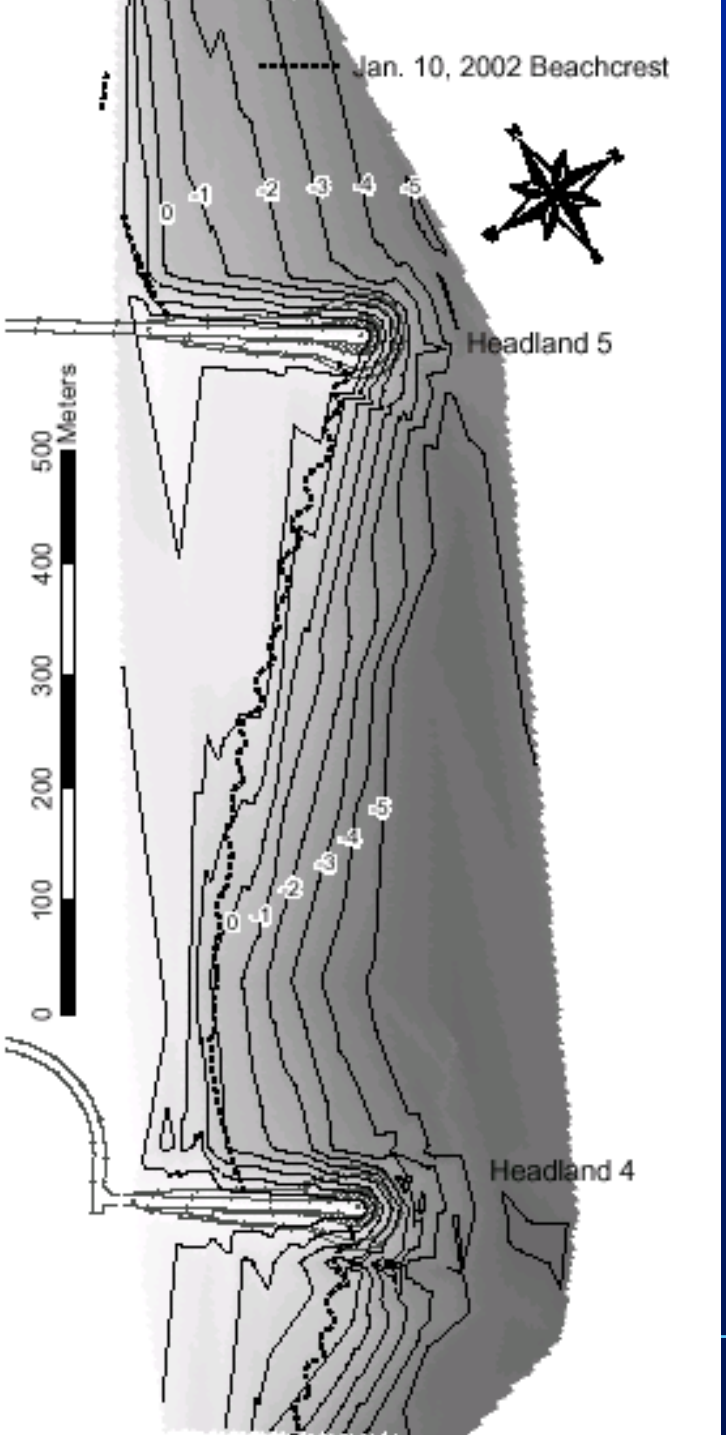
Jan. 10, 2002 Beachcrest
0
-1
-2
-3
-4
-5
Headland 5
Meters
0
100
200
300
400
500
Headland 4

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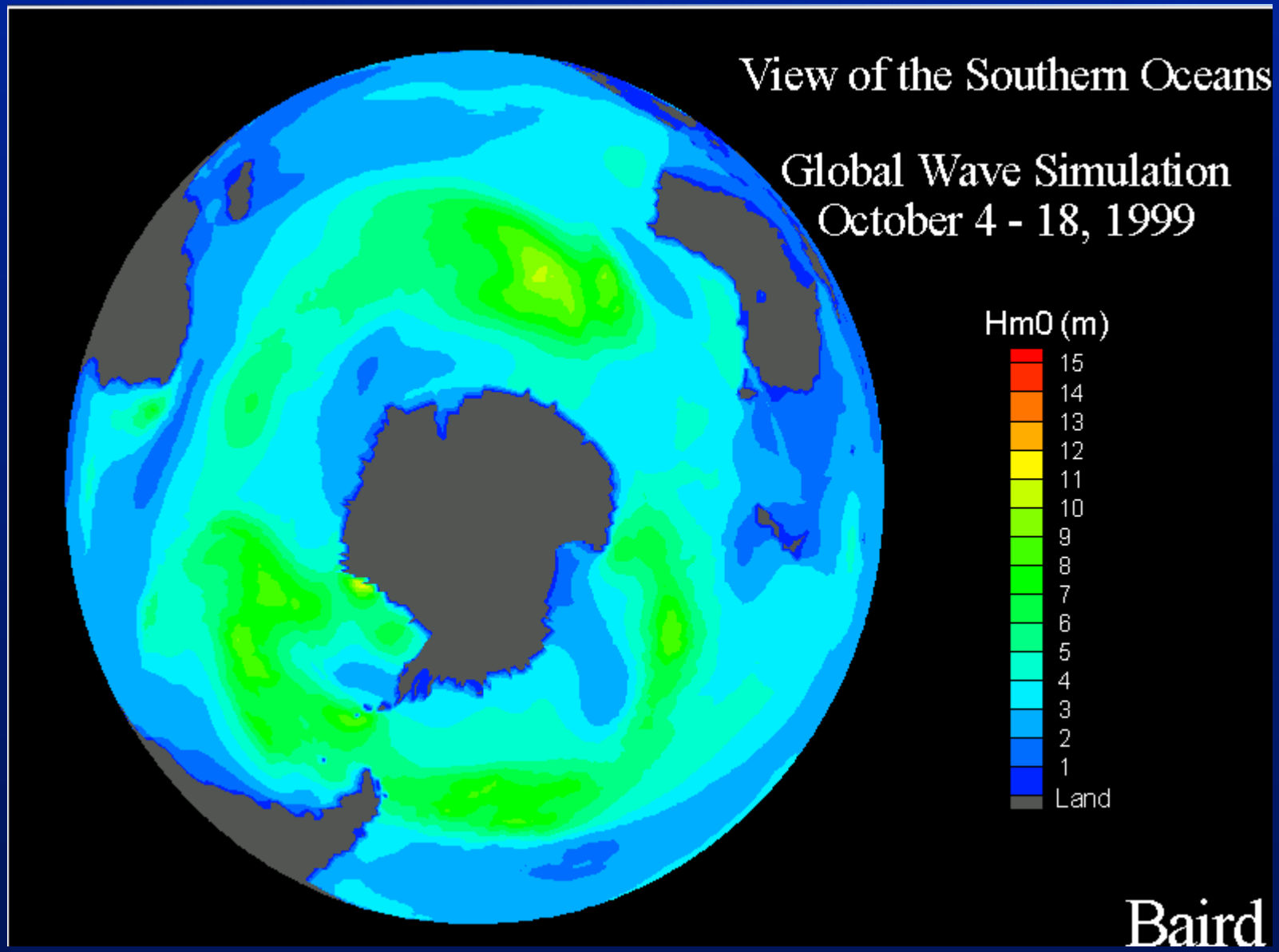
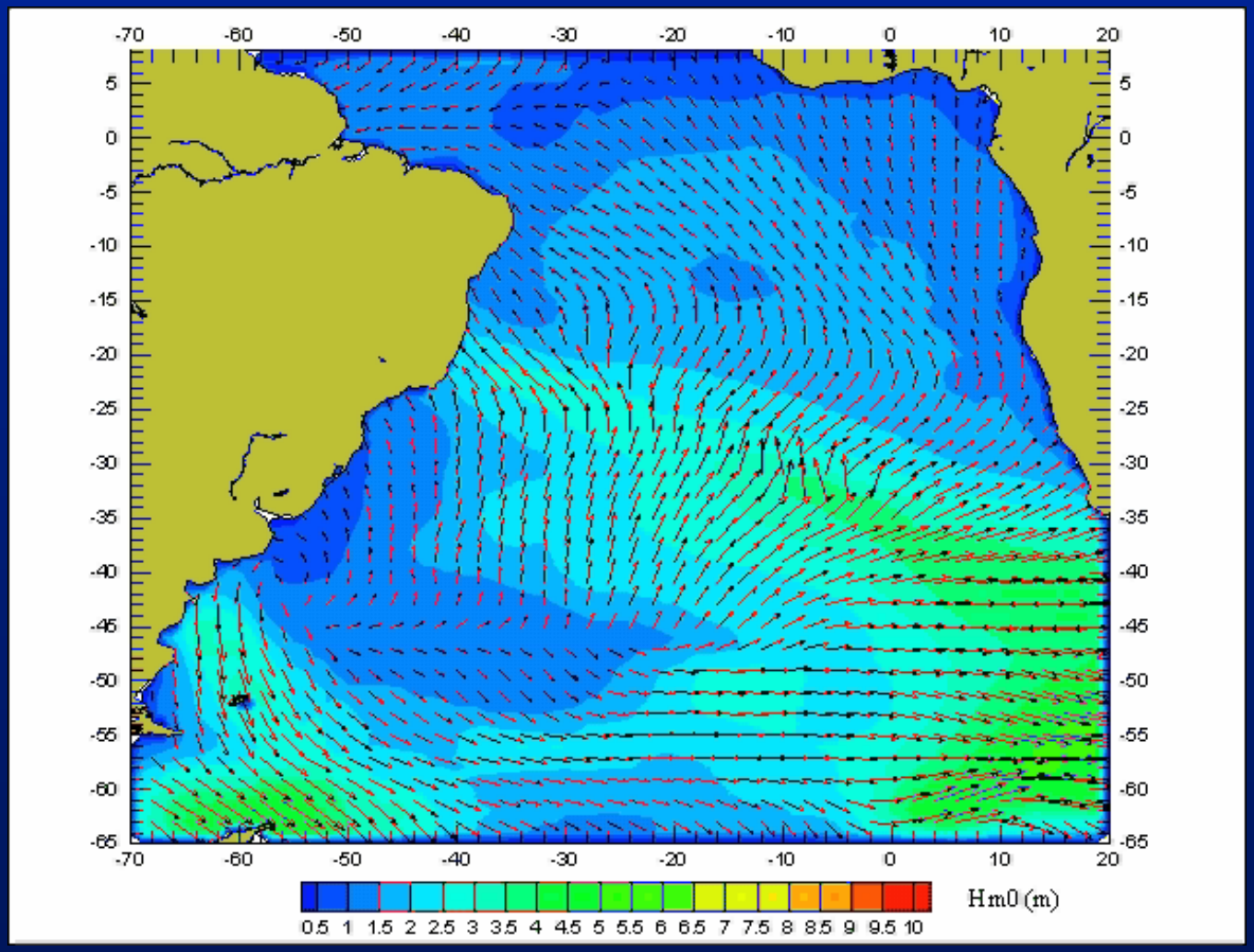

View of the Southern Oceans
Global Wave Simulation
October 4 - 18, 1999
Hm0 (m)
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
Land
Baird


-70 -60 -50 -40 -30 -20 -10 0 10 20
5 0 -5 -10 -15 -20 -25 -30 -35 -40 -45 -50 -55 -60 -65
Hm0 (m)
0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10

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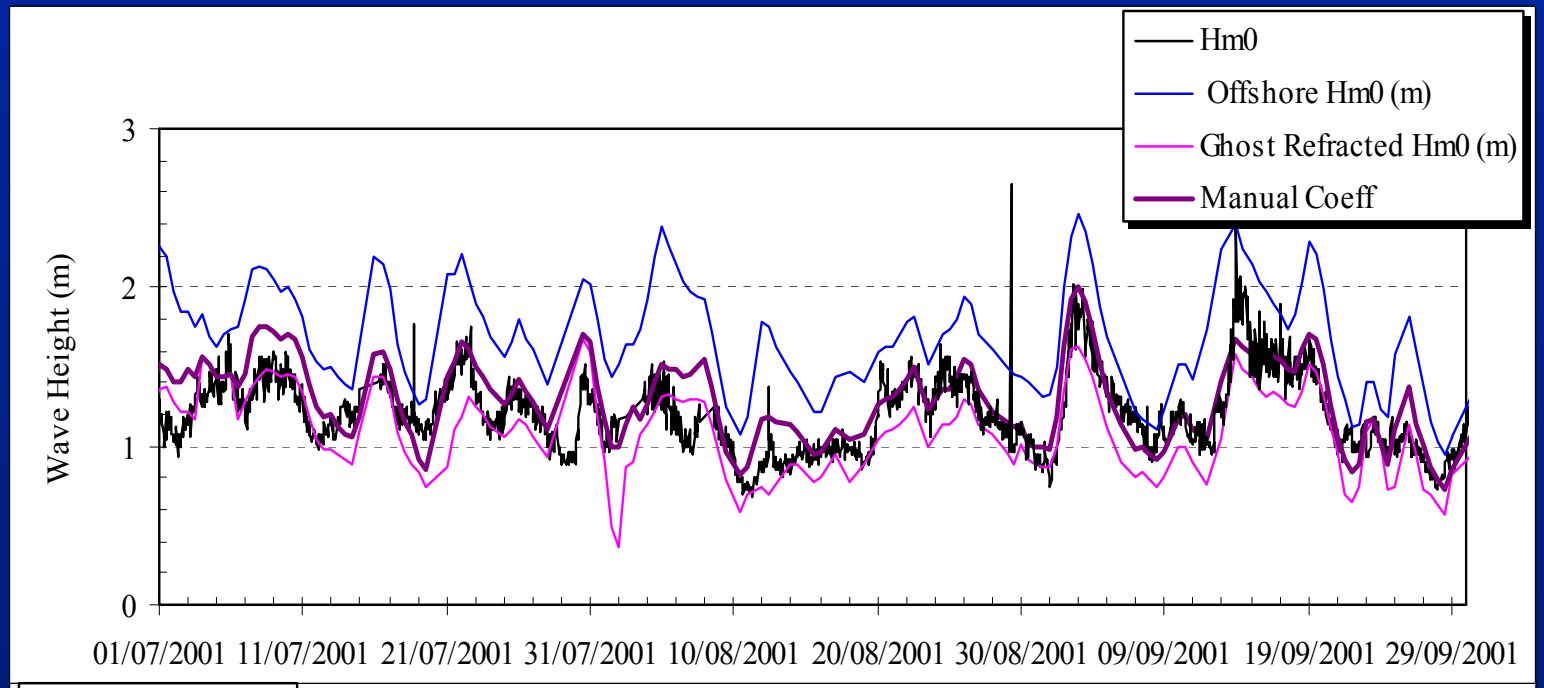
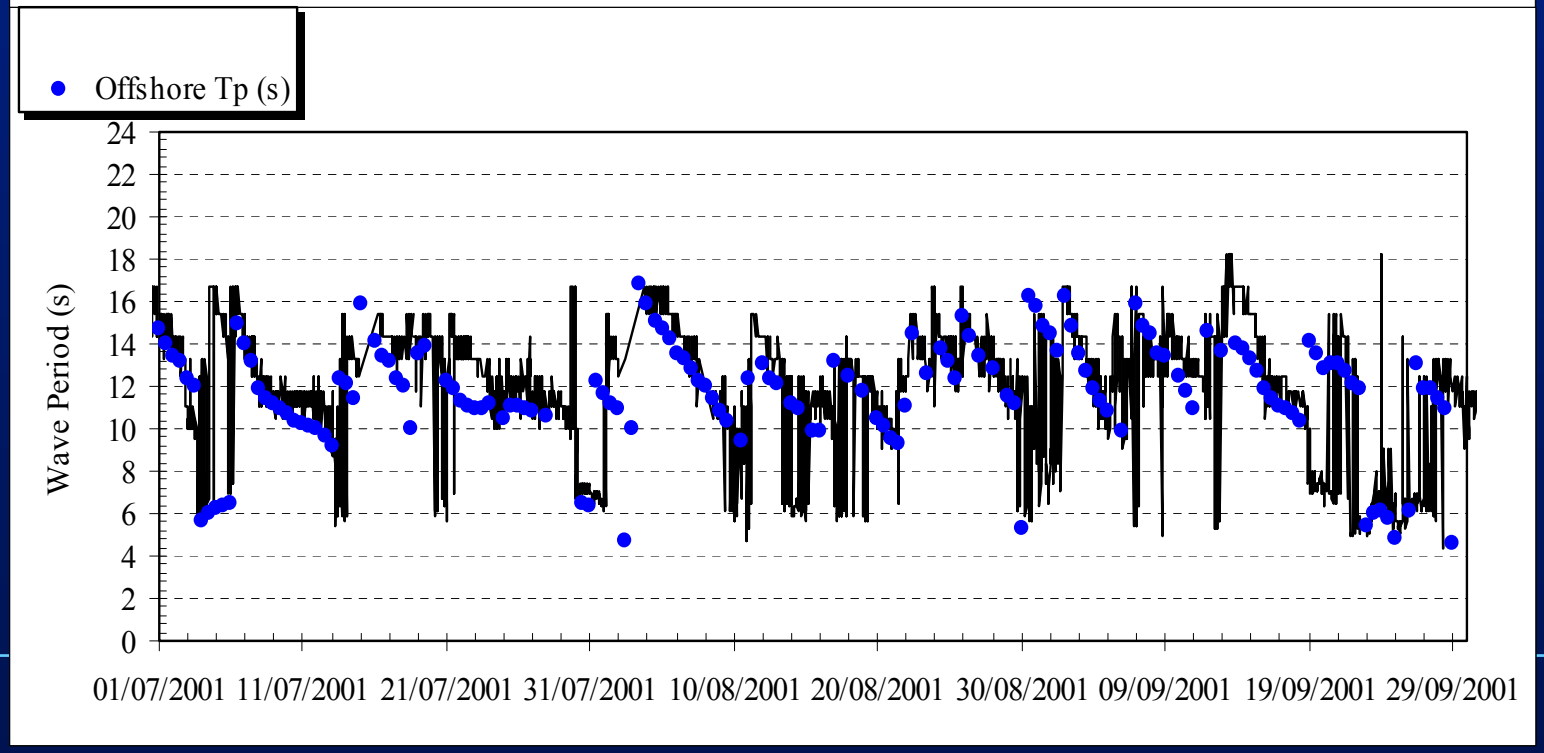
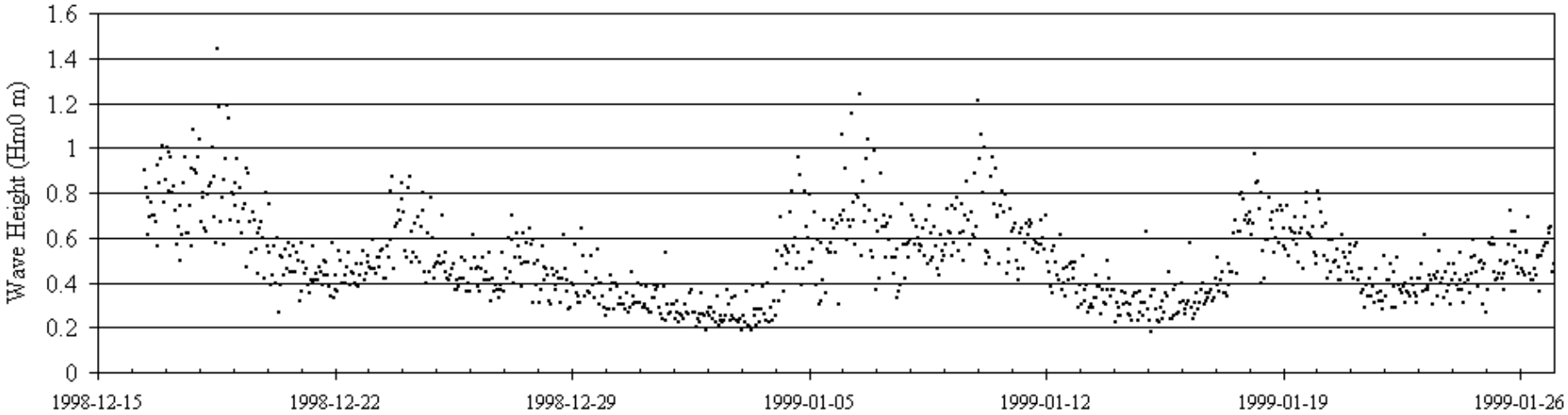
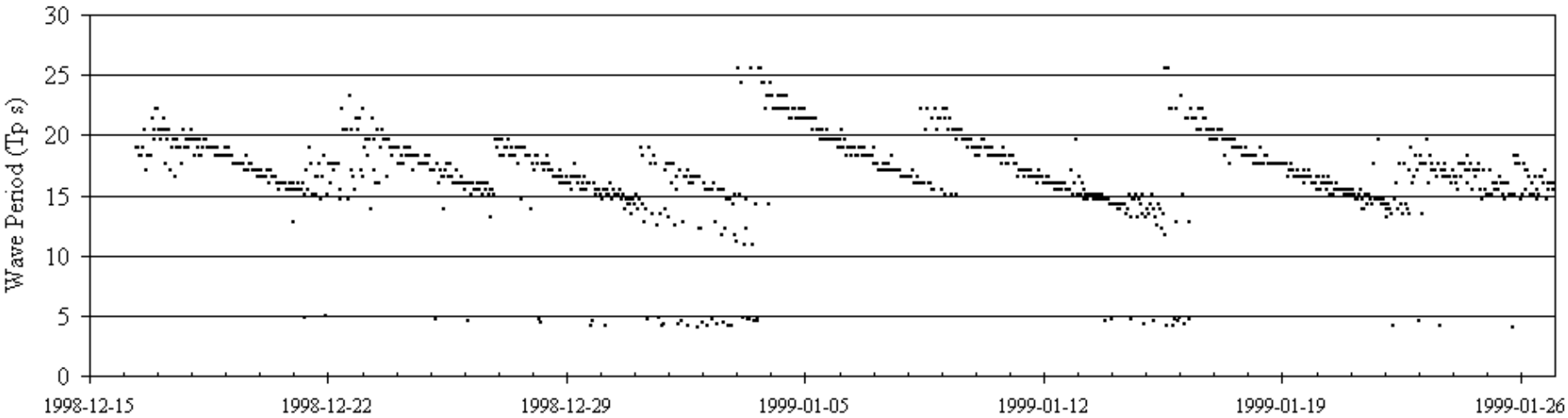

Hm0
Offshore Hm0 (m)
Ghost Refracted Hm0 (m)
Manual Coeff
Wave Height (m)
0
1
2
3
01/07/2001
11/07/2001
21/07/2001
31/07/2001
10/08/2001
20/08/2001
30/08/2001
09/09/2001
19/09/2001
29/09/2001

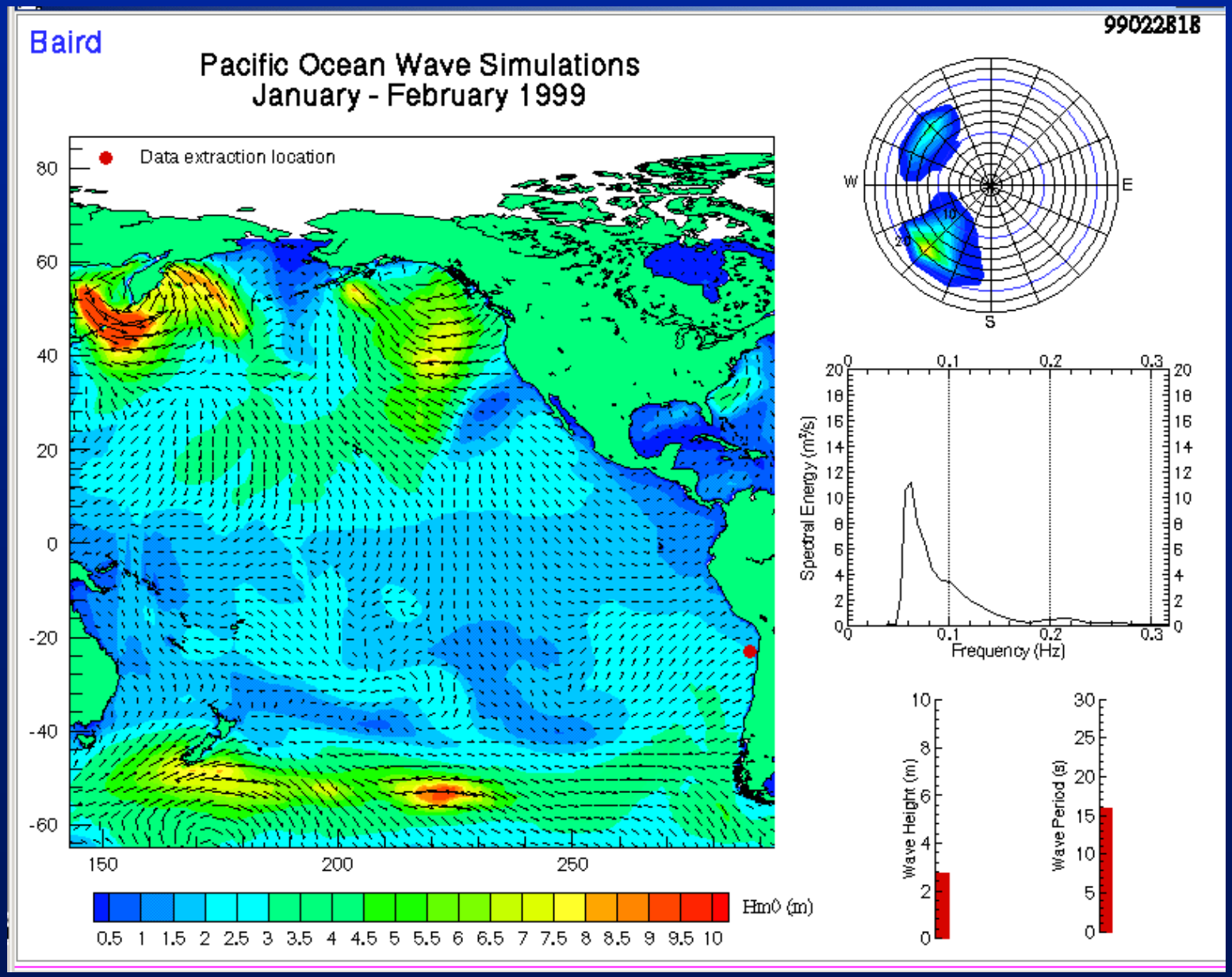

Offshore Tp (s)
Wave Period (s)
0
2
4
6
8
10
12
14
16
18
20
22
24
01/07/2001
11/07/2001
21/07/2001
31/07/2001
10/08/2001
20/08/2001
30/08/2001
09/09/2001
19/09/2001
29/09/2001

Wave Data from Chile



Wave Data Recorded at Mejillones Site by Bentos - Wave Period

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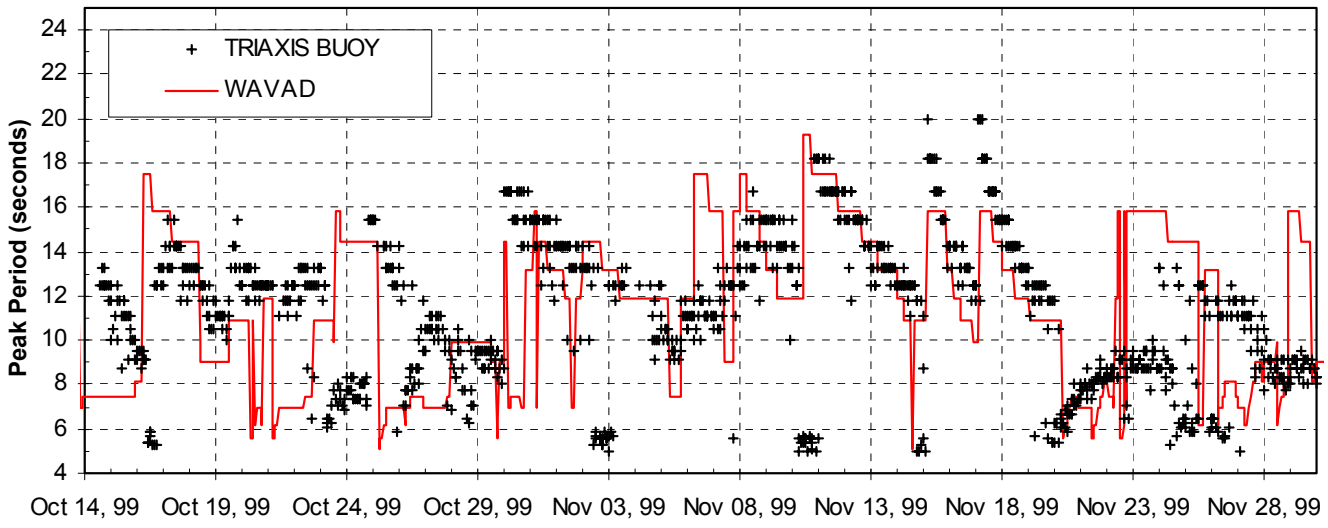
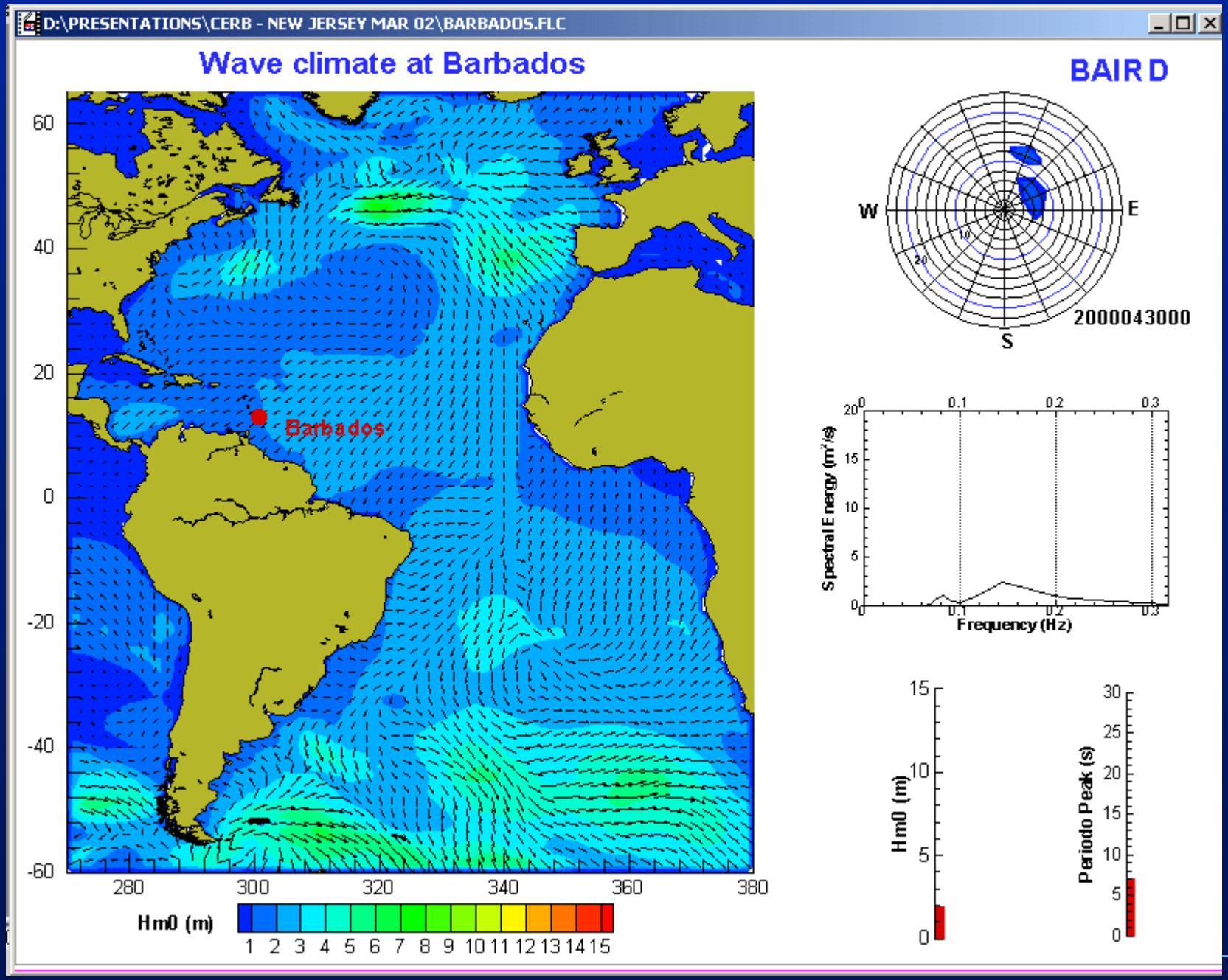
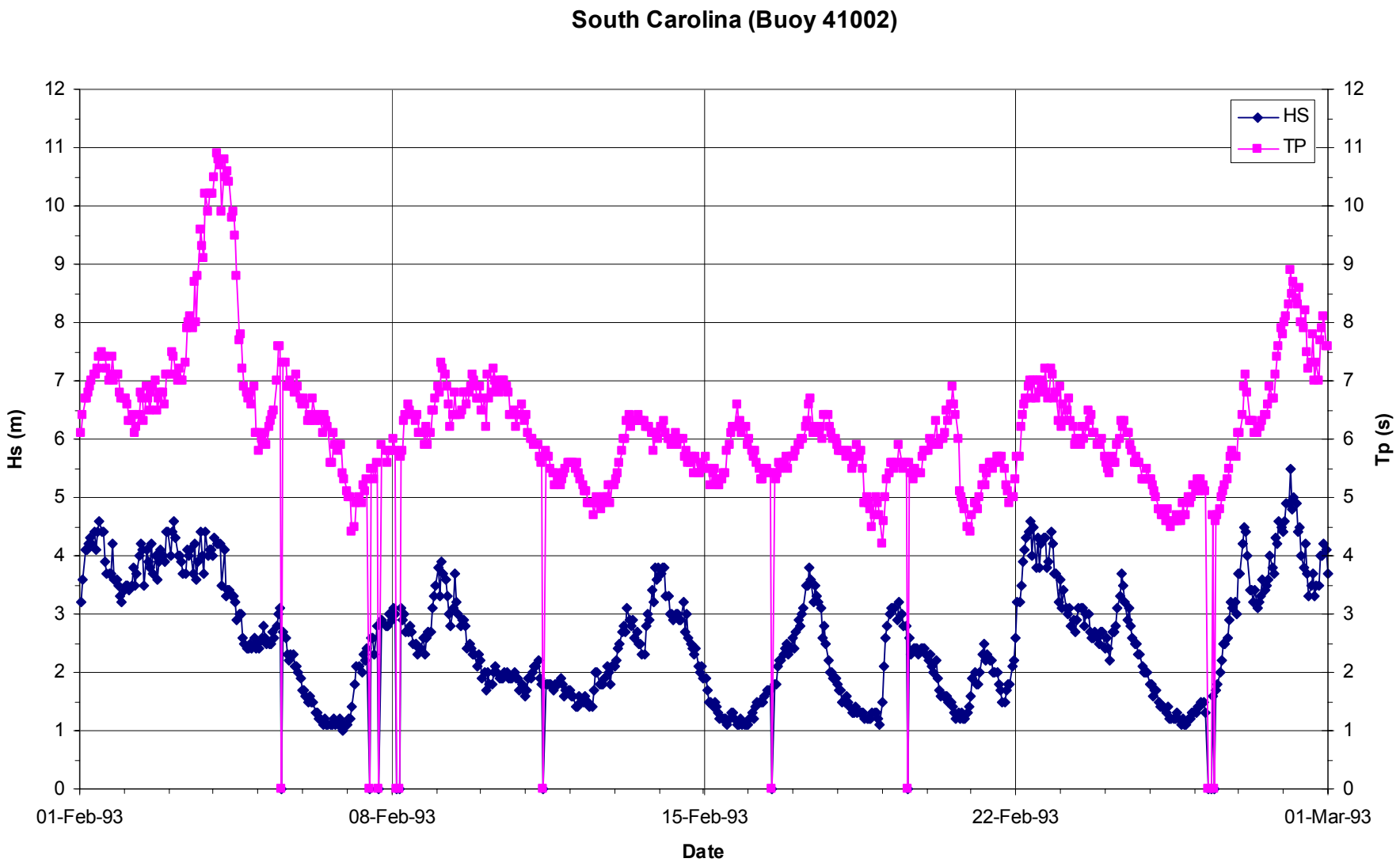
99022818
Pacific Ocean Wave Simulations
January - February 1999
Data extraction location
80
60
40
20
0
-20
-40
-60
150
200
250
Hm0 (m)
0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10
W
E
S
10
20
Spectral Energy (m²/s)
Frequency (Hz)
0 0.1 0.2 0.3
Wave Height (m)
Wave Period (s)

TRIAXIS BUOY
WAVAD
Hmo (metres)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Oct 14, 99
Oct 19, 99
Oct 24, 99
Oct 29, 99
Nov 03, 99
Nov 08, 99
Nov 13, 99
Nov 18, 99
Nov 23, 99
Nov 28, 99


TRIAXIS BUOY
WAVAD
Peak Period (seconds)
24
22
20
18
16
14
12
10
8
6
4
Oct 14, 99
Oct 19, 99
Oct 24, 99
Oct 29, 99
Nov 03, 99
Nov 08, 99
Nov 13, 99
Nov 18, 99
Nov 23, 99
Nov 28, 99

Madagascar


D:\PRESENTATIONS\CERB - NEW JERSEY MAR 02\BARBADOS.FLC
Wave climate at Barbados
BAIRD
Barbados
60
40
20
0
-20
-40
-60
280
300
320
340
360
380
Hm0 (m)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
W
E
S
2000043000
Spectral Energy (m²/s)
Frequency (Hz)
0.1
0.2
0.3
Hm0 (m)
Periodo Peak (s)


South Carolina (Buoy 41002)
HS
TP
Hs (m)
Tp (s)
Date
01-Feb-93
08-Feb-93
15-Feb-93
22-Feb-93
01-Mar-93
0
1
2
3
4
5
6
7
8
9
10
11
12

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Summary

- Ability to describe and simulate swell waves has increased tremendously in the last few years
- Swell waves are prevalent and have an important influence on LST and beach accretion/recovery
- Will support more deterministic assessments of beach nourishment

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