Rip Current Definition:

– a jet-like seaward flow across the surf zone of a beach.

A Overhead View of a California Mega Rip

July 25, 2009 by Tom Cozad, pilot: Howard Hamlin

Types of Rip Currents

From United States Lifesaving Association manual:

Fixed: appear over a rip channel.

Permanent: stationary near a jetty

Flash: due to sets of waves, bi-modal waves

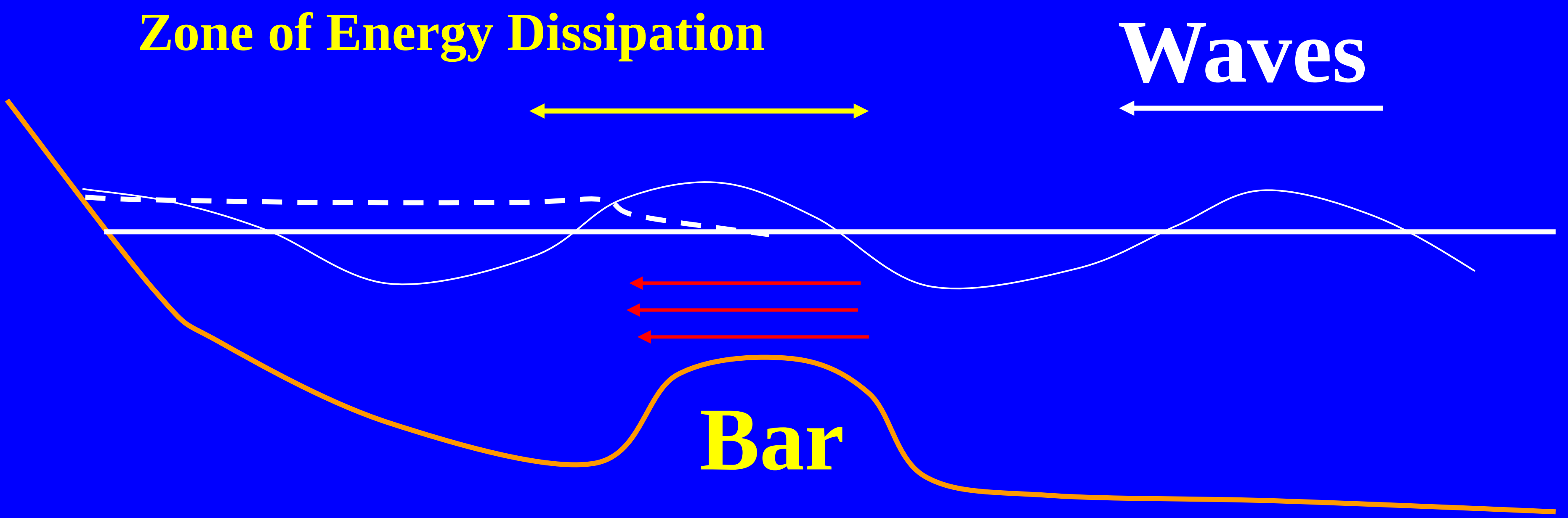
Traveling or migrating: caused by strong swells which strike the beach obliquely.

What causes rip currents ?

<u>Major factors</u>

- **Breaking Waves**
- **Water Level**
- **Beach Characteristics**

Consider Surface Wave Energy Dissipation Over a Sand Bar



---- Increase in Water Level over the Bar

Convert momentum flux forces (KE-PE)

Approaches to Studying Rip Currents

- Laboratory Experiments: Qualitative features, scale problem

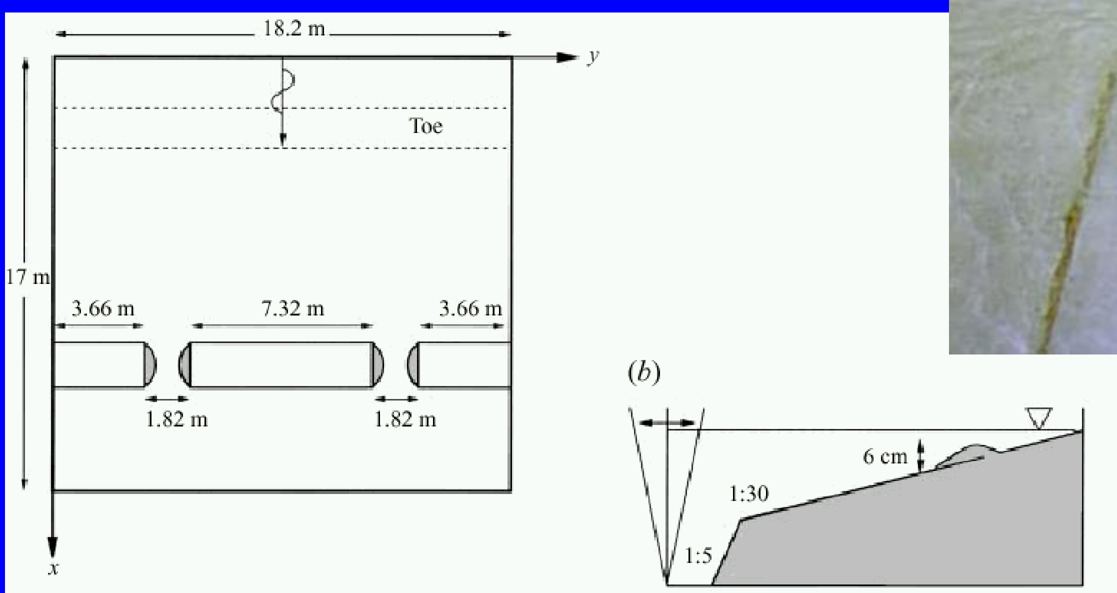
- Field Studies: expensive, not easily repeatable

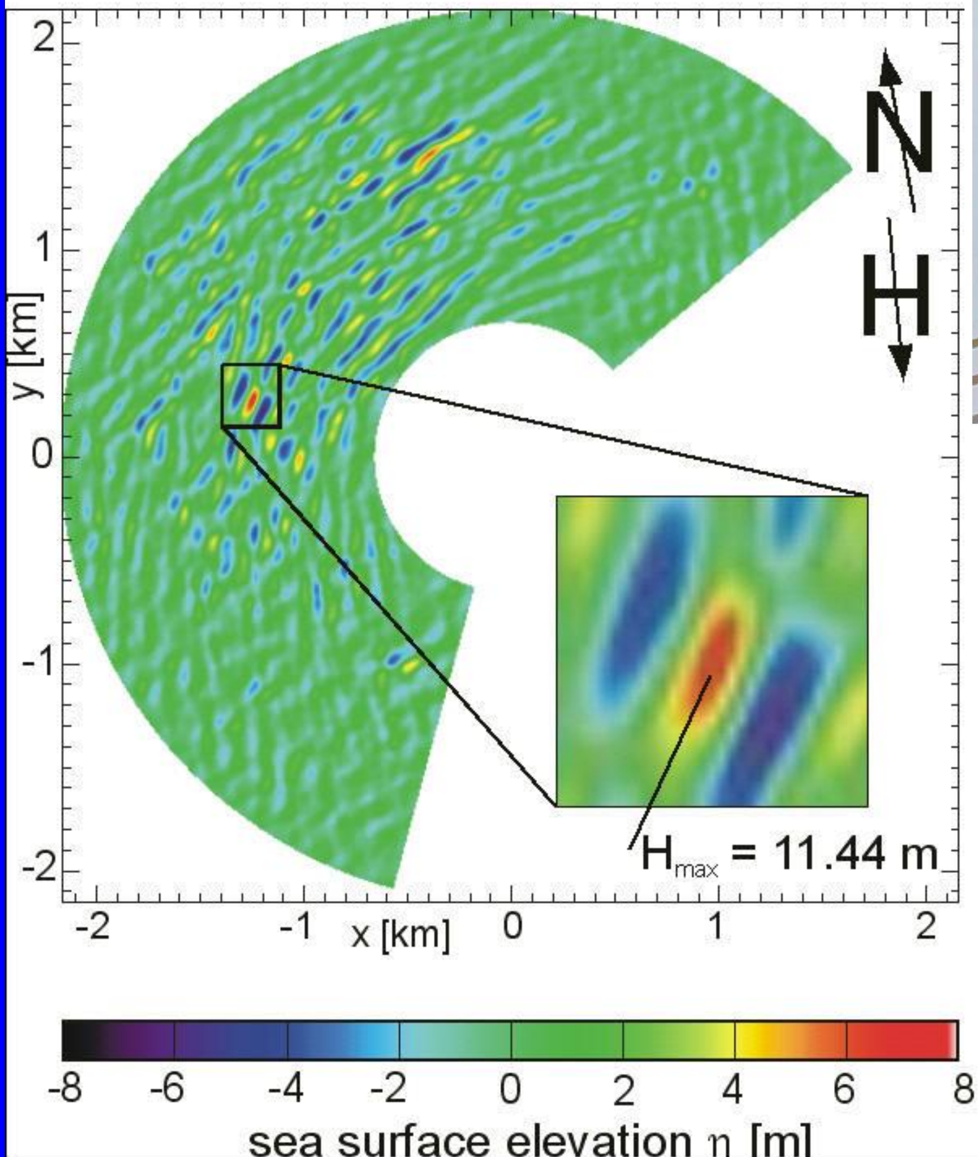
- Theory/Computer modeling: need initial/boundary conditions, CPU intensive

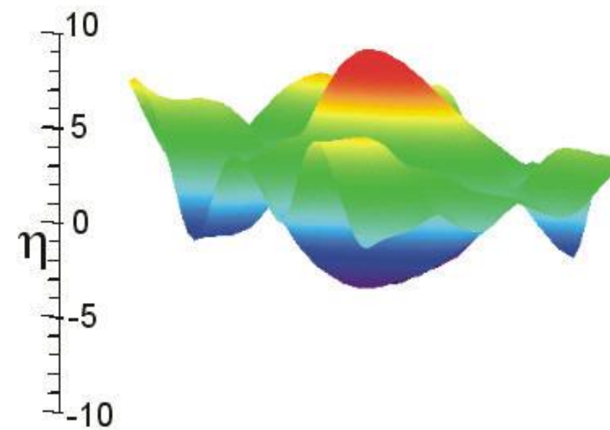
- Diagnostic Monitoring of surf data: our approach

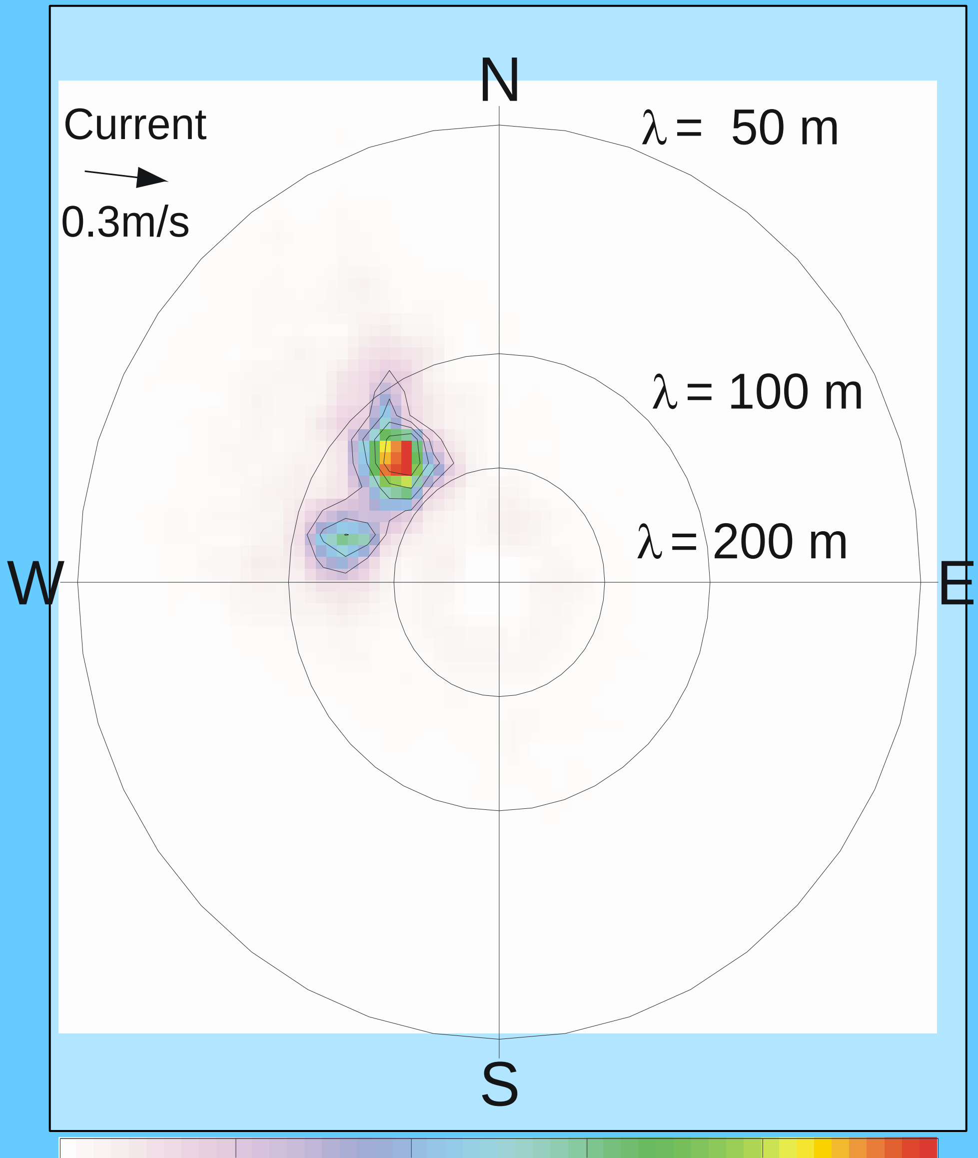
Lab Experiment

Haller *et al*. (2002)
Haller and Dalrymple, 1999




N
H
H_{max} = 11.44 m
y [km]
x [km]
-2
-1
0
1
2
-8
-6
-4
-2
0
2
4
6
8
sea surface elevation η [m]


η
10
5
0
-5
-10



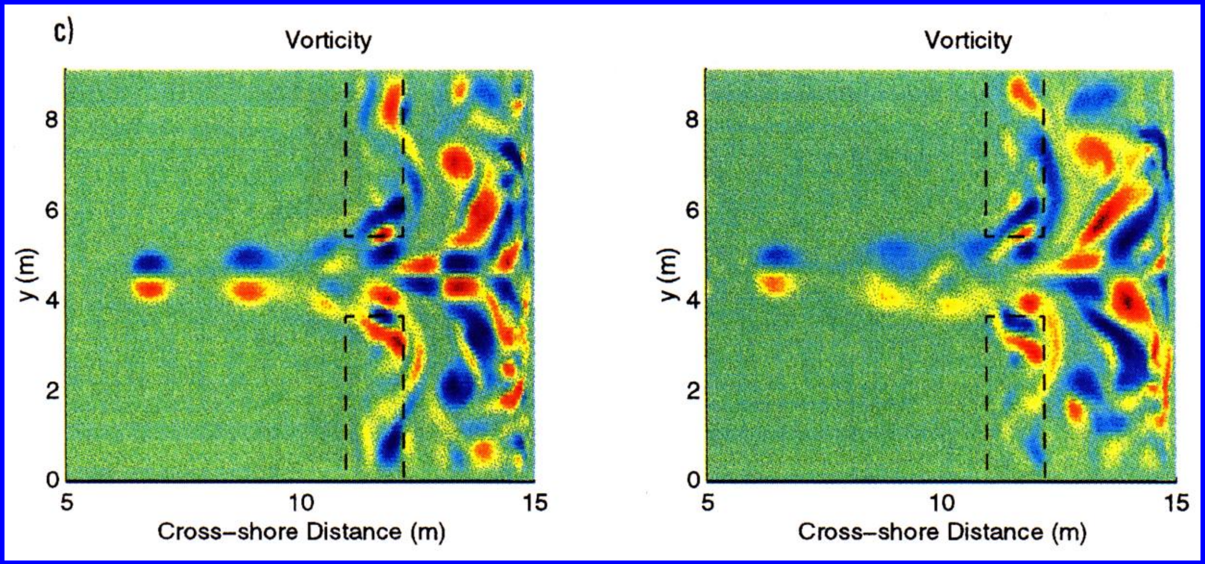
Wave number spectrum observed using *Marine X-band radar*
May 29, 2001, 15:10 UTC

Hs = 4.5 m
Tp = 9.2 s
λp = 133 m

Modeling of Nearshore Current Circulations

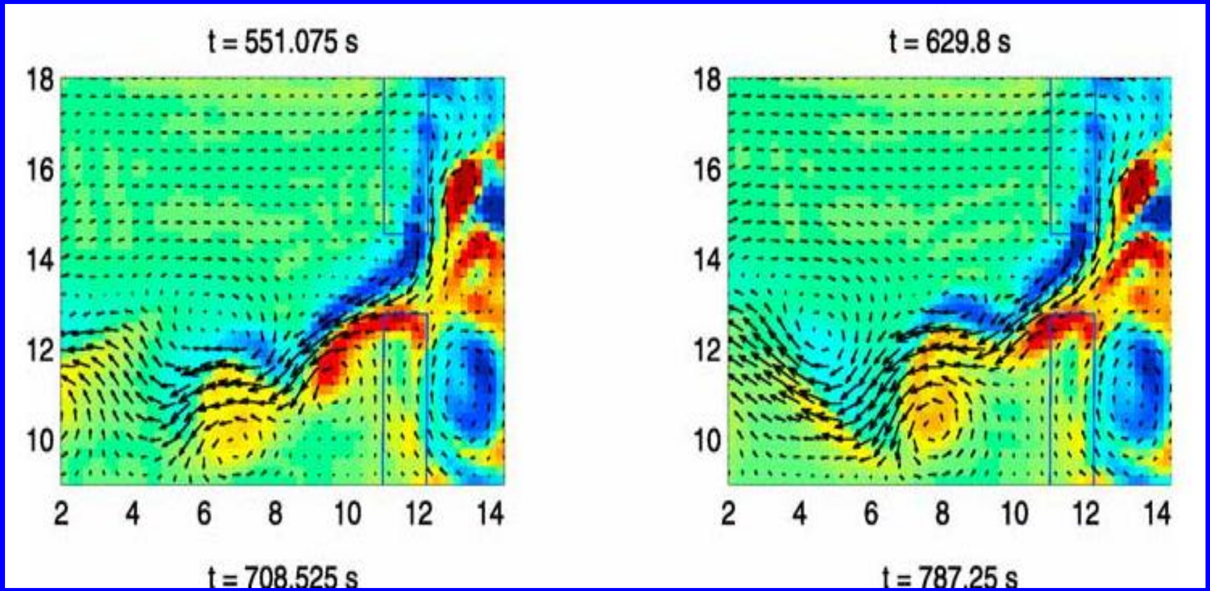
Boussinesq wave/current model on a sand bar bathymetry (FUNWAVE)

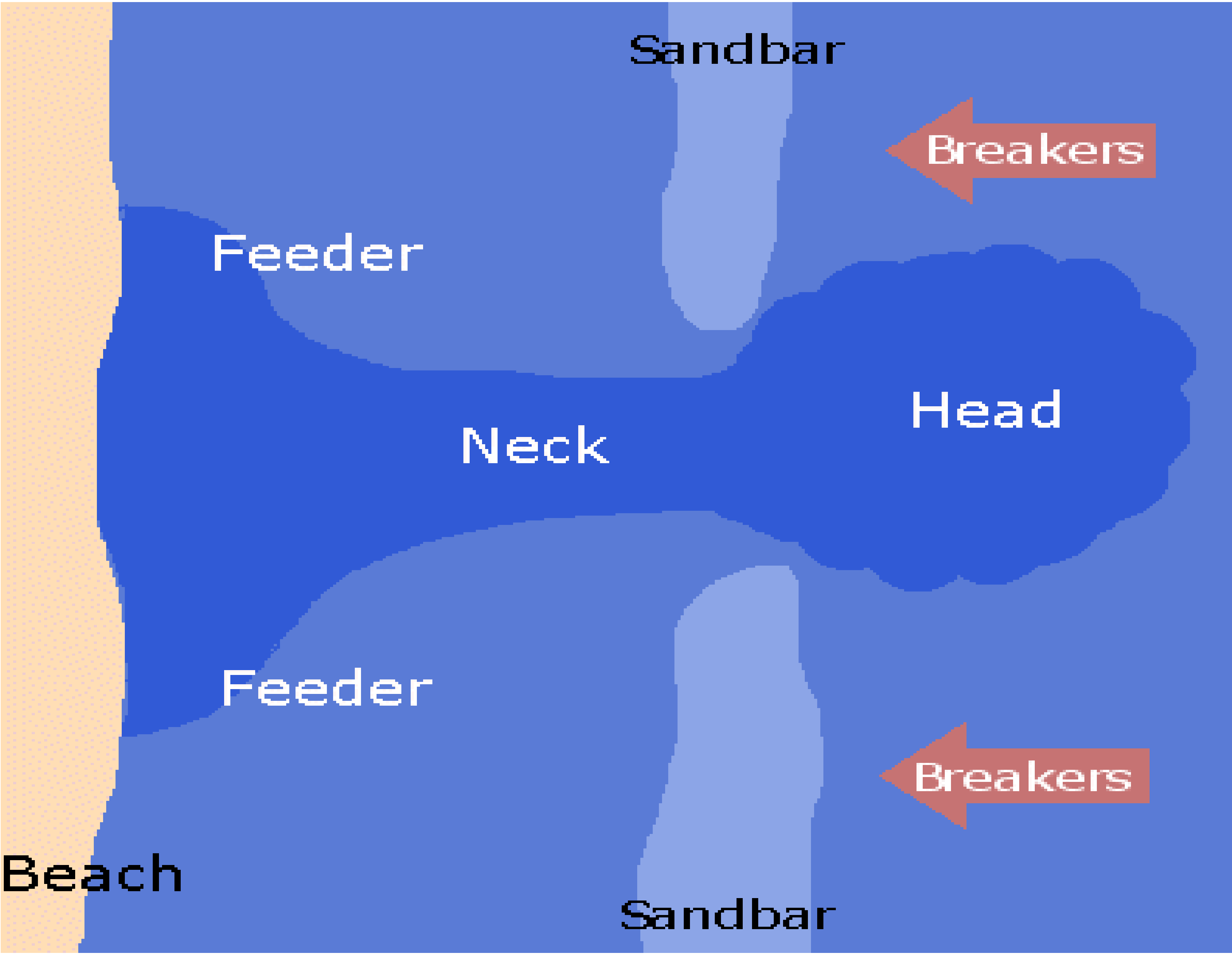
(Chen et al., *J. Geophys. Res.*, 1999)



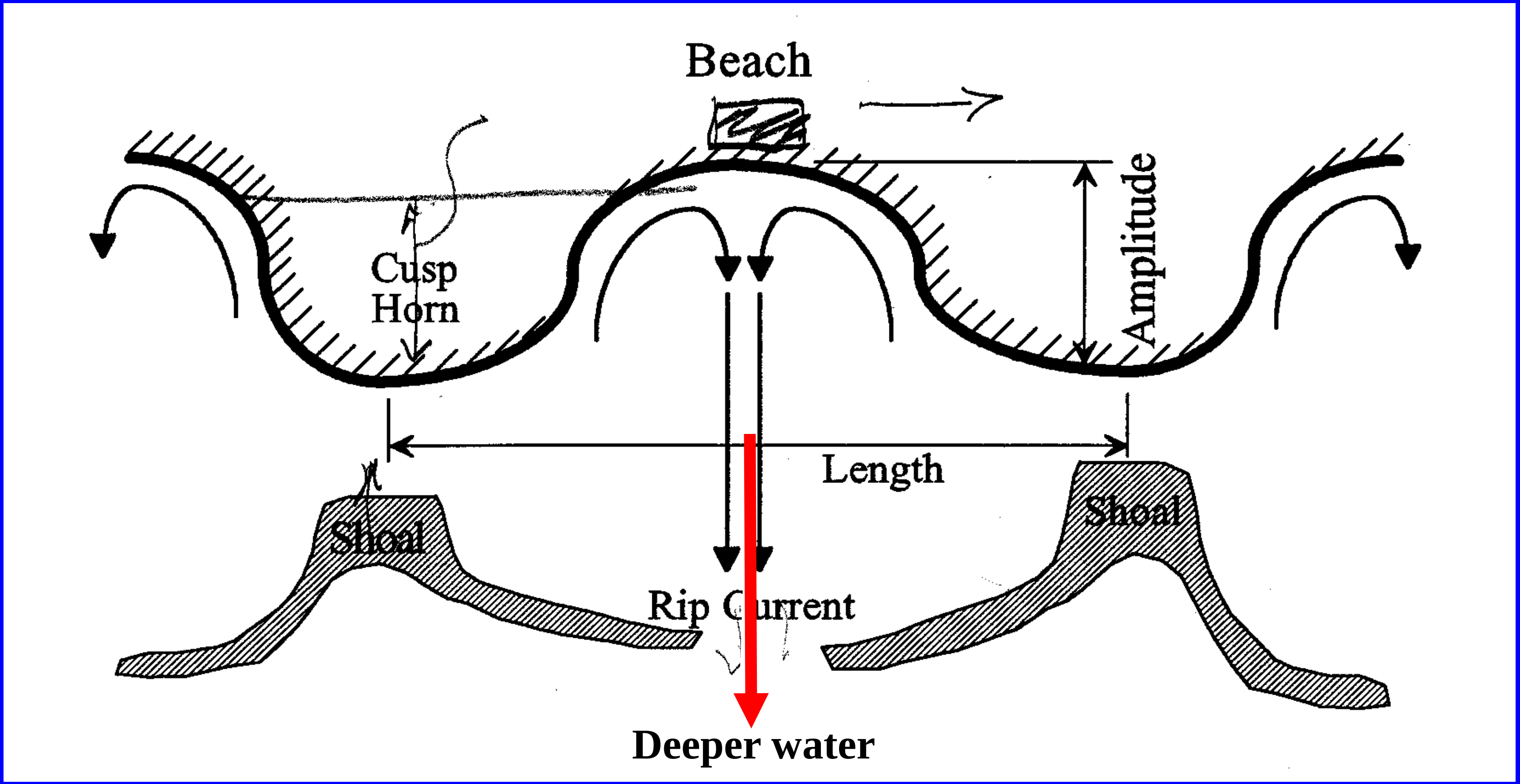
Coupled wave-driver (REF/DIF) & circulation model (SHORECIRC)

(Haas et al., *J. Geophys. Res.*, 2003)




Sandbar
Breakers
Feeder
Head
Neck
Feeder
Breakers
Beach
Sandbar

Rips over Panama City Beach with bar-trough and protruded shore



Southern California Rip Current Monitoring surf zone data

Q1: What are the prevailing **conditions** *for rip currents ?*

Find a rule of thumb from the data.

Q2: How to define the **strength** *of rip currents ?*

Generalize a description of rip risk levels.

Seasonal Wave Characteristics on Moonlight Beach

Mean Waves **Season**	Surf Height (ft)	Wave period (sec)	Surf Zone Width (ft)
Winter	**3.50**	**10.5**	**203**
Spring	**2.89**	**9.8**	**280**
Summer	**2.61**	**12.6**	**242**
Fall	**2.59**	**11.6**	**205**

Winter: **12/15/08-4/16/09** Spring: **4/16/08-06/10/08** Summer: **6/12/08-10/02/08** Fall: **10/03/08-12/14/08**

Seasonal Rip Current Characteristics at Moonlight Beach, CA

Intensity / Season	Weak	Moderate	Strong	No rips
Winter	**50**	**56**	**14**	**22**
Spring	**33**	**26**	**4**	**8**
Summer	**51**	**53**	**5**	**20**
Fall	**37**	**25**	**3**	**14**

Winter: **12/15/08-4/16/09** Spring: **4/16-06/10/08** Summer: **6/12-10/02/08** Fall: **10/03-12/14/08**

Methods of Prediction

I. Rip prevailing condition:

A. Wave -Sediment (by Short and Wright) or M_2

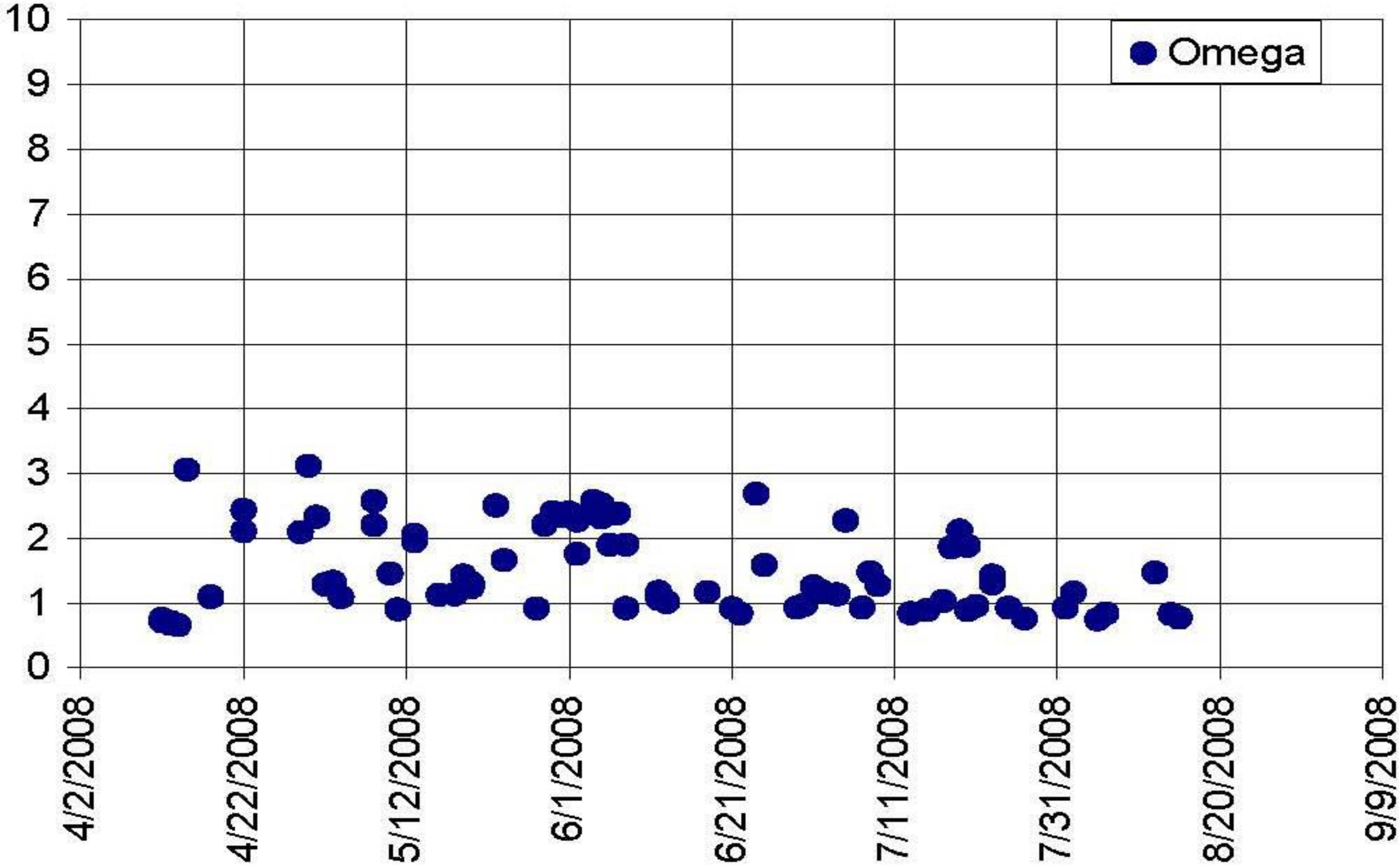
$\Omega = H_b / T w =$ *wave particle speed/sand falling speed*

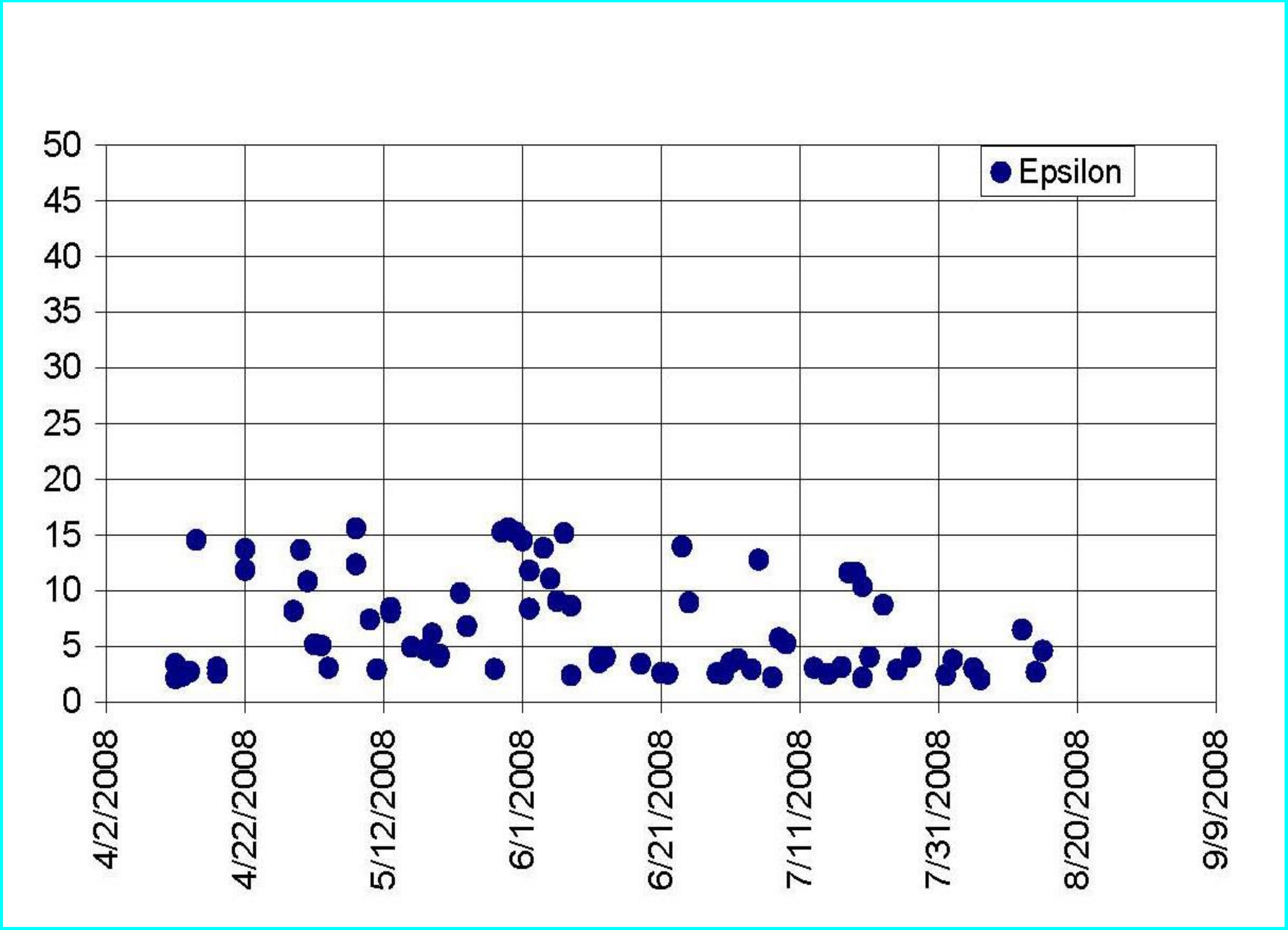
$1 < \Omega < 6$ rips appearing ranges.

B. Surf scale parameter (Wave-Beach) (Guza, Nielsen, etc) or M_3

$2.0 < \varepsilon = a_b \omega^2 / g \tan^2 \beta \Rightarrow$ wave steepness/beach face slope.

II. Rip strength estimate:


Omega
10
9
8
7
6
5
4
3
2
1
0
4/2/2008
4/22/2008
5/12/2008
6/1/2008
6/21/2008
7/11/2008
7/31/2008
8/20/2008
9/9/2008



More sensitive to beach face slope, limited

Critical Skill Performance

During 4/15/08 - 8/16/2008

SCORE / Methods	POD Probability of detection	FAR False Alarm rate	SR Success ratio	CSI Critical success index
Wave-Sand M2	**0.81**	**0.25**	**0.75**	**0.631**
Wave-beach M 3	**0.69**	**0.36**	**0.64**	**0.523**

(A) Spilling breakers in series with saturated surf zones. Usually can be seen at low tide. Waves are high.

(B) Longshore bar-trough with steeper waves that collapse near the shore. Rip appears at bar breaches.

Beach cusps, $\Omega < 1$ or ε < 2.0, waves are reflected

Methods of Prediction

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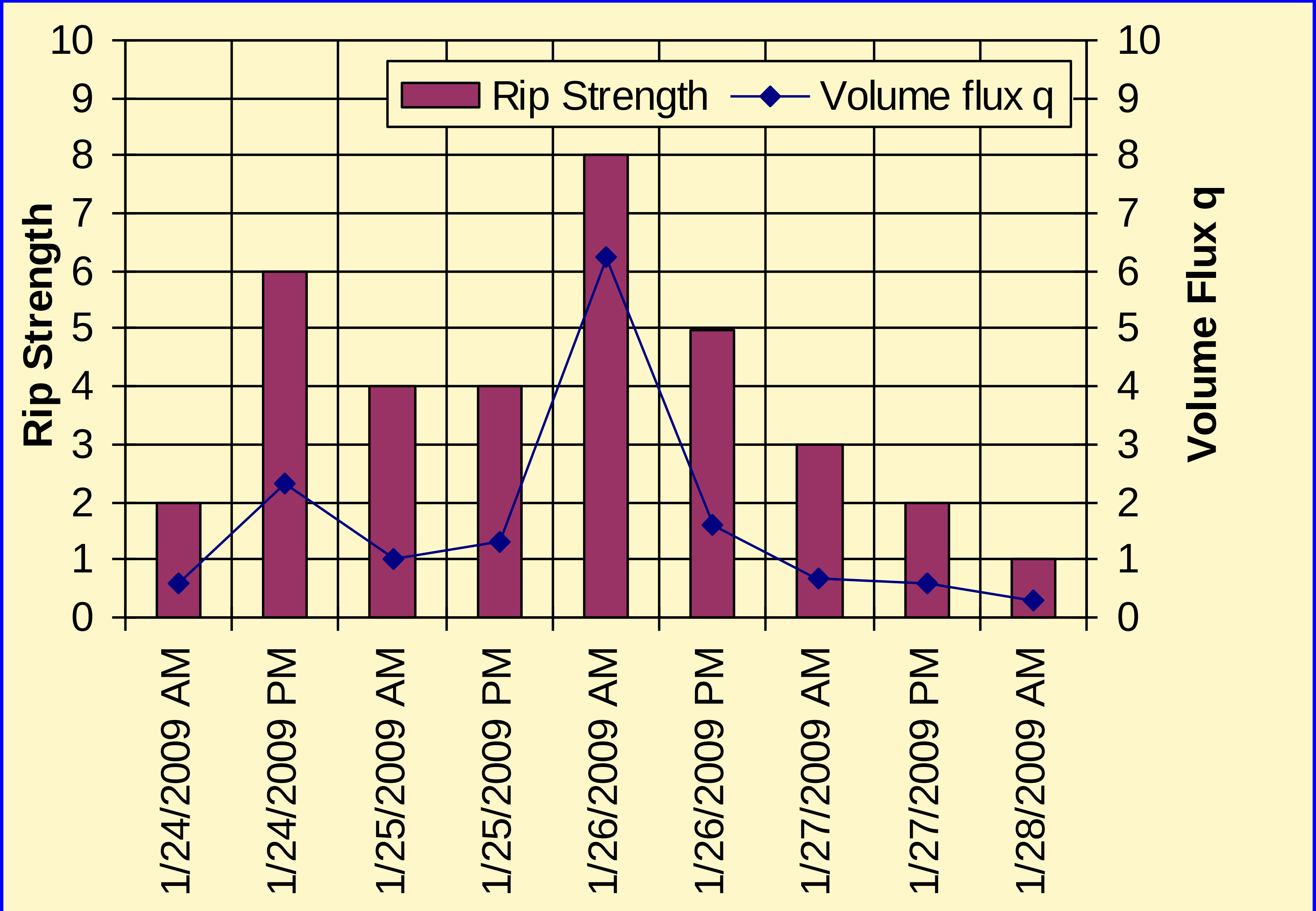
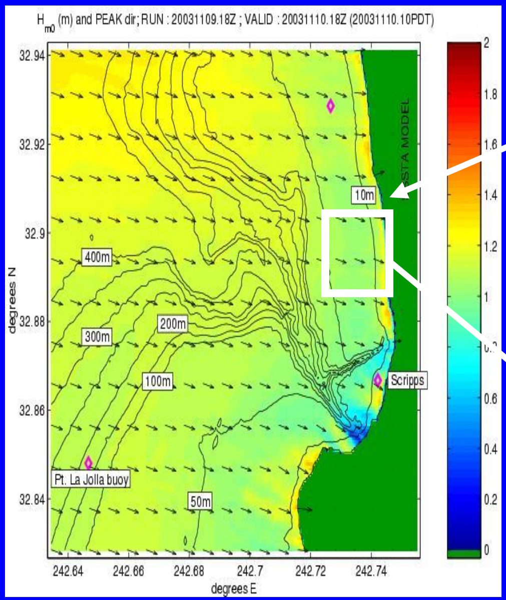
II. Rip strength estimate:

Rip strength versus water volume flux

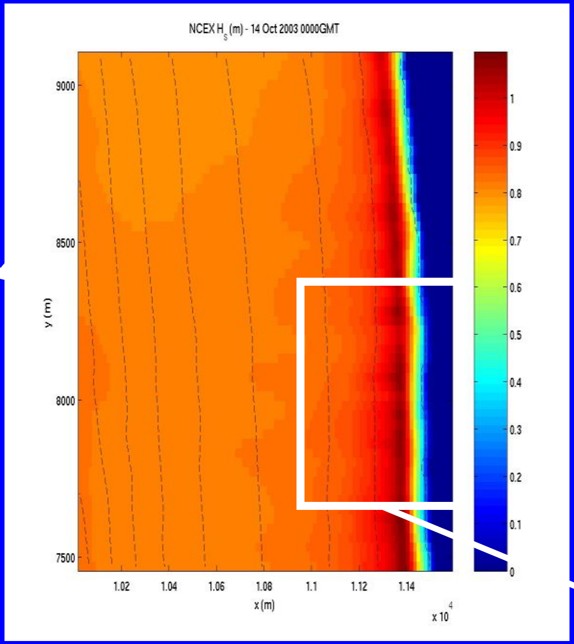


Back-up Slides

Delft 3D Model Setup – Nested Domains

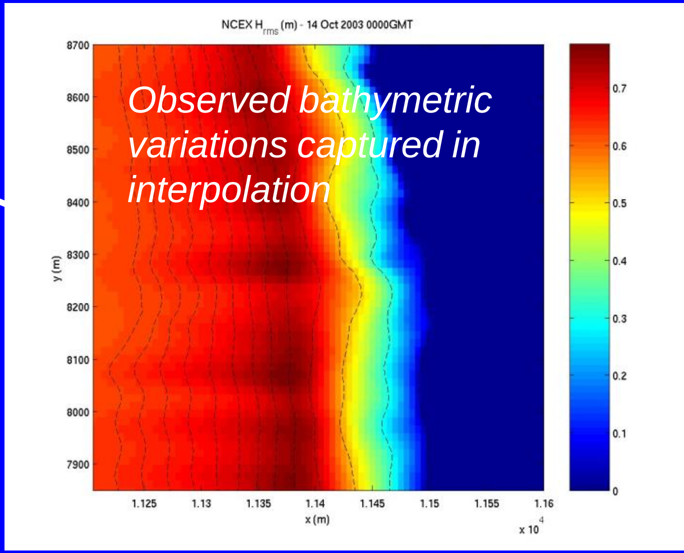


Encircles Area 3



Delft3D SWAN/FLOW Area

- 5m x 15m resolution
- Standard boundary conditions
- No roller activated
- 3 hr run (in 1 hr spin up)



CPU used for initialization: 415.210s

CPU used for simulation: 718.835s

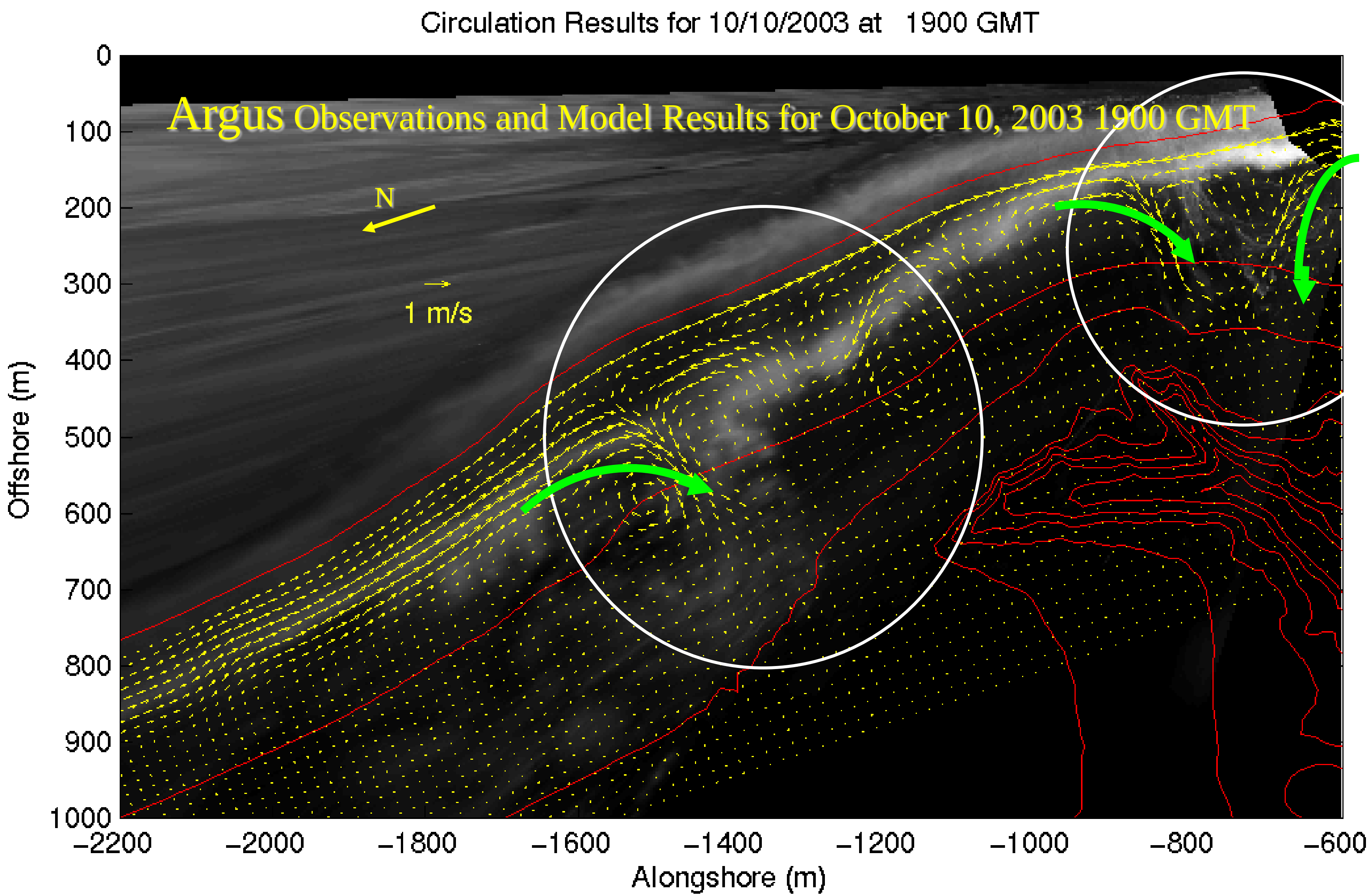
CPU used for close and stop: 0.715s

Delft3D SWAN Area

- 15m x 30m resolution
- Boundary information from DIOPS SWAN

Total: 1134.92s (~19 min.)

Nearshore Circulation: *Model vs. Visual Signals*



Other factors and Variability of Rip Currents

1. Tide effects: within 12 hours, tide rises from low-high
2. Wave direction: normal wave incidence vs. oblique wave

Different beaches, such as in a bay or semi-protected ?

Uncertainties of prediction lies on:

* Lifetime of rips vary: 10 sec~3 min ~ weeks.
* Pulsation of rip: intensities vary with water levels. Low swell waves (~ 2 ft) at low tide can develop

Tide effects on Rip hazard

Rip current results / Water levels	Max rip speed (m/sec)	Rescue numbers	Surf Zone Width (yards)
Low tide (0.5 m)	**0.60**	**465**	**80**
High tide (3.0 m)	**0.25**	**3**	**40**

Nile Mile Beach: H=0.65 m, T= 10 sec and slope = 1/25

Remarks for Operation

- Lifeguards----NWS can collaborate to provide consistent beach safety operation.

- Getting surf heights are crucial for rip currents.

- The beach sand grain size and beach face slope matters, *IT SHOULD BE RECORDED MONTHLY*.

- In Surf zone forecast, changes in sea states (3 hrs) and the beach states (12 hrs) must be noted during a storm.

Surf zone forecast and High Surf complements each other.

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