Littoral Transport Modeling Ocean Beach & San Francisco Bight, California

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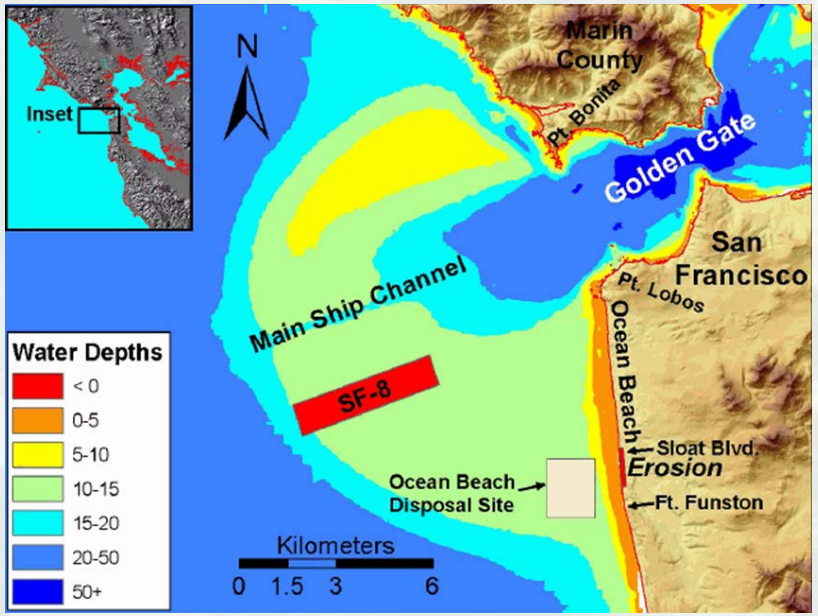
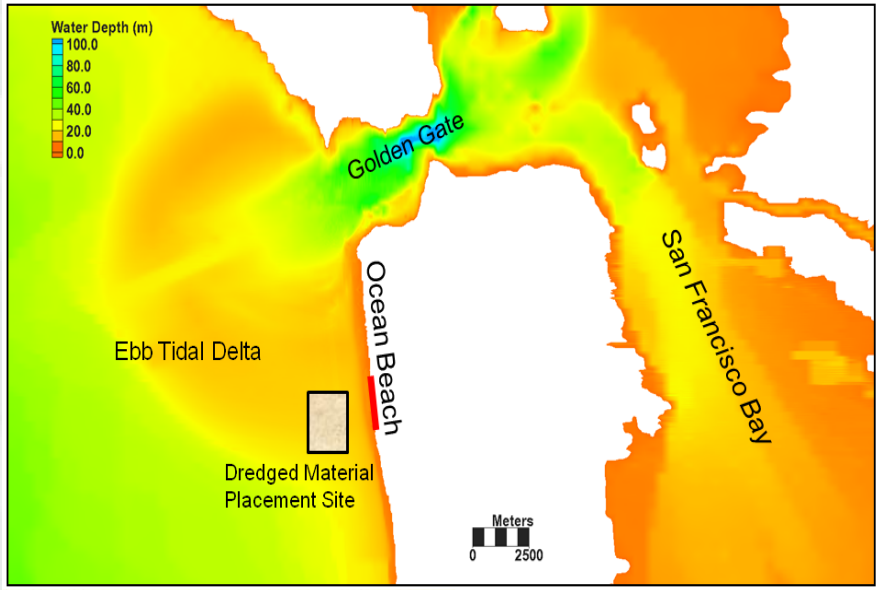
Outline

- Background & Objectives
- Numerical Models & Settings
- Hydro & Wave Simulations
- Alternatives
- Summary & Conclusions



Background

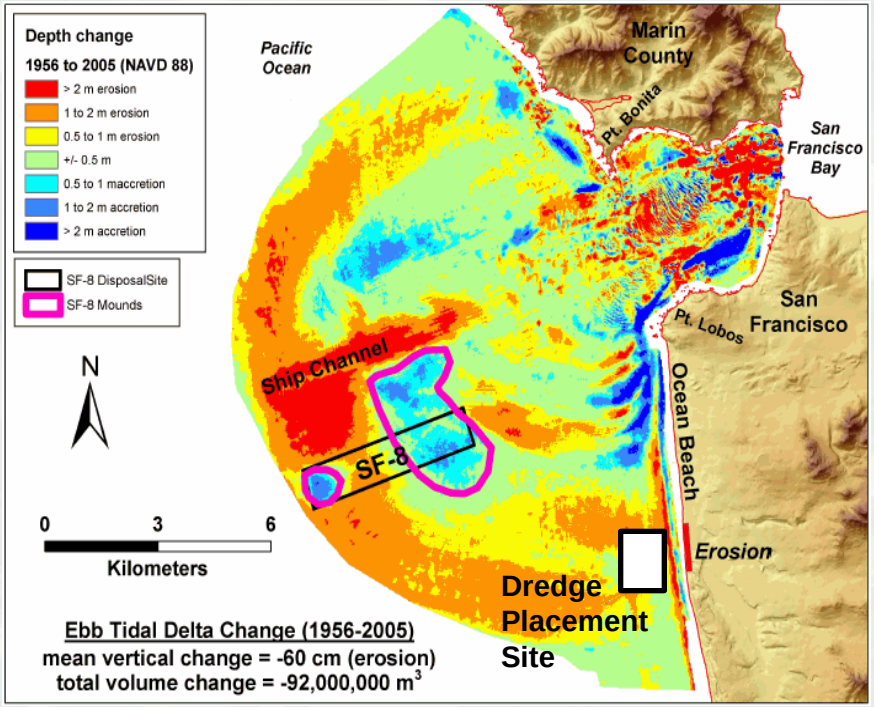
- Ocean Beach is located on the coast of San Francisco to the south of Golden Gate.
- The erosion hotspot is threatening the structural integrity of the adjacent Great Highway.
- San Francisco District has selected nearshore dredged-material placement sites and alternatives to prevent further beach erosion



Ocean Beach, CA
(photo taken 1944)

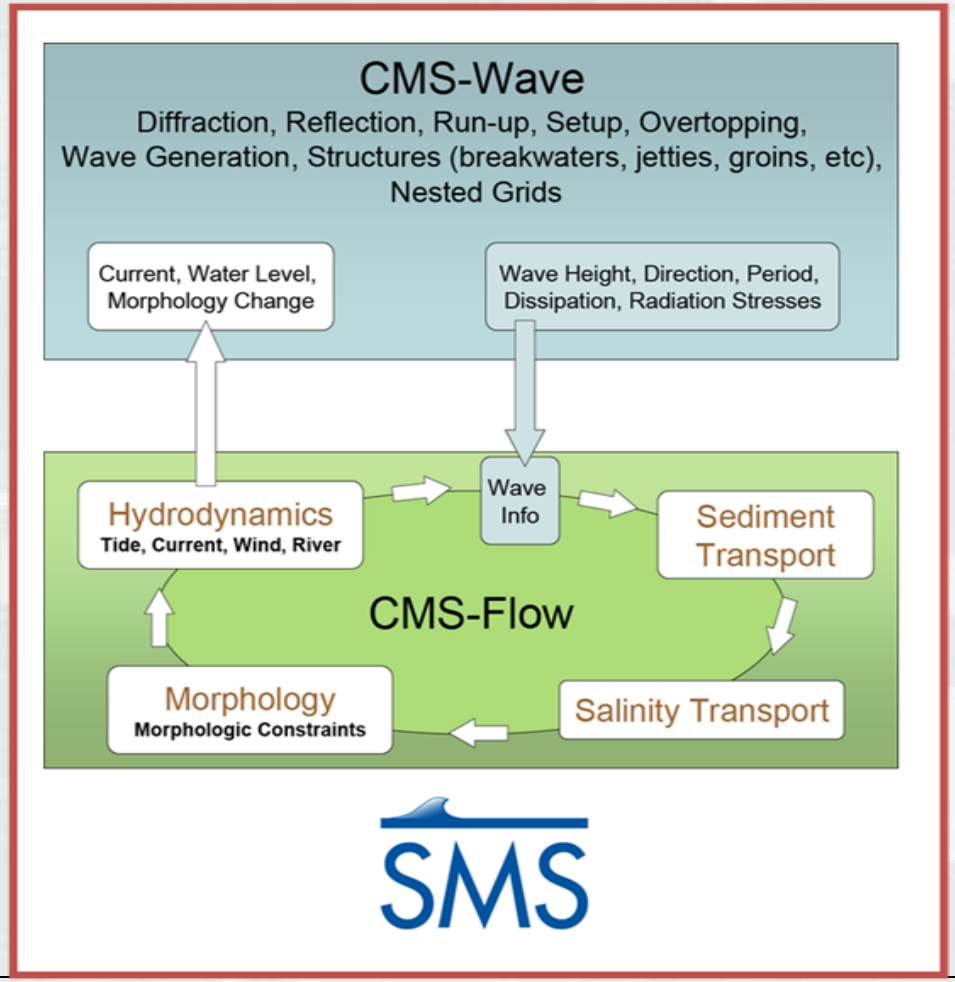
Objectives

- Excise a practical hydrodynamic, waves, and sediment transport model system for Ocean Beach & San Francisco Bight
- Calculate morphology change and sediment flux at Ocean Beach
- Assist navigation O&M projects and beneficial use of dredged material for beach restoration to reduce dredging cycles

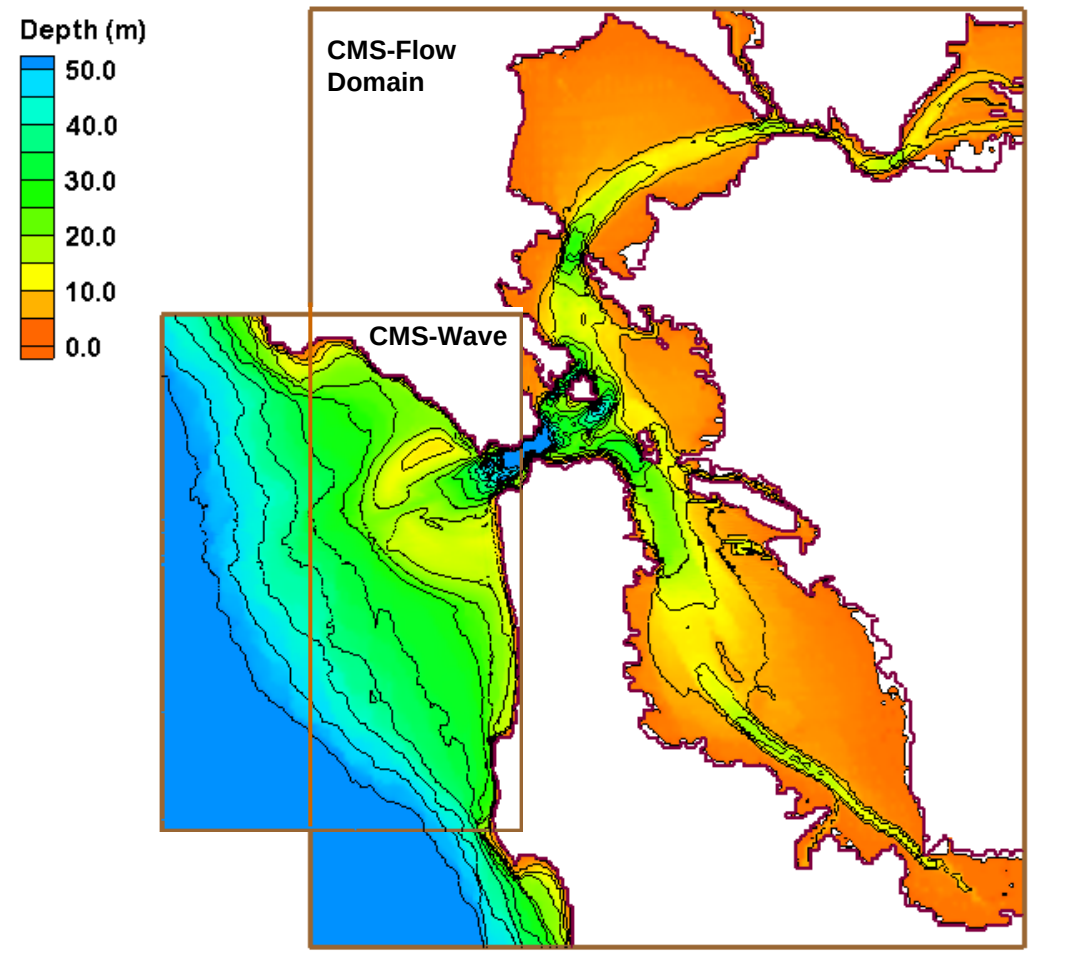


Numerical Models

Coastal Modeling System (CMS)



CMS Bathymetry and Domain



Current, Waves and Sediment Transport

CMS Domain

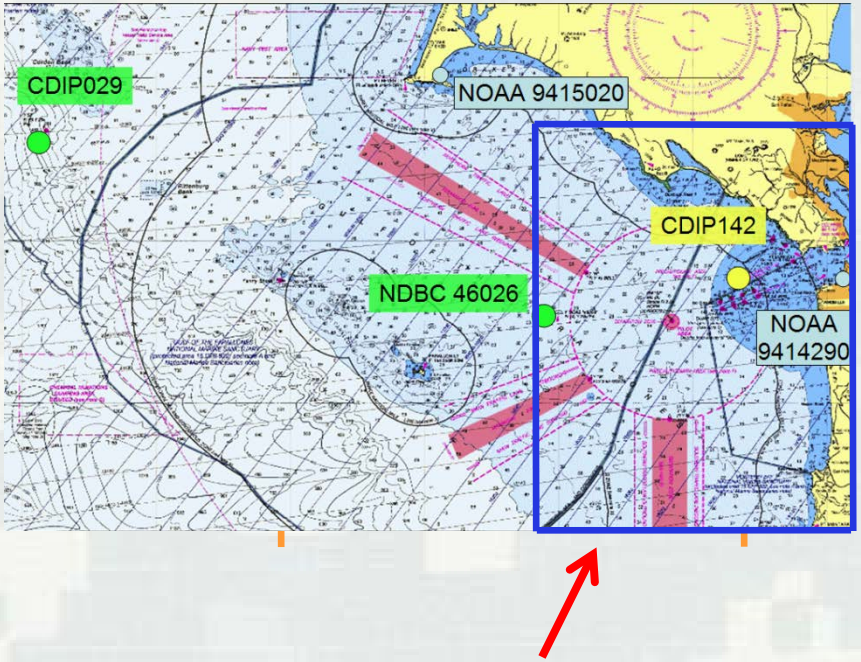
CMS-Flow: 60 x 80 km
CMS-Wave: 30 x 44 km

Cell Size: 20-400 m

Water Depth: 0-110 m

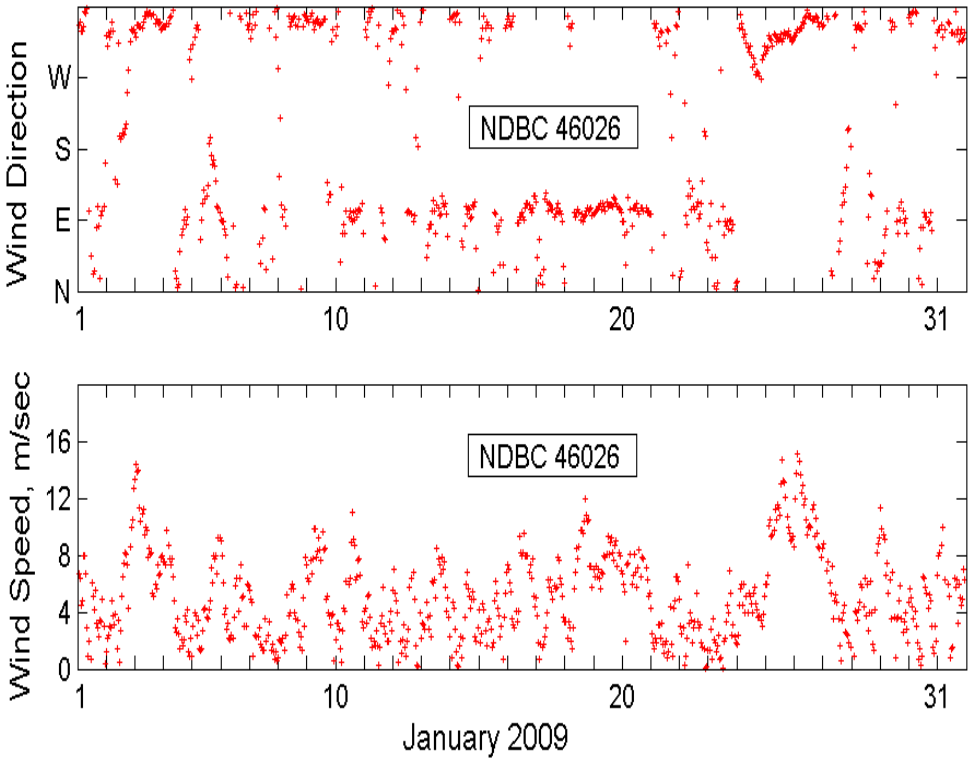
USGS and NOAA Data

CMS-Wave Validation



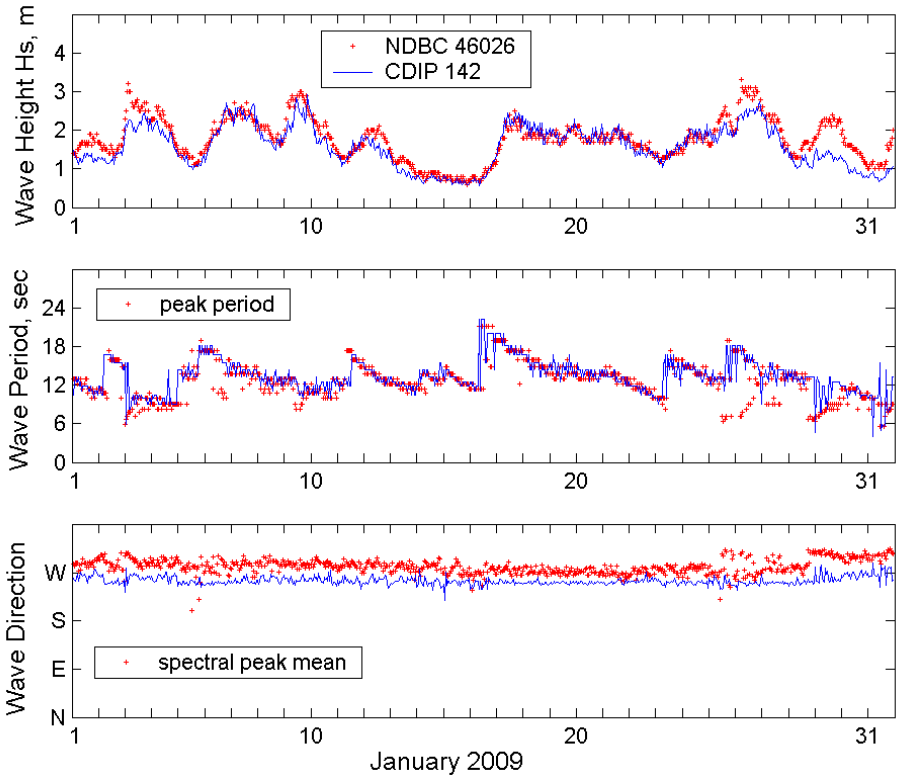
CMS-Wave Domain

Input Wind

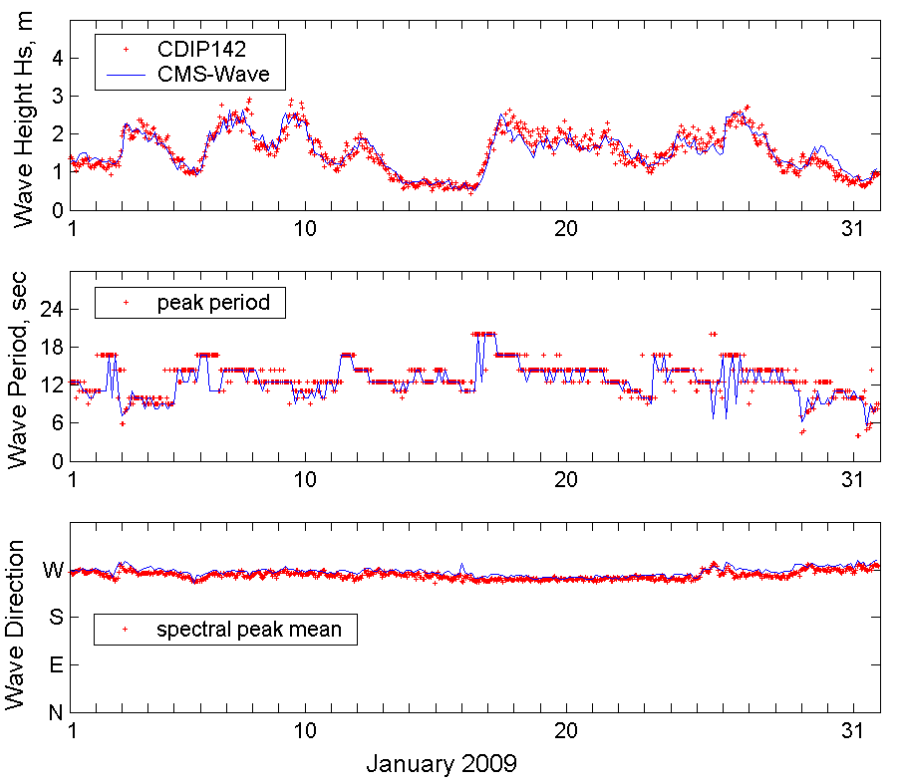


CMS-Wave Validation (Cont.)

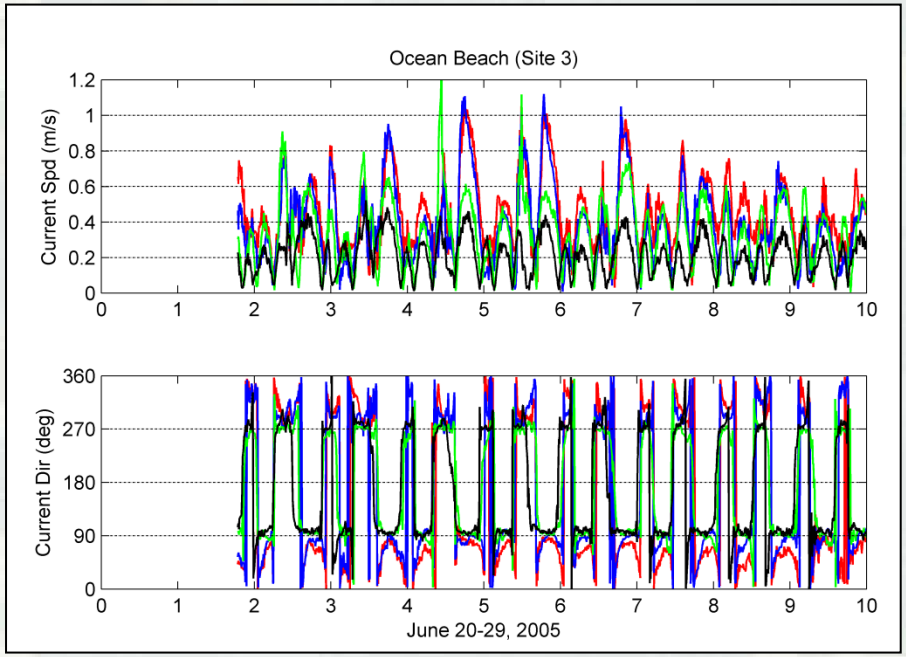
Buoy Wave Data



Calculated Wave and Data



ADCP Measurements (USGS)



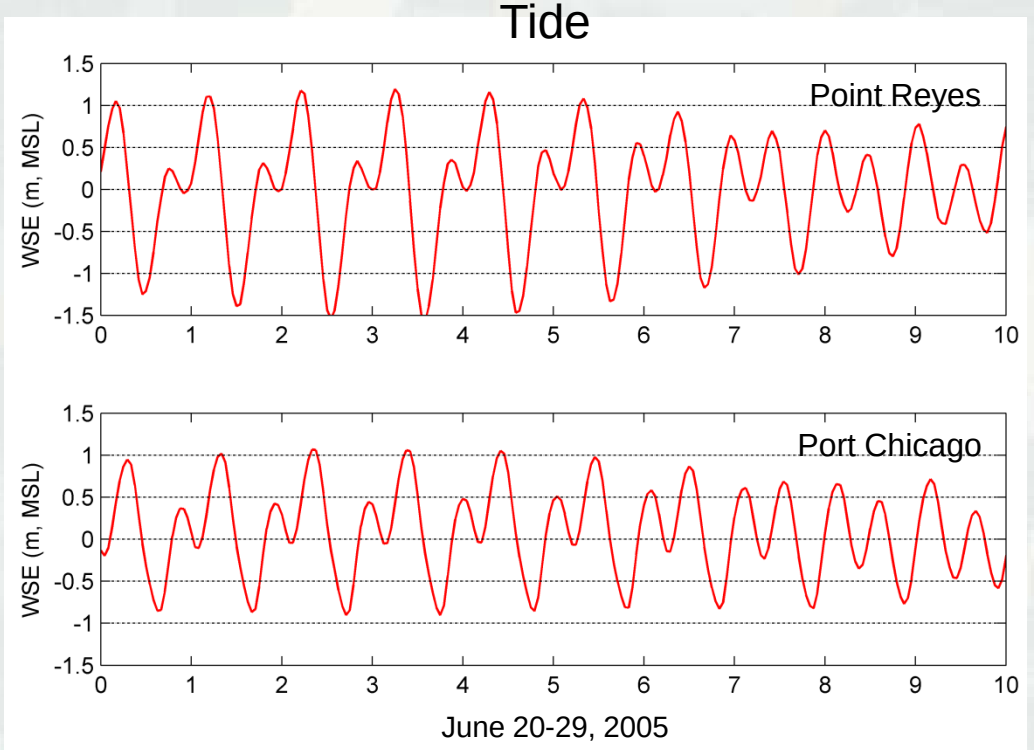
Site1: 7.5 m, 6/21/2005- 6/26/2005

Site 2: 10.9 m, 6/21/2005- 8/01/2005

Site 3: 14.1 m, 6/21/2005- 7/30/2005

CMS Water Level Forcing

Water surface elevation (WSE) at NOAA's Point Reyes (9415020) and Port Chicago (9415144) Gages



Mixed, predominately semi-diurnal tide
Mean tide range (MHW – MLW)

Point Reyes: 1.19 m
Port Chicago: 1.12 m

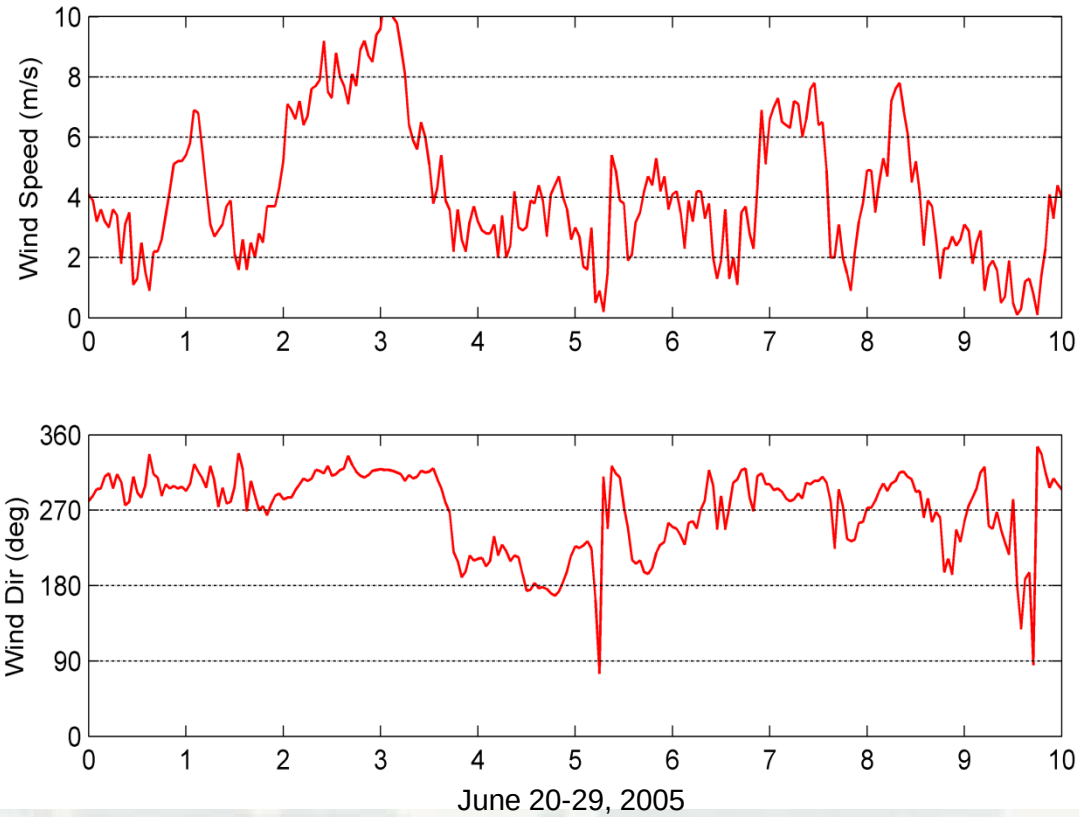
CMS Wind Forcing

Surface boundary forcing for CMS-Flow

Mean Wind Speed: 4.1 m

Mean Wind Direction: 270°

NOAA Buoy 46026



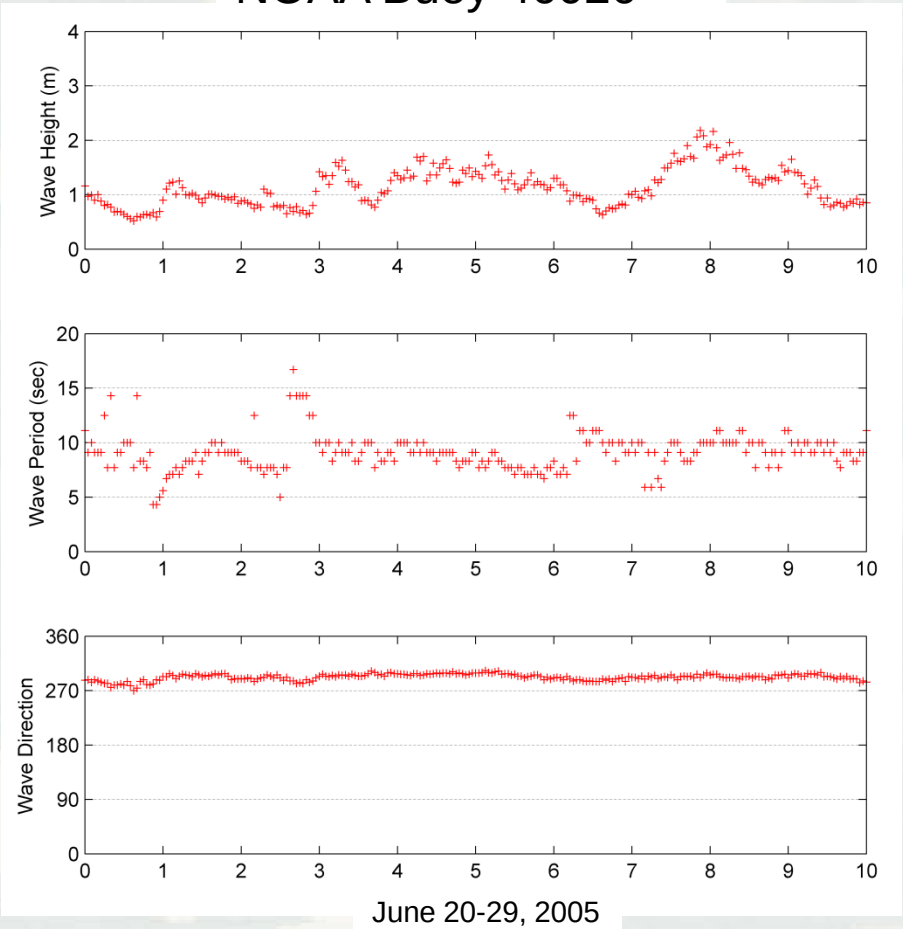
CMS Wave Forcing

Mean significant wave height: 0.91 m

Mean wave period: 9.2 sec

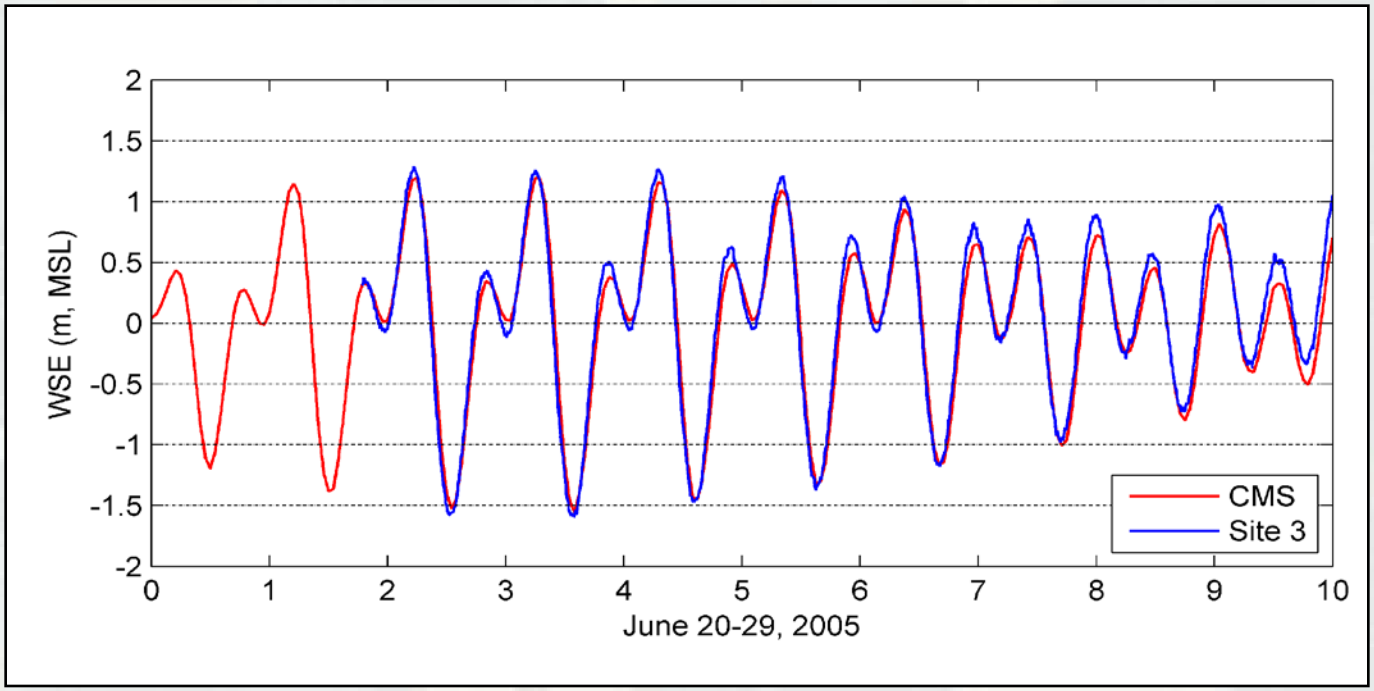
Mean wave direction: 289°

NOAA Buoy 46026

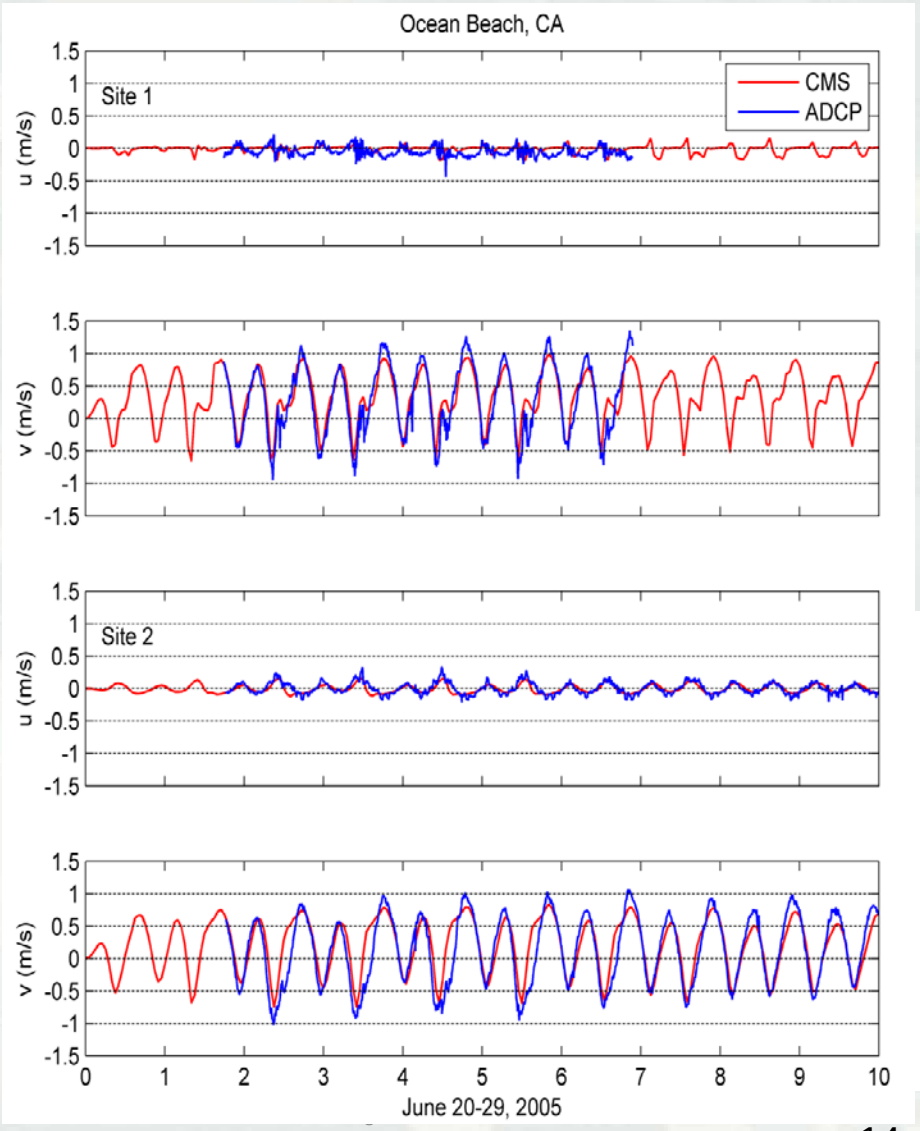


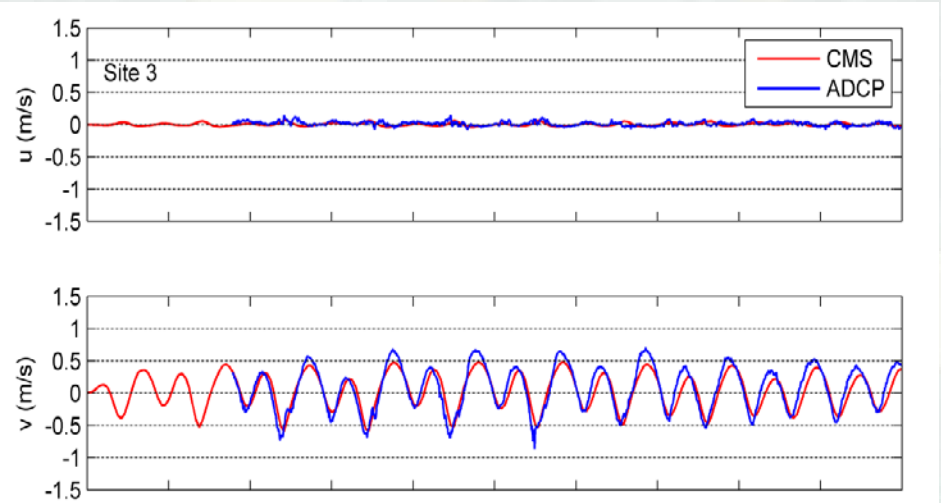
Calculated and Measured Water Levels

Ocean Beach (Site 3)



Calculated and Measured Currents

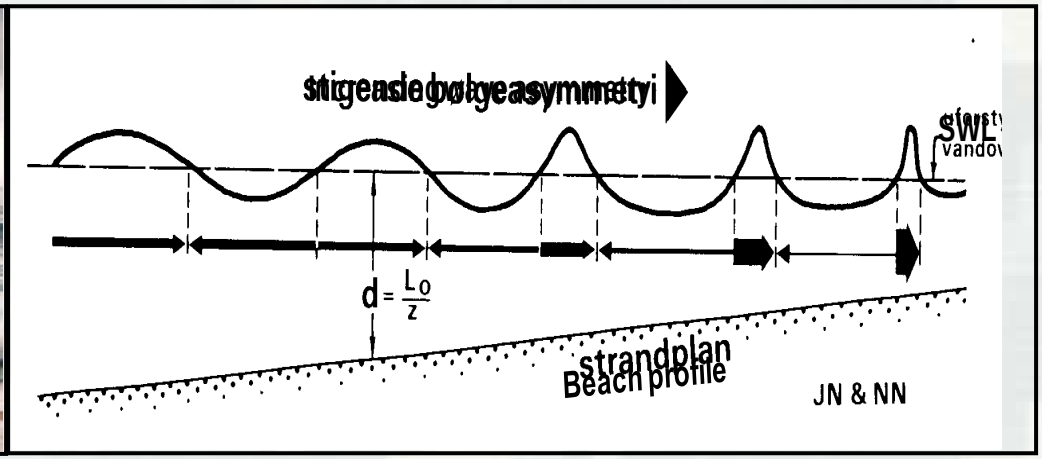




Wave Asymmetry and Undertow

- Wave asymmetry produces larger (stronger) onshore and lower (weaker) offshore mass transport, especially inside surfzone (Isobe and Horikawa1982; Grasmeijer and Ruessink 2003)

- Undertow, always directed offshore, is introduced by breaking waves and the Stokes drift (Rattanapitikon and Shibayama, 2000)

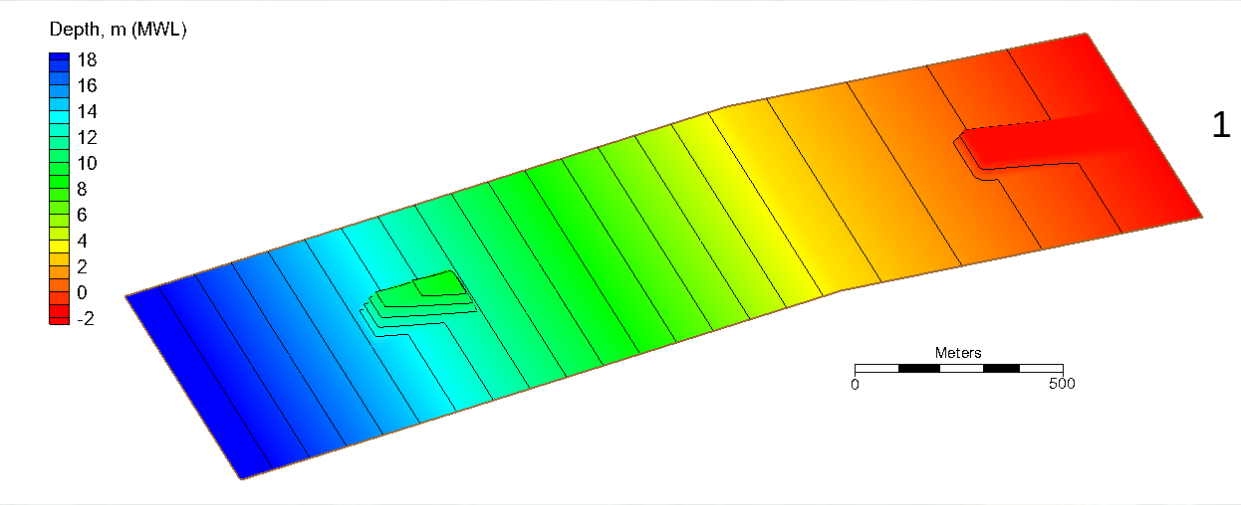


Idealized Berm and Beach Fill

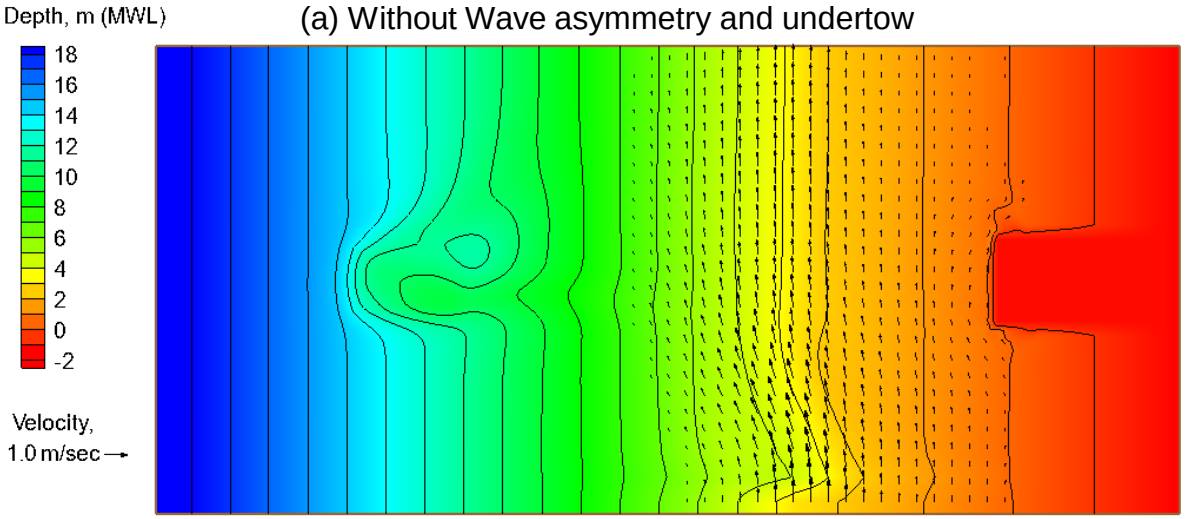
Beach slope: 1:200 Offshore slope: 1:90

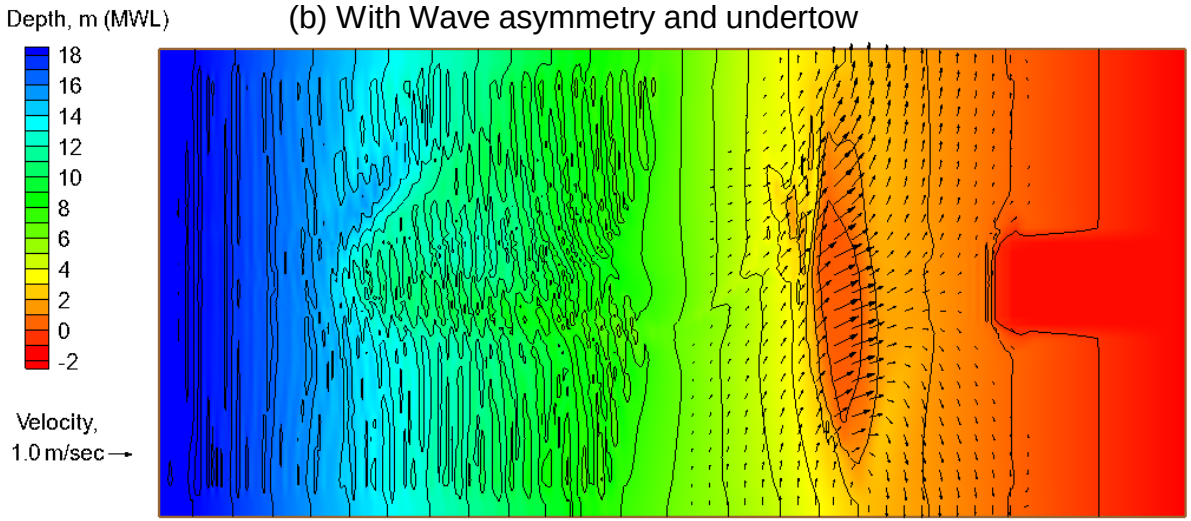
Berm: 250 m (cross-shore) x 150 m (alongshore) x 3.5 m (height)
Beach fill: 250 m (cross-shore) x 250 (alongshore) x 1.8 m (elevation, MSL)

Rectangular grid: 2.4 km x 1 km, square cell size of 10 m x 10 m
Sediment grain size: 0.2 mm



Calculated 10-day Morphology/Current Field

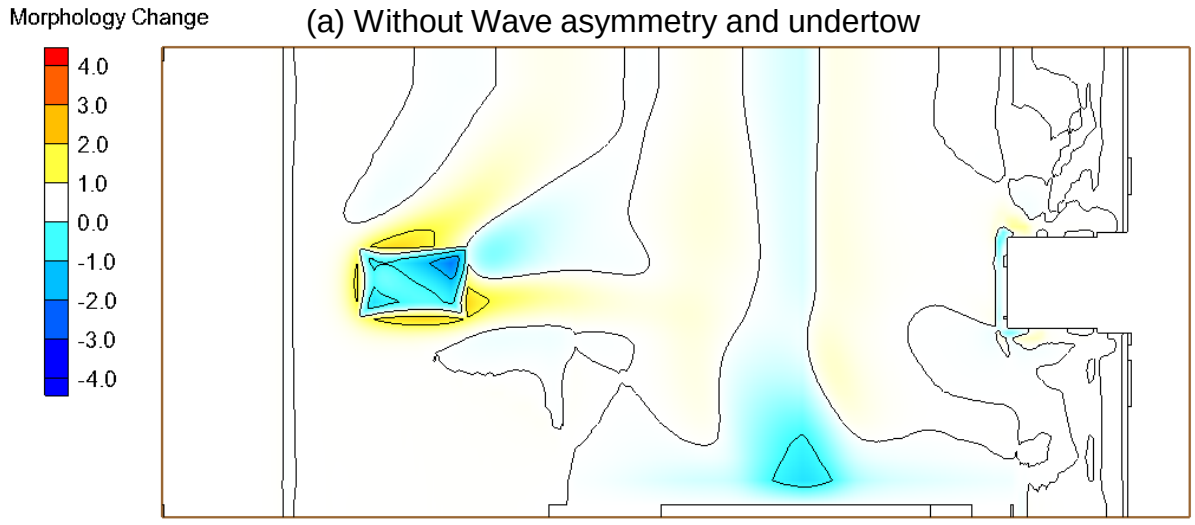


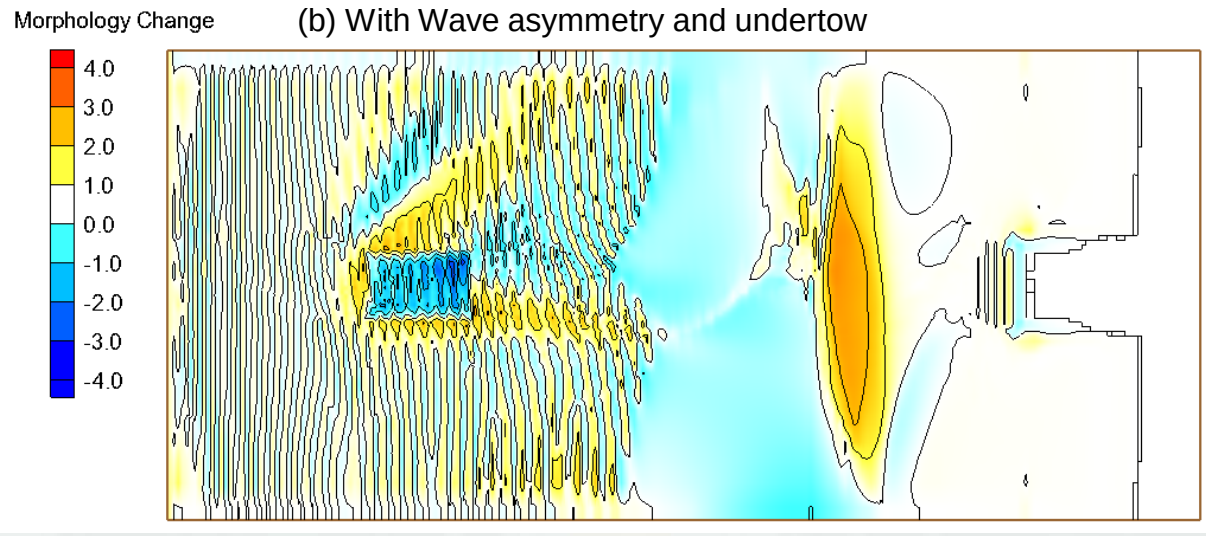


Incident Steady Wave:
4-m
12-sec
30-deg

Constant Water Level:
1-m (MSL)

Calculated 10-day Morphology Change Field

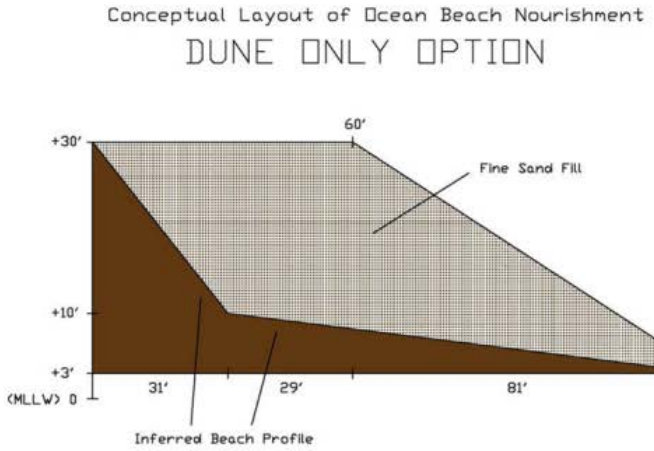


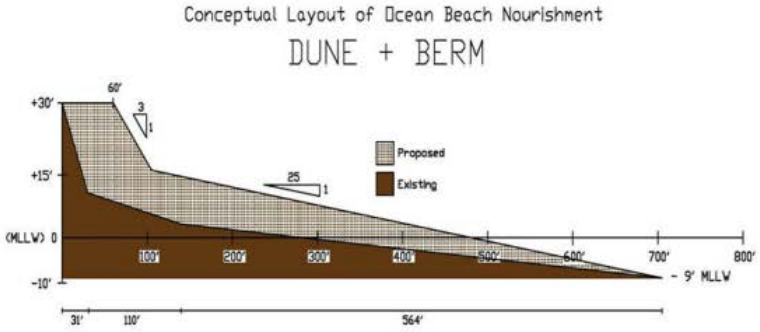


Incident Wave:
4-m
12-sec
30-deg

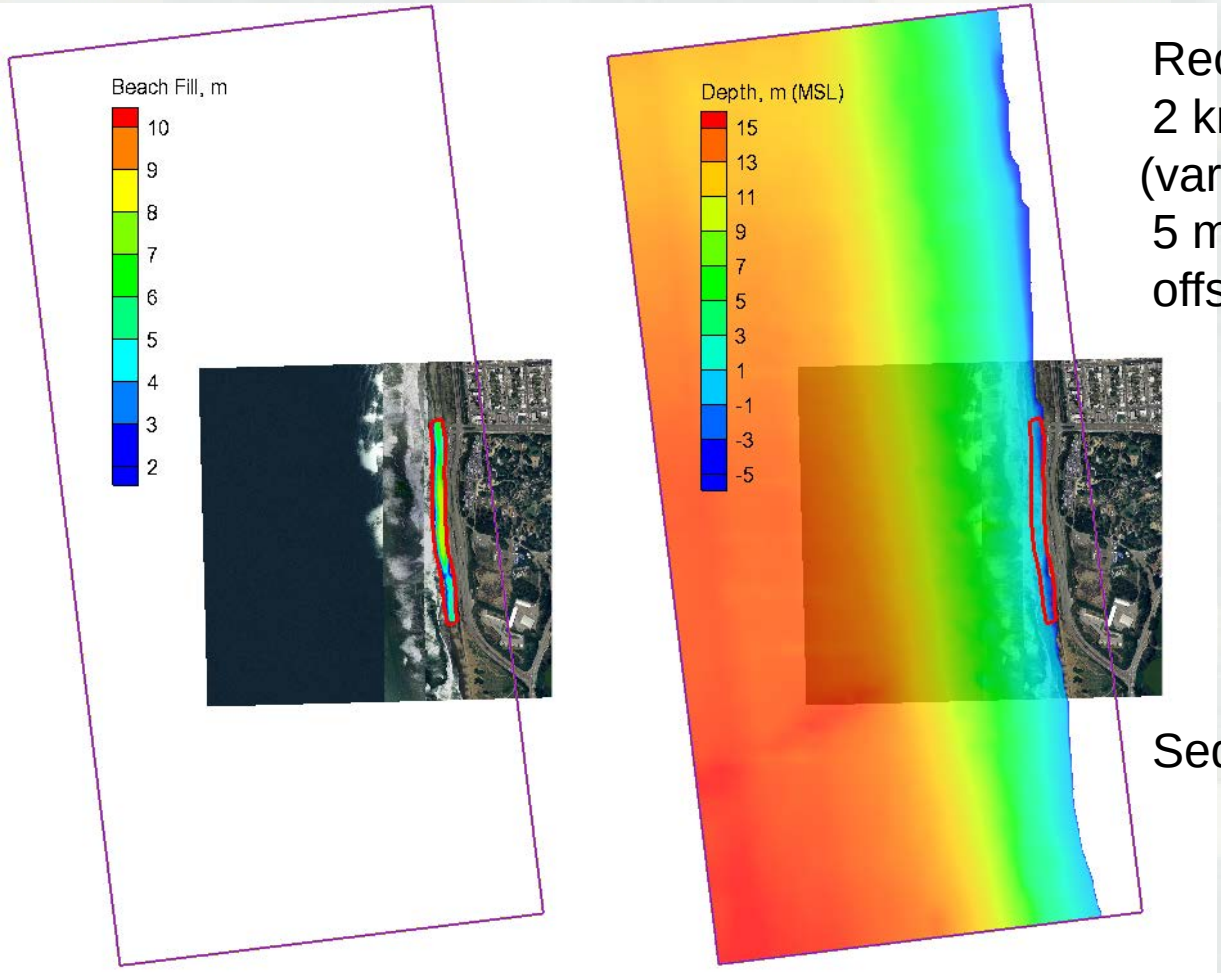
Water Level (WL):
1-m (MSL)

Ocean Beach Nourishment Alternatives





Ocean Beach Dune-Only Placement
300,000 cy along 1-km shoreline

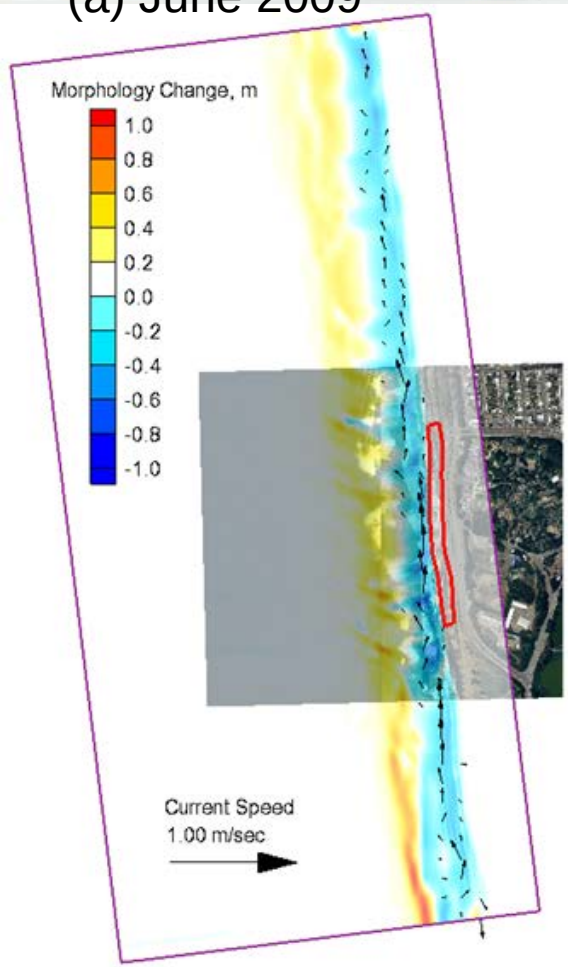


Rectangular grid:
2 km x 4.1 km
(variable cell size from
5 m nearshore to 75 m
offshore)

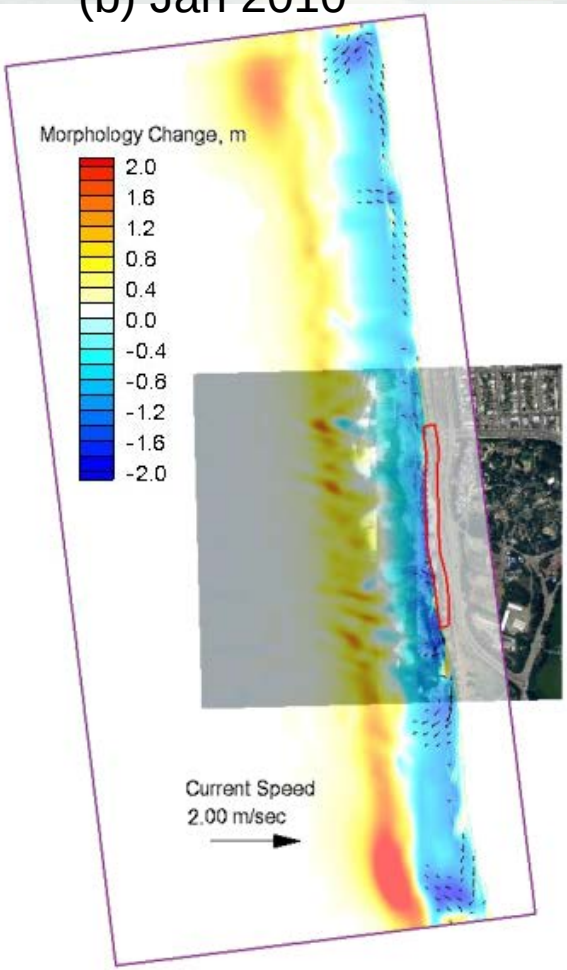
Sediment size: 0.2 mm

Calculated Morphology/Current Field

(a) June 2009



(b) Jan 2010



Water level BC:
Regional CMS

Wind/Wave BC:
Buoys 46013
(Bodega Bay)
46026
(San Francisco)

Ocean Beach Dune-Only Placement
Calculated Volume Loss

Beach Fill Volume Loss Estimate (CY)			
Condition	June 2009	January 2010	1-YR
Normal	3,200	10,000	80,000
El Nino (WL + 1')	4,000	12,000	96,000

Summary & Conclusions

- US Army Engineer RSM, CIRP and San Francisco District are teamed with USGS to investigate the beneficial use of dredge material for nearshore and onshore placement alternatives at Ocean Beach, CA.
- CMS-Wave and CMS-Flow models are validated against coastal buoy data, WL and current measurements (ADCP data).
- Nearshore wave asymmetry and undertow are implemented in CMS for cross-shore sediment transport calculation
- Model results show a dune-only placement of 300,000 cy may have a short 3 to 4-year life-cycle.

Thank you!

Questions?

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