C2SHORE Comparision with Laboratory Data

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Overview

1. C2SHORE Hydrodynamics
2. C2SHORE Sediment Transport
   - Suspended Sediment
   - Bedload
3. CMS Model Results
   - LSTF
   - OSU

C2SHORE Hydrodynamics Fundamentals

Phase-averaged hydrodynamics

Extension to model system for currents and phase-averaged waves

- CMS wave + CMS flow
- STWAVE + AdH

Dissipation and Shear

Time-averaging for hydrodynamics is done with assumed pdf for random waves

Example Hydrodynamic Closure for Bottom Shear

$$\tau_b = \rho \frac{f_b}{2} \overline{|u|u}$$

$$u = \tilde{u} + \overline{U} = \text{total instantaneous velocity}$$

Define probabilistic variable $r = \tilde{u}/\sigma_T$ where $\tilde{u}$ is the instantaneous velocity with a standard deviation of σ_T.

$$f = \frac{1}{\sqrt{2\pi}} \exp\left\{\frac{-r^2}{2}\right\}$$

Then

$$\tau_b = \rho \frac{f_b}{2} \sigma_T^2 \int_{-\infty}^{\infty} \left| \frac{\overline{U}}{\sigma_T} + r \right| \left\{ \frac{\overline{U}}{\sigma_T} + r \right\} f dr$$

C2SHORE Sediment Fundamentals

Sand Suspension

Suspension is assumed proportional to dissipation by breaking and bottom friction

Suspended Transport

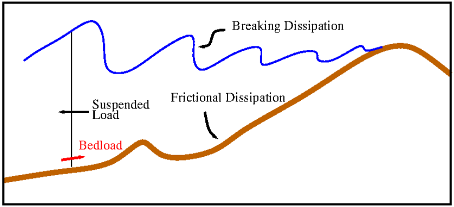
Wave-related suspended transport is fixed empirically in the direction of wave propagation

Bedload

Bedload is assumed to be driven in direction of currents and wave propagation

Sand Suspention

$$V_s = \frac{e_B D_B + e_f D_f}{\rho g(s-1)w_f} P_s$$



$$\begin{aligned}
V_s &= \int_{z_b}^{0} c\, dz \\
e_B, e_f &= \text{Efficiencies} \\
D_f &= \rho \frac{f_b}{2} \overline{|u|u^2} \\
D_B &= \text{CMS wave computation} \\
\rho g &= \text{weight of water} \\
s &= \text{s.g. sand} \\
w_f &= \text{sediment fall velocity} \\
P_s &= \mathbf{Prob}\left(\left\{ \frac{D_f'}{\rho} \right\}^{1/3} > w_f \right)
\end{aligned}$$

Suspended Transport

$$\vec{q}_s = \overline{\int_{z_b}^{\eta} c\vec{u}dz} = \vec{U}_{CMS}V_s + \vec{U}_{RC}V_s + \overline{\int_{z_b}^{\eta} \tilde{c}\tilde{\vec{u}}dz}$$

Some Basis

Empirical
wave-related

Data: Wave-related $\propto H^2$, but $\overline{U} \propto H^2$!

$$q_{sx} = U_{CMS}V_s + aU_{RC}V_s \quad ; \quad a \simeq 0.5$$

Bedload

$$q_{bx} = \frac{P_b}{g(s-1)}\left[b\sigma_u^3\cos\alpha + \left(\frac{f_b}{2}\right)^{3/2}\gamma F_U\right]$$

$$\begin{aligned} P_s &= \mathbf{Prob}\left(\tau_b' > \tau_c\right) \\ b &= \text{empiric bedload parameter} \\ \gamma &= \text{Meyer-Peter Mueller parameter} \\ F_u &= \text{third moments of the currents, waves} \end{aligned}$$

CMS cmcards File

Example (Lund-CIRP transport)

```
!Sediment Transport
CALC_SEDIMENT_TRANSPORT          ON
MORPH_START_TIME                 1.0 hrs
SED_TRANS_FORMULATION            NET
TRANSPORT_FORMULA                LUND-CIRP
```

Example (CSHORE transport)

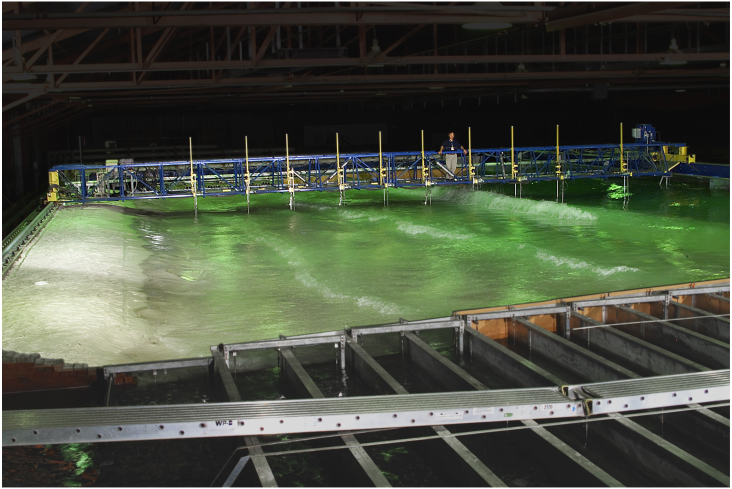
```
!Sediment Transport
CALC_SEDIMENT_TRANSPORT          ON
MORPH_START_TIME                 1.0 hrs
SED_TRANS_FORMULATION            NET
TRANSPORT_FORMULA                CSHORE
CSHORE_EFFB                      0.003
CSHORE_BLP                       0.001
CSHORE_SLP                       0.5
```

Linux/matlab implementation

Example (Matlab script)

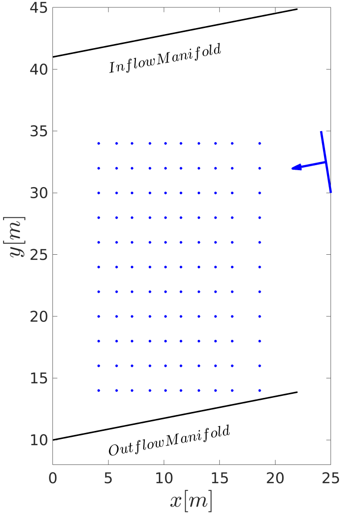
```
% Name assign for site
g.name = 'lstf';
addpath(g.name)
% set the input params
params
% set plotting and save params
g.plot.waves           = 1;
g.plot.vel             = 0;
% Set up bathy
g = make_bathy(g);%(site-specific)
cms_write_cart(g)
% set offshore waves and write bc files
g = make_wavebc(g); %(site-specific)
cms_write_eng(g);
cms_write_dep(g);
% make bid file
g = cms_write_bid(g);
% swap in any params
cms_swapincmcards(g,'TRANSPORT_FORMULA',g.transport_formula);
cms_swapincmcards(g,'CSHORE_EFFB',g.cseffb)
cms_swapincmcards(g,'CSHORE_BLP',g.csblp)
cd(g.name)
%run CMS
system(['/home/johnson/wes/cms-git/cms2d/trunk/source/cms ',g.name,'.cmcards']);
```

LSTF Laboratory Setup

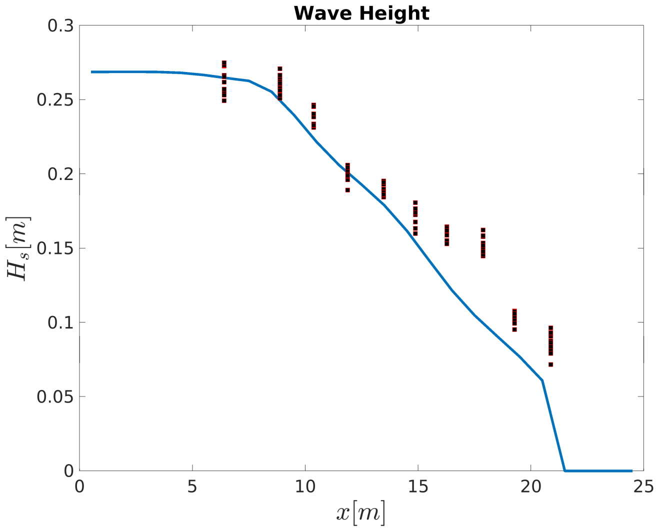


LSTF Laboratory Setup

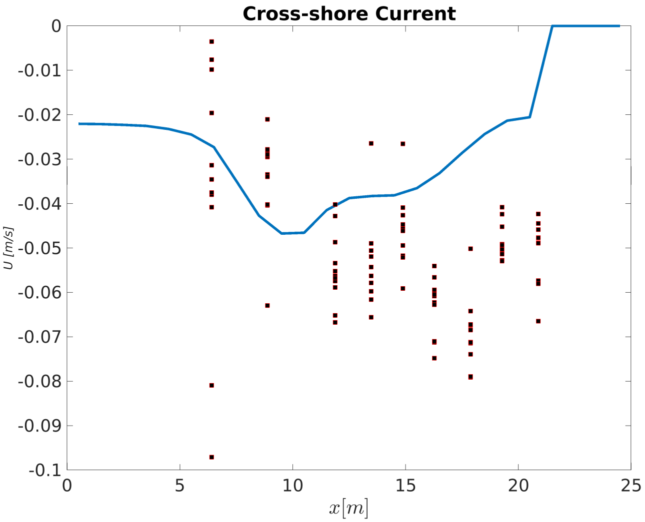
- Longshore uniform
- Random waves
- 10° angle of incidence
- 20 Pumps return flow to up-drift side
- Well-sorted sand, $d = .15mm$
- Quasi-equilibrium beach



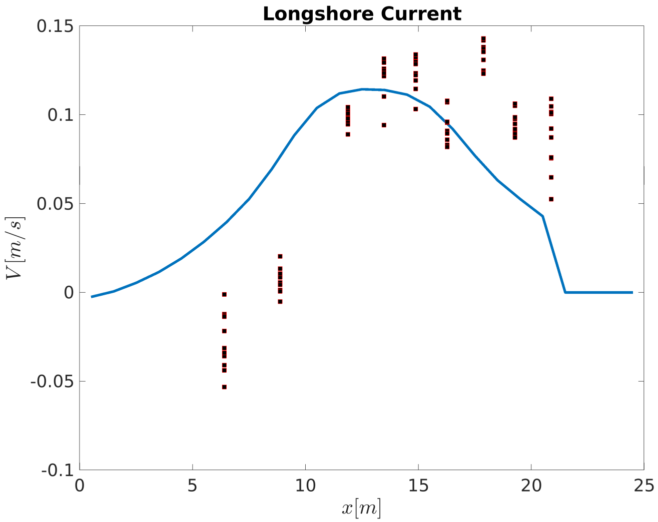
LSTF Wave Height



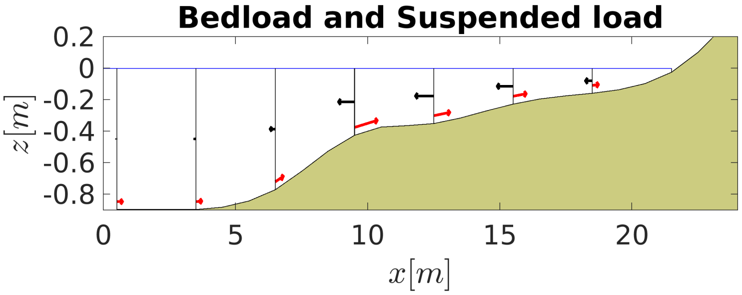
LSTF Cross-shore Current



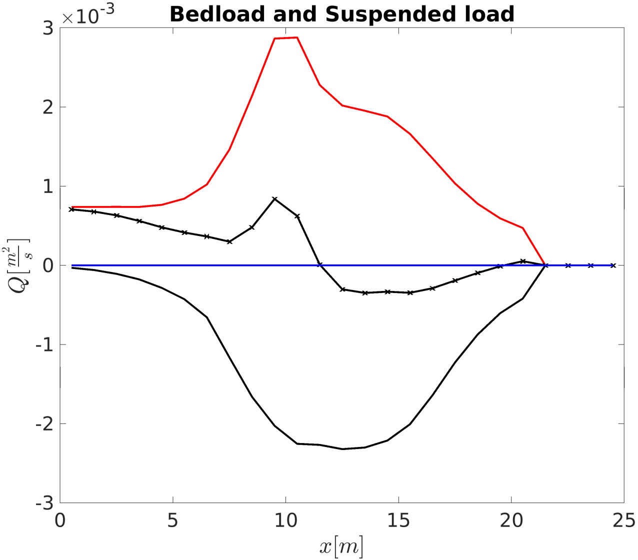
LSTF Longshore Current



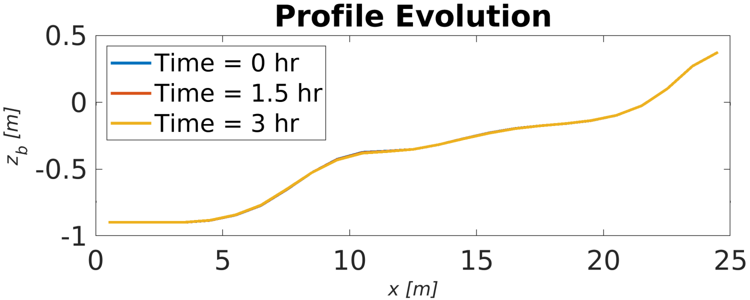
LSTF Sediment Transport



LSTF Sediment Transport

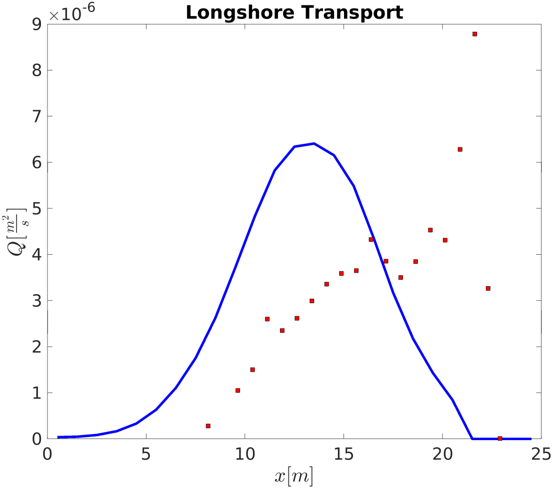


LSTF Morphology Change

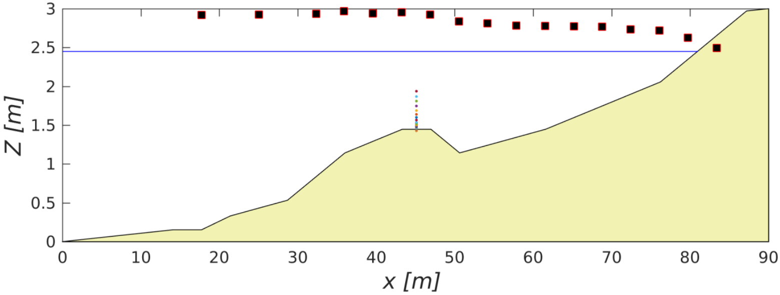


LSTF Longshore Transport

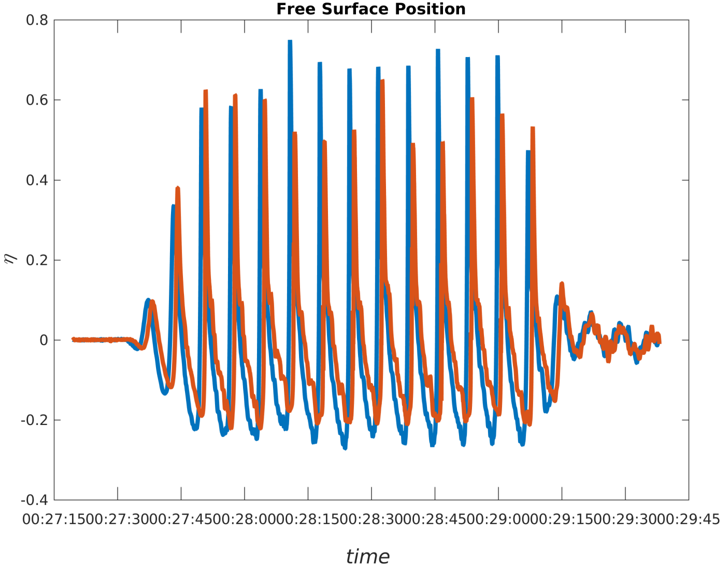
- Total LST is well predicted
- Cross-shore distribution is in error



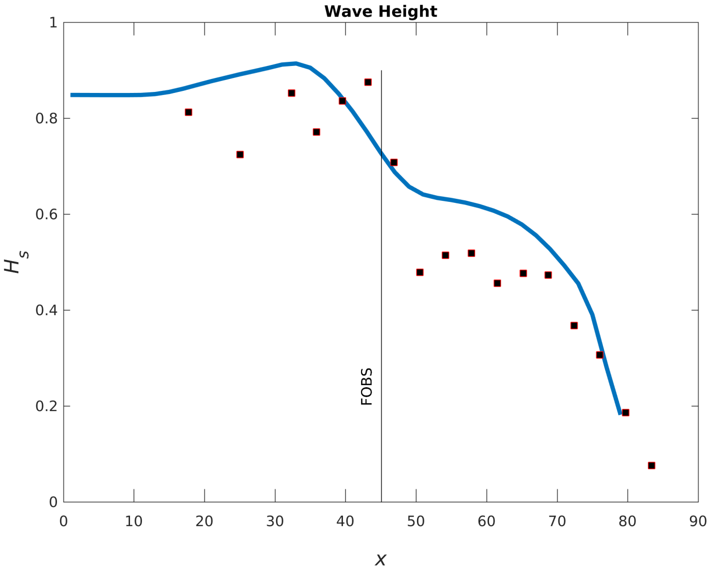
OSU Laboratory Setup



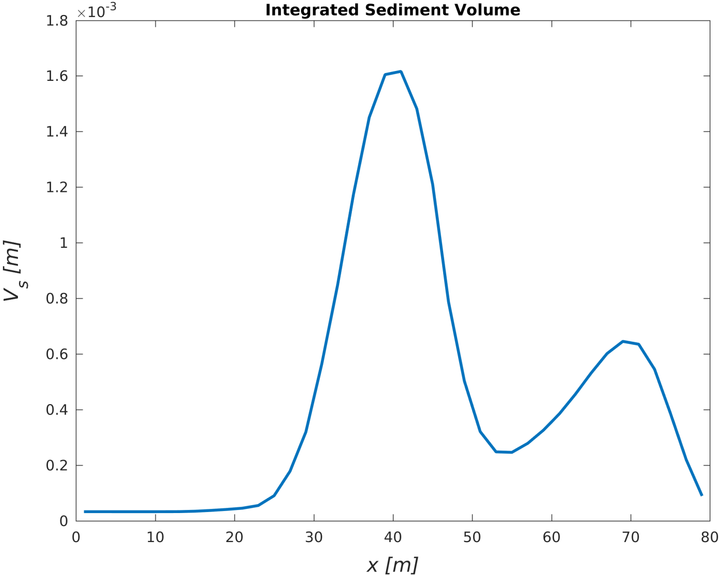
OSU Free Surface



OSU Wave Height

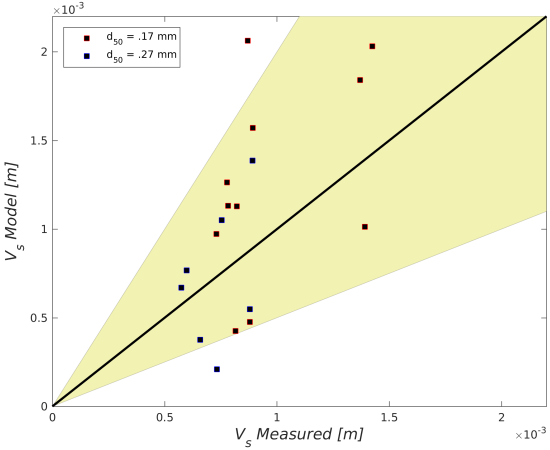


OSU Suspended Sediment



OSU Suspended Sediment

- Concentration is within factor of 2
- e_B twice as large as LSTF case



Concluding Thoughts

- C2SHORE is fully implemented in CMS (For single grain size).
- Extension to 2DH has reasonable justification.
- Matlab interface is more effective for research/production than District use.
- Two cases where we get the unusual opportunity to directly test sed transport
- Reasonable results, indicate some weaknesses, e.g. no swash representation