Sand and Oil Agglomerates in the Surf Zone
Using Science to Aid Deepwater Horizon Clean-up Efforts

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The Problem:

- April, 2010: Deepwater Horizon rig explodes
- July, 2010: well head capped
- September, 2010: well sealed
- Several million barrels of gas and oil released
Oil came ashore as thick, "weathered" oil mousse
Sand and Oil Agglomerates: Submerged Oil Mat (SOM) and Surface Residual Ball (SRB) Formation

- In the surf and swash zones, oil and sand mixed to form dense (sinking) agglomerates
- Some oil/sand mats were 10’s of meters long
- Small pieces break off and can “re-oil” the beach (called surface residual balls, SRBs)
Shoreline Clean-up Assessment Technique (SCAT) teams searched for oil. When found, USCG operations removed as much material as possible.

But…it kept (keeps) coming back. Why?

Federal On-Scene Coordinator (FOSC) chartered the Operational Science Advisory Team (OSAT3) to help figure out what’s going on and improve response.
Key Questions for Response

- “Where could mats still remain?”
- “If we find SRBs, should we be looking for a mat nearby?”
- “Where is it all going to eventually go?”
- “Why do we keep finding SRBs in areas we’ve cleaned?”

Credit: NPR
“Where could mats be hidden?”

- Identify where they could have formed

- Examine bathymetry changes in zones of possible formation, identify areas sand may still hide mats
Key Questions for Response

- “Where could mats still be hidden?”
- “If we find a bunch of SRBs, does that mean we should be go digging for a mat nearby?”
- “Where is it all going to eventually go?”
- “Why do we keep finding SRBs in the same places?”

Credit: NPR
Numerical Approach: Hydrodynamics

Hydrodynamic Model: Delft3D

Nested models:
- Wind, waves, water levels, and currents
- Resolve surf zone and inlets
- Include large number of scenarios (80+)
Waves and currents generate shear stress (force per unit area) on the seafloor. 

- Sediment and SRBs move when stress exceeds a grain-size and density specific threshold.
- Also looked at integrated alongshore potential flux.

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SRB and Sediment Movement Probability

Small Waves (0 – 0.5 m)

Increasing Size

Mobile

Immobile

USGS
SRB and Sediment Movement Probability

Large Waves (> 2.0 m)

Increasing Size

USGS
SRB and Sediment Movement Probability

Large Waves (> 2.0 m)

SRBs:
- less mobile than sand (burial/exhumation likely)
- not mobilized during low-energy wave conditions of northern Gulf of Mexico
Calculating Potential Flux

- Calculate flux (mass/time), assuming particles are present, for given size and density
- Integrate across surf zone

Convergences or decelerations in flux are alongshore areas of likely deposition
Alongshore Current Convergences & Gradients

Areas of likely deposition under given wave conditions identified (Pensacola Pass)
Inlet Dynamics: Little Lagoon

Flood Tide

Ebb Tide

Inlets trap SRBS
Numerical Model Results

- Greater mobility of sand than SRBs makes burial and exhumation likely
- Larger (cm-size) SRBs unlikely to move alongshore outside of storm events
- Eventual long-term distribution patterns predicted, but will take a long time to reach that state and for all SRBs to be uncovered/recovered
- Inlets serve as traps for SRBs
Results:

Methodology can be applied elsewhere
Model Assessment

- Completed after model run and results reported (i.e., no model “tuning”)
- Starting in June, 2011 the Coast Guard collected data (poundage, shape) on SRB/mat material retrieved
- Spatially delineated in alongshore segment (~250 m)
- Some limits (resolution in space and time, doesn’t indicate where SRBs weren’t), but data collected as part of response was extremely valuable
Increased collection moving west in segments from Little Lagoon to Pensacola Pass (consistent with model)
- Higher collection of SRBs in inlet
- Particularly high collection from Pensacola Pass
- Exception: Perdido Pass
Coast Guard Field Collection
Model Assessment & Improvement

Artificial Sand and Oil Agglomerates

Lab-made (paraffin + sand)

Instrumentation Tripod (Waves, Images, Video)
Model Assessment & Improvement
Artificial Sand and Oil Agglomerates

1-m Deployment

Swash Zone Deployment
Seafloor interaction

SRB Burial

SRB Burial

SRB Exhumation
Conclusions

- Identified offshore extent of possible mat formation
- Greater mobility of sand than SRBs makes burial and exhumation likely
- Larger (cm-size) SRBs unlikely to move alongshore outside of storm events
- Eventual long-term distribution patterns predicted, but will take a long time to reach that state and for all SRBs to be uncovered/recovered
- Inlets serve as traps for SRBs
- Results validated against (invaluable) USCG SRB collection data and pseudo-SRB studies
Thank you!

For additional information:


