Evaluation of Physical and Environmental Marine Hydrokinetic (MHK) Interactions

PROPOSAL FOR TUTORIAL
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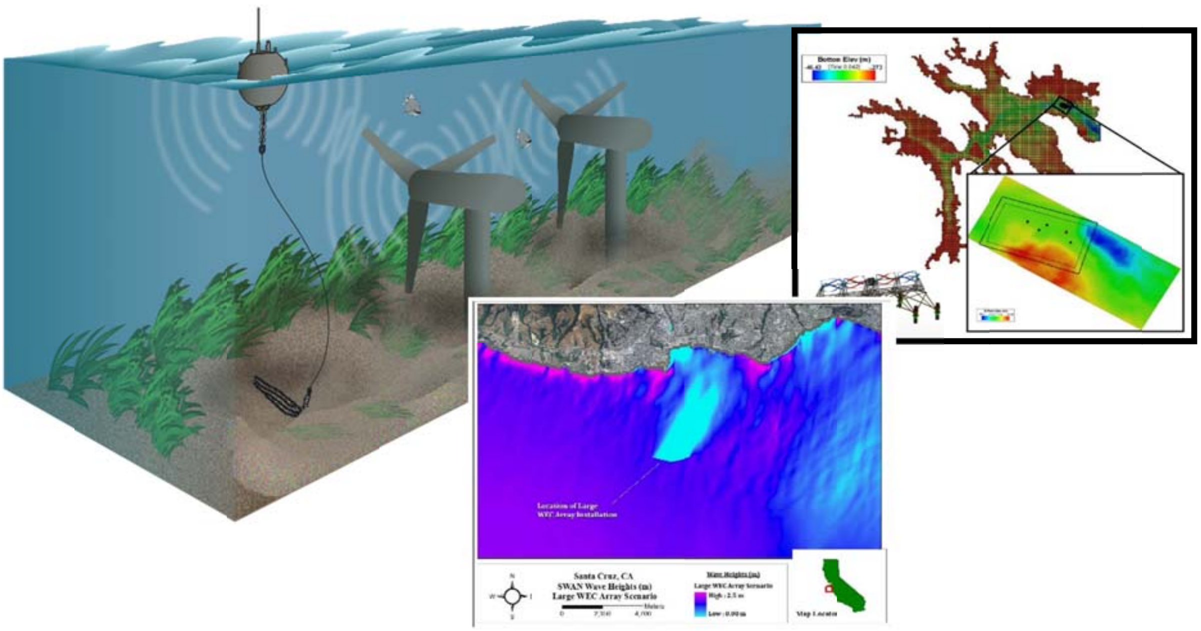
ANCHORAGE, AK



INSTRUCTORS

Craig Jones and Samuel McWilliams (Integral Consulting Inc.)

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ABSTRACT

Worldwide, early marine hydrokinetic (MHK) projects (such as ocean wave and tidal current energy projects) have met significant challenges in permitting and environmental compliance due to the challenges associated with discerning potential environmental effects. Additionally, much of the knowledge required for understanding environmental effects is also necessary for siting and design of MHK facilities. In order to assist this nascent industry in developing a comprehensive understanding of potential changes to the physical environment and ecosystem, Sandia National Laboratories and Integral Consulting (the SNL team) has been developing a suite of MHK capable modeling tools for characterizing coastal, estuarine, and riverine deployments. This tutorial walks users through the characterization of MHK sites including the development of conceptual and numerical models for quantitative site descriptions.

Current energy converters (CECs) harvest energy from natural flowing waters (i.e. canals, rivers, tidal channels, ocean currents, etc.) via arrays or farms of CEC devices in various configurations. By doing this, the CECs modify flow fields which in turn may affect circulation, sediment conveyance, and water levels. The SNL team has been working with multiple researchers to modify the open source Delft-3D FLOW into a customized software capable of simulating flow around CEC arrays. This tool, named SNL-Delft3D-CEC, allows for the optimization of CEC arrays to mitigate environmental changes while maximizing the energy absorbed. The first section of the tutorial will focus on the model theory and application of CECs as incorporated within Delft-3D and applied to relevant current-based marine systems.

In coastal environments, wave energy converters (WECs) absorb energy from offshore waves to produce power. The energy absorbance has the potential to modify the wave propagation inshore of the WEC deployment. The SNL team has developed and deployed a version of the open source SWAN wave propagation model as SNL-SWAN. Similar to SNLDelft-3D-CEC, the implementation simulates the effects of WECs on the wave field to investigate potential physical and environmental effects. Additionally, SNLSWAN and Delft-3D FLOW can be coupled to investigate the effects of offshore MHK arrays on nearshore circulation. The second section of the tutorial will present the theory and implementation of these coupled modeling tools for an example coastal wave energy site.

The tutorial is geared towards applied science and industry applications where site characterization and project assessments are needed. The participants should have basic familiarity with modeling tools, but no specific expertise is necessary. The modeling tools are available via the Sandia website (http://energy.sandia.gov/energy/renewable-energy/water-power/), but this tutorial will not include hands on software training for participants. The participants will leave the session with a working knowledge of the tools and their capabilities to support the MHK industry. Self-guided tutorials will be provided so that participants can follow up after the course at their own pace. A course size of 20-30 participants is anticipated.

INSTRUCTORS

Craig Jones, Ph.D. (Integral Consulting Inc.) – Tutorial Lead – 30%

Craig Jones is Principal at Integral Consulting Inc. and located in Santa Cruz, CA. For the past 18 years, Dr. Jones has had a wide range of experience in applying unique sediment measurements and modeling techniques to study phenomenon in coastal and ocean processes with specific emphasis on marine renewable energy. Dr. Jones' experience has included the development of integrated field and modeling studies at ocean, coastal, and estuarine locations.

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Sam McWilliams, M.S. (Integral Consulting Inc.) – Application Specialist – 30%

Sam McWilliams is a Scientist in the Marine Sciences and Engineering group at Integral Consulting. He has 4 years of experience developing solutions to client issues related to the marine environment. Mr. McWilliams is actively supporting the development and implementation of numerical modeling techniques assessing the interaction of marine hydrokinetic devices with their environment. He has experience with multiple hydrodynamic models including Delft3D and wave models such as SNL-SWAN.

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Jesse Roberts, M.S. (Sandia National Laboratories) – Environmental Perspective – 10%

Jesse Roberts leads Sandia National Laboratories' Marine and Hydrokinetic (MHK) Market Acceleration and Deployment efforts within the Water Power Technologies department since its inception in 2009. Jesse has been with Sandia for 18 years where he began his career working on water resource and sediment management research. He co-founded Sandia's Soil and Sediment Transport Group and holds two patents for devices that make direct measurement of sediment erosion and transport properties.

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Chris Chartrand, M.S. (Sandia National Laboratories) – Application Specialist – 30%

Chris Chartrand is a senior technical staff member in the Water Power Technologies group at Sandia National Laboratories. He is the developer of the WEC power absorption models implemented into SNL-SWAN, and he has implemented CEC power absorption models for use in turbine modeling. Chris has worked in the field of Computational Fluid Dynamics (CFD) for more than 12 years where he has lead numerical code development such as implementing Fluid Structure Interaction into complex CFD codes.

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COURSE OUTLINE

1. Overview of tutorial (0.75 hr)
    a. Introductions and Course Overview
    b. Development of Conceptual Site Models
    c. Basic MHK Device Theory
2. Current Energy Convertors (1.25 hr)
    a. Hydrodynamic Model Framework
    b. CEC Model Theory and Implementation
    c. Sample Case Setup
    d. Results Evaluation

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3. Wave Energy Convertors (1.5 hr)
    a. Wave Model Framework
    b. CEC Model Theory and Implementation
    c. Sample Case Setup
    d. Results Evaluation
4. Summary and Questions

FORMAT

The course will be presented in a PowerPoint format by the instructors on a standard overhead projector. The materials will be provided electronically to all participants. Participants may bring a laptop to follow along and annotate their presentation. Comfortable tabletop seating should be available for all participants. No specialized audio visual equipment will be required.

EXPERIENCE

The lead instructors have conducted over a dozen short courses and tutorials in a similar format on related materials. All of the instructors have worked together for over 4 years and regularly collaborate in joint presentations and tutorials.

PARTIAL COURSE BIBLIOGRAPHY

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