

Field Observations of Turbulence and Suspended Sediments Over an Intertidal Reef

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INTRODUCTION

Sediment suspension and sedimentation affect coral reef ecosystem by altering physical and biological processes. In general, sediment suspension is controlled by the hydrodynamics of turbulence in reef systems (Pomeroy et al., 2017). The structures of colonies increase roughness and enhance turbulence mixing in coral reefs, which might affect sediment suspension. However, such complex processes between the sediment suspension and turbulence in natural reef systems are not well understood. Here, we present field observations of turbulence and suspended sediment concentration (SSC) over an intertidal reef flat. This research aims to understand, quantify, parameterize, and study the physical process of SSC variations, and, to investigate how the turbulence affecting the variation of SSC on the reef flat.

FIELD EXPERIMENTS

The study site is located on an algal reef on the northwest coast of Taiwan, Taoyuan City. A pilot-testing field experiment was conducted in 2013, and an intensive field experiment was conducted in 2022. Acoustic Doppler velocimetries (ADV) were used to measure the tide, waves, and turbulence. Laser in-situ scattering and transmissometries (LISST) were used to measure the particle size of suspended sediment. Optical backscatter sensors (OBS) were used to measure the mass concentration of suspended sediment (mg/L). The OBS were carefully calibrated with in-site water sampling (WS). In 2022, we added more ADVs, OBS, LISST, and two five-beams high-frequency acoustic Doppler current profilers (ADCP, Signature 1000) to measure the currents, waves, and turbulence.

The measured instantaneous velocity vector of the coastal flow is decomposed into a mean component, a wave-induced component, and a turbulent component. The mean velocity component (current) is determined by taking the time average over a 20-minute duration of instantaneous velocity data. A differencing technique with the adaptive least-square filter is used to separate the components of the wave-induced velocities and the turbulent velocities (Huang, 2015).

RESULTS

Figure 1 shows the instruments of the ADVs, OBSs, LISSTs in 2013 and 2022 experiments. The currents in the study site are mainly induced by the tide, and secondarily by the wind and waves. Figure 2 shows an example of the variation of vertical profiles of the measured currents with tidal phases, where open and filled circles are data measured by up-looking and down-looking ADCP. Figure 3 shows the time series of the measured turbulent kinetic energy, turbulent Reynolds stress, and suspended sediment concentration (SSC). A high correlation between the SSC, particle sizes, and turbulent quantities is observed. Testing were performed on the relation between the shear velocities and particle settling velocities. More analysis and results will be presented in the conference.

REFERENCES

- Huang, Z.C., 2015. Vertical structure of turbulence within a depression surrounded by coral-reef colonies. *Coral Reefs*, 34(3), 849-862.
- Pomeroy, A.W.M. et al., 2017. Sediment transport in the presence of large reef bottom roughness. *JGR-Oceans*, 122(2), 1347-1368.

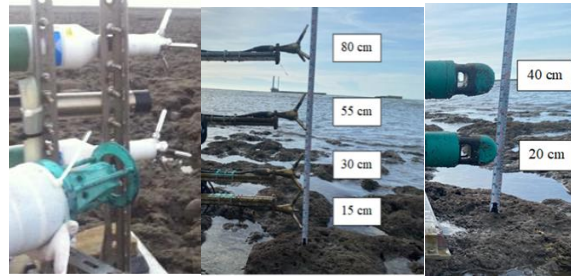


Figure 1. Instrumentation and set up of field experiment. Left panel: 2013 exp; middle and right panel 2022.

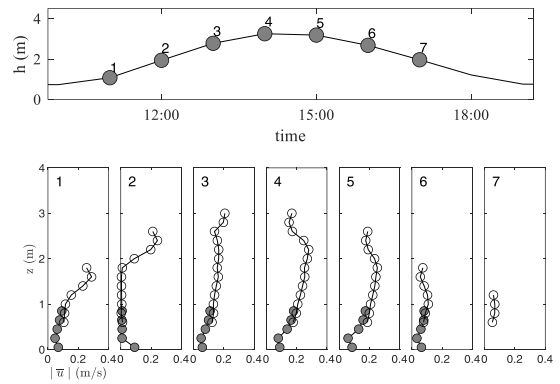


Figure 2. Example of the variation of vertical profiles of the measured currents with tidal phases, where open and filled circles are data measured by up-looking and down-looking ADCP.

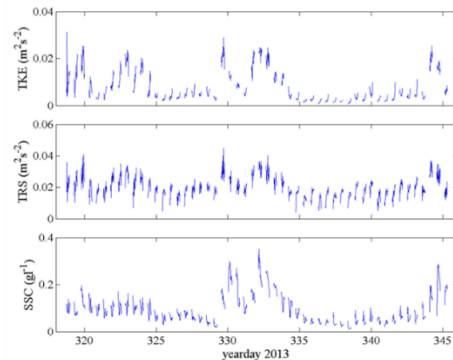


Figure 3. Time-series of the measured turbulent kinetic energy, turbulent Reynolds stress, and suspended sediment concentration (SSC).