

EGU22-13468

<https://doi.org/10.5194/egusphere-egu22-13468>

EGU General Assembly 2022

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Assessing hydrodynamic processes of nearshore coral reefs: numerical modeling and field observations around the island of Curaçao

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The state of coral reef ecosystems is highly dependent on the availability and ratio of essential resources such as oxygen, minerals and nutrients, and the presence of pollutants, pathogens and other possible stressors. The distribution of these inputs is dynamic and depends on many factors, including the nearshore hydrodynamic processes. These are unique processes, consisting of tidal pumping, nearshore circulation, and wave action. Furthermore, these processes are highly influenced by complex reef bathymetry and the physical roughness of the reef. The latter has a crucial role in the boundary layer characteristics, which influences uptake by reef organisms at smaller spatial scales.

The understanding of distribution and transport of particulate and dissolved substances is challenging as field surveys are difficult to perform and there is a large variety of coral shapes. However, assessing the hydrodynamic processes is a necessary first step in order to link the sources and sinks of substances with the coral health and growth. Within the interdisciplinary research program SEALINK, we aim to assess the distribution and pathways of substances around the island of Curaçao. Field observations on selected sites along the coast of Curaçao include current and wave measurements with Acoustic Doppler Current Profilers and flow visualization with fluorescent dye.

We will present preliminary results from the field campaign showing velocity fields and wave transformation on different stations along the cross-shore transects on the reef platform. Using a combination of field observations and 3D non-hydrostatic Computational Fluid Dynamics models, we investigate the mixing mechanisms and local energy balance at scales of $O(10\text{ m})$ on the selected reef quadrants. This serves as a basis for a further analysis with Lagrangian Particle Tracking methods to track the selected substances identified with other field campaigns within the SEALINK program.

