Reactive oxygen species (ROS) are chemically-reactive molecules that form in various metabolic pathways and in photochemical reactions at the ocean surface. Whereas ROS are important signaling molecules, excessive ROS concentrations are highly detrimental to cellular structures and functions. Intercellular ROS levels are, hence, tightly regulated by antioxidant enzymes and small antioxidant molecules. In corals or other reef inhabiting invertebrates, an involvement of ROS and antioxidants in bleaching, infectious diseases, communication, immune response, stress response and reproduction has been documented.

We investigate the sources and sinks of ROS (O$_2^-$ and H$_2$O$_2$) in the coral reef and explore their role in the chemical interactions between corals and their biotic and abiotic surroundings. By applying sensitive and rapid measuring techniques and a kinetic approach we characterize the O$_2^-$ and H$_2$O$_2$ dynamics (that is production and destruction) in a natural coral reef, subjected to changing irradiation, temperature, sea level and currents. Then, scaling down from the ecosystem to the level of the organism, we conduct controlled and semi-controlled experiments with corals, symbiotic algae and mucus-associated bacteria to examine the effects of environmental stressors on both the extracellular production and detoxification of ROS in the different members comprising the coral holobiont.

In this talk we’ll present unpublished field and experimental data on H$_2$O$_2$ and antioxidant release from single corals, coral knolls and reefs. The mucus layer surrounding corals was found to contain strong antioxidant activity capable of degrading H$_2$O$_2$ at appreciable rates, thus enabling corals to offset exogenous H$_2$O$_2$. Currents were found to induce continuous H$_2$O$_2$ release from corals to their surrounding water, probably due to ventilation (mass transfer). Current-induced H$_2$O$_2$ mass transfer may aid corals to discard internal H$_2$O$_2$ and can be viewed as an additional H$_2$O$_2$ detoxification mechanism. Additionally, rapid H$_2$O$_2$ (and O$_2^-$) release from corals upon mechanical stress (touch) was observed, resembling “oxidative burst” commonly applied by various organisms for fighting invading pathogens. Chemical stimuli and the presence of other corals also lead to rapid H$_2$O$_2$ release, possibly indicating that H$_2$O$_2$ plays a role in “chemical talk” between corals.