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Investigating extreme events using the Coupled Ocean Atmosphere Wave Sediment Transport Modeling System (COAWST).

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Extreme events characterizing the climatic variability at mid-latitudes are often associated with intense feedbacks between the atmosphere and the oceanic components. The COAWST (Coupled Ocean Wave Sediment Transport Modeling System) system was developed to couple state of the art numerical models in order to reproduce physically sound and more realistic dynamics and the consequent impacts on oceans and coastal environments. We present here two applications in different geographic areas.

Hurricane Sandy hit the US east coast in 2012, and was one of the most destructive storms in US history with impacts including flooding, coastal erosion, dune overtopping, breaching. The oceanographic processes and morphological changes during Hurricane Sandy on Fire Island, NY and the adjacent inner continental shelf were investigated using geophysical observations and the COAWST system with grid refinement (to simulate oceanographic conditions on a regional 5-km grid along the entire US east coast, with increased resolution of 700 m in the NY bight, 100 m along Fire Island, and 5 m at the breach formed due to Sandy).
Geologic investigations of the seafloor in 2011 and 2014 demonstrate changes of seafloor morphology and modern sediment thickness revealing up to 450 m of lateral movement of sedimentary features and deposition at depths up to 30 m. Model results identify maximum surge of up to 3 m, surface currents up to 2 m/s, and wave heights up to 8 m. Sediment redistribution along Fire Island showed erosional patterns consistent with geologic observations. During the peak of the storm total water level and wave action was able to create a breach.

In the Mediterranean basin intense cyclones called TLC (Like Tropical Cyclones) can develop, having physical characteristics similar to tropical cyclones. We present results from the simulation of the TLC Rolf generated on the Balearic Islands, with gusts up to 28 m/s and 8 meters of significant wave height. Results show the importance of the atmosphere-ocean-wave coupling to obtain more realistic SST and heat fluxes, and highlight the difference in terms of wind speed and distribution, trajectory and dimensions of the cyclone.