Does bottom roughness determine hypoxic extent? A model intercomparison for the northern Gulf of Mexico

KATJA FENNEL[1*], ARNAUD LAURENT[1], ROBERT HETLAND[2], DUBRAVKO JUSTIC[3], DONG S. KO[4], JOHN LEHRTER[5], MICHAEL MURRELL[5], LIXIA WANG[3], LIUQIAN YU[1] AND WENXIA ZHANG[12]

[1]Department of Oceanography, Dalhousie University, Halifax, Canada; *Katja.Fennel@dal.ca
[2]Department of Oceanography, Texas A&M University, College Station, USA
[3]Department of Oceanography and Coastal Sciences, Louisiana State University, Baton Rouge, USA
[4]Naval Research Laboratory, Stennis Space Centre, USA
[5]Gulf Ecology Division, US Environmental Protection Agency, Gulf Breeze, USA

A large hypoxic zone forms every summer over the continental shelf of the northern Gulf of Mexico because of nutrient and freshwater inputs from the Mississippi/Atchafalaya River System. Several coupled circulation-hypoxia models are under development for this region in order to improve mechanistic understanding of hypoxia. Here we report results of an intercomparison of these hypoxia models, which is being undertaken within the NOAA-funded Coastal & Ocean Modeling Testbed (COMT). Four circulation models are included: two implementations of the Regional Ocean Modeling System (ROMS), one implementation of the Finite Volume Coastal Ocean model (FVCOM), and one implementation of the U.S. Navy's coastal ocean model (NCOM). In order to elucidate the effects of model physics on hypoxia, all circulation models were initially run with the same, highly simplified hypoxia model, which parameterizes oxygen sinks in water column and sediment, and includes air-sea gas exchange. The simplified hypoxia models were found to have surprisingly high predictive skill when compared with their corresponding full biogeochemical models. Oxygen consumption by the sediment was found to be the most important oxygen sink driving hypoxia generation in this region. The thickness of the bottom boundary layer effectively defines the timescale of hypoxia generation, making bottom roughness an unexpected but important factor in determining whether a model is likely to generate hypoxic conditions or not. The second step of the intercomparison will include a detailed analysis of the full ecosystem-hypoxia models. Our ultimate goal is to improve model formulations, hindcasts, forecasts and mechanistic understanding.