# HYPOXIA FORECAST IN THE CHESAPEAKE BAY USING CNN AND LSTM

***Guangming Zheng***[1,2] *and Stephanie Schollaert Uz*[3]

[1]NOAA/NESDIS/Center for Satellite Applications and Research, College Park, MD USA
[2]Earth System Science Interdisciplinary Center, University of Maryland Research Park, College Park, MD USA
[3]Earth Science Division, NASA Goddard Space Flight Center, Greenbelt, MD USA

Seasonal hypoxia has been a persistent threat for ecosystems and fisheries in the Chesapeake Bay. Hypoxia forecast based on coupled hydrodynamic and biogeochemical models has proven useful for fisheries management. These models excel in accounting for the effects of physical forcings on oxygen supply, but are not as good at predicting oxygen demand associated with decay of organic matter. Therefore, the accuracy of hypoxia forecast can be potentially improved with satellite-derived water color data which may help constrain the surface concentration of organic matter. Owing to the optical complexity, however, it is not straightforward to extract organic matter information from water color data in a robust fashion. A promising approach to address this issue is to use deep learning which is great at building end-to-end applications. By training a deep neural network with data of all variables that could affect dissolved oxygen (DO) concentration in the water column, improvement of hypoxia forecast is possible. Here we attempt to predict dissolved oxygen concentration with input data that account for both physical and biogeochemical factors. The physical factors are characterized by the 3-D outputs of a hydrodynamic model, which include the current velocity, water temperature, and salinity, as well as wind velocity. The biogeochemical factors are characterized by satellite-derived spectral reflectance data. Both physical and biogeochemical data are sampled on a weekly basis up to 8 weeks before the observation date of each field measured DO, which is obtained from the Chesapeake Bay Program. In total, we obtained 150,656 training examples from 2002-2018, and used data from the period of 2019-2020 for testing. We adopted a model architecture of combined convolutional neural network (CNN) and long short-term memory (LSTM) with 8 time steps. At each time step, a set of CNNs are used to extract information from the input data. This architecture mimics the evolution process of DO in natural waters. Our approach represents an innovative application of deep learning to solving water quality problems.

**<u>PRESENTER BIO:</u>** Guangming Zheng's research focuses on developing and applying remote-sensing algorithms for monitoring and forecasting water quality in coastal and inland waters. He is interested in addressing major water quality issues that may threaten coastal ecosystems, fisheries, and human health such as coastal hypoxia and harmful algal blooms. He employs both traditional physics-based approaches as well as deep learning based artificial intelligence.