**Secchi Disk Depth: Theoretical interpretation of the most common water quality product**

Zhongping Lee,1 Shaoling Shang,2 Chuanmin Hu,3 Alan Weidemann,4 Weilin Hou,4 Keping Du,5 Junfang Lin1

1 School for the Environment, University of Massachusetts Boston, Boston, MA 02125

2 State Key Lab of Marine Environmental Science, Xiamen University, Xiamen 361005, China

3 College of Marine Science, University of South Florida, St. Petersburg, FL 33701

4 Naval Research Laboratory, Stennis Space Center, MS 39529

5 State Key Laboratory of Remote Sensing Science, Beijing Normal University, Beijing, 100875, China

Secchi disk depth (SDD), a measurement of the maximum viewable depth of a white or black-and-white disk with a diameter 20-30 cm when lowered into water, holds the longest (from at least 1880's) records of water transparency. Because of the easy and low-cost nature, SDD has been the most common product for assessing water quality by professionals and seagoers. Theoretical interpretations of SDD have also been established since 1950's, which generally follow the same Law of Contrast Reduction adopted for visual ranging in air established 90 years ago. However, it is found that the assumptions adopted in this theory do not match the observation of a Secchi disk in water. We developed a new theoretical model to interpret SDD based on radiative transfer along with an overhaul of the Law of Contrast Reduction. This model is subsequently validated using SDD data of a wide range of environments, with results showing excellent agreement between measured and theoretically predicted SDD ranging from < 1 m to > 30 m. The new theory and mechanistic model have profound impacts on both the understanding of visibility and the generation of global SDD product from ocean color remote sensing for the monitoring of water quality.