**SWIPE: Spectral Water Inversion Processor and Emulator**

**Jeremy Kravitz1, Liane Guild2, Lisl Lain3, Steffen Mauceri4, Jake Lee4, Didier Ramon5, François Steinmentz5**

1NASA Postdoctoral Program Fellow, NASA Ames Research Center, Moffett Field, CA, United States

2Biospheric Science Branch, Earth Science Division, NASA Ames Research Center, Moffett Field, CA, United States

3Council for Scientific and Industrial Research, Cape Town, South Africa

4Machine Learning & Instrument Autonomy group, JPL, Caltech, CA, United States

5HYGEOS, Euratechnologies, Lille, France

Jeremy.kravitz@nasa.gov

**ABSTRACT**

Degradation of Earth’s inland water resources due to anthropogenic perturbations and climate anomalies at both local and global scales continues to place human health at substantial risk. There is now a growing necessity to develop pragmatic approaches that allow timely and effective extrapolation of local processes, to spatially resolved global products, and to promote operational and sustainable resource policy management. This presentation will be discussing the progress made developing SWIPE: Spectral Water Inversion Processor and Emulator. SWIPE is a platform for advanced modeling of coastal and inland aquatic habitats. The goal is create a comprehensive and cohesive system to leverage recent advancements in computation and machine learning to develop a synthetic training ground for sensitivity studies and algorithm development. The four principal facets of SWIPE include: 1. Advanced two-layer coated sphere bio-optical modeling and GPU radiative transfer modeling, 2. Big Data involving massive synthetic spectral libraries of optical properties of various global aquatic particles, surface reflectance, and top-of-atmosphere reflectance, all at hyperspectral resolution leveraging high-end computing systems at NASA Ames Research Center, 3. Deep Learning for algorithm development for water quality inversion of concentrations of common biogeophysical variables as well as optics, full uncertainty characterization by water type, and forward emulation, and lastly, 4. Image Processing for application of developed retrieval algorithms for both hyperspectral and multispectral sensors with experimental corrections for global adjacency, noise, sunglint, and benthic reflectance. This presentation will demonstrate the Equivalent Algal Populations (EAP) two-layer coated sphere scattering model which has been used develop spectral libraries of hyperspectral inherent optical properties of roughly 80 species of phytoplankton, covering 15 different classes and nine taxonomic functional types. The EAP model was also used to derive spectral properties of 10 different non-algal particle functional types. Examples of how the SMART-G (Speed-up Monte-carlo Advanced Radiative Transfer using GPU) radiative transfer code is used to model optically complex aquatic signals will be presented and discussed in the context of creating a massive synthetic database which can leverage the full power of next generation machine learning techniques and high end computing for water quality inversion. We will discuss our active investigation in things like appropriate model architectures, dimensionality reduction techniques such as PCA and autoencoders, uncertainty quantification and abstaining, and which variables actually benefit most from hyperspectral information versus multispectral resolution. We are also curious about questions relating to cost/benefit analysis in terms of computation resources, neural network complexity, and data volumes. Answers to these questions will hopefully elaborate on cost efficiency for potential future sensor design considerations.