A New MODIS Algorithm for Retrieval of Chlorophyll, Dissolved Organic Carbon, and Suspended Minerals for the Great Lakes and other Coastal Waters

INTRODUCTION AND SUMMARY

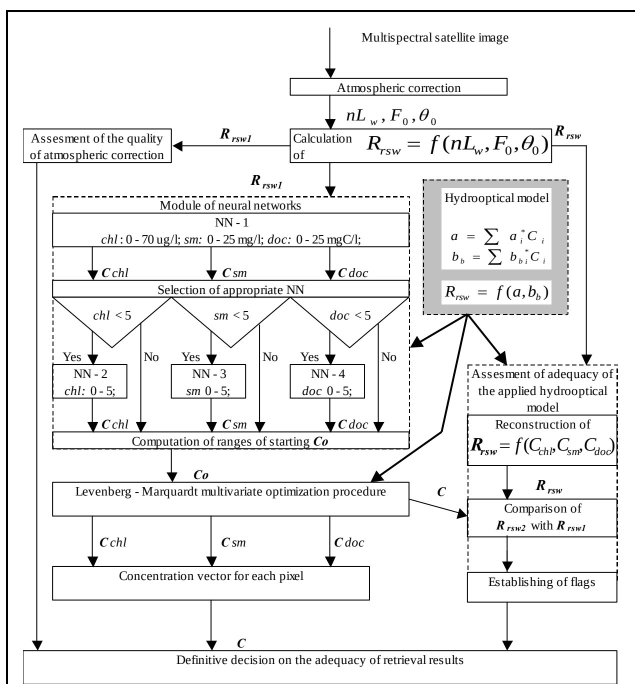
The Michigan Tech Research Institute (MTRI) and the Nansen International Environmental and Remote Sensing Center (NIERSC) of St. Petersburg, Russia have developed a new algorithm for the retrieval of color producing agents (CPAs) for Great Lakes waters. The algorithm is applicable to all coastal (case II) waters, and operates on either SeaWiFS or MODIS data and produces estimates of chlorophyll (chl), dissolved organic carbon (doc), and suspended minerals (sm). The algorithm has undergone a preliminary validation using both dedicated and historical *in situ* water chemistry measurements and the comparison between satellite and *in situ* are within 15%.

ALGORITHM DESCRIPTION AND EXAMPLE

The new algorithm utilizes SeaWiFS and MODIS satellite data to retrieve the concentrations of chl, doc, and sm in surface case II waters. See Pozdnyakov, et al. (2004) for a more extended description.

The new, fast operating algorithm is based both on a previously developed hydro-optical model developed for Lake Ontario (Bukata, et al., 1995) and a combination of the Levenberg-Marquardt (L-M) multivariate optimization approach and neural network (NN) emulation technique. The reason for linking these two computational tools resides in our finding that although in comparison with NN, the L-M technique generally provides more accurate results, and is more robust for noise-contaminated input data, however it is slower than NN (Pozdnyakov, et al., 2004). This is primarily due to the necessity for the L-M procedure to test a wide variety of options of the CPA concentrations before reaching the final solution. The NN emulator proceeds differently: after having been trained and validated, it provides the multivariate solution within a fraction of a second. However, being reasonably accurate for the middle part of the range of the CPA concentrations generally found in mesotrophic to moderately eutrophic waters (Petrova, 1990), it is less accurate for the CPA concentrations that are less than 5 (in respective concentration units).

Therefore the reason for a sequential use of the NN and L-M procedures is prompted by the facility of the NN emulator to provide the L-M



procedure with much narrower limits of the range of the CPA concentration vector, within which the final solution can be reached. This speeds up the retrieval algorithm performance significantly. The search for the solution can be further improved if, along with broad range (BR) NN, a specially trained narrow-range (N-R) NN is used should any of the CPAs determined by the B-R NN fall into the 0-5 range. This again results in further speeding up of the L-M performance.

An example of the algorithm output is shown in Figure 1.

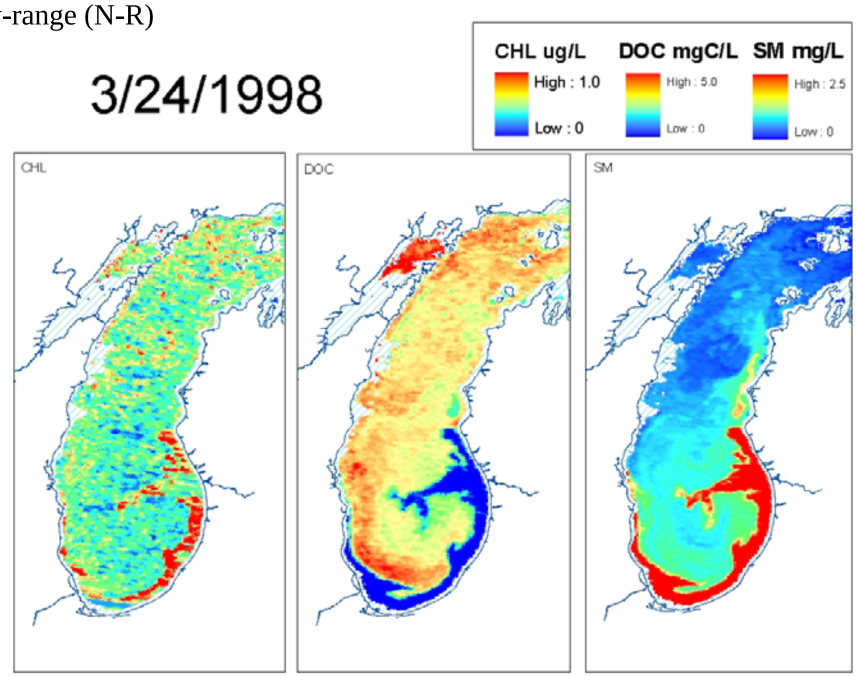


Figure 1. This figure presents the spatial distributions of chl, doc, and sm as they are retrieved from a SeaWiFS image taken on March 24, 1998. The retrieved data quantitatively illustrates the influence of the 1998 springtime episodic event, which resulted in a considerable resuspension of bottom sediments. As seen in the figure, the resuspension of sediments resulted in a pronounced growth of phytoplankton within the plume area, and very significant scavenging of doc from the water column produced by settling sm particulate matter.

References

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