



National Aeronautics and Space Administration  
Goddard Earth Science Data Information and  
Services Center (GES DISC)

# README Document for Carbon Monitoring System (CMS) Great Lakes Primary Production Data

---

**Prepared By:**

***Thomas J. Hearty, III***

***Michael J. Sayers***

---

GES DISC

Goddard Space Flight Center

Code 610.2

Greenbelt Maryland

10/31/2019

---

Michigan Tech

1400 Townsend Drive, Houghton, MI

49931

---

## Revision History

---

<b><i>Revision Date</i></b>	<b><i>Changes</i></b>	<b><i>Author</i></b>
11/13/2019	Added acknowledgements, fixed title, and added a data disclaimer.	Thomas Hearty and Michael Sayers

# Table of Contents

1.0 Introduction.....	3
1.1 Algorithm Background.....	3
1.2 Data Disclaimer.....	3
2.0 Data Organization.....	4
2.1 File Naming Convention.....	4
2.2 File Format.....	4
2.3 Science Data Fields.....	4
3.0 Dimensions.....	4
4.0 Options for Reading the Data.....	5
5.0 Data Services.....	5
6.0 Acknowledgements.....	5
7.0 References.....	5

## 1.0 Introduction

---

This document provides basic information for using Version 1 of the Carbon Monitoring System (CMS) Great Lakes Monthly and Yearly Primary Productivity/Carbon Fixation for Lakes Superior, Michigan, and Huron. The primary production data for the 6 products listed in Table 1 was derived using MODIS imagery with model data.

**Table 1:** CMS Great Lakes Data Products

<b>Title</b>	<b>ShortName</b>	<b>DOI</b>
Carbon Monitoring System Lake Superior Primary Production Monthly	CMSLakeSuperiorPPM	<a href="https://doi.org/10.5067/FZRE98046VM7">10.5067/FZRE98046VM7</a>
Carbon Monitoring System Lake Superior Primary Production Yearly	CMSLakeSuperiorPPM	<a href="https://doi.org/10.5067/SQ2R9DWW6WDV">10.5067/SQ2R9DWW6WDV</a>
Carbon Monitoring System Lake Michigan Primary Production Monthly	CMSLakeMichiganPPM	<a href="https://doi.org/10.5067/5AZRS4SRGS1R">10.5067/5AZRS4SRGS1R</a>
Carbon Monitoring System Lake Michigan Primary Production Yearly	CMSLakeMichiganPPM	<a href="https://doi.org/10.5067/NCJELM4CS8H8">10.5067/NCJELM4CS8H8</a>
Carbon Monitoring System Lake Huron Primary Production Monthly	CMSLakeHuronPPM	<a href="https://doi.org/10.5067/CZ39JIR4ZAT4">10.5067/CZ39JIR4ZAT4</a>
Carbon Monitoring System Lake Huron Primary Production Yearly	CMSLakeHuronPPY	<a href="https://doi.org/10.5067/11TMFK7VSHDY">10.5067/11TMFK7VSHDY</a>

## 1.1 Algorithm Background

The algorithm is described in papers by Fahnenstiel et al. 2016, Shuchman et al. 2013, and Lee et al. 2005.

## 1.2 Data Disclaimer

See Fahnenstiel et al. (2016) for a detailed discussion about this product. Contact the data developer, Michael Sayers ([mjsayers@mtu.edu](mailto:mjsayers@mtu.edu)) for additional science questions.

## 2.0 Data Organization

The data are gridded Monthly and Yearly.

### 2.1 File Naming Convention

The files are named

**CMS\_Lake\_NameofLake\_PP\_TimeStep\_ValidDates.nc**

where *NameofLake* is **Superior**, **Michigan**, or **Huron**, *TimeStep* is **Monthly** or **Yearly**, and *ValidDates* is either the year in yyyy format for the monthly data or yyyy-yyyy for the yearly data.

Sample monthly and yearly filenames are listed below:

CMS\_Lake\_Huron\_PP\_Monthly\_2010.nc

CMS\_Lake\_Huron\_PP\_Yearly\_2010-2013.nc

### 2.2 File Format

The data files are in netCDF format.

### 2.3 Science Data Fields

The 2 science data fields are listed in Table 2. The variable **app** includes a time dimension while the variables in the “geophysical\_data” group have the time information in the variable name.

Table 2: Science Data Fields

Variable	long_name	units
app	Monthly (Yearly) Average Primary Production/Carbon Fixation	mg/m <sup>2</sup> /day
geophysical_data/ YYYY or geophysical_data/ Month_YYYY	Monthly (Yearly) Average Primary Production/Carbon Fixation	mg/m <sup>2</sup> /day

## 3.0 Dimensions

The **app** variable has dimensions for “time”, “longitude”, and “latitude”. The variables in the “geophysical\_data” group have dimensions “number\_of\_lines” and “pixels\_per\_line” which represent the latitude and longitude, respectively. The, “time”, “longitude”, and “latitude” variables also have associate coordinate variables with the same name.

## 4.0 Options for Reading the Data

Since these files are provided in netCDF format they may be read by many software languages and tools such as Python, C, Fortran, Panoply, ncdump, as well as others.

## 5.0 Data Services

If you need assistance or wish to report a problem:

**Email:** [gsfc-help-disc@lists.nasa.gov](mailto:gsfc-help-disc@lists.nasa.gov)

**Voice:** 301-614-5224

**Fax:** 301-614-5268

**Address:**

Goddard Earth Sciences Data and Information Services Center NASA Goddard Space Flight Center  
Code 610.2 Greenbelt, MD 20771 USA

## 6.0 Acknowledgements

This project was funded by the NASA Carbon Monitoring System (CMS) grant no. NNX12AP4G.

## 7.0 References

Fahnenstiel, G.L., Sayers, M, Shuchman, R.A., Yousef, F., Pothoven, S.A. (2016), Lake-wide phytoplankton production and abundance in the Upper Great Lakes: 2010–2013, J. Great Lakes Res., 3, doi:[10.1016/j.jglr.2016.02.004](https://doi.org/10.1016/j.jglr.2016.02.004)

Shuchman, R.A., Leshkevich, G., Sayers, M.J., Johengen, T.H., Brooks, C.N., Pozdnyakov, D. (2013), An algorithm to retrieve chlorophyll, dissolved organic carbon, and suspended minerals from Great Lakes satellite data, J. Great Lakes Res., S1, doi:[10.1016/j.jglr.2013.06.017](https://doi.org/10.1016/j.jglr.2013.06.017)

Lee, Z., Du, K., Arnone, R., Liew, S., Penta, B. (2005), Penetration of solar radiation in the upper ocean: a numerical model for oceanic and coastal waters, J. Geophys. Res. Oceans, doi:[10.1029/2004JC002780](https://doi.org/10.1029/2004JC002780)