MIxed Layer data set of Argo, Grid Point Value: MILA GPV

Introduction

JAMSTEC RIGC produces a global data set of gridded mixed layer depth (MLD) using Argo temperature and salinity profiles, named "MILA GPV (Mixed Layer data set of Argo, Grid Point Value)". Since quality of the profile data which covered fully in the ice-free global ocean is high and uniform and vertical resolution of the profiles is fine (at least 5 dbar in the surface layer), error of MLD is expected to be smaller. Although the coverage of Argo float array was not so good in the earlier stage of Argo project, observing floats almost covered in the World Ocean after 2004. The Argo quality controlled profile data (real time QC and/or delayed mode QC) is obtained from Argo Global Data Archive Center (GDAC). For the obtained data, further quality control is carried out to avoid including inappropriate profile data. To make MLD data set, the finite difference method is used based on sea surface temperature and sea surface potential density. Among the values in the difference of temperature and potential density, mixed layer is chosen with the minimum value between the two values. Two pairs of the temperature and potential density criteria are applied, which are generally used in a lot of researches. The grid point value of MLD is calculated using a median after estimated MLD for individual profiles. Users can use the two data set for their aim of research.

Method

Before estimating MLD, quality controls are carried out for Argo profile data which are quality controlled real time and/or delayed mode data. The quality controls are 1) to check temperature and density inversion, 2) to confirm existence of surface values above 15 dbar and 3) to remove over 3 times of standard deviation at each levels using World Ocean Atlas 2005 (Antonov et al., 2006; Locarnini et al, 2006). For individual profiles, vertical interpolation based on Akima method is done for each 1 dbar (Akima, 1970). Using the interpolated profiles, MLD, isothermal layer thickness (TLD), isopycnal thickness (PLD) and averaged temperature and salinity in the MLD are estimated for each profile. The MLD is defined with the minimum value between TLD and PLD. The TLD and PLD are calculated using the finite difference method based on the temperature and potential density values at 10 dbar. The two pairs of criteria are chosen, which are used in recent research, that is, 1) $0.5\,^\circ C$ of difference in temperature (ΔT) and 0.125 kg m^{-3} of difference in potential density ($\Delta\sigma\theta$; e.g., Monteley and Levitus,1997) and 2) 0.2 ºC of ΔT and 0.03 kg m^{-3} of $\Delta\sigma\theta$ (e.g., de Boyer

Montégut et al., 2004). MLD and the other parameters are gridded in 2°x2° boxes, whose values are calculated using median at each grid; however averaging is done in the case if the number of data within grid is less than 4. The data set is made in the ice-free global ocean a) for each 10 days from 2001- on going, b) monthly average from 2001 to 2010, c) for one month from 2001 – on going. The data set will be renewed within one or two months. The detailed of method, quality control and data set are described in Hosoda et al. (2010).

Dataset

There are three type of datasets as follows:

a) 10days-mean (since Jan.1st, 2001)

b) monthly mean (since Jan.2001)

c) monthly mean climatology

The a) and b) are provided as Near Real Time (hereafter NRT) data using RTQC data and as Deleyed Mode (hereafter DM) data using Argo profile data for the entire time period most recent at the time of the update. DM uses more DMQC profile data than NRT. Both are provided in the same file name, but the version of NRT or DM is described at DATASET_TYPE variable in each NetCDF file.

(1) Parameters and criteria for each gridded data set in a)- c)

i)   Mixed layer depth

i-1) 0.03kg m^{-3} for $\Delta\sigma\theta$ and 0.2°C for ΔT

i-2) 0.125kg m^{-3} for $\Delta\sigma\theta$ and 0.5°C for ΔT

ii)   Isothermal layer thickness

ii-1) 0.2°C for ΔT

ii-2) 0.5°C for ΔT

iii)   Isopycnal layer thickness

iii-1) 0.03kg m^{-3} for $\Delta\sigma\theta$

iii-2) 0.03kg m^{-3} for $\Delta\sigma\theta$

iv)   Averaged temperature in MLD

v)   Averaged salinity in MLD

vi)   Averaged potential density in MLD

vii)   The number of profiles in each grid

(2) Data format

Format of MILA GPV is described with Network Common Data Form (NetCDF) on the basis of COARDS rule. The NetCDF data can convert to ascii format by using "ncdump" software.

If some analysis software such as "GrADS" and "Ocean Data View(ODV)" are used, NetCDF is also available. Method of reading data is written in the attached document.

About this document

Since this document will be occasionally renewed, the date and version of the document must be checked.

Usage of MILA GPV

・ Reprint without permission, the re-distribution, the modification, and the commercial use are prohibited though JAMSTEC does not disturb the free use of this data in principle.

> Hosoda, S., T. Ohira, K. Sato, and T. Suga (2010): Improved description of global mixed-layer depth using Argo profiling floats, J. Oceanogr, 66, 2010,773-787.

・ Please source the above when you make the result using this data public.
・ JAMSTEC doesn't assume the responsibility to any damage of the user of this data.

Information

2021.9.17 According to high salinity drift of CTD sensors on Argo floats that occur more frequently than usual because of a manufacturing problem, we recalculate using the Argo profile data in the latest quality control stage, Please look at the following document for details. We recommend strongly that you should download data files of MILA GPV again if you downloaded them before September 17th, 2021.

https://www.jamstec.go.jp/argo_research/dataset/milagpv/Release_recalculation_MILA.pdf

2015.9.3 We had debugged MLD calculation program and re-calculated the data from 1st January ,2001 to 31st July, 2015 based on Argo profile data downloaded in 1st August 2015 from GDAC. By this re-calculation, error of MLD values with shallower than 10-dbar had been fixed, which were impossible ones according to the

definition of MLDs. After August 2015 MLD data are calculated by the debugged program.

References

Akima, H. (1970): A new method for interpolation and smooth curve fitting based on local procedures. *J. Assoc. Comput. Mech.,* **17**, 589– 603.

Antonov, J. A., R. A. Locarnini, T. P. Boyer, H. E. Garcia, and A. Mishonov (2006): World Ocean Atlas 2005, Vol. 2: Salinity. Ed. S. Levitus. NOAA Atlas NESDIS 62, U.S. Government Printing Office, Wash, D.C.

Argo (2000): Argo float data and metadata from Global Data Assembly Centre (Argo GDAC), Ifremer, http://dx.doi.org/10.12770/1282383d-9b35-4eaa-a9d6-4b0c24c0cfc9.

de Boyer Montégut, C., G. Madec, A. S. Fischer, A. Lazar, and D. Iudicone (2004): Mixed layer depth over the global ocean: An examination of profile data and a profile-based climatology. *J. Geophys. Res*., **109**, C12003, doi:10.1029/ 2004JC002378.

Hosoda, S., T. Ohira, K. Sato, and T. Suga (2010): Improved description of global mixed-layer depth using Argo profiling floats, J. Oceanogr, 66, 2010,773-787.

Locarnini, R. A., A. Mishonov, Antonov, J. A., T. P. Boyer, and H. E. Garcia (2006): World Ocean Atlas 2005, Vol. 1: Temperature. Ed. S. Levitus. NOAA Atlas NESDIS 61, U.S. Government Printing Office, Wash, D.C.

Monterey, G. and S. Levitus (1997): *Seasonal Variability of Mixed Layer Depth for the World Ocean*. NOAA Atlas NESDIS 14, 100 pp.

Appendice

1. Header information of Netcdf

```
netcdf ml_20110401-20110430 {
dimensions:
        LONGITUDE = 360 ;
        LATITUDE = 180 ;
variables:
        float LONGITUDE(LONGITUDE) ;
                LONGITUDE:name = "LONGITUDE" ;
                LONGITUDE:units = "degrees_east" ;
        float LATITUDE(LATITUDE) ;
                LATITUDE:name = "LATITUDE" ;
                LATITUDE:units = "degrees_north" ;
        float MLD(LATITUDE, LONGITUDE) ;
                MLD:name = "MLD" ;
                MLD:long_name = "Mixed layer depth.(dbar)" ;
                MLD:_FillValue = 99999.f ;
                MLD:units = "decibar" ;
        float MLD_TEMP(LATITUDE, LONGITUDE) ;
                MLD_TEMP:name = "MLD_TEMP" ;
                MLD_TEMP:long_name = "Mixed layer Temperature.(ITS90)" ;
                MLD_TEMP:_FillValue = 99999.f ;
                MLD_TEMP:units = "degree_Celsius" ;
        float MLD_PSAL(LATITUDE, LONGITUDE) ;
                MLD_PSAL:name = "MLD_PSAL" ;
                MLD_PSAL:long_name = "Mixed layer Salinity.(PSS-78)" ;
                MLD_PSAL:_FillValue = 99999.f ;
                MLD_PSAL:units = "psu" ;
        float MLD_PDEN(LATITUDE, LONGITUDE) ;
                MLD_PDEN:name = "MLD_PDEN" ;
                MLD_PDEN:long_name = "Mixed layer Potential density." ;
                MLD_PDEN:_FillValue = 99999.f ;
                MLD_PDEN:units = "kg/m3" ;
        float OBS_NUM(LATITUDE, LONGITUDE) ;
                OBS_NUM:name = "OBS_NUM" ;
```

OBS_NUM:long_name = "Number of data points in each grid." ;

OBS_NUM:_FillValue = 99999.f ;

char DATE_GDAC_DOWNLOAD(STRING8) ;

DATE_GDAC_DOWNLOAD:name = "DATE_GDAC_DOWNLOAD" ;

DATE_GDAC_DOWNLOAD:long_name = "Date of GDAC data." ;

DATE_GDAC_DOWNLOAD:units = "YYYYMMDD(UTC)" ;

DATE_GDAC_DOWNLOAD:_FillValue = 99999.f ;

char DATE_UPDATE(STRING8) ;

DATE_UPDATE:name = "DATE_UPDATE" ;

DATE_UPDATE:long_name = "Date of MOAA." ;

DATE_UPDATE:units = "YYYYMMDD(UTC)" ;

DATE_UPDATE:_FillValue = 99999.f ;

char DATASET_TYPE(STRING4) ;

DATASET_TYPE:name = "DATASET_TYPE" ;

DATASET_TYPE:long_name = "Dataset type." ;

DATASET_TYPE:_FillValue = 99999.f ;

// global attributes:

:Conventions = "COARDS" ;

:Title = "Mixed layer properties Global ocean" ;

:Version = "Created Jun.07,2011 by JAMSTEC" ;

Table 1. Parameter names in NetCDF data set for each directory

Directory name / parameter name	mld (1) i-2)	mld2 (1) i-1)	0.2deltaT (1) ii-1)	0.5deltaT (1) ii-2)	0.03sigmaTheta (1) iii-1)	0.125sigmaTheta (1) iii-2)
LON	Longitude	Longitude	Longitude	Longitude	Longitude	Longitude
LAT	Latitude	Latitude	Latitude	Latitude	Latitude	Latitude
MLD	Mixed layer depth	Mixed layer depth	Isothermal layer thickness (TLD)	Isothermal layer thickness (TLD)	Isopycnal layer thickness (PLD)	Isopycnal layer thickness (PLD)
MLD_TEMP	Temperature in	Temperature in	Temperature in	Temperature in	Temperature in PLD	Temperature in PLD

	MLD	MLD	TLD	TLD		
MLD_PSAL	Salinity in MLD	Salinity in MLD	Salinity in TLD	Salinity in TLD	Salinity in PLD	Salinity in PLD
MLD_PDEN	Potential density in MLD	Potential density in MLD	Potential density in TLD	Potential density in TLD	Potential density in PLD	Potential density in PLD
OBS_NUM	Number of data in each grid	Number of data in each grid	Number of data in each grid	Number of data in each grid	Number of data in each grid	Number of data in each grid