

OMUFPITMET and OMVFPITMET README File

1. Overview

This document provides a summary of the OMUFPITMET and OMVFPITMET data products. These products supply meteorological (met) fields at OMI overpass positions from the Forward Processing for Instrument Teams (FP-IT) product produced by the Global Modeling and Assimilation Office (GMAO). FP-IT analysis products are produced in near real-time (NRT) by assimilating high quality observations available at the time into the Goddard Earth Observing System Model, Version 5 (GEOS-5). For the OMUFPITMET and OMVFPITMET products, the OMI Team has selected a subset of the FP-IT met fields. The subsets were selected for use in OMI retrieval algorithms as ancillary data, and for later data analysis. Separate products are provided for the OMI UV2 and VIS channels since they have slightly different geolocation. A corresponding product is not provided for the OMI UV1 channel.

2. Data

GEOS-5 FP-IT is a forward processing data assimilation system that produces analyses in near real time for use by NASA instruments teams. A fixed version of the GEOS-5 model (Lucchesi, 2013) is used to maintain consistent results for use in climate quality satellite retrievals. The spatial resolution of the GEOS-5 model in the FP-IT product is 0.5° latitude by 0.625° longitude on 72 vertical layers. The OMI instrument collects measurements in a swath of 60 across-track pixels dimensioned 13 km x 24 km at nadir with larger FOV observations off nadir. Figure 1 shows a comparison of the resolution of GEOS-5 FP-IT data grid cell centers compared to the center points of OMI measurements.

The co-located OMI/FP-IT product provides linearly interpolated data from FP-IT for the overpass time and locations of all usable pixels in the OMI swaths. The interpolated FP-IT data are processed only for orbits taken in OMI's global measurement mode. OMI zoom mode data were not processed. The products discussed here are reported on the native vertical resolution of the GEOS-5 model in the troposphere, while in the stratosphere the resolution has been degraded in these products by combining adjacent layers in sets of three to reduce the file size. The total number of vertical layers reported is 47. Table 1 lists of the variables from FP-IT interpolated to the OMI measurement locations.

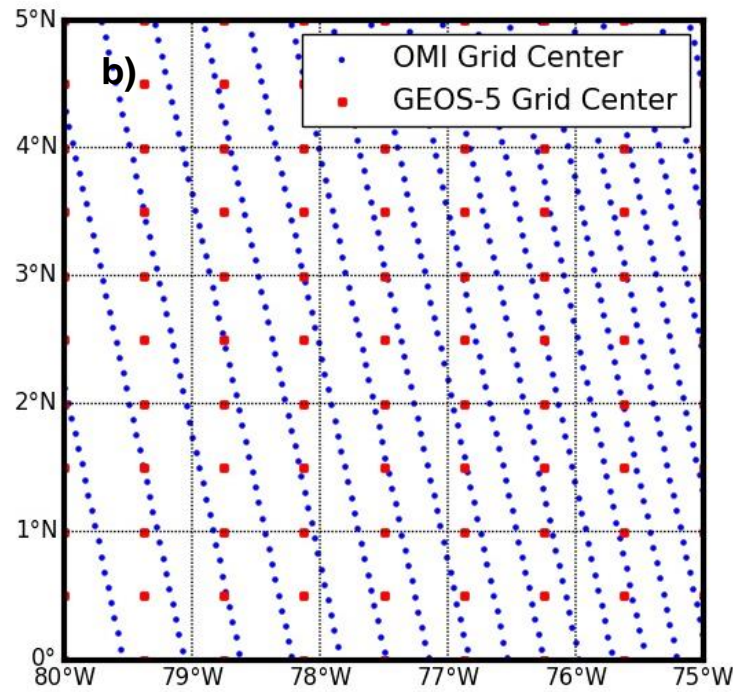
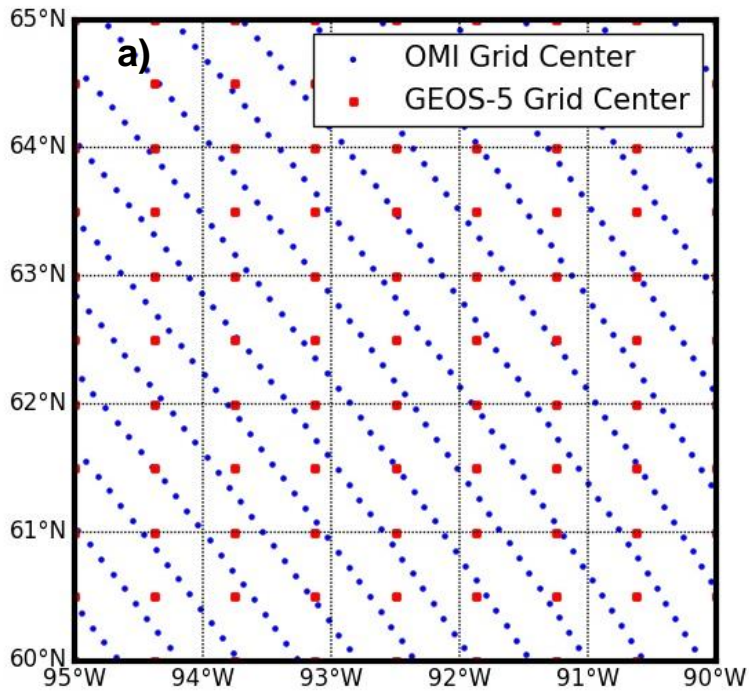


Figure 1. Comparison of the spacing of the FP-IT model grid center points with the FOV center points for OMI measurements. The FP-IT grid cells are lower spatial resolution (0.5° lat x 0.625° lon) than OMI FOVs (13×24 km at nadir). The spatial density of the OMI and FP-IT data varies differently with latitude. Examples shown here for (a) $60\text{--}65^\circ$ N and (b) $0\text{--}5^\circ$ N.

Variable Name	Description	Dimensions	Units
DELP	Layer Pressure Thickness	(nP, nX, nL)	Pa
lat	Latitude (deg. north)	(nX, nL)	deg North
lon	Longitude (deg. east)	(nX, nL)	deg East
PS	Surface Pressure	(nX, nL)	Pa
TROPPB	Blended Tropopause Pressure	(nX, nL)	Pa
PBLTOP	Pressure at PBL Top	(nX, nL)	Pa
T	Air Temperature	(nP, nX, nL)	K
time	Seconds Since 1993-01-01-00 UTC	(nX)	s
U	Eastward Wind Component	(nP, nX, nL)	m·s ⁻¹
V	Northward Wind Component	(nP, nX, nL)	m·s ⁻¹
U10M	Eastward 10-m Wind Component	(nX, nL)	m·s ⁻¹
V10M	Northward 10-m Wind Component	(nX, nL)	m·s ⁻¹
PHIS	Surface Potential	(nX, nL)	m ² ·s ⁻²

Table 1. List of FP-IT meteorological fields interpolated to the OMI grid in the OMUFPITMET and OMVFPITMET products. Abbreviations for the dimensions of the data fields are nP for vertical layers, nX for across-track, and nL for along track.

3. Calculating Pressure Levels

As discussed above, the GEOS-5 models natively provide vertically dimensioned data on 72 pressure layers, while OMUFPITMET and OMVFPITMET report the original GEOS-5 pressure levels in the troposphere and lower stratosphere, but at higher altitudes beginning at 7800 Pa the pressure levels are combined into coarser layers than reported in the original model runs, resulting in 47 pressure layers (48 levels). GEOS-5 products report a data field called DELP, which is layer pressure thickness of each layer, or the pressure difference between bottom and top of the layer. The top level in GEOS-5 vertical grid represents the top of the atmosphere and is defined at 1 Pa. To compute the pressure at the bottom of the top layer, the first DELP is added to the 1 Pa top level. Moving downward, subsequent DELP values are similarly added to get the bottom pressure level of each remaining layer. The following equation can be used to compute the bottom level pressure for any layer, using the corresponding DELP.

$$P(\text{bottom level}) = 1\text{Pa} + \sum_{l=1}^{\text{level}} \text{DEL}P(l)$$

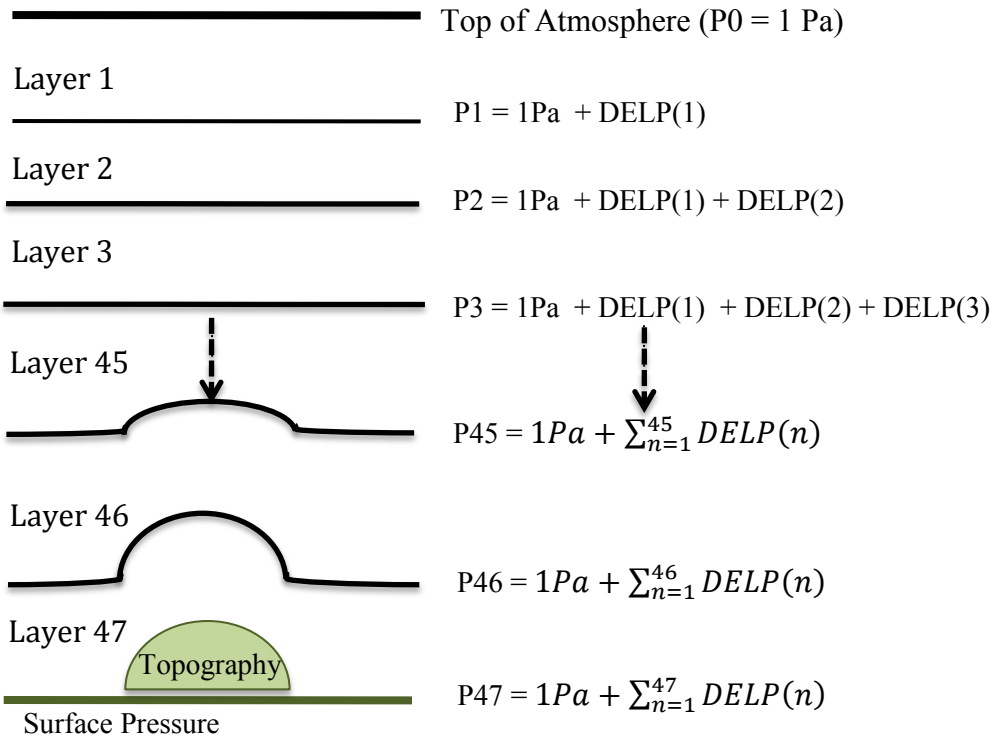


Figure 2. Diagram showing how pressure levels are calculated for vertical fields in OMUFPITMET and OMVFPITMET.

Note that the pressure level at the bottom of the atmosphere, of layer 47 will be very close to the reported surface pressure from the model, but it is not identical. The GEOS-5 model using a terrain following coordinate system, which means the vertical pressure grids do not intersect the surface (for further explanation please see https://gmao.gsfc.nasa.gov/reanalysis/MERRA/pressure_surface.php). The surface pressure field, P_s , should be used as the model surface pressure. In order to calculate the DEM altitude of the FP-IT model, divide the surface geopotential by the gravitational constant 9.8 m/s^2 .

$$\text{Altitude} = \text{PHIS} / 9.8 \text{ m/s}^2$$

4. Data Format

The data files are netCDF4/HDF5 compatible format as recommended by NASA for Earth Science data (<https://earthdata.nasa.gov/user-resources/standards-and-references/netcdf-4hdf5-file-format>). The files can be read with netCDF4 readers as well as any HDF5 reader because of the general interoperability of netCDF4 and HDF5 low level file formats. The following documentation provides information about software to read netCDF4/HDF5 files.

Fortran netCDF4:

<https://www.unidata.ucar.edu/software/netcdf/netcdf-4/newdocs/netcdf-f90.html>

Fortran HDF5:

<https://support.hdfgroup.org/HDF5/examples/f-src.html>

Python netCDF4:

<https://unidata.github.io/netcdf4-python/>

Python HDF5:

<http://docs.h5py.org/en/stable/>

GEOS-5 FP-IT products:

<https://gmao.gsfc.nasa.gov/>

5. Data Access

Data can be accessed at:

<https://disc.gsfc.nasa.gov/datasets?keywords=%22GEOS-5%20FP-IT%20OMI%22>

For questions please contact:

GES DISC Help Desk: gsfc-help-disc@lists.nasa.gov

To cite the data in publications:

Joanna Joiner (2018), "GEOS-5 FP-IT Assimilation Geo-located to OMI/Aura UV-2 1-Orbit L2 Support Swath 13x24km V3", NASA Goddard Space Flight Center, Goddard Earth Sciences Data and Information Services Center (GES DISC), Accessed: [Data Access Date], doi:10.5067/Aura/OMI/DATA2031

Joanna Joiner (2018), "GEOS-5 FP-IT Assimilation Geo-located to OMI/Aura VIS 1-Orbit L2 Support Swath 13x24km V3", NASA Goddard Space Flight Center, Goddard Earth Sciences Data and Information Services Center (GES DISC), Accessed: [Data Access Date], doi:10.5067/Aura/OMI/DATA2033

6. References

Bosilovich, M. G., R. Lucchesi, and M. Suarez, 2016: MERRA-2: File Specification. GMAO Office Note No. 9 (Version 1.1), 73 pp, available from http://gmao.gsfc.nasa.gov/pubs/office_notes.

Lucchesi, R., 2015: File Specification for GEOS-5 FP-IT. GMAO Office Note No. 2 (Version 1.4), 64 pp, available at <https://gmao.gsfc.nasa.gov/pubs/docs/Lucchesi865.pdf>

Appendix

Sample Fortran Reader Code:

```
PROGRAM reader
```

```
USE HDF5 ! This module contains all necessary modules
```

```
IMPLICIT NONE
```

```
CHARACTER(100), PARAMETER :: filename = "OMI-Aura_ANC-  
OMUFITMET_2006m0101t012754-o07788_v003-2018m1015t193030.nc4" ! File name  
CHARACTER(LEN=4), PARAMETER :: dsetname = "T" ! Dataset name
```

```
INTEGER(HID_T) :: file_id ! File identifier  
INTEGER(HID_T) :: dset_id ! Dataset identifier
```

```
INTEGER :: error ! Error flag  
INTEGER :: nXtrack = 60 ! Number of across track positions  
INTEGER :: nLine = 1644 ! Number of along track positions  
INTEGER :: nLayer = 47 ! Number of layers
```

```
REAL(KIND=8), ALLOCATABLE, DIMENSION(:,:,:) :: T ! Data buffers  
INTEGER(HSIZE_T), DIMENSION(3) :: data_dims
```

```
ALLOCATE(T(nLine,nXtrack,nLayer))
```

```
!Define data dimensions  
data_dims(1) = nLine  
data_dims(2) = nXtrack  
data_dims(3) = nLayer
```

```
! Open FORTRAN interface.  
CALL h5open_f(error)
```

```
!Opening HDF5 file  
CALL h5fopen_f(filename, H5F_ACC_RDONLY_F, file_id, error)
```

```
!Opening HDF5 dataset  
CALL h5dopen_f(file_id, dsetname, dset_id, error)
```

```
!Reading the dataset  
CALL h5dread_f(dset_id, H5T_NATIVE_DOUBLE, T, data_dims, error)
```

```
!Close the dataset  
CALL h5dclose_f(dset_id, error)
```

```
!Close the fi;e  
CALL h5fclose_f(file_id, error)
```

```
! Close FORTRAN interface.  
CALL h5close_f(error)
```

```
END PROGRAM reader
```