Global Modeling and Assimilation Office

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File Specification for GEOS FP

(Forward Processing)

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(Forward Processing)

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Approved by:

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REVISION HISTORY

<table>
<tr><th>Version</th><th>Revision Date</th><th>Extent of Changes</th></tr>
<tr><td>1.0</td><td>06/11/2013</td><td>Baseline</td></tr>
<tr><td>1.1</td><td>01/24/2017</td><td>This document update corresponds to the operational upgrade from GEOS-5.13 to GEOS-5.16.
Additional variables have been added to the inst3_3d_aer_Nv, inst3_3d_asm_Np, inst3_3d_asm_Nv, tavg1_2d_ocn_Nx, tavg3_2d_aer_Nx, and tavg3_2d_adg_Nx collections. In the variable table listings of this document, they are represented in italics.
Table of product sizes has been updated. Total daily volume for assimilated products has increased from 67GB/day to 78 GB/day.
Other minor corrections.</td></tr>
<tr><td>1.2</td><td>07/11/2018</td><td>This document update corresponds to the operational upgrade from GEOS-5.17 to GEOS-5.21.
Add tavg1_2d_mdt_Nx collection.
Change “GEOS-5 FP” to “GEOS FP”
Minor clarification of definition of instantaneous products.</td></tr>
</table>

Table of Contents

1. Introduction

The GEOS FP Atmospheric Data Assimilation System (GEOS ADAS) uses an analysis developed jointly with NOAA's National Centers for Environmental Prediction (NCEP), which allows the Global Modeling and Assimilation Office (GMAO) to take advantage of the developments at NCEP and the Joint Center for Satellite Data Assimilation (JCSDA). The GEOS AGCM uses the finite-volume dynamics (Lin, 2004) integrated with various physics packages (e.g, Bacmeister et al., 2006), under the Earth System Modeling Framework (ESMF) including the Catchment Land Surface Model (CLSM) (e.g., Koster et al., 2000). The GSI analysis is a three-dimensional variational (3DVar) analysis applied in grid-point space to facilitate the implementation of anisotropic, inhomogeneous covariances (e.g., Wu et al., 2002; Derber et al., 2003). The GSI implementation for GEOS FP incorporates a set of recursive filters that produce approximately Gaussian smoothing kernels and isotropic correlation functions.

The GEOS ADAS is documented in Rienecker et al. (2008). More recent updates to the model are presented in Molod et al. (2011). The GEOS system actively assimilates roughly 2×10^6 observations for each analysis, including about 7.5×10^5 AIRS radiance data. The input stream is roughly twice this volume, but because of the large volume, the data are thinned commensurate with the analysis grid to reduce the computational burden. Data are also rejected from the analysis through quality control procedures designed to detect, for example, the presence of cloud.

To minimize the spurious periodic perturbations of the analysis, GEOS FP uses the Incremental Analysis Update (IAU) technique developed by Bloom et al. (1996). More details of this procedure are given in Appendix A.

The assimilation is performed on a cubed-sphere grid at C720 resolution (12 km) and all output products are saved on a "normal" geographic latitude-longitude grid at a horizontal resolution of 0.3125-degree longitude by 0.25-degree latitude and at 72 vertical levels, extending to 0.01 hPa. The majority of data products are time-averaged, but six instantaneous products are also available. Hourly data intervals are used for two-dimensional products, while 3-hourly intervals are used for three-dimensional products. These may be on the model's native 72-layer vertical grid or at 42 pressure surfaces extending to 0.1 hPa.

This document describes the gridded output files produced by the GMAO near real-time operational FP, using the most recent version of the GEOS assimilation system. Additional details about variables listed in this file specification can be found in a separate document, the GEOS File Specification Variable Definition Glossary.

Documentation about the current access methods for products described in this document can be found on the GMAO products page: http://gmao.gsfc.nasa.gov/products/.

2. Format and File Organization

GEOS FP files are generated with the Network Common Data Form (NetCDF-4) library, which uses Hierarchical Data Format Version 5 (HDF-5) as the underlying format. NetCDF-4 is an open-source product of UCAR/Unidata (https://www.unidata.ucar.edu/software/netcdf/) and HDF-5 is developed by the HDF Group (http://www.hdfgroup.org/). One convenient method of reading GEOS files is to use the netCDF library, but the HDF-5 library can also be used directly.

Each GEOS file contains a collection of geophysical quantities that we will refer to as "fields" or "variables" as well as a set of coordinate variables that contain information about the grid coordinates. While the coordinate variables are COARDS and CF compliant, the metadata associated with the data variables may not strictly meet all CF requirements.

All products are compressed with a GRIB-like method that is invisible to the user. This method degrades the precision of the data, but every effort has been made to ensure that differences between the product and the original, uncompressed data are not scientifically meaningful. Once the precision has been degraded, the files are written using the standard gzip deflation available in NetCDF-4.

2.1 Dimensions

GMAO NetCDF-4 files contain dimension variables that can be identified and interpreted by the *units* and *positive* metadata attributes, as defined in the CF metadata conventions. The *units* attribute uses standard terminology to define specific coordinate variables, e.g., latitude, while the *positive* attribute defines whether a vertical coordinate increases or decreases from the surface to the top of the atmosphere. Some 3D products are defined on model layers rather than pressure coordinates and the units attribute is set to **layer.** This is allowed under the CF conventions to be backward compatible with the older COARDS conventions.

Table 2.1-1. Dimension Variables Contained in GMAO NetCDF-4 Files

Name	**Description**	**Type**	***units* attribute**	***positive* attribute (3D only)**
lon	longitude	double	degrees_east	n/a
Lat	latitude	double	degrees_north	n/a
lev (3D only)	pressure or layer index	double	hPa or layer	Down
time	minutes since reference date & time	int	Minutes	n/a
TAITIME*	Number of seconds since 1993-01-01 00 UTC, including leap	double	n/a	n/a

*- The "TAITIME" variable is included to maintain continuity with earlier GMAO products that used this ECS convention for time. Metadata attributes identify the contents, but a CF-compliant units attribute is NOT included. For CF-compliant time, use "time".

2.2 Variables

GMAO NetCDF-4 files are written using the NetCDF classic model. Arrays of scientific data are stored as variables of type **float** that contain various attributes such as *units*, *long_name*, *standard_name*, *_FillValue*, and others. Please note that we do not guarantee that the value in the *standard_name* attribute will conform to the CF metadata conventions. You can quickly list the variables as well as the complete structure of the file by using common utilities such as *ncdump* or *h5dump*. The utilities are distributed with the NetCDF and HDF distributions.

Table 2.2-1 Metadata attributes associated with each variable.

Name	Type	Description
_FillValue	float	Floating-point value used to identify missing data. Will normally be set to 1e15. Required by CF.
missing_value	float	Same as _FillValue. Included for backward compatibility.
valid_range	float32, array(2)	This attribute defines the valid range of the variable. The first element is the smallest valid value and the second element is the largest valid value. Required by CF, but this attribute is not
long_name	String	An ad hoc description of the variable as required by COARDS. It approximates the standard names as defined in an early version of CF conventions. (See References). The *Description* column from the tables of Section 6 is based on this name.
standard_name	String	Same as long_name.
Units	String	The units of the variable. Must be a string that can be recognized by UNIDATA's Udunits package.
scale_factor	float32	If variable is packed as 16-bit integers, this is the scale_factor for expanding to floating-point. Currently we do not plan to pack data, thus value will be 1.0
add_offset	float32	If variable is packed as 16-bit integers, this is the offset for expanding to floating-point. Currently, we do not plan to pack data, thus value will be 0.0.

2.3 Global Attributes

In addition to scientific variables and dimension scales, global metadata is also stored in GMAO

NetCDF-4 files. These metadata attributes are largely defined by the CF/COARDS conventions.

Table 2.3-1 Global metadata attributes associated with each variable.

Name	**Type**	**Description**
Conventions	character	Identification of the file convention used, currently “CF”
Title	character	Experiment identification.
History	character	Processing history.
Institution	character	“NASA Global Modeling and Assimilation Office”
Source	character	CVS tag of this release. CVS tags are used internally by the GMAO to designate versions of the svstem.
References	character	GMAO website address
Comment	character	Standard filename of this granule.

3. Instantaneous vs Time-averaged Products

Each file collection listed in Section 6 contains either instantaneous or time-averaged products, but not both.

Most instantaneous collections contain fields written every 3 hours, at *synoptic times* (00 UTC, 06 UTC, 12 UTC, and 18 UTC) and at *mid-synoptic times* (03 UTC, 09 UTC, 15 UTC, and 21 UTC). Instantaneous collections are discrete snapshots in time, valid at the date and time specified in the filename and in the metadata.

Time-averaged collections contain either hourly or three-hourly means, but not mixtures of the two. Each time-averaged collection consists of a continuous sequence of data averaged over the indicated interval and time-stamped with the central time of the interval. For hourly data, these times are 00:30 UTC, 01:30 UTC, 02:30 UTC, etc. Only products consisting exclusively of two-dimensional (horizontal) fields are produced hourly. Three-hourly time-averaged files contain averages over time intervals centered and time stamped at 01:30 UTC, 04:30 UTC, 07:30 UTC, and so on.

Each hourly and three-hourly collection is a series of files, one timestep per file, with the date and time as part of the filename.

4. Grid Structure

4.1 Horizontal Structure

Fields are produced at a resolution of 5/16 degree longitude by 1/4 degree latitude.

The GEOS FP global horizontal grid consists of **IMn=1152** points in the longitudinal direction and **JMn=721** points in the latitudinal direction. The horizontal native grid origin, associated with variables indexed (*i*=1*, j*=1) represents a grid point located at (180°W, 90°S). Latitude and longitude of grid points as a function of their indices (*i, j*) can be determined by:

$$\lambda_i = -180 + (\Delta\lambda)_n (i-1), \quad i = 1, \text{IMn}$$

$$\varphi_j = -90 + (\Delta\varphi)_n (j-1), \quad j = 1, \text{JMn}$$

Where $(\Delta\lambda)_n$=5/16° and $(\Delta\varphi)_n$ = 1/4°. For example, (*i* = 577, *j* = 361) corresponds to a grid point at ($\lambda = 0$, $\varphi = 0$).

4.2 Vertical Structure

Gridded products use four different vertical configurations: horizontal-only (can be vertical averages, single level, or surface values), pressure-level, model-level, or model-edge. Horizontal-only data for a given variable appear as 3-dimensional fields (x, y, time), while pressure-level, model-level, or model-edge data appear as 4-dimensional fields (x, y, z, time). In all cases the time dimension spans multiple files, as each file (granule) contains only one time. Pressure-level data is output on the **LMp=42** pressure levels shown in Appendix B. The model layers used for GEOS FP products are on a terrain-following hybrid sigma-p coordinate. Model-level data is output on the **LM=72** layers shown in the second table of Appendix B. The model-edge products contain fields with **LMe = LM + 1** levels representing the layer edges. The pressure at the model top is a fixed constant, **PTOP=0.01 hPa**. Pressures at model edges should be computed by summing the DELP starting at PTOP. A representative pressure for the layer can then be obtained from these. In the GEOS-4 *eta* files, one could compute the pressure on the edges by using the "ak" and "bk" values and the surface pressure. In GEOS, the full 3-dimensional pressure variables are explicitly provided through ($DELP_{ijl}$) and PTOP. Even though the model-level fields are on a hybrid sigma-p coordinate and their vertical location could be obtained from the "ak-bk" relationship, this may change in future GMAO systems. We thus recommend that users rely on the reported 3D pressure distribution, and not use ones computed from the "ak" and "bk".

Note that the indexing for the GEOS FP vertical coordinate system is top to bottom, i.e., layer 1 is the top layer of the atmosphere, while layer LM is adjacent to the earth's surface. The same is true for edge variables, with level 1 being the top of the model's atmosphere (PTOP), and level LM+1 being the surface.

5. File Naming Conventions

Each GEOS FP product file will have a complete file name identified in the metadata attribute *comment*. EOSDIS also requires abbreviated naming indices for each Earth Science Data Type (ESDT). Each GEOS FP file collection has a unique ESDT index. The ESDT index convention is described in section 5.2.

5.1 File Names

The standard generic complete name for the assimilated GEOS FP products will appear as follows:

GEOS.config.mode.collection.timestamp.file_ver.nc4

A brief description of the node fields appear below:

GEOS:
Identifies output as a data assimilation system product produced by GEOS.

config:
GEOS runs in multiple operational configurations, targeted at different user communities. This document is specific to a single configuration, fp.

fp – Operational forward-processing assimilation tailored for mission customers and other real-time users, nominally 12 hours behind real-time using a DAS version that is updated more frequently to include the latest advancements. The current horizontal resolution is 5/16 x 1/4 degree.

mode:
GEOS runs both assimilation and forecast jobs for operational forward-processing

asm - Assimilation. Uses a combination of atmospheric data analysis and model forecasting to generate a time-series of global atmospheric quantities.

fcst – Forecast. After atmospheric data assimilation has completed for a given synoptic time, typically at 00z and 12z, a model forecast is used to generate a time-series of forecast products some number of days into the future. Five or ten days is typical.

collection:
All GEOS FP data are organized into file *collections* that contain fields with common characteristics. These collections are used to make the data more accessible for specific purposes. Fields may appear in more than one collection. Collection names are of the form *freq_dims_group_HV*, where the four attributes are:

freq: time-independent (**const**), instantaneous (**inst***F***)**, or time-average (**tavg***F*), where *F* indicates the frequency or averaging interval and can be any of the following:

1 = Hourly
3 = 3-Hourly

dims: **2d** for collections with only 2-dimensional fields or **3d** for collections with a mix of 2- and 3-dimensional fields.

group: A three-letter mnemonic for the type of fields in the collection. It is a lowercase version of the group designation used in the ESDT name, as listed in the next section.

HV: Horizontal and Vertical grid.

H can be:

N: Nominal horizontal resolution on lat/lon grid. See config above.

V can be:

x: horizontal-only data (surface, single level, etc.); *dims* must be **2D**
p: pressure-level data (see Appendix B for levels); *dims* must be **3D**
v: model layer centers (see Appendix B); *dims* must be **3D**
e: model layer edges (see Appendix B); *dims* must be **3D**

timestamp:
This node defines the date and time associated with the data in the file. It has the form *yyyymmdd_hhmm* for assimilation files and *yyyymmdd_hh+yyyymmdd_hhmm* for forecast files.

yyyy - year string (e.g. , "2002")
mm - month string (e.g.., "09" for September)
dd - day of the month string
hh – hour (UTC)
mm - minute

The forecast files have two date nodes separated by a '+'. The first date/time node represents the assimilation cycle that initialized the forecast. The second date/time node represents the valid time for the forecasted data within the file. A forecast time-series will contain numerous files with the same initial node while the second node progresses through the time-span of the forecast (typically 5 or 10 days). For example, the following timestamp would represent a 30-hour GCM forecast from an initialization time of 2013-02-01 at 00z: 20130201_00+20130202_0600.

file_ver:
This denotes the file version in the form V##. Under normal conditions ## will be 01. In the event of a processing error that requires a re-processing, this number will be incremented to identify the new version of this file.

nc4:
All files are in NetCDF-4 format, thus the suffix ".nc4".

EXAMPLES
GEOS.fp.asm.tavg1_2d_slv_Nx.20131015_0430.V01.nc4

- fp: forward-processing

- asm: assimilation
- tavg1_2d_slv_Nx: time-averaged 1-hourly data, 2-dimensional, single-level parameters on the native resolution grid.
- 20131015_0430: valid time is 04:30 GMT, which represents the center point of a 1-hour time-averaging period from 04:00 GMT to 05:00 GMT.

GEOS.fp.fcst.inst3_3d_asm_Np.20131001_12+20131005_1500.V01.nc4

- fp – forward processing
- fcst – forecast product
- inst3_3d_asm_Np: instantaneous 3-hourly data, 3-dimensional, assimilation parameters on the native resolution grid.
- 20131001_12+20131005_1500: Forecast initialized at 2013-10-01 12 GMT. The valid time for the data in this file is 2013-10-05 15 GMT. This file represents a 99-hour forecast.

5.2 Earth Science Data Types (ESDT) Name

As required by the EOSDIS system, all GEOS FP products are identified by a relatively short ESDT name. While GEOS FP products are not currently distributed from the GES DISC, we have retained the ESDT designations for assimilation products. This name, also known as the ShortName, is a short handle for users to access and order data products. It takes the form:
DFPTFHVGGG
where

T: Time Description:
I = Instantaneous
T = Time-averaged
C = Time-independent

F: Frequency
0 = Time-independent
1 = Hourly
3 = 3-Hourly

H: Horizontal Resolution
N = Nominal

V: Vertical Location
X = Two-dimensional
P = Pressure
V = model layer center
E = model layer edge

GGG: Group

ASM = assimilated state variables (from the IAU corrector, see Appendix A)
TDT = tendencies of temperature
UDT = tendencies of eastward and northward wind components
QDT = tendencies of specific humidity
ODT = tendencies of ozone
LND = land surface variables
FLX = surface turbulent fluxes and related quantities
MST = moist processes
CLD = cloud-related quantities
RAD = radiation
TRB = turbulence
SLV = single level
INT = vertical integrals
CHM = chemistry forcing
AER = aerosol diagnostics
ADG = aerosol diagnostics (extended)
LSF = large-scale flux
OCN = ocean
LFO = land-surface forcing
NAV = navigation

6. Summary of GEOS FP file collections

The GEOS FP product is organized into the collections listed below. These are described in detail in the next sections. All data is on a regular latitude-longitude grid with a spacing of $1/4^{\circ}$ in latitude and $5/16^{\circ}$ in longitude. Horizontal arrays (1152,721) are ordered by longitude first, with the first point at the Dateline and the South Pole, with the inner index increasing eastward. All 3d collections, except the **inst3_3d_asm_Np**, are on the model's native, hybrid sigma-p vertical grid. See Appendix B for the nominal edge pressures at the top of each layer for a surface pressure of 1000 hPa. Data in the **inst3_3d_asm_Np** collection are interpolated to the 42 pressure levels defined in Appendix B.

Note that the sizes given are the cumulative sizes for all individual granules that comprise one day of assimilation for each collection. If a collection is produced in forecast mode, the size for the forecast will be the daily number multiplied by the number of days in the forecast, typically 5 or 10. Also note that the list of collections here is not comprehensive. GMAO may produce other special-use collections that are not documented here, but are distributed via the NCCS data portal. This is especially true of forecasts, for which certain collections may be added to support specific mission requirements.

Table 6-1 - List of standard assimilation collections. Collections with F in the 2^{nd} column are also produced in forecast mode.

Name		Description	Approx. Daily Size (MB)
const_2d_asm_Nx		Constant fields	
inst3_3d_asm_Nv	F	Basic assimilated fields from IAU corrector	6,900
inst3_3d_asm_Np	F	Basic assimilated fields from IAU corrector	3,800
inst3_2d_asm_Nx		Miscellaneous 2D assimilated fields from IAU corrector	200
tavg3_3d_asm_Nv	F	Basic assimilated fields from IAU corrector	6,100
tavg3_3d_cld_Nv		Upper-air cloud related diagnostics	2,400
tavg3_3d_mst_Nv		Upper-air diagnostics from moist processes	800
tavg3_3d_mst_Ne		Upper-air diagnostics from moist processes at layer edges	720
tavg3_3d_trb_Ne		Upper-air diagnostics from turbulence at layer edges	4,700
tavg3_3d_rad_Nv		Upper-air diagnostics from radiation	2,400
tavg3_3d_tdt_Nv		Upper-air temperature tendencies by process	6,100
tavg3_3d_udt_Nv		Upper-air wind tendencies by process	8,800
tavg3_3d_qdt_Nv		Upper-air humidity tendencies by process	4,300
tavg3_3d_odt_Nv		Upper-air ozone tendencies by process	3,600
tavg3_3d_lsf_Nv		Upper-air large-scale flux	1,600
tavg3_3d_lsf_Ne		Upper-air large-scale flux at layer edges	1,100
tavg1_2d_slv_Nx	F	Single-level atmospheric state variables	1,200
tavg1_2d_flx_Nx	F	Surface fluxes and related quantities	1,100

tavg1_2d_rad_Nx	F	Surface and TOA radiative fluxes	630
tavg1_2d_lnd_Nx	F	Land related surface quantities	780
tavg1_2d_lfo_Nx	F	2D time-averaged land surface forcings	240
inst1_2d_lfo_Nx	F	2D instantaneous land surface forcings	240
tavg1_2d_ocn_Nx		Ocean related surface quantities	790
tavg3_2d_aer_Nx		2D time-averaged aerosol diagnostics	680
tavg3_2d_adg_Nx		2D time-averaged aerosol diagnostics (extended)	940
tavg3_2d_chm_Nx		2D time-averaged chemistry diagnostics	50
inst3_3d_aer_Nv		3D instantaneous aerosol diagnostics	16,000
inst3_3d_chm_Nv		3D instantaneous chemistry diagnostics	1,500
tavg3_3d_nav_Ne		3D time-averaged navigation files (layer edges)	500
tavg3_3d_nav_Nv		3D time-averaged navigation files	500
tavg1_2d_mdt_Nx		2D time-averaged mass tendencies	108

Estimated total 78 GB

Time-independent Variables

These are prescribed 2-dimensional fields that do not vary during the analysis. This collection is available as **GEOS.fp.asm.const_2d_asm_Nx.00000000_0000.V01.nc4**.

const_2d_asm_Nx: constant fields

Frequency: *t-hourly from 03:00 UTC (unknown)*

Spatial Grid: *2D, single-level, full horizontal resolution*

Dimensions: *longitude=1152, latitude=721, time=1*

Granule Size: *~26 MB*

Name	*Dim*	*Description*	*Units*
AREA	tyx	agrid cell area	m+2
FRLAKE	tyx	fraction of lake	1
FRLAND	tyx	fraction of land	1
FRLANDICE	tyx	fraction of land ice	1
FROCEAN	tyx	fraction of ocean	1
PHIS	tyx	surface geopotential height	m+2 s-2
SGH	tyx	isotropic stdv of GWD topography	m

Time-dependent State Variables and Diagnostics

These histories are produced from the GCM during the last pass of the forward model during the analysis cycle. For the 3D-Var scheme currently used in FP, they are from the "corrector" segment of the IAU cycle.

inst1_2d_lfo_Nx: 2d time-averaged land surface forcing

Frequency: *1-hourly from 00:00 UTC (instantaneous)*

Spatial Grid: *2D, single-level, full horizontal resolution*

Dimensions: *longitude=1152, latitude=721, time=1*

Granule Size: *~13 MB*

Name	*Dim*	*Description*	*Units*
HLML	tyx	surface layer height	m
PS	tyx	surface pressure	Pa
QLML	tyx	surface specific humidity	1
SPEEDLML	tyx	surface wind speed	m s-1
TLML	tyx	surface air temperature	K

inst3_2d_asm_Nx: 2d assimilated state

Frequency: *3-hourly from 00:00 UTC (instantaneous)*
Spatial Grid: *2D, single-level, full horizontal resolution*
Dimensions: *longitude=1152, latitude=721, time=1*
Granule Size: *~36 MB*

Name	*Dim*	*Description*	*Units*
DISPH	tyx	zero plane displacement height	m
HOURNORAIN	tyx	time-during an hour with no precipitation	s
PS	tyx	surface pressure	Pa
QV10M	tyx	10-meter specific humidity	kg kg-1
QV2M	tyx	2-meter specific humidity	kg kg-1
SLP	tyx	sea level pressure	Pa
T10M	tyx	10-meter air temperature	K
T2M	tyx	2-meter air temperature	K
T2MMAX	tyx	2-meter air temperature	K
T2MMIN	tyx	2-meter air temperature	K
TO3	tyx	total column ozone	Dobsons
TOX	tyx	total column odd oxygen	kg m-2

TPRECMAX	tyx	total precipitation	kg m-2 s-1
TQI	tyx	total precipitable ice water	kg m-2
TQL	tyx	total precipitable liquid water	kg m-2
TQV	tyx	total precipitable water vapor	kg m-2
TROPPB	tyx	tropopause pressure based on blended estimate	Pa
TROPPT	tyx	tropopause pressure based on thermal estimate	Pa
TROPPV	tyx	tropopause pressure based on EPV estimate	Pa
TROPQ	tyx	tropopause specific humidity using blended TROPP estimate	kg kg-1
TROPT	tyx	tropopause temperature using blended TROPP estimate	K
TS	tyx	surface skin temperature	K
U10M	tyx	10-meter eastward wind	m s-1
U2M	tyx	2-meter eastward wind	m s-1
U50M	tyx	50-meter eastward wind	m s-1
V10M	tyx	10-meter northward wind	m s-1
V2M	tyx	2-meter northward wind	m s-1
V50M	tyx	50-meter northward wind	m s-1

inst3_3d_aer_Nv: 3d instantaneous aerosol diagnostics

Frequency: *3-hourly from 00:00 UTC (instantaneous)*
Spatial Grid: *3D, model-level, full horizontal resolution*
Dimensions: *longitude=1152, latitude=721, level=72, time=1*
Granule Size: *~2.5 GB*

Name	*Dim*	*Description*	*Units*
AIRDENS	tzyx	moist air density	kg m-3
BCPHILIC	tzyx	Hydrophilic Black Carbon	kg kg-1

BCPHOBIC	tzyx	Hydrophobic Black Carbon	kg kg-1
DELP	tzyx	pressure thickness	Pa
DMS	tzyx	Dimethylsulphide	kg kg-1
DU001	tzyx	Dust Mixing Ratio (bin 001)	kg kg-1
DU002	tzyx	Dust Mixing Ratio (bin 002)	kg kg-1
DU003	tzyx	Dust Mixing Ratio (bin 003)	kg kg-1
DU004	tzyx	Dust Mixing Ratio (bin 004)	kg kg-1
DU005	tzyx	Dust Mixing Ratio (bin 005)	kg kg-1
LWI	tyx	land(1) water(0) ice(2) flag	1
MSA	tzyx	Methanesulphonic acid	kg kg-1
NH3	tzyx	Ammonia (NH3, gas phase)	kg kg-1
NH4A	tzyx	Ammonium ion (NH4+, aerosol phase)	kg kg-1
NO3AN1	tzyx	Nitrate size bin 001	kg kg-1
NO3AN2	tzyx	Nitrate size bin 002	kg kg-1
NO3AN3	tzyx	Nitrate size bin 003	kg kg-1
OCPHILIC	tzyx	Hydrophilic Organic Carbon (Particulate Matter)	kg kg-1
OCPHOBIC	tzyx	Hydrophobic Organic Carbon (Particulate Matter)	kg kg-1
PS	tyx	surface pressure	Pa
RH	tzyx	relative humidity after moist	1
SO2	tzyx	Sulphur dioxide	kg kg-1
SO4	tzyx	Sulphate aerosol	kg kg-1
SS001	tzyx	Sea Salt Mixing Ratio (bin 001)	kg kg-1
SS002	tzyx	Sea Salt Mixing Ratio (bin 002)	kg kg-1
SS003	tzyx	Sea Salt Mixing Ratio (bin 003)	kg kg-1
SS004	tzyx	Sea Salt Mixing Ratio (bin 004)	kg kg-1
SS005	tzyx	Sea Salt Mixing Ratio (bin 005)	kg kg-1

inst3_3d_asm_Np: 3d assimilated state on pressure levels

Frequency: *3-hourly from 00:00 UTC (instantaneous)*
Spatial Grid: *3D, pressure-level, full horizontal resolution*
Dimensions: *longitude=1152, latitude=721, level=42, time=1*
Granule Size: *~558 MB*

Name	*Dim*	*Description*	*Units*
EPV	tzyx	ertels potential vorticity	K m+2 kg-1 s-1
H	tzyx	edge heights	m
O3	tzyx	ozone mass mixing ratio	kg kg-1
OMEGA	tzyx	vertical pressure velocity	Pa s-1
PHIS	tyx	surface geopotential height	m+2 s-2
PS	tyx	surface pressure	Pa
QI	tzyx	mass fraction of cloud ice water	kg kg-1
QL	tzyx	mass fraction of cloud liquid water	kg kg-1
QR	tzyx	mass fraction of falling rain	kg kg-1
QS	tzyx	mass fraction of falling snow	kg kg-1
QV	tzyx	specific humidity	kg kg-1
RH	tzyx	relative humidity after moist	1
SLP	tyx	sea level pressure	Pa
T	tzyx	air temperature	K
U	tzyx	eastward wind	m s-1
V	tzyx	northward wind	m s-1

inst3_3d_asm_Nv: 3d assimilated state on native levels

Frequency: *3-hourly from 00:00 UTC (instantaneous)*
Spatial Grid: *3D, model-level, full horizontal resolution*

Dimensions: *longitude=1152, latitude=721, level=72, time=1*

Granule Size: *~1.1 GB*

Name	*Dim*	*Description*	*Units*
CLOUD	tzyx	cloud fraction for radiation	1
DELP	tzyx	pressure thickness	Pa
EPV	tzyx	ertels potential vorticity	K m+2 kg-1 s-1
H	tzyx	mid layer heights	m
O3	tzyx	ozone mass mixing ratio	kg kg-1
OMEGA	tzyx	vertical pressure velocity	Pa s-1
PHIS	tyx	surface geopotential height	m+2 s-2
PL	tzyx	mid level pressure	Pa
PS	tyx	surface pressure	Pa
QI	tzyx	mass fraction of cloud ice water	kg kg-1
QL	tzyx	mass fraction of cloud liquid water	kg kg-1
QR	tzyx	mass fraction of falling rain	kg kg-1
QS	tzyx	mass fraction of falling snow	kg kg-1
QV	tzyx	specific humidity	kg kg-1
RH	tzyx	relative humidity after moist	1
SLP	tyx	sea level pressure	Pa
T	tzyx	air temperature	K
U	tzyx	eastward wind	m s-1
V	tzyx	northward wind	m s-1

inst3_3d_chm_Nv: 3d instantaneous chemistry diagnostic

Frequency: *3-hourly from 00:00 UTC (instantaneous)*

Spatial Grid: *3D, model-level, full horizontal resolution*

Dimensions: *longitude=1152, latitude=721, level=72, time=1*

Granule Size: *~276 MB*

Name	*Dim*	*Description*	*Units*
AIRDENS	tzyx	moist air density	kg m-3
CO	tzyx	Carbon Monoxide (All Sources)	mol mol-1
CO2	tzyx	Carbon Dioxide (All Sources)	mol mol-1
DELP	tzyx	pressure thickness	Pa
PS	tyx	surface pressure	Pa

tavg1_2d_flx_Nx: 2d time-averaged surface flux diagnostics

Frequency: *1-hourly from 00:30 UTC (time-averaged)*
Spatial Grid: *2D, single-level, full horizontal resolution*
Dimensions: *longitude=1152, latitude=721, time=1*
Granule Size: *~53 MB*

Name	*Dim*	*Description*	*Units*
BSTAR	tyx	surface buoyancy scale	m s-2
CDH	tyx	surface exchange coefficient for heat	kg m-2 s-1
CDM	tyx	surface exchange coefficient for momentum	kg m-2 s-1
CDQ	tyx	surface exchange coefficient for moisture	kg m-2 s-1
CN	tyx	surface neutral drag coefficient	1
DISPH	tyx	zero plane displacement height	m
EFLUX	tyx	total latent energy flux	W m-2
EVAP	tyx	evaporation from turbulence	kg m-2 s-1
FRCAN	tyx	areal fraction of anvil showers	1
FRCCN	tyx	areal fraction of convective showers	1
FRCLS	tyx	areal fraction of nonanvil large scale showers	1
FRSEAICE	tyx	ice covered fraction of tile	1
HFLUX	tyx	sensible heat flux from turbulence	W m-2
HLML	tyx	surface layer height	m
NIRDF	tyx	surface downwelling nearinfrared diffuse flux	W m-2
NIRDR	tyx	surface downwelling nearinfrared beam flux	W m-2
PBLH	tyx	planetary boundary layer height	m
PGENTOT	tyx	Total column production of precipitation	kg m-2 s-1
PRECANV	tyx	anvil precipitation	kg m-2 s-1
PRECCON	tyx	convective precipitation	kg m-2 s-1
PRECLSC	tyx	nonanvil large scale precipitation	kg m-2 s-1
PRECSNO	tyx	snowfall	kg m-2 s-1

PRECTOT	tyx	total precipitation	kg m-2 s-1
PREVTOT	tyx	Total column re-evap/subl of precipitation	kg m-2 s-1
QLML	tyx	surface specific humidity	1
QSH	tyx	effective surface specific humidity	kg kg-1
QSTAR	tyx	surface moisture scale	kg kg-1
RHOA	tyx	air density at surface	kg m-3
RISFC	tyx	surface bulk richardson number	1
SPEED	tyx	surface ventilation velocity	m s-1
TAUGWX	tyx	surface eastward gravity wave stress	N m-2
TAUGWY	tyx	surface northward gravity wave stress	N m-2
TAUX	tyx	eastward surface stress	N m-2
TAUY	tyx	northward surface stress	N m-2
TLML	tyx	surface air temperature	K
TSH	tyx	effective surface skin temperature	K
TSTAR	tyx	surface temperature scale	K
ULML	tyx	surface eastward wind	m s-1
USTAR	tyx	surface velocity scale	m s-1
VLML	tyx	surface northward wind	m s-1
Z0H	tyx	surface roughness for heat	m
Z0M	tyx	surface roughness	m

tavg1_2d_lfo_Nx: 2d instantaneous land surface forcing

Frequency: *1-hourly from 00:30 UTC (time-averaged)*
Spatial Grid: *2D, single-level, full horizontal resolution*
Dimensions: *longitude=1152, latitude=721, time=1*
Granule Size: *~11 MB*

Name	*Dim*	*Description*	*Units*

LWGAB	tyx	surface absorbed longwave radiation	W m-2
PARDF	tyx	surface downwelling par diffuse flux	W m-2
PARDR	tyx	surface downwelling par beam flux	W m-2
PRECCU	tyx	liquid water convective precipitation	kg m-2 s-1
PRECLS	tyx	liquid water large scale precipitation	kg m-2 s-1
PRECSNO	tyx	snowfall	kg m-2 s-1
SWGDN	tyx	surface incoming shortwave flux	W m-2
SWLAND	tyx	Net shortwave land	W m-2

tavg1_2d_lnd_Nx: 2d time-averaged land surface diagnostics

Frequency: *1-hourly from 00:30 UTC (time-averaged)*
Spatial Grid: *2D, single-level, full horizontal resolution*
Dimensions: *longitude=1152, latitude=721, time=1*
Granule Size: *~32 MB*

Name	*Dim*	*Description*	*Units*
BASEFLOW	tyx	baseflow flux	kg m-2 s-1
ECHANGE	tyx	rate of change of total land energy	W m-2
EVLAND	tyx	Evaporation land	kg m-2 s-1
EVPINTR	tyx	interception loss energy flux	W m-2
EVPSBLN	tyx	snow ice evaporation energy flux	W m-2
EVPSOIL	tyx	baresoil evap energy flux	W m-2
EVPTRNS	tyx	transpiration energy flux	W m-2
FRSAT	tyx	fractional area of saturated zone	1
FRSNO	tyx	fractional area of land snowcover	1
FRUNST	tyx	fractional area of unsaturated zone	1
FRWLT	tyx	fractional area of wilting zone	1
GHLAND	tyx	Ground heating land	W m-2

GRN	tyx	greenness fraction	1
GWETPROF	tyx	ave prof soil moisture	1
GWETROOT	tyx	root zone soil wetness	1
GWETTOP	tyx	surface soil wetness	1
LAI	tyx	leaf area index	1
LHLAND	tyx	Latent heat flux land	W m-2
LWLAND	tyx	Net longwave land	W m-2
PARDF	tyx	surface downwelling par diffuse flux	W m-2
PARDR	tyx	surface downwelling par beam flux	W m-2
PRECSNO	tyx	snowfall	kg m-2 s-1
PRECTOT	tyx	total precipitation	kg m-2 s-1
PRMC	tyx	water profile	m+3 m-3
QINFIL	tyx	Soil water infiltration rate	kg m-2 s-1
RUNOFF	tyx	overland runoff including throughflow	kg m-2 s-1
RZMC	tyx	water root zone	m+3 m-3
SFMC	tyx	water surface layer	m+3 m-3
SHLAND	tyx	Sensible heat flux land	W m-2
SMLAND	tyx	Snowmelt flux land	kg m-2 s-1
SNODP	tyx	snow depth	m
SNOMAS	tyx	Total snow storage land	kg m-2
SPLAND	tyx	rate of spurious land energy source	W m-2
SPSNOW	tyx	rate of spurious snow energy	W m-2
SPWATR	tyx	rate of spurious land water source	kg m-2 s-1
SWLAND	tyx	Net shortwave land	W m-2
TELAND	tyx	Total energy storage land	J m-2
TPSNOW	tyx	surface temperature of snow	K
TSAT	tyx	surface temperature of saturated zone	K
TSOIL1	tyx	soil temperatures layer 1	K

TSOIL2	tyx	soil temperatures layer 2	K
TSOIL3	tyx	soil temperatures layer 3	K
TSOIL4	tyx	soil temperatures layer 4	K
TSOIL5	tyx	soil temperatures layer 5	K
TSOIL6	tyx	soil temperatures layer 6	K
TSURF	tyx	surface temperature of land incl snow	K
TUNST	tyx	surface temperature of unsaturated zone	K
TWLAND	tyx	Avail water storage land	kg m-2
TWLT	tyx	surface temperature of wilted zone	K
WCHANGE	tyx	rate of change of total land water	kg m-2 s-1

tavg1_2d_mdt_Nx: 2d time-averaged mass tendencies

Frequency: *1-hourly from 00:30 UTC (time-averaged)*
Spatial Grid: *2D, single-level, full horizontal resolution*
Dimensions: *longitude=1152, latitude=721, time=1*
Granule Size: *~4.5 MB*

Name	*Dim*	*Description*	*Units*
DMDTANA	tyx	vertically integrated mass tendency due to analysis	kg m-2 s-1
DMDTDYN	tyx	vertically integrated mass tendency due to dynamics	kg m-2 s-1
DMDTPHY	tyx	vertically integrated mass tendency due to physics	kg m-2 s-1

tavg1_2d_ocn_Nx: 2d time-averaged ocean related variables

Frequency: *1-hourly from 00:30 UTC (time-averaged)*
Spatial Grid: *2D, single-level, full horizontal resolution*
Dimensions: *longitude=1152, latitude=721, time=1*

Granule Size: *~36 MB*

Name	*Dim*	*Description*	*Units*
BCOOL	tyx	buoyancy generation in cool layer	m+2 s-3
COSZ	tyx	cosine of the solar zenith angle	1
DCOOL	tyx	depth of cool layer	m
DELTS	tyx	change of surface skin temperature	K
DTSDT_ANA	tyx	total skin temperature tendency	K s-1
DWARM	tyx	depth at base of warm layer	m
EFLUXICE	tyx	sea ice latent energy flux	W m-2
EFLUXWTR	tyx	open water latent energy flux	W m-2
EVAPOUT	tyx	evaporation	kg m-2 s-1
FRLAKE	tyx	fraction of lake	1
FRLAND	tyx	fraction of land	1
FRLANDICE	tyx	fraction of land ice	1
FROCEAN	tyx	fraction of ocean	1
FRSEAICE	tyx	ice covered fraction of tile	1
HFLUXICE	tyx	sea ice upward sensible heat flux	W m-2
HFLUXWTR	tyx	open water upward sensible heat flux	W m-2
LANGM	tyx	Langmuir number	1
LCOOL	tyx	Saunders parameter	1
LWGNTICE	tyx	sea ice net downward longwave flux	W m-2
LWGNTWTR	tyx	open water net downward longwave flux	W m-2
PHIW	tyx	Similarity function in warm layer	1
PRECSNOOCN	tyx	ocean snowfall	kg m-2 s-1
QCOOL	tyx	net cooling in cool layer	W m-2
QV10M	tyx	10-meter specific humidity	kg kg-1

QWARM	tyx	net heating in warm layer	W m-2
RAINOCN	tyx	ocean rainfall	kg m-2 s-1
SWCOOL	tyx	solar heating in cool layer	W m-2
SWGNTICE	tyx	sea ice net downward shortwave flux	W m-2
SWGNTWTR	tyx	open water net downward shortwave flux	W m-2
SWWARM	tyx	solar heating in warm layer	W m-2
T10M	tyx	10-meter air temperature	K
TAUTW	tyx	relaxation time of TW to TS FOUND	s
TAUXICE	tyx	eastward stress over ice	N m-2
TAUXWTR	tyx	eastward stress over water	N m-2
TAUYICE	tyx	northward stress over ice	N m-2
TAUYWTR	tyx	northward stress over water	N m-2
TBAR	tyx	mean temperature of interface layer	K
TDEL	tyx	temperature at base of cool layer	K
TDROP	tyx	temperature drop across cool layer	K
TSKINICE	tyx	sea ice skin temperature	K
TSKINWTR	tyx	open water skin temperature	K
TS_FOUND	tyx	foundation temperature for interface layer	K
U10M	tyx	10-meter eastward wind	m s-1
USTARW	tyx	ustar over water layer	m s-1
V10M	tyx	10-meter northward wind	m s-1
ZETA_W	tyx	Stability parameter in Warm Layer	1

tavg1_2d_rad_Nx: 2d time-averaged radiation diagnostics

Frequency: *1-hourly from 00:30 UTC (time-averaged)*

Spatial Grid: *2D, single-level, full horizontal resolution*

Dimensions: *longitude=1152, latitude=721, time=1*

Granule Size: *~32 MB*

Name	Dim	Description	Units
ALBEDO	tyx	surface albedo	1
ALBNIRDF	tyx	surface albedo for near infrared diffuse	1
ALBNIRDR	tyx	surface albedo for near infrared beam	1
ALBVISDF	tyx	surface albedo for visible diffuse	1
ALBVISDR	tyx	surface albedo for visible beam	1
CLDHGH	tyx	cloud area fraction for high clouds	1
CLDLOW	tyx	cloud area fraction for low clouds	1
CLDMID	tyx	cloud area fraction for middle clouds	1
CLDTOT	tyx	total cloud area fraction	1
EMIS	tyx	surface emissivity	1
LWGAB	tyx	surface absorbed longwave radiation	W m-2
LWGABCLR	tyx	surface absorbed longwave radiation assuming clear sky	W m-2
LWGABCLRCLN	tyx	surface absorbed longwave radiation assuming clear sky and no aerosol	W m-2
LWGEM	tyx	longwave flux emitted from surface	W m-2
LWGNT	tyx	surface net downward longwave flux	W m-2
LWGNTCLR	tyx	surface net downward longwave flux assuming clear sky	W m-2
LWGNTCLRCLN	tyx	surface net downward longwave flux assuming clear sky and no aerosol	W m-2
LWTUP	tyx	upwelling longwave flux at toa	W m-2
LWTUPCLR	tyx	upwelling longwave flux at toa assuming clear sky	W m-2
LWTUPCLRCLN	tyx	upwelling longwave flux at toa assuming clear sky and no aerosol	W m-2
SWGDN	tyx	surface incoming shortwave flux	W m-2
SWGDNCLR	tyx	surface incoming shortwave flux assuming clear sky	W m-2

SWGNT	tyx	surface net downward shortwave flux	W m-2
SWGNTCLN	tyx	surface net downward shortwave flux assuming no aerosol	W m-2
SWGNTCLR	tyx	surface net downward shortwave flux assuming clear sky	W m-2
SWGNTCLRCLN	tyx	surface net downward shortwave flux assuming clear sky and no aerosol	W m-2
SWTDN	tyx	toa incoming shortwave flux	W m-2
SWTNT	tyx	toa net downward shortwave flux	W m-2
SWTNTCLN	tyx	toa net downward shortwave flux assuming no aerosol	W m-2
SWTNTCLR	tyx	toa net downward shortwave flux assuming clear sky	W m-2
SWTNTCLRCLN	tyx	toa net downward shortwave flux assuming clear sky and no aerosol	W m-2
TAUHGH	tyx	in cloud optical thickness of high clouds(EXPORT)	1
TAULOW	tyx	in cloud optical thickness of low clouds	1
TAUMID	tyx	in cloud optical thickness of middle clouds	1
TAUTOT	tyx	in cloud optical thickness of all clouds	1
TS	tyx	surface skin temperature	K

tavg1_2d_slv_Nx: 2d time-averaged single level diagnostics

Frequency: *1-hourly from 00:30 UTC (time-averaged)*
Spatial Grid: *2D, single-level, full horizontal resolution*
Dimensions: *longitude=1152, latitude=721, time=1*
Granule Size: *~60 MB*

Name	*Dim*	*Description*	*Units*
CLDPRS	tyx	cloud top pressure	Pa

CLDTMP	tyx	cloud top temperature	K
DISPH	tyx	zero plane displacement height	m
H1000	tyx	height at 1000 mb	m
H250	tyx	height at 250 hPa	m
H500	tyx	height at 500 hPa	m
H850	tyx	height at 850 hPa	m
OMEGA500	tyx	omega at 500 hPa	Pa s-1
PBLTOP	tyx	pbltop pressure	Pa
PS	tyx	surface pressure	Pa
Q250	tyx	specific humidity at 250 hPa	kg kg-1
Q500	tyx	specific humidity at 500 hPa	kg kg-1
Q850	tyx	specific humidity at 850 hPa	kg kg-1
QV10M	tyx	10-meter specific humidity	kg kg-1
QV2M	tyx	2-meter specific humidity	kg kg-1
SLP	tyx	sea level pressure	Pa
T10M	tyx	10-meter air temperature	K
T250	tyx	air temperature at 250 hPa	K
T2M	tyx	2-meter air temperature	K
T500	tyx	air temperature at 500 hPa	K
T850	tyx	air temperature at 850 hPa	K
TO3	tyx	total column ozone	Dobsons
TOX	tyx	total column odd oxygen	kg m-2
TQI	tyx	total precipitable ice water	kg m-2
TQL	tyx	total precipitable liquid water	kg m-2
TQV	tyx	total precipitable water vapor	kg m-2
TROPPB	tyx	tropopause pressure based on blended estimate	Pa
TROPPT	tyx	tropopause pressure based on thermal estimate	Pa
TROPPV	tyx	tropopause pressure based on EPV estimate	Pa

TROPQ	tyx	tropopause specific humidity using blended TROPP estimate	kg kg-1
TROPT	tyx	tropopause temperature using blended TROPP estimate	K
TS	tyx	surface skin temperature	K
U10M	tyx	10-meter eastward wind	m s-1
U250	tyx	eastward wind at 250 hPa	m s-1
U2M	tyx	2-meter eastward wind	m s-1
U500	tyx	eastward wind at 500 hPa	m s-1
U50M	tyx	eastward wind at 50 meters	m s-1
U850	tyx	eastward wind at 850 hPa	m s-1
V10M	tyx	10-meter northward wind	m s-1
V250	tyx	northward wind at 250 hPa	m s-1
V2M	tyx	2-meter northward wind	m s-1
V500	tyx	northward wind at 500 hPa	m s-1
V50M	tyx	northward wind at 50 meters	m s-1
V850	tyx	northward wind at 850 hPa	m s-1

tavg3_2d_adg_Nx: 2d time-averaged extended aerosol diagnostics

Frequency: *3-hourly from 01:30 UTC (time-averaged)*
Spatial Grid: *2D, single-level, full horizontal resolution*
Dimensions: *longitude=1152, latitude=721, time=1*
Granule Size: *~140 MB*

Name	*Dim*	*Description*	*Units*
BCDP001	tyx	Black Carbon Dry Deposition Bin 001	kg m-2 s-1
BCDP002	tyx	Black Carbon Dry Deposition Bin 002	kg m-2 s-1
BCEM001	tyx	Black Carbon Emission Bin 001	kg m-2 s-1

BCEM002	tyx	Black Carbon Emission Bin 002	kg m-2 s-1
BCEMAN	tyx	Black Carbon Anthropogenic Emissions	kg m-2 s-1
BCEMBB	tyx	Black Carbon Biomass Burning Emissions	kg m-2 s-1
BCEMBF	tyx	Black Carbon Biofuel Emissions	kg m-2 s-1
BCHYPHIL	tyx	Black Carbon Hydrophobic to Hydrophilic	kg m-2 s-1
BCSV	tyx	black carbon tendency due to conv scav	kg m-2 s-1
BCWT001	tyx	Black Carbon Wet Deposition Bin 001	kg m-2 s-1
BCWT002	tyx	Black Carbon Wet Deposition Bin 002	kg m-2 s-1
DUAERIDX	tyx	Dust TOMS UV Aerosol Index	1
DUDP001	tyx	Dust Dry Deposition Bin 001	kg m-2 s-1
DUDP002	tyx	Dust Dry Deposition Bin 002	kg m-2 s-1
DUDP003	tyx	Dust Dry Deposition Bin 003	kg m-2 s-1
DUDP004	tyx	Dust Dry Deposition Bin 004	kg m-2 s-1
DUDP005	tyx	Dust Dry Deposition Bin 005	kg m-2 s-1
DUEM001	tyx	Dust Emission Bin 001	kg m-2 s-1
DUEM002	tyx	Dust Emission Bin 002	kg m-2 s-1
DUEM003	tyx	Dust Emission Bin 003	kg m-2 s-1
DUEM004	tyx	Dust Emission Bin 004	kg m-2 s-1
DUEM005	tyx	Dust Emission Bin 005	kg m-2 s-1
DUEXTTFM	tyx	Dust Extinction AOT [550 nm] - PM 1.0 um	1
DUSCATFM	tyx	Dust Scattering AOT [550 nm] - PM 1.0 um	1
DUSD001	tyx	Dust Sedimentation Bin 001	kg m-2 s-1
DUSD002	tyx	Dust Sedimentation Bin 002	kg m-2 s-1
DUSD003	tyx	Dust Sedimentation Bin 003	kg m-2 s-1
DUSD004	tyx	Dust Sedimentation Bin 004	kg m-2 s-1
DUSD005	tyx	Dust Sedimentation Bin 005	kg m-2 s-1
DUSV	tyx	dust tendency due to conv scav	kg m-2 s-1
DUWT001	tyx	Dust Wet Deposition Bin 001	kg m-2 s-1

DUWT002	tyx	Dust Wet Deposition Bin 002	kg m-2 s-1
DUWT003	tyx	Dust Wet Deposition Bin 003	kg m-2 s-1
DUWT004	tyx	Dust Wet Deposition Bin 004	kg m-2 s-1
DUWT005	tyx	Dust Wet Deposition Bin 005	kg m-2 s-1
NH3DP	tyx	Ammonia Dry Deposition	kg m-2 s-1
NH3EM	tyx	Ammonia Emission	kg m-2 s-1
NH3SV	tyx	Ammonia Convective Scavenging	kg m-2 s-1
NH3WT	tyx	Ammonia Wet Deposition	kg m-2 s-1
NH4DP	tyx	Ammonium Dry Deposition	kg m-2 s-1
NH4SD	tyx	Ammonium Settling	kg m-2 s-1
NH4SV	tyx	Ammonium Convective Scavenging	kg m-2 s-1
NH4WT	tyx	Ammonium Wet Deposition	kg m-2 s-1
NIDP001	tyx	Nitrate Dry Deposition Bin 001	kg m-2 s-1
NIDP002	tyx	Nitrate Dry Deposition Bin 002	kg m-2 s-1
NIDP003	tyx	Nitrate Dry Deposition Bin 003	kg m-2 s-1
NIHT001	tyx	Nitrate Production from Het Chem Bin 001	kg m-2 s-1
NIHT002	tyx	Nitrate Production from Het Chem Bin 002	kg m-2 s-1
NIHT003	tyx	Nitrate Production from Het Chem Bin 003	kg m-2 s-1
NIPNH3AQ	tyx	Ammonia Change from Aqueous Chemistry	kg m-2 s-1
NIPNH4AQ	tyx	Ammonium Production from Aqueous Chemistry	kg m-2 s-1
NIPNO3AQ	tyx	Nitrate Production from Aqueous Chemistry	kg m-2 s-1
NISD001	tyx	Nitrate Sedimentation Bin 001	kg m-2 s-1
NISD002	tyx	Nitrate Sedimentation Bin 002	kg m-2 s-1
NISD003	tyx	Nitrate Sedimentation Bin 003	kg m-2 s-1
NISV001	tyx	Nitrate Convective Scavenging Bin 001	kg m-2 s-1
NISV002	tyx	Nitrate Convective Scavenging Bin 002	kg m-2 s-1
NISV003	tyx	Nitrate Convective Scavenging Bin 003	kg m-2 s-1
NIWT001	tyx	Nitrate Wet Deposition Bin 001	kg m-2 s-1

NIWT002	tyx	Nitrate Wet Deposition Bin 002	kg m-2 s-1
NIWT003	tyx	Nitrate Wet Deposition Bin 003	kg m-2 s-1
OCDP001	tyx	Organic Carbon Dry Deposition Bin 001	kg m-2 s-1
OCDP002	tyx	Organic Carbon Dry Deposition Bin 002	kg m-2 s-1
OCEM001	tyx	Organic Carbon Emission Bin 001	kg m-2 s-1
OCEM002	tyx	Organic Carbon Emission Bin 002	kg m-2 s-1
OCEMAN	tyx	Organic Carbon Anthropogenic Emissions	kg m-2 s-1
OCEMBB	tyx	Organic Carbon Biomass Burning Emissions	kg m-2 s-1
OCEMBF	tyx	Organic Carbon Biofuel Emissions	kg m-2 s-1
OCEMBG	tyx	Organic Carbon Biogenic Emissions	kg m-2 s-1
OCHYPHIL	tyx	Organic Carbon Hydrophobic to Hydrophilic	kg m-2 s-1
OCSV	tyx	organic carbon tendency due to conv scav	kg m-2 s-1
OCWT001	tyx	Organic Carbon Wet Deposition Bin 001	kg m-2 s-1
OCWT002	tyx	Organic Carbon Wet Deposition Bin 002	kg m-2 s-1
SO2EMAN	tyx	SO2 Anthropogenic Emissions	kg m-2 s-1
SO2EMBB	tyx	SO2 Biomass Burning Emissions	kg m-2 s-1
SO2EMVE	tyx	SO2 Volcanic (explosive) Emissions	kg m-2 s-1
SO2EMVN	tyx	SO2 Volcanic (non-explosive) Emissions	kg m-2 s-1
SO4EMAN	tyx	SO4 Anthropogenic Emissions	kg m-2 s-1
SSAERIDX	tyx	Sea Salt TOMS UV Aerosol Index	1
SSDP001	tyx	Sea Salt Dry Deposition Bin 001	kg m-2 s-1
SSDP002	tyx	Sea Salt Dry Deposition Bin 002	kg m-2 s-1
SSDP003	tyx	Sea Salt Dry Deposition Bin 003	kg m-2 s-1
SSDP004	tyx	Sea Salt Dry Deposition Bin 004	kg m-2 s-1
SSDP005	tyx	Sea Salt Dry Deposition Bin 005	kg m-2 s-1
SSEM001	tyx	Sea Salt Emission Bin 001	kg m-2 s-1
SSEM002	tyx	Sea Salt Emission Bin 002	kg m-2 s-1
SSEM003	tyx	Sea Salt Emission Bin 003	kg m-2 s-1

SSEM004	tyx	Sea Salt Emission Bin 004	kg m-2 s-1
SSEM005	tyx	Sea Salt Emission Bin 005	kg m-2 s-1
SSEXTTFM	tyx	Sea Salt Extinction AOT [550 nm] - PM 1.0 um	1
SSSCATFM	tyx	Sea Salt Scattering AOT [550 nm] - PM 1.0 um	1
SSSD001	tyx	Sea Salt Sedimentation Bin 001	kg m-2 s-1
SSSD002	tyx	Sea Salt Sedimentation Bin 002	kg m-2 s-1
SSSD003	tyx	Sea Salt Sedimentation Bin 003	kg m-2 s-1
SSSD004	tyx	Sea Salt Sedimentation Bin 004	kg m-2 s-1
SSSD005	tyx	Sea Salt Sedimentation Bin 005	kg m-2 s-1
SSSV	tyx	sea salt tendency due to conv scav	kg m-2 s-1
SSWT001	tyx	Sea Salt Wet Deposition Bin 001	kg m-2 s-1
SSWT002	tyx	Sea Salt Wet Deposition Bin 002	kg m-2 s-1
SSWT003	tyx	Sea Salt Wet Deposition Bin 003	kg m-2 s-1
SSWT004	tyx	Sea Salt Wet Deposition Bin 004	kg m-2 s-1
SSWT005	tyx	Sea Salt Wet Deposition Bin 005	kg m-2 s-1
SUDP001	tyx	Sulfate Dry Deposition Bin 001	kg m-2 s-1
SUDP002	tyx	Sulfate Dry Deposition Bin 002	kg m-2 s-1
SUDP003	tyx	Sulfate Dry Deposition Bin 003	kg m-2 s-1
SUDP004	tyx	Sulfate Dry Deposition Bin 004	kg m-2 s-1
SUEM001	tyx	Sulfate Emission Bin 001	kg m-2 s-1
SUEM002	tyx	Sulfate Emission Bin 002	kg m-2 s-1
SUEM003	tyx	Sulfate Emission Bin 003	kg m-2 s-1
SUEM004	tyx	Sulfate Emission Bin 004	kg m-2 s-1
SUPMSA	tyx	MSA Prod from DMS Oxidation [column]	kg m-2 s-1
SUPSO2	tyx	SO2 Prod from DMS Oxidation [column]	kg m-2 s-1
SUPSO4AQ	tyx	SO4 Prod from Aqueous SO2 Oxidation [column]	kg m-2 s-1
SUPSO4G	tyx	SO4 Prod from Gaseous SO2 Oxidation [column]	kg m-2 s-1
SUPSO4WT	tyx	SO4 Prod from Aqueous SO2 Oxidation (wet	kg m-2 s-1

		dep) [column]	
SUSV	tyx	sulfate tendency due to conv scav	kg m-2 s-1
SUWT001	tyx	Sulfate Wet Deposition Bin 001	kg m-2 s-1
SUWT002	tyx	Sulfate Wet Deposition Bin 002	kg m-2 s-1
SUWT003	tyx	Sulfate Wet Deposition Bin 003	kg m-2 s-1
SUWT004	tyx	Sulfate Wet Deposition Bin 004	kg m-2 s-1

tavg3_2d_aer_Nx: 2d time-averaged primary aerosol diagnostics

Frequency: *3-hourly from 01:30 UTC (time-averaged)*
Spatial Grid: *2D, single-level, full horizontal resolution*
Dimensions: *longitude=1152, latitude=721, time=1*
Granule Size: *~98 MB*

Name	*Dim*	*Description*	*Units*
BCANGSTR	tyx	Black Carbon Angstrom parameter [470-870 nm]	1
BCCMASS	tyx	Black Carbon Column Mass Density	kg m-2
BCEXTTAU	tyx	Black Carbon Extinction AOT [550 nm]	1
BCFLUXU	tyx	Black Carbon column u-wind mass flux	kg m-1 s-1
BCFLUXV	tyx	Black Carbon column v-wind mass flux	kg m-1 s-1
BCSCATAU	tyx	Black Carbon Scattering AOT [550 nm]	1
BCSMASS	tyx	Black Carbon Surface Mass Concentration	kg m-3
DMSCMASS	tyx	DMS Column Mass Density	kg m-2
DMSSMASS	tyx	DMS Surface Mass Concentration	kg m-3
DUANGSTR	tyx	Dust Angstrom parameter [470-870 nm]	1
DUCMASS	tyx	Dust Column Mass Density	kg m-2
DUCMASS25	tyx	Dust Column Mass Density - PM 2.5	kg m-2
DUEXTT25	tyx	Dust Extinction AOT [550 nm] - PM 2.5	1

DUEXTTAU	tyx	Dust Extinction AOT [550 nm]	1
DUFLUXU	tyx	Dust column u-wind mass flux	kg m-1 s-1
DUFLUXV	tyx	Dust column v-wind mass flux	kg m-1 s-1
DUSCAT25	tyx	Dust Scattering AOT [550 nm] - PM 2.5	1
DUSCATAU	tyx	Dust Scattering AOT [550 nm]	1
DUSMASS	tyx	Dust Surface Mass Concentration	kg m-3
DUSMASS25	tyx	Dust Surface Mass Concentration - PM 2.5	kg m-3
HNO3CMASS	tyx	Nitric Acid Column Mass Density	kg m-3
HNO3SMASS	tyx	Nitric Acid Surface Mass Concentration	kg m-3
NH3CMASS	tyx	Ammonia Column Mass Density	kg m-3
NH3SMASS	tyx	Ammonia Surface Mass Concentration	kg m-3
NH4CMASS	tyx	Ammonium Column Mass Density	kg m-3
NH4SMASS	tyx	Ammonium Surface Mass Concentration	kg m-3
NIANGSTR	tyx	Nitrate Angstrom parameter [470-870 nm]	1
NICMASS	tyx	Nitrate Column Mass Density	kg m-2
NICMASS25	tyx	Nitrate Column Mass Density [PM2.5]	kg m-2
NIEXTTAU	tyx	Nitrate Extinction AOT [550 nm]	1
NIEXTTFM	tyx	Nitrate Extinction AOT [550 nm] - PM 1.0 um	1
NIFLUXU	tyx	Nitrate column u-wind mass flux	kg m-1 s-1
NIFLUXV	tyx	Nitrate column v-wind mass flux	kg m-1 s-1
NISCATAU	tyx	Nitrate Scattering AOT [550 nm]	1
NISCATFM	tyx	Nitrate Scattering AOT [550 nm] - PM 1.0 um	1
NISMASS	tyx	Nitrate Surface Mass Concentration	kg m-3
NISMASS25	tyx	Nitrate Surface Mass Concentration [PM2.5]	kg m-3
OCANGSTR	tyx	Organic Carbon Angstrom parameter [470-870 nm]	1
OCCMASS	tyx	Organic Carbon Column Mass Density	kg m-2
OCEXTTAU	tyx	Organic Carbon Extinction AOT [550 nm]	1

OCFLUXU	tyx	Organic Carbon column u-wind mass flux	kg m-1 s-1
OCFLUXV	tyx	Organic Carbon column v-wind mass flux	kg m-1 s-1
OCSCATAU	tyx	Organic Carbon Scattering AOT [550 nm]	1
OCSMASS	tyx	Organic Carbon Surface Mass Concentration	kg m-3
SO2CMASS	tyx	SO2 Column Mass Density	kg m-2
SO2SMASS	tyx	SO2 Surface Mass Concentration	kg m-3
SO4CMASS	tyx	SO4 Column Mass Density	kg m-2
SO4SMASS	tyx	SO4 Surface Mass Concentration	kg m-3
SSANGSTR	tyx	Sea Salt Angstrom parameter [470-870 nm]	1
SSCMASS	tyx	Sea Salt Column Mass Density	kg m-2
SSCMASS25	tyx	Sea Salt Column Mass Density - PM 2.5	kg m-2
SSEXTT25	tyx	Sea Salt Extinction AOT [550 nm] - PM 2.5	1
SSEXTTAU	tyx	Sea Salt Extinction AOT [550 nm]	1
SSFLUXU	tyx	Sea Salt column u-wind mass flux	kg m-1 s-1
SSFLUXV	tyx	Sea Salt column v-wind mass flux	kg m-1 s-1
SSSCAT25	tyx	Sea Salt Scattering AOT [550 nm] - PM 2.5	1
SSSCATAU	tyx	Sea Salt Scattering AOT [550 nm]	1
SSSMASS	tyx	Sea Salt Surface Mass Concentration	kg m-3
SSSMASS25	tyx	Sea Salt Surface Mass Concentration - PM 2.5	kg m-3
SUANGSTR	tyx	SO4 Angstrom parameter [470-870 nm]	1
SUEXTTAU	tyx	SO4 Extinction AOT [550 nm]	1
SUFLUXU	tyx	SO4 column u-wind mass flux	kg m-1 s-1
SUFLUXV	tyx	SO4 column v-wind mass flux	kg m-1 s-1
SUSCATAU	tyx	SO4 Scattering AOT [550 nm]	1
TOTANGSTR	tyx	Total Aerosol Angstrom parameter [470-870 nm]	1
TOTEXTTAU	tyx	Total Aerosol Extinction AOT [550 nm]	1
TOTSCATAU	tyx	Total Aerosol Scattering AOT [550 nm]	1

tavg3_2d_chm_Nx: 2d time-averaged chemistry diagnostics

Frequency: *3-hourly from 01:30 UTC (time-averaged)*
Spatial Grid: *2D, single-level, full horizontal resolution*
Dimensions: *longitude=1152, latitude=721, time=1*
Granule Size: *~8 MB*

Name	*Dim*	*Description*	*Units*
CO2CL	tyx	CO2 Bulk Mixing Ratio (Column Mass/ps) Bin 001	1
CO2EM	tyx	CO2 Emission Bin 001	kg m-2 s-1
CO2SC	tyx	CO2 Surface Concentration Bin 001	1e-6
COCL	tyx	CO Column Burden	kg m-2
COEM	tyx	CO Emission	kg m-2 s-1
COLS	tyx	CO Chemical Loss	kg m-2 s-1
COPD	tyx	CO Chemical Production	kg m-2 s-1
COSC	tyx	CO Surface Concentration in ppbv	1e-9
LWI	tyx	land(1) water(0) ice(2) flag	1

tavg3_3d_asm_Nv: 3d time-averaged assimilated state on native levels

Frequency: *3-hourly from 01:30 UTC (time-averaged)*
Spatial Grid: *3D, model-level, full horizontal resolution*
Dimensions: *longitude=1152, latitude=721, level=72, time=1*
Granule Size: *~943 MB*

Name	*Dim*	*Description*	*Units*
DELP	tzyx	pressure thickness	Pa
EPV	tzyx	ertels potential vorticity	K m+2 kg-1 s-1
H	tzyx	mid layer heights	m

O3	tzyx	ozone mass mixing ratio	kg kg-1
OMEGA	tzyx	vertical pressure velocity	Pa s-1
PHIS	tyx	surface geopotential height	m+2 s-2
PS	tyx	surface pressure	Pa
QI	tzyx	mass fraction of cloud ice water	kg kg-1
QL	tzyx	mass fraction of cloud liquid water	kg kg-1
QV	tzyx	specific humidity	kg kg-1
RH	tzyx	relative humidity after moist	1
SLP	tyx	sea level pressure	Pa
T	tzyx	air temperature	K
U	tzyx	eastward wind	m s-1
V	tzyx	northward wind	m s-1

tavg3_3d_cld_Nv: 3d time-averaged cloud diagnostics

Frequency: *3-hourly from 01:30 UTC (time-averaged)*
Spatial Grid: *3D, model-level, full horizontal resolution*
Dimensions: *longitude=1152, latitude=721, level=72, time=1*
Granule Size: *~346 MB*

Name	*Dim*	*Description*	*Units*
CFAN	tzyx	convective cloud area fraction	1
CFCU	tzyx	updraft areal fraction	1
CFLS	tzyx	large scale cloud area fraction	1
DELP	tzyx	pressure thickness	Pa
DTRAIN	tzyx	detraining mass flux	kg m-2 s-1
PS	tyx	surface pressure	Pa
QCCU	tzyx	grid mean convective condensate	kg kg-1
QIAN	tzyx	mass fraction of convective cloud ice water	kg kg-1

QILS	tzyx	mass fraction of large scale cloud ice water	kg kg-1
QLAN	tzyx	mass fraction of convective cloud liquid water	kg kg-1
QLLS	tzyx	mass fraction of large scale cloud liquid water	kg kg-1
RH	tzyx	relative humidity after moist	1
TAUCLI	tzyx	in cloud optical thickness for ice clouds	1
TAUCLW	tzyx	in cloud optical thickness for liquid clouds	1

tavg3_3d_lsf_Ne: Large-scale Flux Diagnostics

Frequency: *3-hourly from 01:30 UTC (time-averaged)*
Spatial Grid: *3D, model-level edge, full horizontal resolution*
Dimensions: *longitude=1152, latitude=721, level=73, time=1*
Granule Size: *~143 MB*

Name	*Dim*	*Description*	*Units*
MFZ	tzyx	vertical mass flux	kg m-2 s-1
PLE	tzyx	edge pressure	Pa

tavg3_3d_lsf_Nv: Large-scale Flux Diagnostics

Frequency: *3-hourly from 01:30 UTC (time-averaged)*
Spatial Grid: *3D, model-level, full horizontal resolution*
Dimensions: *longitude=1152, latitude=721, level=72, time=1*
Granule Size: *~247 MB*

Name	*Dim*	*Description*	*Units*
DELP	tzyx	pressure thickness	Pa
MFXC	tzyx	pressure weighted accumulated eastward mass flux	Pa m+2 s-1
MFYC	tzyx	pressure weighted accumulated northward mass	Pa m+2 s-1

		flux	
PS	tyx	surface pressure	Pa

tavg3_3d_mst_Ne: 3d time-averaged moist processes diagnostics at edges

Frequency: *3-hourly from 01:30 UTC (time-averaged)*
Spatial Grid: *3D, model-edge-level, full horizontal resolution*
Dimensions: *longitude=1152, latitude=721, level=73, time=1*
Granule Size: *~108 MB*

Name	*Dim*	*Description*	*Units*
CMFMC	tzyx	cumulative mass flux	kg m-2 s-1
PFICU	tzyx	3D flux of ice convective precipitation	kg m-2 s-1
PFILSAN	tzyx	3D flux of ice nonconvective precipitation	kg m-2 s-1
PFLCU	tzyx	3D flux of liquid convective precipitation	kg m-2 s-1
PFLLSAN	tzyx	3D flux of liquid nonconvective precipitation	kg m-2 s-1
PLE	tzyx	edge pressure	Pa

tavg3_3d_mst_Nv: 3d time-averaged moist processes diagnostics

Frequency: *3-hourly from 01:30 UTC (time-averaged)*
Spatial Grid: *3D, model-level, full horizontal resolution*
Dimensions: *longitude=1152, latitude=721, level=72, time=1*
Granule Size: *~118 MB*

Name	*Dim*	*Description*	*Units*
DELP	tzyx	pressure thickness	Pa
DQRCU	tzyx	convective rainwater source	kg kg-1 s-1

DQRLSAN	tzyx	large scale rainwater source	kg kg-1 s-1
PS	tyx	surface pressure	Pa
REEVAPCN	tzyx	evap subl of convective precipitation	kg kg-1 s-1
REEVAPLSAN	tzyx	evap subl of non convective precipitation	kg kg-1 s-1

tavg3_3d_nav_Ne: 3d time-averaged vertical coordinate navigation at edges

Frequency: *3-hourly from 01:30 UTC (time-averaged)*
Spatial Grid: *3D, model-edge-level, full horizontal resolution*
Dimensions: *longitude=1152, latitude=721, level=73, time=1*
Granule Size: *~85 MB*

Name	*Dim*	*Description*	*Units*
PLE	tzyx	edge pressure	Pa
ZLE	tzyx	edge heights	m

tavg3_3d_nav_Nv: 3d time-averaged vertical coordinate navigation

Frequency: *3-hourly from 01:30 UTC (time-averaged)*
Spatial Grid: *3D, model-level, full horizontal resolution*
Dimensions: *longitude=1152, latitude=721, level=72, time=1*
Granule Size: *~84 MB*

Name	*Di m*	*Description*	*Units*
H	tzyx	mid layer heights	m
PL	tzyx	mid level pressure	Pa

tavg3_3d_odt_Nv: 3d time-averaged ozone tendencies

Frequency: *3-hourly from 01:30 UTC (time-averaged)*
Spatial Grid: *3D, model-level, full horizontal resolution*
Dimensions: *longitude=1152, latitude=721, level=72, time=1*
Granule Size: *~465 MB*

Name	*Dim*	*Description*	*Units*
DELP	tzyx	pressure thickness	Pa
DOXDTANA	tzyx	total ozone analysis tendency	mol mol-1 s-1
DOXDTCHM	tzyx	tendency of odd oxygen mixing ratio due to chemistry	mol mol-1 s-1
DOXDTDYN	tzyx	tendency of ozone due to dynamics	mol mol-1 s-1
DOXDTMST	tzyx	tendency of odd oxygen due to moist processes	mol mol-1 s-1
DOXDTTRB	tzyx	tendency of odd oxygen due to turbulence	mol mol-1 s-1
PS	tyx	surface pressure	Pa

tavg3_3d_qdt_Nv: 3d time-averaged moisture tendencies

Frequency: *3-hourly from 01:30 UTC (time-averaged)*
Spatial Grid: *3D, model-level, full horizontal resolution*
Dimensions: *longitude=1152, latitude=721, level=72, time=1*
Granule Size: *~530 MB*

Name	*Dim*	*Description*	*Units*
DELP	tzyx	pressure thickness	Pa
DQIDTDYN	tzyx	tendency of ice water due to dynamics	kg/kg/s
DQIDTMST	tzyx	total ice water tendency due to moist	kg kg-1 s-1
DQIDTTRB	tzyx	tendency of frozen condensate due to turbulence	kg kg-1 s-1

DQLDTDYN	tzyx	tendency of liquid water due to dynamics	kg/kg/s
DQLDTMST	tzyx	total liq water tendency due to moist	kg kg-1 s-1
DQLDTTRB	tzyx	tendency of liquid condensate due to turbulence	kg kg-1 s-1
DQVDTANA	tzyx	total specific humidity vapor analysis tendency	kg kg-1 s-1
DQVDTCHM	tzyx	tendency of water vapor mixing ratio due to chemistry	kg kg-1 s-1
DQVDTDYN	tzyx	tendency of specific humidity due to dynamics	kg/kg/s
DQVDTMST	tzyx	specific humidity tendency due to moist	kg kg-1 s-1
DQVDTTRB	tzyx	tendency of specific humidity due to turbulence	kg kg-1 s-1
PS	tyx	surface pressure	Pa

tavg3_3d_rad_Nv: 3d time-averaged radiation diagnostics

Frequency: *3-hourly from 01:30 UTC (time-averaged)*
Spatial Grid: *3D, model-level, full horizontal resolution*
Dimensions: *longitude=1152, latitude=721, level=72, time=1*
Granule Size: *~365 MB*

Name	*Dim*	*Description*	*Units*
CLOUD	tzyx	cloud fraction for radiation	1
DELP	tzyx	pressure thickness	Pa
DTDTLWR	tzyx	air temperature tendency due to longwave	K s-1
DTDTLWRCLR	tzyx	air temperature tendency due to longwave for clear skies	K s-1
DTDTSWR	tzyx	air temperature tendency due to shortwave	K s-1
DTDTSWRCLR	tzyx	air temperature tendency due to shortwave for clear skies	K s-1
PS	tyx	surface pressure	Pa

tavg3_3d_tdt_Nv: 3d time-averaged temperature tendencies

Frequency: *3-hourly from 01:30 UTC (time-averaged)*
Spatial Grid: *3D, model-level, full horizontal resolution*
Dimensions: *longitude=1152, latitude=721, level=72, time=1*
Granule Size: *~843 MB*

Name	*Dim*	*Description*	*Units*
DELP	tzyx	pressure thickness	Pa
DTDTANA	tzyx	total temperature analysis tendency	K s-1
DTDTDYN	tzyx	tendency of air temperature due to dynamics	K s-1
DTDTFRI	tzyx	tendency of air temperature due to friction	K s-1
DTDTFRIC	tzyx	tendency of air temperature due to moist processes friction	K s-1
DTDTGWD	tzyx	air temperature tendency due to GWD	K s-1
DTDTMST	tzyx	tendency of air temperature due to moist processes	K s-1
DTDTRAD	tzyx	tendency of air temperature due to radiation	K s-1
DTDTTOT	tzyx	tendency of air temperature due to physics	K s-1
DTDTTRB	tzyx	tendency of air temperature due to turbulence	K s-1
PS	tyx	surface pressure	Pa

tavg3_3d_trb_Ne: 3d time-averaged turbulence diagnostics at edges

Frequency: *3-hourly from 01:30 UTC (time-averaged)*
Spatial Grid: *3D, model-edge-level, full horizontal resolution*
Dimensions: *longitude=1152, latitude=721, level=73, time=1*
Granule Size: *~687 MB*

Name	*Dim*	*Description*	*Units*

KH	tzyx	total scalar diffusivity	m+2 s-1
KHLK	tzyx	entrainment heat diffusivity from Lock	m+2 s-1
KHLS	tzyx	scalar diffusivity from Louis	m+2 s-1
KHRAD	tzyx	radiation driven scalar diffusivity from Lock scheme	m+2 s-1
KHSFC	tzyx	surface driven scalar diffusivity from Lock scheme	m+2 s-1
KM	tzyx	total momentum diffusivity	m+2 s-1
KMLK	tzyx	entrainment momentum diffusivity from Lock	m+2 s-1
KMLS	tzyx	momentum diffusivity from Louis	m+2 s-1
PLE	tzyx	edge pressure	Pa
RI	tzyx	Richardson number from Louis	1

tavg3_3d_udt_Nv: 3d time-averaged wind tendencies

Frequency: *3-hourly from 01:30 UTC (time-averaged)*
Spatial Grid: *3D, model-level, full horizontal resolution*
Dimensions: *longitude=1152, latitude=721, level=72, time=1*
Granule Size: *~1.2 GB*

Name	*Dim*	*Description*	*Units*
DELP	tzyx	pressure thickness	Pa
DUDTANA	tzyx	total eastward wind analysis tendency	m s-2
DUDTDYN	tzyx	tendency of eastward wind due to dynamics	m/s/s
DUDTGWD	tzyx	tendency of eastward wind due to GWD	m s-2
DUDTMST	tzyx	zonal wind tendency due to moist	m s-2
DUDTTRB	tzyx	tendency of eastward wind due to turbulence	m s-2
DVDTANA	tzyx	total northward wind analysis tendency	m s-2
DVDTDYN	tzyx	tendency of northward wind due to dynamics	m/s/s

DVDTGWD	tzyx	tendency of northward wind due to GWD	m s-2
DVDTMST	tzyx	meridional wind tendency due to moist	m s-2
DVDTTRB	tzyx	tendency of northward wind due to turbulence	m s-2
OMEGA	tzyx	vertical pressure velocity	Pa s-1
PS	tyx	surface pressure	Pa
U	tzyx	eastward wind	m s-1
V	tzyx	northward wind	m s-1

7. Metadata

In addition to the metadata discussed in section 2, we have included additional metadata recommended by the GES DISC. In former versions of GMAO data products, this information as bundled into EOSDIS Metadata. As discussed earlier, metadata related to the CF conventions is also present. In addition to what is documented here, additional metadata may be present.

7.1 GES DISC Metadata

The following metadata values will be included for each data granule (file):

Name	**Description**
ShortName	Short identifier for each product. Also known as ESDT. (See section 5.2)
VersionID	System version. Example: “5.11.0”
LocalVersionID	Processing version. Usually “V01”.
LocalGranuleID	Filename (See section 5.1)
Format	The data format of the product files. (NetCDF-4)
RangeBeginningDate	Start date of data in the file (YYYY-MM-DD)
RangBeginningTime	Start time of data in the file (hh:mm:ssZ)
RangeEndingDate	End date of data in the file (YYYY-MM-DD)
RangeEndingTime	End time of data in the file (hh:mm:ssZ)
NorthBoundingCoordinate	Northern extent of data grid.
WestBoundingCoordinate	Western extent of data grid.

Name	**Description**
SouthBoundingCoordinate	Southern extent of data grid.
EastBoundingCoordinate	Eastern extent of data grid.

These metadata values will be stored as global file attributes.

7.2 CF Metadata

When visualization tools such as GrADS, that are CF aware, are used to read GEOS gridded data sets, the application will use the CF metadata embedded in the data products. These metadata include the following information:

- Space-time grid information (dimension variables)
- Variable names and descriptions
- Variable units
- "Missing" value for each variable

Grid information and units comply with the CF conventions. Most variables, but not all, will conform to CF conventions for identification by having a valid "standard_name" attribute defined.

Appendix A: The IAU procedure

The implementation of the Incremental Analysis Update (IAU, Bloom et al., 1996) used for GEOS is summarized in Figure A.1. Every six hours, at the synoptic times, an analysis is performed using backgrounds at that time, three hours earlier, and three hours later, and assimilating observations during the six-hour period spanned by the three backgrounds. The analysis increments (i.e., the difference between the analysis and the corresponding synoptic background) are then divided by a time scale (currently 6 hours) to produce an "analysis tendency." The model is then "backed-up", restarting it from its state three hours before the analysis time, and run for six hours, adding in the time-invariant "analysis tendency" in addition to its normal physics tendencies. At that point a restart is created that will be used next time the model is backed-up, and the first background for the next analysis cycle is saved. We refer to this first 6-hour run as the "corrector" segment of the IAU. The run is then continued without an analysis tendency for another six hours, saving the other two backgrounds needed by the next analysis---one at the next synoptic time and another at the end of the six hours. We refer to this 6-hour run as the "predictor" segment of the IAU. The entire cycle is then repeated for subsequent synoptic times. Note that during each of the four daily analysis cycles the model is run for 12 hours---a 6-hour "corrector" followed by a 6-hour "predictor."

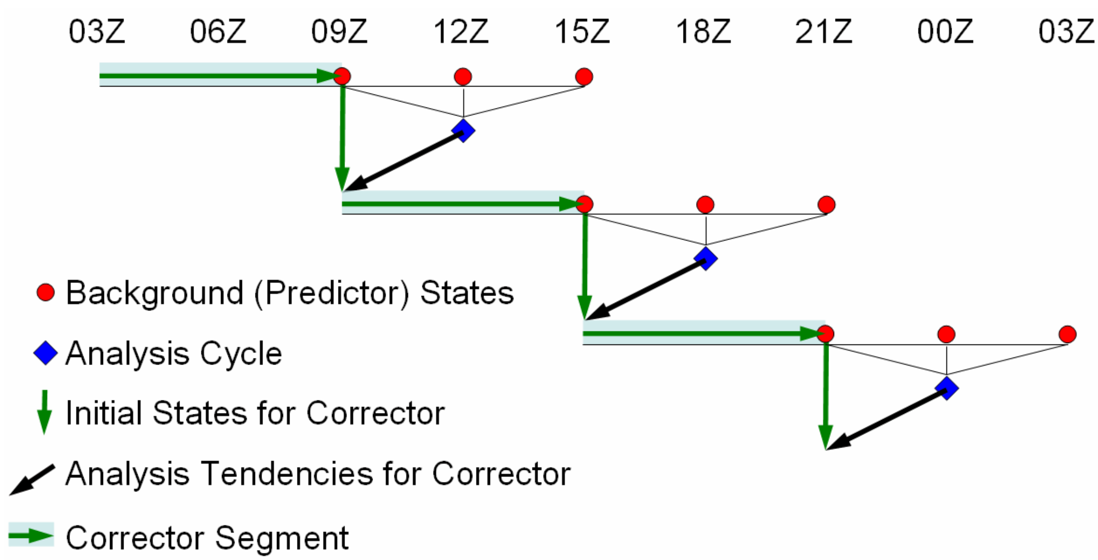


Figure A.1

Except for the analyses themselves, all products from GEOS are produced by the model during the corrector run segment. The sequence of corrector segments (follow the green line in the figure) is a continuous model run, with the extra forcing term from the analysis tendencies. The analysis tendencies do change abruptly every six hours, but state variables are continuous (within the model's time step) solutions of the equations of motion, albeit with the extra forcing term.

Appendix B: Vertical Structure

Pressure-level data will be output on the following 42 pressure levels:

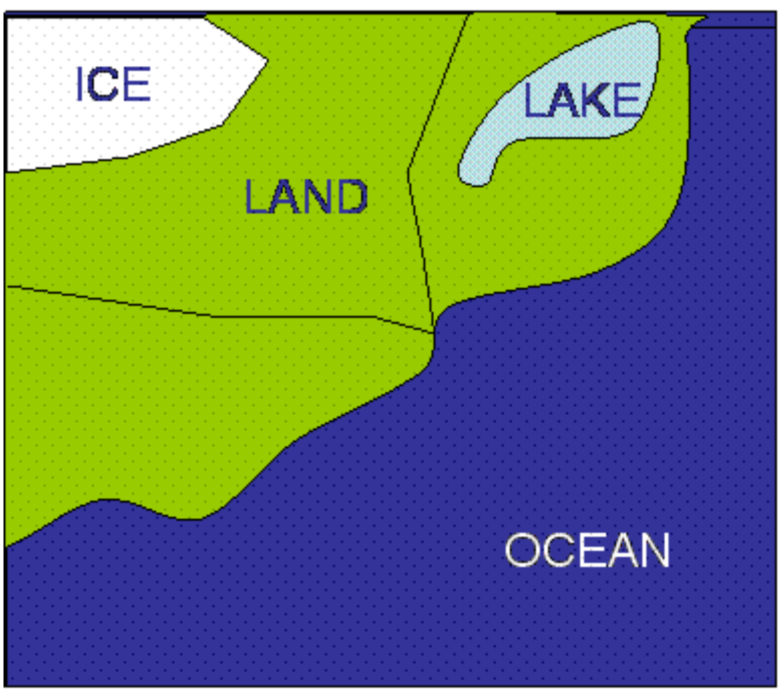
Level	P(hPa)	Level	P(hPa	Level	P(hPa	Level	P(hPa	Level	P(hPa)	Level	P(hPa)
1	1000	8	825	15	600	22	250	29	30	36	2
2	975	9	800	16	550	23	200	30	20	37	1
3	950	10	775	17	500	24	150	31	10	38	0.7
4	925	11	750	18	450	25	100	32	7	39	0.5
5	900	12	725	19	400	26	70	33	5	40	0.4
6	875	13	700	20	350	27	50	34	4	41	0.3
7	850	14	650	21	300	28	40	35	3	42	0.1

Products on the native vertical grid will be output on the following levels. Pressures are nominal for a 1000 hPa surface pressure and refer to the top edge of the layer. Note that the bottom layer has a nominal thickness of 15 hPa.

Lev	P(hPa)	Lev	P(hPa)	Lev	P(hPa)	Lev	P(hPa)	Lev	P(hPa)	Lev	P(hPa)
1	0.0100	13	0.6168	25	9.2929	37	78.5123	49	450.000	61	820.000
2	0.0200	14	0.7951	26	11.2769	38	92.3657	50	487.500	62	835.000
3	0.0327	15	1.0194	27	13.6434	39	108.663	51	525.000	63	850.000
4	0.0476	16	1.3005	28	16.4571	40	127.837	52	562.500	64	865.000
5	0.0660	17	1.6508	29	19.7916	41	150.393	53	600.000	65	880.000
6	0.0893	18	2.0850	30	23.7304	42	176.930	54	637.500	66	895.000
7	0.1197	19	2.6202	31	28.3678	43	208.152	55	675.000	67	910.000
8	0.1595	20	3.2764	32	33.8100	44	244.875	56	700.000	68	925.000
9	0.2113	21	4.0766	33	40.1754	45	288.083	57	725.000	69	940.000
10	0.2785	22	5.0468	34	47.6439	46	337.500	58	750.000	70	955.000
11	0.3650	23	6.2168	35	56.3879	47	375.000	59	775.000	71	970.000
12	0.4758	24	7.6198	36	66.6034	48	412.500	60	800.000	72	985.000

Appendix C: Surface Representation

In GEOS the surface below each atmospheric column consists of a set of tiles that represent various surface types. Tiles can be of four different types: Ocean, Land, Ice, Lake, as illustrated in the figure. In each grid box a single Ice tile represents those areas covered by permanent ice. Similarly a single Lake tile represents continental areas covered permanently by water. Other continental areas (non Lake or Ice) can be further subdivided into tiles that represent parts of the grid box in different hydrological catchments, defined according to the Pfafstetter (1989) system. Each of these is, in turn, divided into subtiles (not shown in figure) that represent the wilted, unsaturated, saturated, and snow-covered fractions of the tile. These fractions vary with time and are predicted by the model based on the hydrological state of the catchment and its fine-scale topographic statistics. Details of the land model, including the partitioning into subtiles, can be found in Koster et al. (2000). The Ocean tile can be divided into two subtiles that represent the ice-covered and ice-free parts of the ocean part of the atmospheric grid box. The fractional cover of these subtiles also varies with time.



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Web Resources

GMAO web site: http://gmao.gsfc.nasa.gov/

GMAO Products page: http://gmao.gsfc.nasa.gov/products/

NetCDF information: http://www.unidata.ucar.edu/software/netcdf/

CF Standard Description: http://cf-pcmdi.llnl.gov/

The HDF Group: http://www.hdfgroup.org /

Acronyms

ADAS	atmospheric data assimilation system
AOT	aerosol optical thickness
CF	Climate and Forecast metadata convention
CLSM	Catchment Land Surface Model
COARDS	Cooperative Ocean/Atmosphere Research Data Service metadata convention
DMS	dimethylsulphide
ECS	EOS Core System
EOS	Earth Observing System
ESDT	Earth Science Data Type
ESMF	Earth System Modeling Framework
FP	Forward-processing
GES DISC	Goddard Earth Sciences Data and Information Services Center
GMAO	Global Modeling and Assimilation Office
GRIB	GRIdded Binary
GSI	Gridpoint Statistical Interpolation
HDF	Hierarchical Data Format
IAU	Incremental Analysis Update
JCSDA	Joint Center for Satellite Data Assimilation
MSA	methane sulphonic acid
NCEP	National Center for Environmental Prediction
NetCDF	Network Common Data Form
PAR	photosynthetically active radiation
TOA	top of atmosphere
TOMS	Total Ozone Mapping Spectrometer
UTC	Universal Time, Coordinated