



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

# README Document for TROPESS Chemistry Reanalysis

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# ● 1.0 Introduction

This document provides basic information for using the TROPES chemical reanalysis datasets listed in Table 1.

Chemical reanalysis a technique that combines observational information from multiple satellite sensors and provides comprehensive information on tropospheric composition variations. In the chemical reanalysis developed at JPL, multi-constituent measurements of ozone (O<sub>3</sub>), nitrogen oxides (NO<sub>2</sub>), carbon monoxide (CO), nitric acid (HNO<sub>3</sub>), and sulfate dioxide (SO<sub>2</sub>) from the OMI, GOME-2, SCIAMACHY, MLS, TES, and MOPITT satellite instruments were assimilated. These products provide global coverage. The data are provided at 1.125 degree lat x 1.125 degree lon grid boxes. The dataset provides 2-hourly, 6-hourly, and monthly averages.

**Table 1.** Datasets / collections described in this document.

Long Name	Short Name	DOI
TROPES Chemical Reanalysis Ozone Monthly 3-dimensional Product	TRPSCRO3M3D	10.5067/H6X584OA098S
TROPES Chemical Reanalysis NO <sub>2</sub> Monthly 3-dimensional Product	TRPSCRNO2M3D	10.5067/F4FE5VWM9501
TROPES Chemical Reanalysis CO Monthly 3-dimensional Product	TRPSCRCOM3D	10.5067/GT835KMBSI8O
TROPES Chemical Reanalysis SO <sub>2</sub> Monthly 3-dimensional Product	TRPSCRSO2M3D	10.5067/546QVG4Q8JZM
TROPES Chemical Reanalysis OH Monthly 3-dimensional Product	TRPSCROHM3D	10.5067/POL5GL2M4JQX
TROPES Chemical Reanalysis NO Monthly 3-dimensional Product	TRPSCRNOM3D	10.5067/LA4K6M5PJHDX
TROPES Chemical Reanalysis HNO <sub>3</sub> Monthly 3-dimensional Product	TRPSCRHNO3M3D	10.5067/0VC7M1P01TQ7

TROPESS Chemical Reanalysis CH2O Monthly 3-dimensional Product	TRPSCRCH2OM3D	10.5067/6F26QNSIODNX
TROPESS Chemical Reanalysis PAN Monthly 3-dimensional Product	TRPSCRPANM3D	10.5067/6CMP6JENQ5AN
TROPESS Chemical Reanalysis Aerosol SO4 Monthly 3- dimensional Product	TRPSCRAERSO4M3D	10.5067/UZUYZGCBVA4F
TROPESS Chemical Reanalysis Aerosol NO3 Monthly 3- dimensional Product	TRPSCRAERNO3M3D	10.5067/BIFZDJ9DIF1J
TROPESS Chemical Reanalysis Aerosol NH4 Monthly 3- dimensional Product	TRPSCRAERNH4M3D	10.5067/JUX7E60YWG7H
TROPESS Chemical Reanalysis Surface Total NOx emissions Monthly 2-dimensional Product	TRPSCRENOXTM2D	10.5067/DDX8VR22HGXR
TROPESS Chemical Reanalysis Surface Anthropogenic NOx emissions Monthly 2- dimensional Product	TRPSCRENOXAM2D	10.5067/KPF561IJQSZ
TROPESS Chemical Reanalysis Surface Biomass Burning NOx emissions Monthly 2- dimensional Product	TRPSCRENOXBM2D	10.5067/HFQ9KKMJMP20
TROPESS Chemical Reanalysis Surface Soil NOx emissions Monthly 2-dimensional Product	TRPSCRENOXSM2D	10.5067/M4LJAG1CKOWQ
TROPESS Chemical Reanalysis Lightning NOx emissions Monthly 2-dimensional Product	TRPSCRENOXLM2D	10.5067/M2YSWFL9RSSH
TROPESS Chemical Reanalysis Surface Total CO emissions Monthly 2-dimensional Product	TRPSCRECO2M2D	10.5067/ABDPEPHV3MMM
TROPESS Chemical Reanalysis	TRPSCRECOAM2D	10.5067/UIT67FUPYYCR

Surface Anthropogenic CO emissions Monthly 2-dimensional Product		
TROPES Chemical Reanalysis Surface Biomass Burning CO emissions Monthly 2-dimensional Product	TRPSCRECOBM2D	10.5067/PCW732JVRWX4
TROPES Chemical Reanalysis Surface Total SO2 emissions Monthly 2-dimensional Product	TRPSCRESO2TM2D	10.5067/TV9NZ8X8C3LS
TROPES Chemical Reanalysis Ozone Spread Monthly 3-dimensional Product	TRPSCRO3SM3D	10.5067/N9MEFZXB9XSW
TROPES Chemical Reanalysis NO2 Spread Monthly 3-dimensional Product	TRPSCRNO2SM3D	10.5067/15MKEFYJ1FJI
TROPES Chemical Reanalysis CO Spread Monthly 3-dimensional Product	TRPSCRO3SM3D	10.5067/XD8KKKO09NS3
TROPES Chemical Reanalysis Ozone Increment Monthly 3-dimensional Product	TRPSCRO3IM3D	10.5067/X9I01Q6H8X22
TROPES Chemical Reanalysis Zonal Wind Monthly 3-dimensional Product	TRPSCRUM3D	10.5067/MEO1208VKTMQ
TROPES Chemical Reanalysis Meridional Wind Monthly 3-dimensional Product	TRPSCRVM3D	10.5067/UD6O2YXON5UR
TROPES Chemical Reanalysis Temperature Monthly 3-dimensional Product	TRPSCR TM3D	10.5067/5XSNDTOMX8ZI
TROPES Chemical Reanalysis Specific Humidity Monthly 3-dimensional Product	TRPSCRQM3D	10.5067/5SD4OKARN8F2
TROPES Chemical Reanalysis Surface Pressure Monthly 2-	TRPSCRPSM2D	10.5067/VKJPX9VQU4J2

dimensional Product		
TROPESS Chemical Reanalysis Ozone 6-Hourly 3-dimensional Product	TRPSCRO36H3D	10.5067/303MWSERDRAN
TROPESS Chemical Reanalysis NO2 6-Hourly 3-dimensional Product	TRPSCRNO26H3D	10.5067/21NOODR2Y2S8
TROPESS Chemical Reanalysis CO 6-Hourly 3-dimensional Product	TRPSCRCO6H3D	10.5067/416SULO2PBF1
TROPESS Chemical Reanalysis SO2 6-Hourly 3-dimensional Product	TRPSCRSO26H3D	10.5067/TVPRSFKWP9OX
TROPESS Chemical Reanalysis OH 6-Hourly 3-dimensional Product	TRPSCROH6H3D	10.5067/AGM913FWORF2
TROPESS Chemical Reanalysis NO 6-Hourly 3-dimensional Product	TRPSCRNO6H3D	10.5067/ATEDBTEL7P97
TROPESS Chemical Reanalysis HNO3 6-Hourly 3-dimensional Product	TRPSCRHNO36H3D	10.5067/RRVFE5X5LL96
TROPESS Chemical Reanalysis CH2O 6-Hourly 3-dimensional Product	TRPSCRCH2O6H3D	10.5067/ETETBGRUIH96
TROPESS Chemical Reanalysis PAN 6-Hourly 3-dimensional Product	TRPSCR PAN6H3D	10.5067/41X2AG4AVAD7
TROPESS Chemical Reanalysis Aerosol SO4 6-Hourly 3-dimensional Product	TRPSCRAERSO46H3D	10.5067/TWDAYANXT8UM
TROPESS Chemical Reanalysis Aerosol NO3 6-Hourly 3-dimensional Product	TRPSCRAERNO36H3D	10.5067/ESC28PW25XIM
TROPESS Chemical Reanalysis	TRPSCRAERNH46H3D	10.5067/4OSQ0X6R3O5N

Aerosol NH4 6-Hourly 3-dimensional Product		
TROPESS Chemical Reanalysis Ozone Spread 6-Hourly 3-dimensional Product	TRPSCRO3S6H3D	10.5067/77WYU7FH83VS
TROPESS Chemical Reanalysis NO2 Spread 6-Hourly 3-dimensional Product	TRPSCRNO2S6H3D	10.5067/RSMDYFYRKPO9
TROPESS Chemical Reanalysis CO Spread 6-Hourly 3-dimensional Product	TRPSCRCOS6H3D	10.5067/1JDNQ39SXZ5Y
TROPESS Chemical Reanalysis Ozone Increment 6-Hourly 3-dimensional Product	TRPSCRO3I6H3D	10.5067/Y8F4UI48O3EG
TROPESS Chemical Reanalysis Zonal Wind 6-Hourly 3-dimensional Product	TRPSCRU6H3D	10.5067/XUON18G3NDXX
TROPESS Chemical Reanalysis Meridional Wind 6-Hourly 3-dimensional Product	TRPSCRV6H3D	10.5067/16U7RUP4RX5W
TROPESS Chemical Reanalysis Temperature 6-Hourly 3-dimensional Product	TRPSCRT6H3D	10.5067/EYL29NMCIMM3
TROPESS Chemical Reanalysis Specific Humidity 6-Hourly 3-dimensional Product	TRPSCRQ6H3D	10.5067/COYVQ8DKV0JH
TROPESS Chemical Reanalysis Surface Pressure 6-Hourly 2-dimensional Product	TRPSCRPS6H2D	10.5067/R9QDK9LWDG32
TROPESS Chemical Reanalysis Surface Ozone 2-Hourly 2-dimensional Product	TRPSCRO32H2D	10.5067/NN87W53OVGUS
TROPESS Chemical Reanalysis Surface NO2 2-Hourly 2-dimensional Product	TRPSCRNO22H2D	10.5067/5FC44ZMSOGB6



TROPESS Chemical Reanalysis Surface SO2 2-Hourly 2-dimensional Product	TRPSCRSO22H2D	10.5067/JM4Z67G0PUSE
TROPESS Chemical Reanalysis Surface CO 2-Hourly 2-dimensional Product	TRPSCRCO2H2D	10.5067/VZXNZR12NPOH
TROPESS Chemical Reanalysis Surface OH 2-Hourly 2-dimensional Product	TRPSCROH2H2D	10.5067/9OXZBTX4CC21
TROPESS Chemical Reanalysis Surface NO 2-Hourly 2-dimensional Product	TRPSCRNO2H2D	10.5067/HY54CQO7ZTHY
TROPESS Chemical Reanalysis Surface HNO3 2-Hourly 2-dimensional Product	TRPSCRHNO32H2D	10.5067/4JTLIQJMMARO
TROPESS Chemical Reanalysis Surface CH2O 2-Hourly 2-dimensional Product	TRPSCRCH2O2H2D	10.5067/RF61MF3UA76G
TROPESS Chemical Reanalysis Surface PAN 2-Hourly 2-dimensional Product	TRPSCR PAN2H2D	10.5067/ZOF1X5E4L5QW
TROPESS Chemical Reanalysis Surface Aerosol SO4 2-Hourly 2-dimensional Product	TRPSCRAERSO42H2D	10.5067/9K96YRHCV5A5
TROPESS Chemical Reanalysis Surface Aerosol NO3 2-Hourly 2-dimensional Product	TRPSCRAERNO32H2D	10.5067/PFZMDRO6AV5N
TROPESS Chemical Reanalysis Surface Aerosol NH4 2-Hourly 2-dimensional Product	TRPSCRAERNH42H2D	10.5067/6QS7DO2FZVY1
TROPESS Chemical Reanalysis Surface Zonal Wind 2-Hourly 2-dimensional Product	TRPSCR U2H2D	10.5067/GG11D3NJ2NXS
TROPESS Chemical Reanalysis Surface Meridional Wind 2-Hourly 2-dimensional Product	TRPSCR V2H2D	10.5067/OXVJR3YLUC4H

TROPESS Chemical Reanalysis Surface Temperature 2-Hourly 2-dimensional Product	TRPSCRT2H2D	10.5067/KABWSVPQDIE9
TROPESS Chemical Reanalysis Surface Specific Humidity 2-Hourly 2-dimensional Product	TRPSCRQ2H2D	10.5067/IKZNCN3J05SP
TROPESS Chemical Reanalysis Surface Pressure 2-Hourly 2-dimensional Product	TRPSCRPS2H2D	10.5067/1KQLWP4ESGXB

## 1.1 Description of the Datasets

These data are processed by the NASA Tropospheric Ozone and Precursors from Earth System Sounding (TROPESS) project, which uses a global chemical transport model using an ensemble Kalman filter technique. The methodology is explained in our publications (Miyazaki et al., 2015, 2017, 2019, 2020a, 2020b, Sekiya et al., 2021, 2022). Consequently, the data sets include the 3-D atmospheric concentrations (horizontal distributions and vertical profiles), 3-D model and data assimilation diagnostic information, and 2-D emissions (horizontal distributions) at various time scales. More information about these data can be found at <https://tes.jpl.nasa.gov/tes/chemical-reanalysis> and [User Guides](#).

## 1.2 Tropospheric Ozone and Precursors from Earth System Sounding (TROPESS) Description

Tropospheric sounding from satellite observations provides critical information about atmospheric composition and its impact on human health and climate. The Tropospheric Ozone and Precursors from Earth System Sounding (TROPESS) project generates Earth System Data Records (ESDRs) of ozone and other atmospheric constituents by processing data from multiple satellites through a common retrieval algorithm and ground data system. These products are rigorously validated using uncertainty analysis in conjunction with independent measurements. These steps quantify the accuracies needed to make long-term trends through multi-satellite records and chemical data assimilation.

Tropospheric Emission Spectrometer (TES) team in combining data from multiple satellites to form a common retrieval framework, which is known as the MUlti-SpEctra, MUlti-SpEcies, Multi-SEnsors (MUSES) science data processing system (MUSES-SDPS). This framework has been applied to a combined suite of hyper-spectral thermal infrared, near-infrared, and ultraviolet instruments to generate ESDRs of Earth's tropospheric composition, including ozone, carbon monoxide, and water vapor deuterium. The ESDRs resulting from combinations of instruments/wavelength regions have increased sensitivity to the lower troposphere relative to composition measurements derived from any single instrument.

The TROPES chemical reanalysis leverages innovative satellite data produced by the TES and TROPES projects as well as other NASA and ESA activities.

## 1.3 Data Disclaimer

The TROPES chemical reanalysis of atmospheric composition in this collection have been validated against various observations, including ground, aircraft, and ozonesonde measurements, as summarized in Miyazaki *et al.*, 2020a. The following evaluations have been done:

- O<sub>3</sub>: The reanalysis monthly ozone bias against ozonesonde measurements was less than 1.2 ppb in the lower troposphere except for the tropics and less than 3.1 ppb in the middle and upper troposphere except for the SH high latitudes, with temporal correlations greater than 0.85 for most regions.
- NO<sub>2</sub>: The global monthly NO<sub>2</sub> column bias against satellite measurements were -0.03 to  $0.02 \times 10^{15}$  molec. cm<sup>-2</sup> and 0.17 to  $0.24 \times 10^{15}$  molec. cm<sup>-2</sup>, while reproducing the observed seasonal and interannual changes for both industrialized and biomass burning regions (temporal correlation,  $r = 0.88\text{--}0.99$ ).
- CO: The monthly mean CO biases against surface measurements are -9.4 to 4.7 ppb with RMSE of 2.0 to 58.4 ppb.
- Aerosols: The monthly mean surface aerosol biases against in situ observations are -0.26 to 0.19  $\mu\text{gm}^{-3}$  for ammonium aerosols, -1.84 to 0.63  $\mu\text{gm}^{-3}$  for nitrate aerosols, and -1.68 to -0.43  $\mu\text{gm}^{-3}$  for sulfate aerosols
- Other species: The validation results for other species: PAN, OH, HO<sub>2</sub>, HNO<sub>3</sub>, CH<sub>2</sub>O, and SO<sub>2</sub> against aircraft observations are also available in Miyazaki *et al.*, 2020a.

### 1.3.1 Data Citation and Acknowledgment

The datasets may be acknowledged in publications using the Digital Object Identifiers (DOIs) listed in Table 1.

If you plan on using any of these data, please cite the following for a general description of the TROPES chemical reanalysis system: (Miyazaki *et al.*, 2020a; Miyazaki *et al.*, 2020b).

In addition, there are several specific science application papers using the chemical reanalysis products. Please cite depending on which data product is used:

- For discussion of the NO<sub>x</sub> emission products, please cite: Thompson *et al.*, (2019), He *et al.*, (2022a, 2022b), Miyazaki *et al.*, (2019, 2020c, 2021, 2022), Elguindi *et al.*, (2020), Miyazaki and Bowman, (2023), Tang *et al.*, (2019), Sekiya *et al.*, (2021, 2022), Jiang *et al.*, (2018, 2022), Laughner *et al.*, (2021)
- For discussion of the ozone products, please cite: Fu *et al.*, (2020), Kuai *et al.*, (2020), He *et al.*, (2022), Miyazaki *et al.*, (2021, 2022), Huijnen *et al.*, (2020), Kanaya *et al.*, (2019), Ogino *et al.*, (2022)

- For discussion of the NO<sub>2</sub> products, please cite: Thompson *et al.*, (2019), Miyazaki *et al.*, (2019)
- For discussion of the CO products, please cite: Gaubert *et al.*, (2020), Kanaya *et al.*, (2019)

### ▪ 1.3.2 Contact Information

Please contact Kazuyuki Miyazaki ([kazuyuki.miyazaki@jpl.nasa.gov](mailto:kazuyuki.miyazaki@jpl.nasa.gov)) for any additional information needed about these data.

### ▪ 1.3.3 Version 2

This is the second version of this product.

## ● 2.0 Data Organization

These data represent a compilation of chemical reanalysis data of different species concentrations (O<sub>3</sub>, NO<sub>2</sub>, CO, SO<sub>2</sub>, OH, NO, HNO<sub>3</sub>, CH<sub>2</sub>O, PAN, SO<sub>4</sub> aerosols, NO<sub>3</sub> aerosols, and NH<sub>4</sub> aerosols) and emissions (NO<sub>x</sub>, SO<sub>2</sub>, and CO).

There is 1 file per species, and the data are divided into a series of yearly segments with one segment per file.

Each file contains all global data of a given species made during a period of exactly 1 year, identified by the date in the filename.

### 2.1 File Format and Structure

The files in these collections are in NetCDF-4 format. NetCDF is a set of software libraries and self-describing, machine-independent data formats that support the creation, access, and sharing of array-oriented scientific data that was developed by UCAR/Unidata:  
<https://www.unidata.ucar.edu/software/netcdf/>.

### 2.2 File Naming Convention

The filenames for these data products are described in Table 2, where YYYYMMDDDD should be replaced by the observation date.

Below is an example of the general TROPES file naming convention used to identify each granule:

**[ProjectID]\_[DataType]\_[DateStamp]\_[ProductType]\_[SurfaceFlag]\_[Year].nc**

TROPESS\_reanalysis\_mon\_emi\_nox\_anth\_2005.nc

where:

- **[ProjectID]**: corresponds to the project identifier for the collection (i.e., TROPESS).
- **[DataType]**: corresponds to the platform used in the generation of the presented data products (i.e., reanalysis).
- **[DateStamp]**: Date stamp is the temporal resolution of the data contained in the product, where:
  - *mon*: is the monthly mean data.
  - *6hr*: is the 6-hourly interval data.
  - *2hr*: is the 2-hourly interval data.
- **[ProductType]**: A short name to describe the primary atmospheric species or parameter included in the data file. Gas phase species names follow the chemical compound name and contain the symbols of the atoms of the elements present in the compound, as well as how many there are for each element in the form of subscripts. “aero” is added to aerosol species.

Acceptable values are:

- o3 = Ozone
- co = Carbon monoxide
- no2 = Nitrogen Oxide
- no = Nitric Oxide
- pan = Peroxyacetyl nitrate
- ch2o = Formaldehyde
- hno3 = Nitric acid
- so2 = Sulfur dioxide
- oh = Hydroxyl radical
- aero\_nh4 = Ammonium aerosol
- aero\_no3 = Nitrate aerosol
- aero\_so4 = Sulfate aerosol
- o3\_inc = Ozone increment by data assimilation
- o3\_spr = Ozone ensemble spread, as a measure of data assimilation analysis uncertainty
- no2\_spr = Nitrogen oxide ensemble spread, as a measure of data assimilation analysis uncertainty
- co\_spr = Carbon monoxide ensemble spread, as a measure of data assimilation analysis uncertainty
- ps = Surface pressure
- t = Atmospheric temperature
- u = Zonal wind
- v = Meridional wind
- q = Specific humidity
- emi\_nox\_tot = Surface total nitrogen oxide emissions
- emi\_nox\_anth = Surface anthropogenic nitrogen oxide emissions
- emi\_nox\_bio = Surface biomass burning nitrogen oxide emissions
- emi\_nox\_soil = Surface soil nitrogen oxide emissions
- emi\_nox\_light = Lightning nitrogen oxide emissions
- emi\_co\_tot = Surface total carbon monoxide emissions
- emi\_co\_anth = Surface anthropogenic carbon monoxide emissions

- emi\_co\_bio = Surface biomass burning carbon monoxide emissions
- emi\_so2\_tot = Surface total sulfate dioxide emissions
- 
- **[SurfaceFlag]:** The frag “\_sfc\_” is added to surface 2-dimensional data sets.
- **[Year]:** Year of the data products in four-digit year format.
- **[ProcessingStrategy]:** a two-letter code for the processing strategy used in generating the L2 science data products. Allowable values are:
  - FS: Forward Stream. Low-latency data products generated from the MUSES-SDPS forward processing streams.
  - RS: Reanalysis Stream. Products are generated from the MUSES-SDPS reanalysis processing streams.
  - SC: Special Collections. Provided on an as-needed and as-available basis to support NASA field missions and individual-investigator requests over specific regions.

**Table 2.** TROPES file naming conventions

Short Name	Filename Pattern
TRPSCRO3M3D	TROPES_reanalysis_mon_o3_2005.nc
TRPSCRNO2M3D	TROPES_reanalysis_mon_no2_2005.nc
TRPSCRCOM3D	TROPES_reanalysis_mon_co_2005.nc
TRPSCRSO2M3D	TROPES_reanalysis_mon_so2_2005.nc
TRPSCROHM3D	TROPES_reanalysis_mon_oh_2005.nc
TRPSCRNOM3D	TROPES_reanalysis_mon_no_2005.nc
TRPSCRHNO3M3D	TROPES_reanalysis_mon_hno3_2005.nc
TRPSCRCH2OM3D	TROPES_reanalysis_mon_ch2o_2005.nc
TRPSCRPANM3D	TROPES_reanalysis_mon_pan_2005.nc
TRPSCRAERSO4M3D	TROPES_reanalysis_mon_aero_so4_2005.nc
TRPSCRAERNO3M3D	TROPES_reanalysis_mon_aero_no3_2005.nc
TRPSCRAERNH4M3D	TROPES_reanalysis_mon_aero_nh4_2005.nc
TRPSCRENOXTM2D	TROPES_reanalysis_mon_emi_nox_tot_2005.nc
TRPSCRENOXAM2D	TROPES_reanalysis_mon_emi_nox_anth_2005.nc
TRPSCRENOXBM2D	TROPES_reanalysis_mon_emi_nox_bio_2005.nc
TRPSCRENOXSM2D	TROPES_reanalysis_mon_emi_snox_soil_2005.nc

TRPSCRENOXLM2D	TROPESS_reanalysis_mon_emi_snox_light_2005.nc
TRPSCRECOTM2D	TROPESS_reanalysis_mon_emi_co_tot_2005.nc
TRPSCRECOAM2D	TROPESS_reanalysis_mon_emi_co_anth_2005.nc
TRPSCRECOBM2D	TROPESS_reanalysis_mon_emi_co_bio_2005.nc
TRPSCRESO2TM2D	TROPESS_reanalysis_mon_emi_so2_2005.nc
TRPSCRO3SM3D	TROPESS_reanalysis_mon_o3_spr_2005.nc
TRPSCRNO2SM3D	TROPESS_reanalysis_mon_no2_spr_2005.nc
TRPSCRCSM3D	TROPESS_reanalysis_mon_co_spr_2005.nc
TRPSCRO3IM3D	TROPESS_reanalysis_mon_o3_inc_2005.nc
TRPSCRUM3D	TROPESS_reanalysis_mon_u_2005.nc
TRPSCRVM3D	TROPESS_reanalysis_mon_v_2005.nc
TRPSCR TM3D	TROPESS_reanalysis_mon_t_2005.nc
TRPSCRQM3D	TROPESS_reanalysis_mon_q_2005.nc
TRPSCRPSM2D	TROPESS_reanalysis_mon_ps_2005.nc
TRPSCRO36H3D	TROPESS_reanalysis_6hr_o3_2005.nc
TRPSCRNO26H3D	TROPESS_reanalysis_6hr_no2_2005.nc
TRPSCR CO6H3D	TROPESS_reanalysis_6hr_co_2005.nc
TRPSCR SO26H3D	TROPESS_reanalysis_6hr_so2_2005.nc
TRPSCR OH6H3D	TROPESS_reanalysis_6hr_oh_2005.nc
TRPSCR NO6H3D	TROPESS_reanalysis_6hr_no_2005.nc
TRPSCR HNO36H3D	TROPESS_reanalysis_6hr_hno3_2005.nc
TRPSCR CH2O6H3D	TROPESS_reanalysis_6hr_ch2o_2005.nc
TRPSCR PAN6H3D	TROPESS_reanalysis_6hr_pan_2005.nc
TRPSCR AERSO46H3D	TROPESS_reanalysis_6hr_aero_so4_2005.nc
TRPSCR AERNO36H3D	TROPESS_reanalysis_6hr_aero_no3_2005.nc
TRPSCR AERNH46H3D	TROPESS_reanalysis_6hr_aero_nh4_2005.nc

TRPSCRO3S6H3D	TROPESS_reanalysis_6hr_o3_spr_2005.nc
TRPSCRNO2S6H3D	TROPESS_reanalysis_6hr_no2_spr_2005.nc
TRPSCRCOS6H3D	TROPESS_reanalysis_6hr_co_spr_2005.nc
TRPSCRO3I6H3D	TROPESS_reanalysis_6hr_o3_inc_2005.nc
TRPSCRU6H3D	TROPESS_reanalysis_6hr_u_2005.nc
TRPSCRV6H3D	TROPESS_reanalysis_6hr_v_2005.nc
TRPSCR6H3D	TROPESS_reanalysis_6hr_t_2005.nc
TRPSCRQ6H3D	TROPESS_reanalysis_6hr_q_2005.nc
TRPSCRPS6H2D	TROPESS_reanalysis_6hr_ps_2005.nc
TRPSCRO32H2D	TROPESS_reanalysis_2hr_o3_sfc_2005.nc
TRPSCRNO22H2D	TROPESS_reanalysis_2hr_no2_sfc_2005.nc
TRPSCRSO22H2D	TROPESS_reanalysis_2hr_so2_sfc_2005.nc
TRPSCR2H2D	TROPESS_reanalysis_2hr_co_sfc_2005.nc
TRPSCROH2H2D	TROPESS_reanalysis_2hr_oh_sfc_2005.nc
TRPSCRNO2H2D	TROPESS_reanalysis_2hr_no2_sfc_2005.nc
TRPSCRHNO32H2D	TROPESS_reanalysis_2hr_hno3_sfc_2005.nc
TRPSCRCH2O2H2D	TROPESS_reanalysis_2hr_ch2o_sfc_2005.nc
TRPSCR2H2D	TROPESS_reanalysis_2hr_pan_sfc_2005.nc
TRPSCRAERSO42H2D	TROPESS_reanalysis_2hr_aero_so4_sfc_2005.nc
TRPSCRAERNO32H2D	TROPESS_reanalysis_2hr_aero_no3_sfc_2005.nc
TRPSCRAERNH42H2D	TROPESS_reanalysis_2hr_aero_nh4_sfc_2005.nc
TRPSCR2H2D	TROPESS_reanalysis_2hr_u_sfc_2005.nc
TRPSCR2H2D	TROPESS_reanalysis_2hr_v_sfc_2005.nc
TRPSCR2H2D	TROPESS_reanalysis_2hr_t_sfc_2005.nc
TRPSCR2H2D	TROPESS_reanalysis_2hr_q_sfc_2005.nc
TRPSCR2H2D	TROPESS_reanalysis_2hr_ps_sfc_2005.nc



## ● 3.0 Data Contents

### 3.1 Data Set Attributes (File Metadata)

A summary of global attributes present in all files is shown in Table 4 below.

**Table 4.** Global data attributes.

Global Attribute	Description	Type
ShortName	ESDT short product name	string
LongName	Full product name	string
VersionID	Version ID for this product	int
IdentifierProductDOIAuthority	Organization providing DOI information	string
IdentifierProductDOI	DOI value	string
Format	Data file format	string
ProcessingLevel	Level of data product	string
SouthBoundingCoordinate	South bounding latitude	double
NorthBoundingCoordinate	North bounding latitude	double
WestBoundingCoordinate	West bounding longitude	double
EastBoundingCoordinate	East bounding longitude	double
Conventions	Name of convention(s) for metadata	string
MeasuredParameter	Species measured for this product	string

### 3.2 Variable Data Attributes

Each variable has its own associated attributes. Variable attributes are a CF standard and are used to describe the variable in more detail to properly interpret its value (see Table 5).

**Table 5.** Per variable data attributes.

Variable Attribute	Description	Type
_FillValue	single value indicating the data point contains fill instead of valid data	float
long_name	longer name describing the quantity being represented; typically used for plot titles	string
units	units for variables that represent physical quantities	string
missing_value	same as _FillValue	float
source	identifies variable from the input product from which this quantity is derived from.	string

### 3.3 Dimensions

The variable dimensions associated with the data products are shown in Table 7.

**Table 6.** Data dimensions.

Global Attribute	Description	Dimension Size
lat	Latitude in degree	160
lon	Longitude in degree	320
level	atmospheric pressure in hPa	3-D data: 27 2-D data: 1
time	UTC expressed as an array of integers year, month, day, hour, minute, second	6

## ● 4.0 Products/Parameters

The science data variables are described in the table below.

### 4.1 Data Fields

The science data fields are shown in Table 7.

**Table 7.** Data fields.

Data Field Name	Long_Name/Description	Type	Dimensions	Undefined Value	Units
species	Retrieved state, as volume mixing ratio (VMR) relative to dry air.	float	target, level	-999.0	1

\*Note: Name of “species” vary by file.

## 4.2 Fill Values

Fill values are indicated in Table 8.

**Table 8.** Fill values.

Variable Type	Fill Value
float	-999.0

## ● 5.0 Options for Reading the Data

### 5.1 Tools/Programming Languages

Support for reading NetCDF is offered in many programming languages, including Python, Matlab, IDL, C/C++ and Fortran. NetCDF4 files are legal HDF5 files with additional bookkeeping information managed by the NetCDF4 library.

The following link provides a list of software and tools for manipulating and displaying NetCDF (\*.nc) data files: <https://www.unidata.ucar.edu/software/netcdf/software.html>.

### 5.2 Command Line Utilities

#### ▪ 5.2.1 ncdump

Outputs contents of a netCDF file as ascii. From Unidata, part of the NetCDF libraries. ncdump documentation:

[https://docs.unidata.ucar.edu/nug/current/netcdf\\_utilities\\_guide.html](https://docs.unidata.ucar.edu/nug/current/netcdf_utilities_guide.html)

The ncdump tool can be used as a simple browser for HDF data files, to display the dimension names and sizes; variable names, types, and shapes; attribute names and values; and optionally, the values of data for all variables or selected variables in a netCDF file. The most common use of ncdump is with the -h option, in which only the header information is displayed.

#### ▪ 5.2.2 NCO

NCO is a package of command-line utilities for manipulating netCDF files. Each NCO command does one very specific kind of manipulation, but you can combine them to powerful effect.

NCO Documentation: <http://nco.sourceforge.net/nco.html>

- [ncap](#) and [ncap2](#): netCDF Arithmetic Processors ([examples](#)) -- algebraic manipulation of data
- [ncatted](#): netCDF Attribute Editor ([examples](#)) -- modify metadata
- [ncbo](#): netCDF Binary Operator (includes ncadd, ncsubtract, ncmultiply, ncdivide) -- ([examples](#)) -- math involving two files
- [ncea](#): netCDF Ensemble Averager ([examples](#)) -- average across multiple input files
- [ncecat](#): netCDF Ensemble Concatenator ([examples](#)) -- combine files into a single record
- [ncflint](#): netCDF File Interpolator ([examples](#)) -- combine inputs via weighted interpolation
- [ncks](#): netCDF Kitchen Sink ([examples](#)) -- copies data to ascii or output file

- [ncpdq](#): netCDF Permute Dimensions Quickly, Pack Data Quietly ([examples](#)) -- rearrange dimensions or pack data
- [ncra](#): netCDF Record Averager ([examples](#)) -- average across time (record dimension)
- [ncrcat](#): netCDF Record Concatenator ([examples](#)) -- combine sequential files
- [ncrename](#): netCDF Renamer ([examples](#)) -- rename dimensions, variables, or attributes
- [ncwa](#): netCDF Weighted Averager ([examples](#)) -- weighted average over one file

## 5.3 GUI Tools

### ▪ 5.3.1 Panoply

Panoply is a good generic and free visualization tool for any netCDF file. A strength of the tool is that data can be previewed “remotely” over the network – i.e., a user can preview file content of HDF files stored on a remote site, without downloading them.

Panoply is available from Goddard Institute for Space Studies (GISS) here:

<https://www.giss.nasa.gov/tools/panoply/>

### ▪ 5.3.2 HDFView

HDFView is a visual tool for browsing and editing HDF (HDF5 and HDF4) and NetCDF files. It can be downloaded from here: <https://www.hdfgroup.org/downloads/hdfview/>.

## ● 6.0 GES DISC Data Services Help Desk

If you need assistance or wish to report a problem:

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

**Voice:** 301-614-5224

**Fax:** 301-614-5268

**Address:**

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

## 6.1 How to Articles

The GESDISC web site contains many informative articles under the “[How To Section](#)”, “[FAQ](#)” (frequently asked questions), “[News](#)”, “[Glossary](#)”, and “[Help](#)”. A sample of these articles includes:

[Earthdata Login for Data Access](#)

[How to Download Data Files from HTTPS Service with wget](#)

[How to Obtain Data in NetCDF Format via OpeNDAP](#)

[Quick View Data with Panoply](#)

[How to Read Data in NetCDF Format with R](#)

[How to Read Data in HDF-5 or netCDF Format with GrADS](#)

[How to read and plot NetCDF MERRA-2 data in Python](#)

[How to Subset Level-2 Data](#)

[How to use the Level 3 and 4 Subsetter and Regridder](#)

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## ● Appendix A. Vertical levels

The table below contains the nominal data levels.

1000, 995, 980, 950, 900, 850, 800, 750, 700, 650, 600, 550, 500, 450, 400, 350, 300, 250, 200, 175, 150, 125, 100, 90, 80, 70, 60

Index	Pressure [hPa]
1	1000.0000
2	995.0000
3	980.0000
4	950.0000
5	900.0000

6	850.0000
7	800.0000
8	750.0000
9	700.0000
10	650.0000
11	600.0000
12	550.0000
13	500.0000
14	450.0000
15	400.0000
16	350.0000
17	300.0000
18	250.0000
19	200.0000
20	175.0000
21	150.0000
22	125.0000
23	100.0000
24	90.0000
25	80.0000
26	70.0000
27	60.0000