Aura Microwave Limb Sounder (MLS)
Derived Meteorological Products (DMPs)

Data Usage and Format Description

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1 Introduction

This document describes the derived meteorological products (DMPs) for the Aura Microwave Limb Sounder [MLS, e.g., *Waters et al.*, 2006; *Livesey et al.*, 2022] Level 2 dataset. The DMPs are meteorological fields interpolated to the measurements' times and locations, as well as several products derived from those meteorological fields, such as static stability and equivalent latitude (EqL). As described in *Manney et al.* [2007], interpolation of the meteorological fields is done linearly in time and bilinearly in latitude and longitude. Vertical interpolations are linear in $\log(\theta)$ for potential vorticity (PV) or in log(pressure) for the other products. EqL is calculated on standard isentropic surfaces (chosen to have resolution comparable to the reanalyses being used) and interpolated linearly in $\log(\theta)$.

The DMPs also include tropopause characterizations. That is, at each measurement location, the dynamical (DYN) tropopause is identified using three PV values (2.0, 3.5, and 4.5 potential vorticity units) and the thermal tropopause using the WMO definition [e.g., *Homeyer et al.*, 2010], that is to say, where the temperature lapse rate falls below $2\,\mathrm{K\,km^{-1}}$ for at least 2 km.

The meteorological fields used to compute the DMPs are obtained from either the GEOS-FP version 2.94 system or the Modern-Era Retrospective Analysis for Research and Applications version 2 (MERRA-2) reanalysis [*Gelaro et al.*, 2017]. The GEOS-FP fields allow the DMPs to be computed concurrently with the Level 2 processing, whereas the MERRA-2 DMPs are generated approximately one month later, as soon as the MERRA-2 data become available. *It is recommended that the MERRA-2 DMPs be used when available, as they are considered more accurate.*

The Aura MLS DMPs are available from the NASA Goddard Space Flight Center Earth Science Data and Information Services Center (GES-DISC, see https://disc.gsfc.nasa.gov/). These DMPs are computed using the JETPAC (Jet and Tropopause Products for Analysis and Characterization) algorithms described in detail by *Manney et al.* [2011, 2014, 2017], *Manney and Hegglin* [2018], and *Millán et al.* [2023].

2 Data Format

The DMPS are stored in standard HDF-EOS (version 5) files, which contains swaths in the Aura-wide standard format. For more information on this format see *Craig et al.* [2003]. The DMPs files are named according to the following convention:

```
MLS-Aura_L2EDMP-<MetInfo>-<vvv>_<MLSver>_<YYYY>d<DOY>.he5
```

where `<MetInfo>` is the meteorological fields used (e.g., `GEOS5MERRA2` or `GEOS5294`), `<vvv>` is the JETPAC version (currently `v201`), `<MLSver>` is the MLS version (including cycle number), and `<YYYY>` and `<DOY>` are the year and day number in that year (`001` = 1 January), respectively.

The variables included in each of these files are given in Table 1.

Table 1: Contents of MLS DMP files. See main text for details.

Name in file	Description	Units
`Altitude`	Altitude	km
`DTDZ`	Lapse Rate	K km^{-1}
`DynTropAltitude`	Dynamical tropopause altitude	km
`DynTropDTDZ`	Dynamical tropopause lapse rate	K km^{-1}
`DynTropFlag`*	Dynamical tropopause flag	unitless
`DynTropPressure`	Dynamical tropopause pressure	hPa
`DynTropStaticStability`	Dynamical tropopause static stability	s^{-2}
`DynTropTemperature`	Dynamical tropopause temperature	K
`DynTropTheta`	Dynamical tropopause potential temperature	K
`GeopotentialHeight`	Geopotential height	km
`HorizontalPVGradient`*	Normalized Horizontal (Isentropic) sPV Gradient	unitless
`HorizontalTemperatureGradient`*	Horizontal (isobaric) Temperature Gradient	K km^{-1}
`MeridionalCompOfPVGrad`*	Normalizing factor for Horizontal sPV Gradient	s^{-1}
`MeriodionalWind`	Meridional wind	m/s
`MontgomeryStreamFunction`*	Montgomery Stream Function	m^2 s^{-2}
`PVEquivalentLatitude`*	Equivalent Latitude	degrees
`PotentialVorticity`	Potential vorticity	K m^2 $(kg\ s)^{-1}$
`RelativeVorticity`	Relative vorticity	10^4 s^{-1}
`ScaledPV`*	Scaled PV	s^{-1}
`StaticStability`*	Static stability	s^{-2}
`Temperature`	Temperature	K
`Theta`	Potential temperature	K
`WMOTropAltitude`	WMO tropopause altitude	km
`WMOTropPV`	WMO tropopause potential vorticity	K m^2 $(kg\ s)^{-1}$
`WMOTropPressure`	WMO tropopause pressure	hPa
`WMOTropStaticStability`	WMO tropopause static stability	s^{-2}
`WMOTropTemperature`	WMO tropopause temperature	K
`WMOTropTheta`	WMO tropopause potential temperature	K
`ZonalWind`	Zonal wind	m/s

*see descriptions in main text.

Specific fields are:

`DynTropFlag`: Flag indicating if the dynamical tropopause was determined using PV (`DynTropFlag` is zero) or potential temperature (`DynTropFlag` is one). Dynamical tropopauses are defined by an isentropic surface (380 K) wherever the PV contour definition would place it at a higher potential temperature [*Schoeberl*, 2004; *Manney et al.*, 2011].

`HorizontalPVgGradient`: The normalized (by the global average on that isentropic level) magnitude of the horizonal gradient of sPV on isentropic surfaces.

`ScaledPV`: To facilitate applicability across multiple potential temperature levels, PV is scaled by dividing by a standard value of static stability as described by *Dunkerton and Delisi* [1986] and *Manney et al.* [1994].

`Static_Stability`: The buoyancy (Brunt-Väisälä) frequency, N^2, that is, the stability of the atmosphere in hydrostatic equilibrium with respect to vertical displacements.

`PVEquivalentLatitude`: A quasi-Lagrangian coordinate widely used in stratospheric studies (e.g., *Butchart and Remsberg* [1986]). Simply put, EqL is the latitude that would enclose the same area between it and the pole as the corresponding potential vorticity contour.

`MeridionalCompOfPVGrad`: The average value of the magnitude of the sPV gradient on each isentropic surface that is used to normalize `HorizontalPVGradient`.

`HorizontalTemperatureGradient`: Magnitude of horizontal gradient of temperature on pressure surfaces.

`MontgomeryStreamFunction`: The Montgomery stream function [*Montgomery*, 1937], is approximated as $M = gz + c_pT$ where g is the acceleration due to gravity, z the height of the isentropic surface used, c_p the specific heat of air at constant pressure, and T is temperature. This is a streamfunction appropriate for isentropic coordinates.

3 Data Screening

Bad data are set to a value of $1\text{x}10^{15}$ and should not be used.

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