

Data User Guidance for the Aura Microwave Limb Sounder



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for the MLS team



Jet Propulsion Laboratory/California
Institute of Technology



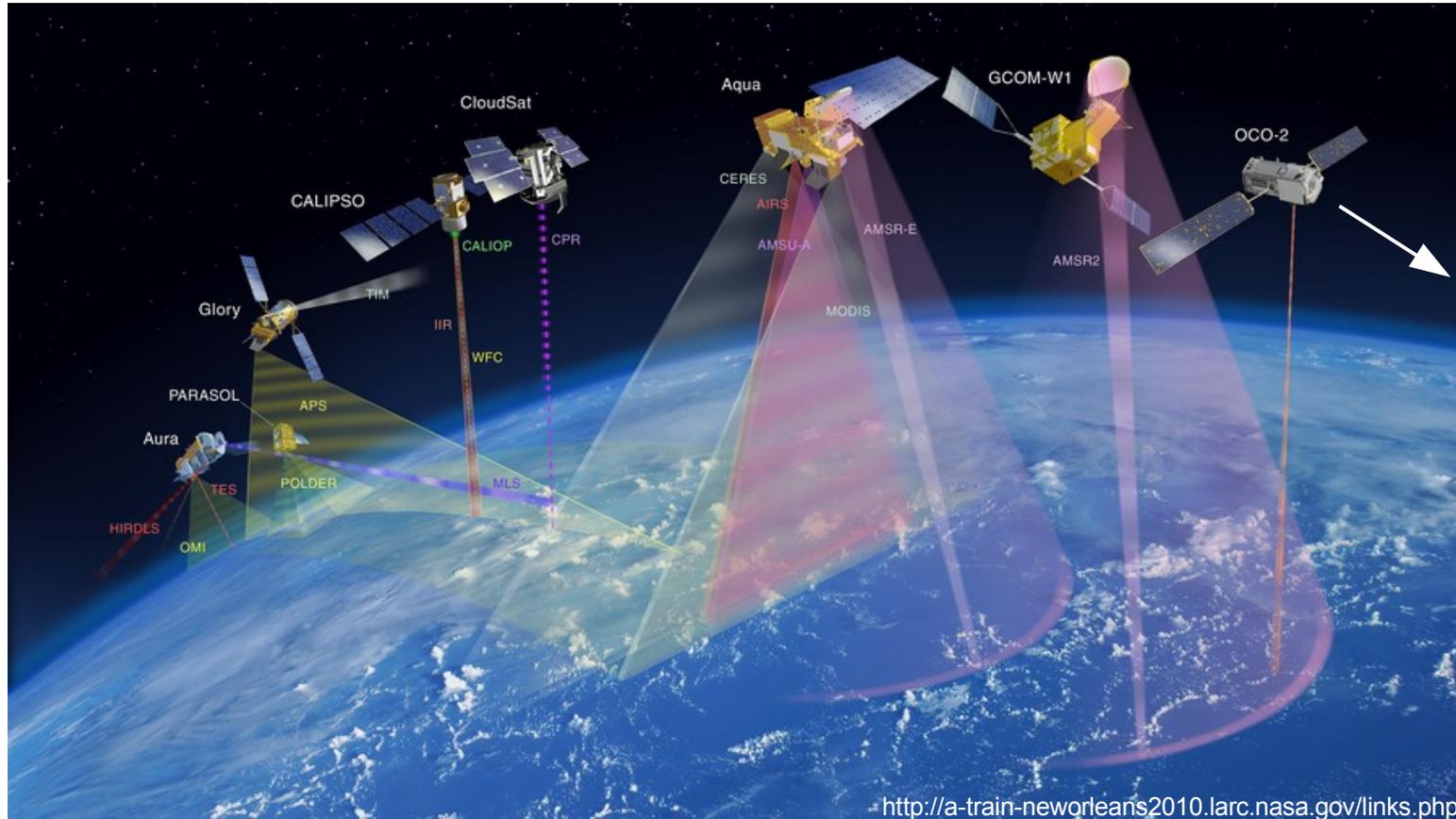
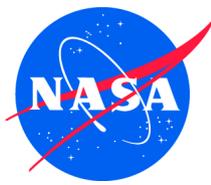
A-Train Workshop

New Orleans

October 25, 2010



A-Train Satellite Constellation

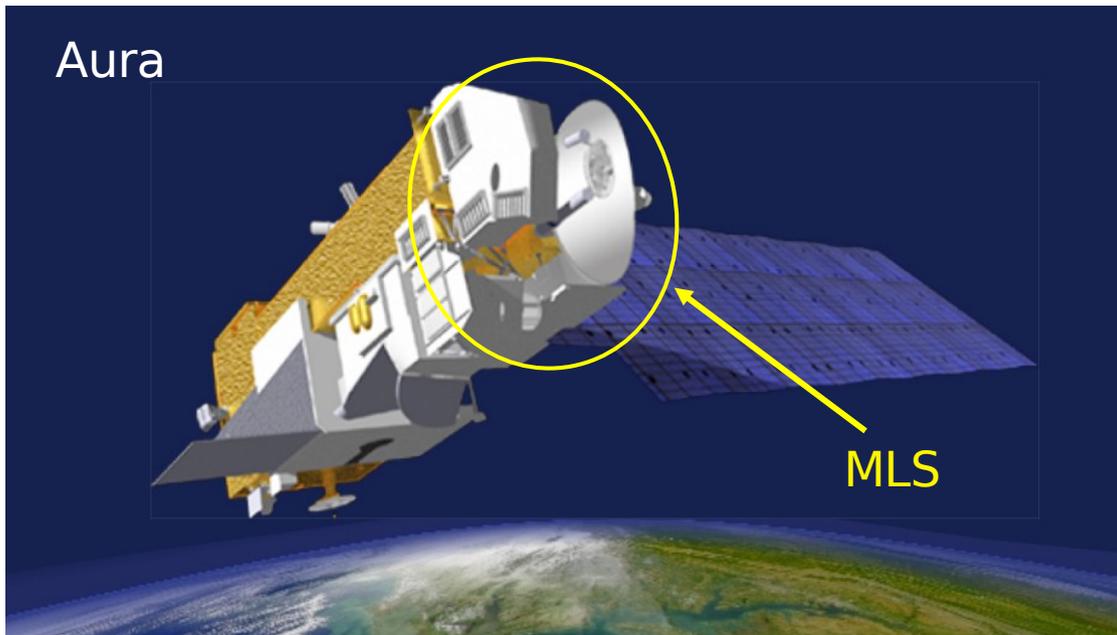


<http://a-train-neworleans2010.larc.nasa.gov/links.php>

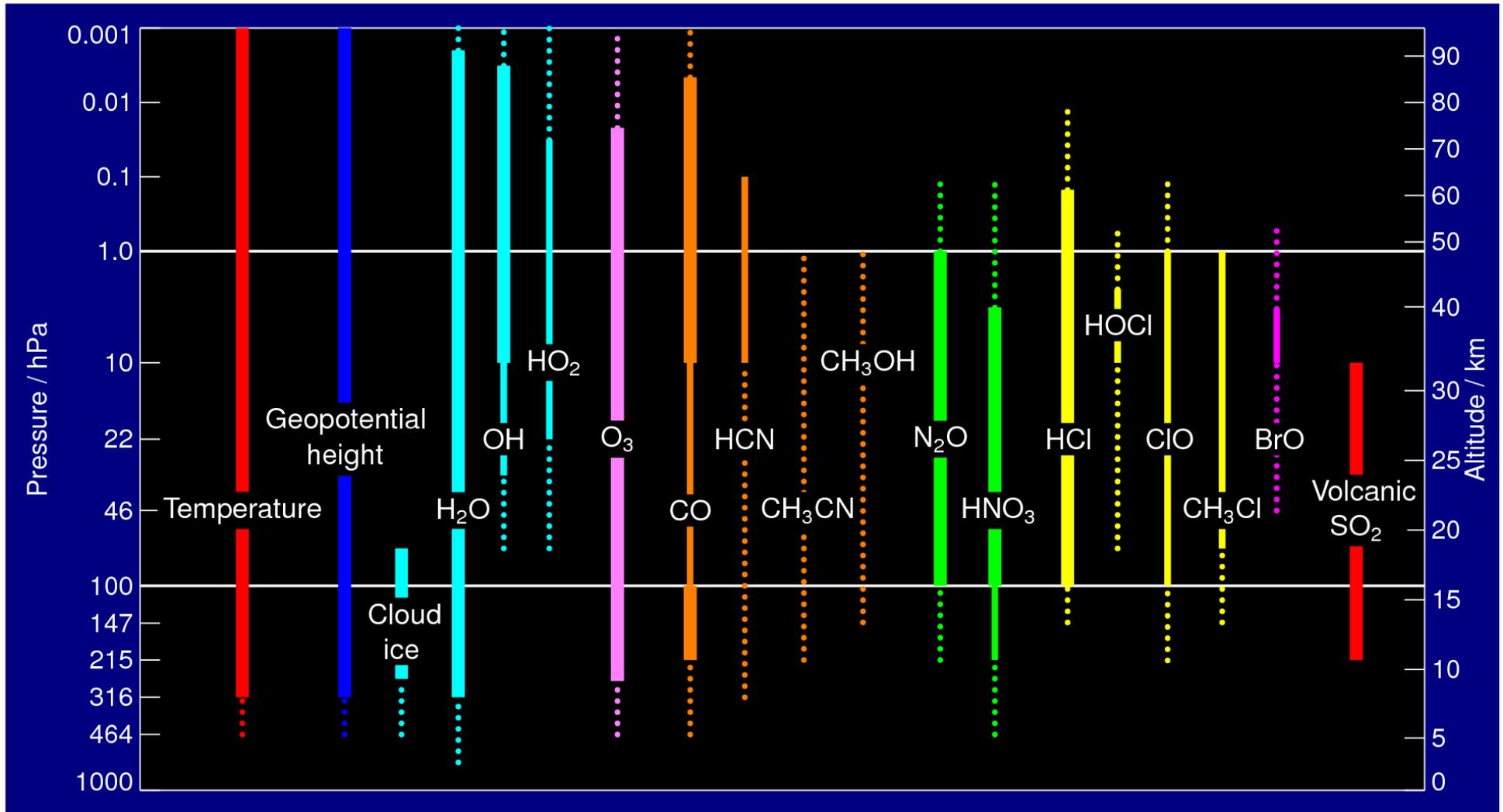
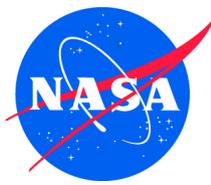
- Microwave Limb Sounder (MLS) on the Aura satellite at the rear of the A-Train views in the forward travel direction
- The satellites all observe nearly the same air-mass (and/or ground pixels) within ~20 minutes of each other
- Glory, GCOM-W1 and OCO-2 are all in development
- Parasol has moved out of the A-train owing to fuel limitations

Aura Microwave Limb Sounder Objectives

- Track the recovery of the ozone layer
- Understand aspects of how atmospheric composition affects climate
- Quantify aspects of pollution in the *upper* troposphere



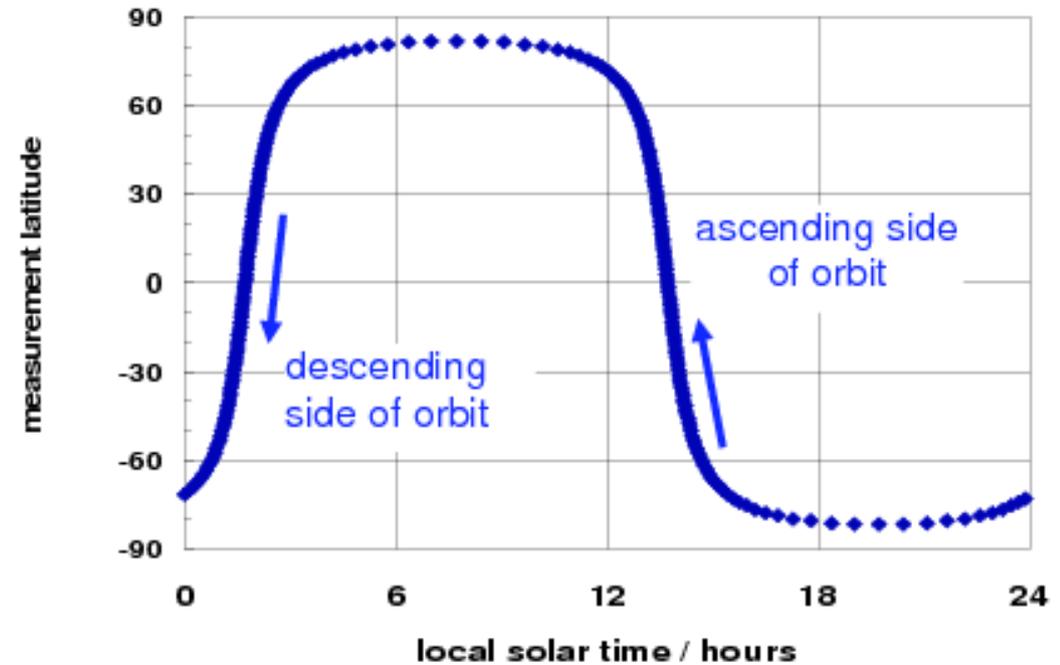
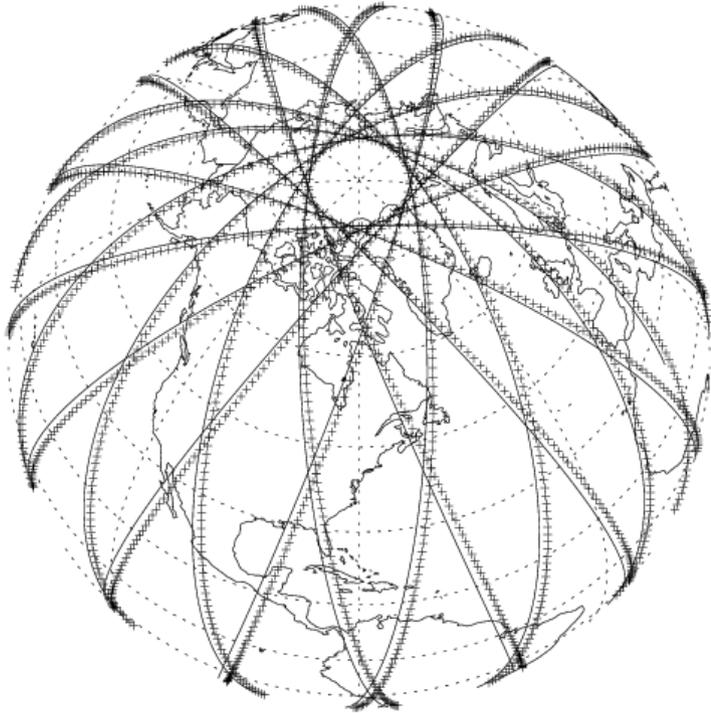
Aura MLS Measurement Objectives



Thinner lines indicate regions/products where averaging (e.g., zonal means) is required for useful signal to noise

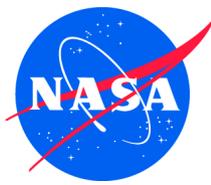
Dotted lines are goals for future versions of the MLS algorithms

Aura MLS Orbit Tracks

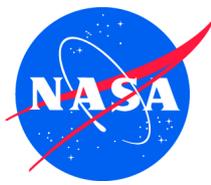


- MLS measurement locations for a 24hr period
- Crosses are the tangent point locations for individual limb scans at the same nominal height
- Continuous line is the sub-orbital track
- Ascending orbits have southeast-northwest tilt
- Aura orbit is Sun-synchronous
- MLS observations at a given latitude on either side of the ascending (north-going) or descending (south-going) parts of the orbit have approximately the same local time throughout the mission

MLS Timeline



L+0	July 15, 2004	Aura Launch
L+29 d	Aug 13, 2004	Full-up science observation start
L+6 m	Jan 2005	First public release of MLS data products (V1.51)
L+18 m	Feb 2006	Band 13 on limited cycle – Feb'06
L+19 m	Mar 2006	Instrument shutdown due to Double Fault
L+16 m	Nov 2006	Initial Validated products (V2.2)
L+3 y	2007	First ROSES Aura Science Team Re-compete
L+5 y	2009	First Senior Review
L+65 m	Dec 2009	THz module in standby mode
L+6 y	2010	Second ROSES Aura Science Team re-compete
L+6 y	Sept 2010	Enhanced products (V3.3)
L+6 y	Sept 30, 2010	Aura End of Prime Mission Review
L+7 y	2011	Second Senior Review

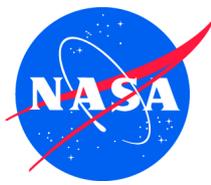


Aura MLS Instrument

- MLS observes thermal microwave emission from rotational lines of atmospheric molecules at sub-mm and mm wavelengths
- Earth limb viewing
 - Improved vertical resolution over passive nadir sounders although the horizontal resolution is worse
 - Lowest level sounded limited to ~400 hPa by continuum emission

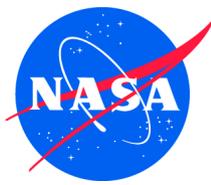
Receiver	Frequency	Main objectives
R1A, R1B	118 GHz	Temperature and pressure (from O ₂)
R2	190 GHz	Upper tropospheric water vapor
R3	240 GHz	Upper tropospheric O ₃ , CO and cloud ice
R4	640 GHz	Stratospheric chemistry
R5H, R5V	2.5 THz	Stratospheric and mesospheric OH

MLS Instrument Status



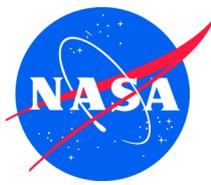
- MLS instrument continues to operate extremely well with a couple of exceptions and is expected to last several more years
- All redundant subsystems are operating on the primary side
- Many 24/7 science data collection weeks
- Current science mode excludes daily measurements for two items (identified as life limited pre-launch)
 - THz Laser Local Oscillator (LLO) exceeded its 1½ year life expectancy by a factor of 3+ and is now powered off to conserve the remaining life
 - Band 13 HCl measurement is now duty cycled to extend the life of this measurement
 - Band 14 provides continuous daily HCl measurements with lower accuracy and precision

MLS Operations



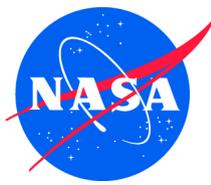
- JPL (MLS)
 - Instrument Project Management
 - Instrument Operations
 - Science
 - Algorithm Development
 - Data Calibration/Validation
 - Data Production (Raytheon)
- GSFC
 - Aura Mission/Science Management
 - Aura Spacecraft Operations
 - Data Operations
 - Data Archives/Distribution
- UK (Univ. Edinburgh)
 - Science
 - Algorithm Development

MLS Data Products



- Level 1 – Calibrated radiances
 - Count – 4 granules/day
 - Size – 3.4 GB/day
- Level 2 – Geophysical parameters as “swaths”
- BrO, ClO, CO, GPH, H₂O, HCl, HCN, HNO₃, HO₂, HOCl, IWC, N₂O, O₃, OH, RHI, SO₂, T, CH₃CN, CH₃Cl
 - Count – 19 granules/day
 - Size – 1 to 2 MB each
- Level 2 – Miscellaneous diagnostic parameters
 - Count – 3 granules/day
 - Size – 725 MB/day
- Near Real Time Products – Temperature and Ozone
 - Count – up to 96 x 2 granules/day
 - Size – < 200 KB/granule
- All output products are formatted in HDF5 or HDF-EOS5 and compliant with Aura Format Guidelines

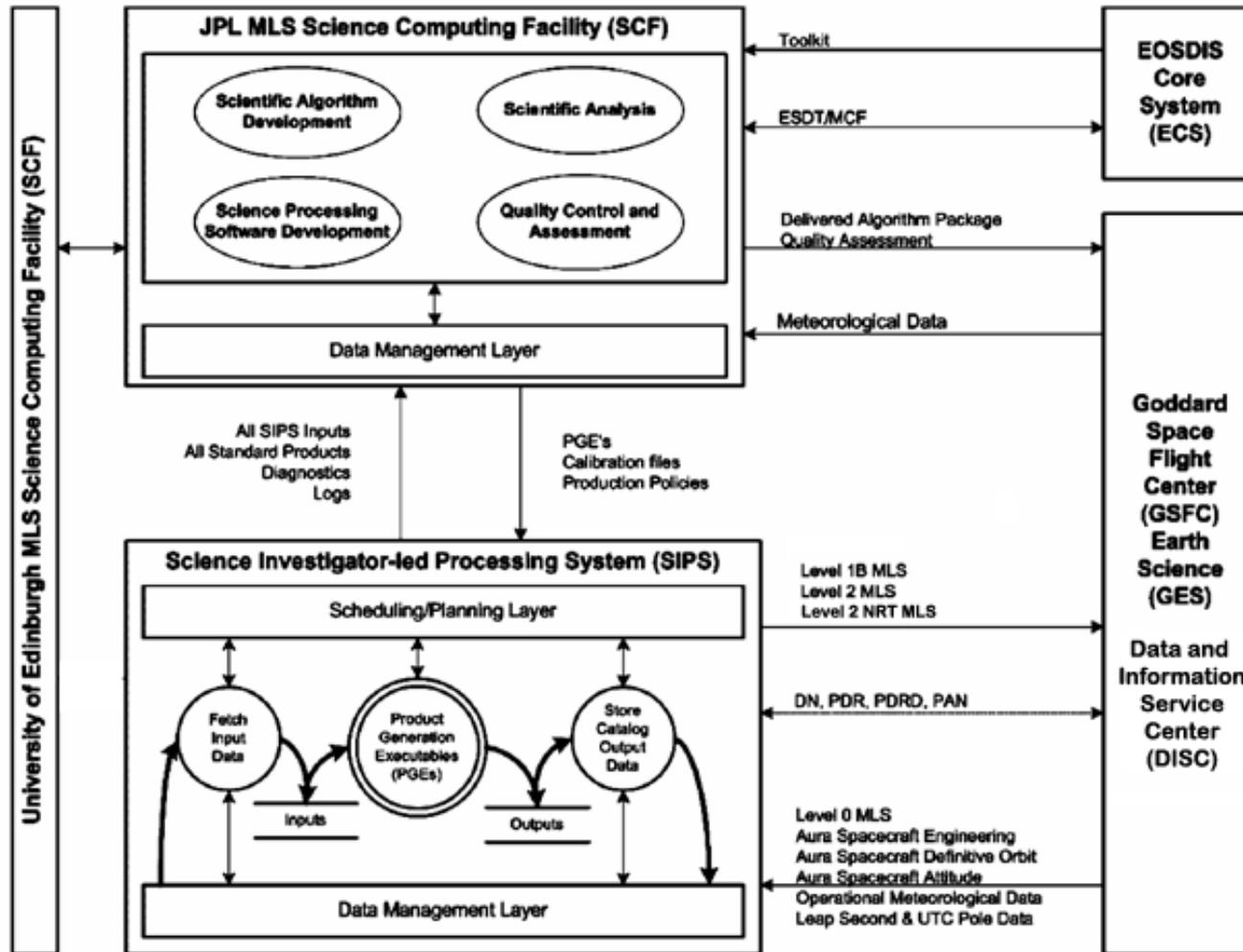
Data Production

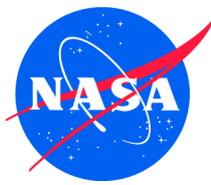


- Operational processing
 - SIPS (Raytheon)
 - GSFC
- Reprocessing
 - Significant effort by the science team to analyze, improve, and test the newer algorithms
 - With 6+ years of archive data, one re-processing campaign can take more than a year with 6x processing power
 - V3.3 expects to consume over 7 million CPU hours

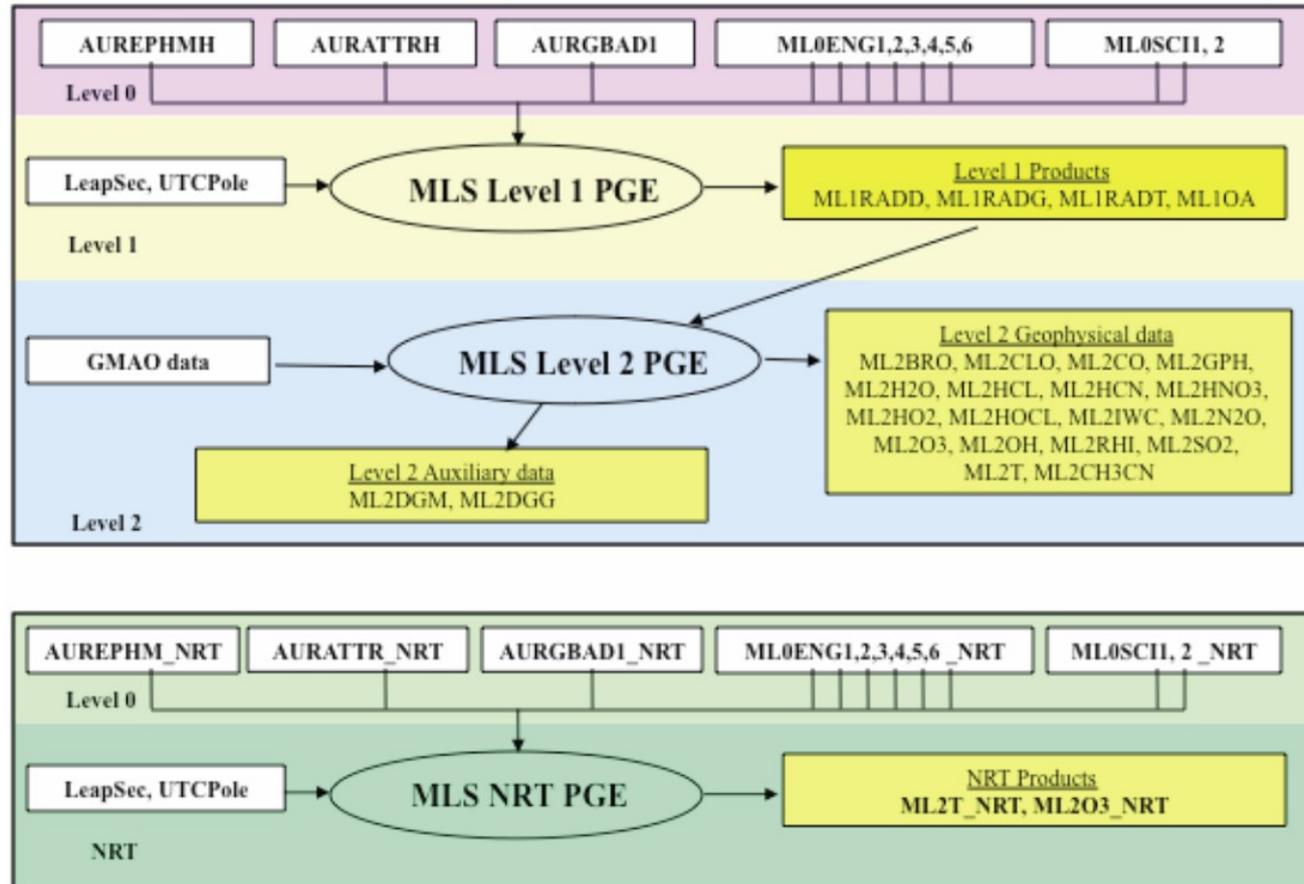


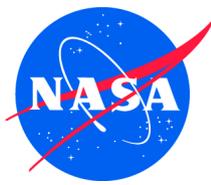
Data Flow





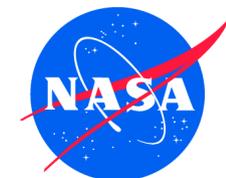
Data Production





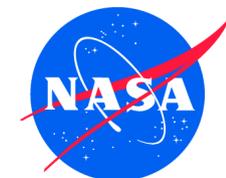
Data Format

- All output products are formatted in HDF5 or HDF-EOS5 and are compliant with Aura Format Guidelines
- Metadata files in XML format accompany each data file
- Filename contains production information:
 - `MLS-Aura_<level>-<product>_<version>-<subversion>-<cycle>_<day>.<extension>`
- Typical data granule consists of a data file and metadata file:
 - `MLS-Aura_L2GP-HCI_v02-23-c01_2010d005.he5`
 - `MLS-Aura_L2GP-HCI_v02-23-c01_2010d005.he5.xml`



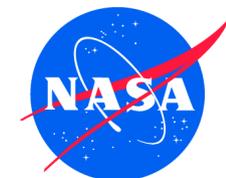
Level 1 Data Products

Product Name	Description	Availability	Contact
ML1OA	Orbit Attitude and Tangent Point Geolocation Data	AUG-04 to Current	Robert Jarnot
ML1RADD	Radiances from Digital Autocorrelators	AUG-04 to Current	Robert Jarnot
ML1RADG	Radiances from Filter Banks for GHz	AUG-04 to Current	Robert Jarnot
ML1RADT	Radiances from Filter Banks for THz	AUG-04 to DEC-09	Robert Jarnot



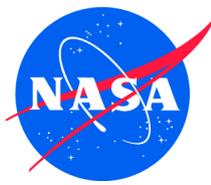
Level 2 Data Products

Product Name	Description	Availability	Contact
ML2BRO	Bromine Monoxide (BrO) Mixing Ratio	AUG-04 to Current	Nathaniel Livesey
ML2CH3CN	Methyl Cyanide (CH3CN) Mixing Ratio		Michelle Santee
ML2CH3CL	Methyl Chloride (CH3Cl) Mixing Ratio		Michelle Santee
ML2CLO	Chlorine Monoxide (ClO) Mixing Ratio		Michelle Santee
ML2CO	Carbon Monoxide (CO) Mixing Ratio		Nathaniel Livesey/ Hugh Pumphrey
ML2DGG	Diagnostics, Geophysical Parameter Grid		N/A
ML2DGM	Diagnostics, Miscellaneous Grid		N/A
ML2GPH	Geopotential Height		Michael Schwartz
ML2H2O	Water Vapor (H2O) Mixing Ratio		Bill Read/ Alyn Lambert
ML2HCL	Hydrogen Chloride (HCl) Mixing Ratio		Lucien Froidevaux
ML2HCN	Hydrogen Cyanide (HCN) Mixing Ratio		Hugh Pumphrey
ML2HNO3	Nitric Acid (HNO3) Mixing Ratio		Gloria Manney/ Michelle Santee



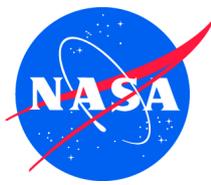
Level 2 Data Products (Cont'd)

Product Name	Description	Availability	Contact
ML2HO2	Hydroperoxy (HO ₂) Mixing Ratio		Shuhui Wang
ML2HOCL	Hypochlorous Acid (HOCl) Mixing Ratio		Lucien Froidevaux
ML2IWC	Cloud Ice Product		Alyn Lambert
ML2N2O	Nitrous Oxide (N ₂ O) Mixing Ratio	AUG-04 to Current	Alyn Lambert
ML2O3	Ozone (O ₃) Mixing Ratio		Nathaniel Livesey/ Lucien Froidevaux
ML2OH	Hydroxyl (OH) Mixing Ratio	AUG-04 to DEC-09	Shuhui Wang
ML2RHI	Relative Humidity With Respect to Ice		Bill Read
ML2SO2	Sulfur Dioxide (SO ₂) Mixing Ratio	AUG-04 to Current	Bill Read
ML2T	Temperature		Michael Schwartz



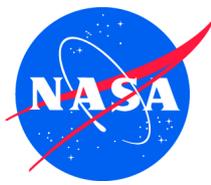
Level 2 NRT Data Products

Product Name	Description	Availability	Contact
ML2O3_NRT	Near-Real-Time L2 Ozone (O ₃) Mixing Ratio	Last 7 days	Alyn Lambert
ML2T_NRT	Near-Real-Time L2 Temperature	Last 7 days	Alyn Lambert



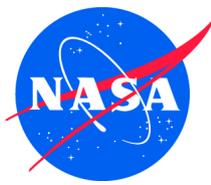
Data Versions

- **Data version 1.5**
 - Covers 08-AUG-2004 through 28-FEB-2007
- **Data version 2.2**
 - Covers 08-AUG-2004 through current time
 - Added the SO₂ product
- **Data version 3.3**
 - Covers 08-AUG-2004 through current time
 - Added the CH₃Cl product
 - Still in reprocessing phase; check for public release soon



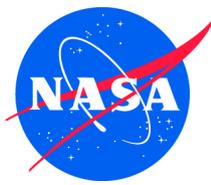
Data Analysis Tools

- The Open Channel Foundation has IDL and Matlab readers for MLS Level 2 data
 - <http://mls.jpl.nasa.gov/data/readers.php>
- The GES-DISC also offers some data readers and on-line data analysis tools, such as Giovanni, which allows users to plot MLS profiles on the web
 - <http://disc.sci.gsfc.nasa.gov/Aura/additional/tools.shtml>



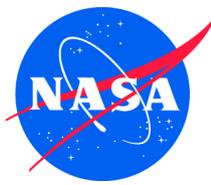
Data Distribution

- The Goddard Earth Science (GES) Data and Information Services Center (DISC) distributes all MLS data
- The GES-DISC is the official archive for all publicly released MLS data
- The GES-DISC makes data available to users free of charge
- For more information visit:
 - <http://disc.gsfc.nasa.gov>
- Aura Validation Center (AVDC) <http://avdc.gsfc.nasa.gov>
 - provides a centralized, long-term, archive for validation data
 - provides predicted and actual field-of-view time/location data for the Aura instruments



Ordering Data: MIRADOR

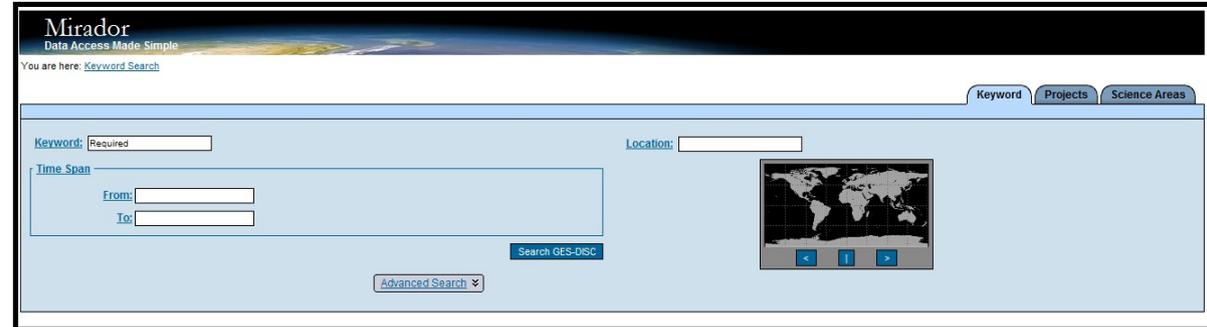
- MIRADOR at the GES-DISC is a tool that allows users to search, browse, and order MLS data
 - <http://mirador.gsfc.nasa.gov>



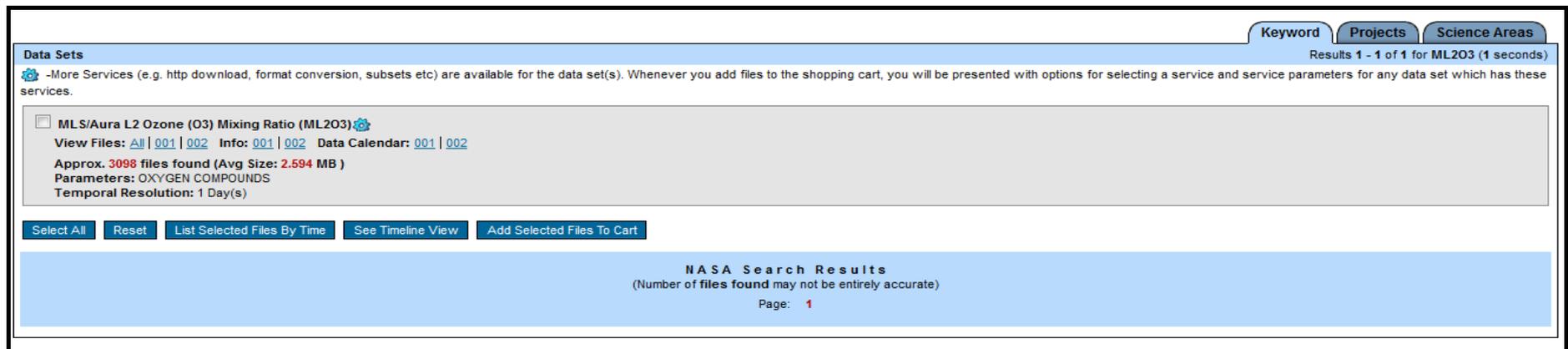
MIRADOR Searching

MIRADOR Search Page

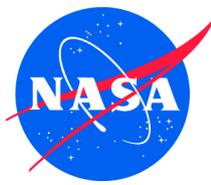
- MIRADOR search lets you search on keyword, date, and spatial location



- Example here shows a search on keyword 'ML2O3'
 - Could also search on 'MLS', 'O3', 'Aura', or 'ozone'
- Results show which version of the data is available and how many files there are



MIRADOR Search Results



MIRADOR Searching

Keyword Projects Science Areas

[A-Train](#) | [AIRS](#) | [GLDAS](#) | [GOCART](#) | [HIRDLS](#) | [LIMS](#) | [MERRA](#) | [MLS](#) | [MSU](#) | [NEESPI](#) | [NLDAS](#) | [OMI](#) | [SORCE](#) | [SSBUV](#) | [TOMS](#) | [TOVS](#) | [TRMM](#) | [UARS](#)

Project	Description	Start Year	End Year
A-Train	Collected with CloudSat subsets of MODIS/Aura, MISR/Era, OH/Aura, and POLSAR/DARASCI	2004	2010

Keyword Projects Science Areas

MLS

The Microwave Limb Sounder (MLS) aboard the EOS-Aura spacecraft (launched July 15, 2004) measures microwave emissions from the Earth's limb at 118, 190, 240 and 640 GHz, and 2.5 THz. These measurements allow MLS to derive vertical profiles of ozone, water vapor, OH, HO₂, CO, HCN, N₂O, HNO₃, HCl, HOCl, ClO, BrO, and SO₂, as well as temperature, cirrus ice, relative humidity with respect to ice, and geopotential height.

Data Group	Description	Date Range
L1_V001	MLS version 1.5 daily level 1 calibrated radiance data products at full temporal resolution (every 24.7 seconds) in the HDF5 (dataset/table model) file format.	2004-08-08 to 2007-02-28
L1_V002	MLS version 2.2 daily level 1 calibrated radiance data products at full temporal resolution (every 24.7 seconds) in the HDF5 (dataset/table model) file format.	2004-08-08 to 2010-10-15
L2_V001	MLS version 1.5 daily level 2 geopotential parameters at full instrument resolution in the HDF5 (dataset/table model) file format.	2004-08-08 to 2007-02-28

Keyword Projects Science Areas

ML2O3.002

MLS Level 2 Ozone (O3) Mixing Ratio

Available Services:

- Subset Spatially
- Download via HTTP

Note: The numbers refer to the number of files available from the archive for that month.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004								20	24	28	30	26
2005						30	30	31	30	30	29	29
2006						30	30	31	30	31	28	31
2007						30	31	29	30	31	29	31
2008						30	31	31	30	31	30	31
2009						30	31	31	30	31	30	31
2010						30	31	31	30	31	30	31

Keyword Projects Science Areas

ML2OH.002

Keyword Projects Science Areas

ML2O3.002

October
15 Data Granules

Su	Mo	Tu	We	Th	Fr	Sa
					1 1	2 1
3 1	4 1	5 1	6 1	7 1	8 1	9 1
10	11	12	13	14	15	16

Keyword Projects Science Areas

MLS/Aura L2 Ozone (O3) Mixing Ratio [Info](#)

Results 1 - 1 for ML2O3 (1 second)

Sort by time: Descending

The following services are available for the data set(s). Whenever you add files to the shopping cart, you will be presented with options for selecting these services.

[Subset Spatially](#) [Download via HTTP](#)

<input checked="" type="checkbox"/> Select All in Page <input type="checkbox"/> File Names/Descriptive File Names	Start Time
<input checked="" type="checkbox"/> MLS-Aura L2GP-O3_v02-23-c01_2010d286.he5 (1.29 MB) Download: HDF5 (FTP) HDF5 (HTTP)	2010-10-13 00:00:00 Metadata

[Add Selected Files To Cart](#)
[Add All Files in All Pages To Cart](#)

NASA Search Results

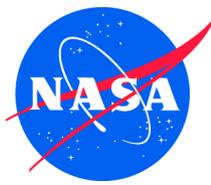
Page: 1



MIRADOR Ordering

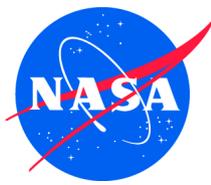
- After your search yields results, you can view the available files
- At this point, you can either download individual files or select the ones you wish to add to your shopping cart

<input checked="" type="checkbox"/> Select All in Page <input type="checkbox"/> File Names/Descriptive File Names		Start Time
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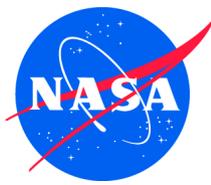
Ordering Data: FTP

- The GES-DISC supports anonymous FTP access to standard Level 1 and Level 2 products
 - ftp://aurapar1u.ecs.nasa.gov/data/s4pa/Aura_MLS_Level1
 - ftp://acdisc.gsfc.nasa.gov/data/s4pa/Aura_MLS_Level2
- For access to NRT data, you must register with the LANCE system for FTP access (it's free)
 - ftp://discnrt1.ecs.nasa.gov/data/Aura_NRT
- Scripts can easily be created to get batches of MLS data or to routinely retrieve the data



Ordering Data: OpenDAP

- Open DAP is the “Open-source Project for a Network Data Access Protocol”
- Allows users to grab data from a file over HTTP
- Users can select and subset data on-the-fly without downloading the entire file to their local system



OPeNDAP Server Dataset Access Form

Action:

Data URL:

Global Attributes:

```
NC_GLOBAL.title: NASA EOS Aura Swath
NC_GLOBAL.Conventions: CF-1.4
/HDFEOS_INFORMATION/coremetadata.0.INVENTORYMETADATA.GROUPTYPE:
MASTERGROUP
/HDFEOS
```

Variables:

Convergence: Array of 32 bit Reals [nTimes = 0..3494]
nTimes:
units: NoUnits
_FillValue: -999.9899902
title: H2OConvergence
missing_value: -999.9899902
UniqueFieldDefinition: MLS-Specific

L2gpPrecision: Array of 32 bit Reals [nTimes = 0..3494][nLevels = 0..46]
nTimes: nLevels:
_FillValue: -999.9899902
title: H2OPrecision
units: var
missing_value: -999.9899902
UniqueFieldDefinition: HIRDLS-MLS-RES-Shared
coordinates: lat lat

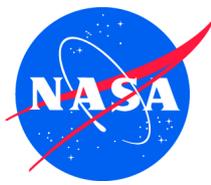
L2gpValue: Array of 32 bit Reals [nTimes = 0..3494][nLevels = 0..46]
nTimes: nLevels:
_FillValue: -999.9899902
title: H2O
units: var
missing_value: -999.9899902
UniqueFieldDefinition: HIRDLS-MLS-RES-Shared
coordinates: lat lat

Quality: Array of 32 bit Reals [nTimes = 0..3494]
nTimes:
units: NoUnits
_FillValue: -999.9899902
title: H2OQuality
missing_value: -999.9899902
UniqueFieldDefinition: MLS-Specific

Status: Array of 32 bit Integers [nTimes = 0..3494]
nTimes:
_FillValue: 513
title: H2OStatus
units: NoUnits
missing_value: 513

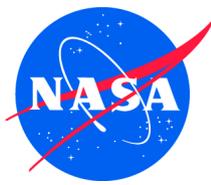
OpenDAP

- With the data URL, users have direct access to the variables within the HDF-EOS5 files
- You can download an ASCII or netCDF subsetted file, or grab the data through a client
- OpenDAP supports clients for Matlab, IDL, and Java



OpenDAP Access

- The GES-DISC OpenDAP server is located at:
 - <http://acdisc.sci.gsfc.nasa.gov/opendap>
- Additional information about OpenDAP is located at: <http://www.opendap.org>



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Microwave Limb Sounder

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- UARS MLS
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Welcome
The Microwave Limb Sounder (MLS) experiments measure naturally-occurring microwave thermal emission from the limb (edge) of Earth's atmosphere to remotely sense vertical profiles of atmospheric gases, temperature, pressure, and cloud ice. The overall objective of these experiments is to provide information that will help improve our understanding of Earth's atmosphere and global change.

QUICK ACCESS

Download MLS Data

From: BrO v2.2 GO

To:

Plots

Register as a Data User

Data Processing Calendar

Documentation

NEAR REAL-TIME DATA VIEWER

Current GMT day: Choose Overlay

Data maps are at 46 hPa

LATEST PUBLICATIONS

1. Haigh, J.D., A.R. Winning, R. Toumi, and J.W. Harder, "An influence of solar spectral variations on radiative forcing of climate," *Nature* 467, 696, 10.1038/nature09426, 2010. [reprint](#)
2. Petropavlovskikh, I., E. Ray, S.M. Davis, K. Rosenlof, G. Manney, R. Shetter, S.R. Hall, K. Ullmann, L. Pfister, J. Hair, M. Fenn, M. Avery, and A.M. Thompson, "Low-ozone bubbles observed in the tropical tropopause layer during the TC4 campaign in 2007," *J. Geophys. Res.* 115, D00J16, 10.1029/2009JD012804, 2010. [reprint](#)
3. Su, H., J.H. Jiang, J. Teixeira, A. Gettelman, X. Huang, G. Stephens, D. Vane, and V.S. Perun, "Comparison of Regime-Sorted Tropical Cloud Profiles Observed by CloudSat with General Circulation Model Simulations," *J. Geophys. Res.*, in review. [reprint](#)
4. Olsen, M.A., A.R. Douglass, M.R. Schoeberl, J.M. Rodriguez, and Y. Yoshida, "Interannual variability of ozone in the winter lower stratosphere and the relationship to lamina and irreversible transport," *J. Geophys. Res.* 115, D15305, doi:10.1029/2009JD013004, 2010. [reprint](#)
5. Claeysman, M., J.L. Attie, L. El Amraoui, D. Cariolle, V. Peuch, H. Teyssedre, B. Josse, P. Ricaud, S. Massart, A. Piacentini, J.P. Cammas, N.J. Livesey, H.C. Pumphrey, and D.P. Edwards, "A linear CO chemistry parameterization in a chemistry-transport model: evaluation and application to data assimilation," *Atmos. Chem. Phys.* 10, 6097-6115, doi:10.5194/acp-10-6097-2010, 2010. [reprint](#)

[> More Publications](#)

MLS MOBILE SITE

ABOUT

The Microwave Limb Sounder (MLS) experiments measure naturally-occurring microwave thermal emission from the limb (edge) of Earth's atmosphere to remotely sense vertical profiles of atmospheric gases, temperature, pressure, and cloud ice. The overall objective of these experiments is to provide information that will help improve our understanding of Earth's atmosphere and global change.

[Aura MLS](#) | [UARS MLS](#)

MLS now has a website that has been optimized for many mobile devices. On this site you can quickly look up information on data products, publications, and even view selected daily plots. Check it out on your iPhone, BlackBerry, or other web-enabled phone today!

[MLS Mobile Site](#)

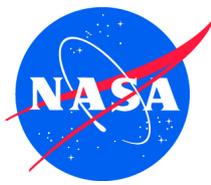
PRIVACY | TEAM

Site Manager: Nathaniel Livesey
Webmaster: Brian Knosp
JPL Clearance: CL# 97-0564

MLS Website

- Website hosts information on MLS project and research activities
- Site averages **14,736** visits per month
- There are currently **343** registered data users

<http://mls.jpl.nasa.gov>



Quick Access Area

A screenshot of a web interface titled "QUICK ACCESS". The main section is "Download MLS Data" with a dropdown arrow. Below this are two input fields: "From:" and "To:". The "From:" field contains "BrO" and has a dropdown arrow. The "To:" field is empty. To the right of the "From:" field is a dropdown menu showing "v2.2" with a dropdown arrow. A "GO" button with a right-pointing arrow is located to the right of the "To:" field. Below the "Download MLS Data" section are four navigation links, each with an upward-pointing arrow: "Plots" (yellow background), "Register as a Data User" (green background), "Data Processing Calendar" (teal background), and "Documentation" (blue background).

- Use the “Quick Access” area to:
 - Search for data
 - Search for plots
 - Register as a user
 - See processing status
 - Read data documentation

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THE MLS ClO PRODUCT

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- HNO3
- HO2
- HOCl
- HNC
- N2O
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Data Plot Gallery

Data User Registration

Data Access

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Documentation

Data Validation

UARS MLS

Research

Publications

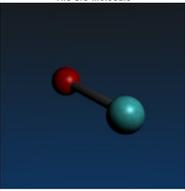
Personnel

Concepts

Contact: [Michelle Santee](#)

Basic Information

Chlorine monoxide (ClO) is the dominant form of reactive chlorine in the stratosphere and is thus the principal agent for chlorine-catalyzed destruction of stratospheric ozone. The primary source of stratospheric chlorine is chlorofluorocarbons, or CFCs, chemical compounds composed of chlorine, fluorine, and carbon that are emitted by human activities at the surface. After they reach the upper stratosphere (primarily by upwelling in the tropics), the CFCs are broken down by high-energy UV radiation, liberating chlorine. Away from the polar regions, most of the chlorine released from CFCs resides in relatively benign reservoir species such as ClONO2 and HCl that do not directly destroy ozone. In the winter polar regions, however, heterogeneous chemical reactions on the surfaces of polar stratospheric clouds convert chlorine to highly reactive forms. Enhanced levels of ClO are a signal that ozone destruction is taking place.

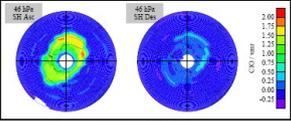


How it is part of MLS Science Objectives

One of the main objectives of the Aura mission in general and MLS in particular is to track the stability of the stratospheric ozone layer. Simultaneous measurements of HCl and ClO from MLS provide information on reservoir and reactive chlorine and the partitioning between them that is crucial for understanding (and thus predicting) stratospheric ozone depletion.

How EOS MLS measures ClO

The standard product for ClO is taken from the 640 GHz (Core+R44) retrieval. ClO is strongly diurnal in the lower stratosphere.

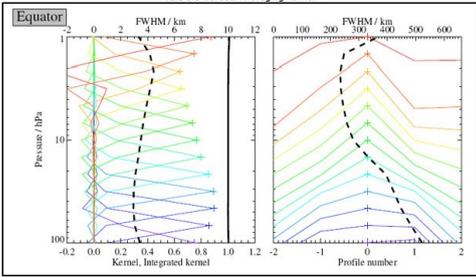


(map from 20050250)

Quick Product Information for data version v2.2

- Precision: +/- 0.1 ppbv from 100-1.5 hPa
- Vertical Resolution: ~3.5km
- Useful Range: 100 - 1 hPa
- DAAC Short Name: ML2CLO
- Artifact: A significant negative bias (ranging from -0.02 to -0.41 ppbv) is present in both daytime and nighttime mixing ratios below 22 hPa. See [v2.2 data quality document](#) for information on correcting this bias.

v2.2 ClO Vertical Averaging Kernel



colored lines are individual kernels; thick dashed line is full width at half maximum; thick solid is integrated kernel value

Publications related to the MLS ClO data product

2010

1. Santee, M.L., S.P. Sander, N.J. Livesey, L. Froidevaux, "Constraining the chlorine monoxide (ClO) / chlorine peroxide (ClOOC) equilibrium constant from Aura Microwave Limb Sounder measurements of nighttime ClO", vol 107, num 15, pgs. 6588-6593, 2010.

2009

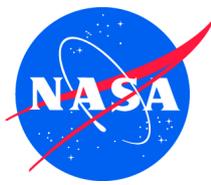
1. Kuttippurath, J., S. Godin-Beekman, F. Lefevre, A. Pazmino, "Ozone depletion in the Arctic winter 2007-2008", vol 30, num 15-16, pgs. 4071-4082, 2009. [Reprint](#)

PRIVACY | TEAM

Site Manager: Nathaniel Livesey
Webmaster: Brian Knopp
JPL Clearance: CL# 97-0564

Product Information

- Product pages on the MLS website give quick information about all the MLS Level 2 products
- Information includes:
 - Overview
 - Version specific details
 - Averaging kernels
 - Publications dealing with the product



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EOS MLS OPERATIONS AND V2.2 DATA

The calendar below displays daily EOS MLS instrument and data version 2.2 processing status. Background colors give instrument status and font colors give data processing status. Aura was launched 15 July 2004 and MLS science data operations began 13 August 2004.

[v2.2 Processing Schedule](#)
[Visit the v1.5 processing calendar](#)

Background Colors (Instrument Op. Status)

Font Colors (Data Processing Status)

No v2.2 Processing (Black)

v2.2 Level 1 Processed (Blue)

v2.2 Level 2 Processed (Green)

Instrument Operation Status:

- "100%" day -- All instrument operations on this day were nominal, which implies that science data collection was performed in a standard fashion.
- "90%-99%" day -- There were instrument or spacecraft events that impacted standard science data collection and there were a few hours of data outages. On these days, one can expect up to ~2 hours of science data outages.
- "<90%" day -- There were instrument or spacecraft events that impacted standard science data collection and major data outages occurred. Whether these events were planned or unplanned, on these days, one can expect > 2 hours of science data outages if these days are processed.

Data Processing Status:

- "No v2.2 Processing" -- No data for this date have been processed using v02.2X software, which could be due to any number of constraints or processing priorities. Data for these days may be re-processed with v2.2 at a later date.
- "v2.2 Level 1 Processed" -- All standard [MLS Level 1 data products](#) have been processed for this day using v02.2X processing, but processing has not yet progressed to Level 2.
- "v2.2 Level 2 Processed" -- All standard [MLS Level 1 and 2 data products](#) have been processed for this day using v2.2 processing software.

On calendar days, the first number denotes day of year and second number is the date.

2004													
August													
228	229	230	231	232	233	234	249	250	251	252	253	254	255
15	16	17	18	19	20	21	05	06	07	08	09	10	11
235	236	237	238	239	240	241	256	257	258	259	260	261	262
22	23	24	25	26	27	28	263	264	265	266	267	268	269
242	243	244	245	246	247	248	270	271	272	273	274	275	276
29	30	31	01	02	03	04	26	27	28	29	30	01	02
September		October		November		December							
277	278	279	280	281	282	283	312	313	314	315	316	317	318
03	04	05	06	07	08	09	07	08	09	10	11	12	13
284	285	286	287	288	289	290	319	320	321	322	323	324	325
10	11	12	13	14	15	16	14	15	16	17	18	19	20
291	292	293	294	295	296	297	326	327	328	329	330	331	332
17	18	19	20	21	22	23	21	22	23	24	25	26	27
298	299	300	301	302	303	304	333	334	335	336	337	338	339
24	25	26	27	28	29	30	28	29	30	01	02	03	04
305	306	307	308	309	310	311							
31	01	02	03	04	05	06							
340	341	342	343	344	345	346							
05	06	07	08	09	10	11							
347	348	349	350	351	352	353							
12	13	14	15	16	17	18							
354	355	356	357	358	359	360							
19	20	21	22	23	24	25							
361	362	363	364	365	366	001							
26	27	28	29	30	31	01							

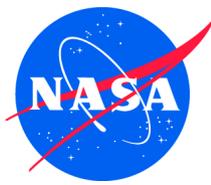
Major MLS operational changes: 2004

Launch from VAFB	15-JUL
Start Normal Science Operations	13-AUG
R1B Turned On	10-SEP
Optical Bench Heaters to 100%	09-NOV

[See v1.5 calendar for 2004](#)

Data Calendar

- Data calendar gives users information on instrument status, data processing, and operational changes



Microwave Limb Sounder



Search Go

EOS MLS DATA DOCUMENTATION

The following are a list of links that are pertinent to the quality of the EOS MLS data. Additionally, information regarding data validation, instrument calibration, and data processing algorithms.

v2.2 Data Quality Documentation

- Publications
 - [Version 2.2 Level 2 Data Quality Document](#)
 - [A short guide to the use and interpretation of v2.2x Level 1 data](#)

Data Processing Information Tables

MLS Version	Major Change
v02.20	Initial release of v2 (validated) data
v02.21	Deconvolve DACS radiances in level 1
v02.22	Level 2 recompiled with Intel for 2x speedup
v02.23	Changes to cope with Aura FMU anomaly

GMAO Version	Dates used in MLS data processing
GEOS 5.0.1	2004 August 8 (d221) - 2007 November 30 (d334)
GEOS 5.1.0	2007 December 1 (d335) - 2008 September 14 (d258)
GEOS 5.2.0	2008 September 15 (d259) - present

v1.5 Data Quality Documentation

- Publications
 - [Version 1.5 Level 2 Data Quality Document](#) (for standard atmospheric products)
 - [Supplement to Version 1.5 Level 2 Data Quality Document](#) (for atmospheric diagnostic products)
 - [Short guide to the use and interpretation of v1.5 Level 1 data](#)

Validation-Related Documentation

- Publications
 - [Early validation of MLS Data](#)
 - [Balloon validation of OH and HO₂](#)
 - [CO first results](#)
 - [Comparisons of ML S CO with global CTM simulation](#)
 - [Comparisons of cloud ice from MLS analyses and GCMs](#)
- [Aura Validation Data Center \(AVDC\) website](#)

Instrument Calibration and Performance Documentation

- Publications
 - [GHz radiometric and spectral calibration](#)
 - [GHz field-of-view calibration](#)
 - [THz calibration](#)

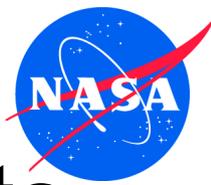
Data Algorithm and Software Documentation

- Publications
 - [Radiance calibration algorithms](#)
 - [Retrieval algorithms](#)
 - [Cloud ice measurements](#)
 - [Standard forward model](#)
 - [Polarized mesospheric O₂ forward model](#)
 - [MLS science data processing system](#)
- Algorithm Theoretical Basis Documents
 - [An Overview of the EOS ML S Experiment](#)
 - [EOS ML S Level 1 Data Processing Algorithm Theoretical Basis](#)
 - [EOS ML S Retrieval Process Algorithm Theoretical Basis](#)
 - [Precision Estimates for the Geophysical Parameters](#)
 - [EOS ML S Forward Model Algorithm Theoretical Basis Document](#)
 - [EOS ML S Algorithm Theoretical Basis for Cloud Measurements](#)
 - [EOS ML S Mesosphere-Specific Forward Model Algorithm Theoretical Basis Document](#)
 - [EOS ML S Level 3 Algorithm Theoretical Basis](#)

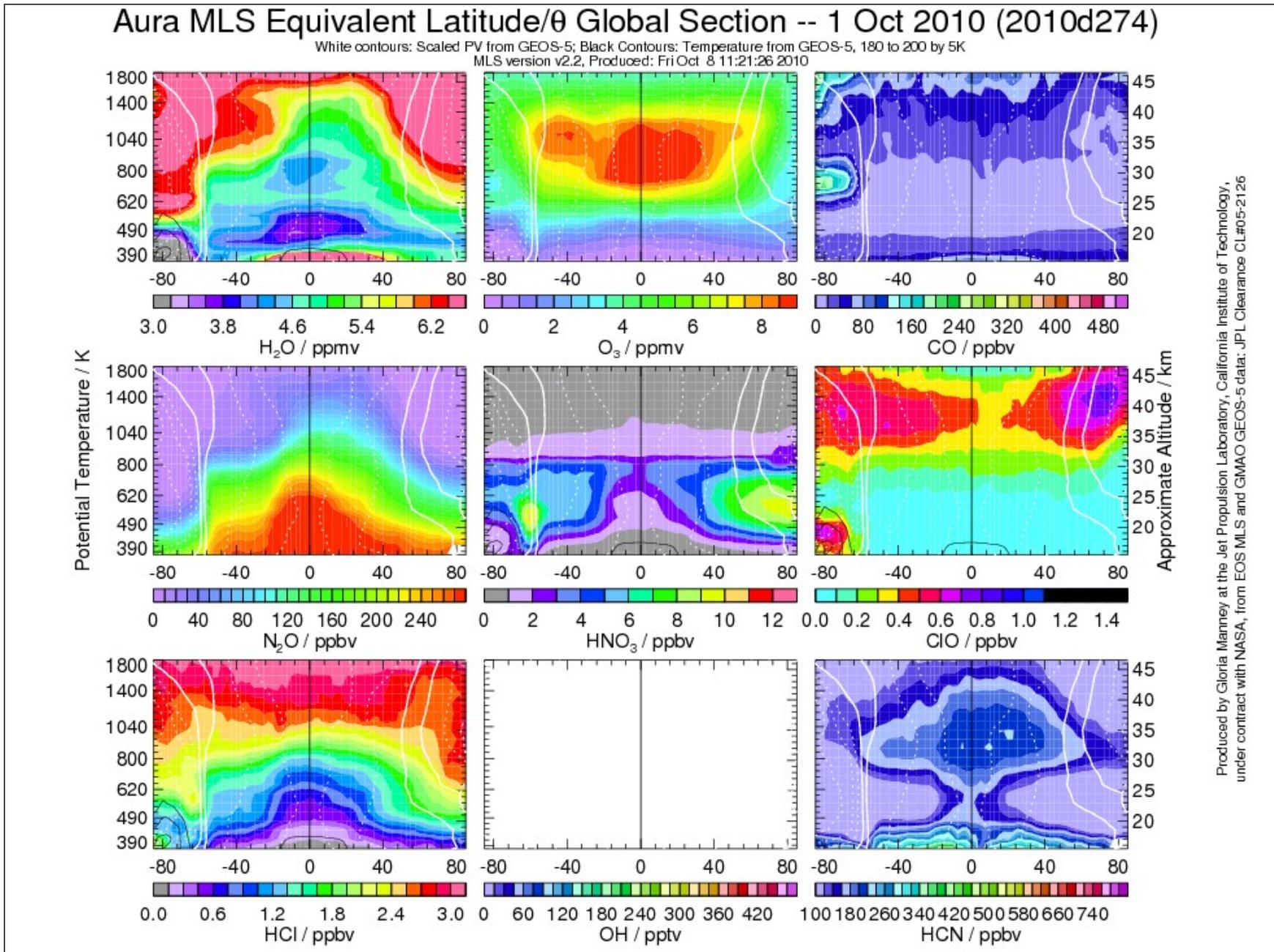
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- Aura Mission
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 - ClO
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Data Documentation

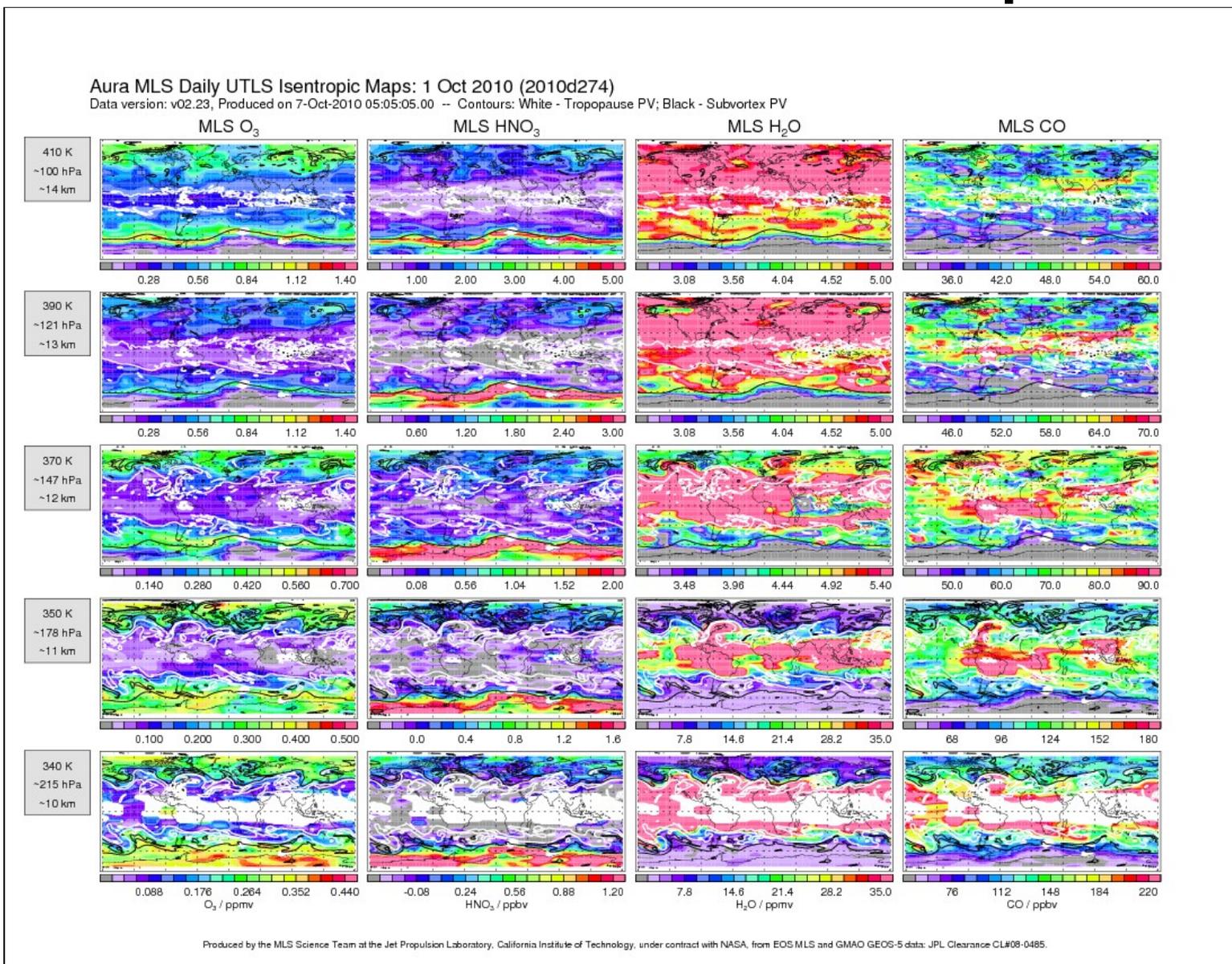
- Data Quality Documents
- Validation Documents
- Instrument/Calibration Documents
- Software Documents
- ATBDs

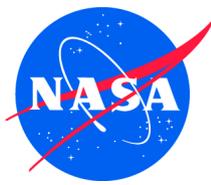


Data Plots: Stratospheric EqL/ θ Plots

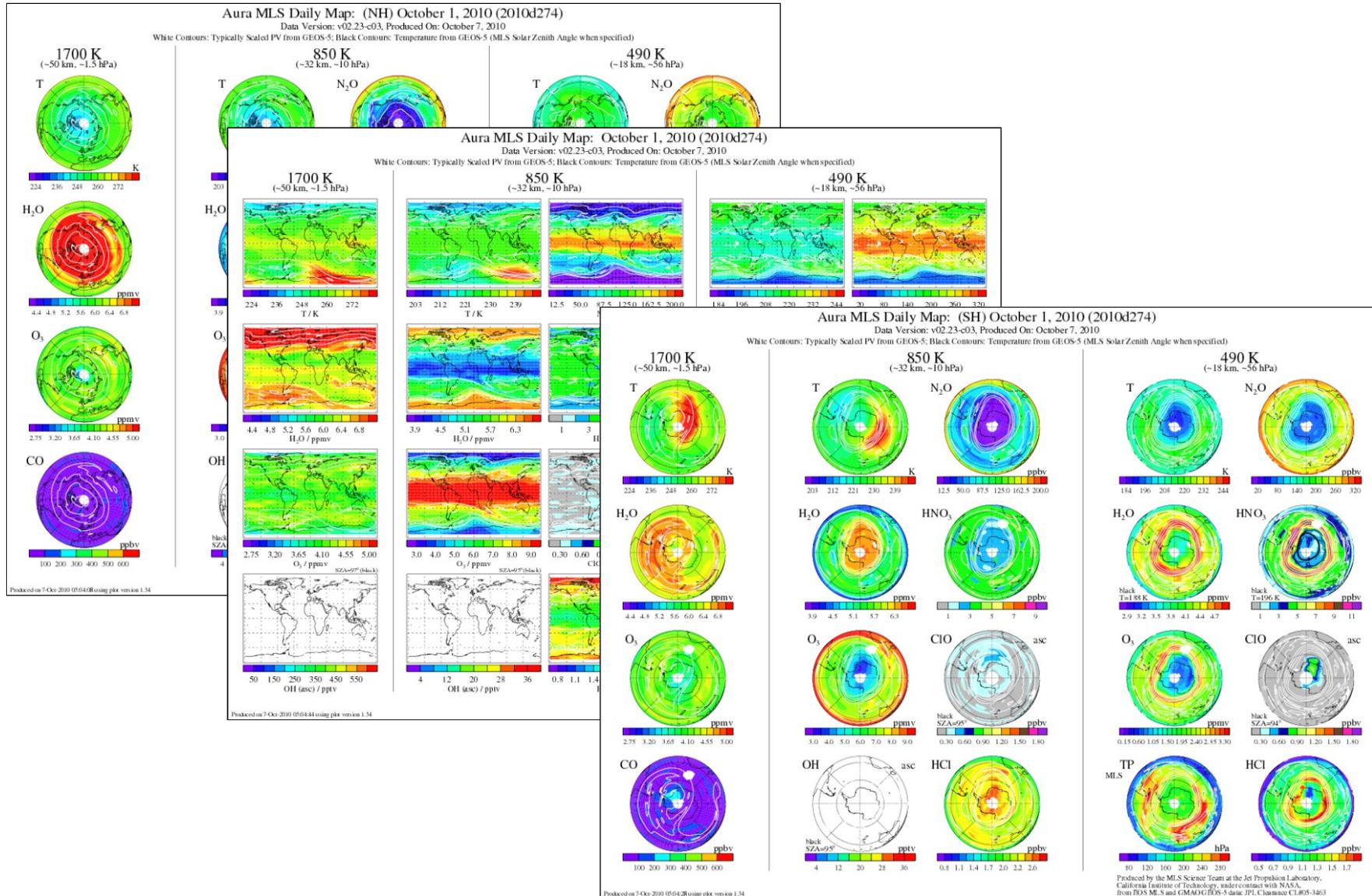


Data Plots: UTLS Isentropic Plots





Data Plots: Polar Projection Plots

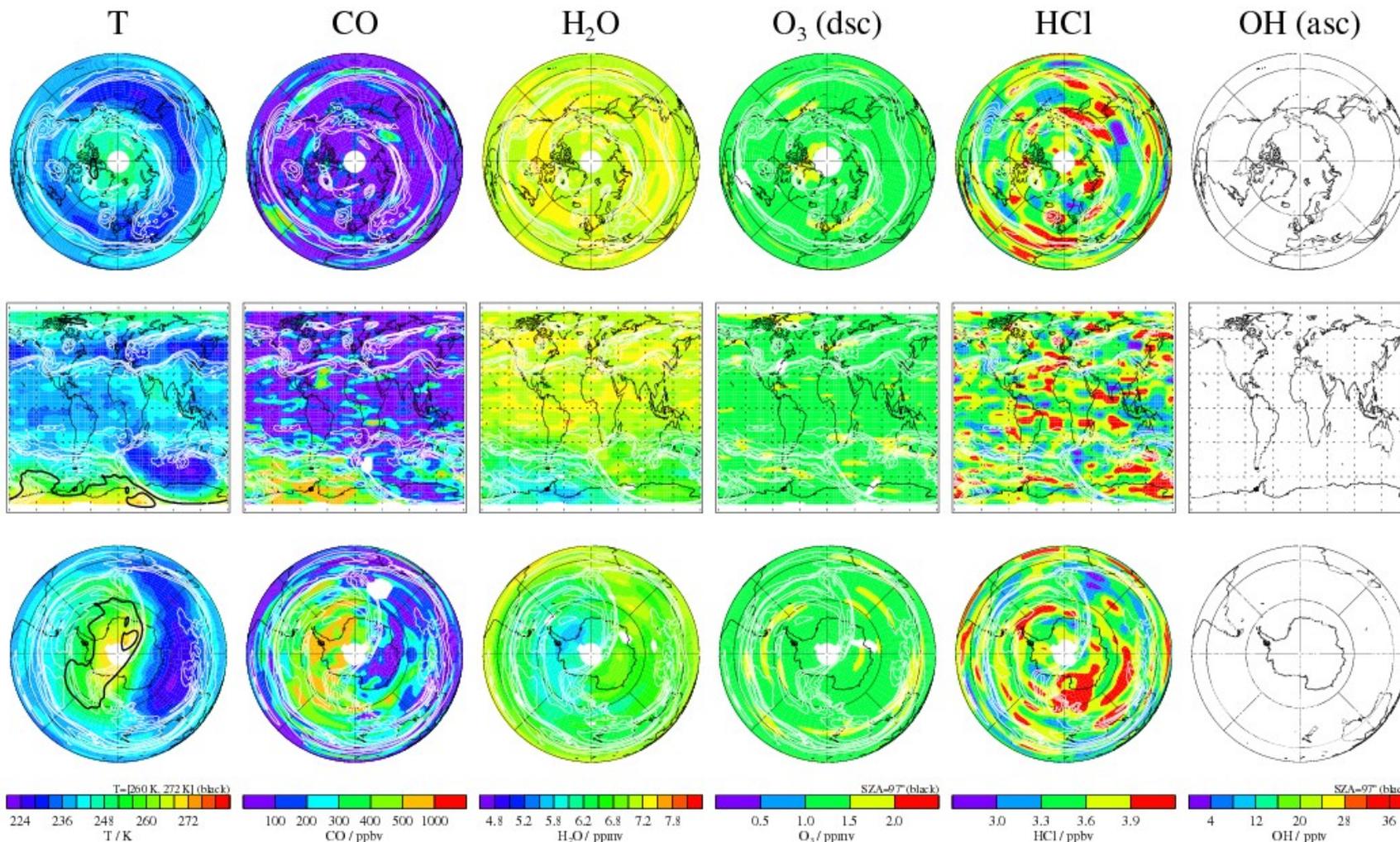


Data Plots: Mesospheric Plots

MLS Aura Daily Map: 2700 K (~60 km, ~0.2 hPa) October 1, 2010 (2010d274)

Data Version: v02.23-c03, Produced On: October 7, 2010

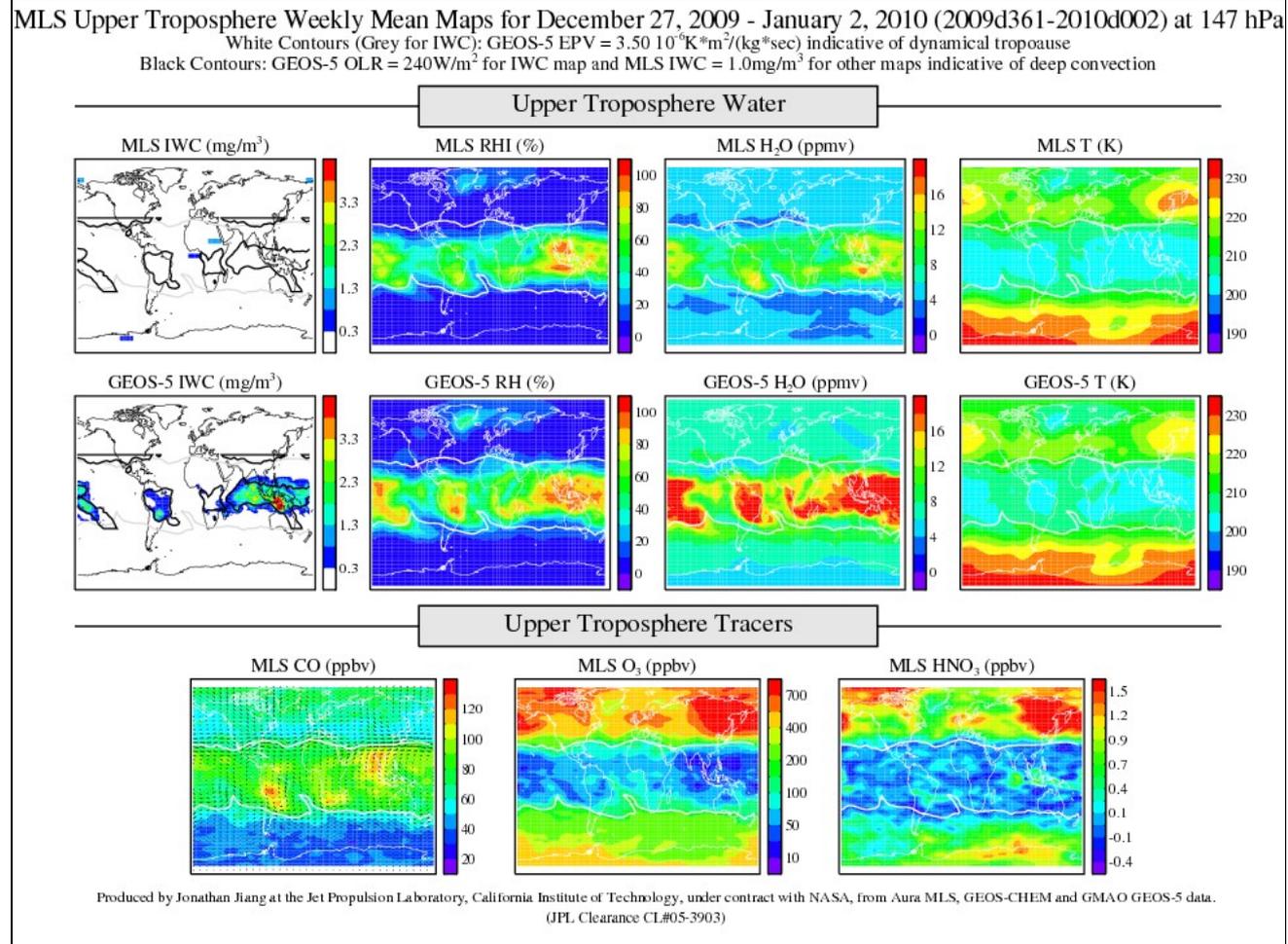
White Contours: Scaled PV from GEOS-5; Black Contours: MLS Solar Zenith Angle (Temperature from GEOS-5 when specified)

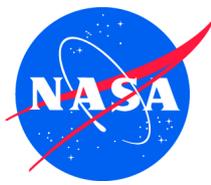


Produced on 7-Oct-2010 05:02:01 using plt4 version 1.24

Produced by the MLS Science Team at the Jet Propulsion Laboratory, California Institute of Technology, under contract with NASA, from EOS MLS and GMAO GEOS-5 data: JPL Clearance CL#05-3463

Data Plots: Weekly Upper Tropospheric Plots

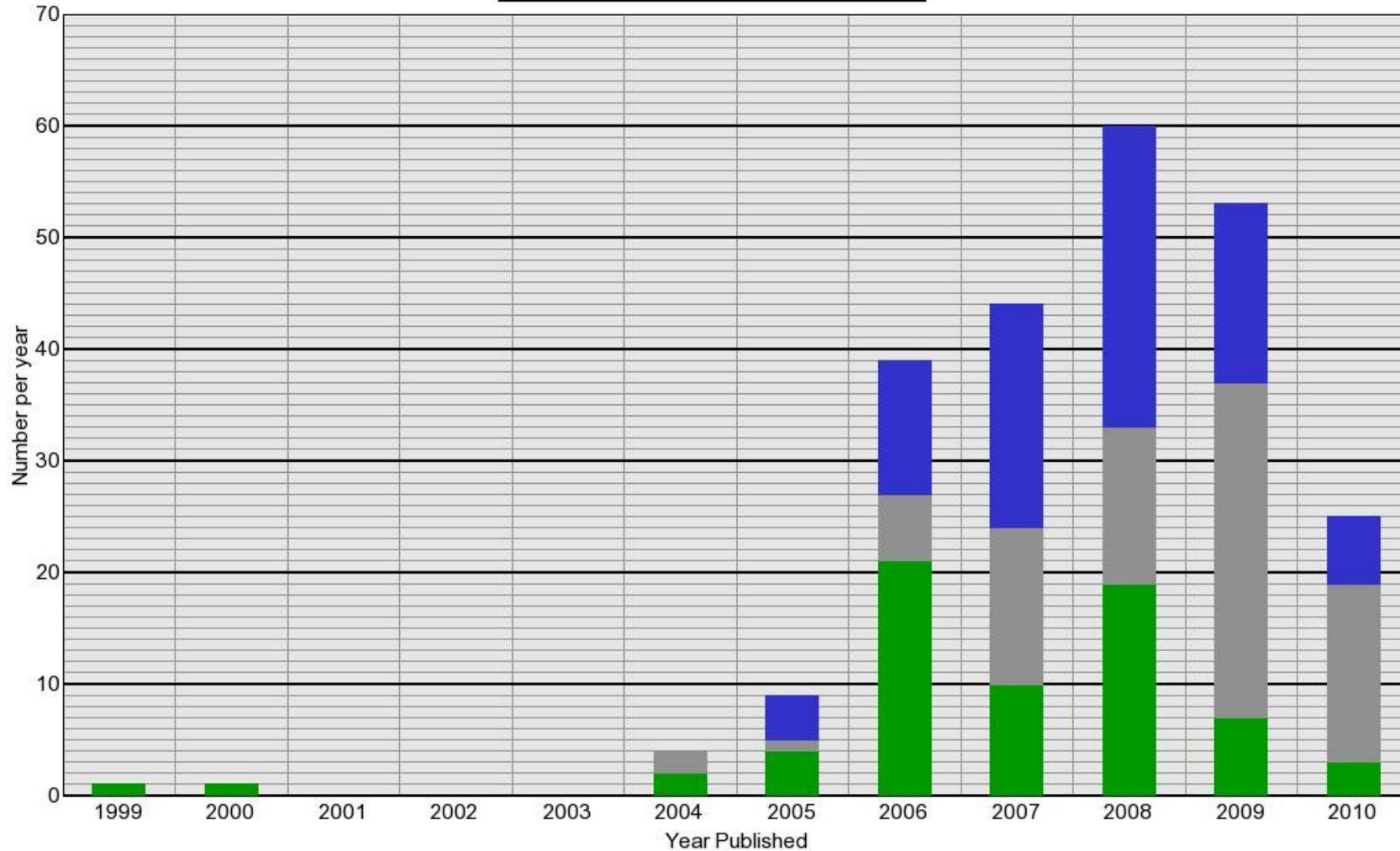
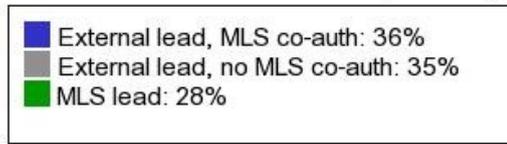


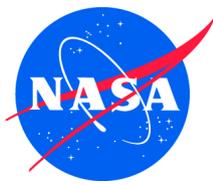


MLS Publications

Aura-MLS-related peer-reviewed publications (1999 - 2010)

(236 total, full citations available at <http://mls.jpl.nasa.gov>)





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MLS-RELATED PUBLICATIONS

Please fill out the form below to search through MLS-related publication from 1973 - present.

Author Last Name:

Title:

Year:

Products (hold Ctrl key for multiple selections):

Subjects (hold Ctrl key for multiple selections):

Instrument: EOS MLS UARS N/A

Journal Name:

(scroll down for search results)

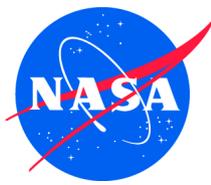


2010 publications

1. Barnett, J.E., Williams, I., Bouarar, Y., Yang, B., Josse, K., Law, M., Pithan, E., LeFlochmoen, C., Liousse, V.H., Peuch, G.D., Carver, J.A., Piva, B., Saayag, P., vanethoven, H., Schlager, C., Han, and J.P. Cammas. "Trend of West African Monsoon convective transport and lightning NOx production upon the upper tropospheric composition: a multi-model study." *Atmos. Chem. Phys.* 10, 5719-5738, doi:10.5194/acp-10-5719-2010, 2010. [\[abstract\]](#)
2. Bhawar, R.L., and P.C. Dewara. "Study of successive contrasting monsoons (2001-2002) in terms of aerosol variability over a tropical station Pune, India." *Atmos. Chem. Phys.* 10, 29-37, 2010. [\[abstract\]](#)
3. Chipperfield, M., D. Kinnison, S. Bekas, H. Bian, C. Bruhl, T. Canty, I. Colino, S. Dhomka, L. Froidevaux, R. Fuller, R. Müller, M. Pithan, R. Salathé, M. Santee, H. Tian, and S. Timme. "SPARC CCMAR: SPARC CCMAR Report: WMO Ozone Res. Monit. Proj., No. 5, 191-253, Chapter 6 (Stratospheric Chemistry), V. Eyring, T. Shepherd and O. Waugh, eds, in press. [\[abstract\]](#)
4. Clayman, M., J.L. Abba, L. El Amraoui, D. Carole, V. Peuch, H. Teyssède, B. Josse, P. Ricaud, S. Massat, A. Placentini, J.P. Cammas, H. L. Linsley, H.C. Pumphrey, and D. Edwards. "A linear CO chemistry parameterization in a chemistry-transport model: evaluation and application to data assimilation." *Atmos. Chem. Phys.* 10, 6007-6115, doi:10.5194/acp-10-6007-2010, 2010. [\[abstract\]](#)
5. Dyrland, M.E., C.M. Hall, F.J. Mulligan, and M. Tsutsui. "Improved estimates for neutral air temperatures of 90 km and 78°N using satellite and meteor radar data." *Radio Science*, 10.1029/2009RS004344, in press. [\[abstract\]](#)
6. El Amraoui, L., J.L. Abba, N. Semane, M. Clayman, V.H. Peuch, J. Warner, P. Ricaud, J.P. Cammas, A. Placentini, B. Josse, D. Carole, S. Massat, and H. Teyssède. "Midlatitude stratosphere-troposphere exchange as diagnosed by MLS O3 and MOPITT CO assimilated fields." *Atmos. Chem. Phys.* 10, 2175-2194, 2010. [\[abstract\]](#)
7. Fadnaiss, S., and G. Beig. "Features of SAO in ozone and temperature over tropical stratosphere by wavelet analysis." *Int. J. Remote Sensing* 31, 2, 299-311, 2010.
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9. Haigh, J.D., A.R. Winning, R. Toumi, and J.W. Harder. "An influence of solar spectral variations on radiative forcing of climate." *Nature* 467, 696, 10.1038/nature09426, 2010. [\[abstract\]](#)
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Publications

- There are **581** citations in the MLS publications database
- When available, users may download an electronic copy of a publication they are interested in
- Database is searchable by the following fields:
 - Author
 - Title
 - Year
 - Publication
 - Data Product
 - Research Subject
 - MLS Instrument



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Microwave Limb Sounder

EOS MLS DATA USER REGISTRATION

Users of EOS (Aura) MLS data are encouraged to register for receiving updates and information from the MLS team. Registration is done by filling out the information below and submitting.

Fields with (*) are required.

(This information will not be released to any outside party. For additional information, please see the [NASA Privacy Statement](#).)

You may also [remove](#) yourself from the user database if you have already registered.

First Name* :

Last Name* :

Affiliation* :

E-Mail* :

Phone:

Fax:

Address:

Comments:

You may select specific MLS data products for receiving updates:

BrO <input type="checkbox"/>	HO ₂ <input type="checkbox"/>	CH ₃ CN <input type="checkbox"/>
HOCI <input type="checkbox"/>	ClO <input type="checkbox"/>	IWC <input type="checkbox"/>
CO <input type="checkbox"/>	N ₂ O <input type="checkbox"/>	GPH <input type="checkbox"/>
O ₃ <input type="checkbox"/>	H ₂ O <input type="checkbox"/>	OH <input type="checkbox"/>
HCl <input type="checkbox"/>	RHI <input type="checkbox"/>	HCN <input type="checkbox"/>
Temperature <input type="checkbox"/>	HNO ₃ <input type="checkbox"/>	All <input type="checkbox"/>

sanctuary bermans

Type the two words:

reCAPTCHA™ stop spam. Read Docs.

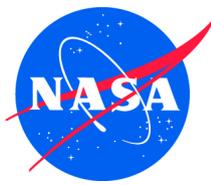
When finished, please click the submit button below and you should receive a confirmation e-mail. Click the reset button to start over.

PRIVACY | TEAM

Site Manager: Nathaniel Livesey
Webmaster: Brian Knosp
JPL Clearance: CL# 97-0564

User Registration

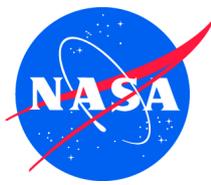
- Data user registration allows the MLS team to communicate with users
- Team sends out occasional e-mails about data updates



MLS Version 3 Algorithm Status

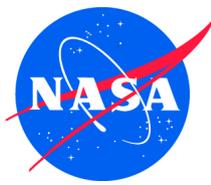
- Forward processing and reprocessing of the entire mission with new v3.3 algorithms is underway
- Version 3 algorithm improvements include:
 - Fixed biases in upper tropospheric CO and HNO₃
 - UT/LS O₃ now retrieved at 12 surfaces / decade (~1.5 km altitude spacing)
 - Fixed biases in lower stratospheric ClO
 - Removed 'kink' in mid-stratospheric H₂O
 - New stratospheric / tropopause CH₃Cl product
- Reprocessing is expected to be completed early in the New Year (March 2011 if not sooner)
- v3.3 data will be released once the new data quality document is completed
 - Final draft is undergoing checks / revision
- A new version of the MLS 'Near Real Time' processing is under development
 - A better (but still fast) forward model has improved NRT UT/LS O₃
 - Adding more species (e.g., H₂O, CO) to the NRT processing is under consideration

V3 Data Quality Document and Description

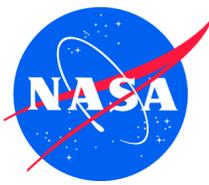


- v3.3 is the 3rd public release of the Aura MLS data
 - v03.30 is the official version name
 - v03.3x (x > 0) will be used to indicate minor revisions to v3.30
- v3 document describes:
 - MLS overview
 - Theoretical basis
 - Noisy products/Averaging
 - Use of the MLS data descriptors: Status, Quality and Convergence
 - Negative precision flag
 - Important differences to v2.2
 - IEEE Special Issue papers on the Aura Mission (May 2006)
 - JGR Aura Validation Special Issue papers (2007-2008)
 - <http://www.agu.org/contents/sc/ViewCollection.do?collectionCode=AURA1>

V3.3 Data Quality Document and Description

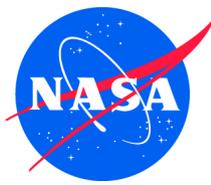


- Available from the MLS website (...soon)
 - General information
 - File formats and contents
 - HDF5-EOS, swath names
 - Granularity: one-day 00 to 23:59:99 UT
 - One file per data product
 - Status Flags : 32-bit integer
 - If bit 1 set = do not use profile
 - Other bits indicate cloud flag, processing problems etc
 - Quality : Larger values indicate better quality
 - Convergence : Values near unity indicate good convergence
 - Negative precision : Retrieved information content too low
 - Specific information for each data product
 - Comparison to v2.2
 - Resolution, Precision, Accuracy



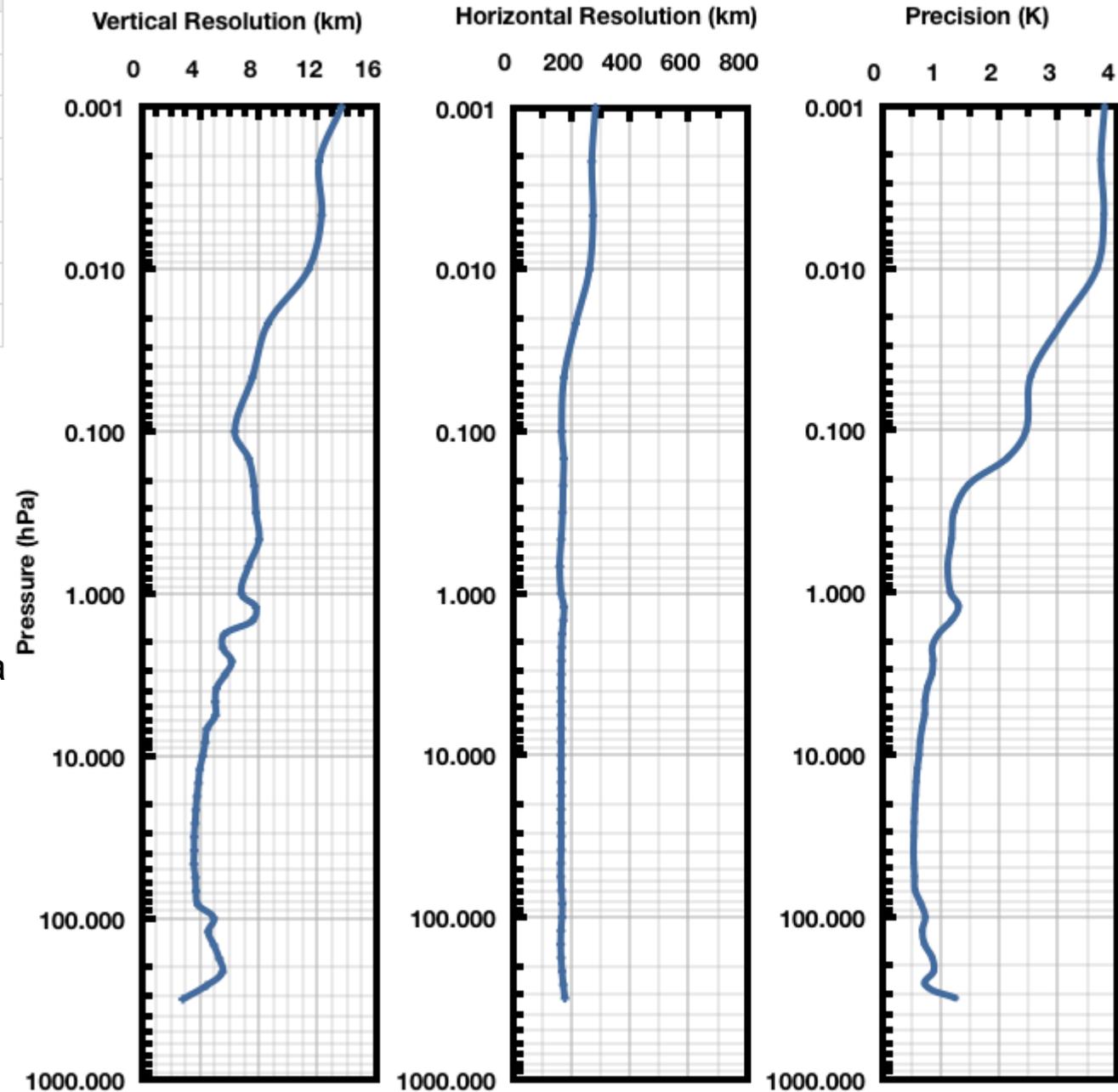
Key information for MLS data product usage

- Follow the data screening rules provided
- Use data only within the appropriate pressure range
- Always consider the precision of the data
 - Do not use data values where the corresponding precisions are set to negative values
- Do not use data for any profile where the field Status is odd
- Check usage of even but non-zero Status data for a particular data product
 - Contains cloud impact flags, and processing problem flags
- Use the data Quality field
 - $Q >$ threshold given for specific data product
- Use the data Convergence field
 - $C <$ threshold for given specific data product

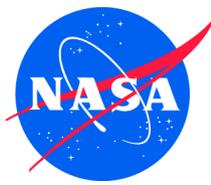


MLS Data Product Overview: T

temperature	
Swath Name	T
Range	316-0.001 hPa
Data Flags:	
Status	even
Cloud	ignore for $p \leq 147$ hPa
Quality	> 0.65
Convergence	< 1.2



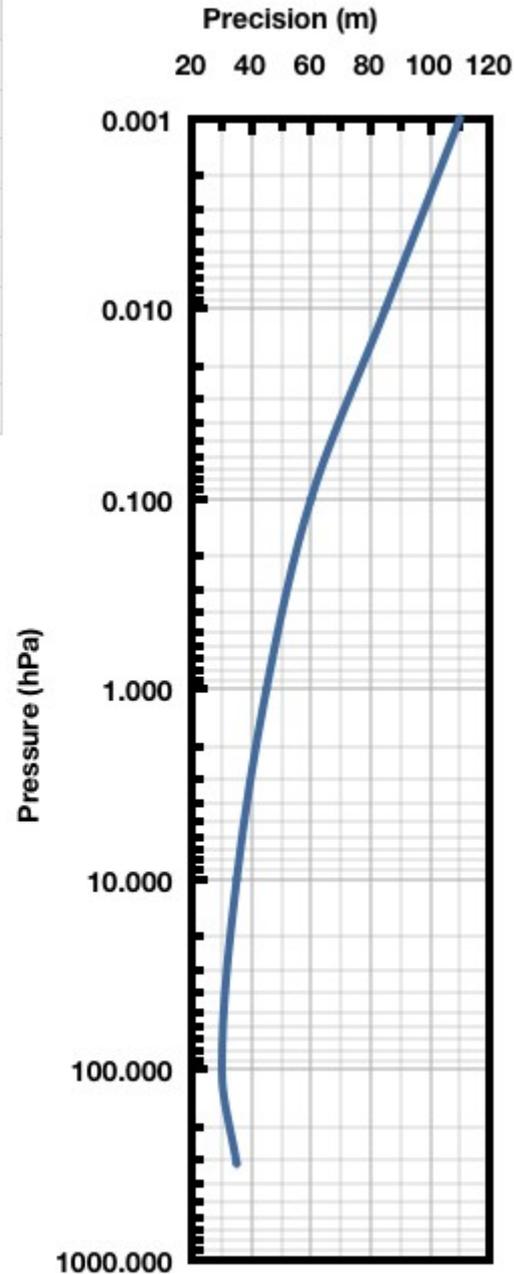
- v3.3 temperature data product is similar to v2.2
- v3.3 has finer retrieval levels in the upper stratosphere
 - 12 levels/decade from 316 to 1 hPa
- Noise and bias reduced at “chunk boundaries”
- Better convergence statistics in polar autumn
- Improved vertical resolution in mesosphere and lower thermosphere at the expense of lower precision



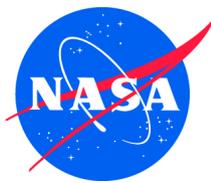
MLS Data Product Overview: GPH

geopotential height	
Swath Name	GPH
Range	316-0.001 hPa
Data Flags:	
Status	even
Cloud	see temperature
Quality	> 0.65
Convergence	< 1.2

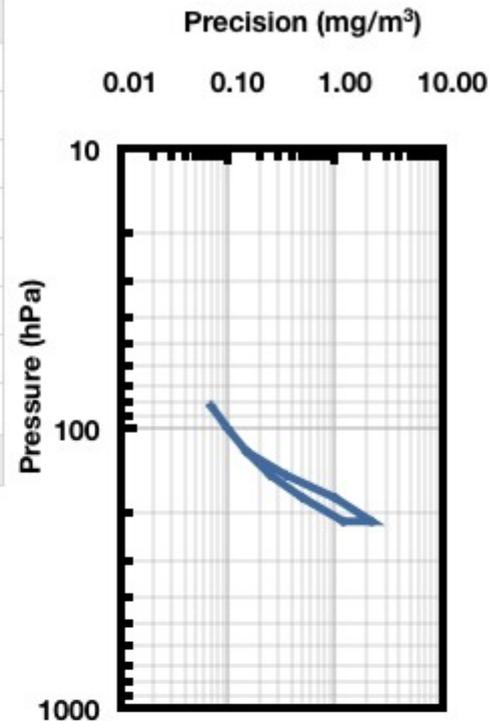
- Geopotential heights of the MLS temperature retrieval grid
- v3.3 GPH data product is similar to v2.2
- v3.3 has finer retrieval levels in the upper stratosphere
 - 12 levels/decade from 316 to 1 hPa



MLS Data Product Overview: IWC, IWP



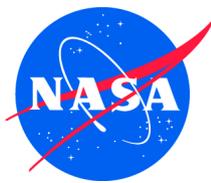
ice water content	
Swath Name	IWC
Range	215-83 hPa
Units	g/m^3
Data Flags:	use Temperature flags
Status	...
Cloud	...
Quality	...
Convergence	...
Threshold detection scheme	



ice water path	
Swath Name	IWP
Range	ice water column > 6km
Units	g/m^2
Data Flags:	use Temperature flags
Status	...
Cloud	...
Quality	...
Convergence	...
Threshold detection scheme	
Precision	3g/m^2

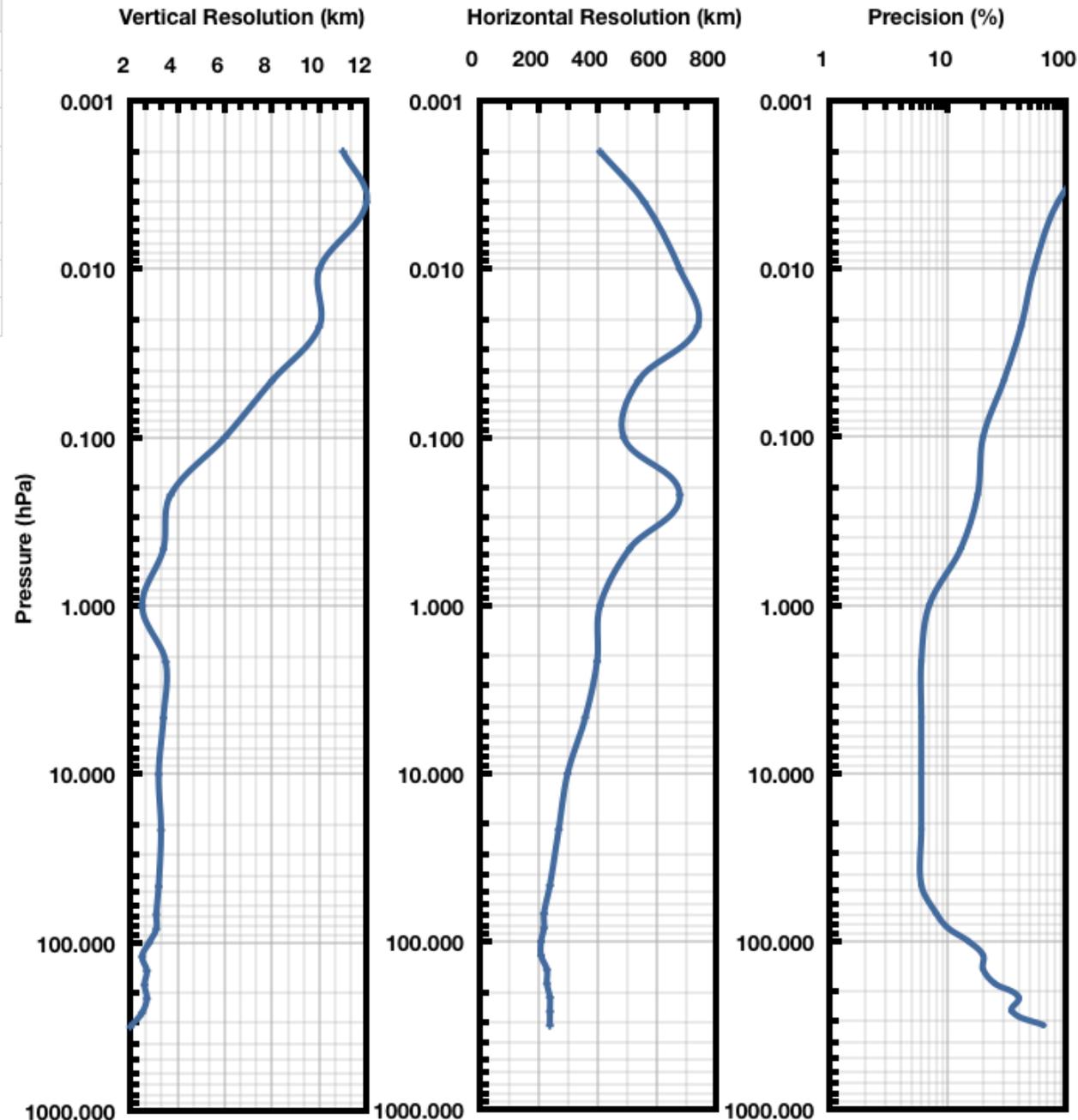
- IWC and IWP data products are derived from 240 GHz radiances
- v3.3 IWC values are 5-20 % smaller than v2.2 in the 215-100 hPa pressure range
- v3.3 IWP values are 2 % smaller than v2.2
- Ignore precision data for IWC and IWP (see below)
- Threshold detection scheme
 - Additional screening for IWC and IWP data is required to remove latitudinal dependent bias and to determine threshold for significant cloud detection above noise floor (details in v3 document) and determine appropriate precision estimates

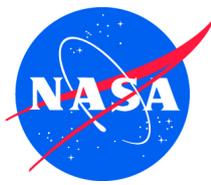
MLS Data Product Overview: H2O



water vapor	
Swath Name	H2O
Range	316-0.002 hPa
Data Flags:	
Status	even
Cloud	ignore for p < 200hPa
Quality	> 1.3
Convergence	< 2.0

- v3.3 H2O data product is similar to v2.2
 - Differences less than 10 % at most levels up to 20 % wetter at 215 hPa for high latitudes
- Improved vertical resolution for p < 1 hPa at the cost of poorer precision
- Fine-scale oscillation in v2.2 between 26 and 31 hPa has been eliminated in v3.3
- H2O is retrieved as log(H2O)
 - Min H2O value is 0.1 ppmv

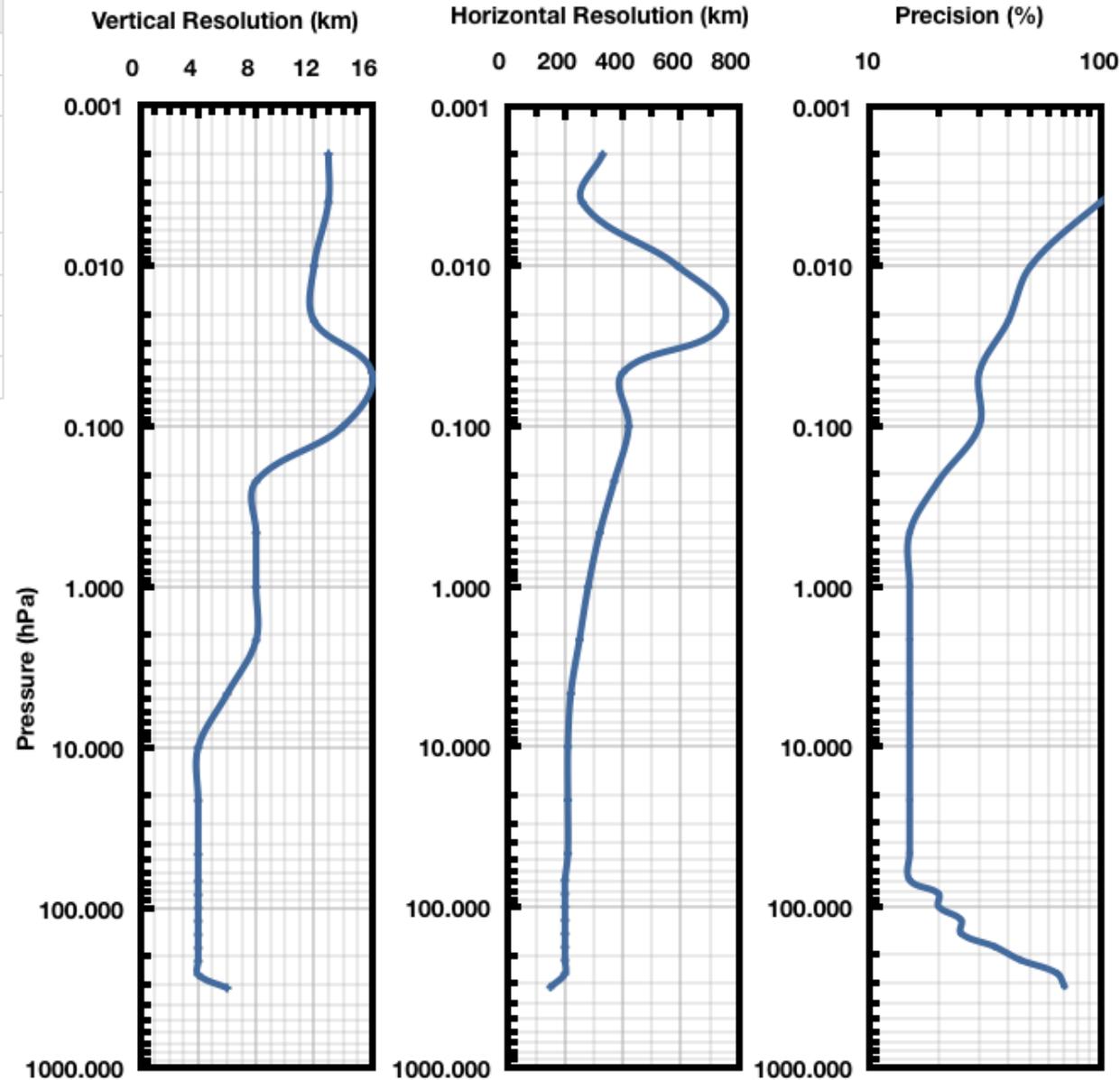


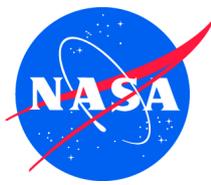


MLS Data Product Overview: RHI

relative humidity	
Swath Name	RHI
Range	316-0.002 hPa
	relative humidity with respect to ice
Data Flags:	
Status	even
Cloud	ignore
Quality	> 1.3
Convergence	< 2.0

- v3.3 RHi data product is similar to v2.2 and inherits the improvements in the H₂O and temperature measurements
- From 316-0.002 hPa RHi is derived from the the H₂O and temperature standard products using the Groff-Gratch ice saturation
- From 1000-383 hPa UT RHi is retrieved directly from optically thick radiances and these pressure levels are filled with the same RHi value

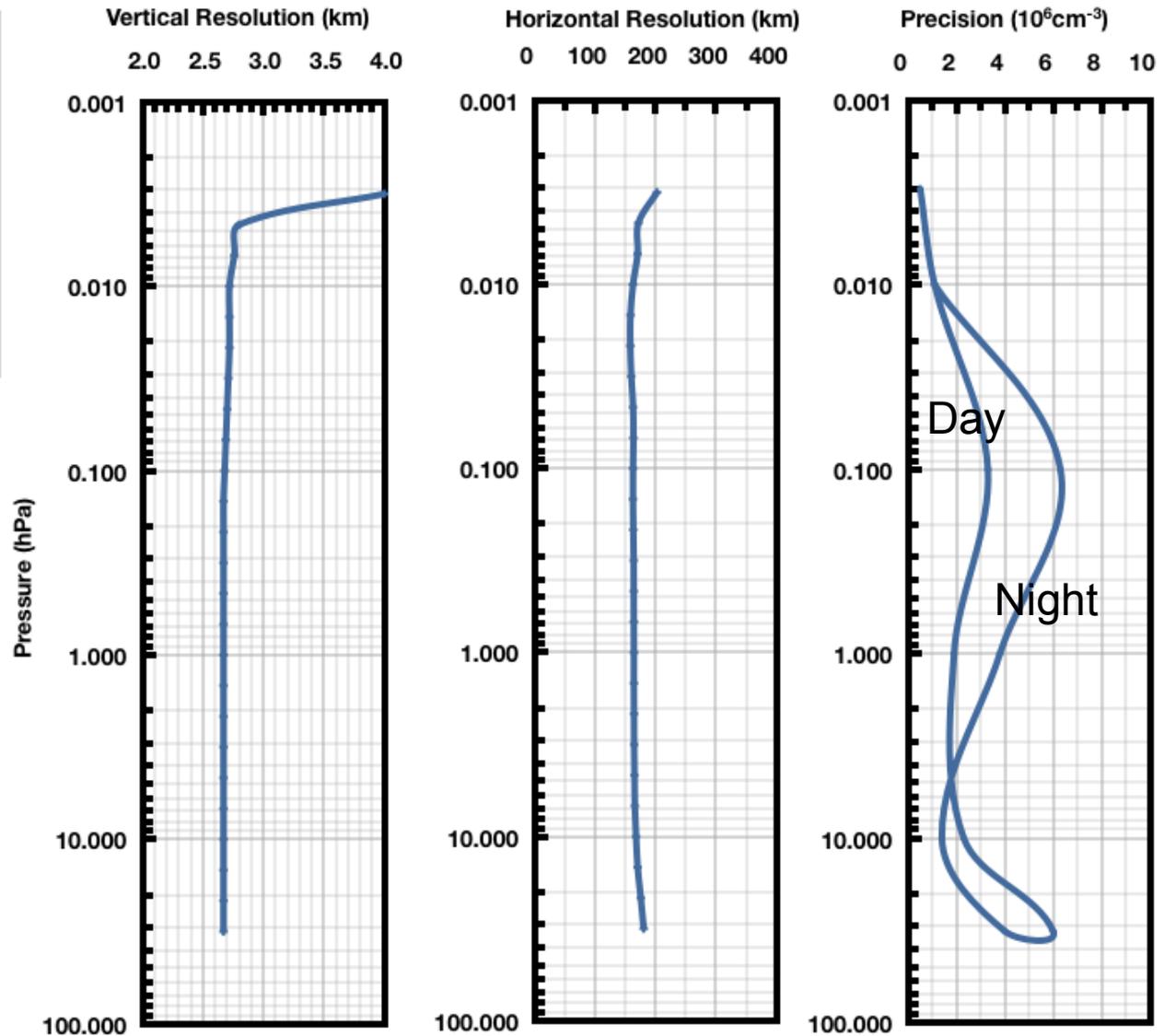


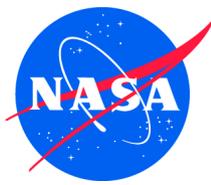


MLS Data Product Overview: OH

hydroxyl radical	
Swath Name	OH
Range	32-0.0032 hPa
Data Flags:	
Status	even
Cloud	ignore
Quality	ignore
Convergence	< 1.1

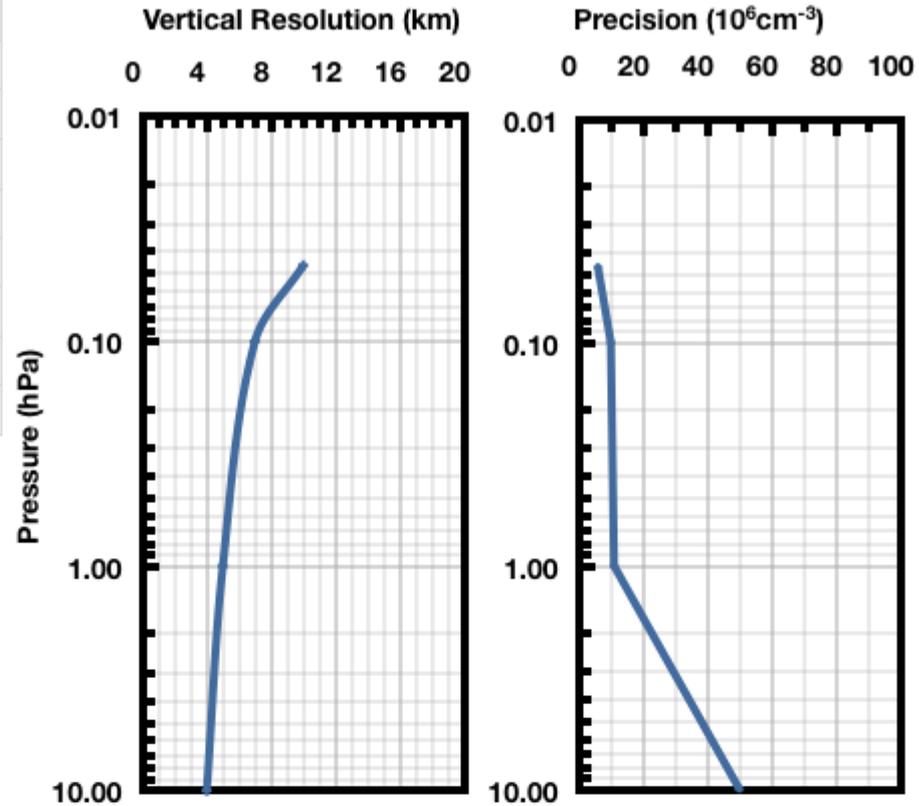
- v3.3 OH data product is similar to v2.2
 - Better convergence statistics
- Recommend removal of biases for $p \geq 10$ hPa by taking day – night differences
- MLS THz radiometer observations are suspended (since Dec 2009) to preserve system life-time
- Next observations planned for Aug 2011





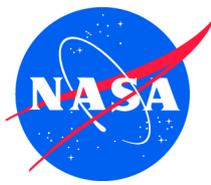
MLS Data Product Overview: HO2

peroxy radical	
Swath Name	HO2
Range	10-0.046 hPa
Data Flags:	
Status	even
Cloud	ignore
Quality	ignore
Convergence	< 1.1



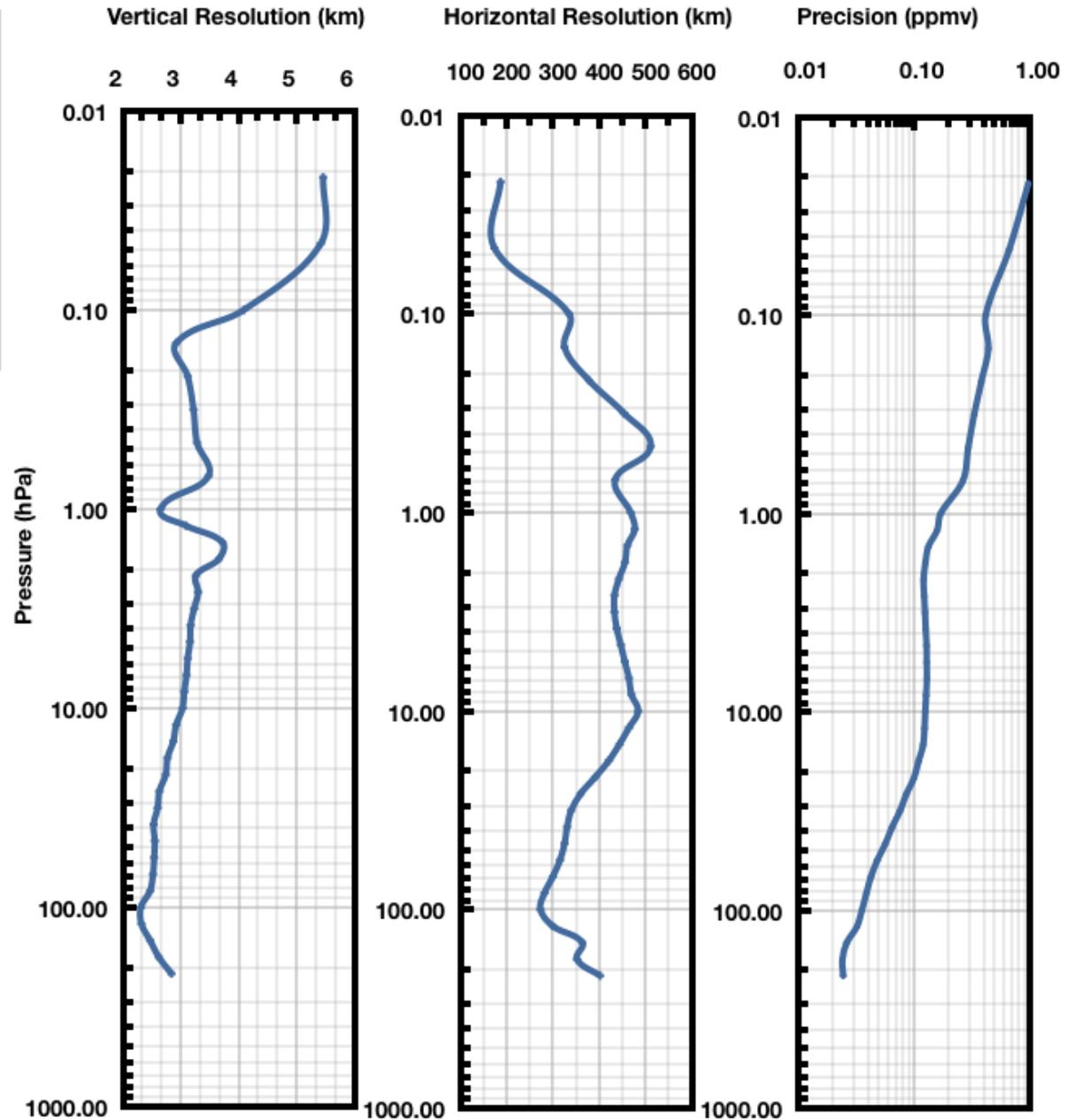
- v3.3 HO2 product is similar to v2.2
 - Better convergence statistics
- HO2 is a fairly 'noisy' data product which benefits from averaging
- Recommend removal of biases by taking day – night differences
- Precisions of ~10 % are attainable by averaging in 10 deg latitude bin zonal means over 3 weeks

MLS Data Product Overview: O3

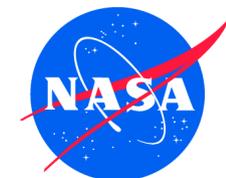


ozone	
Swath Name	O3
Range	215-0.02 hPa
Data Flags:	
Status	even
Cloud	use outlier screening
Quality	> 0.6
Convergence	< 1.18

- v3.3 O3 product is similar to v2.2 in stratosphere and mesosphere
- v3.3 has finer retrieval levels at the cost of poorer horizontal resolution
 - 12 levels/decade from 316 to 1 hPa
 - New recommended retrieval level at 261 hPa
- Ozone column swath names
 - above WMO tropopause definition with MLS or GEOS-5 temperatures
 - 'O3 column-MLS'
 - 'O3 column-GEOS5'
 -
- 'Cloud impacts in v3.3 require 'outlier screening' discussed in the quality document

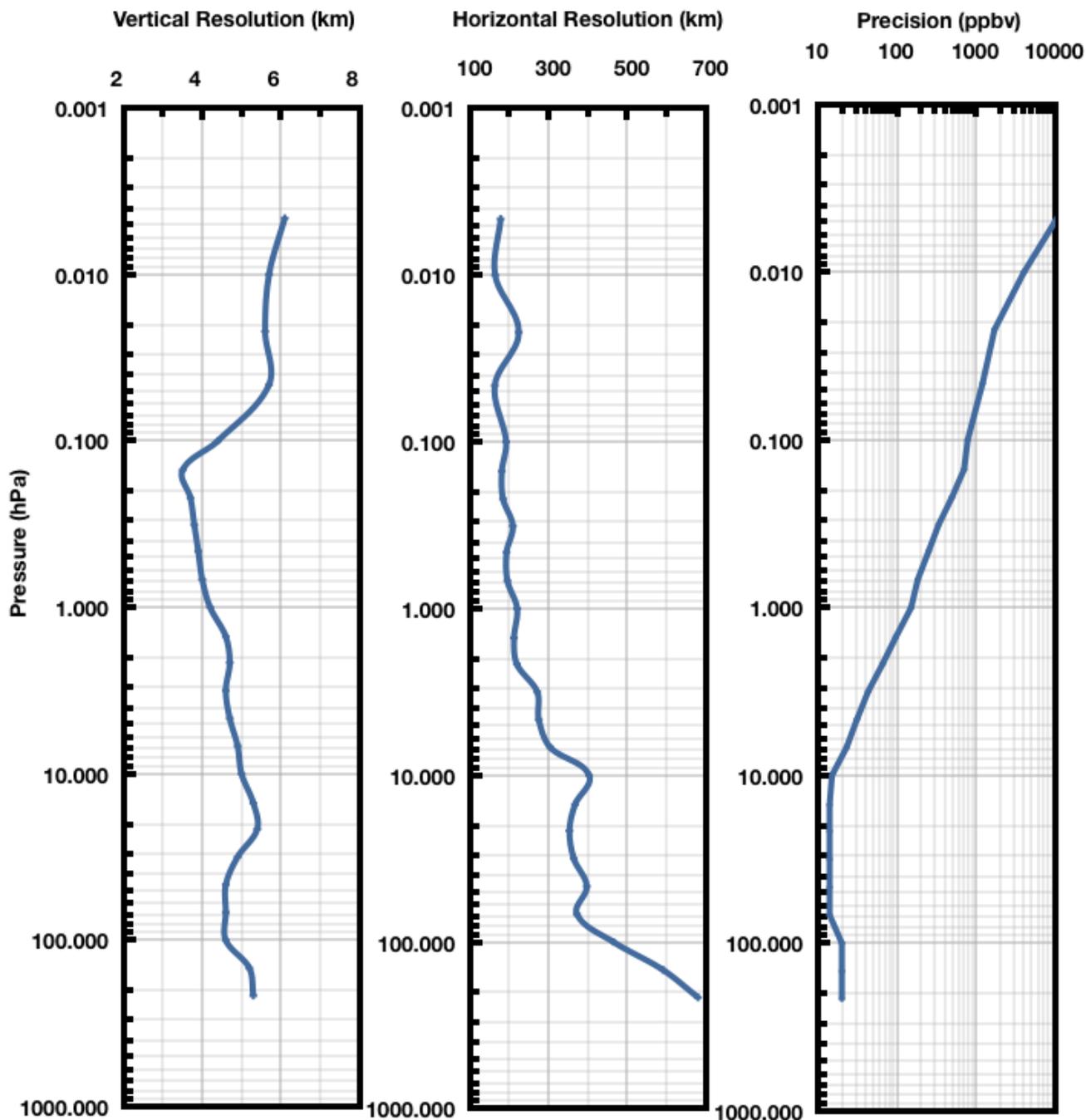


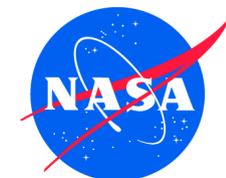
MLS Data Product Overview: CO



carbon monoxide	
Swath Name	CO
Range	215-0.0046 hPa
Data Flags:	
Status	even
Cloud	use outlier screening
Quality (p <= 100 hPa)	> 0.2
Quality (p > 100 hPa)	> 1.1
Convergence	< 1.4

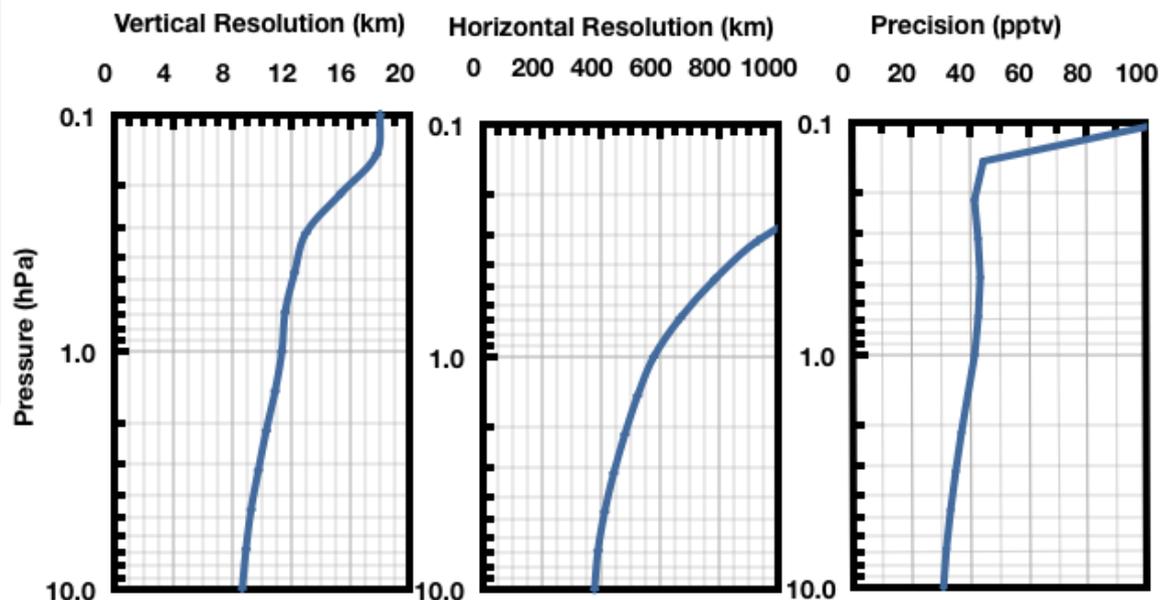
- 50% high bias in UT v2.2 CO at 215 hPa has been eliminated in v3.3
- Stratospheric v3.3 CO is less noisy at the cost of degraded vertical resolution
- Cloud impacts in v3.3 require 'outlier screening' discussed in the quality document



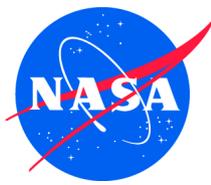


MLS Data Product Overview: HCN

hydrogen cyanide	
Swath Name	HCN
Range	10-0.1 hPa
Data Flags:	
Status	even
Cloud	ignore
Quality	> 0.2
Convergence	< 2.0

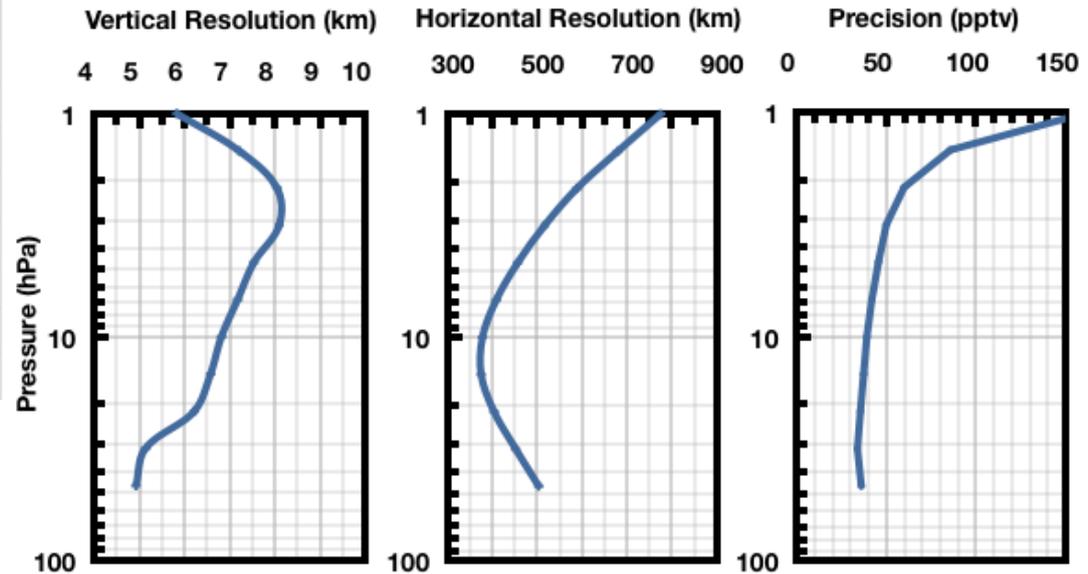


- v3.3 HCN product is similar to v2.2



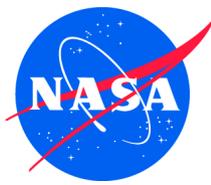
MLS Data Product Overview: CH₃CN

methyl cyanide	
Swath Name	CH ₃ CN
Range	46-1.0 hPa
Data Flags:	
Status	even
Cloud	ignore
Quality	> 1.4
Convergence	< 1.05

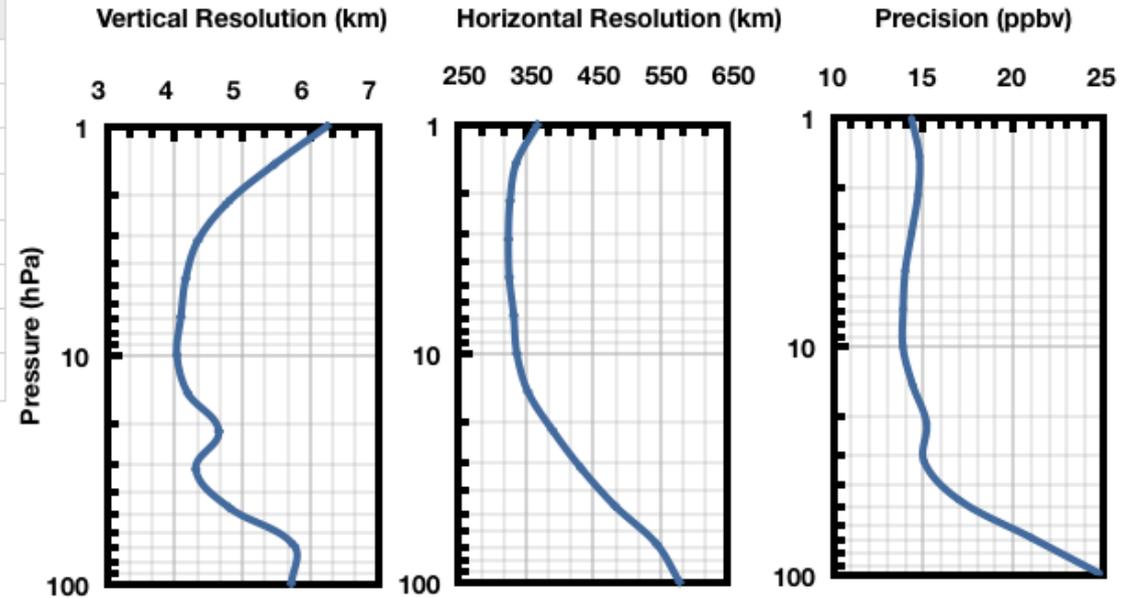


- v3.3 CH₃CN product is retrieved from the 640 GHz radiances whereas v2.2 used the 190 GHz radiances
- Quality and reliability are improved

MLS Data Product Overview: N2O

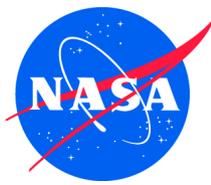


nitrous oxide	
Swath Name	N2O
Range	100-1 hPa
Data Flags:	
Status	even
Cloud	ignore
Quality	> 1.4
Convergence	< 1.01

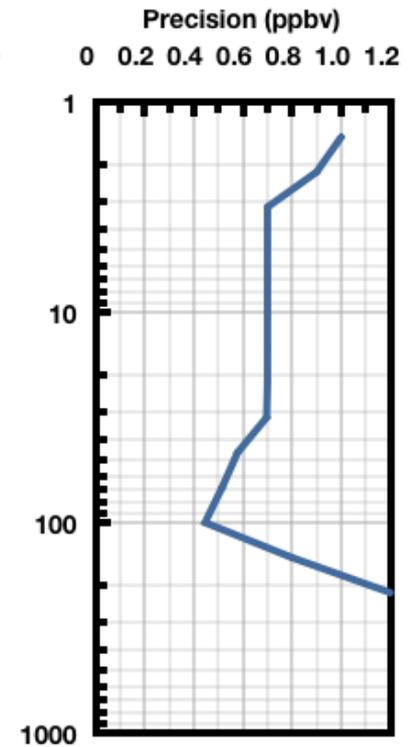
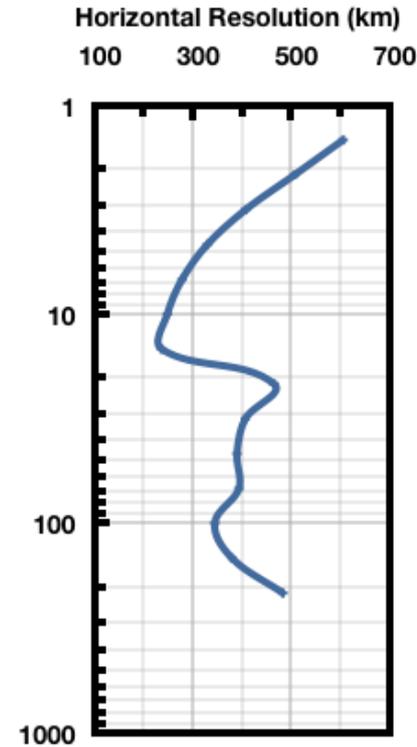
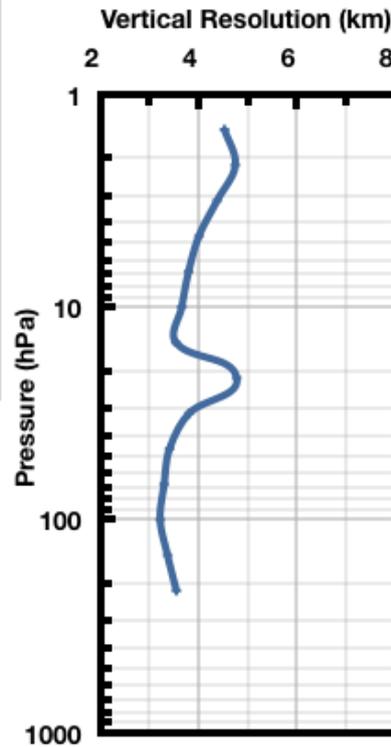


- v3.3 N2O product similar to v2.2
 - within 5 % for $p \geq 22$ hPa
 - v3.3 N2O 20 % larger than v2.2 at 100 hPa, up to 10 % smaller at 46-32 hPa
- Improved convergence statistics at 100-68 hPa

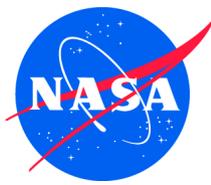
MLS Data Product Overview: HNO₃



nitric acid	
Swath Name	HNO ₃
Range	215-1.5 hPa
Data Flags:	
Status	even
Cloud	use outlier screening
Quality	> 0.5
Convergence	< 1.4

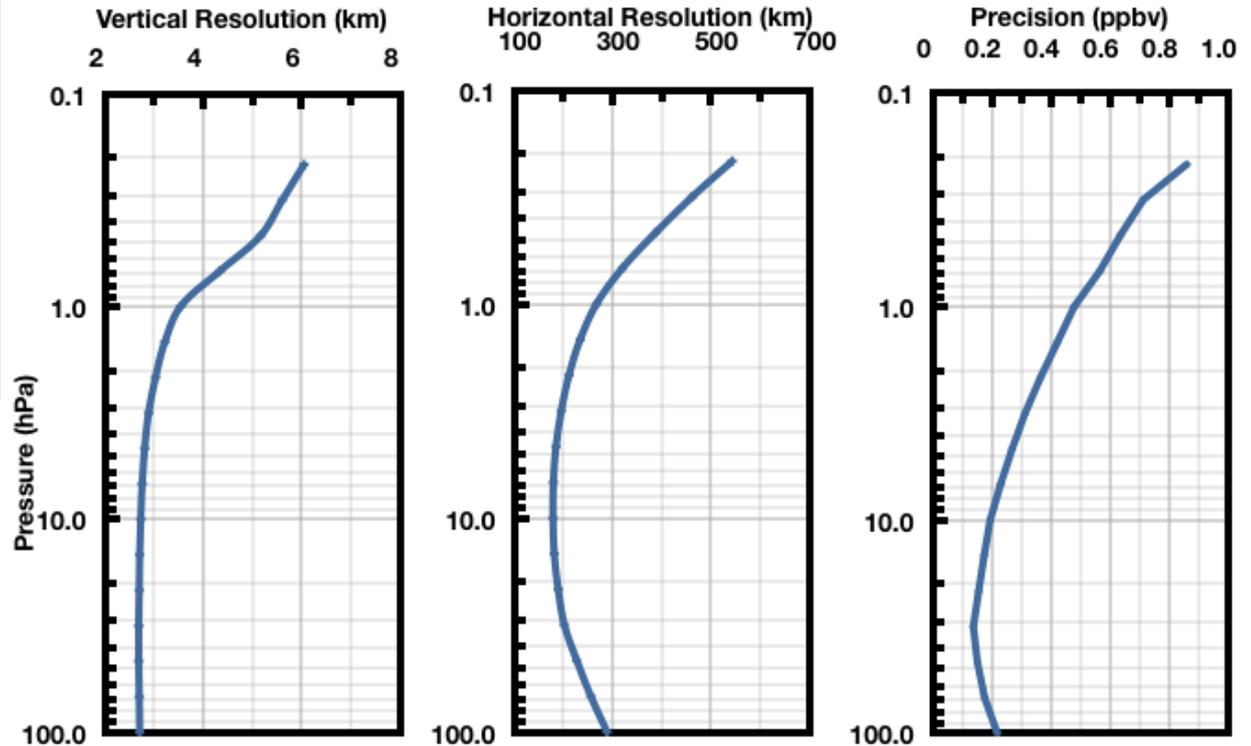


- HNO₃ is a merged product retrieved from the radiances in two radiometer bands at 190 and 240 GHz
 - 190 GHz for $p < 22$ hPa
 - 240 GHz for $p \geq 22$ hPa
- v3.3 HNO₃ product is significantly improved over v2.2
 - low bias in v2.2 lower and middle stratosphere has been eliminated
- Cloud impacts in v3.3 require 'outlier screening' discussed in the quality document

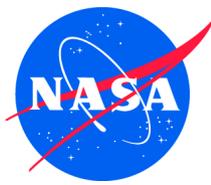


MLS Data Product Overview: HCl

hydrogen chloride	
Swath Name	HCl
Range	100-0.22 hPa
Data Flags:	
Status	even
Cloud	ignore
Quality	> 1.2
Convergence	< 1.05

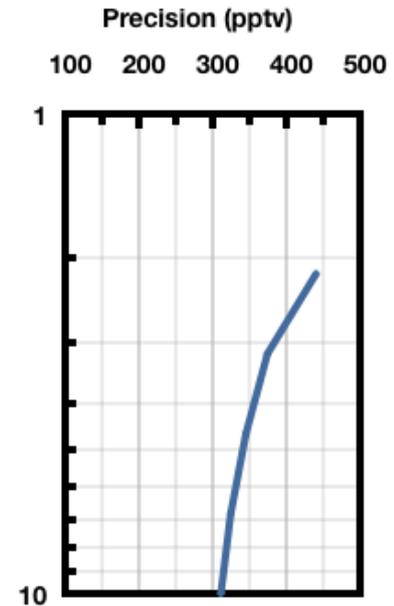
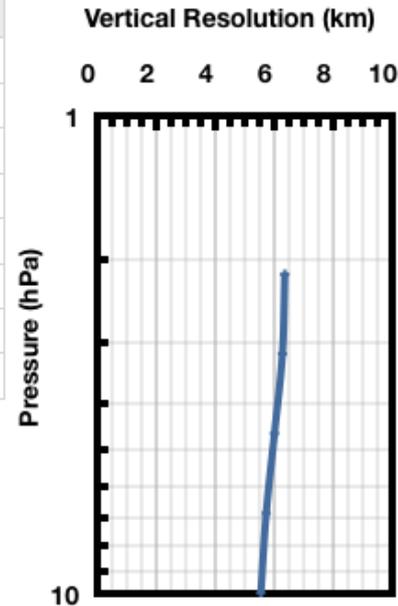


- v3.3 HCl product is similar to v2.2 and within 0.1 ppbv for $p \geq 0.22$ hPa
- Standard product HCl is retrieved from band 14 (640 GHz)
- Band 13 HCl data provide better data for trend studies in the upper stratosphere and mesosphere
 - Stored as swath name 'HCl-640-B13' in a separate L2GP_DGG file
 - Continuous observations from launch until Feb 16 2006 (and only on occasional days afterward)
 - MLS band 13 observations are suspended to preserve system life-time
 - Planned operation of band 13 for a few days at intervals every two years to preserve operational lifetime
 - Next observation planned for early 2012

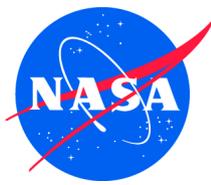


MLS Data Product Overview: HOCl

hypochlorous acid	
Swath Name	HOCl
Range	10-2.2 hPa
	Averaging Required
Data Flags:	
Status	even
Cloud	ignore
Quality	> 1.2
Convergence	< 1.05

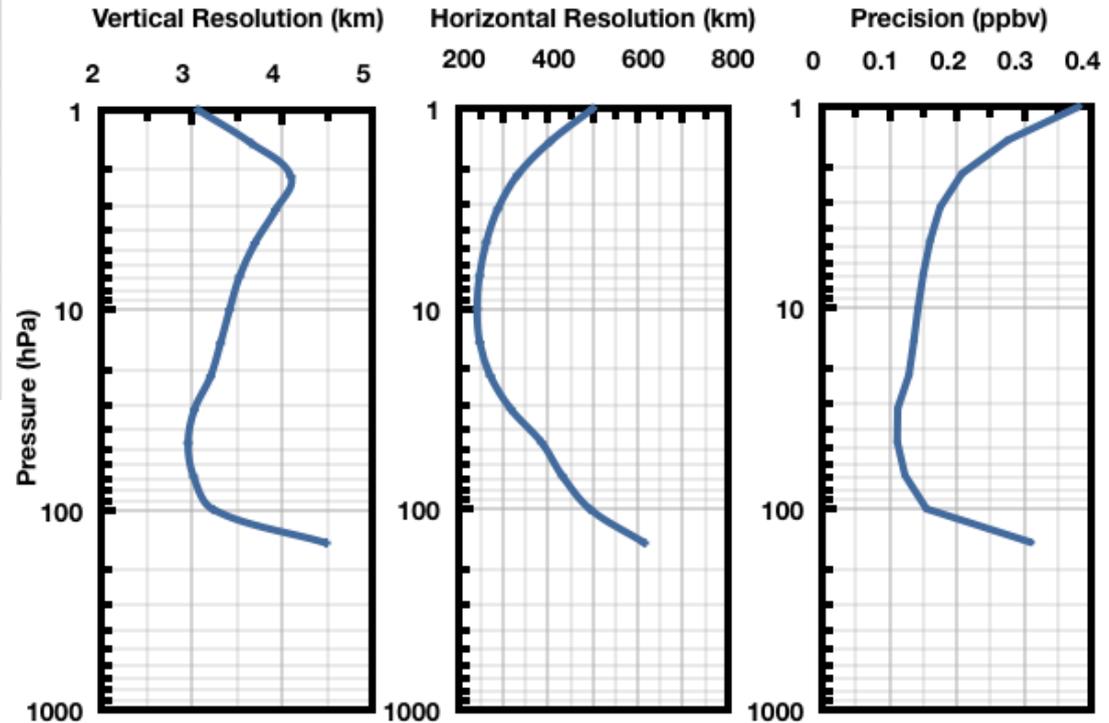


- HOCl is a 'noisy' data product which benefits from averaging
- Precisions of ~10 pptv are attainable by averaging in 10 deg latitude bin zonal means over 1-2 weeks



MLS Data Product Overview: ClO

chlorine monoxide	
Swath Name	ClO
Range	147-1.0 hPa
Data Flags:	
Status	even
Cloud	ignore
Quality	> 1.3
Convergence	< 1.05

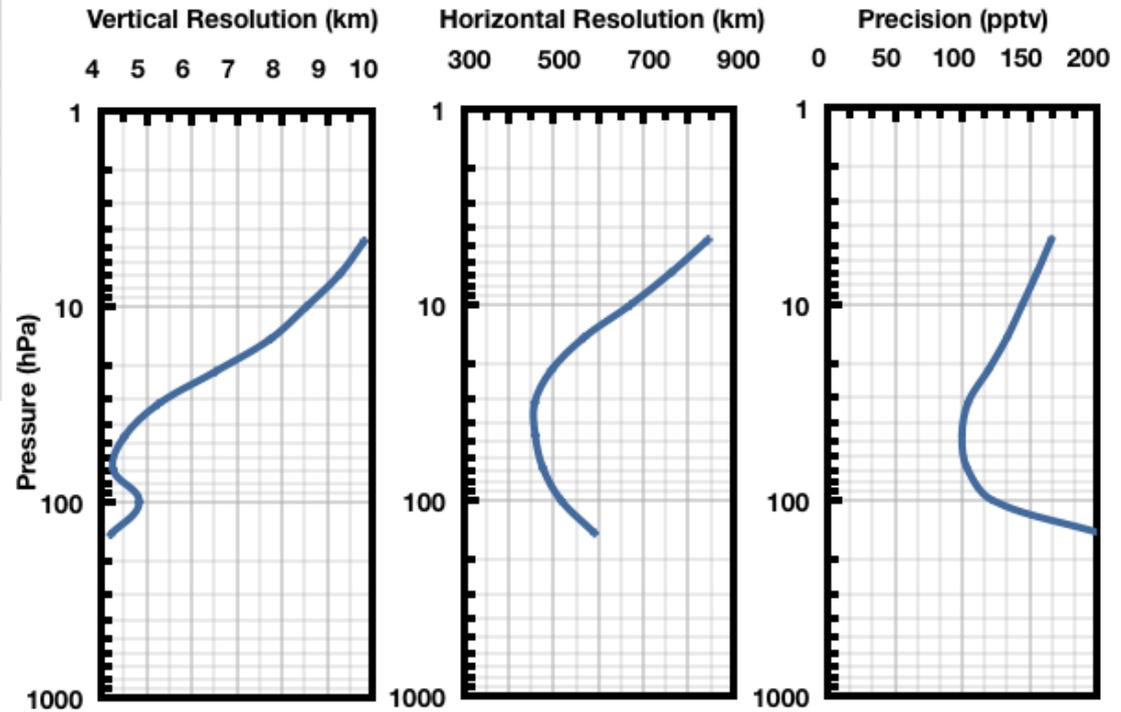


- v3.3 ClO data product is significantly improved over v2.2
 - Small < 0.05 ppbv differences for $p \geq 32$ hPa
- Negative bias of 0.1-0.4 in v2.2 ClO and latitudinal dependence for $p > 22$ hPa has been eliminated for 46-32 hPa and reduced at 68-100 hPa
- New recommended retrieval level at 147 hPa

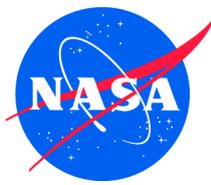
MLS Data Product Overview: CH₃Cl



methyl chloride	
Swath Name	CH ₃ Cl
Range	147-4.6 hPa
Data Flags:	
Status	even
Cloud	ignore
Quality	> 1.3
Convergence	< 1.05

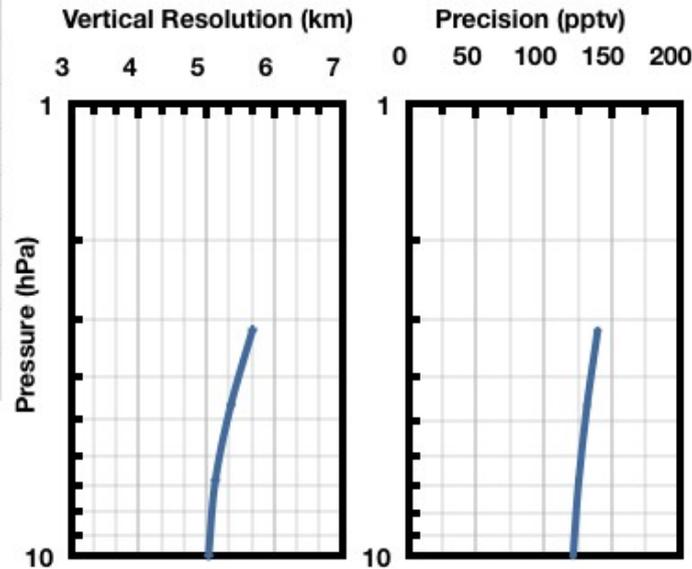


- CH₃Cl is a new (unvalidated) data product released in v3.3

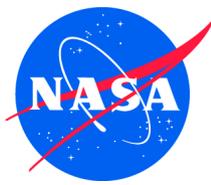


MLS Data Product Overview: BrO

bromine monoxide	
Swath Name	BrO
Range	10-3.2 hPa
	Averaging Required
Data Flags:	
Status	even
Cloud	ignore
Quality	> 1.2
Convergence	< 1.5

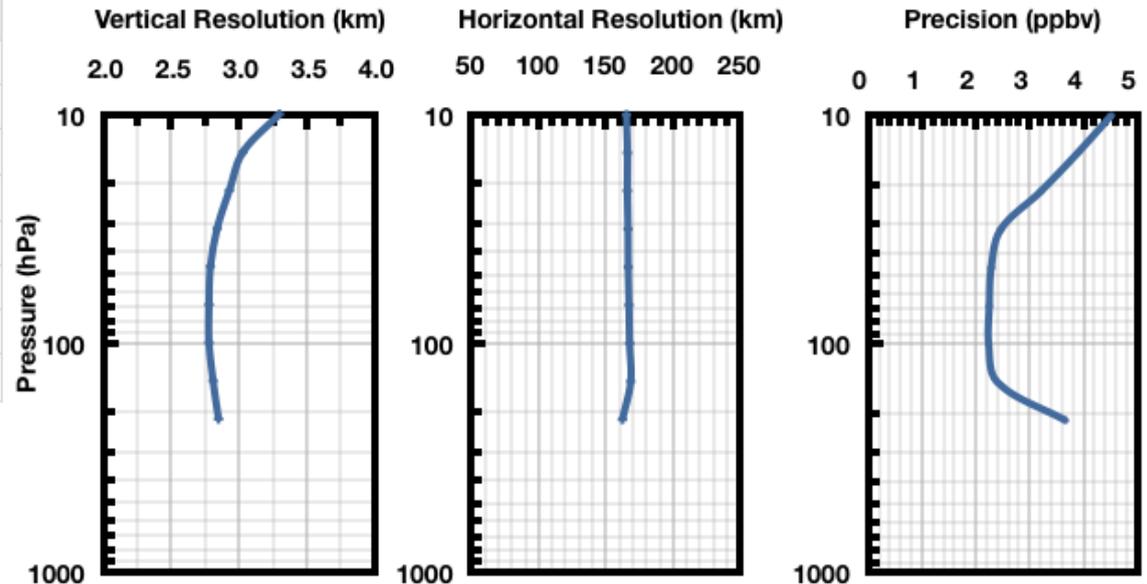


- BrO is a 'noisy' data product which benefits from averaging
- Recommend removal of biases by taking day – night differences
 - day or night data alone are unsuitable for scientific studies
- Precisions of ~4 pptv are attainable by averaging in 10 deg latitude bin zonal means over one month



MLS Data Product Overview: SO2

sulfur dioxide	
Swath Name	SO2
Range	215-10 hPa
Data Flags:	
Status	even
Cloud	ignore
Quality	> 0.6
Convergence	< 1.8



- v3.3 SO2 data product is similar to v2.2
 - cloud impacts in v3.3 can cause spikes in the SO2 values
- MLS can only measure significant enhancements in SO2 above the nominal background such as from volcanic injections – 16 eruptions detected since launch
- SO2 is an exception to the rule not to use data values with corresponding negative precisions
 - a priori for SO2 is set to zero so elevated SO2 values in volcanic plumes are expected to be biased too low
- SO2 has not yet been validated