Earth Observing System
Microwave Limb Sounder
(EOS MLS)
Science Data Processing
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Mission Background

- EOS MLS is an atmospheric remote sensing experiment led by Jet Propulsion Laboratory of the California Institute of Technology with scientific collaboration from the University of Edinburgh Meteorology Department.

- EOS MLS is a passive instrument that observes natural thermal radiation from the limb of Earth's atmosphere and yields the concentration of chemical species and atmospheric parameters.

- EOS MLS will be operational on NASA's EOS Aura spacecraft from 2003 to 2009.

- EOS MLS is a follow-on to the very successful MLS on NASA's Upper Atmospheric Research Satellite (UARS) – 1991 launch.

- EOS MLS objectives are to learn about:
  - Stratospheric chemistry and causes of ozone changes
  - Processes affecting climate variability
  - Pollution in the upper atmosphere
Instrument Specifications

- Makes passive measurements in broad bands at 5 frequencies:
  - 118 GHz for temperature and pressure
  - 190 GHz primarily for H₂O and NHO₃
  - 240 GHz primarily for O₃ and CO
  - 640 GHz primarily for HCl, ClO, N₂O, BrO, HO₂, and HOCl
  - 2.5 THz for OH

- 450 Kg mass
- 550 Watts power consumption
- 100 kb/s data rate
Science Data Software Components

- **MLS Science Investigator-led Processing System (SIPS):**
  - Processes the science data for the entire mission.
  - Delivers standard data products to MLS SCF and GSFC DAAC.
  - Implemented and operated by Raytheon ITSS of Pasadena.

- **MLS Science Computing Facility (SCF):**
  - Develops and tests the science processing software.
  - Determines the quality of data products.
  - Validates the scientific data sets.
  - Performs scientific analyses of the data.
  - Implemented and operated by MLS Science Team at JPL.

- **GSFC Earth Science Distributed Active Archive Center (GES-DAAC)**
  - Provides Level 0 and ancillary data to MLS SIPS.
  - Provides long term archive for standard science data products.
  - Provides distribution for standard science data products to users.
  - Provides user support.
MLS Functional Block Diagram

Science Algorithm Development
Scientific Analysis
Science Processing Software Development
Quality Control and Assessment

Data Management Layer

Level 0 MLS
S/C Engineering
Operational Meteorological Data
Level 1B MLS
Level 2 MLS
Level 3 MLS
Diagnostics
Log files

PGE's Calibration files
Production Policies

Delivered Algorithm Package
Quality Assessment

SDP Toolkit
ESDT/MCF

Search
Order
Data Products
User support

Users

Level 1 MLS
Level 2 MLS
Level 3 MLS
Production Logs

DN, PORD, PAN

Level 0 MLS
Ancillary Data

Level 0 MLS
Aura Spacecraft Engineering
Aura Spacecraft Definitive Orbit
Aura Spacecraft Attitude
Operational Meteorological Data
Leap Second & UTC Pole Data

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MLS Science Data Processing

- **Level 1 Processing:**
  - Accepts Level 0 (unprocessed instrument data) and Aura spacecraft ancillary data
  - Produces Level 1B products (calibrated radiances) and associated instrument engineering and diagnostic data

- **Level 2 Processing:**
  - Accepts Level 1B products and operational meteorological data
  - Produces a set of daily Level 2 products (geophysical parameters at full resolution) and diagnostic and ancillary data

- **Level 3 Processing:**
  - Accepts Level 2 products
  - Produces a set of Level 3 products
    - daily and monthly gridded maps
    - daily and monthly zonal means

- **Software is developed using the Science Data Processing (SDP) Toolkit.**
  - Capable of running in the DAAC environment.

- **All output products are in HDF5 or EOS-HDF5**
MLS Science Data Processing Flow

Aura Spacecraft Engineering Data (Carry-out Files)

 MLS Level 0 data (unprocessed instrument data)

 Aura Spacecraft Definitive Orbit and Attitude Data

 MLS Level 1B data (radiances and instrument eng. data)

 MLS Level 2 data (geophysical parameters at full resolution)

 Forward Model Radiance

 MLS Level 2 information matrices for "Noisy" products

 MLS Level 3 daily maps

 MLS Level 3 monthly maps and daily/monthly zonal means
MLS SIPS

- Accepts all MLS Level 0 data and ancillary data as input from GES-DAAC and stores for subsequent processing.
  - GES-DAAC will push all files to MLS SIPS via ftp.
- Processes the science data for the entire mission from Level 0 to Level 1B, Level 2, and Level 3 products.
- Supports re-processing of data.
  - Stores all incoming data for the duration of the mission.
  - V2 is planned 6 months after receipt of first data.
  - V3 will be 1.5 years after V2.
  - V4 will come 2 years after V3.
- Delivers all standard data products including production history logs to the GES-DAAC for archive and distribution.
  - Using a Product Delivery Record (PDR) server.
- Delivers all data products including inputs, outputs, and diagnostics to MLS SCF.
MLS SIPS - continued

- Requests any historical data using the Machine-to-Machine Gateway (MTMGW).
- Checks the integrity of data holdings against the GES-DAAC data holdings using MTMGW search capabilities.
- Receives MLS PGEs from the MLS Science Team/SCF.
- Receives production policies and calibration parameters from the MLS Science Team.
- Will be staffed only 8 hours/day, 5 days/week, but will be automated and operational 24x7.
- Design and implementation has heritage to ICESat SIPS and to V0 GES-DAAC.
Inputs from GES-DAAC to MLS SIPS

- MLS Level 0 Science Data including memory dump
- MLS Level 0 Instrument Engineering Packets
- Aura spacecraft 1 second GBAD with 8 Hz gyro
- Aura Spacecraft Carryout File
  - Eg. Temperature, survival, voltages, ...
- NCEP Operational Meteorological Data
  - NCEP GDAS/Stratospheric analysis combined product (EOS-HDF)
  - NCEP GDAS Operational Product – GDAS0ZFH (EOS-HDF)
- DAO Operational Meteorological Data
  - DAO tsyn3d_mis_p First Look – DFLAPMIS (EOS-HDF)
  - DAO tsyn2d_mis_x First Look – DFLAXMIS (EOS-HDF)
- Aura Spacecraft Definitive Ephemeris Data (HDF4)
- Aura Spacecraft Attitude Data (HDF4)
- Leap second & UTC Pole data updates
- Various E-mail for notification when exchanging data
Outputs from MLS SIPS to GES-DAAC

- Level 1 - production is daily
  - Calibrated radiances from filter channels and digital autocorrelators
  - Orbit, attitude, and tangent point geolocation data
  - Calibrated diagnostic engineering data
- Level 2 - production is daily
  - 17 geophysical species at full resolution in swath format
  - Ancillary and diagnostic products
- Level 3 - production is monthly, even for daily products
  - Daily Maps for each of 13 species
  - Daily Zonal Means for standard and diagnostic products
  - Monthly Maps for all geophysical species
  - Monthly Zonal Means for standard and diagnostic products
- Production Log Files - for each PGE and each production run
- Delivered Algorithm Package
- Quality Assessment