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# **EOS MLS software**

## **Instrument Data Processing** *[<http://mls.jpl.nasa.gov/>]*

**Paul Wagner**

*[Paul.A.Wagner@Jpl.Nasa.Gov]*

**Jet Propulsion Laboratory**

**California Institute of Technology**

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# Overview

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- ❑ Background
  - ⇒ Mission
  - ⇒ Instrument
  - ⇒ Science objective
- ❑ Software and its division into levels:
  - ⇒ Level 1 outputs radiances
  - ⇒ Level 2 outputs atmospheric molecular abundances
  - ⇒ Level 3 outputs daily and monthly maps and means
- ❑ Data flow between levels
  - ⇒ HDF4 and HDF-EOS1
  - ⇒ Products of Levels 2 and 3 to be archived
  - ⇒ Metadata
- ❑ Future plans–HDF5 and HDF-EOS5

# Background

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## **The mission** What is EOS MLS?

- ❑ Measure atmospheric temperature, water, ozone and significant molecules from ~ 5 – 80km
- ❑ Joint project: JPL (US) and Edinburgh University (UK)
- ❑ Greatly enhanced follow-on to UARS MLS experiment
  - ⇒ Looks and scans limb forward instead of sideways
  - ⇒ More sensitive instruments and more precise measurements
  - ⇒ More radiometers and more atmospheric molecules
  - ⇒ Greater spectral bandwidth and lower altitudes
- ❑ Currently scheduled for launch in July 2003 on AURA spacecraft

## **The instrument** What instruments is it made up of?

- ❑ Four GHz (118, 190, 240, 640) and one THz (2.5) radiometers
- ❑ 1.6m primary antenna for the GHz instruments
- ❑ 35 spectrometers of four different types, simultaneously observing emission from ~ 10 different molecules

# What are its objectives?

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- ❑ Determine if stratospheric ozone is recovering
  - ⇒ Influence of human activities
  - ⇒ Arctic vulnerability
  - ⇒ Stratospheric chemistry producing or destroying ozone
- ❑ Improve understanding of climate variability
  - ⇒ Global warming
  - ⇒ Verify, constrain, or eliminate key climate models
  - ⇒ Distinguish local events (fires, volcanos) from widespread trends
- ❑ Pollution in the upper troposphere

# Level 1 data processing

**Purpose** Convert unprocessed instrument data into calibrated radiances

- ❑ Accepts Level 0 and AURA spacecraft auxiliary data
  - ⇒ Level 0 includes all instrument telemetry
  - ⇒ SDP Toolkit expects ephemeris and attitude data to be binary and therefore platform-specific—we would prefer HDF or HDF-EOS
- ❑ Outputs (All HDF4 SD)
  - ⇒ Two radiance files to stay below 2GB limit imposed by HDF4
  - ⇒ One engineering file
  - ⇒ One orbit and attitude file
  - ⇒ May merge radiance files with move to HDF5

# Level 2 data processing

**Purpose** Convert calibrated radiances into atmospheric abundances

- ❑ Accepts Level 1, AURA spacecraft auxiliary data, and operational meteorology data
  - ⇒ Meteorology—from NCEP and DAO—are expected to be HDF
- ❑ Outputs of two types
- ❑ L2GP
  - ⇒ HDF-EOS swath
  - ⇒ The standard product
  - ⇒ 1 molecule, 1 day in 1 file for most products
  - ⇒ Some may have multiple resolutions and/or include column amounts
- ❑ L2AUX
  - ⇒ HDF4 SD
  - ⇒ Format similar to Level 1 radiances
  - ⇒ Diagnostic

## Level 2 data processing (continued)

### **Products** More about our use of HDF-EOS swaths

- ❑ Geolocation coordinates: time, latitude, longitude, and pressure
- ❑ Adhere to AURA guidelines found at
  - ⇒ Files created using HDF-EOS5 (Not yet); using Swath data type
  - ⇒ Structure names chosen from valids list
  - ⇒ Altitudes by way of a pressure grid
  - ⇒ Data fields ordered so that pressures increment fastest
  - ⇒ Data fields stored in specified units
  - ⇒ HDF Fill and missing values both take value of Missing Value data field attribute
- ❑ (See talk by Cheryl Craig (NCAR) September 19 2:35 pm)
- ❑ Column amounts also stored as swaths; may use pressure coordinate to store tropopause pressure
- ❑ Quality, precision, and possibly other data stored in file with product data

# Level 3 data processing

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**Purpose** Map atmospheric abundances, calculate means

- Accepts Level 2 products

**Outputs** Produced by two separate PGEs

Daily program

- Processes standard Level 2 products
- Produces daily maps

Monthly program

- Processes standard, diagnostic and noisy Level 2 products
- Produces monthly maps
- Produces daily and monthly zonal means



## Level 3 data processing (continued)

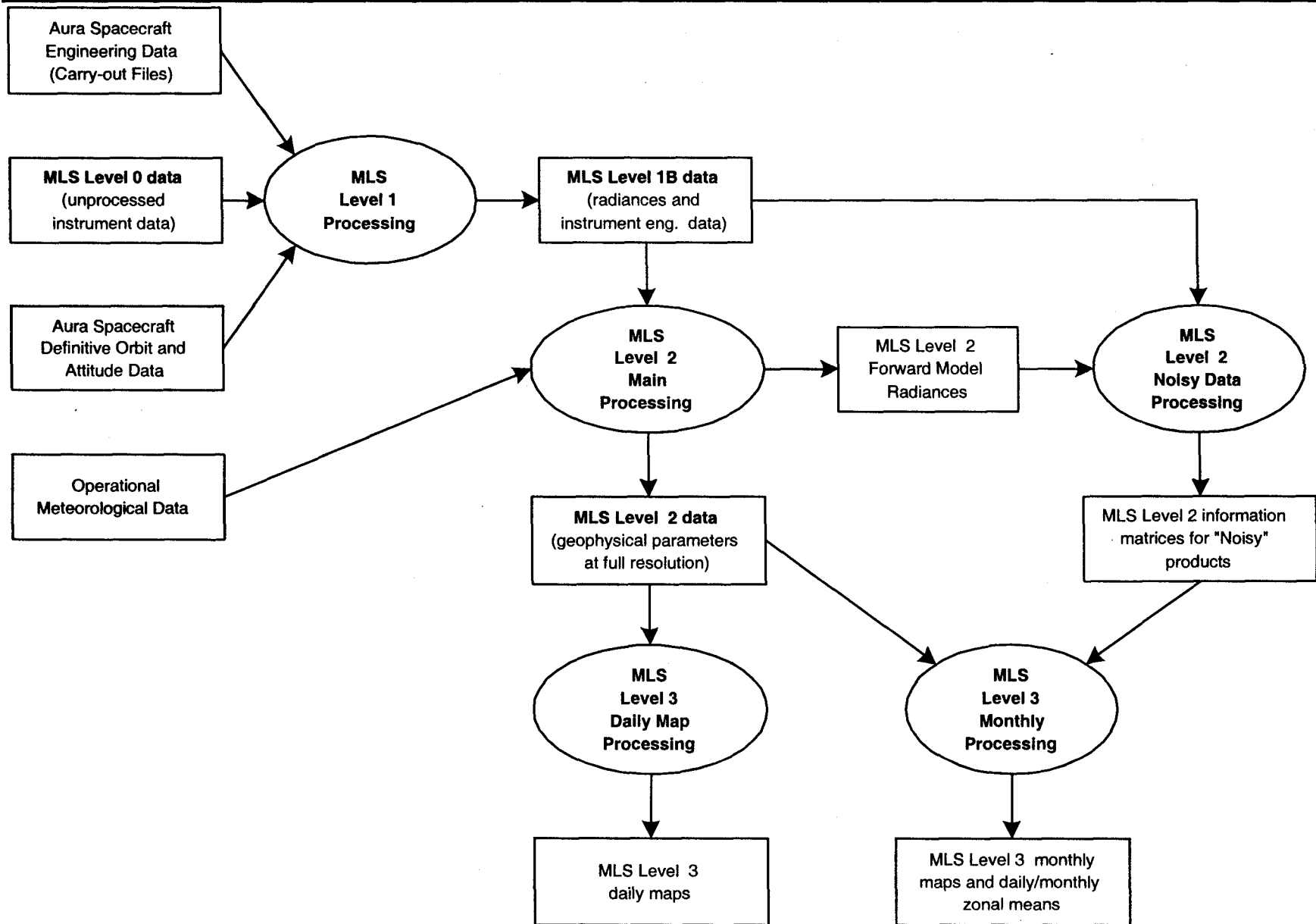
### **Product** Map data

- Daily and monthly
- HDF-EOS grid: both latitudes and longitudes
- longitudes range from  $-180$  to  $179$ deg every 4deg
- latitudes range from  $\pm 82$ deg every 2deg
- Diurnally-varying daily products split into three modes—ascending, descending, and combined; not all products

### **Product** Zonal mean data

- Daily and monthly
- Latitudes only, at Level 2 spacing
- Both daily and monthly split into three modes
- Use HDF-EOS Swath with no longitude data, unless new HDF-EOS Zonal Mean data type defined

# Data flow



# Future plans

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**HDF5 and HDF-EOS5** Welcome or eagerly-awaited changes

- Finally some Linux support
- Awaiting IDL support

**Other new features** Further steps we might take

- We are open to good ideas

**Challenges** No guarantees—hard work ahead

- How to store diagnostics (point, grid, swath, SD?)
- How to make our data products easier to use?
- What standard names, units, axes can we adhere to or force others to adhere to?
- Zonal mean data don't fit neatly into any existing HDF-EOS structure

# Data flow

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**Native Binary** Bad stuff (mostly successful in not using it)

- Platform-dependent; HDF and HDF-EOS are platform-independent
- Currently forced to use with ephemeris and attitude data

**HDF4** Good stuff (but we try to avoid it where we can)

- Forced to use it sometimes
- Will be moving to HDF5

**HDF-EOS** Very good stuff (try to make it the only one our users need)

- Standard geolocations for placing data

**Metadata** Necessary to enable users to order Level 1, 2, and 3 products

- Archived at DAAC
- Describe data product's species, date, goodness, etc.
- Combines static data (attribute names) with dynamic (their values)
- Assume our users will order our data by product/day