



JEM/SMILES

Level 2 Research Data (L2r) Product Guide

for Version 2.1.5

STRUCTURE OF SMILES L2r PRODUCTS

JANUARY 11, 2012



1 LEVEL 2 RESEARCH PRODUCTS OVERVIEW

(1) **FILE NAME**

The file name is defined as follows.

SMILES_L2r_{*product_name*}-{l1b_type} {l1b_version}_{*band_name*}_{l2r_*version_nam*} e}_{*date*}.he5

(ex. SMILES_L2r_O3-std007_A_2.1.5_20100123.he5)

(2) **COMBINATION OF PRODUCT_NAME AND BAND_NAME**

Combinations of product name and band name are as follows.

No.	Product_name	Band_name			
1	O3 (18 - 100 km)	А			
	H37Cl (18 - 90 km)				
	BrO (20 - 80 km)				
	HOCl (20 - 80 km)				
	Temperature (15 - 100 km)				
2	O3(18 - 100 km)	В			
	H35Cl (18 - 90 km)				
	HOCl (20 - 80 km)				
	Temperature (15 - 100 km)				
3	ClO (20 - 90 km)	С			
	BrO (20 - 90 km)				
	HO2 (18 - 100 km)				
	HNO3 (20 - 90 km)				

Other potential products are: Band A: HNO3, CH3CN Band B: HO2

Band C: and O3 isotopomers

For details on these products, please contact the L2r developing team.

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(3) **Level1B_type**

11b_type is represented as follows.
std/rev:
std: Level 1B Standard
rev: Level 1B Revision

(4) $LEVEL1B_Version$

(5) LEVEL2r_VERSION_NAME

l2r_version_name is represented as follows.
 x.x.x:
 x.x.x: Level2r Algorithm version

(6) **D**ATE

date is represented as follows. yyyymmdd: (ex. 20091009) yyyy: Observation year mm: Observation month dd: Observation day



2 PRODUCT FORMAT

(1) STRUCTURE OF HDF5-EOS DATA FILES

The format structure of the HDF5*-EOS data file is shown below.

No.	Field	Attributes
1	File Attribute	File Level Attributes:
		Instrument name
		Processing level
		Version
		Observation day
		• Band name
		• Scan number
		• L1B file name
		AOS unit number
2	Geolocation Field	Geolocation Field Attributes:
		Observation point
		• Time
		• Altitude
		Solar zenith angle
		Ascending/descending flag
2		6 6 6
3	Data Field	Data Field Attributes:
3	Data Field	Data Field Attributes: • Data value
3	Data Field	Data Field Attributes: • Data value • Error estimation

*HTTP://WWW.HDFGROUP.ORG/



(2) STRUCTURE OF STANDARD SMILES L2 PRODUCTS

• Standard processing data (HDF5-EOS)

Structure of standard processing data is as follows.

<File Attributes>

No.	HDF-EOS5 Name	Explanation	Dimension	Data type	Byte
1	L1BID	L1B file name	(n times)	long	8*n times
2	Instrument Name	Instrument name (SMILES)	-	char	6
3	Process Level	Processing level (L2r)	-	char	3
4	Start UTC	Start time in this file	-	char	19
		(yyyy-mm-ddT00:00:00)			
5	End UTC	End time in this file	-	char	19
		(yyyy-mm-ddT23:59:59)			
6	Granule Month	Month (mm)	-	long	8
7	Granule Day	Day (dd)	-	long	8
8	Granule Day of Year	Granule day of year	-	long	8
9	Granule Year	Year (yyyy)	-	long	8
10	PGE Version	Processing version (X.X.X)	-	char	5
11	Start Scan	First scan number in this file	-	long	8
12	End Scan	Last scan number in this file	-	long	8
13	Band Name	Band name	-	char	1
14	AOS Unit Num.	Unit number of the AOS	(n times)	long	1*n times
			Total	101	+ 9*n times

<Swath Attributes>

No.	HDF-EOS5 Name	Explanation	Dimension	Data type	Unit	Byte
1	Altitude	Calculation altitude	(n levels)	double	km	8*n levels
2	Vertical Coordinate	Vertical coordinate	-	char		8
		system name				
		Total		8	+ 8*n levels	



<Geolocation/Data fields Attributes>: Following information is added to each field item.

No.	HDF-EOS5 Name	Explanation	Dimension	Data type	Byte
1	Missing Value	Missing value	-	double	8
2	Title	Filed name	-	char	7
3	Units	Unit	-	char	5
4	Unique Field	Field definition	-	char	15
	Definition				
5	_FillValue	(T.B.D)	-	double	8
			Total		43

<Geolocation Fields>

No.	HDF-EOS5 Name	Explanation	Dimension	Data type Unit B		Byte
1	Time	Observation time	(n times)	double	uble *1	
		(Total seconds since 1/1/1958)				
2	TimeUTC	Observation time (UTC)	(n times)	char -		19*n times
		yyyy-mm-dd hh:mm:ss.sss	· · · ·			
3	Altitude	Representative altitude	(n level)	double	km	8*n level
4	Latitude	Observation latitude	(n times)	double	degrees	8*n times
5	Longitude	Observation longitude	(n times)	double	degrees	8*n times
6	Solar Zenith Angle	Solar zenith angle	(n times)	double	degrees	8*n times
7	Local Time	Local time (hh:mm:ss)	(n times)	char	-	8*n times
8	AscendingDescending	Ascending/descending flag	(n times)	char	-	1*n times
9	Altitude_tp	Altitude grid for auxiliary	(n level_tp)	double	km	8*n
		temperature and pressure				level_tp
		data				
			Total	60*n times + 8*n level + 8*n		h level + 8*n
				level to		

*1: seconds since 1/1/1958



No.	HDF-EOS5 Name	Explanation	Dimension	Data	Unit	Byte
				type		
1	L2 Value	Value	(n level, n times)	double	vmr	8*n times
						*n level
2	L2 Precision	Calculation error	(n level, n times)	double	vmr	8*n times
						*n level
3	Vertical Resolution	Vertical resolution	(n level, n times)	double	km	8*n times
						*n level
4	Measurement Response	Measurement	(n level, n times)	double	-	8*n times
		response				*n level
5	Pressure_tp	Auxiliary pressure	(n level_tp, n times)	double	hPa	8*n times
		data				*n level_tp
6	FOV Interference	Flag of	(n times)	long	-	8*n times
		field-of-view				
		interference on the				
		L1b data				
7	Status	Status information	(n times)	long	-	8*n times
8	Temperature tp	Auxiliary	(n level tp, n times)	double	K	8*n times
	<i>i</i> _ <i>i</i>	temperature data				*n level_tp
9	cloud flag	Cloud flag	(n times n cloud flags)	long	-	8*n times*
		information	n cloud flags = 64	8		64
10	chi?	Chi2	(n times)	double		8*n times
10	Chi2	Tatal			-	
		Iotal	32*n times*n level	+ 16*n time	es™n level_tp	+ 24*n times

<Data Fields>

<StructMetadata>

No.	HDF-EOS5 Name	Explanation	Dimension	Byte
1	StructMetadata.0	Matrix information of swath data	1	32000

< coremetadata >

No.	HDF-EOS5 Name	Explanation	Dimension	Byte
1	coremetadata.0	HDF-EOS information	1	About
				6960



JEM/SMILES L2r data guide for release version 2.1.5

1. SMILES L2r version 2.1.5

The basis of the retrieval algorithm is kept the same as that of version 2.0.1 and described in the following paper.

Baron, P. et al. (2011) "The Level 2 research product algorithms for the Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES)," *Atmos. Meas. Tech.*, 4, pp. 2105-2124. doi:10.5194/amt-4-2105-2011

http://www.atmos-meas-tech.net/4/2105/2011/amt-4-2105-2011.html

Updated from version 2.0.1 (i.e., updates from the configuration described in Baron et al., 2011):

- Version of the L1b data was updated to <u>007</u> from 005. With this L1b version 007, the precision of the non-linearity gain calibration was much improved.
 Also, a new quality flag (temperature of 4 K stage) on L1b is used to select the data to be processed in L2r.
- AOS response function was changed to a double-Gaussian model based on the on-orbit comb measurement, instead using a triple-Gaussian with an ad hoc empirical scaling factor model.
- Deviation on the frequency for each AOS channel was improved by applying a 7-order polynomial correction derived by the SMILES instrumental team.
- Spectroscopic parameter was revised, including the main O_3 625.371 GHz line.
- Inversion altitude grid-intervals and *a priori* error were changed for most of the products.
- No full-band (previously called "band-A_w08," "band-B_w06," or "band-C_w00") configurations were processed. We only plan to release so-called stratospheric products. For those who would like access to the full-band configuration products, please contact the L2r team.

For more detail, please contact the SMILES L2r team.



2. Overview of the retrieval processing (L2r version-2)

As described by Baron et al. (2011), we first go through the cloud flagging procedure, and, at the same time, we correct the LOS elevation angle offset (a constant value for one scan). Then, we extract the limited spectral range around O3 625.371 GHz. and retrieve the LOS elevation angle offset <u>for each tangential point</u> (as well as retrieving O3 and T(z)). This is one of the major differences from the SMILES L2-operational processing chain. By using the retrieved elevation angle offset for each tangential point, we retrieve O3 and temperature. After retrieving O3 and temperature, we then retrieve other species such as HCl with dedicated spectral regions. Once we process band A or B, we then move to band C by using the retrieved O3 profile as a priori.

The summarized outlines are attached below.

For any further detail, please contact the SMILES L2r team.



Outline of L2r-v2.X processing chain

Forward/Inversion models: AMATERASU (Baron et al. 2008; 2011)

- Line-by-line calculation of the molecular lines

- Dry and Wet continuum absorption based on Pardo (2001) formularization, with an ad-hoc scaling of 1.2 on the dry continuum.

- Atmospheric refraction.

- SMILES instrumental modeling (SSB (single-side-band) filter module is omitted)

- Inversion calculation with employing Optimal Estimation Method (OEM, Rodgers, 1976; 1990).

- Levenberg-Marquardt iteration scheme.





Sequential retrieval for band A and B

- 1. Cloud flagging is done using the spectral range of **CF**.
- 2. The LOS elevation angle offsets for each tangential point $\Delta \theta(z)$ are retrieved from w00 (O3 and Temperature is also set as retrieval params, but in a rather sparse vertical grid).
- 3. By using the retrieved $\Delta \theta(z)$ on the previous step, **O3** and Temperature are retrieved from **w01** (with additional params of $\Delta \theta o$ and baselines).
- 4. By using $\Delta \theta(z)$, O3, and T(z) from steps 2–3, then HCl is retrieved from w02.



Sequential retrieval for band C

- 1. Cloud flagging is done using the spectral range of CF.
- 2. No $\Delta \theta(z)$ is retrieved for band-C. Just $\Delta \theta o$ (a constant offset for all the tangential points) is retrieved from the full-band spectrum (w00). **Temperature is fixed to a priori (GEOS5).**
- 3. By using the retrieved $\Delta \theta_0$; **BrO** and **HNO3** are retrieved from **w01**.
- 4. From w02, HO2 is retrieved (with several other params).



3. Some notes on the L2r-hdf contents

SMILES L1b data contains the attitude information from several sources, particularly from the ISS and the Star Tracker (STT) onboard SMILES. The SMILES/ISS attitude data on L2r processing are based on the "ISS" origin information. Latitude and longitude of L2r hdf data are derived from the <u>30th</u> spectrum of each scan (middle of the scan). These configurations cause some differences between the latitude and longitude information for the same scan on L2 operational data. This discrepancy will be solved in a future L2r product release.

The "FOV Interference" field is prepared with the intention of providing quality flag information on L1b data. For the current version of the L2r-hdf, this FOV Interference field includes the quality flag from the level-2 procedure as well. This confusing situation will be improved in the next version of the L2r product.

For version 2.1.5, FOV Inteference means:

0: Normal L1b data and successful level-2 process

1: Normal L1b data, although the level-2 process had some problems.

>= 2: L1b data contain warning flag on the data quality.

>= 16: Warning in the event that the antenna line of sight (LOS) has an object

in it

>= 32: Cold-sky observation has an object within its LOS.

>= 64: Star tracker LOS has an object in it.

For the primary information, we recommend using the measurement response and chi2 for the data selection of the L2r v2.1.5 product.



4. Misc.

Relevant reference papers:

- Baron, P. et al. (2011) "The Level 2 research product algorithms for the Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES)," Atmos. Meas. Tech., 4, pp. 2105 2124.
- Baron. P. et al. (2008) "AMATERASU: Model for Atmospheric TeraHertz Radiation Analysis and Simulation," *Journal of the National Institute of Information and Communications Technology*, **55(1)**, pp. 109 – 121.
 http://www.nict.go.jp/publication/shuppan/kihou-journal/journal-vol55no1/07-04.pdf
- Papers in prep.: Validation of the SMILES O3 product, Error Analysis of SMILES L2r ClO data, Comparison of SMILES ClO with other instrument measurements, and more ⁽ⁱⁱⁱ⁾.

Future development schedule for SMILES-L2r processing:

- Development of a new version that focuses on the UT/LS region.