AWX File Format Specification

Version 2.1

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1. Contents of Distributed Meteorological Satellite Products

1.1 Concept of distributed meteorological satellite products葚

A meteorological satellite can either be a geostationary or a polar orbiting spacecraft by type. The data collected directly by the two types of spacecraft are termed as “raw data”. The products derived from the raw data after processing are called meteorological satellite products. The products would be distributed either through computer networks, or via communication lines, and become distributed products. 葚

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Meteorological satellite products, rich in content, can be broadly categorized as imagery products, quantitative products, and graphical analysis products. The qualitative imagery products are known to people and have been widely used, while quantitative information products are generated and applied in an increased number, showing a promising prospect.

The standard formats for distributed meteorological satellite products introduced here are the one prepared to accommodate the actual needs of meteorological satellite products applications and distribution. With all the explanations made here, one can easily read out or use the products distributed by the National Satellite Meteorological Center either through communication channel 9210, or via the GTS circuits. 葚

1.2 Standard formats of distributed meteorological satellite products葚

The distributed meteorological satellite products can be categorized either by source or by application as follows:

1.2.1 Imagery products 葚

1) Geostationary imagery products 葚

Geostationary imagery products are the imagery products derived from S-VISSR data, though the formats introduced here can also apply to the non-S-VISSR imagery data, when needed operationally.

2) Polar-orbiting imagery products 葚

The imagery products referred to here are the one stemmed from AVHRR data.灌

1.2.2 Grid field quantitative products 葍

1) Polar-orbiting grid field quantitative products

Sea surface temperature, outgoing longwave radiation, vegetation index, snow cover, total cloud cover, fog, soil moisture, clear sky satellite environmental monitor dataset, and ATOVS temperature/humidity.葍

2) Geostationary grid field quantitative products葍

Precipitation estimates, outgoing longwave radiation, temperature of brightness blackbody, total cloud cover, ground incident solar radiation, sea surface temperature, precipitation index, mid and upper tropospheric water vapor, cloud moisture profile, clear sky atmospheric precipitation, cloud classification, and snow cover.漌

1.2.3 Discrete field products 葍

1) Geostationary discrete field products

Atmospheric motion vectors (cloud motion winds) 葍

2) Polar-orbiting discrete field products

ATOVS temperature and humidity profiles

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1.2.4 Graphical analysis products 葍

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The following section will discuss the standard binary code formats of the above-mentioned products. The satellite sounding data exchanged using telegraph codes shall follow the formats prescribed in WMO's Manual on Codes, though it would also be dealt with here.葍

2. Standard file names of distributed meteorological satellite products

The file name used in the distributed meteorological satellite product can serve as the file name of the product itself and the effective information about the product in the file header. 葍葍

2.1 SAT96 file naming

SAT96 products shall be file named in line with the following formats:

T1	T2	D	M	Y	Y	G	g	.	A	W	X

where, the file name part shall be the standard eight-character file name, with a suffix of AWX (Advanced Weather-satellite eXchange format) to show the origin of the product from the National Satellite Meteorological Center. 葍

The characters in the file name would stand for the following meaning: 葍

T1: description character 1 for the distributed product; 葍

T2: description character 2 for the distributed product;; 葍

D: attributes; 葍

M: product generation month; 葍

YY: product generation date;葍

G: product generation time (Universal Time); 葍

g: product generation hour or time range. 葍

Please see the detailed descriptions in Table 1.1. 灌

Table 1 Descriptions of the characters used in file naming

T1	T2	D	M	YY	G	g
E：Satellite Imagery products	I：infrared V：visible W：water vapor S：infrared split window R：mid-infrared Z：multi-channel composite M：mosaic N: surface precipitation estimates U: sandstorm	L：Lambert projection M：Mercator (small-scale) N：Mercator (large-scale) P：stereographic projection E：coordinates transformation O：no projection	J：January F：February M：March A：April Y：May U：June L：July G：August S：September O：October N：November D：December	01：day 1 02：day 2 03：day 3 ┇ 30：day 30 31：day 31	0：0 hour 1：1hour 2：2hour ┇ 9：9hour A：10hour B：11hour C：12hour ┇ M：22hour N：23hour	0：FY-2 cloud imagery 1：MTSAT cloud imagery 2：European satellite disc imagery 3：Mosaic 9:FY-2 cloud imagery（flood season） S：southern hemisphere N：northern hemisphere 0：00min 1：10 min 2：20 min 3：30 min 4：40 min 5：50 min Y：month X：10-day H：5-day R：day O：others
	A：geostationary reception schedule	D：meaningless				
	B：orbit parameters	D：meaningless				
	C：cloud parameters	C: cloud classification E：high cirrus H：cloud top height L：low cloud amount T：cloud top temperature Z：total cloud cover				

T ： satellite numerical data	E ： precipitation estimates	P ： polar-orbiting retrieval G ： geostationary retrieval				
	H ： remote sensing upper air data	transit track number（1，2，3，…）				
	I: ground incident solar radiation	P ： polar-orbiting retrieval G ： geostationary retrieval				
	M ： mean brightness temperature	P ： polar-orbiting retrieval G ： geostationary retrieval				
	O：OLR	P ： polar-orbiting retrieval G ： geostationary retrieval				
	P：data collection platform	D：meaningless				
	R ： clear sky radiation	R：sunshine				
	S：snow cover	P ： polar-orbiting retrieval G ： geostationary retrieval				
	T ： sea surface temperature	P ： polar-orbiting retrieval G ： geostationary retrieval				
	W：wind motion vector	D ： Infrared inversion W: water vapor inversion				
	Y：environmental monitoring data	A ： NOAA three-channel data B:： FY-19-channel data			* Coordinates in the lower left corner NOAA:5º*5º, FY-1:2.5º*5º	
	Z：humidity	C: cloud zone humidity profile P: clear sky atmospheric precipitation T ： mid & upper tropospheric water vapor S：soil moisture				I: standard level, I=1 for 1000 Hpa； I=2 for 925 Hpa； I=3 for 850 Hpa； I=4 for 700 Hpa； I=5 for 500 Hpa； I=6 for 400 Hpa； and I=7 时 for 300Hpa.
P： graphical data	E ： precipitation index C：nephanalyses S：snow cover W ： atmospheric motion vectors	D：meaningless				
X: satellite data	F：fire	G：geostationary P: polar-orbiting				
		F：description				

	W：water	G：geostationary P: polar-orbiting				
		W：description				
	S：snow	G：geostationary P: polar-orbiting				
		W：description				
	I：sea ice	G：geostationary P: polar-orbiting				
		I：description				
	R：drought	G：geostationary P: polar-orbiting				
		R：description				
	U：sandstorm	G：geostationary P: polar-orbiting				
		U：description				
	C ： satellite animation	C：description				
	V ： vegetation index	G：geostationary P: polar-orbiting				
		V：description				
	M ： vegetation index anomaly	G：geostationary P: polar-orbiting				
		M：description				
	o：fog	G：geostationary P: polar-orbiting				
		o：description				
	E: rainstorm	G：geostationary P: polar-orbiting				
		E：description				
▪	V: strong convection	G：geostationary P: polar-orbiting				
		V：description				
C: radiometric calibration	C: China's satellite calibration coefficients	G：geostationary P: polar-orbiting				

• Please see the coding of Gg in attached Tables 1.2 (A), 1.2 (B), 1.2 (C), and 1.2 (D).

Note: In the file name suffix AWX, A is represented by I to show the file number of the product.

Table 1.2 (A) NOAA coding table for Gg

Table 1.2 (B) NOAA coding table for Gg

Table 1.2 (C) FY-1 coding table for Gg

Table 1.2 (D) FY-1 coding table for Gg

2.2 SAT2004 file naming

2.2.1 Characters that can be used in file naming

Only English letters in both upper and lowercases (A - Z, a - z), numbers (0 -

9), underscores (_), and dots (.) can be used. No other special characters are allowed.

2.2.2 Composition of file names

A file name can be composed using meaningful characters, underscores (_), and dots (.). Characters can be English letters in both upper and lowercases (A - Z, a - z) and numbers (0 - 9). Characters can be separated by one or more underscores (_) or dot (.). The naming shall contain satellite name, product type, instrument channel, projection mode, start date of observation, start time of observation, and data format.

Table 4.2（C） SAT2004 file naming

Information	Note	Optional
Satellite name		FY1D FY2C、FY2D、FY2E MST**1～4** NA11～17 MSG1～n MTP1～n NPS1～n EOST、EOSA IST1～n GMS5 MTS1、MTS2
Product type		SST、OLR (see abbreviated products name table)
Instrument channel		IR1、IR2、IR3、IR4、VS1、VS2、VS3、VS4、VIS、MLT
Projection mode		LBT、MCT、OTG、AEA、PSG、NOM、NUL
Start date	Start date	YYYYMMDD
Start time (or in day, 5-day, 10-day, monthly)		HHMM（UTC）（When the first letter is “H”, AOAD stands for daily mean, AOFD for 5-day mean, AOTD for 10-day mean, AOAM for monthly mean, AOAQ for seasonal mean, and AOAY for annual mean. TOAD stands for daily accumulation, TOFD for 5-day accumulation, TOTD for 10-day accumulation, TOAM for monthly accumulation, TOAQ for seasonal accumulation, and TOAY for annual accumulation）
Data format	Suffix	RAW、DAT（Intermediate file）、NOM、AWX 、HDF、TXT、LDS、GIF、JPG、BMP、BUF、GRB、GRD、BIN……

For example, FY2C_OLR_MLT_OTG_20030409_1030.AWX would mean “FY-2C satellite_outgoing longwave radiation_multi-channel data_latitude-longitude projection, a 9210 product prepared at 1030 April 9, 2005”.

3. Binary formats of distributed meteorological satellite products

3.1 Overview

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The distributed meteorological satellite products mentioned in part one of this manual would have a file composed under a unified format, as shown in Table 1.3.

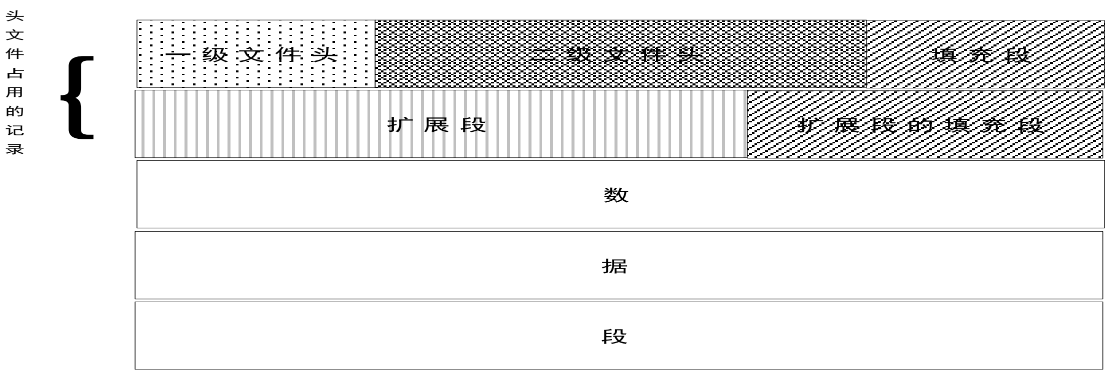
The top-level header, the second-level header, filling segment, extended segment, and the filling segment of the extended segment are collectively termed as file header. Of them, the top-level header has a defined length for 40 bytes. All the products shall have a top-level header that contains the information of file name, attributes, product type, and the way the data is compressed.

In the second-level header, product formats would be specified based on the product type mentioned in the top-level header. The second-level header does not have a defined length, and the content could be varied depending on individual products even under the same category. In the second-level header, the content shall be recorded as defined when the product is generated, though differed to some extent. The extended segment does not have a defined length either.

The filling segment is designed to make up for the possible insufficient length of the file header, so as to generate or read out the product files in a directly accessible manner. The filling segment can either be filled with nothing, or filled with descriptive information, or with something that users would like to add about the format.

To meet the future development needs of meteorological satellite applications, we expanded the AWX format with due consideration to the backward compatibility. In V2.0, the concept of extended segment and the filling segment of expanded segment are introduced as shown in Table 1.3.

Table 1.3 Composition of distributed meteorological satellite product files



top header second header filling segment
extended segment the filling segment of expanded segment
data segment

3.2 Description of formats 灌

3.2.1 Strings 菖

In formatting, all the strings are composed using ASCⅡ codes. When the string length does not reach the defined length, the shortfall shall be filled with spaces. 灌

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3.2.2 Data unit 菖

Data unit, unless otherwise specified, shall be noted in the note column. In formatting, all the data shall be presented in integer, in an attempt to avoid the binary incompatibility due to the number of floating points. When floating points have to be presented, the number shall be multiplied by a factor to be an integer. When using, it shall be divided by the corresponding factor. 灌

3.2.3 Time 菖

In formatting, unless otherwise specified, the universal time is used. 灌

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3.2.4 Satellite name 菖

Satellite name shall be composed using strings to show the source of data. In the future, some products could be generated using the data stemmed from multiple satellites. When this happens, the satellite name can be expressed in the following formats:

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MOSAICGG: using the data from multiple geostationary meteorological satellites 菖

MOSAICPP: using the data from multiple polar orbiting meteorological satellites 菖

MOSAICGP: using the data from multiple geostationary and polar orbiting meteorological satellites 灌

3.2.5 Others 菖

In the prescribed formats, one would see a column marked as "reserved", meaning the column would not be used at this point. When marked with the wording "internally reserved", the column might have a value, though the user shall not be bothered. The column marking "meaningless" shall be zeroed. 菖

3.3 Top-level header 菖

Table 1.4 Composition of top-level header

No.	Byte range	Number of bytes	Type	Description	Note
1	1－12	12	Char×12	Sat96 file name	〖1〗
2	13－14	2	Int16	Integer byte order	〖2〗
3	15－16	2	Int16	Top-level header length	〖3〗
4	17－18	2	Int16	Second-level header length	〖4〗
5	19－20	2	Int16	Filling segment data length	
6	21－22	2	Int16	Record length	〖5〗
7	23－24	2	Int16	Header length in records	**〖5A〗**
8	25－26	2	Int16	Product data length in records	
9	27－28	2	Int16	Product type	〖6〗
10	29－30	2	Int16	Compression	〖7〗
11	31－38	8	Char×8	Format description strings	〖8〗
12	39－40	2	Int16	Product data quality ID	〖9〗

Note 1: Sat96 file name shall be generated in line with the SAT96 naming format.

Note 2: ＝0：when integer data are aligned in INTEL format (for IBM PC and other compatible PCs), namely lower bytes before the higher one.
☐ ＝0：when integer data are aligned in MOTOROLA format (for large PCs and most small PCs), namely higher bytes before the lower one.

Note 3: a fixed value at 40 bytes

Note 4: Calculating the number of bytes based on the actual information content in the second-level header of the products.

Note 5: in byte
Imagery products: record length = imagery width
Grid field products: record length = horizontal grid points × grid data character length

Note 5A: The total number of records occupied by top-level header, second-level header, filling segment, extended segment, and the filling segment of expanded segment.

Note 6: = 0: undefined product type
= 1: geostationary imagery products
= 2: polar-orbiting imagery products
= 3: grid field quantitative products
= 4: discrete field quantitative products
= 5: graphical analysis products

Note 7: = 0: uncompressed
= 1: compressed length codes
= 2: LZW compression
= 3: special compression mode

Note 8: current format version is "SAT2004", and an earlier version is "SAT96"

Note 9: = 0: without quality control
= 1: reliable data quality without missing values or errors. (error rate under 10^{-6}, or a throw line rate less than 0.5 ‰)
= 2: basically reliable quality, with the missing values or errors within the allowable range. (error rate around 10^{-4}-10-^{6}, or a throw line rate between 0.5 ‰ - 2 ‰)
= 3: with missing values or errors, though still usable. (error rate around 10^{-3} - 10^{-4}, or a throw line rate between 2 ‰ - 20 ‰)
= 4: with missing values or errors, literally unusable, though can serve as reference. (error rate around 10^{-2} - 10^{-3}, or a throw line rate between 20 ‰ - 200 ‰)
= 5: unreliable data, unusable. (error rate larger than 10^{-2}, or a throw line rate larger than 200 ‰)

4. Geostationary imagery products葛

4.1 Second-level header 葛

The second-level header of geostationary imagery products would have a file header length for 64 bytes, as described in Table 4.5.

Table 1.5 Second-level header of geostationary imagery products

No.	Byte	Number of bytes	Type	Description	Note
1	41－48	8	A×8	Satellite name	FY2C
2	49－50	2	I×2	Time（year）	Such as 2005〖1〗
3	51－52	2	I×2	Time（month）	
4	53－54	2	I×2	Time（day）	
5	55－56	2	I×2	Time（hour）	
6	57－58	2	I×2	Time（minute）	
7	59－60	2	I×2	Channel number	〖2〗
8	61－62	2	I×2	Projection	〖3〗
9	63－64	2	I×2	Imagery width	
10	65－66	2	I×2	Imagery height	
11	67－68	2	I×2	Scan row number in the upper left corner of the imagery	〖4〗

12	69－70	2	I×2	Pixel number in the upper left corner of the imagery	〖4〗
13	71－72	2	I×2	Sampling Rate	〖5〗
14	73－74	2	I×2	Geographic scope (N)	〖6〗
15	75－76	2	I×2	Geographic scope (S)	〖6〗
16	77－78	2	I×2	Geographic scope (W)	〖6〗
17	79－80	2	I×2	Geographic scope (E)	〖6〗
18	81－82	2	I×2	Projection center latitude	degree×100
19	83－84	2	I×2	Projection center longitude	degree×100
20	85－86	2	I×2	Projection standard latitude 1 (or standard longitude)	degree×100 〖7〗
21	87－88	2	I×2	Projection standard latitude 2	〖7〗
22	89－90	2	I×2	Projection horizontal resolution	km×100
23	91－92	2	I×2	Projection vertical resolution	km×100
24	93－94	2	I×2	Mark for superimposed geographical grids	〖8〗
25	95－96	2	I×2	Superimposed value of geographical grids	〖9〗
26	97－98	2	I×2	Palette table data block length	〖10〗
27	99－100	2	I×2	Calibration data block length	〖11〗
28	101－102	2	I×2	Positioning data block length	〖12〗
29	103－104	2	I×2	Reserved	

Note 1: Start time of reception

Note 2: = 1: infrared channel (10.3-11.3)
= 2: water vapor channel (6.3-7.6)
= 3: IR split window channel (11.5-12.5)
= 4: visible channel (0.5-0.9)
= 5: mid-infrared channel (3.5-4.0)
= 6-100: reserved

Note 3: = 0: without projection (satellite projection)
= 1: Lambert projection
= 2: Mercator projection
= 3: stereographic projection
= 4: latitude/longitude projection
= 5: equal area projection

Note 4: When projection sits at 0, both the items are valid, as it shows the initial coordinates of the original imagery products without projection. It is worth noting that the coordinates are taken from IR channel as reference. In the context of visible imagery products, their coordinates shall be the results of being multiplied by the power of four.

Note 5: The sampling rate of original imagery products without projection. This item would be meaningless when referring to the projected imageries.

Note 6: These items are set to illustrate the approximate area covered by the imageries (in degree).
Latitude range: -90^{o} - $+90^{o}$ (positive N),
Longitude range: -180^{o} - $+180^{o}$ (positive E),
When the information of geographic scope is not given, the item shall be filled with 9999.

Note 7: There are two standard latitudes for the Lambert projection. As a result, both items 20 and 21 are valid;
There is only one standard latitude for the Mercator projection, and only item 20 is valid;
Item 20 shows the standard longitude of stereographic projection, and item 21 is meaningless;
In the context of latitude/longitude projection, both items 20 and 21 are meaningless.

Note 8: = 0: un-superimposed geographic grids
= 1: superimposed geographic grids

Note 9: When item 24 indicates that the imagery has been superimposed with geographic grids, the content of the item would show the gray scale of superimposed geographic grids.

Note 10: 0 means no palette table is applied.

Note 11: 0 means no calibration data block is applied

Note 12: 0 means no positioning data block is applied

Please see the composition of second-level header of geostationary imagery products in Table 1.6.

Table 1.6 Composition of second-level header of geostationary imagery products

Description part
Palette table data block
Calibration data block
Positioning data block

In the header, it is possible that no description is made about palette data block, calibration data block and positioning data block, depending on the defined data block length of items 26, 27 and 28. Meanwhile, data space will not be retained if the block is not there. The data block formats are described as follows.

4.2 Palette table data block

Palette table data block presents the gray value corresponding to R, G, and B colors. Their alignment is given in Table 1.7.

Each color value is represented by a byte, or 768 bytes in total.

Table 1.7 Palette table data block

R palette table (256 bytes)
G palette table (256 bytes)
B palette table (256 bytes)

4.3 Calibration data block

Calibration data block describes the relationship between gray scale and physical values. For example, an infrared imagery would describe the brightness temperature at each point, while a visible imagery would show the reflectance of each point. Infrared and visible imageries are differed in the number of bits. For example, on FY-2B, IR has 8 bits while visible has 6. On FY-2C, both infrared and water vapor have 10 bits with visible having 6. As a result, they would have a differed space for corresponding gray scales. For the sake of convenience, we define the calibration data block length as 1,024 two-byte integers, or 2,048 bytes, as shown in Table 1.8.

Table 1.8 Calibration data block

No.	0	1	...	1024
Content	Calibration data corresponding to gray scale 0	Calibration data corresponding to gray scale 1	...	Calibration data corresponding to gray scale 1024

Note:

1) Unit: 0.01% (reflectance)
0.01K (brightness temperature).

2) One can obtain the calibration data corresponding to a given gray scale in a lookup table. In the context of visible imageries, one can find calibration data in the range of 0-63, when the imagery data is kept at low six bits, or in the range of 0-1024 for more than 6 bits. Outside of the range, a zero shall be filled in.

3) When brightness temperature is greater than 32767, the result would be negative, if the readout is made in two-byte integer. When this happens, one can add 65536 to make it positive (as brightness temperature is not negative, it can be directly defined as unsigned int).

4.4 Positioning data block

Positioning data block presents complete geographic latitude and longitude grids with its composition shown in Table 1.9.

Table 1.9 Positioning data block

Description
Grid data

Table 1.10 shows the partial formats of grid data description.

Table 1.10 Partial formats for grid data description

No.	Bytes range	Number of bytes	Type	Description	Note
1	1－2	2	I×2	Grid point coordinates defined	〖1〗
2	3－4	2	I×2	Grid data source	〖2〗
3	5－6	2	I×2	Grid degree	degree×100
4	7－8	2	I×2	Upper left corner grid points latitude	v×100 〖3〗
5	9－10	2	I×2	Upper left corner grid points	degree×100

				longitude	
6	11－12	2	I×2	Horizontal grid points	〖4〗
7	13－14	2	I×2	Vertical grid points	〖4〗
8	15－16	2	I×2	Reserved	

Note 1: = 0: grid data presented in imagery coordinates
= 1: grid data given in satellite coordinates

Note 2: = 0: imagery grids calculated when generating the products
= 1: simplified grid parameters (by 5 degrees) released by the satellite (2500 bytes in total)

Note 3: Upper left corner grid point means the intersection between the first grid longitude and the first latitude, rather than an upper left point on the imagery.

Note 4: In the context of un-projected products, or some products projected in some other manners, each latitude or longitude line would see an unequal number of grid points horizontally or vertically. When this happens, the largest number of grid points prevails.

Grid data shall be aligned in grid point manner, from north to south, and from west to east. The coordinates of each point shall be expressed in such manner that row number comes before column number. Data type is I × 2. When grid data are given in imagery coordinates, some grid points may fall outside of the imagery, which shall be marked as "-1". 萻

5. Polar-orbiting imagery products 萻

5.1 Second-level header 萻

Polar-orbiting imagery products would have 88 bytes for the length of second-level header, as described in Table 1.11.
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Table 1.11 Second-level header format for polar-orbiting imagery products

No.	Bytes range	Number of bytes	Type	Description	Note
1	41－48	8	A×8	Satellite name	FY-1C
2	49－50	2	I×2	Start time（Y）	Such as 2005 〖1〗
3	51－52	2	I×2	Start time（M）	
4	53－54	2	I×2	Start time（D）	
5	55－56	2	I×2	Start time（H）	
6	57－58	2	I×2	Start time（Min）	
7	59－60	2	I×2	End time（Y）	
8	61－62	2	I×2	End time（M）	

9	63－64	2	I×2	End time（D）	
10	65－66	2	I×2	End time（H）	
11	67－68	2	I×2	End time（Min）	
12	69－70	2	I×2	Channel number	〖2〗
13	71－72	2	I×2	R channel number	〖3〗
14	73－74	2	I×2	G channel number	〖3〗
15	75－76	2	I×2	B channel number	〖3〗
16	77－78	2	I×2	Lower or higher track marker	〖4〗
17	79－80	2	I×2	Track number	
18	81－82	2	I×2	Pixel bytes number	〖5〗
19	83－84	2	I×2	Projection	〖6〗
20	85－86	2	I×2	Product type	〖7〗
21	87－88	2	I×2	Imagery width	
22	89－90	2	I×2	Imagery height	
23	91－92	2	I×2	Upper left corner scan row number	〖8〗
24	93－94	2	I×2	Upper left corner pixel number	〖8〗
25	95－96	2	I×2	Sampling rate	〖9〗
26	97－98	2	I×2	Geographic scope (N)	〖10〗
27	99－100	2	I×2	Geographic scope (S)	〖10〗
28	101－102	2	I×2	Geographic scope (W)	〖10〗
29	103－104	2	I×2	Geographic scope (E)	〖10〗
30	105-106	2	I×2	Projection center latitude	degree×100
31	107-108	2	I×2	Projection center longitude	degree×100
32	109-110	2	I×2	Projection standard latitude 1 (or standard longitude)	degree×100 〖11〗
33	111-112	2	I×2	Projection standard latitude 2	〖11〗
34	113-114	2	I×2	Projection horizontal resolution	km×100
35	115-116	2	I×2	Projection vertical resolution	km×100
36	117-118	2	I×2	Mark for superimposed geographical grids	〖12〗
37	119-120	2	I×2	Values of superimposed geographical grids	〖13〗
38	121-122	2	I×2	Palette table data block length	〖14〗
39	123-124	2	I×2	Calibration Data block length	〖15〗
40	125-126	2	I×2	Positioning data block length	〖16〗
41	127-128	2	I×2	Reserved	

Notes 1: Start time refers to the beginning of track reception, and end time the end of track reception. When there is no end time to give, the end time

entry shall be filled with "0". 漌

Notes 2: = 0: three-channel imageries, aligned in order of R, G and B. 漌
= 1-5: single-channel imagery, presented in the actual number of satellite channels 漌
= 6-100: Reserved 漌
= 101-119: TOVS HIRS channel 漌
= 120-200: Reserved 漌
= 201-204: TOVS MSU channel 漌
= 205 or above: Reserved 漌

Notes 3: When three-channel imageries are synthesized, channels R, G, and B shall correspond to the satellite's channel number.

Note 4: = 0: lower track 漌
= 1: higher track
漌
Note 5: When a pixel is larger than a byte in number, the bytes shall be aligned in line with the order defined for top-level header.

Note 6: = 0: without projection (satellite projection) 漌
= 1: Lambert projection 漌
= 2: Mercator projection 漌
= 3: stereographic projection 漌
= 4: latitude/longitude projection
= 5: equal area projection 漌
= 6: others 漌

Note 7: = 0: average imagery 漌
= 1: fire 漌
= 2: water 漌
= 3: drought 漌
= 4: snow 漌
= 5: vegetation 漌
= 6: ice 漌
= 7: sea surface temperature 漌
= 8: surface temperature 漌
= 9: cloud height 漌
= 10: soil moisture 漌
= 11: estuarine sediment 漌
= 12: Urban Heat Island 漌
= 13: ocean color 漌
= 14-99: reserved 漌
= 100 or above: TOVS imageries

Note 8: When projection mode is set at 0, both items are valid to show the initial coordinates of un-projected imagery products

Note 9: Sampling rate of un-projected imageries in relation to original satellite imageries. The item is meaningless to the projected imageries.

Note 10: These items are to illustrate the approximate areas that the imagery products have covered (in degree). 漌

Latitude range -90° - +90° (positive N), 漌

Longitude range -180° - +180° (positive E),

When geographic scope is not given, one shall fill the item with 9999.

Note 11: There are two standard latitudes for Lambert projection. As a result, both items 32 and 33 are valid;

There is only one standard latitude for Mercator projection, and only item 32 is valid;

Item 32 shows the standard longitude of stereographic projection, and item 33 is meaningless;

In the context of latitude/longitude projection, both items 32 and 33 are meaningless.

Note 12: = 0: un-superimposed geographic grids 漌

= 1: superimposed geographic grids 漌

Note 13: When item 36 shows superimposed geographic grids, its content would show the gray scale of superimposed geographical grids.

漌

Note 14: Being 0 means it does not contain a palette table. 漌

Note 15: Being 0 means there is no calibration data block. 漌

Note 16: Being 0 means there is no positioning data block. 菖

One can see the composition of second-level header of polar-orbit imagery products in Table 1.12.

菖

Table 1.12 Composition of second-level header of polar-orbit imagery products

Description
Palette table data block
Calibration data block
Positioning data block

In the header, it is possible that no description is made about palette data block, calibration data block and positioning data block, depending on the defined data block length of items 38, 39 and 40. Meanwhile, data space will not be retained if the block is not there. The formats of data block are described as follows.

5.2 Palette table data block

Palette table data block shows the gray scale corresponding to R, G, and B colors. Their alignment is given in Table 1.13.

Each color value is represented by a byte, or 768 bytes in total.

Table 1.13 Palette table data block

R palette table (256 bytes)
G palette table (256 bytes)
B palette table (256 bytes)

5.3 Calibration data block 葛

Calibration data block describes the relationship between gray scale and physical values. For example, an infrared imagery would describe the brightness temperature at each point, while a visible imagery would show the reflectance of each point. Calibration data block length is defined as 256 two-byte integers, or 512 bytes. Please see their alignment in Table 1.14.

Table 1.14 Calibration data block

No.	0	1	…	1024
Content	Calibration data corresponding to gray scale 0	Calibration data corresponding to gray scale 1	…	Calibration data corresponding to gray scale 255

Note:

1) Unit: 0.01% (reflectance)
0.01K (brightness temperature).

2) When brightness temperature is greater than 32767, the result would be negative, if the readout is made in two-byte integer. When this happens, one can add 65536 to make it positive (Brightness temperature is not negative. It, therefore, can be directly defined as unsigned int).

5.4 Positioning data block 葛

Positioning data block presents a complete geographic latitude and longitude grids map with its composition shown in Table 1.15.

Table 1.15 Positioning data block

Description
Grid data

Table 1.16 shows the partial formats of grid data description.

Table 1.10 Partial formats for grid data description

No.	Bytes range	Number of bytes	Type	Description	Note
1	1－2	2	I×2	Grid point coordinates defined	〖1〗
2	3－4	2	I×2	Grid data source	〖2〗
3	5－6	2	I×2	Grid degree	degree×100
4	7－8	2	I×2	Upper left corner grid points latitude	degree×100 〖3〗
5	9－10	2	I×2	Upper left corner grid points longitude	degree×100
6	11－12	2	I×2	Horizontal grid points	〖4〗
7	13－14	2	I×2	Vertical grid points	〖4〗
8	15－16	2	I×2	Reserved	

Note 1: = 0: grid data presented in imagery coordinates
= 1: grid data given in satellite coordinates

Note 2: = 0: the imagery grids calculated when generating the products
= 1: 1 degree grid parameters of the entire track generated in the pre-handling.

Note 3: Upper left corner grid point means the intersection between the first grid longitude and the first latitude, rather than an upper left point on the imagery.

Note 4: in the context of un-projected products, or some products projected in some other manners, each latitude or longitude line would see an unequal number of grid points horizontally or vertically. When this happens, the largest number of grid points prevails.

Grid data shall be aligned in grid point manner, from north to south, and from west to east. The coordinates of each point shall be expressed in such manner that row number comes before column number. Data type is I × 2. When grid data are given in imagery coordinates, some grid points may fall outside of the

imagery, which shall be marked as "-1". 畾
畾

6. Grid field quantitative products

6.1 Second-level header

The second-level header of grid field quantitative products is defined with a length of 80 bytes as shown in Table 1.17.

Table 1.17 Composition of grid field second-level header

No.	Bytes range	Number of bytes	Type	Description	Note
1	41—48	8	Char×8	Satellite name	[9]
2	49—50	2	Int16	Grid field elements	[1]
3	51—52	2	Int16	Grid field data bytes	[2]
4	53—54	2	Int16	Grid field data reference value	[3]
5	55—56	2	Int16	Grid field data ratio factor	[4]
6	57—58	2	Int16	Time scope code	[5]
7	59—60	2	Int16	Start year	
8	61—62	2	Int16	Start month	
9	63—64	2	Int16	Start day	
10	65—66	2	Int16	Start hour	
11	67—68	2	Int16	Start minute	
12	69—70	2	Int16	End year	
13	71—72	2	Int16	End month	
14	73—74	2	Int16	End day	
15	75—76	2	Int16	End hour	
16	77—78	2	Int16	End minute	
17	79—80	2	Int16	Upper left corner latitude	degree×100
18	81—82	2	Int16	Upper left corner longitude	degree x100
19	83—84	2	Int16	Lower right corner latitude	degree×100
20	85—86	2	Int16	Lower right corner longitude	degree×100
21	87—88	2	Int16	Unit of grid space	[6]
22	89—90	2	Int16	Horizontal grid space	
23	91—92	2	Int16	Vertical grid space	
24	93—94	2	Int16	Horizontal grid points	
25	95—96	2	Int16	Vertical grid points	
26	97—98	2	Int16	Land presence value	[7]
27	99—100	2	Int16	Specific land presence value	
28	101—102	2	Int16	Cloud presence value	[7]
29	103—104	2	Int16	Specific cloud presence value	
30	105—106	2	Int16	Water body presence value	[7]
31	107—108	2	Int16	Specific water body presence value	

32	109—110	2	Int16	Ice body presence value	[7]
33	111—112	2	Int16	Specific ice body presence value	
34	113—114	2	Int16	Quality control value	[8]
35	115—116	2	Int16	Upper limit of quality control value	
36	117—118	2	Int16	Lower limit of quality control value	
37	119—120	2	Int16	Reserved	

Note 1: = 0: numerical weather prediction
= 1: sea surface temperature (K) 漌
= 2: sea ice distribution (dimensionless) 漌
= 3: sea ice density (dimensionless) 漌
= 4: outgoing longwave radiation (W/m^2) 漌
= 5: normalized vegetation index (dimensionless) 漌
= 6: vegetation index ratio (dimensionless) 漌
= 7: snow distribution (dimensionless) 漌
= 8: soil moisture (kg/m^3) 漌
= 9: sunshine (hour) 漌
= 10: cloud top height (hPa) 漌
= 11: cloud top temperature (K) 漌
= 12: low cirrus (dimensionless) 漌
= 13: high cirrus (dimensionless) 漌
= 14: precipitation index (mm/1h) 漌
= 15: precipitation index (mm/6h) 漌
= 16: precipitation index (mm/12h) 漌
= 17: precipitation index (mm/24h) 漌
= 18: upper tropospheric water vapor (relative humidity) (dimensionless) 漌 = 19: brightness temperature
= 20: cloud amount (percentage)
= 21: cloud classification (dimensionless)
= 22: precipitation estimates (mm/6h)
= 23: precipitation estimates (mm/24h)
= 24: clear sky atmospheric precipitation (mm)
= 25: reserved
= 26: ground incident solar radiation (W/m^2)
= 27-30: reserved 漌
= 31-37 cloud humidity profiles (1000-300hPa), relative humidity fields of 7 standard levels (dimensionless)
= 38-100: reserved
= 101: clear sky environment monitoring datasets, synthesized data from channels 1, 2, and 4 (32 Bit) (see 6.2) 漌
= 102-200: reserved 漌

= 201-215: ATOVS (1000-10 hPa) temperature fields (K) of 15 standard levels 潅

= 216-300: reserved 潅

= 301-314: ATOVS (850 ~ 10 hPa) thickness fields (m) of 14 standard levels 潅

= 315-400: reserved 潅

= 401-406: ATOVS (1000 ~ 300 hPa) dew point temperature fields (K) of 6 standard levels 潅

= 407-500: reserved 潅

= 501: ATOVS atmospheric stability index (dimensionless) 潅

= 502: ATOVS clear sky total atmospheric column water vapor content (mm)

= 503: ATOVS total atmospheric column ozone content (Db) 潅

= 504: ATOVS outgoing longwave radiation (W/m^2) 潅

= 505: ATOVS cloud top height (hPa) 潅

= 506: ATOVS cloud top temperature (K) 潅

= 507: ATOVS cloudiness (dimensionless)(ZK)

Note 2: = 1: 1 byte integer I×1 潅

= 2: 2-byte integer I×2 潅

= 4: 4-byte integer I×4 潅

Note 3: Each grid point data is reduced by this number. As a result, the number has to be added when read out. 潅

Note 4: Each grid point data is multiplied by this number. Consequentially, the data has to be divided by the number when read out. 潅

Actual data = (grid data + reference value) /ratio factor

Note 5: = 0: real time 潅

= 1: daily mean 潅

= 2: 5-day mean 潅

= 3: 10-day mean 潅

= 4: monthly mean 潅

= 5: annual mean 潅

= 6: daily accumulation 潅

= 7: 5-day accumulation

= 8: 10-day accumulation

= 9: monthly accumulation 潅

= 10: annual accumulation 潅

Note 6: = 0:0.01 degree 潅

= 1: km 潅

= 2: m

= 9: 0.5625 degree (for numerical weather prediction)

Note 7: = 0: without judging value 瀧
= 1: with judging value

Note 8: = 0: no quality control value 瀧
= 1: upper limit quality control value only 瀧
= 2: lower limit quality control value only
= 3: having both lower and upper limit quality control values

6.2 Grid point data 葍

Grid data shall be stored in one-dimensional array. Grid point number shall be marked on the upper left corner from left to right and from top to bottom. Except the clear sky environment monitoring dataset, each element's grid point data takes the space of a word length (one or multiples bytes). 葍
葍
In the clear sky environment monitoring dataset, each grid point would have three types of data: reflectance (0.1%) from channel 1, reflectance (0.1%) from channel 2, and infrared brightness temperature value (0.1 K) from channel 4. As the dataset contains a huge amount of data, each grid point data is compressed to 32Bit, or 4 bytes. For example, the reflectance value stemmed from channel 1 takes up the first 10 bits, and the one from channel 2 the following 10 bits, with infrared brightness temperature value from channel 4 taking up the remaining 12 bits. When applied, each grid point data must be read out in a 4-byte integer manner. Not doing so would distort the order of bytes. In this dataset, reference value and ratio factor are meaningless.
葍
Numerical prediction data can be converted into int32 or unsigned int32 data

	Integer bits	Decimal bits	Negative value	Magnification
U、V	2	6	Yes	10E6
PS	4	6	No	10E6
Q	0	6	No	10E6
H	5	2	Yes	10E2
T	3	6	No	10E6

7. Discrete field quantitative products
葍
7.1 Second-level header

The second-level header of discrete field quantitative products is defined with a length of 40 bytes, with formatting details in Table 1.18.

Table 1.18 Discrete field second-level header

No.	Bytes range	Number of bytes	Type	Description	Note
1	41-48	8	A8	Satellite	
2	49-50	2	1×2	Elements	[1]
3	51-52	2	1×2	Number of characters in each record	[2]
4	53-54	2	1×2	Probe points in total	[3]
5	55-56	2	1×2	Start year	
6	57-58	2	1×2	Start month	
7	59-60	2	1×2	Start day	
8	61-62	2	1×2	Start hour	
9	63-64	2	1×2	Start minute	
10	65-66	2	1×2	End year	
11	67-68	2	1×2	End month	
12	69-70	2	1×2	End day	
13	71-72	2	1×2	End hour	
14	73-74	2	1×2	End minute	
15	75-76	2	1×2	Inversion method	[4]
16	77-78	2	1×2	Initial field type	[5]
17	79-80	2	1×2	Default	[6]

Note 1: = 1: polar-orbiting satellite data (ATOVS)
= 2-100: reserved 潼
= 101: geostationary atmospheric motion vectors
潼

Note 2: The number of characters that has been recorded by each data. Each character is tentatively defined as I×2 data.

Note 3: One probe point is equivalent to a radiosonde station. In this context, N number of probing points are equivalent to N number of radiosonde stations.

Note 4: = 1: statistical regression inversion 潼
= 2: physical inversion 潼
= 3: maximum correlation method

Note 5: = 1: climate data 潼
= 2: conventional sounding data analysis fields 潼
= 3: NWP field 潼
= 4: regression inversion results 潼
= 5: T213 report 潼

Note 6: valid data or not

7.2 Discrete field data 潼

7.2.1 ATOVS discrete field data (each probe point) 葛

Polar-orbiting satellite ATOVS' discrete field element is numbered 1, with formatting details in Table 1.19. 潼

Table 1.19 ATOVS' discrete field data

No.	Bytes range	Number of bytes	Type	Description	Note
1	1-2	2	1×2	Probe point latitude	100×100
2	3-4	2	1×2	Probe point longitude	100×100
3	5-6	2	1×2	Probe point elevation	m
4	7-8	2	1×2	Probe point surface pressure	hpa
5	9-10	2	1×2	Probe point clear sky mark	[1]
6-20	11-40	30	1×2	Geopotential height of 15 standard levels (NA)	m 或 m×10
21-35	41-70	30	1×2	Atmospheric temperature of 15 standard levels (1000-10hpa)	k×64
36-41	71-82	12	1×2	Atmospheric dew point temperature of 6 standard levels (1000-300hpa)	k×64
42-50	83-100	18	1×2	Geostrophic wind speed of 9 standard levels (NA)	[3]
51-59	101-118	18	1×2	Geostrophic wind speed of 9 standard levels (NA)	m/s
60	119-120	2	1×2	Atmospheric stability index	×100
61	121-122	2	1×2	Atmospheric column total ozone content	DU×64
62	123-124	2	1×2	Clear sky atmospheric column total water vapor content	mm×100
63	125-126	2	1×2	Outgoing longwave radiation (NA)	$W/m^2 \times 64$
64	127-128	2	1×2	Cloud top pressure	hpa
65	129-130	2	1×2	Cloud top temperature	k×64
66	131-132	2	1×2	Cloudiness	
67	133-134	2	1×2	Visible channel albedo	×100
68	135-136	2	1×2	500 hpa lifting index (NA)	×100
69	137-138	2	1×2	Local zenith	
70	139-140	2	1×2	Solar zenith	
71-80	141-160	20	1×2	Initially estimated temperature of 10 standard levels (1000-100hpa)	k×64
81-85	161-170	10	1×2	Initially estimated dew point temperature of 5 standard levels (850-300hpa)	k×64
86-104	171-208	38	1×2	Brightness temperature from 19 HIRS/2 channels	k×64
105-108	209-216	8	1×2	Brightness temperature from 4 MSU channels	k×64
109-120	217-240	24	1×2	Reserved	

Note 1: = 10: cloudless at the probe point

= 20: some clouds at the probe point

= 30: overcast at the probe point

Note 2: 15 standard levels: 1000, 850, 700, 500, 400, 300, 250, 200, 150, 100, 70, 50, 30, 20, 10 Hpa (1000-100Hpa height unit: m, 70-10 Hpa height unit: m × 10)

Note 3: wind direction: 0-360 degrees (north is 0 degree, clockwise to increase)

7.2.2 Geostationary discrete cloud motion wind field data葍

Geostationary discrete cloud motion wind field is numbered 101, with its formatting details shown in Table 1.20.

Table 1.20 Geostationary discrete cloud motion wind field data

No.	Bytes range	Number of bytes	Type	Description	Note
1	1-2	2	1×2	Probe point latitude	degree×100
2	3-4	2	1×2	Probe point longitude	degree×100
3	5-6	2	1×2	Probe levels	[1]
4	7-8	2	1×2	Wind direction	[2]
5	9-10	2	1×2	Wind velocity	m/s
6	11-12	2	1×2		
7	13-14	2	1×2	Temperature	K's temperature
8-20	15-40	16	1×2	Internally reserved	

Note 1: Altitude range 50 - 925 hpa.

Note 2: Wind direction: 0-359 degrees (north is 0 degree, clockwise to increase).

8. Extended segment

8.1 Extended segment format

The space taken by the extended segment in the record = (extended segment length + filling segment length of extended segment)

The space taken by the file header in the record is the sum of header length and the space taken by the extended segment. The content of extended segment shall sit after the filling segment. The contents of the extended segment are formatted as follows (the filling segment of extended segment sits in the rear of the extended segment, making it a complete record)

8.2 Content of the extended segment

No.	Bytes range	Number of bytes	Type	Description	Note
1	1-64	64	Char×8	Sat2004 file name	〖1〗
2	65-72	8	Char×8	Format version	〖2〗
3	73-80	8	Char×8	Producer	〖3〗
4	81-88	8	Char×8	Satellite name	〖4〗
5	89-96	8	Char×8	Instrument name	
6	**97-104**	**8**	**Char×8**	Processing program version	
7	105-112	8	Char×8	Reserved	
8	113-120	8	Char×8	Copyright	
9	121-128	8	Char×8	Filling segment length of extended segment	

Note 1: Please see data file naming format

Note 2: Format version V2.0

Note 3: NSMC

Note 4: For example, QUICKSCAT, 16 bytes

9. Telegraph codes

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To facilitate international exchange of meteorological satellite data and products, four coding formats defined by WMO’s Manual on Codes are used. 葍

9.1 Coding format for meteorological satellite upper air sounding data (temperature, pressure, humidity)葍

Please see WMO’s Manual on Codes (FM87-V1-Ext SATAD). 葍

9.2 Coding format for clear sky emissivity data

Please see WMO’s Manual on Codes (FM87-V1-Ext SATAD). 葍

9.3 Coding format for cloud radiation and wind data

葍

Please see WMO’s Manual on Codes (FM88-V1-Ext SATOB).

葍

9.4 Coding format for cloud data weather descriptions

Please see WMO’s Manual on Codes (FM85-IX SAREP). 葍