Copernicus Climate Change Service

Product User Guide for the Atmospheric Motion Vectors generated from Metop-AVHRR for the period 2007-2017

D5.1 and D5.2

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Acronyms

AMV	Atmospheric Motion Vector
AVHRR	Advanced Very High Resolution Radiometer
BUFR	Binary Universal Form for the Representation of meteorological data
C3S	Copernicus Climate Change Service
CDR	Climate Data Record
CDS	Climate Data Store
CGS	Core Ground Segment
CTH	Cloud Top Height
DOI	Digital Object Identifier
EBBT	Equivalent Black Body Temperature
ECMWF	European Center for Medium Weather Forecast
EUMETSAT	EUropean organisation for the exploitation of METeorological SATellites
ERA	European ReAnalysis
ERA-Interim	ECMWF interim reanalysis
EPS	EUMETSAT Polar System
GEADR	Global External Auxiliary Data Record
GTS	Global Telecommunication System
IASI	Infrared Atmospheric Sounding Interferometer
IR	InfraRed
L1B	Level 1B data
Metop	Meteorological Operational Satellite
MDR	Measurement Data Record
MPHR	Main Product Header Record
NOAA	National Oceanic and Atmospheric Administration
NRT	Near Real Time
NWP	Numerical Weather Prediction
PDU	Product Data Unit
QI	Quality Indicator
SPHR	Secondary Product Header Record
TCDR	Thematic Climate Data Record
WMO	World Meteorological Organization

1. Introduction

1.1 Purpose and scope

This document contains the results inherent to Work Package 5 → Task 5.1 → Milestone 7 in [AD1]. The purpose of this guide is to provide users with detailed information about the Meteorological Operational Satellite (Metop) Atmospheric Motion Vectors (AMV) derived within the Copernicus Climate Change Service (C3S) framework. The AMVs for this release include wind vectors derived from the Advanced Very High Resolution Radiometer (AVHRR) on-board the Metop-A and B satellites, in the period 2007 – 2017. The AMVs were derived using the algorithm developed by EUMETSAT [RD1]. The datasets were evaluated and validated as shown in the quality report [RD2].

This guide gives:
1. An overview of the specifications of the data record;
2. Scientific details on the generation and definition of the data record;
3. Information on characteristics and limitations of the product;
4. Technical details on the format.

1.2 Structure of this document

Section 1	Introduction (this section)
Section 2	Background
Section 3	Data record Definition
Section 4	Product Generation
Section 5	Validation summary
Section 6	Limitations
Section 7	Data access information
Section 8	Product support and feedback
Section 9	Product referencing

1.3 Applicable documents

AD1.	Draft Multi-Annual Implementation Plan 2016 - 2021. C3S_311b D9.2

1.4 Reference documents

RD1.	EUMETSAT AVHRR L2 wind product ATBD. EUM/RSP/SPE/14/781004
RD2.	Quality Evaluation Report Metop AVHRR AMV. EUM/USC/DOC/19/1065009
RD3.	Holmlund, K., 1998: The utilization of statistical properties of satellite-derived atmospheric motion vectors to derive quality indicators. Wea. Forecasting, 13, 1093–1104. doi:10.1175/1520-0434(1998)013,1093:TUOSPO.2.0.CO;2.
RD4.	AVHRR Level 1b Product Guide. EUM/OPS-EPS/MAN/04/0029.
RD5.	AVHRR Level 2 Polar Winds Product Format Specification EUM/OPS-EPS/SPE/08/0338.

RD6.	Dee et al., 2011: The ERA-Interim reanalysis: configuration and performance of the data assimilation system. Quat. J. Res., Met. Soc., 137, 553-597.
RD7.	Generic Product Format Specification. EPS/GGS/SPE/96167.
RD8.	WMO Manual on the GTS, WMO No. 386.
RD9.	Borde R., M. Doutriaux-Boucher, G. Dew, and M. Carranza, 2014: A direct link between feature tracking and height assignment of operational EUMETSAT atmospheric motion vectors. Journal of Atmospheric and Oceanic Technology, 31, 33–46. doi: http://dx.doi.org/10.1175/JTECH-D-13-00126.1.
RD10.	Report on the quality of AVHRR L1B LAC data, 2018, C3S_311b_T5.1_M04.

2. Background

The Atmospheric Motion Vector (AMV) data records were generated for the Copernicus Climate Change Service [1] (C3S), which is one of the six thematic information services provided by the Copernicus Earth Observation Programme of the European Union [2]. C3S is implemented by the European Centre for Medium-Range Weather Forecasts[3] (ECMWF) on behalf of the European Commission.

In 2006, the polar orbiting Metop-A satellite was launched with the Advanced Very High Resolution Radiometer (AVHRR/3) instrument on board. Its horizontal resolution (1 km pixel at nadir) and orbit characteristics of the Metop satellite provide the opportunity to derive polar winds from consecutive orbits. Since January 2011 EUMETSAT produces polar winds operationally in near real time (NRT). EUMETSAT's second polar orbiting satellite, Metop-B was launched in September 2012. Polar AMVs from Metop-B are produced operationally since June 2013 at EUMETSAT.

In February 2015, the production of global Metop AMVs started. Due to the 180° shift between the orbits of Metop-A and B within the same orbital plane an overlap between the AVHRR orbits is given also in non-polar areas and AMVs can be retrieved on a global scale. In February 2015, EUMETSAT started the production of global Metop AMVs.

The AMV are derived by tracking the cloud motion between two consecutive images. To derive the height of the AMV, the EUMETSAT AMV algorithm uses AVHRR channel 4 (11 µm) images with the possibility to also use the co-located cloud top height derived from the Infrared Atmospheric Sounding Interferometer (IASI) also on board Metop. This release however does not use the IASI data for AMV height assignment because the IASI height has not been reprocessed yet and is not available for the entire time series. To perform the height assignment, the algorithm uses the ERA-interim forecast data. For this AMV CDR the latest available version of the EUMETSAT algorithm [RD1] (3.1.1) was used.

This guide provides information for

[1] https://www.copernicus.eu/en/services/climate-change Link valid 02/07/2019
[2] https://www.copernicus.eu/en Link valid 02/07/2019
[3] https://www.ecmwf.int/ Link valid 02/07/2019

(a) *Single Metop polar AMV product:* This is the oldest AVHRR AMV product retrieved at EUMETSAT. It is extracted from one Metop satellite (Metop-A or Metop-B), using two successive orbit passes and coverage is limited to high latitude regions. The temporal gap between the two consecutive images is about 100 minutes. This refers to the C3S D5.1 data record.

(b) *Dual Metop global coverage AMV product:* The extraction of this product requires two satellites flying on the same orbital plane. The wind extraction is done using image pairs taken successively by the two satellites, Metop A and Metop B. Global coverage is ensured by the use of two complementary products, one using Metop-A as the first image of the pair (denoted Metop-A/B), and the second using Metop-B as the first image of the pair (denoted Metop-B/A). The temporal gap between the two consecutive images is approximately 50 minutes. This refers to the C3S D5.2 data record.

3. Data record definition

Table 1: CDR fact sheet

General	Data record name	AVHRR AMV single polar D5.1 and dual global D5.2
	Data record digital identifier	(Will be added after introduction at EUMETSAT Data Centre)
	Data record short description	Reprocessed level-2 AMVs. Two sets of AMVs are generated using images from AVHRR-3 instrument 1- on board one (single) Metop (D5.1) 2- two (dual) Metop satellites (D5.2)
	Record type	Climate Data Record
	Period covered	Metop-A (single): 1 March 2007 – 31 December 2017 Metop-B (single): 24 April 2013 – 31 December 2017 Metop-A/B (dual): 24 April 2013 – 31 December 2017 Metop-B/A (dual): 24 April 2013 – 31 December 2017
	Content	1- Polar AMVs level-2 products (TCDR) – single mode 2- AMVs level-2 products (TCDR) – dual mode
	Generation frequency	Images from 2 orbits are needed, i.e. every 100 minutes for single and 50 minutes for dual.
	Algorithm version	3.1.1
Instrument	Instrument name	Advanced Very High Resolution Radiometer (AVHRR)
	Instrument description	The Advanced Very High Resolution Radiometer (AVHRR/3) is one of the complement of American instruments provided by the National Oceanic and Atmospheric Administration (NOAA) to fly on Metop-A, -B and -C. The AVHRR/3 is a six-channel imaging radiometer that detects energy in the visible and infrared (IR) portions of the electromagnetic spectrum with channels in the range of 0.58 - 12.5 microns.
Data	Input data	• AVHRR channel 4 (11µm) • ECMWF ERA-interim 6-hourly forecast data
	Output data	AMV (a wind vectors characterized by a speed, a direction, a height and an associated QI) retrieved using the EUMETSAT operational algorithm
	Format	The products are provided in EPS-native and BUFR format
Access	Copernicus Climate Change Service (C3S)	C3S website: https://climate.copernicus.eu.
	EUMETSAT Data Centre	The data set is available from EUMETSAT Data Centre (https://eoportal.eumetsat.int/)
	Delivery (EUM)	• ftp push • html download • physical media.
Cover-age	Spatial	• polar region polar wards of 40º (single) • global (dual)
	Temporal	~100 minutes (single), ~50 minutes (dual)

3.1 AMV Product Content

The Atmospheric Motion Vector (AMV) product provides information on wind speed (m/s), direction (°), and height (hPa) of vectors (as shown in Figure 1) which are derived by tracking clouds between two adjacent images in time. For the wind vectors, the meteorological convention is used:

- 0° : Winds blowing from North
- 90° : Winds blowing from West
- 180°: Winds blowing from South
- 270°: Winds blowing from East

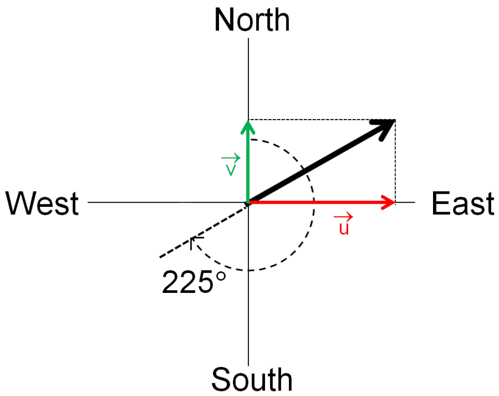

Figure 1: Wind direction measured in degrees in clockwise direction starting from the north. For example, a direction of 225° represents a wind blowing from the southwest. The altitude of the wind is expressed in hPa.

Every AMV product needs data from two consecutive orbits. In the single mode, this is the previous orbit from the same satellite, in the dual mode this is the previous orbit from the paired satellite (Figure 2). The geographical coverage of Metop-A/B (first image is Metop-A) and -B/A (first image is Metop-B) is complementary to the single satellite derived products.

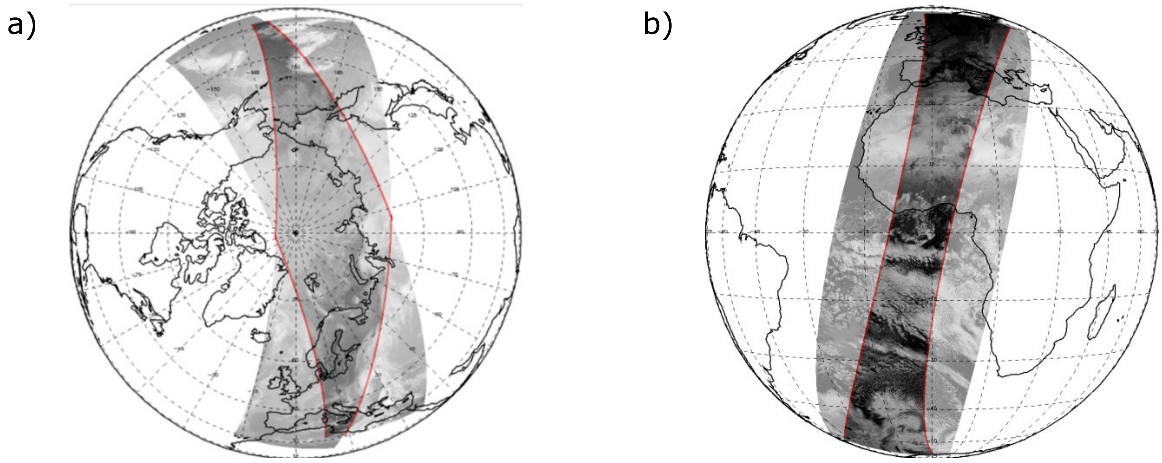

Figure 2: Example of geographical coverage. a) "single mode": Using two successive orbit paths of one Metop satellite allowing coverage of north and south poles pole wards of 45°. The time difference between two images is ~101 minutes. b) "dual mode": Using two successive orbit paths of two different Metop satellites. The time difference between two images is ~50 minutes allowing a full globe coverage.

Each AMV contains a wind speed (in m/s), a wind direction (in degree), and a wind altitude information together with geolocation data (latitude and longitude). The height is given as a pressure in Pascal (Pa); the corresponding brightness temperature (in K) is also recorded in the product. The final height is obtained using the IR EBBT method with the help of the forecast model data (AMV_HA_METHOD=1). It is accompanied by a quality index and other metadata. The quality index amongst others takes into account the temporal and the spatial consistency with the surrounding vectors and consistency with the forecast model field at the same time and location [RD3].

Tropospheric AMVs are retrieved at all heights below the tropopause, derived from the AVHRR/3 infrared (IR) channel 4 at 11μm (see Table 2).

Table 2: Spatial and spectral characteristics of AVHRR/3 channel 4 infrared (IR).

Channel	Resolution at nadir (km)	Swath width
4 (11μm)	1.08	±1447 km

Figure 3 shows an example of the resulting AMV product. The vectors are represented as wind barbs. The colour of each barb gives the retrieved vector height. The generated AMVs are grouped into three height classes according to their height as defined in Table 3.

Table 3: AMV height classes.

CLASS	Description
ALL	*All vectors are considered for calculating the statistics*
HIGH	*Only vectors with a CTP < 400 hPa are considered for calculating the statistics*
MID	*Only vectors with 400 ≤ CTP ≤ 700*
LOW	*Only vectors with a CTP > 700 hPa are considered for calculating the statistics*

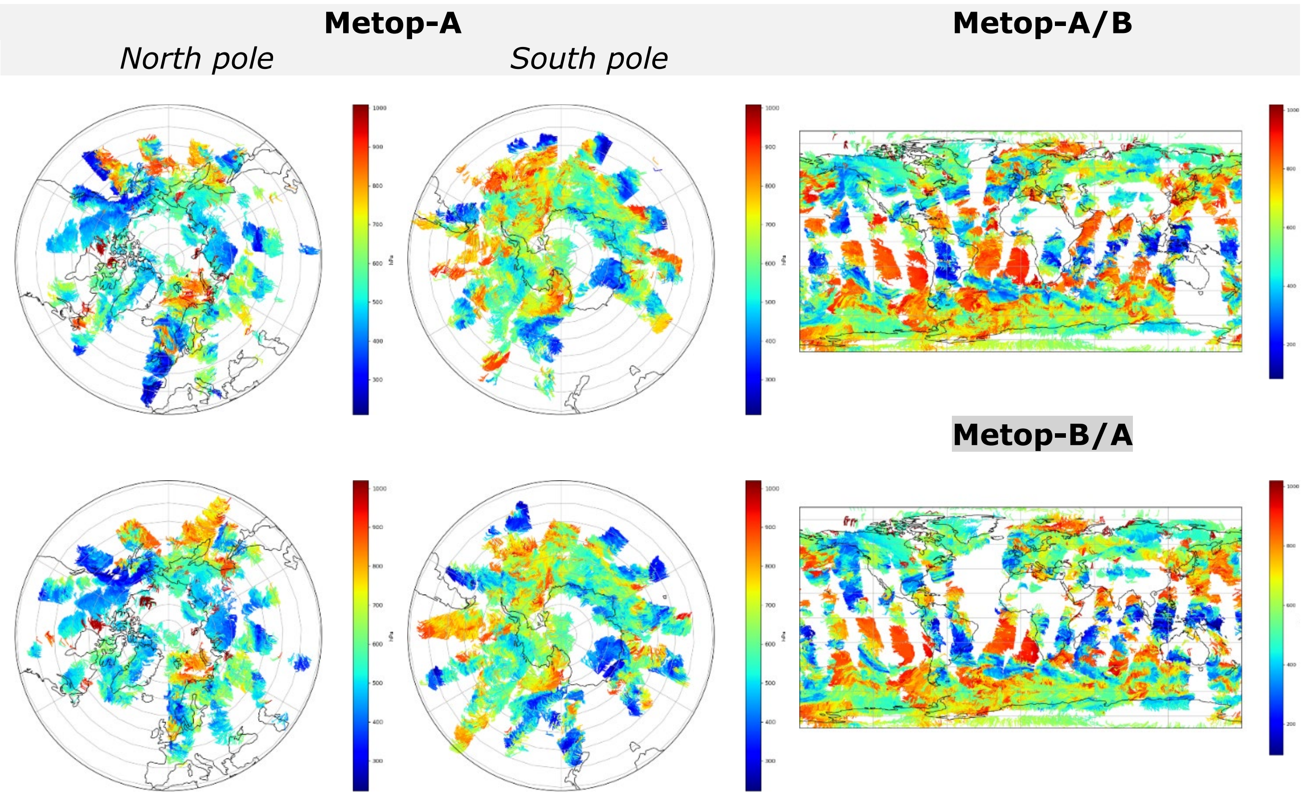

Figure 3: Example of the retrieved AMVs for the 1st of January 2014 at 00 UTC to 12 UTC using one single Metop satellite (Metop-A and Metop-B) and two Metop satellites (Metop-A/B and Metop B-A). The colour indicated the height of the wind (in hPa) and the size of the arrow its speed (in m/s).

3.2 Temporal Coverage and Completeness

The overall dataset temporal coverage is 2007 – 2017, according to the different satellites and products as described in Table 4.

Table 4: Satellite, instrument, spatial and temporal coverage.

Satellite	Instrument	Coverage	Reprocessing period
Metop-A (single)	AVHRR/3	Polar	01/03/2007 - 31/12/2017
Metop-B (single)	AVHRR/3	Polar	24/04/2013 - 31/12/2017
Metop-A/B and -B/A (dual)	AVHRR/3	Global	24/04/2013 - 31/12/2017

3.3 Spatial coverage

The AMVs are derived over the poles for the single instrument products, with a geographical coverage poleward of 40°N and 40°S respectively (see Figure 2). For the dual Metop CDR, the coverage is global.

3.4 Product format

The data records are available in two formats: the EUMETSAT native EPS format and the BUFR format. [RD5] provides information about each format and the correspondence between each format.

3.4.1 EUMETSAT native format

The Generic Product Format Specification for the products produced by the Product Generation functions in the EUMETSAT Polar System (EPS) Core Ground Segment (CGS) is described in details in [RD7]. The parts of the generic products format more specific to the wind products are described in [RD5].

Reprocessed files can be identified by their filenames for which the processing mode is set to ***R***. A reprocessed AVHRR AMV file uses the naming convention described in the Table 5.

Table 5: File names for the reprocessed AVHRR AMV following the EPS naming convention. mode can be 02 for single and 2D for dual. sat_id can be M01 for Metop-B or M02 for Metop-A. For dual Metop, sat_id refers to the first image.

Filename
AVHR_AMV_[mode]_[sat_id]_[start sensing time]_[stop sensing time]_**R**_O_[processing time]

For each file, the native EPS EUMETSAT format is made of:

- a Main Product Header Record, **MPHR**, common to all EPS products,
- a Secondary Product Header Record, **SPHR**, informing about quality flag and general product specific information,
- a Global External Auxiliary Data Record, **GEADR**, providing information about processor configuration data
- several Measurement Data Records, **MDR**, detailing each individual AMV

The Appendix A provides an example of the product output for one file and one MDR. The most important fields of the **MDR** are shown in Table 6.

Table 6: Supplementary information to be used with [RD5] regarding the AMV product. Note that reprocessed AMV do not have IASI method.

Name	Description	Format	Possible value
AMV_PRESSURE	Final height	Unsigned integer	
AMV_HA_METHOD	Method used	Byte	1= EBBT
HA_PRESSURE HA_PRESSURE_SD HA_TEMPERATURE HA_TEMPERATURE_HD	Values for individual pressure	Unsigned integer [4,3]	| X X X X | ref image | X X X X |previous image | X X X X | X EBBT method X IASI method
INTER_DIRECTION INTER_SPEED	Intermediate components	Unsigned integer [2,1]	First value is from the ref image to the previous one Second value is from the previous image to the reference one

3.4.2 BUFR

The second format the date record is available in is the Binary Universal Form for the Representation of meteorological data (BUFR). BUFR is a binary data format maintained by the World Meteorological Organization (WMO). Details on the AMV BUFR format are given in Appendix C. The details concerning the format of the products generated at EUMETSAT are available under:
http://www.eumetsat.int/website/home/Data/Products/Formats/index.html[5].

The BUFR product's filename provides a unique identifier for each product. The filename follows the WMO Global Telecommunication System (GTS) convention [RD8]. AMV BUFR filenames are described in Table 7.

Table 7: File names description for the reprocessed AVHRR AMV following the BUFR naming convention.

Filename	
Single AVHRR AMV	
W_XX-EUMETSAT-Darmstadt,SOUNDING+SATELLITE,METOPB+AVHRR_C_EUMP_20130424231603_03116_eps_r_amv_l2_0200.bin	
Dual AVHRR AMV	
W_XX-EUMETSAT-Darmstadt,SOUNDING+SATELLITE,METOPB+AVHRR_C_EUMP_20130424231603_03116_eps_r_amv_2d_0200.bin	
SATID	satellite id – used for the ref image (first one)
2d	dual mode
r	reprocessed mode
yyymmddhhmmss	start time of the ref PDU image used to derive the AMV product
0nnnn	last orbit number
vvvv	reprocessed release version (0200 = release 2.0)

[4] Link validity tested on 04/07/2019.
[5] Link validity tested on 04/07/2019.

4. Product generation

4.1 Basic retrieval description

Wind vectors are retrieved by tracking the motion of clouds or patterns of other atmospheric constituents such as water vapour. Very generally, as a first step a feature is identified in the first image, the second step is to identify this feature again in the second image. If this is successful then wind speed and direction are calculated based on the geographical displacement and time between images. A height is assigned to each vector based in the case of AVHRR on the brightness temperature. Finally, a quality index is calculated for each AMV.

4.2 Main steps

The operational EUMETSAT AVHRR AMV algorithm is described in detail in [RD1] and depicted in Figure 4. In real time at EUMETSAT, AVHRR data are received every three minutes. Each small file received is called Product Data Unit (PDU). The EUMETSAT algorithm has been developed with this concept of PDUs as a base-line input. Therefore the algorithm used in the reprocessing also uses 3-minute PDUs from AVHRR as input. For each PDU, three PDUs with an overlap from the previous orbit are used to do the feature identification and to allow the full coverage of the reference PDU. Only data from two consecutive orbits are used, which results in AMV retrieved only pole wards of ± 40°. Six hourly ERA-interim forecast data are used as a "first guess" for wind vector speed and direction. Because the time between two images is rather long (100 minutes for single and 50 minutes for dual satellite products), the usage of the first guess is needed in order to save computation power and increase the quality of the retrieved winds. ERA-interim temperature profiles are used for the height assignment.

The EUMETSAT algorithm is summarised by Figure 4. It uses two AVHRR consecutive orbits, allowing winds to be retrieved up to 40° (single mode) and globally (dual mode).

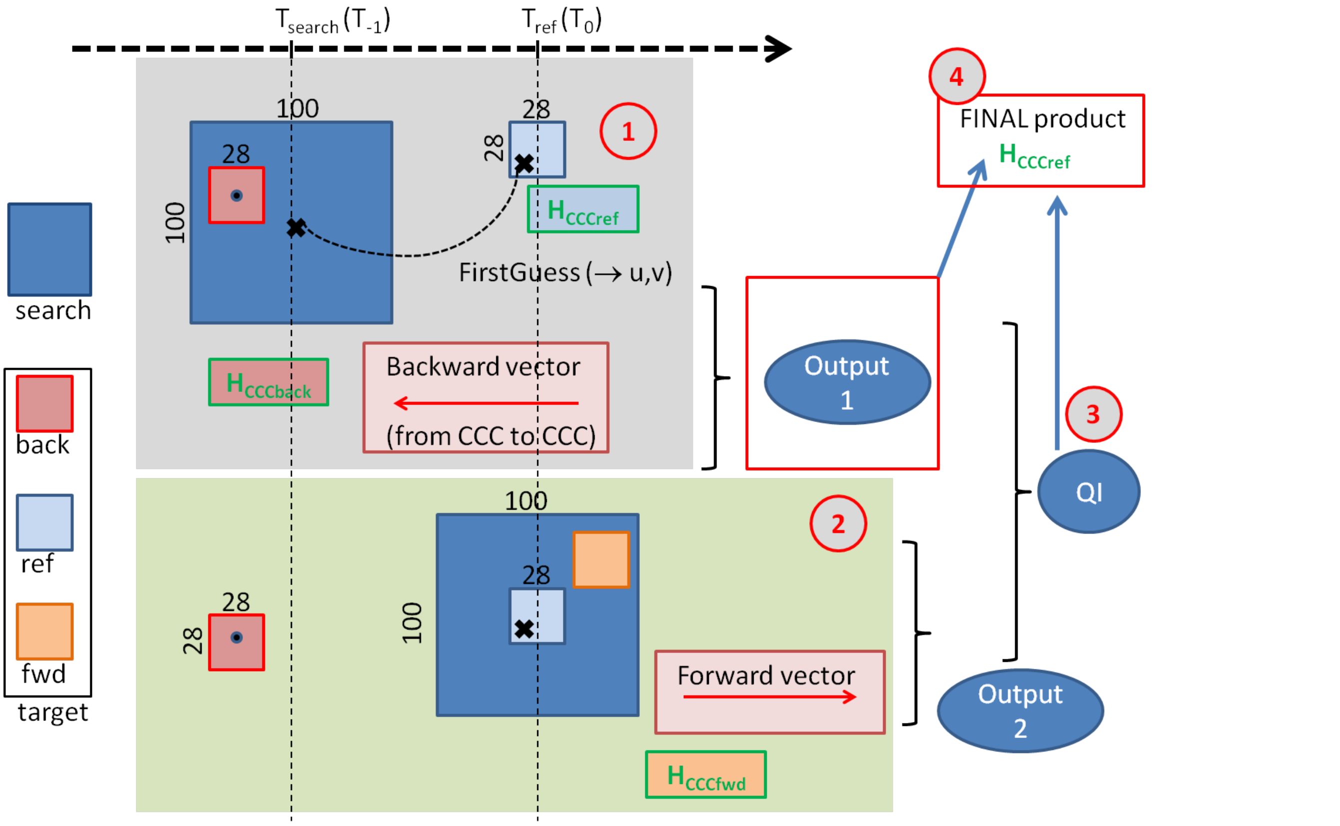

Figure 4: Schematic view of the EUMETSAT AVHRR AMV retrieval. The reference image is observed at time T_{ref} (or T_0), the second image (100 minutes before) is observed at time T_{search} (or T_{-1}). First a reference's target (*ref*) is selected in the image at T_0, the height is computed using the CCC method [RD9]. Using this location, the height and the first guess, a location is found to be the center of the search box in the previous image at T_{-1}. In this search box (50 pixels on each side of the center), the *ref* target is tracked and when found it's named backward target (*back*). The speed is derived using the distance between the *ref* and the *back* targets. The height is assumed unchanged and is provided by the height of the *ref* target. As a second step -2- The forward vector is computed by doing a forward tracking starting from the *back* target and looking for the forward (*fwd*) target in a new search box in the image at T_0. QI are computed comparing backward and forward tracking results. Note that for dual AMVs, Metop-A/B means *ref* is a Metop-A image.

4.3 Input data

This section presents an overview of the input data used for the data record generation: Metop-A, -B AVHRR imagery and ECMWF ERA-interim model forecast data.

4.3.1 AVHRR L1B data

Metop-A and –B L1B AVHRR/3 radiance data show a high level of quality and degree of completeness [RD10]. They are used for the retrieval of AVHRR AMVs. The main part of the data used is the channel 4 (11µm) brightness temperature, including geolocation. The EUMETSAT algorithm also uses information such as the scan angle and cloud cover. Table 8 lists the flight model and satellite platform used.

Table 8: AVHRR flight model on Metop-A. *S/N 307* means the 7^{th} AVHRR/3 instrument (by launch order).

AVHRR instrument flight model	*Satellite platform*
S/N 305	M02 (Metop-A)
S/N 307	M01 (Metop-B)

4.3.2 Reanalysis data

For the first guess, to compute the height (pressure) of each wind vector and its quality indicator, forecast model outputs from ECMWF ERA-Interim reanalysis [RD6] are used as input for the reprocessing. We use the 6 and 12 hour forecast from the 0 and 12 UTC base times, leading to 4 forecast files per day (0, 6, 12 and 18 UTC). The forecast grid is 0.5°x0.5° with 60 vertical levels. The parameters used for the processing are listed in Table 9. More details on the ERA-Interim re-analysis data can be found on the ECMWF web site[6].

Table 9: ERA-Interim data fields used for AMV processing.

Model Layers (1 - 60)	**Surface**
Temperature	Geopotential
u-component	surface pressure
v-component	2m temperature
Specific humidity	2m dew point temperature
	surface skin temperature

4.4 Output data

The system outputs the Atmospheric Motion Vectors (AMV) in the EPS-native format [RD5]. A BUFR encoder is applied to generate BUFR formatted files (see section 3.4) from the EPS-native format.
The AVHRR single and dual CDR are provided every 3 minutes. Table 10 summarizes the annual size and number of files used and generated for this reprocessing.

Table 10: Number of files (first row) and data sizes in GB (second row) for the reprocessing period.

Format		**Year**										
		2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
							Metop-A					
Native	Num	142987	174539	174843	174964	174614	175598	174922	174906	174966	175428	174923
	Size	31	48	47	47	47	48	48	47	48	49	49
BUFR	Num	58687	88613	89434	89589	89252	89985	89523	89614	89912	90185	89876
	Size	5.8	9.1	9.0	9.0	9.0	9.1	9.0	9.0	9.2	9.4	9.4
							Metop-B					
Native	Num							120593	175028	175044	175618	175093
	Size							34	48	49	50	49
BUFR	Num							61829	89872	90137	90480	90103
	Size							6.5	9.2	9.4	9.6	9.6
							Metop-A/B					
Native	Num							120753	174906	174966	175428	174923
	Size							73	105	106	106	106
BUFR	Num							119646	173914	174483	175056	174513
	Size							17	24	24	25	25
							Metop-B/A					
Native	Num							120593	175028	175044	175618	175093
	Size							70	101	102	103	103
BUFR	Num							119573	173783	174403	174957	174406
	Size							16	23	23	24	23

[6] Link valid 04/07/2019 https://www.ecmwf.int/en/forecasts/datasets/archive-datasets/reanalysis-datasets/era-interim

5. Summary of the product validation

Data record of AMVs were generated using the data from the channel 4 (11µm) of AVHRR/3 instrument from single and dual Metop-A and Metop-B. A comprehensive temporal analysis of the stability and consistency of the AVHRR AMVs was performed by comparing AMVs to operational EUMETSAT AMVs and completely independent AMV dataset as from other instruments, e.g. satellite and radiosondes.

The main points from the validation are:

- recent AVHRR data are very similar to the EUMETSAT operational data confirming the correct installation and usage of the operational software;
- the time series of Metop AMVs are stable and homogeneous;
- very good consistency between Metop AMVs retrieved using AVHRR/3 instruments on-board Metop A, B, A/B and B/A;
- there is a very good agreement with external independent AMV data such as ERA-interim, RAOBCORE radiosondes, MODIS Terra;
- Metop AMVs are suitable for usage in reanalysis;
- Metop AMVs are suitable for trends analyses.

6. Limitations

For the current release, there is no limitation of usage. The Metop AMV CDR is very similar to the operational data for the recent period. However, users should note that there are some differences compared to the operational Metop single and dual AMVs:

- No IASI information is used to assign the AMV height;
- 6-hourly ERA-Interim NWP forecast data are used instead of ECMWF real time operational forecast.

AVHRR AMVs for Metop-A should be used only from the 23rd May 2007 onwards, due to some unknown issues with AVHRR L1B data on board Metop-A prior to this date.

7. Data access information

The data products are part of the Copernicus Climate Data Store (CDS) and are available from the Copernicus Climate Change Service (C3S) website: https://climate.copernicus.eu.

The data are also accessible via the EUMETSAT Data Centre. To access the data from EUMETSAT, you need to register with the EUMETSAT Data Centre. When registered, you can order the data through a written request send to EUMETSAT's helpdesk.

7.1 Register with EUMETSAT data center

To register with the EUMETSAT Data Centre:

- Register in the EUMETSAT EO-Portal (https://eoportal.eumetsat.int/) by clicking on the New User – Create New Account tab.
- After finalisation of the registration process, an e-mail is sent to the e-mail address entered in the registration.
- Click the confirmation link in the e-mail to activate your account;
- Login and subscribe to the Data Centre Service by going to the Service Subscription Tab and selecting Data Centre Service.
- Follow instructions issued from the web page to add needed information.

7.2 Order data

The data record described in this product user guide can be ordered via the EUMETSAT User Service Helpdesk in Darmstadt, Germany. Please send a written request to this helpdesk, email *ops@eumetsat.int,* indicating the data record you want to order including its Digital Object Identifier (DOI) number.

If you have more questions or support issues, please contact the User Service Helpdesk directly via e-mail: *ops@eumetsat.int*

8. Product support and feedback

For enquiries or feedback concerning the product described in this product user guide, the CDS offers Help & Support functionality. Alternatively, the user can contact the EUMETSAT User Service Helpdesk by email: *ops@eumetsat.int.*

9. Product referencing

The data record described in this product user guide has a unique DOI that should be used for referencing. The product's filename provides a unique identifier for each product. Please note that the DOI is not included in the native-eps nor in the BUFR files.

Appendix A EPS Format Product Record Example

Table 11 shows an example of a dump of a native-eps AMV file named *AVHR_AMV_02_M01_20130424235503Z_20130424235803Z_R_O_20181126200033Z.* The two interesting quality indicators are highlighted, for the first mdr, they are 45 QI including, and 53 QI excluding forecast. More details are found in [RD5].

For each mdr, *record_stop_time* refers to the time of the center of the search target (previous image in time) and the *record_start_time* refers to the time of the reference target.

Table 11: Extract of a native-eps file

```
MPHR:
    RECORD_HEADER
        RECORD_CLASS: 1 (MPHR)
        INSTRUMENT_GROUP: 0 (Generic)
        RECORD_SUBCLASS: 0
        RECORD_SUBCLASS_VERSION: 2
        RECORD_SIZE: 3307
        RECORD_START_TIME: 2013/04/24 23:55:03.000
        RECORD_STOP_TIME: 2013/04/24 23:58:03.000
    PRODUCT_NAME: AVHR_AMV_02_M01_20130424235503Z_20130424235803Z_R_O_20181126200033Z
    PARENT_PRODUCT_NAME_1: AVHR_xxx_1B_M01_20130424235503Z_20130424235803Z_R_O_20180806104844Z
    PARENT_PRODUCT_NAME_2: xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
    PARENT_PRODUCT_NAME_3: xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
    PARENT_PRODUCT_NAME_4: xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
    INSTRUMENT_ID: AVHR (AVHRR/3)
    INSTRUMENT_MODEL: 4 ()
    PRODUCT_TYPE: AMV ()
    PROCESSING_LEVEL: 02 (Level 2)
    SPACECRAFT_ID: M01 ()
    SENSING_START: 2013/04/24 23:55:03.000         start time of the PDU
    SENSING_END: 2013/04/24 23:58:03.000           end time of the PDU
    SENSING_START_THEORETICAL: 2013/04/24 22:24:00.000
    SENSING_END_THEORETICAL: 2013/04/25 00:06:00.000
    PROCESSING_CENTRE: CGS1 ()
    PROCESSOR_MAJOR_VERSION: 3
    PROCESSOR_MINOR_VERSION: 1
    FORMAT_MAJOR_VERSION: 11
    FORMAT_MINOR_VERSION: 0
    PROCESSING_TIME_START: 2018/11/26 20:00:10.000
    PROCESSING_TIME_END: 2018/11/26 20:00:33.000
    PROCESSING_MODE: R (Reprocessing)
    DISPOSITION_MODE: O (Operational)
    RECEIVING_GROUND_STATION: SVL ()
    RECEIVE_TIME_START: 2000/01/01 00:00:00.000
    RECEIVE_TIME_END: 2000/01/01 00:00:00.000
    ORBIT_START: 3115
    ORBIT_END: 3116
    ACTUAL_PRODUCT_SIZE: 159398 bytes
    STATE_VECTOR_TIME: 20130424215616000Z UTC
    SEMI_MAJOR_AXIS: 7204637838 mm
    ECCENTRICITY: 0.001219
    INCLINATION: 98.704 deg
    PERIGEE_ARGUMENT: 60.31 deg
    RIGHT_ASCENSION: 175.994 deg
    MEAN_ANOMALY: 299.72 deg
    X_POSITION: 7158861.575 m
    Y_POSITION: -771215.358 m
    Z_POSITION: -11356.194 m
    X_VELOCITY: -173.181 m/s
    Y_VELOCITY: -1642.285 m/s
    Z_VELOCITY: 7356.879 m/s
    EARTH_SUN_DISTANCE_RATIO: 99.999999
    LOCATION_TOLERANCE_RADIAL: 0 m
    LOCATION_TOLERANCE_CROSSTRACK: 0 m
    LOCATION_TOLERANCE_ALONGTRACK: 0 m
    YAW_ERROR: 0 deg
    ROLL_ERROR: 0 deg
```

```
    PITCH_ERROR: 0 deg
    SUBSAT_LATITUDE_START: 60.828 Deg
    SUBSAT_LONGITUDE_START: -51.665 Deg
    SUBSAT_LATITUDE_END: 70.677 Deg
    SUBSAT_LONGITUDE_END: -62.311 Deg
    LEAP_SECOND: 0
    LEAP_SECOND_UTC: 2000/01/01 00:00:00.000
    TOTAL_RECORDS: 647
    TOTAL_MPHR: 1
    TOTAL_SPHR: 1
    TOTAL_IPR: 2
    TOTAL_GEADR: 1
    TOTAL_GIADR: 0
    TOTAL_VEADR: 0
    TOTAL_VIADR: 0
    TOTAL_MDR: 642
    COUNT_DEGRADED_INST_MDR: 0
    COUNT_DEGRADED_PROC_MDR: 0
    COUNT_DEGRADED_INST_MDR_BLOCKS: 0
    COUNT_DEGRADED_PROC_MDR_BLOCKS: 0
    DURATION_OF_PRODUCT: 179999 ms
    MILLISECONDS_OF_DATA_PRESENT: 179999 ms
    MILLISECONDS_OF_DATA_MISSING: 0 ms
    SUBSETTED_PRODUCT:  false

SPHR:
    RECORD_HEADER
        RECORD_CLASS: 2 (SPHR)
        INSTRUMENT_GROUP: 4 (AVHRR)
        RECORD_SUBCLASS: 2
        RECORD_SUBCLASS_VERSION: 2
        RECORD_SIZE: 553
        RECORD_START_TIME: 2013/04/24 23:55:03.000
        RECORD_STOP_TIME: 2013/04/24 23:58:03.000
    AMV_TOTAL_NUMBER: 642
    TOTAL_OVERALL_QUALITY: 59 %
    AMV_NUMBER_DISS: 423
    OVERALL_QUALITY: 74 %
    FORECAST_CONSISTENCY: 66 %
    SPATIAL_VECTOR_CONSISTENCY: 76 %
    SPATIAL_HEIGHT_CONSISTENCY: 90 %
    TEMPORAL_HEIGHT_CONSISTENCY: 91 %
    TRACKING_CONSISTENCY: 94 %
    DISSEMINATION_THRESHOLD: 50 %
    SAMPLING_GRID_RESOLUTION: 30800 m
    TARGET_SIZE: 30800 m
    SEARCH_DISTANCE: 110000 m

IPRS[0]:
    RECORD_HEADER
        RECORD_CLASS: 3 (IPR)
        INSTRUMENT_GROUP: 0 (Generic)
        RECORD_SUBCLASS: 0
        RECORD_SUBCLASS_VERSION: 1
        RECORD_SIZE: 27
        RECORD_START_TIME: 2013/04/24 23:55:03.000
        RECORD_STOP_TIME: 2013/04/24 23:58:03.000
    TARGET_RECORD_CLASS: 4 (GEADR)
    TARGET_INSTRUMENT_GROUP: 4 (AVHRR)
    TARGET_RECORD_SUBCLASS: 20
    TARGET_RECORD_OFFSET: 3914

IPRS[1]:
    RECORD_HEADER
        RECORD_CLASS: 3 (IPR)
        INSTRUMENT_GROUP: 0 (Generic)
        RECORD_SUBCLASS: 0
        RECORD_SUBCLASS_VERSION: 1
        RECORD_SIZE: 27
        RECORD_START_TIME: 2013/04/24 23:55:03.000
        RECORD_STOP_TIME: 2013/04/24 23:58:03.000
    TARGET_RECORD_CLASS: 8 (MDR)
    TARGET_INSTRUMENT_GROUP: 4 (AVHRR)
    TARGET_RECORD_SUBCLASS: 4
```

```
    TARGET_RECORD_OFFSET: 4034

GEADR-20:
    RECORD_HEADER
        RECORD_CLASS: 4 (GEADR)
        INSTRUMENT_GROUP: 4 (AVHRR)
        RECORD_SUBCLASS: 20
        RECORD_SUBCLASS_VERSION: 1
        RECORD_SIZE: 120
        RECORD_START_TIME: 2013/04/24 23:55:03.000
        RECORD_STOP_TIME: 2013/04/24 23:58:03.000
    AUX_DATA_POINTER: AVHR_PRC_xx_M01

mdr[0]:     first record out of 642
    RECORD_HEADER
        RECORD_CLASS: 8 (MDR)
        INSTRUMENT_GROUP: 4 (AVHRR)
        RECORD_SUBCLASS: 4
        RECORD_SUBCLASS_VERSION: 2
        RECORD_SIZE: 242
        RECORD_START_TIME: 2013/04/24 23:55:14.667
        RECORD_STOP_TIME: 2013/04/24 22:14:34.833
    DEGRADED_INST_MDR:  false
    DEGRADED_PROC_MDR:  false
    AMV_VALIDITY_TIME: 2013/04/24 23:55:03.000
    LATITUDE: 63.3989 deg
    LONGITUDE: -29.4175 deg
    SURFACE_TYPE: 3 (undefined)
    CHANNEL_ID:
        AVHRR1 (1 bit) : 0
        AVHRR2 (1 bit) : 0
        AVHRR3a (1 bit) : 0
        AVHRR3b (1 bit) : 0
        AVHRR4 (1 bit) : 1
        AVHRR5 (1 bit) : 0
    WIND_METHOD: 1 (Wind derived from cloud motion observed in the infrared channel)
    MATCHING_METHOD: 2 (Cross-correlation method)
    AMV_DIRECTION: 329.1 deg
    AMV_SPEED: 3.9 m/s
    AMV_PRESSURE: 55110 Pa
    AMV_TEMPERATURE: 239.6 K
    ALGORITHM_FLAGS:
        IASICOLOCATEDDATA (1 bit) : 0
        INVERSIONHEIGHTASSIGNMENTCORRECTION (1 bit) : 0
        CLOUDBASEASSIGNMENTCORRECTION (1 bit) : 0
        IMAGEENHANCEMENTAPPLIED (1 bit) : 0
        TRIPLETMODE (1 bit) : 0
    AMV_HA_METHOD: 1 (EBBT height assignment)
    AMV_PRESSURE_SD: 4620 Pa
    AMV_TEMPERATURE_SD: 4.6 K
    QUALITY_VALUES: 45, 53, <invalid>, <invalid>, <invalid>, <invalid>, 12, 7, 1, 99, 100, 91, 100,
<invalid>, <invalid>, <invalid>, 2, 2
    FC_BASETIME: 2013/04/24 12:00:00.000
    FC_STEP: 6, 12 h
    HA_METHODS: 1 (IRW height assignment), 255 (), 255 (), 255 ()
    SENSING_TIME: 20130424221434833Z, 20130424235514667Z, <invalid>
    FC_DIRECTION: 306.2, 313.6, <invalid> deg
    FC_SPEED: 9.2, 8.1, <invalid> m/s
    SAT_ZENITH_ANGLE: 62.36, 3.89, <invalid> m/s
    CLUSTER_SIZE: 45, 50, <invalid>
    HA_PRESSURE
        [0]: 55110, <invalid>, 55110, <invalid> Pa
        [1]: 56990, <invalid>, 56990, <invalid> Pa
        [2]: <invalid>, <invalid>, <invalid>, <invalid> Pa
    HA_PRESSURE_SD
        [0]: 4620, <invalid>, <invalid>, <invalid> Pa
        [1]: 7450, <invalid>, <invalid>, <invalid> Pa
        [2]: <invalid>, <invalid>, <invalid>, <invalid> Pa
    HA_TEMPERATURE
        [0]: 239.6, <invalid>, 239.6, <invalid> K
        [1]: 241.5, <invalid>, 241.5, <invalid> K
        [2]: <invalid>, <invalid>, <invalid>, <invalid> K
    HA_TEMPERATURE_SD
        [0]: 4.6, <invalid>, <invalid>, <invalid> K
```

```
    [1]: 7.2, <invalid>, <invalid>, <invalid> K
    [2]: <invalid>, <invalid>, <invalid>, <invalid> K
INTER_DIRECTION: 329.1, 329 deg
INTER_SPEED: 3.9, 3.1 m/s
MATCHING_VALUE: 7231, 7939
HA_FC_CONSISTENCY
    [0]: 0, <invalid>, <invalid>, <invalid> %
    [1]: <invalid>, <invalid>, <invalid>, <invalid> %
```

Appendix B Description of AMV BUFR message

This appendix gives an example of one particular BUFR message that can be decoded for an AMV product. Relevant parameters are highlighted in colour in the following table.

Table 12 shows an example of a BUFR message (one AMV). AMVs from all channels are contained in the same BUFR file. Only QI (excluding forecast) higher than 30 are BUFR encoded. Two QI are encoded, corresponding to the QIs with and without forecast.

The BUFR start and end of scan times refer to the time of the search and the reference image, respectively.

Table 12: Example of BUFR message from W_XX-EUMETSAT-Darmstadt,SOUNDING+SATELLITE,METOPB+AVHRR_C_EUMP_20130424235503_03116_eps_r_amv_l2_0200.bin (first message). The symbol "///" in front of the field means that the field is not populated.

1: 3 = METOP-1 [Satellite identifier]
2: 254 = (see Code Table 0'01'031) [Identification of
originating/generating centre (see Note 10)]
3: 61 = EUMETSAT Polar System (EPS) [Satellite classification]
4: 30800 m [Segment size at nadir in X direction]
5: 30800 m [Segment size at nadir in Y direction]
6: 2013 Year [Year]
7: 4 Month [Month]
8: 24 Day [Day]
9: 23 Hour [Hour]
10: 55 Minute [Minute]
11: 3 Second [Second]
12: 63.3989 Degree [Latitude (high accuracy)]
13: -29.4175 Degree [Longitude (high accuracy)]
14: 262144 = Bit13 (see Flag Table 0'02'152) [Satellite instrument used in
data processing(6)]
15: 1 = Wind derived from cloud motion observed in the infrared channel
[Satellite derived wind computation method]
16: 55110 Pa [Pressure]
17: 329 Degree true [Wind direction]
18: 3.9 m s-1 [Wind speed]
19: 2.7759e+13 Hz [Satellite channel centre frequency]
20: 2.576e+12 Hz [Satellite channel band width]
21: 239.6 K [Coldest cluster temperature]
22: 1 = IRW height assignment [Height assignment method]
23: 2 = CC - Cross correlation [Tracer correlation method]
24: /// = (CodeTable 0'08'012) [Land/sea qualifier]
25: 62.36 Degree [Satellite zenith angle]

```
26:      2 = Medium Range Forecast (MRF) Model [Origin of first guess
           information for GOES-I/M soundings]
27:     27 = First guess [Time significance]
28:    2013 Year [Year]
29:      4 Month [Month]
30:     24 Day [Day]
31:     12 Hour [Hour]
32:     25 = Nominal reporting time [Time significance]
33:      6 Hour [Time period or displacement]
34:     28 = Start of scan [Time significance]
35:     22 Hour [Hour]
36:     14 Minute [Minute]
37:     35 Second [Second]
38:     29 = End of scan [Time significance]
39:     23 Hour [Hour]
40:     55 Minute [Minute]
41:     15 Second [Second]
42:    329 Degree true [Wind direction]         first component
43:    3.9 m s-1 [Wind speed]
44:     28 = Start of scan [Time significance]
45:    /// Hour [Hour]
46:    /// Minute [Minute]
47:    /// Second [Second]
48:     29 = End of scan [Time significance]
49:    /// Hour [Hour]
50:    /// Minute [Minute]
51:    /// Second [Second]
52:    329 Degree true [Wind direction]           second component
53:    3.1 m s-1 [Wind speed]
54:     28 = Start of scan [Time significance]
55:    /// Hour [Hour]
56:    /// Minute [Minute]
57:    /// Second [Second]
58:     29 = End of scan [Time significance]
59:    /// Hour [Hour]
60:    /// Minute [Minute]
61:    /// Second [Second]
62:    /// Degree true [Wind direction]
63:    /// m s-1 [Wind speed]
64:     28 = Start of scan [Time significance]
65:    /// Hour [Hour]
66:    /// Minute [Minute]
```

67: /// Second [Second]
68: 29 = End of scan [Time significance]
69: /// Hour [Hour]
70: /// Minute [Minute]
71: /// Second [Second]
72: /// Degree true [Wind direction]
73: /// m s-1 [Wind speed]
74: 1 = IRW height assignment [Height assignment method]
75: 55110 Pa [Pressure] height
76: 239.6 K [Temperature/dry-bulb temperature]
77: /// = (CodeTable 0'02'163) [Height assignment method]
78: /// Pa [Pressure]
79: /// K [Temperature/dry-bulb temperature]
80: /// = (CodeTable 0'02'163) [Height assignment method]
81: 55110 Pa [Pressure] height
82: 239.6 K [Temperature/dry-bulb temperature]
83: /// = (CodeTable 0'02'163) [Height assignment method]
84: /// Pa [Pressure]
85: /// K [Temperature/dry-bulb temperature]
86: /// = (CodeTable 0'02'163) [Height assignment method]
87: /// Pa [Pressure]
88: /// K [Temperature/dry-bulb temperature]
89: /// = (CodeTable 0'02'163) [Height assignment method]
90: /// Pa [Pressure]
91: /// K [Temperature/dry-bulb temperature]
92: /// = (CodeTable 0'02'163) [Height assignment method]
93: /// Pa [Pressure]
94: /// K [Temperature/dry-bulb temperature]
95: /// = (CodeTable 0'02'163) [Height assignment method]
96: /// Pa [Pressure]
97: /// K [Temperature/dry-bulb temperature]
98: /// = (CodeTable 0'02'163) [Height assignment method]
99: /// Pa [Pressure]
100: /// K [Temperature/dry-bulb temperature]
101: /// = (CodeTable 0'02'163) [Height assignment method]
102: /// Pa [Pressure]
103: /// K [Temperature/dry-bulb temperature]
104: 103 : ////////// /////+++// +///////// ////////// ////////// ////////// ////////// ////////// ////////// ////////// /// [Data present bit map]
105: 254 = (see Code Table 0'01'031) [Identification of originating/generating centre (see Note 10)]

106: 1 = (see Code Table 0'01'032) [Generating application]
107: 45 % [Per cent confidence] QI including forecast
108: 45 % [Per cent confidence]
109: 45 % [Per cent confidence]
110: 45 % [Per cent confidence]
111: 254 = (see Code Table 0'01'031) [Identification of
originating/generating centre (see Note 10)]
112: 1 = (see Code Table 0'01'032) [Generating application]
113: /// = (CodeTable 0'33'035) [Manual/automatic quality control]
114: /// = (CodeTable 0'33'035) [Manual/automatic quality control]
115: /// = (CodeTable 0'33'035) [Manual/automatic quality control]
116: /// = (CodeTable 0'33'035) [Manual/automatic quality control]
117: 254 = (see Code Table 0'01'031) [Identification of
originating/generating centre (see Note 10)]
118: 1 = (see Code Table 0'01'032) [Generating application]
119: /// % [Nominal confidence threshold]
120: /// % [Nominal confidence threshold]
121: /// % [Nominal confidence threshold]
122: /// % [Nominal confidence threshold]
123: 254 = (see Code Table 0'01'031) [Identification of
originating/generating centre (see Note 10)]
124: 2 = (see Code Table 0'01'032) [Generating application]
125: 53 % [Per cent confidence] QI excluding forecast
126: 53 % [Per cent confidence]
127: 53 % [Per cent confidence]
128: 53 % [Per cent confidence]
129: 254 = (see Code Table 0'01'031) [Identification of
originating/generating centre (see Note 10)]
130: 2 = (see Code Table 0'01'032) [Generating application]
131: /// = (CodeTable 0'33'035) [Manual/automatic quality control]
132: /// = (CodeTable 0'33'035) [Manual/automatic quality control]
133: /// = (CodeTable 0'33'035) [Manual/automatic quality control]
134: /// = (CodeTable 0'33'035) [Manual/automatic quality control]
135: 254 = (see Code Table 0'01'031) [Identification of
originating/generating centre (see Note 10)]
136: 2 = (see Code Table 0'01'032) [Generating application]
137: /// % [Nominal confidence threshold]
138: /// % [Nominal confidence threshold]
139: /// % [Nominal confidence threshold]
140: /// % [Nominal confidence threshold]
141: 254 = (see Code Table 0'01'031) [Identification of
originating/generating centre (see Note 10)]

142:   3 = (see Code Table 0'01'032) [Generating application]
143: /// % [Per cent confidence]
144: /// % [Per cent confidence]
145: /// % [Per cent confidence]
146: /// % [Per cent confidence]
147: 254 = (see Code Table 0'01'031) [Identification of
  originating/generating centre (see Note 10)]
148:   3 = (see Code Table 0'01'032) [Generating application]
149: /// = (CodeTable 0'33'035) [Manual/automatic quality control]
150: /// = (CodeTable 0'33'035) [Manual/automatic quality control]
151: /// = (CodeTable 0'33'035) [Manual/automatic quality control]
152: /// = (CodeTable 0'33'035) [Manual/automatic quality control]
153: 254 = (see Code Table 0'01'031) [Identification of
  originating/generating centre (see Note 10)]
154:   3 = (see Code Table 0'01'032) [Generating application]
155: /// % [Nominal confidence threshold]
156: /// % [Nominal confidence threshold]
157: /// % [Nominal confidence threshold]
158: /// % [Nominal confidence threshold]

Appendix C Table description for individual BUFR message

Table 13: as Table 12 but showing the table reference.

BUFR field	BUFR table
1	0'01'007 Satellite identifier [Code Table 0'01'007] (1:1<10><0>)
2	0'01'031 Identification of originating/generating centre (see Note 10) [Code Table 0'01'031] (3*1<16><0>)
3	0'02'020 Satellite classification [Code Table 0'02'020] (5:7<9><0>)
4	0'02'028 Segment size at nadir in X direction [m] (7:6<18><0>)
5	0'02'029 Segment size at nadir in Y direction [m] (10:6<18><0>)
6	0'04'001 Year [Year] (13:6<12><0>)
7	0'04'002 Month [Month] (15:8<4><0>)
8	0'04'003 Day [Day] (17:2<6><0>)
9	0'04'004 Hour [Hour] (18:6<5><0>)
10	0'04'005 Minute [Minute] (20:1<6><0>)
11	0'04'006 Second [Second] (21:5<6><0>)
12	0'05'001 Latitude (high accuracy) [Degree] (23:1<25><21>)
13	0'06'001 Longitude (high accuracy) [Degree] (108:3<26><20>)
14	0'02'152 Satellite instrument used in data processing(6) [Flag Table 0'02'152] (189*7<31><0>)
15	0'02'023 Satellite derived wind computation method [Code Table 0'02'023] (194*4<4><3>)
16	0'07'004 Pressure [Pa] (207:3<14><12>)
17	0'11'001 Wind direction [Degree true] (256:3<9><6>)
18	0'11'002 Wind speed [m s-1] (281:4<12><9>)
19	0'02'153 Satellite channel centre frequency [Hz] (318:5<26><18>)
20	0'02'154 Satellite channel band width [Hz] (392:3<26><18>)
21	0'12'071 Coldest cluster temperature [K] (466:1<12><9>)
22	0'02'163 Height assignment method [Code Table 0'02'163] (503:2<4><4>)
23	0'02'164 Tracer correlation method [Code Table 0'02'164] (519:8<3><2>)
24	0'08'012 Land/sea qualifier [Code Table 0'08'012] (528:7<2><2>)
25	0'07'024 Satellite zenith angle [Degree] (537:5<15><10>)
26	0'02'057 Origin of first guess information for GOES-I/M soundings [Code Table 0'02'057] (578*8<4><0>)
27	0'08'021 Time significance [Code Table 0'08'021] (580:2<5><0>)
28	0'04'001 Year [Year] (581:5<12><0>)
29	0'04'002 Month [Month] (583:7<4><0>)
30	0'04'003 Day [Day] (585:1<6><0>)
31	0'04'004 Hour [Hour] (586:5<5><0>)
32	0'08'021 Time significance [Code Table 0'08'021] (587:8<5><0>)
33	0'04'024 Time period or displacement [Hour] (589:3<12><0>)
-	1'10'004 Replication Operator (-)
34	0'08'021 Time significance [Code Table 0'08'021] (591:5<5><0>)
35	0'04'004 Hour [Hour] (592:8<5><0>)
36	0'04'005 Minute [Minute] (594:3<6><0>)
37	0'04'006 Second [Second] (595:7<6><0>)
38	0'08'021 Time significance [Code Table 0'08'021] (597:3<5><0>)
39	0'04'004 Hour [Hour] (598:6<5><0>)
40	0'04'005 Minute [Minute] (600:1<6><0>)
41	0'04'006 Second [Second] (601:5<6><0>)
42	0'11'001 Wind direction [Degree true] (603:1<9><7>)
43	0'11'002 Wind speed [m s-1] (632:1<12><9>)
44	0'08'021 Time significance [Code Table 0'08'021] (669:2<5><0>)
45	0'04'004 Hour [Hour] (670:5<5><0>)
46	0'04'005 Minute [Minute] (671:8<6><0>)
47	0'04'006 Second [Second] (673:4<6><0>)
48	0'08'021 Time significance [Code Table 0'08'021] (674:8<5><0>)
49	0'04'004 Hour [Hour] (676:3<5><0>)
50	0'04'005 Minute [Minute] (677:6<6><0>)
51	0'04'006 Second [Second] (679:2<6><0>)
52	0'11'001 Wind direction [Degree true] (680:6<9><6>)
53	0'11'002 Wind speed [m s-1] (705:7<12><9>)
54	0'08'021 Time significance [Code Table 0'08'021] (742:8<5><0>)
55	0'04'004 Hour [Hour] (744:3<5><0>)
56	0'04'005 Minute [Minute] (745:6<6><0>)
57	0'04'006 Second [Second] (747:2<6><0>)
58	0'08'021 Time significance [Code Table 0'08'021] (748:6<5><0>)
59	0'04'004 Hour [Hour] (750:1<5><0>)
60	0'04'005 Minute [Minute] (751:4<6><0>)
61	0'04'006 Second [Second] (752:8<6><0>)
62	0'11'001 Wind direction [Degree true] (754:4<9><6>)

```
 63      0'11'002  Wind speed [m s-1]  (779:5<12><9>)
 64      0'08'021  Time significance [Code Table 0'08'021]  (816:6<5><0>)
 65      0'04'004  Hour [Hour]  (818:1<5><0>)
 66      0'04'005  Minute [Minute]  (819:4<6><0>)
 67      0'04'006  Second [Second]  (820:8<6><0>)
 68      0'08'021  Time significance [Code Table 0'08'021]  (822:4<5><0>)
 69      0'04'004  Hour [Hour]  (823:7<5><0>)
 70      0'04'005  Minute [Minute]  (825:2<6><0>)
 71      0'04'006  Second [Second]  (826:6<6><0>)
 72      0'11'001  Wind direction [Degree true]  (828:2<9><0>)
 73      0'11'002  Wind speed [m s-1]  (830:1<12><0>)
       -   1'03'010  Replication Operator  (-)
 74      0'02'163  Height assignment method [Code Table 0'02'163]  (832:3<4><2>)
 75      0'07'004  Pressure [Pa]  (841:3<14><11>)
 76      0'12'001  Temperature/dry-bulb temperature [K]  (886:4<12><7>)
 77      0'02'163  Height assignment method [Code Table 0'02'163]  (915:7<4><1>)
 78      0'07'004  Pressure [Pa]  (920:8<14><11>)
 79      0'12'001  Temperature/dry-bulb temperature [K]  (966:1<12><8>)
 80      0'02'163  Height assignment method [Code Table 0'02'163]  (999:3<4><4>)
 81      0'07'004  Pressure [Pa]  (1016:1<14><0>)
 82      0'12'001  Temperature/dry-bulb temperature [K]  (1018:5<12><0>)
 83      0'02'163  Height assignment method [Code Table 0'02'163]  (1020:7<4><1>)
 84      0'07'004  Pressure [Pa]  (1025:8<14><8>)
 85      0'12'001  Temperature/dry-bulb temperature [K]  (1059:4<12><5>)
 86      0'02'163  Height assignment method [Code Table 0'02'163]  (1081:1<4><4>)
 87      0'07'004  Pressure [Pa]  (1097:7<14><0>)
 88      0'12'001  Temperature/dry-bulb temperature [K]  (1100:3<12><0>)
 89      0'02'163  Height assignment method [Code Table 0'02'163]  (1102:5<4><4>)
 90      0'07'004  Pressure [Pa]  (1119:3<14><12>)
 91      0'12'001  Temperature/dry-bulb temperature [K]  (1168:3<12><9>)
 92      0'02'163  Height assignment method [Code Table 0'02'163]  (1205:4<4><0>)
 93      0'07'004  Pressure [Pa]  (1206:6<14><0>)
 94      0'12'001  Temperature/dry-bulb temperature [K]  (1209:2<12><0>)
 95      0'02'163  Height assignment method [Code Table 0'02'163]  (1211:4<4><4>)
 96      0'07'004  Pressure [Pa]  (1228:2<14><12>)
 97      0'12'001  Temperature/dry-bulb temperature [K]  (1277:2<12><9>)
 98      0'02'163  Height assignment method [Code Table 0'02'163]  (1314:3<4><4>)
 99      0'07'004  Pressure [Pa]  (1331:1<14><12>)
100      0'12'001  Temperature/dry-bulb temperature [K]  (1380:1<12><12>)
101      0'02'163  Height assignment method [Code Table 0'02'163]  (1428:7<4><0>)
102      0'07'004  Pressure [Pa]  (1430:1<14><12>)
103      0'12'001  Temperature/dry-bulb temperature [K]
       (1479:1<12><0>)
       -   2'22'000  Quality information follows  (-)
         -   1'01'103  Replication Operator  (-)
104      0'31'031  Data present bit map  (1481:3<721><0>)
105      0'01'031  Identification of originating/generating centre (see Note 10) [Code Table 0'01'031]
       (15714<16><0>)
106      0'01'032  Generating application [Code Table 0'01'032]  (1574:2<8><0>)
       -   1'01'004  Replication Operator  (-)
107      0'33'007  Per cent confidence [%]  (1575:8<7><7>)
108      0'33'007  Per cent confidence [%]  (1604:6<7><7>)
109      0'33'007  Per cent confidence [%]  (1633:4<7><7>)
110      0'33'007  Per cent confidence [%]  (1662:2<7><7>)
       -   2'22'000  Quality information follows  (-)
111      0'01'031  Identification of originating/generating centre (see Note 10) [Code Table 0'01'031]
       (1690*8<16><0>)
112      0'01'032  Generating application [Code Table 0'01'032]  (1693:6<8><0>)
       -   1'01'004  Replication Operator  (-)
113      0'33'035  Manual/automatic quality control [Code Table 0'33'035] (1695*4<4><0>)
114      0'33'035  Manual/automatic quality control [Code Table 0'33'035] (1696*6<4><0>)
115      0'33'035  Manual/automatic quality control [Code Table 0'33'035] (1697*8<4><0>)
116      0'33'035  Manual/automatic quality control [Code Table 0'33'035] (1699*2<4><0>)
       - 2'22'000  Quality information follows  (-)
117      0'01'031  Identification of originating/generating centre (see Note 10) [Code Table 0'01'031]
       (1700*4<16><0>)
118      0'01'032  Generating application [Code Table 0'01'032]  (1703:2<8><0>)
       -   1'01'004  Replication Operator  (-)
119      0'33'036  Nominal confidence threshold [%]  (1704:8<7><0>)
120      0'33'036  Nominal confidence threshold [%]  (1706:5<7><0>)
121      0'33'036  Nominal confidence threshold [%]  (1708:2<7><0>)
122      0'33'036  Nominal confidence threshold [%]  (1709:7<7><0>)
         -   2'22'000  Quality information follows  (-)
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123      0'01'031  Identification of originating/generating centre (see Note 10) [Code Table 0'01'031]
        (1711*4<16><0>)
124      0'01'032  Generating application [Code Table 0'01'032]  (1714:2<8><0>)
        -   1'01'004  Replication Operator  (-)
125      0'33'007  Per cent confidence [%]  (1715:8<7><7>)
126      0'33'007  Per cent confidence [%]  (1744:6<7><7>)
127      0'33'007  Per cent confidence [%]  (1773:4<7><7>)
128      0'33'007  Per cent confidence [%]  (1802:2<7><7>)-   2'22'000  Quality information follows
        (-)
129      0'01'031  Identification of originating/generating centre (see Note 10) [Code Table 0'01'031]
        (1830*8<16><0>)
130      0'01'032  Generating application [Code Table 0'01'032]  (1833:6<8><0>)
        -   1'01'004  Replication Operator  (-)
131      0'33'035  Manual/automatic quality control [Code Table 0'33'035] (1835*4<4><0>)
132      0'33'035  Manual/automatic quality control [Code Table 0'33'035] (1836*6<4><0>)
133      0'33'035  Manual/automatic quality control [Code Table 0'33'035](1837*8<4><0>)
134      0'33'035  Manual/automatic quality control [Code Table 0'33'035](1839*2<4><0>)
          -   2'22'000  Quality information follows  (-)
135      0'01'031  Identification of originating/generating centre (see Note 10) [Code Table 0'01'031]
        (1840*4<16><0>)
136      0'01'032  Generating application [Code Table 0'01'032]  (1843:2<8><0>)
          -   1'01'004  Replication Operator  (-)
137      0'33'036  Nominal confidence threshold [%]  (1844:8<7><0>)
138      0'33'036  Nominal confidence threshold [%]  (1846:5<7><0>)
139      0'33'036  Nominal confidence threshold [%]  (1848:2<7><0>)
140      0'33'036  Nominal confidence threshold [%]  (1849:7<7><0>)
        -   2'22'000  Quality information follows  (-)
141      0'01'031  Identification of originating/generating centre (see Note 10) [Code Table 0'01'031]
        (1851*4<16><0>)
142      0'01'032  Generating application [Code Table 0'01'032]  (1854:2<8><0>)
        -   1'01'004  Replication Operator  (-)
143      0'33'007  Per cent confidence [%]  (1855:8<7><0>)
144      0'33'007  Per cent confidence [%]  (1857:5<7><0>)
145      0'33'007  Per cent confidence [%]  (1859:2<7><0>)
146      0'33'007  Per cent confidence [%]  (1860:7<7><0>)
        -   2'22'000  Quality information follows  (-)
147      0'01'031  Identification of originating/generating centre (see Note 10)
        [Code Table 0'01'031]  (1862*4<16><0>)
148      0'01'032  Generating application [Code Table 0'01'032]  (1865:2<8><0>)
          -   1'01'004  Replication Operator  (-)
149      0'33'035  Manual/automatic quality control [Code Table 0'33'035] (1866*8<4><0>)
150      0'33'035  Manual/automatic quality control [Code Table 0'33'035] (1868*2<4><0>)
151      0'33'035  Manual/automatic quality control [Code Table 0'33'035] (1869*4<4><0>)
152      0'33'035  Manual/automatic quality control [Code Table 0'33'035] (1870*6<4><0>)
          -   2'22'000  Quality

153      0'01'031  Identification of originating/generating centre (see Note 10) [Code Table 0'01'031]
        (1871*8<16><0>)
154      0'01'032  Generating application [Code Table 0'01'032]  (1874:6<8><0>)
          -   1'01'004  Replication Operator  (-)
155      0'33'036  Nominal confidence threshold [%]  (1876:4<7><0>)
156      0'33'036  Nominal confidence threshold [%]  (1878:1<7><0>)
157      0'33'036  Nominal confidence threshold [%]  (1879:6<7><0>)
158      0'33'036  Nominal confidence threshold [%]  (1881:3<7><0>)
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